Project Logistics

Milestone Schedule

MADC5 is a two-phase construction project which began preconstruction in early July 2007. It is a unique phasing plan since the entire building core and shell will actually be built with only the interior portion of the building being phased.

The project's preconstruction and design phases lasted for eight months. The weather at this time is much more favorable for construction since the winter months finish just as the site work was scheduled to begin. Construction mobilization was initiated in early February 2008, which is a slight overlap of the preconstruction/design phase, followed immediately by sitework and foundations.

Precast erection began in early May 2008, just as the foundation work was finishing, and lasted approximately 4 months, making it the longest construction duration for the project. The precast was sequenced using two crews that were spaced about a week apart. Crew 1 placed precast members between column lines A-D, while Crew 2 placed members between D-G. Please see Appendix B for a complete detail of the erection plan.

Unlike most typical building schedules, the interior work begins prior to being watertight. This is mainly due to the fact that the project is on such a tight schedule. If the project had to wait until the building was watertight, then the project duration would be extended at least 4 months. Instead, the installation of MEP overhead, fire protection, interior partitions, MEP equipment, access floors, and doors and hardware can occur once there is enough slab-on-grade poured. Overall, the interior work is diligently completed as a parade of trades within each room progressing from west to east.

Please see Appendix B for the summary Gantt chart for MADC5.

Detailed Schedule

Overview

Construction for MADC5 began in early February 2008. The project is scheduled to finish in early March 2009, just over 13 months of construction. Being that the building is approximately 360,000 SF, a detailed construction schedule is vital to successfully completing such a large-scale project in a short amount of time. Appropriate phasing and sequencing was utilized throughout the project to facilitate the process.

Phasing

The overall duration is somewhat devious due to the way the project was phased. Thirteen months to complete a large project is quite impressive, however, the building will not be fully built out during that period. Interior work for MADC5 is phased, while the entire building shell, foundations, MEP underground, and slab-on-grade will be constructed as one entity. Phase 1 and Phase 2 evenly split the building with the office portion considered Phase 1 construction. Each phase has fourteen computer rooms, eight UPS rooms, eight engine-generator rooms, one medium voltage room, and one chiller plant. Phase 2 construction will be held until released by the owner.

Figure 4 depicts the overall floor plan, first level on top and the mezzanine level on the bottom, for MADC5. The light blue section on the west side of the building is considered Phase 1. Phase 2 is the area shown as the dark blue section on the east.

