Senior Thesis Final Report
The Pennsylvania State University
Architectural Engineering

Memorial Hospital Miramar - Aerial View

Bret King
Construction Management Option
Memorial Hospital Miramar
Miramar, Florida
Memorial Hospital Miramar
Miramar, Fl

Bret King
Construction Management

Project Overview
- Cost: $65 million
- Size: 4 Story 275,280 sq ft New
- Type B Occupancy Hospital Building
- Project Duration: March 2003 to March 2005
- Project Delivery Method: CM Guaranteed Maximum Price

Project Team
- Owner: Memorial Healthcare Systems
- Architect: Gresham, Smith, and Partners
- CM: Centex-Rodgers, Inc.
- General Trades: ISEC, Inc.
- Mechanical: John J. Kirlin, Inc.
- Electrical: Meisner Electric, Inc.

Architecture
- Mediterranean Architecture
- Light Stucco Exterior
- Low Pitched Clay Tile Roofs
- Use of Arches in Walkways
- Extensive and Serene Tropical Landscaping

Structure
- Exterior CMU Block Walls
- Poured Concrete Columns and Steel Columns with Concrete Encasement
- Cast in Place Beams and Precast Soffits
- Spread Footing Foundation
- 5” Concrete Slab on Grade

Mechanical
- Air Handling Units ranging from 7,700 to 29,625 CFM
- 3 Cooling Towers at 728 ton capacities
- Two 1,320 ton and one 30 ton chiller
- Pre-action Fire Protection System

Electrical / Lighting
- 480 / 120V Exterior Transformers
- 1600A 277/480 and 120/208 3 phase 4 wire panel boards
- Use of fluorescent, incandescent, and HID metal halide fixtures

CPEP Website:
www.arche.psu.edu/thesis/2005/bwk125
Acknowledgements

I would like to thank the following groups who have assisted me throughout my entire senior thesis experience:

- Penn State AE faculty
- Centex Construction, Inc.
- ISEC, Inc.
- Memorial Healthcare Services

A special thanks goes to the following individuals who lent their much appreciated time and help:

- Carlos Sirgo - Centex Construction, Inc
- Tadd Hilgendorf
- Jeff Strand - ISEC Inc
- Dr. Michael Horman - Penn State AE advisor
- Shawn Smith - Gresham, Smith, and Partners
- My parents for their unlimited support throughout my 5 years at PSU
- Last but not least, a very special thanks goes to the late night AE crew who kept me sane throughout multiple all-nighters
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Executive Summary

The following senior thesis report consists of research investigating the construction of the Memorial Hospital Miramar in Miramar, Florida. Three different analyses were conducted exploring possible system redesigns, schedule reductions, cost savings, and value engineering.

The first analysis deals with the insurance policy used during construction. A contractor controlled insurance policy (CCIP) was the program used for the project. This type of insurance has the potential to save the general contractor money if implemented correctly and few accidents are recorded on the job. The implementation and effectiveness of the CCIP are evaluated to determine whether or not the use of the CCIP was beneficial to the overall project.

The second analysis is of the existing pre-action fire suppression system in the building. An alternate water-mist system is proposed to replace the pre-action system. The system has the potential to greatly reduce water and smoke damage caused by fires which is extremely important in the computer/data rooms where the traditional pre-action system is located.
The third analysis deals with the building design. A flat-slab structural design is proposed to replace the existing concrete beam and girder construction. Panel partition walls are also proposed to replace the current wall system. Together, these two design changes can make the hospital more adaptable to the changing needs of the end user in the future.
General Project Data

- **Building Name:** Memorial Hospital Miramar
- **Location:** 1901 SW 172\textsuperscript{nd} Ave., Miramar, Florida 33027

- **Site:** The site is approximately 124 acres and is separated from a gated residential community to the north and a shopping plaza to the south by a small lake and lush wetlands. The hospital shares the site with a 120,000 square foot medical office building. Future construction is being planned for the site as well.

- **Building Occupant Name:** Memorial Healthcare Systems

- **Occupancy Type:** Group B
- **Size:** 249,200 square feet

- **Number of Stories:** 4

- **Primary Project Team:** Architect: Gresham, Smith & Partners (www.gspnet.com)
  CM: Centex Rodgers, Inc. (www.centexrodgers.com)
  Consulting Engineers: Smith Seckman Reid (www.ssr-inc.com)
  Owner: Memorial Healthcare Systems (www.mhs.net)

- **Construction Dates:** March 2003 – March 2005
- **Cost Information:** Overall Cost – 65 million

- **Project Delivery Method:** Construction Manager
Architecture

- **Architecture:** Memorial Hospital Miramar utilizes Mediterranean style architecture. One of the main features is the tile roof which is generally low pitched and brightly colored. The exterior is white stucco which contrasts well with the roof tile. Other characteristics include the use of arched entrances and walkways, few projections, and little ornamentation.


- **Zoning and Historical:** Memorial Healthcare Systems is among the leaders in hospitals. They have an outstanding reputation and work well with the community. This hospital was constructed to deal with the growing population in Miramar and the surrounding areas.

- **Building Envelope:** The roofs consist of clay S-tile over roofing membrane for water and moisture protection. In roof areas without clay tile, a roofing membrane exists over light weight concrete encapsulated roof insulation. The exterior finish is ¾” cement plaster stucco on 8” CMU wall which is filled with 500 insulating foam. The foundation is concrete slab on grade over a vapor barrier and granular fill.
Project Delivery System

The type of project delivery system utilized on the Memorial Hospital Miramar project is Construction Manager with a guaranteed maximum price. This type was chosen mainly because Memorial Healthcare Systems have constructed many hospitals around the country and have had proven success with this type of delivery system. Centex-Rodgers, Inc., the CM, is a respected and quality manager of hospital projects. They are responsible for the management of the actual building construction itself, as the design and site work contracts are the responsibility of the architect and site work contractor, respectively. The construction manager is also responsible for contracting out part or all of the construction work on behalf of the owner as well as making sure the project is delivered on schedule and within the budget.
Project Schedule Summary

Construction of the Memorial Hospital Miramar commenced in March 2003 and is scheduled to be completed in March of 2005. The schedule of construction of the Memorial Hospital Miramar is broken down into eight sequences, with each sequence representing a different area of the building. This allows for efficient allocation of resources to ensure the building construction is performed effectively and the project is finished on time.

