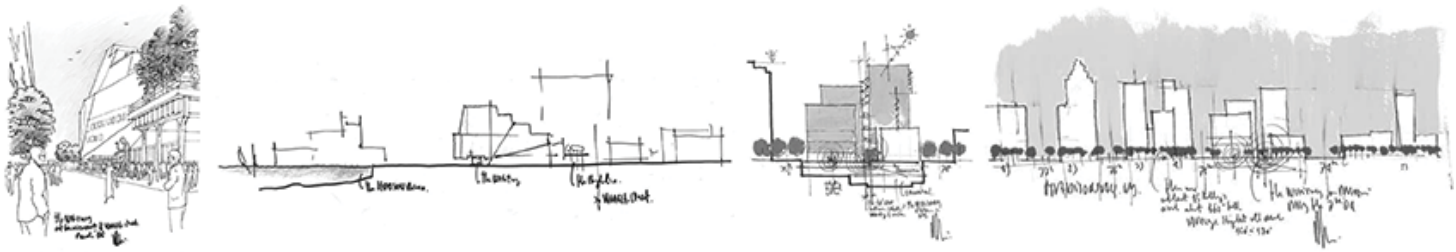
Chang Liu | Lighting + Electrical
M.A.E./B.A.E. Integrated Degree

Technical Assignment 2 | October 12, 2012
Faculty Consultants: Ron Dodson

Renzo Museum of American Art
New York, NY



Executive Summary

This report provides an analysis of the electrical systems of Houston Museum of American Art. Analysis includes developing the electrical systems criteria and scope of work, presenting the currently designed electrical system, as well as evaluation and suggestions for potential changes. Load calculation was performed. Information regarding IBC, NEC code requirement, currently-designed electrical systems was investigated.

Overall, the museum of American Art utilizes an integrated building system. The control system for the building equipment operates using BMS via BACnet. The current electrical design is appropriate. In the attempt to achieve LEED gold, well-thought technology and equipment choice are used for the electrical system such as cogeneration to help with energy reduction.

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Part 1 Develop the Electrical Systems Criteria and Scope of work

Preliminary electrical load calculation

To estimate the preliminary electrical load, following assumptions are made:

Lighting: 1.1 W/SF (ASHREA 90.1)
Receptacles: 1.0 W/SF
HVAC: 4.5 W/SF
Others: 1.0 W/SF

Demand factors are listed as following:

Lighting: 125%
Receptacles: first 10kVA 100%, rest 50%
HVAC and others: 100%

Based on the assumptions made and demand factor, the preliminary total building kVA are listed as following:

Lighting: 245 kVA
Receptacles: 116 kVA
HVAC: 1,000 kVA
Others: 222 kVA

Power company and preliminary rate schedule

The museum of American Art shall have a secondary service from the utility company. Con Edison is the main power company that supplies power for New York.

Preliminary building utilization voltage

The building utilization voltage should be 480Y/277V, with lighting 277V, receptacle 120V, HVAC 208V/480V, and special equipment including elevators 208V, 3 phase, audio signal processing 120 V, information technology 120V.

Emergency power requirements

The emergency power for the museum of American Art (A-3 occupancy) should be provided by a diesel generator at 480/277V.

Based on IBC, emergency power shall be designed and constructed as indicated below:

2702.2.1 Group A occupancies.
Emergency power shall be provided for emergency voice/alarm communication systems in Group A occupancies in accordance with Section 907.5.2.2.4.

2702.2.2 Smoke control systems.
Standby power shall be provided for smoke control systems in accordance with Section 909.11.

2702.2.3 Exit signs.
Emergency power shall be provided for exit signs in accordance with Section 1011.5.3.

2702.2.4 Means of egress illumination.
Emergency power shall be provided for means of egress illumination in accordance with Section 1006.3.

2702.2.5 Accessible means of egress elevators.
Standby power shall be provided for elevators that are part of an accessible means of egress in accordance with Section 1007.4.

2702.2.6 Accessible means of egress platform lifts.
Standby power in accordance with this section or ASME A 18.1 shall be provided for platform lifts that are part of an accessible means of egress in accordance with Section 1007.5.

2702.2.7 Horizontal sliding doors.
Standby power shall be provided for horizontal sliding doors in accordance with Section 1008.1.4.3.

2702.2.19 Elevators.
Standby power for elevators shall be provided as set forth in Sections 3003.1, 3007.7 and 3008.15.

2702.2.20 Smokeproof enclosures.
Standby power shall be provided for smokeproof enclosures as required by Section 909.20.6.2.

Special occupancy requirements

Based on NEC 2011 chapter 5, special occupancy requirements may be needed for [520] Theaters

for the theater located on the 3rd floor.

Special equipment

Based on NEC 2011 chapter 6, a list of potential special equipment is listed below:
[620] Elevators
[640] Audio signal processing
[645] Information technology equipment
[695] Fire pumps

Priority assessment

Reliability - Medium
Power Quality - Low
Redundancy - Medium
Initial Cost (low initial cost) - Low
Long Term Ownership Cost - Medium
Flexibility - High

Optional back-up power

Loads may desire optional back-up power for the project can be the lighting for the mechanical rooms.

Special/communications systems

Potential special/communications systems for the building are listed below:
Telephone/data
Fire Alarm
CATV
Overhead Paging/intercom
Access control
Security – Intrusion Detection, Video Surveillance

> *Fire Alarm IBC requirement:*
> A manual fire alarm system that activates the occupant notification system in accordance with Section 907.5 shall be installed in Group A occupancies having an occupant load of 300

or more. Portions of Group E occupancies occupied for assembly purposes shall be provided with a fire alarm system as required for the Group E occupancy. Manual fire alarm boxes are not required where the building is equipped throughout with an automatic sprinkler system installed in accordance with Section 903.3.1.1 and the occupant notification appliances will activate throughout the notification zones upon sprinkler waterflow.

Activation of the fire alarm in Group A occupancies with an occupant load of 1,000 or more shall initiate a signal using an emergency voice/alarm communications system in accordance with Section 907.5.2.2. Where approved, the prerecorded announcement is allowed to be manually deactivated for a period of time, not to exceed 3 minutes, for the sole purpose of allowing a live voice announcement from an approved, constantly attended location.

Other building services

Other building services may be required are listed below:
Telephone
Data
CATV

Major equipment

Potential major equipment that should be used includes switchgear, main transformer and step-down transformers, generator (if indoor), ATS, distribution panelboards.

