Technical Report 2

Existing Electrical Systems
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Lighting/Electrical Option
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Wentz Concert Hall and Fine Arts Center
171 E. Chicago Avenue
Naperville, IL 60540

Executive Summary

The following report discusses the existing electrical system design for North Central College's Wentz Concert Hall and Fine Arts Center. The building is 57,000 ft^2, and includes a concert hall, black box theater, art gallery, and education spaces. Its electrical systems include, theatrical lighting, and AV systems, as well as more typical power distribution for general lighting, elevators, and mechanical equipment.

The building is powered at 480Y/277 V by a utility company transformer, which feeds into the switchboard in an electrical room on the lower level. Several smaller transformers supply general loads at 280Y/120. An outdoor generator is used to meet emergency electrical requirements. A single-line diagram of the power distribution system is included in the report.

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Summary Description of Distribution System

The Wentz Concert Hall and Fine Arts Center receives power from a pad mounted transformer on the northwest side of the building. A switchboard in the electrical room distributes power at 480Y/277V to the rooftop units, one 480V distribution panel, and to five transformers that convert it to 208Y/120V, which is used for all other loads. Emergency power is supplied by a generator outside the northwest face of the building.

Utility Company Information

Power is provided by Naperville's Department of Public Utilities, 400 S. Eagle Street, Naperville IL 60540. They can be found online at http://www.naperville.il.us/dpu.aspx.

The building is served by a utility owned transformer at 480V, under NDPU's General Service Rate. This includes a minimum $21.65/month customer charge, with power supplied for 8.71 ¢/kWh as of May 1, 2010.

The following is a year of power usage data for the building, from July 2010 through June 2011:

Month	kWh
July	114,000
August	96,000
September	83,250
October	90,000
November	87,000
December	107,250
January	83,250
February	91,500
March	82,500
April	97,500
May	86,250
June	107,250

Service Entrance

The main transformer is utility owned, on a pad outside the northwest wall of the building next to the emergency generator; the service connects to SWBD 1 in the electrical room on the lower level, and is supplied at 480V. It is metered via a remote meter socket reading the switchboard's feeder, with a meter provided by the utility. Power used by the firepump on non-emergency power is metered separately, as it is not supplied through the switchboard.

Voltage Systems

Power is distributed by the main switchboard at 480V, 3Ph, 3W, to the rooftop air handlers. Five transformers throughout the building convert it to 208Y/120, 3Ph, 4W for more general use, such as lighting and receptacle loads.

The emergency generator also provides power at 480Y/277, and is connected to an automatic transfer switch upstream of the transformers.

Emergency Power System

Emergency power is supplied by an emergency generator on the northwest side of the building. This enters at the emergency electrical room on the lower level, where it connects to the emergency transfer switch. Under normal conditions, the transfer switch receives power via LL-HDP-1, which is powered by the main switchboard.

The concert hall lighting includes its own emergency panels, which are powered by the automatic transfer switch, but include a normal power sensing line so that they can automatically adjust lighting as a reaction to a power failure.

A second transfer switch is included in the firepump control center, which is powered directly from the main utility transformer and the emergency generator.

Locations of Switchgear

The building's electrical equipment is primarily located on the lower level's electrical room and in the first floor's dimmer room. A smaller emergency electrical room is connected to the main electrical room, and contains the main emergency equipment. These are all in areas not visible to patrons of the concert hall, located so that equipment is acoustically isolated from sound-sensitive spaces.