Key Elements of Construction:

Foundation:
- Excavation and layout of spread footings
- Form and pour spread footings and grade beams

Structure:
- Prep and pour columns
- Set pre-cast joists
- Form and pour deck and beams
- Erect CMU stem wall

Finishes:
- Metal stud framing and dry wall
- Prime and paint walls
- Install light fixtures
- Casework
- Interior glazing
- Resilient flooring
- Acoustical ceiling tile
Building Systems Summary

The Memorial Hospital Miramar utilizes a cast-in-place concrete spread footing foundation. The typical footings are 4 feet below finished grade and sit on solid lime rock. Dewatering was not necessary because excavation was performed above the water table and consequently no groundwater was present during excavation of the foundation. The exterior walls are constructed of load bearing reinforced 8” concrete masonry units (CMU). The CMU is filled completely with grout and was erected with the aid of fabricated frame scaffolding that can be easily stacked several stories high to ease the placing of the block and also keep the workers safe. Floor construction consists of 6” slab-on-grade and 5 ¾” elevated slabs. 24” x 24” cast-in-place concrete columns in conjunction with cast-in-place beams and pre-stressed pre-cast joists make up the structure of the building. A strong and secure connection was accomplished by monolithically pouring the slab with the beams. Pre-cast joists and soffits were manufactured by Prestress Concrete, Inc. and cast at their location in Miami Lakes, Florida approximately 10 miles from the Memorial Hospital Miramar construction site. A mobile truck crane was used to place the pre-cast members due to its ability to move around the site easily to place the members in all locations.

The type of air conditioning system used in Memorial Hospital Miramar is multi-zone constant air volume. Hot and cold air are blended using mixing dampers controlled by local thermostats and discharged into a number of supply ducts serving different zones. 17 air handling units (AHU) ranging from 7,700-29,625 cfm help supply the air throughout the
building using both rectangular and oval sheet metal ductwork. The AHUs are located in mechanical rooms on each of the four floors and also in the penthouses. Both vacuum steam boilers and hot water boilers are used to help supply the building with heat. These boilers along with the chillers, fire pumps, and power house are located on the ground floor in the far southeastern corner of the building. This area serves as the central station of the building.

The cooling towers are located adjacent to the central station area and are housed separately from the building itself instead of the typical roof location. The type of fire protection system used in the Memorial Hospital Miramar is pre-action. The system is initially a dry-pipe system but water is delivered into the pipes when smoke is detected so water will be available immediately if needed.

Memorial Hospital Miramar utilizes both 277/480V three phase four wire and 120/208V three phase four wire power systems. The higher voltages are mainly supplied to motors and pumps and used for site lighting. The lower voltages are supplied mainly for lighting and receptacles. Two diesel fueled emergency generators with automatic battery chargers are located in the main electrical room on the second floor. The emergency standby system provides a complete automatic synchronizing and paralleling system that runs at 480V 3 phase, 4 wire. It is especially important for hospitals to have adequate emergency power because of the special equipment and life saving devices running off of electricity.
Project Cost Evaluation

Building Sq. Ft.: 275,281

Building Construction Cost (CC): $46,810,633

Building Construction Cost / Sq. Ft. (CC/SF): $170.05

Total Project Cost (TC): $65,201,365

Total Project Cost / Sq. Ft. (TC/SF): $236.85

Mechanical Systems Cost: $13,553,846

Mechanical Systems Cost / Sq. Ft.: $49.24

Electrical Systems Cost: $7,710,113

Electrical Systems Cost / Sq. Ft.: $28.01

Structural Systems Cost: $10,155,276

Structural Systems Cost / Sq. Ft.: $36.89

Design Cost: $2,754,617

% Design Cost to CC: 5.88%
Bret King  
Construction Management  
Memorial Hospital Miramar  
Miramar, Florida  
Advisor: Dr. Michael Horman

## D4 Estimate

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Total Building Costs: 100 191.68 52,764,800

## R.S. Means Cost Estimate

This estimate is based on the 2002 R.S. Means Facilities Construction Cost Data catalog and was performed using 3/4 square foot costs for hospitals. The 3/4 square foot cost from the catalog is multiplied by the square footage of the building then by the city cost index for Miami, Florida which is the closest available city cost index to Miramar.

\[
\text{Sq. Ft. \times \frac{3}{4} S.F. unit cost \times \text{city cost index}} = \$54,583,500
\]

275,281 x 233 x .851 = $54,583,500
Comparison Between Estimates and Actual Costs

The cost estimates obtained from both the D4 software and the R.S. Means catalog were over $10 million less than the actual cost of Memorial Hospital Miramar. Some of this difference can be explained due to the extensive site work, landscaping, and irrigation on this project. While the D4 software estimated the site work to be slightly under $2 million, the actual cost of site work was nearly $8 million. The mechanical systems used in the Memorial Hospital Miramar were also more expensive than estimated by more than $2 million. This difference may be due to the pre-action fire suppression system used in the hospital which is more expensive and complicated than the more commonly used systems.
Local Conditions

The preferred method of construction in South Florida is concrete construction. Concrete’s ability to withstand high wind loads makes it an ideal construction material in an area that is highly susceptible to hurricane force winds. Florida imports roughly 40% of its cement annually and is currently experiencing rising cement prices due to shortages in the region. These shortages cause delivery delays which can have a large impact on the construction schedule. In other areas of the country contractors may be able to have the concrete delivered in days or even hours whereas in Florida it may take up to a week to get the concrete delivered. This requires a great deal of planning and coordination from the construction manager.

South Florida is at high risk during the summer hurricane season. Buildings must be protected from the high force winds and damaging rain caused by hurricanes. Even though Memorial Hospital Miramar is located in Broward County, Miami-Dade County standards, the strictest in the state, were put in to place on the project to further ensure the building’s safety against hurricane conditions. The South Florida Building Code also enforces strict standards which help protect the building’s stability and ensures the safety of the people occupying it.

There is no shortage in availability of labor in South Florida. Florida’s population is among the fastest growing in the nation and as the population increases a need for new
construction arises to cope with the expanding population. A significant amount of these new construction jobs are occupied by immigrants who make up one third of Florida’s population increase. Organized construction labor unions are nearly non-existent in South Florida allowing for cheaper labor to be acquired and put in to practice.

Due to the large site area of Memorial Hospital Miramar, there is plenty of room for staging of materials and no shortage of available construction parking. The local soil conditions consist of a 6 inch top layer of sand followed by 18 inches of milled lime rock, 2 feet of crushed lime rock, and solid lime rock underneath. The solid lime rock provides an excellent surface to base a foundation. Subsurface water conditions can be a concern especially for projects located near the coast because of high water tables. There was no subsurface water present on site at Memorial Hospital Miramar because it is far enough inland not to be greatly affected by the high water tables and also because the fact that the site sits on solid lime rock.
Client Information

The owner of this project, Memorial Healthcare Systems, has extensive experience in building hospitals. They have constructed over 17 hospitals in South Florida, have over 50 years experience, and are among the leaders in the cutting edge of hospital construction and technology. Memorial Healthcare Systems is familiar with construction practices in the area and knows what has to be accomplished to get the project finished satisfactorily. The owner is building this hospital due to the rapidly increasing population of South Florida. Demand was high for a hospital in the Miramar area to fit the needs of the people and to also provide jobs for numerous people.

