Alternate 1

Introduction

Alternate 1 will focus on consolidating the current normal power transformers, feeding all normal power 208Y/120V panels, to a single transformer fed from the 480Y/277V normal branch main distribution panel. From this system consolidation, I will determine whether or not this change will save the hospital money on installation of the system. Due to the characteristics of a hospital's emergency power system, it is not feasible to consolidate any of the emergency branch transformers due to the strict isolation requirements laid out by Article 517 of the NEC code. Thus, I will be focusing solely on the normal power transformers for this investigation.

Goal

I will determine the cost impact of the consolidation of normal power transformers into a single transformer feeding all 208Y/120V panels.

Design Criteria

All electrical sizing and calculations were completed using requirements and tables from the 2002 National Electric Code (NEC). Load calculations for existing conditions can be found on enclosed CD-ROM under the file name 'Master Panel Schedule.xls'. Alternate 1 load calculations can be found under the file name 'Alt 1 Panel Schedule.xls'.

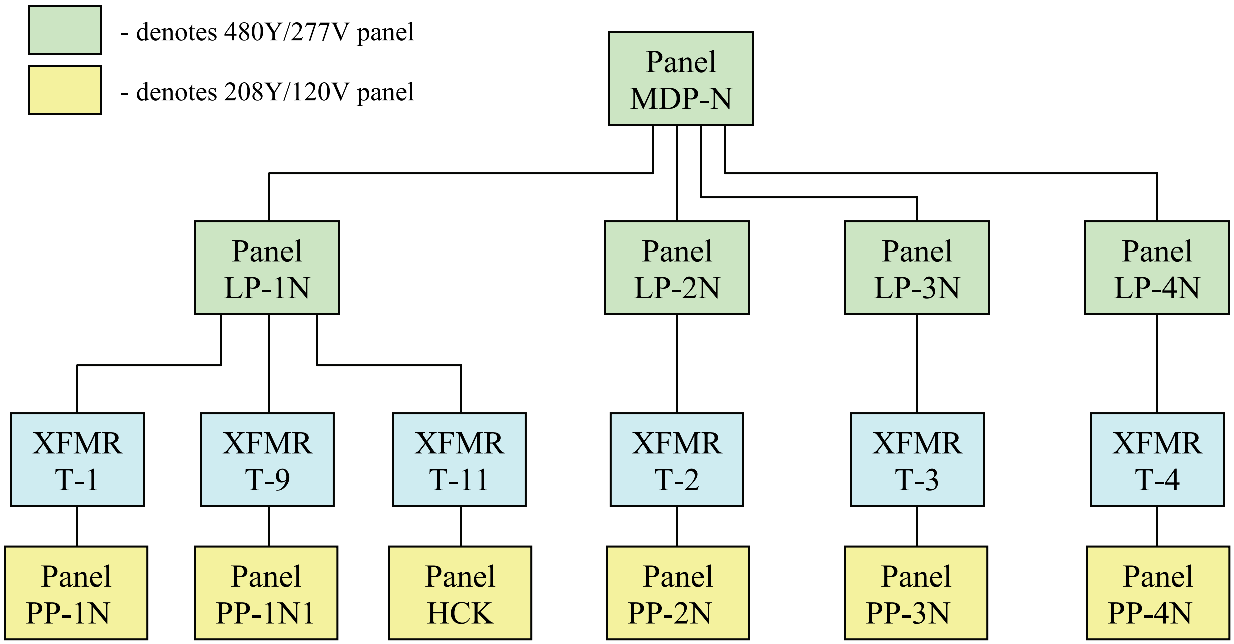
Assumptions

When sizing the existing loads for each Panelboard throughout the system, I had to make a lot of assumptions concerning the known equipment loads. With the assistance of the engineers at Leach Wallace, I assigned load values to these various amounts of equipment. From these assumptions, many of my panels were determined to be loaded past their rated capacity. With respects to the system components I was redesigning and resizing, I accounted for the calculated demand loads determined when surveying the existing system. For simplicity's sake however, I did not resize equipment previously designed and not being touched by my alternates. I am confident the original design was sized correctly and properly and the error was most likely in the many assumptions made concerning equipment loads. Therefore, seemingly undersized equipment as noted was not overlooked but considered and left intact.

