Steve Neimeister
29 October 2003
AE 481W
AstroPower Headquarters
Newark, Delaware
Lighting/Electrical Option
Consultant: M. Moeck

Electrical Systems Existing Conditions and Building Load Summary Report

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EXECUTIVE SUMMARY

The Electrical Systems Existing Conditions and Building Load Summary Report will go into detail about the current electrical system in the AstroPower Headquarters building. A simplified Single Line Diagram will show an overview of the system. Following that will be a short narrative describing the general and special characteristics of this system, along with a summary of the existing building loads. This total will be used to check the size of the existing main distribution equipment. Other information taken from the National Fire Prevention Association 70, the National Electrical Code 2002, part of the International Electrical Code Series, will go into finding the load values for all mechanical equipment, heating elements, elevators, lighting loads, and others.

This report concluded that the building has ample electrical supply to maintain an operational building even in the event of an emergency. Using "Green Building" mentality with energy efficient lighting solutions and diesel generators, it will be difficult to improve upon an already earth-conscious design.

Due to the fact that the AstroPower Headquarters building is currently vacant and for sale, it was not possible to obtain a summary of the Electric Utility Load Data for the previous twelve months to compare to my design loads.

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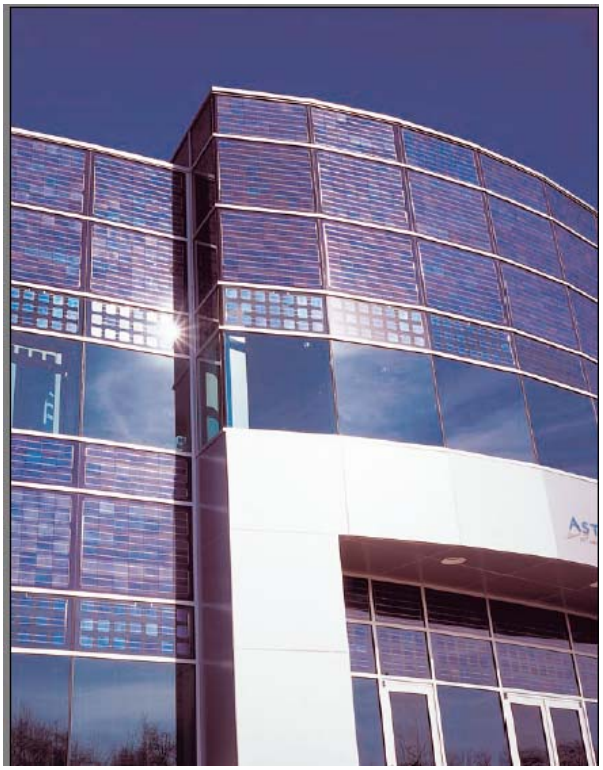

The AstroPower Headquarters building was constructed a few years ago to act as both a Headquarters and to be a display of what the product they manufacture can accomplish when put to work. The building features both office and manufacturing areas, requiring ample power in both spaces to attend to the research and professional sides of their corporation. The electrical system for a building like this must be designed to suit the use of the building, and also be able to provide flexibility for future additions the building might encounter. This report will go into the different aspects of the existing electrical system while providing information related to power usage, power distribution throughout the building, and other electrical load calculations.

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Part I – Single Line Diagram

A simplified version of the buildings electrical distribution system is represented in the drawings to follow. The first is a general overview of the entire system, whereas the three drawings that follow allow you to see the detail of the design.

**Note- The pasted JPEG files can be viewed outside of this document as Adobe Acrobat files by accessing the web page http://www.arche.psu.edu/thesis/2004/san141 and clicking on the Technical Assignments link in the menu bar.

