

Technical Assignment 2  
Electrical System Existing Conditions and Building Load Summary Report



Villanova University: School of Law  
Villanova, PA

Jason Greer  
Lighting/Electrical Option

November 2, 2007

Villanova University: School of Law  
Villanova, PA

**100%-Technical Report 2**

November 2, 2007

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**Executive Summary**

The following Electrical System Existing Conditions and Building Load Summary Report analyzes the current conditions regarding the electrical system of the Villanova University: School of Law. This report analyzes all components of the electrical system as well as studies the sizing of the service entrance equipment. The systems that were analyzed are but are not limited to the service entrance, equipment size, the fire alarm system, the security system, the lighting systems, the mechanical equipment sizes and the telecommunication system. A single line diagram was produced to help better understand the power distribution system of the law school.

Upon completion of the report, it was shown that the switchgear was sized correctly for this particular building. The 3000A switchboard will protect the load that was calculated in all three of the sizing methods. The transformer is undersized but as was discussed in class, this is a practice that is often used. A transformer can withstand short term overloads as the heat in the transformer is the issue unlike tripping in most other equipment. Further downstream, it was also discovered that all busses and over-current devices were sized correctly as well.

Any relevant information that is not located in the body of this report can be found in the appendices that follow. The information located in the appendices include the switchgear detail and schedule, the motor control center and schedule, the luminaire schedule, the mechanical equipment schedule, all service entrance calculations and the single line diagram.

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### Summary Description of Distribution System

The power distribution system for the Villanova University: School of Law is a simple radial system. The electric service is connected to the university's 13.2kV underground primary distribution system with a 15kV primary loop switch.

The service is provided by a 2000kVA, 13.2kV primary voltage to 480Y/277V secondary voltage, 3 phase, 4 wire transformer located outside the building. A 3000A, 480Y/277V, 3 phase, 4 wire switchboard is located in the sub-basement and will distribute power to the building. The switchboard provides power to elevators, the chiller plant, AHUs, and the lighting and receptacle panels. The receptacle panels are supplied through a 480V to 208V transformer.

### Service Entrance

The service for the law school is connected to the university's 13.2kV underground primary distribution system. A 2000kVA, 13.2kV, 3 phase, 3 wire to 480V, 3 phase, 4 wire transformer steps to power down before it enters the building in the sub-basement. In the sub-basement there is a 3000A, 480Y/277V, 3P, 4W switchboard that distributes the power to the rest of the building. The switchboard is of circuit breaker type. It is metal enclosed and is front accessible. The internal bus bars are tinned copper with 100% neutral and ground bus.

Since this is a university building that is connected to the university's primary distribution system, the university has supplied all equipment and is responsible for the maintenance.

### Voltage Systems

The voltage systems for this building are 480Y/277V, 3P, 4W and 208Y/120V, 3P, 4W. The 480V system provides power to mechanical loads, elevators, motors, other large equipment and non-incandescent lighting loads. The 208V system provides power to smaller equipment, receptacles and incandescent lighting loads.

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**Transformers**

INDIVIDUAL TRANSFORMER SCHEDULE								
TAG	PRIMARY VOLTAGE	SECONDARY VOLTAGE	SIZE	TYPE	TEMP. RISE	TAPS	MOUNTING	REMARKS
X-1	13.2kV, 3P, 3W	480Y/277V, 3P, 4W	1500kVA	Silicone-based dielectric filled	55°C	(4) 2.5% Taps (2) Up & (2) Dn	Concrete Pad Mount (outside)	
XS-1	480Y/277V, 3P, 4W	208Y/120V, 3P, 4W	75kVA	Dry Type	115°C	(6) 2.5% Taps (2) Up & (4) Dn	Pad mounted, vibration isolated	
XS-2	480Y/277V, 3P, 4W	208Y/120V, 3P, 4W	75kVA	Dry Type	115°C	(6) 2.5% Taps (2) Up & (4) Dn	Pad mounted, vibration isolated	
XS-3	480Y/277V, 3P, 4W	208Y/120V, 3P, 4W	45kVA	Dry Type	115°C	(6) 2.5% Taps (2) Up & (4) Dn	Pad mounted, vibration isolated	
XS-4	480Y/277V, 3P, 4W	208Y/120V, 3P, 4W	45kVA	Dry Type	115°C	(6) 2.5% Taps (2) Up & (4) Dn	Pad mounted, vibration isolated	
XB-1	480Y/277V, 3P, 4W	208Y/120V, 3P, 4W	30kVA	Dry Type	115°C	(6) 2.5% Taps (2) Up & (4) Dn	Pad mounted, vibration isolated	
X1-1	480Y/277V, 3P, 4W	208Y/120V, 3P, 4W	75kVA	Dry Type	115°C	(6) 2.5% Taps (2) Up & (4) Dn	Pad mounted, vibration isolated	
X1-2	480Y/277V, 3P, 4W	208Y/120V, 3P, 4W	112.5kVA	Dry Type	115°C	(6) 2.5% Taps (2) Up & (4) Dn	Pad mounted, vibration isolated	
X2-1	480Y/277V, 3P, 4W	208Y/120V, 3P, 4W	45kVA	Dry Type	115°C	(6) 2.5% Taps (2) Up & (4) Dn	Pad mounted, vibration isolated	
X2-2	480Y/277V, 3P, 4W	208Y/120V, 3P, 4W	112.5kVA	Dry Type	115°C	(6) 2.5% Taps (2) Up & (4) Dn	Pad mounted, vibration isolated	
X3-1	480Y/277V, 3P, 4W	208Y/120V, 3P, 4W	45kVA	Dry Type	115°C	(6) 2.5% Taps (2) Up & (4) Dn	Pad mounted, vibration isolated	
X3-2	480Y/277V, 3P, 4W	208Y/120V, 3P, 4W	112.5kVA	Dry Type	115°C	(6) 2.5% Taps (2) Up & (4) Dn	Pad mounted, vibration isolated	

**Emergency Power System**

The emergency power for the law school is provided by a 300kW, 480Y/277V, 3P, 4W diesel generator. There is a 300 gallon tank that will hold the diesel fuel. 300 gallons of fuel will allow this generator to provide 13 hours of operation when the primary power is down. The generator and tank are located by the loading dock.

The emergency system consists of a life safety branch and a non-life safety branch. The life safety branch is provided with an automatic transfer switch which will serve all life safety loads which includes all emergency lighting, fire alarm system, and fire pump.

The non-life safety branch is provided with an ATS also and will serve all receptacles for the telecommunication equipment room.

ATS's are completed with all relays, timers and associated control circuitry to automatically start the engine, transfer the load upon primary power failure. Upon restoration of primary power, the ATS will transfer load back and stop the engine

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**Over-current Devices**

Service Generator

15kV primary fuse assembly. Current-limiting fuses are 50kA RMS at specified voltage.

Switchgear

See Appendix A for over-current specs for switchgear

Motor Control Center

See Appendix B for over-current specs for MCC

Panel Boards

Typical circuit breakers

**Locations of Switchgear**

<b>Major Equipment Locations</b>						
<b>Equipment Tag</b>	<b>Type</b>	<b>Floor Level</b>	<b>Room Name</b>	<b>Room Number</b>	<b>1/8th Scale Dwg</b>	<b>Detail Drawing</b>
X-1	Service Transformer	Outside	Outside	Outside	E5.1	N/A
XS-1	Stepdown Transformer	Sub-basement	Electrical Room	B02A	E2.0	N/A
XS-2	Stepdown Transformer	Sub-basement	Electrical Room	B02	E2.0	N/A
XS-3	Stepdown Transformer	Sub-basement	Electrical Room	B02	E2.0	N/A
XS-4	Stepdown Transformer	Sub-basement	Electrical Room	B02	E2.0	N/A
XB-1	Stepdown Transformer	Basement	Electrical Room	L29	E2.0	N/A
X1-1	Stepdown Transformer	First	Electrical Room	188	E2.1	N/A
X1-2	Stepdown Transformer	First	Electrical Room	119A	E2.1	N/A
X2-1	Stepdown Transformer	Second	Electrical Room	266	E2.2	N/A
X2-2	Stepdown Transformer	Second	Electrical Room	219A	E2.2	N/A
X3-1	Stepdown Transformer	Third	Electrical Room	366	E2.3	N/A
X3-2	Stepdown Transformer	Third	Electrical Room	319A	E2.3	N/A
MDB	Switch Board	Sub-basement	Electrical Room	B02	E2.0	E6.1
EDP-BS	Emergency Dist. Panel	Sub-basement	Electrical Room	B02A	E2.0	N/A
MCC	Motor Control Center	Basement	Mechanical Room	L34	E2.0	E6.1
G-1	Emergency Generator	Outside	Outside	Outside	E5.1	N/A
ATS-NLS	Auto. Trans. Switch Non-Life Safety	Sub-basement	Electrical Room	B02A	E2.0	N/A
ATS-LS	Auto. Trans. Switch Life Safety	Sub-basement	Electrical Room	B02A	E2.0	N/A