I am aware a structural analysis should be performed to determine the structural impact of moving the transformers from floor to floor. Due to time considerations, the structural analysis was not performed, but is noted as an issue to be addressed.

Electrical Schematics

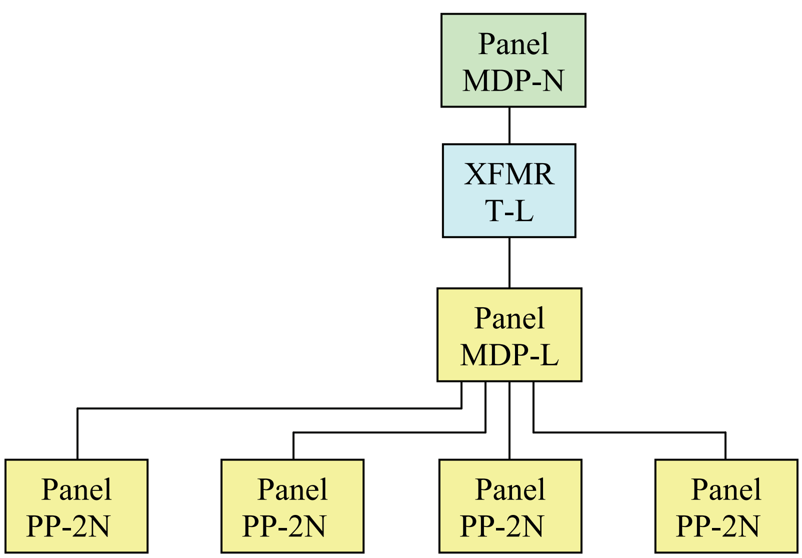
Existing Transformer Configuration:



Refer to one-line diagram inserts for details of existing and proposed changes to the entire system

Figure 20: Alternate 1 Existing Design Schematic

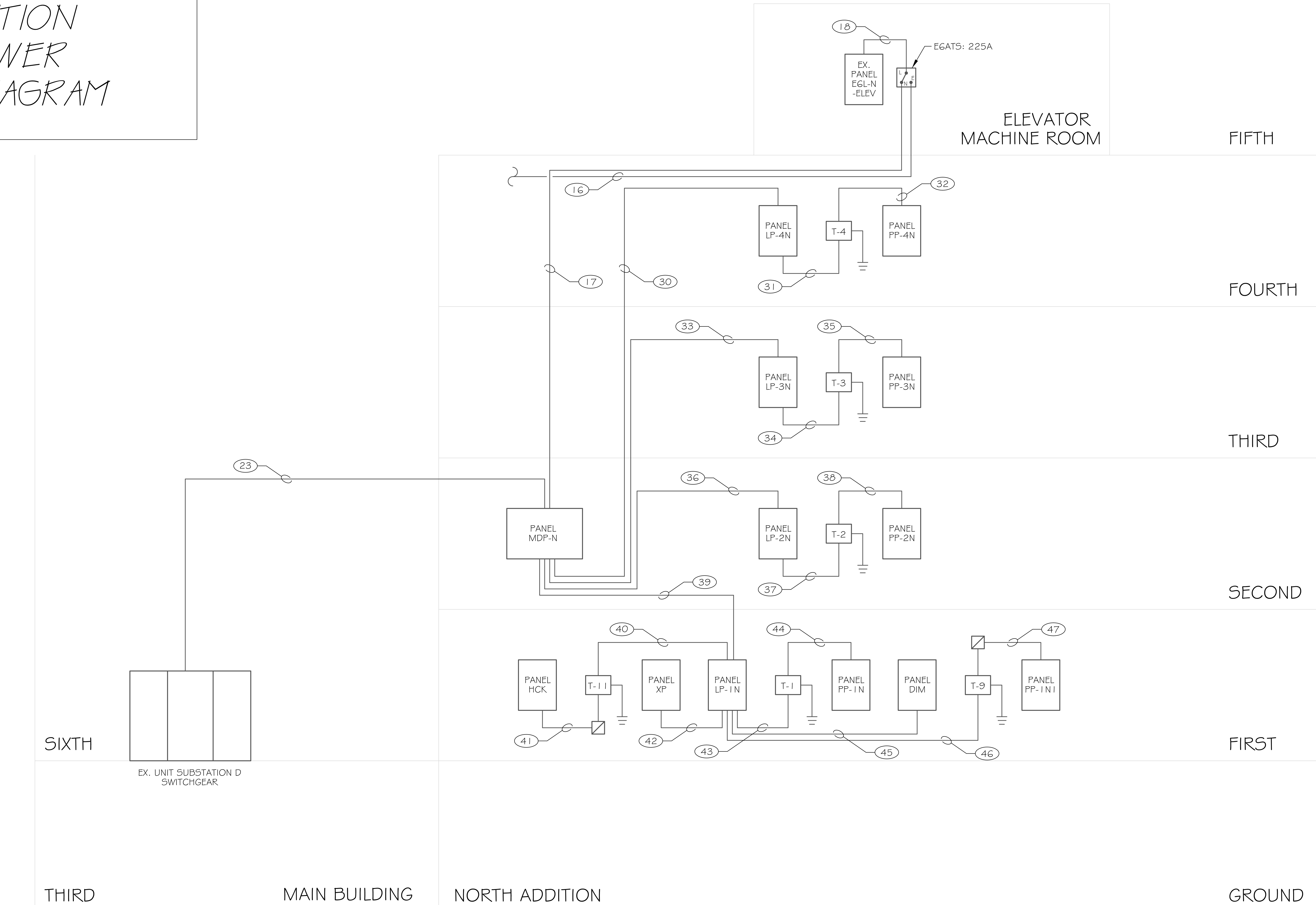
Proposed Transformer Configuration:



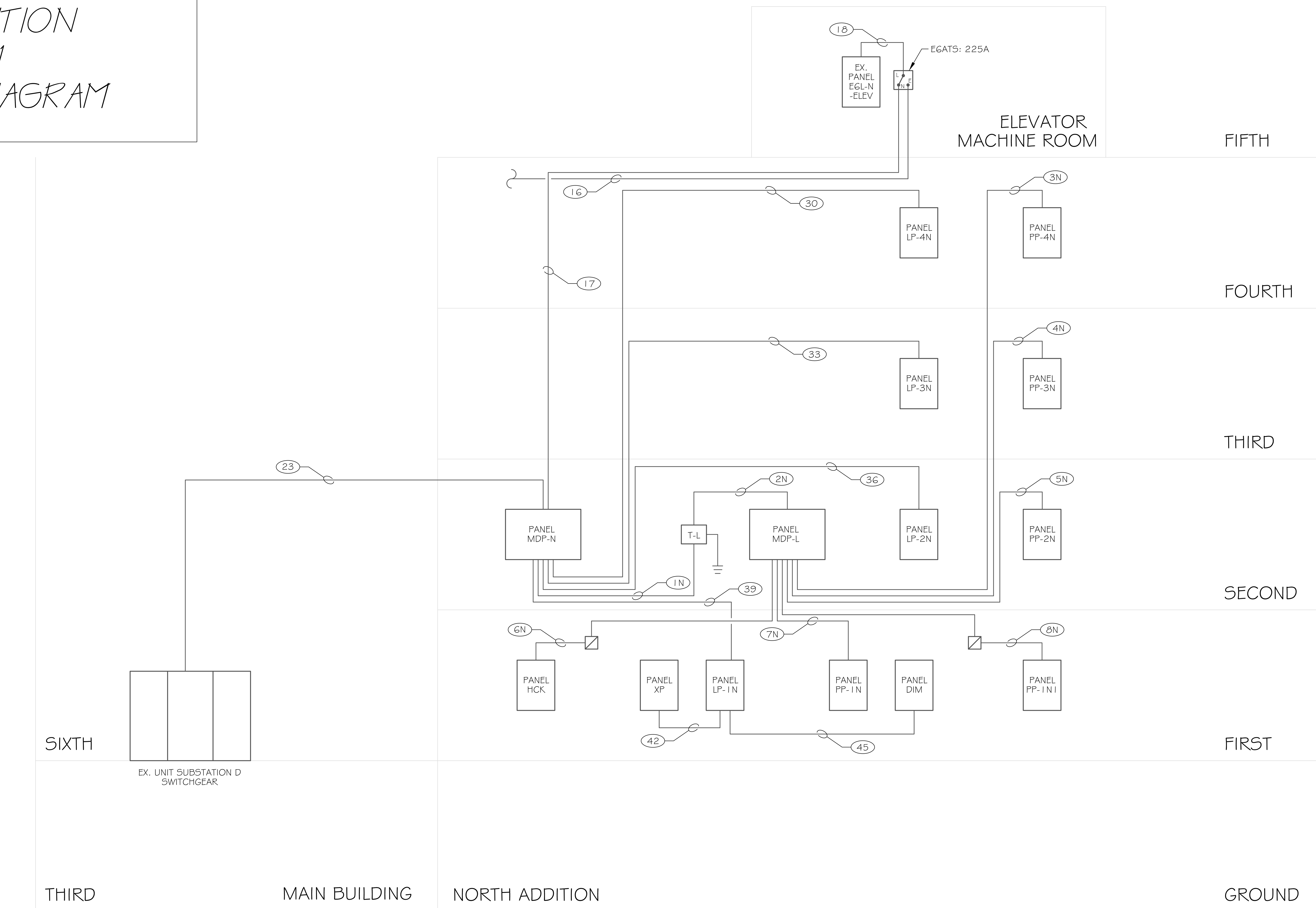
Refer to one-line diagram inserts for details of existing and proposed changes to the entire system