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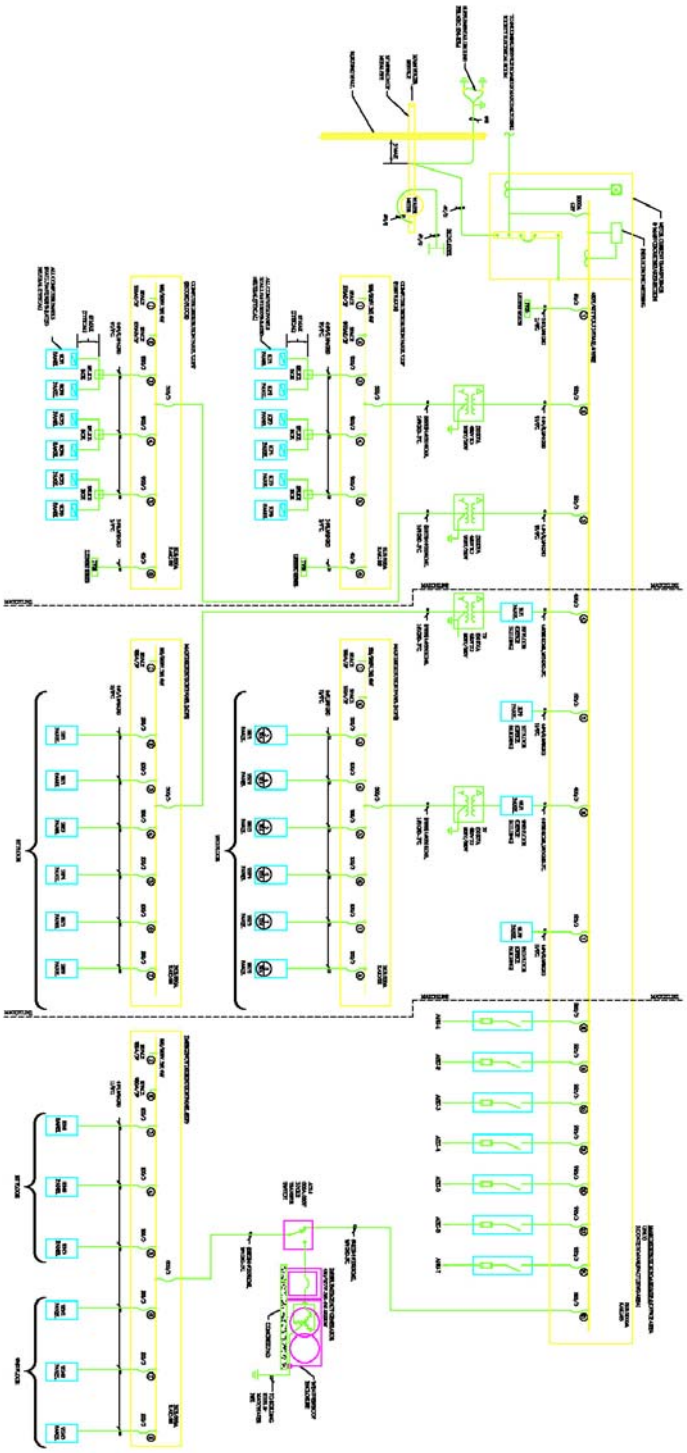

