Final Thesis Report:

An Analysis of Alternative Lighting & Electrical System Solutions

Ann and Richard Barshinger Life Sciences & Philosophy Building
Franklin & Marshall College
Lancaster, PA

Jason Weaver
Lighting Advisor: Dr. Mistrick
Electrical Advisor: Prof. Dannerth
Lighting/Electrical Option
04/09/2008

ANN AND RICHARD BARSHINGER
LIFE SCIENCES & PHILOSOPHY BUILDING

Franklin and Marshall College

Project Team:

Owner: Franklin and Marshall College
Construction Manager: Turner Construction Company
Architect: Einhorn Yaffee Prescott Architecture & Engineering
Structural Engineer: Einhorn Yaffee Prescott
MEP Engineer: Einhorn Yaffee Prescott

Project Data:

Size: 104,000 sq. ft.
Floors Above Grade: 3
Total Floors: 4
Project Cost: GMP of $39 million
Bid Method: Design-Bid-Build
Dates of Construction:
December 2005 - August 2007

Architecture:

-Georgian Revival Style
-Brick façade, tooled to match existing buildings
-Modern 3-story atrium acts as core of building
-Basement Vivarium for visual research

Mechanical:

-Two roof-mounted Air Handling Units with capacity up to 50,000 cfm of supply air
-Central Utility Plant immediately adjacent to main building contains chiller for this building
-Basement contains domestic water heater service
-Medium-pressure steam service from main campus service facility

Structural:

-Steel framing supporting 6 ½” composite concrete slab
-5” concrete slab-on-grade
-2’6” foundation wall with spread footings
-Roof is Vermont slate shingles supported by galvanized metal decking on structural steel

Electrical:

-15 KV service from Franklin & Marshall main switchgear for entire campus
-12.47 KV servicing substation transformed down to 480Y/277V secondary service voltage
-Step down transformers to 208Y/120V for receptacles and incandescent loads
-350 KW diesel generator for emergency power generation

Lighting:

-Majority of lighting operates at 277V
-Recessed, louvered linear fluorescent luminaires for classrooms, labs, and offices
-Recessed compact fluorescent downlights for corridors and circulation spaces
-Daylight sensor photocell in atrium, dimming systems in common room and lecture hall

Jason Weaver
Lighting/Electrical Option

CPEP Website:
http://www.engr.psu.edu/ae/thesis/portfolios/2008/jpw202/

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Executive Summary

The following thesis report details the analytical and design feasibility studies performed on the Ann and Richard Barshinger Life Sciences & Philosophy Building on the campus of Franklin & Marshall College. Particular focus was given to the lighting and electrical systems, with limited analysis of air distribution systems and acoustical materials.

The Lighting Depth focused on the new lighting design for four spaces. Each space had different goals and design objectives, but in all layouts I strove to create a functional, user-friendly design. The majority of the luminaires used are relatively common in the market, making correct installation of the products both easier and more likely. For the East Entry, I paid particular attention to the optics and shielding on the luminaires to make the exterior more dark-sky friendly. In the Frey Atrium, I performed a daylight analysis and created a custom pendant to act as the focal point for the space. For the Ecology Teaching Laboratory, I created a task-oriented layout (putting lighting over the workstations, counters, and chalkboard) and analyzed switching layouts to determine the best control scheme. Finally, in the Bonchek Lecture Hall, I designed a new ceiling for the space and created dimming scenes for four common functions of the space.

The Electrical Depth analyzes two of the most relevant issues to the design of this and many building today: central transformers and aluminum feeders. The first study analyzes using one central 480 V to 208Y/120 V transformer in place on several distributed transformers in the local electrical rooms on each floor. While the layouts tend to become simpler, it often is a more expensive option because of the increased wire sizes that are required with this option. This case was no exception, and as a result I would not recommend this layout. The second study analyzes using aluminum feeders throughout the building instead of copper. With proper installation, this does prove to be a good cost-saving option. I also analyzed the branch circuits and panelboards affected by the new lighting design and performed a protective device coordination study and a fault current analysis. With the exception of a change from 60A to more common 100A panels, the original design appears to be functioning properly.

The Acoustical Breadth analyzed the acoustical characteristics of the new ceiling in the lecture hall. The ceiling was designed to reflect sound to the back of the space as efficiently as possible. With the new ceiling, the lecture hall had a reasonable reverberation time and passed STC and IIC standards. The Mechanical Breadth involved creating a new diffuser layout in the lecture hall, since the new ceiling removed all of the original diffuser locations. I used a linear, low-width diffuser throughout to evenly distribute air throughout the room and to be as minimally intrusive as possible.

Building Overview

Building Statistics:

Building Name:
Ann and Richard Barshinger Life Sciences and Philosophy Building

Location and Site:
Franklin and Marshall College, Lancaster, PA
(main access from Race Avenue)

Building Occupants:
-Department of Biology;
-Department of Philosophy;
-Department of Psychology;
-Biological Foundations of Behavior Interdisciplinary Program;
-Scientific and Philosophical Studies of Mind Interdisciplinary Program

Size: 104,000 sq. ft.
Number of Stories Above Grade: 3
Total Levels: 4

Project Team:

Owner: Franklin and Marshall College
Owner's Representative: Kevin Orris, VP of Administration
Construction Manager: Turner Construction Company
Architect: Einhorn Yaffee Prescott Architecture & Engineering, P.C.
Structural Engineer: Einhorn Yaffee Prescott
MEP Engineer: Einhorn Yaffee Prescott
Interior Design and Planning: Einhorn Yaffee Prescott
Civil Engineering: Derck + Edson Associates
Landscape Architecture: Halvorson Design Partnership

Dates of Construction:
December 2005 - August 2007

Project Cost:
Guaranteed Maximum Price was $39 million (Actual Cost - $38 million)

Project Delivery Method:
Design-Bid-Build, GMP

Architecture (Design/Function):

This building was designed in the Georgian Revival style. The core of the building is perfectly symmetrical. The front door is centered with a complex entablature and modern columns pronouncing it. Two-story glass windows and pilasters also emphasize this as the main entrance. Windows are in symmetrical rows, and aligned both horizontally and vertically. Breaking this symmetry is the far west end of the building. This area, which contains greenhouses and a lounge, is more modern in styling because of extensive glass area, but still has much of the same character of the rest of the facade. Inside, the building revolves around a central three-story atrium with an open staircase and balcony-style corridors. The philosophy and psychology departments are housed on either end of the first floor. The philosophy department is adjacent to one of the feature areas of the buildings: the Humanities Common Room and Gardens, which the university wants to use as a meeting room and study area. Immediately in back of the atrium (and viewable from the front door) is a 120-seat lecture hall that the university wants to use for professional speakers and seminars. The second and third floors are devoted mostly to lab space and functions of the biology department. The main corridor on each floor resembles a "V" shape, with the vertex at the atrium/main staircase. The interior has a relatively open plan, and clear glass walls in many spaces further enhance this open plan.

Major National Model Codes:

- 2003 IBC with 2004 Supplement
- 2003 IFC
- 2003 NFPA
- 2003 IMC
- 2003 IPC
- 2002 NEC
- ASHRAE 90.1

Zoning: Lancaster City

Historical Requirements:

In order to maintain a consistent architecture throughout the campus, Franklin & Marshall College required the architects to match key facade elements (not the least of which was the brick laying technique) of the surrounding buildings.

Building Envelope:

The roofing is a Vermont slate, chosen and entirely paid for by a single donor to match the character of the surrounding buildings. The majority of the facade is brick, but laid in and tooled in a matter more typical of the surrounding buildings. The architect and college wanted the brick imperfections, thicker mortars, and less crisp lines that most modern brick structures don't have. The majority of the glass of the façade is a 1 inch insulating glass unit, with heat-strengthened glass for the skylights and an even more transparent glass over the greenhouse areas.

System Descriptions:

Structural:

The main structural system for the building is a steel frame supporting composite concrete slabs. The typical beam size is W16X26, which distribute the floor loads to girders (typically sized at W18X90). Steel columns are typically W12X65, and are spaced around 20' feet apart between girders and 32' apart between beams. The floors are a 6 ½ composite concrete slab, consisting of 4 ½" normal weight concrete on 2" 18-gage galvanized metal decking. The foundation system is comprised of a 2-6" foundation wall with spread footings. A 5" concrete slab-on grade finishes the basement system. The Vermont slate shingles on the exterior of the roof are supported by galvanized metal decking on structural steel.

Construction:

Construction on the building started in December of 2005. Originally bid and awarded to Skanska, the project was re-awarded to Turner Construction while the building was under construction. The project was bid at a Guaranteed Maximum Price of $39 million. The building was completed and turned over to Franklin & Marshall in August 2007.

Many key elements of the site had to be preserved during demolition, namely the east sidewalk (which connected the campus to the city) and most of the trees. The east side of the site was virtually untouched during demolition, as a large amount of the campus relies on power lines running underground here. A new asphalt driveway was poured to connect the basement loading dock on the west end of the building to an existing parking lot and Race Avenue. Construction staging was originally on the north end of the site, but later in construction was moved to this driveway.

Lighting:

The majority of the lighting in the building runs on 277V (the notable exception being the incandescent lighting, which runs on 120V). Typical classroom, lab, and office spaces use recessed linear fluorescent fixtures with louvers for shielding. In most of these spaces, recessed compact fluorescent wallwashers are used to highlight a chalkboard wall. Most circulation spaces use a layout of recessed round compact fluorescent and linear fluorescent downlights. Specialty spaces use more incandescent lighting, with the humanities common room using incandescent lighting exclusively (in the form of chandeliers, matching wall sconces, and recessed accent lighting). The atrium uses a track system with halogen lighting and cold cathode lighting mounted in a ceiling cove. More extensive exterior lighting is planned for the future, but currently consisted of lighting on the main entrances, existing walkway lightings, and uplights highlighting the beds in the gardens on the south side of the building.

Electrical:

The main power for the Life Sciences & Philosophy comes from the main switchgear for Franklin & Marshall College. Power is run from existing lines in the front of the building to a basement substation at the northwest corner of the building. The 12.47KV service voltage is transformed down to 480Y/277V secondary service. Power is then distributed to various basement panels, 2 bus ducts, and the penthouse level. Each bus ducts serves one half of the building (north or south), and there are 2 electrical rooms on each floor (again, one on the north side of the building, the other servicing the south side). Most of the lighting runs on 277V. There are transformers converting the voltage down to 208Y/120 V service in each electrical room, on the penthouse level, and the main mechanical room. The 208Y/120 service is used for receptacle loads, incandescent lighting, and much of the heating for the space. The main emergency power system for the building is a 300KW diesel powered generator. Power is distributed from the generator at 480Y/277V. 2 main lines run from the generator: one at 400A and one at 100A. 2 4-pole automatic transfer switches are mounted in the penthouse to power the emergency panels, rated at 400A and 100A respectively. The main emergency panels are also located in the penthouse level, which then distribute power to basement emergency panels. Emergency power also passed through a transformer (converting to 208Y/120V service), and is distributed to emergency panels in the south electrical room of each floor.

Mechanical:

Three air handling units serve the building. Two AHUs with supply air rated at 50,000 CFM each serve the majority of the building, while one rated at 15,000 CFM serves exclusively the vivarium. The system uses a glycol energy recovery loop that exchanges energy between the exhaust air and the outdoor air. This in effect reduces the temperature difference the rest of the heating/cooling system must make up before supplying the air to the spaces. Next to the building is the existing Central Utility Plant, which is being expanded as part of this project. The CUP contains a 550-ton centrifugal chiller for the Life Sciences Building, as well as the fuel oil pump for the building. A 550-ton cooling tower is located on the roof of the main building. Domestic water service is located in the basement. While low-pressure steam service comes from a boiler on the roof, the medium-pressure steam service comes from a central campus facility.

Fire Protection:

The main fire alarm control panel is located in the basement, and is linked to fire alarm terminal cabinets on each floor. Those terminal cabinets are linked to smoke and heat detectors throughout the floor, as well as strobe and speaker circuits and magnetic door holders. The third floor terminal cabinet also services the penthouse/roof level, where smoke exhaust is monitored and controlled. The building is fully equipped with a sprinkler system.

Transportation:

There are three main stairwells in the space. The main staircase is an open staircase in the atrium, services the first, second, and third floors of the building. The other two staircases are enclosed, and are located on the north and south ends of the building, respectively. These two staircases service all floors and the roof of the building. In addition, there is a small open staircase on the south side of the building connecting the basement to the first floor. One elevator, located in the center of the building but away from any major entrances, serves all floors and the penthouse/roof.

Telecommunications:

The main telecommunications lines are run into Room M058 in the central part of the basement. From this room, telecommunications lines are run into two smaller telecomm/data rooms on each floor (one on the north end, one on the south end). Telecommunications services include telephone, closed circuit surveillance, data communications, door access/control, and cable TV. Wireless internet service was also provided by F&M College.

Lighting Depth

Overview:

For the lighting depth, I have selected four spaces to perform detailed lighting design and analysis. These spaces were selected either for their important or impact of the function of the building, or because the space is representative of several others throughout the building (thus lending itself well to repetition of key elements).

Selected Spaces:

Exterior Space – East Entry and Façade

This is the main entrance for the building. It lies along a critical link for the campus to the main town area. In addition, this is by far the most interesting façade of the building, with pilasters, large arched windows, and extensive stonework making this a distinctive façade that needs a complementary lighting design.

Circulation Space – Frey Atrium

The east (and main) entry into the Life Sciences and Philosophy Building leads to this atrium. This acts as the circulation core for the entire building, and most everyday users and all university guests must go through this space. The unique elliptical shape, 3-story height, and many modern elements make this an interesting space for study.

Work Space – Ecology Teaching Laboratory

While not a particularly distinctive space in its own right, this laboratory is a great representative of the many other lab spaces in the building, in terms of both size and usability. As a result, it makes the most sense to perform a full lighting design analysis here, and then repeat the concepts in the other labs as appropriate.

Special Purpose Space – Bonchek Lecture Hall

This space was designed as a guest lecture space for use by both the occupying departments and Franklin & Marshall College as a whole. The space has many different design elements and parameters, including three projection screens, good-sized windows facing west, and a cove ceiling system. This space also lends itself well to breadth studies

Spatial Relationships:

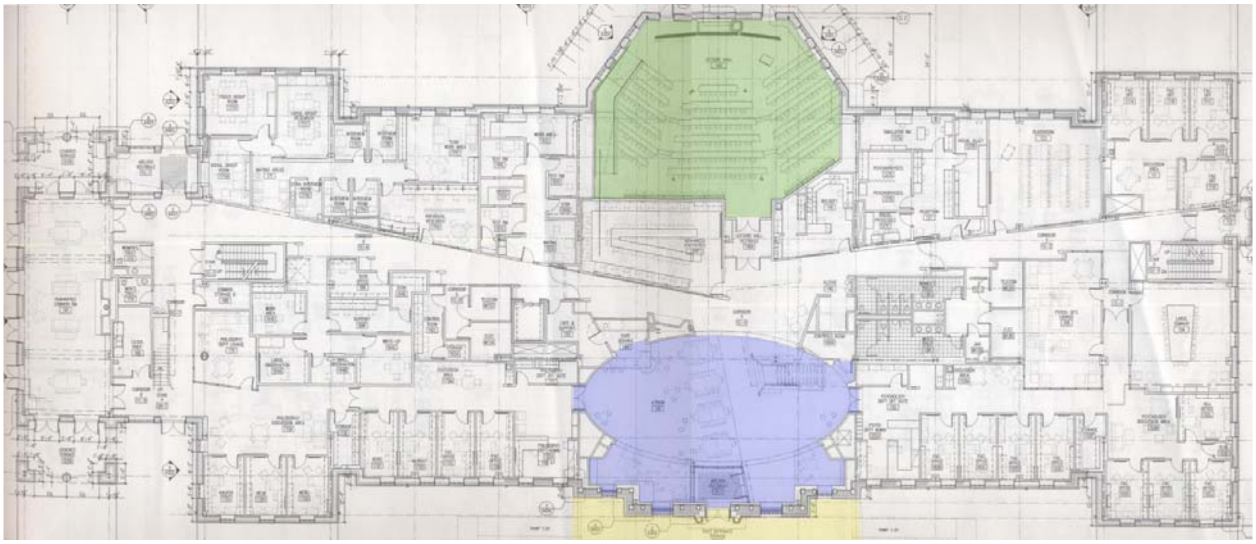


Figure 1.01 *First Floor Plan – Life Sciences & Philosophy Building*
Yellow = East Entry ; Blue = Atrium ; Green = Lecture Hall

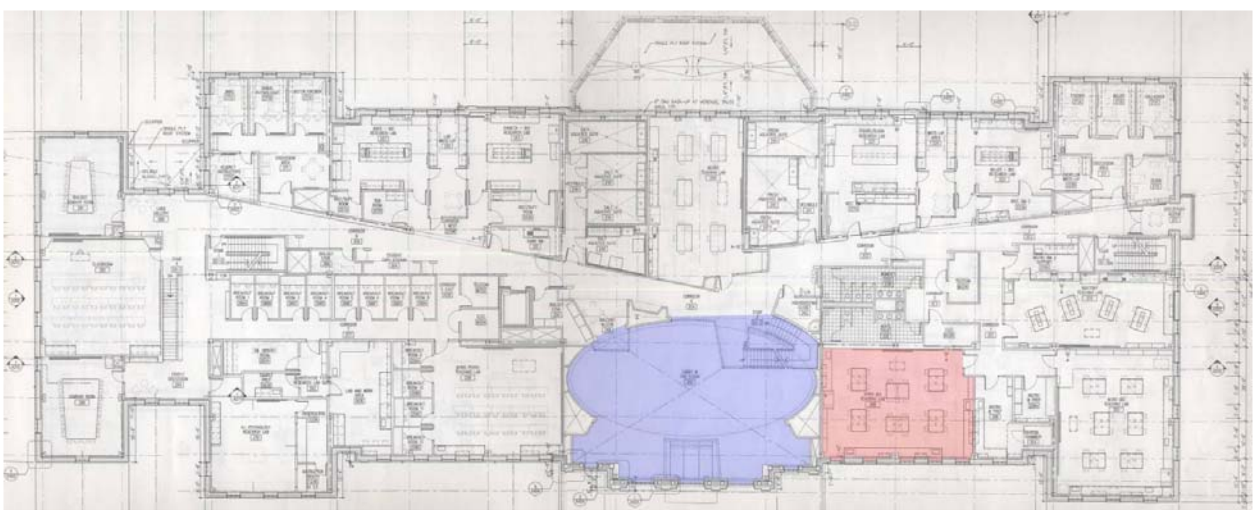


Figure 1.02 *Second Floor Plan – Life Sciences & Philosophy Building*
Blue = Atrium ; Red = Ecology Lab

East Entry & Facade

Overview:

The east entry and facade is a critical space for several reasons. First, it is the entrance that the vast majority of users and guests will use. This façade will be one of the first impressions people will get of Franklin & Marshall College, due to the building's location along the Harrisburg Pike, and because Franklin & Marshall is using photos and rendering of this façade to advertise for the university as a whole. In addition, this façade faces the football stadium and football parking, so even casual visitors will see this façade frequently. One could argue that this is the most critical façade of the entire campus, let alone for this building.

The scope of this space can be defined as the sum of three parts: the façade, the entrance, and the walkway. Each has different design criteria, but in order to be most effective, all three have to be integrated into one seamless design. This can be done by using similar finishes, similar luminaires, similar shapes, etc. The façade is a great example of Georgian revival architecture, complete with pilasters, large windows with white mullions, elaborate stonework, and overall perfect symmetry across the main entry. The entry itself is normally scaled, but the main entrance itself is very long and narrow, and is a couple of feet above ground level. The walkway is the same pink sidewalk Franklin & Marshall College uses throughout the campus. Immediately north on the walkway in the bridge that links the college to the town; not far south on the walkway are the dormitories and other college departments.

Plans:

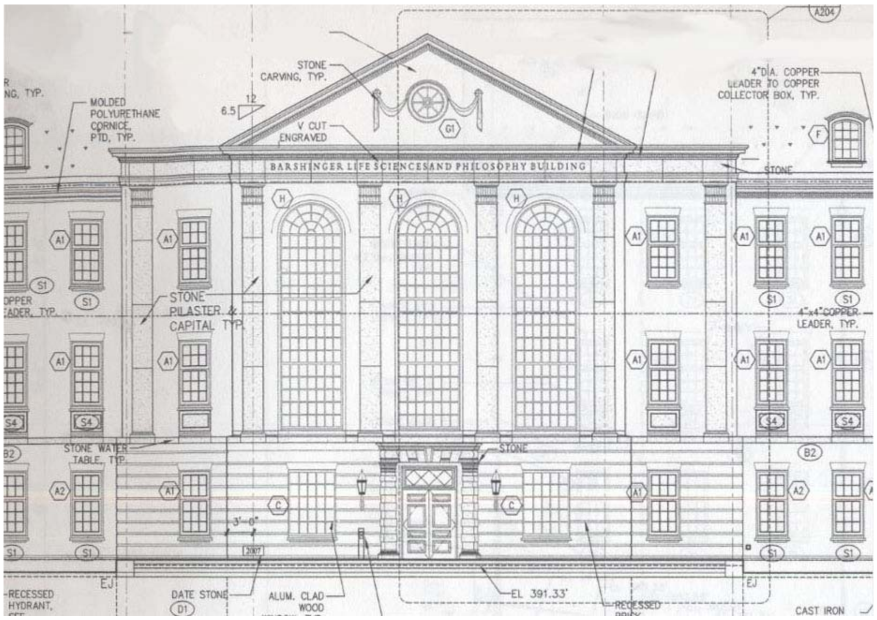


Figure 2.01   East Elevation – Life Sciences & Philosophy Building

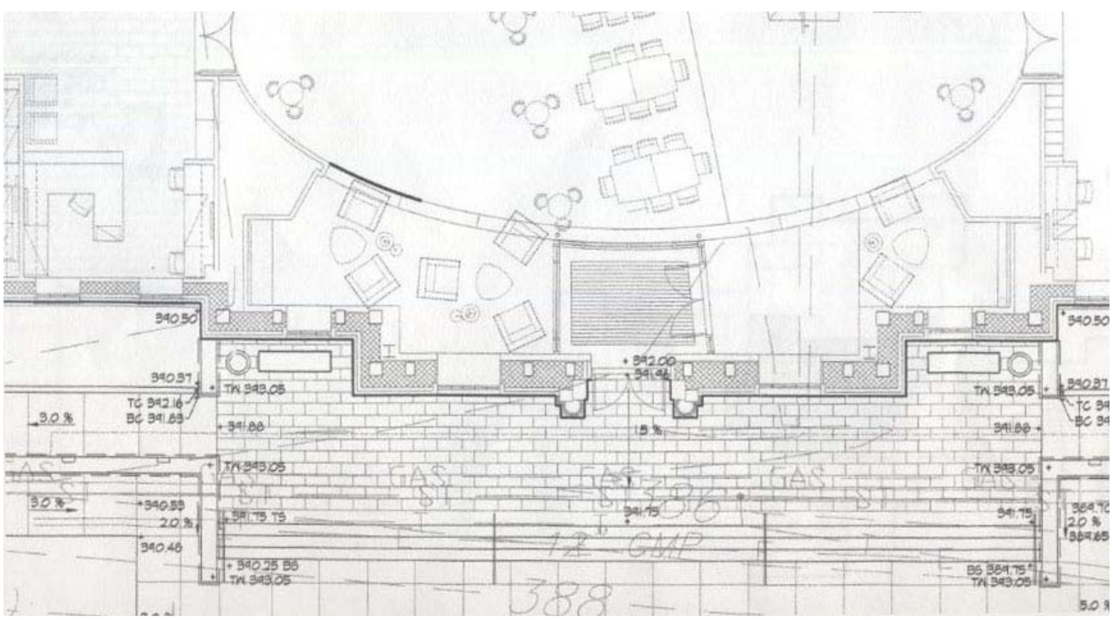


Figure 2.02   Exterior Plan – Life Sciences & Philosophy Building

Surface Characteristics:

Surface	Material	Color	Reflectance	Finish
Main Façade	brick	burnt red	30%	matte
Pilasters / Columns	stone	beige	40%	matte
Carvings	stone	beige	40%	matte
Cornices	polyurethane	beige	40%	semi-gloss
Ground	grass	green	18%	matte
Walkways	concrete	pale pink	40%	matte
Entry	precast concrete unit pavers	grey	20%	matte
Window / Door Trim	painted wood	white	70%	matte

Table 2.01 *Surface Characteristics - Exterior and Façade*

Illuminance Requirements:

IESNA Reference: Building Exteriors – Entrances - Active

Horizontal Illuminance: 5 fc
Vertical Illuminance: 3 fc

Analysis: This seems appropriate, though certain areas of the façade will be higher for emphasis.

Design Criteria and Goals:

Most Important:

Appearance of Space and Luminaires:

- This is the façade that Franklin & Marshall College emphasized when they marketed the building on their website. The façade should be as distinct at night as it is during the day.

Direct Glare:

- This is a security issue. Luminaires that cause glare can temporarily disable people's vision, which is effectively the same as having no light at all, and removes a person's sense of safety.

Modeling of Faces and Objects:

- In order to make people feel more secure, they must have enough light to recognize faces. They must be able to see any object that might interfere with their path and any potential threats.

Points of Interest:

- Key parts of the façade to emphasize are the pilasters, the carvings (including the building name), and the entablature. Also important to draw attention to is the entrance.

Special Considerations:

- One of my design goals is to make the exterior space more dark sky friendly. As a standard, I am shooting for a standard of "CUT-OFF" or "FULLY SHIELDED" or better.

Also Important:

Light Distribution on Surfaces:

- There should be no areas on the sidewalk or entry that appear dark, as dark is associated with unsafe. Spacing of the poles is going to have to be analyzed.

Luminance of Surfaces:

- Generally, most of the surfaces are darker than interior surfaces, and are going to have to be lit to somewhat higher levels than normal. No spot on the building can appear overly bright, as they would effectively create glare because of the dark surround.

Reflected Glare:

- Light can potentially be reflected by the glass and cause glare on people walking past the building.

Shadows:

- Fixtures must be aimed in order to keep shadowing off the walkways and entrances, in order to maintain a secure atmosphere.

Illuminance (Horizontal and Vertical):

- Good horizontal illuminance is required for the walkways and entrance. Good vertical illuminance is needed for the façade.

Luminaire Schedule

Label	Quantity	Description	Number of Lamps / Linear Feet	Lamp Type	Voltage
QQ1	6	Street "acorn" pole fixture with internal reflector to meet "Cutoff" criteria	1	150W MH	277
QQ2	6	Wall-mounted HID projector with 10 degree beam spread and 45 degree shielding	1	39W PAR30L MH	277
QQ3	2	Recessed exterior HID downlight	1	70W CMH	277
QQ4A	1	Linear LED floodlight luminaire with asymmetric optics	36	LED	277
QQ4B	2	Linear LED floodlight luminaire with asymmetric optics	19.5	LED	277
QQ5	2	Exterior wall-mounted acorn fixture at smaller scale to pole fixture	1	39W PAR30L MH	277

Table 2.02 *Compressed Luminaire Schedule for Exterior and Façade*
For Full Luminaire Schedule and Details, Please Refer to Appendix A

QQ1

QQ2

QQ3

QQ4a, QQ4b

QQ5

Ballast Schedule:

Label	Ballast / Driver Type	Power Factor	Ballast Factor	Ballast / Driver Watts
QQ1	Magnetic HID	0.90	-	173
QQ2	Electronic HID	0.95	-	45
QQ3	Electronic HID	0.90	-	79
QQ4A	24V LED Driver	-	-	505.4
QQ4B	24V LED Driver	-	-	280.8
QQ5	Electronic HID	0.95	-	45

Table 2.03 *Compressed Ballast Schedule for Exterior and Façade*
For Full Ballast Details Please Refer to Appendix A

Light Loss Factors:

Label	Maint. Cat.	Degree of Dirt	Cleaning Schedule	Distrib. Cat.	Ballast Factor	Lumin. Dirt Deprec.	Lamp Lumen Deprec.	Room Surface Dirt Deprec.	Total LLF
QQ1	V	Medium	12 mths	Direct	1.000	0.827	0.692	1.000	0.572
QQ2	VI	Medium	12 mths	Indirect	1.000	0.804	0.800	1.000	0.643
QQ3	V	Medium	12 mths	Direct	1.000	0.827	0.710	1.000	0.587
QQ4A	VI	Medium	12 mths	Indirect	1.000	0.804	0.700	1.000	0.563
QQ4B	VI	Medium	12 mths	Indirect	1.000	0.804	0.700	1.000	0.563
QQ5	V	Medium	12 mths	Direct	1.000	0.827	0.800	1.000	0.662

Table 2.04 *Light Loss Factors for Exterior and Facade*

Lighting Plan:

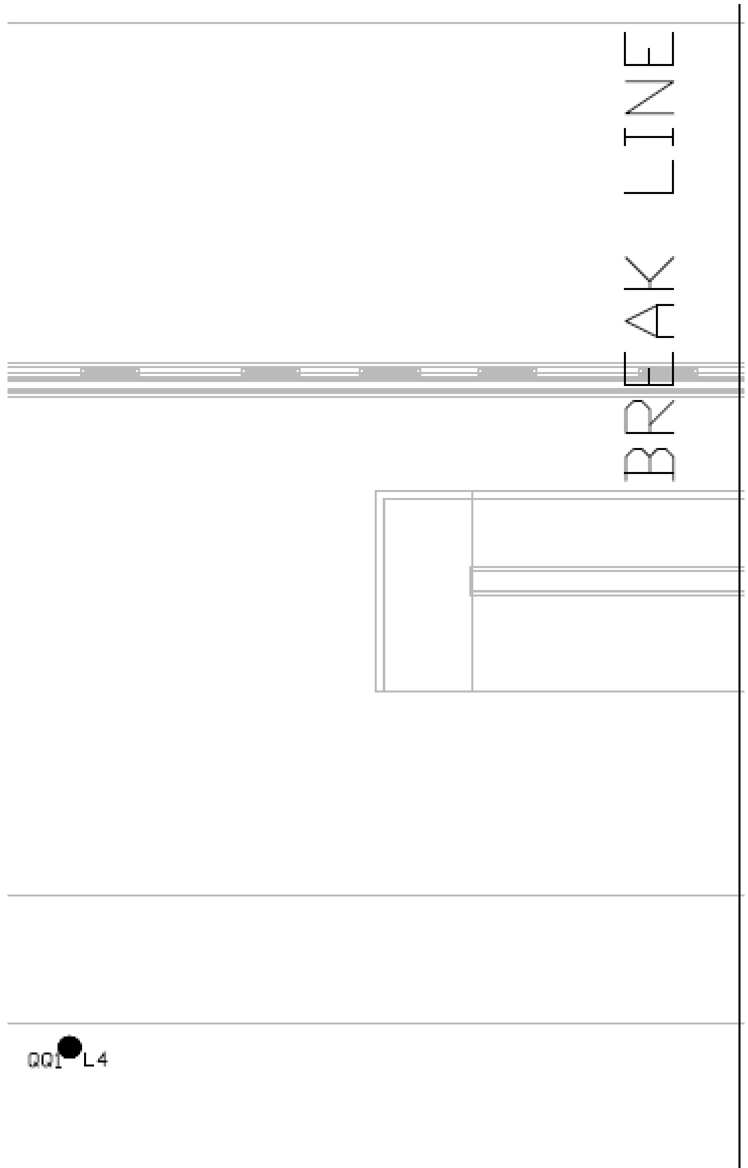


Figure 2.03 *East Entry and Façade Lighting Plan – South of Entry*

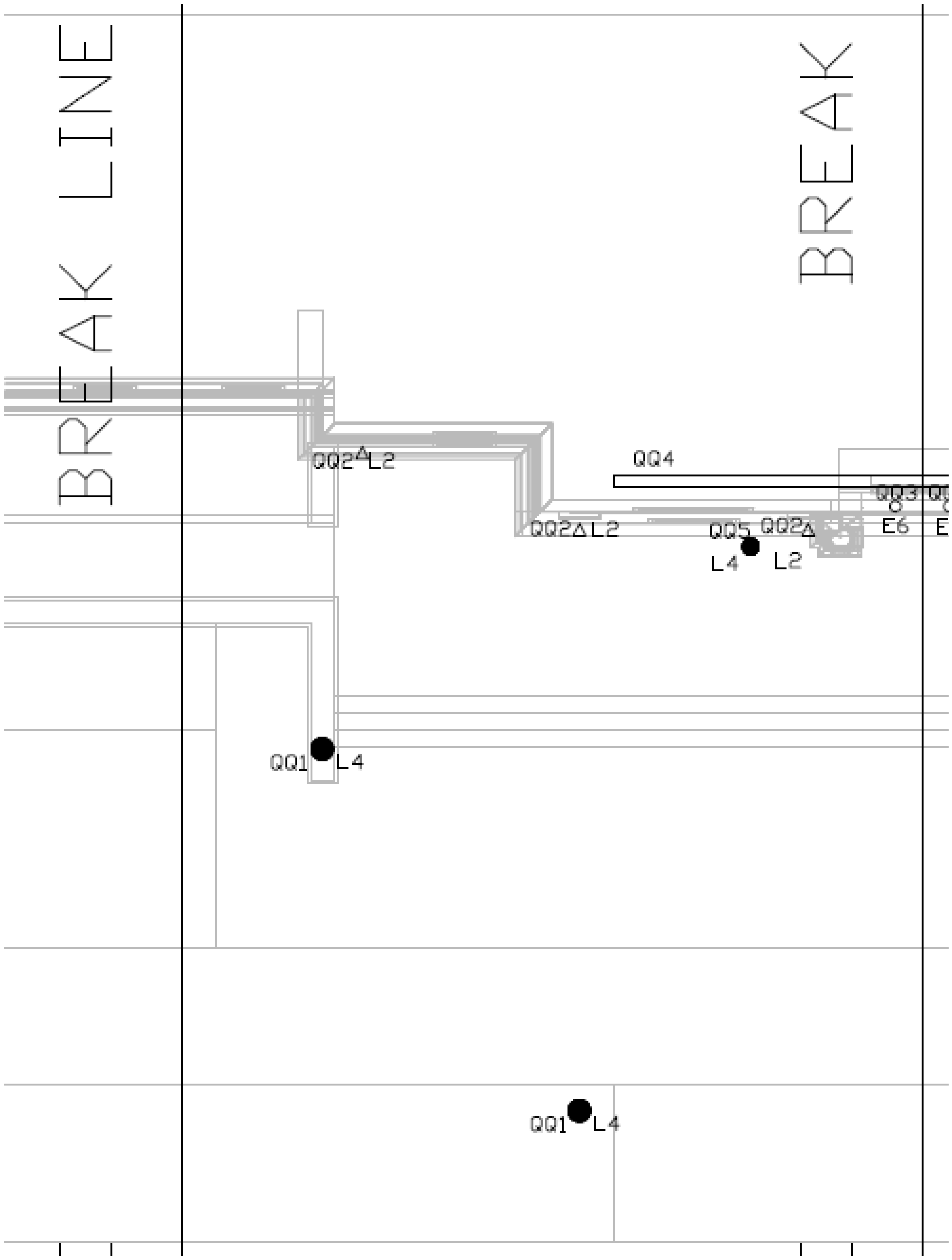


Figure 2.04 *East Entry and Façade Lighting Plan – South Side of Entry*

Note: Design is symmetrical across the main entry; therefore the north side of the plan is exactly the same as the south side.

Details:

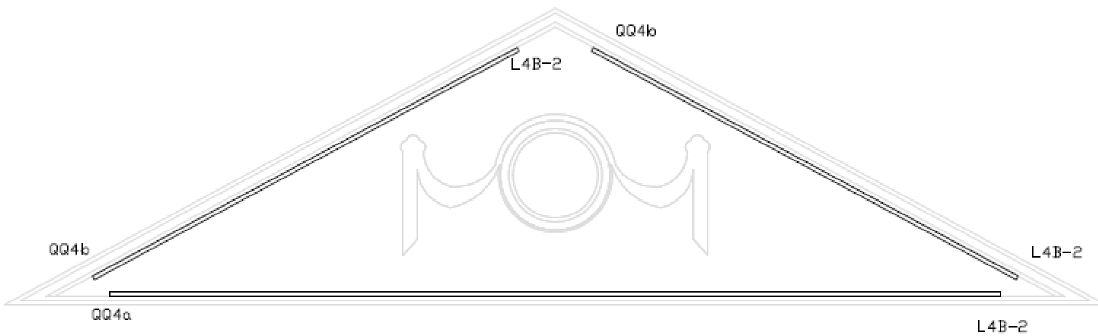


Figure 2.05 *Pediment Lighting Layout – Fixture QQ4*

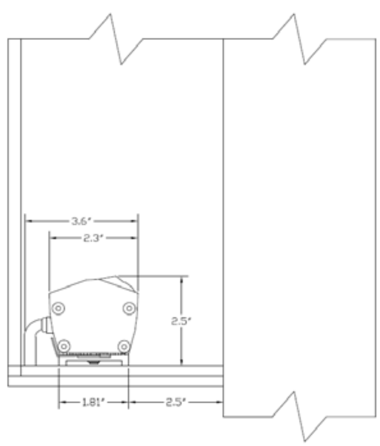


Figure 2.06 *Mounting Detail – Fixture QQ4*

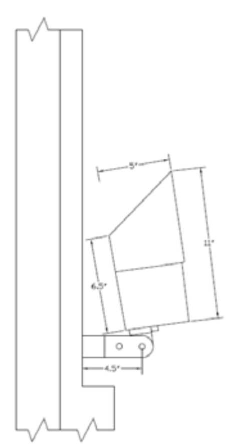


Figure 2.07 *Mounting Detail – Fixture QQ2*

Controls:

The exterior luminaires will be connected to a photocell to determine when they need to switch on. The photocell should be set so that the luminaires turn on at one hour before sunset, and turn on at one hour after sunrise. This allows the automatic shut-off requirement to be met for the exterior.

Calculations and Performance:

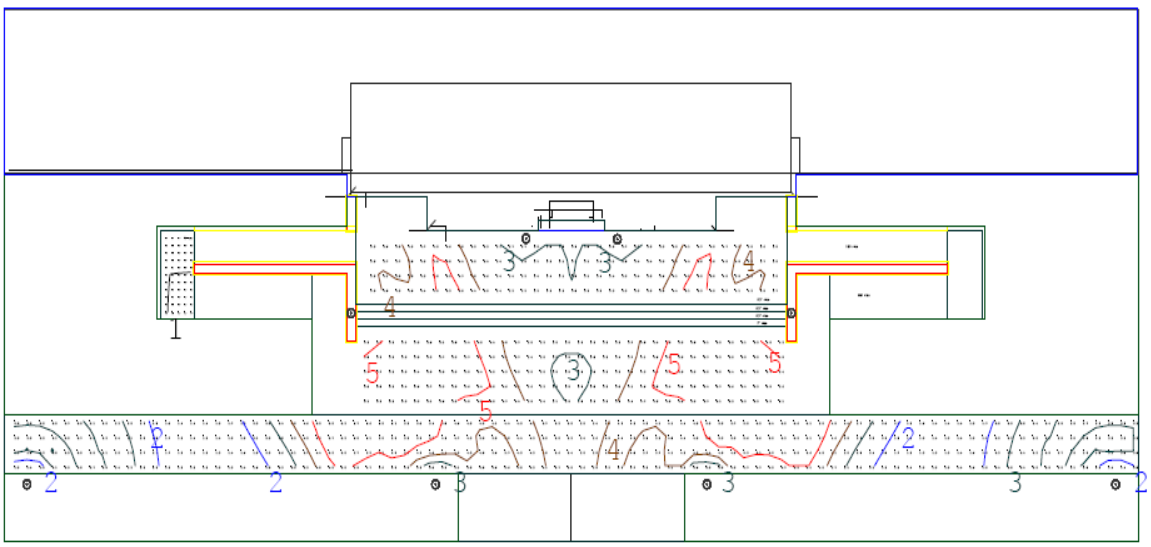


Figure 2.08 *East Entry and Façade – Plan of AGI Model with Footcandle Isolines*

Rendered Images:

Figure 2.09 *East Entry and Façade Rendering – View from Stadium*

Figure 2.10 *East Entry and Façade Rendering – Looking North on Path*

Figure 2.11 *East Entry and Façade Rendering – Main Entrance*

Power Density Calculations:

According to ASHRAE 90.1 – 2004, exterior power allowances for lighting fall into two categories: tradable and non-tradable. The façade falls into the non-tradable category, and any excess allowance not used for lighting the façade cannot be counted towards the power allowance for any other space. The rest of the exterior falls into the tradable category, and can be lumped together as one group.

Area of Space	Matching ASHRAE Category	Power Allowance	Length (ft)	Area (ft^2)	Watts Allowed
Walkway	Walkway < 10 Feet Wide	1.0 W/ft	162	-	162
Plaza	Plaza/Walkway > 10 Feet Wide	0.2 W/ft^2	-	3660	732
Stairway	Stairway	1.0 W/ft^2	-	221	221
Main Entrance	Main Entrance	30.0 W/ft	6	-	180

Total Allowed	1295 W

Table 2.05 *Power Allowances for Exterior Tradable Areas*

Type	Quantity	Input Watts / Luminaire	Total Watts / Type
QQ1	6	173	1038
QQ3	2	79	158
QQ5	2	45	90

Total Watts Consumed	1286 W

Table 2.06 *Power Consumed by Exterior Tradable Areas*

Area of Space	Matching ASHRAE Category	Power Allowance	Length (ft)	Area (ft^2)	Watts Allowed
Façade	Façade	0.2 W/ft^2	-	9120	1824

Total Allowed	1824 W

Table 2.07 *Power Allowance for Façade (Non-Tradable)*

Type	Quantity	Input Watts / Luminaire	Total Watts / Type
QQ2	6	45	270
QQ4a	1	505.44	505.44
QQ4b	2	280	560

Total Watts Consumed	1335.44 W

Table 2.08 *Power Consumed by Façade*

Based on the above calculation, the space meets the energy requirements set forth in ASHRAE 90.1 – 2004.

Conclusions:

This design is a slightly modern take on a simple and traditional design. Acorn pole lighting on its own is hardly cutting edge. However, what makes luminaire Type QQ1 (a version of an acorn pole luminaire) different is optics. With a reflector embedded in the glass to reflect light across the ground, this luminaire becomes a “Full-Cutoff” luminaire, and this helps dramatically reduce light pollution without reducing luminaire spacing or aesthetic appeal. All of the luminaires in this layout have some characteristic that helps to reduce light pollution. Type QQ2, lighting the pilasters, has a very narrow spot distribution and shielding that cuts off any light that missed the building. Type QQ4, highlighting the pediment, has asymmetric optics that directs all of the light towards the pediment. Even Type QQ5, a wall-mounted acorn luminaire, is “Semi-Cutoff”. While I stated earlier that my goal was at least “Cut-Off” or “Fully Shielded”, in order to get the scale and appearance of luminaire I wanted, the best I could accomplish was “Semi-Cutoff”. However, the candelas above 90 degrees nadir are not particularly high (less than 100), and a lot of this strikes the building. The design highlights the traditional elements of the space (namely the pediment and the pilasters) in modern ways (LED optics and narrow spot metal halides), limits light pollution, and manages to come under the energy budget. I feel the design is well suited for this building.

Frey Atrium

Overview:

The Frey Atrium acts as the core of the entire Life Sciences & Philosophy Building. Most of the everyday users, and all of the university guests, enter the building from the east entrance into the atrium. It acts as a direct link to the Bonchek Lecture Hall, the Psychology and Philosophy Departments on the first floor. The open staircase is the main access path to the second and third floor of the building.

The atrium provides a great counterbalance to the east façade. Though they share many windows, including 3 two-story high arched windows, the designs are dramatically different. The exterior embodied a traditional Georgian revival, relying heavily elements of symmetry and balance. Materials used on the façade include brick and concrete, and the whole exterior was designed to look as an enhanced version of the buildings that have been on campus for decades.

The atrium, on the other hand, is a very modern design. The main shape of the space is an ellipse, which is not frequently used in traditional design. The walls are curved in the ellipse shape for all three stories, and the wood ceiling is offset from the walls about 2 feet, but retains the same shape. More noticeable is the difference in symmetry. While the basic shape of the room is symmetrical, many other elements were added to break up the sense of evenness. The balconies (themselves an uneven shape) are only on the south end of the atrium, while the 3-story open staircase dominates the north side of the shape. The first floor is divided into two areas. The seating area has a brown carpet as its floor covering, while the circulation area is a grey terrazzo. There is a clear transition between the two areas, but the division was purposely uneven (the seating area is much bigger).

Materials used here include a lot of dark wood, painted metal, and a translucent metal/frosted glass mesh that is used on the railings. A counter is provided for the café at the back end of the space. Other mobile furnishings will include couches, armchairs, and coffee tables.

Plans:

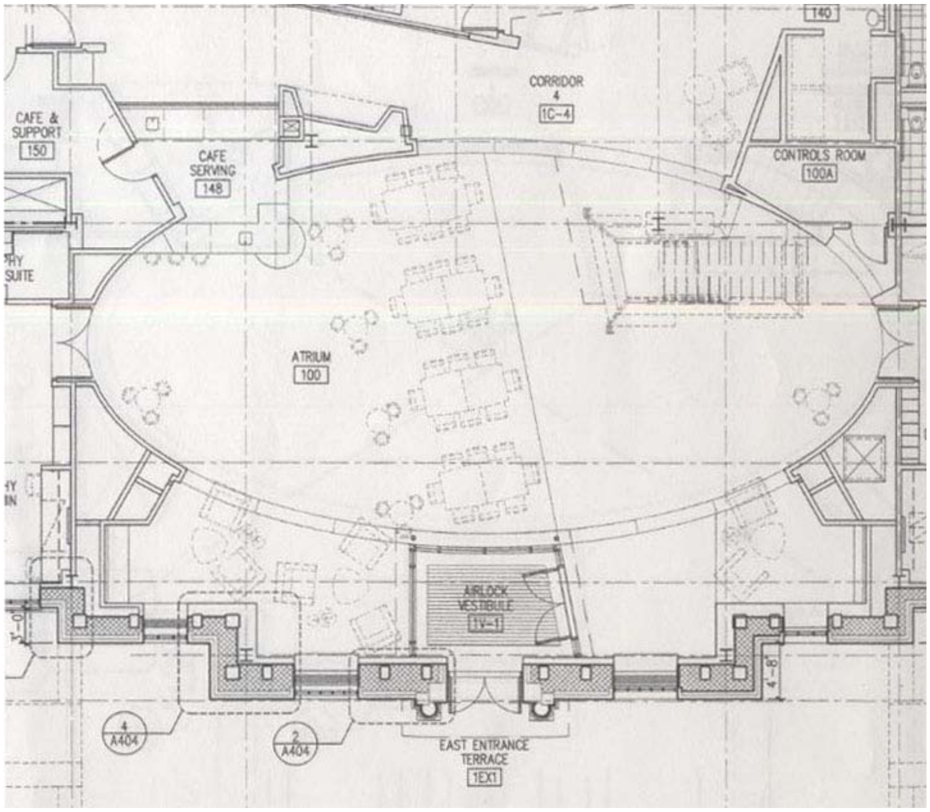


Figure 3.01 First Floor Plan - Atrium

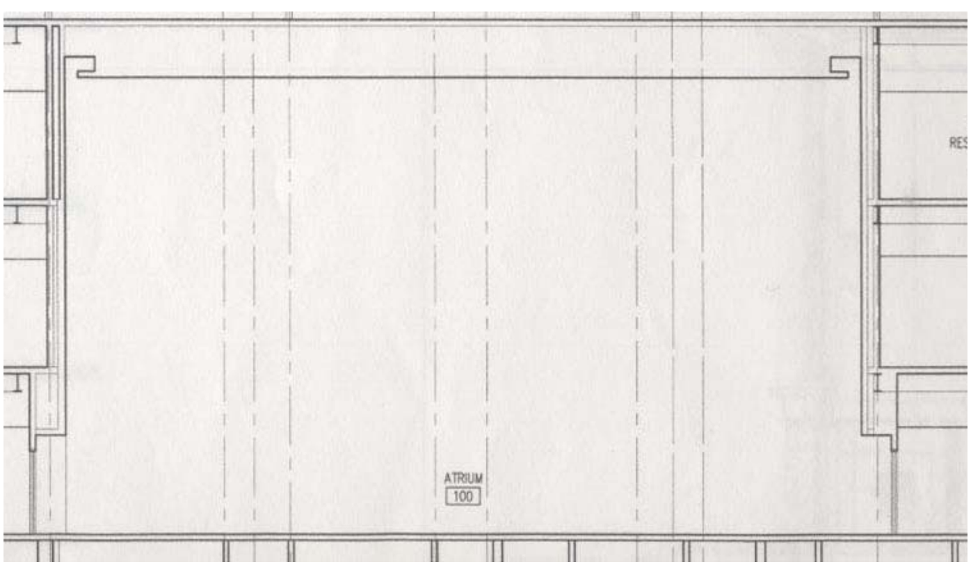


Figure 3.02 East to West Section - Atrium

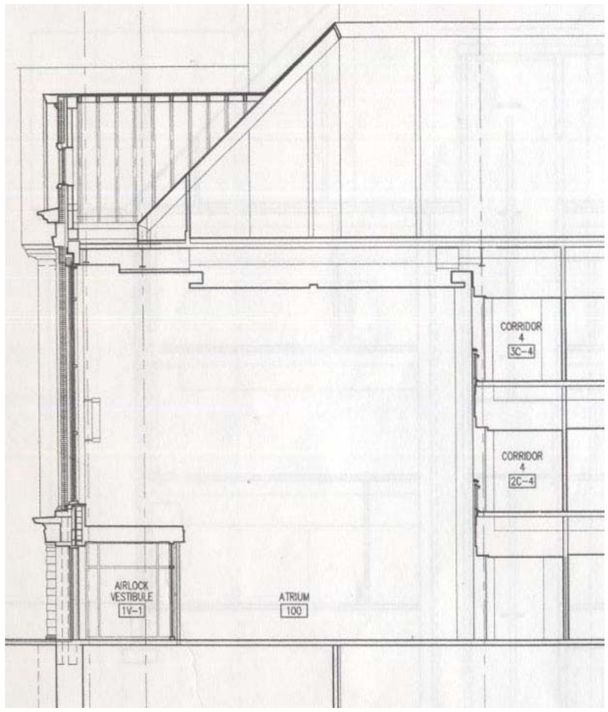


Figure 3.03 *North to South Section - Atrium*

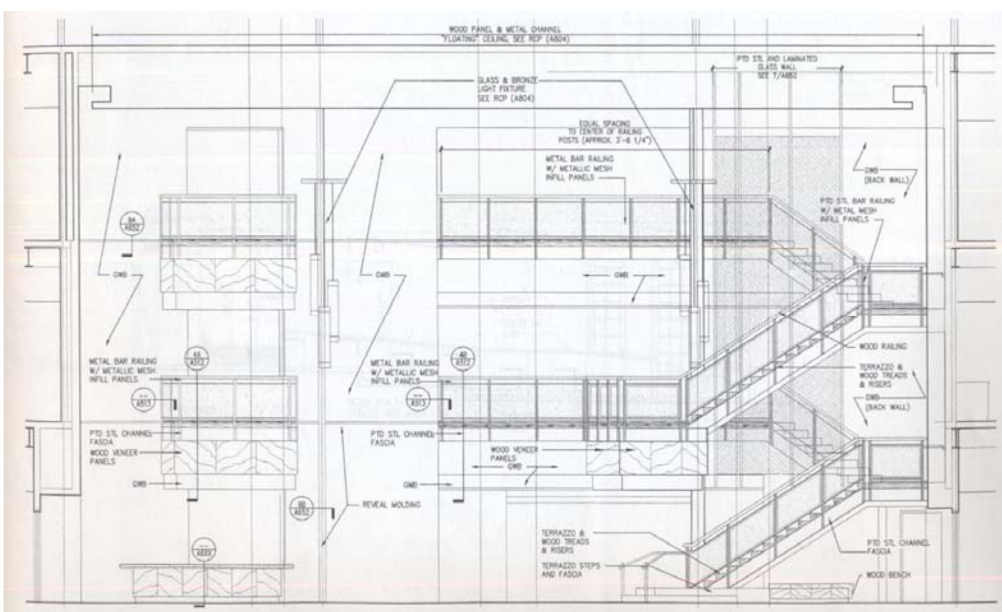


Figure 3.04 *West Elevation – Atrium*

Surface Characteristics:

Surface	Material	Color	Reflectance	Transmittance	Finish
Flat Ceiling	gypsum board	white	70%	-	matte
Acoustical Ceiling	wood slat panel	brown	15%	-	matte
Counter	bluestone	grey	15%	-	matte
Floor - Sitting	Carpet	dark grey	20%	-	matte
Floor - Circulation	terrazzo	light grey	45%	-	semi-specular
Steps	terrazzo	grey	35%	-	semi-specular
Main Walls	gypsum board	white	70%	-	matte
Benches	Wood	brown	15%	-	semi-specular
Balcony Panels	wood veneer panels	brown	15%	-	semi-specular
Decorative Wall	laminated glass	blue	5%	30%	specular
Railings	Wood	brown	15%	-	semi-specular
Rail Supports	Steel	dark grey	20%	-	matte
Rail Sides	translucent glass	clear	10%	40%	specular
Vestibule Ceiling	Wood	brown	15%	-	semi-specular
Vestibule Trim	Wood	brown	15%	-	semi-specular

Table 3.01 *Surface Characteristics - Atrium*

Daylight Elements:

Label	Quantity	Window Type	Mullion Pattern	Max Height	Max Width	Finish	Transmittance	Reflectance
A1	6	Rectangular	3X5	7'-10"	3'-8"	Clear	80%	5%
C	2	Rectangular	5X5	7'-10"	5'-4"	Clear	80%	5%
H	3	Arched Radius	7X15 + arch	25'-11"	7'-0"	Clear	80%	5%

Table 3.02 *Daylight Elements - Atrium*

Illuminance Requirements:

IESNA Reference: Hotels – Lobby – General Lighting (closest equivalent)

Horizontal Illuminance: 10 fc

Analysis: During the day, the daylighting should provide more than this by itself. At night, there are going to be task locations that require 30 fc (particularly the café cashier station and the work areas).

Design Criteria and Goals:

Most Important:

Appearance of Space and Luminaires:

- This space is the first that nearly every person entering the building will see, and this includes guests of the university. It is important that this space appears to be impressively aesthetically and also relaxing. High quality finishes were used here, so equally high-quality luminaires with pleasing aesthetics should be used.

Daylight Integration and Control:

- There is a very large amount of window area on the east wall of the space, and these have the potential to bring enough light into the space for all functions. The glass area is so large, however, that it is probable that too much light is going to enter the space, and good control of this light is critical.

Modeling of Faces and Objects:

- This is a requirement for the café area. Adequate light on faces, food, and menus is needed in order to conduct business. Also, way-finding is a critical task in this space, and being able to pick up on visual cues as to where to go requires a great deal of light on these objects.

Points of Interest:

- The open stairs and balconies are dominant elements of the space, so highlighting these areas would probably be a good idea. I'd also like to emphasize the work areas (the seating areas with tables and chairs) with more light that the general circulation areas.

Also Important:

Direct Glare:

- This relates more to the daylight entering the space. If not shielded properly, it could become impossible to do work in some areas of the spaces during certain daytime hours.

Light Patterns:

- In order to create a relaxing atmosphere, patterns of light can create bits of visual interest and help the space appear more natural.

Source/Task/Eye Geometry

- One of the tasks in this space will be casual reading. If the reading material is particularly glossy, it's going to be important to look at how the daylight is going to reflect off of the pages.

Surface Characteristics:

- The wood ceiling has some gloss to it, so a primarily indirect system would not be very effective here. The terrazzo flooring also is somewhat specular, so any high-intensity beams are going to be reflected strongly off of the floor, which could create some glare.

System Control and Flexibility:

- Daylight sensing controls may be important, as is adapting the system to both day and nighttime use. Different scenes might be good for receptions and regular work, but it's not crucial.

Daylight Study:

In order to determine whether electric light would be required during daytime hours, I performed a daylight study using AGI. The goal is to have at least 15 footcandles throughout the space at all times during the day.

Parameters:

Location: Lancaster, PA
Latitude: 40.07^{O} N
Longitude: 76.47^{O} N
Direction Building Faces: 18^{O} North of East

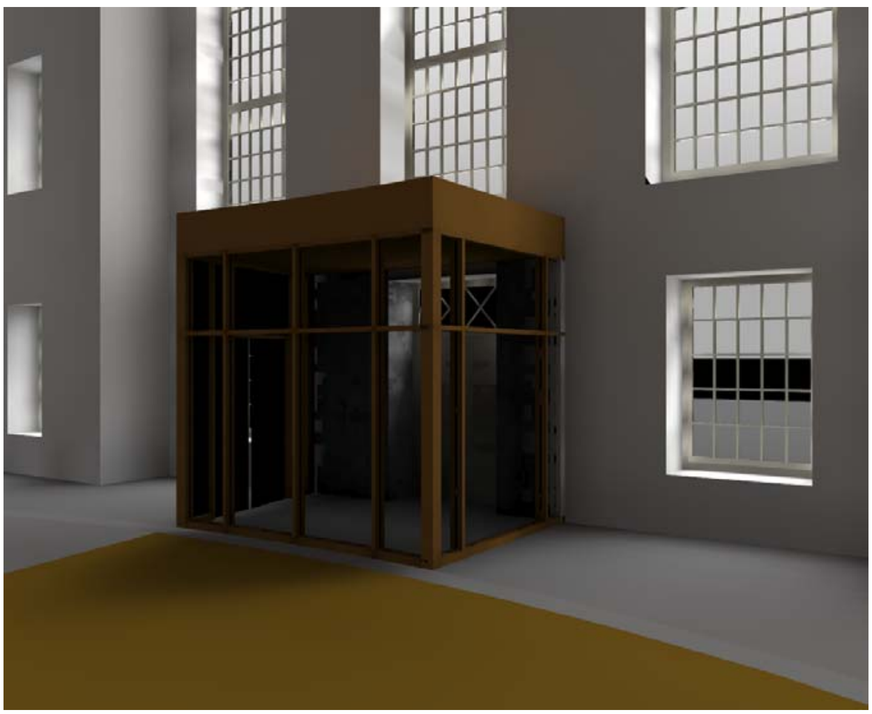


Figure 3.05 *Rendering of Atrium – March 21st, Overcast Sky, 10:00 AM*

Figure 3.06 *Rendering of Atrium – March 21st, Clear Sky, 8:30 AM*

Figure 3.07 *Rendering of Atrium – March 21st, Clear Sky, 12:00 PM*

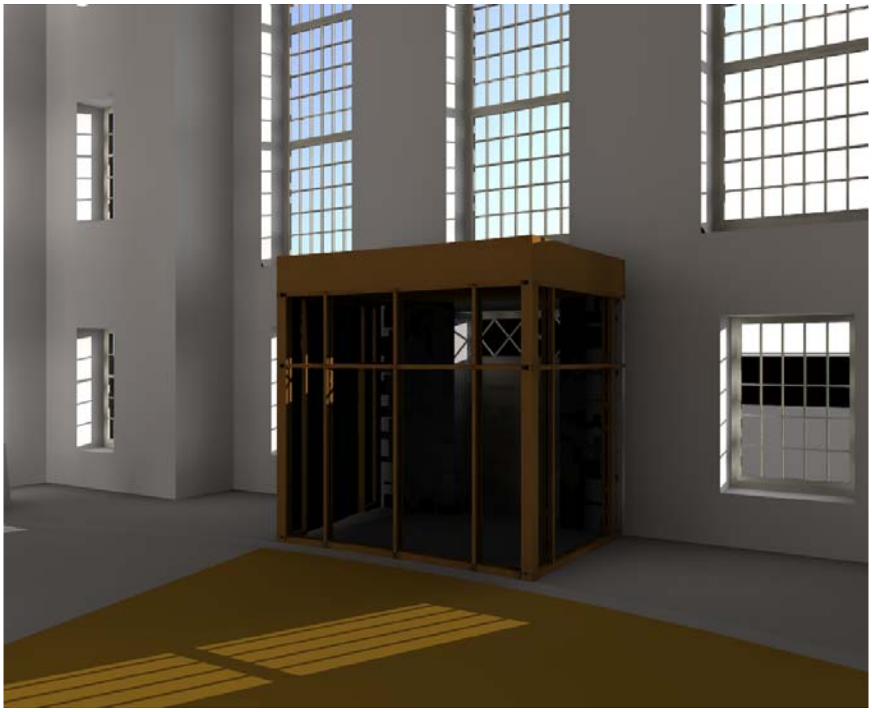


Figure 3.08 *Rendering of Atrium – December 22nd, Clear Sky, 8:30 AM*

Figure 3.09 *Rendering of Atrium – December 22nd, Clear Sky, 12:00 PM*

Figure 3.10 *Rendering of Atrium – June 22nd, Clear Sky, 8:30 AM*

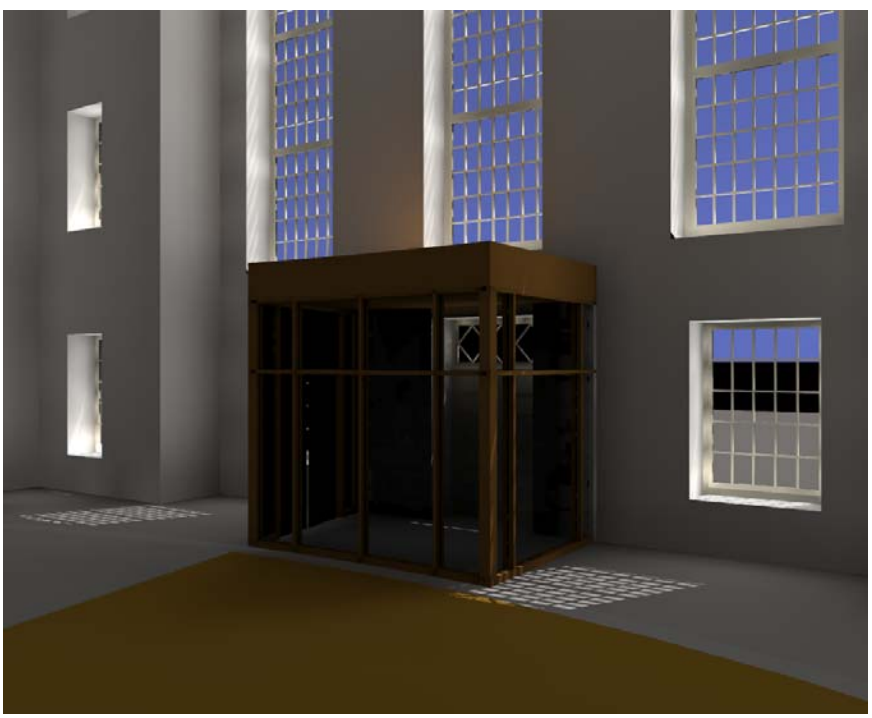


Figure 3.11 *Rendering of Atrium – June 22nd, Clear Sky, 12:00 PM*

Daylight Study Results:

Month	Time	Sky	Footcandles	
			Typ.	Max.
March	8:30 AM	Clear	170	3179
March	10:00 AM	Clear	95	4220
March	10:00 AM	Overcast	23	39
March	12:00 PM	Clear	44	67
March	2:00 PM	Clear	27	35
March	4:00 PM	Clear	16	23
June	7:00 AM	Clear	98	1107
June	8:30 AM	Clear	130	3314
June	10:00 AM	Clear	100	4715
June	12:00 PM	Clear	62	99
June	2:00 PM	Clear	35	48
June	4:00 PM	Clear	25	31
December	8:30 AM	Clear	89	677
December	10:00 AM	Clear	84	1753
December	12:00 PM	Clear	38	53
December	2:00 PM	Clear	19	26
December	4:00 PM	Clear	10	13

Table 3.03 *Compiled Data from Atrium Daylight Study*

As can be seen from the results above, there is more than enough natural light in the space during daytime hours. The height of the windows allows for daylight penetration all the way across the space. The values above are typical for the vast majority of the space. Therefore, I am proposed that the majority of any electric light for the space be turned off from 1 hour after sunrise until 1 hour before sunset. The café service area will require more light over the counters, and the stairs may require some additional light, so any lighting over these areas must remain on. In addition, the planned decorative pendant and other luminaires with decorative elements will likely be on for aesthetic reasons, but both of these are not going to use a tremendous amount of energy.

Luminaire Schedule:

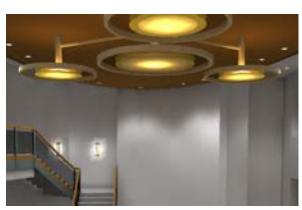
Label	Quantity	Description	Number of Lamps / Linear Feet	Lamp Type	Voltage
SS1	34	Recessed round downlight	1	32W TRT CFL	277
SS2	14	Recessed square downlight	1	32W TRT CFL	277
SS3	14	Luminous wall sconce with brass trim	2'	T5	277
SS4	1	Decorative pendant with 4 luminous glass discs and brass trim	4	42W TRT CFL	277
SS5	1	Oval-shaped low profile linear wallwasher	6'	T5	277

Table 3.04 *Compressed Luminaire Schedule for Atrium*
For Full Luminaire Schedule and Details, Please Refer to Appendix A

SS1

SS2

SS3



SS4

SS5

Ballast Schedule:

Label	Ballast Type	Power Factor	Ballast Factor	Ballast Watts
SS1	Electronic Rapid Start	0.98	0.98	36
SS2	Electronic Rapid Start	0.98	0.98	36
SS3	Electronic Instant Start	0.98	1.05	19
SS4	Electronic Rapid Start	0.98	0.98	184
SS5	Electronic Prog. Start	0.98	1.02	48

Table 3.05 *Compressed Ballast Schedule for Atrium*
For Full Ballast Details, Please Refer to Appendix A, p.145

Light Loss Factors:

Label	Maint. Cat.	Degree of Dirt	Cleaning Schedule	Distrib. Cat.	Ballast Factor	Lumin. Dirt Deprec.	Lamp Lumen Deprec.	Room Surface Dirt Deprec.	Total LLF
SS1	III	Very Clean	12 mths	Direct	0.980	0.924	0.841	0.965	0.735
SS2	III	Very Clean	12 mths	Direct	0.980	0.924	0.841	0.965	0.735
SS3	II	Very Clean	12 mths	Dir-Ind.	1.050	0.968	0.919	0.930	0.869
SS4	VI	Very Clean	12 mths	Dir-Ind.	0.980	0.804	0.841	1.000	0.663
SS5	III	Very Clean	12 mths	Direct	1.020	0.924	0.919	0.960	0.831

Table 3.06 *Light Loss Factors for Exterior and Facade*

Controls:

All of the lighting in the space (with the exception of the café lighting and the vestibule lighting) will be controlled off of a time clock controller. There will be two controllers. The first would be for all of the recessed lighting in the space (except as noted above). The controller will be programmed to turn those luminaires on at one hour before sunset, and turn them off at one hour after sunrise. Combined with the ample natural light entering the space during the day, this ensures that there will be adequate lighting in the space 24 hours a day without switching. The second controller will be for the decorative pendants and the sconces. That controller will be programmed to turn those luminaires on at 6:00 AM, and turn them off at 10:00 PM. This will allow the more decorative fixtures to be on during daytime hours, and to conserve energy by turning off at night. The 10:00 PM switching ensured that the lighting is not switched off during any university events that would be held here. A cutsheet of the proposed time clock controller is in Appendix A, page 222. The café lighting will be switched locally. The vestibule lighting will be on at all times for security reasons, so no switching is required. These controls allow the space to meet the automatic shut-off standard of ASHRAE 90.1-2004.

Lighting Plan – First Floor

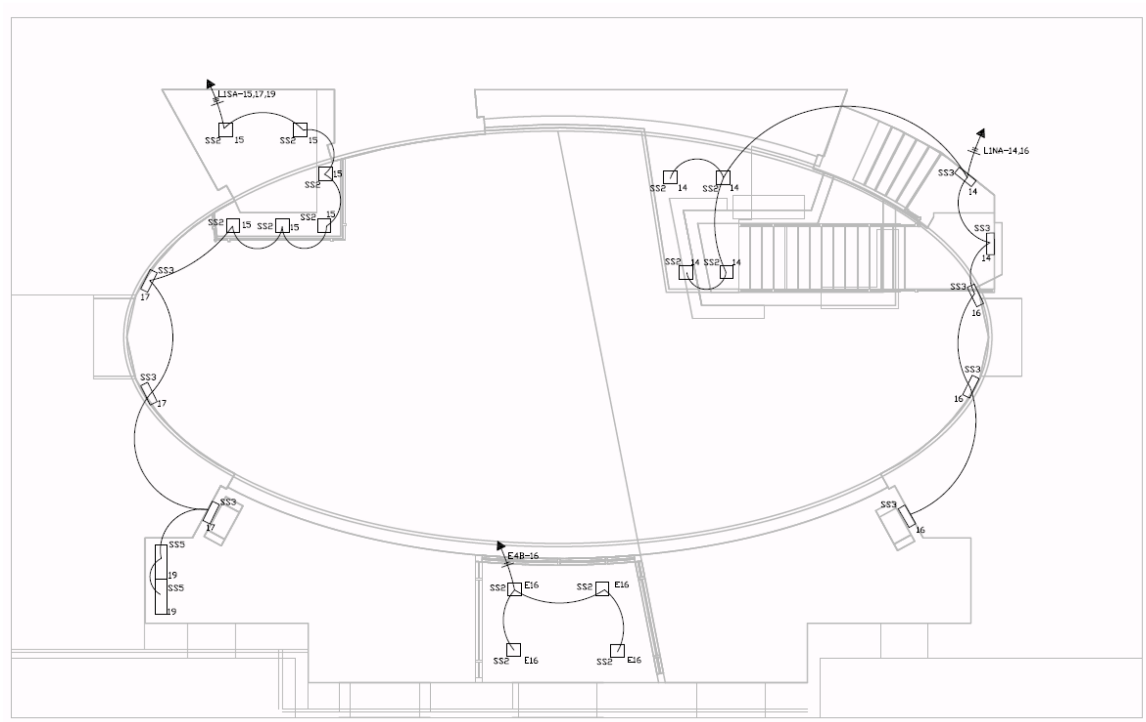


Figure 3.12 *Atrium Lighting Plan – First Floor*

Label	Number	Mounting Type	Mounting Height	Cantilever / Pendant Length	Circuit
SS2	6	Recessed	11'-6"	-	L1SA-15
SS2	4	Recessed	11'-0"	-	E4B-16
SS2	4	Recessed	11'-6"	-	L1NA-14
SS3	2	Surface	5'-0"	-	L1SA-17
SS3	1	Surface	7'-0"	-	L1SA-17
SS3	2	Surface	15'-0"	-	L1NA-14
SS3	2	Surface	5'-0"	-	L1NA-16
SS3	1	Surface	7'-0"	-	L1NA-16
SS5	1	Cantilever	8'-6"	1'-3"	L1SA-19

Table 3.07 *Mounting Details for Atrium – First Floor*

Lighting Plan – Second Floor

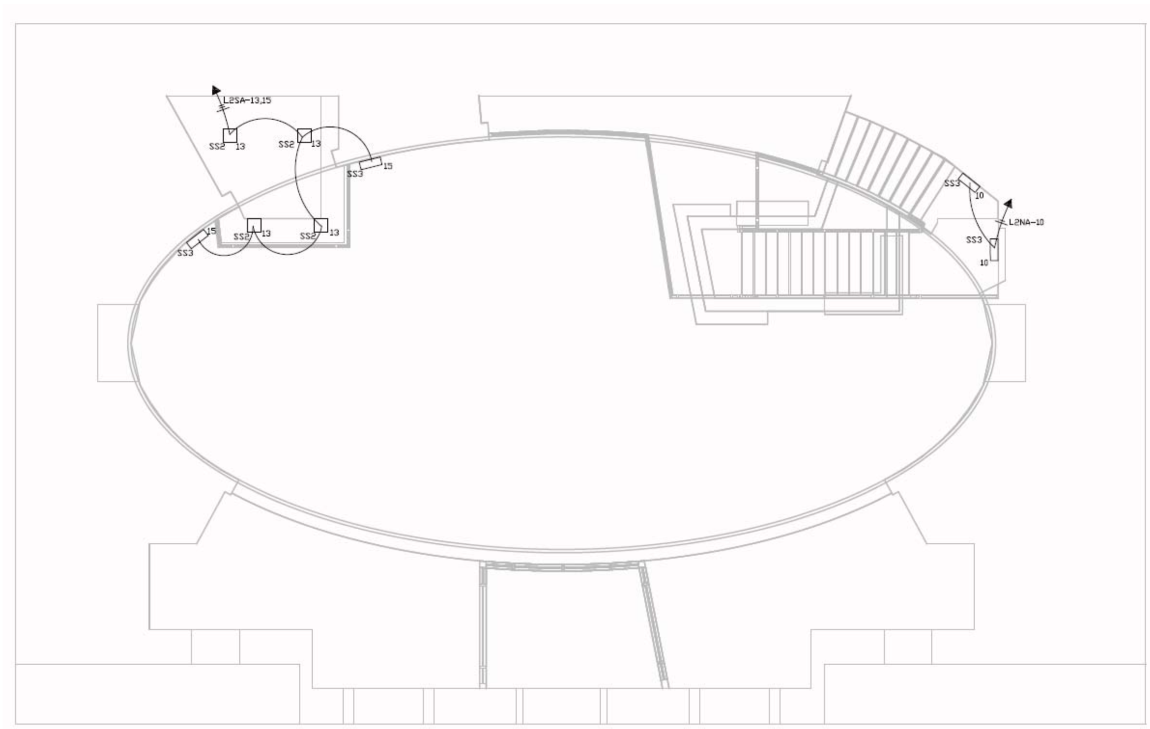


Figure 3.13 *Atrium Lighting Plan – Second Floor*

Label	Number	Mounting Type	Mounting Height	Cantilever / Pendant Length	Circuit
SS2	4	Recessed	25'-6"	-	L2SA-13
SS3	2	Surface	29'-0"	-	L2NA-10
SS3	2	Surface	20'-0"	-	L2SA-15

Table 3.08 *Mounting Details for Atrium – Second Floor*

Lighting Plan – Third Floor

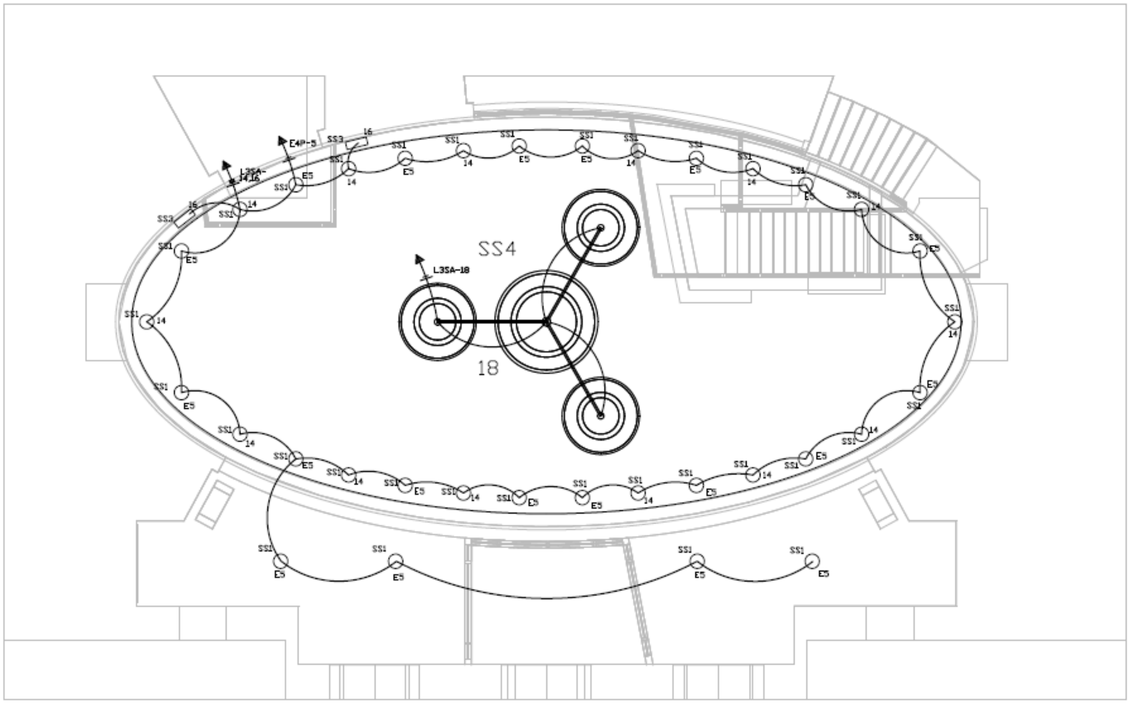


Figure 3.14 *Atrium Lighting Plan – Third Floor*

Label	Number	Mounting Type	Mounting Height	Cantilever / Pendant Length	Circuit
SS1	8	Recessed	38'-0"	-	L3SA-14
SS1	8	Recessed	38'-0"	-	L3SA-16
SS1	7	Recessed	38'-0"	-	E4P-1
SS1	7	Recessed	38'-0"	-	E4P-3
SS1	6	Recessed	38'-0"	-	E4P-5
SS3	2	Surface	34'-0"	-	L3SA-18
SS4	1	Pendant	35'-0"	3'-0"	L3SA-20

Table 3.09 *Mounting Details for Atrium – Third Floor*

Details:

I elected to design a custom pendant for the center of the space, in the hopes of creating a focal point for the atrium and enhancing the other modern design elements. I designed the pendant with the theme of “three merging into one”, to reflect the original purpose of the building (bringing together the departments of psychology, philosophy, and biology in one facility). I was inspired by the concept of luminous discs of light that I saw in a couple of other pendants. I liked the use of different types of glass (clear, frosted, diffuse) that were used of the same disc, since it added both glow and interest that could not be produced with only one type of glass. The custom pendant here needed to be much larger, and it needed to match the atrium and building as a whole more. The trim and supporting elements, therefore, will be brass. Brass is considered a theme material for the building, and many of the places where metal trim was used, it was done in brass.

