

Naval Network & Space Operations Command (NNSOC) Dahlgren, VA



Christopher Ankeny Lighting/Electrical Final Report Spring 2007 Dr. Mistrick – Advisor Ted Dannerth – Electrical Consultant



Naval Network & Space Operations Command (NNSOC)

Naval Surface Warfare Center Dahlgren Division Dahlgren, VA

Project

- **Owner: United States Navy**
- A/E: Kling, Washington, D.C.
- CM Skanska Corp. Design/Build Project Two Story, 75,000 s.f.
 - \$17 Million, Scheduled Opening Oct. 2006

Mechanical

- Three Air Handling Units to supply the 1st and 2nd floor, and theater space
- Three Electric Steam humidifiers for the 1st and 2nd floor, and theater space
- Two expansion tanks for hot/chilled water
- A 1991 MBH Oil-fired Boiler and a 110 ton watercooled chiller
- 330 GPM Cooling Tower

Architecture

- Two story mixed-use business with some A-3 Assembly use (training theater)
- The building serves as the final element in the ensemble with two other buildings
- The entrance lobby is the main focal point of the design bridging the new building with the existing one

Structural

- Superstructure will be framed with structural steel
- Second floor will be a composite metal floor deck and wide flange beams and girders
- Roof will utilize steel joists and a metal roof deck.
- Exterior is 8" reinforced CMU with punched windows
- Slab-on-grade foundation with footers under all columns and exterior walls

Christopher Ankeny

Electrical

- 13.8 KV 3 phase parallel service entrance to existing exterior switchgear
- Power is connected from the existing exterior switchgear to the double-ended Main Switchboard (1600A)
- Two existing 1250 kW diesel-fired engine generators will provide standby power
- Life safety loads will be provided with battery backup from the Standby Power System (SPS)

Lighting

- Site lighting is pole mounted fixtures with bollards along some walkways
- Daylighting the indoor space was maximized using two "L" shaped wings that provide a break in the exterior wall allowing daylight to enter
- Indirect fixtures in the office areas, direct fixtures in most other spaces, specialty lighting in the Auditorium and Lobby

Lighting/Electrical

http://www.arche.psu.edu/thesis/eportfolio/2007/portfolios/CSA130/

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Table of Contents

Section				
*	Executive Summary	4		
*	Background and Building Overview	5		
*	Lighting Depth Report	6-61		
	• Outdoor Area	6		
	o Lobby	16		
	• Training Theater	30		
	• Open Office	43		
*	Electrical Depth Report	62-84		
	• Panelboards and Circuiting	63		
	Overcurrent Protection	74		
	• Rotary UPS vs. Static UPS	76		
	• Photovoltaic Analysis	82		
*	Mechanical Breadth	86		
*	Construction Management Breadth	90		
*	Conclusions	94		
*	Acknowledgements	95		
*	References	96		

Appendix A – Lighting Depth Report

Appendix B – Electrical Depth Report

Appendix C – Breadth Reports

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Executive Summary

The Naval Network Space & Operations Command is a very interesting building to study. The architecture seems very straight forward without any obvious aesthetic designs besides the glass curtain wall lobby. The rest of the building is CMU with punched out windows and all interior spaces are very functional. The challenge of my redesign is to try and enhance the architecture some while maintaining the feel of a Naval Office Building.

The lighting depth is an integration of a new daylight system into the open office area of the building while using controls to limit the amount of electric light needed. I am also redesigning the outdoor entrance area, lobby, and training theater to try and make them somewhat more interesting spaces. The content in the report for these spaces will include design concepts, reflected ceiling plans, section drawings, equipment selections, power densities and control schemes. My goal of the lighting design was to keep it simple following the architecture while giving some aesthetics to certain features of the building such as the training theater and outdoor/lobby spaces. I referenced the IESNA Handbook and ASHRAE 90.1 for lighting design considerations and code requirements.

The electrical depth will be a redesign of the emergency UPS (Uninterruptible Power System) system of the building. The goal of the redesign is to save space in the building by removing the battery bank room, have easier and safer maintenance, and save money over the cost of the entire system. The report will include equipment selections and a 10-year cost analysis between a 7-minute battery bank static UPS system and a rotary UPS system with no battery bank.

The other electrical depth is to see whether Photovoltaic panels would be a beneficial source of power to the building. The analysis will consider the cost of the installation with the expected payback period of the system. Any incentives or credits available by the state or federal government will also be taken into account. The report will have equipment selections, a proposed layout for the system, and the payback analysis.

For my two breadth topics I will be analyzing the affects of adding in the glazing for daylight integration with the HVAC equipment. I will also be doing a Construction Management Coordination of systems with the new daylight design to see what affects the skylights would have on the structural and MEP locations of equipment and systems.

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Background

The Naval Network Space & Operations Command is an office facility of the U.S. Navy. It is part of the Naval Surface Warfare Center Dahlgren Division in Dahlgren, VA. This two-story, 75,000 square feet new construction is connected to an existing building via a new lobby. The building is almost square (199'x188') and used mainly as an open office plan with an assembly training theater located near the center of the 1st floor. The lobby is the main entrance to both the new building and the existing building using two entrances, one for the back parking lot and one for the main front parking area.

Building Overview

General Building Data	
Building Name:	Naval Network & Space Operations Command (NNSOC)
Location/Site:	Naval Surface Warfare Center, Dahlgren, VA
Occupant Name:	Navy
Occupancy:	Mixed use - business with some A-3 Assembly use
	(Training Theater)
<u>Size:</u>	75,000 square feet
<u># of stories:</u>	no below grade floors and 2 stories above grade
Project Team:	Architecture and Engineering – Kling
	www.kling.us
	Construction Management – Skanska Corp.
	www.usacivil.skanska.com
Dates of Construction:	Construction Documents Issued 12/05.
	Construction Expected Complete 3/07.
Cost Information:	\$17 million Total Cost
Delivery Method:	Design-Build

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Lighting Depth

Outdoor Area

Spatial Overview

Outside the building left of the main entrance is a building sign, flagpole and anchor surrounding the walkway into the building. There is also a parking lot here with sidewalks leading to the entrance area. I am keeping the existing lighting design for the parking lot area and changing the lighting outside the entrance. Security bollards are placed every 5' surrounding the lobby and entrance area. The building façade is all CMU except for the punched windows and the glass lobby. The lighting area I am redesigning covers around 2500s.f. of surface space right outside of the entrance.

Performance Considerations

The main performance of the outdoor lighting is to provide enough egress light to walk to and from the building. The outdoor lighting needs to be controlled by either a timer system or photocell for proper ON/OFF during the day and night as required by ASHRAE 90.1. The lighting design also needs to stay under proper power densities for an outdoor egress area.

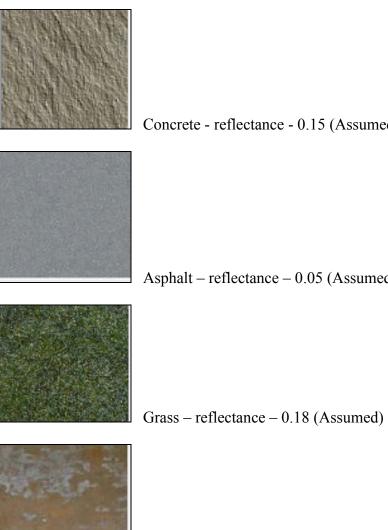
Design Concept

My design concept for the outdoor area is to provide a visually appealing space that commends our Navy and Nation. The flagpole, building sign, and anchor are the three main attractions leading into the building and need to stand out from the rest of the area. The outdoor space also needs to complement the lighting design of the lobby.