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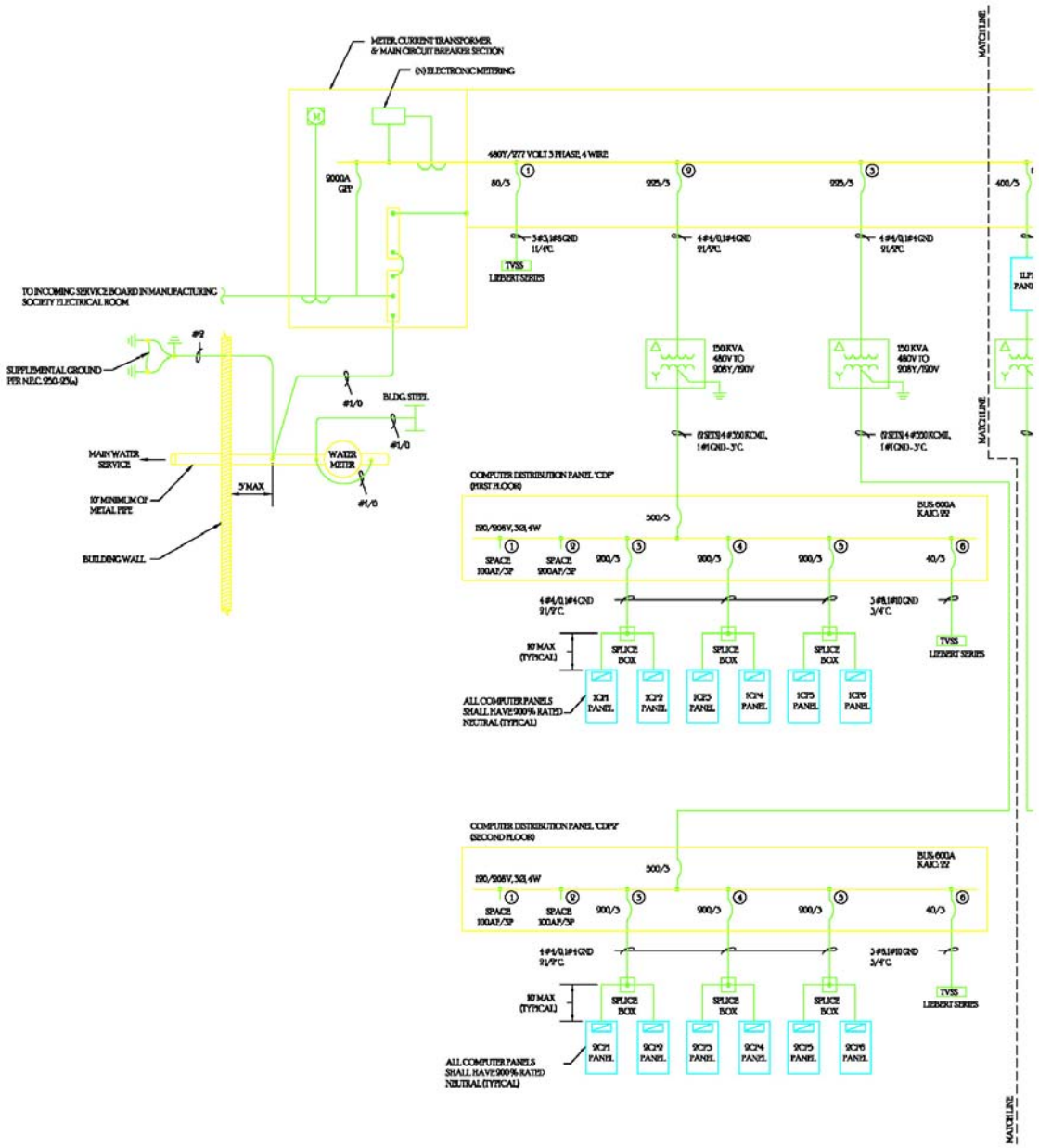

