URBN Center & URBN Center Annex

Philadelphia, PA

Technical Report 2: Electrical Systems Report

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Option: Lighting/Electrical

Faculty Consultant: Dr. Kevin W. Houser

Submission: September 17, 2012

Executive Summary

This report provides electrical information associated with Drexel's URBN Center, home of the Antoinette Westphal College of Media Arts & Design. The electrical distribution system is broken down and analyzed. Discrepancies between electrical requirements, found in various codes and standards, and the as designed characteristics are also discussed.

Three main distribution panels, with a combined power of 2,150kVA, provide power to a calculated building load of 2,100kVA. A 500kW diesel generator is utilized to provide power to the designated emergency power systems. The lighting system effectively uses a Lutron Quantum lighting control system (EcoSystem) to efficiently control the lighting and mechanical shades within and around the URBN Center. The lighting system is primarily run on a 480/277V system as is the HVAC system. The receptacles and other special systems in the structure are provided with 120/208V system.

Overall the building is fairly standard in its electrical design, disregarding the lighting control system. The electrical system could make use of demand shifting, due to the nature of the building. However only after full analysis, can we defer that the as-built design of the electrical system isn't the best alternative for the URBN Center.

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Building Statistics

Building name

URBN Center & URBN Center Annex

Location and Site

3501 Market Street

Philadelphia, PA 19104

Building Occupant Name

URBN Center

Size

145,917 ft^2

Number of stories above grade | Total levels

4 stories above grade (Roof Level – 56 ft.) | 4 total

Primary Project Team

Owner:	Drexel University	http://www.drexel.edu/
Architect:	Meyer Scherer & Rockcastle Ltd	http://msrltd.com/
	Venturi, Scott Brown and Associates (Existing)	http://www.vsba.com/
General Contractor:	Turner	http://www.turnerconstruction.com/
MEP Firm:	PHY Inc.	http://www.phyinc.com/
Acoustical Design:	Walters-Storyk Design Group	http://www.wsdg.com/
Structural Engineer:	O'Donnel & Naccarto	http://www.o-n.com/OdonnellNaccaratohome.asp

Dates of Construction

Start: August 2011 | Finish: September 2008

Actual Cost information

$31 Million

Project Delivery Method

Design-Build

Zoning

Property Zoning | C-4; 61,913 ft^2

PART 1 | ELECTRICAL SYSTEMS CRITERIA AND SCOPE OF WORK

Utility Power Information

Utility Power Company: Peco (An Exelon Company)

Address: 3020 Market Street
Philadelphia, PA 19104

Website: https://www.peco.com/Pages/Home.aspx

Rate Schedule: Rate-PD Primary-Distribution Power

Classification: Group B (Educational occupancies for students above the 12th grade)

The utility service voltage is 13 kV or 33 kV.

Electrical Load Estimate

Ronald Dodson Average Load Estimates | Educational

ANNUAL ELECTRICAL LOAD ESTIMATE			
Type	**W/ft2**	**Area (ft2)**	**kW**
Lighting	2	132,315	260
Receptacles/Misc.	1	132,315	130
HVAC	8	132,315	1,060
Elevators	--	--	215
		Total	1,670

Energy Information Administration

ANNUAL ELECTRICAL LOAD ESTIMATE			
Type	**kWh/ft2**	**Area (ft2)**	**kWh**
Lighting	4.59	132,315	194,226
Ventilation	0.49	132,315	20,734
Cooling	1.31	132,315	55,433
Space Heating	0.49	132,315	20,734
Office Equipment	0.41	132,315	17,349
Other	0.902	132,315	38,168
		Total	1,083,924

NEC 2011 (Lighting and Receptacles Only)

Electrical Load Estimate			
Type	**W/ft2**	**Area (ft2)**	**kW**
Lighting	3	132,315	396
Receptacles	1	132,315	132
		Total	529

Emergency Power Requirements

Emergency power shall be supplied to the following:

- Standby Power Generators
- Smoke Control Systems
- Exit Signs
- Means of Egress Illumination
- Elevators that are part of accessible means of egress
- Standby Power for Elevators
- Smoke proof Enclosures

IBC emergency and standby power requirements can be found in appendix b.

Special Occupancy

This building will most likely require no special occupancy characteristics.

