Technical Report 2

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AE 481W

City of Green Administration Building

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Executive Summary

This report contains detailed information regarding the existing electrical system in the City of Green Administration Building. Each section corresponds to a different component of the system, beginning with a general description and proceeding through to the branch circuit panels. Schedules are included to show the location of equipment, connected loads, and service entrance calculations. All main switchgear and equipment is included within the schedules. The calculations were done using three different methods, and would normally be compared to the existing system. Unfortunately, these numbers were not available at this time, and are not included. Design issues, green design components, and the communication system are also discussed.

Summary Description of Distribution System

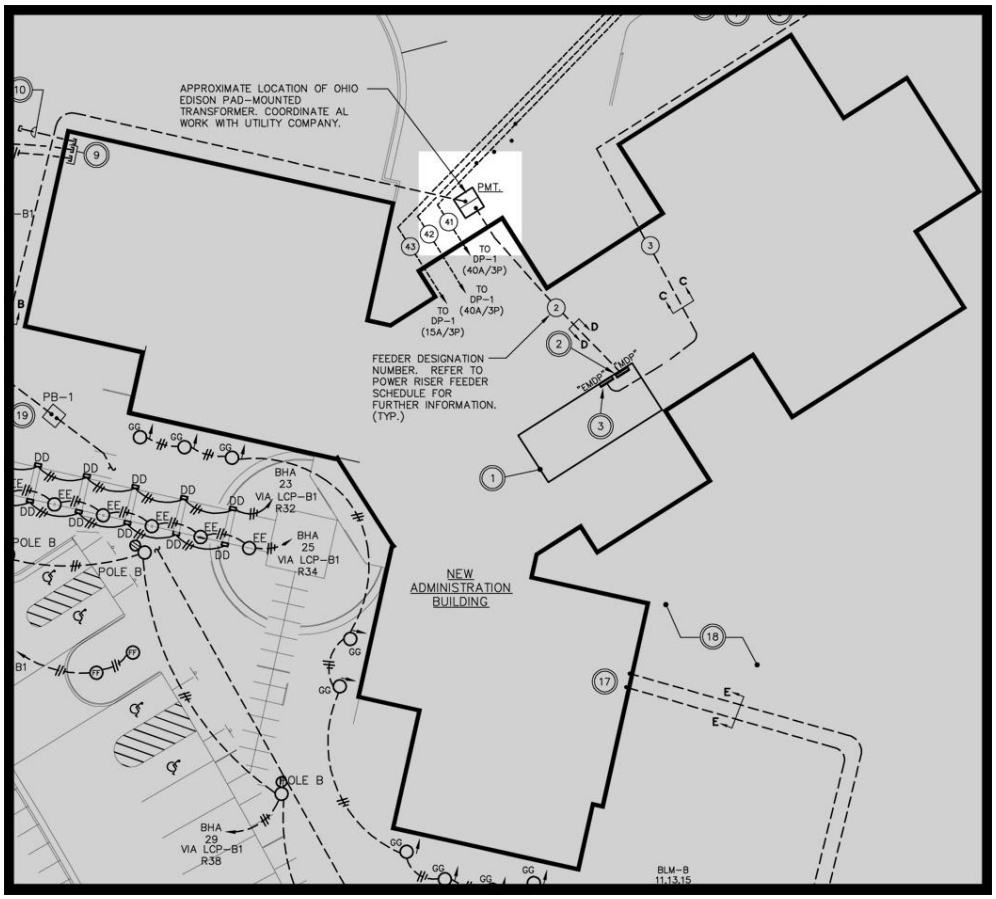
Power for the City of Green Administration Building is provided by Ohio Edison via a utility owned transformer located on site. Conduit from this transformer carries 480/277V WYE into the lower level of the building to a main distribution panel. Power is distributed from this main distribution panel through automatic transfer switches to four distribution panels of various sizes. These distribute power to branch circuit panels located in electrical closets throughout the building. Emergency power is supplied by an on-site 750KW generator which supplies the same 480V/277V WYE connection as the utility owned transformer. It connects to the building's electrical system via the automatic transfer switches off the main distribution panel. Emergency power is connected to all building loads.