Figure 21: Alternate 1 Proposed Design Schematic

NORTH ADDITION NORMAL POWER ONE-LINE DIAGRAM



NORTH ADDITION ALTERNATE 1 ONE-LINE DIAGRAM



Electrical Equipment Schedules

To determine the financial impact of the proposed change stated above, I first had to determine what components I would be deleting from the initial design to accommodate for the new changes. The following table summarizes these deletions:

Electrical Equipment - Deleted Normal System Components (Existing)

	Transformer					Circuit Breaker			
Equipment Type	Name	kVA	Primary Voltage	Secondary Voltage	Type	Feeding	Size (A)	Phase	Voltage
TRANSFORMER	T-1	45	480∆	208Y/120	DRY				
TRANSFORMER	T-2	45	480∆	208Y/120	DRY				
TRANSFORMER	T-3	45	480∆	208Y/120	DRY				
TRANSFORMER	T-4	45	480∆	208Y/120	DRY				
TRANSFORMER	T-9	45	480∆	208Y/120	DRY				
TRANSFORMER	T-11	75	480∆	208Y/120	DRY				
FEEDER									
FEEDER									
FEEDER									
FEEDER									
FEEDER									
FEEDER									
FEEDER									
FEEDER									
FEEDER									
FEEDER									
FEEDER									
FEEDER									
CIRCUIT BREAKER						PP-1N	70	3	208Y/120
CIRCUIT BREAKER						PP-1N1	70	3	208Y/120
CIRCUIT BREAKER						HCK	100	3	208Y/120
CIRCUIT BREAKER						PP-2N	70	3	208Y/120
CIRCUIT BREAKER						PP-3N	70	3	208Y/120
CIRCUIT BREAKER						PP-4N	70	3	208Y/120

Similarly, I needed to determine what components I would be adding to the current system. The following table summarizes those additions:

Electrical Equipment - Added Normal System Components (Proposed)

	Panelboard							Feeder					
Equipment Type	Name	Load Connected (A)	Rating (A)	# Poles	Spaces	Voltage	Protection (A)	Name	Size	Rating (A)	Ground	Conduit Size	Length (ft)
PANEL	MDP-L	644	800	3	24	208Y/120	800						
FEEDER								#1H	2 SETS (3) #1/0	300	#6	1 1/2"	16
FEEDER								#1L	3 SETS (4) #300	855	#2	2 1/2"	20
FEEDER								#1N	(4) #1/0	150	#6	1 1/2"	6
FEEDER								#1N1	(4) #1/0	150	#6	1 1/2"	152
FEEDER								#2N	(4) #1/0	150	#6	1 1/2"	12
FEEDER								#3N	(4) #1/0	150	#6	1 1/2"	24
FEEDER								#4N	(4) #1/0	150	#6	1 1/2"	36
FEEDER								#1HCK	(4) #4/0	230	#4	1 1/2"	88

