George Washington University School of Business and Public Management

Technical Report 2
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Lighting / Electrical
Dr Moeck
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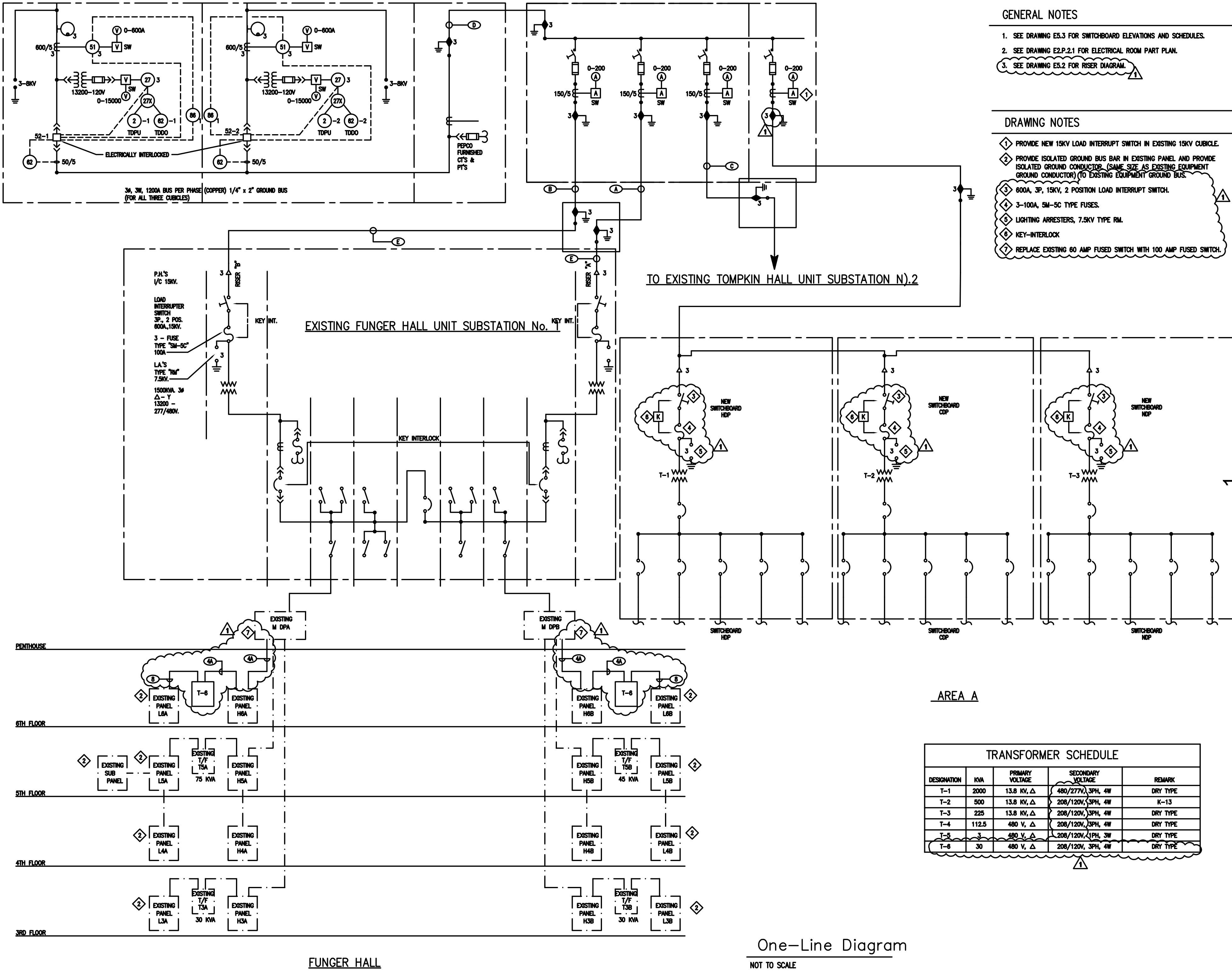
The Purpose of the second technical assignment is to evaluate the existing electrical conditions inside the new George Washington University School of Business and Public management. Using the plans and specifications generously provided to me by Smith Group Inc., a single line diagram and a load summary calculation was performed. Also provided is a narrative on the general information included in the electrical system.

The Load summary Calculations adhere to the NEC standards provided in the NEC Handbook. Loads included in the calculation are lighting loads, receptacle loads, mechanical loads, and elevator loads. Feeders were then sized according to the loads, and the main feeder for the building was also sized accordingly. After compiling the load data, the local power utility data was applied to calculate the building cost.

The overall report is meant to provide general knowledge of the building and its electrical system. It will display both the positive and negative areas of the building and will determine the areas that must be re-evaluated.



GENERAL NOTES

1. SEE DRAWING E5.3 FOR SWITCHBOARD ELEVATIONS AND SCHEDULES.
2. SEE DRAWING E2.P.2.1 FOR ELECTRICAL ROOM PART PLAN.
3. SEE DRAWING E5.2 FOR RISER DIAGRAM.

DRAWING NOTES

1. PROVIDE NEW 15KV LOAD INTERRUPT SWITCH IN EXISTING 15KV CUBICLE.
2. PROVIDE ISOLATED GROUND BUS BAR IN EXISTING PANEL AND PROVIDE ISOLATED GROUND CONDUCTOR. (SAME SIZE AS EXISTING EQUIPMENT GROUND CONDUCTOR) TO EXISTING EQUIPMENT GROUND BUS.
3. 600A, 3P, 15KV, 2 POSITION LOAD INTERRUPT SWITCH.
4. 3-100A, 5M-5C TYPE FUSES.
5. LIGHTING ARRESTERS, 7.5KV TYPE RM.
6. KEY-INTERLOCK
7. REPLACE EXISTING 60 AMP FUSED SWITCH WITH 100 AMP FUSED SWITCH.

