The Winsor School

Centers for Performing Arts and Wellness Academic Wing

103 Pilgrim Road, Boston, Massachusetts

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Technical Report II

September 19th, 2014

TECH REPORT ONE

Executive Summary

In the following report, an analysis was performed to assess the existing electrical systems in The Winsor School Centers for Performing Arts and Wellness Academic Wing. To begin, the report evaluates criteria required to this building in terms of emergency power, power distribution, special occupancies and more in accordance to standards by ASHRAE, NEC and IBC. Furthermore, load calculations are done to assess the estimated vs actual building loads based on occupancy and equipment. The actual load of the building was determined to be 991 kVA and was 20 kVA off from the original estimated value.

Overall, the building performs as expected. It utilizes a voltage of 480/277V that feeds from an exterior transformer through the main 3000A switchboard and to various distribution and panel boards. There are also step-down transformers located at panelboards that require a lower 208/120V for receptacles and mechanical equipment. The telecom and security systems are backed up to allow for a secure and reliable system to support the multitude of cameras, help buttons, intercom, door locks and motion detectors. As for materials, the wiring is mostly aluminum and it is important to note that all emergency branches are fed through mineral insulated cable. The emergency system has three branches, two of which feed "standby" and "emergency" branches that supply power to life safety support and mechanical equipment.

The building is designed to achieve LEED silver through mostly construction techniques but also through daylighting, HVAC specifications and local materials. A further energy reduction in terms of the electrical systems could be done through off-peak loading or more integrated building systems. "Green Energy" generation is not recommended for this site and discuss in greater detail below.

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Building Overview

BUILDING NAME

The Winsor School | Centers for Performing Arts and Wellness Academic Wing

LOCATION AND SITE

103 Pilgrim Road | Boston Massachusetts

BUILDING OCCUPANT NAME

The Winsor School

OCCUPANCY OR FUNCTION TYPE

Theater (A-1), Exercise Spaces (A-3), Offices (B)

The new wing is the performing arts and athletic wing connected to the academic portion of an all-girl preparatory school for young women in grades 5-12.

SIZE [TOTAL SQUARE FEET]

79,000 sf

NUMBER OF STORIES ABOVE GRADE | TOTAL LEVELS

Three Stories above grade | Five Total Levels

LIGHTING RELAVANT PROJECT TEAM

Architect: William Rawn Associates, Architects, Inc. | http://www.rawnarch.com

M / E / P / FP Engineer: Rist-Frost-Shumway Engineering, P.C. | http://www.rfsengineering.com

Landscape Architect: Landworks Studio Inc. | http://www.landworks-studio.com

Theatre Consultant: Theatre Projects Consultants | http://www.theatreprojects.com

Code Consultant: Sullivan Code Group | http://www.rwsullivan.com/services/code-consulting

Lighting Consultant: Horton Lees Brogden Lighting Design | http://www.hlblighting.com

Sustainability Consultant: The Green Engineer | http://www.greenengineer.com/

DATES OF CONSTRUCTION

May 2013 – September 2015

ACTUAL COST INFORMATION

Total Construction - $71,000,000

Electrical / Lighting - $7,200,000

PROJECT DELIVERY METHOD

Design - Bid - Build

Part 1 // Electrical Criteria & Scope of Work

CRITERIA IDENTIFICATION

Power Company

NSTAR Electric and Gas, an operating company of Northeast Utilities.

Preliminary Rate Schedule

The service voltage to the site could not be located, but because the service transformer is 2,00 kVA, it can be assumed, for this purpose, that the wattage delivered to the site is around 2,000 kW. Therefore with a demand that is greater than 10 kW at any given time, the rate schedule from NSTAR is determined to be of category B-7, G-8 Time of Use (T-2) with a service voltage less than 10,0000 V and a monthly demand greater than 10 kW. The snapshot of rate schedule from the NSTAR website can be seen below.

B7, G8 - Time of Use (T-2) (MDTE 134 (PDF))
This rate is for large commercial and industrial customers with a service voltage of less than 10,000 volts and a monthly demand of 10 kW or more. This rate has peak and off-peak periods. Peak is from 9 a.m. to 6 p.m. weekdays from June through September; and 8 a.m. to 9 p.m. weekdays October through May. Off-peak is all other hours including weekends and the 12 Massachusetts holidays.

Delivery Service Charges (October - May)

Customer For demand less than or equal to 150 kW (per month) $27.77	**Customer** For demand greater than 150 kW and less than or equal to 300 kW (per month) $114.62	**Customer** For demand greater than 300 kW and less than or equal to 1,000 kW (per month) $166.67
Customer For demand greater than 1,000 kW (per month) $374.57	**Distribution** **Energy** (per kWh) $0.00777	**Distribution** **Demand** (per kW) $11.20
Transition **Energy** **Peak** (credit per kWh) $0.00268	**Transition** **Energy** **Off-Peak** (credit per kWh) $0.00268	**Transition** **Demand** (per kW) No Charge
Transmission **Demand** (per kW) $9.00	**Energy Conservation** (per kWh) $0.00250	**Renewable Energy** (per kWh) $0.00050

Delivery Service Charges (June - September)

Customer For demand less than or equal to 150 kW (per month) $27.77	**Customer** For demand greater than 150 kW and less than or equal to 300 kW (per month) $114.62	**Customer** For demand greater than 300 kW and less than or equal to 1,000 kW (per month) $166.67
Customer For demand greater than 1,000 kW (per month) $374.57	**Distribution** **Energy** (per kWh) $0.00777	**Distribution** **Demand** (per kW) $19.65
Transition **Energy** **Peak** (credit per kWh) $0.00268	**Transition** **Energy** **Off-Peak** (credit per kWh) $0.00268	**Transition** **Demand** (per kW) No Charge
Transmission **Demand** (per kW) $9.00	**Energy Conservation** (per kWh) $0.00250	**Renewable Energy** (per kWh) $0.00050

Table 1 - Utility Rate Schedule

Building Utilization Voltage

The building utilization voltage should be 408/277V, 3PH so that the large mechanical systems can be run at 408V. Transformers will typically be used to allow for lighting on 120V, as well as receptacles, except for exterior lighting which will run of the 277V. Other mechanical systems such as A/V equipment, refrigerators, freezers and information technology typically use 208/120V.

Emergency Power Requirements

The Performing Arts and Wellness Wing of The Winsor School overall has an IBC 2009 Occupancy Classification of (E) Educational. The additional spaces, outside of entries and circulation spaces, are of types (A-1) Theatre and (A-3) Exercise Spaces. Emergency power requirements were only found in terms of lighting. This requirement calls for the means of egress illumination level should not be less than 1 footcandle or 11 lux at the walking surface.

Additionally, emergency power shall be designed and construction to code per the 2009 International Building Code as described below:

> 2702.1.1 Stationary generators. Stationary emergency and standby power generators required by this code shall be listed in accordance with UL 2200.
>
> 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.
>
> > 907.5.2.2.4 Emergency Power. Emergency voice/alarm communication systems shall be provided with an approved emergency power source.
>
> 2702.2.3 Exit Signs. Emergency Power shall be provided for exit signs in accordance with Section 1011.5.3.
>
> > 1011.5.3 Power source. Exit signs shall be illuminated at all times. To ensure continued illumination for duration of not less than 90 minutes in case of primary power loss, the sign illumination means shall be connected to an emergency power system provided from storage batteries, unit equipment or an on-site generator. The installation of the emergency power system shall be in accordance with Chapter 27. Exception: Approved exit sign illumination means that provide continuous illumination dependent of external power sources for a duration of not less than 90 minutes, in case of primary power loss, are not required to be connected to an emergency electrical system.
>
> 2702.2.4 Means of egress illumination. Emergency power shall be provided for means of egress illumination in accordance with Section 1006.3.
>
> > 1006.3 Illumination emergency power. The power supply for means of egress illumination shall normally be provided by the premises' electrical supply. In the event of power supply failure, an emergency electrical system shall automatically illuminate all of the following areas:
> >
> > - Aisles and enclosed egress stairways in rooms and spaces that require two or more means of egress.
> > - Corridors, interior exit stairways and ramps and exit passageways in buildings required to have two or more exits.
> > - Exterior egress components at other than their levels of exit discharge until exit discharge is accomplished for buildings required to have two or more exits.
> > - Interior exit discharge elements, as permitted in Section 1027.1, in buildings required to have two or more exits.