Electrical Equipment - Cont'd (Proposed)									
	Transformer					Circuit Breaker			
Equipment Type	Name	kVA	Primary Voltage	Secondary Voltage	Type	Feeding	Size (A)	Phase	Voltage
TRANSFORMER	T-L	225	480?	208Y/120	DRY				
CIRCUIT BREAKER						T-L	300	3	480Y/277
CIRCUIT BREAKER						MDP-L	800	3	208Y/120
CIRCUIT BREAKER						PP-1N	150	3	208Y/120
CIRCUIT BREAKER						PP-1N1	150	3	208Y/120
CIRCUIT BREAKER						HCK	200	3	208Y/120
CIRCUIT BREAKER						PP-2N	150	3	208Y/120
CIRCUIT BREAKER						PP-3N	150	3	208Y/120
CIRCUIT BREAKER						PP-4N	150	3	208Y/120

Voltage Drop Calculations

Since my proposed redesign deals with some significantly long feeder runs, I had to make sure the voltage drop for the feeders did not exceed 2% as recommended by NEC Article 215.2 (A) (4). The following table summarizes the voltage drop calculations and what wires were resized to maintain a 2% drop or less:

Voltage Drop Calculations - Alt. 1							
Feeder	Size	$V_{L\text{-}N}$	Amperage	Length	Factor	V_{drop} Factor*	% Vd_{rop}
#1H	(2) #1/0	277	140	16	0.127	0.283	0.10
#1L	(3) #300 MCM	120	215	20	0.0545	0.234	0.20
#1N	#1/0	120	168	6	0.127	0.128	0.11
#1N1	#3/0	120	160	152	0.0865	2.104	1.75
#2N	#1/0	120	148	12	0.127	0.226	0.19
#3N	#1/0	120	160	24	0.127	0.488	0.41
#4N	#1/0	120	32	36	0.127	0.146	0.12
#1HCK	#4/0	120	56	88	0.0695	0.342	0.29

* Assumed a P.F. of 0.95

[yellow box] - denotes upsized feeder to shown size due to voltage drop

Pricing

With the help of a local electrical distributor, I priced the material and labor costs for both the credits and additional costs associated with the above changes to the current normal distribution system. The following table summarizes the credits associated with the deleted components:

System Component Pricing - Alt. 1 Credits							
Equipment Type	Product Number	Quantity	Material Cost	Labor Quantity	Labor Cost ($/hr)	Total Labor Cost	Total Cost
TRANSFORMER T-1	45T3H	1	$3,553.00	48.0	30.45	$1,461.60	$5,014.60
TRANSFORMER T-2	45T3H	1	$3,553.00	48.0	30.45	$1,461.60	$5,014.60
TRANSFORMER T-3	45T3H	1	$3,553.00	48.0	30.45	$1,461.60	$5,014.60
TRANSFORMER T-4	45T3H	1	$3,553.00	48.0	30.45	$1,461.60	$5,014.60
TRANSFORMER T-9	45T3H	1	$3,553.00	48.0	30.45	$1,461.60	$5,014.60
TRANSFORMER T-11	75TH3	1	$5,353.00	48.0	30.45	$1,461.60	$6,814.60
FEEDER (3 #4)	Electrical Contractor	14	$30.24	0.8	30.45	$25.58	$55.82
FEEDER (#8)	Electrical Contractor	14	$4.20	-	-	-	$4.20
EMT (1")	Electrical Contractor	14	$14.69	1.1	30.45	$34.10	$48.79
FEEDER (4 #1/0)	Electrical Contractor	10	$63.20	0.6	30.45	$18.27	$81.47
FEEDER (#6)	Electrical Contractor	10	$4.50	-	-	-	$4.50
EMT (1 1/2")	Electrical Contractor	10	$16.49	0.8	30.45	$24.36	$40.85
FEEDER (3 #4)	Electrical Contractor	15	$28.80	0.9	30.45	$27.41	$56.21
FEEDER (#8)	Electrical Contractor	15	$4.50	-	-	-	$4.50
EMT (1")	Electrical Contractor	15	$15.74	1.2	30.45	$36.54	$52.28
FEEDER (4 #1/0)	Electrical Contractor	12	$75.84	0.7	30.45	$21.92	$97.76
FEEDER (#6)	Electrical Contractor	12	$5.40	-	-	-	$5.40
EMT (1 1/2")	Electrical Contractor	12	$19.79	1.0	30.45	$29.23	$49.02
FEEDER (3 #4)	Electrical Contractor	22	$42.24	1.3	30.45	$40.19	$82.43
FEEDER (#8)	Electrical Contractor	22	$6.60	-	-	-	$6.60
EMT (1")	Electrical Contractor	22	$23.08	1.8	30.45	$53.59	$76.67
FEEDER (4 #1/0)	Electrical Contractor	12	$75.84	0.7	30.45	$21.92	$97.76
FEEDER (#6)	Electrical Contractor	12	$5.40	-	-	-	$5.40
EMT (1 1/2")	Electrical Contractor	12	$19.79	1.0	30.45	$29.23	$49.02
FEEDER (3 #4)	Electrical Contractor	15	$28.80	0.9	30.45	$27.41	$56.21
FEEDER (#8)	Electrical Contractor	15	$4.50	-	-	-	$4.50
EMT (1")	Electrical Contractor	15	$15.74	1.2	30.45	$36.54	$52.28
FEEDER (4 #1/0)	Electrical Contractor	12	$75.84	0.7	30.45	$21.92	$97.76
FEEDER (#6)	Electrical Contractor	12	$5.40	-	-	-	$5.40
EMT (1 1/2")	Electrical Contractor	12	$19.79	1.0	30.45	$29.23	$49.02
FEEDER (3 #4)	Electrical Contractor	20	$38.40	1.2	30.45	$36.54	$74.94
FEEDER (#8)	Electrical Contractor	20	$6.00	-	-	-	$6.00
EMT (1")	Electrical Contractor	20	$20.98	1.6	30.45	$48.72	$69.70
FEEDER (4 #1/0)	Electrical Contractor	152	$960.64	9.1	30.45	$277.70	$1,238.34
FEEDER (#6)	Electrical Contractor	152	$68.40	-	-	-	$68.40
EMT (1 1/2")	Electrical Contractor	152	$250.65	12.2	30.45	$370.27	$620.92
FEEDER (4 #4/0)	Electrical Contractor	88	$830.72	5.3	30.45	$160.78	$991.50
FEEDER (#4)	Electrical Contractor	88	$56.32	-	-	-	$56.32
EMT (1 1/2")	Electrical Contractor	88	$145.11	7.0	30.45	$214.37	$359.48
FEEDER (3 #1)	Electrical Contractor	16	$4.20	1.0	30.45	$29.23	$33.43
FEEDER (#8)	Electrical Contractor	16	$4.80	-	-	-	$4.80
EMT (1 1/2")	Electrical Contractor	16	$26.38	1.3	30.45	$38.98	$65.36
CIRCUIT BREAKER PP-1N	FAL34070	1	$616.00	1.0	30.45	$30.45	$646.45
CIRCUIT BREAKER PP-1N1	FAL34070	1	$616.00	1.0	30.45	$30.45	$646.45
CIRCUIT BREAKER HCK	FAL34100	1	$616.00	1.0	30.45	$30.45	$646.45
CIRCUIT BREAKER PP-2N	FAL34070	1	$616.00	1.0	30.45	$30.45	$646.45
CIRCUIT BREAKER PP-3N	FAL34070	1	$616.00	1.0	30.45	$30.45	$646.45
CIRCUIT BREAKER PP-4N	FAL34070	1	$616.00	1.0	30.45	$30.45	$646.45
						Total Credits:	$40,439.34

After I had determined the financial impact of my proposed deleted components, I determined the impact of my proposed additions to the system in the following table:

System Component Pricing - Alt. 1 Additions

Equipment Type	Product Number	Quantity	Material Cost	Labor Quantity	Labor Cost ($/hr)	Total Labor Cost	Total Cost
TRANSFORMER T-L	225TH3	1	$12,406.00	80.0	$30.45	$2,436.00	$14,842.00
PANEL MDP-L	Eaton Elec. (pg. 27)	1	$12,164.00	2.0	$30.45	$60.90	$12,224.90
FEEDER (6 #1/0)	Electrical Contractor	16	$151.68	1.0	$30.45	$29.23	$180.91
FEEDER (2 #6)	Electrical Contractor	16	$14.40	-	-	-	$14.40
EMT (2 1 1/2")	Electrical Contractor	16	$48.22	1.3	$30.45	$38.98	$87.20
FEEDER (12 #300 MCM)	Electrical Contractor	20	$998.40	1.2	$30.45	$36.54	$1,034.94
FEEDER (3 #2)	Electrical Contractor	20	$66.00	-	-	-	$66.00
EMT (3 2 1/2")	Electrical Contractor	20	$180.84	1.6	$30.45	$48.72	$229.56
FEEDER (4 #1/0)	Electrical Contractor	6	$37.92	0.4	$30.45	$10.96	$48.88
FEEDER (#6)	Electrical Contractor	6	$2.70	-	-	-	$2.70
EMT (1 1/2")	LOWES	6	$9.89	0.5	$30.45	$14.62	$24.51
FEEDER (4 #3/0)	Electrical Contractor	152	$1,355.84	9.1	$30.45	$277.70	$1,633.54
FEEDER (#4)	Electrical Contractor	152	$97.28	-	-	-	$97.28
EMT (1 1/2")	LOWES	152	$250.65	12.2	$30.45	$370.27	$620.92
FEEDER (4 #1/0)	Electrical Contractor	12	$75.84	0.7	$30.45	$21.92	$97.76
FEEDER (#6)	Electrical Contractor	12	$5.40	-	-	-	$5.40
EMT (1 1/2")	LOWES	12	$19.79	1.0	$30.45	$29.23	$49.02
FEEDER (4 #1/0)	Electrical Contractor	24	$151.68	1.4	$30.45	$43.85	$195.53
FEEDER (#6)	Electrical Contractor	24	$10.80	-	-	-	$10.80
EMT (1 1/2")	LOWES	24	$39.58	1.9	$30.45	$58.46	$98.04
FEEDER (4 #1/0)	Electrical Contractor	36	$227.52	2.2	$30.45	$65.77	$293.29
FEEDER (#6)	Electrical Contractor	36	$16.20	-	-	-	$16.20
EMT (1 1/2")	LOWES	36	$59.36	2.9	$30.45	$87.70	$147.06
FEEDER (4 #4/0)	Electrical Contractor	88	$830.72	5.3	$30.45	$160.78	$991.50
FEEDER (#4)	Electrical Contractor	88	$56.32	-	-	-	$56.32
EMT (1 1/2")	LOWES	88	$145.11	7.0	$30.45	$214.37	$359.48
CIRCUIT BREAKER T-L	PL (pg. 8-33)	1	$7,700.00	1.0	$30.45	$30.45	$7,730.45
CIRCUIT BREAKER MDP-L	PL (pg. 8-33)	1	$11,110.00	1.0	$30.45	$30.45	$11,140.45
CIRCUIT BREAKER PP-1N	KCL34150	1	$4,548.00	1.0	$30.45	$30.45	$4,578.45
CIRCUIT BREAKER PP-1N1	KCL34150	1	$4,548.00	1.0	$30.45	$30.45	$4,578.45
CIRCUIT BREAKER HCK	KCL34200	1	$4,548.00	1.0	$30.45	$30.45	$4,578.45
CIRCUIT BREAKER PP-2N	KCL34150	1	$4,548.00	1.0	$30.45	$30.45	$4,578.45
CIRCUIT BREAKER PP-3N	KCL34150	1	$4,548.00	1.0	$30.45	$30.45	$4,578.45
CIRCUIT BREAKER PP-4N	KCL34150	1	$4,548.00	1.0	$30.45	$30.45	$4,578.45
						Total Costs:	$79,769.75

Notes:
1. Material prices were obtained from Hite Electric (Altoona, PA) and Lowe's of State College
2. Electrician Labor Cost was obtained for the Washington, D.C. area from Leach Wallace Assoc.
3. Labor productivity was quoted by Hite Electric (Altoona, PA) and consists of the following:
   - Lay 100' conduit: 1 person, 8 hrs
   - Pull 100' (3-phase) wire: 2 people, 3 hrs
   - Install small (<45 KVA) transformer: 2 people, 3 days (includes all connections)
   - Install large (>45 KVA) transformer: 2 people, 5 days (includes all connections)
   - 42 pole Panelboard: 1 person, 2 hours (not including connections)
   - Circuit Breaker/Circuit connections: 1 person, 1 hr each
   - No additional labor costs to install ground wires. This is included in the price for pulling the feeder.

Conclusions

From the results obtained above, I would not recommend changing the transformer configuration to the proposed change. Although it would simplify the transformer layout, it would cost the client an additional $39,000 and thus would not be ideal. Additionally, the failure of the single transformer in proposed change would constitute a failure of the entire 208Y/120V normal system. With the load distributed amongst six transformers as initially designed, I feel the system is more reliable and less likely to face a global catastrophic failure.