Millennium Science Complex

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Tech Report 2

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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.

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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.

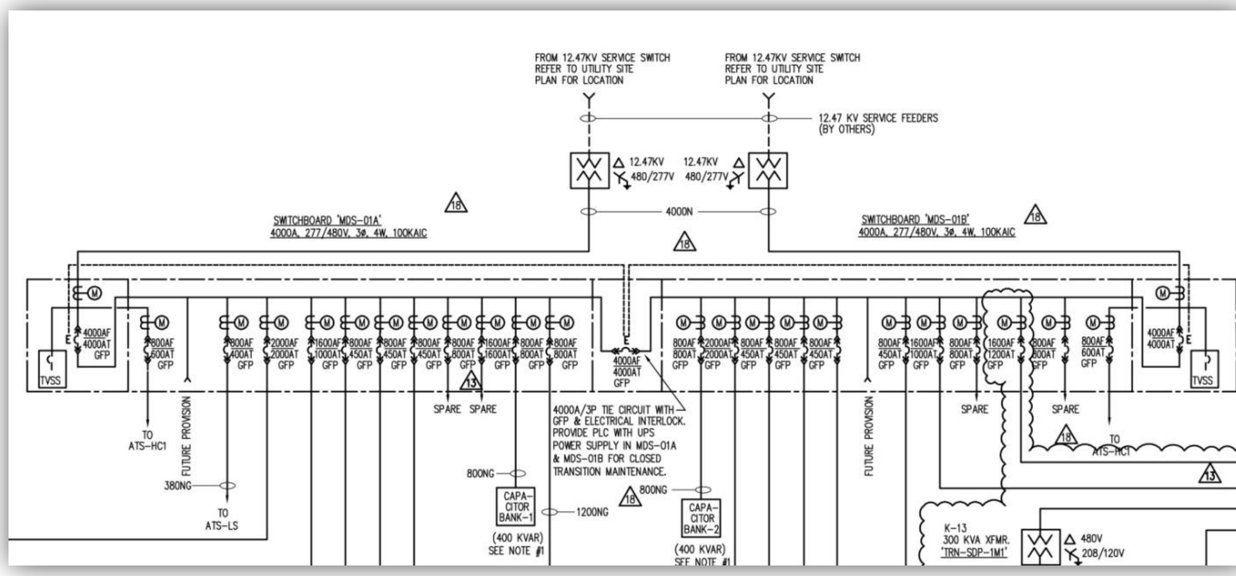


Figure #1.1: One-Line description of the normal-power service entrance.

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 supplies 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 feed 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.

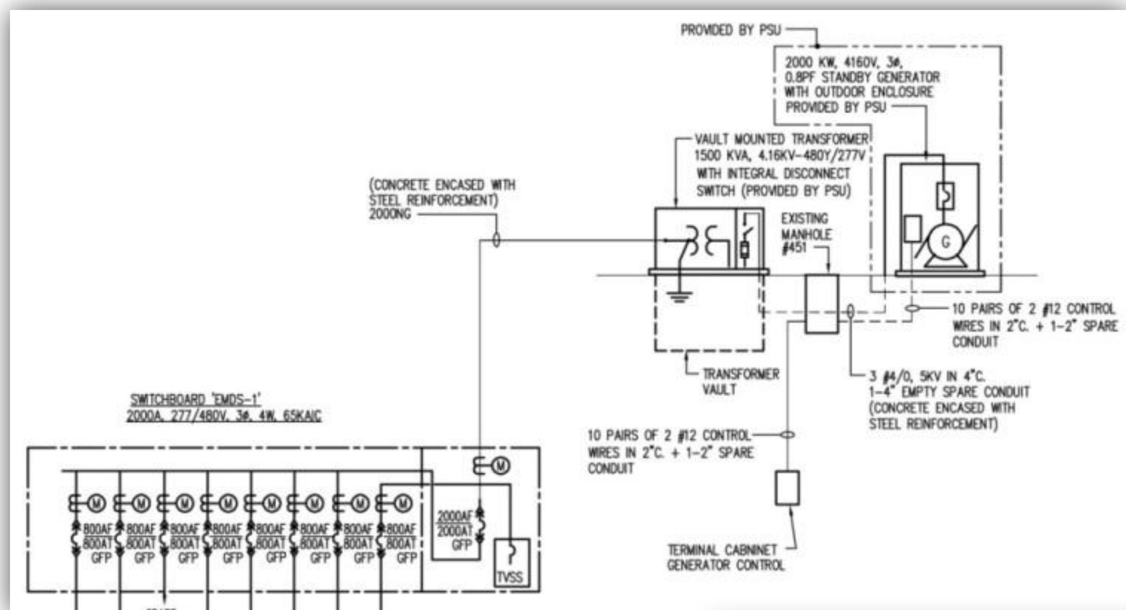


Figure #2.1: One-Line description of the normal/emergency service entrance

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.

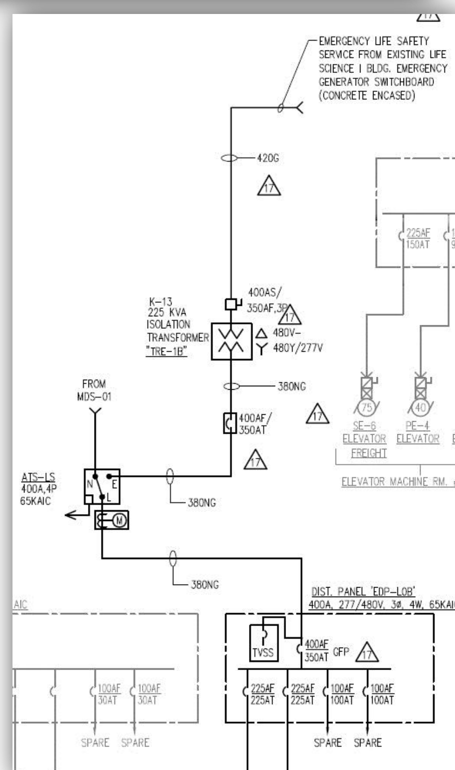


Figure #2.1: One-Line description of the emergency-power service entrance.

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^{st}FlrMez.	*A8.E2.2D-P*	A8.E5.1	N/A	☒		
		DP-5	1^{st}FlrMez.	*A8.E2.2D-P*	A8.E5.1	N/A	☒		
		DP-6	1^{st} FlrMez.	*A8.E2.2D-P*	A8.E5.1	N/A	☒		
		EDP-1	1^{st}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	☒		
	Lvl	**Name**	**Location**	***Floorplan***	**Riser**	**One Line**	**Sched.**	**Volt**	**MCB/MLO**
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	150A
		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 1Mz	DP-4	1st Floor Mezz.	*A8.E2.2D-P*	A8.E5.1	N/A	☒	480/277V	
		DP-5	1st Floor Mezz.	*A8.E2.2D-P*	A8.E5.1	N/A	☒	480/277V	
		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	

Table #2.3: Electrical Equipment Overview: First Floor Panelboards

	Lvl	Name	Location	*Floorplan*	Riser	One Line	Sched.	Volt	MCB/MLO
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.		
Panelboards:	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	*NOT SHOWN ON PLANS*			☑	☑
	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

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.

	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

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

UNINTERUPTABLE 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 lighting 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% if 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 are 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 depended 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^2	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^2**	***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^2**	***Square Feet***	***Load - kVA***
**Demand Factor = 100%*		*3.5*	*276,500*	*968*
HVAC Cooling*(480V)*		**VA/ft^2**	***Square Feet***	***Load - kVA***
		8	*276,500*	*2,212*
Elevators*(480V)*		***VA/Elev.***	***Elevators***	***Load -kVA***
		50	*6*	*300*
Totals				
	120V kVA	***277V kVA***	***480V kVA***	***Total Amps***
	276	*968*	*2,512*	*6,367 A*

Table #4.2: Service Entrance Size: Design Development.

