# Final Report

## Inova Fairfax Hospital South Patient Tower

Falls Church, VA

04/04/2012

**Jianhong Qiu**

**Construction Management Option**

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# INOVA FAIRFAX HOSPITAL SOUTH PATIENT TOWER

## FALLS CHURCH, VA

INOVA FAIRFAX HOSPITAL

Turner

## Project Overview

Owner: Inova Fairfax
HospitalSize:216,000sf
Levels:12above/1below grade
Cost:$76million
Construction Date:Jul2010-Aug2012
Delivery Method: Design-bid-build

## Project Team

General Contractor:Turner Construction
Architect:Wilmot Sanz, Inc.
MEP: RMF Engineering, Inc.
Civil: Dewberry&Davis LLC
Structural: Cagley& Associates
Electrical: Turland Service Corporation

## Structural System

5000PSI Concrete for ground to fourth floor.
4000PSI Concrete for six to 12 floor
Typical Floor with 9 1/2" two-way flat slab with bot top and bottom steel reinforcement
5th Floor 10 1/2" due to the mechanical room

## Electrical System

Fed by two 2,000kVA transformers located to the west of the tower
Seven sets of 4-#750 MCM wires from each transformer
2000KW emergency generator to serve the tower

## Mechanical System

Mechanical room located on the fifth floor
Four 50,000 CFM air handlers for majority of the building
Two other air handlers for the cafe and kitchen
Oxygen, medical air and medical vacuum system piped into the patient room

JIANHONG QIU
Architectural Engineering Construction Option
http://www.engr.psu.edu/ae/thesis/portfolios/2012/JXQ112/

# 1.0 Executive Summary

In the final report, four depth analyses for the Inova Fairfax Hospital South Patient Tower have been performed. Many new strategies and new technologies are addressed into these analyses in order to improve the constructability and efficiency of the project.

***Analysis #1: Increase Building Information Modeling(BIM) servies for the Owner**.*

The first Analysis topic is the critical industry issue that will be pursued based on the experience, interests at the PACE Roundtable meeting. So far, the only usage of BIM into the South Patient Tower is the coordination of the MEP system. The purpose of this analysis is to maximize the implementation of BIM into the project to benefit the owner in terms of cost and time savings by reducing the change orders and coordinating the work at an early stage of the process and also through out the whole construction process.

***Analysis #2: Short Interval Production Schedules (SIPS)-Schedule Acceleration***

Base on the previous study and research, since the South Patient Tower is located on the Inova Fairfax Hospital campus tying to the existing building tower and is surrounded by other buildings such as Heart and Vascular Institue, Emergency Department, Women's center and Children's Hospital. This results the expectation of minimum impact to the neighborhood. For this reason, a more accurate and efficient schedule is expected to avoid the potential mistakes, delays and unforeseen changes of the project. SIPS is the main study focus for this Patient Tower to smooth the construction process, maintain and even accelerate the schedule.

### *Analysis #3: Net Zero Energy Building- Sustainability*

The design and project team for South Patient Tower are striving to achieve LEED silver certification on this project. The major sustainable features include green roof, rain gardens, water cisterns and so on. A higher level of sustainability can be pursued to achieve the Net Zero Energy goal which is becoming a more and more popular issue in building construction industry.

### *Analysis #4: Integrated Project Delivery (IPD)*

Integrated Project Delivery (IPD) is a project delivery approach which integrated people, system, business structures and practices into one process that collaboratively harnesses the talents and insights of all participants to optimize the project results. There is a  potential possibility to accelerate the schedule and increase the constructability of the South Patient Tower by implement the IPD principles.  A study on the IPD Guide from The American Institute of Architects was done to help complete the analysis on IPD.

# 2.0 Acknowledgements

## Academic Acknowledgments

Penn State AE faculty

Thesis advisor:

Craig Dubler

James Faust

## Industry Acknowledgments

Turner

WILMOT SANZ
ARCHITECTURE
PLANNING

VICO SOFTWARE
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Turner Construction Project Team

Tessa R. Teodoro

Holly Allison

Drew Kelleher

Richard S. Davis

Johnny F. Weaver

PACE Industry Members

My Family and Friends

# 3.0 Table of Content

# 4.0Project Overview

## 4.1Project Introduction

Figure1

Inova Fairfax Hospital South Patient Tower, being located on 3300 Gallows Road, Falls Church, VA is a **$76 million** project started in J**uly 2010**. This is an 11 stories patient tower adjacent to the south of the existing hospital building. The tower will include 174 private patient rooms for both general and intensive care units, which will significantly alleviate overcrowding in the existing tower building. Five floors are dedicated to medical/surgery beds and three floors to ICU beds. Hospital officials expect this **216,000-square-foot** tower to be complete by **fall 2012**.

**Wilmot Sanz** of Gaithersburg, MD is the project architecture firm that has worked with the hospital to develop a Master Facilities Plan which addresses the evolving healthcare needs of the region.

**Tuner Construction Company**, the nation's largest builder of healthcare facilites is selected to construct the south tower. The South Patient Tower is designed and being constructed to achieve LEED Sliver certification from the United States Green Building Council. They have the green features including green roof, rain gardens, water cisterns and so forth. Low and no VOC paints, carpets and furniture and the installation of efficient energy and insulation systems are used as well.

**RMF Engineering** is the engineering company for Inova Fairfax Hospital South Patient Tower. It has been working with Inova Fairfax Hospital on other projects such as the heart & vascular institute before. It has the service of mechanical, electrical, civil, and structural engineering as well as utility infrastructure and commissioning.

**Truland Service Corporation**, a member of the Truland Group of Companies is the selected electrical contractor by Turner Construction for the Inova South Patient Tower project. It provides preventive maintenance and repairs; emergency response; disaster recovery; fire alarm, life safety and critical power systems testing and maintenance; predictive maintenance; energy management services; electrical construction including power, critical power, and lighting systems and controls throughout the D.C. metro area.

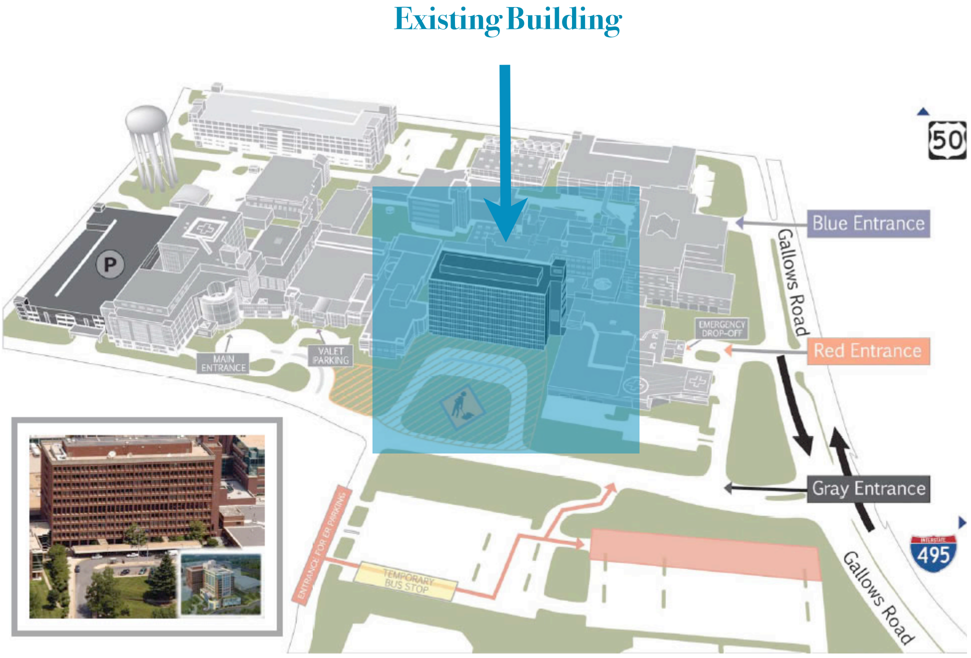


Figure2

# 4.2 Local Condition

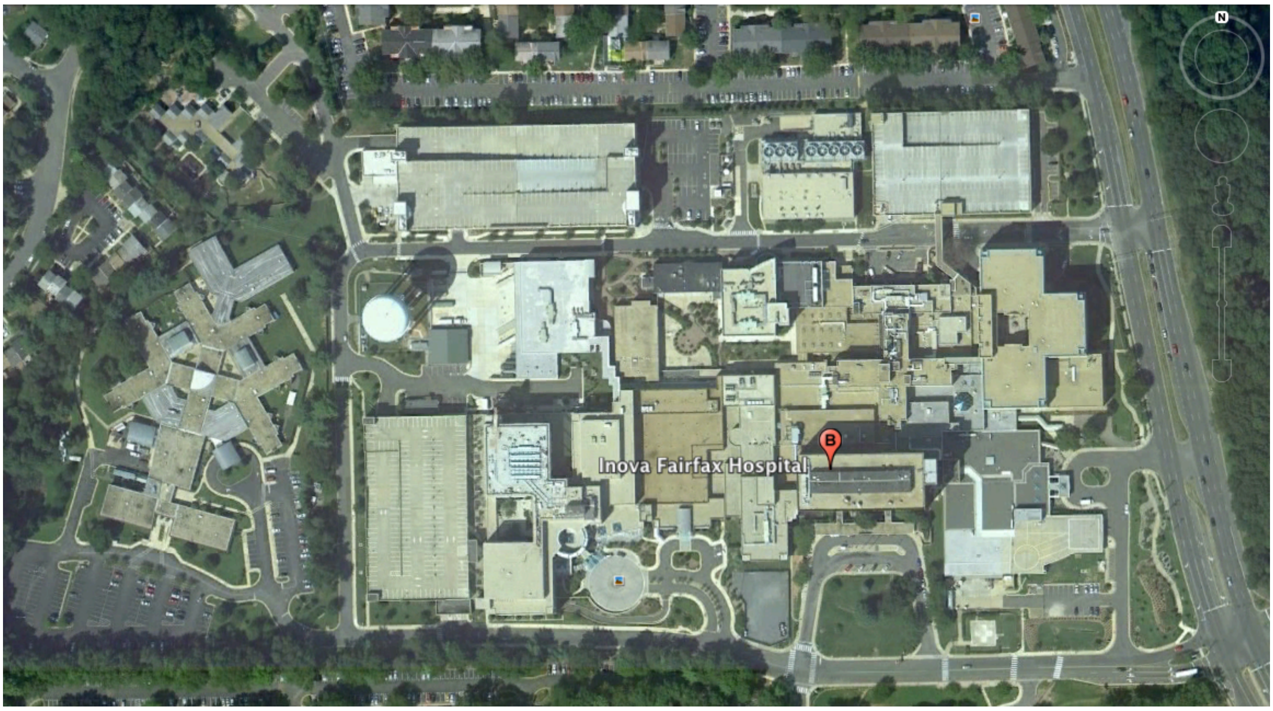


Figure3

The Inova Fairfax Hospital South Patient Tower is located on 3300 Gallows Road Falls Church, Va. The city has a total area of 2.2 square miles , all of it land. The center of the city is the crossroad of VA State Route7. The Tripps Run watershed drains two-thirds of the city of falls church, while the Four Mile Run watershed drains the other third. The ground water quality is generally good in Virginia. This vital resource is threatened by many potential contaminants and there have been isolated cases of serious ground water pollution in the state.

Owner will employ a qualified independent geotechnical engineering testing agency to classify proposed on-site and borrow soil to verify that soils comply with specified requirements and to perform required field and laboratory testing.

Existing utilities do not interrupt existing utilities serving facilities occupied by the owner or others except when permitted in writing by the architect and then only after acceptable temporary utility services have been provided. A minimum 48 hours notice to the architect and receive written notice to proceed before interrupting any utility. Coordinate with utility companies to shit off services if lines are active.

# 4.3Client Information

InovaFairfax Hospital, Inova Health System's flagship hospital, is an 833-bed, nationally recognized regional medical center serving the Washington, D.C., metro area. The hospital is consistently ranked among the top healthcare providers in the United States.

Special emphasis on a safe, healing environment for adult patients, focusing on the specific needs of the medical/surgical patient, who is often 65 years or older. Cost, quality, schedule, and safety are some of the key areas of focus for this project. While cost, quality, and schedule are important, nothing is more important to this client than the safety of its patients and the workers on site.

Because of the growing demand, the new patient tower was constructed. The new tower includes the following highlights and features:

- Physician, nurse and staff input helped determine building design
- Focuses on the specific needs of the medical/surgical patient, who is often 65 years or older
- Special emphasis on a safe, healing environment for adult patients
- 360-degree clinical access to ICU patients
- Patient monitoring systems on all floors
- Strategically positioned workstations to ensure patient privacy while enhancing monitoring capabilities
- “Green” design includes low-flow plumbing, low- or no-VOC buildings materials and furniture, living roof with water cisterns and rain gardens

## 4.4 Project Staffing Plan

### Staffing Plan

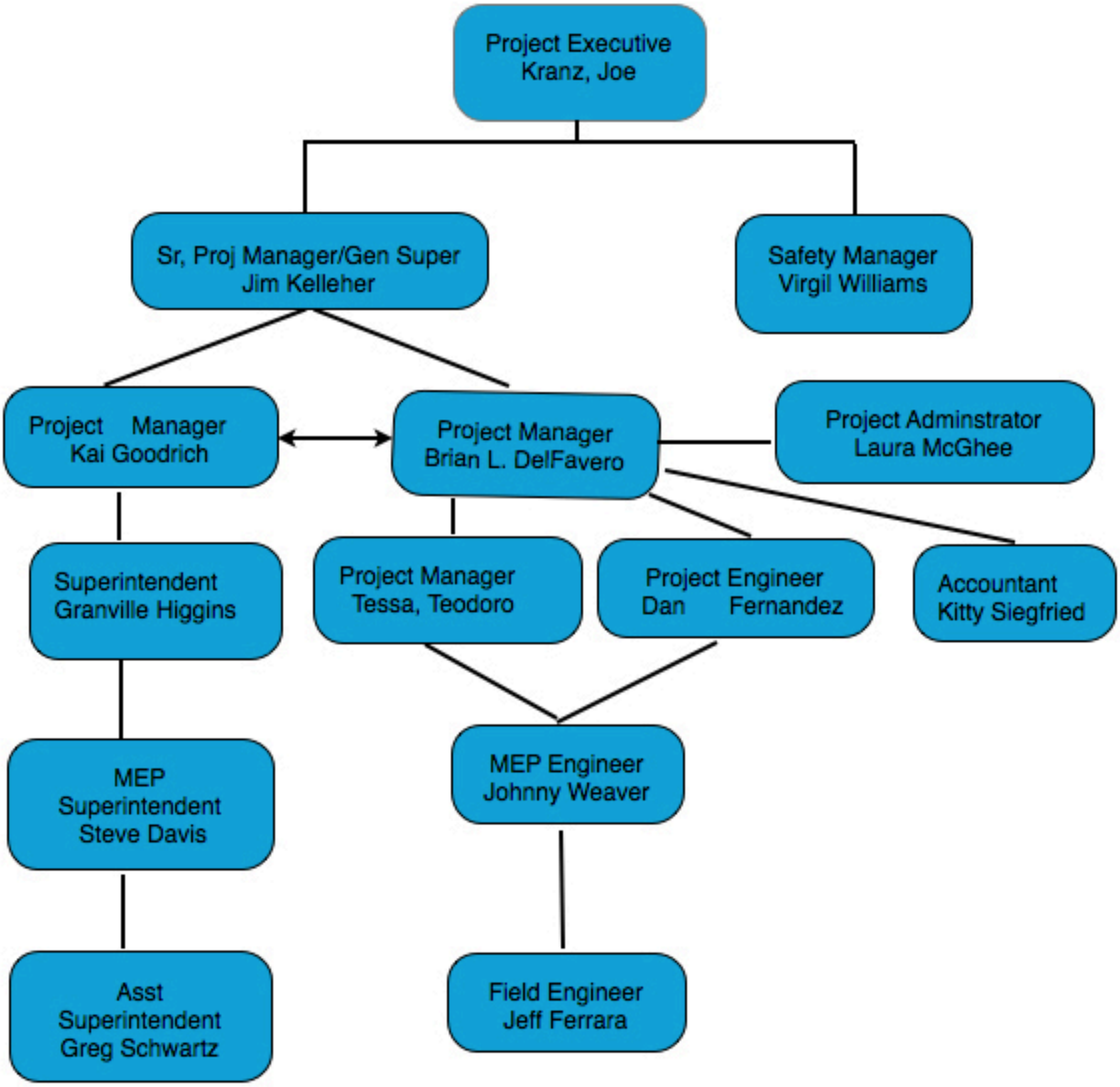


Figure 4

The figure above presented the Turner's managing staff plan for the Inova Fairfax Hospital South Patient Tower project. Turner has put great effort on chooseing their expertises to deliver a final product that will meet the client's needs. As outlined in the organizational chart above, it involves a number of different players that play a key role. First is the project executive who oversees the entire project. Underneath is the senior project manager and the safety manager who reports directly to the safety system such as OSHA. And followings are the project managers and engineers with superintendent below. The staff sizes vary on each project mainly depending on the sizes and complexity of the project.

## 4.5 Project Delivery System

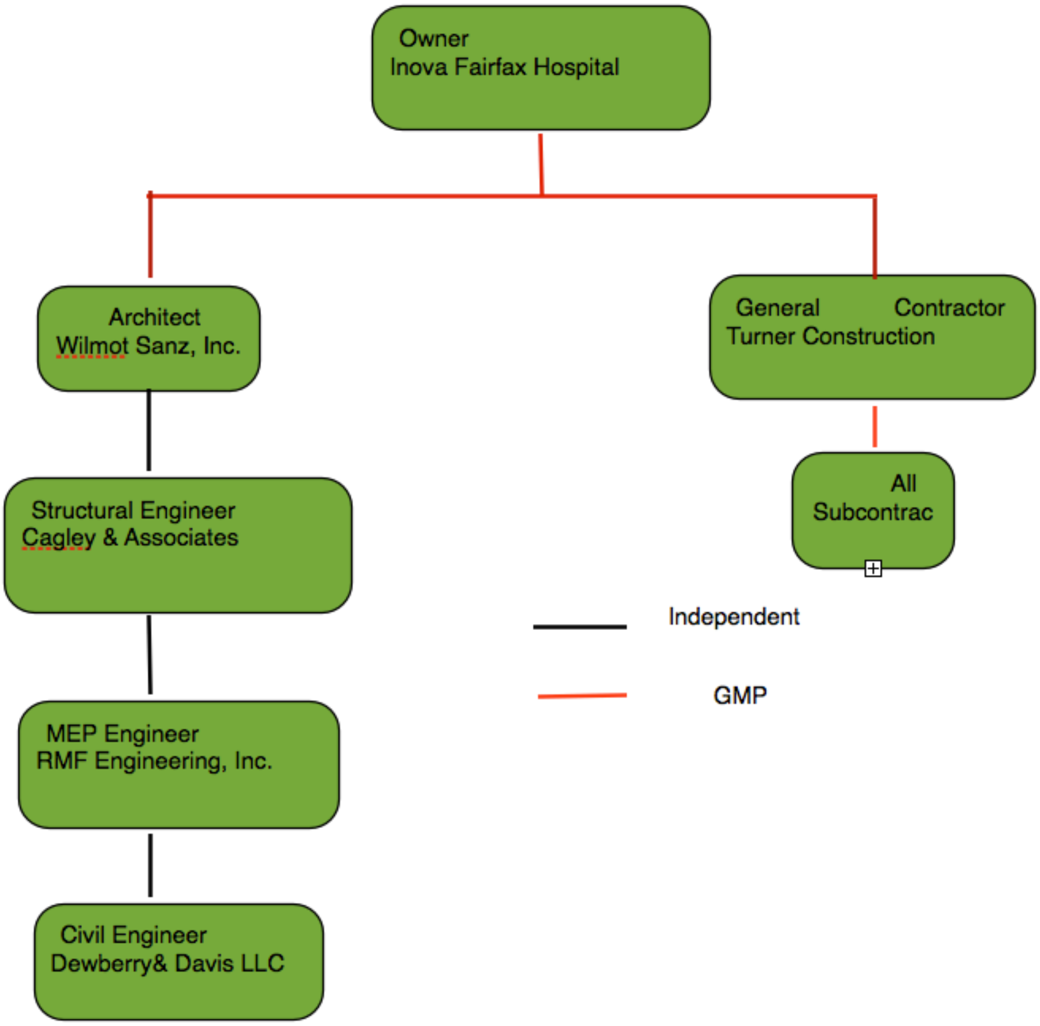


Figure 5

The Project delivery method is Design- bid-build with a negotiated Lump-Sum contract. Turner Construction acts as the general contractor of the project along with the architect and engineering firms to work on the design and construction work. The final BIM is coordinated by Turner construction instead of each engineering firm.

## 4.6 Site Plan

The site of the South Patient Tower is located in the south side of the existing hospital building. which used to be the main entrance of the existing building. So the landscape of the are will be redesigned and re-functioned. On the east side of the tower is the site for Women Hospital, which will be constructed later. And next to the Women Hospital site is the Emergency department of the hospital with the temporary parking lot in front of it. As shown in pictures below.see **APPENDIX B** SITE PLAN.

Figure 6

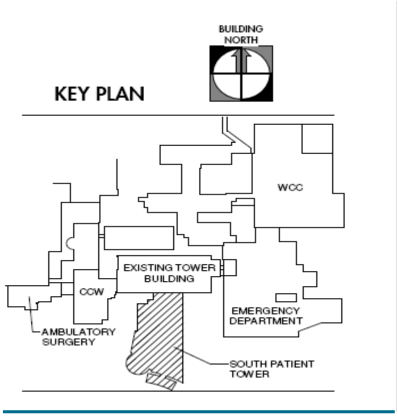


Figure 7

Both the tower crane and the lay-down area will be located on the east down south side of the building.

Figure 8

Figure 9

# 5.0 Design & Construction Overview

## 5.1Building Cost Summary

The actual construction costs are based on a Schedule of Values report provided by the Construction Manager. Though the major building system costs are not provided by the owner. Some of the costs are based on the RS Means Cost Work Report. See **APPENDIX E** COST ESTIMATE.

| | |
|---|---|
| **Original Construction Cost** | $ 76,014,000 |
| **Current Contract Value** | $75,704,832 |
| **Cost/ SF** | $ 325/ SF |

**Building Systems Cost:**

| System | Total Cost | Cost per Square Foot |
|---|---|---|
| Mechanical System | $7,930,500 | $33.89 |
| Electrical System | $6,656,500 | $28.45 |
| Structural System | $29,888,500 | $127.73 |
| HVAC/Plumbing System | $5,059,500 | $21.62 |
| Fire Protection | $672,000 | $2.87 |
| Elevators | $1,510,500 | $6.46 |

## RS Means Estimate:

| | |
|---|---|
| Perimeter | 2,000LF |
| Square Footage | 234,000SF |
| Floor Height | 12.00LF |
| Cost Per Square Foot | $324.96 |
| Total Building Cost | $76,040,000 |
| Actual Building Cost | $ 76,014,000 |

## Cost Comparison

There is a slightly amount of differences of the building cost between the actual cost and the RS Means estimate cost. The causes can be the location factors, the building information set up in the RS Means cost estimate program. It may also because of some missing components of the building construction process. Besides these factors above, the cost estimate is relatively close to the actual cost.

# 5.2 General Condition Estimate

The General Condition estimate for Inova Fairfax Hospital South Patient Tower is broken into the following categories: Personnel, Construction Facilities& Aids, Temporary utilities and Miscellaneous Costs.

Due to the availability of the information from Turner Construction, the following Assumptions were made throughout the estimate:

- RS Means2012 was used for the personnel salaries reference.
- Some of the unit prices are based on the online researching results.
- Labor durations are approximation numbers based on the duration of the whole project, which do not reflect the actual number for the project.

The Total General Condition Cost is $601,850 - approximately 7.9% of the total building cost of $76million, which is reasonable for most general condition cost in United States. The personnel is found as the largest part around 63% of the total estimate. Construction Facilities & Aids costs 20.7% of the total. It includes items such as office trailers, storage trailers and office supplies. Temporary utilities spent around9.5% of the total and Miscellaneous cost count as 6.7% of the total General Condition Cost. It is difficult to guarantee the accuracy of the temporary utilities since the durations for the items such as temporary toilets, power, scaffoldings are difficult to decide. Some miscellaneous information is from the experience of previous Turner Construction projects for the insurance, bonds and so forth.

Below is the summary of the General Condition Cost Estimate:

| General Condition Summary | |
|---|---|
| DESCRIPTION | COST($) |
| PERSONNEL | 378,720 |
| CONSTRUCTION FACILITIES&AIDS | 125,180 |
| TEMPORARY UTILITIES | 57,550 |
| MISCELLANEOUS COSTS | 40,400 |
| TOTAL | 601,850 |

# 5.3 Detailed Schedule

The Inova Fairfax Hospital South Patient Tower started the permits & site development on November 3rd 2009 and started the construction on July 8th, 2010. And the expected finish date is June 21, 2010. In order to keep the project on schedule, many milestones are set up for the South Patient Tower. Below is the summary of the Milestone of the project:

| Milestone | Contract Days | Current Date | Inova Milestone |
|---|---|---|---|
| Issue NTP | | | 11-oct-10 |
| Make Ready Work | 66 | 14-oct-10 | 16-dec-10 |
| Concrete Substantial Complete | 364 | 16-sep-11 | 10-oct-111 |
| Building Watertight | 446 | 15-dec-11 | 31-dec-11 |
| Plumbing &HVAC Major Components | 476 | 04-jan-12 | 30-jan-12 |
| Electrical Major Components-Perm Power | 442 | 05-oct-11 | 27-dec-11 |
| Conditioned Air | 490 | 18-jan-12 | 13-feb-12 |
| Issue Non RUP | 681 | 21-jun=12 | 22-aug-12 |
| Substantial Completion | 681 | 18-jun-12 | 22-aug-12 |

See **APPENDIX I** DETAILED SCHEDULE.

The preconstruction phase has the duration of 110 days, began on March 6th, 2010. It also took 131days for the BIM coordination by Turner Construction to coordinate the MEP system of the building. The major utilities and site work started on October 7, 2011 with a total 127days. The structure will finish on March 6th, 2012 with the floor pour completed on August 30th, 2011.

## ***Critical Path***

As of right now, Tuner Construction are not working any overtime for the South Patient Tower project. Turner is allowing subcontractors to work on the weekends to help maintain the project schedule, but only at the subcontractors' cost. Turner is not paying for this overtime.

In the contract, there have six (6) milestones to track the South Patient Tower's scheduled progress:

1) topping out of the concrete;
2) building being watertight;
3) permanent power into the building;
4) plumbing and HVAC major components;
5) conditioned air;
6) Issuance of Certificate of Occupancy from local jurisdiction.

If these schedule milestones are not met, then Turner Construction will have to pay liquidated damages for each specific milestone. As a team, they meet every week to review materials that have been released and when materials are being delivered to the job site. They are coordinated with the above milestone dates so that Turner all strive to meet these goals. See detailed schedule in **APPENDIX G** MILESTONES SCHEDULE.

# 5.4 Building System Summary

| Work Scope | Yes | No |
|---|---|---|
| Demolition | x | |
| Structural Steel Frame | x | |
| Cast-in-place Concrete | x | |
| Precast Concrete | x | |
| Mechanical System | x | |
| Electrical System | x | |
| Masonry | x | |
| Curtain Wall | x | |
| Support of Excavation | x | |

## 5.4.1Demolition

Demolition is required since the new south patient tower connects to the existing 11-story patient building to maximize space and patient care efficiencies. Many existing water valve, fire hydrant power line, storm pipe 12" rcp, F.O cables are needed to be either relocated or removed.

## 5.4.2 Structural Steel Frame

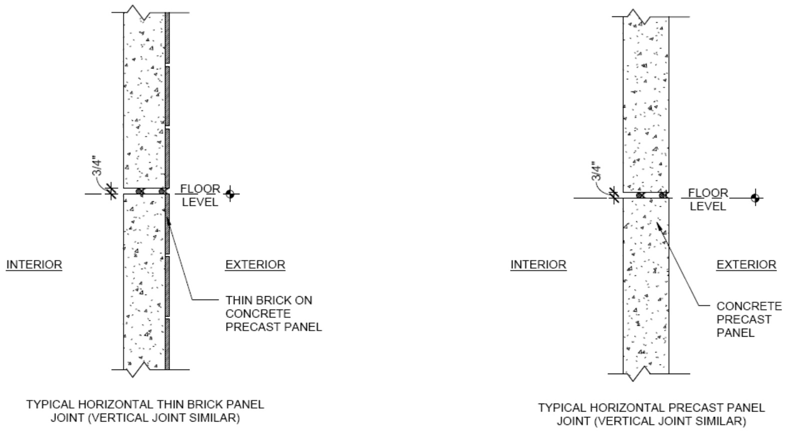
exterior erect cold-formed metal framing to withstand design loads non load bearing framing some of the products have recycled content. Cold-formed metal may be shop or field fabricated for installation or it may be field assembled. Temporary bracing and supports are installed to secure framing and support loads comparable in intensity to those for which structure was designed. Maintain braces and supports in place until entire integrated supporting structure has been complete and permanent connections to framing are secured For exterior non-load-bearing wall installation continuous tracks sized to match studs. Align tracks accurately and securely anchor to supporting structure.

### 5.4.3 Cast in place concrete

Cast-in-place concrete including formwork, reinforcement, concrete materials mixture design for the footing foundation walls, slabs on grade, building walls and so on. All of the 11 level of the building need concrete pour.

### 5.4.4 Precast Concrete

Clips, hangers, bearing pads and other accessories required for connecting architectural precast concrete units are used to support members and backup materials. Erecting architectural precast concrete level, plumb, and square within specified allowable tolerances. Temporary supports and bracing are provided to maintain position, stability and alignment as units are being permanently connected connect precast cu in position by bolting ,welding grouting. At bolted connections use lock washers, tack welding to prevent loosening of nuts after final adjustment. Place concrete in a continuous operation to prevent seams or planes of weakness from forming in precast unites. Reinforcing bars are ASTM A 615/A 615M GRADE60 DEFORMED



TYPICAL HORIZONTAL THIN BRICK PANEL JOINT (VERTICAL JOINT SIMILAR)

TYPICAL HORIZONTAL PRECAST PANEL JOINT (VERTICAL JOINT SIMILAR)

Figure 10

### 5.4.5Masonry

The masonry used on the South Patient Tower are used for load bearing purposes. Both CMUs and new face bricks are used for infill and repairs at EBT. Reinforcing steel along with mortar and grout Masonry joint, reinforcement ties and anchors will be used for both interior and exterior walls. And masonry joint reinforcement for exterior walls are hot-dip galvanized carbon steel wire for side roads and veneer ties is W2.8 OR 0.188-Inch diameter masonry masonry containing reinforcing steel in grouted cell.

## 5.4.6 Mechanical System

The main mechanical system room is located on the fifth floor of the building. The system includes totally six air handling unites and medical gas system, which provide oxygen ….. System type distribution The fire suppression system in place is a wet sprinkler pipe system. In new sprinkler zone assemblies, water flow switches and valve tampers are furnished and installed. The patient elevator machine room in the penthouse, which is located on the roof of the building has three geared elevator machines. Escalator will be installed from the ground floor to the 1st floor.

## 5.4.7 Electrical System

Dominion Virginia Power is in charge to set the South Patient Tower transformers and pulled the primary feeders into the Existing Tower Building vault. The six transformers are located outside the west side of the building. Truland Service was able to pull the feeders from the Transformers into the Switchgear in preparation for Permanent Power and continue to construct the Main Electrical Switchgear room.

## 5.4.8 Curtain wall

The curtain wall on the South Patient Tower is to be constructed on all south, east and west sides of the building. The curtain wall is make up of aluminum and glass with metal panels glazed into the curtain wall. Since the south side will look curved, the glass is made up of segmented glass pieces.

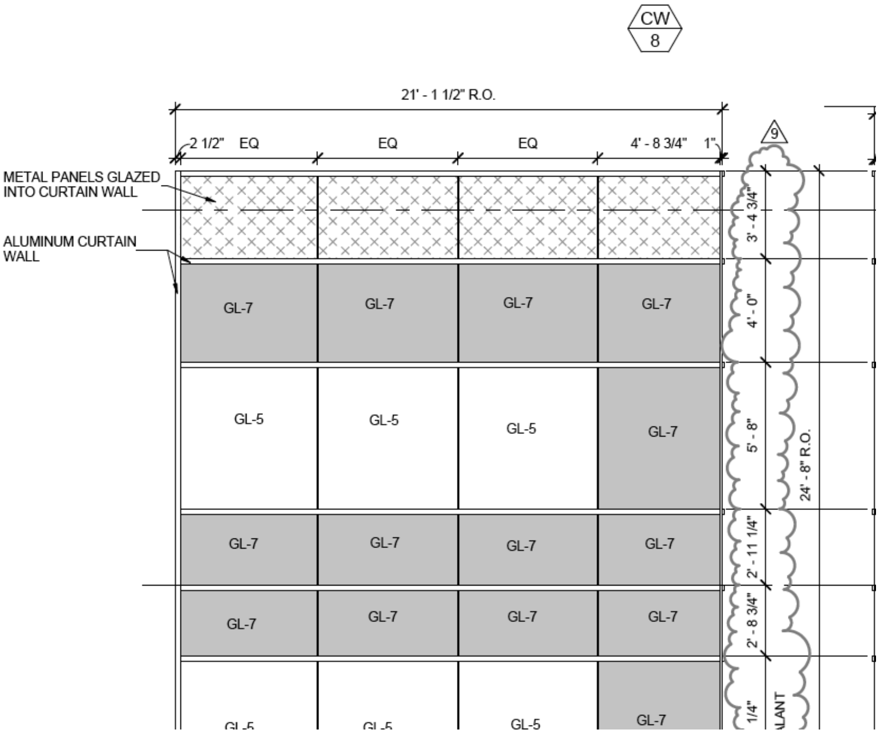


Figure11

## 5.4.9 LEED

The design and project team on Inova Fairfax Hospital South Patient Tower are striving to achieve LEED silver certification on this project. The major sustainable features include green roof, rain gardens, water cisterns and so on.  The “Green” design also includes low-flow plumbing, low- or no-VOC buildings materials and furniture. The new tower will utilize the latest technology and design for a patient centered, environmentally sustainable facility. Here is the picture from Wilmot Sanz Architect Inc. Showing the major green features in the design.

