

Benjamin Hagan

Lighting/Electrical Option

James J. Whalen Center for Music, Ithaca, NY

Primary Faculty Consultant: Mistrick



Photo courtesy of HOLT Architects, P.C.

Electrical Systems Existing Conditions and Building Load Summary Report October 29, 2003

Executive Summary

This report evaluates the designed electrical system for the Whalen Center. Through analysis of electrical floor plans, riser diagrams, and specifications, a clear overview of the system was developed. It is noted that this facility connects to a campus regulated electric supply of 5kV and utilizes electricity at both 480/277V and 208/120V within the facility. To clearly illustrate system layout, a one line diagram was created by simplifying the riser diagram E401, part of the contract documents. A 200kW natural gas emergency generator provides power to the emergency loads isolated to a single distribution panel, EDP-1. The system also consists of a wide variety of fluorescent, HID, and incandescent lighting loads operating at 208/120V. The system's largest loads are from mechanical equipment such as AHU's, chillers, and cooling towers operating at 480/277V. A full building electric load calculation was completed and the resulting load was compared to the ratings of the primary switchgear and primary transformers. Finally, it is noted that there could be a serious problem with the sizing of the fused disconnects within the primary switchgear.

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System Narrative

The electrical system for this facility is a load center with radial circuit arrangement. Multiple distinct circuits are served out of the primary switchgear, and two separate distribution panels feed directly from the main distribution panel, creating the mixed system.

The Ithaca College campus has only one electric utility supply (by NYSEG) and maintains its own distribution system to route electricity and other utilities through campus. The Whalen Center taps into the A1 and A2 campus electricity loops at 5kV and brings the supply into the primary switchgear for distribution to both the Whalen Center and the adjacent Gannett Library. There are two feeders coming out of the primary switchgear that service the Whalen Center. Feeder one is taken from 5kV to 480Y/277V by T4 to supply the main distribution panel (MDP-1) which feeds the large motor loads of the building. A branch circuit from MDP-1 goes to another transformer, T1, and is taken down to 208Y/120V to supply secondary distribution panel 1 (SDP-1) which provides electricity to most remaining 'power' type loads in the building. SDP-1 has a branch circuit that connects to an automatic transfer switch feeding the emergency building loads on EDP-1. The automatic transfer switch is fed a backup electric supply by a 200kW natural gas generator providing electricity at 480Y/277 and is taken down to 208Y/120V by T2 to match the voltage provided by SDP-1 during normal operation. Then back at the primary switchgear, feeder two is connected to transformer T3, taking the voltage from 5kV to 208Y/120V to supply secondary distribution panel 2 (SDP-2) which handles mostly lighting loads for the facility. (See attached single line diagram for clarification) All transformers are Δ primary to Y secondary configuration.

Transformer Schedule								
Name	KVA	Primary	Secondary	Phase	Type	Served By	Serves	Location
T1	500	480 V	208Y/120	3	Dry - K4	MDP-1	SDP-1	Ground Floor, Electric Room
T2	150	480 V	208Y/120	3	Dry	Generator	EDP-1	Ground Floor, Electric Room
T3	300	5 kV	208Y/120	3	Dry	Primary Switchgear	SDP-2	Ground Floor, Electric Room
T4	750	5 kV	277Y/480	3	Dry	Primary Switchgear	MDP-1	Ground Floor, Electric Room

Mentioned earlier, there is a 200kW natural gas generator providing emergency power to both the Whalen Center and the adjacent Gannett Library in case of an electric supply interruption. All emergency lighting loads and emergency building loads are fed by EDP-1 which itself is either fed by SDP-1 or the emergency generator.

Located in the Electrical Switchgear Room #G19B are: transformers T1, T3 and T4; distribution panels MDP-1, SDP-1 and EDP-1; and automatic transfer switch ATS-1. Located in the Emergency Generator Room #G19A are the emergency generator and transformer T2. From these ground floor utility rooms the feeders connect to the various panelboards throughout the building.

