Final Report

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4/3/2013
Advisor: Dr. Messner

[FISK CORPORATE HEADQUARTERS]

Houston, Texas

Fisk Corporate Headquarters

Houston, TX

Building Information

Name: Fisk Corporate Headquarters
Location: 10855 Westview Drive
Houston, TX 77043
Occupant/Owner: Fisk Electric Corporation
Size of Office Building: 37,780 square feet
Size of Fabrication Shop: 16,380 square feet
Stories Above Grade: 2

Structural

- Drilled Pier Foundation System
- Structural Steel Frame
- Lateral-Force Resisting System
- 2nd Level and Roof Structural Diaphragms

Mechanical

- (2) 60 Ton Rooftop Units
- (37) Fan Powered Terminal Distribution Units
- (16) Fab-Shop Ventilation Exhaust Fans

Electrical

- 480 Volt Main Electrical Service
- One Electric Room per Floor
- 230 kW Outdoor Generator
- 2nd Floor Houses a Small Data Center

Project Team

Architect: Gensler
CM/GC: Tutor Perini Corporation
Structural Engineer: Walter P. Moore
MEP Engineer: Fisk Electric Corp.
Civil Engineer: DevTex Engineering LP
Landscape Architect: SWA Group
Electrical Contractor: Fisk Electric Corp.
Mech./Plumbing Contractor: TDIndustries

Architecture

- Isolated & Spacious Project Site
- Brick Veneer and Curtain Wall Enclosure

Construction Information

- Design-Bid-Build Delivery Method
- 11 Months Construction Duration
- $12.8 Million Total Project Cost

Thanks To:

FISK

Tutor Perini CORPORATION

Stephen Blanchard | CM Option

<http://www.engr.psu.edu/ae/thesis/portfolios/2013/smb544/index.html>

Executive Summary

Throughout the 2012/2013 academic calendar year, the Fisk Corporate Headquarters project was studied and analyzed to target project challenges and propose alternative means and methods as solutions to those challenges. After careful investigation of the project, three major areas were targeted for improvement; the project's sequencing and schedule, the costly electrical distribution system, and the lack of LEED Building Certification. This report details the challenges associated with these areas, suggests solutions, and analyzes the solutions' implementation in the Fisk Corporate Headquarters project. While these areas were perceived as having opportunities for improvement, the purpose of this report is not to critique the project team. Rather, this report seeks to study their already efficient project plan for educational purposes.

Analysis #1: Project Sequencing Improvement
The first analysis attempted to reduce the overall project schedule duration by altering the original activity sequence. Because of Fisk Electric's unique relationship with the general contractor, Fisk decided to carry the cost of general conditions themselves. As such, any reduction in the overall project schedule duration would result in direct savings for Fisk.

The proposed schedule re-sequencing in this report shortened the project's construction schedule by 4 weeks, without hindering any worker productivity. The total owner savings due to the reduction of the schedule amounts to over $50,000.

Analysis #2: Detailed Analysis of Electrical System Redesign
The second analysis involved a redesign of the Fisk Corporate Headquarters' electrical distribution system in an attempt to reduce the system's construction costs by eliminating the number of distribution components while still maintaining the integrity of the original system's design intent. This redesign resulted in a cost savings of $11,669 and a schedule savings of just less than 4.5 days.

Analysis #3: Implementation of LEED
The final major analysis sought to determine whether Fisk Electric should have applied for a LEED Building Certification on their new facility. Because the building's systems were already designed with LEED principles in place, the only additional costs required to achieve a LEED rating were construction based ones. These minor costs totaled $28,266. This report also designed a series of architectural overhangs that, if implemented, would result in an increase in the building's energy efficiency and allowing a potential LEED Silver rating.

In conclusion, it is recommended that all three of the proposed analyses be adopted by the project team on the Fisk Corporate Headquarters job. The cost savings from the first two analyses totaled $62,267. If the Fisk Electric ownership team elected to apply for a LEED rating it would cost them $28,266. When subtracted from the first two analyses savings, it would result in a total project savings of $34,101 while being able to boast a LEED building certification. Along with the total cost savings, the overall project schedule would be reduced by over 4 weeks if Fisk chose to implement the strategies outlined in this report. They also would be aided by the many business benefits associated with owning and maintaining a LEED facility.

Acknowledgements

Academic:

Penn State Architectural Engineering Faculty

Dr. John Messner

Dr. Robert Leicht

Dr. Richard Mistrick

Ronald Dodson

Bob Holland

Industrial:

Special Thanks:

Wayne McDonald

David Rinehart

Ted Robertson

The Fisk Corporate Headquarters Project Team

PACE Industry Members

My Family and Friends

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Building Introduction

Fisk Electric Corporation is a large, nationally recognized electrical contractor which specializes in the installation of electric, telecom, and security systems in commercial buildings. While Fisk has branch offices in Los Angeles, Las Vegas, San Antonio, Dallas, New Orleans, and Miami, their corporate headquarters have always been located in Houston, Texas. Their previous headquarters' location was built in the early 1970s just inside Houston's inner 610 loop. Due to advancements in building technologies and growing space requirements, Fisk decided in February 2010 that it was time to upgrade their facilities. Once Fisk Electric decided relocation was necessary, they immediately hired a construction manager, Tutor Perini, and an architect, Gensler Architects, to help them finalize a program and design a facility. This new facility came to be known as the Fisk Corporate Headquarters project.

The Fisk Corporate Headquarters project is comprised of two separate buildings located on the same project site. The first, and most prominent, building is a new two story 37,780 square foot office building. Complimenting this facility is Fisk Electric's new 16,380 square foot pre-fabrication shop. While the pre-fabrication shop can be categorized similarly to a single story warehouse, the office building is a more complex, aesthetically pleasing environment. The following details key client information, existing conditions, and building systems that pertain to the Fisk Corporate Headquarters project.

Client Information

When an owner decides to construct a new facility, he or she has to prioritize between three different aspects of the project. These essential project aspects are cost, quality, and schedule with overall project safety tying all aspects of a project together. Due to Fisk Electric and Tutor Perini's standing in the construction industry, it was understood from the beginning of the project that safety was a top priority. In an ideal world, Fisk Electric would be able to attain success in all three of the remaining categories, but in reality one aspect is typically sacrificed. In the case of the Fisk Corporate Headquarters project, the two prioritized aspects were quality and costs. Because Fisk Electric already had a fully operational, existing building, no urgency to complete the new facility was present. As such, Fisk understood that sacrificing some scheduling desires would help ensure success in the other two main facets of the project.

Figure 1: Fisk Company Logo - Provided by Fisk Electric

Existing Conditions

Fisk Electric's new corporate headquarters building is located on the western side of Houston, Texas, just outside of Beltway 8. This location in the city is considered a hub of new growth and construction with recent medical and residential projects being completed in the surrounding areas. Fisk's principles decided this would be a prime location for a new corporate office, relatively central to Houston's main expansion areas, while still being in an area with plenty of available land for expansion. Figure 2 gives the relative location of the new facility with relation to Houston, Texas.

The new location for the Fisk Corporate Headquarters building is located on a site with ample amounts of space. The site was actually purchased by Fisk during the design process. It is surrounded on all four sides by two way streets. The only existing, developed area on the site is a small, fenced in parking lot located on the site's southeastern corner which belongs to the 5 story hospital across the street on the site's eastern side. Barring that, no real structural objects are close enough to the site to hinder construction in any way or become an integral factor in a site logistics plan.

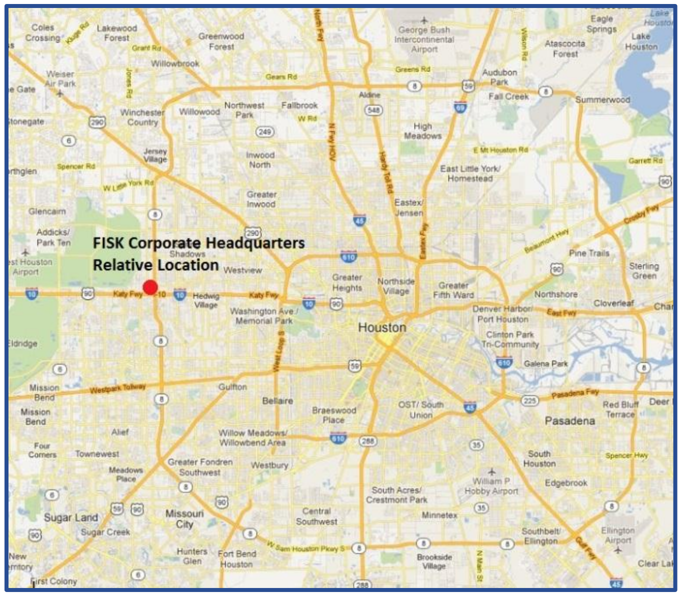


Figure 2: Relative Building Location – Image from Google Maps

Since the site was previously undeveloped, the only underground utilities presently installed on the site are a water main under a sidewalk on the west side of the site and a storm water line located below grade on the eastern and southern site edges. However, accessible fire hydrants and utility manholes do exist either along the site's fringes or directly across perimeter streets. These convenient locations made a majority of the utility connection sequences relatively economical.

The site's undeveloped nature also makes it an area rarely utilized by pedestrians and the surrounding streets are relatively vacant. The only potential pedestrian traffic comes from people entering the existing parking lot from the hospital. Luckily, this area is already isolated via an iron fencing system and the pedestrians within the area are safe from any construction hazards. All the sidewalks along the site's exterior edges lie outside of Fisk's property line and a simple, chain-link fence was used to keep pedestrians from entering the potentially dangerous jobsite.

For a complete existing conditions plan, please reference Appendix A.

Structural System

Fisk's new Corporate Headquarters is primarily a structural steel framed facility. Walter P. Moore designed the framing system specifically to combat lateral loads and provide stability under gravity loads by implementing what they call a "Lateral-Force Resisting System" in the office building. This system is comprised of two parts. First, the engineer designed steel braced frames consisting of steel diagonal members, steel columns and connecting steel floor beams. He then completed the design by implementing two structural diaphragms located on the second floor and roof levels that are completely attached to all steel floor beams and roof members respectively. The second floor diaphragm is a composite slab that contains shear studs and rests on a 2" deep, 18 gauge composite metal deck.

Figure 3: Structural Steel Frame - Image Provided by Tutor Perini

Due to its simplicity, the pre-fabrication shop was simply comprised of steel columns and a LH roofing truss system that ties into W18x35 beams spanning between the steel columns.

In order to hoist and install the steel members in both the office building and fabrication shop a 50 ton crawler crane was employed by Tutor Perini. This crawler crane was stationed in the area between the two buildings where there was plenty space for steel laydown and safe crane operation. From there, the crane could easily move from building to building as required and lift the members directly into their final positions.

Since the Fisk Corporate Headquarters building is primarily comprised of structural steel framing members, very little cast in place concrete was utilized. The only areas requiring cast in place concrete were the foundations, slabs on grade, and the second floor deck in the office building. The foundations consisted of spread footings, grade beams, and drilled piers which were all earth formed and poured directly into the compacted soil. Both slabs on grade were formed using wood members. The concrete was then directly poured from the concrete truck into the slab's rebar mesh. The last cast in place concrete pour occurred on the second floor deck of the office building. This pour can be considered the most unique due to the implementation of a pump truck which aided in moving the concrete vertically to the second floor and its final resting place. The deck was formed using angled steel concrete forms along its edges.

Mechanical System

Fisk's Corporate Headquarters project's Mechanical System is comprised of large packaged rooftop units, fan powered terminal units, and exhaust fans. The office building houses two large 55 and 60 ton rooftop units that can both supply up to 16,000 CFMs of air to the offices below. These rooftop units are connected to 37 fan powered terminal units which distribute the air to the offices for which they are responsible. Three exhaust fans are also housed on the office roof and ventilate the bathrooms and janitor's closets. This segmentation of the distribution system allows greater comfort control of each individual area along with the potential for energy savings when those areas in question are not exposed to direct sunlight. It also eliminates the need for a mechanical room because all the units are either housed on the roof or within the dropped ceiling.

Unfortunately, the fabrication shop does not have the same type of A/C capabilities as the office and is simply comprised of one small 3 ton, 1200 CFM rooftop unit that supplies air to the prefabrication shop offices. The rest of the space is ventilated via sixteen 5600 CFM fans.

In an effort to provide adequate fire protection for the building and its inhabitants, a 100% coverage wet-pipe sprinkler system was specified to be designed by the sprinkler contractor awarded the job. Due to the building size and classification, no other building fire suppression elements are rated by IBC 2006 Table 601.

Electrical System

Drawing on their obvious history in commercial systems, Fisk Electric designed a relatively cheap, yet efficient electrical system for their new Corporate Headquarters. The system requires a demand service of 608.7 kVA. It is supplied via a 480V utility feed that travels through an 800 amp transfer switch directly into the building's main 800 amp distribution board. This distribution board then splits the supply into two different feeds; one 150 amp feed services the fabrication shop and other miscellaneous equipment, while the other feeds the second 800 amp distribution panel board within the system. It is from this second distribution board that a majority of the facility's power requirements are supplied. All of the smaller panel boards that are directly supplied by the two distribution boards are rated at 480/277 volts and primarily service the equipment and lighting loads. They also supply power to the 120/208 volt panel boards by passing through step-down transformers located within close proximity of their location.

The Fisk Electric Corporate Headquarters project implemented two different redundancy systems within their electrical system. The first is a 230 kW generator that they are transferring from their previous location to the new project site. This generator ties directly into the main service feed to the building and can be used to energize the necessary loads during an outage. The second redundant feature can be found in the small data center located on the second floor of the office building. Within this data center resides a small UPS system which will provide uninterrupted power to the data center equipment in the event of an outage intermediately while the generator powers up.

Exterior Facade

The façade system designed for the Fisk office building is a simple, yet elegant system that primarily serves as one of the building's main architectural features. In an effort to break up the simplicity of the building's box-like appearance, Gensler Architects implemented a horizontal curtain wall strip on both levels that is crossed by vertical strips of veneer bricks. This curtain wall works to not only allow the office inhabitants to connect with nature, but also take advantage of Houston's efficient daylight. No curtain wall system was designed for the prefabrication shop.

Figure 4: Facade System - Image Provided by Gensler

Aluminum framing and dual pane low E glass are the only two components of the curtain wall system. The aluminum framing located between the large panes of glass is directly sealed to the steel stud framing wall system located both above and below the curtain wall strip. Due to the simplistic nature of the curtain wall, the construction team utilized a technique known as stick construction during installation. While this installation practice does not take advantage of prefabrication efficiencies, the construction team believed that it was the most viable due to the relatively small size of the curtain wall on the project.

Cost Overview

When evaluating the costs associated with constructing a facility, it is important to first breakdown those costs into smaller, more descriptive categories. In the case of the Fisk Corporate Headquarters Project, the first step in cost evaluation was to differentiate between the total project cost and the cost of the building as an individual item. It is worth noting that the two different facilities' costs are not broken out separately because that information was not supplied. The results of this analysis can be found below in Table 1.

Table 1: Actual Cost Data - Information Provided by Fisk Electric

Actual Building Costs Summary		
Description	**Cost $**	**Cost $ per Square Foot**
Construction Costs	$6,843,238	$126.35
Total Project Costs	$12,831,888	$236.93

As evidenced by the table results, almost 47% of the total project costs were not directly incurred via a construction activity. After further investigation, it was discovered that almost 45% of these non-construction costs came from the price of the land on which the building resides. Furthermore, another 9% was spent cultivating that land to place the building in an aesthetically pleasing environment. The remainder of the costs came from miscellaneous charges and consulting and managing fees. After discerning what comprised the non-construction costs, the next step was to break down the construction costs by building system. This evaluation would give insight to systems in which the owner either under or over values based on their spending breakdown. The results from this breakdown can be found in Table 2.

Table 2: Systems Summary - Information Provided by Fisk Electric

Building Systems Cost Summary		
System	**Cost $**	**Cost $ per Square Foot**
Structural Steel	$1,002,989	$18.52
Enclosure	$998,497	$18.44
Walls and Finishes	$1,380,391	$25.49
Electrical	$1,223,400	$22.59
Mechanical & Plumbing	$826,415	$15.26
Fire Protection	$139,813	$2.58
Elevator	$50,550	$0.93
Earthwork/Foundations	$1,046,380	$19.32
Utilities	$174,803	$3.23

After careful review it quickly becomes obvious that the owner incurred larger than typical construction costs for both their electrical system and earthwork/foundation packages. In the case of the electrical system, a large majority of the increased system cost stem from some redundant, unnecessary distribution components. The earthwork and foundation package's cost growth can be directly attributed to the information found in the geotechnical report. Upon its completion, the structural engineer calculated that the original soil was unfit to support the structure Fisk desired. The contractor then was forced to take steps to rectify the subsurface condition. This added unforeseen condition greatly increased the total construction cost incurred by the owner.

Schedule Overview

The Fisk Corporate Headquarters' detailed project schedule begins on February 17, 2010 at the first meeting Fisk had to discuss relocation and finishes with the completed building turnover on October 5, 2012. The project schedule details over 150 different activities pertaining to both the office building and prefabrication shop. The following table gives a summary of the facilities' major design and construction phases:

Table 3: Key Schedule Phase Summary

Detailed Schedule Summary			
Phase Description	**Start Date**	**End Date**	**Dur. (Wks.)**
Design and Pre-Construction	2/17/10	1/10/12	99
Office Building Structure	12/12/11	4/13/12	18
Office Building Enclosure/Roof	4/16/12	8/24/12	19
Office Building Interior			
1st Floor	4/2/12	9/24/12	25
2nd Floor	4/19/12	9/27/12	23
Fab-Shop Structure	1/4/12	3/27/12	12
Fab-Shop Enclosure/Roof	4/24/12	6/6/12	6
Fab-Shop Interior	4/9/12	9/19/12	23
Landscape/Hardscape	4/9/12	9/21/12	24
Final Testing and Closeout	9/24/12	10/5/12	2

Design and Pre-Construction

While the design and pre-construction phase spans the longest time period of the various phases at 99 weeks, it is one of the simplest in terms of activities on the schedule. Once the initial relocation meeting was complete, it took nearly ten months for the design to actually begin. A majority of this time was spent procuring both a construction manager and a capable design consultant team. The three phases of design, schematic, design development, and construction documents, took approximately the same amount of time to develop with the schematic design phase taking slightly longer than the other two due to heavy owner involvement. Upon the completion of the project's construction documents, the design and pre-construction phase came to a close and the project team was able to focus solely on the projects various construction phases.

Another task of note that occurred within the design and pre-construction phase was the geotechnical report that took place during the summer of 2011. It was this geotechnical report that first documented the unsuitable subsurface conditions investigated in both Technical Report 1 and later in this report.

Office Building Structure

The office building's structural erection phase began at the beginning of the 2012 calendar year and ended in the middle of April of the same year. It started with the drilling and pouring of structural caissons, followed closely by the installation of pier caps and grade beams as detailed on the plans found in Figure 5. Upon completion of the foundation installation, both the MEP underground rough-in and the slab on grade were placed so that the structural steel erection could begin. Luckily, the construction team was able to begin the steel shop drawing and fabrication activities before the foundations even began to be drilled into the soil. This proactive approach allowed for a seamless transition between the foundation installation and steel erection without any available time being wasted. The entire steel superstructure was erected and the metal deck was installed in just under 4 weeks using a single crawler crane.

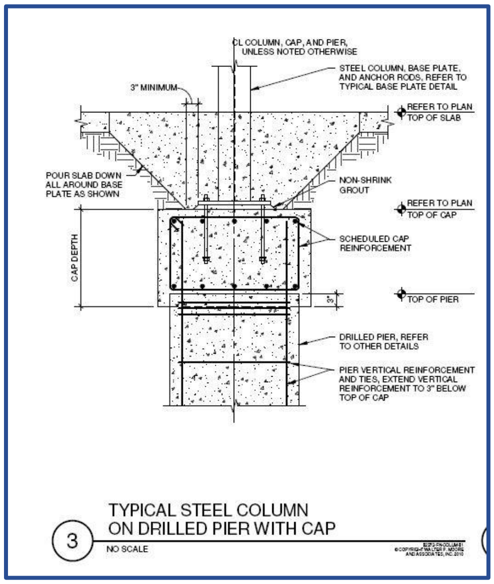


Figure 5: Cap Detail - Provided by Fisk Electric

Office Building Enclosure & Roof

One of the most difficult construction aspects of the Fisk Corporate Headquarters project was the office building's façade system. Comprised of both brick veneer and curtain wall, it quickly became evident to the construction team that careful planning and activity sequencing would be crucial to the success of this phase. Work on the building's façade system began in mid-April shortly after the completion of the building's structural system with the installation of the steel framing system. Due to a lack of scheduling flexibility, the relationship between this steel framing system and the curtain wall panels that were placed within it is investigated later in this report in the section titled Constructability Challenges. Once the framing system was complete, all other aspects of the building enclosure, including the air membrane, brick veneer, and curtain wall system, were installed simultaneously. Through careful coordination and material placement, each trade was able to successfully install its portion of the building envelope without getting into one another's way.

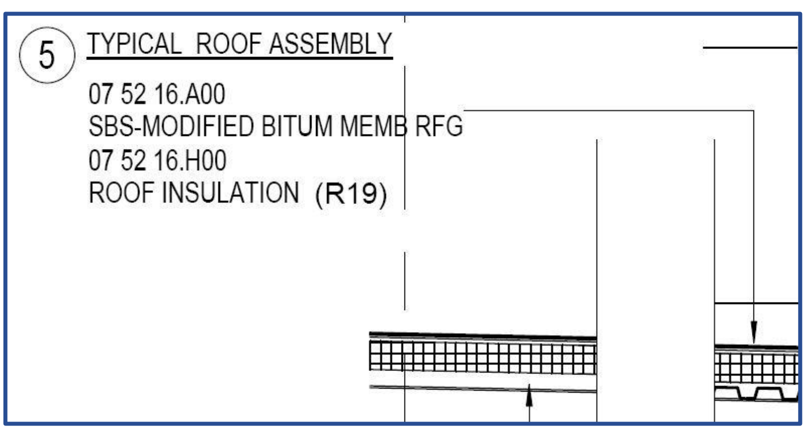


Figure 6: Roof Detail - Provided by Fisk Electric

Due to the simplicity of the roof design as evidenced in Figure 6, the roof was installed at the construction manager's leisure upon the completion of the structural steel. However, it is worth noting that the large mechanical rooftop units needed to be installed before any air could be pumped into the interior sections of the building. This became crucial during the late summer months when the ambient temperature in Houston reaches over 95 degrees on a daily basis. During this time, pumping cool air into the building becomes important not only for the safety of sensitive equipment, but also for the workers who could easily overheat in a confined space under those conditions.

Office Building Interior

The last phase of office building construction is the interior finishes phase. Because it is the most complex of the three main office building construction phases, it has the longest duration and encompasses the largest number of trades working at one time. Tutor Perini decided to implement a fairly traditional top-down approach to the installation of the interior finishes. They began each floor with the major MEP overhead rough-in installation, followed closely by the wall framing. Once the walls were framed, the various MEP wall rough-ins were placed and the walls were closed up. Afterwards, the construction team installed the ceiling grid, MEP ceiling drops, and finally the ceiling tiles themselves. This was followed by the floor and door installation which brought an end to the phase.

It is worth noting that both the first and second floors of the building were constructed at virtually the same time. This was made possible through not only careful scheduling, but also because of the relatively small size of the building coupled with an office building's inherent relative lack of complexity. Tutor Perini utilized the flexibility presented to them from the smaller crew sizes and was able to move the trades efficiently from one area to another without the laborers getting in the way of one another.

Fab-Shop

Fisk's new fabrication shop is a simple facility comprised of a structural steel skeleton, masonry wall enclosure, high bay fixtures, and virtually no air conditioning system. Figure 7 shows a detail of the simplicity of the building's façade and structural

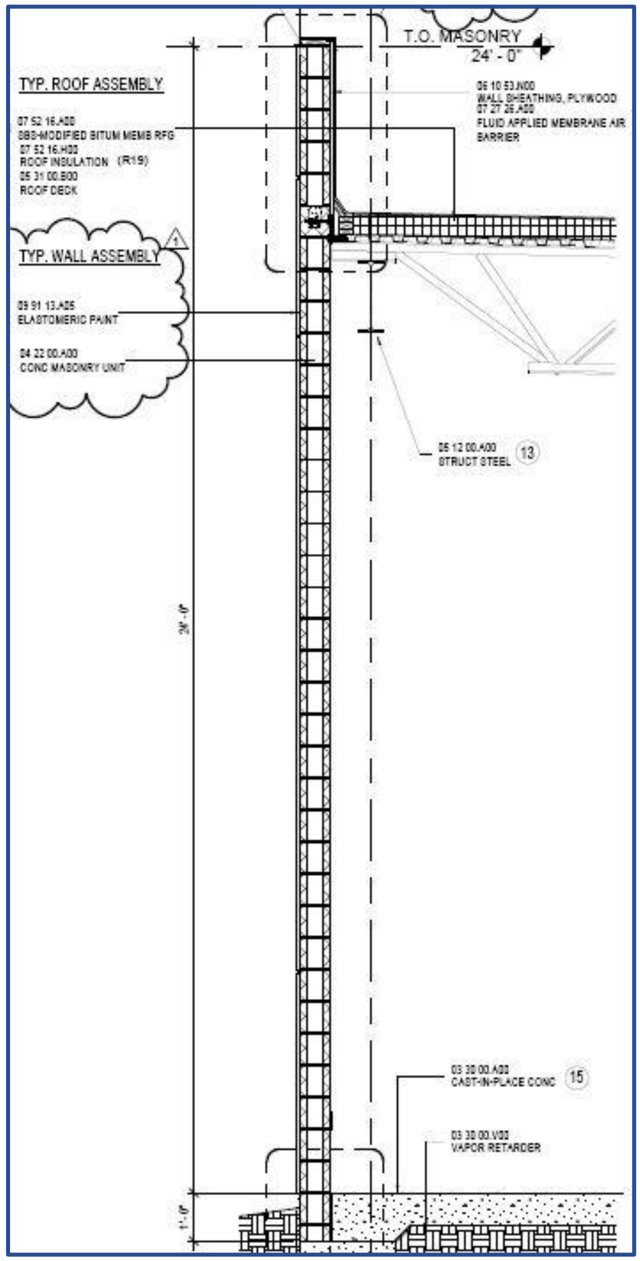


Figure 7: Fab-Shop Detail - Provided by Fisk Electric

systems. As a result of this simplicity, Tutor Perini decided to just parallel its tasks with those of a similar nature within the office building. The only difference was that some of fabrication shop's activities were staggered slightly behind those of the office building. This allowed the crews to wrap up their tasks on the office building, and then move directly over to the fabrication shop. In some instances, the tasks required of the various crews were so minimal in the fab-shop that they were able to actually complete their assignments in both buildings simultaneously.

Hardscape/Landscape

The only details worth mentioning regarding the project's landscaping phase stem from the unforeseen surface condition of the soil. This condition is responsible for the longevity of the phase and is described in further detail later in this report under the section labeled Constructability Challenges. Once the issue was adequately addressed, the schedule was altered accordingly and the phase was completed without incident.

Final Testing and Closeout

Due to Fisk's knowledge of the various building systems within their new facilities, very little third party testing was completed in the new buildings. A majority of the phase consisted of architectural punch-lists and knowledgeable Fisk representatives checking on the building's equipment and installed systems. The phase only lasted about two weeks.

For the complete detailed project schedule, please reference Appendix B.

LEED Summary

While many members of the Fisk Electric Ownership team saw value in constructing a sustainable facility, the team ultimately decided that the added costs associated with applying for LEED certification were too substantial to undertake. This decision was realized during the early planning and design stages and eliminated the team's desire to try and acquire any specific LEED points over the project's duration.

Even though the project did not apply for official LEED certification, Fisk still made many sustainable design and construction decisions. They understood that a sustainable building was not only good for the environment, but also beneficial for the health and productivity of its inhabitants. As such, this report investigated what LEED rating the Fisk Corporate Headquarters project could have achieved using the new 2009 LEED version. While many of the points are already naturally attained by the facility, this report assumed that if an official LEED certification was desired by Fisk Electric, they would have agreed to incur some very minor costs in order to achieve a higher rating. The results of this analysis can be seen in Figure 8.

For the full potential LEED checklist, please reference Appendix C.

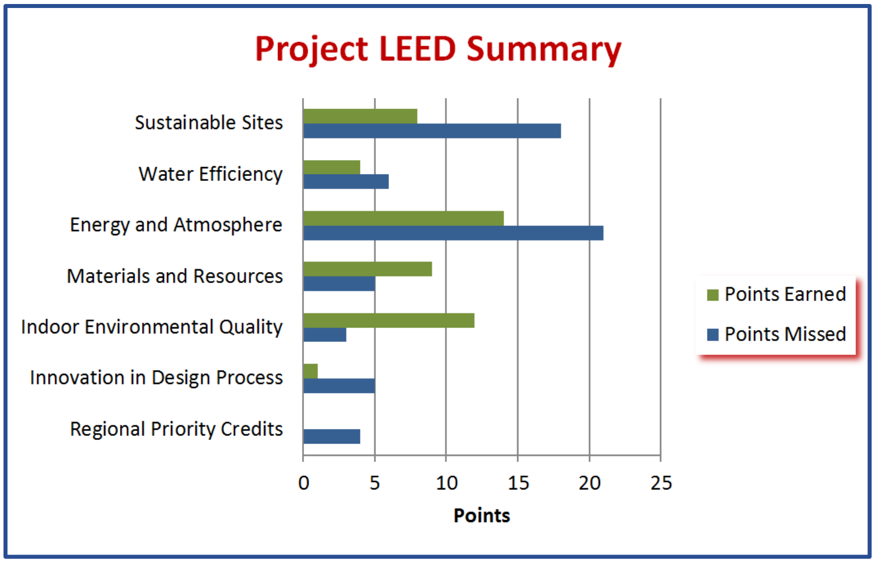


Figure 8: Fisk Corporate Headquarters - Potential LEED Summary

As evidenced above, the Fisk Corporate Headquarters would have been able to attain roughly 48 LEED points using the 2009 rating system had they decided to incur some small, upfront costs. This point total of 48 would have been enough to make the project LEED accredited. However, if the team had been able to identify an additional 2 points to increase the total to 50 points, the project would have been able to achieve a LEED silver rating. Members of the design team believe that those two points could have been easily obtained by making some minor tweaks to the various building systems.

BIM Summary

Even though BIM was used sparingly on the Fisk Corporate Headquarters project, every instance where it was implemented was done both efficiently and effectively. Both the architect and structural engineer saw the value in using BIM to aide in their respective design disciplines. Figure 9 shows a screenshot of the structural model created by the Walter P. Moore engineer. However, the project team did not take full advantage of the tools available to them. While the implementation of BIM would have increased the project's initial costs, the payback in labor savings would have more than offset those costs. Through effective use of the MEP coordination model, site utilization plans, and curtain wall layout, the construction team could have reaped the benefits of BIM in the same manner experienced by the various participating design entities.

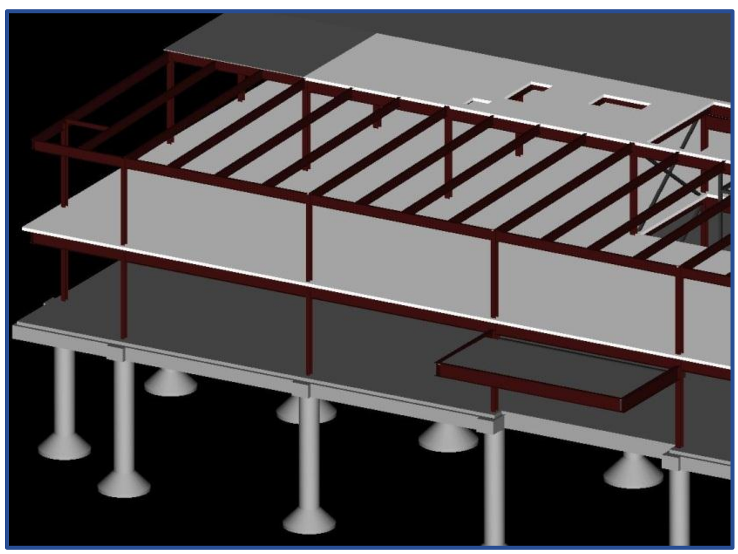


Figure 9: Structural Revit Model - Courtesy of Walter P. Moore

Analysis #1: Project Sequencing Improvements

Problem Identification

As previously mentioned, Fisk Electric chose to prioritize quality and price over the project's schedule. During the construction of their new facility, Fisk Electric was able to remain housed in the office building on T.C. Jester Blvd. that they have owned since the mid-1970s. As such, the ownership team felt no urgency in completing the project at a faster rate if it jeopardized the project's cost or quality. However, upon quick study of the Fisk Corporate Headquarters' 11 month construction schedule, it quickly became evident that there was significant room for improvement without endangering cost or quality.

The first aspect of the schedule that hinted at potential improvement is the overall schedule length. The original project schedule for both the office building and fabrication shop combined lasted 11 months. Even though this includes two different facility types, the total combined square footage is just over 54,000 square feet. While 11 months is not overly long for a project of this size, the simplicity of the facility combined with the size implies there is room for improvement in the overall schedule length.

The second trait of the Fisk project that indicates room for improvement is the activity sequencing. After careful examination of the existing sequence, it became apparent that Tutor Perini decided to schedule a majority of the construction activities finish to start rather than allowing some overlap to exist between trades. While this does guarantee no conflict between the various trades, it does not optimize scheduling efficiencies by allowing different areas of the building to be completed simultaneously. It was also realized that unnecessary gaps were left in the schedule that could be removed.

For the full original detailed project schedule, please reference Appendix B.

Background Information

Even though the project schedule was not emphasized by the ownership team, Fisk Electric could still have directly benefitted from a cost standpoint due to a compressed schedule. Fisk Electric is owned by Tutor Perini, a large nationally recognized general contractor based in Los Angeles, California. As such, Tutor Perini acted as the general contractor for the Fisk Corporate Headquarters job. Due to this unique relationship, Fisk Electric decided to utilize Tutor Perini strictly as a construction manager. Fisk also chose to carry the cost of jobsite general conditions. These general conditions included not only typical items like temporary facilities and permitting costs, but also Tutor Perini's fee and staffing requirements.

Because Fisk Electric carried the cost of general conditions for the job, any compression to the project schedule results in direct savings for them. The general conditions estimate originally included 47 weeks of work for weekly line items and 11 months for months paid items. These items that would be affected by scheduling changes account for approximately $592,000 or 53% of the total general conditions estimate. Therefore, any shortening of the project schedule would result in significant owner savings.

For the full original general conditions estimate, please reference Appendix D.

Analysis Goals

The main goal of this analysis is to intelligently sequence the project's construction activities in a manner that naturally reduces the project schedule without altering any of the activity durations. At a minimum, the goal of the analysis will hopefully result in schedule reduction of at least one week. This week will drop the overall duration to 46 weeks and 10 months rather than 47 and 11 due to how the project fits within the calendar year. If the 1 week reduction goal is realized, it will result in an owner general conditions savings of approximately $16,363 as evidenced by Table 4 below.

Table 4: General Conditions Savings (1 week)

General Conditions Savings (1 week goal)					
Description	**New Dur.**	**Orig. Dur.**	**Unit**	**Cost/Unit**	**Total $**
Project Manager	46	47	Wks	$3,100	($3,100)
Project Manager	46	47	Wks	$2,625	($2,625)
Superintendent	46	47	Wks	$2,250	($2,250)
Laborer/Flagger	46	47	Wks	$1,375	($1,375)
Timekeeper	46	47	Wks	$1,150	($1,150)
Jobsite Trailer	10	11	Mo	$627	($628)
Temporary Storage	10	11	Mo	$93	($93)
Office Equipment	10	11	Mo	$272	($272)
Continuous Clean	46	47	Wks	$570	($570)
Waste Removal	46	47	Wks	$375	($375)
Temporary Power	10	11	Mo	$1,000	($1,000)
Temporary Water	10	11	Mo	$1,000	($1,000)
Equip. Insurance/Repairs	10	11	Mo	$1,000	($1,000)
Temporary Toilets	10	11	Mo	$900	($9,000)
Safety Supplies	10	11	Mo	$24	($24)
Grand Total					**($16,363)**

This reduction of project costs will easily justify the schedule re-work. However, ultimately the goal of this analysis is to maximize the potential schedule savings and increase the potential savings by as wide a margin as potentially possible.

As previously mentioned, Tutor Perini structured the schedule in a manner that virtually isolated the various trades from one another, particularly during the structural steel erection phase of the project. While it would be possible to quickly shorten the schedule by simply overlapping the trades, at some point the schedule will begin to experience negative effects because of space constraints. If too many different tradesman attempt to work in the same area, the congestion will result in labor inefficiencies and the time saved from the overlap will be lost. Therefore, another goal of the re-sequencing is to actually improve upon worker efficiencies by scheduling workers to be on-site completing activities in succession rather than having to leave the site between their respective activities. This would eliminate crews being forced to mobilize and demobilize multiple times over the course of the job. While the result of this saved time is not easily quantifiable, it is still a goal of this analysis to maximize the amount of time trades are allowed to work on-site continuously.

Process

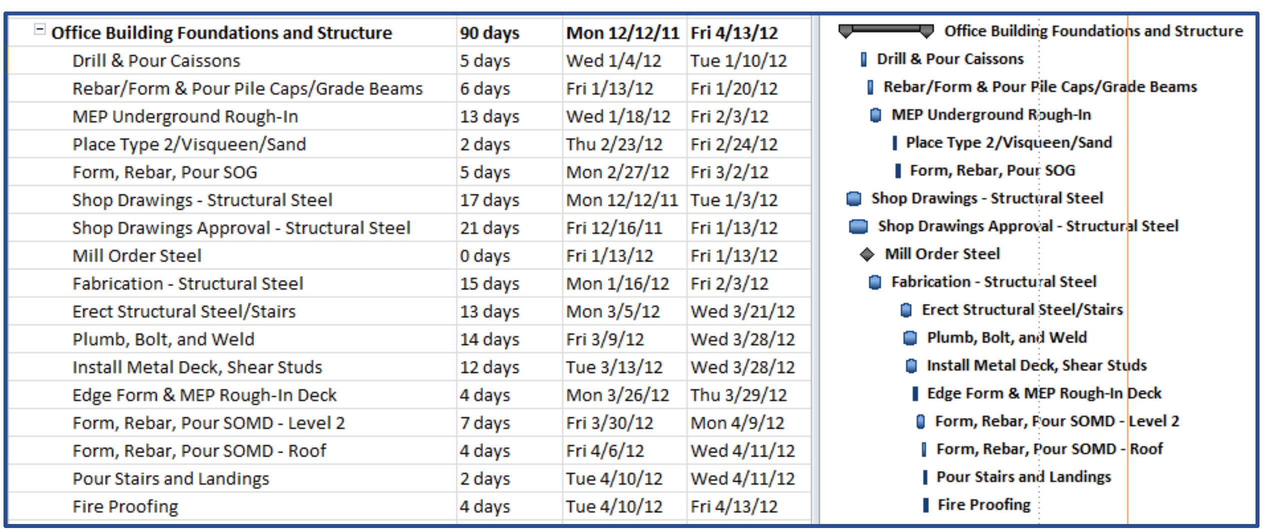
The first step in completing the Project Sequencing Improvements Analysis is to study the existing schedule and identify areas that could be reworked or adjusted. Because the schedule contains so many different line items, it had to be broken up into 9 different construction sections highlighted by Table 5. Each isolated scheduling phase was evaluated for unnecessary float, sequencing improvements, and the potential for some activities to overlap one another without creating worker inefficiencies.

Table 5: Key Schedule Section Summary (Original)

Detailed Schedule Summary (Original)			
Phase Description	**Start Date**	**End Date**	**Dur. (Wks.)**
Site Work	11/21/11	5/10/12	18
Office Building Structure	12/12/11	4/13/12	18
Office Building Enclosure/Roof	4/16/12	8/24/12	19
Office Interior 1st Floor	4/2/12	9/24/12	25
Office Interior 2nd Floor	4/19/12	9/27/12	23
Fab-Shop Structure	1/4/12	5/15/12	19
Fab-Shop Enclosure/Roof	4/24/12	9/11/12	20
Fab-Shop Interior	4/9/12	9/19/12	23
Landscape/Hardscape	4/9/12	9/21/12	24
Final Testing and Closeout	9/24/12	10/5/12	2

Of the aforementioned scheduling sections, only the Landscape/Hardscape section was not analyzed in an effort to shorten the overall Fisk Corporate Headquarters project schedule because none of the included construction activities resided on the schedule's critical path.

One example of how each section was studied can be outlined through a walkthrough of the analysis of the office building's structural erection phase. Figure 10 below shows the original office building foundation and structural erection phase's schedule.



