American Speech - Language - Hearing Association

AtSite Real Estate

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Rockville, MD
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Final Report

American Speech Language – Hearing Assoc. National Headquarters
Rockville, MD • Michael V. Abbondante • Construction Management

http://www.arche.psu.edu/thesis/eportfolio/2007/portfolios/MVA107/

Structural:

-Slab on Grade with C.I.P. piers, foundation walls, and grade beams.

-Structural Steel Skeleton above grade

-- Shear walls used for below grade support

-- Glass curtain wall, and pre-cast panels connected to steel for facade

Building Overview:

Name: American Speech Language -Hearing Assoc. National Headquarters

Location: Rockville, MD

Use: Office Space

137,000 Sq. Ft.

5 Stories Above Grade 2 Below Grade

Project Costs: $23 Million

LEED Silver Rating

Construction: July '06 – October '07

Mechanical:

(2) 200 Ton Chillers with condenser and evaporator

-(2) Cooling Towers

- Heat Recovery Unit

-8000cfm ahu

-25000cfm ahu

-(3) 22000cfm ahu

-23000cfm ahu

Architecture:

-Glass curtain wall consisting of seven different types of glass including two storefront glasses, three different glass finishes, and two spandrel glasses.

-The remaining facades are three different types of pre-cast concrete. Each is a different shade of grey. The darkest of which is used to emphasize aspects of the facades.

-Small Metal Panels will also be included on the curtain wall and facades. They provide no structural support but help highlight the building.

Project Team:

Owner: American Speech Language – Hearing Assoc.

Developer: AtSite Construction

Construction Manager: Davis

Architect: Boggs and Partners

Structural Engineer: Cagley and Associates

MEP Engineer: Vanderweil

Lighting Electrical:

The lighting electrical is a separate bid and is still in the design phase.

EXECUTIVE SUMMARY:

The ASHA is a non-profit organization that is in the process of construction of their new headquarters in Rockville, MD. This project offered many interesting opportunities in the field of construction management involving all aspects from cost and schedule analysis to sustainability and procurement methods.

The ASHA is attempting to attain a LEED silver rating for sustainable design. Green Globes is a new sustainable rating system introduced to America in 2005. This analysis is designed to compare and contrast the systems through surveys, case studies, and by comparing the scorecards of LEED and Green Globes in reference to the ASHA headquarters. These comparisons will not only give insight for the ASHA project but hopefully for sustainable rating in the future.

Traditional design-bid-build was used by the ASHA. However many procurement methods offer different opportunities such as bid-build. Each of these systems is compared through the advantages and disadvantages of both from an economical stand point to the opinions of multiple owners in the construction field. The ASHA was then analyzed based upon the owners opinions as well as an economical standpoint and the better of the two systems was selected. This study also hopes to show what may become the future procurement method for construction.

Energy efficiency of the ASHA building is extremely important especially with a LEED silver rating attempt. The windows of the building were replaced by multiple low energy high efficiency windows and then through EQuest calculations were run to compare energy savings. Finally the prices of the windows themselves were compared and an analysis was completed of whether or not the energy savings were efficient enough for the higher initial costs.

The columns of the building were originally designed as steel to reduce the schedule and complete the building faster. Using pcaColumn the steel was then re-designed as concrete members and the savings were calculated. The extension in the schedule do to the concrete was also analyzed to determine the cost of back renting to discover if the material change was cost effective.

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BUILDING STATISTICS:

Name:
American Speech-Language Hearing Association National Office
Location:
Rockville, MD
Function:
Office in suburban area of Maryland
Size:
137000sq ft office
Stories:
5 stories above grade 7 total levels
Project Team:
Owner:
ASHA
CM:
Davis Construction davisconstruction.com
Development Team:
Atsite Construction
Building Arch.:
Boggs and Partners Architecture boggspartners.com
Structural Eng.:
Cagley and Associates cagley.com
MEP Eng:
Vanderweil vanderweil.com
Civil Eng.:
Loiederman Soltesz Associates lsassociates.net
Landscape Arch.:
Lewis Scully Gionet lsginc.com
Construction Dates:
July 1, 2006 – October 15, 2007
Cost:
Building:
23 Million
Soft:
Owner Restricted
Total:
23 Million
Delivery Method:
Guaranteed Maximum Price

Design/Functional Components:

LEED silver rating building that will act as an office building. The building will be a standard office building that will hold the administration offices of the national headquarter for the American Speech-Language Hearing Association.

Codes:

Building, Plumbing, Mechanical:
2003 IBC

Fire Prevention:
NFPA 2003

Sprinkler, Fire Alarm:
NFPA 1999

Energy:
1998 International Energy Conservation

Elevator:
MD State Elevator

Handicap:
ADAAG latest edition

Zoning:

City of Rockville Falls Grove Development Guidelines

Site Zoned:
CPD-0004

Site Area:
7265 Acres

Footprint:
24116sq. ft

Gross Floor:

Lower Level Parking	0sq ft
Mid Level Parking	14622sq ft
Plaza	23285sq ft
Second	24116sq ft
Third	24116sq ft
Fourth	24116sq ft
Fifth	23615sq ft
Penthouse	3200sq ft
Total	137070 sq ft

Height:
83ft 6in

Historical:

N/A

Envelope:

The envelope consists of structurally reinforced pre-cast concrete. The concrete façade is used on three of the buildings sides. It is an architectural concrete with three specific colors used for the concrete. Each consisting of a white, gray, and slightly darker gray, on the fourth side of the building and entrance of the building a glass curtain wall is in place. The glass rises on the upper four stories of the building and is surrounded by metal panels. The pre-cast section of the envelope also has strip windows on each of the levels. The roof is a TPO or thermoplastic membrane roof with insulation underneath that rests on metal decking.

Structural System:

The structural system is an interesting one in that it is an integrated steel and concrete building. The building begins with a simple poured in place concrete slab. Then concrete columns will be poured on for the below grade levels. Two of the seven total stories are below grade. The columns are highly repeatable and are primarily 18x30 columns at 5000psi. In each of these columns 9 #7 rebar are used to help with tension support. Once the above grade levels are reached the system switches to a structural steel system, in which the pre-cast panels and glass curtain wall will be attached to. The steel columns vary in size but the two primary columns used are 14x53 and 12x40. A steel deck is then placed on top. The decks are two inches thick and are 18 gage. The concrete beams that will have to be poured on site for the lower levels range from 10x23 to 30x24 with the most common size being 12x18. Most of these beams again have #8 and #9 rebar in them to help with tension. Finally the building has seven shear walls that are of 4000psi concrete and simply help with structural stability.

Mechanical System:

The mechanical system in the ASHA headquarters consists of two 200 ton chillers with condenser and evaporator, two cooling towers on the roof, a heat recovery unit, and air handling units. The mechanical room is located in the penthouse on the top floor as well as the roof for the open cell cooling towers. The heat recovery unit is located in the penthouse and serves for ventilated air. There is one air handling unit per floor each of a slightly different size due to the size of the floor and its primary purpose. The first floor contains a 25000cfm, the basement has a 8000cfm air handling unit, and the second, third, and fourth floors all contain 22000cfm air handling units while the fifth floor has a 23000cfm unit. There are two open cell cooling towers on the roof of the building. Each acts as a condenser and is an induced draft counterflow cooling tower. The two water chillers are centrifugal. The pumps that are contained in the chiller plant are composed of three primary chilled water pumps and three condenser water pumps. Each floor also

consists of a set of diffusers and the fire suppression system is simply the sprinkling of the entire building.

Electrical System:

The electrical system has not been completely determined due to the fact that the space is not being fitted out yet. The electrical will come in the next awarded bid. However in the lobby lighting has been determined. The only thing determined for the lighting in the lobby is the lighting fixture schedule. The size of the lighting for the requirements as well as redundancy will not be determined until the next bid is awarded.

Building Façade:

The building façade is very unique and interesting. It consists of not only a glass curtain wall with multiple glasses, pre-cast concrete panels with different finishes, but also uses steel on the façade for aesthetic purposes only. The glass curtain wall with the primary wall and faces the road but also south which will help with energy absorption and the LEED rating. There are seven different types of glass used on the curtain wall. There are three different types of vision glass that are used on the upper levels primarily are being inserted as gigantic sheets. There are two types of spandrel glass being used, primarily for narrow strips that run across the curtain wall as well as for the strip windows on the other sides of the façade. Finally on the lower levels at ground level two types of storefront glass will be used. One will be tempered and the other will not. The curtain wall also is using metal panels. These will simply be for aesthetic purposes only and will be attached in a similar fashion as the glass. They will be used to help differentiate the levels as well as help the building stand out. One the other sides of the façade three different pre-cast panels will be used. They will vary in color from a light grey, dark grey, and near black color. These are simply being used for aesthetic purposes. The dark black panels are spandrel panels and will be used to primarily "highlight" areas rather than provide the primary closure of the building.

Project Schedule Summary:

The Schedule in appendix a the schedule of all major milestones of the project as well as the important concerns for Davis Construction during preconstruction.

The foundations are very simple but contain a few key elements during construction. The under slab piping must be laid not only on time in order to maintain the schedule but also properly. If there is a problem with the piping and it is not discovered until after the first pour. Either certain pipes or utilities will have to be above the slab or certain areas of the slab may be torn up so that the piping can be corrected. This could and would have a serious impact on a schedule that is crucial to this project. Obtaining the building permit is also essential because the job will be forced to wait until the building permit is obtained which is scheduled to be obtained just before the first pour which again could lead to schedule difficulties. Also the slab will be completed in four pours while walls and other pours occur in-between. If the slab pours are delayed or are not poured properly so that they mesh together re-pours may need to occur again greatly affecting the schedule.

The steel is also a key element. It is important that the steel be erected on time. Not only is obtaining the steel on time important due to its lead time but erecting it quickly is essential. As multiple levels of steel are erected at once such as the second and third floor the concrete for those floors will be waiting until the erection is complete. Meanwhile while pours are occurring the upper floors of steel will be erected keeping the schedule concise and time dependent.

The sequencing of this job is very straight forward. The project will begin with the basic site work and then continue out of the ground. Once the floors begin to be poured and the steel is placed the mechanical systems will be installed. Since there are no real concerns with interior delays due to the lack of an electrical system the overall

enclosure of the building is what is considered most important. Therefore, the project will place the steel and pour all of the floors. Once this is complete the curtain wall and enclosure will begin. While enclosure begins the mechanical systems will begin to be placed at the same time, that way time can be saved in the schedule.

SITE LAYOUT PLANNING:

The advantage to having the project be found in Rockville, MD is that there is very little or no concern for site congestion. Although the site has little to worry about with congestion of other buildings due to the speed of the project it is essential to have the site laid out properly to conserve the most space throughout the project.

While setting up the site one of the essential aspects was having the sediment pond immediately set up. The pond then had a pipe run to it so that any rain water that could have ruined the site due to the water tables was avoided. It was also decided that two different cranes would be used throughout the project which was essential to the sequencing. The project would begin with a tower crane to help with the C.I.P. and formwork. Once the site work was completed the crane would be disassembled and removed from the site and a mobile crane would then enter the site. The mobile crane simply allows for better mobility and for more lifts to occur in a day. The building is not very high, but it is quite long and oddly shaped. Therefore, a tower crane may have difficulty with some of the lifts while a mobile crane could simply move to the most convenient location and continue with the lift.

Although there are no surrounding buildings, the building footprint, stockpiling, and pond all require a lot of the land. The land on the project is the only available place to store machines, workers need to park, and trailers needed to be placed. Access to the site became an essential concern. Trucks and other equipment needed to easily be able to leave the main road enter the site, drop off or pick up the necessary items and leave again. The main access road then became a simply u at the beginning of the site that could be easily accessed and parking was available just off to the side for both workers and machinery that would allow them all to be off and out of the way of construction.

The trailers and temporary utilities were then placed near the road that way

workers and subs could easily access the trailers and they were close enough to the site that it was easy to observe what was occurring on the site. Although the site is large the same rules apply on the importance on conserving space and maintaining easy access are essential to every slight plan. A site layout plan can be observed in appendix b.

UN-UNIFIED SUSTAINABLE RATING SYSTEM AND INDUSTRY IMPACTS:

Problem:

Although there is popularity of sustainability and green buildings in the industry today there is a lack of unification on one consistent rating system that can be used to compare all buildings. This along with the abundance of current rating systems confuses owners and impacts the overall decision of which method to use. This was true of the ASHA that is attempting LEED silver based on the recommendation by those involved in the project and its current popularity in the industry without research to determine which system would be best for the project and owner.

Solution:

Projects should be analyzed on the project type, as well as owner, and overall experience of the GC to determine which sustainability rating is most suitable. This method should be used until a unified sustainable system is determined for all building projects. In the case of the ASHA the LEED system used will be compared to the "simpler" survey based system of Green Globes.

Methodology:

The history of each of the sustainable systems was researched to determine the base of their popularity. Each system was then analyzed on their ease of use and methodology for completing, as well as, their overall construction impacts. Past case studies of the comparisons of Green Globes and LEED were then analyzed, and through surveys market trends and opinions of owners and well as GC's were determined.

Finally the current LEED scorecard was compared to the Green Globes system and a comparable score was determined for a final recommendation based on the project.

Sustainability History:

LEED accreditation was created by the USGBC or United States Green Building Council. The USGBC is a "coalition of leaders from every sector of the building industry working to promote buildings that are environmentally responsible, profitable and healthy places to live and work." This group was primarily founded to bring sustainable awareness to the rest of the country and show the importance of green buildings. The LEED rating system came into inception in 1998. It is considered to be a scoring system based on the "consensus" of a diverse group of members from the USCGBC. In order for a LEED point to pass a two-thirds majority must approve the concern or idea. Since LEED was the first sustainable rating system in the United States it has quickly become the most popular used by those in the industry today.

Green globes actually originated in Canada in early 1996 as a BREEAM project or Building Research Establishment's Environmental Assessment Method project. A system was designed to simply rate existing buildings on a sustainability level. This project quickly grew and over the years has evolved into an online survey style rating system of the sustainability of construction projects from Canada to the U.K. In 2005 the Green Globes initiative was adopted in the United States. Shortly thereafter in late 2005 the Green Globes system was the first sustainable rating system adopted by the ANSI or American National Standards Institute.

LEED may be the oldest methodology of rating in the United States which is where its popularity stems from, but the newer Green Globes system with an ANSI approval can not be ignored. Just as both systems have very different beginnings the methodology of each system is also very different.

Sustainable Methodology:

LEED is a rating system that uses specific requirements is six categories to score points for their completion on a project and a comparable score is then given. LEED is a quite complex method that requires both a vast knowledge of not only the system and how to score points but also that of the building. Not only is the system itself considered complex, but all scoring is done by paperwork and not online. Points in this system are only awarded on completion and are not considered in the design phase or through out the project. These points are awarded over six major areas that are considered most important to the construction industry; sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, and innovation and design-process. Scores can vary from 26 to 69 points ranging from simple certification to the fourth and highest rating of platinum.

The primary methodology of Green Globes appears to be nearly identical on the surface, however the system can be considered quite different. The project is awarded accreditation on a point basis much like that of LEED. This point system is however on a 1000 point scale from 350 for one globe to 850 for the possibility of four globes. Green Globes like that of LEED also contains four levels of rating. Green Globes also uses criteria in specific categories two of which do not exist in LEED; project management, site, energy, water, resources, emissions and effluents, and indoor environment. Although these similarities exist this is where it ends between the two systems, the methodology is very different. Green Globes is considered the simpler of the two methods. It is an online survey that is completed as the project is being completed. Points for this system can be scored for completion but also for project design. The system consists of a simple survey that “can be completed by any individual with base project

knowledge.” The rating begins at the beginning of the project and are checked by a third party of Green Globes to determine what points will be awarded. A final analysis is done at the end of the project and then the final rating is given to the project.

Construction Impacts:

Although the overall use of the systems may be different it is there overall impact on the construction process that has the greatest impact on a project. The most important of these impacts are the cost and schedule of a project. Both of these aspects can be affected greatly by the style of sustainable system for rating.

Ironically these are two of the primary concerns with the LEED method of rating. The cost of LEED certification can be quite substantial. Registration alone for LEED is $750 to $3000 whereas Green Globes uses a flat rate of registration of $500 for any project. That does not include the final analysis of the system or rating. Eric Trulove the Director of Sustainable Services at the Renschler Co. in Madison points out that a Green Globe project at a maximum will cost $10,000 and that a LEED project at a minimum with cost $35,000. Another concern for General Contractors is having to pay for employees to become LEED certified. Projects will receive a LEED point if the project has a LEED certified employee on the job. However, this is not the only concern. As stated previously LEED is considered a complex system that is considered to require a large knowledge base of the system, requirements, and how points can be scored. Therefore, it has become important to General Contractors to invest in LEED certified individuals. Green Globes does not require this certification. Instead the entire survey can be completed by someone with a limited knowledge of the project, not the system, and the final analysis will be done by those involved in the Green Globes process through out the project.

Schedule is also highly important in the construction industry. A shorter schedule allows owners to open a building sooner. This enables tenants to begin to rent and move in allowing the owner to begin to turn a profit. The primary concern with LEED involves the long commissioning period after the building is complete. Many LEED points are attained in commissioning therefore the process can be long and drag the overall project past the expected completion date. Although Green Globes also scores points based on commissioning since the entire process is monitored throughout the entire length of the project it can be easier to complete. Another concern to the projects schedule is that LEED is a completely paper based system. This adds a large amount of paperwork to any project. These papers must be completed and filed properly in order for points to be accredited a project. These papers add great concern to a general contractor because the project is continually changing adding standard change orders, and schedule adjustments, the addition of LEED sheets adds to the amount of paperwork that if lost could cost a project greatly in either money or LEED rating. Since the Green Globes system is completed completely online, this additional paperwork does not become a concern and can be avoided.

Case Study Analysis:

The University of Minnesota's Timothy Smith completed a Green Globes and LEED comparison on a courthouse in Washington D.C. The courthouse was a $57 million that attempting a LEED certification rating. Through Dr. Smith's research he discovered that although both LEED and Green Globes wish to improve sustainability and have similar criteria they are quite different. He discovered that 80% of all information found in Green Globes could be found in LEED and 85% of LEED data could be found in Green Globes. Although these systems seem similar he found it difficult to compare the two systems.

The difficulties began with that of pre-requisites for each system. Both systems require pre-requisites before a project can be assessed. However, while LEED does not score any points for these pre-requisites Green Globes allows for up to 69 points to be attained. He believes this can lead to an easier certification by Green Globes.

Lower levels of assessment are also quite different. LEED provides most of its base points into materials, such as local materials used, and the recyclablility of the material. Green Globes on the other hand focuses on the energy, from lighting to overall energy consumption. Not only are different criteria focused upon, but specific points can be scored in completely different areas. Public transportation for example in Green Globes is found in energy, but in LEED it can be found under sustainable sites. To show this Dr. Smith analyzed each rating system and the percentage of each criterion required to attain a specific rating. He did this by creating his own rating system that included the broad topics of each system so that nearly all aspects of each system could be included. As can be seen below although most of the ratings are near in percentages the materials and energy categories can be quite different.