Special Equipment

- Elevators
- Freight Elevator
- Audio Amplifier/Audio Preamplifier
- Audio Signal Processing Equipment
- Equipment Racks
- Loudspeakers/Powered Louder Speakers
- Switchers
- Information Technology Equipment
    - Information Technology Equipment (ITE)
    - Critical Operations Data Systems
    - Information Technology Equipment Room
    - Remote Disconnect Control
    - Zone
- Fire Pumps
    - On-Site Standby Generator
    - Continuity of Power

- Fire Pump Controller
- IBC fire alarm system requirements can be found in appendix c.

Priority Assessment

Reliability: High

Power Quality: Med

Redundancy: Med

Initial Cost: High

Long Term Ownership Cost: Med

Flexibility: Med

Back-up Power

Long Term

- Smoke Evacuation Fans
- Roof Top Air Handling Units
- Fire Pump Controller
- Emergency Lighting
- Security Systems

Short Term

- I.T. Servers

Special/Communication Systems

- Audio Recording/Remastering Systems
- Telecom Systems
- Video Conference Systems
- Audio Systems
- Projection Screens
- Telephone Systems
- Data Systems
- Fire Alarm System (IBC requirements to follow)
- Wireless Data Systems (Wifi)

Building Services

- Telephone
- Data
- CATV

Major Electrical Equipment

- Transformer
- Switchgear
- Switchboard
- Servers
- Emergency Generator
- Battery Bank
- Bus Bank
- Distribution Panels

PART 2 | ELECTRICAL SYSTEMS AS CURRENTLY DESIGNED

Utility Power Information

Utility Power Company: Peco (An Exelon Company)

Address: 3020 Market Street
Philadelphia, PA 19104

Website: https://www.peco.com/Pages/Home.aspx

Rate Schedule: Rate-PD Primary-Distribution Power

RATE SCHEDULE - PD	
Charge Type	**Charge**
Fixed Distribution Charge	$295.15
Variable distribution Charge	$4.68 per kW of billing demand $0.32 per kWh for all kwh
Energy Efficiency Charge	$0.91 per kW of Peak Load Contribution

IBC Classification: Group B (Educational occupancies for students above the 12th grade)

The utility service voltage is 13.2 kV and the primary utilization voltage is 480/277V. The lighting and mechanical systems are primarily powered by a 480/277 voltage system. All lighting fixtures are powered through this 277 volt system except for low voltage LED fixtures located on stairwell handrails and other various places.

Electrical Load Calculation

LOAD CALCULATION	
End Use	**kW**
Lighting	180
Receptacle/Room Power	290
HVAC	1,040
Elevators	254
Total	1,770

Load Calculation	
End Use	**kVA**
Lighting	200
Receptacle/Room Power	580
HVAC	1,040
Elevators	300
Total	2,119

Emergency Power Requirements

Emergency power is supplied to the following:

- Standby Power Generators
- Smoke Control Systems
  - 4 Smoke Evacuation Fans
- Exit Signs
- Means of Egress Illumination
- Elevators that are part of accessible means of egress
  - 4 Elevators
- Standby Power for Elevators
- Smoke proof Enclosures
- Roof Top Air Handling Units (4 @ 480V 3P)
- Fire Pump Controller with Integral Transfer Switch
- Computer Room Air Conditioning Units
- Dry cooler (Outside Units)
- Information Technology Systems

IBC emergency and standby power system requirements can be found in appendix b

URBN Center Applicable Codes and Standards

- Regulations of State of Pennsylvania
- Regulations of City of Philadelphia
- B.O.C.A.
- National Fire Protection Association (NFPA) #110
- National Electrical Code – latest edition
- Underwriters' Laboratories, Inc.
- National Electrical Manufacturers Association

Emergency Load Calculation

Emergency Load Calculation	
End Use	**kVA**
Lighting	31,360
Receptacle/Room Power	40,285
HVAC	537,773
Total	609,419

Emergency Generator

- 500kW/625kVA, 480/277V Emergency Diesel Generator
- Located on metal frame outside of the URBN Center Annex (3401 Filbert Street)

The emergency power system in the URBN Center is powered by a 500 kilowatt diesel generator located outside of the URBN Center Annex across the street on a metal frame. The frame is quiet site II level II sound attenuated walk-in enclosure with a sub base tank. The emergency power is distributed through 4 main feeds, each utilizing their own individual automatic transfer switch.

