

A E 481 THESIS TECHNICAL REPORT TWO

# Shepherd University Wellness Center | AE 481 Thesis Lighting Technical Report 2

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Shepherdstown, West Virginia

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## **Executive Summary**

The Shepherd University Wellness Center is a 73,400 square foot multi-function facility that provides a balanced recreational program for the students, faculty, and staff of the University. The Technical Report Two is a thorough analysis of the electrical systems found in the Shepherd University Wellness Center.

The report consists of the analysis and documentation of the system components, including a list of schedules for each electrical component of the system and a single-line diagram of the electrical system layout. The communications systems are also described. After examining the electrical system for this University facility, the service entrance size is calculated for different phases in the design.

## Summary Description of Distribution System

The Shepherd University Wellness Center has a simple radial electrical system that enters the building through one service entrance point located in the building's main electrical room. The main transformer, which is provided by the contractor, has a secondary voltage of 480Y/277V, 3Ph, 4W. The 2500A main distribution panel supplies power to subsequent feeders and panels. Emergency power is provided by a 75kW propane fired generator.

## Utility Company

### Information

The Potomac Edison Company (doing business as Allegheny Power)

[www.alleghenypower.com](http://www.alleghenypower.com)

### Rate Structure

The rate schedule as well as the Electric Utility Load Data for this campus building is not available. Below is information obtained from the Power Company's website.

Municipality: Shepherdstown

Residential and Commercial Lighting: 0.04

Other Services: 0.03

Excise: 0.02

## Service Entrance

Within the distribution system, the electric utility company's service ends at the power company's transformer. The outside work of the service entrance is made up of a ductbank and service transformer. The service entrance is located within the main electrical room number 152 on the first floor of the building. At this location, the service entrance equipment is a 2500A, 480Y/277V, 3Ph, 4W service entrance switchboard.

The utility company will provide the pad-mounted transformer, all primary cable with connectors and connections, and the electric metering at the transformer location. The electrical contractor will provide the secondary service grounding, the secondary service ductbank, and the secondary conductors from the transformer pad to the main switchboard. The distribution system is fed directly from an electrical utility company. Information on the existing campus electrical system is unavailable.

## Voltage Systems

The typical voltage system used throughout the building is 480Y/277V, 3Ph, 4W. The service entrance switchboard, the main switchboards and distribution panels, lighting panels, and mechanical panels all run on this voltage system. The receptacle panels run on 208Y/120V, 3Ph, 4W.

## Emergency Power System

A 75kW, 480Y/277V, 3Ph, 4W propane fired generator distributes emergency power to the circuit breaker for the equipment branch automatic transfer switch and the life safety branch automatic transfer switch, both 60A, 600V. When transferred to the emergency power position, power is distributed to the emergency distribution panels EL, for the emergency equipment and fire alarms, and EHP1, for the life safety equipment and egress lighting.

## Locations of Switchgear

Located in the main electrical room 152 are the service entrance switchboard, the two main distribution switchboards, the automatic transfer switch for life safety branch, and the automatic transfer switch for equipment branch.

The following table lists those pieces of equipment, their locations within the building as well as their locations on the drawings.

Major Equipment Schedule						
Tag	Type	Floor Level	Room No.	Room Name	1/8 Scale DWG	Enlarged DWG
T-1	Main Transformer	Ground	N/A	N/A	E-400	N/A
GEN	Emergency Generator	Ground	N/A	N/A	E-400	N/A
MSB	Main Switchboard	First	152	Main Electrical	E-400	E-402
DS1	Switchboard Distribution Section 1	First	152	Main Electrical	E-400	E-402
DS2	Switchboard Distribution Section 2	First	152	Main Electrical	E-400	E-402
ATS-1	Transfer Switch- Life Safety	First	152	Main Electrical	E-400	E-402
ATS-2	Transfer Switch- Equipment	First	152	Main Electrical	E-400	E-402
T-2	Transformer- Panel EL	First	152	Main Electrical	E-400	E-402
T-3	Transformer- Panel SP	First	152	Main Electrical	E-400	E-402

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PANEL BOARDS						
TAG	VOLTAGE SYSTEM	MAIN SIZE	FLOOR LEVEL	ROOM NO.	ROOM NAME	PLAN DWG.
EL	208Y/120V,3PH,4W	100A	First	152	Main Electrical	E-402
H1	480Y/277V,3PH,4W	400A	First	152	Main Electrical	E-402
SP	208Y/120V,3PH,4W	100A	First	152	Main Electrical	E-402
LDP	208Y/120V,3PH,4W	1000A	First	152	Main Electrical	E-402
P1	208Y/120V,3PH,4W	400A	First	152	Main Electrical	E-402
P2	208Y/120V,3PH,4W	225A	First	152	Main Electrical	E-402
XP	208Y/120V,3PH,4W	225A	First	152	Main Electrical	E-402
XP2	208Y/120V,3PH,4W	225A	First	152	Main Electrical	E-402
EHP1	480Y/277V,3PH,4W	100A	First	127	Electrical	E-402
JP	208Y/120V,3PH,4W	225A	First	127	Electrical	E-402
HP1	480Y/277V,3PH,4W	225A	First	127	Electrical	E-402
LP1	208Y/120V,3PH,4W	225A	First	127	Electrical	E-402

### Over-Current Devices

Throughout the electrical system, circuit breakers on branch devices make up the over-current system. The main switchboard is protected by a 2500A circuit breaker. The automatic transfer switches for the life safety and emergency equipment are each protected by a 60A circuit breaker. The main switchboard distributes power on 3 circuit breakers, which are protected by three pole circuit breakers and set to trip at 400A, 225A, and 100A respectively. The remaining circuit breakers are fed by the LDP panel and contain main lugs only (MLO).

### Transformers

The building utilizes four transformers throughout the electrical system all located in the main electrical room. The main transformer steps down the primary power supplied by the utility company to 480Y/277V, 3Ph, 4W power. The remaining three transformers step down the 480Y/277V, 3Ph, 4W power to 208Y/120V, 3Ph, 4W power. The following schedule describes the transformers used in the Shepherd University Wellness Center.

INDIVIDUAL TRANSFORMER SCHEDULE								
TAG	PRIMARY VOLTAGE	SECONDARY VOLTAGE	SIZE	TYPE	TEMP. RISE	TAPS	MOUNTING	REMARKS
T-1	N/A	480Y/277V,3PH,4W.	N/A	N/A	N/A	N/A	PAD MOUNTED ON GRADE BY CONTRACTOR	
T-2	480V,3PH,3W.	208Y/120V,3PH,4W	30	DRY TYPE	150 DEGREE C	(6) 2.5%	PAD MOUNTED ON FLOOR	1
T-3	480V,3PH,3W.	208Y/120V,3PH,4W	30	DRY TYPE	115 DEGREE C	(6) 2.5%	PAD MOUNTED ON FLOOR	K-13 RATED
T-4	480V,3PH,3W.	208Y/120V,3PH,4W	300	DRY TYPE	150 DEGREE C	(6) 2.5%	PAD MOUNTED ON FLOOR	1

NOTES:  
1. REFER TO SPECIFICATIONS FOR ADDITIONAL REQUIREMENTS

KEY:  
N/A=NOT APPLICABLE  
A/N=AS NOTED

## Grounding

Grounding is not shown on the drawings. The building grounding information can be found in the Wellness Center Specifications in *Section 260526: Grounding and Bonding for Electrical Systems*.

