



MILLENNIUM SCIENCE COMPLEX

JASON BROGNANO, MICHAEL LUCAS, CHRISTOPHER J RUSSELL

TECH REPORT 2

*Dr. Richard Mistrick  
October 4th, 2010  
Lighting/Electrical*

*This Report was created during the AE Department's BIM Thesis. This program is focused on Building Information Modeling and Integrated Project Delivery.*

**TABLE OF CONTENTS**

Table of Contents ..... 1

Executive Summary..... 2

Power Distribution Systems ..... 3

    SUMMARY DESCRIPTION OF DISTRIBUTION SYSTEM ..... 3

    UTILITY COMPANY INFORMATION ..... 3

    SERVICE ENTRANCE..... 4

    VOLTAGE SYSTEMS ..... 4

    EMERGENCY POWER SYSTEMS ..... 5

    LOCATION OF SWITCHGEAR ..... 7

    OVER-CURRENT DEVICES ..... 14

    TRANSFORMERS..... 15

    GROUNDING ..... 16

    SPECIAL EQUIPMENT ..... 16

    LIGHTING LOADS..... 17

    LIGHTING CONTROL ..... 17

    MECHANICAL AND OTHER LOADS ..... 17

    SERVICE ENTRANCE SIZE ..... 18

    ENVIRONMENTAL STEWARDSHIP DESIGN..... 19

    DESIGN ISSUES ..... 19

    SINGLE LINE DIAGRAMS..... 21

COMMUNICATIONS SYSTEMS..... 21

    Television System:..... 21

Appendix A: Lighting Load Schedule & HID Cutsheets ..... 22

Appendix B: Mechanical & Other Load Schedule ..... 33

Appendix C: Single Line Diagrams..... 37

    ELECTRICAL NORMAL POWER ONE LINE DIAGRAM..... 37

    ELECTRICAL EMERGENCY POWER ONE LINE DIAGRAM..... 38

***EXECUTIVE SUMMARY***

The following report provides a comprehensive diagnosis of the electrical systems in the Millennium Science Complex at Penn State's University Park Campus. This document will describe the existing design of the electrical distribution system through detailed reviews of the electrical system components. Research includes detailed overviews of the following: descriptions of service entrances, utility company information, voltage systems, emergency distribution systems, electrical equipment such as transformers, switchgears switchboards, panelboards, uninterruptable power supplies and automatic transfer switches, lighting loads, mechanical loads, and communication systems.

**POWER DISTRIBUTION SYSTEMS**

**SUMMARY DESCRIPTION OF DISTRIBUTION SYSTEM**

Millennium Science Complex merges two buildings into one, a Life Science wing and a Material Science wing. The electrical system is a simple radial system with three service entrances. One service entrance feeds the normal double-ended switchgear, while one feeds emergency loads, and another feeds life-safety loads.

The main emergency system is run as a normal/emergency load, switching over to an emergency generator via eight automatic transfer switches located in the basement of the Material Science wing. A second emergency system, feeding all of the buildings life safety loads, is fed from an emergency generator switchboard located in the adjacent Life Science I Building.

Unique loads of the building include both the Clean Room in Material Science, and the Vivarium in Life Science. The clean room uses its own dedicated switchgear located in the basement of Material Science. Clean Room loads have not yet been designed, and are unknown as of now. The Vivarium loads are fed from multiple distribution panels located in the central hallway of the first floor of Life Science.

**UTILITY COMPANY INFORMATION**

The Millennium Science Complex is connected to the Penn State campus distribution system. The campus buys power from Allegheny Power for distribution throughout campus. The following information was obtained courtesy of Penn State Office of the Physical Plant and the website provided below:

Name: Allegheny Power, an Allegheny Energy company

Address: Allegheny Energy, Inc.  
800 Cabin Hill Drive  
Greensburg, PA 15601-1689

Website: <http://www.alleghenyenergy.com>

Utility Rate Schedule: Tariff 37

Distribution:

Demand Charge:

First 10,000kVA.....	\$0.91/kVA
Additional kVA.....	\$0.90/kVA

Energy Charge:

All kWh.....	\$0.00277/kWh
--------------	---------------

Transmission:

Demand Charge:

First 10,000kVA.....	\$0.19/kVA
Additional kVA.....	\$0.18/kVA

Energy Charge:

All kWh.....	\$0.00240/kWh
--------------	---------------

The University's demand shall not be less than the highest of the following:

- a) 50% of the kVA demand capacity of Tariff 37 agreement.
- b) 50% of the highest demand previously established during the term of Tariff 37.

## SERVICE ENTRANCE

Millennium Science Complex has two normal power service entrances that enter through the Life Science basement into Electrical Room W-P003. Penn State provides up to and including the (2) 12.47kVA transformers that feed the main switchboard. Feeders from the transformers to the double ended switchgear, MDS-01A/B, are to be provided by the electrical contractor.

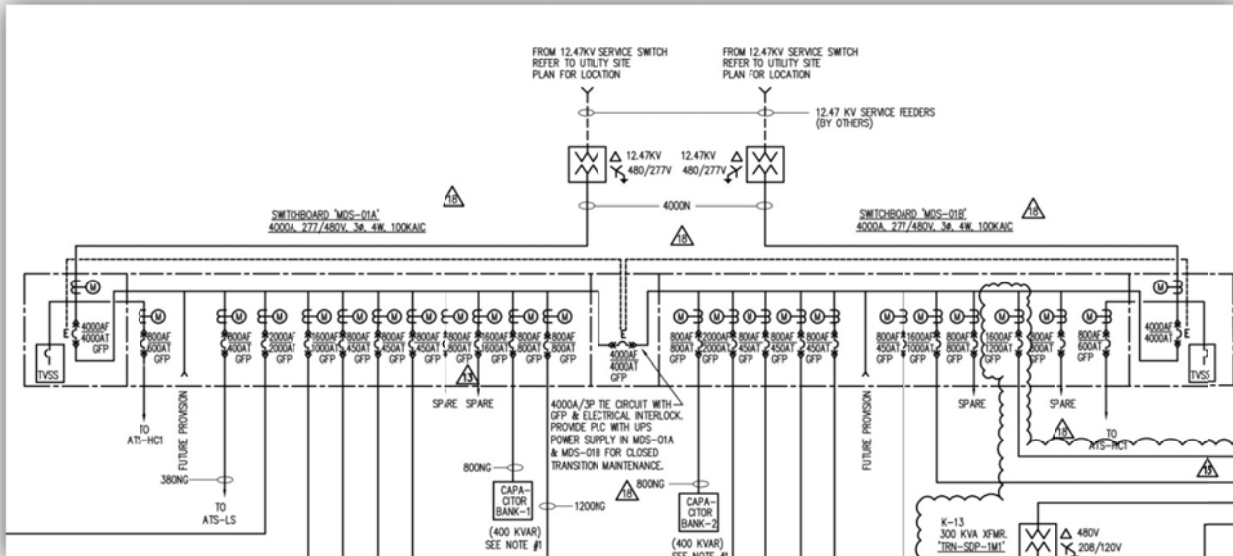


Figure #1.1: One-Line description of the normal-power service entrance.

Underground electrical utility service comes from two separate locations in Penn State’s existing infrastructure. A feed comes from the northwest of the site out of a concrete electrical vault located on the loading dock area of the existing Life Science Building I. A second feed comes from the southeast of the site. The electrical utility runs under the north sidewalk along Pollock Road, and crosses under Millennium Science Complex’s loading dock. Both utility lines feed the one of two 12.47kVA transformers atop the loading dock roof. Meters are placed on each breaker of the switchgear, while primary utility meters are located on the secondary side of the service entrance transformers.

## VOLTAGE SYSTEMS

After entering the Millennium Science Complex, the voltage system is stepped down to 480/277V. This voltage handles all lighting loads, motor and HVAC equipment loads, and specialty equipment loads. Several transformers then step the voltage down to 208/120V to be used for receptacle loads, security system, and fire alarm.



**EMERGENCY POWER SYSTEMS**

The Millennium Science Complex has two separate emergency systems. A dedicated system for life safety loads, and a normal/emergency distribution feeds other emergency loads throughout the building.

The emergency side of the normal/emergency distribution system enters the building on the north side of the basement-mezzanine electrical room N-P052. The Penn State provided 2,000kW, 4.16kV, 3-phase standby generator and a Penn State provided 1500kVA, 4.16kV-480Y/277V transformer fed the 2,000A normal/emergency switchgear, EMDS-1. Both the generator and transformer are located off-site. Figure #2.1 shows the normal/emergency service entrance.

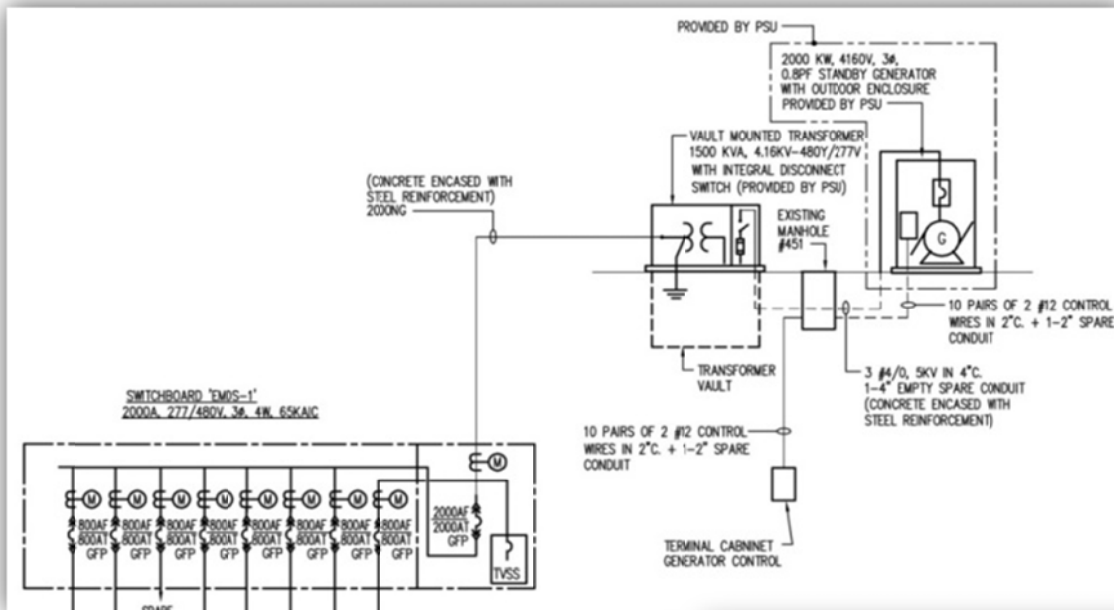


Figure #2.1: One-Line description of the normal/emergency service entrance

A third service entrance feeds all the life safety loads in the building. It is fed from an emergency generator switchboard in the nearby Life Science I Building. This entrance enters from an underground run into a small electrical room, W-P002, adjacent to the main electrical room. As with the other service entrances, Penn State will supply up to and including the buck-up 480V-480Y/277V transformer shown in Figure #1.3. The electrical contractor’s responsibility starts on the secondary side of TRE-1B.

Life safety loads are picked up by emergency panel EDP-LOB in room W-P002. The feed comes from the nearby Life Science Building I, west of the project’s site. The feed serves EDP-LOB with 480/277V power, which then feeds (9) 480/277V panels and (11) 208/120V panels. Table #1 shows these panels and the types of loads they serve.

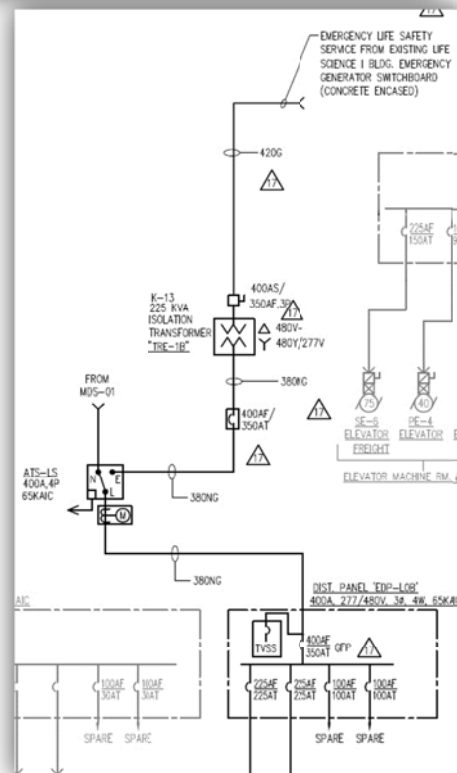


Figure #2.1: One-Line description of the emergency-power service entrance.

480/277V Panels Life Safety Loads Served	
HLE-0B	Emergency Lighting (corridors, stairs, exit)
HLE-0D	Emergency Lighting (corridors, stairs, exit, tunnel); Lighting Control Panel 'LCPE-1'
HLE-1B	Emergency Lighting (corridors, stairs, exit, site, exterior canopy, and rooms elec., telecom., labs)
HLE-1D	Emergency Lighting (corridors, stairs, catwalk, vivarium, clean rooms); Panels 'HLE-1E' & 'LE-1D & 2D'
HLE-2B	Emergency Lighting (corridors, stairs, computational, warning, dark room); Panels 'LE-2B & 3B'
HLE-2D	Emergency Lighting (corridors, stairs, warning)
HLE-3B	Emergency Lighting (café/commons, stairs, exit, warning)
HLE-3D	Emergency Lighting (corridors, stairs, exit, offices)
HLE-M4	Penthouse Emergency Lighting; Exit lights; Heat Trace
208/120V Panels Life Safety Loads Served	
LE-0B	Fire Alarm Control Panel; Panel 'LE-0D'
LE-0D	Receptacles; (8) F.S.D.'s; Dedicated Riser Security & Security Control Receptacles
LCPE-1	"Lighting Control Panel: Emergency" – Lighting Zones 37-43 (lobby, exterior and loading dock)
LE-1B	Receptacles; (2) Motorized Dampers; TRFW-(102, 120 & 106); EFN-(2,27,28,29 & 30); SFN-8; and CUHWZ-(103,001_2, 002, 003)
LE-1D	Receptacles; (16) F.S.D.'s; Dedicated Riser Security Receptacles
LE-2B	Receptacles; (7) F.S.D.'s; Dedicated Riser Security Receptacles; Panel 'LE-2A'
LE-2D	Receptacles; (9) F.S.D./S.D.'s; Dedicated Riser Security Receptacles; Panel 'LE-2E1'
LE-2E1	Receptacles
LE-2A	Receptacles
LE-3B	Receptacles; (13) F.S.D.'s; Dedicated Riser Security Receptacles
LE-3D	Receptacles; (10) F.S.D.'s; Dedicated Riser Security Receptacles

Table#1: Life Safety Panels & Load Descriptions

## **LOCATION OF SWITCHGEAR**

The dual 5,000A main-tie-main switchgear, comprised of MDS-01A and MDS-01B, is fed from two 12.47kVA transformers that sit on the roof of this room near the loading dock. MDS-01A/B then feeds both the secondary dual 2,000A main-tie-main switchgear, MDS-02A and MDS-02B, in the Material Science basement-mezzanine electrical room N-P051 and the 1,200A switchgear MDS-03. MDS-03 supplies the clean room in the first floor Material Science wing. EMDS-1, the only emergency switchgear in the project, is located in N-P052, adjacent to N-P051 & N-P053.

Electrical rooms are located in the core of each wing, positioned between both shafts of each Material Science and Life Science wings. In the basement level, the electrical rooms are located directly below the mechanical shafts, posing problems getting conduits from the basement levels to the upper levels.

Clean room design was a separate bid-package sent out in November of 2009. Flak & Kurtz, the main MEP engineering firm, was not contracted for this design. Instead, a specialist in clean room design, IDC Architects, was brought in on the design. There are noticeable discrepancies on equipment designations between the two designers. Flak & Kurtz owns MDS-03, and the four distribution panels that supply the clean room, where IDC Architects own the panels fed from these distribution panels. Flak & Kurtz uses designations MDS-03 for the switchgear, SDP-1M1, SDP-1M2, SDP-1M3, and EDPS-1M for the distribution panels. IDC Architects use CLMS-1, DP-1, DP-2, DP-3, and “*existing basebuild standby emergency panel*” as respective names. Since the clean room documents provided to the IPD/BIM teams are basis of design documents, the designations from Flak & Kurtz will be used to spare any confusion. No panel schedules of any clean room panels have been provided, leaving loads unknown.

Most electrical equipment can be found in at least 4 or 5 places: 1/8” floor plans, panel schedules, riser diagrams, normal one-line diagram, emergency one-line diagram, and in some cases ¼” scale detail sheets. Some discrepancies were found when doing a detailed overview of these sheets. Tables #2.1 – 2.6 show these items in list format with where they were or weren’t found. A list of notable discrepancies and possible solutions are listed below.

- Clean room panels do not have panel schedules, as IDC Architects have not released design documents.
- The one-line shows MDS-01A/B as have a 4,000A M.C.B., but the riser diagram shows 5,000A. The electrical contractor has verified it to be 5,000A
- EDPS-M43 was found only on the riser diagram. After talking with the electrical contractor, it was determined that EDPS-M43 has been deleted.
- LE-0D is found in two rooms, N-M020 and N-P004.
- LS-0D2 and LS-0D3 were found in all applicable spaces aside from the one-line diagrams.
- LBS-1D1 and LBS-1D2 were found in all applicable spaces aside from any floor plans. In the Bulletin 19 issue, several panels were deleted from its feeding panel, EDPS-1D. The electrical contractor says an RFI is currently waiting to be answered on which panels were actually deleted, and if these two were supposed to be left or removed.
- LB-1E11 was found in all applicable spaces aside from the one-line diagrams.
- LBR-2D15 and LBR-2D16 are shown as “feed-thru” (15 feeds through to 16) on all applicable drawings except on the one-line diagram.
- LBS-1D1 and LBS-1D2 were found in all applicable spaces aside from any floor plans.
- HLE-1E was found in all applicable spaces aside from any floor plans. After talking to the electrical contractor, it was determined to be in room N-P129A.



