Construction Management Depth

Depth Overview

My depth study in the construction management is a supplement to the electrical work that has already been done on Duques Hall. Two alternative options have been presented, Riser 1 and Riser 2, to the existing 208/120 V power distribution system. Although these systems by adequately provide power through the building, the feasibility of implementing the design lies in the cost value of the systems. The existing system and the two alternate systems have been compared in the sections below.

The primary goal is to determine the costs settings, when applicable, to the two possible systems. A secondary goal is to not view the projects in a monetary value, but also in the additional construction costs and construction difficulties that present themselves.

Existing Distribution System –

The existing electrical system can be found in my electrical narrative. While performing this analysis, there were a few assumptions that needed to be taken into consideration.

- All prices were taken from a Square D manufacturer's catalog. System prices will vary compared to competitor prices, and the pricing data used is not scaled to encompass discount for large-scale construction.
- Prices are based purely on component cost. Overhead and profit have not been factored into the total price.
- All wire runs are assumed to have been measured accurately, and each run provides for additional wire to be tied into the equipment.
- The 480/277 V distribution system, emergency power, and any other system outside of the 480/277 volt system have not been changed. Because these systems are not changing, the cost of the system remains constant and was not factored into the system.
- All interior wires are run through EMT conduit.
- Conduit was sized assuming the ground wire was the same size as the feeder wires and was subsequently priced accordingly.
- Labor costs for wiring were priced according to DC union regulations.
- Branch circuit cost was calculated assuming the panels were fully loaded with single pole breakers.
- The wire and pricing data was obtained by an electrical contractor who did not wish to be named.

The majority of the pricing calculations have been performed using excel spreadsheets. These spreadsheets can be found on the attached CD. Pricing has been performed for the existing system and that data is below. Pricing for Riser 1 has not been

included here, but can be found on the excel spreadsheet on the attached CD. Following the cost information for the existing system is the pricing data for Riser 2.

Existing Systems

Panel Prices

Existing Pricing										
Pannel Info	**Panel Type**	**Panel Cost**	**Frame (")**	**# Poles**	**Frame Size**	**Frame Cost**	**Breaker Size**	**Breaker Cost**	**Branch costs**	**Branch Bkr Cost**
P2										
NP2	MLO	$3,869	20"	42	100 A	$1,396	110 A	$1,381	$26	$1,092
Floor 1										
N1	MCB	$3,925	20"	42	225 A	$2,001	175 A	$832	$26	$1,092
N1B	MLO	$2,389	20"	24	100 A	$1,022	70 A	$743	$26	$624
C1 Sect 1	MCB	$6,086	20"	42	400 A	$2,440	400 A	$2,554	$26	$1,092
C1 Sect 2	MLO	$2,949	20"	42	400 A	$1,857			$26	$1,092
C1B	MLO	$3,280	20"	42	225 A	$1,356	150 A	$832	$26	$1,092
Floor 2										
N2	MCB	$3,336	20"	30	225A	$1,724	150 A	$832	$26	$780
N2B	MLO	$2,389	20"	24	100 A	$1,022	70 A	$743	$26	$624
C2 Sect 1	MCB	$6,086	20"	42	400 A	$2,440	400 A	$2,554	$26	$1,092
C2 Sect 2	MLO	$2,949	20"	42	400 A	$1,857			$26	$1,092
C2B	MLO	$3,280	20"	42	225 A	$1,356	150 A	$832	$26	$1,092
Floor 3										
N3	MCB	$3,336	20"	30	225 A	$1,724	150 A	$832	$26	$780
N3B	MLO	$2,389	20"	24	100 A	$1,022	70 A	$743	$26	$624
C3 Sect 1	MCB	$6,086	20"	42	400 A	$2,440	400 A	$2,554	$26	$1,092
C3 Sect 2	MLO	$2,949	20"	42	400 A	$1,857			$26	$1,092
C3B	MLO	$3,280	20"	42	225 A	$1,356	150 A	$832	$26	$1,092
Floor 4										
N4	MCB	$3,336	20"	30	225 A	$1,724	150 A	$832	$26	$780
N4B	MLO	$2,389	20"	24	100 A	$1,022	70 A	$743	$26	$624
C4	MCB	$3,925	20"	42	225 A	$2,001	250 A	$832	$26	$1,092
C4B	MLO	$3,320	20"	42	100 A	$1,396	110 A	$832	$26	$1,092
Floor 5										
N5	MCB	$3,336	20"	30	225 A	$1,724	225 A	$832	$26	$780
N5B	MLO	$2,389	20"	24	100 A	$1,022	70 A	$743	$26	$624
C5	MCB	$3,925	20"	42	225 A	$2,001	250 A	$832	$26	$1,092
C5B	MLO	$3,320	20"	42	100 A	$1,396	110 A	$832	$26	$1,092
Floor 6										
N6	MCB	$3,336	20"	30	225 A	$1,724	225 A	$832	$26	$780
N6B	MLO	$2,250	20"	24	100 A	$1,022	50 A	$604	$26	$624
C6	MCB	$6,086	20"	42	400 A	$2,440	400 A	$2,554	$26	$1,092
C6B	MLO	$3,320	20"	42	225 A	$1,396	150 A	$832	$26	$1,092
Penthouse										
NPH	MLO	$2,478	20"	24	100 A	$1,022	110 A	$832	$26	$624
Totals =		$101,988				$46,760		$28,396		$26,832

