Technical Report #2 - Massachusetts Public Library

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Lighting-Electrical Option
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Electrical Systems Existing Conditions and Building Load Summary Report l

AE Senior Thesis Project

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Appendices:

Include Feeder Schedule, Diagrams and Ballast Information

I. Power Distribution Systems

Note: A Single-Line Diagram and feeder schedule are attached to the appendix.

Executive Summary
This report describes the of electrical distribution systems for Massachusetts Public Library. Because the existing historic portion of the library is gaining a new large addition, the building desires to consolidate the entire electrical system. The building will finish construction in 2009.

The building is still under construction the information may change after completion. The information provided within this report is as accurate as possible.

Within this report is an explanation of the electrical systems and special characteristics of each system, along with a summary of the total building electrical loads. In addition, the report includes a single-line diagram that describes the full extent of the existing electrical distribution system. The size of the existing main distribution equipment has been checked to determine if it is appropriate for the building.

This report is available in electronic format at:
http://www.engr.psu.edu/edu/ae/thesis/portfolios/2009/meg5021

Summary of Distribution System

The building is serviced by a 2000 kVA service entrance transformer by NSTAR Electric, which is then transformed to both 480V primary and 208/120V secondary systems. Emergency power is fed from a 300kW/375kVA, Diesel Generator which outputs power at 480Y/277V. A main transformer provides the power to the main switchboard. The main switchboard is 2000 A, 480Y/277V, 3-Ph, 4 W with a 65K AIC rating.

Utility Company Information

NSTAR-Utility Company
NSTAR One NSTAR Way Westwood, MA 02090 800-595-2000
http://www.nstaronline.com/business/

A utility Rate structure:

02 - General (G-1)

This rate is for non-residential customers with a load that is greater than 10 kW for three consecutive billing months but not greater than 100 kilowatts in each of 12 consecutive billing months.

Delivery Service Charges

Customer (per month) $7.32	**Distribution Demand** First 10 kW (per kW) $3.76	**Distribution Demand** Over 10 kW (per kW) $7.01
Distribution Energy (per kWh) $0.01099	**Transition Demand** (per kW) $2.97	**Transition Energy** (credit per kWh) $0.00102
Transmission Demand (per kW) $2.42	**Energy Conservation** (per kWh) $0.00250	**Renewable Energy** (per kWh) $0.00050

The Distribution Charge includes a credit of $0.00002 for a Pension Adjustment Factor. The Transition Charge includes a $0.00102 Default Service Adjustment.

The above table is for the delivery services portion of your bill. To calculate your total bill, you also need to add the supplier services charges (Basic Service or a third-party energy supplier).

Service Entrance

The service entrance is located underground, on the east side of the building. From there the electricity is fed to a specified room on the 1st level of the basement, called the NSTAR Vault. In this location the building is fed directly from the electrical utility company. The building has incoming 15KV feeders via electrical ductbank. The encased ductbank runs along the top of the garage roof within a concrete slab and turns down into primary feed pull box within the NSTAR vault. The feeder conductors are provided by NSTAR. NSTAR provides all primary service conductors and connections within primary switchgear and at primary terminals of NSTAR station transformer. NSTAR is also responsible for all secondary connections.

(2) 500 KCMIL bare conductors are provided for NSTAR primary switchgear grounding. The conductors are exothermically bonded to the vault ground system. The conductors are terminated inside the footprint of the primary switchgear and do not interfere with any cabling work provided within switchgear.

Vault grounding in this location is based on IEEE 80 and the requirements of the Massachusetts Electrical Code.

Two NSTAR utility meters (micro processor based) are located within the main switchboard, in the basement electrical room. A third meter is also located in the same location for customer metering.

Voltage Systems

The building is serviced by a 2000 kVA service entrance transformer. The power is converted to both 480V primary and 208/120V secondary systems.

Equipment operating at 480Y/277 V, 3-Ph, 4 W includes:

- Most HVAC equipment (hot water pumps, fans, AHUs, and chillers)
- Fire Pump Breaker
- Storm Water Retention Tank Control Panel
- Sewage Ejectors
- Elevators

Equipment operating at 208Y/120 V, 3- Ph, 4 W includes:

- AV equipment
  (such as VCRs Projectors and DVD players)
- Electrical Water Heaters
- Some Exhaust Fans
- Sump Pumps
- Some Lighting
- Receptacles

Emergency Power System(s)

Emergency power is fed from a 300kW/375kVA, Diesel Generator. The generator is located in the basement of the new building, and outputs power at 480Y/277V.
The emergency generator outputs power to these main loads:

- Fire Pump
- Fire Alarm System
- Emergency Distribution Panels
  (D4LRB, D4LS)
  - Elevators
  - Panel boards serving emergency lighting and exit signs
  - Panel boards serving some mechanical equipment (Servicing emergency exhaust fans, waste pumps and sump pumps)

When any of the systems loose normal power then the automatic transfer switch will trip and the power source changes to the emergency generator. There are three automatic transfer switches connected to the emergency generator which are then connected to Emergency Distribution Panels. Between the time when the NSTAR utility power is lost and the generator becomes operational, power may be lost temporarily.

Locations of Switchgear

Majority of the new buildings switchgear is located below ground in the basement. The main electrical room for the building is positioned in the rear of the building on the 2nd floor basement level. The generator room is located adjacent to the main electrical room. Another electrical room is located on the 1st floor of the basement next to the data closet/server room. A third larger electrical room is placed next to the NSTAR vault on the same floor at the front of the facility.