IBC Emergency Power Requirements can be found in appendix c.

Special Occupancy

This building has no special occupancies.

Special Equipment

- Elevators
- Freight Elevator
- Musical Instrument Digital Interface (MIDI) Systems
  - Audio Amplifier/Audio Preamplifier
- Audio Signal Processing Equipment
- Equipment Racks
- Loudspeakers/Powered Louder Speakers
- Mixers
- Switchers
- Information Technology Equipment
  - Information Technology Equipment (ITE)
  - Critical Operations Data Systems
  - Information Technology Equipment Room
  - Remote Disconnect Control
  - Zone
- Fire Pumps
  - On-Site Standby Generator

- Continuity of Power
- Fire Pump Controller

Back-up Power

Long Term

- Smoke Evacuation Fans
- Roof Top Air Handling Units
- Fire Pump Controller
- Emergency Lighting
- Security Systems

These loads are connected to the back-up generator.

Short Term

- I.T. Servers

This load is connected to both the back-up generator and the UPS.

Special/Communication Systems

- Musical Instrument Digital Interface (MIDI) systems
- Telecom Systems
- Video Conference Systems
  - Speaker Systems
- Projection Screens
- Telephone Systems
- CAT5
- Data Systems
- Fire Alarm System (IBC requirements to follow)
  - See Appendix B for IBC requirements
- Wireless Data Systems (Wifi)
- Lighting Control Systems
  - Occupancy Sensors
  - Vacancy Sensors
  - Motorized Shading System (MechoShade Systems)

The URBN Center makes use of the Lutron Quantum lighting control system (EcoSystem). This system utilizes computer based software to control, configure, monitor, and alter the lighting throughout the entire building. The system collects data as well and creates statistical reports. These reports can be advantageous for the long term matinance of the building and help reduce operating costs by affectively identifying wasted energy. Many spaces throughout the building incorporate daylight harvesting techniques. Natural light makes it penetrates through the 4 story high atrium that cuts through the entire width of the building (North-South direction).

IBC fire alarm system requirements can be found in appendix c.

Space Specifications

Electrical Room

- 1,196 ft^2 – 0.90% of building's total area

Telecom/Electrical Room

- 378 ft^2 – 0.28% of building's total area

IRT Server Room

- 576 ft^2 – 0.44% of building's total area

I.T. Server Room

- 162 ft^2 – 0.12% of building's total area0

Building Services

- Telephone
- Data
- CATV
- RCA Audio (MIDI)
- VGA (MIDI)
- DVI (MIDI)

Major Electrical Equipment

- Transformer
- Switchgear
- Servers
- Emergency Generator
  - Battery Bank
- Bus Bank
- Distribution Panels
  - Panelboards

Main Service and Distribution Equipment

- Switchboard – 3P, 480/277V Single Ended
- Switchboard – 3P, 480/277V Single Ended
- Fire Pump Switchboard – 3P, 480/277V Single Ended

Main Service Equipment

- Optional Standby Distribution Panel – 3P, 480/277V Single Ended

- Emergency Distribution Panel – 3P, 120/208V Single Ended
- Legal Standby Mechanical equipment Panel – 3P, 480/277V Single Ended

Main Service Transformer

- 1500kVA Transformer – Indoor, Dry-Type, Owner Owned
- 500kVA Transformer – Indoor , Dry-Type, Owner Owned
- 150kVA Transformer – Indoor , Dry-Type, Owner Owned

Distribution Step Down Transformers

- (2) 30kVA Transformer
- (2) 75kVA Transformer
- 15kVA Transformer

Panelboards

- MLO, Mix of Plug-in and Bolt-in, Copper

Main Risers and Feeders

- Trench Duct Feeder Systems

Conductors/Sables

- 98% Copper
- Armored Cable – Type AC
- Metal cable – Type MC

Conduit

- Intermediate Metal conduit (IMC)
  - Hot-dip galvanized steel with zinc-coated threads, UL listed
- Electrical Metallic Tubing (EMT)
- Schedule 40 polyvinylchloride
- Flexible Metal Conduit
- Flexible Non-metallic Tubing (ENT)

Receptacles

- Flush Type
- Monument Type
- Gang Type
- Hinge-type cover (Meeting and Assembly Rooms)