The building sign is uplighted from the ground with a small T5 fixture. A narrow beam spotlight is located on the top canopy aimed at the anchor and the same fixture on top of the lower canopy aimed at the flag. Four security bollards are being replaced by lighting bollards along the pathway to reach the required illuminance value for walkway egress. The entrance is lighted by four downlights recessed into the exterior canopy.

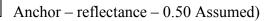


Finishes



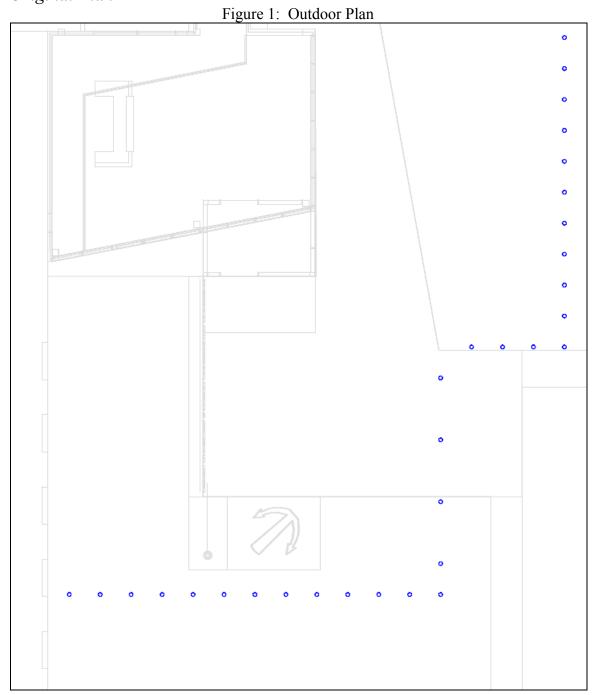
Concrete - reflectance - 0.15 (Assumed)

Asphalt – reflectance – 0.05 (Assumed)



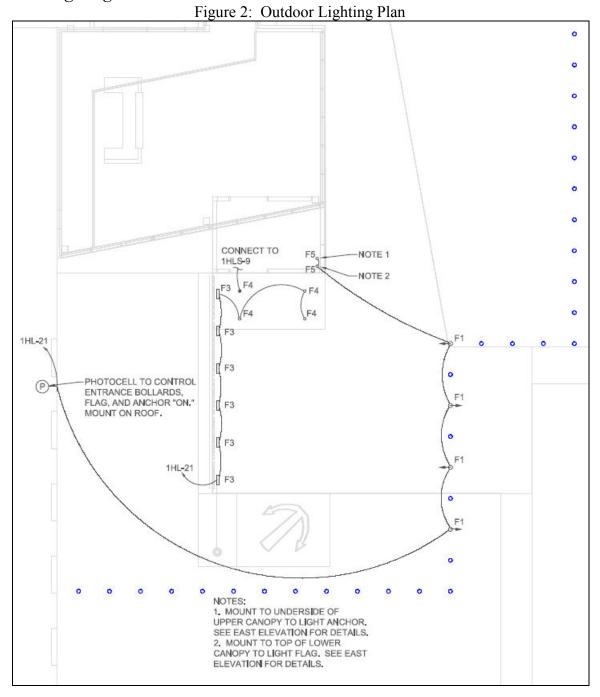


Original Plan



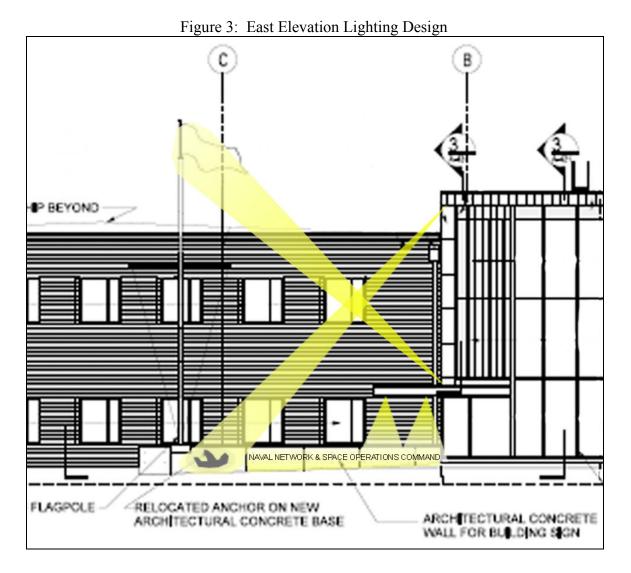


New Lighting Plan





East Elevation Design Intent





Luminaires

	Table 1		
	LUMINAIRE SCHEDULE		
Туре	Description	Lamping	CCT
F1	EXTRUDED ALUMINUM BOLLARD LUMINAIRE WITH TYPE V, 360 DEGREE LATERAL LIGHT DISTRIBUTION. NOMINAL 42" HIGH x 8.5" DIAMETER. FINISH IS TO MATCH SECURITY BOLLARDS.	(1) CMH70/TD/942RX7S	4200
F3	RECESSED PROJECTOR, TYPE VI, FIXED REFLECTOR LUMINAIRE, NOMINAL 19" x 3.6". DRIVE OVER RATED, WATERPROOF.	(1) FM 11W/760 W4,3 UNV1	6000
F4	CAST ALUMINUM, SILVER POWDER-COATED TYPE V DOWNLIGHT, NOMINAL 8" DIAMETER x 9" DEPTH. CUT-OFF ANGLE 30 DEGREES. WATER-JET PROOF.	(1) F18TBX/SPX41/A/4	4100
F5	CORROSION-RESISTANT CAST ALUMINUM TYPE V BEAMER II PROJECTOR, NOMINAL 12" HIGH x 6.25" DIAMETER. 130 DEGREE TILT, MOUNTING PLATE FOR METAL HALIDE LAMPS. CUT-OFF ANGLE 50 DEGREES. WATER-JET PROOF.	(1) CMH35/T/UVC/U/830/G1 2	3000

*Full Luminaire, Ballast, LLF schedule and cutsheets attached in Appendix A.



F5

I	I	F	'r	
L	L	1'	3	

_			Table 2	2			
TYPE	BF	CLEANING	MAINTENANCE	LLD	LDD	RSDD	LLF
F1	1.00	12 Month	V	0.77	0.87	-	0.67
F3	1.00	12 Month	VI	0.92	0.85	-	0.78
F4	1.05	12 Month	V	0.85	0.87	-	0.78
F5	1.00	12 Month	V	0.80	0.87	-	0.70



Power Density

		Table 5		
TYPE	# LUMINAIRES	# LAMPS/LUMINAIRE	WATTAGE/LAMP	WATTAGE
F1	4	1	77	308
F3	6	1	11	66
F4	4	1	39-(2) LAMPS	78
F5	2	1	35	70
	44			

Table 2

Wattage on Walkways 10' or greater (F1, (4) F3, F5) = 422WWattage under Canopy (F4, (2) F3) = 100W

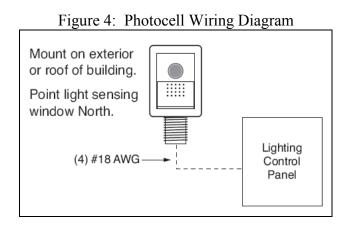
Power Density on Walkways: 422/2500 = 0.17 W/sq ft. Power Density under Canopy: 100/180 = 0.56 W/sq ft.

