Josh Raphael | CM | Faust

Final Report

Holiday Inn Express

Absecon, NJ

April 7, 2010

Holiday Inn Express

Hotel & Suites

Absecon, New Jersey

Joshua D. Raphael | Construction Management

Project Team

Owner: Renuka Hospitality, LLC
GC, CM: DRK Associates
Architect, Structural, Mechanical, Electrical, Fire Engineer: Harry S. Harpers Architects

Project Overview

Function: Hotel & Suite
Use Group: R-1 Residential/ A-3 Assembly
Construction Type: V-B
Size: Total Area - 53,390 SF
First Floor Area - 20,065 SF
Second Floor Area - 16,662 SF
Third Floor Area - 16,62 SF
Height: 3 Stories, 40'-0"
Construction Dates: April 2009 - April 2010
Delivery Method: Design - Bid - Build

Electrical System

Lighting: 2' x 2' Clg. Mtd. Flourescent (Typ)
2' x 4' Clg. Mtd. Flourescent (Typ)
Clg. Recessed Hi-Hats
Electrical: 600 A/3PH Panelboard w/ 6 New Panels
Panel "A" 250 A/3PH 1st Flr.
Panels "B, C, & D" 225 A/3PH 1st Flr.
Panels "E & F" 300 A/3PH 2nd & 3rd Flr.

Facade

First Flr: Cultured Stone Veneer, **Second & Third Flr:** EIFS (Typ.)

Mechanical System

1st Flr. HVAC Units:
-Unit #1 120,000 BTU Gas Hot Air w/ 5 Ton A/C
-Unit #2 40,000 BTU Gas Hot Air w/ 2 Ton A/C
-Unit #3 R/T 100,000 BTU Heat w/ 3.5 Ton A/C
HVAC (Typ) Rm. Units:
-Amana 9,000 BTU PTAC w/ Digital Controls on Unit
Pool Room:
-(2) Desert Air Systems
Stair Towers:
-Mitsubishi Slim-Ductless M-Series Multi-Split Heat Pump Sized by Mfr.

Structural System

Footings:
-Cont. 3' x 12" Conc. Ftgs. under curtain wall
-Columns & Baring Walls Supported by 3' x 3' x 12" to 9'-3" x 11'-7" x 12" Conc. Ftgs.
First Floor Construction:
- 4" Thk. Conc. Slab W/ 6x6 W1.4 x W1.4 WWF on 8mm VB on 6" of Drainage Fill & Comp. Soil
-Note: Conc. is Min. 28-Day 3500psi Comp. Strength
Second & Third Floor Construction:
- 16" L65 TJI Flr. Jst. @ 16" O/C Topped W/ 3/4" Gypcrete on 3/4" T&G Plywood
- Supported by 4" x 4" x 3/16" to 5" x 5" 1/4" & W10 x 68 Steel Columns
Wall Construction:
- 2 x 6 Stud Curtain Walls @ 16" O/C (Typ.)
- 8" CMU's at Stair Tower

E-Portfolio CPEP: http://www.engr.psu.edu/ae/thesis/portfolios/2010/jdr277

Table of Contents

Acknowledgments

I would like to show my deepest appreciation for those who helped me through this project over the past year:

- **Harry S. Harper Architects**
    - Harry S. Harper, Lead Architect
    - Norman Westcoat, Architect
- **DRK Associates**
    - Barry Gardella, Project Manager
- **Renuka Hospitality, LLC**
    - Ajay Khatiwala, Owner
- **Penn State Faculty**
    - Professor Kevin Parfitt
    - Professor Robert Holland
    - Dr. David Riley
    - Professor Chris Magent
    - Professor James Faust
- **Family & Friends**
    - Karen Meyh, Mom
    - Kenneth Raphael, Dad
    - Michael Librone, Stepfather
    - Daniel Alexander, Peer

Executive Summary

This report is a comprehensive technical analysis of the construction approaching completion of the Holiday Inn Express addition in Absecon, NJ. Background information on this project was researched last semester and is compiled in the front of this report. This report includes information on the client, schedule, project costs, building systems, and site layout.

Three analyses were performed that focus on value engineering, schedule reduction, constructability, and critical industry issues. For my project value engineering and schedule reduction were heavily weighted. These analyses were done in the efforts to cut schedule time and reduce energy cost by implementing energy efficient systems.

The first analysis is the implementation of Solyndra solar panels. These 360 degree cylindrical PV cells are the latest in solar panel technology. The analysis analyzes the energy produced by the 500 panels I set to install on the south facing roofs of both the new and existing building. The initial cost of the panels after rebates was $394,041 with an annual savings of $15,455 and 118,886 kWh. This meant that the payback period was about 25.5 years unless a carbon tax is implemented, then it would only be about 14 years. In my opinion, this implementation is unfeasible at the present time due to initial budget. However, as solar panels decrease in price and increase in efficiency the owner may want to reconsider this a few years down the road.

The second analysis involved substituting traditional 2 x 6" exterior walls with 6" SIP panels to increase strength and reduce heating and cooling loads due to the SIP panel's high R value and reduced leakage. In addition the SIP panels reduce the schedule 9 days because of the ease of installation. The initial budget increase was determined to be $14,690. Mechanical calculations showed that the SIP panels will save $14,512 and 381 MBTUs annually. This was the most feasible analysis I made because the annual savings are huge and the payback period is very small, about a year.

The final analysis involved installing motion sensors to control hallway lighting, bathroom lighting, and hotel unit heating and cooling. All of these implementations were made to reduce energy loads due to hotel guest energy abuse. Some major issues were using bathroom lights as nightlights and leaving the HVAC units on when the rooms were vacant. The initial budget increased $10,285 with these three additions, most of which is from the motion sensor heating and cooling units. These additions save a total of $12,096 and 93,039 kWh annually. This analysis is very feasible with its 1 year payback period and as energy cost increases these savings will become more valuable.

Client Information

Renuka Hospitality L.L.C. is a private owner of one Holiday Inn Express in the south Jersey area. Their goal is to increase occupancy capacity and to provide alternate building usage.

Renuka Hospitality L.L.C. chose the location and size of the existing site to allow for expansion. The original design of the existing building was small to allow the business to grow. Once revenue was sufficient to expand the owner had the adjacent land to construct the new 3-story hotel addition and pool/gym facilities.

The expansion was developed for traditional growth of a company. With only 49 existing room units this particular Holiday Inn Express is on the smaller end of the spectrum. At the current size the hotel was not generating enough revenue to higher manager staff positions. Since those key staff members do not currently exist, the hotel must be operated internally meaning that the building owner must run the facility to generate profit. The owner also owns a large portion of the market share and they believe that their location outside of Atlantic City, NJ is a prime enough to fill their expanded 39 units.

The addition of a pool, spa, gym, and meeting rooms were also developed to increase profit. The pool itself is now a requirement of the Holiday Inn Express brand, and the gym and spas are other amenities that traveler's seek when looking for hospitality. The meeting rooms will help bring in corporate traveler's and be able to accommodate larger groups.

One of the largest concerns for the owner is that the construction does not affect the continuous operation of existing facilities. The existing hotel will be fully functional during the construction phases. With the hotel being a place for rest and comfort, the noise created by construction processes can pose troublesome therefore construction must be done during appropriate operating hours. Also keeping the site clean and having available parking spots is needed to allow for continuous business.

The schedule is also a very important concern for the owner. The end date of construction and occupancy is in April 2010. For this location summer is prime time for tourist and generates the largest revenue period. It is urgent that the schedule does not extend into this time frame.

As for cost the owner is less worried about this because they are using a GC and the contract budget must be met. Any over charges or change orders are to be paid by the GC.

Project Schedule Summary

The schedule for Holiday Inn Express addition was geared around peak revenue creating periods. For the Atlantic City, NJ area summer is the best time of the year for tourism and for hotel revenue. This is why the design had been completely finished 3 months before construction had started.

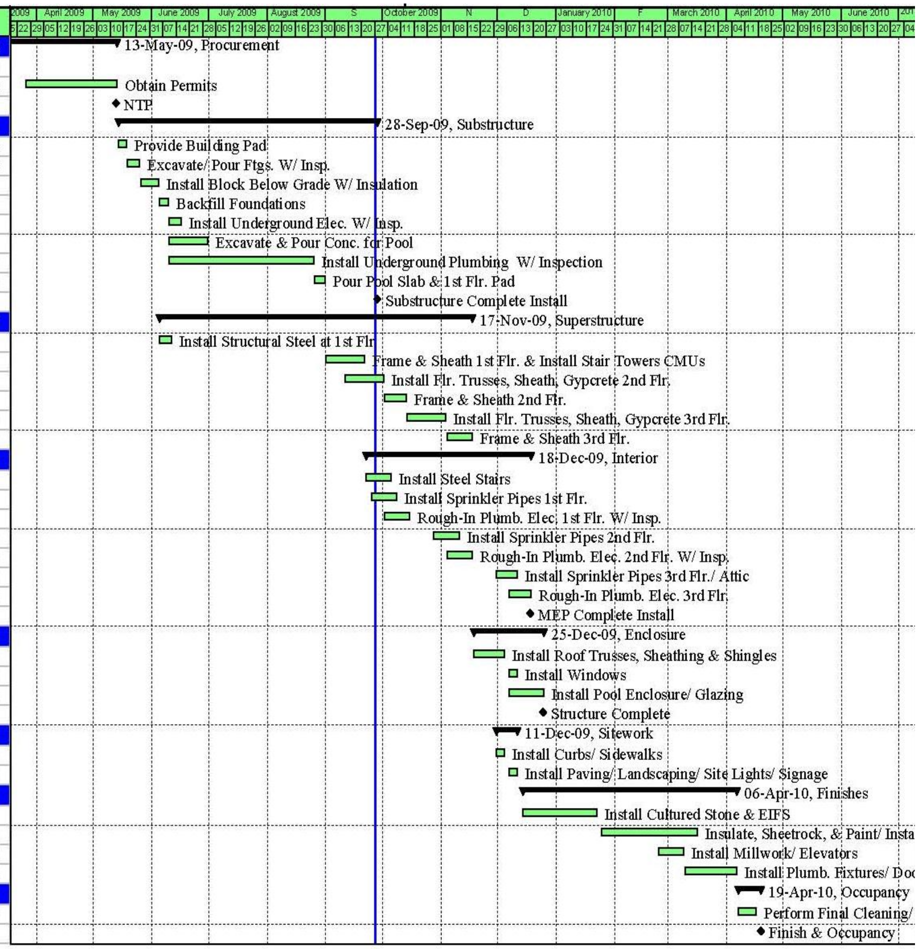
The substructure phase was started in March of 2009 and ends towards the end of August 2009. As you can see below there is a large amount of time allotted for the placement of underground plumbing. My instinct tells me that this delay is due to the continuous usage of the existing structure. The owner most likely did not want to bring more equipment and construction on site until after the summer so they don't lose summer revenue. Also a small portion of the first floor existing structure must be demolished in order to construct the first floor connection and the hotel would have to be closed during that process.

The superstructure begins in September of 2009 except the first floor structural steel which was installed during the substructure phase of construction. During the fall, winter, and early spring months the business is pretty slow and it is a great time for the superstructure to be constructed with little effect on revenue. By mid November 2009 all of the exterior curtain walls are framed and the floor trusses are installed. MEP rough-in is installed almost simultaneously with the superstructure and is completed in mid December 2009.

After the superstructure is complete the roof is enclosed and after rough-in is complete the curtain walls and pool are to be enclosed ending in late December 2009. Site work is being constructed during the enclosure phase.

Floor and exterior wall finishing began in mid December 2009 and finished in early April 2010 along with the installation of fixtures, elevators, and millwork. By mid April the owner has decided to use the rest of the budget to try and add as many wow factors as possible before the summer season and occupancy. Occupancy is permitted after April 19, 2010 but will depend on owner decisions.

Activity ID	Activity Name	Original Duration	Start	Finish
Procurement		183	01-Sep-08	13-May-09
A1290	Design Phase	61	01-Sep-08	24-Nov-08
A1000	Obtain Permits	35	26-Mar-09	13-May-09
A1340	NTP	0	13-May-09	
Substructure		97	14-May-09	28-Sep-09
A1010	Provide Building Pad	3	14-May-09	18-May-09
A1020	Excavate/ Pour Ftgs. W/ Insp.	5	19-May-09	25-May-09
A1030	Install Block Below Grade W/ Insulation	8	26-May-09	04-Jun-09
A1040	Backfill Foundations	3	05-Jun-09	09-Jun-09
A1060	Install Underground Elec. W/ Insp.	5	10-Jun-09	16-Jun-09
A1070	Excavate & Pour Conc. for Pool	15	10-Jun-09	30-Jun-09
A1080	Install Underground Plumbing W/ Inspection	55	10-Jun-09	25-Aug-09
A1090	Pour Pool Slab & 1st Flr. Pad	4	26-Aug-09	31-Aug-09
A1370	Substructure Complete Install	0	28-Sep-09	
Superstructure		118	05-Jun-09	17-Nov-09
A1050	Install Structural Steel at 1st Flr.	5	05-Jun-09	11-Jun-09
A1100	Frame & Sheath 1st Flr. & Install Stair Towers CM...	15	01-Sep-09	21-Sep-09
A1110	Install Flr. Trusses, Sheath, Gypcrete 2nd Flr.	15	11-Sep-09	01-Oct-09
A1140	Frame & Sheath 2nd Flr.	8	02-Oct-09	13-Oct-09
A1160	Install Flr. Trusses, Sheath, Gypcrete 3rd Flr.	15	14-Oct-09	03-Nov-09
A1180	Frame & Sheath 3rd Flr.	10	04-Nov-09	17-Nov-09
Interior		64	22-Sep-09	18-Dec-09
A1120	Install Steel Stairs	10	22-Sep-09	05-Oct-09
A1130	Install Sprinkler Pipes 1st Flr.	10	25-Sep-09	08-Oct-09
A1150	Rough-In Plumb. Elec. 1st Flr. W/ Insp.	10	02-Oct-09	15-Oct-09
A1170	Install Sprinkler Pipes 2nd Flr.	10	28-Oct-09	10-Nov-09
A1190	Rough-In Plumb. Elec. 2nd Flr. W/ Insp.	10	04-Nov-09	17-Nov-09
A1250	Install Sprinkler Pipes 3rd Flr./ Attic	10	30-Nov-09	11-Dec-09
A1230	Rough-In Plumb. Elec. 3rd Flr.	10	07-Dec-09	18-Dec-09
A1360	MEP Complete Install	0	18-Dec-09	
Enclosure		28	18-Nov-09	25-Dec-09
A1200	Install Roof Trusses, Sheathing & Shingles	13	18-Nov-09	04-Dec-09
A1240	Install Windows	5	07-Dec-09	11-Dec-09
A1260	Install Pool Enclosure/ Glazing	15	07-Dec-09	25-Dec-09
A1350	Structure Complete	0	25-Dec-09*	
Sitework		10	30-Nov-09	11-Dec-09
A1210	Install Curbs/ Sidewalks	5	30-Nov-09	04-Dec-09
A1220	Install Paving/ Landscaping/ Site Lights/ Signage	5	07-Dec-09	11-Dec-09
Finishes		82	14-Dec-09	06-Apr-10
A1270	Install Cultured Stone & EIFS	30	14-Dec-09	22-Jan-10
A1280	Insulate, Sheetrock, & Paint/ Install RestRm. Flrs.	37	25-Jan-10	16-Mar-10
A1300	Install Millwork/ Elevators	10	24-Feb-10	09-Mar-10
A1310	Install Plumb. Fixtures/ Doors / Flr. Finishes	20	10-Mar-10	06-Apr-10
Occupancy		8	07-Apr-10	19-Apr-10
A1320	Perform Final Cleaning/ Obtain CO	8	07-Apr-10	16-Apr-10
A1330	Finish & Occupancy	0	19-Apr-10*	



Building Systems Summary

Demolition

- Demolition occurs in August 2009
- The existing unit directly across from the lobby will be demoed along with the lobby itself for renovations. The unit will be turned into a lobby expansion and will be the connection to the pool room and addition.
- Salvaged furniture and fixtures are to be reused in the new addition.