Major Pieces Of Equipment

Tag	Type of equipment	Floor level	Room #	Room Name	1/8 scale Drawing #	Enlarged Plan Drawing #
	POWER TRANSFORMER	NEW BUILDING BASEMENT	B108	NSTAR VAULT	E-2.00B1	E-3.02
	NSTAR PRIMARY SWITCHGEAR	NEW BUILDING BASEMENT	B108	NSTAR VAULT	E-2.00B1	E-3.02
D2NBC	DISTRIBUTION PANEL	NEW BUILDING BASEMENT	B110	ELECTRICAL ROOM	E-2.00B1	E-3.02
D4NGB	DISTRIBUTION PANEL	NEW BUILDING BASEMENT	B110	ELECTRICAL ROOM	E-2.00B1	E-3.02
SWRTCP	SWITCHBOARD	NEW BUILDING BASEMENT	B110	ELECTRICAL ROOM	E-2.00B1	E-3.02
SS4NB	MAIN	NEW	B110	ELECTRICAL	E-2.00B1	E-3.02

	SWITCHBOARD	BUILDING BASEMENT		ROOM		
T4	TRANSFORMER	NEW BUILDING BASEMENT	B110	ELECTRICAL ROOM	E-2.00B1	E-3.02
TA	TRANFORMER	NEW BUILDING BASEMENT	B110	ELECTRICAL ROOM	E-2.00B1	E-3.02
D4NBA	DISTRIBUTION PANEL	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	E-3.01
D2NBA	DISTRIBUTION PANEL	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	E-3.01
T6	TRANFORMER	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	E-3.01
T1	TRANFORMER	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	E-3.01
T3	TRANFORMER	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	E-3.01
T2	TRANFORMER	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	E-3.01
	AUTOMATIC TRANSFER SWITCH	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	E-3.01
	DIESEL GENERATOR	NEW BUILDING BASEMENT	B226	GENERATOR ROOM	E-2.00B2	NA
D4LRB	DISTRIBUTION PANEL	NEW BUILDING BASEMENT	B226	GENERATOR ROOM	E-2.00B2	NA
	AUTOMATIC TRANSFER SWITCH	NEW BUILDING BASEMENT	B226	GENERATOR ROOM	E-2.00B2	NA
D4LSB	DISTRIBUTION PANEL	NEW BUILDING BASEMENT	B226	GENERATOR ROOM	E-2.00B2	NA
	AUTOMATIC TRANSFER SWITCH	NEW BUILDING BASEMENT	B226	GENERATOR ROOM	E-2.00B2	NA
TB	TRANSFORMER	NEW BUILDING BASEMENT	B226	GENERATOR ROOM	E-2.00B2	NA

Lighting/Appliance Equipment

Tag	Equipment	Floor level	Room #	Room Name	Drawing #	Voltage System	Main Size (AMPS)
L4LS2B	LIGHTING PANEL	EXISTING BUILDING 2ND FLOOR	X-222	MECHANICAL ROOM	XE-1.02	480Y/277 V, 3-Ph, 4 W	125
L4N2B	LIGHTING PANEL	EXISTING BUILDING 2ND FLOOR	X-212	CORRIDOR CLOSET	XE-1.02	480Y/277 V, 3-Ph, 4 W	125
R2N2C	RECEPTAC LE PANEL	EXISTING BUILDING 2ND FLOOR	X-212	CORRIDOR CLOSET	XE-1.02	208Y/120 V, 3- Ph, 4 W	125
M4N2B	MECHANICAL PANEL	EXISTING BUILDING 2ND FLOOR	X-202	EMERG. ELECTRIC CLOSET	XE-1.02	480Y/277 V, 3-Ph, 4 W	125
R2N1A	RECEPTACLE PANEL	EXISTING BUILDING 1ST FLOOR	X-116	COMPUTER CLASSROOM	XE-1.01	208Y/120 V, 3- Ph, 4 W	125
M4NBB	MECHANICAL PANEL	EXISTING BUILDING BASEMENT	X-033	VESTIBULE	XE-1.00	480Y/277 V, 3-Ph, 4 W	150
L4NBB	LIGHTING PANEL	EXISTING BUILDING BASEMENT	X-010	ELECTRICAL ROOM	XE-1.00	480Y/277 V, 3-Ph, 4 W	125
R2NBB	RECEPTACLE PANEL	EXISTING BUILDING BASEMENT	X-010	ELECTRICAL ROOM	XE-1.00	208Y/120 V, 3- Ph, 4 W	125
R2NGA	RECEPTACLE PANEL	NEW BUILDING BASEMENT	B110	ELECTRICAL ROOM	E-2.00B1	208Y/120 V, 3- Ph, 4 W	150
R2NGB	RECEPTACLE PANEL	NEW BUILDING BASEMENT	B110	ELECTRICAL ROOM	E-2.00B1	208Y/120 V, 3- Ph, 4 W	20
L4NGB	LIGHTING PANEL	NEW BUILDING BASEMENT	B110	ELECTRICAL ROOM	E-2.00B1	480Y/277 V, 3-Ph, 4 W	225
L4LSBB	LIGHTING PANEL	NEW BUILDING BASEMENT	NA	EMERGENCY ELECTRICAL CLOSET	E-2.00B1	480Y/277 V, 3-Ph, 4 W	125
L4NMA	LIGHTING PANEL	NEW BUILDING	B128	ELECTRICAL CLOSET	E-2.00B1	480Y/277 V, 3-Ph, 4	125

