TECHNICAL REPORT 3

C-5 Fuel Cell Facility

167th Airlift Wing

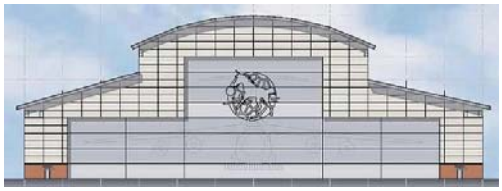
Martinsburg, WV

Kyle Goodyear

Construction Management

December 1, 2009

Dr. Magent



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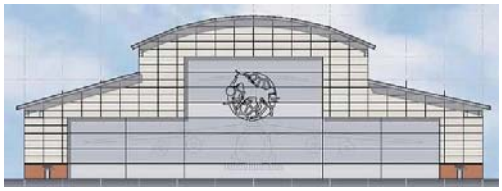
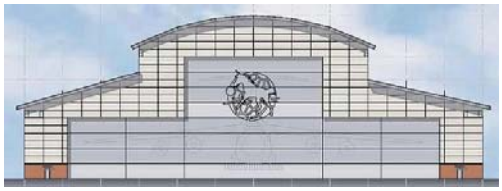


EXECUTIVE SUMMARY

For this technical assignment, the purpose is to identify potential research topics concerning the C-5 Fuel Cell Facility project. These research topics consist of particular areas of the project that could possibly be improved through investigation and in-depth study. The identification process includes an interview with the Project Manager on the Fuel Cell Facility project and my personal observations of potential opportunities for improvement.

During the project manager interview, there were three main topics discussed: constructability challenges, schedule acceleration scenarios, and value engineering topics. Within the constructability challenges topic we discussed what the project manager determined to be the three most challenging issues on the project: structural steel erection, the slab on grade in the hangar area, and the height of the building. For each issue, we discussed the reasons why it is an issue and the solution that the project team came up with to handle the challenge. For the schedule acceleration scenarios, we discussed the parts of the project that have created, and are expected to create, the greatest risk to completing the project on time. The project manager then informed me of the ways in which the schedule is being accelerated for certain activities. In most cases, the acceleration of activities on the Fuel Cell Facility has been done by way of working overtime. Finally, in the value engineering section, we discussed the value engineering ideas that were proposed by Kinsley Construction and how they were accepted or rejected by the owner.

In the portion of the assignment based on my observations, several problematic issues of the project are identified. These are issues that can be researched and analyzed based on construction methods and technical building systems. After the identification section, four analysis topics are discussed, including potential solutions to the problems and the research that will be required to properly determine the viability of the solutions.



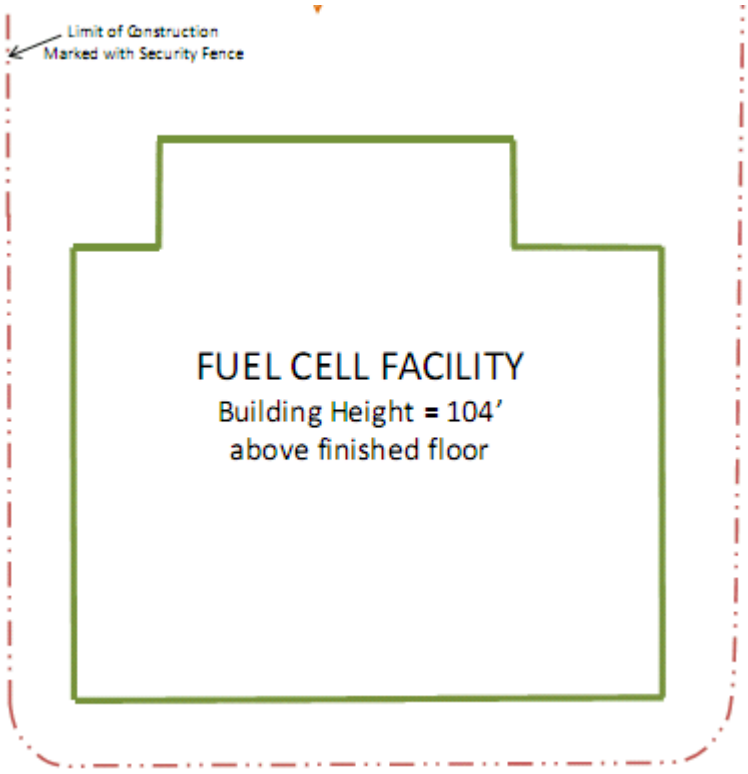
PROJECT MANAGER INTERVIEW

Through discussion with the Project Manager for Kinsley Construction who is in charge on site at the C-5 Fuel Cell Facility, I was able to identify some of the key areas of concern for him. For this technical assignment, the top three constructability challenges, schedule acceleration techniques, and value engineering ideas will be discussed.