= Entry Level Certification (One Globe; Certified)
= Two Globes; Silver Certified
= Three Globes; Gold Certified
= Four Globes; Platinum Certified

Green Globes v.0

Harmonized Category	Pnts.	%	%1G	%2G	%3G	%4G
Energy use	300	30%	86%	55%	43%	35%
Water use	75	8%	21%	14%	11%	9%
Pollution (emissions, solid waste, effluents)	100	10%	29%	18%	14%	12%
Material/Product Inputs	90	9%	26%	16%	13%	11%
Indoor air quality & occupant comfort	200	20%	57%	36%	29%	24%
Transport	80	8%	23%	15%	11%	9%
Site ecology	115	12%	33%	21%	16%	14%
Other sustainable systems & processes	40	4%	11%	7%	6%	5%
Total Available/Required Points		1000	350	550	700	850

LEED 2.2

Harmonized Category	Pnts.	%	%C	%S	%G	%P
Energy use	15	22%	58%	45%	38%	29%
Water use	4	6%	15%	12%	10%	8%
Pollution (emissions, solid waste, effluents)	6	9%	23%	18%	15%	12%
Materials	11	16%	42%	33%	28%	21%
Indoor air quality & occupant comfort	14	20%	54%	42%	36%	27%
Transport	4	6%	15%	12%	10%	8%
Site ecology	9	13%	35%	27%	23%	17%
Other sustainable systems & processes	6	9%	23%	18%	15%	12%
		69	26	33	39	52

*Percentages refer to the percentage of points required at the respecitve certification level that could be attained based on the respective category alone

Once an overall system was determined Dr. Smith then attempted to rate the five story courthouse in Washington D.C. that was originally analyzed as LEED certified. Any value that was found in the LEED scorecard was marked as yes on the survey. Any information however that could not be found or determined was marked with the appropriate no. Smith believes this led to a conservative Green Globes score because there were specific questions asked in Green Globes that were not even considered in LEED. However he found the points for each category and determined the percentage in each category shown in the graph below.

He was able to determine that the D.C. Courthouse would have determined a Green Globes rating of two globes quite easily. For example although materials is close in percentage below, Green Globes scores points for the durability of the materials used which couldn’t be scored from LEED since Green Globes focuses more one lifecycle. Therefore, although the project could only attain a LEED certification, based upon a

"conservative" rating two globes could have been easily attained. He then recommends the use of Green Globes over that of LEED.

Universy of Minnesota's D.C. Courthouse Analysis		
Rated Topics	***LEED (%of pts attained)***	***Green Globes(% of Points attained)***
Sustainable Sites	70	96
Water Efficiency	60	32
Energy/Atmosphere	11.7	54
Materials/Resources	30.7	31
Indoor Environmental Quality	53	58
Management*	n/a	94
Emmission Effluents*	n/a	37

Current Market Trends:

Many of the critics of both LEED and Green Globes have the same criticism of each. LEED is criticized on many aspects as well is Green Globes. LEED by many articles is criticized for its complexity and cost. The strong knowledge base required for LEED is always a concern. As stated before the overall cost becoming LEED certified is also important as well as the months after completion that it can take to complete commissioning to attain the LEED rating. Many projects also have a concern for losing LEED points. On many projects there is miscommunication or misunderstanding which can lead to the loss of LEED points at the end of a project This could cost a project a score and rating and a large sum of money. Another concern with LEED is point

chasing. This is when General Contractors tend to interpret LEED points to their advantage in order to score points while not making that large of a sustainable impact.

Green Globes also has its concerns as well. Since the system uses such a yes or no survey, many of the points can be left to interpretation. This can lead to a misunderstanding about points and once again those points may not be scored on the final project. Green Globes has also been described as hollow in a number of articles. This refers to the fact that points can be scored for design as well as completion. Points can then be scored for design alone, but may not be fulfilled in the final project. This leads to a false score because although the design may be sustainable the final building did not meet the majority of the designs, but was still able to attain a rating.

There are concerns for both systems, but the final assessment comes from that of the owners and general contractors. Through interviews of those at Barton Malow, Davis, and assorted owner including the ASHA opinions of each system could be determined which can be seen in appendix D. Many owners prefer LEED because it is currently the competitive sustainable rating system. It is the belief of many GC's as well as owners that LEED is the future of the industry and will be what all building sustainability is soon compared to in years to come. Some major General Contractors and especially owners had never even heard of Green Globes and the potential it has. The government is also supporting systems such as Green Globes now, but it was a primary supporter of LEED which is why so many government or non-profit organizations that have attempted sustainability have gone LEED.

Once the cost benefits and simple method of Green Globes was brought up however many owners, but especially GC's became interested. Not only could cost possibly be saved, but employees would not need to be trained and their time could be focused on the project rather than the LEED rating. Many GC's believe that too much focus is being placed on sustainability and project managers are forced to worry about the final LEED rating rather than the project itself. Green Globes provides the opportunity to

allow an intern to complete the sustainability survey quite easily. Owners also commended Green Globes on their ANSI rating approval.

Unfortunately, both owners and GC's see the industry continuing to grow with LEED, because of its popularity and use by the government. It is what many owners feel they need to use in order to remain competitive and that it is how their building will be compared to others in the future.

Conclusion & Recommendations:

The ASHA is a small non-profit organization located in Rockville, MD. It is a smaller project at $27 million and both cost and schedule are crucial. The government in Maryland just began to support Green Globes projects financially just as they do LEED projects in that region. Financially the project would then make more sense as a Green Globes project. Costs is highly important and on a smaller project the savings of using Green Globes from the overall of certification to the extended time for commissioning of the project would be great. The schedule is also crucial. The ASHA is currently paying back rent until they are able to move into the new complex. If they were able to move in earlier it could save costs on the project by preventing more back rent to be paid.

An equivalent Green Globes scorecard was also completed, by using the current LEED scorecard used and transferring the points. Like the D.C. courthouse project points were only assessed and given in those categories that were met in both systems or could be answered by the General Contractor.

Green Globes Summary		
Project Management (40/50)		Indoor Environment (111/200)
Site (65/115)		Water (55/100)
Energy (241/360)		Resources/Building Materials (40/100)
		Emmissions and Effluents (28/75)
	Final Score (580/1000)	
	Green Globes Score: Two Globes	

Both scorecards can be seen in appendix C. Although the final score was two globes this is a highly conservative score. It is my belief that this project could have attained a three globe score. It was able to; however, meet the requirements of the project. The ASHA was attempting a LEED silver rating and the equivalent of two globes was met.

The only disadvantage the Green Globes truly has on the this project is it's popularity. The owner was not truly aware of Green Globes and as a non-profit organization LEED seemed the natural choice. It is my final recommendation that if this project could have been rescored it should have been scored a Green Globes project to conserve cost and schedule while possibly providing a higher score.

Procurement Method Selection and Impacts:

Problem Statement:

The proper procurement method selected for individual projects has been debated for years. The traditional design – bid – build has always remained the favorite among owners and has been the standard in the industry. Although it is so popular it is not always considered the best method for every project. Design – build is a method that is continually growing in popularity. Many CM's are open to the use of design – build and the ability to impact a project from the design phase.

The ASHA elected to use the traditional method as a first time owner and non – profit organization. The current market trends as well as their inexperience were the primary reasons for the traditional system being used. This project may have greater benefited from the use of a design – build method since the overall cost and schedule were so important to the project.

Solution:

To determine the proper procurement method for a project it should be analyzed on multiple levels. These include the laws of the government, the traits of the owner and project including construction experience, and complexity. All of these aspects will be analyzed in relationship to the ASHA and the construction of the new headquarters to determine whether the traditional method selected or design – build method would have been more appropriate.

Methodology:

The procurement methods will be analyzed and compared on many levels and rating systems. First the method of each system will be analyzed to determine how each system is used in the construction industry and what makes each system so different. Next the overall impact of each on the construction industry will be compared through the use of articles and individuals opinions. What makes each system unique and popular with be compared to gain a further understanding of procurement in construction today. Survey responses will then be compiled and compared to understand how both owners and GC's feel about each method.

These comparisons and opinions will then be used to analyze the most appropriate method for the ASHA. The procurement laws of Maryland will first be analyzed to ensure that these laws will have no affect on the procurement method selected and if there are restrictions what do they consist of. A PDSS analysis will then be performed to analysis both the owner and the ASHA project. A general opinion of the method used should then be determined from this analysis. This will be followed by the PDSS survey which will follow the general chart used to determine a procurement method to reference the previous selection. Finally the computer analysis of PDCS will be used as a final analysis. The methods selected by each of these methods will be then be compared and a final suggestion will be made.

Procurement Methodologies:

The design-bid-build process is very straight forward and simple for not only the owner but also all of the firms involved. The owner begins by hiring a design team that will solely be responsible for the design of the building from start to finish. These

architects and designers will be selected upon qualifications. The firms current work load, as well as former projects will all be considered to select the proper design firms. Once the design is completed it is approved the owner. Once the owner approves the design the bid phase will begin.

During the design phase the owner has multiple options. They can elect to ask for credentials and qualifications and then allow only specific firms to bid the job or they can simply open the bid to the public, which means that anyone who wishes may secure a bid on the project. Once the bids are submitted generally the lowest bidder will be awarded the project.

The final aspect of this procurement method is to build the project. Once the bid is awarded it is the job of the winning firm to begin construction and complete the project on time. This method is very straight forward and understood by everyone in the construction industry which is why it is so popular.

Design-build began in the construction industry as a third party agency. It was this agencies job to re-analyze the design in a design-bid-build project and simplify some of the design or correct some of the mistakes made in the design so that those mistakes would not be multiplied through the entire project in construction. Eventually these third party firms either joined with a construction management firm or construction management firms began to become more involved in the design phases beginning the design – build process.

Design-build is the conjoining of both the design firm and primary construction company. In some cases this can be one company that has taken on the role of both designer and builder. The two companies will come together at the beginning of the project and work together through the design in an attempt to produce not only the finest architectural building but also the most economical design, which will simplify the design and hopefully speed the schedule and lower the cost.

Design-build also allows construction to begin before the designs are completely finalized. This allows construction to begin sooner and while the primary design may be nearly finished, allowing for adjustments to be made throughout the project until completion.

Construction Impact Overview:

There are many advantages and disadvantages to each system. Many times procurement method depends upon the owner's opinion of each method and what they prefer. Design-bid-build has the overwhelming advantage of being the most traditional of the methods; however that statistic is quickly changing as many owners are introduced to design-build.

Ironically the aspects of design-build that are able to save time and potentially money are those that concern many owners. Some owners feel that contractors will control too much of the design process. Since the contractors hold the primary contracts it is very easy for a contractor too overlook an architectural design for simplicity and cost savings.

Government restrictions also play a part in the use of traditional procurement methods over design-build. Many state governments still restrict publicly funded projects. They refuse to allow any public funded project to be used on a design-build method; instead they are required to use the traditional method. The overwhelming use of the traditional method also influences new owners, because they are unsure of what method to use and traditional seems the most logical. Complex design jobs also use a lot of traditional procurement. Traditional is common for complex jobs since the project will require a great deal of focus in the design phase and does not provide the same opportunities to simplify the overall design.

Although traditional procurement is highly coveted, design-build is becoming more popular and for good reason. Many studies show that projects under the design-build method decrease project schedule, but also as a lower overall cost. The design-build process is able to catch and simplify any possible construction complexities. In the actual construction this reduces the amount of change orders that are required to be made and lowers the overall cost of the project. Below is a common table used that points out the common advantages of each method that generally helps an owner make a decision about the proper method to use.

Procurement Method Advantages	
Design-Bid-Build	Design Build
Not government restricted	Designer and contractors working together
Designer has full control of design	Less change orders during construction
Owner feels a greater part of design process	Overall faster schedules
Bid selection easy	Generally lower costs
Tradition	Construction begins earlier

These are some of the primary advantages but Richard Mayo in his book Construction Management Fundamentals points out these supporting reasons for Design-Bid-Build:

- Low bid regulations are firmly entrenched in most government systems for the purpose of promoting fairness
- It is easy to justify the selection of the low bidder. The fact that the bidder is low is irrefutable.
- Contractors understand the system
- Voters understand the system
- There is always resistance to change

The traditional method benefits from its overwhelming use, simplicity, and owner popularity. Although design – build has non of these advantages the DBIA through multiple studies shows the cost savings and schedule impacts of using design build.

- Savings in unit cost of at least 6.1%
- Construction speed at least 12% faster
- Overall project delivery speed at least 35.5% faster
- Cost growth at least 5.2% less
- Schedule growth was at least 11.4% less
- Quality equal or better

Current Market Overview:

The current market trends support those of many of those in the industry today. While design – build slowly grows in popularity it has not "exploded" as expected by many. Instead many projects still continue to use the traditional method even where other methods may be more beneficial.

Members of the construction industry including owners and general contractors were surveyed about general opinions of procurement as well their experiences involving the methods they have used. An example of the survey used as well as the general consensus by both owners and GC's is available in appendix D.

Since it is the owner that makes the final decision on the type of method used they were the primary concern for the survey. The opinions were varied depending on the experience of the owner as well as the type of projects they were primarily involved in. Smaller and new owners still enjoyed the method of design-bid-build. Small owners enjoyed being involved in the design process and wanted to ensure that the design was exactly what they had envisioned along with the designers. New owners also enjoyed the method but for simpler reasons. They preferred the straight forward method of design-bid-build. From this method many owners felt that they were able to control the entire project from start to finish. The project begins with a design that they can influence and also have to ultimately approve. The owner is then able to select the bidder and will use a lump sum value confirming the exact cost of the project for the owner and finally they are able to see the finalized building throughout construction. The primary concern with

design-bid build was either a need for "control" of the project or a "young" owner simply having a concern for the project and used the most common methodology that seemed simplest.

Owners however that produce larger jobs as well as a high amount of projects seemed more comfortable with design-build. These owners are more concerned with the bottom lines of moving individuals into a project and completing the project as cost effective as possible. Owners were still concerned with being involved in the design process however if schedule was a primary concern such as with the University of Maryland many owners are willing to use design – build and lose some of the control over the design of the project. More experienced owners understand the power that they have and control over a project and are not afraid to use that power to make sure a project is completed as they the owner expected.

Although there were differences of opinion between what method to use and why there were a few general consensus among owners. The primary opinion being the concern of governmental control; many owners feel that as the owners they are left with the task of doing what is best for the project which means that they should be able to pick the procurement method that most greatly affects the project whether it be a public project or not. Owners also understand the benefits of both procurement methods, but generally choose the method in which they are most comfortable and have used most often. Some feel however that the popularity of design-build will continue to grow in the industry as those in the industry become more educated of the system, its benefits, and the ability to still control a project while allowing constructability to be taken into consideration in design.

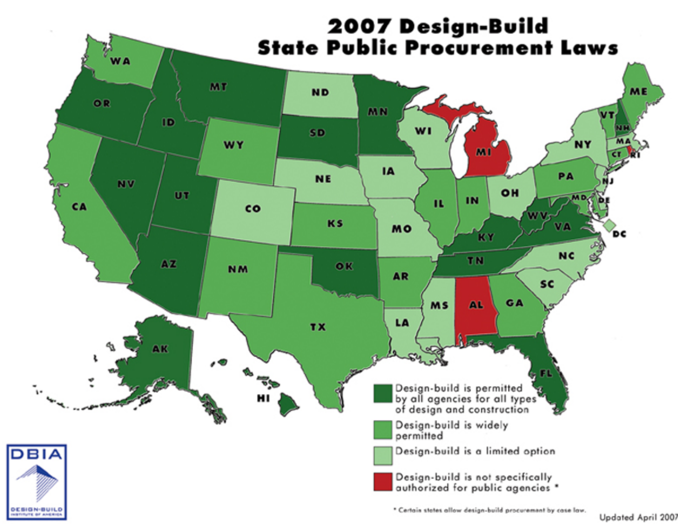
Although there were many differences of opinions of owners the opinions of General Contractors was nearly a consensus. General Contractors such as Barton Malow overwhelmingly prefer the use of design –build if possible. The design – build method allows the GC to be involved in the design process and adjust any mistakes that could

require change orders, or be able to simplify a design to improve cost or schedule. Much design – build projects are also bid as a GMP although owners feel that many GC's inflate this value, it allows the GC to allow for possible cost inflations throughout a project.

Unfortunately, owners possess the control over procurement methods and which will be used for specific projects. Many are so comfortable with the traditional method or do not "trust" design – build that the growth of design – build is slow even though many GC's would prefer to use the design – build method.

State Procurement Method Restrictions:

As stated previously procurement methods can be regulated by the government. These restrictions can prevent specific projects from using procurement methods specifically design –build. These laws depend upon the state. Some states such as New York limit owners from using design – build while other states such as Virginia allow design build to be used by all owners and projects.



Above is a map of the United States referencing how widely permitted design – build is allowed to be used in a specific state. These “ratings” are determined upon each state’s specific procurement laws and how they can affect public projects.

As is shown from the map above Maryland allows design – build to be widely used. Although design –build can be widely used the procurement laws in Maryland could still restrict the use of design – build by the ASHA and would therefore completely prevent design – build from being an option.

The American Institute of Architecture provides a list of every state along with the statutes of each state that would affect a design – build project. In the case of Maryland these statutes are; 4-126, 3-602, and 3-102. These statutes affect educational buildings, state funded building, and finally the competitive bidding of projects.

According to 4-126: Design – build arrangements, that permit a county board to contract with a design build business entity for the combined design and construction of qualified education facilities, including financing mechanisms where the business entity assists the local governing body in obtaining project financing.

This refers only to educational buildings and is stating that if an educational building does go design build the design –Build Company must help the county government finance the job. This statute does not affect the ASHA at all and will not restrict its use of design –build.

According to 3-602: Study required – The Department shall study each capital project proposed by any unit of State government

(g) Alternative construction methods – total project funding may utilize alternative construction methods such as:

(1) design/build which involves a single solicitation to design and build the facility

This statue is referring to a state project that will be publicly funded. The capital project can use design/build as long as the request is submitted and the project will only consist of one contract for the design and build of the project. Once again although the ASHA is a non-profit organization they are not a state organization and are not restricted by this statute.

According to 3-102: Design/build contract means a contract that provides for both the architectural and engineering services and construction services as a part of a single contract.

This is the only statute that will affect the construction of the ASHA and could have been complete easily by the organization. It is simply state that the design –build contract must contain one entity for the design and construction. This is how a design – build contract is generally completed with the General Contractor holding all of the contracts.

Therefore, while the state of Maryland does have restrictions on the use of design – build they are primarily concerned with education and state funded buildings. The state procurement laws of Maryland would not restrict or prevent the use of design – build.

Owner & Project Analysis:

Although the project would not be restricted by the state government it is important to look at both the owner and project to determine what procurement method may be most effective for each.

The ASHA is a highly inexperienced owner that is completing their first project. The ASHA is also quite small and relies on the knowledge and connections of the design team and construction manager. PDSS is a ranking system that helps determine what procurement method may be most effective for an owner to use. The PDSS analyzes the owner, project and other assorted information and can be found in appendix E. According to the PDSS structure decision table owner experience is highly important in selecting a project. The PDSS states that the traditional method is better suited for an inexperienced owner because they are able to rely on the architect and construction manager. It also states that the design – build process can also be used for an inexperienced owner, but that the owner loses the power of checks and balances since the GC will control most of the contracts of design and construction.

Although the PDSS states that either method could be selected for an inexperienced owner. The ASHA as an owner alone were correct in selecting the traditional method. It allows the ASHA to be involved in the design and construction. It is also a simpler method that is easily understood and can be implemented quickly. For an inexperienced owner with few connections or an understanding of building design – build may be overwhelming and confuse them.

The PDSS does not only analyze the impact of owner knowledge but also that of the project itself. The project is analyzed from time, cost, characteristics, and quality. The PDSS states that if a project is well defined than either method could be used, although according to time design build is considered better when time is of the essence. The schedule on this project is “of the essence” as the schedule increases the ASHA is

forced to pay back rent costing them valuable money as a non-profit organization. Cost is also the other essential element to the ASHA. As a non-profit the organization must make sure that the budget is closely followed and that the project does not exceed the expected bid. Although the PDSS says that the traditional method is works when cost is important it states that if cost is “critical” design – build is an excellent method. Once again based solely upon project the ASHA should have selected the design – build method. Quality is the final aspect of the project. The ASHA wants to make an impact with this building, attempting LEED silver rating and being a non-profit. The PDSS both methods will provide the industry standard, but design –build may provide a slightly higher standard. On this project the quality is important but a slight improvement will not greatly affect the selection of the procurement method, therefore either method could be selected based upon quality.

While both the owner and project were analyzed by the PDSS they provided very different selections. Based upon the inexperience of the ASHA as an overall owner the traditional method seems logical, but as the project itself it analyzed the cost and schedule the selections seems it should be design build. Therefore further analysis must be complete to determine the proper solution.