Figure12

LEED certification is the most recognized standard for building sustainability measurement. The design and project team on Inova Fairfax Hospital South Patient Tower are striving to achieve LEED silver certification on this project. According to LEED rating system, the project is rated based on the LEED 2009 new construction standard, which includes 100 base points for variety of sustainable design strategies. 6 possible Innovation in Design and 4 Regional Priority points. The point range for Silver is from 50-59. See APPENDIX C for LEED Scorecard for detailed subcategories rating of South Patient Tower.

The point system is distributed as below through the six categories:

| Category | Points |
|---|---|
| Sustainable Sites | 13 |
| Water Efficiency | 6 |
| Energy&Atmosphere | 18 |
| Materials& Resources | 6 |
| Indoor Environmental Quality | 14 |
| Innovation &Design process | 0 |
| Total | 57 |

See **APPENDIX D** LEED SCORE CARD.

**Summery of LEED Points**

***Sustainable Sites***

Construction Activity Pollution Prevention: In order to reduce pollution from construction activities by controlling soil erosion, waterway sedimentation and airborne dust generation, control plan during design phase should be created such as mulching and silt fencing .

Site Selection: The South Patient Tower is connected to the existing main hospital building and will enable the master planned expansion of the women's hospital on the east side. So the area is used efficiently without inappropriate site development such as restrictive high-value farmland, high hydrogeologic risk previously undeveloped land, and public parkland. A suitable location and minimal footprint should be designed.

Development Density and Community Connectivity: For this point, there are two options: development density and community connectivity. According to situation of the Inova Fairfax South Patient Tower, option two can be achieved. The site is located on previously developed site with convenient basic services such as bank, restaurant, convenience grocery and so on.

### *Alternative Transportation*

Public Transportation Access: Option 2- Bus Stop Proximity can be achieved for the South Patient Tower. The project is located within 1/4miles walking distance of one or more stops for 2 or more public, campus, or private bus lines usable by building occupants. There three metro bus lines connect the hospital campus with major North Virginia locations,  including the Dunn Loring Metro rail Station.

Bicycle Storage& Changing Rooms: bicycle racks and shower/ changing facilities can be adopted into the project to reduce pollution and land development impacts from auto mobile use. As non residential project, the South Patient Tower need to provide bicycle racks within200 yards of the building entrance for 5% or more of building users.

Low-Emitting and Fuel-Efficient Vehicles: The good environmental condition for the is very important for the patients at Inova Fairfax Hospital. Therefore, it is quite necessary to reduce the pollution and land development impacts from the automobile use. The pollution can be reduced or controlled by providing transportation amenities such as alternative fuel refueling stations.

Parking Capacity: In order to minimize parking lot/garage size, South Patient can consider sharing parking facilities with adjacent buildings such as number12 and number13 existing parking for the hospital show in figure 1 below:

Storm-water Design,Quantity: is to limit the disruption of natural hydrology by reducing impervious cover, increasing on-site infiltration, reducing or eliminating pollution from storm-water run off and eliminating contaminants. Pervious paving and other measures can be designed to minimize impervious surfaces in order to protect the natural hydrology

Heat Island Effect, Roof: The South Patient Tower did a good job in reducing heat island effect by designing the green roof and white roof to minimize the impacts on human and wildlife habitats.

Light Pollution Reduction: The site lighting is minimized where possible. Computer software should be used to model the site lighting. light trespass and sky-glow should be minimized.

### *Water Efficiency*

Water Use Reduction:Certain requirement of toilets, urinals, lavatory faucets, showers should be met in order to increase the efficiency of building water uses and also reduce the burden on wastewater systems.

### *Energy & Atmosphere*

Fundamental Refrigerant Management:For new constructed South Patient Tower, specify new HVAC equipment in the base building that uses no CFC-based refrigerants to reduce ozone depletion.

Optimize Energy Performance: The minimum energy cost saving percentage for South Patient Tower is targeting 30% with 10 points rewarded.

On-Site Renewable Energy: Renewable energy such as solar, low-impact hydro  can be used instead of fossil fuel energy to reduce both environmental and economic impacts.

### *Materials & Resources*

Construction Waste Management: The goal for the Turner construction is to divert 50% construction and demolition debris from Disposal

Materials Reuse: 10% reuse of refurbished or salvaged materials can earn South Patient Tower 2 points. This helped to reduce the demand for virgin materials and reduce the waste.

Recycled Content: Project goal should be established to use 10 % of materials with recycled content. Only the materials permanently installed in the project will be counted.

Regional Materials, 20% Extracted: This means the materials needed for the building are processed & manufactured regionally from VA. The environmental impacts will be reduced from transportation.

### *Indoor Environmental Quality*

Outdoor Air Delivery Monitoring: CO2 and airflow measurement equipment need to be installed for South Patient Tower to ensure the quality of air and promote occupant comfort.

Increased Ventilation: Natural ventilation systems for occupied spaces should be put into design to meet the recommendation set forth in the CIBSE.

Construction IAQ Management Plan: An IAQ management plan for both during construction and before occupancy should be generated to reduce in door air quality problems to promote the comfort of construction workers and the patients.

Low-emitting material: Many sustainable features such as adhesives&sealants, paints&coatings, Carpet systems, composite wood, low or no-VOC buildings materials and furniture are attributed to South Patient Tower to guarantee the health and comfort of the occupants.

Indoor Chemical & Pollutant Source Control:Potential entry of pollutants into building should be controlled to minimize the building occupant exposure to the hazardous particulates and chemical pollutants.

Controllability of Systems for Lighting and Thermal Comfort: The patient tower should provide a high level of individual or groups control of lighting and thermal comfort system to make it as convenient as possible for patients to get access to them.

Daylight&Views, Daylight 75% of spaces: The natural daylight and view are very important for the patients in South Patient Tower. So a goal to achieve daylighting in 75% of regularly occupied spaces are needed to provide patients with a connection between indoor spaces and the outdoors.

### 5.4.10 National Model Codes

- Virginia Uniform Statewide Building Code-2006 edtion
- International Building Code(IBC)2006&2006 supplement
- ICC international mechanical code 2006
- ICC international plumbing code 2006
- National Electriccal Code 2005
- International Energy Conservation code 2000
- NFPA National Fire Alarm Code 2007

# 6.0 Analysis#1 Implementation of Building Information Modeling (BIM)

## 6.1 Problem Identification

Turner Construction is the leading industry exponent with a lot of BIM project experience. They are willing to help the clients to understand enormous benefits that BIM can offer and prepare themselves for this new technology. Therefore Building Information Modeling(BIM) was only implemented for the coordination of its MEP system into South Patient Tower. Since the South Patient Tower is designed to be connected to the Existing Tower Building (ETB), which was built early in the 1950's when high ceiling space were not considered for the complex MEP system. Therefore, the implementation of BIM in this project was not achieved to its full extension.

As a new innovated healthcare project, South Patient Tower has the potential capability and should pursue a higher level of technology implementation. There are still space that can be explored for additional BIM usage on other portion of the building to shorten the schedule and save the budget.

### 6.2 Idea and Thoughts from PACE Roundtable meeting

With the in-depth discussions and more researches at the 2011 PACE Roundtable Conference, more ideas and benefits of BIM application are presented. Prior the discussion, professionals and students have reached a consensus that the two main benefits of using BIM are the reducing of change orders and the cost saving. Therefore, many barriers and problems have come up.

Building information modeling(BIM) is changing the way buildings are designed and constructed.The use of BIM has been around for approximately

10 years. It continues to grow. But not all the architects, engineers, manufactures, or construction professionals are eager to jump on board.

One of the problem mention in the discussion is the lag between technological capability and user adoption. When looking at the use of BIM from the owners' perspective, they are usually confused. For most of the time they do not know what they want at the end. Many BIM requirements are not very clear. BIM is implemented into the project sometimes just because it is out there and it is a new technology.

Is BIM changing how buildings are operated and maintained? The introduction of BIM in facility management is also mentioned in the discussion. The majority of the life-cycle cost of a building does not come from the design and construction phase, but from operating the building over 20 to 50 years. BIM can be a helpful tool for performing facility management during the operational phase of a building's life cycle, which can extend over decades to enhance buildings' performance and manage operations more efficiently. It is very tough to specify the level of details of the model is.

Separate groups must get together for BIM coordination, which results in another challenge of risks and liabilities. Since a lot of sharing information and coordinations are needed through the whole process. It is quite crucial to draw distinction between each groups when addressing the responsibilities.

When BIM is introduced into a project, challenge at subcontractor level must also be considered. It is difficult for smaller firms to keep up with the technology maintenance. Current workforce need to be educated and retrained to adopt BIM. Companies need a series of training programs to assit training their workers. Behavioral barriers make the more practical and appealing use of BIM implementation a long term process.
See **APPENDIX F** BIM ANALYSIS.

### 6.3 Identify and Recommend Other Potential Areas of BIM Application

Building Information Modeling (BIM) was used in South Patient Tower building as a tool to help coordinate the complex MEP system for this healthcare project. This has greatly helped to minimized problems during the installation process. As a new innovated medical project, South Patient Tower has the capability and should pursue a higher level of technology implementation. Combining the facility management with BIM could be a great way to help Inova healthcare system to win in a long run.

Utilizing BIM for other areas of the project can by identified in further research. These specific areas can be pre-construction phase, facility management, and even a fully developed strategy for the owner's future use on its projects. BIM 3D AND 4D modeling can make great contribution to communications between owners, designers, and contractors.

Benefits from BIM in facility Management has taken project construction technology to the next level. Inova health system can benefit from BIM post-construction to visualize the space, review layout changes, analyze energy use data, allocate asset and maintain facilities.

## 6.4 Investigation of Potential tools

The scope of BIM needs high level of communication, data and information exchange to reach its full capacity. Many tools are created to support BIM. The following are the research on the authoring BIM tools:

### *6.4.1 VICO 5D MODEL SOFTWARE*

is able to leverage many really important BIM files formats such as Revit, Tekla, ArchiCAD and so on.

- 2D Drawing: Tells a much more engaging story especially for the owner and so help to win the deal.
- 3D Construct-ability and Coordination: Changes can be proposed, thousands of RFIs can be resolved even prior the shovel breaks ground, instead of on-site or at last minutes.

- 4D Scheduling and Production Control: trades can be sequences in a optimized way so that undue rushing and low quality issues can be avoided and guarantee a smooth flow through the construction site.
- 5D Estimation and Cost Planning: A insight for subcontractors and self performed work cost help to preserve the interests of both the owners and the general contractors.

Figure13

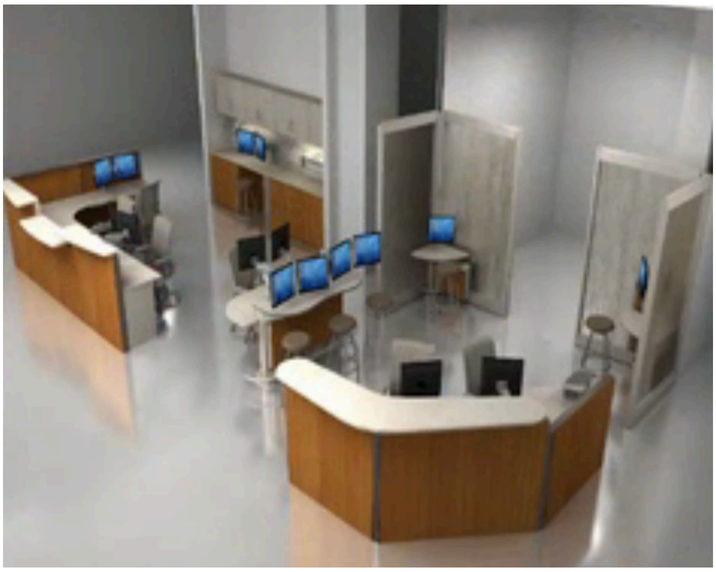


Figure 14

### How the data flow work

A simple structure such as a column can be built first, and then the data such as materials, quantities can be put in to specify the characteristics of components. The system will automatically  generate the related needs for equipment, labors and so on for the activity. Whenever the design is changed, the estimates will be updated automatically as well. The system can also add zones to the building and coming up with the duration of the activities which is the schedule of the project. There are all the automatic behavior from the system. It can be connected to external systems such as google sketch-up,Revit, CAD Duct, Primavera and so on.A tightly integrated BIM workflow are as follows:

- 3D BIM Visualization
- clash detection
- quantity takeoff

- scheduling and production control
- estimating

As shown below in the figures:

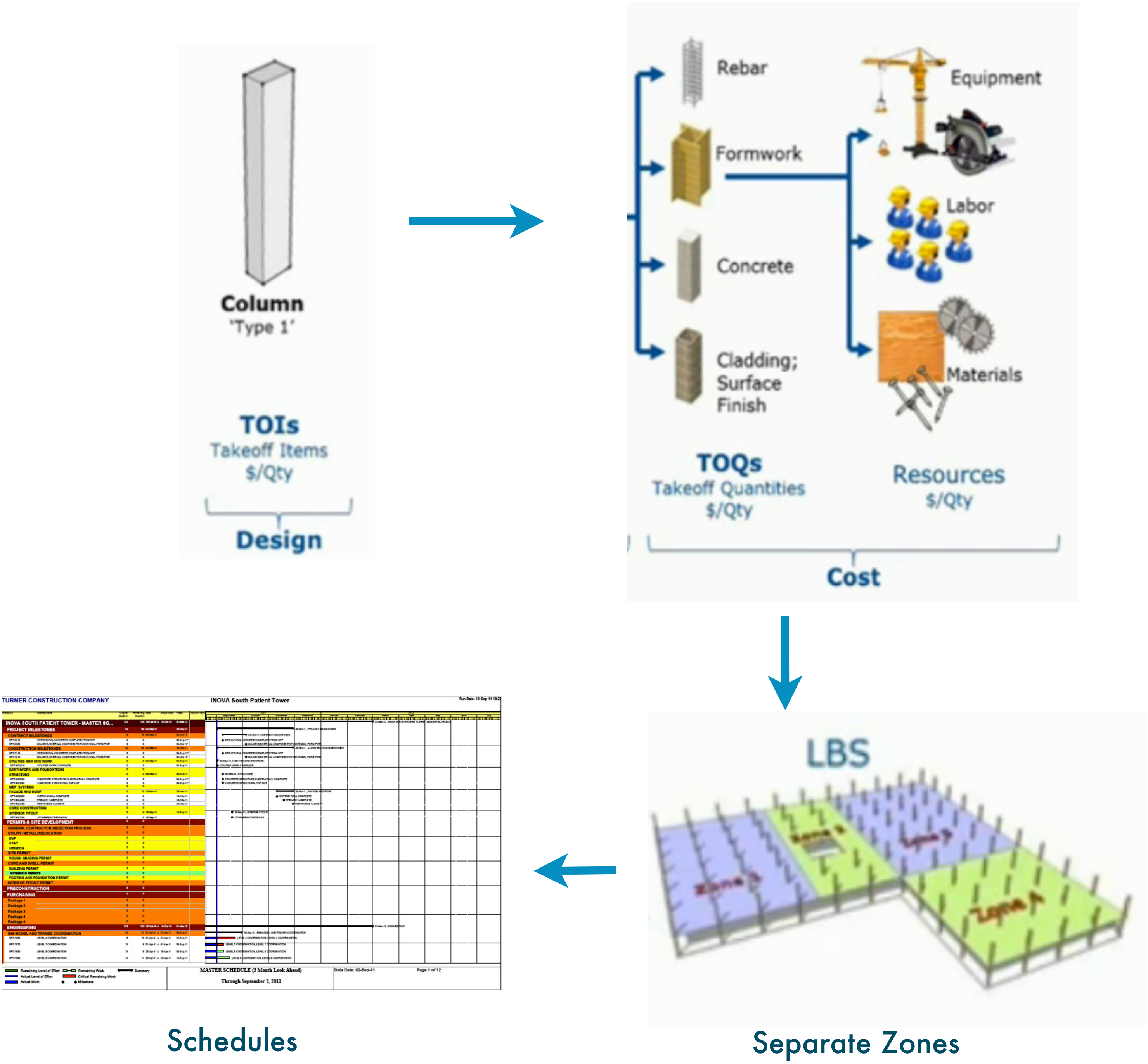


Figure15

### *6.4.2 TEKLA Structure*

Tekla Structure software used for creating and management of accurately detailed and highly constructible 3D structural models regardless of the materials and complexity. It will cover the whole process from conceptual design to fabrication, erection and construction management.

The functionalities includes:

- steel detailing:
    - modeling function It can create and modify grids, model parts and bolts, create welds, detailed steel connections, erection sequences and so on.

- precast concerete detailing:
    - modeling function it will add load to a model, model reinforcements, create cast units of concrete parts, detailed concerete connections, erection sequences and so on.
- cast in place
- engineering: Professionals in structural engineering and design are able to collaborate with participants from other projects by sharing same models.
- construction management
- engineering
- viewer

*Output function*: It can create general arrangement drawings, singel part and assembly drawings, reports and so on.

*Collaboration properties*: import, export and exchange data with several users in different kinds of formats and be able to be published to be viewed on the internet.

## 6.5 BIM Scorecard

An calculation of BIM score is achieved here for the South Patient Tower project. BIM scorecard is used to determine how many BIM capabilities are used in the operation with the idea that BIM is not limited to 3D modeling, it is a throughout combination of integrated construction information including design, cost, schedule, cost, coordination, management and so forth.

The BIM capabilities are divided into 6 categories for calculation:

1. Portfolio and Project Management: involves the creation and use of project status reports that provide managers insight in planned versus actual progress, material and resource usage, as well as forecasts based on the performance so far. Portfolio Management contains a roll up of this type of reports to the enterprise level.
2. Cost Planning: is the evolution of estimating into a more proactive methodology to calculate and report projected cost, using the integration and cooperation with the design discipline to provide rapid and more frequent feedback to partners and owners.
3. Cost control: goes along with Cost Planning and is used to determine current status of the project's cost, as compared to earlier versions as well as a set of cost targets per building system.
4. Schedule Planning: is more than just drawing bars that reflect the expected (desired?) duration of a task, which results in just an uncoordinated "window of opportunity" for subcontractors that come on board in a later stage: it determines the amount of work by using BIM quantities per location and applying production rates obtained by measuring performance in previous and current projects.
5. Production Control: using BIM means: checking completion of the project per location, and deriving the actual progress from quantities rather than guesstimates.
6. Design Coordination: Most companies who have "implemented BIM" today are already familiar with the Design Coordination category: clash detections are run on the sets of trade models and issues are resolved by

working with the various parties involved, to create a coordinated 3D model for all trades. Design Coordination also involves change management and constructability reviews.

7. Design Team Engagement: planning and organizing your design, cost and schedule content to connect seamlessly, and defining a process that all parties follow during the design phases of the project falls in the Design Team Engagement category.

For all of the categories, we have developed three questions: one about use of software, one about best practices and processes and one question about the level of integration with other categories.
Area with the most opportunities are highlighted for further improvement, as well as concerete ideas for improving BIM benefits. Calculated BIM score along with supporting graphs see **APPENDIX A** BIM SCORE REPORT.

### 6.6 Return on Investment (ROI) of BIM

Before committing more funds to the BIM technology, an analysis will be conducted here as part of the study of implementation of BIM to check the feasibility of BIM to the South Patient Tower.

**ROI=Earning/cost**

One of the factor need to be consider with the implementation of BIM is the change in productivity. The productivity during the design phase will be low and as time goes by, the project will gain its productivity again after new construction system is put in place.
The following is a standard formula for calculating the first year ROI

$$\frac{(B-(B/(1+E))) \text{ X } (12-C)}{A+ ( B \text{ x } C \text{ x } D)} = \text{1st Year ROI}$$

A: Cost of hardware and software($)

B: Monthly labor cost($)

C: Training time (Months)

D: Productivity lost during training(%)

E: productivity gain after training(%)

A survey created by Revit Architecture Software has collected the approximate data from their online users with the result :

| | |
|---|---|
| A | 6000 |
| B | 4200 |
| C | 3 |
| D | 50 |
| E | 25 |

$$\frac{(4200-(4200/(1+25\%)))\ \mathrm{X}\ (12-3)}{6000+ (\ 4200 \times 3 \times 50\%)} = 61.46\%$$

Calculations for a design system is relatively simple. The more complicated the investment, the more complicated the formular will become. For Turner Construction Company, they have many successful experience on utilization of BIM. So the initial cost of hardware and software can be neglected here and the training time can also be shortened or even neglected with the consideration of some new-in employees. Amount all these factors Productivity plays the most important role and hardware and software cost matters the least. The schedule of the project is expected to be compressed by 10%.

### 6.7 Further benefit from implementation of BIM

*Case Study*

One of the similar successful case by Turner Construction Company is the 555,000 sq. ft. healthcare facilities at Middle Tennessee Medical Center with a saving of budgeted costs of $3 millions below the owner's initial target and an additional $1 million savings due to the BIM enabled prefabrication alone at by the end of the project. The medical center was also completed two months ahead of schedule. The project is about twice the size of South Patient Tower.

The South Patient Tower being complete in August 2012, is only part of the Inova Fairfax 2015 Campus Improvement Plan. Completion of the new patient tower will enable the master planned expansion of the 600 sf Women's Hospital on campus (As shown in figure). The whole plan also includes further a new access road, another parking garage, maybe medical offices. This makes the implementation of BIM to the South Patient Tower more feasible and beneficial. Since the investment of the technology and information for SPT can also be fully utilized as reference for the following Women’s hospital project.

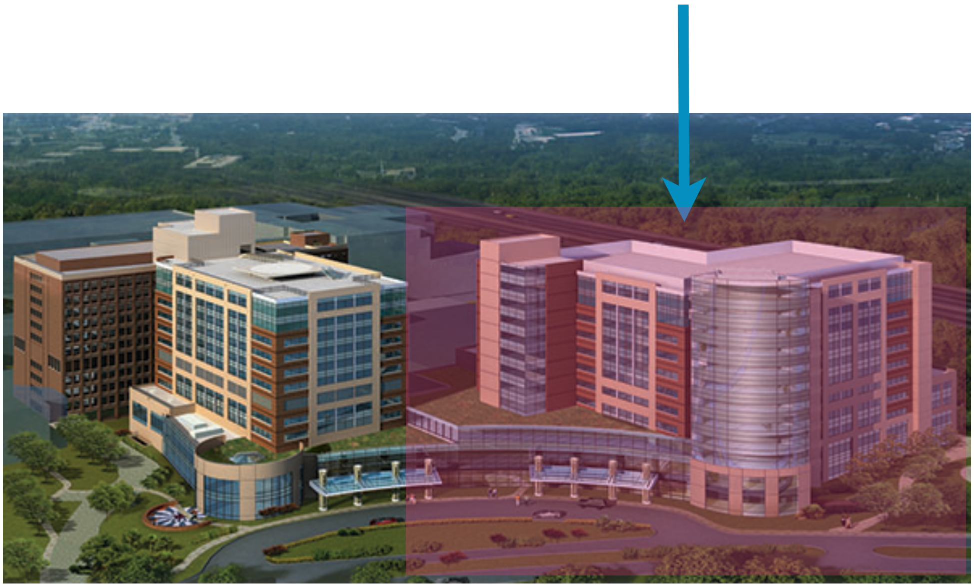


Figure 16

# 7.0 Analysis#2 Short Interval Production Schedules(SIPS)

## 7.1 Problem Identification

SIPS is a very detailed way to make schedule for a repetitive construction project. It can help to make sure that the project will be complete on time and within the budget. Highly repeatable activities can be the most beneficial by using SIPS such as dorms, hotels, and apartment building. Usually they will have a relatively uniform interior floor plan or building layout. SIPS can be detailed to day to day task and schedule, even to the crew level. The success implementation of SIPS in the project can even save a great amount of time for the construction process.

### Resources and Tools to be used

- Architectural Engineering Department Faculty
- AE473 Course Building Construction Management and Control
- Microsoft Project for developing a possible new schedule

### Expected Outcome

Development a short interval production schedule for the defined repetitive portion of the construction building so that the overall schedule for the project is expected to be reduced. The related issue such as change of cost and safety concerns due to the develop of SIPS will also be studied and discussed. Since they are two of the most priority concerns for both the construction team and also the owners.

## 7.2 Research study and Recommendations

The South Patient Tower is an 11 stories patient tower adjacent to the south of the existing hospital building. The tower includes 174 private patient rooms for both general and intensive care units.The first two floors are the main lobby area.The following five floors are dedicated to medical/surgery beds and last three floors to ICU beds.

The floor plans started from the third floor up to the top floor are relatively similar and repetitive excluded the fifth floor, which is for the mechanical. Even the ceiling height is higher than other floors. So SIPS is considered here as a proposal which may potentially speed up the schedule of the project. As shown in the figures, the main area that SIPS may be implemented is the red section starts from second floor to the top, and the sequences from east to he south side of the building. An detailed schedule is achieved. See **APPENDIX J** SIPS SCHEDULE.

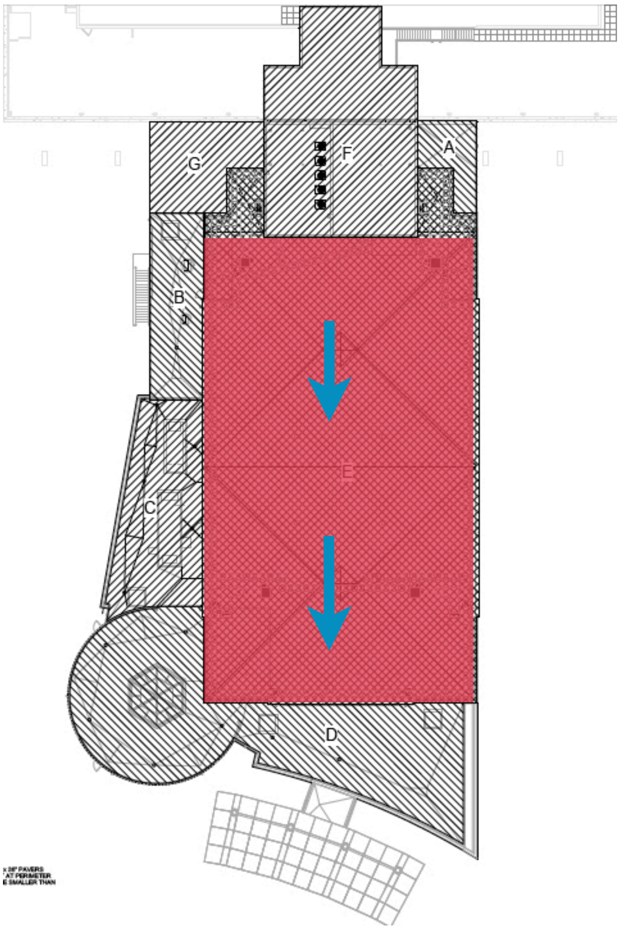


Figure 17

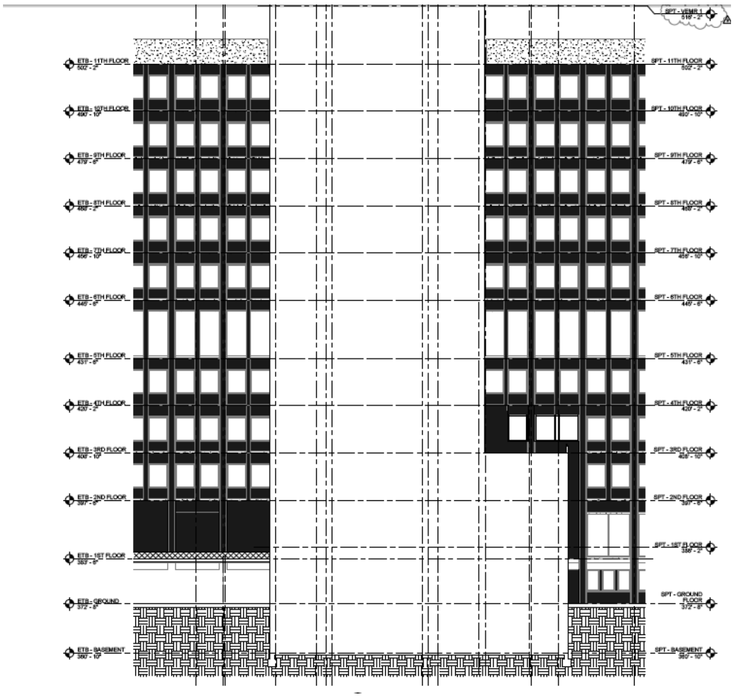


Figure18

The following pictures shows the rough originally designed construction process of the South Patient Tower.

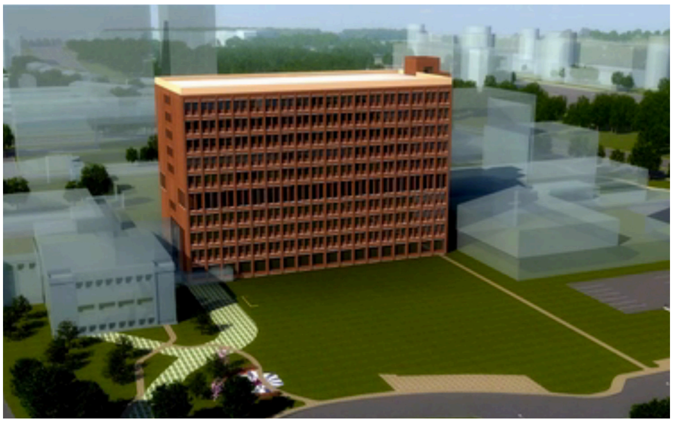


Figure 19

Figure 20

Figure 21

Figure 22

Figure 23

Figure 24

The floor plans are most likely as shown in the figure below with patient rooms around along the building and the working sessions in the center part of the floor. With identify room numbers and dimensions, standard high performance pre-designed patient and surgery rooms can be pursued.

Figure 25

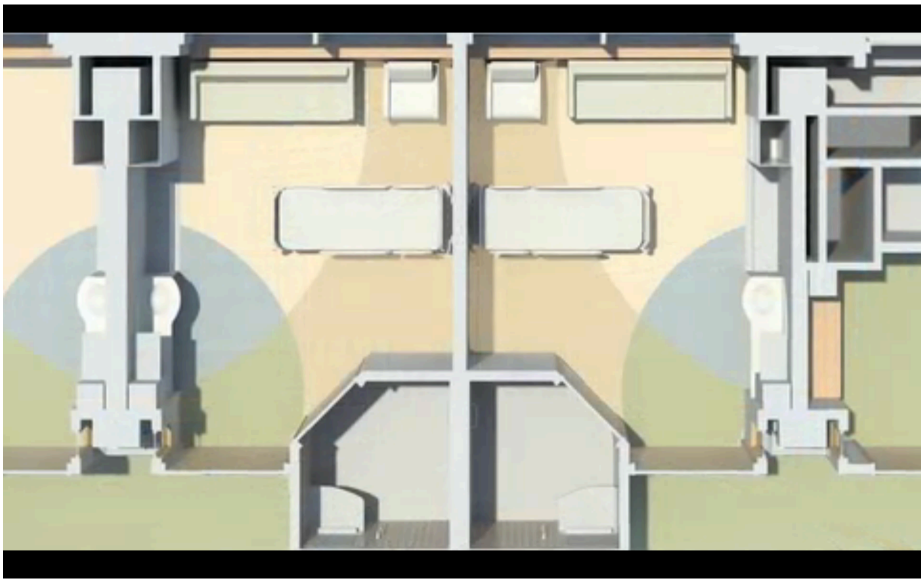


Figure 26

After research, Hill-Rom is proposed as a predesigned medical care/surgery room as part of SIPS to assist as the accelerators of the schedule. With the Room Builder Design Services, Hill-Rom can help to take the guesswork out of planning the new care environment for the hospital.

The closer to the completion date of the project, the more pressure the project team will get to keep staying on schedule and budget. Small details can make the differences. Hill-Rom has provided a very efficient way to finalize the interior room layout in advance to save construction schedule. The clients will be able to see the design in 2D and even 3D renderings.

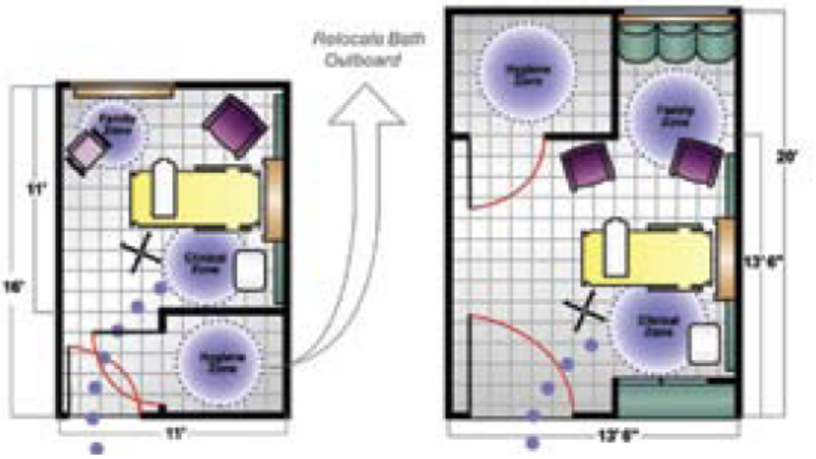


Figure 27

Figure 28

See **APPENDIX H** HILL-ROM PRODUCT SHEETS.

# 8.0 Analysis#3 Net Zero Energy Building Sustainability

## 8.1 Problem Identification

Hospitals are among the most energy intensive of all commercial buildings in the U.S. and the healthcare industry as a whole represents a substantial fraction of total U.S. commercial building energy use.

- Hospitals must operate 24/ 7 with high demands for cooling, electricity, and hot water.
- Hospitals require redundancy and emergency backup power at all times, and must remain operational even during natural or other disasters.
- Very tight controls are required for temperature, humidity, and ventilation, and those requirements often vary among different space types.
- Precautions must be taken to reduce or eliminate the transmission of infectious diseases through HVAC systems.
- Day-to-day operations are equipment-intensive, but no efficiency rating systems exist for medical equipment.