Panelboard Schedule							
Name	Voltage	Amp Rating	Active Branch Circuits / Circuit Breaker Size				
			20A	30A	40A	50A	70A
PP-1A	120/208	100	20	-	-	-	-
PP-2A	120/208	100	26	-	-	-	-
PP-3A	120/208	100	32	-	-	-	-
PP-4A	120/208	225	35	-	-	-	-
PP-5A	120/208	100	16	-	-	-	-
PP-6A	120/208	100	8	-	-	-	-
PP-7A	120/208	100	20	1	-	-	-
PP-8A	120/208	100	25	1	-	-	-
PP-9A	120/208	100	25	1	-	-	-
PP-10A	120/208	100	26	2	-	-	-
PP-11A	120/208	100	18	2	-	1	-
PP-T	120/208	225	15	-	-	1	-
PP-GA	120/208	225	15	-	1	-	2
EP-1	120/208	225	10	-	2	2	1
EP-1A	120/208	100	6	-	-	-	-
EP-2A	120/208	100	10	-	-	-	-
EP-3A	120/208	100	5	-	-	-	-
EP-5A	120/208	100	8	-	-	-	-

Overcurrent protection in all panelboards is provided by molded case circuit breakers and are protected by type two surge suppression units. The supply to MDP-1 is protected by a solid state trip circuit breaker rated at 1200A. The primary switchgear has a 600A main bus rating and is braced for 2.0MVA fault loads. The loads connected to the primary switchgear are protected by fused disconnect switches, 30A for the SDP-2 feeder and 90A for the MDP-1 feeder. All power transmission fused disconnect switches are to have an E rating, indicating their special melting-time-current characteristics according to ANSI C37.46

There does not seem to be any attempt at power factor correction in the system. Also, there are no specific reliability requirements noted in the contract documents. Yet a facility that relies heavily on electric power for audio amplification, audio recording, and for performance lighting, reliability should have undoubtedly been a concern during design.

The lighting loads in the Whalen Center are primarily fluorescent with some HID lighting and incandescent lighting. The variety of spaces within the facility call for a variety of lighting situations and fall under a number of ASHRAE/IESNA categories. All lighting systems operate at 120V. Actual operating conditions (PF, VA) for purchased and installed luminaires have been requested from the sales representative for the job and are “on the way.” Future calculations will benefit from this information, but is not currently available for the luminaire schedule.