- Exterior landings as required by Section 1008.1.6 for exit discharge doorways in buildings required to have two or more exits.

The emergency power system shall provide power for a duration of not less than 90 minutes and shall consist of storage batteries, unit equipment or an on-site generator. The installation of emergency power systems shall be in accordance with Section 2702.

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.

1007.4 Elevators. In order to be considered part of an accessible means of egress, an elevator shall comply with emergency operation and signaling device requirements of Section 2.27 of ASME A17.1. Standby power shall be provided in accordance with Chapter 27 and Section 3003. The elevator shall be accessed from either an *area of refuge* complying with Section 1007.6 or a *horizontal exit*.

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

2702.2.19 Elevators. Standby power for elevators shall be provided as set forth in Sections 3003.1, 3007.9 and 3008.9: In buildings and structures where standby power is required or furnished to operate an elevator, the operation shall be in accordance with Sections 3003.1.1 through 3003.1.4.

2702.2.20 Smoke-proof enclosures. Standby power shall be provided for smoke-proof enclosures as required by Section 909.20.6.2.

909.20.6.2 Standby power. Mechanical vestibule and stair shaft ventilation systems and automatic fire detection systems shall be powered by an approved standby power system conforming to Section 403.4.8 and Chapter 27.

Special Occupancy Requirements

According to Chapter 5 of the National Electric Code – the following articles apply to the design of this building:

Article 520: Theaters and Similar Locations. This article relates to the various overcurrent, wiring and other electrical features that differ for a performance hall from everyday spaces. For more information, please consult pages 70-459 – 70-468 in the 2011 NEC.

Priority Assessment

High

Low Life Cycle Cost is very important because the other buildings on this lot have stood for a very long time. The main academic building has been in use since the early 1900s, therefore it can be assumed that this building should stand the test of a time to match its long term predecessor.

Reliability is very high because if the power is not reliable students may not be allowed in this building. The school has been made possible by many parents and alumni who have generously donated to this school and, in doing so, expect the school to be able to run at full force at all time.

Medium

Initial Cost is always something that needs to be looked over and evaluated through design and construction of a building. It is not something that anyone can really disregard. The money for this project, as said above, comes from wealthy alumni and family members of the school. The donations are not limited and the school met the goal of assumed cost fairly quickly. But, it is important to watch the cost of the systems of the building so that no more money is requested.

Power Quality is also of concern in this building. While the telecommunications are not as high level or demanding as other types of buildings there are a lot of digital control systems, especially in the theatre. Disrupted harmonics in this space could have a negative effect on the systems in the space.

Low

Flexibility is a low priority assessment for the same reasoning for the low life cycle cost being a high priority. The building can be assumed to remain for a long time, as the other buildings on the site. In fact, because this building is so specific in its function of theatre and physical performances that it will probably stay as the function for the building and spaces for a long time.

Redundancy is a low priority because there are little to no critical systems in the building since the building is made up of mostly classrooms, theatre spaces and gyms. Therefore, it is not critical to duplicate any components.

Optional Back-up Power

Back-up power is not necessary outside the already recommended generator loads. This is a day school where occupants can be sent home at the school closure in the event of a long-term power outage. The only technology that could be applicable would be a Uninterruptible Power Supply for the telecommunications and data throughout the building.

Special / Communication Systems

The following are special systems that can be implemented in new Windsor School wing. Most of these were chosen for their ability to increase safety and wellness of the students with in the school. Furthermore, with the implementation of the Fire Alarm systems, the corresponding Internation Building Code requirements were listed as well.

Telephone/Data

CATV

Overhead Paging / Intercom

Security – Video Surveillance, Access Control

Fire Alarm – IBC 2009 requirements are listed below:

907.2 Where required-new buildings and structures. An approved fire alarm system installed in accordance with the provisions of this code and NFPA 72 shall be provided in new buildings and structures in accordance with Sections 907.2.1 through 907.2.23 and provide occupant notification in accordance with Section 907.5, unless other requirements are provided by another section of this code. A minimum of one manual fire alarm box shall be provided in an approved location to initiate a fire alarm signal for fire alarm systems employing automatic fire detectors or water flow detection devices. Where other sections of this code allow elimination of fire alarm boxes due to sprinklers, a single fire alarm box shall be installed.

907.2.1 Group A. 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. 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 water flow.

907.2.11.4 Power source. In new construction, required smoke alarms shall receive their primary power from the building wiring where such wiring is served from a commercial source and shall be equipped with a battery backup. Smoke alarms with integral strobes that are not equipped with battery backup shall be connected to an emergency electrical system. Smoke alarms shall emit a signal with the batteries are low. Wiring shall be permanent and without a disconnecting switch other than as required for overcurrent protection. Exception: Smoke alarms are not required to be equipped with battery backup where they are connected to an emergency electrical system

907.5 Occupant notification systems. A fire alarm system shall annunciate at the panel and shall initiate occupant notification upon activation, in accordance with Sections 907.5.1 through 907.5.2.3.4. Where a fire alarm system is required by another section of this code, it shall be activated by:

1. Automatic fire detectors.
2. Sprinkler water flow devices.
3. Manual fire alarm boxes.
4. Automatic fire-extinguishing systems.

907.5.1 Pre-signal feature. A pre-signal feature shall not be installed unless approved by the fire code official and the fire department. Where a pre-signal feature is provided, a signal shall be annunciated at a constantly attended location approved by the fire department, in order that occupant notification can be activated in the event of fire or other emergency.

Major Equipment

This building will be almost completely independent from the main academic wing even though the building is connected by a tunnel bridge. Therefore, it will require mechanical and electrical equipment in the basement and ground floor. To be more specific, the mechanical systems demand pumps, air handling units, rooftop units, VAV boxes and fan coil units. Electrical equipment will include switchgears, switchboards, step-down transformers, a UPS system and a generator. There will also be server racks, digital control systems and fire protection systems. Roughly for this size of a building, the main distribution room with require roughly a 15x20ft space with 8x10ft (80 sf) branch rooms per 20,000 sf or per floor. This should roughly equal around 2% of the total square footage of the building (1,500 sf).

In terms of fire protection, per IBC 2009, means of egress doors are required to provide a door width in terms of occupancy. Because the building can have more than 500 people, a minimum of 3 exits per story are required with a minimum height of 80 inches. For fire-rated walls, where like occupancies share a wall, no fire rating is required. Where occupancies do not match, for instance where the theatre may meet a wall of the gym, a fire rating of 2 hours is required.

PRELIMINARY LOAD CALCULATION

Below is a rough preliminary load calculation based on the square footage of the building and standard rates for systems within the building. These loads have been found from NEC 2011 Table 220.12. Additionally based on these loads, the total kVA and Amperage of the building was determined. This was used to size the recommended switchboard size.

Type of Loading	Unit Load	Unit Measurement	Load
Schools - General	3 VA/sf	79,000 sf	237,000 VA
Receptacles	180 VA/Recep	436 receps	48480 VA
HVAC Systems	7 VA/sf	79,000 sf	553,000 VA
Elevators	50000 VA/elevator	2 Elevators	100,000 VA
		Total kVA	**969,000 VA**

Total Current at 480V	2019 Amp
Recommended Switchboard Size	3000 Amp

Table 2 - Estimated Building Load

Part 2 // Existing Electrical System

UTILITY COMPANY INFORMTION

Same as stated in Part 1 // Electrical Criteria.

BUILDING UTILIZATION VOLTAGE

The actual building utilization voltage is 480/277V 3PH, 4W. The power is distributed through the main electric room on the basement level. The breakdown of voltages can be seen below. The rooms where the lighting voltage isn't 277V are as follows: Make-up Room, Cardio/Fitness Room, Wellness Lobby, Dance/Drama Storage, Workroom, Fly Tower, Theatre, Stage and Catwalk. The special equipment category includes telecom, theatre fly tower, acoustical smoke vent, smoke dampers, security cameras, gymnasium curtain, operating doors and water cooler.