Using the Space-by-Space Method in ASHRAE 90.1 Walkways 10' wide or greater = 0.2 W/sq ft. Canopy = 1.25 W/sq ft.

All the requirements are met for ASHRAE 90.1 for the outdoor power density.

Controls

The entire Naval Base is controlled by the Base Public Works Department (PWD) using a central SCADA (Supervisory Control and Data Acquisition) system. This system controls all of the lighting on the base and keeps all internal clocks synchronized within the system. They control when interior and exterior lights are turned on/off by a predetermined time setting. To provide the PWD with more flexibility, I am providing a photocell interface on the roof to be able to control the bollard, parking and signage lighting (Circuit 1HL-21). The existing diagram of the Naval Base's SCADA system is in Appendix A.





Renderings and Calculation Results





Figure 6: Outdoor Rendering







Figure 7: Outdoor Rendering

Figure 8: Outdoor Rendering





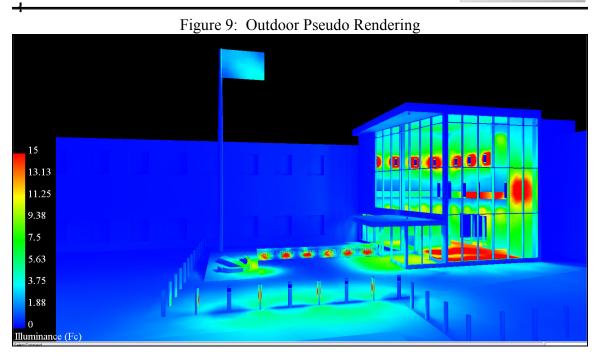
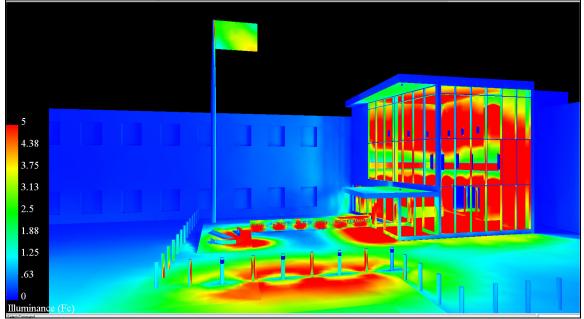


Figure 10: Outdoor Pseudo Rendering



Conclusion

All the locations that I felt were important have a nice contrast between their lighted surface and the surrounding space. Overall I think the design highlights the areas that I feel are the most important to the space. The flag is only receiving 1-2 fc but I feel is this acceptable since the surround is dark sky. The anchor and sign seem to have the most light and should draw a person's attention to each of these items along with the entrance to the lobby.



Lobby Space

Spatial Overview

The lobby area is the main feature of the building. It connects the existing building with the new building (NNSOC) and acts as a bridge between the two. This two story space is mostly a glass curtain wall and serves as a welcome area to the occupants. The space is 35' floor to ceiling and is the only public entrance to these facilities. There are two entrances into the lobby, one from the back parking lot and another from the front lot. The lobby has a bridge on the 2^{nd} floor, 17'4" from the ground that extends about 6' from the NNSOC wall and connects to the existing building on the 2^{nd} floor. There are no pictures or artwork hanging on the walls and the only furniture in the space is a security desk and an X-RAY machine.

Performance Considerations

The lobby is a circulation area with many people passing through it all day. Tasks such as reading and writing do not apply in here, except possibly for an information directory or directional sign. The security desk will need extra vertical and horizontal illuminance for facial appearance and writing tasks. The best way to achieve this is with task lighting on the desk surface. This will keep the direct glare out of the security guard's eyes while providing the needed levels to prevent fatigue by straining the eyes.

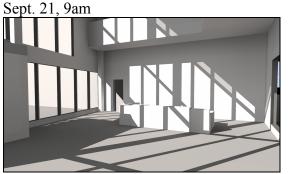
Another important issue in a lobby design is the transition from outside to inside and vise-versa. The light levels need to help adjust the eyes to the upcoming environment so people do not have to pause or squint when entering. This can be hard to do, but implementing a daylight photocell can be a good method to keep a constant lighting ratio between outside and inside the lobby space.

Daylight

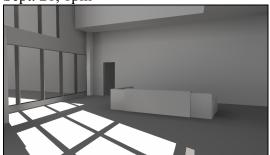
Daylight analysis of this space is very important due to the lobby's orientation and massive glass surfaces. The glass curtain wall is just slightly off from being directly east facing, and the main entrance doors are facing south. After running daylight studies on in the space, for clear days on June 21, Sept. 21, and Dec. 21, at 9am and 1pm, my results suggest there needs to be daylight integration incorporated into the lighting design of the lobby.

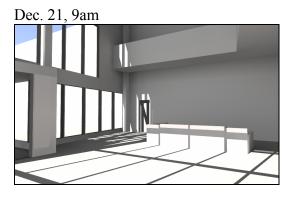
The lobby sees some direct sun until well after 1pm on every day of the year so adding photocells to the lobby can help regulate the amount of time that the luminaires need to be on any given day. This can cut down on electricity by a fair amount and enable the constant ratio between the outside and inside lighting. Another issue direct sunlight causes is radiation, or heating of the space. To prevent the direct sunlight from penetrating the lobby, low solar heat gain windows would be advisable. Shading devices could be impletement but for a lobby space this seems unnessary due to the constant traveling through the space. The results of my study are below, each showing the direct daylight penatration in a rendered image.





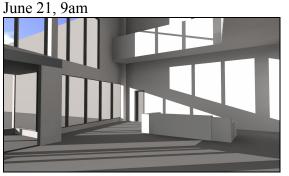




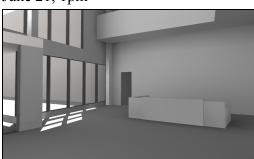








June 21, 1pm



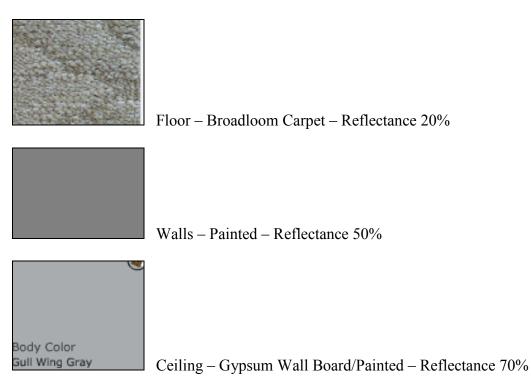
Design Concept

The idea behind this design is to provide an overall appealing look to the building. Since the lobby is the only area that a passerby can see into, and the architecture is very plain here, the lighting design has to make it look interesting. My idea was to provide some type of pendant fixture hanging from the ceiling and then have sconces on the walls to further add to the space. Having different fixtures for the pendants and sconces seem to be fighting each other visually, so I decided to use the same type of fixture for both, just different sizes. I was having trouble trying to find something that looked nautical for the space so I went with a simple circular fluorescent fixture. Downlights were added to the underside of the 2nd floor bridge for proper lighting around the security desk and X-RAY machine. There was task lighting added to the desk for the security guards.