Office Building Foundations and Structure	**90 days**	**Mon 12/12/11**	**Fri 4/13/12**
Drill & Pour Caissons	5 days	Wed 1/4/12	Tue 1/10/12
Rebar/Form & Pour Pile Caps/Grade Beams	6 days	Fri 1/13/12	Fri 1/20/12
MEP Underground Rough-In	13 days	Wed 1/18/12	Fri 2/3/12
Place Type 2/Visqueen/Sand	2 days	Thu 2/23/12	Fri 2/24/12
Form, Rebar, Pour SOG	5 days	Mon 2/27/12	Fri 3/2/12
Shop Drawings - Structural Steel	17 days	Mon 12/12/11	Tue 1/3/12
Shop Drawings Approval - Structural Steel	21 days	Fri 12/16/11	Fri 1/13/12
Mill Order Steel	0 days	Fri 1/13/12	Fri 1/13/12
Fabrication - Structural Steel	15 days	Mon 1/16/12	Fri 2/3/12
Erect Structural Steel/Stairs	13 days	Mon 3/5/12	Wed 3/21/12
Plumb, Bolt, and Weld	14 days	Fri 3/9/12	Wed 3/28/12
Install Metal Deck, Shear Studs	12 days	Tue 3/13/12	Wed 3/28/12
Edge Form & MEP Rough-In Deck	4 days	Mon 3/26/12	Thu 3/29/12
Form, Rebar, Pour SOMD - Level 2	7 days	Fri 3/30/12	Mon 4/9/12
Form, Rebar, Pour SOMD - Roof	4 days	Fri 4/6/12	Wed 4/11/12
Pour Stairs and Landings	2 days	Tue 4/10/12	Wed 4/11/12
Fire Proofing	4 days	Tue 4/10/12	Fri 4/13/12

Figure 10: Original Office Structural Schedule

The first way each section was evaluated was for any unnecessary float or days where no work was scheduled to be completed. An example of this unnecessary float can be seen between the first two line items where there is a 2 day gap between an activity ending and another beginning. Once gaps like this one were discovered, each was then individually researched in order to discern if the gap was required for construction purposes. If the gap was not required, as in the case of the completion of the caissons and the forming of the pile caps and grade beams, it was systematically removed from the schedule. It is worth noting that not all the scheduling gaps that were identified and removed were as obvious as the prior example.

After all the phase gaps were removed, the schedule was then studied for potential sequencing improvements. In the case of the office building structural phase, an example of how the construction sequence was improved was through the reorganization of the slab pours. Originally, the three slabs were scheduled to be poured spaced out over a period of 7 weeks. While both the roof and second floor slabs were scheduled to be poured back to back, the slab on grade was poured 5 weeks earlier. This implies that the concrete contractor was forced to mobilize on-site on two separate occasions. By placing all the slab pours back to back, it enables the contractor to remain on-site for the full duration of his scope of work at one time. The order of the pours was also reversed from lowest pour to highest pour beginning with the roof pour and ending with the slab pour as demonstrated by Figure 11. The reasoning behind this change is that it eliminates the need for the concrete contractor to clean the slab below from concrete debris that will fall from the pour above. By working from the top down, this debris is able to fall to the floor below and simply becomes a part of the lower level slab pour. While reorganizing the slab pour sequence does not result in a quantifiable schedule savings, it will increase worker efficiency and eliminate unnecessary mobilizations by the concrete contractor and was therefore included in the new schedule. Other instances of smarter re-sequencing were also implemented in the remaining scheduling phases.

Office Building Foundations and Structure	**79 days**	**Mon 12/12/11**	**Thu 3/29/12**
Drill & Pour Caissons	5 days	Wed 1/4/12	Tue 1/10/12
Rebar/Form & Pour Pile Caps/Grade Beams	6 days	Wed 1/11/12	Wed 1/18/12
MEP Underground Rough-In	13 days	Mon 1/16/12	Wed 2/1/12
Shop Drawings - Structural Steel	17 days	Mon 12/12/11	Tue 1/3/12
Shop Drawings Approval - Structural Steel	21 days	Fri 12/16/11	Fri 1/13/12
Mill Order Steel	0 days	Fri 1/13/12	Fri 1/13/12
Fabrication - Structural Steel	15 days	Mon 1/16/12	Fri 2/3/12
Erect Structural Steel/Stairs	13 days	Mon 2/6/12	Wed 2/22/12
Plumb, Bolt, and Weld	14 days	Fri 2/10/12	Wed 2/29/12
Install Metal Deck, Shear Studs	12 days	Tue 2/14/12	Wed 2/29/12
Edge Form & MEP Rough-In Deck	4 days	Mon 2/27/12	Thu 3/1/12
Place Type 2/Visqueen/Sand	2 days	Fri 3/2/12	Mon 3/5/12
Form, Rebar, Pour SOMD - Roof	4 days	Tue 3/6/12	Fri 3/9/12
Form, Rebar, Pour SOMD - Level 2	7 days	Mon 3/12/12	Tue 3/20/12
Form, Rebar, Pour SOG	5 days	Wed 3/21/12	Tue 3/27/12
Pour Stairs and Landings	2 days	Wed 3/28/12	Thu 3/29/12
Fire Proofing	4 days	Wed 2/29/12	Mon 3/5/12

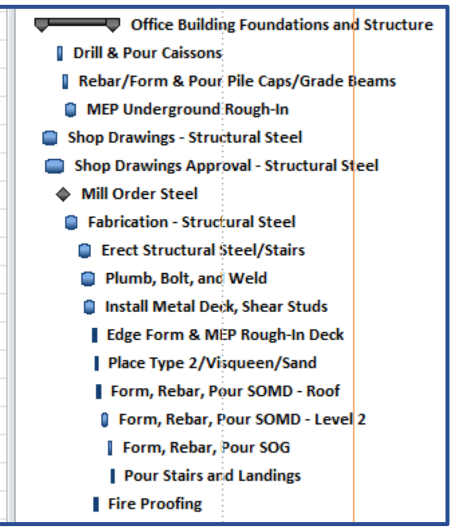


Figure 11: Revised Office Structural Schedule

The last way each scheduling phase was altered was through the study of potential scheduling overlaps. In the case of the structural scheduling sequence, once again the slab pours were an area that could be improved. Typically speaking, slab pours do not reside on a project's critical path. Unless there are abnormal conditions or restraints, slabs can always be poured while other construction activities are being completed simultaneously. As evidenced by figure 10, the original slab pours for the Fisk Corporate Headquarters project actually rested on the critical path. Because there were no constraints on the project that demanded this sequence, the project fireproofing and building enclosure phase were actually moved up to begin at the same time as the slab pours. Other activity overlapping principles similar to the slab pours were completed in the re-sequencing of the schedule and this scheduling technique resulted in the most time saved out of the three re-sequencing techniques.

Results

Upon completion of the investigation of the various scheduling phases and the implementation of the re-sequencing techniques, a revised Fisk Corporate Headquarters project schedule was produced. A summary of the improved, revised project schedule by scheduling section can be found in Table 6 below.

For the full revised detailed project schedule, please reference Appendix E.

Table 6: Key Schedule Section Summary (Post Improvements)

Detailed Schedule Summary			
Phase Description	**Start Date**	**End Date**	**Dur. (Wks.)**
Site Work	11/28/11	5/10/12	17
Office Building Structure	12/12/11	3/29/12	16
Office Building Enclosure/Roof	3/6/12	7/16/12	19
Office Building 1st Floor	3/5/12	8/20/12	24
Office Building 2nd Floor	3/19/12	8/28/12	23
Fab-Shop Structure	1/4/12	5/15/12	19
Fab-Shop Enclosure/Roof	4/9/12	7/10/12	13
Fab-Shop Interior	3/26/12	8/22/12	21
Landscape/Hardscape	4/9/12	9/3/12	21
Final Testing and Closeout	8/29/12	9/11/12	2

As seen in the above table, the re-sequencing of the project schedule was successful. The site work portion of the schedule was reduced by 1 week as a result of shaving off a week from the beginning of the project that eliminated a large gap between the beginning site work activities and the erection of the building's structure. The other two critical path sections, the office building structure and 1st floor, were reduced by 2 weeks and 1 week respectively. These reductions resulted in a total overall project schedule savings of 4 weeks, greatly surpassing the minimum analysis reduction goal of 1 week.

While many of the other scheduling sections were affected as a result of the re-sequencing techniques, they do not lie on the schedule's critical path and therefore did not affect the overall schedule duration. Some of the notable changes include a reduction to the fabrication shop's enclosure and interior scheduling sections by 7 and 2 weeks respectively. The landscape/hardscape portion of the schedule was also reduced by two weeks. All of these reductions came as a result of simply moving activities around that did not affect the start dates of any other critical activities. Even though these changes would result in no general conditions savings by the owner, they did work to tighten up and, in some areas, allow trades to complete tasks back to back rather than with gaps in-between.

As previously stated, the re-sequencing of the various construction activities located on the Fisk Corporate Headquarters' critical path resulted in an overall construction schedule reduction of 4 weeks. Had Fisk Electric and Tutor Perini decided to implement these re-sequencing techniques, the resulting general conditions savings they could have realized are summarized by Table 7 below.

Table 7: Total Potential General Conditions Savings

General Conditions Savings					
Description	**New Dur.**	**Orig. Dur.**	**Unit**	**Cost/Unit**	**Total $**
Project Manager	43	47	Wks	$3,100	($12,400)
Project Manager	43	47	Wks	$2,625	($10,500)
Superintendent	43	47	Wks	$2,250	($9,000)
Laborer/Flagger	43	47	Wks	$1,375	($5,500)
Timekeeper	43	47	Wks	$1,150	($4,600)
Jobsite Trailer	10	11	Mo	$627	($628)
Temporary Storage	10	11	Mo	$93	($93)
Office Equipment	10	11	Mo	$272	($272)
Continuous Clean	43	47	Wks	$570	($2,280)
Waste Removal	43	47	Wks	$375	($1,500)
Temporary Power	10	11	Mo	$1,000	($1,000)
Temporary Water	10	11	Mo	$1,000	($1,000)
Equip. Insurance/Repairs	10	11	Mo	$1,000	($1,000)
Temporary Toilets	10	11	Mo	$900	($9,000)
Safety Supplies	10	11	Mo	$24	($24)
Grand Total					**($50,698)**

As demonstrated by the above table, implementing the aforementioned re-sequencing schedule techniques would have resulted in substantial savings by the owner. Because the re-sequencing resulted in a 4 week schedule savings as opposed to the original analysis goal of 1 week, the resultant savings equated to $50,698 or $34,334 more than the original goal. In fact, a reduction of the general conditions by $50,698 represents approximately 4.5% of the original general conditions cost of $1,122,906. If realized, this construction cost reduction would equate to roughly just less than 1% of the total construction costs incurred by the ownership team.

For the full revised general conditions estimate, please reference Appendix F.

Recommendations

In conclusion, it is recommended that the Fisk Electric and Tutor Perini ownership team should have considered implementing some scheduling re-sequencing techniques on the Fisk Corporate Headquarters project. Any time an owner can save a relatively significant amount of money without drastically altering a project, they should take advantage of the opportunity. The proposed schedule re-sequencing in this report does not alter any of the building's systems, nor the already employed construction practices. It was able to shorten the project's construction schedule by 4 weeks, without hindering any worker productivity. In some cases, the re-sequencing would have actually improved worker efficiency by allowing trades to complete all their work at one time instead of having to mobilize multiple times unnecessarily. In essence, by simply altering the proposed schedule plan before construction began, the owner would have been able to save over $50,000 while exerting minimal effort. This savings represents just less than 1% of the total construction costs and would represent an extremely positive investment if employed by the Fisk Electric ownership team.

Analysis #2: Detailed Analysis of Electrical System Redesign

Problem Identification

As previously revealed by the Cost Overview portion of the Building Introduction section in this report, one of the systems with an atypically large cost was the Fisk Corporate Headquarters project's electrical system. The following table depicts the cost of the facility's electrical system compared to the total cost of construction along with the other major MEP systems.

Table 8: Summary of MEP System Costs

MEP System Costs		
System	Total System Cost	% of Total Construction Cost
Electrical	$1,223,400	18%
Mechanical/Plumbing	$826,415	12%
Fire Protection	$139,813	2%

**Note: The % of total construction cost is based on the Fisk Corporate Headquarters' total cost of $6,843,328.*

As evidenced from the above table, the cost of the Fisk Corporate Headquarters' electrical system was substantial compared to the remaining MEP systems. A common rule of thumb for buildings is that the electrical system should cost 10% of the total building cost while the mechanical and plumbing system should combine for 15%. In the case of the Fisk Electric office building, the electrical system cost surpassed this rule of thumb by 8% while the mechanical and plumbing system fell short by 3%. In fact, the electrical system actually cost $257,172, or 27%, more than the other MEP systems combined, including fire protection. This high system cost is atypical for any type of building, but to have it cost this much more for an office building is extremely rare.

Due to this abnormality, an in-depth study was conducted to analyze the high electrical system cost.

Background Information

After studying the various system components, it was discovered that two aspects of the electrical system account for the unusually high cost of the facility's electrical system. The first is the data center located on the ground floor of the office building. Data centers contain very complex, expensive electrical components not typically found in average office buildings. However, due to Fisk's knowledge of electrical systems, it was ultimately decided by the ownership team that the benefits of owning their own small data center outweighed the costs of construction. Therefore, the first reason for the high electrical cost was considered an owner requirement and remains justifiable.

For the full detailed division 26 electrical system estimate, please reference Appendix G.
**Note: The detailed division 26 estimate does not include the costs of the low voltage electrical systems. These systems account for the gap between the total electrical system costs and that of the detailed division 26 estimate.*

The second aspect of the electrical system that resulted in an abnormally high system cost is the overdesigned one-line diagram. After close inspection of the facility's one-line schematic diagram, it was discovered that distribution system for the office building was isolated by floor. While this is a common practice in larger buildings or healthcare facilities where the building loads are substantial, it is atypical for office buildings that are 2 stories tall and less than 40,000 square feet. Rather than have one main distribution board that feeds all the 480Y/227 voltage panels and 480 voltage rated equipment, Fisk Electric has one smaller distribution panel board on each floor. The first floor distribution board is considered the main board, and it in turn feeds the second floor distribution board. Also, rather than having one step-down transformer that could feed all the 208Y/120 voltage panels, they have a smaller step-down transformer on each floor. Isolating each floor's distribution system in this manner adds redundant components and costs to the system without actually creating a redundant system. If a problem occurs with the main distribution panel board, the entire building's electrical system will still go down. However, the system does do a good job of isolating the downstream components. For instance, if one of the step-down transformers goes down, only the floor fed by that transformer will be affected. Nonetheless, this is not considered a common occurrence and one can surmise that the electrical contractor who owns the building will do an excellent job of maintaining their electrical system. As such, the unnecessary redundancy of the electrical distribution system's components presents an opportunity for adjustments that will help reduce total cost of the system. Figure 12 depicts the two, isolated distribution systems located on their respective floors.

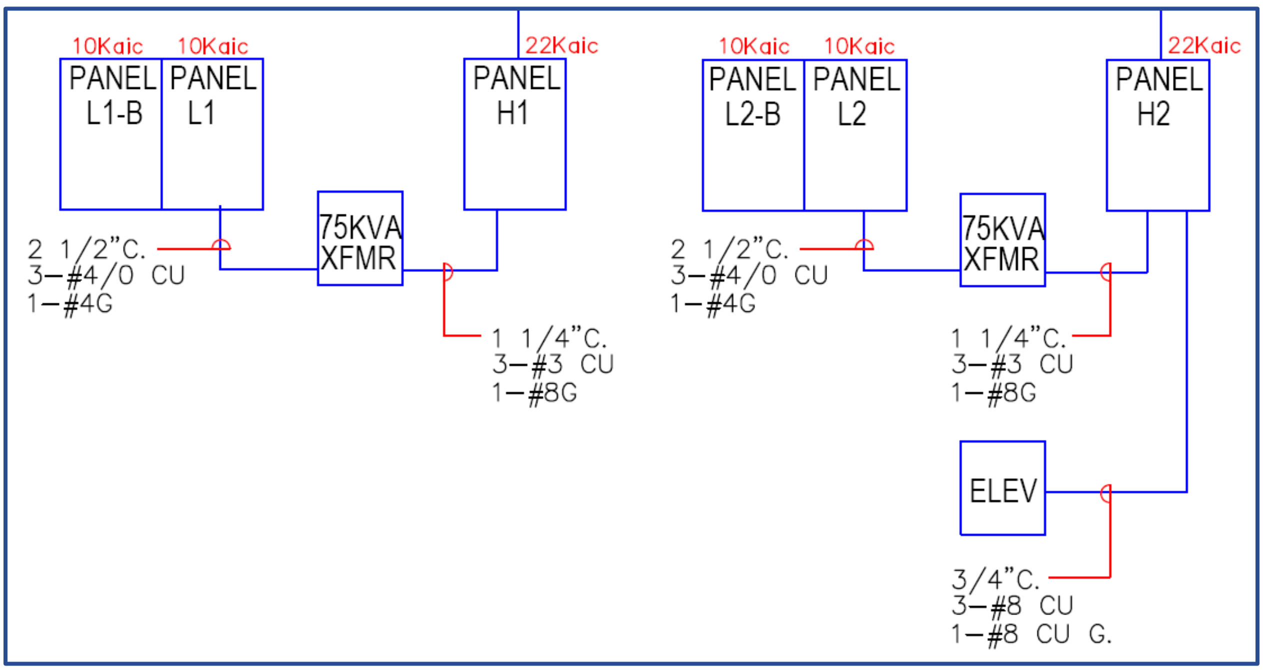


Figure 12: Image of the Isolated Distribution Systems Located on Each Floor – Provided by Fisk Electric

For the original Fisk Corporate Headquarters' one-line diagram, please reference Appendix H. For all the original panel schedules, please reference Appendix I.

Redesign and Analysis Goals

Due to the completion of all the electrical system design courses offered by the Pennsylvania State University's Architectural Engineering department and his relatively extensive work experience, the author of this report will be completing extensive electrical redesign work for his electrical breadth. Even though the author is considered a construction management student, his working knowledge of electrical systems coupled with his coursework has given him adequate tools to attempt a redesign of the facility's main electrical distribution system. Upon conclusion of the electrical redesign an in-depth analysis of the new system with regards to cost, schedule, and constructability will be completed to compare the new distribution system with the original one.

The electrical redesign seeks to eliminate some of the unnecessary system components without compromising the system's integrity. The new system is to function in the exact manner as the original with fewer pieces of distribution equipment and fewer feeders. It is hypothesized that the easiest way to complete this goal is through combining the two isolated distribution systems on each floor into one main distribution system. Space and capacities allowing, this will cut the number of distribution panel boards and step-down transformers in half, significantly reducing the cost and schedule of the building's distribution system.

The main driver for eliminating redundant components that do not add redundancy within the Fisk Corporate Headquarters project's electrical system is the potential to reduce system costs. Table 9 below shows the cost of the components that could potentially by affected by the redesign of the electrical distribution system.

Table 9: Cost of the Components Potentially Affected by the System Redesign

Cost of Components	
Distribution Gear	$147,805
Feeders	$90,030

The combination of distribution gear and system conductors currently account for $237,835 or 19% of the building's total electrical system. The goal of this redesign is to decrease the combined cost of both of these components by at least $10,000.

Changes in design can affect the project a variety of ways other than simply costs. Redesigning systems and components have a direct effect on the overall project schedule. Even though the main goal of this redesign is to reduce the cost of the building's electrical system, another goal of the assignment is to reduce the distribution system's installation schedule by at least 4 days. One can reasonably assume that a majority of the panelboards, transformers, and feeders that will be affected by the system redesign will take a minimum of two men working together to install. Assuming an 8 hour workday with two men working together, a reduction of the distribution system's installation schedule by 4 days will require a minimum of 64 hours to be removed from the schedule. While 64 hours does not appear to be overly substantial compared to the total hours applied to the project, it does equate to approximately $2,700 in labor savings. On top of that, removing almost an entire week off the duration of an activity is always valuable and adds float to the project schedule that could be applied elsewhere as needed.

The final way the system redesign will be analyzed is for constructability. The goal of this section of the analysis is to verify that the new system can be installed either using less or, at worst, the same level of effort. Even if the cost and schedule of the electrical system are reduced by the redesign, that does not ensure that the overall project's cost and schedule will be reduced in the same manner. For instance, if the redesign forces some of the combined components to be larger than the previously sized electrical closets will allow, the owner will be forced to incur additional costs in order to expand the closet. As such, all the new components will be placed within close proximity of their appropriate locations within their designated closet to ensure that they can fit without the need to alter the size of the closet. In addition to checking special requirements, the new system will also be examined for ease of construction. This will be accomplished through an interview where the new components compared to the old ones will be discussed with a general foreman who has worked for an electrical contractor for over 30 years. His experience installing the various types of components will be invaluable in determining whether the system can be constructed with similar ease as the original design. If the new system's components require different equipment or attention not previously required, those costs will need to be taken into account to ensure an accurate comparison between the two different systems.

Electrical System Redesign (Breadth #1)

Redesign Process

As previously stated, the purpose of this depth is to redesign and complete an in-depth analysis of the Fisk Corporate Headquarters project's electrical distribution in an effort to reduce the overall system's cost. In an effort to complete this distribution re-design, a systematic analysis and redesign process was undertaken. The first step in the redesign process was to identify areas within the electrical distribution system that possessed unnecessary, redundant components. After careful study of the existing distribution system, three main areas were targeted as having potential savings. The first, depicted in Figure 13, is the two distribution boards located on level 1 and level 2.

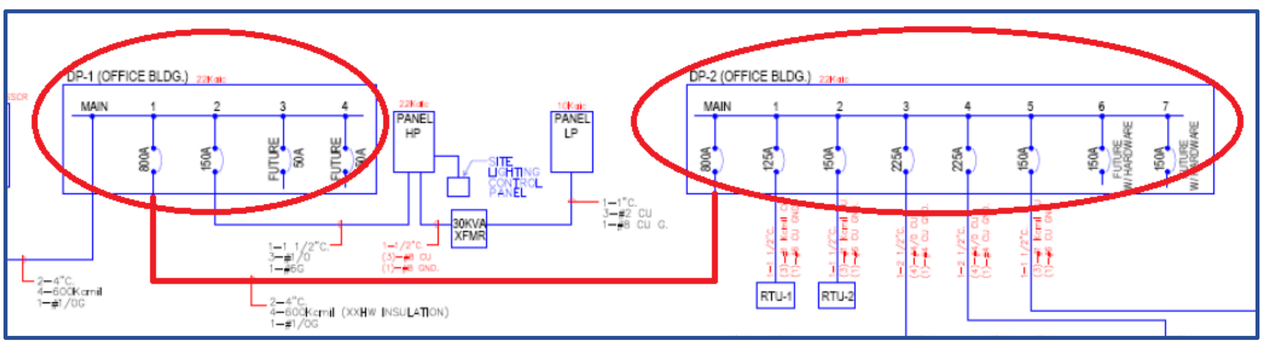


Figure 13: Redesign Target Area #1 – Distribution Panelboards

Having two separate distribution panelboards is an unnecessary expense given the relatively small size of the building. Also, the electrical rooms in the Fisk Electric building are actually stacked, making it even easier to combine the boards into one, larger panelboard. Once combined, the single distribution board would simply feed the panels located on both the lower and upper floors. This would eliminate the purchasing and installation of two separate boards, along with approximately 45 feet of a 600 Kcmil distribution feeder connecting the two boards.

The second part of the distribution system targeted for improvement was the two distribution systems located on each respective floor. As evidenced by Figure 14 below, each floor was equipped with a 480Y/277 high voltage panel, a 75 kVA step-down transformer, and a 208Y/120 two section low voltage panel.

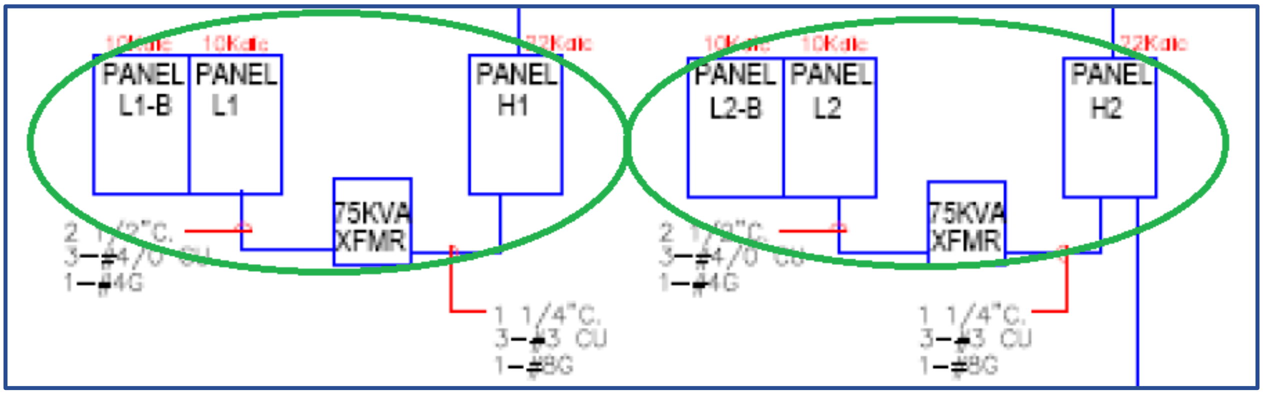


Figure 14: Redesign Target Area #2 – 1st and 2nd Floor Distribution Systems

While this setup does effectively isolate each floor from one another, having two transformers is another unnecessary expense. Rather than having each floor separated, the step-down transformers could be combined to create a single high voltage to low voltage transition sequence. Once stepped down, the first low voltage panel could then simply sub-feed the other required 208Y/120 volt panels.

The third target area was the data center distribution system depicted in Figure 15. Currently all of the panelboards and transformers associated with the data centered are separated from the rest of the building's distribution system even though the data center components are hardly loaded. If they were to be placed on other distribution system components, it would effectively eliminate all the current data center components.

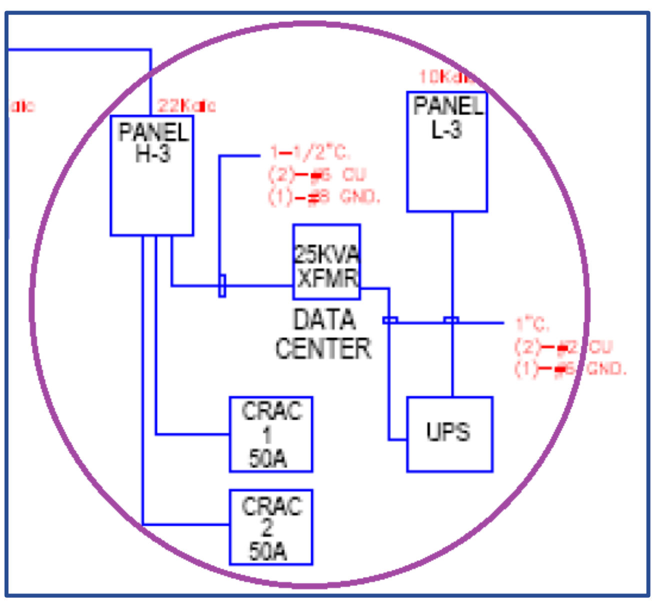


Figure 15: Target Area #3 – Data Center Distribution System

Once the potential improvement areas were targeted, the second step in the process becomes completing research to ensure that the aforementioned areas could adapt to the proposed changes. This included checking the loading on each panel and the available breaker space per the existing panel schedules to make sure every panel could handle the additional loading. Additionally, the Fisk Electric project team was contacted to guarantee that they would not be opposed to the three proposed one-line changes.

After all the necessary research was complete, the final step in the process was laying out the new one-line schematic diagram and completing all the required calculations needed to implement the proposed changes. This included recalculating and documenting all the affected panel schedule loads. Once the loads were rearranged, all the new feeders and breakers were sized and their respective information was placed on both the new panel schedules and one-line schematic diagram.

Redesign Results

After completing the redesign process for the Fisk Corporate Headquarters building, a new one-line schematic diagram was produced along with all the required supporting panel schedules. The first targeted area, the originally separated distribution panels labeled DP-1 and DP-2, was successfully redesigned by combining the two panels into one distribution panelboard as supported by Figure 16.

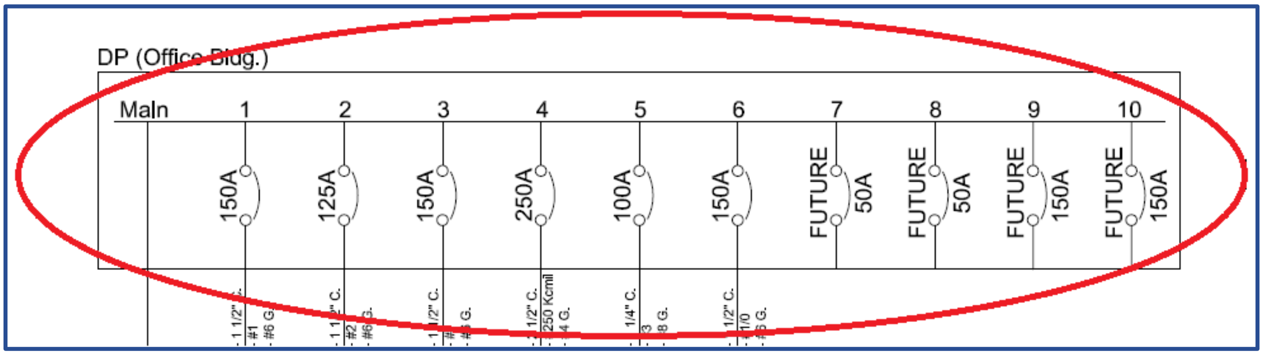


Figure 16: Target Area #1 Redesigned – Distribution Panelboards

This successful consolidation of the two panels meets the design goal of reducing the number of switchboards by 50%. Figure 17 below shows a majority of the important electrical data information regarding the new distribution panel labeled DP. DP's complete panel schedule can be referenced in Appendix K.

DP (800 Amp Panelboard)															
V:	480Y/277	Rm # 1-505		22000 AIC	3P - 4W			Fdr:	2 x (4) 600 & #1/0G.	2 x 4"C	625 kVA		800 A		MCB
Designations		VA/Phase			Bkr/Pole/Wire			Designations		VA/Phase			Bkr/Pole/Wire		
Ckt	Description	A	B	C	Bkr	# P	W	Ckt	Description	A	B	C	Bkr	# P	W
1	Panel H-3 (1-505)	22750			150	3	#1	2	RTU-1 (Roof)	29550			125	3	#2
3	-		22750		-	-	-	4	-		29550		-	-	-
5	-			22750	-	-	-	6	-			29550	-	-	-
7	RTU-2 (Roof)	34294			150	3	#1	8	Panel H-1 (1-505)	65667			250	3	250
9	-		34294		-	-	-	10	-		65667		-	-	-
11	-			34294	-	-	-	12	-			65667	-	-	-

Figure 17: Top Section of Panel Schedule 'DP'

The second targeted area included the two 480Y/227 to 208Y/120 voltage distribution systems located on each floor. Through a systematic reorganization of the step-down distribution, the redesign eliminated the need for two separate transformers on each floor by consolidating them into one larger transformer located on the first floor. The low voltage panelboard on that floor would then feed panelboard L-2 in the same manner it was formerly fed from panelboard H-2 and its previously associated 75 kVA transformer. For the new step-down distribution layout, see Figure 18 below.

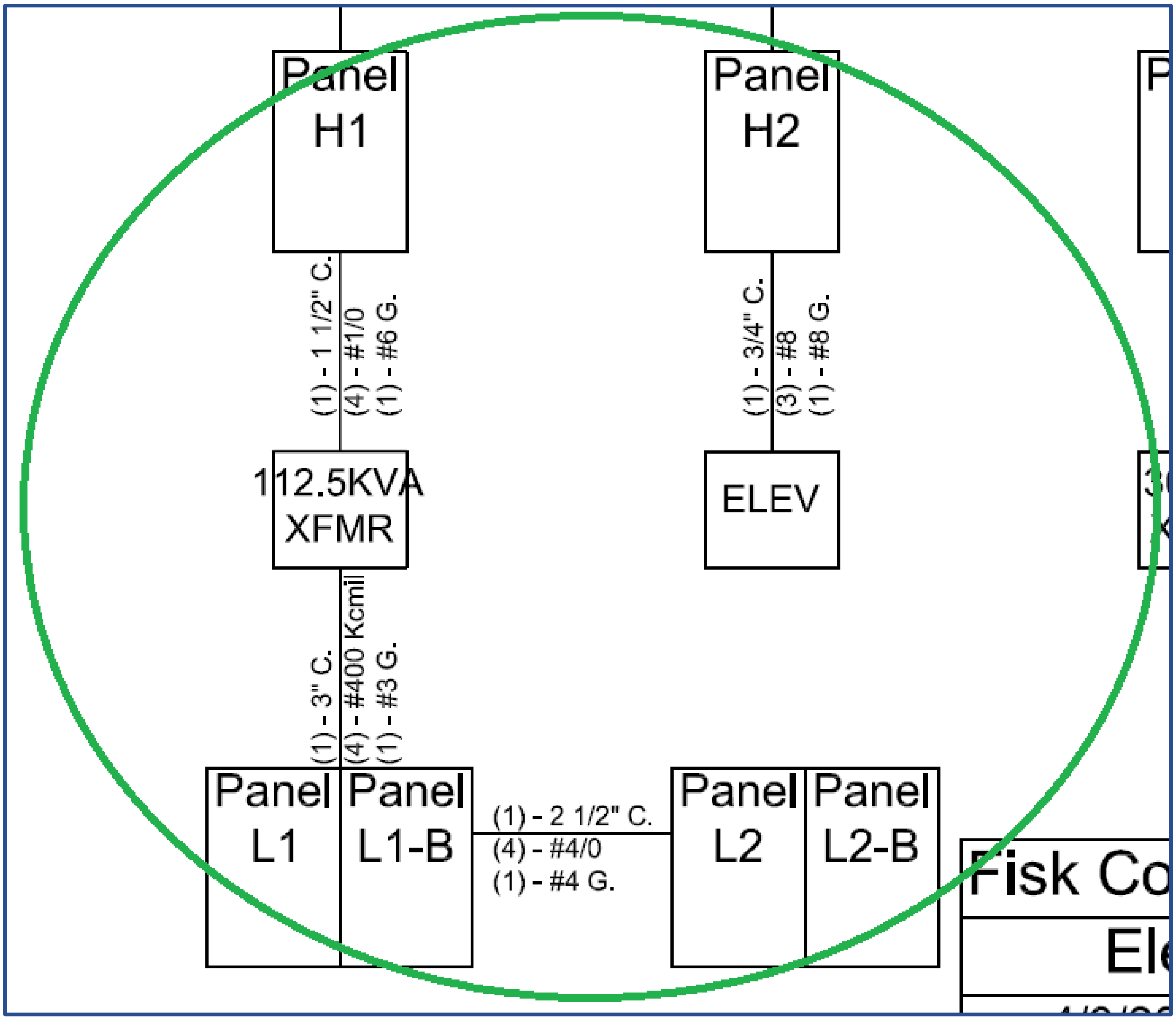


Figure 18: Target Area #2 Redesigned – New Step-Down Distribution Layout

The panel schedule on the following page depicts Panel L-1B. This second section panel of panel L1 is what sub-feeds panelboard L-2, thus eliminating the need for two 75 kVA transformers. The layout allows the various panelboards to remain located in their original positions, therefore eliminating any potential changes to the branch circuit wiring that could have been required had the redesign been accomplished differently. All of the other panelboards' panel schedules affected by the redesign can be found in Appendix K. This includes 480Y/277 volt panelboards H-1 and H-2 along with 208Y/120 volt panelboards L-1 and L-1B.

L-1B																
V:	208Y/120	Rm # 1-505		10000 AIC		3P - 4W		Fdr:	Section #2		73 kVA					MLO
Designations		VA/Phase			Bkr/Pole/Wire			Designations		VA/Phase			Bkr/Pole/Wire			
Ckt	Description	A	B	C	Bkr	# P	W	Ckt	Description	A	B	C	Bkr	# P	W	
1	Sign on Westview (Site	500			20	1	#12	2	AV Equipment (309)	720			20	1	#12	
3	Gate Motor 1 (East)		1176		20	1	#12	4	Receptacles (309)		900		20	1	#12	
5	Gate Motor 2 (East)			1176	20	1	#12	6	Receptacles (318-320)			1080	20	1	#12	
7	Gate Motor 1 (West)	1176			20	1	#12	8	Receptacles (310-314)	1080			20	1	#12	
9	Gate Motor 2 (West)		1176		20	1	#12	10	Spare		0		0	0	#####	
11	Elev. Sump Pump (Elev.)			1176	20	1	#12	12	Fire Alarm Panel (IDF)			360	20	1	#12	
13	Elev. Pit Light (Elev.)	330			20	1	#12	14	Receptacles (Sprinkler	360			20	1	#12	
15	Elev. GFCI (Elev.)		180		20	1	#12	16	Space		0		0	0	#####	
17	Hallway Power (403)			540	20	1	#12	18	Space			0	0	0	#####	
19	Projector (Training Roo	800			20	1	#12	20	Space	0			0	0	#####	
21	Projector (Training Room)		800		20	1	#12	22	Space		0		0	0	#####	
23	Shade (Break Room)			720	20	1	#12	24	Space			0	0	0	#####	
25	Proj. and Screen (309)	720			20	1	#12	26	Space	0			0	0	#####	
27	Receptacles (202)		900		20	1	#12	28	Space		0		0	0	#####	
29	Receptacles (200)			720	20	1	#12	30	Space			0	0	0	#####	
31	Copier (207)	1920			20	1	#12	32	Space	0			0	0	#####	
33	Laser Printer (207)		800		20	1	#12	34	Space		0		0	0	#####	
35	Receptacles (102)			720	20	1	#12	36	Space			0	0	0	#####	
37	Receptacles (103)	720			20	1	#12	38	Panel L2 & L2B (2-505	18158			225	3	4/0	
39	Receptacles (Lobby)		180		20	1	#12	40	-		18158		-	-	-	
41	Spare			0	0	0	#####	42	-			18158	-	-	-	

Figure 19: Redesigned Panel Schedule 'L-1B'

It is worth noting that while combining two 75 kVA transformers into one 112.5 kVA transformer does reduce material costs and man hours, it also decreases the maximum capacity of the low voltage panelboards in the Fisk Electric office building. Originally, the low voltage distribution had a maximum capacity of 150 kVA. That number was reduced by 37.5 kVA in the process of combining the two 75 kVA transformers. However, a closer look at the low voltage panel schedules' loads reveals that this decrease in maximum kVA is acceptable. Table 10 below supports this theory.

Table 10: kVA Capacity Reduction Support

208Y/120 kVA Data	
Description	**kVA**
L-1	34
L-1B	21
L-2	39
L-2B	15
Combined Demand	109
Maximum Capacity	112.5

As evidenced by the above table, the total demand kVA for the 208Y/120 voltage side of the distribution system is 109 kVA. This is only 3.5 kVA below the maximum capacity of 112.5 kVA. Even though this allows very little system growth, it is considered acceptable for three reasons. First, the total kVA represented above does not take into account allowable receptacle demand factors. By code, after the first 10 kVA of receptacle loads, the remaining receptacles' loads are allowed to be treated as 50% of their typical demand kVA. Were this taken into account in the above chart, the gap between the combined demand and maximum capacity would have significantly increased. The second reason this resizing is acceptable is because the Fisk Corporate Headquarters project is already completely designed. There are no areas currently set aside for expansion, nor are there any undeveloped areas that could add additional loads to the system. To further back up this claim, one need only look to the capacity the original distribution boards were sized around. The main breaker entering the building is sized for 800 amps. This means the maximum allowable capacity for the entire system is 665 kVA, a paltry 40 kVA less than the currently building load. An electrical system designed for a maximum growth of only 6% is not one that is indicative of future expansion or changes. The last reason this is acceptable stems from the additional capacity available in the building's data center distribution system. If some minor circuitry changes needed to be added to the system, Fisk Electric could simply feed these new circuits off of the barely loaded UPS distribution system that is equipped with a step-down transformer of its own.

Unfortunately, the final area targeted for redesign changes could not be addressed per the instructions of the owner. Due to Fisk Electric's knowledge of electrical systems, they understood the value of having the data center's distribution isolated from the rest of the distribution system. As such, no changes were made to the small, data center distribution system.

Overall, the Fisk Corporate Headquarters redesign was a success. Two of the three potential improvement areas were addressed and the savings they achieved will be discussed in the following sections.

For the redesigned Fisk Corporate Headquarters' one-line diagram, please reference Appendix J. For all the redesigned panel schedules, please reference Appendix K.