Part 2 Understand and Describe the Electrical Systems as Currently Designed

Actual connected building load

The actual connected building loads were calculated and summarized in the following tables:

Table 1 Connected building loads

Connected Building Loads (KVA)	
Lighting	179
Receptacle	310
HVAC	1,234
Special Equipment	276
Total loads	1,999

Table 2 Connected loads for special equipment

Connected Loads Special Equipment (KVA)	
BMS	8
Dock Leveler	25
Pavement & Gutter snow melting	70
Kitchen appliance	127
Shade controller	4
UV sterilizer	4
Mechanical Tools	38

Power company and rate schedule

The utility company for the project is the Consolidated Edison Company of New York. The service is feed to the switchgears located on the cellar level. The secondary service voltage is 208Y/120V. Information about the rate schedule and primary service voltage were requested from the building owner. Figure 1 and 2 shows the service entrance detail.

Figure 1 Cellar electrical room enlarged plan

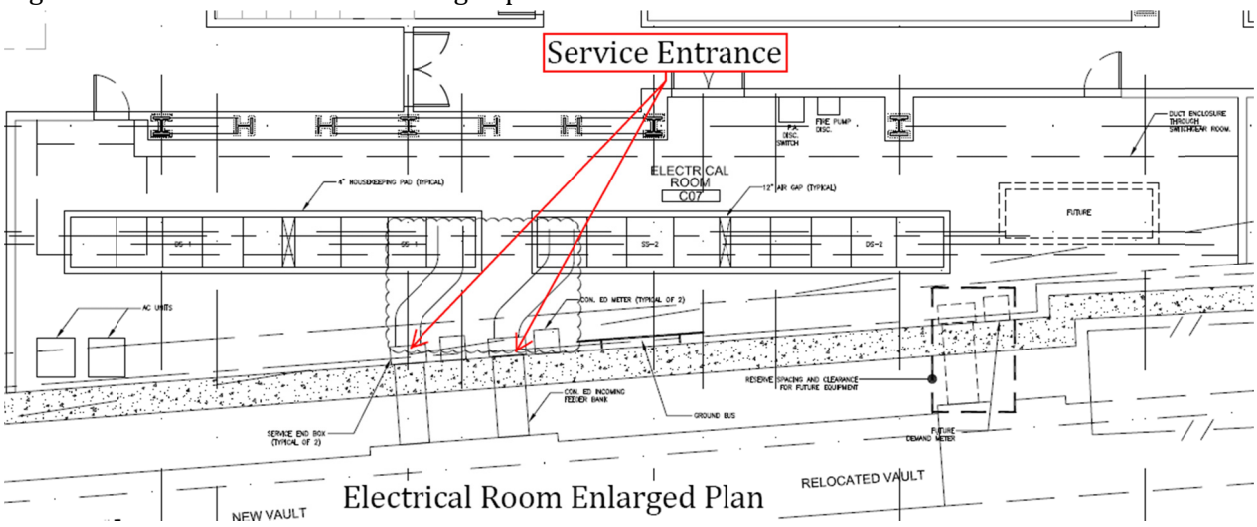
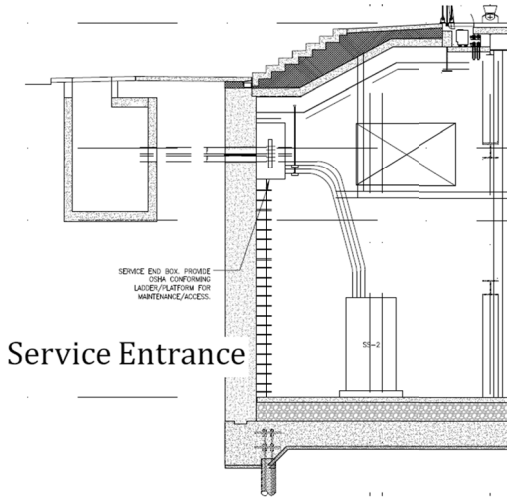


Figure 2 Service entrance detail



Building utilization voltage

The electrical service

a. Lighting – 120 V
b. Receptacle – 120 V
c. Mechanical
    - Air conditioning unit – 208 V, 3 phase
    - Hot water boiler – 208 V, 3 phase
    - Fan coil unit – 115 V, 1 phase
    - Exhaust and ventilation fan – 208 V, 3 phase & 120 V, 1 phase
    - Pumps – 208 V, 3 phase
    - Expansion tanks/ make-up pump – 208 V, 3 phase

d. Elevator – 208 V, 3 phase
e. Hydraulic Levelers – 208 V, 3 phase

Emergency power system loads

A 750KW No.2 fuel oil generator located on the second floor is used to feed the emergency service switchboard ESS, and then branches off to the emergency distribution switchboards. In case of emergency, automatic transfer switch will allow emergency switchboards and panelboards powered by the generator power. The power from the generator is used to feed loads such as emergency lighting, fire suppression system, etc. Because of the time delay of the generator, the UPS distribution system is used to feed loads such as IDF rack j-box, control room workstation, etc. Figure 3 and 4 shows the load details for the emergency power system. A summary of emergency power devices are listed below:

1 emergency service switchboards: 208/120V - 3phase - 4 wires – 65,000 AIC
ESS
2 emergency distribution switchboards: 208/120V - 3phase - 4 wires –100,000 AIC
EDS-2-EM-A, EDS-2-EM-B
4 emergency distribution panelboards: 208/120V - 3phase - 4 wires – 65,000 AIC
EDP-C-A, EDP-C-B, EDP-C-K, EDP-9
1 optional emergency distribution panelboard: 208/120V-3phase - 4 wires – 22,000 AIC
EODP-C

Figure 3 Emergency power load details

LOAD DESCRIPTION	LOAD (KVA)	Q F
MAIN	–	
EDP–C–A	104.9	
EDP–9	151.5	
EUP–LL, ELCP–LL, EUP–2	17.0	
EUP–3, EUP–4	26.0	
EPP–EL–9–A	122.2	
SPARE	–	
SPARE	–	
SPARE	–	
MAIN	–	
EDP–C–B	121.2	
EUP–2–GEN	10.0	
EUP–5, EUP–6, EUP–7, EUP–8	36.5	
EPP–C–K	106.8	
EPP–EL–9–B	138.6	
SPARE	–	
SPARE	–	
SPARE	–	
SPARE	–	

EDS-2-EM-A

EDS-2-EM-B

Figure 4 Emergency power load details cont.