		BASEMENT				W	
R2NMA	RECEPTACLE PANEL	NEW BUILDING BASEMENT	B128	ELECTRICAL CLOSET	E-2.00B1	208Y/120 V, 3- Ph, 4 W	125
R2NMB	RECEPTACLE PANEL	NEW BUILDING BASEMENT	B128	ELECTRICAL CLOSET	E-2.00B1	208Y/120 V, 3- Ph, 4 W	125
R2NBA	RECEPTACLE PANEL	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	208Y/120 V, 3- Ph, 4 W	225
M2NB	MECHANICAL PANEL	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	208Y/120 V, 3- Ph, 4 W	40
M4NBA	MECHANICAL PANEL	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	480Y/277 V, 3-Ph, 4 W	400
M2LRB	MECHANICAL PANEL	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	208Y/120 V, 3- Ph, 4 W	100
M20SBA	MECHANICAL PANEL	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	208Y/120 V, 3- Ph, 4 W	70
M40SB	MECHANICAL PANEL	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	480Y/277 V, 3-Ph, 4 W	60
M4NS	MECHANICAL PANEL	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	480Y/277 V, 3-Ph, 4 W	600
R2NS	RECEPTACLE PANEL	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	208Y/120 V, 3- Ph, 4 W	100
L4NBA	LIGHTING PANEL	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	480Y/277 V, 3-Ph, 4 W	125
L4LSBA	LIGHTING PANEL	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	480Y/277 V, 3-Ph, 4 W	125
R2LSB	RECEPTACLE PANEL	NEW BUILDING BASEMENT	B224	MAIN ELECTRIC ROOM	E-2.00B2	208Y/120 V, 3- Ph, 4 W	30
L4N2A	LIGHTING PANEL	NEW BUILDING 2ND FLOOR	234	ELECTRICAL CLOSET	E-2.02	480Y/277 V, 3-Ph, 4 W	125
R2N2B	RECEPTACLE PANEL	NEW BUILDING 2ND	234	ELECTRICAL CLOSET	E-2.02	208Y/120 V, 3- Ph, 4 W	NA

		FLOOR					
R2N2A	RECEPTACLE PANEL	NEW BUILDING 2ND FLOOR	234	ELECTRICAL CLOSET	E-2.02	208Y/120 V, 3- Ph, 4 W	150
M4N2A	MECHANICAL PANEL	NEW BUILDING 2ND FLOOR	234	ELECTRICAL CLOSET	E-2.02	480Y/277 V, 3-Ph, 4 W	125
M4LR2	MECHANICAL PANEL	NEW BUILDING 2ND FLOOR	234	ELECTRICAL CLOSET	E-2.02	480Y/277 V, 3-Ph, 4 W	125
L4LS2A	LIGHTING PANEL	NEW BUILDING 2ND FLOOR		EMERGENCY ELECTRIC CLOSET	E-2.02	480Y/277 V, 3-Ph, 4 W	100

Over-current Devices

There is one set of fuses located in the NSTAR primary switchgear to protect the main service entrance. Sixteen additional circuit breakers are located within the main switchboard (SS4NB) 480Y/277V, 3-Ph, 4 W. The main circuit breaker has an over current device with a 2000 A trip. The fire pump breaker has an 800 A trip. There are two chiller circuit breakers with 500 A trips. The panel board breaks down into 6 distribution, 1 lighting panel, 4 mechanical panels and 1 receptacle panel circuit breaker. All of these remaining circuit breakers maintain less than 600 A trips.

Transformers

The building has one main transformer in the NSTAR vault connected to the primary switchgear. Twelve other dry type transformers are located throughout the building to protect other electrical equipment.

INDIVIDUAL TRANSFORMER SCHEDULE

TAG	PRIMARY VOLTAGE	SECONDARY VOLTAGE	SIZE (kVA)	TYPE	TEMP. RISE	TAPS	MOUNTING	REMARKS
T-A	480V,3PH, 3W	208Y/120V,3PH ,4W	3	DRY TYPE	115 DEGREES C	N/A	WALL BRACKETS FOR WALL MOUNTED TRANSFORMERS	
T-B	480V,3PH, 3W.	208Y/120V,3PH ,4W	6	DRY TYPE	115 DEGREES C	N/A	WALL BRACKETS FOR WALL MOUNTED TRANSFORMERS	
T-1	480V,3PH, 3W.	208Y/120V,3PH ,4W	9	DRY TYPE	115 DEGREES C	N/A	WALL BRACKETS FOR WALL MOUNTED TRANSFORMERS	
T-2	480V,3PH, 3W.	208Y/120V,3PH ,4W	15	DRY TYPE	150 DEGREES C	N/A	WALL BRACKETS FOR WALL MOUNTED TRANSFORMERS	
T-3	480V,3PH, 3W.	208Y/120V,3PH ,4W	30	DRY TYPE	150 DEGREES C	N/A	PLATFORMS FOR TRAPEZE MOUNTED TRANSFORMERS	
T-4	480V,3PH, 3W.	208Y/120V,3PH ,4W	45	DRY TYPE	150 DEGREES C	N/A	PLATFORMS FOR TRAPEZE MOUNTED TRANSFORMERS	
T-5	480V,3PH, 3W.	208Y/120V,3PH ,4W	75	DRY TYPE	150 DEGREES C	N/A	PLATFORMS FOR TRAPEZE MOUNTED TRANSFORMERS	
T-6	480V,3PH, 3W.	208Y/120V,3PH ,4W	112 1/2	DRY TYPE	150 DEGREES C	N/A	PLATFORMS FOR TRAPEZE MOUNTED TRANSFORMERS	
T-7	480V,3PH, 3W.	208Y/120V,3PH ,8W	150	DRY TYPE	150 DEGREES C	N/A	PLATFORMS FOR TRAPEZE MOUNTED TRANSFORMERS	
T-8	480V,3PH, 3W.	208Y/120V,3PH ,8W	225	DRY TYPE	150 DEGREES C	N/A	PLATFORMS FOR TRAPEZE MOUNTED TRANSFORMERS	
T-9	480V,3PH, 3W.	208Y/120V,3PH ,12W	300	DRY TYPE	150 DEGREES C	N/A	PLATFORMS FOR TRAPEZE MOUNTED TRANSFORMERS	
T-10	480V,3PH, 3W.	208Y/120V,3PH ,20W	500	DRY TYPE	150 DEGREES C	N/A	PLATFORMS FOR TRAPEZE MOUNTED TRANSFORMERS	

Notes:

1. BOND NEUTRAL OF TRANSFORMER SECONDARY TO THE TRANSFORMER CASE WITH BONDING JUMPER AS PER NATIONAL ELECTRIC CODE.
2. GROUND THE CASING OF THE TRANSFORMER TO THE SEPARATELY DERIVED SYSTEM GROUNDED CONDUCTORS. CONDUSTORS SHALL BE BONDED TO THE GROUNDING ELECTRODE RISER.
3. ALL CONDUCTOR SIZES ARE FOR COPPER CONDUCTORS.