Switch and Receptacle Faceplates

- Push Type (Switches)
- Sierra WP-1, and WP-2 (Switches)

- Sierra WPH-8 (Receptacles)
- Finish Type 302 Stainless Steel
  - Emergency Power – Red
  - Isolated Ground - Orange

Priority Assessment

Reliability: High

Power Quality: Med

Redundancy: Med

Initial Cost: High

Long Term Ownership Cost: Med

Flexibility: High

Single Line Diagram

Single Line Diagram – see appendix A

Energy Efficiency

The URBN Centers biggest contribution to energy efficiency is the Lighting/shading control system. The building makes use of the Lutron Quantum Lighting Control System (EcoSystem). See Special/communication Systems for full explanation of the Ecosystem. Besides this lighting/shading control system the building does not take advantage of any alternate fuel/energy systems or demand reduction strategies. The URBN Center is not LEED certified.

PART 3 | ELECTRICAL SYSTEMS EVALUATION

Estimated Load vs Actual Connected Load

Estimated Load

ANNUAL ELECTRICAL LOAD ESTIMATE			
Type	**W/ft2**	**Area (ft2)**	**kW**
Lighting	2	132,315	260
Receptacles/Misc.	1	132,315	130
HVAC	8	132,315	1,060
Elevators	--	--	215
		Total	1,670

Actual Connected Load

LOAD CALCULATION	
End Use	**kW**
Lighting	180
Receptacle/Room Power	290
HVAC	1,040
Elevators	254
Total	1,770

The estimated load turned out to be quite accurate in ordinance with the actual connected load. The estimated load came up a little short. The URBN Center makes use of T5 fluorescent lamps in the lighting system which accounts for the discrepancy in the lighting calculation. T5 fluorescent lamps are very efficient. The actual load will continue to drop due to the integration of the Lutron Lighting Control System (EcoSystem). The building has a large amount of special computer labs as well as special digital music reproduction studios. This contributes to the heft receptacle load.

Power Rate Schedule

Due to the previous service to the existing building the building did not have much of a choice in terms of electrical tariffs. Peco electrical service provider is also a fairly easy decision because they are located right down the block.

Building Utilization Voltage

The building utilization voltage for the lighting and HVAC systems is 480/277V. This is the most effective choice there is in terms of energy efficiency. The receptacles have to be run on 208/120V systems due to their application. The URBN center does not make use of low voltage systems throughout the building,

disregarding the LED lights in the stairwells. Incorporating more low voltage LED lighting systems could reduce energy cost as well as maintenance cost.

Major Electrical Equipment

The major electrical equipment used in the URBN Center is for the most part quite standard.