Luminaire Schedule			
Name	Type	Lamp	Ballast
FA	2x4' Recessed Static Troffer	(3) F32/T8	<20% THD Electronic
FB	2x4' Recessed Static Troffer	(2) F32/T8	<20% THD Electronic
FC	2x4' Recessed Parabolic Troffer	(3) F32/T8	<20% THD Electronic
FC-D	2x4' Recessed Parabolic Troffer	(3) F32/T8	Electronic Dimming
FD	2x4' Recessed Parabolic Troffer	(2) F32/T8	<20% THD Electronic
FE	1x4' Recessed Static Troffer	(2) F32/T8	<20% THD Electronic
FF	6" Round CF Downlight	(1) 26W HTT	<20% THD Electronic
FF-D	6" Round CF Downlight	(1) 26W HTT	Electronic Dimming
FG	9" Round CF Downlight	(2) 26W HTT	<20% THD Electronic
FG-D	9" Round CF Downlight	(2) 26W HTT	Electronic Dimming
FH	9"x4' Recessed Wallwash	(2) F32/T8	<20% THD Electronic
FI	9"x4' Recessed Parabolic Troffer	(2) F32/T8	<20% THD Electronic
FI-D	9"x4' Recessed Parabolic Troffer	(2) F32/T8	Electronic Dimming
FJ	2x2' Recessed Parabolic Troffer	(2) F32/U6	<20% THD Electronic
FK	6"x4' Staggered Strip	(2) F32/T8	<20% THD Electronic
FL	9" Round CF Downlight	(2) 13W HTT	<20% THD Electronic
FM	2x4' Recessed Parabolic Troffer	(3) F32/T8	<20% THD Electronic
FM-S	2x4' Surface Mounted Parabolic	(3) F32/T8	<20% THD Electronic
FO	Suspended Industrial	(2) F32/T8	<20% THD Electronic
FP	Direct/Indirect Pendant 8'	(8) F32/T8	<20% THD Electronic
FQ	1x4' Surface Wraparound	(2) F32/T8	<20% THD Electronic
FR	2x2' Recessed Static Troffer	(2) F32/U6	<20% THD Electronic
FS	9" Round CF Downlight	(2) 18W DTT	<20% THD Electronic
FT	9"x4' Recessed Wallwash	(2) F32/T8	<20% THD Electronic
FV	4"x4' Fluorescent Sconce	(2) F32/T8	<20% THD Electronic
FX	5" Round Decorative Downlight	(1) F13/DTT	<20% THD Electronic
FY	9"x2' Surface Wraparound	(2) F17/T8	<20% THD Electronic
A	Track Spots	(1) Par 30 - 75W	N/A
B	Pinhole Low Voltage Downlight	(1) MR16 - 50W	N/A
C	Pendant Bowl Chandelier	(4) T4 - 500W	N/A
D	Wall Mounted Uplight	(1) T4 - 500W	N/A
E	Steplight Low Voltage	(1) GA - 20W	N/A
G	6" Wall Mounted Downlight	(1) Par 38 - 150W	N/A
I	Wall Mounted Decorative CF	(1) 18W TT	PF>.9 30dBA Max
HA	6" Round MH Downlight	(1) Par 38 - 100W	PF>.9 30dBA Max
HB	Wall Mounted MH Downlight	(1) ED17 - 70W	PF>.9 30dBA Max
HC	Pole Top Walkway Luminaire	(1) ED17 - 100W	PF>.9 30dBA Max
HD	Recessed Walkway Luminaire	(1) ED17 - 100W	PF>.9 30dBA Max
HE	Large Wall Mounted MH DL	(1) E37 - 400W	PF>.9 30dBA Max
HG	Ground Mounted MH Flood	(1) ED17 - 70W	PF>.9 30dBA Max
HH	Wall Mounted Decorative MH	(1) ED17 - 100W	PF>.9 30dBA Max
HI	MH Bollard	(1) ED17 - 100W	PF>.9 30dBA Max

Building Design Load Calculations

The equipment load is determined by using NEC suggested calculation methods and provided equipment schedules, amperage ratings were determined using NEC tables 430.148 and 430.150.