## Special Equipment

No special equipment is shown on the Riser Diagram or Floor Plans. Special equipment would include a capacitor, an uninterruptible power supply (UPS), harmonic filter, etc.

Power generation equipment includes the propane fired emergency generator powered at 75kW.

## Lighting Loads

The typical lighting system within the building uses linear fluorescent sources. Metal halide sources are used in the gymnasium and pool areas. Daylighting is provided by the façade glazing in the rotunda and complimented by linear fluorescent, metal halide, and xenon sources.

The luminaire schedule below summarizes the lighting loads throughout the building. Fluorescent and metal halide luminaires typically operate at 277V, while incandescent operate at 120V. High intensity discharge ballasts may be found in Appendix B.

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LUMINAIRE SCHEDULE										
TAG	SOURCE	TYPE	LAMP WATTAGE	NO. OF LAMPS	BALLAST TYPE	VOLTAGE	INPUT WATTS	BALLAST FACTOR	CURRENT	POWER FACTOR
OA-64	TRIPLE TUBE CF	F32TBX/835/A/ECO	32	2	ELECTRONIC, PS	277	64	0.98	0.32	0.98
OB-32	TRIPLE TUBE CF	F32TBX/835/A/ECO	32	1	ELECTRONIC, PS	277	32	0.98	0.32	0.98
OC-100	MH	MXR100/C/U/MED	100	1	MAGNETIC	277	120	1	0.33/0.3	0.9
OD-300	MH	MXR100/C/U/MED	100	1	MAGNETIC	277	120	1	0.33/0.3	0.9
PA-400	MH	MPR400/VBU/O/40	400	1	ELECTRONIC	277	428	1	1.65	0.99
PB-400-										
A-250	MH	MPR400/VBU/O/40	400	1	ELECTRONIC	277	428	1	1.65	0.99
PC-400-										
A-250	MH	MPR400/VBU/O/40	400	1	ELECTRONIC	277	428	1	1.65	0.99
PD-64	T8 FLUOR.	F32T8/SP35/ECO	32	2	ELECTRONIC	277	62	0.88	0.52	0.9
PE-128	T8 FLUOR.	F32T8/SP35/ECO	32	2	ELECTRONIC	277	62	0.88	0.52	0.9
PF-50	BI-PIN HALOGEN	50MR16/Q/20/TL	50	1	--	120	50	--	--	--
PG-64	T8 FLUOR.	F32T8/SP35/ECO	32	2	ELECTRONIC	277	62	0.88	0.52	0.9
PH-400	MH	MPR400/VBU/O/40	400	1	ELECTRONIC	277	428	1	1.65	0.99
PI-400-										
A-250	MH	MPR400/VBU/O/40	400	1	ELECTRONIC	277	428	1	1.65	0.99
PJ-400-										
E-250	MH	MPR400/VBU/O/40	400	1	ELECTRONIC	277	428	1	1.65	0.99
PK-100	MH	MXR100/C/U/MED	100	1	ELECTRONIC, PS	277	107	1	0.41	0.98
PL-96	T8 FLUOR.	F32T8/SP35/ECO	32	3	ELECTRONIC	277	92	0.88	0.77	0.9
RA-96	T8 FLUOR.	F32T8/SP35/ECO	32	3	ELECTRONIC	277	92	0.88	0.77	0.9
RB-64	T8 FLUOR.	F32T8/SP35/ECO	32	2	ELECTRONIC	277	62	0.88	0.52	0.9
RC-32	T8 FLUOR.	F32T8/SP35/ECO	32	1	ELECTRONIC	277	32	0.88	0.27	0.9
RD-32	TRT CF	F32T8/SP35/ECO	32	1	ELECTRONIC	120/277	32	0.88	0.27	0.9
RE-32	T8 FLUOR.	F32T8/SP35/ECO	32	1	ELECTRONIC	277	32	0.88	0.27	0.9
RF-32	TRT CF	F32T8/SP35/ECO	32	1	ELECTRONIC	120/277	32	0.88	0.27	0.9
RG-64	T8 FLUOR.	F32T8/SP35/ECO	32	2	ELECTRONIC	277	62	0.88	0.52	0.9
RH-100	A21 INCAN.	100A 60PK	100	1	--	120	100	--	--	--
RI-50	MR16 HALOGEN	50MR16/Q/20/TL	50	1	--	277	50	--	--	--
RJ-100	MH	MXR100/C/U/MED	100	1	MAGNETIC	277	120	1	0.33/0.3	0.9
RK-220	BIAX CF	F55BX/835	55	4	ELECTRONIC, PS	277	218	1.06	0.81	0.98
SA-64	T8 FLUOR.	F32T8/SP35/ECO	32	2	ELECTRONIC	277	62	0.88	0.52	0.9
SB-70	CF	F32TBX/835/A/ECO	32	1	ELECTRONIC, PS	277	32	0.98	0.32	0.98
SC-24	T5HO FLUOR.	F24W/T5/835/ECO	24	1	ELECTRONIC	277	28	1	0.18	0.98
SD-60	XENON	FT-24-10	10	6	--	120	10	--	--	--
SE-400	MH	MPR400/VBU/O/40	400	1	ELECTRONIC	277	428	1	1.65	0.99
SF-60	XENON FESTOON	FT-24-10	10	6	--	120	10	--	--	--
SG-32	T8 FLUOR.	F32T8/SP35/ECO	32	1	ELECTRONIC	120	32	0.88	0.27	0.9
SH-24	T5HO FLUOR.	F24W/T5/835/ECO	24	1	ELECTRONIC	120	28	1	0.18	0.98
WA-32	TRT CF	F32T8/SP35/ECO	32	1	ELECTRONIC	277	32	0.88	0.27	0.9
WB-100	A21 INCAN.	100A 60PK	100	1	--	120	100	--	--	--
WC-96	T8 FLUOR.	F32T8/SP35/ECO	32	3	ELECTRONIC	277	92	0.88	0.77	0.9
XA	LED	EMERGENCY LED	2.7	--	--	120/277	2.7	--	0.095	--
XB	LED	EMERGENCY LED	2.7	--	--	120/277	2.7	--	0.095	--
XC	LED	EMERGENCY LED	2.7	--	--	120/277	2.7	--	0.095	--

## Lighting Control

The lighting control system is digital and consists of a master LCP with up to 48 individual relays, slave LCPs with up to 49 individual relays in each panel, a micro LCP with up to four individual relays, which can be switchable or 0-10V DC dimmable, digital switches and digital interface cards. All system components connect in a “daisy chain” style configuration and are controlled by category five patch cables with RJ45 connectors, providing real-time two-way communication with each system component. All incandescent lighting circuits are controlled by a NC/Softstart relay.

ASHRAE 90.1 requires that all buildings larger than 5,000 square feet be controlled with an automatic control device to shut off building lighting in all spaces. This building meets these requirements using a digital time clock (DTC) that controls and programs the entire lighting control system. The lighting control system consists of master and slave panels controlled by a 32-channel DTC.



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All switches communicate by RS 485, cat 5 patch cable with RJ45 connectors. Photocells provide readout on the DTC screen in number values analogous to footcandles. The system interfaces include a dry contact input interface, BMS interface, dimming system interface, Ethernet/internet interface, and an interface to smartbreaker panel boards. Standard lighting control software uses standard graphical management software (GMS) pages.

### Mechanical and Other Loads

The mechanical system consists of six rooftop units, two energy recovery rooftop units, and two pool dehumidification units. The following tables describe each equipment load and provide a total load for the equipment schedule. The mechanical equipment schedule includes all of the fans, while the plumbing equipment schedule includes all of the pumps. The fitness equipment is provided in its own schedule.