Back-up and Standby Power

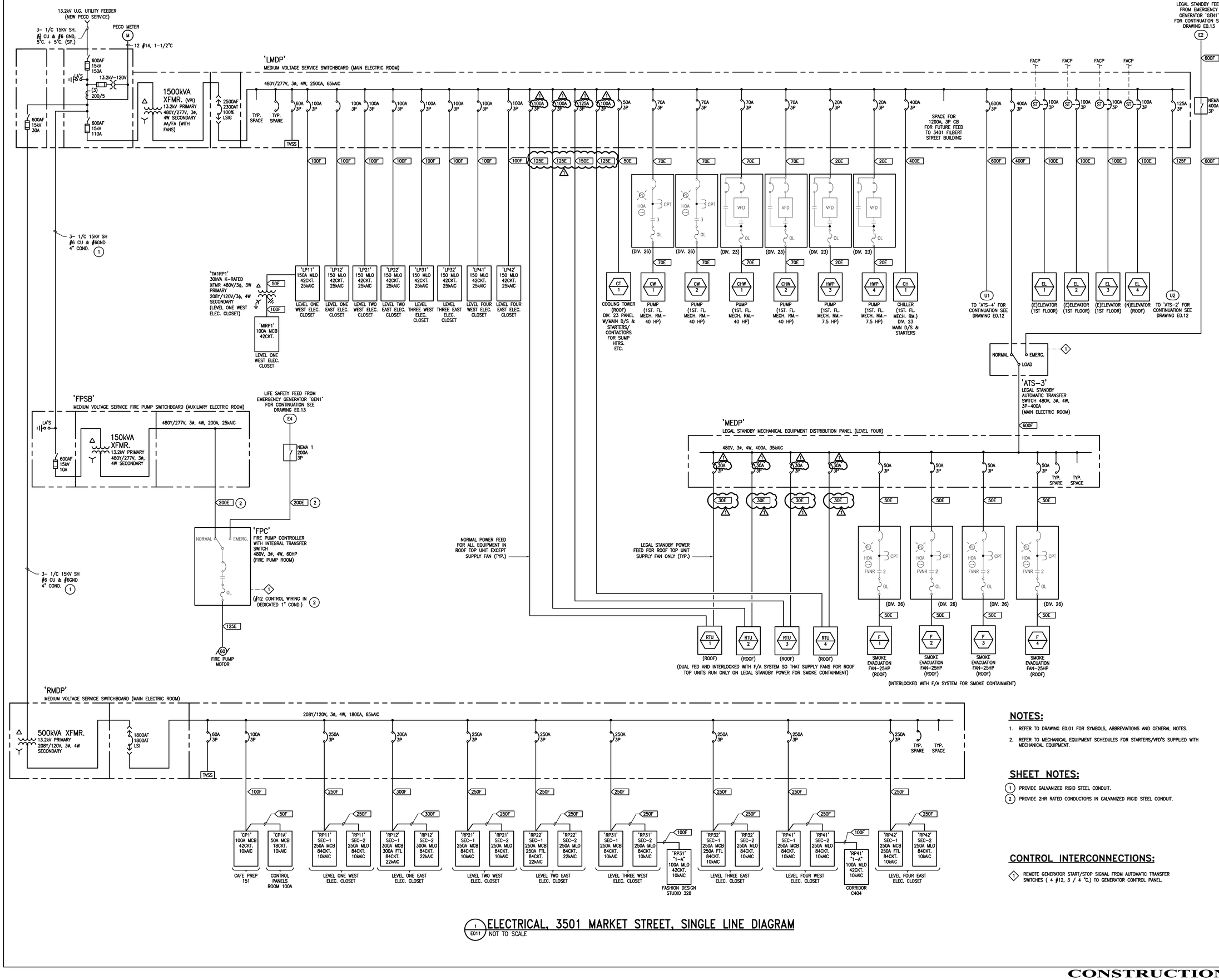
A UPS system was not described in the construction documents. Drexel University's ITS department is responsible for providing the UPS. The emergency backup generator is robust enough to handle the connected emergency loads.

Systems Integration Possibilities

Although the lighting system makes use of occupancy and vacancy sensors, I would suggest that photo sensors could be integrated into the lighting design. Photo sensors in combination with dimming ballast in daylight applicable spaces could be utilized to save energy and reduce the monthly electric bill. This type of systems offers a fairly fast payback period. Due to the weather in Philadelphia the system would have to very carefully calibrate to each specific space.

Additional Energy Cost Savings Techniques

Because this building is an educational building a very specific schedule will soon become apparent and the use of demand shifting could be incorporated into the electrical controls. This would first require equipment that can effectively monitor where energy is be utilized throughout the day in specific place. Lucid offers a system called the building dashboard which can be used with square d metering equipment. The combination of these two resources could help to delineate where energy is wasted in the building. The dashboard also offers networking capabilities where buildings throughout the campus can compete in energy savings. The incentive of competition encourages students and faculty to use less energy.



NOTES:

1. REFER TO DRAWING E0.01 FOR SYMBOLS, ABBREVIATIONS AND GENERAL NOTES.
2. REFER TO MECHANICAL EQUIPMENT SCHEDULES FOR STARTERS/VFD'S SUPPLIED WITH MECHANICAL EQUIPMENT.

SHEET NOTES:

(1) PROVIDE GALVANIZED RIGID STEEL CONDUIT.
(2) PROVIDE 2HR RATED CONDUCTORS IN GALVANIZED RIGID STEEL CONDUIT.

CONTROL INTERCONNECTIONS:

(1) REMOTE GENERATOR START/STOP SIGNAL FROM AUTOMATIC TRANSFER SWITCHES (4 #12, 3 / 4 "C.) TO GENERATOR CONTROL PANEL.