4. SECONDARY OVERCURRENT PROTECTION SHALL BE LOCATED WTIH TEN (10) FEET OF THE TRANSFORMER SECONDARY TERMINALS EITHER IN A PANELBOARD (MAIN BREAKER) OR AN INDIVIDUALLY MOUNTED CIRCUIT BREAKER.
5. WHERE ISOLATED GROUND PANELBOARDS & GROUND WIRES ARE REQUIRED REFER TO ISOLATED GROUNDING DETAIL FOR ADDITIONAL INFORMATION.

Special Equipment

Note: This building does not appear to utilize any power factor correction systems.

Emergency power is fed from a 300kW/375kVA, Diesel Generator which outputs power at 480Y/277V. There appears to be no other special generators, wind turbines or solar panels utilized. The library does not appear to maintain any special harmonic filters or isolation transformers. (These topics are still under further investigation)

Lighting Loads

The building actually lacks a "typical lighting system". The library utilizes a wide variety of different light sources. Because the existing building contrasts in design in comparison to the addition, the lighting does as well. The selection of lamps ranges from LEDs to metal halide to induction lamps. The luminaires are tagged F, E, X, L and G due to their location. The tags F and E refer to the future expansion vs. the existing luminaires in the historic portion. The L tag represents landscape lighting and the X represents exterior lighting. The last tag G, refers to luminaires placed within the garage.

Lighting Loads

Tag	Lamp Type	Individual Lamp Wattage	# Lamps	Ballast Type	Operating Voltage (V)	Fixture Input Watts	Ballast Factor	Current (A) @ Start and Operating	Power Factor @ Start and Operating
F1	T5HO	54 W	1	ADVANCE CENTIUM T5HO (2) LAMP BALLAST	277	120 W	1.0	0.35 A	0.98
F1A	T5HO	54 W	1	ADVANCE CENTIUM T5HO (2) LAMP BALLAST	277	120 W	1.0	0.35 A	0.98
F1B	T5HO	54 W	1	ADVANCE CENTIUM T5HO (2) LAMP BALLAST	277	120 W	1.0	0.35 A	0.98
F3	ED17 MH	70 W	1	INTEGRAL HPF E-VISION ELECTRONIC	277	79 W	1.0	0.30 A	0.90
F4	T5HO	54 W	2	INTEGRAL HPF MARK 10	277	24/125 W	0.03/1.00	0.45 A	0.98

				POWERLINE DIMMING					
F5	T6 MH	35 W	1	INTEGRAL HPF ELECTRONIC	277		MIN 0.88		
F6	T4 CFL	18 W	1	INTEGRAL HPF SMARTMATE ELECTRONIC	277	19 W	1.00	0.16 A	0.97
F7	T4 CFL	32 W	1	INTEGRAL SMARTMATE HPF ELECTRONIC	277	36 W	0.98	0.13 A	0.98
F8	T6 MH	39 W	1	INTEGRAL HPF E-VISION ELECTRONIC	277	45 W	1.0	0.18 A	0.95
F8Q	T6 MH	39 W	1	INTEGRAL HPF E-VISION ELECTRONIC	277	45 W	1.0	0.18 A	0.95
F8A	T6 MH	39 W	1	INTEGRAL HPF E-VISION ELECTRONIC	277	45 W	1.0	0.18 A	0.95
F8AQ	T6 MH	39 W	1	INTEGRAL HPF E-VISION ELECTRONIC	277	45 W	1.0	0.18 A	0.95
F8B	T6 MH	39 W	1	INTEGRAL HPF E-VISION ELECTRONIC	277	45 W	1.0	0.18 A	0.95
F9	LED	1.6 W	-	REMOTELY LOCATED	120	-	-	-	-
F10	T5HO	54 W	1	ADVANCE CENTIUM T5HO (2) LAMP BALLAST	277	120 W	1.0	0.35 A	0.98
F13	MH	39 W	1	INTEGRAL HPF E-VISION ELECTRONIC	277	45 W	1.0	0.18 A	0.95
F14	T5	14 W	1	HPF CENTUIUM MICRO PRO ELECTRONIC	277	19 W	1.05	0.08	0.98
F17	T5	40 W	1	INTEGRAL HPF ELECTRONIC	277		MIN 0.88		
F18	N/A	N/A	N/A	-	120	-	-	-	-
F18A	T4	75 W	1	-	120				
F18B	PAR30 HALOGEN	75 W	1	-	120	75 W	-	-	1.00
F18	MR16	75 W	1	-	120	75 W	-	-	1.00