Structural Steel

- The only structural steel used on the project are columns on the first floor.
- Columns range from 4" x 4" x 3/16" to 5" x 5" x ¼" and W10 x 68.
- Structural steel is installed in June 2009 and is completed in a 5 day period.

Cast in Place Concrete

- Continuous footings, Slab on grade, Concrete pool, Column footers
- All concrete has a minimum 28 day compressive strength of 3500psi.
- Footers used the ground as formwork, and the sizes ranged from 3' x 3' x 12" to 9'-3" x 11'-7" x 12".
- The slab on grade is 4" thick with 6 x 6 W1.4 x W1.4 WWM. Formwork was typical horizontal 2x4 edge forms. The concrete was placed via direct chute.
- All of the concrete is placed between May and August 2009.

Mechanical System

- The mechanical system is broken up into 3 main parts.
- The entire system consists of 2 desert air systems and 3 HVAC units.
- The hotel rooms each have Amana 9,000 BTU PTAC units with digital controls.
- The desert air systems are used in the pool area and are designed by the manufacturer.
- Unit #1 is a 120,000 BTU gas hot air with 5 ton A/C and is used in the new meeting room areas. Unit #1 is located in the storage room on the first floor.

- Unit # 2 is a 40,000 BTU gas hot air with 2 ton A/C and is used in the new electrical room and vending area. Unit #2 is also located in the storage room on the first floor.
- Unit #3 is 100,000 BTU gas hot air with 3.5 ton A/C and is used in the gym, pool equipment room, pool toilet rooms, and the pool/gym vestibule. Unit #3 is located on the roof above the gym.
- Mitsubishi slim-ductless m-series multi-split heat pumps are used in the stair towers.
- Fire suppression consist of expanded sprinkler systems on all floors

Electrical System

- Lighting is typically 2' x 2' ceiling mounted fluorescent lights in the meeting room area. The hallways and pool room are illuminated by ceiling recessed hi-hats. The hotel units are lit using decorative lamps to match existing rooms.
- The electrical system for the addition is to be connected to the existing utilities.
- A new 600 Amp/3phase panelboard is added to the existing switchgear unit in the first floor electrical room.
- 6 new panels are installed. 3 of the panels are 225 Amp/3phase, one panel is 250 Amp/3phase, and the last 2 panels are 300 Amp/3phase.

Masonry

- The 2 stair towers are constructed of 8" CMUs and are fire-rated.
- Scaffolding is used for the entire height.

Curtain Wall

- The wall system is typical 2 x 6 stud walls @ 16" O/C.
- The first floor exterior is topped with cultured stone veneer.
- The second and third floor exteriors are topped with typical EIFS.

Excavation Support

- Little excavation is to be done since there is no basement. Excavation consists of digging for the pool and foundation.
- Typical shoring and trench-boxes were used.

Local Conditions

The Holiday Inn Express Addition is being constructed in Absecon, NJ just outside of Atlantic City, NJ on a 2.18 acre property. This site currently has a 3-story existing hotel building and the majority of extra space is currently used for parking and landscape. The proposed addition will be located on the existing retention basin south of the existing hotel.

For the Absecon, NJ areas there are height and area restrictions. For a three story building the allowable height is 60'-0" and the allowable area is 25,200 SF/Floor. This building meets these requirements because the proposed height is 40'-0" and the total area is 53,390 SF which is less than the allowed 75,600 SF.

Absecon, NJ is very big on recycling and so is DRK Associates which is why they plan to achieve 50% recycling on the project. Wood, concrete, steel, and glass will be recycled and the rest of the debris will be separated. Teesdale Trash Removal will be responsible for renting out the dumpsters and for waste removal. The dumpsters will be pulled once or twice per week at a rate of $350/pull.

Four soil samples were taking on the property and their complete detail can be seen in Appendix A Figure 1. The soil logs showed that the type of soil tends to be loamy sands for about 45" then medium-coarse sand below that. There are no signs of large aggregates or boulders so the site should be easy to excavate and backfill. No drilling is necessary. The highest water table is approximately 120" below grade but should not pose a threat since there is no basement and the foundation shall not exceed 48" below grade and the pool shall not exceed 96" below grade.

The contractor must construct inlet sediment filters specific locations to prevent transportation of sediment into the stormwater management system. Silt fences should also be constructed on downhill slopes. In addition the contractor is responsible for cleaning surrounding areas including public right-of-ways and neighboring properties.

Site Plan of Existing Conditions

The Holiday Inn Express addition is being constructed on the south side of the existing building. The addition is limited to setbacks of 35'-0" on the front and sides and 30'-0" on the rear from the property line as shown in the figure below. That being said the size of the addition was constrained to a limited area and the footprint is almost on each of the setback lines.

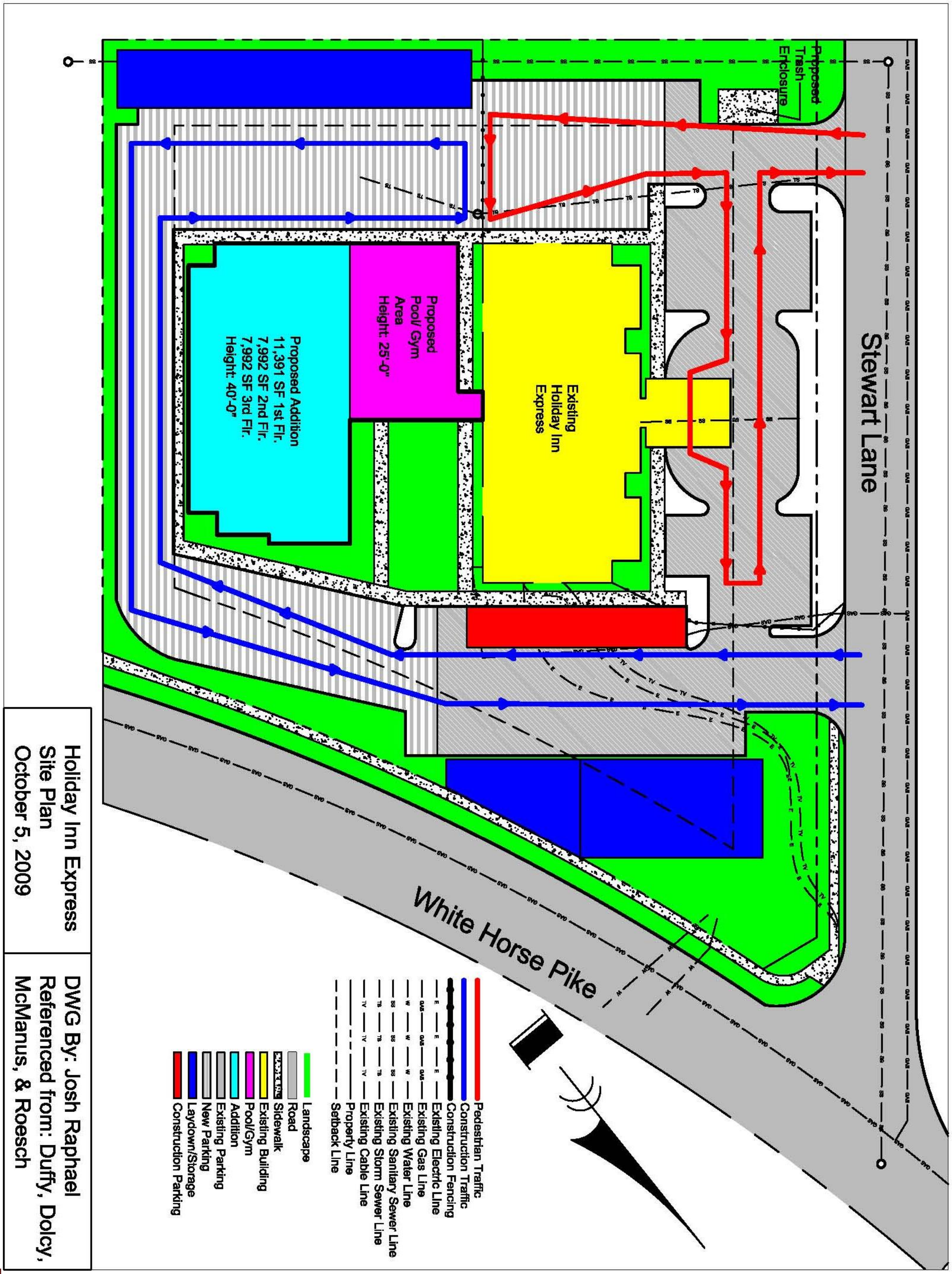
The addition plans to be connected to all the existing utilities available to the existing building. This will allow the existing and new buildings to act as one whole hotel.

Since the building will remain fully operable during construction the temporary customer parking will be in the front and to the right of the existing building. The rest of the existing and new parking spaces will be used for construction traffic, material laydown, storage, temporary trash facilities, equipment, and construction parking.

The site is accessible by making a right off of the White Horse Pike onto Stewart Lane. The accessible route could cause some delay due to traffic but all the materials and the contractors are local so this should not be a problem. The major concern for the site access is that with only one entrance is directing the customer parking away from the construction traffic. The use of signs and fencing will be very helpful in this situation.

The site is restricted to using only the area inside of the property line because surrounding the site on three sides are main roads and the last side is heavily forested area. This site could become tight and cluttered but luckily since DRK is the contractor for all MEPS systems they are the only ones on site and will have little coordination problems.

Overall the main concern for the site is construction traffic not interfering with pedestrian traffic and having construction areas noticeably fenced off with clear signage.


Holiday Inn Express
Site Plan
October 5, 2009
DWG By: Josh Raphael
Referenced from: Duffy, Dolcy, McManus, & Roesch
Stewart Lane
White Horse Pike
Proposed Trash Enclosure
Existing Holiday Inn Express
Proposed Pool/ Gym Area Height: 25'-0"
Proposed Addition
11,391 SF 1st Flr.
7,992 SF 2nd Flr.
7,992 SF 3rd Flr.
Height: 40'-0"
Pedestrian Traffic
Construction Traffic
Construction Fencing
Existing Electric Line
Existing Gas Line
Existing Water Line
Existing Sanitary Sewer Line
Existing Storm Sewer Line
Existing Cable Line
Property Line
Setback Line
Landscape
Road
Sidewalk
Existing Building
Pool/Gym
Addition
Existing Parking
New Parking
Laydown/Storage
Construction Parking

Site Layout Planning

Although the site is fairly open with a lot of room to move around, site planning is still an issue because the land is to be shared with the existing hotel being operable. One thing that I was not aware of when writing my tech 1 assignment was the implementation of a second construction entrance at the south end of the site were the new hotel addition is being constructed. This additional entrance allows less interaction between the existing facility operations and the new addition construction. Because the existing entrance and the parking in the front and partially on the side will still be used for existing operations most construction traffic will arrive through the new temporary entrance.

The site layout will appear differently during two different phases of construction. The phases are Excavation, Demolition, & Substructuture, and Superstructure. These two site layouts can be found in Appendix A Figures 2 and 3 at the back of this assignment.

Excavation, Demolition, & Substructure

During this phase of construction four main pieces of equipment are used. An excavator, a bull dozer, and a direct chute concrete truck. Construction for this phase begins May 14, 2009 and ends on August 31, 2009.

Shallow excavation is needed for the new hotel addition to allow underground piping and foundation work. They must excavate much deeper for the pool area. The excavator can be removed from the site on June 30, 2009 after the pool area is completely excavated.

The bull dozer is used to help assist in the demolition of the one existing room that will act as the new lobby connection. In addition the dozer moves the removed soil around the site and can also be removed from the site along with the excavator.

The direct chute concrete truck is used for pouring the footings and pads of the substructure and can be removed from the site upon substructure completion.

Superstructure

The superstructure will only be using the crane and man power to complete construction. This phase will begin on September 1, 2009 and will be finished on December 25, 2009.

The framing of the building is done by hand and does not utilize any equipment until the third floor joists are being installed. A 125' reach crawler crane is used to install the third floor and roof of the hotel addition. The crane will begin at the south end of the addition near the west staircase and move towards the east staircase for the third floor and back for the roof installation. The crane can be removed from site after the roof is installed.

Project Cost Evaluation

The Holiday Inn Express actual total project cost is $4,000,000. This is a rough but close estimate of the project. The contract cost for the design of the architectural and MEPS drawings from Harry S. Harper Architects was $25,000. The contract cost for the construction from DRK Associates was approximately $3,092,937 (# is rough estimate and has changed.) The remaining balance of $882,063 is budgeted to be used by the owner to purchase furniture, fixtures, and equipment.

In the figure below you can see the actual estimate and two other cost estimates. The first estimate which was created by using the 2009 RS Means Square Footage Estimate text. In appendix I you can see that I used the square foot estimate of a 2-3 story Motel and interpolated for the Cost/SF and you can also see where the cost adjustments and location factor were determined from. This estimated a total project cost of $4,686,892 which is 117% larger than the actual cost. This estimate was most likely larger because part of project is a pre-manufactured pool house enclosure which would have a cheaper Cost/SF than a 2-3 story Motel.

The second estimate was created using the D4 Cost program and the probable cost statement can be found in Appendix A Figure 4. The D4 estimated a total project cost of $3,532,364 which is under budget at only 88% the actual cost. The main reason for this budget to be low is most likely due to the fact that the owner plans to spend up to $1,000,000 on FFE's and the D4 only accounted for about 25% of that.