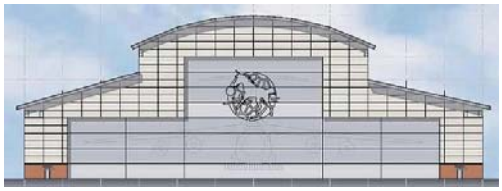
CONSTRUCTABILITY CHALLENGES

#1 Structural Steel Erection

Due to the structural requirements of the building, the erection of steel became a very difficult portion of the project. The spans which were necessary meant that several members must be extremely large in comparison to most other structural steel buildings. When construction involves large steel members, there are several challenges that arise. These problems were amplified by the tight limits of construction surrounding the structure. While there was much space available for office trailers and storage as mentioned in previous technical assignments, the actual space between the outside of the building and the extents of construction were minimal.

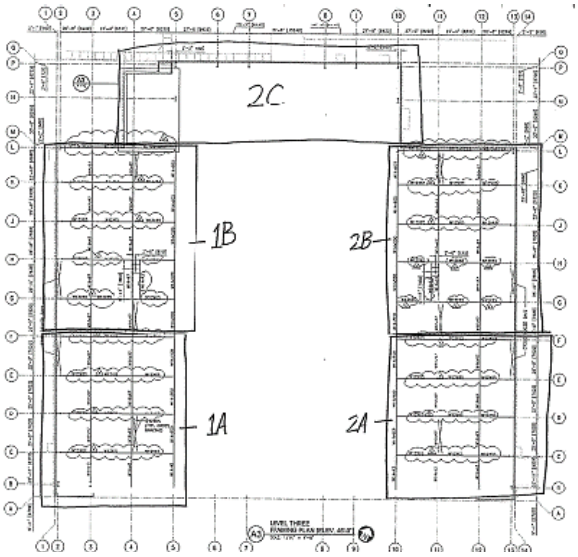


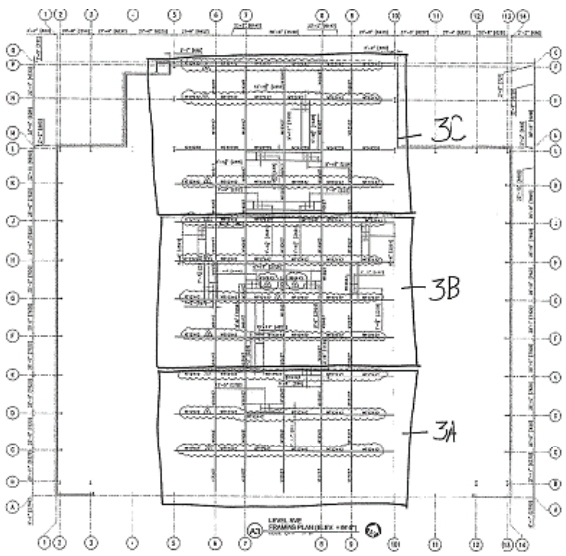
This site plan for project shows the limited space on either side of the proposed building.

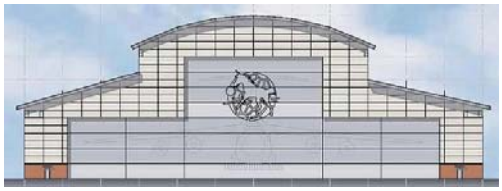


The first specific issue related to steel erection was the transportation of the steel to the site. The structural steel for this project was fabricated in York, PA and then needed to be transported to Martinsburg, WV. Due to the size of the steel members and state highway restrictions concerning load size, the steel could only be transported at certain times and only with a permit. To minimize the number of large loads, the steel was only partially fabricated in York, with the final assembly taking place on site prior to erection. Since there is a limited amount of space on site for this steel fabrication, deliveries not only had to be scheduled around the state highway restrictions, but also around the completion and erection of the members being fabricated.