Utility Company Information

- Name
  - Ohio Edison, a FirstEnergy Company
- Address
  - FirstEnergy Corp. 76 South Main Street, Akron, Ohio 44308
- Website
  - https://www.firstenergycorp.com/Ohio_Edison/index.html
- Phone
  - (800) 633-4766
- Utility Rate Structure
  - Have contacted building owner and am waiting confirmation for assumed rate schedule:
    - General Service – Transmission (Rate "GT") – Greater or equal to 69,000 V
    - Distribution Charges
      - Service Charge: $320.00
      - Capacity Charge: $0.3672 per kVA of billing demand
      - Billing demand for the month shall be the greatest of:
        - Measured Demand, being the highest thirty minute integrated kVA
        - 100.0 kVA
        - The contract demand
- Electric Utility Load Data for Previous 12 Months
  - Have contacted building owner and am waiting to receive previous 12 months of electric load data

Service Entrance

- Electrical service for the building is provided via a new utility owned pad-mounted transformer located on site and fed from an existing sectionalizer directly from utility company.
- Sectionalizer switch located East of building near vehicle entrance
    - Underground primary conduit (Feeder No. 1) travels to utility owned box pad located on South side of West wind, then from box pad to utility owned transformer “PMT”
- Transformer was furnished and installed, and is maintained / owned, by Ohio Edison
    - All primary / secondary connections made by Ohio Edison at transformer
    - 500 kVA, 12.47 kV, 3 phase grounded primary to 480/277V WYE secondary
    - Primary side metering by electric company on transformer
    - Cad-weld to ground rod at transformer pad
    - Located is the corner between the West and North wing, pictured below
- Secondary side conduit (Feeder No. 2) enters building and feeds to main distribution panel (MDP-1) located in electrical room on lower level, begins owner responsibility
    - Customer metering on MDP-1



Voltage Systems

- The building's electricity is fed from the utility owned transformer to the MDP-1
    - 408/277V, 3 Phase, 4 Wire
- MDP-1 feeds two distribution panels (DP-1, DP-2)
    - 408/277V, 3 Phase, 4 Wire
- MDP-1 also feeds through one panel board to a step down transformer (T-3) serving the emergency lighting system / fire protection panel board.
    - 408/277V, 3 Phase, 4 Wire, to 208/120V, 3 Phase, 4 Wire
- DP-1 provides power to mechanical systems at 408/277V, 3 Phase, 4 Wire. Also feeds to DP-4 through transformer (T-2).
    - (T-2) 408/277V, 3 Phase, 4 Wire to 208V, 3 Phase, 4 Wire
    - DP-4 serves multiple panel boards throughout building at this secondary voltage
- DP-2 serves three panel boards and the elevator at 408/277V, 3 Phase, 4 Wire. Also feeds to DP-3 through transformer (T-1)
    - (T-1) 408/277V, 3 Phase, 4 Wire to 208V, 3 Phase, 4 Wire
    - DP-3 serves multiple panel boards throughout building at this secondary voltage
- Emergency power system is 408/277V, 3 Phase, 4 Wire from generator through emergency distribution panel (EMDP)

Emergency Power System

- The emergency power system supply is a 750 KW on site generator
    - 408/277V, 3 Phase, 4 Wire
- This generator feeds to emergency distribution panel, then through three automatic transfer switches (one for each connection to MDP-1)
- Emergency power system is capable of supplying power to the entire building

Locations of Switchgear

- All distribution panel boards (DP-1,2,3,4 and EDP-1/EMDP), automatic transfer switches, and transformers are located in the electrical room.
- One electrical closet per wing per floor houses panel boards for lighting and mechanical equipment and are fed from the electrical room main distribution system.
- Some equipment (Network panel boards) are located in rooms, not electrical closets.