WORKING DRAWINGS – ACTUAL LOADING

Panel	N/E/LS	Phase A (kVA)	Phase B (kVA)	Phase C (kVA)	Voltage	Panel Demand Factor*	Total kVA	Total Connected (A)	Total Connected Load (A) Panel Demand	Total NEC Recp. Demand (A)
LB3B7	N	2.88	2.88	2.52	120	0.8	8.28	23.00	18.40	23.00
LB0C20	N	44.2	44.2	43.1	120	0.6	131.5	365.28	219.17	196.53
LB0C22	N	5.6	5.62	6.16	120	0.6	17.38	48.28	28.97	38.03
LBR2D15	N	24.16	24.16	24.16	120	0.6	72.48	201.33	120.80	114.56
LBR2D16	N	23.6	23.6	23.6	120	0.6	70.8	196.67	118.00	112.22
LCP1	N	5.6	7	8.5	277	0.8	21.1	25.39	20.31	25.39
LB0C19	N	30.63	29.53	29.01	120	0.6	89.17	247.69	148.62	137.74
LBR2D16	N	23.6	23.6	23.6	120	0.6	70.8	196.67	118.00	112.22
LB0C19	N	6.6	6.2	5.5	120	0.6	18.3	50.83	30.50	39.31
HLEM4	LS	1.5	1.3	1.8	277	0.6	4.6	5.54	3.32	5.54
LBS3B1	E	10.9	7.4	7.1	120	0.6	25.4	70.56	42.33	49.17
LBS3B2	E	9.3	10.3	9.8	120	0.6	29.4	81.67	49.00	54.72
LBS3B3	E	3.1	2.4	4.3	120	0.6	9.8	27.22	16.33	27.22
LBS3D1	E	2.48	1.66	0	120	0.6	4.14	11.50	6.90	11.50
LBS3D2	E	1.08	0.4	0.54	120	0.6	2.02	5.61	3.37	5.61

Panel	N/E/LS	Phase A (kVA)	Phase B (kVA)	Phase C (kVA)	Voltage	Panel Demand Factor*	Total kVA	Total Connected (A)	Total Connected Load (A) Panel Demand	Total NEC Recp. Demand (A)
LBS3D5	E	4.18	4.18	2.46	120	0.6	10.82	30.06	18.03	28.92
LBS3D6	E	8.8	6.5	6.1	120	0.6	21.4	59.44	35.67	43.61
LE3B	LS	5.8	6.1	5.3	120	0.6	17.2	47.78	28.67	37.78
LE3D	LS	6.44	5.3	5.3	120	0.6	17.04	47.33	28.40	37.56
LS3B	E	0.36	0.75	0.75	120	0.6	1.86	5.17	3.10	5.17
LS3D	E	1.9	0.75	0.75	120	0.6	3.4	9.44	5.67	9.44
LE4C	N	1.55	1.05	1.05	120	0.6	3.65	10.14	6.08	10.14
LR3B	N	9.39	7.84	5.81	120	0.6	23.04	64.00	38.40	45.89
LBS3B4	E	5.11	3.9	2.71	120	0.6	11.72	32.56	19.53	30.17
LB3D1	N	6.24	2.79	2.79	120	0.6	11.82	32.83	19.70	30.31
LB3D2	N	9.92	5.32	6.22	120	0.6	21.46	59.61	35.77	43.69
LB3D5	N	6.73	5.63	5.45	120	0.6	17.81	49.47	29.68	38.63
LB3D6	N	2.1	2.16	2.58	120	0.6	6.84	19.00	11.40	19.00
LB3D7	N	8.11	7.57	7.89	120	0.6	23.57	65.47	39.28	46.63
LR3D6	N	5.81	6.47	6.17	120	0.6	18.45	51.25	30.75	39.51
LR3B5	N	8.64	7.92	8.64	120	0.6	25.2	70.00	42.00	48.89
LR3B6	N	4	5.64	7.1	120	0.6	16.74	46.50	27.90	37.14
LR3C1	N	8.64	8.64	8.64	120	0.6	25.92	72.00	43.20	49.89
LR3C2	N	9.59	9.58	9.64	120	0.6	28.81	80.03	48.02	53.90
LR4C	N	2.26	1.54	2.5	120	0.6	6.3	17.50	10.50	17.50
LR3D1	N	9.18	7.74	8.86	120	0.6	25.78	71.61	42.97	49.69
LR3D2	N	7.74	7.02	5.76	120	0.6	20.52	57.00	34.20	42.39
LR3D3	N	9.82	9.36	9.64	120	0.6	28.82	80.06	48.03	53.92
LR3D4	N	4.32	5.22	3.24	120	0.6	12.78	35.50	21.30	31.64
HL3B	N	15.8	13.2	11.8	277	0.9	40.8	49.10	44.19	49.10
HL3D	N	7.74	7.59	7.98	277	0.6	23.31	28.05	16.83	28.05
HLM4	N	3.44	3.92	0.24	277	0.6	7.6	9.15	5.49	9.15
HLE3B	LS	3.56	3.05	0.86	277	0.6	7.47	8.99	5.39	8.99
HLE3D	LS	1.18	3.61	2.3	277	0.6	7.09	8.53	5.12	8.53
LB3B1	N	5.27	6.53	5.46	120	0.6	17.26	47.94	28.77	37.86
LB3B2	N	12.99	5.17	9.32	120	0.6	27.48	76.33	45.80	52.06
LB3B3	N	4.6	4.6	0.18	120	0.6	9.38	26.06	15.63	26.06
LB3B4	N	13.07	9.47	12.16	120	0.6	34.7	96.39	57.83	62.08
LB3B5	N	7.45	11.86	7.09	120	0.6	26.4	73.33	44.00	50.56
LB3B6	N	9.25	11.19	9.52	120	0.6	29.96	83.22	49.93	55.50
LB3C1	N	2.16	1.8	0.72	120	0.6	4.68	13.00	7.80	13.00
LBS2D2	E	11.2	11.2	11.2	120	0.6	33.6	93.33	56.00	60.56
LBS2D4	E	0.8	0.4	0.4	120	0.6	1.6	4.44	2.67	4.44
LE2B	LS	7.36	5.06	4.54	120	0.6	16.96	47.11	28.27	37.44
LE2D	LS	6.4	5.44	5.9	120	0.8	17.74	49.28	39.42	38.53
LE2E1	LS	4.2	4.16	3.8	120	0.6	12.16	33.78	20.27	30.78
LB2A8	N	22.58	18.78	16.38	120	0.6	57.74	160.39	96.23	94.08

Panel	N/E/LS	Phase A (kVA)	Phase B (kVA)	Phase C (kVA)	Voltage	Panel Demand Factor*	Total kVA	Total Connected (A)	Total Connected Load (A) Panel Demand	Total NEC Recp. Demand (A)
LR2B5	N	1.7	0.72	1.2	120	0.6	3.62	10.06	6.03	10.06
LS2B	E	1.93	2.65	1.9	120	0.6	6.48	18.00	10.80	18.00
LS2D	E	0.93	2.65	1.9	120	0.6	5.48	15.22	9.13	15.22
LBR2D13	N	5.46	7.32	6.32	120	0.6	19.1	53.06	31.83	40.42
LBR2D14	N	4.74	5.6	5.74	120	0.6	16.08	44.67	26.80	36.22
LB2A9	N	8.7	7.5	7.04	120	0.6	23.24	64.56	38.73	46.17
LR2B4	N	11.16	10.34	10.28	120	0.6	31.78	88.28	52.97	58.03
LR2D	N	0	0	0.36	120	0.6	0.36	1.00	0.60	1.00
LR2D2	N	11.62	10.9	10.54	120	0.6	33.06	91.83	55.10	59.81
LR2D10	N	4.5	3.6	3.6	120	0.6	11.7	32.50	19.50	30.14
LR2D11	N	8.62	9.82	8.32	120	0.6	26.76	74.33	44.60	51.06
LR2D12	N	5.9	5.88	6.96	120	0.6	18.74	52.06	31.23	39.92
LBS2A1	E	9.7	12.9	9.5	120	0.6	32.1	89.17	53.50	58.47
LBS2A2	E	7.4	6.9	7.95	120	0.6	22.25	61.81	37.08	44.79
LBS2A3	E	7.5	7.9	3.6	120	0.6	19	52.78	31.67	40.28
LBS2A4	E	6.73	9.13	5.88	120	0.6	21.74	60.39	36.23	44.08
LBS2A7	E	9.6	9.3	7.1	120	0.6	26	72.22	43.33	50.00
LBS2A6	E	2.9	5.2	5.1	120	0.6	13.2	36.67	22.00	32.22
LB S2D1	E	5.1	4.99	5.4	120	0.6	15.49	43.03	25.82	35.40
LBS2D2	E	1	0	0	120	0.6	1	2.78	1.67	2.78
LBS2A5	E	14.1	14.3	9.9	120	0.6	38.3	106.39	63.83	67.08
LR2D4	N	4.66	4.32	3.42	120	0.6	12.4	34.44	20.67	31.11
LR2D5	N	2.82	2.52	2.52	120	0.6	7.86	21.83	13.10	21.83
LR2D6	N	3.3	1.96	1.8	120	0.6	7.06	19.61	11.77	19.61
LR2D7	N	3.9	6.02	5.82	120	0.6	15.74	43.72	26.23	35.75
LR2D8	N	2.52	2.34	2.54	120	0.6	7.4	20.56	12.33	20.56
LR2D9	N	1.8	3	1.25	120	0.6	6.05	16.81	10.08	16.81
LR2D10	N	1.06	0.72	0.72	120	0.6	2.5	6.94	4.17	6.94
LR2E1	N	2.72	3.06	4.02	120	0.6	9.8	27.22	16.33	27.22
LB2E2	N	3.6	4.32	3.96	120	0.6	11.88	33.00	19.80	30.39
LR2A5	N	5.76	5.04	4.72	120	0.6	15.52	43.11	25.87	35.44
LR2A6	N	8.82	7.38	6.3	120	0.6	22.5	62.50	37.50	45.14
LBR2D15	N	24.16	24.16	24.16	120	0.6	72.48	201.33	120.80	201.33
LR2B	N	11.86	10.74	10.96	120	0.6	33.56	93.22	55.93	60.50
LR2B1	N	8.64	8.28	7.2	120	0.6	24.12	67.00	40.20	47.39
LR2B2	N	8.64	7.74	7.2	120	0.6	23.58	65.50	39.30	46.64
LR2B3	N	9.2	7	7.16	120	0.6	23.36	64.89	38.93	46.33
HL2B	N	11.5	15.7	13.6	277	0.9	40.8	49.10	44.19	49.10
HL2D	N	12.3	12.5	8.56	277	0.9	33.36	40.14	36.13	40.14
HLE2B	LS	2.68	2	0.85	277	0.6	5.53	6.65	3.99	6.65
HLE2D	LS	5.2	1.3	1.5	277	0.6	8	9.63	5.78	9.63
LR2A1	N	8.56	6.53	6.71	120	0.6	21.8	60.56	36.33	44.17