Memorial Healthcare Systems has extremely high expectations to keep the project on schedule and within budget. Memorial Healthcare Systems has a good reputation within the community and plans to uphold it by opening the building on the date they promise.

Joe Alcure, Memorial Healthcare Systems representative on the Miramar project, makes sure operations are running smoothly by enthusiastically interacting daily with many managers and superintendents on the project. Memorial Healthcare Systems will be satisfied when the project is finished on time, within the budget, and with the quality deserved of a Memorial Healthcare hospital.
Assemblies Estimate

The assemblies estimate was performed using Means Cost Works 2004 for substructures. This substructure estimate was composed using the following systems:

- Strip footings (L.F.)
- Spread footings of various sizes (Ea)
- 5” thick slab-on-grade (S.F.)
- 4’ high cast-in-place foundation walls (L.F.)

The total price was modified using the city cost index for Miami, Florida.

Assumptions:

- All strip footings are 24” wide by 12” deep
- All footing sizes used in the Memorial Hospital Miramar can be matched with the sizes given in Means Cost Works 2004
- All slab-on-grade is 5” thick
- Square footage for SOG is a rough estimate
- Foundation walls are cast-in-place concrete

Substructure Estimate

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<th>Inst.</th>
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Totals: $615,904.40 $772,346.40 $1,388,250.80

Modified for the city cost index (Miami, Fl)..........................$1,388,250.80 * .851 = $1,181,401.40
Contracts

The owner of the Memorial Hospital Miramar, Memorial Healthcare Systems, has fixed price contracts with the architect, engineers, site work contractor, and CM @ Risk. All subcontracts of the CM, Centex-Rodgers are also fixed price contracts. In this type of contract, the owner agrees to pay a fixed amount of money to each contractor which includes overhead and profit for all work being performed for the specific scope of work. If the costs incurred by the contractor exceed the fixed price amount, the owner is only required to pay the amount of the original fixed price contract. To avoid this happening, each contractor adds contingencies and allowances in the price of their bid. Allowances must be approved by the owner before they can be added to the contract amount.

The use of fixed price/lump sum contracts has increased in the healthcare market in the past few years. Both Memorial Healthcare Systems and Centex-Rodgers specialize in healthcare facility construction. They are very knowledgeable of the scope of work and delivering services due to this specialization. This makes both companies very confident in managing the risk associated with the project which makes for an appropriate and ideal environment for the use of fixed price contracts.

A contractor controlled insurance policy (CCIP), or wrap-up program, is put in to place at the Memorial Hospital Miramar. In this case, the CM controls all the insurance under one insurance program. CCIPs are generally best used on safe projects ranging from $50-100 million where there is a minimum amount of claims filed. The premium
achieved through the use of CCIP is usually significantly less than if each contractor buys its own insurance and includes that price along with any markup in their bids. This allows the contractor to actually make profit from the use of a CCIP. The types of insurance included in the CCIP for this project are worker’s compensation, employer’s liability, general liability, and builder’s risk. Centex-Rodgers has extensive experience in handling CCIP insurance policies which is needed to successfully carry out the insurance program.

The types of bonds used in the Memorial Hospital Miramar are 100 percent payment and performance bonds. For the payment bond, a surety company guarantees the contractor will 100 percent off all debts that arise throughout the construction project even if the contractor goes bankrupt during construction. The performance bond guarantees that 100 percent of the work specified in the contract will be performed to the standards set on behalf of the contractor to the owner. The use of a bid bond was not utilized on this project.

The contractors on this project had to be pre-qualified to bid on the work under each contractor’s scope of work. The pre-qualification was based on bonding capacity, amount of backlogging, and whether or not the contractor has completed satisfactory work with the hiring party in the past. This was done to ensure the quality and standards expected of a healthcare facility built by Memorial Healthcare Systems. If bids were based on lowest price, the highest quality contractors might not have been selected
Bret King
Construction Management
Memorial Hospital Miramar
Miramar, Florida
Advisor: Dr. Michael Horman

Staffing Plan

CENTEX RODGERS, INC.
MEMORIAL HOSPITAL MIRAMAR
On-Site Staff

Kevin Ream
Senior Project Manager

Carlos Sirgo
Project Manager

Gary Kirk
Project Superintendent

Jamie Malick
Project Accountant

Katie Rogalski
Receptionist/Assistant

Steve Welton
Assistant Project Manager

Gary Pedroni
Site, Landscaping/ MOB Superintendent

Herb Carnes
Ext. Enclosure, Roofing Superintendent

Project Engineer
M.E.P.

Tedd Hinzendorf
Office Engineer
Structure, Ext. Enclosure, Finishes, Int. Buildout

David Dzialal
Office Engineer
Stiewk, Landscaping, OFE - Hospital, MOB

Color Code:
Management: Field: Office: 
Kevin Ream is the senior project manager for Centex-Rodgers. He oversees all operations for the project and has daily close relations directly with the owner’s representative Joseph Alcure, Jr. Mr. Ream has final say of decisions regarding the project. Carlos Sirgo is the project manager and oversees daily operations in the site office as well as also having much interaction with the owner’s representative. Gary Kirk is the project superintendent and he supervises the actual construction taking place on the Memorial Hospital Miramar. His job is to manage daily construction and to inform the project managers of any potential problems associated with the construction as well as give an updated status on the progression of the project. Gary Pedroni is an assistant project superintendent particularly in charge of site construction, landscaping, and the medical office building being constructed adjacent to the Memorial Hospital Miramar. Herb Carnes is also a project superintendent who is in charge of exterior enclosures and roofing construction. Assigning multiple superintendents allows for the construction to be monitored more closely for the most efficient construction possible. Steve Welton is an assistant project manager that helps manage daily operations in the field office. Centex-Rodgers employs three office engineers to run different operations in specific areas of the project’s construction. An office engineer is in charge of the MEP systems, Tadd Hilgendorf is in charge of the building structure, exterior enclosure, finishes, and interior build out and David Dasal is in charge of sitework, landscaping, owner furnished equipment, and the medical office building construction. Having multiple office
engineers to handle different areas of construction also helps to keep the project running smoothly, on schedule, and within the budget proposed. Jamie Malick is the project accountant who handles all of Centex-Rodgers’ financial data for the Memorial Hospital Miramar and makes sure the company is in adequate financial shape to be able to perform daily operations as per the construction contract. Katie Rogala is the receptionist/assistant on the project. She keeps daily operations organized and helps to ensure everything runs smoothly in the field office.
Design Coordination

The design and coordination of the MEP work on the Memorial Hospital Miramar is extremely important in the overall construction of the building. Hospitals generally have more complicated and extensive MEP systems due to ventilation requirements, additional piping for medical gas, and complicated electrical controls. MEP coordination was taken very seriously on the project as much coordination was required.

