Center For The Arts Towson University

TOWSON, MARYLAND 21252

EXISTING ELECTRICAL CONDITIONS

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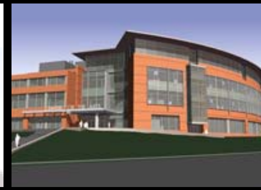
LIGHTING/ELECTRICAL

OCTOBER 27, 2004

TOWSON UNIVERSITY

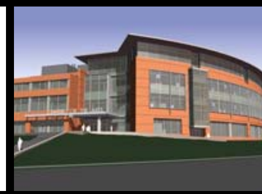
Index



Executive Summary

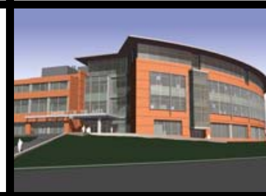
The following report is an in-depth analysis of the existing electrical conditions throughout the Center for the Arts Building at Towson University. Incorporated in this report is a building systems description including types of generators found in the building, wiring, motor power distribution, lighting characteristics, mechanical equipment characteristics, and the utility rate structure for the building.

Also found in the report, is in-depth calculations of building design loads according to the NEC, calculations such as demand loads for lighting, receptacles, motors, and mechanical equipment. With the results, an analysis was made with the existing main distribution panel to see if the panel is adequately sized to handle the building load. My findings are the panel is adequately sized and it can handle the building load.



Introduction

Included in this write-up is the existing electrical condition of the Center for the Arts Building. A building systems description is included which includes the building distribution type, the building utilization voltages, transformer configurations, emergency power and lighting, overcurrent devices used, wiring and bus types used, motor power distribution, typical lighting systems, power factor correction, and UPS systems. Also included is a single line diagram of the system, lighting equipment characteristics; primary lamps and ballasts used in the building and there electrical operating characteristics, mechanical equipment characteristics and there electrical operating conditions. There is also an NEC building design load calculation which took into consideration the lighting, receptacle, and motor connected and demand load. From these calculations, the main distribution panel was sized and compared to the existing main distribution panel. The Utility Rate Structure of the building was also analyzed.



Distribution Type

The distribution type in the Center for the Arts Building is an expanded radial distribution. In the system, the voltage passes through switchgears and then distributed to the two substations in the building. At each substation, the voltage travels through a step-down transformer and is distributed to the main switch boards. From the main switch boards, the volts are distributed to the various panel boards around the building. Step-down transformers are placed through out the system where necessary in order to step down the voltage even further. Figure 1 shows an example of expanded radial distribution.

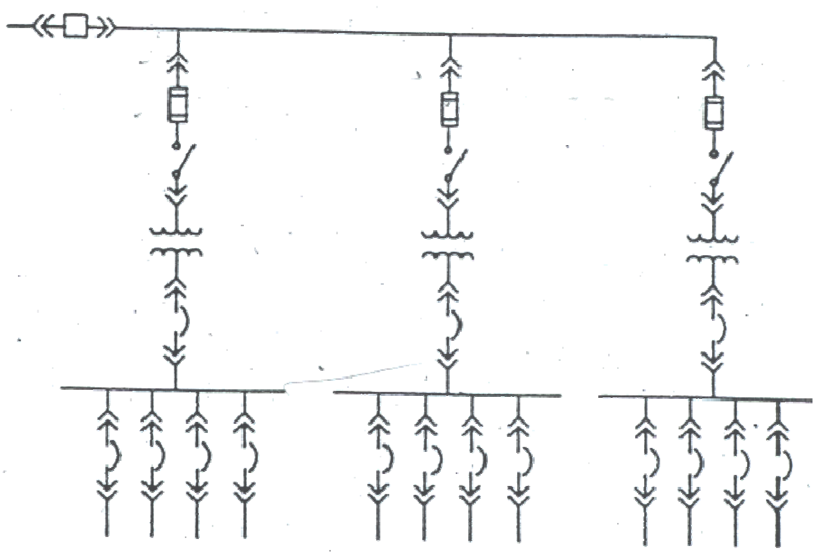


Figure 1. Expanded Radial Distribution

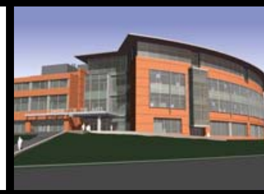
Building Utilization Voltage

The building utilization voltage is 277/480 volts, three phase and four wires.

Transformer Configurations

The different types of transformer configurations used in the design of the Center for the Arts Building are:

- 480 V Δ - 208Y/120 V, 3 Phase



- 480 V Δ - 240 V, 3 Phase
- 480 V Δ - 120/240 V, 1 Phase

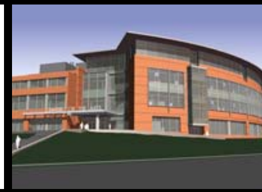
The transformers used in the building are all dry-type distribution transformers rated for 600V and less, with capacities up to 1000 kVA. The different types of transformers can be found in Table 1 below. The transformers are provided from one of the following manufacturers:

- Cutler-Hammer.
- GE Electrical Distribution & Control.
- Siemens Energy & Automation, Inc.
- Square D/ Groupe Schneider NA.

Transformer Schedule

kVA	Hz	Primary, 3 Phase	Secondary, 3 Phase
150	60	480 V, Delta	208Y/120, 3 Phase
112.5	60	480 V, Delta	208Y/120, 3 Phase
75	60	480 V, Delta	240V, 3 Phase
100	60	480 V, Delta	120/240V, 3 Phase
112.5	60	480 V, Delta	208Y/120, 3 Phase
45	60	480 V, Delta	208Y/120, 3 Phase
45	60	480 V, Delta	208Y/120, 3 Phase
150	60	480 V, Delta	208Y/120, 3 Phase
225	60	480 V, Delta	208Y/120, 3 Phase
500	60	480 V, Delta	208Y/120, 3 Phase
300	60	480 V, Delta	208Y/120, 3 Phase
150	60	480 V, Delta	208Y/120, 3 Phase
30	60	480 V, Delta	208Y/120, 3 Phase
45	60	480 V, Delta	208Y/120, 3 Phase
30	60	480 V, Delta	208Y/120, 3 Phase
75	60	480 V, Delta	208Y/120, 3 Phase
225	60	480 V, Delta	208Y/120, 3 Phase
112.5	60	480 V, Delta	208Y/120, 3 Phase
45	60	480 V, Delta	208Y/120, 3 Phase
150	60	480 V, Delta	208Y/120, 3 Phase
30	60	480 V, Delta	208Y/120, 3 Phase
30	60	480 V, Delta	208Y/120, 3 Phase
15	60	480 V, Delta	208Y/120, 3 Phase
75	60	480 V, Delta	208Y/120, 3 Phase
30	60	480 V, Delta	208Y/120, 3 Phase
112.5	60	480 V, Delta	208Y/120, 3 Phase

Table 1



Emergency Power/Lighting

The emergency power is serviced by a 125 kW natural gas generator. The generator has two 150 amp enclosed circuit breakers mounted at the generator to service the emergency and the standby power systems. Two 150 amp, 480 V, 3 pole automatic transfer switches also service the emergency and standby power systems. The generator is supplied from one of the following manufacturers:

- Caterpillar; Engine Div.
- Elliot Power Systems, Inc.
- Kohler Co; Generator Division.
- Onan Corp./Cummins Power Generation; Industrial Business Group.
- Spectrum Detroit Diesel.
- Dresser Industries, Inc.; Waukesha Engine Division.

