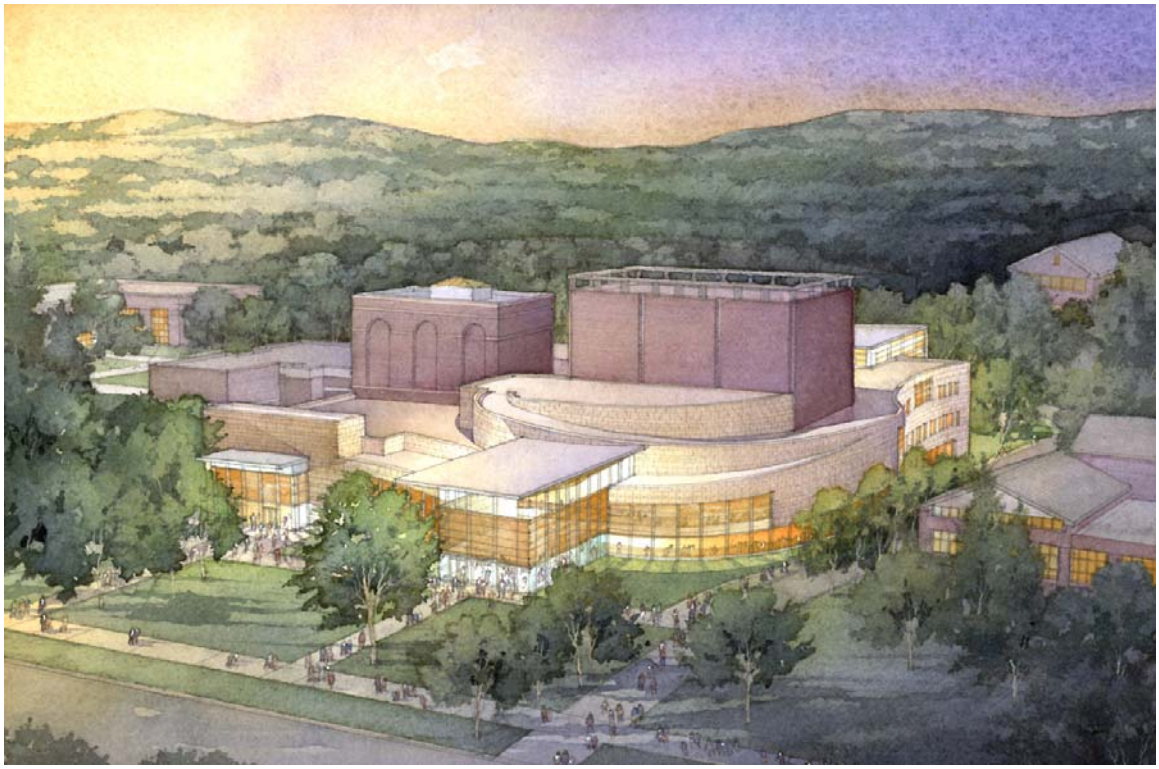
Williams College

'62 Center for Theatre & Dance



Electrical Systems

Existing Conditions & Load Summary

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Lighting/Electrical Option
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Executive Summary

The electrical distribution system of the building is serviced by two 1500kva transformers, fed through the Williams College campus-wide distribution system. 480/277v and 208Y/120v systems run throughout the building, powering an extensive array of mechanical and lighting loads in the theatrical and back-of-house spaces. In the even of power failure, a 100kw diesel emergency generator kicks on for powering emergency lighting throughout the building.

The lighting loads that need to be serviced by the electrical distribution system are primarily fluorescent and incandescent halogen. These lighting systems are all connected to a main building automation system which controls an automated time clock for shutting off the main building lighting through the use of relay panels.

There is a heavy use of communications systems throughout the building, including data, voice, audio/visual, active fire protection, and smoke detection. An intense grid of communication wires is necessary within the theatrical spaces throughout the building due to the amount of audio/visual equipment in these spaces.