	Lvl	Name	Location	Floorplan	Riser	One Line	Schd	Volt	RATING
Switch Gears	0	MDS-01A	W-P003	E2.0B-P	✓	✓		480/277V	5,000A
		MDS-01B	W-P003	E2.0B-P	✓	✓	✓	480/277V	5,000A
	0M	MDS-02A	N-P051	E2.0MD-LP	✓	✓	✓	480/277V	2,000A
		MDS-02B	N-P051	E2.0MD-LP	✓	✓		480/277V	2,000A
		MDS-03 (CLMS-1)	N-P053	E2.0MD-LP	✓	✓		480/277V	1,200A
		EMDS-1	N-P052	E2.0MD-LP	✓	✓	✓	480/277V	2,000A
	Lvl	Name	Location	Floorplan	Riser	One Line	Schd	Volt	MCB/MLO
SwitchBoards	Level 0	EDP-L0B	W-P003	E2.0B-P	✓	✓	✓	480/277V	350A
		SDP-0B	W-P001	E2.0B-P	✓	✓	✓	480/277V	1,000A
		SDP-0B3	W-P003	E2.0B-P	✓	✓	✓	480/277V	1,000A
		SDP-0D	N-P004	E2.0D-P	✓	✓	✓	480/277V	1,000A
	Level 0M	EDPS-1E1	N-P052	E2.0MD-LP	✓	✓	✓	480/277V	800A
		EDPS-1E2	N-P052	E2.0MD-LP	✓	✓	✓	480/277V	800A
		EDPS-1M	N-P053	E2.0MD-LP	✓	✓	✗	480/277V	400A
		MDP-1E1	N-P052	E2.0MD-LP	✓	✓	✓	480/277V	800A
		SDP-1M1 (DP-1)	N-P053	E2.0MD-LP	✓	✓	✗	480/277V	1,000A
		SDP-1M2 (DP-2)	N-P053	E2.0MD-LP	✓	✓	✗	480/277V	1,000A
		SDP-1M3 (DP-3)	N-P053	E2.0MD-LP	✓	✓	✗	480/277V	800A/MLO
	Level 1	EDPS-1B	W-P127	E2.1B-P	✓	✓	✓	208/120V	800A
		EDPS-1D	N-P152	E2.1D-P	✓	✓	✓	208/120V	800A
		EDPS-1E3	N-P129A	E2.1E-P	✓	✓	✓	480/277V	800A
		SDP-1D	N-P152	E2.1D-P	✓	✓	✓	480/277V	1,000A
	Level 1M	DP-4	1 <sup>st</sup> FlrMez.	A8.E2.2D-P	A8.E5.1	N/A	✗		
		DP-5	1 <sup>st</sup> FlrMez.	A8.E2.2D-P	A8.E5.1	N/A	✗		
		DP-6	1 <sup>st</sup> FlrMez.	A8.E2.2D-P	A8.E5.1	N/A	✗		
		EDP-1	1 <sup>st</sup> FlrMez.	A8.E2.2D-P	A8.E5.1	N/A	✗		
	Level 2	SDP-2B	W-P249	E2.2B-P	✓	✓	✓	480/277V	1,000A
		SDP-2D	N-P258	E2.2BD-P	✓	✓	✓	480/277V	1,000A
		SDP-2D1	N-P238	E2.2E-P	✓	✓	✓	480/277V	1,000A
	Lvl 3	EDPS-3B	W-P338	E2.3B-P	✓	✓	✓	208/120V	800A
		EDPS-3D	N-P347	E2.3D-P	✓	✓	✓	208/120V	800A
	Level 4	EDPC-M41	N-M401	E2.4C-P	✓	✓	✓	480/277V	600A
		EDPC-M42	N-M401	E2.4C-P	✓	✓	✓	480/277V	800A
		EDPS-M41	N-M401	E2.4C-P	✓	✓	✓	480/277V	800A
		EDPS-M42	N-M401	E2.4C-P	✓	✓	✓	480/277V	800A
		EDPS-M43	DELETED		✓	✗	✗	DELETED	
		MDP-M41	N-M401	E2.4C-P	✓	✓	✓	480/277V	1,000A
		MDP-M42	N-M401	E2.4C-P	✓	✓	✓	480/277V	1,000A

Table #2.1: Electrical Equipment Overview: Switchgear & Switchboards

	Lvl	Name	Location	Floorplan	Riser	One Line	Sched.	Volt	MCB/MLO
Panelboards: Level 0	Level 0B	HL-0B	W-P001	E2.0B-P	✓	✓	✓	480/277V	100A
		HLE-0B	W-P001	E2.0B-P	✓	✓	✓	480/277V	200A
		HM-0B	W-P001	E2.0B-P	✓	✓	✓	480/277V	100A
		HMS-0B	W-P001	E2.0B-P	✓	✓	✓	480/277V	200A
		LE-0B	W-P001	E2.0B-P	✓	✓	✓	208/120V	100A
		LR-0B	W-P001	E2.0B-P	✓	✓	✓	208/120V	150A
		LR-0B1	W-P001	E2.0B-P	✓	✓	✓	208/120V	150A
		LR-0B2/3	W-006	E-4.0B	✓	✓	✓	208/120V	225A/MLO
		LM-0B4	W-006	E-4.0B	✓	✓	✓	208/120V	100A
	LS-0B	W-P001	E2.0B-P	✓	✓	✓	208/120V	100A	
	Level 0C	LB-0C1/2	N-Q008	E4.0C-3	✓	✓	✓	208/120V	175A/MLO
		LB-0C11/12	N-027	E4.0C-2	✓	✓	✓	208/120V	175A/MLO
		LB-0C13/14	N-016	E4.0C-4	✓	✓	✓	208/120V	175A/MLO
		LB-0C15/16	N-016	E4.0C-4	✓	✓	✓	208/120V	225A/MLO
		LB-0C17/18	N-Q008	E4.0C-3	✓	✓	✓	208/120V	175A/MLO
		LB-0C19/21	N-027	E4.0C-2	✓	✓	✓	208/120V	400A
		LB-0C20	N-027	E4.0C-2	✓	✓	✓	208/120V	400A
		LB-0C22	N-001	E4.0C-2	✓	✓	✓	208/120V	225A
		LB-0C3/4	N-Q008	E4.0C-3	✓	✓	✓	208/120V	175A/MLO
		LB-0C5/6	N-030	E4.0C-1	✓	✓	✓	208/120V	175A/MLO
		LB-0C7/8	N-030	E4.0C-1	✓	✓	✓	208/120V	175A/MLO
		LB-0C9/10	N-030	E4.0C-1	✓	✓	✓	208/120V	175A/MLO
		LBR-0C1/2	N-Q008	E4.0C-3	✓	✓	✓	208/120V	225A/MLO
		LBR-0C11/12	N-027	E4.0C-2	✓	✓	✓	208/120V	175A/MLO
	LBS-0C1/2	N-Q008	E4.0C-3	✓	✓	✓	208/120V	225A	
	LBS-0C5/6	N-027	E4.0C-2	✓	✓	✓	208/120V	225A	
	Level 0D	HL-0D	N-P004	E2.0D-P	✓	✓	✓	480/277V	100A
		HLE-0D	N-P004	E2.0D-P	✓	✓	✓	480/277V	100A
		HM-0D	N-P004	E2.0D-P	✓	✓	✓	480/277V	100A
		HMS-0D	N-P004	E2.0D-P	✓	✓	✓	480/277V	100A
		LE-0D	N-M020 & N-P004	E4.0C-2	✓	✓	✓	208/120V	100A
		LR-0D	N-P004	E2.0D-P	✓	✓	✓	208/120V	MLO
		LS-0D1	N-M020	E4.0C-2	✓	✓	✓	208/120V	400A
		LS-0D2/3	N-020	E4.0C-2	✓	✗	✓	208/120V	225A/MLO
	Level 0M	LCP-1	N-P052	E2.0MD-LP	✓	✓	✓	208/120V	NO NOTE
		PP-1	N-051	A8.E2.0D-P	A8.E5.1	N/A	✗		
PP-2		N-051	A8.E2.0D-P	A8.E5.1	N/A	✗			
PP-3		N-051	A8.E2.0D-P	A8.E5.1	N/A	✗			
Panelboards: I1	Lvl 1 Clean Room	PP-4	N-109X	A8.E2.1D-P	A8.E5.1	N/A	✗		
		PP-5	N-109V	A8.E2.1D-P	A8.E5.1	N/A	✗		
		PP-6	N-109R	A8.E2.1D-P	A8.E5.1	N/A	✗		
		PP-7	N-109R	A8.E2.1D-P	A8.E5.1	N/A	✗		
		PP-8	N-109F	A8.E2.1D-P	A8.E5.1	N/A	✗		
		PP-9	N-109D	A8.E2.1D-P	A8.E5.1	N/A	✗		
		PP-10	N-109B	A8.E2.1D-P	A8.E5.1	N/A	✗		

Table #2.2: Electrical Equipment Overview: Clean Room and Basement Panelboards

	Lvl	Name	Location	Floorplan	Riser	One Line	Sched.	Volt	MCB/MLO
Panelboards: Level 1	Level 1A	LB-1A1	W-108Q	E2.1A-P	✓	✓	✓	208/120V	225A
		LB-1A2	W-108Q	E2.1A-P	✓	✓	✓	208/120V	225A/MLO
		LB-1A3	W-108Q	E2.1A-P	✓	✓	✓	208/120V	225A/MLO
		LBS-1A1/2	W-108Q	E2.1A-P	✓	✓	✓	208/120V	225A
		LBS-1A3	W-108Q	E2.1A-P	✓	✓	✓	208/120V	225A/MLO
	Level 1B	HL-1B	W-P127	E2.1B-P	✓	✓	✓	480/277V	100A
		HLE-1B	W-P127	E2.1B-P	✓	✓	✓	480/277V	100A
		HM-1B	W-P127	E2.1B-P	✓	✓	✓	480/277V	100A
		HMS-1B	W-P127	E2.1B-P	✓	✓	✓	480/277V	100A
		LB-1B1/2	W-Q101	E4.1B	✓	✓	✓	208/120V	225A
		LB-1B3/4	W-121	E4.1-P	✓	✓	✓	208/120V	225A
		LBS-1B1/2	W-Q101	E4.1B	✓	✓	✓	208/120V	225A
		LE-1B	W-T127	E2.1-P	✓	✓	✓	208/120V	150A
		LR-1B	W-P127	E2.1B-P	✓	✓	✓	208/120V	150A
		LR-1B3/4	W-Q104	E4.1B	✓	✓	✓	208/120V	225A
		LR-1B5/6	W-Q104	E4.1B	✓	✓	✓	208/120V	150A
		LS-1B	W-P127	E2.1B-P	✓	✓	✓	208/120V	100A/MLO
		Level 1D	LE-1D	N-P152	E2.1D-P	✓	✓	✓	208/120V
	HL-1D		N-P152	E2.1D-P	✓	✓	✓	480/277V	100A
	HLE-1D		N-P152	E2.1D-P	✓	✓	✓	480/277V	150A
	HM-1D		N-P152	E2.1D-P	✓	✓	✓	480/277V	200A
	HMS-1D		N-P152	E2.1D-P	✓	✓	✓	480/277V	100A
	LB-1D1/4		N-160	E4.1D	✓	✓	✓	208/120V	175A
	LB-1D2/5		N-160	E4.1D	✓	✓	✓	208/120V	225A
	LB-1D3		N-160	E4.1D	✓	✓	✓	208/120V	400A
	LBS-1D1/2				✗	✓	✓	208/120V	NO NOTE
	LR-1D1/2		N-P152	E2.1D-P	✓	✓	✓	208/120V	225A/200A
	LS-1D	N-P152	E2.1D-P	✓	✓	✓	208/120V	100A/MLO	
	Level 1E	HC-1E	N-P129A	E2.1E-P	✓	✓	✓	480/277V	400A
		HL-1E	N-P129A	E2.1E-P	✓	✓	✓	480/277V	225A
		HLE-1E			✓	✓	✓	480/277V	40A
		HME-1E	N-P129A	E2.1E-P	✓	✓	✓	480/277V	400A
		LB-1E1	N-129A	E4.1E	✓	✓	✓	208/120V	225A
		LB-1E10	N-160	E4.1E	✓	✓	✓	208/120V	400A
		LB-1E11	N-160	E4.1E	✓	✗	✓	208/120V	225A
		LB-1E2	N-129A	E4.1E	✓	✓	✓	208/120V	225A
		LB-1E5/3	N-160	E4.1E	✓	✓	✓	208/120V	225A/225A
		LB-1E6/4	N-160	E4.1E	✓	✓	✓	208/120V	225A/MLO
		LB-1E7/8	N-160	E4.1E	✓	✓	✓	208/120V	200A
		LB-1E9	N-160	E4.1E	✓	✓	✓	208/120V	225A
LBS-1E1/4		N-160	E4.1E	✓	✓	✓	208/120V	225A	
LBS-1E3/2		N-160	E4.1E	✓	✓	✓	208/120V	225A	
LBS-1E5/6		N-160	E4.1E	✓	✓	✓	208/120V	225A	
LCPE-1	N-P052	E2.0MD-LP	✓	✓	✓	208/120V	60A		
LR-1E	N-P129A	E2.1E-P	✓	✓	✓	208/120V	100A		
Lvl	DP-4	1st Floor Mezz.	A8.E2.2D-P	A8.E5.1	N/A	✗	480/277V		
Lvl	DP-5	1st Floor Mezz.	A8.E2.2D-P	A8.E5.1	N/A	✗	480/277V		

Table #2.3: Electrical Equipment Overview: First Floor Panelboards

Lvl	Name	Location	Floorplan	Riser	One Line	Sched.	Volt	MCB/MLO
	DP-6	1st Floor Mezz.	A8.E2.2D-P	A8.E5.1	N/A	☒	480/277V	
	EDP-1	1st Floor Mezz.	A8.E2.2D-P	A8.E5.1	N/A	☒	480/277V	
Panelboards: Level 2	Level 2A							
	LB-2A1/2	W-223B	E4.2A	☑	☑	☑	208/120V	225A/225A
	LB-2A3/4	W-223B	E4.2A	☑	☑	☑	208/120V	225A/MLO
	LB-2A7/8	W-223B	E4.2A	☑	☑	☑	208/120V	225A
	LBS-2A1/2	W-223B	E4.2A	☑	☑	☑	208/120V	225A
	LBS-2A3/4	W-223B	E4.2A	☑	☑	☑	208/120V	225A
	LBS-2A5/6	W-223B	E4.2A	☑	☑	☑	208/120V	225A/MLO
	LBS-2A7/8	W-223B	E4.2A	☑	☑	☑	208/120V	225A
	LE-2A	W-T227	E2.2A-P	☑	☑	☑	208/120V	70A
	LR-2A5/6	W-223B	E4.2A	☑	☑	☑	208/120V	200A/200A
	LB-2A9	W-223B	E4.2A	☑	☑	☑	208/120V	225A/MLO
	Level 2B							
	HLE-2B	W-P249	E2.2B-P	☑	☑	☑	480/277V	150A
	HL-2B	W-P249	E2.2B-P	☑	☑	☑	480/277V	100A
	HM-2B	W-P249	E2.2B-P	☑	☑	☑	480/277V	100A
	HMS-2B	W-P249	E2.2B-P	☑	☑	☑	480/277V	100A
	LE-2B	W-T249	E2.2B-P	☑	☑	☑	208/120V	150A
	LR-2B	W-P249	E2.2B-P	☑	☑	☑	208/120V	225A
	LR-2B1/2	W-212A	E4.2A-P	☑	☑	☑	208/120V	225A
	LR-2B3/4	W-244B	E4.2A-P	☑	☑	☑	208/120V	225A
	LR-2B5/6	W-212A	E4.2A-P	☑	☑	☑	208/120V	225A
	LS-2B	W-P249	E2.2B-P	☑	☑	☑	208/120V	100A
	Level 2D							
	HL-2D	N-P258	E2.2BD-P	☑	☑	☑	480/277V	100A
	HLE-2D	N-P258	E2.2BD-P	☑	☑	☑	480/277V	200A
	HM-2D	N-P258	E2.2BD-P	☑	☑	☑	480/277V	200A
	HMS-2D	N-P258	E2.2BD-P	☑	☑	☑	480/277V	60A
	LB-2D1/2	N-270	E4.2D-2	☑	☑	☑	208/120V	175A
	LB-2D3/4	N-270	E4.2D-2	☑	☑	☑	208/120V	175A
	LB-2D5/6	N-270	E4.2D-1	☑	☑	☑	208/120V	175A
	LB-2D7/8	N-270	E4.2D-1	☑	☑	☑	208/120V	175A
	LB-2D9/10	N-Q204	E4.2D-1	☑	☑	☑	208/120V	175A
	LBR-2D13/14	N-270	E4.2D-1	☑	☑	☑	208/120V	225A
	LBR-2D15/16	N-P238	E2.2E-P	☑	(2)	☑	208/120V	*225A/225A
	LBS-2D1/2	N-270	E4.2D-2	☑	☑	☑	208/120V	225A
	LBS-2D3/4	N-270	E4.2D-1	☑	☑	☑	208/120V	225A
LE-2D	N-T258	E2.2BD-P	☑	☑	☑	208/120V	150A	
LR-2D	N-P258	E2.2BD-P	☑	☑	☑	208/120V	150A	
LR-2D11/12	N-Q206	E4.2D-1	☑	☑	☑	208/120V	225A	
LR-2D9/10	N-270	E4.2D-2	☑	☑	☑	208/120V	225A	
LS-2D	N-P258	E2.2BD-P	☑	☑	☑	208/120V	100A	
Lvl 2E								
LBS-2E1/2	N-P238	E2.2E-P	☑	☑	☑	208/120V	225A	
LE-2E1	N-T237	E2.2E-P	☑	☑	☑	208/120V	50A	
LB-2E1/2	N-P238	E2.2E-P	☑	☑	☑	208/120V	225A	