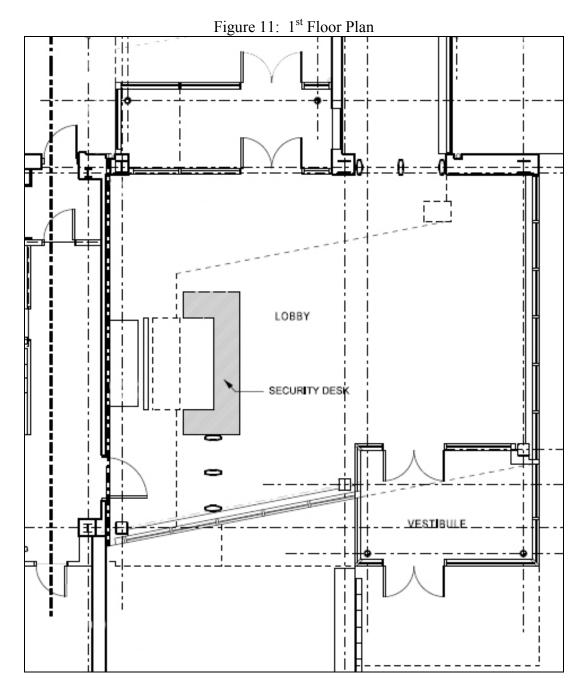
Finishes

Glass curtain wall has a visible transmittance of 72%

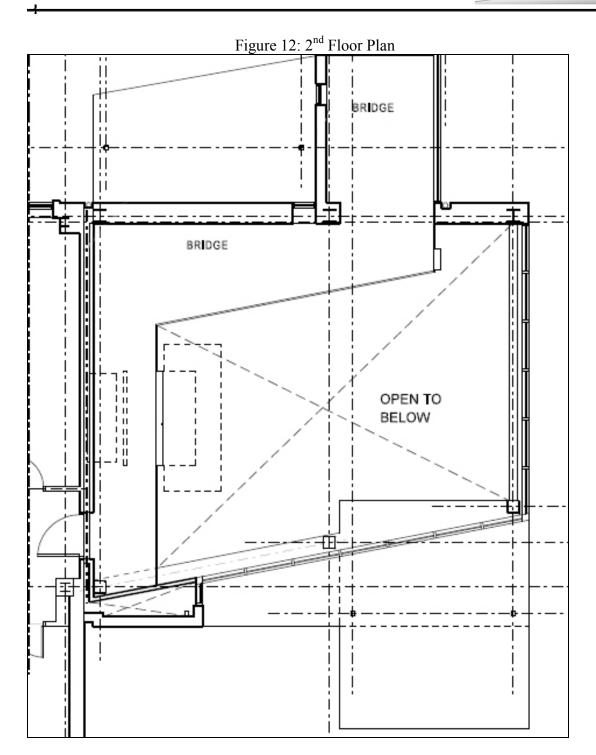




Original Plan

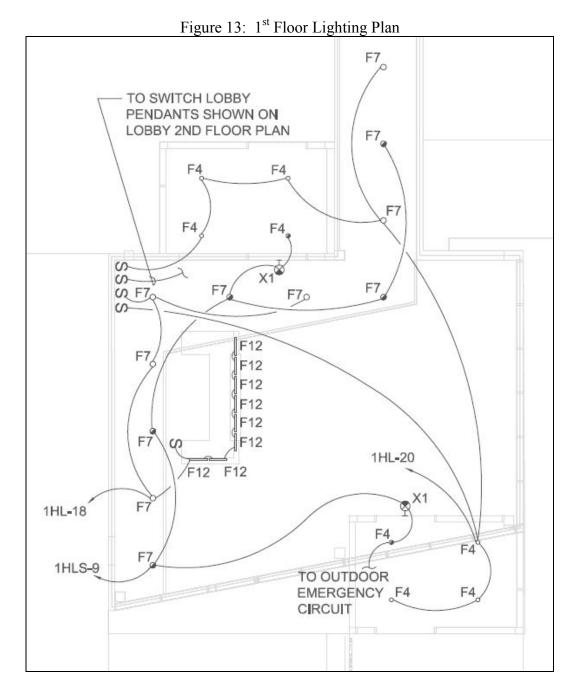








Lighting Plan





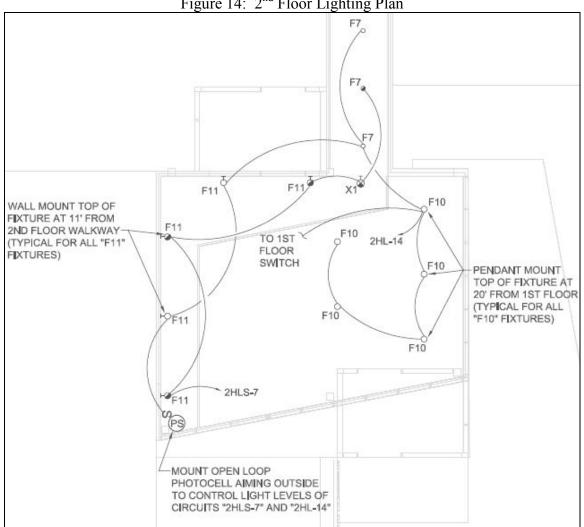
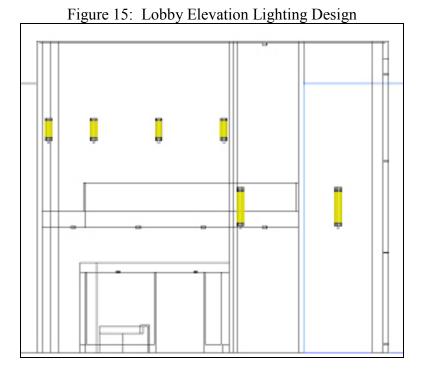


Figure 14: 2nd Floor Lighting Plan



Lobby Elevation



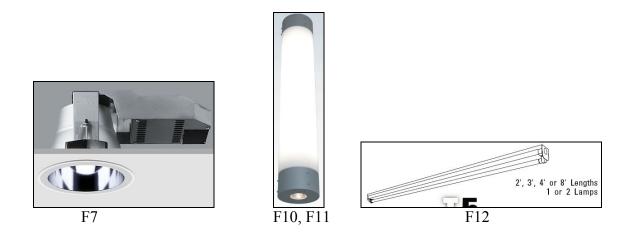
Luminaires

	Table 4		
	LUMINAIRE SCHEDULE		
Туре	Description	Lamping	ССТ
F7	CAST ALUMINUM DOWNLIGHT, WHITE POWDER COATED TYPE V SYMMETRIC DISTRIBUTION. NOMINAL 8" DIAMETER x 7" DEPTH	(1) F32TBX/830/A/ECO	4100
F10	KONE PENDANT CYLINDER WITH DOWNLIGHT COMPONENT, EXTRUDED ALUMINUM CENTER TUBE IS LAMP HOLDER AND ELECTRONIC BALLAST. TYPE V SYMMETRIC DISTRIBUTION, TOP AND BOTTOM CYLINDER IS 1/4" THICK WITH ALUMINUM COVER PLATES WITH SILVER POWDER COAT FINISH.	(3) F32T8SP30ISWMECO (1) CMH39UPAR20FL25	4100 3000
F11	KONE PENDANT CYLINDER, EXTRUDED ALUMINUM CENTER TUBE IS LAMP HOLDER AND ELECTRONIC BALLAST. TYPE V SYMMETRIC DISTRIBUTION, TOP AND BOTTOM CYLINDER IS 1/4" THICK WITH ALUMINUM COVER PLATES WITH SILVER POWDER COAT FINISH.	(3) F17T8XL/SPX41ECO	4100
F12	LINEAR DIRECT FLUORESCENT LOW-PROFILE FIXTURE. NOMINAL 2"x2"x22.5". HIGH GLOSS, BAKED WHITE ENAMEL FINISH. TYPE IV SYMMETRIC DISTRIBUTION.	(1) F21W/T5/841/ECO	4100

*Full Luminaire, Ballast, LLF schedule and cutsheets attached in Appendix A.