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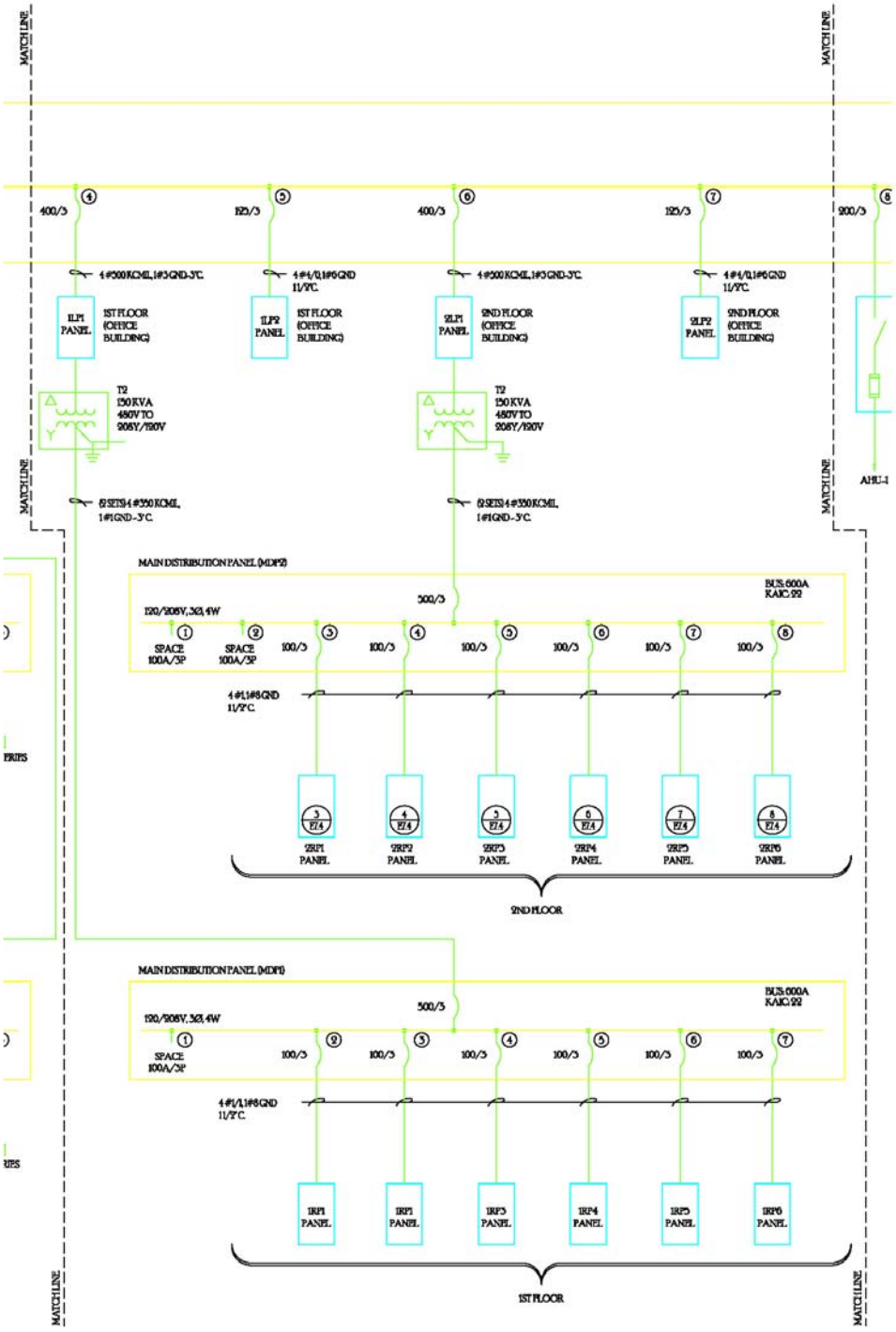