Table #2.4: Electrical Equipment Overview: Second Floor Panelboards

\*Shunt Trip with Feed Thru Lugs, MCB

	Lvl	Name	Location	Floorplan	Riser	One Line	Sched.	Volt	MCB/MLO	
Panelboards: Level 3	Level 3B	HL-3B	W-P338	E2.3B-P	✓	✓	✓	480/277V	200A	
		HLE-3B	W-P338	E2.3B-P	✓	✓	✓	480/277V	100A	
		HM-3B	W-P338	E2.3B-P	✓	✓	✓	480/277V	100A	
		HMS-3B	W-P338	E2.3B-P	✓	✓	✓	480/277V	100A	
		LB-3B1/2	W-Q304	E4.3B	✓	✓	✓	208/120V	225A	
		LB-3B3/4	W-321	E4.3B	✓	✓	✓	208/120V	225A	
		LB-3B5/6	W-337	E4.3B	✓	✓	✓	208/120V	225A	
		LB-3B7	W-Q304	E4.3B	✓	✓	✓	208/120V	225A/MLO	
		LBS-3B1/2	W-Q304	E4.3B	✓	✓	✓	208/120V	225A	
		LBS-3B3/4	W-321	E4.3B	✓	✓	✓	208/120V	225A	
		LE-3B	W-T338	E2.3B-P	✓	✓	✓	208/120V	150A	
		LR-3B	W-P338	E2.3B-P	✓	✓	✓	208/120V	150A	
		LR-3B5/6	W-337	E4.3B	✓	✓	✓	208/120V	225A	
		LS-3B	W-P338	E2.3B-P	✓	✓	✓	208/120V	100A	
		Lvl 3C	LB-3C1/2	W-Q302	E2.3C-P	✓	✓	✓	208/120V	150A
	LB-3C3/4		N-Q302	E2.3C-P	✓	✓	✓	208/120V	225A	
	LR-3C1/2		N-Q307	E2.3C-P	✓	✓	✓	208/120V	225A	
	Level 3D	HL-3D	N-P347	E2.3D-P	✓	✓	✓	480/277V	200A	
		HLE-3D	N-P347	E2.3D-P	✓	✓	✓	480/277V	100A	
		HM-3D	N-P347	E2.3D-P	✓	✓	✓	480/277V	100A	
		HMS-3D	N-P347	E2.3D-P	✓	✓	✓	480/277V	100A	
		LB-3D1/2	N-361	E4.3D	✓	✓	✓	208/120V	175A	
		LB-3D5/6	N-361	E4.3D	✓	✓	✓	208/120V	175A	
		LB-3D7/8	N-361	E4.3D	✓	✓	✓	208/120V	175A	
		LBS-3D1/2	N-Q304	E4.3D	✓	✓	✓	208/120V	225A	
		LBS-3D5/6	N-361	E4.3D	✓	✓	✓	208/120V	225A	
		LE-3D	N-T347	E2.3D-P	✓	✓	✓	208/120V	100A	
		LR-3D1/2	N-P346	E2.3D-P	✓	✓	✓	208/120V	225A	
		LR-3D3/4	N-P346	E2.3D-P	✓	✓	✓	208/120V	225A	
		LS-3D	N-P347	E2.3D-P	✓	✓	✓	208/120V	100A	
		Lvl	Name	Location	Floorplan	Riser	One Line	Sched.	Volt	MCB/MLO
	Panelboards: Penthouse	Penthouse	LR-4C	N-M401	E2.3B-P	✓	✓	✓	208/120V	100A
			HM-4A	N-M401	E2.3B-P	✓	✓	✓	480/277V	400A/MLO
			HLE-M4	N-M401	E2.3B-P	✓	✓	✓	480/277V	100A
			HL-M4	N-M401	E2.3B-P	✓	✓	✓	480/277V	100A/MLO
			HM-4B	N-M401	E4.3B	✓	✓	✓	480/277V	400A/MLO
LE-4C			N-M401	E4.3B	✓	✓	✓	208/120V	100A	

Table #2.5: Electrical Equipment Overview: Third Floor & Penthouse Panelboards

Lvl	Name	Type of Equip.	Location	Floorplan	Enl. Plan	Riser	One Line
Level 0	ATS-HC1	Automatic Trans. Switch	W-P003	E2.0B-P	E2.0B-P	☑	☑
	ATS-LS	Automatic Trans. Switch	W-P002	E2.0B-P	E2.0B-P	☑	☑
	CAPACITOR BANK-1	Capacitor Bank	W-P003	E2.0B-P	E2.0B-P	☑	☑
	CAPACITOR BANK-2	Capacitor Bank	W-P003	E2.0B-P	E2.0B-P	☑	☑
	TRE-LE-0B	Clg. Mounted XFMR	W-P001	E2.0B-P	E2.0B-P	☑	☑
	TRN-SDP-0B	Pad Mounted XFMR	W-P001	E2.0B-P	E2.0B-P	☑	☑
	TRN-SDP-0B3	Pad Mounted XFMR	W-P003	E2.0B-P	E2.0B-P	☑	☑
	TRN-SDP-1D	Pad Mounted XFMR	W-P004	E2.0D-P	E2.0D-P	☑	☑
	TRN-SDP-0D	Pad Mounted XFMR	W-P004	E2.0D-P	E2.0D-P	☑	☑
	TRE-EDPS-1D	Pad Mounted XFMR	W-P004	E2.0D-P	E2.0D-P	☑	☑
	TRE-1B	Pad Mounted XFMR	W-P002	E2.0B-P	E2.0B-P	☑	☑
	UPS-OC-1/2	UPS	W-P001	E2.0B-P	E2.0B-P	☑	☑
	UPS-OC-3/4	UPS	N-031	E4.0C-1	E4.0C-1	☑	☑
	UPS-OC-5/6	UPS	N-030	E4.0C-1	E4.0C-1	☑	☑
	UPS-OC-7/8	UPS	W-P001	E2.0B-P	E2.0B-P	☑	☑
	UPS-OC-9/10	UPS	N-030	E4.0C-1	E4.0C-1	☑	☑
	UPS-OC-11/12	UPS	N-027	E4.0C-2	E4.0C-2	☑	☑
	UPS-OC-13/14	UPS	N-016	E4.0C-4	E4.0C-4	☑	☑
UPS-OC-17/18	UPS	N-031	E4.0C-1	E4.0C-1	☑	☑	
UPS-ROC-11/12	UPS	N-027	E4.0C-2	E4.0C-2	☑	☑	
Level 1	PDTR-1	Pad Mounted XFMR	Roof	E2.0B-P	E2.0B-P	☑	☑
	PDTR-2	Pad Mounted XFMR	Roof	E2.0B-P	E2.0B-P	☑	☑
	TRE-EDPS-1B	Pad Mounted XFMR	W-P127	E2.1B-P	E2.1B-P	☑	☑
	TRE-LE-1D	Ceiling Mounted XFMR	N-P152	E2.1D-P	E2.1D-P	☑	☑
	TRE-LR-1E	Ceiling Mounted XFMR	N-P129	E2.1E-P	E2.1E-P	☑	☑
	UPS-1D-1/4	UPS	N-160	E4.1D	E4.1D	☑	☑
	UPS-1E-5/3	UPS	N-160	E4.1E	E4.1E	☑	☑
	UPS-S1E-3/2	UPS	N-160	E4.1D	E4.1D	☑	☑
Level Mezzanine	ATS-HS1	Automatic Trans. Switch	N-P052	E2.0MD-LP	E2.0MD-LP	☑	☑
	ATS-HS2	Automatic Trans. Switch	N-P052	E2.0MD-LP	E2.0MD-LP	☑	☑
	ATS-HS3	Automatic Trans. Switch	N-P052	E2.0MD-LP	E2.0MD-LP	☑	☑
	ATS-HS4	Automatic Trans. Switch	N-P052	E2.0MD-LP	E2.0MD-LP	☑	☑
	ATS-HS5	Automatic Trans. Switch	N-P052	E2.0MD-LP	E2.0MD-LP	☑	☑
	ATS-HC2	Automatic Trans. Switch	N-P052	E2.0MD-LP	E2.0MD-LP	☑	☑
	ATS-HC3	Automatic Trans. Switch	N-P052	E2.0MD-LP	E2.0MD-LP	☑	☑
	PSU Supplied	Vault Mounted XFMR	<i>NOT SHOWN ON PLANS</i>			☑	☑
	TRN-SPD-1M1	Pad Mounted XFMR	N-P053	E2.0MD-LP	E2.0MD-LP	☑	☑
	TRN-SPD-1M2	Pad Mounted XFMR	N-P053	E2.0MD-LP	E2.0MD-LP	☑	☑
Level 2	TRE-LE-2B	Trapeze Mounted XFMR	W-P249	E2.2B-P	E2.2B-P	☑	☑
	TRN-SDP-2B	Pad Mounted XFMR	W-P249	E2.2B-P	E2.2B-P	☑	☑
	TRN-SDP-2D	Pad Mounted XFMR	N-P258	E2.2D-P	E2.2D-P	☑	☑
	TRN-SDP-2D1	Pad Mounted XFMR	N-P238	E2.2E-P	E2.2E-P	☑	☑
	UPS-2D-1/2	UPS	N-270	E4.2D-1	E4.2D-1	☑	☑
	UPS-2D-3/4	UPS	N-270	E4.2D-1	E4.2D-1	☑	☑
	UPS-2D-5/6	UPS	N-270	E4.2D-1	E4.2D-1	☑	☑



	UPS-2D-7/8	UPS	N-270	E4.2D-1	E4.2D-1	☑	☑
	UPS-2D-9/10	UPS	N-270	E4.2D-2	E4.2D-2	☑	☑
	UPS-2E-1/2	UPS	N-270	E4.2D-2	E4.2D-2	☑	☑
Lvl	Name	Type of Equip.	Location	Floorplan	Enl. Plan	Riser	One Line
Level 3	TRE-EDPS-3B	Pad Mount XFMR	W-P338	E2.3B-P	E2.3B-P	☑	☑
	TRE-LE-3D	Trapeze Mounted XFMR	N-P347	E2.3D-P	E2.3D-P	☑	☑
	TRE-EDPS-3D	Pad Mounted XFMR	N-P347	E2.3D-P	E2.3D-P	☑	☑
	UPS-3D-1/2	UPS	N-361	E4.3D	E4.3D	☑	☑
	UPS-3D-5/6	UPS	N-361	E4.3D	E4.3D	☑	☑
Lvl 4	TRE-LR-4C	Pad Mounted XFMR	N-M401	E2.4C-P	N/A	☑	☑

Table #3.2: Additional Electrical Equipment 2 of 2

### OVER-CURRENT DEVICES

Main switchgear for the Millennium Science Complex is rated for a 600V AC service. Main, tie, and feeder overcurrent protection are drawout power circuit breakers with frame ratings of 800, 1600, 4000, or 5000 amps as noted in the drawings and 100% rated with ground fault protection. These breakers are either manually or electrically operated. The main and tie breakers are electrically operated via programmable logic controllers from MDS-01A and MDS-01B.

Main service branch feeders are also protected by drawout power circuit breakers. Solid state overcurrent trip devices contain one or two current transformers or sensors per phase, a release mechanism and the following features:

- Long-time-delay, short-time-delay, and instantaneous trip functions
- Temperature compensation for accuracy and calibration from -5C to +40C
- Field-adjustable time-current characteristics
- Dial settings and rating plugs for current adjustability
- Three bands for minimum, long-time- and short-time-delay functions
- Minimum of five pickup points
- LED colored lamps to indicate “open,” “closed,” or “tripped” breaker
- Provide time monitoring that can communicate directly with Penn State central monitoring system
- Arc Flash sensing

Distribution panelboards are protected by plastic molded case, bolt-on circuit breakers. Typical panelboards are protected by circuit breakers with the following interrupting current capacity:

- 102/208V breakers have a capacity not less than 10,000 AIC
- 277/480V breakers have a capacity not less than 14,000 AIC
- Distribution panel breakers have a capacity not less than 42,000 AIC

Breakers are thermal-magnetic trip-free, trip-indicating, quick-make/quick-break with inverse time delay characteristics. All circuit breakers with frame size of 400A or greater have electronic trip indicators. Distribution branch protection is provided by the same type circuit breakers and characteristics.

Branch circuit panelboards are powered by distribution panelboards and are protected by the same criteria circuit breakers as discussed above. Several branch panelboards are multiple sections or feed through. Feed through panels are the same height and number of poles. Where feed through panels exist in the building, the upstream panel is protected by a main circuit breaker as described above and the downstream panel is main lugs only. On rare occasions are both panels protected by main circuit breakers or have a shunt trip option installed.

**TRANSFORMERS**

	Tag	Primary Voltage	Secondary Voltage	Size (kVA)	Type	Temp. Rise	Taps	Mounting	Remarks
PSU	PDTR-1	12.47kV, 3PH, 3W	480Y/277V, 3PH, 4W	N/A	N/A	N/A	N/A	Pad	Supplied by PSU
	PTDR-2	12.47kV, 3PH, 3W	480Y/277V, 3PH, 4W	N/A	N/A	N/A	N/A	Pad	Supplied by PSU
	N/A	4.16kV, 3PH, 3W	480Y/277V, 3PH, 4W	1500	DRY	80C	N/A	Vault	Supplied by PSU
Level 0	TRN-SDP-0B	480V, 3PH, 3W	208Y/120V, 3PH, 4W	300	DRY	80C	(4)-2.5%, (2)+2.5%	Pad	K-13 Rated
	TRN-SDP-0B3	480V, 3PH, 3W	208Y/120V, 3PH, 4W	300	DRY	80C	(4)-2.5%, (2)+2.5%	Pad	K-13 Rated
	TRE-LE-0B	480V, 3PH, 3W	208Y/120V, 3PH, 4W	45	DRY	80C	(4)-2.5%, (2)+2.5%	Ceiling	K-13 Rated
	TRN-SDP-0D	480V, 3PH, 3W	208Y/120V, 3PH, 4W	300	DRY	80C	(4)-2.5%, (2)+2.5%	Pad	K-13 Rated
Level 1	TRE-1B	480V, 3PH, 3W	480Y/277V, 3PH, 4W	225	DRY	80C	(4)-2.5%, (2)+2.5%	Pad	K-13 Rated, Isolation
	TRE-EDPS-1B	480V, 3PH, 3W	208Y/120V, 3PH, 4W	225	DRY	80C	(4)-2.5%, (2)+2.5%	Pad	K-13 Rated
	TRE-EDPS-1D	480V, 3PH, 3W	208Y/120V, 3PH, 4W	225	DRY	80C	(4)-2.5%, (2)+2.5%	Pad	K-13 Rated
	TRE-LE-1D	480V, 3PH, 3W	208Y/120V, 3PH, 4W	45	DRY	80C	(4)-2.5%, (2)+2.5%	Ceiling	K-13 Rated
	TRN-SDP-1D	480V, 3PH, 3W	208Y/120V, 3PH, 4W	300	DRY	80C	(4)-2.5%, (2)+2.5%	Pad	K-13 Rated
	TRE-LR-1E	480V, 3PH, 3W	208Y/120V, 3PH, 4W	45	DRY	80C	(4)-2.5%, (2)+2.5%	Ceiling	K-13 Rated
	TRN-SDP-1M1	480V, 3PH, 3W	208Y/120V, 3PH, 4W	300	DRY	80C	(4)-2.5%, (2)+2.5%	Pad	K-13 Rated
	TRN-SDP-1M2	480V, 3PH, 3W	208Y/120V, 3PH, 4W	300	DRY	80C	(4)-2.5%, (2)+2.5%	Pad	K-13 Rated
Level 2	TRN-SDP-2B	480V, 3PH, 3W	208Y/120V, 3PH, 4W	300	DRY	80C	(4)-2.5%, (2)+2.5%	Trapeze	K-13 Rated
	TRE-LE-2B	480V, 3PH, 3W	208Y/120V, 3PH, 4W	45	DRY	80C	(4)-2.5%, (2)+2.5%	Pad	K-13 Rated
	TRN-SDP-2D	480V, 3PH, 3W	208Y/120V, 3PH, 4W	300	DRY	80C	(4)-2.5%, (2)+2.5%	Pad	K-13 Rated
	TRN-SDP-2D1	480V, 3PH, 3W	208Y/120V, 3PH, 4W	300	DRY	80C	(4)-2.5%, (2)+2.5%	Pad	K-13 Rated
Level 3	TRE-EDPS-3B	480V, 3PH, 3W	208Y/120V, 3PH, 4W	225	DRY	80C	(4)-2.5%, (2)+2.5%	Pad	K-13 Rated
	TRE-EDPS-3D	480V, 3PH, 3W	208Y/120V, 3PH, 4W	225	DRY	80C	(4)-2.5%, (2)+2.5%	Pad	K-13 Rated
	TRE-LE-3D	480V, 3PH, 3W	208Y/120V, 3PH, 4W	30	DRY	80C	(4)-2.5%, (2)+2.5%	Trapeze	K-13 Rated
Lvl. 4	TRE-LR-4C	480V, 3PH, 3W	208Y/120V, 3PH, 4W	30	DRY	80C	(4)-2.5%, (2)+2.5%	Pad	K-13 Rated

Table #3: Transformer Schedule

The Millennium Science Complex receives three transformers from Penn State – two main service transformers and one emergency power transformer. All transformers within the building are 80C rise unless otherwise noted, equipped with copper windings, and capable of carrying a 30% continuous overload without exceeding 150C rise in a 40C ambient environment. NEMA standard taps are provided on all transformers. The transformers listed in the table below are connected to the nearest approved grounding point and are mounted on a four inch housekeeping pad, unless otherwise noted in the table.

## ***GROUNDING***

Equipment grounding can be found on the riser diagram, while feeder and circuit grounding appear on one-line diagrams. Detailed information about the grounding system components can be found in specification section 16450. Absolute configuration of the grounding system cannot be inferred from either architectural or electrical drawing sets. Grounding rods are three-quarter inch diameter by ten foot depth and composed of copper-clad steel. Service switchgears are grounded through bare copper buses mounted within the electrical switchgear room. Specifications indicate that grounding grids and with ground rods shall be installed per Contract Documents; however, grounding system diagrams are not present in the available document set.

## ***SPECIAL EQUIPMENT***

### ***UNINTERRUPTABLE POWER SUPPLIES***

Added in Bulletin 17 were 21 UPS devices. Twenty of these are located on the normal power system, while one feeds emergency panels LBS-1E3/2. The emergency and normal loads are primarily sensitive lab equipment in the Material Science wing.

Submittal documentation shows that the battery packs are not included with the UPS devices, though provisions for them are still there. Confirmation of this has not yet been found in specs, but the head engineer from Flak & Kurtz has confirmed that their primary use is power conditioning, not for a true battery back-up. Other configurations of equipment are more costly as well as take up a larger footprint.

### ***TRANSIENT VOLTAGE SURGE SUPPRESSION (TVSS)***

Transient Voltage Surge Suppression is used on switchboards and distribution panels. The transient voltage suppression provides protection of all AC electrical circuits and electronic equipment from the effects of lightning induced voltages, external switching transients, and internally generated switching transients. The TVSSs provide surge suppression for all modes of protection: L-N, L-G, and N-G in WYE systems. They are designed to withstand a maximum continuous voltage (MCOV) of not less than 115% of nominal RMS voltage. Surge protection devices use a separate path to building ground. The TVSS fusing system is comprised of a portion that will open in the event of a high fault current condition, and a portion that will open in the event of a limited fault current condition.

### ***POWER FACTOR CORRECTION WITH CAPACITOR BANKS***

A future provision for a pair of power correcting capacitor banks allows for an internal power clean-up. They have been assigned to two separate 800AF/800AT breakers, on MDS-01A and one on MDS-01B. Each capacitor bank has been assigned to 480V, 3-phase, and 60Hz. The KVAR rating (not to exceed 35kVAR) will be determined within 6-months of building start-up to insure accurate sizing. These units are dry-type, self-healing design using low loss metalized dielectric system. Individual capacitor elements are connected in delta to minimize loss of kVAR in the event of failure of any single element. The capacitors are rated for 110% continuous overvoltage and 130% continuous overcurrent.

### **LIGHTING LOADS**

The Millennium Science Complex utilizes mostly fluorescent lighting systems on the interior, and a combination of metal halide and LED fixtures on the exterior. The system contains fluorescent fixtures with emergency lighting capabilities along with emergency retractable quartz fixtures.

The lighting loads table (*found in Appendix A*) contains the luminaire tag, light source, lamp type, lamp wattage, number of lamps per fixture, ballast type, input voltage, input watts, ballast factor, current, and power factor for each luminaire.