The generator powers only the emergency lighting system, the fire alarm controls, and deluge system control panel.

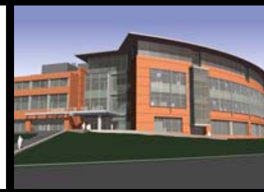
The emergency lighting system is controlled by the automatic transfer switches. When there is a power failure, the transfer switches will trip and transfer the power supply to the generator any where from zero to six seconds. The generator supplies the power to certain luminaires in corridors and rooms and to the exit signs. The automatic transfer switches are supplied from one of the following manufacturers:

- Caterpillar; Engine Div.
- Emerson; ASCO Power Technologies, LP.
- Kohler Co; Generator Division.
- Onan Corp./Cummins Power Generation; Industrial Business Group.
- Russelectric, Inc.
- Spectrum Detroit Diesel.

Overcurrent Devices

The overcurrent devices used on this project are:

- Nonfusible Safety Switches
- Molded-Case Circuit Breakers
- Motor Circuit Protectors
- Fusible Safety Switches



The circuit breakers, fusible, and nonfusible switches are supplied from one of the following manufacturers:

- Eaton Corporation; Cutler-Hammer Products.
- GE Electrical Distribution & Control.
- Siemens Energy & Automation, Inc.
- Square D/ Groupe Schneider NA.

The sizes of the various overprotection devices vary.

- The nonfusible safety switches range from 200 amps to 30 amps.
- The circuit breakers range from 3000 amps to 15 amps and there are one, two, and three pole breakers used through out the building.
- The motor circuit protectors range from 100 amps to 7 amps.
- The fusible safety switches range from 400 amps to 60 amps.

Wiring and Bus Types

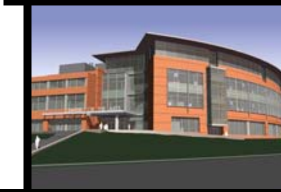
Conductors and Cables

- The type of feeder used for a branch circuit is MC Cable or THHN-THWN, single conductor in a raceway.
- Feeders and branch circuit's underground use THWN insulated conductors in a raceway.
- Cord Drops and Portable Appliance Connections use type SP, hard service cord.
- For the fire alarm circuit's Power-limited, fire-protective, signaling circuit cable is used.
- THHN-THWN in a raceway is used for Class 1 control circuits.
- For Class 2 control circuits a power-limited cable is used.

Wire sizes in the building vary from #12 to 500 kcmil. Conduit sizes in the building vary from ¾" to 4". Bus ratings are as high as 3000 amps and as low as 100 amps.

The conductors and cables used for this project are provided by one of the following manufacturers:

- American Insulated Wire Corp.; a Leviton Company
- General Cable Corporation.



- Senator Wire & Cable Company.
- Southwire Company.
- Pirelli Cables.

Medium-Voltage cables are used to supply power to the building from the main utility power. The type of cable used is MV-105. The rated voltage for the cable is 15 kV. The cable jacket is a sunlight-resistant and oil-resistant PVC. The MV cable is provided by one of the following manufacturers:

- Kerite Co.; Hubbell Incorporated.
- Okonite Company.
- Pirelli Cables & Systems NA.

The conduit used in the project is one of the following types:

- EMT: Electrical Metallic Tubing.
- FMC: Flexible Metal Conduit.
- IMC: Intermediate Metal Conduit.
- LFMC: Liquidtight Flexible Metal Conduit.
- RNC: Rigid Nonmetallic Conduit.

The metal conduit for the project is supplied by one of the following manufacturers:

- AFC Cable Systems, Inc.
- Alflex Inc.
- Allied Tube and Conduit.
- Anamet Electrical, Inc.; Anaconda Metal Hose.
- Electri-Flex Co.
- Grinnell Co./Tyco International; Allied Tube and Conduit Div.
- LTV Steel Tubular Products Company.
- Manhattan/CDT/Cole-Flex.
- O-Z Gedney; Unit of General Signal.
- Wheatland Tube Co.

The nonmetallic conduit for the project is supplied by one of the following manufacturers:

- American International.
- Anamet Electrical, Inc.; Anaconda Metal Hose.

- Arnco Corp.
- Cantex Inc.
- Certaineed Corp.; Pipe and Plastic Group/
- Condux International.
- ElecSYS, Inc.
- Electri-Flex Co.
- Lamson & Sessions; Carlon Electrical Products.
- Manhattan/CDT/Cole-Flex.
- RACO; Division of Hubbell, Inc.
- Spiralduct, Inc. /AFC Cable Systems, Inc.
- Thomas & Betts Corporation.

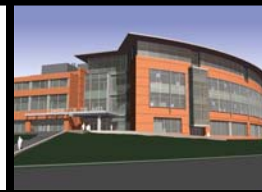
Motor Power Distribution

The motor power is distributed by two motor control centers. The motor control centers control mechanical equipment such as the chillers, boilers, chilled and hot water pumps, condenser pumps, ventilation fans, and a domestic water booster pump. Motor Control Center 1 is a Cutler Hammer Freedom Series 2100 with a horizontal bus of 1200 amps. It is a 480 volt, 3 phase, 3 wire system. Motor Control Center 2 has a 600 amp horizontal bus, 480Y/277 volt, 3 phase, 3 wire. The buses are plated hard-drawn copper, 98 percent conductivity. Motor Control Center 2 is supplied from one of the following manufacturers:

- Eaton Corporation; Cutler-Hammer Products.
- General Electric Company; GE Industrial Systems.
- Siemens/Furnas Controls.
- Square D.

Besides the Motor Control Centers some motors are also attached to panelboards. Air handling supply and exhaust fans, elevator motors, and other ventilation fans are a few of the motors connected to panelboards. The panelboards are supplied by one of the following manufacturers:

- Eaton Corporation; Cutler-Hammer Products.
- General Electric Co.; Electrical Distribution & Protection Div.
- Siemens Energy & Automation, Inc.
- Square D.



Each Motor Control Center is located in a mechanical room. The panelboards are located through out the building in electrical closets and mechanical rooms.

There is a variety of volts that control the motors. These voltages are 480, 277,208, 120, and 115. The motors are either single or three phase motors. The disconnects for the motors used on this project are Nonfusible Safety Switches, Molded-Case Circuit Breakers, Motor Circuit Protectors, Fusible Safety Switches. The disconnects range from 400 amps to 3 amps.

There are two types of controllers used for the motors; variable frequency controller and full voltage non-reversing. The variable frequency controllers have an input ac tolerance of 380 to 500 volts, plus or minus 10 percent; an input frequency tolerance of 50/60 Hz, plus or minus 6 percent; a minimum efficiency of 96 percent at 60 Hz, full load; and a minimum displacement input power factor of 96 percent. The variable frequency controllers are supplied by one of the following manufacturers:

- ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
- Eaton Corporation; Cutler-Hammer Products.
- Robicon Corporation
- Square D.