Major Equipment:

Tag	Type	Floor	Room #	Room Name	1/8 scale drawing	Enlarged drawing
1-SWBD-1	Switchboard	LL	49	Electrical room	E-100	E-100
LL-HDP-1	Distribution panel	LL	49	Electrical room	E-100	E-100
LL-LDP-1	Distribution panel	LL	49	Electrical room	E-100	E-100
1-TLDP-2	Distribution panel	1	138	Dimmer room	E-101	E-101
1-TLDP-1	Distribution panel	1	139	Dimmer room	E-101	E-101
1-DCTP-1	Distribution panel	1	140	Amp. Room	E-101	E-101
T1-TLDP-2	Transformer	1	139	Dimmer room	E-101	E-101
T1-TLDP-1	Transformer	1	139	Dimmer room	E-101	E-101
T1-DCTP-1	Transformer	1	139	Dimmer room	E-101	E-101
TLL-LDP-1	Transformer	LL	49	Electrical room	E-100	E-100
TLL-ELP-1	Transformer	LL	50	Emergency elec. room	E-100	E-100
ATS-1	Transfer switch	LL	50	Emergency elec. Room	E-100	E-100
FPC-ATS	Transfer switch	LL	48	Plumbing Room	E-100	N/A
GEN-1	Generator	LL	N/A	Site	ES-001	N/A

Lighting and Appliance Panelboards:

Tag	Voltage	Main Type	Floor	Room #	Room Name	1/8 scale drawing	Enlarged drawing
LL-HP-1	480Y/277	MLO	LL	49	Electrical Room	E-100	E-100
LL-HP-2	480Y/277	MLO	LL	37	Elec. Closet	E-100	N/A
LL-LP-1	208Y/120	MLO	LL	49	Electrical Room	E-100	E-100
LL-LP-2	208Y/120	MLO	LL	37	Elec. Closet	E-100	N/A
LL-LL-1	208Y/120	MLO	LL	49	Electrical Room	E-100	E-100
LL-LL-2	208Y/120	MLO	LL	49	Electrical Room	E-100	E-100
LL-KP-1	208Y/120	MLO	LL	47	Kitchen	E-100	N/A
LL-ELP-1	208Y/120	MLO	LL	50	Emergency elec. Room	E-100	E-100
DP-1	208Y/120	MLO	1	111	Dimmer Closet	E-101	N/A
DP-2	208Y/120	MLO	1	139	Dimmer Room	E-101	E-101
DP-3	208Y/120	MLO	1	111	Dimmer Closet	E-101	N/A
1-HP-1	480Y/277	MLO	1	173	Elec. Closet	E-101	N/A
1-HP-1A	480Y/277	MLO	1	173	Elec. Closet	E-101	N/A
1-HP-2	480Y/277	MLO	1	135	Elec. Closet	E-101	N/A
1-TLP-2	208Y/120	MLO	1	139	Dimmer Room	E-101	E-101
1-TLP-1	208Y/120	MLO	1	139	Dimmer Room	E-101	E-101
1-TLP-1A	208Y/120	MLO	1	139	Dimmer Room	E-101	E-101
1-AVP-1	208Y/120	MLO	1	140	Amp. Room	E-101	E-101
1-CTP-1	208Y/120	MLO	1	140	Amp. Room	E-101	E-101
1-CTP-2	208Y/120	MLO	1	140	Amp. Room	E-101	E-101
1-LP-1	208Y/120	MLO	1	173	Elec. Closet	E-101	N/A
1-LP-2	208Y/120	MLO	1	135	Elec. Closet	E-101	N/A
1-LL-1	208Y/120	MLO	1	173	Elec. Closet	E-101	N/A
1-LL-2	208Y/120	MLO	1	135	Elec. Closet	E-101	N/A
1-ELP-1	208Y/120	MLO	1	173	Elec. Closet	E-101	N/A

Over-current Devices

Main switchboard: Fused switch

Distribution panelboard: MLO protected by fused switch (typ. 400AS/300AF) in main switchboard.

Branch panelboard: MLO protected by fused switch (typ. 200AS/200AF) in distribution panelboards.

Grounding

Electrical service grounding is detailed in drawing 3 on page E-002. The building ground box connects to six (6) ground rods below the electrical room, an underground water pipe, and a ½" concrete encased rod electrode in the foundation.

Transformers

The main transformer is utility owned, and serves the building at 480Y/277 V. Throughout the building five transformers provide 208Y/120 V to panels for general use.