C									
F20	T4 CFL	18 W	1	HPF SMART MATE ELECTRONIC	277	20 W	1.05	0.08	0.97
F21	T4 CFL	32 W	1	INTEGRAL SMARTMATE HPF ELECTRONIC	277	36 W	0.98	0.13 A	0.98
F23	T5HO	54 W	1	ADVANCE CENTIUM T5HO (2) LAMP BALLAST	277	120 W	1.0	0.35 A	0.98
F25	T5HO	54 W	2	HPF CENTIUM ELECTRONIC	277	63 W	1.03	0.23 A	0.99
F26	T5 BIAX	40 W	2	HPF ELECTRONIC	277		MIN 0.88		
F27	MH	70 W	1/15”	INTEGRAL HPF ELECTRONIC	277	79 W	1.0	0.3 A	0.9
F27A	PAR38 INCANDESCENT	100W	1/12"	-	120	100 W	-	-	1.00
F30	T4 CFL	32 W	1	HPF DIMMING MARK 10 POWERLINE	277	09/38	0.05/1.05	0.14	0.98
F32	FLUORSCENT STRIP	14 W	1	HPF CENTUIUM MICRO PRO ELECTRONIC	277	19 W	1.05	0.08	0.98
F34	T4 CFL	32 W	1	INTEGRAL SMARTMATE HPF ELECTRONIC	277	36 W	0.98	0.13 A	0.98
F37	T4 CFL	32 W	1	REMOTELY LOCATED SMARTMATE HPF ELECTRONIC	277	36 W	0.98	0.13 A	0.98
F38	N/A	N/A	N/A	-	120				
F38A	PAR 30 HALOGEN	75 W	1	-	120	75 W	-	-	1.00
F39	T4 BIAX	40 W	1	INTEGRAL DIMMING HI-LUME/LUTRON	277				
F41	T5HO	54 W	1	ADVANCE	277	120 W	1.0	0.35 A	0.98

				CENTIUM T5HO (2) LAMP BALLAST					
F42	T6 MH	39 W	1	INTEGRAL HPF E-VISION ELECTRONIC	277	45	1.0	0.18 A	0.95
F43	T4 CFL	32 W	1	INTEGRAL SMARTMATE HPF ELECTRONIC	277	36 W	0.98	0.13 A	0.98
F44	PAR 38 HALO GEN	100 W	1	-	120	100 W	-	-	1.00
F45	PAR 38 HALO GEN	100W	1	-	120	100 W	-	-	1.00
E1	FT	40 W	2	HPF ELECTRONIC	277		MIN 0.88		
E1A	FT	40 W	4	HPF ELECTRONIC	277		MIN 0.88		
E2	CFL	32 W	1	INTEGRAL SMARTMATE HPF ELECTRONIC	277	36 W	0.98	0.13 A	0.98
E4	CFL	18 W	2	HPF SMART MART ELECTRONIC	277	39 W	1.05	0.17	0.99
E4A	CFL	18 W	2	HPF SMART MART ELECTRONIC	277	39 W	1.05	0.17	0.99
E7	T5HO	54 W	1	ADVANCE CENTIUM T5HO (2) LAMP BALLAST	277	120 W	1.0	0.35 A	0.98
E7A	T5HO	54 W	1	ADVANCE CENTIUM T5HO (2) LAMP BALLAST	277	120 W	1.0	0.35 A	0.98
E9	MR 16	37 W	1	-	120/12	37 W	-	-	1.00
E9A	N/A	N/A	N/A	-	120				
E10	CFL	28 W	8	SELF BALLASTED SCREW-IN	120		MIN 0.88		
E11	T6 MH	150 W	1	INTEGRAL HPF E-VISION ELECTRONIC	277	166 W	1.0	0.6 A	0.9

E14	T3.25 XENON	10 W	1	-	12	10 W	-	-	1.0
E15	CFL	32 W	1	INTEGRAL SMARTMATE HPF ELECTRONIC	277	36 W	0.98	0.13 A	0.98
E18	T5HO	54 W	1	ADVANCE CENTIUM T5HO (2) LAMP BALLAST	277	120 W	1.0	0.35 A	0.98
E19	HALOGEN/ CFL	300 W/18 W	4/2	-/	120	300 W/	-/	-/	1.00/
E20	T6 MH	39 W	1	INTEGRAL HPF E-VISION ELECTRONIC	277	45 W	1.0	0.18 A	0.95
E21	T6 MH	39 W	1	INTEGRAL HPF E-VISION ELECTRONIC	277	45 W	1.0	0.18 A	0.95
E22	LED	-	-	-	120				
E23	T4 CFL	32 W	1	INTEGRAL SMARTMATE HPF ELECTRONIC	277	36 W	0.98	0.13 A	0.98
E25	T5HO	54 W	1	ADVANCE CENTIUM T5HO (2) LAMP BALLAST	277	120 W	1.0	0.35 A	0.98
E27	CFL	32 W	1	INTEGRAL SMARTMATE HPF ELECTRONIC	277	36 W	0.98	0.13 A	0.98
E28	BT15	60 W	2	-	120				
E29	N/A	N/A	N/A	REMOTELY LOCATED	120		MIN 0.88		
E29A	PAR 30 TUNSTEN HALOGEN	75 W	1	-	120	75 W	-	-	1.00
E31	CFL	32 W	1	INTEGRAL SMARTMATE HPF ELECTRONIC	277	36 W	0.98	0.13 A	0.98
E32	T5HO	54 W	1	ADVANCE CENTIUM T5HO (2) LAMP	277	120 W	1.0	0.35 A	0.98