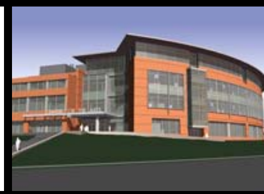
Typical Lighting Systems

There are several different types of lighting systems in this building. There are direct/indirect fixtures, fluorescent parabolic troffers, recessed can down lights, and perimeter lighting. There are also several types of specialty lighting in the building. These systems are the Theater and Concert hall stage lighting, Dance studio #1lighting, the Asian Arts Exhibit, the Thesis Gallery, the Holtzman Gallery, and the Recital Hall.

Lighting System Components

Lamp Specifications

- Incandescent/Tungsten-Halogen Lamps.
  - All incandescent lamps should be long life and rated 130 volts.
- High Intensity Discharge (HID) Lamps.
- Fluorescent Lamps.



- T-8, 265 MA, Rapid Start
- Color Temperature of 4100 °K
- Minimum color rendering index (CRI) of 80
- Compact Fluorescent Lamps.
  - Quad or triple tube compact fluorescent lamps with 4-pin base and no integral starter.

Ballast Specifications

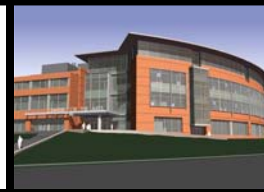
- Fluorescent Ballasts
  - Full light output, solid-state, instant start type designed for use with 2, 3, and 4 foot, 265 MA, rapid-start T-8 lamps.
  - Minimum Power Factor: 0.90
- Fluorescent Dimming Ballasts
  - Minimum Power Factor: 0.95
- Compact Fluorescent Ballasts
  - Full light output, solid-state, instant start type designed for use with 39, 40, 50 watt T-5 biax lamps and 18, 26, 32, and 42 watt double and triple tube T-4, 4-pin rapid start CF lamps.
  - Power Factor: 0.98
- Compact Fluorescent Dimming Ballasts
  - Power Factor: 0.95
- HID Ballasts

Lighting System Controls

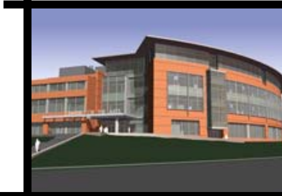
Most of the lighting systems are controlled by relay panels. These panels are located through out the building in closets and storage.

The panel distribution components are as follows:

- 20 amp relays.
  - On/off control of lighting and other electrical loads; mechanically latching.
  - Single- or double-pole construction.
  - Rated life: 30,000 cycles or more at full load @ 20 cpm.
  - Electrical Ratings:
    - General Use: 20 A, 300 VAC.
    - Tungsten: 2400 W, 120 VAC.



        - HID: 20 A, 300 VAC.
        - Ballast: 20 A, 300 VAC.
        - Motor: ½ HP at 110-125 VAC; 1 ½ HP at 220-277 VAC.
        - Inrush Capability: 2000 A.
        - Withstand Rating: 5000 A.
    - Integral manual override switch.
    - English Language indication of the on/off state of the relay.
    - Send relay status to relay controller for transmission to switch LEDs.
- Relay Controllers.
    - Send signals to open and close 20 A relays.
    - Monitor 20 A relay status and provide feedback to system
    - Provide unique address setting and control of one to four addresses.
    - Provide control of one to four single or double pole 20 A relays per address.
    - Address setting configuration shall be done on a hand-held configuration device through an infrared link to the relay controller.
    - Communicates with the two-wire non-polarized signal bus.
- 6 Amp relays with Integral Controller.
    - On/Off control of lighting and other electrical loads; mechanically latched.
    - Four independently addressable and independently controllable relays.
    - Electrical Rating:
        - General Use: 20 A, 300 VAC.
        - Tungsten: 720 W, 120 VAC.
        - Ballast: 20 A, 300 VAC.
        - Motor: ¼ HP at 125-250 VAC
    - Integral manual override switch.
    - Power to operate modules shall be provided from the two-wire non-polarized signal bus.
    - Address setting configuration shall be done on a hand-held configuration device through an infrared link to the 6A relay unit.
    - Units may be mounted in central panel, plenum box or wall box.



- Modular Relay Panels.
  - Cabinet: Steel with hinged, locking door
    - Barriers separate low-voltage and line-voltage components.
    - Directory.
    - Control Power Supply: Transformer with 24 VAC output.

The lighting systems through out the building are controlled in many different ways. The controls can be any one of the following:

- Individual, group, or pattern on/off switches.
- Time delay functions.
- Staggered Start.
- Programmability.
- Interface with non-system control devices.
- Status Indication, Diagnostics, and Overrides.
- Wall switch occupancy sensors.
- Ceiling occupancy sensors.

The lighting control system is provided by one of the following manufacturers:

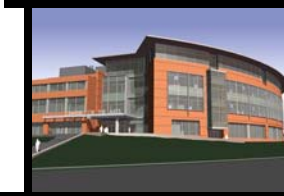
- NexLight: Northport Engineering, Inc.
- Lighting Control and Design, Inc.

Power Factor Correction

Capacitors were not needed to correct the power factor for the building.

UPS System

The Center for the Arts does not have any special or critical equipment that would need a UPS system to stay on in the event of a surge or trip



Single Line Diagram

Figure 2 shows the single line diagram of the utility service coming into the building. It shows how the main power supply is distributed through out the building via the two unit substations.