TAG	PRIMARY VOLTAGE	SECONDARY VOLTAGE	SIZE	TYPE	TEMP. RISE	TAPS	MOUNTING	REMARKS
T1-TLDP-2	480V, 3PH, 3W	208Y/120, 3PH, 4W	225	DRY	150 °C	(2) 2.5%	PAD	K-13 RATED
T1-TLDP-2	480V, 3PH, 3W	208Y/120, 3PH, 4W	225	DRY	150 °C	(2) 2.5%	PAD	K-13 RATED
T1-DCTP-1	480V, 3PH, 3W	208Y/120, 3PH, 4W	75	DRY	150 °C	(7) 5%	PAD	SEE NOTE 2
TLL-LDP-1	480V, 3PH, 3W	208Y/120, 3PH, 4W	300	DRY	150 °C	(2) 2.5%	PAD	
TLL-ELP-1	480V, 3PH, 3W	208Y/120, 3PH, 4W	30	DRY	150 °C	(2) 2.5%	PAD	

NOTES:
1. REFER TO SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS
2. POWER CONDITIONER SHALL BE 75KVA 480V DELTA PRIMARY AND 280Y/120V SECONDARY BY CONTROLLED POWER COMPANY (SERIES 700A)

Special Equipment

Transformer T1-DCTP-1 is an isolation transformer and power conditioner serving the AV system. It includes electrostatic shielding, transient attenuation, and uses microprocessor controlled tap switching to provide consistent voltage at every cycle.

Lighting Loads

Lamp				Luminaire						
Tag	Source	Lamp	Wattage	No.	Ballast	Voltage	Watts	BF	Current	PF
SA	QUAR	T4-500W	500	1	N/A	120	500	N/A	4.17	1
SB	QUAR	250PAR38/FL	250	1	N/A	120	250	N/A	2.08	1
SB-1	QUAR	250PAR38/FL	250	1	N/A	120	250	N/A	2.08	1
SD	INCAN	100A	100	1	N/A	120	100	N/A	0.83	1
SD-1	INCAN	100A	100	1	N/A	120	100	N/A	0.83	1
SE	QUAR	150PAR38/FL	150	1	N/A	120	150	N/A	1.25	1
SF	CFL	9W PL	9	1	N/A	120	9	N/A	0.08	1
SG	INCAN	20-T6.5	20	1	N/A	120	20	N/A	0.17	1
SH	QUAR	50PAR20/NFL/H	50	1	N/A	120	50	N/A	0.42	1
SH-1	QUAR	50PAR20/NFL/H	50	1	N/A	120	50	N/A	0.42	1
SJ	LINFL	F32T8/827	32	2	ELEC	120	65	1.01	0.54	0.98
SK	LINFL	F32T8/827	32	2	ELEC	120	65	1.01	0.54	0.98
SK-1	LINFL	F32T8/827	32	2	ELEC	120	65	1.01	0.54	0.98
SL	LINFL	F32T8/827	32	2	ELEC	120	65	1.01	0.54	0.98
SM	CFL	32PL/827	32	1	ELEC	120	36	1.00	0.31	0.98
SM-1	CFL	28PL/827	28	1	ELEC	120	27	0.98	0.23	0.98
SN	INCAN	150A21	150	1	N/A	120	150	N/A	1.25	1
SP	CFL	42W PL TRIPLE	42	1	ELEC	120	46	0.98	0.38	0.98
SQ	QUAR	HPL575/115X	575	1	N/A	120	575	N/A	4.79	1
SQ-1	QUAR	HPL575/115	575	1	N/A	120	575	N/A	4.79	1
SQ-2	QUAR	HPL575/115X	575	1	N/A	120	575	N/A	4.79	1
SR	QUAR	HPL575/115	575	1	N/A	120	575	N/A	4.79	1
SS	MH	175W MH	175	1	ELEC	120	194	1	1.70	1
ST	INCAN	60A BLUE	60	1	N/A	120	60	N/A	0.50	1
SU	INCAN	60A	60	1	N/A	120	60	N/A	0.50	1
SV	INCAN	60A	60	1	N/A	120	60	N/A	0.50	1
SX	QUAR	Q500 T3 FROSTED	500	1	N/A	120	500	N/A	4.17	1
SX-1	QUAR	Q500 T3 FROSTED	500	1	N/A	120	500	N/A	4.17	1
SAA	QUAR	Q250DC	250	1	N/A	120	250	N/A	2.08	1
SAB	INCAN	100A/IF	100	1	N/A	120	100	N/A	0.83	1
SAC1	QUAR	100PAR/HIR/SP10	100	1	N/A	120	100	N/A	0.83	1
SAC2	QUAR	100PAR/HIR/SP10	100	1	N/A	120	100	N/A	0.83	1
SAD	QUAR	HPL575/LL/C 120V	575	1	N/A	120	575	N/A	4.79	1
SAF	QUAR	75PAR30/H/FL25	75	1	N/A	120	75	N/A	0.63	1
SAG	QUAR	100PAR/HIR/FL25	100	1	N/A	120	100	N/A	0.83	1
SAJ	QUAR	100PAR/HIR/SP10	100	2	N/A	120	200	N/A	1.67	1
SAK	INCAN	100A/IF	100	1	N/A	120	100	N/A	0.83	1
SAL	QUAR	100PAR/HIR/FL25	100	1	N/A	120	100	N/A	0.83	1
SAM	QUAR	Q250PAR/FL30	250	1	N/A	120	250	N/A	2.08	1