Lighting – 277 V

Lighting (Exceptions) – 120V

Receptacle – 120 V

Mechanical –

- Fans – 480 V, 120 V
- Air Handling Units – 460 V, 208 V
- Heaters – 208 V
- Air Conditioning Unit – 208 V
- All other major equipment – 480 V

Elevators – 480 V

Special Equipment – 208V

BUILDING LOADS

Special Equipment includes telecom, theatre fly tower, acoustical smoke vent, smoke dampers, security cameras, gymnasium curtain, operating doors and water cooler. Please see below the breakdown of loads by systems and panelboards. All numbers below are listed in Volt-Amps combining for a total of 992 kVA.

Panel	Lighting	Receptacle	Mechanical	Special Equipment
MSB			12969	33255
M4NBA			69996	
M4NBB			19398	2826
M4N4A			141360	
M2N5A		2340	13964	2280
D2N2C			54024	21000
D4SBA			1746	43233
D2S5A		1920	10304	
L4NBA	37938			
L4EBA	22057			
L4N3A	24942			
L4E3A	7388			
L4N5A	9362			
L4N5A	4887			
P2NBA	1500	15300	12768	1000
P2NBB		7560	17424	500
P2NBC		680	996	
P4SBA			2826	
P2SBA		1980	4500	
P2N1A		3770	12202	1000
P2N1B	200	27345		1000
P2N1C		17364		

Panel	Lighting	Receptacle	Mechanical	Special Equipment
P2S1A		11100		
P2EBA	1508			2000
P2N2A	3990	16620	4676	
P2N2B		9540	4396	5500
P2N2C	26	13701		1000
P2N2D		6612		2739
P2N3A (L)		9680	1380	1296
P2N3A (R)	1500	5040		1513
P2N3B		4920		1000
P2S3A		3360		8856
P2E3A	6890			
P2NMZA	1500	8020	2400	500
C2N1A	3015	2368		3000
C2N2A		9222		
C2N2B		6220		
C2N2B		14380		
L2N3A	3264	7200		
A2N3A		31680		
A2N3B		16320		
M2N4A			23572	
M2N5A			16647	
P2SBC		1800	15600	28781

Summation of Systems	129967	256042	443148	162279

Total VA	**991436**

Table 3 - Actual Building Load

EMERGENCY POWER SYSTEM

The emergency power system is located on the roof. It is a 500 kW / 600 kVA alternating current standby #2 diesel generator that operates on 480/277V 3PH, 4W. It is required that if the power fails, the generator must respond and supply power within 10 seconds of failure. For more information on the generator, please look at the generator system in the electrical system equipment section. The generator distributes power through three outputs down to a large amount of distribution and power boards and a fire pump. All emergency cables are mineral insulated cables. As stated above, two wires output power to a “standby” line and an “emergency” line. Both lines hold life safety loads for lighting and power. The “standby” line holds much more loading, a total of 136 kVA, and is protected by circuit breakers. The standby holds much of the technical equipment such as the elevator, load bank, exhaust fans, telecom lighting and receptacles, UPS unit, smoke dampers and access panel controls. The “emergency” line holds much less loading, about 45 kVA, is protected by fuses. The loading sums for a total of about 181 kVA, this is roughly 18% of the total load of the building. This line holds mostly lighting and power for life safety in the mechanical, IT, theater and electrical rooms. It also controls the fire command center and smoke control panel.

MAJOR ELECTRICAL AND TELECOM FLOOR SPACE

The Electrical and Data rooms take up a total square footage of 1,209 sf and this is roughly 1.5% of the total building.

Electrical Rooms

Main Electrical Room // Room 082 – 416 sf

Main Emergency Room // 080 – 100 sf
All other Electrical floor space – 424 sf

Telecom and Data Rooms

Main Data Center // Room 014 – 150 sf
All other Telecom floor space – 119 sf

OPTIONAL BACK-UP POWER

A UPS unit is installed and located in the main telecom room. For more information on it, please view the section on uninterruptible power supply in the electrical system equipment breakdown. The loading on the UPS system and panelboard is around 20 kVA.

SPECIAL OCCUPANCY REQUIREMENTS

According to Chapter 5 of the National Electric Code – the following articles apply to the design of this building:

Article 520: Theaters and Similar Locations. This article relates to the various overcurrent, wiring and other electrical features that differ for a performance hall from everyday spaces. For more information, please consult pages 70-459 – 70-468 in the 2011 NEC.

SPECIAL EQUIPMENT

According to Chapter 6 of the National Electric Code – the following special equipment were applied in this building:

Article 620: Elevators.
Section 640: Audio Signal Processing.
Article 645: Information Technology Equipment.
Section 685: Integrated Electrical Systems.
Section 695: Fire Pumps.

ELECTRICAL SYSTEM EQUIPMENT

Switchboard

The switchboard, located in the Main Electrical Room (Room 082) in the sub-basement level of the building houses a 3000A switchboard with a voltage of 408/277V 3PH, 4W with a main circuit breaker, ground fault current interruption, phase loss, surge suppression protections with a 100% neutral bus and full ground bus. The switchboard itself is allowed to be chosen by the electrical contractors but must be rated NEMA 1 with a busbar of high conductivity aluminum. The switchboard will be divided into a main section (designated MSB), metering and distribution sections that will feed into various panel and distribution boards.

Substation/Transformers

The pad mounted transformer, provided by NSTAR, will meet NEMA TR1 standards. The medium voltage will be fed from the utility manhole located on Brookline Avenue through (1) 5" Conduit and (1) 5" Spare. The transformer will take the primary voltage (which could not be located in the drawings or specifications) and reduce it to a 480/277 V to feed to the buildings Main Circuit Breaker Switchboard. More information about the inner workers or possible redundancy features could not be located on the NSTAR website.

Generator

The emergency generator is located on the roof. It is a 500 kW / 600 kVA alternating current standby #2 diesel generator that operates on 480/277V 3PH, 4W. It is required that if the power fails, the generator must respond and supply power within 10 seconds of failure. It is covered in a water jacket heater to protect it in the winter cold and it contains a 300 amp, 200 amp and 600 amp breaker. It is accompanied by a central load bank, though the load bank is fed by the normal power though is part of the panel board that is powered during emergency situations. The generator supplies power through three mineral insulated cable for 2-hour fire rated protection. The power is distributed through an automatic standby system, automatic emergency system and a fire pump. The automatic systems feed life safety receptacles and lighting as well as smoke dampers, exhaust fans, air conditioning units, the load bank and the UPS system.

Step-Down Transformers

The step-down transformers located within the building are ventilated, air-cooled, dry type and meet the energy efficiency standards of NEMA TP-1 with an EPA "Energy Star" label. They are located on every floor to address the supply of lighting, receptacles and mechanical equipment that require 208/120V power. Below in Table X is a schedule of the various transformers and the panelboards in which they feed.

Tag	Primary Voltage	Secondary Voltage	Feeds	Size	Type
T1	480/277 V	208/120 V	Panel D2NBA	150 kVA	Dry
T2			Panel D2N2B	150 kVA	
T3			Panel M4N4A	45 kVA	
T4			Panel M2N5A	45 kVA	
TD1			Theatre Dimming Panel	225 kVA	
TD2			Rehearsal Dimming Panel	112.5 kVA	
TS1			Panel P2SBA	75 kVA	
TS2			Panel D2S5A	30 kVA	
TS3			Panel D2S5A	30 kVA	
TS4			Panel P2SBC	75 kVA	
TE1			Panel P2EBA	15 kVA	
TE2			Panel P2E3A	15 kVA	
TA1			Panel A2N3A	75 kVA	
TCS1			Panel D2N2C	225 kVA	
TC2			Panel D2N2A	75 kVA	

Table 4 - Transformer Schedule

Panelboards

The following table describes the designed panelboards, distribution panels, associated load and locations. The panelboards are comprised of main lugs only, main circuit breakers or main fuse and enclosed by NEMA 1 container for dry locations and NEMA 3R for damp or exterior locations. All buses are made up of high conductivity aluminum. To protect the panelboards, they shall be equipped with surge suppression to the standards of UL 1449 and UL 1283. There are also locations where the ground bus must be isolated and insulated, this is shown on the drawings.