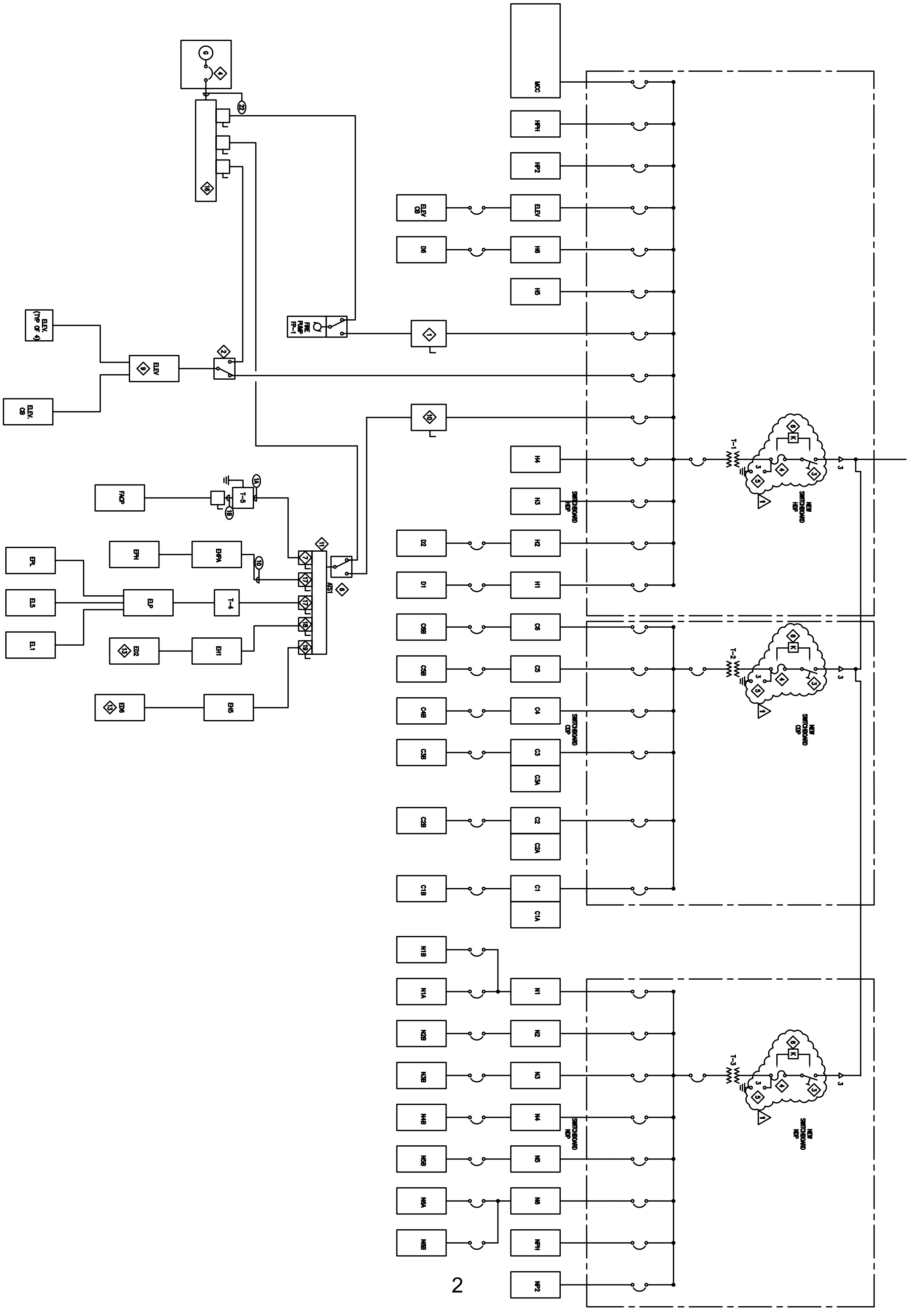
TRANSFORMER SCHEDULE

DESIGNATION	KVA	PRIMARY VOLTAGE	SECONDARY VOLTAGE	REMARK
T-1	2000	13.8 KV, Δ	480/277V, 3PH, 4W	DRY TYPE
T-2	500	13.8 KV, Δ	208/120V, 3PH, 4W	K-13
T-3	225	13.8 KV, Δ	208/120V, 3PH, 4W	DRY TYPE
T-4	112.5	480 V, Δ	208/120V, 3PH, 4W	DRY TYPE
T-5	3	480 V, Δ	208/120V, 1PH, 3W	DRY TYPE
T-6	30	480 V, Δ	208/120V, 3PH, 4W	DRY TYPE