Lighting Loads (continued):

Lamp				Luminaire						
Tag	Source	Lamp	Wattage	No.	Ballast	Voltage	Watts	BF	Current	PF
SAN	INCAN	100A/IF	100	1	N/A	120	100	N/A	0.83	1
SAP	QUAR	100PAR/HIR/FL25	100	1	N/A	120	100	N/A	0.83	1
SAQ	QUAR	60PAR16/H/SP10	60	5	N/A	120	300	N/A	2.50	1
SAQ1	QUAR	60PAR16/H/SP10	60	6	N/A	120	360	N/A	3.00	1
SAR	QUAR	Q40G9/CD	40	1	N/A	120	40	N/A	0.33	1
SAS	LED	LED (2800K)	?	1	N/A	120	?	N/A	?	1
SAT	MH	CMH39/UPAR20/FL25	39	1	ELEC	120	44	1	0.17	0.95
SAU	LINFL	F28W/T5/830	28	1	ELEC	120	33	1.04	0.28	0.98
SAU1	LINFL	F21W/T5/830	21	1	ELEC	120	26	1.03	0.21	0.98
SAV	QUAR	Q250PAR/FL30	250	1	N/A	120	250	N/A	2.08	1
SAW	QUAR	100PAR/HIR/SP10	100	2	N/A	120	200	N/A	1.67	1
SAX1	INCAN	100A/IF	100	4	N/A	120	400	N/A	3.33	1
SAX2	INCAN	100A/IF	100	6	N/A	120	600	N/A	5.00	1
SAY	LINFL	F14W/T8/830	14	1	MAG	120	20	0.97	0.35	0.46
SAZ	INCAN	100A/IF	100	1	N/A	120	100	N/A	0.83	1

Lighting Control

Concert hall lighting is controlled via dimmer racks on the first floor, with a similar system used for black box theatre, allowing for automatic shutoff when the building is not in use. The main lobby and black box theatre lobby have lighting control panels with preset scenes allowing easier manual control. In smaller spaces, such as music practice rooms, occupancy sensors automatically shut off lighting on a room-by-room basis.

Mechanical and Other Loads

The Concert Hall and Fine Arts Center includes a fairly typical air conditioning system, with the exception that the concert hall airflow is designed to be almost completely inaudible. Air is supplied through concrete vaults under the floor and up through vents under the seats. The system includes both CAV and VAV units, as well as condensing units, fans, and electric cabinet heaters.