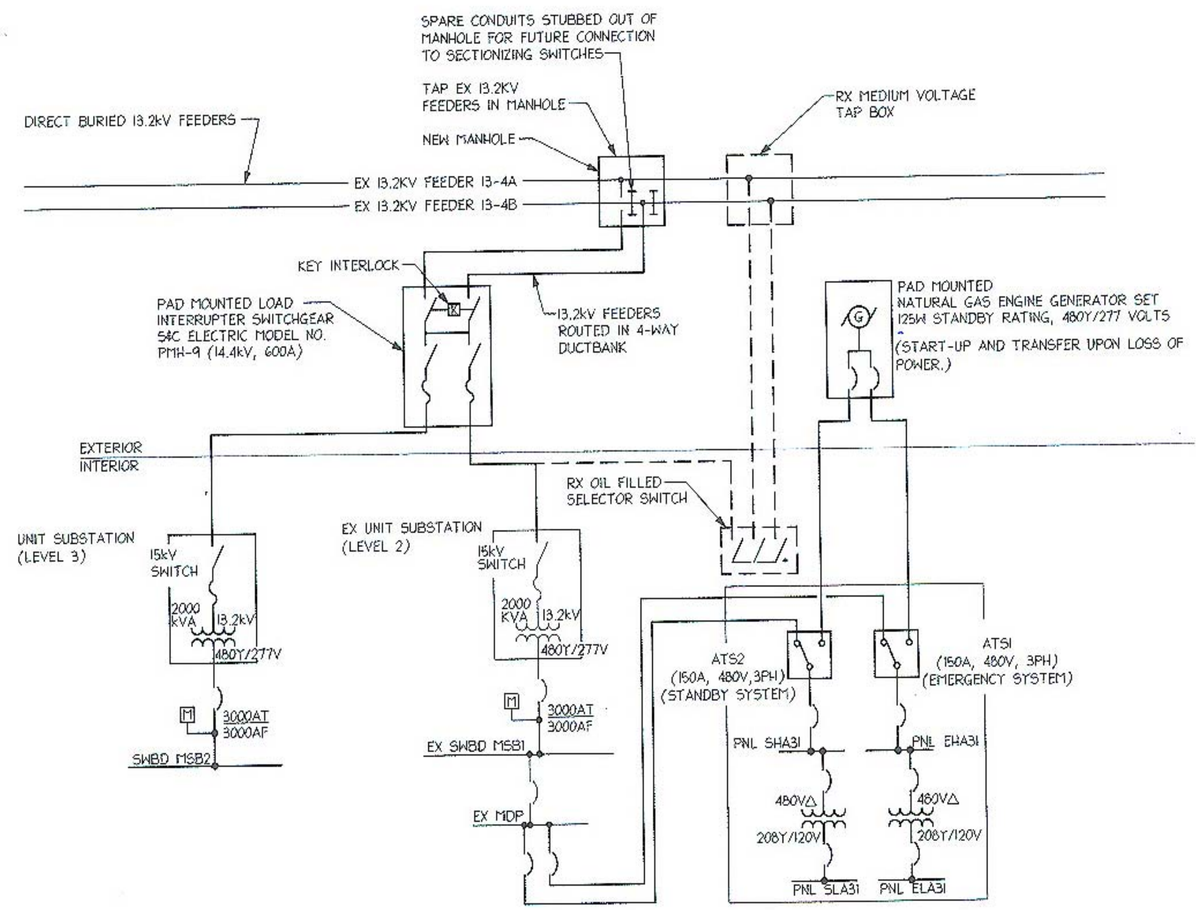
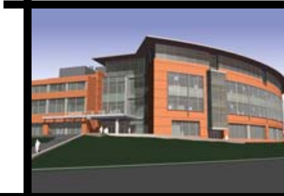


Figure 2. Single Line Diagram

Lighting Equipment Characteristics

Table 2 provides information on the lamps and ballasts used through out the building. It also has the current of each lamp type calculated.



Lamps and Ballasts Used

Lamp Type	# of lamps	Ballast	Ballast Factor	Power Factor	Input Watts	Operating volts	Current amp
F17/841	1	Advance RCN-1P32-SC	0.92	0.93	20	120	0.18
FO25/841	1	Advance RCN-1P32-SC	0.92	0.98	27	120	0.23
FO32/841	1	Advance VEL-1P32-SC	0.92	0.98	32	277	0.12
"	2	Advance VEL-2P32-SC	0.88	0.98	58	277	0.21
"	3	Advance VEL-3P32-SC	0.88	0.99	85	277	0.31
"	4	Advance VEL-4P32-SC	0.88	0.99	112	277	0.41
F32T8/835	2	Advance REL-2P32-SC	0.88	0.99	58	120	0.49
CF7DS/841	1	Robertson RSU113T5120	1.18	0.98	9	277	0.03
CF13/835	1	Robertson RSZ114T5120	1.03	0.98	14	120	0.12
"	2	Robertson RSU213T5120	0.8	0.98	25	120	0.21
CF18DT/E/841	1	Robertson RSM218CQMVW	1.2	0.97	24	277	0.09
CF26DT/E/841	1	Robertson RSM218CQMVW	1	0.98	30	277	0.11
CF26 Quad/835	1	Robertson RSM218CQMVW	1	0.98	30	277	0.11
PLL/40W/41/RS(BIAX)	1	Robertson PAT139T5MV	0.99	0.98	49	277	0.18
"	2	Robertson PSP242TRMVW	1	0.98	91	277	0.34
40A/Clear	1	n/a	n/a	n/a	40	120	0.33
100A/Clear	1	n/a	n/a	n/a	100	120	0.83
60 A/ Clear	1	n/a	n/a	n/a	60	120	0.50
50PAR20/H/SP10	1	n/a	n/a	n/a	50	120	0.42
75 A	1	n/a	n/a	n/a	75	120	0.63
75ER30	1	n/a	n/a	n/a	75	120	0.63
300A	1	n/a	n/a	n/a	300	120	2.50
60A/Red (red)	1	n/a	n/a	n/a	60	120	0.50
90PAR/CAP/SPL/FL30	1	n/a	n/a	n/a	90	120	0.75
60W A19	1	n/a	n/a	n/a	60	120	0.50
100A21	1	n/a	n/a	n/a	100	120	0.83
150 A	1	n/a	n/a	n/a	150	120	1.25
100PAR38	1	n/a	n/a	n/a	100	120	0.83
25PAR36/WFL 12-volt	1	n/a	n/a	n/a	25	12	2.08
200WA23	1	n/a	n/a	n/a	200	120	1.67
15WA15	1	n/a	n/a	n/a	15	120	0.13
40G25/DL	4	n/a	n/a	n/a	160	120	1.33
40A/DLSW	1	n/a	n/a	n/a	40	120	0.33
HPL575/115	1	n/a	n/a	n/a	575	120	4.79
MHC70/C/U/M	1	single	1	n/a	70	277	0.25
MP250/BU-Only	1	single	1	n/a	250	277	0.90

Table 2

Mechanical Equipment Characteristics

The mechanical equipment characteristics can be found on the tables below. These tables provide the voltage, phase and hertz, as well as horsepower and full load amps of the mechanical equipment.

Humidifiers			
Designation	Volts/PH/Hz	HP	FLA
H-2-1	460/3/60		
H-3-1	460/3/60		
H-3-2	460/3/60		
H-6-1	460/3/60	51.474	67
H-9-1	460/3/60	26.11	35
H-9-2	460/3/60	13.428	17
H-9-3	460/3/60	38.792	51
H-12-1	460/3/60	5.6696	8.3
H-12-2	460/3/60	5.6696	8.3
H-13-1	460/3/60	5.6696	8.3

Table 3

Boilers			
Designation	Volts/PH/Hz	HP	FLA
Base Bid			
B-1	460/3/60	15	21
B-2	460/3/60	15	21
Alternate			
B-1	460/3/60	25	34
B-2	460/3/60	25	34

Table 4

Dust Collectors			
Designation	Volts/PH/Hz	HP	FLA
DC-1	460/3/60	5	7.6
DC-2	460/3/60	10	14

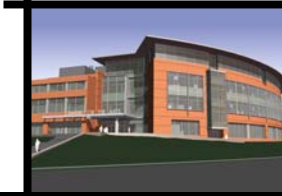
Table 5

Chiller			
Designation	Volts/PH/Hz	HP	FLA
CH-1	460/3/60	111.9	231
CH-2	460/3/60	113.392	231
CH-3	460/3/60	214.102	392