Locations of Switchgear						
Equip. Tag	Type	Floor Level	Room Number	Room Name	1/8" Drawing Number	Enlarged Plan Number
MDP-1	Distribution Panel Board	Lower	008	Electrical Room	E103	E103
EMDP	Distribution Panel Board	Lower	008	Electrical Room	E103	E103
ATS-1	Automatic Transfer Switch	Lower	008	Electrical Room	E103	E103
ATS-2	Automatic Transfer Switch	Lower	008	Electrical Room	E103	E103
ATS-3	Automatic Transfer Switch	Lower	008	Electrical Room	E103	E103
DP-1	Distribution Panel Board	Lower	008	Electrical Room	E103	E103
DP-2	Distribution Panel Board	Lower	008	Electrical Room	E103	E103
DP-3	Distribution Panel Board	Lower	008	Electrical Room	E103	E103
DP-4	Distribution Panel Board	Lower	008	Electrical Room	E103	E103
LS-1H	100A Panel Board	Lower	008	Electrical Room	E103	E103
LS-1L	60A Panel Board	Lower	008	Electrical Room	E103	E103
BLM-A	225A Panel Board	Lower	009	Mechanical Room	E103	E101
BLM-B	225A Panel Board	Lower	009	Mechanical Room	E103	E101
GLM-A	150A Panel Board	Ground	147B	Corridor Closet	E201	N/A
GLM-B	225A Panel Board	Ground	103	Elec. Closet	E203	N/A
GLM-C	225A Panel Board	Ground	159	Elec. Closet	E203	N/A
2LM-A	150A Panel Board	Upper	218	Common Work Area	E300	N/A
2LM-B	225A Panel Board	Upper	211	Elec. Closet	E300	N/A
2LM-C	225A Panel Board	Upper	232	Elec. Closet	E300	N/A
BHA	100A Panel Board	Lower	009	Electrical Room	E103	E103
GHA	100A Panel Board	Ground	114A	Data Systems Room/Elec.	E203	N/A
2HA	100A Panel Board	Upper	218	Common Work Area	E300	N/A

BLA	200A Panel Board	Lower	008	Electrical Room	E103	E103
GLA	100A Panel Board	Ground	147B	Corridor Closet	E201	N/A
GLA2	100A Panel Board	Ground	114A	Data Systems Room/Elec.	E203	N/A
GLB	100A Panel Board	Ground	103	Elec. Closet	E203	N/A
GLC	100A Panel Board	Ground	159	Elec. Closet	E203	N/A
2LA	100A Panel Board	Upper	218	Common Work Area	E300	N/A
2LB	100A Panel Board	Upper	211	Elec. Closet	E300	N/A
2LC	100A Panel Board	Upper	232	Elec. Closet	E300	N/A
T-1	Transformer	Lower	008	Electrical Room	E103	E103
T-2	Transformer	Lower	008	Electrical Room	E103	E103
T-3	Transformer	Lower	008	Electrical Room	E103	E103
BL-TELE	200A Panel Board	Lower	022	Network	E103	N/A
GMA	Not on Riser Diagram	Ground	159	Elec. Closet	E202	N/A

Lighting and Appliance panel boards and load centers						
Equip. Tag	Voltage	Main Size/Type	Level	Room Number	Room name	Floor Plan Number
LCP-B1	408/277V	Lighting Control Panel Board - 200VA	Lower	009	Electrical Room	E103
LCP-G1	408/277V	Lighting Control Panel Board - 200VA	Ground	114A	Data Systems Room/Elec.	E200
LCP-G1D	408/277V	Lighting Control Panel Board - 200VA	Ground	114A	Data Systems Room/Elec.	E200
LCP-G2	408/277V	Lighting Control Panel Board - 200VA	Ground	159	Elec. Closet	E200
LCP-3G	408/277V	Lighting Control Panel Board - 200VA	Ground	103	Elec. Closet	E200
LCP-3GD	408/277V	Lighting Control Panel Board - 200VA	Ground	103	Elec. Closet	E200
LCP-2	408/277V	Lighting Control Panel Board - 200VA	Upper	Unable to Locate		