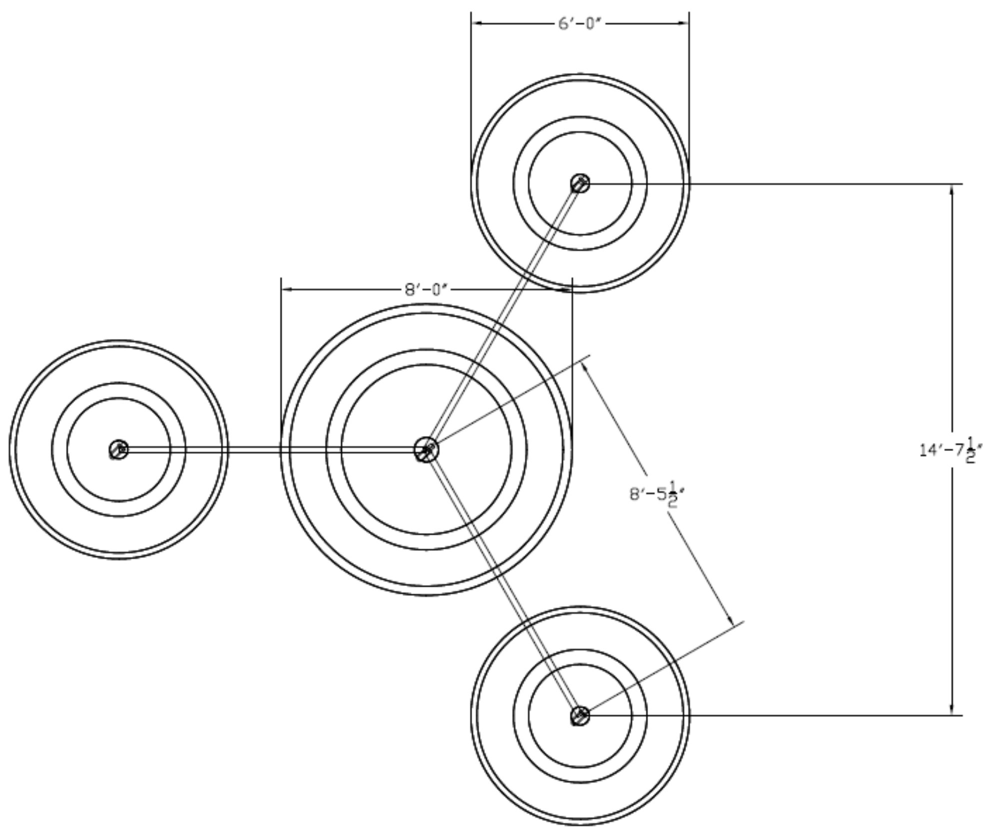


Figure 3.15 *Custom Pendant for Atrium (Type SS4) – Plan*

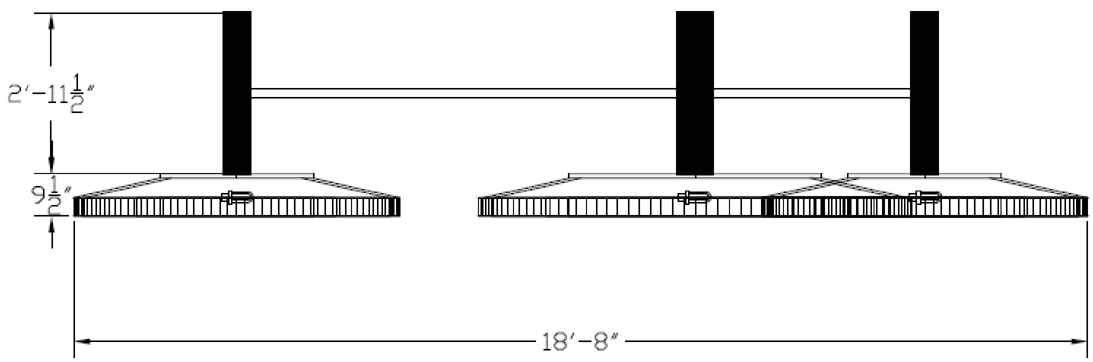


Figure 3.16 *Custom Pendant for Atrium (Type SS4) – Elevation*

Figure 3.17 *Custom Pendant for Atrium (Type SS4) – Rendered Image*

Calculations and Performance:

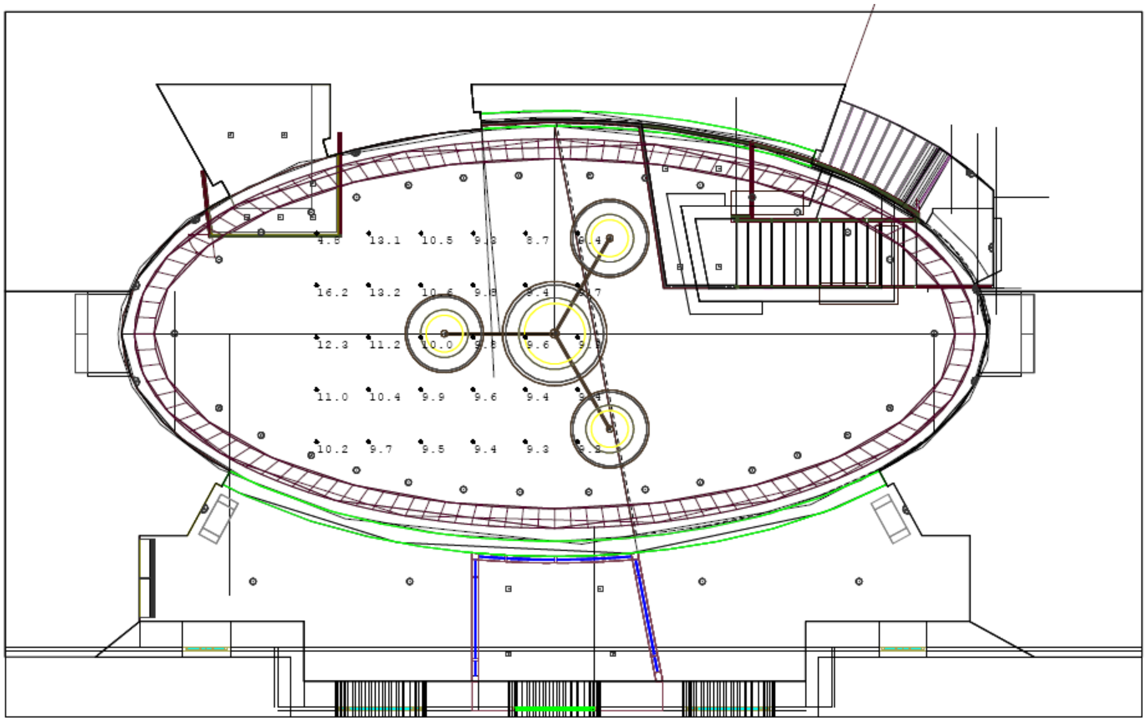


Figure 3.18 *Atrium – Plan of AGI Model with Calculation Grid*

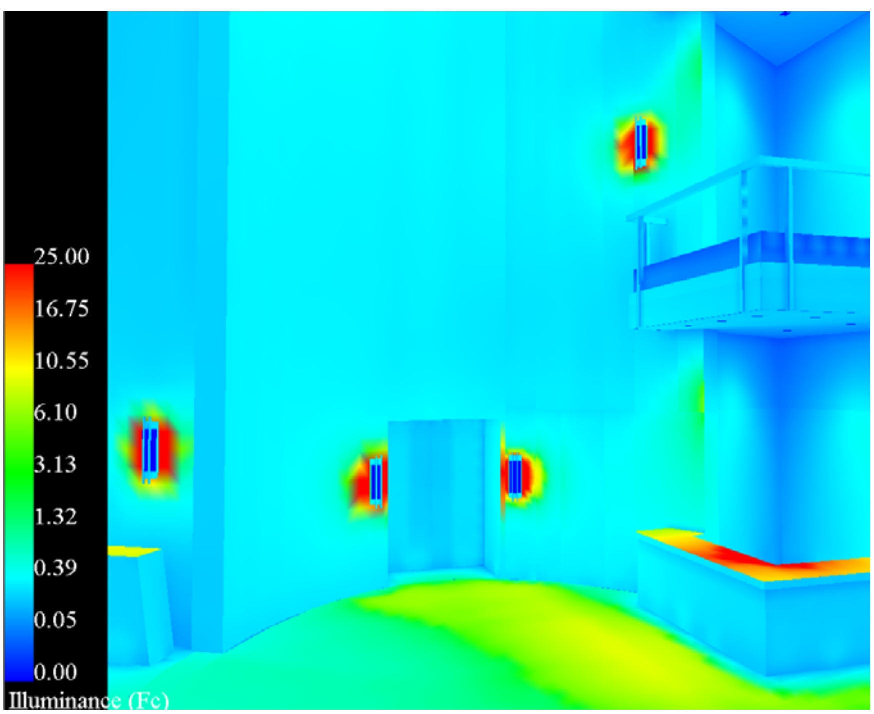


Figure 3.19 *Pseudocolor Rendering of Atrium – Facing South*

Rendered Images:

Figure 3.20 *Color Rendering of Atrium – Facing North*

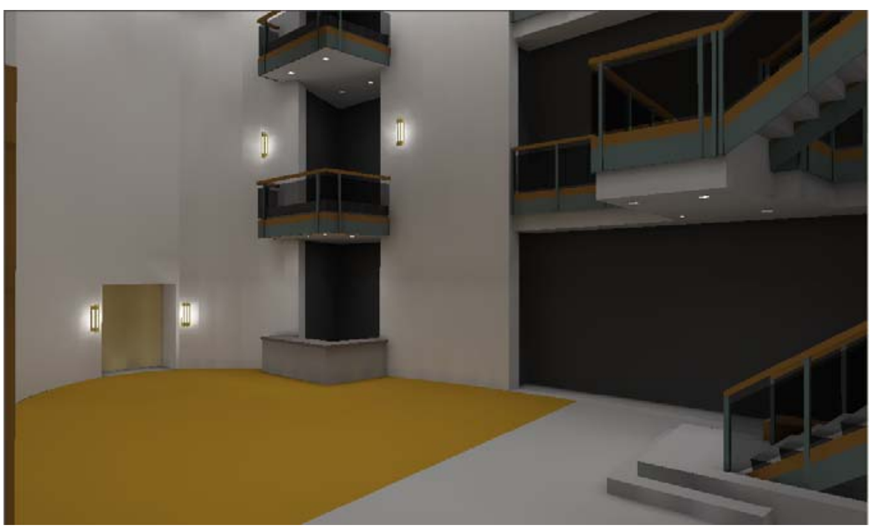


Figure 3.21 *Color Rendering of Atrium – From Main Entry*

Figure 3.22 *Color Rendering of Atrium – From Balcony*

Figure 3.23 *Color Rendering of Atrium – Ceiling and Custom Pendant*

Power Density Calculations:

Because of the height, dimensions, and purpose of this space, this is by far the most difficult space to meet the power allowance in. I originally designed the space using ceramic metal halide downlights because of their high efficacy, a color that best fit the modern theme of the space, and long lamp life. The light levels were more than adequate, and would have allowed for some half-on, half-off scenarios. However, the energy consumption was nearly 1.5 Watts per square foot. Because ASHRAE 90.1 only considers connecting load, not the length of time the luminaires will be on, the 70W ceramic metal halide lamps had to be switched. I sacrificed the ability to get up to 30 footcandles at the ground. This would have been nice for some functions, but overall isn't a requirement for the atrium (10 footcandles will suffice). By switching to 32W compact fluorescent triple tube lamps, I was able to get the energy consumption low enough here to make use of the Space-by-Space procedure. Since these lamp meet illuminance goals and energy requirements, and since the lamp life is almost comparable, I feel that the overall design has not been downgraded as a result of having to design to ASHRAE 90.1-2004.

Space	Matching ASHRAE Category	Power Allowance	Length (ft)	Area (ft^2)	Watts Allowed
Atrium	Atrium - First Three Floors	0.6 W/ft^2	-	2672	1603.2

Total Allowed	1603.2 W

Table 3.10 *Power Allowance for Atrium – Functional Lighting*

Type	Quantity	Input Watts / Luminaire	Total Watts / Type
SS1	34	36	1224
SS2	14	36	504
SS5	1	48	48

Total Watts Consumed	1776 W

Table 3.11 *Power Consumed by Atrium – Functional Lighting*

Space	Matching ASHRAE Category	Power Allowance	Length (ft)	Area (ft^2)	Watts Allowed
Atrium	Decorative Lighting	1.0 W/ft^2	-	2672	2672

Total Allowed	2672 W

Table 3.12 *Power Allowance for Atrium – Decorative Lighting*

Type	Quantity	Input Watts / Luminaire	Total Watts / Type
SS3	14	19	266
SS4	1	184	184

Total Watts Consumed	450 W

Table 3.13 *Power Consumed by Atrium – Decorative Lighting*

Based on the charts above, it would appear that I have exceeded my energy budget. However, since the Space-by-Space method allows for the trading of allowable energy between spaces, I will have no difficulty meeting the standards set forth in ASHRAE 90.1-2004. I will discuss this further in the full conclusion.

Conclusions:

I like what the custom pendant brings to the space. The scale is good: large enough to be a focal point, but not so much that it covers the entire wood ceiling. It also is noticeable, but not intrusive. People can appreciate the entire space from the balconies without being blocked by the pendant. The sconces add some attention to the doors, stairs, and balconies, and the brass in them matches well with the theme materials for the space. The downlights from the wood ceiling help to emphasize the shape of the ceiling and the atrium as a whole, but still provide a relatively even distribution of light (which can be expected from a 40-foot mounting height). Despite all of this, I think it is the large windows that really allow this space to function as well as it does. The amount of daylight that penetrates the space allows most of the electric lighting to be completely off during the day, and this allows the space to have essentially two different lighting schemes for the price of one. The time clock settings allow the atrium to be alive and dynamic during the day, simple and elegant in the evening, and functional and secure at night.

Ecology Teaching Lab

Overview:

The Ecology Teaching Lab is one of fifteen throughout the second and third floors. As a result, the lighting design of this space would likely carry over to the design of the other laboratories. This laboratory is located on the second floor, immediately adjacent to (but not immediately accessible from) the atrium. The main function of this laboratory is for teaching to first and second-year students. That said, all of the labs are available to graduate students for 24-hour use. For this space, it will be important to design to both a full class of 24 students and the lone graduate student working late at night.

Major furnishings include lab stations with a workplane at 3' AFF, a podium workstation at the front of the room, sink cabinets, storage shelving, and other safety equipment. A chalkboard and a retractable projection screen will also be furnished.

Plans:

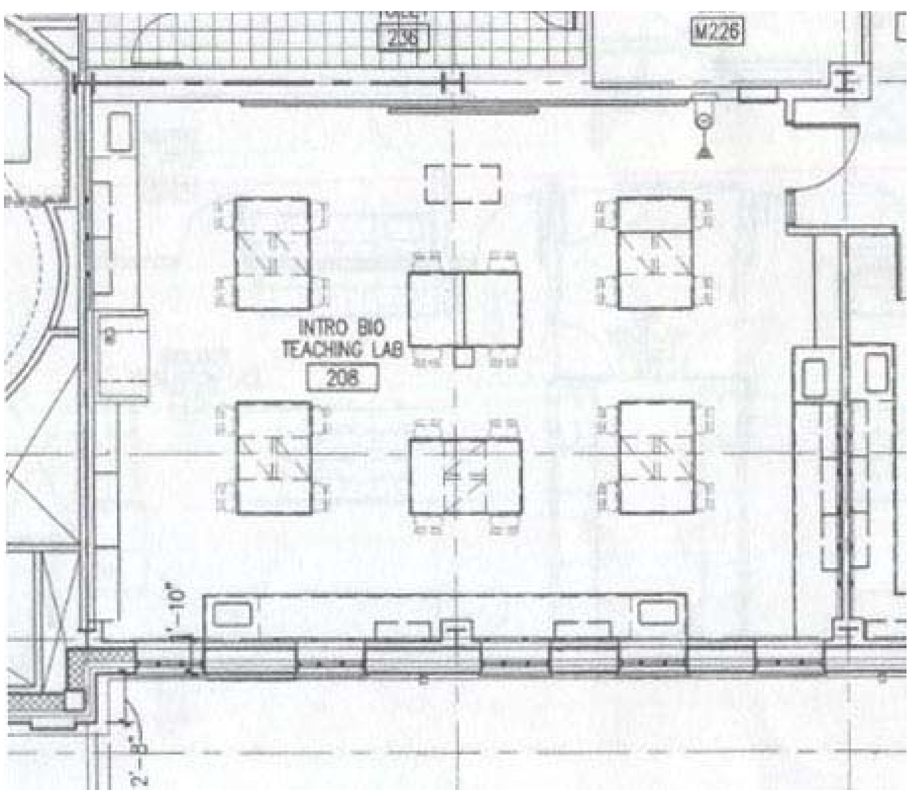


Figure 4.01 *Second Floor Plan – Ecology Teaching Lab*

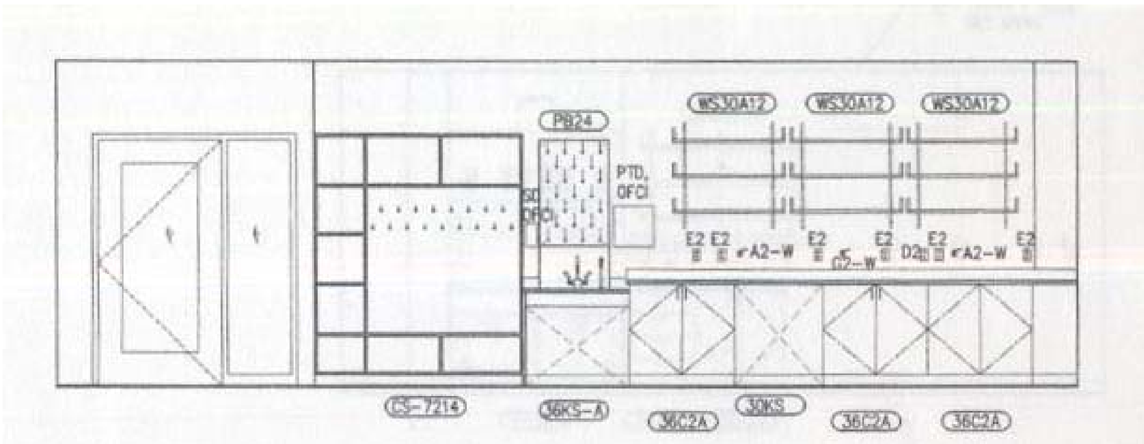


Figure 4.02 *North Elevation – Ecology Teaching Lab*

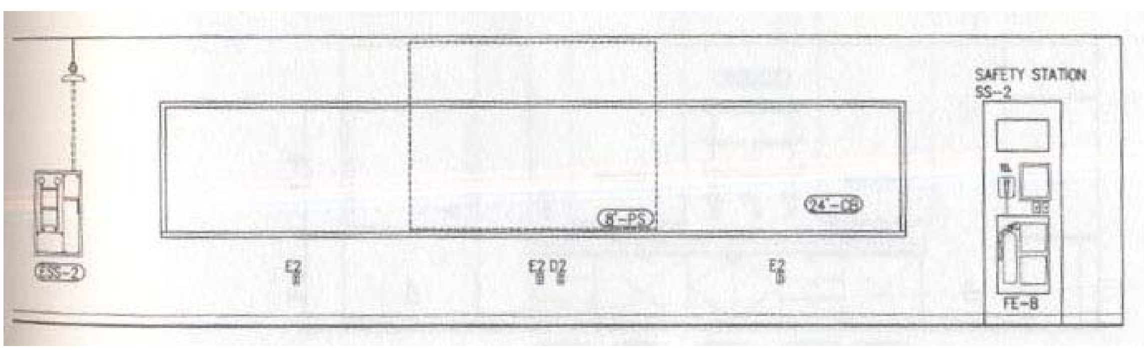


Figure 4.03 *West Elevation – Ecology Teaching Lab*

Surface Characteristics:

Surface	Material	Color	Reflectance	Finish
Ceiling	acoustical ceiling tile	white	80%	matte
Walls	gypsum board	white	70%	matte
Floor	vinyl composition tile	white	55%	semi-specular
Floor	vinyl composition tile	blue	15%	semi-specular
Cabinets	wood	tan	30%	semi-specular
Worksurface	epoxy resin	black	10%	semi-specular

Table 4.01 *Surface Characteristics – Ecology Lab*

Daylight Elements:

Label	Quantity	Window Type	Mullion Pattern	Max Height	Max Width	Finish	Transmittance	Reflectance
A1	5	Rectangular	3X5	7'-10"	3'-8"	Clear	80%	5%

Table 4.02 *Daylight Elements – Ecology Lab*

Illuminance Requirements:

IESNA Reference: Classrooms – Science Laboratories

Horizontal Illuminance: 50 fc
Vertical Illuminance: 30 fc

Analysis: Appropriate for this environment, but would like system to be capable of 75-80 fc for some experiments

Design Criteria and Goals:

Most Important:

Color Appearance and Color Contrast:

- The experiments being performed in this laboratory require the experimenter/student to be able to distinguish subtle differences in color, as well as to be able to correctly decipher color to begin with. A high CRI source would be required.

Light Distribution on Task Plane:

- In order to have a reasonably controlled environment for all experiments, it is best to have each lab station as identical to the next as possible. This includes having approximately the same illuminance and luminance levels. Also, in order to make it equally possible to learn from any place in the room, it would be practical to make the workstations as uniformly lit as possible. It is acceptable to have lower light levels over the egress areas.

Luminances of Room Surfaces:

- The chalkboard is a major task in this room, and it is imperative that the chalkboard is lit well enough to be seen.

Modeling of Faces and Objects:

- This is critical if the professor is planning on performing demonstrations in front of the class, which based on the layout of the lab, appears to be the case. The students need to be able to see distinct features of objects both at their station and the professor's. Good facial rendering is also a critical part of the learning process, as being able to see what the professor is saying both connects the professor to his/her audience and helps reinforce the information they are hearing.

Points of Interest:

- Major tasks to focus on are the chalkboard and the individual workstations. A task lighting system might be a good way to emphasize the importance of these areas.

Also Important:

Source/Task/Eye Geometry:

- Objects used during labs may be specular or glossy. If a direct lighting system is used, it is important to consider where a person is likely to sit/stand and where they are likely to view glossy objects.

Surface Characteristics:

- The major task surfaces (the workstation and the chalkboard) are very low reflectance. Generally, more light than normally required will be needed to work well in this space.

Special Considerations (VDT/Projection Screen):

- The projection screen will be over the chalkboard. Any lighting specifically for the chalkboard must be controlled separately from the rest of the space, so that people may still see to take notes during presentations. Any ambient light should be examined to make sure there isn't a significant amount striking the projection screen.

Illuminance (Horizontal and Vertical):

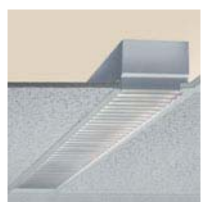
- Good illuminance is required to learn and to perform detailed experimentation. Appropriate horizontal illuminance is needed on the workstations, and appropriate vertical illuminance is required on the chalkboard.

Luminaire Schedule:

Label	Quantity	Description	Number of Lamps	Lamp Type	Voltage
RR1	23	Recessed direct-indirect LTT luminaire with louvers and white reflector	1	40W LTT	277
RR2	9	Recessed T8 fluorescent downlight with parabolic louver	1	32W T8	277
RR3	6	Surface mounted T8 chalkboard light	1	32W T8	277

Table 4.03 *Compressed Luminaire Schedule for Ecology Teaching Lab*
For Full Luminaire Schedule and Details, Please Refer to Appendix A

RR1



RR2

RR3

Ballast Schedule:

Label	Ballast/Driver Type	Power Factor	Ballast Factor	Ballast Watts
RR1	Electronic Ballast	0.90	1.02	40
RR2	Electronic Ballast	0.98	0.90	34
RR3	Electronic Ballast	0.98	0.90	34

Table 4.04 *Compressed Ballast Schedule for Ecology Teaching Lab*
For Full Ballast Details, Please Refer to Appendix A

Light Loss Factors:

Label	Maint. Cat.	Degree of Dirt	Cleaning Schedule	Distrib. Cat.	Ballast Factor	Lumin. Dirt Deprec.	Lamp Lumen Deprec.	Room Surface Dirt Deprec.	Total LLF
RR1	II	Very Clean	12 mths	Direct	1.020	0.968	0.908	0.973	0.872
RR2	III	Very Clean	12 mths	Direct	0.900	0.924	0.950	0.973	0.769
RR3	III	Very Clean	12 mths	Direct	0.900	0.924	0.950	0.973	0.769

Table 4.05 *Light Loss Factors for Ecology Teaching Lab*

Lighting Plan:

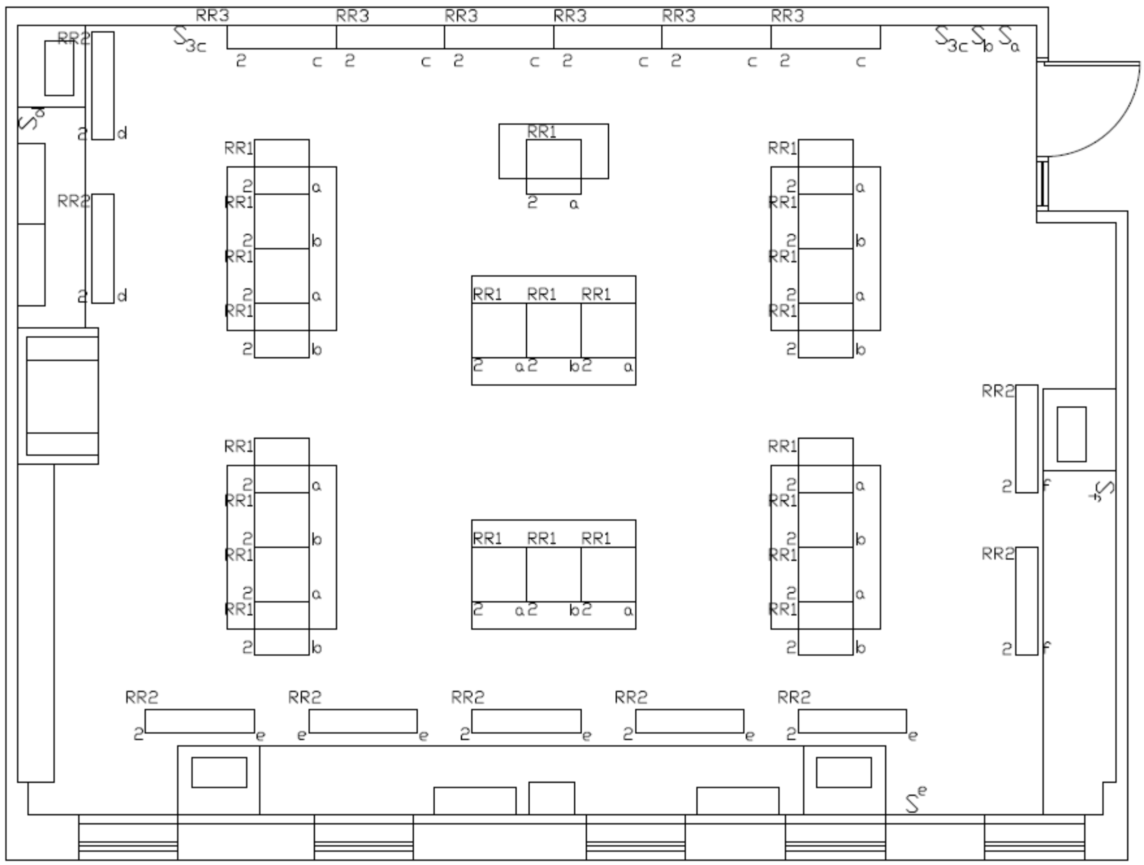


Figure 4.04 Lighting Plan – Ecology Teaching Lab

Controls:

For this layout, I explored two different switching options. From the beginning of the design process, I designed that I would like bi-level switching capabilities for the luminaires over the lab workstations. I also wanted localized switching for the luminaires over the side counters.

The difference between the two options is the location(s) where the second level of the bi-level switching occurs. In both systems, the first level is at the front entry, and allows for a light level of 35-40 footcandles to strike the desks.

In the first option, the second level of switching also occurs at the front entry of the room, and switches the second set of luminaires over all six lab workstations.

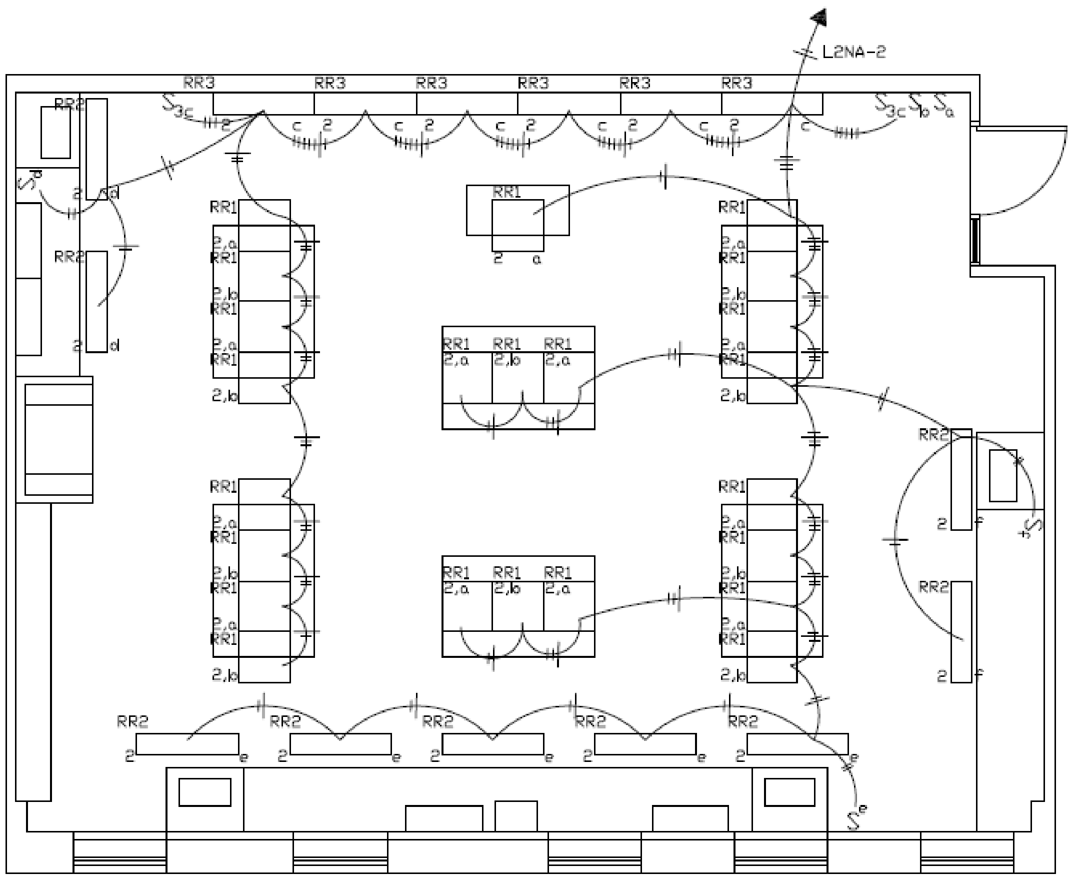


Figure 4.05 *Switching Option #1 – Ecology Teaching Lab*

The second option would allow the second light level to be switched on separately for each individual workstation. The switch would be located underneath the worksurface of the station.

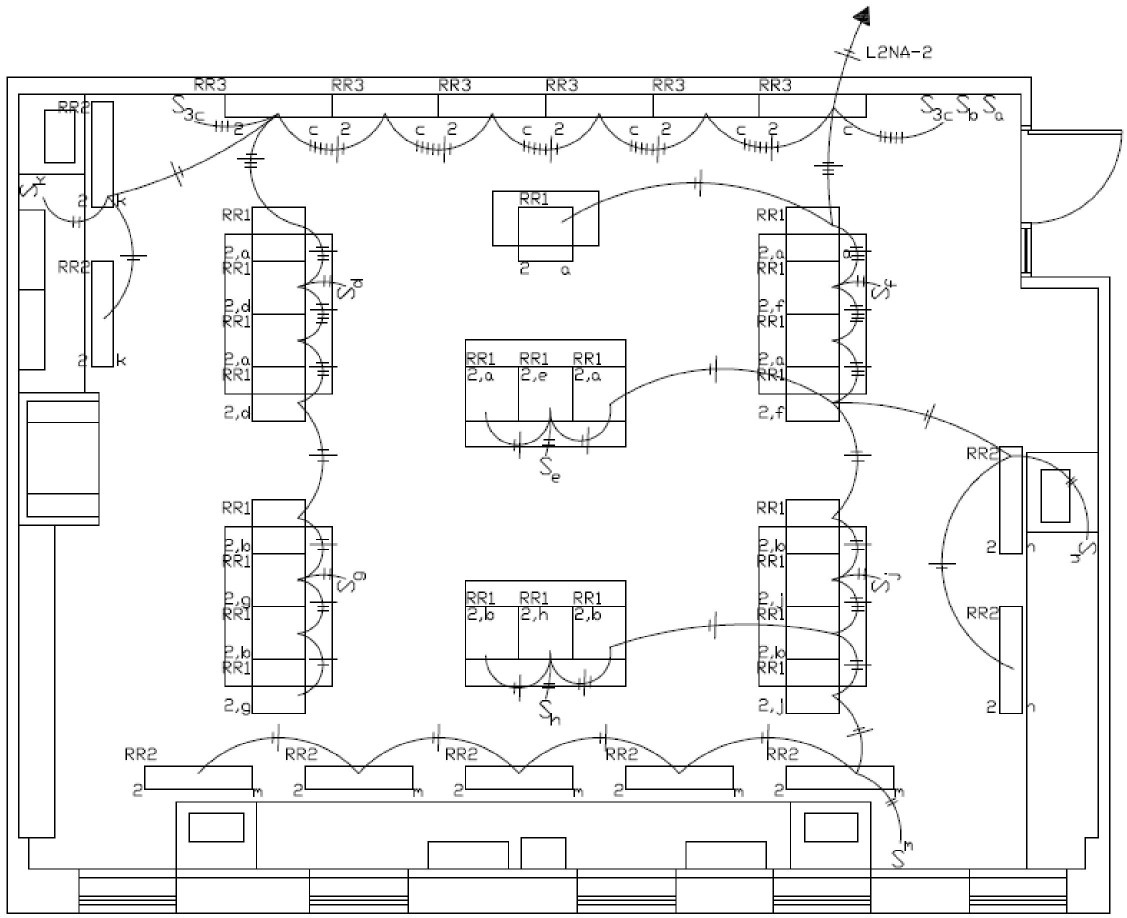


Figure 4.06 *Switching Option #2 – Ecology Teaching Lab*

While the second option would offer the most potential for energy savings, and provides the most individualized control, it has many drawbacks. Since putting a raceway of some sort through each workstation is not a viable option, wires would have to be run from the home run location through the floor to each workstation switch, then back to a wall to go up to the ceilings and the luminaires. Besides being a lot more complicated, this adds a lot more wire to the project, and therefore significantly increases the cost. For these reasons, I am recommending the first control system. With time clocks for the entire building, this space meets the requirements for automatic shut-off.

Calculations and Performance:

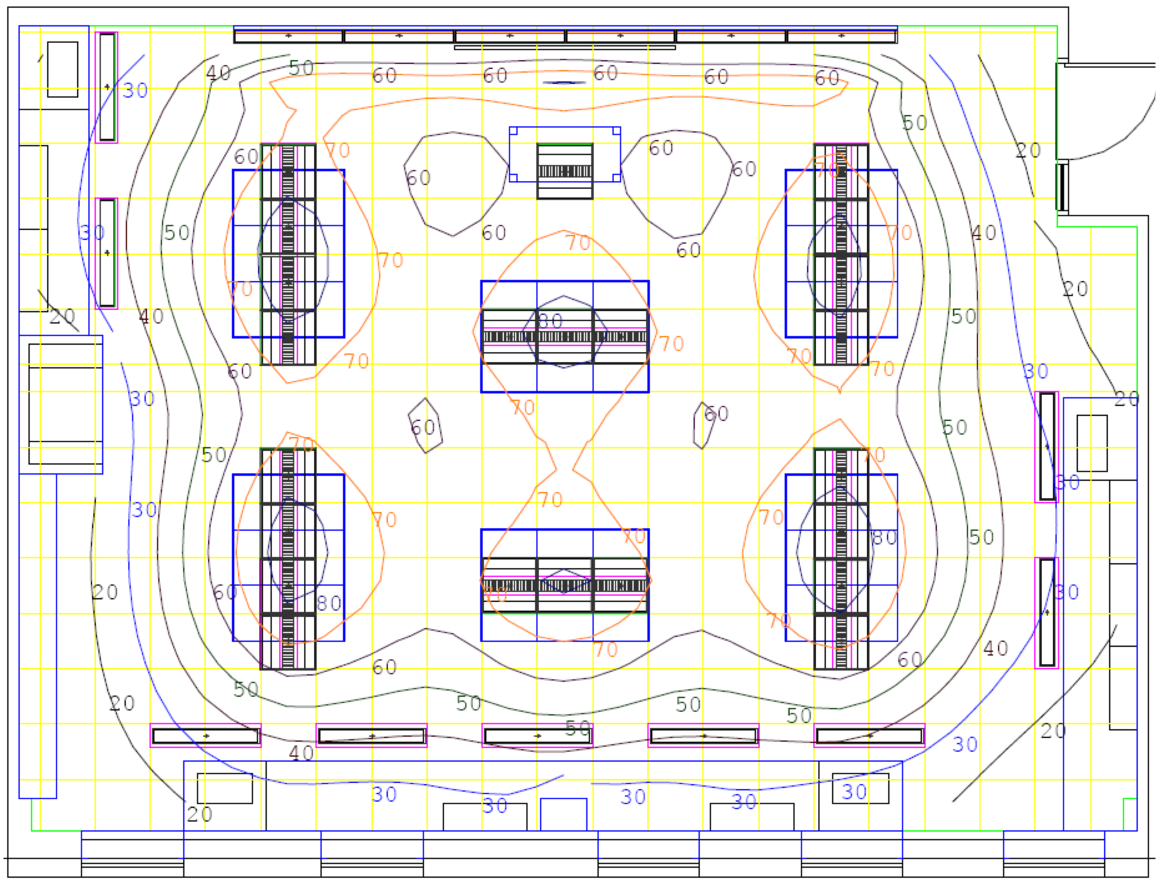


Figure 4.07 *Ecology Teaching Lab – Plan of AGI Model with Footcandle Isolines*

75.2	76.4	74.9	74.0	74.6	76.4	76.3	74.5	73.8	74.8	76.0	73.8
27.0	28.4	26.7	25.7	26.5	28.5	28.5	26.4	25.5	26.5	27.6	25.4
23.2	24.0	22.9	22.0	22.8	24.5	24.5	22.6	21.8	22.5	23.2	21.3
22.3	23.2	22.7	22.2	22.6	23.9	23.8	22.4	21.9	22.3	22.4	20.7

Figure 4.08 *Ecology Teaching Lab – Elevation of Chalkboard with Calculation Grid*

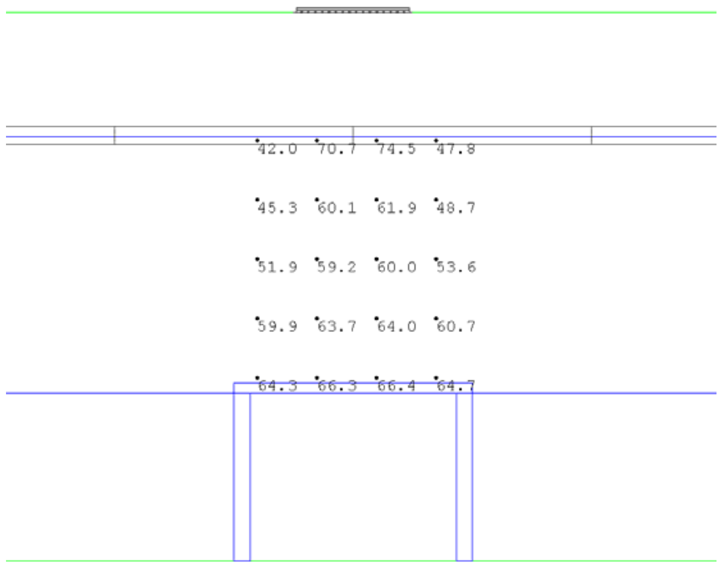


Figure 4.09 *Ecology Teaching Lab – Elevation of Lecture Area with Calculation Grid*

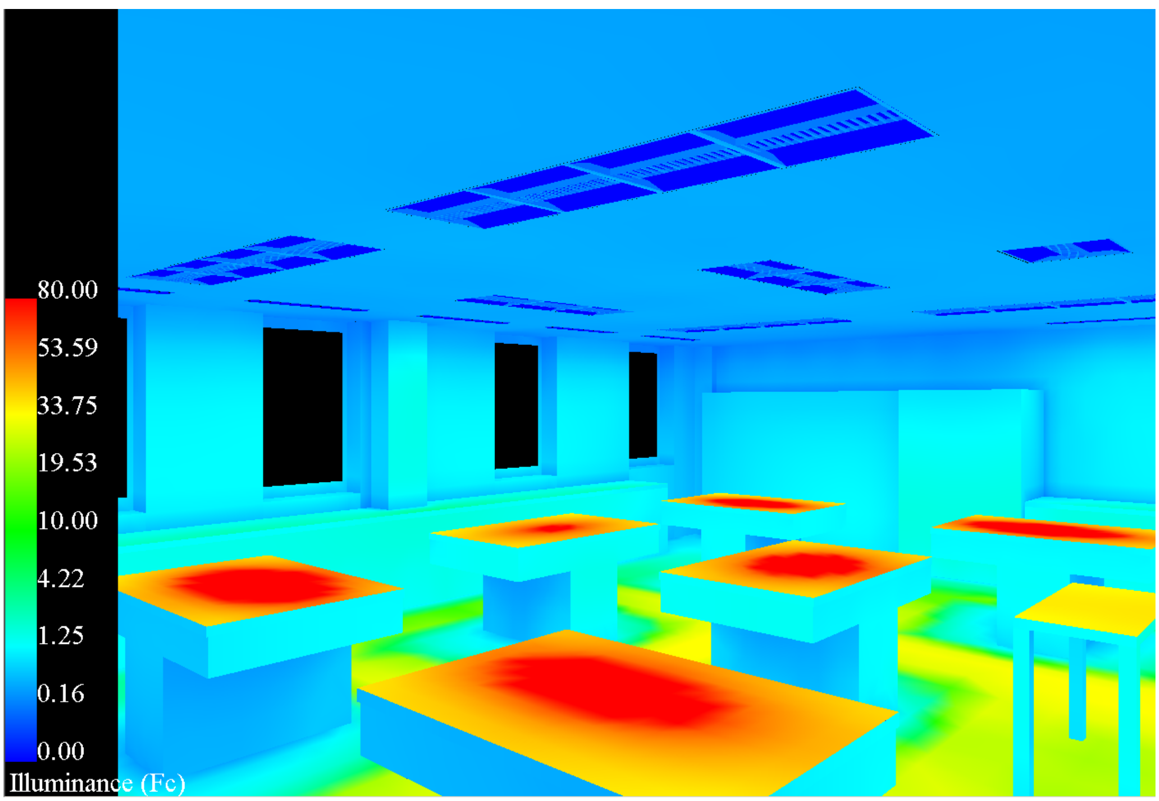


Figure 4.10 *Pseudocolor Rendering of Ecology Teaching Lab – From Entrance*

Rendered Images:

Figure 4.11 *Color Rendering of Ecology Teaching Lab – From Entrance*

Figure 4.12 *Color Rendering of Ecology Teaching Lab – From Back Workstation*

Power Density Calculations:

Space	Matching ASHRAE Category	Power Allowance	Length (ft)	Area (ft^2)	Watts Allowed
Ecology Lab	Laboratories	1.4 W/ft^2	-	1160	1624

Total Allowed	1624 W

Table 4.06 *Power Allowance for Ecology Lab*

Type	Quantity	Input Watts / Luminaire	Total Watts / Type
RR1	23	40	920
RR2	9	34	306
RR3	6	34	204

Total Watts Consumed	1430 W

Table 4.07 *Power Consumed by Ecology Lab*

Based on the above calculation, the space meets the energy requirements set forth in ASHRAE 90.1 – 2004.

Conclusions:

I feel the task-oriented approach was a very strong one for this space. First, it draws a lot of attention to the major task areas in the room: the workstations, the lecturer, and the chalkboard. This focus also has another key advantage. Since only the workstations were designed for 50 footcandles, rather than the entire space, this allowed for significant energy saving over a traditional, 2X4 or 1X4 recessed layout throughout. I also feel the switching system will be a good choice for this space. It allows the occupants of the space to use only the light they need, while allowing them enough light for any of their needs in the space. Although the layout with individualized workstation control would have been an excellent choice for function and energy savings, the room isn't properly equipped with raceways and columns, and with the much higher cost in wiring, I can't justify this option. I think I accomplished my goal of creating a layout that can be replicated throughout the other labs in the building, with similar success and energy savings.

Bonchek Lecture Hall

Overview:

This lecture hall was designed as a presentation space for guest lecturers of the departments housed in this building and for Franklin & Marshall College as a whole. Although perhaps not its original intent, the space is also now commonly used for regularly scheduled classes. Access to this space is from the atrium via a corridor width and a vestibule.

At between 9' and 13' above finished floor throughout the space, the lecture hall is not as voluminous as many lecture halls with similar footprints. There are 2 separate 1-foot step-down areas to allow a better view of the speaker and to increase the sense of spaciousness. The required handicapped ramp is at the left (south) end of the space. There is enough seating in this lecture hall for 100 attendees, plus a small number of overflow seats.

The general palette for finishes here was high-end, but simple and clean. The color in the space is restricted to the wood and to the view from the large arched windows (when the black-out shades aren't down). Aside from that, the materials remain in the white, black, and gray tones. Build-in elements include wood-trimmed laminate tables and chairs for audience members. Three projection screens (which are retractable but frequently in use) are also built-in.

Plans:

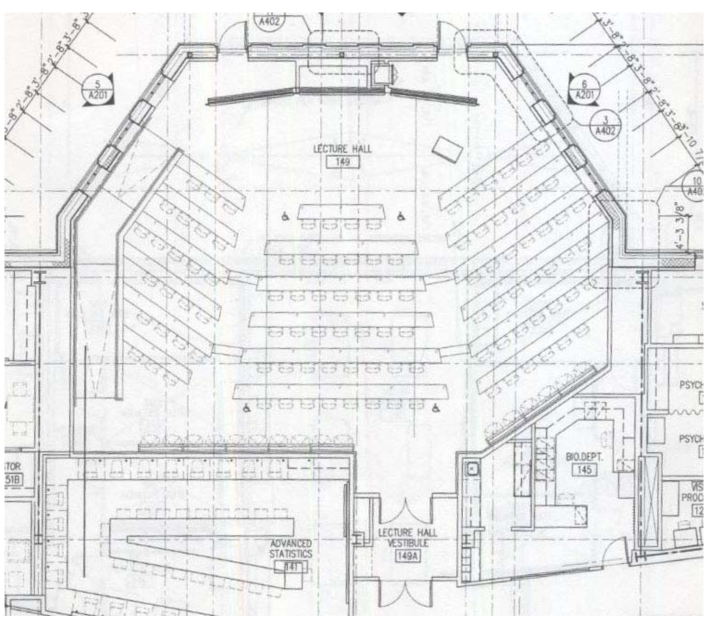


Figure 5.01 *First Floor Plan – Lecture Hall*

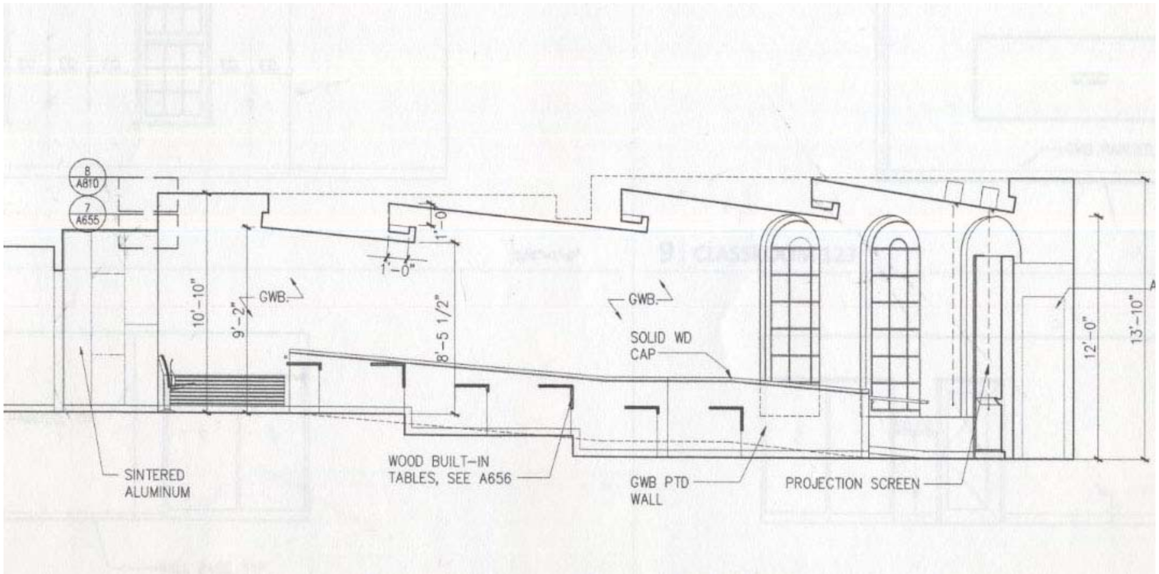


Figure 5.02   *North to South Section – Lecture Hall*

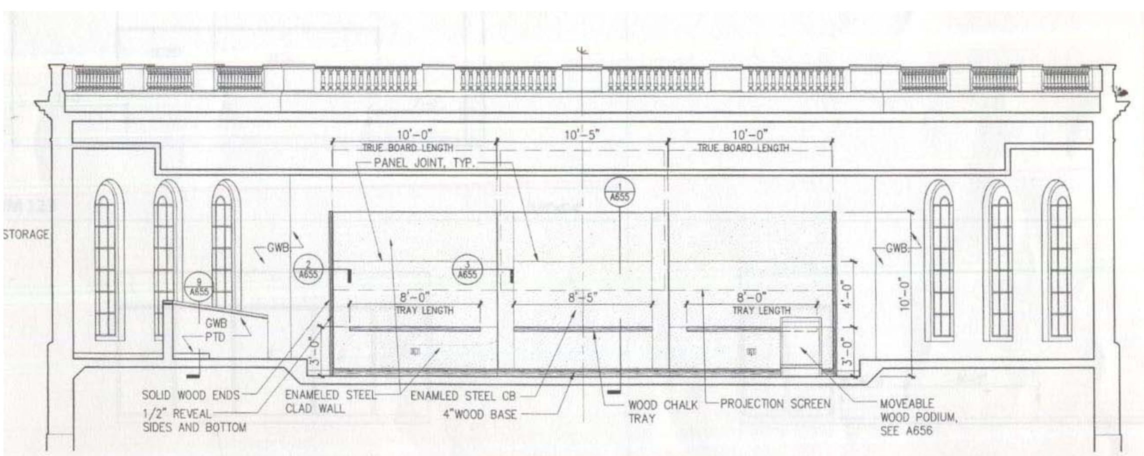


Figure 5.03   *West Elevation – Lecture Hall*

Surface Characteristics:

Surface	Material	Color	Reflectance	Finish
Side Walls	gypsum board	white	70%	matte
Back Walls	sintered aluminum panels (AWT)	silver	40%	semi-specular
Screen Walls	enamel steel clad	dark grey	10%	matte
Floor	carpet	grey	20%	matte
Desks - Trim	light wood	tan	30%	semi-specular
Desks - Top	plastic laminate	light grey	50%	matte
Railing - Top	wood	tan	30%	semi-specular
Railing - Sides	gypsum board	white	70%	matte
Ceiling - Seating	gypsum board	white	70%	matte
Ceiling - Edge	acoustical plaster	white	79%	semi-gloss

Table 5.01 *Surface Characteristics – Lecture Hall*

Daylight Elements:

Label	Quantity	Window Type	Mullion Pattern	Max Height	Max Width	Finish	Transmittance	Reflectance
J1	6	Arched Radius	3X6 + arch	9'-4"	3'-8"	Clear	80%	5%

Table 5.02 *Daylight Elements – Lecture Hall*

Illuminance Requirements:

IESNA Reference: Lecture Halls (audience/demonstration), #2 pencil/photocopies

Horizontal Illuminance: 100 fc (demonstration), 30 fc (audience)
Vertical Illuminance: 50 fc

Analysis: Vertical illuminance is appropriate, but horizontal illuminance on the demo area is way too high here (the slope of the space is not as great as many lecture halls, and vertical illuminance becomes more critical). I will design the stage area for 70 fc.

Design Criteria and Goals:

Most Important:

Appearance of Space and Luminaires:

- Many of the guest lectures and presentations for the entire university will be taking place in this room. The space should look very professional, and the fixtures should be generally recessed or aesthetically clean.

Light Distribution on Task Plane:

- Every desk in the lecture hall should be equally lit, so that there is no place in the room where it is more difficult to learn from.

Modeling of Faces and Objects:

- In presentations and demonstrations, it is critical for audience members to be able to see the presenters and details of any objects they are using. It is also critical for the faces of the audience to be somewhat lit, so that the presenter can pick up visual cues that he/she is getting their point across, and can try other things if one method is not working.

Points of Interest:

- The two major focus areas in the space are the podium and the coves, and lighting should be used to effectively accentuate these areas.

Special Considerations (VDT/Projection Screen):

- Nearly all presentations in this space will be in PowerPoint / digital format, so the projection screen is a critical task plane. Because the presentations in this room are professional in nature, it is not acceptable to simply shut off all of the lights in the room when the projection screen is being used. A high quality design will put light on the audience while limiting the illuminance on the screen to less than 5 footcandles.

System Control and Flexibility:

- At least two different scenes would be great in this space; one to be used for presentations on the projection screen, and one to be used for before and after presentations that allows more light on the stage.

Also Important:

Color Appearance and Color Contrast:

- Any demonstrations that occur as part of presentation will require reasonably good color contrast.

Shadows:

- The lighting system cannot create any shadows over the projection screen, both because of the physical fixture and the visual effects caused by the lighting system.

Illuminance (Horizontal and Vertical):

- Good horizontal illuminance is required for note taking. Good vertical illuminance is required for reading off the vertical surfaces of the space (which may include a chalkboard or whiteboard)

Ceiling Redesign:

The original ceiling for the space was a linear cove system at varying heights. One of my major goals for the lighting design here is to evenly distribute light on the work surfaces throughout the lecture hall. Because the furniture layout does not match up well with the original ceiling design, using the original ceiling would make it difficult to achieve this goal. Additional reasons for the re-design include acoustical enhancement (which is discussed in the acoustical breadth) and the opportunity to make the space more visually interesting, which will be a combination of ceiling design and lighting design.

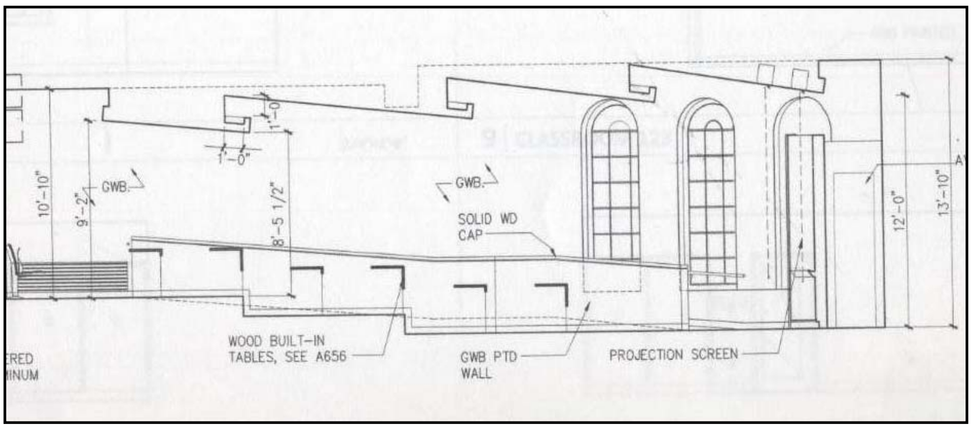


Figure 5.04   *Section of Lecture Hall – Original Cove Ceiling*

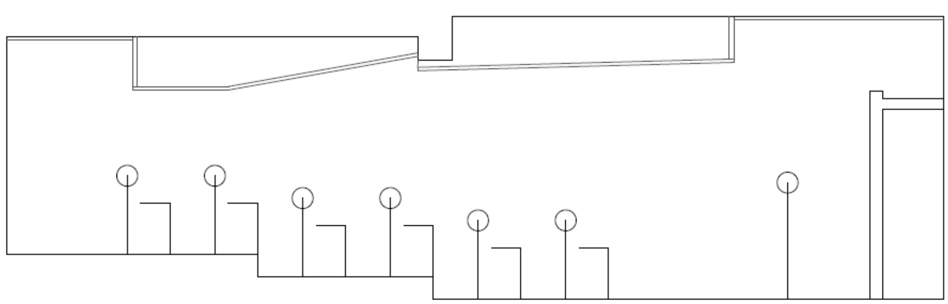


Figure 5.05   *Section of Lecture Hall – Proposed Ceiling Reflectors*

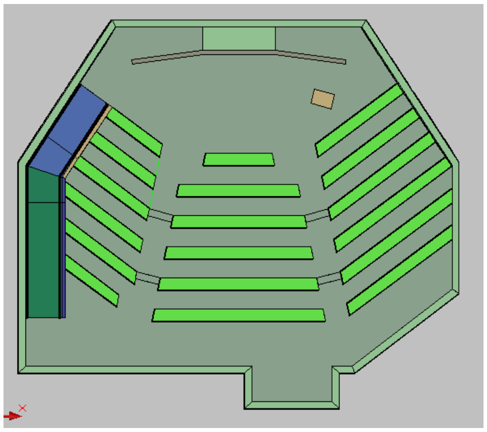


Figure 5.06 *Lecture Hall Model – Plan View*

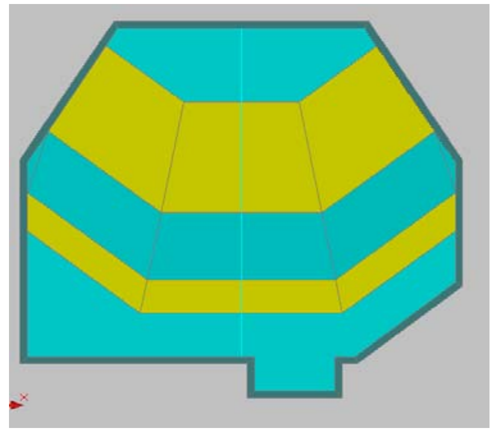


Figure 5.07 *Lecture Hall Model – Plan View of Ceiling*

Impact of New Ceiling Design on Structure:

One of the advantages of the original cove lighting systems was that it worked in very well with the structural framing for the space. The new design of the lecture hall ceiling has both a different shape (which by itself shouldn't be a huge issue) as well as lower ceiling heights in some critical areas. A key concern here was working around the bottom section of a Vierendell truss that goes across the middle of the space. Should the beam have to protrude into the space, it would interfere with the overall goals of the design (to enhance the acoustical efficiency of the space and to better match the geometry of the space and furnishing). The following diagram shows a section of the space with measurements to determine if this becomes an issue. As illustrated below, it appears that the new ceiling design will not affect the structural framing design, and vice versa.

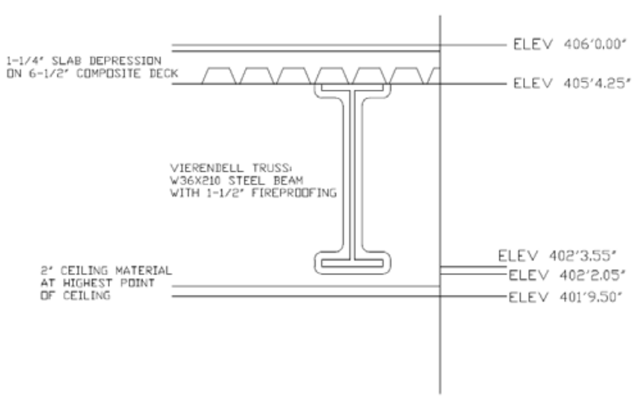


Figure 5.08 *Lecture Hall – Simplified Section of Vierendell Truss with Measurements*

Luminaire Schedule:

Label	Quantity	Description	Number of Lamps / Linear Feet	Lamp Type	Voltage
PP1	62	Recessed linear fluorescent downlight	4'	T5	277
PP2	14	Recessed compact fluorescent wall washer	1	42W CFL TRT	277
PP3	24	Recessed compact fluorescent downlight	1	26W CFL TRT	277
PP4	33	Floor recessed LED uplight for ramp and stairs	1	LED	277
PP5	8	Luminous wall sconce with brass trim	2'	T5	277

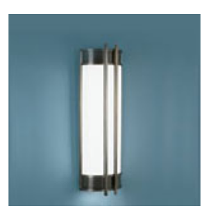
Table 5.03 *Compressed Luminaire Schedule for Lecture Hall*
For Full Luminaire Schedule and Details, Please Refer to Appendix A

PP1

PP2

PP3

PP4



PP5

Ballast Schedule:

Label	Ballast/Driver Type	Power Factor	Ballast Factor	Ballast Watts
PP1	Dimmable Electronic	0.98	1.00	29
PP2	Dimmable Electronic	0.99	1.00	47
PP3	Dimmable Electronic	0.98	1.05	31
PP4	24V LED Driver	1.00	-	4.2
PP5	Dimmable Electronic	0.98	1.05	19

Table 5.04 *Compressed Ballast Schedule for Lecture Hall*
For Full Ballast Details, Please Refer to Appendix A

Light Loss Factors:

Label	Maint. Cat.	Degree of Dirt	Cleaning Schedule	Distrib. Cat.	Ballast Factor	Lumin. Dirt Deprec.	Lamp Lumen Deprec.	Room Surface Dirt Deprec.	Total LLF
PP1	III	Very Clean	12 mths	Direct	1.000	0.924	0.919	0.980	0.832
PP2	III	Very Clean	12 mths	Direct	1.000	0.924	0.841	0.980	0.762
PP3	III	Very Clean	12 mths	Direct	1.050	0.924	0.841	0.980	0.800
PP4	V	Very Clean	12 mths	Indirect	1.000	0.925	0.700	1.000	0.648
PP5	II	Very Clean	12 mths	Dir-Ind	1.050	0.968	0.919	0.930	0.869

Table 5.05 *Light Loss Factors for Lecture Hall*

Lighting Plan:

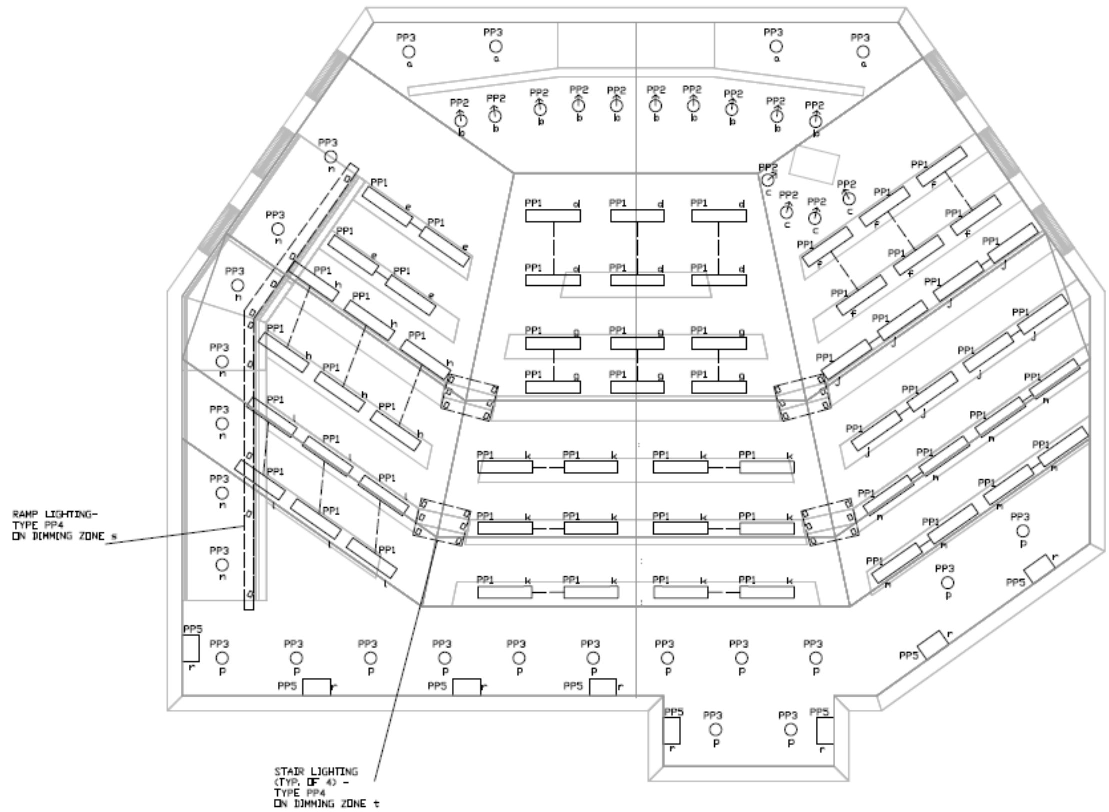


Figure 5.09 *Lighting Plan – Lecture Hall*

Controls:

Every luminaire in the lecture hall is connected to one of two dimming panels: one for normal power, and one for normal and emergency power. Since it is possible to dim every fixture in this layout, it allows this space to serve several different functions for several different effects. I am using four different scenes: LECTURE, A/V, MOVIE, and MAINTENANCE. This is in addition to an all-off scenario. In combination with time clocks for the entire building, this allows the space to meet automatic shut-off criteria.

Zone	Description	Circuit #	Fixture Load	# of Fixtures	Total Load
a	Front Exit Lighting (PP3)	EDM4P-1	31	4	124 W
b	Front Chalkboard Lighting (PP2)	DM4P-1	47	10	470 W
c	Front Speaker Lighting (PP2)	DM4P-2	47	4	188 W
d	Front Center Downlighting (PP1)	DM4P-3	29	6	174 W
e	Front Left Downlighting (PP1)	DM4P-4	29	4	116 W
f	Front Right Downlighting (PP1)	DM4P-5	29	6	174 W
g	Middle Center Downlighting (PP1)	EDM4P-2	29	6	174 W
h	Middle Left Downlighting (PP1)	EDM4P-3	29	6	174 W
j	Middle Right Downlighting (PP1)	EDM4P-4	29	8	232 W
k	Back Center Downlighting (PP1)	EDM4P-5	29	12	348 W
l	Back Left Downlighting (PP1)	EDM4P-7	29	6	174 W
m	Back Right Downlighting (PP1)	EDM4P-8	29	8	232 W
n	Ramp Downlighting (PP3)	EDM4P-11	31	7	217 W
p	Back Exit Downlighting (PP3)	EDM4P-12	31	13	403 W
q	Existing Vestibule Lighting (A17B)	EDM4P-6	34	2	68 W
r	Sconces (PP5)	DM4P-6	19	8	152 W
s	In-Ramp Lighting (PP4)	EDM4P-13	4.2	9	37.8 W
t	In-Stair Lighting (PP4)	EDM4P-14	4.2	24	100.8 W

Table 5.06 *Lecture Hall Dimming System – Zone Layout*

"LECTURE" Scene:

This is a high light-level scene that focuses a lot of light on the front stage and speaker. The desk lighting is on at 80% light output, which still provides 50 footcandles but helps to extend lamp life. The side and back lighting features are on at 40% to focus attention to the front, but to make a more pleasant condition for the speaker to look at.

Zone	Description	Percent Full Output
a	Front Exit Lighting (PP3)	100%
b	Front Chalkboard Lighting (PP2)	100%
c	Front Speaker Lighting (PP2)	100%
d	Front Center Downlighting (PP1)	100%
e	Front Left Downlighting (PP1)	80%
f	Front Right Downlighting (PP1)	80%
g	Middle Center Downlighting (PP1)	80%
h	Middle Left Downlighting (PP1)	80%
j	Middle Right Downlighting (PP1)	80%
k	Back Center Downlighting (PP1)	80%
l	Back Left Downlighting (PP1)	80%
m	Back Right Downlighting (PP1)	80%
n	Ramp Downlighting (PP3)	40%
p	Back Exit Downlighting (PP3)	40%
q	Existing Vestibule Lighting (A17B)	100%
r	Sconces (PP5)	40%
s	In-Ramp Lighting (PP4)	100%
t	In-Stair Lighting (PP4)	100%

Table 5.07 *Lecture Hall Dimming System – Zone Output Levels for "LECTURE" Scene*

"A/V" Scene:

This is a lower light-level scene that removed as much light as possible from the front of the space, while still leaving lighting on over most of the desk areas. The front desk lighting is either at 25% light output or off, and the rest of the desk lighting is on at 75% light output, which still provides around 30-40 footcandles on the desks. The side and back lighting features are on at 25% to allow for egress without distracting from the front. This layout is good for PowerPoint presentations, slide shows, and other static visual presentations.

Zone	**Description**	**Percent Full Output**
a	Front Exit Lighting (PP3)	0%
b	Front Chalkboard Lighting (PP2)	0%
c	Front Speaker Lighting (PP2)	0%
d	Front Center Downlighting (PP1)	0%
e	Front Left Downlighting (PP1)	25%
f	Front Right Downlighting (PP1)	25%
g	Middle Center Downlighting (PP1)	75%
h	Middle Left Downlighting (PP1)	75%
j	Middle Right Downlighting (PP1)	75%
k	Back Center Downlighting (PP1)	75%
l	Back Left Downlighting (PP1)	75%
m	Back Right Downlighting (PP1)	75%
n	Ramp Downlighting (PP3)	25%
p	Back Exit Downlighting (PP3)	25%
q	Existing Vestibule Lighting (A17B)	100%
r	Sconces (PP5)	25%
s	In-Ramp Lighting (PP4)	100%
t	In-Stair Lighting (PP4)	100%

Table 5.08 *Lecture Hall Dimming System – Zone Output Levels for "A/V" Scene*

"MOVIE" Scene:

This is a very low light-level scene that removed nearly all light from the room. The desk lighting is completely off, as is all lighting in the front area. The side and back lighting features are on at 10%, and the ramp and stair uplighting are still on for 100% to allow for emergency egress. This layout is appropriate for movies, video demonstrations, and other dynamic or low contrast visual presentations.

Zone	**Description**	**Percent Full Output**
a	Front Exit Lighting (PP3)	0%
b	Front Chalkboard Lighting (PP2)	0%
c	Front Speaker Lighting (PP2)	0%
d	Front Center Downlighting (PP1)	0%
e	Front Left Downlighting (PP1)	0%
f	Front Right Downlighting (PP1)	0%
g	Middle Center Downlighting (PP1)	0%
h	Middle Left Downlighting (PP1)	0%
j	Middle Right Downlighting (PP1)	0%
k	Back Center Downlighting (PP1)	0%
l	Back Left Downlighting (PP1)	0%
m	Back Right Downlighting (PP1)	0%
n	Ramp Downlighting (PP3)	10%
p	Back Exit Downlighting (PP3)	10%
q	Existing Vestibule Lighting (A17B)	100%
r	Sconces (PP5)	10%
s	In-Ramp Lighting (PP4)	100%
t	In-Stair Lighting (PP4)	100%

Table 5.09 *Lecture Hall Dimming System – Zone Output Levels for "MOVIE" Scene*

"MAINTENANCE" Scene:

This is a high light-level scene in which nearly all of the luminaires are on at 100%. The exception is the stair and ramp uplighting (which is off, to avoid any conflict with carpet-cleaning equipment). This is ideal for after-hours maintenance. I would also like this scene to be the default scene, in case of power failure reset.