Acting as a big energy consumer, South Patient Tower has the demand to perform better in sustainability and energy savings. The design and project team for South Patient Tower are striving to achieve LEED silver certification on this project. The South Patient Tower currently has the energy reduction goal of at least 24.5 % based on a database of similar buildings. Many fixtures are attributed to the design to help peruse the goal. The building is highly insulated to improve the building enclosure. Its design of solar control for south-east tower can reduce glare and solar heat gain during summer time. The low emissivity windows will increase the R-value from 10.4 ro 22.4. The design of highly insulated white roof can reduce the urban heat island effect and help to lower the air conditioning costs. Highly efficient mechanical equipment also reduce the costs. There are also green designs including low or no-VOC building materials and furniture, water cisterns, rain gardens and so on. Solar panels used at the main entrance to the lobby of the SPT capture free and clean solar energy from the sunlight to power the canopy light at night.

## 8.2 Study and research on Net-zero energy

The Zero Net Energy (ZNE) goal with the idea of buildings producing as much energy as they use has become a more and more popular issue in building construction industry, which is considered to be the next big movement in green design. Net zero energy is accomplished when the right combination of efficient mechanical equipment, building materials, lighting and appliances are matched with a properly sized solar electric system.

Net-zero energy building is increasingly become the goal for many new constructed buildings all over the world. It is defined that 100% of the building 's energy consumption must be supplied by the on-site renewable energy. Currently, there are only a small number of highly efficient buildings that meet the criteria to be called "Net Zero".

As a result of advances in construction technologies, renewable energy systems, and academic research, creating Net Zero Energy buildings is becoming more and more feasible.The focus is green within the green by seeking environmentally sustainable solution that are cost effective at the same time. The net zero energy building certification is a program operated by the international living future institute. National Renewable energy laboratory (NREL) in its publication Zero Energy Building: A Critical Look at the Dfinition suggests the ways below to define net zero energy:

- Net Zero Site Energy
- Net Zero Source Energy
- Net Zero Energy Costs
- Net Zero Energy Emissions

Net Zero Energy building certification requirement:

- The NZE building’s construction and renewable-energy system curb the project’s contribution to the effects of sprawled development.
- The building operates at net zero energy.
- The project is built in a way that does not preclude another building from achieving net zero energy operation as a result of excessive shading.
- Renewable-energy systems must be incorporated into the building in ways that are “attractive and inspiring.”

## 8.3 Investigation on additional energy efficient solutions

### Top strategies for Energy efficient hospital design

1. Chilled beams

One of the latest innovative cooling technologies to run chilled water through cooling coils located at ceiling level to cool rising warm air. The cooled air then gently descends to occupant levels. It provides a cooling effect with minimal air movement and fan power. The chilled beams achieve their effect by convection. There are available in three types

- Passive
- Active
- Multi-service

Chilled beams may be an efficient, cost-saving alternative to traditional variable-air-volume (VAV) systems in hospital wards where medical equipment is a significant source of internal heat gains

2. Combined heat and power

(CHP, also known as cogeneration) is the use of a generator, such as a steam turbine, heat engine, micro turbine, or fuel cell, to simultaneously produce both electricity and useful heat. Conventional power plants emit the heat created as a byproduct of electricity generation into the environment through cooling towers, as flue gas, or by other means. CHP captures the byproduct heat for domestic or industrial heating purposes, either very close to the generator or for distribution through pipes to meet local heating requirements. Byproduct heat at moderate temperatures (100 to 180°C) can also be used in absorption chillers for cooling. Such a system is sometimes called combined cooling, heating, and power (CCHP) or trigeneration.

CHP is thermodynamically the most efficient use of fuel. In separate production of electricity, some energy must be rejected as waste heat that is given off to the environment, whereas in cogeneration, this excess thermal energy is captured and used, thereby reducing the energy required from other sources to meet heating loads. Depending on the technology used, the efficiency of the system can be raised to 60-80% if supplying heat along with electricity, compared to about 33%, the average efficiency of U.S. fossil-fueled power plants producing electricity only. Hospitals are one of the best cogeneration applications because of their year-round need for hot water or steam. In addition, cogeneration options may help hospitals meet their need for standby generation in the event of a grid outage.

Net Zero Energy Certified members understand the relationship between insulation levels, glass performance, HVAC specifications, lighting design, appliance selection and un-shaded south facing area needed for solar panels. The more efficient the house, the smaller the area required for solar energy production. Very early in the NZE Certified process your architect will need to know how many square feet of solar panels will be required for the project and very likely your architect will have creative ideas of how to accommodate the solar panels without compromising the design. The panels can be roof; ground or trellis mounted and need to face south. Furthermore, they must not be in the shade between 9:00 am and 3:00 pm on December 21.The solar systems will add 2-4% net cost of the building but will eliminate a utility bill and often will be immediately cash positive.

3. Solar electric

Solar Power yield in Falls Church

| ITEMS | DATA |
|---|---|
| Solar Radiation | 1432kwh available amount of solar radiation on the project site |
| Yearly Energy Yield | 2,852,646kwh amount of electric energy produced by the photovoltaic system |
| Peak Power | 2766kwh maximum power output the system can produce under ideal circumstances |
| Daily Energy Yield | 7815kwh average electric energy produced by the system on day. |

There are still many other issues related to the solar electric. The replacement of whole electrical system with solar electric is still not quite feasible for large project such as South Patient Tower. With the research data,  the ratio for the area needed such as for solar panel versus the area of the a typical family house is around 0.2. For SPT, it is 12 floors building with high demand of electricity usage, which makes the need of area of the solar panel too large to be considered.

**Utility Bills**

The way you pay your utility bills changes when you own a solar electric system. The first difference is the meter. The utility will put in a "net meter" that measures how much energy is being produced compared to how much is being used. For example, if more energy is used than is produced by the PV system, the meter may read a positive number. You can look at this positive number as you owing money to the utility. However, it is apparent that some months are much sunnier than others and therefore, your system will produce more energy. Further, the winter months force one to consume more because of the outside temperature as well as decreased sunny hours. Because of these factors that change throughout the year, the utility company adds up the monthly readings over the course of one year before billing the customer. So instead of paying a monthly bill, you only pay at the end of the year. This means that if you produce as much as you consume over the course of the year, you will owe no money regardless of the individual months that you used more than your solar electric system produced.

### More energy than needed

As of now, the best case scenario for a home is to produce as much energy as it uses. There are no benefits to producing more that it uses. However, there are already feed in tariffs that do apply to many commercial utility customers. These tariffs allow the customers to actually sell back the extra energy their system produces to the utility companies. The sell back rates will be a fixed, non-negotiable price over an extended period of time. Some counties in Florida actually have a feed in tariff program that buys back all of the energy produced by a commercial or residential system at a higher rate than they sell energy for. This gives utilities customers a great advantage by putting in a PV system. In California, they are working to propose a similar system come January 13, 2011.

Windows can have a significant impact on building operating costs, health, productivity and occupant well-being. The traditional purpose of windows was to provide light, view, and fresh air for the occupants. As completely sealed, mechanically ventilated, and electrically lit commercial buildings have become the norm in the last half of the twentieth century, the role of the window in addressing occupant needs has declined. However, there is a growing recognition that the benefits of windows are valuable and contribute to the satisfaction, health, and productivity of building occupants. In addition to the trend toward more human-centered design, there is an urgent need for significant improvements in building energy performance.

### Energy & Cost

Windows can be one of the most important components influencing buildings' energy usage, peak electricity demand, and environmental impacts. By providing natural light, windows can reduce electric lighting loads. Proper window selection and design can also cut peak electricity and cooling loads, thereby avoiding costly peak demand charges. In addition, high-performance windows can impact mechanical systems, not only contributing to reduced operation expense but also to potential equipment downsizing, saving capital costs.

### Human Factors

Windows have a direct impact on occupant health, well-being and productivity. Windows directly affect design attributes such as daylight, glare, view, thermal comfort and natural ventilations. The benefits of them can be achieved with careful design that mitigates the potential negative effects of increased glare and reduced thermal comfort

### Energy Codes and Standards

In most places in United States, building energy codes are based on the following two codes for a minimum energy efficiency baselines.

- International Energy Conservation Code(IECC)
- ASHRAE Standard 90.1
- National Fenestration Ratings Council Standards (NFRC)

There are other standards developed with more ambitious energy efficiency

- ASHRAE Standard 189
- International Green Construction Code(IGCC)

# Mechanical Breadth

Proper window selection and design can reduce peak electricity and cooling loads, thereby avoiding costly peak demand charges and easing the need for new power plants. In addition, high-performance windows impact mechanical systems, not only contributing to reduced operation expense but also to potential equipment downsizing, saving capital costs.Tools such as the Facade Design Tool demonstrate the environmental impacts of various design scenarios—allowing for decisions to be made early in the design process
The fenestration area is 22450 ft2, the wall area is 59120ft2. The window area is around 27.5%.

**The Facade Design Tool** lets you choose the design conditions of a window and rank and compare the performance data in terms of annual energy, peak demand, carbon, daylight illuminance, glare, and thermal comfort. After a location, building type, and orientation have been selected, you have the choice to Refine & Explore or Compare the performance data of window design options that you define in terms of orientation, window area, daylight controls, interior shades, exterior shades, and window type.

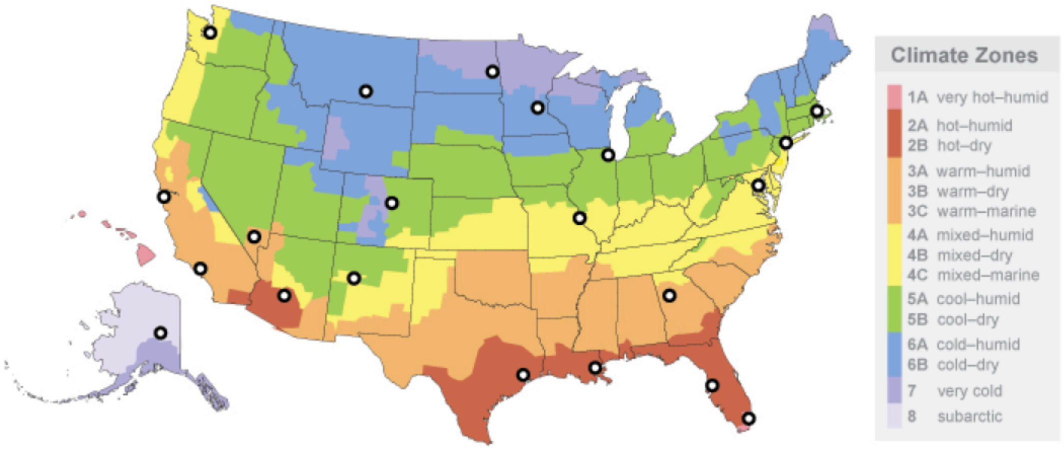


Figure 29

Falls church belongs to 4A DC Washington area The mixed-humid. In the report, U-factor, SHGC, VT are analyzed.

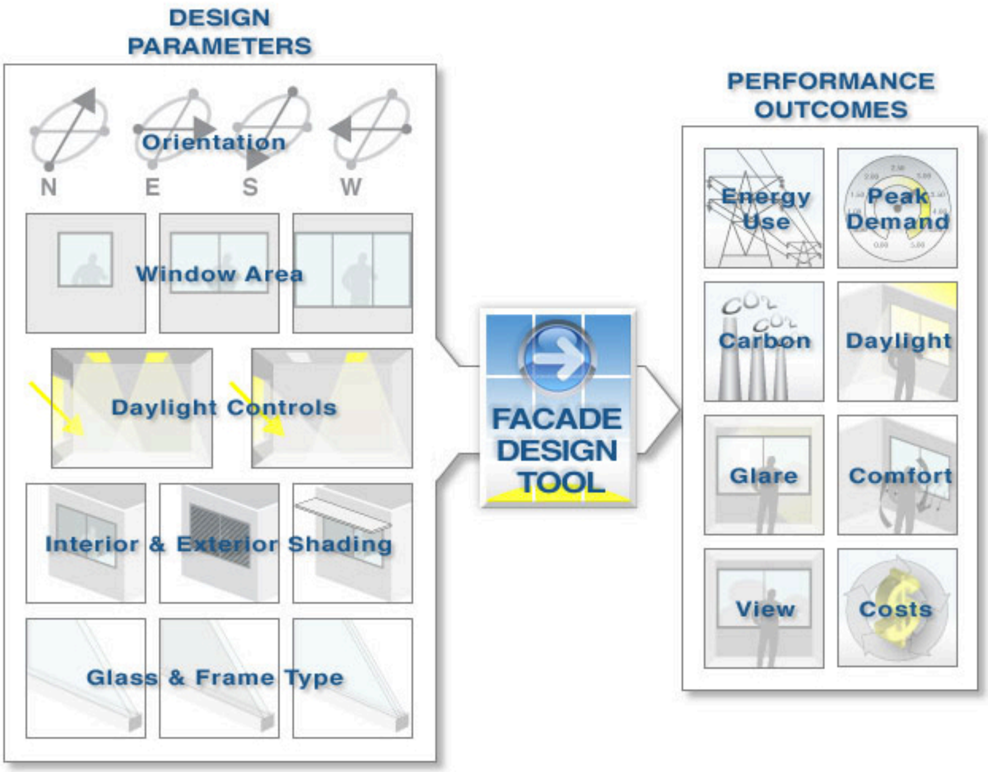


Figure 30

The following factos are considered and used in the calculation in the Facade Design Tool:

### U-factor

U-factor is the rate of heat transfer through windows per unit area and per unit temperature difference. The typical units are BTU/hr-ft2-F. The energy lost or gain equals:

$$\textbf{U factor x Area (ft2) x (T}_{\textbf{inside}}\textbf{-T}_{\textbf{outside}}\textbf{)}$$

### Solar Heat Gain Coefficient

When sunlight hits the windows, some of it goes right through, and some is reflected back and some is absorbed, heating up the window itself. SHGC represents the fraction of solar energy that strikes the window that ends up warming the house.

**VT**

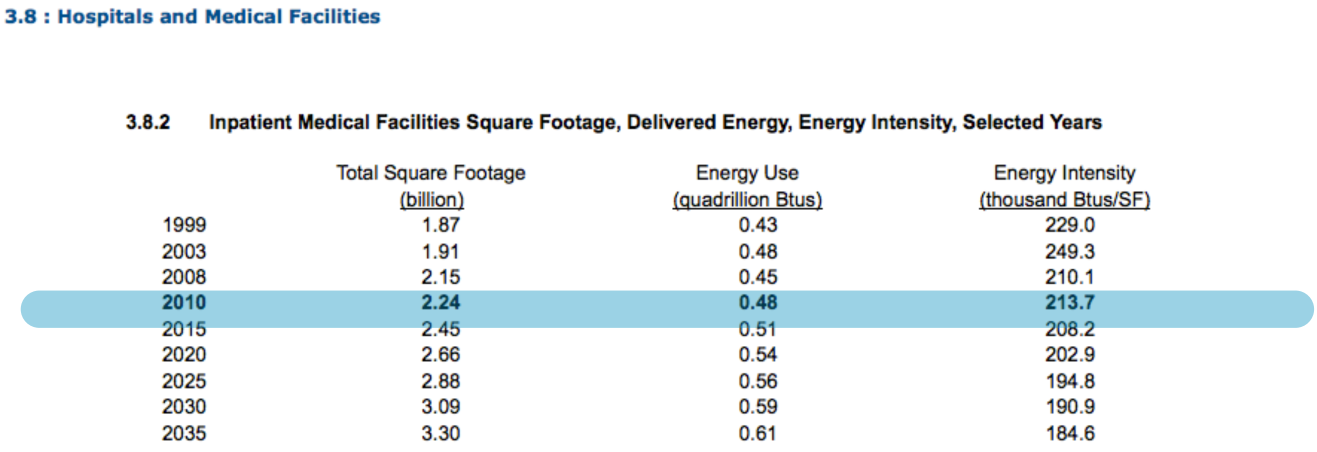
VT is the visual transmittance which represent the fraction of visible light that comes through the window. The greater the VT, the better the potential for daylighting. Usually a reduction in SHGC come with a reduction in VT.

An analysis is accomplished by Facade Design Tool to demonstrate the environmental impacts of various design scenarios to allow earlier decisions in design process. The data tells the annual energy use per square goot of heating, cooling, fans and lights for several scenarios in DC area with 30% window area and unshaded glazing types, also the electric peak demand, annual carbon emissions, annual daylights, thermal comfort and so on.

- See **APPENDIX C** FACADE DESIGN ENERGY ANALYSIS.

# Electrical Breadth

Electrochromic glass which can reduce visual glare and cut cooling and heating costs it can fit well in energy efficient building. It can reduce heating cooling usage by 25% and peak load (morning and early evening) by 30%.

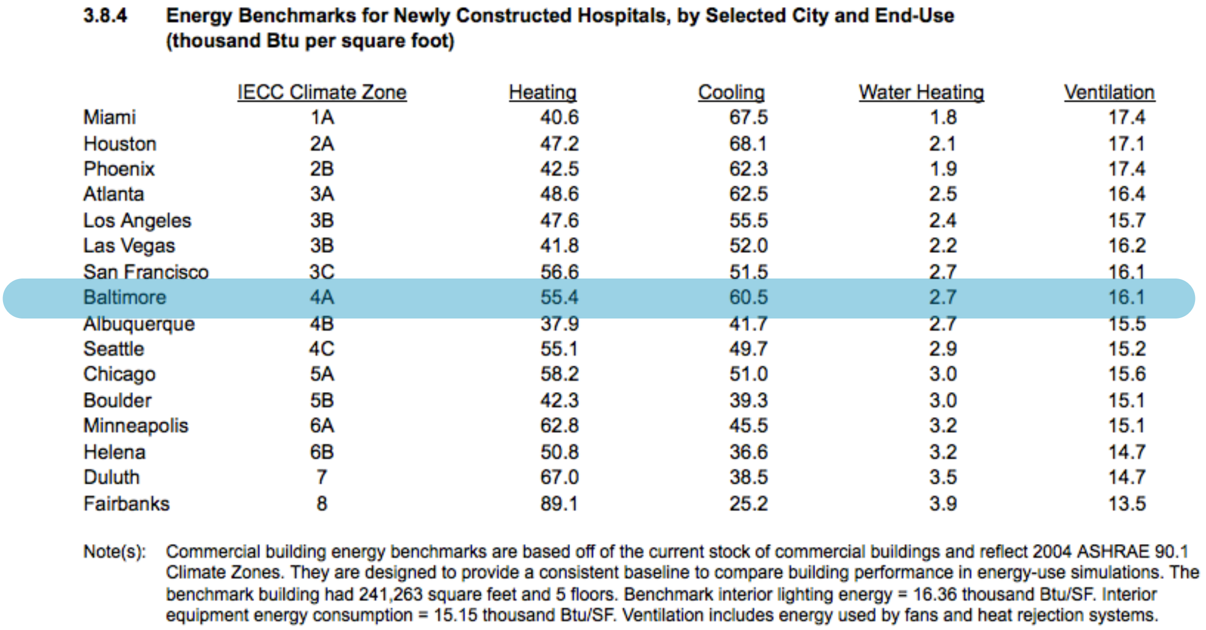


**3.8 : Hospitals and Medical Facilities**

**3.8.2 Inpatient Medical Facilities Square Footage, Delivered Energy, Energy Intensity, Selected Years**

| | Total Square Footage (billion) | Energy Use (quadrillion Btus) | Energy Intensity (thousand Btus/SF) |
|---|---|---|---|
| 1999 | 1.87 | 0.43 | 229.0 |
| 2003 | 1.91 | 0.48 | 249.3 |
| 2008 | 2.15 | 0.45 | 210.1 |
| **2010** | **2.24** | **0.48** | **213.7** |
| 2015 | 2.45 | 0.51 | 208.2 |
| 2020 | 2.66 | 0.54 | 202.9 |
| 2025 | 2.88 | 0.56 | 194.8 |
| 2030 | 3.09 | 0.59 | 190.9 |
| 2035 | 3.30 | 0.61 | 184.6 |

Figure 31



**3.8.4 Energy Benchmarks for Newly Constructed Hospitals, by Selected City and End-Use (thousand Btu per square foot)**

| | IECC Climate Zone | Heating | Cooling | Water Heating | Ventilation |
|---|---|---|---|---|---|
| Miami | 1A | 40.6 | 67.5 | 1.8 | 17.4 |
| Houston | 2A | 47.2 | 68.1 | 2.1 | 17.1 |
| Phoenix | 2B | 42.5 | 62.3 | 1.9 | 17.4 |
| Atlanta | 3A | 48.6 | 62.5 | 2.5 | 16.4 |
| Los Angeles | 3B | 47.6 | 55.5 | 2.4 | 15.7 |
| Las Vegas | 3B | 41.8 | 52.0 | 2.2 | 16.2 |
| San Francisco | 3C | 56.6 | 51.5 | 2.7 | 16.1 |
| Baltimore | 4A | 55.4 | 60.5 | 2.7 | 16.1 |
| Albuquerque | 4B | 37.9 | 41.7 | 2.7 | 15.5 |
| Seattle | 4C | 55.1 | 49.7 | 2.9 | 15.2 |
| Chicago | 5A | 58.2 | 51.0 | 3.0 | 15.6 |
| Boulder | 5B | 42.3 | 39.3 | 3.0 | 15.1 |
| Minneapolis | 6A | 62.8 | 45.5 | 3.2 | 15.1 |
| Helena | 6B | 50.8 | 36.6 | 3.2 | 14.7 |
| Duluth | 7 | 67.0 | 38.5 | 3.5 | 14.7 |
| Fairbanks | 8 | 89.1 | 25.2 | 3.9 | 13.5 |

Note(s): Commercial building energy benchmarks are based off of the current stock of commercial buildings and reflect 2004 ASHRAE 90.1 Climate Zones. They are designed to provide a consistent baseline to compare building performance in energy-use simulations. The benchmark building had 241,263 square feet and 5 floors. Benchmark interior lighting energy = 16.36 thousand Btu/SF. Interior equipment energy consumption = 15.15 thousand Btu/SF. Ventilation includes energy used by fans and heat rejection systems.

Figure 32

Estimation is made based on the data from the figures above. Data from Baltimore area is selected where the SPT is closed to.These data are specified for new constructed hospital at well.

Heating 55.4 kBTU x236,000 ft2 =13,074,400 kBTU
Cooling 60.5 kBTU x236,000 ft2 =14,278,000 kBTU
Water Heating 2.7 kBTU x236,000 ft2 =637,200 kBTU
Ventilation 16.1 kBTU x236,000 ft2 =3,799,600 kBTU

Total energy=13,074,400 kBTU+14,278,000 kBTU+637,200 kBTU+3,799,600 kBTU = 31,789,200 kBTU

**Total energy savings**= 31,789,200 kBTU x 25%= **7,947,300 kBTU**

Electricity price with appliance efficiency 100% =$ 35.16 per million BTU

**Total cost savings**=7.9473 x 1000 x 35.16= **$ 279,427.068**

After several research, the products from Soladigm Inc. is selected for the alternative window materials for the South Patient Tower. Soladigm is a developer of next-generation green building solutions designed to improve energy efficiency. The high energy-efficient dynamic glasses can switch from clear to tinted on demand, resulting in significant cost savings, environmental benefits, and quality of life enhancements. The approximate price is $20 per ft2.

Total Cost= $20/ ft2 x 22450 ft2 = $449,000

Since the price of the window materials and installation labor cost information is not provided by neither Inova hospital nor the Turner Construction, the comparison of the price and cost savings can not be accomplished. Therefore, dynimic glasses is believed to be the most efficient and proper window materials for South Patient Tower based on the researches done so far.

# 9.0 Analysis#4 Integrated Project Delivery (IPD)

## 9.1 Problem Identification

Integrated project delivery is a collaborative project delivery approach that utilizes the talents and insights of all the project participants through all phases of design and construction process.

All the activities mentioned above are seen as the biggest risks for the South Patient Tower project. Every step is crucial in order to meet the schedule completion date. If these schedule milestones are not met, then Tuner Construction will have to pay liquidated damages for each specific milestone. One of the biggest risks to the project completion date is the slight interruption with the Earthquake that occurred on August 23, 2011 and a Hurricane that we had to prepare for on August 27, 2007. As a result the crane was shut down the day after the Earthquake for a re-inspection and to repair water damage on the crane motors after the hurricane.

Also, There were coordination issues during the construction of first and second floor for the curved wall on south side of the South Patient Tower. The two curves did not match with each other due to the drawing on the architecture and engineering drawings. The schedule was delayed to cut and reshape the first floor. As shown in the figures below:

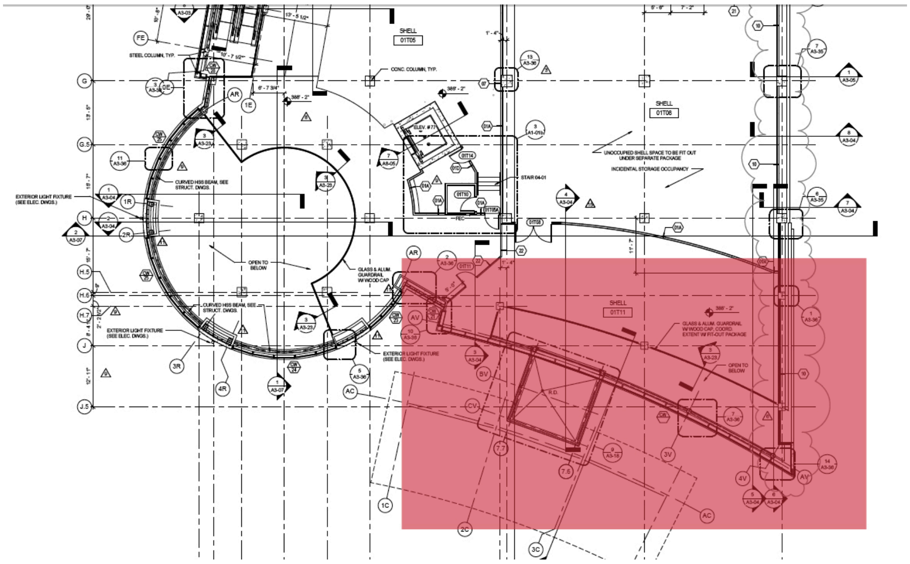


Figure 33

Figure 34

Exterior Wall: The installation of the Light Gage Metal framing on the East elevation started this month and was stopped as a result of a redesign that will coordinate better with the Women's Hospital Construction. Currently the revised Engineered drawings are being prepared by the framing subcontractor. This work was started in September.

Figure 35

Due to the complexity of the MEP system of the South Patient Tower, Turner has spent more than one year to implement BIM to coordinated the MEP system after got all the files from the subcontractors to make sure that everything fit in the tight ceiling that the SPT has. Meetings are set up at least twice a week to figure out how everything will be routed in these tight conditions. Therefore, the availability of the personnel from each contract group. At the mean time, Turner Construction can not make earlier contribution to the design phase and coordination process.

Figure 36

## 9.2 Research Goals (steps to achieve the analysis/research)

- Technology has played an important role in the IPD. Traditional IT solution may not be conducive to the collaborative work among the teams, which means the exploration on new collaborative software is extremely urgent.
- Study the Integrated Project Delivery Guide from The American Institute of Architects.
- Understand the issues that must be addressed in an IPD document

## 9.3 Potential Solutions

Integrated project delivery is changing the design world. It can minimize some risks, but may increase the exposure to other risks at the same time.The utilization of Integrated Project Delivery(IPD) will provide the opportunity for the early contributions of knowledge and expertises, which allows all the team members to realize their highest potentials to optimize project results, increase value to the owner, reduce waste, and maximize efficiency through all design, fabrication, construction and pos-construction process.

## 9.4 Expected Outcome

IPD method brings all participants such as Inova Fairfax Hospital, Turner Construction, and all other subcontractors together early with collaborative incentives to maximize the benefit of the project. The goal is to eliminates a great amount of waste in the design phase, and also allows data sharing directly between the design and construction team to eliminate the large barrier and increased productivity in construction at the same time.

Issues need to be considered:

- control the risks of sharing information
- compare the legal underpinnings of traditional design and construction delivery models to IPD.
- identify the attributes of contracts for IPD, and the professional liability insurance issues unique to IPD.

## 9.3 Study on Integrated Project Delivery A Guide(AIA)

AIA DOCUMENTS

American Institute of Architects published 6 new documents:

1. Two are contract documents or the Standard form single purpose entity agreement for IPD.
2. Third document.
3. Two of the new AIA documents are standard agreements for use in design-build practices. They establish relationships between contractors and subcontractors and between architects and their consultants. They outline rights and responsibilities of the parties and scope of work to be performed. They also outline rights and responsibilities of the parties and scope of work to be performed, and they address various key issues such as shared risk, dispute resolution, communications, and compensation.
4. Standard form of architect's services on-site project representation. This scope of services document outlines responsibilities of and compensation for architect's representatives on job sites.

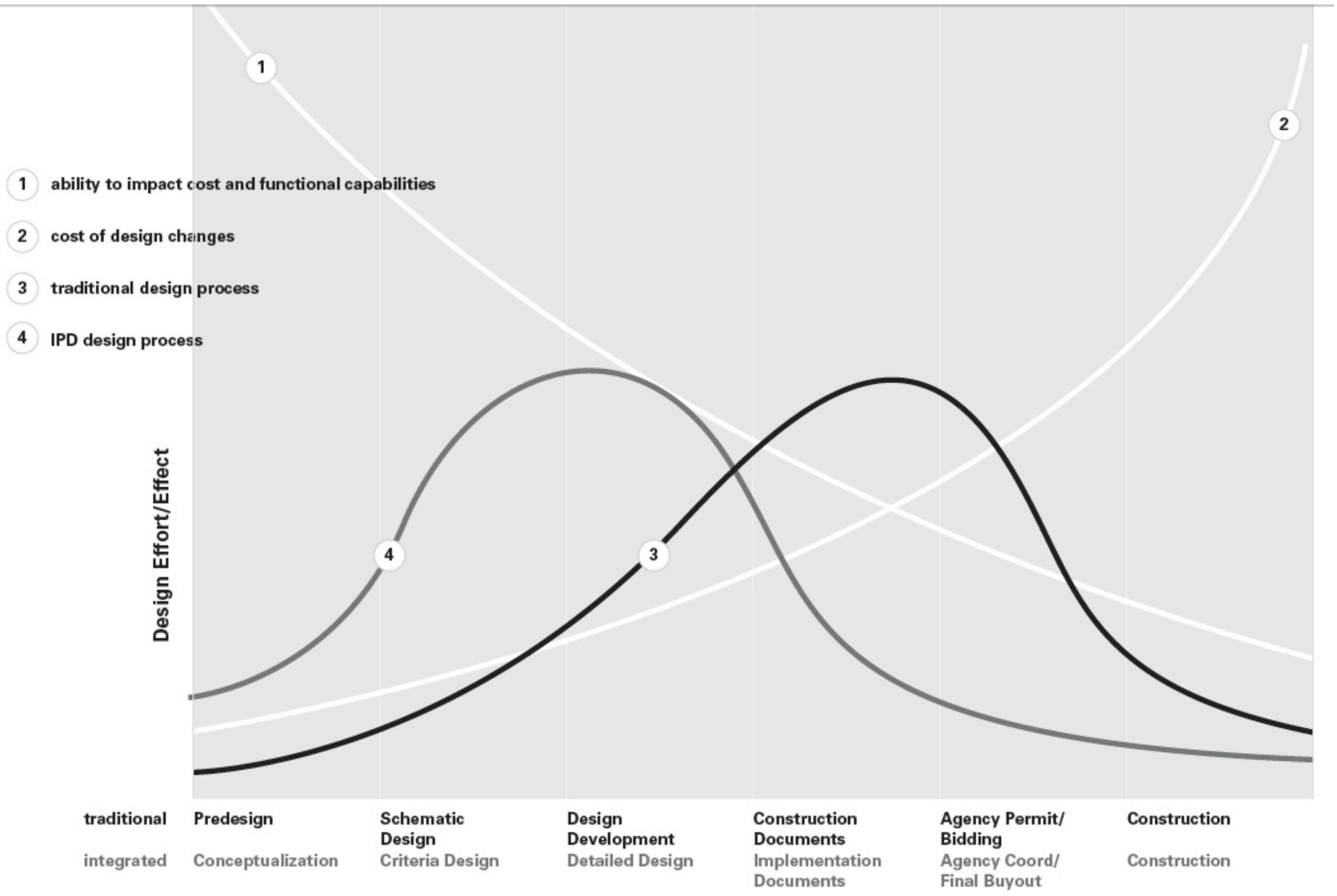


Figure 37

| Items | Traditional Project Delivery | Integrated Project Delivery |
|---|---|---|
| Team | Fragmented, “minimum-necessary” basis, strongly hierarchical | Mutual Respect and Trust |
| Compensation/ reward | Individually pursued | Mutual Benefit and Reward |
| Risk | Individually managed, transferred to the greatest extent possible | Collaborative Innovation and Decision |
| Process | linear, segregated,information hoarded. | Early Involvement of Key Participants, goal Definition, Intensified Planning |
| Communication | Paper based,2 dimensional | Digital based, BIM, Open Communication |

Figure38

## 9.4 Proposal: Multi Prime Contracts

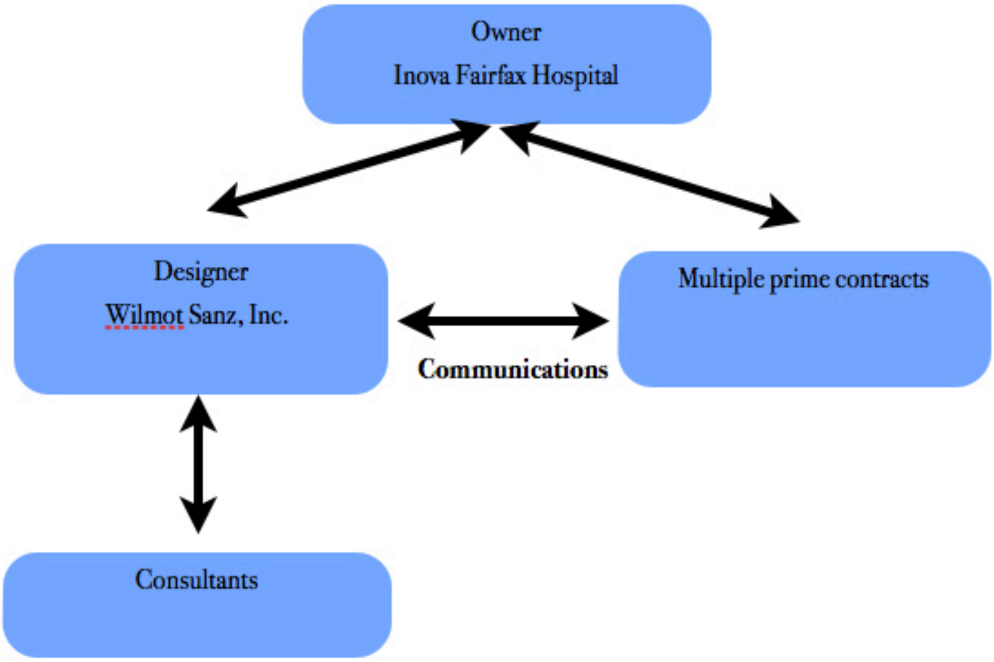


Figure 39

South Patient Tower is Design-bid-build method of project procurement. Barton Malow was the previous General Contrator for the Inova Fairfax Hospital South Patient Tower. They have been working on the pre-construction work for almost one year. Therefore, Barton Malow could not make it at the bidding price. The South Patient Tower Project was re-competed. Turner Construction won the work finally at the price of $76 million. The estimate profit and overhead total is about 12-16% percent of the project cost. This is a negotiated lump sum contract.Turner construction acts as the general contractor of the project along with the architect and engineering firms to work on the design and construction work.