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LLF's

			Table 5	5			
TYPE	BF	CLEANING	MAINTENANCE	LLD	LDD	RSDD	LLF
F4	1.05	12 Month	V	0.85	0.87	0.97	0.75
F7	0.05/1.00	12 Month	V	0.84	0.87	0.97	0.71
F10	0.05/1.00	12 Month	V	0.9	0.87	0.92	0.71
F10	0.99	12 Month	V	0.9	0.87	0.92	0.71
F11	0.03/1.00	12 Month	V	0.95	0.87	0.92	0.76
F12	1.03	12 Month	II	0.92	0.94	0.97	0.86

*Assuming a clean environment.

Power Density

	2	Table 6		
TYPE	# LUMINAIRES	# LAMPS/LUMINAIRE	WATTAGE/LAMP	WATTAGE
F4	8	1	39-(2) LAMPS	156
F7	14	1	75-(2) LAMPS	525
F10	5	4	155-(4) LAMPS	775
F11	5	3	54-(3) LAMPS	270
F12	4	1	26	104

Total Wattage = 1830

Total Square Ft. = 1900s.f.

Power Density = 0.96 W/sq ft.

Using the Space-by-Space Method in ASHRAE 90.1 Lobby: 1.3 W/sq ft.

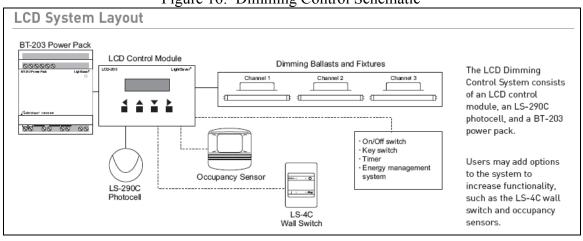
All the requirements are met for ASHRAE 90.1 for the lobby power density.

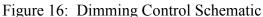


Controls

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There will be a photocell controlled system for the lobby space due the massive amount of daylight coming from the glass façade. The photocell will control circuits "2HLS-7" and "2HL-14." These circuits control the majority of the light in the space and dimming them should provide good energy savings. I am leaving the 1st floor lighting (F7 fixtures) on at full output under the bridge so the security guards will always have plenty of light.







Renderings and Calculation Results

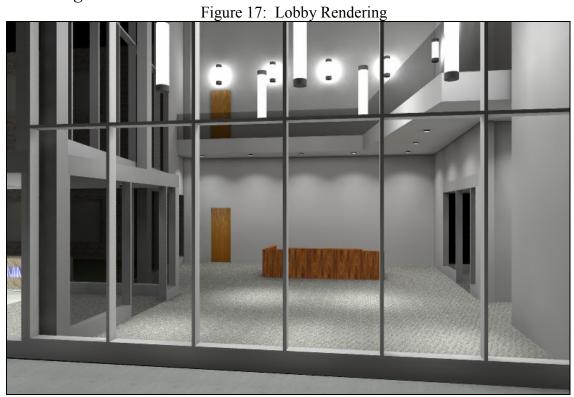


Figure 18: Lobby Rendering





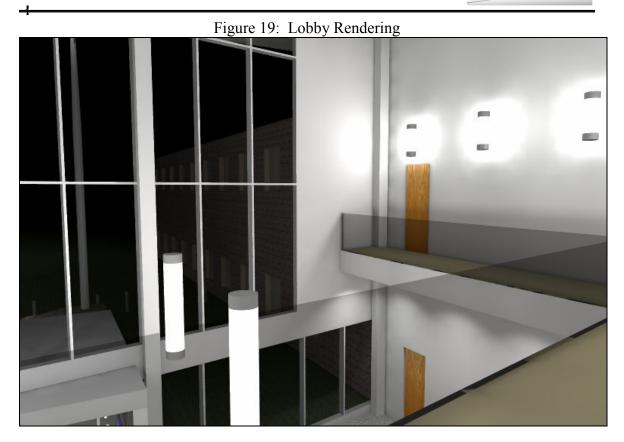
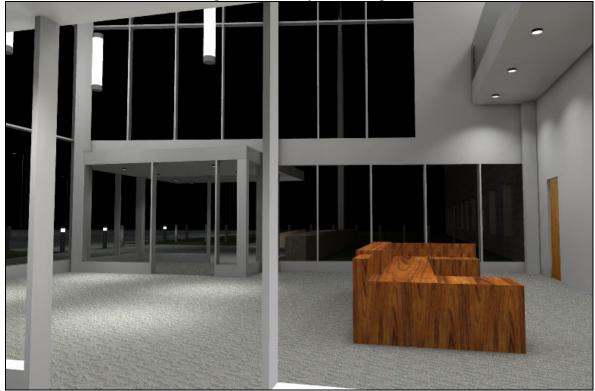


Figure 20: Lobby Rendering







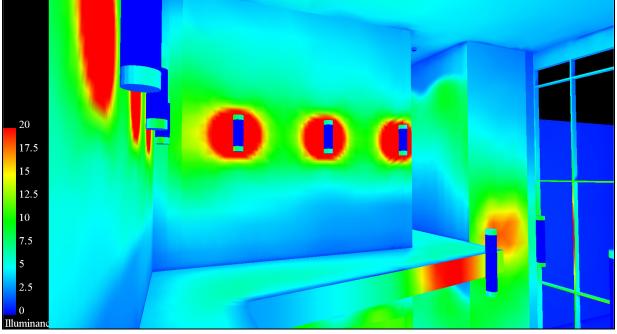
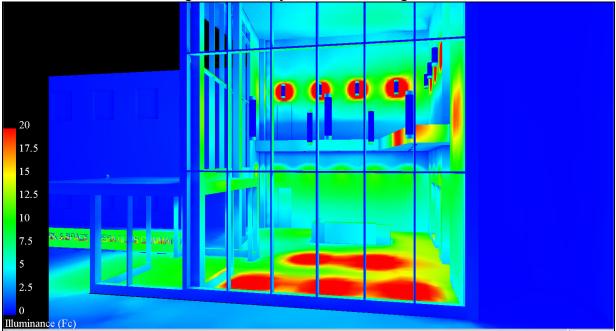
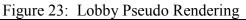
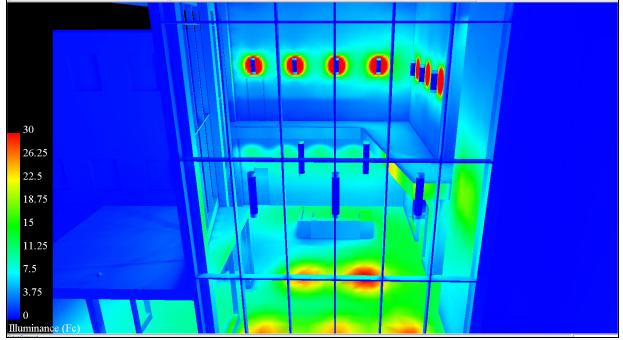


Figure 22: Lobby Pseudo Rendering









Conclusion

The same fixture for the pendants and sconces really helps to balance out the space out well. The larger pendant fixtures coupled with the smaller sconces give a nice visual look from the exterior of the building. Dimming the pendant and sconces should help to keep an even ratio of light between the exterior and interior giving an easier transition between the two areas. Overall I think the space is visually pleasing yet simple enough for a Naval Command Center.