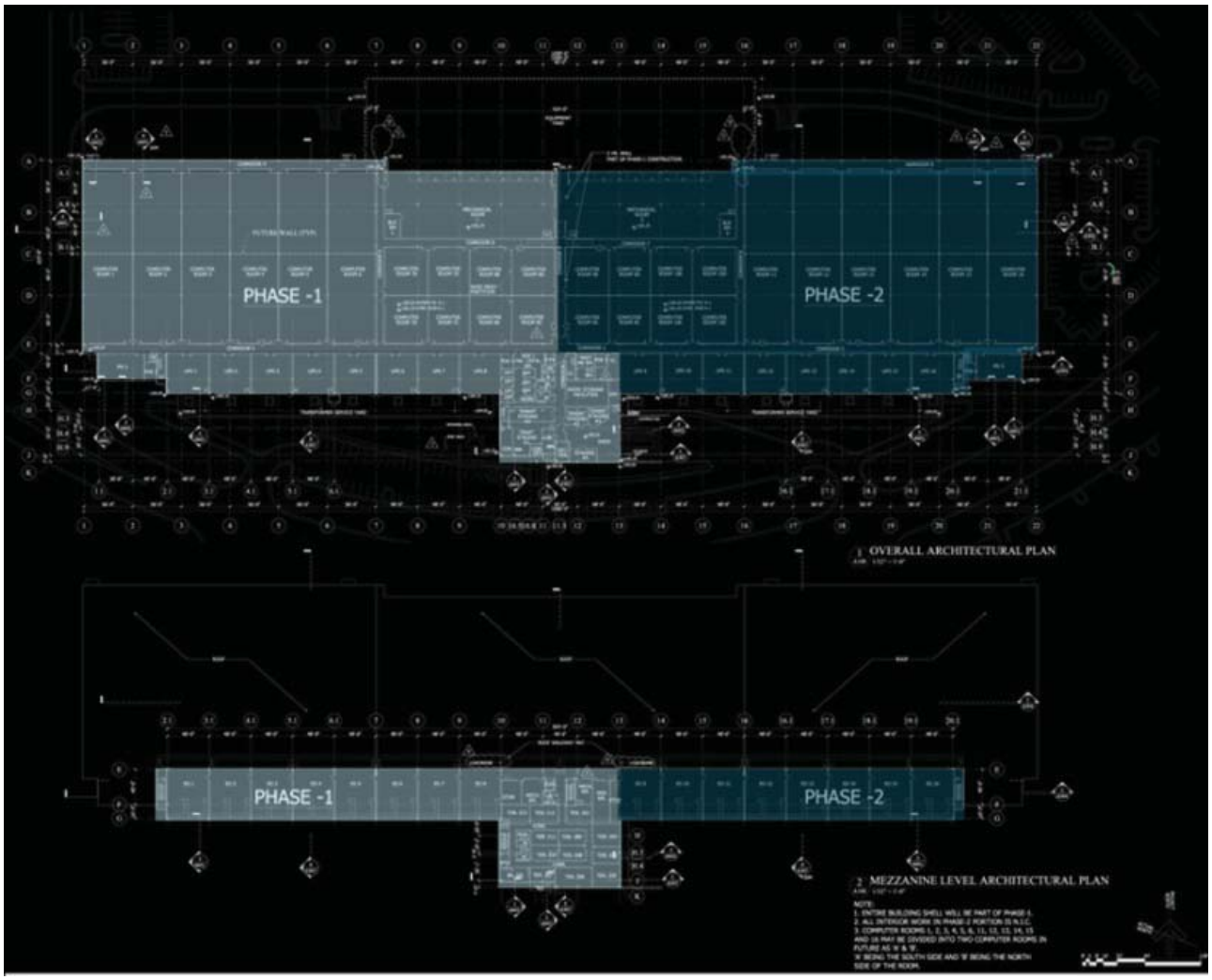

Figure 4 - Overall plan showing the two phases.

Please see Appendix B for the detailed Gantt chart for MADC5.

Sequencing

The nature of the building is directly responsible for the way that the project was sequenced. First and foremost, there are 21 subcontractors with approximately 500 workers on site, which causes severe congestion and delays if left unorganized. To remedy this, the construction manager has developed a specific sequence where work progresses as a parade of trades, beginning on the west and advancing to the east. As soon as a trade has finished work in a given area, the next trade follows immediately in order to meet the tight schedule. Site work, foundations, underground MEP, and precast erection initiate the parade. Approximately two weeks after precast starts, slab-on-grade work begins for the computer rooms, UPS rooms, and engine-generator rooms and follows in the same direction. Likewise, once the concrete has cured enough and the concrete contractors have advanced, interior work on the aforementioned rooms ensues. Unlike most cases where a building is completely enclosed prior to interior work, interior construction begins as soon as the immediately surrounding area is watertight. For example, finishes are installed in the first computer room on the west side while the entire east side of the building is exposed to the elements. This sequencing plan continues for the duration of the project.

The following three tables, Table 4, Table 5, and Table 6, illustrate the typical room sequences for computer rooms, UPS rooms, and engine-generator rooms:

Table 4 - Computer Room Sequence

Computer Room Sequence		Duration
Activity	Seal Concrete Floors	2d
	MEP Overhead/Pull Wire	10d
	Fire Protection	5d
	Below Floor Chilled Water Pipe	15d
	Paint Precast Tees	5d
	Interior Partitions	5d
	MEP Rough In Partitions	5d
	Prime Paint	5d
	Lighting Buss /Fixtures/Fire Alarm Devices	10d
	Install EPO Kiosk	5d
	Set D Boards/Terminate	5d
	Insulate Chilled Water Piping	5d
	Pipe/Insulate CRAH's	5d
	Underfloor Fire Alarm	5d
	Set CRAH Stands/CRAH Units	10d
	Incipient Detection	10d
	Finish Paint	5d
	Grounding Grid	5d
	Access Flooring	5d
	Doors/Hardware	5d
	Base	2d
	Superclean	4d
	Final Clean	5d

Table 5 - UPS Room Sequence

	UPS Room Sequence	Duration
Activity	Seal Concrete Floors	1d
	Pull Cable	10d
	MEP Overhead	15d
	Interior Partitions	10d
	Paint Precast Tees	2d
	"Set Switchgear (M's, C's) "	5d
	Fire Protection	5d
	MEP Rough In Partitions	5d
	Prime Paint	1d
	Set CRAH Unit/Terminate/Pipe	10d
	Install Overhead Buss	5d
	Terminate Switchgear	5d
	Set Piller Unit	5d
	Lighting	15d
	Doors/Hardware	5d
	Set IP	5d
	Terminate Piller/IP Units	10d
	Finish Paint	3d
	Base	2d
	Final Clean	5d