The next issue concerning the steel erection, also caused by the size of the steel members, is the necessity for large cranes on a limited amount of space. Obviously, the larger the steel is, the larger the equipment will need to be to handle it. As mentioned in a previous technical assignment, three crawler cranes were used for steel erection on the Fuel Cell Facility project, and at several times it was necessary to use multiple cranes in tandem with each other. With this many cranes on site, it was crucial to create an effective erection sequence that would keep the cranes within the confines of the construction site, but still be capable of setting all of the members. The sequencing plans which were discussed in Technical Assignment #2 are shown below.





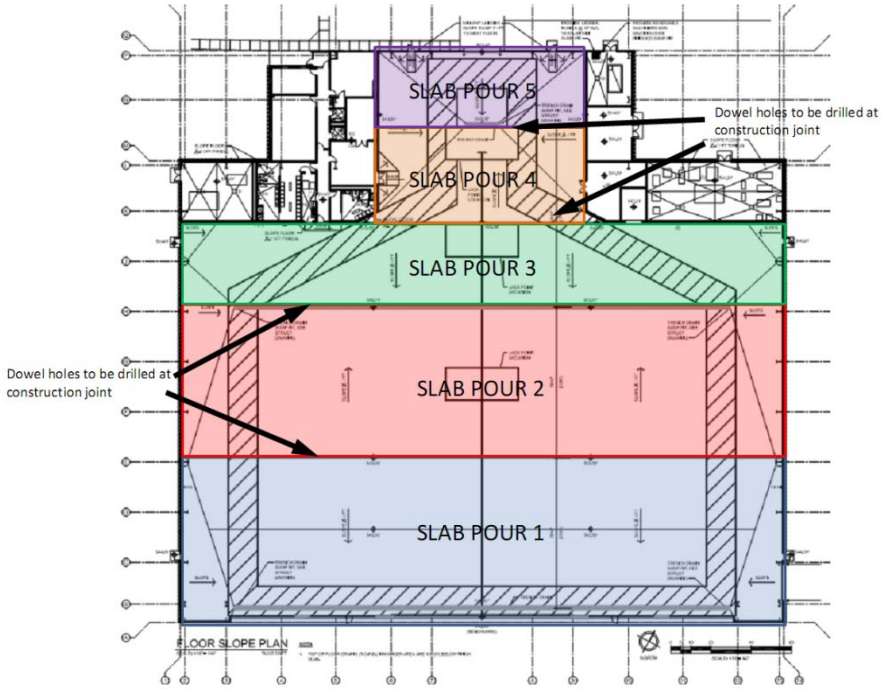


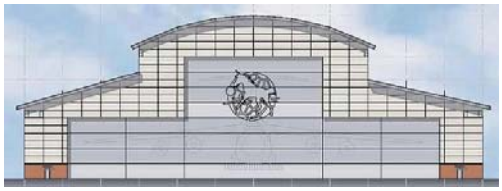
#2 Hangar Slab on Grade

Since this project is part of the 167th Airlift Wing conversion project and will be housing the C-5 aircraft, it must meet certain specifications. One of the specifications is for the slab on grade within the hangar area to meet airfield pavement requirements. Under this specification, many additional studies must be completed concerning the concrete being placed. Included in these studies are tests of the aggregates and the cement being used in the mixture, and studies of the proportions of the proposed mixtures.

Additional requirements such as these can become a major issue on a project, especially if the supplier is not accustomed to dealing with them. It was the decision of the project team to be sure to select a high quality concrete supplier who understood the necessary requirements and would be able to produce the necessary material for approval by the Contracting Officer. While this meant that a supplier other than the lowest bidder was selected, the team saved money overall by purchasing the experienced supplier.