MECHANICAL EQUIPMENT SCHEDULE										
TAG	LOAD			MOTOR AMPS	VOLTAGE	PHASE	POWER FACTOR	LOAD (kVA)	LOAD (kW )	QUANTITY
	DESCRIPTION	MAGNITUDE	UNITS							
RTU-1	ROOF SUPPLY FAN	15	HP	21	460	3	0.95	16.7118	11.03	1
RTU-2	ROOF SUPPLY FAN	15	HP	21	460	3	0.95	16.7118	11.03	1
RTU-3	ROOF SUPPLY FAN	15	HP	21	460	3	0.95	16.7118	11.03	1
RTU-4	ROOF SUPPLY FAN	15	HP	21	460	3	0.95	16.7118	11.03	1
RTU-5	ROOF SUPPLY FAN	15	HP	21	460	3	0.95	16.7118	11.03	1
RTU-6	ROOF SUPPLY FAN	3	HP	4.8	460	3	0.95	3.81984	2.206	1
RTU-1	ROOF EXHAUST FAN	5	HP	7.6	460	3	0.95	6.04808	3.677	1
RTU-2	ROOF EXHAUST FAN	5	HP	7.6	460	3	0.95	6.04808	3.677	1
RTU-3	ROOF EXHAUST FAN	5	HP	7.6	460	3	0.95	6.04808	3.677	1
RTU-4	ROOF EXHAUST FAN	5	HP	7.6	460	3	0.95	6.04808	3.677	1
RTU-5	ROOF EXHAUST FAN	5	HP	7.6	460	3	0.95	6.04808	3.677	1
RTU-6	ROOF EXHAUST FAN	1	HP	1.8	460	3	0.85	1.43244	0.735	1
ERU-1	ROOF SUPPLY FAN	7.5	HP	11	460	3	0.95	8.7538	5.52	1
ERU-2	ROOF SUPPLY FAN	7.5	HP	11	460	3	0.95	8.7538	5.52	1
ERU-1	ROOF EXHAUST FAN	5	HP	7.6	460	3	0.95	6.04808	3.677	1
ERU-2	ROOF EXHAUST FAN	7.5	HP	11	460	3	0.95	8.7538	5.52	1
DU-1	POOL SUPPLY FAN	25	HP	34	460	3	0.95	27.0572	18.39	1
DU-2	POOL SUPPLY FAN	25	HP	34	460	3	0.95	27.0572	18.39	1
DU-1	POOL RETURN FAN	30	HP	40	460	3	0.95	31.832	22.065	1
DU-2	POOL RETURN FAN	30	HP	40	460	3	0.95	31.832	22.065	1
CWP-1&2	POOL FILTER PUMP	5	HP	7.6	460	3	0.95	6.04808	3.677	1
EF-1	EXHAUST FAN	1/30	HP	--	115	1	0.75	--	0.02	1
EF-2	EXHAUST FAN	1/30	HP	--	115	1	0.75	--	0.02	1
EF-3	EXHAUST FAN	1/8	HP	--	115	1	0.75	--	0.09	1
EF-4	EXHAUST FAN	1/4	HP	5.8	115	1	0.75	1.15391	0.18	1
EF-5	EXHAUST FAN	1/3	HP	7.2	115	1	0.75	1.43244	0.24	1
EF-6	EXHAUST FAN	1/2	HP	9.8	115	1	0.85	1.94971	0.37	1
EF-7	EXHAUST FAN	1/3	HP	7.2	115	1	0.75	1.43244	0.24	1
EF-8	EXHAUST FAN	1/30	HP	--	115	1	0.75	--	0.02	1
EF-9	EXHAUST FAN	1/3	HP	7.2	115	1	0.75	1.43244	0.24	1
TOTAL LOAD: 182.72kW										

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PLUMBING EQUIPMENT SCHEDULE										
TAG	LOAD			MOTOR AMPS	VOLTAGE	PHASE	POWER FACTOR	LOAD (kVA)	LOAD (kW )	QUANTITY
	DESCRIPTION	MAGNITUDE	UNITS							
P-1	ELEVATOR SUMP PUMP	1/3	HP	7.2	120	1	0.75	1.49472	0.24	1
P-2	CIRC PUMP	--	--	--	120	1	--	--	0.8	1
P-3	SEWAGE EJECTOR	1	HP	2.1	480	3	0.85	1.74384	0.735	1
P-4	SEWAGE EJECTOR	1	HP	2.1	480	3	0.85	1.74384	0.735	1
P-5	POOL SUMP PUMP	2	HP	3.4	480	3	0.85	2.82336	1.471	1
P-6	POOL SUMP PUMP	2	HP	3.4	480	3	0.85	2.82336	1.471	1
P-7	SUMP PUMP	1/3	HP	7.2	120	1	0.75	1.49472	0.24	1
TOTAL LOAD: 5.692kW										

FITNESS EQUIPMENT SCHEDULE										
TAG	LOAD			MOTOR AMPS	VOLTAGE	PHASE	POWER FACTOR	LOAD (kVA)	LOAD (kW )	QUANTITY
	DESCRIPTION	MAGNITUDE	UNITS							
F-1	TREADMILL	2 1/25	HP	13.6	120	3	0.85	2.82336	1.5	11
F-2	EXERCISE	2 1/25	HP	13.6	120	3	0.85	2.82336	1.5	12
TOTAL LOAD: 34.5kW										

## Service Entrance Size

Three different methods of calculations are summarized to size the service entrance. The first sizing method is used for the Conceptual or Schematic Design phase, in which the building square footage is multiplied by the demand load in VA/ square feet based on general building types. It is assumed that this building is classified as a College Student Union. The second sizing method is used for the Design Development phase, in which the demand loads are added in the VA/ square feet for specific building loads. The third sizing method is used for the Working Drawings, in which actual building loads and NEC demand loads are used. The breakdown of each sizing method is shown in the tables below.

SERVICE ENTRANCE SIZE CALCULATION: CONCEPTUAL/ SCHEMATIC DESIGN		
BUILDING SQUARE FOOTAGE	VA/ SQ. FT.	LOAD (VA)
73,400	13	954,200

SERVICE ENTRANCE SIZE CALCULATION: DESIGN DEVELOPMENT			
LIGHTING	VA/ SQ. FT.	SQ. FT.	LOAD (KVA)
	3	73,400	220
RECEPTACLES	VA/ SQ. FT.	SQ. FT.	LOAD (KVA)
	1	73,400	73
MECHANICAL	VA/ SQ. FT.	SQ. FT.	LOAD (KVA)
EXHAUST FANS	2	73,400	147
PLUMBING	VA/ SQ. FT.	SQ. FT.	LOAD (KVA)
CIRCULATING PUMPS	2	73,400	147
<b>TOTAL KVA</b>			<b>587</b>

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<b>SERVICE ENTRANCE SIZE CALCULATION: WORKING DRAWINGS</b>		
<b>LOAD</b>	<b>CONNECTED LOAD (KVA)</b>	<b>DEMAND LOAD (KVA)</b>
LIGHTING	94.1	94.1
RECEPTACLES	121.9	65.95
MECHANICAL	273	273
PLUMBING	87	87
FITNESS EQUIPMENT	75	75
TOTAL KVA		595.05
TOTAL CURRENT (AMPS)		715.73

<b>SERVICE ENTRANCE SIZE</b>			
<b>PHASE</b>	<b>LOAD (KVA)</b>	<b>VOLTAGE SYSTEM (V)</b>	<b>LOAD (AMPS)</b>
CONCEPTUAL/ SCHEMATIC	954	480Y/277V, 3PH, 4W	1147.72
DESIGN DEVELOPMENT	587	480Y/277V, 3PH, 4W	706.05
WORKING DRAWINGS	715.73	480Y/277V, 3PH, 4W	860.89
ACTUAL CONDITIONS	*	480Y/277V, 3PH, 4W	**

\* Information not available

\*\* Unable to complete calculation due to lack of information

Note: The Service Entrance Summary cannot be calculated since the Actual Service Entrance Conditions are unavailable.