I. Power Distribution Systems

The electrical distribution system for the Williams College '62 Center for Theater & Dance is a radial system that is powered by two 1500A pad-mounted transformers, located on the west side of the building. These transformers are the access point from the campus-wide distribution system. Once in the building, the system goes through two main distribution panels, with a manual tie breaker linking them. Since this project consists of both a renovation portion (The Adams Memorial Theatre) and a new construction portion (The Center for Theatre & Dance, built around The Adams Memorial Theatre), it will be necessary to describe the interaction between these two spaces. The existing 600A feeder service for the existing Adams Memorial Theatre was removed and new 480/277v and 208Y/120v systems were brought into the theatre. The 480/277v line feeds a single lighting control panel that services the 277v main and ground floor lighting. The 208Y/120v line feeds a 1200A distribution panel which sends power to multiple lighting control panels for the house and theatrical stage lights, as well as a 225kva rooftop AC unit. There's also both 480/277v and 208Y/120v systems in the new Center for Theater & Dance, which are used for similar applications. See Table 1 in Appendix A for schedule of transformers.

II. Emergency Power System

The building is serviced by a 100kw diesel sound attenuated vibration-reducing pad-mounted emergency generator, located in the main emergency electrical room on the ground floor. The generator is connected to four automatic transfer switches, which control the overall emergency lighting system in both the Center for Dance & Theatre and the Adam's Memorial Theatre renovation. Two of the automatic transfer switches control power transfer for the emergency lighting panels and elevators, and the other two switch emergency power for the fire alarm system's "full-bright" panic signal.

III. Overcurrent Protection

The electrical distribution system relies on circuit breakers and fused disconnect switches to provide the overcurrent protection. Most panelboards and switchgear are located within dedicated electrical rooms or closets. Motor control centers are located generally located in dedicated mechanical rooms. Large units such as switchgear and motor control centers are in the basement, while smaller panelboards are located in the closets on upper floors. The third floor contains all the dimmer racks for the main theatre and the studio theatre in a shared dimmer room. The dedicated main lighting electrical closets and emergency lighting electrical closets have been separated from each other in all instances.

IV. Lighting Systems

The entry vestibule on the south side of the building uses halogen sources for both interior and exterior lighting. The interior lobby space also uses halogen, but switches to incandescent with quartz accents as the space transitions into the theatre. Most other general lighting away from the main entry to the theatre is either compact fluorescent or linear fluorescent. A detailed list of lamps in the building and their operating characteristics can be found in appendix B.

V. ASHRAE 90.1 Shutoff Requirements

The building is monitored by an energy management control system (EMCS) that optimizes energy consumption while maintaining occupant comfort. This EMCS is connected to relay panels at each lighting panel and maintains a time-clock control device for shutting off electrical lighting within the building and the control of exterior site lighting. This system also has the capability to reduce and shut off motors once the peak demand load has been reached for a month to conserve energy and electricity costs.

Small offices and other rooms throughout the building that are not performance spaces or spaces intended for 24-hour occupancy have been equipped with occupancy sensors for savings in energy consumption.

VI. Power Factor Correction

There are no power factor correction devices used in the electrical system for this building.

VII. Design Considerations

The building does not have an overly large footprint, so there don't seem to be too many concerns about voltage drop from long runs. A consideration that will need to be made is the temperature differential between the basement feeder and any lines run to the top of the 80 ft fly tower of the main stage. It will need to be considered that ballasts will be running at 35c or above and will affect the output of most fluorescent lamps.

The control for the tie breaker between the two main incoming feeders in the main switchgear may be beneficial to be automatic in the event of significant voltage drop so that if it were to occur during a performance, the performance could still go on with just a slight interruption. Currently, the tie breaker is manual and would require someone to go down in the mechanical room and switch the breaker, increasing the amount of time the building is without primary power.