The Inova Fairfax Hospital together with Turner has also evaluated and went through all the proposed design changes and value engineering concepts.

Some of them are accepted and some are rejected. Some of them are still pending. Turner Construction's value engineers mainly focused on:

- Life cycle savings in long terms under the risk of resulting a higher initial cost
- Optimizing Constructability
- Materials Substitutions

From the Division of Capital Asset Management of the Commonwealth of Massachusetts study case in the IPD for Public and Private Owners, many key provisions can be utilized as references by Inova and Turner Construction. Inova Fairfax act as one entity, the Wilmots Sanz Inc. and engineering firms as the second, and the Turner Construction company as the third. They have together build the primary participants and key supporting participant. Followings are the suggestions and potential methods to help improve the team work and therefore accelerate the schedule and the gain the productivity of the project:

- Frequent Meetings
- BIM(Sharing sensitive, proprietary or confidential information)
- Project cost :owner's interests in lower price, designer and contractor may have have a financial incentive to seek a higher target price. the conflict is managed through careful participant selection, open book estimating, proper use of independent consultants.
- Schedule: one of the main benefits of IPD is the reduction of construction time due to the extensive planning and changes to project processes. Early ordering of materials by key supporting participant trade contractors to coordinate with the development of the design reduce the time from the completion of design to beginning of active work on site.
- Understand how economic and market factors are driving IPD adoption.
- Apply successes from IPD projects across the nation.
- Master the key components of IPD contracts and risk management.
- Use technology and teaming techniques to build collaborative success.
- Select and build strong IPD project teams.
- Forecast the future of the industry, and how broad market factors such as BIM, Vertical Integration and Sustainability are all driving IPD process

The most ideal and efficient way to achieve IPD is to combine all the new technologies such as BIM, Lean, Sustainability together to optimize the construction process

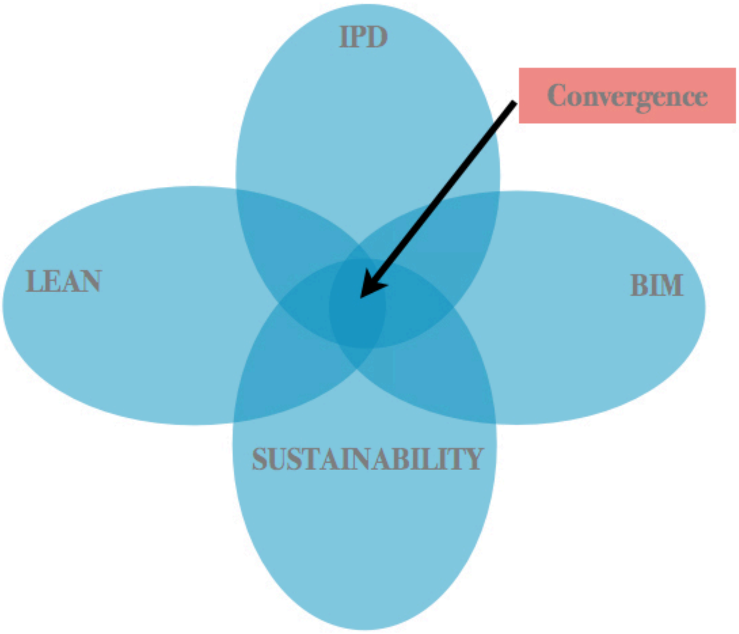


Figure 39

**Risks**

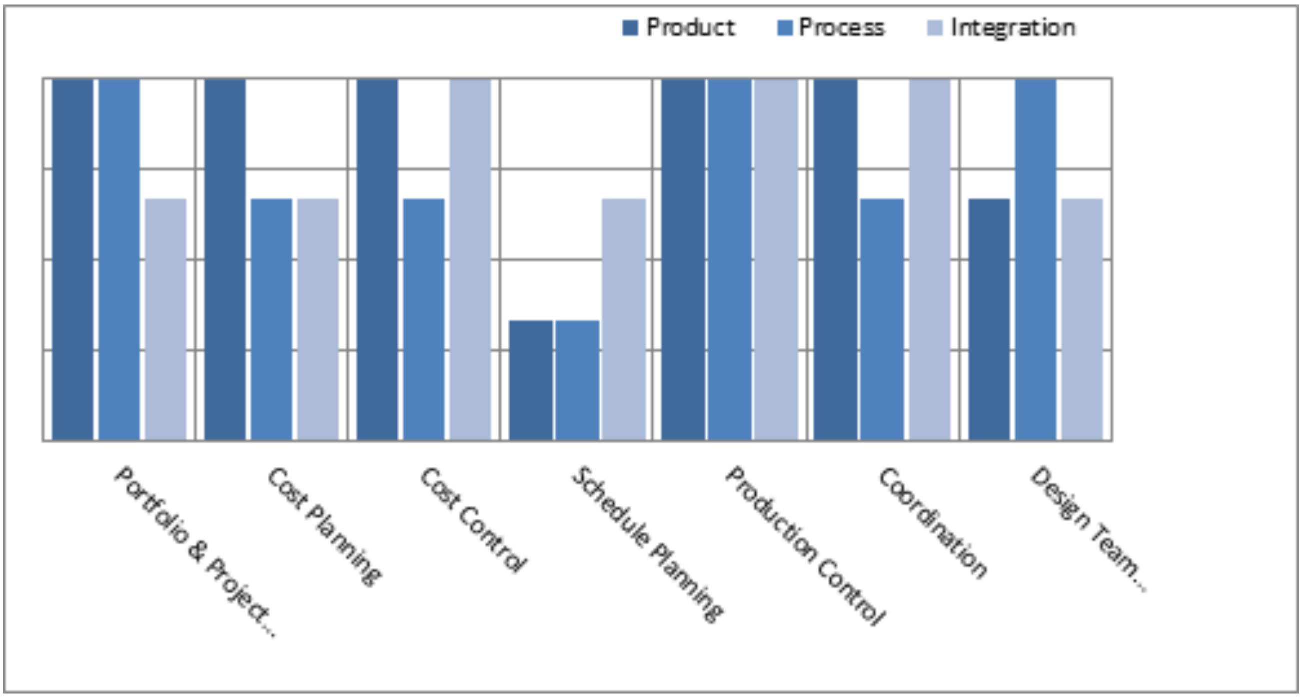
- Trying something new and untested, issues are still new.
- Building without a GMP
- Surrendering command and control
- Owner is taking some of the risks back
- May not get what we are expecting after a huge investment of time
- It is difficult to measure the benefit

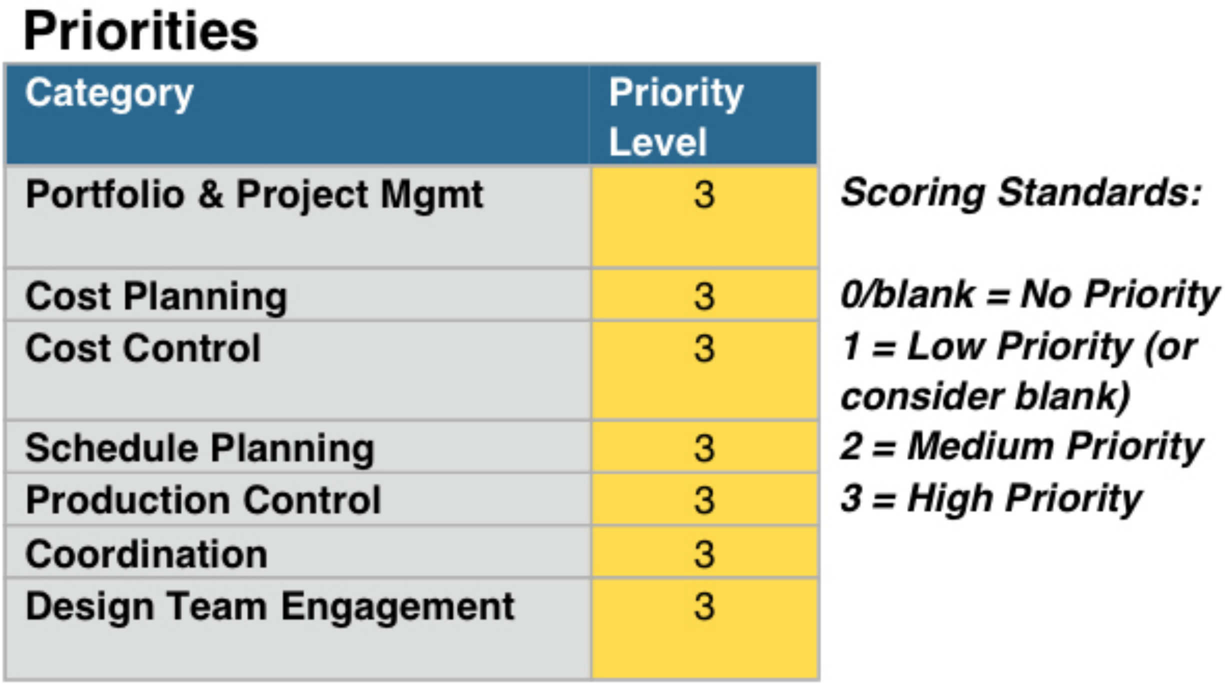
# APPENDIX A BIM SCORE REPORT

1 81 *out of 100*

**Scores**

| | Product | Process | Integration |
|---|---|---|---|
| **Portfolio & Project Management** | *3* | *3* | *2* |
| **Cost Planning** | *3* | *2* | *2* |
| **Cost Control** | *3* | *2* | *3* |
| **Schedule Planning** | *1* | *1* | *2* |
| **Production Control** | *3* | *3* | *3* |
| **Coordination** | *3* | *2* | *3* |
| **Design Team Engagement** | *2* | *3* | *2* |



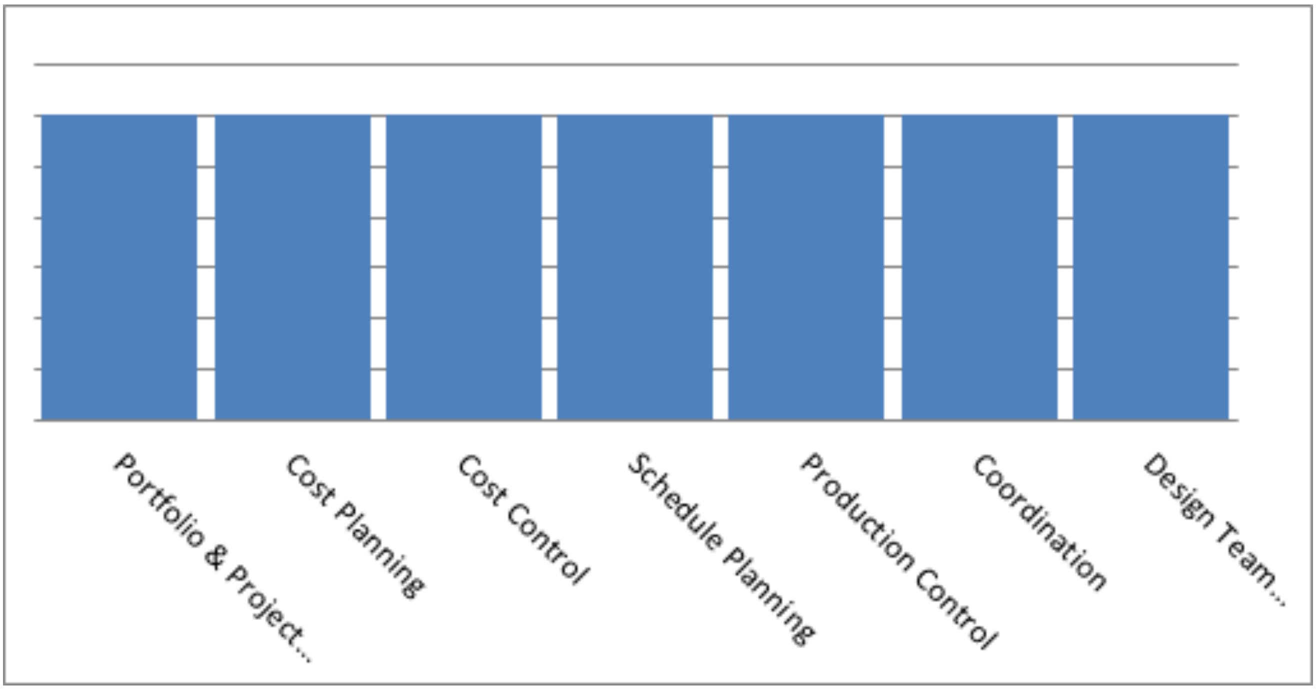


## Priorities

| Category | Priority Level |
|---|---|
| Portfolio & Project Mgmt | 3 |
| Cost Planning | 3 |
| Cost Control | 3 |
| Schedule Planning | 3 |
| Production Control | 3 |
| Coordination | 3 |
| Design Team Engagement | 3 |

***Scoring Standards:***

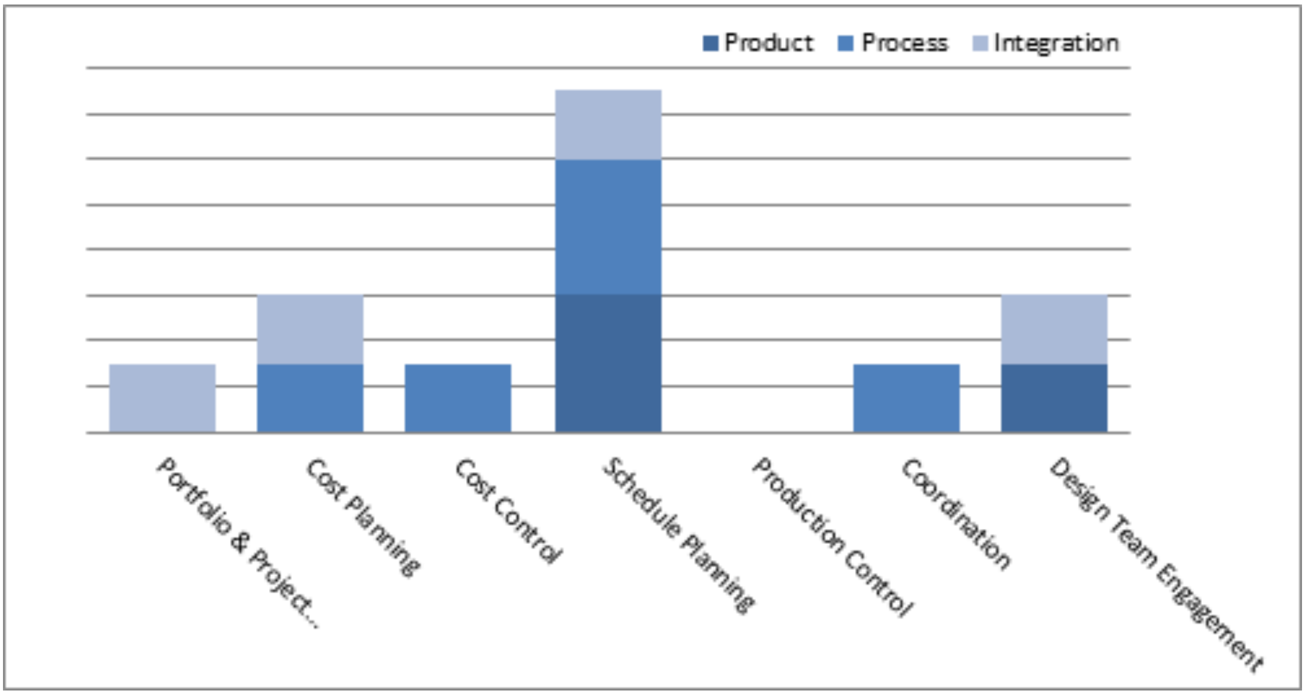
***0/blank = No Priority***
***1 = Low Priority (or consider blank)***
***2 = Medium Priority***
***3 = High Priority***

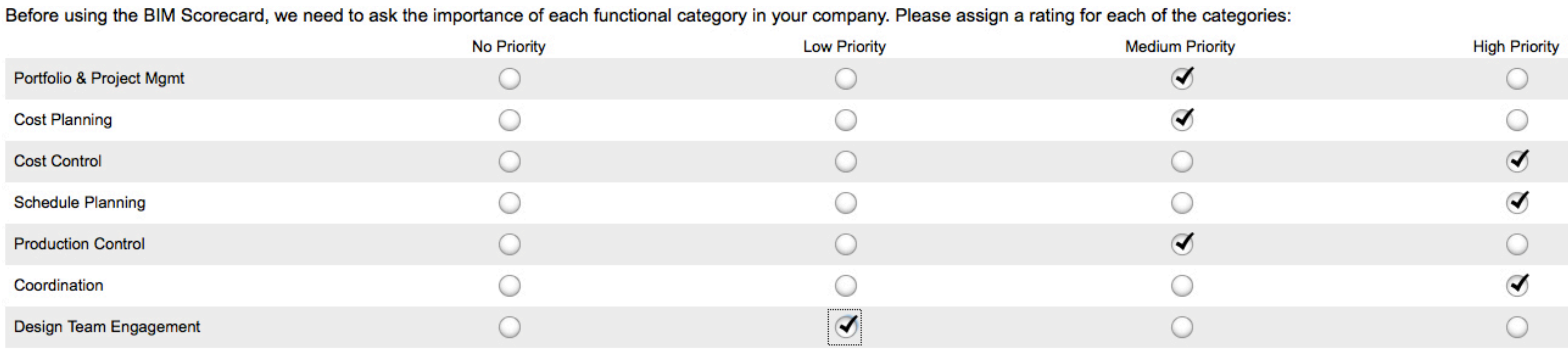


**3** Review areas for improvement

## Improvement Opportunities

| | Product | Process | Integration |
|---|---|---|---|
| **Portfolio & Project Management** | | | *3* |
| **Cost Planning** | | *3* | *3* |
| **Cost Control** | | *3* | |
| **Schedule Planning** | *6* | *6* | *3* |
| **Production Control** | | | |
| **Coordination** | | *3* | |
| **Design Team Engagement** | *3* | | *3* |

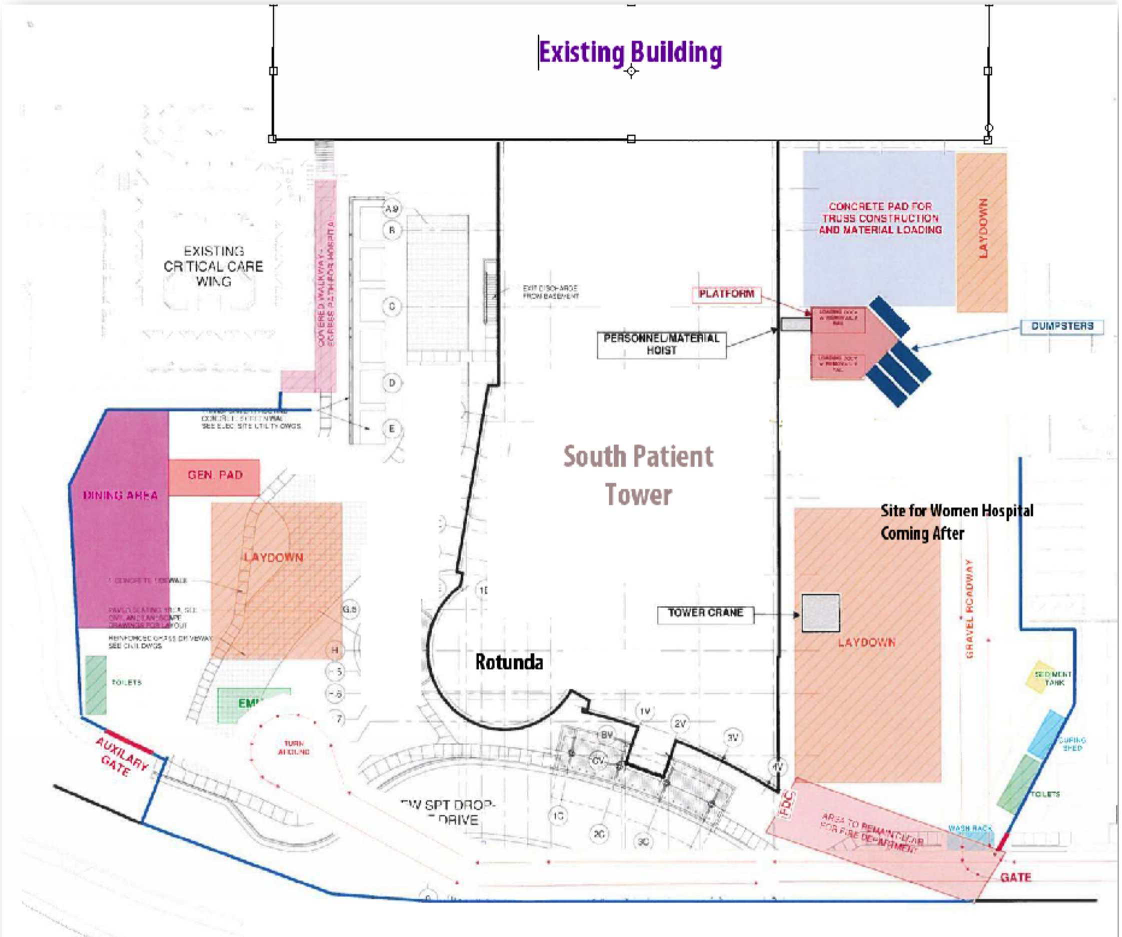




Before using the BIM Scorecard, we need to ask the importance of each functional category in your company. Please assign a rating for each of the categories:

| | No Priority | Low Priority | Medium Priority | High Priority |
|---|---|---|---|---|
| Portfolio & Project Mgmt | ○ | ○ | ☑ | ○ |
| Cost Planning | ○ | ○ | ☑ | ○ |
| Cost Control | ○ | ○ | ○ | ☑ |
| Schedule Planning | ○ | ○ | ○ | ☑ |
| Production Control | ○ | ○ | ☑ | ○ |
| Coordination | ○ | ○ | ○ | ☑ |
| Design Team Engagement | ○ | ☑ | ○ | ○ |

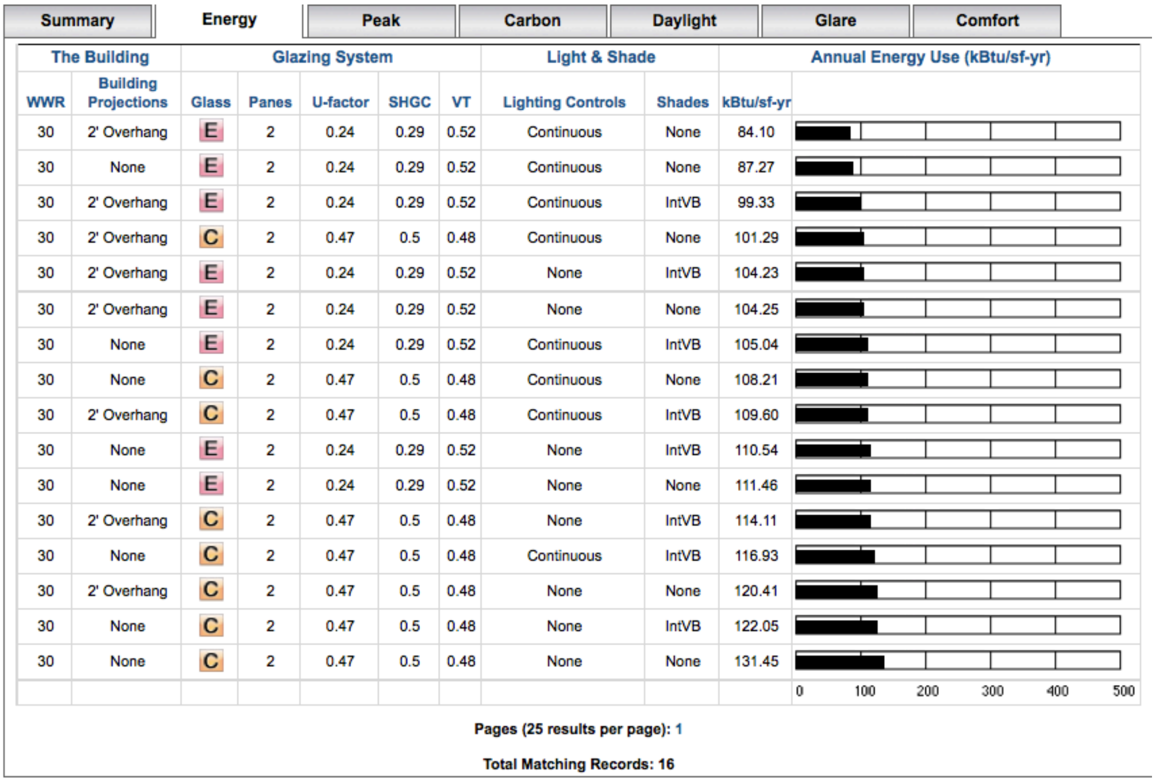
# APPENDIX B SITE PLAN



Inova Fairfax Hospital South Patient Tower Site Layout Plan

# APPENDIX C FACADE DESIGN ENERGY ANALYSIS

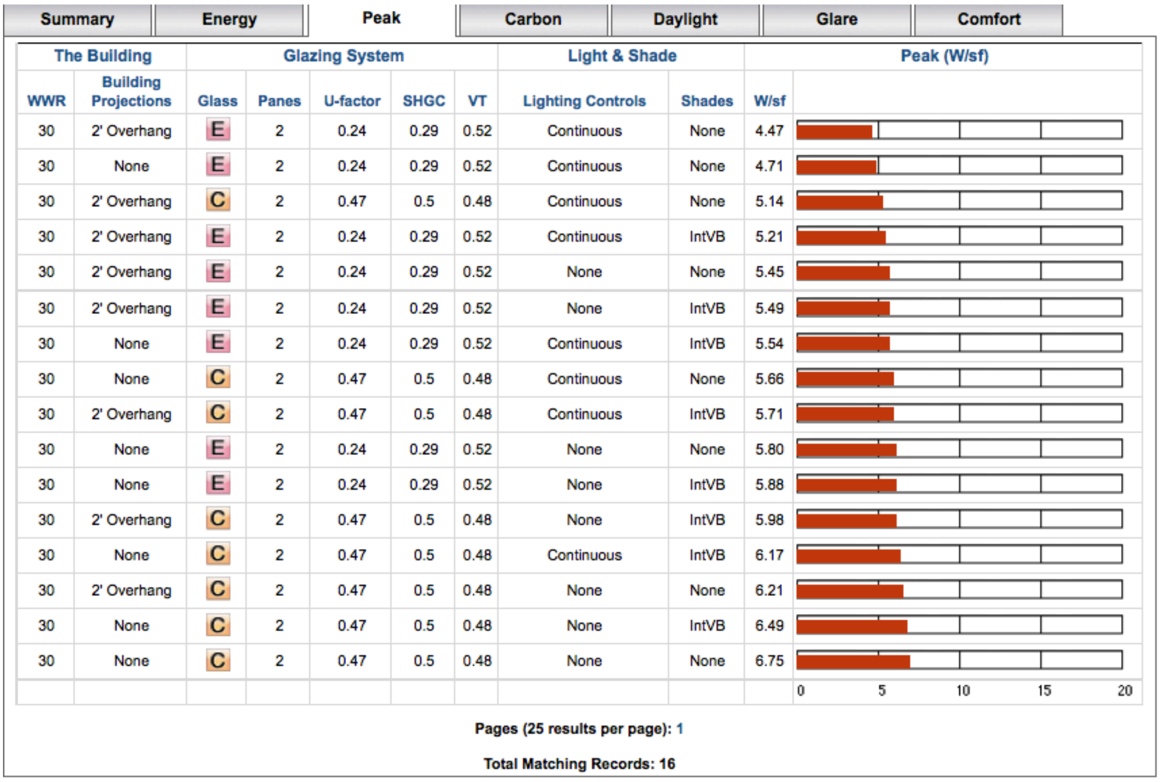
# East Facade



| The Building | | Glazing System | | | | | Light & Shade | | Annual Energy Use (kBtu/sf-yr) |
|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | kBtu/sf-yr |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | None | 84.10 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | None | 87.27 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | IntVB | 99.33 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | None | 101.29 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | IntVB | 104.23 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 104.25 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | IntVB | 105.04 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | None | 108.21 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | IntVB | 109.60 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | IntVB | 110.54 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 111.46 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | IntVB | 114.11 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | IntVB | 116.93 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 120.41 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | IntVB | 122.05 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 131.45 |

Pages (25 results per page): 1

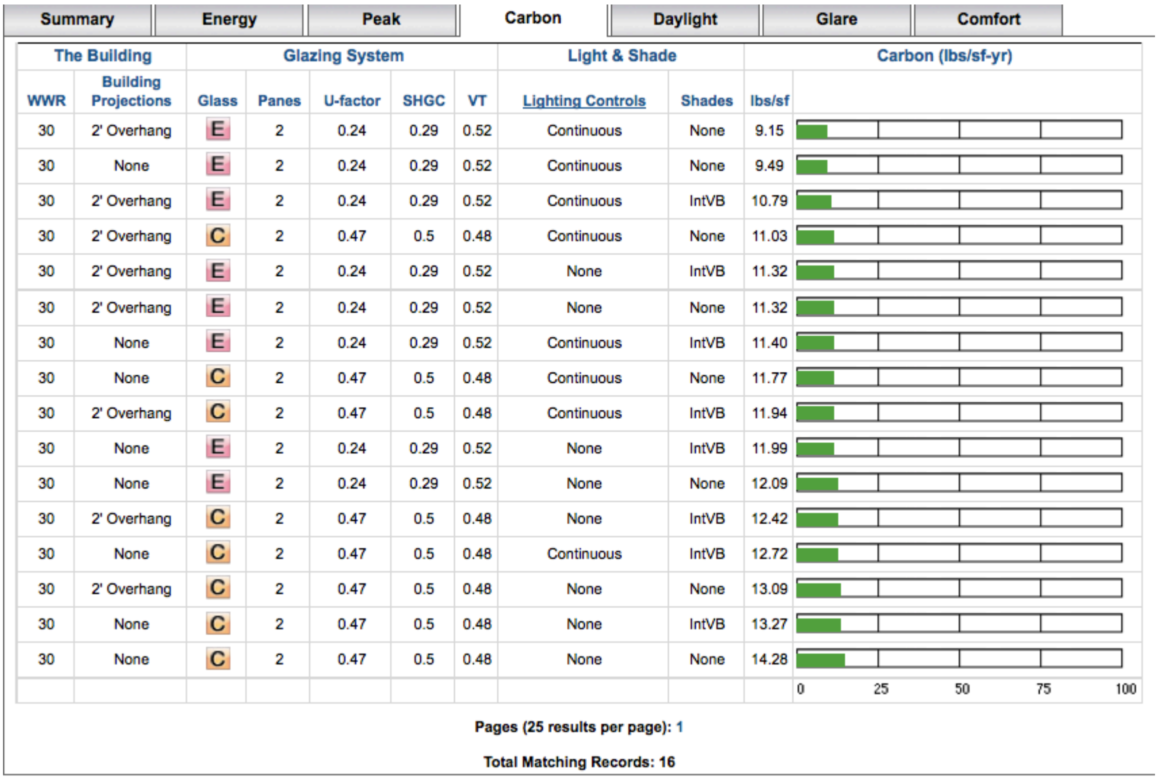
Total Matching Records: 16



| The Building | | Glazing System | | | | | Light & Shade | | Peak (W/sf) |
|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | W/sf |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | None | 4.47 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | None | 4.71 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | None | 5.14 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | IntVB | 5.21 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 5.45 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | IntVB | 5.49 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | IntVB | 5.54 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | None | 5.66 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | IntVB | 5.71 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 5.80 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | IntVB | 5.88 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | IntVB | 5.98 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | IntVB | 6.17 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 6.21 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | IntVB | 6.49 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 6.75 |