Electrical Redesigned System Cost Analysis

The cost analysis of the original and redesigned system constituted a three step process. Firstly, all the affected components of both the original and redesigned distribution system were taken off and recorded. Next, the takeoffs were sent through a slightly different version of Fisk Electric's estimating historical database. Due to the competitive nature of corporate historical databases, the estimating results obtained via the Fisk database were deliberately adjusted. These adjustments were equitably implemented on both estimates and do not detract from the accuracy of the total savings. Finally, all the distribution equipment was quoted by Crawford Electric. Crawford Electric is a large, electrical vendor located in Houston, Texas that constantly updates equipment pricing based on current market value. Once all three steps were completed, the material pricing and labor hours were compiled into two complete estimates. An estimated cost of $42.50 per hour for an electrician, provided by Fisk Electric, was implemented in order to convert labor hours into dollars. Table 11 depicts a summary of the redesigned system's cost analysis.

For the summarized takeoff of the original affected components, please reference Appendix L.
For the summarized takeoff of the redesigned components, please reference Appendix M.

Table 11: Summary of the Redesign Costs

Redesign Cost Summary			
Description	**Original $**	**Redesign $**	**Savings $**
DP-1 (800A Distribution Panelboard)	$5,390		$5,390
DP-2 (800A Distribution Panelboard)	$10,133		$10,133
DP (800A Distribution Panelboard)		$9,213	($9,213)
H-1 (480Y/277V Panelboard)	$2,883	$3,770	($888)
L-1 (208Y/120V Panelboard)	$2,180	$2,759	($579)
L-1B (208Y/120V Panelboard)	$1,308	$1,895	($588)
H-2 (480Y/277V Panelboard)	$2,960	$2,675	$285
75 kVA Step-Down Xfmer	$8,189		$8,189
112.5 kVA Step-Down Xfmer		$5,651	($5,651)
Feeder: DP-1 to DP-2	$7,178		$7,178
Feeder: DP to H-1	$1,564	$1,756	($192)
Feeder: DP to H-2	$1,802	$810	$993
Feeder: DP to H-3		$553	($553)
Feeder: DP to RTU-1		$484	($484)
Feeder: DP to RTU-2		$799	($799)
Feeder: L-1B to L-2		$1,553	($1,553)
Totals	**$43,586**	**$31,917**	**$11,669**

The goal of this redesign was to reduce the cost of the system by a minimum of $10,000. As shown by the above table, the total cost savings amounted to $11,669 or 5% of the original cost of the building's distribution system. Approximately $8,800 in savings was realized as a direct result of reduction in the number of distribution panelboards and transformers by 50%. The remaining savings resulted from changes to the various distribution feeders. Because the original redesign savings goal was surpassed by roughly $1,700, the redesign was successful in reducing the cost of the electrical distribution system.

For the complete original bill of material for affected components, please reference Appendix N.
For the complete redesigned bill of material, please reference Appendix O.

Electrical Redesigned System Schedule Analysis

The schedule analysis for the Fisk Corporate Headquarters project's electrical distribution redesign was carried out using the same resources as the aforementioned cost analysis. The components were taken off and passed through the altered version of Fisk Electric's estimating system. Once complete, the labor hours associated with each affected component were compiled and summarized in Table 12, below.

For the summarized takeoff of the original affected components, please reference Appendix L.
For the summarized takeoff of the redesigned components, please reference Appendix M.

Table 12: Summary of Redesign Labor Hours

Redesign Labor Hours Summary			
Description	**Original**	**Redesign**	**Savings**
DP-1 (800A Distribution Panelboard)	30		30
DP-2 (800A Distribution Panelboard)	45		45
DP (800A Distribution Panelboard)		55	(55)
H-1 (480Y/277V Panelboard)	29	28	1
L-1 (208Y/120V Panelboard)	28	27.5	.5
L-1B (208Y/120V Panelboard)	19	24	(.5)
H-2 (480Y/277V Panelboard)	30	30	0
75 kVA Step-Down Xfmer	63		63
112.5 kVA Step-Down Xfmer		46	(46)
Feeder: DP-1 to DP-2	78		78
Feeder: DP to H-1	18	19	(1)
Feeder: DP to H-2	20	12	8
Feeder: DP to H-3		8	(8)
Feeder: DP to RTU-1		7.5	(7.5)
Feeder: DP to RTU-2		11	(11)
Feeder: L-1B to L-2		19	(19)
Totals	**360**	**287**	**73**

As evidenced by the above table, the redesign resulted in a labor savings of approximately 73 man hours. Assuming all the electrical distribution tasks require a minimum crew size of two men to complete, 73 saved man hours results in a schedule savings of just under 4.5 days. The original redesign schedule reduction goal was a minimum of 4 days. The redesign was clearly successful in accomplishing that goal.

While 73 man hours seems insignificant, the truly valuable savings comes from the shortening of the electrical schedule by just over 4 days. The installation of a building's electrical distribution system always lies along the MEP schedule's critical path because many MEP building components rely on the equipment being hot. Without hot distribution gear, none of the branch wiring or devices can be turned on and checked. More importantly, none of the HVAC, plumbing, or fire protection equipment can be turned on, tested, or commissioned until the electrical gear is energized. As such, an electrical distribution installation schedule reduction of over 4 days would be extremely valuable to the project team and would justify the implementation of the electrical system redesign.

For the complete original bill of material for affected components, please reference Appendix N.
For the complete redesigned bill of material, please reference Appendix O.

Electrical Redesigned System Constructability Analysis

As previously stated in the Redesign and Analysis Goals section of this report, one of the goals of the electrical redesign was to reconfigure the system without creating any new constructability concerns. One aspect of constructability typically affected by design changes is space requirements. In the Fisk Corporate Headquarters project electrical distribution redesign completed in this report, many of the components were changed, combined, or deleted. This reconfiguring of the system's components had the potential to affect electrical closet space requirements. Due to this potential concern, all the new components were researched in order to acquire their pertinent dimensions. They were then placed within the appropriate electrical closet to ensure adequate space existed to house all the necessary components. Figure 20 below depicts the built-out first floor electric room.

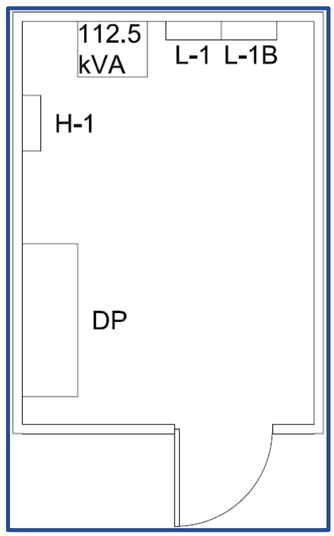


Figure 20: Layout of 1st Floor Electrical Closet

The first floor electric closet is scheduled to house the new, combined 800A distribution board, panelboard H-1, the 112.5 kVA transformer, and both sections of panelboard L-1. As illustrated by the above figure, more than enough space currently exists in the first floor electric room to house all these now enlarged components.

The second floor electric room also has more than adequate space as shown by Figure 21 below. Both panelboards H-2 and sections one and two of panelboard L-2 can easily fit inside the closet with room to spare.

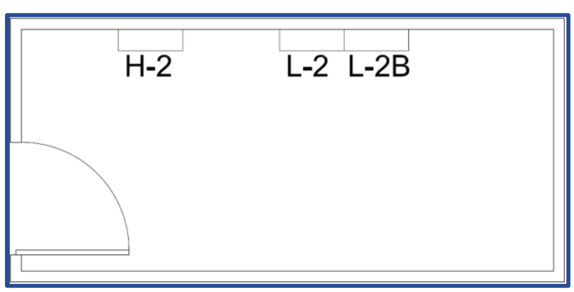


Figure 21: Layout of 2nd Floor Electrical Closet

Based on the dimensions of the electrical rooms on the architectural plans, combined with the aforementioned closet layouts, space is not a key constructability concern associated with the newly designed electrical system. Assuming the gear can be ordered far enough in advance that transportation to the rooms will not be an issue, both electrical closets are big enough for no space or obstruction constructability concern to need to be addressed if the newly design system was adopted by Fisk Electric.

After ensuring that space is not a major concern, the next major constructability concern is the ease of installation of the different components themselves. Due to the author of this report's inexperience with physically installing any of these components himself, two interviews were conducted with industry professionals to gain insight in installing the redesigned components. The first industry professional interviewed was Ted Robertson. Mr. Robertson is currently employed by Fisk Electric and serves in the capacity of Operations Manager for the Houston, Texas Commercial Division. Mr. Robertson began his career over 30 years ago as an electrician for Fisk. After working as an electrician, Mr. Robertson became the manager of Fisk's drafting department. He later became a project manager where he successfully completed multiple, high-profile jobs in the Houston area. After experiencing success as a project manager, Mr. Robertson was promoted to his current position where he actually served as Fisk Electric's Project Manager for the Fisk Corporate Headquarters project. Figure 22 shows a portion of the interview with Ted Robertson when he was discussing the differences in installation between the old and new electrical distribution systems. According to Mr. Robertson, he foresaw no added constructability concerns that would be associated with the new distribution system.

Q: What about the installation of a larger 112.5 kVA transformer as opposed to two smaller ones? Do size and weight become a factor?

A: *No, the 112.5 kVA transformer is maybe 50-75 pounds heavier and 2-3 inches wider. The 75 kVA transformer is already big enough to where small equipment would be needed to move it from place to place. That same equipment would be sufficient to move the 112.5 kVA transformer. As far as size goes, the electrical room that would house this slightly larger transformer is more than big enough to house a few extra inches. In fact, the electric closet as it currently sits actually has 2 walls completely bare of any type of equipment.*

Figure 22: Highlight of Ted Robertson's Interview

The second industry professional interviewed was David Rinehart. Mr. Rinehart has worked in the electrical contracting industry for over 30 years. Mr. Rinehart has climbed the operations ladder from electrician, to power foreman, to now one of Fisk Electric's top general foreman. Mr. Rinehart's sentiments regarding the constructability of the new system compared to the old basically mirrored that of Mr. Robertson's. Mr. Rinehart believed that the newly designed system will produce labor savings without adding any type of constructability concerns. In fact, Mr. Rinehart pointed out that by keeping all the new system's major components on the first floor, the electricians would be able to save time and money by not having to use equipment to move a 550 plus pound 75 kVA transformer to the second floor.

For the full Q&A with Ted Robertson, please reference Appendix P.
For the full Q & A with David Rinehart, please reference Appendix Q.

Overall, the new system was a complete success in terms of constructability concerns. Not only did it meet the goal of not creating installation difficulties, it actually made the system easier to install by placing most of the larger items on the first floor.

Recommendations

This analysis proves that adopting the recommended electrical distribution system redesign for the Fisk Corporate Headquarters project would be in the best interest of the project team. The redesign was successful in reducing the number of distribution components while still maintaining the integrity of the original system's design intent. Accordingly, none of the panel locations were changed, nor was any of the branch wiring affected by the redesign. The redesign analysis resulted in a cost savings of $11,669 and a schedule savings of just less than 4.5 days. Both these figures surpass the initial redesign savings goal of $10,000 and 4 days, respectively. Also, two key electrical contracting professionals with over thirty years of experience in the industry were consulted in order to ensure the new system did not add any constructability concerns to the electrical distribution system. All the consultants interviewed maintained that the redesigned system would be as-easy if not easier to install than the original electrical distribution system. In conclusion, it is recommended that Fisk Electric should choose to adopt and implement the suggested redesign changes to their electrical distribution system. Unfortunately the project is already complete prohibiting Fisk Electric from benefitting from the redesign.

Analysis #3: Implementation of LEED

Problem Identification

As outlined by the LEED Summary sections of this report, it was discerned after a careful study of the Fisk Corporate Headquarters' site, designed systems, materials, and construction practices that the project could have easily scored a 48 out of 110 possible LEED credit points. These 48 points could be accumulated without making any design changes. The project team would have only needed to adopt some changes in their construction methods, along with some relatively minor fees to acquire these points. A breakdown of these credits can be found in Figure 23 below.

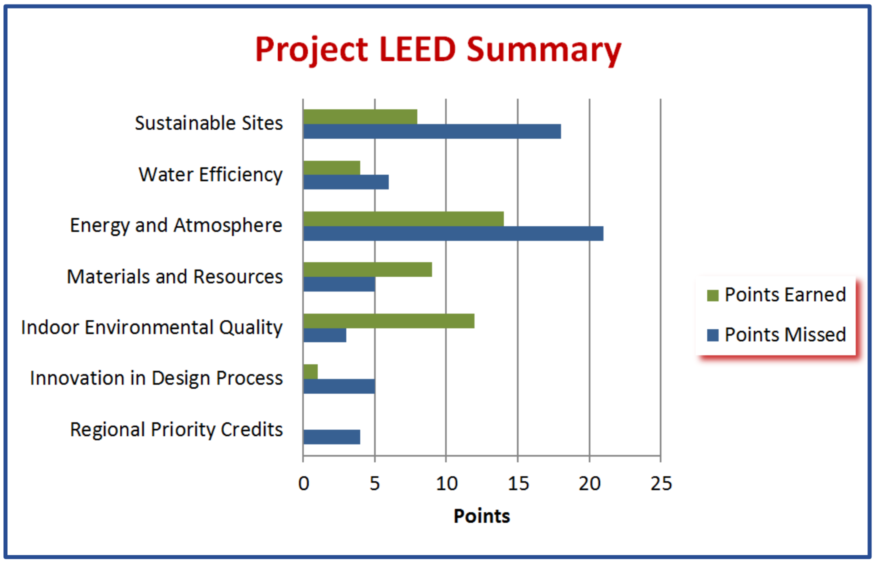


Figure 23: Fisk Corporate Headquarters - Potential LEED Summary

This total score of 48 credits would have resulted in the Fisk Corporate Headquarters project receiving a LEED rating of Certified. However, the ownership team ultimately decided that the benefits realized by achieving a LEED rating did not outweigh the added construction and paperwork costs.

The purpose of this analysis is to determine the additional construction and paperwork costs. Once identified, these individual costs will be summarized and compared to the benefits Fisk Electric would have realized had they decided to target a LEED rating. If the additional costs remain within or below 1-2% of the total cost of construction, it would lend weight to the argument that Fisk Electric should have targeted a minimum LEED rating of Certified.

It is also worth noting that the Fisk Corporate Headquarters was only two points away from being able to achieve a LEED rating of silver. The Architectural Breadth portion of this analysis will cover a way Fisk Electric could have made some minor design changes in order to achieve LEED silver.

For the complete potential LEED checklist, please reference Appendix C.

Background Information

One of the ways background research was completed for this analysis was through a brief conversation with Wayne McDonald, Vice President of Fisk Electric's Houston Division. Mr. McDonald was the primary contact in Fisk Electric Corporation for the project. He was involved with all the major design decisions, including the decision to not pursue a LEED rating for the Fisk Corporate Headquarters project. His interview responses can be found in Figure 24 below.

Q: Mr. McDonald, can you briefly explain how LEED was approached on the Fisk Corporate Headquarters project?

A: *The ownership team decided to not acquire a LEED rating due to the additional construction and paperwork costs they would have needed to assume in order to obtain it. However, Fisk Electric still wanted to have all the system benefits associated with owning and maintaining a LEED building. As such, Fisk instructed the design team to design a building that would achieve a LEED rating if they choose to apply for it. All the systems were designed in a manner that emphasized energy efficiency. For instance, the Fisk Corporate Headquarters project contains 35% more square footage than our prior facility but the electric bill amounts to about 60% of the original. Fisk also instructed the design team to include a shower and bike rack in case the ownership team decided to change its stance regarding LEED ratings.*

Due to the increased energy efficiency of its new facility, Fisk Electric feels that they did an excellent job of taking advantages of LEED principles even though they did not apply for a LEED plaque.

Figure 24: Wayne McDonald LEED Interview

As demonstrated by the above interview, Fisk Electric did implement numerous LEED design principles in their facility. Fisk was able to realize a 40% energy savings while increasing the size of their facility by 35%. These implemented principles account for an adequate number of design LEED credits to achieve a LEED rating of Certified.

The next step in the background research is to discern which of the potential 48 credits are directly affected by construction practices. After consulting with the project team, it was determined that even though Fisk Electric instructed the design team to design for LEED, it did not instruct the construction team to implement some simple LEED construction principles. However, after close examination of the available LEED points, the only ones potentially affected by construction are outlined in the table below.

Table 13: Potential Construction LEED Points

Construction LEED Credits	
Credit Description	#
Construction Waste Management	2
Construction IAQ Management Plan – During Construction	1
Construction IAQ Management Plan – Before Occupancy	1
Regional Materials	2

Closer investigation into these credits showed that only 2 of the potential construction credits would need to be addressed by this analysis. Both of the Construction IAQ Management Plan credits were already completed by the project team because Fisk Electric did emphasize indoor air quality in their overall project plan. They felt that enriched indoor air quality would lead to improved worker productivity along with healthier employees. Due to the resources available in Houston, the Fisk Corporate Headquarters project was completed using Regional Materials but the LEED paperwork was never completed. However, they did not implement any construction waste management plan that used LEED principles. The actual waste removal plan was a simple $375/week plan where a waste management company would visit the site and haul off all the construction waste once a week. This plan did not include any recycling provisions which would lead to zero of the potential two LEED points. However, by using a different third party waste management company, Fisk Electric would have been able to acquire both these available LEED points.

After conducting extensive background research, it was determined that even fewer steps would need to be taken by Fisk Electric to receive a LEED rating of Certified. Fisk Electric would need to change their construction waste management plan to include LEED recycling and sorting principles. They would also need to pay for additional project manager hours due to the increased demands of LEED paperwork on a project along with all the fees associated with applying for a LEED rating.

Business Benefits

Before completing an analysis regarding the various costs that will be associated with applying for a LEED rating on the Fisk Corporate Headquarters project, it is important to first highlight some of the business benefits associated with the LEED rating. The first and most direct benefit associated with LEED are the tax incentives. In the case of the Fisk Corporate Headquarters project, Fisk Electric would have been eligible for any potential LEED taxes benefits associated with Harris County in Houston, Texas. Figure 25 shows the percentage of property tax abatement owners can take advantage of if they choose to acquire a LEED rating for new construction in Harris County.

Amount:	Certified LEED (Basic): 1.0%
	LEED Silver: 2.5%
	LEED Gold: 5.0%
	LEED Platinum: 10%

Figure 25: Harris County LEED Tax Abatement Incentives

As the above figure illustrates, Fisk Electric could have easily realized 1% property tax abatement had they chosen to apply for a LEED rating of Certified. If they made some of the changes proposed later in this analysis and achieved a silver rating that tax abatement would raise even higher to 2.5%.

The other benefit Fisk Electric could realize by achieving a LEED rating is more subjective. Because Fisk is a contractor currently competing for jobs in the commercial construction industry, building, operating, and maintaining a LEED facility would show Fisk Electric's dedication to green buildings. This could create business opportunities for Fisk due to the growing owner demand for LEED projects. It is difficult to quantify the value of this benefit other than it could be substantial with regard to future business opportunities.

Construction Cost Research

After defining some of the business incentives associated with LEED, the next step in the analysis process was to determine the extent of the up-front costs Fisk Electric would have to incur in order to achieve a LEED rating. This step was accomplished through an interview with Anthony Rubino who is not a Fisk employee. An analysis of the interview results can be found in the next section.

Anthony Rubino Interview

Anthony Rubino is currently employed as a project manager for Tellepsen Builders in Houston, Texas. He graduated from Texas A&M's Construction Management program and has more than a decade of project managerial experience and has been involved with numerous LEED projects throughout the city of Houston. Because of his background, he is qualified to comment on recycling waste management fees, LEED application fees, and the total number of extra hours typically required of project managers on LEED projects. The following excerpt from the interview with Mr. Rubino supports the prior claim that a majority of the costs associated with LEED stem from design changes.

> Q: Mr. Rubino, you have been a project manager in Houston for many years and have been involved with a variety of LEED projects. Can you please explain the various construction costs associated with LEED?
>
> A: *Unfortunately, a vast majority of LEED costs are not decided by the construction team. Most of the costs associated with LEED projects come from various design decisions. The increased emphasis on energy efficiency and improved design components are what typically drives the price of LEED projects upward. Once the design is in place, very few costs are actually associated with construction.*

Figure 26: Excerpt from Anthony Rubino Interview

Once it was established that a majority of LEED costs are from design changes, the next series of questions asked Mr. Rubino to comment with more specificity regarding the exact construction costs associated with LEED. The first cost he referred to was associated with the increased recycling demands. Mr. Rubino said the easiest way to achieve these LEED points was to pay for a third party to remove and sort a majority of the construction wastes offsite. This minimizes the demands on the project's onsite superintendent and places the success of the credits in the hands of an organization more accustomed to managing and recycling construction waste. However, while this minimizes additional superintendent costs, Mr. Rubino believes that having a company sort waste typically increases waste removal costs by approximately 30%. This uptick takes into account waste removal from the site, sorting costs, and reporting back on the total tonnage of recycled wastes.

The next cost mentioned by Mr. Rubino is a direct result of the added demands LEED places on a project manager. Many of the aforementioned credits associated with construction require additional paperwork and coordination not typically necessary on construction projects. The following details Mr. Rubino's thoughts on the additional demands to a project manager on a LEED project.

Q: Earlier you mentioned that there needed to be an uptick to the total project manger's hours. Roughly how much does the increase in paperwork requirements, material tracking, and coordination add hours to the project manager's overall time spent on the project?

A: *Yes, depending on the number of project managers located on the job and the size of the job, there will be an uptick in project manager hours of anywhere from 10% to 15%. On a project like the Fisk Corporate Headquarters job, adding 10% to the lead project manager's total hours would be enough to cover all the additional paperwork and other project manager demands if the project were to target a LEED rating.*

Figure 27: Excerpt from Anthony Rubino Interview

As indicated by the above figure, Mr. Rubino believes from his past experiences that roughly 10% additional hours need to be added to the total lead project manager hours in the job. This increase would cover all the additional paperwork and coordination required on a LEED project.

The last construction cost associated with LEED projects mentioned by Mr. Rubino in his interview were the fees associated with applying for LEED. Mr. Rubino stated that they best way to estimate this cost was to go to GBCI's homepage. This page includes all the various potential fees associated with new construction projects attempting to apply for a LEED rating. From there, one need only analyze the type of project attempting to apply for a LEED rating and choose the correct fee structure.

For the full Q&A with Anthony Rubino, please reference Appendix R.

Cost Analysis

One additional construction cost mentioned by Anthony Rubino was the fees required to apply for a LEED rating. The fee information can be found at the Green Building Certification Institute's webpage. The Green Building Certification Institute is a government entity that manages LEED building certification. According to their fee schedule for new construction, the Fisk Corporate Headquarters project would need to pay two fees to the GBCI organization in order to certify their building. The first fee is the building registration fee. Because Fisk is not a USGBC silver, gold, or platinum member, that fee amounts to $1,200. The second fee is the standard design and construction review that fluctuates depending on the size of the project. Since the Fisk Corporate Headquarters project falls between 50,000 and 500,000 square feet, the standard review fee is $0.055 per square foot. When multiplied by 54,160 total square feet, the standard review fee amounts to $2,978.80. This brings the total cost of all LEED application and review fees to $4,178.80.

For the complete GBCI LEED fees, please reference Appendix S.

The second additional construction cost stems from the increased demands to the construction waste management plan. It is assumed by this report that if Fisk Electric did attempt to achieve a LEED rating, they would use a third party waste management company to haul, sort, and track the recyclable waste on the project. According to Mr. Rubino, this would equate to an approximately 30% increase in construction waste management costs. Currently, the waste hauling on the Fisk Corporate Headquarters project amounts to $375 a week. If this was increased by 30%, the total weekly cost of waste management on the project would become $487.50, or $112.50 more than the current cost. When multiplied by the job's 47 week construction duration, the total third party waste management cost would increase by $5,287.50.

The last significant cost increase associated with the desired LEED rating stems from the extra management hours that will be required to respond to the increased coordination and documentation demands of a LEED project compared to a normal one. The following Figures depict how both the project manager and superintendent's additional hours and costs were calculated.

$$\frac{\$3{,}100}{wk} * \frac{wk}{40hrs} = \frac{\$77.50}{hr}$$

$$\frac{47wks}{job} * \frac{40hrs}{wk} * 10\% = 188hrs$$

$$\frac{\$77.50}{hr} * 188hrs = \$14{,}570$$

Figure 28: Project Manager Additional Costs

Per Mr. Rubino's direction, 188 hours were added to the lead project manager's total job hours. Based on the estimated weekly cost of an experienced project manager, this equates to a cost increase of $14,570.

$$\frac{\$2{,}250}{wk} * \frac{wk}{40hrs} = \frac{\$56.25}{hr}$$

$$\frac{47wks}{job} * \frac{40hrs}{wk} * 4\% = 75.2hrs$$

$$\frac{\$56.25}{hr} * 75.2hrs = \$4{,}230$$

Figure 29: Superintendent Additional Costs

Even though Mr. Rubino suggested an increase of project superintendent's hours of 5-10%, this report assumed that an additional 4% would suffice. This equates to just over 75 extra hours. Because the building was already designed with complex, LEED efficient systems, it was assumed that a majority of the surplus coordination typically associated with LEED was already accounted for in the original general conditions estimate. As such, the 4% increase included in this report only needs to cover the time spent dealing with the emphasized construction waste management plan and other minor coordination concerns. The additional 75 hours would translate to an inflated cost of $4,230.

Analysis Results

After all the additional LEED costs were isolated and accounted for, they were summarized to gauge whether they would be worth adopting on the Fisk Corporate Headquarters project. The summary table of all the additional LEED construction costs can be found below.

Table 14: Construction LEED Costs

Construction LEED Summary Costs				
Item Description	**Quantity**	**Unit**	**$/Unit**	**Total $**
Project Manager	188	Hourly	$77.50	$14,570
Superintendent	75.2	Hourly	$56.25	$4,230
Waste Removal	47	Weeks	$112.50	$5,288
GBCI Registration Fee	1	Flat Rate	$1,200	$1,200
GBCI Standard Review	54160	Sq. Footage	$0.055	$2,979
Total Cost				**$28,266**

As outlined by the above table, the total additional LEED construction costs amount to only $28,266. The following chart demonstrates how this additional cost compares to the total cost of construction, including general conditions.

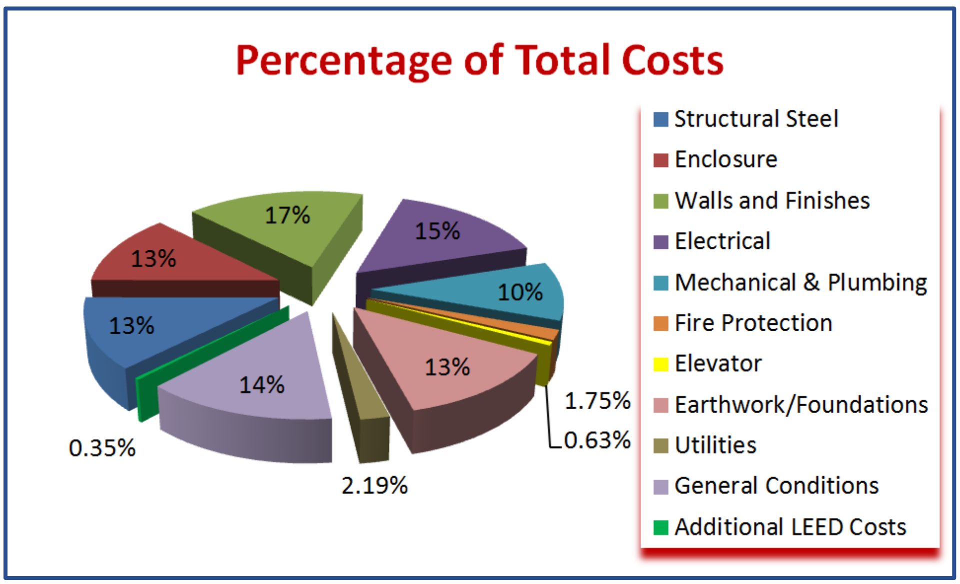


Figure 30: Percentage of LEED Costs compared to the Building Total

The additional $28,266 LEED construction costs amount to only 0.35% of the total cost of construction. In the Problem Introduction section of this analysis, it was mentioned that if the additional construction costs were within or less than 1-2% of the total construction costs, it would support the argument that Fisk Electric should have applied for a LEED rating on the project. 0.35% is substantially less the required 1-2%. When considering the gap between owning a LEED facility or not amounts to only $28,266, the Fisk Corporate Headquarters project probably should have applied for LEED Building Certification. Taking into account both the industry benefits along with the property tax incentives, the additional $28,266 in LEED construction costs would quickly pay out and make the investment profitable.

Architectural Breadth

As previously mentioned, the total number of potential LEED credits the Fisk Corporate Headquarters project could have realized without making any changes to the original design was 48. This would equate to a LEED rating of Certified, just two points shy of LEED Silver. While becoming Building Certified does equate to substantial incentives, those incentives increase for LEED Silver projects. Because Fisk Electric was only two points away from LEED Silver, a study was conducted in an effort to determine an efficient way to obtain those two points. One solution realized by this report was through the addition of an architectural overhang.

Problem Identification

After careful examination of the potential LEED points, it was discovered that one of the categories that could use improvement was Energy and Atmosphere. One of the credit sections within this category is labeled Optimize Energy Performance and is worth a maximum of nineteen points. Currently, the Fisk Corporate Headquarters project only scored a seven out of the nineteen potential points. This means the building is only 24 % more efficient than the ANSI/ASHRAE/IESNA Standard 90.1-2007. For each 2% the building becomes more efficient than the standard, the building is eligible for another energy efficiency credit. This means that if the Fisk Electric building was able to increase its energy efficiency to 28% better than the standard, it would become eligible for a LEED Silver rating. As such, the goal of this architectural breadth is to change the architecture in a way that increases the energy efficiency by at least 4%.

The Fisk Corporate Headquarters building is a rectangular, brick and window façade structure. It is oriented with the main entrance facing due south. This means that three of the four exterior facades are exposed to direct sunlight on a daily basis. Because of its orientation, the northern side of the building is never exposed to direct sunlight. Unfortunately, the three exposed sides of the building have no form of solar protection other than manually operated interior shades that the building's occupants can lower for personal comfort. All three sides also have a similar brick to glazing ratio as demonstrated by Figure 31. The dark areas represent brick while the white areas are representative of glazing.

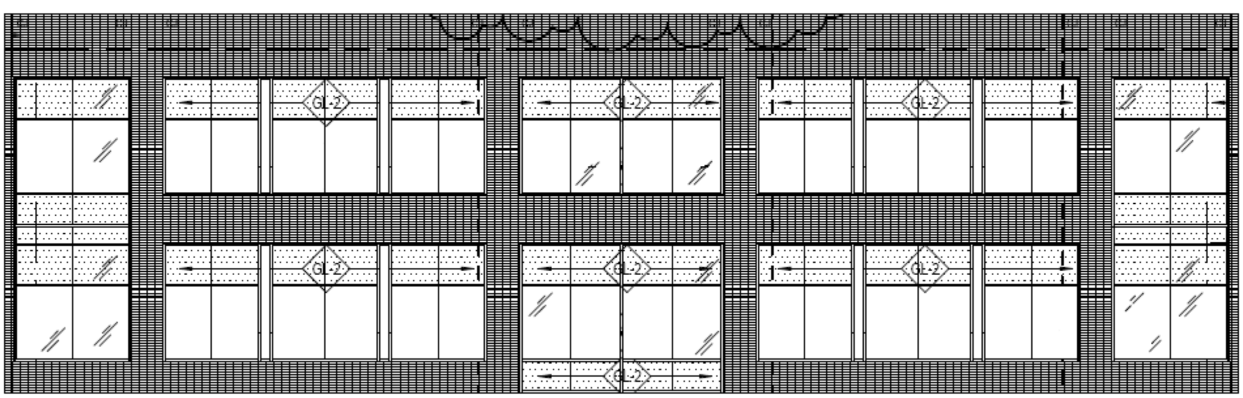


Figure 31: Western Facade Elevation

Due to their orientation, high amount of glazing, and lack of solar protection, all three façades contribute a significant solar heat load to the building significantly increasing the loads on the mechanical system.

One way to combat this high solar heat gain loading is through the addition of architectural overhangs. These solar shields will work to not only negate some of the building's high solar loading, but also add a spatial component to the facility's architecture. The original hypothesis is that adding a second floor overhand that extends six feet away from the building on all three exposed sides will be able to accomplish both these goals. Due to Houston's relative location compared to the equator, the sun often passes over the facility at a high solar angle. This means that a 6 foot overhang will be able to effectively shade large portions of the glazing throughout the year. This protrusion away from the building will also work to break up the box-like façade of the building by adding a horizontal component.

Architectural Shading Designs

The first architectural shading option modeled in this report is a simple, 6 foot, black extrusion composed of metal. This option is visually depicted in the below rendering.

Figure 32: Architectural Option #1: Black Metallic Shade (Southeast Corner)

Even though the rendering shows the entranceway overhang as having a white color scheme, in reality that overhang is actually solid black. The black architectural overhang located directly above the second story windows would do an excellent job of architecturally complimenting the already existing overhang while shading the glazing. The new overhang is also an appropriate size compared to the scale of the building.

Looking closer at the picture, one will notice how the overhang is actually casting a large enough shadow to protect the southern façade of the building from direct sunlight. This shading allows the glazing on that façade to function similar to north facing glass. North facing glass is the most energy efficient and should help increase the overall energy efficiency of the facility. It also helps the occupants by removing any uncomfortable glares originating from direct sunlight. This will allow the inhabitants to dim their electric lights and continue working using comfortable daylight. This reduction of electric lighting load will also increase the energy efficiency of the facility.

The pattern of the shadows also suggests that this rendering was produced during the morning hours when the sun is rising in the east. While the architectural overhang is able to partially shade the upper portion of the second level façade, the occupants of the lower level will still be forced to use their operable shades if they do not want to be exposed to direct sunlight. Unfortunately, the only way to combat this would be to extend the architectural overhang much further than six feet. This will both be very costly, and detract from the building's other architectural features.

For all the architectural shading option #1 images, please reference Appendix T.

The second option for the Fisk Corporate Headquarters project's architectural overhang is depicted in Figure 33, below.

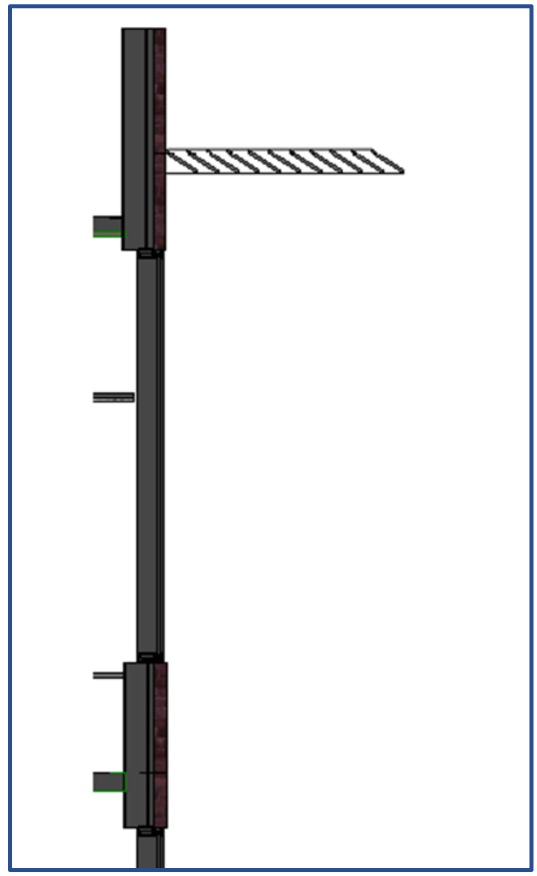
Figure 33: Architectural Option #2: Acrylic Translucent Shade (Southwest Corner)

This option is an overhang composed primarily of white, acrylic glazing. The glazing would function like a translucent overhang, allowing some indirect daylight to pass through the overhang while eliminating any direct rays from passing through. While this option does an excellent job of maximizing the amount of daylight in the spaces behind the facades, it does not produce the same energy savings as the first option due to the increased amount of solar heat that can pass through the translucent screen.

This view also offers an opportunity to notice the supports associated with all three overhang options. The grey circular columns located directly to the left of the vertical brick columns represent tubular steel columns that connect the architectural overhang directly to the ground. These supports allow the architectural overhangs to be isolated from the building's structure, effectively removing any additional structural loads that would otherwise need to be accounted for by the current structural system.

For all the architectural shading option #2 images, please reference Appendix U.

The last potential option for the Fisk Corporate Headquarters' architectural shading is comprised of metallic louvers spaced equidistant from one another as evidenced by the below figures.



Figures 34 (left) & 35 (right): Architectural Option #3: Metallic Louver Shades

The louvers are then angled in a manner that allows them to block sunlight penetration to the façade below as depicted by the section in Figure 35. As demonstrated by Figure 34, this option still does an adequate job of shading the façade below the overhang even though it is not a solid extrusion. The lines above and below the louvers in Figure 34 are representative of the metallic supports that would extend away from the building at the column locations to connect and support the louvers together. In between these supporting locations, the louvers will have nothing either above or below them.

Ultimately, this is the most elegant of the three solutions. It moves away from simply placing a solid extrusion along the eastern, southern, and western facades. The louvers effectively add a modern element to the building without detracting from any of the existing architectural elements.

For all the architectural shading option #3 images, please reference Appendix V.

After careful review, all three shading options are viable solutions as architectural overhangs for the Fisk Corporate Headquarters project. While each offers the building a unique architectural feature, they also come with various positives and negatives. However, by gauging the owner's preferences and available budget, a conclusion could be drawn as to which shading system fits best.

Energy Efficiency/Savings Results

Once the overhangs were designed, the next step in the quest for LEED Silver was to test how the overhangs affected the building's energy efficiency. This was accomplished through a façade simulation program called COMFEN which allows designers to simply model a face of their building like the model shown below.

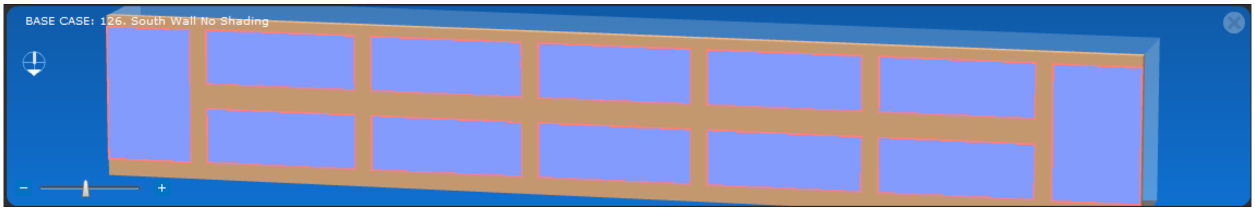


Figure 36: Southern Facade: No Shades Modeled

The models include both the brick and window elements of the façade along with the area of the first room off the façade. In the case of the Fisk Corporate Headquarters project, directly behind each of the three modeled facades are a row of offices that extend approximately 17 feet into the middle of the building. Once the original facades were modeled, they were simulated using a Houston weather file to provide insight as to the amount of energy being expended due to the facades.

After the three original facades were modeled, they were then remodeled in a manner that included the geometry of the shades. An example of this type of model can be seen in Figure 37, below.

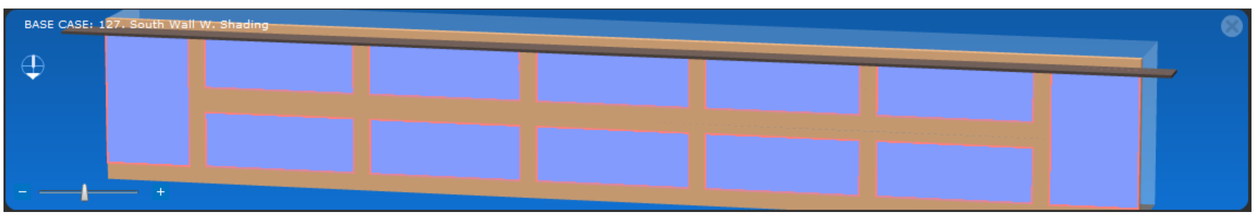


Figure 37: Southern Facade: Shades Modeled

After the shaded models were created, they were individually simulated. Once simulated, the results could be compared using COMFEN's software which produces charts like the one found below.

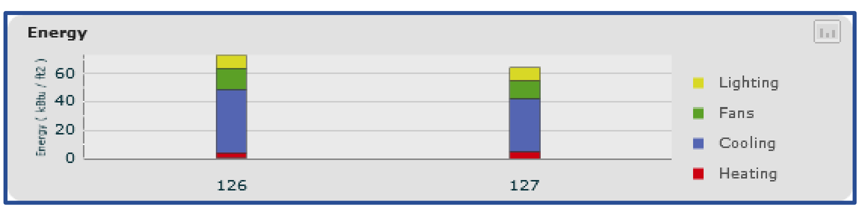


Figure: 38: Total Annual Energy in KBTU/ft^2 for Southern Wall

(Left: Without Shading**; Right:** With Shading)

The categories compared for the shade less and shaded facades include the total annual energy, peak electricity demand, and electric CO2 emissions. Each of these categories was compared using a graph similar to the one depicted in Figure 38.