A lot of consideration needs to be placed on the design of the communications systems throughout the building. The buildings occupancy as an educational facility and as a theatrical performance building increases the need for wired and wireless data transfer for laptops, inter-system controls for a/v integration into overall building and stage performance, and technological expansion. Upgrading a system of this magnitude would be incredibly costly for the college, so looking towards expansion capabilities during construction can save a lot of money in the future.

VIII. NEC Design Load

The total calculated NEC design load was approximately 1400kw. Two 1500kw transformers feed the main distribution panels for the building. I'm assuming that this discrepancy, the amount of available power being twice the design load, has to do with the manual tie breaker between the two sides of the main switchgear. This would allow for one transformer to temporarily carry the load for the entire building until the second transformer could be repaired. The main transformers are rated at 1500kva, which equates to maximum output amperage of 1805A. This value is less than the rated value of the wire, which is 80% of the ampacity of seven sets of 500MCM wire, or 2128A. The wire is adequately sized for the size

of the transformers. The two main distribution panels that are fed by the main switchgear both sized appropriately as well. Distribution panel DHB has an 800A trip and is fed by 2 sets of 600MCM wire rated at 840A. Distribution panel DHBB has a 1200A trip and is fed by 4 sets of 500MCM wired rated at 1520A. Detailed calculations for the NEC design load can be found in Appendix D.

IX. Electric Utility Rates

Electric utility is provided by Williams College through their campus-wide distribution system. According to the Utilities Program Director of the Williams College Facilities Department, the Center for Theatre & Dance is a part of the medium voltage campus-wide distribution system and they do not track peak demand charges for each individual building on this system. The total usage of the building over the past 12 month period (July05-June06), was 1,219,964 kwh at a rate of $0.084/kwh, including transmission and distribution charges.

X. Communication Systems

Ethernet/Phone/AV: All Data/Voice/Coax conduits in the building are fed from room 052, Tel/Data, located in the basement of the 550 seat main theatre. Two data racks house the input/output data streams and are backed up by a UPS. Data and voice inputs are primarily located in offices and the theatrical control room in the 550 seat main theatre. Other inputs are placed at intervals throughout the rest of the building for a flexible data communication system. Most lines are run through conduit and cable trays that run throughout the circulation spaces in the building.

Fire Protection: The Center for Theatre & Dance utilizes two levels of fire protection. The first is a wet system with sprinkler heads throughout the building. In theatrical spaces where efforts were taken to preserve the beauty of the space, concealed sprinkler heads were used. The second system is a fire department hookup which is controlled by three separate automatic control valves in the main mechanical room in the basement of the west side of the building. The fire department inlet is located by the north entrance to the building. Ceiling mounted smoke detectors are located throughout the building.

Appendix A (Transformers)

INDIVIDUAL TRANSFORMER SCHEDULE

Linear Dry-Type Transformers

TAG	PRIMARY VOLTAGE	SECONDARY VOLTAGE	SIZE	TYPE	TEMP. RISE	TAPS	MOUNTING
T0	1500KVA, 3PH, 3W	480/277, 3PH, 4W	N/A	N/A	N/A	N/A	PAD MOUNTED
T1	480/277, 3PH, 3W	208Y/120, 3PH, 4W	9	DRY	115 DEGREE C	(6) 2.5%	CEILING SUSPENDED
T2	480/277, 3PH, 3W	208Y/120, 3PH, 4W	15	DRY	150 DEGREE C	(6) 2.5%	CEILING SUSPENDED
T3	480/277, 3PH, 3W	208Y/120, 3PH, 4W	30	DRY	150 DEGREE C	(6) 2.5%	CEILING SUSPENDED
T4	480/277, 3PH, 3W	208Y/120, 3PH, 4W	45	DRY	150 DEGREE C	(6) 2.5%	CEILING SUSPENDED
T5	480/277, 3PH, 3W	208Y/120, 3PH, 4W	75	DRY	150 DEGREE C	(6) 2.5%	PAD MOUNTED
T6	480/277, 3PH, 3W	208Y/120, 3PH, 4W	112.5	DRY	150 DEGREE C	(6) 2.5%	PAD MOUNTED
T7	480/277, 3PH, 3W	208Y/120, 3PH, 4W	150	DRY	150 DEGREE C	(6) 2.5%	PAD MOUNTED
T8	480/277, 3PH, 3W	208Y/120, 3PH, 4W	225	DRY	150 DEGREE C	(6) 2.5%	PAD MOUNTED
T9	480/277, 3PH, 3W	208Y/120, 3PH, 4W	300	DRY	150 DEGREE C	(6) 2.5%	PAD MOUNTED
TSB	480/277, 3PH, 3W	208Y/120, 3PH, 4W	1500	DRY	150 DEGREE C	(6) 2.5%	PAD MOUNTED