LOAD DESCRIPTION	LOAD (KVA)	Q F
MAIN	–	
FOP–C1–1	2.8	
RF–C1–1	41.2	
RF–C1–3	41.2	
JOCKEY PUMP	3.9	
SP–C1–1	16.7	
SP–C1–2	16.7	
SPARE	–	
SPARE	–	
SPARE	–	
MAIN	–	
EF–C1–1	16.7	
RF–C1–5	16.7	
RF–C1–2	41.2	
RF–C1–7	11.2	
RF–C1–8	3.9	
EUP–C	39.0	
FOP–C1–2	2.8	
SPARE	–	
SPARE	–	
MAIN	–	
FIRE SUPPRES	0.5	
RF–C1–6	9.0	
RESTAURANT ELEV.	47.0	
CAB LIGHTING AND EXHAUST FAN	2.0	
FCU–C1–1	11.0	
EMR RECEPTACLES	2.0	
EM KITCHEN LIGHTING	1.5	
ELEV. PIT LIGHTING	3.0	
EUP–8–K	28.8	
FIRE SUPPRESSION SYSTEM (116)	.48	
EMERGENCY KITCHEN LIGHTING	1.5	
SPARE		
MAIN	–	
SP–R–1	16.7	
SPARE	–	
SPARE	–	
RF–9–1	21.4	
EF–R–1	10.6	
SP–9–1	21.5	
SPARE	–	
SPARE	–	
SPARE	–	
SPARE	–	
SPARE	–	
EF–R–2	1	
EUP–9	31.2	
RF–9–2	2.4	

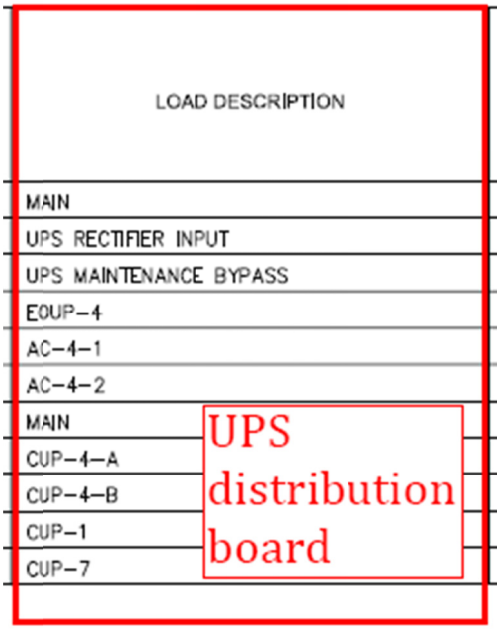
EDP-C-A

EDP-C-B

EPP-C-K

EDP-9

Figure 5 UPS distribution board loads detail



Special occupancy requirements

There is no special occupancy in the design document.

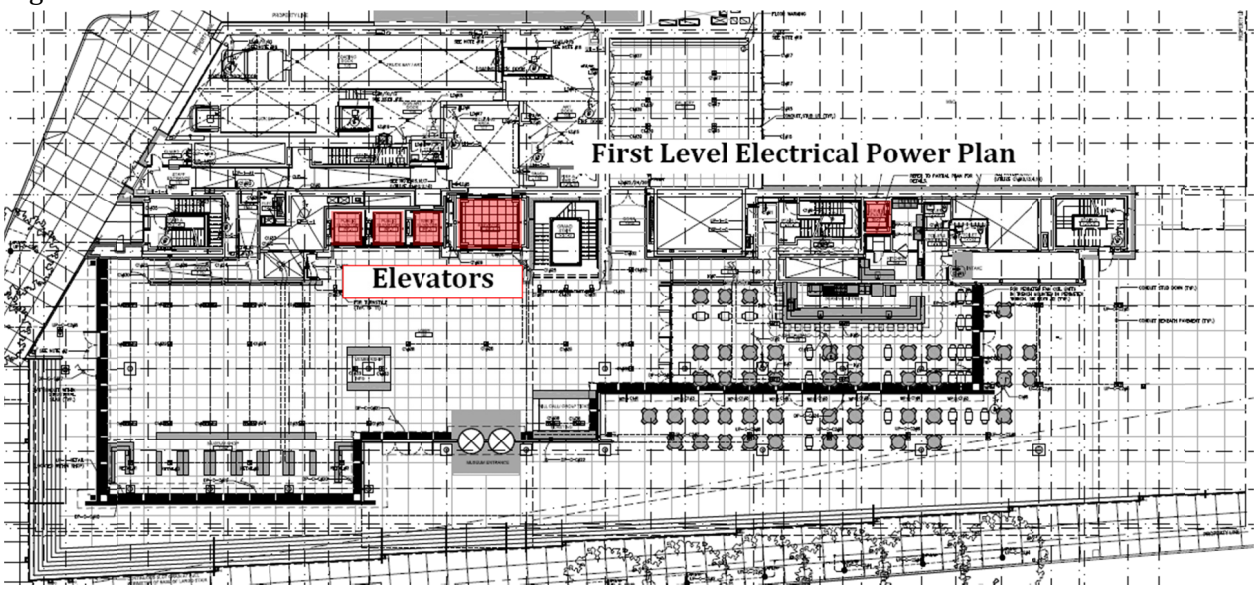
Special equipment

Special equipment found in the design documents are listed below:

[620] Elevators
[640] Audio signal processing
[645] Information technology equipment
[695] Fire pumps

There are 5 elevators in the building, locations shown by figure 5. The audio signal processing section includes video surveillance and recording system and intercom. Information technology server room and local floor closets are used for equipment such as UPS.

Figure 6 Elevators



General equipment

Four indoor free-standing, dead-front single ended 4000A service switchboards are used to feed the power to the rest of the building. They are all 208Y/120V, 3 phase, 4 wires, 200,000 AIC, with individually mounted circuit protective devices, including surge protection devices (SPD's).

As the utility company will provide the secondary service voltage of 208Y/120V, there's no transformer (including step-down transformers) specified in the design document.

The panelboards are MCB, bolt-in with NEMA 1 for indoor enclosure, NEMA 3R for wet locations.