PDSS Selection System Survey:

Not only does the PDSS provide information about owners and projects, but it also provides a selection system that consists of a survey. This can be seen in appendix E. The survey takes into consideration aspects such as time, and owner experience, but also provides the analysis of the team experience and other aspects. Each line is followed to the next question. Once each question is answered two options are then provided as the suggested procurement method. For the ASHA the survey was completed as follows:

- Time (critical)

- Owner Experience (inexperienced)
- Team Experience (experienced)
- Quality (industry standard)
- Cost (critical)
    - Lead to option 25

When this option was looked up in the appropriate chart, design – build, not the traditional method was the recommended procurement method. The traditional methods consideration of schedule and cost are what affected the outcome. The first question about the importance of time immediately pushed the project to design – build. If time was not so important the project would have gone to option 10 which allows the owner the option between design – build and the traditional method.

PDCS Selection Program:

The final option would be to use the PDCS program to provide an output of which procurement method to select. The method is similar to the selection survey, but allows for more project specific information to be input, but also to be scored accordingly. The first step is to review the project and determine what factors most greatly affect the project. These can be cost and schedule, but also include aspects such as the complexity of the project the owners want to be involved with design or their connections, and even the confidentiality of the project. Up to six of these factors can be selected. Once the six factors are determined they are then ranked from 1-6. A preference score is then given to each category. It the case of the ASHA a score out of 100 was used for each category. The program then calculates a preference weight for each category. Finally pre-determined values are copied into the appropriate cells under each factor. The final score of each procurement decision is then scored out of 100. The

higher the value the greater it's recommendation for the specific method. As the chart can be seen below the six factors were: control cost growth, control schedule growth, lowest cost and shortest schedule, promote early procurement, and analyze the complexity of the project. The ASHA did not have a strong opinion on the other factors that included their control or lack of control of the project.

The growth of the schedule and cost are most important because as a non-profit if the cost were to greatly fluctuate it would greatly affect the organization, and again if the schedule were to increase greatly back – rent would could cost the organization a great deal of money. Although it seems repetitive the initial cost and schedule are important, but not as important as growth. The organization had a very specific budget. If the initial cost or schedule were considered unimportant, the project may have never been able to be built if bids were high and the budget or back rent were not initially considered. Procurement is important since the project is using steel for the primary above grade columns. If the lead time is not carefully calculated the lack of steel could greatly slow the project and again cause the project to go over budget. Finally the complexity of the job was considered since the project is attempting LEED silver, which can involve, design innovation and be quite complex to ensure every point is scored.

Table A-1: Compute Preference Weights

Factor Action Statement	Preference Rank	Preference Scores	Normalized Preference Weight
Control cost growth	1	100	0.21
Control time growth	2	95	0.20
Promote early procurement	5	60	0.13
Ensure lowest cost	3	90	0.19
Ensure shortest schedule	4	80	0.17
Efficiently coordinate project complexity or innovation	6	50	0.11
		475	

Table A-2: Compute Aggregate Scores

PDCS Alternatives	Factor →	Control cost growth	Control time growth	Promote early procurement	Ensure lowest cost	Ensure shortest schedule	Efficiently coordinate project complexity or innovation	Aggregate Score
↓	Preference Weight →	0.21	0.20	0.13	0.19	0.17	0.11	↓
PDCS 01	Predetermined Effectiveness Values (Table EV-1)	80	20	0	90	0	70	45.26
PDCS 02		50	50	90	100	50	60	65.58
PDCS 03		80	20	0	70	10	50	41.05
PDCS 04		80	20	0	70	0	40	38.32
PDCS 05		50	50	90	60	40	40	54.21
PDCS 06		60	70	100	40	80	70	67.68
PDCS 07		90	90	100	80	100	100	92.11
PDCS 08		70	80	100	80	90	80	82.11
PDCS 09		0	0	80	0	90	0	25.26
PDCS 10		0	0	50	0	60	0	16.42
PDCS 11		100	100	100	80	100	90	95.16
PDCS 12		40	80	100	40	100	80	69.89

Once the aggregate scores were calculated the highest corresponding score refers to the PDCS is that is most recommended by the program. In the case of the ASHA PDCS 11 was selected with an extremely high score of 95.16. When the corresponding procurement decision was matched, design build would be considered the most effective. Again this is clearly due to the importance of the schedule and cost. PDCS 1 corresponds with the traditional method. This only had a score of 45.26 with only 3 methods scoring lower. It is primarily because in this program the experience of the owner and project team greatly affect the traditional method. Therefore if the project did not have the importance surrounding cost and schedule the project with an inexperienced owner would more than likely have been considered traditional, but again the project outweighs that of the owner.

Conclusion & Recommendations:

The ASHA clearly had reasons for using the traditional procurement method. They are an inexperienced owner that is building for the first time. It seemed logical to use that method which is most supported in the industry today.

However if the project were analyzed strictly a technical level design-build seems most logical. It would present the greatest savings in cost and schedule. The state also does not restrict the use of design-build and it could have been easily implemented.

Although the suggestion of design –build seems most logical for this project it is again about the comfort level of the owner and the method in which they prefer. However, with a strong construction company such as Davis and the potential cost savings in both back rent and construction design – build seems the most logical selection.

Window Efficiency Analysis:

Problem:

Currently the ASHA building envelope consists of pre-caste concrete panels with a concentration of glass on each side of the façade especially on the south side which consists of a glass curtain wall. The glasses on the building façade are a single low – emissive window that will allow for energy savings in the building, reduce the costs of heating and cooling, and help attain the LEED silver rating.

Solution:

The goal is to analyze the possibility of other low – emissive windows such as a triple and double pane as well as a high technology window or "smart" window that uses electrochromics to conserve energy to determine if the overall energy savings will outweigh the initial costs. If the initial costs are too great the long term savings will be deciphered to determine how many years it would take to pay off the initial costs. Finally the percentage of electrical energy will be analyzed to determine if LEED points can be attained.

Methodology:

EQuest is a mechanical program used in the industry today to determine a basis for energy savings for mechanical systems. The program requires 39 pages of information to be completed. This information includes the basic building information of location, orientation, and square footage, to detailed information about the mechanical system itself, and the occupancy types. Most importantly for this analysis it asks for the building envelope information; more specifically the typical window sizes, the percentages of those windows on each façade, and the material that is used for each

window. All of the general information except the window material will remain constant. Once the calculations are run the percentages of energy savings will be calculated.

A cost for each window will then be determined using R.S. Means as well as industry consultants to estimate the rise in initial costs. Finally the long term savings will be determined and the years to make up the initial costs will be determined.

Window Selection:

The façade of the building consists of seven different types of glasses. However two of these glasses make up the primary glass on each of the facades. They are both single low emissive windows each with a slightly different color for architectural purposes. The basic window input into the EQuest program is found below.

Façade Orientation	Glass Type	Avg. Glass Size	% Glass
North	GL-4	5x5	23
	GL-8	6x8	30
South	GL-4	5x5	34
	GL-8	6x8	27
East	GL-4	5x5	3
	GL-8	6x8	10
West	GL-4	5x5	12
	GL-8	6x8	13

Three different window types were then selected at these same sizes and percentages and input into the program. These consisted of two low emissive windows of both two panes and three panes. Although these would consist of the same coating the additional spaces between the windows would retain heat and absorb energy therefore lowering the overall energy required by the mechanical system. The third type of glass was a "smart" glass or electrochromic windows. As different amounts of light enter these windows they are able to change their optical properties in order to be most energy

efficient. They consist of two electrodes which are separated by an ion conductor which allows for the change when the light hits the window.

Energy Savings:

The energy consumption of each system was then analyzed by the EQuest program. The output of these analyses can be seen in appendix F.

Window Efficiency				
Window	*Electric Consumption (kwh x 000)*	*Gas Consumption (Btu x 000,000)*	*% Electricity Saved*	*% Gas Saved*
Single Low E	2761.2	5848.4	n/a	n/a
Double Low E	2747.2	5297.2	1	9
Triple Low E	2681.1	4740.4	5	19
Double Electro	2622.5	4673.2	5	20

Above is a chart of each window beginning with the baseline single low emissive window. Each window was then analyzed and compared to the baseline. As can be seen the improved windows save approximately 5% of electricity and nearly 20% on gas energies. Although the percentages are noticeable they may not be large enough to overcome the initial costs of the installment of each of these windows.

Immediate Cost Analysis:

Not only are energy saving important but the replacement cost of each of these windows is extremely important. The ASHA is a non-profit organization that cannot afford to replace windows at high cost if the overall energy savings are going to be minimal. The chart below is representation of the costs of each of the replacement windows that were analyzed. These values were determined from R.S. Means as well as

the opinions of industry consultants. Although the electrochromic windows would save the most energy of both gas and electricity the costs are more than double the initial costs of the single low – e windows originally used. Based upon initial cost and energy savings the triple pane low emissive windows would be most appropriate since they save nearly as much as the electrochromic windows and are only 1.5 times the cost of the baseline window.

Window Cost				
Window	Avg. Cost per sqft.	Sq.ft	Total Cost	% Cost Increase
Single Low E	16.3	59384	967959.2	n/a
Double Low E	19.6	59384	1163926.4	1.202453988
Triple Low E	25.25	59384	1499446	1.549079755
Double Electro	33.6	59384	1995302.4	2.061349693

Long Term Savings:

Although the initial costs of a project may be important to an owner on a project the long term savings can a large factor in the determination of materials used. The nationalgridus.com determines energy use throughout the country has determined that for a mid-level office complex the average costs of energy is $1.34 for electricity and $0.18 for gas per square foot. Based on the energy saving of both gas and electricity by the replacement windows per year it can be determined how many years it would take to make up the initial costs of each of the windows. The chart below shows these savings and the overall timeline it would require the ASHA to retain the initial costs through energy savings.

Long Term Energy Savings						
Window Type	***% Electrical Savings***	***Electrical Cost/sq. ft***	***% Gas Savings***	***Gas Cost/sq. ft***	***Savings/Yr***	***Yrs to attain initial cost***
Single Low E	n/a	1.34	n/a	0.18	n/a	n/a
Double Low E	1	1.32	9	0.16	5480	35
Triple Low E	5	1.27	19	0.15	13700	38
Double Electro	5	1.27	20	0.14	15070	68

As shown above at best it would require at best 35 years for the ASHA to make the initial costs of the least efficient window and over 65 years for what was considered the most efficient. Again over long term savings the most cost effective window would be the triple low emissive windows, but 38 years for energy savings is extreme.

LEED Impact:

LEED points can be attained through conserving energy on a project. The ASHA already meets the minimum requirements for LEED points on energy efficiency however the introduction of a more efficient window may provide more points to be scored. Unfortunately to attain 1 LEED point 15% electrical energy savings must be shown and in order to attain 2 LEED points 20% of savings must be proven. The window replacements alone will not produce the required energy saving to attain these points however; if the entire mechanical system were to be re-analyzed the additional ten to fifteen percent may be able to be saved to produce more LEED points and a possible LEED gold rating.

Conclusion & Recommendations:

Although the assessment of the new windows shows that each would save energy for the ASHA the initial costs are too extreme and the long term costs do not produce enough profit to replace the original windows designed for the project. The greatest replacement would be the triple low emissive windows conserving 5% of electricity and 20% of gas. On the other hand this window is 1.5 times the cost of the original window and it would take approximately 38 years before the cost savings by energy would equal that of the initial costs. The replacement does not even allow the project to attain LEED points which would lead to a gold rating. Therefore the original windows should remain in the system and be used.

STRUCTURAL COLUMN RE-DESIGN:

Problem:

Washington D.C. as well as the surrounding areas are specifically known for their C.I.P. concrete systems. These systems are used throughout D.C. and surrounding areas primarily because of height restrictions in the metropolitan D.C. area. These restrictions have allowed cast-in-place concrete to become the niche market in the area and highly cost effective.

However, the ASHA chose a combination of steel and concrete structural system. The system remains primarily concrete with concrete shear walls, all below grade columns, and primary beams using a high strength concrete caste in place. The columns above grade are where steel is most prevalent. Steel requires a long lead time and can be expensive which can both greatly affect the highly sensitive cost and schedule for a non-profit organization such as the ASHA.

Solution:

The above grade steel columns could be replaced with equivalent C.I.P. columns. The lead time of steel nearly affected the total schedule of the project by being delivered late to the site. Permits had not been issued to the project therefore delaying the start date of construction. This delay allowed for the concern of a late steel delivery to become non-existent. With a C.I.P. project the lead time would be removed along with any concerns of a late delivery. The equipment for the concrete pours would also already exist on site since other aspects of the building are also poured concrete. The steel would also be quite expensive. The use of concrete would also reduce the costs of construction, which are extremely important especially for the non-profit ASHA organization. Although steel can have a high construction cost it can be erected very

quickly and can help reduce a schedule. The schedule is extremely important, since the ASHA is currently paying back rent on their previous office until construction is complete. It is possible that although the schedule would be increased with the use of concrete the construction costs and lack of required lead time could outweigh the cost of schedule improvement.

Methodology:

The steel columns will be re-analyzed and calculated as equivalent C.I.P. columns. A program known as pcaColumn is a highly popular design program used by many structural engineers to determine efficient concrete columns. Data about each column is input from size, the loads, amount and size of rebar, as well as the strength of concrete. The program then analyzes this information and outputs an interaction diagram. This diagram informs the designer of whether the columns will or will not fail as well as if the column is the most efficiently designed, from the size of the column to the size of the rebar.

Once the pcaColumn program has analyzed each of the columns and output the according interaction diagrams, the most efficient columns that will not fail will be selected and used to replace the steel columns. Hand calculations will then be completed to analyze the accuracy of those columns designed by pcaColumn and their efficiency. These hand calculations will produce their own interaction graph which will be compared to that of the program.

Once the program has been checked the overall cost savings of the new columns will be determined. The initial cost savings of the concrete system will be analyzed using Ice 2000. These determined costs will then be compared to an in depth structural steel column analysis that will include data from a previous structural estimate as well as new information that includes more data such as fire proofing.

The schedule impact will then be analyzed to determine whether the initial savings of the project outweighs that of the potential of paying more back rent for a longer schedule. A final decision will then be determined based upon the overall initial savings compared to that of the potential costs in back rent, to determine which system may be the most cost effective.

PcaColumn analysis:

The sizes and lengths of each steel column were analyzed from the drawings to be input into pcaColumn. Once the sizes were input the loads on each column needed to be adjusted accordingly. Therefore a Third Edition Steel Manual was used in order to determine the safest maximum load on each of the columns according to their sizes and lengths. The load for each column was then input into the program. The building already is designed to use concrete sheer walls that will remove the concern of the majority of moment effects on each column. Therefore the moment effects on each column were considered minimal.

The vast majority of the concrete used on the project was 4000psi strength therefore that was the strength assumed for each of the concrete columns. Each column was analyzed as a square column with rebar in each of the corners. This would allow the design and construction to remain as minimally complex for the field as possible. 1.5 inches of cover was used as a standard in each column for all of the rebar. However the percentage was kept as close as possible to 1% to reduce the overall cost of rebar.

Once all of this data was determined and input into pcaColumn each column was designed. If a column would fail or was considered inefficient and over analyzed a new size and rebar were considered to produce the most efficient columns possible. Each interactive diagram can be seen in appendix G. The chart below represents the most efficient columns designed.

Equivalent Concrete Columns				
Steel Column	Length	Loading (k)	Concrete Equivalent	Rebar
12x58	15	496	18x18 (4ksi)	4 #9
12x58	13.5	535	18x18 (4ksi)	4 #9
12x65	15	626	18x18 (4ksi)	4 #9
12x65	13.5	657	18x18 (4ksi)	4 #9
12x53	15	451	16x16 (4ksi)	4 #8
12x53	13.5	485	16x16 (4ksi)	4 #8
14x90	15	947	22x22 (4ksi)	4 #10
14x90	13.5	979	22x22 (4ksi)	4 #10
14x82	15	694	18x18 (4ksi)	4 #10
14x82	13.5	747	18x18 (4ksi)	4 #11
14x132	15	1390	24x24 (4ksi)	4 #18
14x99	15	1040	24x24 (4ksi)	4 #11
14x74	15	630	18x18 (4ksi)	4 #9
12x72	15	694	18x18 (4ksi)	4 #10
12x72	13.5	729	18x18 (4ksi)	4 #11
12x45	15	299	14x14 (4ksi)	4 #10
12x45	13.5	336	14x14 (4ksi)	4 #10
12x80	13.5	805	20x20 (4ksi)	4 #9
14x43	13.5	312	14x14 (4ksi)	4 #10
14x53	13.5	394	14x14 (4ksi)	4 #11
14x48	13.5	354	14x14 (4ksi)	4 #11
14x68	13.5	678	18x18 (4ksi)	4 #9
14x61	13.5	553	16x16 (4ksi)	4 #11

Column Design Calculation Analysis:

Although pcaColumn produces interaction diagrams and potential concrete columns the program must also be checked to ensure that the calculations are correct and produce a safe and accurate column. The most common column used to replace those of steel were 18”x18” concrete columns with four # 9 rebar in each of the corners, therefore it was most logical for these columns to be those analyzed by hand calculations to determine their efficiency and overall design. In order to produce an interactive diagram three essential calculations must be completed; pure axial, strength at balanced condition, and pure moment. Each of these points are then graphed on the interactive diagram. They are then connected to produce the curve in which the acceptable columns can fall under. The closer a column appears to the curve the more efficient the design. If the column were to fall out of the curve, the member would not be considered safe and failure could occur under that specific loading.

To complete these calculations the same assumptions as those in pcaColumn were made. These hand calculations and interaction diagram can also be seen in appendix G. The results of the hand calculations shown below:

- Pure Axial
  - Mn = 0
  - Pn = 1328 k
- Strength at balanced condition
  - Mn = 354.93 ‘k
  - Pn = 511.32 k
- Pure Moment
  - Mn = 138.97 ‘k
  - Pn = 0

The hand calculations prove that the columns designed by pcaColumn are acceptable. The graphs are different however, because the axial loads and balanced conditions as calculated by hand are higher than those of pcaColumn. Therefore, the columns designed fall further from the hand constructed curve, although this shows that the columns may not be as efficient as originally assumed the columns are still structurally sound and can be used.

Material Cost Analysis:

Ice 2000 was then used to analyze each column for an overall cost of the newly designed structural concrete columns. 4 ksi concrete was used for the estimate since it is the primary strength being used on site, and is what was used in each of the column redesigns. The appropriate rebar size was also input for each column as well as the number of each column to determine an overall cost of the production of each. The forms used for the analysis were the same as those used for the other pours on the site, a one use rectangular ply-wood form. A crane already exists on site for the previous pours. All pours were assumed to occur by crane since it will already be onsite and the project site has enough room to support a crane for all of the pours.

The original steel columns were also re-estimated for a more competitive value. Previous structural estimates were used and compared to Ice 2000 estimates. These new estimates also included the one inch mineral fire proofing that would be used on each column. The fire proofing was added since it is an additional cost to the steel that would be unnecessary if concrete were used. Once the values of the columns were estimated for the concrete and steel the estimations were compared to determine approximately how much would be saved by converting to a concrete column system. Appendix G has the entire break down and cost estimations.

Concrete vs Steel Summary		
Total Concrete Cost	**Total Steel Cost**	**Cost Savings with Concrete**
$92,873	$202,011	$109,138

The chart above summarizes the overall material savings by converting to a C.I.P. system. Although these savings are large this is not the only cost that must be considered to the overall cost of the structural change.

Schedule Impact:

The ASHA schedule is just as crucial as the overall cost of the project. The ASHA is currently paying back-rent to its' old office building while the new headquarters is being completed. If the columns were to be poured as concrete the overall schedule of the project would be increased potentially escalating the amount of back rent required to be paid and overall project cost. Therefore, the finish date is absolutely crucial to the project.