### **LIGHTING CONTROL**

Typical office spaces have wall mounted occupancy sensors located at the switch. The Conference and Seminar rooms have ceiling mounted occupancy sensors. The controls also utilize four separate programmable zones, allowing for different scene selections. Perimeter open area zones have ceiling mounted occupancy sensors tied into Lutron's Ecosystem. This allows the fixtures in the zone to be integrated into the daylighting system. These fixtures have dimming capabilities that adjust depending on photo sensor readings. The lighting control system within the Millennium Science Complex is in compliance with ASHRAE/IESNA Standard 90.1.

### **MECHANICAL AND OTHER LOADS**

The Millennium Science Complex utilizes air systems to supply heating and cooling to spaces within the building. The laboratories are served by five 50,000 CFM variable air volume air handling units. The offices, lobbies, and common areas are served by three 40,000 CFM variable air volume air handling units. The animal care facilities are also supplied by variable air volume air handling units. Campus steam and chilled water are pumped into these units to supply heating and cooling coils. Also included in the system are cabinet unit heaters, electric heaters, fan coil units, supplementary air conditioning units, and other local equipment to address specific issues that are not able to be served by the main air handling units.

The equipment table below outlines main mechanical and other equipment within the Millennium Science Complex. These loads include equipment directly wired into the electrical system. Assumed power factors for motors and pumps are from research by Ampteks. These loads are summarized in Appendix B.

**SERVICE ENTRANCE SIZE**

**CONCEPTUAL/SCHEMATIC PHASES - LOAD PER SQUARE FOOT**

Service Entrance Size: Schematic Design of College Laboratory		
Building Square Footage	VA/ft <sup>2</sup>	Load - kVA
276,500	30	8,295

Table #4.1: Service Entrance Size: Schematic Design.

**DESIGN DEVELOPMENT - NEC LAODING**

Service Entrance Size: Design Development			
Receptacles*(120V)	VA/ft <sup>2</sup>	Square Feet	Load - kVA
*Demand factor left at 100% to account for highvolume of Lab plug-in Loads.	1.0	276,500	276
Lighting**(277V)	VA/ft <sup>2</sup>	Square Feet	Load - kVA
*Demand Factor = 100%	3.5	276,500	968
HVAC Cooling(480V)	VA/ft <sup>2</sup>	Square Feet	Load - kVA
	8	276,500	2,212
Elevators(480V)	VA/Elev.	Elevators	Load -kVA
	50	6	300
Totals			
	<b>120V kVA</b>	<b>277V kVA</b>	<b>480V kVA</b>
	276	968	2,512
			<b>Total Amps</b>
			6,367 A

Table #4.2: Service Entrance Size: Design Development.

**WORKING DRAWINGS - ACTUAL LOADING**

Service Entrance	Size - Amps	Voltage System	Capacity - KVA
Actual Conditions – Service Entrance 1	14323.85	480Y/277V	<b>10916.32</b>
Actual Conditions – Service Entrance 2	3304.23	480Y/277V	<b>3480.87</b>
Actual Conditions – Service Entrance 3	330.26	480Y/277V	<b>646.80</b>
Total Actual Conditions – All Services	18274.83	480Y/277V	<b>14695.19</b>
Summary - VA/Sq.Ft.	<b>66.09 A/SF</b>	<b>480Y/277V</b>	<b>53.15 VA/SF</b>

Table #4.3: Service Entrance Size: Working Drawings.

**SUMMARY TABLES**

Phase	Load - kVA	Voltage System	Load - Amps
Conceptual/Schematic Design	8,295	480V	<b>9,977</b>
Design Development	276	120V	1328
	968	277V	2,017.6
	2,512	480V	3,021.5
		Total Amps:	<b>6367 A</b>
Working Drawings			
Totals	18274.83	480Y/277V	14695.19

Table #4.4: Service Entrance Size: Summary Tables.

## ENVIRONMENTAL STEWARDSHIP DESIGN

The Millennium Science Complex is expected to achieve a LEED Gold certification. Electrically this is achieved through green power, daylighting, lighting control, and meeting prescriptive requirements of ASHRAE/IESNA 90.1-2004 lighting power densities. Green power is achieved through owner intent or already has entered into a contract for electricity from renewable sources. The daylighting system provides over 84% of all spaces with a daylight factor of 2% for 25fc at 30" above the floor. The building also complies with daylighting views, 90% of the regularly occupied spaces must have a direct line of sight to vision glazing. The building lighting control system provides individual controls for 90% of building occupants and comfort controls for all multi-occupant spaces.

## DESIGN ISSUES

### ELECTROMAGNETIC SHEILDING

With a rather intense slew of highly sophisticated and sensitive lab equipment, The Millennium Science Complex has a rather interesting issue to deal with, electromagnetic interference.

The Millennium Science Complex utilizes an AC ELF (extremely low frequency) magnetic shielding system to combat electromagnetic interference with sensitive lab equipment. Shielded electrical rooms maintain a low EMF (electromagnetic frequency) environment in the sensitive research areas of the basement, 1st and 2nd floor Material Science wings.

AC ELF EMI thresholds for screen jitter and noise are as follows:

- 10mG for 12-15 inch computer monitors and AV equipment.
- 5mG for 17-21 inch CRT monitors and medical equipment.
- 1mG for clean room environments.
- 0.3mG recommended for clean room environments.
- 0.1mG recommended for Quiet Labs and EM Laboratories.
- (IRPA/INIRC) - 833mG over 24 hours max for general public exposure.
- (NYS Public Service Commission) - 200mG at 1-meter on edge, or 50ft from 69kV poles.
- (ACGIH) - 1000mG for general public and workers with cardia pacemakers.
- (Swiss Bunderstat NCRP Draft Report) - 10mG from overhead/underground transmission/distribution lines, substations, etc.

Electrical room shielding consist of a highly conductive ¼" thick seam-welded aluminum plates installed on walls, floors and ceilings with a continuous gas metal arc weld. The clean room electrical room, N-P053, uses an additional layer of 1/8" low carbon steel near electrical equipment do to the rooms close proximity to the 1st floor clean room. Electrical rooms to be shielded are:

- N-P051/N-P052 (6-sides)
- N-P053 (6-sides)
- N-P238 (6-sides)
- W-P003/W-P002 (5-sides)
- W-P001 (4-sides)
- N-P129 (4-sides)
- N-P004 (4-sides)
- N-P152 (1-side)
- N-P258 (1-side)
- N-P347 (1-side)

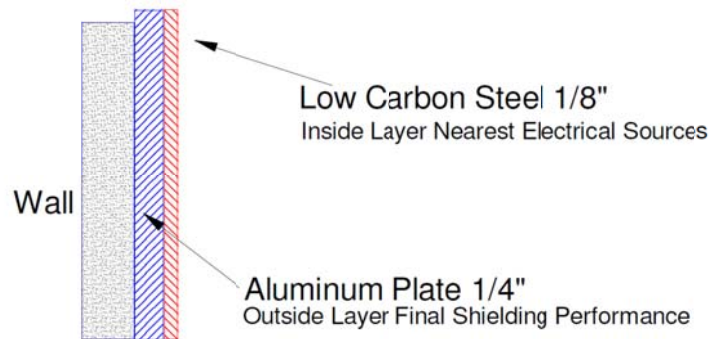


Figure #3.1: Dual substrate shielding in Room N-P053



Additional shielding will come from wall shields used behind 26 panels in the basement quiet labs, 21 panels on the first floor, 14 on the second floor, and 16 on the third floor. Roughly 20 UPS units located in service corridors throughout the building will require wall shielding as well. The majority of the Material Science wing requires use of RMT (rigid metal tubing) conduit as opposed to standard EMT (Electromagnetic tubing) conduit. RMT is a much thicker, denser conduit, limiting the EMF interference with nearby research equipment.

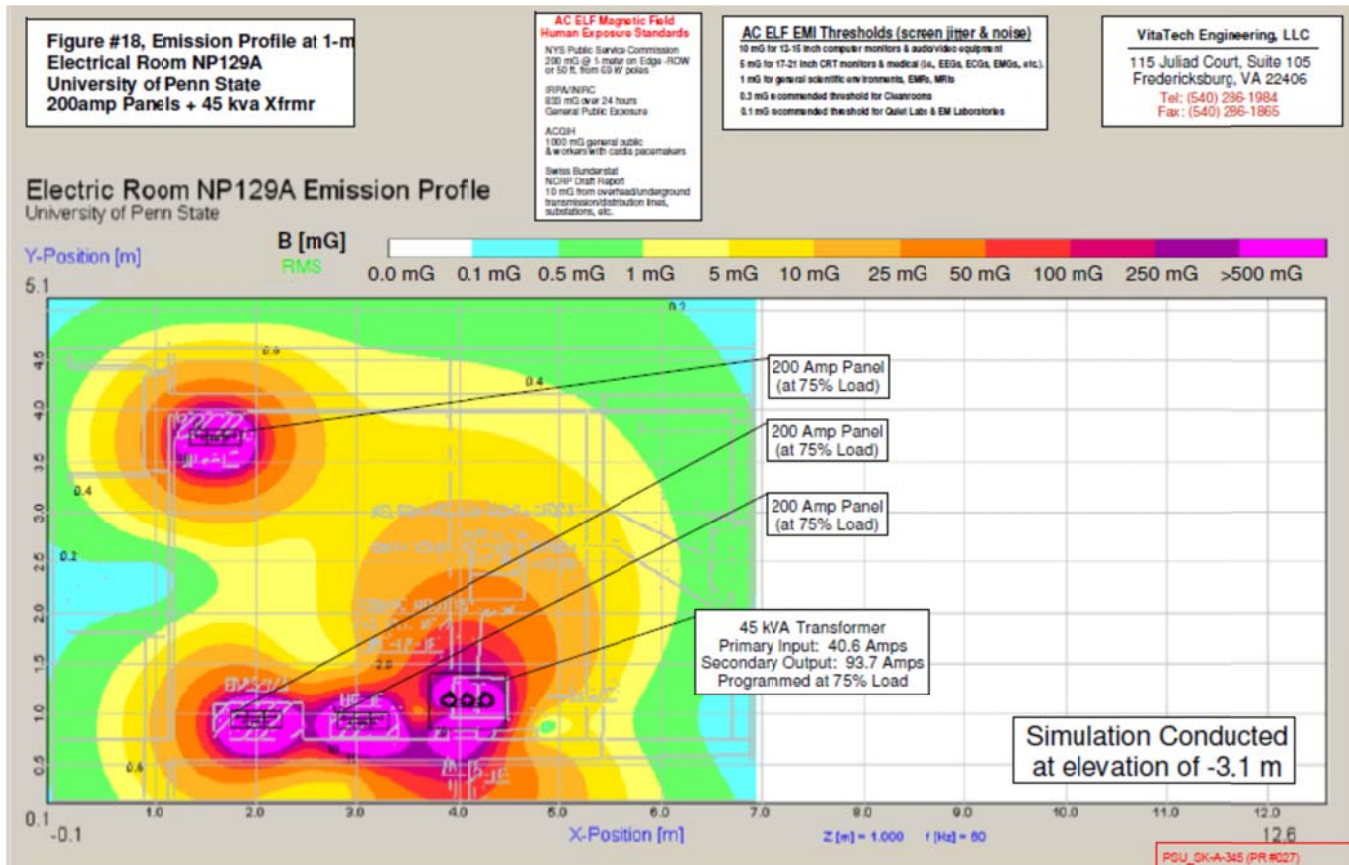


Figure # 3.2: Example of Vita-Tech’s EMF study. Example shown is of room N-P129.

### VIBRATION ISOLATION

Due to the sensitive nature of the nanotechnologies labs, vibration isolation is required for dry type transformers, UPS devices, dimmer racks, and electrical connections to rotating and vibrating equipment.

### VOLTAGE DROP

The length of the building from the Life Science Wing to the Material Science wing creates voltage drop issues. Many feeders leave MDS-01A/B in the basement of the Life Science wing, and travel to the second and third floors of the Material Science wing. These lengths can exceed well over 400’, some reaching upwards of 700’. Wire sizes have to be increased to compensate for voltage drop for many feeders.

## **SINGLE LINE DIAGRAMS**

See Appendix C.

## **COMMUNICATIONS SYSTEMS**

All telecommunications systems are fed from the Computer Building through existing campus manholes and enter the Millennium Science Complex in the Main Distribution Frame/Telecommunications Room N-T020. Transmission lines from the Computer Building include a 48-pair single-mode and a 24-pair single-mode fiber optic cable to terminate on two panels in the Millennium Science Complex's main distribution frame – one 72-port and one 48-port floor-mount rack. Also entering the MDF is a 200-pair outside plant copper cable. Telecommunication cables are distributed throughout the building via a central main distribution frame, a Life Science/Material Science server room, two Life Science Data Centers, and nine intermediate distribution frames – each supplying a different section of each floor.

Horizontal distribution cables are routed through basket-type cable trays located in the plenum space of main corridors of each wing. Main and intermediate distribution frames utilize ladder-type cable trays for internal distribution. Data Centers and the Server Room are connected to the MDF via two four inch conduits routed through main corridors between said rooms. Laboratory spaces utilize surface mounted raceway systems to distribute cabling throughout the rooms. Student study areas and other perimeter open spaces are either supplied by ceiling mounted or floor poke-through outlets.

Grounding for the telecommunications system ends at the telecommunications main grounding bus bar in the main distribution frame. Each intermediate distribution frame contains its own telecommunications grounding bus bar that feeds back to the main frame.

### **Television System:**

Each laboratory space contains two CATVP terminations, one on each side of the room, that are fed from their associated intermediate distribution frame. The surface mounted coaxial cable patch panel is located in each intermediate distribution frame and has a 96-port capacity. The horizontal distribution from main distribution frame to intermediate distribution frame is carried through one RG-11 coaxial cable.

### **Data System:**

Each distribution frame contains three or more 19"x84" telecommunications racks for relaying of data cables. These frames supply data to above ceiling wireless access points in corridors, floor poke-through terminals for study areas, furniture integrated terminations for laboratories, and wall mounted jacks for office spaces. Data distribution cables are of the category six variety, with the exception of category three being used from the main distribution frame to each intermediate distribution frame. Also carried between the main frame and each independent frame are one multimode and one single mode fiber optic cables. It is assumed that phone service will be provided through Ethernet communication.

**APPENDIX A: LIGHTING LOAD SCHEDULE & HID CUTSHEETS**

Luminaire Tag	Lamp Source	Lamp Type	Lamp Watts	Num. of Lamps	Ballast Type	Input Voltage (V)	Input Watts (W)	Ballast factor	Start/Op Current (A)	Power Factor Start/Op
AL-1	QUART	GX5.3 MR16	50W	1	NA	277	75	NA	0.27	1.00
DC-1	CFL	CFTR32	32W	1	RS Elec.	277	36	0.98	0.31	0.98
DC-1A	CFL	CFTR42	42W	1	RS Elec.	277	46	0.98	0.38	0.98
DC-2	CFL	CFTR32	32W	1	RS Elec.	277	36	0.98	0.31	0.98
DC-2A	CFL	CFTR32	32W	1	RS Elec.	277	36	0.98	0.31	0.98
DC-4	CFL	CFTR42	42W	1	RS Elec.	277	46	0.98	0.38	0.98
DC-4-d1	CFL	CFTR42	42W	1	PS Elec.	277	47	1.00	0.39	0.99
DC-5	CFL	CFTR42	42W	1	RS Elec.	277	46	0.98	0.38	0.98
DC-6	CFL	CFTR42	42W	1	RS Elec.	277	46	0.98	0.38	0.98
DC-6-d1	CFL	CFTR42	42W	1	PS Elec.	277	47	1.00	0.39	0.99
DF-1	FLUOR	F17/T8	17W	4	IS Elec.	277	58	0.90	0.49	0.99
DF-1A	FLUOR	F32/T8	32W	4	PS Elec.	277	121	0.88	0.45	0.99
DF-1A-d1	FLUOR	F32/T8	32W	4	PS Elec.	277	116	1.00	0.42	0.99
DF-1B	FLUOR	F32/T8	32W	3	PS Elec.	277	91	0.88	0.34	0.99
DF-1B-1	FLUOR	F32/T8	32W	2	IS Elec.	277	59	0.88	0.21	0.98
DF-5	FLUOR	F17/T8	32W	4	PS Elec.	277	121	0.88	0.45	0.99
DF-5-d2	FLUOR	F17/T8	17W	4	IS Elec.	277	76.3	1.00	0.28	0.95
DF-5A	FLUOR	F32/T8	32W	4	PS Elec.	277	116	1.00	0.42	0.99
DF-5A-d2	FLUOR	F32/T8	32W	4	PS Elec.	277	116	1.00	0.42	0.99
DF-5A-q	FLUOR	F32/T8	32W	4	PS Elec.	277	116	1.00	0.42	0.99
DF-5B	FLUOR	F32/T8	32W	3	PS Elec.	277	91	0.88	0.34	0.99
DF-8	FLUOR	F32/T8	32W	2	IS Elec.	277	59	0.88	0.21	0.98
DR-1	CFL	CFTR42	42W	1	RS Elec.	277	46	0.98	0.38	0.98
	CFL	CFT9	9W	1	IS Elec.	120	10	1.10	0.16	0.52
ES-1	LED	-	3.9W	-	-	277	3.9	NA	-	-
EL-5	QUART	GU-10 bipin	75W	2	NA	277	75	NA	0.54	1.00
NF-1	FLUOR	F32/T8	32W	2	IS Elec.	277	59	0.88	0.21	0.98
NF-1A-d1	FLUOR	F32/T8	32W	3	PS Elec.	277	91	1.00	0.34	0.99
NF-1A-1-d1	FLUOR	F32/T8	32W	2	PS Elec.	277	67	1.00	0.56	0.99
NF-1B	FLUOR	F32/T8	32W	2	IS Elec.	277	59	0.88	0.21	0.98
NF-1B-d1	FLUOR	F32/T8	32W	2	PS Elec.	277	67	1.00	0.56	0.99
NF-3A	FLUOR	F32/T8	32W	2	PS Elec.	277	67	1.00	0.56	0.99
NF-4	FLUOR	F32/T8	32W	2	IS Elec.	277	59	0.88	0.21	0.98
NF-5	FLUOR	F32/T8	32W	2	IS Elec.	277	59	0.88	0.21	0.98
NF-7	FLUOR	F32/T8	32W	1	IS Elec.	277	29.5	0.88	0.1	0.98
NF-10	FLUOR	F32/T8	32W	2	IS Elec.	277	59	0.88	0.21	0.98
PC-1	CFL	CFTR32	32W	1	RS Elec.	277	36	0.98	0.31	0.98
SC-2	CFL	CFQ18	18W	1	RS Elec.	277	20	1.05	0.17	0.99
SL-1	FLUOR	F32/T8	32W	2	IS Elec.	277	59	0.88	0.21	0.98
WC-1	CFL	CFTR32	32W	1	RS Elec.	277	36	0.98	0.31	0.98
YP-1	INCAN	75W PAR30	75W	1	NA	277	75	NA	0.27	1.00
SDF-1	FLUOR	F17/T8	17W	4	IS Elec.	277	58	0.90	0.49	0.99
SDF-1A	FLUOR	F32/T8	32W	4	PS Elec.	277	121	0.88	0.45	0.99
SDF-1A-d2	FLUOR	F32/T8	32W	4	PS Elec.	277	116	1.00	0.42	0.99