The first façade tested in COMFEN was the building's eastern façade. A summary of the results is depicted in Table 15, below.

Table 15: Eastern Facade Energy Summary

Eastern Façade Energy Summary			
Category Description	Original	W/ Shades	Savings
Total Annual Energy (kBtu/ft^2)	98.3	86.4	11.9
Peak Electric Demand (W/ft^2)	13.3	11.7	1.6
CO2 Emissions Electric (lb/ft^2)	40.8	35.3	5.5

As evidenced by the above table, the eastern façade experienced significant savings in all three green, sustainable categories. A graph of the before and after total annual energy comparison is depicted in Figure 39.

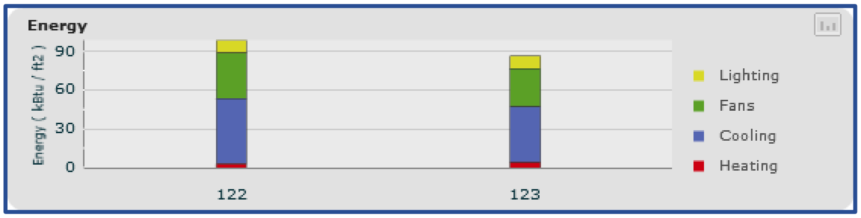


Figure 39: Eastern Façade Total Annual Energy Comparison in KBTU/ft^2

(Left: Without Shading**; Right:** With Shading)

The addition of the architectural shades resulted in an energy savings of 11.9 kBtu/ft^2 annually. This represents an annual energy reduction of 12.1% along the Fisk Corporate Headquarters' eastern façade. Considering the goal of this architectural breadth is to increase the energy efficiency by 4%, decreasing the amount of energy required to counteract solar loading along one wall by over 12% is a significant step toward accomplishing that goal.

The improvements to the required annual energy consumption due to the shading system also improved the façade in terms of peak electric demand and overall CO2 emissions. Both categories were reduced by over 12% and further prove the value of the shading system in terms of LEED and energy efficiency.

For the full version of the eastern façade energy comparison charts, please reference Appendix W.

After the eastern façade was compared, the southern façade simulations were analyzed to determine the effects the architectural shade had on building's energy efficiency. A summary of the findings are tabulated below.

Table 16: Southern Facade Energy Summary

Southern Façade Energy Summary			
Category Description	Original	W/ Shades	Savings
Total Annual Energy (kBtu/ft^2)	73.1	64.1	9.0
Peak Electric Demand (W/ft^2)	9.0	8.1	.9
CO2 Emissions Electric (lb/ft^2)	29.7	25.5	4.2

Due to the sun being at its highest location in the sky when it passes over the southern façade, the six foot overhang had the largest effect on the energy consumption in that location. The overall energy consumption was decreased by 9 kBtu/ft^2 annually which represents a decrease in 12.3% of the total energy in the spaces along the façade. However, the category which experienced the greatest savings compared to the other façades was the decrease in electric CO2 emissions. The CO2 comparison graph can be found below.

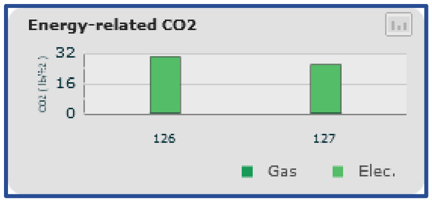


Figure 40: Southern Façade Energy Related Annual CO2 Emissions in lbs/ft^2

(Left: Without Shading**; Right:** With Shading)

The southern façade was able to realize a decrease in CO2 emissions of 14.1%. The next closest façade was only able to decrease its carbon footprint by 13.5%.

For the full version of the southern façade energy comparison charts, please reference Appendix X.

The last wall where shading was applied and tested was the Fisk Corporate Headquarters' western façade. Table 17 depicts a summary of the green savings the western façade would realize were the six foot architectural overhang included in the design.

Table 17: Western Facade Energy Summary

Western Façade Energy Summary			
Category Description	**Original**	**W/ Shades**	**Savings**
Total Annual Energy (kBtu/ft^2)	102.5	90.1	12.4
Peak Electric Demand (W/ft^2)	14.8	13.1	1.8
CO2 Emissions Electric (lb/ft^2)	42.4	36.7	5.7

Once again, the amount of savings due to the shades was significant. One area in which the western façade outperformed the other two was in its reduction of peak electric demand. Figure 41 depicts the 12.2%, or 1.8 W/ft^2, of peak demand reduction as a result of the shading application on the western façade.

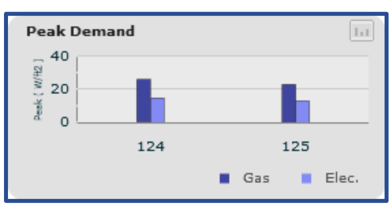


Figure 41: Western Façade Peak Demand in W/ft^2

(Left: Without Shading**; Right:** With Shading)

For the full version of the western façade energy comparison charts, please reference Appendix Y.

In conclusion, the addition of an architectural shade provided the Fisk Corporate Headquarters project with consistent annual energy, peak demand, and CO2 emissions across all three of the affected façades. The following graph depicts the percentage of savings of all three categories on all three different façades.

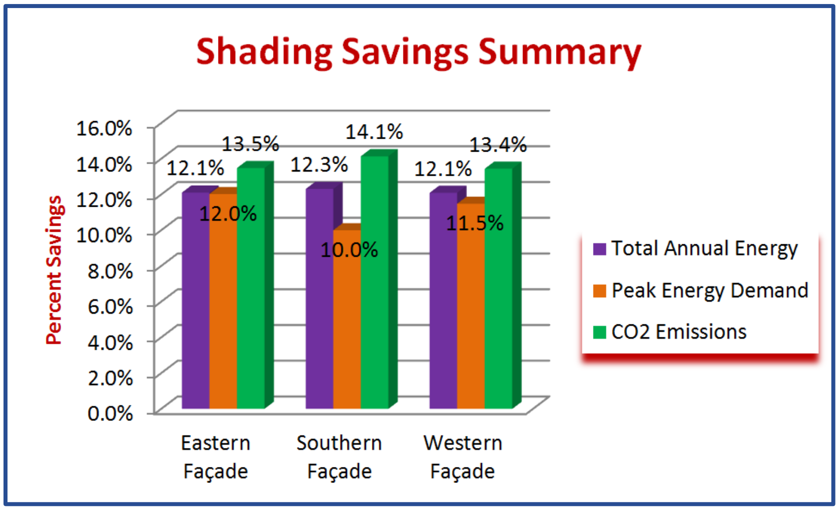


Figure 41: Architectural Shading Savings Summary Graph

On each façade, the architectural shade was able to reduce the total annual amount of energy required to combat the strong solar loads by just over 12%. While this reduction in energy does only apply to the three affected façades, it is important to remember that the climate, coupled with the large number of sunny days, in Houston accounts for a large amount the load placed on the building's mechanical system.

It is also worth noting that the ratio of simulated square footage affected by the shades to the remaining building square footage is 1:2 as depicted in Figure 42.

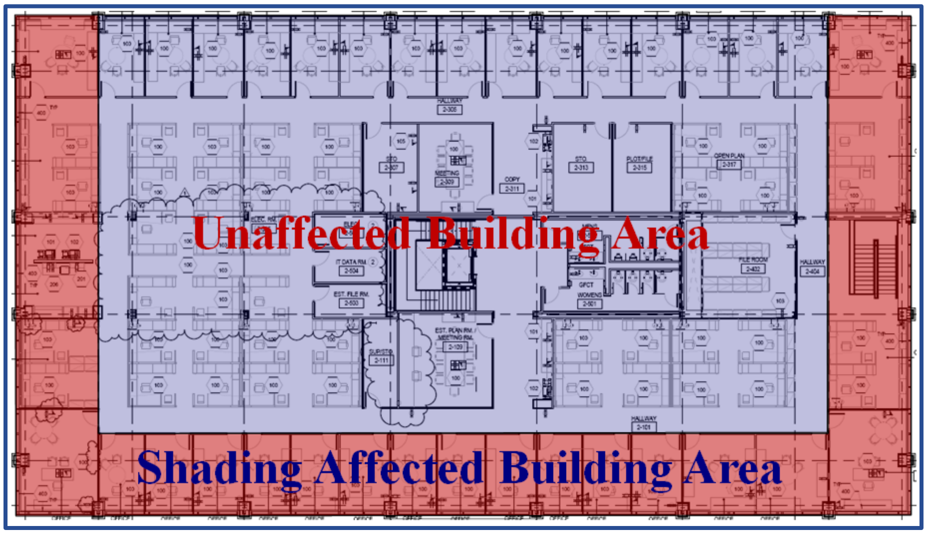


Figure 42: Architectural Overhang Affected Building Areas

This ratio of building areas accounted for in the simulation makes up 1/3 of the building's total square footage. If taken at face value, 1/3 of the total area multiple by a 12% energy reduction would reduce the total building energy consumption by 4%. A reduction in energy of 4% would grant Fisk Electric the additional 2 LEED points it needs to make a silver rating. In actuality, the high solar loads associated with the affected areas imply that the total reduction in annual energy would actually exceed 4%, making the addition of the architectural overhangs a potential solution to obtaining LEED Silver.

BIM Research

In Technical Report #2, one of the major constructability concerns highlighted on the Fisk Corporate Headquarters project was the installation of the building's façade system. In many cases, building façade issues typically stem from an overly complex design, a lack of communication, or a contractor simply installing one of the façade's components incorrectly.

The aforementioned architectural overhangs could add to the potential façade issues assumed on the Fisk Corporate Headquarters project. Even though the architectural overhangs are not designed to be reliant upon the façade for support, their location and purpose makes them a façade system element. Additional system elements not only increase the complexity of the design, but also increase the amount of field coordination required to install them.

One way to combat this increase in required coordination complexity is through the use of BIM. BIM, or Building Information Modeling, is the practice of using technology to communicate information between various team members or individuals. The type of technology can range from 3D coordination models to 4D sequencing models. BIM has been proven to reduce the number of field coordination issues, RFI's, and other communication concerns that often arise on jobsites. However, BIM does come with some drawbacks. Firstly, there is a cost associated with acquiring the various modes of technology. BIM software is very complex and quite often the cost to purchase and run the technology can be very extensive. Secondly, a learning curve exists between someone who has never used BIM and someone who can be considered fluent in the technology. The time it takes for someone to overcome this learning curve varies, and the training required costs companies both time and money. Lastly, once the BIM technology is in place, it becomes of paramount importance that companies continue to use the technology efficiently and effectively. If a company does not stay current with new, available technology or industry trends, it could quickly find itself being outperformed by its competitors.

In the case of the Fisk Corporate Headquarters project, both the original architectural and structural designs, along with the new architectural shading system, were originally designed in Revit. Revit is a three dimensional modeling program that allows designers to model their design in three dimensions. From there, designers are able to quickly produce 2 dimensional plans that they can pass on to the project team. An example of the Fisk Corporate Headquarters project's architectural model can be found below.

Figure 43: Fisk Corporate Headquarters Architectural Model - Provided by Gensler

Unfortunately, once the model was used for design purposes on the Fisk Corporate Headquarters project, it stopped having a purpose. The key members of the construction team did not use the model for coordination or sequencing and the facility was built in the traditional, two dimensional manner. However, because both the building and the shades were already designed in Revit, it would have been easy for the design team to hand the model over to the construction team to be used as a tool.

Once acquired, the construction team could then use the model to sequence and coordinate the various façade system components required for a complete installation. Working as a team, the construction trades could have communicated via the Revit model and pre-planned precisely how the building's façade would be constructed while incorporating the new architectural overhangs. This would make a seamless transition between the original construction plan, and the revamped plan that would include the addition of the overhangs. Because the new components were already modeled during the design phase, the contractors would not need to incur any costs modeling the overhangs for coordination.

The following case study was researched to determine whether applying BIM to the Fisk Corporate Headquarters project would have eliminated the façade construction difficulties that arose during the course of the project.

Case Study

After careful investigation of the complications and conversations with the project team, it was discerned that the primary reason for the façade construction difficulties stemmed from the unusual manner in which the façade was assembled. Typically when a brick with steel stud back-up façade is integrated with curtain wall glazing, the steel contractor will be the first entity to begin work on the façade wall. While he is installing the metal stud system, the steel contractor will simultaneously frame-out the glazing openings per the project documents. Once completed, the glazing contractor will then manufacture his glazing panes to fit within the framing created by the steel contractor. However, in the case of the Fisk Corporate Headquarters project, the schedule forced these two activities to occur simultaneously. Tutor Perini worked with Haley Greer, the glazing contractor, and Steel Masters, the steel erectors to agree upon what they called the "two dimensions." The "two dimensions" by definition were the heights and widths of the various curtain wall sections. Once these dimensions were agreed upon by the two contractors, they could go about their respective tasks independently of one another. Figure 44 depicts the two dimensions agreed upon by the two façade contractors.

Figure 44: Depiction of the "Two Dimensions"

In theory, the contractors should have been able to successfully work independently of one another and then interface their two façade systems together without any difficulty. The extensive pre-planning and agreement of the "two dimensions" should have negated any potential for field clashes. However, once the steel contractor framed-out the windows and the glazing was manufactured, it was quickly discovered that the two systems did not connect together appropriately. This led to extensive schedule delays that slowed the façade installation. Furthermore, back charges were implemented by various contractors to account for these delays.

Andy Graham Interview

The first step in determining whether or not BIM could have eliminated the field challenges was to contact Haley Greer's project manager. Haley Greer's glazing project manager on the Fisk Corporate Headquarters project was Andy Graham. Mr. Graham actually ran the project out of his Dallas office but he was intimately aware of the construction concerns that arose on the jobsite due to the façade construction complications.

According to Mr. Graham, the problems that arose on the Fisk Corporate Headquarters project stemmed more from steel erection labor mistakes than communication or coordination ones. He stated that these mistakes ended up resulting in Haley Greer receiving around $20,000 in back charges stemming from them being forced to not only wait on the framing to be fixed, but also being asked to rework their glazing to fit within the incorrectly shaped openings. The following excerpt from the interview demonstrates Mr. Graham's opinion on whether or not BIM could have been used to mitigate these issues.

Q: Do you have experience using BIM for coordination and do you believe that BIM could have been used to help mitigate the challenges that arose on the Fisk Corporate Headquarters project?

A: *Yes, I do have experience with BIM being used both successfully and unsuccessfully on various projects. However, I do not believe that BIM would have been able to solve the issues that arose on the Fisk project. The issue on the project stemmed from the steel contractor being forced to work within tight tolerances unsuccessfully. I do not believe that giving him the same tolerances in a model rather than a 2 dimensional drawing would have changed the result.*

Figure 45: Excerpt from Interview with Andy Graham

For the full Q&A with Andy Graham, please reference Appendix Z.

Based on Mr. Graham's professional opinion, BIM would not have been a good solution for the problems that arose on the Fisk Corporate Headquarters project. While it would have made it easy for the two contractors to receive their coordination information, it would not have eliminated the challenges that arose due to the steel erectors installing their framing incorrectly.

Phillip Smith Interview

To further enforce Mr. Graham's professional opinion, Phillip Smith, the manager of Fisk Electric's drafting department, was interviewed to try and price the cost to implement BIM on the Fisk Corporate Headquarters office. Mr. Smith worked on the project by laying-out and drawing the building's electrical system. In Mr. Smith's capacity as drafting manager for Fisk Electric, he has spent many hours detailing coordination models so that the information can be read and applied by Fisk's labor force. As such, the first question asked to Mr. Smith was if he could estimate approximately how many hours it would take for a draftsman to fully detail for construction all the window openings on the Fisk Corporate Headquarters project. The following excerpt from the interview illustrates his answer.

A: *If I had to guess how long it would take one technician to detail every single window, I would estimate it at roughly one month. One month might actually be a little bit more than he would actually need, but if I were being conservative I would guess a month.*

Figure 46: Excerpt from Interview with Phillip Smith

According to Mr. Smith, it would take a BIM technician roughly one month to fully detail all the Fisk Corporate Headquarters project's windows for construction. Assuming a month could contain 22 total working days, this would equate to 176 man hours. Multiplied by $30/hr. the cost of implementing BIM on the Fisk Corporate Headquarters project to help try and solve the window coordination challenges would have amounted to $5,280.

For the full Q&A with Phillip Smith, please reference Appendix AA.

Even though $5,280 is less than the $20,000 that were incurred due to back charges, it is important to remember that the underlying cause for the problems that arose was a worker tolerance deficiency, not a communication error. If the Fisk Corporate Headquarters project team had instituted a BIM plan to try to mitigate the window framing issues, they would have incurred an additional $5,280 in BIM costs. Unfortunately, the problems would not be resolved, and the $20,000 in back chargers would still be charged to the project.

This case study illustrates a situation in which BIM would not have been able to solve a coordination issue. However, it is believed that if the design team decided to adopt the proposed architectural overhangs into their design, that BIM would have been an excellent way to not only sell their idea to the owner, but also pass information to the construction team. The already modeled overhangs could easily be distributed to the project team. Once in their possession, they could use the model to plan the overhang's construction sequence. This would help make a seamless transition between the two designs and help negate coordination issues before they reached the field.

Recommendations

After careful review of the results of the LEED implementation analysis, it is the opinion of this report that the Fisk Corporate Headquarters project should have applied for a LEED rating of Certified at a minimum. Because the building's systems were already designed with LEED principles in place, the only additional costs required to achieve a LEED rating were construction based ones. These minor costs totaled $28,266, or 0.35% of the total cost of construction. When compared to the property tax incentives available in Harris County along with the potential business benefits an electrical contractor could realize by constructing a LEED facility, twenty-eight thousand dollars is a small sacrifice. If Fisk Electric did decide to apply for a LEED rating, this report would strongly advise them to also adopt one of the architectural overhangs designed in this analysis. This analysis proved that the overhangs would increase the energy efficiency of the facility which would allow the Fisk Corporate Headquarters project to gain at a minimum the two additional credits they would need to achieve LEED Silver. Achieving a LEED Silver rating would only bolster the incentives and benefits they would already be attaining by becoming Building Certified. Finally, the research into BIM showed that while BIM is a useful communication tool, it would not have been able to solve the façade installation problems that developed over the course of the project. However, if the project team decided to include the architectural overhangs in the building's design, BIM would have been an excellent way to not only design, but communicate the overhang's technical information to the construction team.

MAE Requirements

The integrated BAE/MAE requirements for this thesis report were met by integrating some of the topics and materials discussed in the masters' coursework into this report.

AE 598C: Sustainable Construction Project Management

The purpose of this course is to not only define sustainable construction and the benefits associated with building sustainably, but also study the methods in which sustainable practices are integrated into construction projects. One of the ways material from this class was included in this thesis report was through the study of the connection between government entities and building owners. Over the course of the semester, large quantities of time were spent discussing the best ways to educate and persuade building owners to adopt sustainable practices. Often times the class would agree that monetary incentives which are usually government regulated or energy bill reductions were the best way to encourage owners to implement sustainable practices. Because the Fisk Corporate Headquarters project already incorporated many of the sustainable design features associated with LEED projects, a study of the potential government regulated incentives was researched and documented to make a business case for applying for LEED Building Certification.

The second way AE 598C was incorporated into this thesis was by implementing energy management principles into the Fisk Corporate Headquarters project. After discussing how energy management can affect building performance, LEED credits, and a facility's public image, architectural overhangs were designed and studied in an attempt to take advantage of these potential benefits. Because the overhangs were designed with energy management in mind, they were able to increase Fisk Electric building's energy efficiency performance by over 4% and deliver a higher LEED project rating.

Final Recommendations

Throughout the 2012/2013 academic calendar year, the Fisk Corporate Headquarters project was studied and analyzed to target project challenges and propose alternative means and methods as solutions to those challenges. After careful investigation of the project, three major areas were targeted for improvement; the project's sequencing and schedule, the costly electrical distribution system, and the lack of LEED Building Certification. This report details the challenges associated with these areas, suggests solutions, and analyzes the solutions' implementation in the Fisk Corporate Headquarters project. While these areas were perceived as having opportunities for improvement, the purpose of this report is not to critique the project team. Rather, this report seeks to study their already efficient project plan for educational purposes.

Analysis #1: Project Sequencing Improvement

The first analysis attempted to reduce the overall project schedule duration by altering the original activity sequence. Because of Fisk Electric's unique relationship with the General Contractor, Fisk decided to carry the cost of general conditions themselves. As such, any reduction in the overall project schedule duration would result in direct savings incurred by Fisk Electric.

The proposed schedule re-sequencing in this report does not alter any of the building's systems, nor the already employed construction practices. It was able to shorten the project's construction schedule by 4 weeks, without hindering any worker productivity. In some cases, the re-sequencing would have actually improved worker efficiency by allowing trades to complete all their work at one time instead of having to mobilize multiple times unnecessarily. The total owner savings would amount to over $50,000 while exerting minimal effort. This report recommends that the potential savings, which equate to just less than 1% of the total construction costs, would represent an extremely positive investment if employed by the Fisk Electric ownership team.

Analysis #2: Detailed Analysis of Electrical System Redesign

The second analysis involved a redesign of the Fisk Corporate Headquarters' electrical distribution system in an attempt to reduce the system's construction costs. The redesign was successful in reducing the number of distribution components while still maintaining the integrity of the original system's design intent. It resulted in a cost savings of $11,669 and a schedule savings of just less than 4.5 days. Also, various electrical contracting professionals with over thirty years of experience in the industry were consulted in order to ensure the new system did not add any constructability concerns to the electrical distribution system. All the professionals interviewed maintained that the redesigned system would be as-easy if not easier to install than the original electrical distribution system. This report recommends that were the project not already complete, Fisk Electric should choose to adopt and implement the suggested redesign changes to their electrical distribution system.

Analysis #3: Implementation of LEED

The final major analysis sought to determine whether Fisk Electric should have applied for a LEED Building Certification on their new facility. Because the building's systems were already designed with LEED principles in place, the only additional costs required to achieve a LEED rating were construction based ones. These minor costs totaled $28,266, or 0.35% of the total cost of construction. When compared to the property tax incentives available in Harris County along with the potential business benefits an electrical contractor could realize by constructing a LEED facility, twenty-eight thousand dollars is a small price. If Fisk Electric did decide to apply for a LEED rating, this report would strongly advise them to also adopt one of the architectural overhangs designed in this analysis. This analysis proved that the overhangs would increase the energy efficiency of the facility which would allow the Fisk Corporate Headquarters project to gain at a minimum the two additional credits needed to achieve LEED Silver. Achieving a LEED Silver rating would bolster the incentives and benefits Fisk Electric would already be achieving by becoming Building Certified.

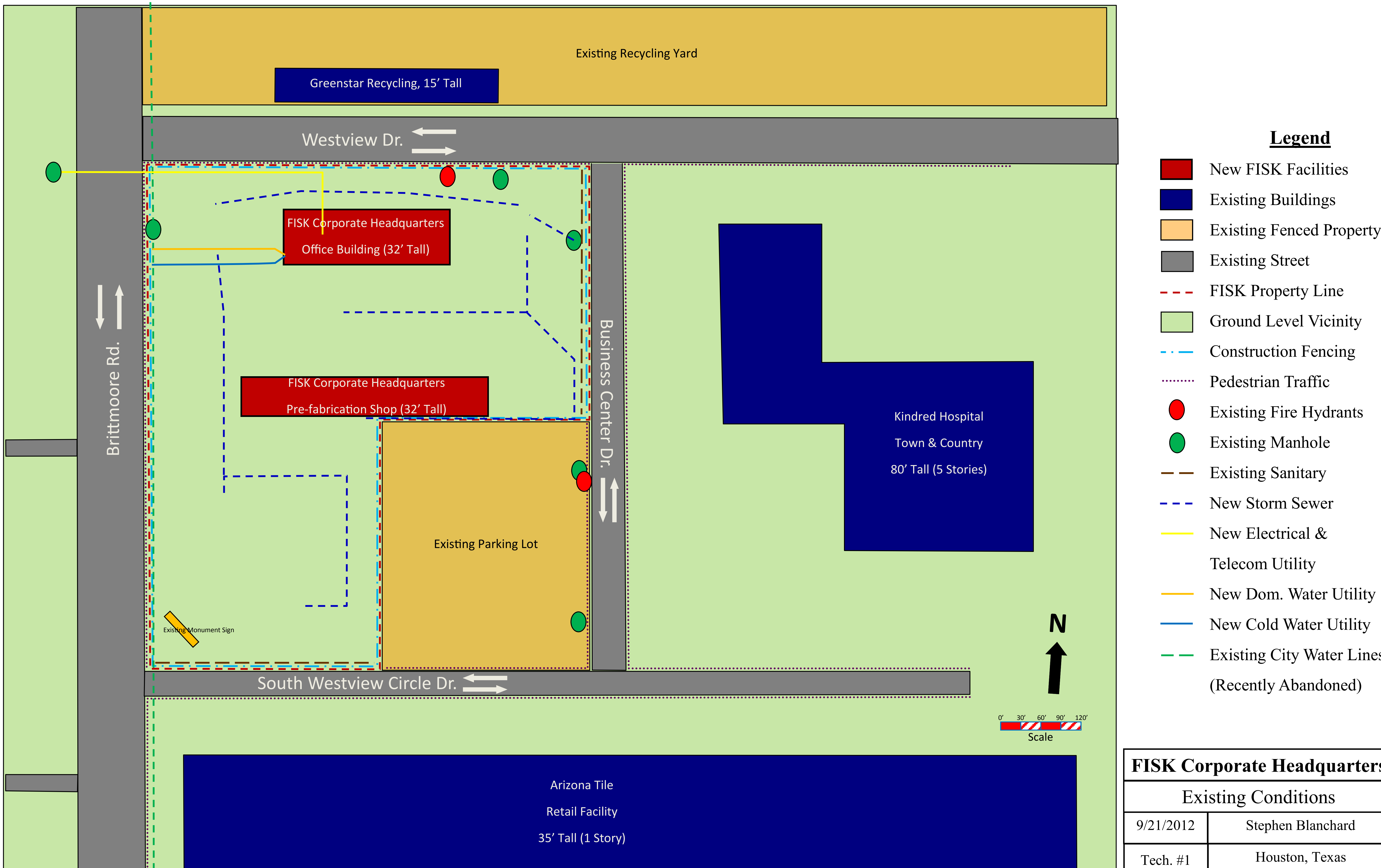
In addition to the LEED implementation analysis, research into BIM technologies was undertaken to determine if BIM could have mitigated some of the façade installation problems that developed over the course of the project. Unfortunately, it was ultimately determined that the issues did not arise from a lack of communication, but rather from an abnormality in typical worker tolerances. However, if the project team decided to include the architectural overhangs in the building's design, BIM would have been an excellent way to not only design, but communicate the overhang's technical information to the construction team.

Conclusion

In conclusion, it is recommended that all three of the proposed analyses be adopted by the project team on the Fisk Corporate Headquarters job. The cost savings from the first two analyses totaled $62,267. If the Fisk Electric ownership team elected to apply for a LEED rating it would cost $28,266. When subtracted from the first two analyses savings, it would result in a total project savings of $34,101 while also being able to boast a LEED building certification. Along with the total cost savings, the overall project schedule would be reduced by over 4 weeks if Fisk chose to implement the strategies depicted in this report. They also would achieve the many business benefits associated with owning and maintaining a LEED facility.

If Fisk did decide to adopt the major changes proposed in the three analyses, it is also recommended that they consider including an architectural overhang into the design that would increase the energy efficiency of the building. Using BIM as an effective design and communication tool would enable the project team to effectively improve the building's design, obtain a LEED Silver rating, and benefit from greater tax and business incentives.

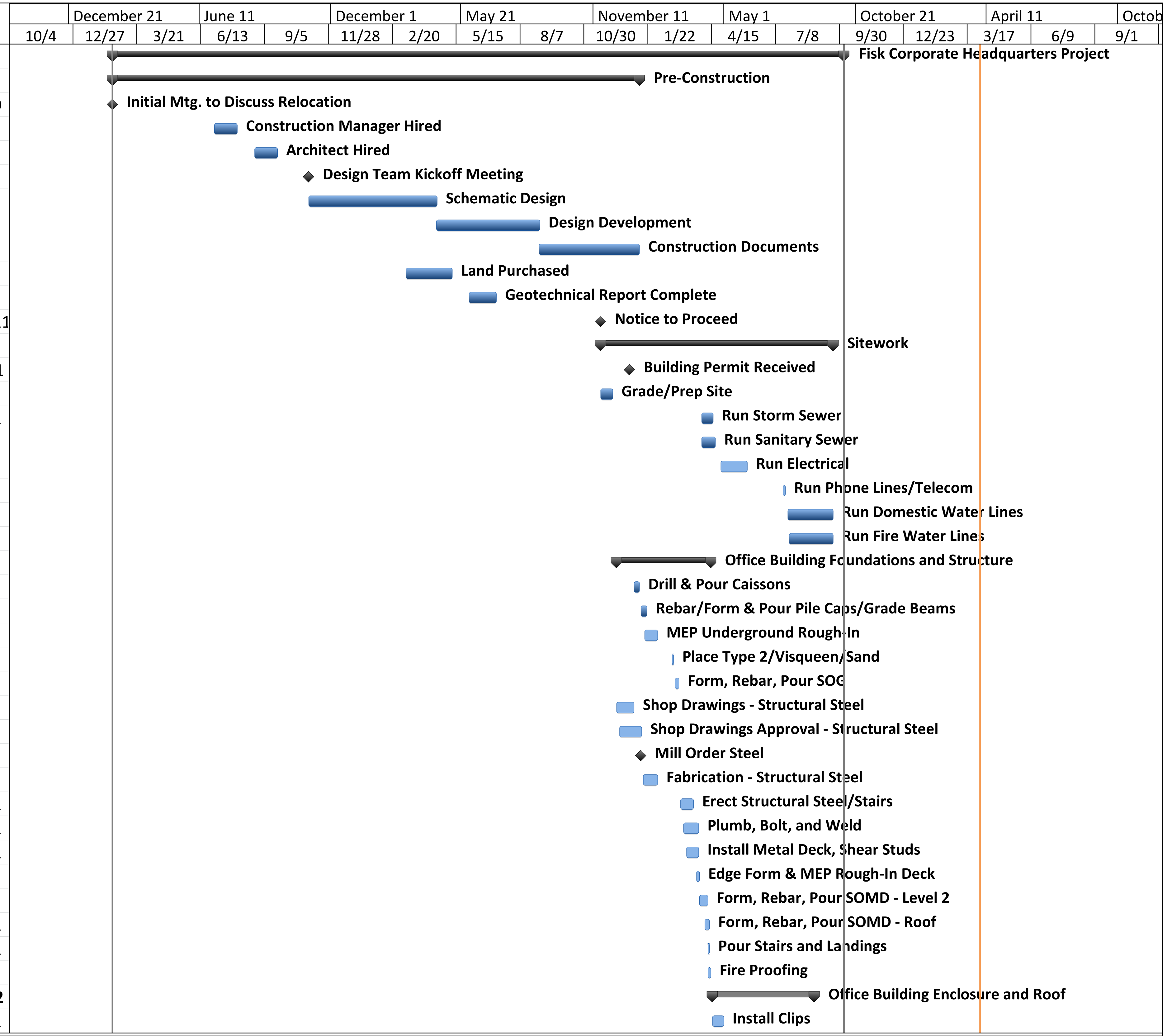
Appendix A: Existing Conditions Plan



FISK Corporate Headquarters	
Existing Conditions	
9/21/2012	Stephen Blanchard
Tech. #1	Houston, Texas

Appendix B: Original Detailed Project Schedule

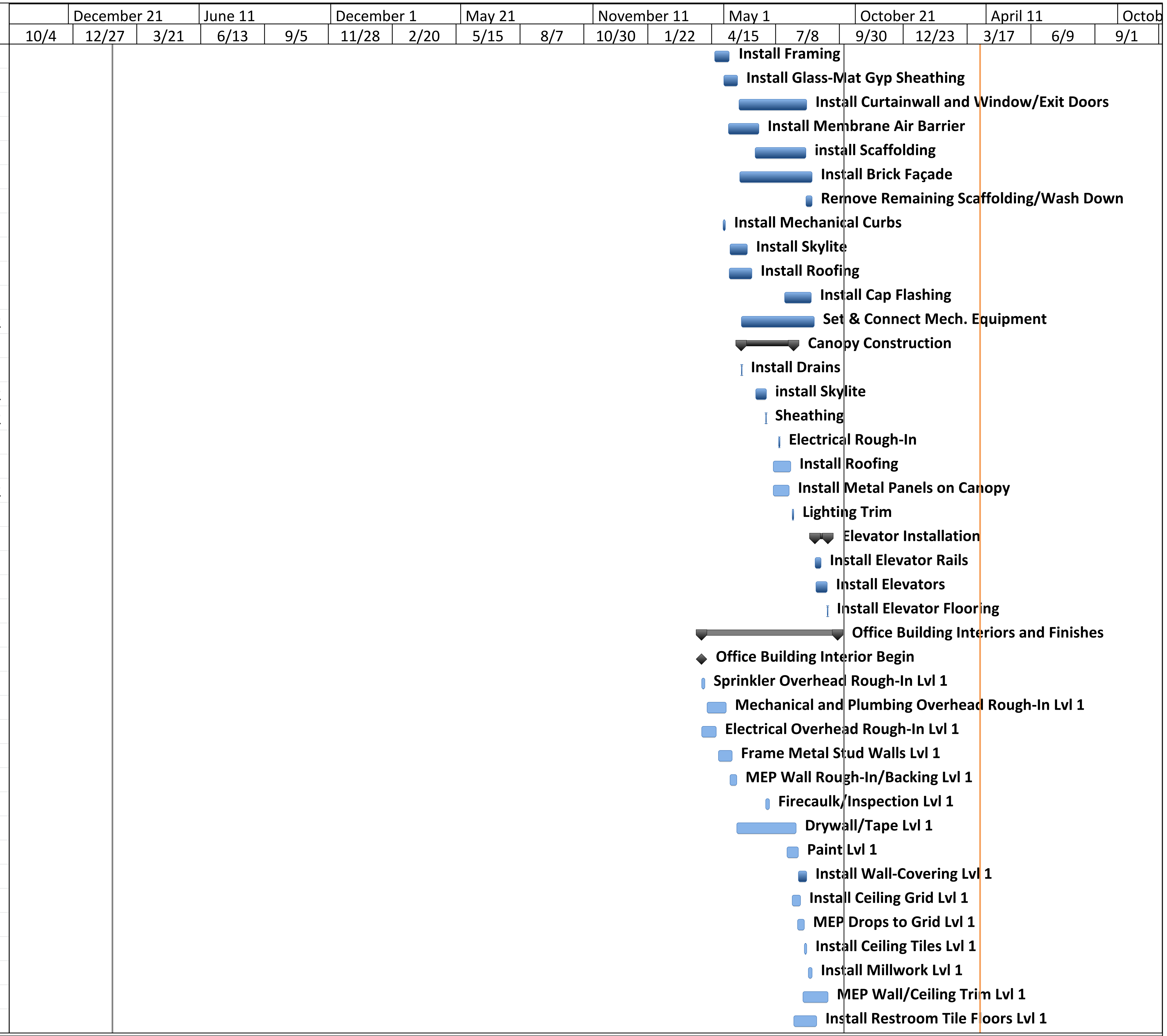
ID	Task Name	Duration	Start	Finish
1	**Fisk Corporate Headquarters Project**	**688 days**	**Wed 2/17/10**	**Fri 10/5/12**
2	**Pre-Construction**	**495 days**	**Wed 2/17/10**	**Tue 1/10/12**
3	Initial Mtg. to Discuss Relocation	0 days	Wed 2/17/10	Wed 2/17/10
4	Construction Manager Hired	22 days	Thu 7/1/10	Fri 7/30/10
5	Architect Hired	22 days	Mon 8/23/10	Tue 9/21/10
6	Design Team Kickoff Meeting	0 days	Tue 11/2/10	Tue 11/2/10
7	Schematic Design	121 days	Tue 11/2/10	Tue 4/19/11
8	Design Development	98 days	Tue 4/19/11	Thu 9/1/11
9	Construction Documents	94 days	Thu 9/1/11	Tue 1/10/12
10	Land Purchased	43 days	Thu 3/10/11	Mon 5/9/11
11	Geotechnical Report Complete	26 days	Wed 6/1/11	Wed 7/6/11
12	Notice to Proceed	0 days	Mon 11/21/11	Mon 11/21/11
13	**Sitework**	**220 days**	**Mon 11/21/1:**	**Fri 9/21/12**
14	Building Permit Received	0 days	Thu 12/29/11	Thu 12/29/11
15	Grade/Prep Site	12 days	Mon 11/21/11	Tue 12/6/11
16	Run Storm Sewer	11 days	Mon 4/2/12	Mon 4/16/12
17	Run Sanitary Sewer	14 days	Mon 4/2/12	Thu 4/19/12
18	Run Electrical	25 days	Fri 4/27/12	Thu 5/31/12
19	Run Phone Lines/Telecom	3 days	Wed 7/18/12	Fri 7/20/12
20	Run Domestic Water Lines	44 days	Tue 7/24/12	Fri 9/21/12
21	Run Fire Water Lines	42 days	Thu 7/26/12	Fri 9/21/12
22	**Office Building Foundations and Structure**	**90 days**	**Mon 12/12/1:**	**Fri 4/13/12**
23	Drill & Pour Caissons	5 days	Wed 1/4/12	Tue 1/10/12
24	Rebar/Form & Pour Pile Caps/Grade Beams	6 days	Fri 1/13/12	Fri 1/20/12
25	MEP Underground Rough-In	13 days	Wed 1/18/12	Fri 2/3/12
26	Place Type 2/Visqueen/Sand	2 days	Thu 2/23/12	Fri 2/24/12
27	Form, Rebar, Pour SOG	5 days	Mon 2/27/12	Fri 3/2/12
28	Shop Drawings - Structural Steel	17 days	Mon 12/12/11	Tue 1/3/12
29	Shop Drawings Approval - Structural Steel	21 days	Fri 12/16/11	Fri 1/13/12
30	Mill Order Steel	0 days	Fri 1/13/12	Fri 1/13/12
31	Fabrication - Structural Steel	15 days	Mon 1/16/12	Fri 2/3/12
32	Erect Structural Steel/Stairs	13 days	Mon 3/5/12	Wed 3/21/12
33	Plumb, Bolt, and Weld	14 days	Fri 3/9/12	Wed 3/28/12
34	Install Metal Deck, Shear Studs	12 days	Tue 3/13/12	Wed 3/28/12
35	Edge Form & MEP Rough-In Deck	4 days	Mon 3/26/12	Thu 3/29/12
36	Form, Rebar, Pour SOMD - Level 2	7 days	Fri 3/30/12	Mon 4/9/12
37	Form, Rebar, Pour SOMD - Roof	4 days	Fri 4/6/12	Wed 4/11/12
38	Pour Stairs and Landings	2 days	Tue 4/10/12	Wed 4/11/12
39	Fire Proofing	4 days	Tue 4/10/12	Fri 4/13/12
40	**Office Building Enclosure and Roof**	**96 days**	**Mon 4/16/12**	**Mon 8/27/12**
41	Install Clips	11 days	Mon 4/16/12	Mon 4/30/12