There are 300 structural steel columns on the project. The columns were broken into even groupings for each floor. The upper floors are highly repetitive and therefore the amount of lifts each day is nearly identical throughout the schedule for each floor.

The overall average size of the re-designed concrete columns is approximately .5cy. The average cubic yards carried by a concrete truck is approximately 10cy. Therefore twenty columns could be poured in a single day by a single truck. If three trucks were to deliver in a single day then approximately 60 columns could be poured, which based upon R.S. Means could be completed by the crane on site. If the columns were broken down evenly than with 60 columns completed in a single day, then the concrete could be completed in five phases.

The current steel system however would be able to complete the same amount of work in a much shorter period of time. It is a general consensus in the construction industry that two floors can be completed in a single day with steel columns. Three days was then placed between the first and second lifts in order for decks and other members to be inserted in order to provide more support before the next set of columns were raised. A schedule of this comparison between the two systems can then be found in appendix G.

Concrete Column Schedule vs Steel Schedule		
Days to complete concrete work	Days to complete Steel work	Savings in Structural Material
71	5	$109,138
Cost/ Day to replace structural Savings	Cost/Month	
$1,653.61	$49,608.18	

Although the amount being paid back during construction is remaining confidential the chart below shows the cost comparison of structural saving to back rent costs. As the chart shows if the ASHA were paying a minimum of $1,653.61 a day in back rent or $49,608.18 per month than the steel would be the optimal selection, however if the value were less than that the structural concrete makes more economical sense.

Conclusion & Recommendations:

The assessment above shows that replacing the steel columns in the ASHA is feasible. Equivalent concrete columns were designed and would be cost effective based on the overall back rent paid by the ASHA. The savings in material alone is over $100,000. The schedule is the only aspect that a concrete system falters. It would take increase the schedule by over two months and would cause the ASHA to pay back rent during that time as the building would be completed. However, if the back rent is

anything smaller than the approximate $50,000 per month converting to a concrete column system would still be cost beneficial and should be the recommended system.

SUMMARY AND CONCLUSIONS:

The ASHA was an outstanding building that provided many challenges as well as rewards. Although the ASHA decided to try to attain a LEED silver rating the project may have even had more success under a Green Globes system. The system is not only simpler but the points are easy to score and as shown under Green Globes more points were actually scored for the project. If the scoring had not been so conservative and smaller initiative under Green Globes had been analyzed the project may have received a three globe rating or LEED gold equivalent.

A traditional design-bid-build system was also used for the ASHA however after analyzing the needs of the project itself and what both the traditional and design-build systems provide a design-build method may have provided a more substantial outcome. The PDSS analysis as well as PDCS program also concluded that due to the time and cost dependence of this project design – build may have been the best method.

The mechanical system was prepared for LEED rating, but the window analysis was used to determine if more points could be scored or if a better cost efficient window was available. Although all of the glasses that were used to replace the single low e windows conserved slightly more energy and gas consumption the costs were to great for the overall replacement of the window system. The most efficient and affordable system of a triple low e window would save nearly 5% in electricity and 20% in gas but would cost 1.5 times the original windows. The long term costs would take nearly 38 years to pay off the initial costs of a more efficient window. Therefore, ASHA was correct in using a simple low e window.

The structural system was a concrete and steel mix with steel being used for all of the columns. After replacing these columns with a concrete equivalent and doing a cost analysis nearly 50% of the costs could be saved. The schedule had to be taken into consideration as well though and as long as the back rent was less than $50,000 per month than the system of steel should have been replaced.

APPENDIX A

- Project Schedule Summary

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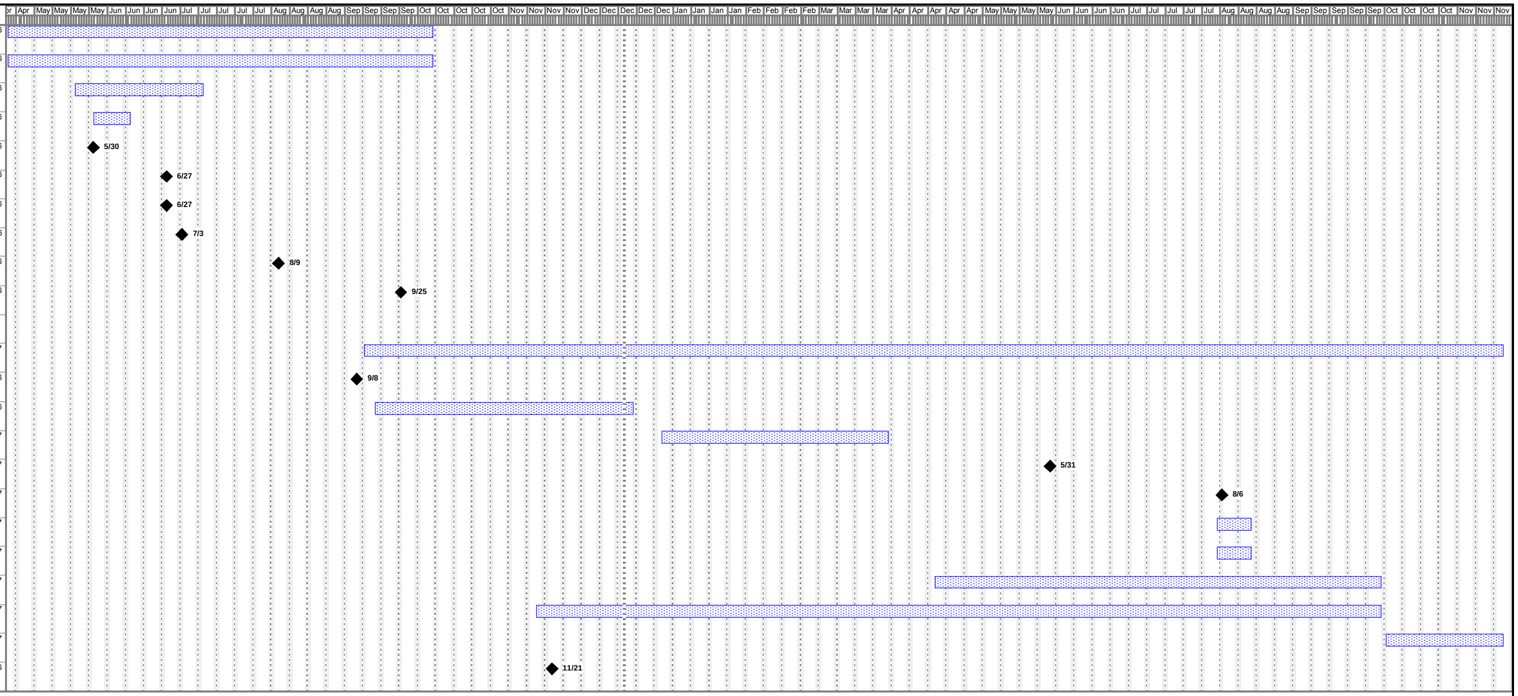
ID		Task Name	Duration	Start	Finish
1		Preconstruction	117 days?	Thu 4/27/06	Fri 10/6/06
2		Temporary Power	117 days?	Thu 4/27/06	Fri 10/6/06
3		MD Tree Permit Issued	35 days?	Tue 5/23/06	Mon 7/10/06
4		Stakeout Property Corners	10 days?	Tue 5/30/06	Mon 6/12/06
5		Start Project	0 days	Tue 5/30/06	Tue 5/30/06
6		Sediment Permit Issued	0 days	Tue 6/27/06	Tue 6/27/06
7		Stormwater Management Permit Issued	0 days	Tue 6/27/06	Tue 6/27/06
8		Forest Conservation Plans Issued	0 days	Mon 7/3/06	Mon 7/3/06
9		Foundation Permit Issued	0 days	Wed 8/9/06	Wed 8/9/06
10		Water/Sewer Permits Issued and Easmonts	0 days	Mon 9/25/06	Mon 9/25/06
11					
12		Milestones	314 days?	Mon 9/11/06	Wed 11/21/07
13		Building Permits	0 days	Fri 9/8/06	Fri 9/8/06
14		Complete Concrete Garage	71 days?	Fri 9/15/06	Fri 12/22/06
15		Steel Completion	63 days?	Wed 1/3/07	Fri 3/30/07
16		Owner Permanent Power	0 days	Thu 5/31/07	Thu 5/31/07
17		Interior Contract Start	0 days	Mon 8/6/07	Mon 8/6/07
18		Complete Façade Installation	10 days?	Sat 8/4/07	Thu 8/16/07
19		Watertight	10 days?	Sat 8/4/07	Thu 8/16/07
20		Complete All Finishes and Perimeter	124 days?	Wed 4/18/07	Fri 10/5/07
21		Complete MEP Risers and Equip Start	233 days?	Thu 11/16/06	Fri 10/5/07
22		Complete Inspections	33 days?	Mon 10/8/07	Wed 11/21/07
23		Current Completion Date	0 days	Tue 11/21/06	Tue 11/21/06



APPENDIX B
- Site Layout Planning

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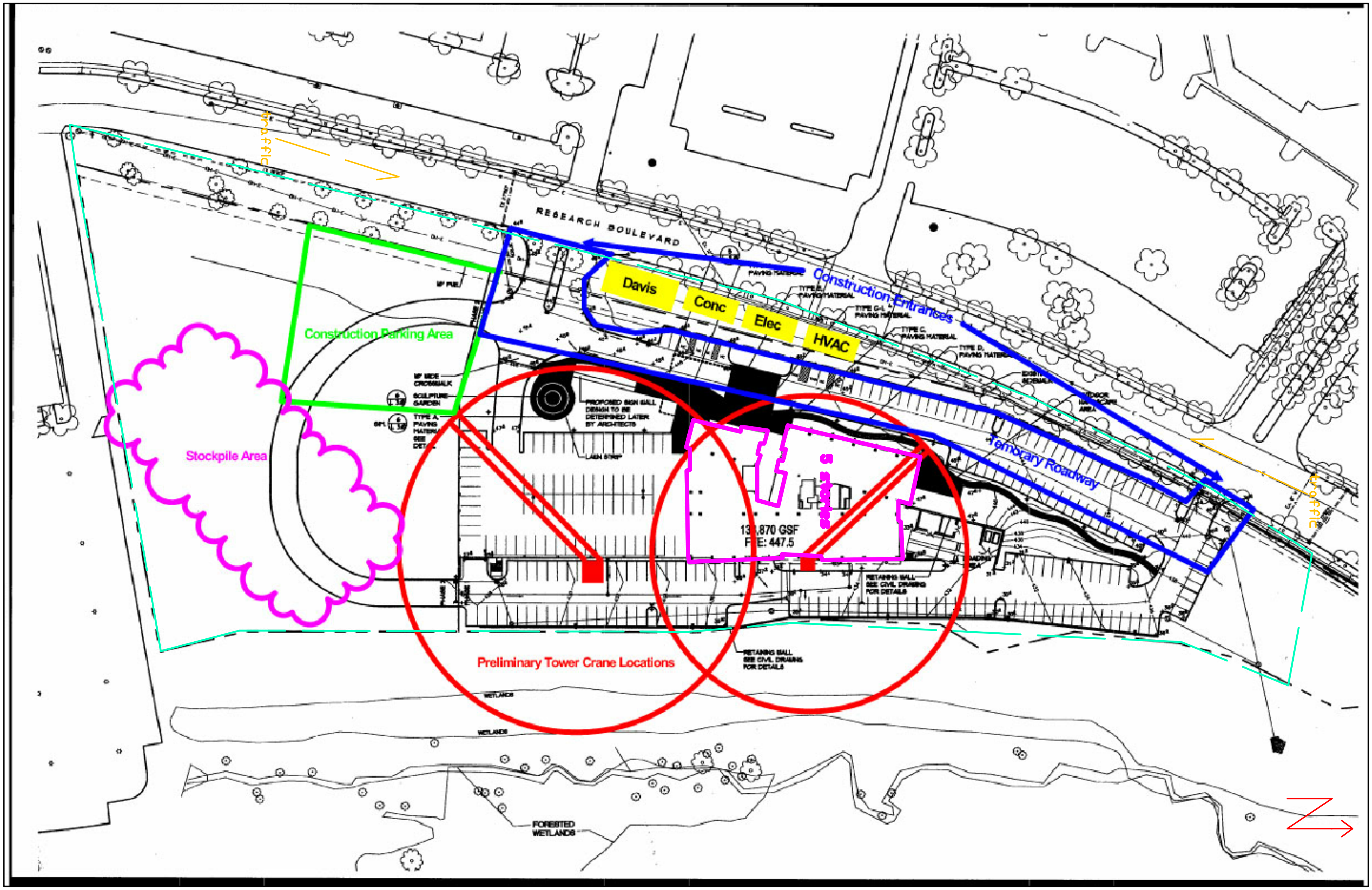

ASHA National HQ
Site Layout
Oct. 6, 2006
Michael Abbondante

APPENDIX C

- Sustainability Depth
- *LEED Scorecard*
- *Green Globes Scorecard*

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LEED™ Credit Scorecard

LEED-NC Green Building Rating System, version 2.1, final version w/ revisions

ASHA National Office

Rockville, MD

March 12, 2007

			Total Project Score	Possible Points 69
39	6	24	Total Project Score	Possible Points 69

Certified 26 to 32 points **Silver** 33 to 38 points **Gold** 39 to 51 points **Platinum** 52 or more points

Sustainable Sites — Possible Points 14

Y	?	N			Points
8	1	5		**Sustainable Sites**	14
Y			Prereq 1	Erosion & Sedimentation Control	
1			Credit 1	Site Selection	1
		1	Credit 2	Development Density	1
		1	Credit 3	Brownfield Redevelopment	1
1			Credit 4.1	Alternative Transportation, Public Transportation Access	1
1			Credit 4.2	Alternative Transportation, Bicycle Storage & Changing Rooms	1
	1		Credit 4.3	Alternative Transportation, Alternative Fuel Refueling Stations	1
1			Credit 4.4	Alternative Transportation, Parking Capacity and Carpooling	1
		1	Credit 5.1	Reduced Site Disturbance, Protect or Restore Open Space	1
1			Credit 5.2	Reduced Site Disturbance, Development Footprint	1
		1	Credit 6.1	Stormwater Management, Rate and Quantity	1
1			Credit 6.2	Stormwater Management, Treatment	1
1			Credit 7.1	Landscape & Exterior Design to Reduce Heat Islands, Non-Roof	1
1			Credit 7.2	Landscape & Exterior Design to Reduce Heat Islands, Roof	1
		1	Credit 8	Light Pollution Reduction	1

Water Efficiency — Possible Points 5

Y	?	N			Points
4		1		**Water Efficiency**	5
1			Credit 1.1	Water Efficient Landscaping, Reduce by 50%	1
1			Credit 1.2	Water Efficient Landscaping, No Potable Use or No Irrigation	1
		1	Credit 2	Innovative Wastewater Technologies	1
1			Credit 3.1	Water Use Reduction, 20% Reduction	1
1			Credit 3.2	Water Use Reduction, 30% Reduction	1

Energy & Atmosphere — Possible Points 17

Y	?	N			Points
4	3	10		**Energy & Atmosphere**	17
Y			Prereq 1	Fundamental Building Systems Commissioning	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	CFC Reduction in HVAC&R Equipment	
1	1		Credit 1.1	Optimize Energy Performance, 20% New / 10% Existing	2
	1	1	Credit 1.2	Optimize Energy Performance, 30% New / 20% Existing	2
		2	Credit 1.3	Optimize Energy Performance, 40% New / 30% Existing	2
		2	Credit 1.4	Optimize Energy Performance, 50% New / 40% Existing	2
		2	Credit 1.5	Optimize Energy Performance, 60% New / 50% Existing	2
		1	Credit 2.1	Renewable Energy, 5%	1
		1	Credit 2.2	Renewable Energy, 10%	1
		1	Credit 2.3	Renewable Energy, 20%	1
1			Credit 3	Additional Commissioning	1
1			Credit 4	Elimination of HCFC's and Halons	1
1			Credit 5	Measurement & Verification	1
	1		Credit 6	Green Power	1

(yellow) Credit ready to submit to USGBC

(pink) Design Credit not ready to submit to USGBC

Materials & Resources — Possible Points 13

Y	?	N			Points
7	1	5		**Materials & Resources**	13
Y			Prereq 1	Storage & Collection of Recyclables	
		1	Credit 1.1	Building Reuse, Maintain 75% of Existing Shell	1
		1	Credit 1.2	Building Reuse, Maintain 100% of Shell	1
		1	Credit 1.3	Building Reuse, Maintain 100% Shell & 50% Non-Shell	1
1			Credit 2.1	Construction Waste Management, Divert 50%	1
1			Credit 2.2	Construction Waste Management, Divert 75%	1
		1	Credit 3.1	Resource Reuse, Specify 5%	1
		1	Credit 3.2	Resource Reuse, Specify 10%	1
1			Credit 4.1	Recycled Content, Specify 5% (post-consumer + 1/2 post-industri	1
1			Credit 4.2	Recycled Content, Specify 10% (post-consumer + 1/2 post-industr	1
1			Credit 5.1	Local/Regional Materials, 20% Manufactured Locally	1
1			Credit 5.2	Local/Regional Materials, of 20% Above, 50% Harvested Locally	1
	1		Credit 6	Rapidly Renewable Materials	1
1			Credit 7	Certified Wood	1

Indoor Environmental Quality — Possible Points 15

Y	?	N			Points
11	1	3		**Indoor Environmental Quality**	15
Y			Prereq 1	Minimum IAQ Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1			Credit 1	Carbon Dioxide (CO2) Monitoring	1
		1	Credit 2	Ventilation Effectiveness	1
1			Credit 3.1	Construction IAQ Management Plan, During Construction	1
1			Credit 3.2	Construction IAQ Management Plan, Before Occupancy	1
1			Credit 4.1	Low-Emitting Materials, Adhesives & Sealants	1
1			Credit 4.2	Low-Emitting Materials, Paints	1
1			Credit 4.3	Low-Emitting Materials, Carpet	1
1			Credit 4.4	Low-Emitting Materials, Composite Wood	1
1			Credit 5	Indoor Chemical & Pollutant Source Control	1
		1	Credit 6.1	Controllability of Systems, Perimeter	1
		1	Credit 6.2	Controllability of Systems, Non-Perimeter	1
1			Credit 7.1	Thermal Comfort, Comply with ASHRAE 55-1992	1
1			Credit 7.2	Thermal Comfort, Permanent Monitoring System	1
	1		Credit 8.1	Daylight & Views, Daylight 75% of Spaces	1
1			Credit 8.2	Daylight & Views, Views for 90% of Spaces	1

Innovation & Design Process — Possible Points 5

Y	?	N			Points
5				**Innovation & Design Process**	5
1			Credit 1.1	Innovation in Design: 40% Locally Manufactured Materials	1
1			Credit 1.2	Innovation in Design: User Education	1
1			Credit 1.3	Innovation in Design: 40% Water Use Reduction	1
1			Credit 1.4	Innovation in Design: Green Housekeeping Plan	1
1			Credit 2	LEED™ Accredited Professional	1

Green Globes Scorecard	
Project Management (40/50)	***Water (55/100)***
Integrated design (18/20)	Water Efficiency (30/30)
Environmental Purchasing (5/5)	Water Conserving (15/40)
Commissioning (17/20)	Reduce Off-Site Treatment (10/20)
Emergency Response Plan (0/5)	
Site (65/115)	***Resources/Building Materials (40/100)***
Site Development (15/45)	Materials with Low Environmental Impact (20/40)
Reduce Ecological Impacts (29/40)	Minimized Consumption and Depletion (10/30)
Enhancement of Watershed Features (15/15)	Re-use of Existing Structures (0/10)
Site Ecology Improvements (6/15)	Building Durability, Adaptibility, and Disassembly (3/12)
	Reduction and Re-use (7/10)
Energy (241/360)	***Emmissions and Effluents (28/75)***
Energy Consumption (70/110)	Air Emissions (5/15)
Energy Demand Minimization (70/135)	Ozone and Global Awareness (20/30)
"Right Sized" Energy Efficient Systems (72/110)	Contamination for Sewers/Waterways (2/12)
Renewable Sources of Energy (0/45)	Land/Water Pollution (1/9)
Energy Efficient Transportation (36/70)	Integrated Pest Management (0/4)
	Storage of Hazardous Materials (0/5)
Indoor Environment (111/200)	***Final Score (580/1000)***
Effective Ventilation System (38/60)	Project Management (40/50)
Source Control of Indoor Pollutants (23/45)	Site (65/115)
Lighting Design Integration (10/40)	Energy (241/360)
Thermal Comfort (35/55)	Indoor Environment (111/200)
	Water (55/100)
	Resources/Building Materials (40/100)
	Emmissions and Effluents (28/75)
	Green Globes Score: Two Globes

APPENDIX D

- Surveys
- *Sustainability Survey*
- *Procurement Survey*

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Sustainability Survey

- Have you ever been a part of a LEED rated project?
    - If so why was a LEED rating attempted to be attained and what was the rating attempted and finally attained?
    - What difficulties occurred or worries occurred throughout the project that may not have occurred if the building was not LEED rated?
    - How much higher were the initial costs of the project?
    - What is the projected savings on the project due to LEED rating in the future?
    - In your opinion were the difficulties and restrictions worth a LEED rating in the end?
    - Will you pursue LEED rated projects in the future?
- Have you ever been apart of a project that attempted another sustainable rating system other than LEED and which was it?
    - Why did you not attempt a LEED rating?
    - What sustainability system did you use?
    - What were the initial costs compared to a non-green building, and what are the savings projected due to the design?
    - Was attempting sustainability worth the initial costs?
    - Do you wish you had pursued a LEED rating?
    - Will future projects use this sustainable system?
- Is sustainability the future of this industry with or without LEED?
- Do you believe LEED should be followed extensively or are future green and sustainable rankings going to be accepted?
- Although LEED is always a hot topic why is it not always used?
- Is the LEED scorecard to complicated causing its unpopularity?
- Should a simpler system be implemented?
- What should the scorecard include?
- If LEED is not used how should be sustainable buildings be ranked or should sustainable buildings become a standard?
- Have you ever heard of Green Globes?
    - Does Green Globes seem to simple?
    - Does Green Globes appoint to many “easy points”?
    - Do you support the use of points for design as well as completion?
- How important is overall cost to attain a desired rating system?
- Is an ANSI approval important?
- In your opinion is sustainable design worth initial costs, and is it worth the change in the industry or should the industry remain constant?