Overall the best estimate to use would be the RS Means Square Foot estimate because although the cost was a little high the estimate was fairly close to the actual budget. Also the owner explained that because of these economic times and the location of the addition labor was surprisingly cheaper than usual and could also account for the RS means being over budgeted.

Cost Breakdown

		Cost	Cost/SF
Total Project Cost		$4,000,000	$146
Total Hotel Cost		$3,373,344	$124
Total Pool Cost		$340,000	$12.53
Design Cost		$25,000	$0.92
Systems			.
	Mechanical	$257,432	$9.42
	Electrical	$367,000	$13.42
	Plumbing	$280,037	$10.24
	Structural Steel	$95,000	$3.47
	Fire Suppression	$65,000	$2.38
	Concrete (Site+Building)	$200,000	$7.31
	Building Masonry	$70,000	$2.56

Square Footage Cost

Total Building Area	27355 SF
Total Building Perimeter	493 LF
Story Height	10 FT
Interpolated RS Means Value	$160.44 Cost/SF
Total Project Cost	**$4,388,836**

Means Cost Adjustment & Breakdown

Adjustment for Story Height	Add	$1.60 Cost/FT
Adjustment for Perimeter	Add	$4.60 Cost/100FT
Location Factor		1.05
Final RS Means SF Cost		**$171.34 Cost/ST**
Total Project Cost		**$4,686,892**

D4 Estimate

Total Project Cost	$3,532,364
Total Building Cost	$3,062,580
General Requirements	$183,350
Bidding Requirements	$125,863
Site Work	$286,309

Detailed Structural System Estimate

The Holiday Inn Express addition has a minimum amount of structural steel and concrete. The first floor is the only floor with steel columns and there are a variety of steel beams throughout the building but not enough to give a decent structural estimate. The foundation and first floor slab is the only place where concrete is used. The floor joists are wood beams and the exterior walls are wood studs. In addition the stair cases are CMU masonry. Since the building is mainly constructed of wood and masonry I decided to also do a detailed estimate of those structural elements.

The steel estimate was determined by using structural drawings and counting the individual pieces. The concrete estimate was determined by using the first floor area for the slab and counting column footings and the length of the continuous footings to determine CY's. For the wood estimate the floor area and joist spacing were used to calculate the number of pieces at each different length to get a LF amount. The amount of stud pieces were determined by using the building perimeter and stud spacing. The masonry was also determined using the perimeter of the foundation wall and stair cases.

The Summary of the structural estimate shown below the assumptions gives a total of $232,161. This estimate may seem low but this does not include the pool area addition because the portion is designed by a manufacturer so determining structural elements is not possible using my drawing set. The detailed Structural Estimate can be found in Appendix A figure 5 at the back of this assignment.

Assumptions

- R.S. Means 2009
- Location factor of 1.05 for Atlantic City used in structural estimate summary
- Overhead & Profit not included
- Used concrete slab (4" thk.) unreinforced
- Used closest R.S. Means values for unlisted column sizes

Detailed Structural Estimate	
Location Factor =	**1.05**
Steel	
Columns	$10,437.00
Beams	$18,010.00
Wood	
Floor Joists	$72,701.00
Studs	$26,601.00
Concrete	
Floor Slab	$33,200.00
Foundation	$26,106.00
Masonry	
CMU's	$45,106.00
Total =	$232,161.00

General Conditions Estimate

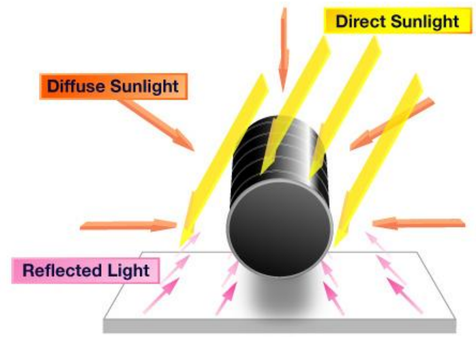
The general conditions estimate was broken up into four different categories of analysis. These categories consist of Personnel, Utilities/Facilities, Site Office Support, and General Requirements. The personnel cost were determined by speaking with the DRK Associates representative who gave me rough estimates of yearly salaries for each position. The rest of the sections were determined by using R.S. Means 2009 and also an early schedule of values prepared by DRK Associates. The final cost for the general conditions estimate which is in the summary below is $341,458. This calculates out to %8.5 of the original bid price. A reason for this unusually high percentage is because R.S. means typically deals with larger buildings causing some of the figures to be larger.

The detailed General Conditions Estimate can be found in Appendix A Figure 6 at the back of this assignment.

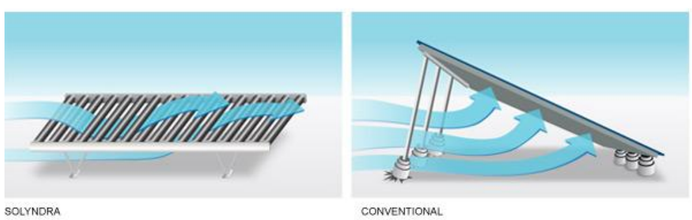
General Conditions Summary		
Personnel		$293,800.00
Utilities/Facilities		$8,399.00
Site Office Support		$12,365.00
General Requirements		$26,894.00
	Total =	**$341,458.00**

Analysis 1: Solyndra Solar Panels

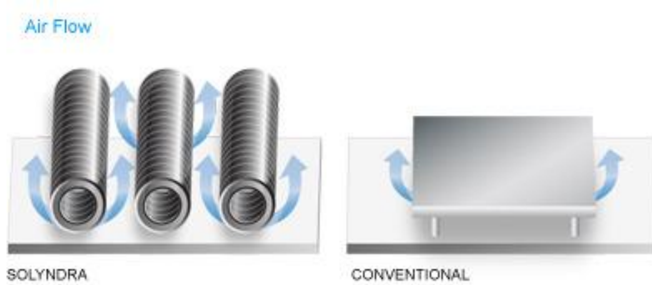
About Solyndra



Solyndra Solar Panels are the new look of solar energy. These panels consist of a frame with multiple cylindrical PV tubes running along it. This unique shape when matched with a reflective roof surface allows the panels to absorb sunlight from a 360˚ surface converting direct, diffuse, and reflected sunlight into energy. This also allows the panels to be equally efficient without mounting them at an angle. In addition the shape allows wind to flow through the panels allowing them to be installed without roof penetration, attachments, or ballasts, making installation quicker, easier, and cheaper than conventional models. This also makes the panels easily removable for roof maintenance.



The panel spacing between PV tubes allows natural airflow allowing the panel to operate at a lower temperature which allows the module to create higher energy production. The panel shape and weight also allows wind up to 130mph. The windiest city in this location requires buildings to be designed to withstand 120mph wind; therefore this system is more than qualified for local wind design.



Installation Location

After analyzing the location of the hotel I have come to a conclusion of where the Solyndra Panels will be applied. I have decided to only cover the back half of both new and existing roofs for a few good reasons. The first reason is that the back of each building faces south, and in south Jersey this is where the roof will see the most sunlight. The second main reason is that the solar panels aren't aesthetically appealing therefore placing them on the roof portions most visible to the public was deemed unacceptable by the building owner. As for placing solar panels on the new pool enclosure, it did not seem efficient since the existing and new building shade the pool structure through most of the day, except when sunlight is directly overhead.

Panel & Roofing Selection

Currently Solyndra's highest producing panel is their SL-001-191 model with a maximum power rating of 191 Wp at standard test conditions (irradiance of 1000 W/m^2, air mass 1.5, and cell temperature of 25˚C. Full specifications for the Solar panels are in Appendix B figure 1 at the back of this assignment.

Since the panels are more efficient on a reflective roof surface it was important to choose a new roof with high reflectivity. I have chosen the EverGuard Freedom TPO HW self adhered membrane in white for the reflective surface. The roofs are at a 6/12 slope which makes it hard to apply a liquid membrane, which is why I selected the self adhered membrane. This membrane has a reflectivity of 0.76 and an emissivity of 0.9.

Sizing the System

These panels are 1.82m x 1.08m x 0.05m in size and with both rear roof areas totaling approximately 11760 ft^2 we can install about 250 panels to each roof (calculations below). There is more roof area available than the area of 250 panels, but we need to keep room for roof obstacles and panel spacing.

Roof Area = $5880ft^2 * 2 = 11760ft^2$

Panel size = $(1.82m)*(1.08m)*(3.28ft/m)^2 = 21.2ft^2$

# of Panels (No Spacing)= $11760ft^2/21.2ft^2$ = 554.7 Panels

# of Panels (W/ Spacing)= approximately 500 Panels (250/roof)

System Power = 191Wp * 500 Panels = 95.5kW Power

Schedule Analysis

The labor rate for this Solyndra Solar Panel system is 10 panels/hr, using a crew of 3 men. The labor rate at which they install the panels may seem higher than usual PV panel installation because Solyndra panels have a much simpler installation process. With a total of 500 panels being installed at a rate of 10 panels/ hr, we can see that it will take 50 hours for the 3 man crew to finish. With an average work day consisting of 8 hrs, we can see that it will take 6.25 days to complete the system installation.

The best time for this system to be implemented would be directly after the roof is completed. Also, because the tasks that must be done after roof installation are not directly related to the completion of the roof, the schedule will not change due to solar panel installation. However, a labor cost will be added for the 6.25 days it will take to install the system.

Cost Analysis

To determine the cost we must look at a few different factors. First we must determine the product cost, which Solyndra panels include the panel and the mounting equipment together. This value was obtained from a Solyndra representative to be $5.42/W including installation. In addition we need to purchase a 100kw commercial inverter to cover the load and a monitoring system to ensure the system is functioning at its expected output. We also need to include the cost for permits to install the system.

Although solar panels seem incredibly expensive to install and may appear to have ridiculous pay back periods, there are state and federal tax incentives and rebates that makes these systems more affordable.

Federal – Federal tax cuts offer a business energy Investment Tax Credit(ITC) on a variety of alternative energy systems. The credit is available until December 31, 2016 for energy systems like solar, wind, and geothermal. This credit will pay for 30% of the entire systems expenditures and has no maximum limit.

State – In the state of New Jersey, solar panel implementation is eligible for a sales tax incentive which eliminates the 7% state tax. This incentive is available for all solar energy equipment and is available to all New Jersey taxpayers. This incentive doesn't apply to buildings which actually need an alternative source to run. Luckily this specific system is designed to produce energy to reduce the buildings total energy load; therefore it is eligible.

Renewable Energy Incentive Program (REIP) – For commercial buildings in New Jersey, a $1.00/W rebate is available to those who install up 50 kW systems. Unfortunately this current system is 95.5 kW which makes it ineligible for this rebate.

Description	Cost
Solyndra Solar Panels (500)	$517,610
Labor Combiner Boxes Wiring	
Monitoring System	$6,500
100 kW Inverter (w/ 10 yr warranty)	$51,215
Permitting	$5,000
7% NJ State Tax	$40,623
Total System Cost	**$620,948**
System Cost per Watt	**$6.50**
Incentives	**Savings**
Federal Investment Tax Credit (30%) NJ Solar System Tax Exemption	$186,284 $40,623
New Total System Cost	**$394,041**
New System Cost per Watt	**$4.13**

Energy Efficiency Analysis: Electrical Breadth

In order to determine payback rate, annual savings, and annual energy produced I used the PV Watts calculator from pvwatts.org. This program takes into account the specific locations solar radiation (kWh/m^2/day), electricity cost ($/kWh), array tilt, and array azimuth.

In addition to determining the energy savings presently, it is also useful to determine future annual savings due to the future proposed carbon tax. In the future there will most likely be an additional $0.1027 – $0.1137 /kWh increase in electrical cost (Referenced in Lindsay Hagemann's Thesis Report 2009). This tax is to help reduce the amount of carbon dioxide and greenhouse gas emissions in the US. We can also determine how many pounds of CO_2 we will save to see the reduction in environmental pollution from the solar panel system implementation. Approximately 1.43 lbs of CO_2 is produced by 1 kWh of energy in New Jersey.

Below is a summary of the results from the PV Watts calculator. This table shows savings with and without carbon tax. A solar radiation map is located in Appendix B Figure 2 and the full PV Watts results are located in Appendix B Figure 3 at the back of this assignment.

Location	Atlantic City, NJ
Array Tilt (6/12 slope)	26.6˚
Array Azimuth (SE)	45˚
Avg. Solar Radiation	4.67
Electricity Cost	13 ¢/kWh
DC Power Rating	95.5 kW
AC Power Rating	73.5 kW
Annual AC Energy Produced (kWh)	**118,886 kWh**
Annual Energy Savings ($)	**$15,455.18**
Savings (lbs of CO_2/yr)	**170,007**

With Future Carbon Tax	
Electricity Cost	24 ¢/kWh
Annual AC Energy Produced (kWh)	**118,886 kWh**
Annual Energy Savings ($)	**$28,532.64**
Savings (lbs of CO_2/yr)	**170,007**

Currently the existing building uses an average of 20,000 kWh/ month, and with the addition being approximately the same size as the existing plus a pool enclosure we can expect the new average to be about 45,000 kWh/ month. With that being said we can determine the percentage of building energy that will be supplied by the solar panels.

$$\frac{118{,}886\ kWh}{45{,}000\ kWh * 12} = 22\%$$

Payback

The payback period is one of the main concerns from an owner's perspective. If the owner plans on owning the building for longer than the payback period, then they will most likely benefit from the implementation of the solar system. However, if the owner doesn't plan on keeping the building for that length of time they will most likely be losing money in investing in this system, unless they get compensation for the system from the individual purchasing the building. Below are the calculations to determine payback period, with and without a carbon tax.

No Carbon Tax – $394,041/$15,455.18 = 25.5 years

With Carbon Tax - $394,041/$28,532.64 = 13.8 years

As you can probably tell this is a very long payback period, but with the implementation of a carbon tax, increased fuel cost, and environmental requirements that will be seen in the future the payback period may be less as these changes are made. One thing is for sure you will not see an increased payback period over time.

Analysis 2: SIPs Panels

About Structurally Insulated Panels

SIP panels are a fairly new type of construction that consists of wall framing and insulation in one combined panel. These panels are typically straighter and stronger than regular stick built stud framing. Since the panels do not require studs interior work like drywall and millwork can be installed quicker and easier without searching for studs or flat surfaces.

SIP panels are not only structurally better but they are also more energy efficient too. The current plans call for 2 x 6 wood studs 16" o/c with R-19 Batting. This type of construction yields an R value of about 13.7, whereas the 6" SIP panel has an R-value of 24.7, making it approximately 58% more efficient. This allows less heat transfer through the walls creating less energy usage in both winter and summer.