Project: Fisk Corporate Headquart
Date: Sun 2/10/13

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

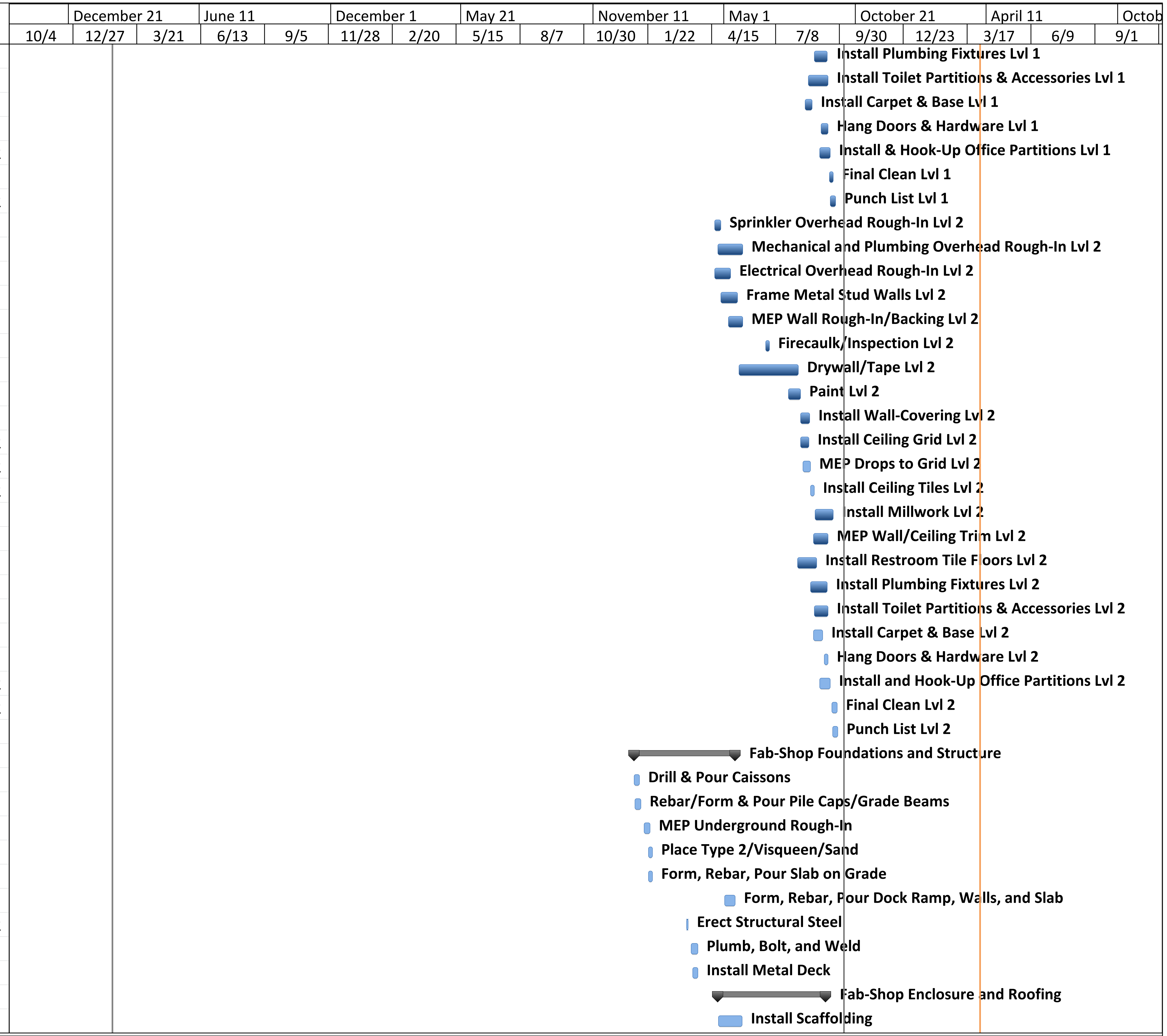
ID	Task Name	Duration	Start	Finish
42	Install Framing	13 days	Thu 4/19/12	Mon 5/7/12
43	Install Glass-Mat Gyp Sheathing	14 days	Tue 5/1/12	Fri 5/18/12
44	Install Curtainwall and Window/Exit Doors	65 days	Mon 5/21/12	Fri 8/17/12
45	Install Membrane Air Barrier	30 days	Mon 5/7/12	Fri 6/15/12
46	install Scaffolding	49 days	Mon 6/11/12	Thu 8/16/12
47	Install Brick Façade	69 days	Tue 5/22/12	Fri 8/24/12
48	Remove Remaining Scaffolding/Wash Down	6 days	Fri 8/17/12	Fri 8/24/12
49	Install Mechanical Curbs	3 days	Mon 4/30/12	Wed 5/2/12
50	Install Skylite	17 days	Wed 5/9/12	Thu 5/31/12
51	Install Roofing	22 days	Tue 5/8/12	Wed 6/6/12
52	Install Cap Flashing	25 days	Fri 7/20/12	Thu 8/23/12
53	Set & Connect Mech. Equipment	68 days	Thu 5/24/12	Mon 8/27/12
54	**Canopy Construction**	**49 days**	**Thu 5/24/12**	**Tue 7/31/12**
55	Install Drains	1 day	Thu 5/24/12	Thu 5/24/12
56	install Skylite	10 days	Tue 6/12/12	Mon 6/25/12
57	Sheathing	1 day	Mon 6/25/12	Mon 6/25/12
58	Electrical Rough-In	2 days	Thu 7/12/12	Fri 7/13/12
59	Install Roofing	17 days	Thu 7/5/12	Fri 7/27/12
60	Install Metal Panels on Canopy	15 days	Thu 7/5/12	Wed 7/25/12
61	Lighting Trim	2 days	Mon 7/30/12	Tue 7/31/12
62	**Elevator Installation**	**13 days**	**Wed 8/29/12**	**Fri 9/14/12**
63	Install Elevator Rails	6 days	Wed 8/29/12	Wed 9/5/12
64	Install Elevators	11 days	Thu 8/30/12	Thu 9/13/12
65	Install Elevator Flooring	1 day	Fri 9/14/12	Fri 9/14/12
66	**Office Building Interiors and Finishes**	**129 days**	**Mon 4/2/12**	**Thu 9/27/12**
67	Office Building Interior Begin	0 days	Mon 4/2/12	Mon 4/2/12
68	Sprinkler Overhead Rough-In Lvl 1	4 days	Mon 4/2/12	Thu 4/5/12
69	Mechanical and Plumbing Overhead Rough-In Lv	19 days	Mon 4/9/12	Thu 5/3/12
70	Electrical Overhead Rough-In Lvl 1	15 days	Mon 4/2/12	Fri 4/20/12
71	Frame Metal Stud Walls Lvl 1	14 days	Tue 4/24/12	Fri 5/11/12
72	MEP Wall Rough-In/Backing Lvl 1	7 days	Wed 5/9/12	Thu 5/17/12
73	Firecaulk/Inspection Lvl 1	5 days	Mon 6/25/12	Fri 6/29/12
74	Drywall/Tape Lvl 1	56 days	Fri 5/18/12	Fri 8/3/12
75	Paint Lvl 1	11 days	Mon 7/23/12	Mon 8/6/12
76	Install Wall-Covering Lvl 1	9 days	Tue 8/7/12	Fri 8/17/12
77	Install Ceiling Grid Lvl 1	9 days	Mon 7/30/12	Thu 8/9/12
78	MEP Drops to Grid Lvl 1	7 days	Mon 8/6/12	Tue 8/14/12
79	Install Ceiling Tiles Lvl 1	3 days	Wed 8/15/12	Fri 8/17/12
80	Install Millwork Lvl 1	5 days	Mon 8/20/12	Fri 8/24/12
81	MEP Wall/Ceiling Trim Lvl 1	25 days	Mon 8/13/12	Fri 9/14/12
82	Install Restroom Tile Floors Lvl 1	22 days	Wed 8/1/12	Thu 8/30/12



Project: Fisk Corporate Headquart
Date: Sun 2/10/13

Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Deadline	
Split		External Tasks		Inactive Summary		Manual Summary		Progress	
Milestone		External Milestone		Manual Task		Start-only			
Summary		Inactive Task		Duration-only		Finish-only			

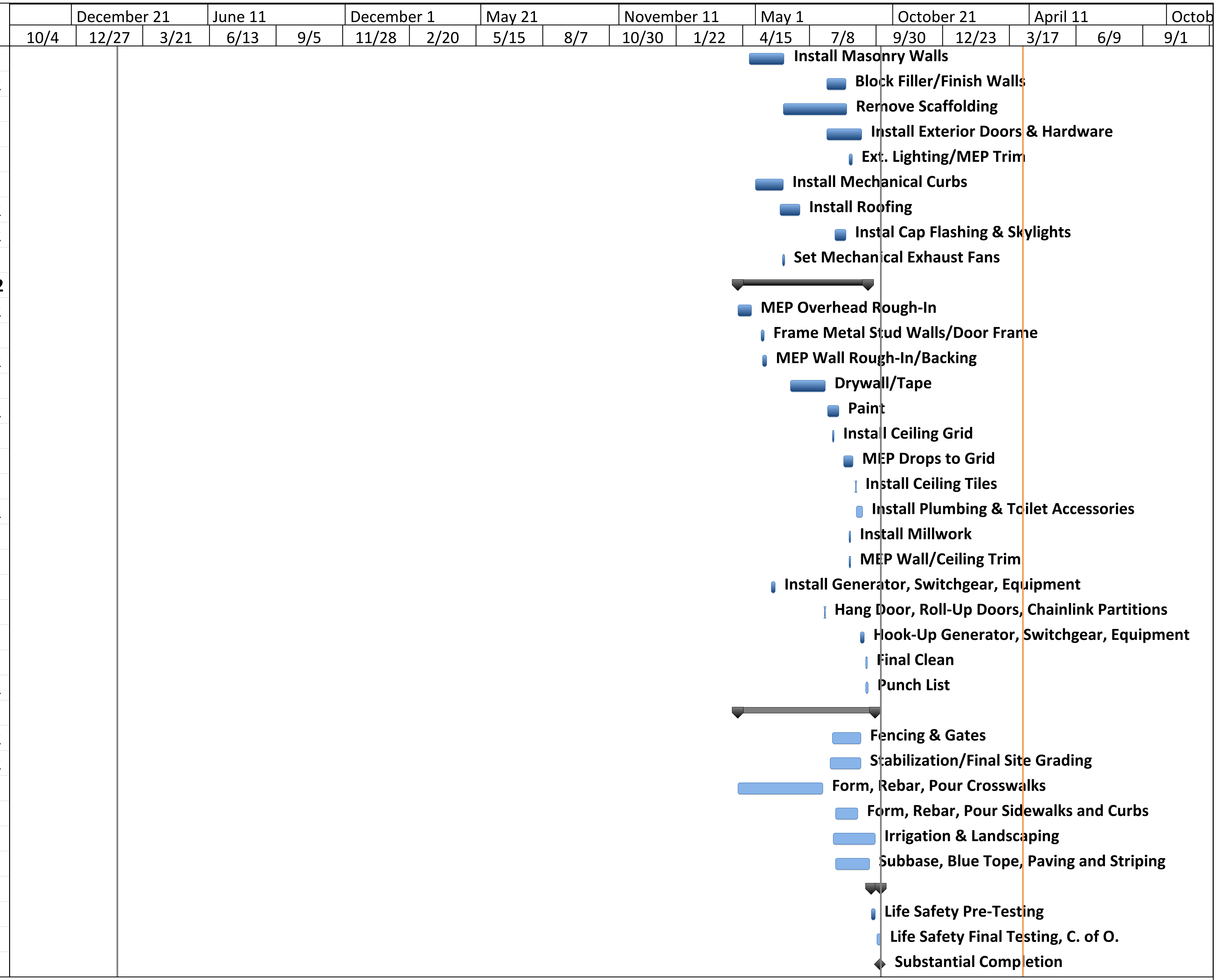
ID	Task Name	Duration	Start	Finish
83	Install Plumbing Fixtures Lvl 1	13 days	Tue 8/28/12	Thu 9/13/12
84	Install Toilet Partitions & Accessories Lvl 1	20 days	Mon 8/20/12	Fri 9/14/12
85	Install Carpet & Base Lvl 1	7 days	Thu 8/16/12	Fri 8/24/12
86	Hang Doors & Hardware Lvl 1	7 days	Thu 9/6/12	Fri 9/14/12
87	Install & Hook-Up Office Partitions Lvl 1	10 days	Tue 9/4/12	Mon 9/17/12
88	Final Clean Lvl 1	5 days	Mon 9/17/12	Fri 9/21/12
89	Punch List Lvl 1	5 days	Tue 9/18/12	Mon 9/24/12
90	Sprinkler Overhead Rough-In Lvl 2	6 days	Thu 4/19/12	Thu 4/26/12
91	Mechanical and Plumbing Overhead Rough-In L	25 days	Mon 4/23/12	Fri 5/25/12
92	Electrical Overhead Rough-In Lvl 2	15 days	Thu 4/19/12	Wed 5/9/12
93	Frame Metal Stud Walls Lvl 2	16 days	Fri 4/27/12	Fri 5/18/12
94	MEP Wall Rough-In/Backing Lvl 2	15 days	Mon 5/7/12	Fri 5/25/12
95	Firecaulk/Inspection Lvl 2	5 days	Mon 6/25/12	Fri 6/29/12
96	Drywall/Tape Lvl 2	56 days	Mon 5/21/12	Mon 8/6/12
97	Paint Lvl 2	12 days	Wed 7/25/12	Thu 8/9/12
98	Install Wall-Covering Lvl 2	8 days	Fri 8/10/12	Tue 8/21/12
99	Install Ceiling Grid Lvl 2	7 days	Fri 8/10/12	Mon 8/20/12
100	MEP Drops to Grid Lvl 2	8 days	Mon 8/13/12	Wed 8/22/12
101	Install Ceiling Tiles Lvl 2	3 days	Thu 8/23/12	Mon 8/27/12
102	Install Millwork Lvl 2	18 days	Wed 8/29/12	Fri 9/21/12
103	MEP Wall/Ceiling Trim Lvl 2	15 days	Mon 8/27/12	Fri 9/14/12
104	Install Restroom Tile Floors Lvl 2	19 days	Mon 8/6/12	Thu 8/30/12
105	Install Plumbing Fixtures Lvl 2	16 days	Thu 8/23/12	Thu 9/13/12
106	Install Toilet Partitions & Accessories Lvl 2	14 days	Tue 8/28/12	Fri 9/14/12
107	Install Carpet & Base Lvl 2	10 days	Mon 8/27/12	Fri 9/7/12
108	Hang Doors & Hardware Lvl 2	5 days	Mon 9/10/12	Fri 9/14/12
109	Install and Hook-Up Office Partitions Lvl 2	10 days	Tue 9/4/12	Mon 9/17/12
110	Final Clean Lvl 2	5 days	Thu 9/20/12	Wed 9/26/12
111	Punch List Lvl 2	5 days	Fri 9/21/12	Thu 9/27/12
112	**Fab-Shop Foundations and Structure**	**95 days**	**Wed 1/4/12**	**Tue 5/15/12**
113	Drill & Pour Caissons	5 days	Wed 1/4/12	Tue 1/10/12
114	Rebar/Form & Pour Pile Caps/Grade Beams	6 days	Thu 1/5/12	Thu 1/12/12
115	MEP Underground Rough-In	6 days	Tue 1/17/12	Tue 1/24/12
116	Place Type 2/Visqueen/Sand	5 days	Mon 1/23/12	Fri 1/27/12
117	Form, Rebar, Pour Slab on Grade	5 days	Mon 1/23/12	Fri 1/27/12
118	Form, Rebar, Pour Dock Ramp, Walls, and Slab	10 days	Wed 5/2/12	Tue 5/15/12
119	Erect Structural Steel	2 days	Tue 3/13/12	Wed 3/14/12
120	Plumb, Bolt, and Weld	7 days	Mon 3/19/12	Tue 3/27/12
121	Install Metal Deck	5 days	Wed 3/21/12	Tue 3/27/12
122	**Fab-Shop Enclosure and Roofing**	**102 days**	**Mon 4/23/12**	**Tue 9/11/12**
123	Install Scaffolding	23 days	Tue 4/24/12	Thu 5/24/12



Project: Fisk Corporate Headquart
Date: Sun 2/10/13

Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Deadline	
Split		External Tasks		Inactive Summary		Manual Summary		Progress	
Milestone		External Milestone		Manual Task		Start-only			
Summary		Inactive Task		Duration-only		Finish-only			

ID	Task Name	Duration	Start	Finish
124	Install Masonry Walls	32 days	Mon 4/23/12	Tue 6/5/12
125	Block Filler/Finish Walls	18 days	Mon 7/30/12	Wed 8/22/12
126	Remove Scaffolding	58 days	Tue 6/5/12	Thu 8/23/12
127	Install Exterior Doors & Hardware	32 days	Mon 7/30/12	Tue 9/11/12
128	Ext. Lighting/MEP Trim	4 days	Mon 8/27/12	Thu 8/30/12
129	Install Mechanical Curbs	25 days	Tue 5/1/12	Mon 6/4/12
130	Install Roofing	17 days	Fri 6/1/12	Mon 6/25/12
131	Instal Cap Flashing & Skylights	10 days	Thu 8/9/12	Wed 8/22/12
132	Set Mechanical Exhaust Fans	3 days	Mon 6/4/12	Wed 6/6/12
133	**Fab-Shop Interior**	**118 days**	**Mon 4/9/12**	**Wed 9/19/12**
134	MEP Overhead Rough-In	13 days	Mon 4/9/12	Wed 4/25/12
135	Frame Metal Stud Walls/Door Frame	4 days	Tue 5/8/12	Fri 5/11/12
136	MEP Wall Rough-In/Backing	3 days	Thu 5/10/12	Mon 5/14/12
137	Drywall/Tape	32 days	Thu 6/14/12	Fri 7/27/12
138	Paint	10 days	Tue 7/31/12	Mon 8/13/12
139	Install Ceiling Grid	2 days	Mon 8/6/12	Tue 8/7/12
140	MEP Drops to Grid	10 days	Mon 8/20/12	Fri 8/31/12
141	Install Ceiling Tiles	1 day	Tue 9/4/12	Tue 9/4/12
142	Install Plumbing & Toilet Accessories	6 days	Wed 9/5/12	Wed 9/12/12
143	Install Millwork	2 days	Mon 8/27/12	Tue 8/28/12
144	MEP Wall/Ceiling Trim	2 days	Mon 8/27/12	Tue 8/28/12
145	Install Generator, Switchgear, Equipment	5 days	Mon 5/21/12	Fri 5/25/12
146	Hang Door, Roll-Up Doors, Chainlink Partitions	1 day	Fri 7/27/12	Fri 7/27/12
147	Hook-Up Generator, Switchgear, Equipment	5 days	Mon 9/10/12	Fri 9/14/12
148	Final Clean	2 days	Mon 9/17/12	Tue 9/18/12
149	Punch List	3 days	Mon 9/17/12	Wed 9/19/12
150	**Landscape/Hardscape**	**125 days**	**Mon 4/9/12**	**Fri 9/28/12**
151	Fencing & Gates	26 days	Mon 8/6/12	Mon 9/10/12
152	Stabilization/Final Site Grading	27 days	Fri 8/3/12	Mon 9/10/12
153	Form, Rebar, Pour Crosswalks	77 days	Mon 4/9/12	Tue 7/24/12
154	Form, Rebar, Pour Sidewalks and Curbs	20 days	Fri 8/10/12	Thu 9/6/12
155	Irrigation & Landscaping	39 days	Tue 8/7/12	Fri 9/28/12
156	Subbase, Blue Tope, Paving and Striping	31 days	Fri 8/10/12	Fri 9/21/12
157	**Final Testing and Closeout**	**10 days**	**Mon 9/24/12**	**Fri 10/5/12**
158	Life Safety Pre-Testing	5 days	Mon 9/24/12	Fri 9/28/12
159	Life Safety Final Testing, C. of O.	5 days	Mon 10/1/12	Fri 10/5/12
160	Substantial Completion	0 days	Fri 10/5/12	Fri 10/5/12



Project: Fisk Corporate Headquart
Date: Sun 2/10/13

Task	Project Summary	Inactive Milestone	Manual Summary Rollup	Deadline
Split	External Tasks	Inactive Summary	Manual Summary	Progress
Milestone	External Milestone	Manual Task	Start-only	
Summary	Inactive Task	Duration-only	Finish-only	

Appendix C: Potential LEED Checklist

LEED 2009 for New Construction and Major Renovations

Project Checklist

Fisk Corporate Headquarters Project - Potential LEED Points

Sustainable Sites

Y	?	N			Possible Points: 26
8		18		**Sustainable Sites**	26
Y			Prereq 1	Construction Activity Pollution Prevention	
1			Credit 1	Site Selection	1
		5	Credit 2	Development Density and Community Connectivity	5
1			Credit 3	Brownfield Redevelopment	1
		6	Credit 4.1	Alternative Transportation—Public Transportation Access	6
1			Credit 4.2	Alternative Transportation—Bicycle Storage and Changing Rooms	1
		3	Credit 4.3	Alternative Transportation—Low-Emitting and Fuel-Efficient Vehicles	3
		2	Credit 4.4	Alternative Transportation—Parking Capacity	2
1			Credit 5.1	Site Development—Protect or Restore Habitat	1
1			Credit 5.2	Site Development—Maximize Open Space	1
1			Credit 6.1	Stormwater Design—Quantity Control	1
1			Credit 6.2	Stormwater Design—Quality Control	1
		1	Credit 7.1	Heat Island Effect—Non-roof	1
		1	Credit 7.2	Heat Island Effect—Roof	1
1			Credit 8	Light Pollution Reduction	1

Water Efficiency

Y	?	N			Possible Points: 10
4		6		**Water Efficiency**	10
Y			Prereq 1	Water Use Reduction—20% Reduction	
2		2	Credit 1	Water Efficient Landscaping	2 to 4
		2	Credit 2	Innovative Wastewater Technologies	2
2		2	Credit 3	Water Use Reduction	2 to 4

Energy and Atmosphere

Y	?	N			Possible Points: 35
14		21		**Energy and Atmosphere**	35
Y			Prereq 1	Fundamental Commissioning of Building Energy Systems	
Y			Prereq 2	Minimum Energy Performance	
Y			Prereq 3	Fundamental Refrigerant Management	
7		12	Credit 1	Optimize Energy Performance	1 to 19
		7	Credit 2	On-Site Renewable Energy	1 to 7
2			Credit 3	Enhanced Commissioning	2
2			Credit 4	Enhanced Refrigerant Management	2
3	?		Credit 5	Measurement and Verification	3
		2	Credit 6	Green Power	2

Materials and Resources

Y	?	N			Possible Points: 14
9		5		**Materials and Resources**	14
Y			Prereq 1	Storage and Collection of Recyclables	
		3	Credit 1.1	Building Reuse—Maintain Existing Walls, Floors, and Roof	1 to 3
		1	Credit 1.2	Building Reuse—Maintain 50% of Interior Non-Structural Elements	1
2			Credit 2	Construction Waste Management	1 to 2
2			Credit 3	Materials Reuse	1 to 2

Materials and Resources, Continued

Y	?	N			
2			Credit 4	Recycled Content	1 to 2
2			Credit 5	Regional Materials	1 to 2
		1	Credit 6	Rapidly Renewable Materials	1
1			Credit 7	Certified Wood	1

Indoor Environmental Quality

Y	?	N			Possible Points: 15
12		3		**Indoor Environmental Quality**	15
Y			Prereq 1	Minimum Indoor Air Quality Performance	
Y			Prereq 2	Environmental Tobacco Smoke (ETS) Control	
1			Credit 1	Outdoor Air Delivery Monitoring	1
1			Credit 2	Increased Ventilation	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 and Sealants	1
1			Credit 4.2	Low-Emitting Materials—Paints and Coatings	1
1			Credit 4.3	Low-Emitting Materials—Flooring Systems	1
1			Credit 4.4	Low-Emitting Materials—Composite Wood and Agrifiber Products	1
		1	Credit 5	Indoor Chemical and Pollutant Source Control	1
1			Credit 6.1	Controllability of Systems—Lighting	1
		1	Credit 6.2	Controllability of Systems—Thermal Comfort	1
1			Credit 7.1	Thermal Comfort—Design	1
1			Credit 7.2	Thermal Comfort—Verification	1
1			Credit 8.1	Daylight and Views—Daylight	1
		1	Credit 8.2	Daylight and Views—Views	1

Innovation and Design Process

Y	?	N			Possible Points: 6
1		5		**Innovation and Design Process**	6
		1	Credit 1.1	Innovation in Design: Specific Title	1
		1	Credit 1.2	Innovation in Design: Specific Title	1
		1	Credit 1.3	Innovation in Design: Specific Title	1
		1	Credit 1.4	Innovation in Design: Specific Title	1
		1	Credit 1.5	Innovation in Design: Specific Title	1
1			Credit 2	LEED Accredited Professional	1

Regional Priority Credits

Y	?	N			Possible Points: 4
		4		**Regional Priority Credits**	4
		1	Credit 1.1	Regional Priority: Specific Credit	1
		1	Credit 1.2	Regional Priority: Specific Credit	1
		1	Credit 1.3	Regional Priority: Specific Credit	1
		1	Credit 1.4	Regional Priority: Specific Credit	1

Total

Y	?	N		Possible Points: 110
48		62	**Total**	110

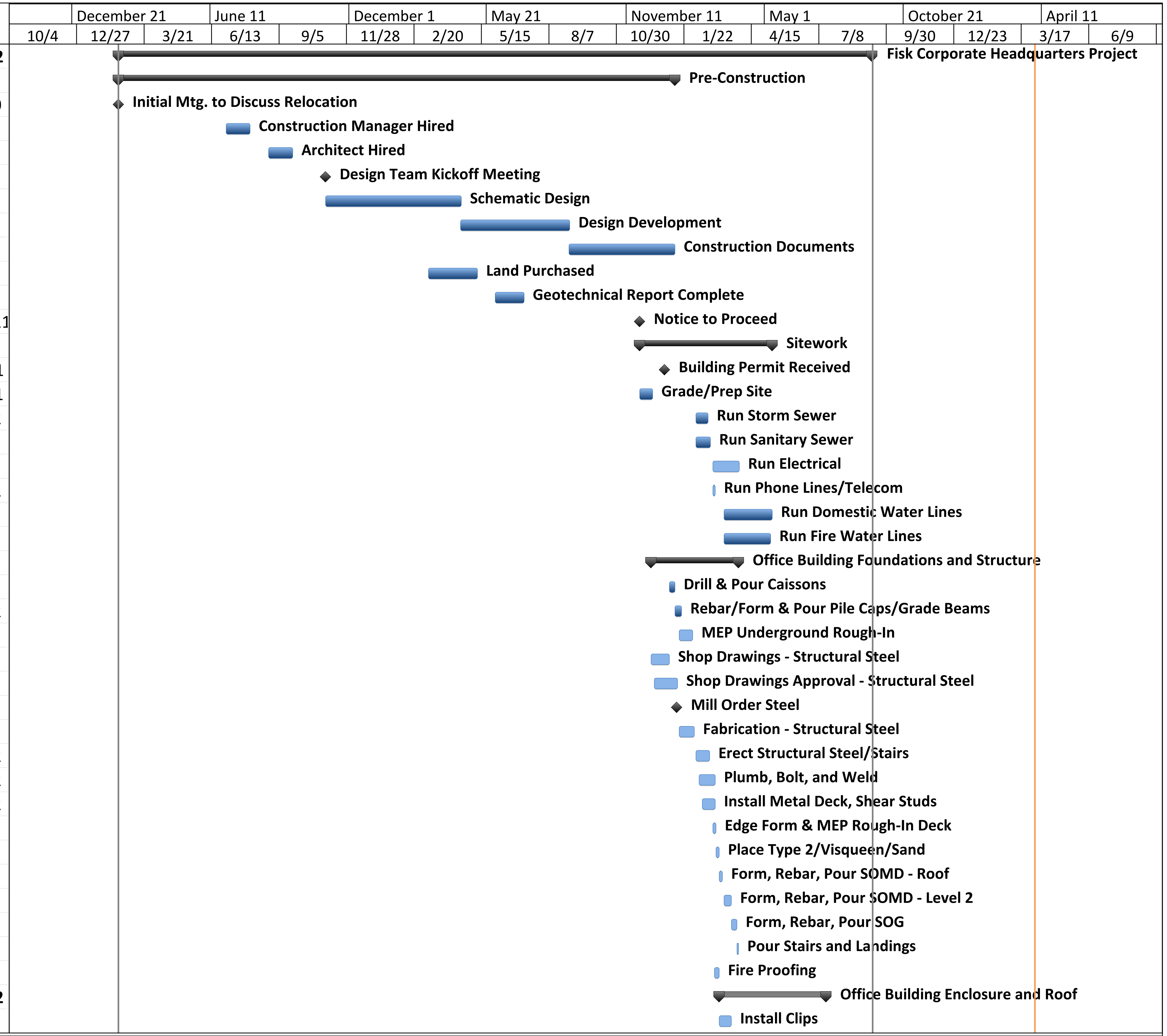
Certified 40 to 49 points   Silver 50 to 59 points   Gold 60 to 79 points   Platinum 80 to 110

Appendix D: Original General Conditions Estimate

General Conditions Estimate				
Description	**Quantity**	**Unit**	**Cost/Unit**	**Total $**
Preconstruction Services	1	LS	$90,000	$90,000
Project Manager	47	Wks	$3,100	$145,700
Project Manager	47	Wks	$2,625	$123,375
Superintendent	47	Wks	$2,250	$105,750
Laborer/Flagger	47	Wks	$1,375	$64,625
Timekeeper	47	Wks	$1,150	$54,050
CPM Scheduling	7,276,510	Job	2%	$145,530
Permit	1	LS	$38799	$38,799
Jobsite Trailer	11	Mo	$627.81	$6,906
Temporary Storage	11	Mo	$93.15	$1,025
Office Equipment	11	Mo	$272.33	$2,996
Small Tools	7,276,510	Job	.05%	$3,638
Temporary Fencing	1985	L.F.	$4.57	$9,071
Project Drawings	1	LS	$5,000	$5,000
Continuous Clean	47	Wks	$570	$26,790
Final Cleaning	1	LS	$15,000	$15,000
Waste Removal	47	Wks	$375	$17,625
Job Signs	70	S.F	$33.69	$2,358
Temporary Power	11	Mo	$1,000	$11,000
Temporary Water	11	Mo	$1,000	$11,000
Equip. Insurance/Repairs	11	Mo	$1,000	$11,000
Testing	1	Job	$4,072.95	$4,073
Drug Testing	40	EA	$100	$4,000
Job Photos	4	Set	$525.23	$2,101
Temporary Toilets	11	Mo	$900	$9,900
Fire Marshall Inspection	5	EA	$250	$1,250
Survey	4	Day	$492.09	$1,968
Safety Supplies	11	Mo	$24.28	$267
Liability Insurance	7,276,510	Job	2.02%	$146,986
Builder's Risk	7,276,510	LS	0.24%	$17,464
Subcontractor Bonds	7,276,510	LS	0.60%	$43,659
Grand Total				**$1,122,906**

Appendix E: Revised Detailed Project Schedule

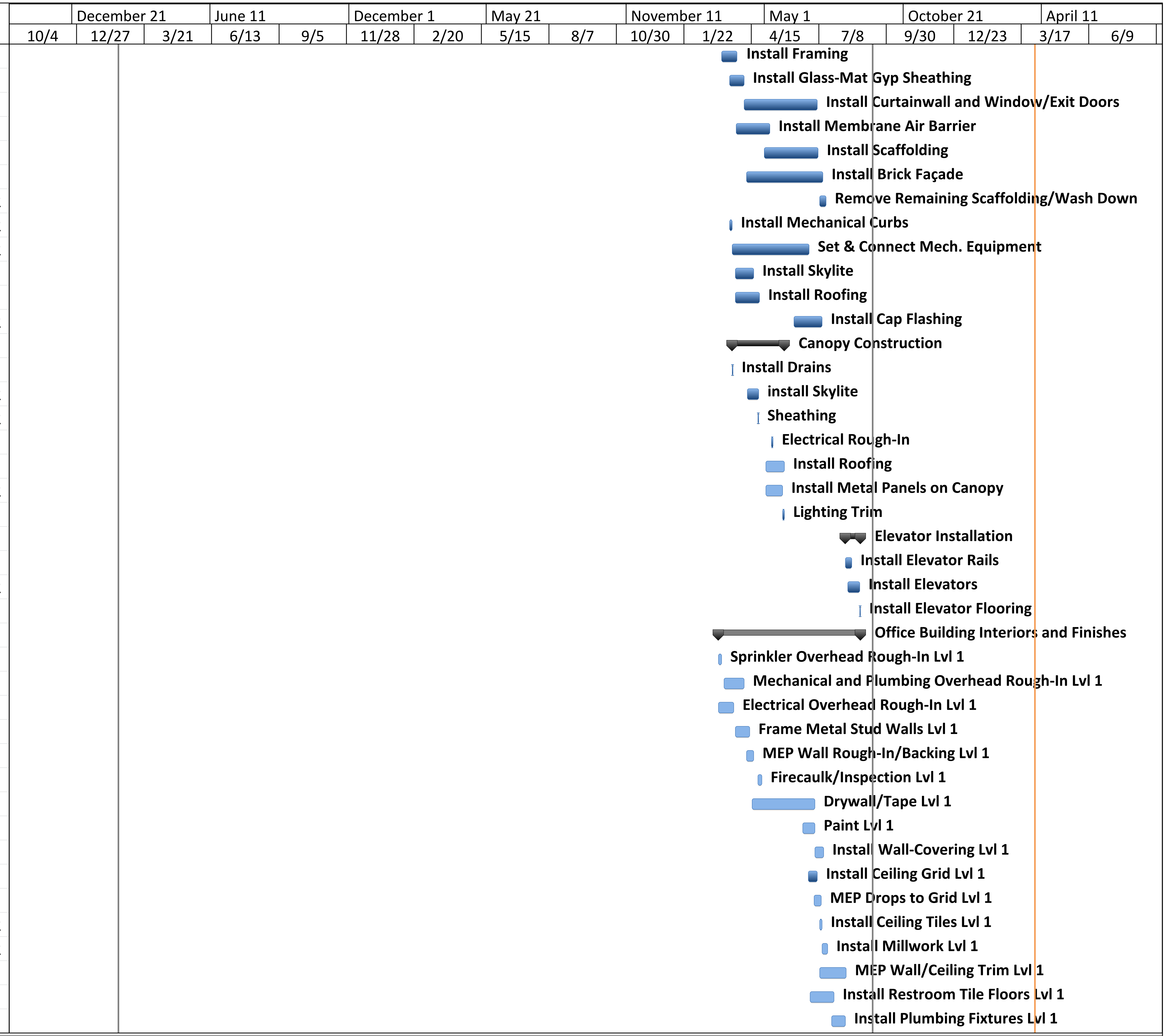
ID	Task Name	Duration	Start	Finish
1	**Fisk Corporate Headquarters Project**	**670 days**	**Wed 2/17/10**	**Wed 9/12/12**
2	**Pre-Construction**	**495 days**	**Wed 2/17/10**	**Tue 1/10/12**
3	Initial Mtg. to Discuss Relocation	0 days	Wed 2/17/10	Wed 2/17/10
4	Construction Manager Hired	22 days	Thu 7/1/10	Fri 7/30/10
5	Architect Hired	22 days	Mon 8/23/10	Tue 9/21/10
6	Design Team Kickoff Meeting	0 days	Tue 11/2/10	Tue 11/2/10
7	Schematic Design	121 days	Tue 11/2/10	Tue 4/19/11
8	Design Development	98 days	Tue 4/19/11	Thu 9/1/11
9	Construction Documents	94 days	Thu 9/1/11	Tue 1/10/12
10	Land Purchased	43 days	Thu 3/10/11	Mon 5/9/11
11	Geotechnical Report Complete	26 days	Wed 6/1/11	Wed 7/6/11
12	Notice to Proceed	0 days	Mon 11/28/11	Mon 11/28/11
13	**Sitework**	**119 days**	**Mon 11/28/1**	**Thu 5/10/12**
14	Building Permit Received	0 days	Thu 12/29/11	Thu 12/29/11
15	Grade/Prep Site	12 days	Mon 11/28/11	Tue 12/13/11
16	Run Storm Sewer	11 days	Mon 2/6/12	Mon 2/20/12
17	Run Sanitary Sewer	14 days	Mon 2/6/12	Thu 2/23/12
18	Run Electrical	25 days	Mon 2/27/12	Fri 3/30/12
19	Run Phone Lines/Telecom	3 days	Mon 2/27/12	Wed 2/29/12
20	Run Domestic Water Lines	44 days	Mon 3/12/12	Thu 5/10/12
21	Run Fire Water Lines	42 days	Mon 3/12/12	Tue 5/8/12
22	**Office Building Foundations and Structure**	**79 days**	**Mon 12/12/1**	**Thu 3/29/12**
23	Drill & Pour Caissons	5 days	Wed 1/4/12	Tue 1/10/12
24	Rebar/Form & Pour Pile Caps/Grade Beams	6 days	Wed 1/11/12	Wed 1/18/12
25	MEP Underground Rough-In	13 days	Mon 1/16/12	Wed 2/1/12
26	Shop Drawings - Structural Steel	17 days	Mon 12/12/11	Tue 1/3/12
27	Shop Drawings Approval - Structural Steel	21 days	Fri 12/16/11	Fri 1/13/12
28	Mill Order Steel	0 days	Fri 1/13/12	Fri 1/13/12
29	Fabrication - Structural Steel	15 days	Mon 1/16/12	Fri 2/3/12
30	Erect Structural Steel/Stairs	13 days	Mon 2/6/12	Wed 2/22/12
31	Plumb, Bolt, and Weld	14 days	Fri 2/10/12	Wed 2/29/12
32	Install Metal Deck, Shear Studs	12 days	Tue 2/14/12	Wed 2/29/12
33	Edge Form & MEP Rough-In Deck	4 days	Mon 2/27/12	Thu 3/1/12
34	Place Type 2/Visqueen/Sand	2 days	Fri 3/2/12	Mon 3/5/12
35	Form, Rebar, Pour SOMD - Roof	4 days	Tue 3/6/12	Fri 3/9/12
36	Form, Rebar, Pour SOMD - Level 2	7 days	Mon 3/12/12	Tue 3/20/12
37	Form, Rebar, Pour SOG	5 days	Wed 3/21/12	Tue 3/27/12
38	Pour Stairs and Landings	2 days	Wed 3/28/12	Thu 3/29/12
39	Fire Proofing	4 days	Wed 2/29/12	Mon 3/5/12
40	**Office Building Enclosure and Roof**	**95 days**	**Tue 3/6/12**	**Mon 7/16/12**
41	Install Clips	11 days	Tue 3/6/12	Tue 3/20/12



Project: Fisk Corporate Headquart
Date: Sat 2/23/13

Task | Project Summary | Inactive Milestone | Manual Summary Rollup | Deadline
Split | External Tasks | Inactive Summary | Manual Summary | Progress
Milestone | External Milestone | Manual Task | Start-only
Summary | Inactive Task | Duration-only | Finish-only