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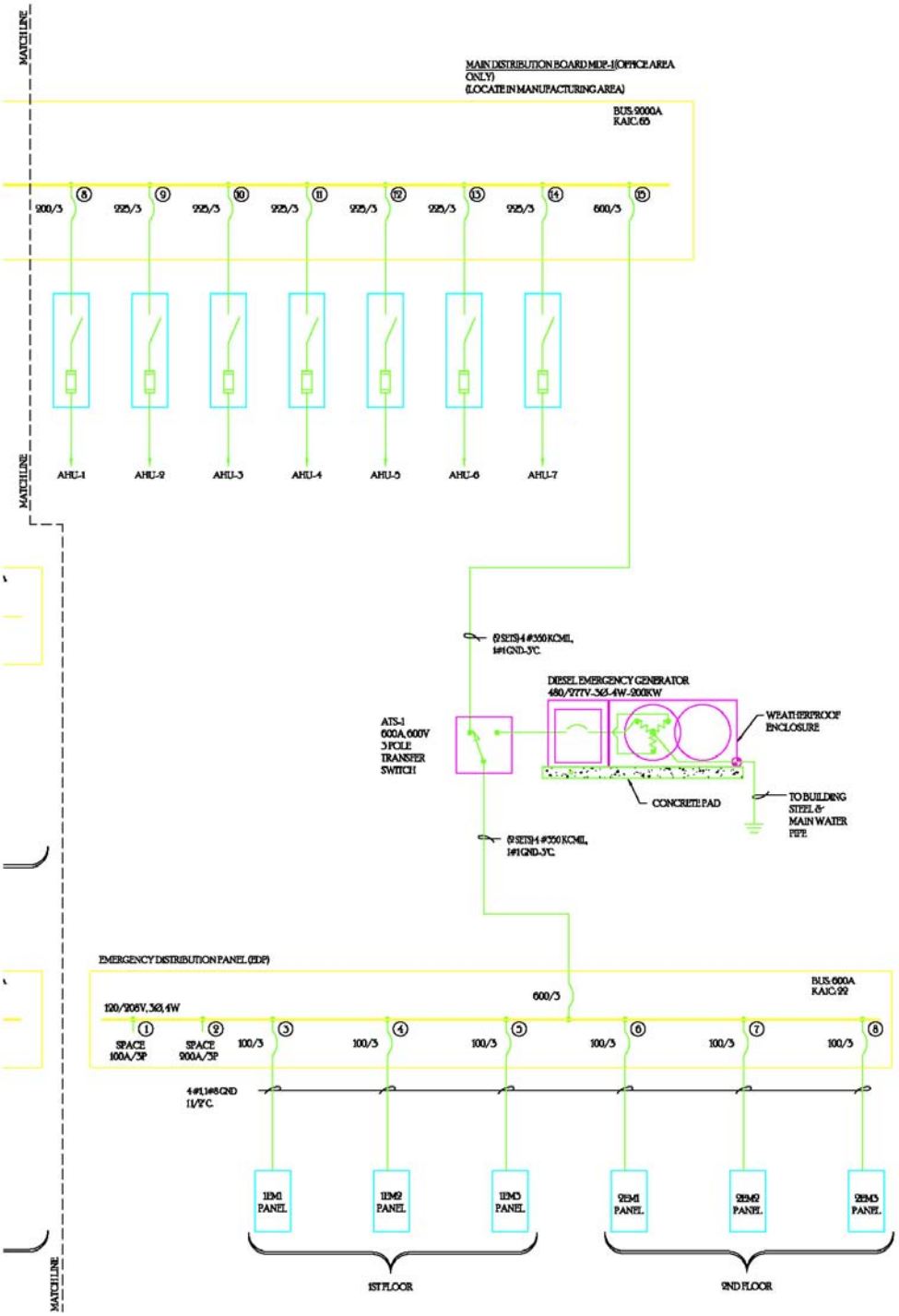

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Part II – Electrical Systems Existing Conditions

The following is a compilation of information pertaining to the building electrical system that currently exists in the AstroPower Headquarters building.

System Type

The AstroPower Headquarters building features a Load-center system using radial-type circuit arrangement. This design allows the power to be distributed at the highest economical voltage level to areas of concentrated load where the voltage is transferred down to the utilization level. The utilization equipment is then supplied using relatively short low-voltage feeders.

The load-center type of distribution has been made possible by the development of dry-type medium-voltage switchgear and transformers that do not require expensive fireproof vaults and by the development of lower-cost medium-voltage feeder cables. The primary distribution switchgear is the metal-clad type using medium-voltage air circuit breakers.

Building Utilization Voltage

Incoming electrical power is provided at 12kV, which is then transferred into 480Y/277V to be distributed to the different distribution panels and air handling units for the mechanical systems. The lines are transferred again into 120/208V for receptacles and other power loads.