Over-Current Devices

- Main Switchgear MDP-1
    - 65KAIC
    - 1200A / 3P circuit breaker
- Distribution Panel boards
    - (DP-1) 800A/3P circuit breaker, 65KAIC
    - (DP-2) 225A/3P circuit breaker, 65KAIC
    - (DP-3) 400A/3P circuit breaker, 65KAIC
    - (DP-4)1200A/3P circuit breaker, 65KAIC
- Branch Circuit Panel boards
    - For most loads, 20A/1P circuit breaker
    - HVAC loads are either 15A/2P, 20A/2P, or 50,15,25A/3P

Transformers

- There are three transformers located in the electrical room on the lower level
- T-1
    - 112.5KVA
    - 480/277V Primary to 208/120V Secondary
- T-2
    - 300KVA
    - 480/277V Primary to 208/120V Secondary
- T-3
    - 30KVA
    - 480/277V Primary to 208/120V Secondary

Grounding

A big loop ground is located near the service entrance. There are 8 grounding rods located around the building. A dedicated ground connection is provided for the main distribution equipment, and conduit ground to all branch circuits.

Special Equipment

See emergency generation system. Output line reactors are located at variable frequency drivers serving the cooling tower because of the length of connecting wire. No other special equipment was used. Power factor correction is monitored by both the service provider and the building system.

Lighting Loads

- The typical lighting system throughout the building uses both linear fluorescent and compact fluorescent lamps with step dimming ballasts. These are controlled via a central electronic control system, and each luminaire circuit is assigned to a relay. The main type of fixture is a two foot by four foot recessed linear fluorescent. This type is supported by compact fluorescent down-lights and pendants. Some office spaces use two foot by two foot recessed linear fluorescent luminaires.
- The luminaire table below lists each luminaire type and associated information for that type. The table covers every type of fixture inside and surrounding the building.

Lighting Loads										
Tag	**Light Source**	**Lamp Type**	**Lamp (W)**	**# Lamps**	**Ballast Type**	**Input Voltage**	**Input Watts**	**Ballast Factor**	**Current @ Operating/Start**	**PF @ Start/Operating**
A	Linear Fluorescent	FP54/835/HO	54 W	2	Electronic Step Dimming	120 V	120 W	0.92	0.99 A / 1.683 A	0.98
A1	Linear Fluorescent	FP54/835/HO	54 W	2	GEB 95 Ballast	120 V	120 W	0.92	0.99 A / 1.683 A	0.98
BX	Linear Fluorescent	FP54/835/HO	54 W	2	Electronic	277 V	120 W	0.92	0.99 A / 1.683 A	0.98
C	Linear Fluorescent	FO32/835	32 W	2	Electronic	120 V	72 W	0.87	.23 A / .368 A	0.98
D	Linear Fluorescent	FP54/835/HO	54 W	1	Electronic	120 V	120 W	0.92	0.99 A / 1.683 A	0.98
F	Linear Fluorescent	FP14/835/HO	14 W	2	Electronic Step Dimming	120 V	32 W	1.28	.16 A / .24 A	0.98
G	Linear Fluorescent	FP24/835/HO	24 W	2	Electronic	120 V	56 W	0.96	.21 A / .34 A	0.98
H	Compact Fluorescent	CF26DT/E/835	26 W	2	Electronic	120 V	58 W	0.98	.10 A / .15 A	0.98