1 E011 ELECTRICAL, 3501 MARKET STREET, SINGLE LINE DIAGRAM
NOT TO SCALE

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URBN CENTER

3501 MARKET STREET
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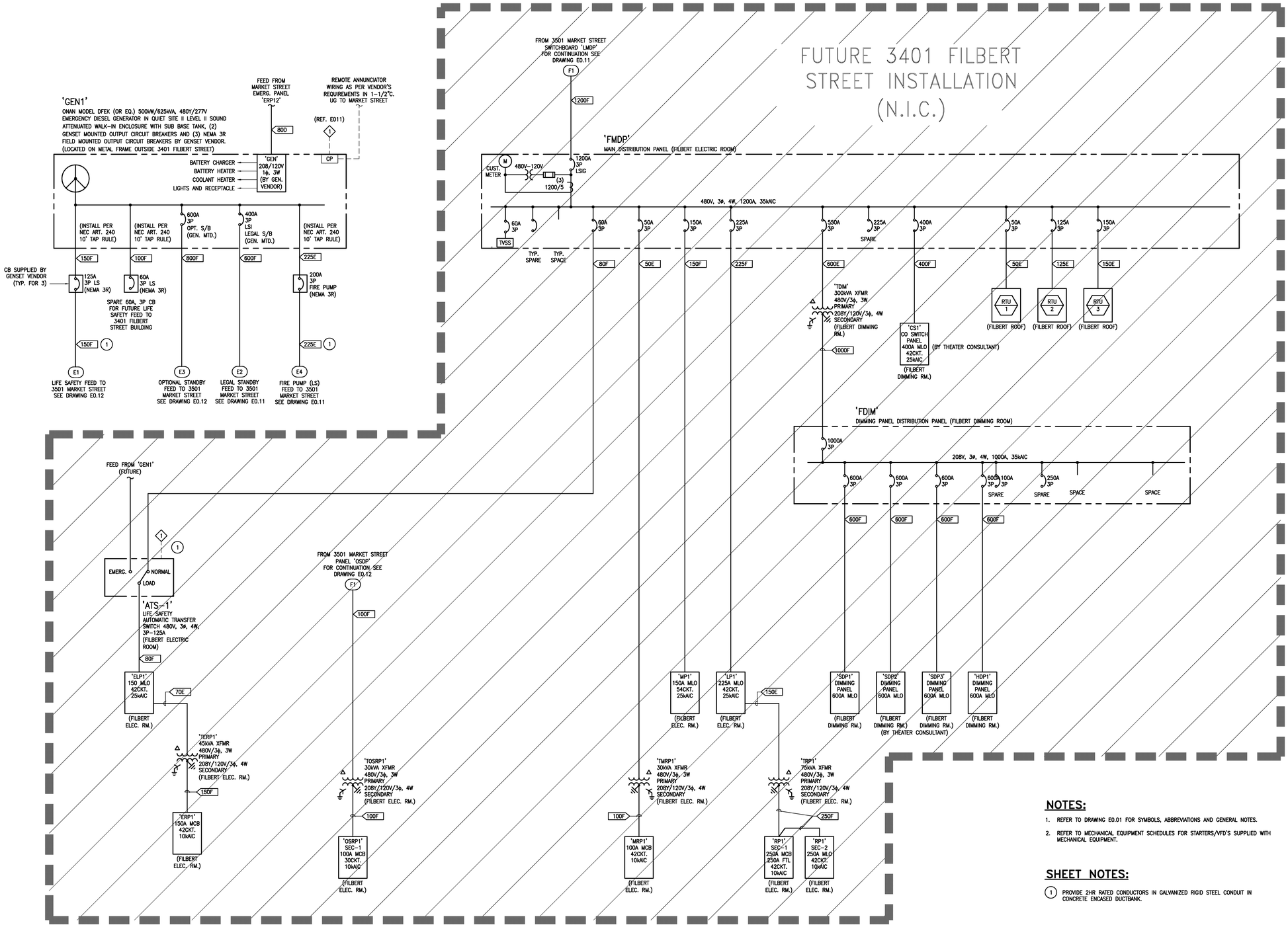
ISSUE / DATE		
1	08.29.2011	ADDENDUM #4 TO BID ISSUE
	08.01.2011	ISSUE FOR BID
MARK	DATE	DESCRIPTION

MSR PROJECT NO. 2009029
PHY PROJECT NO. 1210401
PROJECT PHASE: Construction Documents
DRAWN BY: JRT
CHECKED BY: PAC

ELECTRICAL
3501 MARKET ST.
SINGLE LINE DIAGRAM

E011

CONSTRUCTION DOCUMENTS



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(1) PROVIDE 2HR RATED CONDUCTORS IN GALVANIZED RIGID STEEL CONDUIT IN CONCRETE ENCASED DUCTBANK.