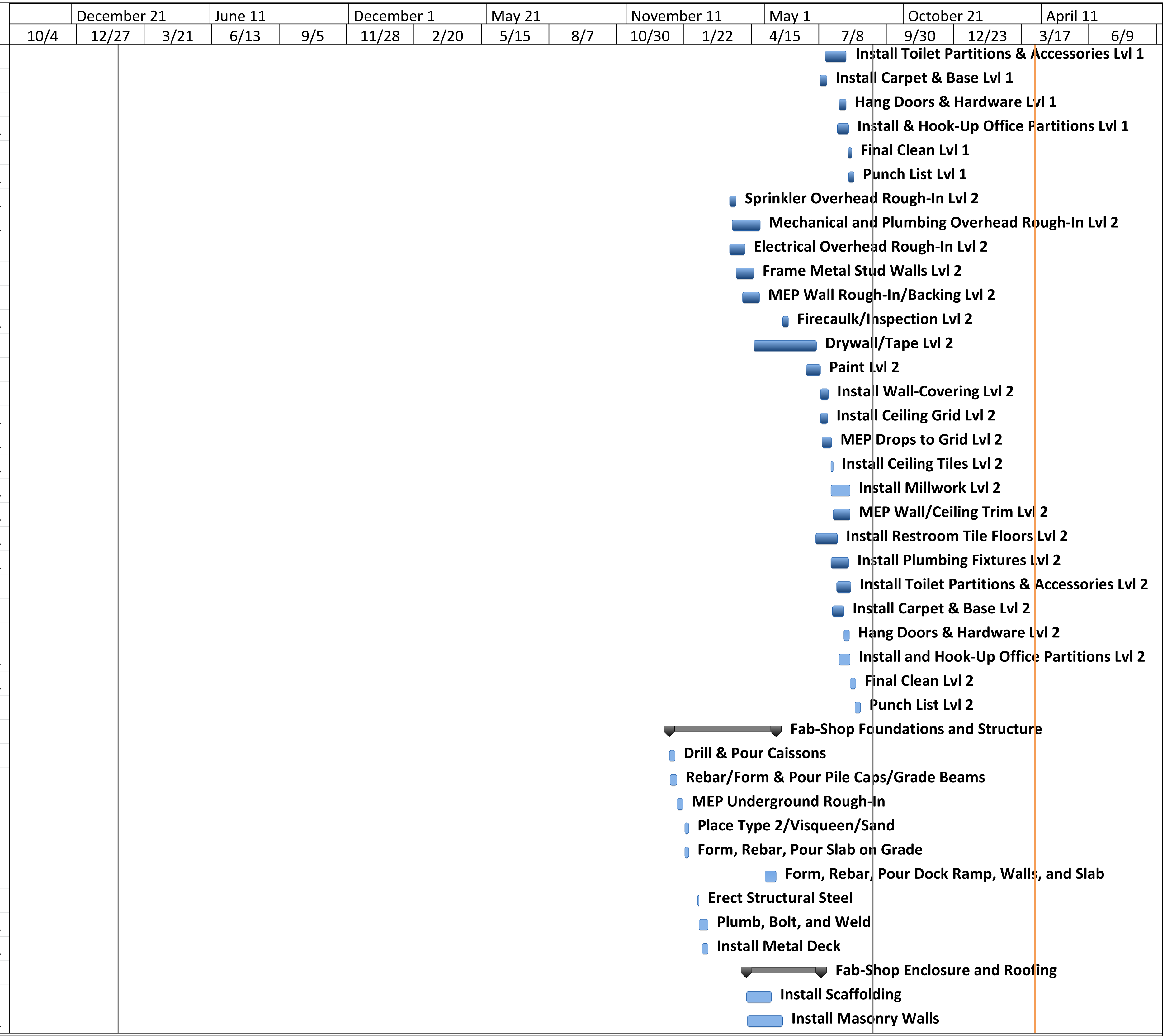
ID	Task Name	Duration	Start	Finish
42	Install Framing	13 days	Fri 3/9/12	Tue 3/27/12
43	Install Glass-Mat Gyp Sheathing	14 days	Mon 3/19/12	Thu 4/5/12
44	Install Curtainwall and Window/Exit Doors	65 days	Fri 4/6/12	Thu 7/5/12
45	Install Membrane Air Barrier	30 days	Tue 3/27/12	Mon 5/7/12
46	Install Scaffolding	49 days	Tue 5/1/12	Fri 7/6/12
47	Install Brick Façade	69 days	Mon 4/9/12	Thu 7/12/12
48	Remove Remaining Scaffolding/Wash Down	6 days	Mon 7/9/12	Mon 7/16/12
49	Install Mechanical Curbs	3 days	Mon 3/19/12	Wed 3/21/12
50	Set & Connect Mech. Equipment	68 days	Thu 3/22/12	Mon 6/25/12
51	Install Skylite	17 days	Mon 3/26/12	Tue 4/17/12
52	Install Roofing	22 days	Mon 3/26/12	Tue 4/24/12
53	Install Cap Flashing	25 days	Thu 6/7/12	Wed 7/11/12
54	**Canopy Construction**	**47 days**	**Thu 3/22/12**	**Fri 5/25/12**
55	Install Drains	1 day	Thu 3/22/12	Thu 3/22/12
56	install Skylite	10 days	Tue 4/10/12	Mon 4/23/12
57	Sheathing	1 day	Mon 4/23/12	Mon 4/23/12
58	Electrical Rough-In	2 days	Thu 5/10/12	Fri 5/11/12
59	Install Roofing	17 days	Thu 5/3/12	Fri 5/25/12
60	Install Metal Panels on Canopy	15 days	Thu 5/3/12	Wed 5/23/12
61	Lighting Trim	2 days	Thu 5/24/12	Fri 5/25/12
62	**Elevator Installation**	**13 days**	**Fri 8/10/12**	**Tue 8/28/12**
63	Install Elevator Rails	6 days	Fri 8/10/12	Fri 8/17/12
64	Install Elevators	11 days	Mon 8/13/12	Mon 8/27/12
65	Install Elevator Flooring	1 day	Tue 8/28/12	Tue 8/28/12
66	**Office Building Interiors and Finishes**	**127 days**	**Mon 3/5/12**	**Tue 8/28/12**
67	Sprinkler Overhead Rough-In Lvl 1	4 days	Mon 3/5/12	Thu 3/8/12
68	Mechanical and Plumbing Overhead Rough-In L	19 days	Mon 3/12/12	Thu 4/5/12
69	Electrical Overhead Rough-In Lvl 1	15 days	Mon 3/5/12	Fri 3/23/12
70	Frame Metal Stud Walls Lvl 1	14 days	Mon 3/26/12	Thu 4/12/12
71	MEP Wall Rough-In/Backing Lvl 1	7 days	Mon 4/9/12	Tue 4/17/12
72	Firecaulk/Inspection Lvl 1	5 days	Mon 4/23/12	Fri 4/27/12
73	Drywall/Tape Lvl 1	56 days	Mon 4/16/12	Mon 7/2/12
74	Paint Lvl 1	11 days	Mon 6/18/12	Mon 7/2/12
75	Install Wall-Covering Lvl 1	9 days	Tue 7/3/12	Fri 7/13/12
76	Install Ceiling Grid Lvl 1	9 days	Mon 6/25/12	Thu 7/5/12
77	MEP Drops to Grid Lvl 1	7 days	Mon 7/2/12	Tue 7/10/12
78	Install Ceiling Tiles Lvl 1	3 days	Mon 7/9/12	Wed 7/11/12
79	Install Millwork Lvl 1	5 days	Thu 7/12/12	Wed 7/18/12
80	MEP Wall/Ceiling Trim Lvl 1	25 days	Mon 7/9/12	Fri 8/10/12
81	Install Restroom Tile Floors Lvl 1	22 days	Wed 6/27/12	Thu 7/26/12
82	Install Plumbing Fixtures Lvl 1	13 days	Tue 7/24/12	Thu 8/9/12



Project: Fisk Corporate Headquart
Date: Sat 2/23/13

Task
Split
Milestone
Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Manual Task
Duration-only
Manual Summary Rollup
Manual Summary
Start-only
Finish-only
Deadline
Progress

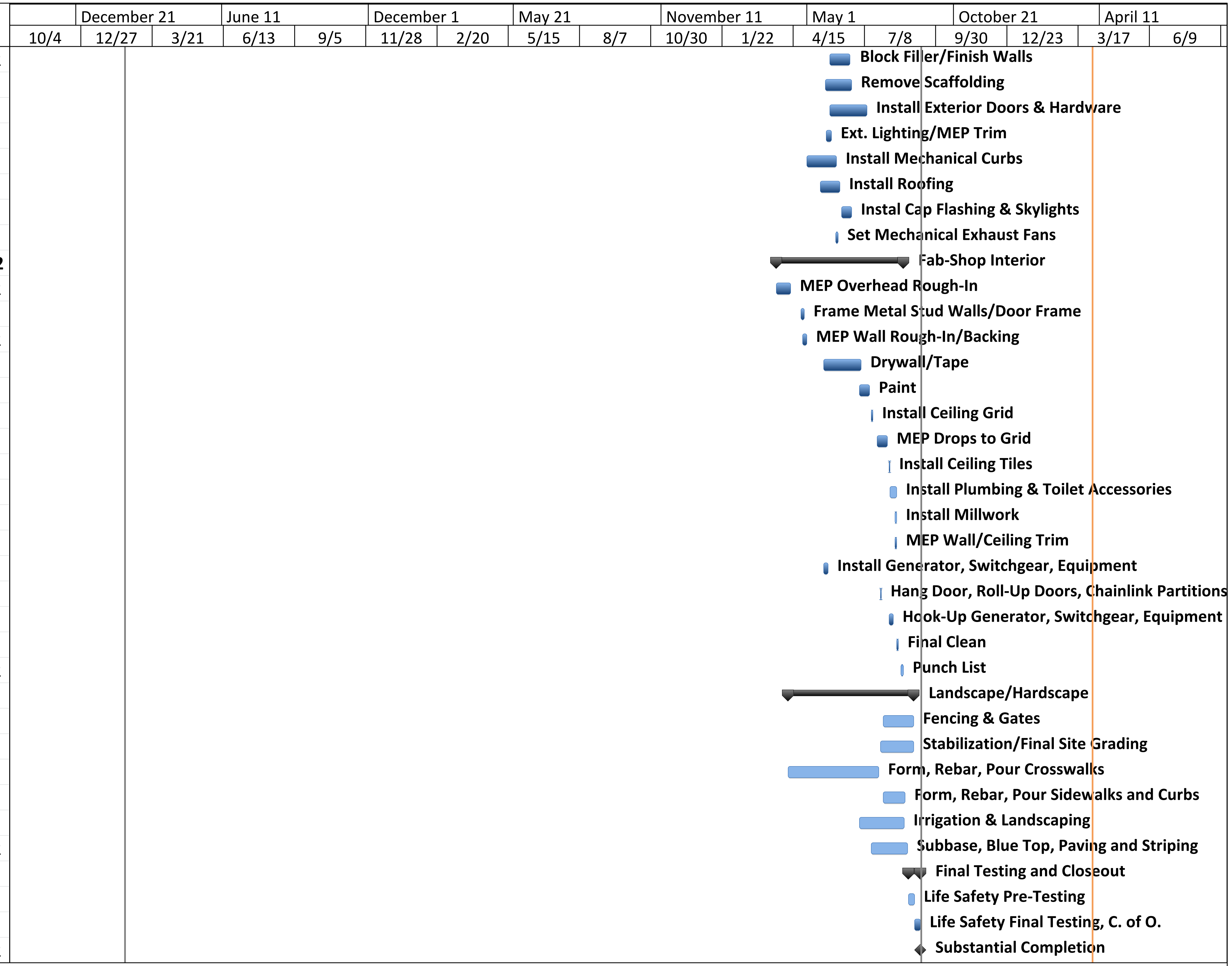
ID	Task Name	Duration	Start	Finish
83	Install Toilet Partitions & Accessories Lvl 1	20 days	Mon 7/16/12	Fri 8/10/12
84	Install Carpet & Base Lvl 1	7 days	Mon 7/9/12	Tue 7/17/12
85	Hang Doors & Hardware Lvl 1	7 days	Thu 8/2/12	Fri 8/10/12
86	Install & Hook-Up Office Partitions Lvl 1	10 days	Tue 7/31/12	Mon 8/13/12
87	Final Clean Lvl 1	5 days	Mon 8/13/12	Fri 8/17/12
88	Punch List Lvl 1	5 days	Tue 8/14/12	Mon 8/20/12
89	Sprinkler Overhead Rough-In Lvl 2	6 days	Mon 3/19/12	Mon 3/26/12
90	Mechanical and Plumbing Overhead Rough-In Lv	25 days	Thu 3/22/12	Wed 4/25/12
91	Electrical Overhead Rough-In Lvl 2	15 days	Mon 3/19/12	Fri 4/6/12
92	Frame Metal Stud Walls Lvl 2	16 days	Tue 3/27/12	Tue 4/17/12
93	MEP Wall Rough-In/Backing Lvl 2	15 days	Wed 4/4/12	Tue 4/24/12
94	Firecaulk/Inspection Lvl 2	5 days	Thu 5/24/12	Wed 5/30/12
95	Drywall/Tape Lvl 2	56 days	Wed 4/18/12	Wed 7/4/12
96	Paint Lvl 2	12 days	Fri 6/22/12	Mon 7/9/12
97	Install Wall-Covering Lvl 2	8 days	Tue 7/10/12	Thu 7/19/12
98	Install Ceiling Grid Lvl 2	7 days	Tue 7/10/12	Wed 7/18/12
99	MEP Drops to Grid Lvl 2	8 days	Thu 7/12/12	Mon 7/23/12
100	Install Ceiling Tiles Lvl 2	3 days	Mon 7/23/12	Wed 7/25/12
101	Install Millwork Lvl 2	18 days	Mon 7/23/12	Wed 8/15/12
102	MEP Wall/Ceiling Trim Lvl 2	15 days	Thu 7/26/12	Wed 8/15/12
103	Install Restroom Tile Floors Lvl 2	19 days	Wed 7/4/12	Mon 7/30/12
104	Install Plumbing Fixtures Lvl 2	16 days	Mon 7/23/12	Mon 8/13/12
105	Install Toilet Partitions & Accessories Lvl 2	14 days	Mon 7/30/12	Thu 8/16/12
106	Install Carpet & Base Lvl 2	10 days	Wed 7/25/12	Tue 8/7/12
107	Hang Doors & Hardware Lvl 2	5 days	Wed 8/8/12	Tue 8/14/12
108	Install and Hook-Up Office Partitions Lvl 2	10 days	Thu 8/2/12	Wed 8/15/12
109	Final Clean Lvl 2	5 days	Thu 8/16/12	Wed 8/22/12
110	Punch List Lvl 2	5 days	Wed 8/22/12	Tue 8/28/12
111	**Fab-Shop Foundations and Structure**	**95 days**	**Wed 1/4/12**	**Tue 5/15/12**
112	Drill & Pour Caissons	5 days	Wed 1/4/12	Tue 1/10/12
113	Rebar/Form & Pour Pile Caps/Grade Beams	6 days	Thu 1/5/12	Thu 1/12/12
114	MEP Underground Rough-In	6 days	Fri 1/13/12	Fri 1/20/12
115	Place Type 2/Visqueen/Sand	5 days	Mon 1/23/12	Fri 1/27/12
116	Form, Rebar, Pour Slab on Grade	5 days	Mon 1/23/12	Fri 1/27/12
117	Form, Rebar, Pour Dock Ramp, Walls, and Slab	10 days	Wed 5/2/12	Tue 5/15/12
118	Erect Structural Steel	2 days	Wed 2/8/12	Thu 2/9/12
119	Plumb, Bolt, and Weld	7 days	Fri 2/10/12	Mon 2/20/12
120	Install Metal Deck	5 days	Tue 2/14/12	Mon 2/20/12
121	**Fab-Shop Enclosure and Roofing**	**67 days**	**Mon 4/9/12**	**Tue 7/10/12**
122	Install Scaffolding	23 days	Mon 4/9/12	Wed 5/9/12
123	Install Masonry Walls	32 days	Tue 4/10/12	Wed 5/23/12



Project: Fisk Corporate Headquart
Date: Sat 2/23/13

Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Deadline	
Split		External Tasks		Inactive Summary		Manual Summary		Progress	
Milestone		External Milestone		Manual Task		Start-only			
Summary		Inactive Task		Duration-only		Finish-only			

ID	Task Name	Duration	Start	Finish
124	Block Filler/Finish Walls	18 days	Mon 5/28/12	Wed 6/20/12
125	Remove Scaffolding	23 days	Wed 5/23/12	Fri 6/22/12
126	Install Exterior Doors & Hardware	32 days	Mon 5/28/12	Tue 7/10/12
127	Ext. Lighting/MEP Trim	4 days	Thu 5/24/12	Tue 5/29/12
128	Install Mechanical Curbs	25 days	Tue 5/1/12	Mon 6/4/12
129	Install Roofing	17 days	Thu 5/17/12	Fri 6/8/12
130	Instal Cap Flashing & Skylights	10 days	Mon 6/11/12	Fri 6/22/12
131	Set Mechanical Exhaust Fans	3 days	Mon 6/4/12	Wed 6/6/12
132	**Fab-Shop Interior**	**108 days**	**Mon 3/26/12**	**Wed 8/22/12**
133	MEP Overhead Rough-In	13 days	Mon 3/26/12	Wed 4/11/12
134	Frame Metal Stud Walls/Door Frame	4 days	Tue 4/24/12	Fri 4/27/12
135	MEP Wall Rough-In/Backing	3 days	Thu 4/26/12	Mon 4/30/12
136	Drywall/Tape	32 days	Mon 5/21/12	Tue 7/3/12
137	Paint	10 days	Mon 7/2/12	Fri 7/13/12
138	Install Ceiling Grid	2 days	Mon 7/16/12	Tue 7/17/12
139	MEP Drops to Grid	10 days	Mon 7/23/12	Fri 8/3/12
140	Install Ceiling Tiles	1 day	Mon 8/6/12	Mon 8/6/12
141	Install Plumbing & Toilet Accessories	6 days	Tue 8/7/12	Tue 8/14/12
142	Install Millwork	2 days	Mon 8/13/12	Tue 8/14/12
143	MEP Wall/Ceiling Trim	2 days	Mon 8/13/12	Tue 8/14/12
144	Install Generator, Switchgear, Equipment	5 days	Mon 5/21/12	Fri 5/25/12
145	Hang Door, Roll-Up Doors, Chainlink Partitions	1 day	Fri 7/27/12	Fri 7/27/12
146	Hook-Up Generator, Switchgear, Equipment	5 days	Mon 8/6/12	Fri 8/10/12
147	Final Clean	2 days	Wed 8/15/12	Thu 8/16/12
148	Punch List	3 days	Mon 8/20/12	Wed 8/22/12
149	**Landscape/Hardscape**	**106 days**	**Mon 4/9/12**	**Mon 9/3/12**
150	Fencing & Gates	26 days	Mon 7/30/12	Mon 9/3/12
151	Stabilization/Final Site Grading	27 days	Fri 7/27/12	Mon 9/3/12
152	Form, Rebar, Pour Crosswalks	77 days	Mon 4/9/12	Tue 7/24/12
153	Form, Rebar, Pour Sidewalks and Curbs	20 days	Mon 7/30/12	Fri 8/24/12
154	Irrigation & Landscaping	39 days	Mon 7/2/12	Thu 8/23/12
155	Subbase, Blue Top, Paving and Striping	31 days	Mon 7/16/12	Mon 8/27/12
156	**Final Testing and Closeout**	**10 days**	**Wed 8/29/12**	**Tue 9/11/12**
157	Life Safety Pre-Testing	5 days	Wed 8/29/12	Tue 9/4/12
158	Life Safety Final Testing, C. of O.	5 days	Wed 9/5/12	Tue 9/11/12
159	Substantial Completion	0 days	Wed 9/12/12	Wed 9/12/12



Project: Fisk Corporate Headquart
Date: Sat 2/23/13

Task		Project Summary		Inactive Milestone		Manual Summary Rollup		Deadline	
Split		External Tasks		Inactive Summary		Manual Summary		Progress	
Milestone		External Milestone		Manual Task		Start-only			
Summary		Inactive Task		Duration-only		Finish-only			

Appendix F: Revised General Conditions Estimate

Revised General Conditions Estimate				
Description	**Quantity**	**Unit**	**Cost/Unit**	**Total $**
Preconstruction Services	1	LS	$90,000	$90,000
Project Manager	43	Wks	$3,100	$133,300
Project Manager	43	Wks	$2,625	$112,875
Superintendent	43	Wks	$2,250	$96,750
Laborer/Flagger	43	Wks	$1,375	$59,125
Timekeeper	43	Wks	$1,150	$49,450
CPM Scheduling	7,276,510	Job	2%	$145,530
Permit	1	LS	$38799	$38,799
Jobsite Trailer	10	Mo	$627.81	$6,280
Temporary Storage	10	Mo	$93.15	$932
Office Equipment	10	Mo	$272.33	$2,273
Small Tools	7,276,510	Job	.05%	$3,638
Temporary Fencing	1985	L.F.	$4.57	$9,071
Project Drawings	1	LS	$5,000	$5,000
Continuous Clean	43	Wks	$570	$24,510
Final Cleaning	1	LS	$15,000	$15,000
Waste Removal	43	Wks	$375	$16,125
Job Signs	70	S.F.	$33.69	$2,358
Temporary Power	10	Mo	$1,000	$10,000
Temporary Water	10	Mo	$1,000	$10,000
Equip. Insurance/Repairs	10	Mo	$1,000	$10,000
Testing	1	Job	$4,072.95	$4,073
Drug Testing	40	EA	$100	$4,000
Job Photos	4	Set	$525.23	$2,101
Temporary Toilets	10	Mo	$900	$9,000
Fire Marshall Inspection	5	EA	$250	$1,250
Survey	4	Day	$492.09	$1,968
Safety Supplies	10	Mo	$24.28	$243
Liability Insurance	7,276,510	Job	2.02%	$146,986
Builder's Risk	7,276,510	LS	0.24%	$17,464
Subcontractor Bonds	7,276,510	LS	0.60%	$43,659
Grand Total				**$1,072,208**

Appendix G: Detailed Division 26 Estimate

Conduit/Raceway Takeoff

Code	Description	Quantity	Unit	Mat./Unit	Mat. Tot.	Lab./Equip.	L/E Tot.	Total $
260533135020	3/4" EMT Conduit	32000	L.F.	$1.08	$34,560	$2.14	$68,480	$103,040
260533136220	3/4" EMT Coupling	3200	EA	$3.06	$9,792			$9,792
260533136520	3/4" EMT Conduit Conn	2640	EA	$2.53	$6,679	$2.53	$6,679	$13,358
260533132030	3/4" GRC Elbow	66	EA	$10.95	$723	$9.96	$657	$1,380
260533152580	3/4" GRC Nipple	37	EA	$4.92	$182	$10.29	$381	$563
260533139470	3/4" PVC Adapter	26	EA	$0.66	$17	$6.62	$172	$189
260533139110	3/4" PVC Conduit	3290	L.F.	$1.30	$4,277	$1.92	$6,317	$10,594
260533350200	3/4" Steel Flex	198	L.F.	$1.04	$206	$1.74	$345	$550
260533350440	3/4" Steel Flex Conn	132	L.F.	$4.10	$541	$3.98	$525	$1,067
260533135040	1" EMT Conduit	502	L.F.	$1.87	$939	$2.42	$1,215	$2,154
260533136240	1" EMT Coupling	50	EA	$4.97	$249			$249
260533136540	1" EMT Conduit Conn	84	EA	$4.79	$402	$3.09	$260	$662
260533139480	1" PVC Adapter	24	EA	$0.88	$21	$7.32	$176	$197
260533139120	1" PVC Conduit	1200	L.F.	$2.22	$2,664	$2.23	$2,676	$5,340
260533135060	1 1/4" EMT Conduit	25	L.F.	$3.11	$78	$2.78	$70	$147
260533136560	1 1/4" EMT Conduit Conn	4	EA	$9.31	$37	$3.98	$16	$53
260533135720	1 1/4" EMT Elbow	1	EA	$10.47	$10	$8.71	$ 9	$19
260533350300	1 1/4" Steel Flex	136	L.F.	$2.45	$333	$3.98	$541	$874
260533350452	1 1/4" Steel Flex Conn	30	EA	$10.62	$319	$6.18	$185	$504
260533135080	1 1/2" EMT Conduit	495	L.F.	$4.07	$2,012	$3.09	$1,530	$3,542
260533136280	1 1/2" EMT Coupling	49	EA	$15.05	$737			$737
260533136580	1 1/2" EMT Conduit Conn	14	EA	$13.46	$188	$4.62	$65	$253
260533135740	1 1/2" EMT Elbow	56	EA	$12.16	$681	$11.61	$650	$1,331
260533139510	2" PVC Adapter	6	EA	$1.92	$12	$10.29	$62	$73
260533139150	2" PVC Conduit	1350	L.F.	$4.17	$5,630	$3.09	$4,172	$9,801
260533139270	2" PVC Elbow	6	EA	$5.65	$34	$17.55	$105	$139
260533135120	2 1/2" EMT Conduit	50	L.F.	$12.59	$630	$4.62	$231	$861
260533136320	2 1/2" EMT Coupling	5	EA	$58.38	$292			$292
260533136620	2 1/2" EMT Conduit Conn	8	EA	$65.14	$521	$7.73	$62	$583
260533135780	2 1/2" EMT Elbow	16	EA	$43.43	$695	$23.29	$373	$1,068
260533135180	4 " EMT Conduit	70	L.F.	$20.75	$1,453	$6.95	$487	$1,939
260533136380	4" EMT Coupling	7	EA	$79.13	$554			$554
260533136700	4 " EMT Conduit Conn	18	EA	$121.59	$2,189	$17.55	$316	$2,505
260533135840	4" EMT Elbow	4	EA	$102.29	$409	$46.24	$185	$594
260533131970	4" GRC Conduit	60	L.F.	$30.40	$1,824	$13.84	$830	$ 2,654
260533132470	4" GRC Coupling	6	EA	$41.98	$252			$252
260533132220	4" GRC Elbow	4	EA	$192.04	$768	$69.53	$278	$1,046
260533139550	4" PVC Adapter	20	EA	$8.25	$165	$25.31	$506	$671
260533139190	4" PVC Conduit	2475	L.F.	$12.55	$31,061	$6.18	$15,296	$46,357
260533139310	4" PVC Elbow	10	EA	$27.02	$270	$46.24	$462	$733

Box Takeoff

Code	Description	Quantity	Unit	Mat./Unit	Mat. Tot.	Lab./Equip.	L/E Tot.	Total $
260533160370	4 x 1 1/2" Sq. Box	293	EA	$21.86	$6,405	$19.11	$5,599	$12,004
260533160370	4 x 2 1/8" Sq. Box	785	EA	$15.05	$11,814	$19.11	$15,001	$26,816
260533180220	12 x 12 x4" Screw Cvr Box	4	EA	$34.74	$139	$42.86	$171	$310
260533161150	2G Floor Box	11	EA	$180.46	$1,985	$69.53	$765	$2,750
Estimated	T-Bar Hanger	15	EA	$5.00	$75	$19.11	$287	$362
260533182600	Utility Pullbox	16	EA	$569.35	$9,110	$185.63	$2,970	$12,080

Utility Excavation Takeoff

Code	Description	Quantity	Unit	Mat./Unit	Mat. Tot.	Lab./Equip.	L/E Tot.	Total $
312316143100	16" W by 24" D Excavation	1450	L.F.			$0.88	$1,276	$1,276
312316140100	Machine Trench	4100	L.F.			$0.46	$1,886	$1,886
33053403825	Red Concrete	11	C. Y.	$157.35	$1,731	$42.62	$469	$2,200

Wire & Grounding Takeoff

Code	Description	Quantity	Unit	Mat./Unit	Mat. Tot.	Lab./Equip.	L/E Tot.	Total $
260519901000	#14 Control Cable	220	C.L.F	$9.02	$20	$21.26	$47	$67
260519900940	#12 THHN	120470	C.L.F	$11.97	$14,420	$25.31	$30,491	$44,911
260519900960	#10 THHN	24693	C.L.F	$18.87	$4,660	$27.68	$ 6,836	$11,496
260519901300	#8 THHN	4710	C.L.F	$32.33	$1,523	$34.76	$1,637	$3,160
260519901350	#6 THHN	635	C.L.F	$55.49	$352	$42.86	$272	$625
260526800400	#6 Bare Copper	210	C.L.F	$54.52	$114	$27.68	$58	$173
260519901400	#4 THHN	230	C.L.F	$86.85	$200	$52.65	$121	$321
260519901450	#3 THHN	140	C.L.F	$110.01	$154	$55.69	$78	$232
260519901500	#2 THHN	35	C.L.F	$138.00	$48	$61.76	$22	$70
260519901550	#1 THHN	445	C.L.F	$180.16	$802	$69.53	$309	$1,111
260519901600	#1/0 THHN	2450	C.L.F	$218.09	$5,343	$84.38	$2,067	$7,411
260526800700	#1/0 Bare Copper	200	C.L.F	$203.62	$407	$69.53	$139	$546
260519901700	#3/0 THHN	355	C.L.F	$342.58	$1,216	$111.38	$395	$1,612
260519902000	#4/0 THHN	395	C.L.F	$429.43	$1,696	$126.23	$499	$2,195
260519902200	#250 MCM	80	C.L.F	$511.45	$409	$139.05	$111	$520
260519902800	#600 MCM	5665	C.L.F	$1,114.58	$63,141	$191.57	$10,852	$73,993
260519351780	#8 Crimp Lug	12	EA	$2.54	$30	$7.73	$93	$123
260519351800	#6 Crimp Lug	4	EA	$3.34	$13	$9.28	$37	$50
260519352000	#4 Crimp Lug	14	EA	$4.54	$64	$10.29	$144	$208
260519352400	#1 Crimp Lug	10	EA	$7.33	$73	$13.84	$138	$212
260519352500	#1/0 Crimp Lug	7	EA	$7.82	$55	$15.86	$111	$166
260519352800	#3/0 Crimp Lug	4	EA	$10.71	$43	$23.29	$93	$136
260519353200	#250 Crimp Lug	10	EA	$14.04	$140	$31.05	$311	$451
260526800100	Grounding Rod - 10' Long	16	EA	$37.15	$594	$63.11	$1010	$1604
260526800250	Grounding Clamp - 3/4" Dia.	16	EA	$8.44	$135	$8.71	$139	$274

Distribution Gear Takeoff

Code	Description	Quantity	Unit	Mat./Unit	Mat. Tot.	Lab./Equip.	L/E Tot.	Total $
262816204350	600V 30A Disc.	4	EA	$313.63	$1,255	$87.08	$348	$1,603
262816204380	600V 60A Disc.	2	EA	$381.18	$762	$120.83	$242	$1,004
262923100150	VFD 20 HP Motor Starter	2	EA	$2,436.63	$4,873	$624.38	$1,249	$6,122
262413300300	800A Distribution Board	2	EA	$2,822.63	$5,645	$631.13	$1,262	$6,908
262816101000	800A MCB	2	EA	$4,921.5	$9,843	$590.63	$1,181	$11,024
262816100600	SWBD BKR 125A	1	EA	$1,519.88	$1,520	$185.63	$186	$1,706
262816100600	SWBD BKR 150A	3	EA	$1,519.88	$4,560	$185.63	$557	$5,117
262816100600	SWBD BKR 225A	2	EA	$1,519.88	$3,040	$185.63	$371	$3,411
262816100700	BKR 400A Gen.	1	EA	$2,605.5	$2,606	$347.63	$348	$2,953
262416301300	Panel 480V 20 Ckts	2	EA	$1,712.88	$3,426	$462.38	$925	$4,351
262416301450	Panel 480V 36 Ckts	2	EA	$2,702	$5,404	$776.25	$1,553	$6,957
262416300600	Panel 208V 12 Ckts	1	EA	$617.6	$618	$276.75	$277	$894
262416300650	Panel 208V 16 Ckts	3	EA	$709.28	$2,128	$371.25	$1,114	$3,242
262416300800	Panel 208V 30 Ckts	1	EA	$1,013.25	$1,013	$526.5	$527	$1,540
262416300950	Panel 208V 36 Ckts	1	EA	$1,182.13	$1,182	$691.88	$692	$1,874
262416301000	Panel 208V 42 Ckts	1	EA	$1,326.88	$1,327	$826.88	$827	$2,154
263353100262	75kVA UPS	1	EA	$46,609.5	$46,610	$3628.13	$3,628	$50,238
263353100400	120V DC Battery Bank	3	EA	$12,159	$36,477	$961.88	$2,886	$39,363
262213103300	30 kVA Xfmer	2	EA	$1,254.5	$2,509	$617.63	$1,235	$3,744
262213103700	75 kVA Xfmer	2	EA	$2,267.75	$4,536	$793.13	$1,586	$6,122
263213132800	250 kW Generator	1	EA	Owned Prior		$2,986.88	$2,987	$2,987
263623100900	800A ATS	1	EA	$9,601.75	$9,602	$691.88	$692	$10,294
263623101700	Adjustable Time Delay	1	EA	$193.97	$194	$0	$0	$194
263623102200	Pilot Light Normal	1	EA	$78.65	$79	$0	$0	$79
263623102100	Pilot Light Emergency	1	EA	$78.65	$79	$0	$0	$79
263623102300	Auxiliary Contact	1	EA	$91.19	$91	$0	$0	$91

Fixture Takeoff								
Code	**Description**	**Quantity**	**Unit**	**Mat./Unit**	**Mat. Tot.**	**Lab./Equip.**	**L/E Tot.**	**Total $**
265113500400	Type A1 2 x 4 Fluorescent	57	EA	$55.97	$3,190	$52.65	$3,001	$6,191
265113500400	Type A1-D 2 x 4 Fluorescent	18	EA	$55.97	$1,007	$52.65	$948	$1,955
265113500300	Type A2 2x2 Fluorescent	277	EA	$57.42	$15,905	$48.94	$13,556	$29,462
265113500300	Type A3 2x2 Fluorescent	146	EA	$57.42	$8,383	$48.94	$7,145	$15,529
265113503535	Type B Fluorescent D.L.	54	EA	$106.15	$5,732	$34.76	$1,877	$7,609
265113503540	Type C Wall Washer	28	EA	$106.15	$2,972	$34.76	$973	$3,945
265113502310	Type D3 3' Strip	32	EA	$66.1	$2,115	$34.76	$1,112	$3,228
265113502310	Type D4 4' Strip	16	EA	$66.1	$1,058	$34.76	$556	$1,614
265113503420	Type F Chain Hung Strip	24	EA	$151.51	$3,636	$55.69	$1,337	$4,973
265113500910	Type G4 Linear Fluorescent	6	EA	$64.66	$388	$48.94	$294	$682
265113500910	Type G6 Linear Fluorescent	8	EA	$64.66	$517	$48.94	$392	$909
265113500940	Type H4 2x4 Fluorescent	7	EA	$69.96	$490	$52.65	$369	$858
265113500940	Type H8 2x4 Fluorescent	2	EA	$69.96	$140	$52.65	$105	$245
265113500940	Type H9 2x4 Fluorescent	1	EA	$69.96	$70	$52.65	$53	$123
265113401500	Type I Metal Halide D.L.	8	EA	$414.95	$3,320	$81.68	$653	$3,973
265113503535	Type J Sconce	12	EA	$106.15	$1,274	$34.76	$417	$1,691
265113502950	Type K HBay Fluorescent	38	EA	$216.16	$8,214	$62.44	$2,373	$10,587
265113401500	Type L MH Down light	12	EA	$414.95	$4,979	$81.68	$980	$5,960
265619209100	Type M LED Parking Light	14	EA	$554.88	$7,768	$103.28	$1,446	$9,214
265619209100	Type M2 LED Parking Light	7	EA	$554.88	$3,884	$103.28	$723	$4,607
265113401980	Type O-CMH Wall Washer	6	EA	$506.63	$3,040	$95.85	$575	$3,615
265313100100	Exit Fixture	20	EA	$36.67	$733	$41.51	$830	$1,564
266113300360	Fixture Whip	86	EA	$14.841	$1,276	$8.71	$749	$2,025
265613103200	30' Aluminum Pole	14	EA	$1592.26	$22,292	$313.43	$4,388	$26,680
265613105400	Bracket Arms - 1 Arm	7	EA	$117.73	$824	$34.76	$243	$1,067

Wiring Devices								
Code	**Description**	**Quantity**	**Unit**	**Mat./Unit**	**Mat. Tot.**	**Lab./Equip.**	**L/E Tot.**	**Total $**
262726200500	20A Single Pole Switch	15	EA	$7.33	$110	$10.29	$154	$264
266113100150	Occupancy Sensor Switch	60	EA	$63.21	$3,793	$11.61	$697	$4,489
262726202460	Duplex Receptacles	316	EA	$10.57	$3,340	$10.29	$3,252	$6,592
262726202482	GFI Receptacles	13	EA	$38.12	$496	$10.29	$134	$629
266113100100	24W Sensor	11	EA	$107.12	$1,178	$39.83	$438	$1,616
266113100200	24V Power Pack	18	EA	$35.22	$634	$27.68	$498	$1,132

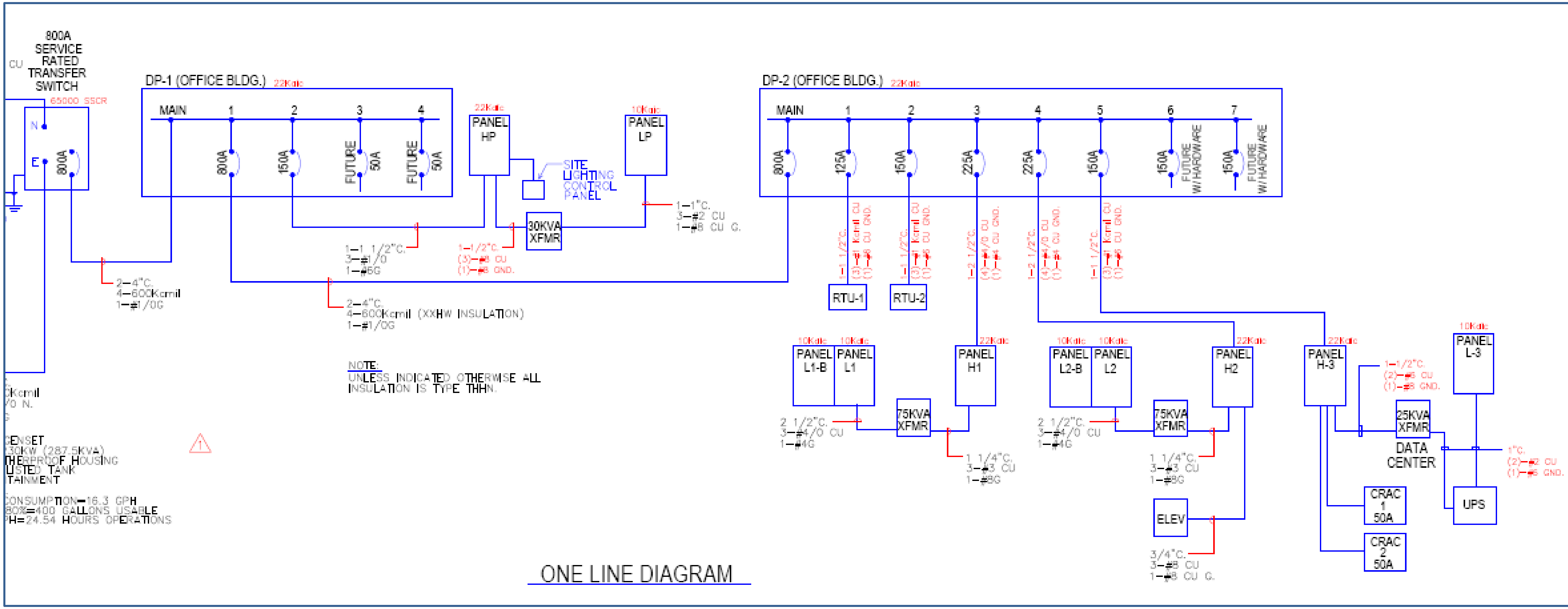
Motor Connections								
Code	**Description**	**Quantity**	**Unit**	**Mat./Unit**	**Mat. Tot.**	**Lab./Equip.**	**L/E Tot.**	**Total $**
260580100020	1 HP and less Motor Conn.	61	EA	$9.94	$606	$34.76	$2,120	$2,727
260580100050	2 HP Motor Conn.	3	EA	$10.18	$31	$42.86	$129	$159
260580102015	20 HP Motor Conn.	2	EA	$30.4	$61	$46.24	$92	$153

Estimate Summary						
Item		**Material $**		**Labor/Equip. $**		**Total $**
Subtotal		$477,833.40		$274,103.10		$751,936.50
Misc. Material (5%)		$23,891.67				$23,891.67
O & P (9%)		$45,155.26		$24,669.28		$69,824.54
Grand Total		$546,880.33		$298,772.38		**$845,653**

Appendix H: Original Electrical One-Line Schematic Diagram

Provided by Fisk Electric

Fisk Electric Original One-Line Diagram



Note: Electrical Service and Generator Excluded to Increase One-Line Readability

Note: No Component Upstream of the Building's First Distribution Panel Was Affected by the Distribution System Redesign

Appendix I: Original Panel Schedules Affected by the Redesign

Provided by Fisk Electric

Distribution Panel DP-1 (Main Service)

SERVICE AMPERES:	**800 AMPS**
SERVICE VOLTAGE:	**480Y/277 VOLTS, 3Ø, 4 WIRE, 60 HERTZ**
OCCUPANCY TYPE:	**OFFICE BUILDING+Fab Shop/Warehouse**

VOLT AMPS	WIRE/ CONDUIT	SERVING	BKR		3P-800A		BKR	SERVING	WIRE/ CONDUIT	VOLT AMPS
192466	REFER TO DISTRIBUTION DIAGRAM	DP-2	REFER TO DISTRIBUTION DIAGRAM	1	A	2	REFER TO DISTRIBUTION DIAGRAM	Panel HP	REFER TO DISTRIBUTION DIAGRAM	35199
197106		|			B			|		26641
180009		|			C			|		23473
				3	A	4				
					B					
					C					
				5	A	6				
					B					
					C					
				7	A	8				
					B					
					C					
			A		B		C	TOT. CONN. LOAD:	654.89	KVA
			227.7		223.7		203.5	@ 480V. 3 PHASE:	787.7	AMPS

LOAD ANALYSIS FOR Distribution Panel DP-1 (Main Service)

LOAD TYPE	CONNECTED (V.A.)	DEMAND FACTOR	DEMAND (V.A.)	REMARKS	
LIGHTING	43362	125 %	54203		
GEN'L USE RECEP.	156451	* %	83226	*	FIRST 10,000 VA - 100% , REMAINDER - 50%
IT EQUIPMENT	35080	50 %	17540		
KITCHEN	10510	100 %	10510		
AC REFIG. EQPT.	259842	100 %	259842		
SPACE HEATING	152910	*** %	30000	***	Space Heaters in Prefab/Warehouse
WATER HEATING	6000	100 %	6000		
OTHER MOTORS	5880	100 %	5880		
ELEVATORS	28266	100 %	28266		
LIFE SAFETY MTRS.	0	100 %	0		
MISC. POWER	0	100 %	0		
OTHER	0	100 %	0		
SUBTOTAL:	698301		4 495466		
25% CONT. LOAD			10841		
25% LARGEST MOTOR Fan Motor at RTU 2 (20 Hp)			5378		
TOTAL LOAD:	698301		511685	DEMAND AMPS:	615.5
TOTAL SERVICE CAPACITY:			665108	SERVICE CAPACITY AMPS:	800.0
TOTAL SPARE CAPACITY:			153423	SPARE CAPACITY AMPS:	184.5