The foundation for MEP coordination is laid out in the contract documents. The contract documents outline procedures for coordination meetings prior to construction. These meetings involve all parties relevant to the construction being discussed and lay out specific agendas to be followed to allow for the most efficient coordination. Pre-installation meetings take place to make sure everything is on track before the actual construction commences. Progress meetings are also required on a monthly basis to make sure the construction is being performed on schedule and without problems.

The contract documents also require coordination drawings for the first through fourth floors to avoid conflicts and identify problems prior to construction. These drawings show the placement of beams, MEP work, lights, security systems, and all other construction needing coordination. The coordination drawings also illustrate the required installation sequences so a trade does not install their equipment before scheduled which could lead to major complications and delays in construction.
Full sized mock-ups are required for the LDRP, ICU, Medical Surgery, and Patient Rooms prior to the installation of medical gas piping, electrical outlets, systems, and lighting to make sure no casework, devices, or outlets interfere with these systems. Mock-ups are also required for other specific areas that require extensive coordination to be able to realize the physical aspects and feasibility of the locations of different MEP systems.

An area that exhibited coordination challenges during the construction of the hospital was ceiling heights. The owner wanted the ceilings to be very high and to fit most of the MEP work in the corridors. A plan was attempted to be able to fit the systems in the space provided, but with the amount of MEP work on the project, this idea was not feasible. Ceiling heights had to be lowered in order to have enough plenum space to accommodate all the MEP systems. The construction manager on the project is also encountering problems as the City of Miramar inspects the building. Miramar is inexperienced in inspecting complex buildings like the Memorial Hospital Miramar as there has been no other construction of this type in the area. This can lead to installation and/or construction delays due to the inspector’s slow and unknowledgeable inspections.

MEP coordination is a very important and integral part of any construction especially projects as MEP intensive as healthcare buildings. The Memorial Hospital Miramar is a very extensive MEP project that takes thorough and careful coordination to ensure construction is carried out without problems or delay. It takes active participation
and close cooperation of all parties involved in the MEP construction process to ensure successful installation of MEP systems.
**Temporary Facilities**

Temporary facilities are an important part of any construction project. They ensure the project is able to support functions necessary for construction before the permanent systems are ready for use. How these facilities are managed, operated, and transitioned to permanent systems plays a great deal in the success of the project. The temporary facilities are specified with great detail for the Memorial Hospital Miramar to make sure all goes smoothly.

The temporary utilities specified for the hospital include:

- Self-contained vented toilet units and wash facilities with temporary connections to sewers, drainage ditches, dry wells, stabilization ponds, or containers
- Bottled water, drinking water units kept at 45 degrees where electricity is accessible
- Water service and distribution piping in sizes and pressures adequate for construction
- Temporary heating and cooling for curing/drying and to maintain minimum 50 deg F in permanently enclosed areas and 65 deg F for finishing activities.
• Weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics. Use of NEMA-polarized outlets with GFCI, reset button, and pilot light is required.

• Temporary lighting with local switching; one 100W incandescent lamp per 500 sq. ft. general lighting, every 50 ft. in traffic areas, and per story in stairway and ladder runs.

• Telephone service throughout construction for common-use facilities

The temporary support facilities include:

• Roads and paved areas adequate to support loads and exposure to traffic in same location as permanent roads and paved areas

• Insulated, weather tight, air-conditioned field office with private toilet and of sufficient size to accommodate a meeting of at least 12 persons

• Facilities for hoisting materials and personnel excluding truck cranes and similar devices

Protection facilities for the project include:

• Earthen embankments in and around excavation and subgrade construction sufficient to prevent flooding
• Pest control service to perform extermination at regular intervals so project will be free of pests

• Portable chain-link enclosure fence with lockable entrance gates for sufficient area of project site

• Temporary enclosure for protection of construction and completed work from bad weather, construction operations, and similar activities.

• Fire protection facilities complying with NFPA 241 including fire extinguishers and temporary standpipes and hoses

All facilities must be kept in good condition at all times to ensure both safety and the efficient running of daily construction operations. As soon as a permanent system is up and ready, the temporary facility is to be discontinued.
Insurance Policies in the Construction Industry

Introduction

The construction industry is among the most dangerous and volatile industries in the world. If a major player on a construction project is not intensely focused on jobsite safety and properly insured, the results could be devastating for the project and potentially the company. In the case of injuries and unforeseen circumstances, effective insurance policies are needed. One such type of insurance policy which has gained popularity over the past few years is the wrap-up policy, specifically an Owner Controlled Insurance Policy (OCIP) and a Contractor Controlled Insurance Policy (CCIP). These wrap-up insurance policies provide a potential for owners or general contractors to save money on the project by purchasing the insurance for all the subcontractors at a reduced rate and also by eliminating mark-ups from subcontractors that have their own coverage. A CCIP is utilized on the Memorial Hospital Miramar in lieu of the traditional type of insurance coverage offered by each sub-contractor. The main factor to a successful CCIP policy is jobsite safety. Centex Construction conducted daily orientation safety meetings for all personnel new to the jobsite. If a worker did not go through orientation, they would not be allowed to work on site. Centex also utilized an on-site safety coordinator that was there 3 days a week. This helped to ensure the jobsite was a safe one.
**Problems**

Despite the potential to make money from the CCIP, there can be complications when trying to initiate this type of insurance. Additional costs are often associated with CCIPs including additional accounting efforts, monitoring efforts to ensure claims from subcontractor’s employees injured on other jobs are not charged to the OCIP/CCIP, and increased responsibilities for the implementation of safety programs. The use of OCIP/CCIP tends to make the subcontractors more relaxed on safety issues, which makes the jobsite potentially more dangerous as well as increasing the responsibility of the on-site safety coordinator. Other problems that may arise through the implementation of a CCIP are:

- Difficulty getting subcontractors to agree with the wrap-up policies due to unfair bid deduct calculations
- Subcontractor unfamiliarity of the programs
- Loss of mark-up on insurance costs to the subcontractor

The safety precautions implemented at the Memorial Hospital Miramar were successful, with 0 significant claims being filed for the entire project. Centex was able to make approximately $500,000 on the project attributed to mark-up cost savings and the excellent safety record.
Despite these savings at the Memorial Hospital Miramar, the mechanical sub-contractor did not initially agree to the terms of the CCIP. The sub-contractor felt the bid amount was being unfairly deducted and a contract amount could not be agreed upon. This disagreement could be attributed to the contractor’s unfamiliarity of the CCIP terms. The disagreement significantly delayed the project by approximately two months which came out of the general contractor’s pocket through overtime wages in order to ultimately get the project back on track. This delay cost the general contractor approximately $750,000 for the overtime work.