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Panel Board Locations								
Equipment Tag	Type	Voltage	Main Size	Floor Level	Room Name	Room Number	Dwg No.	Detail Drawing
ENP-MDF	Non-Life Safety Emerg. Panel	208V	100	Sub-basement	MDF	B01	E2.0	NA
LP-BS	Lighting Panel	480V	225	Sub-basement	Electrical Room	B02	E2.0	NA
ENDPH-BS	Non-Life Safety Emerg. Panel	480V	225	Sub-basement	Electrical Room	B02A	E2.0	NA
ENDPL-BS	Non-Life Safety Emerg. Panel	208V	400	Sub-basement	Electrical Room	B02A	E2.0	NA
ENP-BS	Non-Life Safety Emerg. Panel	480V	100	Sub-basement	Electrical Room	B02A	E2.0	NA
ELP-BS	Life Safety Emerg. Panel	480V	100	Sub-basement	Electrical Room	B02A	E2.0	NA
ERP-BS	Emergency Receptacle Panel	208V	100	Sub-basement	Electrical Room	B02A	E2.0	NA
LP-BN	Lighting Panel	480V	225	Basement	Electrical Room	L29	E2.0	NA
RP-BN	Receptacle Panel	208V	100	Basement	Electrical Room	L29	E2.0	NA
ELEV-BN	Elevator Panel	480V	400	Basement	Elev. Mach. Room	L19	E2.0	NA
RP-K(sec.1)	Receptacle Panel (kitchen)	208V	225	Basement	Kitchen	L15	E2.0	E2.5
RP-K(sec.2)	Receptacle Panel (kitchen)	208V	225	Basement	Kitchen	L15	E2.0	E2.5
RP-BSA	Receptacle Panel	208V	100	Basement	Electrical Closet	N/A	E2.0	NA
RP-BS	Receptacle Panel	208V	450	Basement	Electrical Closet	N/A	E2.0	NA
LP-1N	Lighting Panel	480V	400	First	Electrical Room	188	E2.1	NA
RP-1NA	Receptacle Panel	208V	400	First	Electrical Room	188	E2.1	NA
ELP-1N	Emergency Lighting Panel	480V	100	First	Electrical Room	188	E2.1	NA
RP-1NB	Receptacle Panel	208V	100	First	Electrical Closet	N/A	E2.1	NA
LP-1S	Lighting Panel	480V	400	First	Electrical Room	119A	E2.1	NA
PR-1SA-1	Receptacle Panel	208V	225	First	Electrical Room	119A	E2.1	NA
RP-1SA-2	Receptacle Panel	208V	225	First	Electrical Room	119A	E2.1	NA
RP-1SA-3	Receptacle Panel	208V	225	First	Electrical Room	119A	E2.1	NA
ENP-1S	Non-Life Safety Emerg. Panel	208V	100	First	Electrical Room	119A	E2.1	NA
ELP-1S	Life Safety Emerg. Panel	480V	100	First	Electrical Room	119A	E2.1	NA
ERP-1S	Emerg. Receptacle Panel	208V	100	First	Electrical Room	119A	E2.1	NA
RP-1SB	Receptacle Panel	208V	100	First	Electrical Closet	N/A	E2.1	NA
ENP-MDF2	Non-Life Safety Emerg. Panel	208V	100	First	Network Server Room	146	E2.1	NA
LP-2N	Lighting Panel	480V	225	Second	Electrical Room	266	E2.2	NA
RP-2NA	Receptacle Panel	208V	225	Second	Electrical Room	266	E2.2	NA
RP-2NB	Receptacle Panel	208V	100	Second	Electrical Closet	N/A	E2.2	NA
LP-2S	Lighting Panel	480V	225	Second	Electrical Room	219A	E2.2	NA
RP-2SA-1	Receptacle Panel	208V	225	Second	Electrical Room	219A	E2.2	NA
RP-2SA-2	Receptacle Panel	208V	225	Second	Electrical Room	219A	E2.2	NA
RP-2SA-3	Receptacle Panel	208V	225	Second	Electrical Room	219A	E2.2	NA
RP-2SB	Receptacle Panel	208V	100	Second	Electrical Closet	N/A	E2.2	NA
LP-3N	Lighting Panel	480V	225	Third	Electrical Room	366	E2.3	NA
RP-3NA	Receptacle Panel	208V	225	Third	Electrical Room	366	E2.3	NA
ELP-3N	Life Safety Emerg. Panel	480V	100	Third	Electrical Room	366	E2.3	NA
RP-3NB	Receptacle Panel	208V	225	Third	Electrical Closet	N/A	E2.3	NA
LP-3S	Lighting Panel	480V	100	Third	Electrical Room	319A	E2.3	NA
RP-3SA-1	Receptacle Panel	208V	225	Third	Electrical Room	319A	E2.3	NA
RP-3SA-2	Receptacle Panel	208V	225	Third	Electrical Room	319A	E2.3	NA
RP-3SA-3	Receptacle Panel	208V	225	Third	Electrical Room	319A	E2.3	NA
ENP-3S	Non-Life Safety Emerg. Panel	208V	100	Third	Electrical Room	319A	E2.3	NA
ELP-3S	Life Safety Emerg. Panel	480V	100	Third	Electrical Room	319A	E2.3	NA
ERP-3S	Emergency Receptacle Panel	208V	100	Third	Electrical Room	319A	E2.3	NA
RP-3SB	Receptacle Panel	208V	100	Third	Electrical Closet	N/A	E2.3	NA

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### Power Factor Correction

This project has no capacitors for power factor correction.

### Design Issues

This issue is more of a communication issue than a design issue but I will address it here nonetheless. During the completion of the construction documents, the owner added additional receptacle multiple times. This resulted in panels that are lacking in spares and spaces. This issue could have been avoided if during DD the proper amount of receptacles were discussed.

### Lighting Loads

See Appendix C

The spaces in the Villanova University: School of Law utilize occupancy sensors, photocells, time switches to meet ASHRAE 90.1 automatic shutoff requirements. The main spaces are controlled using centralized lighting control panels that turn the lights on at a set time and off at another.

### Mechanical and Other Loads

See Appendix D

### Service Entrance Size

Service Entrance Summary		J. Greer
Phase	Total Load (kVA)	Total Current (A)
Concept	1541	1854
Design Development	2504	3012
Construction	2376	2858
Design Equipment	Transformer	Switchboard
	1500kVA	3000A

See Appendix E for more detailed calculations.

### Utility Company Information

The following rate structure was obtained from PECO's website, <http://www.exeloncorp.com/ourcompanies/peco>. This structure applies to customers that require untransformed power service from the primary supply lines of PECO's distribution system. The customer installs, owns and maintains any transforming, switching and other receiving equipment required.



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## MONTHLY RATE TABLE

FIXED DISTRIBUTION SERVICE CHARGE: \$279.67

METERING AND BILLING CREDITS: A customer receiving Advanced Meter Services from a AMSP other than the Company will receive a credit on the Fixed Distribution Service Charge equal to the Total Metering Credit set forth for this Base Rate in Appendix B to the Joint Petition for Full Settlement. A customer receiving Consolidated EGS Billing will receive a credit on the Fixed Distribution Service Charge equal to the Billing and Collection Credit set forth for this Base Rate in Appendix B to the Joint Petition for Full Settlement.

## VARIABLE DISTRIBUTION SERVICE CHARGE:

\$1.82 per kW of billing demand

1.62¢ per kWh of the first 150 hours' use of billing demand

0.96¢ per kWh of the first next 150 hours' use of billing demand

0.31¢ per kWh for additional use.