When comparing the three sizing methods, the Conceptual/ Schematic phase service size is larger than those of the Design Development and Working Drawings phases. This is likely due to the building classification as a College Student Union. The College Fitness Center may require fewer loads. The Design Development phase service size is smaller than the Working Drawings phase service size, which may be due to the NEC loading method underestimating some of the equipment power required.

## Environmental Stewardship Design

There is no evidence of any environmental electrical system design features and no energy producing devices were used for this building. The Shepherd University Wellness Center is not a LEED rated project.

## Design Issues

The electrical system designed is straight forward and does not pose any known issues. An important design consideration was easy maintenance by the University facility. In some parts of the design, including the lighting system, University standard equipment was taken into account.

## Single-Line Diagram Drawing List

The following drawing was used to prepare the single-line diagram. A copy can be located in Appendix A.

E-400: Details 1- Electrical

## Communication Systems

### Telephone System

The Telephone System connects the separate building existing telephone service to the new wire closet as shown on the drawings. The telephone service provider is Frontier.

### Cable Television System

The Cable Television System connects the separate building existing cable television service to the new building as noted on the drawings. Nine flat screen televisions are located in the fitness room.

### Audio-Video System

The Audio-Video System includes a pool with a 70V loudspeaker system, gymnasium with a 70V loudspeaker system, rotunda with a 70V loudspeaker system, recessed ceiling-mounted loudspeakers in the fitness center and locker rooms, recessed ceiling-mounted loudspeakers and subwoofers in both multipurpose rooms, ancillary devices related to the input, mixing, processing, and amplification of audio into the system, and microphones, jacks, wire, and all miscellaneous parts of the system.

### Fire Alarm and Smoke Detection System

The Fire Alarm System provides an EST 3 Fire Alarm Control Panel (FAP), remote Fire Alarm Annunciators (FAA), alarm initiating devices, and alarm indicating appliances. The FAP is UL listed for use as per Control Units (UOJZ). The Detection System provides smoke and heat detectors, manual pull stations and duct detectors. Audible and visible notification is provided throughout the building.

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## Appendix A: Single-Line Diagram and Existing Drawings

FEEDER SCHEDULE																		
TAG	FROM	TO	NO. OF SETS	CONDUIT (PER SET)			CONDUCTORS (PER SET)									SIZE OF OVERCURRENT PROTECTION	FRAME OR SWITCH SIZE	REMARKS
				SIZE	TYPE	PHASE CONDUCTORS			NEUTRAL CONDUCTORS			GROUND CONDUCTORS						
						No.	SIZE	TYPE	No.	SIZE	TYPE	No.	SIZE	TYPE				
1	TRANSFORMER	MSB	6	4"	EMT	3	600MCM	CU THWN	1	600MCM	CU THWN	1	1/0AWG	CU THWN	100A	100A	BY CONTRACTOR	
2	GENERATOR	WIREWAY	1	2"	EMT	3	1/0AWG	CU THWN	1	1/0AWG	CU THWN	1	6AWG	CU THWN	100A	100A	1	
3	WIREWAY	ATS-1	1	1"	EMT	3	6AWG	CU THWN	1	6AWG	CU THWN	1	10AWG	CU THWN	100A	100A	1	
4	WIREWAY	ATS-2	1	1"	EMT	3	6AWG	CU THWN	1	6AWG	CU THWN	1	10AWG	CU THWN	100A	100A	1	
5	SB-1	ATS-1	1	1"	EMT	3	6AWG	CU THWN	1	6AWG	CU THWN	1	10AWG	CU THWN	100A	100A	1	
6	SB-1	ATS-2	1	1"	EMT	3	6AWG	CU THWN	1	6AWG	CU THWN	1	10AWG	CU THWN	100A	100A	1	
7	SB-1	T-3	1	1"	EMT	3	6AWG	CU THWN	--	--	--	1	10AWG	CU THWN	100A	100A	1	
8	SB-2	PNL HP1	1	2 1/2"	EMT	3	4/0AWG	CU THWN	1	4/0AWG	CU THWN	1	4AWG	CU THWN	100A	100A	1	
9	SB-2	T-4	2	2"	EMT	3	4/0AWG	CU THWN	--	--	--	1	2AWG	CU THWN	100A	100A	1	
10	SB-2	PNL H1	1	4"	EMT	3	600MCM	CU THWN	1	600MCM	CU THWN	1	3AWG	CU THWN	100A	100A	1	
11	ATS-1	PNL EH P1	1	1 1/2"	EMT	3	4AWG	CU THWN	1	4AWG	CU THWN	1	8AWG	CU THWN	60A	100A	1	
12	ATS-2	PNL EL	1	2"	EMT	3	1AWG	CU THWN	1	1AWG	CU THWN	1	8AWG	CU THWN	50A	100A	1	
13	T-3	PNL SP	1	2"	EMT	3	1AWG	CU THWN	1	1AWG	CU THWN	1	8AWG	CU THWN	100A	100A	1	
14	T-4	LDP	3	3 1/2"	EMT	3	500MCM	CU THWN	1	500MCM	CU THWN	1	2/0AWG	CU THWN	100A	100A	1	
15	PNL LDP	PNL P1	1	3"	EMT	3	350MCM	CU THWN	1	350MCM	CU THWN	1	3AWG	CU THWN	100A	100A	1	
16	PNL LDP	PNL P2	1	2"	EMT	3	1/0AWG	CU THWN	1	1/0AWG	CU THWN	1	6AWG	CU THWN	100A	100A	1	
17	PNL LDP	PNL XP	1	2"	EMT	3	1/0AWG	CU THWN	1	1/0AWG	CU THWN	1	6AWG	CU THWN	100A	100A	1	
18	PNL LDP	PNL XP2	1	2"	EMT	3	1/0AWG	CU THWN	1	1/0AWG	CU THWN	1	6AWG	CU THWN	100A	100A	1	
19	PNL LDP	PNL JP	1	2"	EMT	3	1/0AWG	CU THWN	1	1/0AWG	CU THWN	1	6AWG	CU THWN	100A	100A	1	
20	PNL LDP	PNL LP1	1	2 1/2"	EMT	3	4/0AWG	CU THWN	1	4/0AWG	CU THWN	1	4AWG	CU THWN	100A	100A	1	