**Solution Overview**

The solution to the above problems can be approached from two sides. The use of traditional insurance policies would have eliminated the delays caused by the mechanical contractor not agreeing to the terms of the CCIP. The two months would not have been needed to be made up and the general contractor would have saved the money that had been lost through the additional overtime work. Additional administrative costs would have also been eliminated through the use of the traditional insurance policies.

Although delays in the schedule existed, there was the potential for the CCIP to run smoothly and ultimately be a success. A way to remedy that situation would be to educate subcontractors on the terms of the CCIP to make sure they are familiar with how the CCIP works. This could be accomplished through pre-bid meetings and seminars to
ensure that all contractors under the terms of the CCIP know what is being offered. Contractors that aren’t familiar with CCIPs would be hesitant to bid the project allowing contractors who have worked with CCIPs before to gain a competitive advantage. It would also be advantageous to hold pre-construction meetings to discuss the insurance policy. On this project, the CCIP forms were just given to the subcontractors without explanation of terms or how the program works. Through conferences conducted by the risk manager, any potential problems could then be dealt with and settled before the construction schedule would be impacted.

**Conclusion**

A summary of the costs associated with the implementation of the CCIP are as follows:

- Administration Costs: \(0.03\% \times \$65,201,000 = \$196,000\)
- Cost savings from elimination of mark-ups: \$$500,000\$
- Schedule: Two month delay
- Overtime to make up schedule loss: \$$750,000\$

Total cost savings from implementation of CCIP = \$$-446,000\$
A total of $446,000 was actually lost on the project due to the implementation of the CCIP program. The main factor contributing to the loss of money was the significant delay caused by disagreements of the CCIP contract. To keep the project on schedule, the general contractor had to pay the sub-contractor $750,000 in overtime work. If the CCIP program would have went smoothly, however, a potential profit of $304,000 could have been realized. Although it would have been ultimately advantageous to use traditional insurance programs on this particular project, the use of CCIP at the Memorial Hospital Miramar provided stepping stones for successful implementation of subsequent CCIP programs on other projects. Initiative must be taken to ensure all the contractors bidding and working on the project know and understand the terms of the CCIP to alleviate or address problems before they have the potential to significantly impact a construction project.
**Water-Mist Fire Suppression System**

**Introduction**

Fire suppression systems are an extremely important part of every commercial building that ensures the safety of the occupants and limits damage due to fire. The Memorial Hospital Miramar utilizes both a wet system and pre-action system to meet the needs of fire suppression. Both systems are popularly used in all types of commercial buildings. An alternative system that is being used in the market today is a water-mist fire suppression system. The system was initially developed for protection of lumber drying kilns and later for use on ships. When Halon suppression systems were deemed environmentally unsafe in 1995, water-mist systems became the leading candidate for replacement. Today, water-mist systems are used primarily to suppress fires related to gas turbines, machine rooms, and ships, and have also been used in computer rooms and laboratories to protect the equipment. The water mist system has been most recently used in The National Gallery of Art to protect expensive artwork, which received a WBC craftsmanship award for the system.
Water-mist systems use pressurized nozzles which release water droplets of varying size. The mist encapsulates the fire and as it turns to vapor, removes heat from the source. As the mist turns to steam, it expands immensely (1700 times) forcing oxygen away from the flame. This denies the fire the necessary oxygen to be able to sustain itself.

One company on the forefront of research in the water-mist category is NanoMist Systems, LLC. The water-mist system they have developed, NanoMist, uses an extremely fine mist that exhibits gas-like dispersion behaviors to absorb the energy of the fire and act as a flooding agent to extinguish fires. Their use of computer simulation models has made it easier, faster, and more affordable for water-mist technology to be developed. Through the use of a computational fluid dynamics (CFD) program called FLUENT, the NanoMist system could be compared to other systems in terms of extinguishment time, the mist’s wetting nature, total water needed, and mass flow requirements.

Another high density system that has been proven effective in land-based systems is HI-FOG, a class 1 water mist as defined by NFPA 750, developed by the Marioff Corporation. This is the system used in the National Gallery of Art in Washington, DC which is the first museum in the United States to use this system. The HI-FOG system uses technology similar to that of the NanoMist system to suppress and extinguish fires.
The extremely small drop size used in the HI-FOG system generates a vaporization rate around 400 times that of a conventional sprinkler system. The vaporization absorbs energy and can cool fires much faster than conventional sprinkler systems.

<table>
<thead>
<tr>
<th>Drop Size Comparison</th>
<th>Drop Size (avg um)</th>
<th>Vaporization Rate</th>
<th>No. of Drops</th>
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<tr>
<td>Sprinkler</td>
<td>&gt; 1000</td>
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<td>1</td>
</tr>
<tr>
<td>Class 2/3 Mist</td>
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<td>10</td>
<td>40</td>
</tr>
<tr>
<td>HI-FOG</td>
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<td>400</td>
<td>8000</td>
</tr>
</tbody>
</table>

The vaporization effect also locally inerts the environment from the volumetric expansion of the water. This allows for the mist to penetrate the flame where the effect is most pronounced. The small water droplets also have another effect on the fire. The drops effectively block radiant heat. This property enables fire fighters to stand closer to the fire.
to extinguish it more efficiently. The radiant heat blocking also helps to protect against structural damage by protecting members from immense heat caused by the flames.

**Problems**

The Memorial Hospital Miramar is a very MEP intensive project, as is the case with most other healthcare facilities. This means that space is at a premium when trying to coordinate the location of all the mechanical, electrical, and plumbing equipment. A pre-action system requires much piping and controls that add to the complexity of the coordination and installation process.

The main disadvantage of the traditional pre-action system in the Memorial Hospital Miramar is the amount of water it uses to suppress fires. The main reason this is a disadvantage is because the system is located in computer and IT rooms which contain expensive equipment. If a fire exists, the water from the sprinklers could damage the equipment and any important data within the equipment would be lost as well. The amount of water released also makes clean up and restoration a more difficult process. It would take longer for the water to be removed from the rooms and the restoration would be more extensive due to greater water damage.