Wire Prices

Wiring Sizes

Run	Length	# Runs	# Wires	Wire Size	Wire price	Cost / per Length	Conduit Size	Conduit Price	Cost / per Length
Gear NDP to NP2	20	1	5	(4) #4/0, (1) #4	$2.36	$236.00	2 - 1/2"	$3.14	$62.80
Gear NDP to N1	50	1	5	(4) #4/0, (1) #4	$2.36	$590.00	2 - 1/2"	$3.14	$157.00
N1 to N1B	170	1	5	(4) #1, (1) #6	$1.42	$1,207.00	1 - 1/4"	$1.35	$229.50
Gear NDP to N2	65	1	5	(4) #4/0, (1) #4	$2.36	$767.00	2 - 1/2"	$3.14	$204.10
N2 to N2B	170	1	5	(4) #1, (1) #6	$1.42	$1,207.00	1 - 1/4"	$1.35	$229.50
Gear NDP to N3	80	1	5	(4) #4/0, (1) #4	$2.36	$944.00	2 - 1/2"	$3.14	$251.20
N3 to N3B	170	1	5	(4) #1, (1) #6	$1.42	$1,207.00	1 - 1/4"	$1.35	$229.50
Gear NDP to N4	91.5	1	5	(4) #4/0, (1) #4	$2.36	$1,079.70	2 - 1/2"	$3.14	$287.31
N4 to N4B	170	1	5	(4) #1, (1) #6	$1.42	$1,207.00	1 - 1/4"	$1.35	$229.50
Gear NDP to N5	105	1	5	(4) #4/0, (1) #4	$2.36	$1,239.00	2 - 1/2"	$3.14	$329.70
N5 to N5B	170	1	5	(4) #1, (1) #6	$1.42	$1,207.00	1 - 1/4"	$1.35	$229.50
Gear NDP to N6	117	1	5	(4) #4/0, (1) #4	$2.36	$1,380.60	2 - 1/2"	$3.14	$367.38
N6 to N6B	170	1	5	(4) #1, (1) #6	$1.42	$1,207.00	1 - 1/4"	$1.35	$229.50
Gear NDP to NPH	132	1	5	(4) #4/0, (1) #4	$2.36	$1,557.60	2 - 1/2"	$3.14	$414.48
Gear CDP to C1	50	1	7	(5) #3/0, (2) *#3*	$2.23	$780.50	(2) 2 - 1/2"	$3.14	$157.00
C1 to C1B	170	1	7	(5) #1/0, (2) #6	$1.58	$1,880.20	2"	$3.45	$586.50
Gear CDP to C2	65	1	7	(5) #3/0, (2) *#3*	$2.23	$1,014.65	(2) 2 - 1/2"	$3.14	$204.10
C2 to C2B	170	1	7	(5) #1/0, (2) #6	$1.58	$1,880.20	2"	$3.45	$586.50
Gear CDP to C3	80	1	7	(5) #3/0, (2) *#3*	$2.23	$1,248.80	(2) 2 - 1/2"	$3.14	$251.20
C3 to C3B	170	1	7	(5) #1/0, (2) #6	$1.58	$1,880.20	2"	$3.45	$586.50
Gear CDP to C4	91.5	1	7	(5) #3/0, (2) *#3*	$2.23	$1,428.32	(2) 2 - 1/2"	$3.14	$287.31
C4 to C4B	170	1	7	(5) #1, (2) #6	$1.42	$1,689.80	2"	$3.45	$586.50
Gear CDP to C5	105	1	7	(5) #3/0, (2) *#3*	$2.23	$1,639.05	(2) 2 - 1/2"	$3.14	$329.70
C5 to C5B	170	1	7	(5) #1, (2) #6	$1.42	$1,689.80	2"	$3.45	$586.50
Gear CDP to C6	117	1	7	(5) #3/0, (2) *#3*	$2.23	$1,826.37	(2) 2 - 1/2"	$3.14	$367.38
C6 to C6B	170	1	7	(5) #1/0, (2) #6	$1.58	$1,880.20	2"	$3.45	$586.50
Sums -	3209					$33,873.99			$8,566.66