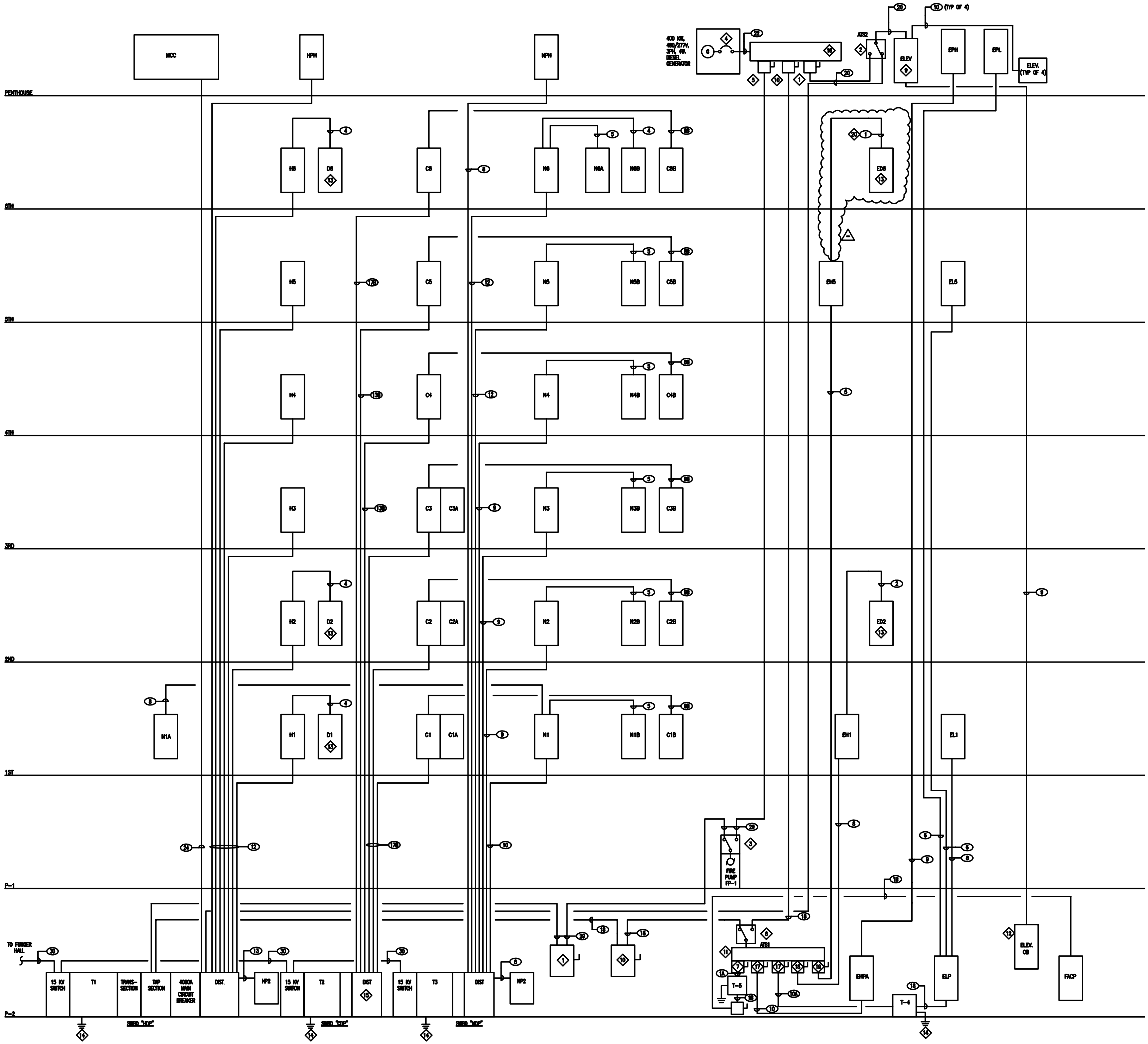
One–Line Diagram

NOT TO SCALE

1



MCC
HPH
HP2
ELEV
ELEV CB
FIRE PUMP FP-1
ELEV. (TYP OF 4)
ELEV. CB
FACP
T-5
EPH
EHPA
EPL
EL5
ELP
T-4
EL1
ED2
EH1
ED6
EH5
ATS1
T-1
T-2
T-3
NEW SWITCHBOARD HDP
SWITCHBOARD HDP
NEW SWITCHBOARD CDP
SWITCHBOARD CDP
NEW SWITCHBOARD NDP
SWITCHBOARD NDP



GENERAL NOTES

1. SEE DRAWING E5.3 FOR MCC ELEVATION AND SCHEDULE.
2. SEE DRAWING E5.3 FOR MCC, SWITCHBOARD ELEVATIONS AND SCHEDULES.
3. SEE DRAWING E5.1 FOR TRANSFORMER SCHEDULE.

DRAWING NOTES

1. 600 AMP, 3 POLE, DISCONNECT SWITCH WITH 600 AMP FUSES.
2. 600 AMP, 3 POLE AUTOMATIC TRANSFER SWITCH WITH OVERLAPPING NEUTRAL.
3. AUTOMATIC TRANSFER SWITCH INTEGRAL TO THE FIRE PUMP CONTROLLER/STARTER PROVIDED BY FIRE PUMP MANUFACTURER.
4. 800 AMP, 3 POLE GENERATOR MAIN CIRCUIT BREAKER.
5. 200 AMP, 3 POLE DISCONNECT SWITCH WITH 175 AMP FUSES.
6. 400 AMP, 3 POLE ATS WITH OVERLAPPING NEUTRAL.
7. 30 AMP, 3 POLE, 15 AMP FUSED DISCONNECT SWITCH.
8. 30 AMP, 2 POLE, 20 AMP FUSED DISCONNECT SWITCH FOR FACP (120 VOLT).
9. ELEVATOR PANEL WITH 4-175 AMP, 3 POLE AND 1-150 AMP, 3 POLE FUSIBLE SHUNT TRIP SWITCH. SEE DRAWING E2.7.1 FOR SPECIFICATIONS.
10. 400A, 3P DISCONNECT SWITCH WITH 400 AMP FUSES.
11. 8" x 8" x 7' LONG WIRE TROUGH.
12. PROVIDE 150 AMP, 3P CIRCUIT BREAKER FOR ELEVATOR.
13. LUTRON LIGHTING DIMMING PANEL.
14. GROUND TO 24" X 12" GROUND BUS BAR
15. ISOLATED GROUND AND EQUIPMENT GROUND SHALL BE CONNECTED TO TRANSFORMER GROUND.
16. PROVIDE 150 AMP, 3 POLE SHUNT TRIP CIRCUIT BREAKER FOR ELEVATOR.
17. 12" X 12"X 6'-0" LONG WIRE TROUGH IN NEMA 3R ENCLOSURE.
18. 200 AMP, 3 POLE DISCONNECT SWITCH WITH 175 AMP FUSES.
19. 100 AMP, 3 POLE DISCONNECT SWITCH WITH 100 AMP FUSES.
20. 60 AMP, 3 POLE DISCONNECT SWITCH WITH 60 AMP FUSES.
21. REUSE EXISTING BRANCH CIRCUIT WIRING FOR EMERGENCY DIMMING CIRCUIT TO PANEL ED2.