Pages (25 results per page): 1

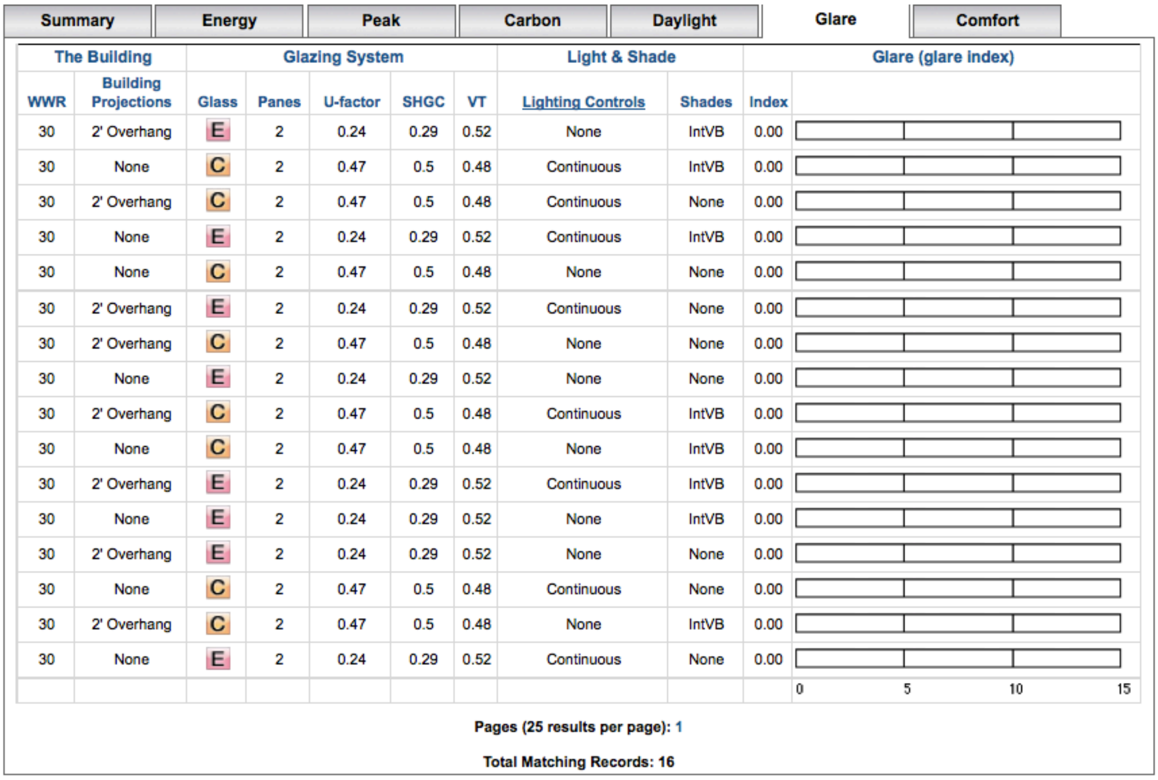
Total Matching Records: 16



| The Building | | Glazing System | | | | | Light & Shade | | Carbon (lbs/sf-yr) |
|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | lbs/sf |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | None | 9.15 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | None | 9.49 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | IntVB | 10.79 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | None | 11.03 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | IntVB | 11.32 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 11.32 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | IntVB | 11.40 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | None | 11.77 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | IntVB | 11.94 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | IntVB | 11.99 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 12.09 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | IntVB | 12.42 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | IntVB | 12.72 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 13.09 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | IntVB | 13.27 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 14.28 |

**Pages (25 results per page): 1**

**Total Matching Records: 16**



| The Building | | Glazing System | | | | | Light & Shade | | Glare (glare index) |
|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | Index |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | IntVB | 0.00 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | IntVB | 0.00 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | None | 0.00 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | IntVB | 0.00 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 0.00 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | None | 0.00 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 0.00 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 0.00 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | IntVB | 0.00 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | IntVB | 0.00 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | IntVB | 0.00 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | IntVB | 0.00 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 0.00 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | None | 0.00 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | IntVB | 0.00 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | None | 0.00 |

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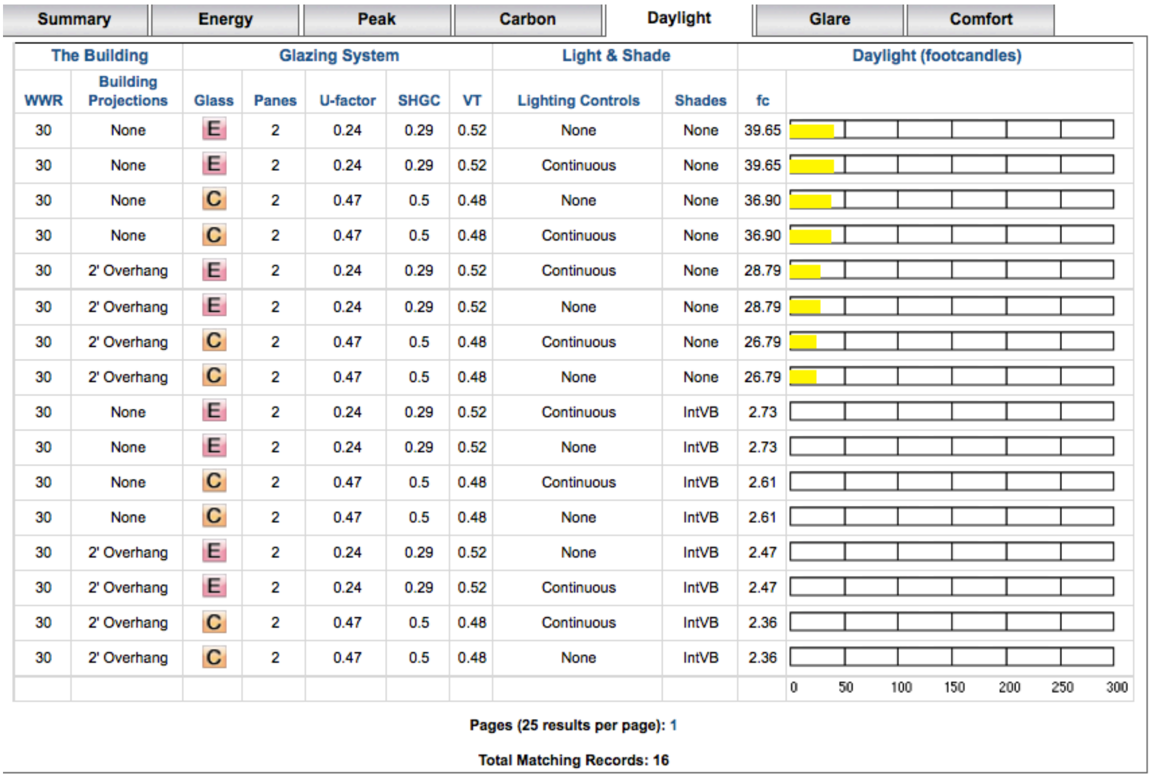
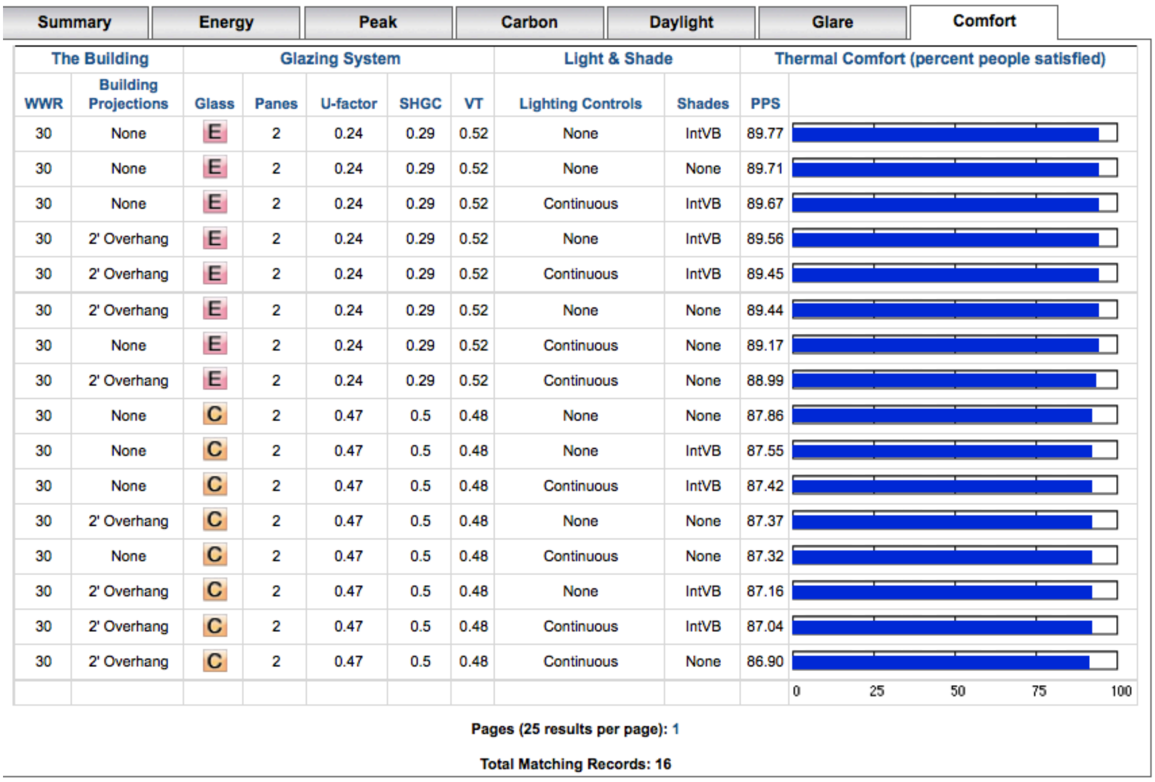
**Total Matching Records: 16**



| The Building | | Glazing System | | | | | Light & Shade | | Daylight (footcandles) |
|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | fc |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 39.65 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | None | 39.65 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 36.90 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | None | 36.90 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | None | 28.79 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 28.79 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | None | 26.79 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 26.79 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | IntVB | 2.73 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | IntVB | 2.73 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | IntVB | 2.61 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | IntVB | 2.61 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | IntVB | 2.47 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | IntVB | 2.47 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | IntVB | 2.36 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | IntVB | 2.36 |

Pages (25 results per page): 1

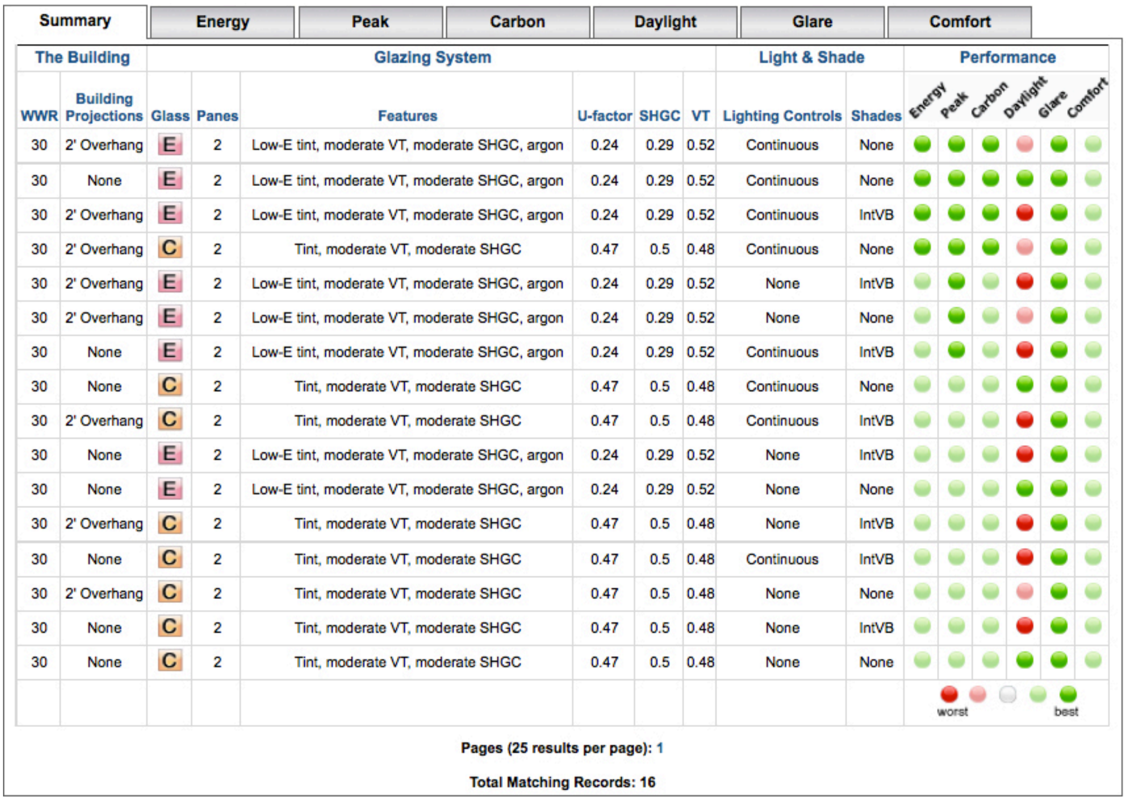
Total Matching Records: 16



| The Building | | Glazing System | | | | | Light & Shade | | Thermal Comfort (percent people satisfied) |
|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | PPS |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | IntVB | 89.77 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 89.71 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | IntVB | 89.67 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | IntVB | 89.56 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | IntVB | 89.45 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 89.44 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | None | 89.17 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | Continuous | None | 88.99 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 87.86 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | IntVB | 87.55 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | IntVB | 87.42 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 87.37 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | None | 87.32 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | IntVB | 87.16 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | IntVB | 87.04 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | Continuous | None | 86.90 |

Pages (25 results per page): 1

Total Matching Records: 16



| The Building | | Glazing System | | | | | | Light & Shade | | Performance | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | Features | U-factor | SHGC | VT | Lighting Controls | Shades | Energy | Peak | Carbon | Daylight | Glare | Comfort |
| 30 | 2' Overhang | E | 2 | Low-E tint, moderate VT, moderate SHGC, argon | 0.24 | 0.29 | 0.52 | Continuous | None | 🟢 | 🟢 | 🟢 | ◉ | 🟢 | ◎ |
| 30 | None | E | 2 | Low-E tint, moderate VT, moderate SHGC, argon | 0.24 | 0.29 | 0.52 | Continuous | None | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | ◎ |
| 30 | 2' Overhang | E | 2 | Low-E tint, moderate VT, moderate SHGC, argon | 0.24 | 0.29 | 0.52 | Continuous | IntVB | 🟢 | 🟢 | 🟢 | 🔴 | 🟢 | ◎ |
| 30 | 2' Overhang | C | 2 | Tint, moderate VT, moderate SHGC | 0.47 | 0.5 | 0.48 | Continuous | None | 🟢 | 🟢 | 🟢 | ◉ | 🟢 | ◎ |
| 30 | 2' Overhang | E | 2 | Low-E tint, moderate VT, moderate SHGC, argon | 0.24 | 0.29 | 0.52 | None | IntVB | ◎ | 🟢 | ◎ | 🔴 | 🟢 | ◎ |
| 30 | 2' Overhang | E | 2 | Low-E tint, moderate VT, moderate SHGC, argon | 0.24 | 0.29 | 0.52 | None | None | ◎ | 🟢 | ◎ | ◉ | 🟢 | ◎ |
| 30 | None | E | 2 | Low-E tint, moderate VT, moderate SHGC, argon | 0.24 | 0.29 | 0.52 | Continuous | IntVB | ◎ | 🟢 | ◎ | 🔴 | 🟢 | ◎ |
| 30 | None | C | 2 | Tint, moderate VT, moderate SHGC | 0.47 | 0.5 | 0.48 | Continuous | None | ◎ | ◎ | ◎ | 🟢 | 🟢 | ◎ |
| 30 | 2' Overhang | C | 2 | Tint, moderate VT, moderate SHGC | 0.47 | 0.5 | 0.48 | Continuous | IntVB | ◎ | ◎ | ◎ | 🔴 | 🟢 | ◎ |
| 30 | None | E | 2 | Low-E tint, moderate VT, moderate SHGC, argon | 0.24 | 0.29 | 0.52 | None | IntVB | ◎ | ◎ | ◎ | 🔴 | 🟢 | ◎ |
| 30 | None | E | 2 | Low-E tint, moderate VT, moderate SHGC, argon | 0.24 | 0.29 | 0.52 | None | None | ◎ | ◎ | ◎ | 🟢 | 🟢 | ◎ |
| 30 | 2' Overhang | C | 2 | Tint, moderate VT, moderate SHGC | 0.47 | 0.5 | 0.48 | None | IntVB | ◎ | ◎ | ◎ | 🔴 | 🟢 | ◎ |
| 30 | None | C | 2 | Tint, moderate VT, moderate SHGC | 0.47 | 0.5 | 0.48 | Continuous | IntVB | ◎ | ◎ | ◎ | 🔴 | 🟢 | ◎ |
| 30 | 2' Overhang | C | 2 | Tint, moderate VT, moderate SHGC | 0.47 | 0.5 | 0.48 | None | None | ◎ | ◎ | ◎ | ◉ | 🟢 | ◎ |
| 30 | None | C | 2 | Tint, moderate VT, moderate SHGC | 0.47 | 0.5 | 0.48 | None | IntVB | ◎ | ◎ | ◎ | 🔴 | 🟢 | ◎ |
| 30 | None | C | 2 | Tint, moderate VT, moderate SHGC | 0.47 | 0.5 | 0.48 | None | None | ◎ | ◎ | ◎ | 🟢 | 🟢 | ◎ |

🔴 worst ◉ ○ ◎ 🟢 best

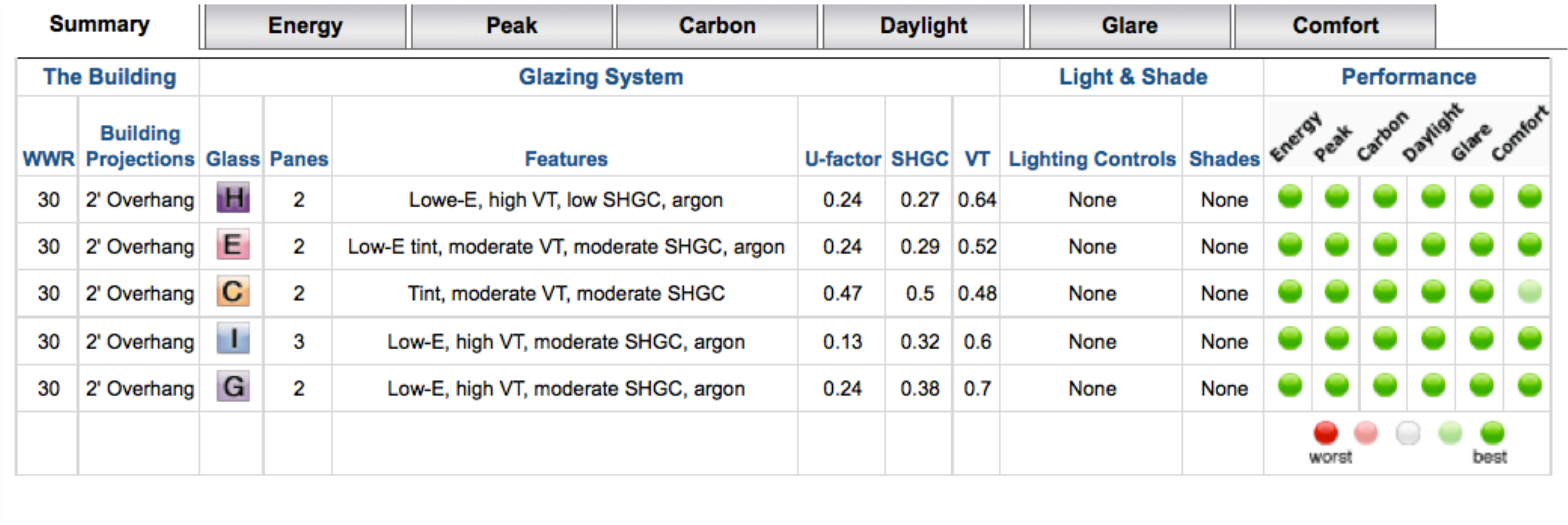
Pages (25 results per page): 1

Total Matching Records: 16

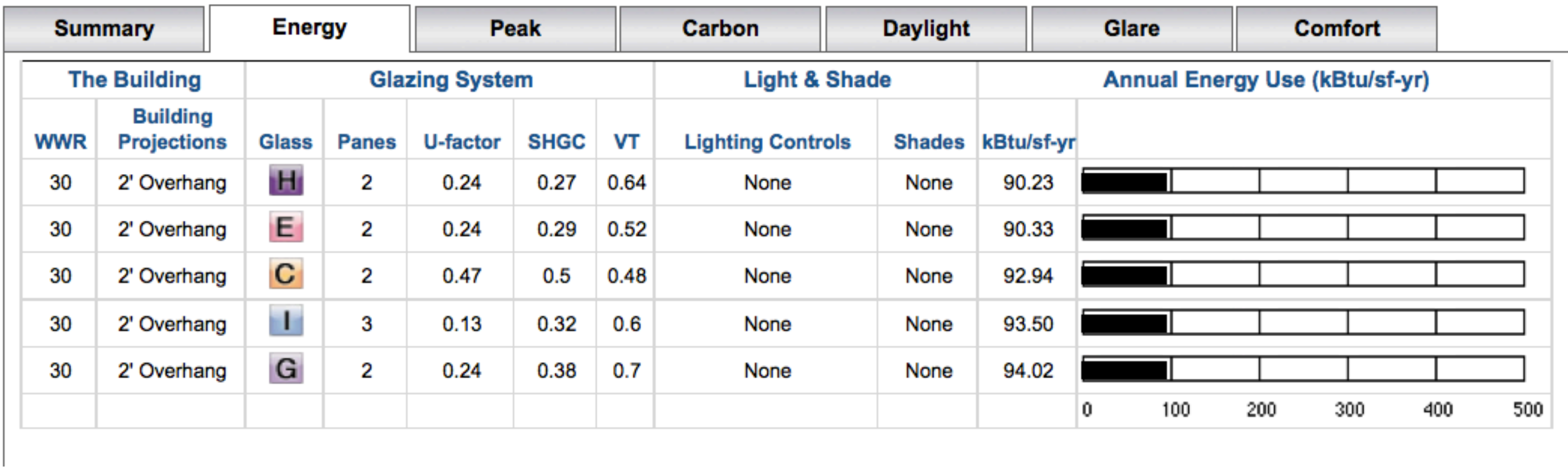
| Scenario | Zone Orientation | WWR | Building Projections | Glass | Lighting Controls | Shades |
|---|---|---|---|---|---|---|
| 1 | South | 30% | None | E: Double tint low-E, mod VT, mod SHGC | No Controls | No Shades |
| 2 | West | 30% | None | E: Double tint low-E, mod VT, mod SHGC | No Controls | No Shades |
| 3 | East | 30% | None | E: Double tint low-E, mod VT, mod SHGC | No Controls | No Shades |
| 4 | North | - | - | - | - | - |
| 5 | North | - | - | - | - | - |

| Scenario | Annual Energy (lower is better) kBty/sf-yr | Peak Demand (lower is better) W/sf | Carbon (lower is better) lbs/sf-yr | Daylight Illuminance (higher is better) FC | Thermal Comfort (higher is better) PPS | Glare Index (lower index is better) Index |
|---|---|---|---|---|---|---|
| 1 | 97.40 | 5.27 | 10.55 | 48.18 | 90.97 | 0.00 |
| 2 | 111.46 | 5.80 | 12.09 | 39.65 | 89.71 | 0.00 |
| 3 | 113.23 | 5.85 | 12.28 | 42.05 | 89.72 | 0.00 |
| 4 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| 5 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

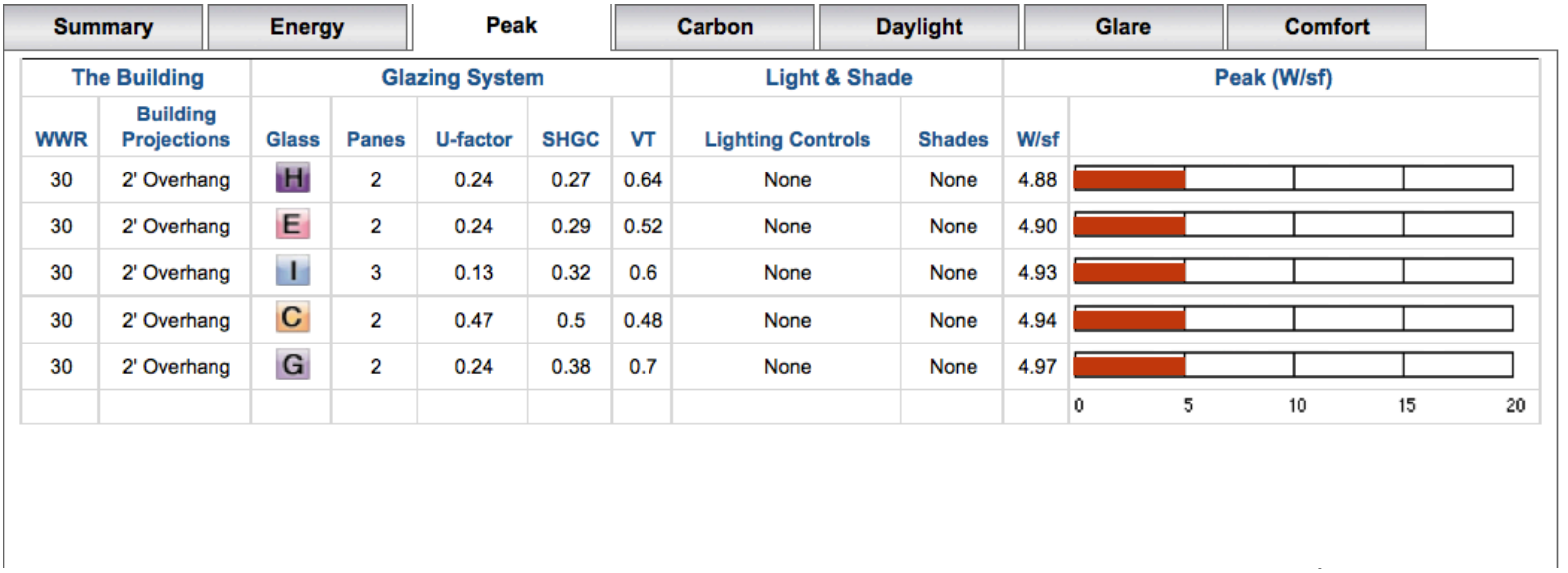
## South Facade



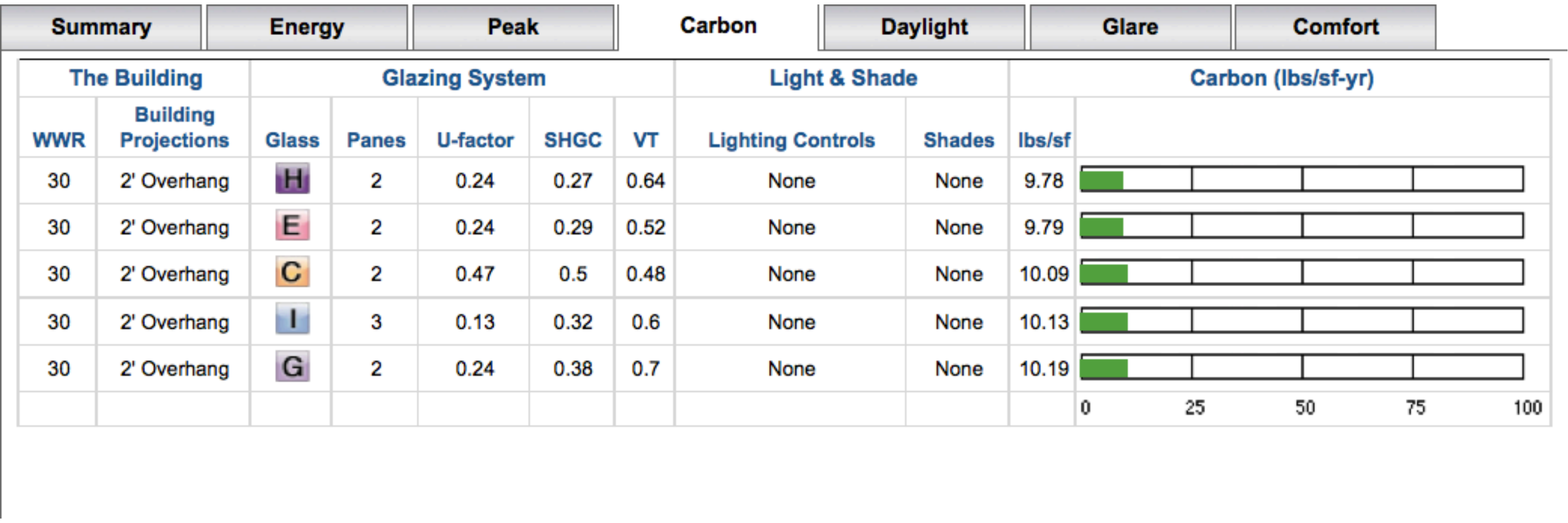
| The Building | | Glazing System | | | | | | Light & Shade | | Performance | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | Features | U-factor | SHGC | VT | Lighting Controls | Shades | Energy | Peak | Carbon | Daylight | Glare | Comfort |
| 30 | 2' Overhang | H | 2 | Lowe-E, high VT, low SHGC, argon | 0.24 | 0.27 | 0.64 | None | None | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 |
| 30 | 2' Overhang | E | 2 | Low-E tint, moderate VT, moderate SHGC, argon | 0.24 | 0.29 | 0.52 | None | None | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 |
| 30 | 2' Overhang | C | 2 | Tint, moderate VT, moderate SHGC | 0.47 | 0.5 | 0.48 | None | None | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | ◯ |
| 30 | 2' Overhang | I | 3 | Low-E, high VT, moderate SHGC, argon | 0.13 | 0.32 | 0.6 | None | None | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 |
| 30 | 2' Overhang | G | 2 | Low-E, high VT, moderate SHGC, argon | 0.24 | 0.38 | 0.7 | None | None | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 | 🟢 |
| | | | | | | | | | | 🔴 worst | ⭕ | ⚪ | ◯ | 🟢 best | |



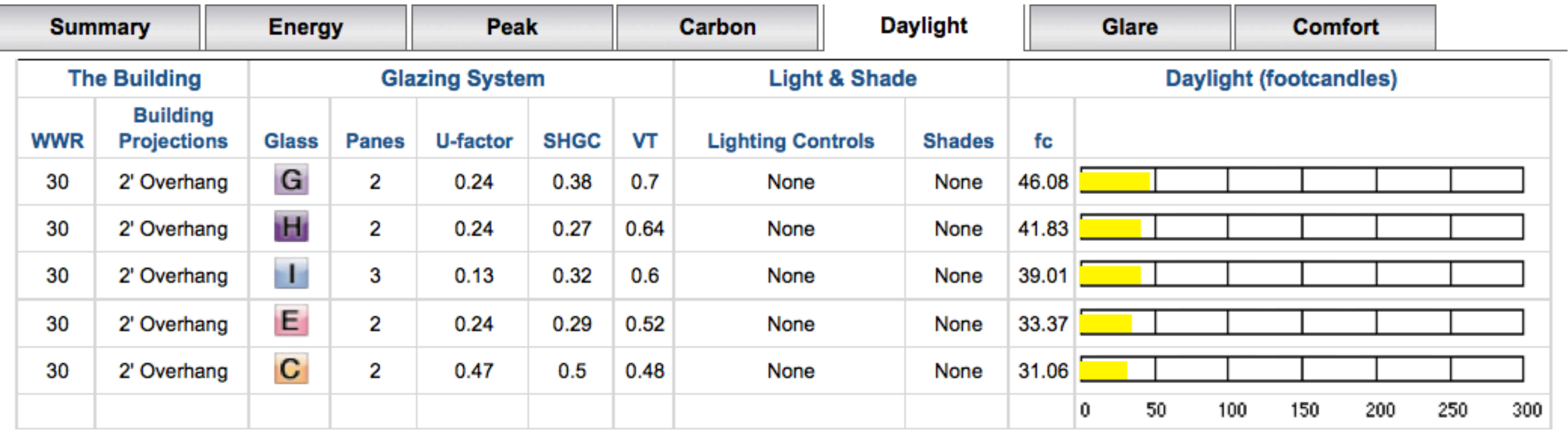
| The Building | | Glazing System | | | | | Light & Shade | | Annual Energy Use (kBtu/sf-yr) | |
|---|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | kBtu/sf-yr | |
| 30 | 2' Overhang | H | 2 | 0.24 | 0.27 | 0.64 | None | None | 90.23 | |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 90.33 | |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 92.94 | |
| 30 | 2' Overhang | I | 3 | 0.13 | 0.32 | 0.6 | None | None | 93.50 | |
| 30 | 2' Overhang | G | 2 | 0.24 | 0.38 | 0.7 | None | None | 94.02 | |
| | | | | | | | | | | 0 100 200 300 400 500 |



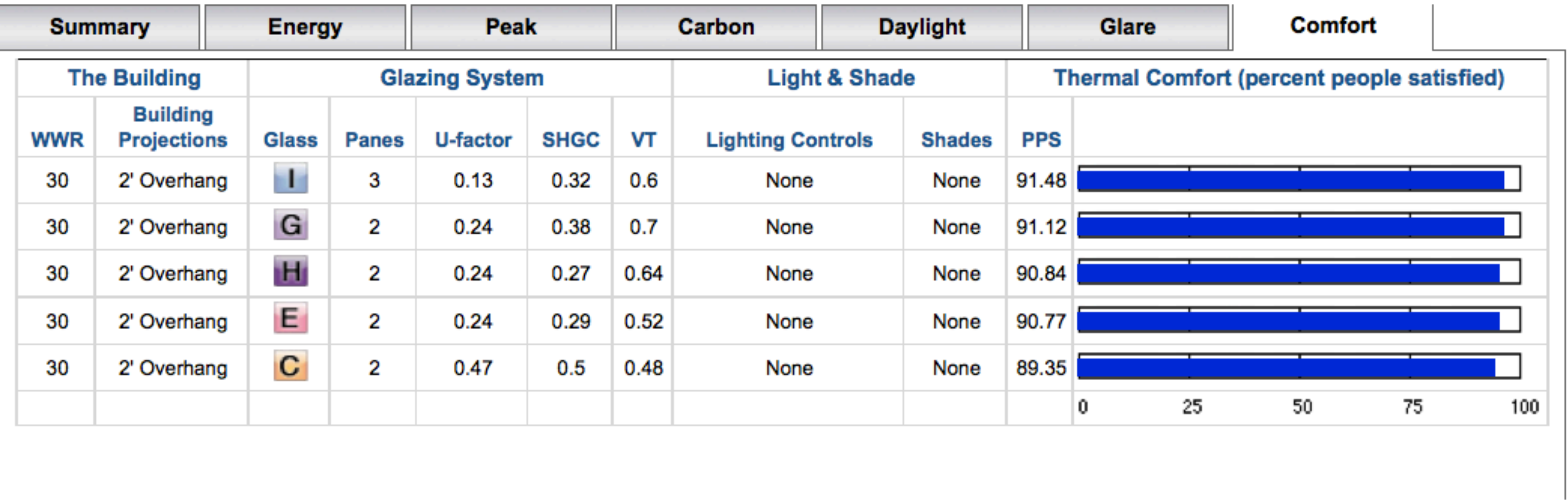
| The Building | | Glazing System | | | | | Light & Shade | | Peak (W/sf) | |
|---|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | W/sf | |
| 30 | 2' Overhang | H | 2 | 0.24 | 0.27 | 0.64 | None | None | 4.88 | |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 4.90 | |
| 30 | 2' Overhang | I | 3 | 0.13 | 0.32 | 0.6 | None | None | 4.93 | |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 4.94 | |
| 30 | 2' Overhang | G | 2 | 0.24 | 0.38 | 0.7 | None | None | 4.97 | |
| | | | | | | | | | | 0 5 10 15 20 |



| The Building | | Glazing System | | | | | Light & Shade | | Carbon (lbs/sf-yr) |
|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | lbs/sf |
| 30 | 2' Overhang | H | 2 | 0.24 | 0.27 | 0.64 | None | None | 9.78 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 9.79 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 10.09 |
| 30 | 2' Overhang | I | 3 | 0.13 | 0.32 | 0.6 | None | None | 10.13 |
| 30 | 2' Overhang | G | 2 | 0.24 | 0.38 | 0.7 | None | None | 10.19 |