## COMPETITIVE TRANSITION CHARGE:

\$3.17 per kW of billing demand

2.81¢ per kWh of the first 150 hours' use of billing demand

1.67¢ per kWh for the next 150 hours' use of billing demand

0.54¢ per kWh for additional use.

ENERGY AND CAPACITY CHARGE: The following Energy and Capacity Charges will apply to the customer if the customer receives Default PLR Service. These charges are not applicable to the customer if it obtains Competitive Energy Supply.

\$4.85 per kW of billing demand

6.07¢ per kWh of the first 150 hours' use of billing demand

4.32¢ per kWh for the next 150 hours' use of billing demand

2.59¢ per kWh for additional use.

**Telecommunications/Security Systems**

A duct bank for telecommunication service to the law school is provided from Villanova University's campus telecommunication network. A main telecom demarcation room is located in the basement. Two telecom rooms are located on each floor also. A complete telecom raceway system consisting of back boxes, conduits, and ladder trays are run throughout the building on each floor.

All voice and data cables are provided by others as part of a separate contract. Card access system equipment is also provided as part of a separate contract.

Finally, a complete security raceway system is provided throughout the building where needed.

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**Fire Alarm System**

The fire alarm system is a solid state, multiplex, addressable fire alarm system that consists of graphic annunciation panels at the entrance lobby. Manual pull stations, audio/visual devices, flow switches, tamper switches and smoke and heat detectors are located throughout the building.

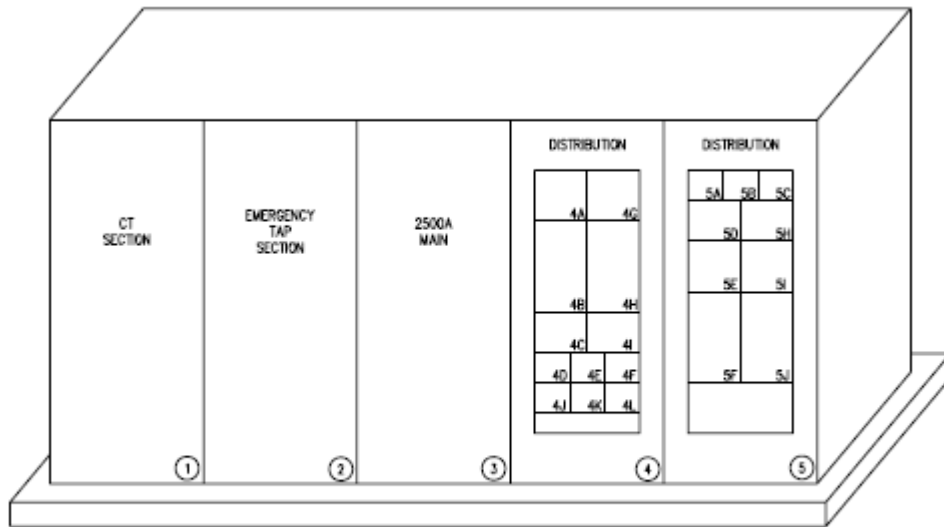
The fire alarm system is connected between the building security system and the campus central security console. The fire alarm system can be monitored through any computer and a printer can output all fire alarm activity. The smoke and heat detectors for the elevator system are interfaced with the elevator controllers for elevator recall and shut down requirements.

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Appendix A



2 SWITCHBOARD MDB ELEVATION  
SCALE: 1/2" = 1'

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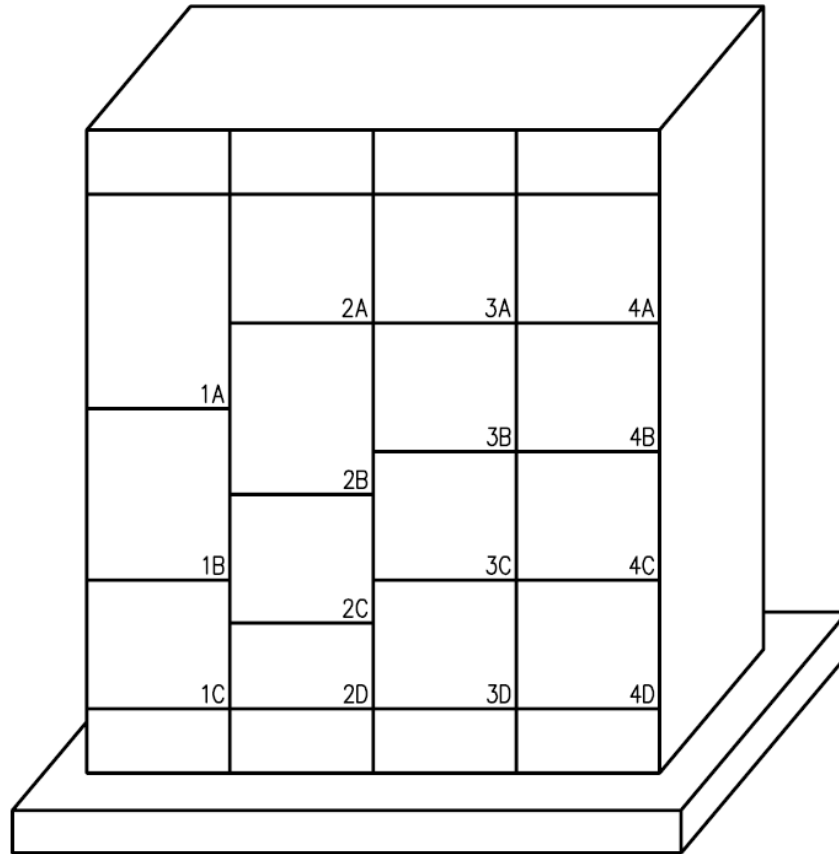
SWITCHBOARD SCHEDULE																			
480/277		VOLTAGE		3		PHASE		4		WIRE		3,000		AMPS		100,000		AIC RATING	
SECTION NUMBER	BRANCH DEVICES (BREAKERS)			BRANCH DEVICES (FUSED SWITCHES)			NAMEPLATE DESIGNATION/ ITEMS SERVED	REMARKS											
	FRAME	TRIP	POLES	SWITCH	FUSES	POLES													
①	-	-	-	-	-	-	CT CABINET	-											
②	-	-	-	-	-	-	EMERGENCY TAP SECTION	-											
③	2500	2500	3	-	-	-	MAIN CIRCUIT BREAKER	-											
④A	400	400	3	-	-	-	PANEL LP-1N	-											
④B	400	350	3	-	-	-	PANEL LP-1S	-											
④C	225	225	3	-	-	-	PANEL RP-K	-											
④D	225	225	3	-	-	-	PANEL LP-BN	-											
④E	100	100	3	-	-	-	ELEVATOR	-											
④F	225	225	3	-	-	-	PANEL LP-BS	-											
④G	400	400	3	-	-	-	PANEL ELEV-BN	-											
④H	800	600	3	-	-	-	MCC	-											
④I	225	225	3	-	-	-	75 KVA XFMR FOR KITCHEN	-											
④J	225	225	3	-	-	-	PANEL LP-25	-											
④K	400	400	3	-	-	-	PANEL LP-35	-											
④L	100	100	3	-	-	-	SPARE	-											
⑤A	100	100	3	-	-	-	SPARE	-											
⑤B	100	100	3	-	-	-	SNOW MELT 2	-											
⑤C	100	100	3	-	-	-	SPARE	-											
⑤D	225	225	3	-	-	-	PANEL EDP- BS	-											
⑤E	800	750	3	-	-	-	MCC	-											
⑤F	225	225	3	-	-	-	PANEL DP-PH	-											
⑤H	100	75	3	-	-	-	PHASE ENDPH-BS	-											
⑤I	-	-	-	-	-	-	SPACE	-											
⑤J	-	-	-	-	-	-	SPACE	-											