As for electrical and plumbing fit outs, with the SIP panel's standard chases we can eliminate conduit material in exterior walls because these chases act like conduit. These chases shown on the right allows us to cut cost for electrical conduit and time from installation.

Reasons for Analysis

There are a lot of reasons to use SIP paneling over traditional stick built. First, I am interested in making this hotel more structurally sound, and with SIP panels we can assure that the building will be stronger, straighter, and quieter. The second reason is to try and cut schedule time and labor cost. SIP panels are prefabricated off site which cuts construction time because they only need to be tilted up and connected. Finally, since the SIP panels are more energy efficient, the owner will be able to save money on his heating and cooling bill and the building will be more environmentally friendly.

SIP Issues

Although, this sounds like a great alternative to the typical stud framed walls some issues have occurred. After speaking with Barry the construction manager of DRK Associates, he has informed me that his crew has not worked with this type of construction yet creating a learning curve delay. In addition, he mentioned that they were bidding a SIP panel project that decided not to move forward with SIP panels due to budget issues, which insists that this process will be initially more expensive. With that being said, the SIP panels must be that much more energy efficient and stronger to continue with this approach.

SIPs Application

For this analysis I will be looking at applying 6" SIP panels to the exterior walls of all three floors of this new addition instead of the typical 2 x 6 stud framed walls. This is approximately 15,274ft^2 of surface area. The interior walls will remain 2 x 6 stud framed walls because energy efficiency is unaffected by interior wall construction.

Cost Analysis

To do the cost analysis we must take a few things into consideration. First of all, the SIP paneling consists of sheathing and insulation and does not need lumber. The 2 x 6 construction must include material costs for the 2 x 6 lumber, the R-19 Insulation and the 3/8" sheathing on both sides. In addition since the time of construction for the SIP panels is shorter than the stud construction, labor is approximately 30% cheaper for the SIP panels. Below is a cost breakdown of material and labor needs for both constructions. Costs were taken from R.S. Means 2009 and the SIP supplier.

Description	2" x 6" Stick Built	Quantity	Total Cost	6 1/2" SIP Panels	Quantity	Total Cost
Material	$520/M.B.F.	21.84 M.B.F.	$11,357	$3.30/SF	15,274 SF	$50,404
R-19 Insulation	$0.52/SF	15,274 SF	$7,943			
3/8" Plywood	$0.40/SF	30,548 SF	$12,220			
Labor	$640/M.B.F.	21.84 M.B.F.	$13,978	$0.64/SF	15,274 SF	$9,784
Total Cost			$45,498			$60,188

As you can see from the table above the initial cost of the SIP panels is about 33% more expensive than the traditional stick built. This was expected and hopefully the energy efficiency increase will help payback this initial cost fairly shortly.

Schedule Analysis

Currently the schedule suggest that it will take 8 days to frame and sheath the first floor, 8days for the second floor, and 10 days for the third floor, taking 26 days to construct all three frames with 2 x 6 stick built construction. After speaking with SIP suppliers who told me the same crew could install the SIP panels 50-70% faster and Barry the construction manager from DRK, I have concluded that the crew would take about 5 days for the first floor, 5 for the second floor, and 7 for the third floor compared to the 8-10 days per floor. The reason the schedule was not cut 50-70% was because Barry explained that his crew was inexperienced in the construction, and also the supplier is trying to sell me a product and will only tell me the best possible situation in order to sell their product. The construction manager explained that if the SIP construction was similar to a prefabricated 2 x 6 stud wall already combined with the insulation and sheathing (which it is) his crew could most likely cute each floors duration by about 3 days. Therefore I went with the 5-7 day per floor installation duration which means we will cut 9 days off the total schedule. An updated schedule can be found in the conclusion section.

A nine day reduction in schedule is not worth the $14,690 increase in initial budget. Therefore, we must now look at how energy efficiency will reduce future heating and cooling bills to determine if this substitution is worth proceeding with.

Energy Efficiency Analysis: Mechanical Breadth

In order to determine the energy savings from the reduced cooling and heating needs I used a SIP energy calculator from r-control.com. The calculator takes into account building location, building size (width, length, and height), the size of the SIP panels used, and the size of the original stud wall with batting rating. Although this is only an estimate and not exact figures we can get a very good idea of annual savings and be able to determine whether the SIP construction is practical. The calculator results for both poor and average leakage, can be seen in Appendix C Figure 1 and Figure 2 respectfully at the back of this assignment. Below is a summary of the SIP energy calculator results.

	Conventional 2 x 6 Construction (Poor leakage)	Conventional 2 x 6 Construction (Average leakage)	6" SIP Construction
Heating (MBTU)	775 MBTU	606 MBTU	257 MBTU
Heating Cost	$9,525	$7,448	$3,306
Cooling (MBTU)	82 MBTU	72 MBTU	40 MBTU
Cooling Cost	$1,008	$885	$492
Total (MBTU)	**857 MBTU**	**678 MBTU**	**297 MBTU**
Total Cost	**$10,533**	**$8,333**	**$3,798**

As you can see from this table the calculator expects the SIP construction to result in a 64%(poor leakage)/54%(average leakage) savings which is a total of $6,735(poor leakage)/$4,535(average leakage) savings annually on heating and cooling bills.

Since this calculation assumes that the roof is also SIP paneling and the cost is not specific to the exact electricity cost of my building, I must do some calculations to determine a more accurate annual savings. First I must add the amount of BTUs needed for heating and cooling for both the conventional and SIP construction but use the conventional roof BTUs for the SIP construction because SIP paneling roofs aren't a part of my analysis. In addition, my project uses electricity for both heating and cooling whereas the calculator uses natural gas for heating. The heating and cooling of the hotel rooms are done by individual electrical heating/cooling units to allow for individual comfort. Finally, they are considering a $0.04/kWh electricity cost whereas my building has a $0.13/kWh electricity cost making the calculators values much lower than the actual.

The conventional construction is estimated to use 775 MBTUs for the heating season and 82 MBTUs for the cooling season for a total of 857 MBTUs with poor leakage. The conventional construction is estimated to use 606 MBTUs for the heating season and 72 MBTUs for the cooling season for a total of 678 MBTUs with average leakage. The SIP construction is estimated to use 257 MBTUs for the heating season and 40 MBTUs for the cooling season for a total of 297 MBTUs. Now that we have the total BTUs I must convert this to kWhs so I can determine the cost using the exact electricity cost for my project. Below are the calculations from BTUs to kWhs.

1 BTU = .000293 kWhs

Conventional Energy Usage Poor Leakage
857,000,000 BTU*(.000293 kWh/BTU) = 251,101 kWh

Conventional Energy Usage Average Leakage
678,000,000 BTU*(.000293 kWh/BTU) = 198,654 kWh

SIP Construction Energy Usage
297,000,000 BTU*(.000293 kWh/BTU) = 87,021 kWh

Now we can determine the cost by using $0.13 kWh which is the electricity cost of my building. Calculations for new cost are below.

Conventional Energy Cost Poor Leakage
251101 kWh*($0.13/kWh) = $32,643

Conventional Energy Cost Poor Leakage
198654 kWh*($0.13/kWh) = $25,825

SIP Construction Energy Cost
87021 kWh*($0.13/kWh) = $11,313

The values I received with the Holiday Inn Express electricity cost were significantly higher than the calculator had originally expected. With these values the SIP panel construction will save approximately $21,330(poor leakage)/$14,512(average leakage) per year, making the building 65%(poor leakage)/55% (average leakage) more energy efficient. Note that it is likely that the new construction will have an average leakage rather than poor leakage because the construction is new. With that being said we will use the average leakage values to determine the payback period of the SIP installation.

Payback

Even if the annual $14,512 savings is higher than expected, with an initial budget increase of $14,690, the owner will still be able to pay off the difference in 1-2 years. With that being said, the implementation of SIP panels vs. the traditional stick built construction is very practical for the owner.

Analysis 3: Building Automotive Systems & Wireless Controls

About BAS Systems & Wireless Controls

Building Automotive Systems have become very common in commercial construction. BAS systems have the ability to limit water and electrical consumption by shutting off these systems when they aren't in use. With the use of motion sensors unoccupied rooms and hallways will no longer consume unnecessary energy.

Wireless controls can be used for virtually any on off switch. The way it works is with the press of the switch or possibly a key card swipe a small amount of energy transmits a signal to a receiver allowing wireless control. The use of wireless controls allows the owner to have full control of the entire building from one location.

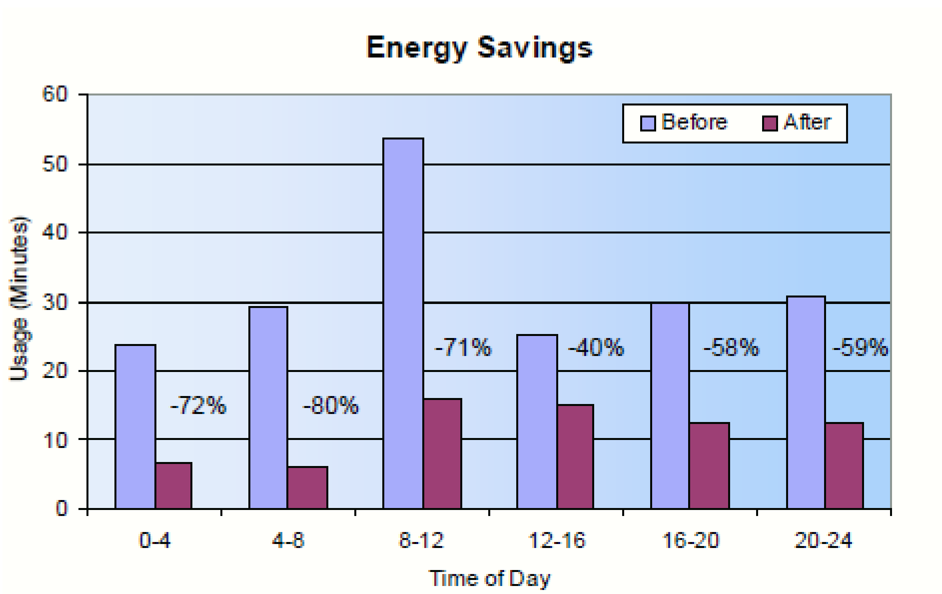
Applications of BAS systems & Wireless Controls

For this hotel project I intend to substitute all bathroom light switches with motion sensor/night light combination switches, and all the hotel HVAC units with upgraded units that can be controlled by occupancy sensors. In addition the second and third floor hallway lights will be scheduled to become motion censored between the hours of 11pm and 6am, to eliminate the need for lit hallways when they are unoccupied.

The BAS and Wireless products will be acquired from Prolighting, Lutron, and Watt Stoppers Inc. due to their experience with hotels and their fair pricing.

Bathroom Motion Sensor Nightlight Switch Analysis

In hotel units the most abused energy consumption comes from the bathroom lighting. A report by the Lawrence Berkeley National Laboratory said, it was estimated that 40% of hotel guests use the bathroom light as a nightlight. In addition, 75% of the fixtures energy usage occurs when the fixture is on for more than two hours, usually overnight or during guest vacancy. The solution is to combine an appeal to the guests needs while reducing unnecessary energy consumption. This combination switch not only shuts the lighting system off when vacant it also serves as a nightlight for guests comfort. Surveys have been done to ensure that the nightlight on the switch is an acceptable substitute for leaving the bathroom light on. Below is a graph taken from the Lawrence Berkeley National Laboratory research which shows typical bathroom light use before and after the installation of the motion sensor nightlight switch.



The graph explains that typically, the bathroom fixtures are on for about (190min/day)/unit compared to (68min/day)/unit with the motion sensor nightlight switch. This is an energy savings of about 64% in each hotel bathroom unit. Now I must determine the difference in initial cost and the annual energy savings from this implementation on my particular project. Labor will not be compared nor will schedule time because the new switch has the same installation costs and rates as a typical light switch making it a negligible analysis.

Cost Analysis

The cost of the WN-100 Motion Sensor Nightlight switches are $38/each when bought in bulk and a typical switch runs about $16-20/each. So taking an average we can see that the new switches will cost about $20 more per unit. So with 49 new hotel units we can tell that the initial budget will be increased by about $980, which is hardly noticeable in a project of this magnitude.

Energy Efficiency Analysis: Electrical Breadth

To determine the energy savings from this implementation, the Holiday Inn Expresses lighting type and electricity cost must be used to get a result that's personal to this project. The lighting in each bathroom consists of three 100W incandescent light bulbs. The calculations below will explain the energy savings per year.

$$3(100W) * \left(\frac{190min}{\frac{60min}{hr}} \right) * \frac{365days}{year} = 346.8kWh/year$$

$$346.8kWh/year * \frac{\$0.13}{kWh} * 49units = \$2{,}210/year$$

Two 100W light bulbs running for (190min/day)/unit will use 346.8kWh/year. With the new switches implemented in all 49 units the owner will have a savings of $2,210/year which isn't much now, but will add up to be big savings as energy cost increases.