Table 6 - Engine-Generator Room Sequence

	Engine-Generator Room Sequence	Duration
Activity	Install Louvers/Attenuation/Dampers/Plenums North Wall	15d
	MEP Overhead	5d
	Pour Concrete Fuel Curbs	2d
	Fire Protection	3d
	Interior Partitions	5d
	Set/Pipe Day Tanks EG 1A and 1B	15d
	MEP Rough In Partitions	5d
	Epoxy Membrane in Fuel Containment Curbs	2d
	Paint Precast Tees	2d
	Prime Paint	2d
	Lighting	15d
	Install Exhaust Supports and Mufflers/SCR's	15d
	Set EG 1A and 1B	5d
	Final Muffler Connections	2d
	Install Louvers/Attenuation/Dampers/Plenums South Wall	10d
	Pull Cable/Terminate EG 1A and 1B	20d
	Install Plenum From Radiator to Louvers	2d
	Finish Paint	3d
	Epoxy Generator RM Floors	5d
	Install Unit Heaters	5d
	Doors/Hardware	3d
	Complete Pneumatics	3d
	Base	1d
	Final Clean	5d

Project Cost Summary

Table 7 - Project Cost Breakdown

	Cost	Cost/SF
	Overall Costs	
Actual Building Construction Cost	$ 148,720,000	$ 414
Total Project Cost	$ 170,916,000	$ 475
	Building Systems Costs	
Building Concrete	$ 8,957,000	$ 25
Structural Precast	$ 1,696,000	$ 5
Access Floor	$ 2,110,000	$ 6
Fire Protection	$ 1,308,000	$ 4
Mechanical	$ 33,232,000	$ 93
Electrical	$ 47,087,000	$ 131
Security	$ 1,150,000	$ 4
Mechanical Controls	$ 3,100,000	$ 9
Mechanical Equipment	$ 4,406,000	$ 13
Electrical Equipment	$ 26,798,000	$ 75

Square Foot Estimate

Total Building Area:	360,000 SF
Total Building Perimeter:	3,646 LF
Story Height:	23'-6" FT
RS Means Value:	$137.50/SF

Story Height Adjustment:	Negligible
Perimeter Adjustment:	Negligible
Time Adjustment:	Current time – No adjustment needed.
Location Factor:	0.92 (Fairfax, VA is closest location to Ashburn)

Final RS Means Value:	$126.50/SF
Project Total Cost:	$45,540,000

As shown above in Table 7, the RS Means Square Foot Estimate is not even close to the actual cost of the building. MADC5 is an extremely large data center that cannot be accounted for using RS Means, which only sizes up to 40,000SF and 800LF whereas MADC5 is 360,000SF and 3,646LF. Any adjustments to the story height and perimeter would have a negligible effect on the square foot value since the values decrease as the size of the building increases and the differences between the values is so extreme. In addition, the building estimate does not account for the $33 million of MEP controls and equipment involved with the data center. Please see Appendix C for the detailed RS Means Square Foot analysis.

Parametric Estimate

Total Project Cost:	$19,579,868	$55/SF
Total Building Cost:	$18,179,868	$51/SF

Unfortunately, the D4Cost Estimate software does not have a data base for anything similar to a data center. This is more likely attributed to the fact that data centers are more of a "new" design in comparison to the typical commercial buildings featured in the software. Therefore, the D4Cost software is inappropriate to use for estimating. To illustrate this, an estimate has been developed based off an industrial building, Siemens Westinghouse Fuel Cell Facility, with sized at 190,000SF. As shown above, the total project cost is approximately $150 million short of the true estimate. Please see Appendix C for the detailed D4Cost Parametric analysis.

General Conditions Estimate Summary

MADC5 had a combination of construction requirements, insurance and permits, general conditions, and labor falling within the general conditions that generates an estimate amount of **$7,025,338**, as shown in Table 8 below. In comparison to the overall project cost, this number is approximately **4.1%** of the overall budget. The value may be slightly low then the average percent and could be attributed to the fact that the construction contingency was not included as well as differing staffing costs.

Table 8 - General Conditions Summary

General Conditions Summary Estimate				
Description	**Qty.**	**Unit**	**Cost/Unit**	**Total Cost**
Construction Requirements	58	WK	$ 49,362	$ 2,863,000
Insurance/Permits/Fees	58	WK	$ 29,948	$ 1,737,001
Project Team: Field/Staff	58	WK	$ 18,704	$ 1,084,847
General Conditions	58	WK	$ 11,146	$ 646,480
Miscellaneous Labor	58	WK	$ 11,966	$ 694,010
			TOTAL	$ 7,025,338

Please see Appendix C for a detailed breakdown of the General Conditions estimate.