Labor Data

Labor Cost

Type	Run	Crew	hours/100'	Wage	Total Time	Total Cost
Wire	3209	2	3	$30.45	96.27	$2,931.42
Conduit	3209	1	8	$30.45	256.72	$7,817.12

Transformer Pricing

Transformer pricing		
Label	Size	Cost
T1	2000 KVA	$60,000
T2	500 KVA	$25,215
T3	300 KVA	$15,910
	Total =	$101,125

Total Pricing

Total Pricing	
Equipment	**Cost**
Transformer	$101,125.00
Panel Boards	$101,988.00
Wire Cost	$33,873.99
Conduit Cost	$8,566.66
Wire labor Cost	$2,931.42
Conduit Labor Ct.	$7,817.12
Total =	$256,302.19

Adequate means for pricing switchgears was not found. Therefore, I made an assumption regarding the switchgears. Switchgears typically run about six figures or more in cost. In the situations here, there were three switchgears in the basement. This is compared to the number of gears in the later designs

The pricing data might not seem incredibly high for a distribution system, but this only takes into account the distribution for the 208/120 V system. The other parts of the distribution system were unchanging and not contained in this write up.

Riser 1 –

The design of riser 1 is similar to the design of the existing system. After resizing the panels and feeders, the cost was performed in the same way as the cost was found for the existing electrical system. The cost calculations for Riser one can be found in the spreadsheet, which has been saved on the CD that is attached.

Riser 2 -

The electrical distribution and the sizing of its component can be found in the Electrical Depth section. What sets this design apart from the existing design and the design of Riser 1 is the location of the second Switchgear. The Switchgear was placed on the roof to help eliminate some of the longer wire runs and negate some voltage drop while also dividing the load of the building into two separate portions. Placing the switchgear on the roof though is not as simple as carrying it up a flight of stairs. This leads to some more serious construction management concerns.

A schedule or timetable of the project was not available for me to use. Therefore, all references made to a schedule or timetable where made in general terms, and were not implemented into a fixed schedule so an exact amount of time could be determined.

Schedule

Switchgears are not simple pieces of equipment. Their larger sizes and important design characteristics require a large amount of lead-time to obtain the proper gear. Having three switchgears in the primary design, lead-time must have already been considered and factored into the timeline. Placing a switchgear on the roof though requires for the second switchgear to arrive at a later date. This variance in time can have a large implication to the building depending on whether the building is ahead or behind schedule.