Payback

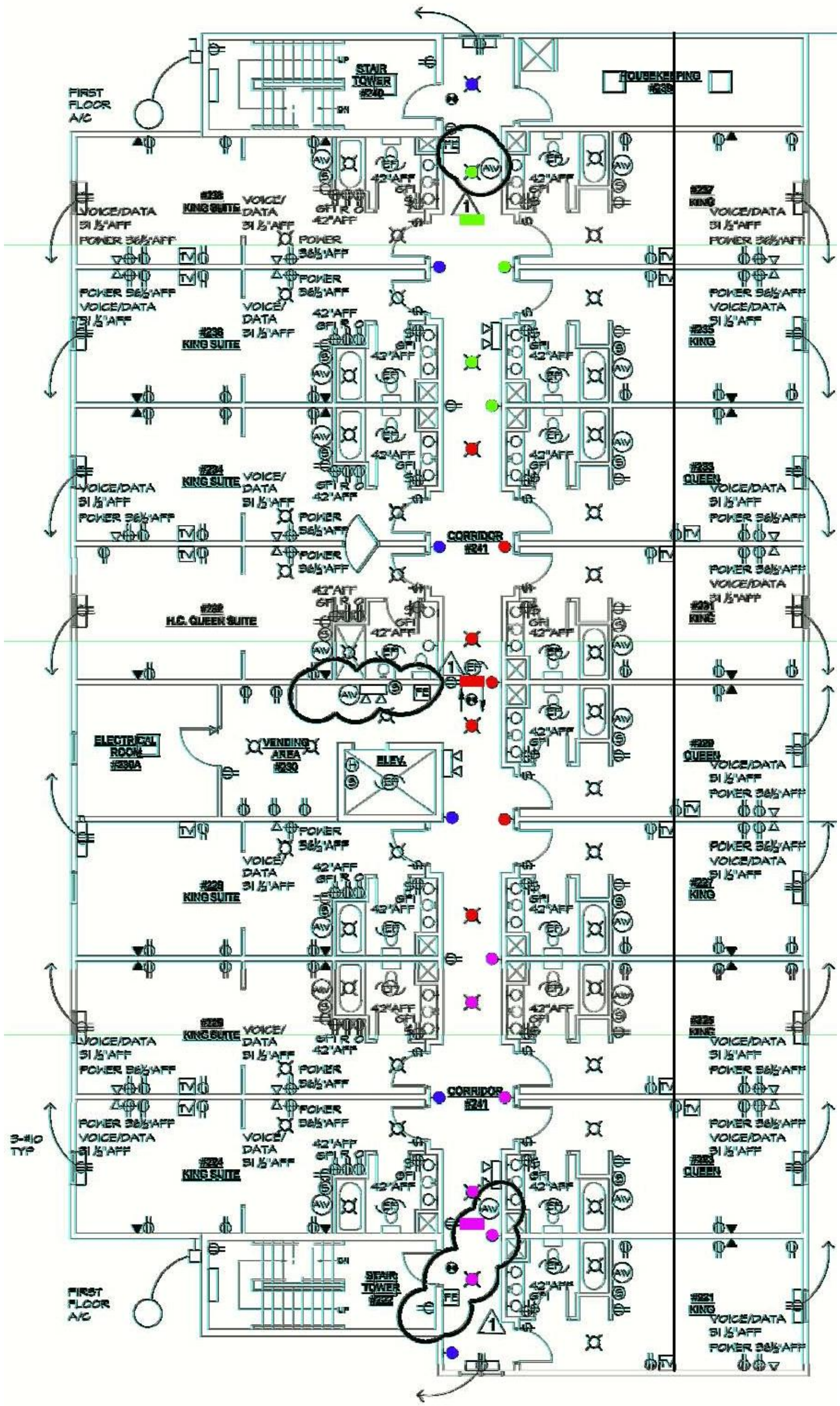
The initial cost increase is only $980, so with an average savings of $2,210/year we can see that the owner will be repaid for his investments in about .5 years. With that being said this investment is very practical. Also, the new switches reduce maintenance and operation cost by 33% due to increased length of light bulb life. However, this savings is a negligible amount.

Hallway Motion Sensor Analysis

In a typical hotel building hallway lights are left on at all times to allow guests to safely find their way through the building at anytime and to provide lighting in case of necessary emergency evacuation. However, these lights are useless outside of these few instances. Therefore, I believe the owner would benefit greatly by having these lights activated by motion sensors between the hours of 11PM and 6AM when most guests are sleeping. In order to do this, three RAB LOS2400H Smart Hallway Sensors will be installed on both the second and third floors. These sensors will control the entire hallway lighting except a few lights which will remain on continuously incase of severe emergencies.

Design Layout

The RAB LOS2400H Smart Hallway Sensors have a 16' x 80' maximum viewing range and can control 2400 Watts of lighting per sensor. Since the length of the hallway is 123' we must evenly separate the sensors to gain full coverage. Starting with the one sensor in the center of the hallway, and offsetting the other two sensors 46' on either side we can ensure full coverage. The reason I am using three sensors and not two is because walls and other objects can decrease viewing range, so to be safe an additional sensor was used. Also the reason the side sensors are closer to the end of the hallways than they are to the center sensor is because their viewing path is also decreased by the end of the hallways. The sensors will be ceiling mounted at 8'-8" to try and gain the greatest viewing range. Below is a layout of the motion sensors. The blue circle lights indicate those which will be left on continuously for emergency purposes. The rest of the lights will be color coded to match the sensors that trigger them. Sensors are designated by colored rectangles.



FIRST FLOOR A/C
STAIR TOWER
HOUSEKEEPING
KING SUITE
VOICE/DATA
POWER
KING
QUEEN
CORRIDOR
H.C. QUEEN SUITE
ELECTRICAL ROOM
VENDING AREA
ELEV.
STAIR TOWER
FIRST FLOOR A/C

	Bulb Quantity/Floor	Bulb Type
Green Sensor 1	4	100W Incandescent
Red Sensor 2	7	100W Incandescent
Magenta Sensor 3	6	100W Incandescent
Continuous Blue	6	100W Incandescent

Cost Analysis

Each sensor costs $139 for a total cost of $834 for all 6 sensors. Since relays and sensors are all in one in this product installation cost is low. Also the system is wireless which also keeps installation cost down. Since it will only take about 30min to install each unit, a total of 3hrs. We can assume that at a standard electrician rate of $60/hr the labor will cost about $180. This makes the total initial cost $1,014 for products and installation.

Energy Efficiency Analysis: Electrical Breadth

For this analysis I am going to assume that between the hours of 11PM and 6AM, a maximum of 1 hour of operation will be necessary for hallway lighting with the implementation of the motion sensors. This leaves us with 6hrs of energy savings. The calculations below explain the annual energy consumption before and after the motion sensor implementation.

Before
23(100W) * (2 Floors) * (24hrs) * (365 days) = 40,296 kWh/year

After
[6(100W) * (2 Floors) * (24hrs) * (365 days)] + [17(100W) * (2 Floors) * (18hrs) * (365 days)] = 32,850 kWh/year

With the motion sensors the owner will be able to save 7,446 kWh/year, which is a cost savings of $968 annually.

Payback

With an initial cost of $1,014 and an annual savings of $968 we can see that the owner shall make up for his investment in just over 1 year. Again this is not great deal of savings but it is still practical and it is always good to reduce energy consumption in a sustainable era.

Motion Sensor Package Terminal Air Conditioner Analysis

In the background section under the building system summary it is noted that each hotel unit will have a 9000 BTU Amana PTAC unit for individual heating and cooling. For an additional $60/unit the owner can substitute this unit for the DigiSmart version of the same unit. The difference here is that a wireless occupancy sensor can be connected to the heater to return the room to set temperature when the room is vacant. The occupancy sensors run about$109/unit. Using this upgraded PTAC system typically results in a 35% reduction in heating and cooling loads. Specs for these two products can be seen in Appendix D Figure 1.

Cost Analysis

The budget will initially increase $169/room to make this change in HVAC systems. Therefore, the total cost of implementing the new system is $8,291. Labor is negligible because the DigiSmart system is installed the same as the original system and the occupancy sensors are wireless running off 2 AAA batteries which makes their installation extremely simple and quick.

Energy Efficiency Analysis: Mechanical Breadth

With the help of the PTAC energy calculator I was able to determine that for my location in south Jersey the typical 9000 BTU PTAC unit will use approximately 4,400 kWh/year. The occupancy sensor 9000 BTU PTAC unit will use approximately 3,000 kWh/year. The calculations below explain the annual energy consumption for both units and the overall annual cost.

Original PTAC Unit
(4,400 kWh/year) * (49 units) = 215,600 kWh/year

(215,600 kWh/year) * ($0.13/kWh) = $28,028/year

DigiSmart PTAC Unit
(3,000 kWh/year) * (49 units) = 147,000 kWh/year

(147,000 kWh/year) * ($0.13/kWh) = $19,110/year

The substitution in HVAC units resulted in an $8,918/year savings. In addition we can see that the new system is about 32% more efficient than the original.

Payback

The initial cost increase was $8,291 and the savings per year was $8,918. We can see that the payback period for the implementation of motion sensor PTAC units is just less than 1 year, making this a practical move by the owner.

Conclusion

Final Budget/Energy Analysis

Below is a table which consist of the totals in budget increase and annual energy savings (cost, kWh, and lbs of CO_2). The reason there is a row which details the totals without solar panels is because I believe that the initial cost and payback period of the solar panels would not be favorable for this particular owner. Without the solar panels the annual savings is 37% less, but the initial cost is 94% cheaper.

Analysis	Initial Budget Increase	Energy Savings (kWh/year)	Energy Savings ($/year)	Energy Savings (lbs of CO_2/year)
Solyndra Solar Panels	$394,041	118,886 kWh	$15,455	170,007 lbs of CO_2
6" SIP Panels	$14,690	111,633 kWh	$14,512	159,635 lbs of CO_2
Motion Sensor Nightlight Switch	$980	16,993 kWh	$2,210	24,300 lbs of CO_2
Hallway Occupancy Sensor	$1,014	7,446 kWh	$968	10,648 lbs of CO_2
Motion Sensor PTAC	$8,291	68,600 kWh	$8,918	98,098 lbs of CO_2
Totals w/o Solar Panels	**$24,975**	**204,672 kWh**	**$26,608**	**292,681 lbs of CO_2**
Totals	**$419,016**	**323,558 kWh**	**$42,063**	**462,688 lbs of CO_2**

Final Payback Period

The final payback period if the owner were to implement all of the analysis would be approximately 10 years. If the owner were to opt out of the solar panel installation the payback period would be less than 1 year. In my opinion the solar panels are not worth it for many reasons. The first reason is that the initial budget will increase approximately 10% from the solar panels alone. The second reason is that this installation can occur any time after project completion and with the decrease in solar panel cost and increase in solar panel efficiency every year with new technologies, the owner would benefit more from waiting a few years before installation.

Final Schedule Analysis

The original finish date for this project was April 16, 2010 the new finish date is April 7, 2010. The only analysis that positively affected the schedule was the implementation of SIP panels. With its prefabricated panels, easy installation, and all in one sheathing, wall, and insulation, we saved 9 days total on the schedule. The solar panels were estimated to take about 7 days to install, but because they can be installed concurrently with the tasks that are involved after the roofing is placed, it does not affect the overall finish date. The BAS systems and wireless controls did not reduce the amount of needed conduit and wiring like I had hoped. The wireless system must still be connected to wires in order to gain electricity. An upgraded schedule can be found in Appendix E Figure 1 at the back of this assignment. The tasks highlighted in yellow represent the major changes to the schedule.

Works Cited

"America's Power - The Facts." *America's Power - Home*. Web. 31 Mar. 2010. <http://www.americaspower.org/The-Facts/>.

"Building Automation Systems on ThomasNet.com." *ThomasNet*. Web. 31 Mar. 2010. <http://www.thomasnet.com/products/building-automation-systems-96051701-1.html>.

"Carpentry Cost Raw Data." *Repair-Home - Kitchen, Bathroom, Window, HVAC and Other Home Improvements*. Web. 31 Mar. 2010. <http://www.repair-home.com/info/carpentry_cost.htm#P>.

"CFL Stats for New Jersey - Greenhouse Gas Emission and Cost Savings -." *One Billion Bulbs*. Web. 31 Mar. 2010. <http://www.onebillionbulbs.com/Stats/State/NJ>.

Commercial Lighting Tax Deduction. Web. 03 Apr. 2010. <http://www.lightingtaxdeduction.org/technologies/occupancy-sensors.html>.

"Commercial Roofing - Green Roof Central." *GAF Roofing ? GAF Materials Corporation*. Web. 31 Mar. 2010. <http://www.gaf.com/Roofing/Commercial-Roofing/Green-Roof-Central/Green-Roof-Central.asp#reflective>.

"Elastomeric Roofing - EnergyCote Coating." *GAF Roofing ? GAF Materials Corporation*. Web. 31 Mar. 2010. <http://www.gaf.com/Roofing/Commercial-Roofing/Commercial-Grade-Roofing-Products/Elastomeric-Liquid-Membranes-Coatings-Sealants-Adhesives/TOPCOAT/EnergyCote-Coating.asp>.

Electricity Price Comparison. Web. 31 Mar. 2010. <http://www.electricitypricecomparison.org/>.

"EnOcean Alliance - Member News | EnOcean| Independent Study: EnOcean-based Verde Controls." *EnOcean Alliance - The Energy Harvesting Wireless Standard for*

Building Automation. Web. 31 Mar. 2010. <http://www.enocean-alliance.org/en/enocean_study_wyndham_hotel0/>.

"Frequently Asked Questions about Structural Insulated Panels | Premier Building Systems." *Structural Insulated Panels | Premier Building Systems SIPs*. Web. 31 Mar. 2010. <http://www.pbssips.com/about-premier-sips/question-answer/>.

"Hotel Room Controls | ILLUMRA Self-powered Wireless Controls." *Home | ILLUMRA Self-powered Wireless Controls*. Web. 31 Mar. 2010. <http://www.illumra.com/applications/Sample_Applications/Hotel_Room_Controls.html>.

Innovative Renewables. Web. 31 Mar. 2010. <http://www.innovativerenew.com/CommercialSolar.html>.

"Occupancy Sensors and Motion Sensors." *Outdoor Lighting, Light Fixtures, Landscape Lighting, Online Store*. Web. 03 Apr. 2010. <http://www.residential-landscape-lighting-design.com/store/occupancy_sensors_and_motion_sensors.htm>.

PV Watt Solar Energy Calculator PVWatts. Web. 31 Mar. 2010. <http://www.pvwatts.org/>.

"RAB LOS2400H Smart Switch Hallway Sensor - ProLighting.com." *Commercial Lighting SALE. Fluorescent Fixtures T5HO T8, HID Lamps, Ballasts. Save on Lutron Dimmers, RAB Lighting, JUNO & Advance - ProLighting.com*. Web. 03 Apr. 2010. <http://www.prolighting.com/rablosmswhas.html>.

"Renewable Energy Incentive Program Incentives | NJ OCE Web Site." *Home | NJ OCE Web Site*. Web. 31 Mar. 2010. <http://www.njcleanenergy.com/renewable-energy/programs/renewable-energy-incentive-program/renewable-energy-incentive-program-cust>.

SIP Home Systems, Structural Insulated Panels, SIP Panels. Web. 31 Mar. 2010. <http://www.siphomesystems.com/>.

"SIPs Pricing Structural Insulated Panels." *Structural Insulated Panels (SIPs)*. Web. 31 Mar. 2010. <http://www.foamlaminates.com/sip_pricing.html>.

"Solar Insolation - Sun Hours Per Day." *Big Frog Mountain- Solar Electric Systems, Solar Attic Fans, SunTunnels, Solar Panels, Low Energy Appliances*. Web. 31 Mar. 2010. <http://www.bigfrogmountain.com/SunHoursPerDay.html>.

"Solar Panel Watt Calculations and Costs." *DIY Renewable Energy - Home Solar Power Kits | Home Wind Turbine*. Web. 31 Mar. 2010. <http://diy-renewable-energy.com/articles/calculating-basic-solar-panel-watt-requirements-and-costs/>.

"Solar Photovoltaic, PV Module, Panel Prices." *Solarbuzz| Portal to the World of Solar Energy*. Web. 31 Mar. 2010. <http://www.solarbuzz.com/ModulePrices.htm>.