Non-Linear Dry-Type Transformers

TAG	PRIMARY VOLTAGE	SECONDARY VOLTAGE	SIZE	TYPE	TEMP. RISE	TAPS	MOUNTING
T1C	480/277, 3PH, 3W	208Y/120, 3PH, 4W	9	DRY	150 DEGREE C	(6) 2.5%	CEILING SUSPENDED
T2C	480/277, 3PH, 3W	208Y/120, 3PH, 4W	15	DRY	150 DEGREE C	(6) 2.5%	CEILING SUSPENDED
T3C	480/277, 3PH, 3W	208Y/120, 3PH, 4W	30	DRY	150 DEGREE C	(6) 2.5%	CEILING SUSPENDED
T4C	480/277, 3PH, 3W	208Y/120, 3PH, 4W	45	DRY	150 DEGREE C	(6) 2.5%	CEILING SUSPENDED
T5C	480/277, 3PH, 3W	208Y/120, 3PH, 4W	75	DRY	150 DEGREE C	(6) 2.5%	PAD MOUNTED
T6C	480/277, 3PH, 3W	208Y/120, 3PH, 4W	112.5	DRY	150 DEGREE C	(6) 2.5%	PAD MOUNTED
T7C	480/277, 3PH, 3W	208Y/120, 3PH, 4W	150	DRY	150 DEGREE C	(6) 2.5%	PAD MOUNTED
T8C	480/277, 3PH, 3W	208Y/120, 3PH, 4W	225	DRY	150 DEGREE C	(6) 2.5%	PAD MOUNTED

NOTES:
1. REFER TO SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS

Table 1 – Transformer Schedule

Appendix B (Lamps)

Lamp/Ballast Characteristics									
Lamp Type	**Lamp Watts**	**Lamp Qty**	**Voltage**	**Current (Starting)**	**Current (Operating)**	**Ballast Factor**	**Power Factor (Starting)**	**Power Factor (Operating)**	**Input Watts**
100A19	100	1	120	0.83	0.83	N/A	1	1	100
150PAR38	150	1	120	1.25	1.25	N/A	1	1	150
26W Quad Tube	26	1	120	0.23	0.23	1	0.98	0.98	27
26W Triple Tube	26	1	277	0.1	0.1	1	0.99	0.99	28
42W Triple Tube	42	1	277	0.17	0.17	1	0.99	0.99	46
50PAR20	50	1	120	0.42	0.42	N/A	1	1	50
5W Xenon	5	---	24	0.21	0.21	N/A	1	1	5
60G25	60	1	120	0.5	0.5	N/A	1	1	60
75PAR16	75	1	120	0.63	0.63	N/A	1	1	75
75PAR30	75	1	120	0.63	0.63	N/A	1	1	75
90PAR38	90		120	0.75	0.75	N/A	1	1	90
9W Quad Tube	9	1	120	0.2	0.1	0.92	0.91	0.91	11
CDM35T6	35	1	120	0.45	0.5	1	0.9	0.9	55
F17T8	17	1	277	0.07	0.07	0.9	0.97	0.97	16
F22T5	22	1	120	0.22	0.22	1.1	0.98	0.98	27
F25T8	25	2	277	0.16	0.16	0.88	0.99	0.99	43
F32T8	32	1	277	0.11	0.11	0.98	0.98	0.98	30
F32T8	32	2	277	0.23	0.23	0.94	0.98	0.98	62
F32T8	32	3	277	0.33	0.33	0.92	0.99	0.99	89
F32T8	32	4	277	0.39	0.39	0.88	0.99	0.99	107
F54T5HO	54	1	277	0.23	0.23	1.02	0.96	0.96	62
FC12T9	32	1	120	0.59	0.59	0.68	0.45	0.45	32
FT40	40	3	277	0.37	0.37	0.86	0.99	0.99	103
MH175	175	1	277	0.4	0.8	1	0.9	0.9	208
MS320	320	1	277	1.45	1.3	1	0.9	0.9	342
Q350T3	350	1	120	2.92	2.92	N/A	1	1	350
Q500PAR56	500	2	120	4.17	4.17	N/A	1	1	500
Q500T3	500	1	120	4.17	4.17	N/A	1	1	500
Q50MR16	50	1	120	0.42	0.42	N/A	1	1	50