Table 6

Pumps			
Designation	BHP/Motor HP	Volts/PH/Hz	FLA
P-1	5.5 / 7.5	460/3/60	11
P-2	5.5 / 7.5	460/3/60	11
P-3	19.5 / 25.0	460/3/60	34
P-4	-	460/3/60	
P-5	47.1 / 75.0	460/3/60	96
P-6	47.1 / 75.0	460/3/60	96
P-7	47.1 / 75.0	460/3/60	96
P-8	/ 20	460/3/60	20
P-9	/ 20	460/3/60	20
P-10	32.5 / 40.0	460/3/60	40
P-11	-	460/3/60	
P-12	2.1 / 3.0	460/3/60	3
P-13	2.1 / 3.0	460/3/60	3
P-14	18.9 / 30.0	460/3/60	30
P-15	18.9 / 30.0	460/3/60	30
P-16	18.9 / 30.0	460/3/60	30
P-17	1.8 / 3.0	460/3/60	4.8
P-PHC-1	0.1 / 0.25	115/1/60	5.8
P-PHC-3	0.1 / 0.25	115/1/60	5.8
P-PHC-5	0.1 / 0.25	115/1/60	5.8
P-PHC-6	0.1 / 0.25	115/1/60	5.8
P-PHC-9	0.1 / 0.25	115/1/60	5.8
P-PHC-11	0.1 / 0.25	115/1/60	5.8
P-PHC-12	0.1 / 0.25	115/1/60	5.8
P-PHC-13	0.1 / 0.25	115/1/60	5.8
P-PHC-15	0.14 / 0.25	115/1/60	5.8
P-PHC-16	0.51 / 1.0	460/3/60	5.8
P-PHC-17	0.17 / 0.25	115/1/60	5.8
P-PHC-18	0.2 / 0.33	115/1/60	5.8
P-PHC-19	0.1 / 0.25	115/1/60	2.1
P-PHC-VF4	0.11 / 0.25	115/1/60	

Table 7



Designation	BHP/Motor HP	Volts/PH/Hz	FLA
F-1-1	14.7 / 20.0	460/3/60	27
F-1-2	5.4 / 7.5	460/3/60	11
F-2-1	16.8 / 20.0	460/3/60	
F-2-2	11.2 / 15.0	460/3/60	
F-3-1	24.0 / 30.0	460/3/60	40
F-3-2	7.7 / 10	460/3/60	14
F-4-1	4.8 / 7.5	460/3/60	
F-4-2	2.4 / 3.0	460/3/60	
F-5-1	11.7 / 15.0	460/3/60	21
F-5-2	4.9 / 7.5	460/3/60	11
F-6-1	7.8 / 10.0	460/3/60	14
F-6-2	1.9 / 3.0	460/3/60	4.8
F-7-1	11.3 / 15.0	460/3/60	
F-7-2	5.7 / 7.5	460/3/60	
F-9-1A	7.4 / 10.0	460/3/60	14
F-9-1B	7.4 / 10.0	460/3/60	14
F-9-2	3.9 / 7.5	460/3/60	11
F-10-1	5.1 / 7.5	460/3/60	
F-10-2	4.1 / 5.0	460/3/60	
F-11-1	16.3 / 20.0	460/3/60	27
F-11-2	6.0 / 7.5	460/3/60	11
F-12-1	16.4 / 20.0	460/3/60	27
F-12-2	3.6 / 5.0	460/3/60	7.6
F-13-1	8.4 / 15.0	460/3/60	21
F-13-2	3.0 / 5.0	460/3/60	7.6
F-14-1A&B	/ 0.75	115/1/60	13.8
F-15-1	41.0 / 50.0	460/3/60	65
F-15-2	11.5 / 15.0	460/3/60	21
F-16-1A	38.9 / 50.0	460/3/60	65
F-16-1B	38.9 / 50.0	460/3/60	65
F-16-2A	31.2 / 40.0	460/3/60	52
F-16-2B	31.2 / 40.0	460/3/60	52
F-17-1A	31.8 / 40.0	460/3/60	52
F-17-1B	31.8 / 40.0	460/3/60	52
F-17-2	10.5 / 15.0	460/3/60	21
F-18-1A	37.3 / 50.0	460/3/60	65

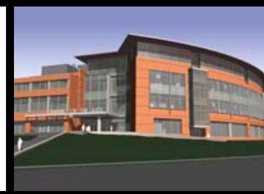
Fans

Table 8a

Designation	BHP/Motor HP	Volts/PH/Hz	FLA
F-18-1B	37.3 / 50.0	460/3/60	65
F-18-2	20.0 / 25.0	460/3/60	34
F-19-1	29.1 / 40.0	460/3/60	52
F-19-2	8.4 / 10.0	460/3/60	14
EF-1A	1.7 / 2.0	460/3/60	3.4
EF-1B	0.5 / 0.75	460/3/60	1.6
EF-1C	0.4 / 0.75	460/3/60	1.6
EF-1D	0.3 / 0.5	115/1/60	7.2
EF-1E	/ 0.25	115/1/60	5.8
EF-1F	0.7 / 1	460/3/60	2.1
EF-1H	1.2 / 2.0	460/3/60	3.4
EF-1J	0.1 / 0.25	115/1/60	5.8
EF-1K	0.2 / 0.33	115/1/60	7.2
EF-1M	0.1 / 0.25	115/1/60	5.8
EF-2A	0.33 / 0.5	115/1/61	7.2
EF-2B	0.15 / 0.25	115/1/60	5.8
EF-2C	0.1 / 0.25	115/1/60	5.8
EF-3A	0.4 / 0.75	460/3/60	1.6
EF-3B	0.6 / 0.75	460/3/60	1.6
EF-3C	1.6 / 2.0	460/3/60	1.6
EF-3D	0.7 / 1.0	460/3/60	1.6
EF-3E	0.6 / 0.75	460/3/60	2.1
EF-3F	0.2 / 0.33	115/1/60	5.8
EF-3G	0.1 / 0.25	115/1/60	5.8
VF-1-1	3.2	460/3/60	7.6
VF-1-2	1.9	460/3/60	4.8
VF-2-1	3.2	460/3/60	7.6
VF-2-2	1.9	460/3/60	4.8
VF-3-1	1.1	460/3/60	3.4
VF-3-2	2.7 / 3.0	460/3/60	4.8
VF-4-1	4.1 / 5.0	460/3/60	7.6
VF-4-2	1.1 / 1.5	460/3/60	3
VF-4-3	1.1 / 1.5	460/3/60	3
VF-5-1	0.5 / 1.0	460/3/60	2.1
VF-5-2	0.3 / 0.5	460/3/60	1.1
VF-6-1	/ 0.04	115/1/60	

Fans Cont.