Solyndra - The New Shape of Solar. Web. 31 Mar. 2010. <http://www.solyndra.com/>.

"Structural Insulated Panel - Energy Savings Calculator." *Structural Insulated Panels from R-Control*. Web. 31 Mar. 2010. <http://www.r-control.com/calculations/energy-calculator.asp>.

Structural Insulated Panels from R-Control. Web. 31 Mar. 2010. <http://www.r-control.com/>.

Appendix A

Figure 1

SOIL LOG

CLIENT: Renuka Hospitality, LLC

LOT LOCATION: Block 189, Lots 1 & 2
Absecon, New Jersey

SAMPLING LOCATION: SP#10

DATE: 20 August 2007

LOG BY: Janeann Armbruster P-07131

Depth Inches	Color	Unified Classif.	Description
0 – 10	10YR 6/6, brownish yellow	SP/SM	Loamy sand (fill), 20% gravel
10 – 18	10YR 3/2, very dark grayish brown	SP/SM	Loamy sand
18 – 44	10YR 5/8, yellowish brown	SM	Sandy loam
44 – 74	10YR 6/6, brownish yellow	SP	Sand-coarse
74 – 107	10YR 6/4, light yellowish brown w/ 10YR 6/6, brownish yellow & 10YR 7/1, light gray mottles	SP	Sand-coarse
107 – 120	10YR 7/4, very pale brown w/ 10YR 6/6, brownish yellow & 10YR 8/1, white mottles	SP	Sand-coarse

Estimated seasonally high water table at: 74 inches
Estimated actual water table at: >120 inches.
Permeability test: Depth of test: 18 - 44 inches Permeability rate: 7.5 in/hr

APPROXIMATE GRADE ELEVATION= 20.5'
APPROXIMATE HIGH WATER TABLE ELEVATION= 10.5'
SEASONAL HIGH WATER TABLE ELEVATION= 14.3'

SOIL LOG

CLIENT: Renuka Hospitality, LLC

LOT LOCATION: Block 189, Lots 1 & 2
Absecon, New Jersey

SAMPLING LOCATION: SP#11

DATE: 20 August 2007

LOG BY: Janeann Armbruster P-07131

Depth Inches	Color	Unified Classif.	Description
0 – 3	10YR 3/2, very dark grayish brown	SP/SM	Loamy sand
3 – 24	10YR 5/4, yellowish brown	SP/SM	Loamy sand, 20% gravel
24 – 46	10YR 5/8, yellowish brown	SP/SM	Loamy sand, 10% gravel
46 – 77	10YR 6/4, light yellowish brown w/ 10YR 5/8, yellowish brown lamellae	SP	Sand-med
77 – 123	10YR 6/4, light yellowish brown w/ 10YR 5/6, yellowish brown & 10YR 7/2, light gray mottles	SP	Sand-med

Estimated seasonally high water table at: 77 inches
Estimated actual water table at: >123 inches.
Permeability test: Depth of test: 24 - 46 inches Permeability rate: 17.1 in/hr

APPROXIMATE GRADE ELEVATION= 18.5'
APPROXIMATE HIGH WATER TABLE ELEVATION= 8.2'
SEASONAL HIGH WATER TABLE ELEVATION= 12.1'

SOIL LOG

CLIENT: Renuka Hospitality, LLC

LOT LOCATION: Block 189, Lots 1 & 2
Absecon, New Jersey

SAMPLING LOCATION: SP#12

DATE: 20 August 2007

LOG BY: Janeann Armbruster P-07131

Depth Inches	Color	Unified Classif.	Description
0 – 3	10YR 3/2, very dark grayish brown	SP/SM	Loamy sand
3 – 25	10YR 5/8, yellowish brown	SM	Sandy loam, 20% gravel
25 – 36	10YR 6/6, brownish yellow	SP/SM	Loamy sand
36 – 45	10YR 6/4, light yellowish brown	SP	Sand-med
45 – 74	10YR 6/4, light yellowish brown w/ 10YR 5/8, yellowish brown lamellae	SP	Sand-med
74 – 122	10YR 7/4, very pale brown w/ 10YR 6/8, brownish yellow & 10YR 7/1, light gray mottles	SP	Sand-med/coarse

Estimated seasonally high water table at: 74 inches
Estimated actual water table at: >122 inches.
Permeability test: Depth of test: 25-36 inches Permeability rate: 16.5 in/hr

APPROXIMATE GRADE ELEVATION= 17.2'
APPROXIMATE HIGH WATER TABLE ELEVATION= 7.0'
SEASONAL HIGH WATER TABLE ELEVATION= 11.0'

SOIL LOG

CLIENT: Renuka Hospitality, LLC

LOT LOCATION: Block 189, Lots 1 & 2
Absecon, New Jersey

SAMPLING LOCATION: SP#13

DATE: 20 August 2007

LOG BY: Janeann Armbruster P-07131

Depth Inches	Color	Unified Classif.	Description
0 – 4	10YR 7/1, light gray	SP	Sand-fine
4 – 30	10YR 5/6, yellowish brown	SP/SM	Loamy sand, 10% gravel
30 – 44	10YR 6/8, brownish yellow	SP/SM	Loamy sand/Sand
44 – 71	10YR 6/4, light yellowish brown w/ 10YR 6/8, brownish yellow lamellae	SP	Sand-fine
71 – 124	10YR 7/4, very pale brown w/ 7.5YR 6/8, reddish yellow & 10YR 7/1, light gray mottles	SP	Sand-med

Estimated seasonally high water table at: 71 inches
Estimated actual water table at: >124 inches.
Permeability test: Depth of test: 4 - 30 inches Permeability rate: 15.9 in/hr

ARMBRUSTER ENVIRONMENTAL – 607 Biscayne Avenue, Galloway, NJ 08205

APPROXIMATE GRADE ELEVATION= 19.7'
APPROXIMATE HIGH WATER TABLE ELEVATION= 9.4'
SEASONAL HIGH WATER TABLE ELEVATION= 13.8'

Figure 2

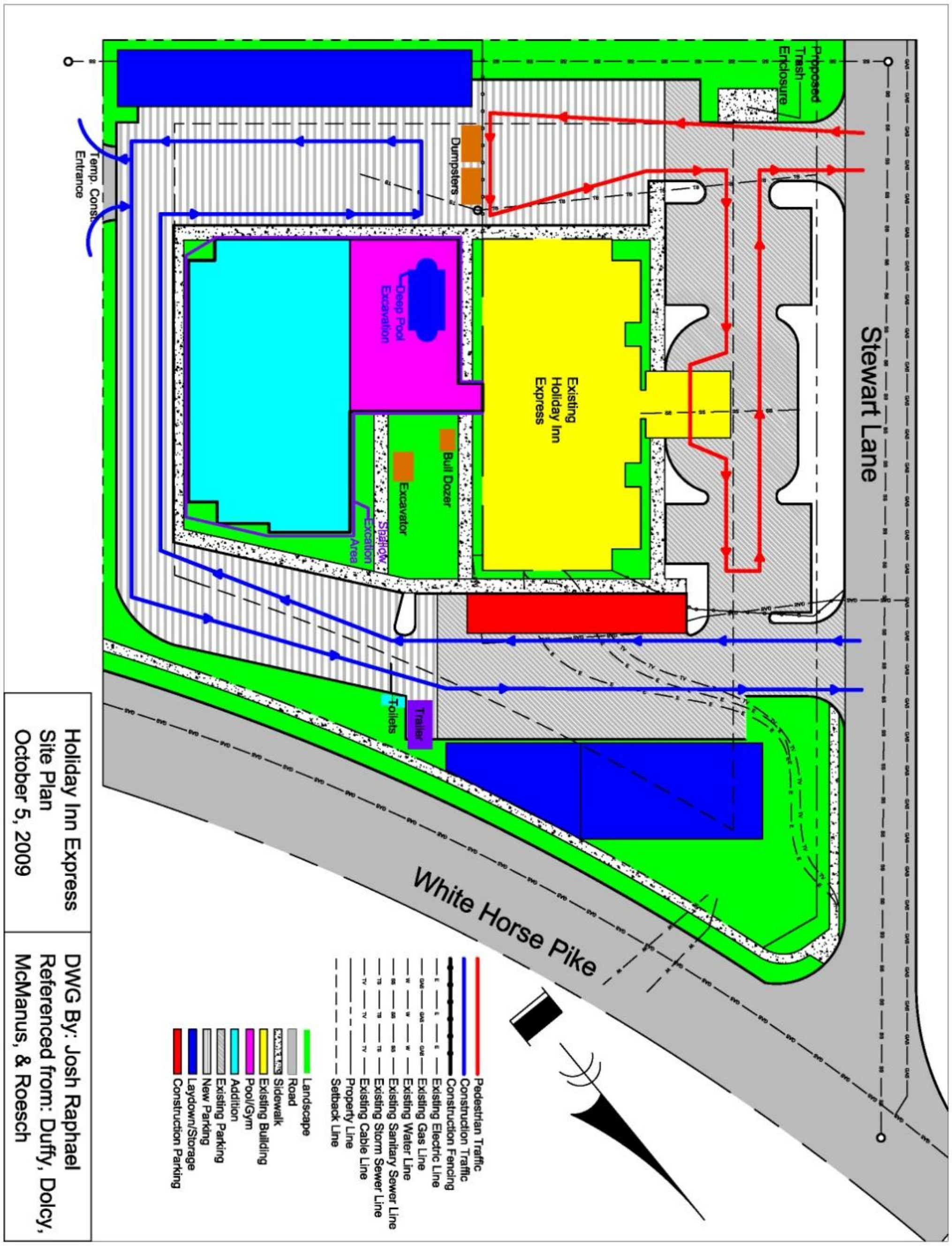
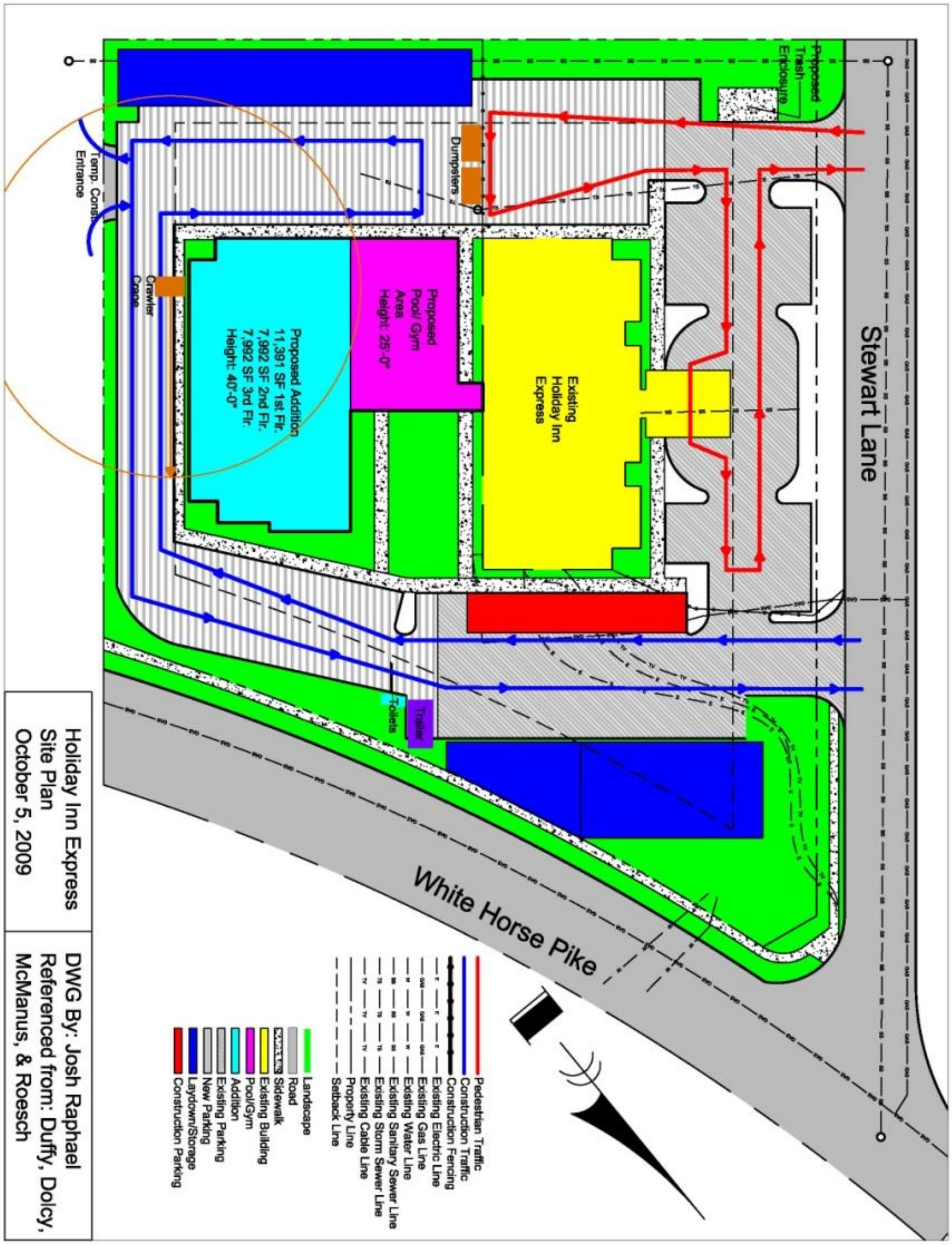

Proposed Trash Enclosure
Dumpsters
Temp. Const. Entrance
Deep Pool Excavation
Existing Holiday Inn Express
Bull Dozer
Excavator
Shallow Excation Area
Stewart Lane
Trailer
Toilets
White Horse Pike
Pedestrian Traffic
Construction Traffic
Construction Fencing
Existing Electric Line
Existing Gas Line
Existing Water Line
Existing Sanitary Sewer Line
Existing Storm Sewer Line
Existing Cable Line
Property Line
Setback Line
Landscape
Road
Sidewalk
Existing Building
Pool/Gym
Addition
Existing Parking
New Parking
Laydown/Storage
Construction Parking
Holiday Inn Express
Site Plan
October 5, 2009
DWG By: Josh Raphael
Referenced from: Duffy, Dolcy, McManus, & Roesch