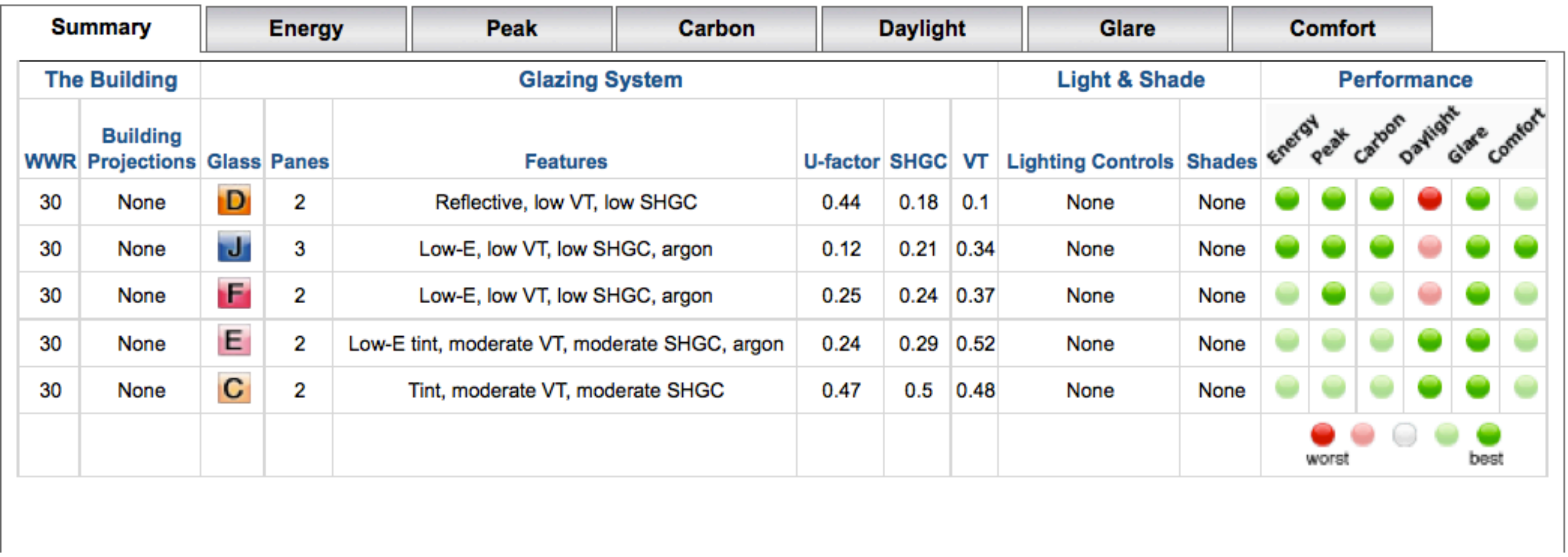


| The Building | | Glazing System | | | | | Light & Shade | | Daylight (footcandles) |
|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | fc |
| 30 | 2' Overhang | G | 2 | 0.24 | 0.38 | 0.7 | None | None | 46.08 |
| 30 | 2' Overhang | H | 2 | 0.24 | 0.27 | 0.64 | None | None | 41.83 |
| 30 | 2' Overhang | I | 3 | 0.13 | 0.32 | 0.6 | None | None | 39.01 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 33.37 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 31.06 |



| The Building | | Glazing System | | | | | Light & Shade | | Thermal Comfort (percent people satisfied) |
|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | PPS |
| 30 | 2' Overhang | I | 3 | 0.13 | 0.32 | 0.6 | None | None | 91.48 |
| 30 | 2' Overhang | G | 2 | 0.24 | 0.38 | 0.7 | None | None | 91.12 |
| 30 | 2' Overhang | H | 2 | 0.24 | 0.27 | 0.64 | None | None | 90.84 |
| 30 | 2' Overhang | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 90.77 |
| 30 | 2' Overhang | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 89.35 |

## West Facade



| The Building | | Glazing System | | | | | | Light & Shade | | Performance | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | Features | U-factor | SHGC | VT | Lighting Controls | Shades | Energy | Peak | Carbon | Daylight | Glare | Comfort |
| 30 | None | D | 2 | Reflective, low VT, low SHGC | 0.44 | 0.18 | 0.1 | None | None | 🟢 | 🟢 | 🟢 | 🔴 | 🟢 | 🟩 |
| 30 | None | J | 3 | Low-E, low VT, low SHGC, argon | 0.12 | 0.21 | 0.34 | None | None | 🟢 | 🟢 | 🟢 | 🩷 | 🟢 | 🟢 |
| 30 | None | F | 2 | Low-E, low VT, low SHGC, argon | 0.25 | 0.24 | 0.37 | None | None | 🟩 | 🟢 | 🟩 | 🩷 | 🟢 | 🟩 |
| 30 | None | E | 2 | Low-E tint, moderate VT, moderate SHGC, argon | 0.24 | 0.29 | 0.52 | None | None | 🟩 | 🟩 | 🟩 | 🟢 | 🟢 | 🟩 |
| 30 | None | C | 2 | Tint, moderate VT, moderate SHGC | 0.47 | 0.5 | 0.48 | None | None | 🟩 | 🟩 | 🟩 | 🟢 | 🟢 | 🟩 |

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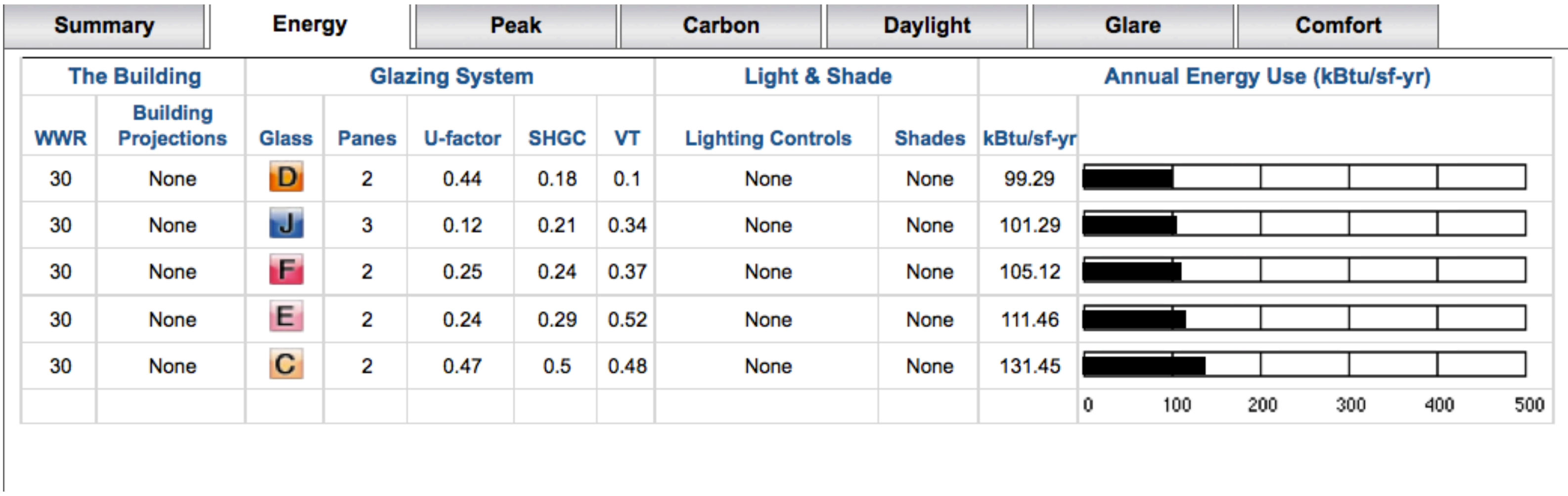
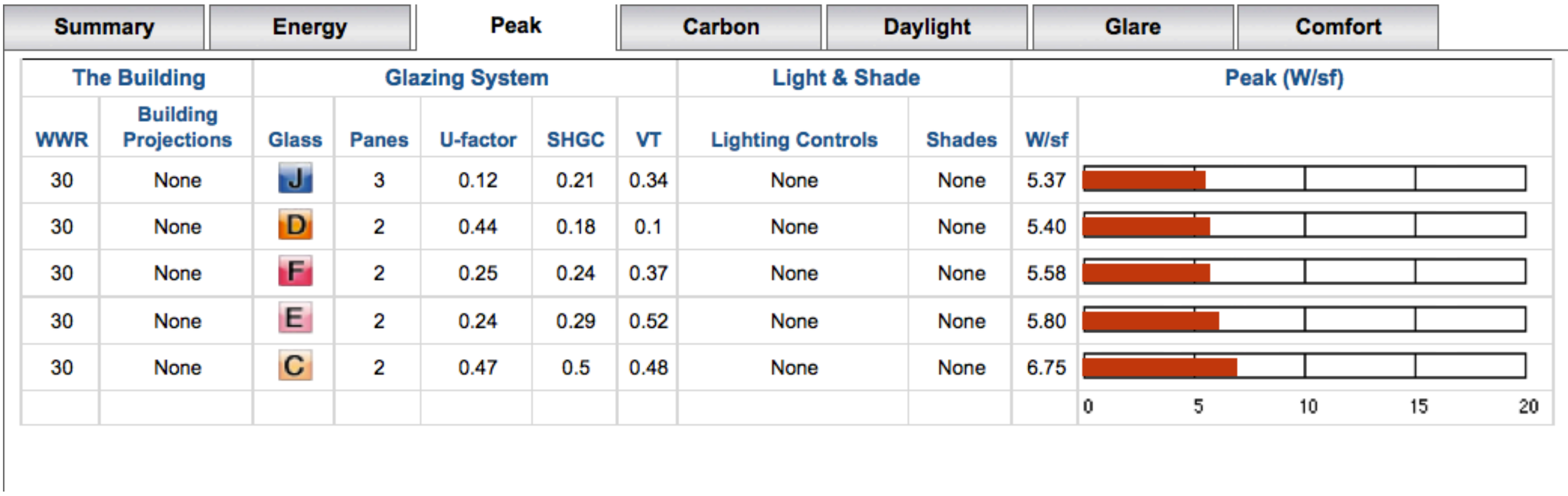
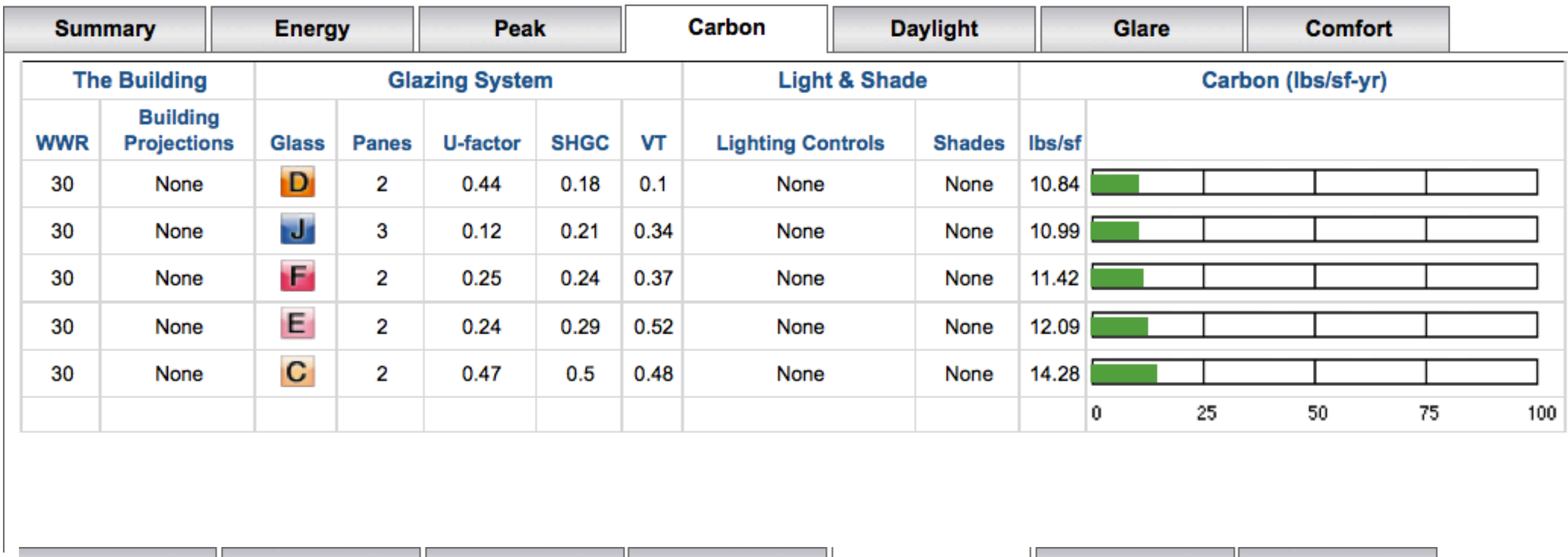
worst best



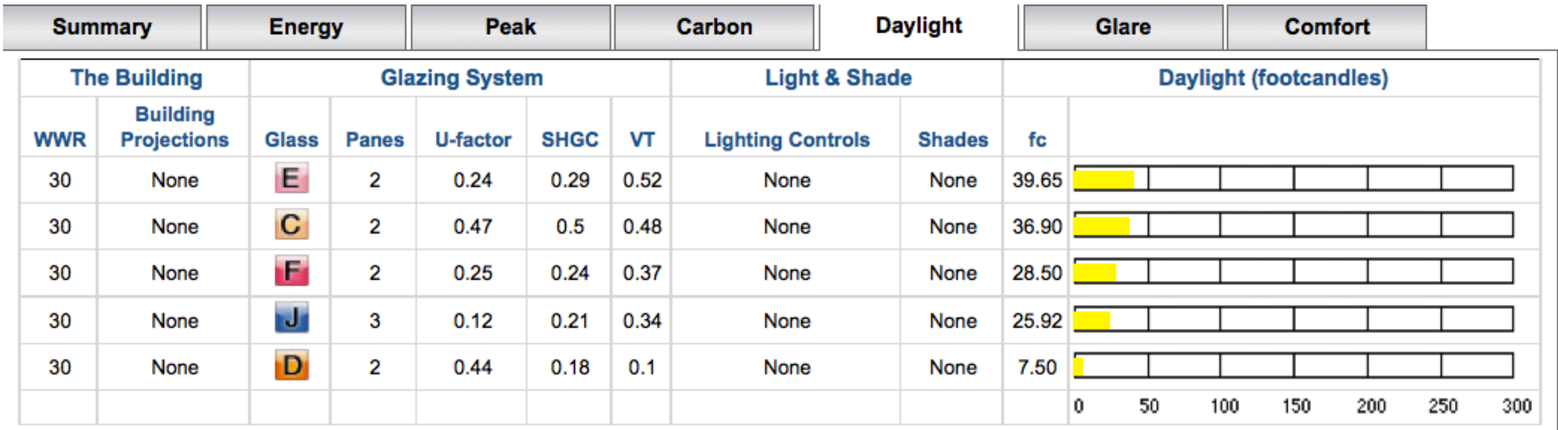
| The Building | | Glazing System | | | | | Light & Shade | | Annual Energy Use (kBtu/sf-yr) | |
|---|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | kBtu/sf-yr | |
| 30 | None | D | 2 | 0.44 | 0.18 | 0.1 | None | None | 99.29 | |
| 30 | None | J | 3 | 0.12 | 0.21 | 0.34 | None | None | 101.29 | |
| 30 | None | F | 2 | 0.25 | 0.24 | 0.37 | None | None | 105.12 | |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 111.46 | |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 131.45 | |
| | | | | | | | | | | 0 100 200 300 400 500 |



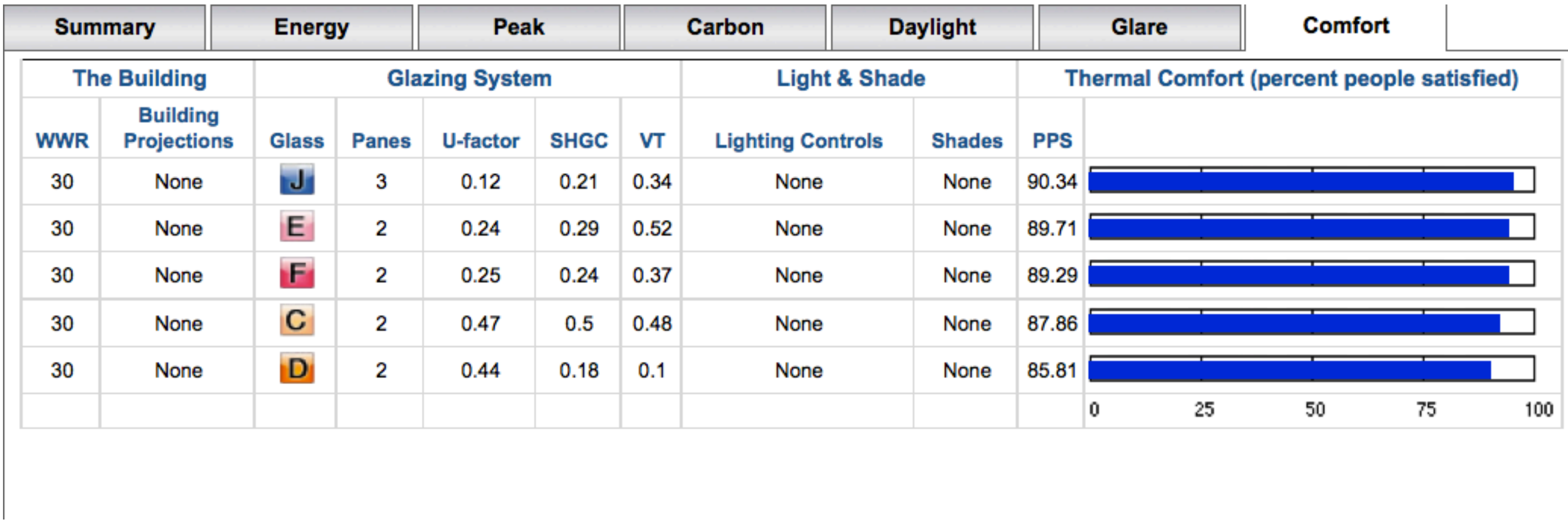
| The Building | | Glazing System | | | | | Light & Shade | | Peak (W/sf) | |
|---|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | W/sf | |
| 30 | None | J | 3 | 0.12 | 0.21 | 0.34 | None | None | 5.37 | |
| 30 | None | D | 2 | 0.44 | 0.18 | 0.1 | None | None | 5.40 | |
| 30 | None | F | 2 | 0.25 | 0.24 | 0.37 | None | None | 5.58 | |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 5.80 | |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 6.75 | |
| | | | | | | | | | | 0 5 10 15 20 |



| The Building | | Glazing System | | | | | Light & Shade | | Carbon (lbs/sf-yr) |
|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | lbs/sf |
| 30 | None | D | 2 | 0.44 | 0.18 | 0.1 | None | None | 10.84 |
| 30 | None | J | 3 | 0.12 | 0.21 | 0.34 | None | None | 10.99 |
| 30 | None | F | 2 | 0.25 | 0.24 | 0.37 | None | None | 11.42 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 12.09 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 14.28 |



| The Building | | Glazing System | | | | | Light & Shade | | Daylight (footcandles) |
|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | fc |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 39.65 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 36.90 |
| 30 | None | F | 2 | 0.25 | 0.24 | 0.37 | None | None | 28.50 |
| 30 | None | J | 3 | 0.12 | 0.21 | 0.34 | None | None | 25.92 |
| 30 | None | D | 2 | 0.44 | 0.18 | 0.1 | None | None | 7.50 |



| The Building | | Glazing System | | | | | Light & Shade | | Thermal Comfort (percent people satisfied) |
|---|---|---|---|---|---|---|---|---|---|
| WWR | Building Projections | Glass | Panes | U-factor | SHGC | VT | Lighting Controls | Shades | PPS |
| 30 | None | J | 3 | 0.12 | 0.21 | 0.34 | None | None | 90.34 |
| 30 | None | E | 2 | 0.24 | 0.29 | 0.52 | None | None | 89.71 |
| 30 | None | F | 2 | 0.25 | 0.24 | 0.37 | None | None | 89.29 |
| 30 | None | C | 2 | 0.47 | 0.5 | 0.48 | None | None | 87.86 |
| 30 | None | D | 2 | 0.44 | 0.18 | 0.1 | None | None | 85.81 |

# APPENDIX D LEED SCORE CARD

# LEED-NC Version 2009 PROJECT CHECKLIST

INOVA FAIRFAX HOSPITAL SOUTH PATIENT TOWER
FALLS CHURCH VIRGINIA

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 0 | 13 | 0 | | **Sustainable Sites** | **26** Points |
| Y | | | Prereq 1 | **Construction Activity Pollution Prevention** | Required |
| x | 1 | | Credit 1 | **Site Selection** | 1 |
| x | 3 | | Credit 2 | **Development Density & Community Connectivity** | 5 |
| | | X | Credit 3 | **Brownfield Redevelopment** | 1 |
| x | | | Credit 4.1 | **Alternative Transportation**, Public Transportation Acces | 6 |
| | | X | Credit 4.2 | **Alternative Transportation**, Bicycle Storage & Changin | 1 |
| x | 3 | | Credit 4.3 | **Alternative Transportation**, Low-Emitting and Fuel-Effic | 3 |
| x | 2 | | Credit 4.4 | **Alternative Transportation**, Parking Capacity | 2 |
| | | X | Credit 5.1 | **Site Development,** Protect of Restore Habitat | 1 |
| | | X | Credit 5.2 | **Site Development,** Maximize Open Space | 1 |
| x | 1 | | Credit 6.1 | **Stormwater Design,** Quantity Control | 1 |
| x | 1 | | Credit 6.2 | **Stormwater Design,** Quality Control | 1 |
| | | X | Credit 7.1 | **Heat Island Effect,** Non-Roof | 1 |
| x | 1 | | Credit 7.2 | **Heat Island Effect,** Roof | 1 |
| x | 1 | | Credit 8 | **Light Pollution Reduction** | 1 |

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 0 | 6 | 0 | | **Water Efficiency** | **10** Points |
| x | | | Prereq 1 | **Water Use Reduction** | required |
| | | | Credit 1 | **Water Efficient Landscaping** | 2-4 |
| x | 2 | | Credit 2 | **Innovative Wastewater Technologies** | 2 |
| x | 4 | | Credit 3 | **Water Use Reduction** | 2-4 |
| | | | | | |

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 0 | 18 | 0 | | **Energy & Atmosphere** | **35** Points |
| Y | | | Prereq 1 | **Fundamental Commissioning of the Building Energy** | Required |
| Y | | | Prereq 2 | **Minimum Energy Performance** | Required |
| Y | | | Prereq 3 | **Fundamental Refrigerant Management** | Required |
| x | 15 | | Credit 1 | **Optimize Energy Performance** | 1 to 19 |
| x | 3 | | Credit 2 | **On-Site Renewable Energy** | 1 to 7 |
| | | | Credit 3 | **Enhanced Commissioning** | 2 |
| | | | Credit 4 | **Enhanced Refrigerant Management** | 2 |
| | | | Credit 5 | **Measurement & Verification** | 3 |
| | | | Credit 6 | **Green Power** | 2 |

continued…

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 0 | 6 | 0 | | **Materials & Resources** | **13** Points |
| Y | | | Prereq 1 | **Storage & Collection of Recyclables** | Required |
| | | | Credit 1.1 | **Building Reuse**, Maintain Existing Walls, Floors & Roof | 1-3 |
| | | | Credit 1.2 | **Building Reuse**, Maintain Existing Interior Non-Structura | 1 |
| x | 1 | | Credit 2 | **Construction Waste Management** | 1-2 |
| x | 2 | | Credit 3 | **Materials Reuse** | 1-2 |
| x | 1 | | Credit 4 | **Recycled Content** | 1-2 |
| x | 2 | | Credit 5 | **Regional Materials** | 1-2 |
| | | | Credit 6 | **Rapidly Renewable Materials** | 1 |
| | | | Credit 7 | **Certified Wood** | 1 |

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 0 | 14 | 0 | | **Indoor Environmental Quality** | **15** Points |
| Y | | | Prereq 1 | **Minimum IAQ Performance** | Required |
| Y | | | Prereq 2 | **Environmental Tobacco Smoke** (ETS) **Control** | Required |
| x | 1 | | Credit 1 | **Outdoor Air Delivery Monitoring** | 1 |
| x | 1 | | Credit 2 | **Increased Ventilation** | 1 |
| x | 1 | | Credit 3.1 | **Construction IAQ Management Plan**, During Construct | 1 |
| x | 1 | | Credit 3.2 | **Construction IAQ Management Plan**, Before Occupanc | 1 |
| x | 1 | | Credit 4.1 | **Low-Emitting Materials**, Adhesives & Sealants | 1 |
| x | 1 | | Credit 4.2 | **Low-Emitting Materials**, Paints & Coatings | 1 |
| x | 1 | | Credit 4.3 | **Low-Emitting Materials**, Carpet Systems | 1 |
| x | 1 | | Credit 4.4 | **Low-Emitting Materials**, Composite Wood & Agrifiber P | 1 |
| x | 1 | | Credit 5 | **Indoor Chemical & Pollutant Source Control** | 1 |
| x | 1 | | Credit 6.1 | **Controllability of Systems**, Lighting | 1 |
| x | 1 | | Credit 6.2 | **Controllability of Systems**, Thermal Comfort | 1 |
| x | 1 | | Credit 7.1 | **Thermal Comfort**, Design | 1 |
| x | 1 | | Credit 7.2 | **Thermal Comfort**, Verification | 1 |
| x | 1 | | Credit 8.1 | **Daylight & Views**, Daylight 75% of Spaces | 1 |
| | | | Credit 8.2 | **Daylight & Views**, Views for 90% of Spaces | 1 |

| Yes | ? | No | | | |
|---|---|---|---|---|---|
| 0 | 0 | 0 | | **Innovatio** in Design and Regional Priority | **10**Points |
| | 0 | x | Credit 1 | **Innovation in Design** | 1-5 |
| | 0 | x | Credit 1.2 | **LEED Accredited Professional** | 1 |
| | 0 | x | Credit 2 | **Regional Priority** | 1-4 |

| Yes | ? | No | | |
|---|---|---|---|---|
| 0 | 57 | | **Project Totals** (pre-certification estimates) | **00** Points |

**Certified** 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

# APPENDIX E COST ESTIMATE

| | |
|---|---|
| Estimate Name: | **inova** |
| Building Type: | **Hospital, 4-8 Story with Precast Concrete Panels With Exposed Aggregate / R/Conc. Frame** |
| Location: | **FAIRFAX, VA** |
| Story Count: | **12** |
| Story Height (L.F.): | **12** |
| Floor Area (S.F.): | **234000** |
| Labor Type: | **Union** |
| Basement Included: | **Yes** |
| Data Release: | **Year 2010 Quarter 3** |
| Cost Per Square Foot: | **$324.96** |
| Building Cost: | **$76,040,000** |

Costs are derived from a building model with basic components.

Scope differences and market conditions can cause costs to vary significantly.

**Parameters are not within the ranges recommended by RSMeans.**

| | | % of Total | Cost Per S.F. | Cost |
|---|---|---|---|---|
| **A Substructure** | | **4.50%** | **$10.75** | **$2,516,500** |
| **A1010** | **Standard Foundations**<br>Strip footing, concrete, reinforced, load 14.8 KLF, soil bearing capacity 6 KSF, 12" deep x 32" wide<br>Spread footings, 3000 PSI concrete, load 400K, soil bearing capacity 6 KSF, 8' - 6" square x 27" deep | | **$8.25** | **$1,929,500** |
| **A1030** | **Slab on Grade**<br>Slab on grade, 4" thick, non industrial, reinforced | | **$0.37** | **$86,000** |
| **A2010** | **Basement Excavation**<br>Excavate and fill, 10,000 SF, 8' deep, sand, gravel, or common earth, on site storage | | **$0.24** | **$56,000** |
| **A2020** | **Basement Walls**<br>Foundation wall, CIP, 12' wall height, pumped, .52 CY/LF, 24.29 PLF, 14" thick | | **$1.90** | **$445,000** |
| **B Shell** | | **31.90%** | **$76.04** | **$17,793,500** |
| **B1010** | **Floor Construction**<br>Cast-in-place concrete column, 16" square, tied, 400K load, 12' story height, 251 lbs/LF, 4000PSI<br>Cast-in-place concrete column, 20" square, tied, 600K load, 12' story height, 394 lbs/LF, 4000PSI<br>Flat slab, concrete, with drop panels, 6" slab/2.5" panel, 12" column, 15'x15' bay, 75 PSF superimposed load, 153 PSF total load<br>Waffle slab, cast-in-place concrete, 12" deep rib, 18" column, 30'x30' bay, 75 PSF superimposed load, 204 PSF total load | | **$24.23** | **$5,670,000** |
| **B1020** | **Roof Construction** | | **$1.53** | **$358,000** |

| | | | | |
|---|---|---|---|---|
| | Floor, concrete, beam and slab, 35'x35' bay, 40 PSF superimposed load, 16" deep beam, 14" slab, 174 PSF total load | | | |
| **B2010** | **Exterior Walls** | | **$35.12** | **$8,219,000** |
| | Exterior wall, precast concrete, flat, 8" thick, 10' x 10', white face, 2" rigid insulation, low rise | | | |
| **B2020** | **Exterior Windows** | | **$13.72** | **$3,210,000** |
| | Windows, aluminum, sliding, insulated glass, 5' x 3' | | | |
| **B2030** | **Exterior Doors** | | **$0.72** | **$169,500** |
| | Door, aluminum & glass, with transom, full vision, double door, hardware, 6'-0" x 10'-0" opening | | | |
| | Door, aluminum & glass, with transom, non-standard, double door, hardware, 6'-0" x 10'-0" opening | | | |
| | Door, steel 18 gauge, hollow metal, 1 door with frame, no label, 3'-0" x 7'-0" opening | | | |
| **B3010** | **Roof Coverings** | | **$0.69** | **$161,500** |
| | Roofing, single ply membrane, reinforced, PVC, 48 mils, fully adhered, adhesive | | | |
| | Insulation, rigid, roof deck, composite with 2" EPS, 1" perlite | | | |
| | Roof edges, aluminum, duranodic, .050" thick, 6" face | | | |
| | Flashing, copper, no backing, 16 oz, < 500 lbs | | | |
| **B3020** | **Roof Openings** | | **$0.02** | **$5,500** |
| | Roof hatch, with curb, 1" fiberglass insulation, 2'-6" x 3'-0", galvanized steel, 165 lbs | | | |
| C Interiors | | 17.20% | $40.93 | $9,578,500 |
| **C1010** | **Partitions** | | **$6.42** | **$1,503,000** |
| | Metal partition, 5/8" vinyl faced gypsum board face, 5/8"fire rated gypsum board base, 3-5/8" @ 24",s ame opposite face, no insulation | | | |
| | Gypsum board, 1 face only, 5/8" with 1/16" lead | | | |
| **C1020** | **Interior Doors** | | **$10.63** | **$2,487,500** |
| | Door, single leaf, kd steel frame, hollow metal, commercial quality, flush, 3'-0" x 7'-0" x 1-3/8" | | | |
| | Door, single leaf, kd steel frame, metal fire, commercial quality, 3'-0" x 7'-0" x 1-3/8" | | | |
| **C1030** | **Fittings** | | **$0.93** | **$217,000** |
| | Partitions, hospital curtain, ceiling hung, poly oxford cloth | | | |
| **C2010** | **Stair Construction** | | **$1.22** | **$284,500** |
| | Stairs, steel, cement filled metal pan & picket rail, 12 risers, with landing | | | |
| **C3010** | **Wall Finishes** | | **$6.68** | **$1,562,000** |
| | Glazed coating | | | |
| | Painting, interior on plaster and drywall, walls & ceilings, roller work, primer & 2 coats | | | |
| | Vinyl wall covering, fabric back, medium weight | | | |
| | Ceramic tile, thin set, 4-1/4" x 4-1/4" | | | |
| **C3020** | **Floor Finishes** | | **$8.66** | **$2,026,500** |
| | Composition flooring, epoxy terrazzo, maximum | | | |
| | Terrazzo, maximum | | | |