Table 8b



Cooling Tower				
Designation	Equipment	Volts/PH/Hz	HP	FLA
CT-1	Fan 1	460/3/60	30	40
	Fan 2	460/3/61	30	40
	Basin Heater	460/3/62	9	40
CT-2	Fan 1	460/3/63	30	40
	Fan 2	460/3/64	30	14.5
	Basin Heater	460/3/65	30	40

Table 9

Propeller Unit & Cabinet Unit Heaters		
Designation	Volts/PH/Hz	FLA
UH-1	115/1/60	0.125
UH-2	115/1/61	0.05
UH-3	460/3/60	3.73
UH-4	115/1/63	0.05
CUH-1	115/1/64	0.035
CUH-2	115/1/65	0.035
CUH-3	115/1/66	0.035
CUH-4	115/1/67	0.1
CUH-5	115/1/68	0.035
CUH-6	115/1/69	0.035
CUH-7	115/1/70	0.1
CUH-8	115/1/71	0.035

Table 10

NEC Building Design Load

In order to calculate the total building electrical load, the overall buildings mechanical and electrical loads needed to be looked at. In order to do this, the NEC as set some ground rules in calculating the building load. The receptacles, lighting, and overall mechanical loads were analyzed.

In order to determine the receptacle load, all the receptacles were counted up and then a 180 VA/ receptacle was applied. To find the demand load of the receptacles, the first 10 kVA is analyzed at 100% and the remaining receptacle load is analyzed at 50%.

For the lighting load, the NEC provides a table which states unit loads in VA per square foot for certain building types areas. In the case of the Center for the Arts building, a 3VA per square foot was used to calculate the lighting demand load.

In order to find the overall mechanical load, all of the mechanical equipment was analyzed by the full load amperes. These amperes were converted into a demand with a power factor of 89%. Elevator motors were also analyzed with a demand factor of 85% for 4 elevators on a single feeder. Table 11 is a summary of these calculations. The in-depth calculations are located in Appendix A.

NEC Building Design Load

Receptacle Demand Load			
First 10 kVA @ 100%-		10	kVA
Remaining @50%-		225.31	kVA
Receptacle Demand Load		**235.31**	**kVA**
Lighting Demand Load			
Total Lighting Load		**722.58**	**kVA**
Overall Mechanical Load			
Total 1 Phase Load		37.1	kVA
Total 3 Phase Load		1824.3	kVA
Total Elevator Load		138.2	kVA
Total Motor Load		78.0	kVA
	Total Mechanical Load	**2077.5**	**kVA**

Total Load	3035.43	**kVA**

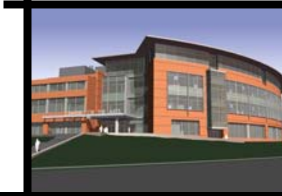
Table 11

Table 12 is the overall analysis of the existing system. The NEC calculated design load is compared to the Main Distribution Panel. The Volt-Amperes of the MDP are found and then an 80% design factor is applied. This value is then compared to the NEC calculated design load.

Main Distribution Calculation					
		2- Panels at 3000A a piece. 6000A overall.			
VA	**=**	**1.732 (480 V) (6000 A) (1.0)**	**=**	**4988160 VA**	
		Design Factor of 80% is applied:			
4988160 VA * 0.8 = 3990.528 kVA					

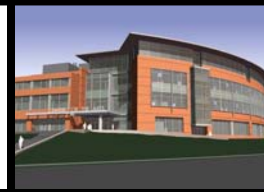
Table 12

For the Center for the Arts, the maximum load of the Main Distribution Panel (3990 kVA) is greater than the design load and, therefore, the Main Distribution Panel is sized adequately to carry the buildings load(3035 kVA).



Utility Rate Structure

The utility in Towson is Baltimore Gas and Electric (BGE). Due to deregulation, the supplier of electricity is Reliant Energy and the distributor is BGE. The contract with Reliant for electricity is a flat rate of $.05665 per kwh. On top of that, there is a distribution charge by BGE which is a combination of demand and consumption rates. These rates along with the utility fault current at the site will be provided to me at a later date.



Appendix A

In-depth Calculations

Mechanical and Motor

Single Phase Mechanical Equipment						
Serves	HP [A]	Volts	Phase	FLA	Corrected Amperes	kVA
Preheat Coil Pump P-PHC-1	0.25	115	1	5.8	6.5	0.749
Preheat Coil Pump P-PHC-3	0.25	115	1	5.8	6.5	0.749
Preheat Coil Pump P-PHC-5	0.25	115	1	5.8	6.5	0.749
Preheat Coil Pump P-PHC-6	0.25	115	1	5.8	6.5	0.749
Preheat Coil Pump P-PHC-9	0.25	115	1	5.8	6.5	0.749
Preheat Coil Pump P-PHC-11	0.25	115	1	5.8	6.5	0.749
Preheat Coil Pump P-PHC-12	0.25	115	1	5.8	6.5	0.749
Preheat Coil Pump P-PHC-13	0.25	115	1	5.8	6.5	0.749
Preheat Coil Pump P-PHC-15	0.25	115	1	5.8	6.5	0.749
Preheat Coil Pump P-PHC-17	0.25	115	1	5.8	6.5	0.749
Preheat Coil Pump P-PHC-18	0.25	115	1	5.8	6.5	0.749
Preheat Coil Pump P-PHC-19	0.25	115	1	5.8	6.5	0.749
AHU-14 Supply Fan F-14-1A	0.75	115	1	13.8	15.5	1.783
AHU-14 Supply Fan F-14-1B	0.75	115	1	13.8	15.5	1.783
Exhaust Fan EF-1D	0.33	115	1	7.2	8.1	0.930
Exhaust Fan EF-1E	0.25	115	1	5.8	6.5	0.749
Exhaust Fan EF-2A	0.33	115	1	7.2	8.1	0.930
Exhaust Fan EF-2B	0.25	115	1	5.8	6.5	0.749
Unit Heater UH-1	0.125	115	1	0.125	0.1	0.016
Unit Heater UH-2	0.05	115	1	0.05	0.1	0.006
Cabinet Unit Heater CUH-1	0.035	115	1	0.035	0.0	0.005
Cabinet Unit Heater CUH-2	0.035	115	1	0.035	0.0	0.005
Cabinet Unit Heater CUH-3	0.035	115	1	0.035	0.0	0.005
Domestic HW Recirc Pump	0.125	115	1	5.8	6.5	0.749
Exhaust Fan EF-1J	0.25	115	1	5.8	6.5	0.749
Exhaust Fan EF-1K	0.33	115	1	7.2	8.1	0.930
Exhaust Fan EF-1M	0.25	115	1	5.8	6.5	0.749
Exhaust Fan EF-2C	0.25	115	1	5.8	6.5	0.749
Hazardous Materials Fan EF-3G	0.25	115	1	5.8	6.5	0.749
Cabinet Unit Heater CUH-4	0.1	115	1	0.1	0.1	0.013
Cabinet Unit Heater CUH-5	0.035	115	1	0.035	0.0	0.005
Cabinet Unit Heater CUH-6	0.035	115	1	0.035	0.0	0.005
Cabinet Unit Heater CUH-7	0.1	115	1	0.1	0.1	0.013
Metal Studio Spray Booth Fan	0.75	115	1	13.8	15.5	1.783
Silk/Paint Spray Booth Fan	0.75	115	1	13.8	15.5	1.783
CeramicsSpray Booth Fan	0.75	115	1	13.8	15.5	1.783
Clay Mixing Exhaust Fan EF-3F	0.25	115	1	5.8	6.5	0.749
Nederman Snorkel Exhaust	0.5	115	1	9.8	11.0	1.266
Nederman Snorkel Exhaust	1	115	1	16	18.0	2.067
Water Softener	[15]	115	1	15	16.9	1.938

Cabinet Unit Heater CUH-8	0.035	115	1	0.035	0.0	0.005
Electric Baseboard EB-1	3.3	277	1	11.9	13.4	3.704
Electric Baseboard EB-2	1.2	277	1	4.2	4.7	1.307
			Total 1 Phase Load			**37.1**

*Assumed a 0.89 p.f. for load
*Full load currents for single phase motors are obtained from Table 430.148 of the 2002 NEC.