Training Theater

Spatial Overview

The training theater is used as a training assembly for the occupants. The theater is tiered following the existing site grading down to the front of the room. One ramp is available along the north side of the auditorium for handicap access and the seating is arranged in a gentle arc, focusing attention toward the presenter and projection screen. There are three aisles that lead down the rows to the front of the room, one in the middle and two on each end. The main purpose of the space is to attend lectures and view presentations. Structural columns were carefully placed in areas where there would be no site line obstructions to the front wall.

Performance Considerations

A space like a training theater has a few different scenarios in which lighting design must be taken into account. Sitting in one of the seats a person will typically have two or three different areas to look at. One is at the projection screen, another would be toward a presenter/speaker and the third would be reading/writing sitting in a seat. For most cases, the eyes will be switching back and forth between two of them. Care has to be taken in the lighting design to make sure the ratios of the speaker and the screen are relatively similar, within 3:1. This ratio should be the same for these tasks to the background wall as well, with the background being darker.

Reflectances can be a huge issue when they are discussed with VDT and projection screens. First thing is to realize that having a high reflectance floor is not suitable. Carpet is the best choice because it has a matte surface which is able to diffuse the light in a non-glaring manner. Choice of light fixtures is also a daunting task. Direct glare, multiple light levels, and a comfortable feeling all need to be evaluated for an auditorium space. A designer needs to make sure that the fixtures won't cause glare to the audience, as well as on the projection screen. Recessed fixtures are usually a good choice for a space like this, especially when multiple lamps can be placed in the fixtures and switched on for different lighting levels. The walls should be fairly bland and not draw attention by having pictures or artwork hanging anywhere. This will keep the eyes from wandering around and help keep attention on the presentation, instead of somewhere else.

Controlling a space like an auditorium is a must for today's technologies. With all the different events that a space this flexible can hold, it is imperative to be able to control multiple lighting fixtures, with multiple settings such as dimming and switching of different lamps within a single fixture. Adding more fixtures to the space can also add flexibility. Placing step lights in the aisles can allow all the overhead fixtures to be turned off, providing the brightest screen possible for the projector. Once again, having control over the lighting system to meet each individual presenters needs is probably the best possible solution. Being able to control the lighting environment completely, allows the greatest flexibility without sacrificing quality.



Design Concept

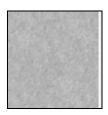
The design concept for the theater is to provide a flexible lighting system that minimizes glare and has a comfortable look. My design attempt is to draw away from the acoustical ceiling tile with typical 2'x2' fluorescent troffers, and replace them with a gypsum wallboard cove system. The cove system follows the form and dimensions of the tiered floor system which gives a nice balance to the space. The lighting controls are all dimmable and separated into different zones, giving the user optimal control over the entire space.

Finishes

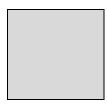
The materials used in this space were chosen to provide good acoustics and to minimize future maintenance needs. *Finishes*



Floor – Broadloom Carpet – Reflectance 20%



Walls - Acoustical Wall Covering - Reflectance 30%



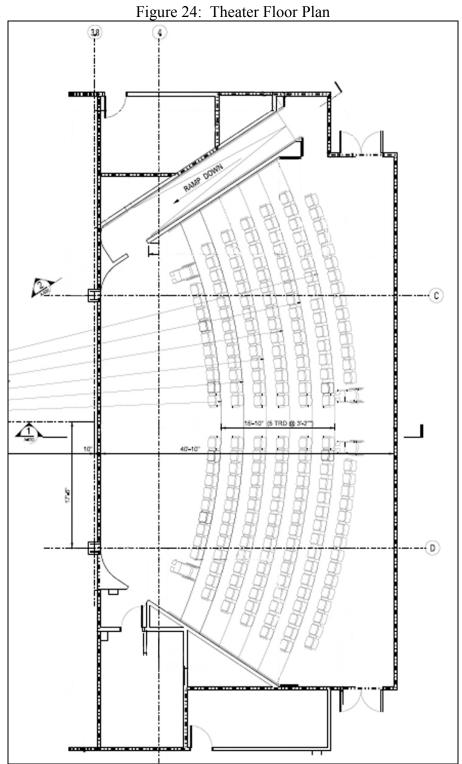
Ceiling - White Painted Gypsum Wallboard - Reflectance 85%



Seating – Blue Seat Coverings – Reflectance 21%



Original Plan





Section Drawings

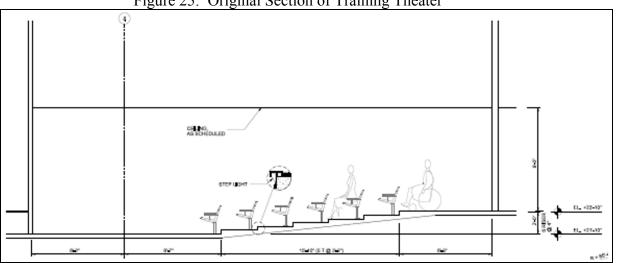
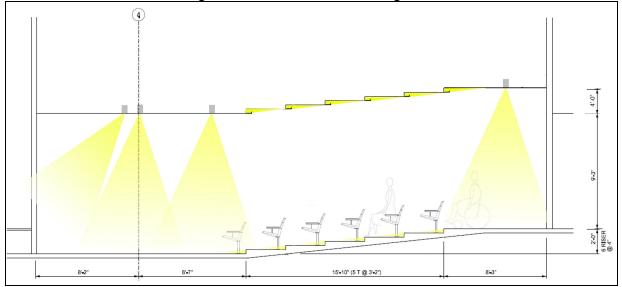