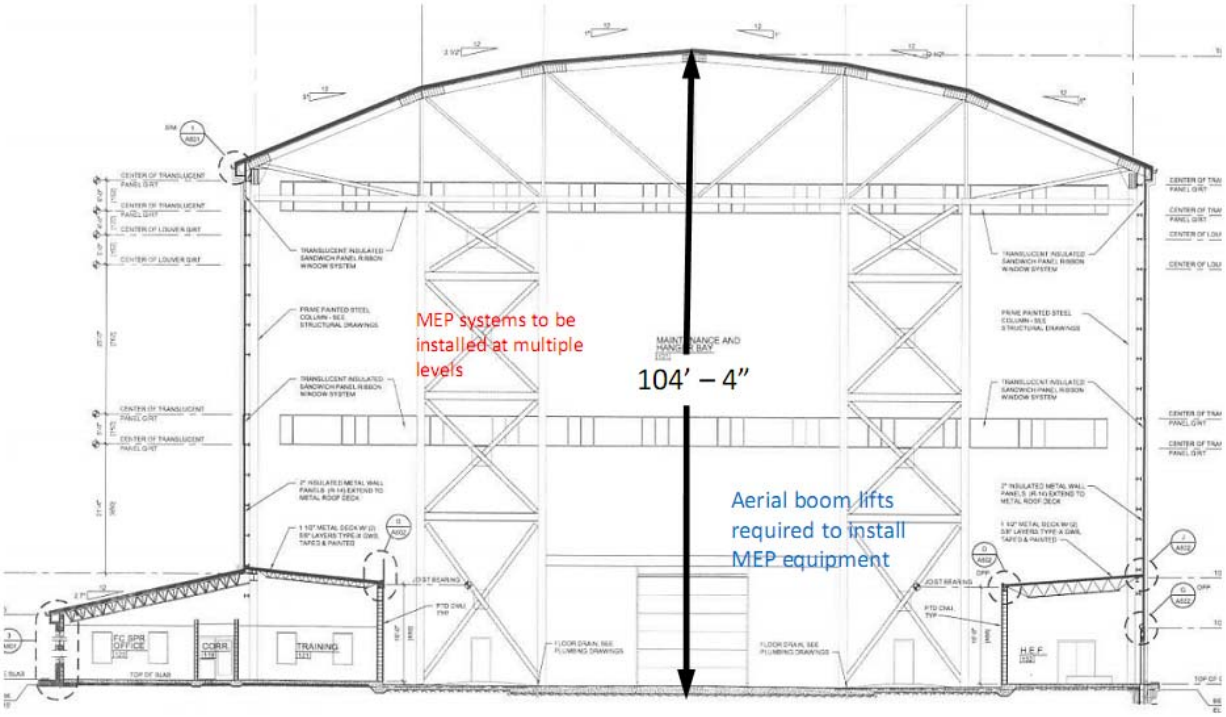
Another requirement of the airfield pavement specification which deviates from typical standard is the method for installation of dowels at the construction joints of the slab. The specification calls for the hangar slabs to be drilled for the insertion of the epoxy-coated dowels. In order to drill the slab, a minimum of three days must pass from the time of placement, thus slowing down the rate of placement. To save time, the team decided to make the placement sizes as large as possible, therefore minimizing the number of times that drilling would be necessary. The hangar slab will be completed in five total pours, three in the main hangar area and two in the smaller north end.

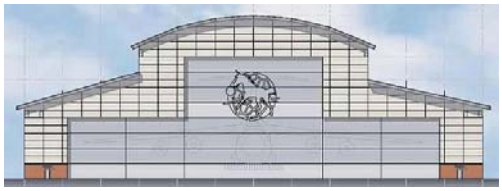




#3 Height of the Building

As may be noted from the Building Statistics page, this structure is only one story but is very tall in the hangar area. In addition, all MEP systems must be installed very high up in the building structure, which is not exactly an easy task for the subcontractors. In order to complete the work, they must use lifting equipment such as aerial boom lifts. Coordination of the trades becomes more difficult than normal once everything starts taking place high up in the air rather than down on floor level, especially when the systems continue to weave around following the structure at various heights. In order to give each subcontractor space to work, the project team is implementing a "parade of trades", but since the equipment must be installed at the varying heights, the "parade" will take place in a sort of cycle, or as the project manager put it, "a merry-go-round" until the subs install all of their equipment at each level.