The piping for the pre-action system must be designed for the amount of water flowing through them and the pipes must also be designed to handle the pressure from the
flowing water. In traditional systems, this requires the pipes to be considerably larger than that used in water-mist systems. The larger pipes make it more difficult to fit in the space required due to all the other MEP systems needed in the Memorial Hospital Miramar. The larger size of the pipes in turn makes them heavier than those of the water-mist system, especially when they are filled with water.

**Solution Overview**

The traditional pre-action system used in the Memorial Hospital Miramar will be replaced with a HI-FOG water mist system. The pipes in the area occupied by the pre-action system are required to be dry by code. In effect, the HI-FOG system will also incorporate qualities of the traditional pre-action system. The pipes will be dry until a detection device (smoke detectors) detects the presence of a possible fire. A supply valve opens and the pipes will then be filled with water ready to be distributed.

The HI-FOG system proposed for use in the Memorial Hospital Miramar will also incorporate a smoke scrubbing element. The plastics used in computer equipment have the potential to produce large amounts of smoke, even with small fires. The smoke produced has the potential to do much damage to the equipment therefore the equipment must be protected from this smoke in order to avoid damage. Pipes will be located in the sub-floor as well as being located in the ceiling. Upon activation of the initial smoke detection alarm, the horseshoe shaped pipes in the sub-floor discharge the water mist in
opposite directions which in turn causes the smoke to be sucked in and scrubbed by the mist. Drops containing the smoke particles condense at the bends in the piping and are collected at a later time for retrieval. The ceiling mounted system then discharges water mist directly into the room to suppress and extinguish the fire. Additional smoke will be absorbed by the fog and fall to the floor.

The piping in the HI-FOG system is also considerable smaller than the existing pre-action system. The HI-FOG system will utilize 1” stainless steel pipes instead of 2 ½” steel pipes. The smaller size of the pipes also reduces the weight of the system. The amount of water discharged by the HI-FOG system is only 10-20% of the water discharged in the traditional pre-action system. This significantly reduces the amount of damage done to the equipment by water discharge.

**Comparison of HI-FOG System vs. Traditional Sprinkler Systems**

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<th>PROPERTY</th>
<th>SPRINKLERS</th>
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<tbody>
<tr>
<td>Extinguishing</td>
<td>No</td>
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<tr>
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<td>Yes</td>
</tr>
<tr>
<td>Safe for Equipment</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>
Conclusions

The initial cost of both systems was analyzed for the existing pre-action system and the proposed water-mist system, respectively. The results were as follows:

- Pre-action system - $810,500.00
- Water-Mist system - $912,000.00

The HI-FOG water-mist system was estimated to be $101,500.00 more than the pre-action system in regards to initial cost. This can be contributed to special parts unique to the water-mist system. The particular system proposed for use in the Memorial Hospital Miramar requires two separate detection systems in order for the system to function properly. This adds to the initial costs of implementing the system. The water-mist system also uses more expensive piping to hold the water. Even though the piping is smaller than the pipes used for the pre-action system, the material used is of better quality and therefore more expensive. Since the technology of water mist systems is still emerging in the computer/data/laboratory sector, most of the parts are all specially made by a small number of manufacturers. This allows the manufacturers to charge premium prices for the equipment used in the systems.
Even though the water mist system was estimated to have higher initial costs, there is the possibility for savings in case a fire does break out in the area occupied by the sprinkler systems. If the existing pre-action system is activated, it is possible that all of the equipment in the room could be damaged. The amount of damage varies on the severity of the fire, amount of smoke created, and amount of water damage sustained. The water damage is potentially much less with the water-mist system proposed. Little to no equipment damage could be realized. Since the system also effectively disperses smoke out of the space, smoke damage is considerably reduced. The water-mist system has the potential to save owners a substantial amount in damage control, which varies depending on the equipment in the rooms.

Initially, the maintenance costs of the water-mist system were thought to be lower than that of the traditional pre-action system. After research though, this was proven to be untrue. Average yearly maintenance costs for pre-action systems ranges from approximately $500 - $1000 for testing and cleaning out of pipes. According to NFPA 750, water mist systems are required to have quarterly checks, and must be fully tested every year. The costs associated with this are approximately $1000 - $2000 per year. The small number of qualified installers and testers along with the special considerations that must be made for this system drives the maintenance costs up.
Taking into consideration the lower initial costs and lower maintenance costs, it would be advantageous to not implement the HI-FOG water mist system in the Memorial Hospital Miramar. Although the potential for cost savings exists through damage control, it would be more feasible to stick with the current pre-action system used in the Memorial Hospital Miramar.
Flexible Building Design

Introduction

Technology in the healthcare field has continued to steadily advance in the past decade. As healthcare technology rapidly advances, the functionality of building spaces will become increasingly important. Needs of the user as well as building spaces will change and evolve to match the changing technology.

Florida is among the fastest growing states in the United States with a population growth rate of 23.5%. In particular, the city of Miramar is experiencing rapid increases in population. A growth of 76.43% was recorded from 1990-2000 and the trend is continuing. A higher overall population inevitably leads to more patients at healthcare facilities. As the number of patients increases, building spaces may need to be altered to comfortably accommodate all patients. More patients also mean a heightened need for a larger staff. To accommodate the staff and keep satisfactory production rates, rearrangement of office space and staff work areas will need to be adapted.

These factors require the building to be flexible and adaptable to most efficiently meet the changing needs of the user. Intelligent facilities design can contribute significantly to reducing the cost of operations in terms of improved staff productivity, reduced building operations and maintenance expense, and improved safety for patients and staff.
Problems

The current structural system consists of poured concrete columns with cast-in-place beams and pre-cast soffits. The cast-in-place beams increase the complexity of required formwork. This can lead to increased construction time and also drives the cost of the project up. In a building that requires extensive MEP work, there must be a significant amount of space available to most efficiently fit the equipment in the building. The owner initially wanted 10 foot ceiling heights for most of the rooms in the building. After MEP analysis, however, this height would not allow enough plenum space to properly fit all of the MEP equipment. The ceiling heights had to be lowered to allow enough space to fit the equipment. The beams reduced the space available for the MEP equipment. Penetrations through the beams would not be a feasible solution in order to better fit the MEP equipment. The beams can also hinder the placement of partitions. This in turn effects room layouts and limits the flexibility of design of the room spaces.