Distribution Panel DP-2										
SERVICE AMPERES:		800 AMPS								
SERVICE VOLTAGE:		480Y/277 VOLTS, 3Ø, 4 WIRE, 60 HERTZ								
OCCUPANCY TYPE:		OFFICE BUILDING								
VOLT AMPS	WIRE/ CONDUIT	SERVING	BKR	3P-800A			BKR	SERVING	WIRE/ CONDUIT	VOLT AMPS
29550	REFER TO DISTRIBUTION DIAGRAM	RTU-1	REFER TO DISTRIBUTION DIAGRAM	1	A	2	REFER TO DISTRIBUTION DIAGRAM	RTU-2	REFER TO DISTRIBUTION DIAGRAM	34294
29550		|			B			|		34294
29550		|			C			|		34294
46508		Panel H1		3	A	4		PANEL: H2		48094
44269		|			B			|		47585
44639		|			C			|		45944
27086		Panel H3		5	A	6		Space		0
26830		|			B			|		0
14330		|			C			|		0
		Space		7	A	8		Space		0
		|			B			|		0
		|			C			|		0
			A		B		C	TOT. CONN. LOAD :	536.82	KVA
			185.5		182.5		168.8	@ 480V. 3 PHASE :	645.7	AMPS

LOAD ANALYSIS FOR Distribution Panel DP-2

LOAD TYPE	CONNECTED (V.A.)	DEMAND FACTOR	DEMAND (V.A.)	REMARKS	
LIGHTING	28884	125 %	36105		
GEN'L USE RECEP.	114300	* %	62150	* FIRST 10,000 VA - 100% , REMAINDER - 50%	
IT EQUIPMENT	35440	50 %	17720		
KITCHEN	11000	100 %	11000		
AC REFIG. EQPT.	223782	100 %	223782		
SPACE HEATING	122910	*** %	0	*** NON-CONCURRENT LOAD	
WATER HEATING	3000	100 %	3000		
OTHER MOTORS	7800	100 %	7800		
ELEVATORS	28266	100 %	28266		
LIFE SAFETY MTRS.	0	100 %	0		
MISC. POWER	1575	100 %	1575		
OTHER	0	100 %	0		
SUBTOTAL:	576957		4 391398		
25% CONT. LOAD			7221		
25% LARGEST MOTOR			5378		
Fan Motor at RTU 2 (20 Hp)					
TOTAL LOAD:	576957		403997	DEMAND AMPS:	485.9
TOTAL SERVICE CAPACITY:			665108	SERVICE CAPACITY AMPS:	800.0
TOTAL SPARE CAPACITY:			261111	SPARE CAPACITY AMPS:	314.1

			PANEL H 1					480Y/277V, 3 PHASE, 4 WIRE, 225 AMPS		
VOLT AMPS	WIRE/ CONDUIT	SERVING	BKR		MLO		BKR	SERVING	WIRE/ CONDUIT	VOLT AMPS
2244	2-#12s+#12gnd, 1/2"C	Offices - North	1P-20	1	A	2	1P-20	Offices - West	2-#12s+#12gnd, 1/2"C	714
644	2-#12s+#12gnd, 1/2"C	Lobby	1P-20	3	B	4	1P-20	Workstations -SW	2-#12s+#12gnd, 1/2"C	1360
576	2-#12s+#12gnd, 1/2"C	Training	1P-20	5	C	6	1P-20	Workstations-NW	2-#12s+#12gnd, 1/2"C	1164
778	2-#12s+#12gnd, 1/2"C	Core - East	1P-20	7	A	8	1P-20	Core -West	2-#12s+#12gnd, 1/2"C	1036
660	2-#12s+#12gnd, 1/2"C	Breakroom & Corridor	1P-20	9	B	10	1P-20	Boardroom	2-#12s+#12gnd, 1/2"C	680
400	2-#12s+#12gnd, 1/2"C	Conf. Rm - East	1P-20	11	C	12	1P-20	Workstations - East	2-#12s+#12gnd, 1/2"C	782
1792	2-#12s+#12gnd, 1/2"C	File Room/toilets	1P-20	13	A	14	3P-20	FPB-3,4,5,6,11	4-#12s+#12gnd, 1/2"C	3768
3160	4-#12s+#12gnd, 1/2"C	FPB - 1,2,15,16	3P-20	15	B	16	|	|	|	3768
3160	|	|	|	17	C	18	|	|	|	3768
3160	|	|	|	19	A	20	3P-20	FPB -7,8,9,10	4-#12s+#12gnd, 1/2"C	11000
2330	4-#12s+#12gnd, 1/2"C	FPB - 12,13,14	3P-20	21	B	22	|	|	|	11000
2330	|	|	|	23	C	24	|	|	|	11000
2330	|	|	|	25	A	26	3P-30	SPARE	|	0
3000	2-#10s+#10gnd, 3/4"C	EWH-1 Water Heater	2P-30	27	B	28	|	|	|	0
3000		|	|	29	C	30	|	|	|	0
0		SPARE	1P-20	31	A	32	1P-20	3P-30	SPARE	0
0		SPARE	1P-30	33	B	34	1P-20	|	|	0
702		Egress Lighting	1P-20	35	C	36	1P-20	|	|	0
0		SPARE	3P-30	37	A	38	3P-125	Panel 1 LA	See one line diagram	19686
0		SPARE	|	39	B	40	|	Panel 1 LA	|	17667
0		SPARE	|	41	C	42	|	Panel 1 LA	|	17757
			A		B		C	TOT. CONN. LOAD :	135.42	KVA
			46.5		44.3		44.6	@ 480V. 3 PHASE :	162.9	AMPS

LOAD ANALYSIS FOR PANEL H 1

LOAD TYPE	CONNECTED (V.A.)	DEMAND FACTOR	DEMAND (V.A.)	REMARKS
LIGHTING	17032	125 %	21290	
GEN'L USE RECEP.	37730	* %	30003	* FIRST 10,000 VA - 100% , REMAINDER - 50%
IT EQUIPMENT	0	100 %	0	
KITCHEN	11000	100 %	11000	
AC REFIG. EQPT.	0	100 %	0	
SPACE HEATING	60774	100 %	60774	
WATER HEATING	3000	100 %	3000	
OTHER MOTORS	5880	100 %	5880	
ELEVATORS	0	100 %	0	
LIFE SAFETY MOTORS	0	100 %	0	
MISC. POWER	0	100 %	0	
OTHER	0	100 %	0	
TOTAL LOAD:	135416		131947	DEMAND AMPS: 158.7

				PANEL H 2				480Y/277V, 3 PHASE, 4 WIRE, 225 AMPS		
VOLT AMPS	WIRE/ CONDUIT	SERVING	BKR	3P 225A MainBkr MLO			BKR	SERVING	WIRE/ CONDUIT	VOLT AMPS
2091	2- #12s+#12gnd, 1/2"C	Offices - South	1P-20	1	A	2	1P-20	Offices _ North	2- #12s+#12gnd, 1/2"C	1938
1904	2- #12s+#12gnd, 1/2"C	Workstations SW	1P-20	3	B	4	1P-20	Workstations NW	2- #12s+#12gnd, 1/2"C	1751
1236	2- #12s+#12gnd, 1/2"C	Workstations SE	1P-20	5	C	6	1P-20	Workstations NE	2- #12s+#12gnd, 1/2"C	1128
340	2- #12s+#12gnd, 1/2"C	Conf. Rm - South	1P-20	7	A	8	1P-20	Conf. Rm - North	2- #12s+#12gnd, 1/2"C	308
704	2- #12s+#12gnd, 1/2"C	Core - West	1P-20	9	B	10	1P-20	Core East	2- #12s+#12gnd, 1/2"C	874
504	2- #12s+#12gnd, 1/2"C	Egress Ltg.	1P-20	11	C	12	1P-20	Stairs - East	2- #12s+#12gnd, 1/2"C	234
5775	4- #10s+#10gnd, 3/4"C	FPB 2- 1,2,3,15,16,17	3P-30	13	A	14	3P-20	FPB 2- 4,5,6,18	4- #12s+#12gnd, 1/2"C	3935
5775	|	|	|	15	B	16	|	|		3935
5775	|	|	|	17	C	18	|	|		3935
5376	4- #10s+#10gnd, 3/4"C	FPB 2- 11,12,13,14,20,21	3P-30	19	A	20	3P-30	FPB 2-7,8,9,10,19	4- #10s+#10gnd, 3/4"C	5154
5376	|	|	|	21	B	22	|	|		5154
5376	|	|	|	23	C	24	|	|		5154
0		SPARE	1P-20	25	A	26	1P-20	SPARE		0
0		SPARE	1P-20	27	B	28	1P-20	SPARE		0
0		SPARE	1P-20	29	C	30	1P-20	SPARE		0
0		Spare	3P-30	31	A	32	3P-30	Spare	4- #10s+#10gnd, 3/4"C	0
0		|	|	33	B	34	|	|		0
0		|	|	35	C	36	|	|		0
9422	4- #8s+#8gnd, 1"C	ELEVATOR	3P-50	37	A	38	3P-125	Panel L2 and L2B	See one line diagram	13755
9422	|	|	|	39	B	40	|	|		12690
9422	|	|	|	41	C	42	|	|		13180
			A		B		C	TOT. CONN. LOAD :	141.62	KVA
			48.1		47.6		45.9	@ 480V. 3 PHASE :	170.3	AMPS

LOAD ANALYSIS FOR PANEL H 2

LOAD TYPE	CONNECTED (V.A.)	DEMAND FACTOR	DEMAND (V.A.)	REMARKS	
LIGHTING	11596	125 %	14495		
GEN'L USE RECEP.	75710	* %	42855	* FIRST 10,000 VA - 100% , REMAINDER - 50%	
IT EQUIPMENT	3240	100 %	3240		
KITCHEN	0	100 %	0		
AC REFIG. EQPT.	10755	100 %	10755		
SPACE HEATING	62136	109 %	67958		
WATER HEATING	0	100 %	0		
OTHER MOTORS	1920	100 %	1920		
ELEVATORS	28266	100 %	28266		
LIFE SAFETY MOTORS	0	100 %	0		
MISC. POWER	1575	100 %	1575		
OTHER	0	100 %	0		
TOTAL LOAD:	195198		171064	DEMAND AMPS:	205.8

			PANEL L1					208Y/120V, 3 PHASE, 4 WIRE, 225 AMPS		
VOLT AMPS	WIRE/ CONDUIT	SERVING	BKR		3P 225A Main Bkr FTL		BKR	SERVING	WIRE/ CONDUIT	VOLT AMPS
1260	2- #12s+#12gnd, 1/2"C	Receptacles Rm 300,301	1P-20	1	A	2	1P-20	Receptacles Rm 320.321,322	2- #12s+#12gnd, 1/2"C	1080
1440	2- #12s+#12gnd, 1/2"C	Receptacles RM 203-206	1P-20	3	B	4	1P-20	Receptacles Rm 322	2- #12s+#12gnd, 1/2"C	1080
180	2- #12s+#12gnd, 1/2"C	Receptacles RM 304, 306	1P-20	5	C	6	1P-20	Copier Rm 313	2- #12s+#12gnd, 1/2"C	1620
720	2- #12s+#12gnd, 1/2"C	Receptacles RM 208,302,303	1P-20	7	A	8	1P-20	Wk Stations 313	2- #12s+#12gnd, 1/2"C	720
340	2- #12s+#12gnd, 1/2"C	Transfmr for Toilet Fl Valve	1P-20	9	B	10	1P-20	Workstations 311	2- #12s+#12gnd, 1/2"C	600
1620	2- #12s+#12gnd, 1/2"C	Receptacles Rm 308-316	1P-20	11	C	12	1P-20	Work Station 311	2- #12s+#12gnd, 1/2"C	600
800	2- #12s+#12gnd, 1/2"C	Board Rm Projector	1P-20	13	A	14	1P-20	Receptacles Mt Rm 309	2- #12s+#12gnd, 1/2"C	900
1000	2- #12s+#12gnd, 1/2"C	Training Room Projectors	1P-20	15	B	16	1P-20	Copy Rm 313	2- #12s+#12gnd, 1/2"C	360
400	2- #12s+#12gnd, 1/2"C	Training Rm Screen+Shades	1P-20	17	C	18	1P-20	SPARE	2- #12s+#12gnd, 1/2"C	0
720	2- #12s+#12gnd, 1/2"C	Meeting Rm 307	1P-20	19	A	20	1P-20	Breakroom Receptacle	2- #12s+#12gnd, 1/2"C	180
540	2- #12s+#12gnd, 1/2"C	Work Stations 305	1P-20	21	B	22	1P-20	Breakroom Ice Machine	2- #12s+#12gnd, 1/2"C	960
720	2- #12s+#12gnd, 1/2"C	Work Stations	1P-20	23	C	24	1P-20	Breakroom coffee maker	2- #12s+#12gnd, 1/2"C	1550
720	2- #12s+#12gnd, 1/2"C	Work Stations	1P-20	25	A	26	1P-20	Breakroom Dishw asher	2- #12s+#12gnd, 1/2"C	1500
720	2- #12s+#12gnd, 1/2"C	Work Stations	1P-20	27	B	28	1P-20	Breakroom Microw ave	2- #12s+#12gnd, 1/2"C	1575
720	2- #12s+#12gnd, 1/2"C	Work Stations	1P-20	29	C	30	1P-20	Breakroom Microw ave	2- #12s+#12gnd, 1/2"C	1575
720	2- #12s+#12gnd, 1/2"C	Work Stations	1P-20	31	A	32	1P-20	Recept. Training 404	2- #12s+#12gnd, 1/2"C	720
720	2- #12s+#12gnd, 1/2"C	Work Stations	1P-20	33	B	34	1P-20	Recept. Training 404	2- #12s+#12gnd, 1/2"C	360
0		Spare	1P-20	35	C	36	1P-20	Recept. Training 404	2- #12s+#12gnd, 1/2"C	360
960	3- #12s+#12gnd, 3/4"C	Breakroom Vending Machine	1P-20	37	A	38	1P-20	Recept. Training 404	2- #12s+#12gnd, 1/2"C	360
960	3- #12s+#12gnd, 3/4"C	Breakroom Vending Machine	1P-20	39	B	40	1P-20	Recep 501,502,401	2- #12s+#12gnd, 1/2"C	900
960	3- #12s+#12gnd, 3/4"C	Breakroom Refrigerator	1P-20	41	C	42	1P-20	Breakroom Refrigerator	2- #12s+#12gnd, 1/2"C	960
			A		B		C	TOT. CONN. LOAD :	34.18	KVA
			11.4		11.6		11.3	@ 208V. 3 PHASE :	94.9	AMPS

LOAD ANALYSIS FOR PANEL L1

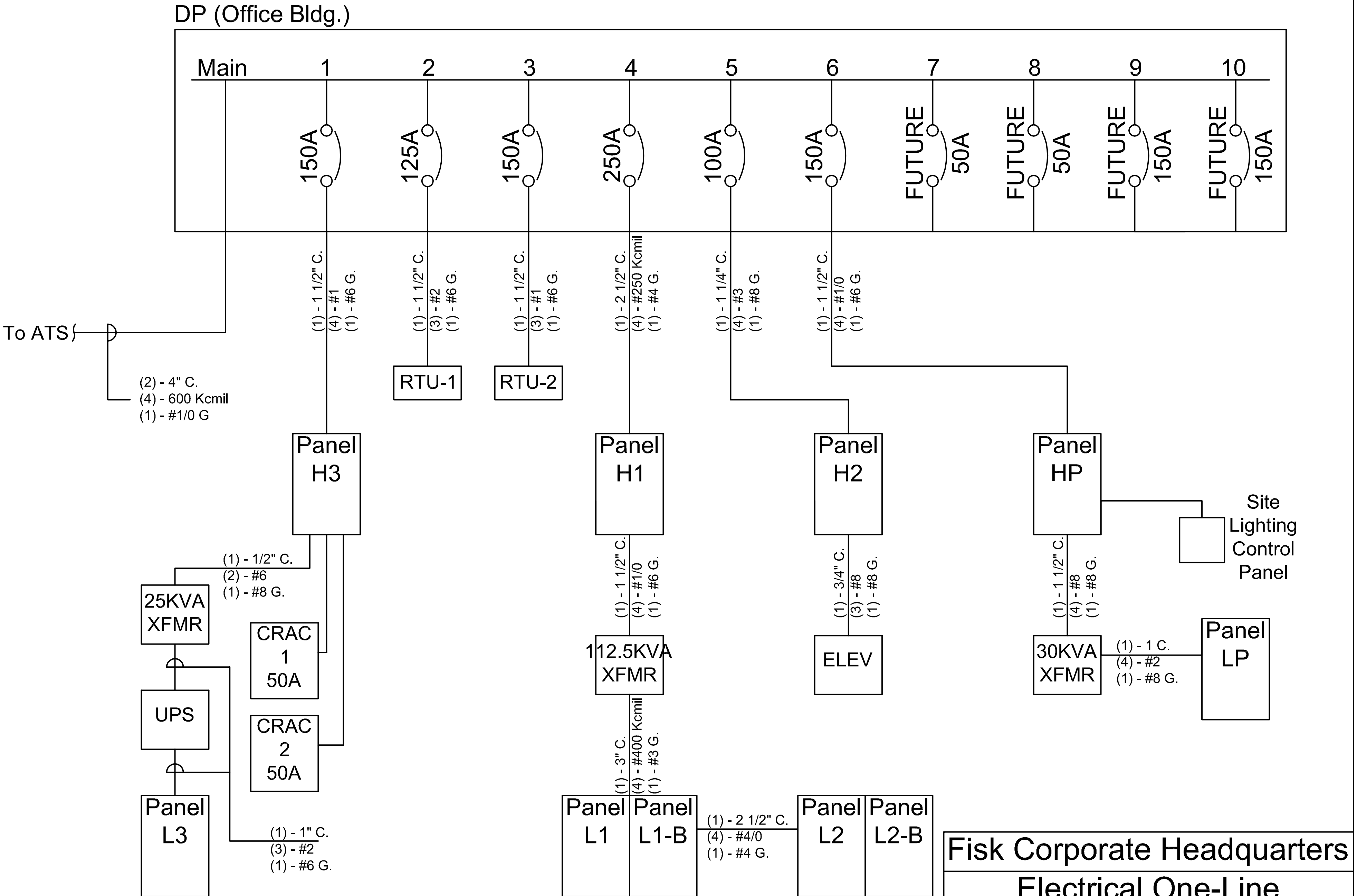
LOAD TYPE	CONNECTED (V.A.)	DEMAND FACTOR		DEMAND (V.A.)	REMARKS
LIGHTING	500	125	%	625	
GEN'L USE RECEP.	37730	*	%	30003	* FIRST 10,000 VA - 100% , REMAINDER - 50%
IT EQUIPMENT	0	100	%	0	
KITCHEN	11000	100	%	11000	
AC REFIG. EQPT.	0	100	%	0	
SPACE HEATING	0	100	%	0	
WATER HEATING	0	100	%	0	
OTHER MOTORS	5880	100	%	5880	
ELEVATORS	0	100	%	0	
LIFE SAFETY MOTORS	0	100	%	0	
MISC. POWER	0	100	%	0	
OTHER	0	100	%	0	
TOTAL LOAD:(Incl L1-B)	55110			47508	DEMAND AMPS: 131.9

PANEL L1B								208Y/120V, 3 PHASE, 4 WIRE, 225 AMPS		
VOLT AMPS	WIRE/ CONDUIT	SERVING	BKR	MLO			BKR	SERVING	WIRE/ CONDUIT	VOLT AMPS
500	2- #12s+#12gnd, 1/2"C	Sign on Westview	1P-20	1	A	2	1P-20	AV equip rm 309	2- #12s+#12gnd, 1/2"C	720
1176	2- #12s+#12gnd, 1/2"C	Gate Motor 1 East Gate 1/2 hp	1P-20	3	B	4	1P-20	recep mtg room 309	2- #12s+#12gnd, 1/2"C	900
1176	2- #12s+#12gnd, 1/2"C	Gate Motor 2 East Gate 1/2hp	1P-20	5	C	6	1P-20	recep rm 318-320	2- #12s+#12gnd, 1/2"C	1080
1176	2- #12s+#12gnd, 1/2"C	Gate Motor 1 West Gate 1/2 h	1P-20	7	A	8	1P-20	recep rm 310-314	2- #12s+#12gnd, 1/2"C	1080
1176	2- #12s+#12gnd, 1/2"C	Gate Motor 2 West Gate 1/2 h	1P-20	9	B	10	1P-20	SPARE		0
1176	2- #12s+#12gnd, 1/2"C	Elev Sump Pump ESP-1 1/2hp	1P-20	11	C	12	1P-20	Fire Alarm Panel	2- #12s+#12gnd, 1/2"C	360
330	2- #12s+#12gnd, 1/2"C	Elev. Pit light	1P-20	13	A	14	1P-20	Sprinkler Room Recep	2- #12s+#12gnd, 1/2"C	360
180	2- #12s+#12gnd, 1/2"C	Elev GFCI recep	1P-20	15	B	16	1P-20	SPARE		0
540	2- #12s+#12gnd, 1/2"C	Hallw ay 403	1P-20	17	C	18	1P-20	SPARE		0
800	2- #12s+#12gnd, 1/2"C	Training rm projector	1P-20	19	A	20	1P-20	SPARE		0
800	2- #12s+#12gnd, 1/2"C	Training rm projector	1P-20	21	B	22	1P-20	SPARE		0
720	2- #12s+#12gnd, 1/2"C	Break rm shade	1P-20	23	C	24	1P-20	SPARE		0
720	2- #12s+#12gnd, 1/2"C	Rm 309 proj and screen	1P-20	25	A	26	1P-20	SPARE		0
900	2- #12s+#12gnd, 1/2"C	Recep Hall 202	1P-20	27	B	28	1P-20	SPARE		0
720	2- #12s+#12gnd, 1/2"C	Recep Rm 200	1P-20	29	C	30	1P-20	SPARE		0
1920	2- #12s+#12gnd, 1/2"C	Copier rm 207	1P-20	31	A	32	1P-20	SPARE		0
800	2- #12s+#12gnd, 1/2"C	Laser Printer rm 207	1P-20	33	B	34	1P-20	SPARE		0
720	2- #12s+#12gnd, 1/2"C	recep rm 102	1P-20	35	C	36	1P-20	SPARE		0
720	2- #12s+#12gnd, 1/2"C	Recep rm 103	1P-20	37	A	38	1P-20	SPARE		0
180	2- #12s+#12gnd, 1/2"C	Lobby recep	1P-20	39	B	40	1P-20	SPARE		0
0		SPARE	1P-20	41	C	42	1P-20	SPARE		0
			A		B		C	TOT. CONN. LOAD:	20.93	KVA
			8.3		6.1		6.5	@ 208V, 3 PHASE:	58.1	AMPS

LOAD ANALYSIS FOR PANEL L1B

LOAD TYPE	CONNECTED (V.A.)	DEMAND FACTOR	DEMAND (V.A.)	REMARKS
LIGHTING	500	125 %	625	
GEN'L USE RECEP.	14550	* %	12275	* FIRST 10,000 VA - 100% , REMAINDER - 50%
IT EQUIPMENT	0	100 %	0	
KITCHEN	0	100 %	0	
AC REFIG. EQPT.	0	100 %	0	
SPACE HEATING	0	100 %	0	
WATER HEATING	0	100 %	0	
OTHER MOTORS	5880	100 %	5880	
ELEVATORS	0	100 %	0	
LIFE SAFETY MOTORS	0	100 %	0	
MISC. POWER	0	100 %	0	
OTHER	0	100 %	0	
TOTAL LOAD:	20930		18780	DEMAND AMPS: 52.1

Appendix J: Redesigned Electrical One-Line Schematic Diagram



Fisk Corporate Headquarters	
Electrical One-Line	
4/3/2013	Stephen Blanchard
Final Report	Houston, Texas

Appendix K: Redesigned Electrical Panel Schedules

DP (800 Amp Panelboard)

V:	480Y/277	Rm # 1-505	22000 AIC	3P - 4W	Fdr:	2 x (4) 600 & #1/0G.	2 x 4"C	625 kVA	800 A	MCB

Designations		VA/Phase			Bkr/Pole/Wire					Designations		VA/Phase			Bkr/Pole/Wire				
Ckt	Description	A	B	C	Bkr	/	# P	/	W	Ckt	Description	A	B	C	Bkr	/	# P	/	W
1	Panel H-3 (1-505)	22750			150	/	3	/	#1	2	RTU-1 (Roof)	29550			125	/	3	/	#2
3	-		22750		-	/	-	/	-	4	-		29550		-	/	-	/	-
5	-			22750	-	/	-	/	-	6	-			29550	-	/	-	/	-
7	RTU-2 (Roof)	34294			150	/	3	/	#1	8	Panel H-1 (1-505)	65667			250	/	3	/	250
9	-		34294		-	/	-	/	-	10	-		65667		-	/	-	/	-
11	-			34294	-	/	-	/	-	12	-			65667	-	/	-	/	-
13	Panel H-2 (2-505)	26000			100	/	3	/	#3	14	Panel HP (Fab Shop)	29837			150	/	3	/	1/0
15	-		26000		-	/	-	/	-	16	-		29837		-	/	-	/	-
17	-			26000	-	/	-	/	-	18	-			29837	-	/	-	/	-
19	Spare	0			50	/	3	/	-	20	Spare	0			50	/	3	/	-
21	-		0		-	/	-	/	-	22	-		0		-	/	-	/	-
23	-			0	-	/	-	/	-	24	-			0	-	/	-	/	-
25	Spare	0			150	/	3	/	-	26	Spare	0			150	/	3	/	-
27	-		0		-	/	-	/	-	28	-		0		-	/	-	/	-
29	-			0	-	/	-	/	-	30	-			0	-	/	-	/	-
31	Space	0			0	/	0	/	#####	32	Space	0			0	/	0	/	#####
33	Space		0		0	/	0	/	#####	34	Space		0		0	/	0	/	#####
35	Space			0	0	/	0	/	#####	36	Space			0	0	/	0	/	#####
37	Space	0			0	/	0	/	#####	38	Space	0			0	/	0	/	#####
39	Space		0		0	/	0	/	#####	40	Space		0		0	/	0	/	#####
41	Space			0	0	/	0	/	#####	42	Space			0	0	/	0	/	#####

H-1 (400 Amp Panelboard)

V:	480Y/277	Rm # 1-505	22000 AIC	3P - 4W	Fdr:	(4) 250 & #4 G.	2.5" C	197 kVA	250 A	MLO

Designations		VA/Phase			Bkr/Pole/Wire			Designations		VA/Phase			Bkr/Pole/Wire		
Ckt	Description	A	B	C	Bkr	# P	W	Ckt	Description	A	B	C	Bkr	# P	W
1	Office Ltg. (North)	2244			20	1	#12	2	Office Ltg. (West)	714			20	1	#12
3	Lobby Ltg.		644		20	1	#12	4	Work Stations Ltg. (SW)		1360		20	1	#12
5	Training Ltg.			576	20	1	#12	6	Work Stations Ltg. (NW)			1164	20	1	#12
7	Core Ltg. (East)	778			20	1	#12	8	Core Ltg. (West)	1036			20	1	#12
9	Break & Corridor Ltg.		660		20	1	#12	10	Boardroom Ltg.		630		20	1	#12
11	Conf. Rm. Ltg. (East)			400	20	1	#12	12	Work Stations Ltg. (East)			732	20	1	#12
13	File Rm. Ltg.	1792			20	1	#12	14	FPB - 3,4,5,6,11	3768			20	3	#12
15	FPB - 1,2,15,16		3160		20	3	#12	16	-		3768		-	-	-
17	-			3160	-	-	-	18	-			3768	-	-	-
19	-	3160			-	-	-	20	FPB - 7,8,9,10	11000			45	3	#8
21	FPB - 12,13,14		2330		20	3	#12	22	-		11000		-	-	-
23	-			2330	-	-	-	24	-			11000	-	-	-
25	-	2330			-	-	-	26	Spare	0			0	0	#####
27	EWH-1		3000		20	1	#12	28	Spare		0		0	0	#####
29	-			3000	-	-	-	30	Spare			0	0	0	#####
31	Spare	0			0	0	#####	32	Spare	0			0	0	#####
33	Spare		0		0	0	#####	34	Spare		0		0	0	#####
35	Egress Lighting (Hall)			702	20	1	#12	36	Spare			0	0	0	#####
37	Spare	0			0	0	#####	38	Panel L1 (1-505)	37500			150	3	1/0
39	Spare		0		0	0	#####	40	-		37500		-	-	-
41	Spare			0	0	0	#####	42	-			37500	-	-	-

H-2 (100 Amp Panelboard)

V:	480Y/277	Rm # 1-505	22000 AIC	3P - 4W	Fdr:	(4) #3 & #8 G.	1.25" C	78 kVA	100 A	MLO

Designations		VA/Phase			Bkr/Pole/Wire					Designations		VA/Phase			Bkr/Pole/Wire				
Ckt	Description	A	B	C	Bkr	/	# P	/	W	Ckt	Description	A	B	C	Bkr	/	# P	/	W
1	Workstations - Ltg. (SW	1904			20	/	1	/	#12	2	Workstations - Ltg. (NE	1128			20	/	1	/	#12
3	Workstations - Ltg. (SE)		1236		20	/	1	/	#12	4	Workstations - Ltg. (NW)		1751		20	/	1	/	#12
5	Offices - Ltg. (North)			2091	20	/	1	/	#12	6	Offices - Ltg. (North)			1938	20	/	1	/	#12
7	Conf. Rm. - Ltg. (South	340			20	/	1	/	#12	8	Conf. Rm. - Ltg. (North	308			20	/	1	/	#12
9	Core - Ltg. (West)		704		20	/	1	/	#12	10	Core - Ltg. (East)		874		20	/	1	/	#12
11	Egress - Ltg. (Hall)			504	20	/	1	/	#12	12	Stairs (East)			234	20	/	1	/	#12
13	FPB 2- 1,2,3,15,16,17	5775			30	/	3	/	#10	14	FPB 2-4,5,6,18	3935			20	/	3	/	#12
15	-		5775		-	/	-	/	-	16	-		3935		-	/	-	/	-
17	-			5775	-	/	-	/	-	18	-			3935	-	/	-	/	-
19	FPB 2- 11,12,13,14,20,	5376			30	/	3	/	#10	20	FPB 2- 7,8,9,10,19	5154			30	/	3	/	#10
21	-		5376		-	/	-	/	-	22	-		5154		-	/	-	/	-
23	-			5376	-	/	-	/	-	24	-			5154	-	/	-	/	-
25	Spare	0			0	/	0	/	#####	26	Spare	0			0	/	0	/	#####
27	Spare		0		0	/	0	/	#####	28	Spare		0		0	/	0	/	#####
29	Spare			0	0	/	0	/	#####	30	Spare			0	0	/	0	/	#####
31	Spare	0			0	/	0	/	#####	32	Spare	0			0	/	0	/	#####
33	Spare		0		0	/	0	/	#####	34	Spare		0		0	/	0	/	#####
35	Spare			0	0	/	0	/	#####	36	Spare			0	0	/	0	/	#####
37	Elevator	9422			50	/	3	/	#8	38	Spare	0			0	/	0	/	#####
39	-		9422		-	/	-	/	-	40	Spare		0		0	/	0	/	#####
41	-			9422	-	/	-	/	-	42	Spare			0	0	/	0	/	#####

L1 (400 Amp Panelboard)

V:	208Y/120	Rm # 1-505	10000 AIC	3P - 4W	Fdr:	(4) 400 & #3 G.	3" C	109 kVA	350 A	MCB

Designations		VA/Phase			Bkr/Pole/Wire			Designations		VA/Phase			Bkr/Pole/Wire		
Ckt	Description	A	B	C	Bkr	# P	W	Ckt	Description	A	B	C	Bkr	# P	W
1	Receptacles (300301)	1260			20	1	#12	2	Receptacles (32032132	1080			0	1	#12
3	Receptacles (203-206)		1440		20	1	#12	4	Receptacles (322)		1080		0	1	#12
5	Receptacles (304-306)			180	20	1	#12	6	Copier (313)			1620	0	1	#12
7	Receptacles (208, 302,	720			20	1	#12	8	Work Stations (313)	720			0	1	#12
9	Transformer (Bathroom)		340		20	1	#12	10	Work Stations (311)		600		0	1	#12
11	Receptacles (308-316)			1620	20	1	#12	12	Work Stations (311)			600	0	1	#12
13	Projector (Board Rm.)	800			20	1	#12	14	Receptacles (309)	900			0	1	#12
15	Projector (Training Rm.)		1000		20	1	#12	16	Copier (313)		360		0	1	#12
17	Screen & Shades (Training Rm.)			400	20	1	#12	18	Spare			0	0	0	#####
19	Receptacles (307)	720			20	1	#12	20	Receptacles (Break Rm	180			0	1	#12
21	Work Stations (305)		540		20	1	#12	22	Ice Machine (Break Rm.)		960		0	1	#12
23	Work Stations			720	20	1	#12	24	Coffee Maker (Break Rm.)			1550	0	1	#12
25	Work Stations	720			20	1	#12	26	Dishwasher (Break Rm	1500			0	1	#12
27	Work Stations		720		20	1	#12	28	Microwave (Break Rm.)		1575		0	1	#12
29	Work Stations			720	20	1	#12	30	Microwave (Break Rm.)			1575	0	1	#12
31	Work Stations	720			20	1	#12	32	Receptacles (404)	720			0	1	#12
33	Work Stations		720		20	1	#12	34	Receptacles (404)		360		0	1	#12
35	Spare			0	0	0	#####	36	Receptacles (404)			360	0	1	#12
37	Vending Machine (Bre	960			20	1	#12	38	Receptacles (404)	360			0	1	#12
39	Vending Machine (Break Rm,)		960		20	1	#12	40	Receptacles (501502401)		900		0	1	#12
41	Refrigerator (Break Rm,)			960	20	1	#12	42	Refrigerator (Break Rm.)			960	0	1	#12

L-1B

V:	208Y/120	Rm # 1-505	10000 AIC	3P - 4W	Fdr:	Section #2		73 kVA		MLO

Designations		VA/Phase			Bkr/Pole/Wire					Designations		VA/Phase			Bkr/Pole/Wire				
Ckt	Description	A	B	C	Bkr	/	# P	/	W	Ckt	Description	A	B	C	Bkr	/	# P	/	W
1	Sign on Westview (Site	500			20	/	1	/	#12	2	AV Equipment (309)	720			20	/	1	/	#12
3	Gate Motor 1 (East)		1176		20	/	1	/	#12	4	Receptacles (309)		900		20	/	1	/	#12
5	Gate Motor 2 (East)			1176	20	/	1	/	#12	6	Receptacles (318-320)			1080	20	/	1	/	#12
7	Gate Motor 1 (West)	1176			20	/	1	/	#12	8	Receptacles (310-314)	1080			20	/	1	/	#12
9	Gate Motor 2 (West)		1176		20	/	1	/	#12	10	Spare		0		0	/	0	/	#####
11	Elev. Sump Pump (Elev.)			1176	20	/	1	/	#12	12	Fire Alarm Panel (IDF)			360	20	/	1	/	#12
13	Elev. Pit Light (Elev.)	330			20	/	1	/	#12	14	Receptacles (Sprinkler	360			20	/	1	/	#12
15	Elev. GFCI (Elev.)		180		20	/	1	/	#12	16	Space		0		0	/	0	/	#####
17	Hallway Power (403)			540	20	/	1	/	#12	18	Space			0	0	/	0	/	#####
19	Projector (Training Roo	800			20	/	1	/	#12	20	Space	0			0	/	0	/	#####
21	Projector (Training Room)		800		20	/	1	/	#12	22	Space		0		0	/	0	/	#####
23	Shade (Break Room)			720	20	/	1	/	#12	24	Space			0	0	/	0	/	#####
25	Proj. and Screen (309)	720			20	/	1	/	#12	26	Space	0			0	/	0	/	#####
27	Receptacles (202)		900		20	/	1	/	#12	28	Space		0		0	/	0	/	#####
29	Receptacles (200)			720	20	/	1	/	#12	30	Space			0	0	/	0	/	#####
31	Copier (207)	1920			20	/	1	/	#12	32	Space	0			0	/	0	/	#####
33	Laser Printer (207)		800		20	/	1	/	#12	34	Space		0		0	/	0	/	#####
35	Receptacles (102)			720	20	/	1	/	#12	36	Space			0	0	/	0	/	#####
37	Receptacles (103)	720			20	/	1	/	#12	38	Panel L2 & L2B (2-505	18158			225	/	3	/	4/0
39	Receptacles (Lobby)		180		20	/	1	/	#12	40	-		18158		-	/	-	/	-
41	Spare			0	0	/	0	/	#####	42	-			18158	-	/	-	/	-

Appendix L: Original One-Line Takeoffs of Affected Redesign Components

Takeoff of Original Affected One Line Components					
Name	**Description**	**Length**	**Count**	**Material ($)**	**Labor (Hrs.)**
DP-1	800A Distribution Panelboard (480Y/277)		1	$4,115	30
DP-2	800A Distribution Panelboard (480Y/277)		1	$8,220	45
H-1	225A Panelboard (480Y/277)		1	$1,650	29
L-1	225A Panelboard (208Y/120)		1	$990	28
L-1B	225A Panelboard (208Y/120)		1	$500	19
H-2	225A Panelboard (480Y/277)		1	$1,685	30
Xfmer	75 kVA Step Down Transformer		2	$5,511	63
Feeder	DP-1 to DP-2	45	1	$3,863.32	78
Feeder	DP-2 to Panel H-1	21	1	$798.64	18
Feeder	DP-2 to Panel H-2	28	1	$952.23	20
Original Total				**$28,286**	**360**

Appendix M: One-Line Takeoffs of Redesigned Components

Takeoff of Redesigned One Line Components					
Name	**Description**	**Length**	**Count**	**Material ($)**	**Labor (Hrs.)**
DP	800A Distribution Panelboard (480Y/277)		1	$6,875	55
H-1	400A Panelboard (480Y/277)		1	$2,580	28
L-1	400A Panelboard (208Y/120)		1	$1,590	27.5
L-1B	400A Panelboard (208Y/120)		1	$875	24
H-2	100A Panelboard (480Y/277)		1	$1,400	30
Xfmer	112.5 kVA Step Down Transformer		1	$3,696	46
Feeder	DP to Panel H-3	8	1	$213.08	78
Feeder	DP to RTU-1	12	1	$165.24	7.5
Feeder	DP to RTU-2	28	1	$331.62	11
Feeder	DP to Panel H-1	26	1	$948.19	19
Feeder	DP to Panel H-2	28	1	$299.66	12
Feeder	Panel L-1B to Panel L2	28	1	$745.47	19
Original Total				**$19,720**	**287**

Appendix N: Bill of Material for Original One-Line Affected Redesign Components

Bill of Material for Original Affected Components

Description	Quantity	Unit	Mat./Unit	Material $	Lab./Unit	Labor (Hrs.)	Total $
DP-1 800A	1	E	$4,115	$4,115	8.8	8.8	$4,489
DP-2 800A	1	E	$8,220	$8,220	13.2	13.2	$8,781
225A H-1 PANELBOARD	1	E	$1,650	$1,650	24.2	24.2	$2,678.50
225A L-1 PANELBOARD	1	E	$990	$990	27.5	27.5	$2,158.75
225A L-1B PANELBOARD	1	E	$500	$500	18.7	18.7	$1,294.75
225A H-2 PANELBOARD	1	E	$1,685	$1,685	24.2	24.2	$2,713.50
2 1/2" EMT CONDUIT FEEDERS	49	C	$245.44	$120.27	13.2	6.4	$395.16
4" EMT CONDUIT FEEDERS	90	C	$422.40	$380.16	25.3	22.7	$1347.89
2 1/2" EMT STL SS CONN	4	C	$391.95	$15.68	0	0	$15.68
4" EMT STL SS CONN	4	C	$88.35	$3.53	0	0	$3.53
2 1/2" EMT STL SS CPLG	13	C	$306.16	$39.80	0	0	$39.80
4" EMT STL SS CPLG	18	C	$471	$84.78	0	0	$84.78
2 1/2" EMT 90 DEG ELBOW	4	C	$1212.51	$48.50	77	3.0	$179.40
4" EMT 90 DEG ELBOW	8	C	$2850.94	$228.08	220	17.6	$976.08
1 1/2" PLASTIC BUSHING	4	C	$12.86	$0.51	0	0	$0.51
2 1/2" PLASTIC BUSHING	8	C	$29.23	$2.34	0	0	$2.34
4" PLASTIC BUSHING	4	C	$37.50	$1.50	0	0	$1.50
1 1/2" STEEL FLEX	8	C	$289.86	$23.19	12.4	0.9	$65.27
2 1/2" STEEL FLEX	8	C	$430.77	$34.46	20.6	1.6	$104.59
1 1/2" STL FLEX CONN	2	C	$755.35	$15.11	55	1.1	$61.86
2 1/2" STL FLEX CONN	2	C	$1933.31	$38.67	88	1.7	$113.47
1 1/2" STL 90 DEG FLEX CONN	2	C	$1924.89	$38.50	55	1.1	$85.25
2 1/2" STL 90 DEG FLEX CONN	2	C	$6414.77	$128.30	88	1.7	$203.10
#6 THHN BLACK	20	M	$568.61	$11.37	13.2	0.2	$22.59
#4 THHN BLACK	159	M	$902.50	$143.5	14.3	2.2	$240.13
#1/0 THHN BLACK	60	M	$2230.02	$133.8	20.9	1.2	$187.10
#4/0 THHN BLACK	316	M	$4444.89	$1404.59	27.5	8.6	$1773.92
#250MCM THHN BLACK	80	M	$5359.13	$428.73	30.8	2.4	$533.45
#1/0 XHHW BLACK	60	M	$2125.54	$127.53	20.9	1.2	$180.83
#600MCM XHHW BLACK	240	M	$10884.45	$2612.27	48.4	11.6	$3105.95
1-H CRIMP LUG #6 BLUE	4	C	$153.53	$6.14	14.3	0.5	$30.45
1-H CRIMP LUG #4 GRAY	8	C	$200.26	$16.02	16.5	1.32	$72.12
1-H CRIMP LUG #1/0 PINK	6	C	$428.64	$25.72	26.4	1.6	$93.04