Table 2 – Lamp/Ballast Characteristics

Appendix C (Mechanical Equipment)

Mechanical Loads								
Designation	**Type**	**Voltage**	**F.L.Amps**	**Phase**	**Power (HP)**	**Power (KVA)**	**PF**	**Power (KW)**
ACLC-1	Air Chiller	480	46	3	44	38.24	0.90	34.42
AHU-1A	Air Handling Unit	480	96	3	75	79.81	0.90	71.83
AHU-1B	Air Handling Unit	480	96	3	75	79.81	0.90	71.83
AHU-1C	Air Handling Unit	480	40	3	30	33.26	0.90	29.93
AHU-1D	Air Handling Unit	480	40	3	30	33.26	0.90	29.93
AHU-2A	Air Handling Unit	480	34	3	25	28.27	0.90	25.44
AHU-2B	Air Handling Unit	480	14	3	10	11.64	0.90	10.48
AHU-3A	Air Handling Unit	480	14	3	10	11.64	0.90	10.48
AHU-3B	Air Handling Unit	480	7.6	3	5	6.32	0.90	5.69
AHU-4A	Air Handling Unit	480	27	3	20	22.45	0.90	20.20
AHU-4B	Air Handling Unit	480	11	3	7.5	9.15	0.90	8.23
AHU-5A	Air Handling Unit	480	21	3	15	17.46	0.90	15.71
AHU-5B	Air Handling Unit	480	11	3	7.5	9.15	0.90	8.23
AHU-6	Air Handling Unit	480	7.6	3	5	6.32	0.90	5.69
AHU-7	Air Handling Unit	480	11	3	7.5	9.15	0.90	8.23
AHU-8	Air Handling Unit	480	7.6	3	5	6.32	0.90	5.69
AHU-9A	Air Handling Unit	480	21	3	15	17.46	0.90	15.71
AHU-9B	Air Handling Unit	480	4.8	3	3	3.99	0.90	3.59
AHU-10	Air Handling Unit	480	7.6	3	5	6.32	0.90	5.69
AHU-11	Air Handling Unit	480	7.6	3	5	6.32	0.90	5.69
AHU-12A	Air Handling Unit	277	4.9	1	0.5	1.36	0.85	1.15
AHU-12B	Air Handling Unit	277	4.9	1	0.5	1.36	0.85	1.15
AHU-13	Air Handling Unit	277	2.2	1	0.167	0.61	0.85	0.52
AHU-14	Air Handling Unit	277	2.2	1	0.167	0.61	0.85	0.52
AHU-15A	Air Handling Unit	277	4.9	1	0.5	1.36	0.85	1.15
AHU-15B	Air Handling Unit	277	4.9	1	0.5	1.36	0.85	1.15
AHU-16	Air Handling Unit	277	4.9	1	0.5	1.36	0.85	1.15
AHU-17A	Air Handling Unit	277	4.9	1	0.5	1.36	0.85	1.15
AHU-17B	Air Handling Unit	277	4.9	1	0.5	1.36	0.85	1.15
AHU-19	Air Handling Unit	277	2.2	1	0.167	0.61	0.85	0.52
AHU-21A	Air Handling Unit	277	4.9	1	0.5	1.36	0.85	1.15
AHU-21B	Air Handling Unit	277	4.9	1	0.5	1.36	0.85	1.15
B-1	Boiler	480	3.4	3	2	2.83	0.90	2.54
CP-1	Condensate Pump	480	13.5	3	9.36	11.22	0.90	10.10
CUH-1	Unit Heater	277	4.9	1	0.5	1.36	0.85	1.15
CUH-2	Unit Heater	277	4.9	1	0.5	1.36	0.85	1.15
CUH-3	Unit Heater	120	5.8	1	0.25	0.70	0.85	0.59
CUH-4	Unit Heater	120	2.9	1	0.125	0.35	0.85	0.30
CUH-5	Unit Heater	120	2.9	1	0.125	0.35	0.85	0.30
CUH-6	Unit Heater	277	4.9	1	0.5	1.36	0.85	1.15
CUH-7	Unit Heater	120	2.9	1	0.125	0.35	0.85	0.30
CUH-8	Unit Heater	277	4.9	1	0.5	1.36	0.85	1.15
CUH-10	Unit Heater	120	4.4	1	0.167	0.53	0.85	0.45