Table A. Single Phase Load Calculation

3 Phase Mechanical Equipment							
Serves	**HP [A]**	**Volts**	**Phase**	**FLA**	**Corrected Amperes**	**KVA**	**Notes**
Chilled Water Pump P-1	7.5	460	3	11	12.4	5.685	
Chilled Water Pump P-2	7.5	460	3	11	12.4	5.685	
Chilled Water Pump P-3	25	460	3	34	38.2	17.573	
Chilled Water Pump P-5	75	460	3	96	107.9	49.618	
Chilled Water Pump P-6	75	460	3	96	107.9	49.618	
Chilled Water Pump P-7	75	460	3	96	0.0	0.000	off, redundent pump
Ex Condenser Water Pump P-8	20	460	3	27	30.3	13.955	
Ex Condenser Water Pump P-9	20	460	3	27	30.3	13.955	
Condenser Water Pump P-10	40	460	3	52	58.4	26.876	
Heating Water Pump P-12	3	460	3	21	23.6	10.854	
Heating Water Pump P-13	3	460	3	21	23.6	10.854	
Heating Water Pump P-14	30	460	3	40	44.9	20.674	
Heating Water Pump P-15	30	460	3	40	0.0	0.000	off, redundent pump
Heating Water Pump P-16	30	460	3	40	44.9	20.674	
Centrifugal Separator S-1	10	460	3	14	15.7	7.236	
Energy Recovery Pump P-17	3	460	3	4.8	5.4	2.481	
Preheat Coil Pump P-PHC-16	1	460	3	2.1	2.4	1.085	
AHU-1 Supply Fan F-1-1	20	460	3	27	30.3	13.955	
AHU-1 Return Fan F-1-2	7.5	460	3	11	12.4	5.685	
AHU-2 Rooftop Unit	[136]	460	3	136	152.8	70.292	
AHU-3 Supply Fan F-3-1	30	460	3	40	44.9	20.674	
AHU-3 Return Fan F-3-2	10	460	3	14	15.7	7.236	
AHU-4 Rooftop Unit	[53]	460	3	53	59.6	27.393	
AHU-5 Supply Fan F-5-1	15	460	3	21	23.6	10.854	
AHU-5 Return Fan F-5-2	7.5	460	3	11	12.4	5.685	
AHU-6 Supply Fan F-6-1	10	460	3	14	15.7	7.236	
AHU-6 Return Fan F-6-2	3	460	3	4.8	5.4	2.481	
AHU-7/8 Rooftop Unit	[135]	460	3	135	151.7	69.775	
AHU-9 Supply Fan F-9-1A	10	460	3	14	15.7	7.236	
AHU-9 Supply Fan F-9-1B	10	460	3	14	15.7	7.236	
AHU-9 Return Fan F-9-2	7.5	460	3	11	12.4	5.685	
AHU-10 Rooftop Unit	[65]	460	3	65	73.0	33.596	
AHU-11 Supply Fan F-11-1	20	460	3	27	30.3	13.955	
AHU-11 Return Fan F-11-2	7.5	460	3	11	12.4	5.685	

AHU-12 Supply Fan F-12-1	20	460	3	27	30.3	13.955
AHU-12 Return Fan F-12-2	5	460	3	7.6	8.5	3.928
AHU-13 Supply Fan F-13-1	15	460	3	21	23.6	10.854
AHU-13 Return Fan F-13-2	5	460	3	7.6	8.5	3.928
AHU-15 Supply Fan F-15-1	50	460	3	65	73.0	33.596
AHU-15 Return Fan F-15-2	15	460	3	21	23.6	10.854
AHU-16A Supply Fan F-16-1A	50	460	3	65	73.0	33.596
AHU-16A Supply Fan F-16-1B	50	460	3	65	73.0	33.596
AHU-16E Exhaust Fan F-16-2A	40	460	3	52	58.4	26.876
AHU-16E Exhaust Fan F-16-2B	40	460	3	52	58.4	26.876
AHU-17 Supply Fan F-17-1A	40	460	3	52	58.4	26.876
AHU-17 Supply Fan F-17-1B	40	460	3	52	58.4	26.876
AHU-17 Return Fan F-17-2	15	460	3	21	23.6	10.854
AHU-18 Supply Fan F-18-1A	50	460	3	65	73.0	33.596
AHU-18 Supply Fan F-18-1B	50	460	3	65	73.0	33.596
AHU-18 Return Fan F-18-2	25	460	3	34	38.2	17.573
AHU-19 Supply Fan F-19-1	40	460	3	52	58.4	26.876
AHU-19 Return Fan F-19-2	10	460	3	14	15.7	7.236
Ventilation Fan VF-1-1	5	460	3	7.6	8.5	3.928
Ventilation Fan VF-1-2	3	460	3	4.8	5.4	2.481
Ventilation Fan VF-2-1	5	460	3	7.6	8.5	3.928
Ventilation Fan VF-2-2	3	460	3	4.8	5.4	2.481
Ventilation Fan VF-3-1	2	460	3	3.4	3.8	1.757
Ventilation Fan VF-3-2	3	460	3	4.8	5.4	2.481
Ventilation Fan VF-4-1	5	460	3	7.6	8.5	3.928
Ventilation Fan VF-4-2	1.5	460	3	3	3.4	1.551
Ventilation Fan VF-4-3	1.5	460	3	3	3.4	1.551
Ventilation Fan VF-5-1	1	460	3	2.1	2.4	1.085
Ventilation Fan VF-5-2	0.5	460	3	1.1	1.2	0.569
Exhaust Fan EF-1A	2	460	3	3.4	3.8	1.757
Exhaust Fan EF-1B	0.75	460	3	1.6	1.8	0.827
Exhaust Fan EF-1C	0.75	460	3	1.6	1.8	0.827
Exhaust Fan EF-1F	1	460	3	2.1	2.4	1.085
Exhaust Fan EF-1H	2	460	3	3.4	3.8	1.757
Exhaust Fan EF-3A	0.75	460	3	1.6	1.8	0.827
Ex Chiller CH-1	111.9	460	3	231	259.6	119.393
Ex Chiller CH-2	113.39 2	460	3	231	259.6	119.393
500 Ton Chiller CH-3	214.10 2	460	3	392	440.4	202.607
Cooling Tower CT-1 Fan #1	30	460	3	40	44.9	20.674
Cooling Tower CT-1 Fan #2	30	460	3	40	44.9	20.674
Cooling Tower CT-2 Fan #1	30	460	3	40	44.9	20.674
Cooling Tower CT-2 Fan #2	30	460	3	40	44.9	20.674
CT-1 Basin Heater	8.952	460	3	14. 5	16.3	7.494
CT-2 Basin Heater	30	460	3	40	44.9	20.674
Boiler B-1 (Base Bid)	15	460	3	21	23.6	10.854
Boiler B-2 (Base Bid)	15	460	3	21	23.6	10.854
Boiler B-1 (Alternate)	25	460	3	34	38.2	17.573
Boiler B-2 (Alternate)	25	460	3	34	38.2	17.573
Humidifier H-6-1	51.474	460	3	66.	75.1	34.526