				BALLAST					
E33	T6 MH	35 W	1	INTEGRAL HPF ELECTRONIC	277		MIN 0.88		
E34	T5HO	54 W	1	ADVANCE CENTIUM T5HO (2) LAMP BALLAST	277	120 W	1.0	0.35 A	0.98
E35	MR 16	37 W	1	-	277	37 W	-	-	1.00
E36	MR 16	37 W	1	-	120	37 W	-	-	1.00
E42	FP 28	28 W (4') OR 21 W (3')			120				
V1	T8	32 W	2	HPF OPTANIUM ELECTRONIC	277	58 W	0.89	0.49	0.99
V2	T5	28 W	1	HPF CENTUIUM ELECTRONIC	277	33 W	1.04	0.12 A	0.98
V3	A21	150 W	1	-	120	150 W	-	-	1.00
V4	T8	32 W	2	-	277		-		
V5	T5	14 W	2	HPF CENTUIUM ELECTRONIC	277	36 W	1.10	0.31	0.97
V6	T5	14 W	1	HPF CENTUIUM MICRO PRO ELECTRONIC	277	19 W	1.05	0.08	0.98
V7	ED 17 MH/ T4 HALO GEN	50 W	1	HPF E-VISION ELECTRONIC /-	277	55 W/50 W	1.0/-	0.20/-	0.90/1.00
V8	ED 17 MH/ T4 HALO GEN	50 W	1	HPF E-VISION ELECTRONIC /-	277	55 W/50 W	1.0/-	0.20/-	0.90/1.00
V9	ED17 MH / T4 HALO GEN	50 W	1	HPF E-VISION ELECTRONIC /-	277	55 W/50 W	1.0/-	0.20/-	0.90/1.00
X1	LED	-	-	-	277	-	-	-	-
X2	LED	-	-	-	120/277	-	-	-	-
L1	ED17 MH	100 W	1	INTEGRAL HPF E-VISION ELECTRONIC	277	109 W	1.0	0.40 A	0.9
L1A	ED17	100 W	1	INTEGRAL	277	109 W	1.0	0.40 A	0.9

	MH			HPF E-VISION ELECTRONIC					
L1B	ED17 MH	100 W	1	INTEGRAL HPF E-VISION ELECTRONIC	277	109 W	1.0	0.40 A	0.9
L2	ED17 MH	100 W	1	INTEGRAL HPF E-VISION ELECTRONIC	277	109 W	1.0	0.40 A	0.9
L3	T6 MH	70 W	1	INTEGRAL HPF ELECTRONIC	277	79 W	1.0	0.3 A	0.9
L5	MR16	50 W	1	REMOTELY LOCATED	277	50 W	-	-	1.00
L6	T4 CFL	32 W	1	INTEGRAL SMARTMATE HPF ELECTRONIC	277	36 W	0.98	0.13 A	0.98
L7	T5	14 W	1	HPF CENTUIUM MICRO PRO ELECTRONIC	277	19 W	1.05	0.08	0.98
L8	MH T6	150 W	1	INTEGRAL HPF E-VISION ELECTRONIC	277	166 W	1.0	0.6 A	0.9
G1	QL	85 W	1	-	277	-	-	-	-
G2	T5HO	54 W	1	ADVANCE CENTIUM T5HO (2) LAMP BALLAST	277	120 W	1.0	0.35 A	0.98
G3	T6 MH	70 W	1	HPF E-VISION ELECTRONIC	277	79 W	1.0	0.3 A	0.9
G3A	-	-	1	-	277		-		
G4	T5HO	54 W	2	HPF CENTIUM ELECTRONIC	277	63 W	1.03	0.23 A	0.99

Note: Manufactures cuts are included as an appendix

ASHRAE/IESNA 90.1 shut-off requirements are fulfilled with controls given. All luminaires are set on time-clocks for automatic shut-off. In some places photo cells are used.

l. Mechanical and Other Loads

The building includes a variety of mechanical equipment. The systems for both buildings is forced air heating and cooling with additional fin tube and fan coil units spread throughout. All major systems

are either located in the main basement mechanical room of the addition or in the attic space of the historic building. Any minor pieces of equipment were not included within the list below.

Mechanical and Other Loads

Tag	Description	Load (HP)	Amps	Voltage	Phase	PF	KVA	KW
HPW-3	HOT WATER PUMP	5	7.6	480	3P	0.92	6.3	5.8
HWP-4	HOT WATER PUMP	2	3.4	480	3P	0.85	2.8	2.4
HWP-4A	HOT WATER PUMP	20	27	480	3P	0.94	22.4	21.1
P-1	EMERG. GEN. RADIATOR PUMP	7.5	11	480	3P	0.92	9.1	8.4
P-2	EMERG. GEN. RADIATOR PUMP	7.5	11	480	3P	0.92	9.1	8.4
RF-1	RETURN FAN	25	34	480	3P	0.94	28.3	26.6
RF-2	RETURN FAN	25	34	480	3P	0.94	28.3	26.6
RF-3	RETURN FAN	15	21	480	3P	0.94	17.5	16.4
RF-4	RETURN FAN	2	3.4	480	3P	0.85	2.8	2.4
RR-1	REMOTE GEN. RADIATOR	7.5	11	480	3P	0.92	9.1	8.4
SE-1(A)	SUMP PUMP	(2) 5	(2) 7.6	480	3P	0.9	(2) 6.3	(2) 5.7
SE-2(A)	DUPLEX SUMP PUMP	(2) 2	(2) 3.4	480	3P	0.85	(2) 2.8	(2) 5.7
SF-3	CHILLER MAKE-UP-AIR FAN	1.5	3	480	3P	0.82	2.5	2.0
SF-4	EMER. MAKE-UP-AIR FAN	7.5	11	480	3P	0.92	9.1	8.4
SF-5	ELEC. MAKE-UP-AIR FAN	2	3.4	480	3P	0.85	2.8	2.4
SFF-2	FAN-	5	7.6	480	3P	0.92	6.3	5.8
SMP-2	SNOWMELT PRIMARY PUMP	7.5	11	480	3P	0.92	9.1	8.4
SMP-2	SNOWMELT PRIMARY PUMP	1.5	3	480	3P	0.82	2.5	2.0
SP-2(A)	ELEVATOR SUMP PUMP	1/2	9.8	120	1P	0.8	1.2	0.9
SP-2(B)	SUMP PUMP	1/2	9.8	120	1P	0.8	1.2	0.9
SP-2(B)	SUMP PUMP	1/2	9.8	120	1P	0.8	1.2	0.9
AHU-1	AIR HANDLING UNIT	75	96	480	3P	0.94	69.1	65.0
AHU-2	AIR HANDLING UNIT	75	96	480	3P	0.94	69.1	65.0
AHU-5	AIR	25	96	480	3P	0.94	69.1	65.0