The following assumptions were made throughout the estimate process:

- Cost Data provided by RS Means 2008 and Holder Construction Company. The numbers from Holder were provided as estimates based on their historical data and RS Means. These values were derived by myself and project team members.
- RS Means 2008 was utilized to derive individual staffing salaries for the job.
- Where staff salaries were not available in RS Means, a logical 10% increase was used for each respective level.
- Values provided from Holder were lump sum amounts, not a unit cost. Thus, the total cost was divided by the project duration to derive a cost/unit value. This value will be beneficial for a future analysis.
- Construction Durations: **13 months** or **58 weeks**
    - Non-working days and holidays are not accounted for, rather based off of the standard calendar

- Staffing durations are based off of start dates on the job. (Information received from Holder)
- All staff is assumed to be on the job through completion since the project team is unsure of status of Phase 2.

Detailed Structural Systems Estimate Summary

All take-off calculations for the structural estimate were performed by hand based off of the construction documents and precast shop drawings. As previously mentioned, the data center portion of the building is symmetrical; therefore, the take-off needed to only be prepared for half of the building and simply multiplied by a factor of two to account for the other half. A complete take-off had to be done for both floors of the office building since this portion was not symmetrical.

The following assumptions were made throughout the take-off:

- All concrete is pumped.
- Formwork was added as an allowance value provided by the contractor (who uses RS means and historical data) due to sporadic use throughout the project.
- Open Shop labor
- Fairfax, VA was used as the location factor (0.92). It was the closest city to Ashburn; however, the cost may be higher due to a slightly higher cost of living in Fairfax. The calculations include this factor within the unit costs.
- Overhead and profit are omitted from the cost estimate
- RS Means 2008 Online and average unit cost estimates from the precast subcontractor (The Shockey Precast Group) were utilized for the cost calculations.

Please see Table 9 below for a summary of the structural systems. A complete detailed estimate can be found in Appendix C.

Table 9 - Structural Systems Summary Estimate

Structural Systems Summary Estimate		
Division	*Description*	*Total Cost*
02465	Caissons	$ 161,716
03210	Rebar	$ 436,486
03220	Welded Wire Fabric	$ 260,850
03310	Normal Weight Concrete	$ 2,051,131
03310	Formwork Allowance	$ 270,000
03310	Concrete Placement	$ 403,763
03310	CIP – Piers	$ 267,630
03310	CIP – Spread Footing	$ 344,501
03310	CIP – Continuous Footing	$ 126,055
03310	CIP – Slab on Grade	$ 1,821,380
03310	CIP – Topping Slab	$ 1,242,534
03310	CIP – Stairs	$ 3,063
03410	Precast Concrete	$ 9,219,840
	TOTAL	**$16,608,949**

The estimate total for MADC5 is $16,608,949. In comparison to the Technical Assignment 1 assignment, this number is much lower with a percent difference of 25.12%. However, the values utilized for Tech. 1 were based off of preliminary values for the project. A more recent estimate involving the schedule of values for the structural systems provides a much stronger estimate to compare. Please see Table 10 below for the comparison.

Table 10 - Structural Systems Cost Comparison

System	Tech 1	Tech 2	System	SOV	Tech 2
Precast Concrete	$11,695,484	$9,219,840	Precast Concrete	$9,706,654	$9,219,840
CIP Concrete	$8,956,928	$7,227,393	CIP Concrete	$7,204,000	$7,227,393
Caissons	$728,079	$161,716	Caissons	$493,044	$161,716
Total	$21,380,491	$16,608,949	Total	$17,403,698	$16,608,949
% Difference	***25.12%***		***% Difference***	***4.67%***	

Differences between the Tech. 1, the schedule of values, and Tech. 2 values can be attributed to several items. Closeout costs, change orders, mobilization/demobilization, and shipping are not accounted for within the precast concrete value. Initially, the large discrepancy between the CIP concrete estimates is due to inclusion of closeout, change orders, contingency, contractor's fee, construction requirements, and excavation costs. As for the caisson estimate, entities such as mobilization/demobilization, bonds, layout, extra reinforcement, and closeout are responsible for the cost gap. Overall, differing unit prices between RS Means and contractor/subcontractor values all influence the 4.67% differential. For a better comparison of the materials and labor, the above mentioned entities have all been removed from of the original estimate.