Figure 25: Original Section of Training Theater

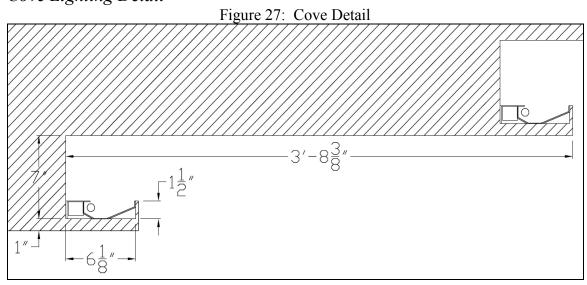
Figure 26: New Section Drawing



Chris Ankeny
NNSOC
Dahlgren, VA



Cove Lighting Detail



+



Lighting Plan

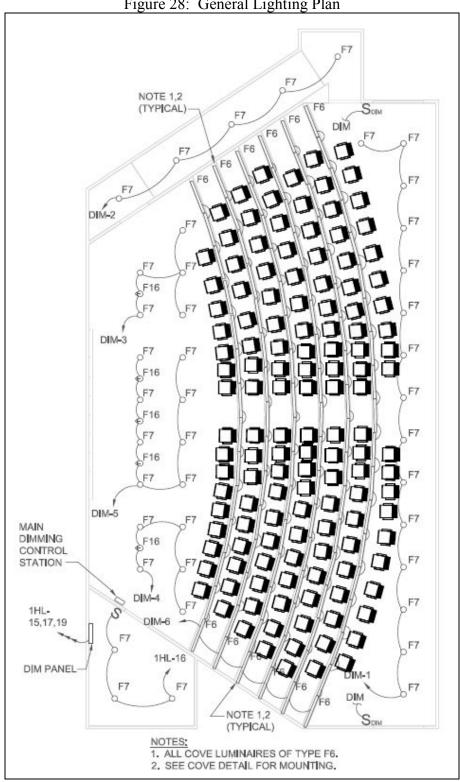
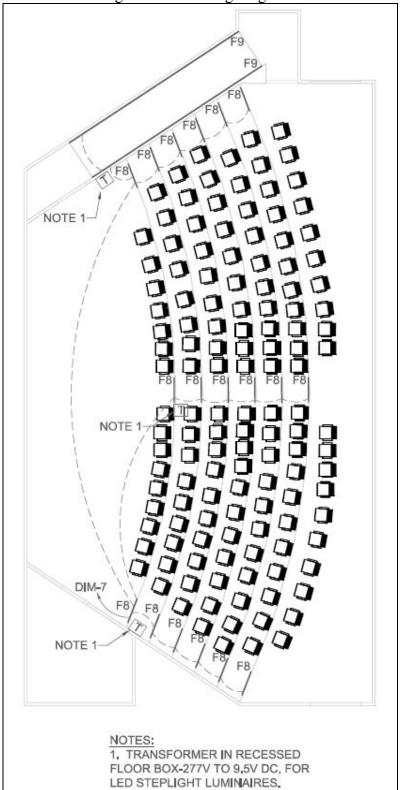


Figure 28: General Lighting Plan





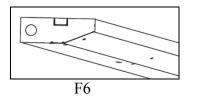




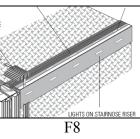
Luminaires

	Table 7		
	LUMINAIRE SCHEDULE		
Туре	Description	Lamping	ССТ
F6	DIE-FORMED 24 GAUGE METAL PAINTED WHITE COVE LUMINAIRE. NOMINAL 6" x 48" x 1.5" DEPTH, TYPE VI ASYMMETRIC DISTRIBUTION.	(1) F32T8SP30ISWMECO	4100
F7	CAST ALUMINUM DOWNLIGHT, WHITE POWDER COATED TYPE V SYMMETRIC DISTRIBUTION. NOMINAL 8" DIAMETER x 7" DEPTH	(1) F32TBX/830/A/ECO	4100
F8	DELINEATED STAIRNOSE LED LUMINAIRE, LOW VOLTAGE, COMPLIES WITH NFPA'S LIFE SAFETY CODE (0.2 FC) WHEN INSTALLED AS RECOMMENDED.	INCLUDED IN LUMINAIRE	4100
F9	CARPET TO WALL PATH LIGHT LED LUMINAIRE, LOW VOLTAGE, COMPLIES WITH NFPA'S LIFE SAFETY CODE(0.2FC) WHEN INSTALLED AS RECOMMENDED.	INCLUDED IN LUMINAIRE	4100
F16	LOW VOLTAGE, RECESSED DIRECTIONAL SPOTLIGHT. BLACK POWDER-COATED, 0-40 DEGREE TILT. NOMINAL 7" DIAMETER x 6" DEPTH, TYPE V SYMMETRIC DISTRIBUTION.	(1) Q100T3/12V/CL	3000

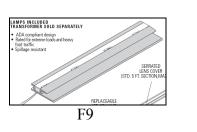
*Full Luminaire, Ballast, LLF schedule and cutsheets attached in Appendix A.













F16

LLF's

-			Table 8	8			
TYPE	BF	CLEANING	MAINTENANCE	LLD	LDD	RSDD	LLF
F6	0.05/0.88	12 Month	VI	0.94	0.85	0.85	0.6
F7	0.05/1.00	12 Month	V	0.84	0.87	0.97	0.71
F8	1	12 Month	V	0.9	0.87	0.94	0.74
F9	1	12 Month	V	0.9	0.87	0.94	0.74
F16	1	12 Month	V	0.85	0.87	0.97	0.72

*Assuming a clean environment.



Power Density

Table	9
1 4010	

TYPE	# LUMINAIRES	# LAMPS/LUMINAIRE	WATTAGE/LAMP	WATTAGE
F6	99	1	116-(4) LAMPS	2871
F7	41	1	75-(2) LAMPS	1537.5
F8	18	6	0.2	21.6
F9	2	25	0.2	10
F16	5	1	100	500

Total Wattage = 4940.1 W

Total Square Ft. = 3000s.f.

Power Density = 1.65 W/sq ft.

Using the Space-by-Space Method in ASHRAE 90.1 Classroom/Lecture/Training: 1.4 W/sq ft.

This lighting design is slightly higher than the power density allowed for this space, but I plan to make up the difference in the other spaces.

Controls

Automated lighting control panel is provided to enable remote monitoring and control of the building's non-emergency interior and exterior lighting from the Base's MODBUS SCADA System. The training theater has an automatic programmable remote control. There are 7 dimmable zones in the theater; the following chart describes each zone:

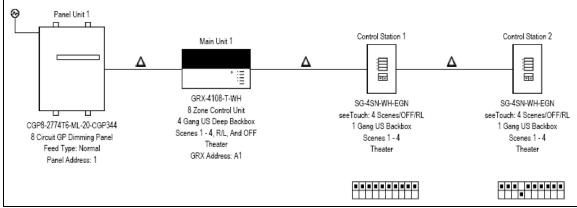
Table 10

		Table 10		-	
		ining Theater Summary Lo		ule	
Lutron Zone	DIM Zone	Zone/Circuit Description	Voltage	Load Type	Wattage
DIM 1	1	Back Downlights	277	Mark 7 0-10V	563
DIM 2	2	Ramp Downlights	277	Mark 7 0-10V	188
DIM 3	3	Left Front Downlights	277	Mark 7 0-10V	288
DIM 4	4	Right Front Downlights	277	Mark 7 0-10V	288
DIM 5	5	Middle Front Downlights	277	Mark 7 0-10V	600
DIM 6		Cove Lighting	277	Mark 7 0-10V	2871
DIM 7	7	Steplights	277	Magnetic LV	31.6

This Lutron system has one control box at each entrance to control Dim Zones 1-4, and a Master Control Station in the front left corner that has control over the entire system. This control solution for the theater provides many different options regarding which lights are on and at what levels are wanted for each specific configuration.