NEC Equipment Calc						
Equip	Serves	Volt	Phase	HP	Amps	Total
EF-1	Elev. Mech. Tower-2	115	1	0.33	7.2	828.0
EF-2	Prep 234	115	1	0.25	5.8	667.0
EF-3	Elev. Mech. 236	115	1	0.25	5.8	667.0
EF-4	Restrooms	208	3	0.50	2.4	499.2
EF-5	Recycle Closet 231	115	1	0.25	5.8	667.0
EF-6	Work Room G03B	115	1	0.33	7.2	828.0
EF-7	Vestibule G18A	115	1	0.25	5.8	667.0
EF-8	Elev. Mach. G18A	115	1	0.33	7.2	828.0
EF-9	Janitor Closet	115	1	0.25	5.8	667.0
EF-10	Boiler Room G21	208	3	1.50	6.6	1372.8
EF-11	Elec. Switchgear Room G19	208	3	1.00	4.6	956.8
EF-12	Mech. Room G19	208	3	5.00	16.7	3473.6
EF-13	Mech. Room 402	208	3	0.50	2.4	499.2
EF-14	Mech. Room 402	208	3	0.50	2.4	499.2
EF-15	Restrooms	115	3	0.25	2.2	253.0
CT-2	Cooling Tower Fan	480	3	10.00	14	6720.0
CT-2	Cooling Tower Pan Heater	208	3	6kW	32	6656.0
HWP-1	AHU	208	3	15.00	46.2	9609.6
HWP-2	AHU	208	3	15.00	46.2	9609.6
HWP-5	Fin Radiation	208	3	7.50	24.2	5033.6
HWP-6	Fin Radiation	208	3	7.50	24.2	5033.6
HWP-14	Boiler Hot Water Loop	208	3	10.00	30.8	6406.4
HWP-15	Boiler Hot Water Loop	208	3	10.00	30.8	6406.4
HWP-16	Boiler #1	208	3	3.00	10.6	2204.8
HWP-17	Boiler #2	208	3	3.00	10.6	2204.8
HWP-18	Boiler #3	208	3	3.00	10.6	2204.8
HWP-19	Reheat Coils	208	3	10.00	30.8	6406.4
HWP-20	Reheat Coils	208	3	10.00	30.8	6406.4
HWP-21	Reheat AHU-7	208	3	3.00	10.6	2204.8
HWP-22	Reheat AHU-8	208	3	1.00	4.6	956.8
HWP-23	Reheat AHU-9	208	3	0.75	3.5	728.0
CWP-1	Primary Cold Water Loop	480	3	15.00	21	10080.0
CWP-3	Secondary CW Loop	480	3	60.00	77	36960.0
CWP-4	Secondary CW Loop	480	3	60.00	77	36960.0
CP-1	Condenser Water	480	3	40.00	52	24960.0
CP-2	Condenser Water	480	3	40.00	52	24960.0
HRP-1	Humidification	208	3	0.50	2.4	499.2
AHU-7	Atrium Supply Fan	208	3	60.00	169	35152.0
AHU-7	Atrium Return Fan	208	3	50.00	143	29744.0
AHU-8	Faculty Studio Supply Fan	480	3	50.00	65	31200.0
AHU-8	Faculty Studio Return Fan	480	3	20.00	27	12960.0
AHU-9	Recital Hall Supply Fan	480	3	15.00	21	10080.0
AHU-9	Recital Hall Return Fan	480	3	5.00	7.6	3648.0
AHU-10	Rehearsal Supply Fan	480	3	15.00	21	10080.0
AHU-10	Rehearsal Return Fan	480	3	7.50	11	5280.0
CH-1	Centrifugal Water Chiller	480	3	339kW	785	376800.0
CUH-1	Vestibule G01	115	1	0.10	2.3	264.5
CUH-2	Vestibule 215	115	1	0.10	2.3	264.5
CUH-3	Vestibule 225	115	1	0.10	2.3	264.5
UH-1	Recycle Closet 231	115	1	0.05	1.72	1978.0
UH-2	Elev. Mech. Tower-2	115	1	0.05	1.72	1978.0
UH-3	Elev. Mech. 236	115	1	0.05	1.72	1978.0
UH-6	Boiler Room G21	115	1	0.25	5.8	667.0
UH-7	DDC Contr. G20B	115	1	0.05	1.72	1978.0
UH-8	Telephone Equipment E20A	115	1	0.05	1.72	1978.0
UH-10	Mech. Room G19	115	1	0.25	5.8	667.0
UH-11	Emergency Generator G19A	115	1	0.03	0.77	88.6
UH-12	Elev. Mech. G19B	115	1	0.05	1.72	1978.0
UH-13	Mech. Room 402	115	1	0.25	5.8	667.0
UH-14	Mech. Room 402	115	1	0.25	5.8	667.0
B-1	Boiler 1	208	3	2.00	7.5	1560
B-2	Boiler 2	208	3	2.00	7.5	1560
B-3	Boiler 3	208	3	2.00	7.5	1560
B-4	Boiler 4	208	3	2.00	7.5	1560
JP-1	Jockey Pump	208	3	5.00	16.7	3473.6
AC-1	Air Compressor Control	208	3	15.00	46.2	9609.6
RS-1	Rolling Fire Shutter	115	1	0.25	5.8	667
P-1	Boiler Room G21	115	1	0.17	4.4	506
P-2	Mech. Room 402	115	1	0.08	2.3	264.5
P-3	Elev. Sump Room	115	1	0.33	7.2	828
P-4	Boiler Room G21	208	3	5	16.7	3473.6
TOTAL (kVA)						888.8

The Receptacle Load is determined by using NEC suggested calculation methods and the electrical floor plans giving a count of designed number of receptacles.