Mechanical and Other Loads:

Load				Characteristics					
Tag	Description	Magnitude	Units	NEC	Voltage	Phase(s)	PF	kVA	kW
RTU-1	Constant volume	95.5	FLA	N/A	480	3	0.95	45.8	43.5
RTU-2	Constant volume	95.5	FLA	N/A	480	3	0.95	45.8	43.5
RTU-3	Constant volume	90.2	FLA	N/A	480	3	0.95	43.3	41.1
RTU-4	Constant volume	90.2	FLA	N/A	480	3	0.95	43.3	41.1
RTU-5	Variable volume	48.6	FLA	N/A	480	3	0.95	23.3	22.2
RTU-6	Variable volume	138.7	FLA	N/A	480	3	0.95	66.6	63.2
RTU-7	Constant volume	134.0	FLA	N/A	480	3	0.95	64.3	61.1
RTU-8	Constant volume	46.0	FLA	N/A	480	3	0.95	22.1	21.0
EF-1	Fan	1	HP	16	480	3	0.85	7.68	6.53
EF-2	Fan	1/2	HP	9.8	480	3	0.85	4.70	4.00
EF-3	Fan	1/6	HP	4.4	120	1	0.75	0.53	0.40
EF-4	Fan	1/3	HP	7.2	120	1	0.75	0.86	0.65
EF-5	Fan	1/3	HP	7.2	120	1	0.75	0.86	0.65
EF-6	Fan	1/3	HP	7.2	120	1	0.75	0.86	0.65
EF-8	Fan	1/4	HP	5.8	120	1	0.75	0.70	0.52
EF-9	Fan	1/10	HP	N/A	120	1	0.75	0.35	0.26
EF-10	Fan	129	W	N/A	120	1	0.75	0.17	0.13
EF-11	Fan	217	W	N/A	120	1	0.75	0.29	0.22
AC-1	AC unit	29.6	FLA	N/A	208	1	0.95	6.16	5.85
AC-2	AC unit	26.4	FLA	N/A	208	3	0.95	5.49	5.22
AC-3	AC unit	21.28	FLA	N/A	277	1	0.95	5.89	5.60
AC-4	AC unit	0.48	FLA	N/A	120	1	0.75	0.06	0.04
AC-5	AC unit	0.48	FLA	N/A	120	1	0.75	0.06	0.04
ACC-1	Condensing unit	6.4	FLA	N/A	480	3	0.85	3.07	2.61
ACC-2	Condensing unit	11.2	FLA	N/A	480	3	0.85	5.38	4.57
ACC-3	Condensing unit	11.12	FLA	N/A	208	1	0.85	2.31	1.97
ACC-4	Condensing unit	9.6	FLA	N/A	208	1	0.85	2.00	1.70
ACC-5	Condensing unit	9.6	FLA	N/A	208	1	0.85	2.00	1.70
ECH-1	Cabinet heater	5	kW	N/A	480	3	1	5.00	5.00
ECH-2	Cabinet heater	10	kW	N/A	480	3	1	10.00	10.00
ECH-3	Cabinet heater	15	kW	N/A	480	3	1	15.00	15.00
ECH-3R	Cabinet heater	15	kW	N/A	480	3	1	15.00	15.00
EWH-1	Wall heater	1.5	kW	N/A	277	1	1	1.50	1.50
ERH-1	Heating coil	40	kW	N/A	480	3	1	40	40
ERH-2	Heating coil	40	kW	N/A	480	3	1	40	40
1	Heated cabinet	12	A	N/A	120	1	1	1.5	1.5
2	Coffee brewer	8.7	A	N/A	208	3	1	1.8	1.8
3	Reach-in cooler	10	A	N/A	120	1	0.75	1.2	0.9
4	Ice machine	10	A	N/A	120	1	0.75	1.2	0.9

Service Entrance Size

Conceptual/Schematic Phases – Load per Square Foot

A large portion of the building is for offices and educational use, so the college classroom occupancy is the closest available. Using the college classroom building load estimation:

$(18\ VA/ft^2) \times (57{,}000\ ft^2) = 1{,}026\ KVA$

Design Development – NEC Loading

The NEC occupancies do not provide an exact fit, but School is reasonably close.