Zone	**Description**	**Percent Full Output**
a	Front Exit Lighting (PP3)	100%
b	Front Chalkboard Lighting (PP2)	100%
c	Front Speaker Lighting (PP2)	100%
d	Front Center Downlighting (PP1)	100%
e	Front Left Downlighting (PP1)	100%
f	Front Right Downlighting (PP1)	100%
g	Middle Center Downlighting (PP1)	100%
h	Middle Left Downlighting (PP1)	100%
j	Middle Right Downlighting (PP1)	100%
k	Back Center Downlighting (PP1)	100%
l	Back Left Downlighting (PP1)	100%
m	Back Right Downlighting (PP1)	100%
n	Ramp Downlighting (PP3)	100%
p	Back Exit Downlighting (PP3)	100%
q	Existing Vestibule Lighting (A17B)	100%
r	Sconces (PP5)	100%
s	In-Ramp Lighting (PP4)	0%
t	In-Stair Lighting (PP4)	0%

Table 5.10 *Lecture Hall Dimming System – Zone Output Levels for "MAINTENANCE" Scene*

Calculations and Performance:

"LECTURE" Scene:

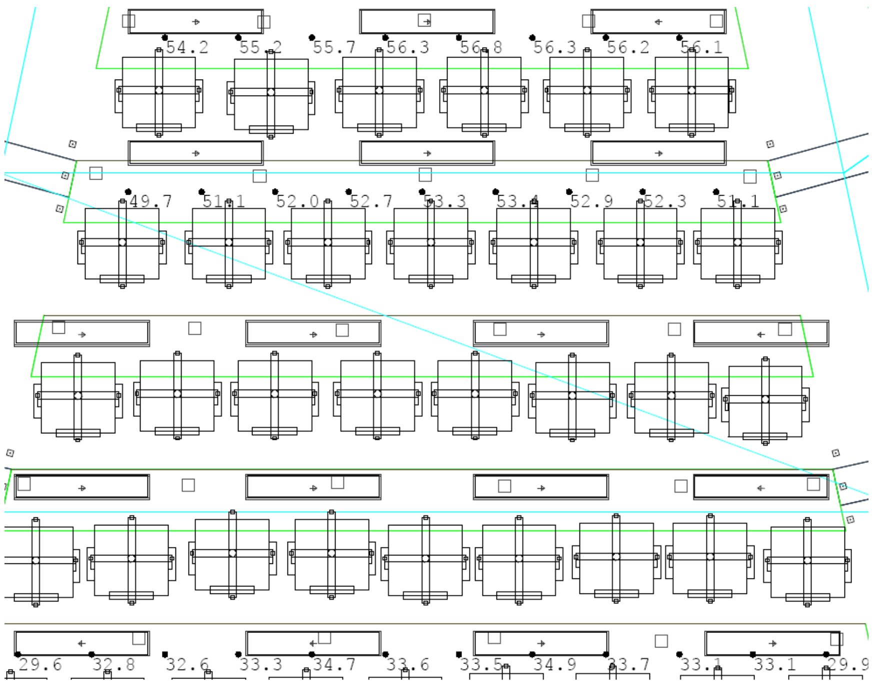


Figure 5.10 *Lecture Hall – Illuminance on Desks During "LECTURE" Scene*

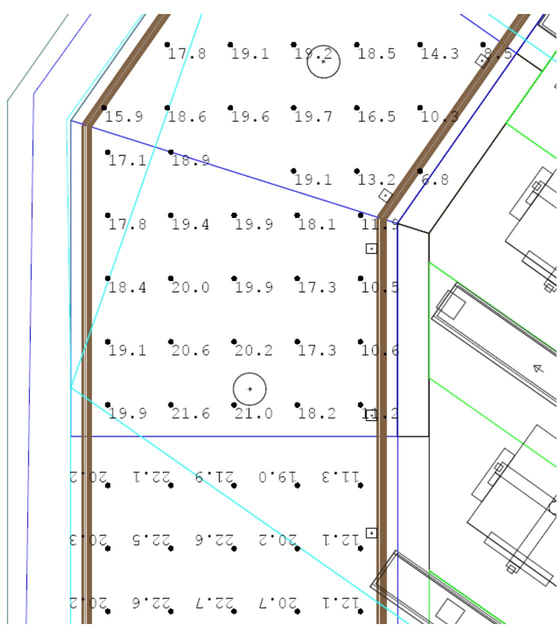


Figure 5.11 *Lecture Hall – Illuminance on Ramp During "LECTURE" Scene*

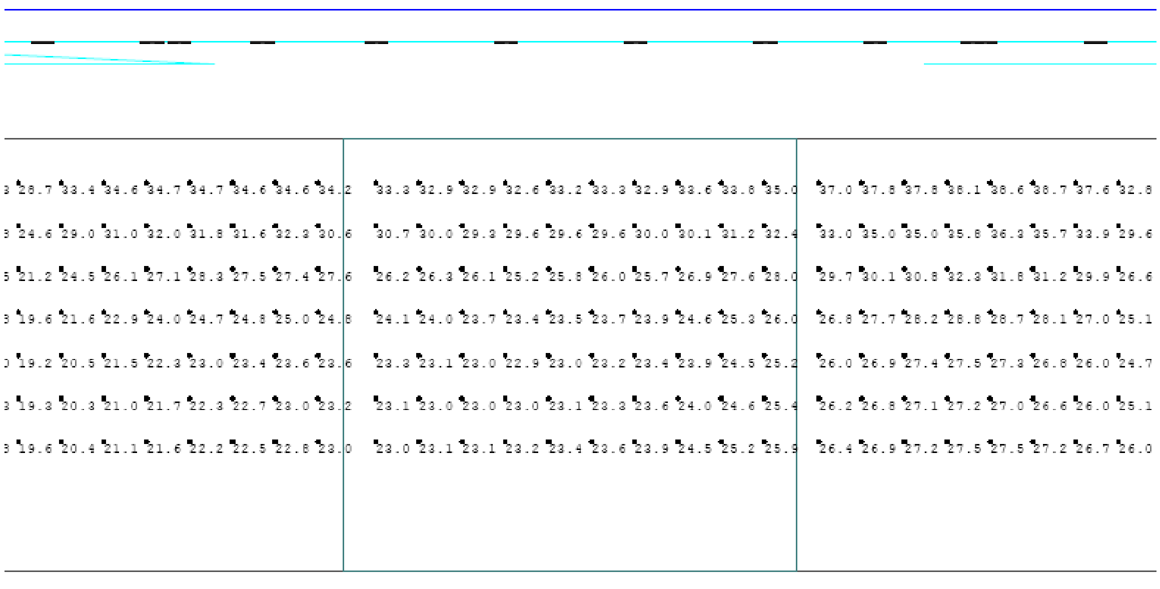


Figure 5.12 *Lecture Hall – Illuminance on Projection Screen During "LECTURE" Scene*

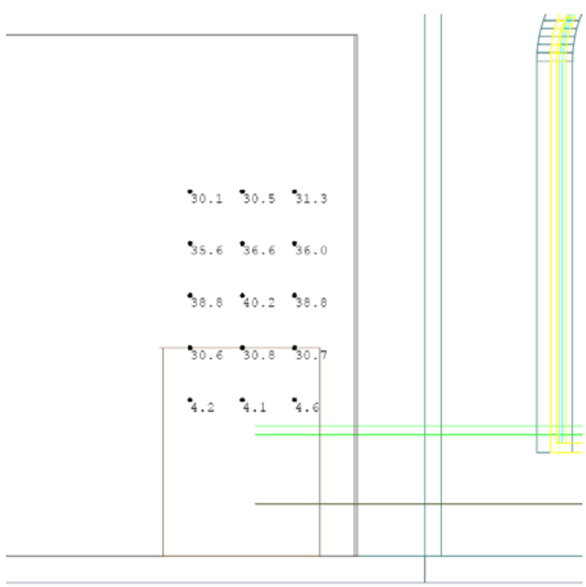


Figure 5.13 *Lecture Hall – Illuminance on Speaker During "LECTURE" Scene*

“A/V” Scene:

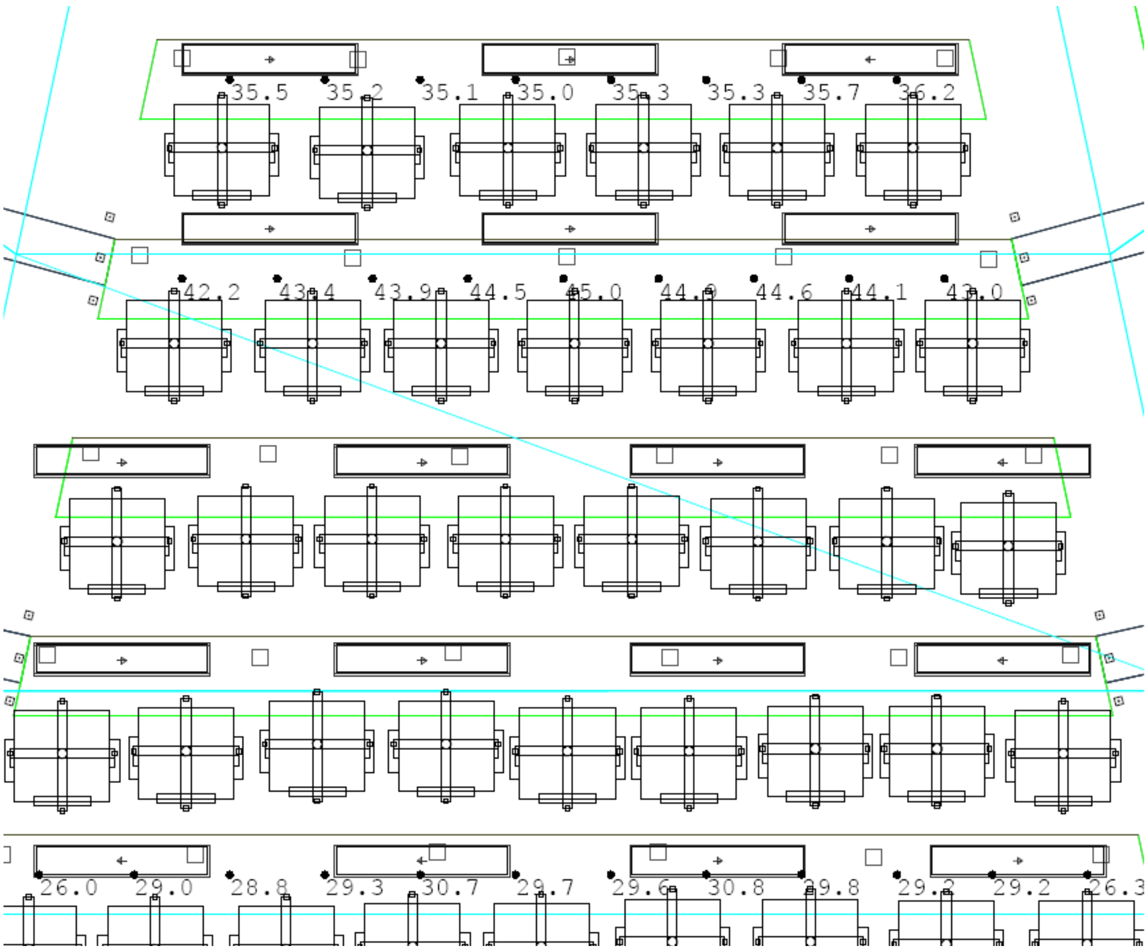


Figure 5.14 *Lecture Hall – Illuminance on Desks During “A/V” Scene*

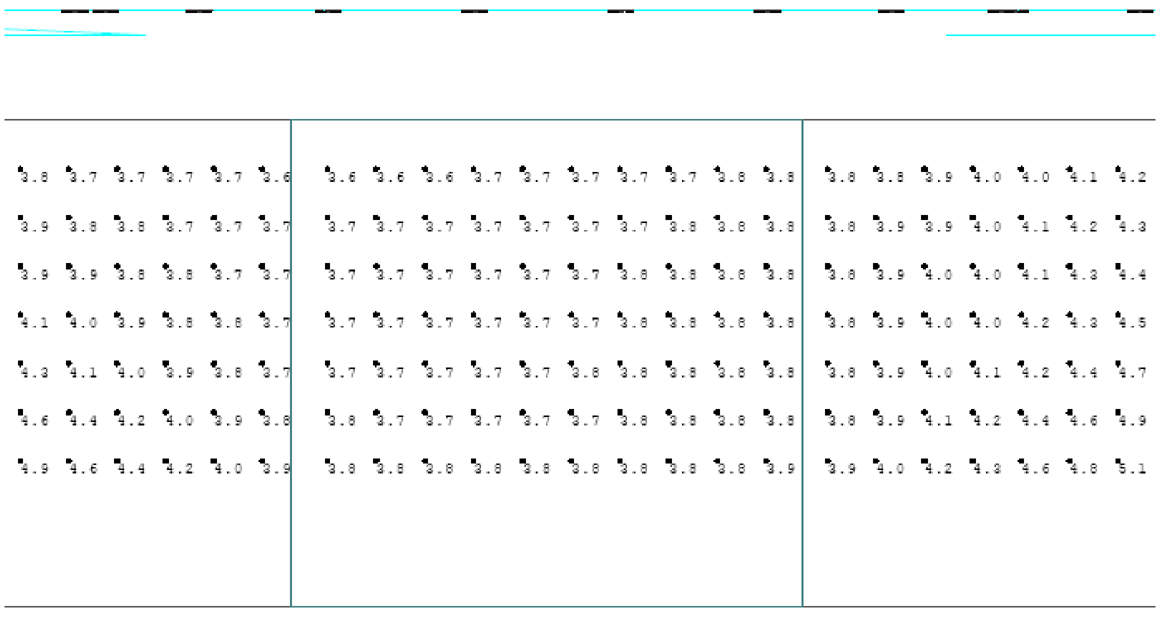


Figure 5.15 *Lecture Hall – Illuminance on Projection Screen During "A/V" Scene*

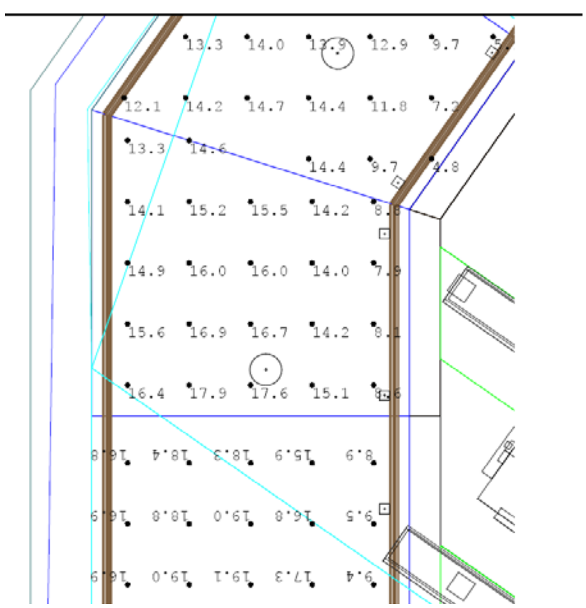


Figure 5.16 *Lecture Hall – Illuminance on Ramp During "A/V" Scene*

Rendered Images:

Figure 5.17 *Color Rendering of Lecture Hall*
From Back Row Seating – "LECTURE" Scene

Figure 5.18 *Color Rendering of Lecture Hall*
From Speaker Podium - "LECTURE" Scene

Figure 5.19 *Color Rendering of Lecture Hall*
From Back Row Seating - "A/V" Scene

Figure 5.20 *Color Rendering of Lecture Hall*
From Speaker Podium - "A/V" Scene

Figure 5.21 *Color Rendering of Lecture Hall*
From Back Row Seating - "MOVIE" Scene

Figure 5.22 *Color Rendering of Lecture Hall*
From Speaker Podium - "MOVIE" Scene

Figure 5.23 *Color Rendering of Lecture Hall*
From Back Row Seating - "MAINTENANCE" Scene

Figure 5.24 *Color Rendering of Lecture Hall*
From Speaker Podium - "MAINTENANCE" Scene

Power Density Calculations:

Space	Matching ASHRAE Category	Power Allowance	Length (ft)	Area (ft^2)	Watts Allowed
Lecture Hall	Classroom/Lecture/Training	1.4 W/ft^2	-	2500	3500

Total Allowed	3500 W

Table 5.11 *Power Allowance for Lecture Hall*

Type	Quantity	Input Watts / Luminaire	Total Watts / Type
PP1	62	29	1798
PP2	14	47	658
PP3	24	31	744
PP4	33	4.2	138.6
PP5	8	19	152

Total Watts Consumed	3490.6 W

Table 5.12 *Power Consumed by Lecture Hall*

Based on the above calculation, the space meets the energy requirements set forth in ASHRAE 90.1 – 2004.

Conclusions:

The use of all –recessed luminaires in the ceiling allows for the maximization of the height the space has. Aligning the linear luminaires with the desks, though not typically the best layout for a learning space, works out well here because of the even distribution on the desks and the shape of the ceiling. There is plenty of light on the lecture area for good rendering of facial features and chalkboard writings. The control devices created 4 scenes that are representative of all of the major functions of the space. The “A/V” scene limits to light on the projection screens to less than 5 footcandles, meeting IES recommendations, while still putting 30-35 footcandles on the desks, which is more than acceptable. The new ceiling appears to be working well with the furniture and lighting layouts; I will analyze the success of the ceiling in relation to acoustics and incorporation of air distribution in the breadth studies.

Electrical Depth

Overview:

The main power for the Life Sciences & Philosophy comes from the main switchgear for Franklin & Marshall College. Power is run from existing lines in the front of the building to a basement substation at the northwest corner of the building. The 12.47KV service voltage is transformed down to 480Y/277V secondary service. Power is then distributed to various basement panels, 2 bus ducts, and the penthouse level. Each bus ducts serves one half of the building (north or south), and there are 2 electrical rooms on each floor (again, one on the north side of the building, the other servicing the south side). Most of the lighting runs on 277V. There are transformers converting the voltage down to 208Y/120 V service in each electrical room, on the penthouse level, and the main mechanical room. The 208Y/120 service is used for receptacle loads, incandescent lighting, and much of the heating for the space.

This Electrical Depth will focus on several components of the electrical distribution system. I have divided this into four separate studies, and for consistency, I have elected to do these studies independently of one another. While I acknowledge that anything that I change in the electrical distribution may have an effect on the system as a whole, it would be impractical to compare, say, the impact of changing copper feeders to aluminum, between the original system and the new system with various enhancements. This is because it would be more difficult to pinpoint what is actually causing the results to be the way they are. Like any good experiment or study, one independent variable needs to be isolated, and everything else needs to remain the same.

The first study will look at the impact of the new lighting design on the branch circuits and panelboards serving it. The second study is an analysis of creating one central 480 to 208Y/120 transformer to replace the seven transformers distributed to the various electrical rooms in the building. The third study looks at changing all of the copper feeders in the building to aluminum, in the hopes of saving significant money. The final study is a protective device coordination and fault current analysis to ensure that the system was properly designed.

Analysis of Circuits Affected By Lighting Design

Overview :

Although the majority of the building uses lighting at 277V (and thus, relatively low current), it is nevertheless still important to analyze the lighting design's effect on the panelboards serving the lighting. I will summarize the effects of each space's new lighting design on the panelboards and feeders serving the panelboards, and will then show calculations of each panelboard affected. Since I was unable to get detailed load calculations from the electrical engineer, I will be assuming that the original panelboards were designed appropriately. All feeders were copper with type THHN insulation in EMT conduit. As a design decision, I have opted to change all of my panelboards up to a minimum of 100A, which is more common than the 60A panels originally used here.

Exterior and Façade:

Since much of the lighting design for the exterior had not been performed yet, the loading for the exterior did go up a bit. However, the original lighting panels were sized with dedicated circuits for lighting, and the panels were sized with an anticipated lighting load.

Frey Atrium:

The atrium lighting system was originally controlled off of separate dimming panels. Since I will not require dimming for my design, I have decided to place all of the luminaires directly on the existing lighting panels. A total of seven panels will receive additional (albeit very small) loads, and the four dimming panels will receive a reduced load.

Ecology Teaching Lab:

All of the lighting for the space is on one circuit. Because I saved energy off of the original design, as shown below, I can confidently state that the new lighting design will have no effect on the sizing of the panelboard L2NA.

Bonchek Lecture Hall:

The lecture hall was also controlled off of dimming panels. Since scene and dimming control is critical for this space, the dimming panels would still make sense here. However, since I have no 120V lighting in the space, there will no longer be any load on the two 208Y/120 dimming panels from either the atrium or the lecture hall.

Exterior and Façade Circuiting Plans:

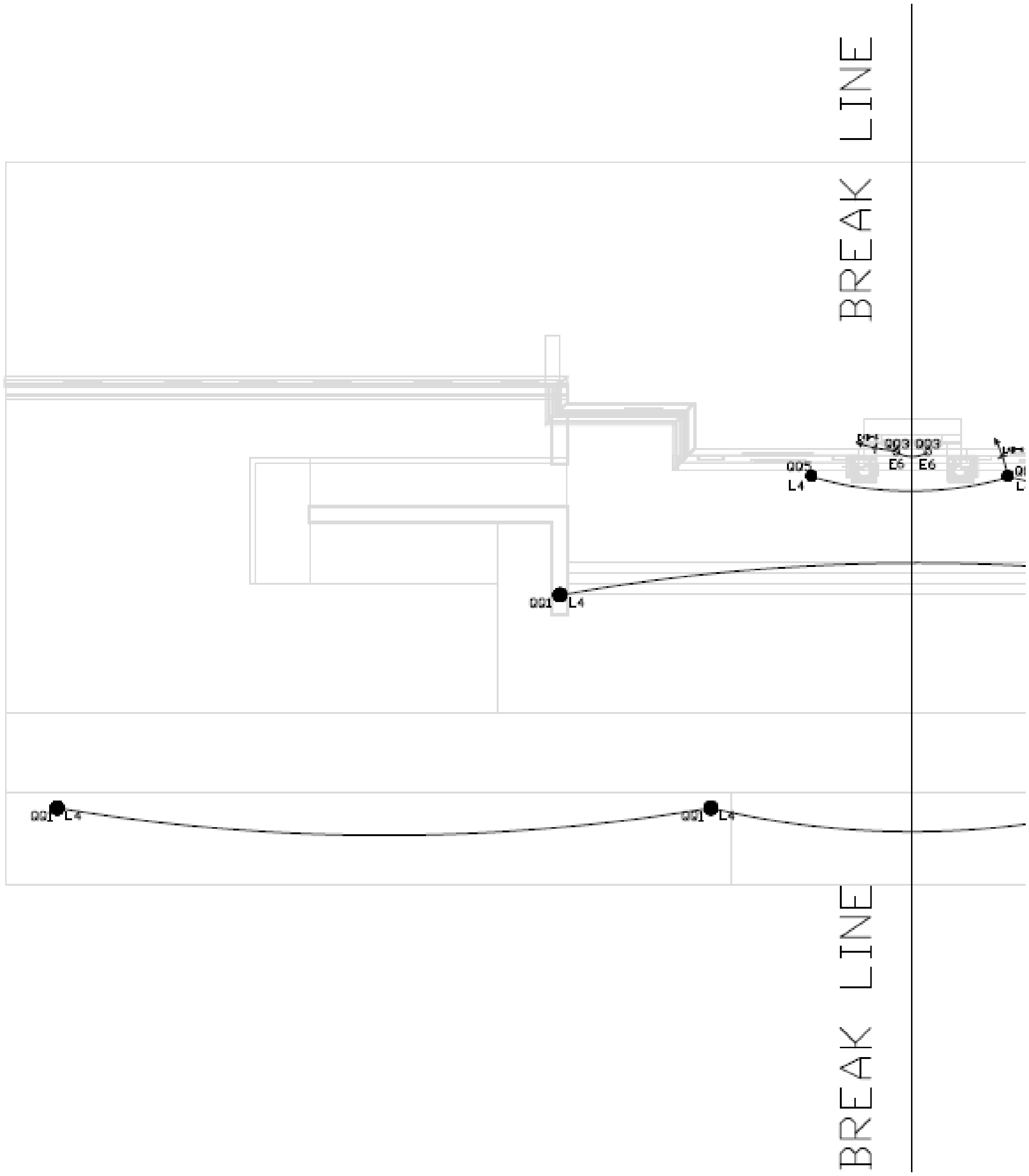


Figure 6.01 *First Floor Circuiting Plan for East Entry and Façade – South Of Entrance*

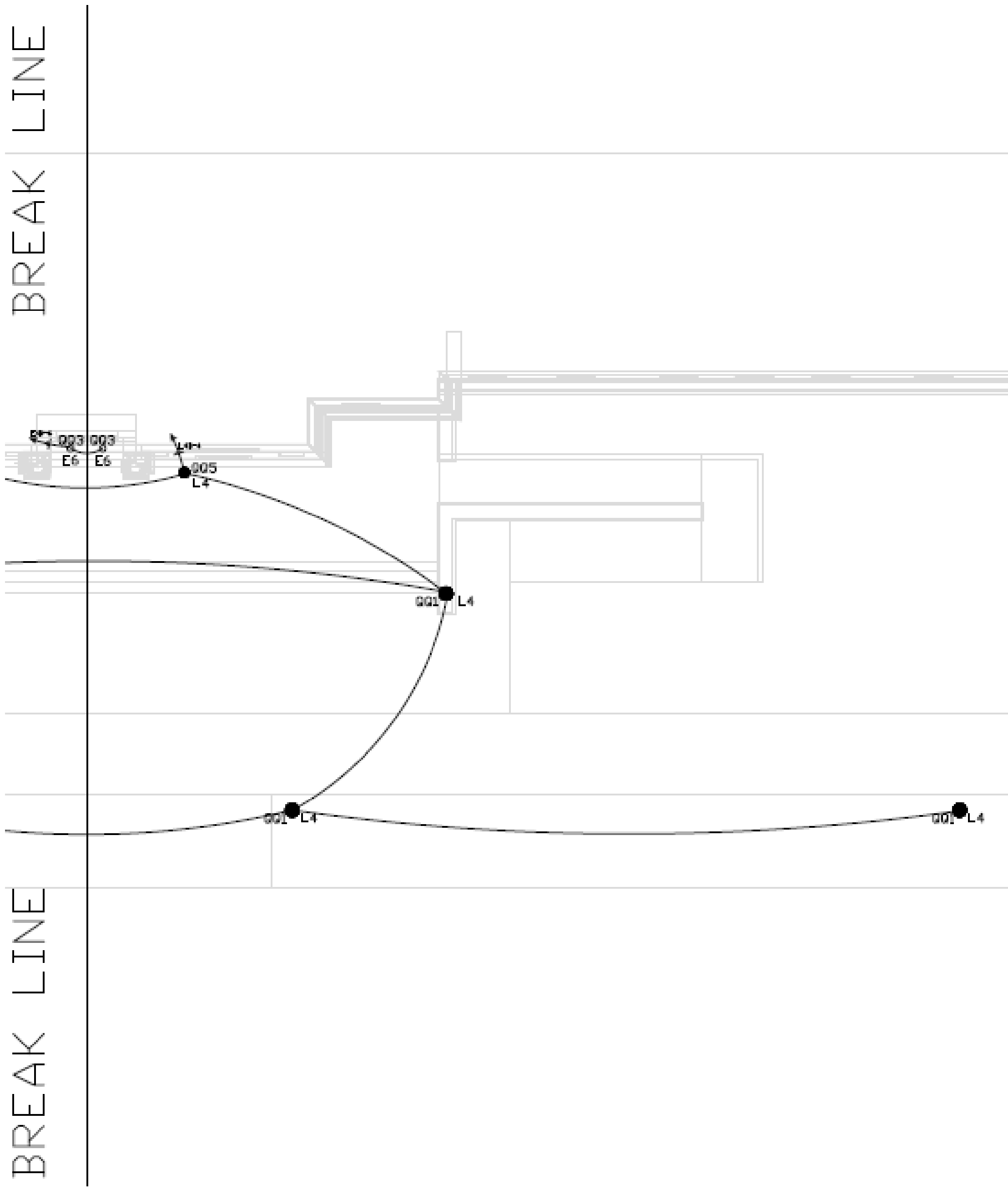


Figure 6.02 First Floor Circuiting Plan for East Entry and Façade – North Of Entrance

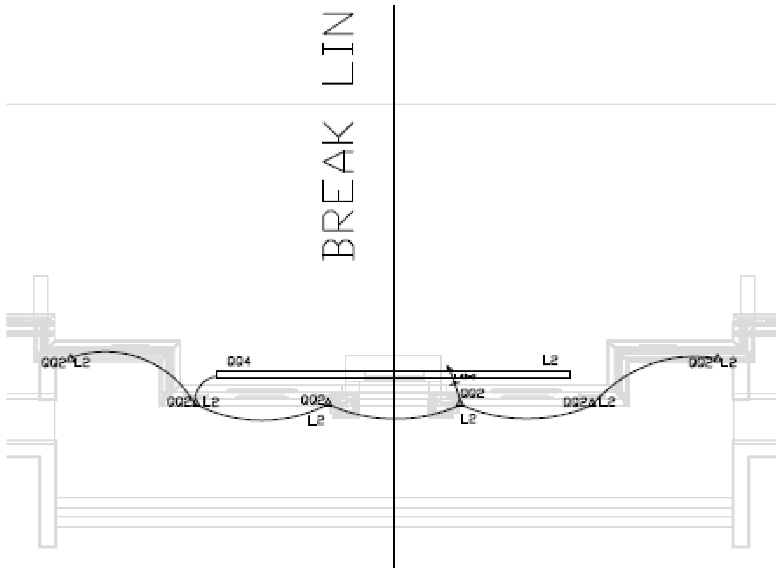


Figure 6.03 *Second Floor Circuiting Plan – East Entry and Façade*

Frey Atrium Circuiting Plans:

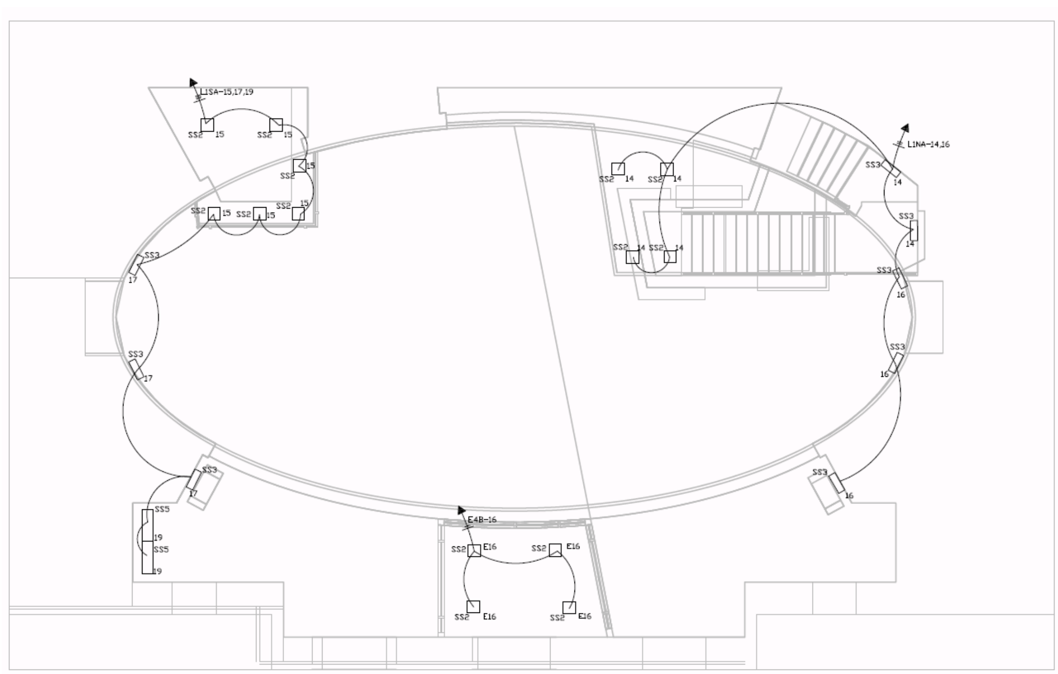


Figure 6.04 *First Floor Circuiting Plan – Atrium*

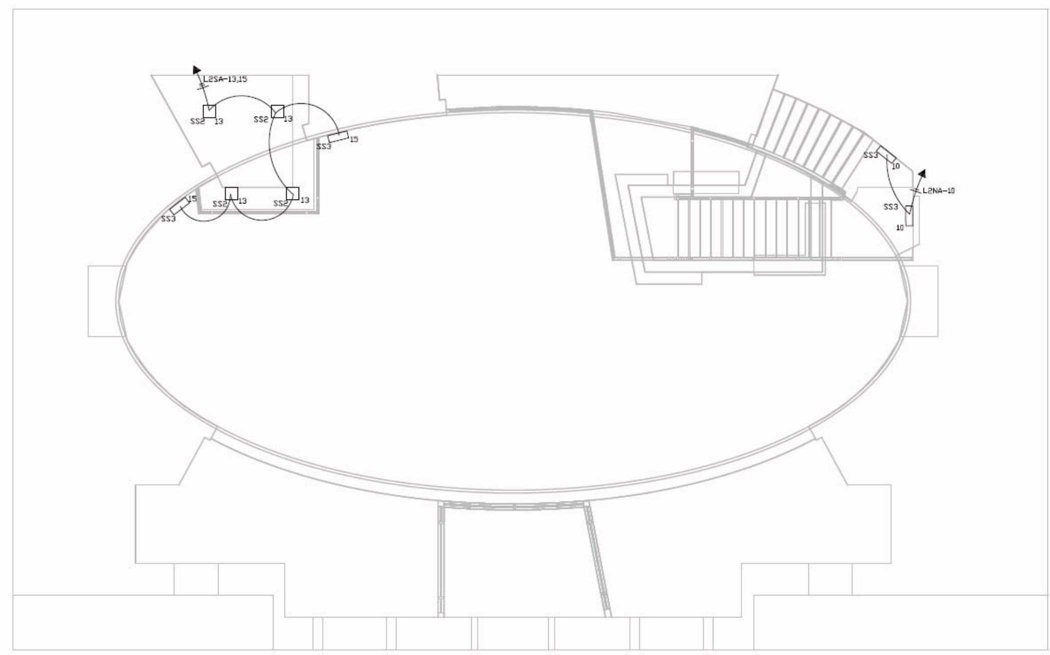


Figure 6.05 *Second Floor Circuiting Plan – Atrium*

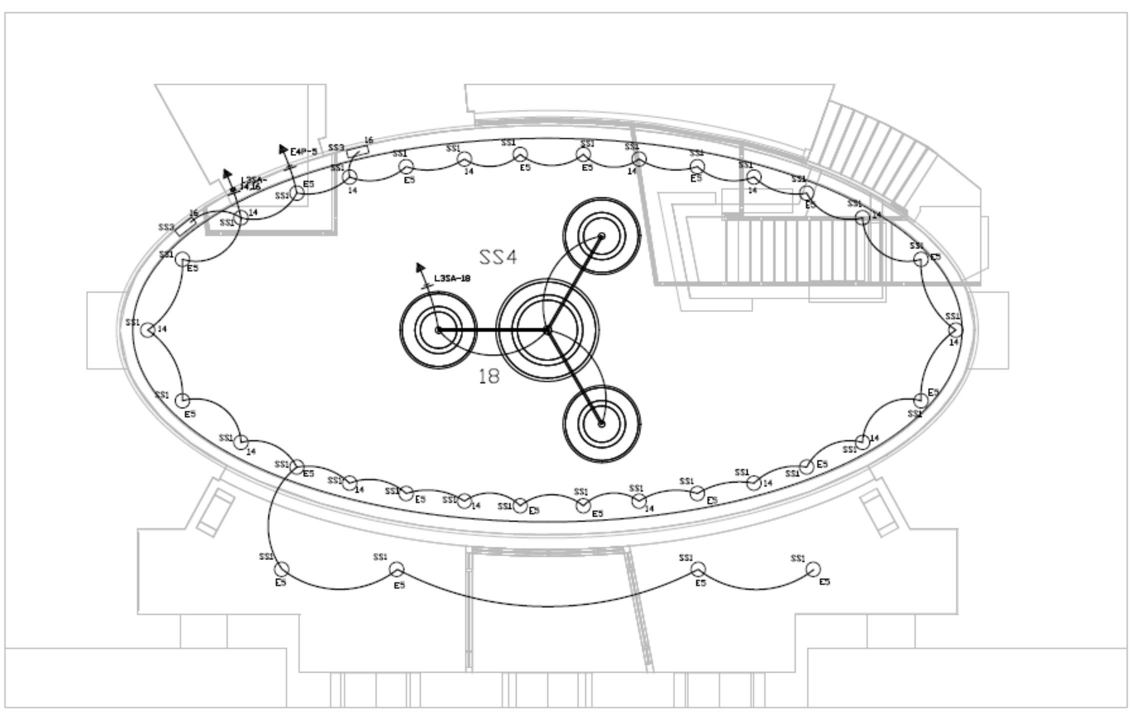


Figure 6.06 *Third Floor Circuiting Plan – Atrium*

Ecology Teaching Laboratory Circuiting Plan:

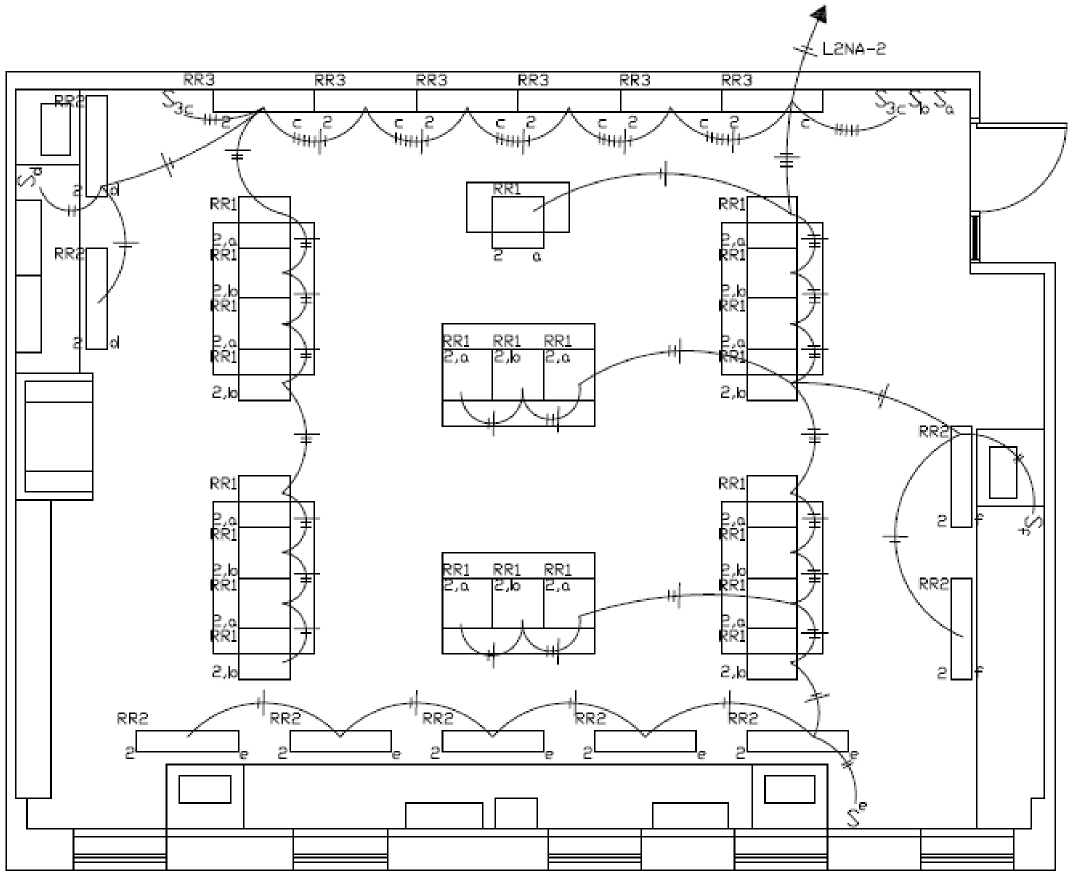


Figure 6.07 *Second Floor Circuiting Plan – Ecology Teaching Lab*

Bonchek Lecture Hall Circuiting Plan:

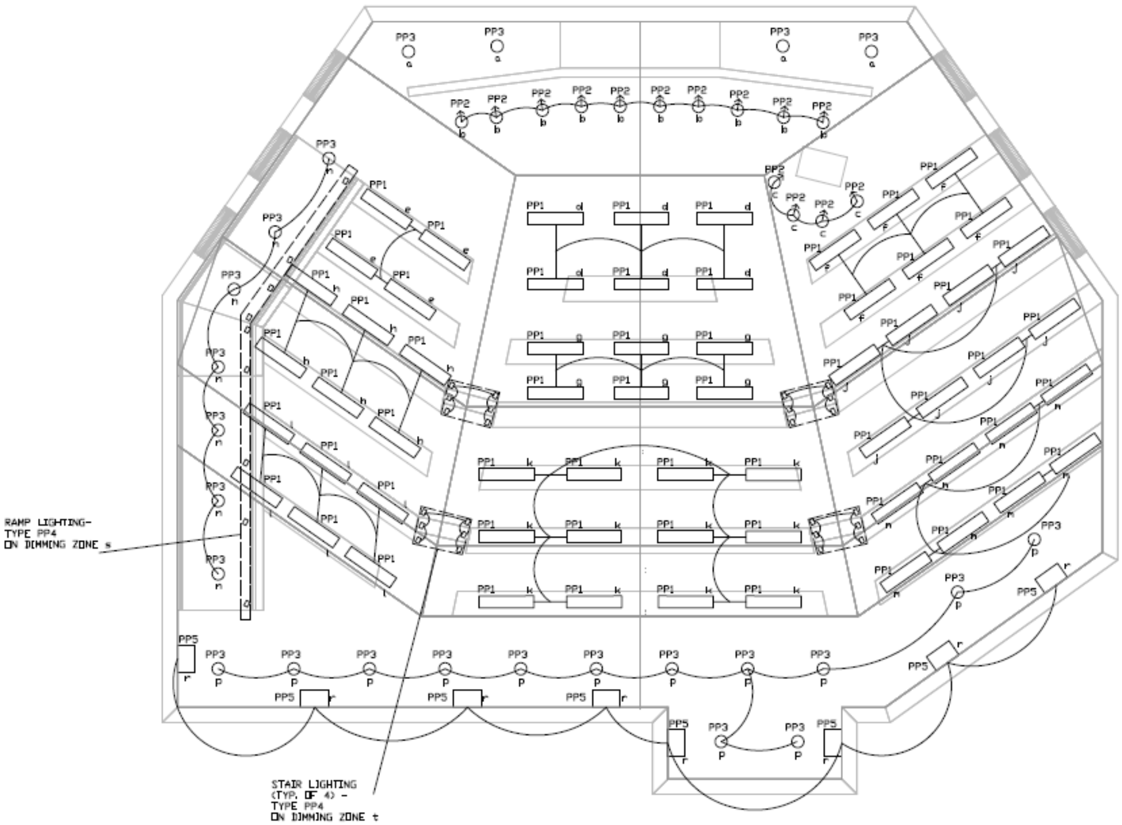


Figure 6.08 *First Floor Circuiting Plan – Lecture Hall*

Panel L4B:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1” conduit

Lighting Design(s) Affecting Panel: Exterior

Circuit(s) Affected: 2, 4

Existing Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 60A SIZE/TYPE MAIN: 60A/3P C/B	PANEL TAG: L4B PANEL LOCATION: Main Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 22K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	RM 43-45	1625	20A/1P	1	*			2	20A/1P	0	Future Use	HID Lighting
Fluorescent Ltg	RM 33, 40	2005	20A/1P	3		*		4	20A/1P	525	POLE EAST	HID Lighting
Fluorescent Ltg	COR 000	1492	20A/1P	5			*	6	20A/1P	1295	POLE SOUTH WEST	HID Lighting
Fluorescent Ltg	RM 50-55	1206	20A/1P	7	*			8	20A/1P	1480	POLE WEST	HID Lighting
Fluorescent Ltg	STAIR WEST	314	20A/1P	9		*		10	20A/1P	750	GARDEN SOUTH	Incandescent Ltg
Fluorescent Ltg	STAIR SOUTH	216	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
space	0	0	20A/1P	19	*			20	20A/1P	0	0	space
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		4.31								TOTAL DESIGN LOAD (KW)		13.64
CONNECTED LOAD (KW) - B		3.59								POWER FACTOR		0.95
CONNECTED LOAD (KW) - C		3.00								TOTAL DESIGN LOAD (AMPS)		17

Table 6.01 *Existing Panelboard Schedule – Lighting Panel L4B*

Revised Panelboard:

PANELBOARD SCHEDULE

VOLTAGE:	480Y/277V,3PH,4W	PANEL TAG:	L4B	MIN. C/B AIC:	22K
SIZE/TYPE BUS:	100A	PANEL LOCATION:	Main Electrical Room	OPTIONS:	
SIZE/TYPE MAIN:	50A/3P C/B	PANEL MOUNTING:	SURFACE		

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	RM 43-45	1625	20A/1P	1	*			2	20A/1P	622	FRONT/EAST	HID Lighting
Fluorescent Ltg	RM 33, 40	2005	20A/1P	3		*		4	20A/1P	788	POLE EAST	HID Lighting
Fluorescent Ltg	COR 000	1492	20A/1P	5			*	6	20A/1P	1295	POLE SOUTH WEST	HID Lighting
Fluorescent Ltg	RM 50-55	1206	20A/1P	7	*			8	20A/1P	1480	POLE WEST	HID Lighting
Fluorescent Ltg	STAIR WEST	314	20A/1P	9		*		10	20A/1P	750	GARDEN SOUTH	Incandescent Ltg
Fluorescent Ltg	STAIR SOUTH	216	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
space	0	0	20A/1P	19	*			20	20A/1P	0	0	space
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space

CONNECTED LOAD (KW) - A	4.93	TOTAL DESIGN LOAD (KW)	14.74
CONNECTED LOAD (KW) - B	3.86	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	3.00	TOTAL DESIGN LOAD (AMPS)	19

Table 6.02 *Revised Panelboard Schedule – Lighting Panel L4B*

Revised Panel Load: 19A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1" conduit

Voltage Drop:

Panel	D4BA
Phase Wire Size	600KCMIL
Feeder Length	35
Load (A)	169
Voltage Drop	-0.036%

Panel	L4B
Phase Wire Size	#8AWG
Feeder Length	10
Load (A)	19
Voltage Drop	-0.036%

Total Voltage Drop	-0.072%

Table 6.03 *Voltage Drop Calculation – Feeder for Lighting Panel L4B*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel L4B as a result of change in load or voltage drop.

Panel L1NA:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1" conduit

Lighting Design(s) Affecting Panel: Atrium

Circuit(s) Affected: 14, 16

Existing Panelboard:

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 60A SIZE/TYPE MAIN: 60A/3P C/B			PANEL TAG: L1NA PANEL LOCATION: North Electrical Room PANEL MOUNTING: SURFACE						MIN. C/B AIC: 22K OPTIONS:			
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
spare	0	0	20A/1P	1	*			2	20A/1P	1124	RM 100A, 114,120	Fluorescent Ltg
spare	0	0	20A/1P	3		*		4	20A/1P	2578	R 115-19, 121-24	Fluorescent Ltg
spare	0	0	20A/1P	5			*	6	20A/1P	1485	R 100B-C,131-2	Fluorescent Ltg
spare	0	0	20A/1P	7	*			8	20A/1P	2017	RM 110, 130	Fluorescent Ltg
spare	0	0	20A/1P	9		*		10	20A/1P	3079	RM 132A-E, 138	Fluorescent Ltg
spare	0	0	20A/1P	11			*	12	20A/1P	1512	R 139, 9A-E, 140, A	Fluorescent Ltg
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		3.14								TOTAL DESIGN LOAD (KW)		14.74
CONNECTED LOAD (KW) - B		5.66								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		3.00								TOTAL DESIGN LOAD (AMPS)		19

Table 6.04 *Existing Panelboard Schedule – Lighting Panel L1NA*

Revised Panelboard:

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B			PANEL TAG: L1NA PANEL LOCATION: North Electrical Room PANEL MOUNTING: SURFACE						MIN. C/B AIC: 22K OPTIONS:			
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
spare	0	0	20A/1P	1	*			2	20A/1P	1124	RM 100A, 114,120	Fluorescent Ltg
spare	0	0	20A/1P	3		*		4	20A/1P	2578	R 115-19, 121-24	Fluorescent Ltg
spare	0	0	20A/1P	5			*	6	20A/1P	1485	R 100B-C,131-2	Fluorescent Ltg
spare	0	0	20A/1P	7	*			8	20A/1P	2017	RM 110, 130	Fluorescent Ltg
spare	0	0	20A/1P	9		*		10	20A/1P	3079	RM 132A-E, 138	Fluorescent Ltg
spare	0	0	20A/1P	11			*	12	20A/1P	1512	R 139, 9A-E, 140, A	Fluorescent Ltg
spare	0	0	20A/1P	13	*			14	20A/1P	38	STRS 1ST TO 2ND	Fluorescent Ltg
spare	0	0	20A/1P	15		*		16	20A/1P	57	SCNS NORTH	Fluorescent Ltg
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		3.18								TOTAL DESIGN LOAD (KW)		14.86
CONNECTED LOAD (KW) - B		5.71								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		3.00								TOTAL DESIGN LOAD (AMPS)		19

Table 6.05 *Revised Panelboard Schedule – Lighting Panel L1NA*

Revised Panel Load: 19A

Revised Overcurrent Protection Trip Rating: 100A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	NORTH BUS DUCT
Phase Wire Size	#2AWG
Feeder Length	105
Load (A)	157
Voltage Drop	-0.578%

Panel	L1NA
Phase Wire Size	#8AWG
Feeder Length	10
Load (A)	19
Voltage Drop	-0.036%

Total Voltage Drop	-0.614%

Table 6.06 *Voltage Drop Calculation – Feeder for Lighting Panel L1NA*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel L1NA as a result of change in load or voltage drop.

Panel L1SA:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1" conduit

Lighting Design(s) Affecting Panel: Atrium

Circuit(s) Affected: 15, 17, 19

Existing Panelboard:

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 60A SIZE/TYPE MAIN: 60A/3P C/B			PANEL TAG: L1SA PANEL LOCATION: South Electrical Room PANEL MOUNTING: SURFACE						MIN. C/B AIC: 22K OPTIONS:			
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	R 161,70,52, COR	3124	20A/1P	1	*			2	20A/1P	0	0	spare
Fluorescent Ltg	RM 156, 62-69	2184	20A/1P	3		*		4	20A/1P	0	0	spare
Fluorescent Ltg	R 173,74,75,81,84	1780	20A/1P	5			*	6	20A/1P	0	0	spare
Fluorescent Ltg	RM 151A-J	2269	20A/1P	7	*			8	20A/1P	0	0	spare
Fluorescent Ltg	RM 151D,E,144,43	2850	20A/1P	9		*		10	20A/1P	0	0	spare
spare	0	0	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		5.39								TOTAL DESIGN LOAD (KW)		15.26
CONNECTED LOAD (KW) - B		5.03								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		1.78								TOTAL DESIGN LOAD (AMPS)		19

Table 6.07 *Existing Panelboard Schedule – Lighting Panel L1SA*

Revised Panelboard:

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B			PANEL TAG: L1SA PANEL LOCATION: South Electrical Room PANEL MOUNTING: SURFACE							MIN. C/B AIC: 22K OPTIONS:		
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	R 161,70,52, COR	3124	20A/1P	1	*			2	20A/1P	0	0	spare
Fluorescent Ltg	RM 156, 62-69	2184	20A/1P	3		*		4	20A/1P	0	0	spare
Fluorescent Ltg	R 173,74,75,81,84	1780	20A/1P	5			*	6	20A/1P	0	0	spare
Fluorescent Ltg	RM 151A-J	2269	20A/1P	7	*			8	20A/1P	0	0	spare
Fluorescent Ltg	RM 151D,E,144,43	2850	20A/1P	9		*		10	20A/1P	0	0	spare
spare	0	0	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
Fluorescent Ltg	ATR CAFÉ	216	20A/1P	15		*		16	20A/1P	0	0	spare
Fluorescent Ltg	SCNS ATR NORTH	57	20A/1P	17			*	18	20A/1P	0	0	spare
Fluorescent Ltg	DISPLAY WALL	48	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		5.44								TOTAL DESIGN LOAD (KW)		15.66
CONNECTED LOAD (KW) - B		5.25								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		1.84								TOTAL DESIGN LOAD (AMPS)		20

Table 6.08 *Revised Panelboard Schedule – Lighting Panel L1SA*

Revised Panel Load: 20A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	SOUTH BUS DUCT
Phase Wire Size	350KCMIL
Feeder Length	240
Load (A)	188
Voltage Drop	-0.578%

Panel	L1SA
Phase Wire Size	#8AWG
Feeder Length	10
Load (A)	20
Voltage Drop	-0.036%

Total Voltage Drop	-0.614%

Table 6.09 *Voltage Drop Calculation – Feeder for Lighting Panel L1SA*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel L1SA as a result of change in load or voltage drop.

Panel L2NA:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1" conduit

Lighting Design(s) Affecting Panel: Ecology Lab, Atrium

Circuit(s) Affected: 2 (Ecology Lab), 10 (Atrium)

Existing Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 60A
SIZE/TYPE MAIN: 60A/3P C/B

PANEL TAG: L2NA
PANEL LOCATION: North Electrical Room
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 22K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
spare	0	0	20A/1P	1	*			2	20A/1P	2696	R 210-212	Fluorescent Ltg
spare	0	0	20A/1P	3		*		4	20A/1P	3498	R 213-214	Fluorescent Ltg
spare	0	0	20A/1P	5			*	6	20A/1P	3357	R 204-06, 238-41	Fluorescent Ltg
spare	0	0	20A/1P	7	*			8	20A/1P	3023	RM 200, 231-32	Fluorescent Ltg
spare	0	0	20A/1P	9		*		10	20A/1P	0	0	spare
spare	0	0	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		5.72								TOTAL DESIGN LOAD (KW)		15.72
CONNECTED LOAD (KW) - B		3.50								POWER FACTOR		0.95
CONNECTED LOAD (KW) - C		3.36								TOTAL DESIGN LOAD (AMPS		20

Table 6.10 *Existing Panelboard Schedule – Lighting Panel L2NA*

Revised Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B	PANEL TAG: L2NA PANEL LOCATION: North Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 22K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
spare	0	0	20A/1P	1	*			2	20A/1P	1896	R 210-212	Fluorescent Ltg
spare	0	0	20A/1P	3		*		4	20A/1P	3498	R 213-214	Fluorescent Ltg
spare	0	0	20A/1P	5			*	6	20A/1P	3357	R 204-06, 238-41	Fluorescent Ltg
spare	0	0	20A/1P	7	*			8	20A/1P	3023	RM 200, 231-32	Fluorescent Ltg
spare	0	0	20A/1P	9		*		10	20A/1P	38	ATR STR 2ND 3RD	Fluorescent Ltg
spare	0	0	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		4.92								TOTAL DESIGN LOAD (KW)		14.77
CONNECTED LOAD (KW) - B		3.54								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		3.36								TOTAL DESIGN LOAD (AMPS		19

Table 6.11 *Revised Panelboard Schedule – Lighting Panel L2NA*

Revised Panel Load: 19A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1" conduit

Voltage Drop:

Panel	NORTH BUS DUCT
Phase Wire Size	#2AWG
Feeder Length	105
Load (A)	157
Voltage Drop	-0.578%

Panel	L2NA
Phase Wire Size	#8AWG
Feeder Length	10
Load (A)	19
Voltage Drop	-0.036%

Total Voltage Drop	-0.614%

Table 6.12 *Voltage Drop Calculation – Feeder for Lighting Panel L2NA*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel L2NA as a result of change in load or voltage drop.

Panel L2SA:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1” conduit

Lighting Design(s) Affecting Panel: Atrium

Circuit(s) Affected: 13, 15

Existing Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 60A SIZE/TYPE MAIN: 60A/3P C/B	PANEL TAG: L2SA PANEL LOCATION: South Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 22K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	R 262, 262 A-M	3096	20A/1P	1	*			2	20A/1P	0	0	spare
Fluorescent Ltg	R 260, 261	2752	20A/1P	3		*		4	20A/1P	0	0	spare
Fluorescent Ltg	R 256-258	3197	20A/1P	5			*	6	20A/1P	0	0	spare
Fluorescent Ltg	R 248, 54	2699	20A/1P	7	*			8	20A/1P	0	0	spare
Fluorescent Ltg	R 243, 245, 42, 46	3543	20A/1P	9		*		10	20A/1P	0	0	spare
Fluorescent Ltg	R 200, 280, 255	2862	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space

CONNECTED LOAD (KW) - A	5.80	TOTAL DESIGN LOAD (KW)	22.69
CONNECTED LOAD (KW) - B	6.30	POWER FACTOR	0.96
CONNECTED LOAD (KW) - C	6.06	TOTAL DESIGN LOAD (AMPS)	29

Table 6.13 *Existing Panelboard Schedule – Lighting Panel L2SA*

Revised Panelboard:

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B			PANEL TAG: L2SA PANEL LOCATION: South Electrical Room PANEL MOUNTING: SURFACE							MIN. C/B AIC: 22K OPTIONS:		
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	R 262, 262 A-M	3096	20A/1P	1	*			2	20A/1P	0	0	spare
Fluorescent Ltg	R 260, 261	2752	20A/1P	3		*		4	20A/1P	0	0	spare
Fluorescent Ltg	R 256-258	3197	20A/1P	5			*	6	20A/1P	0	0	spare
Fluorescent Ltg	R 248, 54	2699	20A/1P	7	*			8	20A/1P	0	0	spare
Fluorescent Ltg	R 243, 245, 42, 46	3543	20A/1P	9		*		10	20A/1P	0	0	spare
Fluorescent Ltg	R 200, 280, 255	2862	20A/1P	11			*	12	20A/1P	0	0	spare
Fluorescent Ltg	DOWN BALC	144	20A/1P	13	*			14	20A/1P	0	0	spare
Fluorescent Ltg	SCNS BALC	38	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		5.94								TOTAL DESIGN LOAD (KW)		22.91
CONNECTED LOAD (KW) - B		6.33								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		6.06								TOTAL DESIGN LOAD (AMPS)		29

Table 6.14 *Revised Panelboard Schedule – Lighting Panel L2SA*

Revised Panel Load: 29A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	SOUTH BUS DUCT
Phase Wire Size	350KCMIL
Feeder Length	240
Load (A)	188
Voltage Drop	-0.578%

Panel	L2SA
Phase Wire Size	#8AWG
Feeder Length	10
Load (A)	29
Voltage Drop	-0.072%

Total Voltage Drop	-0.650%

Table 6.15 *Voltage Drop Calculation – Feeder for Lighting Panel L2SA*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel L2SA as a result of change in load or voltage drop.

Panel L3SA:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1" conduit

Lighting Design(s) Affecting Panel: Exterior

Circuit(s) Affected: 14, 16, 18

Existing Panelboard:

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 60A SIZE/TYPE MAIN: 60A/3P C/B				PANEL TAG: L3SA PANEL LOCATION: South Electrical Room PANEL MOUNTING: SURFACE						MIN. C/B AIC: 22K OPTIONS:		
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	R 374,75,76	3083	20A/1P	1	*			2	20A/1P	880	R 355G	Fluorescent Ltg
Fluorescent Ltg	R 361,62,63	3583	20A/1P	3		*		4	20A/1P	660	R 355F	Fluorescent Ltg
Fluorescent Ltg	R 373, CORR F-H	2039	20A/1P	5			*	6	20A/1P	880	R 355E	Fluorescent Ltg
Fluorescent Ltg	R 346,7,54	2918	20A/1P	7	*			8	20A/1P	880	R 355C	Fluorescent Ltg
Fluorescent Ltg	R 343,44,45,45A	4191	20A/1P	9		*		10	20A/1P	880	R 355B	Fluorescent Ltg
spare	0	0	20A/1P	11			*	12	20A/1P	1760	R 355A	Fluorescent Ltg
HVAC Fans	HT TRACE CT	1040	20A/1P	13	*			14	20A/1P	0	0	spare
HVAC Fans	HT TRACE CT	1040	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		8.80								TOTAL DESIGN LOAD (KW)		29.27
CONNECTED LOAD (KW) - B		10.35								POWER FACTOR		0.94
CONNECTED LOAD (KW) - C		4.68								TOTAL DESIGN LOAD (AMPS)		37

***Table 6.16** Existing Panelboard Schedule – Lighting Panel L3SA*

Revised Panelboard:

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B			PANEL TAG: L3SA PANEL LOCATION: South Electrical Room PANEL MOUNTING: SURFACE						MIN. C/B AIC: 22K OPTIONS:			
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	R 374,75,76	3083	20A/1P	1	*			2	20A/1P	880	R 355G	Fluorescent Ltg
Fluorescent Ltg	R 361,62,63	3583	20A/1P	3		*		4	20A/1P	660	R 355F	Fluorescent Ltg
Fluorescent Ltg	R 373, CORR F-H	2039	20A/1P	5			*	6	20A/1P	880	R 355E	Fluorescent Ltg
Fluorescent Ltg	R 346,7,54	2918	20A/1P	7	*			8	20A/1P	880	R 355C	Fluorescent Ltg
Fluorescent Ltg	R 343,44,45,45A	4191	20A/1P	9		*		10	20A/1P	880	R 355B	Fluorescent Ltg
spare	0	0	20A/1P	11			*	12	20A/1P	1760	R 355A	Fluorescent Ltg
HVAC Fans	HT TRACE CT	1040	20A/1P	13	*			14	20A/1P	504	ATR DWN NOR	Fluorescent Ltg
HVAC Fans	HT TRACE CT	1040	20A/1P	15		*		16	20A/1P	38	SCNS BALC	Fluorescent Ltg
spare	0	0	20A/1P	17			*	18	20A/1P	184	DECOR PEND	Fluorescent Ltg
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		9.31								TOTAL DESIGN LOAD (KW)		30.18
CONNECTED LOAD (KW) - B		10.39								POWER FACTOR		0.94
CONNECTED LOAD (KW) - C		4.86								TOTAL DESIGN LOAD (AMPS)		39

Table 6.17 *Revised Panelboard Schedule – Lighting Panel L3SA*

Revised Panel Load: 39A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	SOUTH BUS DUCT
Phase Wire Size	350KCMIL
Feeder Length	240
Load (A)	188
Voltage Drop	-0.578%

Panel	L3SA
Phase Wire Size	#6AWG
Feeder Length	10
Load (A)	39
Voltage Drop	-0.108%

Total Voltage Drop	-0.686%

Table 6.18 *Voltage Drop Calculation – Feeder for Lighting Panel L3SA*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel L3SA as a result of change in load or voltage drop.

Panel E4B:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1" conduit

Lighting Design(s) Affecting Panel: Exterior, Atrium

Circuit(s) Affected: 6 (Exterior), 16 (Atrium)

Existing Panelboard:

PANELBOARD SCHEDULE		
VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 60A SIZE/TYPE MAIN: 60A/3P C/B	PANEL TAG: E4B PANEL LOCATION: Main Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 22K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	VIVR EMERG	593	20A/1P	1	*			2	20A/1P	129	REAR EXTERIOR	HID Lighting
Fluorescent Ltg	MECH/ELEC NORTH	1365	20A/1P	3		*		4	20A/1P	1621	2ND FL N EMERG	Fluorescent Ltg
Fluorescent Ltg	2ND FL S EMERG	1267	20A/1P	5			*	6	20A/1P	326	EAST ENT EMERG	HID Lighting
Fluorescent Ltg	ELEV ROOM	130	20A/1P	7	*			8	20A/1P	556	WEST EMERG	HID Lighting
spare	0	0	20A/1P	9		*		10	20A/1P	703	GARDEN EMERG	HID Lighting
Fluorescent Ltg	N STAIR EMERG	1937	20A/1P	11			*	12	20A/1P	0	0	spare
Fluorescent Ltg	S STAIR EMERG	1900	20A/1P	13	*			14	20A/1P	0	0	space
Fluorescent Ltg	1ST FL N EMERG	1238	20A/1P	15		*		16	20A/1P	0	0	space
Fluorescent Ltg	1ST FL S EMERG	1515	20A/1P	17			*	18	20A/1P	1175	BASEMENT EMERG	Fluorescent Ltg
space	0	0	20A/1P	19	*			20	20A/1P	0	0	space
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		3.31								TOTAL DESIGN LOAD (KW)		18.07
CONNECTED LOAD (KW) - B		4.93								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		6.22								TOTAL DESIGN LOAD (AMPS)		23

Table 6.19 *Existing Panelboard Schedule – Lighting Panel E4B*

Revised Panelboard:

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B			PANEL TAG: E4B PANEL LOCATION: Main Electrical Room PANEL MOUNTING: SURFACE						MIN. C/B AIC: 22K OPTIONS:			
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	VIVR EMERG	593	20A/1P	1	*			2	20A/1P	129	REAR EXTERIOR	HID Lighting
Fluorescent Ltg	MECH/ELEC NORTH	1365	20A/1P	3		*		4	20A/1P	1621	2ND FL N EMERG	Fluorescent Ltg
Fluorescent Ltg	2ND FL S EMERG	1267	20A/1P	5			*	6	20A/1P	198	EAST ENT EMERG	HID Lighting
Fluorescent Ltg	ELEV ROOM	130	20A/1P	7	*			8	20A/1P	556	WEST EMERG	HID Lighting
spare	0	0	20A/1P	9		*		10	20A/1P	703	GARDEN EMERG	HID Lighting
Fluorescent Ltg	N STAIR EMERG	1937	20A/1P	11			*	12	20A/1P	0	0	spare
Fluorescent Ltg	S STAIR EMERG	1900	20A/1P	13	*			14	20A/1P	0	0	space
Fluorescent Ltg	1ST FL N EMERG	1238	20A/1P	15		*		16	20A/1P	184	VESTIBULE LTG	Fluorescent Ltg
Fluorescent Ltg	1ST FL S EMERG	1515	20A/1P	17			*	18	20A/1P	1175	BASEMENT EMERG	Fluorescent Ltg
space	0	0	20A/1P	19	*			20	20A/1P	0	0	space
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		3.31								TOTAL DESIGN LOAD (KW)		18.14
CONNECTED LOAD (KW) - B		5.11								POWER FACTOR		0.96
CONNECTED LOAD (KW) - C		6.09								TOTAL DESIGN LOAD (AMPS)		23

Table 6.20 *Revised Panelboard Schedule – Lighting Panel E4B*

Revised Panel Load: 23A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	E4P
Phase Wire Size	#8AWG
Feeder Length	285
Load (A)	29
Voltage Drop	-1.119%

Panel	E4B
Phase Wire Size	#8AWG
Feeder Length	200
Load (A)	23
Voltage Drop	-0.614%

Total Voltage Drop	-1.733%

Table 6.21 *Voltage Drop Calculation – Feeder for Lighting Panel E4B*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel E4B as a result of change in load or voltage drop.

Panel E4P:

Original Overcurrent Protection Trip Rating: 100A

Original Feeder: 4-#2AWG wires + 1-#8AWG wires in 1-1/4" conduit

Lighting Design(s) Affecting Panel: Atrium

Circuit Affected: 5

Existing Panelboard:

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 100A/3P C/B			PANEL TAG: E4P PANEL LOCATION: Penthouse Electrical Room PANEL MOUNTING: SURFACE							MIN. C/B AIC: 22K OPTIONS:		
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
spare	0	0	20A/1P	1	*			2	20A/1P	1318	EM 3RD FL COL N	Fluorescent Ltg
spare	0	0	20A/1P	3		*		4	20A/1P	1399	EM 3RD FL COL S	Fluorescent Ltg
spare	0	0	20A/1P	5			*	6	20A/1P	0	0	spare
Fluorescent Ltg	RM 401	325	20A/1P	7	*			8	20A/1P	0	0	spare
spare	0	0	20A/1P	9		*		10	20A/1P	0	0	spare
spare	0	0	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A CONNECTED LOAD (KW) - B CONNECTED LOAD (KW) - C		1.64 1.40 0.00								TOTAL DESIGN LOAD (KW) POWER FACTOR TOTAL DESIGN LOAD (AMPS)		3.80 0.96 5

Table 6.22 *Existing Panelboard Schedule – Lighting Panel E4P*

Revised Panelboard:

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B			PANEL TAG: E4P PANEL LOCATION: Penthouse Electrical Room PANEL MOUNTING: SURFACE						MIN. C/B AIC: 22K OPTIONS:			
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
spare	0	0	20A/1P	1	*			2	20A/1P	1318	EM 3RD FL COL N	Fluorescent Ltg
spare	0	0	20A/1P	3		*		4	20A/1P	1399	EM 3RD FL COL S	Fluorescent Ltg
Fluorescent Ltg	EM ATR DWN	720	20A/1P	5			*	6	20A/1P	0	0	spare
Fluorescent Ltg	RM 401	325	20A/1P	7	*			8	20A/1P	0	0	spare
spare	0	0	20A/1P	9		*		10	20A/1P	0	0	spare
spare	0	0	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		1.64							TOTAL DESIGN LOAD (KW)			4.70
CONNECTED LOAD (KW) - B		1.40							POWER FACTOR			0.97
CONNECTED LOAD (KW) - C		0.72							TOTAL DESIGN LOAD (AMPS)			6

Table 6.23 *Revised Panelboard Schedule – Lighting Panel E4P*

Revised Panel Load: 6A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	E4P
Phase Wire Size	#8AWG
Feeder Length	285
Load (A)	29
Voltage Drop	-1.119%

Table 6.24 *Voltage Drop Calculation – Feeder for Lighting Panel E4P*

Remarks:

The original design was excessive. As a result, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel E4P as a result of change in load or voltage drop.

Panel DM4P:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1” conduit

Lighting Design(s) Affecting Panel: Lecture Hall

Circuits Affected: 1, 2, 3, 4, 5, 6, 7

Existing Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 60A SIZE/TYPE MAIN: 60A/3P C/B	PANEL TAG: DM4P PANEL LOCATION: Penthouse Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 22K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	LEC COVE	510	20A/1P	1	*			2	20A/1P	630	LEC COVE	Fluorescent Ltg
Fluorescent Ltg	LEC COVE	750	20A/1P	3		*		4	20A/1P	765	LEC COVE	Fluorescent Ltg
Fluorescent Ltg	LEC BACK DOWN	238	20A/1P	5			*	6	20A/1P	170	LEC WW SOUTH	Fluorescent Ltg
Fluorescent Ltg	LEC WW NORTH	306	20A/1P	7	*			8	20A/1P	1517	ATR DOWN COR	Fluorescent Ltg
Fluorescent Ltg	ATR WALL COR	1110	20A/1P	9		*		10	20A/1P	750	HUM WALL	Fluorescent Ltg
Fluorescent Ltg	HUM ACCENT	150	20A/1P	11			*	12	20A/1P	150	HUM ACCENT	Fluorescent Ltg
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		2.96								TOTAL DESIGN LOAD (KW)		8.81
CONNECTED LOAD (KW) - B		3.38								POWER FACTOR		0.98
CONNECTED LOAD (KW) - C		0.71								TOTAL DESIGN LOAD (AMPS)		11

Table 6.25 *Existing Panelboard Schedule Dimming Panel DM4P*

Revised Panelboard:

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B			PANEL TAG: DM4P PANEL LOCATION: Penthouse Electrical Room PANEL MOUNTING: SURFACE						MIN. C/B AIC: 22K OPTIONS:			
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	LEC CHALK	470	20A/1P	1	*			2	20A/1P	188	LEC SPEAKER	Fluorescent Ltg
Fluorescent Ltg	LEC CEN FRONT	174	20A/1P	3		*		4	20A/1P	116	LEC LEFT FRON	Fluorescent Ltg
Fluorescent Ltg	LEC RIGHT FRON	174	20A/1P	5			*	6	20A/1P	152	LEC SCONCES	Fluorescent Ltg
spare	0	0	20A/1P	7	*			8	20A/1P	1517	ATR DOWN COR	Fluorescent Ltg
Fluorescent Ltg	ATR WALL COR	1110	20A/1P	9		*		10	20A/1P	750	HUM WALL	Fluorescent Ltg
Fluorescent Ltg	HUM ACCENT	150	20A/1P	11			*	12	20A/1P	150	HUM ACCENT	Fluorescent Ltg
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		2.18							TOTAL DESIGN LOAD (KW)			6.19
CONNECTED LOAD (KW) - B		2.15							POWER FACTOR			0.99
CONNECTED LOAD (KW) - C		0.63							TOTAL DESIGN LOAD (AMPS)			8

Table 6.26 *Revised Panelboard Schedule – Dimming Panel DM4P*

Revised Panel Load: 8A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	D4BA
Phase Wire Size	600KCMIL
Feeder Length	35
Load (A)	169
Voltage Drop	-0.036%

Panel	DM4P
Phase Wire Size	#6AWG
Feeder Length	20
Load (A)	8
Voltage Drop	-0.036%

Total Voltage Drop	-0.072%

Table 6.27 *Voltage Drop Calculation – Feeder for Dimming Panel DM4P*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel DM4P as a result of change in load or voltage drop.

Panel EDM4P:

Original Overcurrent Protection Trip Rating: 60A

Original Feeder: 4-#6AWG wires + 1-#10AWG wires in 1” conduit

Lighting Design(s) Affecting Panel: Lecture Hall

Circuits Affected: 1, 2, 3, 4, 5, 7, 8, 11, 12, 13, 14

Existing Panelboard:

PANELBOARD SCHEDULE												
VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 60A SIZE/TYPE MAIN: 60A/3P C/B			PANEL TAG: EDM4P PANEL LOCATION: Penthouse Electrical Room PANEL MOUNTING: SURFACE							MIN. C/B AIC: 22K OPTIONS:		
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	LEC DOWN CENT	384	20A/1P	1	*			2	20A/1P	1152	LEC DOWN CENT	Fluorescent Ltg
Fluorescent Ltg	LEC DOWN CENT	1088	20A/1P	3		*		4	20A/1P	180	LEC STEP	Fluorescent Ltg
Fluorescent Ltg	LEC RAMP	36	20A/1P	5			*	6	20A/1P	68	LEC DOWN VEST	Fluorescent Ltg
Fluorescent Ltg	LEC DOWN EGRS	68	20A/1P	7	*			8	20A/1P	200	ATR DOWN VEST	Fluorescent Ltg
Fluorescent Ltg	ATR DOWN COR	962	20A/1P	9		*		10	20A/1P	1200	HUM EMERG DOWN	Fluorescent Ltg
spare	0	0	20A/1P	11			*	12	20A/1P	0	0	spare
spare	0	0	20A/1P	13	*			14	20A/1P	0	0	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space
CONNECTED LOAD (KW) - A		1.80								TOTAL DESIGN LOAD (KW)		6.67
CONNECTED LOAD (KW) - B		3.43								POWER FACTOR		0.98
CONNECTED LOAD (KW) - C		0.10								TOTAL DESIGN LOAD (AMPS)		8

Table 6.28 *Existing Panelboard Schedule – Dimming Panel EDM4P*

Revised Panelboard:

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B	PANEL TAG: EDM4P PANEL LOCATION: Penthouse Electrical Room PANEL MOUNTING: SURFACE	MIN. C/B AIC: 22K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Fluorescent Ltg	LEC DOWN FRONT	124	20A/1P	1	*			2	20A/1P	174	LEC CEN MIDDLE	Fluorescent Ltg
Fluorescent Ltg	LEC LEFT MIDDLE	174	20A/1P	3		*		4	20A/1P	232	LEC RIGHT MIDDLE	Fluorescent Ltg
Fluorescent Ltg	LEC CEN BACK	348	20A/1P	5			*	6	20A/1P	68	LEC VEST	Fluorescent Ltg
Fluorescent Ltg	LEC LEFT BACK	174	20A/1P	7	*			8	20A/1P	232	LEC RIGHT BACK	Fluorescent Ltg
Fluorescent Ltg	ATR DOWN COR	962	20A/1P	9		*		10	20A/1P	1200	HUM EMERG DOWN	Fluorescent Ltg
Fluorescent Ltg	LEC DOWN RAMP	217	20A/1P	11			*	12	20A/1P	403	LEC DOWN BACK	Fluorescent Ltg
spare	LEC STAIRS	38	20A/1P	13	*			14	20A/1P	101	LEC RAMP	spare
spare	0	0	20A/1P	15		*		16	20A/1P	0	0	spare
spare	0	0	20A/1P	17			*	18	20A/1P	0	0	spare
spare	0	0	20A/1P	19	*			20	20A/1P	0	0	spare
space	0	0	20A/1P	21		*		22	20A/1P	0	0	space
space	0	0	20A/1P	23			*	24	20A/1P	0	0	space
space	0	0	20A/1P	25	*			26	20A/1P	0	0	space
space	0	0	20A/1P	27		*		28	20A/1P	0	0	space
space	0	0	20A/1P	29			*	30	20A/1P	0	0	space
space		0	20A/1P	31	*			32	20A/1P	0		space
space		0	20A/1P	33		*		34	20A/1P	0		space
space		0	20A/1P	35			*	36	20A/1P	0		space
space		0	20A/1P	37	*			38	20A/1P	0		space
space		0	20A/1P	39		*		40	20A/1P	0		space
space		0	20A/1P	41			*	42	20A/1P	0		space

CONNECTED LOAD (KW) - A	0.84	TOTAL DESIGN LOAD (KW)	5.39
CONNECTED LOAD (KW) - B	2.57	POWER FACTOR	0.98
CONNECTED LOAD (KW) - C	1.04	TOTAL DESIGN LOAD (AMPS)	7

Table 6.29 *Revised Panelboard Schedule – Dimming Panel EDM4P*

Revised Panel Load: 7A

Revised Overcurrent Protection Trip Rating: 50A

Revised Feeder: 4-#8AWG wires + 1-#10AWG wires in 1” conduit

Voltage Drop:

Panel	EQD4P
Phase Wire Size	600KCMIL
Feeder Length	210
Load (A)	250
Voltage Drop	-0.397%

Panel	EDM4P
Phase Wire Size	#8AWG
Feeder Length	20
Load (A)	7
Voltage Drop	-0.036%

Total Voltage Drop	-0.433%

Table 6.30 *Voltage Drop Calculation – Feeder for Dimming Panel EDM4P*

Remarks:

The original design was excessive. While I switched up to a more-common 100A panel, I had to switch down to a 50A feeder and breaker. If this were a retrofit project, I would not be recommending any changes to the feeder or panelboard sizing for panel EDM4P as a result of change in load or voltage drop.

Analysis of Central vs. Distributed Transformers

Overview:

In the original design, there was a 480Δ to 208Y/120V transformer in each electrical room to step down voltage for receptacle, motor, and other equipment loads. Each of these transformers was rated at 112.5 KVA, and with the exception of the basement transformer, each was connected to the building's distribution system through a 600A bus duct. I felt that it might be possible to combine these transformers (seven in all) into one central transformer in the hopes of lowering costs (both for materials and labor).

Specific Transformers Being Replaced:

Label	Level	Room	KVA Rating	Primary Voltage	Secondary Voltage	Type	Primary OLP	Secondary OLP
A	1st Floor	South Electrical	112.5	480Δ	208Y/120	Dry Type	200A	400A
B	2nd Floor	South Electrical	112.5	480Δ	208Y/120	Dry Type	200A	400A
C	3rd Floor	South Electrical	112.5	480Δ	208Y/120	Dry Type	200A	400A
D	1st Floor	North Electrical	112.5	480Δ	208Y/120	Dry Type	200A	400A
E	2nd Floor	North Electrical	112.5	480Δ	208Y/120	Dry Type	200A	400A
F	3rd Floor	North Electrical	112.5	480Δ	208Y/120	Dry Type	200A	400A
G	Basement	Main Electrical	112.5	480Δ	208Y/120	Dry Type	200A	400A

Table 7.01 *Details for Existing Transformers to be Combined*

From a calculation of the loads that these transformers service, and adding approximate 15% spare capacity, it was determined that a 750 KVA transformer would be most appropriate for handling these loads. This transformer would be placed in the basement, in the approximate location where transformer G is currently. The calculation for this can be found in Appendix E.

Label	Level	Room	KVA Rating	Primary Voltage	Secondary Voltage	Type	Primary OLP	Secondary OLP
A	Basement	Main Electrical	750	480Δ	208Y/120	Dry Type	1000A	2500A

Table 7.02 *Details for Proposed Central Transformer*

Other Components Affected:

The first issue that arose was locating a distribution panel for the secondary side feeder from the central transformer to connect into. The logical choice was distribution panel D2BA, which was originally being fed by transformer G. Since D2BA would have to be sized at 2500A, this put D2BA into the switchboard class.

The 480Y/277V bus ducts would only be servicing 3 lighting panelboards each. Each duct would be used for no more than 80 A, making bus duct impractical here. Instead, I chose to feed the lighting panels from distribution panel D4BA. The panelboards would change to “feed-through” panelboards, allowing the panels to be fed directly through each other. This allows for the least length of wire to be used, and for the lowest installation costs.

Bus duct would still be useful, but for 208Y/120Vdistribution. In the same locations as the original location, I chose to use 1200A bus ducts for the 208Y/120V system. As stated above, these are being fed off of distribution panel (now switchboard) D2BA. Breakers off of the bus ducts would change accordingly.

Distribution panel D4BA would remain the same size, as all six lighting panels and the original 112.5 KVA transformer in the basement require about the same amount of power. Other than that, the only other major change would be the various feeders.