Panelboard	Voltage System	Main size (Amps)	Main Type	Location
MSB	480/277 3PH, 4W	400	MCB	Main Electric Room 082
M4NBA	480/277 3PH, 4W	225	MLO	Mech Room 092
M4NBB	480/277 3PH, 4W	400	MLO	Central Plant 016
M4N4A	480/277 3PH, 4W	400	MLO	Mech Penthouse 406
M2N5A	480/277 3PH, 4W	100	MCB	Electrical Room 531
D2NBA	208/120 3PH, 4W	600	MCB	Main Electric Room 082
D2N2C	480/277 3PH, 4W	800	MCB	Electrical Room 206A
D4SBA	480/277 3PH, 4W	600	MCB	Main Emergency Rm 080
D4EBA	480/277 3PH, 4W	200	MF	Main Emergency Rm 080
D2N2A	208/120 3PH, 4W	400	MCB	Electrical Room 266A
D4S5A	480/277 3PH, 4W	225	MLO	Emergency Electrical Rm 530
D2S5A	208/120 3PH, 4W	100	MCB	Emergency Electrical Rm 530
L4NBA	480/277 3PH, 4W	125	MLO	Main Electric Room 082
L4EBA	480/277 3PH, 4W	125	MLO	Main Emergency Rm 080
L4N3A	480/277 3PH, 4W	125	MLO	Electrical Room 304
L4E3A	480/277 3PH, 4W	125	MLO	Electrical Room 304A
L4N5A	480/277 3PH, 4W	125	MLO	Electrical Room 531
L4E5A	480/277 3PH, 4W	100	MLO	Emergency Electrical Rm 530
P2NBA	480/277 3PH, 4W	225	MLO	Fan Room 086
P2NBB	480/277 3PH, 4W	125	MLO	Central Plant 016
P2NBC	480/277 3PH, 4W	225	MLO	Fan Room 086
P4SBA	480/277 3PH, 4W	125	MLO	Fan Room 086
P2SBA	480/277 3PH, 4W	225	MCB	Main Emergency Rm 080
P2N1A	208/120 3PH, 4W	125	MLO	Electrical Room 144
P2N1B	208/120 3PH, 4W	225	MLO	Electrical Room 144

Panelboard	Voltage System	Main size (Amps)	Main Type	Location
P2N1C	208/120 3PH, 4W	125	MLO	Electrical Room 144
P2S1A	208/120 3PH, 4W	125	MLO	Electrical Room 144
P2EBA	208/120 3PH, 4W	100	MF	Main Emergency Rm 080
P2N2A	208/120 3PH, 4W	225	MLO	Electrical Room 266A
P2N2B	208/120 3PH, 4W	225	MLO	Electrical Room 206A
P2N2C	208/120 3PH, 4W	125	MLO	Electrical Room 239
P2N2D	208/120 3PH, 4W	125	MLO	Back Stage Tech 280A
P2N3A (L)	208/120 3PH, 4W	225	MLO	Electrical Room 304
P2N3A (R)	208/120 3PH, 4W	225	MLO	Electrical Room 304
P2N3B	208/120 3PH, 4W	125	MLO	Janitors Closet 387A
P2S3A	208/120 3PH, 4W	100	MCB	Electrical Room 304
P2E3A	208/120 3PH, 4W	100	MF	Electrical Room 304
P2NMZA	208/120 3PH, 4W	125	MLO	Electrical Room 151
C2N1A	208/120 3PH, 4W	225	MLO	Electrical Room 144
C2N2A	208/120 3PH, 4W	125	MLO	Electrical Room 239
C2N2B	208/120 3PH, 4W	125	MLO	Electrical Room 239
C2NMZA	208/120 3PH, 4W	125	MLO	Electrical Room 180
D2N2B	208/120 3PH, 4W	600	MCB	Electrical Room 266A
L2N3A	208/120 3PH, 4W	125	MLO	Dimmer Room 378
A2N3A	208/120 3PH, 4W	225	MCB	Sound Rack Room 380
A2N3B	208/120 3PH, 4W	225	MLO	Sound Booth
M2N4A	208/120 3PH, 4W	225	MCB	Mech 406
M4N5A	480/277 3PH, 4W	400	MLO	Electrical Room 530
M2N5A	208/120 3PH, 4W	225	MCB	Data Center 014
UPS1	208/120 3PH, 4W	-	MCB	Data Center 014

Overcurrent Protection Devices

In this building, the panelboards are protected by a number of circuit breakers ranging from about 3000 A to 75 A of types MLO, MCB and MF. The 3000 A occurring on the transformer level. In the panel boards, the range is about 600 A to 75 A. As stated above, the generator has three breakers protecting the life safety, fire pump and standby features.

There are two types of breakers used in the building. They are thermal magnetic breakers and electronic trip breakers. The electronic trips are used for larger amperages, like in the main switchboard, while the thermal magnetic breaks are used in the small amperage panelboards. The switches are heavy-duty and must be able to be locked in the open positon. If they are enclosed on their own, they should be rated NEMA 1 for interior use and NEMA 3R for exterior. Also seen on the on-line diagram are fuses but no further information is specified about the type of fuse in the construction documents.

Grounding

The main grounding is provided from the switchboard to an electrode ground bar then through (2) #4/0 insulated copper conductors in 1-1/2" conduit and finally into #3/0 Ground Conductor in 1 ¼" PVC Conduit and terminate through underground 10' Copper ground rods. All other building steel or metal piping must be connected to the ground per article 250 of the NEC. Furthermore, the grounding is also used to ground the telecommunications in the building. Each telecommunications room will have their own grounding electrode that connects to the main ground bar. The grounding occurs in the switchboard and therefore grounds all systems. To see the connections, please see the one-line diagram at the end of this report.

Main Risers and Feeders

The service entrance is fed by 8 sets of 4#500 kcmil of type XHHW when used outside or THWN on the interior. To service panelboards, the same wiring shall be used (THHN, THWN or XHHW). The feeder cables are designated to be aluminum alloy of type XHHW-2. There are also two types of cables used. The first is MC cable with copper conductors of type THHN insulation. The other cable is a First Rated mineral insulated cable to NFPA 70 standards with a two hour fire rating.

Conductors

Both aluminum and copper conductors are used. Aluminum in the feeder cables and wires of types THHN, THWN, and copper in the MC and MI cables.

Conduit

There are multiple types of conduit used throughout The Winsor School. The types are broken down below:

- Rigid Steel Conduit with zinc-coating and fittings of cast malleable iron
- Liquid-Tight Flexible Metal Conduit of double wrapped steel and flexible PVC with iron fittings
- Electrical Metallic Tubing (EMT)
- Electrical Plastic Conduit for heavy wall conduit that is concrete encased and PVC fittings

Receptacles

The most common receptacle in this building is the standard duplex receptacle. Rated at NEMA Type 5 20R. Within this category there are also Ground Fault interrupter receptacles rated at 20 amps with built in test and reset buttons, per standards, as well as isolated ground receptacles and TVSS receptacles for surge protection. There are also pin and sleeve receptacles with black boxes as shown on the drawings and retractable extension cord receptacles with an SJ type cord and suitable listing for a ceiling mount.

Switch and Receptacle Faceplates

For the cover plates, the materials are stainless steel for interior use, galvanized steel in interior dry utility locations and cast metal for exterior or high moisture locations with rubber sealing gaskets. Exterior cover plates must comply with a self-closing cover rated NEMA 3R when weatherproofing is needed.

Motor Starters

Single-Phase and Poly-Phase constant speed motors and power motors and poly-phase variable speed invertor-duty motors are used. They are required to be tested before use with a service factor of 1.25. They are also open drip-proof or totally enclosed and fan cooled based on type. The invertor-duty motor must be corona-free. The adjustable frequency drives should operate from ½ to 3 horsepower. The 2 to 3 HP VFD will operate at 240 V with 1 phase and output 3 phase

Uninterruptible Power Supply (UPS)

The UPS is services by a panelboard UPS1 in the data center. It is 20 kVA, 208/120V 3PH, 4W unit that services two data racks and two future data racks, as well as receptacles for the racks. It is under a surge protective receptacles and on emergency power.