Copper conductors with soft-drawn annealed copper, having a conductivity of not less than 98% of that of pure copper, using an ampacity as described for a 75°C are used.

i. All copper conductor insulation shall be type "THHN" or "THHN/THWN"
ii. Field-installed conductors within lighting fixtures, fixture bodies, sections of fixtures unless used as a branch circuit conductor, used as raceways, or within 3 inches of a ballast, shall be type SFF-2
iii. All conductors installed vertically for a distance in excess of 35 ft. shall be Type "XHHW".
iv. All conductors installed in conduit that is in contact with earth shall be type "THWN".

For conduits, rigid steel and intermediate metal conduit (RMC), electrical metallic tubing (EMT), flexible metal conduit (FMC), and liquid-tight flexible metal conduit (LFMC) are used.

Receptacles used are standard duplex convenience receptacles that shall be specification grade NEMA 5-15R, 5-20R, 2 pole, 3 wire, grounded, 15 or 20 ampere rated for devices shown on a 15 or 20 ampere circuit respectively.

For switch and receptacle wall plates, plastics are used for all back-of-house devices and architectural metal finish are used for all others. Additionally, switches are “Decora” style “Paddle” type.

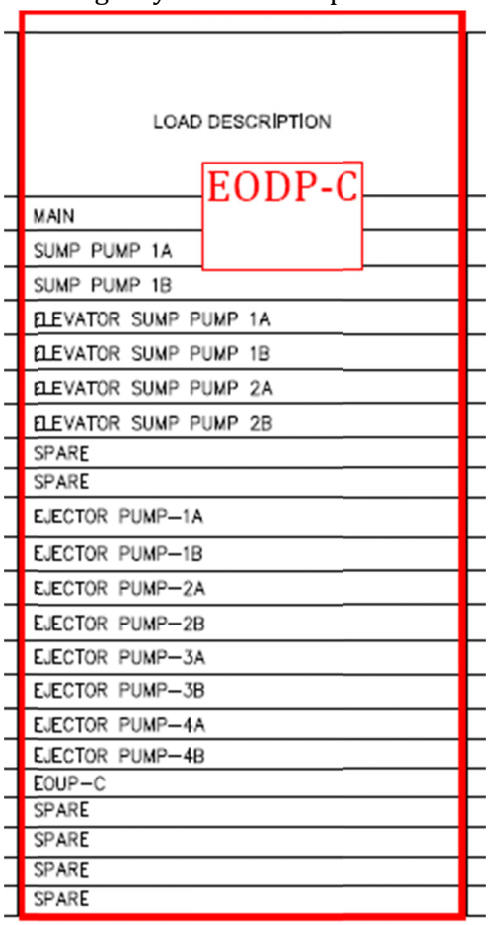
Motors are TEFC premium-efficiency type and be provide with variable speed drive.

UPS are 75 KVA/64KW at 0.9 power factor. The UPS system has a 20 minutes life and an on-line double conversion system with wrap around maintenance bypass circuit.

Optional back-up loads

As mentioned in the Emergency system load section, there is an optional emergency distribution panelboard EODP-C (208Y/120V, 3 phase, 4 wires) feeding power to sump pumps and ejector pumps which are all 208V, 3 phase. The optional emergency distribution panelboard is directed feed by the emergency switchboard. Load details are indicated in figure below.

Figure 7 Optional emergency distribution panelboard load description



Special/communications systems

The project has telephone/data system, fire alarm system (IBC 2007), CATV, Overhead paging/intercom, access control, as well as intrusion detection and video surveillance and recording system for security. The building automation system in place uses industry standard AHSRAE 135 BACnet protocol.

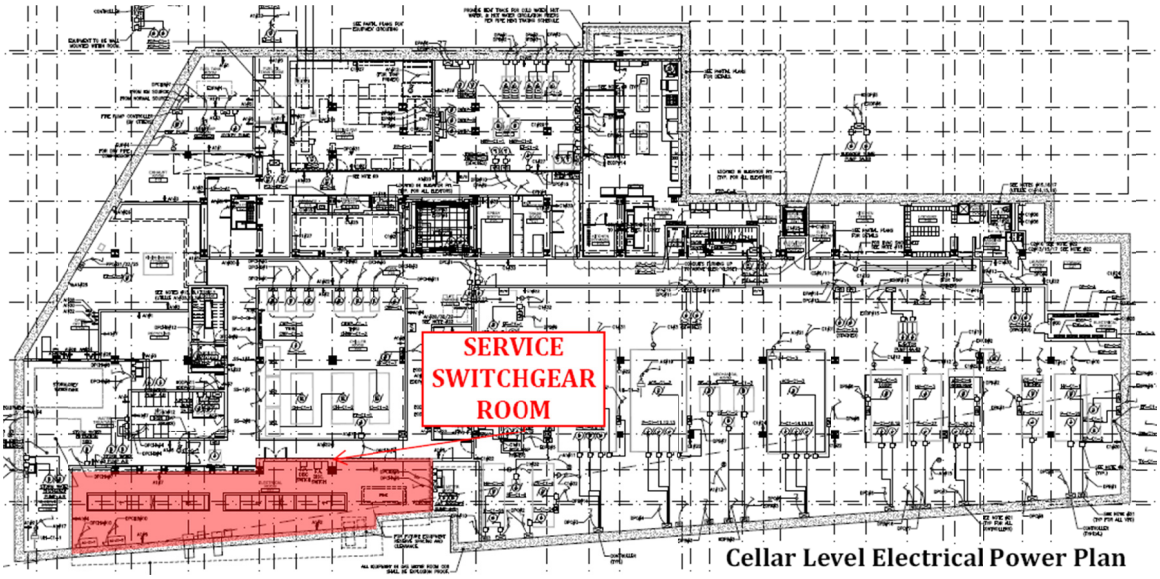
Other Building Services

Other building services that can be found in the design document include Telephone, data, and CATV.