SUSTAINABILITY GENERAL CONSENSUS

Owners:

- Remaining competitive in sustainability is essential
- LEED raises the cost of a project but is worth it if the final rating is met
- Government owners pointed out the popularity of LEED's use on projects
- Many did not even know of Green Globes
- Believe the future of the industry will be in LEED and sustainability
- Green Globes peaked interest
- ANSI rating was very highly recieved
- Ability to possibly save costs and time were well received
- LEED can be frustrating but will more likely be used by the owner in the future
- Sustainability will only grow in the industry

General Contractors:

- Many General Contractors have used LEED
- Do not like the complexity and practical requirement of needing a LEED certified PM on the project
- Do not like the ability to lose points at the end of a project and not reach suspected goal
- It is currently what owners expect and is most popular
- Some GC's have not even heard of Green Globes
- Interest in use of interns or general knowledge employees to complete surveys
- Fear that overall control of LEED will not allow for new systems to flourish
- But also agree with owners that sustainability is the future of the industry

Procurement Survey

- As an owner which procurement method do you prefer design-build or design-bid-build?
    - Why do you prefer that specific method?

- Have you ever been a part of a Design-Build rated project?
    - If so why did you use design-build procurement?
    - What worries or concerns did you have about the project being design-build instead of a design-bid-build-project?
    - Was the project completed on time and on budget?
    - Were there multiple project saving, if so what were they, and what was the reason?
    - Did you feel disconnected from the project at anytime during the design phase?
    - Will you continue to use the design-build method?

- What aspects of design-bid-build do you prefer?
    - Although design-build generally saves time and money why do you not always use it and why is it not always used in the industry today?
    - Do you feel that a direct low bid is the best way to bid a project?
    - Do you prefer being an integral role in the design process?
    - Do you continue to use a tradition method because it is so popular with the industry and work force?

- Should governments be dictating project methods used?
- Do you see design-build as the future of procurement?
- What makes design-bid-build so popular?
- What makes design-build so popular?

Procurement General Consensus

Owners:

- Control in a project can be highly important
- Important to owners to be involved in the design process
- Traditional methods are easy to understand and is industry standard
- Many owners prefer familiarity to a system
- Design – Build can remove owners control
- Schedule and cost can affect procurement method
- Design – Build is growing but very slowly
- Many owners do not like the use of GMP feel prices are inflated

General Contractors:

- Would like to be more involved in design
- Change orders and design mistakes can lead to high costs
- GMP allows for “padding” in bid in case of price inflations
- The traditional method remains the market trend
- Design – build presents many opportunities to save money and time
- Traditional method benefits more experienced GC’s
- Traditional generally provides lowest initial bid

APPENDIX E

- Procurement Depth
- PDSS Decision Table
- PDSS Selection System Survey

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Table 3: A PDSS Risk/Organizational Structure Decision Table

Risk Factors/Org. Structure	Traditional (TD)	Design/Build (D/B)	CM (General Contractor) (CMGC)	CM (Agency) (CMA)	Risk Factor Range	Organization
Project Characteristics (scope, complexity)	well defined, better suited for industry standard jobs	well defined projects; industry standard as well as slightly complex jobs	fairly well defined, relatively complex	poorly defined, highly complex jobs	well defined poorly defined	TD D/B CMGC CMA
Time	not of the essence	better when time is of the essence	time is generally critical	o.k. for both - slightly better when time is of the essence	of the essence not of the essence	D/B CMGC CMA TD
Owner Experience	o.k. for both - better suited for an inexperienced owner(relies on a/e)	inexperienced owner; owner loses "checks and balances"	critical that the owner be experienced	o.k. for both - better for an inexperienced owner	experienced inexperienced	CMGC CMA TD, D/B
Team Experience	o.k. for both - better for inexperienced	better for an experienced team	critical that an experienced team be in place	o.k. for both - slightly better for an inexperienced team	experienced inexperiencced	CMGC, D/B CMA TD
Quality	industry standard as well as "monuments"	industry standard and jobs with a little higher quality requirement	o.k. for both - better for industry standard jobs	o.k. for both - better for higher quality projects	above standard industry standard	CMA D/B CMGC TD
Cost	better when cost is important but not "critical"	o.k. for both - better when cost is critical	better when cost is critical	not critical	critical not critical	D/B CMGC TD CMA
Composite Risk	low risk	low - medium risk	high risk	high risk	low high	TD D/B CMGC CMA

THE PROJECT [illegible]VERY SELECTION SYSTEM

BY VESAY, T. & SANVIDO, V.

Figure [illegible] The PDSS Model - Decision Tree

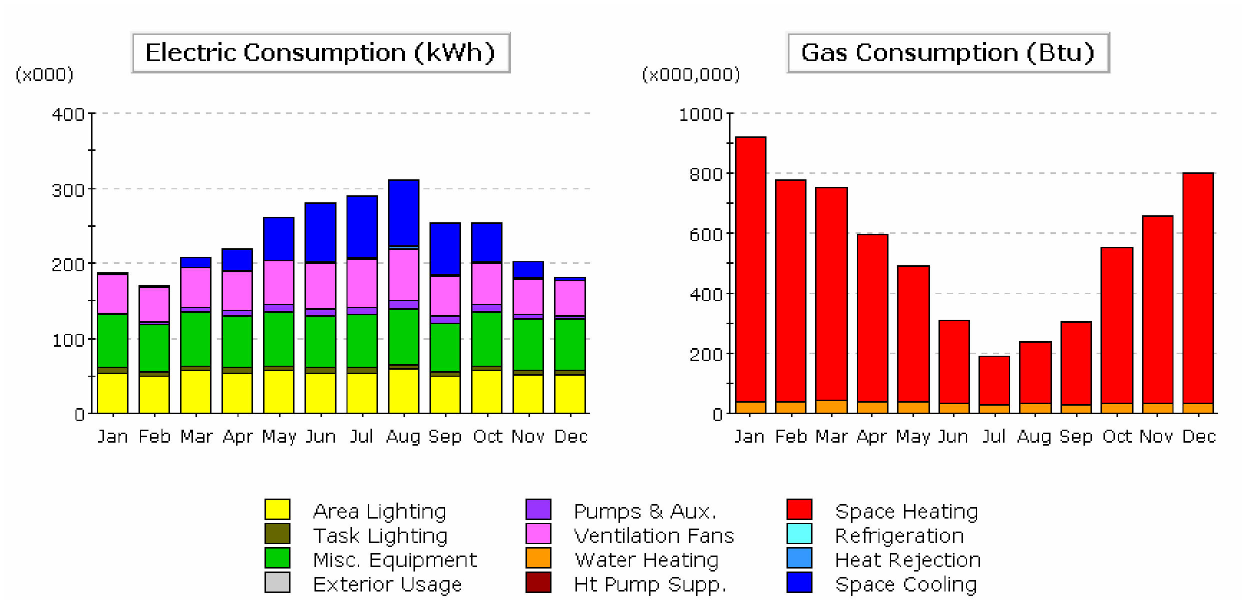
APPENDIX F

- Mechanical Breadth
- Window Efficiencies
  - ***Single Low E***
  - ***Double Low E***
  - ***Triple Low E***
  - ***Electro***

American Speech - Language - Hearing Association

AtSite Real Estate

SINGLE LOW E
(BASELINE)



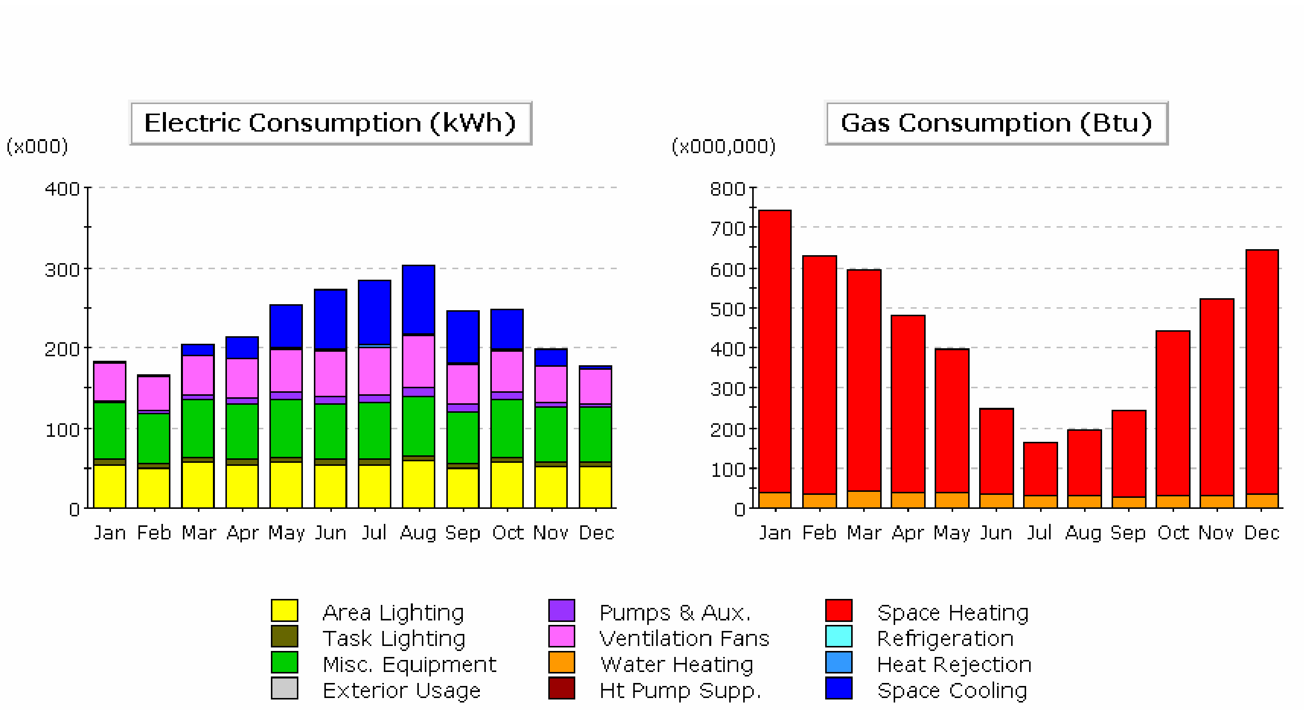
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	2.3	3.2	13.3	29.4	56.5	78.0	81.5	87.2	67.5	50.9	21.5	3.1	494.4
Heat Reject.	-	0.0	0.2	0.5	1.4	2.7	3.4	3.4	2.3	1.2	0.3	-	15.3
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	49.9	45.3	53.9	53.0	58.3	59.7	64.0	68.9	53.4	56.9	49.2	47.6	660.1
Pumps & Aux.	3.3	3.1	5.1	6.9	9.3	10.2	10.4	11.2	9.1	8.8	5.6	3.4	86.4
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	70.5	63.8	72.4	69.5	72.4	69.5	70.5	74.2	65.8	72.4	67.7	68.7	837.4
Task Lights	6.2	5.6	6.5	6.2	6.5	6.2	6.2	6.8	5.6	6.5	5.9	5.9	74.2
Area Lights	54.0	48.9	56.4	53.9	56.4	53.9	54.0	58.7	49.1	56.4	51.5	51.6	644.6
Total	186.2	170.0	207.6	219.4	260.7	280.1	289.9	310.4	252.8	253.0	201.8	180.3	2,812.4

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	878.2	740.3	713.4	557.5	454.0	278.4	161.6	207.6	279.9	522.0	624.3	767.3	6,184.5
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	38.6	36.1	41.3	38.4	37.2	32.7	30.4	31.6	26.5	32.0	31.7	34.6	411.0
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	916.8	776.4	754.7	595.9	491.2	311.1	191.9	239.2	306.4	554.0	656.0	801.8	6,595.5

DOUBLE LOW E



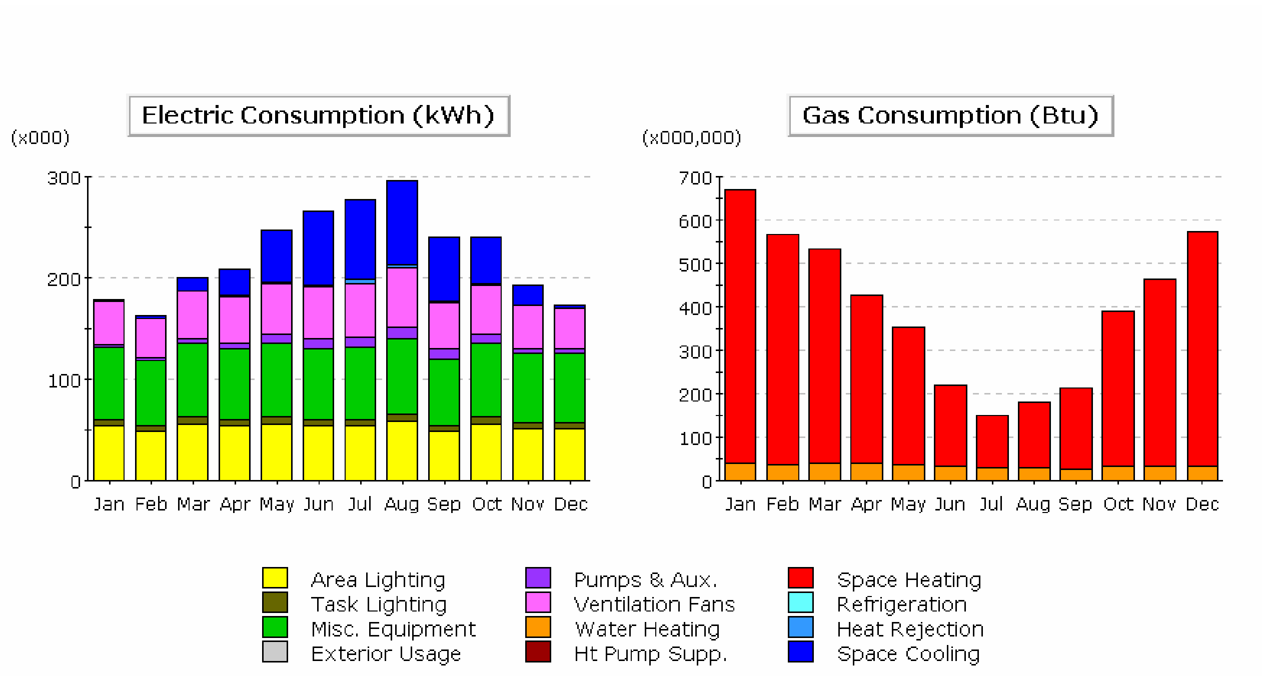
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	2.2	3.1	12.9	27.9	53.5	74.9	80.6	85.2	65.0	48.6	20.6	3.0	477.6
Heat Reject.	-	0.0	0.2	0.4	1.3	2.6	3.3	3.3	2.2	1.1	0.3	-	14.7
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	46.2	42.1	50.4	49.4	54.3	55.5	58.7	63.5	49.7	53.1	46.0	44.3	613.2
Pumps & Aux.	3.2	3.1	5.0	6.8	9.2	10.2	10.3	11.1	9.0	8.8	5.6	3.3	85.5
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	70.5	63.8	72.4	69.5	72.4	69.5	70.5	74.2	65.8	72.4	67.7	68.7	837.4
Task Lights	6.2	5.6	6.5	6.2	6.5	6.2	6.2	6.8	5.6	6.5	5.9	5.9	74.2
Area Lights	54.0	48.9	56.4	53.9	56.4	53.9	54.0	58.7	49.1	56.4	51.5	51.6	644.6
Total	182.4	166.6	203.7	214.2	253.5	272.7	283.7	302.9	246.4	246.8	197.5	176.8	2,747.2

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	704.0	593.4	554.2	441.1	358.1	214.2	132.5	164.6	216.5	409.7	489.3	608.5	4,886.2
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	38.6	36.1	41.3	38.4	37.2	32.7	30.4	31.6	26.5	32.0	31.7	34.6	411.0
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	742.6	629.5	595.5	479.5	395.3	246.9	162.9	196.2	243.0	441.7	521.0	643.0	5,297.2