Riser Diagrams of Main Electrical Room:

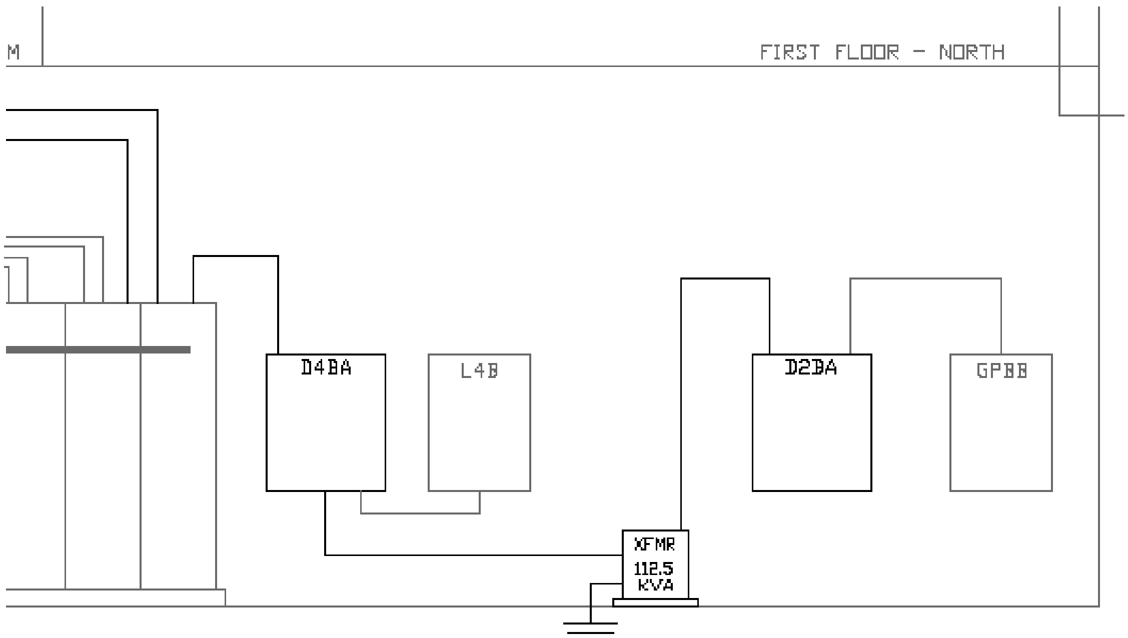


Figure 7.01 Riser Diagram of Main Electrical Room – Existing System

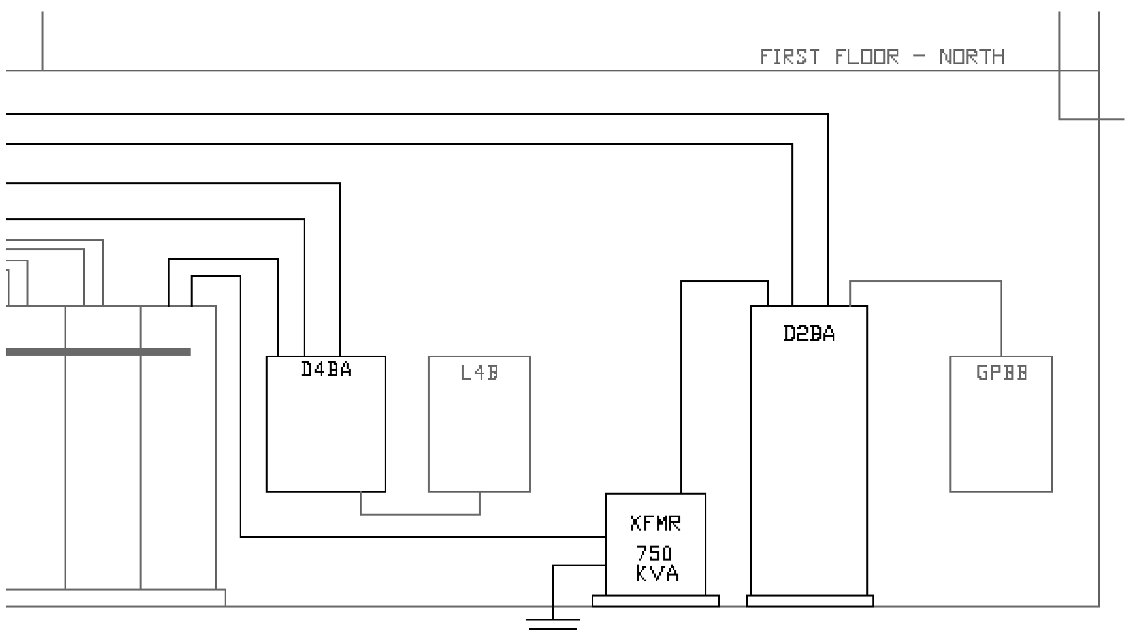


Figure 7.02 Riser Diagram of Main Electrical Room – Proposed System

Riser Diagrams of First Floor South Electrical Room:

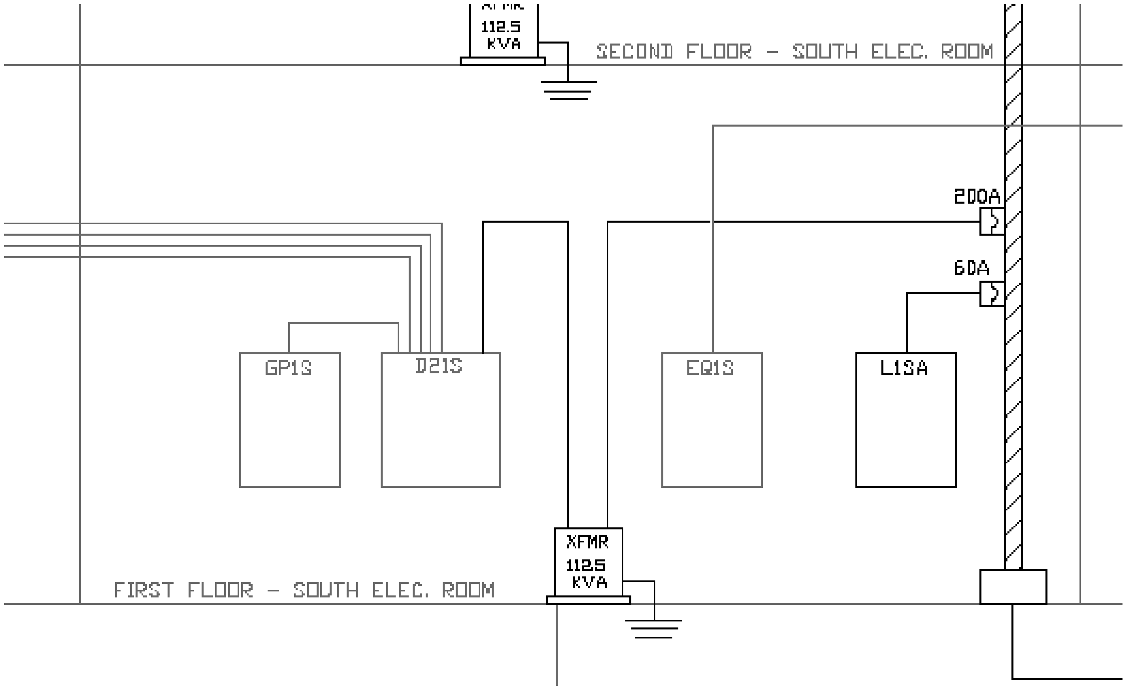


Figure 7.03 *Riser Diagram of South Electrical Room – Existing System*

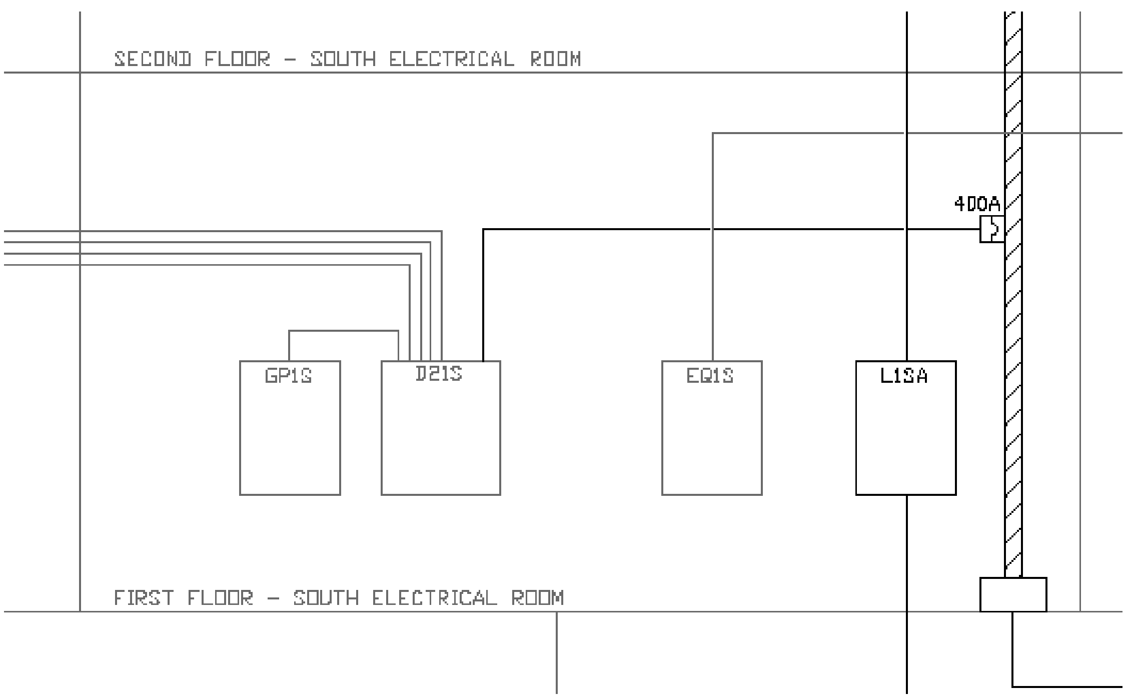


Figure 7.04 *Riser Diagram of South Electrical Room – Proposed System*

Cost Analysis:

The following data was compiled using the 2008 version of RS Means Electrical Cost Data. Full calculations are available in Appendix E of this report.

Category	Cost of Existing System	Cost Of New System	Difference
Feeders	$61,096.37	$141,472.34	$80,375.97
Transformers	$56,832.30	$46,737.00	($10,095.30)
Breakers	$23,222.70	$36,720.00	$13,497.30
Bus Ducts	$22,680.00	$36,720.00	$14,040.00
Panelboards	$30,341.25	$49,762.35	$19,421.10
TOTAL	$194,172.62	$311,411.69	$117,239.07
TOTAL w/ Loc. Factor	$177,862.12	$285,253.11	$107,390.99

Table 7.03 *Cost Analysis for Central and Distributed Transformer Systems*

This chart clearly showed that using a central transformer in this scenario is not an economically viable option, and since the original design works just as effectively, I would recommend remaining with the existing transformer layout.

Reasons for This Outcome:

A further look at the calculations shows why the central transformer system is so much more expensive. The feeders distributing power to the bus ducts are among the longest in the building. To accommodate the higher currents required for the lower voltage system, the wires had to be greatly upsized and use many sets of wires. As a result, the feeder to the South Bus Duct increased in cost by over $40,000; the feeder to the North Bus Duct nearly $30,000. In addition, the fact that distribution panel D2BA had to be upsized and changed to a switchboard greatly increased the cost of that panel (by nearly $25,000).

One of the aspects of this building that works against a central transformer system is the location of the main electrical room. The main electrical room is located at the northwest corner of the building, requiring great distance to feed both bus ducts, especially the South Bus Duct. Had the electrical room been more centrally located, the costs of these feeders, and many other feeders throughout the basement floor, could have been greatly reduced. It would be incorrect to state that changing the location would make a central transformer system more viable; other factors would still leave it as a more expensive option. However, the differences would have been less pronounced.

Analysis of Aluminum vs. Copper Feeders

Overview:

The price of copper continues to increase, and many electrical designers and contractors are exploring aluminum as a more cost-effective option. Given the number of feeders in the building and the lengths of many of these feeders, this may be a good building to take advantage of potentially significant savings.

Besides providing cost-savings, aluminum is significantly lighter than copper, which can make labor for wire installation easier and potentially less time consuming. It is for these reasons that the vast majority of utility transmission is done using aluminum wiring. That said, many owners are still leery of using aluminum wiring. One of the major reasons for this is reported fires as a result of improper terminations of the aluminum wire. Most of these were caused by poor installation, and improved technology and labor practices have made this virtually a non-issue today. Aluminum wiring is still banned for use for branch circuit wiring, but is approved by the NEC and NFPA for use in feeders.

There are a couple of steps for aluminum wire installation that are different than copper installation, and thus must be considered. Aluminum is much more prone to oxidation that copper, which can block connections from being complete and can potentially result in fire. Therefore, prior to terminating the feeders, the wires need to be cleaned to remove any oxidation already formed and treated with an antioxidant joint compound. Also, like copper wiring, aluminum wiring connections must be properly torqued. If the connection is too loose, this can create an open circuit scenario. If the connection is too tight, this can reduce the ability of the current to flow properly, which can create a hot termination, and once again can result in fire. All that said, the majority of electrical contractors are knowledgeable in the safe installation of aluminum wiring, and can help owners take advantage of significant cost-savings without compromising the safety of their occupants.

Cost Analysis:

The following calculations were done using data from the 2008 version of RS Means Electrical Cost Data. Full details of these calculations can be found in Appendix F.

Feeder Label	Start	End	Wires (LF)	Conduit (LF)	Copper Feeder Cost	Aluminum Feeder Cost
3	SWB-1	NORTH DUCT	105	95	16,611.62	10,780.02
4	NORTH DUCT	L1NA	10	6	110.04	106.50
5	NORTH DUCT	XFMR 1	10	6	294.81	257.18
6	XFMR 1	D21N	10	6	1,063.53	608.04
7	D21N	GP1N	15	10	290.66	232.94
8	D21N	R1NA	55	50	3,052.72	2,221.86
9	D21N	R1NB	65	60	848.78	866.33
10	D21N	R1NC	90	85	1,187.46	1,215.47
11	D21N	R1ND	75	70	984.25	1,005.99
12	NORTH DUCT	L2NA	10	6	110.04	106.50
13	NORTH DUCT	XFMR 2	10	6	294.81	257.18
14	XFMR 2	D22N	10	6	1,063.53	608.04
15	D22N	GP2N	25	20	620.87	529.34
16	D22N	R2NA	90	85	1,187.46	1,215.47
17	D22N	R2NB	40	35	1,214.53	951.01
18	D22N	R2NC	70	65	2,169.11	1,707.95
19	NORTH DUCT	L3NA	10	6	110.04	106.50
20	NORTH DUCT	XFMR 3	10	6	294.81	257.18
21	XFMR 3	D23N	10	6	1,063.53	608.04
22	D23N	GP3N	10	6	188.24	148.80
23	D23N	R3NA	55	50	713.31	726.67
24	D23N	R3NB	60	55	1,850.92	1,455.64
25	D23N	R3NC	50	45	1,532.72	1,203.32
26	SWB-1	SOUTH DUCT	240	230	38,623.77	25,294.41
27	SOUTH DUCT	L1SA	10	6	110.04	106.50
28	SOUTH DUCT	XFMR 4	10	6	294.81	257.18
29	XFMR 4	D21S	10	6	1,063.53	608.04
30	D21S	GP1S	10	6	188.24	148.80
31	D21S	R1SA	65	60	848.78	866.33
32	D21S	R1SB	105	100	1,390.67	1,424.96
33	D21S	R1SC	55	50	713.31	726.67
34	D21S	R1SD	100	95	1,322.93	1,355.13
35	SOUTH DUCT	L2SA	10	6	110.04	106.50
36	SOUTH DUCT	XFMR 5	10	6	294.81	257.18
37	XFMR 5	D22S	10	6	1,063.53	608.04
38	D22S	GP2S	10	6	271.59	205.71
39	D22S	R2SA	45	40	1,373.63	1,077.17
40	D22S	R2SB	100	95	2,172.56	1,829.12
41	SOUTH DUCT	L3SA	10	6	110.04	106.50

Table 8.01a *Compressed Version of Copper and Aluminum Feeder Cost Comparison*

Feeder Label	Start	End	Wires (LF)	Conduit (LF)	Copper Feeder Cost	Aluminum Feeder Cost
42	SOUTH DUCT	XFMR 6	10	6	294.81	257.18
43	XFMR 6	D23S	10	6	1,063.53	608.04
44	D23S	GP3S	10	6	188.24	148.80
45	D23S	R3SA	50	45	1,065.56	890.19
46	D23S	R3SB	65	60	2,010.02	1,581.80
47	D23S	R3SC	85	80	4,776.20	3,492.15
48	D23S	R3SD	75	70	984.25	1,005.99
49	D23S	R3SE	30	25	622.76	514.62
50	SWB-1	D4P	200	190	32,101.65	20,993.85
51	D4P	G4P	20	15	486.95	411.82
52	SWB-1	D4BA	35	30	3,998.16	2,513.30
53	D4BA	XFMR 7	10	6	294.81	257.18
54	XFMR 7	D2BA	10	6	1,063.53	608.04
55	D2BA	GPBA	10	6	188.24	148.80
56	D4BA	L4B	10	6	110.04	106.50
57	SWB-1	D4BB	280	270	8,792.96	6,948.32
58	D4BB	XFMR 8	10	6	86.01	94.35
59	XFMR 8	GPBB	10	6	188.24	148.80
60	SWB-1	ATS 100	200	190	4,345.11	3,658.23
61	GEN	ATS 100	70	65	1,508.36	1,265.76
62	ATS 100	E4P	15	10	290.66	232.94
63	E4P	XFMR 9	10	6	62.72	57.94
64	XFMR 9	E2P	10	6	84.66	85.74
65	E4P	E4B	200	190	2,645.87	2,710.26
66	SWB-1	ATS 400	200	190	23,415.75	15,156.45
67	GEN	ATS 400	70	65	8,149.55	5,240.57
68	ATS 400	EQD4P	15	10	1,625.94	954.86
69	EQD4P	EQD4B	200	195	15,855.41	10,404.11
70	EQD4B	V4BA	10	6	110.04	106.50
71	EQD4B	XFMR 10	10	6	213.73	174.80
72	XFMR 10	EQD2B	10	6	554.24	369.70
73	EQD2B	V2BA	10	6	271.59	205.71
74	EQD4P	XFMR 11	10	6	294.81	257.18
75	XFMR 11	EQD2P	10	6	1,063.53	608.04
76	EQD2P	EQ1S	140	135	1,864.82	1,913.76
77	EQD2P	EQ2S	125	120	7,074.17	5,185.86
78	EQD2P	EQ3S	110	105	3,441.89	2,717.21
79	EQD2P	EQ3SA	110	105	3,441.89	2,717.21
80	EQD2P	EQ2P	15	10	754.75	528.15

Table 8.01b *Compressed Version of Copper and Aluminum Feeder Cost Comparison*

Type of Wiring	Total Cost
Copper	$222,195.49
Aluminum	$157,434.85

Table 8.02 *Summary of Total Cost of Copper and Aluminum Feeders*

Type of Wiring	Total Cost
Copper	$203,531.07
Aluminum	$144,210.32

Table 8.03 *Summary of Total Cost of Copper and Aluminum Feeders With Location Factor of 91.6%*

Conclusion:

With the potential to save nearly $60,000, I would recommend that the owner consider using aluminum feeders for this building. When properly installed, an aluminum wiring system provides no additional risk of fire over a comparable copper wiring system. The benefits of this system outweigh any perceived disadvantages to this system.

Protective Device Coordination and Fault Current Study

Overview:

In order to avoid a potential shut-down of an entire wing, or the entire building, it is important to make sure that the protective devices will trip in an appropriate order. I chose to study a basement path: from main switchboard SWB-1 to the distribution panel D4BA to the lighting panelboard L4B.

It is also crucial to analyze the fault current at every point in the system. Panelboards must be able to handle at least the available fault current at their location, so that in the case of a fault current occurring, damage to the equipment is limited and the risk of fire is greatly reduced. I will analyze the path from the main switchboard SWB-1 to the receptacle panel R3SC.

Protective Device Coordination:

The path I am analyzing is from the main switchboard circuit breaker (rated at 1600A), to the distribution panel circuit breaker D4BA (rated at 400A), and finally to the basement lighting panel L4B. Panel L4B is a main lugs only (MLO) panelboard, so the only protective device for the panel is the breaker on panel D4BA.

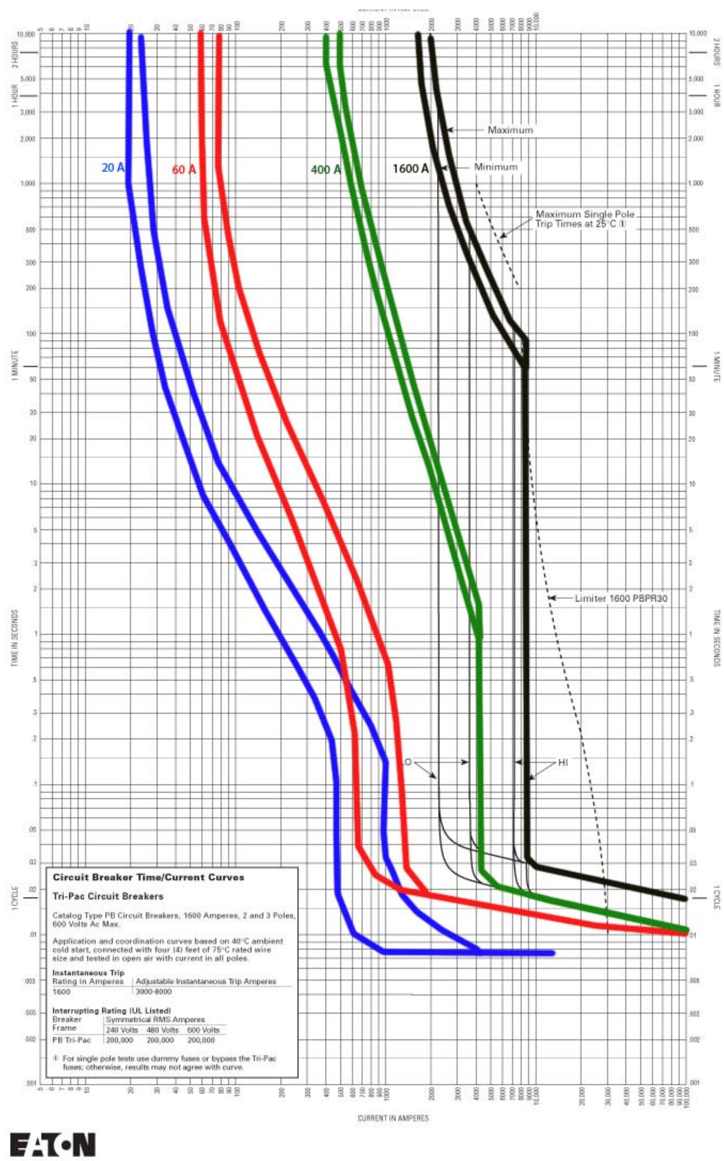


Figure 9.01 *Protective Device Coordination – Time-Current Curves for Circuit Breakers*

There is a small area of concern here. There is a slight overlap between the maximum trip line for the 20 A branch circuit breaker and the minimum trip line for the 60 A lighting panel breaker. However, judging from the graph above, it is very unlikely that the 60 A would trip before the branch circuit. Therefore, I feel that the protective devices are properly coordinated here, and they will trip in the correct order (branch circuit, lighting panel, distribution panel, switchboard).

Fault Current Analysis:

The path to receptacle panel R3SE started at the main switchboard SWB-1, and goes to the South Bus Duct in the basement. At the third floor, a feeder connects the bus duct to a 112.5 KVA transformer, which transforms the power to 208Y/120 and feeds into distribution panel D23S. D23S then connects to R3SC.

Utility

$KV_{secondary}$	0.48 KV
$KVA_{utility}$	173010 KVA
$Z_{utility}$	1.33 mΩ
$(X/R)_{utility}$	4.8
$R_{utility}$	0.27
$X_{utility}$	1.30 j

Main Transformer

$KV_{secondary}$	0.48 KV
$KVA_{main\ xfmr}$	1000 KVA
$(\%Z)_{main\ xfmr}$	5.8
$(X/R)_{main\ xfmr}$	2.38
$R_{main\ xfmr}$	5.18
$X_{main\ xfmr}$	12.32 j

Feeder to South Bus Duct

Size of Phase Wire	350KCMIL
$R_{SBD\ feeder}$	3.33
$X_{L,\ SBD\ feeder}$	4.07
Length	240 ft
Number of Sets	2
$R_{cond,\ SBD\ feeder}$	4.00
$X_{cond,\ SBD\ feeder}$	4.88 j

South Bus Duct

Bus Duct Rating	600 A
$R_{bus\ duct}$	1.78
$X_{bus\ duct}$	2.3
Length	40 ft
$R_{south\ bus\ duct}$	0.71
$X_{south\ bus\ duct}$	0.92 j

Table 9.01a *Fault Current Analysis – Impedance Calculations*

Feeder to XFMR 6

Size of Phase Wire	3/0AWG	
$R_{xfmr\ 6\ feeder}$	6.68	
$X_{L,\ xfmr\ 6\ feeder}$	4.22	
Length	10	ft
Number of Sets	1	
$R_{cond,\ xfmr\ 6\ feeder}$	0.67	
$X_{cond,\ xfmr\ 6\ feeder}$	0.42	j

Transformer 6

$KV_{secondary}$	0.208	KV
$KVA_{xfmr\ 6}$	112.5	KVA
$(\%Z)_{xfmr\ 6}$	6.1	
$(X/R)_{xfmr\ 6}$	1.51	
$R_{xfmr\ 6}$	12.95	
$X_{xfmr\ 6}$	19.56	j

Feeder to D23S

Size of Phase Wire	600KCMIL	
$R_{D23S\ feeder}$	2.09	
$X_{L,\ D23S\ feeder}$	4.01	
Length	10	ft
Number of Sets	1	
$R_{cond,\ D23S\ feeder}$	0.21	
$X_{cond,\ D23S\ feeder}$	0.40	j

Feeder to R3SC

Size of Phase Wire	4/0AWG	
$R_{R3SC\ feeder}$	5.34	
$X_{L,\ R3SC\ feeder}$	4.14	
Length	85	ft
Number of Sets	1	
$R_{cond,\ R3SC\ feeder}$	4.54	
$X_{cond,\ R3SC\ feeder}$	3.52	j

Table 9.01b *Fault Current Analysis – Impedance Calculations*

Point	R	X	|Z|	I_{sc}
Utility	0.27	1.30	1.331715	20800.2
Main Xfmr Secondary	5.45	13.62	14.67256	18878.78
Tap Box SBD	9.44	18.51	20.77791	13331.47
3rd Floor South Bus Duct	10.16	19.43	21.92207	12635.67
Xfmr 6 Primary	10.82	19.85	22.609	12251.76
Xfmr 6 Secondary	23.78	39.41	46.02542	2607.255
D23S	23.99	39.81	46.47675	2581.936
R3SC	28.52	43.33	51.87479	2313.263

Table 9.02 *Fault Current Analysis – Short Circuit Current Calculations*

The panelboards are all rated for an AIC of 22,000A. Based on this, I can confidently state that the system was properly designed to account for potential fault current.

Acoustics Breadth

Overview:

As part of my re-design of the lecture hall, I elected to re-design the ceiling for the space. As stated earlier, I had two goals for this design: to better work with the overall geometry and furnishings of the lecture hall; and to create an acoustically efficient space. The first goal has been discussed previously. This acoustical breadth will explore the second.

The success of the new ceiling in relation to acoustics will be measured by the following standards:

- Ability to distribute sound to all seating areas of the space
- Ability to maintain reverberation times at appropriate levels
- Contribute to the solution of any sound transmission issues from and to other spaces

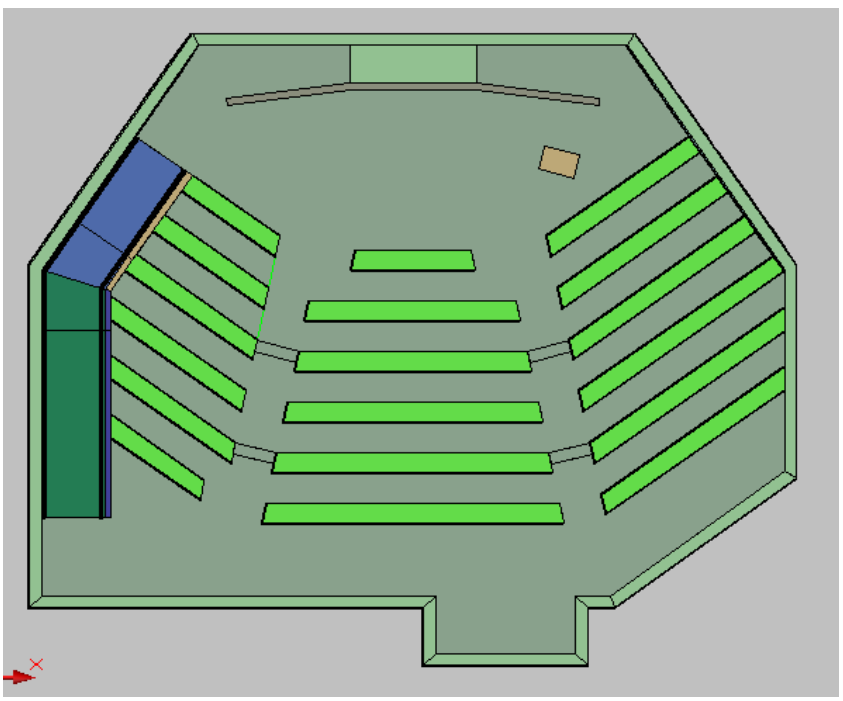


Figure 10.01 *Lecture Hall Model – Plan View*

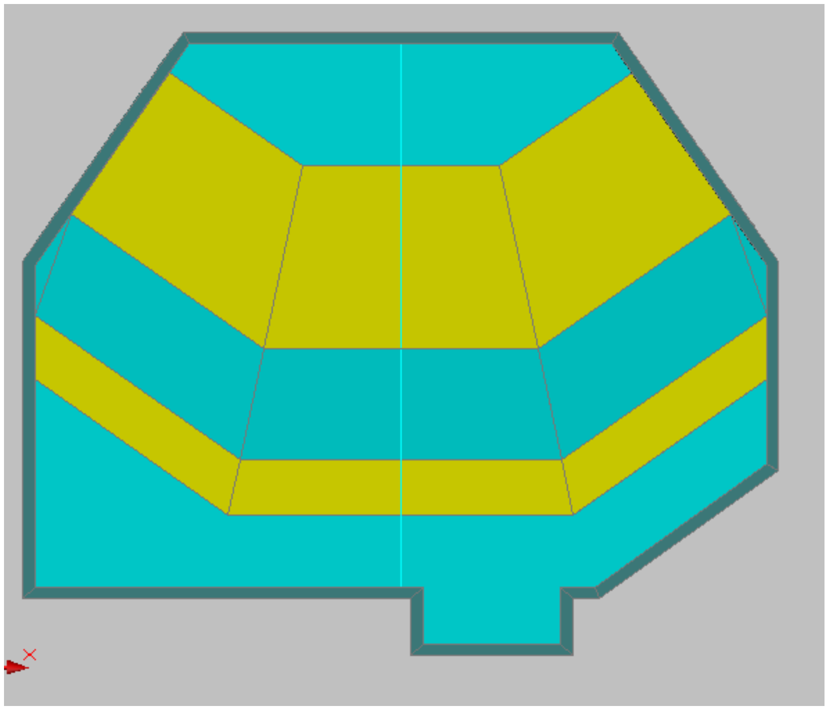


Figure 10.02 *Lecture Hall Model – Plan View of Ceiling*

Figure 10.03 *Preliminary Color Rendering of Lecture Hall – From Speaker*

Analysis of Sound Reflection:

This lecture hall has a couple of things working against it acoustically. The height of the space is generally low, which means the slope of any ceiling reflectors can't be too great without risking making the space feel too enclosed. Also as a result of the height restrictions, it's not feasible to raise the height of the stage or further slope the floor to improve the line of sight with the speaker. One of the aspects of the design that is conducive to sound distribution is the seating, which is unfixed. This allows students to essentially "self-stagger" their seating and improve their line of sight with the speaker.

In order for the space to work as optimally as possible, ceiling reflectors have to be oriented so that more sound is reflected to the back of the space. The listeners in the front benefit from being closer to the speaker and from having a less obstructed view, so this is not a critical area for the ceiling to reflect to. Below illustrates how sound is distributed across the space with the new ceiling.

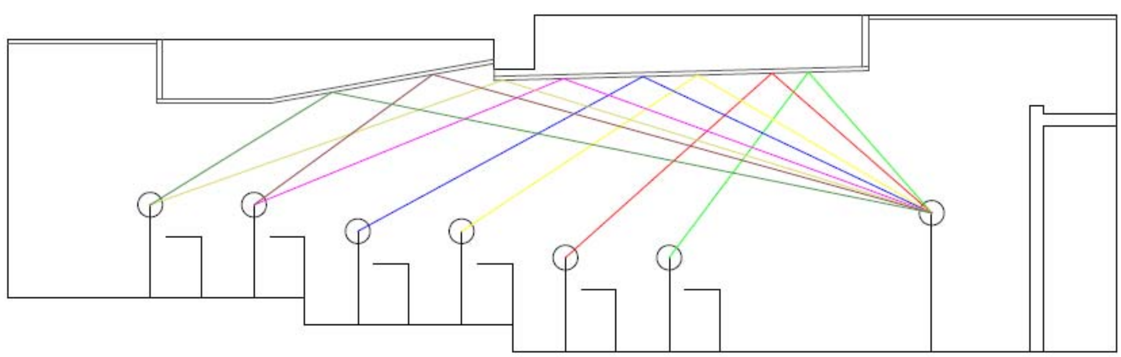


Figure 10.04 Section of Lecture Hall – Proposed Ceiling with Sound Reflection

Overall, the ceiling seems to be distributing sound well to the rear of the classroom. Both sloped sections of the ceiling can reflect sound to the last two rows of seating without interference, which should help the speaker project to the entire space more easily.

Analysis of Sound Absorption:

In order to determine an appropriate material for the new ceiling, I needed to calculate the reverberation time for the space. From these calculations I was then able to determine a range for the sound absorption coefficient for each frequency. The optimal range of reverberation time for this space is 0.7 to 1.1 seconds (AA P&D, p.218).

Frequency (Hz)	Lowest Acceptable α	Highest Acceptable α
500	0.68	1.50
1000	0.26	1.05
2000	0.15	0.50
4000	0.08	0.43

Table 10.01 *Range of Acceptable Sound Absorption Coefficients (α) For Solid Ceiling*

Frequency (Hz)	Lowest Acceptable α	Highest Acceptable α
500	0.54	0.98
1000	0.42	0.86
2000	0.30	0.75
4000	0.23	0.66

Table 10.02 *Range of Acceptable Sound Absorption Coefficients (α) For Porous/Gapped Ceiling*

From this calculation, I found some general materials that would be appropriate for the space, based solely on sound absorption coefficients. These included perforated metal with fiberglass backing, pegboard over fiberglass, and fiberboard. Aesthetically, I feel that the perforated metal will be the strongest in appearance, so I selected this product. A copy of the specifications for this product is available in Appendix C. The ceiling will be considered a solid ceiling, since the insulation for the product helps to cover the perforations from above, and thus doesn't allow enough air through to be considered porous.

Frequency (Hz)	500	1000	2000	4000
Sound Absorp. (α)	0.81	0.85	0.93	0.88
Reverb. Time (sec)	0.65	0.57	0.51	0.50

Table 10.03 *Sound Absorption Coefficient Data for Perforated Metal Ceiling Material And Corresponding Impact on Reverberation Time for Lecture Hall Source: Architectural Acoustics – Principles and Design, 1999, p.411*

Although the reverberation times are below my desired range of 0.7 to 1.1 seconds, they are still acceptable by most standards (0.5 seconds being the absolute acceptable minimum). They are also relatively close to each other, meaning that ending consonants of words won't reach the listeners before vowels, and vice versa. Speech will be relatively intelligible, and while the room would be considered relatively "flat" for a lecture hall, it would be neither detrimental to the success of lectures nor distracting for listeners. As a result, I have concluded that the new ceiling design meets the criteria for appropriate sound absorption.

Analysis of Airborne Sound Insulation:

The current structural assembly was studied to determine if additional sound insulation would be required to reduce the impact of airborne sound. The target Sound Transmission Class (STC) levels for the lecture hall are as follows:

Area Studied	Nearest Equivalent	Adjacent Area	Nearest Equivalent	Recommended STC
Lecture Hall	Classroom	2nd Floor Laboratory	Laboratory	50
Lecture Hall	Classroom	1st Floor Corridor	Corridor	50

Table 10.04 *Recommended STC Values for Selected Occupancies*
Source: Architectural Acoustics – Principles and Design, 1999, p.176

Testing in a laboratory setting of a 6" solid concrete slab revealed a STC of 56 (AAP&D, p.420). The concrete slab over the lecture hall is actually a 6-1/2" composite deck. Since it can be assumed that the addition of 1/2" of concrete and metal decking will only improve the sound insulation, I can conclude the current assembly will easily meet the STC standard between the 2nd floor laboratory and the Lecture Hall.

Testing of a standardized metal stud assembly (5/8" gypsum board on each side, 3 5/8" studs 24" o.c., 2" fiberglass insulation) results in a STC of 51 (AAP&D, p.414). The only area that would not have a similar assembly to the above is the door. That said, the vestibule at this entry should create enough of a barrier to meet the criteria. Again, no changes need to be made to the current assemblies to meet STC criteria.

Analysis of Structure-Borne Sound Insulation:

The current structural assembly was studied to determine if additional sound insulation would be required to reduce the impact of structure-borne sound. The target Impact Insulation Class (IIC) between the Lecture Hall and the 2nd Floor Laboratory is 50.

For a typical VCT floor assembly, the IIC is only 34. Therefore, I am recommending that the vinyl composite tiles above the lecture hall be replaced with a more sound-insulating material: cork. Besides being a better acoustical insulator, the cork offers thermal and moisture insulation, and when properly sealed, cork is durable enough to meet the usage needs of the lab environment. In addition, cork is a rapidly renewable resource, making it a better choice for the environment as a whole. A floor assembly with cork floor tiles, 8" concrete slab, and dropped ceiling has an IIC of 73. Even taking into consideration that there is only a 6 ½" slab, the IIC would still remain over 50. With this simple change, the space now meets recommended criteria for structural-borne sound insulation. A cutsheet for a suitable cork flooring option is available in Appendix C.

Mechanical Breadth

Overview:

The original air distribution system for the lecture hall had diffusers mounted in the vertical sections of a cove system that also served as a lighting element. As part of my redesign of the lecture hall, these coves were removed; therefore, it became necessary to create a new layout for these diffusers. In keeping with the lighting design and new ceiling for the room, I would like to analyze using linear diffusers throughout. This will allow me to use a slimmer, more minimally invasive diffuser width. Care also needs to be taken to make sure the acoustics of the space aren't negatively impacted by the re-design.

Details of Existing Air Distribution to Be Retained:

There are four VAV boxes with reheat capabilities servicing the lecture hall. Two on the northern portion of the room are served by one air-handling unit, the southern two VAV boxes by another. Each VAV handles a minimum of 500 cfm of air and a maximum of 1000 cfm, for a total maximum of 4000 cfm for the room. I am assuming that the original space was properly designed for ventilation in line with ASHRAE 62.1-2007. The VAV boxes and all duct work (with the exception of those leading directly to the diffusers) are well above the new ceiling, and thus have not been affected by the new ceiling. Therefore, I am proposing no changes to the bulk of the existing air distribution system.

Standards to Adhere to For New Diffuser Layout:

One of my goals is to make the diffusers layout as slender as possible. However, as the area of the diffuser goes down, the velocity of the air goes up, and a concern is that if the diffuser area is too small, there could be too much draft in the space. The threshold for acceptable air velocity out of the diffusers to avoid this draft is 500 ft/min, and my goal is to be well under that. In addition, the diffuser system as a whole must be able to handle at least 4000 cfm of air.

Description of New Layout:

In most of the lecture hall, it's not going to be possible to do vertically oriented diffusers, as they are in the original design. However, in the very front and very back of the room, there is enough vertical distance to comfortably lay in diffusers, and this will allow good ventilation throw in the front speaker area as well as all three exit areas. There will be one row of linear diffusers over the center of the seating area. These diffusers will be aligned with the new ceilings. Since the pitch is only slightly off from horizontal, I don't anticipate any greatly uneven conditions parts of the lecture hall as a result of the ceiling design.

New Layout Drawings:

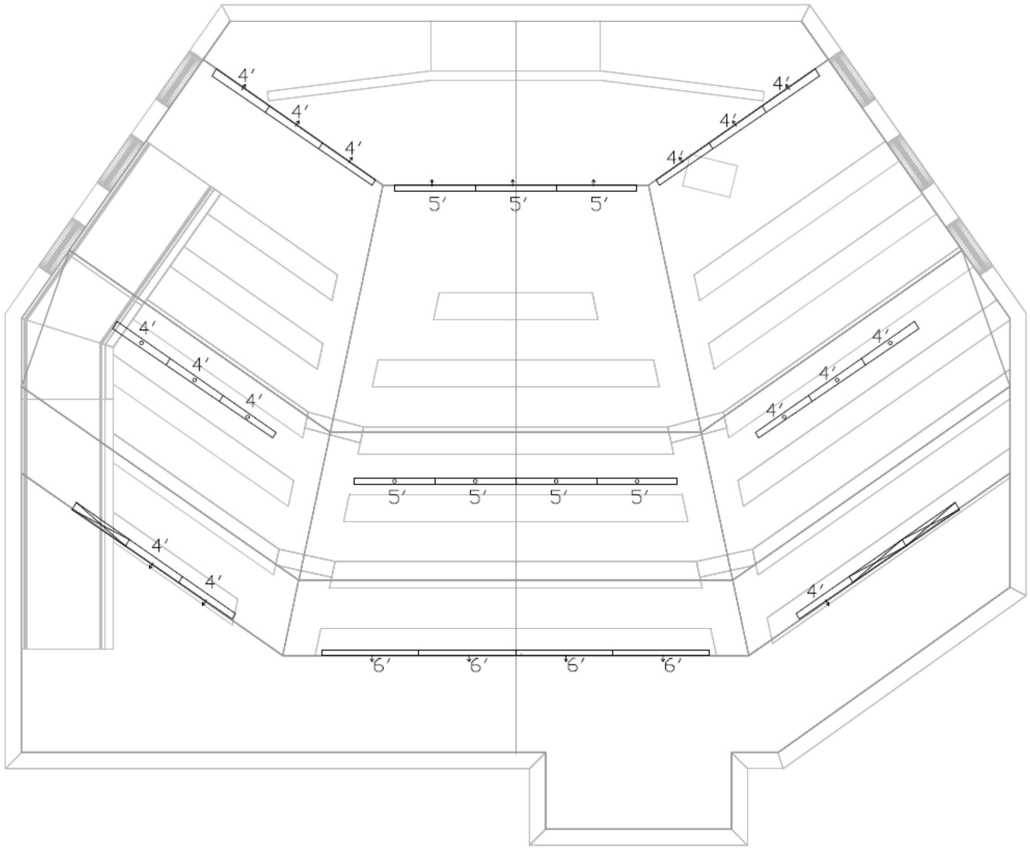


Figure 11.01 *Lecture Hall Reflected Ceiling Plan – Diffusers Only*

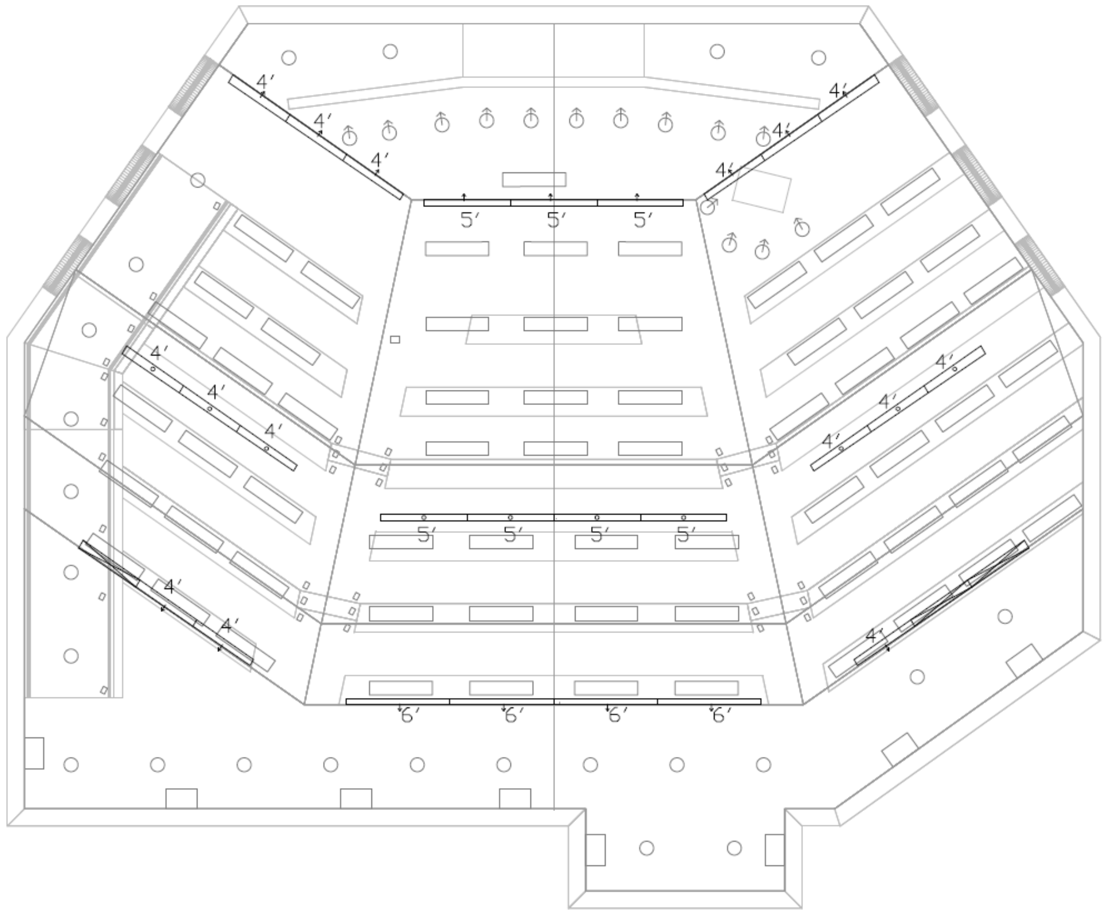


Figure 11.02 *Lecture Hall Reflected Ceiling Plan – Diffusers and Lighting*

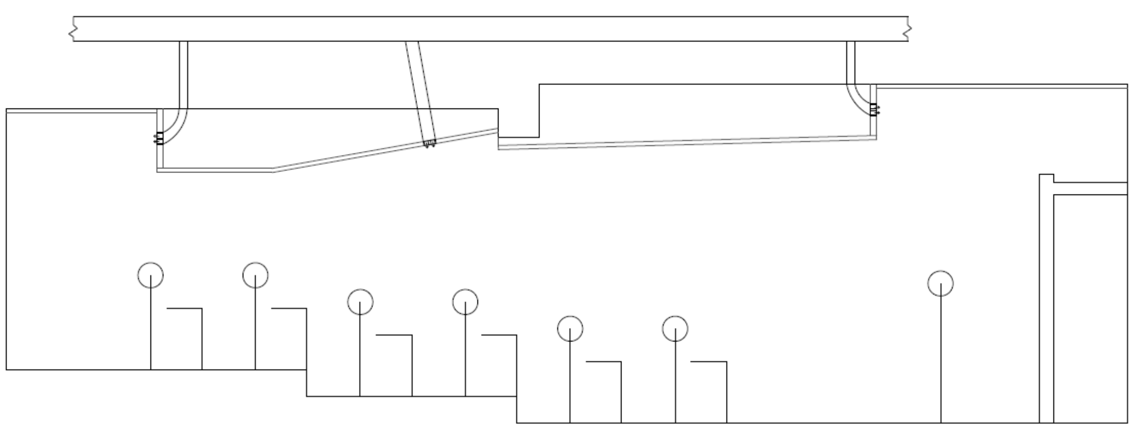


Figure 11.03 *Lecture Hall Section – Diffusers and Schematic of Air Distribution System*

Calculations:

Row	Left			Center			Right		
	Quantity	Length	Total	Quantity	Length	Total	Quantity	Length	Total
1	2	4	8	3	5	15	1	4	4
2	3	4	12	4	5	20	3	4	12
3	3	4	12	4	6	24	3	4	12

Total Length of Diffusers:	119 feet

Additional Length of Grill:	12 feet

Table 11.01 *Take-Off of Diffusers – Total Length Used in Lecture Hall*

Calculation	Quantity
Length of Diffusers	119'
Slot Diffuser Width	1"
Number of Slots	2
Maximum Air Flow	4000 cfm
Minimum Air Flow Required	33.61 cfm/ft
Air Flow Selected	40 cfm/ft
Air Flow Area	19.83 ft^2
Velocity of Air	201.68 ft/min
Minimum Air Flow	2000 cfm
Velocity of Air	100.84 ft/min

Table 11.02 *Air Velocity Calculations – Lecture Hall Diffusers*

Based on the above calculations, a diffuser with 2” of usable air flow width will have no problems limiting the air velocity to well under 500 ft/min, thus avoiding a draft issue. The diffusers must be able to handle around 34 cfm of air per foot of diffuser, and since they have been sized at 40 cfm, that is also not an issue. A cutsheet for the diffusers selected is included in Appendix C.

Acoustical Considerations:

A couple of locations will have the grill face of the diffuser, but no air flow connected to it. This is because of their proximity to the return air ducts. Because they are so close, most of the supply air here would simply flow into the return air, which is not only wasteful, but could cause some distracting noise in the space. With select diffusing sections removed, this becomes much less of an issue. The supply air system already has some acoustical duct silencers on it, so nothing else needs to be added. Overall, the layout as designed should not be detrimental to the acoustical quality of the space.

Conclusions:

The linear diffuser system seems to be a good choice for this new ceiling. Since the equipment used is comparable to the equipment used in the original layout, the cost of the air distribution system has not been greatly increased as a result of the new ceiling system. The layout works well with the lighting and the architectural design of the space. So long as there is proper coordination between the mechanical, electrical, and ceiling contractors, I feel this new ceiling will have a positive impact on the lecture hall.

Summary and Conclusions

As a whole, the Barshinger Life Sciences and Philosophy functions as the signature building it was designed to be. The exterior's traditional appeal and the interior's modern functionality make it a strong standard for new buildings at Franklin & Marshall College. Throughout this process, I tried to keep in line with this philosophy, and show that when done properly, traditional and modern elements can co-exist, as can good aesthetic quality and high functionality.

The East Entry's use of light here is less traditional, but because it is a modern way of showing off the building's traditional elements, it does not look like a clash of styles. The functionally of this layout is the control of the light, focused on the tasks at hand rather than general ambience. As a result, this layout reduced light trespass and pollution, and also managed to stay under the energy budget. The Atrium is a standout space on its own, and the generous window areas allow a ton of daylight to penetrate and dramatize the space. What it needed was a simple focal point, and just enough light to make egress easier and the space usable for 24 hours a day. The simple discs of luminous glass draw attention without being intrusive, and the time clock allows for three different life schemes to allow for maximum usability and energy efficiency.

The Ecology Teaching Lab used a task-oriented approach to great success, putting lighting only where is needed to be. More than enough light reflected to the ground for egress, and an efficient switching layout allows the space to conserve even more energy in an already-conscious design. The Bonchek Lecture Hall is transformed with a new ceiling that adds interest and some volume, and the new lighting design shows off the new shape well. The four-scene control makes this space as multi-purpose as it wants and needs to be. As a whole, the four lighting designs did very well in sticking to their energy budget. The Atrium on its own exceeded the energy allowances, but using the extra 200W of energy saved in the laboratory, the building as a whole was able to meet ASHRAE 90.1 – 2004.

Study on the electrical breadth shows me a lot of the reasoning behind the original design. The branch circuits and lighting panels all remained relatively unaffected, and the protective device coordination study and fault current analysis showed that the system components were properly selected. The original choice of distributed transformers was a far more economical choice than a central one. The only place I found a great opportunity for savings was a proper installation of aluminum feeders, in place of the more expensive copper. Acoustically, the lecture hall is a sound design, and the new mechanical layout is able to work well in the new ceiling. The results of all of this are an efficient and functional design that allows the character of the building to come through and complements the elements of this building that have made and should make Franklin & Marshall College proud.

References

ASHRAE 90.1-2004. "Energy Standards for Building Except Low-Rise Residential Buildings." ASHRAE, 2004.

Hughes, David S. Electrical Systems in Buildings. 1988.

Kooiman, Brent. "Aluminum vs. Copper Conductors – A Serious Alternative?" Interstates Engineering (2006).

Mehta, Madan, Jim Johnson, and Jorge Rocafort. Architectural Acoustics - Principles and Design. 1999.

National Electric Code. NFPA 70, 2005.

Rea, Mark S., ed. The IESNA Lighting Handbook. 9th ed. Illuminating Engineering Society of North America, 2000.

RS Means Electrical Cost Data. 2008.

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-My family and friends, for their love and support throughout everything;

-And last, but certainly not least, the AE Senior Class of 2008, for their comradery at all hours of the day and night, and for some of the best moments of my college career!

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Appendix A

Lighting Depth Supplemental Information

Full Luminaire Schedule

Label	Quantity	Manufacturer	Catalog #	Description	Number of Lamps	Linear Feet / Luminaire	Lamp Type	CCT	CRI	Voltage	Watts / Lamp	Watts / Linear Foot	Total Luminaire Watts	Ballast Watts	Driver Watts	Power Factor	Ballast Factor	Amps
PP1	62	Peerless	LSR9-LDL-	Recessed linear fluorescent downlight	-	4	T5	3000K	85	277	150	-	28	29	-	0.98	1.00	0.11
PP2	14	Iris	PN7-M42T-E7TWW-C	Recessed compact fluorescent wall washer	1	-	42W CFL TRT	3000K	82	277	39	-	42	47	-	0.99	1.00	0.17
PP3	24	Iris	P5-M32T-E5T-C	Recessed compact fluorescent downlight	1	-	26W CFL TRT	3000K	82	277	26	-	26	31	-	0.98	1.05	0.11
PP4	33	Erco	0-04-E-3K-90-102-2-(36'-0")-2	Floor recessed LED uplight for ramp and stairs	1	-	LED	3500K	-	277	-	12	3.6	-	4.212	1.00	-	0.02
PP5	8	Shaper	673-25-T5/1/14-277V-PB-2VPTB	Luminous wall sconce with brass trim	-	2	T5	3000K	85	277	-	7	14	19	-	0.98	1.05	0.07
QQ1	6	Holophane	GVP-15DMH-27-M-B-8-R-S-B	Street "acorn" pole fixture with internal reflector to meet "Cutoff" criteria	1	-	150W MH	4200K	88	277	150	-	150	173	-	0.90	-	0.69
QQ2	6	B-K Lighting	SE-60-WHW-9-11-A-RM35-277	Wall-mounted HID projector with 10 degree beam spread and 45 degree shielding	1	-	39W PAR30L MH	3000K	81	277	39	-	39	45	-	0.95	-	0.17
QQ3	2	Erco	81030.000 HIT-CE 70W G12	Recessed exterior HID downlight	1	-	70W CMH	3000K	83	277	70	-	70	79	-	0.90	-	0.32
QQ4A	1	Io	0-04-E-3K-90-102-2-(36'-0")-2	Linear LED floodlight luminaire with asymmetric optics	-	36	LED	3000K	-	277	-	12	432	-	505.44	1.00	-	1.82
QQ4B	2	Io	0-04-E-3K-90-102-2-(19'-6")-2	Linear LED floodlight luminaire with asymmetric optics	-	19.5	LED	3000K	-	277	-	12	234	-	280.8	1.00	-	1.01
QQ5	2	Holophane	MGV-39EMH-27-S-B-5-2-B	Exterior wall-mounted acorn fixture at smaller scale to pole fixture	1	-	39W PAR30L MH	3000K	81	277	39	-	39	45	-	0.95	-	0.17
RR1	23	Zumtobel	GVP-15DMH-27-M-B-8-R-S-B	Recessed direct-indirect LTT luminiare with louvers and white reflector	1	-	40W LTT	3000K	82	277	40	-	40	40	-	0.90	1.00	0.16
RR2	9	Neoray	81-R-1-T8-ETG-2-EB-SI	Recessed T8 fluorescent downlight with parabolic louver	1	-	32W T8	3000K	78	277	32	-	32	34	-	0.98	0.90	0.13
RR3	6	Litecontrol	W-ADW-66N28T8-BW-CWM-ELB-WCB-277	Surface mounted T8 chalkboard light	1	-	32W T8	3000K	78	277	32	-	32	34	-	0.98	0.90	0.13
SS1	34	Iris	P5-M32T-E5T-C	Recessed compact fluorescent downlight	1	-	32W CFL TRT	3000K	82	277	32	-	32	36	-	0.98	0.98	0.13
SS2	14	Iris	P406TAT-MH4CFL-42E-E4DL-BH	Recessed square downlight	1	-	32W CFL TRT	3000K	82	277	32	-	32	36	-	0.98	0.98	0.13
SS3	14	Shaper	673-25-T5/1/14-277V-PB-2VPTB	Luminous wall sconce with brass trim	-	2	T5	3000K	85	277	-	7	14	19	-	0.98	1.05	0.07
SS4	1	Custom	Custom	Decorative pendant with 4 luminuous glass discs and brass trim	4	-	42W TRT CFL	3000K	82	277	42	-	168	184	-	0.98	0.98	0.68
SS5	1	elliptipar	F140-T221-X-02-2-000	Oval-shaped low profile linear wallwasher	-	6	T5	3000K	85	277	-	7	42	48	-	0.98	1.02	0.18

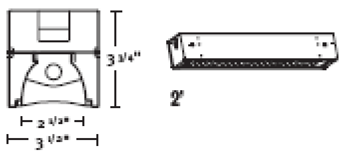
Luminaire Type PP1 – Luminaire Cutsheet

LIGHTLINE™

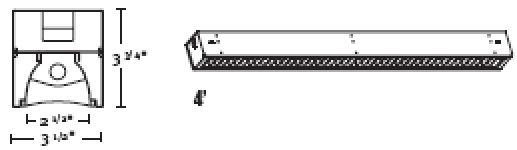
PEERLESS® — **2 1/2" Aperture**

Recessed Mount Symmetric — SPECIFICATIONS

AVAILABLE FIXTURE

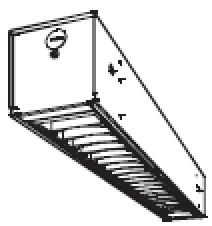


LSR9 2' T5HO/T5



LSR9 4' T5HO/T5

SPECIFICATIONS



CONSTRUCTION
Housing is formed from one piece painted cold-rolled steel. Four-stage iron-phosphate pretreatment ensures superior paint adhesion and rust resistance. Painted parts are finished with low-gloss baked enamel.

REFLECTORS
Die formed reflector with baked white enamel finish. Nominal reflectance 90%.

SHIELDING
Arc-shaped, parabolic low iridescent semi-specular aluminum louver.

ELECTRICAL
Specify 120 volt , 277 volt, or 347[1] volt. Non EL versions damp location labeled. UL and C-UL listed and labeled.
For special circuiting, consult factory.

FIXTURE SIZE
Nominal 2 1/2" aperture. 2' and 4' lengths available.

ORDERING LOGIC

Quantity | Fixture | Ceiling Type | # of Lamps in Cross Section | Lamp Type | Reflector/Shielding | Nominal Length | Voltage | Ballast Type | Emergency Options | Lamp Color | Options

[ ] [ ] [ ] [1] [ ] [ ] [ ] [ ] [ ] [ ] [ ] [ ]

- **Fixture:** LSR9 – Symmetric Recessed
- **Ceiling Type:** G – Lay in grid; ST – Screw Slot; Gyp-board[3]
- **# of Lamps in Cross Section:** 1
- **Lamp Type:** 24T5HO – 24W 2' T5HO; 54T5HO – 54W 4' T5HO; 14T5 – 14W 2' T5; 28T5 – 28W 4' T5
- **Reflector/Shielding:** LDL – Low Iridescent Louver
- **Nominal Length:** U2 – 2'; U4 – 4'
- **Voltage:** 120; 277; 347[1]
- **Ballast Type:** GEB10 – 10% THD Ballast
  - Dimming Ballasts Available: ADEZ – Advance Mark X[1]; ADZT – Advance Mark VII[1]; ECO10 – Lutron ECO 10[1]; DMHL – Lutron Hi-Lume (FDB)[1]; OSDIM – Osram 0-10V[1]
- **Emergency Options:** EL – Emergency Battery Pack (550-700 lumens)[2]
- **Lamp Color:** L/LP – No Lamp; LP830 3000k 80+ CRI; LP835 3500k 80+ CRI; LP841 4100k 80+ CRI
- **Options:** GLR – Fast Blow Fuse; GMF – Slow Blow Fuse; CP – Chicago Plenum; NYC – New York City Calendar

Accessories (order separately)
DHSGS2 - Gyp-board Flange Kit 2'
DHSGS4 - Gyp-board Flange Kit 4'
BAK000800 - Extra Mounting Clip Set

1 Only available with 54T5HO
2 Only available with 28T5 & 54T5HO
3 Order 'G' Lay-in grid fixture + flange kit accessory
4 Option available on select models. Order fixtures in pairs. Factory will supply correct number of Master and Satellite units. 9' cable standard.

EXAMPLE:

Qty	Fixture section
4	LSR9 ST 1 54T5HO LDL U4 120 GEB10 L/LP
1	LSR9 G 1 14T5 LDL U2 277 GEB10 LP835

Peerless Lighting reserves the right to change materials or modify the design of its product without notification as part of the company's continuing product improvement program.

PEERLESS LIGHTING Box 2556, Berkeley, CA 94702-0556 510.845-2760 Fax 510.845-2776 www.peerless-lighting.com

LSR-1

LIGHTLINE™

PEERLESS® — 2 1/2" Aperture

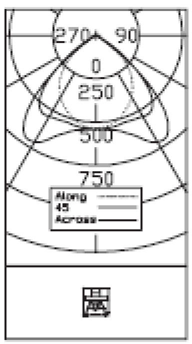
PHOTOMETRICS

Recessed Mount Symmetric

1-LAMP 24W T5 HIGH-OUTPUT

FAR-FIELD PHOTOMETRY
DATE: 5-6-2004
REPORT NUMBER: 6168

CATALOG NUMBER: LSR9-1-24T5HO
LUMINAIRE: 3 1/2"W X 3 3/4"H DIRECT LIGHT WITH WHITE PAINTED REFLECTOR AND PARABOLIC SEMI-SPECULAR BAFFLE
LAMP(S): FP24/835/HO RATED @ 2000 LUMENS
BALLAST: QTP 1X39-24T5HO/UNV PSH
MOUNTING:
LUMEN TO CANDELA RATIO USED = 9.15
TOTAL INPUT WATTS = 27.4 AT 120.0 VOLTS
THE 0 DEGREE PLANE IS PARALLEL WITH THE LAMPS.



CANDELA DISTRIBUTION

	0.0	22.5	45.0	67.5	90.0	FLUX
0	540	540	540	540	540	
5	532	533	539	543	546	51
15	487	506	531	559	573	151
25	444	465	532	618	565	251
35	389	416	543	652	712	334
45	282	323	428	471	506	306
55	81	121	165	135	102	121
65	12	15	18	22	17	18
75	3	4	5	5	4	5
85	0	1	1	1	1	1
90	0	0	0	0	0	

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LAMP	%TOT
0- 30	484	23.7	38.7
0- 40	788	38.4	63.7
0- 60	1213	60.7	98.1
0- 90	1237	61.8	100.0
90-180	0	0.0	0.0
0-180	1237	61.9	100.0

TOTAL LUMINAIRE EFFICIENCY = 61.8 %
CIE TYPE - DIRECT

LUMINANCE DATA IN FOOTLAMBERTS

ANGLE IN DEG	AVERAGE 0-DEG	AVERAGE 45-DEG	AVERAGE 90-DEG
45	2430.	3969.	4686.
55	630.	1687.	1184.
65	189.	276.	257.
75	88.	117.	111.
85	0.	72.	72.

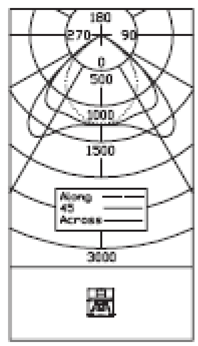
APPROVED BY:

BARE LAMP LUMEN VALUE IS RATED AT LAMP OPERATING TEMPERATURE INSIDE THE LUMINAIRE. FOR DETAIL EXPLANATIONS, PLEASE SEE PEERLESS PUBLICATION # A82

1-LAMP 54W T5 HIGH-OUTPUT

FAR-FIELD PHOTOMETRY
DATE: 5-6-2004
REPORT NUMBER: 6169

CATALOG NUMBER: LSR9-1-54T5HO
LUMINAIRE: 3 1/2"W X 3 3/4"H DIRECT LIGHT WITH WHITE PAINTED REFLECTOR AND PARABOLIC SEMI-SPECULAR BAFFLE
LAMP(S): FP54/835/HO RATED @ 5000 LUMENS
BALLAST: QTP 1X54T5HO/UNV PSH
MOUNTING:
LUMEN TO CANDELA RATIO USED = 9.15
TOTAL INPUT WATTS = 59.1 AT 120.0 VOLTS
THE 0 DEGREE PLANE IS PARALLEL WITH THE LAMPS.



CANDELA DISTRIBUTION

	0.0	22.5	45.0	67.5	90.0	FLUX
0	1263	1263	1263	1263	1263	
5	1243	1257	1265	1272	1276	120
15	1160	1184	1242	1291	1313	352
25	1038	1085	1217	1368	1466	578
35	867	971	1249	1546	1703	766
45	625	763	1047	1196	1294	761
55	210	312	427	381	324	321
65	30	38	46	57	39	46
75	7	9	9	9	9	11
85	2	1	1	2	2	2
90	1	0	0	1	1	

ZONAL LUMEN SUMMARY

ZONE	LUMENS	%LAMP	%TOT
0- 30	1050	21.0	35.3
0- 40	1836	36.7	61.8
0- 60	2909	58.2	97.9
0- 90	2970	59.4	100.0
90-180	0	0.0	0.0
0-180	2970	59.4	100.0

TOTAL LUMINAIRE EFFICIENCY = 59.4 %
CIE TYPE - DIRECT

LUMINANCE DATA IN FOOTLAMBERTS

ANGLE IN DEG	AVERAGE 0-DEG	AVERAGE 45-DEG	AVERAGE 90-DEG
45	2909.	4652.	5968.
55	1197.	2436.	1849.
65	334.	370.	306.
75	90.	111.	111.
85	82.	51.	82.

APPROVED BY:

BARE LAMP LUMEN VALUE IS RATED AT LAMP OPERATING TEMPERATURE INSIDE THE LUMINAIRE. FOR DETAIL EXPLANATIONS, PLEASE SEE PEERLESS PUBLICATION # A82

PEERLESS LIGHTING Box 2556, Berkeley, CA 94702-0556 510.845-2760 Fax 510.845-2776 www.peerless-lighting.com

LSR-2

Luminaire Type PP1 – Lamp Information

GE Lighting

WORLDWIDE PARTNER

Commercial Products & Solutions

SITE SEARCH | HOME | PRODUCTS | EDUCATION / RESOURCES | LIGHTING APPLICATIONS

Where to Buy | FAQs | Contact Us | EliteNet

Products > Linear Fluorescent > Straight Linear > 21 - 30 Watts > 46704

46704 – F28W/T5/830/ECO

GE Ecolux® Starcoat® T5

PRINT

- Passes TCLP, which can lower disposal costs.

High Color Rendering

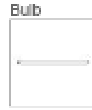
GENERAL CHARACTERISTICS	
Lamp type	Linear Fluorescent - Straight Linear
Bulb	T5
Base	Miniature Bi-Pin (G5)
Wattage	28
Voltage	167
Rated Life	30000 hrs
Rated Life (rapid start) @ Time	30000 h @ 3 h 36000 h @ 12 h
Bulb Material	Soda lime
Starting Temperature (MIN)	-20 °C (-4 °F)
Additional Info	TCLP compliant

PHOTOMETRIC CHARACTERISTICS	
Initial Lumens	2900
Mean Lumens	2660
Nominal Initial Lumens per Watt	103
Color Temperature	3000 K
Color Rendering Index (CRI)	85
S/P Ratio (Scotopic/Photopic Ratio)	1.3

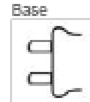
ELECTRICAL CHARACTERISTICS	
Open Circuit Voltage (rapid start) Min @ Temperature	425 V @ 10 °C
Cathode Resistance Ratio - Rh/Rc (MIN)	4.25
Cathode Resistance Ratio - Rh/Rc (MAX)	6.5
Current Crest Factor (MAX)	1.7

DIMENSIONS	
Maximum Overall Length (MOL)	45.8000 in (1163.3 mm)
Nominal Length	45.200 in (1148.0 mm)
Bulb Diameter (DIA)	0.625 in (15.8 mm)
Bulb Diameter (DIA) (MAX)	0.670 in (17.0 mm)
Max Base Face to Base Face (A)	45.240 in (1149.0 mm)

Bulb



Base



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ADDITIONAL RESOURCES

Catalogs

Testimonials

Brochures

Application/Segment Brochures

- Contractor Lighting
- Healthcare Lighting

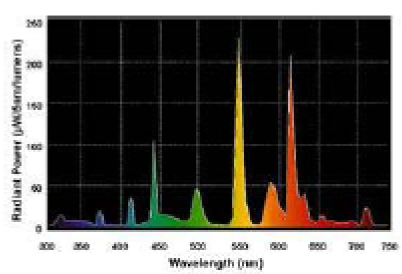
Product Brochures

- Ecolux
- Ecolux (Environmental)

Disposal Policies & Recycling Information

GRAPHS & CHARTS

Spectral Power Distribution



Lamp Mortality

Luminaire Type PP1 – Ballast Information

Product Line Guide - Electronic Ballasts

Item Number	OSRAM SYLVANIA Description	Input Voltage (VAC)	Input Current (AMPS)	Lamp Type	Rated Lumens (lm)	No. of Lamps	Ballast Factor (BF)	System Lumens	Input Wattage (W)	System Efficacy (lm/W)
QUICKTRONIC® PROFESSIONAL PROStart® COMPACT FLUORESCENT - UNIVERSAL VOLTAGE DUAL ENTRY[4]										
NORMAL BALLAST FACTOR										
51818 [illegible]	QTP 1/2x13CF/UNV *QTP1/2x13CF/UNV-KT ▲*	120-277	0.25/0.11	13W DD/E,T/E 13W DD/E,T/E	900 900	1 2	1.00 1.00	900 1800	16 29	56 62
51823 [illegible]	QTP 1/2x18CF/UNV *QTP1/2x18CF/UNV-KT ▲*	120-277	0.32/0.14	18W DD/E,T/E 18W DD/E,T/E	1200 1200	1 2	1.00 1.00	1200 2400	20 38	60 63
51833 [illegible] 51898	QTP 2x26CF/UNV *QTP2x26CF/UNV-KT ▲* QTP 2x26CF/UNV PEM	120-277	0.50/0.22	26W DD/E,T/E 26W DD/E,T/E 32W DT/E 42W DT/E	1800 1800 2400 3200	1 2 1 1	1.00 1.00 0.98 1.00	1800 3600 2350 3200	28 54 35 45	64 67 67 71
51843 [illegible] 51863	QTP 2x26/32/42CF/UNV M *QTP2x26/32/42CF/UNV M-KT ▲* QTP 2x26/32/42CF/UNV M PEM	120-277	0.90/0.40 0.53/0.23 0.57/0.25	26W DT/E 32W DT/E 42W DT/E 57W DT/E 70W DT/E	1800 2400 3200 4300 5200	2 2 2 1 1	1.02 0.96 0.95 1.00 0.92	3670 4600 6080 4300 4780	54 69 94 62 71	68 67 65 69 67
Also operates: see Ballast Technology & Specification Guide for additional lamp types. ▲ KT Kits include a ballast, screws, wire, mounting bracket, an instruction sheet and a wire removal tool.										
NORMAL BALLAST FACTOR - QTP CF models above replace gray shaded models below										
51718 51748	QTP 1/2x13CF/UNV BS QTP 1/2x13CF/UNV TS	120-277	0.25/0.11	13W DD/E,T/E 13W DD/E,T/E	900 900	1 2	1.00 1.00	900 1800	16 29	56 62
51723 51753	QTP 1/2x18CF/UNV BS QTP 1/2x18CF/UNV TS	120-277	0.32/0.14	18W DD/E,T/E 18W DD/E,T/E	1200 1200	1 2	1.00 1.00	1200 2400	20 38	60 63
51733 51763	QTP 2x26CF/UNV BS QTP 2x26CF/UNV TS	120-277	0.50/0.22	26W DD/E,T/E 26W DD/E,T/E 32W DT/E 42W DT/E	1800 1800 2400 3200	1 2 1 1	1.00 1.00 0.98 1.00	1800 3600 2350 3200	28 54 35 45	64 67 67 71
51738 51798 51768	QTP 1/2xCF/UNV BM QTP 1/2xCF/UNV PM QTP 1/2xCF/UNV TM	120-277	0.57/0.25	26W DD/E,T/E 26W DD/E,T/E 32W DT/E 42W DT/E	1800 1800 2400 3200	1 2 1 1	1.02 1.02 0.97 1.00	1830 3670 2330 3200	28 57 36 46	65 64 65 70
51743 51803 51773	QTP 2x26/32/42CF/UNV BM QTP 2x26/32/42CF/UNV PM QTP 2x26/32/42CF/UNV TM Also operates one 57W or 70W CFL lamps	120-277	0.90/0.40 0.53/0.23 0.57/0.25	26W DT/E 32W DT/E 42W DT/E 57W DT/E 70W DT/E	1800 2400 3200 4300 5200	2 2 2 1 1	1.02 0.96 0.95 1.00 0.92	3670 4600 6080 4300 4780	54 69 94 62 71	68 67 65 69 67
QUICKTRONIC® HIGH EFFICIENCY POWERSENSE™ 32 T8 DIMMING SYSTEMS - A list of controllers is available from OSRAM SYLVANIA										
Power-line control (2-wire) or 0-10Vdc control (4-wire) - 100-5% Dimming Range - <10% THD										
50705	QTP 1x32T8/UNV DIM-TC	120-277	0.27/0.12	FO32/XP	3000	1	0.88 0.05	2640 150	30 8	88
50707	QTP 2x32T8/UNV DIM-TC	120-277	0.54/0.24	FO32/XP	3000	2	0.88 0.05	5280 300	60/58 15	88/91
50714	QTP 3x32T8/UNV DIM-TCL	120-277	0.73/0.30	FO32/XP	3000	3	0.88 0.05	7920 450	87/84 20	91/94
50716	QTP 4x32T8/UNV DIM-TCL	120-277	0.96/0.40	FO32/XP	3000	4	0.88 0.05	10560 600	114/110 27	92/96
POWERSENSE™ QTP models above also operate these lamps: [illegible]. POWERSENSE T8 replaces former Helios T8 dimming products.										
QUICKTRONIC® HIGH EFFICIENCY HELIOS™ 32 T8 DIMMING SYSTEMS - A list of controllers is available from OSRAM SYLVANIA										
High Ballast Factor - "PLUS" High Light Output System - For 277V, 0-10Vdc Control Applications Only										
50718	QTP 4x32T8/277 DIM PLUS-TCL	277	0.53	FO32/XP	3000	4	1.20 0.05	14400 600	145 28	99
QUICKTRONIC® HIGH EFFICIENCY POWERSENSE™ 28 T5 DIMMING SYSTEMS - A list of controllers is available from OSRAM SYLVANIA										
Power-line control (2-wire) or 0-10Vdc control (4-wire) - 100-1% Dimming Range - <10% THD										
50726	QTP 2x28T5/UNV DIM-TCL	120-277	0.53/0.23	FP28	2900	2	1.00 0.01	5800 58	63/62 10	92/94
POWERSENSE™ QTP models above also operate these lamps: [illegible]										
QUICKTRONIC® PROFESSIONAL HELIOS™ 54 T5 HO DIMMING SYSTEMS[3] - A list of controllers is available from OSRAM SYLVANIA										
(0-10Vdc control) - 100-1% Dimming Range - <10% THD										
49671	QT1x54/120PHO-DIM	120	0.54	FP54T5HO	5000	1	1.00 0.01	5000 50	62 8	81
49672	QT1x54/277PHO-DIM	277	0.23	FP54T5HO	5000	1	1.00 0.01	5000 50	61 8	82
49673	QT2x54/120PHO-DIM	120	1.07	FP54T5HO	5000	2	1.00 0.01	10000 100	120 18	83
49674	QT2x54/277PHO-DIM	277	0.46	FP54T5HO	5000	2	1.00 0.01	10000 100	117 18	85
HELIOS™ QT models above also operate these lamps: [illegible]										

[illegible] Rated lamp lumens and performance data based on PENTRON® HO lamps. Rated lumens at 35°C lamp ambient temperature. [illegible] Rated lamp lumens and performance data based on [illegible] lamps. [4] Data is for all models within the bracket. The maximum input current is shown for maximum input power. [5] New Product: Contact OSRAM SYLVANIA for product availability.

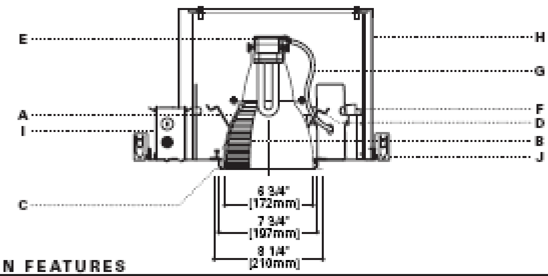
2 OSRAM SYLVANIA National Customer Service and Sales Center
1-800-LIGHTBULB (1-800-544-4828) or www.sylvania.com

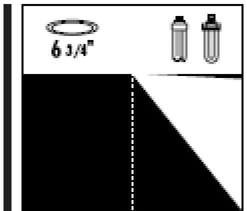
Luminaire Type PP2 – Luminaire Cutsheet

IRiS CATALOG#: TYPE:

DESCRIPTION

Specification grade 42 Watt triple tube compact fluorescent wall wash fixture. Insulation must be kept 3" from fixture sides and top of fixture. The stepped kicker reflector maximizes light towards the wall for smooth, pattern free wall illumination. Cutoff to lamp and lamp image is 50°. Unit can be relamped from above. Lamp module and optical element can be changed after installation to provide a variety of lamp sources and distributions. e.g. into a PAR36 Adjustable.