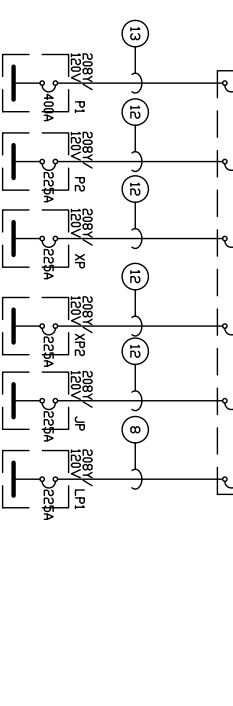
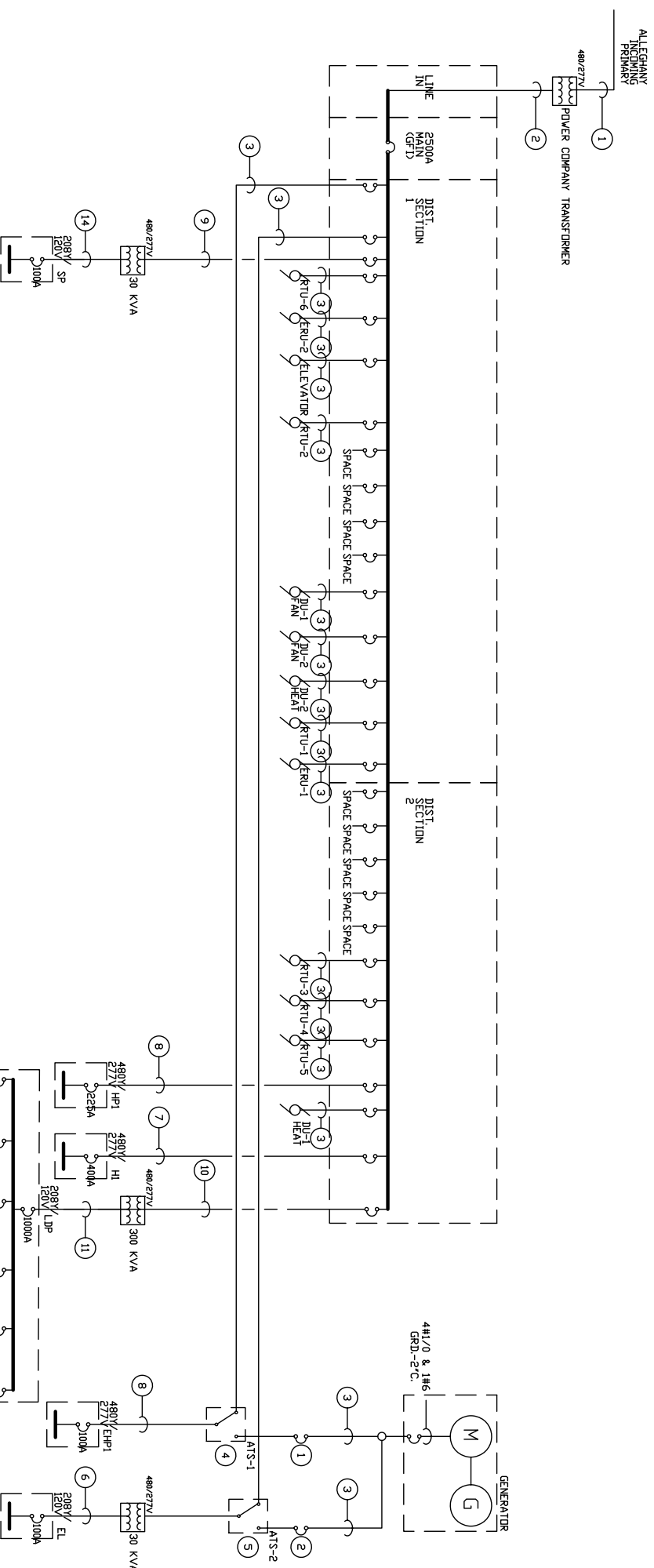
NOTES:  
1. REFER TO RISER DIAGRAM FOR FEEDER TAGS

AL=ALUMINUM  
CU=COPPER

BREAKER	SERVING
100/3/60	EQUIPMENT AIS
100/3/60	LIFE SAFETY AIS
100/3/90	PANEL "SP" TRANSFORMER
100/3/90	RTU-6
100/3/60	ERTU-2
100/3/90	ELEVATOR
(SHUNT TRIP BREAKER)	
100/3/100	RTU-2
100/3/--	SPACE & BUS
100/3/--	SPACE & BUS
225/3/--	SPACE & BUS
225/3/175	DU-1 PANS/COMPRESSORS
225/3/175	DU-2 HEAT
225/3/150	RTU-1
225/3/155	ERTU-1

BREAKER	SERVING
100/3/--	SPACE & BUS
100/3/--	SPACE & BUS
100/3/--	SPACE & BUS
100/3/--	SPACE & BUS
225/3/175	RTU-3
225/3/175	RTU-4
225/3/200	RTU-5
225/3/225	PANEL "HP1"
400/3/230	DU-1 HEAT
600/3/450	PANEL "HP"
600/3/450	300 KVA TRANSFORMER

- KEYED NOTES:**
- 1 60/3 ENCLOSED CIRCUIT BREAKER FOR EQUIPMENT BRANCH AUTOMATIC TRANSFER SWITCH, 7MVA GENERATOR FEEDER IN THROUGH.
  - 2 50/3 ENCLOSED CIRCUIT BREAKER FOR LIFE SAFETY BRANCH AUTOMATIC TRANSFER SWITCH, 7MVA GENERATOR FEEDER IN THROUGH.
  - 3 4#6 & 1#10 GRD.-1°C.
  - 4 50A, 4P, 600V, AUTOMATIC TRANSFER SWITCH FOR LIFE SAFETY BRANCH.
  - 5 60A, 4P, 600V, AUTOMATIC TRANSFER SWITCH FOR EQUIPMENT BRANCH.
  - 6 4#1 & 1# 8BRO.-2°C.
  - 7 4#600MVA & 1#3 GRD.-4°C.
  - 8 4#4/0 & 1# 4 GRD.-2 1/2°C.
  - 9 3#6 & 1#10 GRD.-1°C.
  - 10 2 SETS - 3#4/0 & 1#2 GRD.-2°C.
  - 11 3 SETS - 4#500MVA & 1#2/0 GRD.-3 1/2°C.
  - 12 4#1/0 & 1#6 GRD.-2°C.
  - 13 4#500MVA & 1#3 GRD.-3°C.
  - 14 4#1, 1# 8BRO. & 1# 8 ISOLATED GRD.-2°C.



**SINGLE-LINE DIAGRAM**

NOT TO SCALE

SHEPHERD UNIVERSITY  
WELLNESS CENTER  
SHEPHERDSTOWN,  
WEST VIRGINIA

LISHA A BROWN

A E 481: SENIOR THESIS  
OCTOBER 25, 2010



## **Appendix B: High Intensity Discharge Lamps and Ballasts**

Fixture Tag: PK-100

Lamp: 100W Metal Halide (MXR100/C/U/MED)

Ballast: Electronic Pulse Start

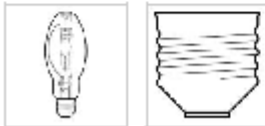
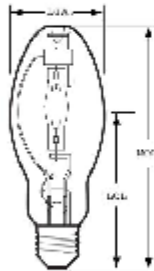




GE  
Lighting

**18679 - MXR100/C/U/MED**

GE Multi-Vapor® PulseArc® Quartz Metal Halide BD17



**CAUTIONS & WARNINGS**

**R- WARNING:** This lamp can cause serious skin burn and eye inflammation from shortwave ultraviolet radiation if outer envelope of the lamp is broken or punctured, and the arc tube continues to operate. Do not use where people will remain for more than a few minutes unless adequate shielding or other safety precautions are used. Certain types of lamps that will automatically extinguish when the outer envelope is broken or punctured are commercially available. Visit the FDA website for more information: <http://www.fda.gov/cdrh/rdmt/Products/uturns.html>

**Caution**

- Lamp may shatter and cause injury if broken
- Dispose of lamp in a closed container.
- Do not use excessive force when installing lamp.
- Do not use lamp if outer glass is scratched or broken.