Panel	N/E/LS	Phase A (kVA)	Phase B (kVA)	Phase C (kVA)	Voltage	Panel Demand Factor*	Total kVA	Total Connected (A)	Total Connected Load (A) Panel Demand	Total NEC Recp. Demand (A)
LR2A2	N	6	4.44	4.44	120	0.6	14.88	41.33	24.80	34.56
LR2A3	N	5.76	4.68	4.14	120	0.6	14.58	40.50	24.30	34.14
LR2A4	N	8.51	7.84	5.81	120	0.6	22.16	61.56	36.93	44.67
LR2A7	N	4.78	3.18	3.62	120	0.6	11.58	32.17	19.30	29.97
LR2D1	N	6.89	4.58	7.16	120	0.6	18.63	51.75	31.05	39.76
LR2D2	N	1.08	1.64	1.26	120	0.6	3.98	11.06	6.63	11.06
LB2D3	N	5.31	2.34	5.83	120	0.6	13.48	37.44	22.47	32.61
LBS1A1	E	3.8	4.7	3.6	120	0.6	12.1	33.61	20.17	30.69
LBS1A2	E	7.3	5.9	6.84	120	0.6	20.04	55.67	33.40	41.72
LBS1B1	E	3.03	3.48	3.63	120	0.6	10.14	28.17	16.90	27.97
LBS1B2	E	6.8	5.5	6.4	120	0.6	18.7	51.94	31.17	39.86
LBS1E1	E	15.7	13.7	14.6	120	0.6	44	122.22	73.33	122.22
LBS1E2	E	3.1	2.9	3.5	120	0.6	9.5	26.39	15.83	26.39
LBS1E3	E	4.6	4.6	3.2	120	0.6	12.4	34.44	20.67	31.11
LBS1E4	E	5.64	5.64	5.64	120	0.6	16.92	47.00	28.20	47.00
LBS1E5	E	5.88	3.26	5.34	120	0.6	14.48	40.22	24.13	34.00
LBS1E6	E	3	2.36	2.26	120	0.6	7.62	21.17	12.70	21.17
LE1B	N	2.52	2.75	1.5	120	0.6	6.77	18.81	11.28	18.81
LE1D	LS	2.86	2.7	2.56	120	0.6	8.12	22.56	13.53	22.56
LS1D	E	2.2	0.68	1.5	120	0.6	4.38	12.17	7.30	12.17
LS1B	E	0.72	0.8	0.68	120	0.6	2.2	6.11	3.67	6.11
LR1D1	N	6.79	5.04	3.66	120	0.6	15.49	43.03	25.82	35.40
LR1D2	N	5.94	5.24	3.96	120	0.6	15.14	42.06	25.23	34.92
LR1E	N	1.44	0.9	0.64	120	0.6	2.98	8.28	4.97	8.28
LBS1A3	E	3.8	4.72	2.36	120	0.6	10.88	30.22	18.13	29.00
LB1E7	N	7.14	4.76	7.4	120	0.6	19.3	53.61	32.17	40.69
LB1E6	N	11.25	11.25	10.71	120	0.6	33.21	92.25	55.35	92.25
LB1E9	N	8.36	9.51	5.78	120	0.6	23.65	65.69	39.42	65.69
LB1D5	N	3.08	1.82	2.7	120	0.6	7.6	21.11	12.67	21.11
LB1E11	N	1.08	1.08	0.54	120	0.6	2.7	7.50	4.50	7.50
LB1A3	N	7.2	3.6	3.78	120	0.6	14.58	40.50	24.30	34.14
LB1D1	N	2.52	3.6	1.8	120	0.6	7.92	22.00	13.20	22.00
LB1D2	N	5.8	7.06	4.9	120	0.6	17.76	49.33	29.60	38.56
LB1D3	N	35.88	39.62	45.24	120	0.6	120.7	335.39	201.23	335.39
LB1D4	N	1.96	1.42	4.86	120	0.6	8.24	22.89	13.73	22.89
LB1E1	N	25.1	25.1	25.1	120	0.6	75.3	209.17	125.50	209.17
LB1E2	N	25.64	25.64	25.64	120	0.6	76.92	213.67	128.20	213.67
LB1E4	N	7.48	12.57	10.22	120	0.6	30.27	84.08	50.45	84.08
LB1E5	N	3.26	4.84	3.62	120	0.6	11.72	32.56	19.53	30.17
LB1E6	N	9.61	7.67	10.56	120	0.6	27.84	77.33	46.40	77.33
LB1E10	N	26.21	26.21	26.21	120	0.6	78.63	218.42	131.05	218.42
LR1B	LS	1.48	1.98	1.08	120	0.6	4.54	12.61	7.57	12.61

Panel	N/E/LS	Phase A (kVA)	Phase B (kVA)	Phase C (kVA)	Voltage	Panel Demand Factor*	Total kVA	Total Connected (A)	Total Connected Load (A) Panel Demand	Total NEC Recp. Demand (A)
LR1B3	N	8.64	7.92	7.92	120	0.6	24.48	68.00	40.80	47.89
LR1B4	N	6.48	5.76	5.04	120	0.6	17.28	48.00	28.80	37.89
LR1B6	N	6.3	6.48	6	120	0.6	18.78	52.17	31.30	39.97
HL1B	N	9.6	8.4	9.1	277	0.9	27.1	32.61	29.35	32.61
HL1D	N	9.9	7.76	4.73	277	0.9	22.39	26.94	24.25	26.94
HL1E	N	6.83	2.92	3.66	277	0.9	13.41	16.14	14.52	16.14
HLE1B	LS	3.7	0.04	2.7	277	0.6	6.44	7.75	4.65	7.75
HLE1D	LS	5.84	5.83	0.97	277	0.9	12.64	15.21	13.69	15.21
HLE1E	LS	7.22	5.23	3.99	277	0.9	16.44	19.78	17.81	19.78
LCPE1	LS	1.7	0.9	1.1	277	0.6	3.7	4.45	2.67	4.45
LB1A1	N	8.48	7.46	8.21	120	0.6	24.15	67.08	40.25	67.08
LB1A2	N	4.14	4.32	3.24	120	0.6	11.7	32.50	19.50	30.14
LB1B1	N	3.96	3.6	3.08	120	0.6	10.64	29.56	17.73	28.67
LB1B3	N	2.56	2.16	1.26	120	0.6	5.98	16.61	9.97	16.61
LB1B4	N	7.08	9.96	9.62	120	0.6	26.66	74.06	44.43	50.92
LBS0C1	E	6.62	5.18	4.93	120	0.6	16.73	46.47	27.88	46.47
LBS0C2	E	6	7	8.18	120	0.6	21.18	58.83	35.30	43.31
LBS0C5	E	10.5	9.08	8.84	120	0.6	19.58	54.39	32.63	41.08
LBS0C6	E	4.89	5.8	6.57	120	0.6	17.26	47.94	28.77	37.86
LE0D	LS	6.7	6.5	7	120	0.6	20.2	56.11	33.67	41.94
LS0B	E	1.86	1	1.2	120	0.6	4.06	11.28	6.77	11.28
LS0D1	N	5.56	6.31	5.21	120	0.85	17.08	47.44	40.33	37.61
LS0D2	N	16.66	16.5	14.24	120	0.85	47.4	131.67	111.92	79.72
LS0D3	N	21.84	19.46	19.46	120	0.6	60.76	168.78	101.27	98.28
LHR0C1	N	5.23	4.49	6.49	120	0.6	16.21	45.03	27.02	36.40
LHR0C2	N	5.94	5.76	4.12	120	0.6	15.82	43.94	26.37	35.86
LHR0C11	N	1.98	2.16	1.82	120	0.6	5.96	16.56	9.93	16.56
LHR0C12	N	1.44	1.44	1.26	120	0.6	4.14	11.50	6.90	11.50
LB0C2	N	3.24	2.52	1.8	120	0.6	7.56	21.00	12.60	21.00
LB0C10	N	2.34	4.68	4.14	120	0.6	11.16	31.00	18.60	29.39
LB0C11	N	5.31	3.87	2.16	120	0.6	11.34	31.50	18.90	29.64
LB0C12	N	3.61	4.78	3.61	120	0.6	12	33.33	20.00	30.56
LB0C15	N	2.88	1.98	3.48	120	0.6	8.34	23.17	13.90	23.17
LB0C14	N	3.06	2.7	4.62	120	0.6	10.38	28.83	17.30	28.31
LB0C17	N	1.62	1.06	1.06	120	0.6	3.74	10.39	6.23	10.39
LB0C18	N	1.08	0.36	0.36	120	0.6	1.8	5.00	3.00	5.00
LM0B4	N	7.86	7	6.42	120	0.6	21.28	59.11	35.47	59.11
LR0B1	N	2.7	5.04	3.78	120	0.6	11.52	32.00	19.20	29.89
LR0B2	N	15.94	14.44	14.44	120	0.6	44.82	124.50	74.70	76.14
LR0B3	N	18.4	15.6	15.6	120	0.6	49.6	137.78	82.67	82.78
LR0C15	N	6.62	6.28	5.63	120	0.6	18.53	51.47	30.88	39.63
LR0C19	N	6.6	5.54	3.84	120	0.6	15.98	44.39	26.63	36.08