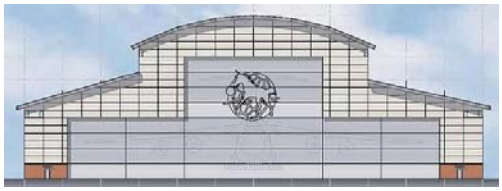
SCHEDULE ACCELERATION SCENARIOS

The critical path of the C-5 Fuel Cell Facility project schedule is weighted heavily on the structural steel in the early portion of the project. Unfortunately, as was discussed in Technical Assignment #2, this became a major problem due to issues with the design of the steel. Since the steel design was completed later than initially scheduled, the fabrication and erection processes were forced to begin late. Due to the fact that the later portions of the project could not be completed until the steel erection was done, schedule acceleration for both the fabrication and erection was necessary to avoid pushing the overall project completion date back.

Acceleration of these activities was done by increasing the number of hours worked each week. In the fabrication stage, six day weeks were employed with two shifts working each day on the steel for this project. On site, the steel erectors worked six or seven days each week at a rate of twelve hours per day in order to get more steel in place each week. Obviously, increasing the manhours for a given week means that overtime charges will be present, costing more than initially budgeted for the activity. However, due to the consequences of allowing the project to remain behind schedule, it was determined that paying for the extra labor was worthwhile.

Another key portion of the project that is a risk to a successful and timely completion is getting the building enclosed before winter arrives. The project manager explained that the installation of the insulated metal panels on the higher part of the building is a very time-consuming and labor intensive activity which must be completed prior to the arrival of winter weather. If this is not complete, the trades who need to be working inside will be put at a great disadvantage. To avoid this potential outcome, an increase of manhours has been implemented. Though this type of activity could also be accelerated by increasing the number of crews on site, it was determined that the site is already busy enough with the amount of people currently working. Adding more individuals to the project would have most likely decreased efficiency not only for the wall panel installation, but also for other activities that are going on simultaneously. Therefore, the project team decided to increase the number of hours worked and pay for the overtime.

The third area of concern for the project manager as far as the schedule is concerned, is the completion of the MEP systems. These systems must be installed with enough time available to do testing and balancing activities before the building is scheduled to be turned over to the owner. This has become a potential problem area mainly because of the delays to the steel erection process that have already been discussed. To accelerate the schedule for this group of activities, crew sizes will be increased as well as working overtime. The project team has determined that some of the other trades who are currently on site will be finished before the MEP installation gets into the full swing, so increasing the number of workers will not create too much inefficiency. Six day weeks with twelve hours worked per day are the planned rate to complete the MEP systems on time. This will again cost more than was originally budgeted but is the preferred choice when compared to a late project completion.



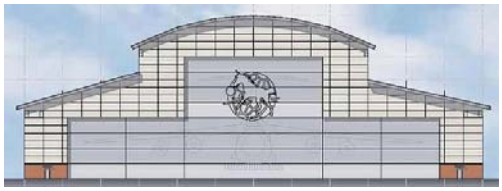
VALUE ENGINEERING

Kinsley Construction, Inc. examined the C-5 Fuel Cell Facility project and proposed five main value engineering ideas to decrease the cost of the building, four of which were accepted. The most important of the VE items proposed by Kinsley Construction was to deviate from the original design intent concerning the location of the administration area of the building, as well as the locker rooms. The RFP documents for the project proposed that a mezzanine level be created above the office spaces in order to house the administration spaces and the locker rooms, but Kinsley proposed that the administration area be added outside the originally proposed hangar footprint. They also suggested that the locker rooms be constructed within the hangar space but simply isolated from the maintenance area. By eliminating the mezzanine level, significant cost reduction was achievable. These costs include the steel framing of the mezzanine and the slab on deck construction process as well as an elevator, all of which became unnecessary with a single floor building. This particular value engineering idea played a key role in Kinsley Construction being selected to complete the project.

The other three value engineering ideas that were approved did not affect the project cost quite so drastically but were still effective in maintaining quality while reducing cost. One of these suggestions was to use a different brand of translucent wall panels. The Contracting Officer was unwilling to accept this change until a great deal of information was gathered by the project team to back up the suggested product. In order to avoid advertisement of either company, the product names will not be used. The original wall panel system that was specified in the RFP documents is the same that had been used for the two existing hangars on the base, and had been promoted for its “Anti-Terrorism Blast Resistant” characteristics which are required for Department of Defense projects. This was the Contracting Officer’s major concern with switching to a different system, but after thorough research of the suggested product, the project team proved that the two systems have equivalent blast resistant properties. The only major differences between the two systems are the popularity and the cost.