The switchgear arriving on time with the building progressing at the proper rate allows for smooth installation of the equipment. However, if the building is ahead or behind schedule, the switchgear could possibly be left without a home. If the building is behind schedule, it could be possible that the penthouse is not yet able to house the switchgear, and the gear would have to be set-aside until later use. If the building is ahead of schedule, it is possible to incur extra crane costs to keep the crane on site until the switchgear arrives. The same implications will come into affect if the switchgear arrives early or late and the building is running on schedule.

Another implication that could have major cost affects is how the switchgear plays into the roll of distribution power to the site. At some point in the project the, construction will switch from temporary to permanent power. When the gears are all on the bottom floor, they will most likely be placed in the basement before the bottom portion of the building is enclosed, and will be ready to provide power at a very early point in the construction process. With the switchgear in the penthouse, it is very likely

that some of the systems on the fourth and fifth floor could be ready before the switchgear can be placed in the penthouse.

The implications of the switchgear running behind schedule can affect the construction manager, particularly if it is vital in switching the buildings power from temporary power to permanent power. The construction management firm is responsible for the cost of the temporary power system, but the responsibility changes to the owner once the power system is switched to the permanent system. If the gear is late in getting installed, or the building is running behind schedule, the longer the switch to permanent power is delayed, the more it will cost the CM in the long run.

Logistics

The placement of the switchgear brings many logistical concerns to the forefront as well. With the gear, or gears for the existing system, it is a matter of leaving a space open so that the switchgear and other larger equipment can be brought into the building when the time comes. With the gear on the penthouse, it is a matter of getting the switchgear seven stories into the air. A crane will be required to place the switchgear on the roof of the structure. Getting a crane for the project is not an overwhelming issue, as the crane will already be needed for the placement of the steel and the other equipment to be placed on the roof. However, the crane placement and the incurred cost of placing a late switchgear on the roof must still be taken into account.

The installation of the switchgear provides another logistical task for the CM. One of the first concerns in placing the switchgear is providing it with a housekeeping pad to eliminate any acoustical concerns that would be caused from the operation of the equipment. The second concern is the coordination with the other important contractors on the project. As with the installation of any type of MEP system, it is important to coordinate the installation with the other contractors to ensure adequate space and easy installation. To smoothly install the switchgear and the different portions of it's service, it would be for the contractor to explore sequencing with the other contractors, particularly the concrete, mechanical and electrical contractors.

Probably the biggest concern with moving a switchgear to the penthouse is the structural implications. Having the switchgear in the penthouse adds another large load to the structural system of the building, and the also a significant load to the area directly underneath the penthouse. The building will have to be adjusted if the structural load is not insignificant to the existing design, and the structural integrity of the system should also be tested before the placement of the switchgear to test for any flaws or impurities.

Cost

Cost plays a very important roll in the design of any system, but with the placement of a switchgear on the roof it becomes very important. In this case, most of the costs are negligible. Because there is already a crane on the site, additional costs will only be incurred if the project is running behind schedule or the delivery of the switchgear is late. Installation of the switchgear and the other parts of the distribution

system is negligible because of the similarity in the systems. The only glaring difference being the location of the second switchgear, installation costs are negligible except for the wire runs. Of course, the major cost discrepancies will be found in the cost of the existing system vs. the cost of the new system.

The cost of Riser 2 is provided below.