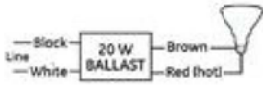
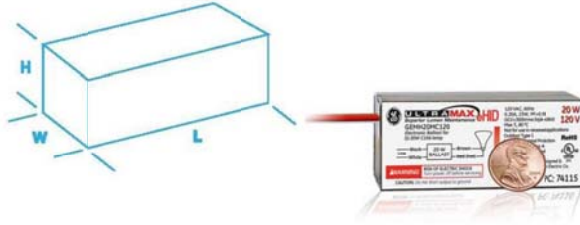
Luminaire Tag	Lamp Source	Lamp Type	Lamp Watts	Num. of Lamps	Ballast Type	Input Voltage (V)	Input Watts (W)	Ballast Factor	Start/Op Current (A)	Power Factor Start/Op
SDF-1B	FLUOR	F32/T8	32W	3	PS Elec.	277	121	0.88	0.45	0.99
	FLUOR	F32/T8/R	32W	1						
SDF-2	QUART	75W TUNGSTEN HALLOGEN	75W	1	NA	277	75	NA	0.27	1.00
SDF-3	FLUOR	F32/T8	32W	3	PS Elec.	277	91	0.88	0.34	0.99
SDF-3A	FLUOR	F32/T8	32W	2	IS Elec.	277	59	0.88	0.21	0.98
SDF-4	FLUOR	F17/T8	17W	4	IS Elec.	277	58	0.90	0.49	0.99
SDF-4A	FLUOR	F32/T8	32W	4	PS Elec.	277	121	0.88	0.45	0.99
SDF-4A-1	FLUOR	F32/T8	32W	3	PS Elec.	277	96	1.00	0.35	0.99
SDF-4A-d2	FLUOR	F32/T8	32W	4	PS Elec.	277	116	1.00	0.42	0.99
SDF-4B	FLUOR	F32/T8	32W	3	PS Elec.	277	91	0.88	0.34	0.99
SDF-4B-1	FLUOR	F32/T8	32W	2	IS Elec.	277	59	0.88	0.59	0.98
SDF-4B-d2	FLUOR	F32/T8	32W	3	PS Elec.	277	96	1.00	0.35	0.99
SDF-5	FLUOR	F32/T8	32W	4	PS Elec.	277	121	0.88	0.45	0.99
SDF-6	CFL	CFTR26	26W	2	RS Elec.	277	54	1.00	0.45	0.98
SDF-7	INCAN	Globe	100W	1	NA	277	100	NA	0.36	1.00
XAM-1	MH	PAR30M	70W	1	Elec.	277	85	1.00	0.50/0.32	0.90
XAM-1A	MH	PAR30M	70W	1	Elec.	277	85	1.00	0.50/0.32	0.90
	INCAN	-	60W	1	NA	277	60	NA	0.22	1.00
XAM-2	MH	PAR30N	70W	1	Elec.	277	85	1.00	0.50/0.32	0.90
XAM-2A	MH	PAR30N	70W	1	Elec.	277	85	1.00	0.50/0.32	0.90
	INCAN	-	60W	1	NA	277	60	NA	0.22	1.00
XBO-1	MH	T4.5 bipin G8.5	20W	1	LF Elec.	120	23	1.00	0.2	0.99
XDM-1	MH	T-6	39W	1	Elec.	277	48	1.00	0.30/0.19	0.90
XDM-1A	MH	T-6	39W	1	Elec.	277	48	1.00	0.30/0.19	0.90
	INCAN	-	60W	1	NA	277	60	NA	0.22	1.00
XDM-3	MH	PAR30FL	70W	1	Elec.	277	85	1.00	0.50/0.32	0.90
XLE-1	LED	-	14.8W	-	-	277	14.8	-	0.05	-
XPO-1	MH	ED-17	100W	1	Elec.	277	118	1.00	0.70/0.45	0.90
XSC-1	CFL	CFTR32	32w	1	HF Elec.	277	33W	0.98	0.12	-
XSC-2	LED	-	45W	-	-	277	45	-	0.16	-
XST-1	LED	-	10.2W	-	-	277	10.2	-	0.04	-
XWM-1	MH	PAR20	35W	1	Elec.	277	48	1.00	0.30/0.19	0.90



**74115 - GEMH20-MC-120**

GE HID UltraMax™ eHID Electronic Low Frequency Ballast

- Light-weight, Low Profile Housing
- Superior low frequency square wave frequency design maximizes performance and life of ceramic metal halide lamps.
- Ultra slim car size for fixture design flexibility



**GENERAL CHARACTERISTICS**

Application	1- 20W M156 120V Micro Electronic HID
Category	High Intensity Discharge
Ballast Type	Electronic - Low Frequency
Starting Method	n/a
Line Voltage Regulation (+/-)	10 %
Ambient Temperature (MAX)	55 °C(13 °C)
Case Temperature	80 °C(176 °F)
Ballast Factor	Normal-High (1.0)
Power Factor Correction	Active
Circuit Type	Electronic
Sound Rating	A (20-24 decibels)
Enclosure Type	Plastic
Distance to Lamp	8 ft
Additional Info	End of Life Protection (EOL)
Primary Application	Indoor Floodlight

**PRODUCT INFORMATION**

Product Code	74115
Description	GEMH20-MC-120
Standard Package	Case
Standard Package GTIN	10043168741153
Standard Package Quantity	10
Sales Unit	Case
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	10
UPC	043168741156

**DIMENSIONS**

Case dimensions			
Length (L)	3.0 in(75.95 mm)		
Width (W)	1.3 in(33.02 mm)		
Height (H)	1.1 in(27.94 mm)		
Mounting dimensions			
Weight	0.38 lb		
Exit Type	Side		
Remote Mounting Distance to Lamp	8 ft		
Remote Mounting Wire Gauge	18 AWG		
Lead lengths	Qty	Exit	Length (± 1 in.)
Red	1	Left	6.0 (152mm)
White	1	Left	6.0 (152mm)
Brown	1	Left	6.0 (152mm)
Black	1	Left	6.0 (152mm)

**ELECTRICAL CHARACTERISTICS**

Lamp Operating Frequency	133 Hz
Supply Current Frequency	60 Hz/50 Hz/50 Hz

**SAFETY & PERFORMANCE**

- cUL Listed
- UL Listed
- RoHS Compliant
- UL 1029 Listed
- FCC Part 18 (Class A) for EMI and RFI Non-Consumer Limits
- ANSI - C82.14-2008
- UL94V0 Flame Retardant
- Short Circuit Protection
- Inherent Thermal Protection

**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
M156	120	23.0	0.2A	1	0.87			4000V	96V	0.99	0.0°F	1   1/2	

**CAUTIONS & WARNINGS**


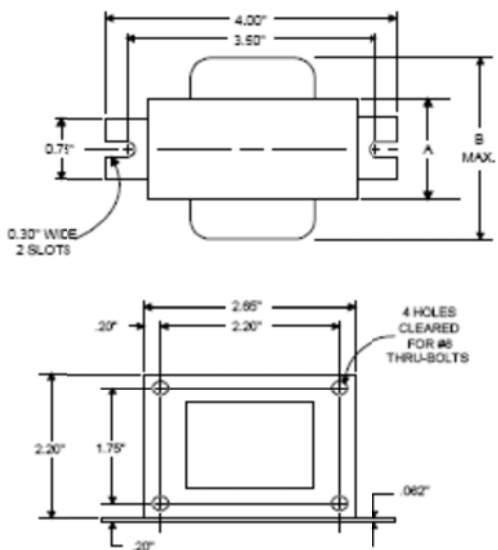

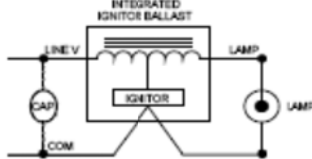
- **Caution**
- - Do not connect Brown or Red wires to ground
- - Not designed for recessed applications.

**NOTES**

- Not designed for recessed applications.
  - 150C rated lead wires
  - Short Circuit Protection
- For additional information, visit [www.gelighting.com](http://www.gelighting.com)

Figure A.1: Ballast for fixture XBO-1



	<b>Metal Halide Lamp Ballast</b>	<b>Catalog Number 71A5037BP</b> <b>For 35/39W M130</b> <b>60 Hz R-HPF</b> <b>Status: Active</b>																																																																																																																																																																																																																		
<b>DIMENSIONS AND DATA</b>																																																																																																																																																																																																																				
<p style="text-align: center;">2 5/8 X 2 3/16 CORE</p> 	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>INPUT VOLTS</td> <td style="text-align: right;">277</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CIRCUIT TYPE</td> <td style="text-align: right;">R-HPF</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>POWER FACTOR (min)</td> <td style="text-align: right;">90%</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>REGULATION</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Line Volts</td> <td style="text-align: right;">±5%</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Lamp Watts</td> <td style="text-align: right;">±10%</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>LINE CURRENT (Amps)</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Operating.....</td> <td style="text-align: right;">0.19</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Open Circuit.....</td> <td style="text-align: right;">0.52</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Starting.....</td> <td style="text-align: right;">0.30</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>UL TEMPERATURE RATINGS</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Insulation Class</td> <td style="text-align: right;">H(180°C)</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Coil Temperature Code</td> <td style="text-align: right;">1029</td> <td style="text-align: right;">A</td> <td></td> <td></td> <td></td> </tr> <tr> <td>MIN. AMBIENT STARTING TEMP.</td> <td style="text-align: right;">-20°F or -30°C</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>NOM. OPEN CIRCUIT VOLTAGE</td> <td style="text-align: right;">277</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>INPUT VOLTAGE AT LAMP DROPOUT.....</td> <td style="text-align: right;">190</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>INPUT WATTS</td> <td style="text-align: right;">48</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>RECOMMENDED FUSE (Amps).....</td> <td style="text-align: right;">2</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CORE and COIL</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Dimension (A)</td> <td style="text-align: right;">0.95</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Dimension (B)</td> <td style="text-align: right;">2.70</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Weight (lbs.)</td> <td style="text-align: right;">1.9</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Lead Lengths</td> <td style="text-align: right;">12"</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CAPACITOR REQUIREMENT</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Microfarads</td> <td style="text-align: right;">5.0</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Volts (min.)</td> <td style="text-align: right;">280</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Fault Current Withstand (amps)</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>60 Hz TEST PROCEDURES (Refer to Philips Lighting Electronics N.A. TEST Procedure for HID Ballasts - Form 127)</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  High Potential Test (Volts)</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>    1 minute</td> <td style="text-align: right;">2000</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>    2 seconds</td> <td style="text-align: right;">2500</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Open Circuit Voltage Test (Volts)</td> <td style="text-align: right;">260-290</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Short-Circuit Current Test (Amps)</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>    Secondary Current</td> <td style="text-align: right;">0.50-0.80</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>    Input Current.....</td> <td style="text-align: right;">0.10-0.16</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>		INPUT VOLTS	277					CIRCUIT TYPE	R-HPF					POWER FACTOR (min)	90%					REGULATION						Line Volts	±5%					Lamp Watts	±10%					LINE CURRENT (Amps)						Operating.....	0.19					Open Circuit.....	0.52					Starting.....	0.30					UL TEMPERATURE RATINGS						Insulation Class	H(180°C)					Coil Temperature Code	1029	A				MIN. AMBIENT STARTING TEMP.	-20°F or -30°C					NOM. OPEN CIRCUIT VOLTAGE	277					INPUT VOLTAGE AT LAMP DROPOUT.....	190					INPUT WATTS	48					RECOMMENDED FUSE (Amps).....	2					CORE and COIL						Dimension (A)	0.95					Dimension (B)	2.70					Weight (lbs.)	1.9					Lead Lengths	12"					CAPACITOR REQUIREMENT						Microfarads	5.0					Volts (min.)	280					Fault Current Withstand (amps)						60 Hz TEST PROCEDURES (Refer to Philips Lighting Electronics N.A. TEST Procedure for HID Ballasts - Form 127)						High Potential Test (Volts)						1 minute	2000					2 seconds	2500					Open Circuit Voltage Test (Volts)	260-290					Short-Circuit Current Test (Amps)						Secondary Current	0.50-0.80					Input Current.....	0.10-0.16				
INPUT VOLTS	277																																																																																																																																																																																																																			
CIRCUIT TYPE	R-HPF																																																																																																																																																																																																																			
POWER FACTOR (min)	90%																																																																																																																																																																																																																			
REGULATION																																																																																																																																																																																																																				
Line Volts	±5%																																																																																																																																																																																																																			
Lamp Watts	±10%																																																																																																																																																																																																																			
LINE CURRENT (Amps)																																																																																																																																																																																																																				
Operating.....	0.19																																																																																																																																																																																																																			
Open Circuit.....	0.52																																																																																																																																																																																																																			
Starting.....	0.30																																																																																																																																																																																																																			
UL TEMPERATURE RATINGS																																																																																																																																																																																																																				
Insulation Class	H(180°C)																																																																																																																																																																																																																			
Coil Temperature Code	1029	A																																																																																																																																																																																																																		
MIN. AMBIENT STARTING TEMP.	-20°F or -30°C																																																																																																																																																																																																																			
NOM. OPEN CIRCUIT VOLTAGE	277																																																																																																																																																																																																																			
INPUT VOLTAGE AT LAMP DROPOUT.....	190																																																																																																																																																																																																																			
INPUT WATTS	48																																																																																																																																																																																																																			
RECOMMENDED FUSE (Amps).....	2																																																																																																																																																																																																																			
CORE and COIL																																																																																																																																																																																																																				
Dimension (A)	0.95																																																																																																																																																																																																																			
Dimension (B)	2.70																																																																																																																																																																																																																			
Weight (lbs.)	1.9																																																																																																																																																																																																																			
Lead Lengths	12"																																																																																																																																																																																																																			
CAPACITOR REQUIREMENT																																																																																																																																																																																																																				
Microfarads	5.0																																																																																																																																																																																																																			
Volts (min.)	280																																																																																																																																																																																																																			
Fault Current Withstand (amps)																																																																																																																																																																																																																				
60 Hz TEST PROCEDURES (Refer to Philips Lighting Electronics N.A. TEST Procedure for HID Ballasts - Form 127)																																																																																																																																																																																																																				
High Potential Test (Volts)																																																																																																																																																																																																																				
1 minute	2000																																																																																																																																																																																																																			
2 seconds	2500																																																																																																																																																																																																																			
Open Circuit Voltage Test (Volts)	260-290																																																																																																																																																																																																																			
Short-Circuit Current Test (Amps)																																																																																																																																																																																																																				
Secondary Current	0.50-0.80																																																																																																																																																																																																																			
Input Current.....	0.10-0.16																																																																																																																																																																																																																			
<p>Capacitor: 7C050L30RA</p>  <p>Capacitance: 5 Dial/Oval Dim: 1.25 Height: 2.25 Temp Rating: 105°C</p>	<p style="text-align: center;">Wiring Diagram:</p>  <p style="text-align: center;">Fig. H</p>																																																																																																																																																																																																																			
<p>Ignitor: INTEGRAL</p> <p>An ignitor integral to the core and coil assembly is used to start the lamp.</p> <p>Ballast to Lamp Distance (BTL) = 2 feet Temp Rating: 125°C</p>	<p style="text-align: center;"><b>Typical Ordering Information</b></p> <p style="text-align: center;">(please call Philips Lighting Electronics N.A. for suffix availability)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 50%;">Order Suffix</th> <th style="width: 50%;">Description</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> </tr> </tbody> </table>		Order Suffix	Description																																																																																																																																																																																																																
Order Suffix	Description																																																																																																																																																																																																																			
<p>Data is based upon tests performed by Philips Lighting Electronics N.A. in a controlled environment and is representative of relative performance. Actual performance can vary depending on operating conditions. Specifications are subject to change without notice.</p>																																																																																																																																																																																																																				


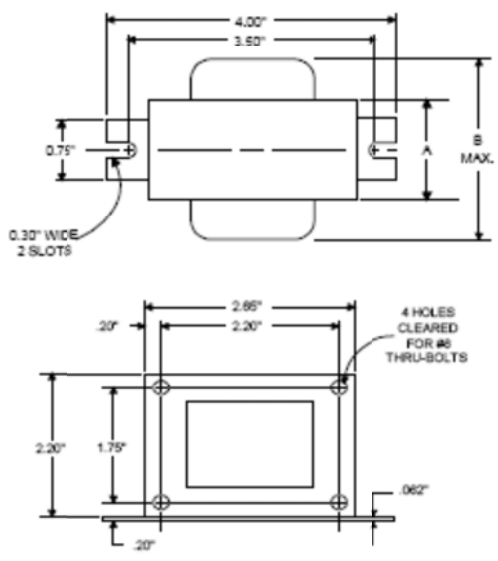

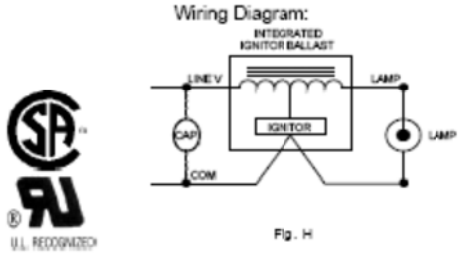
**PHILIPS LIGHTING ELECTRONICS N.A.**

10275 WEST HIGGINS ROAD · ROSEMONT, IL 60018  
 Tel: 800-322-2086 · Fax: 888-423-1882 · www.philips.com/advance  
 Customer Support/Technical Service: 800-372-3331 · OEM Support: 888-915-5886