NEC Receptacle Calc		
Name	# Recepts	Total
Ground Floor	120	21600
First Floor	150	27000
Second Floor	180	32400
Third Floor	145	26100
Fourth Floor	15	2700
Tower	5	900
	TOTAL	110700
	ADJUSTED TOTAL (kVA)	60.35

The Lighting Load is determined by using ASHRAE/IESNA suggested calculation methods and power density allowances.

ASHRAE/IESNA 90.1-1999 Lighting Calc			
Name	Area (sf)	Allowance (W/sf)	Total
Ground Floor Corridor	690	0.7	483
Ground Floor Atrium	2150	1.3	2795
Ground Floor General/Class.	6980	1.6	11168
Ground Floor Stairway	250	0.9	225
Ground Floor Utility Room	4180	1.3	5434
First Floor Corridor	1800	0.7	1260
First Floor Atrium	1950	1.3	2535
First Floor General/Class.	7100	1.6	11360
First Floor Stairway	250	0.9	225
Second Floor Corridor	5840	0.7	4088
Second Floor Atrium	1073	1.3	1394.9
Second Floor General/Class.	12670	1.6	20272
Second Floor Performance	3790	1.8	6822
Second Floor Stairway	250	0.9	225
Third Floor Corridor	7230	0.7	5061
Third Floor Atrium	1420	0.2	284
Third Floor General/Class.	6240	1.6	9984
Third Floor Stairway	250	0.9	225
Fourth Floor Utility Room	4570	1.3	5941
Fourth Floor Stairway	250	0.9	225
Fourth Floor General	320	1.6	512
Outdoor Overhang	970	3	2910
		TOTAL (kVA)	93.4

Load Summary	
Lighting Load	93.4
Receptacle Load	60.4
Equipment Load	888.8
Total	1042.6
Building Design Load (kVA)	1303.2