SUMMARY OF SPECIAL/COMMUNICATION SERVICES

Telephone/Data

Telecommunication Rooms are located on the basement, first, second and fifth floors of the buildings and designated IT Rooms on the plans. The basement telecom room holds the data center where the main telephone equipment, servers, CCTV, intercom equipment and data racks are located. This is in the north part of the building. The rest of the telecom rooms are more centrally located on the floor plan and house equipment racks, CATV and telephone equipment. Each of these rooms have their own individual grounding bar that feeds down to the overall building grounding bar.

Fire Alarm

The fire alarm is an analogue addressable fire detection and alarm system with both manual and automation initiation. It allows special loading and editing instructions and loss of power will not erase the instructions in the memory. There will be both speakers and strobes, as noted on the plans. In the event of a fire, the system will be able to give full manual or automatic control of elevators, door hold open devices, sprinklers, fire pump and emergency power. There is also an alarm silence button, located in the main office of the building. It receives 120 V power with battery capacity to run for the duration of a power outage and the generator to kick in. Smoke control systems with pressurization located in Stair #2 and Stair #4 with fans are meant to dissipate and damper smoke. There is also a firefighter smoke control panel to indicate to firefighters whether the systems are operating or not.

CCTV

As stated in the telephone/data section, the CATV cable runs throughout the building with equipment located in IT rooms on the basement, first, second and fifth floors. The CCTV equipment offers LCD displays for workstations, network video recorders running at 240/100 V, indoor color pan/tilt/zoom dome cameras and door intercom systems.

Access Control

The access control portion is very extensive as security measures are fairly high in this school. It is required that S2 NetBox/ Extreme Security Management System be implemented and embedded in the building, no substitutions are allowed. The access control can be broken down into three different sections: Configuration Reports, History Reports and People Reports. For the configuration reports, the access control handles camera displays, elevators, portals (doors/windows), resources like temperature points and assigned threat level groups. The people reports log current uses, occupancy, photo ID gallery and information, roll call, time specifications and even sound files in emergency situations. The history report logs both of these overtime to develop a report where patterns can be found, if necessary. The groupings allow for a password protected viewing system to allow security officials to assess where people are located throughout the school and what is going on in those locations. Many settings can be activated to trigger possible alarms from video motion detection, camera failure, high or low temperature events, forced or held portals or occupancy limit violations.

Security

Security speakerphones are located in every classroom space. The unit is vandal resistant and ADA complient. There is a button labeled "PUSH FOR HELP" that will activate a strobe and place a call. Otherwise, the call button can be used to allow calls to be made from the keypad and be projected through the room. It is housed in stainless steel. The Access Control system is listed above alone with its security measures. Cameras are located in every corridor and focused on every entrance and stairwell. They are configured for very little blind spots. There are also wall mounted and ceiling mounted motion detectors.

Lighting Controls

The Corridors will be controlled mainly by occupancy sensors and this corridor in particular will be controlled by daylight sensors as well. The high bay occupancy sensor in this hallway uses infrared technology. These sensors will reduce the light output or turn the fixtures off after a certain owner-determined time delay. They can be seen on the plan below label HB_{IR}. Also designated by the owner, a time clock shall switch off all luminaires at a designated time and have a manual override. The Daylight sensors in the space are a wireless open-loop system with an integral IR receiver and provides a linear response from 0 to 10,000 footcandles and are documented by $_{W}PCD$ on the plan below.

In most performance based spaces, will be a Dimmer Rack which will accept (2) DMX systems and an Ethernet control signal. This system will be 3 phase, 4 wire and allow input line voltage as well as DMX input. A 3-pole circuit breaker will trigger emergency lighting if there is a power failure. The control systems should filter down to a user interface of push buttons or touchscreen. The House/Work Lights should be controlled by dim/non-dim buttons in various locations and a console panel with scene settings (5 Presets TBD, Show, Work, Reh, Night, Manual, Record and Off) while the performance lights will be powered by a 500 channel lighting console. For the work lights, LED fixtures will be controlled by the DMX system and every fixture must be able to dim smoothly to 0.1%. It is recommended to use Electrical Theatre Controls, Inc. as the manufacturer.

All other interior spaces will have occupancy sensor control and emergency lighting where indicated.

Site Lighting will be controlled by an astronomic time clock with a manual override for daytime re-lamping.

ENERGY EFFICIENT DESIGN

As per the specifications, in regards to sustainability efforts, the designers strove for a LEED accreditations of level LEED Silver. Most of this was planned to be obtained during construction. As for information about the Electrical sustainability features, the specifications only calls out the use of recycled content for system devices, if possible labeled credit MR4.

SINGLE LINE DIAGRAM

Please refer to Appendix A for the Electrical and Telecom Single-Line Diagram.

Part 3 // Evaluation of System Design

BUILDING LOAD ESTIMATION

Estimated	Actual
969 kVA	991 kVA

As you can see above in the table summarizing the estimated and actual load calculations for The Winsor School, the estimated and actual loads differ by about 20 kVA. This is a large difference that can probably be attributed for loads in the building that were not accounted for in the estimation. For instance, when an average square footage for mechanical systems was applied, this did not take into account future loads that were going to be implemented in the building in the near future. A parking garage is going underground nearby this building during Phase 2 of construction and therefore, loads had to be accounted for in the current phase of construction. That being said, both scenarios produce the same required switchboard of 3000A.

UTILITY RATE SCHEDULE AND BUILDING UTILIZATION VOLTAGE

Since the utility rate schedule is based on load required to the building, the rate schedule cannot differ much. The school is already using the most flexible rate by accounting for mostly daytime and non-holiday loading because of the school year. Furthermore, implementing a building utilization voltage of 480/277V is wise in a building of this size and height. Since most of the lighting and mechanical systems run on this voltage, it would be wise to use this as the main utilization voltage then step down to 208/120V when necessary.

ELECTRICAL EQUIPMENT EVALUATION

The wiring system is very interesting in this building. For the majority of the wiring system, aluminum is utilized providing a more economical choice though less conductive. This is contradictive to the amount of Mineral Insulated cable used in the emergency systems. Mineral insulated cable is very expensive. It is not shown why they chose to use this on all of the generator branches instead of just the main feeder and a further evaluation could prove whether this cost is justified.

It may also be possible to combine more panelboards to allow for less step-down transformers. Almost all of the panelboards are half empty leaving plenty of room for spare and future systems. As this building is not subject to expand on a regular basis or in the foreseeable future, it may be better to combine some panelboards to utilize transformers.

EMERGENCY & OPTIONAL BACK-UP POWER EVALUATION

The emergency system in The Winsor School is very hearty. The 600 kVA generator only covers a total of 181 kVA in loads, meaning that a smaller generator could be utilized to save on cost. Though there might by more loads on here where the building connects to the old academic wing. These loads were unknown based on the Construction Documents and couldn't be addressed in the report. The generator might be also be sized with the future systems of the parking garage or other endeavors that come around a later time. The uninterruptible power supply device to allow for a continuous supply to telecommunication devices in the result of a failure of power is wise with the amount of telecom and data systems are in the building not just for school purposes but also for security systems. The security system is one of the most complex parts of the building and should be able to function through any type of event.

When analyzing the wiring of the emergency power, some critical information was left out of the construction documents while others were more confusing. For instance, why are there two different branches of emergency power? As stated above there is a “standby” branch and an “emergency” branch, where does that difference come from? And is it necessary to have both or could they be combined. Also the generator, which is located on the roof, filters down through all the floors to the main emergency room in the basement then back up through the floors. Would it be more economical to locate the emergency power room on the fifth floor, closest to the generator? This would require the electrical space on the fifth floor to be doubled to accommodate the required equipment. Also, the two branches use different protection devices and little to no information could be found on the fuses that protect the “emergency” line and more information could not be requested from the architect.

All IBC emergency codes from illumination in paths of egress, functionality of smoke dampers and elevators as well as all others addressed in Part 1 of this report were met by the buildings emergency systems.

FURTHER ENERGY REDUCTION STRATEGIES

There are several methods that could be implemented to promote energy reduction. In terms of further LEED credits which seem to be lacking in the electrical portions of the design, a demand response program, like shedding part of its peak electrical demand, could be set up for the entire Winsor School campus that could be used in the Performing Arts and Wellness wing. This could be done by generators or load banks that collect power during the non-peak hours when the school is also closed for the night then using this to redistribute the energy during the peak hours.