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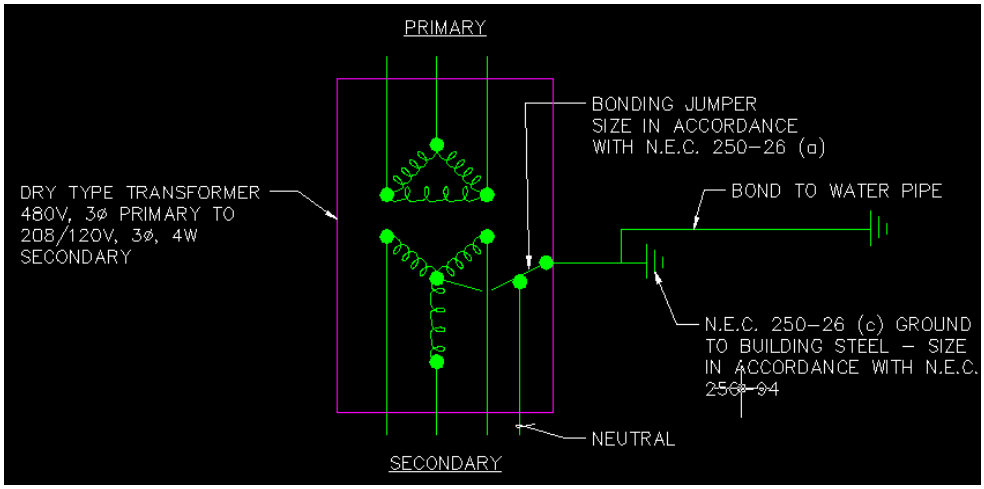
Transformer Configuration

All transformers used in the electrical distribution system are dry energy saving units square "D" T3HB series. The transformers convert three phase, three wire 460 volt delta primary to three phase, four wire 208/120V grounded wye secondary. The transformers also have a 220° insulation and 80° rise temperature rating, with 2 ½ % FCAN and 4 – 2 ½ % FCBN taps. For the computer distribution panels the TC-1 transformers are used. They are K-rated, electrostatically shielded, square D and Class 7400.



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Emergency Power Systems

Emergency power in the AstroPower Headquarters is provided by a Diesel Emergency Generator located outside the building. It is underneath a weatherproof enclosure and on top of a concrete pad. The generator is a 480/277V three phase, four wire system that provides 200 kilowatts of power. When the Emergency Generator is not in use, the Emergency Distribution panel is powered by a line coming in from the Main Distribution Board. Upon power shut down, a three pole transfer switch connects to the generator providing 600 volts to the Emergency Distribution panel. This panel is equipped with 120/208V, three phase four wire connections to power the emergency lighting, exhaust fans, and other equipment located in the building.

Over-current Protective Devices

The AstroPower Headquarters uses several measures for over-current protection. After the transformer steps down the power from 12 kV to 480/277V, circuit breakers are located on each line out to the individual distribution panels. On the main distribution board, the circuit breakers are listed as three pole 80, 125, 200, 225, 400, or 600 amp circuit breakers. On the computer distribution panels, three pole 200 amp and 40 amp circuit breakers are used. On the main distribution panels, three pole 100 amp circuit breakers are used. Finally, the emergency distribution panel uses three pole 100 amp circuit breakers.

The air handling units are equipped with fuses and fused switches. They lead off the main distribution board with three pole 225 amps circuit breakers. There are a total of seven air handling units.

Finally, off of the main distribution board and the two computer distribution panels there are Libert Interceptor series transient voltage surge suppressors. They lead off the main lines with

three pole 40 amp circuit breakers. With these protective devices, any type of damage will hopefully be prevented.

Location of Electrical Rooms and Equipment

A main electrical room, number 154, is located between columns L and M and line six, on the first floor in the office area. It is approximately twenty feet deep by eight feet wide. The room has the following panels and equipment: two 150kVA transformers, a security panel, and emergency distribution panel, a fire alarm panel, a 600A transfer switch, along with the panels 1EM1, 1EM2, 1CP1, 1CP2, 1CP3, 1RP1, 1RP2, 1RP3, MDP1, 1LP1, and CDP.

A secondary electrical room, number 174, is located between columns K and L and line three, on the first floor in the office area. It is approximately ten feet deep by six feet wide. The room has the following panels: 1LP2, 1RP4, 1RP5, 1RP6, 1CP4, 1CP5, 1CP6, 1EM3.

Another main electrical room, number 244, is located between columns L and M and line six, on the second floor in the office area. It is approximately sixteen feel deep by eight feet wide. The room has the following panels and equipment: two 150kVA transformers, along with panels 2EM1, 2EM2, 2CP1, 2CP2, 2CP3, CDP2, 2RP1, 2RP2, 2RP3, MDP2, and 2LP1.