TRIPLE LOW E



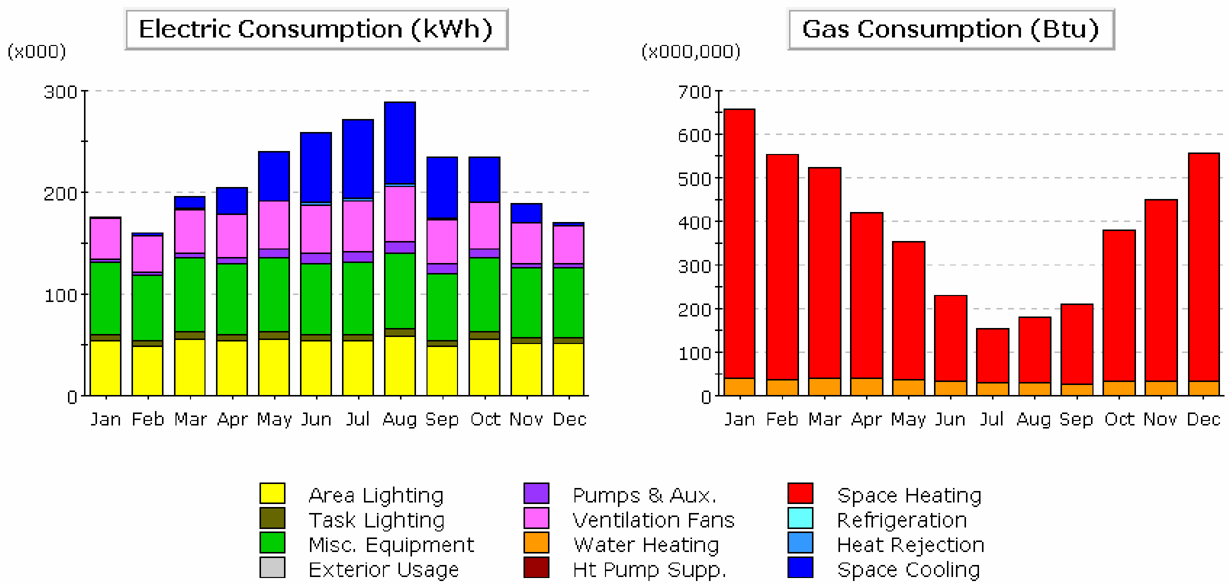
Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	2.2	3.0	12.4	26.4	50.9	71.9	79.4	82.9	62.2	45.8	19.5	2.9	459.4
Heat Reject.	-	0.0	0.2	0.4	1.2	2.5	3.3	3.2	2.1	1.0	0.3	-	14.1
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	42.7	38.9	46.6	45.8	50.3	51.4	54.0	58.5	46.0	49.2	42.6	41.0	567.0
Pumps & Aux.	3.2	3.0	4.9	6.7	9.0	10.1	10.2	11.1	8.9	8.6	5.5	3.3	84.5
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	70.5	63.8	72.4	69.5	72.4	69.5	70.5	74.2	65.8	72.4	67.7	68.7	837.4
Task Lights	6.2	5.6	6.5	6.2	6.5	6.2	6.2	6.8	5.6	6.5	5.9	5.9	74.2
Area Lights	54.0	48.9	56.4	53.9	56.4	53.9	54.0	58.7	49.1	56.4	51.5	51.6	644.6
Total	178.8	163.2	199.3	208.9	246.7	265.4	277.6	295.4	239.7	239.9	192.9	173.4	2,681.1

Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	631.5	529.2	490.4	389.3	315.0	187.1	121.1	148.5	188.1	359.5	431.3	538.3	4,329.4
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	38.6	36.1	41.3	38.4	37.2	32.7	30.4	31.6	26.5	32.0	31.7	34.6	411.0
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	670.1	565.3	531.7	427.7	352.1	219.9	151.5	180.1	214.6	391.5	463.0	572.9	4,740.4

ELECTRO



Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	2.1	2.9	11.7	25.0	48.5	69.1	76.8	80.1	59.8	43.2	18.5	2.8	440.7
Heat Reject.	-	0.0	0.2	0.4	1.1	2.4	3.2	3.1	2.0	0.9	0.3	-	13.5
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	39.9	36.3	43.4	42.7	46.7	47.5	50.4	54.7	42.9	46.0	39.8	38.3	528.7
Pumps & Aux.	3.1	3.0	4.9	6.7	8.9	10.0	10.2	11.0	8.8	8.4	5.4	3.2	83.6
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	70.5	63.8	72.4	69.5	72.4	69.5	70.5	74.2	65.8	72.4	67.7	68.7	837.4
Task Lights	6.2	5.6	6.5	6.2	6.5	6.2	6.2	6.8	5.6	6.5	5.9	5.9	74.2
Area Lights	54.0	48.9	56.4	53.9	56.4	53.9	54.0	58.7	49.1	56.4	51.5	51.6	644.6
Total	175.8	160.4	195.4	204.3	240.5	258.6	271.3	288.6	234.1	233.9	189.1	170.6	2,622.6

Gas Consumption (Btu x000,000)

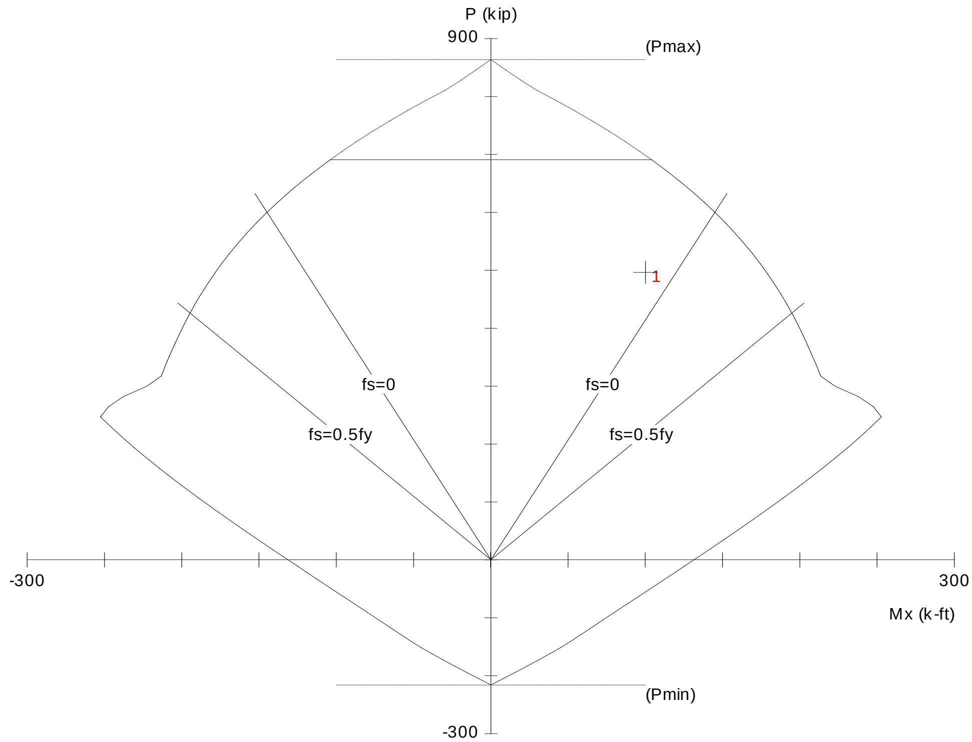
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	619.6	518.2	482.9	382.9	316.5	197.2	123.6	149.6	184.5	346.9	417.8	522.5	4,262.2
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	38.6	36.1	41.3	38.4	37.2	32.7	30.4	31.6	26.5	32.0	31.7	34.6	411.0
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	658.2	554.3	524.2	421.3	353.7	229.9	154.0	181.2	210.9	378.9	449.5	557.1	4,673.2

APPENDIX G

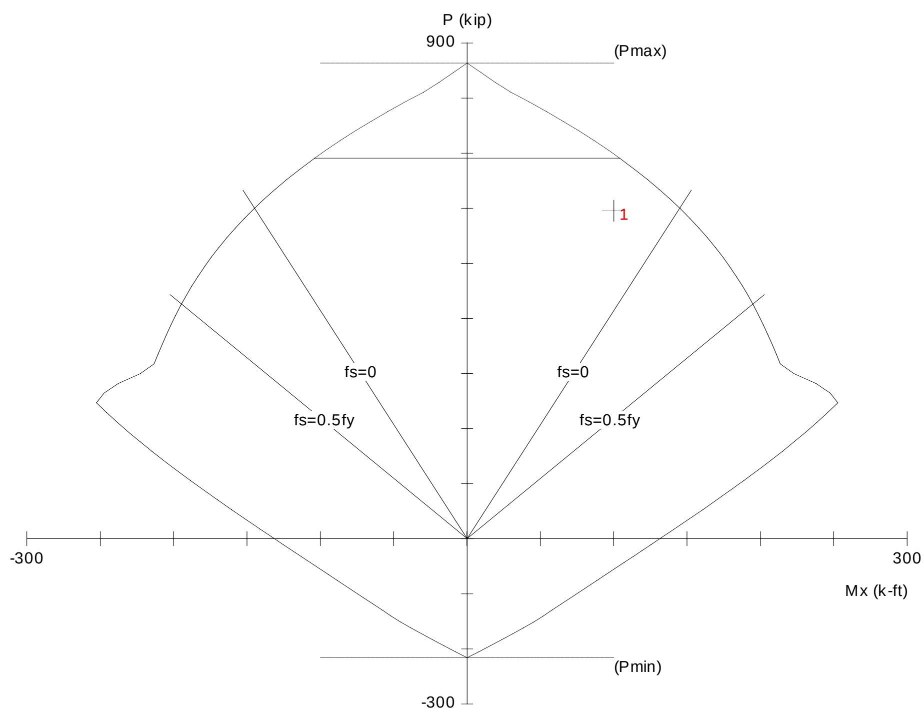
- **Structural Breadth**
- ***Concrete pcaColumn graphs***
- ***Hand Calculation***
- ***Concrete vs Steel Costs***
- ***Concrete vs Steel Schedules***

American Speech - Language - Hearing Association

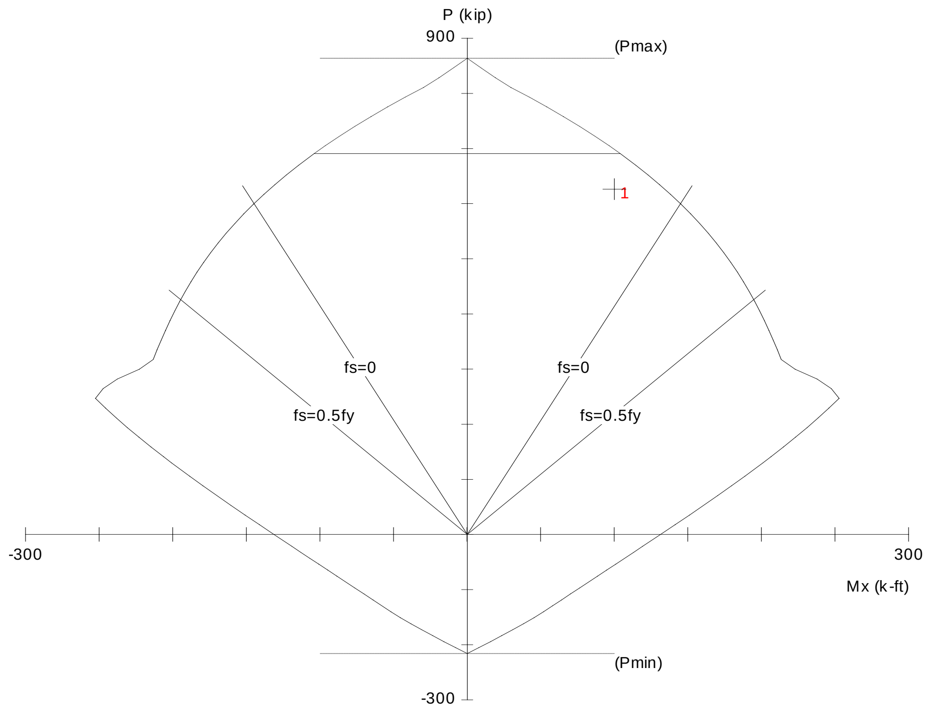
AtSite Real Estate



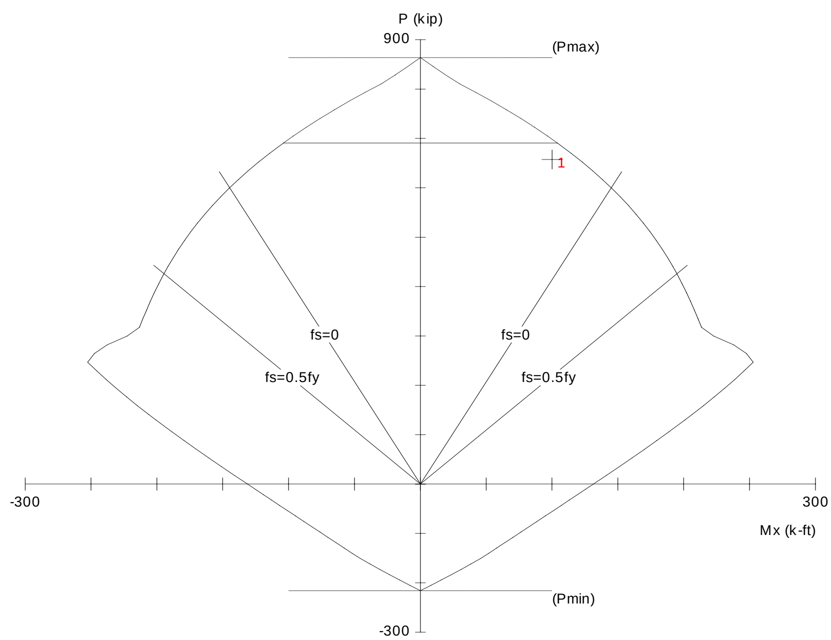
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
12x58	15	496	18x18 (4ksi)	4 #9



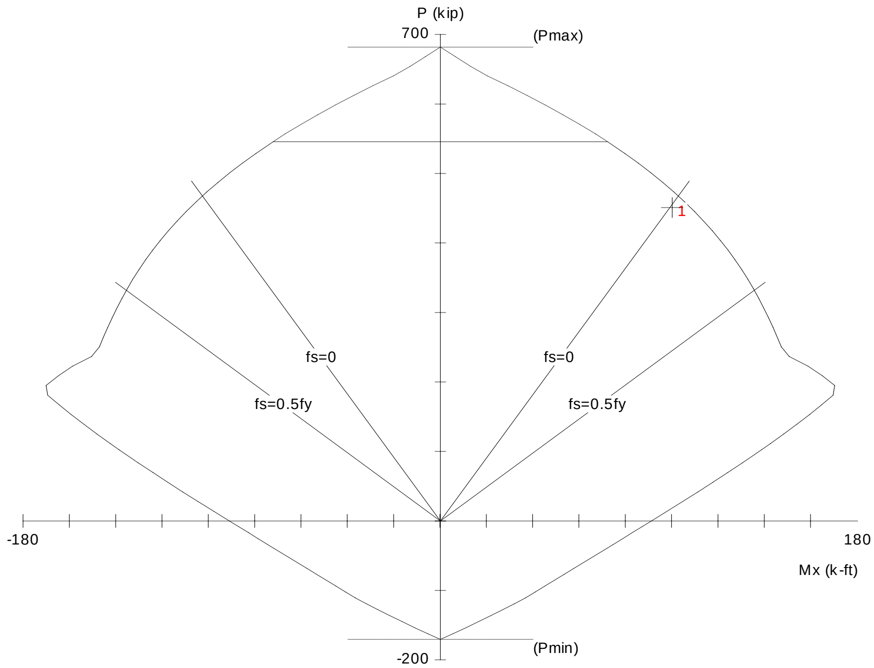
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
12x58	13.5	535	18x18 (4ksi)	4 #9



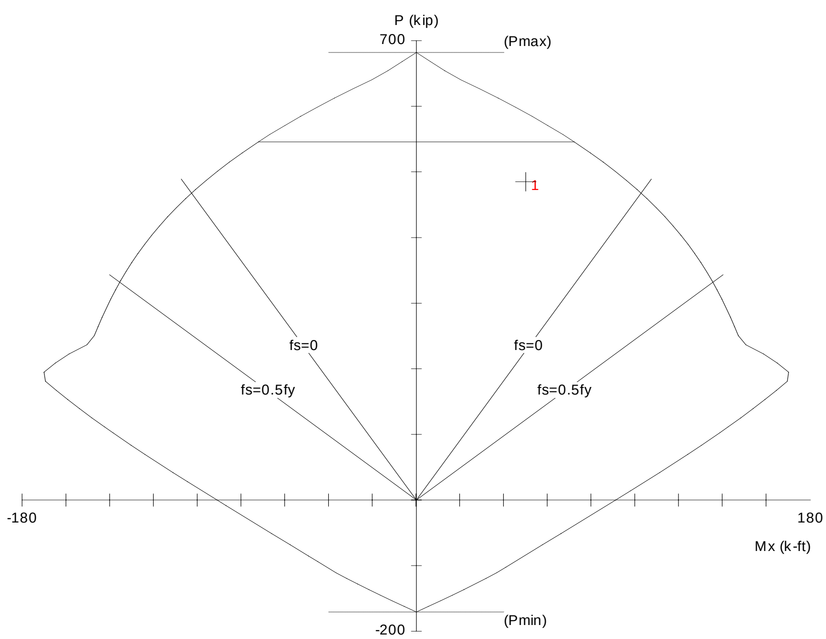
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
12x65	15	626	18x18 (4ksi)	4 #9



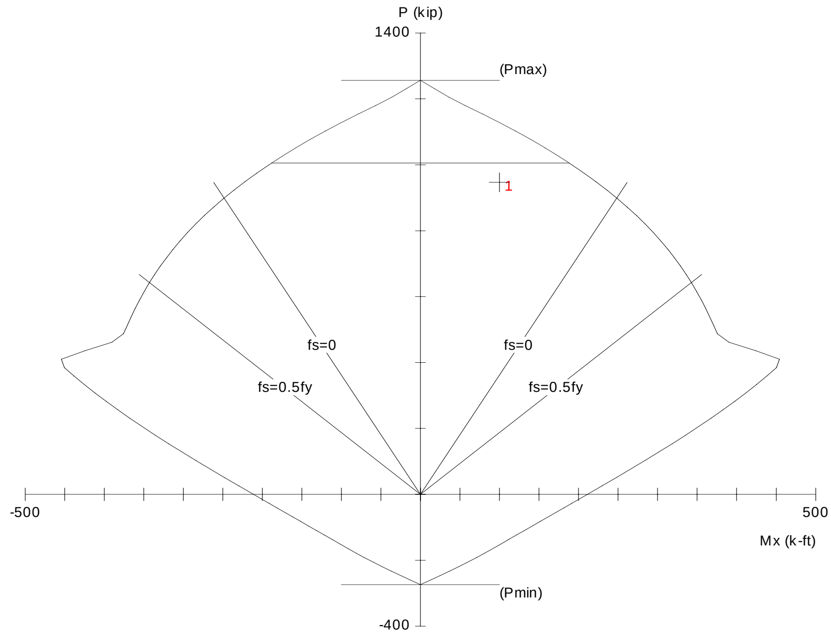
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
12x65	13.5	657	18x18 (4ksi)	4 #9



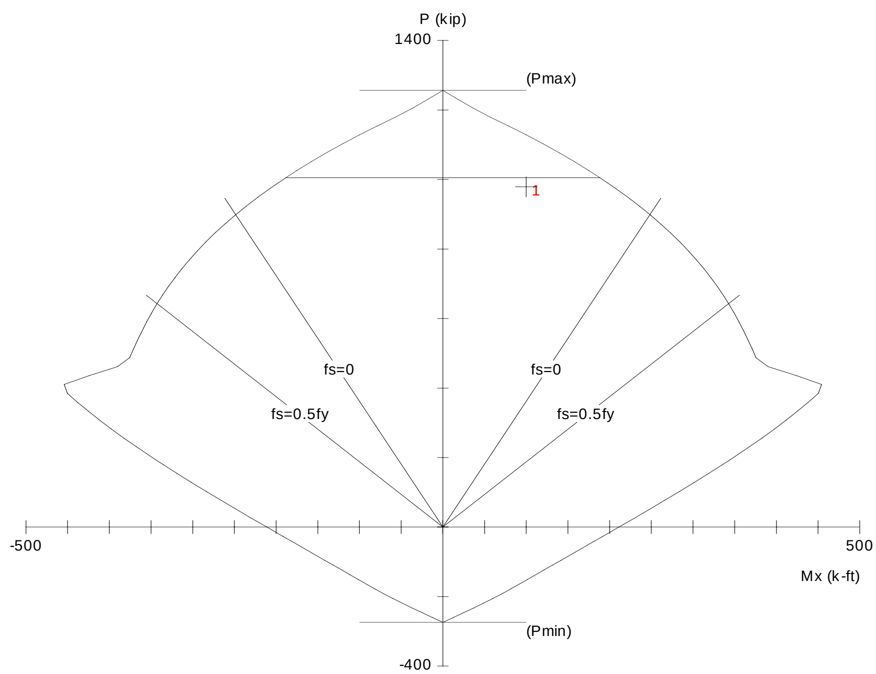
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
12x53	15	451	16x16 (4ksi)	4 #8