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FEEDER SCHEDULE

FEEDER NO.	FEEDER SIZE	NO. SETS	WIRE NO. AND SIZE	GROUND NO. AND SIZE	CONDUIT NO. AND SIZE	REMARKS
1	20A	1	4#12	1#12	(1)-3/4"	
1A	20A	1	3#12	1#12	(1)-3/4"	
1B	20A	1	2#12	1#12	(1)-3/4"	
2	30A	1	4#10	1#10	(1)-3/4"	
3	40A	1	4#8	1#10	(1)-1"	
3A	40A	1	3#8	1#10	(1)-1"	
4	50A	1	4#6	1#10	(1)-1"	
4A	50A	1	3#6	1#10	(1)-1"	
4B	50A	1	5#6	2#10	(1)-1 1/4"	
5	70A	1	4#4	1#8	(1)-1 1/4"	
5A	70A	1	3#4	1#8	(1)-1 1/4"	
5B	70A	1	5#4	2#8	(1)-1 1/4"	
6	85A	1	4#3	1#8	(1)-1 1/4"	
7	95A	1	4#2	1#6	(1)-1 1/4"	
8	110A	1	4#1	1#6	(1)-1 1/4"	
8A	110A	1	3#1	1#6	(1)-1 1/4"	
8B	110A	1	5#1	2#6	(1)-2"	
9	150A	1	4#1/0	1#6	(1)-2"	
9B	150A	1	5#1/0	2#6	(1)-2"	
10	175A	1	4#2/0	1#6	(1)-2"	
10A	175A	1	3#2/0	1#6	(1)-2"	
10B	175A	1	5#2/0	2#6	(1)-2 1/2"	
11	200A	1	4#3/0	1#6	(1)-2"	
12	225A	1	4#4/0	1#4	(1)-2 1/2"	
12A	225A	1	3#4/0	1#4	(1)-2"	
12B	225A	1	5#4/0	2#4	(1)-3"	
13	250A	1	4#250KCMIL	1#4	(1)-2 1/2"	
13B	250A	1	5#250KCMIL	2#4	(1)-3"	
14	275A	1	4#300KCMIL	1#4	(1)-2 1/2"	
15	300A	1	4#350KCMIL	1#3	(1)-3"	
16	325A	1	4#400KCMIL	1#3	(1)-3"	
17	375A	1	4#500KCMIL	1#3	(1)-3"	
17B	375A	1	5#500KCMIL	2#3	(1)-4"	
18	400A	2	4#3/0	1#3	(2)-2"	
18A	400A	2	3#3/0	1#3	(2)-2"	
18B	400A	2	5#3/0	2#3	(2)-2 1/2"	
19	550A	2	4#300KCMIL	1#1	(2)-3"	
20	600A	2	4#350KCMIL	1#1	(2)-3"	
21	750A	2	4#500KCMIL	1#1/0	(2)-4"	
21A	750A	2	3#500KCMIL	1#1/0	(2)-4"	
22	800A	3	4#300KCMIL	1#1/0	(3)-3"	
23	1,000A	3	4#400KCMIL	1#2/0	(3)-3"	
24	1,250A	4	4#350KCMIL	1#3/0	(4)-3"	
24A	1,250A	4	3#350KCMIL	1#3/0	(4)-3"	
25	1,600A	4	4#600KCMIL	1#4/0	(4)-4"	
26	2,000A	5	4#600KCMIL	1#250KCMIL	(5)-4"	
27	2,500A	7	4#500KCMIL	1#250KCMIL	(7)-4"	
28	-	1	-	1#500KCMIL	(1)-4"	
29	-	1	3#1/0	1#6	(1)-2"	SEE NOTE 2
30	-	1	3#2	1#6	(1)-4"	15 KV CONDUCTOR.

NOTES:
1. OMIT NEUTRAL FOR BALANCED THREE PHASE LOADS.
2. ENCASED IN MIN. OF 3" CONCRETE FOR FIRE PUMP FEEDER OR MINERAL INSULATED CABLE.

System Narrative

The electrical power for the new George Washington School of Business and Public Management is fed from an existing system. The utility is run in at 13200 – 120V and split so it runs to an existing substation at Funger Hall, an existing substation at Tompkin Hall and to the new Business School. The system can be described as a primary selective radial distribution system. The building utilizes two separate types of utility voltage, a 480/277 system and a 208/120 system. The 480/277 system feeds the majority of the mechanical equipment and most of the electrical lights for the building. The 208/120 system feeds some of the lights and the receptacles. There are two separate panels for the receptacles, as one has been designated isolated ground for computer loads.

Loads for the building are distributed from three switchboards. Switchboard HDP is 4000 Amp, 480/277 Volt, 3 phase, and 4 wire. It feeds the H panels which provide power to the lighting systems along with the motor control center and the elevator loads. Switchboard CDP is a 1600 Amp, 208/120 volt, 3 phase, and 4 wire. It provides power to the C panels which are the isolated ground receptacles. The last switchboard is the NDP one, it is rated at 800 Amps, 208/120 Volt, 3 phase, and 4 wires. It provides power to the H panels which provide power to the normal receptacle loads. Emergency power is provided by a diesel generator found in the penthouse of the building. It is connected by automatic switches which will throw in case of power lose and send emergency power to the elevators and the Emergency panels. Otherwise, the elevator power is provided by HDP Switchboard.

Transformers

Information on the transformers are provided below. One transformer steps down the primary voltage from 13.8 KVA to 480V. The rest of the transformers step down the primary voltage to 208/120V.

Transformer Schedule				
Designation	KVA	Primary Voltage	Secondary Voltage	Remark
T-1	2000	13.8 KV, Δ	480/277V, 3PH, 4W	Dry
T-2	500	13.8 KV, Δ	208/120V, 3PH, 4W	K-13
T-3	225	13.8 KV, Δ	208/120V, 3PH, 4W	Dry
T-4	112.5	480 V, Δ	208/120V, 3PH, 4W	Dry
T-5	3	480 V, Δ	208/120V, 1PH, 3W	Dry
T-6	30	480 V, Δ	208/120V, 3PH, 4W	Dry

Emergency

The emergency power for the Business School is provided by a 400 KW, 480/277, 3PH, 4 wire diesel generator. When power is cut to the building, there are two automatic switches that are thrown automatically. The automatic switch on the top floor in the penthouse redirects the power from the generator to the elevators and also sends power down to the bottom floor and the second automatic switch. Power is directed from the generator in the form of a long wire trough. The second switch provides power to another long wire trough. From the trough, power is run directly to the four emergency lighting panels, which provides all emergency light on the four floors. Power is also run from the trough to a step down transformer to provide 208/120V power to the emergency receptacle power panels.

Power is being supplied to the lighting system through the EH1, ED2, EH5, and ED6 panels. The EH and ED panels are rated at 408/277V, 3ph, and 4 wires. They provide power to the emergency lighting systems, with the EH1 panel providing emergency light on the façade. The ELP, EL1, and EL5 are stepped down to 208/120V. These panels provide power to the emergency receptacles as well as the fire systems. All these panels have a 100A circuit breakers.