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**Appendix B**



**1** **MOTOR CONTROL CENTER ELEVATION**  
SCALE: 1/2" = 1'

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MOTOR CONTROL CENTER SCHEDULE (MCC)																					
		480/277		VOLTAGE		3		PHASE		4		WIRE		600		AMPS		42,000		AIC RATING	
ITEM NO.	NAMEPLATE DESIGNATION	LOAD			BRANCH DEVICE (BREAKERS)			STARTER SIZE	PB	LTS	REMARKS										
		HP	FLA	KW/KVA	FRAME	TRIP	POLES														
1A	CH-1: ABSORPTION CHILLER	-	9.4	7.8	30	15	3	-	(1)(2)	(3)(4)	(5)	-									
1B	CH-2: CENTRIFUGAL CHILLER	-	267	181	400	350	3	-	(1)(2)	(3)(4)	(5)	-									
1C	CP-1: CONDENSATE PUMP	2	3.4	2.7	100	15	3	1	(1)(2)	(3)(4)	(5)	-									
2A	EF-L-1: EXHAUST FAN	2	3.4	2.7	100	15	3	1	(1)(2)	(3)(4)	(5)	-									
2B	CWP-1: CONDENSOR WATER PUMP	30	40	31.8	100	90	3	3	(1)(2)	(3)(4)	(5)	-									
2C	CWP-2: CONDENSOR WATER PUMP	25	34	27.1	100	70	3	2	(1)(2)	(3)(4)	(5)	-									
2D	SNOW MELT 1	-	-	-	225	225	3	-		(3)(4)	(5)	-									
3A	HHWP-2: HOT WATER PUMP	15	21	16.7	100	40	3	2	(1)(2)	(3)(4)	(5)	-									
3B	DBP-1: BOOSTER PUMP	10	14	3.7	100	30	3	1	(1)(2)	(3)(4)	(5)	-									
3C	SCHWP-1: WATER PUMP	25	34	27.1	100	70	3	2	(1)(2)	(3)(4)	(5)	-									
3D	SCHWP-2: WATER PUMP	25	34	27.1	100	70	3	2	(1)(2)	(3)(4)	(5)	-									
3E	SPARE	-	-	-	100	100	3	2	(1)(2)	(3)(4)	(5)	-									
4A	PCHWP-1: WATER PUMP	7.5	11	8.8	100	30	3	1	(1)(2)	(3)(4)	(5)	-									
4B	PCHWP-2: WATER PUMP	10	14	11.1	100	30	3	1	(1)(2)	(3)(4)	(5)	-									
4C	HHWP-1: HOT WATER PUMP	15	21	16.7	100	40	3	2	(1)(2)	(3)(4)	(5)	-									
4D	SPACE	-	-	-	-	-	-	1	(1)(2)	(3)(4)	(5)	-									
-	-	-	-	-	-	-	-	-				-									

(1) "START" PUSHBUTTON    (2) "STOP" PUSHBUTTON    (3) RED "RUNNING" LIGHT    (4) GREEN "STOPPED" LIGHT    (5) H-O-A SWITCH

Appendix C

VILLANOVA UNIVERSITY: SCHOOL OF LAW																
LUMINAIRE SCHEDULE																
Jason Greer																
TAG	DESCRIPTION	Finish	VOLTAGE	INPUT WATTS	START CURRENT	OPERATING CURRENT	STARTING P.F.	OPERATING P.F.	MANUFACTURER	CATALOG NO.	LAMPS		BALLAST	B.F.	MOUNTING	REMARKS
											NO.	TYPE				
F1	Pendant Lighting	White	277	68	0.25	0.25	0.98	0.98	Axis Lighting	BD PL 4 T5 1 W E 1 SA# C	2	28W T5	Electronic	1.05	Pendant	-
F1a	Pendant Lighting	White	277	136	0.50	0.50	0.98	0.98	Axis Lighting	BD PL 4 T5 1 W E 1 SA# C	4	28W T5	Electronic	1.05	Pendant	Provide (2) two lamp ballasts per fixture. Provide (1) two lamp emergency ballast and (1) normal ballast when designated as emergency
F1b	Pendant Lighting	White	277	204	0.75	0.75	0.98	0.98	Axis Lighting	BD PL 4 T5 1 W E 1 SA# C	6	28W T5	Electronic	1.05	Pendant	Provide (3) two lamp ballasts per fixture. Provide (1) two lamp emergency ballast and (2) normal ballast when designated as emergency
F2	Pendant Lighting	White	277	68	0.25	0.25	0.98	0.98	Axis Lighting	LT PL 4 T5 W ** E 277 1 SA	2	28W T5	Electronic	1.05	Pendant	-
F2a	Pendant Lighting	White	277	136	0.50	0.50	0.98	0.98	Axis Lighting	LT PL 4 T5 W ** E 277 1 SA	4	28W T5	Electronic	1.05	Pendant	Provide (2) two lamp ballasts per fixture. Provide (1) two lamp emergency ballast and (1) normal ballast when designated as emergency
F2b	Pendant Lighting	White	277	204	0.75	0.75	0.98	0.98	Axis Lighting	LT PL 4 T5 W ** E 277 1 SA	6	28W T5	Electronic	1.05	Pendant	Provide (3) two lamp ballasts per fixture. Provide (1) two lamp emergency ballast and (2) normal ballast when designated as emergency
F3	Recessed 2x2 Troffer	White	277	71	0.26	0.26	0.98	0.98	Focal Point	FMA2 22 2 BX40 1C 277 E G WH	2	T5 40 BIAx	Electronic	1.00	Recessed	-
F4	Pendant Lighting	White	277	68	0.25	0.25	0.98	0.98	Axis Lighting	CU PL 4 T5 W ** E 277 1 SA	2	28W T5	Electronic		Pendant	-
F4a	Pendant Lighting	White	277	136	0.50	0.50	0.98	0.98	Axis Lighting	CU PL 4 T5 W ** E 277 1 SA	4	28W T5	Electronic	1.05	Pendant	Provide (2) two lamp ballasts per fixture. Provide (1) two lamp emergency ballast and (1) normal ballast when designated as emergency
F4b	Pendant Lighting	White	277	204	0.75	0.75	0.98	0.98	Axis Lighting	CU PL 4 T5 W ** E 277 1 SA	6	28W T5	Electronic	1.05	Pendant	Provide (3) two lamp ballasts per fixture. Provide (1) two lamp emergency ballast and (2) normal ballast when designated as emergency
F5	Adjustable Board Light	White	277	34	0.12	0.12	0.98	0.98	Insight	CF5 SMS 4 270 W LV5	1	28W T5	Electronic	1.05	Surface	-
F6	Industrial Strip	White	277	34	0.12	0.12	0.98	0.98	Prudential	PT5-STD 1T5 4 BWE 277	1	28W T5	Electronic	1.05	Surface	-
F7	Industrial Strip	White	277	68	0.25	0.25	0.98	0.98	Prudential	PT5-STD 2T5 4 BWE 277	2	28W T5	Electronic	1.05	Surface	-
F8	2x4 Lensed Troffer	White	277	102	0.37	0.37	0.98	0.98	Lithonia		3	28W T5	Electronic	1.05	Recessed	-
F9	Linear Strip	White	277	34	0.12	0.12	0.98	0.98	Lithonia	MS5 Series	1	28W T5	Electronic	1.05	Surface	Use 3' and 4' lengths to continuously fill cover. All unused space shall be equally distributed on both ends.
F9a	Linear Strip	White	277	13/63	0.23	0.23	0.98	0.98	Lithonia	MS5 Series	1	28W T5	Dimming	1.00	Surface	Use 3' and 4' lengths to continuously fill cover. All unused space shall be equally distributed on both ends.
F10	6" Downlight	Clear	277	36	0.13	0.13	0.98	0.98	Gotham	AFV Series	1	32W CFL	Electronic	1.10	Recessed	-
F10a	6" Downlight	Clear	277	36	0.13	0.13	0.98	0.98	Gotham	AFV Series	1	32W CFL	Electronic	1.10	Recessed	-
F11	Linear Indirect	Satin Anodized	277	24/124	0.45	0.45	0.98	0.98	Peerless	Lightedge	2	28W T5	Dimming	1.00	Surface	-
F12	Linear Wallslot	White	277	34	0.12	0.12	0.98	0.98	Focal Point	Focus 4	1	28W T5	Electronic	1.05	Recessed	Use 3' and 4' lengths to continuously fill cover. All unused space shall be equally distributed on both ends.
F13	Pendant Lighting	Aluminum	277	68	0.25	0.25	0.98	0.98	Axis Lighting	Cubic Series	2	28W T5	Electronic	1.05	Pendant	Extruded aluminum housing and perforated diffuser
F14	Linear Downlight	White	277	34	0.12	0.12	0.98	0.98	Selux	M100 Series	1	28W T5	Electronic	1.05	Recessed	Continuous spackle flange and silky specular parabolic louver
F15	6" Dia. Wallwasher	Clear	277	36	0.13	0.13	0.98	0.98	Gotham	AFVW	1	32W CFL	Electronic	1.10	Recessed	-
F15a	6" Dia. Wallwasher	Clear	277	9/38	0.14	0.14	0.98	0.98	Gotham	AFVW	1	32W CFL	Dimming	1.00	Recessed	-
F16	Linear Undercabinet	White	277	34	0.12	0.12	0.98	0.98	Alkco	Little Inch Series	1	28W T5	Electronic	1.05	Surface	-
F17	6" Width Linear Asymmetric	White	277	68	0.25	0.25	0.98	0.98	Ledailite	In-Cove LP	2	28W T5	Electronic	1.05	Surface	-
F17a	6" Width Linear Asymmetric	White	277	24/124	0.45	0.45	0.98	0.98	Ledailite	In-Cove LP	2	28W T5	Dimming	1.00	Surface	-
F18	Linear Direct Strip	Grey	277	34	0.12	0.12	0.98	0.98	Exterieur Vert	Lineos	1	28W T5	Electronic	1.05	Surface	Exterior rated. Extruded aluminum housing and polycarbonate lens.
F19	Cylindrical Wall Sconce	Natural Alum.	277	19	0.07	0.07	0.97	0.97	Allscape	BL-127 Series	1	18W CFL	Electronic	1.05	Surface	Exterior rated. Downlight only distribution.
F20	2x2 Louvered Troffer	Aluminum	277	71	0.26	0.26	0.98	0.98	Lithonia	2PM3G G A 2 CF40 12 277	2	T5 40 BIAx	Electronic	1.00	Recessed	-
F21	Industrial Strip	White	277	34	0.12	0.12	0.98	0.98	Prudential	S1-175-4-YGW-277-SUR-X3	1	28W T5	Electronic	1.05	Surface	Capable of wall or ceiling mount
F22	Linear Pendant	White	277	34	0.12	0.12	0.98	0.98	Waldman	RL40 Series	1	28W T5	Electronic	1.05	Pendant	Polycarbonate satin lens, remote ballast aluminum pendant bracket
F23	Linear Fluorescent w/ MR16	White	277/120	137	0.85	0.85	0.98	0.98	Mark Architectural	Slot 6	1&2	28w T5/ 37W MR 16	Dimming	1.00	Recessed	Separate circuits for incandescent and fluorescent
F24	Lensed Troffer	White	277	34	0.12	0.12	0.98	0.98	Prudential	P-82-T5-16-PRA-SC-277-X1	1	28W T5	Electronic	1.05	Recessed	-
F25	Downlight	White	277	36	0.13	0.13	0.98	0.98	Gotham	LGF-32TRT-GR2-T73-277	1	32W CFL	Electronic	1.10	Recessed	-
F26	Downlight	White	277	36	0.13	0.13	0.98	0.98	Delray	4740.0.2	1	32W CFL	Electronic	1.10	Recessed	Recessed downlight w/ semi-recessed glass diffuser
T1	6" Dia Ingrade	Silver	120	74	#VALUE!	0.62	1	1	Exterieur Vert	Phenix C1R Series	2	37W MR16	-	1.00	Ingrade	Remote transformer w/ straight edge trim
T2	4" Dia. Adjustable accent	Clear	120	37	#VALUE!	0.31	1	1	Gotham	DLV	1	37W MR16	-	1.00	Recessed	Lockable aiming, standard softening lens, tapered cut for angles 25-45
T3	Track	Silver	12	37	#VALUE!	3.08	1	1	LSI	LN16 Series	1	37W MR16	Low Volt	1.00	Track	Low Voltage
T5	Decorative Pendant	Matte Chrome	120	50	#VALUE!	0.42	1	1	Bruck	Candle Down Series	1	50W Halogen	-	1.00	Pendant	-
T6	Cylindrical Decorative Pendant	Satin Nickel	120	24/125	1.05	1.05	0.98	0.98	Schmitz	Tool	2	28W T5	Dimming	1.00	Pendant	72", Satin acrylic diffuser
T7	Cylindrical Decorative Pendant	Matte Chrome	120	93	0.78	0.78	0.99	0.99	Schmitz	Tool	2	42W CFL	Electronic	0.97	Pendant	15", Satin acrylic diffuser
H1	Ceiling Washer	Aluminum	277	45	0.18	0.18	0.95	0.95	Elliptipar	Style 105	1	39W MH T6	Electronic	1.00	Surface	Low Profile
H2	Adjustable Downlight		120	26	0.23	0.23	0.9	0.9	Amerlux	Evoke	1	20W MH T4	Electronic	1.00	Recessed	-
H4	Track Spot	Aluminum	277	45	0.18	0.18	0.95	0.95	Lightolier	Lytespan	1	39W MH T6	Electronic	1.00	Track	Surface mount canopy w/ decorative shroud enclosure and payne sparkman emergency interface module
H5	Ceiling Washer	Silver	277	161	0.69	0.69	0.9	0.9	Elliptipar	Style 407	1	150W MH T6	Electronic	1.00	Surface	-
H6	Ceiling Washer	Silver	277	161	0.69	0.69	0.9	0.9	Elliptipar	Style 407	1	150W MH T6	Electronic	1.00	Pendant	-
H7	Wallpack		277	129	0.5	0.50	0.90	0.9	Lithonia	TWR1S-2-TB-LPI	1	100W MH	Magnetic	1.00	Wall Mount	Full cutoff; for mechanical maintenance
L1	Linear LED Strip	Black	24	14W/ft	Length. Dep	Length Dep.	0.90	0.9	Winona	V Gen 2	-	Warm White	-	-	Surface	Exterior rated; remote driver; 30 deg distribution; length as indicated on drawings
L2	LED		24	100	0.13A/ft	0.13A/ft			illight	PN-24-B-S-CL	-	Blue LED	-	-	Surface	Field bendable plexiglass