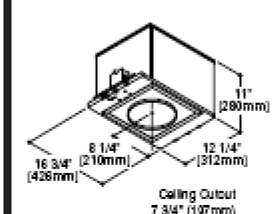




PN7
M42T
E7TWW

42W Triple
32W Triple
Compact Fluorescent

7" WALL WASH DOWNLIGHT



SPECIFICATION FEATURES

A···Reflector
.040 thick aluminum specular clear kicker and spun parabolic reflector in Clear, Gold, Haze, Warm Haze, Black Alzak® finish, painted gloss white or matte white. Special cone colors listed below.

B···Kicker
Injection molded, vacuum metalized stepped optics with hardcoat finish is specular clear to minimize flashback. Available in single (120°), double (for corridors (2)120° @180° apart), corner (for inside corners 240°), and half (for outside corners and doors 60°) wall wash versions.

C···Flange
Self flange reflector or die-cast flange with either matte white or clear coat finish. Die-cast flanges are easily removed for field painting. Elements are keyed for proper insertion.

D···Attachment
Positive torsion springs pull flange tight to ceiling. Mechanical light trap eliminates spill light at edge of flange or reflector. The two reflectors are keyed for top relaming.

E···Socket
4 pin G24q4 base for 42W PLT, TBX and TTT lamps (G24q3 for 32W lamps). Fatigue free stainless steel spring ensures positive lamp retention. Fixed socket height ensures consistent lamp position.

F···Electronic Ballast
Thermally protected, current controlled rapid start ballast produces full light output and rated lamp life. Provides flicker-free and noise-free operation and starting. Meets stringent Class B requirements, FCC part 18, for non-commercial applications.

G···Electrical
Keyed quick connect provides easy lamp module installation.

H···Frame/Housing
Hot dipped galvanized 20 gauge steel frame with built in 1/2 inch plaster lip. Aluminum .032 thick housing allows for heat dissipation and reduces weight. Top is removable for above ceiling access.

I···Junction Box
19 cubic inches, listed for 4#12 AWG or 6#14 AWG 90° C additional feed through conductors, has five 1/2" pryouts.

J···Bar Hangers
No Flex® bar hangers with positive locking, for use with wood, engineered wood and steel frame joists ship with platform. For use in T-bar ceilings order accessory MBCLP.

K···Codes
Thermally protected, IP labeled. Unit is airtight and exchanges less than 2.0 CFM with the plenum at apressure of 75 pascals. Insulation must be kept three inches away from fixture sides and none on top as to entrap heat.

L···Labels
UL and cUL listed, standard damp label, IBEW union made.

ENERGY DATA
7" AirTight®

42W Lamp
Input Power:
120V = 53W
Input Current (Max.):
120V = .45A
Power Factor:
120V = >99
T.H.D.:
120V = <10%

32W Lamp
Input Power:
120V = 36W
Input Current (Max.):
120V = .306
Power Factor:
120V = > .98
T.H.D.:
120V = < 10%

M32T -Lutron
Input Power:
120V = 36W
Input Current (Max.):
120V = .33A
Power Factor:
120V = > .95
T.H.D.:
120V = < 20%

ORDERING INFORMATION

Complete unit consists of a platform, module and element

Platform	Lamp Module	Optical Element	Finish		Flange	Accessories
PN7						
PN7 = 7" Non- IC Housing	M42T = 42W Compact Fluorescent Ballast M32T = 32/26W Compact Fluorescent Ballast M32T-Lutron = 32W Tu Wire Lutron Dimming	E7TWW = 7" Wall Wash E7TDWW = 7" Double Wall Wash E7TCWW = 7" Corner Wall Wash E7THWW = 7" Half Wall Wash	**Standard** C=Clear H=Haze G=Gold WMH=Warm Haze W=Gloss White MW= Matte White B= Black **Custom** K=Cognac KH=Cognac Haze CC=Chocolate	**Custom Cont.** CCH=Chocolate Haze BU=Blush BUH=Blush Haze GP=Graphite GPH=Graphite Haze PN=Pine PNH=Pine Haze SK=Sky SKH=Sky Haze	Blank= Matte White Die-cast SF= Self Flange RAW= Natural Die-cast SFWF= Self Flange Painted White	MBCLP = 40 Push On T Bar Clips (for 10 Units) PLE7 = Plaster Lip Extension for Max 2" Thick Ceiling

For additional options please consult factory. Matte white is recommended for self flanged reflectors

COOPER LIGHTING

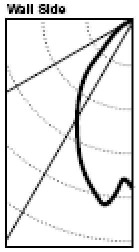
ADI030798

Unit Number: PN7-M42T-E7TWW_

PHOTOMETRICS

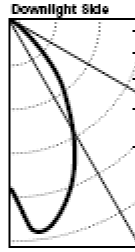
PN7-M42T-E7TWWC

Test No.	H35060
Lamp:	42W PLT
Lumens:	3200
Cutoff:	50°
Spacing:	1.1
Efficiency:	48.1%
Unit LPW:	



Candelas

CD Wall	Vertical Angle	CD Downlight
0	90	0
3	85	0
32	75	0
81	65	0
139	55	0
299	45	130
594	35	600
855	25	961
1142	15	1344
1209	5	1463
1172	0	1172



Luminance

Degree	cd/m² @ 180°
85°	0
75°	0
65°	0
55°	0
45°	7980

Single Fixture 2' Distance from Wall

DD	0	1'	2'	3'	4'
1	16	11	4	1	0
2	26	15	6	2	0
3	27	20	9	2	0
4	18	16	10	5	1
5	12	12	8	5	3
6	8	8	6	4	3
7	6	6	5	3	2
8	4	4	3	3	2
9	3	3	3	2	2
10	3	2	2	2	1

1'6" Distance from Wall

DD	16" O.C.			24" O.C.		
1	52	50	52	41	36	41
2	77	79	77	63	57	63
3	69	75	69	54	54	54
4	50	53	50	40	43	40
5	34	35	34	29	30	29
6	23	24	23	20	21	20
7	17	17	17	15	15	15
8	12	12	12	10	11	10
9	9	9	9	8	9	8
10	7	7	7	6	6	6

2'0" Distance from Wall

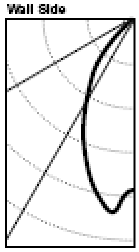
DD	24" O.C.			32" O.C.		
1	24	23	24	19	16	19
2	38	34	38	32	22	32
3	44	45	44	39	40	39
4	40	42	40	31	31	31
5	31	33	31	25	27	25
6	23	24	23	19	20	19
7	18	18	18	15	16	15
8	13	14	13	12	12	12
9	10	10	10	9	9	9
10	8	8	8	7	7	7

2'6" Distance from Wall

DD	24" O.C.			32" O.C.		
1	15	15	15	12	11	12
2	24	24	24	20	18	20
3	32	33	32	26	25	26
4	34	35	34	27	27	27
5	30	32	30	24	25	24
6	24	26	24	20	22	20
7	19	20	19	16	17	16
8	15	15	15	13	13	13
9	12	12	12	10	11	10
10	9	9	9	8	9	8

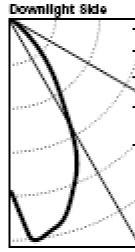
PN7-M32T-E7TWWC

Test No.	H35093
Lamp:	32W PLT
Lumens:	2400
Cutoff:	50°
Spacing:	1.1
Efficiency:	46.4%
Unit LPW:	



Candelas

CD Wall	Vertical Angle	CD Downlight
0	90	0
2	85	0
28	75	0
61	65	1
90	55	2
172	45	88
373	35	401
609	25	818
871	15	1093
1013	5	1139
905	0	905



Luminance

Degree	cd/m² @ 180°
85°	0
75°	0
65°	0
55°	0
45°	5389

Single Fixture 2' Distance from Wall

DD	0	1'	2'	3'	4'
1	12	9	4	1	0
2	15	9	4	2	1
3	17	13	6	2	1
4	13	11	7	3	1
5	9	9	6	4	2
6	7	6	5	3	2
7	5	5	4	3	2
8	4	4	3	3	2
9	3	3	3	2	2
10	2	2	2	2	2

1'6" Distance from Wall

DD	16" O.C.			24" O.C.		
1	38	38	38	30	27	30
2	47	50	47	40	36	40
3	46	47	46	36	34	36
4	36	38	36	28	30	28
5	25	27	25	21	22	21
6	18	19	18	15	16	15
7	13	13	13	11	12	11
8	9	10	9	8	9	8
9	7	7	7	6	7	6
10	5	5	5	5	5	5

2'0" Distance from Wall

DD	24" O.C.			32" O.C.		
1	20	20	20	15	14	15
2	24	21	24	20	15	20
3	28	28	28	21	21	21
4	26	26	26	20	19	20
5	22	23	22	17	18	17
6	17	18	17	14	15	14
7	13	14	13	11	11	11
8	10	10	10	9	9	9
9	8	8	8	7	7	7
10	6	6	6	6	6	6

2'6" Distance from Wall

DD	24" O.C.			32" O.C.		
1	13	14	13	11	11	11
2	16	17	16	13	13	13
3	20	21	20	16	16	16
4	22	22	22	17	17	17
5	20	21	20	16	16	16
6	17	18	17	14	15	14
7	14	15	14	12	12	12
8	11	12	11	9	10	9
9	9	9	9	8	8	8
10	7	7	7	6	7	6

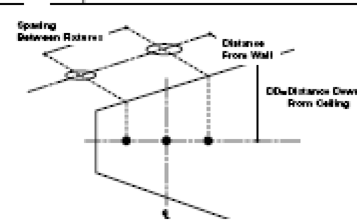
Notes and Formulas:

- Illuminance values for multiple fixtures are based upon the center two units of a four unit array. Footcandle values are centerline of fixtures and centered between fixtures.
- Illuminance values are cosine corrected initial values with no contribution from inter reflections from other room surfaces. Total illumination may increase from contributions from other surfaces.
- DD=Distance Down from Ceiling.
- Changing fixture spacing will affect illuminance level.

New Fc= $\frac{\text{Existing Spacing}}{\text{New Spacing}}$ x Average Table Fc Level

- When selecting colored cones option, only downlight cone is colored; the wall wash reflector is specular clear. This allows the color (CRI, °K) of the light source to be unaffected and maximizes lumen output.

For optimal wall washing, space fixtures no more than 1.5 the distance from the wall.



Note: Specifications and Dimensions subject to change without notice.

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Cooper Lighting 5925 McLaughlin Rd. Mississauga, Ontario, Canada L5R 1B8 905.507.4000 FAX 905.568.7049

Luminaire Type PP2 – Lamp Information

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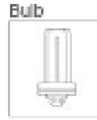
97630 – F32TBX/830/A/ECO

GE Ecolux® Biax® T4 - Facilities; Retail Display; Hospitality; Office; Restaurant; Warehouse

PRINT

High Color Rendering
Energy Savings

Bulb



Base

View Larger

GENERAL CHARACTERISTICS

Lamp type	Compact Fluorescent - Plug-In
Bulb	T4
Base	GX24q-3
Wattage	32
Voltage	120/100
Rated Life	12000 hrs
Starting Temperature (MIN)	0 °C (32 °F)
Cathode Resistance	2.700 Ohm
Rated Life (rapid start) @ Time	12000 h @ 3 h 20000 h @ 12 h
Additional Info	Dimmable with appropriate dimming ballast., End of Life Protection (EOL), TCLP compliant
Primary Application	Facilities; Retail Display; Hospitality; Office; Restaurant; Warehouse

PHOTOMETRIC CHARACTERISTICS

Initial Lumens	2200
Mean Lumens	1850
Nominal Initial Lumens per Watt	68
Color Temperature	3000 K
Color Rendering Index (CRI)	82

ELECTRICAL CHARACTERISTICS

Current (max)	5.2500 A
Open Circuit Voltage (after preheating) (MAX)	265 V
Open Circuit Voltage (MIN)	515 V
Lamp Current	0.320 A
Preheat Voltage (MIN)	4 V
Current Crest Factor (MAX)	1.7
Supply Current Frequency	20000 Hz

ADDITIONAL RESOURCES

Catalogs

Testimonials

Brochures

Product Brochures

- Ecolux
- Ecolux (Environmental)

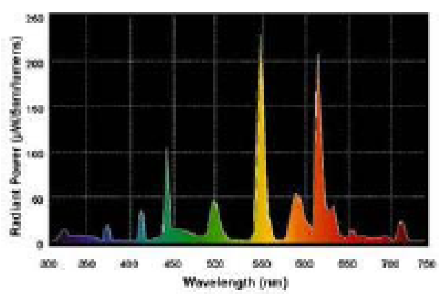
Sell Sheets

- Fast Warming
- Biax® T/E 32W with Amalgam

Disposal Policies & Recycling Information

GRAPHS & CHARTS

Spectral Power Distribution



Luminaire Type PP2 – Ballast Information

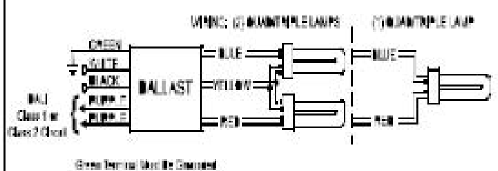
ADVANCE

Electrical Specifications

IDL-2S26-M5-BS@277	
Brand Name	ROVR
Ballast Type	Electronic Dimming
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (Watts) (min/max)	Ballast Factor (min/max)	MAX THD %	Power Factor	Lamp Current Crest Factor	B.E.F.
* CFTR42W/GX24Q	1	42	50/10	0.17	09/47	0.03/1.00	10	0.99	1.6	2.13

Wiring Diagram



Diag. 165

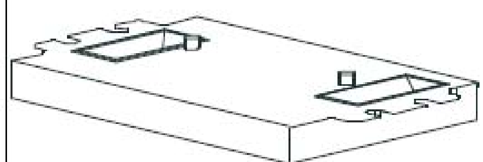
The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

	in.	cm.
Black	0	0
White	0	0
Blue	0	0
Red	0	0
Yellow	0	0
Gray		0
Violet		0

	in.	cm.
Yellow/Blue		0
Blue/White		0
Brown		0
Orange		0
Orange/Black		0
Black/White		0
Red/White		0

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
4.98 "	3.00 "	1.18 "	2.00 "
4 49/50	3	1 9/50	2
12.6 cm	7.6 cm	3 cm	5.1 cm

Revised 10/23/2007

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

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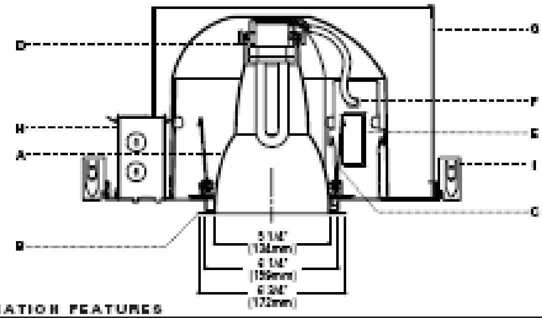
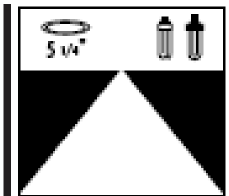
Luminaire Type PP3 – Luminaire Cutsheet

IRiS CATALOG#: TYPE:

DESCRIPTION

Specification grade 32 Watt triple tube compact fluorescent fixture rated for direct contact with insulation. The 50° cutoff to lamp and lamp image provides a glare free, smooth, medium beam distribution. Triple tube lamps provide excellent color, long life, and low radiant heat. Dimming and emergency ballast options are available. Lamp module and optical element can be changed after installation to provide a variety of lamp sources and distributions. e.g. into a PAR36 adjustable

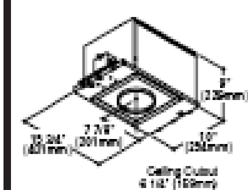




P5
M32T
E5T

32W TRIPLE
Compact Fluorescent

5" DOWNLIGHT



SPECIFICATION FEATURES

A···Reflector
.040 thick aluminum spun parabolic reflector in iridescence-free Clear, Gold, Haze, Warm Haze Alzak® or painted Gloss White finish. Special cone colors listed below

B···Flange
Self flange reflector or die-cast flange with either matte white or clear coat finish. Die-cast flanges are easily removed for field painting. Elements are keyed for proper insertion.

C···Attachment
Positive torsion springs pull flange tight to ceiling. Mechanical light trap eliminates spill light at edge of flange or reflector.

D···Socket
4 pin G24q3 base for 32W PLT, TBX and TTT lamps. Fatigue free stainless steel spring ensures positive lamp retention. Fixed socket height ensures consistent lamp position.

E···Electronic Ballast
Thermally protected, current controlled electronic ballast produces full light output and rated lamp life. For 32W and 26W triple tube lamps. Provides flicker-free and noise-free operation and starting with 120 or 277 volt input. Meets stringent Class B requirements, FCC part 18, for non-commercial applications. M32T Lutron for use with 32W lamp only.

F···Electrical
Keyed quick connect provides easy lamp module installation.

G···Frame/Housing
Hot dipped galvanized 20 gauge steel frame with built in 1/2 inch plaster lip. Gunsights allow for consistent alignment. Aluminum .032 thick housing allows for heat dissipation and reduces weight.

H···Junction Box
18 cubic inches, listed for 4#12 AWG or 6#14 AWG 90° C additional feed through conductors, has six 1/2 inch pryouts.

I···Bar Hangers
No Flex® bar hangers with positive locking, for use with wood, engineered wood and steel frame joists spaced up to 24" O.C. ship with platform for use in T-bar ceilings order accessory MBCLP clips. Nailess barb and locator lip provide consistent installation height.

Codes
Thermally protected, IP labeled, for use in direct contact with insulation. Meets Washington State Air tight requirements, 1995 CABO Model Energy Code.

Labels
UL and cUL listed, standard damp label, IBEW union made.

ENERGY DATA
M32T
Input Power:
120V = 36W
Input Current (Max.):
120V = .306A
Power Factor:
120V = > .98
T.H.D.:
120V = < 10%

M32T Lutron
Input Power:
120V = 36W
Input Current (Max.):
120V = .33A
Power Factor:
120V = > .95
T.H.D.:
120V = < 20%

ORDERING INFORMATION
Complete unit consists of a platform, module and element

Platform	Lamp Module	Optical Element	Finish		Flange	Accessories
P5	M32T					
P5=5" Airtight IC Rated Housing	M32T=32/26W Compact Fluorescent Ballast M32T Lutron=32W Tu Wire Dimmable Ballast	E5T=5" Downlight Reflector	Standard C=Clear H=Haze G=Gold WMH=Warm Haze W=Gloss White MW=Matte White Custom K=Cognac KH=Cognac Haze CC=Chocolate	Custom Cont. CCH=Chocolate Haze BU=Blush BUH=Blush Haze GP=Graphite GPH=Graphite Haze PN=Pine PNH=Pine Haze SK=Sky SKH=Sky Haze	Blank=White die-cast SF=Self Flange RAW=Natural Die-cast SFWF=Self Flange Painted White	MBCLP=40 Push On T Bar Clips (for 10 Units) PLE5=Plaster Lip Extension for Max 2" Thick Ceiling RMC5= Flush Mount Collar

For Emergency Option order P532TEMER and E5T_ see catalog for ordering information. For additional options please consult factory.

COOPER LIGHTING ADI020703

Unit Number: F5-M32T-E5T_

PHOTOMETRICS

F5-M32T-E5TC
Test No. H36067

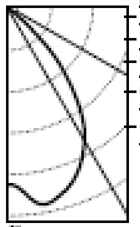
Lamp: 32W PLT
Lumens: 2400

Cutoff: 50°
Spacing: 1.1
Efficiency: 33.7%
Unit LPW: 22.4

Candelas

Vertical Angle	CD
90	0
85	0
75	0
65	0
55	0
45	134
35	365
25	522
15	605
5	596
0	552

Distribution



Luminance

Degree	cd/m²
85°	0
75°	0
65°	0
55°	0
45°	13594

Cone of Light

Distance to Illuminated Plane	Initial Nadir Footcandles	Beam Diameter
4'6"	29	5'0"
5'6"	19	6'6"
6'6"	14	7'6"
8'0"	9	9'6"
10'0"	6	11'6"
12'0"	0	14'0"

Zonal Lumen Summary

Zone	Lumens	%Lamp	%Luminaire
0-30	496	19.4	57.6
0-40	690	28.8	65.5
0-60	803	33.4	88.1
0-90	910	33.7	100.0
90-180	0	0.0	0.0
0-180	910	33.7	100.0

Coefficient of Utilization

Ceiling Reflectance	80%				70%		50%		30%		0%
Wall Reflectance	70	50	30	10	50	10	50	10	50	10	0
Room Cavity Ratio											
0	40	40	40	40	39	39	37	37	36	36	34
1	39	37	37	36	37	35	35	34	34	33	32
2	37	35	34	33	34	32	33	32	32	31	30
3	35	33	31	30	32	30	31	29	31	28	28
4	33	31	29	28	30	27	30	27	29	27	26
5	31	29	27	25	29	25	28	25	27	25	24
6	30	27	25	24	27	24	26	23	26	23	23
7	29	25	23	22	25	22	25	22	24	21	21
8	27	23	21	20	23	20	23	20	23	20	19
9	25	22	20	19	22	19	21	19	21	19	18
10	24	20	19	17	20	17	20	17	20	17	16

F5-M32T-E5TC
Test No. H36107

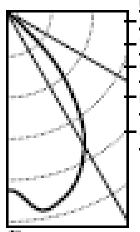
Lamp: 26W PLT
Lumens: 1800

Cutoff: 50°
Spacing: 1.1
Efficiency: 38.7%
Unit LPW: 23.2

Candelas

Vertical Angle	CD
90	0
85	0
75	0
65	0
55	0
45	103
35	305
25	460
15	566
5	572
0	540

Distribution



Luminance

Degree	cd/m²
85°	0
75°	0
65°	0
55°	123
45°	10606

Cone of Light

Distance to Illuminated Plane	Initial Nadir Footcandles	Beam Diameter
4'6"	27	5'0"
5'6"	19	6'0"
6'6"	13	7'0"
8'0"	9	9'0"
10'0"	5	11'0"
12'0"	4	12'0"

Zonal Lumen Summary

Zone	Lumens	%Lamp	%Luminaire
0-30	426	23.7	60.9
0-40	476	26.2	67.9
0-60	698	38.8	99.6
0-90	701	38.9	100.0
90-180	0	0.0	0.0
0-180	701	38.9	100.0

Coefficient of Utilization

Ceiling Reflectance	80%				70%		50%		30%		0%
Wall Reflectance	70	50	30	10	50	10	50	10	50	10	0
Room Cavity Ratio											
0	46	46	46	46	45	45	43	43	41	41	38
1	44	42	42	42	42	41	41	40	40	39	37
2	425	41	39	39	40	38	38	37	38	36	35
3	41	38	36	35	38	35	37	34	36	34	33
4	39	36	34	33	36	32	35	32	34	32	31
5	37	34	32	30	33	30	33	30	32	29	29
6	35	32	30	28	32	28	31	29	30	28	27
7	33	30	28	26	30	26	29	26	29	26	25
8	31	28	26	25	29	25	27	24	27	24	23
9	30	26	24	22	26	22	25	22	25	22	21
10	28	24	22	21	24	21	24	21	24	20	20

Notes and Formulas:

Luminance: To convert cd/m² to footlamberts, multiply by 0.2919

Cone of Light:
- Beam diameter is to 50% of maximum footcandles, rounded to the nearest half-foot.
- Footcandle values are initial. Apply appropriate light loss factors where necessary. See page 6845 of catalog.

CU Notes/Formulas:
- maintained illuminance = $\frac{\text{lamp lumens} \times \text{CU} \times \text{light loss factors}}{\text{room area}}$
- total number of luminaires = $\frac{\text{total room area} \times \text{maintained illuminance}}{\text{lamp lumens} \times \text{CU} \times \text{light loss factors}}$
- CU data based on 20% effective floor cavity reflectance.

Note: Specifications and Dimensions subject to change without notice.

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Luminaire Type PP3 – Lamp Information

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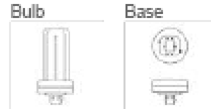
97615 – F26TBX/830/A/ECO

GE Ecolux® Biax® T4 - Facilities; Retail Display; Hospitality; Office; Restaurant; Warehouse

PRINT

High Color Rendering
Energy Savings



View Larger

GENERAL CHARACTERISTICS

Lamp type	Compact Fluorescent - Plug-In
Bulb	T4
Base	GX24q-3
Wattage	26
Voltage	120/105
Rated Life	12000 hrs
Starting Temperature (MIN)	0 °C (32 °F)
Cathode Resistance	2.700 Ohm
Rated Life (rapid start) @ Time	12000 h @ 3 h 20000 h @ 12 h
Additional Info	Dimmable with appropriate dimming ballast., End of Life Protection (EOL), TCLP compliant
Primary Application	Facilities; Retail Display; Hospitality; Office; Restaurant; Warehouse

PHOTOMETRIC CHARACTERISTICS

Initial Lumens	1710
Mean Lumens	1440
Nominal Initial Lumens per Watt	65
Color Temperature	3000 K
Color Rendering Index (CRI)	82

ELECTRICAL CHARACTERISTICS

Current (max)	5.2500 A
Open Circuit Voltage (after preheating) (MAX)	265 V
Open Circuit Voltage Across Starter (MIN)	198 V
Lamp Current	0.325 A
Preheat Voltage (MIN)	4 V
Current Crest Factor (MAX)	1.7
Supply Current	20000 Hz

ADDITIONAL RESOURCES

Catalogs
Testimonials
Brochures
Product Brochures
- Ecolux
- Ecolux (Environmental)

Sell Sheets
- Fast Warming

Disposal Policies & Recycling Information

Luminaire Type PP3 – Ballast Information

ADVANCE

VEZ-1T42-M2-BS	
Brand Name	MARK 10 POWERLINE
Ballast Type	Electronic Dimming
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	277
Input Frequency	60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (Watts) (min/max)	Ballast Factor (min/max)	MAX THD %	Power Factor	Lamp Current Crest Factor	B.E.F.
CFQ26W/G24Q	1	26	50/10	0.11	08/31	0.05/1.05	10	0.98	1.6	3.39
* CFTR26W/GX24Q	1	26	50/10	0.11	08/31	0.05/1.05	10	0.98	1.6	3.39
CFTR32W/GX24Q	1	32	50/10	0.14	09/38	0.05/1.05	10	0.98	1.6	2.76
CFTR42W/GX24Q	1	42	50/10	0.18	10/49	0.05/1.05	10	0.99	1.6	2.14

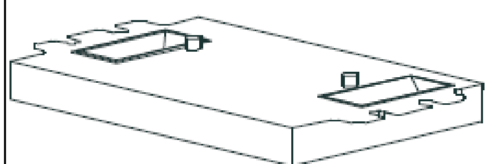
Wiring Diagram

Diag. 134

The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
4.98 "	3.00 "	1.29 "	2.00 "
4 49/50	3	1 29/100	2
12.6 cm	7.6 cm	3.3 cm	5.1 cm

Revised 09/10/2002

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

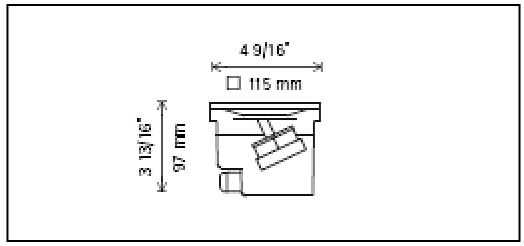
ADVANCE
O'HARE INTERNATIONAL CENTER · 10275 WEST HIGGINS ROAD · ROSEMONT, IL 60018
Customer Support/Technical Service: Phone: 800-372-3331 · Fax: 630-307-3071
Corporate Offices: Phone: 800-322-2086

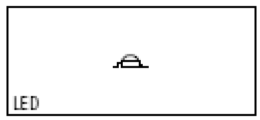
Luminaire Type PP4 – Luminaire Cutsheet

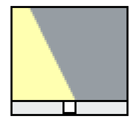
ERCO

Nadir Recessed floor luminaire

Grazing light wallwasher with LED







33804.023 LED warm white
LED 3.6W 90lm 3500K

Product description
Size 4
For mounting in accessories.
Housing: corrosion-resistant cast aluminum, No-Rinse surface treatment. Black double powder-coated.
Lampholder carrier 0°-25° tilt.
Electronic control gear 120V, 60Hz.
Connection cable, 2xAWG14, L 19 11/16" / 500mm.
Version 1
Replaceable LED module.
Aperture mask: aluminum, silver, specular anodized. Sculpture lens.
Safety glass: 1/4" / 6mm, clear.
Load: 1124lb.wt / 5kN.
Mounting accessories to be ordered separately.
Suitable for wet location (IP67): dust-proof and protected against immersion damage.
To avoid submersion in standing water provide local drainage.
Weight 1.98lbs / 0.90kg
Temperature on the cover glass 87°F / 30°C

ERCO Lighting, Inc.
160 Raritan Center Parkway
Suite 10
Edison, NJ 08837
USA
Tel: +1 732 225 8856
Fax: +1 732 225 8857
info.us@erco.com

Technical Region: 120V/60Hz
Edition: 11.15.2007
Please download latest version from
www.erco.com/33804.023

1/3

Luminaire Type PP5 – Luminaire Cutsheet

Shaper
shaperlighting.com

DESCRIPTION

673 luminous Half Cylinder features a variety of decorative options such as perforated metal, colored acrylic, trim bars and is ADA compliant.

Catalog #		Type
Project		
Comments		Date
Prepared by		

SPECIFICATION FEATURES

Material
Painted or plated solid aluminum with a 1/8" matte white extruded acrylic panel.

Finish
Standard: Natural Aluminum (NA). [Sustainable Design] Premium: Polished Chrome (PC), Satin Brass (SB), Polished Brass (PB), Lacquered Satin Aluminum (SAL), Matte White (MW), Satin Copper (SCP), Polished Copper (PCP), Satin Nickel (SN), Polished Nickel (PN), Oxidized Brass (OBRS), Lacquered Satin Chrome (SCL), Lacquered Satin Nickel (SNL) or Custom Color (CC).

Optics
Refer to www.shaperlighting.com for complete photometrics.

Ballast
Integral electronic HPF, multi-volt 120/277V (347V Canada), thermally protected with end-of-life circuitry to accommodate the specified lamp wattage.

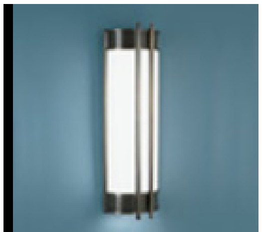
Lamp/Socket
12": One (1) or two (2) 18W (2G11) 4-pin high lumen CFL lamps or one (1) 60W frosted T-10 lamp.
16": Two (2) 27W (2G11) 4-pin high lumen CFL lamps or two (2) 60W frosted T-10 lamps.
25": One (1) or two (2) 14W T5 linear fluorescent lamps.
37": One (1) or two (2) 21W T5 linear fluorescent lamps. CFL lamps or two (2) 60W Frosted T-10 lamps. CFL socket injection molded plastic. Lamps furnished by others.

Installation
Supplied with a universal circular strap for a standard 4" J-box or plaster ring.

Options
Hand-Painted Faux Alabaster Acrylic Diffuser (FD), Remote Emergency Battery (12" and 16" only) - Supplied by others (REM), Integrated Emergency Battery (IEM) (25" and 37"), Dimming Ballast - Contact the factory for ballast options (DM), Top and Bottom Cover (TBC), Two Vertical Trim Bars (2VTB), Two Horizontal Trim Bars (2HTB), Two Vertical and Horizontal Trim Bars (2HTB/2VTB), Two Vertical Trim Bars with Perf Sides (2VTB/PS), Two Vertical Trim Bars with Four Wide Trim Bars (2VTB/4WTB), Two Vertical and Horizontal Trim Bars with Perf Center (2HTB/2VTB/PC), Two Proud Extended Vertical Trim Bars (2PVETB), Two Horizontal Trim Bars and One Proud Vertical Trim Bar (2HTB/1PVTB), MRI Applications (INC only) - Contact factory, Accent Balls (ACB), Three Horizontal and One Vertical Trim Bars with Perf (3HTB/1VTB/P), Damp Location (DL): All Painted Finishes, Lacquered Satin Chrome (SCL) and Lacquered Satin Nickel (SNL) finishes only. Energy Star Rating - Consult factory. MRI Applications (INC only) - Contact Factory.

Labels
U.L. and C.U.L approved for indoor and damp location. See options for damp location finishing requirements. ADA compliant (except 2PVTB, 2PVETB, 2HTB/1PVTB).

Modifications
Shaper's skilled craftspeople with their depth of experience offer the designer the flexibility to modify standard wall luminaires for project specific solutions. Contact the factory regarding scale options, unique finishes, mounting, additional materials/colors, or decorative detailing.



673 SERIES

Interior Wall Luminaire
Luminous Half Cylinder

ADA

ORDERING INFORMATION

Sample Number: 673-12-CFL/2/18-277V-PCP

Series
673 Luminous Half Cylinder

Size
12"
16"
25"
37"

Lamp
CFL/1/18[1]
CFL/2/18[1]
CFL/2/27[2]
INC/1/60[1]
INC/2/60[2]
T5/1/14[3]
T5/1/21[4]
T5/2/14[3]
T5/2/21[4]

Voltage
120V
277V[6]
347V[6]

Finish
Standard
NA Natural Aluminum
Premium
CC Custom Color
MW Matte White
OBRS Oxidized Brass
PB Polished Brass
PC Polished Chrome
PCP Polished Copper
PN Polished Nickel
SAL Lacquered Satin Aluminum
SB Satin Brass
SCP Satin Copper
SN Satin Nickel
SNL Lacquered Satin Nickel

Options
2HTB Two Horizontal Trim Bars
2HTB/1 PVTB Two Horizontal Trim Bars and 1 Proud Vertical Trim Bar
2HTB/2VTB Two Horizontal and Vertical Trim Bars
2HTB/2VTB/PC Two Horizontal and Vertical Trim Bars w/ Perf Center
2PVTB Two Proud Vertical Trim Bars
2VTB Two Vertical Trim Bars
2VTB/4WTB Two Vertical Trim Bars w/ Four Wide Trim Bars
2VTB/PS Two Vertical Trim Bars w/ Perforated Sides
3HTB/1 VTB/P Three Horizontal and One Vertical Trim Bars w/ Perf
ACB Accent Balls
DL Damp Location
DM CFL Dimming Ballast[6]
IEM Integral Emergency Ballast[3, 4]
REM Remote Emergency Battery[1, 7]
FD Hand Painted Faux Alabaster Diffuser
TBC Top and Bottom Cover

Notes:
1 Available in 12".
2 Available in 16".
3 Available in 24".
4 Available in 37".
5 Available with CFL only.
6 Consult the factory for available options.
7 Supplied by others.

COOPER Lighting
www.cooperlighting.com

Specifications and Dimensions subject to change without notice.
Consult your representative for additional options and finishes.

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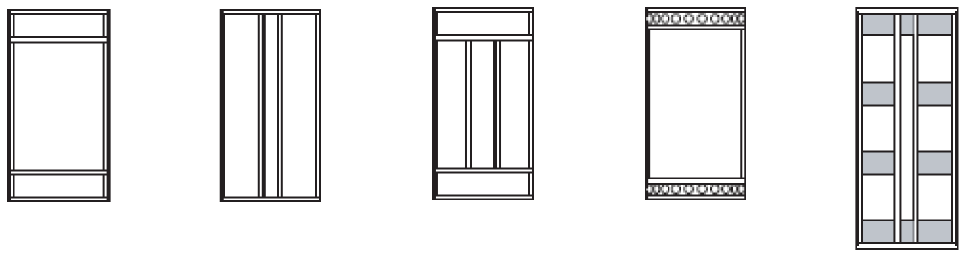
673 SERIES INTERIOR WALL LUMINAIRE

DIMENSIONS

TRIM OPTIONS



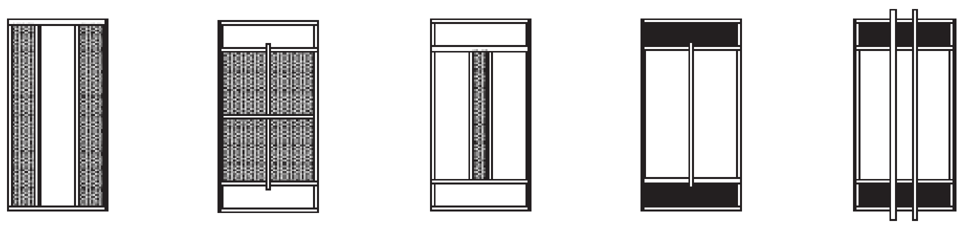
TWO HORIZONTAL TRIM BARS (2HTB)

TWO VERTICAL TRIM BARS (2VTB)

TWO HORIZONTAL AND TWO VERTICAL TRIM BARS (2HTB/2VTB)

ACCENT BALLS (ACB)

TWO VERTICAL TRIM BARS WITH FOUR WIDE TRIM BARS (2VTB/4WTB)



TWO VERTICAL TRIM BARS WITH PERF SIDES (2VTB/PS)

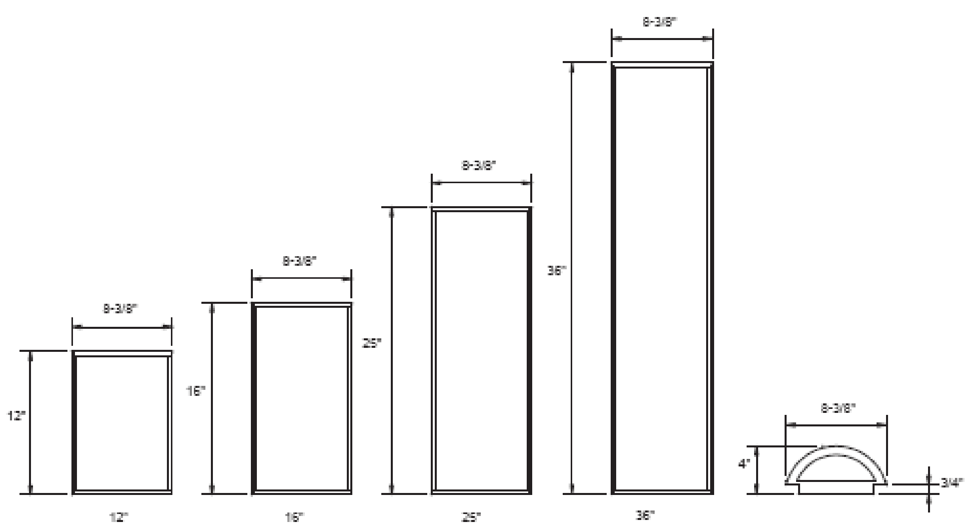
THREE HORIZONTAL & ONE VERTICAL TRIM BARS WITH PERF (3HTB/1VTB/P)

TWO HORIZONTAL & TWO VERTICAL TRIM BARS WITH PERF CENTER (2HTB/2VTB/PC)

ONE PROUD VERTICAL TRIM BAR (1PVTB)

TWO PROUD VERTICAL TRIM BARS (2PVTB)

DIMENSIONS



COOPER Lighting
www.cooperlighting.com

Specifications and Dimensions subject to change without notice.
Shaper Lighting • 1141 Marina Way South • Richmond, CA 94804 • ph 510.234.2370 • fax 510.234.2371

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Luminaire Type PP5 – Lamp Information

WORLDWIDE PARTNER

GE Lighting

Commercial Products & Solutions

SITE SEARCH | HOME | PRODUCTS | EDUCATION / RESOURCES | LIGHTING APPLICATIONS

Where to Buy | FAQs | Contact Us | EliteNet

Products > Linear Fluorescent > Straight Linear > T5 > 31590

31590 – F14W/T5/830/ECO

GE Ecolux® Starcoat® T5

PRINT

• Passes TCLP, which can lower disposal costs.

High Color Rendering

GENERAL CHARACTERISTICS	
Lamp type	Linear Fluorescent - Straight Linear
Bulb	T5
Base	Miniature Bi-Pin (G5)
Wattage	14
Voltage	82
Rated Life	30000 hrs
Rated Life (rapid start) @ Time	30000 h @ 3 h 36000 h @ 12 h
Bulb Material	Soda lime
Starting Temperature (MIN)	-20 °C (-4 °F)
Additional Info	TCLP compliant

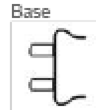
PHOTOMETRIC CHARACTERISTICS	
Initial Lumens	1350
Mean Lumens	1240
Nominal Initial Lumens per Watt	96
Color Temperature	3000 K
Color Rendering Index (CRI)	85
S/P Ratio (Scotopic/Photopic Ratio)	1.3

ELECTRICAL CHARACTERISTICS	
Open Circuit Voltage (rapid start) Min @ Temperature	230 V @ 10 °C
Cathode Resistance Ratio - Rh/Rc (MIN)	4.25
Cathode Resistance Ratio - Rh/Rc (MAX)	6.5
Current Crest Factor (MAX)	1.7

DIMENSIONS	
Maximum Overall Length (MOL)	22.1700 in (563.1 mm)
Nominal Length	21.600 in (548.6 mm)
Bulb Diameter (DIA)	0.625 in (15.8 mm)
Bulb Diameter (DIA) (MAX)	0.670 in (17.0 mm)
Max Base Face to Base Face (A)	21.610 in (548.8 mm)

Bulb

Base



View Larger

ADDITIONAL RESOURCES

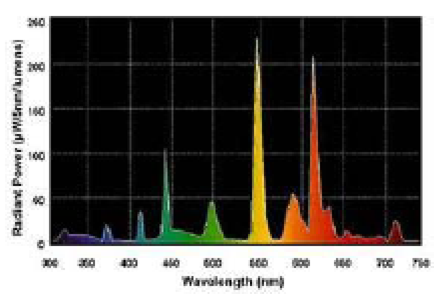
Catalogs
Testimonials
Brochures
Application/Segment Brochures
- Contractor Lighting
- Healthcare Lighting

Product Brochures
- Ecolux

Disposal Policies & Recycling Information

GRAPHS & CHARTS

Spectral Power Distribution



Lamp Mortality

Luminaire Type PP5 – Ballast Information

Lutron® | Hi-lume®, Compact SE™, Eco-10™
277 volt 3-wire dimming ballasts

► **NEW!**
For the latest model numbers:
www.lutron.com/ballasts

Lamp Type	Lamp Watts (Length)	Lamps per Ballast	Case Type[1]	1% Dimming Hi-lume	5% Dimming	10% Dimming Eco-10	Ballast Current[2] – Amps
T5 Linear	14W	1	C[3]	—		E 3 T514 C 277 1	.08
	(22")	2	C[3]	—		E 3 T514 C 277 2	.14
5/8" Dia	21W	1	C[3]	—		E 3 T521 C 277 1	.11
	(34")	2	C[3]	—		E 3 T521 C 277 2	.19
	28W	1	C[3]	—		ECO-T528-277-1	.14
	(45")	2	C[3]	—		ECO-T528-277-2	.25
T5-HO	24W	1	C[3]	FDB-T524-277-1		ECO-T524-277-1	.13
Linear	(21.5")	2	C[3]	FDB-T524-277-2		ECO-T524-277-2	.20
	39W	1	C[3]	FDB-T539-277-1		ECO-T5H39-277-1	.17
5/8" Dia	(33.4")	2	C[3]	FDB-T539-277-2		ECO-T5H39-277-2	.31
	54W	1	C[3]	FDB-T554-277-1		ECO-T554-277-1	.25
	(45")	2	C[3]	FDB-T554-277-2		ECO-T554-277-2	.45
T8 Linear	17W	1	F	FDB-2427-277-1		ECO-T817-277-1	.08
and U-Bent	(24")	2	F	FDB-2427-277-2		ECO-T817-277-2	.15
		3	F	FDB-2427-277-3		ECO-T817-277-3	.20
1" Dia	25W	1	F	FDB-3627-277-1		ECO-T825-277-1	.12
	(36")	2	F	FDB-3627-277-2		ECO-T825-277-2	.19
		3	F	FDB-3627-277-3		—	.28
	32W	1	F	FDB-4827-277-1		ECO-T832-277-1	.14/.15[4]
	(48")	1	D	—		ECO-T832-277-1-L	.14
		1	D	—		ECO-T832-277-1-T	.14
		2	F	FDB-4827-277-2		ECO-T832-277-2	.25/.22[4]
		2	D	—		ECO-T832-277-2-L	.23
		2	D	—		ECO-T832-277-2-T	.23
		3	F	FDB-4827-277-3		ECO-T832-277-3	.35
	40W	1	F	FDB-6027-277-1		—	.16
	(60")	2	F	FDB-6027-277-2		—	.30

1 For case type information, see pages 32 and 33.
2 To calculate ballast input power, use the following formula: Watts = Ballast Current x 277.
3 Standard with terminals. Leaded options available. Please consult factory.
4 Eco-10 ballast current.

26 | Lutron

Luminaire Type QQ1– Luminaire Cutsheet

GranVille® Premier

| Decorative | Historical |

Featuring ISD SuperGlass® with Cutoff Optics

Preferred Selections:

Most Frequently Ordered Catalog Number

GVP	175MH	MA	M	B	6	R	S	B
1	2	3	4	5	6	7	8	9
Luminaire	Wattage	Voltage	Housing	Color	Optics	Trim	Finial	Trim Finish
GVP	175MH 250MH	MA	M	B	6	R	S	B

Holophane's new Cutoff optical design utilizes a precision segmented Miro® 4 reflector design to control up-light and a bottom prismatic glass refractor to provide a very uniform distribution pattern.

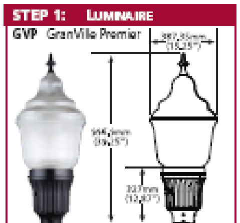
Miro® 4 is a Registered Trade Mark of Alanod

Catalog Numbers for Entire Product Offering
(Pricing and lead times may be affected)

c UL US LISTED

STEP 1: Luminaire

GVP GranVille Premier



STEP 2: Source and Wattage

HIGH PRESSURE SODIUM

Medium Base
- 50DHP 50W HPS
- 70DHP 70W HPS
- 10DHP 100W HPS
- 15DHP 150W/55V HPS

Mogul Base
- 050HP[1] 50W HPS
- 070HP 70W HPS
- 100HP 100W HPS
- 15AHP 150W/55V HPS

1 Not available with 347V

STEP 2: Wattage (continued)

METAL HALIDE

Medium Base
- 70DMH[2] 70W MH
- 10DMH[2] 100W MH
- 15DMH[2] 150W MH
- 17DMH 175W MH

Mogul Base
- 175MH 175W MH
- 250MH 250W MH

INCANDESCENT
- 20DIN 200W Inc

COMPACT FLUORESCENT
- 42CFL 42W CFL
- 57CFL 57W CFL
- 70CFL 70W CFL

INDUCTION
- 055QL[3] 55W Ind
- 085QL[3] 85W Ind

1 Not available with 347V
2 Not available with 480V
3 35°C maximum ambient

STEP 3: Voltage
- 08[1] 208V
- 12 120V
- 20 208V
- 24 240V
- 27 277V
- 34 347V
- 40[1] 240V
- 48 480V

Multi-tap, factory installed
- MA 120 volt only
- MB 208 volt only
- MC 240 volt only
- MD 480 volt only

1 Isolated secondary. Not available with "CFL", "70DMH", "10DMH", "15DMH", and "QL"

STEP 4: Housing
- M Modern fluted swing open design

STEP 5: Color
- B Black
- N Green
- Z Bronze
- A As specified

STEP 6: Optics
- 3 Asymmetric
- 5 Symmetric
- 6 Asymmetric, with Lunar Optics
- 8 Symmetric, with Lunar Optics

STEP 7: Trim
- B Band only
- N No trim
- R Band and ribs

STEP 8: Finial

Painted Cast Aluminum
- B Ball
- E Eagle
- F Flower
- P Pawn
- R Cross
- S Standard

Other
- C Clear Acrylic, 3"
- N None

STEP 9: Trim Finish
- B Black
- N Green
- Z Bronze
- A As specified
- U No trim and clear or no finial

STEP 10: Options/Accessories

DTL Twist-off photocontrols
- PCTWSTL120 120 volt
- PCTWSTL1202427 120-277 volt
- PCTWSTL480 480 volt
- PCTWSTLSHRTCAP Shorting cap
- FCVRX[1] Full decorative aluminum cover for "GV" (finial required)
- H NEMA twist-off photocontrol
- NEMA-XXXXX NEMA labels. Insert wattage for "XXXXX"
- P Protected starter for HPS units
- S Orient door with street

Pre-wired leads
- LEADS-XXX-FT10GA Pre-wired leads. Insert length for "XXX"

1 For color insert "B", "G", "N", "Z" or "A" for "X"

HOLOPHANE® LEADER IN LIGHTING SOLUTIONS
An Acuity Brands Company

Acuity Brands Lighting, Inc.
Holophane Headquarters, 3825 Columbus Road, Granville, OH 43023
Holophane Canada, Inc. 9040 Leslie Street, Suite 208, Richmond Hill, ON L4B 3M4
Holophane Europe Limited, Bond Ave., Milton Keynes MK1 1JG, England
Holophane, S.A. de C.V., Apartado Postal No. 986, Naucalpan de Juarez, 53000 Edo. de Mexico

Contact your local Holophane factory sales representative for application assistance, and computer-aided design and cost studies. For information on other Holophane products and systems, call the Inside Sales Service Department at 740-345-9631. In Canada call 905-707-5830 or fax 905-707-5695.

Limited Warranty and Limitation of Liability Refer to the Holophane limited material warranty and limitation of liability on this product, which are published in the "Terms and Conditions" section of the current Buyers Guide, and is available from your local Holophane sales representative.

experience lighting's best.

Visit our web site at www.holophane.com

Printed in USA

Luminaire Type QQ1 – Lamp Information

Return to: Open/Enclosed Fixtures | Print Page

Product Number:	64403
Order Abbreviation:	MPD150/U/MED/840
General Description:	150W, 4000K, high CRI, reduced color shift, high performance, open fixture rated metal halide lamp, clear, universal burn

Product Information	
Abbrev. With Packaging Info.	MPD150UMED840 20/CS 1/SKU
ANSI Code	M102/O
Approx. Lumens (initial - horizontal)	12500
Approx. Lumens (initial - vertical)	12500
Approx. Lumens (mean - horizontal)	11000
Approx. Lumens (mean - vertical)	11000
Arc Length (in)	0.62
Arc Length (mm)	15.7
Average Rated Life - Horizontal (hr)	6000
Average Rated Life - (hr)	6000
Average Rated Life - Vertical (hr)	7500
Base	E26 Medium
Bulb	E17
Color Rendering Index (CRI)	88
Color Temperature/CCT (K)	4200
Diameter (in)	2.125
Diameter (mm)	54
Family Brand Name	Designer Series Metalarc® Pro-Tech
Fixture Requirement	O
Hot Restrike Time (min)	5-7
Lamp Finish	Clear
Light Center Length - LCL (in)	3.39
Light Center Length - LCL (mm)	86
Maximum Base Temperature - Fahrenheit	410
Maximum Base Temperature - Celsius	210
Maximum Bulb Temperature - Fahrenheit	752
Maximum Bulb Temperature - Celsius	400
Maximum Overall Length - MOL (in)	5.43
Maximum Overall Length - MOL (mm)	138
Nominal Voltage (V)	90.00
Nominal Wattage (W)	150.00

Luminaire Type QQ1 – Ballast Information

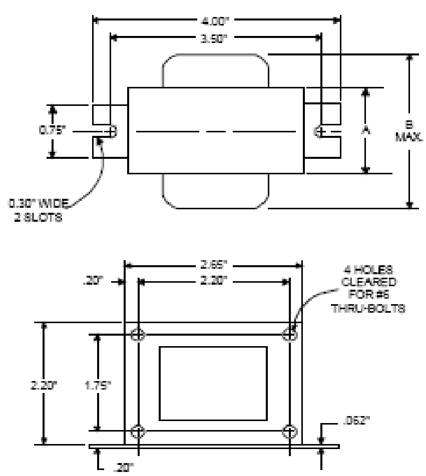
ADVANCE

Metal Halide Lamp Ballast

Catalog Number 71A5437P
For 150W M102
60 Hz R-HPF
Status: Active

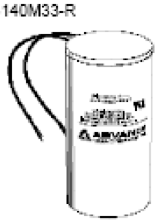
DIMENSIONS AND DATA

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		0.63				
Open Circuit		1.50				
Starting		0.70				
UL TEMPERATURE RATINGS						
Insulation Class	H(180°C)					
Coil Temperature Code	1029	B				
MIN. AMBIENT STARTING TEMP.	-20°F or -30°C					
NOM. OPEN CIRCUIT VOLTAGE	277					
INPUT VOLTAGE AT LAMP DROPOUT		170				
INPUT WATTS	173					
RECOMMENDED FUSE (Amps)		4				
CORE and COIL						
Dimension (A)	2.50					
Dimension (B)	3.80					
Weight (lbs.)	4					
Lead Lengths	12"					
CAPACITOR REQUIREMENT						
Microfarads	14.0					
Volts (min.)	280					
Fault Current Withstand (amps)						
60 Hz TEST PROCEDURES (Refer to Advance Test Procedure for HID Ballasts - Form 1270)						
High Potential Test (Volts)						
1 minute	2000					
2 seconds	2500					
Open Circuit Voltage Test (Volts)	250-305					
Short-Circuit Current Test (Amps)						
Secondary Current	2.00-2.50					
Input Current		0.50 0.75	-	-	-	-

Capacitor: 7C140M33-R



Capacitance: 14
Dia/Oval Dim: 1.5
Height: 2.9
Temp Rating: 105°C

Wiring Diagram:

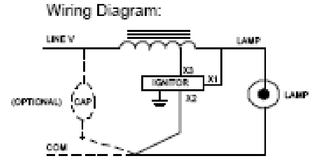
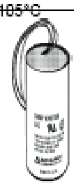


Fig. G

Ignitor: LI533-H4



Ballast to Lamp Distance (BTL) = 2 feet
Temp Rating: 105°C

Typical Ordering Information
(please call Advance for suffix availability)

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

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

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

09/20/00

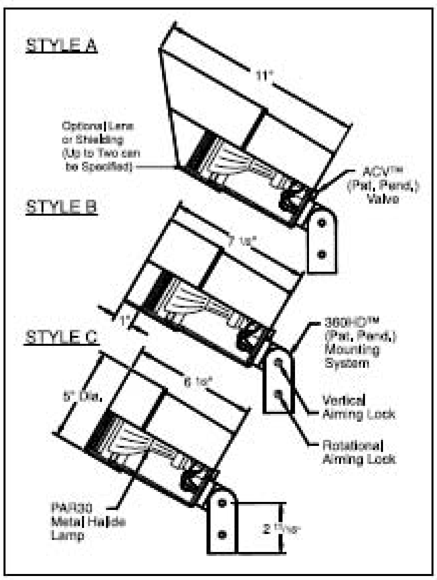
Luminaire Type QQ2– Luminaire Cutsheet

Sierra Series™

The **Sierra Series™** is designed for use with the PAR30 Master Color™ and other PAR30 metal halide lamps in wattages of 35W and 70W. The all aluminum construction and rich polyester powder coat finish will provide years of performance for this very popular lamp. The lighting designer has seven different ballast options to choose from, which facilitate a wide variety of practical applications. The Sierra Series incorporates the ACV™ (Pat. Pend.) Valve System for increased protection against internal condensation corrosion. It also incorporates the 360HD™ (Pat. Pend.) Mounting System with B-K Lighting's exclusive 'aim-and-lock technology'.

Features

- Tamper proof design.
- Completely sealed optical compartment.
- Clear, tempered glass lens, factory sealed.
- Machined aluminum construction with stainless steel hardware.
- ACV™ (Pat. Pend.) Valve System. See page 33.
- 360HD™ (Pat. Pend.) Mounting System allows vertical to horizontal and rotational aiming with positive 'aim-and-lock technology', provides integral wireway. See page 33.
- Medium base pulse rated lamp holder with 250° C, 18 ga., wire leads.
- & Listed with 35W and 70W PAR30 metal halide lamps.
- For use with 35W or 70W, 120V or 277V metal halide ballast.



CATALOG NUMBER LOGIC

Example: SE - 63 - BLW - 10 - 11 - C - PC70-120

Series

Lamp Type
0 - By others
60 - 35 PAR30/MH/SP(35W), 10° Spot
61 - 35 PAR30/MH/FL(35W), 30° Flood
62 - 70 PAR30/MH/SP(70W), 10° Spot
63 - 70 PAR30/MH/FL(70W), 40° Flood

Finish

Powder Coat Color	Satin	Wrinkle
Bronze	BZP	BZW
Black	BLP	BLW
White(Gloss)	WHP	WHW
Aluminum	SAP	—
Verde	—	VER

Lens Type
9 - Clear (Standard), 10 - Spread, 13 - Rectilinear

Shielding
11 - Honeycomb Baffle

Cap Style
A - 45°, B - 90°, C - Flush

Ballast Style and Input Voltage
HP35-120 or 277 - Recessed in grade (35W)*
HP70-120 or 277 - Recessed in grade (70W)*
HPRM35-120 or 277 - Recessed in grade (35W)*
HPRM70-120 or 277 - Recessed in grade (70W)*
PPII-120 or 277 - Power Pipe II™ above grade (35W only)
PC35-120 or 277 - Power Canopy™, wall or ceiling mount (35W)
PC70-120 or 227 - Power Canopy™, wall or ceiling mount (70W)
RM35-120 or 277 - Remote wall mounted housing (35W)
RM70-120 or 277 - Remote wall mounted housing (70W)
TSB35-120 or 277-LENGTH - Tree strap mounted electronic ballast (35W)
TSB70-120 or 277-LENGTH - Tree strap mounted electronic ballast (70W)
TMB35-120 or 277 - Pole top or tenon mount electronic ballast (35W)
TMB70-120 or 277 - Pole top or tenon mount electronic ballast (70W)

*HP bottom conduit entry standard. For side conduit entry, specify 'SE'. For concrete pour collar option specify 'CPC'.

For ballast information, see page 25.

B-K LIGHTING

24

Luminaire Type QQ2 – Lamp Information

GE Lighting

WORLDWIDE PARTNER

Commercial Products & Solutions

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Products > High Intensity Discharge > Ceramic Metal Halide > PAR > PAR30L > 45066

45066 – CMH39/PAR30LSP10

GE ConstantColor® PulseArc® CMH® Ceramic Metal Halide PAR30L

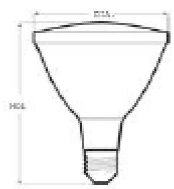
PRINT

GENERAL CHARACTERISTICS	
Lamp type	High Intensity Discharge - Ceramic Metal Halide
Bulb	PAR30L
Base	Medium Screw (E26)
Wattage	39
Rated Life	10000 hrs
Bulb Material	Hard glass
Lamp Enclosure Type (LET)	Open or enclosed fixtures
Additional Info	Ballast thermal protection, UV control

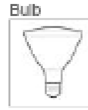
PHOTOMETRIC CHARACTERISTICS	
Initial Lumens	2400
Nominal Initial Lumens per Watt	61
Beam Spread	10 °
Center Beam Candlepower (CBCP)	39600
Color Temperature	3000 K
Color Rendering Index (CRI)	81

ELECTRICAL CHARACTERISTICS	
Burn Position	Universal burning position
Open Circuit Voltage (peak lead ballast) (MIN)	280 V
Open Circuit Voltage (RMS lag ballast) (MIN)	198 V
Warm Up Time to 90%	2 min
Warm Up Time to 90% (MAX)	2 min/3 min
Hot Restart Time to 90% (MIN)	10 min
Hot Restart Time to 90% (MAX)	15 min

DIMENSIONS	
Maximum Overall Length (MOL)	4.7500 in (120.6 mm)
Nominal Length	4.600 in (116.8 mm)
Bulb Diameter (DIA)	3.813 in (96.8 mm)



Bulb



Base

View Larger

ADDITIONAL RESOURCES

Catalogs
Testimonials
Brochures
- Product Brochures
  - Ceramic Metal Halide
  - Color
  - HID Lamps
- Application/Segment Brochures
  - Contractor Lighting

Sell Sheets
- GE ConstantColor® CMH® Lamps

IES/Photometric Download
MSDS (Material Safety Data Sheets)
Disposal Policies & Recycling Information

Luminaire Type QQ2 – Ballast Information

ADVANCE

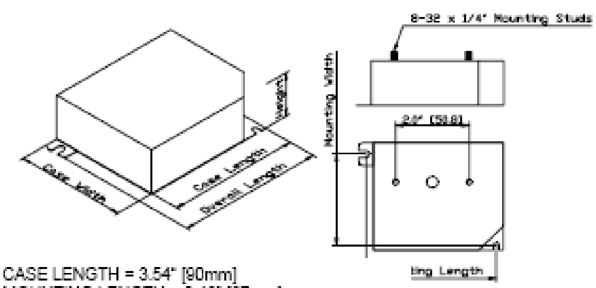
e-Vision® Electronic Ballast for Metal Halide Lamps

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

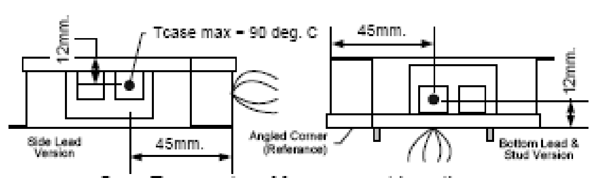
DIMENSIONS AND DATA

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

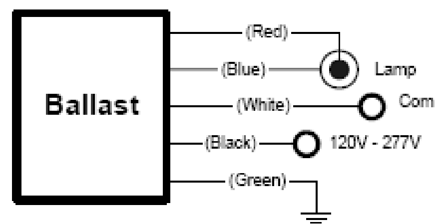
Figure G



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



Case Temperature Measurement Location



Ballast Case must be Grounded

Wiring Diagram 3

INSTALLATION & APPLICATION NOTES:

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

*Ordering Information

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

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

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

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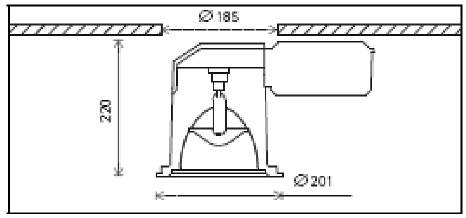
Revised 1/16/06

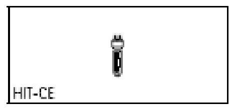
Luminaire Type QQ3– Luminaire Cutsheet

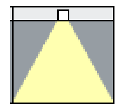
ERCO

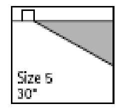
Lightcast Downlight

for metal halide lamps

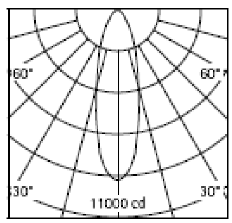








IP65



HIT-CE 70W G12 6600lm

h(m)	E(lx)	D(m) 29°
1	9043	0.52
2	2261	1.03
3	1005	1.55
4	565	2.07
5	362	2.59

81030.000 Reflector silver
HIT-CE 70W G12 6600lm

Product description
Housing: cast aluminium, silver powder-coated. Mounting with 3-point support and screw fixing, for ceiling thicknesses of 1-30mm. Side-mounted control gear: cast aluminium, powder-coated black. 2 cable entries. Through-wiring possible. 5-pole terminal block. Control gear with temperature controller, timer-ignitor, capacitor. Darklight reflector: aluminium, bright anodised. Cut-off angle 30°. Diffuser as lamp cover: glass, frosted.
Screw-fastened cover ring with safety glass: corrosion-resistant, cast aluminium, No-rinse surface treatment. Silver double powder-coated. To be removed together with Darklight reflector for lamp replacement.
Protection mode IP65: dust-proof and water-jet proof.
Weight 4.20kg

ERCO Leuchten GmbH
Postfach 2460
58505 Lüdenscheid
Germany
Tel.: +49 2351 551 0
Fax: +49 2351 551 300
info@erco.com

Technical Region: 230V/50Hz
We reserve the right to make technical and design changes.
Edition: 13.11.2007
Please download the current version from
www.erco.com/81030.000

1/2

Luminaire Type QQ3 – Lamp Information

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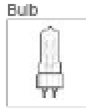
Products > High Intensity Discharge > Ceramic Metal Halide > Single-Ended > T6 > 20016

20016 – CMH70TU/830/G12

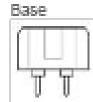
GE ConstantColor® PulseArc® CMH® Ceramic Metal Halide T6

PRINT

Bulb



Base



View Larger

GENERAL CHARACTERISTICS

Lamp type	High Intensity Discharge - Ceramic Metal Halide
Bulb	T6
Base	Bi-Pin (G12)
Wattage	70
Rated Life	15000 hrs
Bulb Material	Quartz
Lamp Enclosure Type (LET)	Enclosed fixtures only
Additional Info	UV control

PHOTOMETRIC CHARACTERISTICS

Initial Lumens	6200
Mean Lumens	4700
Nominal Initial Lumens per Watt	88
Color Temperature	3000 K
Color Rendering Index (CRI)	83

ELECTRICAL CHARACTERISTICS

Burn Position	Universal burning position
Warm Up Time to 90% (MAX)	2 min/3 min
Hot Restart Time to 90% (MIN)	10 min
Hot Restart Time to 90% (MAX)	15 min

DIMENSIONS

Maximum Overall Length (MOL)	3.5600 in (90.4 mm)
Light Center Length (LCL)	2.180 in (55.3 mm)

PRODUCT INFORMATION

Product Code	20016
Description	CMH70TU/830/G12
ANSI Code	C139/M139
Standard Package	Case
Standard Package GTIN	10043168200162
Standard Package	12

ADDITIONAL RESOURCES

Catalogs
Testimonials
Brochures
- Product Brochures
  - Ceramic Metal Halide
- Application/Segment Brochures
  - Contractor Lighting

MSDS (Material Safety Data Sheets)
Disposal Policies & Recycling Information

Luminaire Type QQ3 – Ballast Information

ADVANCE

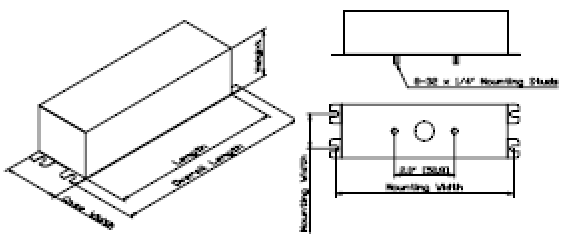
e-Vision® Electronic Ballast for Metal Halide Lamps

Catalog Number IMH-70-J
For 70W Metal Halide Lamps
ANSI M98, M143 or M139
120-277V 50/60Hz Electronic
Status: Preliminary

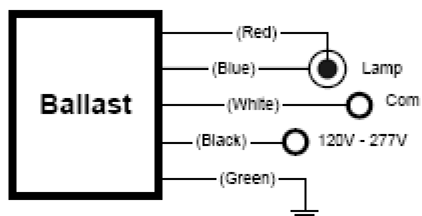
DIMENSIONS AND DATA

Lamp Data Number	Lamp Data Watts	Input Volts	Catalog Number*	Line Current (Amps)	Input Power (W)	Ballast Factor	Max THD (%)	Min Power Factor	Wiring Dia	Figure	Weight (lb)	Max Distance to Lamp (ft)
70W Watt Lamp, ANSI Code M M98, M143 or M139 Minimum Starting Temp -30°C/-20°F												
1	70	120	IMH-70-J-xxx	0.67	80	1.0	15%	0.90	3	J	0.9	5
		277		0.30	79							

Figure J

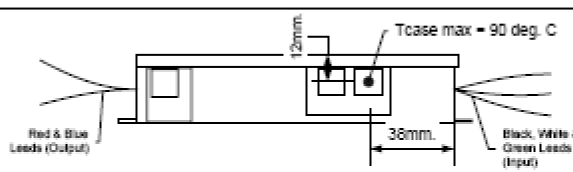


CASE LENGTH = 5.51" [140mm]
MOUNTING LENGTH = 5.71" [145mm]
MOUNTING WIDTH = 1.08" [27mm]
OVERALL LENGTH = 5.87" [149mm]
CASE WIDTH = 1.81" [46mm]
HEIGHT = 1.18" [30mm]



Ballast Case must be Grounded

Wiring Diagram 3



Case Temperature Measurement Location

INSTALLATION & APPLICATION NOTES:

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

*Ordering Information

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

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

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Revised 1/16/06

Luminaire Types QQ4a and QQ4b– Luminaire Cutsheet

line™ 2.0
ASYMMETRIC

io

Application
Io Lighting's **line series 2.0** is a low voltage linear floodlight luminaire that utilizes high brightness LEDs. **series 2.0** may be specified for interior or exterior applications and may be ordered in nominal lengths of 18", 36", 54", and 72". The precise asymmetric beam spread along the perpendicular axis of the fixture is excellent for wall washing, sign lighting or pathway applications. **series 2.0**'s patented optical assembly is designed to practically eliminate stray light, making it perfect for applications where light pollution and/or light trespass are important design considerations.

series 2.0's low profile housing enables the luminaire to be integrated within "tight" architectural details while delivering high intensity illumination.

LEDs are similar to halogen light sources in that they are point sources that can reveal superior definition to three-dimensional objects and sparkle to reflective surfaces.

Io ensures that each LED is driven with the proper current and voltage which enables the average rated life to be 50,000 hours at 70% of lamp lumen output. To ensure proper performance, architectural details should allow for ventilation and air flow around the fixture. Ambient temperature surrounding the fixture shall not exceed 120° F.

Light Output
Asymmetric series 2.0's patented optical assembly offers a fixture efficiency in excess of 83%. Refer to light output tables for footcandle values at various distances. Two luminous intensities are available for white light. IES format files may be obtained from the factory or downloaded from www.iolighting.com.

Standard Output	High Output
3000K White: 213 lms/ft	3000K White: 320 lms/ft
5000K White: 300 lms/ft	5000K White: 450 lms/ft

Construction
Heavy-duty aluminum housing provides recommended heat sink requirements for LEDs. Precision optics are composed of a customized acrylic material offering excellent light transmission and UV stability. High strength adhesive bonds the housing and patented optical assembly. **series 2.0** is UL Listed for wet locations.

Mounting Options
series 2.0 may be surface mounted, side surface mounted or surface mounted with field adjustability and lockable aiming. **series 2.0** may not be mounted vertically in exterior applications.

Electrical
All fixtures are pre-wired and pre-assembled for easy installation. 6'-0", 14 AWG electrical feed is side mounted to enable continuous row mounting. Universal 120v - 277v supply required for remote driver. Driver enclosures for interior or exterior applications may be provided by **io.** 100W advance drivers may be remotely located up to 46'-0" (w/14 AWG), 71'-0" (w/12 AWG) and 120'-0" (w/10 AWG).

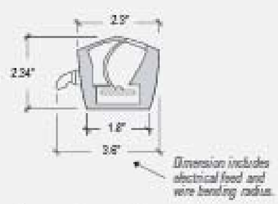
Power supply and dimming module must be specified separately. For detailed information, see the **LED Linear** brochure or download the Power Supply specification sheet from **www.iolighting.com.**

Power Consumption
Standard Output: 12 w/ft **High Output: 17.9 w/ft**

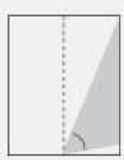
Power consumption does not include power supply losses. Consult io driver specification sheets for losses associated with each driver option.

Finish
Anodized aluminum finish is standard. Custom finishes may be available upon request.

Dimensions



Beam Spread



Asymmetric

Lengths

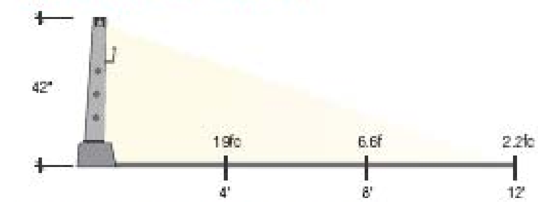
Io Lighting
370 Corporate Woods Pkwy Vernon Hills, IL 60061-3107
T 847.735.7000 F 847.735.7001 E info@iolighting.com W iolighting.com

line™ 2.0

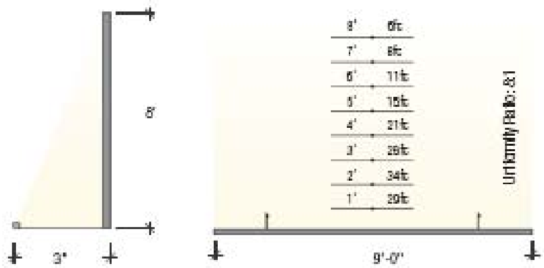
ASYMMETRIC

Applications / Light Output

BRIDGE / PATHWAY LIGHTING (3000K H.O. WHITE)



SIGN LIGHTING / BUILDING FLOOD LIGHTING (3000K WHITE)



LIGHT OUTPUT CONVERSION TABLE

White Light Output	3000K S.O.	5000K S.O.	3000K H.O.	5000K H.O.
Light Output Multiplier	0.67[1]	0.94[1]	1.0[1]	1.4[1]

Color Light Output	RED	GREEN	BLUE
Light Output Multiplier	.83[1]	1.08[1]	0.4[1]

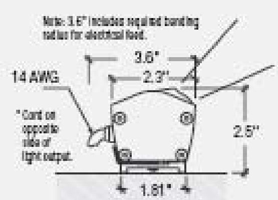
IES format photometrics may be downloaded from www.iolighting.com

line series 2.0 is UL Listed for wet locations. It is not rated for submersible applications. line 2.0 should not be mounted in conditions where there is any standing water whatsoever.

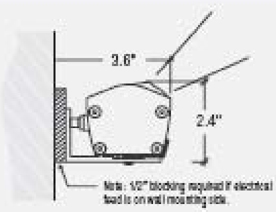
series 2.0's patented optical assembly is designed to practically eliminate stray light, making it perfect for applications where light pollution and/or light trespass are important design considerations.

Note: Electrical feed is located on opposing side of lens.

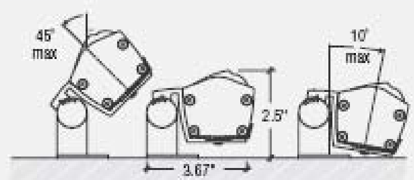
Mounting Options



100 Surface (io part #: LA.BK.SURFMT)



101 Side surface (io part #: LA.BK.WALLMT)



102 Field adjustable with lockable aiming (io part #: LA.BK.ADJMT)

Order Code

0				90					
io	1	2	3	4	5	6	7	8	9

1. LIGHT OUTPUT
- 04 2.0 S.O. (Standard Output)
- 05 2.0 H.O. (High Output)

2. LOCATION
- I Interior
- E Exterior

3. COLOR
- 3K White 3000K [2]
- 5K White 5000K [2]
- R Red [1]
- G Green [1]
- B Blue [1]

4. DISTRIBUTION
- 90 Asymmetric

5. MOUNTING
- 100 Surface
- 101 Side surface
- 102 Field adjustable

6. FINISH
- 1 Anodized Aluminum
- 2 Anodized Custom Color

7. LENGTH

UNITS
- 18 18" (17.71" actual)
- 36 36" (34.71" actual)
- 54 54" (51.71" actual)
- 72 72" (68.71" actual)

FOR CONTINUOUS ROW
Specify length (i.e., 96'-0")
Note: Overall length must be divisible by 18"

8. VOLTAGE / DIMMING

SIDE FEED STANDARD
- 1 120v
- 2 277v
- 3 120v w/dim
- 4 277v w/dim
- 5 Other

9. SPECIFY DRIVER / DIMMING

Note: Reference io power supply specification sheet for driver and dimming options. If left blank, io will supply 100 watt drivers.

Footnotes

Footnotes
1. Refer to conversion table for output. Available in Standard Output only (1.2w/ft)
2. White light variance between LED's within a single fixture will not exceed +/- 200k

Luminaire Types QQ4a and QQ4b – Driver Information

ADVANCE

XITANIUM
LED Drivers

Universal Outdoor Drivers for 12V and 24V LED systems

Applications

Orientation/Step Lighting
Architectural Lighting
Channel Letters
Contour Lighting
Edge Lighting

LEDs have evolved into a practical, flexible light source for a wide variety of illumination applications. Common LED products available in the market today are configured in a series-parallel array – designed to be powered by a suitable 24vdc driver – which allows flexibility to connect variable load levels. These operating voltages have become the standard in the industry.

The Brain Behind the Bright Idea

Xitanium LED drivers from Advance are designed specifically for 24V LED systems and incorporate features that enable broad commercialization of end-use solid-state lighting products.