Riser 2										
Pannel Info	**Panel Type**	**Cost**	**Frame (")**	**# Poles**	**Frame Size**	**Frame Cost**	**Breaker Size**	**Breaker Cost**	**Branch costs**	**Branch Bkr Cost**
P2										
NP2	MCB	$3,320	20"	42	225 A	$1,396	125 A	$832	$26	$1,092
Floor 1										
N1	MLO	$3,320	20"	42	225 A	$1,396	200 A	$832	$26	$1,092
N1B	MLO	$2,250	20"	24	100 A	$1,022	40 A	$604	$26	$624
C1 Sect 1	MLO	$3,320	20"	42	225 A	$1,396	175 A	$832	$26	$1,092
C1 Sect 2	MLO	$2,488	20"	42	225 A	$1,396			$26	$1,092
C1B	MLO	$3,231	20"	42	100 A	$1,396	70 A	$743	$26	$1,092
Floor 2										
N2	MCB	$3,020	20"	30	100 A	$1,636	60 A	$604	$26	$780
N2B	MLO	$2,250	20"	24	100 A	$1,022	40 A	$604	$26	$624
C2 Sect 1	MCB	$3,925	20"	42	225 A	$2,001	200 A	$832	$26	$1,092
C2 Sect 2	MLO	$2,488	20"	42	225 A	$1,396			$26	$1,092
C2B	MLO	$3,231	20"	42	100 A	$1,396	80 A	$743	$26	$1,092
Floor 3										
N3	MLO	$2,649	20"	30	100 A	$1,126	70 A	$743	$26	$780
N3B	MLO	$2,250	20"	24	100 A	$1,022	15 A	$604	$26	$624
C3 Sect 1	MLO	$3,320	20"	42	225 A	$1,396	225 A	$832	$26	$1,092
C3 Sect 2	MLO	$2,488	20"	42	225 A	$1,396			$26	$1,092
C3B	MLO	$3,231	20"	42	100 A	$1,396	90 A	$743	$26	$1,092
Floor 4										
N4	MLO	$2,649	20"	30	100 A	$1,126	100 A	$743	$26	$780
N4B	MLO	$2,250	20"	24	100 A	$1,022	30 A	$604	$26	$624
C4	MLO	$3,320	20"	42	225 A	$1,396	125 A	$832	$26	$1,092
C4B	MLO	$3,092	20"	42	100 A	$1,396	50 A	$604	$26	$1,092
Floor 5										
N5	MCB	$2,755	20"	30	100 A	$1,636	100 A	$339	$26	$780
N5B	MLO	$2,250	20"	24	100 A	$1,022	25 A	$604	$26	$624
C5	MCB	$3,925	20"	42	225 A	$2,001	125 A	$832	$26	$1,092
C5B	MLO	$3,092	20"	42	100 A	$1,396	40 A	$604	$26	$1,092
Floor 6										
N6	MLO	$2,828	20"	30	225 A	$1,216	175 A	$832	$26	$780
N6B	MLO	$2,250	20"	24	100 A	$1,022	40 A	$604	$26	$624
C6	MLO	$3,320	20"	42	225 A	$1,396	150 A	$832	$26	$1,092
C6B	MLO	$3,231	20"	42	100 A	$1,396	90 A	$743	$26	$1,092
Penthouse										
NPH	MLO	$2,250	20"	24	100 A	$1,022	20 A	$604	$26	$624
Total =		$83,993				$38,836		$18,325		$26,832