Appendix E

<b>Service Entrance Sizing - Conceptual</b>						<b>J. Greer</b>
<b>Building Type</b>	<b>Usage Type</b>	<b>Demand Power Density (VA/SF)</b>	<b>Floor</b>	<b>Area</b>	<b>Load (kVA)</b>	<b>Load (A) @ 480V</b>
College Building	Classrooms	8	Sub-Basement	2,332	19	22.43968046
			Basement	36,495	292	351.1733012
			1st Floor	45,430	363	437.1503788
			2nd Floor	45,430	363	437.1503788
			3rd Floor	45,430	363	437.1503788
			<b>Total</b>	<b>175,117</b>	<b>1,401</b>	<b>1685</b>
			<b>Total w/ Growth (10%)</b>		<b>1541</b>	<b>1854</b>

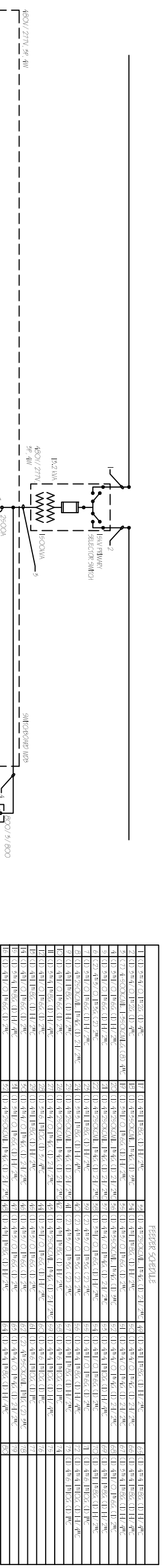
Appendix F

Service Entrance - DD					J. Greer
Category	Demand (VA/SF)	Floor	Area	Load (kVA)	Load (A) @ 480V
Lighting	3	Sub-Basement	2,332	7.00	
		Basement	36,495	109.49	
		1st Floor	45,430	136.29	
		2nd Floor	45,430	136.29	
		3rd Floor	45,430	136.29	
		<b>Total</b>	<b>175,117</b>	<b>525.35</b>	<b>631.90</b>
Receptacles	1	Sub-Basement	2,332	2.33	
		Basement	36,495	36.50	
		1st Floor	45,430	45.43	
		2nd Floor	45,430	45.43	
		3rd Floor	45,430	45.43	
		<b>Total</b>	<b>175,117</b>	<b>175.12</b>	<b>210.63</b>
Fans/Pumps	2	Sub-Basement	2,332	4.66	
		Basement	36,495	72.99	
		1st Floor	45,430	90.86	
		2nd Floor	45,430	90.86	
		3rd Floor	45,430	90.86	
		<b>Total</b>	<b>175,117</b>	<b>350.23</b>	<b>421.27</b>
HVAC	7	Sub-Basement	2,332	16.32	
		Basement	36,495	255.47	
		1st Floor	45,430	318.01	
		2nd Floor	45,430	318.01	
		3rd Floor	45,430	318.01	
		<b>Total</b>	<b>175,117</b>	<b>1225.82</b>	<b>1474.43</b>
			<b>Total</b>	<b>2277</b>	<b>2738</b>
			<b>Total w/ Growth</b>	<b>2504</b>	<b>3012</b>