Panel	N/E/LS	Phase A (kVA)	Phase B (kVA)	Phase C (kVA)	Voltage	Panel Demand Factor*	Total kVA	Total Connected (A)	Total Connected Load (A) Panel Demand	Total NEC Recp. Demand (A)
LR0D	N	0.54	0	0	120	0.6	0.54	1.50	0.90	1.50
HL0B	N	11.6	9.04	7.19	277	0.9	27.83	33.49	30.14	33.49
HL0D	N	5.65	6.24	2.97	277	0.9	14.86	17.88	16.09	17.88
HLE0B	LS	15	13.1	11.3	277	0.9	39.4	47.41	42.67	47.41
HLE0D	LS	3.77	1.81	2.56	277	0.9	8.14	9.80	8.82	9.80
LB0C1	N	9.92	9.14	6.14	120	0.6	25.2	70.00	42.00	48.89
LB0C2	N	2.94	2.24	3.72	120	0.6	8.9	24.72	14.83	24.72
LB0C3	N	4.8	6.94	4.5	120	0.6	16.24	45.11	27.07	45.11
LB0C4	N	6.38	6.02	5.38	120	0.6	17.78	49.39	29.63	49.39
LB0C5	N	2.94	3.36	3.22	120	0.6	9.52	26.44	15.87	26.44
LB0C6	N	1.88	1.6	1.68	120	0.6	5.16	14.33	8.60	14.33
LB0C7	N	5.7	3.96	5.22	120	0.6	14.88	41.33	24.80	34.56
LB0C8	N	2.7	3	2.2	120	0.6	7.9	21.94	13.17	21.94

		Phase A (kVA)	Phase B (kVA)	Phase C (kVA)		Total kVA	Total Connected (A)	Total Connected Load (A) Panel Demand	Total NEC Recp. Demand (A)
Total Ltg/Rec/Other		**1403.13**	**1323.50**	**1249.68**		**3976.31**	**10403.57**	**6413.73**	**8293.00**
	Normal	1089.00	1036.00	991.00		3116.00	8225.57	5069.42	6501.78
	Emergency	221.54	212.06	193.61		627.21	1717.69	1030.62	1388.28
	Life Safety	92.59	75.41	65.41		233.41	460.30	313.70	402.94
Mechanical Loads						**4376.90**	**x**	**x**	**2231.87**
Normal						2894.7			1681.30
Emergency						1476.9			436.10
Life Safety						30.8			114.50
Clean Rooms	Normal	(4) sets of 3 - 600 kcmil			420 A/wire	2722.356	3276		
	Emergency	3 - 600 kcmil			420 A/wire	680.589	819		
Total						**14695.19**	**x**	**x**	**18274.83**
Normal						10916.32			14323.85
Emergency						3480.87			3304.23
Life Safety						330.26			646.80
*Taken from panel schedules					**Total/SF**	**53.15**			**66.09**
					Normal	39.48			51.80
					Emergency	12.59			11.95
					Life Safety	1.19			2.34

Table #4.3: Service Entrance Size: Working Drawings Calculations.

SUMMARY TABLES

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

Table #4.4: Service Entrance Size: Summary Tables.

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

Table #4.5: Service Entrance Size: Working Drawings.

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)

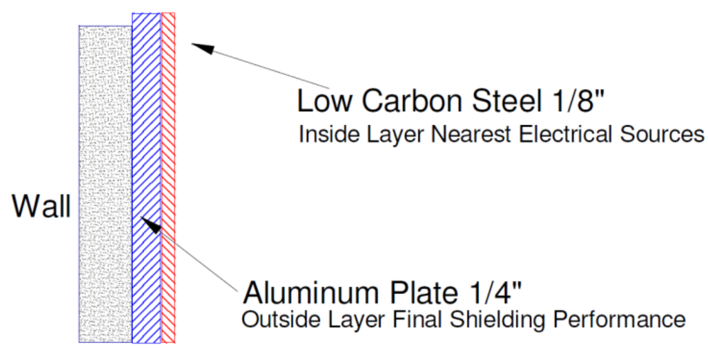


Figure #3.1: Dual substrate shielding in Room N-P053

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 (Electrical metallic tubing) conduit. RMC is a much thicker, limiting the EMF interference with nearby research equipment.