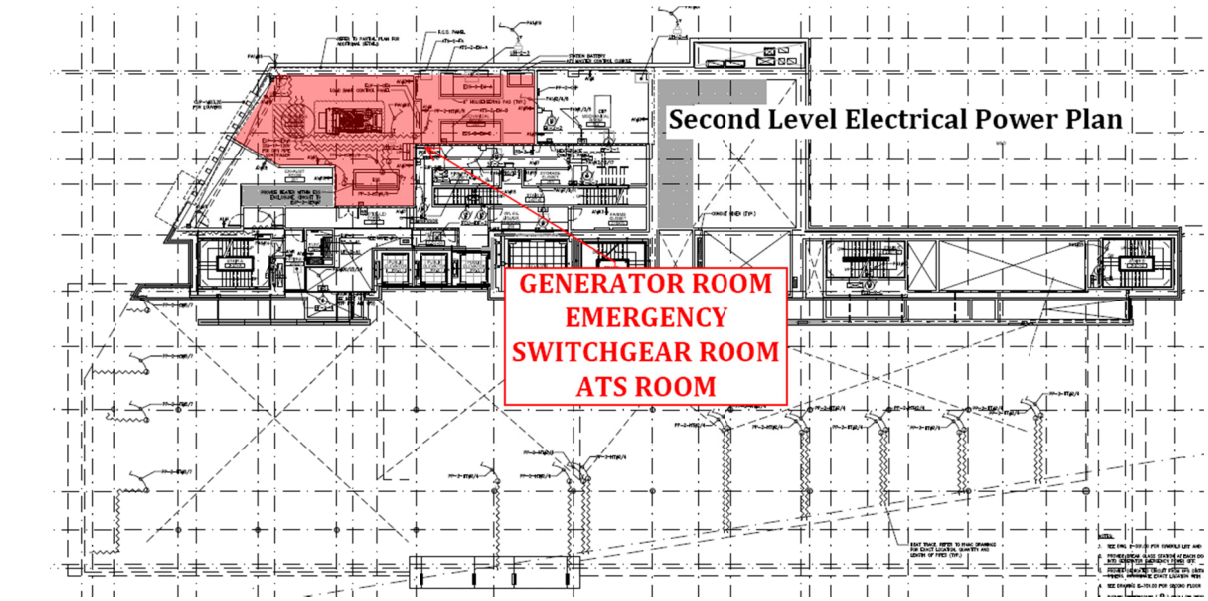
Electrical and communication system spaces

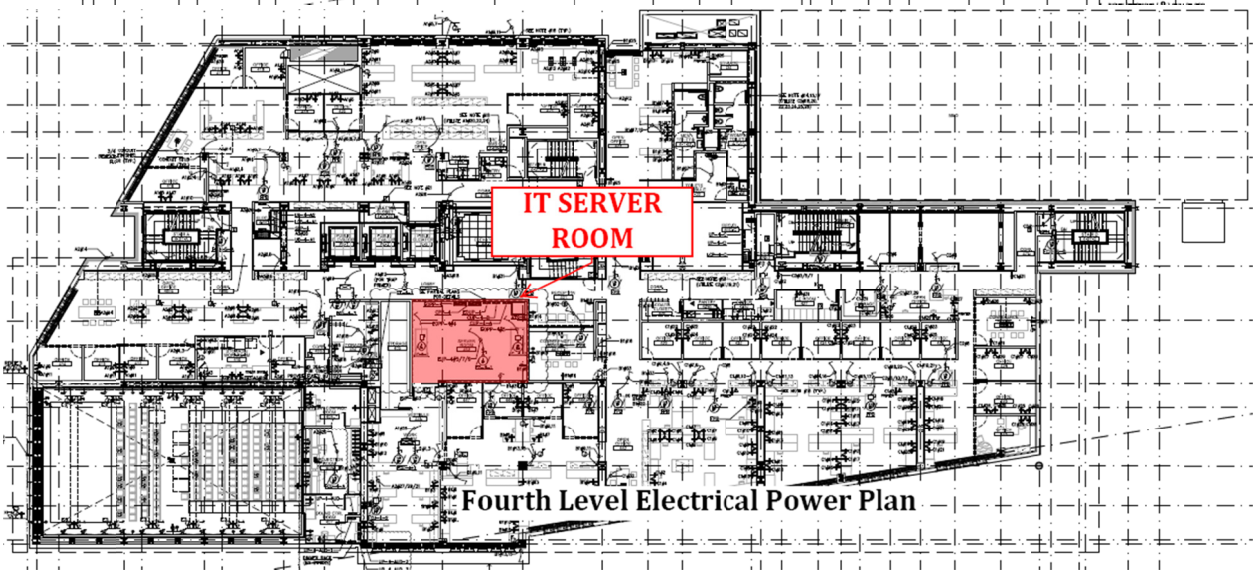
The building has electrical rooms on the cellar, second and ninth level and IT room on the fourth level. There are three electrical closets A, B and C, details are indicated by figure below. The figures below indicate the location of individual major electrical rooms.

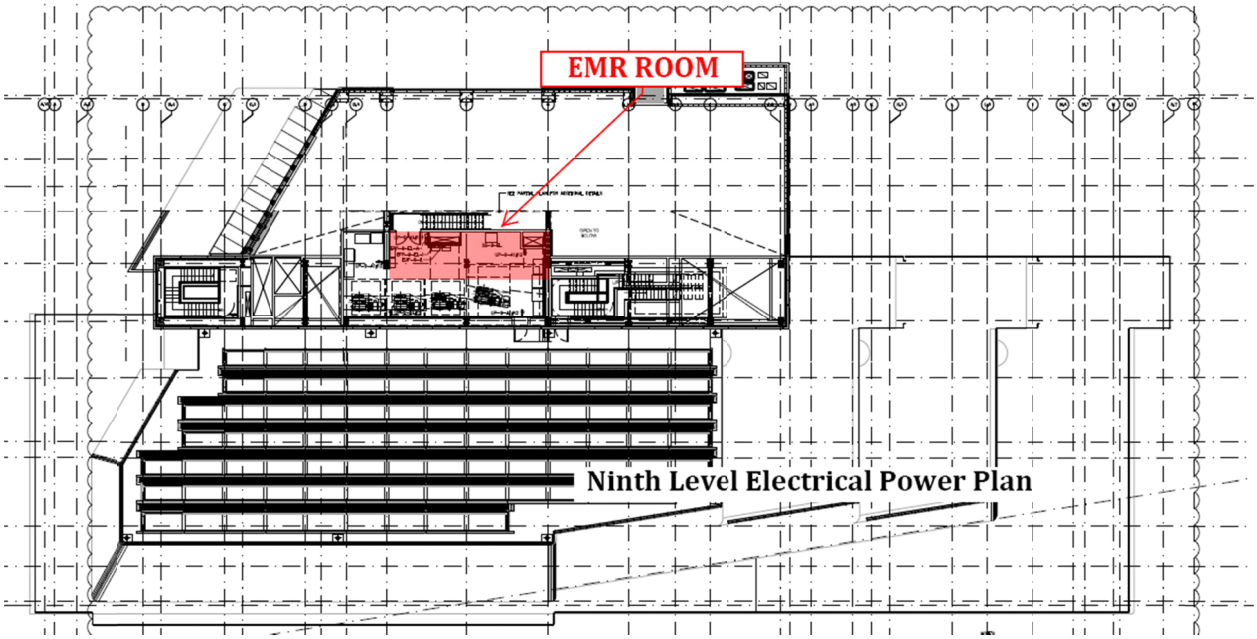
Cellar level: Main service room + Electrical closet = 2,045 SF
Lower level: Electrical closet + Telecom closet = 170 SF
1st level: Electrical closet = 85 SF
2nd level: Electrical closet + Telecom closet + Generator room + Emergency switchboard room = 1,875 SF
3rd level: Electrical closet + Telecom closet = 155 SF
4th level: Electrical closet + Telecom closet + IT server room = 733 SF
5th level: Electrical closet + Telecom closet = 155 SF
6th level: Electrical closet + Telecom closet = 150 SF
7th level: Electrical closet + Telecom closet = 148 SF
8th level: Electrical closet + Telecom closet = 148 SF
9th level: EMR room = 250 SF
Total dedicated electrical and communications systems space is 5,914 SF, 2.7% of the total building area (222,952SF)