				8		
Humidifier H-9-1	26.11	460	3	34.8	39.1	17.987
Humidifier H-9-2	13.428	460	3	16.5	18.5	8.528
Humidifier H-9-3	38.792	460	3	50.5	56.7	26.101
Humidifier H-12-1	5.6696	460	3	8.3	9.3	4.290
Humidifier H-12-2	5.6696	460	3	8.3	9.3	4.290
Humidifier H-13-1	5.6696	460	3	8.3	9.3	4.290
Unit Heater UH-3	3.73	460	3	3.73	4.2	1.928
Duplex Air Compressor	30	460	3	80	89.9	41.348
Duplex Air Compressor	30	460	3	80	89.9	41.348
Domestic Water Booster Pump	1	460	3	2.1	2.4	1.085
Dust Collector DC-1	5	460	3	7.6	8.5	3.928
Dust Collector DC-2	10	460	3	14	15.7	7.236
Domestic Water Heater Burner	1.5	208	3	6.9	7.8	1.613
Metal Studio Exhaust Fan EF-3C	0.75	460	3	1.6	1.8	0.827
Metal Studio Gas Forge Fan EF-3E	1	460	3	2.1	2.4	1.085
Kiln Exhaust Fan EF-3B	0.75	460	3	1.6	1.8	0.827
Ceramics Exhaust Fan EF-3D	0.75	460	3	1.6	1.8	0.827
Drapery Machine Disconnect D1D	1	208	3	4.8	5.4	1.122
Drapery Machine Disconnect D2D	1	208	3	4.8	5.4	1.122
Drapery Machine Disconnect D3D	1	208	3	4.8	5.4	1.122
Drapery Machine Disconnect D4D	1	208	3	4.8	5.4	1.122
Drapery Machine Disconnect D5D	1	208	3	4.8	5.4	1.122
Lineshaft Winch Disconnect LWD1	10	460	3	14	15.7	7.236
Lineshaft Winch Disconnect LWD2	10	460	3	14	15.7	7.236
Lineshaft Winch Disconnect LWD3	10	460	3	14	15.7	7.236
			Total 3 Phase Load			**1824.3**

*Assumed a 0.89 p.f. for load

*Full load currents for three phase motors are obtained from Table 430.150 of the 2002 NEC.

Table B. Three Phase Load Calculation

Elevator Equipment						
Serves	**HP [A]**	**Volts**	**Phase**	**FLA**	**kVA**	**Demand kVA**
Ex Elevator EL2 (Part B)	25	460	3	34	27.088	23.025
Ex Elevator EL3 (Part C)	25	460	3	34	27.088	23.025
Elevator EL1 (Part A)	75	460	3	96	76.485	65.012
Elevator EL2 (Part C)	30	460	3	40	31.869	27.088
		Total Elevator Load				**138.2**

*85% demand factor taken into consideration for elevators

Table C. Elevator Equipment Calculation

Largest Motor Load						
Serves	**HP [A]**	**Volts**	**Phase**	**FLA**	**kVA**	**Demand kVA**
500 Ton Chiller CH-3	214.102	460	3	392	311.954	77.988
		Total Motor Load				**78.0**

*For the largest motor, an extra 25% must be added to the demand load according to the NEC.

Table D. Largest Motor Calculation

Overall Mechanical Load	
Total 1 Phase Load	**37.1**
Total 3 Phase Load	**1824.3**
Total Elevator Load	**138.2**
Total Motor Load	**78.0**
Total Load	**2077.5**

Table E. Overall Mechanical Load Calculation

Receptacle

NEC Building Design Load- Receptacles								
	Floor 1 Receptacles	**Floor 2** Receptacles	**Floor 3** Receptacles	**Floor 4** Receptacles	**Roof** Receptacles	**Total Receptacles**	**NEC Receptacle Load** VA/ Recept.	Volt-amperes
Section A	234	424	530	344	7	1539	180	277020
Section B	0	84	140	3	1	228	180	41040
Section C	0	103	179	19	7	308	180	55440
Section D	0	36	161	17	1	215	180	38700
Section E	0	0	88	29	0	117	180	21060
Section F	0	0	82	70	0	152	180	27360
					Total Receptacle Load			**460.62 kVA**

*180 VA is assumed for a duplex receptacle according to the NEC 2002 Code. The Demand Load is calculated as follows; 100% for the first 10,000 VA and 50% for the remaining Load over 10,000 VA.

Table F. Receptacle Calculations

Receptacle Demand Load		
First 10 kVA @ 100%-	10	kVA
Remaining @50%-	225.31	kVA
Receptacle Demand Load	**235.31**	**kVA**

Table G. Receptacle Demand Load

Lighting

NEC Building Design Load- Lighting								
	Floor 1	**Floor 2**	**Floor 3**	**Floor 4**	**Total**	**NEC Unit Load for Lighting**		
	Sq. Ft	Sq. Ft	Sq. Ft	Sq. Ft	Sq. Ft	VA/Ft^2	Volt-amperes	kVA
School Occupancy	12265	61018	105366	21703	200352	3	601056	601.06
Storage Space	1015	2848	4581	1027	9471	0.25	2367.75	2.37
Corridor Space	7620	16831	29367	10075	209823	0.5	104911.5	104.91
Theater			7956		7956	1	7956	7.96
Concert Hall			6292		6292	1	6292	6.29
						Total Lighting KVA		**722.58**

* NEC Unit Load for Lighting is found on Table 220.3A of the 2002 NEC.

*All area values on table are approximations.

Table H. Lighting Load Calculations

Overall Load

Receptacle Demand Load		
First 10 kVA @ 100%-	10	kVA
Remaining @50%-	225.31	kVA
Receptacle Demand Load	**235.31**	**kVA**
Lighting Demand Load		
Total Lighting Load	**722.58**	**kVA**
Overall Mechanical Load		
Total 1 Phase Load	37.1	kVA
Total 3 Phase Load	1824.3	kVA
Total Elevator Load	138.2	kVA
Total Motor Load	78.0	kVA
Total Mechanical Load	**2077.5**	**kVA**

Total Load	3035.43	**kVA**

Table I. Total Load Calculations

Main Distribution Panel

Main Distribution Calculation			
	2- Panels at 3000A a piece. 6000A overall.		
VA =	**1.732 (480 V) (6000 A) (1.0)**	**=**	**4988160 VA**
	Design Factor of 80% is applied:		
	4988160 VA * 0.8 = 3990.528 kVA		

Table J. Main Distribution Panel Calculation