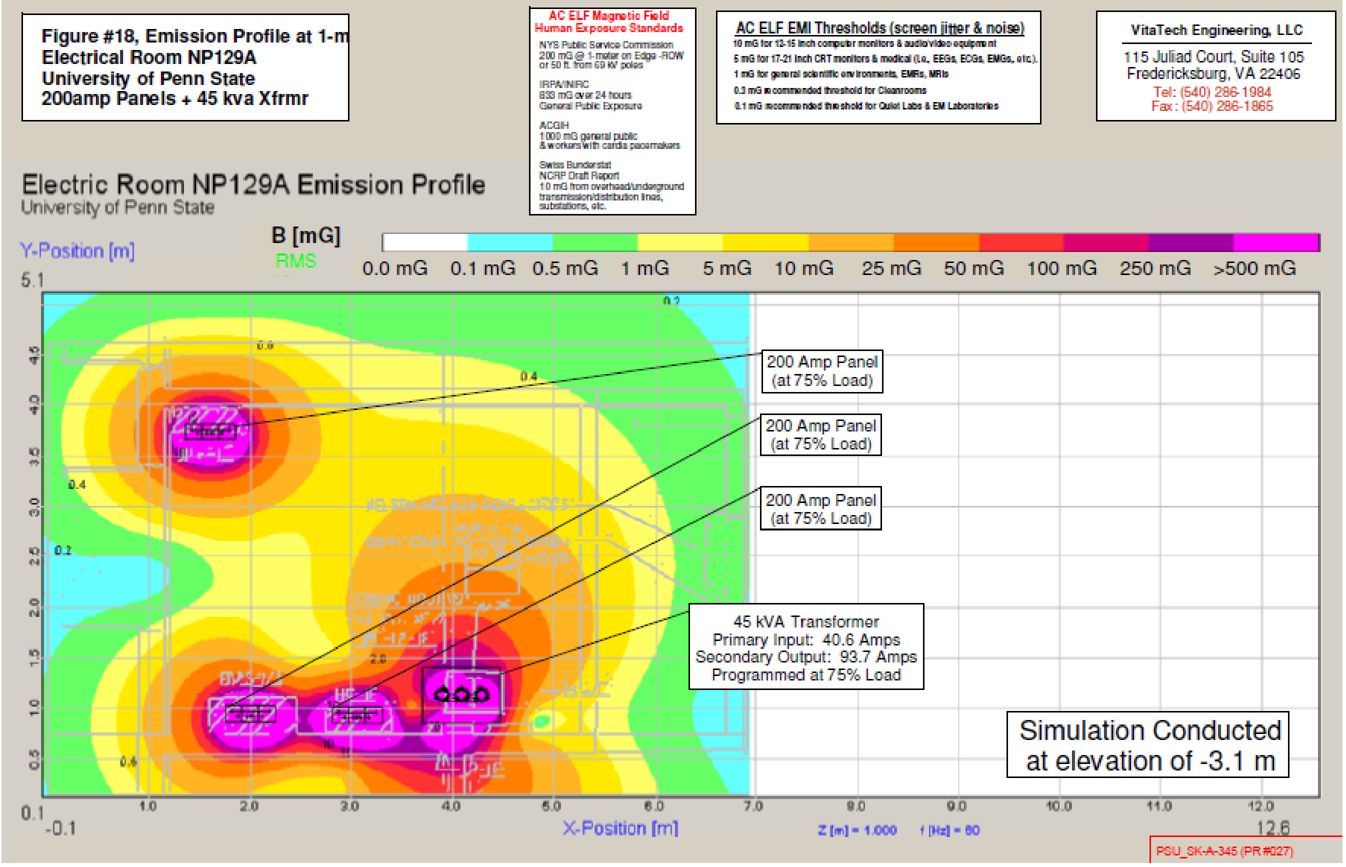


Figure # 3.2: Example of Vita-Tech's EMF study. Example shown is of room N-P129.

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

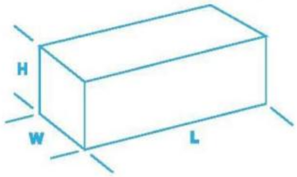
Luminaire Tag	Lamp Source	Lamp Type	Lamp Watts	Num. of Lamps	Ballast Type	Input Voltage (V)	Input Watts (W)	Ballast Factor	Start/Op Current (A)	Power Factor Start/Op
SDF-1B	FLUOR	F32/T8	32W	3	PS Elec.	277	121	0.88	0.45	0.99
	FLUOR	F32/T8/R	32W	1						
SDF-2	QUART	75W TUNGSTEN HALLOGEN	75W	1	NA	277	75	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

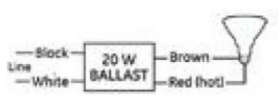
GE Lighting

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 can 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 - C82.14-2006
- UL94V0 Flame Retardant
- Short Circuit Protection
- Inherent Thermal Protection

SPECIFICATIONS BY LAMP & LINE VOLTAGE

Lamp	# of Lamps	Specifications by Line Voltage	System Wattage	Nominal Current	Ballast Factor	Ballast Efficiency	Max.Input Current	Starting Current	Open Circuit Voltage	Drop Out Voltage	Power factor	Min.starting temperature	Fuse rating	UL bench top rise
M156	1	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

Page 1

Figure A.1: Ballast for fixture XBO-1

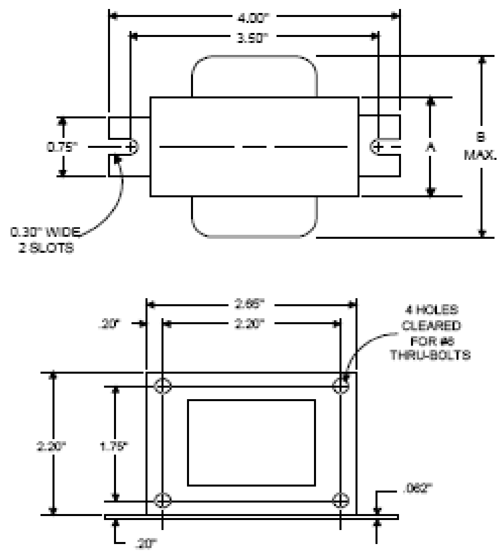
PHILIPS ADVANCE

Metal Halide Lamp Ballast

Catalog Number 71A5037BP
For 35/39W M130
60 Hz R-HPF
Status: Active

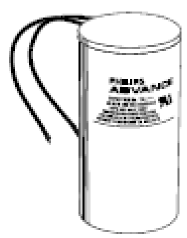
DIMENSIONS AND DATA

2 5/8 X 2 3/16 CORE



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	-	-	-	-

Capacitor: 7C050L30RA



Capacitance:	5
Dia/Oval Dim:	1.25
Height:	2.25
Temp Rating:	105°C

Wiring Diagram:

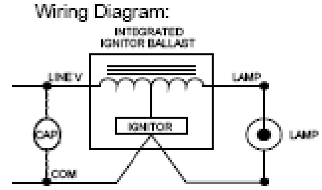


Fig. H

U.L. RECOGNIZED

Ignitor: INTEGRAL

An ignitor integral to the core and coil assembly is used to start the lamp.

Ballast to Lamp Distance
(BTL) = 2 feet
Temp Rating: 125°C

Typical Ordering Information
(please call Philips Lighting Electronics N.A. for suffix availability)

Order Suffix	Description

Data is based upon tests performed by Philips Lighting Electronics N.A. in a controlled environment and is representitive of relative performance. Actual performance can vary depending on operating conditions. Specifications are subject to change without notice.

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Revised: 07/31/09

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

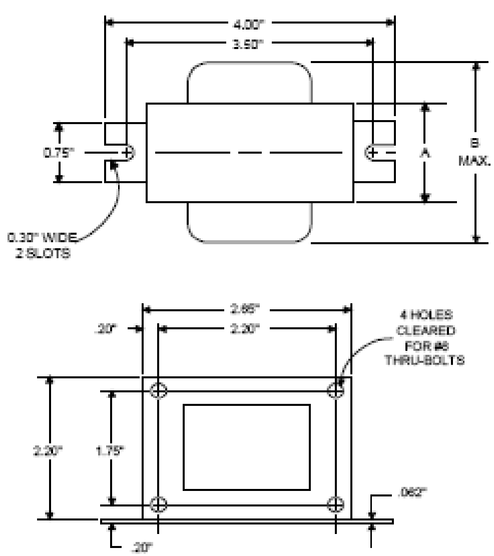
PHILIPS ADVANCE

Metal Halide Lamp Ballast

Catalog Number 71A5237BP
For 70W M98/M143
60 Hz R-HPF
Status: Active

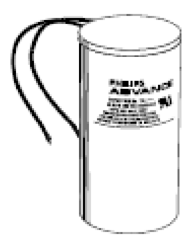
DIMENSIONS AND DATA

2 5/8 X 2 3/16 CORE



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		0.60				
Starting		0.50				
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	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	-	-	-	-

Capacitor: 7C080L30RA



Capacitance: 8
Dia/Oval Dim: 1.25
Height: 2.75
Temp Rating: 105°C

Wiring Diagram:

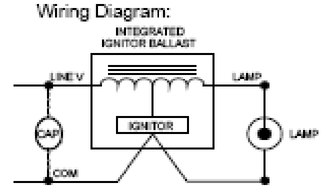


Fig. H

U.L. RECOGNIZED

Ignitor: INTEGRAL

An ignitor integral to the core and coil assembly is used to start the lamp.

Ballast to Lamp Distance
(BTL) = 2 feet
Temp Rating: 125°C

Typical Ordering Information
(please call Philips Lighting Electronics N.A. for suffix availability)

Order Suffix	Description

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Revised: 07/31/09

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

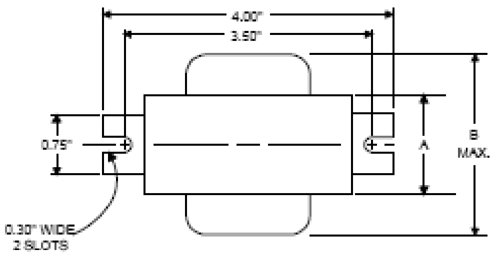
PHILIPS ADVANCE

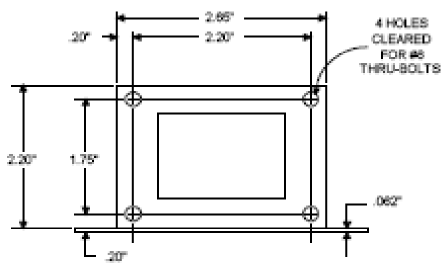
Metal Halide Lamp Ballast

Catalog Number 71A5337BP
For 100W M90/M140
60 Hz R-HPF
Status: Active

DIMENSIONS AND DATA

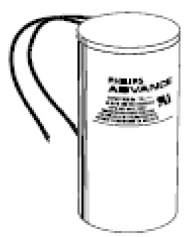
2 5/8 X 2 3/16 CORE





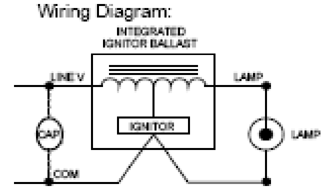
INPUT VOLTS		277				
CIRCUIT TYPE	R-HPF					
POWER FACTOR (min)	90%					
REGULATION						
Line Volts	±5%					
Lamp Watts	±10%					
LINE CURRENT (Amps)						
Operating		0.45				
Open Circuit		1.05				
Starting		0.70				
UL TEMPERATURE RATINGS						
Insulation Class	H(180°C)					
Coil Temperature Code	1029	A				
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	-	-	-	-

Capacitor: 7C100M30RA



Capacitance: 10
Dia/Oval Dim: 1.65
Height: 2.75
Temp Rating: 105°C

Wiring Diagram:



U.L. RECOGNIZED

Fig. H

Ignitor: INTEGRAL

An ignitor integral to the core and coil assembly is used to start the lamp.