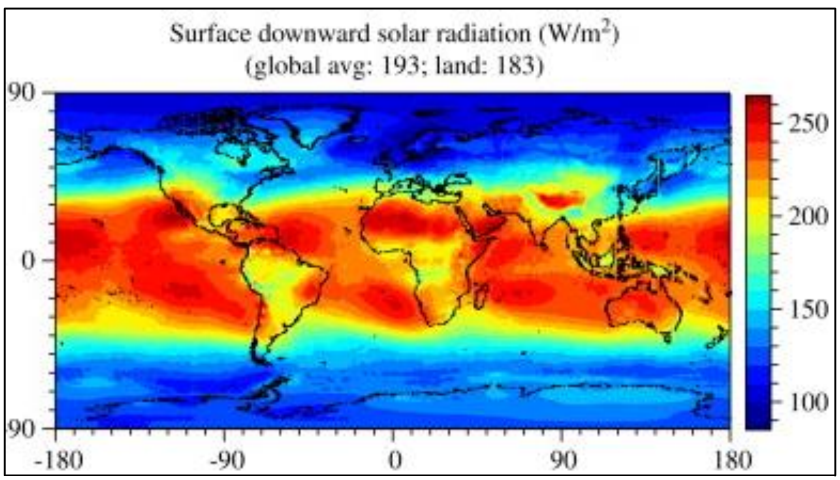

Figure 1 - Solar Radiation in w/sm

While more well-known energy systems PV panels and Wind generation are applicable in other scenarios, based on the geographical location in the northern United States, the school is not in an area that would receive justifiable radiation to produce energy by use of photovoltaic panels. Figure 1 shows the downward radiation in watts per meter squared for the world. It can be seen that Boston is located in the blue colored area and therefore does not receive a substantial amount of solar radiation. Furthermore, it doesn’t have the space, being fairly close to the urban Boston metropolitan, to justify wind or any other energy generation method.

Though traditional energy generation methods may not be best for this site, a more attainable method of energy reduction is the use of full building controls to further integrate the electrical, mechanical and other systems throughout the building. There is a small amount of integration in the security system in its ability to sense temperature of various spaces throughout the building but an overall systems integration would allow for a higher energy reduction in the building. For instance, the daylighting sensors, that already control lighting in certain exposed spaces, could further tie into the mechanical systems in terms of heat gain, especially in the winter when heat gain in Boston is not such a bad idea.

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"Chapter 27- Electrical." International Code Council. International Building Code 2009. Web. 7 Oct 2014. <http://publicecodes.cyberregs.com/icod/ibc/2009/icod_ibc_2009_27_sec002.htm?bu=IC-P-2009-000001&bu2=IC-P-2009-000019>.

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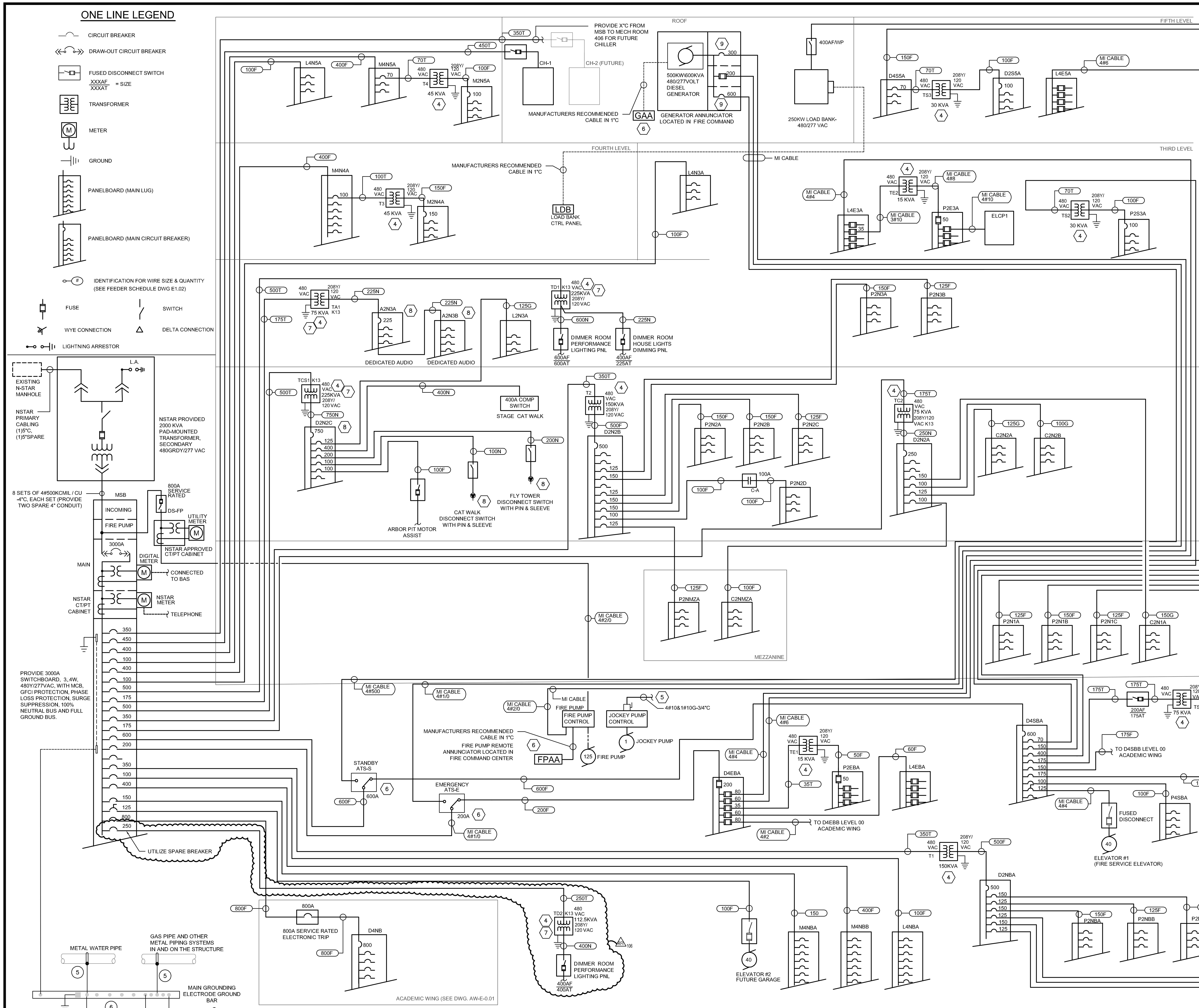
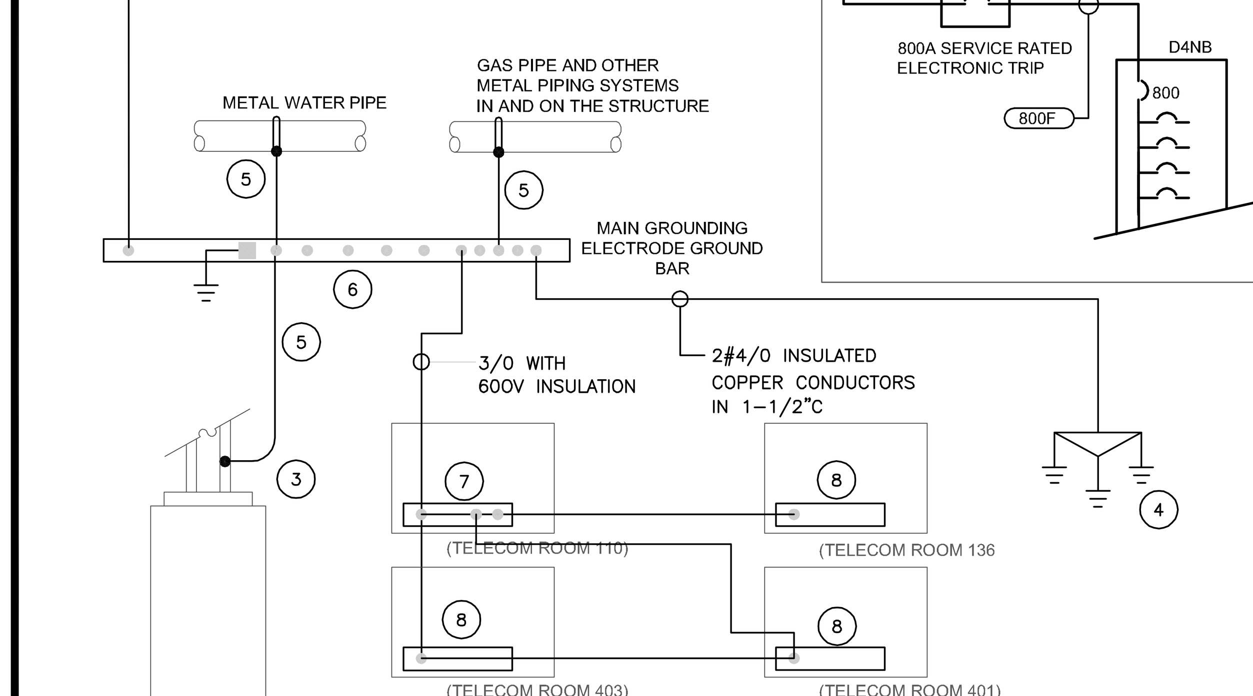
New Construction & Major Renovations. New Construction. US Green Building Council, 2014. Web 14 October 2014. <http://www.usgbc.org/credits/new-construction/v4>.