Protection Devices

There are a variety of different electrical protection devices ranging from where the power is run into the building up into the panels that provide the power to the lights and receptacles. The power is run from the company feed into a switchboard, which is then split and run into the basement of the New Business School. The Power is then fed through another load interrupt switch rated the same as in the switchboard, 600A, 3P, 15KV, and set at 2 positions.

Power is fed into Switchboard HDP and tapped from there to Switchboards CDP and NDP. Each switchboard is rated with a new 15KV load interrupt switch in the existing 15KV cubicle on the board. The switches have the switch itself loaded at the same rate mentioned previously, a 3-100A, 5M-5C type fuse, a lighting arrester at 7.5Kv, and a Key interlock. Each Switchboard also has a transformer to step down the electrical load. Switchboard HDP has transformer T-1, Switchboard CDP has transformer T-2 and Switchboard NDP has transformer T-3. For more information on the transformer, view the table in the section above.

Once run from the Switchboards, the panels are protected individually with their individual bus ratings, and their wire sizes.

Other forms of electrical protection have already been mentioned in the emergency power section. The switches that divert the power to the emergency system and the generator have already been mentioned. Also, the two circuit breakers leading to the automatic transfer switches have been discussed above in the emergency power section.

Equipment Location

The electrical equipment is located in two primary locations. The Penthouse level on the roof above the sixth floor holds a lot of the emergency equipment. The generator is located in the mechanical room. Also located there are the wire long wire trough and the automatic transfer switch. Next to the mechanical room is the elevator room. The elevator room contains the elevator panel along with the four elevator motors. The motor control center is also located in the penthouse on the roof.

The electrical room on floor P2 is where the majority of the other big electrical systems are located. The 3 switchboards are located in that electrical room, along with the second wire trough and transformers associated with the emergency system.

The panels for each of the floors are located in electrical rooms on each of the floors.

Lighting Systems

Typical lighting system throughout the building is fluorescent system. Fluorescents are used in the circulation spaces, as well as all of the classrooms and the offices. Classrooms take advantage of primarily indirect light, while the circulation spaces use direct light, and the auditorium takes advantage of cove lighting. The fluorescent systems, of course, operate off of 480/277 V power. Accent lighting and under cabinet fluorescent lighting systems are also used to provide light in areas or on task planes. These systems are run off of 208/120V power.

Shutoff Requirements

The new Business School takes advantage of numerous types of shut-off devices. Most of the rooms have occupancy sensors. The occupancy sensors are provided so that they detect motion within the rooms. When no motion is detected for a preprogrammed amount of time, the lights will automatically shut off. Another type of system that is used in this building is automatic timers. The timers are set to turn off and on at designated times. This type of lighting is used mainly for circulation spaces where it would not be ideal to place a switch in an open area. The automatic switches are run to the building time clock, and often run to a switch that can be controlled from a more discrete location. Finaly, on the exterior of the building, daylight sensors are used. The daylight sensors measures the amount of daylight being received, and turns the lights on or off accordingly.

Power Factor

There are no capacitors in my building; therefore there are no major power factor corrections.

Design Requirements

The biggest issue in the design requirements is allowing for voltage drops. Because the building is 6 stories, plus the two floors below grade, you have to take into account voltage drop calculations. These calculations for running wires to the penthouse on the roof are very important to the wire sizing.

Lamp Data

The plans and specifications were provided for me by Smith Group, who did the lighting and electrical design. Smith Group does not spec product data for lamps and ballasts. Therefore, using the information that was given, I chose a set of general lamps.

Lamp	Wattage	Initial Lumens	Mean Lumens	CRI	CCT	Ballast
Compact Fluorescent	5W	250	210	82	2700	Electronic/Dimming
Metal Halide	150W	13250	11260	88	3000	Electronic/Dimming
Metal Halide	70W	6500	5200	82	3000	Electronic/Dimming
Linear Fluorescent	54W	5000	4500	83	3000	Electronic/Dimming
Long Fluorescent	50W	4000	-	82	3000	Electronic/Dimming
Long Fluorescent	50W	4000	-	82	3000	Hi-Lume Dimming
Compact Triple Tube	42W	3200	-	82	3000	Electronic/Dimming
Compact Triple Tube	32W	2400	-	82	3000	Electronic/Dimming
Linear Fluorescent	32W	3100	2959	85	3000	Electronic/Dimming
Linear Fluorescent	28W	2800	-	85	3000	Electronic/Dimming
Linear Fluorescent	28W	2800	-	85	3000	Hi-Lume Dimming
Compact Triple Tube	26W	1800	-	83	3000	Electronic/Dimming
Compact Triple Tube	18W	1200		83	3000	Electronic/Dimming
Short Tube Compact	9W	600	-	82	2700	Electronic/Dimming
Short Tube Compact	5W	250	210	82	2700	Electronic/Dimming

Mechanical Equipment

Description	HP	KVA	Voltage	Phase	Comb. Starter Size	Nema. Encl.	CB Size	Wiring Size
AHU-1	"1-25" "1-7.5"	35.8	480	3	-	1	90	3/4 + 1/10 G. 3/4"C
AHU-2	"1-15" "1-7.5"	35.5	480	3	-	1	60	3/8 + 1/10 G. 3/4"C
AHU-3	"1-20" "1-7.5"	30.2	480	3	-	1	90	3/6 + 1/10 G. 3/4"C
AHU-4	"1-20" "1-5"	27.5	480	3	-	1	70	3/6 + 1/10 G. 3/4"C
AHU-5	"1-25" "1-10"	38.2	480	3	-	1	90	3/4 + 1/10 G. 1"C