Future changes in need or use of spaces in a building requires significant remodeling. The removal and addition of wall layouts comprises a substantial amount of this remodeling. A significant amount of dust can be generated from the stripping of drywall. This is undesirable, especially in healthcare facilities where cleanliness is of the utmost importance. The dust generated also requires significant clean up after construction is complete. This adds to clean up time and cost and also delays the re-institution of normal day to day operations.
Solution Overview

A flat slab system with drop panels and without beams will be instituted in place of the current cast-in-place beam system. By using the flat slab system, formwork can be simplified allowing for lower labor costs and faster construction time. The elimination of beams also provides additional plenum space to fit MEP equipment. Ceiling heights could then be effectively raised to the desired height. Flat slab construction without beams also has the possibility to reduce building height. The reduction in building height can reduce costs associated with cladding, piping, elevators, and other materials. Height reduction also reduces effective area for wind loads which is a big consideration in Miramar, which is located in a high-velocity hurricane zone.

The flat slab system will comprise of 10” slabs with drop panels extending 3” past below the slab at the columns. Shear walls of 8” thickness will also be implemented around the stairways and elevators. The shear walls help to ensure the structure meets requirements set forth in the 2001 Florida Building Code for High-Velocity Hurricane Zones. All other elements meet the standards in the 2001 Florida Building Code.
In addition to the flat slab system without beams, panel partition wall systems will also be implemented into the building. If room layouts need to be changed in the future, the panel partition walls can be disassembled, reused, and put back up in other locations. This greatly reduces the material needed for future construction due to the fact that the walls can be reused. The walls can be taken down and reassembled quickly reducing renovation durations. This enables day to day operations to be up and running sooner than with traditional wall systems. The amount of dust generated by the panel partition system is minimal compared to that of traditional wall systems. This reduces clean-up duration and cost which makes the panel system a more desirable alternative. If the wall is damaged in the panel system, it is also easier to repair. Instead of having to rip down additional drywall, the damaged panel can simply be taken out and replaced by a new panel without having to remove adjacent panels. This quality also greatly reduces waste associated with building renovations making them safer for the environment.

The panel walls can also be easily insulated to achieve sound attenuation requirements and fire rated for up to a one hour fire rating. Electrical and data/phone conduits can be provided by the panel wall provider or by others if necessary.
Conclusions

The costs of the existing slab and beam structural system and the proposed flat slab without beams system is as follows:

- Existing System - $11,121,278.00
- Flat Slab System - $8,221,602.00

As initially thought, the flat slab system offers initial cost savings of nearly three million dollars. Formwork is much simpler in this system, considerably reducing the cost. The concrete can also be poured more efficiently thus taking away from the installation costs.

The implementation of the flat slab construction also shortened the schedule by approximately three weeks. This is extremely important because the erection of the superstructure is on the critical path in determining the project duration. The saving in schedule time gives the contractor some leeway in case the project has unforeseen delays. The contractor can also save money by finishing the project earlier than anticipated. This is realized through lower operation costs and possible incentives or bonuses for finishing the project ahead of schedule.
The panel partition wall system also generated cost savings. The costs of the two systems are as follows:

- Existing walls - $593,000.00
- Panel System - $566,250.00

The extent of the cost savings was approximately $26,750. Most of the savings are realized through decreased labor costs. The installation of the panel walls is easier than the traditional wall system which cuts down on labor time and costs. The panel walls can also cut erection time by 13 days. Schedule savings are also realized when renovations are taken into account. The panel walls are erected faster in areas that require additional walls and are also disassembled and put back together in another location close to two times faster than a traditional wall can be torn down and rebuilt in another location.

Given the cost saving and schedule reduction abilities of both systems, it would be a wise choice to implement them in the Memorial Hospital Miramar. Along with these construction management attributes, the new design would incorporate greater flexibility in both functionality and architectural design. Flexibility of new construction is an important issue in the healthcare industry. Buildings must be able to adapt to the changing world around them to stay functional, just like a living being.
Summary/Conclusions

Insurance Policies in the Construction Industry

Insurance programs are a very important aspect in the construction industry. If a contractor has inadequate coverage, the results could be disastrous to the project and possibly even the entire company. Wrap-up insurance provides more than sufficient coverage while also supplying the owner or general contractor the potential to gain more profit on a construction project. In order to accomplish this, safety on the jobsite is of the utmost importance. This often requires rigorous safety monitoring on part of the general contractor or owner’s on-site safety manager. Another key to wrap-up insurance success is the knowledge of the program by all contractors involved in the construction project. This was the downfall of the CCIP used for the Memorial Hospital Miramar. Contract disagreements led to the project being delayed and ultimately cost the general contractor money in the long run. Through pre-bid and pre-construction meetings specifically tailored toward understanding the wrap-up insurance program, problems could be alleviated that could ultimately lead to delays and lost revenue down the road.
Water Mist Fire Suppression Systems

Water-mist fire suppression systems are still an emerging technology in land-based computer/data rooms. As technology advances and a better understanding of water-mist systems is attained, these systems will be considered more frequently as a safe and cost-effective solution for fire protection needs. The potential exists through water-mist systems to safely protect sensitive equipment that could be harmed by extensive saturation of water. Clean up times could be reduced and damage due to smoke could also be kept at a minimum. For the Memorial Hospital Miramar, however, it would be advantageous to keep the existing traditional pre-action system. With few reputable water mist systems on the market for computer/data rooms today, the cost to implement and sustain water mist systems is higher than the pre-action system in use. Water mist systems are considered a specialty construction item and are presently better suited for government and military projects where cost is not a critical issue. Water mist systems are also more popularly used on cruise ships and boats where it is advantageous to use as little water as possible in piping to keep the weight of the vessel as low as possible.
Flexibility in Building Design

As healthcare technology advances, it is critical to design facilities that can adapt as efficiently as possible to changing end user needs. Population increases, especially in Broward County where the Memorial Hospital Miramar is located, also require healthcare buildings to be flexible. Easier adaptability is ideal for the user so they can make necessary changes and continue normal operations as quickly as possible. Flat Slab construction without beams and the use of panel partition wall systems is an efficient means to reach flexibility in building design. In addition to providing the building adequate flexibility in design, the above systems can also offer cost and schedule reduction properties. These properties are desirable in the construction management process.
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Appendices

A. Site Plan
### B. Sprinkler Estimates

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<thead>
<tr>
<th>Qty</th>
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### Water-Mist System Estimate

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<td>$527,000.00</td>
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### C. Structural Estimates