Revised: 07/31/06

Figure A.2: Ballast for fixtures XDM-1 XDM-1A, and XWM-1




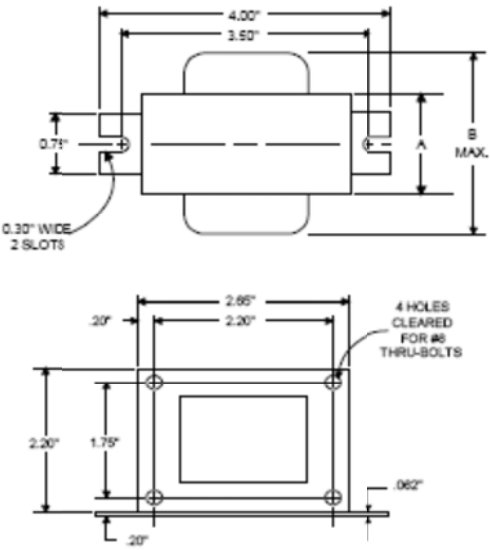

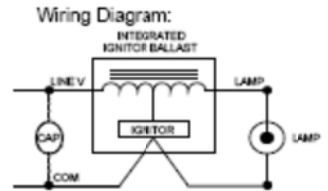
	<b>Metal Halide Lamp Ballast</b>	<b>Catalog Number 71A5237BP</b> <b>For 70W M98/M143</b> <b>60 Hz R-HPF</b> <b>Status: Active</b>																																																																																																																																																																																																																			
<b>DIMENSIONS AND DATA</b>																																																																																																																																																																																																																					
<p style="text-align: center;">2 5/8 X 2 3/16 CORE</p> 	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>INPUT VOLTS</td> <td style="text-align: right;">277</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CIRCUIT TYPE</td> <td style="text-align: right;">R-HPF</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>POWER FACTOR (min)</td> <td style="text-align: right;">90%</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>REGULATION</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Line Volts</td> <td style="text-align: right;">±5%</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Lamp Watts</td> <td style="text-align: right;">±10%</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>LINE CURRENT (Amps)</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Operating</td> <td style="text-align: right;">0.32</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Open Circuit</td> <td style="text-align: right;">0.80</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Starting</td> <td style="text-align: right;">0.50</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>UL TEMPERATURE RATINGS</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Insulation Class</td> <td style="text-align: right;">H(180°C)</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Coil Temperature Code</td> <td style="text-align: right;">1029</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>MIN. AMBIENT STARTING TEMP.</td> <td style="text-align: right;">-20°F or -30°C</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>NOM. OPEN CIRCUIT VOLTAGE</td> <td style="text-align: right;">277</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>INPUT VOLTAGE AT LAMP DROPOUT</td> <td style="text-align: right;">190</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>INPUT WATTS</td> <td style="text-align: right;">85</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>RECOMMENDED FUSE (Amps)</td> <td style="text-align: right;">2</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CORE and COIL</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Dimension (A)</td> <td style="text-align: right;">1.50</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Dimension (B)</td> <td style="text-align: right;">2.90</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Weight (lbs.)</td> <td style="text-align: right;">2.9</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Lead Lengths</td> <td style="text-align: right;">12"</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CAPACITOR REQUIREMENT</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Microfarads</td> <td style="text-align: right;">8.0</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Volts (min.)</td> <td style="text-align: right;">280</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Fault Current Withstand (amps)</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>60 Hz TEST PROCEDURES (Refer to Philips Lighting Electronics N.A. TEST Procedure for HID Ballasts - Form 127)</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  High Potential Test (Volts)</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>    1 minute</td> <td style="text-align: right;">2000</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>    2 seconds</td> <td style="text-align: right;">2500</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Open Circuit Voltage Test (Volts)</td> <td style="text-align: right;">260-290</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>  Short-Circuit Current Test (Amps)</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>    Secondary Current</td> <td style="text-align: right;">0.85-1.25</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>    Input Current</td> <td style="text-align: right;">0.20-0.45</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>	INPUT VOLTS	277					CIRCUIT TYPE	R-HPF					POWER FACTOR (min)	90%					REGULATION						Line Volts	±5%					Lamp Watts	±10%					LINE CURRENT (Amps)						Operating	0.32					Open Circuit	0.80					Starting	0.50					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	277					INPUT VOLTAGE AT LAMP DROPOUT	190					INPUT WATTS	85					RECOMMENDED FUSE (Amps)	2					CORE and COIL						Dimension (A)	1.50					Dimension (B)	2.90					Weight (lbs.)	2.9					Lead Lengths	12"					CAPACITOR REQUIREMENT						Microfarads	8.0					Volts (min.)	280					Fault Current Withstand (amps)						60 Hz TEST PROCEDURES (Refer to Philips Lighting Electronics N.A. TEST Procedure for HID Ballasts - Form 127)						High Potential Test (Volts)						1 minute	2000					2 seconds	2500					Open Circuit Voltage Test (Volts)	260-290					Short-Circuit Current Test (Amps)						Secondary Current	0.85-1.25					Input Current	0.20-0.45					<p>Capacitor: 7C080L30RA</p>  <p>Capacitance: 8 Dia/Oval Dim: 1.25 Height: 2.75 Temp Rating: 105°C</p>	<p style="text-align: center;">Wiring Diagram: INTEGRATED IGNITOR BALLAST</p>  <p style="text-align: center;">Fig. H</p>
INPUT VOLTS	277																																																																																																																																																																																																																				
CIRCUIT TYPE	R-HPF																																																																																																																																																																																																																				
POWER FACTOR (min)	90%																																																																																																																																																																																																																				
REGULATION																																																																																																																																																																																																																					
Line Volts	±5%																																																																																																																																																																																																																				
Lamp Watts	±10%																																																																																																																																																																																																																				
LINE CURRENT (Amps)																																																																																																																																																																																																																					
Operating	0.32																																																																																																																																																																																																																				
Open Circuit	0.80																																																																																																																																																																																																																				
Starting	0.50																																																																																																																																																																																																																				
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	277																																																																																																																																																																																																																				
INPUT VOLTAGE AT LAMP DROPOUT	190																																																																																																																																																																																																																				
INPUT WATTS	85																																																																																																																																																																																																																				
RECOMMENDED FUSE (Amps)	2																																																																																																																																																																																																																				
CORE and COIL																																																																																																																																																																																																																					
Dimension (A)	1.50																																																																																																																																																																																																																				
Dimension (B)	2.90																																																																																																																																																																																																																				
Weight (lbs.)	2.9																																																																																																																																																																																																																				
Lead Lengths	12"																																																																																																																																																																																																																				
CAPACITOR REQUIREMENT																																																																																																																																																																																																																					
Microfarads	8.0																																																																																																																																																																																																																				
Volts (min.)	280																																																																																																																																																																																																																				
Fault Current Withstand (amps)																																																																																																																																																																																																																					
60 Hz TEST PROCEDURES (Refer to Philips Lighting Electronics N.A. TEST Procedure for HID Ballasts - Form 127)																																																																																																																																																																																																																					
High Potential Test (Volts)																																																																																																																																																																																																																					
1 minute	2000																																																																																																																																																																																																																				
2 seconds	2500																																																																																																																																																																																																																				
Open Circuit Voltage Test (Volts)	260-290																																																																																																																																																																																																																				
Short-Circuit Current Test (Amps)																																																																																																																																																																																																																					
Secondary Current	0.85-1.25																																																																																																																																																																																																																				
Input Current	0.20-0.45																																																																																																																																																																																																																				
<b>Typical Ordering Information</b> (please call Philips Lighting Electronics N.A. for suffix availability)																																																																																																																																																																																																																					
<b>Ignitor: INTEGRAL</b>	<b>Order Suffix</b>	<b>Description</b>																																																																																																																																																																																																																			
<p>An ignitor integral to the core and coil assembly is used to start the lamp.</p> <p>Ballast to Lamp Distance (BTL) = 2 feet Temp Rating: 125°C</p>																																																																																																																																																																																																																					
Data is based upon tests performed by Philips Lighting Electronics N.A. in a controlled environment and is representative of relative performance. Actual performance can vary depending on operating conditions. Specifications are subject to change without notice.																																																																																																																																																																																																																					

**PHILIPS LIGHTING ELECTRONICS N.A.**

10275 WEST HIGGINS ROAD · ROSEMONT, IL 60018  
 Tel: 800-322-2086 · Fax: 888-423-1882 · www.philips.com/advance  
 Customer Support/Technical Service: 800-372-3331 · OEM Support: 888-915-6886

Revised: 07/31/09

Figure A.3: Ballast for fixtures XAM-1, XAM-1A, XAM-2, XAM-2A, and XDM-3

	<b>Metal Halide Lamp Ballast</b>	<b>Catalog Number 71A5337BP</b> <b>For 100W M90/M140</b> <b>60 Hz R-HPF</b> <b>Status: Active</b>																																																																																																																																																																																																																		
<b>DIMENSIONS AND DATA</b>																																																																																																																																																																																																																				
<p style="text-align: center;">2 5/8 X 2 3/16 CORE</p> 	<table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td>INPUT VOLTS</td> <td style="text-align: right;">277</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CIRCUIT TYPE</td> <td style="text-align: right;">R-HPF</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>POWER FACTOR (min)</td> <td style="text-align: right;">90%</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>REGULATION</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Line Volts</td> <td style="text-align: right;">±5%</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Lamp Watts</td> <td style="text-align: right;">±10%</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>LINE CURRENT (Amps)</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Operating</td> <td style="text-align: right;">0.45</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Open Circuit</td> <td style="text-align: right;">1.05</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Starting</td> <td style="text-align: right;">0.70</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>UL TEMPERATURE RATINGS</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Insulation Class</td> <td style="text-align: right;">H(180°C)</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Coil Temperature Code</td> <td style="text-align: right;">1029</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>MIN. AMBIENT STARTING TEMP.</td> <td style="text-align: right;">-20°F or -30°C</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>NOM. OPEN CIRCUIT VOLTAGE</td> <td style="text-align: right;">277</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>INPUT VOLTAGE AT LAMP DROPOUT</td> <td style="text-align: right;">190</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>INPUT WATTS</td> <td style="text-align: right;">118</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>RECOMMENDED FUSE (Amps)</td> <td style="text-align: right;">3</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CORE and COIL</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Dimension (A)</td> <td style="text-align: right;">1.80</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Dimension (B)</td> <td style="text-align: right;">3.10</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Weight (lbs.)</td> <td style="text-align: right;">3.2</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Lead Lengths</td> <td style="text-align: right;">12"</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>CAPACITOR REQUIREMENT</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Microfarads</td> <td style="text-align: right;">10.0</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Volts (min.)</td> <td style="text-align: right;">280</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Fault Current Withstand (amps)</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>60 Hz TEST PROCEDURES (Refer to Philips Lighting Electronics N.A. TEST Procedure for HID Ballasts - Form 127)</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>High Potential Test (Volts)</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>1 minute</td> <td style="text-align: right;">2000</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>2 seconds</td> <td style="text-align: right;">2500</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Open Circuit Voltage Test (Volts)</td> <td style="text-align: right;">260-290</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Short-Circuit Current Test (Amps)</td> <td></td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Secondary Current</td> <td style="text-align: right;">1.05-1.55</td> <td></td> <td></td> <td></td> <td></td> </tr> <tr> <td>Input Current</td> <td style="text-align: right;">0.25-0.35</td> <td></td> <td></td> <td></td> <td></td> </tr> </table>		INPUT VOLTS	277					CIRCUIT TYPE	R-HPF					POWER FACTOR (min)	90%					REGULATION						Line Volts	±5%					Lamp Watts	±10%					LINE CURRENT (Amps)						Operating	0.45					Open Circuit	1.05					Starting	0.70					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	277					INPUT VOLTAGE AT LAMP DROPOUT	190					INPUT WATTS	118					RECOMMENDED FUSE (Amps)	3					CORE and COIL						Dimension (A)	1.80					Dimension (B)	3.10					Weight (lbs.)	3.2					Lead Lengths	12"					CAPACITOR REQUIREMENT						Microfarads	10.0					Volts (min.)	280					Fault Current Withstand (amps)						60 Hz TEST PROCEDURES (Refer to Philips Lighting Electronics N.A. TEST Procedure for HID Ballasts - Form 127)						High Potential Test (Volts)						1 minute	2000					2 seconds	2500					Open Circuit Voltage Test (Volts)	260-290					Short-Circuit Current Test (Amps)						Secondary Current	1.05-1.55					Input Current	0.25-0.35				
INPUT VOLTS	277																																																																																																																																																																																																																			
CIRCUIT TYPE	R-HPF																																																																																																																																																																																																																			
POWER FACTOR (min)	90%																																																																																																																																																																																																																			
REGULATION																																																																																																																																																																																																																				
Line Volts	±5%																																																																																																																																																																																																																			
Lamp Watts	±10%																																																																																																																																																																																																																			
LINE CURRENT (Amps)																																																																																																																																																																																																																				
Operating	0.45																																																																																																																																																																																																																			
Open Circuit	1.05																																																																																																																																																																																																																			
Starting	0.70																																																																																																																																																																																																																			
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	277																																																																																																																																																																																																																			
INPUT VOLTAGE AT LAMP DROPOUT	190																																																																																																																																																																																																																			
INPUT WATTS	118																																																																																																																																																																																																																			
RECOMMENDED FUSE (Amps)	3																																																																																																																																																																																																																			
CORE and COIL																																																																																																																																																																																																																				
Dimension (A)	1.80																																																																																																																																																																																																																			
Dimension (B)	3.10																																																																																																																																																																																																																			
Weight (lbs.)	3.2																																																																																																																																																																																																																			
Lead Lengths	12"																																																																																																																																																																																																																			
CAPACITOR REQUIREMENT																																																																																																																																																																																																																				
Microfarads	10.0																																																																																																																																																																																																																			
Volts (min.)	280																																																																																																																																																																																																																			
Fault Current Withstand (amps)																																																																																																																																																																																																																				
60 Hz TEST PROCEDURES (Refer to Philips Lighting Electronics N.A. TEST Procedure for HID Ballasts - Form 127)																																																																																																																																																																																																																				
High Potential Test (Volts)																																																																																																																																																																																																																				
1 minute	2000																																																																																																																																																																																																																			
2 seconds	2500																																																																																																																																																																																																																			
Open Circuit Voltage Test (Volts)	260-290																																																																																																																																																																																																																			
Short-Circuit Current Test (Amps)																																																																																																																																																																																																																				
Secondary Current	1.05-1.55																																																																																																																																																																																																																			
Input Current	0.25-0.35																																																																																																																																																																																																																			
<p>Capacitor: 7C100M30RA</p>  <p>Capacitance: 10 Dia/Oval Dim: 1.65 Height: 2.75 Temp Rating: 105°C</p>	<p style="text-align: center;">Wiring Diagram:</p>  <p style="text-align: center;">Fig. H</p>																																																																																																																																																																																																																			
<p>Ignitor: INTEGRAL</p> <p>An ignitor integral to the core and coil assembly is used to start the lamp.</p> <p>Ballast to Lamp Distance (BTL) = 2 feet Temp Rating: 125°C</p>	<p style="text-align: center;"><b>Typical Ordering Information</b></p> <p style="text-align: center;">(please call Philips Lighting Electronics N.A. for suffix availability)</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 30%;">Order Suffix</th> <th>Description</th> </tr> </thead> <tbody> <tr> <td> </td> <td> </td> </tr> </tbody> </table>		Order Suffix	Description																																																																																																																																																																																																																
Order Suffix	Description																																																																																																																																																																																																																			
Data is based upon tests performed by Philips Lighting Electronics N.A. in a controlled environment and is representative of relative performance. Actual performance can vary depending on operating conditions. Specifications are subject to change without notice.																																																																																																																																																																																																																				

**PHILIPS LIGHTING ELECTRONICS N.A.**

10275 WEST HIGGINS ROAD · ROSEMONT, IL 60018  
 Tel: 800-322-2086 · Fax: 888-423-1882 · www.philips.com/advance  
 Customer Support/Technical Service: 800-372-3331 · OEM Support: 888-915-5886

Revised: 07/31/09

Figure A.4: Ballast for fixture XPO-1

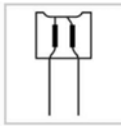
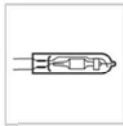


GE  
Lighting

**92696 - CMH20TC/U830G8.5**

GE ConstantColor® PulseArc® CMH® Ceramic Metal Halide T4.5

a product of  
**ecomagination**



**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.
- Do not use excessive force when installing lamp.
- Do not use lamp if outer glass is scratched or broken.

**Warning**

- 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.
- 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 Fire
  - Keep combustible materials away from lamp.
  - Use fused or thermally protected ballast - see instructions.
  - 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.
  - Operate lamp only in specified position.
  - Use in enclosed fixture rated for this product.
  - Use only properly rated ballast.

**GENERAL CHARACTERISTICS**

Lamp Type	High Intensity Discharge - Ceramic Metal Halide
Bulb	T4.5
Base	Bi-Pin (G8.5)
Wattage	20
Rated Life	12000 hrs
Bulb Material	Quartz
Lamp Enclosure Type (LET)	Enclosed fixtures only
LEED-EB MR Credit	184 picograms Hg per mean lumen hour
Additional Info	UV control

**PHOTOMETRIC CHARACTERISTICS**

Initial Lumens	1650
Mean Lumens	1090
Nominal Initial Lumens per Watt	82
Color Temperature	3000 K
Color Rendering Index (CRI)	81

**ELECTRICAL CHARACTERISTICS**

Burn Position	Universal burning position
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)	3.37 cm
Bulb Diameter (DIA)	0.563 cm
Bulb Diameter (DIA) (MAX)	0.563 cm
Light Center Length (LCL)	2 cm

**PRODUCT INFORMATION**

Product Code	92696
Description	CMH20TC/U830G8.5
ANSI Code	C156/M156
Standard Package	Case
Standard Package GTIN	10043168926963
Standard Package Quantity	12
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	12
UPC	043168926966

Figure A.5: lamp for fixture XBO-1

Philips MasterColor® Ceramic Metal Halide 3000K Tubular Single-Ended T6 Lamps

Ordering Data

Product Number	Ordering Code	Pkg. Qty.	Nom. Watt.	ANSI Ballast Code	Approx. Initial Lumens <sup>1</sup>	Approx. Mean Lumens <sup>2</sup>	CRI
12328-9	CDM35/T6/830	12	39	M130/E	3300	2600	81
12337-0	CDM70/T6/830	12	70	M139/E	6600	4950	81
12272-8	CDM150/T6/830	12	150	M142, M102/E	14,000	9800	85

Electrical and Technical Data

Lamp Operating Volt. (rms)(Nom.)<sup>3</sup> —88 (39W/70W)  
 —96 (150W)  
 Initial Lamp Volt. Range (rms)<sup>4</sup> —85-105 (39W/150W)  
 —80-100 (70W)  
 Lamp Operating Current (Amps) Nominal (rms) —0.53 (39W)  
 —0.98 (70W)  
 —1.8 (150W)  
 Lamp Current Crest Factor (Maximum) —1.8  
 Warm-up to 80% Full Brightness —2 minutes  
 Retrike Time for Hot Lamps —4-8 minutes  
 Ballast Open Circuit Voltage —198 RMS Min.  
 Pulse Peak Volts —3000-4000  
 Pulse Width @ 90% Peak —2 Micro Sec. Minimum  
 Pulse Repetition Rate (Minimum)<sup>5</sup> —2 per Half Cycle  
 Minimum Operating Temp. —30°C (-22°F)

Physical Characteristics

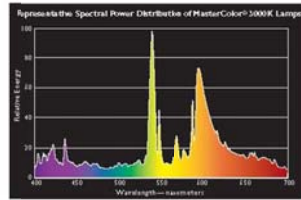
Bulb Size —T-6  
 Bulb Finish —Clear  
 Base —G-12 Bi-Pin  
 Max. Overall Length (MOL) —3 1/4" (39W/70W)  
 —4 1/2" (150W)  
 Light Center Length (LCL) —2 3/4"  
 Arc Length —0.2" (5mm) (39W)  
 —0.275" (7mm) (70W)  
 —0.354" (9mm) (150W)  
 Max. Bulb Temp. —500° C (932° F) (39W/70W)  
 —650° C (1202° F) (150W)  
 Max. Base Temp. —280° C (536° F) (39W/70W)  
 —250° C (482° F) (150W)  
 Arc Tube Material —Poly Crystalline Alumina  
 Max Bulb to Base Eccentricity —3"  
 Max. Arc Tube to Base Eccentricity —3"

Operating Characteristics

Rated Average Life, Hours<sup>6</sup> —12,000  
 Correlated Color Temp. (CCT)<sup>7</sup> —3000K  
 CIE Chromaticity Approx.<sup>1</sup> —x-.428, y-.397 (39W)  
 —x-.428, y-.394 (70W)  
 —x-.435, y-.400 (150W)  
 Efficacy (lpw) —87 (39W)  
 —94 (70W)  
 —93 (150W)

Operating Position

Universal-Enclosed Luminaires Only



- 1) Measured at 100 hrs. life. Approximate lumen values listed are for vertical operation of the lamp.
- 2) Approximate lumen output at 40% of lamp rated average life.
- 3) Measured at rated lamp watts on a linear reactor. LPW does not include ballast losses.
- 4) Measured with the lamp operating at rated watts.
- 5) Option-Pulse Width @ 90% Peak, 1 micro second minimum with 2 pulses per half cycle.
- 6) Rated average life is the life obtained, on the average, from large representative groups of lamps in laboratory tests under controlled conditions at 10 or more operating hours per start. It is based on survival of at least 50% of the lamps and allows for individual lamps or groups of lamps to vary considerably from the average.