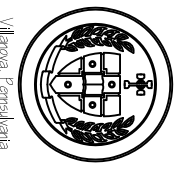
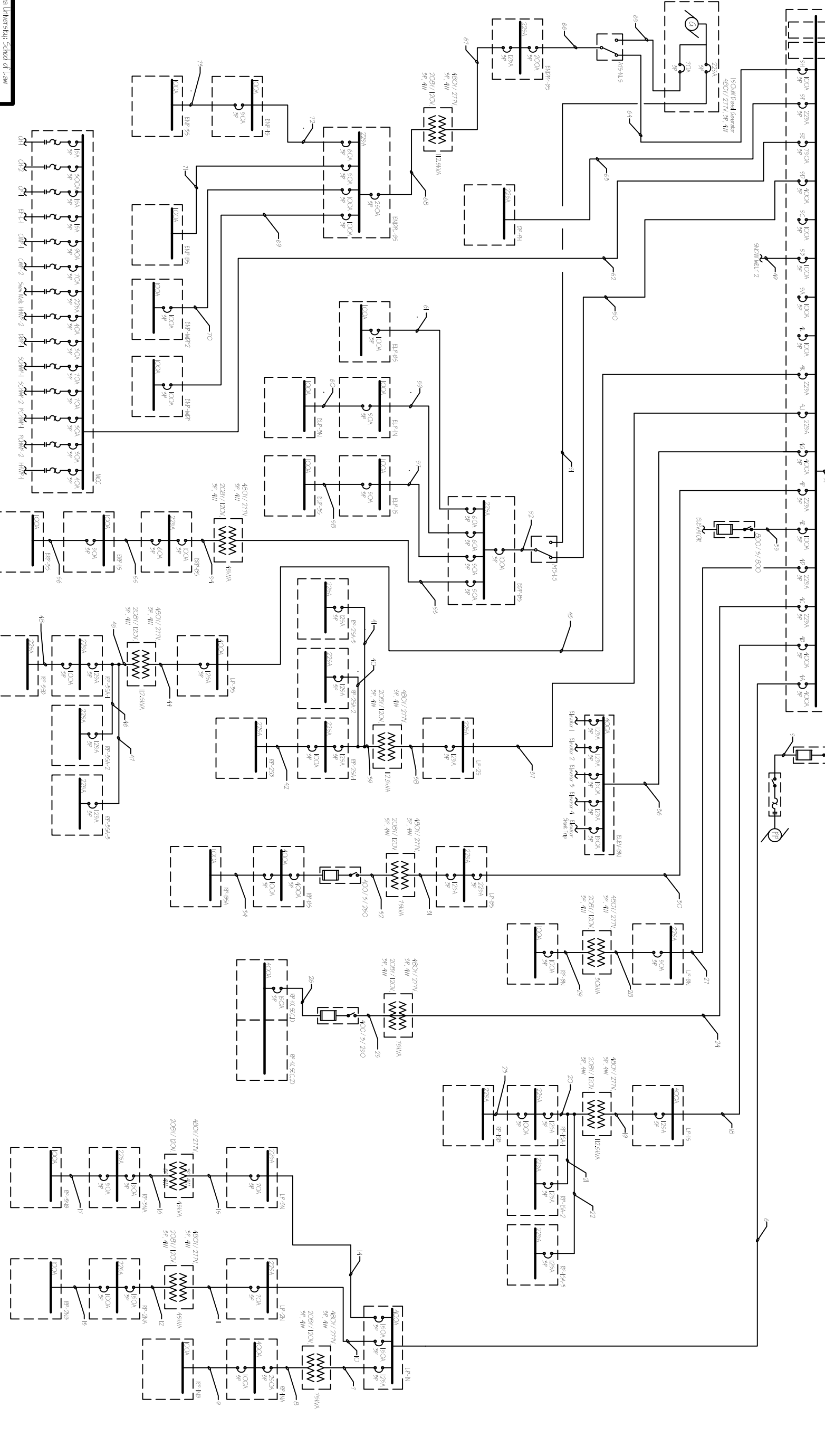
# Appendix H

<b>Service Entrance Summary</b>		<b>J. Greer</b>
Phase	Total Load (kVA)	Total Current (A)
Concept	1541	1854
Design Development	2504	3012
Construction	2376	2858
Design Equipment	Transformer	Switchboard
	<b>1500kVA</b>	<b>3000A</b>



**FEEDER SCHEDULE**

No	Description	Rating (kVA)	Rating (kW)	Rating (kVA)	Rating (kW)	Rating (kVA)	Rating (kW)	Rating (kVA)	Rating (kW)
1	LP-25A	25	20	25	20	25	20	25	20
2	LP-25B	25	20	25	20	25	20	25	20
3	LP-25C	25	20	25	20	25	20	25	20
4	LP-25D	25	20	25	20	25	20	25	20
5	LP-25E	25	20	25	20	25	20	25	20
6	LP-25F	25	20	25	20	25	20	25	20
7	LP-25G	25	20	25	20	25	20	25	20
8	LP-25H	25	20	25	20	25	20	25	20
9	LP-25I	25	20	25	20	25	20	25	20
10	LP-25J	25	20	25	20	25	20	25	20
11	LP-25K	25	20	25	20	25	20	25	20
12	LP-25L	25	20	25	20	25	20	25	20
13	LP-25M	25	20	25	20	25	20	25	20
14	LP-25N	25	20	25	20	25	20	25	20
15	LP-25O	25	20	25	20	25	20	25	20
16	LP-25P	25	20	25	20	25	20	25	20
17	LP-25Q	25	20	25	20	25	20	25	20
18	LP-25R	25	20	25	20	25	20	25	20
19	LP-25S	25	20	25	20	25	20	25	20
20	LP-25T	25	20	25	20	25	20	25	20
21	LP-25U	25	20	25	20	25	20	25	20
22	LP-25V	25	20	25	20	25	20	25	20
23	LP-25W	25	20	25	20	25	20	25	20
24	LP-25X	25	20	25	20	25	20	25	20
25	LP-25Y	25	20	25	20	25	20	25	20
26	LP-25Z	25	20	25	20	25	20	25	20
27	LP-25AA	25	20	25	20	25	20	25	20
28	LP-25AB	25	20	25	20	25	20	25	20
29	LP-25AC	25	20	25	20	25	20	25	20
30	LP-25AD	25	20	25	20	25	20	25	20
31	LP-25AE	25	20	25	20	25	20	25	20
32	LP-25AF	25	20	25	20	25	20	25	20
33	LP-25AG	25	20	25	20	25	20	25	20
34	LP-25AH	25	20	25	20	25	20	25	20
35	LP-25AI	25	20	25	20	25	20	25	20
36	LP-25AJ	25	20	25	20	25	20	25	20
37	LP-25AK	25	20	25	20	25	20	25	20
38	LP-25AL	25	20	25	20	25	20	25	20
39	LP-25AM	25	20	25	20	25	20	25	20
40	LP-25AN	25	20	25	20	25	20	25	20
41	LP-25AO	25	20	25	20	25	20	25	20
42	LP-25AP	25	20	25	20	25	20	25	20
43	LP-25AQ	25	20	25	20	25	20	25	20
44	LP-25AR	25	20	25	20	25	20	25	20
45	LP-25AS	25	20	25	20	25	20	25	20
46	LP-25AT	25	20	25	20	25	20	25	20
47	LP-25AU	25	20	25	20	25	20	25	20
48	LP-25AV	25	20	25	20	25	20	25	20
49	LP-25AW	25	20	25	20	25	20	25	20
50	LP-25AX	25	20	25	20	25	20	25	20