The next value engineering topic was similar in nature to the translucent panels change, in that it simply dealt with using a different manufacturer. This idea was to employ a different standing seam metal roof system. Unlike the translucent panels, the Contracting Officer was much more willing to accept this change as there was no major difference as far as perceived characteristics. The only concern the owner had was to be certain that the color matched the systems used on the two existing hangars, which turned out to be no problem whatsoever. This was not a major cost change, but still significant enough to make the switch. The final VE idea that was accepted by the owner was to use welded wire fabric mats in place of rebar in certain locations of the concrete construction. This idea did not really meet any argument once it was proved that the strength of the concrete would not be diminished by making the change. Savings in labor costs was the main reason for this suggestion by Kinsley Construction, as the placement of the mats is far less time-consuming and labor intensive as compared to laying out and tying the rebar.

The only value engineering idea that Kinsley Construction suggested for the project that was not accepted was to utilize light gauge metal framing with gypsum wall board for the partition walls in the administration area rather than the CMU construction. This cost savings was not approved due to requirements under the Air National Guard Engineering Technical Literature (ANGETL). These documents prohibit the use of any materials other than CMU for partition wall construction.



PROBLEM IDENTIFICATION

Although the Fuel Cell Facility project has not experienced too many major problems outside of the delays in the structural design, there are issues that could be resolved in an effort to reduce cost and accelerate the schedule. There is also room for improvement in design to create a more efficient building.

Lack of Sustainable Design

The original RFP documents for the C-5 Fuel Cell Facility contained a bid option which specified that the building was to be capable of obtaining LEED-NC Silver certification. However, due to the bids being over budget for this option, it was not selected and therefore kept the sustainable features to a minimum. The layout and usage of the building make energy efficiency difficult, but for a government-owned building, sustainability should be a key point of the design.

Lack of Design Coordination

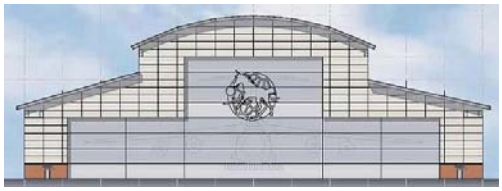
As a project utilizing a design-build delivery method, coordination during the design phase is critical. This is one of the key advantages as compared to the traditional design-bid-build method of construction. However, for this project, the full potential of the design-build approach was never realized do to a lack of coordination by the design professionals. It became apparent that the design teams had not been working closely together when the on-site project team discovered that the required supports for part of the HEF fire protection system were designed to be in a different bay of the structure than where the fire protection engineer had located the same part.

Housing Costs

One of the major differences between Kinsley Construction and most other general contractors today is that they still self-perform a fairly large portion of the work on their projects. One additional cost that arose on this project due to that methodology was paying for housing of employees. According to the project manager, about 55% of the Kinsley employees who have worked on the site live far enough away from the project site that they required housing in a local hotel. This is a cost that could have potentially been eliminated by hiring more subcontractors.

Damaged CMU's

One quality issue that occurred on this project was with the masonry work. Due to some poor weather conditions and an accelerated schedule, there are some unsatisfactory portions of the exterior CMU façade. A few of the CMU's have been partially broken on the corners with chunks missing. Also, due to the rainy conditions, efflorescence has appeared in many locations around the building.

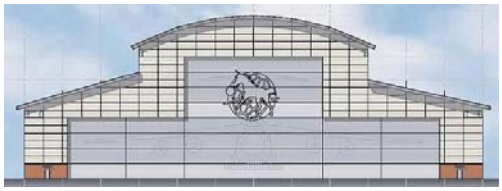


Height of MEP Installation

As discussed in the *Constructability Challenges* section, a large portion of the MEP installation takes place high above the finished floor level, making it even more difficult than normal to coordinate the trades who need to complete this installation. Coordination of the MEP trades is always a potential area for problems, but when it becomes necessary to coordinate space for extra equipment, for example aerial boom lifts, the task becomes even more difficult. Not only is the installation process causing overcrowding up in the air where the equipment is to be located, but it is also taking up valuable ground space.