CDM/T6

WARNINGS, CAUTIONS AND OPERATING INSTRUCTIONS FOR MasterColor® Ceramic Metal Halide Lamps: Single-Ended CDM-T G12, CDM-TC G8.5 (Universal); Double-Ended CDM-TD RX7 (Horizontal : 45°, Enclosed Fixtures Only)

**WARNING:** These lamps can cause serious skin burn and eye inflammation from short wave ultraviolet radiation if outer envelope of the lamp is broken or punctured. Do not use where people will remain for more than a few minutes unless adequate shielding or other safety precautions are used. Certain lamps that will automatically extinguish when the outer envelope is broken or punctured are commercially available. This lamp complies with FDA radiation performance standard 21 CFR subchapter J, (USA 21 CFR 1040.30 Canada/SOR/DORS/80-381)

**If the outer bulb is broken or punctured, turn off at once and replace the lamp to avoid possible injury from hazardous short wave ultraviolet radiation. Do not scratch the outer bulb or subject it to pressure as this could cause the outer bulb to crack or shatter. A partial vacuum in the outer bulb may cause glass to fly if the envelope is struck.**  
**WARNING:** The arc-tube of metal halide lamps are designed to operate under high pressure and at temperatures up to 1000° C and can unexpectedly rupture due to internal or external factors such as a ballast failure or misapplication. If the arc-tube ruptures for any reason, the outer bulb may break and pieces of extremely hot glass might be discharged into the surrounding environment. If such a rupture were to happen, THERE IS A RISK OF PERSONAL INJURY, PROPERTY DAMAGE, BURNS AND FIRE. Certain lamps that will retain all the glass particles should inner arc-tube rupture occur are commercially available from Philips Lighting Company.

**REPLACE FIXTURES AT OR BEFORE THE END OF RATED LIFE.** Allowing lamps to operate until they fail is not advised and may increase the possibility of inner arc tube rupture.

This lamp contains an arc tube with a filling gas containing less than 10 nCi of Kr-85 and is distributed by Philips Lighting Company, a division of Philips Electronics North America Corporation, Somerset, New Jersey, 08875.

**CAUTION:** TO REDUCE THE RISK OF PERSONAL INJURY, PROPERTY DAMAGE, BURNS AND FIRE RESULTING FROM AN ARC-TUBE RUPTURE THE FOLLOWING LAMP OPERATING INSTRUCTIONS MUST BE FOLLOWED:

- LAMP OPERATING INSTRUCTIONS:**
1. **REPLACE FIXTURES AT OR BEFORE THE END OF RATED LIFE.**  
 Allowing lamps to operate until they fail is not advised and may increase the possibility of inner arc tube rupture.
  2. Use only in fully enclosed fixtures capable of withstanding particles of glass having temperatures up to 1000° C. Lens/diffuser material must be heat resistant. Consult fixture manufacturer regarding the suitability of the fixture for this lamp.
  3. Do not operate a fixture with a missing or broken lens/diffuser.
  4. Operate lamp only within specified limits of operating position.
  5. Before lamp installation/replacement, shut power off and allow lamp and fixture to cool to avoid electrical shock and potential burn hazards.
  6. Use only auxiliary equipment meeting Philips and/or ANSI standards. Use within voltage limits recommended by ballast manufacturer.  
 A. Operate lamp only within specified limits of operation.  
 B. For total supply load refer to ballast manufacturers electrical data.
  7. **Operate CDM-T (G12 base) lamps only on thermally protected ballasts.**  
**Operate CDM-TC lamps (G8.5 base) only on thermally protected electronic ballasts.**  
**Operate CDM-T (G12 base) 39W/841 lamps only on thermally protected electronic ballasts.**
  8. Periodically inspect the outer envelope. Replace any lamps that show scratches, cracks or damage.
  9. If a lamp bulb support is used, be sure to insulate the support electrically to avoid possible decomposition of the bulb glass.
  10. Protect lamp base, socket and wiring against moisture, corrosive atmospheres and excessive heat.
  11. Time should be allowed for lamps to stabilize in color when turned on for the first time. This may require several hours of operation, with more than one start. Lamp color is also subject to change under conditions of excess vibration or shock and color appearance may vary between individual lamps.
  12. Lamps may require 4 to 8 minutes to re-light if there is a power interruption.
  13. Take care in handling and disposing of lamps. If an arc tube is broken, avoid skin contact with any of the contents or fragments.



Specifications are subject to change without notice.  
 © 2007 Philips Lighting Company. All rights reserved.  
 Printed in USA 07/07  
 P-5434-C  
 www.philips.com

Philips Lighting Company  
 300 Franklin Square Drive  
 P.O. Box 6800  
 Somerset, NJ 08875-6800  
 1-800-555-0050  
 A Division of Philips Electronics North America Corporation

Philips Lighting  
 281 Hillmount Road  
 Markham, Ontario  
 Canada L6C 2S3  
 1-800-555-0050  
 A Division of Philips Electronics Ltd.

Figure A.6: lamp for fixtures XDM-1 and XDM-1A



# MasterColor® CDM PAR20

MasterColor CDM 35W/830 Med PAR20 FL 1CT

Philips MasterColor® Ceramic Metal Halide PAR Lamps offer an array of compact, high-efficiency, ceramic metal halide reflector lamps with a stable color over lifetime and a crisp, sparkling light. They deliver superior, energy-efficient accent lighting with consistent, outstanding color required for retail and architectural applications.

## Product data

### Product Data

Product number	233643
Full product name	MasterColor CDM 35W/830 Med PAR20 FL 1CT
Short product name	CDM 35W/830 Med PAR20 FL 1CT
Pieces per Sku	1
Skus/Case	12
Bar code on pack	046677233648
Bar code on case	50046677233643
Logistics code(s)	928601133401

### General Characteristics

Base	Medium [Single Contact Medium Screw]
Base Information	Nic/Brass [Nickel/Brass Base]
Bulb	PAR20 [PAR 2.5 inch]
Bulb Material	Hard Glass
Bulb Finish	Reflector
Operating Position	Universal [Any or Universal (U)]
Main Application	General Lighting
RatedAvgLife(See Family Notes)	9000 hr

### Electrical Characteristics

Watts	35 W
Lamp Wattage Technical	38 W
Lamp Voltage	88 V
Lamp Current	0.525 A
Ignition Time	30 s
Re-ignition Time [min]	15 min

### Environmental Characteristics

Mercury (Hg) Content	2.8 mg
Picogram per Lumen Hour	239 p/LuHr

### Light Technical Characteristics

Beam Description	Flood [Flood]
Beam Angle	30 D
Approx. MBCP	5000 cd
Color Code	830 [CCT of 3000K]
Color Rendering Index	75 (min), 81 (nom) Ra8
Color Temperature technical	3000 K
Chromaticity Coordinate X	433 -
Chromaticity Coordinate Y	402 -
Initial Lumens	2000 Lm
Luminous Efficacy Lamp	57 Lm/W
Lumen Maintenance 2000h	70 %
Lumen Maintenance 5000h	55 %
Design Mean Lumens	1300 Lm

### UV-related Characteristics

PET (NIOSH)	100 h.idx
Damage Factor D/fc	0.20 -



Figure A.7: lamp for fixtures XWM-1

# MasterColor® CDM PAR30L

MasterColor CDM 70W/830 Med PAR30L FL 1CT

Philips MasterColor® Ceramic Metal Halide PAR30L Lamps offer high-efficiency, ceramic metal halide reflector lamps with a stable color over lifetime and a crisp, sparkling light.

## Product data

### • Product Data

Product number	232215
Full product name	MasterColor CDM 70W/830 Med PAR30L FL 1CT
Short product name	CDM 70W/830 Med PAR30L FL 1CT
Pieces per Sku	1
Skus/Case	6
Bar code on pack	046677232214
Bar code on case	50046677232219
Logistics code(s)	928601133201

### • General Characteristics

Base	Medium [Single Contact Medium Screw]
Base Information	Nic/Brass [Nickel/Brass Base]
Bulb	PAR30L [PAR 3.75 inch/95mm Long]
Bulb Material	Hard Glass
Bulb Finish	Reflector
Operating Position	Universal [Any or Universal (U)]
Main Application	General Lighting
RatedAvgLife(See Family Notes)	11000 hr

### • Electrical Characteristics

Watts	70 W
Lamp Wattage Technical	79 W
Lamp Voltage	102 V
Lamp Current	0.93 A
Ignition Time	30 s
Re-ignition Time [min]	10 min

### • Environmental Characteristics

Mercury (Hg) Content	10.1 mg
----------------------	---------

### • Light Technical Characteristics

Beam Description	Flood [Flood]
Beam Angle	40 D
Approx. MBCP	10000 cd
Color Code	830 [CCT of 3000K]
Color Rendering Index	78 (min), 82 (nom) Ra8
Color Temperature	3000 K
Color Temperature technical	3000 K
Chromaticity Coordinate X	432 -
Chromaticity Coordinate Y	390 -
Initial Lumens	5000 Lm
Luminous Efficacy Lamp	71.4 Lm/W
Lumen Maintenance 5000h	65 %
Design Mean Lumens	3050 Lm

### • UV-related Characteristics

PET (NIOSH)	100 h.idx
Damage Factor D/fc	0.25 -

### • Product Dimensions

Max Overall Length (MOL) - C	4.750 in
Diameter D	3.740 in

**PHILIPS**  
sense and simplicity

Figure A.8: lamp for fixtures XAM-1, XAN-1A, XAM-2, XAM-2A, and XDM-3





## MasterColor® CDM ED17 Protected

MasterColor CDM 100W/830 Med ED17P CL ALTO+FB

Range of protected, high-efficiency long life ceramic metal halide lamps with a stable color over lifetime and a crisp, sparkling light to be used in open fixtures.

### Product data

#### • Product Data

Product number	233684
Full product name	MasterColor CDM 100W/830 Med ED17P CL ALTO+FB
Short product name	CDM 100W/830 Med ED17P CL ALTO+FB
Pieces per Sku	1
Skus/Case	12
Bar code on pack	046677233686
Bar code on case	50046677233681
Logistics code(s)	928601137601

#### • General Characteristics

Base	Medium [Single Contact Medium Screw]
Base Information	Brass [Brass Base]
Bulb	ED17P [Protected]
Bulb Material	Hard Glass
Bulb Finish	Clear
Operating Position	Universal [Any or Inverted (U)]
Main Application	General Lighting
RatedAvgLife(See Family Notes)	16000 hr

#### • Electrical Characteristics

Watts	100 W
Lamp Voltage	101 V
Lamp Current	1.1 A
Ignition Time	10 s
Ignition Supply Voltage	235 V
Re-ignition Time [min]	10 min

#### • Environmental Characteristics

Mercury (Hg) Content	5.8 mg
----------------------	--------

#### • Light Technical Characteristics

Color Code	830 [CCT of 3000K]
Color Rendering Index	80 (min), 85 (nom) Ra8
Color Designation	Warm White
Color Temperature	3000 K
Color Temperature technical	2800 (min), 3000 (nom), 3200 (max) K
Chromaticity Coordinate X	.421 (min), .430 (nom), .439 (max) -
Chromaticity Coordinate Y	.386 (min), .392 (nom), .398 (max) -
Initial Lumens	8600 Lm
Luminous Efficacy Lamp	86 Lm/W
Lumen Maintenance 2000h	86 %
Lumen Maintenance 5000h	79 %
Design Meas Lumens	6450 Lm

#### • UV-related Characteristics

PET (NIOSH)	322 h.klx
Damage Factor D/fe	.201 -

#### • Product Dimensions

Light Center Length L	3.438 in
Max Overall Length (MOL) - C	5.438 in

**PHILIPS**  
 sense and simplicity

Figure A.9: lamp for fixture XPO-1

**APPENDIX B: MECHANICAL & OTHER LOAD SCHEDULE**

MECHANICAL LOADS										
Load Tag	Tag Number(s)	Quantity	Load Description	Load Magnitude	Load Units	NEC Motor Amps	Voltage/Phase	Assumed PF	Eq. Load (kVA)	Eq. Load (kW)
ACF	1-5,9-10	7	Supply Fan	100	hp	124	460/3	0.82	691.57	567.09
ACF	1-5	10	Exhaust Fan	50	hp	65	460/3	0.82	517.88	424.66
ACF	6-8	3	Supply Fan	60	hp	77	460/3	0.82	184.05	150.92
ACF	9-10	2	Supply Fan	40	hp	52	460/3	0.82	82.86	67.95
ACF	11	1	Supply Fan	25	hp	34	460/3	0.82	27.09	22.21
ACF	12	1	Supply Fan	125	hp	156	460/3	0.82	124.29	101.92
HRW	1-5	5	Heat Recovery Unit	1	hp	2.1	460/3/60	0.8	8.37	6.69
ACU	1,4,5,8,11-15	9	Supplimentary AC	2.8	FLA	x	208/3	0.8	1.01	0.81
ACU	2-3,9-10	4	Supplimentary AC	9.8	FLA	x	460/3	0.82	31.23	25.61
ACU	16-17	2	Supplimentary AC	5.8	FLA	x	208/3	0.8	2.09	1.67
ACU	18-20	3	Supplimentary AC	17.3	FLA	x	460/3	0.82	41.35	33.91
CSG	1-3	3	Clean Steam Gen.				120/1/60	0.8		0.00
DDU	1-3	3	Dehumid. w/ Heating Coil and Fan	22.3	FLA	x	460/3	0.82	53.30	43.71
EFN	1	1	Exhaust Fan	80	W	4.4	115/1	0.8	0.51	0.40
EFN	2	1	Exhaust Fan	1/2	hp	9.8	115/1	0.8	1.13	0.90
TRF	NP001	1	Return Fan	1/2	hp	9.8	115/1	0.8	1.13	0.90
EFN	3	1	Exhaust Fan	2	hp	3.4	460/3	0.8	2.71	2.17
EFN	4,12,39-41	5	Exhaust Fan	1.5	hp	3	460/3	0.8	11.95	9.56
EFN	5-8	4	Exhaust Fan	7.5	hp	11	460/3	0.8	35.06	28.05
SFN	4-7	4	Supply Fan	7.5	hp	11	460/3	0.8	35.06	28.05
EFN	9	1	Exhaust Fan	3	hp	4.8	460/3	0.8	3.82	3.06
EFN	10,25	2	Exhaust Fan	1/3	hp	7.2	115/1	0.8	0.83	0.66
TRF	N206,W254,N310B	2	Return Fan	1/3	hp	7.2	115/1	0.8	0.83	0.66
SFN	8	1	Supply Fan	1/3	hp	7.2	115/1	0.8	0.83	0.66
EFN	10,37,38	3	Exhaust Fan	3/4	hp	1.6	460/3	0.6	3.82	2.29
EFN	13,14,16	3	Exhaust Fan	1	hp	2.1	460/3	0.8	5.02	4.02
SFN	3	1	Supply Fan	1	hp	2.1	460/3	0.8	1.67	1.34
EFN	15,26	2	Exhaust Fan	40	hp	52	460/3	0.82	82.86	67.95
EFN	17-19,23,24	5	Exhaust Fan	50	hp	65	460/3	0.82	258.94	212.33
EFN	20-22	3	Exhaust Fan	25	hp	34	460/3	0.82	81.27	66.64
RTF	1	1	Return Fan	30	hp	40	460/3	0.82	31.87	26.13