Ballast to Lamp Distance (BTL) = 2 feet
Temp Rating: 125°C

Typical Ordering Information
(please call Philips Lighting Electronics N.A. for suffix availability)

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.

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Revised: 07/31/09

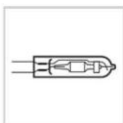
Figure A.4: Ballast for fixture XPO-1

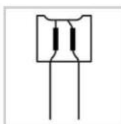
GE Lighting

92696 - CMH20TC/U830G8.5

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

a product of ecomagination





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

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/radhealth/products/urburns.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.

Oct 17, 2010 8:27:22 PM
For additional information, visit www.gelighting.com

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Figure A.5: lamp for fixture XBO-1

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

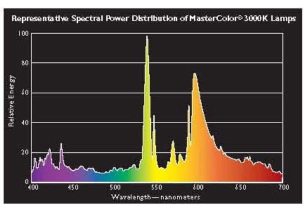
CDM/T6

Ordering Data

Product Number	Ordering Code	Pkg. Qty.	Nom. Watt.	ANSI Ballast Code	Approx. Initial Lumens[1]	Approx. Mean Lumens[2]	CRI
22328-9	CDM35/T6/830	12	39	M130/E	3300	2600	81
22337-0	CDM70/T6/830	12	70	M139/E	6600	4950	81
23272-8	CDM150/T6/830	12	150	M142, M102/E	14,000	9800	85

Electrical and Technical Data

Lamp Operating Volt. (rms)(Nom.)[3] —88 (39W/70W)
—96 (150W)
Initial Lamp Volt. Range (rms)[4] —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
Restrike 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)[5]—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 15/16" (39W/70W)
—4 1/2" (150W)
Light Center Length (LCL)—2 1/2"
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.[6]—12,000
Correlated Color Temp. (CCT)[2] —3000K
CIE Chromaticity Approx.[2]—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.

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)

R "**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:21CFR 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.**

RELAMP 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. RELAMP 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.
   C. Operate CDM-T (G12 base) lamps only on thermally protected ballasts.
   D. Operate CDM-TC lamps (G8.5 base) only on thermally protected electronic ballasts.
   E. Operate CDM-T (G12 base) 39W/842 lamps only on thermally protected electronic ballasts.
7. Periodically inspect the outer envelope. Replace any lamps that show scratches, cracks or damage.
8. If a lamp bulb support is used, be sure to insulate the support electrically to avoid possible decomposition of the bulb glass.
9. Protect lamp base, socket and wiring against moisture, corrosive atmospheres and excessive heat.
10. 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.
11. Lamps may require 4 to 8 minutes to re-light if there is a power interruption.
12. Take care in handling and disposing of lamps. If an arc tube is broken, avoid skin contact with any of the contents or fragments.

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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 arange of compact, high-efficiency, ceramic metal halide reflectorlamps with a stable color over lifetime and a crisp, sparkling light.They deliver superior, energy-efficient accent lighting with consisten, 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	3000 K
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.klx
Damage Factor D/fc	0.20 -

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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.klx
Damage Factor D/fc	0.25 -

• Product Dimensions

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

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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 Universal (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 Mean Lumens	6450 Lm

• UV-related Characteristics

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

• Product Dimensions

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

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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

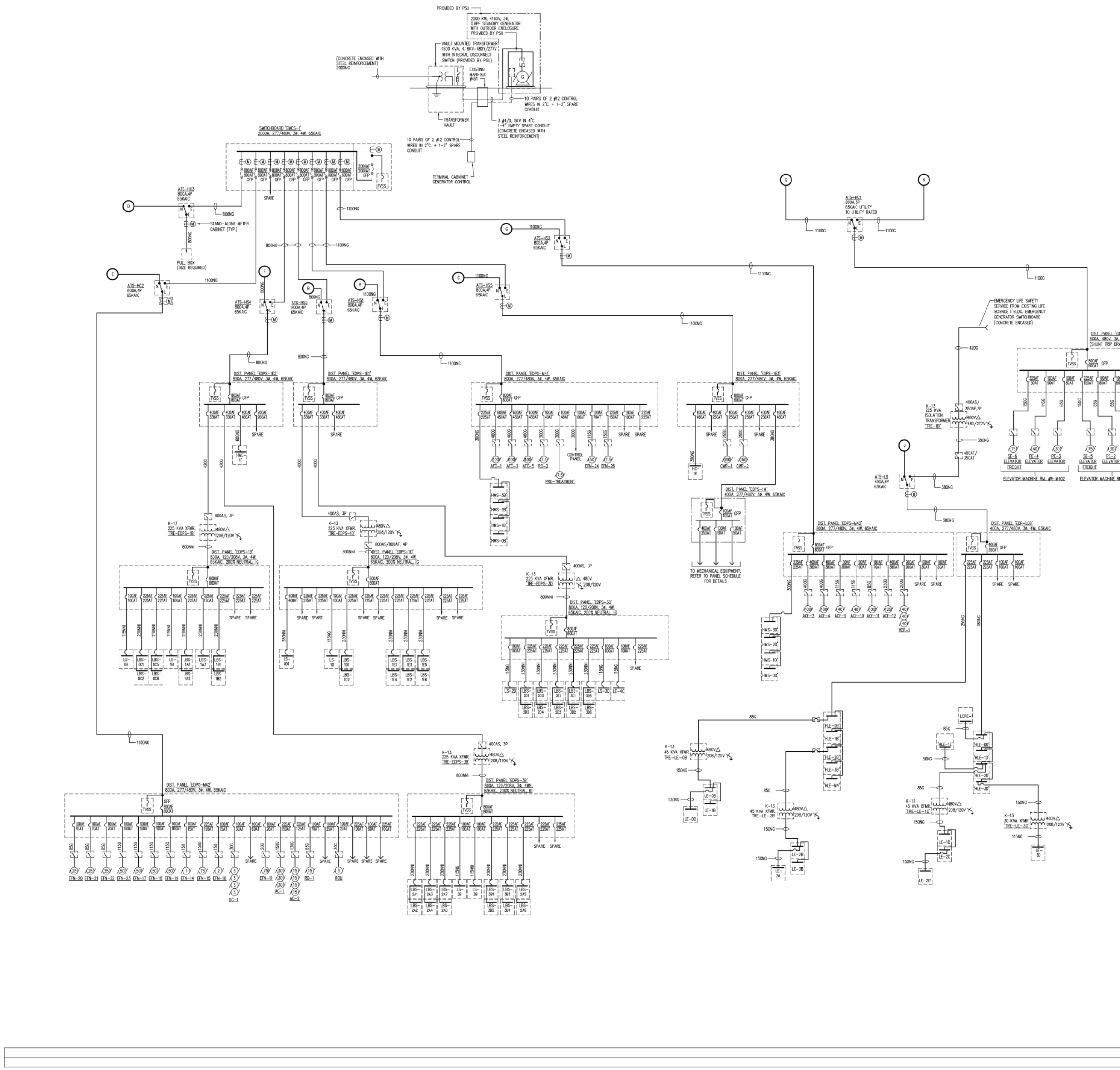
Load Tag	Tag Number(s)	Quantity	Load Description	Load Magnitude	Load Units	NEC Motor Amps	Voltage/Phase	Assumed PF	Eq. Load (kVA)	Eq. Load (kW)
CUH	Various	1	Electrical Cabinet Unit Heater	1/20	hp	2.40	208/3	1	0.86	0.86
Motorized Damper		6	Motorized Damper	0.06	kVA	x	120/1	0.82	0.06	0.05
Main Chiller		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
								Total Load (k-Unit):	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
								Total Load (k-Unit):	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
								Total Load (k-Unit):	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
								Total Load (k-Unit):	252.14	205.20
								Building Total Load:	4340.90	3549.27
									kVA	kW