Width of Hangar Slabs

In the *Constructability Challenges* section earlier in this report, some of the specifications of the hangar slab were discussed. It was mentioned in that section that the project team elected to complete the hangar slab in as few of pours as possible in order to reduce the time necessary for drilling the slabs for dowel placement. The problem that was created by this is finding a way to produce a quality product on such a large pour. In reference to the slab pour diagram in the *Constructability Challenges* section, "Slab Pour 1" and "Slab Pour 2" measure 75 feet in width. This adds a great deal of difficulty to the finishing process.



TECHNICAL ANALYSIS METHODS

SUSTAINABLE FEATURES

As a government-owned building, the addition of sustainable features is an important step in the promotion of green building. Due to its usage type, it is difficult to find many ways to improve the efficiency of the building with respect to the HVAC system, as can be done in many buildings. Instead, for this project there is an opportunity to create energy from solar power which can help reduce the amount of energy that the building would be taking from the grid. With the large roof area of the building, and the orientation of the building, a fairly large amount of solar power should be possible.

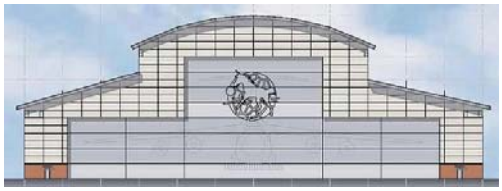
To quantify the amount of power that could be generated, research on solar collectors will be necessary; I will specifically be researching the Solyndra product which was introduced to me at the PACE Roundtable Discussion. I will also need to analyze design issues concerning the connection of the Solyndra system to the roof of the Fuel Cell Facility. After this, it will be important to figure out how long this installation will take in order to discover the impact that this system will have on the project schedule. This portion of the study will be based on estimated productivities for the given working conditions of the high roof.

PREFABRICATED WALL PANELS

As mentioned previously, the exterior CMU façade was somewhat of a quality issue with CMUs being partially broken and efflorescence becoming visible due to rainy conditions on site. A potential solution to these issues is to utilize prefabricated concrete wall panels in place of the CMU. This would be a fairly simple switch considering the use of insulated metal wall panels occurred higher up on the wall; the same installation technique would most likely apply. Although the concrete would obviously be heavier, it would only be installed within the first ten feet above finished floor level so the height of the lift would be minimal. The exact installation process would need to be analyzed to determine things such as schedule impact, crew sizes, and equipment costs. Each of these will need to be calculated in order to find the total cost difference from the CMU system. Research on the possibilities of the prefabricated concrete wall will also need to be done to make sure that the final product still has the same aesthetic features.

MEP INSTALLATION

Since the installation of many MEP items must take place high above the finished floor level and requires a large amount of equipment, a better installation technique seems necessary. One possible solution would be to create platforms on the steel frame, on which the MEP subcontractors could complete their work. This would need to be researched concerning cost of installing such a system, specifically one that would meet safety requirements. Also the simple logistics of whether or not it would be efficient due to the various truss members would need to be analyzed. Research on this topic will be done primarily through the project team for the Fuel Cell Facility as well as the subs who performed the work. It will also include asking the team about any other potential solutions. If several potential solutions are discovered a comparative analysis can be done. It will be necessary to find the schedule impact of each solution as well as the cost impacts of any equipment or materials required.



SLAB ON GRADE WIDTH

Although it was deemed necessary by the project team to use the widest slab pours possible for the purpose of minimizing the number of times drilling for dowels would be done, it has become a constructability issue of its own now to figure out how to finish the concrete. The finishing requirements according to the specifications, coupled with the wide slabs, create the need for some ingenuity. When I last visited the site, the project team was briefly discussing some possible solutions of how to complete the finishing process. I will analyze the ideas that the project team came up with, as well as looking into alternative slab configurations.

This second part will require me to figure out the relationship between the width of the pour and the efficiency of the crew, as well as incorporating the time necessary after the pour before drilling for dowels can be done. I will attempt to create a more time and cost efficient slab pour plan. I will then be able to compare the installation of the alternative slab plan to the method that the project team is using. This comparison will include schedule duration, crew sizes, equipment required, and of course the cost impact.