**Warning**

- A damaged lamp emits UV radiation which may cause eye/skin injury
- Turn power off if glass bulb is broken. Remove and dispose of lamp.
- Risk of Burn
- Allow lamp to cool before handling.
- Do not turn on lamp until fully installed.
- Risk of Electric Shock
- Do not use where directly exposed to water or outdoors without an enclosed fixture.
- Turn power off before inspection, installation or removal.
- Risk of Fire
- Keep combustible materials away from lamp.
- Use in fixture rated for this product.
- Unspecified lamp rupture may cause injury, fire, or property damage
- Do not exceed rated voltage.
- Do not turn on lamp until fully installed.
- Do not use beyond rated life.
- Do not use lamp if outer glass is scratched or broken.
- Do not use where directly exposed to water or outdoors without an enclosed fixture.
- Turn lamp off at least once for 15 minutes per week.
- Use in enclosed fixture rated for this product.
- Use only properly rated ballast.

**GRAPHS & CHARTS**

Spectral Power Distribution

**GENERAL CHARACTERISTICS**

Lamp Type	High Intensity Discharge - Quartz Metal Halide
Bulb	BD17
Base	Medium Screw (E26)
Bulb Finish	Coated
Wattage	100
Voltage	100
Rated Life	15000 hrs
Bulb Material	Hard glass
Lamp Enclosure Type (LET)	Enclosed fixtures only
LEED-EB MR Credit	111 picograms Hg per mean lumen hour

**PHOTOMETRIC CHARACTERISTICS**

Initial Lumens	8500
Mean Lumens	5900
Nominal Initial Lumens per Watt	85
Color Temperature	3200 K
Color Rendering Index (CRI)	70

**ELECTRICAL CHARACTERISTICS**

Burn Position	Universal burning position
Open Circuit Voltage (peak lead ballast)	332 V
Open Circuit Voltage (RMS lag ballast)	235 V
Warm Up Time to 90%	2 min
Warm Up Time to 90% (MIN)	2 min
Warm Up Time to 90% (MAX)	2 min
Hot Restart Time to 90% (MIN)	10 min
Hot Restart Time to 90% (MAX)	15 min

**DIMENSIONS**

Maximum Overall Length (MOL)	5.4300 in(137.9 mm)
Nominal Length	5.430 in(137.9 mm)
Bulb Diameter (DIA)	2.125 in(54.0 mm)
Bulb Diameter (DIA) (MAX)	2.125 in(54.0 mm)
Light Center Length (LCL)	3.430 in(87.1 mm)

**PRODUCT INFORMATION**

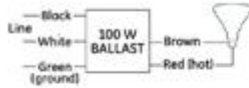
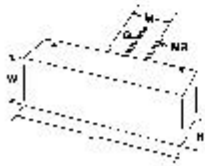
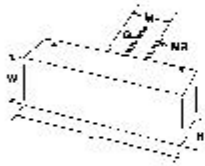
Product Code	18679
Description	MXR100/C/U/MED
ANSI Code	M90
Standard Package	Case
Standard Package GTIN	10043168186794
Standard Package Quantity	6
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	6
UPC	043168186797



GE Lighting

**87561 - GEMH100-SLJ-MV**

GE HID UltraMax™ eHID Electronic Low Frequency Ballast



**GENERAL CHARACTERISTICS**

Category	High Intensity Discharge
Ballast Type	Electronic - Low Frequency
Line Voltage Regulation (+/-)	10 %
Ambient Temperature (MAX)	55 °C(13 °C)
Case Temperature	90 °C(194 °F)
Ballast Factor	Normal
Sound Rating	A (20-24 decibels)
Enclosure Type	Metal
Distance to Lamp	8 ft
Additional Info	End of Life Protection (EOL) Thermally protected

**PRODUCT INFORMATION**

Product Code	87561
Description	GEMH100-SLJ-MV
Standard Package	Case
Standard Package GTIN	10043168875612
Standard Package Quantity	10
Sales Unit	Case
No Of Items Per Sales Unit	1
No Of Items Per Standard	10
Package	
UPC	043168875615

**DIMENSIONS**

<b>Case dimensions</b>			
Length (L)		7.3 In(184.91 mm)	
Width (W)		2.6 In(65.53 mm)	
Height (H)		2.2 In(55.88 mm)	
<b>Mounting dimensions</b>			
Mount Length (M)		0.4 In(10.92 mm)	
Weight		0.38 lb	
Exit Type		Bottom Leads with Studs	
Remote Mounting Distance to Lamp		8 ft	
Remote Mounting Wire Gauge	18 AWG		
Lead lengths	Qty	Exit	Length (± 1 In.)
Black	1	Left	10.0 (254mm)
Red	1	Right	10.0 (254mm)
White	1	Left	10.0 (254mm)
Brown	1	Right	10.0 (254mm)

**ELECTRICAL CHARACTERISTICS**

Lamp Operating Frequency 130 Hz

**SAFETY & PERFORMANCE**

- ANSI - C82.41
- cUL Listed
- UL Type 1 Outdoor
- RoHS Compliant
- UL 1029 Listed
- Suitable for recessed use

**SPECIFICATIONS BY LAMP & LINE VOLTAGE**

Lamp # of Lamps by Line	Specifications by Line Voltage	System Wattage	Nominal Current	Ballast Factor	Ballast Efficiency	Max.Input Current	Starting Current	Open Circuit Voltage	Drop Out Voltage	Power factor	Min.starting temperature	Fuse rating	UL bench top rise
M90	1 277	107.0	0.41A	1	0.935				96V	0.98	0.0°F	3	
M90	1 120	110.0	0.93A	1	0.909				96V	0.99	0.0°F	3	
M140	1 277	107.0	0.41A	1	0.935				96V	0.98	0.0°F	3	
M140	1 120	110.0	0.93A	1	0.909				96V	0.99	0.0°F	3	
C140	1 120	110.0	0.93A	1					96V	0.99	0.0°F	3	
C140	1 277	107.0	0.41A	1					96V	0.98	0.0°F	3	

**NOTES**

- 200C rated lead wires
- Do not connect brown or red wires to ground

**WARRANTY INFORMATION**

GE Lighting warrants to the purchaser that each ballast will be free from defects in material or workmanship for period as defined in the attached documents from the date of manufacture when properly installed and under normal conditions of use.

Lisha A Brown

Fixture Tag: OC-100, OD-300, RJ-100

Lamp: 100W Metal Halide (MXR100/C/U/MED)

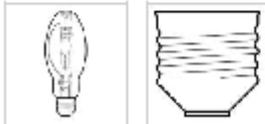
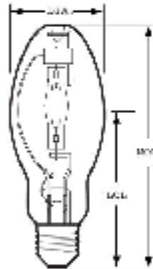
Ballast: Magnetic



GE Lighting

**18679 - MXR100/C/U/MED**

GE Multi-Vapor® PulseArc® Quartz Metal Halide BD17



**CAUTIONS & WARNINGS**

**R-WARNING:** This lamp can cause serious skin burn and eye inflammation from shortwave ultraviolet radiation if outer envelope of the lamp is broken or punctured, and the arc tube continues to operate. Do not use where people will remain for more than a few minutes unless adequate shielding or other safety precautions are used. Certain types of lamps that will automatically extinguish when the outer envelope is broken or punctured are commercially available. Visit the FDA website for more information: <http://www.fda.gov/cdrh/rdmt/H/Products/utbms.html>

**Caution**

- Lamp may shatter and cause injury if broken
- Dispose of lamp in a closed container.
- Do not use excessive force when installing lamp.
- Do not use lamp if outer glass is scratched or broken.