	HANDLING UNIT							
AHU-6	AIR HANDLING UNIT	5	7.6	480	3P	0.91	5.5	5.0
AHU-7	AIR HANDLING UNIT	5	7.6	480	3P	0.91	5.5	5.0
B-1	BOILER FAN	1.5	3	480	3P	0.85	2.2	1.8
B-1	CONTR0L			120	1P		-	-
B-2	BOILER FAN	1.5	3	480	3P	0.85	1.4	1.2
B-2	CONTR0L			120	1P		-	-
BH-1	COOLING TOWER BASIN HEATERS	2@ 3kW	-	480	3P	-	-	6kW
CT-1	COOLING TOWER FAN (CELL #1)	25	34	480	3P	0.94	28.3	26.6
CT-2	COOLING TOWER FAN (CELL #2)	25	34	480	3P	0.94	28.3	26.6
CH-1	WATER CHILLER	225 TONS	-	480	3P	-	-	-
CH-2	WATER CHILLER	225 TONS	-	480	3P	-	-	-
CHP-1	PRIMARY CHILLED WATER PUMP	15	21	480	3P	0.94	17.5	16.4
CHP-2	PRIMARY CHILLED WATER PUMP	15	21	480	3P	0.94	17.5	16.4
CHP-3	PRIMARY CHILLED WATER PUMP	15	21	480	3P	0.94	17.5	16.4
CHP-4	SECONDARY CHILLED WATER PUMP	30	40	480	3P	0.94	33.3	31.3
CHP-4A	SECONDARY CHILLED WATER PUMP	30	40	480	3P	0.94	33.3	31.3
CHP-5	WINTER CHILLED WATER PUMP	7.5	11	480	3P	0.94	9.1	8.6
CHP-5A	WINTER CHILLED WATER	7.5	11	480	3P	0.94	9.1	8.6

	PUMP							
CWP-1	CONDENSER WATER PUMP	7.5	11	480	3P	0.94	9.1	8.6
CWP-2	CONDENSER WATER PUMP	15	21	480	3P	0.94	17.5	16.4
CWP-3	CONDENSER WATER PUMP	15	21	480	3P	0.94	17.5	16.4
CWP-4	CONDENSER WATER PUMP	15	21	480	3P	0.94	17.5	16.4
CWP-4A	CONDENSER WATER PUMP	7.5	11	480	3P	0.94	9.1	8.6
EF-1	EXHAUST FAN GARAGE	7.5	11	480	3P	0.94	9.1	8.6
EF-2	EXHAUST FAN	25	34	480	3P	0.94	28.3	26.6
EF-3	EXHAUST FAN	25	34	480	3P	0.94	28.3	26.6
EF-4	EXHAUST FAN	5	7.6	480	3P	0.91	6.3	5.7
EF-5	EXHAUST FAN	2	3.4	480	3P	0.85	2.8	2.4
EF-6	EXHAUST FAN	7.5	11	480	3P	0.94	9.1	8.6
EF-7	EXHAUST FAN	87 W	0.73	120	1	-	0.1	0.1
EF-9	EXHAUST FAN	1.5	3	480	3P	0.82	2.5	2.0
EF-10	EXHAUST FAN	3/4	1.6	480	3P	0.82	1.3	1.1
EF-11	EXHAUST FAN	2	3.4	480	3P	0.82	2.8	2.3
EF-12	EXHAUST FAN	1	2.1	480	3P	0.82	1.7	1.4
EF-13	EXHAUST FAN	154 W	1.28	120	1P	-	0.2	0.2
EF-14	EXHAUST FAN	87 W	0.73	120	1P	-	0.1	0.1
EF-15	EXHAUST FAN	87 W	0.73	120	1P	-	0.1	0.1
EF-16	EXHAUST FAN	87 W	0.73	120	1P	-	0.1	0.1
EF-17	EXHAUST FAN	1/2	1.1	480	3P	0.8	0.9	0.7
EF-18	EXHAUST FAN	119 W	1	120	1P	-	0.1	0.1
EF-19	EXHAUST FAN	166 W	1.4	120	1P	-	0.2	0.2
EF-20	EXHAUST	166 W	1.4	120	1P	-	0.2	0.2