Features	Benefits
UL Class 2	Limited output voltage and current plus isolation for safe operation
UL Outdoor Damp location rated - IP 66	Fully potted for moisture resistance and thermal benefits
Ultra small, compact size	Facilitates new, low-profile fixture design
Extreme low temperature Performance (-40°C)	Allows use in any outdoor application
Generous high temperature capability (+60°C)	Margin flexibility to facilitate fixture design
Tightly regulated output (1% line, 5% load)	Consistent light output across line and load levels
5 year warranty	Peace of mind for your new products and for end users…from the industry's most trusted component maker
Powered by Advance	Advance is preferred by end users – Enhance the value of your product

Quick Selection Table

Catalog Number	Description	Application
LEDINTA0024V41FO	Intellivolt 100 Watt 24Vdc Outdoor	• 24Vdc LED Systems

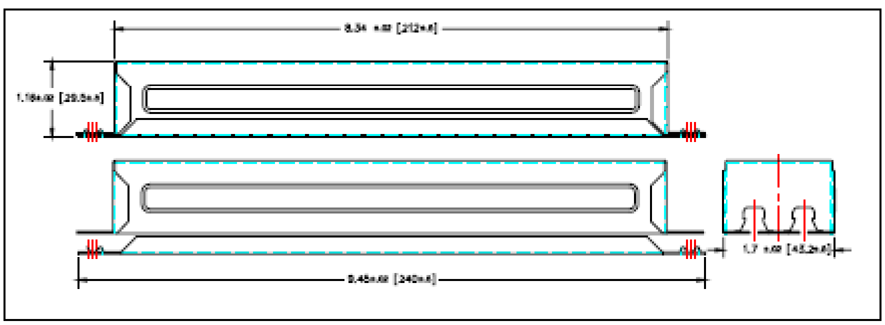
LED Driver Specifications

		Input			Output			Case		
Description	Catalog Number	Volts (V)	Power Max (W)	Current Max (A)	Power Max (W)	Voltage Nom (V)	Current Max (A)	Temp Max (°C)	Figure	Weight (Grams)
100 Watt	LEDINTA0024V41FO	120	117.0	0.98	100.0	24.0	4.1	90	A	640
		230		0.51						
		277		.042						

Total Harmonic Distortion: 20% max
Power Factor: 90% min
Line Regulation: 1% output variation across input voltage range
Load Regulation: 5% output variation across input voltage range
Current Crest Factor: 1.5 max
Environmental Protection: IP66 outdoor rated
EMI: FCC47 SubPart15, CISPR15 and CISPR22 Class A
Protection: Meet UL1310 for Class 2; Inherent short-circuit protection, self-limited; overload protected; 3.2KV output insulation
AC Input and DC Output: 2 (0.78mm²) Solid Copper Wires, 15cm long

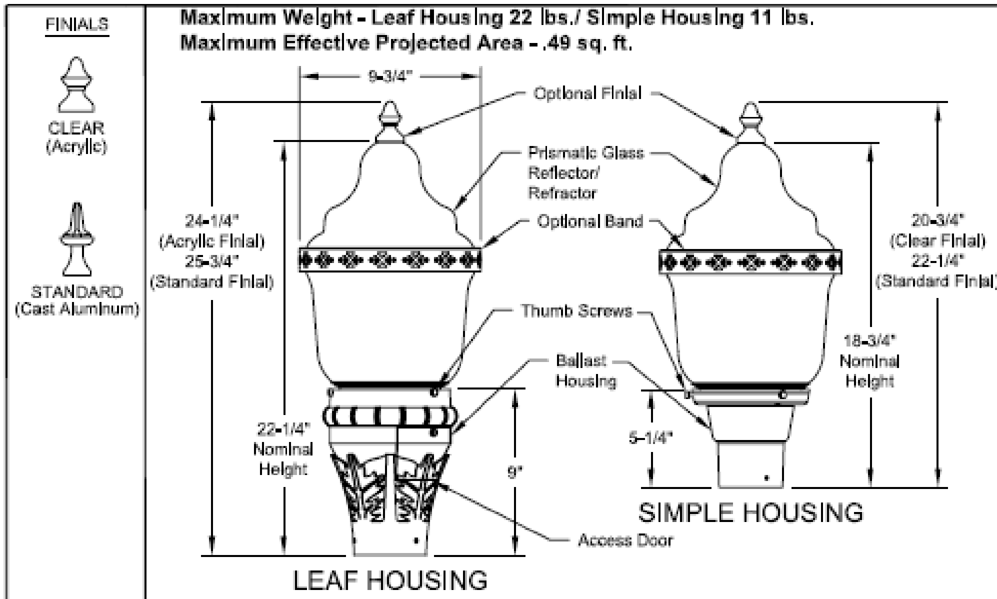
Dimensions

Fig. A



Advance, A Division of Philips Electronics North America · 10275 W Higgins Road · Rosemont, IL 60018 · USA
Tel: + 1 847 390-5205 · Fax: + 1 847 390-5264 · Revised 09/05PJJ

Luminaire Type QQ5– Luminaire Cutsheet



Granville® Mini

Architectural Outdoor

HOLOPHANE® LEADER IN LIGHTING SOLUTIONS An Acuity Brands Company

ORDERING INFORMATION:

MGV

MGV 70DMH 12 L A 3 1 A

LUMINAIRE
MGV = Granville Mini

Source and Wattage
42CFL = 42W CFL
35DHP = 35W HPS
50DHP = 50W HPS
70DHP = 70W HPS
20EMH = 20W Electronic MH
39EMH = 39W Electronic MH
50DMH = 50W MH
70DMH = 70W MH
20DIN = 200W INCANDESCENT
055QL = 55W QL

Voltage
12 = 120 VOLT
20 = 208 VOLT
24 = 240 VOLT
27 = 277 VOLT
34 = 347 VOLT
MT = Multitap

Housing
S = SIMPLE
L = LEAF

Housing Color
A = As Specified
B = Black
N = Green
W = White
Z = Bronze

Optics
3 = Asymmetric
5 = Symmetric

Band & Finial
N = No Finial, No Decorative Band
1 = Clear Acrylic Finial, No Decorative Band
2 = Standard Finial, No Decorative Band
3 = Clear Acrylic Finial, Decorative Band
4 = Standard Finial, Decorative Band
5 = No Finial, Decorative Band

Cast Finial and Band Color
A = As Specified
B = Black
G = Gold
N = Green
R = Red
S = Silver
W = White
Z = Bronze
U = No Band with Clear Finial or No Band, No Finial

ORDER #:
TYPE:
DRAWN: BRL
DATE: 01/21/08
DWG #: MA-5349
1 of 2

Luminaire Type QQ5– Lamp Information

GE Lighting

WORLDWIDE PARTNER

Commercial Products & Solutions

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Where to Buy | FAQs | Contact Us | EliteNet

Products > High Intensity Discharge > Ceramic Metal Halide > PAR > PAR30L > 45066

45066 – CMH39/PAR30LSP10

GE ConstantColor® PulseArc® CMH® Ceramic Metal Halide PAR30L

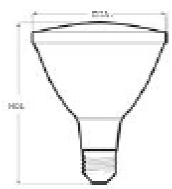
PRINT

GENERAL CHARACTERISTICS	
Lamp type	High Intensity Discharge - Ceramic Metal Halide
Bulb	PAR30L
Base	Medium Screw (E26)
Wattage	39
Rated Life	10000 hrs
Bulb Material	Hard glass
Lamp Enclosure Type (LET)	Open or enclosed fixtures
Additional Info	Ballast thermal protection, UV control

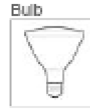
PHOTOMETRIC CHARACTERISTICS	
Initial Lumens	2400
Nominal Initial Lumens per Watt	61
Beam Spread	10 °
Center Beam Candlepower (CBCP)	39600
Color Temperature	3000 K
Color Rendering Index (CRI)	81

ELECTRICAL CHARACTERISTICS	
Burn Position	Universal burning position
Open Circuit Voltage (peak lead ballast) (MIN)	280 V
Open Circuit Voltage (RMS lag ballast) (MIN)	198 V
Warm Up Time to 90%	2 min
Warm Up Time to 90% (MAX)	2 min/3 min
Hot Restart Time to 90% (MIN)	10 min
Hot Restart Time to 90% (MAX)	15 min

DIMENSIONS	
Maximum Overall Length (MOL)	4.7500 in (120.6 mm)
Nominal Length	4.600 in (116.8 mm)
Bulb Diameter (DIA)	3.813 in (96.8 mm)



Bulb



Base

View Larger

ADDITIONAL RESOURCES

Catalogs

Testimonials

Brochures

Product Brochures

- Ceramic Metal Halide
- Color
- HID Lamps

Application/Segment Brochures

- Contractor Lighting

Sell Sheets

- GE ConstantColor® CMH® Lamps

IES/Photometric Download

MSDS (Material Safety Data Sheets)

Disposal Policies & Recycling Information

Luminaire Type QQ5 – Ballast Information

ADVANCE

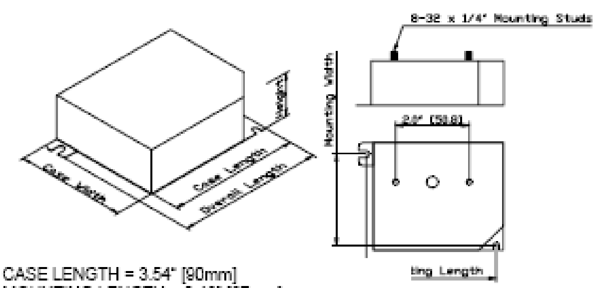
e-Vision® Electronic Ballast for Metal Halide Lamps

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

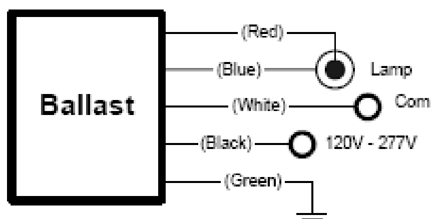
DIMENSIONS AND DATA

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

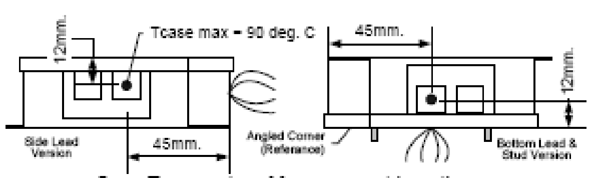
Figure G



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



Wiring Diagram 3



Case Temperature Measurement Location

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

*Ordering Information

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

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

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

A DIVISION OF PHILIPS ELECTRONICS NORTH AMERICA CORPORATION

Revised 1/16/06

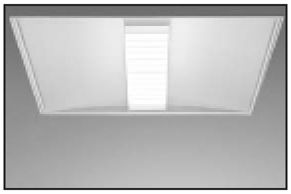
Luminaire Type RR1– Luminaire Cutsheet

SYNTO T5

Fluorescent
One or Two Lamp Twin Tube (T5TT)
Two Lamp T5 HO

Recessed **2' x 2'**

online Find It Fast 243



Applications: The SYNTO family of fixtures combines indirect illumination with a direct component controlled with a T5 louver to minimize brightness. The Zumtobel exclusive light chamber provides soft and diffused general illumination; the louver has been specifically developed to minimize glare when using T5 lamps. This solution is best for open offices, retail spaces and institutions.

Meets RP-1-04 guidelines for normal VDT-use environments (2245 C/W, 1405 C/W, 2405 C, 1505 C)

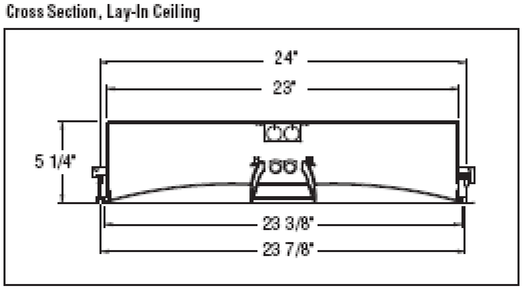
Type: ____________________

Project: ____________________

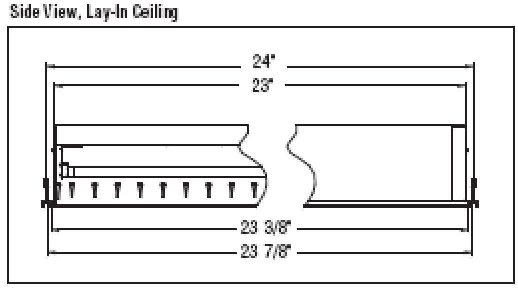
ORDERING NOTE: Specify fixture/ceiling type, lamping, louver, voltage/ballast and options.

▼ Fixture/Ceiling Type	▼ Length	▼ Lamping	▼ Louver	▼ Voltage/Ballast	▼ Options
SY5__	22	______	______	______	______
SY5U SYNTO T5 Recessed 15/16" Lay-In, Flush 9/16" Slot-Grid, Flush 9/16" Lay-In, Tegular SY5F SYNTO T5 Recessed 9/16" Lay-In, Flush SY5E SYNTO T5 Recessed Concealed *For flange details, see next page*	22 2' x 2'	1405 (1) 40W T5TT 1505 (1) 50W T5TT 2405 (2) 40W T5TT 2245 (2) 24W T5 HO	C Matte W White CO Matte with Frosted Inlay WO White with Frosted Inlay	U Universal 120/277V 347 347V (may not be available with EM, dimming) DA_* Dimming, Analog (0-10V) DD_* Dimming, DALI DE_* Dimming, Lutron ECO-10 DH_* Dimming, Lutron Hi-Lume * *Specify "1" for 120V or "2" for 277V. Some lamp types may not be available.*	WF Whip Flex 3/8" x 6' 14 AWG WN_* Whip Flex 3/8" x 6' 14 AWG (NYC) EM1_* Stand-by Battery Pack/1 lamp SS Separate Switching (2-lamp fixtures only) AR Air Return CP Chicago Plenum F Fusing

Cross Section, Lay-In Ceiling



Side View, Lay-In Ceiling



c UL us LISTED
Suitable for damp locations

IBEW Union Made

1. Housing - 20 gauge cold-rolled steel. Finish is powder-coated white. Right-angle access plate (two per fixture) allows feed from top or side of unit.

2. Light Chamber - Powder-coated high-reflectance white interior reflector and shaped extruded acrylic diffusers.

3. Louver - The 16-cell louver has blades 7/8" high by 1 7/16" o.c. Available with white or matte finish. Louver hinges for ease of maintenance. Optional opal inlay is white acrylic.

4. Lamps/Sockets - One or two 40W or one 50W compact fluorescent lamps, with 2G11 four-pin lamp sockets. Two 24W T5 HO fluorescent lamps with miniature bi-pin sockets. Lamps supplied by others.

5. Ballast - Universal voltage electronic 120/277V ballast. Consult factory for 347V. Ballasts are mounted in luminaire. Accessible from below.

6. Mounting - Integral bend-out tabs are provided in the universal (SY5U and SY5F) ceiling fixture types. Adjustable mounting brackets provided for selected concealed tee or gypsum board (SY5E) ceiling installations.

7. Stand-by Battery Pack - Integral stand-by battery pack with integral test switch. Will operate one lamp with an initial output of up to 450 lumens (24W T5 HO or 40W T5 TT), 625 lumens (50W T5 TT) for 90 minutes.

8. Dimming - Consult factory for specific dimming requirements other than those listed above.

9. Weight - 21.0 lbs.

In a continuing effort to offer the best product possible we reserve the right to change, without notice, specifications or materials that in our opinion will not alter the function of the product. Technical specification sheets that appear on www.zumtobel.us are the most recent version and supersede all other versions that exist in any other printed or electronic form.

Zumtobel Lighting Inc. ©2007
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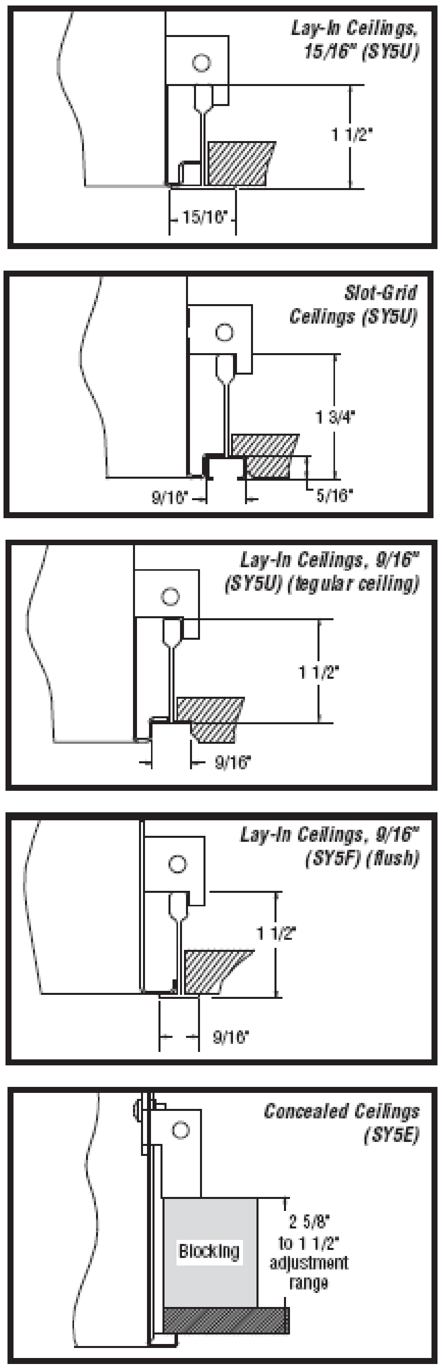
6/15/07

SY5-1

ZUMTOBEL

Mounting with common ceiling types



Photometric Data

SY5 22 1505 W (1) 50W T5TT

2x2 RECESSED, WHITE LOUVER

PRORATED FROM LTL 09164

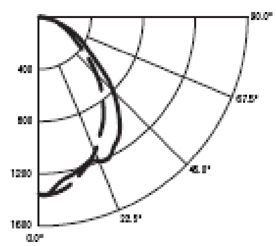
Total Luminaire Efficiency 73%

0% Uplight 100% Downlight

Spacing Criteria Lateral Plane	0°	90°
	1.1	1.3

TOTAL LAMP LUMENS = 4000
INPUT WATTS = 60

Candela Distribution



Vertical Angle	Horizontal Angle 0°	45°	90°	Zonal Lumens
0°	1358	1358	1358	
5°	1355	1345	1316	117.1
15°	1236	1192	1204	339.3
25°	1067	1050	1211	502.6
35°	858	946	1077	586.2
45°	622	719	804	544.1
55°	368	458	479	396.7
65°	231	253	297	256.9
75°	119	124	135	133.8
85°	31	25	24	30.5
90°	0	0	0	

Luminance Data in Candela / Sq. Meter

Angle In Vertical°	Average 0°	Average 45°	Average 90°
45°	2596	2999	3354
55°	1895	2358	2462
65°	1613	1764	2074
75°	1361	1418	1534
85°	1033	860	816

Coefficients of Utilization

Effective Floor Cavity Reflectance = 20%

pcc	0.8				0.7				0.5			0.3		
pw	0.7	0.5	0.3	0.1	0.7	0.5	0.3	0.1	0.5	0.3	0.1	0.5	0.3	0.1
0	87	87	87	87	85	85	85	85	81	81	81	78	78	78
1	81	77	75	72	79	76	73	71	73	71	69	70	68	67
2	74	69	64	60	72	67	63	60	65	61	58	62	59	57
3	68	61	56	51	66	60	55	51	58	53	50	56	52	49
4	63	55	49	44	61	54	48	44	52	47	43	50	46	43
5	58	49	43	39	56	48	43	38	47	42	38	45	41	38
6	54	45	38	34	52	44	38	34	43	37	34	41	37	33
7	50	41	35	30	49	40	34	30	39	34	30	38	33	30
8	47	37	31	27	46	37	31	27	36	31	27	35	30	27
9	44	34	29	25	43	34	28	25	33	28	25	32	28	24

Air Return

SYNTO Return Air Volume, CFM:
Negative Static Pressure, in. H20

Fixture Size	0.04	0.05	0.07	0.08	0.1
2 x 2	80	90	100	110	120
1 x 4	150	170	210	225	250
2 x 4	150	170	210	225	250

Test performed in accordance with ASHRAE-70-1991 by Intertek ETL SEMKO. Consult factory for full report.

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SY5-1A

ZUMTOBEL

Luminaire Type RR1– Lamp Information

GE Lighting

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Products > Compact Fluorescent > Plug-In > High Lumen Biax® > 16953

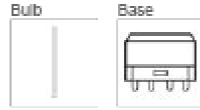
16953 – F4030BXSPX30 10P

GE Biax® T5 - Facilities; Retail Display; Hospitality; Office; Restaurant; Warehouse

PRINT

High Color Rendering
Energy Savings

Bulb Base



View Larger

GENERAL CHARACTERISTICS	
Lamp type	Compact Fluorescent - Plug-In
Bulb	T5
Base	4-Pin (2G11)
Wattage	40
Voltage	126
Rated Life	20000 hrs
Starting Temperature (MIN)	10 °C (50 °F)
Primary Application	Facilities; Retail Display; Hospitality; Office; Restaurant; Warehouse

PHOTOMETRIC CHARACTERISTICS	
Initial Lumens	3150
Mean Lumens	2840
Nominal Initial Lumens per Watt	78
Color Temperature	3000 K
Color Rendering Index (CRI)	82

ELECTRICAL CHARACTERISTICS	
Lamp Current	0.320 A
Current Crest Factor (MAX)	1.7

DIMENSIONS	
Maximum Overall Length (MOL)	22.5000 in (571.5 mm)
Nominal Length	22.500 in (571.5 mm)

PRODUCT INFORMATION	
Product Code	16953
Description	F4030BXSPX30 10P
ANSI Code	60901-IEC-6240-2
Standard Package	Master
Standard Package GTIN	10043168169537
Standard Package Quantity	40
Sales Unit	Unit

ADDITIONAL RESOURCES

Catalogs
Testimonials
Brochures
Application/Segment Brochures
- Restaurant Lighting
- Retail Lighting
- Office Lighting
- Healthcare Lighting
- Contractor Lighting

Product Brochures
- Industrial Lighting

Disposal Policies & Recycling Information

Luminaire Type RR1 – Ballast Information

GE Lighting

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Products > Ballasts > Compact Fluorescent > Plug-In > 80681

80681 – C240SI277RH-IP

GE CFL Electronic Standard Instant Start Ballast

PRINT

- Electronic compact fluorescent ballasts for all general fluorescent applications
- Low profile case

View Larger

GENERAL CHARACTERISTICS

Application	2- FT40W/2G11- IS 277
Category	Compact Fluorescent
Ballast Type	Electronic - Standard Instant Start
Starting Method	Instant start
Lamp Wiring	Series
Line Voltage Regulation (+/-)	10 %
Ambient Temperature (MAX)	105 °F (41 °C)
Case Temperature (MAX)	70 °C (158 °F)
Ballast Factor	Normal
Power Factor Correction	Passive
Sound Rating	A (20-24 decibels)
Enclosure Type	Metal
Additional Info	End of Life Protection (EOL), Thermally protected

ELECTRICAL CHARACTERISTICS

Supply Current Frequency	50 Hz/60 Hz

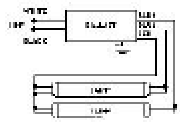
PRODUCT INFORMATION

Product Code	80681
Description	C240SI277RH-IP
Standard Package	Master
Standard Package GTIN	30043168806818
Standard Package Quantity	10
Sales Unit	Individual Pack
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	10
UPC	043168806817

DIMENSIONS

Case dimensions	
Length (L)	8.3 in (211.07 mm)
Width (W)	2.4 in (60.96 mm)
Height (H)	1.6 in (39.37 mm)
Mounting dimensions	
Bracket Length (BL)	9.5 in (241.30 mm)
Mount Length (M)	8.9 in (225.80 mm)
Mount Width (X or F)	1.7 in (42.87 mm)
Mount Slots (MS)	0.3 in (7.92 mm)
Weight	2.70 lbs
Exit Type	Side
Remote mounting distance to lamp	12 ft
Remote Mounting Wire Gauge	18 AWG

Lead lengths	Qty	Exit	Length (± 1 in.)
Blue	1	Right	33.0 in (838 mm)
White	1	Left	25.0 in (635 mm)
Red	1	Right	33.0 in (838 mm)
Black	1	Left	25.0 in (635 mm)



View Larger

SPECIFICATIONS BY LAMP & WATTAGE

Lamp	# of Lamps	Line Volts	System Watts	Nom. Line Current	System Ballast Factor	Ballast Efficacy Factor	Power Factor % (>=)	Crest Factor (<=)	THD% (<=)	Min. Starting Temp (°F/°C)	
FT40W/4P	1	277	40	0.17 A	1.02	2.55	90	1.7	20	50.0 / 10	System specs
	2	277	67	0.27 A	0.88	1.31	95	1.7	20	50.0 / 10	System specs

Safety & Performance

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

See list of cautions & warnings.

NOTES

- This product contains an End of Lamp Life Safety Shutdown circuit. When replacing a lamp, the power to the ballast must be re-cycled for 5 seconds to reset the shutdown circuit.

WARRANTY INFORMATION

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

Download full warranty

ADDITIONAL RESOURCES

Catalogs
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Application/Segment Brochures
- Healthcare Lighting
- Office Lighting
- Retail Lighting

Product Brochures
- Industrial Lighting

Disposal Policies & Recycling Information

Return To Top

Photos are representational only. Sizes, shapes and labels of ballast may vary.

Luminaire Type RR2– Luminaire Cutsheet

NEO-RAY™

DESCRIPTION

Series 81 can be used individually or in illuminated rows and patterns, each fixture is uniquely suited to achieve many functional and aesthetic spatial effects. Shielding locks in place without hardware. The trim is rigid "U" shaped, doubled formed with a 3/8" regress soft lit edge.

Catalog #		Type
Project		
Comments		Date
Prepared by		

SPECIFICATION FEATURES

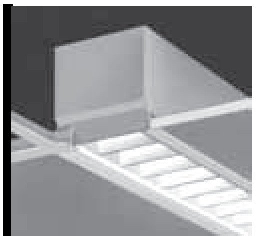
A ... Construction
20-gauge steel housing. Nominal 3' or 4' illuminated sections.

B ... Shielding
Acrylic diffuser or lens, parabolic or bold baffle shielding.

C ... Electrical
120, 277, 347 or Universal Voltage electronic ballast. Fixtures and electrical components certified to UL and CUL standards.

D ... Finish
Durable, low gloss, white, powder coated acrylic finish.

Mounting
Recessed. (ETG) Exposed T-Grid only.

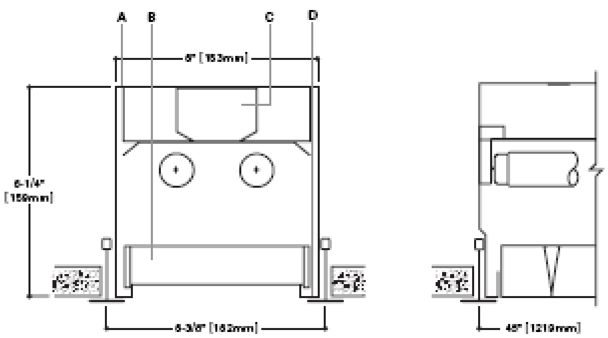


81

1 & 2T8
1 & 2T5
1 & 2T5HO

Recessed
Direct

Light Distribution
Indirect - 0.0%
Direct - 100.0%



4' Section Shown

ORDERING INFORMATION

Sample Number: S81R/2T8/ETG/1EB-DU

Series	Mounting	Number of Lamps	Lamp Type	Voltage [1]	Ballast	Switching Options	Fusing	Shielding Options
81= 81	R= Recessed	1= 1 Lamp	T8= T8	1= 120V	EB= Electronic Ballast	SS= Single Switching	GLR= GLR	S22= Acrylic Diffuser
		2= 2 Lamps	T5= T5	2= 277V	DB= Dimming Ballast	DU= Double Switching	GMF= GMF	S58= KSH-12 Acrylic Lens
			T5HO= T5HO	3= 347V		**Emergency**		S72= Bold Baffle
			Ceiling Type			EM= Emergency Pack		S79= Parabolic Baffle
			ETG= Exposed T-Grid					

Notes: 1 Not all options available. Please consult your Cooper Lighting Representative for availability.

COOPER Lighting
www.cooperlighting.com

Specifications and Dimensions subject to change without notice.
Consult your representative for additional options and finishes.

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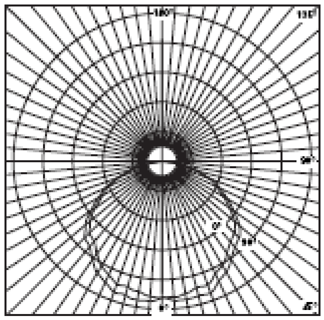
PHOTOMETRICS



Series 81
(2) F40T12RS/WW
3200 Lumens

Efficiency 38.4%

Test Report
#3010.0

Coefficients of Utilization

Effective floor cavity reflectance 20%										
rc	80%				50%			30%		
rw	70	50	30	10	50	30	10	50	30	10
RCR										
1	43	41	40	39	39	38	37	38	37	36
2	40	38	36	34	36	34	33	34	33	32
3	37	34	32	30	32	31	29	31	30	28
4	35	31	28	26	30	27	26	29	27	25
5	32	28	25	23	27	25	23	26	24	23
6	30	26	23	21	25	22	21	24	22	20
7	28	24	21	19	23	20	19	22	20	18
8	26	22	19	17	21	18	17	20	18	17
9	24	20	17	15	19	17	15	19	16	15
10	23	18	15	14	18	15	13	17	15	13

Zonal Lumen Summary

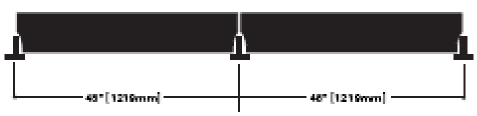
Zone	Lumens	%Lamp	%Fixture
0-30	1069	16.7	43.4
0-40	1580	24.7	64.2
0-60	1814	56.7	65.9
0-90	2460	38.4	100.0
90-180	0	0.0	0.0
0-180	2460	38.4	100.0

Total Luminaire Efficiency = 38.4%

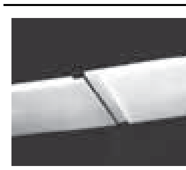
Candela

Angle	Along ‖	45°	Across ⊥
0	1596	1596	1596
5	1565	1596	1624
10	1445	1491	1526
15	1359	1395	1462
20	1239	1275	1373
25	1085	1099	1235
30	929	979	1156
35	721	792	966
40	551	652	766
45	351	471	566
50	270	355	446
55	228	263	363
60	179	195	340
65	140	152	261
70	92	102	162
75	63	71	95
80	37	43	51
85	14	22	21
90	0	0	0

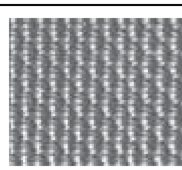
MOUNTING INFORMATION



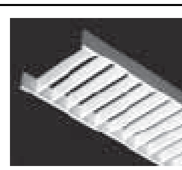
SHIELDING INFORMATION



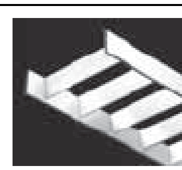
822 Acrylic Diffuser
3/16" thick, matte white finish, rabbeted joints, no light leaks.



858 Acrylic Lens
1/8" thick, clear acrylic prismatic lens.



872 Bold Baffle
1" high x 1.2"o.c., 3/16" thick aluminum baffle, continuous and unbroken, no visible joints.



879 Parabolic Baffle
1-1/4" high blade, 2.4" o.c., semi-specular low-brightness Pearlescent Aluminum baffle. Continuous and unbroken, no visible joints.

COOPER Lighting
www.cooperlighting.com

Specifications and Dimensions subject to change without notice.
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Luminaire Type RR2– Lamp Information

GE Lighting

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Products > Linear Fluorescent > Straight Linear > T8 > 26666

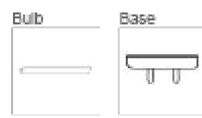
26666 – F32T8/SP30/ECO

GE Ecolux® Starcoat® T8

PRINT

• Passes TCLP, which can lower disposal costs.

High Color Rendering
Meets Federal Minimum Efficiency Standards



View Larger

GENERAL CHARACTERISTICS

Lamp type	Linear Fluorescent - Straight Linear
Bulb	T8
Base	Medium Bi-Pin (G13)
Wattage	32
Voltage	137
Rated Life	20000 hrs
Rated Life (instant start) @ Time	20000 h @ 3 h 24000 h @ 12 h
Rated Life (rapid start) @ Time	24000 h @ 12 h
Bulb Material	Soda lime
Starting Temperature (MIN)	10 °C (50 °F)
Additional Info	TCLP compliant

PHOTOMETRIC CHARACTERISTICS

Initial Lumens	2800
Mean Lumens	2660
Nominal Initial Lumens per Watt	87
Color Temperature	3000 K
Color Rendering Index (CRI)	78
S/P Ratio (Scotopic/Photopic Ratio)	1.3

ELECTRICAL CHARACTERISTICS

Open Circuit Voltage (rapid start) Min @ Temperature	315 V @ 10 °C
Cathode Resistance Ratio - Rh/Rc (MIN)	4.25
Cathode Resistance Ratio - Rh/Rc (MAX)	6.5
Current Crest Factor (MAX)	1.7

DIMENSIONS

Maximum Overall Length (MOL)	47.7800 in (1213.6 mm)
Minimum Overall Length	47.6700 in (1210.8 mm)
Nominal Length	48.000 in (1219.2 mm)
Bulb Diameter (DIA)	1.000 in (25.4 mm)

ADDITIONAL RESOURCES

Catalogs
Testimonials
Brochures
Product Brochures
- Color
- Ecolux
- Ecolux (Environmental)
- Industrial Lighting
- Linear Fluorescent Lamps

Application/Segment Brochures
- Contractor Lighting
- Healthcare Lighting
- Office Lighting
- Retail Lighting

MSDS (Material Safety Data Sheets)
Disposal Policies & Recycling Information

GRAPHS & CHARTS

Spectral Power Distribution

Luminaire Type RR2– Ballast Information

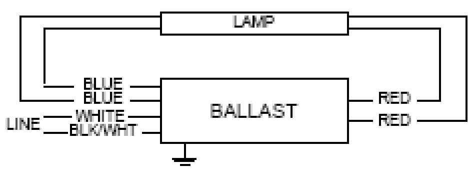
ADVANCE

Electrical Specifications

VCN-1S32-SC	
Brand Name	CENTIUM
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	277
Input Frequency	60 HZ
Status	Active

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
F17T8	1	17	32/00	0.08	22	1.00	10	0.97	1.7	4.55
F25T8	1	25	32/00	0.10	28	0.95	10	0.98	1.7	3.39
* F32T8	1	32	32/00	0.13	34	0.90	10	0.98	1.7	2.65

Wiring Diagram



Diag. 20

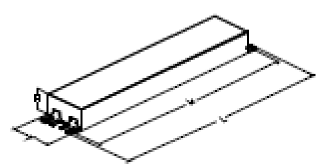
The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

	in.	cm.
Black		0
White	22L	55.9
Blue	36L	91.4
Red	26R	66
Yellow		0
Gray		0
Violet		0

	in.	cm.
Yellow/Blue		0
Blue/White		0
Brown		0
Orange		0
Orange/Black		0
Black/White	22L	55.9
Red/White		0

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
9.50 "	1.7 "	1.18 "	8.90 "
9 1/2	1 7/10	1 9/50	8 9/10
24.1 cm	4.3 cm	3 cm	22.6 cm

Revised 11/13/2001

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

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

Luminaire Type RR3– Luminaire Cutsheet

LITECONTROL

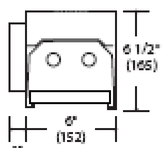
Type:
Project:

Mod-66™

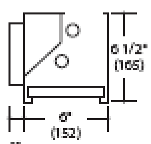
W-D-66N, W-ID-66N,
W-ADW-66N (chalkboard)
Wall-Mounted

Specifications

W-D-66N



W-ID-66N



HOUSING. Die-formed and welded steel, with 3/8" regression at housing bottom for rigidity and appearance, furnished with 6" long, 20-gauge steel splines for precise alignment at each joint. End headers have clearance holes for easy row installation and are notched under lamps for more even diffuser luminance and continuous baffle appearance. W-ID-66N. Three-inch wide opening in housing top provides 36-50% uplight ceiling and wall illumination.
END CAPS. Steel, 14-gauge, with no holes or knockouts, finished to match housing. Four fasteners on each end cap allow tight attachment to ends of individual fixtures and ends of rows.
REFLECTOR. W-D-66N. Standard: Die-formed steel with high-reflectance white finish. Parabolic Reflector/Baffle (PARSS): Die-formed semi-specular anodized aluminum reflector and baffle assembly. W-ID-66N. Die-formed steel with high-reflectance white finish. W-ADW-66N. Die-formed semi-specular aluminum (on lamp side) and die-formed steel with high-reflectance white finish.
LAMPING. Available in one- and two-lamp T8.
BALLAST. Electronic Ballast (ELB), high power factor, thermally protected Class P, Sound Rated A, less than 10% THD, manufactured by a UL Listed manufacturer, as available, determined by Litecontrol. Ballasts with a voltage range of 120 to 277 will be used when fixture configuration and ballast availability allow. The minimum number of ballasts will be used.
TANDEM WIRING. When selected from Ordering guide below, fixtures wired to switch in-line lamps separately, providing two levels of light (two-lamp cross-section fixtures only).
SYSTEM CONNECTORS. Corners and straight extensions available. Die-formed steel. Bottom and exposed sides to be smooth with no exposed fasteners or knockouts. See Field Measurement Procedure for instructions.
MOUNTING. Provided with two wall-mounting brackets measuring 4 1/2" square x 1" deep. Finish is CBC (Camera Black). W-ADW-66N. Provided with two wall-mounting brackets (WCB) measuring 4 1/2" x 6" deep, finished to match housing.
CERTIFICATION. Fixture and electrical components shall be UL and/or CUL Listed and shall bear the I.B.E.W., A.F. of L. label.

Note: Litecontrol reserves the right to change specifications without notice for product development and improvement.

Ordering guide

Product, lamping, & length						Options						
W -	D -	66N	2	4	T8 -	BW -	CWM -	- -	ELB -	-	EF -	120
Mounting	Distribution	Series	Lamp Count	Nominal Length(ft)	Lamp Type	Diffuser	Finish	Tandem Wiring	Ballast	Bracket	Other options	Volts
W Wall-Mounted	D Direct ID Indirect/Direct ADW * Asymmetric Direct	66N	1,2 → 1,2 → 1,2 → 2,4 → 2,4 → see notes	2 3 4 6 8	T8	BW PBSS PWA PAT. 12 (XA) PAT. 19 FP PARSS *(1-lamp D only)* 6044 *(ADW only)* see Diffusers	CWM (Matte White) is standard see *LiteColors*™ in Product Guide for other finishes	– TW see notes	ELB is standard DA/ELB HEL/ELB ECO/ELB see Ballast options	WCB *(ADW only)*	EF F see Other options	120 277

notes:
Lamp Count = total number of lamps in the fixture
Tandem Wiring not available for one-lamp cross-section fixtures
*W-ADW-66N available in one-lamp cross-section only
For Ordering guide information in shaded areas, choose selection by reading ACROSS the shaded areas for correct specifications.

Cross-section lamping

W-D-66N W-ID-66N W-ADW-66N

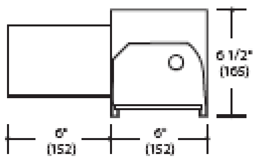
W-D-66N24T8-BW-CWM-ELB-EF-120 is a typical catalog number for a 2-lamp (2 lamps in cross-section), 4-foot long T8 fixture with white blade baffle, Matte White finish, electronic ballast, emergency fluorescent ballast, 120 volts.
W-ADW-66N14T8-6044-CWM-ELB-WCB-EF-120 is a typical catalog number for a 1-lamp (1-lamp in cross-section), 4-foot long T8 fixture with a 6044 lens, Matte White finish, electronic ballast, chalkboard mounting brackets, emergency fluorescent ballast, 120 volts.

Questions to Ask
1. 120 or 277 volt? **2.** Row information, including desired fixture lengths?
3. Diffuser type? **4.** White, *LiteColor*, or special color? **5.** Tandem wiring?
6. Other options?

litecontrol.com

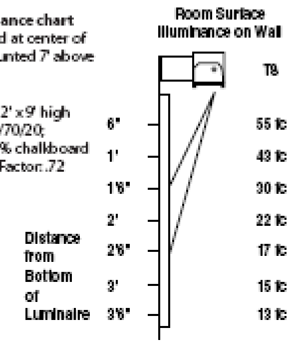
Chalkboard fixture

W-ADW-66N



Vertical illuminance chart
Values calculated at center of 12-foot row mounted 7' above the floor.

Room size: 8' x 12' x 9' high
Reflectances: 80/70/20; 30% chalkboard
Total Light Loss Factor: .72



Diffusers (W-D-66N & W-ID-66N only)

BW	Blade Baffle, White. 3/4" high x 3/4" OC, 20-gauge steel, regressed.
PBSS	Parabolic Baffle. Semi-specular anodized aluminum, 1.4" high x 2" OC. (Used with standard reflector.)
PWA	Louver. Parabolic specular aluminum, acrylic 1/2" cube, regressed.
PAT.12(XA)	Lens. Diagonal 3/16" conical prisms, .100" thick extruded acrylic, regressed.
PAT.19	Lens. 3/16" square prisms, .156" thick extruded acrylic, regressed.
FP	Lens. White acrylic, .100" thick, regressed.
PARSS	Parabolic Reflector/Baffle. Semi-specular anodized aluminum, parabolic reflector with 1.4" high x 2" OC parabolic baffles. One-lamp cross-section W-D-66N only
6044	Asymmetric Lens. 210" thick acrylic asymmetric lens (6044) to direct light towards wall. **W-ADW-66N only**

Ballast options

Specify in place of **ELB**, contact factory for availability/compatibility with lamping:

DA/ELB	Advance Mark VII Dimming Ballast.
HEL/ELB	Osram Sylvania Dimming Ballast.
ECO/ELB	Lutron ECO-10 Dimming Ballast.

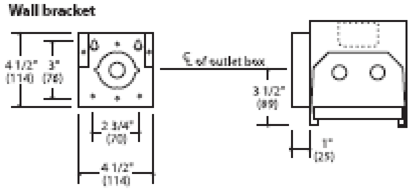
Other options

EF	Emergency Fluorescent Ballast. Battery-powered ballast from a UL Listed manufacturer will operate one T8 lamp for 1 1/2 hours.
F	Fuse. Slow or fast low, determined by Litecontrol.

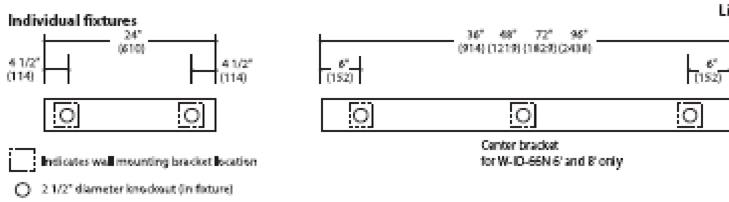
Planning for installation

For special system connectors needed to exactly fill a wall or follow a perimeter, field-measured dimensions may be required from the job site. Minimum SE length is 3.25". Please refer to Field Measurement Procedure for instructions.

Wall bracket



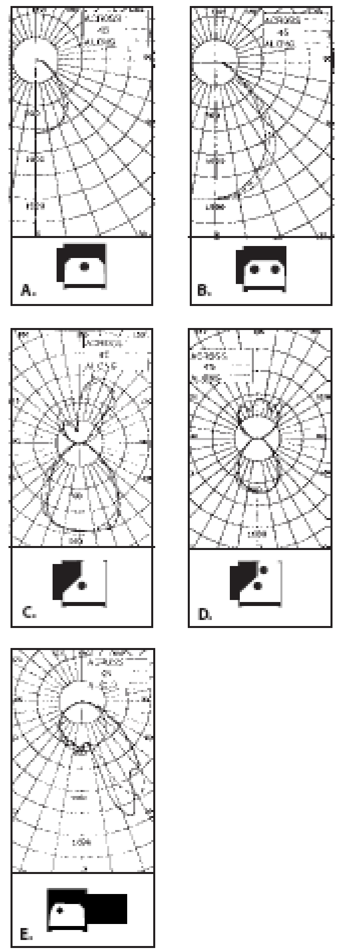
Individual fixtures



Indicates wall mounting bracket location

2 1/2" diameter knockout (in fixture)

Photometric data



A. W-D-66N14T8-XA 58.2% Efficiency
Litecontrol Certified Test Report #12111010

B. W-D-66N24T8-XA 51.1% Efficiency
Litecontrol Certified Test Report #12121010

C. W-ID-66N14T8-XA 69.4% Efficiency
Litecontrol Certified Test Report #10411010

D. W-ID-66N24T8-XA 67.2% Efficiency
Litecontrol Certified Test Report #10421010

E. W-ADW-66N14T8-6044 55.7% Efficiency
Litecontrol Certified Test Report #17811070

For complete photometric information, see website.

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Luminaire Type RR3– Lamp Information

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26666 – F32T8/SP30/ECO

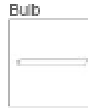
GE Ecolux® Starcoat® T8

PRINT

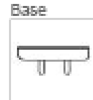
• Passes TCLP, which can lower disposal costs.

High Color Rendering
Meets Federal Minimum Efficiency Standards

Bulb



Base



View Larger

GENERAL CHARACTERISTICS

Lamp type	Linear Fluorescent - Straight Linear
Bulb	T8
Base	Medium Bi-Pin (G13)
Wattage	32
Voltage	137
Rated Life	20000 hrs
Rated Life (instant start) @ Time	20000 h @ 3 h 24000 h @ 12 h
Rated Life (rapid start) @ Time	24000 h @ 12 h
Bulb Material	Soda lime
Starting Temperature (MIN)	10 °C (50 °F)
Additional Info	TCLP compliant

PHOTOMETRIC CHARACTERISTICS

Initial Lumens	2800
Mean Lumens	2660
Nominal Initial Lumens per Watt	87
Color Temperature	3000 K
Color Rendering Index (CRI)	78
S/P Ratio (Scotopic/Photopic Ratio)	1.3

ELECTRICAL CHARACTERISTICS

Open Circuit Voltage (rapid start) Min @ Temperature	315 V @ 10 °C
Cathode Resistance Ratio - Rh/Rc (MIN)	4.25
Cathode Resistance Ratio - Rh/Rc (MAX)	6.5
Current Crest Factor (MAX)	1.7

DIMENSIONS

Maximum Overall Length (MOL)	47.7800 in (1213.6 mm)
Minimum Overall Length	47.6700 in (1210.8 mm)
Nominal Length	48.000 in (1219.2 mm)
Bulb Diameter (DIA)	1.000 in (25.4 mm)

ADDITIONAL RESOURCES

Catalogs
Testimonials
Brochures
Product Brochures
- Color
- Ecolux
- Ecolux (Environmental)
- Industrial Lighting
- Linear Fluorescent Lamps

Application/Segment Brochures
- Contractor Lighting
- Healthcare Lighting
- Office Lighting
- Retail Lighting

MSDS (Material Safety Data Sheets)
Disposal Policies & Recycling Information

GRAPHS & CHARTS

Spectral Power Distribution

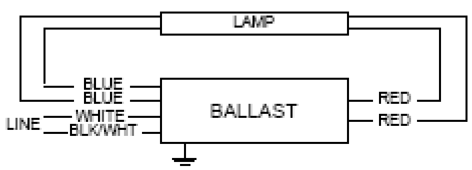
Luminaire Type RR3– Ballast Information

Electrical Specifications

VCN-1S32-SC	
Brand Name	CENTIUM
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	277
Input Frequency	60 HZ
Status	Active

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
F17T8	1	17	32/00	0.08	22	1.00	10	0.97	1.7	4.55
F25T8	1	25	32/00	0.10	28	0.95	10	0.98	1.7	3.39
* F32T8	1	32	32/00	0.13	34	0.90	10	0.98	1.7	2.65

Wiring Diagram



Diag. 20

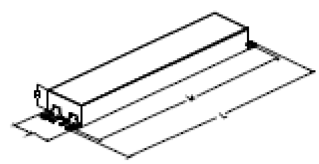
The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

	in.	cm.
Black		0
White	22L	55.9
Blue	36L	91.4
Red	26R	66
Yellow		0
Gray		0
Violet		0

	in.	cm.
Yellow/Blue		0
Blue/White		0
Brown		0
Orange		0
Orange/Black		0
Black/White	22L	55.9
Red/White		0

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
9.50 "	1.7 "	1.18 "	8.90 "
9 1/2	1 7/10	1 9/50	8 9/10
24.1 cm	4.3 cm	3 cm	22.6 cm

Revised 11/13/2001

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

ADVANCE
O'HARE INTERNATIONAL CENTER · 10275 WEST HIGGINS ROAD · ROSEMONT, IL 60018
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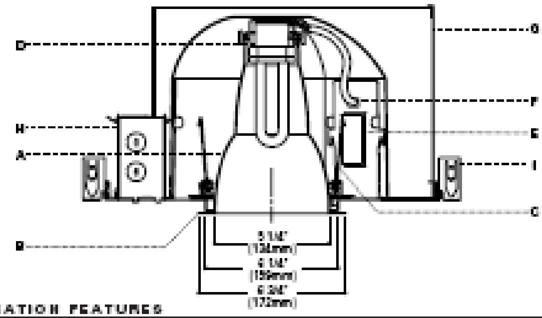
Corporate Offices: Phone: 800-322-2086

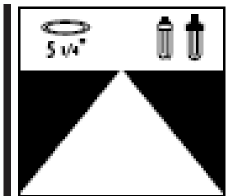
Luminaire Type SS1– Luminaire Cutsheet

IRiS CATALOG#: TYPE:

DESCRIPTION

Specification grade 32 Watt triple tube compact fluorescent fixture rated for direct contact with insulation. The 50° cutoff to lamp and lamp image provides a glare free, smooth, medium beam distribution. Triple tube lamps provide excellent color, long life, and low radiant heat. Dimming and emergency ballast options are available. Lamp module and optical element can be changed after installation to provide a variety of lamp sources and distributions. e.g. into a PAR36 adjustable

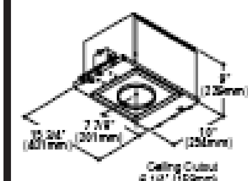




P5
M32T
E5T

32W TRIPLE
Compact Fluorescent

5" DOWNLIGHT



SPECIFICATION FEATURES

A···Reflector
.040 thick aluminum spun parabolic reflector in iridescence-free Clear, Gold, Haze, Warm Haze Alzak® or painted Gloss White finish. Special cone colors listed below

B···Flange
Self flange reflector or die-cast flange with either matte white or clear coat finish. Die-cast flanges are easily removed for field painting. Elements are keyed for proper insertion.

C···Attachment
Positive torsion springs pull flange tight to ceiling. Mechanical light trap eliminates spill light at edge of flange or reflector.

D···Socket
4 pin G24q3 base for 32W PLT, TBX and TTT lamps. Fatigue free stainless steel spring ensures positive lamp retention. Fixed socket height ensures consistent lamp position.

E···Electronic Ballast
Thermally protected, current controlled electronic ballast produces full light output and rated lamp life. For 32W and 26W triple tube lamps. Provides flicker-free and noise-free operation and starting with 120 or 277 volt input. Meets stringent Class B requirements, FCC part 18, for non-commercial applications. M32T Lutron for use with 32W lamp only.

F···Electrical
Keyed quick connect provides easy lamp module installation.

G···Frame/Housing
Hot dipped galvanized 20 gauge steel frame with built in 1/2 inch plaster lip. Gunsights allow for consistent alignment. Aluminum .032 thick housing allows for heat dissipation and reduces weight.

H···Junction Box
18 cubic inches, listed for 4#12 AWG or 6#14 AWG 90° C additional feed through conductors, has six 1/2 inch pryouts.

I···Bar Hangers
No Flex® bar hangers with positive locking, for use with wood, engineered wood and steel frame joists spaced up to 24" O.C. ship with platform for use in T-bar ceilings order accessory MBCLP clips. Nailess barb and locator lip provide consistent installation height.

Codes
Thermally protected, IP labeled, for use in direct contact with insulation. Meets Washington State Air tight requirements, 1995 CABO Model Energy Code.

Labels
UL and cUL listed, standard damp label, IBEW union made.

ENERGY DATA
M32T
Input Power:
120V = 36W
Input Current (Max.):
120V = .308A
Power Factor:
120V = > .98
T.H.D.:
120V = < 10%

M32T Lutron
Input Power:
120V = 36W
Input Current (Max.):
120V = .33A
Power Factor:
120V = > .95
T.H.D.:
120V = < 20%

ORDERING INFORMATION

Complete unit consists of a platform, module and element

Platform	Lamp Module	Optical Element	Finish	Flange	Accessories
P5	M32T				
P5=5" Airtight IC Rated Housing	M32T=32/26W Compact Fluorescent Ballast M32T Lutron=32W Tu Wire Dimmable Ballast	E5T=5" Downlight Reflector	Standard C=Clear H=Haze G=Gold WMH=Warm Haze W=Gloss White MW=Matte White Custom K=Cognac KH=Cognac Haze CC=Chocolate Custom Cont. CCH=Chocolate Haze BU=Blush BUH=Blush Haze GP=Graphite GPH=Graphite Haze PN=Pine PNH=Pine Haze SK=Sky SKH=Sky Haze	Blank=White die-cast SF=Self Flange RAW=Natural Die-cast SFWF=Self Flange Painted White	MBCLP=40 Push On T Bar Clips (for 10 Units) PLE5=Plaster Lip Extension for Max 2" Thick Ceiling RMC5= Flush Mount Collar

For Emergency Option order P532TEMER and E5T_ see catalog for ordering information. For additional options please consult factory.

COOPER LIGHTING

ADIB20702

Unit Number: P5-M32T-E5T_

PHOTOMETRICS

P5-M32T-E5TC
Test No. H36087

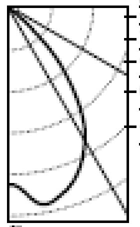
Lamp: 32W PLT
Lumens: 2400

Cutoff: 50°
Spacing: 1.1
Efficiency: 33.7%
Unit LPW: 22.4

Candelas

Vertical Angle	CD
90	0
85	0
75	0
65	0
55	0
45	134
35	365
25	522
15	605
5	596
0	553

Distribution



Luminance

Degree	cd/m²
85°	0
75°	0
65°	0
55°	0
45°	13594

Cone of Light

Distance to Illuminated Plane	Initial Nadir Footcandles	Beam Diameter
4'6"	29	5'0"
5'6"	19	6'6"
6'6"	14	7'6"
8'0"	9	9'6"
10'0"	6	11'6"
12'0"	0	14'0"

Zonal Lumen Summary

Zone	Lumens	%Lamp	%Luminaire
0-30	496	19.4	57.6
0-40	690	28.8	65.5
0-60	900	33.4	99.1
0-90	910	33.7	100.0
90-180	0	0.0	0.0
0-180	910	33.7	100.0

Coefficient of Utilization

Ceiling Reflectance	80%				70%		50%		30%		0%
Wall Reflectance	70	50	30	10	50	10	50	10	50	10	0
Room Cavity Ratio											
0	40	40	40	40	39	39	37	37	36	36	34
1	39	37	37	36	37	35	35	34	34	33	32
2	37	35	34	33	34	32	33	32	32	31	30
3	35	33	31	30	32	30	31	29	31	28	28
4	33	31	29	28	30	27	30	27	29	27	26
5	31	28	27	25	29	25	28	25	27	25	24
6	30	27	25	24	27	24	26	23	26	23	23
7	28	25	23	22	25	22	25	22	24	21	21
8	27	23	21	20	23	20	23	20	23	20	19
9	25	22	20	19	22	19	21	19	21	18	18
10	24	20	19	17	20	17	20	17	20	17	16

P5-M32T-E5TC
Test No. H36107

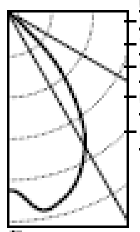
Lamp: 26W PLT
Lumens: 1800

Cutoff: 50°
Spacing: 1.1
Efficiency: 38.7%
Unit LPW: 23.2

Candelas

Vertical Angle	CD
90	0
85	0
75	0
65	0
55	0
45	103
35	305
25	460
15	566
5	572
0	540

Distribution



Luminance

Degree	cd/m²
85°	0
75°	0
65°	0
55°	123
45°	10606

Cone of Light

Distance to Illuminated Plane	Initial Nadir Footcandles	Beam Diameter
4'6"	27	5'0"
5'6"	19	6'0"
6'6"	13	7'0"
8'0"	9	9'0"
10'0"	5	11'0"
12'0"	4	12'0"

Zonal Lumen Summary

Zone	Lumens	%Lamp	%Luminaire
0-30	426	23.7	60.8
0-40	616	34.2	87.9
0-60	698	38.8	99.6
0-90	701	38.9	100.0
90-180	0	0.0	0.0
0-180	701	38.9	100.0

Coefficient of Utilization

Ceiling Reflectance	80%				70%		50%		30%		0%
Wall Reflectance	70	50	30	10	50	10	50	10	50	10	0
Room Cavity Ratio											
0	46	46	46	46	45	45	43	43	41	41	38
1	44	43	42	42	43	41	41	40	40	39	37
2	425	41	39	39	40	39	38	37	38	36	35
3	41	38	36	35	38	35	37	34	36	34	33
4	39	36	34	33	36	32	35	32	34	32	31
5	37	34	32	30	33	30	33	30	32	28	28
6	35	32	30	28	32	28	31	29	30	28	27
7	33	30	28	26	30	26	28	26	29	26	25
8	31	28	26	25	29	25	27	24	27	24	23
9	30	26	25	22	26	22	25	22	25	22	21
10	28	24	22	21	24	21	24	21	24	20	20

Notes and Formulas:

Luminance: To convert cd/m² to footlamberts, multiply by 0.2919

Cone of Light:
- Beam diameter is to 50% of maximum footcandles, rounded to the nearest half-foot.
- Footcandle values are initial. Apply appropriate light loss factors where necessary. See page 6645 of catalog.

CU Notes/Formulas:
- maintained illuminance = $\frac{\text{lamp lumens x CU x light loss factors}}{\text{room area}}$
- total number of luminaires = $\frac{\text{total room area x maintained illuminance}}{\text{lamp lumens x CU x light loss factors}}$
- CU data based on 20% effective floor cavity reflectance.

Note: Specifications and Dimensions subject to change without notice.

Visit our web site at www.cooperlighting.com

COOPER Lighting

Customer First Center 1121 Highway 74 South Peachtree City, GA 30269 770.486.4800 FAX 770.486.4801 ADI830702
Cooper Lighting 5925 McLaughlin Rd. Mississauga, Ontario, Canada L5R 1B8 905.507.4000 FAX 905.568.7089

Luminaire Type SS1– Lamp Information

GE Lighting

WORLDWIDE PARTNER

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Products > Compact Fluorescent > Plug-In > Triple Biax® > T4 > 97630

97630 – F32TBX/830/A/ECO

GE Ecolux® Biax® T4 - Facilities; Retail Display; Hospitality; Office; Restaurant; Warehouse

PRINT

High Color Rendering
Energy Savings

Bulb

Base

View Larger

GENERAL CHARACTERISTICS

Lamp type	Compact Fluorescent - Plug-In
Bulb	T4
Base	GX24q-3
Wattage	32
Voltage	120/100
Rated Life	12000 hrs
Starting Temperature (MIN)	0 °C (32 °F)
Cathode Resistance	2.700 Ohm
Rated Life (rapid start) @ Time	12000 h @ 3 h 20000 h @ 12 h
Additional Info	Dimmable with appropriate dimming ballast., End of Life Protection (EOL), TCLP compliant
Primary Application	Facilities; Retail Display; Hospitality; Office; Restaurant; Warehouse

PHOTOMETRIC CHARACTERISTICS

Initial Lumens	2200
Mean Lumens	1850
Nominal Initial Lumens per Watt	68
Color Temperature	3000 K
Color Rendering Index (CRI)	82

ELECTRICAL CHARACTERISTICS

Current (max)	5.2500 A
Open Circuit Voltage (after preheating) (MAX)	265 V
Open Circuit Voltage (MIN)	515 V
Lamp Current	0.320 A
Preheat Voltage (MIN)	4 V
Current Crest Factor (MAX)	1.7
Supply Current Frequency	20000 Hz

ADDITIONAL RESOURCES

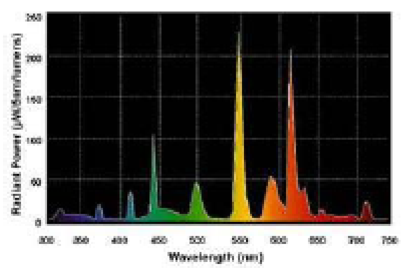
Catalogs
Testimonials
Brochures
Product Brochures
- Ecolux
- Ecolux (Environmental)

Sell Sheets
- Fast Warming
- Biax® T/E 32W with Amalgam

Disposal Policies & Recycling Information

GRAPHS & CHARTS

Spectral Power Distribution



Luminaire Type SS1– Ballast Information

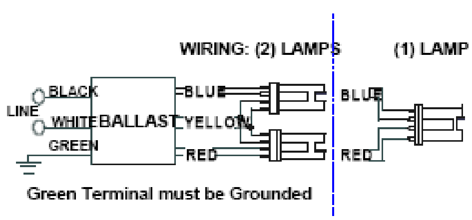
ADVANCE

Electrical Specifications

ICF2S26M1LSQS@277	
Brand Name	SMARTMATE
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
CFQ26W/G24Q	1	26	0/-18	0.10	27	1.00	10	0.99	1.7	3.70
CFQ26W/G24Q	2	26	0/-18	0.19	51	1.00	10	0.99	1.7	1.96
CFTR26W/GX24Q	1	26	0/-18	0.11	19	1.10	10	0.99	1.7	5.79
CFTR26W/GX24Q	2	26	0/-18	0.21	54	1.00	10	0.99	1.7	1.85
* CFTR32W/GX24Q	1	32	0/-18	0.13	36	0.98	10	0.98	1.7	2.72
CFTR42W/GX24Q	1	42	0/-18	0.17	46	0.98	10	0.98	1.7	2.13

Wiring Diagram



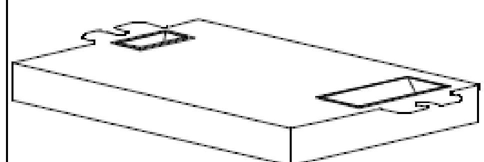
The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

	in.	cm.
Black	0	0
White	0	0
Blue	0	0
Red	0	0
Yellow	0	0
Gray		0
Violet		0

	in.	cm.
Yellow/Blue		0
Blue/White		0
Brown		0
Orange		0
Orange/Black		0
Black/White		0
Red/White		0

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
4.98 "	2.4 "	1.0 "	4.6 "
4 49/50	2 2/5	1	4 3/5
12.6 cm	6.1 cm	2.5 cm	11.7 cm

Revised 11/20/2007

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

ADVANCE
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Customer Support/Technical Service: Phone: 800-372-3331 · Fax: 630-307-3071
Corporate Offices: Phone: 800-322-2086

Luminaire Type SS2– Luminaire Cutsheet

IRIS®

DESCRIPTION

Recessed medium beam downlight luminaire with 4 inch square aperture utilizing horizontal 26W DTT or 26/32/42W TTT compact fluorescent lamp. Modular platform can be reconfigured from below the ceiling to accept a broad range of lamp modules and optical elements. Platform is suitable for shallow plenum commercial construction. Insulation must be kept 3" from top and sides of housing. Platform + module + element combination produces square distribution with excellent light control and low aperture brightness.

Catalog #		Type
Project		
Comments		Date
Prepared by		

SPECIFICATION FEATURES

Frame
Galvanized steel plaster frame with integral bar hanger receivers. Setscrews provide positive horizontal locking.

Collar
Matte black steel collar adjusts vertically for 1/2" - 1" thick ceilings and can be rotated +/- 7.5° thru the aperture. Integral gun sights facilitate the use of guide strings or laser lines. Shipped with a paint overspray protector.

Lamp Module
Installed or removed thru the aperture or from the top and allows lamp orientation at 0°, 90°, 180° and 270° positions (except for 26W DTT and 42W TTT lamps).

Housing
Steel housing painted matte black for a visually dark interior. Removable hinged top allows for top access. All fasteners are captive.

Gaskets
Closed cell gaskets achieve restrictive airflow requirements without additional caulking.

Optical Element
Mousetrap type springs pull flange tight to ceiling. Light trap eliminates spill light at edge of flange and reflector. Available in self-flanged or metal trim ring versions. May also be installed rimless using optional plastering lathing ring.

Bar Hangers
Captive preinstalled bar hangers adjusts from 8-1/2" to 24" wide; pass thru feature allows shortening without removal. Captive nail penetrates standard and engineered lumber. Mounting flange levels platform with ceiling. Integral clip attaches directly to t-bar.

Butterfly Bracket
Provides 3" of vertical adjustment and accept 1/2" EMT, C channel or bar hangers.

Primary Reflector
Miro® Erotek segmented upper reflector yields a smooth square beam with medium distribution. Accepts 26W DTT, 26/32/42W TTT compact fluorescent lamps.

Lower Reflector
Aluminum parabolic shielding prismatoid provides for 55° cutoff and is available in a wide range of semi specular Alzak® finishes. Corrugated Baffle: An optional embossed pattern that extends through the flange adding a subtle design element and reduces aperture brightness.

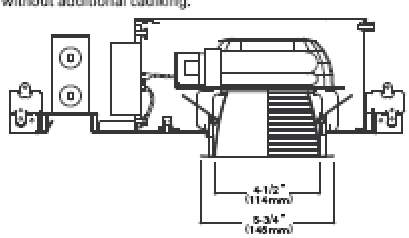
Junction Box
(7) 1/2" trade size pry outs, (3) integral clamps for non-metallic cable. Rated for (8) #12 thru branch circuits. Wago® type push wire connectors for field connections.

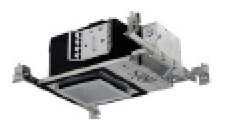
Thermal Protector
Self-resetting thermal protector protects against improper lamping and direct contact with insulation.

Ballast
Universal input electronic ballast features multi-watt capability operating 26W DTT and 26/32/42W TTT lamps. Programmed rapid start allows use with occupancy sensors and building control systems.

Lamp Socket
4 pin Gx24q3/4 base with rotary lock socket ensures positive lamp retention. Lamp socket locks into one of two positions accommodating different lamp lengths.

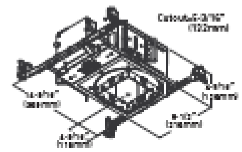
Code Compliance
Thermally protected, IP labeled and cULus listed for damp locations and ASTM-E283 AIRTITE(tm).





P406TAT
MH4CFL42E
E4DL E4DLCB
26W DTT
26/32/42W TTT
Compact
Fluorescent

4 Inch Square Downlight



BALLAST DATA			
Min. Starting Temp -18°C		Sound Rating Class A	
EMI/RFI Emissions: FCC Part 18		Input Frequency 50/60 Hz	
Power Factor > 0.98		THD < 10%	
Input Voltage		120V - 277V	347V
26W	Input Power	28W	31W
	Input Current	0.25A	0.09A
32W	Input Power	36W	36W
	Input Current	0.31A	0.11A
42W	Input Power	46W	50W
	Input Current	0.38A	0.15A
BALLAST DATA - [illegible]			
Min. Starting Temp 10°C			
Sound Rating Inaudible in a 27dBa Ambient			
EMI/RFI Emissions: FCC Part 18 Consumer Limits			
Input Frequency 60 Hz		Power Factor > 0.98	
Input Voltage 120V		THD < 20%	
26W Input Current		0.25A	
32W Input Current		0.30A	

ORDERING INFORMATION: Complete unit consists of platform, lamp module and optical element.

Platform	Lamp Module	Ballast Option	Optical Element	Finish	Flange	Accessories
	MH4CFL					

Platform
P406TAT = 4" Square Aperture Non-IC Housing
P406TCP = 4" Square Aperture Non-IC Chicago Plenum Housing

Lamp Module
MH4CFL = Horizontal Compact Fluorescent Lamp Module

Ballast Option
42E = 26W DTT 26/32/42W TTT 120-277V UNV
423E = 26W DTT 26/32/42W TTT 347V
1D26 = 26W DTT/TTT Lutron TuWire Dimming 120V
1D32 = 32W TTT Lutron Tuwire Dimming 120V

Optical Element
E4DL = 4" Square Aperture Lower Shielding Prismatoid, Open
E4DLCB = 4" Square Aperture Corrugated Lower Shielding Prismatoid, Open

Finish
Alzak® Finishes
H = Clear Haze
WMH = Warm Haze
WHH = Wheat Haze
KH = Cognac Haze
GPH = Graphite Haze
CTH = Cobalt Haze
CCH = Chocolate Haze
BH = Black Haze
Painted Finishes
MW = Matte White
MB = Matte Black

Flange
(Blank) = Metal Trim Ring, Matte White
SF = Self Flanged
SFWF = Self Flanged, Matte White Flange (SFWF not available with corrugated baffle)

Accessories
FLR4x4 = Plaster lathing ring for rimless
RLA4x4 = Rimless adapter for solid ceiling surfaces
EDC4x41 = Extended depth collar for 1" - 1-1/2" thick ceilings
EDC4x42 = Extended depth collar for 1-1/2 - 2" thick ceilings
L4X4HEX = Matte black hex cell louver
MTR4MW = Metal trim ring, matte white
MTR4MB = Metal trim ring, matte black
MTR4SN = Metal trim ring, satin nickel
MTR4AC = Metal trim ring, antique copper
MTR4TBZ = Metal trim ring, tuscan bronze

COOPER Lighting
www.cooperlighting.com

Specifications and Dimensions subject to change without notice.
Consult your representative for additional options and finishes.

ADI060686
02/26/2008 5:24:01 PM

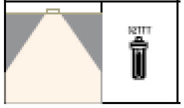
F406TAT MH4CFL E4DL E4DLCB

Photometrics

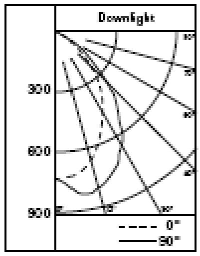
Photometric Results

Spacing Criterion = 1, 1.3
Efficiency = 50.6%

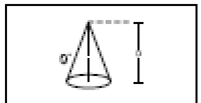
Test No. 254P232
Platform = P4
Element = E4DLH
Lumens = 2400
Lamp = CF32TTT/E/841



Candlepower Distribution



Cone of Light



D	FC	L	W
4'	47	4.0'	4.9'
5'	30	5.0'	6.2'
6'	21	6.1'	7.4'
7'	15	7.1'	8.7'
8'	12	8.1'	9.9'

Candelas

Vertical Angle	CD
90	0
85	2
75	15
65	44
55	113
45	248
35	396
25	525
15	650
5	704
0	711

Zonal Lumens Summary

Zone	Lumens	% Lamp	% Luminaire
0- 30	568	23.7	46.8
0- 40	856	35.7	70.5
0- 60	1162	48.4	95.7
0- 90	1214	50.6	100
90-180	0	0	0
0-180	1214	50.6	100

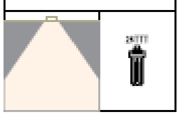
Coefficients of Utilization

Ceiling Wall % RCR	70 50 30 10	70 50 30 10	50 30 10	50 30 10	50 30 10	0
	Zonal cavity method -- floor reflectance = 20%					
0	60 60 60 60	59 59 59 59	56 56 56	54 54 54	52 52 52	51
1	57 55 53 52	55 54 52 51	52 51 50	50 49 48	48 47 47	46
2	53 50 47 45	52 49 47 45	47 45 44	46 44 43	44 43 42	41
3	49 45 42 40	48 45 42 39	43 41 39	42 40 38	41 39 37	37
4	46 41 38 35	45 41 37 35	40 37 35	38 36 34	37 35 34	33
5	43 38 34 31	42 37 34 31	36 33 31	35 33 31	35 32 30	30
6	40 35 31 28	39 34 31 28	33 30 28	33 30 28	32 30 28	27
7	38 32 28 26	37 32 28 26	31 28 26	30 27 25	30 27 25	24
8	35 30 26 24	35 29 26 23	29 26 23	28 25 23	28 25 23	22
9	33 28 24 22	33 27 24 22	27 24 21	26 23 21	26 23 21	20
10	31 26 22 20	31 25 22 20	25 22 20	25 22 20	24 22 20	19

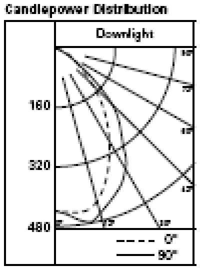
Photometric Results

Spacing Criterion = 1, 1.2
Efficiency = 39.5%

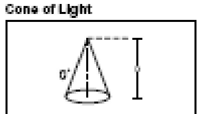
Test No. 254P229
Platform = P4
Element = E4DLH
Lumens = 1800
Lamp = CF26TTT/E/830



Candlepower Distribution



Cone of Light



D	FC	L	W
4'	28	4.0'	4.9'
5'	18	5.0'	6.1'
6'	12	6.0'	7.3'
7'	9	7.0'	8.6'
8'	7	8.0'	9.8'

Candelas

Vertical Angle	CD
90	0
85	1
75	8
65	24
55	61
45	140
35	239
25	338
15	427
5	442
0	438

Zonal Lumens Summary

Zone	Lumens	% Lamp	% Luminaire
0- 30	339	18.8	47.6
0- 40	507	28.2	71.3
0- 60	682	37.9	95.9
0- 90	711	39.5	100
90-180	0	0	0
0-180	711	39.5	100

Coefficients of Utilization

Ceiling Wall % RCR	70 50 30 10	70 50 30 10	50 30 10	50 30 10	50 30 10	0
	Zonal cavity method -- floor reflectance = 20%					
0	47 47 47 47	46 46 46 46	44 44 44	42 42 42	40 40 40	40
1	44 43 42 41	43 42 41 40	40 40 39	39 38 38	38 37 37	36
2	41 39 37 35	41 38 37 35	37 36 34	36 35 33	35 34 33	32
3	39 36 33 31	38 35 33 31	34 32 30	33 31 30	32 31 29	29
4	36 32 30 28	35 32 29 28	31 29 27	30 28 27	29 28 26	26
5	34 30 27 25	33 29 27 25	29 26 24	28 26 24	27 25 24	23
6	32 27 24 22	31 27 24 22	26 24 22	26 24 22	25 23 22	21
7	30 25 22 20	29 25 22 20	24 22 20	24 22 20	23 21 20	19
8	28 23 21 19	27 23 20 19	23 20 18	22 20 18	22 20 18	18
9	26 22 19 17	26 21 19 17	21 19 17	21 18 17	20 18 17	16
10	25 20 18 16	24 20 17 16	20 17 16	19 17 16	19 17 16	15

COOPER Lighting
www.cooperlighting.com

Specifications and Dimensions subject to change without notice.
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Luminaire Type SS2– Lamp Information

GE Lighting

WORLDWIDE PARTNER

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Products > Compact Fluorescent > Plug-In > Triple Biax® > T4 > 97630

97630 – F32TBX/830/A/ECO

GE Ecolux® Biax® T4 - Facilities; Retail Display; Hospitality; Office; Restaurant; Warehouse

PRINT

High Color Rendering
Energy Savings

Bulb

Base

View Larger

GENERAL CHARACTERISTICS

Lamp type	Compact Fluorescent - Plug-In
Bulb	T4
Base	GX24q-3
Wattage	32
Voltage	120/100
Rated Life	12000 hrs
Starting Temperature (MIN)	0 °C (32 °F)
Cathode Resistance	2.700 Ohm
Rated Life (rapid start) @ Time	12000 h @ 3 h 20000 h @ 12 h
Additional Info	Dimmable with appropriate dimming ballast., End of Life Protection (EOL), TCLP compliant
Primary Application	Facilities; Retail Display; Hospitality; Office; Restaurant; Warehouse

PHOTOMETRIC CHARACTERISTICS

Initial Lumens	2200
Mean Lumens	1850
Nominal Initial Lumens per Watt	68
Color Temperature	3000 K
Color Rendering Index (CRI)	82

ELECTRICAL CHARACTERISTICS

Current (max)	5.2500 A
Open Circuit Voltage (after preheating) (MAX)	265 V
Open Circuit Voltage (MIN)	515 V
Lamp Current	0.320 A
Preheat Voltage (MIN)	4 V
Current Crest Factor (MAX)	1.7
Supply Current Frequency	20000 Hz

ADDITIONAL RESOURCES

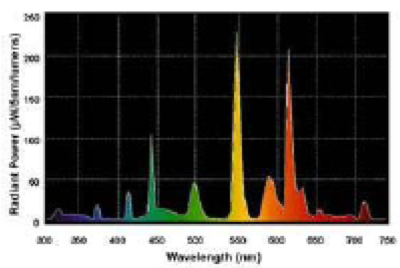
Catalogs
Testimonials
Brochures
Product Brochures
- Ecolux
- Ecolux (Environmental)

Sell Sheets
- Fast Warming
- Biax® T/E 32W with Amalgam

Disposal Policies & Recycling Information

GRAPHS & CHARTS

Spectral Power Distribution



Luminaire Type SS2– Ballast Information

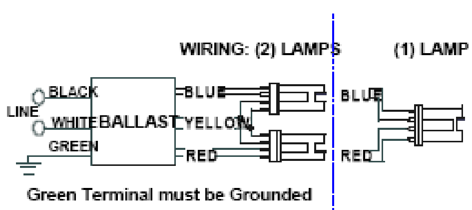
ADVANCE

ICF2S26M1LSQS@277	
Brand Name	SMARTMATE
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
CFQ26W/G24Q	1	26	0/-18	0.10	27	1.00	10	0.99	1.7	3.70
CFQ26W/G24Q	2	26	0/-18	0.19	51	1.00	10	0.99	1.7	1.96
CFTR26W/GX24Q	1	26	0/-18	0.11	19	1.10	10	0.99	1.7	5.79
CFTR26W/GX24Q	2	26	0/-18	0.21	54	1.00	10	0.99	1.7	1.85
* CFTR32W/GX24Q	1	32	0/-18	0.13	36	0.98	10	0.98	1.7	2.72
CFTR42W/GX24Q	1	42	0/-18	0.17	46	0.98	10	0.98	1.7	2.13

Wiring Diagram



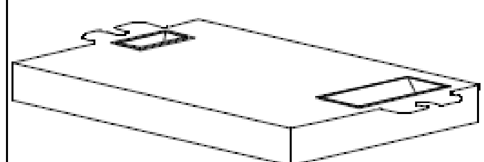
The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

	in.	cm.
Black	0	0
White	0	0
Blue	0	0
Red	0	0
Yellow	0	0
Gray		0
Violet		0

	in.	cm.
Yellow/Blue		0
Blue/White		0
Brown		0
Orange		0
Orange/Black		0
Black/White		0
Red/White		0

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
4.98 "	2.4 "	1.0 "	4.6 "
4 49/50	2 2/5	1	4 3/5
12.6 cm	6.1 cm	2.5 cm	11.7 cm

Revised 11/20/2007

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

ADVANCE
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Customer Support/Technical Service: Phone: 800-372-3331 · Fax: 630-307-3071
Corporate Offices: Phone: 800-322-2086

Luminaire Type SS3 – Luminaire Cutsheet

Shaper™
shaperlighting.com

DESCRIPTION

673 luminous Half Cylinder features a variety of decorative options such as perforated metal, colored acrylic, trim bars and is ADA compliant.