AHU-6	"1-25" "1-7.5"	35.8	480	3	-	1	90	3/4 + 1/10 G. 3/4"C
AHU-7	"1-15" "1-7.5"	25.5	480	3	-	1	60	3/8 + 1/10 G. 3/4"C
AHU-8	"1-20" "1-7.5"	30.2	480	3	-	1	90	3/6 + 1/10 G. 3/4"C
AHU-9	"1-15" "1-5"	22.8	480	3	-	1	60	3/8 + 1/10 G. 3/4"C
AHU-10	"1-15" "1-5"	22.8	480	3	-	1	60	3/8 + 1/10 G. 3/4"C
AHU-11	"1-20" "1-5"	27.5	480	3	-	1	70	3/6 + 1/10 G. 3/4"C
AHU-12	"1-20" "1-5"	27.5	480	3	-	1	70	3/6 + 1/10 G. 3/4"C
P-17 AHU-1 Preheat Coil	"3/4"	1.1	480	3	-	1	15	3/12 + 1/10 G. 3/4"C
P-18 AHU-2 Preheat Coil	"3/4"	1.1	480	3	-	1	15	3/12 + 1/10 G. 3/4"C
P-10 AHU-3 Preheat Coil	"3/4"	1.1	480	3	-	1	15	3/12 + 1/10 G. 3/4"C
P-20 AHU-4 Preheat Coil	"3/4"	1.1	480	3	-	1	15	3/12 + 1/10 G. 3/4"C
P-21 AHU-5 Preheat Coil	"3/4"	1.1	480	3	-	1	15	3/12 + 1/10 G. 3/4"C
P-22 AHU-6 Preheat Coil	"3/4"	1.1	480	3	-	1	15	3/12 + 1/10 G. 3/4"C
P-23 AHU-7 Preheat Coil	"3/4"	1.1	480	3	-	1	15	3/12 + 1/10 G. 3/4"C
P-24 AHU-8 Preheat Coil	"3/4"	1.1	480	3	-	1	15	3/12 + 1/10 G. 3/4"C
P-25 AHU-9 Preheat Coil	"3/4"	1.1	480	3	-	1	15	3/12 + 1/10 G. 3/4"C
P-26 AHU-10 Preheat Coil	"3/4"	1.1	480	3	-	1	15	3/12 + 1/10 G. 3/4"C
P-27 AHU-11 Preheat Coil	"3/4"	1.1	480	3	-	1	15	3/12 + 1/10 G. 3/4"C
P-28 AHU-12 Preheat Coil	"3/4"	1.1	480	3	-	1	15	3/12 + 1/10 G. 3/4"C
P-32 FOR BCU-1	"1/3"	0.8	120	1	Manual	1	15	2/12 + 1/10 G. 3/4"C
P-33 FOR BCU-2	"1/3"	0.8	120	1	Manual	1	15	2/12 + 1/10 G. 3/4"C
AIRC-1	"2-1/2"	2.3	208	1	1	1	20	2/12 + 1/10 G. 3/4"C
TRACKTION ELEVATOR	75	76.4	480	3	-	1	175	3/1 + 1/6 G. 1 1/2"C
HYDRAULIC ELEVATOR	60	61.3	480	3	-	1	150	4/2 + 1/6 G. 1 1/4"C

HEATING COIL, AC-4		3.8	208	1	30A, 2P, NFSS	1	25	2/12 + 1/10 G. 3/4"C
HEATING COIL, AC-5		7.5	208	1	30A, 2P, NFSS	1	45	2/6 + 1/10 G. 3/4"C
HEATING COIL, AC-6, AC-7		10	480	3	30A, 2P, NFSS	1	15	3/12 + 1/12 G. 3/4"C
CU-2,3, 13.5 RLA, 2-3/4 HP CONDENSER	"2 - 3/4"	13	480	3	1	1	40	3/10 + 1/10 G. 3/4"C
CU-4, 14.7 RLA, 1/4 HP CONDENSER	"1/4"	3.7	208	1	1	1	40	2/8 + 1/10 G. 3/4"C
CU-5, 7.7 RLA, 1-1/12 HP CONDENSER	"1/12"	1.8	208	1	1	1	20	2/12 + 1/10 G. 3/4"C
CU-6,7 13.5 RLA, 2-3/4 HP CONDENSER	"2 - 3/4"	13	480	3	1	3R	40	3/10 + 1/10 G. 3/4"C
AC-2,3,6,7	"1 - 1/2"	2.1	480	3	1	1	15	3/12 + 1/12 G. 3/4"C
AC-4	"1/2"	1.1	208	1	1	1	15	2/12 + 1/12 G. 3/4"C
AC-5	"1/4"	0.7	208	1	1	1	15	2/12 + 1/12 G. 3/4"C
CDP-1	"1/5"	670	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
EFT-1	-	1.5	277	1	-	1	15	2/12 + 1/12 G. 3/4"C
EFT-2	-	1	277	1	-	1	15	2/12 + 1/12 G. 3/4"C
EFT-3	-	1.5	120	1	-	1	15	2/12 + 1/12 G. 3/4"C
EHT-1,2	-	-	277	1	-	1	15	2/12 + 1/12 G. 3/4"C
EF-1.1,1.3	10	11.2	480	3	1	1	30	3/12 + 1/12 G. 3/4"C
EF-1.2	10	11.2	480	3	1	1	30	6/12 + 1/12 G. 3/4"C
EF-2,3	10	11.2	480	3	1	1	30	6/12 + 1/12 G. 3/4"C
EF-4	15	16.7	480	3	2	1	40	3/10 + 1/10 G. 3/4"C
EF-5	"1/3"	0.83	480	1	Manuel	1	15	2/12 + 1/12 G. 3/4"C
EF-6A, 6B	"3/4"	2.1	120	3	1	1	15	3/12 + 1/12 G. 3/4"C
EF-7	"1/3"	0.83	480	1	Manual	1	15	2/12 + 1/12 G. 3/4"C

EF-8	"1/3"	0.83	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
EF-9	"1/3"	0.83	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
EF-10	"1/5"	0.67	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
EF-11	"1/5"	0.67	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
EF-12	"1/6"	0.51	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
EF-13	-	0.08	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
EF-14	-	0.06	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
EF-15	-	0.06	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
EF-16	-	0.06	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
EF-17	-	0.08	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
EF-18	-	0.14	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
EF-19	-	0.05	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
EF-20	-	0.3	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
EF-21	"1/4"	0.67	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
OAF-1	"1/4"	0.67	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
SF-17,18	30	31.8	480	3	3	3R	90	3/6 + 1/10 G. 3/4"C
VCB-1F,2F	"1/3"	0.83	277	1	1	1	15	2/12 + 1/12G. 3/4"C
VCB-3F	"2-1/3"	1.7	277	1	1	1	15	2/12 + 1/12 G. 3/4"C
UH-1	"1/20"	0.25	120	1	Manual	1	15	2/12 + 1/12 G. 3/4"C
EUH-1	-	3.3	277	1	1	1	15	2/12 + 1/12 G. 3/4"C
EUH-2	-	5	277	1	1	1	25	2/10 + 1/10 G. 3/4"C
EUH-3	-	7.5	277	1	2	1	35	2/8 + 1/10 G. 3/4"C
CUH-1	"1/15"	0.3	120	1	-	1	15	3/8 + 1/10 G. 3/4"C
CUH-2	"1/10"	0.4	120	1	-	1	15	2/12 + 1/12 G. 3/4"C