Figure 3



Stewart Lane
White Horse Pike
Proposed Trash Enclosure
Dumpsters
Temp. Const. Entrance
Crawler Crane
Existing Holiday Inn Express
Proposed Pool/ Gym Area Height: 25'-0"
Proposed Addition 11,391 SF 1st Flr. 7,992 SF 2nd Flr. 7,992 SF 3rd Flr. Height: 40'-0"
Trailer
Toilets
Pedestrian Traffic
Construction Traffic
Construction Fencing
Existing Electric Line
Existing Gas Line
Existing Water Line
Existing Sanitary Sewer Line
Existing Storm Sewer Line
Existing Cable Line
Property Line
Setback Line
Landscape
Road
Sidewalk
Existing Building
Pool/Gym
Addition
Existing Parking
New Parking
Laydown/Storage
Construction Parking
Holiday Inn Express Site Plan October 5, 2009
DWG By: Josh Raphael Referenced from: Duffy, Dolcy, McManus, & Roesch

Figure 4

Thursday, October 1, 2009

Statement of Probable Cost

HIE - Apr 2010 - NJ - Atlantic City

Prepared By:		Prepared For:	
	,		,
	Fax:		**Fax:**
Building Sq. Size:	**27355**	Site Sq. Size:	**123048**
Bid Date:	**3/26/2009**	Building use:	
No. of floors:	**3**	Foundation:	
No. of buildings:	**1**	Exterior Walls:	
Project Height:	**40**	Interior Walls:	
1st Floor Height:	**10**	Roof Type:	
1st Floor Size:	**11391**	Floor Type:	
		Project Type:	

Division		Percent	Sq. Cost	Amount
00	**Bidding Requirements**	**3.56**	**4.60**	**125,863**
	Bidding Requirements	3.56	4.60	125,863
01	**General Requirements**	**5.19**	**6.70**	**183,350**
	General Requirements	5.19	6.70	183,350
02	**Site Work**	**8.11**	**10.47**	**286,309**
	Site Work	8.11	10.47	286,309
03	**Concrete**	**12.61**	**16.28**	**445,284**
	Concrete	12.61	16.28	445,284
04	**Masonry**	**4.39**	**5.66**	**154,916**
	Masonry	4.39	5.66	154,916
05	**Metals**	**2.19**	**2.82**	**77,272**
	Metals	2.19	2.82	77,272
06	**Wood & Plastics**	**8.84**	**11.42**	**312,278**
	Wood & Plastics	8.84	11.42	312,278
07	**Thermal & Moisture Protection**	**4.65**	**6.00**	**164,170**
	Thermal & Moisture Protection	4.65	6.00	164,170
08	**Doors & Windows**	**5.57**	**7.19**	**196,701**
	Doors & Windows	5.57	7.19	196,701
09	**Finishes**	**15.81**	**20.41**	**558,377**
	Finishes	15.81	20.41	558,377
10	**Specialties**	**0.99**	**1.27**	**34,802**
	Specialties	0.99	1.27	34,802
11	**Equipment**	**1.40**	**1.81**	**49,609**
	Equipment	1.40	1.81	49,609
12	**Furnishings**	**3.99**	**5.16**	**141,088**
	Furnishings	3.99	5.16	141,088
13	**Special Construction**	**0.93**	**1.21**	**32,972**
	Special Construction	0.93	1.21	32,972
14	**Conveying Systems**	**1.02**	**1.31**	**35,964**
	Conveying Systems	1.02	1.31	35,964
15	**Mechanical**	**13.24**	**17.09**	**467,554**
	Mechanical	13.24	17.09	467,554
16	**Electrical**	**7.53**	**9.72**	**265,855**
	Electrical	7.53	9.72	265,855
Total Building Costs		**100.00**	**129.13**	**3,532,364**

Figure 5

Structural Steel							
	Quantity	Unit	Mat. Cost	Labor Cost	Equip. Cost	Total Unit Cost	Total
Columns							
4" x 4" x 3/16" x 12'	5	LF	248	42	30	320	1600
5" x 5" x 1/4" x 12'	15	LF	326.5	43.5	31	401	6015
W10 x 68	20	LF	112	2.48	1.77	116.25	2325
Beams							
W12 x 22	14	LF	36.5	2.77	1.98	41.25	577.5
W12 x 26	44	LF	43	2.77	1.98	47.75	2101
W14 x 30	55	LF	49.5	2.71	1.93	54.14	2977.7
W16 x 26	26	LF	43	2.44	1.74	47.18	1226.68
W16 x 40	84	LF	66	3.05	2.18	71.23	5983.32
W24 x 76	33	LF	125	3.18	1.69	129.87	4285.71
						Total =	27091.91

Structural Wood							
	Quantity	Unit	Mat. Cost	Labor Cost	Equip. Cost	Total Unit Cost	Total
Floor Joists							
16" L65 TJI 1st Flr.	6.524	M.B.F.	3250	820		4070	26552.68
16" L65 TJI 2nd Flr.	5.244	M.B.F.	3250	820		4070	21343.08
16" L65 TJI 3rd Flr.	5.244	M.B.F.	3250	820		4070	21343.08
Studs							
2" x 6" 1st Flr.	7.32	M.B.F.	520	640		1160	8491.2
2" x 6" 2nd & 3rdFlr.	14.52	M.B.F.	520	640		1160	16843.2
						Total =	94573.24

Concrete							
	Quantity	Unit	Mat. Cost	Labor Cost	Equip. Cost	Total Unit Cost	Total
Floor Slab							
Slab on Grade (4")	11391	SF	1.36	0.75	0.28	2.39	27224.49
6x6 WWF W1.4 x 1.4	114	C.S.F.	18.05	20.5		38.55	4394.7
Foundation							
Cont. Footings	99	C.Y.	144	80.5	0.5	225	22275
Column Footings	22	C.Y.	104	13.2	0.43	117.63	2587.86
						Total =	56482.05

Masonry							
	Quantity	Unit	Mat. Cost	Labor Cost	Equip. Cost	Total Unit Cost	Total
CMU's							
Stair Twr. 8" CMU's	3720	SF	3.65	4.13		7.78	28941.6
Fnd. Wall 8" CMU's	2268	SF	2.68	3.5		6.18	14016.24
						Total=	42957.84

Figure 6

General Conditions Estimate				
Total Project Weeks	52			
Total Project Months	13			

Personnel	% of Time on Project	Total Billable Weeks	Cost/Week	Total Cost
Project Manager	100%	52	$1,450.00	$75,400.00
Site Supervisor	100%	52	$1,200.00	$62,400.00
Sevice Manager	100%	52	$1,200.00	$62,400.00
Safety Inspector	100%	52	$1,100.00	$57,200.00
Office Manager	100%	52	$700.00	$36,400.00
			Total =	**$293,800.00**

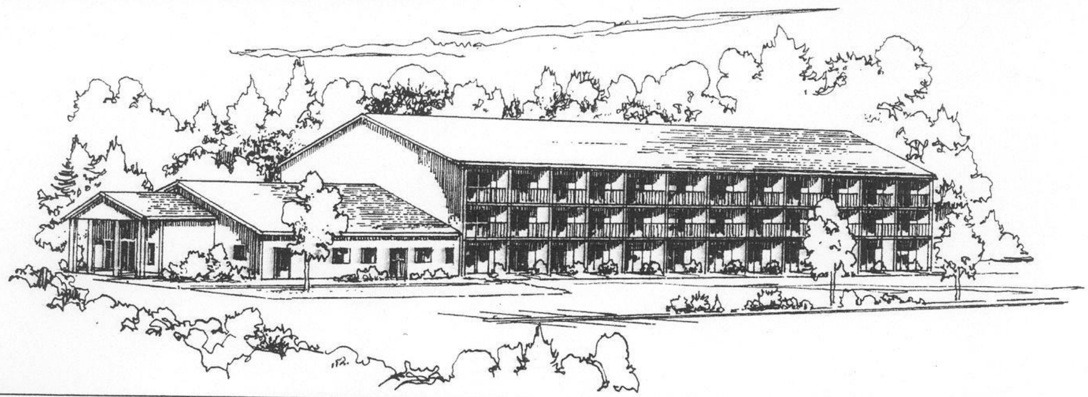
Utillities/Facilities	Frequency	Duration	Cost/Unit Time	Total Cost
Electric/Water	Monthly	13	$100.00	$1,300.00
Utility Hook-Up	Lum-Sum			$300.00
Internet	Monthly	13	$40.00	$520.00
Port-O-Potty	Weekly	52	$60.00	$3,120.00
Telephone	Monthly	13	$80.00	$1,040.00
Trailer	Monthly	13	$163.00	$2,119.00
			Total =	**$8,399.00**

Site Office Support	Frequency	Duration	Cost/Unit Time	Total Cost
Office Supplies	Monthly	13	$85.00	$1,105.00
Cell Phone	Monthly	13	$40.00	$520.00
Computer	Lump-Sum			$1,250.00
Trailer Janitorial Services	Monthly	13	$30.00	$390.00
Job Vehicle Fuel	Monthly	13	200	$2,600.00
Job Auto Allowance	Monthly	13	500	$6,500.00
			Total =	**$12,365.00**

General Requirements	Frequency	Duration	Cost/Unit Time	Total Cost
Temp Fencing	Lump-Sum			$3,864.00
Signage	Lump-Sum			$2,000.00
Dumpsters	Weekly	52	$350.00	$18,200.00
Survey and Layout	Lump-Sum			$1,280.00
Final Clean Up	Lump-Sum			$1,550.00
			Total =	**$26,894.00**

Figure 7

COMMERCIAL/INDUSTRIAL/ INSTITUTIONAL | **M.430** | **Motel, 2-3 Story**



Costs per square foot of floor area

Exterior Wall	S.F. Area	25000	37000	49000	61000	73000	81000	88000	96000	1040
	L.F. Perimeter	433	593	606	720	835	911	978	1054	107
Decorative Concrete Block	Wood Joists	161.35	156.70	151.00	149.40	148.35	147.80	147.40	147.05	146.1
	Precast Conc.	172.70	168.10	162.35	160.75	159.75	159.15	158.80	158.40	157.5
Stucco on Concrete Block	Wood Joists	160.55	156.00	150.20	148.70	147.65	147.05	146.70	146.30	145.4
	Precast Conc.	172.55	168.00	162.25	160.70	159.65	159.05	158.70	158.30	157.4
Wood Siding	Wood Frame	157.70	153.30	148.20	146.75	145.75	145.15	144.85	144.45	143.7
Brick Veneer	Wood Frame	164.85	159.90	153.30	151.55	150.45	149.85	149.45	149.05	148.0
Perimeter Adj., Add or Deduct	Per 100 L.F.	4.60	3.20	2.35	1.90	1.55	1.40	1.35	1.20	1.05
Story Hgt. Adj., Add or Deduct	Per 1 Ft.	1.60	1.50	1.15	1.05	1.05	1.00	1.05	0.95	0.95

***For Basement**, add $28.70 per square foot of basement area*

The above costs were calculated using the basic specifications shown on the facing page. These costs should be adjusted where necessary for design alternatives and owner's requirements. Reported completed project costs, for this type of structure, range from $60.40 to $310.55 per S.F.

Common additives

Description	Unit	$ Cost
Closed Circuit Surveillance, One station		
Camera and monitor	Each	1850
For additional camera station, add	Each	1000
Elevators, Hydraulic passenger, 2 stops		
1500# capacity	Each	62,800
2500# capacity	Each	66,300
3500# capacity	Each	69,800
Additional stop, add	Each	7825
Emergency Lighting, 25 watt, battery operated		
Lead battery	Each	282
Nickel cadmium	Each	805
Laundry Equipment		
Dryer, gas, 16 lb. capacity	Each	885
30 lb. capacity	Each	3600
Washer, 4 cycle	Each	1075
Commercial	Each	1450

Description	Unit	$ Cost
Sauna, Prefabricated, complete		
6′ x 4′	Each	5850
6′ x 6′	Each	6950
6′ x 9′	Each	8525
8′ x 8′	Each	10,100
8′ x 10′	Each	11,300
10′ x 12′	Each	14,000
Smoke Detectors		
Ceiling type	Each	187
Duct type	Each	480
Swimming Pools, Complete, gunite	S.F.	64 - 78.5
TV Antenna, Master system, 12 outlet	Outlet	315
30 outlet	Outlet	203
100 outlet	Outlet	194

Figure 8

Location Factors

STATE/ZIP	CITY	Residential	Commercial
MINNESOTA (CONT'd)			
559	Rochester	1.03	1.01
560	Mankato	1.01	.99
561	Windom	.82	.88
562	Willmar	.83	.90
563	St. Cloud	1.06	1.05
564	Brainerd	.96	.97
565	Detroit Lakes	.95	.96
566	Bemidji	.94	.97
567	Thief River Falls	.94	.95
MISSISSIPPI			
386	Clarksdale	.78	.81
387	Greenville	.84	.88
388	Tupelo	.79	.83
389	Greenwood	.80	.82
390-392	Jackson	.85	.87
393	Meridian	.83	.86
394	Laurel	.80	.84
395	Biloxi	.82	.83
396	Mccomb	.77	.81
397	Columbus	.78	.82
MISSOURI			
630-631	St. Louis	1.03	1.03
633	Bowling Green	.95	.94
634	Hannibal	.86	.89
635	Kirksville	.80	.88
636	Flat River	.94	.95
637	Cape Girardeau	.88	.94
638	Sikeston	.82	.88
639	Poplar Bluff	.83	.88
640-641	Kansas City	1.03	1.02
644-645	St. Joseph	.93	.95
646	Chillicothe	.87	.84
647	Harrisonville	.96	.96
648	Joplin	.83	.85
650-651	Jefferson City	.87	.92
652	Columbia	.87	.93
653	Sedalia	.85	.90
654-655	Rolla	.87	.85
656-658	Springfield	.87	.89
MONTANA			
590-591	Billings	.88	.90
592	Wolf Point	.84	.89
593	Miles City	.86	.88
594	Great Falls	.89	.91
595	Havre	.82	.89
596	Helena	.88	.90
597	Butte	.87	.90
598	Missoula	.85	.88
599	Kalispell	.83	.87
NEBRASKA			
680-681	Omaha	.91	.91
683-685	Lincoln	.87	.89
686	Columbus	.87	.88
687	Norfolk	.91	.90
688	Grand Island	.92	.91
689	Hastings	.93	.92
690	Mccook	.85	.88
691	North Platte	.92	.92
692	Valentine	.85	.88
693	Alliance	.85	.87
NEVADA			
889-891	Las Vegas	1.03	1.06
893	Ely	.85	.88
894-895	Reno	.93	.97
897	Carson City	.94	.97
898	Elko	.91	.90
NEW HAMPSHIRE			
030	Nashua	.94	.94
031	Manchester	.94	.94
032-033	Concord	.92	.92
034	Keene	.75	.78
035	Littleton	.81	.81
036	Charleston	.74	.76
037	Claremont	.75	.76
038	Portsmouth	.93	.94