Villanova University, School of Law

Student: Jason Greer, L/E  
 Date: November 2, 2007  
 Electrical Consultant: Tad Parenti, P.E.  
 Facility Consultant: Richard Mierand, Ph.D., P.E., FIES  
 Assignment: Technical Report II: Single Line Diagram

The Pennsylvania State University | Architectural Engineering  
 AE 481W | Senior Thesis | 2007-2008



**e-Vision® Electronic  
Metal Halide  
Lamp Ballast**

Catalog Number RMH-20-E  
For 20W Philips Mini MasterColor® Lamp  
ANSI M175  
120V 50/60Hz Electronic  
Status: Active

**DIMENSIONS AND DATA**

Lamp Data		Input Volts	Catalog Number*	Line Current (Amps)	Input Power (W)	Ballast Factor	Max THD (%)	Min Power Factor	Wiring Dia	Figure	Weight (lb)	Max Distance to Lamp (ft)
Number	Watts											
20 Watt Philips Mini MasterColor Lamp, CDM-Tm 20W/830, ANSI Code M175 Minimum Starting Temp -20°C/-4°F												
1	22	120	RMH-20-E-XXX	0.23	26	1.0	10	0.9	4	E	0.42	6

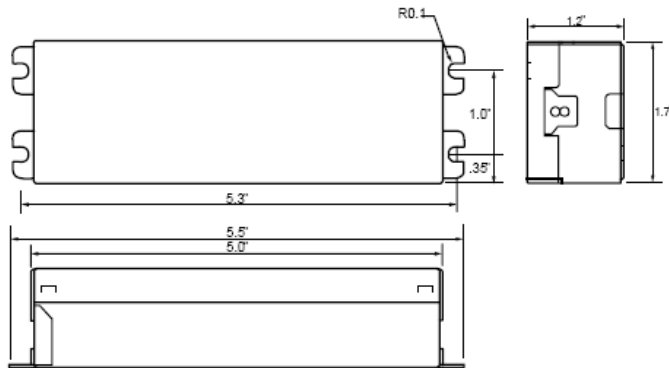
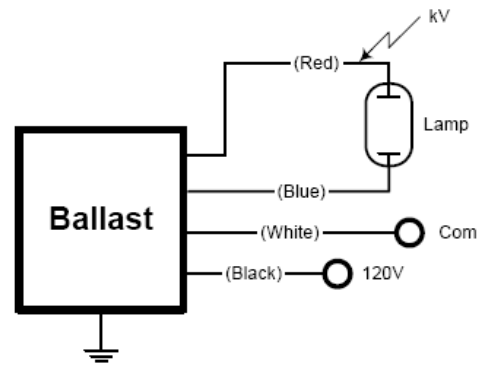
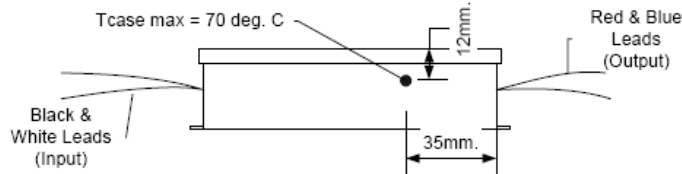


Figure E



Ballast Case must be Grounded

Wiring Diagram 4



Case Temperature Measurement Location



**INSTALLATION & APPLICATION NOTES:**

1. Maximum allowable case temperature is 70°C. See figure above for measurement location
2. Ignition pulse is 1.5 kV max
3. All leads are 12 inches long
4. Ballast output will shutdown after 20 minutes if lamp fails to ignite
5. Power must be cycled off – then on, after replacing lamp

**\*Ordering Information**

Order Suffix	Description
-LF	Ballast with side exit leads and mounting feet

Data is based on tests performed by Advance transformer in a controlled environment and representative of relative performance. Actual performance can vary depending on operating conditions. Specifications are subject to change without notice. All specifications are nominal unless otherwise noted.

Advance Transformer Co. • 10275 West Higgins Road • Rosemont, Illinois 60018-5603 • (847) 390-5000 • fax: 847-390-5109 • www.advancetransformer.com

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Revised: 1/13/06



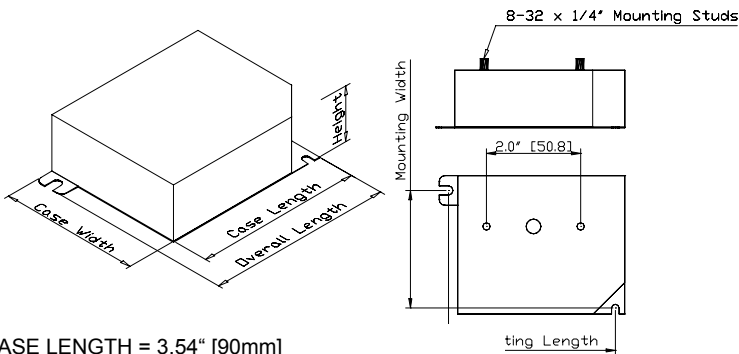
# e-Vision® Electronic Ballast for Metal Halide Lamps

Catalog Number IMH-39-G  
 For 39W Metal Halide Lamps  
 ANSI M130  
 120-277V 50/60Hz Electronic  
 Status: Preliminary

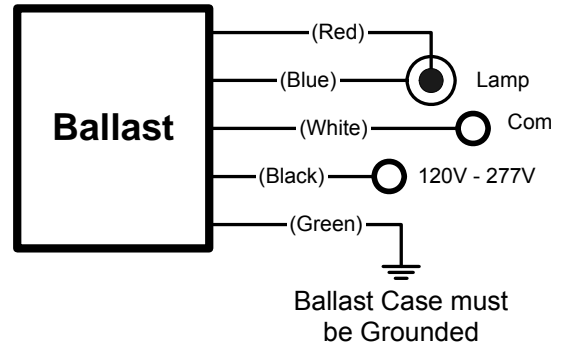
## DIMENSIONS AND DATA

Lamp Data		Input Volts	Catalog Number*	Line Current (Amps)	Input Power (W)	Ballast Factor	Max THD (%)	Min Power Factor	Wiring Dia	Figure	Weight (lb)	Max Distance to Lamp (ft)
Number	Watts											
39W Watt Lamp, ANSI Code M130 Minimum Starting Temp -30°C/-20°F												
1	39	120	IMH-39-G-xxx	0.39	46	1.0	15%	0.95	3	G	0.9	5
		277		0.18	45							

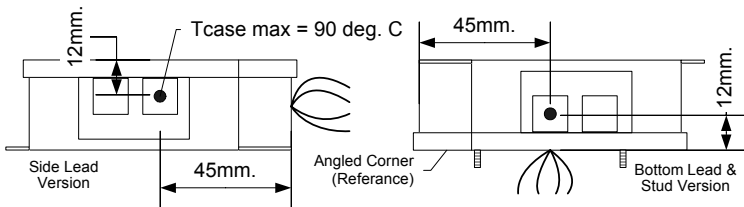
Figure G



CASE LENGTH = 3.54" [90mm]  
 MOUNTING LENGTH = 3.43" [87mm]  
 MOUNTING WIDTH = 2.64" [67mm]  
 OVERALL LENGTH = 3.82" [97mm]  
 CASE WIDTH = 3.03" [77mm]  
 HEIGHT = 1.18" [30mm]



Wiring Diagram 3



Case Temperature Measurement Location



**INSTALLATION & APPLICATION NOTES:**

1. Maximum allowable case temperature is 90°C. See figure above for measurement location
2. Ignition pulse is 4 kV max
3. All leads are 9 inches long
4. Ballast output will shutdown after 20 minutes if lamp fails to ignite
5. Power must be cycled off – then on, after replacing lamp
6. Connect the red leads to the center terminals of the lamp when using screw base lamps

**\*Ordering Information**

Order Suffix	Description
-LF	Ballast with side exit leads and mounting feet
-BLS	Ballast with bottom exit leads and mounting studs

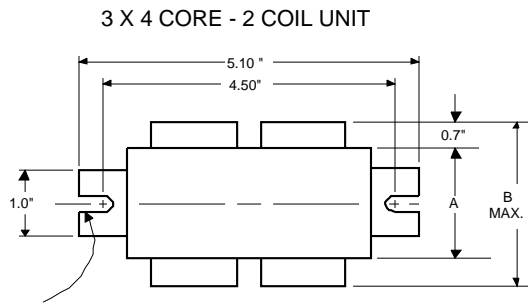
Data is based on tests performed by Advance transformer in a controlled environment and representative of relative performance. Actual performance can vary depending on operating conditions. Specifications are subject to change without notice. All specifications are nominal unless otherwise noted.