| | | | | |
|---|---|---|---|---|
| | Vinyl, composition tile, maximum | | | |
| | Tile, ceramic natural clay | | | |
| **C3030** | **Ceiling Finishes** | | **$6.40** | **$1,498,000** |
| | Plaster ceilings, 3 coat prl, 3.4# metal lath, 3/4" crc, 12"OC furring, 1-1/2" crc, 36" OC support | | | |
| | Acoustic ceilings, 3/4"mineral fiber, 12" x 12" tile, concealed 2" bar & channel grid, suspended support | | | |
| **D Services** | | **39.10%** | **$93.29** | **$21,829,000** |
| **D1010** | **Elevators and Lifts** | | **$6.46** | **$1,510,500** |
| | Traction, geared hospital, 6000 lb, 6 floors, 12' story height, 2 car group, 200 FPM | | | |
| **D2010** | **Plumbing Fixtures** | | **$11.20** | **$2,621,000** |
| | Water closet, vitreous china, bowl only with flush valve, wall hung | | | |
| | Urinal, vitreous china, wall hung | | | |
| | Lavatory w/trim, wall hung, PE on CI, 19" x 17" | | | |
| | Kitchen sink w/trim, raised deck, PE on CI, 42" x 21" dual level, triple bowl | | | |
| | Laundry sink w/trim, PE on CI, black iron frame, 48" x 21" double compartment | | | |
| | Service sink w/trim, PE on CI,wall hung w/rim guard, 22" x 18" | | | |
| | Bathtub, recessed, PE on CI, mat bottom, 5'-6" long | | | |
| | Shower, stall, baked enamel, terrazzo receptor, 36" square | | | |
| | Water cooler, electric, wall hung, wheelchair type, 7.5 GPH | | | |
| **D2020** | **Domestic Water Distribution** | | **$6.62** | **$1,548,000** |
| | Electric water heater, commercial, 100< F rise, 1000 gal, 480 KW 1970 GPH | | | |
| **D2040** | **Rain Water Drainage** | | **$0.50** | **$117,000** |
| | Roof drain, CI, soil,single hub, 5" diam, 10' high | | | |
| | Roof drain, CI, soil,single hub, 5" diam, for each additional foot add | | | |
| **D3010** | **Energy Supply** | | **$3.31** | **$773,500** |
| | Hot water reheat system for 200,000 SF hospital | | | |
| **D3020** | **Heat Generating Systems** | | **$0.37** | **$85,500** |
| | Boiler, electric, steel, steam, 510 KW, 1,740 MBH | | | |
| **D3030** | **Cooling Generating Systems** | | **$2.60** | **$607,500** |
| | Chiller, reciprocating, water cooled, standard controls, 100 ton | | | |
| | Chiller, reciprocating, water cooled, standard controls, 150 ton | | | |
| | Chiller, reciprocating, water cooled, standard controls, 200 ton | | | |
| **D3090** | **Other HVAC Systems/Equip** | | **$30.93** | **$7,237,500** |
| | Ductwork for 200,000 SF hospital model | | | |
| | Boiler, cast iron, gas, hot water, 2856 MBH | | | |
| | Boiler, cast iron, gas, hot water, 320 MBH | | | |
| | AHU, rooftop, cool/heat coils, VAV, filters, 5,000 CFM | | | |

| | | | |
|---|---|---|---|
| | AHU, rooftop, cool/heat coils, VAV, filters, 10,000 CFM | | |
| | AHU, rooftop, cool/heat coils, VAV, filters, 20,000 CFM | | |
| | VAV terminal, cooling, hot water reheat, with actuator / controls, 200 CFM | | |
| | AHU, rooftop, cool/heat coils, VAV, filters, 30,000 CFM | | |
| | Roof vent. system, power, centrifugal, aluminum, galvanized curb, back draft damper, 1500 CFM | | |
| | Roof vent. system, power, centrifugal, aluminum, galvanized curb, back draft damper, 2750 CFM | | |
| | Commercial kitchen exhaust/make-up air system, rooftop, gas, 5000 CFM | | |
| | Plate heat exchanger, 400 GPM | | |
| **D4010** | **Sprinklers** | **$2.47** | **$579,000** |
| | Wet pipe sprinkler systems, steel, light hazard, 1 floor, 10,000 SF | | |
| | Wet pipe sprinkler systems, steel, light hazard, each additional floor, 10,000 SF | | |
| | Standard High Rise Accessory Package 8 story | | |
| **D4020** | **Standpipes** | **$0.40** | **$93,000** |
| | Wet standpipe risers, class III, steel, black, sch 40, 4" diam pipe, 1 floor | | |
| | Wet standpipe risers, class III, steel, black, sch 40, 4" diam pipe, additional floors | | |
| | Cabs, hose rack assembly, & extinguisher, 2-1/2" x 1-1/2" valve & hose, steel door & frame | | |
| | Alarm, electric pressure switch (circuit closer) | | |
| | Escutcheon plate, for angle valves, polished brass, 2-1/2" | | |
| | Fire pump, electric, with controller, 5" pump, 100 HP, 1000 GPM | | |
| | Fire pump, electric, for jockey pump system, add | | |
| | Siamese, with plugs & chains, polished brass, sidewalk, 4" x 2-1/2" x 2-1/2" | | |
| | Valves, angle, wheel handle, 300 lb, 2-1/2" | | |
| | Cabinet assembly, includes. adapter, rack, hose, and nozzle | | |
| **D5010** | **Electrical Service/Distribution** | **$3.39** | **$792,500** |
| | Service installation, includes breakers, metering, 20' conduit & wire, 3 phase, 4 wire, 120/208 V, 2000 A | | |
| | Feeder installation 600 V, including RGS conduit and XHHW wire, 2000 A | | |
| | Switchgear installation, incl switchboard, panels & circuit breaker, 2000 A | | |
| **D5020** | **Lighting and Branch Wiring** | **$18.48** | **$4,324,000** |
| | Receptacles incl plate, box, conduit, wire, 20 per 1000 SF, 2.4 W per SF, with transformer | | |
| | Wall switches, 5.0 per 1000 SF | | |
| | Miscellaneous power, 1.2 watts | | |
| | Central air conditioning power, 4 watts | | |
| | Motor installation, three phase, 460 V, 15 HP motor size | | |

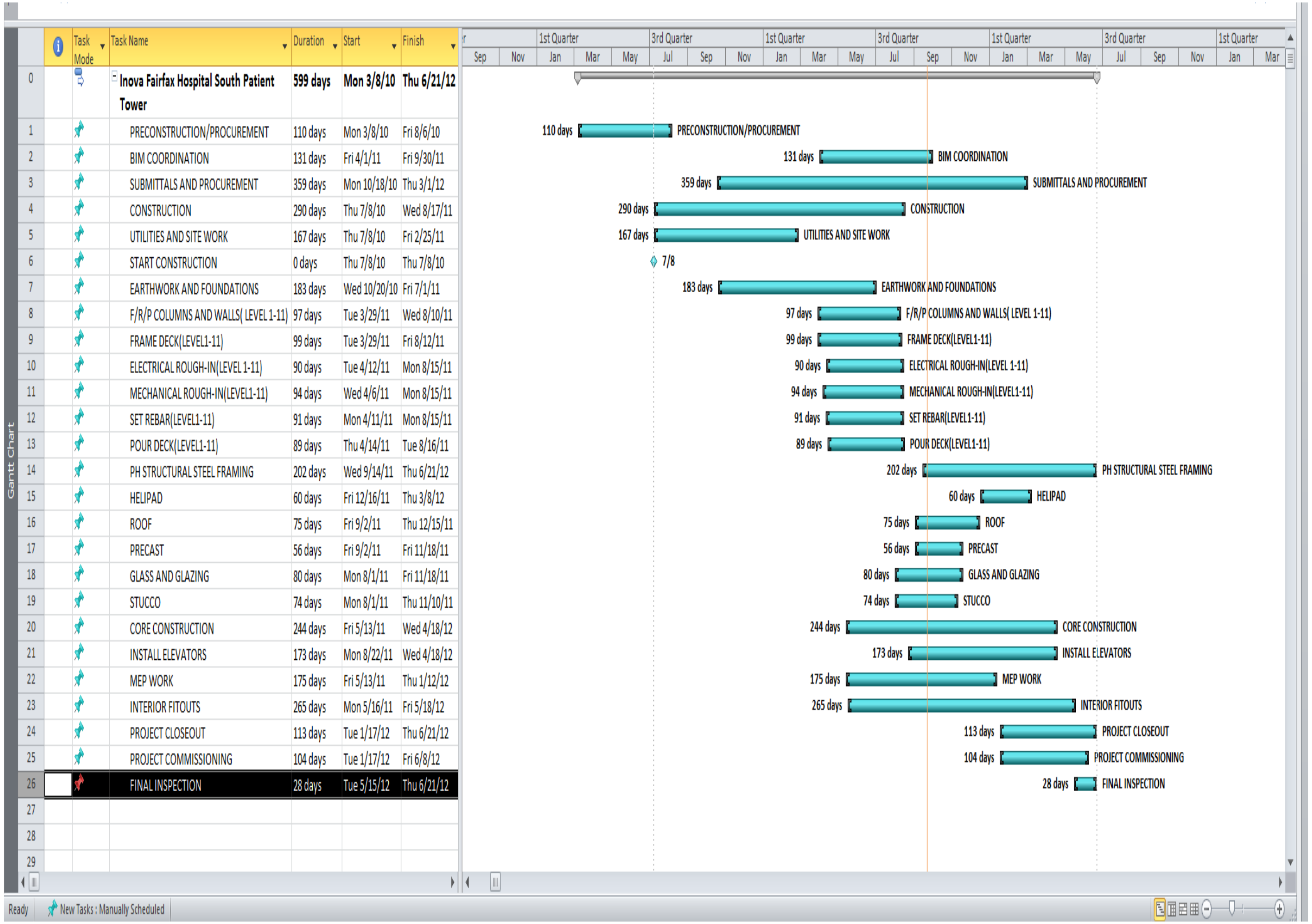
| | | | | |
|---|---|---|---|---|
| | Motor feeder systems, three phase, feed to 200 V 5 HP, 230 V 7.5 HP, 460 V 15 HP, 575 V 20 HP | | | |
| | Fluorescent fixtures recess mounted in ceiling, 0.8 watt per SF, 20 FC, 5 fixtures @32 watt per 1000 SF | | | |
| **D5030** | **Communications and Security** | | **$2.35** | **$551,000** |
| | Communication and alarm systems, fire detection, addressable, 100 detectors, includes outlets, boxes, conduit and wire | | | |
| | Fire alarm command center, addressable with voice, excl. wire & conduit | | | |
| | Internet wiring, 8 data/voice outlets per 1000 S.F. | | | |
| **D5090** | **Other Electrical Systems** | | **$4.23** | **$989,000** |
| | Generator sets, w/battery, charger, muffler and transfer switch, diesel engine with fuel tank, 100 kW | | | |
| | Generator sets, w/battery, charger, muffler and transfer switch, diesel engine with fuel tank, 400 kW | | | |
| | Uninterruptible power supply with standard battery pack, 15 kVA/12.75 kW | | | |
| **E Equipment & Furnishings** | | **7.30%** | **$17.49** | **$4,091,500** |
| **E1020** | **Institutional Equipment** | | **$13.18** | **$3,084,000** |
| | Architectural equipment, laboratory equipment glassware washer, distilled water, economy | | | |
| | Architectural equipment, sink, epoxy resin, 25" x 16" x 10" | | | |
| | Architectural equipment, laboratory equipment eye wash, hand held | | | |
| | Fume hood, complex, including fixtures and ductwork | | | |
| | Architectural equipment, medical equipment sterilizers, floor loading, double door, 28"x67"x52" | | | |
| | Architectural equipment, medical equipment, medical gas system for large hospital | | | |
| | Architectural equipment, kitchen equipment, commercial dish washer, semiautomatic, 50 racks/hr | | | |
| | Architectural equipment, kitchen equipment, food warmer, counter, 1.65 KW | | | |
| | Architectural equipment, kitchen equipment, kettles, steam jacketed, 20 gallons | | | |
| | Architectural equipment, kitchen equipment, range, restaurant type, burners, 2 ovens & 24" griddle | | | |
| | Architectural equipment, kitchen equipment, range hood, including CO2 system, economy | | | |
| | Special construction, refrigerators, prefabricated, walk-in, 7'-6" high, 6' x 6' | | | |
| | Architectural equipment, darkroom equipment combination, tray & tank sinks, washers & dry tables | | | |
| **E1090** | **Other Equipment** | | **$0.00** | **$0** |
| **E2020** | **Moveable Furnishings** | | **$4.31** | **$1,007,500** |
| | Furnishings, hospital furniture, patient wall system, no utilities, deluxe , per room | | | |
| **F Special Construction** | | **0.00%** | **$0.00** | **$0** |
| **G Building Site Work** | | **0.00%** | **$0.00** | **$0** |

| | | | |
|---|---|---|---|
| **Subtotal** | **100%** | **$238.50** | **$55,809,000** |
| **Contractor Fees (General Conditions,Overhead,Profit)** | **25.00%** | **$59.63** | **$13,952,500** |
| **Architectural Fees** | **9.00%** | **$26.83** | **$6,278,500** |
| **User Fees** | **0.00%** | **$0.00** | **$0** |
| **Total Building Cost** | | **$324.96** | **$76,040,000** |

# APPENDIX F BIM ANALYSIS

| BIM Use* | Value to Project | Responsible Party | Value to Resp Party | Capability Rating | | | Proceed with Use |
|---|---|---|---|---|---|---|---|
| | High / Med / Low | | High / Med / Low | Scale 1-3 (1 = Low) | | | YES / NO / MAYBE |
| | | | | Resource | ompetenc | xperience | |
| Record Modeling | HIGH | Contractor | MED | 2 | 2 | 2 | **NO** |
| | | Facility Man | HIGH | 1 | 2 | 1 | |
| | | Designer | MED | 3 | 3 | 3 | |
| Cost Estimation | MED | Contractor | MED | 2 | 1 | 1 | **YES** |
| | | | | | | | |
| | | | | | | | |
| 4D Modeling | HIGH | Contractor | HIGH | 3 | 2 | 2 | **YES** |
| | | | | | | | |
| | | | | | | | |
| 3D Co. (Cons.) | HIGH | Contractor | HIGH | 3 | 3 | 3 | **YES** |
| | | Subcontract | HIGH | 1 | 3 | 3 | |
| | | Designer | LOW | 2 | 3 | 3 | |
| Engineering Anal | HIGH | MEP Engr | HIGH | 2 | 2 | 2 | **YES** |
| | | Architect | LOW | 2 | 2 | 2 | |
| | | | | | | | |
| Design Reviews | MED | Arch | LOW | 1 | 2 | 1 | **YES** |
| | | | | | | | |
| | | | | | | | |
| 3D Co.(Design) | HIGH | Architect | HIGH | 2 | 2 | 2 | **YES** |
| | | MEP Engr | MED | 2 | 2 | 1 | |
| | | Structural E | HIGH | 2 | 2 | 1 | |
| Design Authoring | HIGH | Architect | HIGH | 3 | 3 | 3 | **YES** |
| | | MEP Engr | MED | 3 | 3 | 3 | |
| | | Structural E | HIGH | 3 | 3 | 3 | |
| | | Civil Engr | LOW | 2 | 1 | 1 | |
| Programming | MED | | | | | | **NO** |
| | | | | | | | |
| | | | | | | | |

# APPENDIX G MILESTONES SCHEDULE



|  | Task Mode | Task Name | Duration | Start | Finish |
|---|---|---|---|---|---|
| 0 |  | **Inova Fairfax Hospital South Patient Tower** | **599 days** | **Mon 3/8/10** | **Thu 6/21/12** |
| 1 |  | PRECONSTRUCTION/PROCUREMENT | 110 days | Mon 3/8/10 | Fri 8/6/10 |
| 2 |  | BIM COORDINATION | 131 days | Fri 4/1/11 | Fri 9/30/11 |
| 3 |  | SUBMITTALS AND PROCUREMENT | 359 days | Mon 10/18/10 | Thu 3/1/12 |
| 4 |  | CONSTRUCTION | 290 days | Thu 7/8/10 | Wed 8/17/11 |
| 5 |  | UTILITIES AND SITE WORK | 167 days | Thu 7/8/10 | Fri 2/25/11 |
| 6 |  | START CONSTRUCTION | 0 days | Thu 7/8/10 | Thu 7/8/10 |
| 7 |  | EARTHWORK AND FOUNDATIONS | 183 days | Wed 10/20/10 | Fri 7/1/11 |
| 8 |  | F/R/P COLUMNS AND WALLS( LEVEL 1-11) | 97 days | Tue 3/29/11 | Wed 8/10/11 |
| 9 |  | FRAME DECK(LEVEL1-11) | 99 days | Tue 3/29/11 | Fri 8/12/11 |
| 10 |  | ELECTRICAL ROUGH-IN(LEVEL 1-11) | 90 days | Tue 4/12/11 | Mon 8/15/11 |
| 11 |  | MECHANICAL ROUGH-IN(LEVEL1-11) | 94 days | Wed 4/6/11 | Mon 8/15/11 |
| 12 |  | SET REBAR(LEVEL1-11) | 91 days | Mon 4/11/11 | Mon 8/15/11 |
| 13 |  | POUR DECK(LEVEL1-11) | 89 days | Thu 4/14/11 | Tue 8/16/11 |
| 14 |  | PH STRUCTURAL STEEL FRAMING | 202 days | Wed 9/14/11 | Thu 6/21/12 |
| 15 |  | HELIPAD | 60 days | Fri 12/16/11 | Thu 3/8/12 |
| 16 |  | ROOF | 75 days | Fri 9/2/11 | Thu 12/15/11 |
| 17 |  | PRECAST | 56 days | Fri 9/2/11 | Fri 11/18/11 |
| 18 |  | GLASS AND GLAZING | 80 days | Mon 8/1/11 | Fri 11/18/11 |
| 19 |  | STUCCO | 74 days | Mon 8/1/11 | Thu 11/10/11 |
| 20 |  | CORE CONSTRUCTION | 244 days | Fri 5/13/11 | Wed 4/18/12 |
| 21 |  | INSTALL ELEVATORS | 173 days | Mon 8/22/11 | Wed 4/18/12 |
| 22 |  | MEP WORK | 175 days | Fri 5/13/11 | Thu 1/12/12 |
| 23 |  | INTERIOR FITOUTS | 265 days | Mon 5/16/11 | Fri 5/18/12 |
| 24 |  | PROJECT CLOSEOUT | 113 days | Tue 1/17/12 | Thu 6/21/12 |
| 25 |  | PROJECT COMMISSIONING | 104 days | Tue 1/17/12 | Fri 6/8/12 |
| 26 |  | FINAL INSPECTION | 28 days | Tue 5/15/12 | Thu 6/21/12 |
| 27 |  |  |  |  |  |
| 28 |  |  |  |  |  |
| 29 |  |  |  |  |  |

# APPENDIX H Hill-Rom Product sheets

# APPENDIX I DETAILED SCHEDULE

# APPENDIX J SIPS SCHEDULE

**Hill-Rom®**

# Design Services: RoomBuilder®

## Visualize details with RoomBuilder® Design Service.

The closer you get to completing your renovation or new construction project, the greater the pressure to stay on schedule, and on budget. But still, it's the details that make the difference, so you need an efficient way to finalize room layouts and select architectural elements and patient room equipment.

That's where RoomBuilder® Design Service excels – at the point where the overall space has been planned, but the room details have not been finalized.

### At a glance

- Interactive real-time visualization of your patient rooms
  - ICU/CCU, med-surg, bariatric, perinatal rooms and ED suites
  - Helps your team "see" and understand design alternatives and equipment considerations
- 2-D layouts and 3-D views for optimal spatial reference when you "imagine" the room in action
- Product and layout recommendations sent to your architect for efficient incorporation into the overall design
- 3-D animated room walkthrough on CD-ROM lets you experience the room you've designed, before you build it
- Entire process facilitated by Hill-Rom Design Service consultants experienced in patient room design

This collaborative service pairs a Hill-Rom Design Service consultant with your planning team and Hill-Rom sales representative to refine patient room design and select products and their placement for optimal caregiver efficiency and better patient care.

### Investigate. Evaluate. Agree… on the spot.

The RoomBuilder® software tool features 3-D visualization that lets your team select, view and evaluate different room and equipment configurations. Because all stakeholders have the ability to "see" the room design in action, they can make confident decisions, on the spot. This prevents unnecessary spending, and keeps your project on schedule.

### Drive toward decisions that work for your staff, your patients and your facility.

One of the key benefits to using RoomBuilder® Design Service is its collaborative approach that drives rapid decision making. You have the ability to include not only people concerned with room design, but also caregivers whose primary focus is how the room will be used. It saves your team – architect included – both time and effort as decisions can be made effectively and immediately.

**Hill-Rom®**

# Design Services:
# RoomBuilder®

## Draw on Hill-Rom's design experience.

The RoomBuilder® Design Service is anchored by an experienced member of the Hill-Rom Design Services team who will help you understand critical design requirements and how they affect the overall efficiency of the room. In the end, we help you find the most direct route to a design solution… without taking short-cuts along the way that can compromise the end result.

## Reach design consensus and proceed with confidence in the construction.

As your team works with the projected room layout, you will readily identify potentially costly choices and discuss solutions that can be implemented on the spot. This decision-making process typically enables teams to rapidly reach consensus. This confidence can be translated to other stakeholders by showing the 3-D animated room walkthrough that Hill-Rom will send to you on CD-ROM.

**Ask your Hill-Rom sales representative about other Design Services such as the Room of the Future Seminar and Room Design Workshop.**

## See your design in action.

Using your design input, a 2-D layout is projected onto the Design Center's large screen. This image lets you see how the pieces fit together as part of a comprehensive room design, and analyze traffic patterns for caregivers and patients.

### How it works

1. Notify your Hill-Rom sales representative to request the RoomBuilder® Design Service
2. Your architect e-mails AutoCAD drawings to Hill-Rom Design Services consultant
3. Assemble your team – architect, planning team and other key decision makers – for the trip to Hill-Rom's Design Centers in Batesville, IN or Irvine, CA
4. Participate in a RoomBuilder® session – A Design Services consultant will construct AutoCAD 2-D layouts for you
5. Design Services will construct 3-D walkthrough animation included on presentation CD sent one week later

CTG572 rev 2 7/23/08

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Canada 800-267-2337

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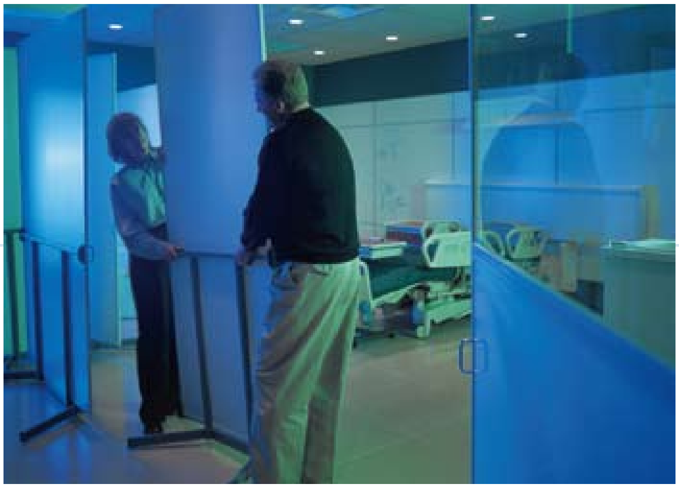
# Design Services: Room Design Workshop



## Design a room that's thought of everything. A better environment. A better experience. Better care.

Patient room design goes far beyond how a room simply looks. It influences how your patients feel and what they experience. It differentiates your facility from the next. It can even improve the efficiency of your staff, enabling them to focus on providing better care. With Room Design Workshop (RDW), Hill-Rom's Design Services consultants help your planning team take all these factors into account. Whether you're planning to build a new ICU/CCU tower or remodeling to create more unique and effective Med-Surg patient rooms, this two-day, hands-on workshop fosters consensus and takes the guesswork out of room design.

### At a glance

- Two-day Room Design Workshop
- Learning modules led by Hill-Rom's Design Services consultants
- Travel arrangements and accommodations provided for your planning team
- In-depth Summary Report of process and results
- CD-ROM of your custom room design

## Bring designs and drawings to life.

Your planning team — including caregivers and your architect — will have the opportunity to experience the patient room environment they have designed. By seeing it for themselves, key stakeholders can make design decisions with confidence. Architects, in turn, can complete your project on time, with fewer change orders and unpleasant surprises.

Hill-Rom®

Enhancing Outcomes for Patients and Their Caregivers.™

## Start with thinking about your future patient room environment

### 1 Module 1 – Envision your future environment

The Workshop begins with visioning your "patient room of the future." We will explore the evolution of patient rooms and the development of cutting-edge design strategies.

### 2 Module 2 – Define your future environment

A facilitator will work with your planning team to identify the key design attributes that will make your future patient rooms an exceptional healing environment.

## Finish the design of your future patient room environment

### 5 Module 5 – Experiment with room designs

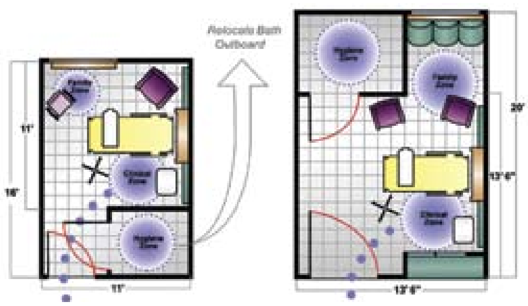
Your planning team will create room layouts using Hill-Rom's Room Design kits. These kits make it easy for the planning team to explore and experiment with alternative layouts.

### 6 Module 6 – Experience the design in the Active Learning™ Labs

Witness the exciting transformation of your room layout into a full-scale room model full of equipment in Hill-Rom's Active Learning™ Lab. Here, your team can evaluate changes on the spot by positioning moveable wall panels and arranging equipment and furniture to refine the design and reach team consensus.

### 3 Module 3 – Discover architectural alternatives and innovations

Your team will review best-in-class projects and explore each design's benefits and trade-offs so that your team can make fully informed choices when you design your patient room.

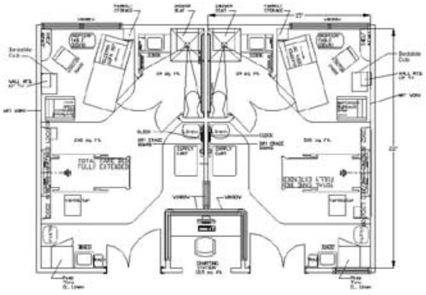


### 4 Module 4 (Optional) – Solidify your vision with a site visit

Hill-Rom can arrange a site visit to an award-winning care unit with numerous innovative features that have enhanced patient satisfaction and improved care delivery. A second-night stay may be required.

### 7 Post-Workshop: Summary Report and animated walk-through of room design

**AutoCAD drawing** of your team's finalized room design for use by your architect.



**Summary report** provided on an easy-to-use CD-ROM.

**RoomBuilder℠ Design Service 3-D animation** will allow other stakeholder's to "walk through" the final design.

## An environment that drives rapid decision making to resolve complex design challenges.

The workshop provides the necessary focus to leave behind the interruptions experienced at work and to be fully engaged in the process toward achieving design consensus. By creating a forum for generating ideas and allowing your team to experiment with room design, RDW's hands-on process encourages innovation and promotes forward thinking that goes beyond the typical discussions around room design, and in a much shorter time frame.

## Take advantage of Hill-Rom's Professional Services consultants.

Hill-Rom's Professional Services consultants focus on practice areas such as Clinical, Safety, and Design, and work with health care organizations to achieve goals in effectiveness, efficiency and satisfaction. Our Design consultants work with you, helping you understand design choices for the patient room, starting with the construction planning stages and ending with the configuration of equipment within the room. Ask your Hill-Rom sales representative about our Room of the Future seminar and RoomBuilder℠ Design Service.

The results and output of Room Design Workshop prepare the hospital's design team to begin working with their architect with a common, validated design direction. The resulting designs, drawings or concepts are not a final construction-ready product. The hospital's licensed architect provides all legal, construction-ready drawings and documents.

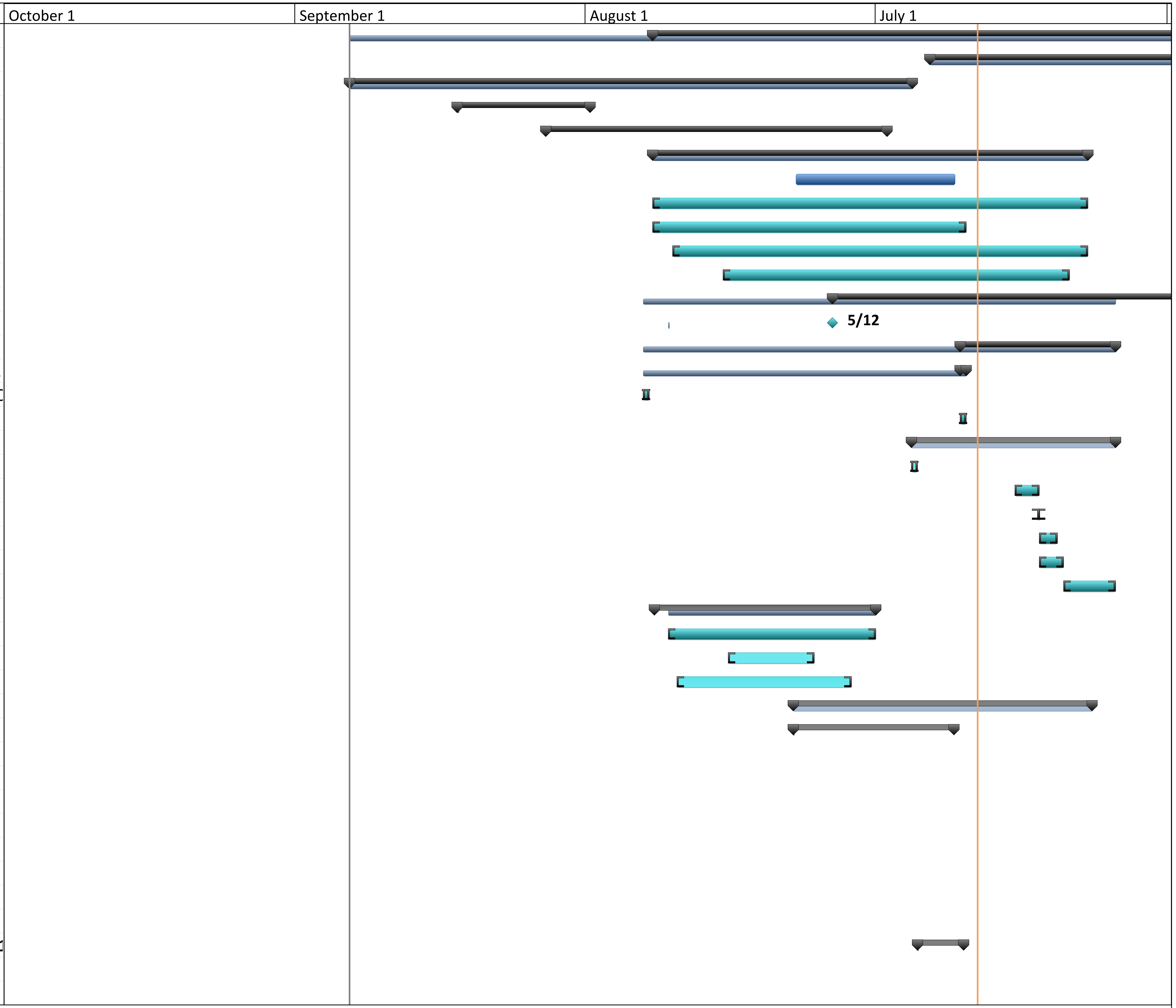
## How it works

① Submit required pre-work, including floor plans and drawings.

② All key design participants – both customer and architect(s) – travel to Hill-Rom's Corporate Conference Center for a two-day workshop. Hill-Rom takes care of all your travel needs, including a stay at JAWACDAH Farm, to ensure your total focus on the workshop.