Another secondary electrical room, number 272, is located between columns K and L and line three, on the second floor in the office area. It is approximately ten feet deep by six feet wide. The room has the following panels: 2LP2, 2RP4, 2RP5, 2RP6, 2CP4, 2CP5, 2CP6, and 2EM3.

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Typical Lighting Systems

The lighting used in the AstroPower Headquarters is categorized as being fluorescent. All fluorescent fixtures in the building are to have an input of 120V and a frequency of 60 Hz. The THD shall be less than 20% for the main lamp design, and the Lamp Current Crest factor shall not exceed 1.7. The power factor must be greater than 98%, but for most lamps is assumed to be 1.0. The ballasts must be CSA approved and UL listed class P.

Power Factor Corrections

The electrical distribution system in the AstroPower Headquarters building does not have any capacitors in its design.

Important Design Requirements

Since two of the four electrical panels feed the computer areas, a Leibert Interceptor Series transient voltage surge suppressor is connected. There is also one off the main line on the main distribution board after the transformer steps down the 12kV line in. There are also four additional transformers from the main distribution board to the four other panels that step down the voltage from 150 kVA 480V to 208Y/120V.

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Part III – Existing Lighting and Mechanical Systems Information

The following tables list the primary lamps and ballasts that are used in the AstroPower Headquarters building.

Ballasts

Name	UL Listed	Lamp Current Crest Factor	THD	Minimum P.F.	Maximum P.F.	Frequency	Starting Temp.
Electronic Ballast Rapid Start Fluorescent (T8 Linear bulb)	Class P	1.6	< 20%	0.98	1.0	60 Hz	-20° F
Electronic Ballast Rapid Start Fluorescent (Compact Lamps)	Class P	1.6	< 20%	0.98	1.0	60 Hz	-20° F

Both ballasts above are from Advance, and for further information can be accessed at http://www.advancetransformers.com.

Lamps

Type	CCT	CRI	Life	Wattage	Lumens
Fluorescent T8	3500	85	20,000 hrs.	32	1100
Triple Tube Fluorescent	3500	85	20,000 hrs.	26	1100

The lamps chosen for the luminaires are from Phillips, and for further information can be accessed at http://www.phillipslighting.com.

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Mechanical Equipment – Roof Top Units

Symbol	Description	Tot. CFM	Min. O.A. CFM	Net Cooling Capacity	Mixed Air Ent.		Capacity (MBH)		Net Heating Capacity			Power
				Amb D.B. Temp.	D.B.	W.B.	Tot.	Sens.	Ent. Air Temp.	Input (MBH)	Output (MBH)	V/PH/Hz
RTU-1	1Fl.Perim.	12,000	1,020	93	76.5	64	361	328	69.5	500	240	460/3/60
RTU-2	1Fl.North	12,000	1,520	93	77.3	64.5	360	292	66.8	500	170	460/3/60
RTU-3	2Fl.North	16,000	1,520	93	76.7	64.1	436	395	68.8	850	216	460/3/60
RTU-4	2Fl.South	16,000	1,520	93	76.7	64.1	436	395	68.8	850	216	460/3/60
RTU-5	1Fl.South	12,000	1,520	93	77.3	64.5	360	292	66.8	500	170	460/3/60
RTU-6	2Fl.Perim.	14,000	1,020	93	76.3	63.9	436	395	70.3	500	224	460/3/60
RTU-7	Air Hand. Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60
RTU-8	Air Hand. Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60
RTU-9	Air Hand. Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60
RTU-10	Air Hand. Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60
RTU-11	Air Hand. Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60
RTU-12	Air Hand. Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60
RTU-13	Air Hand. Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60
RTU-14	Air Hand. Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60

Symbol	Basis
RTU-1	Trane SFHFC4OP, 40 ton nom.
RTU-2	Trane SFHFC4OP, 40 ton nom.
RTU-3	Trane SFHFC4OP, 40 ton nom.
RTU-4	Trane SFHFC4OP, 40 ton nom.
RTU-5	Trane SFHFC4OP, 40 ton nom.
RTU-6	Trane SFHFC4OP, 40 ton nom.
RTU-7	Trane SFHFC75P, 75 ton nom.
RTU-8	Trane SFHFC75P, 75 ton nom.
RTU-9	Trane SFHFC75P, 75 ton nom.
RTU-10	Trane SFHFC75P, 75 ton nom.
RTU-11	Trane SFHFC75P, 75 ton nom.
RTU-12	Trane SFHFC75P, 75 ton nom.
RTU-13	Trane SFHFC75P, 75 ton nom.
RTU-14	Trane SFHFC75P, 75 ton nom.