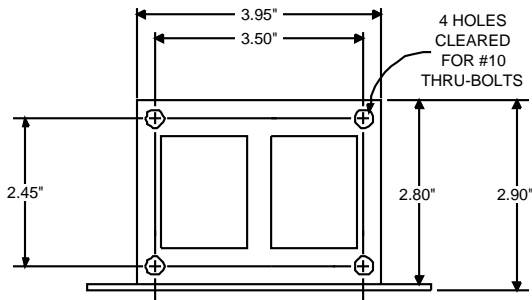
**Metal Halide Lamp Ballast**

**Catalog Number 71A5380**  
**For 100W M90/M140**  
**60 Hz HX-HPF**  
**Status: Active**

**DIMENSIONS AND DATA**



0.25" WIDE  
2 SLOTS



INPUT VOLTS	120	277			
CIRCUIT TYPE	HX-HPF				
POWER FACTOR (min)	90%				
REGULATION					
Line Volts	±5%				
Lamp Watts	±12%				
LINE CURRENT (Amps)					
Operating.....	1.15	0.50			
Open Circuit.....	2.30	1.00			
Starting.....	1.20	0.60			
UL TEMPERATURE RATINGS					
Insulation Class	H(180°C)				
Coil Temperature Code	1029				
MIN. AMBIENT STARTING TEMP.	-20°F or -30°C				
NOM. OPEN CIRCUIT VOLTAGE	265				
INPUT VOLTAGE AT LAMP DROPOUT.....	90	208			
INPUT WATTS	129				
RECOMMENDED FUSE (Amps).....	6	3			
CORE and COIL					
Dimension (A)	1.50				
Dimension (B)	2.80				
Weight (lbs.)	5.5				
Lead Lengths	12"				
CAPACITOR REQUIREMENT					
Microfarads	12.0				
Volts (min.)	280				
Fault Current Withstand (amps)					
60 Hz TEST PROCEDURES (Refer to Advance Test Procedure for HID Ballasts - Form 1270)					
High Potential Test (Volts)					
1 minute	2000				
2 seconds	2500				
Open Circuit Voltage Test (Volts)	240-300				
Short-Circuit Current Test (Amps)					
Secondary Current	1.35-1.70				
Input Current.....	1.00	0.40	-	-	-
	1.50	0.65			

Capacitor: 7C120M33-R

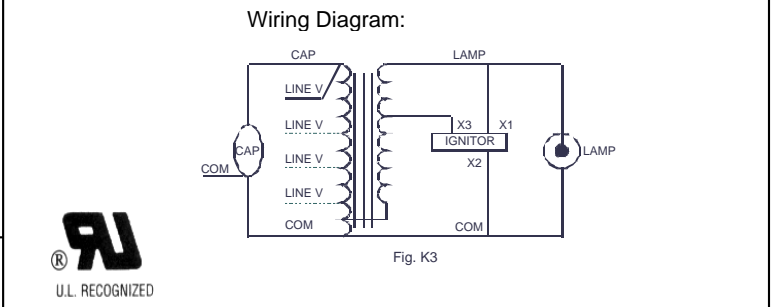


Capacitance: 12  
 Dia/Oval Dim: 1.5  
 Height: 2.9  
 Temp Rating: 105°C

Ignitor: LI533-H4



Ballast to Lamp Distance (BTL) = 20 feet  
 Temp Rating: 105°C



**Typical Ordering Information**

(please call Advance for suffix availability)

Order Suffix	Description
500D.	Ballast With Ignitor and Dry Film Capacitor
510D.	Ballast w/Welded Bracket, Ignitor, & Dry Film Capacitor
600.	Ballast and Ignitor, No Capacitor
610.	Ballast with Welded Bracket and Ignitor, No Capacitor

Data is based upon tests performed by Advance Transformer in a controlled environment and representative of relative performance. Actual performance can vary depending on operating conditions. Specifications are subject to change without notice.

**ADVANCE**

O'HARE INTERNATIONAL CENTER · 10275 WEST HIGGINS ROAD · ROSEMONT, IL 60018  
 Customer Support/Technical Service: Phone: 800-372-3331 · Fax: 630-307-3071  
 Corporate Offices: Phone: 800-322-2086

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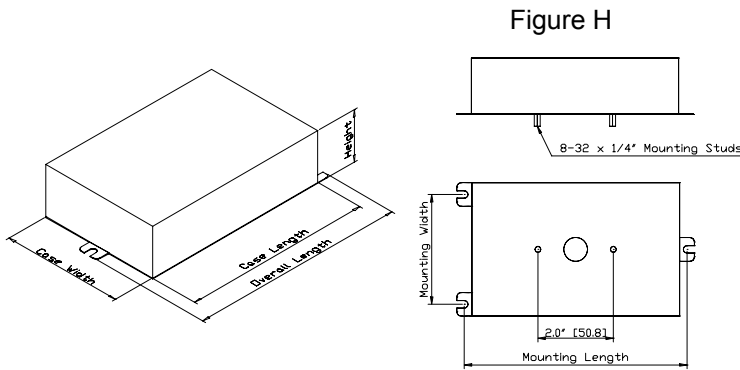


# e-Vision® Electronic Ballast for Metal Halide Lamps

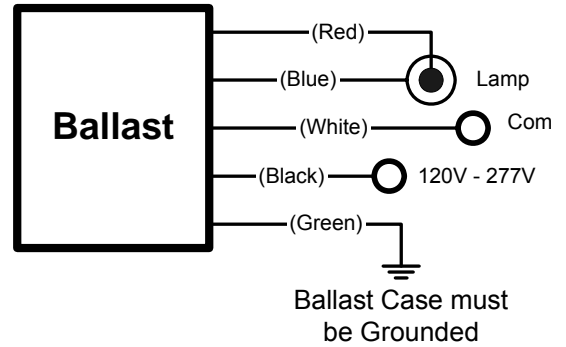
Catalog Number IMH-150-H  
 For 150W Metal Halide Lamps  
 ANSI M142, M102  
 120-277V 50/60Hz Electronic  
 Status: Released

## DIMENSIONS AND DATA

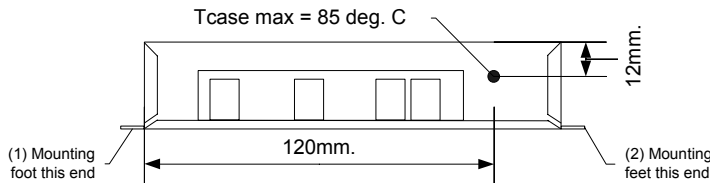
Lamp Data		Input Volts	Catalog Number*	Line Current (Amps)	Input Power (W)	Ballast Factor	Max THD (%)	Min Power Factor	Wiring Dia	Figure	Weight (lb)	Max Distance to Lamp (ft)
Number	Watts											
150W Watt Lamp, ANSI Code M142, M102 Minimum Starting Temp -30°C/-20°F												
1	150	120	IMH-150-H-xxx	1.38	165	1.0	10%	0.90	3	H	1.9	5
		277		0.69	161							



CASE LENGTH = 5.67" [144mm]  
 MOUNTING LENGTH = 6.0" [152mm]  
 MOUNTING WIDTH = 2.87" [73mm]  
 OVERALL LENGTH = 6.34" [161mm]  
 CASE WIDTH = 3.62" [92mm]  
 HEIGHT = 1.5" [38mm]



Wiring Diagram 3



Case Temperature Measurement Location



### INSTALLATION & APPLICATION NOTES:

1. Maximum allowable case temperature is 85°C. See figure above for measurement location
2. Ignition pulse is 4 kV max
3. All leads are 12 inches long
4. Ballast output will shutdown after 20 minutes if lamp fails to ignite
5. Power must be cycled off – then on, after replacing lamp
6. Connect the red lead to the center terminal of the lamp when using screw base lamps

### \*Ordering Information

Order Suffix	Description
-LF	Ballast with side exit leads and mounting feet
-BLS	Ballast with bottom exit leads and mounting studs

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