③ Two to three weeks following the workshop, design participants and architects receive a summary report and CD-ROM containing the final design image, AutoCAD drawing, and animated room walk-through.

| Task Name | Start | Finish |
|---|---|---|
| **INOVA FAIRFAX SOUTH PATIENT TOWER** | **Mon 10/18/1(** | **Thu 6/21/12** |
| **CONSTRUCTION MILESTONES** | **Fri 9/2/11** | **Thu 6/21/12** |
| **PERMIT & SITE DEVELPMENT** | **Tue 11/3/09** | **Fri 8/12/11** |
| **PRECONSTRUCTION** | **Sat 3/6/10** | **Fri 8/6/10** |
| **PURCHASING** | **Thu 6/17/10** | **Thu 7/14/11** |
| **ENGINEERING** | **Mon 10/18/1(** | **Thu 3/1/12** |
| BIM COORDINATION | Fri 4/1/11 | Fri 9/30/11 |
| SUBMITTALS AND PROCUREMENT | Mon 10/18/1( | Thu 3/1/12 |
| TURNER REVIEW AND COORDINATION | Mon 10/18/1( | Thu 10/13/11 |
| OWNER REVIEW/APPROVE SUBMITTALS | Wed 11/10/1( | Thu 3/1/12 |
| FABRICATION/DELIVERY | Fri 1/7/11 | Thu 2/9/12 |
| **CONSTRUCTION** | **Fri 5/13/11** | **Thu 6/21/12** |
| **MAKE READY TO WORK** | **Thu 5/12/11** | **Thu 5/12/11** |
| **UTILITIES AND SITE WORK** | **Fri 10/7/11** | **Mon 4/2/12** |
| **UTILITES** | **Fri 10/7/11** | **Thu 10/13/11** |
| INSTALL NEW TRENCH DRAIN WEST OF WALL AND TIE IN | Thu 10/7/10 | Wed 10/13/1( |
| INSTALL STORM/TRENCH DRAIN AROUOND TRANSFORMER | Fri 10/7/11 | Thu 10/13/11 |
| **LANDSCAPE AND HARDSCAPE** | **Fri 8/12/11** | **Mon 4/2/12** |
| POUR TRANSFORMER PAD | Fri 8/12/11 | Thu 8/18/11 |
| GRADE FOR REVISED ENTRANCE DRIVE | Fri 12/9/11 | Thu 1/5/12 |
| SITE CONCERETE | Thu 1/5/12 | Thu 1/5/12 |
| PAVING | Fri 1/6/12 | Thu 1/26/12 |
| INSTALL GRASS CRETE | Fri 1/6/12 | Thu 2/2/12 |
| LANDSCAPE | Fri 2/3/12 | Mon 4/2/12 |
| **EARTHWORK AND FOUNDATIONS** | **Wed 10/20/1(** | **Fri 7/1/11** |
| BASEMENT | Fri 11/5/10 | Fri 7/1/11 |
| GROUND LEVEL | Thu 1/13/11 | Thu 4/21/11 |
| TUNNEL | Mon 11/15/1( | Fri 6/3/11 |
| **STURCTURE** | **Tue 3/29/11** | **Tue 3/6/12** |
| **LEVEL1-11** | **Tue 3/29/11** | **Thu 9/29/11** |
| F/R/P COLUMNS AND WALLS | | |
| FRAME DECK | | |
| MECHANICAL ROUGH-IN | | |
| SET REBAR | | |
| ELECTRICAL ROUGH-IN | | |
| POUR DECK | | |
| STRIP FORMWORK | | |
| REMOVE RESHORES | | |
| **ROOF** | **Fri 8/19/11** | **Mon 10/10/1** |
| F/R/P COLUMNS AND WALLS | | |
| FRAME DECK | | |



Project: INOVA FAIRFAX HOSTPITA
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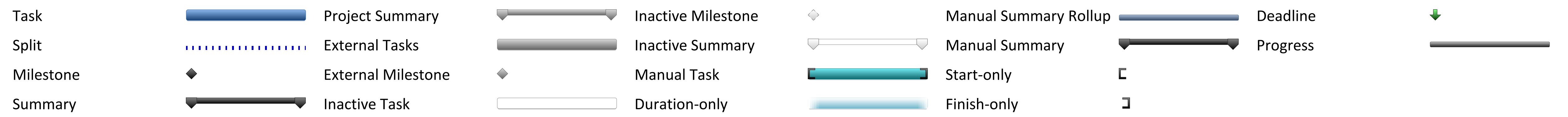
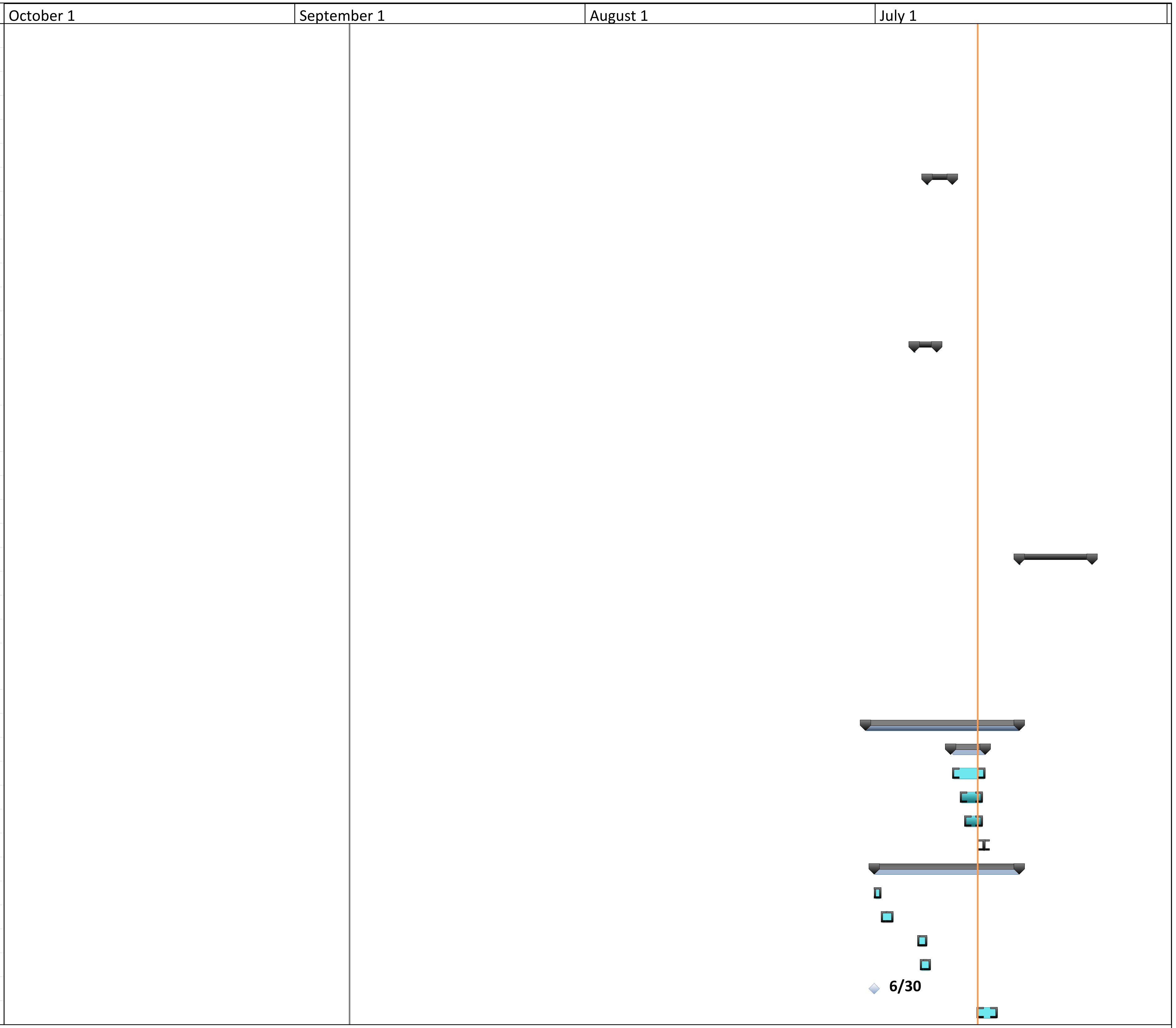


| Task Name | Start | Finish |
|---|---|---|
| ELECTRICAL ROUGH-IN | | |
| MECHANICAL ROUGH-IN | | |
| SET REBAR | | |
| POUR DECK | | |
| STRIP FORMWORK | | |
| REMOVE RESHORES | | |
| **PENTHOUSE** | **Tue 8/30/11** | **Tue 9/27/11** |
| F/R/P COLUMNS AND WALLS | | |
| FRAME WORK | | |
| ELECTRICAL ROUGH-IN | | |
| MECHANICAL ROUGH-IN | | |
| SET REBAR | | |
| POUR DECK | | |
| **PH STRUCTURAL STEEL FRAMING** | **Mon 8/15/11** | **Fri 9/9/11** |
| FORM & POUR CONCRETE CURBS AT ETB ROOF | | |
| TEMP WATER PROOFING FOR CURBS AT ETB ROOF | | |
| ERECT STEEL FRAMING | | |
| DETAIL STRUCTURE STEEL | | |
| INSTALL DECK | | |
| POUR SLAB METAL DECK | | |
| **HELIPAD** | **Wed 12/14/1** | **Tue 3/6/12** |
| INSTALL POSTS FOR HELIPAD | | |
| INSTALL HELIPAD FRAMING | | |
| INSTALL HELIPAD DECK AND WALKWAY | | |
| INSTALL ICE MELT SYSTEM/DELUGE SYSTEMS | | |
| HELIPAD TRIM AND TEST | | |
| **FAÇADE&ROOF** | **Mon 6/20/11** | **Tue 12/13/11** |
| **PENTHOUSE** | **Mon 9/26/11** | **Fri 11/4/11** |
| LGMF/LAYOUT | Wed 9/28/11 | Fri 11/4/11 |
| SHEATHING&INSTALL DUROCK | Fri 10/7/11 | Tue 11/1/11 |
| INSTALL METAL PANELS | Wed 10/12/11 | Tue 11/1/11 |
| CAULKING METAL PANELS | Wed 11/2/11 | Fri 11/4/11 |
| **ROOF** | **Thu 6/30/11** | **Tue 12/13/11** |
| PARAPET BACKUP, FRAMING& SHEATHING-3RD FLOOR | Thu 6/30/11 | Thu 7/7/11 |
| TEMP IN LOWER ROOF | Fri 7/8/11 | Thu 7/21/11 |
| DEMO PARAPET WALL ON ETB | Fri 8/19/11 | Mon 8/29/11 |
| TEMP IN 11TH FLOOR AT ETB | Mon 8/22/11 | Fri 9/2/11 |
| BUILDING TEMP WATER TIGHT THROUGH 3RD FLOOR | | |
| INSTALL LOWER ROOF | Wed 10/26/11 | Fri 11/18/11 |



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| Task | ▬ | Project Summary | ▬ | Inactive Milestone | ◇ | Manual Summary Rollup | ▬ | Deadline | ⬇ |
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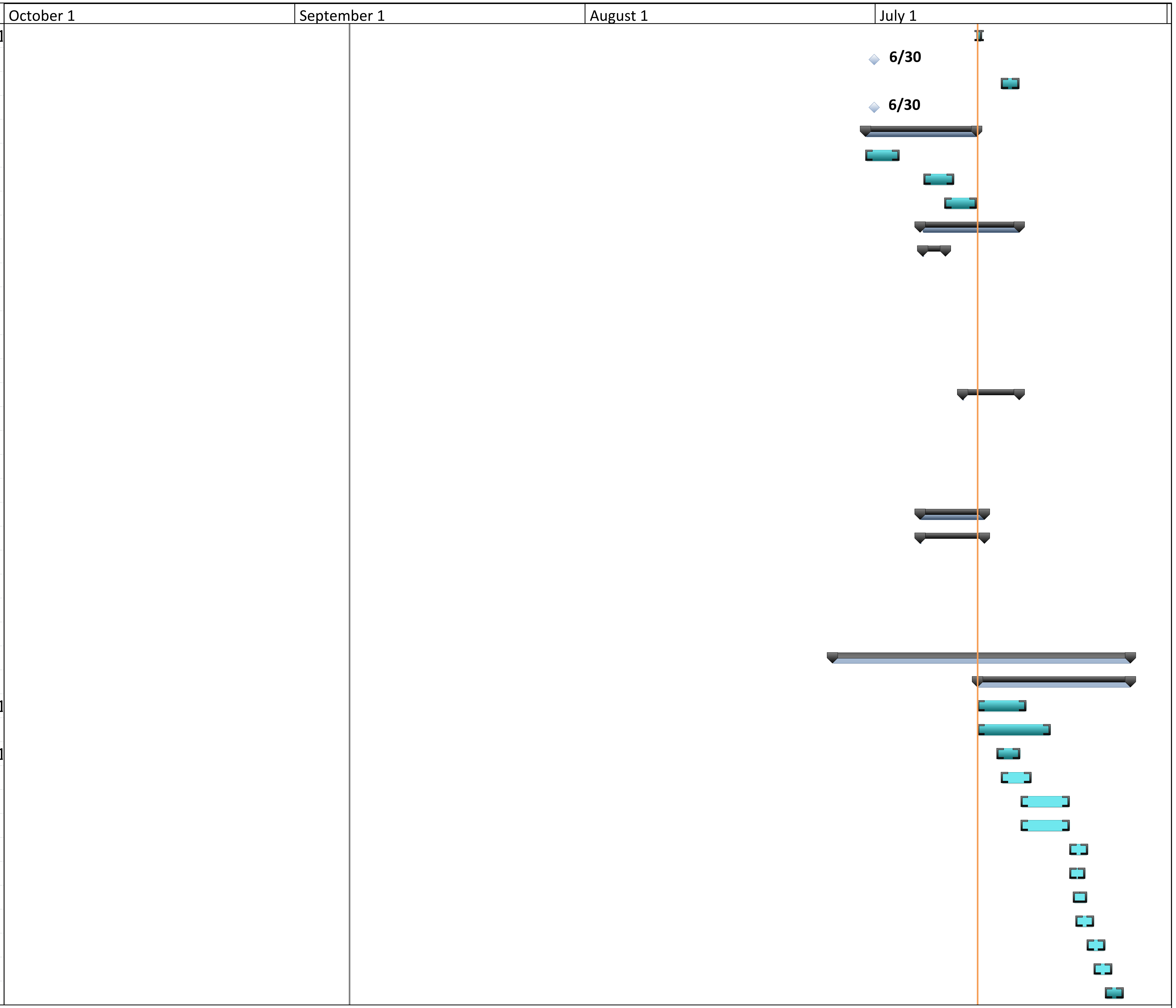
| Task Name | Start | Finish |
|---|---|---|
| PARAPET BACKUP, FRAMING& SHEATHING-12RD FLOOR | Wed 10/26/11 | Mon 10/31/11 |
| BUILDING TEMP WATER TIGHT THROUGH 10TH FLOOR | | |
| INSTALL UPPER ROOF | Wed 11/23/11 | Tue 12/13/11 |
| BUILDING PERM WATER TIGHT | | |
| **PRECAST** | **Mon 6/20/11** | **Tue 10/25/11** |
| GROUD-2ND LEVEL | Mon 6/20/11 | Thu 7/28/11 |
| 3RD-6TH LEVEL | Fri 8/26/11 | Thu 9/29/11 |
| 7TH-ROOFLEVEL | Mon 9/19/11 | Tue 10/25/11 |
| **GLASS AND GLAZING** | **Mon 8/22/11** | **Tue 12/13/11** |
| **GROUND -2ND LEVEL** | **Thu 8/25/11** | **Mon 9/19/11** |
| WATERPROOF SLAB EDGE | | |
| INSTALL PEA GRAVEL FILL | | |
| CAULK PEA GRAVEL | | |
| INSTALL FRAMING/GLASS | | |
| CAULKING | | |
| **3RD TO ROOF LEVEL** | **Mon 10/10/1** | **Tue 12/13/11** |
| INSTALL LOUVERS | | |
| EAST ELEVATION | | |
| SOUTH ELEVATION | | |
| WEST ELEVATION | | |
| **STUCCO** | **Mon 8/22/11** | **Thu 11/3/11** |
| **EAST ELEVATION** | **Mon 8/22/11** | **Thu 11/3/11** |
| LGMF/LAYOUT | | |
| SHEATHING& TAPE JOINTS | | |
| INSTALL DUROCK& TAPE JOINTS | | |
| INSTALL MASONRY PARTITIONS | | |
| **CORE CONSTRUCTION** | **Fri 5/13/11** | **Thu 4/19/12** |
| **ELEVATORS** | **Thu 10/27/11** | **Thu 4/19/12** |
| INSTALL HYDRAULIC LOBBY ELEVATOR | Thu 10/27/11 | Wed 12/21/11 |
| INSTALL ESCALATOR | Thu 10/27/11 | Wed 1/18/12 |
| SET ELEV MACHINES IN EMR | Fri 11/18/11 | Wed 12/14/11 |
| INSTALL MACHINES/CONTROLLERS | Wed 11/23/11 | Tue 12/27/11 |
| INSTALL ELEVATOR RAILS-PATIENT | Fri 12/16/11 | Thu 2/9/12 |
| INSTALL ELEVATOR RAILS-PUBLIC | Fri 12/16/11 | Thu 2/9/12 |
| SET ELEV DOOR BUCKS-PATIENTS | Fri 2/10/12 | Thu 3/1/12 |
| SET ELEV DOOR BUCKS-PUBLIC | Fri 2/10/12 | Mon 2/27/12 |
| CLOSE UP ELEVATOR FRONTS-PUBLIC | Tue 2/14/12 | Wed 2/29/12 |
| CLOSE UP ELEVATOR FRONTS-PATIENTS | Fri 2/17/12 | Thu 3/8/12 |
| INSTALL CAB-PUBLIC | Thu 3/1/12 | Wed 3/21/12 |
| INSTALL CABS-PATIENT | Fri 3/9/12 | Thu 3/29/12 |
| TEST AND BALANCE-PUBLIC | Thu 3/22/12 | Wed 4/11/12 |



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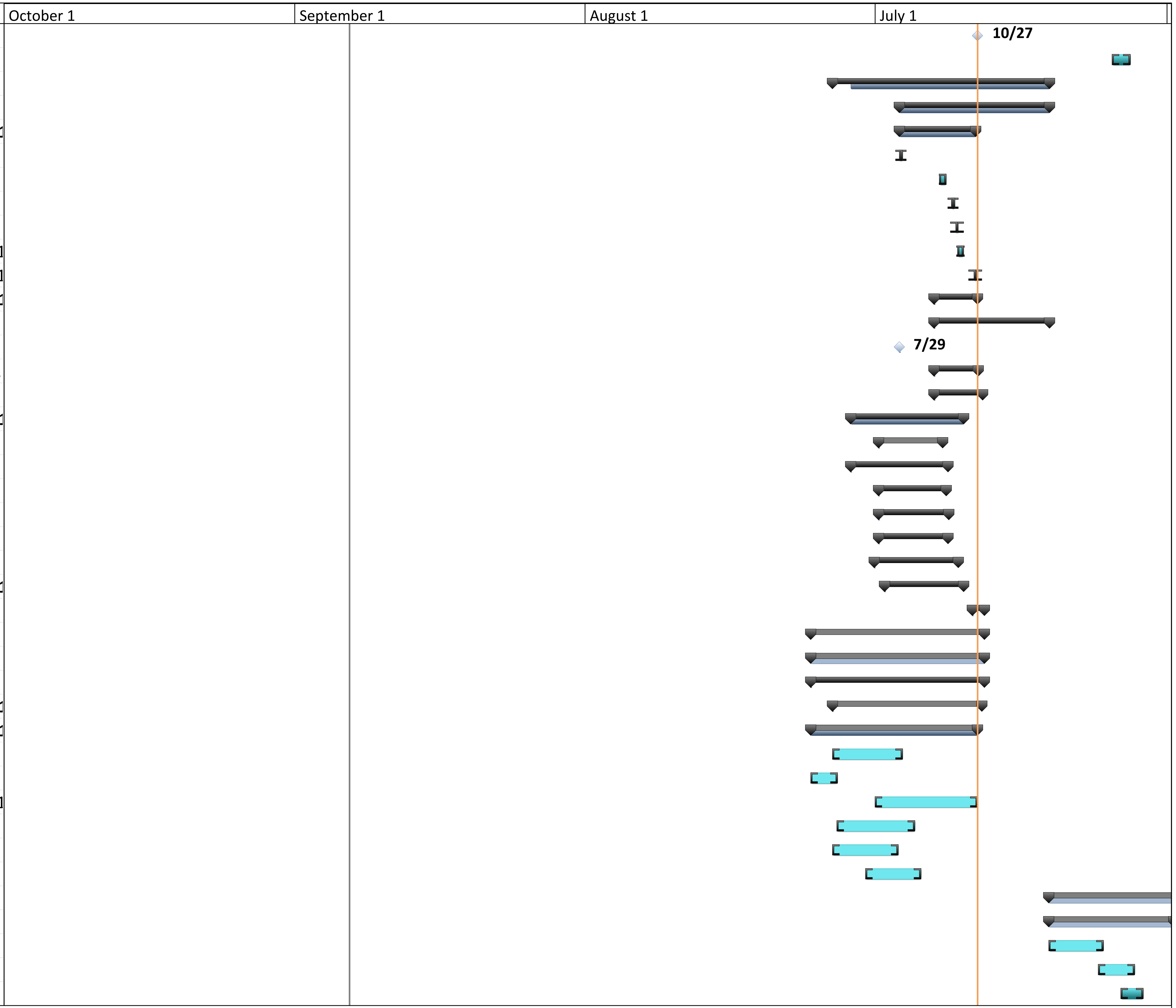
| Task Name | Start | Finish |
|---|---|---|
| 1 PATIENT ELEVATOR READY FOR TEMP USE | | |
| TEST AND BALANCE PATIENT | Fri 3/30/12 | Thu 4/19/12 |
| **MEP** | **Fri 5/13/11** | **Tue 1/17/12** |
| **ELECTRICAL RISERS** | **Fri 7/29/11** | **Tue 1/17/12** |
| **CAFÉ RISER** | **Fri 7/29/11** | **Mon 10/24/1** |
| MOUNT BACK BOSES&TRANSFORMER | Fri 7/29/11 | Mon 8/1/11 |
| INSTALL FEEDER CONDUIT | Tue 9/13/11 | Tue 9/20/11 |
| PIPE IN WIRE PANELS&TRANSFORMERS | Tue 9/27/11 | Fri 9/30/11 |
| TERMINATE FEEDER CABLE | Mon 10/3/11 | Mon 10/3/11 |
| TESTING&INSPECTIONS | Tue 10/4/11 | Mon 10/10/11 |
| ENERGIZE | Mon 10/24/11 | Mon 10/24/11 |
| **5TH FLOOR RISER** | **Wed 9/7/11** | **Wed 10/26/1** |
| **CRITICAL RISER** | **Wed 9/7/11** | **Tue 1/17/12** |
| **GROUNDING SYSTEM** | | |
| **LIFE SAFETY RISER** | **Wed 9/7/11** | **Thu 10/27/11** |
| **PENTHOUSE RISER** | **Wed 9/7/11** | **Tue 11/1/11** |
| **MECHANICAL RISERS** | **Fri 6/3/11** | **Mon 10/10/1** |
| **DOMESTIC WATER SYSTEM** | **Tue 7/5/11** | **Fri 9/16/11** |
| **SANITARY/STORM WATER SYSTEMS** | **Fri 6/3/11** | **Thu 9/22/11** |
| **HOT WATER SYSTEM** | **Tue 7/5/11** | **Tue 9/20/11** |
| **CHILLED WATER SYSTEM** | **Tue 7/5/11** | **Fri 9/23/11** |
| **STEAM RISERS** | **Tue 7/5/11** | **Thu 9/22/11** |
| **DUCT RISERS** | **Thu 6/30/11** | **Tue 10/4/11** |
| **MED GAS RISERS** | **Tue 7/12/11** | **Mon 10/10/1** |
| **CONTROLS** | **Fri 10/21/11** | **Thu 11/3/11** |
| **INTERIOR FITOUTS** | **Mon 4/18/11** | **Thu 11/3/11** |
| **BASEMENT** | **Mon 4/18/11** | **Thu 11/3/11** |
| **ETB** | **Mon 4/18/11** | **Thu 11/3/11** |
| **ELECTRICAL SYSTEMS** | **Fri 5/13/11** | **Mon 10/31/1** |
| **MECHANICAL SYSTEMS** | **Mon 4/18/11** | **Wed 10/26/1** |
| DOMIESTIC WATER SYSTEM | Fri 5/13/11 | Mon 8/1/11 |
| SANITARY/STORM SYSTEM | Mon 4/18/11 | Wed 5/18/11 |
| HOT WATER HEATING | Fri 7/1/11 | Wed 10/26/11 |
| STEAM SYSTEM | Wed 5/18/11 | Mon 8/15/11 |
| HVAC SYSTEM | Fri 5/13/11 | Wed 7/27/11 |
| MED GAS SYSTEM | Mon 6/20/11 | Mon 8/22/11 |
| **PROJECT CLOSEOUT** | **Tue 1/17/12** | **Thu 6/21/12** |
| **COMMISSIONING** | **Tue 1/17/12** | **Fri 6/8/12** |
| HVAC EQUIPMENT | Tue 1/17/12 | Mon 3/19/12 |
| ELECTRICAL SERVICE | Wed 3/14/12 | Tue 4/24/12 |
| MEDICAL GAS SYSTEMS | Mon 4/9/12 | Fri 5/4/12 |



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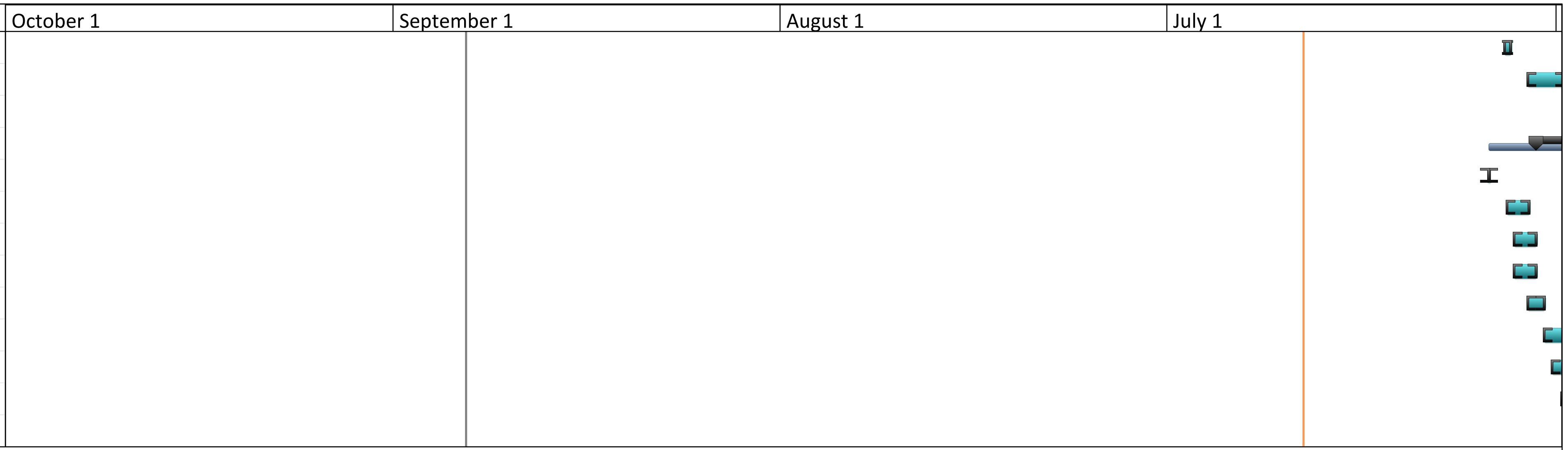
| Task Name | Start | Finish |
|---|---|---|
| CHANGE FILTERS | Tue 4/17/12 | Mon 4/23/12 |
| PLUMBING SYSTEMS | Mon 5/7/12 | Fri 6/8/12 |
| SYSTEMS ACCEPTANCE | Fri 6/8/12 | Fri 6/8/12 |
| **FINAL INSPECTION** | **Tue 5/15/12** | **Thu 6/21/12** |
| FINAL MECHANICAL INSPECTION | Wed 4/4/12 | Wed 4/4/12 |
| ELEVATOR FINALS | Thu 4/19/12 | Wed 5/9/12 |
| LOW VOLTAGE FINALS | Wed 4/25/12 | Tue 5/15/12 |
| ELECTRICAL FINAL | Wed 4/25/12 | Tue 5/15/12 |
| FINAL PLUMBING INSPECTION | Mon 5/7/12 | Tue 5/22/12 |
| FIRE ALARM FINALS | Mon 5/21/12 | Fri 6/15/12 |
| BUILDING FINAL | Mon 5/28/12 | Fri 6/15/12 |
| SITE FINAL | Tue 6/5/12 | Mon 6/18/12 |
| NON-RUP ISSUED BY COUNTY | Thu 6/21/12 | Thu 6/21/12 |



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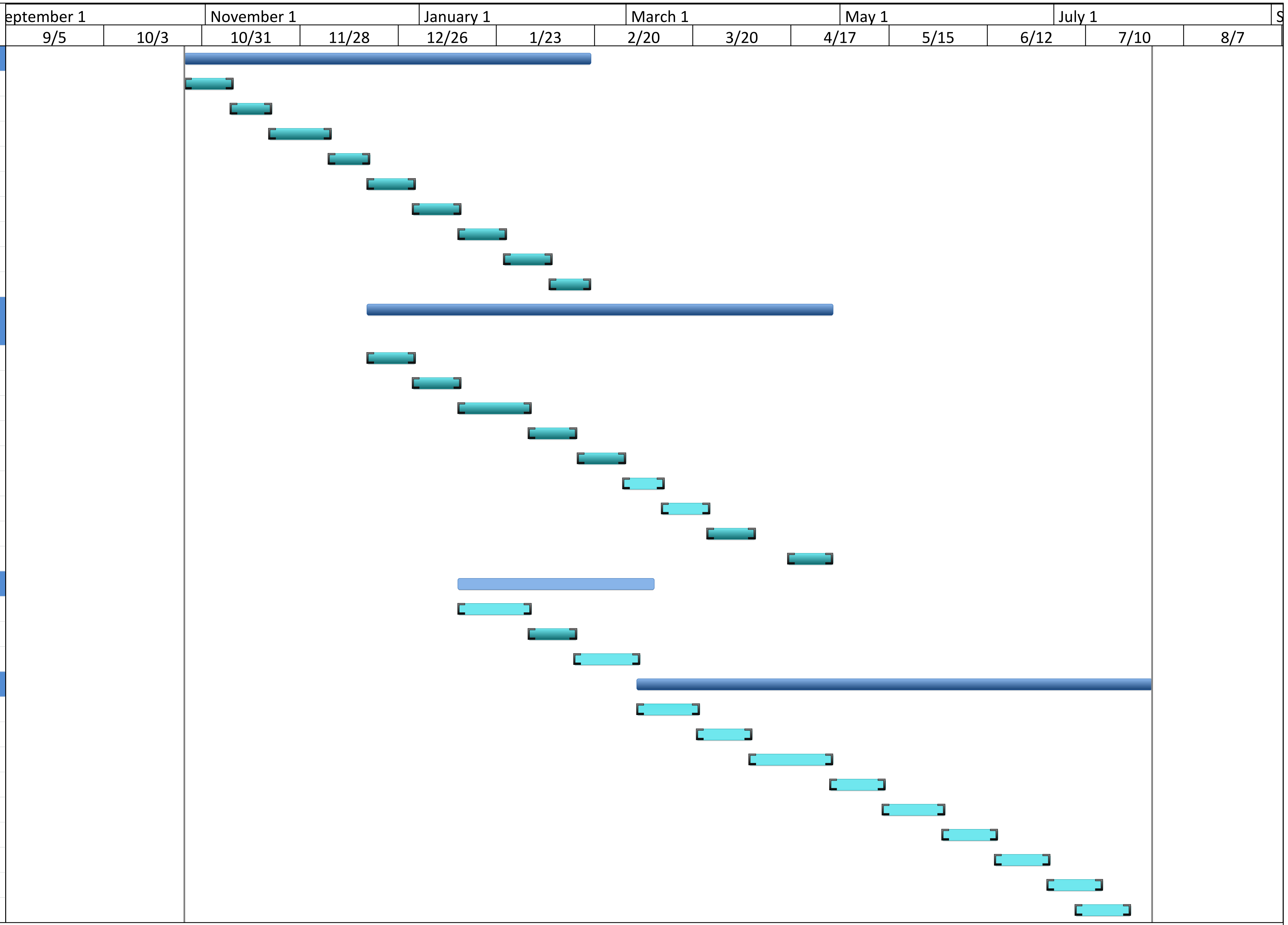
| ID | ℹ | Task Mode | Task Name | Duration | Start | Finish |
|---|---|---|---|---|---|---|
| 1 | ▦ | | Phase1 Superstructure | 84 days? | Tue 10/26/10 | Fri 2/18/11 |
| 2 | | | 3rd floor | 10 days | Tue 10/26/10 | Mon 11/8/10 |
| 3 | | | 4th floor | 10 days | Mon 11/8/10 | Fri 11/19/10 |
| 4 | | | 5th floor | 12 days | Fri 11/19/10 | Mon 12/6/10 |
| 5 | | | 6th floor | 10 days | Mon 12/6/10 | Fri 12/17/10 |
| 6 | | | 7th floor | 10 days | Fri 12/17/10 | Thu 12/30/10 |
| 7 | | | 8th floor | 10 days | Thu 12/30/10 | Wed 1/12/11 |
| 8 | | | 9th floor | 10 days | Wed 1/12/11 | Tue 1/25/11 |
| 9 | | | 10th floor | 10 days | Tue 1/25/11 | Mon 2/7/11 |
| 10 | | | 11th floor | 10 days | Mon 2/7/11 | Fri 2/18/11 |
| 11 | ▦ | | Phase2 Above Ceiling MEP | 95 days | Fri 12/17/10 | Thu 4/28/11 |
| 12 | | | 3rd floor | 10 days | Fri 12/17/10 | Thu 12/30/10 |
| 13 | | | 4th floor | 10 days | Thu 12/30/10 | Wed 1/12/11 |
| 14 | | | 5th floor | 15 days | Wed 1/12/11 | Tue 2/1/11 |
| 15 | | | 6th floor | 10 days | Tue 2/1/11 | Mon 2/14/11 |
| 16 | | | 7th floor | 10 days | Tue 2/15/11 | Mon 2/28/11 |
| 17 | | | 8th floor | 10 days | Mon 2/28/11 | Fri 3/11/11 |
| 18 | | | 9th floor | 10 days | Fri 3/11/11 | Thu 3/24/11 |
| 19 | | | 10th floor | 10 days | Thu 3/24/11 | Wed 4/6/11 |
| 20 | | | 11th floor | 10 days | Sat 4/16/11 | Thu 4/28/11 |
| 21 | ▦ | | Phase3 facede | 40 days? | Wed 1/12/11 | Tue 3/8/11 |
| 22 | | | West façade | 15 days | Wed 1/12/11 | Tue 2/1/11 |
| 23 | | | South façade | 10 days | Tue 2/1/11 | Mon 2/14/11 |
| 24 | | | East Façade | 15 days | Mon 2/14/11 | Fri 3/4/11 |
| 25 | ▦ | | Phase4 Interior | 105 days | Fri 3/4/11 | Thu 7/28/11 |
| 26 | | | 3rd floor | 12 days | Fri 3/4/11 | Mon 3/21/11 |
| 27 | | | 4th floor | 12 days | Mon 3/21/11 | Tue 4/5/11 |
| 28 | | | 5th floor | 18 days | Tue 4/5/11 | Thu 4/28/11 |
| 29 | | | 6th floor | 12 days | Thu 4/28/11 | Fri 5/13/11 |
| 30 | | | 7th floor | 12 days | Fri 5/13/11 | Mon 5/30/11 |
| 31 | | | 8th floor | 12 days | Mon 5/30/11 | Tue 6/14/11 |
| 32 | | | 9th floor | 12 days | Tue 6/14/11 | Wed 6/29/11 |
| 33 | | | 10th floor | 12 days | Wed 6/29/11 | Thu 7/14/11 |
| 34 | | | 11th floor | 12 days | Thu 7/7/11 | Fri 7/22/11 |



Project: INOVA FAIRFAX HOSPITAL
Date: Wed 4/4/12

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|---|---|---|---|---|---|---|---|---|---|
| Task | ▬ | Project Summary | ▬ | Inactive Milestone | ◇ | Manual Summary Rollup | ▬ | Deadline | ⬇ |
| Split | ┈ | External Tasks | ▬ | Inactive Summary | ▭ | Manual Summary | ▬ | Progress | ▬ |
| Milestone | ◆ | External Milestone | ◆ | Manual Task | ▬ | Start-only | [ | | |
| Summary | ▬ | Inactive Task | ▭ | Duration-only | ▬ | Finish-only | ] | | |