	VA/ft²	Area (ft²)	KVA	With Demand Factors
Lighting	33	57000	1881	1881 KVA
Receptacles	1	57000	57	34 KVA
Fans	2	57000	114	114 KVA
Fossil Fuel Heating	3	57000	171	171 KVA
Cooling	8	57000	456	456 KVA
Kitchen	10	57000	570	365 KVA
Elevators	2	57000	114	114 KVA

Total load: 3,135 KVA

Working Drawings – Actual Loading

Lighting loads:

Tag	Demand Load
LL-ELP-1	38 KVA
LL-LP-1	24.8 KVA
LL-LP-2	22.7 KVA
1-LP-1	27.9 KVA
1-LP-2	48.7 KVA
LL-LL-1	11.3 KVA
LL-LL-2	5.4 KVA
1-LL-1	17.6 KVA
1-LL-2	6.7 KVA
DP-1	26.4 KVA
DP-2	8.9 KVA
DP-3	14.4 KVA
DR-101	86 KVA
1-TLP-2	14.2 KVA
1-TLP-1	50.6 KVA
DR-1	66 KVA
1-CTP-1	30 KVA
1-CTP-2	15 KVA
1-AVP-1	15 KVA

Lighting demand load: 529.6 KVA

HVAC and kitchen demand load: 1103.4 KVA

Total demand load = 1633 KVA

Growth = 0.25 x 1065.7 KVA = 408 KVA

Total = 2041 KVA

SERVICE ENTRANCE SIZING TABLE				
Phase	Load - kVA	Voltage System	Load - Amps	Switchboard Size (amps)
Conceptual/Schematic Design	1026	480Y/277	1234	1600
Design Development	3135	480Y/277	3771	4000
Working Drawings	2041	480Y/277	2455	2500

EXISTING SERVICE ENTRANCE			
Service Entrance	Size - Amps	Voltage System	Capacity - KVA
Actual Conditions – Service Entrance 1	3000	480Y/277	2494
Actual Conditions – Service Entrance 2	200	480Y/277	166
Total Actual Conditions – All Services	3200	480Y/277	2660
Summary - VA/Sq.Ft.	46.67 VA/ft^2		

Environmental Stewardship Design

Lighting in the office spaces is controlled using occupancy sensors to prevent wasted energy. The mechanical systems in the black box theater and the concert hall are designed to reduce energy use when the spaces aren't in active use.

Design Issues

In a building with a large dependence on incandescent lighting to meet the needs of the concert hall and theater, it is difficult to reduce energy use. Exploring ways to reduce power requirements would also allow for cost savings from a smaller electrical system.

Single-Line Diagram

Communication Systems

Telecom system: Combined data and phone ports are included throughout the lower and first levels, and on the balcony level in the foyer and west reverb chamber.

Rescue assistance system: The rescue assistance control panel on the first floor connects to a rescue assistance call station on the lower level, two on the first floor, and two on the balcony level.

Fire alarm system: The fire alarm system uses smoke detectors, heat detectors, duct detectors, and water flow switches in the sprinkler system. General air handling units are wired to shut down when the alarm is triggered. The fire alarm control panel is on the lower level, with a fire alarm annunciator panel on the first floor.

Audiovisual system: AV systems are included in several areas of the building. The main system in the concert hall is controlled from an audio control booth behind the first floor seating area. Plug boxes are positioned throughout the concert hall, catwalks, control room, and audio room. The plug boxes provide connections for intercom, voice, data, microphones, speakers, and video. Power for the AV system is conditioned, and catwalk plug boxes include connections to the dimmer panels for lighting control.

The black box theater and rehearsal room have similar AV systems, with plug boxes throughout for data, video, intercom, speakers, and lighting control.

Back of house AV is limited to speakers, intercom, and volume control.

In the lobby, the AV system mostly provides speaker systems, with a microphone and intercom panel in the box office.

Appendix

Fixture Type: SS

Lamp: PS MH Std 175W/635 Mog ED28 CL
Lamp Quantity: 1
Ballast Type: Electronic

Fixture Type: SAE

Lamp: CMH39UPAR20FL25
Lamp Quantity: 1
Ballast Type: Electronic