	FAN							
EF-21	EXHAUST FAN	3/4	1.6	480	3P	0.82	1.3	1.1
EF-22	EXHAUST FAN	67 W	0.56	120	1P	-	0.1	0.1
EF-23	EXHAUST FAN	70 W	0.58	120	1P	-	0.1	0.1
EF-24	EXHAUST FAN	1/2	1.1	480	3P	0.8	0.9	0.7
EF-25	EXHAUST FAN	1/2	1.1	480	3P	0.8	0.9	0.7
EF-26	EXHAUST FAN	1/4	5.8	120	1P	0.75	0.7	0.5
EWH-1 (A)	ELEC. W. HEATER	3 kW	-	480	3P	-	3.0	0.0
EWH-1 (A)	CIRC. PUMP	1/4	5.8	120	1P	0.75	0.7	0.5
EWH-2 (A)	ELEC. W. HEATER	1.5 kW	5.4	277	1	-	1.5	1.5
EWH-2 (B)	ELEC. W. HEATER	1.5 kW	5.4	277	1	-	1.5	1.5
EWH-3(A)	ELEC. W. HEATER	4 kW	8.3	480	3P	-	4.0	-
EWH-4 (A)	ELEC. W. HEATER	3 kW	10.8	277	1	-	3.0	33.0
EWH-(A)5	ELEC. W. HEATER	6 kW	12.5	480	3P	-	6.0	-
EWH-(A)5	CIR. PUMP	1/4	5.8	120	1P	0.75	0.7	0.5
EWH-6 (A)	ELEC. W. HEATER	1 kW	8.33	120	1P	-	1.0	1.0
EWH-6 (A)	ELEC. W. HEATER	1 kW	8.33	120	1P	-	1.0	1.0
FOP-1	FUEL OIL PUMP	1/3	7.2	120	1P	0.77	0.9	0.7
FOP-2	FUEL OIL PUMP	1/3	7.2	120	1P	0.77	0.9	0.7
FOP-2	TANK PUMP	1/3	7.2	120	1P	0.77	0.9	0.7
GWP-1 (A)	GAR. WASTE PUMP	1/2	1.1	480	3P	0.8	0.9	0.7
GWP-1 (A)	GAR. WASTE PUMP	1/2	1.1	480	3P	0.8	0.9	0.7
GCS-1	GLYCOL CHARGING STATION	1/4	5.8	120	1	0.75	0.7	0.5
HWP-1	HOT WATER PUMP	5	7.6	480	3P	0.91	6.3	5.7
HWP-2	HOT WATER PUMP	5	7.6	480	3P	0.91	6.3	5.7
Totals							789.5	760

ELEVATOR LOADS

Tag	Description	Load (HP)	Amps	Voltage	Phase	PF	KVA	KW
B302 ELEV.	ELEVATOR	20	27	480	3P	0.94	12.96	12.2
B304 ELEV.	ELEVATOR	20	27	480	3P	0.94	12.96	12.2
B206 ELEV	ELEVATOR	30	40	480	3P	0.94	19.2	18
B200 ELEV	ELEVATOR	50	65	480	3P	0.94	31.2	29.3

Service Entrance Size

1. Square Foot Method- Conceptual/Schematic Design Phases

Category	Value
Building Type	Library
Category Estimate	11 VA/(Sq. Ft.)
Building Area	105,000 Sq. Ft.
Total KVA Estimate	1155 KVA
Total Current at 480 V	1389 A

2. Square Foot and Estimated Loads- Design Development

Equipment System	VA/Sq. ft	Sq.ft.	Total
Lighting	3	105,000	315 KVA
Receptacles	1	105,000	15.5 KVA
Computers	-	-	10 KVA
Fans and Pumps	2	105,000	210 KVA
Mechanical	7	105,000	735 KVA
Elevators	50kw per	4 elevators	200 KVA
Total KVA			1485.5 KVA
Total Current at 480 V			2743 A

3. Final Design Loads- Working Drawings

Load Description	Demand Factors	Load (KVA)	Total
Lighting	-	315	315 kVA
Receptacles	-	15.5	15.5 KVA
Mechanical	0.8	789.5	631.6 kVA
Total			962 KVA
Total Amperage @ 480			1157 A

4. Summary

Method	kVA	Voltage System	Load - Amps
Square Footage Method- Conceptual/Schematic Design Phases	1155	480	1389
Square Foot and Estimated Loads- Design Development	1486	480	2743
Final Design Loads- Equipment Working Drawings	962	480	1157
Actual Conditions- Service Entrance	2000	480	2406

Environmental Stewardship Design

The Massachusetts Public Library tried to use energy efficient lighting equipment in the controls system. In many of the rooms, in both the existing and new building they have implemented dimming controls. These are particularly nice in the rooms in the building with projection screens and particular AV equipment. Majority of the luminaires throughout the building are actually on a time clock which is very beneficial considering the building is typically open during normal business hours. Many rooms maintain occupancy sensors and the exterior luminaires are powered by a photo cell receiver.
The open floor plan of the addition, allows for deep penetration of daylight from the stat-of-the-art curtain wall facade. A sunshade system protects the facade from direct glare and produces diffuse ambient lighting throughout the library's interior spaces.

Because majority of the electrical equipment was provided by NSTAR, it is considered to be energy efficient according to their standards. (Further investigation is still being taken for equipment specifications)

Conscious efforts have been taken to provide a sustainable building design. The building is attempting to receive LEED certification after it is completed in 2009.

Design Issues

As the building is an addition to a historical site the existing conditions were an issue which had to be considered. The main concern was the positioning of a service entrance and electrical rooms. The major pieces of electrical equipment are all located within the basement of the new building. The

addition did allow for a large expansion that provided services spaces such as this. Complications of addition created many different panel boards and transformers creating a slightly more complex electrical system. The entire electrical system in the historic building was redone to be compatible with the new building. However, creating an electrical system which worked around the existing architecture was a challenge. The most interesting portion of the electrical design is the usage of the lighting system Lutron control system. Many deliberate efforts were taken to create an energy efficient electrical system. However, because the plans for construction began approximately ten years ago, daylighting sensors were not implemented in the scope of the project.

II. Communication Systems

Fire Protection System

In the existing building there is a typical floor control valve assembly over fire department valve in cabinet. In the new building this system is exposed and there is also a pre-action system. If power is lost within the building, there is an automatic transfer switch which switches the power source to the emergency generator. The system also includes electric bell annunciators, exterior flashing signal beacon, fire alarm annunciators, as well as audible and visual alarm signals. A graphic floor map and fire alarm system control panel are located in the main entrance lobby on the first floor of the new building.

Information Technology System

Audio/visual equipment is located throughout the building. Equipment includes jacks for laptop VGA interface, microphone jacks, DVD,VCR, DSP, AAP, 4" color touch screens, LCD projectors, assistive listening transmitters and receivers. Throughout the rooms are ceiling mounted speakers which include two-way loudspeakers as well as subwoofers. Data equipment racks are located in a data closet/server room on the 1st basement floor in which the control data for the entire building.