**Warning**

- A damaged lamp emits UV radiation which may cause eye/skin injury
- Turn power off if glass bulb is broken. Remove and dispose of lamp.
- Risk of Burn
- Allow lamp to cool before handling.
- Do not turn on lamp until fully installed.
- Risk of Electric Shock
- Do not use where directly exposed to water or outdoors without an enclosed fixture.
- Turn power off before inspection, installation or removal.
- Risk of Fire
- Keep combustible materials away from lamp.
- Use in fixture rated for this product.
- Unexpected lamp rupture may cause injury, fire, or property damage
- Do not exceed rated voltage.
- Do not turn on lamp until fully installed.
- Do not use beyond rated life.
- Do not use lamp if outer glass is scratched or broken.
- Do not use where directly exposed to water or outdoors without an enclosed fixture.
- Turn lamp off at least once for 15 minutes per week.
- Use in enclosed fixture rated for this product.
- Use only properly rated ballast.

**GRAPHS & CHARTS**

Spectral Power Distribution

**GENERAL CHARACTERISTICS**

Lamp Type	High Intensity Discharge - Quartz Metal Halide
Bulb	BD17
Base	Medium Screw (E26)
Bulb Finish	Coated
Wattage	100
Voltage	100
Rated Life	15000 hrs
Bulb Material	Hard glass
Lamp Enclosure Type (LET)	Enclosed fixtures only
LEED-EB MR Credit	111 picograms Hg per mean lumen hour

**PHOTOMETRIC CHARACTERISTICS**

Initial Lumens	8500
Mean Lumens	5900
Nominal Initial Lumens per Watt	85
Color Temperature	3200 K
Color Rendering Index (CRI)	70

**ELECTRICAL CHARACTERISTICS**

Burn Position	Universal burning position
Open Circuit Voltage (peak lead ballast)	332 V
Open Circuit Voltage (RMS lag ballast)	235 V
Warm Up Time to 90%	2 min
Warm Up Time to 90% (MIN)	2 min
Warm Up Time to 90% (MAX)	2 min
Hot Restart Time to 90% (MIN)	10 min
Hot Restart Time to 90% (MAX)	15 min

**DIMENSIONS**

Maximum Overall Length (MOL)	5.4300 In(137.9 mm)
Nominal Length	5.430 In(137.9 mm)
Bulb Diameter (DIA)	2.125 In(54.0 mm)
Bulb Diameter (DIA) (MAX)	2.125 In(54.0 mm)
Light Center Length (LCL)	3.430 In(87.1 mm)

**PRODUCT INFORMATION**

Product Code	18679
Description	MXR100/C/U/MED
ANSI Code	M90
Standard Package	Case
Standard Package GTIN	10043168186794
Standard Package Quantity	6
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	6
UPC	043168186797

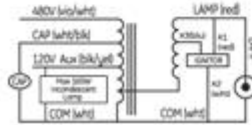
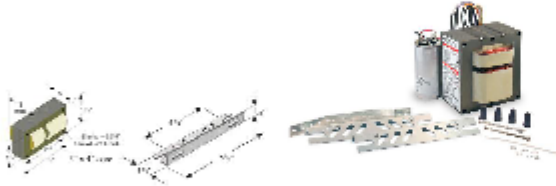


GE  
Lighting

**86667 - GEM10048TLC3D-5**

**GE HID Distributor Replacement Kit Magnetic Core & Coil Ballast**

- Magnetic ballast construction ideal for a wide variety of lighting applications.
- Precision-wound coils, ensuring even heat dissipation and the highest electrical integrity.
- Distributor replacement kit contains the appropriate core & coil with color coded leads, a properly rated capacitor and ignitor (if required) and all other components required for ballast replacement



**GENERAL CHARACTERISTICS**

Application	1- 100w MH M 90 or M140 480
Category	High Intensity Discharge
Ballast Type	Magnetic - Core & Coil
Type	Replacement kit
Line Voltage Regulation (+/-)	5 %
Ballast Factor	Normal
Circuit Type	HX-HPF
Insulation Class	180C
Enclosure Type	None
Capacitance	12 µF
Voltage	280
Capacitor Temperature Rating	100 °C(212 °F)
Diameter	1.6 In(40.6 mm)
Distance to Lamp	5 ft

**PRODUCT INFORMATION**

Product Code	86667
Description	GEM10048TLC3D-5
Standard Package	Master
Standard Package GTIN	
Standard Package Quantity	6
Sales Unit	Distributor Kit
No Of Items Per Sales Unit	1
No Of Items Per Standard	6
Package	
UPC	043168866675

**DIMENSIONS**

Case dimensions	
Length (L)	4.0 In(101.60 mm)
Width (W)	2.8 In(71.45 mm)
Mounting dimensions	
Bracket Length (BL)	5.5 In(139.70 mm)
Mount Length (M)	3.5 In(88.90 mm)
Mount Width (X or F)	2.4 In(61.93 mm)
Mount Slots (MS)	0.2 In(4.95 mm)
Weight	5 lb
Exit Type	Slide
Nominal Length	2.7 In
Frame size (H x L)	2.813 x 3.939 In

**ELECTRICAL CHARACTERISTICS**

Supply Current Frequency	60 Hz
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**SAFETY & PERFORMANCE**

- eUL Listed
- UL Listed

**SPECIFICATIONS BY LAMP & LINE VOLTAGE**

Lamp # of	Specifications	System	Nominal	Ballast	Ballast	Max.Input	Starting	Open	Drop Out	Power	Min.starting	Fuse	UL bench
Lamps by Line	by Line	Wattage	Current	Factor	Efficiency	Current	Current	Circuit	Voltage	factor	temperature	rating	top rise
480	Voltage							Voltage					
M92	1	480	120.0	0.3A	1		0.56A	0.33A	271V	300V	0.9	-22.0°F	2 C
M90	1	480	120.0	0.3A	1	0.833	0.56A	0.33A	271V	300V	0.9	-22.0°F	2 C
40	1	480	120.0	0.3A	1		0.56A	0.33A	271V	300V	0.9	-22.0°F	2 C

**CAUTIONS & WARNINGS**

- Warning
- Risk of Electric Shock
  - Properly ground ballast and fixture.
  - Turn power off before servicing—see instructions.

**ACCESSORIES**

Dry Film Capacitor	
Product Code	75427
Description	GECAP-12/280V-D
Ignitors	
Product Code	88864
Description	MH100-3A
Ignitors	
Product Code	75440
Description	MH350-1A

**NOTES**

- Kit contains the appropriate core & coil with color coded leads, a properly rated capacitor and ignitor (if required) and all other components required for ballast replacement

**WARRANTY INFORMATION**

GE Lighting warrants to the purchaser that each ballast will be free from defects in material or workmanship for period as defined in the attached documents from the date of manufacture when properly installed and under normal conditions of use.