DRY TYPE TRANSFORMER SCHEDULE

KVA RATING	PRIMARY 480V, 3 PHASE – 3 WIRE: PROTECTION (AMPS)	PRIMARY: FEEDER DESIGNATION	SECONDARY 208Y/120V, 3 PHASE – 4 WIRE: PROTECTION (AMPS)	SECONDARY: FEEDER DESIGNATION *	GROUNDING ELECTRODE
3	15	15 G	15	15 NG	1 # 8
6	15	15 G	20	20 NG	1 # 8
9	15	15 G	30	30 NG	1 # 8
15	25	30 G	50	50 NG	1 # 8
30	50	50 G	100	115NG	1 # 6
45	70	85 G	150	150 NG	1 # 6
75	125	130 G	225	230 NG	1 # 2
112.5	175	175 G	400	380 NG	1 # 1/0
150	225	230 G	500	500 NG	1 # 1/0
225	350	380 G	800	800 NG	1 # 2/0
300	450	460 G	1000	1000 NG	1 # 3/0
500	800	700 G	1600	1600 NG	1 # 3/0
750	1200	1200 G	2500	2500 NG	1 # 3/0

TRANSFORMER SCHEDULE NOTES:

1. PROVIDE CONDUIT SIZED PER N.E.C..
2. CONNECT GROUNDING ELECTRODE TO BUILDING STEEL OR NEAREST APPROVED GROUNDING POINT.
3. ALL TRANSFORMERS SHALL BE MOUNTED ON A 4" HIGH CONCRETE HOUSEKEEPING PAD, U.O.N..
4. ALL TRANSFORMERS SHALL BE RATED FOR 80°C TEMPERATURE RISE, U.O.N..
5. ALL TRANSFORMERS SHALL BE EQUIPPED WITH COPPER WINDINGS.
6. PROVIDE FEEDERS AS INDICATED ON SCHEDULE, UNLESS OTHERWISE NOTED ON DRAWINGS.
7. ALL SHIELDED ISOLATION TRANSFORMERS SHALL BE K-13 RATED.

* FOR TRANSFORMERS SERVING ISOLATED GROUND PANELS FEEDERS SHALL BE TYPE ____ NNI IN LIEU OF TYPE ____ NG

FEEDER SCHEDULE

FEEDER DESIGNATION	No. OF SETS	COPPER CONDUCTORS (75° C) PER SET: PHASE CONDUCTORS	P PARTIAL NEUTRAL CONDUCTOR	N NEUTRAL CONDUCTOR	NN OVERSIZED NEUTRAL CONDUCTOR	G GROUND CONDUCTOR	I ISOLATED & EQUIPMENT GROUND CONDUCTOR
15	1	3 # 12		1 # 12	1 # 10	1 # 12	2 # 12
20	1	3 # 12		1 # 12	1 # 8	1 # 12	2 # 12
30	1	3 # 10		1 # 10	1 # 6	1 # 10	2 # 10
50	1	3 # 8		1 # 8	1 # 2	1 # 10	2 # 10
60	1	3 # 6		1 # 6	1 # 1	1 # 10	2 # 10
85	1	3 # 4		1 # 4	1 # 2/0	1 # 8	2 # 8
100	1	3 # 2	1 # 8	1 # 2	1 # 3/0	1 # 8	2 # 8
115	1	3 # 2	1 # 6	1 # 2	1 # 4/0	1 # 6	2 # 6
130	1	3 # 1	1 # 6	1 # 1	1 # 300	1 # 6	2 # 6
150	1	3 # 1/0	1 # 4	1 # 1/0	2 # 1/0	1 # 6	2 # 6
175	1	3 # 2/0	1 # 2	1 # 2/0	2 # 2/0	1 # 6	2 # 6
200	1	3 # 3/0	1 # 2	1 # 2/0	2 # 2/0	1 # 6	2 # 6
230	1	3 # 4/0	1 # 2	1 # 3/0	2 # 3/0	1 # 6	2 # 6
255	1	3 # 250	1 # 1	1 # 4/0	2 # 4/0	1 # 4	2 # 4
300	1	3 # 350	1 # 1/0	1 # 250	2 # 250	1 # 4	2 # 4
380	1	3 # 500	1 # 3/0	1 # 350	2 # 350	1 # 4	2 # 4
400	1	3 # 500	1 # 3/0	1 # 500	2 # 500	1 # 2	2 # 2
420	1	3 # 600	1 # 4/0	1 # 600	2 # 600	1 # 1	2 # 1
460	2	3 # 4/0	1 # 2	1 # 4/0	2 # 4/0	1 # 2	2 # 2
500	2	3 # 250	1 # 1	1 # 250	2 # 250	1 # 2	2 # 2
600	2	3 # 350	1 # 1/0	1 # 350	2 # 350	1 # 1	2 # 1
700	2	3 # 500	1 # 2/0	1 # 500	2 # 500	1 # 1/0	2 # 1/0
800	2	3 # 600	1 # 3/0	1 # 600	2 # 600	1 # 1/0	2 # 1/0
1000	3	3 # 400	1 # 2/0	1 # 400	2 # 400	1 # 2/0	2 # 2/0
1100	3	3 # 500	1 # 2/0	1 # 500	2 # 500	1 # 3/0	2 # 3/0
1200	3	3 # 600	1 # 3/0	1 # 600	2 # 600	1 # 3/0	2 # 3/0
1600	4	3 # 600	1 # 3/0	1 # 600	2 # 600	1 # 4/0	2 # 4/0
2000	5	3 # 600	1 # 3/0	1 # 600	2 # 600	1 # 250	2 # 250
2500	6	3 # 600	1 # 3/0	1 # 600	2 # 600	1 # 350	2 # 350
3000	8	3 # 500	1 # 3/0	1 # 500	2 # 500	1 # 400	2 # 400
3500	9	3 # 600	1 # 3/0	1 # 600	2 # 600	1 # 500	2 # 500
4000	10	3 # 600	1 # 3/0	1 # 600	2 # 600	1 # 500	2 # 500

FEEDER SCHEDULE NOTES:

1. PROVIDE CONDUIT SIZED PER N.E.C.
2. PROVIDE AN INDIVIDUAL CONDUIT FOR EACH SET.
3. ALL FEEDERS SHALL BE EQUIPPED WITH A GROUND CONDUCTOR.

EXAMPLES:

300 NNG – INDICATES 5#350Kcmil AND 1#4 GROUND CONDUCTOR.
500 NI – INDICATES 2 SETS OF 4#250kcmil AND 2#2 GROUND CONDUCTORS (ONE OF WHICH IS AN ISOLATED GROUND CONDUCTOR) PER SET.
1000 P – INDICATES 3 SETS OF 3#400kcmil AND 1#2/0 PARTIAL NEUTRAL CONDUCTORS PER SET.

AE 481 - Senior Thesis I

Centennial 2010

The Pennsylvania State University
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IPD/BIM Thesis Project 2010-2011

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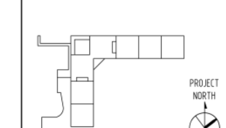
ASSIGNMENT
Technical Report 2: L/E - 100%

DATE
October 27, 2010

LOCATION MAP:



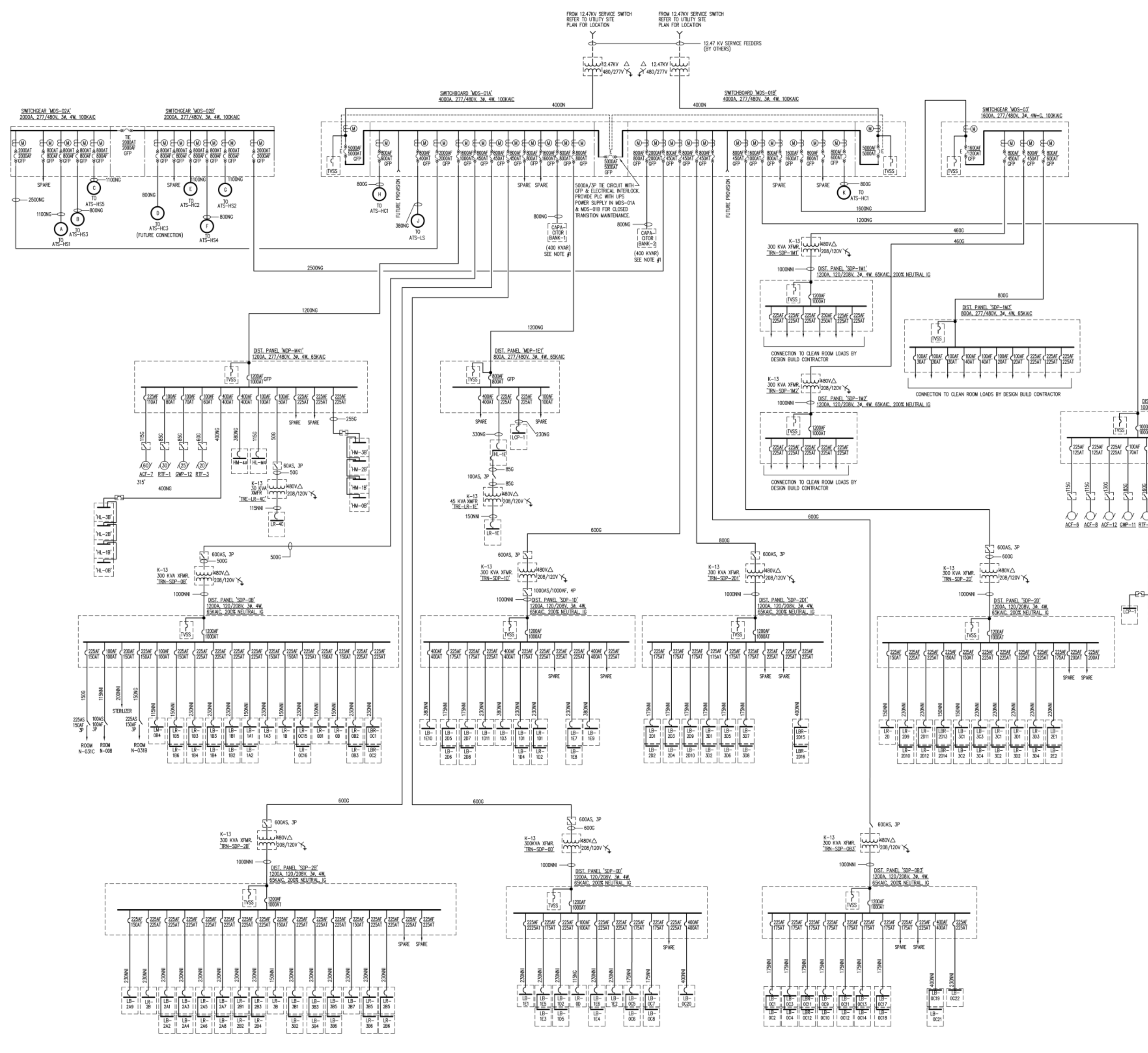
Site Plan & North Arrow

SHEET TITLE
ELECTRICAL EMERGERNCY POWER ONE LINE DIAGRAM

DRAWING SCALE
N.T.S

SHEET NUMBER
E5.0B

JASON BROGNANO | MICHAEL LUCAS | CHRISTOPHER RUSSELL



NORMAL POWER RISER DIAGRAM 1
SCALE: N.T.S.

DRY TYPE TRANSFORMER SCHEDULE					
KVA RATING	PRIMARY 480V, 3 PHASE – 3 WIRE		SECONDARY 208Y/120V, 3 PHASE – 4 WIRE		GROUNDING ELECTRODE
	PROTECTION (AMPS)	FEEDER DESIGNATION	PROTECTION (AMPS)	FEEDER DESIGNATION *	
3	15	15 G	15	15 NG	1 # 8
6	15	15 G	20	20 NG	1 # 8
9	15	15 G	30	30 NG	1 # 8
15	25	30 G	50	50 NG	1 # 8
30	50	50 G	100	115NG	1 # 6
45	70	85 G	150	150 NG	1 # 6
75	125	130 G	225	230 NG	1 # 2
112.5	175	175 G	400	380 NG	1 # 1/0
150	225	230 G	500	500 NG	1 # 1/0
225	350	380 G	800	800 NG	1 # 2/0
300	450	460 G	1000	1000 NG	1 # 3/0
500	800	700 G	1600	1600 NG	1 # 3/0
750	1200	1200 G	2500	2500 NG	1 # 3/0

TRANSFORMER SCHEDULE NOTES:

1. PROVIDE CONDUIT SIZED PER N.E.C..
2. CONNECT GROUNDING ELECTRODE TO BUILDING STEEL OR NEAREST APPROVED GROUNDING POINT.
3. ALL TRANSFORMERS SHALL BE MOUNTED ON A 4" HIGH CONCRETE HOUSEKEEPING PAD, U.O.N..
4. ALL TRANSFORMERS SHALL BE RATED FOR 80°C TEMPERATURE RISE, U.O.N..
5. ALL TRANSFORMERS SHALL BE EQUIPPED WITH COPPER WINDINGS.
6. PROVIDE FEEDERS AS INDICATED ON SCHEDULE, UNLESS OTHERWISE NOTED ON DRAWINGS.
7. ALL SHIELDED ISOLATION TRANSFORMERS SHALL BE K-13 RATED.

* FOR TRANSFORMERS SERVING ISOLATED GROUND PANELS FEEDERS SHALL BE TYPE ____ NNI IN LIEU OF TYPE ____ NG

NOTES:

1. THE ELECTRICAL CONTRACTOR SHALL PROVIDE THE DYNAMIC PF CORRECTION BANK AS AN ALTERNATE. ACTUAL SIZE OF THESE UNITS SHALL BE DETERMINED WITHIN 6 MONTHS AFTER BUILDING OCCUPANCY.

FEEDER SCHEDULE							
FEEDER DESIGNATION	No. OF SETS	COPPER CONDUCTORS (75° C) PER SET					
		PHASE CONDUCTORS	P PARTIAL NEUTRAL CONDUCTOR	N NEUTRAL CONDUCTOR	NN OVERSIZED NEUTRAL CONDUCTOR	G GROUND CONDUCTOR	I ISOLATED & EQUIPMENT GROUND CONDUCTOR
15	1	3 # 12		1 # 12	1 # 10	1 # 12	2 # 12
20	1	3 # 12		1 # 12	1 # 8	1 # 12	2 # 12
30	1	3 # 10		1 # 10	1 # 6	1 # 10	2 # 10
50	1	3 # 8		1 # 8	1 # 2	1 # 10	2 # 10
60	1	3 # 6		1 # 6	1 # 1	1 # 10	2 # 10
85	1	3 # 4		1 # 4	1 # 2/0	1 # 8	2 # 8
100	1	3 # 2	1 # 8	1 # 2	1 # 3/0	1 # 8	2 # 8
115	1	3 # 2	1 # 6	1 # 2	1 # 4/0	1 # 6	2 # 6
130	1	3 # 1	1 # 6	1 # 1	1 # 300	1 # 6	2 # 6
150	1	3 # 1/0	1 # 4	1 # 1/0	2 # 1/0	1 # 6	2 # 6
175	1	3 # 2/0	1 # 2	1 # 2/0	2 # 2/0	1 # 6	2 # 6
200	1	3 # 3/0	1 # 2	1 # 2/0	2 # 2/0	1 # 6	2 # 6
230	1	3 # 4/0	1 # 2	1 # 3/0	2 # 3/0	1 # 6	2 # 6
255	1	3 # 250	1 # 1	1 # 4/0	2 # 4/0	1 # 4	2 # 4
300	1	3 # 350	1 # 1/0	1 # 250	2 # 250	1 # 4	2 # 4
380	1	3 # 500	1 # 3/0	1 # 350	2 # 350	1 # 4	2 # 4
400	1	3 # 500	1 # 3/0	1 # 500	2 # 500	1 # 2	2 # 2
420	1	3 # 600	1 # 4/0	1 # 600	2 # 600	1 # 1	2 # 1
460	2	3 # 4/0	1 # 2	1 # 4/0	2 # 4/0	1 # 2	2 # 2
500	2	3 # 250	1 # 1	1 # 250	2 # 250	1 # 2	2 # 2
600	2	3 # 350	1 # 1/0	1 # 350	2 # 350	1 # 1	2 # 1
700	2	3 # 500	1 # 2/0	1 # 500	2 # 500	1 # 1/0	2 # 1/0
800	2	3 # 600	1 # 3/0	1 # 600	2 # 600	1 # 1/0	2 # 1/0
1000	3	3 # 400	1 # 2/0	1 # 400	2 # 400	1 # 2/0	2 # 2/0
1100	3	3 # 500	1 # 2/0	1 # 500	2 # 500	1 # 3/0	2 # 3/0
1200	3	3 # 600	1 # 3/0	1 # 600	2 # 600	1 # 3/0	2 # 3/0
1600	4	3 # 600	1 # 3/0	1 # 600	2 # 600	1 # 4/0	2 # 4/0
2000	5	3 # 600	1 # 3/0	1 # 600	2 # 600	1 # 250	2 # 250
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4000	10	3 # 600	1 # 3/0	1 # 600	2 # 600	1 # 500	2 # 500

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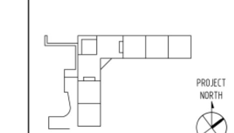

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