Figure 1 Reference:

Jacobson, Mark Z., and Mark A. Delucchi. "Providing All Global Energy with Wind, Water, and Solar Power, Part I: Technologies, Energy Resources, Quantities and Areas of Infrastructure, and Materials." Energy Policy 39.3 (2011): 1154-169. Web. 17 Oct. 2014. <http://www.sciencedirect.com/science/article/pii/S0301421510008645>.

Appendix A // One-Line Diagrams





ONE-LINE DIAGRAM
NOT TO SCALE

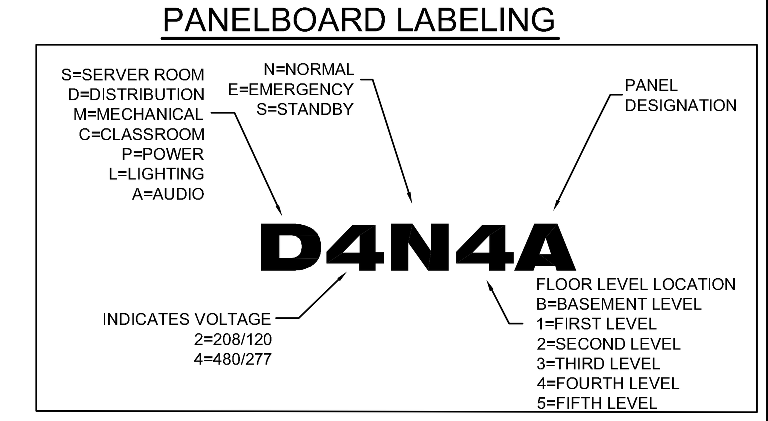
DRAWING NOTES

1. THE FOLLOWING NOTES ONLY APPLY TO THIS DRAWING.
2. REFER TO GENERAL NOTES, ELECTRICAL TRADE NOTES, LEGEND AND ABBREVIATIONS ON DRAWING E-0.00.
3. PROVIDE DOUBLE-TUB PANELS. FOR FURTHER INFORMATION, REFER TO PANELBOARD SCHEDULES.
4. PROVIDE GROUND CONDUCTOR IN PVC CONDUIT. SIZE AND PROPERLY CONNECT TO BUILDING STEEL AS REQUIRED BY ARTICLE 250 OF THE NATIONAL ELECTRIC CODE.
5. JOCKEY PUMP CIRCUIT TO PANEL D4SBA.
6. PROVIDE ATS-E/ATS-S/FIRE PUMP/GENERATOR ANNUNCIATOR PANELS IN FIRE COMMAND CENTER & MAIN ELECTRIC ROOM. PROVIDE MANUFACTURER RECOMMENDED CABLE IN 1" (ONE) CONDUIT EACH. PROVIDE MI CABLE FOR CONTROL SIGNALS TO GENERATOR AND TRANSFER SWITCHES.
7. PROVIDE K-13 TRANSFORMER.
8. PROVIDE DOUBLE NEUTRALS WITH AN ISOLATED GROUND.
9. PROVIDE ELECTRONIC TRIP BREAKERS.

EQUIPMENT GROUNDING NOTES

1. THE FOLLOWING NOTES APPLY TO ONLY THIS DRAWING.
3. INSTALL IRREVERSIBLE COMPRESSION CONNECTOR WITH TAMPER- PROOF HARDWARE OR INSTALL EXOTHERMIC WELD.
4. PROVIDE #3/0 GROUND CONDUCTOR IN 1 1/4" PVC CONDUIT AND TERMINATE UNDERGROUND AT THREE 10' COPPER GROUND RODS, 10' APART. CONNECT GROUND TO ALL OTHER BUILDING STEEL, METAL PIPING, ETC., AS REQUIRED BY ARTICLE 250 OF THE NEC
5. INSTALL GROUNDING ELECTRODE CONDUCTOR, SIZED BASED ON NEC TABLE 250-66 USING THE SERVICE PHASE CONDUCTOR SIZE, BUT NOT SMALLER THAN NO 4.
6. INSTALL A "MAIN GROUND ELECTRODE GROUND BAR" FOR SINGLE POINT GROUNDING. LOCATE AT AN ACCESSIBLE POINT NEAR THE SERVICE ENTRANCE EQUIPMENT. MAKE CONNECTIONS TO THE GROUND ELECTRODE CONDUCTOR USING IRREVERSIBLE COMPRESSION OR EXOTHERMIC WELDS. MAKE OTHER CONNECTIONS TO THE GROUND BAR USING TWO-HOLE COMPRESSION SPADE LUGS THAT MEET IEEE 837 REQUIREMENTS. LABEL EACH CONNECTION TO THE GROUND BAR.
7. INSTALL A COPPER TELECOMMUNICATIONS GROUNDING BAR(TMGB) IN THE MAIN TELECOMMUNICATIONS ROOM. CONNECT TO THE "MAIN GROUNDING ELECTRODE GROUND BAR" USING 600V INSULATED 3/0 COPPER CABLE AND COMPRESSION SPADE LUGS.
7. INSTALL A COPPER TELECOMMUNICATIONS GROUNDING BAR(TGB) IN EACH TELECOMMUNICATIONS ROOM. CONNECT TO THE "MAIN GROUNDING ELECTRODE GROUND BAR" USING 600V INSULATED 3/0 COPPER CABLE AND COMPRESSION SPADE LUGS.

PANELBOARD LABELING



THE WINSOR SCHOOL · FOUNDED 1886

The Winsor School
Centers for Performing Arts and Wellness
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Boston, MA 02115

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SUSTAINABILITY CONSULTANT:
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Concord, MA 01742 (978) 369-8978

PERMIT SET

KEY PLAN:

DRAWING TITLE:
ELECTRICAL ONE-LINE

DATE	REVISION
2013-03-01	1 CONFORMANCE
2013-03-01	2 REVISIONS
2013-03-01	3 VALUE MANAGEMENT
2013-03-01	4 EXTERIOR ENVELOPE REVIEW
2013-10-21	5 ELEC. ROOM 012

DRAWN BY: R. BENJAMIN
CHECKED BY: P. WHITTON
SCALE: N/A
DATE: MARCH 1, 2013
DRAWING NUMBER:
E-0.10

DRAWING NOTES

1. THE FOLLOWING NOTES APPLY TO ONLY THIS DRAWING.
2. FOR TELECOMMUNICATION SYMBOLS LEGEND AND TELECOMMUNICATION TRADE NOTES, REFER TO DRAWING T1.00.

3 QUANTITY OF DEVICES VARIES, SEE PLANS FOR EXACT QUANTITY AND LOCATIONS. PROVIDE 10' SERVICE LOOP AT THE STATION END OF EACH CABLE DROP.

4 TELECOMMUNICATION CONTRACTOR SHALL PROVIDE SUFFICIENT QUANTITY OF PATCH PANEL PORTS PLUS 20% SPARE, MINIMUM. CONTRACTOR SHALL PROVIDE ALL TERMINATIONS AT DATA JACKS AND AT PATCH PANELS. PROVIDE 3' SERVICE LOOP ON ALL CABLES.