Wiring Sizes

Wiring Sizes									
Run	**Length**	**# Runs**	**# Wires**	**Wire Size**	**Wire price**	**Cost / per Length**	**Conduit Size**	**Conduit Price**	**Cost / per Length**
Gear HDP to TC2	65	2	3	(2 sets) 250 MCM	$3.50	$1,365.00	(2) 3"	$3.79	$492.70
Gear HDP to TN2	65	2	3	(2 sets) 2/0 AWG	$1.86	$725.40	(2) 1 - 1/2"	$1.65	$214.50
Gear HDP to TN5	105	2	3	(2 sets) 2/0 AWG	$1.86	$1,171.80	(2) 1 - 1/2"	$1.65	$346.50
Gear HDP to TC5	105	2	3	(2 sets) 2/0 AWG	$1.86	$1,171.80	(2) 1 - 1/2"	$1.65	$346.50
TC2 to C2	15	3	7	(3 sets) 300 MCM	$4.16	$1,310.40	(3) 3"	$3.79	$170.55
C2 to C2B	170	1	7	1/0 AWG	$1.58	$1,880.20	2 - 1/2"	$3.14	$533.80
C2 to C1	15	1	7	2/0 AWG	$1.86	$195.30	2 - 1/2"	$3.14	$47.10
C2 to C1B	185	1	7	1/0 AWG	$1.58	$2,046.10	2 - 1/2"	$3.14	$580.90
C2 to C3	15	1	7	4/0 AWG	$2.36	$247.80	3"	$3.79	$56.85
C2 to C3B	185	1	7	2/0 AWG	$1.86	$2,408.70	2 - 1/2"	$3.14	$580.90
TN2 to N2	15	2	5	(2 sets) 250 MCM	$3.50	$525.00	(2) 2 - 1/2"	$3.14	$94.20
N2 to N2B	170	1	5	4 AWG	$0.64	$544.00	1 - 1/4"	$1.35	$229.50
N2 to N1	15	1	5	3/0 AWG	$2.23	$167.25	2 - 1/2"	$3.14	$47.10
N2 to N1B	185	1	5	2 AWG	$1.20	$1,110.00	1 - 1/2"	$1.65	$305.25
N2 to N3	15	1	5	4 AWG	$0.64	$48.00	1 - 1/4"	$1.35	$20.25
N2 to N3B	185	1	5	8 AWG	$0.30	$277.50	1"	$1.05	$194.25
N2 to NP2	58	1	5	1 AWG	$1.42	$411.80	2"	$3.45	$200.10
TC5 to C5	15	2	7	(2 sets) 4/0 AWG	$2.36	$495.60	(2) 3"	$3.79	$113.70
C5 to C5B	170	1	7	4 AWG	$0.64	$761.60	1 - 1/2"	$1.65	$280.50
C5 to C4	15	1	7	1 AWG	$1.42	$149.10	2"	$3.45	$51.75
C5 to C4B	185	1	7	2 AWG	$1.20	$1,554.00	2"	$3.45	$638.25
C5 to C6	15	1	7	1/0 AWG	$1.58	$165.90	2 - 1/2"	$3.14	$47.10
C5 to C6B	185	1	7	2/0 AWG	$1.86	$2,408.70	2 - 1/2"	$3.14	$580.90
TN5 to N5	15	2	5	(2 sets) 3/0 AWG	$2.23	$334.50	(2) 2 - 1/2"	$3.14	$94.20
N5 to N5B	170	1	5	6 AWG	$0.45	$382.50	1 - 1/4"	$1.35	$229.50
N5 to N4	15	1	5	3 AWG	$0.72	$54.00	1 - 1/4"	$1.35	$20.25
N5 to N4B	185	1	5	4 AWG	$0.64	$592.00	1 - 1/4"	$1.35	$249.75
N5 to N6	15	1	5	2/0 AWG	$1.86	$139.50	2"	$3.45	$51.75
N5 to N6B	185	1	5	2 AWG	$1.20	$1,110.00	1 - 1/2"	$1.65	$305.25
N5 to NPH	50	1	5	8 AWG	$0.30	$75.00	3/4"	$0.90	$45.00
Sums -	2788					$19,394.45			$5,768.65

Labor Costs

Labor Cost						
Type	Run	Crew	hours/100'	Wage	Total Time	Total Cost
Wire	2788	2	3	$30.45	83.64	$2,546.84
Conduit	2788	1	8	$30.45	223.04	$6,791.57

Transformer / Switchgear Pricing

Transformer pricing		
Label	**Size**	**Cost**
T-C2	225 KVA	$12,406
T-N2	150 KVA	$9,306
T-C5	150 KVA	$9,306
T-N5	150 KVA	$9,306
	Total =	$40,324

Total Pricing

Total Pricing	
Equipment	**Cost**
Transformer	$40,324.00
Panel Boards	$83,993.00
Wire Cost	$19,394.45
Conduit Cost	$5,768.65
Wire labor Cost	$2,546.84
Conduit Labor Ct.	$6,791.57
Total =	$158,818.51

Conclusion

There was substantial price savings found in both the systems that I designed to implement as possible replacement for the existing system. For both the situations, there will be additional savings because riser one and riser two both eliminated a switchgear from the design.