1 / E013 ELECTRICAL, 3501 MARKET STREET, SINGLE LINE DIAGRAM
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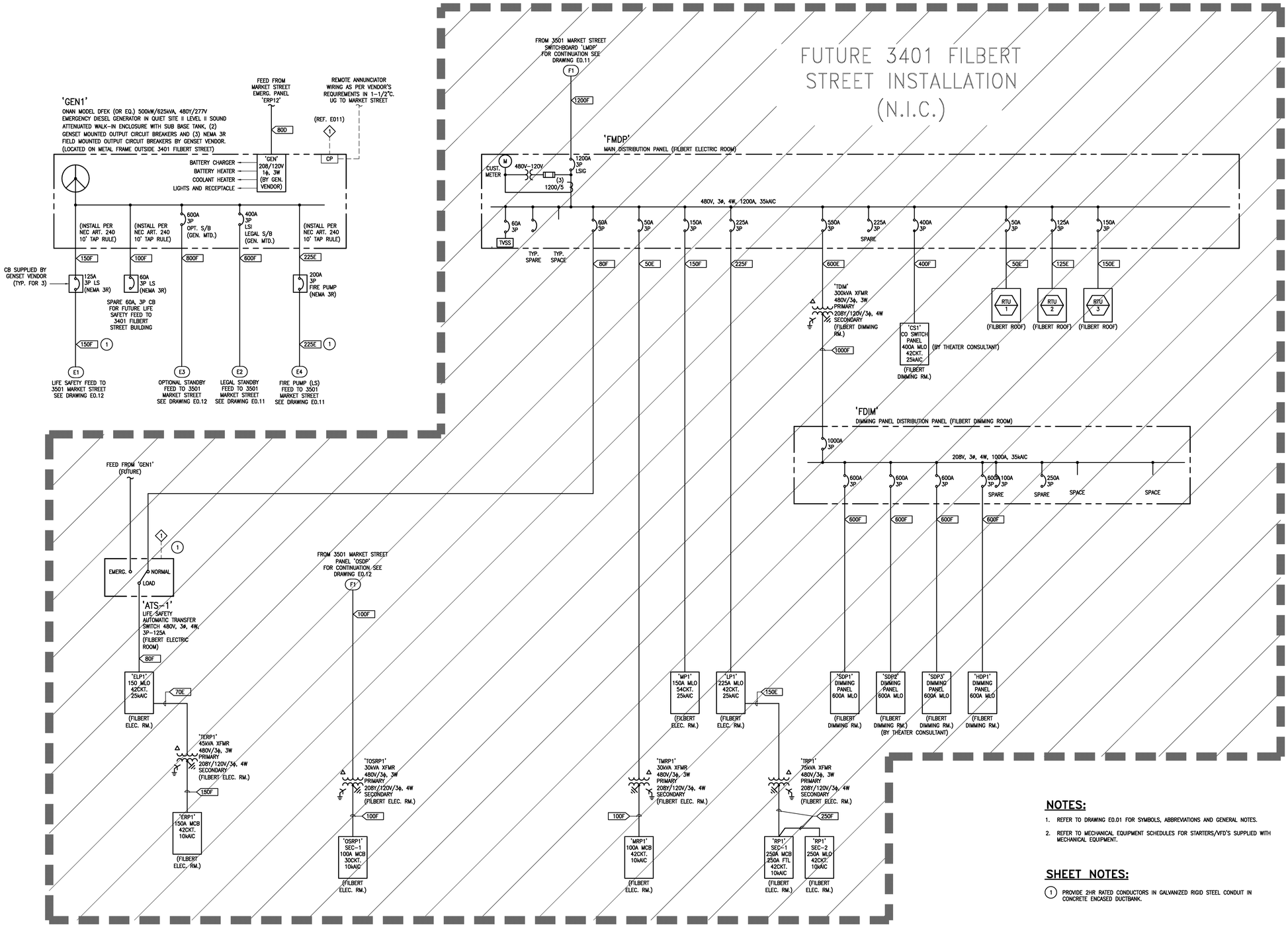
3501 MARKET ST.
SINGLE LINE DIAGRAM