5 PROVIDE SUFFICIENT QUANTITY OF PATCH PORTS PLUS 20% SPARE, MINIMUM. CONTRACTOR SHALL PROVIDE ALL TERMINATIONS AT TELEPHONE JACKS AND AT PATCH PANELS. PROVIDE 3' SERVICE LOOP ON ALL CABLES.

6 PROVIDE SUFFICIENT QUANTITY OF 25-PAIR CAT 3 CABLES AND 110-BLOCKS TO TERMINATE 1-PAIR PER TELEPHONE JACK PLUS 20%. COORDINATE PAIR TERMINATION OF 25-PAIR CABLES WITH TELEPHONE SYSTEM CONTRACTOR PRIOR TO PUNCHING DOWN AT PATCH PANELS AND 110-BLOCKS.

7 QUANTITY OF CABLES VARIES WITH OUTLET CONFIGURATION. PROVIDE CABLES AS REQUIRED FOR A COMPLETE CATEGORY 6 INSTALLATION.

8 PROVIDE DIRECT CONNECTION TO DEDICATED TELEPHONE LINES FOR ELEVATOR, ETC.

9 TELECOM CONTRACTOR SHALL PROVIDE #4 BARE COPPER GROUND WIRE TO LOCAL GROUNDING BUSBAR TO GROUND ALL METALLIC TELECOMM EQUIPMENT, RELAY RACKS, CABLETRAY, 110-BLOCKS, ETC.

10 ELECTRICAL CONTRACTOR SHALL PROVIDE TGB ISOLATED COPPER BUSBAR IN ALL TELECOMMUNICATIONS ROOMS. BOND BUSBAR TO BUILDING STEEL AND TO GROUNDING BUSBAR IN MAIN TELECOMMUNICATIONS ROOM WITH 3/0 BARE COPPER GROUND WIRE IN 1" PVC CONDUIT.

11 ELECTRICAL CONTRACTOR SHALL PROVIDE TMGB ISOLATED COPPER BUSBAR. GROUND BUSBAR BACK TO BUILDING GROUND GRID WITH 3/0 BARE COPPER GROUND WIRE IN 1" PVC CONDUIT.

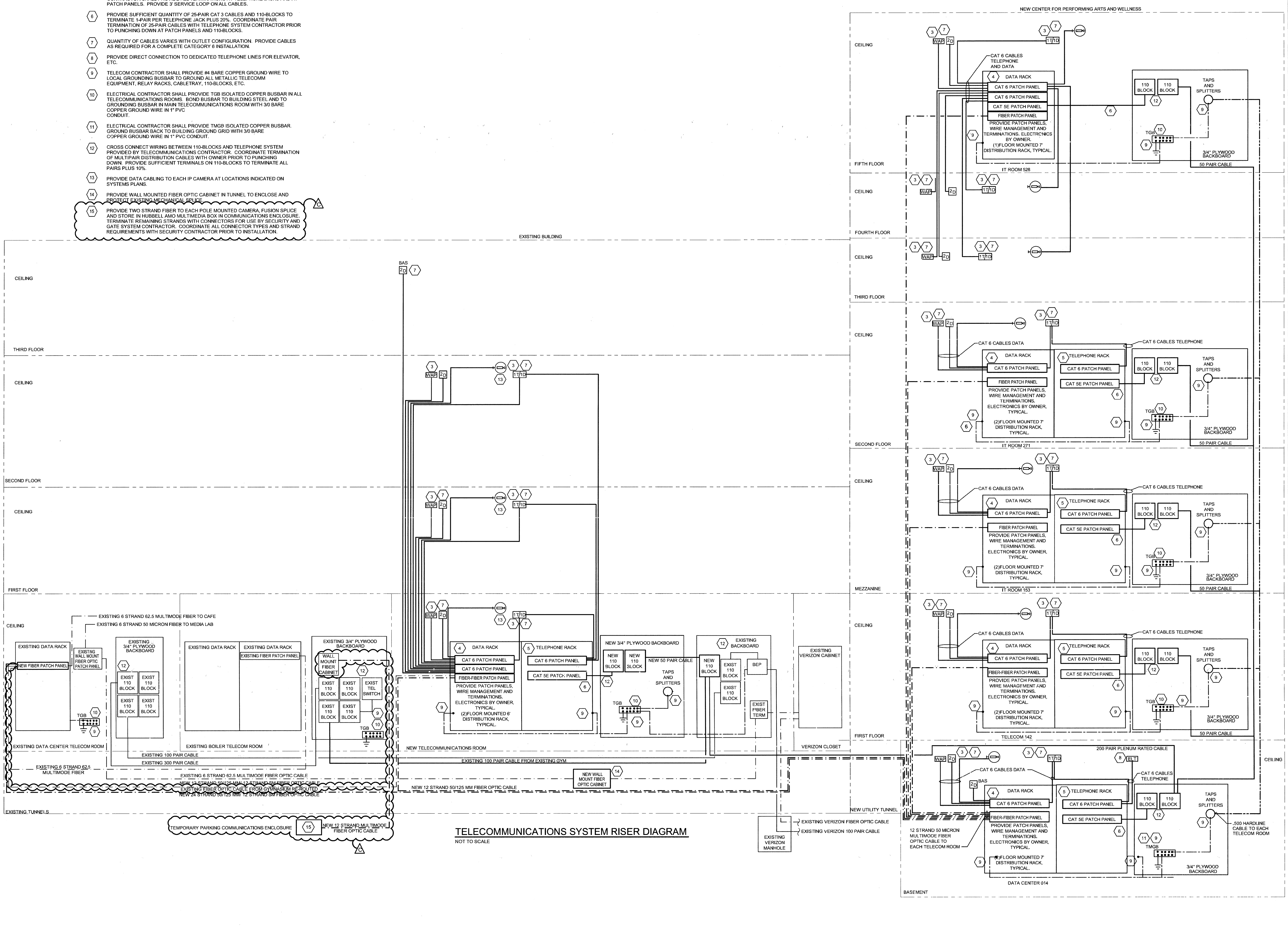
12 CROSS CONNECT WIRING BETWEEN 110-BLOCKS AND TELEPHONE SYSTEM PROVIDED BY TELECOMMUNICATIONS CONTRACTOR. COORDINATE TERMINATION OF MULTIPAIR DISTRIBUTION CABLES WITH OWNER PRIOR TO PUNCHING DOWN. PROVIDE SUFFICIENT TERMINALS ON 110-BLOCKS TO TERMINATE ALL PAIRS PLUS 10%.

13 PROVIDE DATA CABLING TO EACH IP CAMERA AT LOCATIONS INDICATED ON SYSTEMS PLANS.

14 PROVIDE WALL MOUNTED FIBER OPTIC CABINET IN TUNNEL TO ENCLOSE AND PROTECT EXISTING MECHANICAL SPLICE.

15 PROVIDE TWO STRAND FIBER TO EACH POLE MOUNTED CAMERA, FUSION SPLICE AND STORE IN HUBBELL AMO MULTIMEDIA BOX IN COMMUNICATIONS ENCLOSURE. TERMINATE REMAINING STRANDS WITH CONNECTORS FOR USE BY SECURITY AND GATE SYSTEM CONTRACTOR. COORDINATE ALL CONNECTOR TYPES AND STRAND REQUIREMENTS WITH SECURITY CONTRACTOR PRIOR TO INSTALLATION.

C



TELECOMMUNICATIONS SYSTEM RISER DIAGRAM

NOT TO SCALE

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Centers for Performing Arts and Wellness

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Boston, MA 02110 (617) 229-5190

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50 Beharrell Street
Concord, MA 01742 (978) 369-8978

PERMIT SET

KEY PLAN:

ACADEMIC WING

DRAWING TITLE:
TELECOMMUNICATIONS RISER DIAGRAM

DATE	REVISION
2013-03-01	C CONFORMANCE
2013-03-01	1 REVISIONS
2013-03-01	2 VALUE MANAGEMENT
2013-03-01	3 EXTERIOR ENVELOPE REVIEW

DRAWN BY: GJH
CHECKED BY: PGW
SCALE: NOT TO SCALE
DATE: MARCH 1, 2013

DRAWING NUMBER:
T-0.10