Williams College '62 Center For Theater & Dance
Williamstown, MA

Mechanical Loads								
Designation	**Type**	**Voltage**	**F.L.Amps**	**Phase**	**Power (HP)**	**Power (KVA)**	**PF**	**Power (KW)**
DC-1	Dust Collector	480	11	3	7.5	9.15	0.90	8.23
EH-1	Humidification	480	20	3	6.71	16.63	0.90	14.96
EH-2	Humidification	480	20	3	6.71	16.63	0.90	14.96
EUH-1	Electric Unit Heater	480	20	3	6.96	16.63	0.90	14.96
EUH-2	Electric Unit Heater	277	1.5	1	0.125	0.42	0.85	0.35
F-01	Fan	480	1	3	0.5	0.83	0.90	0.75
F-02	Fan	480	2.6	3	1.5	2.16	0.90	1.95
F-03	Fan	120	7.2	1	0.33	0.86	0.85	0.73
F-04	Fan	480	1.4	3	0.75	1.16	0.90	1.05
F-05	Fan	120	5.8	1	0.25	0.70	0.85	0.59
F-06	Fan	120	5.8	1	0.25	0.70	0.85	0.59
F-08	Fan	480	1.8	3	1	1.50	0.90	1.35
F-09	Fan	480	1.8	3	1	1.50	0.90	1.35
F-010	Fan	480	1.4	3	0.75	1.16	0.90	1.05
F-011	Fan	120	13.8	1	0.75	1.66	0.85	1.41
F-012	Fan	120	5.8	1	0.25	0.70	0.85	0.59
F-013	Fan	120	5.8	1	0.25	0.70	0.85	0.59
F-014	Fan	480	1.8	3	1	1.50	0.90	1.35
F-015	Fan	480	1.8	3	1	1.50	0.90	1.35
F-016	Fan	480	1.8	3	1	1.50	0.90	1.35
F-017	Fan	480	1.4	3	0.75	1.16	0.90	1.05
FPB-6	Fan Powered Box	277	1.5	1	0.167	0.42	0.85	0.35
FPB-8	Fan Powered Box	277	2.9	1	0.25	0.80	0.85	0.68
FPB-10	Fan Powered Box	277	4.9	1	0.5	1.36	0.85	1.15
FPB-12	Fan Powered Box	277	10	1	1.5	2.77	0.85	2.35
FPB-14	Fan Powered Box	277	8	1	1	2.22	0.85	1.88
P-1	Pump	480	52	3	40	43.23	0.90	38.91
P-2	Pump	480	52	3	40	43.23	0.90	38.91
P-3	Pump	480	27	3	25	22.45	0.90	20.20
P-4	Pump	480	27	3	25	22.45	0.90	20.20
P-5	Pump	480	7.6	3	5	6.32	0.90	5.69
P-6	Pump	480	7.6	3	5	6.32	0.90	5.69
P-7	Pump	480	3	3	1.5	2.49	0.90	2.24
P-8	Pump	480	3	3	1.5	2.49	0.90	2.24
P-10	Pump	480	1.8	3	1	1.50	0.90	1.35
P-20	Pump	480	1.4	3	0.75	1.16	0.90	1.05
P-21	Pump	120	2.9	1	0.167	0.35	0.85	0.30
P-30	Pump	120	9.5	1	0.4	1.14	0.85	0.97
P-31	Pump	120	2.2	1	0.083	0.26	0.80	0.21
P-40	Pump	480	1	3	0.5	0.83	0.90	0.75
P-41	Pump	120	2.2	1	0.083	0.26	0.80	0.21
P-50	Pump	480	1	3	0.5	0.83	0.90	0.75
P-60	Pump	120	2.9	1	0.167	0.35	0.85	0.30
P-61	Pump	120	2.2	1	0.083	0.26	0.80	0.21