E013

CONSTRUCTION DOCUMENTS



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ELECTRICAL
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SINGLE LINE DIAGRAM

E013

CONSTRUCTION DOCUMENTS

Appendix B

IBC Emergency and Standby Power System Requirements

- Emergency and standby power systems required by this code or the International Fire Code shall be installed in accordance with this code, NFPA 110 and 111.
- Emergency and standby power systems shall be maintained and tested in accordance with the International Fire Code.
- Standby power for elevators shall be provided
- Standby power shall be provided for smoke proof enclosures
- Standby power shall be provided for elevators that are part of an accessible means of egress
- Emergency power shall be provided for means of egress illumination
- Emergency power shall be provided for exit signs
- Standby power shall be provided for smoke control systems

APPENDIX C

IBC Fire Alarm System Requirements

- Where required: A manual fire alarm system shall be installed in Group B occupancies having an occupant load of 500 or more persons or more than 100 persons above or below the lowest level of exit discharge.
- The primary and secondary power supplies for the fire alarm system shall be provided in accordance with NFPA 72.
- Wiring shall comply with the requirements of the ICC Electrical Code and NFPA 72. Wireless protection systems utilizing radio-frequency transmitting devices shall comply with the special requirements for supervision of low-power wireless systems in NFPA 72.
- Where an alarm notification system is required by another section of this code, it shall be activated by:

    1. A required automatic fire alarm system.
    2. Sprinkler water-flow devices.
    3. Required manual fire alarm boxes.

- Presignal systems shall not be installed unless approved by the fire code official and the fire department. Where a presignal system is installed, 24-hour personnel supervision shall be provided at a location approved by the fire department, in order that the alarm signal can be actuated in the event of fire or other emergency.
- Each floor shall be zoned separately and a zone shall not exceed 22,500 square feet (2090 m2). The length of any zone shall not exceed 300 feet (91 440 mm) in any direction.
- Alarm notification appliances shall be provided and shall be listed for their purpose.
- Automatic fire detectors utilized for the purpose of performing fire safety functions shall be connected to the building's fire alarm control panel where a fire alarm system is required by Section 907.2. Detectors shall, upon actuation, perform the intended function and activate the alarm notification appliances or a visible and audible supervisory signal at a constantly attended location. In buildings not required to be equipped with a fire alarm system, the automatic fire detector shall be powered by normal electrical service and, upon actuation, perform the intended function. The detectors shall be located in accordance with NFPA 72.
- Duct smoke detectors shall be connected to the building's fire alarm control panel when a fire alarm system is provided. Activation of a duct smoke detector shall initiate a visible and audible supervisory signal at a constantly attended location. Duct smoke detectors shall not be used as a substitute for required open-area detection.
- Access shall be provided to each detector for periodic inspection, maintenance and testing.
- Automatic fire-extinguishing systems shall be connected to the building fire alarm system where a fire alarm system is required by another section of this code or is otherwise installed.
- Fire alarm systems required by this chapter or the International Fire Code shall be monitored by an approved supervising station in accordance with NFPA 72.

- Automatic telephone-dialing devices used to transmit an emergency alarm shall not be connected to any fire department telephone number unless approved by the fire chief.
- Upon completion of the installation of the fire alarm system, alarm notification appliances and circuits, alarm-initiating devices and circuits, supervisory-signal initiating devices and circuits, signaling line circuits, and primary and secondary power supplies shall be tested in accordance with NFPA 72.
- A record of completion in accordance with NFPA 72 verifying that the system has been installed in accordance with the approved plans and specifications shall be provided.
- Operating, testing and maintenance instructions, and record drawings (“as builts”) and equipment specifications shall be provided at an approved location.
- The maintenance and testing schedules and procedures for fire alarm and fire detection systems shall be in accordance with the International Fire Code.

REFERENCES

1. "Access Our Website When You're On-the-go." *PECO*. N.p., n.d. Web. 12 Oct. 2012. <https://www.peco.com/>.
2. *International Building Code.* Falls Church, VA: International Code Council, 2006. Print.
3. *NEC: 2011.* Quincy, MA: National Fire Protection Association, 2010. Print.