BCU-1	5	6	480	3	1	1	15	3/12 + 1/12 G. 3/4"C
BCU-2	"1 1/2"	2.1	480	3	1	1	15	3/12 + 1/12 G. 3/4"C
BCU-3	1	1.4	480	3	1	1	15	3/12 + 1/12 G. 3/4"C
EWH-1	-	3	277	1	30A, 2P, NFSS	1	15	2/12 + 1/12 G. 3/4"C

Total KVA = 1368.12 KVA

Plumbing Equipment

Description	HP	KVA	Voltage	Phase	Comb. Starter Size	Nema. Encl.	CB Size	Wiring Size
Fire Pump Fp-1	75	76.4	480	3	-	1	-	3/ 1/0 + 1/6 g. 2"C
Jockey Pump JP -1	"1 1/2"	2.1	480	3	1	1	15	3/12 + 1/12 g. 3/4" C
Electric Water Heater DWH-1	-	18	480	3	30A, 3P, NFSS	1	30	3/10 + 1/10 g. 3/4" C
Electric Water Heater DWH-2	-	18	480	3	30A, 3P, NFSS	1	30	3/10 + 1/10 g. 3/4" C
Electric Water Heater DWH-3	-	3	277	1	30A, 3P, NFSS	1	15	2/12 + 1/12 g. 3/4" C
Cooling Tower Pump, CT-1	" 1 1/2"	2.1	480	3	1	3R	15	3/12 + 1/12 g. 3/4" C
Elevator Sump Pump	"1/2"	1.1	120	1	Manual	3R	20	-
Sewage Ejector Pump, SSP -1	2	2.7	480	3	1	3R	15	3/12 + 1/12 g. 3/4" C
Duplex Sump Pump, DSP-1	5	6.1	480	3	1	3R	15	3/12 + 1/12 g. 3/4" C
Air Compressor, AC-1, Fire Pump Room	"1 1/2"	2.1	480	3	1	1	15	3/12 + 1/12 g. 3/4" C
Recirculating Pump, HWRP-1 Penthouse	"1/8"	0.4	120	1	Manual	1	15	2/12 + 1/12 g. 3/4" C
Recirculating Pump, HWRP-2 Penthouse	"1/40"	0.2	120	1	Manual	1	15	2/12 + 1/12 g. 3/4" C

Total KVA = 132.2 KVA

NEC Load Calculations

The Lighting Loads have been calculated according to NEC table 220.3A.

1st floor

	Area	Load Factor	VA
Classroom	14187	3	42561
Circulation	5184	0.5	2592

2nd Floor

	Area	Load Factor	VA
Classroom	13900	3	41700
Circulation	5600	0.5	2800

3rd Floor

	Area	Load Factor	VA
Classroom	13900	3	41700
Circulation	5600	0.5	2800

4th Floor

	Area	Load Factor	VA
Classroom	13900	3	41700
Circulation	5600	0.5	2800

5th Floor

	Area	Load Factor	VA
Classroom	13900	3	41700
Circulation	5600	0.5	2800

6th Floor

	Area	Load Factor	VA
Classroom	13900	3	41700
Circulation	5600	0.5	2800

P1 and P2

	Area	Load Factor	VA
P1 Garage	19500	0.5	9750
P2 Garage	19500	0.5	9750

The Receptacle loads were taken from the panel boards. Feeder sizes were calculated by using the KVA loads from the existing panels.

Receptacle Loads

Receptacle Loads

Ampacity

$I = (KVA * 1000) / (sqrt(3) * V)$

1st Floor	KVA
C1	57.4
C1A	22
C1B	30
N1	56.8
N1A	27.8
N1B	10.2

Non IG VA	57.4
IG VA	109.4

	Amps	1.25 Sized
I =	159.3	199.2
I =	303.7	379.6

2nd Floor	KVA
C2	58.6
C2A	37.1
C2B	32.2
N2	23.5
N2B	8.7

Non IG VA	32.2
IG VA	95.7

	Amps	1.25 Sized
I =	89.4	111.7
I =	265.6	332.0

3rd Floor	KVA
C3	66
C3a	40.6
C3B	40.4
N3	19.1
N3B	3.4

Non IG VA	19.1
IG VA	106.6

	Amps	1.25 Sized
I =	53.0	66.3
I =	295.9	369.9

4th Floor	KVA
C4	47.7
C4B	17.6
N4	32
N4B	7.6

Non IG VA	32
IG VA	65.3

	Amps	1.25 Sized
I =	88.8	111.0
I =	181.3	226.6

5th Floor	KVA
C5	50.5
C5B	10.9
N5	27.8
N5B	6.1

			Amps	1.25 Sized
Non IG VA	27.8	I =	77.2	96.5
IG VA	61.4	I =	170.4	213.0

6th Floor	KVA
C6	71.3
C6B	36.6
N6	49.3
N6A	19.9
N6B	8.7

			Amps	1.25 Sized
Non IG VA	49.3	I =	136.8	171.1
IG VA	107.9	I =	299.5	374.4

P1 - P2	KVA
NP2	29.5
NPH	4.8

			Amps	1.25 Sized
Non IG VA	29.5	I =	81.9	102.4
Non IG VA	4.8	I =	13.3	16.7

Total VA =	954.1

Total N Panel VA =	335.2
Total C Panel VA =	618.9

Elevator Loads were calculated by sizing the loads on the existing panel.

KVA =	367.2

To size the main electrical feed, the loads of all the systems were summed and accounted for.

Main Feed

N Panels	C Panels	Elevators	Lighting	480/277 Mech	
335.2	618.9	367.2	245.5	795.0	

total =	2361.8	3542.63

The second number is the KVA load value after being sized up by the typical 1.25 factor. The feeder must be sized with a 15KV conductor, and in this case placed in 3/ 2AWG wire size with a 4" conductor.