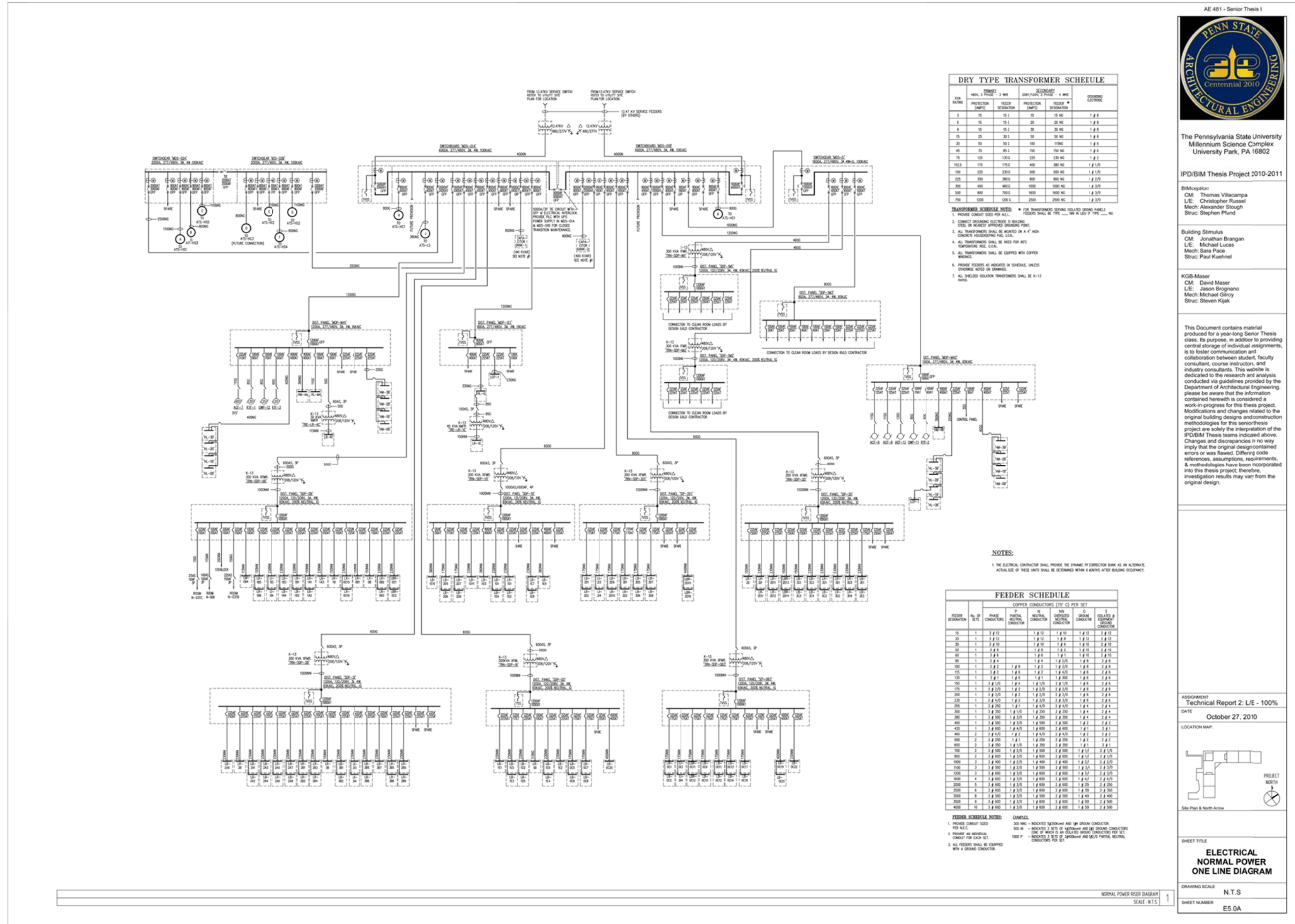
Load Tag	Tag Number(s)	Quantity	Load Description	Load Magnitude	Load Units	NEC Motor Amps	Voltage/Phase	Assumed PF	Eq. Load (kVA)	Eq. Load (kW)
RTF	2,3	2	Return Fan	20	hp	27	460/3	0.8	43.02	34.42
TRF	N049, WP001, W101, W130, N044, W005B, N101, NP238, W106	9	Return Fan	1/4	hp	5.8	115/1	0.8	0.67	0.53
EFN	27-31	5	Exhaust Fan	1/4	hp	5.8	115/1	0.8	0.67	0.53
TRF	NP129	1	Return Fan	0.1	hp	4.4	115/1	0.8	0.51	0.40
EFN	32	1	Exhaust Fan	129	W	5.8	115/1	0.8	0.67	0.53
EFN	33-36	4	Exhaust Fan	100	hp	124	460/3	0.82	395.18	324.05
SFN	9,10	2	Supply Fan	5	hp	7.6	460/3	0.8	12.11	9.69
FCU		10	Fan Coil Unit	1/6	hp	2.2	277/1	0.8	0.61	0.49
FCU	NP053	1	Fan Coil Unit	3/4	hp	13.8	115/1	0.8	1.59	1.27
CRAC	1	1		169.9	FLA	x	480/3	0.82	135.37	111.00
XDP	W003-1, N009-1, W244B-1	3	Chilled Water Pumping Unit	4	FLA	x	208/3/60	0.8	1.44	1.15
XDH	W003-1 thru 3, N009-1&2	5	Rack Cooling Modules	5	FLA	x	120/1/60	0.8	0.60	0.48
XDV	W003-1 thru 8, N009-1 thru 3, W244B-1 thru 14	25	Rack Cooling Modules	2	FLA	x	120/1/60	0.8	0.24	0.19
DC	1	1	Dry Cooler	14	FLA	x	208/3	0.8	5.04	4.03
CWP	1-3	3	Pump	150	hp	180	460/3	0.82	430.24	352.80
CWP	4	1	Pump	20	hp	27	460/3	0.8	21.51	17.21
HWP	5-6	2	Pump	40	hp	52	460/3	0.82	82.86	67.95
PCWP	7-8	2	Pump	25	hp	34	460/3	0.82	54.18	44.43
CWP	9-10	2	Pump	1.5	hp	3	460/3	0.8	4.78	3.82
GWP	11-12	2	Pump	25	hp	34	460/3	0.82	54.18	44.43
GHWP	13	1	Pump	1.5	hp	3	460/3	0.8	2.39	1.91
HV	1	1	H & V System	2	hp	3.4	460/3	0.8	2.71	2.17
HV	2	1	H & V System	5	hp	7.6	460/3	0.8	6.06	4.84
LEB	Various	256	Exhaust Air Flow Control	0.06	FLA	x	277/1	0.8	4.25	3.40
LSB	Various	188	Supply Air Flow Control	0.06	FLA	x	277/1	0.8	3.12	2.50
VAV	Various	217	Variable Air Volume Boxes	0.06	FLA	x	277/1	0.8	3.61	2.89
CUH	Various	13	Cabinet Unit Heater	1/11	hp	0.10	115/1	1	0.15	0.15
UHT	Various	2	Cabinet Unit Heater	1/3	hp	7.20	115/1	1	1.66	1.66
UHT	Various	8	Cabinet Unit Heater	1/20	hp	0.30	115/1	1	0.28	0.28
CUH	Various	3	Cabinet Unit Heater	1/10	hp	4.40	115/1	1	1.52	1.52

Load Tag	Tag Number(s)	Quantity	Load Description	Load Magnitude	Load Units	NEC Motor Amps	Voltage/Phase	Assumed PF	Eq. Load (kVA)	Eq. Load (kW)
CUH	Various	1	Electrical Cabinet Unit Heater	1/20	hp	2.40	208/3	1	0.86	0.86
	Motorized Damper	6	Motorized Damper	0.06	kVA	x	120/1	0.82	0.06	0.05
	Main Chiller	1	Chiller	4.80	kVA	x	208/3	0.8	4.80	3.84
	AC Unit	5	Air Conditioning Unit	0.30	kVA	x	208/1	0.6	0.30	0.18
	AC Compressor	5	Air Conditioning Compressor	2.46	kVA	x	208/3	0.8	2.46	1.97
	Air Cooled Compressor	1	Air Cooled Compressor	9.00	kVA	x	208/3	0.8	9.00	7.20
	Water Cooled Compressor	1	Water Cooled Compressor	9.00	kVA	x	208/3	0.8	9.00	7.20
<b>Total Load (k-Unit):</b>									3597.90	2946.00

**PLUMBING LOADS**

Load Tag	Tag Number(s)	Quantity	Load Description	Load Magnitude	Load Units	NEC Motor Amps	Voltage/Phase	Assumed PF	Eq. Load (kVA)	Eq. Load (kW)
VCP	1	3	Vacuum Pump	40	hp	52	460/3	0.82	124.29	101.92
CP	1	1	Circulating Pump	1	hp	2.1	460/3	0.8	1.67	1.34
DBP	x	1	Domestic Booster Pump	10	kVA	x	460/3	0.8	10.00	8.00
P	4	2	Trench Pit SP	1	hp	2.1	460/3	0.8	3.35	2.68
	Vacuum Pump	7	Vacuum Pump	0.48	kVA	x	120/1	0.6	0.48	0.29
	Mechanical Pump	1	Pump	0.6	kVA	x	115/1	0.6	0.60	0.36
	Heat Trace	5	Heat Trace	3.33	kVA	x	208/1	0.8	3.33	2.67
	Rotary Pump	1	Pump	6.2	kVA	x	208/1	0.8	6.20	4.96
	Mechanical Pump	1	Pump	1.1	kVA	x	120/1	0.6	1.10	0.66
	Roughling Pump	1	Pump	1.2	kVA	x	120/1	0.6	1.20	0.72
	Rotary Pump	2	Pump	1.44	kVA	x	120/1	0.6	1.44	0.86
	Sump Pump	3	Pump	0.86	kVA	x	120/1	0.6	0.86	0.52
	Vacuum Pump	4	Vacuum Pump	0.96	kVA	x	120/1	0.6	0.96	0.58
	Vacuum Pump	3	Vacuum Pump	1.96	kVA	x	120/1	0.6	1.96	1.18
	Elevator Sump Pump	4	Pump	1.18	kVA	x	120/1	0.6	1.18	0.71
	Tunnel Duplex Sump Pump	1	Pump	2.36	kVA	x	208/1	0.8	2.36	1.89
	Irrigation Pump Station	1	Pump Station	17.4	kVA	x	208/3	0.8	17.40	13.92
	Submersible Pump Station	1	Pump Station	1.53	kVA	x	208/3	0.6	1.53	0.92
	Mechanical Vacuum Pump	4	Vacuum Pump	8.64	kVA	x	208/3	0.8	8.64	6.91
	Vacuum Pump	1	Vacuum Pump	3.33	kVA	x	208/1	0.8	3.33	2.67
	Vacuum Pump	1	Vacuum Pump	5.76	kVA	x	208/3	0.8	5.76	4.61
<b>Total Load (k-Unit):</b>									197.65	158.34

ARCHITECTURAL LOADS										
Load Tag	Tag Number(s)	Quantity	Load Description	Load Magnitude	Load Units	NEC Motor Amps	Voltage/Phase	Assumed PF	Eq. Load (kVA)	Eq. Load (kW)
PE	1-3	3	Passenger Elevator Motor	30	hp	40	460/3	0.82	95.61	78.40
PE	4	1	Passenger Elevator Motor	40	hp	52	460/3	0.82	41.43	33.97
SE	5-6	2	Service Elevator Motor	75	hp	96	460/3	0.82	152.97	125.44
	Projector Screen	11	Motorized Projector Screen	1	kVA	x	120/1	0.6	1.00	0.60
	Loading Dock Door	3	Motorized Overhead Door	0.9	kVA	x	120/1	0.6	0.90	0.54
	Ceiling Mounted Projector	4	Projector	0.8	kVA	x	120/1	0.6	0.80	0.48
	Motorized Shades	5	Motorized Shades	0.5	kVA	x	120/1	0.6	0.50	0.30
<b>Total Load (k-Unit):</b>									293.21	239.73
OTHER LOADS										
Load Tag	Tag Number(s)	Quantity	Load Description	Load Magnitude	Load Units	NEC Motor Amps	Voltage/Phase	Assumed PF	Eq. Load (kVA)	Eq. Load (kW)
AC	1	3	Air Compressor	30	hp	40	460/3	0.82	95.61	78.40
AC	2	4	Air Compressor	15	hp	21	460/3	0.8	66.93	53.54
	Thermal Electronic Chiller	1	Air Cooled Chiller	7.5	kVA	x	208/3	0.8	7.50	6.00
	Chiller	1	Chiller	0.4	kVA	x	120/1	0.6	0.40	0.24
	Chiller	1	Chiller	7.5	kVA	x	208/3	0.8	7.50	6.00
	Chiller	1	Chiller	5	kVA	x	208/3	0.8	5.00	4.00
	RF Generator	1	Radio Freq. Generator	62.1	kVA	x	480/3	0.82	62.10	50.92
	Cryo Compressor	2	Compressor	5	kVA	x	208/1	0.8	5.00	4.00
	Drying Oven	2	Drying Oven	1.32	kVA	x	208/1	1	1.32	1.32
	Vacuum Oven	3	Vacuum Oven	0.78	kVA	x	208/1	1	0.78	0.78
<b>Total Load (k-Unit):</b>									252.14	205.20
<b>Building Total Load:</b>									4340.90	3549.27
									kVA	kW



The Pennsylvania State University  
Millennium Science Complex  
University Park, PA 16802

IPD/BIM Thesis Project 2010-2011

IPD/BIM/Thesis:  
CM: Thomas Villacampa  
L/E: Christopher Russel  
Mech: Alexander Slough  
Struc: Stephen Plund

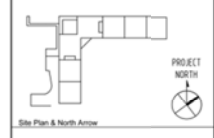
Building Stimulus  
CM: Jonathan Brangan  
L/E: Michael Lucas  
Mech: Sara Pace  
Struc: Paul Kuehnle

KGB-Maser  
CM: David Maser  
L/E: Jason Brognano  
Mech: Michael Glynn  
Struc: Steven Kjak

This Document contains material produced for a year-long Senior Thesis class. Its purpose, in addition to providing central storage of individual assignments, is to foster communication and collaboration between student, faculty consultant, course instructor, and industry consultants. This website is dedicated to the research and analysis conducted via guidelines provided by the Department of Architectural Engineering. Modifications and changes related to the original building designs and construction methodologies for this senior thesis project are solely the interpretation of the IPD/BIM Thesis teams indicated above. Changes and discrepancies in no way imply that the original design contained errors or was flawed. Differing code references, assumptions, requirements, & methodologies have been incorporated into this thesis project. Therefore, investigation results may vary from the original design.

ASSIGNMENT  
Technical Report 2: L/E - 100%

DATE  
October 27, 2010

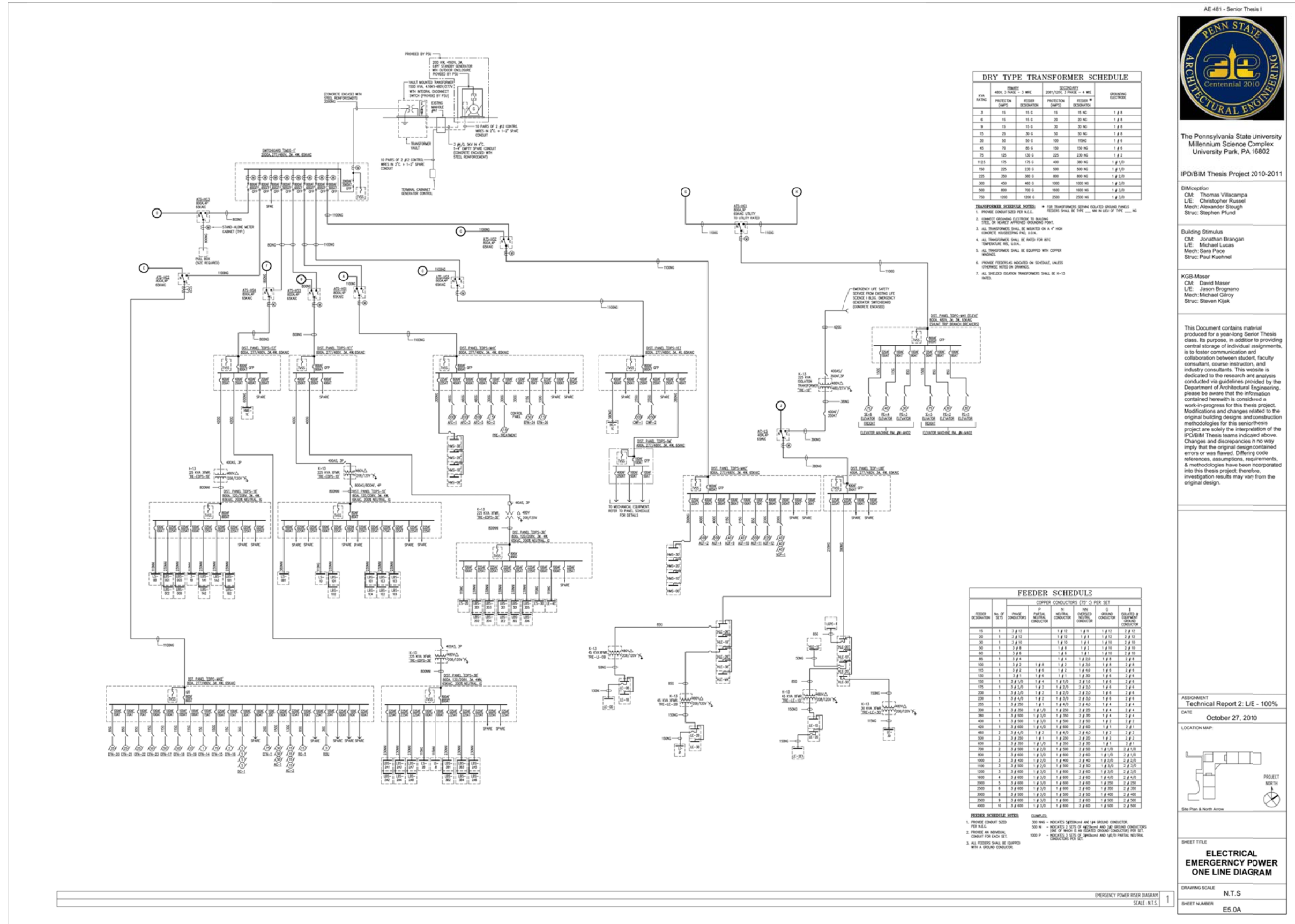


SHEET TITLE  
**ELECTRICAL  
NORMAL POWER  
ONE LINE DIAGRAM**

DRAWING SCALE  
N.T.S.

SHEET NUMBER  
E5.0A





The Pennsylvania State University  
Millennium Science Complex  
University Park, PA 16802

IPD/BIM Thesis Project 2010-2011

BIM/Author:  
CM: Thomas Villacampa  
L/E: Christopher Russel  
Mech: Alexander Slough  
Struc: Stephen Plund

Building Stimulus  
CM: Jonathan Brangan  
L/E: Michael Lucas  
Mech: Sara Pace  
Struc: Paul Kuehnel

KGB-Maser  
CM: David Maser  
L/E: Jason Brognano  
Mech: Michael Glynn  
Struc: Steven Kjak

This Document contains material produced for a year-long Senior Thesis class. Its purpose, in addition to providing central storage of individual assignments, is to foster communication and collaboration between student, faculty consultant, course instructor, and industry consultants. This website is dedicated to the research and analysis conducted via guidelines provided by the Department of Architectural Engineering. Please be aware that the information contained herewith is considered a work-in-progress for this thesis project. Modifications and changes related to the original building designs and construction methodologies for this senior thesis project are solely the interpretation of the IPD/BIM Thesis teams indicated above. Changes and discrepancies in no way imply that the original design contained errors or was flawed. Differing code references, assumptions, requirements, & methodologies have been incorporated into this thesis project. Therefore, investigation results may vary from the original design.

ASSIGNMENT  
Technical Report 2: L/E - 100%

DATE  
October 27, 2010

LOCATION MAP:



SHEET TITLE  
**ELECTRICAL  
EMERGENCY POWER  
ONE LINE DIAGRAM**

DRAWING SCALE  
N.T.S

SHEET NUMBER  
E5.0A