H2	Compact Fluorescent	CF26DT/E/835	26 W	2	High-Lume Electronic Dimming Ballast	120 V	58 W	0.98	.10 A / .15 A	0.98
H3	Compact Fluorescent	CF42DT/E/835	42 W	1	Electronic Dimming Ballast	277 V	47 W	0.98	.17A / .289 A	0.98
H4	Compact Fluorescent	CF26DT/E/835	26 W	1	Electronic	120 V	58 W	0.98	.10 A / .15 A	0.98
H5	Compact Fluorescent	CF26DT/E/836	26 W	1	Electronic Dimming Ballast	277 V	58 W	0.98	.10 A / .15 A	0.98
H6	Compact Fluorescent	CF42DT/E/835	42 W	1	Electronic	277 V	47 W	0.98	.17A / .289 A	0.98
H7	Compact Fluorescent	CF13DD/E/835	13 W	2	Electronic	277 V	30 W	1	.11 A / .165 A	0.98
K1	Fluorescent	FO32/835	32W	2	Electronic	277 V	72 W	0.87	.23 A / .368 A	0.98
K2	Fluorescent	FO32/835	32W	4	Electronic	277 V	72 W	0.87	.23 A / .368 A	0.98
L	Compact Fluorescent	CF26DT/E/835	26W	2	Electronic	277 V	58 W	0.98	.10 A / .15 A	0.98
M	Compact Fluorescent	CF32DT/E/IN/835	32W	2	Electronic	120 V	63 W	1.51	.23 A / .368 A	0.98
N1	Fluorescent	F27BX/SPX/RS	27W	2	Electronic	277 V	58 W	0.98	.10 A / .15 A	0.98
N2	Fluorescent	F27BX/SPX/RS	27W	2	Electronic	277 V	58 W	0.98	.10 A / .15 A	0.98
N3	Fluorescent	F14T5/835	14W	2	Electronic	277 V	32 W	1.28	.16 A / .24 A	0.98

V	Metal Halide	150W MH	150 W	1	Electronic	277 V	186 W	1	.70 A / .77 A	0.98
W	Compact Fluorescent	CF13DD/E/835	13W	2	Electronic	277 V	28 W	0.98	.16 A / .24 A	0.98
P1	Compact Fluorescent	CF42DT/E/835	42 W	8	Electronic	277 V	86 W	0.98	.17A / .289 A	0.98
P2	Compact Fluorescent	CF42DT/E/835	42 W	6	Electronic	277 V	86 W	0.98	.17A / .289 A	0.98
P3	Compact Fluorescent	CF42DT/E/835	42 W	4	Electronic	277 V	47 W	0.98	.17A / .289 A	0.98
U	Fluorescent	FO32/835	32 W	2	Electronic	277 V	72 W	0.87	.23 A / .368 A	0.98
DD	Compact Fluorescent	CF42DT/E/IN/835	42 W	1	Electronic	277 V	47 W	0.98	.17A / .289 A	0.98
EE	Metal Halide	50W MH	50 W	1	Electronic	120 V	112 W	1	.58 A / 1.86 A	0.98
FF	Metal Halide	M175/MED	175 W	1	Electronic	277 V	210 W	1	.96 A / 1.2 A	0.98
GG	Metal Halide	M100/U/MED	100 W	1	Electronic	277 V	110 W	1	2.8 A / 3 A	0.98
P A	Metal Halide	400W MH	400 W	1	Electronic	277 V	431 W	1	2.5 A /2.23 A	0.98
P B	Metal Halide	175W MH	175 W	1	Electronic	277 V	186 W	1	.96 A / 1.2 A	0.98
UC	Fluorescent	FO32/835	32 W	1	Electronic	277 V	38 W	0.87	.15 A / .22 A	0.98
UC 1	Fluorescent	FO25/835	25 W	1	Electronic	277 V	28 W	0.9	.10 A / .15 A	0.98
X	LED Exit Sign	Integral LED	Unknown	Integral LED	Unknown	Unknown	Unknown	Unknown	Unknown	0.98

Lighting Control

ASHRAE 90.1 states that the building is required to have an automatic control device to shut off the interior lighting when the space is not in use. The City of Green Administration Building does not meet any of the exceptions. The entire lighting system is controlled with a digital communication system capable of manipulating light levels of each lighting zone separately. The system automatically turns off all non-emergency lighting at a time after the building is closed. This can be overridden or changed by the control software.

Mechanical and Other Loads

The building is served by numerous electrically driven heat pumps located throughout the spaces. Two large heat pumps in the basement serve the main air handling unit, which is also located in the basement. The heat pumps are connected through a water loop with two pumps and two natural gas fired boilers in the basement.

The following equipment tables give data for all known mechanical, plumbing, architectural, kitchen, and other equipment throughout the spaces. They are arranged by the type of equipment, with all supporting data located in the respective horizontal row.