Catalog #		Type
Project		
Comments		Date
Prepared by		

SPECIFICATION FEATURES

Material
Painted or plated solid aluminum with a 1/8" matte white extruded acrylic panel.

Finish
Standard: Natural Aluminum (NA). [Sustainable Design] Premium: Polished Chrome (PC), Satin Brass (SB), Polished Brass (PB), Lacquered Satin Aluminum (SAL), Matte White (MW), Satin Copper (SCP), Polished Copper (PCP), Satin Nickel (SN), Polished Nickel (PN), Oxidized Brass (OBRS), Lacquered Satin Chrome (SCL), Lacquered Satin Nickel (SNL) or Custom Color (CC).

Optics
Refer to www.shaperlighting.com for complete photometrics.

Ballast
Integral electronic HPF, multi-volt 120/277V (347V Canada), thermally protected with end-of-life circuitry to accommodate the specified lamp wattage.

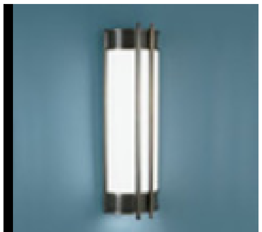
Lamp/Socket
12": One (1) or two (2) 18W (2G11) 4-pin high lumen CFL lamps or one (1) 60W frosted T-10 lamp.
16": Two (2) 27W (2G11) 4-pin high lumen CFL lamps or two (2) 60W frosted T-10 lamps.
25": One (1) or two (2) 14W T5 linear fluorescent lamps.
37": One (1) or two (2) 21W T5 linear fluorescent lamps. CFL lamps or two (2) 60W Frosted T-10 lamps. CFL socket injection molded plastic. Lamps furnished by others.

Installation
Supplied with a universal circular strap for a standard 4" J-box or plaster ring.

Options
Hand-Painted Faux Alabaster Acrylic Diffuser (FD), Remote Emergency Battery (12" and 16" only) - Supplied by others (REM), Integrated Emergency Battery (IEM) (25" and 37"), Dimming Ballast - Contact the factory for ballast options (DM), Top and Bottom Cover (TBC), Two Vertical Trim Bars (2VTB), Two Horizontal Trim Bars (2HTB), Two Vertical and Horizontal Trim Bars (2HTB/2VTB), Two Vertical Trim Bars with Perf Sides (2VTB/PS), Two Vertical Trim Bars with Four Wide Trim Bars (2VTB/4WTB), Two Vertical and Horizontal Trim Bars with Perf Center (2HTB/2VTB/PC), Two Proud Extended Vertical Trim Bars (2PVETB), Two Horizontal Trim Bars and One Proud Vertical Trim Bar (2HTB/1PVTB), MRI Applications (INC only) - Contact factory, Accent Balls (ACB), Three Horizontal and One Vertical Trim Bars with Perf (3HTB/1VTB/P), Damp Location (DL): All Painted Finishes, Lacquered Satin Chrome (SCL) and Lacquered Satin Nickel (SNL) finishes only. Energy Star Rating - Consult factory. MRI Applications (INC only) - Contact Factory.

Labels
U.L. and C.U.L approved for indoor and damp location. See options for damp location finishing requirements. ADA compliant (except 2PVTB, 2PVETB, 2HTB/1PVTB).

Modifications
Shaper's skilled craftspeople with their depth of experience offer the designer the flexibility to modify standard wall luminaires for project specific solutions. Contact the factory regarding scale options, unique finishes, mounting, additional materials/colors, or decorative detailing.



673 SERIES

Interior Wall Luminaire
Luminous Half Cylinder

ADA

ORDERING INFORMATION

Sample Number: 673-12-CFL/2/18-277V-PCP

Series:
673 Luminous Half Cylinder

Size
12"
16"
25"
37"

Lamp
CFL/1/18
CFL/2/18
CFL/2/27
INC/1/60
INC/2/60
T5/1/14
T5/1/21
T5/2/14
T5/2/21

Voltage
120V
277V
347V

Finish
Standard
NA Natural Aluminum
Premium
CC Custom Color
MW Matte White
OBRS Oxidized Brass
PB Polished Brass
PC Polished Chrome
PCP Polished Copper
PN Polished Nickel
SAL Lacquered Satin Aluminum
SB Satin Brass
SCP Satin Copper
SN Satin Nickel
SNL Lacquered Satin Nickel

Options
2HTB Two Horizontal Trim Bars
2HTB/1PVTB Two Horizontal Trim Bars and 1 Proud Vertical Trim Bar
2HTB/2VTB Two Horizontal and Vertical Trim Bars
2HTB/2VTB/PC Two Horizontal and Vertical Trim Bars w/ Perf Center
2PVTB Two Proud Vertical Trim Bars
2VTB Two Vertical Trim Bars
2VTB/4WTB Two Vertical Trim Bars w/ Four Wide Trim Bars
2VTB/PS Two Vertical Trim Bars w/ Perforated Sides
3HTB/1VTB/P Three Horizontal and One Vertical Trim Bars w/ Perf
ACB Accent Balls
DL Damp Location
DM CFL Dimming Ballast
IEM Integral Emergency Ballast
REM Remote Emergency Battery
FD Hand Painted Faux Alabaster Diffuser
TBC Top and Bottom Cover

Notes:
1 Available in 12".
2 Available in 16".
3 Available in 24".
4 Available in 37".
5 Available with CFL only.
6 Consult the factory for available options.
7 Supplied by others.

COOPER Lighting
www.cooperlighting.com

Specifications and Dimensions subject to change without notice.
Consult your representative for additional options and finishes.

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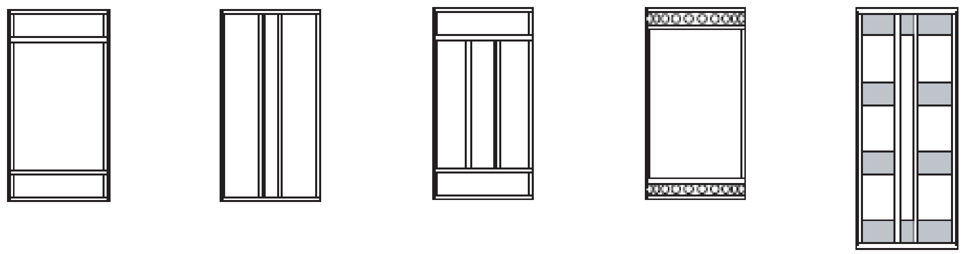
673 SERIES INTERIOR WALL LUMINAIRE

DIMENSIONS

TRIM OPTIONS



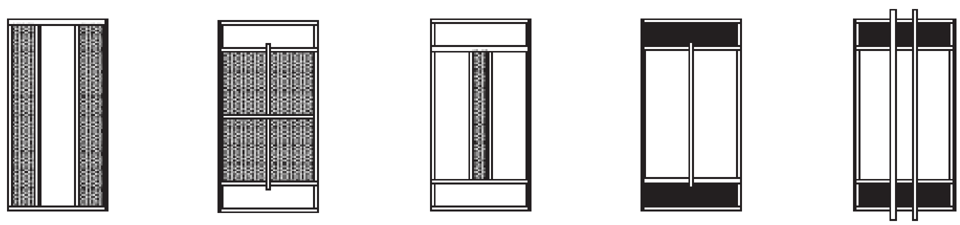
TWO HORIZONTAL TRIM BARS (2HTB)

TWO VERTICAL TRIM BARS (2VTB)

TWO HORIZONTAL AND TWO VERTICAL TRIM BARS (2HTB/2VTB)

ACCENT BALLS (ACB)

TWO VERTICAL TRIM BARS WITH FOUR WIDE TRIM BARS (2VTB/4WTB)



TWO VERTICAL TRIM BARS WITH PERF SIDES (2VTB/PS)

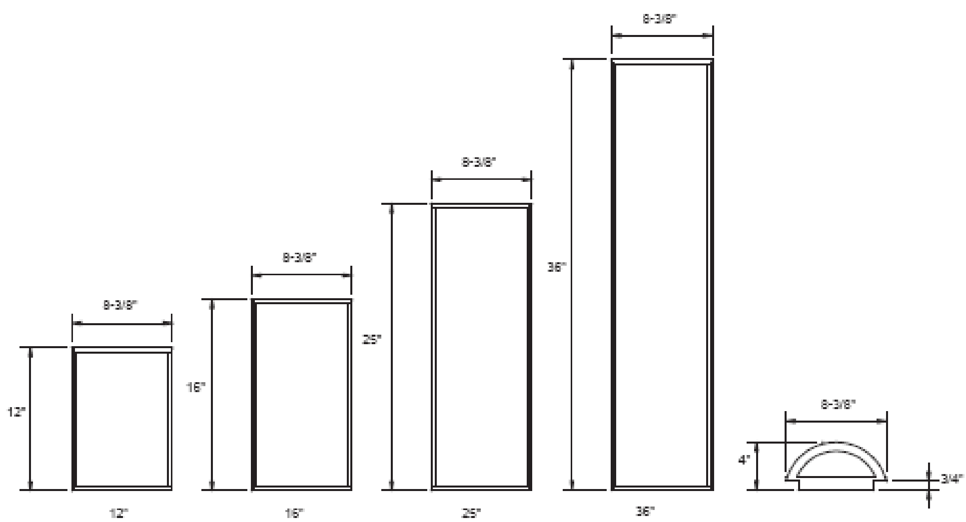
THREE HORIZONTAL & ONE VERTICAL TRIM BARS WITH PERF (3HTB/1VTB/P)

TWO HORIZONTAL & TWO VERTICAL TRIM BARS WITH PERF CENTER (2HTB/2VTB/PC)

ONE PROUD VERTICAL TRIM BAR (1PVTB)

TWO PROUD VERTICAL TRIM BARS (2PVTB)

DIMENSIONS



COOPER Lighting
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Luminaire Type SS3 – Lamp Information

WORLDWIDE PARTNER

GE Lighting

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Products > Linear Fluorescent > Straight Linear > T5 > 31590

31590 – F14W/T5/830/ECO

GE Ecolux® Starcoat® T5

PRINT

• Passes TCLP, which can lower disposal costs.

High Color Rendering

GENERAL CHARACTERISTICS	
Lamp type	Linear Fluorescent - Straight Linear
Bulb	T5
Base	Miniature Bi-Pin (G5)
Wattage	14
Voltage	82
Rated Life	30000 hrs
Rated Life (rapid start) @ Time	30000 h @ 3 h 36000 h @ 12 h
Bulb Material	Soda lime
Starting Temperature (MIN)	-20 °C (-4 °F)
Additional Info	TCLP compliant

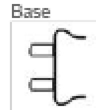
PHOTOMETRIC CHARACTERISTICS	
Initial Lumens	1350
Mean Lumens	1240
Nominal Initial Lumens per Watt	96
Color Temperature	3000 K
Color Rendering Index (CRI)	85
S/P Ratio (Scotopic/Photopic Ratio)	1.3

ELECTRICAL CHARACTERISTICS	
Open Circuit Voltage (rapid start) Min @ Temperature	230 V @ 10 °C
Cathode Resistance Ratio - Rh/Rc (MIN)	4.25
Cathode Resistance Ratio - Rh/Rc (MAX)	6.5
Current Crest Factor (MAX)	1.7

DIMENSIONS	
Maximum Overall Length (MOL)	22.1700 in (563.1 mm)
Nominal Length	21.600 in (548.6 mm)
Bulb Diameter (DIA)	0.625 in (15.8 mm)
Bulb Diameter (DIA) (MAX)	0.670 in (17.0 mm)
Max Base Face to Base Face (A)	21.610 in (548.8 mm)

Bulb

Base



View Larger

ADDITIONAL RESOURCES

Catalogs

Testimonials

Brochures

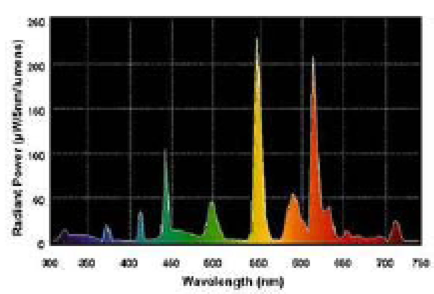
Application/Segment Brochures
- Contractor Lighting
- Healthcare Lighting

Product Brochures
- Ecolux

Disposal Policies & Recycling Information

GRAPHS & CHARTS

Spectral Power Distribution



Lamp Mortality

Luminaire Type SS3 – Ballast Information

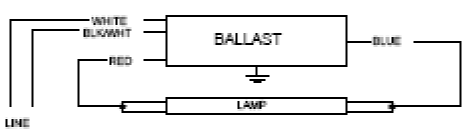
ADVANCE

ICN-132-MC@277V	
Brand Name	CENTIUM MICRO CAN
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Series
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
* F14T5	1	14	32/00	0.07	19	1.05	20	0.98	1.7	5.53
F17T8	1	17	0/-18	0.06	17	0.88	20	0.98	1.7	5.18
F21T5	1	21	32/00	0.09	26	1.05	15	0.98	1.7	4.04
F25T8	1	25	0/-18	0.09	23	0.88	15	0.98	1.7	3.83
F28T5	1	28	32/00	0.12	34	1.05	10	0.98	1.7	3.09
F32T8	1	32	0/-18	0.11	30	0.88	10	0.98	1.7	2.93
F32T8/ES (30W)	1	30	60/16	0.10	27	0.88	10	0.98	1.7	3.26

Wiring Diagram

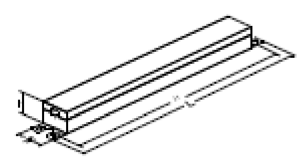


Diag. 63

The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

Enclosure



Enclosure Dimensions

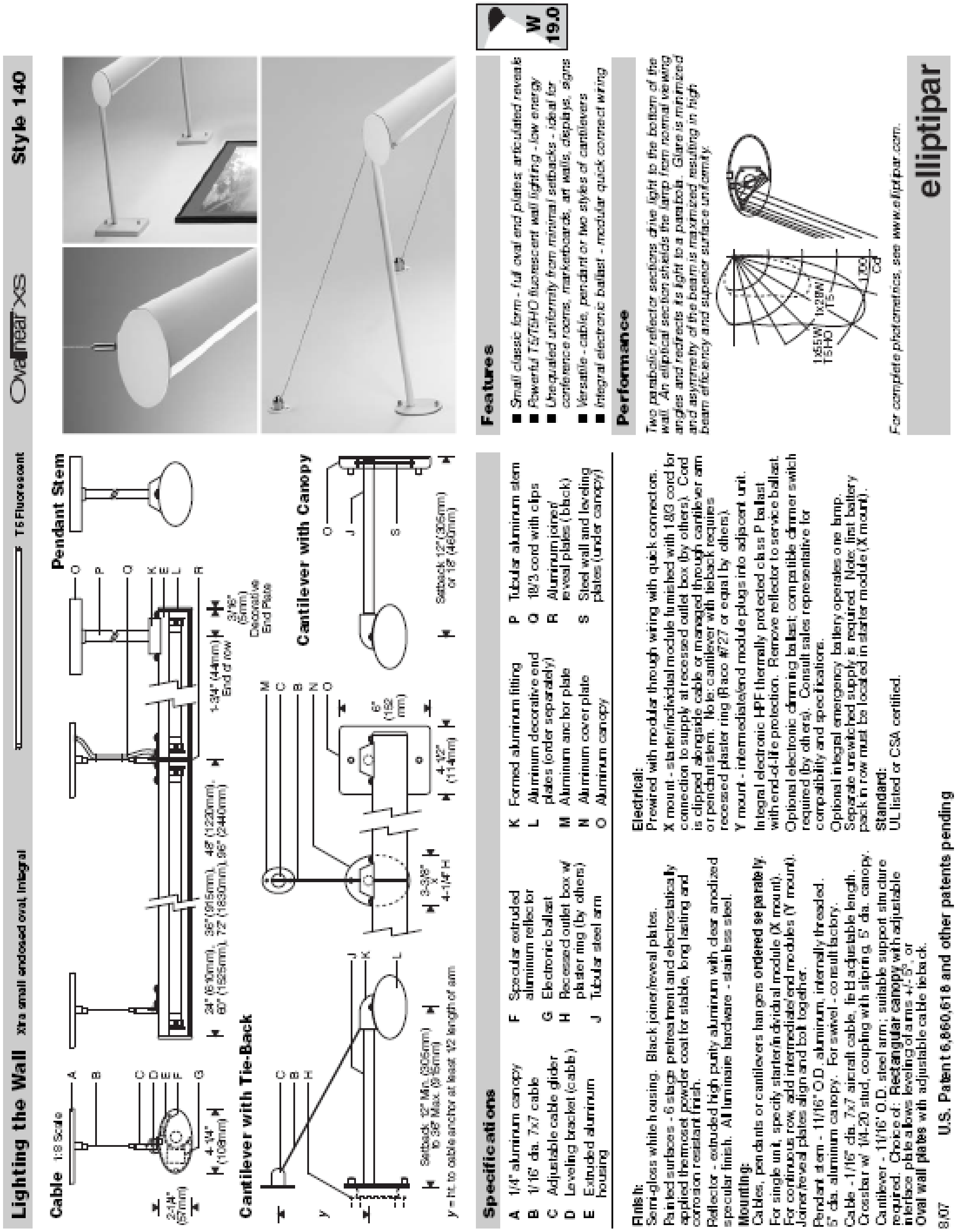
OverAll (L)	Width (W)	Height (H)	Mounting (M)
9.50 "	1.08 "	1.05 "	8.91 "
9 1/2	1 2/25	1 1/20	8 91/100
24.1 cm	2.7 cm	2.7 cm	22.6 cm

Revised 01/06/2005

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

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

Luminaire Type SS5– Luminaire Cutsheet



Lighting the Wall Xtra small enclosed oval, integral — T5 Fluorescent — Ovalinear XS — **Style 140**

Specifications

A 1/4" aluminum canopy	F Specular extruded aluminum reflector	K Formed aluminum fitting	P Tubular aluminum stem
B 1/16' dia. 7x7 cable	G Electronic ballast	L Aluminum decorative end plates (order separately)	Q 18/3 cord with clips
C Adjustable cable glider	H Recessed outlet box w/ plaster ring (by others)	M Aluminum anchor plate	R Aluminum joiner/ reveal plates (black)
D Leveling bracket (cable)	J Tubular steel arm	N Aluminum cover plate	S Steel wall and leveling plates (under canopy)
E Extruded aluminum housing		O Aluminum canopy	

Finish:
Semi-gloss white housing. Black joiner/reveal plates.
Painted surfaces - 6 stage pretreatment and electrostatically applied thermoset powder coat for stable, long lasting and corrosion resistant finish.
Reflector - extruded high purity aluminum with clear anodized specular finish. All luminaire hardware - stainless steel.

Mounting:
Cables, pendants or cantilevers hangers **ordered separately**.
For single unit, specify starter/individual module (X mount). For continuous row, add intermediate/end modules (Y mount). Joiner/reveal plates align and bolt together.
Pendant stem - 11/16" O.D. aluminum, internally threaded. 5" dia. aluminum canopy. For swivel - consult factory.
Cable - 1/16" dia. 7x7 aircraft cable, field adjustable length. Crossbar w/ 1/4-20 stud, coupling with slipring, 5' dia. canopy.
Cantilever - 11/16" O.D. steel arm; suitable support structure required. Choice of: **Rectangular canopy** with adjustable interface plate allows leveling of arms +/- 5°, or **Oval wall plates** with adjustable cable tieback.

Electrical:
Prewired with modular through wiring with quick connectors.
X mount - starter/individual module furnished with 18/3 cord for connection to supply at recessed outlet box (by others). Cord is clipped alongside cable or managed through cantilever arm or pendant stem. Note: cantilever with tieback requires recessed plaster ring (Raco #727 or equal by others).
Y mount - intermediate/end module plugs into adjacent unit.
Integral electronic HPF thermally protected class P ballast with end-of-life protection. Remove reflector to service ballast.
Optional electronic dimming ballast; compatible dimmer switch required (by others). Consult sales representative for compatibility and specifications.
Optional integral emergency battery operates one lamp. Separate unswitched supply is required. Note: first battery pack in row must be located in starter module (X mount).

Standard:
UL listed or CSA certified.

Features

- *Small classic form - full oval end plates, articulated reveals*
- *Powerful T5/T5HO fluorescent wall lighting - low energy*
- *Unequaled uniformity from minimal setbacks - ideal for conference rooms, markerboards, art walls, displays, signs*
- *Versatile - cable, pendant or two styles of cantilevers*
- *Integral electronic ballast - modular quick connect wiring*

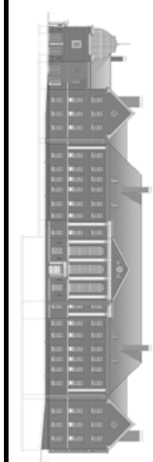
Performance

Two parabolic reflector sections drive light to the bottom of the wall. An elliptical section shields the lamp from normal viewing angles and redirects its light to a parabola. Glare is minimized and asymmetry of the beam is maximized resulting in high beam efficiency and superior surface uniformity.

For complete photometrics, see www.elliptipar.com.

elliptipar

8/07 **U.S. Patent 6,860,618 and other patents pending**



To Order

Ovalinear XS **Style 140**

To form a Catalog Number

F | 1 4 0 - T ___ - ___ - ___ - ___ - ___ ___
1 2 3 4 5 6 7 8

1 Source
F = Linear fluorescent

2 Style
140 = Xtra small enclosed oval, **Integral** ballast

3 Lamp
T ___ ___ = **T5 Fluorescent Lamp Code**
Lamp Wattage (see chart below)
Number of Lamps in Length, specify 1 or 2

Example: **T155** = 4' (1.2m) housing with one 54W T5HO lamp

Length*	T5 Code	T5 Lamp(s)	T5HO Code	T5HO Lamp(s)
T5 Fluorescent				
24" (610mm)	T114	1 x F14T5	T124	1 x F24T5/HO
36" (915mm)	T121	1 x F21T5	T139	1 x F39T5/HO
48" (1220mm)	T128	1 x F28T5	T155	1 x F54T5/HO
60" (1525mm)	T135	1 x F35T5	T180	1 x F80T5/HO
72" (1830mm)	T221	2 x F21T5	T239	2 x F39T5/HO
96" (2440mm)	T228	2 x F28T5	T255	2 x F54T5/HO

For complete lamp and ballast information, see Accessories Section. Standard T5 lamp color is 3000K / 80+ CRI.
* Add 3/8" (10mm) to row or single unit for **ADE** Decorative End Plates

W 19.1

4 Mounting
X = Starter/individual module with electrical feed (18/3 cord)
Note: units with dimming or battery will be provided with 18/4 or two (2) 18/3 cords as required.
Y = Intermediate/end module with modular through wiring with quick connectors

Note: Order cable, pendant, or cantilever hangers separately.

5 Finish
02 = Semi-gloss white
99 = Custom RAL or computer matched color to be specified, consult sales representative

8/07 **elliptipar**

Project:

6 Voltage/Ballast

Electronic
1 = 120V
2 = 277V
3 = 347V (Canada)
Note: Not available for use with cable hangers.

*Dimming**
T = 120V
V = 277V

* Consult sales representative for dimming 5' lamps (lamp codes T135, T180). Availability for wattages and voltages varies with ballast manufacturer and control type - see **www.elliptipar.com** for additional dimming specifications and limitations.
Consult factory when dimming units with cable supports. The quantity of electrical feed cable hangers to accommodate the control circuit varies with ballast manufacturer and control type.

7 Option (See Accessories Section for specifications)
00 = No option
0E = Integral emergency battery pack with indicator lamp and test button. Operates one lamp. Available in 4', 5', 6' and 8' lengths (lamp codes T128, T135, T221, T228, T155, T239 and T255).
Note: For rows, 0E option must be specified for the starter/individual module (X mount). Additional battery packs may be specified on intermediate/end modules.
XX = For modification not listed, include detailed description. Consult factory prior to specification.

8 Standard
0 = UL, Underwriters Laboratories
J = CSA, Canadian Standards Association

Example

F140 - T155 - X - 02 - 2 - 000

Xtra small enclosed oval series for use with one 4' F54T5HO lamp, 48" long housing (not including decorative end plates). For use with cable, pendant or cantilever hangers (order separately). Semi-gloss white. Integral 277V Ballast. UL. Order decorative end plates and hangers separately.

Accessories
Order separately. See Accessories Section for specifications.

ADE40 ___ 0 = **Decorative end plates**, pair, white, or custom color to match housing
5
Note: adds 3/8" (10mm) to length

elliptipar
114 Boston Post Road, West Haven, Connecticut 06516, USA
Voice 203.931.4455 • Fax 203.931.4464 • **www.elliptipar.com**

Type:

Hangers
Order separately. See Accessories Section for specifications.

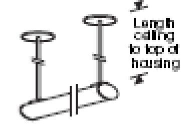
Cable supports
Order one non-electrical and one electrical feed cable support for each starter/individual module (X mount). Order one non-electrical cable support for each additional intermediate/end module (Y mount) in a row.
Note: For dimming (voltage/ballast code T or V), an additional electrical feed cable support may be required depending on ballast manufacturer and control type - consult factory.

Pendant and Cantilevers
Order one hanger for each module (X or Y mount) plus one hanger for the end of each row. At location with outlet box, prewired cord on starter/individual module (X mount) is managed through stem or arm.

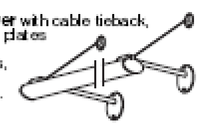
Electrical feed can be located at ends or intermediate joints.

VX ___ ___ ___ 0 = **Cable support**, field adjustable
48 = up to 48" (1.2m)
96 = up to 96" (2.4m)
5 Finish
Note: canopy is white unless specified other
R = Non-electrical
S = Electrical feed, white or black 18/3 cord

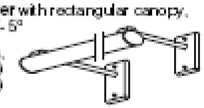
VXF ___ ___ 0 = **Pendant stem**, 11/16" O.D. aluminum
Length in inches, up to 60" (1.5m), 6" minimum
5 Finish



VXV ___ ___ 0 = **Cantilever** with cable tieback, oval wall plates
Setback in inches, 12" (305mm) min. 36" (915mm) max.
5 Finish



VXC ___ ___ 0 = **Cantilever** with rectangular canopy, levels +/- 5°
Setback in inches,
12 = 12" (305mm)
18 = 18" (460mm)
5 Finish



Luminaire Type SS5 – Lamp Information

GE Lighting

WORLDWIDE PARTNER

Commercial Products & Solutions

SITE SEARCH | HOME | PRODUCTS | EDUCATION / RESOURCES | LIGHTING APPLICATIONS

Where to Buy | FAQs | Contact Us | EliteNet

Products > Linear Fluorescent > Straight Linear > T5 > 46677

46677 – F21W/T5/830/ECO

GE Ecolux® Starcoat® T5

PRINT

• Passes TCLP, which can lower disposal costs.

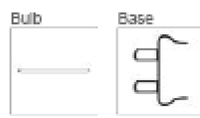
High Color Rendering

GENERAL CHARACTERISTICS	
Lamp type	Linear Fluorescent - Straight Linear
Bulb	T5
Base	Miniature Bi-Pin (G5)
Wattage	21
Voltage	123
Rated Life	30000 hrs
Rated Life (rapid start) @ Time	30000 h @ 3 h 36000 h @ 12 h
Bulb Material	Soda lime
Starting Temperature (MIN)	-20 °C (-4 °F)
Additional Info	TCLP compliant

PHOTOMETRIC CHARACTERISTICS	
Initial Lumens	2100
Mean Lumens	1930
Nominal Initial Lumens per Watt	100
Color Temperature	3000 K
Color Rendering Index (CRI)	85
S/P Ratio (Scotopic/Photopic Ratio)	1.3

ELECTRICAL CHARACTERISTICS	
Open Circuit Voltage (rapid start) Min @ Temperature	340 V @ 10 °C
Cathode Resistance Ratio - Rh/Rc (MIN)	4.25
Cathode Resistance Ratio - Rh/Rc (MAX)	6.5
Current Crest Factor (MAX)	1.7

DIMENSIONS	
Maximum Overall Length (MOL)	33.9800 in (863.0 mm)
Nominal Length	33.400 in (848.3 mm)
Bulb Diameter (DIA)	0.625 in (15.8 mm)
Bulb Diameter (DIA) (MAX)	0.670 in (17.0 mm)
Max Base Face to Base Face (A)	33.430 in (849.1 mm)



View Larger

ADDITIONAL RESOURCES

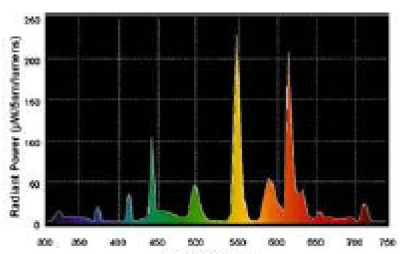
Catalogs
Testimonials
Brochures
Application/Segment Brochures
- Contractor Lighting
- Healthcare Lighting

Product Brochures
- Ecolux
- Ecolux (Environmental)

Disposal Policies & Recycling Information

GRAPHS & CHARTS

Spectral Power Distribution



Lamp Mortality

Luminaire Type SS5 – Ballast Information

ADVANCE

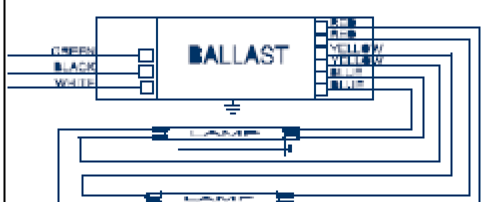
ICN-2S28@277

Brand Name	CENTIUM T5
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
F14T5	1	14	0/-18	0.07	19	1.07	20	0.90	1.7	5.63
F14T5	2	14	0/-18	0.13	34	1.06	10	0.98	1.7	3.12
F21T5	1	21	0/-18	0.10	26	1.03	15	0.95	1.7	3.96
* F21T5	2	21	0/-18	0.17	48	1.02	10	0.98	1.7	2.13
F28T5	1	28	0/-18	0.12	33	1.04	10	0.98	1.7	3.15
F28T5	2	28	0/-18	0.23	63	1.03	10	0.99	1.7	1.63
F35T5	1	35	0/-18	0.15	41	1.01	10	0.98	1.7	2.46
F35T5	2	35	0/-18	0.28	77	1.00	10	0.99	1.7	1.30

Wiring Diagram



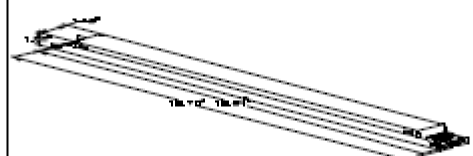
The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (inches)

	in.	cm.
Black	0	0
White	0	0
Blue	0	0
Red	0	0
Yellow	0	0
Gray	0	0
Violet	0	0

	in.	cm.
Yellow/Blue	0	0
Blue/White	0	0
Brown	0	0
Orange	0	0
Orange/Black	0	0
Black/White	0	0
Red/White	0	0

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
16.70 "	1.18 "	1.00 "	16.34 "
16 7/10	1 9/50	1	16 17/50
42.4 cm	3 cm	2.5 cm	41.5 cm

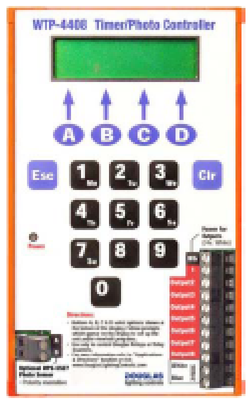
Revised 09/01/2004

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

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

Cutsheet for Time Clock Controller

8 Output Time/Photo Controller WTP-4408 Technical Data

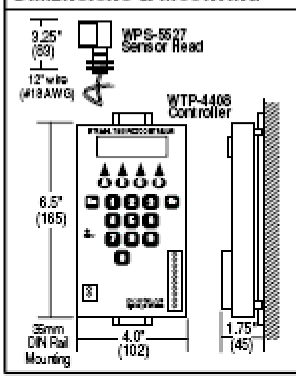


PART No.	DESCRIPTION	SPECIFICATION
WTP-4408 Time / Photo Controller ONLY WPS-5527 Optional Remote Daylight Sensor	• Electronic 365 day astronomic time/photo controller for switching Douglas 2-wire relays and/or relay scanners. • Controller is designed to fit in Douglas relay panels on center DIN rail. • The Time/Photo Controller uses a LCD display and membrane key pad for programming. • Each output is programmed to switch ON or OFF when an event occurs. Events can be: *Time Based:* Lights are turned ON or OFF at a specific time of day, *Astro Based:* Lights are turned ON or OFF depending on solar position of the sun, *Photo Based:* Lights are turned ON or OFF depending on the true ambient light level (requires WPC-5527 Sensor).	***Inputs*** • Power: 24VAC / 100mA Class 2 Low Voltage device. • Power rating does not include power for switching relays or scanners. • Connect switches in parallel with controller outputs for remote override switching. • Optional WPS-5527 Photo Sensor. Range: 1 to 6,500 fc; remote mount. ***Outputs*** • 8 time/photo controlled outputs for Douglas relays and scanners. • Maximum relays per output is 4. Use #18 AWG wire. Maximum length for relay control: 500'. • Maximum scanners per output is 20. Use #18 AWG wire. Maximum length for scanner control 2000.

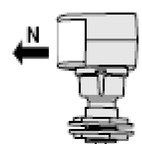
Programming
- Membrane key pad entry with LCD display graphic.
- Any output can be time, astro, photo controlled or combination time and photo/astro controlled.
- Using sensor, any output can be set to switch at a specific light level. (eg1: ON 10fc; OFF 40fc Day Night) (eg2: ON 2000fc; OFF 4000fc Skylight)
- Up to 600 events per week.
- Set any output schedule to run on any week day (Su-Mo-Tu-W-Th-F-Sa).
- 32 holiday dates are available.
- The controller's memory and time are not lost when power fails. Programs are held indefinitely and time is held for a minimum of 72 hours.

Environment
- Indoors, stationary, non-vibrating, non-corrosive atmosphere and non-condensing humidity.
- Ambient operating temperature: +15° to +120°F (-10°C to +50°C).

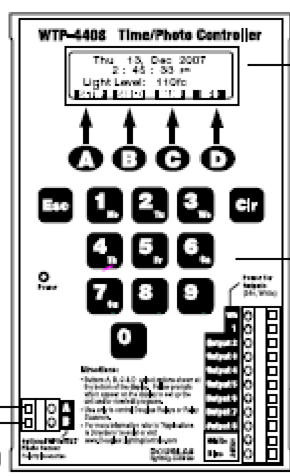
DIMENSIONS & MOUNTING



WPS-5527
Remote Sensor Head
Point sensor to the Northern sky for the most consistent readings.
Connect sensor to only one photo controller.



WTP-4408
8 Output Time/Photo Controller
Install Controller in relay panel.
Connect to relays or relay scanners.



LCD Display
In normal operating mode the LCD display shows the present time.
In all other modes, the LCD display shows various prompts to help guide viewing and editing the Controller's programs.

Membrane Keypad
Membrane Keypad is used to set the time clock's time and is used to enter the programs.

Outputs
There are 8 outputs designed to switch Douglas 2-wire relays or scanners.

Wiring
Wire length max: 500' (150M)
Use two #18 AWG, unshielded wire.

Components 6.1 www.DouglasLightingControls.com DOUGLAS lighting controls
B4-1,2,3,4 -Auto, Time & Photo Control

Access to Modeling Files

P:\Thesis AGI Models

-Lab, Atrium, Atrium Daylight Study, Lecture Hall, Exterior QuickCalc

P:\Thesis Model Files

-Exterior Renderings in VIZ, all AutoCAD model files

P:\Thesis AutoCAD Files

-Lighting and Circuiting Plans for all layouts

Appendix B

Electrical Depth Supplemental Information

Panelboard Calculations – Panel L4B (Revised)

PANELBOARD SIZING WORKSHEET											
Panel Tag----------------------->					L4B	Panel Location:			North Electrical Room		
Nominal Phase to Neutral Voltage------>					277				3		
Nominal Phase to Phase Voltage------>					480	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Fluorescent Ltg	3	RM 43-45	1625	w	0.99	1625	1641		
2	A	HID Lighting	4	FRONT/EAST	622.22	w	0.93	622	672		
3	B	Fluorescent Ltg	3	RM 33, 40	2005	w	0.97	2005	2076		
4	B	HID Lighting	4	POLE EAST	788.04	w	0.91	788	870		
5	C	Fluorescent Ltg	3	COR 000	1492	w	0.94	1492	1581		
6	C	HID Lighting	4	POLE SOUTH WEST	1295	w	0.90	1295	1439		
7	A	Fluorescent Ltg	3	RM 50-55	1206	w	0.99	1206	1221		
8	A	HID Lighting	4	POLE WEST	1480	w	0.90	1480	1644		
9	B	Fluorescent Ltg	3	STAIR WEST	314	w	0.98	314	320		
10	B	Incandescent Ltg	5	GARDEN SOUTH	750	w	1.00	750	750		
11	C	Fluorescent Ltg	3	STAIR SOUTH	216	w	0.98	216	220		
12	C	spare				w	1.00	0	0		
13	A	spare				w	1.00	0	0		
14	A	spare				w	1.00	0	0		
15	B	spare				w	1.00	0	0		
16	B	spare				w	1.00	0	0		
17	C	spare				w	1.00	0	0		
18	C	spare				w	1.00	0	0		
19	A	space				w	1.00	0	0		
20	A	space				w	1.00	0	0		
21	B	space				w	1.00	0	0		
22	B	space				w	1.00	0	0		
23	C	space				w	1.00	0	0		
24	C	space				w	1.00	0	0		
25	A	space				w	1.00	0	0		
26	A	space				w	1.00	0	0		
27	B	space				w	1.00	0	0		
28	B	space				w	1.00	0	0		
29	C	space				w	1.00	0	0		
30	C	space				w	1.00	0	0		
31	A	space				w	1.00	0	0		
32	A	space				w	1.00	0	0		
33	B	space				w	1.00	0	0		
34	B	space				w	1.00	0	0		
35	C	space				w	1.00	0	0		
36	C	space				w	1.00	0	0		
37	A	space				w	1.00	0	0		
38	A	space				w	1.00	0	0		
39	B	space				w	1.00	0	0		
40	B	space				w	1.00	0	0		
41	C	space				w	1.00	0	0		
42	C	space				w	1.00	0	0		
PANEL TOTAL								11.8	12.4	Amps=	15.0
PHASE LOADING							kW	kVA	% Total	Amps	% +/-
		PHASE TOTAL	A				4.9	5.2	42%	18.7	24.94%
		PHASE TOTAL	B				3.9	4.0	32%	14.5	-3.10%
		PHASE TOTAL	C				3.0	3.2	26%	11.7	-21.84%
LOAD CATEGORIES				Connected			Demand				
				kW	kVA	DF	kW	kVA	PF		
1		receptacles		0.0	0.0	0.70	0.0	0.0			
2		computers		0.0	0.0	0.90	0.0	0.0			
3		fluorescent lighting		6.9	7.1	1.00	6.9	7.1	0.97		
4		HID lighting		4.2	4.6	1.00	4.2	4.6	0.90		
5		incandescent lighting		0.8	0.8	1.00	0.8	0.8	1.00		
6		HVAC fans		0.0	0.0	0.80	0.0	0.0			
7		heating		0.0	0.0	1.25	0.0	0.0			
8		kitchen equipment		0.0	0.0	0.80	0.0	0.0			
		Total Demand Loads					11.8	12.4			
		Spare Capacity		25%			2.9	3.1			
		Total Design Loads					14.7	15.5	0.95	Amps=	18.7
		Total Design Loads								Amps=	

Panelboard Calculations – Panel L1NA (Revised)

PANELBOARD SIZING WORKSHEET											
Panel Tag----------------------->					L1NA	Panel Location:			North Electrical Room		
Nominal Phase to Neutral Voltage------>					277				3		
Nominal Phase to Phase Voltage------>					480	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	spare				w	1.00	0	0		
2	A	Fluorescent Ltg	3	RM 100A, 114,120	1124	w	0.97	1124	1164		
3	B	spare				w	1.00	0	0		
4	B	Fluorescent Ltg	3	R 115-19, 121-24	2578	w	0.95	2578	2711		
5	C	spare				w	1.00	0	0		
6	C	Fluorescent Ltg	3	R 100B-C,131-2	1485	w	0.97	1485	1526		
7	A	spare				w	1.00	0	0		
8	A	Fluorescent Ltg	3	RM 110, 130	2017	w	0.98	2017	2058		
9	B	spare				w	1.00	0	0		
10	B	Fluorescent Ltg	3	RM 132A-E, 138	3079	w	0.95	3079	3248		
11	C	spare				w	1.00	0	0		
12	C	Fluorescent Ltg	3	R 139, 9A-E, 140, A	1512	w	0.95	1512	1595		
13	A	spare				w	1.00	0	0		
14	A	Fluorescent Ltg	3	STRS 1ST TO 2ND	38	w	0.98	38	39		
15	B	spare				w	1.00	0	0		
16	B	Fluorescent Ltg	3	SCNS NORTH	57	w	0.98	57	58		
17	C	spare				w	1.00	0	0		
18	C	spare				w	1.00	0	0		
19	A	spare				w	1.00	0	0		
20	A	spare				w	1.00	0	0		
21	B	space				w	1.00	0	0		
22	B	space				w	1.00	0	0		
23	C	space				w	1.00	0	0		
24	C	space				w	1.00	0	0		
25	A	space				w	1.00	0	0		
26	A	space				w	1.00	0	0		
27	B	space				w	1.00	0	0		
28	B	space				w	1.00	0	0		
29	C	space				w	1.00	0	0		
30	C	space				w	1.00	0	0		
31	A	space			0	w	1.00	0	0		
32	A	space			0	w	1.00	0	0		
33	B	space			0	w	1.00	0	0		
34	B	space			0	w	1.00	0	0		
35	C	space			0	w	1.00	0	0		
36	C	space			0	w	1.00	0	0		
37	A	space			0	w	1.00	0	0		
38	A	space			0	w	1.00	0	0		
39	B	space			0	w	1.00	0	0		
40	B	space			0	w	1.00	0	0		
41	C	space			0	w	1.00	0	0		
42	C	space			0	w	1.00	0	0		
PANEL TOTAL								11.9	12.4	Amps=	14.9
PHASE LOADING							kW	kVA	% Total	Amps	% +/-
PHASE TOTAL			A				3.2	3.3	26%	11.8	-21.11%
PHASE TOTAL			B				5.7	6.0	49%	21.7	45.59%
PHASE TOTAL			C				3.0	3.1	25%	11.3	-24.48%
LOAD CATAGORIES				Connected			Demand				
				kW	kVA	DF	kW	kVA	PF		
1	receptacles			0.0	0.0	0.70	0.0	0.0			
2	computers			0.0	0.0	0.90	0.0	0.0			
3	fluorescent lighting			11.9	12.4	1.00	11.9	12.4	0.96		
4	HID lighting			0.0	0.0	1.00	0.0	0.0			
5	incandescent lighting			0.0	0.0	1.00	0.0	0.0			
6	HVAC fans			0.0	0.0	0.80	0.0	0.0			
7	heating			0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment			0.0	0.0	0.80	0.0	0.0			
Total Demand Loads							11.9	12.4			
Spare Capacity				25%			3.0	3.1			
Total Design Loads							14.9	15.5	0.96	Amps=	18.7
Total Design Loads										Amps=	

Panelboard Calculations – Panel L1SA (Revised)

PANELBOARD SIZING WORKSHEET											
Panel Tag----------------------->					L1SA	Panel Location:			South Electrical Room		
Nominal Phase to Neutral Voltage------>					277				3		
Nominal Phase to Phase Voltage------>					480	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Fluorescent Ltg	3	R 161,70,52, COR	3124	w	0.98	3124	3201		
2	A	spare				w	1.00	0	0		
3	B	Fluorescent Ltg	3	RM 156, 62-69	2184	w	0.95	2184	2294		
4	B	spare				w	1.00	0	0		
5	C	Fluorescent Ltg	3	R 173,74,75,81,84	1780	w	0.95	1780	1872		
6	C	spare				w	1.00	0	0		
7	A	Fluorescent Ltg	3	RM 151A-J	2269	w	0.96	2269	2373		
8	A	spare				w	1.00	0	0		
9	B	Fluorescent Ltg	3	RM 151D,E,144,43	2850	w	0.97	2850	2938		
10	B	spare				w	1.00	0	0		
11	C	spare				w	1.00	0	0		
12	C	spare				w	1.00	0	0		
13	A	spare				w	1.00	0	0		
14	A	spare				w	1.00	0	0		
15	B	Fluorescent Ltg	3	ATR CAFÉ	216	w	0.98	216	220		
16	B	spare				w	1.00	0	0		
17	C	Fluorescent Ltg	3	SCNS ATR NORTH	57	w	0.98	57	58		
18	C	spare				w	1.00	0	0		
19	A	Fluorescent Ltg	3	DISPLAY WALL	48	w	0.98	48	49		
20	A	spare				w	1.00	0	0		
21	B	space				w	1.00	0	0		
22	B	space				w	1.00	0	0		
23	C	space				w	1.00	0	0		
24	C	space				w	1.00	0	0		
25	A	space				w	1.00	0	0		
26	A	space				w	1.00	0	0		
27	B	space				w	1.00	0	0		
28	B	space				w	1.00	0	0		
29	C	space				w	1.00	0	0		
30	C	space				w	1.00	0	0		
31	A	space			0	w	1.00	0	0		
32	A	space			0	w	1.00	0	0		
33	B	space			0	w	1.00	0	0		
34	B	space			0	w	1.00	0	0		
35	C	space			0	w	1.00	0	0		
36	C	space			0	w	1.00	0	0		
37	A	space			0	w	1.00	0	0		
38	A	space			0	w	1.00	0	0		
39	B	space			0	w	1.00	0	0		
40	B	space			0	w	1.00	0	0		
41	C	space			0	w	1.00	0	0		
42	C	space			0	w	1.00	0	0		
PANEL TOTAL								12.5	13.0	Amps=	15.7
PHASE LOADING							kW	kVA	% Total	Amps	% +/-
PHASE TOTAL			A				5.4	5.6	43%	20.3	29.71%
PHASE TOTAL			B				5.3	5.5	42%	19.7	25.77%
PHASE TOTAL			C				1.8	1.9	15%	7.0	-55.48%
LOAD CATAGORIES				Connected			Demand				
				kW	kVA	DF	kW	kVA	PF		
1	receptacles			0.0	0.0	0.70	0.0	0.0			
2	computers			0.0	0.0	0.90	0.0	0.0			
3	fluorescent lighting			12.5	13.0	1.00	12.5	13.0	0.96		
4	HID lighting			0.0	0.0	1.00	0.0	0.0			
5	incandescent lighting			0.0	0.0	1.00	0.0	0.0			
6	HVAC fans			0.0	0.0	0.80	0.0	0.0			
7	heating			0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment			0.0	0.0	0.80	0.0	0.0			
Total Demand Loads							12.5	13.0			
Spare Capacity				25%			3.1	3.3			
Total Design Loads							15.7	16.3	0.96	Amps=	19.6
Total Design Loads										Amps=	

Panelboard Calculations – Panel L2NA(Revised)

PANELBOARD SIZING WORKSHEET											
Panel Tag----------------------->					L2NA	Panel Location:			North Electrical Room		
Nominal Phase to Neutral Voltage----->					277				3		
Nominal Phase to Phase Voltage----->					480	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	spare				w	1.00	0	0		
2	A	Fluorescent Ltg	3	R 210-212	1896	w	0.97	1896	1948		
3	B	spare				w	1.00	0	0		
4	B	Fluorescent Ltg	3	R 213-214	3498	w	0.95	3498	3686		
5	C	spare				w	1.00	0	0		
6	C	Fluorescent Ltg	3	R 204-06, 238-41	3357	w	0.95	3357	3532		
7	A	spare				w	1.00	0	0		
8	A	Fluorescent Ltg	3	RM 200, 231-32	3023	w	0.97	3023	3126		
9	B	spare				w	1.00	0	0		
10	B	Fluorescent Ltg	3	ATR STR 2ND 3RD	38	w	0.98	38	39		
11	C	spare				w	1.00	0	0		
12	C	spare				w	1.00	0	0		
13	A	spare				w	1.00	0	0		
14	A	spare				w	1.00	0	0		
15	B	spare				w	1.00	0	0		
16	B	spare				w	1.00	0	0		
17	C	spare				w	1.00	0	0		
18	C	spare				w	1.00	0	0		
19	A	spare				w	1.00	0	0		
20	A	spare				w	1.00	0	0		
21	B	space				w	1.00	0	0		
22	B	space				w	1.00	0	0		
23	C	space				w	1.00	0	0		
24	C	space				w	1.00	0	0		
25	A	space				w	1.00	0	0		
26	A	space				w	1.00	0	0		
27	B	space				w	1.00	0	0		
28	B	space				w	1.00	0	0		
29	C	space				w	1.00	0	0		
30	C	space				w	1.00	0	0		
31	A	space			0	w	1.00	0	0		
32	A	space			0	w	1.00	0	0		
33	B	space			0	w	1.00	0	0		
34	B	space			0	w	1.00	0	0		
35	C	space			0	w	1.00	0	0		
36	C	space			0	w	1.00	0	0		
37	A	space			0	w	1.00	0	0		
38	A	space			0	w	1.00	0	0		
39	B	space			0	w	1.00	0	0		
40	B	space			0	w	1.00	0	0		
41	C	space			0	w	1.00	0	0		
42	C	space			0	w	1.00	0	0		
PANEL TOTAL								11.8	12.3	Amps=	14.8
PHASE LOADING							kW	kVA	% Total	Amps	% +/-
PHASE TOTAL			A				4.9	5.1	41%	18.3	23.44%
PHASE TOTAL			B				3.5	3.7	30%	13.4	-9.37%
PHASE TOTAL			C				3.4	3.5	29%	12.8	-14.07%
LOAD CATAGORIES				Connected			Demand				
				kW	kVA	DF	kW	kVA	PF		
1	receptacles			0.0	0.0	0.70	0.0	0.0			
2	computers			0.0	0.0	0.90	0.0	0.0			
3	fluorescent lighting			11.8	12.3	1.00	11.8	12.3	0.96		
4	HID lighting			0.0	0.0	1.00	0.0	0.0			
5	incandescent lighting			0.0	0.0	1.00	0.0	0.0			
6	HVAC fans			0.0	0.0	0.80	0.0	0.0			
7	heating			0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment			0.0	0.0	0.80	0.0	0.0			
Total Demand Loads							11.8	12.3			
Spare Capacity				25%			3.0	3.1			
Total Design Loads							14.8	15.4	0.96	Amps=	18.5
Total Design Loads										Amps=	

Panelboard Calculations – Panel L2SA (Revised)

PANELBOARD SIZING WORKSHEET											
Panel Tag----------------------->					L2SA	Panel Location:			South Electrical Room		
Nominal Phase to Neutral Voltage------>					277				3		
Nominal Phase to Phase Voltage------>					480	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Fluorescent Ltg	3	R 262, 262 A-M	3096	w	0.95	3096	3243		
2	A	spare				w	0.95	0	0		
3	B	Fluorescent Ltg	3	R 260, 261	2752	w	0.94	2752	2928		
4	B	spare				w	0.94	0	0		
5	C	Fluorescent Ltg	3	R 256-258	3197	w	0.96	3197	3318		
6	C	spare				w	0.96	0	0		
7	A	Fluorescent Ltg	3	R 248, 54	2699	w	0.95	2699	2831		
8	A	spare				w	0.95	0	0		
9	B	Fluorescent Ltg	3	R 243, 245, 42, 46	3543	w	0.95	3543	3736		
10	B	spare				w	1.00	0	0		
11	C	Fluorescent Ltg	3	R 200, 280, 255	2862	w	0.98	2862	2920		
12	C	spare				w	1.00	0	0		
13	A	Fluorescent Ltg	3	DOWN BALC	144	w	0.98	144	147		
14	A	spare				w	1.00	0	0		
15	B	Fluorescent Ltg	3	SCNS BALC	38	w	0.98	38	39		
16	B	spare				w	1.00	0	0		
17	C	spare				w	1.00	0	0		
18	C	spare				w	1.00	0	0		
19	A	spare				w	1.00	0	0		
20	A	spare				w	1.00	0	0		
21	B	space				w	1.00	0	0		
22	B	space				w	1.00	0	0		
23	C	space				w	1.00	0	0		
24	C	space				w	1.00	0	0		
25	A	space				w	1.00	0	0		
26	A	space				w	1.00	0	0		
27	B	space				w	1.00	0	0		
28	B	space				w	1.00	0	0		
29	C	space				w	1.00	0	0		
30	C	space				w	1.00	0	0		
31	A	space			0	w	1.00	0	0		
32	A	space			0	w	1.00	0	0		
33	B	space			0	w	1.00	0	0		
34	B	space			0	w	1.00	0	0		
35	C	space			0	w	1.00	0	0		
36	C	space			0	w	1.00	0	0		
37	A	space			0	w	1.00	0	0		
38	A	space			0	w	1.00	0	0		
39	B	space			0	w	1.00	0	0		
40	B	space			0	w	1.00	0	0		
41	C	space			0	w	1.00	0	0		
42	C	space			0	w	1.00	0	0		
PANEL TOTAL								18.3	19.2	Amps=	23.1
PHASE LOADING							kW	kVA	% Total	Amps	% +/-
PHASE TOTAL			A				5.9	6.2	32%	22.5	-2.61%
PHASE TOTAL			B				6.3	6.7	35%	24.2	4.94%
PHASE TOTAL			C				6.1	6.2	33%	22.5	-2.33%
LOAD CATAGORIES				Connected			Demand				
				kW	kVA	DF	kW	kVA	PF		
1	receptacles			0.0	0.0	0.70	0.0	0.0			
2	computers			0.0	0.0	0.90	0.0	0.0			
3	fluorescent lighting			18.3	19.2	1.00	18.3	19.2	0.96		
4	HID lighting			0.0	0.0	1.00	0.0	0.0			
5	incandescent lighting			0.0	0.0	1.00	0.0	0.0			
6	HVAC fans			0.0	0.0	0.80	0.0	0.0			
7	heating			0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment			0.0	0.0	0.80	0.0	0.0			
Total Demand Loads							18.3	19.2			
Spare Capacity				25%			4.6	4.8			
Total Design Loads							22.9	24.0	0.96	Amps=	28.8
Total Design Loads										Amps=	

Panelboard Calculations – Panel L3SA (Revised)

PANELBOARD SIZING WORKSHEET											
Panel Tag----------------------->					L3SA	Panel Location:			South Electrical Room		
Nominal Phase to Neutral Voltage------>					277				3		
Nominal Phase to Phase Voltage------>					480	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Fluorescent Ltg	3	R 374,75,76	3083	w	0.95	3083	3250		
2	A	Fluorescent Ltg	3	R 355G	880	w	0.90	880	978		
3	B	Fluorescent Ltg	3	R 361,62,63	3583	w	0.96	3583	3720		
4	B	Fluorescent Ltg	3	R 355F	660	w	0.90	660	733		
5	C	Fluorescent Ltg	3	R 373, CORR F-H	2039	w	0.98	2039	2089		
6	C	Fluorescent Ltg	3	R 355E	880	w	0.90	880	978		
7	A	Fluorescent Ltg	3	R 346,7,54	2918	w	0.95	2918	3064		
8	A	Fluorescent Ltg	3	R 355C	880	w	0.90	880	978		
9	B	Fluorescent Ltg	3	R 343,44,45,45A	4191	w	0.95	4191	4429		
10	B	Fluorescent Ltg	3	R 355B	880	w	0.90	880	978		
11	C	spare			0	w	1.00	0	0		
12	C	Fluorescent Ltg	3	R 355A	1760	w	0.90	1760	1956		
13	A	HVAC Fans	6	HT TRACE CT	1040	w	0.95	1040	1095		
14	A	Fluorescent Ltg	3	ATR DWN NOR	504	w	0.98	504	514		
15	B	HVAC Fans	6	HT TRACE CT	1040	w	0.95	1040	1095		
16	B	Fluorescent Ltg	3	SCNS BALC	38	w	0.98	38	39		
17	C	spare			0	w	1.00	0	0		
18	C	Fluorescent Ltg	3	DÉCOR PEND	184	w	0.98	184	188		
19	A	spare				w	1.00	0	0		
20	A	spare				w	1.00	0	0		
21	B	space				w	1.00	0	0		
22	B	space				w	1.00	0	0		
23	C	space				w	1.00	0	0		
24	C	space				w	1.00	0	0		
25	A	space				w	1.00	0	0		
26	A	space				w	1.00	0	0		
27	B	space				w	1.00	0	0		
28	B	space				w	1.00	0	0		
29	C	space				w	1.00	0	0		
30	C	space				w	1.00	0	0		
31	A	space			0	w	1.00	0	0		
32	A	space			0	w	1.00	0	0		
33	B	space			0	w	1.00	0	0		
34	B	space			0	w	1.00	0	0		
35	C	space			0	w	1.00	0	0		
36	C	space			0	w	1.00	0	0		
37	A	space			0	w	1.00	0	0		
38	A	space			0	w	1.00	0	0		
39	B	space			0	w	1.00	0	0		
40	B	space			0	w	1.00	0	0		
41	C	space			0	w	1.00	0	0		
42	C	space			0	w	1.00	0	0		
PANEL TOTAL								24.6	26.1	Amps=	31.4
PHASE LOADING							kW	kVA	% Total	Amps	% +/-
PHASE TOTAL			A				9.3	9.9	38%	35.7	13.62%
PHASE TOTAL			B				10.4	11.0	42%	39.7	26.45%
PHASE TOTAL			C				4.9	5.2	20%	18.8	-40.07%
LOAD CATAGORIES				Connected			Demand				
				kW	kVA	DF	kW	kVA	PF		
1	receptacles			0.0	0.0	0.70	0.0	0.0			
2	computers			0.0	0.0	0.90	0.0	0.0			
3	fluorescent lighting			22.5	23.9	1.00	22.5	23.9	0.94		
4	HID lighting			0.0	0.0	1.00	0.0	0.0			
5	incandescent lighting			0.0	0.0	1.00	0.0	0.0			
6	HVAC fans			2.1	2.2	0.80	1.7	1.8	0.95		
7	heating			0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment			0.0	0.0	0.80	0.0	0.0			
Total Demand Loads							24.1	25.6			
Spare Capacity				25%			6.0	6.4			
Total Design Loads							30.2	32.1	0.94	Amps=	38.6
Total Design Loads										Amps=	

Panelboard Calculations – Panel E4B (Revised)

PANELBOARD SIZING WORKSHEET											
Panel Tag---------------------->					E4B	Panel Location:			North Electrical Room		
Nominal Phase to Neutral Voltage------>					277				3		
Nominal Phase to Phase Voltage------>					480		Wires:		4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Fluorescent Ltg	3	VIVR EMERG	593	w	0.99	593	599		
2	A	HID Lighting	4	REAR EXTERIOR	129	w	1.00	129	129		
3	B	Fluorescent Ltg	3	MECH/ELEC NORTH	1365	w	0.99	1365	1379		
4	B	Fluorescent Ltg	3	2ND FL N EMERG	1621	w	0.96	1621	1681		
5	C	Fluorescent Ltg	3	2ND FL S EMERG	1267	w	0.96	1267	1321		
6	C	HID Lighting	4	EAST ENT EMERG	198	w	0.92	198	216		
7	A	Fluorescent Ltg	3	ELEV ROOM	130	w	0.99	130	131		
8	A	HID Lighting	4	WEST EMERG	556	w	0.91	556	614		
9	B	spare				w	1.00	0	0		
10	B	HID Lighting	4	GARDEN EMERG	703	w	0.90	703	781		
11	C	Fluorescent Ltg	3	N STAIR EMERG	1937.22	w	0.98	1937	1977		
12	C	spare				w	1.00	0	0		
13	A	Fluorescent Ltg	3	S STAIR EMERG	1900.22	w	0.98	1900	1939		
14	A	space				w	1.00	0	0		
15	B	Fluorescent Ltg	3	1ST FL N EMERG	1238	w	0.96	1238	1295		
16	B	Fluorescent Ltg	3	VESTIBULE LTG	184	w	0.98	184	188		
17	C	Fluorescent Ltg	3	1ST FL S EMERG	1515	w	0.96	1515	1575		
18	C	Fluorescent Ltg	3	BASEMENT EMERG	1175	w	0.96	1175	1226		
19	A	space				w	1.00	0	0		
20	A	space				w	1.00	0	0		
21	B	space				w	1.00	0	0		
22	B	space				w	1.00	0	0		
23	C	space				w	1.00	0	0		
24	C	space				w	1.00	0	0		
25	A	space				w	1.00	0	0		
26	A	space				w	1.00	0	0		
27	B	space				w	1.00	0	0		
28	B	space				w	1.00	0	0		
29	C	space				w	1.00	0	0		
30	C	space				w	1.00	0	0		
31	A	space				w	1.00	0	0		
32	A	space				w	1.00	0	0		
33	B	space				w	1.00	0	0		
34	B	space				w	1.00	0	0		
35	C	space				w	1.00	0	0		
36	C	space				w	1.00	0	0		
37	A	space				w	1.00	0	0		
38	A	space				w	1.00	0	0		
39	B	space				w	1.00	0	0		
40	B	space				w	1.00	0	0		
41	C	space				w	1.00	0	0		
42	C	space				w	1.00	0	0		
PANEL TOTAL								14.5	15.0	Amps=	18.1
PHASE LOADING							kW	kVA	% Total	Amps	% +/-
PHASE TOTAL			A				3.3	3.4	23%	12.3	-31.98%
PHASE TOTAL			B				5.1	5.3	35%	19.2	6.12%
PHASE TOTAL			C				6.1	6.3	42%	22.8	25.86%
LOAD CATAGORIES				Connected			Demand				
				kW	kVA	DF	kW	kVA	PF		
1	receptacles			0.0	0.0	0.70	0.0	0.0			
2	computers			0.0	0.0	0.90	0.0	0.0			
3	fluorescent lighting			12.9	13.3	1.00	12.9	13.3	0.97		
4	HID lighting			1.6	1.7	1.00	1.6	1.7	0.91		
5	incandescent lighting			0.0	0.0	1.00	0.0	0.0			
6	HVAC fans			0.0	0.0	0.80	0.0	0.0			
7	heating			0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment			0.0	0.0	0.80	0.0	0.0			
Total Demand Loads							14.5	15.0			
Spare Capacity				25%			3.6	3.8			
Total Design Loads							18.1	18.8	0.96	Amps=	22.6
Total Design Loads										Amps=	

Panelboard Calculations – Panel E4P (Revised)

PANELBOARD SIZING WORKSHEET											
Panel Tag----------------------->					E4P	Panel Location:			Electrical Room		
Nominal Phase to Neutral Voltage------>					277				3		
Nominal Phase to Phase Voltage------>					480	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	spare				w	1.00	0	0		
2	A	Fluorescent Ltg	3	EM 3RD FL COL N	1318	w	0.96	1318	1372		
3	B	spare				w	1.00	0	0		
4	B	Fluorescent Ltg	3	EM 3RD FL COL S	1399	w	0.96	1399	1458		
5	C	Fluorescent Ltg	3	EM ATR DWN	720	w	0.98	720	735		
6	C	spare				w	1.00	0	0		
7	A	Fluorescent Ltg	3	RM 401	325	w	0.98	325	332		
8	A	spare				w	0.98	0	0		
9	B	spare				w	1.00	0	0		
10	B	spare				w	1.00	0	0		
11	C	spare				w	1.00	0	0		
12	C	spare				w	1.00	0	0		
13	A	spare				w	1.00	0	0		
14	A	spare				w	1.00	0	0		
15	B	spare				w	1.00	0	0		
16	B	spare				w	1.00	0	0		
17	C	spare				w	1.00	0	0		
18	C	spare				w	1.00	0	0		
19	A	spare				w	1.00	0	0		
20	A	spare				w	1.00	0	0		
21	B	space				w	1.00	0	0		
22	B	space				w	1.00	0	0		
23	C	space				w	1.00	0	0		
24	C	space				w	1.00	0	0		
25	A	space				w	1.00	0	0		
26	A	space				w	1.00	0	0		
27	B	space				w	1.00	0	0		
28	B	space				w	1.00	0	0		
29	C	space				w	1.00	0	0		
30	C	space				w	1.00	0	0		
31	A	space			0	w	1.00	0	0		
32	A	space			0	w	1.00	0	0		
33	B	space			0	w	1.00	0	0		
34	B	space			0	w	1.00	0	0		
35	C	space			0	w	1.00	0	0		
36	C	space			0	w	1.00	0	0		
37	A	space			0	w	1.00	0	0		
38	A	space			0	w	1.00	0	0		
39	B	space			0	w	1.00	0	0		
40	B	space			0	w	1.00	0	0		
41	C	space			0	w	1.00	0	0		
42	C	space			0	w	1.00	0	0		
PANEL TOTAL								3.8	3.9	Amps=	4.7
PHASE LOADING							kW	kVA	% Total	Amps	% +/-
PHASE TOTAL			A				1.6	1.7	44%	6.1	31.16%
PHASE TOTAL			B				1.4	1.5	37%	5.3	12.27%
PHASE TOTAL			C				0.7	0.7	19%	2.7	-43.43%
LOAD CATAGORIES				Connected			Demand				
				kW	kVA	DF	kW	kVA	PF		
1		receptacles		0.0	0.0	0.70	0.0	0.0			
2		computers		0.0	0.0	0.90	0.0	0.0			
3		fluorescent lighting		3.8	3.9	1.00	3.8	3.9	0.97		
4		HID lighting		0.0	0.0	1.00	0.0	0.0			
5		incandescent lighting		0.0	0.0	1.00	0.0	0.0			
6		HVAC fans		0.0	0.0	0.80	0.0	0.0			
7		heating		0.0	0.0	1.25	0.0	0.0			
8		kitchen equipment		0.0	0.0	0.80	0.0	0.0			
Total Demand Loads							3.8	3.9			
Spare Capacity				25%			0.9	1.0			
Total Design Loads							4.7	4.9	0.97	Amps=	5.9
Total Design Loads										Amps=	

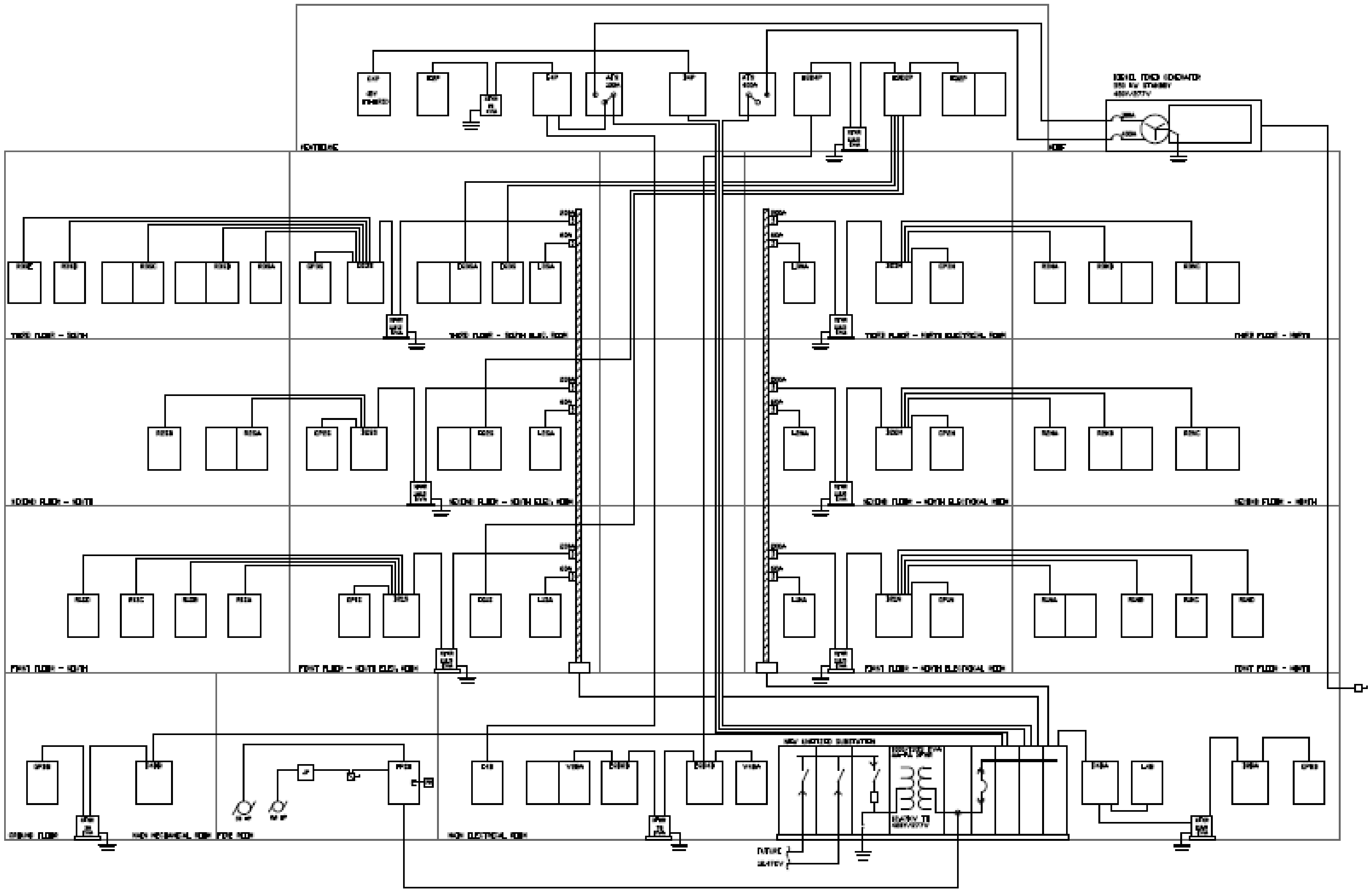
Panelboard Calculations – Panel DM4P (Revised)

PANELBOARD SIZING WORKSHEET											
Panel Tag----------------------->					DM4P	Panel Location:			North Electrical Room		
Nominal Phase to Neutral Voltage------->					277				3		
Nominal Phase to Phase Voltage------->					480	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Fluorescent Ltg	3	LEC CHALK	470	w	0.99	470	475		
2	A	Fluorescent Ltg	3	LEC SPEAKER	188	w	0.99	188	190		
3	B	Fluorescent Ltg	3	LEC CEN FRONT	174	w	0.98	174	178		
4	B	Fluorescent Ltg	3	LEC LEFT FRON	116	w	0.98	116	118		
5	C	Fluorescent Ltg	3	LEC RIGHT FRON	174	w	0.98	174	178		
6	C	Fluorescent Ltg	3	LEC SCONCES	152	w	0.98	152	155		
7	A	spare			0	w	1.00	0	0		
8	A	Fluorescent Ltg	3	ATR DOWN COR	1517	w	0.98	1517	1548		
9	B	Fluorescent Ltg	3	ATR WALL COR	1110	w	0.98	1110	1133		
10	B	Fluorescent Ltg	3	HUM WALL	750	w	1.00	750	750		
11	C	Fluorescent Ltg	3	HUM ACCENT	150	w	1.00	150	150		
12	C	Fluorescent Ltg	3	HUM ACCENT	150	w	1.00	150	150		
13	A	spare				w	1.00	0	0		
14	A	spare				w	1.00	0	0		
15	B	spare				w	1.00	0	0		
16	B	spare				w	1.00	0	0		
17	C	spare				w	1.00	0	0		
18	C	spare				w	1.00	0	0		
19	A	spare				w	1.00	0	0		
20	A	spare				w	1.00	0	0		
21	B	space				w	1.00	0	0		
22	B	space				w	1.00	0	0		
23	C	space				w	1.00	0	0		
24	C	space				w	1.00	0	0		
25	A	space				w	1.00	0	0		
26	A	space				w	1.00	0	0		
27	B	space				w	1.00	0	0		
28	B	space				w	1.00	0	0		
29	C	space				w	1.00	0	0		
30	C	space				w	1.00	0	0		
31	A	space			0	w	1.00	0	0		
32	A	space			0	w	1.00	0	0		
33	B	space			0	w	1.00	0	0		
34	B	space			0	w	1.00	0	0		
35	C	space			0	w	1.00	0	0		
36	C	space			0	w	1.00	0	0		
37	A	space			0	w	1.00	0	0		
38	A	space			0	w	1.00	0	0		
39	B	space			0	w	1.00	0	0		
40	B	space			0	w	1.00	0	0		
41	C	space			0	w	1.00	0	0		
42	C	space			0	w	1.00	0	0		
PANEL TOTAL								5.0	5.0	Amps=	6.0
PHASE LOADING							kW	kVA	% Total	Amps	% +/-
PHASE TOTAL			A				2.2	2.2	44%	8.0	32.13%
PHASE TOTAL			B				2.2	2.2	43%	7.9	30.09%
PHASE TOTAL			C				0.6	0.6	13%	2.3	-62.22%
LOAD CATAGORIES				Connected			Demand				
				kW	kVA	DF	kW	kVA	PF		
1	receptacles			0.0	0.0	0.70	0.0	0.0			
2	computers			0.0	0.0	0.90	0.0	0.0			
3	fluorescent lighting			5.0	5.0	1.00	5.0	5.0	0.99		
4	HID lighting			0.0	0.0	1.00	0.0	0.0			
5	incandescent lighting			0.0	0.0	1.00	0.0	0.0			
6	HVAC fans			0.0	0.0	0.80	0.0	0.0			
7	heating			0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment			0.0	0.0	0.80	0.0	0.0			
Total Demand Loads							5.0	5.0			
Spare Capacity				25%			1.2	1.3			
Total Design Loads							6.2	6.3	0.99	Amps=	7.6
Total Design Loads										Amps=	

Panelboard Calculations – Panel EDM4P (Revised)