STATE/ZIP	CITY	Residential	Commercial
NEW JERSEY			
070-071	Newark	1.12	1.10
072	Elizabeth	1.14	1.08
073	Jersey City	1.10	1.08
074-075	Paterson	1.11	1.09
076	Hackensack	1.10	1.08
077	Long Branch	1.11	1.07
078	Dover	1.11	1.08
079	Summit	1.11	1.08
080,083	Vineland	1.08	1.05
081	Camden	1.09	1.06
082,084	Atlantic City	1.11	1.05
085-086	Trenton	1.10	1.07
087	Point Pleasant	1.09	1.07
088-089	New Brunswick	1.11	1.08
NEW MEXICO			
870-872	Albuquerque	.85	.90
873	Gallup	.85	.90
874	Farmington	.85	.90
875	Santa Fe	.86	.91
877	Las Vegas	.85	.89
878	Socorro	.85	.89
879	Truth/Consequences	.84	.87
880	Las Cruces	.83	.85
881	Clovis	.85	.88
882	Roswell	.85	.89
883	Carrizozo	.85	.90
884	Tucumcari	.86	.89
NEW YORK			
100-102	New York	1.37	1.31
103	Staten Island	1.31	1.27
104	Bronx	1.33	1.26
105	Mount Vernon	1.14	1.14
106	White Plains	1.17	1.14
107	Yonkers	1.18	1.17
108	New Rochelle	1.18	1.14
109	Suffern	1.13	1.09
110	Queens	1.31	1.27
111	Long Island City	1.34	1.28
112	Brooklyn	1.35	1.29
113	Flushing	1.33	1.28
114	Jamaica	1.33	1.27
115,117,118	Hicksville	1.20	1.20
116	Far Rockaway	1.32	1.28
119	Riverhead	1.21	1.21
120-122	Albany	.94	.96
123	Schenectady	.95	.97
124	Kingston	1.02	1.06
125-126	Poughkeepsie	1.19	1.12
127	Monticello	1.04	1.06
128	Glens Falls	.88	.92
129	Plattsburgh	.92	.92
130-132	Syracuse	.96	.96
133-135	Utica	.94	.94
136	Watertown	.93	.96
137-139	Binghamton	.93	.93
140-142	Buffalo	1.04	1.02
143	Niagara Falls	1.00	.99
144-146	Rochester	.96	.97
147	Jamestown	.87	.90
148-149	Elmira	.85	.91
NORTH CAROLINA			
270,272-274	Greensboro	.83	.79
271	Winston-Salem	.83	.79
275-276	Raleigh	.84	.80
277	Durham	.83	.80
278	Rocky Mount	.73	.74
279	Elizabeth City	.75	.75
280	Gastonia	.84	.78
281-282	Charlotte	.85	.80
283	Fayetteville	.82	.81
284	Wilmington	.81	.77
285	Kinston	.74	.73
286	Hickory	.78	.75
287-288	Asheville	.81	.78
289	Murphy	.73	.71
NORTH DAKOTA			
580-581	Fargo	.78	.85
582	Grand Forks	.75	.82
583	Devils Lake	.78	.82
584	Jamestown	.73	.79
585	Bismarck	.78	.85

455

Appendix B

Figure 1

Product Specifications

Electrical Data

Measured at Standard Test Conditions (STC) irradiance of 1000 W/m², air mass 1.5, and cell temperature 25° C

Model Number		SL-001-150	SL-001-157	SL-001-165	SL-001-173	SL-001-182	SL-001-191	SL-001-200 Release Date TBD
Power Rating (P_{mp})	Wp	150 Wp	157 Wp	165 Wp	173 Wp	182 Wp	191 Wp	200 Wp
Power Tolerance (%)	%/Wp	+4, -5	+/-4	+/-4	+/-4	+/-4	+/-4	+/-4
V_{mp} (Voltage at Maximum Power)	Volts	65.7 V	67.5 V	69.6 V	71.7 V	73.9 V	76.1 V	78.3 V
I_{mp} (Current at Maximum Power)	Amps	2.28 A	2.33 A	2.37 A	2.41 A	2.46 A	2.51 A	2.55 A
V_{oc} (Open Circuit Voltage)	Volts	91.4 V	92.5 V	93.9 V	95.2 V	96.7 V	98.2 V	99.7 V
I_{sc} (Short Ciruit Current)	Amps	2.72 A	2.73 A	2.74 A	2.75 A	2.76 A	2.77 A	2.78 A
Temp. Coefficient of V_{oc}	%/°C	-.24						
Temp. Coefficient of I_{sc}	%/°C	-.02						
Temp. Coefficient of Power	%/°C	-.26						

System Information

Cell type	Cylindrical CIGS
Maximum System Voltage	Universal design: 1000V (IEC) & 600V (UL) systems
Dimensions	Panel: 1.82 m x 1.08 m x 0.05 m Height: 0.3 m to top of panel on mounts
Mounts	Non-penetrating, powder-coated Aluminum Up to 2.17 mounts per panel
Connectors	4 Tyco Solarlok; 0.20 m cable
Series Fuse Rating	23 Amps
Roof Load	16 kg/m² (3.3 lb/ft²) panel and mounts
Panel Weight	31 kg (68 lb) without mounts
Snow Load Maximum	2800 Pa (58.5 lb/ft²)
Wind Performance	208 km/h (130 mph) maximum Self-ballasting with no attachments
Operating and Storage Temp	-40°C to +85°C
Normal Operating Cell Temperature (NOCT)	41.7°C at 800 W/m², Temp = 20°C, Wind = 1m/s
Certifications/Listings	UL1703, IEC 61646, CEC listing IEC 61730, IEC 61646, CE Mark Application Class A per IEC 61730-2 Fire Class C
Warranty	25 year limited power warranty 5 year limited product warranty

Solyndra's panels come with all of the mounts, grounding connectors, lateral clips, and fasteners required to build a standard array.

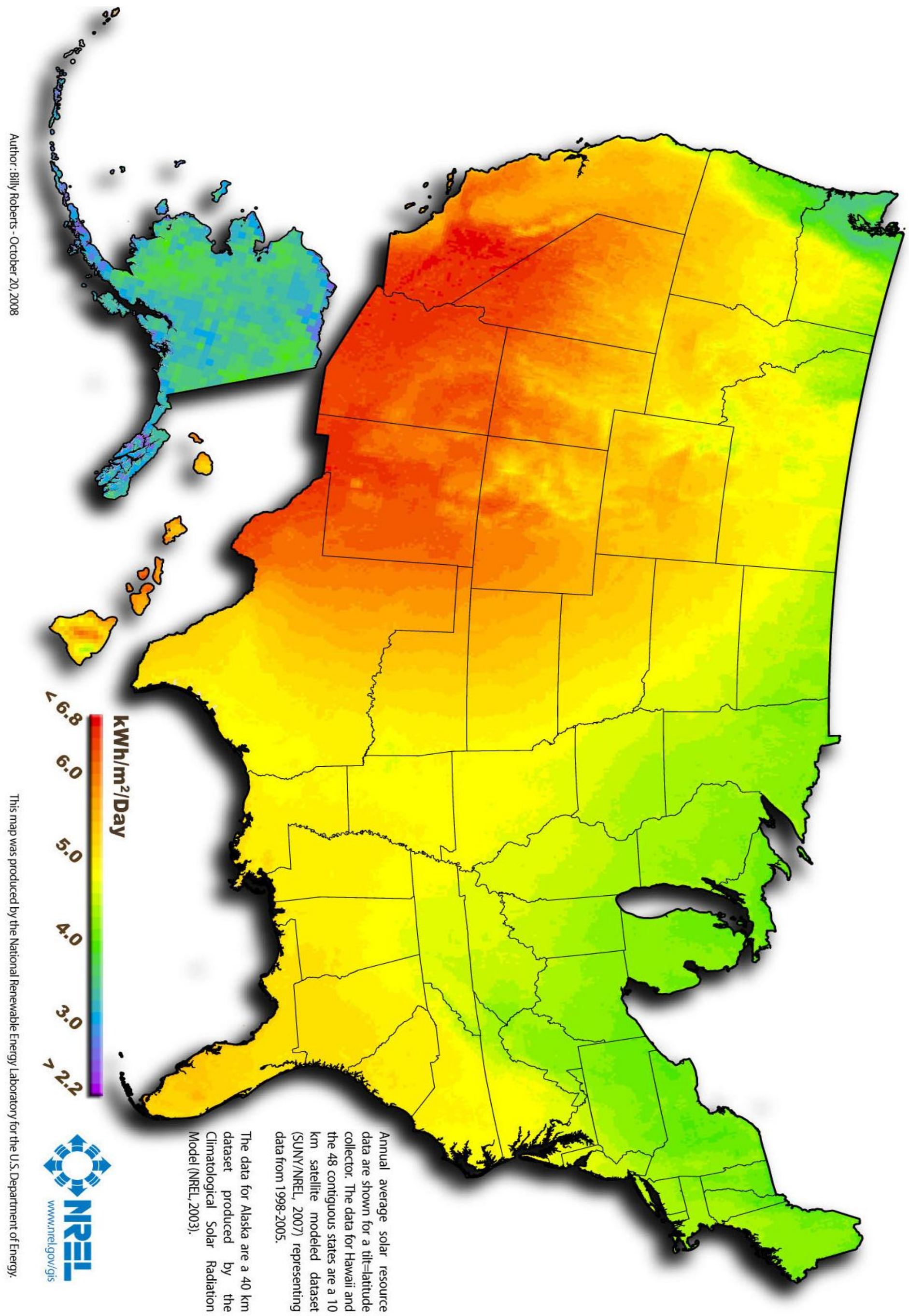
Specifications subject to change without notice.

SOLYNDRA™ The new shape of solar™

Solyndra, Inc. • 47700 Kato Road • Fremont, CA • www.solyndra.com

Revision: 3 / Released: 3/11/09

Figure 2



Author: Billy Roberts - October 20, 2008
kWh/m²/Day
< 6.8
6.0
5.0
4.0
3.0
> 2.2
Annual average solar resource data are shown for a tilt=latitude collector. The data for Hawaii and the 48 contiguous states are a 10 km satellite modeled dataset (SUNY/NREL, 2007) representing data from 1998-2005.
The data for Alaska are a 40 km dataset produced by the Climatological Solar Radiation Model (NREL, 2003).
NREL
www.nrel.gov/gis
This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy.

Figure 3

PVWatts

AC Energy & Cost Savings

Cautions for Interpreting the Results

Station Identification	
City:	Atlantic_City
State:	New_Jersey
Latitude:	39.45° N
Longitude:	74.57° W
Elevation:	20 m
PV System Specifications	
DC Rating:	95.5 kW
DC to AC Derate Factor:	0.770
AC Rating:	73.5 kW
Array Type:	Fixed Tilt
Array Tilt:	26.6°
Array Azimuth:	180.0°
Energy Specifications	
Cost of Electricity:	13.0 ¢/kWh

Results			
Month	Solar Radiation ($kWh/m^2/day$)	AC Energy (kWh)	Energy Value ($)
1	3.24	7611	989.43
2	3.92	8281	1076.53
3	4.69	10557	1372.41
4	5.35	11324	1472.12
5	5.76	12363	1607.19
6	5.90	11800	1534.00
7	5.91	12064	1568.32
8	5.61	11480	1492.40
9	5.20	10505	1365.65
10	4.35	9320	1211.60
11	3.26	7106	923.78
12	2.84	6477	842.01
Year	4.67	118886	15455.18

Appendix C

Figure 1

Estimated Energy Savings Results:

Building with R-Control SIPs save you 64% per year in energy usage.

That is a savings of $6,734.92 for the first year over conventional building methods by using R-Control SIPs.

Over 30 years this equals a savings of $447,198.69 by using R-Control SIPs assuming a 5% annual energy cost increase.

Estimated Energy Usage (MBTU) Comparison Results:
(the smaller the heat loss MBTU number, the better the energy savings)

COMPARISON CHART

CONVENTIONAL

R-CONTROL SIP

Heating Season		
Walls (MBTU)	98	59
Windows (MBTU)	79	79
Roof (MBTU)	35	47
Air Leakage (MBTU)	563	84
Total Heating Cost	$9,524.75	$3,306.01
Cooling Season		
Walls (MBTU)	16	10
Windows (MBTU)	13	13
Roof (MBTU)	6	8
Air Leakage (MBTU)	47	9
Total Cooling Cost	$1,007.78	$491.60
Total Cost	**$10,532.53**	**$3,797.61**

Note: MBTU = millions of BTUs

Figure 2

Estimated Energy Savings Results:

Building with R-Control SIPs save you 54% per year in energy usage.

That is a savings of $4,535.01 for the first year over conventional building methods by using R-Control SIPs.

Over 30 years this equals a savings of $301,124.66 by using R-Control SIPs assuming a 5% annual energy cost increase.

Estimated Energy Usage (MBTU) Comparison Results:

(the smaller the heat loss MBTU number, the better the energy savings)

COMPARISON CHART

	CONVENTIONAL	R-CONTROL SIP
	Heating Season	
Walls (MBTU)	98	59
Windows (MBTU)	79	79
Roof (MBTU)	35	47
Air Leakage (MBTU)	394	84
Total Heating Cost	$7,447.74	$3,306.01
	Cooling Season	
Walls (MBTU)	16	10
Windows (MBTU)	13	13
Roof (MBTU)	6	8
Air Leakage (MBTU)	37	9
Total Cooling Cost	$884.88	$491.60
Total Cost	**$8,332.62**	**$3,797.61**

Note: MBTU = millions of BTUs

Appendix D

Figure 1

AMANA® DIGISMART™ PTAC

Amana's® Quietest and Best Selling Unit Ever!

Product Features Include:

Heat pump and cooling only models with nominal capacities of: 7,000 BTU/h - 9,000 BTU/h - 12,000 BTU/h - 15,000 BTU/h

EER as high as 12.8
COP as high as 3.3
5-year warranty
Available with electric heat
Available with hydronic heat
On-board energy management software:

OCCUPANCY SENSOR

The occupancy sensor is a combination door-switch and room motion sensor powered by 2 AAA batteries that are included in the kit.

Once wirelessly linked to Amana® DigiSmart™ PTAC, the occupancy sensor monitors the room.

When the room is unoccupied, the sensor automatically activates the temperature set-back function on the in-room PTAC.

The setback function is a part of the DigiSmart™ standard Energy Management System (EMS) in the DigiSmart™ PTAC control board.

The DigiSmart™ EMS software can be set in up to 100,000 set-back combinations to maximize energy savings and is programmed through either the remote thermostat or the platform controller.

The sensor communicates to the Amana® DigiSmart™ suite of devices via an encrypted 2.4 Ghz signal using the 802.15.4 standard.

For the door sensor to operate, the in-room PTAC must be equipped with a DigiSmart™ Gateway Antenna.

Appendix E

Figure 1