Mechanical and Other Loads						
Equipment Type	**Drawing #**	**Voltage / Phase**	**Power**	**Assumed PF**	**Equivalent Load (kVA)**	**Quantity**
Heat Pump	HP-1	208 V /1 Phase	4.5 FLA	0.95	.89 kVA	7
Heat Pump	HP-2	208 V /1 Phase	6.5 FLA	0.95	1.28 kVA	6
Heat Pump	HP-3	208 V /1 Phase	5.7 FLA	0.95	1.13 kVA	9
Heat Pump	HP-4	208 V /1 Phase	6.1 FLA	0.95	1.21 kVA	6
Heat Pump	HP-5	208 V /1 Phase	10.7 FLA	0.95	2.15 kVA	10
Heat Pump	HP-6	208 V / 3 Phase	9.3 FLA	0.95	1.84 kVA	7
Heat Pump	HP-7	208 V / 3 Phase	13.5 FLA	0.95	2.67 kVA	2
Heat Pump	HP-8	208 V / 3 Phase	13.7 FLA	0.95	2.71 kVA	3
Heat Pump	HP-9	208 V / 3 Phase	14.7 FLA	0.95	2.90 kVA	5
Heat Pump	HP-10	208 V / 3 Phase	19.4 FLA	0.95	3.83 kVA	4

Heat Pump	HP-11	208 V / 3 Phase	25.4 FLA	0.95	5.02 kVA	6
Heat Pump	HP-12 / HP-13	480 V / 3 Phase	32 FLA	0.95	14.59 kVA	2
Pump	P-1	480 V / 3 Phase	27 FLA	0.95	12.31 kVA	1
Pump	P-2	480 V / 3 Phase	27 FLA	0.95	12.31 kVA	1
Pump	P-3	480 V / 3 Phase	4.8 FLA	0.95	2.19 kVA	1
Pump	P-4	480 V / 3 Phase	4.8 FLA	0.95	2.19 kVA	1
Electric Heater	ECUH-1	480 V / 3 Phase	9.6 FLA	0.95	5 kVA	2
Electric Heater	ECUH-2	480 V / 3 Phase	13.9 FLA	0.95	8 kVA	2
Air Handling Unit Supply Fan	AHU-1	480 V / 3 Phase	21 FLA	0.95	9.57 kVA	1
Air Handling Unit Exhaust Fan	AHU-1	480 V / 3 Phase	11 FLA	0.95	5.12 kVA	1
Exhaust Fan	EF-1	480 V / 3 Phase	1/2 HP	0.95	.48 kVA	1
Exhaust Fan	EF-2	480 V / 3 Phase	1/4 HP	0.95	.24 kVA	1
Exhaust Fan	EF-3	120 V / 1 Phase	1/8 HP	0.95	.12 kVA	1
Boiler	B-1	120 V / 1 Phase	4 FLA	0.95	.46 kVA	1
Boiler	B-2	120 V / 1 Phase	4 FLA	0.95	.46 kVA	1
Water Heater	PE-1	120 V / 1 Phase	125,000 BTU Input	0.95	34.8 kVA	1
Water Heater	PE-2	120 V / 1 Phase	125,000 BTU Input	0.95	34.8 kVA	1
Pump	PE-5	120 V / 1 Phase	1/25 HP	0.95	.04 kVA	1

Pump	PE-7/9/10	208 V / 3 Phase	2 HP	0.95	1.9 kVA	3
Garbage Disposal	N/A	120 V / 1 Phase	13.8 FLA	0.95	1.57 kVA	4
Motor for Window Shades	N/A	120 V / 1 Phase	2.3 A	0.95	.26 kVA	1
Hand Dryer	N/A	120 V / 1 Phase	20 FLA	0.95	2.28 kVA	4
Fluid Cooler	FC-1	480 V / 3 Phase	20 HP	0.95	9.12 kVA	1

Mechanical Load Category Totals:

Heat Pumps = 168.31 kVA

Pumps = 34.74 kVA

Electric Heaters = 12 kVA

Fans = 15.53 kVA

Boilers = .92 kVA

Water Heaters = 69.6 kVA

Other Loads = 24.78 kVA

Service Entrance Size

Step 1: Conceptual / Schematic Phases: Load per Square Foot			
Floor Level	Area (SF)	VA / SF Used	Floor Total
Basement	19,742 SF	12 VA / SF	236,904 VA
Ground	13,997 SF	12 VA / SF	167,964 VA
2nd	13,997 SF	12 VA / SF	167,964 VA
Building Total			572,832 VA

Step 2: Design Development: NEC Loading		
Load Type	VA / SF	kVA
Lighting (100 % DF)	3.5 VA / SF	167.1 kVA
Receptacles	1 VA / SF	47.7 kVA
Mechanical Loads	N/A	325.88 kVA
Total Building		540 kVA

Step 3: Working Drawings: Actual Loading	
Panel Number	Connected Load (VA) (Lighting / Receptacles)
BLM-A	0 / 0
BLM-B	0 / 200
BLA	27600 / 0
BHA	23010 / 0
GLM-A	0 / 0
GLM-B	0 / 0
GLM-C	0 / 0
GHA	26887 / 0
GLA	0 / 21800
GLA2	0 / 1870
GLB	0 / 20700
GLC	0 / 19000
2LM-A	0 / 0
2LM-B	0 / 0
2LM-C	0 / 0
2LA	0 / 13200
2LB	0 / 11000
2LC	0 / 16800
2HA	21202 / 0
BL-TEL	0 /0
LS-1H	10861 / 0
LS-1L	500 / 0
Total L/R Load	214630 VA (214.6 kVA)
Add Mechanical	325.88 kVA
Total Building Load	540.48 kVA
25% Spare Capacity	675 kVA

Phase	Load (kVA)	Voltage System	Load (A)
Conceptual / Schematic Design	573 kVA	480/277V WYE	40,000 A
Design Development	540 kVA	480/277V WYE	40,000 A
Working Drawings	675 kVA	480/277V WYE	40,000 A

Service Entrance	Size (A)	Voltage System	Capacity (kVA)
Service Entrance 1 (Utility)	40,000 A	480/277V WYE	500 kVA
Total Actual Conditions (All)	40,000 A	480/277V WYE	500 kVA
Summary (VA / SF)	9 VA / SF		

Environmental Stewardship Design

The City of Green Administration Building does not carry a LEED rating. The lighting system is fully capable of dimming each zone, which can be used to save energy. Besides the advanced lighting control system, there are no notable green design elements.

Design Issues

Several design issues were considered when designing the building, as well as realized after and during construction. One design issue arose when the diesel emergency generator and cooling tower arrived on site, and the architect realized that they would be aesthetically displeasing if placed as is drawn on the plans. Because of this the cooling tower and generator were moved away from the front façade, farther away from the building on the West side. During construction, 3 sub pumps had to be installed in the basement because of unforeseen interference with natural springs. After construction, the owner has had issues with the lighting control system. As built the lights in the lobby will not turn off automatically as required by ASHRAE 90.1. This appears to be a user end problem relating to insufficient knowledge of the control software.

Drawings

- Single Line Diagram Drawing List
  - E400: Power Riser Diagram and Schedules
    - Power riser diagram from service entrance to building panel boards
    - Power riser feeder schedule
    - Motor starter schedule
  - E500: Electrical Details
    - Typical Single Line Diagram
      - Shows connections from GR-2400 relay panel to lighting control panels to individual lighting control of individual rooms
- Feeder Schedule
  - See PDF in Appendix
- Single Line diagram of Distribution System
  - See PDF in Appendix

Communication Systems

A digital lighting control communications system controls all luminaires through the building. The Commlink 2400 connects to an Ethernet based local area network using TCP/IP, and to one or more lighting control panel on each floor. These have a DTC-2400 control device which communicates via relays to individual switches through the building. The building has fire alarms with visual and audible sounds (horns), and is a non-addressable system. Cat-5e cabling for owner provided network equipment terminates into two data rooms.

Appendix