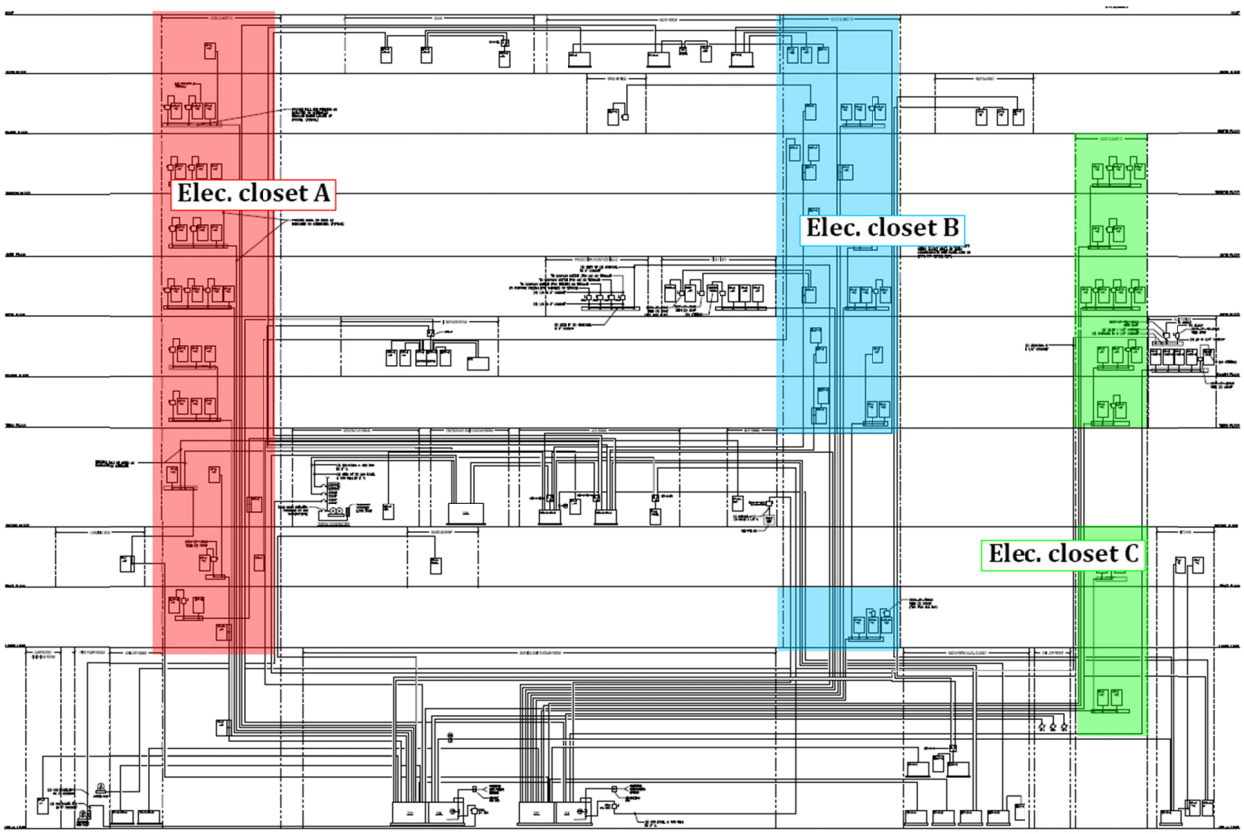


Cellar Level Electrical Power Plan


Second Level Electrical Power Plan
GENERATOR ROOM
EMERGENCY
SWITCHGEAR ROOM
ATS ROOM