For additional information, visit [www.gelighting.com](http://www.gelighting.com)

Lisha A Brown

Fixture Tag: PA-400, PB-400-A-250, PC-400-A-250, PH-400, PI-400-A-250, PJ-400-E-250, SE-400

Lamp: 400W Metal Halide (MPR400/VBU/O/40)

Ballast: Electronic



GE  
Lighting

**18709 - MPR400/VBU/O/40**

GE Multi-Vapor® Protected Quartz Metal Halide ED37

RoHS Compliant



**GENERAL CHARACTERISTICS**

Lamp Type	High Intensity Discharge - Quartz Metal Halide
Bulb	ED37
Base	Export Mogul Screw (E40)
Bulb Finish	Clear
Wattage	400
Rated Life	20000 hrs
Bulb Material	Hard glass
Lamp Enclosure Type (LET)	Open or enclosed fixtures
Base Temperature	210 °C
Bulb Temperature (MAX)	400 °C
LEED-EB MR Credit	121 picrograms Hg per mean lumen hour

**PHOTOMETRIC CHARACTERISTICS**

Initial Lumens	40000
Mean Lumens	26000
Nominal Initial Lumens per Watt	100
Color Temperature	3400 K
Color Rendering Index (CRI)	65

**ELECTRICAL CHARACTERISTICS**

Burn Position	Vertical base up ±15°
Warm Up Time to 90% (MIN)	2 min
Warm Up Time to 90% (MAX)	5 min
Hot Restart Time to 90% (MIN)	10 min
Hot Restart Time to 90% (MAX)	15 min

**DIMENSIONS**

Maximum Overall Length (MOL)	11.5000 In(292.1 mm)
Bulb Diameter (DIA)	4.625 In(117.5 mm)
Bulb Diameter (DIA) (MAX)	4.625 In(117.5 mm)
Light Center Length (LCL)	7.000 In(177.8 mm)

**PRODUCT INFORMATION**

Product Code	18709
Description	MPR400/VBU/O/40
ANSI Code	M59
Standard Package	Case
Standard Package GTIN	10043168187098
Standard Package Quantity	6
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	6
UPC	043168187091

**CAUTIONS & WARNINGS**

**R- WARNING:** This lamp can cause serious skin burn and eye inflammation from shortwave ultraviolet radiation if outer envelope of the lamp is broken or punctured, and the arc tube continues to operate. Do not use where people will remain for more than a few minutes unless adequate shielding or other safety precautions are used. Certain types of lamps that will automatically extinguish when the outer envelope is broken or punctured are commercially available. Visit the FDA website for more information: <http://www.fda.gov/cdrh/rdmt/health/products/ultrav.html>

**Caution**

- Lamp may shatter and cause injury if broken
- Dispose of lamp in a closed container.
- Do not use excessive force when installing lamp.
- Do not use lamp if outer glass is scratched or broken.

**Warning**

- Risk of Burn
  - Allow lamp to cool before handling.
  - Do not turn on lamp until fully installed.
- A damaged lamp emits UV radiation which may cause eye/skin injury
  - Turn power off if glass bulb is broken. Remove and dispose of lamp.
- Risk of Electric Shock
  - Do not use where directly exposed to water or outdoors without an enclosed fixture.
  - Turn power off before inspection, installation or removal.
- Unexpected lamp rupture may cause injury, fire, or property damage
  - Do not exceed rated voltage.
  - Do not store flammable materials near/below lamp.
  - Do not turn on lamp until fully installed.
  - Do not use beyond rated life.
  - Do not use lamp if outer glass is scratched or broken.
  - Do not use where directly exposed to water or outdoors without an enclosed fixture.
  - If used on a dimming system, see instructions.
  - Operate lamp only in specified position.
  - Turn lamp off at least once for 15 minutes per week.
  - Use only properly rated ballast.
- Risk of Fire
  - Keep combustible materials away from lamp.
  - Use in fixture rated for this product.

**GRAPHS & CHARTS**

Spectral Power Distribution

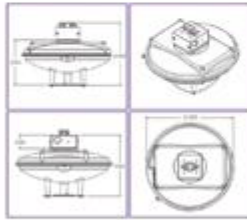


GE Lighting

**29377 - GE-MH-250-400-MA**

GE HID UltraMax™ eHID Electronic Low Frequency Ballast

- High efficiency electronic ballast provides 45% less ballast losses compared to electromagnetic CWA ballasts
- Improves lumen maintenance by 10 points on pulse start lamps.
- Multi-Voltage Technology handles voltage from 208 to 277V
- Multi-Voltage operates 250W, 300W, 320W, 350W and 400W pulse start and ceramic metal halide lamps.
- Superior low frequency square wave frequency design maximizes performance and life of ceramic metal halide lamps.



**GENERAL CHARACTERISTICS**

Application	1- 250 to 400w UltraMax HID Electronic 208-277 50-60Hz
Category	High Intensity Discharge
Ballast Type	Electronic - Low Frequency
Line Voltage Regulation (+/-)	10 %
Ambient Temperature (MAX)	130 °F(54 °C)
Ballast Factor	Normal
Power Factor Correction	Active
Circuit Type	Electronic
Sound Rating	D (37-42 decibels)
Enclosure Type	Metal
Additional Info	Thermally protected

**PRODUCT INFORMATION**

Product Code	29377
Description	GE-MH-250-400-MA
Standard Package	Case
Standard Package GTIN	10043168293775
Standard Package Quantity	1
Sales Unit	Standard Pack
No Of items Per Sales Unit	1
No Of items Per Standard Package	1
UPC	043168293778

**DIMENSIONS**

<b>Case dimensions</b>			
Length (L)	14.9 In(378.66 mm)		
Width (W)	14.9 In(378.66 mm)		
Height (H)	9.4 In(237.79 mm)		
<b>Mounting dimensions</b>			
Bracket Length (BL)	6.5 In(165.10 mm)		
Weight	10.2 lb		
Exit Type	Bottom		
Lead lengths	Qty	Exit	Length (± 1 In.)
Yellow	2	Bottom	9.0 (229mm)
White	1	Bottom	9.0 (229mm)
Red	1	Bottom	10.0 (254mm)
Green	1	Bottom	9.0 (229mm)
Brown	1	Bottom	10.0 (254mm)
Black	1	Bottom	9.0 (229mm)
Black	1	Bottom	9.0 (229mm)
Brown	1	Bottom	10.0 (254mm)
Green	1	Bottom	9.0 (229mm)
Red	1	Bottom	10.0 (254mm)
White	1	Bottom	9.0 (229mm)
Yellow	2	Bottom	9.0 (229mm)

**ELECTRICAL CHARACTERISTICS**

Lamp Operating Frequency	75 Hz
Supply Current Frequency	50 Hz/60 Hz

**SAFETY & PERFORMANCE**

- eUL Listed
- FCC - CLASS A Non-Consumer
- UL Class P
- UL Listed
- UL Type 1 Outdoor
- UL Type HL

**SPECIFICATIONS BY LAMP & LINE VOLTAGE**

Lamp # of Lamps	Specifications by Line Voltage	System Wattage	Nominal Current	Ballast Factor	Ballast Efficiency	Max.Input Current	Starting Current	Open Circuit Voltage	Drop Out Voltage	Power factor	Min.starting temperature	Fuse rating	UL bench top rise
No CMH4( ANSI code	1 208	431.0	2.23A		0.928					0.99	-20.0°F		
No CMH4( ANSI code	1 240	431.0	1.92A		0.928					0.99	-20.0°F		
No CMH4( ANSI code	1 277	428.0	1.65A		0.935					0.99	-20.0°F		

For additional information, visit [www.gelighting.com](http://www.gelighting.com)