Mechanical Equipment – Exhaust Fans

Symbol	Description	Location	C.F.M.	E.S.P.	Fan R.P.M.	Motor H.P.	Sones	V/PH/Hz	Basis
EF-1	1Fl. Core	Roof	1,800	1.5	1445	1	13.9	208/3/60	Penn Ventilator Domex DX14B
EF-2	2Fl. Core	Roof	1,000	1	1282	0.5	9.6	208/3/60	Penn Ventilator Domex DX11B
EF-3	Machine Rm.	Roof	400	1	1223	0.25	9.1	115/1/60	Penn Ventilator Domex DX11B
EF-4	Elec. RMS	Roof	400	1	1223	0.25	9.1	115/1/60	Penn Ventilator Domex DX11B
EF-5	Elec. RMS	Roof	400	1	1223	0.25	9.1	115/1/60	Penn Ventilator Domex DX11B

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Part IV – Building Load Calculations

The total building loads were tabulated for the AstroPower Headquarters building. Listed below are the total loads from the lighting and receptacle equipment. Unfortunately, the mechanical schedule did not have horsepower listed for the roof top equipment, thus prohibiting the inclusion the load in the building total. Information from the Mechanical Engineer has been requested and will be added in an Addendum to this document after calculations have been made.

Receptacle Load

Location	Square Feet	Number of Receptacles
Warehouse	100,909	2,019
Office - Fl. 1	29,645	593
Office - Fl. 2	29,563	589
Total Number of Receptacles		3,201
x 180 VA / Receptacle =		x 180
Receptacle Load (VA)		576,180
First 10,000 VA at 100%		10,000
Remaining 566,180 at 50%		283,090
TOTAL Computed Load (VA)		293,090
(kVA)		**293.09**

The **Total Receptacle Load** = 293,090 = **293.09 kVA**

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Lighting Load

Data taken from NEC 2002 Table 220-3(a) General Lighting Load by occupancy:

Warehouse/Manufacturing: 100,909 ft.^{2} x 2 VA = 201,818 VA

Office Area: 59,208 ft.^{2} x 3 ½ VA = 207,228 VA

Total Lighting Load = 409,046 VA = **409.046 kVA**

Demand Factor

Data taken from NEC 2002 Table 220-11 Lighting Load Demand Factors:

All Others – Total volt-amperes = 100%

Total Building Load (for Lighting and Receptacles)

The total building load for Lighting and Receptacles (excluding Mechanical) is **702.136 kVA**.

Part V – Utility Rate Structure

Due to the fact that the AstroPower Headquarters has been vacant since this past summer, an accurate utility rate summary could not be provided. The electric service provider for the building is Connectiv, and pending a response from them regarding access to their private records for the space, a summary and comparison will be posted as an Addendum to this report.

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Appendix

Bibliography

1. Hughes, David S. Electrical Systems in Buildings. Delmar Publishers, Albany, New York, 1988.

2. NFPA 70, National Electrical Code 2002 Edition. National Fire Protection Agency, 2001.

Additional Notes:

As of 28 October 2003, the publishing date of this report, several parts have been omitted due to lack of information. The first is the Mechanical Load total, due to the fact that the equipment on the Mechanical Schedule did not have horsepower and other information necessary to compute a total figure. The second is the Utility Use Summary, due to the fact that the building is now vacant and it is difficult to obtain accurate information from when the building was one hundred percent operational. Once the figures necessary to complete these two sections is obtained, Addendums will be published with this information.