Below is the comparison of the existing feeder size and wire feeds to what I calculated above for the receptacle panels.

First Floor

	Existing Panel	Calculated Panel
	Feeder Size	Feeder Size
IG	375A, 5/500MCM	375A, 5/500MCM
Non-IG	175A, 4/ 2/0 AWG	200A, 4/ 2/0AWG

Second Floor

	Existing Panel	Calculated Panel
	Feeder Size	Feeder Size
IG	375A, 5/500MCM	375A, 5/500MCM
Non-IG	150A, 4/ 1/0 AWG	150A, 4/ 1/0 AWG

Third Floor

	Existing Panel	Calculated Panel
	Feeder Size	Feeder Size
IG	375A, 5/500MCM	375A, 5/500MCM
Non-IG	150A, 4/ 1/0 AWG	70A, 4/ 4 AWG

Fourth Floor

	Existing Panel	Calculated Panel
	Feeder Size	Feeder Size
IG	250A, 5/250MCM	250A, 5/250MCM
Non-IG	150A, 4/ 1/0 AWG	150A, 4/ 1/0 AWG

Fifth Floor

	Existing Panel	Calculated Panel
	Feeder Size	Feeder Size
IG	250A, 5/250MCM	250A, 5/250MCM
Non-IG	225A, 4/ 4/0AWG	110A, 4/ 1AWG

Sixth Floor

	Existing Panel	Calculated Panel
	Feeder Size	Feeder Size
IG	375A, 5/500MCM	375A, 5/500MCM
Non-IG	110A, 3/1 AWG	175A, 4/ 2/0 AWG

P1 and P2

	Existing Panel	Calculated Panel
	Feeder Size	Feeder Size
IG	-	-
Non-IG	40A, 4/8 AWG	30A, 4/8 AWG

For the most part, the feeders are sized properly. There are a few instances where the calculations to not mimic the existing conditions. This is most likely due to the type of loads contained on the panel board.

The calculations for the lighting loads are provided below along with the existing wire and feeder sizes for the building.

Lighting Calculations

	Existing Panel	Calculated Panel
	Feeder Size	Feeder Size
First Floor	225A, 4/ 4/0AWG	200A, 4/ 2/0AWG
Second Floor	225A, 4/ 4/0AWG	200A, 4/ 2/0AWG
Third Floor	225A, 4/ 4/0AWG	200A, 4/ 2/0AWG
Fourth Floor	225A, 4/ 4/0AWG	200A, 4/ 2/0AWG
Fifth Floor	225A, 4/ 4/0AWG	200A, 4/ 2/0AWG
Sixth Floor	225A, 4/ 4/0AWG	200A, 4/ 2/0AWG
P1 and P2	250A, 5/250MCM	200A, 4/ 2/0AWG

Calculated KVA for each floor of the lighting load was calculated at approximately 45KVA. It was then sized up and a feeder size was calculated according to that sized value. These panel boards also have various pieces of mechanical equipment on them, which would account for why the existing conditions is slightly larger than what was calculated.

POTOMAC ELECTRIC POWER COMPANY
DISTRICT OF COLUMBIA
STANDARD OFFER SERVICE RATES
EFFECTIVE FEBRUARY 8, 2005 THROUGH MAY 31, 2006

GENERAL SERVICE PRIMARY SERVICE
SCHEDULE "GS 3A"

	Billing Months of <u>June – October</u> (Summer)	Billing Months of <u>November – May</u> (Winter)
<u>Generation</u>		
First 6,000 kwh	$ 0.06826 per kwh	$ 0.06478 per kwh
Additional kwh	$ 0.06809 per kwh	$ 0.06379 per kwh
First 25 kw	No charge	No charge
Additional kw	$ 0.42377per kw	$ 0.37121 per kw
Procurement Cost Adjustment	**www.pepco.com/dc-rates/ for monthly rate**	
<u>Transmission</u>		
All kwh	$ 0.00349 per kwh	$ 0.00349 per kwh
<u>Distribution</u>		
Customer Charge	$ 6.48 per month	$ 6.48 per month
First 6,000 kwh	$ 0.04067 per kwh	$ 0.03371 per kwh
Additional kwh	$ 0.02558 per kwh	$ 0.01654 per kwh
First 25 kw	-	-
Additional kw	$ 4.69 per kw	$ 4.09 per kw
Delivery Tax	$ 0.0077 per kwh	$ 0.0077 per kwh
Public Space Occupancy Surcharge	$ 0.00159 per kwh	$ 0.00159 per kwh
Administrative Credit	**www.pepco.com/dc-rates/ for monthly rate**	
Reliability Energy Trust Fund	$ 0.0001 per kwh	$ 0.0001 per kwh

Utility Information

Because the new Business School has not yet been completed, the cost data for a typical month can not yet be calculated. Knowing that the provider was Pepco, I went to their site and picked out cost data that I believed would applied. Applying the General Service Primary Service Schedule “FS 3A” from the Large Commercial Customer section. Provided below is a copy of those rates for February 8th 2005 through May 31st 2006. Also Included is the calculated rate for the KVA data that I calculated above. The rate was calculated for an assumed 12 hour day at full load. KW was not considered.

June - 30 days	
KVA =	2400
Hours =	12
Generation	
6000 kwh	$.06826 kwh
additional	$.06809 kwh
Transmission	
all kwh	$.00349 kwh
Distribution	
$6.48 per month	
6000 kwh	0.04067 kwh
additional	$.02558 kwh
Delivery Tax	
$.0077 per kwh	
Public Space Occupancy	
$.00159 kwh	
Reliability Energy Trust Fund	
$.0001 kwh	
KWH Cost =	$94,812.48

November - 30 days

KVA =	2400
Hours =	12

Generation

6000 kwh	$.06478 kwh
additional	$.06379 kwh

Transmission

all kwh	$.00349 kwh

Distribution

$6.48 per month

6000 kwh	$.03371 kwh
additional	$.01654 kwh

Delivery Tax

$.0077 per kwh

Public Space Occupancy

$.00159 kwh

Reliability Energy Trust Fund

$.0001 kwh

KWH Cost = $83,808.72