1-H CRIMP LUG #250 YELLOW	10	C	$770.24	$77.02	37.4	3.74	$235.97
WIRE TERM. 4/0 to 400 MCM	16	E	$2.29	$36.64	0.99	15.84	$709.84
WIRE TERM. 500 to 1000 MCM	8	E	$8.16	$65.28	1.32	10.56	$514.08
1/4" THREADED ROD - PLTD	14	C	$3.20	$0.45	2.75	0.385	$16.81
3/8" THREADED ROD - PLTD	28	C	$6.84	$1.92	3.3	0.924	$41.19
1/4-20 HEX NUT - PLTD STL	10	C	$1.77	$0.18	2.2	0.22	$9.53
3/8-16 HEX NUT - PLTD STL	18	C	$3.49	$0.63	2.42	0.4	$19.14
1/4" FLANGE W/ 1/4" THRD ROD	5	C	$87.09	$4.35	7.7	0.4	$20.71
1/2" FLANGE W/ 3/8" THRD ROD	10	C	$105.67	$10.57	7.7	0.77	$43.30
ERICO 2 1/2" EMT/GRC CLAMP	5	C	$159.32	$7.97	22	1.1	54.72
ERICO 4" EMT/GRC CLAMP	10	C	$270.79	$27.08	33	3.3	$167.33
50A 3P MOLDED CASE BRKR	3	E	Inc. Above	Inc. Above	1.65	4.95	$210.38
125A 3P MOLDED CASE BRKR	3	E	Inc. Above	Inc. Above	4.4	13.2	$561
150A 3P MOLDED CASE BRKR	5	E	Inc. Above	Inc. Above	4.4	22	$935
225A 3P MOLDED CASE BRKR	2	E	Inc. Above	Inc. Above	4.95	9.9	$420.75
800A 3P MOLDED CASE BRKR	1	E	Inc. Above	Inc. Above	13.75	13.75	$584.38
75KVA 3PH 480V DRY XMER	2	E	$4,395	$4,395	19.8	39.6	$6,078
1" GRD CLAMP	4	E	$16.41	$65.64	0.8	3.08	$196.54
BLOCKOUT/SLEEVE/SEAL 500	8	E	$40	$320	1.1	8.8	$694
Grand Total				**$28,286**		**360**	**$43,586**

Appendix O: Bill of Material for Redesigned Components

Bill of Material for Revised Components							
Description	Quantity	Unit	Mat./Unit	Material $	Lab./Unit	Labor (Hrs.)	Total $
DP 800A	1	E	$1,685	$1,685	16.5	16.5	$7,576.25
400A H-1 PANELBOARD	1	E	$2,580	$2,580	24.2	24.2	$3,608.50
400A L-1 PANELBOARD	1	E	$1,590	$1,590	27.5	27.5	$2,758.75
400A L-1B PANELBOARD	1	E	$875	$875	18.7	18.7	$1,669.75
100A H-2 PANELBOARD	1	E	$1400	$1400	24.2	24.2	$2,428.50
1 1/4" EMT CONDUIT FEEDERS	28	C	$104.69	$29.31	6.6	1.8	$107.85
1 1/2" EMT CONDUIT FEEDERS	48	C	$128.21	$61.54	8.8	4.2	$241.06
2 1/2" EMT CONDUIT FEEDERS	54	C	$245.44	$132.54	13.2	7.1	$435.48
1 1/4" EMT STL SS CONN	2	C	$65.20	$1.30	0.0	0.0	$1.30
1 1/2" EMT STL SS CONN	0	C	$92.51	$0	0.0	0.0	$0
2 1/2" EMT STL SS CONN	4	C	$391.95	$15.68	0.0	0.0	$15.68
1 1/4" EMT STL SS CPLG	7	C	$65.12	$4.56	0.0	0.0	$4.56
1 1/2" EMT STL SS CPLG	17	C	$102.06	$17.35	0.0	0.0	$17.35
2 1/2" EMT STL SS CPLG	14	C	$306.16	$42.86	0.0	0.0	$42.86
1 1/4" EMT 90 DEG ELBOW	2	C	$341.64	$6.83	44.0	0.9	$44.23
1 1/2" EMT 90 DEG ELBOW	4	C	$358.99	$14.36	44.0	1.8	$89.16
2 1/2" EMT 90 DEG ELBOW	4	C	$1212.51	$48.50	77.0	3.1	$179.40
1 1/4" PLASTIC BUSHING	2	C	$7.82	$0.16	0.0	0.0	$0.16
1 1/2" PLASTIC BUSHING	6	C	$12.86	$0.77	0.0	0.0	$0.77
2" PLASTIC BUSHING	6	C	$15.81	$0.95	0.0	0.0	$0.95
2 1/2" PLASTIC BUSHING	4	C	$29.23	$1.17	0.0	0.0	$1.17
2" STRAIGHT FLEX CONN	3	C	$1071.75	$32.15	77.0	2.3	$130.33
2" STEEL FLEX	12	C	$354.33	$42.52	16.5	2.0	$126.67
2" STL 90 DEG FLEX CONN	3	C	$2417.55	$72.53	77.0	2.3	$170.71
#8 THHN BLACK	38	M	$369.60	$14.04	11.0	0.4	$31.81
#6 THHN BLACK	93	M	$568.61	$52.88	13.2	1.2	$105.05
#4 THHN BLACK	84	M	$902.50	$75.81	14.3	1.2	$126.86
#3 THHN BLACK	202	M	$1130.55	$228.37	15.4	3.1	$360.58
#2 THHN BLACK	81	M	$1415.10	$114.62	15.4	1.2	$167.63
#1 THHN BLACK	221	M	$1876.59	$414.73	17.6	3.9	$580.04
#3/0 THHN BLACK	80	M	$3506.90	$280.55	25.3	2.0	$366.57
#4/0 THHN BLACK	143	M	$4444.89	$635.62	27.5	3.9	$802.75
#250MCM THHN BLACK	144	M	$5359.13	$771.71	30.8	4.4	$960.21

1-H CRIMP LUG #4 GRAY	2	C	$200.26	$4.01	16.5	0.3	$18.04
1-H CRIMP LUG #2 BROWN	6	C	$391.02	$23.46	18.7	1.1	$71.15
1-H CRIMP LUG #3/0 ORANGE	10	C	$587.78	$58.78	30.8	3.1	$189.68
1-H CRIMP LUG #4/0 PURPLE	3	C	$655.55	$19.67	33.0	1.0	$61.75
WIRE TERM #6 THRU #2	14	E	$0.63	$8.82	0.6	7.7	$336.07
WIRE TERM. #1 THRU 3/0	14	E	$1.24	$17.36	0.7	9.2	$410.06
WIRE TERM. 4/0 THRU 400 MCM	16	E	$2.29	$36.64	1.0	15.8	$709.84
1/4" THREADED ROD - PLTD	46	C	$3.20	$1.47	2.8	1.3	$55.23
1/4-20 HEX NUT - PLTD STL	30	C	$1.77	$0.53	2.2	0.7	$28.58
1/4" FLANGE W/ 1/4" THRD ROD	17	C	$87.09	$14.81	7.7	1.3	$70.44
ERICO 1 1/2" EMT/1 1/4" GRC	4	C	$65.72	$2.63	11.0	0.4	$21.33
ERICO 1 1/2" GRC CLAMP	7	C	$80.42	$5.63	11.0	0.8	$38.36
ERICO 2 1/2" EMT/GRC CLAMP	6	C	$159.32	$9.56	22.0	1.3	$65.66
50A 3P MOLDED CASE BRKR	3	E	Inc. Above	Inc. Above	1.7	5.0	$210.38
100A 3P MOLDED CASE BRKR	1	E	Inc. Above	Inc. Above	3.3	3.3	$140.25
125A 3P MOLDED CASE BRKR	2	E	Inc. Above	Inc. Above	4.4	8.8	$374
150A 3P MOLDED CASE BRKR	6	E	Inc. Above	Inc. Above	4.4	26.4	$1122
225A 3P MOLDED CASE BRKR	1	E	Inc. Above	Inc. Above	5.0	5.0	$210.38
250A 3P MOLDED CASE BRKR	1	E	Inc. Above	Inc. Above	6.1	6.1	$257.13
112.5KVA 3PH 480V DRY XMER	1	E	$2,930	$2930	28.6	28.6	$4,145.50
1" GRD CLAMP FOR BARE WIRE	2	E	$16.41	$32.82	0.8	1.5	$98.27
BLOCKOUT/SLEEVE/SEAL 200	2	E	$30	$60	0.7	1.3	$116.10
BLOCKOUT/SLEEVE/SEAL 300	2	E	$30	$60	0.7	1.3	$116.10
Grand Total				**$19,720**		**287**	**$31,918**

Appendix P: Full Q & A with Ted Robertson (Fisk Electric)

Q: Mr. Robertson, as the acting project manager for the electrical contractor on the completed Fisk Corporate Headquarters project, did you experience any major constructability issues with the installation of the current electrical distribution system designed for the project?

A: *No, we had very little difficulty with the installation of the electrical distribution system on the project. The one-line was clear and accurate and everything regarding the system installation went smoothly.*

Q: After reviewing the new, proposed one-line schematic for the project, what is your initial reaction.

A: *The consolidation of the two distribution boards into one will give immediate savings, both in material and labor. Combining the distribution system transformers into one slightly larger transformer will also return substantial savings.*

Q: Do you see any major constructability differences in the two systems that would favor one over the other? Disregarding the simple labor hours you would save from simply combining the components into bigger ones.

A: *No the components of the two systems are similar enough in size and weight that no new constructability concerns would need to be addressed if one design was chosen over the other.*

Q: Can you speak towards the installation differences between two smaller distribution panelboards verse one, slightly larger one.

A: *Other than the savings I alluded to earlier, there are virtually no differences in terms of constructability. The panels will be installed in exactly the same manner. The only difference is in the new design, only one panel needs to be installed verse two panels in the original design.*

Q: What about the installation of a larger 112.5 kVA transformer as opposed to two smaller ones? Do size and weight become a factor?

A: *No, the 112.5 kVA transformer is maybe 50-75 pounds heavier and 2-3 inches wider. The 75 kVA transformer is already big enough to where small equipment would be needed to move it from place to place. That same equipment would be sufficient to move the 112.5 kVA transformer. As far as size goes, the electrical room that would house this slightly larger transformer is more than big enough to house a few extra inches. In fact, the electric closet as it currently sits actually has 2 walls completely bare of any type of equipment.*

Appendix Q: Full Q & A with David Rinehart (Fisk Electric)

Q: Mr. Rinehart, based on your 30 years of experience as both an electrician and electrical general foreman, is there anything that jumps out at you as you review the two different one-line electrical distribution systems for the Fisk Corporate Headquarters project?

A: *The main thing that stands out to me is the potential labor savings that one could realize if they used the redesigned one-line over the original. The reduced number of components along with the elimination of fifty feet of a 600 Kcmil feeder would result in a substantial amount of man hour savings.*

Q: Do you see any major constructability differences in the two systems that would favor one over the other, other than the saved man hours.

A: *No the installation techniques would be the same for each system. I do have one question though. Are the locations of the panelboards downstream from DP in the same locations that they were originally designed to be?*

Q: Yes, none of the panelboards or transformers has moved in terms of physical location. The only difference between the two designs is how they are fed.

A: *Good, that means that none of the branch circuit wiring would need to be adjusted in order to accommodate the second design.*

Q: Can you speak towards the installation differences between two smaller distribution panelboards verse one, slightly larger one.

A: *There is no difference in the installation of the two different panelboard layouts. In the consolidated version, the number and size of conduits is such that plenty of space will exist in the top of the panel can for all of them to be easily installed. As long as that is the case, the only difference is simply the number of boards that are being installed.*

Q: What about the installation of a larger 112.5 kVA transformer as opposed to two smaller ones?

A: *In both cases, a pallet jack will be used to transport the transformers from location to location. As long as adequate space remains inside the electrical closet for the larger transformer, no added constructability concerns will arise if the redesigned one-line was implemented instead of the original one. In fact, the second one-line diagram is actually easier to install than the original because it does not require any heavy equipment to be moved to the second floor. By keeping a majority of the equipment on the first floor, no time will be lost by the electricians having to move heavy components up to the second floor.*

Appendix R: Harris County Property Tax Abatement LEED Policy

TEXAS

Incentives/Policies for Renewables & Efficiency

Printable Version

Harris County - Green Building Tax Abatement for New Commercial Construction

Like 0

Last DSIRE Review: 06/06/2012

Program Overview:

State:	Texas
Incentive Type:	Property Tax Incentive
Eligible Efficiency Technologies:	Comprehensive Measures/Whole Building
Applicable Sectors:	Commercial
Amount:	Certified LEED (Basic): 1.0% LEED Silver: 2.5% LEED Gold: 5.0% LEED Platinum: 10%
Equipment Requirements:	Must be LEED certified Must be new construction
Start Date:	05/20/2008
Web Site:	http://www.csd.hctx.net/edah_taxabatement.aspx
Authority 1: **Date Enacted:** **Date Effective:** **Expiration Date:**	Tax Abatement Guidelines 2012-2013 03/27/2012 04/01/2012 03/31/2014

Summary:

In 2008, the Harris County Commissioners Court adopted guidelines for partial tax abatements for new construction of commercial LEED-certified buildings. The tax abatement was renewed in 2009, and is currently in effect through December 31, 2011. Projects must be registered with the U.S. Green Building Council ***before*** submitting an application to Harris County Community Services Department and must be submitted to the County ***before*** construction of the project commences, otherwise the project is not eligible for this type of tax abatement. Tax abatement agreements are effective for up to 10 years, and are based are based on a percentage of the incremental investment associated with obtaining LEED certification.

Developers must make a minimum investment in the green building improvements of the building in order to qualify. Other requirements may apply if the Green Building Tax Abatement is paired with Harris County's standard economic development tax abatement.

Appendix S: Full Q & A with Anthony Rubino (Tellepsen Builders)

Q: Mr. Rubino, you have been a project manager in Houston for many years and have been involved with a variety of LEED projects. Can you please explain the various construction costs associated with LEED?

A: *Unfortunately, a vast majority of LEED costs are not decided by the construction team. Most of the costs associated with LEED projects come from various design decisions. The increased emphasis on energy efficiency and improved design components are what typically drives the price of LEED projects upward. Once the design is in place, very few costs are actually associated with construction.*

Q: Mr. Rubino, can you think offhand of some of the direct, construction-only costs associated with LEED projects?

A: *One of the direct construction costs found on LEED projects is the additional time and money that needs to be placed into construction waste recycling. While it is possible to handle material sorting and recycling on-site, often times this turns into a huge project headache. It becomes very time consuming for the project's superintendent, and will frequently be done incorrectly due to laborers not paying attention to marked disposal signs. Accurately weighing the tonnage of waste also becomes a burden. In my experience, it becomes more cost effective to simply have a waste management company remove the construction waste from the site and then sort it using their own facilities, especially on a smaller job. This will typically cost 30% more than simple waste removal, but it is usually done more accurately and removes a majority of the burden from the superintendent. Were the job's materials purchased close enough to qualify for the Regional Materials credits?*

Q: Yes, the team just did not file any of the required paperwork or documentation.

A: *Good, a simple uptick to the project manager's hours should be able to account for that in order to receive that credit.*

Q: Even though using third party recycling reduces the strain on the superintendent, are there still additional hours or costs that must be accounted for due to the increased coordination time required by superintendents?

A: *Yes, however on a smaller job this will only be an uptick in superintendent hours of roughly 5-10%.*

Q: Earlier you mentioned that there needed to be an uptick to the total project manger's hours. Roughly how much does the increase in paperwork requirements, material tracking, and coordination add hours to the project manager's overall time spent on the project?

A: *Yes, depending on the number of project managers located on the job and the size of the job, there will be an uptick in project manager hours of anywhere from 10% to 15%. On a project like the Fisk Corporate Headquarters job, adding 10% to the lead project manager's total hours would be enough to cover all the additional paperwork and other project manager demands if the project were to target a LEED rating.*

Q: What about application, processing, or LEED inspection fees?

A: *I do not know offhand exactly what the fee structure is for applying for a LEED rating. However, if you visit the GBCI.org webpage, you should be able to find the various fee structures for applying for a LEED rating.*

Appendix T: GBCI Fees Sheet

My Credentials | LEED Online | My GBCI.org | Help

GBCI

The Green Building Certification Institute (GBCI) recognizes excellence in green building practice and performance globally through its third-party certification services and professional credentials supporting market transformation.

PROFESSIONAL EXAMS

CREDENTIAL MAINTENANCE

BUILDING CERTIFICATION

- LEED Certification
- Certification Guide
- Fees
- Resources & FAQs
- LEED Project Directory
- LEED Online

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BUILDING DESIGN + CONSTRUCTION FEES

Registration and certification fees are subject to change and are to be calculated separately on the dates of registration and certification submission, respectively.

These fees apply to all versions of the LEED New Construction, Core & Shell, Schools, Retail: NC, and Healthcare rating systems and are for single -building projects only.

Projects currently registered under a previous LEED Rating System may upgrade to the corresponding LEED 2009 Rating System. View more details on upgrading »

	Project Gross Floor Area in Sq Ft (excluding all parking areas)			
	Less than 50,000	**50,000-500,000**	**More than 500,000**	Expedited Review
Registration				
USGBC Silver, Gold and Platinum Members		$900		N/A
Organizational or Non-Members		$1,200		
Precertification Review (Optional, LEED CS only)				
USGBC Silver, Gold and Platinum Members		$3,250		$5,000 surcharge
Organizational or Non-Members		$4,250		
Standard Review	Flat rate	Per Sq Ft	Flat rate	
Design & Construction Review				
USGBC Silver, Gold and Platinum Members	$2,250	$0.045/sf	$22,500	$10,000 surcharge
Organizational or Non-Members	$2,750	$0.055/sf	$27,500	
Split Review	Flat rate	Per Sq Ft	Flat rate	
Design Review				
USGBC Silver, Gold and Platinum Members	$2,000	$0.04/sf	$20,000	$5,000 surcharge
Organizational or Non-Members	$2,250	$0.045/sf	$22,500	
Construction Review				
USGBC Silver, Gold and Platinum Members	$500	$0.010/sf	$5,000	$5,000 surcharge
Organizational or Non-Members	$750	$0.015/sf	$7,500	

- Building Design + Construction
- Interior Design + Construction
- Operations + Maintenance
- Neighborhood Development
- LEED 2009 Multiple Buildings and On-Campus Projects
- Volume
- IMPORTANT TERMS

Appendix U: Architectural Shading Option #1

Top Rendering of Southeastern Corner Façade Shade

6' Architectural Overhang

East, South, and Western Facades

Located above the Second Story Glazing

Material: Solid Black Painted Aluminum Cantilever

Supports: HSS Metal Columns Driven Directly into the Ground

Bottom Rendering of Southwestern Corner Façade Shade

Appendix V: Architectural Shading Option #2

Top Rendering of Southeastern Corner Façade Shade

6' Architectural Overhang

East, South, and Western Facades

Located above the Second Story Glazing

Material: White, Acrylic Translucent Glazing

Supports: HSS Metal Columns Driven Directly into the Ground

Bottom Rendering of Southwestern Corner Façade Shade

Appendix W: Architectural Shading Option #3

Top Rendering of Southwestern Corner Façade Shade

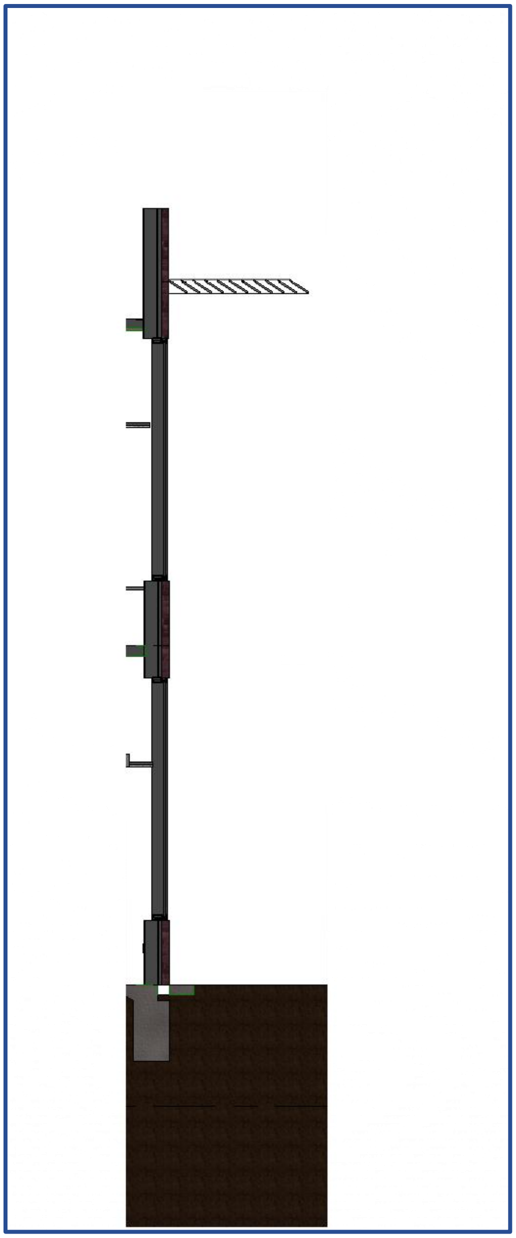
6' Architectural Overhang

East, South, and Western Facades

Located above the Second Story Glazing

Material: Louvered Aluminum Metallic Panes

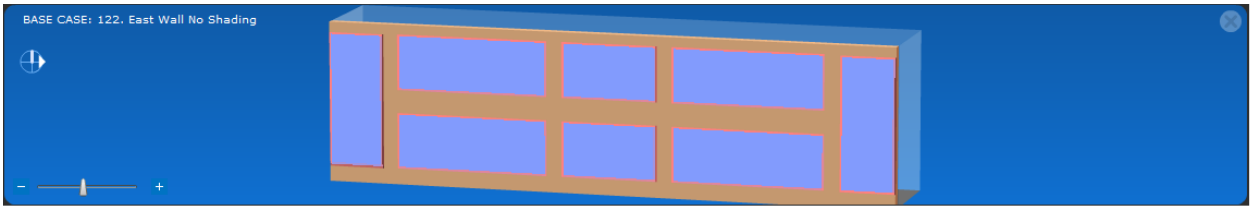
Supports: HSS Metal Columns Driven Directly into the Ground



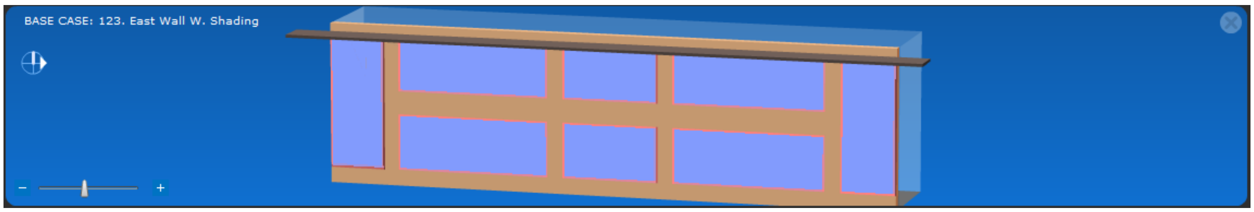
Section of Louvered Architectural Shade

Appendix X: Eastern Façade Energy Results Charts

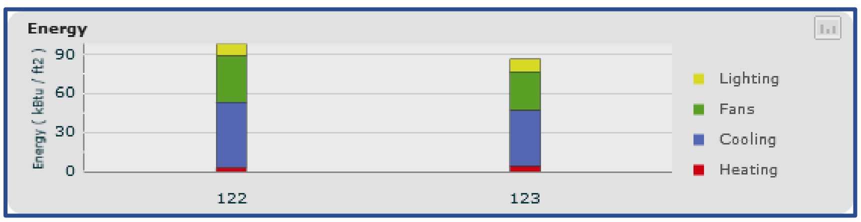
Produced by COMFEN program



Eastern Wall Model: No Shades Modeled

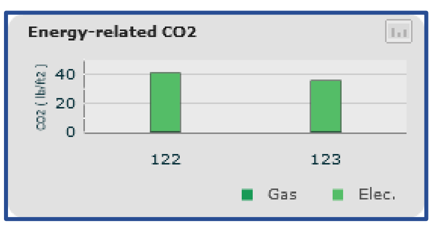


Eastern Wall Model: Shades Modeled



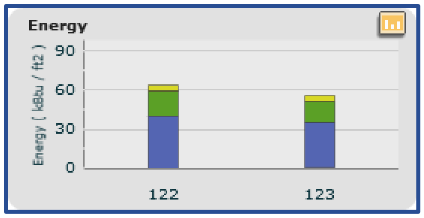
Total Annual Energy in KBTU/ft^2

(Left: Without Shading**; Right:** With Shading)



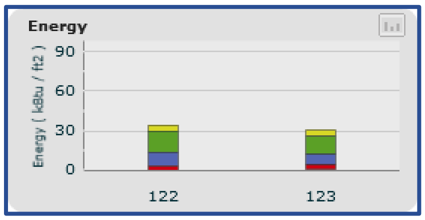
Energy Related Annual CO2 Emissions in lbs/ft^2

(Left: Without Shading**; Right:** With Shading)



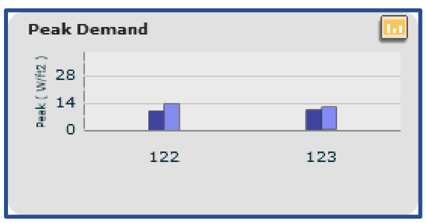
Total Annual Cooling Energy in KBTU/ft^2

(Left: Without Shading**; Right:** With Shading)



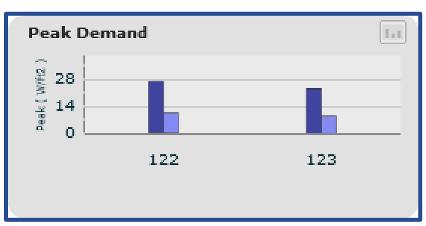
Total Annual Heating Energy in KBTU/ft^2

(Left: Without Shading**; Right:** With Shading)



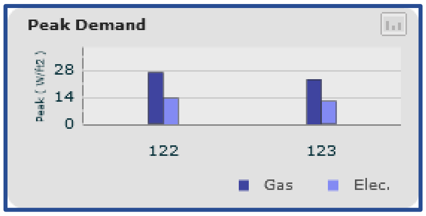
Peak Cooling Demand in W/ft^2

(Left: Without Shading**; Right:** With Shading)



Peak Heating Demand in W/ft^2

(Left: Without Shading**; Right:** With Shading)

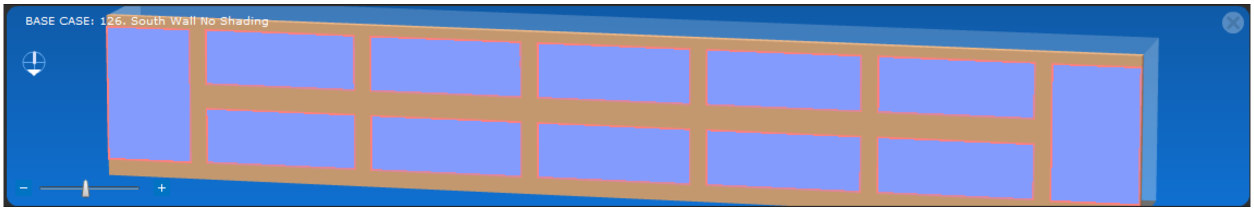


Peak Demand in W/ft^2

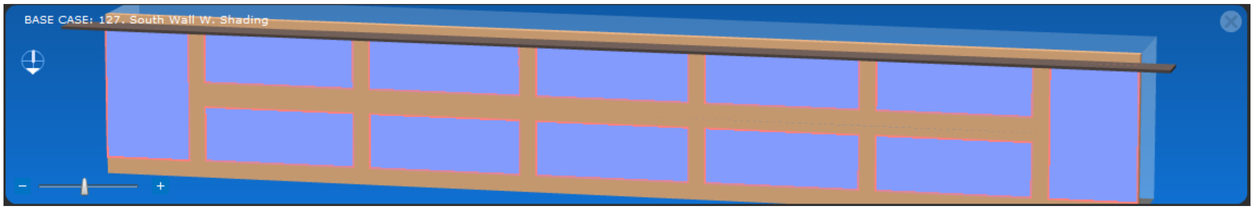
(Left: Without Shading**; Right:** With Shading)

Appendix Y: Southern Façade Energy Results Charts

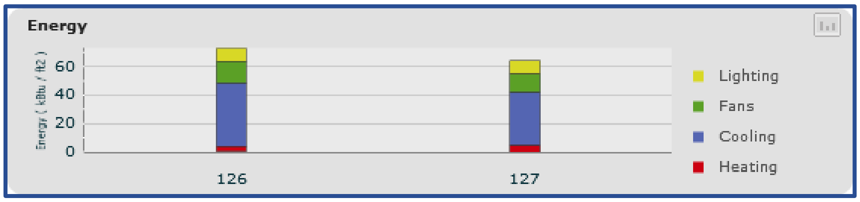
Produced by COMFEN



Southern Wall Model: No Shades Modeled

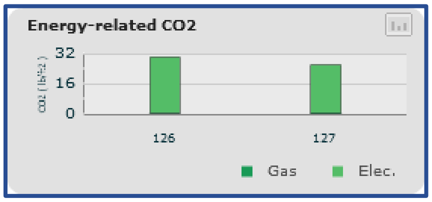


Southern Wall Model: Shades Modeled



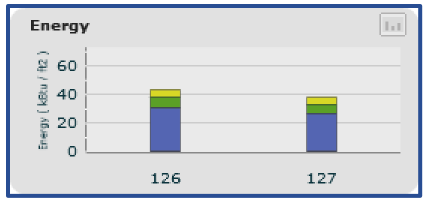
Total Annual Energy in KBTU/ft^2

(Left: Without Shading**; Right:** With Shading)



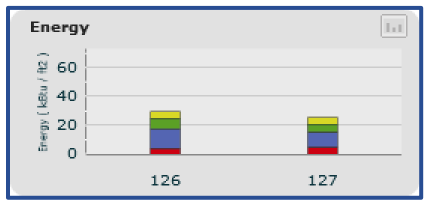
Energy Related Annual CO2 Emissions in lbs/ft^2

(Left: Without Shading**; Right:** With Shading)



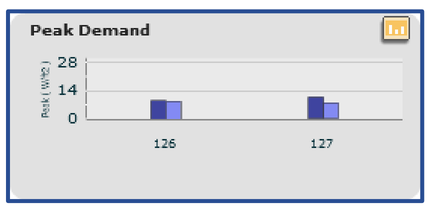
Total Annual Cooling Energy in KBTU/ft^2

(Left: Without Shading**; Right:** With Shading)



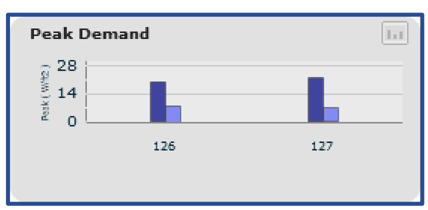
Total Annual Heating Energy in KBTU/ft^2

(Left: Without Shading**; Right:** With Shading)



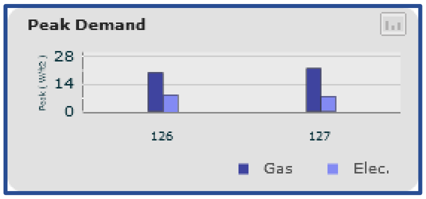
Peak Cooling Demand in W/ft^2

(Left: Without Shading**; Right:** With Shading)



Peak Heating Demand in W/ft^2

(Left: Without Shading**; Right:** With Shading)

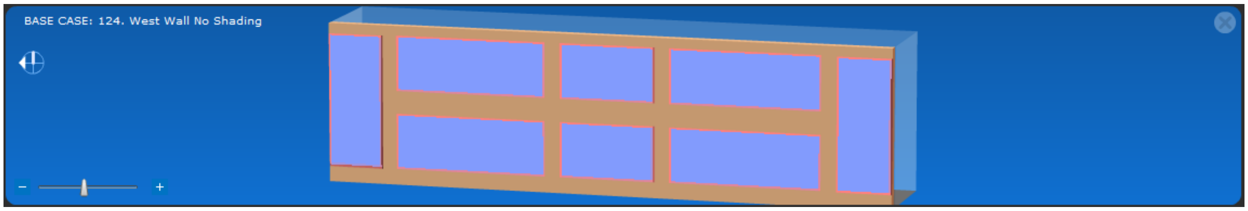


Peak Demand in W/ft^2

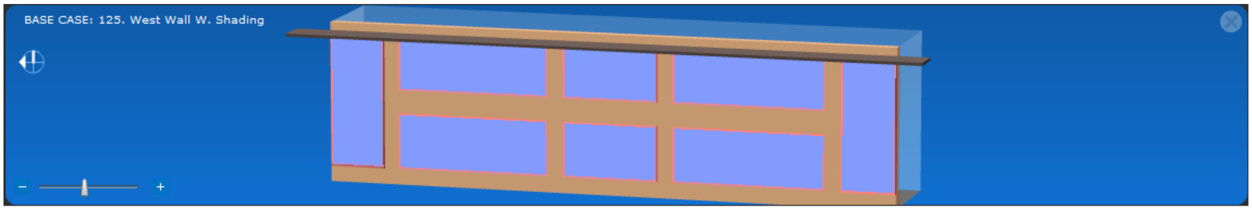
(Left: Without Shading**; Right:** With Shading)

Appendix Z: Western Façade Energy Results Charts

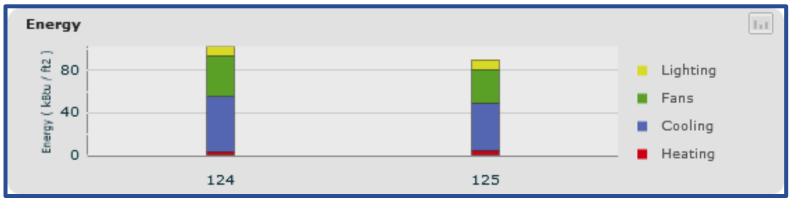
Produced by COMFEN



Western Wall Model: No Shades Modeled

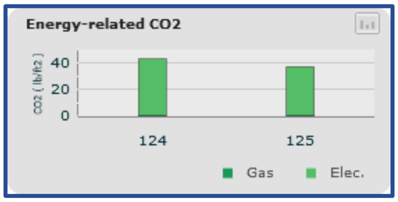


Western Wall Model: Shades Modeled



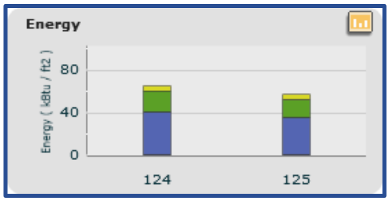
Total Annual Energy in KBTU/ft^2

(Left: Without Shading**; Right:** With Shading)



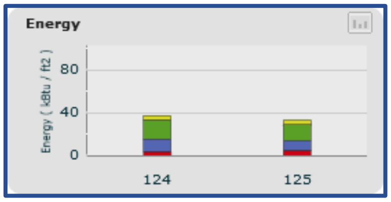
Energy Related Annual CO2 Emissions in lbs/ft^2

(Left: Without Shading**; Right:** With Shading)



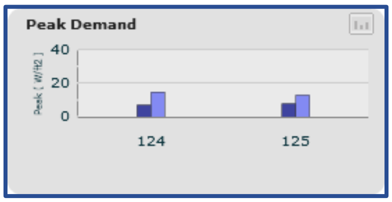
Total Annual Cooling Energy in KBTU/ft^2

(Left: Without Shading**; Right:** With Shading)



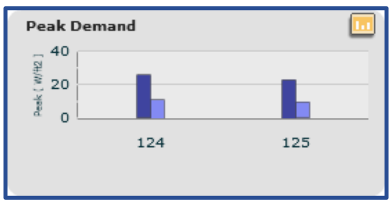
Total Annual Heating Energy in KBTU/ft^2

(Left: Without Shading**; Right:** With Shading)



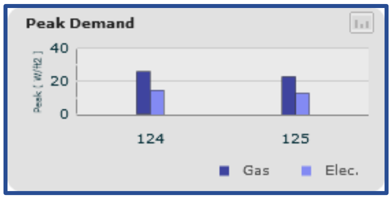
Peak Cooling Demand in W/ft^2

(Left: Without Shading**; Right:** With Shading)



Peak Heating Demand in W/ft^2

(Left: Without Shading**; Right:** With Shading)



Peak Demand in W/ft^2

(Left: Without Shading**; Right:** With Shading)

Appendix AA: Full Q & A with Andy Graham (Haley Greer)

Q: Mr. Graham, you were the project manager for Haley Greer, the glazing contractor on the Fisk Corporate Headquarters project. After speaking with the project team, it was understood that one of the more difficult areas in terms of construction on the project was the façade installation. According to the ownership team, this problem arose from the abnormal way in which the various façade systems were assembled. Can you please explain this abnormal process and how it was detrimental to façade install?

A: *The reason this process turned into a problem on the project stemmed more from tolerances than the process itself. Typically, the steel contractor is allowed to frame-out the window opening before we as the window contractor manufacture our glazing. However, due to tight scheduling constraints, these two activities had to happen simultaneously. When we came together to interface our systems, the framing for the windows did not line up with the glazing itself. After close investigation, it was determined that the reason for this failure was that the steel framing was not square. Our manufactured windows were therefore not able to fit within the available openings.*

Q: Once this was discovered, how was the situation remedied? Was there any time lost by either contractor?

A: *Ultimately, the situation was remedied by both contractors having to rework various components. In some situations we ended up having to alter our manufactured glass to fit within the available openings. In others, the steel framing was so unacceptable that the steel contractor was forced to re-frame out the entire opening.*

I do not remember the exact amount of the back charges associated with the rework, but I believe we ended up receiving roughly $20,000 in back charges due to our lost time and required rework.

Q: Do you have experience using BIM for coordination and do you believe that BIM could have been used to help mitigate the challenges that arose on the Fisk Corporate Headquarters project?

A: *Yes, I do have experience with BIM being used both successfully and unsuccessfully on various projects. However, I do not believe that BIM would have been able to solve the issues that arose on the Fisk project. The issue on the project stemmed from the steel contractor being forced to work within tight tolerances unsuccessfully. I do not believe that giving him the same tolerances in a model rather than a 2 dimensional drawing would have changed the result.*

Appendix BB: Full Q & A with Phillip Smith (Fisk Electric)

Q: Mr. Smith, as you are well aware, one of the biggest challenges on the Fisk Corporate Headquarters project was the installation of the façade, in particular the window framing. This analysis is seeking to determine whether or not implementing BIM to aid in the coordination of the window frames would have helped to eliminate the challenges. In your experience with detailing from BIM models, roughly how many hours do you think it would take a BIM technician to detail all the windows on the Fisk building for the construction?

A: *If I had to guess how long it would take one technician to detail every single window, I would estimate it at roughly one month. One month might actually be a little bit more than he would actually need, but if I were being conservative I would guess a month.*

Q: If it was assumed that one month consisted of 22 working days, this would equate to 176 man hours. Does this number seem reasonable?

A: *Yes, conservatively speaking, a BIM technician should be able to properly detail each window and provide the crews with the required information for installation in that time.*

Q: Mr. Smith, can you give me a rough estimate of the cost of a BIM technician in Houston, Texas without any overhead and profit?

A: *For a technician with the skills required to produce detailing diagrams, I would say that he would cost a company around $30 per hour.*

Q: In your experience, can you think of any problem that might arise from using BIM as a detailing or communication tool on the Fisk Corporate Headquarters project?

A: *As you well know, BIM is a fantastic tool when used appropriately. In my opinion, it has the capacity to eliminate 95% of field problems if the systems are installed identical to the BIM model. However, the biggest two drawbacks to using BIM are the up-front costs and the time it takes to create the models. In the case of the Fisk Corporate Headquarters project, BIM was not used for coordination because the project team did not believe the cost of implementing BIM would have been worth the benefits. Another problem typically associated with BIM is the lack of time often built into the job to complete coordination. Often times the coordination model does not begin until after construction begins. The BIM team inevitably ends up falling behind and the construction team is not able to take full advantage of the technology.*