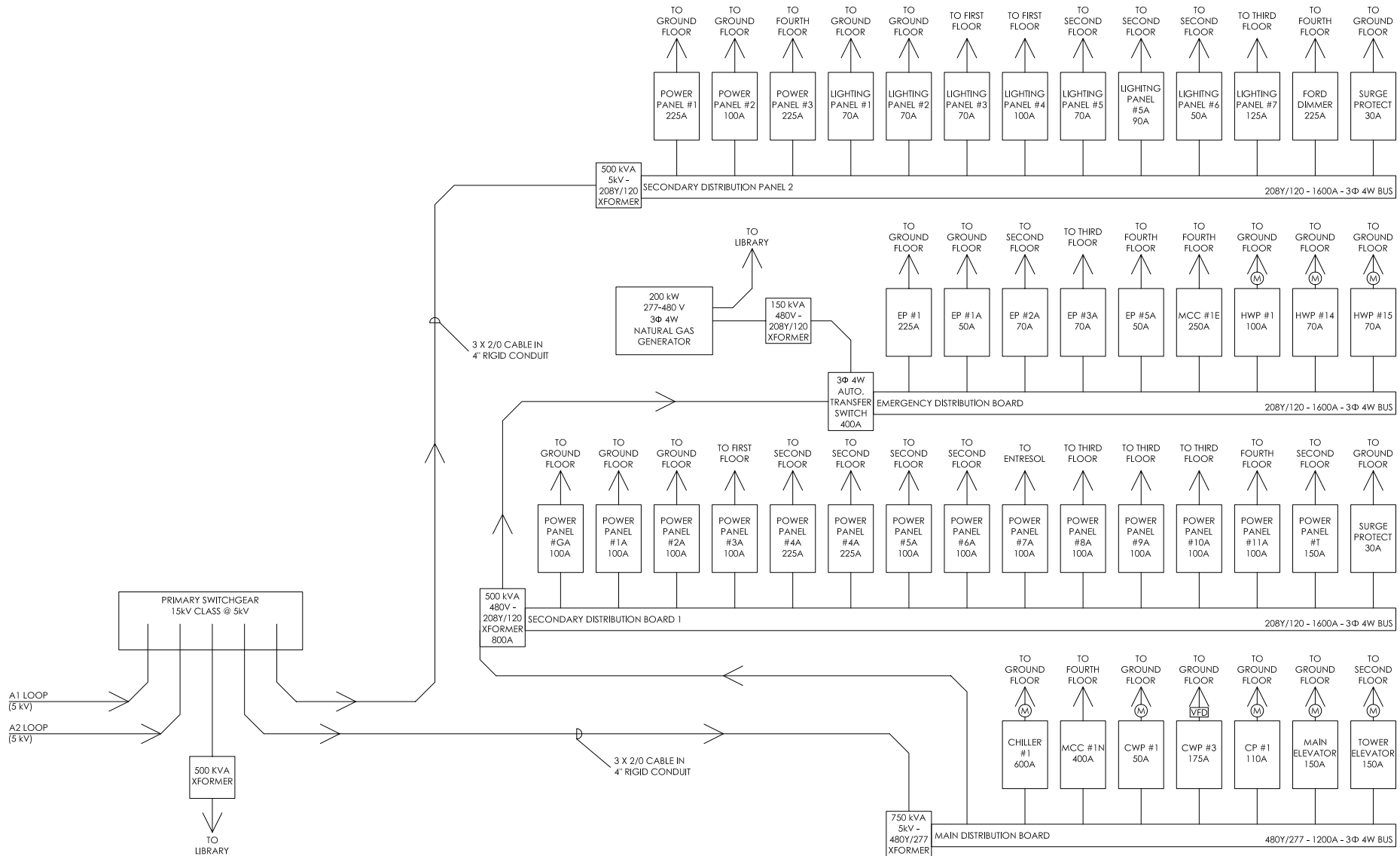
The total building design load includes a .8 design factor. The primary transformers T3 and T4 will allow a total building load of 1050kVA, which is reassuringly close to the total load I calculated before the .8 design factor is applied. Yet the fused disconnects in the primary switchgear will only allow a total of 120A at 5kV resulting in an allowed supply of 600kVA. Research will be done to find if the fused disconnects are wrongly labeled and if the fused disconnects installed in the primary switchgear are as noted on the drawings or if they were changed during construction to handle the full system load requirements.

The electrical system is centralized in the ground floor mechanical space and therefore very long runs at utilization voltage must be made to reach the furthest points of the facility. This could result in unacceptable voltage drops as well as costly over sizing of feeders and conduit. Research will be done as to alternate locations of transformers and main distribution panels for cost saving purposes.

Ithaca College does not track individual building energy consumption, so figures for electric usage are not available. However, the utility rate structure is available. New York is still in the early stages of de-centralization of utilities, and most non-residential customers choose to stay with the state supplier, New York State Electric and Gas (NYSEG) Ithaca College falls under service classification #7, which is for any customer with a billing demand equal to or greater than 500 KW during any two of the previous twelve months and for continuing service thereafter. This service classification offers either primary (regulated) or subtransmission (non-regulated) service.

It is not known which rate structure Ithaca College chooses to subscribe to from those available to service classification #7 customers. Basically, the rate structures have different basic customer charges and demand charges, while energy charges remain the same. As basic charges go up, demand charges go down. This is an average rate structure for service classification #7 customers.

VOLTAGE	Effective Date*		
	01/01/03	04/01/03	10/01/03
PRIMARY S.C. 7-2 DISTRIBUTION			
Customer Charge	\$75.00	\$75.00	\$75.00
Demand Charge All kilowatts, per kW			
On-Peak Service	\$7.67	\$7.67	\$7.67
Off-Peak Service	N/A	N/A	N/A
Energy Charge All kilowatt-hours, per kWh			
On-Peak Service	\$0.08215	\$0.09417	\$0.08702
Off-Peak Service	\$0.06363	\$0.07504	\$0.07160
Reactive Charge Reactive kilovolt-ampere hours, per billing reactive kilovolt-ampere hour			
	\$0.00095	\$0.00095	\$0.00095



ONE LINE DIAGRAM - DERIVED FROM DRAWING E401