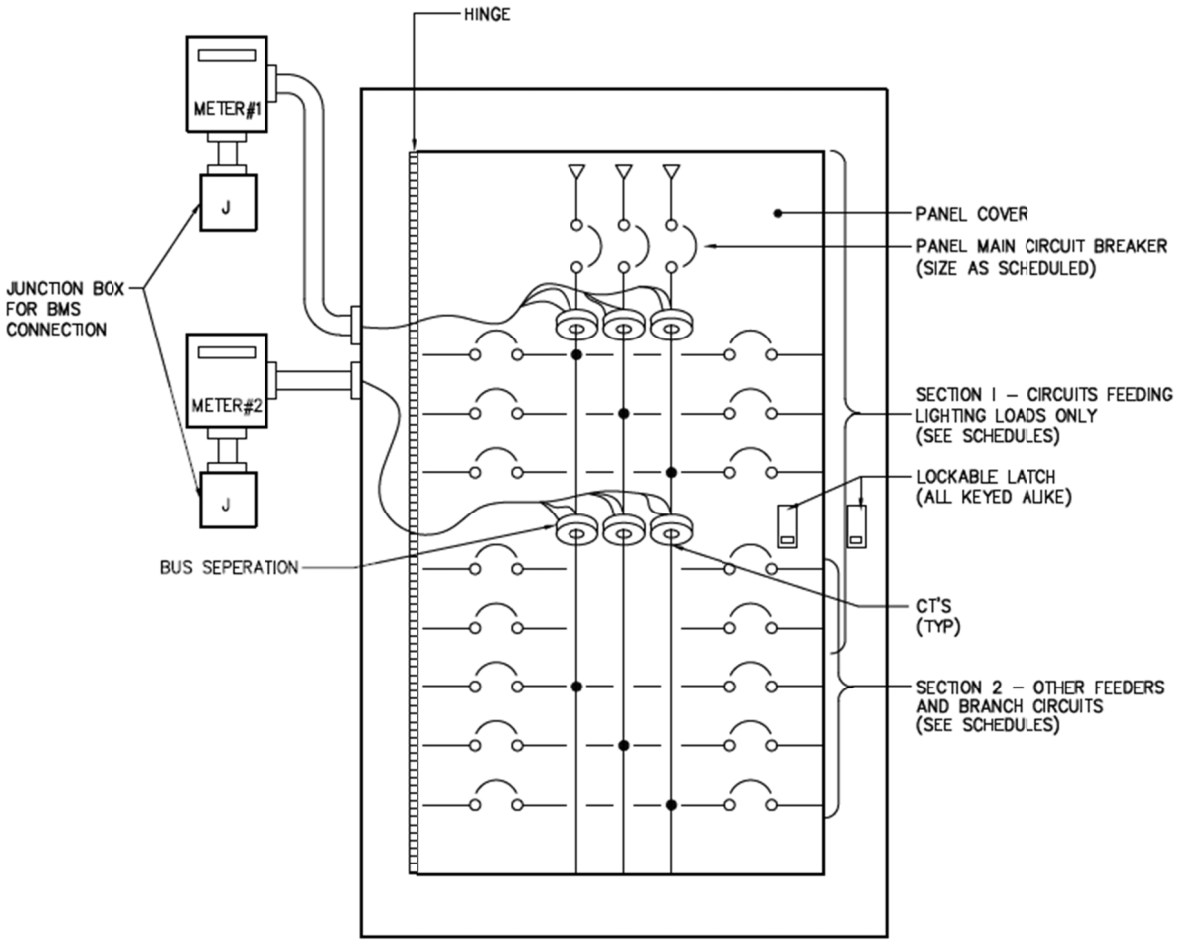

IT SERVER
ROOM
Fourth Level Electrical Power Plan


EMR ROOM
Ninth Level Electrical Power Plan


Elec. closet A
Elec. closet B
Elec. closet C

Energy cost savings and energy reduction techniques

The project aims to achieve a LEED gold in new construction. It utilizes cogeneration technology, a complete, fully operational, natural gas-driven, combined heat and power generation (CHP) system for production of heat and power throughout the project. It also uses a LEED metering system for LEED measurement and verifications with detail showed by the figure below.



LEED METERING DETAIL
N.T.S.

Single line diagram

Please see attachment on the last page.

Part 3 Evaluation of Criteria vs. Current Design

Building loads

The total actual building load is greater than the estimated load. The actual lighting loads are less than the estimated lighting loads. However, receptacles, HVAC as well as other equipment require additional power than estimated. Larger HVAC loads may result from the rather large portion glazing of the facades. To differentiate from a traditional museum, theta museum takes up a modern system design. Extra loads are resulted from the additional equipment implemented.

	estimated kVA	actual kVA
Lighting	245	179
Receptacles	116	310
HVAC	1,000	1,234
Others	222	276
Total	1,583	1,999

Power company rate schedule

Not sufficient information is obtained at the time of this report was written, thus no adequate evaluation can be made.

Building utilization voltage

The actual building utilization voltage is 208Y/120V instead of the proposed 480Y/208V in part 1. 480y/208V is the more reasonable choice with a building this size to reduce the wire sizes and power consumption. Exact reasoning behind the choice of 208Y/120V over 480Y/208V was required from the contractor.

Emergency power system

The actual fuel and power source for the emergency power system is diesel, same as expected. The size of the generator is sufficient for the connected building loads. The loads connected meet the IBC emergency requirements. The optional back-up loads for sump pumps and ejector pumps were not expected, but make sense for the actual design.

General equipment

As mentioned in the building utilization voltage section, information is requested regarding the choice of 208Y/120V instead of 480Y/120V. The utilization voltage limited the equipment choice for lighting, HVAC, and other equipment.

Aside from the potential problem resulted from the utilization voltage, the overall equipment choice to serve the building is appropriate and compatible. The choice for conductors, conduit, and receptacles is industrial standard for this type of building. Because of the busy urban site of the project, the choice of indoor electrical equipment is very reasonable. Spare spaces on the panelboard and switchboard allow for flexibility and future expansion. The cogeneration system implemented is energy efficient and cost saving.

Optional back-up power and UPS system

As mentioned in the emergency power system section, the current design for optional back-up is rather reasonable. The loads, feed by UPS system in case of power outage, are rather industrial standard. Thus, the optional back-up power and UPS system design is practical.

Cost reduction techniques

Using higher quality equipment may increase the initial cost and reduce the long term cost. As discussed in part 1, cost overall has a rather low propriety. However, with higher efficiency and long-lasting equipment, the building will encounter less problems in the future and also save cost long term.

Systems integration

The entire building system designed is rather integrated, operates with BMS via BACnet. Building system equipment such as ventilation, lighting, power systems, fire systems, and security systems can be controlled and override at a central location.

Energy cost savings and energy reduction techniques

The building uses cogeneration for heat and power generation and meets LEED power consumption requirement in attempt to achieve LEED gold.

As the building is located at a busy downtown area, with tall buildings around, it may not seem worth to use PV array or wind generation. As a public museum, the comfort-ability of the gallery space should stay rather constant. Demand reduction and shifting may be reasonable in spaces such as open office areas in the building.

NOTES:

1. REFER TO GENERAL NOTES AND SYMBOLS LIST FOR MORE INFORMATION.
2. PROVIDE METERING FOR LEED MEASUREMENT AND VERIFICATIONS.
3. LCP (LIGHTING CONTROL PANELS) SPECIFIED BY OTHERS, FURNISHED AND INSTALLED BY THIS CONTRACTOR. REFER TO LIGHTING AND LIGHTING CONTROL SPECIFICATIONS FOR DETAILS.
4. PROVIDE ALL METERING, MONITORING, CONTROLS, RELAYS, WIRING, ETC IN ACCORDANCE WITH ICC STANDARDS AND AUTHORITY WITH HAVING JURISDICTION FOR INTERCONNECT OF COGEN TO BUILDING ELECTRICAL EQUIPMENT. THIS CONTRACTOR SHALL BE RESPONSIBLE FOR ALL COGEN FILING, ETC.
5. PROVIDE PULLBOXES IN ELECTRICAL CONDUIT RISERS FOR EVERY 50 FEET IN THE VERTICAL DIRECTION. PROVIDE AND COORDINATE ACCESS DOORS WITH ARCHITECT.