#### Existing Structure Estimate

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<th>Qty</th>
<th>Description</th>
<th>Unit</th>
<th>Mat.</th>
<th>Inst.</th>
<th>Total</th>
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<tbody>
<tr>
<td>1922</td>
<td>Strip footing, 24&quot; wide x 12&quot; deep, reinf</td>
<td>L.F.</td>
<td>21,622.50</td>
<td>34,884.30</td>
<td>56,506.80</td>
</tr>
<tr>
<td>3</td>
<td>Spread tgs 6'-0&quot; sq x 14&quot; d</td>
<td>Ea.</td>
<td>537.00</td>
<td>819.00</td>
<td>1,416.00</td>
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<tr>
<td>18</td>
<td>Spread tgs, 7'-6&quot; sq x 18' d</td>
<td>Ea.</td>
<td>6,940.00</td>
<td>8,280.00</td>
<td>15,120.00</td>
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<tr>
<td>40</td>
<td>Spread tgs, 12'-6&quot; sq x 26' d</td>
<td>Ea.</td>
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<td>56,000.00</td>
<td>121,000.00</td>
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<tr>
<td>4</td>
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<td>10,600.00</td>
<td>23,500.00</td>
</tr>
<tr>
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<td>22</td>
<td>Spread tgs 4'-6&quot; sq x 12&quot; d</td>
<td>Ea.</td>
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<td>3,542.00</td>
<td>5,720.00</td>
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<tr>
<td>42</td>
<td>Spread tgs, 8'-6&quot; sq x 20' d</td>
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<td>25,410.00</td>
<td>48,090.00</td>
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<tr>
<td>97</td>
<td>Spread tgs, 10'-6&quot; sq x 25&quot; d</td>
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<td>192,545.00</td>
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<tr>
<td>72</td>
<td>Spread tgs, 14'-0&quot; sq x 31&quot; d</td>
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<td>297,000.00</td>
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<td>551,145.00</td>
<td>767,340.00</td>
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<td>294</td>
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<td>16,023.00</td>
<td>20,597.60</td>
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<td>668,930.40</td>
<td>1,332,355.20</td>
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<td>82,883.62</td>
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<td>401,391.88</td>
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<td>18,142.40</td>
<td>29,152.96</td>
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<tr>
<td>55</td>
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<td>259.28</td>
<td>3,787.28</td>
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<tr>
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### Proposed Flat Slab System w/ Drop Panels

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<th>Mat.</th>
<th>Inst.</th>
<th>Total</th>
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<tbody>
<tr>
<td>1922</td>
<td>Strip footing, 24&quot; wide x 12&quot; deep, reinf.</td>
<td>L.F.</td>
<td>21,622.50</td>
<td>34,684.30</td>
<td>56,506.80</td>
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<tr>
<td>3</td>
<td>Spread fps 6'-0&quot; sq x 14&quot; d</td>
<td>Ea</td>
<td>597.00</td>
<td>619.00</td>
<td>1,416.00</td>
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<tr>
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<td>16,120.00</td>
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<tr>
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<td>58,000.00</td>
<td>121,000.00</td>
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<tr>
<td>4</td>
<td>Spread fps, 16'-0&quot; sq x 35&quot; d</td>
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<td>12,900.00</td>
<td>10,600.00</td>
<td>23,500.00</td>
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<tr>
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<td>Spread fps, 17'-0&quot; sq x 37&quot; d</td>
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<td>20,400.00</td>
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<tr>
<td>2</td>
<td>Spread fps, 18'-0&quot; sq x 35&quot; d</td>
<td>Ea</td>
<td>8,960.00</td>
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<td>15,960.00</td>
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<tr>
<td>22</td>
<td>Spread fps 4'-5&quot; sq x 12&quot; d</td>
<td>Ea</td>
<td>2,176.00</td>
<td>3,542.00</td>
<td>5,720.00</td>
</tr>
<tr>
<td>42</td>
<td>Spread fps, 8'-6&quot; sq x 20&quot; d</td>
<td>Ea</td>
<td>22,680.00</td>
<td>25,410.00</td>
<td>48,090.00</td>
</tr>
<tr>
<td>97</td>
<td>Spread fps, 10'-6&quot; sq x 25&quot; d</td>
<td>Ea</td>
<td>97,000.00</td>
<td>95,545.00</td>
<td>192,545.00</td>
</tr>
<tr>
<td>72</td>
<td>Spread fps, 14'-0&quot; sq x 31&quot; d</td>
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<td>136,600.00</td>
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<td>216,195.00</td>
<td>551,145.00</td>
<td>767,340.00</td>
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<tr>
<td>294</td>
<td>CIP col, sq tied-min reinf,10-14' sty ht,16&quot;</td>
<td>V.L.F.</td>
<td>4,674.60</td>
<td>16,023.00</td>
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<td>663,424.80</td>
<td>666,930.40</td>
<td>1,332,355.20</td>
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<tr>
<td>300,000,000</td>
<td>Ft slb w/drp pln,25x30,24&quot;col, 10&quot; 10&quot;</td>
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<tr>
<td>15,056,000</td>
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<td>S.F.</td>
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<td>233,462.96</td>
<td>401,401.96</td>
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<td>6266</td>
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<td>19,142.40</td>
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</tr>
<tr>
<td>56</td>
<td>Structural steel member, W14x90</td>
<td>L.F.</td>
<td>3,528.00</td>
<td>259.28</td>
<td>3,787.28</td>
</tr>
<tr>
<td>56</td>
<td>Structural steel member, W14x74</td>
<td>L.F.</td>
<td>2,912.00</td>
<td>252.56</td>
<td>3,164.56</td>
</tr>
<tr>
<td>322</td>
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### D. Wall Estimates

#### Existing Wall System Estimate

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<th>Qty</th>
<th>Description</th>
<th>Crew</th>
<th>Daily Output</th>
<th>Unit</th>
<th>Bare Mat.</th>
<th>Bare Labor</th>
<th>Total</th>
<th>Total Incl. O&amp;P</th>
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</thead>
<tbody>
<tr>
<td>10,000,000</td>
<td>16&quot; O.C. x 10' H, incl cap top &amp; bottom track, etc</td>
<td>2 Carp</td>
<td>75</td>
<td>L.F.</td>
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<td>72,000</td>
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<tr>
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<td>S.F.</td>
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#### Panel Wall System Estimate

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<th>Unit</th>
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<th>Bare Labor</th>
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### E. Structural Schedule
## Existing Structure

### Classic Schedule Layout

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<th>Activity Name</th>
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<th>Remaining Duration</th>
<th>Resources</th>
<th>Budgeted Total Cost</th>
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<tr>
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**Tasks Summary**

- Actual Work
- Remaining Work
- Critical Remaining Work
- Milestone

**Task Filter:** All Activities

© Primavera Systems, Inc.
<table>
<thead>
<tr>
<th>Activity ID</th>
<th>Activity Name</th>
<th>Original Duration</th>
<th>Remaining Duration</th>
<th>Start</th>
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<th>Budgeted Total Cost</th>
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