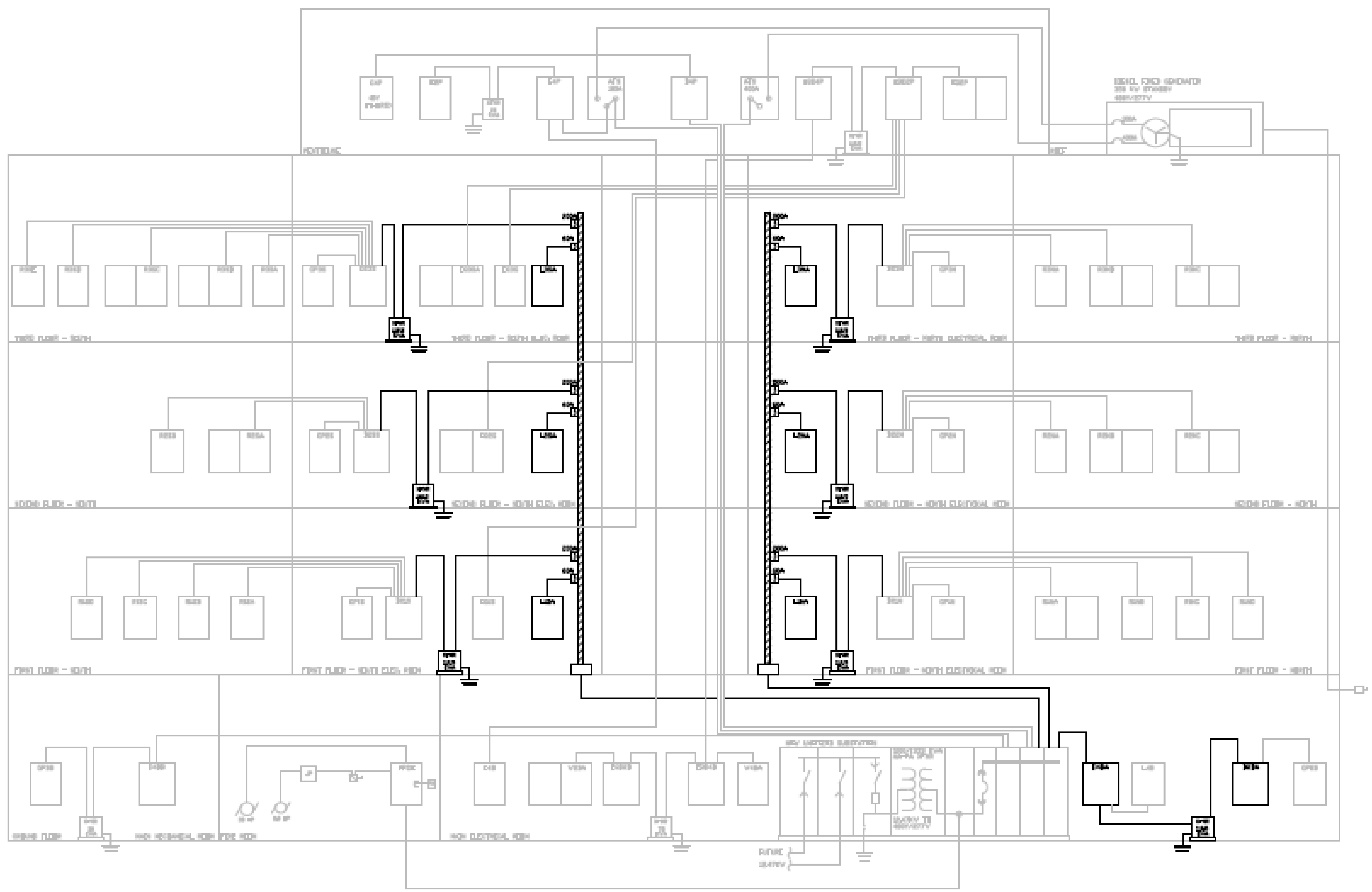
PANELBOARD SIZING WORKSHEET											
Panel Tag------------------------>					EDM4P	Panel Location:			North Electrical Room		
Nominal Phase to Neutral Voltage------>					277				3		
Nominal Phase to Phase Voltage------>					480	Wires:			4		
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Fluorescent Ltg	3	LEC DOWN FRONT	124	w	0.98	124	127		
2	A	Fluorescent Ltg	3	LEC CEN MIDDLE	174	w	0.98	174	178		
3	B	Fluorescent Ltg	3	LEC LEFT MIDDLE	174	w	0.98	174	178		
4	B	Fluorescent Ltg	3	LEC RIGHT MIDDLE	232	w	0.98	232	237		
5	C	Fluorescent Ltg	3	LEC CEN BACK	348	w	0.98	348	355		
6	C	Fluorescent Ltg	3	LEC VEST	68	w	0.98	68	69		
7	A	Fluorescent Ltg	3	LEC LEFT BACK	174	w	0.98	174	178		
8	A	Fluorescent Ltg	3	LEC RIGHT BACK	232	w	0.98	232	237		
9	B	Fluorescent Ltg	3	ATR DOWN COR	962	w	0.98	962	982		
10	B	Fluorescent Ltg	3	HUM EMERG DOWN	1200	w	0.98	1200	1224		
11	C	Fluorescent Ltg	3	LEC DOWN RAMP	217	w	0.98	217	221		
12	C	Fluorescent Ltg	3	LEC DOWN BACK	403	w	0.98	403	411		
13	A	spare		LEC STAIRS	37.8	w	1.00	38	38		
14	A	spare		LEC RAMP	100.8	w	1.00	101	101		
15	B	spare				w	1.00	0	0		
16	B	spare				w	1.00	0	0		
17	C	spare				w	1.00	0	0		
18	C	spare				w	1.00	0	0		
19	A	spare				w	1.00	0	0		
20	A	spare				w	1.00	0	0		
21	B	space				w	1.00	0	0		
22	B	space				w	1.00	0	0		
23	C	space				w	1.00	0	0		
24	C	space				w	1.00	0	0		
25	A	space				w	1.00	0	0		
26	A	space				w	1.00	0	0		
27	B	space				w	1.00	0	0		
28	B	space				w	1.00	0	0		
29	C	space				w	1.00	0	0		
30	C	space				w	1.00	0	0		
31	A	space			0	w	1.00	0	0		
32	A	space			0	w	1.00	0	0		
33	B	space			0	w	1.00	0	0		
34	B	space			0	w	1.00	0	0		
35	C	space			0	w	1.00	0	0		
36	C	space			0	w	1.00	0	0		
37	A	space			0	w	1.00	0	0		
38	A	space			0	w	1.00	0	0		
39	B	space			0	w	1.00	0	0		
40	B	space			0	w	1.00	0	0		
41	C	space			0	w	1.00	0	0		
42	C	space			0	w	1.00	0	0		
PANEL TOTAL								4.4	4.5	Amps=	5.5
PHASE LOADING							kW	kVA	% Total	Amps	% +/-
		PHASE TOTAL	A				0.8	0.9	19%	3.1	-43.30%
		PHASE TOTAL	B				2.6	2.6	58%	9.5	73.36%
		PHASE TOTAL	C				1.0	1.1	23%	3.8	-30.06%
LOAD CATAGORIES				Connected			Demand				
				kW	kVA	DF	kW	kVA	PF		
1		receptacles		0.0	0.0	0.70	0.0	0.0			
2		computers		0.0	0.0	0.90	0.0	0.0			
3		fluorescent lighting		4.3	4.4	1.00	4.3	4.4	0.98		
4		HID lighting		0.0	0.0	1.00	0.0	0.0			
5		incandescent lighting		0.0	0.0	1.00	0.0	0.0			
6		HVAC fans		0.0	0.0	0.80	0.0	0.0			
7		heating		0.0	0.0	1.25	0.0	0.0			
8		kitchen equipment		0.0	0.0	0.80	0.0	0.0			
		Total Demand Loads					4.3	4.4			
		Spare Capacity		25%			1.1	1.1			
		Total Design Loads					5.4	5.5	0.98	Amps=	6.6
		Total Design Loads								Amps=	

Riser Diagram - Existing



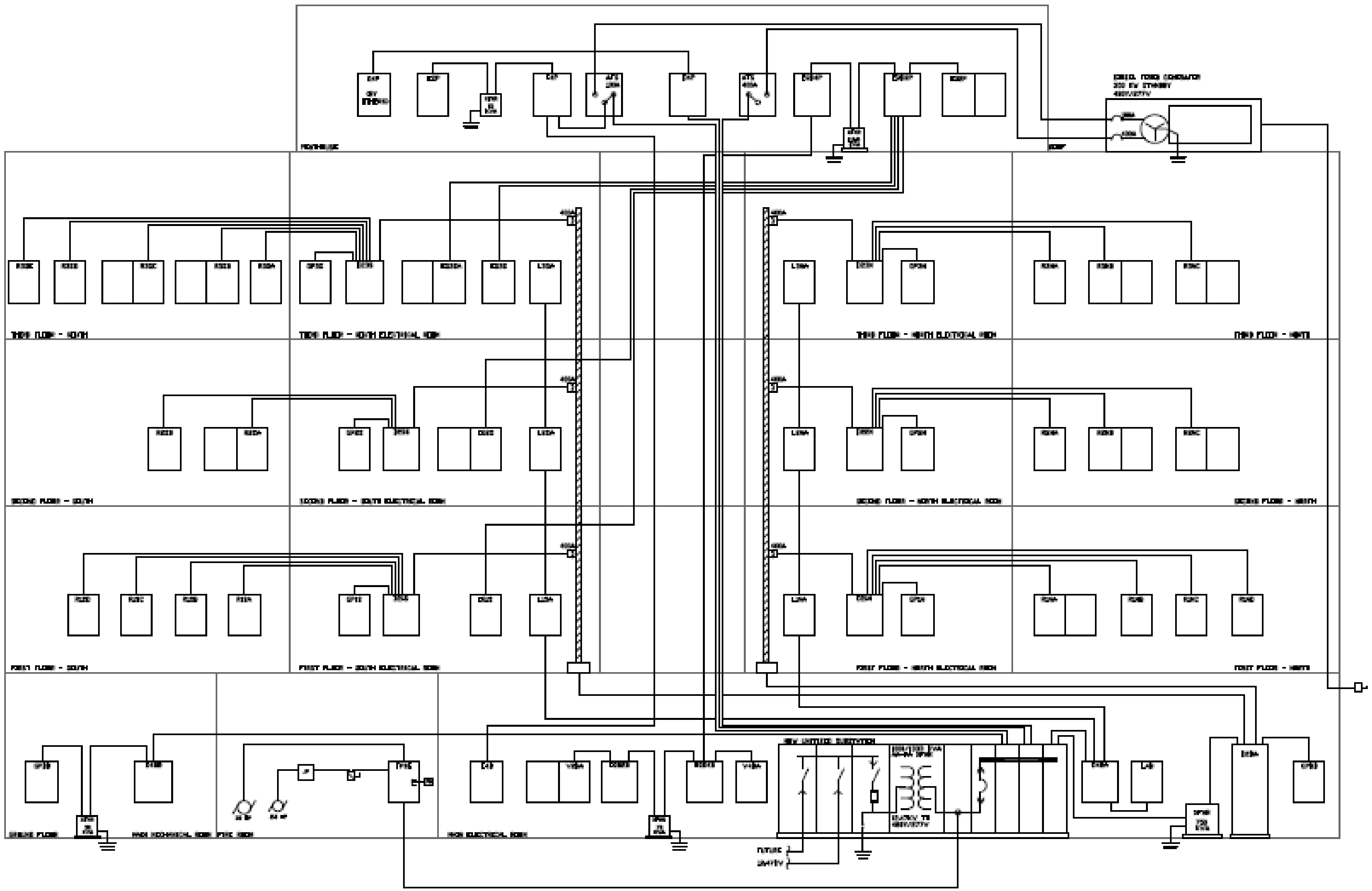
Access to File: P:\Thesis AutoCAD Files\new riser diagram.dwg

Riser Diagram – Existing with Affected Equipment Highlighted



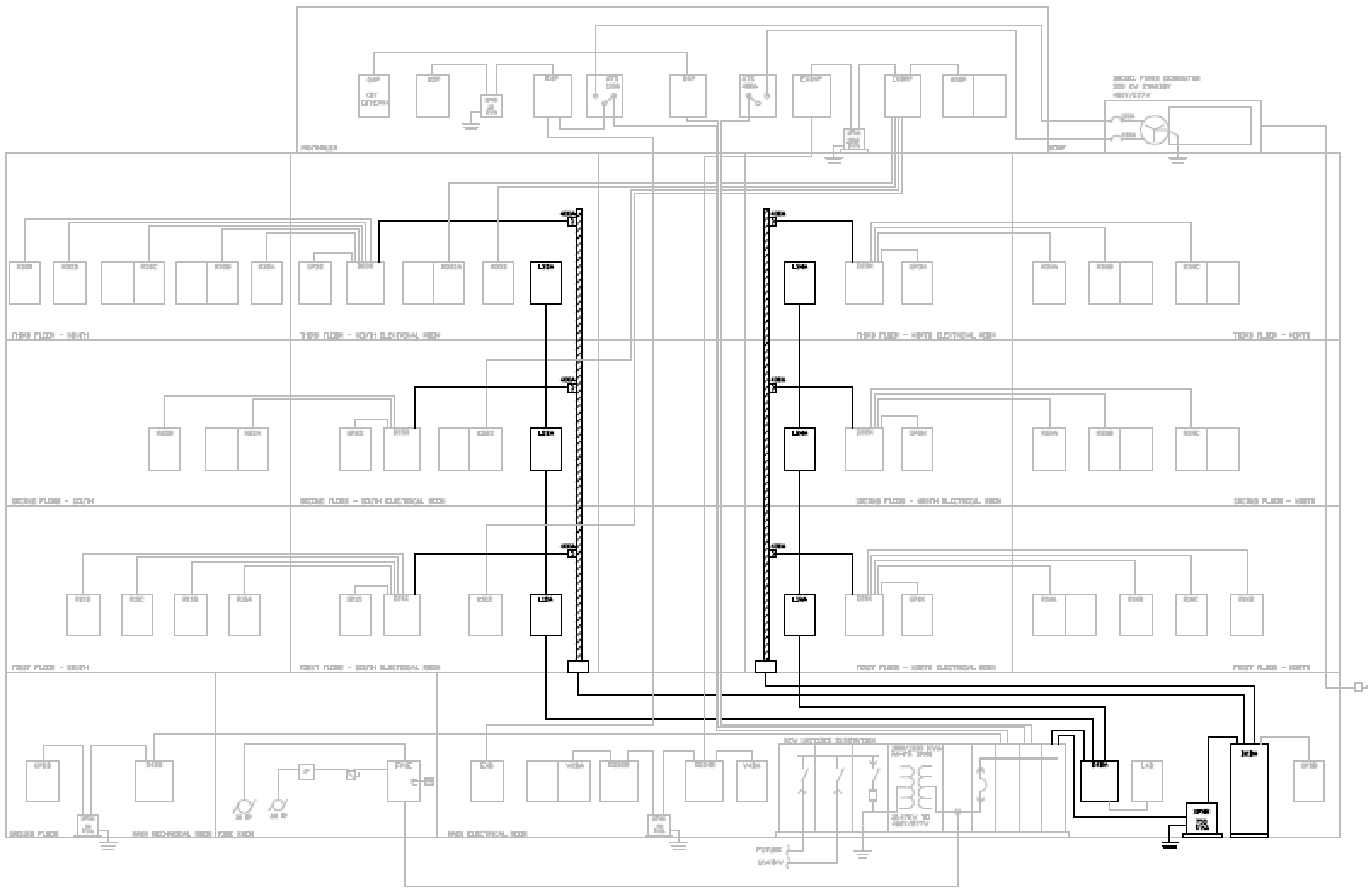
Access to File: P:\Thesis AutoCAD Files\new riser diagram.dwg

Riser Diagram - Proposed



Access to File: P:\Thesis AutoCAD Files\new riser diagram.dwg

Riser Diagram – Proposed with Affected Equipment Highlighted



Access to File: P:\Thesis AutoCAD Files\new riser diagram.dwg

Central Transformer – Quick Estimate for Sizing

Panelboard	Rating	Amps	Max Demand	Notes
GPBA	150A	150	31200	
GPBB	100A	100	20800	
GP1N	100A	100	20800	
R1NA	225A	225	46800	
R1NB	60A	60	12480	
R1NC	60A	60	12480	
R1ND	60A	60	12480	
GP1S	100A	100	20800	
R1SA	60A	60	12480	
R1SB	60A	60	12480	
R1SC	60A	60	12480	
R1SD	60A	60	12480	
GP2N	100A	100	20800	
R2NA	60A	60	12480	
R2NB	150A	150	31200	
R2NC	150A	150	31200	
GP2S	100A	100	20800	
R2SA	150A	150	31200	
R2SB	60A	60	12480	
GP3N	100A	100	20800	
R3NA	60A	60	12480	
R3NB	150A	150	31200	
R3NC	150A	150	31200	
GP3S	100A	100	20800	
R3SA	100A	100	20800	
R3SB	150A	150	31200	
R3SC	225A	225	46800	
R3SD	60A	60	12480	
R3SE	100A	100	20800	
D2BA	400A	400	39520	*Subtracts GPBA and DM2P
DM2P	60A	60	12480	

Total VA	**688480**
Demand Factor	0.7
Spare Capactiy	1.15
Total VA	**554226.4**
Xfmr KVA Rating	**750 KVA**

Central Transformer– Detailed Sizing Calculations

Panel	Receptacles		Total Motor Loads		Four Plex Receptacles		Number 4 Outlets		J Outlets		Strip Receptacles		Disconnects for Lab Equip.		Lighting	Total
Label	#	VA	Motor VA	Motor W	#	VA	#	VA	#	VA	Length	VA	#	VA	VA	VA
GPBA	23	4140	1210.59	939	1	360		0		0	81	9720	0	0	0	15431
GPBB	8	1440	6852	6306		0		0	1	1920		0		0	0	10212
GP1N	56	10080	1296	976.8	4	1440		0	3	5760		0		0	0	18576
R1NA	31	5580	0	0	8	2880		0		0	314	37680	0	0	0	46140
R1NB	35	6300	0	0	2	720		0		0		0		0	0	7020
R1NC	43	7740	0	0	12	4320		0		0		0		0	0	12060
R1ND	27	4860	0	0	6	2160		0		0		0		0	0	7020
GP1S	58	10440	600	420	7	2520		0	9	17280		0		0	0	30840
R1SA	20	3600	0	0	0	0		0	0	0		0		0	0	3600
R1SB	42	7560	0	0	4	1440		0	0	0		0		0	0	9000
R1SC	40	7200	0	0	1	360		0	0	0		0		0	0	7560
R1SD	21	3780	0	0	3	1080		0	2	3840		0		0	0	8700
GP2N	33	5940	696	556.8	4	1440		0	1	1920		0	6	11520	0	21516
R2NA	36	6480	0	0	1	360	2.5	4800	1	1920	23	2760		0	0	16320
R2NB	105	18900	0	0	16	5760		0	3	5760	22.5	2700		0	0	33120
R2NC	34	6120	0	0	11	3960		0	3	5760	41	4920		0	0	20760
GP2S	49	8820	0	0	14	5040		0		0		0	6	11520	0	25380
R2SA	45	8100	0	0	12	4320	2	3840	2	3840	42	5040	2	3840	0	28980
R2SB	79	14220	0	0	3	1080		0		0		0		0	0	15300
GP3N	44	7920	1296	1021.8	5	1800		0	3	5760		0	4.5	8640	0	25416
R3NA	61	10980	0	0	2	720		0	1	1920	8	960		0	0	14580
R3NB	45	8100	0	0	5	1800	3	5760	2	3840	45.5	5460		0	0	24960
R3NC	41	7380	0	0	2	720	4	7680	2	3840	58	6960		0	0	26580
GP3S	40	7200	480	384	4	1440		0		0		0		0	0	9120
R3SA	81	14580	0	0	8	2880		0	2	3840	17	2040	3	5760	0	29100
R3SB	38	6840	0	0	5	1800	2	3840	2	3840	76	9120		0	0	25440
R3SC	63	11340	0	0	0	0	20	38400	5	9600		0		0	0	59340
R3SD	32	5760	0	0	4	1440	1	1920	1	1920	11.5	1380		0	0	12420
R3SE	48	8640	0	0	3	1080	2	3840	2	3840	50	6000		0	0	23400
D2BA	0	0	0	0	0	0	0	0	0	0	0	0	14	26880		26880
DM2P	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16865	16865
Total	1278	**230040**	**12430.59**	10604.4	147	**52920**	36.5	**70080**	45	**86400**	789.5	**94740**	35.5	**68160**	**16865**	**631636**

Total Demand Load	**447785.59**
Spare Capacity	1.15
Total VA	**514953.43**
Xfmr KVA Rating	**750 KVA**

Central Transformer– Detailed Motor Calculations

Panel	Motor 1							Motor 2							Motor 3							Motor 4							Motor 5						
Label	Motor HP	#	FLC	Voltage	PF	VA	W	Motor HP	#	FLC	Voltage	PF	VA	W	Motor HP	#	FLC	Voltage	PF	VA	W	Motor HP	#	FLC	Voltage	PF	VA	W	Motor HP	#	FLC	Voltage	PF	VA	W
GPBA	0.05	2	1.25	120	1.00	300	300	-	1	0.088	120	0.85	10.59	9	0.2	1	5	120	0.70	600	420	0.1	1	2.5	120	0.70	300	210	-	-	-	-	-	0	0
GPBB	0.1	1	2.5	120	0.70	300	210	0.25	1	5.8	120	0.80	696	557	0.08	2	2.2	120	0.70	528	370	0.17	1	4.4	120	0.70	528	370	-	2	20	120	1.00	4800	4800
GP1N	0.2	1	5	120	0.70	600	420	0.25	1	5.8	120	0.80	696	557	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R1NA	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R1NB	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R1NC	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R1ND	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
GP1S	0.2	1	5	120	0.70	600	420	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R1SA	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R1SB	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R1SC	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R1SD	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
GP2N	0.25	1	5.8	120	0.80	696	556.8	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R2NA	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R2NB	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R2NC	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
GP2S	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R2SA	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R2SB	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
GP3N	0.1	1	2.5	120	0.70	300	210	0.25	1	5.8	120	0.80	696	556.8	0.05	2	1.25	120	0.85	300	255	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R3NA	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R3NB	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R3NC	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
GP3S	0.14	1	4	120	0.80	480	384	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R3SA	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R3SB	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R3SC	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R3SD	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
R3SE	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
D2BA	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0
DM2P	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0	-	-	-	-	-	0	0

Breakdown of Electrical Take-Off for Existing Equipment

Existing Circuit Breakers:

FLOOR LEVEL	ROOM NAME	FROM	TO	SIZE	COST
1st Floor	SOUTH ELEC. ROOM	SOUTH BUS DUCT	L1SA	60A	$1,084.05
1st Floor	SOUTH ELEC. ROOM	SOUTH BUS DUCT	D21S	200A	$2,786.40
2nd Floor	SOUTH ELEC. ROOM	SOUTH BUS DUCT	L2SA	60A	$1,084.05
2nd Floor	SOUTH ELEC. ROOM	SOUTH BUS DUCT	D22S	200A	$2,786.40
3rd Floor	SOUTH ELEC. ROOM	SOUTH BUS DUCT	L3SA	60A	$1,084.05
3rd Floor	SOUTH ELEC. ROOM	SOUTH BUS DUCT	D23S	200A	$2,786.40
1st Floor	NORTH ELEC. ROOM	NORTH BUS DUCT	L1NA	60A	$1,084.05
1st Floor	NORTH ELEC. ROOM	NORTH BUS DUCT	D21N	200A	$2,786.40
2nd Floor	NORTH ELEC. ROOM	NORTH BUS DUCT	L2NA	60A	$1,084.05
2nd Floor	NORTH ELEC. ROOM	NORTH BUS DUCT	D22N	200A	$2,786.40
3rd Floor	NORTH ELEC. ROOM	NORTH BUS DUCT	L3NA	60A	$1,084.05
3rd Floor	NORTH ELEC. ROOM	NORTH BUS DUCT	D23N	200A	$2,786.40
			Total		$23,222.70

Existing Panelboards:

TAG	VOLTAGE SYSTEM	MAIN SIZE	MLO OR MCB?	FLOOR LEVEL	ROOM NAME	REMARKS	COST
L1SA	480Y/277V, 3 PH, 4W	60	MLO	FIRST FLOOR	SOUTH ELEC. ROOM	-	$2,841.75
L2SA	480Y/277V, 3 PH, 4W	60	MLO	SECOND FLOOR	SOUTH ELEC. ROOM	-	$2,841.75
L3SA	480Y/277V, 3 PH, 4W	60	MLO	THIRD FLOOR	SOUTH ELEC. ROOM	-	$2,841.75
L1NA	480Y/277V, 3 PH, 4W	60	MLO	FIRST FLOOR	NORTH ELEC. ROOM	-	$2,841.75
L2NA	480Y/277V, 3 PH, 4W	60	MLO	SECOND FLOOR	NORTH ELEC. ROOM	-	$2,841.75
D4BA	480Y/277V, 3 PH, 4W	400	MCB	BASEMENT	MAIN ELEC. ROOM	-	$8,066.25
D2BA	208Y/120V, 3 PH, 4W	400	MCB	BASEMENT	MAIN ELEC. ROOM	-	$8,066.25
						Total	$30,341.25

Existing Feeders:

FROM	TO	NO. OF SETS	CONDUIT (PER SET)		CONDUCTORS (PER SET)									COST
					PHASE CONDUCTORS			NEUTRAL CONDUCTORS			GROUND CONDUCTORS			
			SIZE	LENGTH	No.	SIZE	LENGTH	No.	SIZE	LENGTH	No.	SIZE	LENGTH	
SWB-1	South Bus Duct	2	3"	230	3	350KCMIL	240	1	350KCMIL	240	1	1AWG	240	$38,623.77
South Bus Duct	L1SA	1	1"	6	3	6AWG	10	1	6AWG	10	1	10AWG	10	$110.04
South Bus Duct	XFMR A	1	2"	6	3	3/0AWG	10	0	3/0AWG	10	1	6AWG	10	$294.81
XFMR A	D21S	1	3 1/2"	6	3	600KCMIL	10	1	600KCMIL	10	1	3AWG	10	$1,063.53
South Bus Duct	L2SA	1	1"	6	3	6AWG	10	1	6AWG	10	1	10AWG	10	$110.04
South Bus Duct	XFMR B	1	2"	6	3	3/0AWG	10	0	3/0AWG	10	1	6AWG	10	$294.81
XFMR B	D22S	1	3 1/2"	6	3	600KCMIL	10	1	600KCMIL	10	1	3AWG	10	$1,063.53
South Bus Duct	L3SA	1	1"	6	3	6AWG	10	1	6AWG	10	1	10AWG	10	$110.04
South Bus Duct	XFMR C	1	2"	6	3	3/0AWG	10	0	3/0AWG	10	1	6AWG	10	$294.81
XFMR C	D23S	1	3 1/2"	6	3	600KCMIL	10	1	600KCMIL	10	1	3AWG	10	$1,063.53
SWB-1	North Bus Duct	1	3"	95	3	350KCMIL	105	1	350KCMIL	105	1	1AWG	105	$8,305.81
North Bus Duct	L1NA	1	1"	6	3	6AWG	10	1	6AWG	10	1	10AWG	10	$110.04
North Bus Duct	XFMR D	1	2"	6	3	3/0AWG	10	0	3/0AWG	10	1	6AWG	10	$294.81
XFMR D	D21N	1	3 1/2"	6	3	600KCMIL	10	1	600KCMIL	10	1	3AWG	10	$1,063.53
North Bus Duct	L2NA	1	1"	6	3	6AWG	10	1	6AWG	10	1	10AWG	10	$110.04
North Bus Duct	XFMR E	1	2"	6	3	3/0AWG	10	0	3/0AWG	10	1	6AWG	10	$294.81
XFMR E	D22N	1	3 1/2"	6	3	600KCMIL	10	1	600KCMIL	10	1	3AWG	10	$1,063.53
North Bus Duct	L3NA	1	1"	6	3	6AWG	10	1	6AWG	10	1	10AWG	10	$110.04
North Bus Duct	XFMR F	1	2"	6	3	3/0AWG	10	0	3/0AWG	10	1	6AWG	10	$294.81
XFMR F	D23N	1	3 1/2"	6	3	600KCMIL	10	1	600KCMIL	10	1	3AWG	10	$1,063.53
SWB-1	D4BA	1	3 1/2"	30	3	600KCMIL	35	1	600KCMIL	35	1	3AWG	35	$3,998.16
D4BA	XFMR G	1	2"	6	3	3/0AWG	10	0	3/0AWG	10	1	6AWG	10	$294.81
XFMR G	D2BA	1	3 1/2"	6	3	600KCMIL	10	1	600KCMIL	10	1	3AWG	10	$1,063.53
													Total	$61,096.37

Existing Bus Duct:

BUILDING SIDE	LENGTH	VOLTAGE	RATING	COST
SOUTH	40	480Y/277V	600A	$11,340.00
NORTH	40	480Y/277V	600A	$11,340.00
			Total	$22,680.00

Existing Transformers:

Label	Level	Room	KVA Rating	Primary Voltage	Secondary Voltage	Type	Temp. Rise	Taps	Mounting	Cost
A	1st Floor	South Electrical	112.5	480Δ	208Y/120	Dry Type	150 ºC	(4) 2.5%	Floor Mounted With Pad	$8,118.90
B	2nd Floor	South Electrical	112.5	480Δ	208Y/120	Dry Type	150 ºC	(4) 2.5%	Floor Mounted With Pad	$8,118.90
C	3rd Floor	South Electrical	112.5	480Δ	208Y/120	Dry Type	150 ºC	(4) 2.5%	Floor Mounted With Pad	$8,118.90
D	1st Floor	North Electrical	112.5	480Δ	208Y/120	Dry Type	150 ºC	(4) 2.5%	Floor Mounted With Pad	$8,118.90
E	2nd Floor	North Electrical	112.5	480Δ	208Y/120	Dry Type	150 ºC	(4) 2.5%	Floor Mounted With Pad	$8,118.90
F	3rd Floor	North Electrical	112.5	480Δ	208Y/120	Dry Type	150 ºC	(4) 2.5%	Floor Mounted With Pad	$8,118.90
G	Basement	Main Electrical	112.5	480Δ	208Y/120	Dry Type	150 ºC	(4) 2.5%	Floor Mounted With Pad	$8,118.90
									Total	$56,832.30

Breakdown of Electrical Take-Off for Existing Equipment

Proposed Circuit Breakers:

FLOOR LEVEL	ROOM NAME	FROM	TO	SIZE	COST
1st Floor	SOUTH ELEC. ROOM	SOUTH BUS DUCT	D21S	400A	$5,089.50
2nd Floor	SOUTH ELEC. ROOM	SOUTH BUS DUCT	D22S	400A	$5,089.50
3rd Floor	SOUTH ELEC. ROOM	SOUTH BUS DUCT	D23S	400A	$5,089.50
1st Floor	NORTH ELEC. ROOM	NORTH BUS DUCT	D21N	400A	$5,089.50
2nd Floor	NORTH ELEC. ROOM	NORTH BUS DUCT	D22N	400A	$5,089.50
3rd Floor	NORTH ELEC. ROOM	NORTH BUS DUCT	D23N	400A	$5,089.50
			Total		$30,537.00

Proposed Panelboards:

TAG	VOLTAGE SYSTEM	MAIN SIZE	MLO OR MCB?	FLOOR LEVEL	ROOM NAME	REMARKS	COST
L1SA	480Y/277V, 3 PH, 4W	100	MLO	FIRST FLOOR	SOUTH ELEC. ROOM	FEED THROUGH	$2,841.75
L2SA	480Y/277V, 3 PH, 4W	100	MLO	SECOND FLOOR	SOUTH ELEC. ROOM	FEED THROUGH	$2,841.75
L3SA	480Y/277V, 3 PH, 4W	100	MLO	THIRD FLOOR	SOUTH ELEC. ROOM	FEED THROUGH	$2,841.75
L1NA	480Y/277V, 3 PH, 4W	100	MLO	FIRST FLOOR	NORTH ELEC. ROOM	FEED THROUGH	$2,841.75
L2NA	480Y/277V, 3 PH, 4W	100	MLO	SECOND FLOOR	NORTH ELEC. ROOM	FEED THROUGH	$2,841.75
L3NA	480Y/277V, 3 PH, 4W	100	MLO	THIRD FLOOR	NORTH ELEC. ROOM	FEED THROUGH	$2,841.75
D2BA	208Y/120V, 3 PH, 4W	2500	MCB	BASEMENT	MAIN ELEC. ROOM	SWITCHBOARD	$32,711.85
						Total	$49,762.35

Proposed Feeders:

FROM	TO	NO. OF SETS	CONDUIT (PER SET)		CONDUCTORS (PER SET)									COST
					PHASE CONDUCTORS			NEUTRAL CONDUCTORS			GROUND CONDUCTORS			
			SIZE	LENGTH	No.	SIZE	LENGTH	No.	SIZE	LENGTH	No.	SIZE	LENGTH	
SWB-1	D4BA	1	2 1/2"	30	3	4/0AWG	35	1	4/0AWG	35	1	4AWG	35	$1,903.74
D4BA	L1SA	1	1 1/4"	245	3	3AWG	255	1	3AWG	255	1	8AWG	255	$5,025.78
L1SA	L2SA	1	1 1/4"	10	3	3AWG	15	1	3AWG	15	1	8AWG	15	$259.07
L2SA	L3SA	1	1 1/4"	10	3	3AWG	15	1	3AWG	15	1	8AWG	15	$259.07
D4BA	L1NA	1	1 1/4"	110	3	3AWG	120	1	3AWG	120	1	8AWG	120	$2,321.19
L1NA	L2NA	1	1 1/4"	10	3	3AWG	15	1	3AWG	15	1	8AWG	15	$259.07
L2NA	L3NA	1	1 1/4"	10	3	3AWG	15	1	3AWG	15	1	8AWG	15	$259.07
SWB-1	XFMR	3	3"	15	3	400KCMIL	10	0	400KCMIL	10	1	2/0AWG	10	$2,631.89
XFMR	D2BA	7	3"	6	3	500KCMIL	10	1	500KCMIL	10	1	350KCMIL	10	$6,907.95
D2BA	South Bus Duct	4	3"	230	3	350KCMIL	240	1	350KCMIL	240	1	3/0AWG	240	$80,228.34
South Bus Duct	D21S	2	2"	10	3	3/0AWG	15	1	3/0AWG	15	1	3AWG	15	$1,148.31
South Bus Duct	D22S	2	2"	10	3	3/0AWG	15	1	3/0AWG	15	1	3AWG	15	$1,148.31
South Bus Duct	D23S	2	2"	10	3	3/0AWG	15	1	3/0AWG	15	1	3AWG	15	$1,148.31
D2BA	North Bus Duct	4	3"	95	3	350KCMIL	105	1	350KCMIL	105	1	3/0AWG	105	$34,527.33
North Bus Duct	D21N	2	2"	10	3	3/0AWG	15	1	3/0AWG	15	1	3AWG	15	$1,148.31
North Bus Duct	D22N	2	2"	10	3	3/0AWG	15	1	3/0AWG	15	1	3AWG	15	$1,148.31
North Bus Duct	D23N	2	2"	10	3	3/0AWG	15	1	3/0AWG	15	1	3AWG	15	$1,148.31
													Total	$141,472.34

Proposed Bus Duct:

BUILDING SIDE	LENGTH	VOLTAGE	RATING	COST
SOUTH	40	208Y/120V	1200A	$18,360.00
NORTH	40	208Y/120V	1200A	$18,360.00
			Total	$36,720.00

Proposed Transformer:

Label	Level	Room	KVA Rating	Primary Voltage	Secondary Voltage	Type	Temp. Rise	Taps	Mounting	Cost
AA	Basement	Main Electrical	750	480Δ	208Y/120	Dry Type	150 ºC	(4) 2.5%	Floor Mounted With Pad	$46,737.00

Copper to Aluminum Feeders – Full Calculations and Measurements

Start	End	Wires (CLF)	Conduit (LF)	Copper Pricing										Aluminum Pricing									
				# of Sets	Phase		Neutral		Ground		Conduit		Total	# of Sets	Phase		Neutral		Ground		Conduit		Total
					Size	Price/CLF	Size	Price/CLF	Size	Price/CLF	Size	Price/LF			Size	Price/CLF	Size	Price/CLF	Size	Price/CLF	Size	Price/LF	
SWB-1	NORTH DUCT	1.05	95	2	350KCMIL	1,305.45	350KCMIL	1,305.45	1AWG	386.10	3"	25.45	16,611.62	2	500KCMIL	641.25	500KCMIL	641.25	2/0AWG	265.95	3"	25.45	10,780.02
NORTH DUCT	L1NA	0.1	6	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	110.04	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	106.50
NORTH DUCT	XFMR 1	0.1	6	1	3/0AWG	696.60	-	0.00	6AWG	159.30	2"	11.65	294.81	1	250KCMIL	388.80	-	0.00	4AWG	121.50	2 1/2"	21.40	257.18
XFMR 1	D21N	0.1	6	1	600KCMIL	2,133.00	600KCMIL	2,133.00	3AWG	264.60	3 1/2"	30.65	1,063.53	2	250KCMIL	388.80	250KCMIL	388.80	1AWG	201.15	2 1/2"	21.40	608.04
D21N	GP1N	0.15	10	1	2AWG	317.25	2AWG	317.25	8AWG	116.10	1 1/4"	8.29	290.66	1	1AWG	201.15	1AWG	201.15	6AWG	98.55	1 1/2"	9.75	232.94
D21N	R1NA	0.55	50	1	4/0AWG	845.10	4/0AWG	845.10	4AWG	224.78	2 1/2"	21.40	3,052.72	1	300KCMIL	484.65	300KCMIL	484.65	2AWG	155.93	2 1/2"	21.40	2,221.86
D21N	R1NB	0.65	60	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	848.78	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	866.33
D21N	R1NC	0.9	85	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	1,187.46	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	1,215.47
D21N	R1ND	0.75	70	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	984.25	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	1,005.99
NORTH DUCT	L2NA	0.1	6	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	110.04	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	106.50
NORTH DUCT	XFMR 2	0.1	6	1	3/0AWG	696.60	-	0.00	6AWG	159.30	2"	11.65	294.81	1	250KCMIL	388.80	-	0.00	4AWG	121.50	2 1/2"	21.40	257.18
XFMR 2	D22N	0.1	6	1	600KCMIL	2,133.00	600KCMIL	2,133.00	3AWG	264.60	3 1/2"	30.65	1,063.53	2	250KCMIL	388.80	250KCMIL	388.80	1AWG	201.15	2 1/2"	21.40	608.04
D22N	GP2N	0.25	20	1	1AWG	386.10	1AWG	386.10	6AWG	159.30	1 1/2"	9.75	620.87	1	2/0AWG	265.95	2/0AWG	265.95	4AWG	121.50	2"	11.65	529.34
D22N	R2NA	0.9	85	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	1,187.46	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	1,215.47
D22N	R2NB	0.4	35	1	1/0AWG	464.40	1/0AWG	464.40	6AWG	159.30	2"	11.65	1,214.53	1	3/0AWG	309.15	3/0AWG	309.15	4AWG	121.50	2"	11.65	951.01
D22N	R2NC	0.7	65	1	1/0AWG	464.40	1/0AWG	464.40	6AWG	159.30	2"	11.65	2,169.11	1	3/0AWG	309.15	3/0AWG	309.15	4AWG	121.50	2"	11.65	1,707.95
NORTH DUCT	L3NA	0.1	6	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	110.04	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	106.50
NORTH DUCT	XFMR 3	0.1	6	1	3/0AWG	696.60	-	0.00	6AWG	159.30	2"	11.65	294.81	1	250KCMIL	388.80	-	0.00	4AWG	121.50	2 1/2"	21.40	257.18
XFMR 3	D23N	0.1	6	1	600KCMIL	2,133.00	600KCMIL	2,133.00	3AWG	264.60	3 1/2"	30.65	1,063.53	2	250KCMIL	388.80	250KCMIL	388.80	1AWG	201.15	2 1/2"	21.40	608.04
D23N	GP3N	0.1	6	1	2AWG	317.25	2AWG	317.25	8AWG	116.10	1 1/4"	8.29	188.24	1	1AWG	201.15	1AWG	201.15	6AWG	98.55	1 1/2"	9.75	148.80
D23N	R3NA	0.55	50	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	713.31	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	726.67
D23N	R3NB	0.6	55	1	1/0AWG	464.40	1/0AWG	464.40	6AWG	159.30	2"	11.65	1,850.92	1	3/0AWG	309.15	3/0AWG	309.15	4AWG	121.50	2"	11.65	1,455.64
D23N	R3NC	0.5	45	1	1/0AWG	464.40	1/0AWG	464.40	6AWG	159.30	2"	11.65	1,532.72	1	3/0AWG	309.15	3/0AWG	309.15	4AWG	121.50	2"	11.65	1,203.32
SWB-1	SOUTH DUCT	2.4	230	2	350KCMIL	1,305.45	350KCMIL	1,305.45	1AWG	386.10	3"	25.45	38,623.77	2	500KCMIL	641.25	500KCMIL	641.25	2/0AWG	265.95	3"	25.45	25,294.41
SOUTH DUCT	L1SA	0.1	6	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	110.04	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	106.50
SOUTH DUCT	XFMR 4	0.1	6	1	3/0AWG	696.60	-	0.00	6AWG	159.30	2"	11.65	294.81	1	250KCMIL	388.80	-	0.00	4AWG	121.50	2 1/2"	21.40	257.18

Start	End	Wires (CLF)	Conduit (LF)	Copper Pricing										Aluminum Pricing									
				Number of Sets	Phase		Neutral		Ground		Conduit		Total	Number of Sets	Phase		Neutral		Ground		Conduit		Total
					Size	Price/CLF	Size	Price/CLF	Size	Price/CLF	Size	Price/LF			Size	Price/CLF	Size	Price/CLF	Size	Price/CLF	Size	Price/LF	
XFMR 4	D21S	0.1	6	1	600KCMIL	2,133.00	600KCMIL	2,133.00	3AWG	264.60	3 1/2"	30.65	1,063.53	2	250KCMIL	388.80	250KCMIL	388.80	1AWG	201.15	2 1/2"	21.40	608.04
D21S	GP1S	0.1	6	1	2AWG	317.25	2AWG	317.25	8AWG	116.10	1 1/4"	8.29	188.24	1	1AWG	201.15	1AWG	201.15	6AWG	98.55	1 1/2"	9.75	148.80
D21S	R1SA	0.65	60	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	848.78	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	866.33
D21S	R1SB	1.05	100	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	1,390.67	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	1,424.96
D21S	R1SC	0.55	50	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	713.31	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	726.67
D21S	R1SD	1	95	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	1,322.93	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	1,355.13
SOUTH DUCT	L2SA	0.1	6	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	110.04	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	106.50
SOUTH DUCT	XFMR 5	0.1	6	1	3/0AWG	696.60	-	0.00	6AWG	159.30	2"	11.65	294.81	1	250KCMIL	388.80	-	0.00	4AWG	121.50	2 1/2"	21.40	257.18
XFMR 5	D22S	0.1	6	1	600KCMIL	2,133.00	600KCMIL	2,133.00	3AWG	264.60	3 1/2"	30.65	1,063.53	2	250KCMIL	388.80	250KCMIL	388.80	1AWG	201.15	2 1/2"	21.40	608.04
D22S	GP2S	0.1	6	1	1/0AWG	464.40	1/0AWG	464.40	6AWG	159.30	2"	11.65	271.59	1	3/0AWG	309.15	3/0AWG	309.15	4AWG	121.50	2"	11.65	205.71
D22S	R2SA	0.45	40	1	1/0AWG	464.40	1/0AWG	464.40	6AWG	159.30	2"	11.65	1,373.63	1	3/0AWG	309.15	3/0AWG	309.15	4AWG	121.50	2"	11.65	1,077.17
D22S	R2SB	1	95	1	2AWG	317.25	2AWG	317.25	8AWG	116.10	1 1/4"	8.29	2,172.56	1	1AWG	201.15	1AWG	201.15	6AWG	98.55	1 1/2"	9.75	1,829.12
SOUTH DUCT	L3SA	0.1	6	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	110.04	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	106.50
SOUTH DUCT	XFMR 6	0.1	6	1	3/0AWG	696.60	-	0.00	6AWG	159.30	2"	11.65	294.81	1	250KCMIL	388.80	-	0.00	4AWG	121.50	2 1/2"	21.40	257.18
XFMR 6	D23S	0.1	6	1	600KCMIL	2,133.00	600KCMIL	2,133.00	3AWG	264.60	3 1/2"	30.65	1,063.53	2	250KCMIL	388.80	250KCMIL	388.80	1AWG	201.15	2 1/2"	21.40	608.04
D23S	GP3S	0.1	6	1	2AWG	317.25	2AWG	317.25	8AWG	116.10	1 1/4"	8.29	188.24	1	1AWG	201.15	1AWG	201.15	6AWG	98.55	1 1/2"	9.75	148.80
D23S	R3SA	0.5	45	1	2AWG	317.25	2AWG	317.25	8AWG	116.10	1 1/4"	8.29	1,065.56	1	1AWG	201.15	1AWG	201.15	6AWG	98.55	1 1/2"	9.75	890.19
D23S	R3SB	0.65	60	1	1/0AWG	464.40	1/0AWG	464.40	6AWG	159.30	2"	11.65	2,010.02	1	3/0AWG	309.15	3/0AWG	309.15	4AWG	121.50	2"	11.65	1,581.80
D23S	R3SC	0.85	80	1	4/0AWG	845.10	4/0AWG	845.10	4AWG	224.78	2 1/2"	21.40	4,776.20	1	300KCMIL	484.65	300KCMIL	484.65	2AWG	155.93	2 1/2"	21.40	3,492.15
D23S	R3SD	0.75	70	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	984.25	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	1,005.99
D23S	R3SE	0.3	25	1	2AWG	317.25	2AWG	317.25	8AWG	116.10	1 1/4"	8.29	622.76	1	1AWG	201.15	1AWG	201.15	6AWG	98.55	1 1/2"	9.75	514.62
SWB-1	D4P	2	190	2	350KCMIL	1,305.45	350KCMIL	1,305.45	1AWG	386.10	3"	25.45	32,101.65	2	500KCMIL	641.25	500KCMIL	641.25	2/0AWG	265.95	3"	25.45	20,993.85
D4P	G4P	0.2	15	1	1AWG	386.10	1AWG	386.10	6AWG	159.30	1 1/2"	9.75	486.95	1	2/0AWG	265.95	2/0AWG	265.95	4AWG	121.50	2"	11.65	411.82
SWB-1	D4BA	0.35	30	1	600KCMIL	2,133.00	600KCMIL	2,133.00	3AWG	264.60	3 1/2"	30.65	3,998.16	2	250KCMIL	388.80	250KCMIL	388.80	1AWG	201.15	2 1/2"	21.40	2,513.30
D4BA	XFMR 7	0.1	6	1	3/0AWG	696.60	-	0.00	6AWG	159.30	2"	11.65	294.81	1	250KCMIL	388.80	-	0.00	4AWG	121.50	2 1/2"	21.40	257.18
XFMR 7	D2BA	0.1	6	1	600KCMIL	2,133.00	600KCMIL	2,133.00	3AWG	264.60	3 1/2"	30.65	1,063.53	2	250KCMIL	388.80	250KCMIL	388.80	1AWG	201.15	2 1/2"	21.40	608.04

Start	End	Wires (CLF)	Conduit (LF)	Copper Pricing										Aluminum Pricing									
				Number of Sets	Phase		Neutral		Ground		Conduit		Total	Number of Sets	Phase		Neutral		Ground		Conduit		Total
					Size	Price/CLF	Size	Price/CLF	Size	Price/CLF	Size	Price/LF			Size	Price/CLF	Size	Price/CLF	Size	Price/CLF	Size	Price/LF	
D2BA	GPBA	0.1	6	1	2AWG	317.25	2AWG	317.25	8AWG	116.10	1 1/4"	8.29	188.24	1	1AWG	201.15	1AWG	201.15	6AWG	98.55	1 1/2"	9.75	148.80
D4BA	L4B	0.1	6	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	110.04	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	106.50
SWB-1	D4BB	2.8	270	1	1/0AWG	464.40	1/0AWG	464.40	6AWG	159.30	2"	11.65	8,792.96	1	3/0AWG	309.15	3/0AWG	309.15	4AWG	121.50	2"	11.65	6,948.32
D4BB	XFMR 8	0.1	6	1	6AWG	159.30	-	0.00	10AWG	81.68	3/4"	5.01	86.01	1	4AWG	121.50	-	0.00	8AWG	81.68	1 1/4"	8.29	94.35
XFMR 8	GPBB	0.1	6	1	2AWG	317.25	2AWG	317.25	8AWG	116.10	1 1/4"	8.29	188.24	1	1AWG	201.15	1AWG	201.15	6AWG	98.55	1 1/2"	9.75	148.80
SWB-1	ATS 100	2	190	1	2AWG	317.25	2AWG	317.25	8AWG	116.10	1 1/4"	8.29	4,345.11	1	1AWG	201.15	1AWG	201.15	6AWG	98.55	1 1/2"	9.75	3,658.23
GEN	ATS 100	0.7	65	1	2AWG	317.25	2AWG	317.25	8AWG	116.10	1 1/4"	8.29	1,508.36	1	1AWG	201.15	1AWG	201.15	6AWG	98.55	1 1/2"	9.75	1,265.76
ATS 100	E4P	0.15	10	1	2AWG	317.25	2AWG	317.25	8AWG	116.10	1 1/4"	8.29	290.66	1	1AWG	201.15	1AWG	201.15	6AWG	98.55	1 1/2"	9.75	232.94
E4P	XFMR 9	0.1	6	1	10AWG	81.68	-	0.00	10AWG	81.68	3/4"	5.01	62.72	1	10AWG	65.75	-	0.00	8AWG	81.68	3/4"	5.01	57.94
XFMR 9	E2P	0.1	6	1	8AWG	116.10	8AWG	116.10	10AWG	81.68	3/4"	5.01	84.66	1	6AWG	98.55	6AWG	98.55	8AWG	81.68	1"	6.36	85.74
E4P	E4B	2	190	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	2,645.87	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	2,710.26
SWB-1	ATS 400	2	190	1	600KCMIL	2,133.00	600KCMIL	2,133.00	3AWG	264.60	3 1/2"	30.65	23,415.75	2	250KCMIL	388.80	250KCMIL	388.80	1AWG	201.15	2 1/2"	21.40	15,156.45
GEN	ATS 400	0.7	65	1	600KCMIL	2,133.00	600KCMIL	2,133.00	3AWG	264.60	3 1/2"	30.65	8,149.55	2	250KCMIL	388.80	250KCMIL	388.80	1AWG	201.15	2 1/2"	21.40	5,240.57
ATS 400	EQD4P	0.15	10	1	600KCMIL	2,133.00	600KCMIL	2,133.00	3AWG	264.60	3 1/2"	30.65	1,625.94	2	250KCMIL	388.80	250KCMIL	388.80	1AWG	201.15	2 1/2"	21.40	954.86
EQD4P	EQD4B	2	195	1	350KCMIL	1,305.45	350KCMIL	1,305.45	4AWG	224.78	3"	25.45	15,855.41	1	500KCMIL	641.25	500KCMIL	641.25	2AWG	155.93	3"	25.45	10,404.11
EQD4B	V4BA	0.1	6	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	110.04	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	106.50
EQD4B	XFMR 10	0.1	6	1	1/0AWG	464.40	-	0.00	6AWG	159.30	1 1/2"	9.75	213.73	1	3/0AWG	309.15	-	0.00	4AWG	121.50	2"	11.65	174.80
XFMR 10	EQD2B	0.1	6	1	250KCMIL	1,008.45	250KCMIL	1,008.45	4AWG	224.78	2 1/2"	21.40	554.24	1	350KCMIL	503.55	350KCMIL	503.55	2AWG	155.93	3"	25.45	369.70
EQD2B	V2BA	0.1	6	1	1/0AWG	464.40	1/0AWG	464.40	6AWG	159.30	2"	11.65	271.59	1	3/0AWG	309.15	3/0AWG	309.15	4AWG	121.50	2"	11.65	205.71
EQD4P	XFMR 11	0.1	6	1	3/0AWG	696.60	-	0.00	6AWG	159.30	2"	11.65	294.81	1	250KCMIL	388.80	-	0.00	4AWG	121.50	2 1/2"	21.40	257.18
XFMR 11	EQD2P	0.1	6	1	600KCMIL	2,133.00	600KCMIL	2,133.00	3AWG	264.60	3 1/2"	30.65	1,063.53	2	250KCMIL	388.80	250KCMIL	388.80	1AWG	201.15	2 1/2"	21.40	608.04
EQD2P	EQ1S	1.4	135	1	6AWG	159.30	6AWG	159.30	10AWG	81.68	1"	6.36	1,864.82	1	4AWG	121.50	4AWG	121.50	8AWG	81.68	1 1/4"	8.29	1,913.76
EQD2P	EQ2S	1.25	120	1	4/0AWG	845.10	4/0AWG	845.10	4AWG	224.78	2 1/2"	21.40	7,074.17	1	300KCMIL	484.65	300KCMIL	484.65	2AWG	155.93	2 1/2"	21.40	5,185.86
EQD2P	EQ3S	1.1	105	1	1/0AWG	464.40	1/0AWG	464.40	6AWG	159.30	2"	11.65	3,441.89	1	3/0AWG	309.15	3/0AWG	309.15	4AWG	121.50	2"	11.65	2,717.21
EQD2P	EQ3SA	1.1	105	1	1/0AWG	464.40	1/0AWG	464.40	6AWG	159.30	2"	11.65	3,441.89	1	3/0AWG	309.15	3/0AWG	309.15	4AWG	121.50	2"	11.65	2,717.21
EQD2P	EQ2P	0.15	10	1	4/0AWG	845.10	4/0AWG	845.10	4AWG	224.78	2 1/2"	21.40	754.75	1	300KCMIL	484.65	300KCMIL	484.65	2AWG	155.93	2 1/2"	21.40	528.15
										Total Copper Cost			222,195.49								Total Aluminum Cost		157,434.85

20A Breaker Time-Current Trip Curve

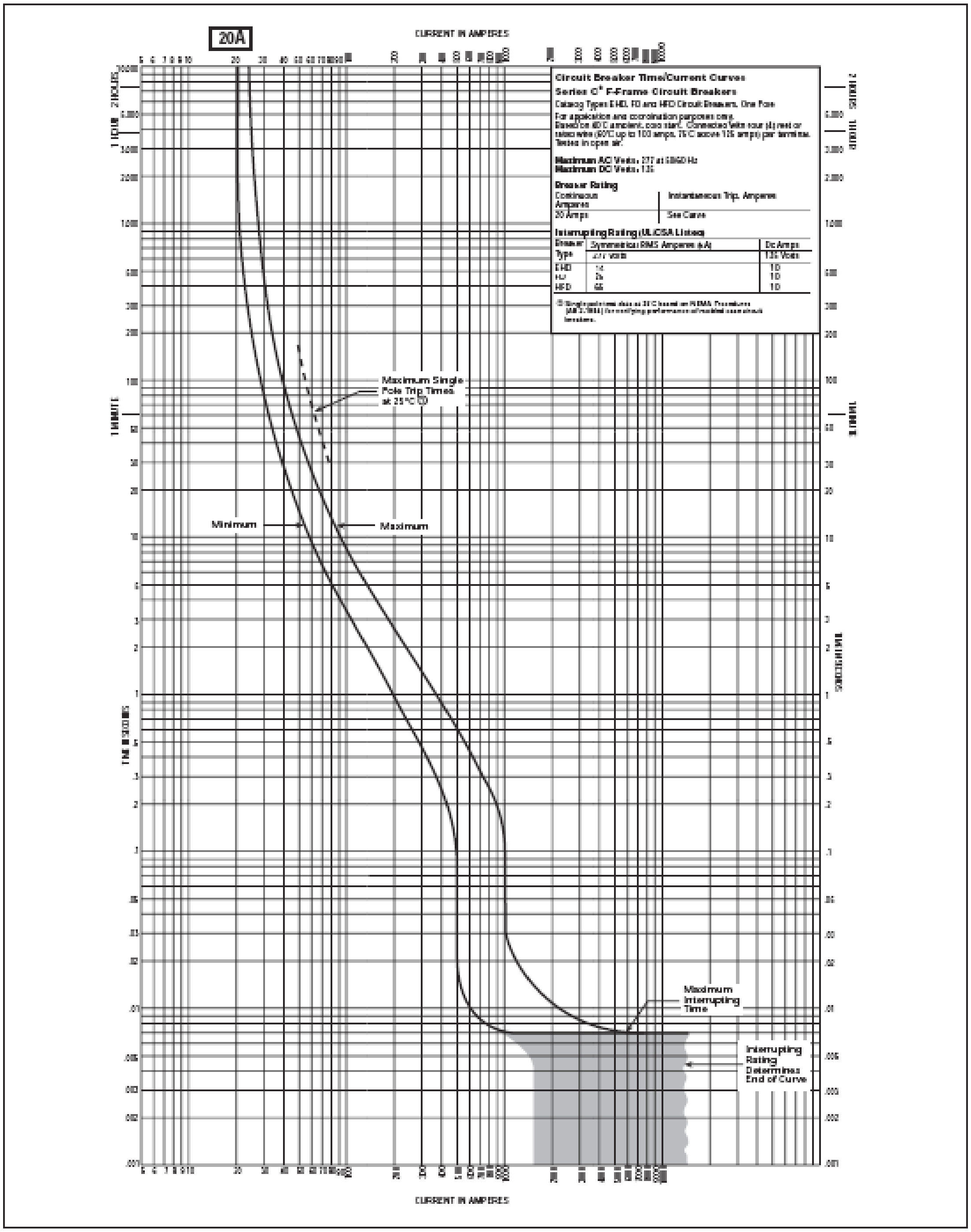


FIGURE 2. TYPES EHD, FD AND HFD 20 AMPERES — CURVE NO. SC-4424-88A

60A Breaker Time-Current Trip Curve

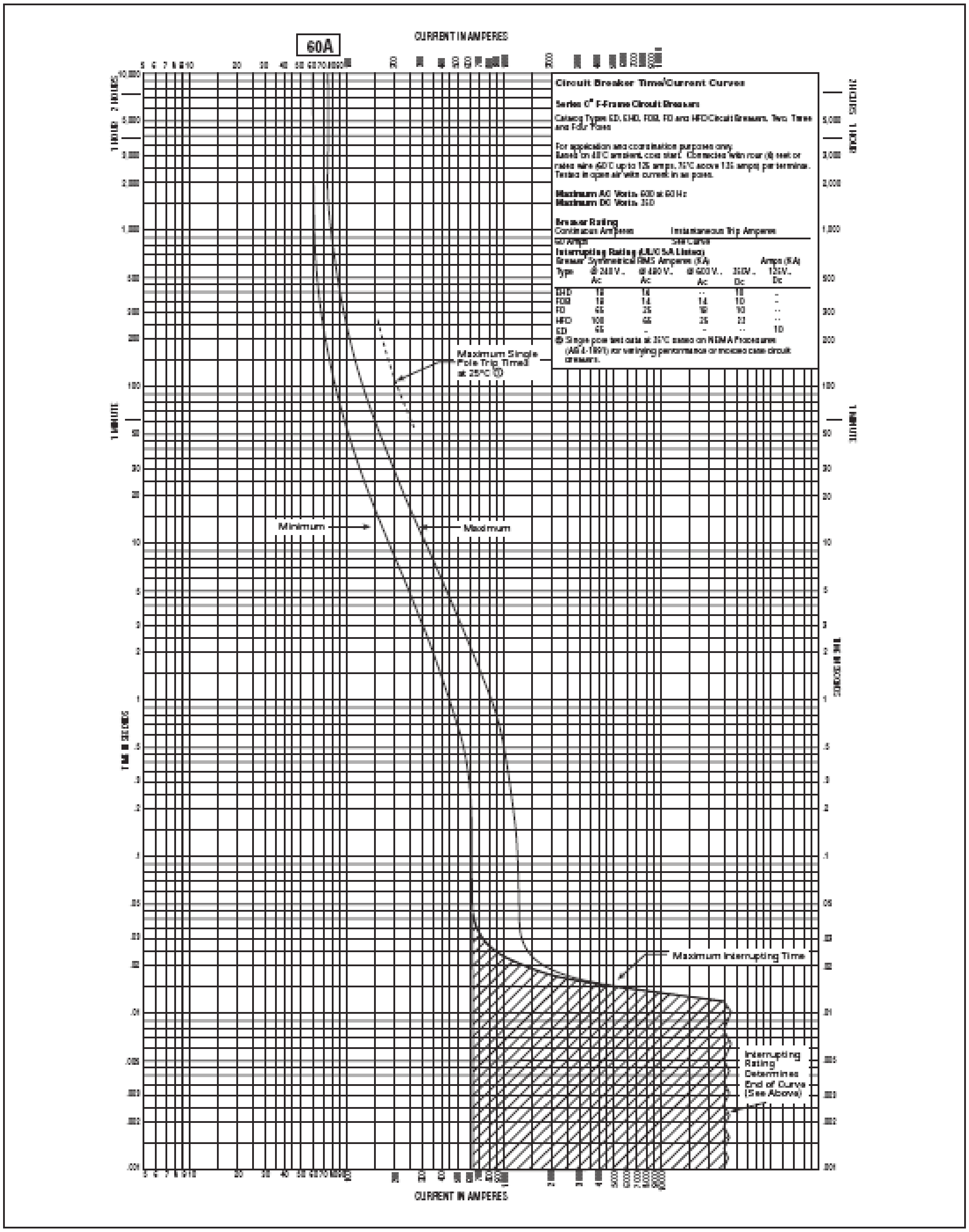


FIGURE 25. TYPES ED, EHD, FDB, FD AND HFD 60 AMPERES — CURVE NO. SC-4142-87B

400A Breaker Time-Current Trip Curve

Application Data
29-167C

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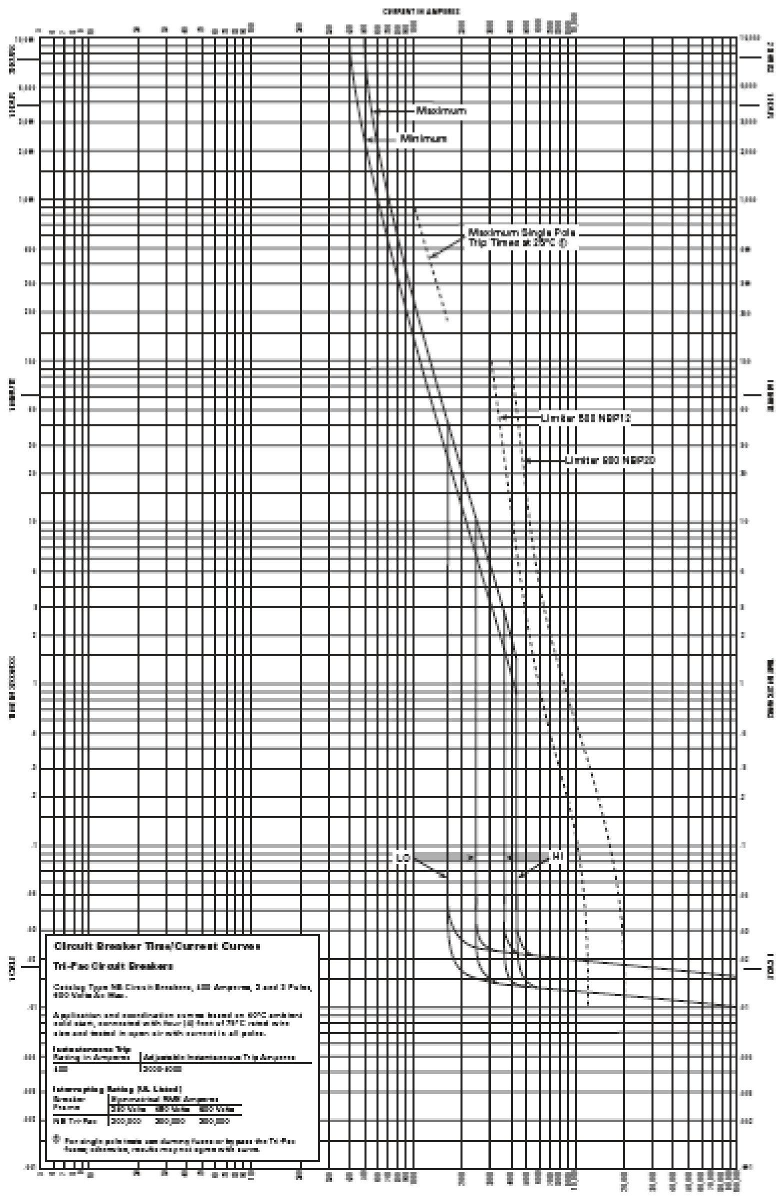
AB DE-ION Tri-Pac® Circuit Breakers

Type NB, 400 Amperes, 2 and 3 Poles



Curve No. SC-3594-76B

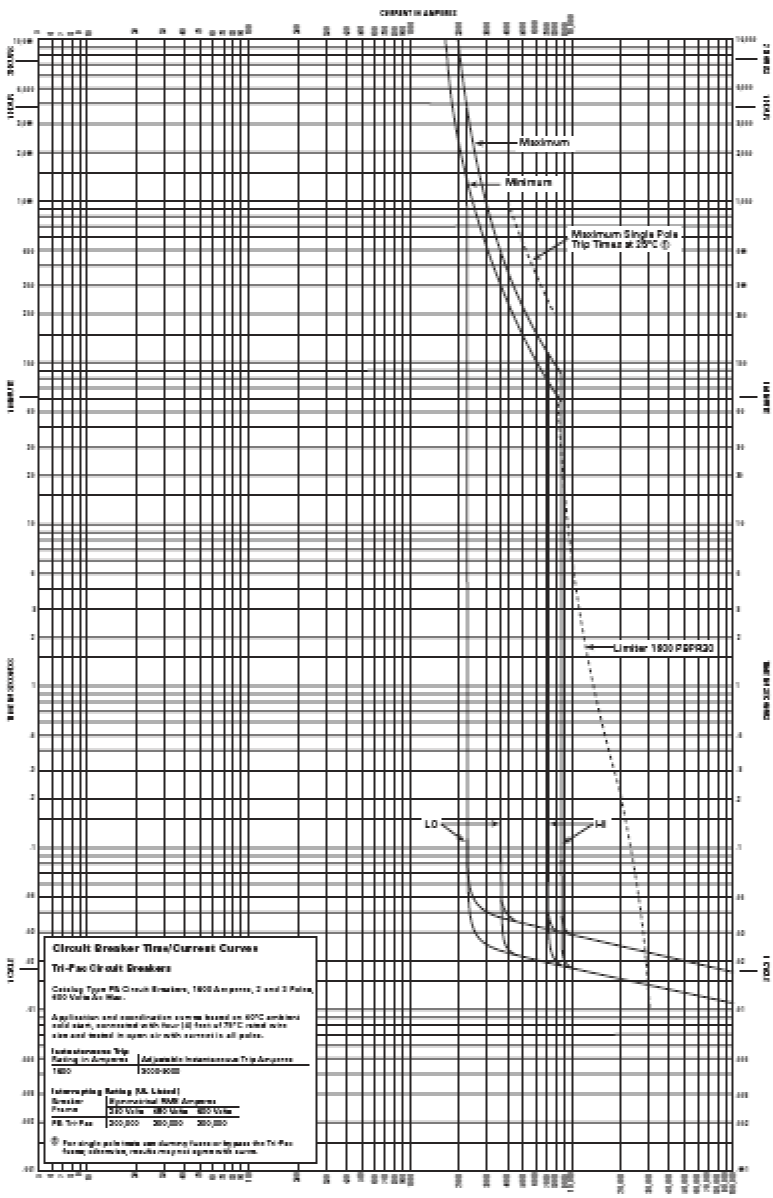
October 1997

1600A Breaker Time-Current Trip Curve

Application Data
29-167C
Page 52

AB DE-ION Tri-Pac® Circuit Breakers

Type PB, 1600 Amperes, 2 and 3 Poles



Curve No. SC-3604-76B
October 1997

EATON

Appendix C

Breadth Studies Supplemental Information

Acoustical Breadth – Reverberation Time Calculations

Surface Properties:

Surface	Sound Absorption Coefficient (α) at Frequency						Surface Area	Assumption	Average α
	125	250	500	1000	2000	4000			
Carpet	0.05	0.06	0.14	0.37	0.6	0.65	1302.10	Carpet, heavy, over concrete	0.31
Sintered Aluminum Panels	0.4	0.3	0.15	0.1	0.04	0.12	560.13	Metal Roof Deck, plain	0.19
Drywall	0.16	0.07	0.04	0.04	0.03	0.03	1150.37	1/2 GB, 3.625 St, Fiber	0.06
Glass	0.35	0.25	0.18	0.12	0.07	0.04	172.80	Glass window	0.17
Chalkboard	0.01	0.01	0.02	0.02	0.02	0.03	307.40	Clay Brick (Painted)	0.02
Ceiling	0.07	0.21	0.81	0.85	0.93	0.88	1921.80	Perf metal ceiling	0.63
Drywall Ceiling	0.16	0.07	0.04	0.04	0.03	0.03	834.20	1/2 GB, 3.625 St, Fiber	0.06
Desks	0.58	1.18	0.07	0.04	0.03	0.07	456.74	Plywood. 1/4" air	0.33
Wood	0.35	0.22	0.07	0.04	0.03	0.07	416.53	Plywood. 1/4" air	0.13
Door	0.58	0.22	0.07	0.04	0.03	0.07	48.00	Plywood. 1/4" air	0.17
People In Chairs	0.68	0.75	0.82	0.85	0.86	0.86	456.74	Audience, medium uphol	0.80

Approximate Volume of Lecture Hall:

Area of Room	FA	Avg Hgt	Volume
Front Exit	303	12	3636
Front Desks	781	11.302	8826.862
Middle Desks	590	9.65	5693.5
Back Desks	309	8.167	2523.603
Back Exit	532	10.583	5630.156

Total Volume	26310.121

Reverberation Time Calculation:

Calculation	Sound Absorption Coefficient (α) at Frequency					
	125	250	500	1000	2000	4000
ΣA	1243.30	1476.08	2004.09	2314.44	2696.36	2745
RT (Solid)	1.06	0.89	0.66	0.57	0.51	0.50
RT (Porous	1.31	1.11	0.82	0.71	0.61	0.60

Access to Calculation File:

P:/Thesis Spreadsheets/Acoustics.xls

Acoustical Breadth – New Lecture Hall Ceiling Material Cutsheet

Acoustical Surfaces, Inc.

SOUNDPROOFING, ACOUSTICS, NOISE & VIBRATION CONTROL SPECIALISTS
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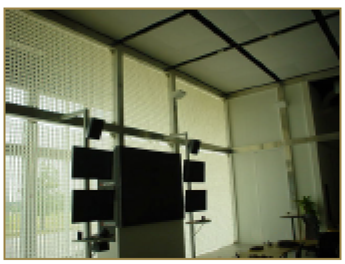
We Identify and S.T.O.P. Your Noise Problem

Noise S.T.O.P.™ ACOUSTIMETAL™

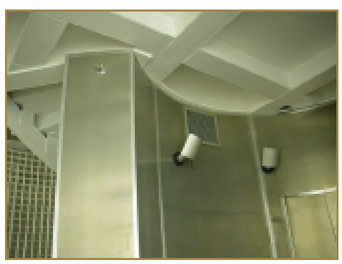
- *Durable* ■ *Impact Resistant* ■ *Walls & Ceilings*
- *Class A-1 ASTM E-84 Nonflammable*

Introducing Acoustimetal™, the latest advancement in noise control and acoustic treatment. Acoustimetal™ combines the durability of a perforated metal shell and the superior noise control, properties of our exclusive nonflammable acoustical material. Acoustimetal™ is ideal for demanding environments where noise control applications are exposed to physical impact. Indoor or outdoor use.

The Acoustimetal™ shell is available in electrostatically finished, anodized aluminum or optional painted white. The Acoustimetal™ shell is designed to withstand the harshest industrial installations or visually appealing interior design. The unique 50% perforation pattern gives maximum sound control with the use of our Class 1, Fiberglass Free (LEED ELIGIBLE) Echo Eliminator or Sound Silencer material inside. *Custom panel sizes available.*

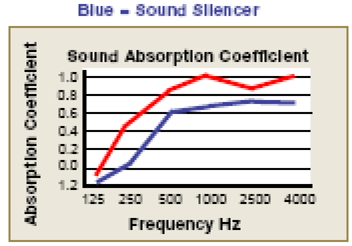






Sound Absorption Coefficients Within Speech Frequency Range

Red – Echo Eliminator
Blue – Sound Silencer



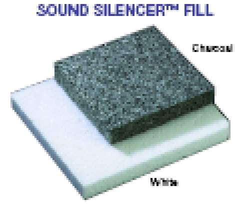
	250	500Hz	1KHz	NRC
Acoustimetal	0.69	1.13	1.00	0.95

with 2" Echo Eliminator and 1/8" Round Perf X 3/4" staggered centers.

(LEED ELIGIBLE) ECHO ELIMINATOR™ FILL

Nom. Size	125Hz	250Hz	500Hz	1KHz	2KHz	4KHz	NRC
1" x 2' x 4'	.08	.31	.79	1.01	1.00	.99	.80
2" x 2' x 4'	.25	.94	1.22	1.22	1.08	1.03	1.15

SOUND SILENCER™ FILL



Nom. Size	125Hz	250Hz	500Hz	1KHz	2KHz	4KHz	NRC/STC
1" x 2' x 4'	.05/6	.06/5	.21/7	.60/8	.65/10	.75/14	.45/9
2" x 2' x 4'	.07/9	.21/8	.91/10	.85/10	.93/17	.88/20	.70/13

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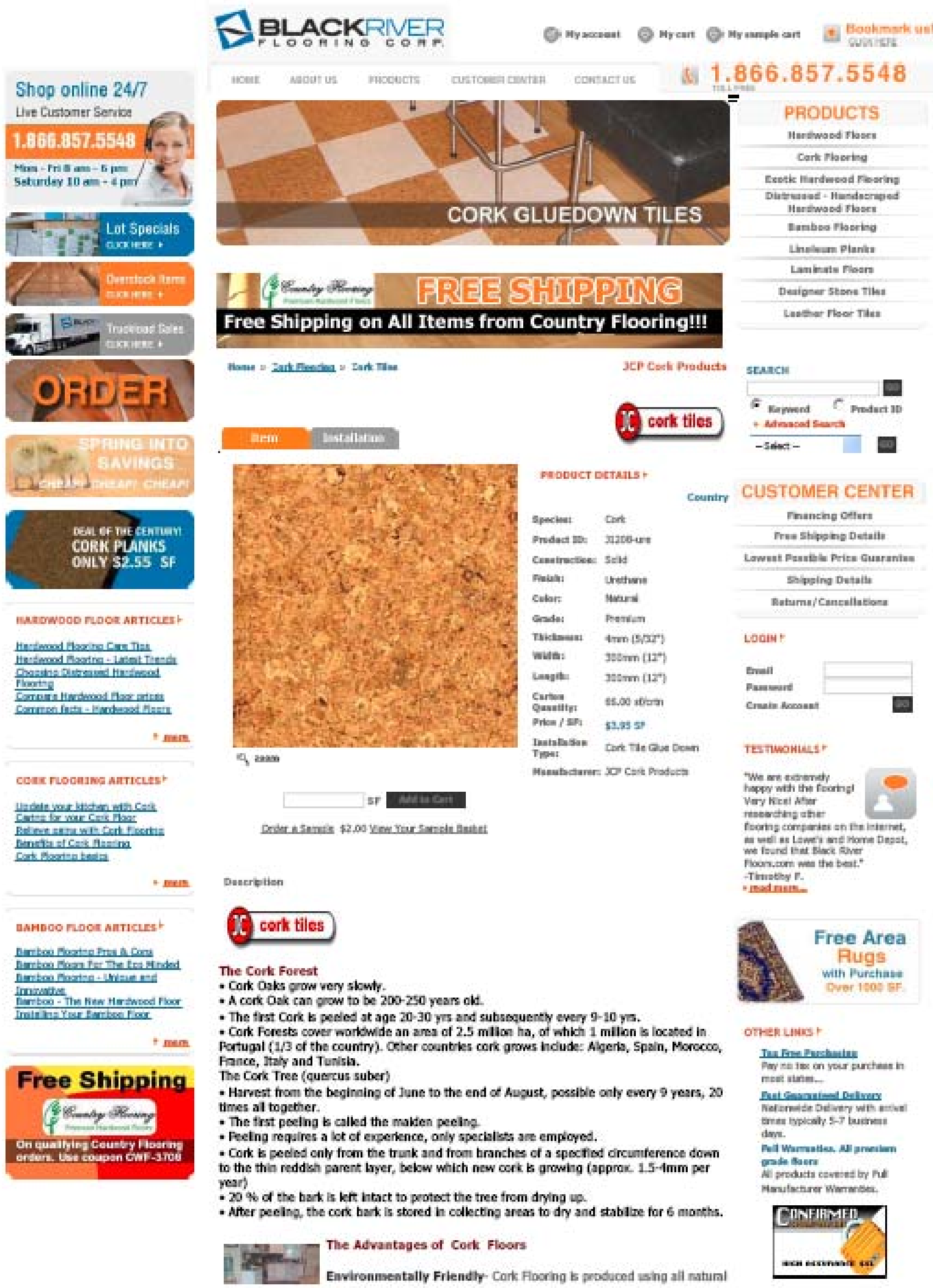
Acoustical Breadth – New 2nd Floor Lab Flooring Material Cutsheet



Mechanical Breadth – New Linear Diffuser Cutsheet

F8

Diffusers • Linear Slot • Description

F

ML(R)-37, -38, -39

Linear Slot Ceiling Diffusers

Modulinear • Aluminum

ML-37, -38, -39 Slotted • Supply

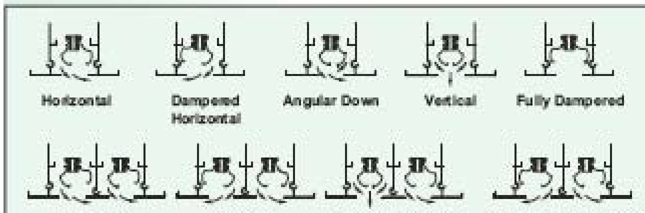
MLR-37, -38, -39 Slotted • Return

Supply Models:
- ML-37 • ½" Slot
- ML-38 • ¾" Slot
- ML-39 • 1" Slot

Return Models:
- MLR-37 • ½" Slot
- MLR-38 • ¾" Slot
- MLR-39 • 1" Slot

These Products Include:
- Standard Finish: #26 White border. Black pattern controllers.
- Optional Finishes: Anodized finishes available.

- TITUS modulinear diffusers are designed for variable air volume systems. They project a uniform blanket of air that adheres to the ceiling even at low flow rates.
- Both the direction and volume of the discharge air can be adjusted gradually by moving the pattern controllers (see diagrams below).
- Full 180° pattern controller adjustment means there are no "lefts" or "rights." Specifying, ordering, and installing are simplified.
- Model MLR returns are the same as the Model ML supply diffusers except that the pattern controllers are omitted.
- Choice of borders and mounting frames for various types of installations (diagrams below and on next page).
- Available with one to eight slots.
- Ideal for continuous length applications. Multiple sections are shipped with required alignment strips or pins for field installation.
- Maximum one piece section is 6 feet. Lengths greater than 6 feet are furnished in multiple sections.
- Optional Model MLF and MLRF diffusers are designed for field cutting to length and are furnished in 6-foot sections.
- Maximum pattern controller length is 3 feet. Pattern controllers are furnished in multiple sections for a diffuser longer than 3 feet.
- Mounting frames are cut to length and assembled in the field.
- Material is extruded aluminum with steel pattern controllers.
- Optional curving to a 6-foot minimum radius available for architectural enhancement (fixed blades only).

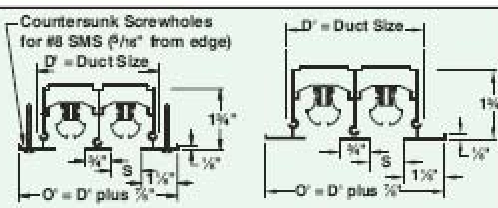


Frame and Border Types

Note: See page F10 for Duct Dimensions.

All dimensions are in inches.

Border Types 1A, 1B both with
- Flange Border
- (1A) Screw Mounting
- (1B) Duct Mounting, No Screw Holes



Border Type 1A

Border Type 1B

Border Types 2A, 2B both with
- Flange Border
- Concealed Mounting

Type	A	O'
2A	1⅜	D' + ¾
2B	⅜	D' + ¾