ROOF
NINTH FLOOR
EIGHTH FLOOR
SEVENTH FLOOR
SIXTH FLOOR
FIFTH FLOOR
FOURTH FLOOR
THIRD FLOOR
SECOND FLOOR
FIRST FLOOR
LOWER LEVEL
CELLAR LEVEL

ELEC CLOSET A
EMR
MECH ROOM
ELEC CLOSET B
OPEN OFFICE
RESTAURANT
ELEC CLOSET C
PROJECTION ROOM VESTIBULE
FILM / VIDEO
IT SERVER ROOM
AUDITORIUM
GENERATOR ROOM
EMERGENCY SWITCHGEAR ROOM
ATS ROOM
CHP ROOM
LOADING DOCK
MUSEUM SHOP
KITCHEN
CARPENTRY FINISHING ROOM
FIRE PUMP ROOM
CHILLER ROOM
SERVICE SWITCHGEAR ROOM
MECH ROOM ELEC. CLOSET
CHILLER ROOM

PROVIDE FULL SIZE FEEDERS AS INDICATED ON SCHEDULES THROUGH ENTIRE LENGTH OF TROUGH. (TYPICAL)

FEEDERS SHALL BE SIZED AS INDICATED ON SCHEDULES. (TYPICAL)

WIRING FROM TROUGH TO EQUIPMENT WITHIN CLOSET SHALL BE SIZED COMMENSURATE WITH PANEL MAIN OR FIRST OCP DEVICE (TYP).

250V-3P-100AS WITH (3) 100AF

250V-3P-30AS WITH (3) 30AF (BY OTHERS)

250V-3P-40AS WITH (3) 40AF (TYP. FOR ELCP)

(4) SETS OF (4) 400KCMIL IN 3" CONDUIT

TO COMPANY SWITCH (FOR A/V) ON TERRACE
TO COMPANY SWITCH (FOR A/V) ON TERRACE
TO COMPANY SWITCH (FOR THEATER) ON TERRACE
TO COMPANY SWITCH (FOR THEATER) ON TERRACE
(4) 1/0 IN 2" CONDUIT
(4) 1/0 IN 2" CONDUIT

100A 100A 100A 100A

(4) SETS OF (4) 400KCMIL IN 3" CONDUIT

ATS-4

UPS

(4) 350KCMIL IN 2 1/2" CONDUIT

250V-3P-4W-100AS WITH 60AF
TO ASMCP
250V-3P-4W-60AS WITH 40AF
(4) #8 IN 1 1/4" CONDUIT
(4) 350KCMIL IN 2 1/2" CONDUIT
(4) #8 IN 3/4" CONDUIT
(BY OTHERS)
250V-3P-400AS WITH (3) 250AF

FEEDERS SHALL BE SIZED AS INDICATED ON SCHEDULE.

(4) 250 KCMIL + GND RNH IN 2" C.
(3) SETS OF (4) 600 KCMIL + GND RNH IN 4" C.
3200AF/3200AT
250AF/250AT
450AF/450AT

LOAD BANK BREAKER, PROVIDED BY GEN MANUFACTURER.

RADIATOR MOUNTED LOAD BANK

750KW GENERATOR

ATS-2-GM-B
ATS-2-GM-A
ATS-2-FA
ATS-2-GM-C

(3) 500KCMIL + (1) 1/0 GND IN 3 1/2" C

400A-3P-250V W/250A FUSE

75KW CHP

SEE NOTE #4

250V-3P-400AS WITH (3) 225AF (TYP. FOR ALL LCP)

ATS-C-C

(3) 500 KCMIL EPC IN 3" CONDUIT
(3) 500 KCMIL EPC IN 3" CONDUIT
JOCKEY PUMP
AUTOMATIC FIRE PUMP

INCOMING CON EDISON SERVICE
SERVICE END BOX
1600A F.P. SWC
250A F.A. SWC
(4) 250 KCMIL + GND RNH IN 2" C.

DS-1 SS-1 DS-2 SS-2

WHITNEY
Whitney Museum of American Art

945 Madison Avenue
New York, NY 10021 - USA
Tel: 212.570.7721
Fax: 212.570.7711

Design Architect:
RPBW
RENZO PIANO BUILDING WORKSHOP
34 Rue des Archives, F-75004 Paris - France

Executive Architect:
Cooper, Robertson & Partners
311 West 43rd Street
New York, NY 10036

Structural Engineers:
Robert Silman Associates
88 University Place
New York, NY 10003

MEP/FP/FA
Jaros Baum & Bolles
80 Pine Street, 12 Floor
New York, New York 10005

Construction Manager:
Turner Construction
375 Hudson Street, 6 Floor
New York, New York 10014

Civil Engineers:
Phillip Habib & Associates
226 West 26th Street
New York, NY 10001

Building Envelope:
R.A. Heintges & Associates
440 Park Avenue South, 15th Floor
New York, NY 10016

Audio/Visual and Acoustical:
Cerami & Associates
404 Fifth Avenue
New York, NY 10001

Lighting Design:
Arup Lighting
155 Avenue of the Americas
New York, NY 10013

IT:
TM Technology
250 West 39th Street
New York, NY 10018

LEED Consultant:
Viridian Energy Environmental
21 West 38th Street, 16th Floor
New York, NY 10018

Theater Consultant:
Theatre Projects
25 Elizabeth Street
South Norwalk, CT 06854

Facade Maintenance:
Entek Engineering
166 Ames Street
Hackensack, NJ 07601

Security:
Layne Consultants International
11984 East Lake Circle
Greenwood Village, CO 80111

Index	Issuance	Date
	BID PACKAGE 2	8/01/2011
	MEP ADDENDUM 1	9/15/2011
	MEP ADDENDUM 2	10/21/2011
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Key Plan:

Date: 8/01/2011

Scale: NTS

Project No: 14396.0.000

Drawn By:

Drawing Title:

ELECTRICAL POWER RISER DIAGRAM

Drawing No:

E-400.00

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