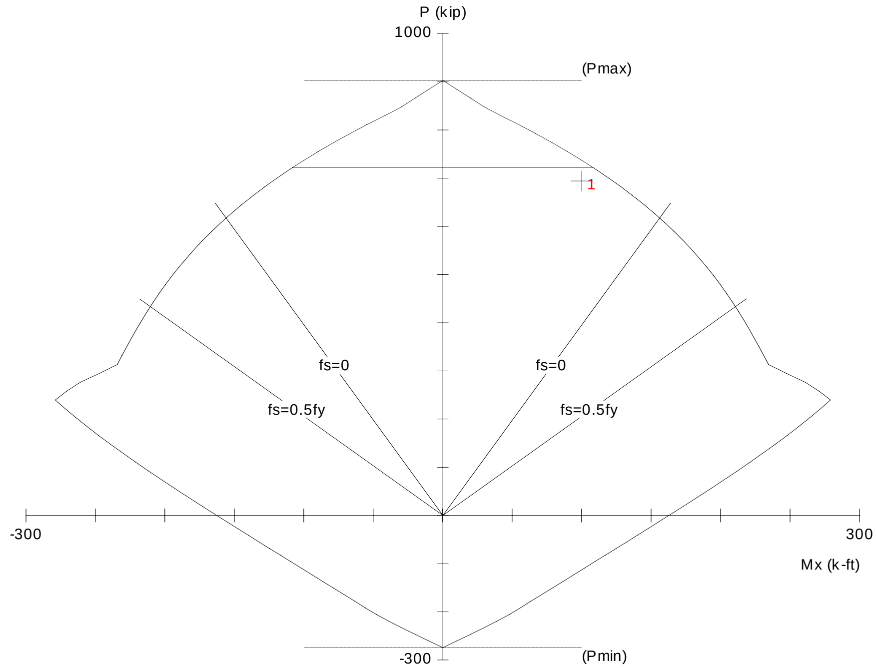
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
12x53	13.5	485	16x16 (4ksi)	4 #8



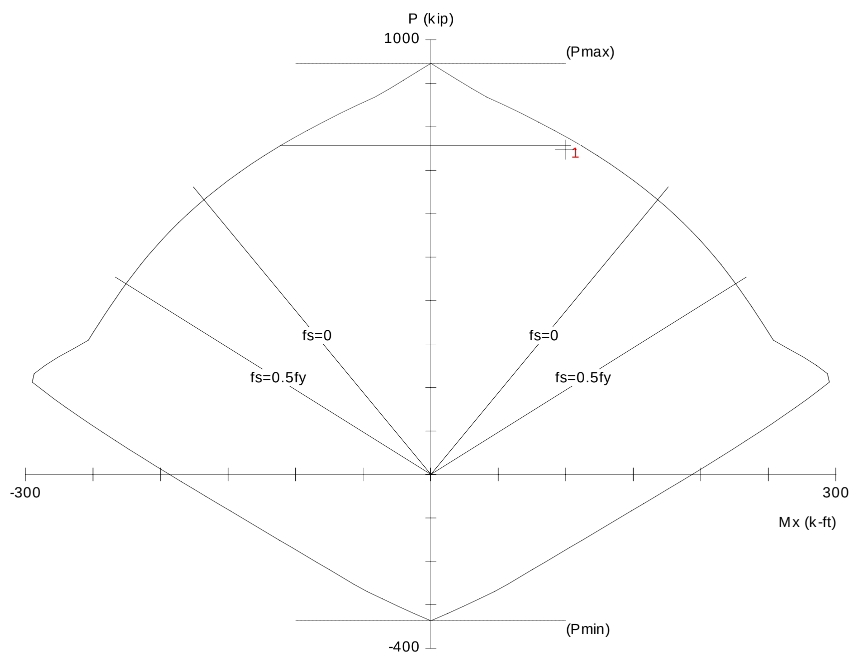
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
14x90	15	947	22x22 (4ksi)	4 #10



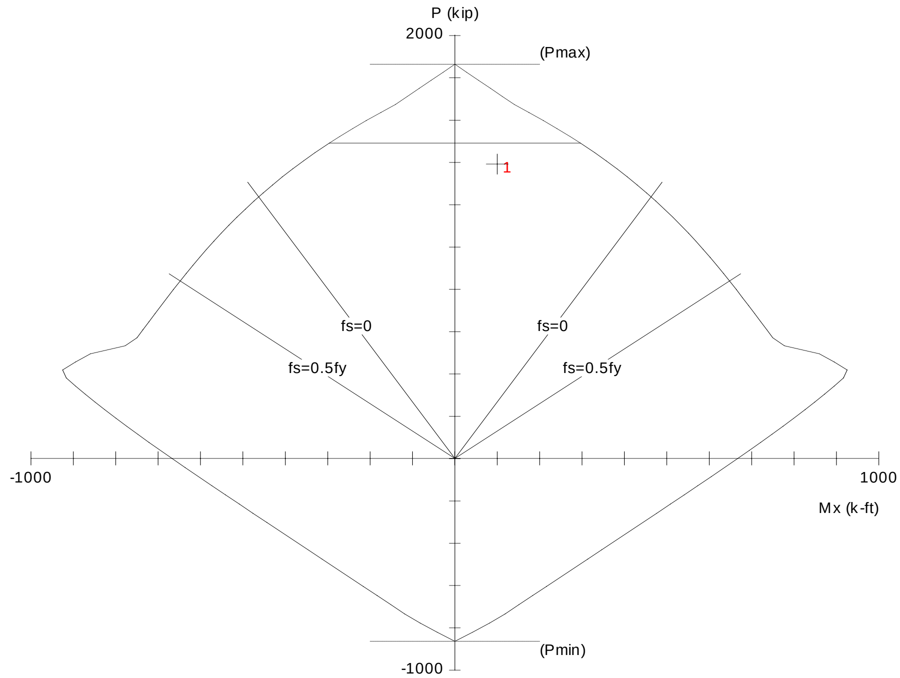
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
14x90	13.5	979	22x22 (4ksi)	4 #10



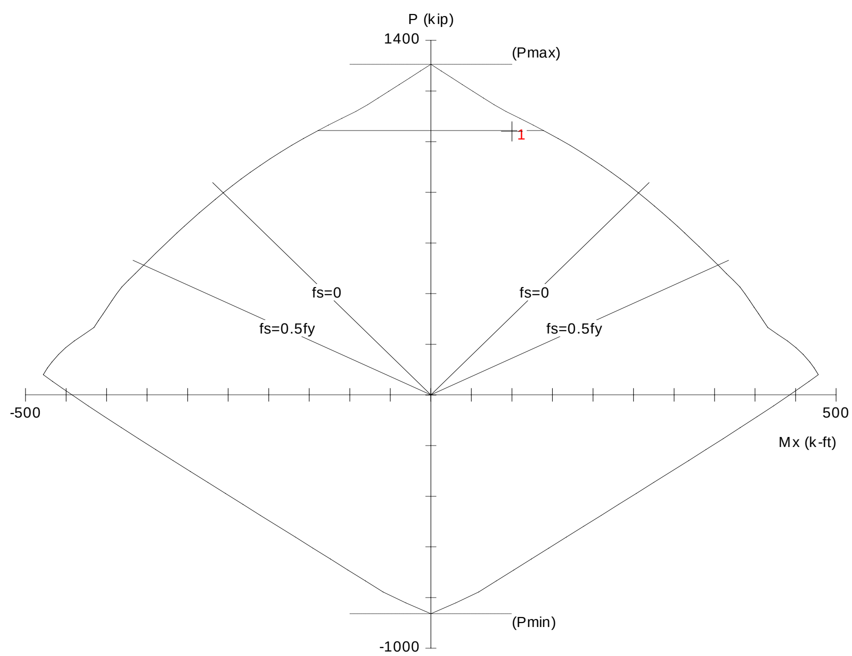
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
14x82	15	694	18x18 (4ksi)	4 #10



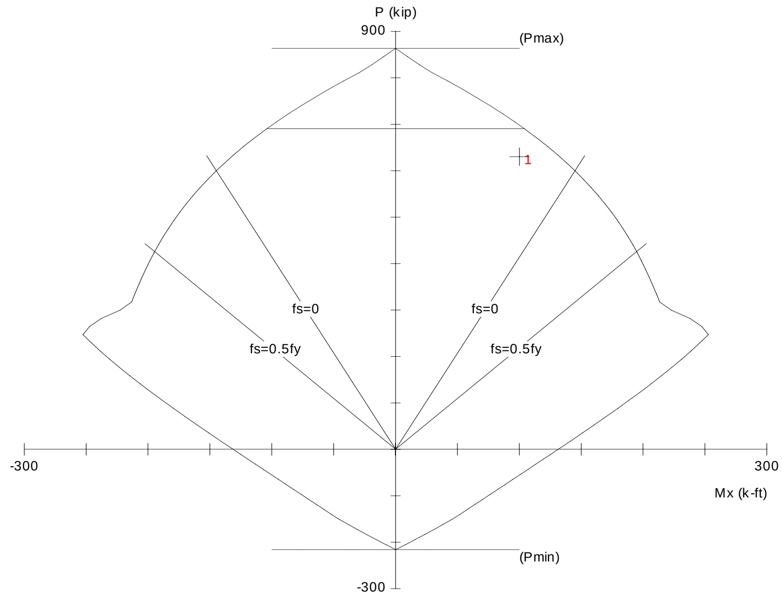
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
14x82	13.5	747	18x18 (4ksi)	4 #11



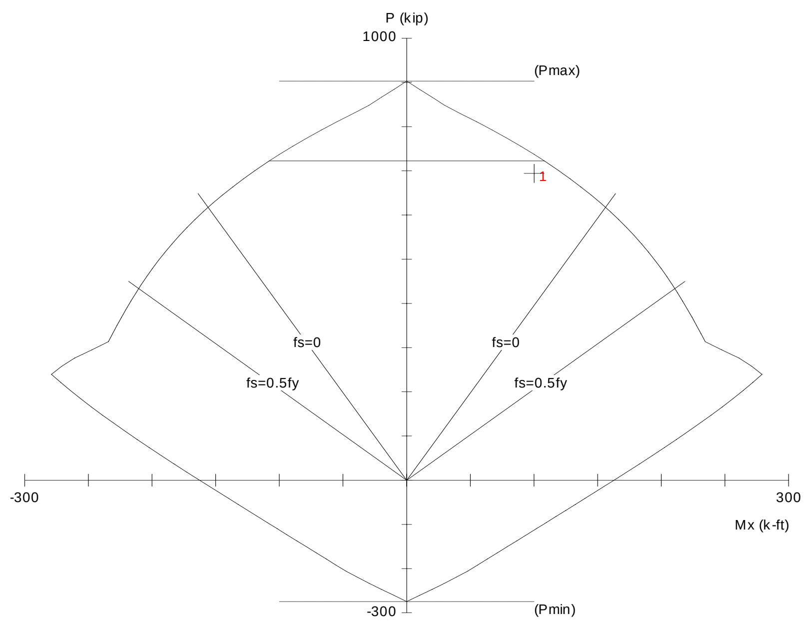
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
14x132	15	1390	24x24 (4ksi)	4 #18



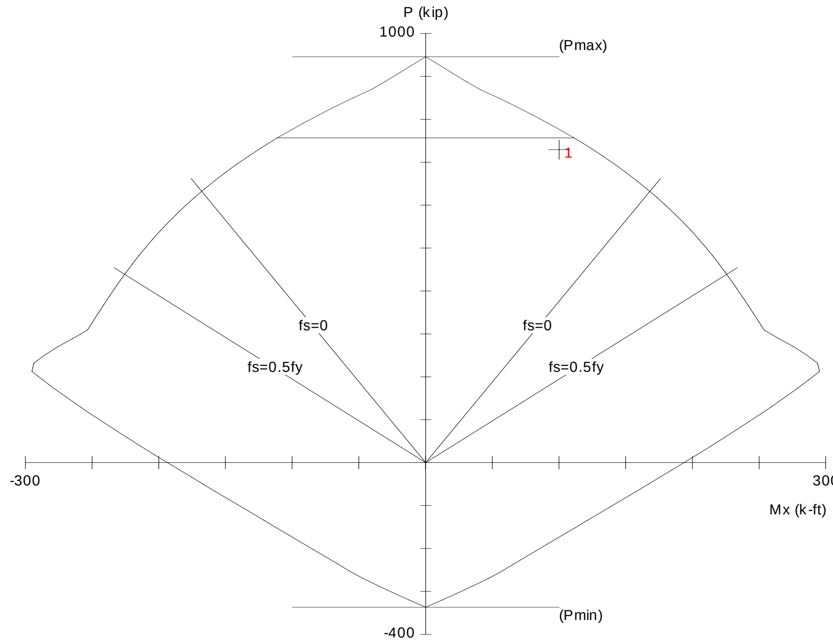
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
14x99	15	1040	24x24 (4ksi)	4 #11



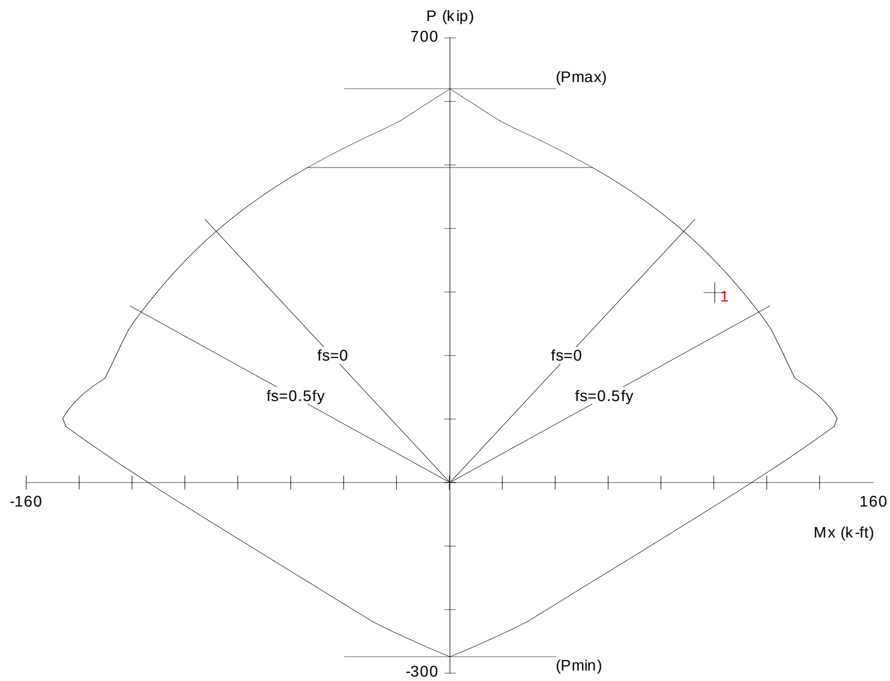
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
14x74	15	630	18x18 (4ksi)	4 #9



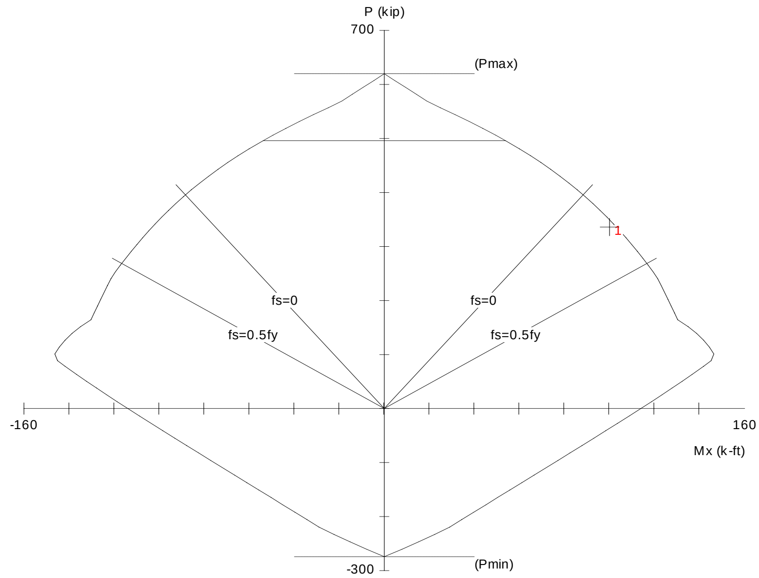
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
12x72	15	694	18x18 (4ksi)	4 #10



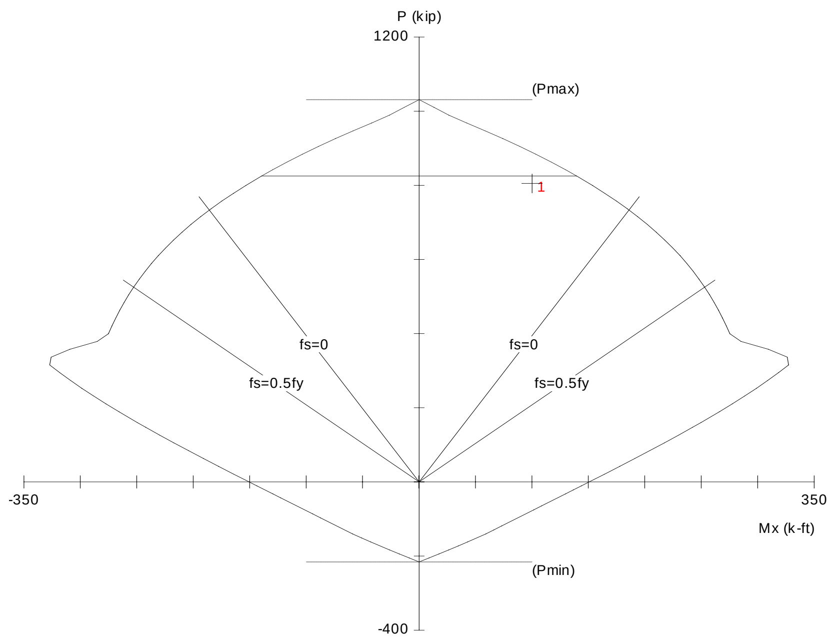
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
12x72	13.5	729	18x18 (4ksi)	4 #11



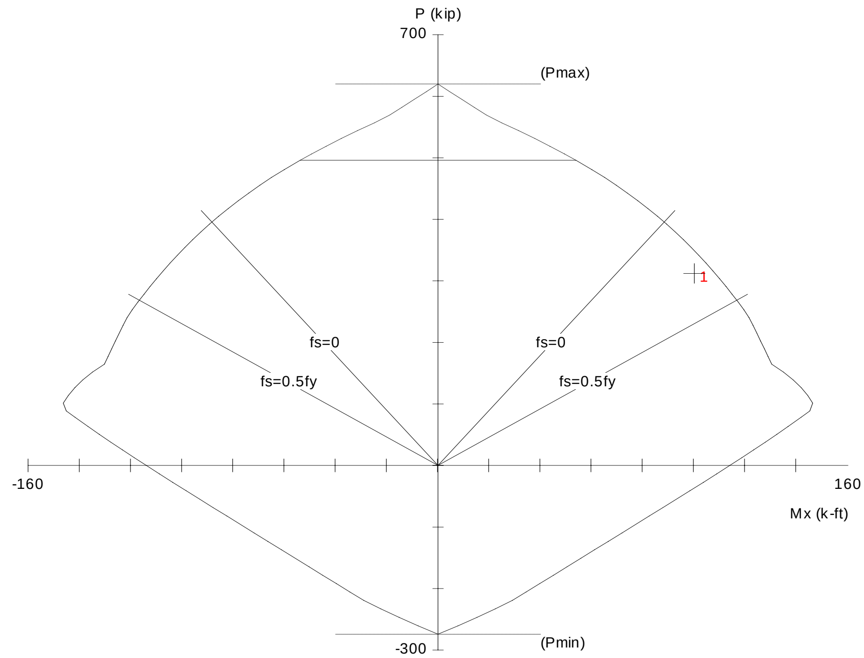
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
12x45	15	299	14x14 (4ksi)	4 #10