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Mechanical Loads								
Designation	**Type**	**Voltage**	**F.L.Amps**	**Phase**	**Power (HP)**	**Power (KVA)**	**PF**	**Power (KW)**
P-71	Pump	120	2.2	1	0.083	0.26	0.80	0.21
P-80	Pump	120	9.5	1	0.4	1.14	0.85	0.97
P-81	Pump	120	2.2	1	0.083	0.26	0.80	0.21
P-90	Pump	120	2.9	1	0.167	0.35	0.85	0.30
RFM-1	Radiant Floor Manifold	120	7.2	1	0.33	0.86	0.85	0.73
WWP-1	Pump	120	0.72	1	0.033	0.09	0.80	0.07
UH-1	Unit Heater	120	2.9	1	0.167	0.35	0.85	0.30
UH-2	Unit Heater	120	5.8	1	0.25	0.70	0.85	0.59
UH-3	Unit Heater	120	0.98	1	0.05	0.12	0.80	0.09
AC-1	Air Compressor	480	21	3	15	17.46	0.90	15.71
RP-1	Recirculation Pump	120	7.2	1	0.33	0.86	0.85	0.73
NGB-1	Gas Booster	480	2.1	3	1	1.75	0.90	1.57
D-1	Dryer	208	2.4	1	0.75	0.50	0.85	0.42
WH-1	Water Heater	120	0.98	1	0.05	0.12	0.80	0.09
					Total:	24.81		22.01

Table3 – Mechanical Load Calculations

Appendix D (NEC Design Calculations)

	Demand Load	Gross Sq.Ft.	Available KW	Demand Factor	Total Available KW	Available KW
Lighting	1.5	126054	189.08	1	189.08	
Performance Ltg	4	126054	504.22	0.4	201.69	
Receptacles	0.5	126054	63.03	1	63.03	
Mechanical	-------	----------	638.55	1	638.55	
Heaters	-------	----------	25.39	1.25	31.74	
Elevators	-------	----------				
				Overall Building Demand Load:	1124.08	----------
				+ Expansion (x1.25):	1405.10	3000.00

1. Note that some demand load and gross sq.ft. columns are blank, meaning the available KW loads were based on calculated loads within the building.

2. Performance lighting demand load was included as a separate item in the building demand load calculation because of the nature of the building occupancy and the intense lighting load that theatrical fixtures can have on an electrical system. The 0.4 d

3. I've been unable to ascertain the elevator loads in the building. I've contacted the architect multiple times to get the information and he has said that he's working on it. The elevator specifications were in volume one of the specification set and

Table 4 – NEC Design Load Calculations & Assumptions