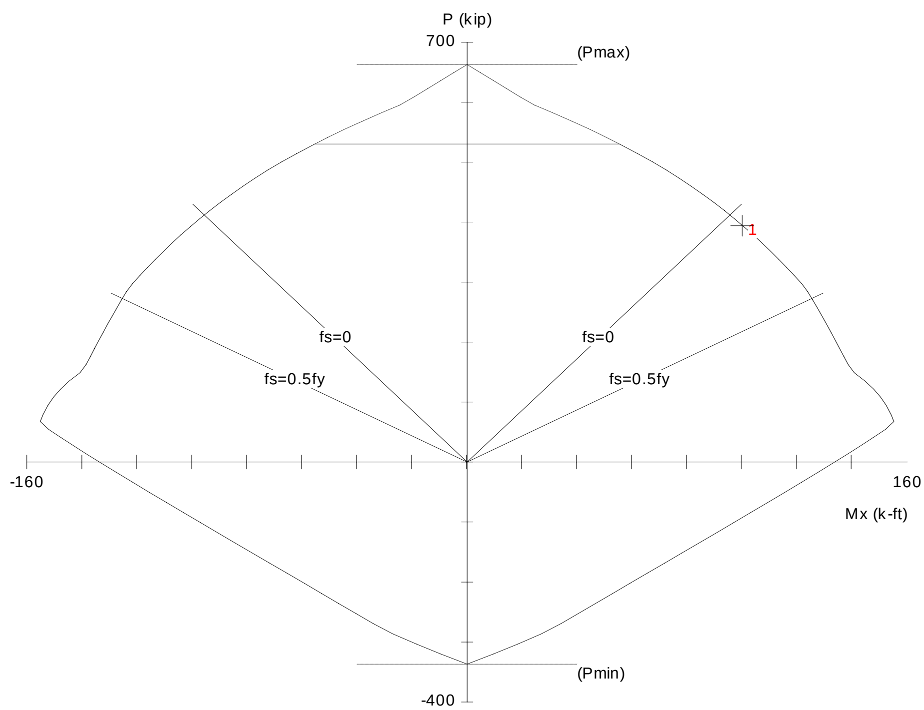
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
12x45	13.5	336	14x14 (4ksi)	4 #10



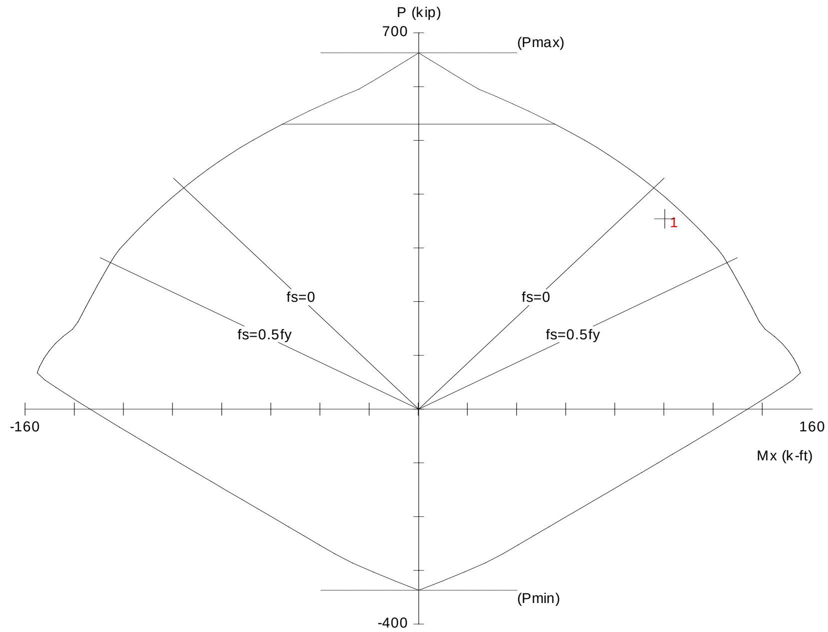
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
12x80	13.5	805	20x20 (4ksi)	4 #9



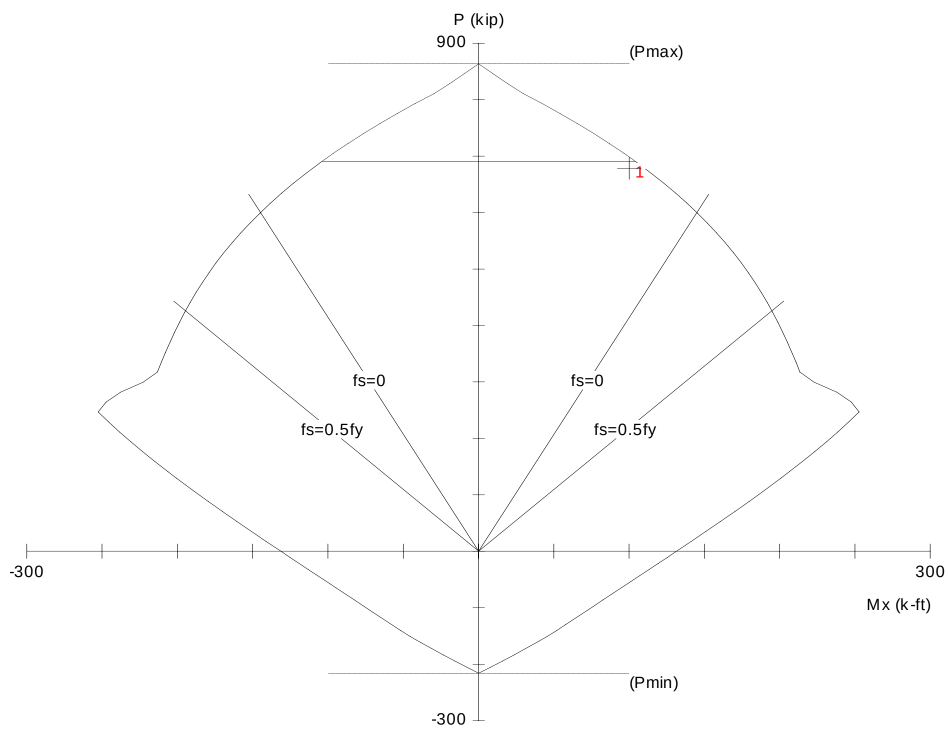
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
14x43	13.5	312	14x14 (4ksi)	4 #10



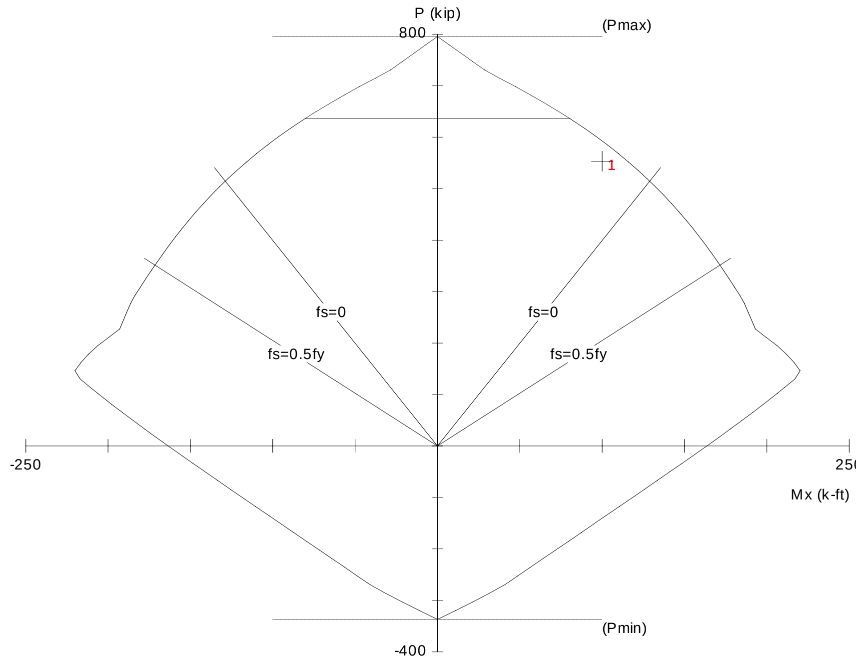
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
14x53	13.5	394	14x14 (4ksi)	4 #11



Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
14x48	13.5	354	14x14 (4ksi)	4 #11



Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
14x68	13.5	678	18x18 (4ksi)	4 #9



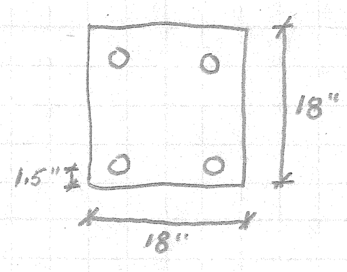
Steel Column	Length (ft)	Loading (k)	Concrete Equivalent	Rebar
14x61	13.5	553	16x16 (4ksi)	4 #11

concrete column

18×18 (4^{ksi}) $\quad 4\#9 \rightarrow A_s = 1(4) = 4''^2$

$f_y = 60$ ksi

$f'_c = 4$ ksi



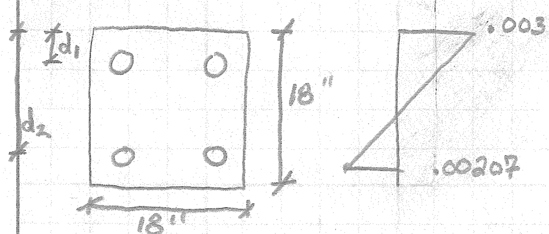
Pure Axial:

$M_n = 0$

$P_n = .85 f'c (A_g - A_s) + A_s f_y$

$.85(4)(324-4) + 4(60) = 1328^{k}$

strength @ balanced condition



$$C_{bal} = \frac{.003}{.003 + .00207}(16) = 9.46''$$

$d_1 = 2''$ $\quad A_{s_1} = 2''^2$ $\quad \varepsilon_{s_1} = \frac{.003}{9.46}(9.46 - 2) = .0024$

$d_2 = 16''$ $\quad A_{s_2} = 2''^2$ $\quad \varepsilon_{s_2} = .00207$

$f_{s_1} = .0024(29000) = 69.6$

$f_{s_2} = -60$

$$P_n = .85(4)(.85)(9.46)(18) + 69.6(2) + -60(2) =$$
$$492.12 + 139.2 + -120 = 511.32$$

$$M_n = .85(4)(.85)(9.46)(18)\left(\tfrac{18}{2} - \frac{.85(9.46)}{2}\right) + 69.6(2)\left(\frac{18}{2} - 2\right) + -60(2)\left(\frac{18}{2} - 16\right)$$
$$2450.45 + 968.8 + 840 = 4259.25 \text{ in K} = 354.93^{'K}$$

Pure Moment:

$$.85(4)(.85)(18)(c) + 2\left(\frac{.003}{c}\right)(c-2)(29000) = 2(60)$$

$$52.02(c) + \frac{.006c - .012}{c}(29000) = 120$$

$$52.02(c) + \frac{174c - 348}{c} = 120$$

$$52.02(c) + 174 - \frac{348}{c} = 120$$

$$52.02(c) - \frac{348}{c} = -54 \quad = \quad 52.02c^2 - 348 = -54c$$

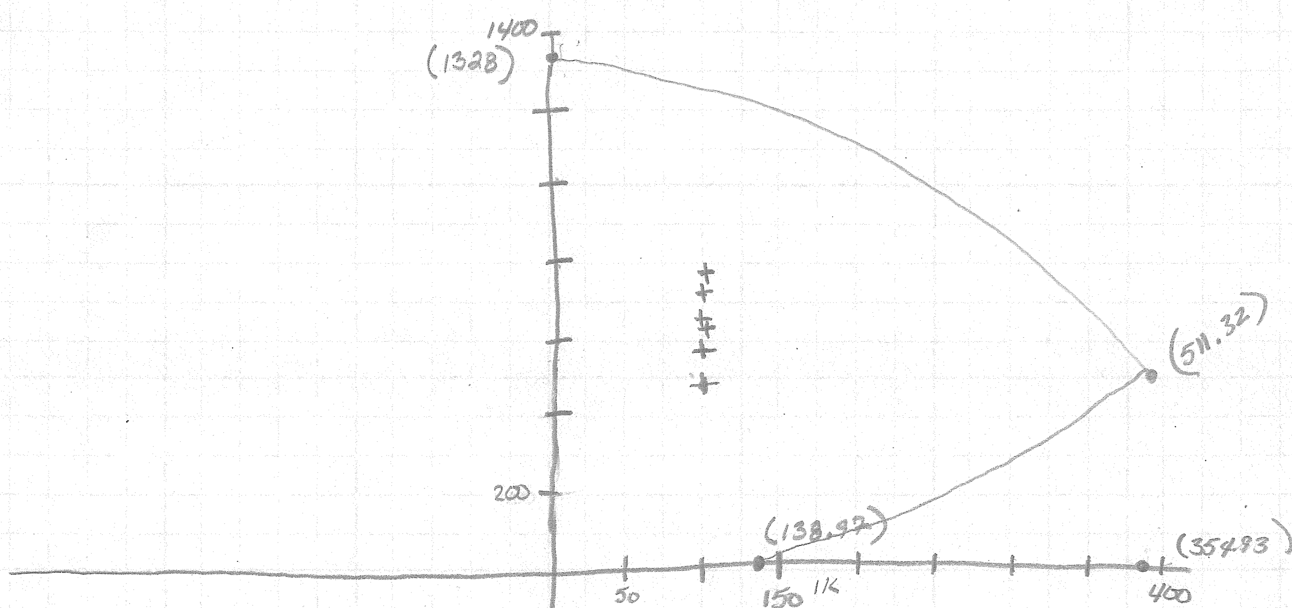
$$52.02c^2 + 54c - 348 = 0 \quad = \quad 2.1 \text{ in}$$

$P_n = 0$

$$M_n = .85(4)(18)(.85)(2.1)\left(\frac{18}{2} - \frac{.85(2.1)}{2}\right) + 2(-4.14)\left(\frac{18}{2} - 2\right) + 2(-60)\left(\frac{18}{2} - \right.$$

$$f_{s_1} = \frac{.003}{2.1}(2.1 - 2.6)(29000) = -4.14$$

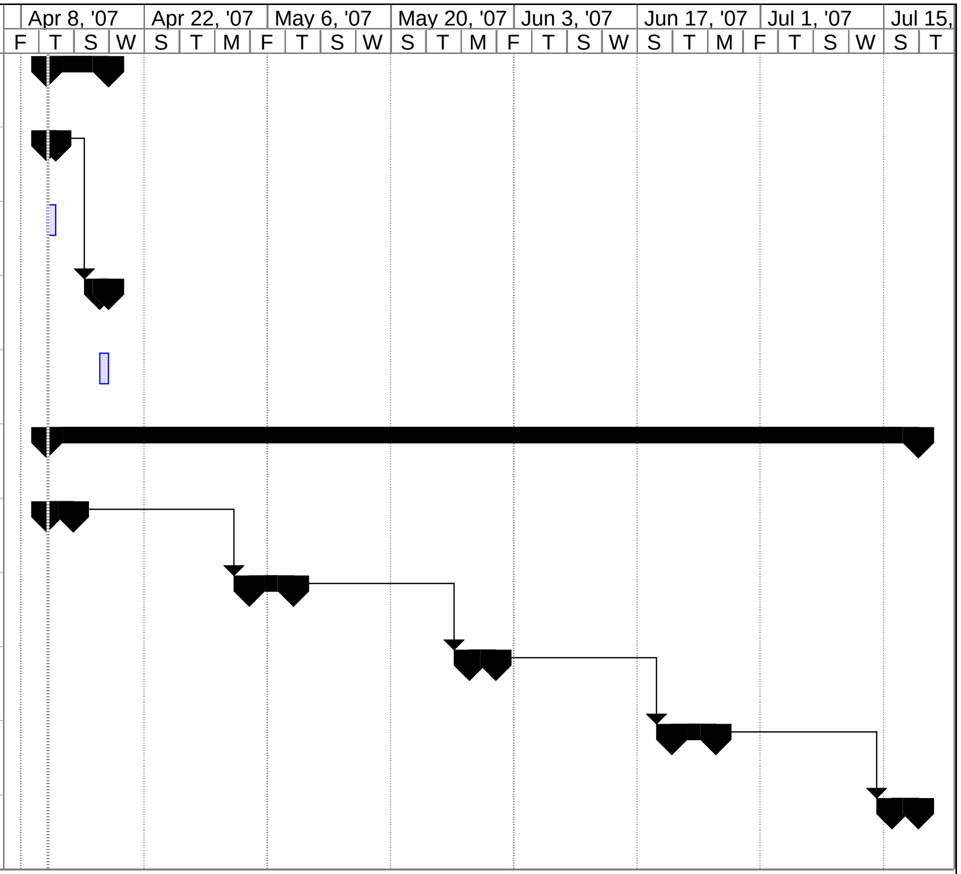
$$885.68 + -57.96 + 840 = 1667.72 = 138.97^{1K}$$



ex. 18×18 w/ 4 #9
all columns represented by crosses | all designed columns would work

Concrete vs Steel Cost					
# of Members	Length (ft)	Steel Member	Steel Cost ($)	Concrete Member (4ksi)	Concrete Cost($)
20	15	12x58	13048	18x18 (4 #9)	6867
40	13.5	12x58	23486	18x18 (4 #9)	12361
5	15	12x65	3657	18x18 (4 #9)	1716.75
10	13.5	12x65	6582	18x18 (4 #9)	3090.25
2	15	12x53	1202	16x16 (4 #8)	591
22	13.5	12x53	11897	16x16 (4 #8)	5853
6	15	14x90	6006	16x16 (4 #10)	2676
12	13.5	14x90	10811	16x16 (4 #10)	4817
4	15	14x82	3615	22x22 (4 #10)	1373
8	13.5	14x82	6506	22x22 (4 #11)	2472
1	15	14x132	1436	24x24 (4 #18)	501
1	15	14x99	1094	24x24 (4 #11)	501
1	15	14x74	821	18x18 (4 #9)	343
4	15	12x72	3215	18x18 (4 #10)	1373
8	13.5	12x72	5787	18x18 (4 #11)	1802
2	15	12x45	1023	14x14 (4 #10)	500
3	13.5	12x45	1381	14x14 (4 #10)	676
72	13.5	12x80	56209	20x20 (4 #9)	25499
18	13.5	14x43	7992	14x14 (4 #10)	4054
24	13.5	14x53	12897	14x14 (4 #11)	5405
12	13.5	14x48	5888	14x14 (4 #11)	2703
12	13.5	14x68	8194	18x18 (4 #9)	3708
15	13.5	14x61	9264	16x16 (4 #11)	3991
			Total:		Total:
			202011		92873
				Concrete Savings:	
				109138	

ID		Task Name	Duration	Start	Finish
1		**Steel**	**5 days**	**Wed 4/11/07**	**Tue 4/17/07**
2		**1st-3rd**	**1 day**	**Wed 4/11/07**	**Wed 4/11/07**
3		group 1	1 day	Wed 4/11/07	Wed 4/11/07
4		**3rd-5th**	**1 day**	**Tue 4/17/07**	**Tue 4/17/07**
5		group 1	1 day	Tue 4/17/07	Tue 4/17/07
6		**Concrete**	**71 days?**	**Wed 4/11/07**	**Wed 7/18/07**
7		**1st**	**3 days?**	**Wed 4/11/07**	**Fri 4/13/07**
41		**2nd**	**3 days?**	**Fri 5/4/07**	**Tue 5/8/07**
75		**3rd**	**3 days?**	**Tue 5/29/07**	**Thu 5/31/07**
109		**4th**	**3 days?**	**Thu 6/21/07**	**Mon 6/25/07**
143		**5th**	**3 days?**	**Mon 7/16/07**	**Wed 7/18/07**



Project: Column Schedule.mpp
Date: Wed 4/11/07

Task		Milestone		External Tasks	
Split		Summary		External Milestone	
Progress		Project Summary		Deadline	