Renderings and Calculation Results Figure 31: Theater Rendering





Figure 32: Theater Rendering



Figure 33: Theater Rendering





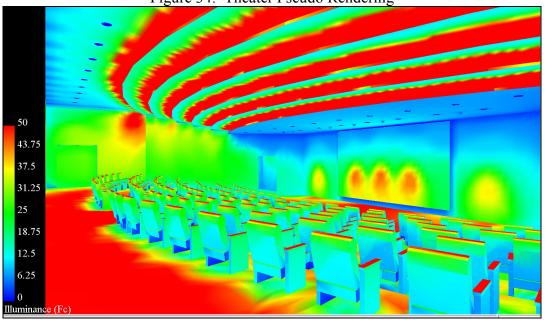


Figure 34: Theater Pseudo Rendering

Figure 35: Theater Pseudo Rendering

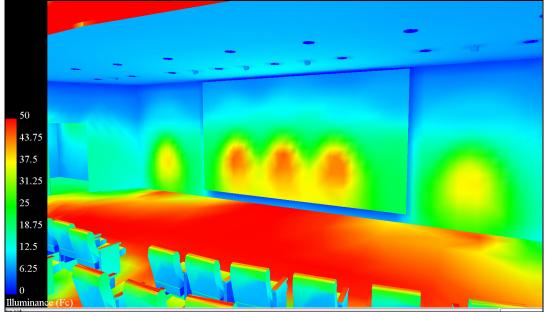
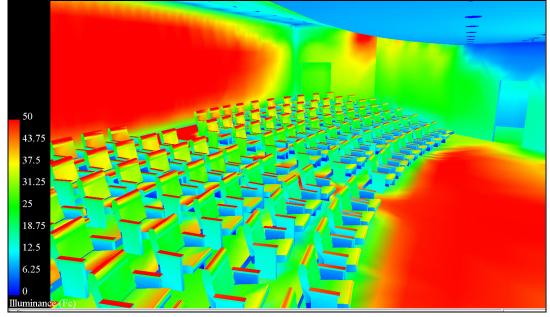




Figure 36: Theater Pseudo Rendering



Conclusion

I feel these renderings show really well how this space would perform with the exception of the omitted step lighting. The cove lighting in the first rendering seems really bright, and a high contrast surface compared to the rest of the space, but that is at full output. Dimming down the cove lighting would provide a much more comfortable sitting area for listening to lectures while still being able to take notes.

In these pseudo images, the front of the room is dark on the ceiling which I consider good since the projection screen will normally be on and a dark front area will have a clearer image on the screen for the viewer. Having the front lights separated into 3 zones will also help control where the light is going and which of the three areas a user wants turned on or be dimmed. On each chair arm is an illuminance of 50fc so at full output there is enough light to take notes. The back wall has more light on it than I would like, but I believe this is from the coves bouncing light from the ceiling to the back wall. If a lower surface reflectance is used on the back wall then I believe this space would become more comfortable when all the lights are on at full output.



Open Office

Spatial Overview

The office space I am redesigning is oriented along the west façade of the building on the 2^{nd} floor. The desk layout is set up in four cubicle groups, placed along the walls of the office. The cubicle heights are not given but the window height is 4' so I will be assuming 4' for the cubicle height in the analysis. Windows are 6'wide by 6' high are spaced evenly along the south, west, and north walls. These provide some daylight but become a problem in the afternoon with direct glare into the cubicles along the west wall. Each cubicle has a computer station so care has been taken to provide the least amount of glare possible on each computer screen.

Performance Considerations

Performance in an open office space has everything to do with comfort, and how well the surroundings interact with each individual's personal preference. Although it is just about impossible to please everyone in an office, a few basic strategies can help to get the most production out of the staff. Performance criteria in an office include glare, veiling reflections, light distribution and daylight integration.

Glare is a major issue that needs to be dealt with anytime computer work is involved. Glare can come from the ceiling to the computer screen, directly from the luminaires and from windows or skylights. Using VDT luminaires works well for reducing glare, but seems to bring a more depressing mood to the office. Adding in wall washers can help make the space more comfortable again. Another issue that VDT luminaires have is that they can create shadows.

Light distribution in an office needs to be fairly uniform if possible. This is so the ratios of tasks to background stay within the 3:1 acceptable levels. Another reason is that open office plans tend to change and move cubicles here and there, and a uniform distribution over the whole space will alleviate any problems with illumination on any workplane.

Design Concept

The lighting design of the office will incorporate a skylight system for a more comfortable feel while working. The skylights have splayed wells and are diffuse 16mm polygal glazing. The polygal glazing helps to thermally insulate the glass surface while providing good diffuse light into the space. To reduce glare from the south and west windows I am proposing manual shades for these windows. The lighting system is broken into an ambient system and a task system.

The ambient system will be suspended indirect/direct fixtures in groups of four, mounted 2' from the ceiling, over each cubicle section along the perimeter of the office area. These will provide general illuminance levels around 20-30fc on the workplane, while brightening up the ceiling to complement the diffuse skylight additions running through the center walkway of the office. Lighting the ceiling helps reduce glare coming

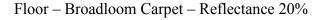


through the skylights by lower the contrast ratio between the skylights and the ceiling. These luminaires will be controlled with a ceiling mounted photosensor and occupancy sensor. The zones and controls are shown on Figure 44 and Figure 45.

The task lighting system is a movable plug-in cord luminaire that attaches to each cubicle. The system provides a bright, even distribution over the desk while keeping the wattage fairly low for 50+ fc of illuminance.

Finishes





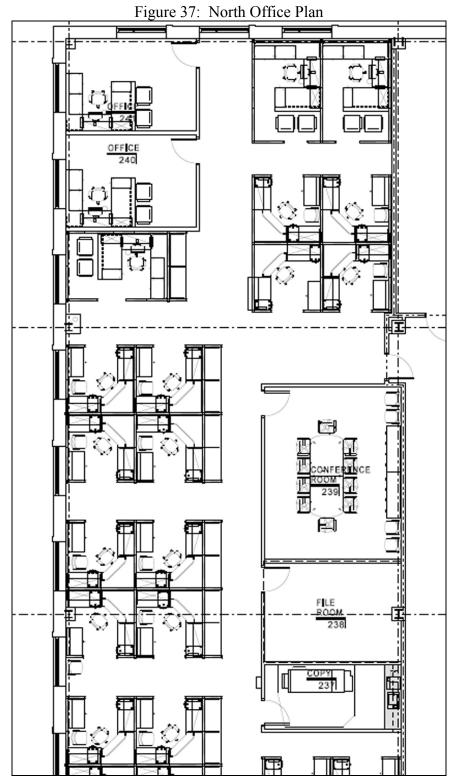


Walls – Painted – Reflectance 60%

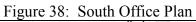
Ceiling – Acoustical Ceiling Tile – Reflectance 85%

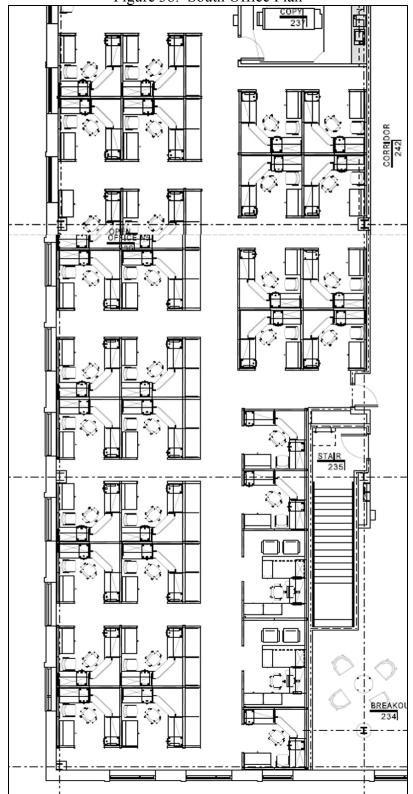


Original Plan











Skylight Design

The skylight design is used to provide a better overall daylight integration within the open office area. Each skylight is a nominal 4.5' x 4.5' wide square opening. From the top of the skylight until it splays out is 4.5'. The splay is at a 45 degree angle and extends the opening at the bottom to 8.5' x 8.5' square. The reason for the splay is to allow some more spread of daylight throughout the office without adding more or larger skylights. The overall height of the skylight system comes to 6.5'. I chose these results using the program Skycalc, which provides an estimation of the energy balance between lighting savings and HVAC losses with the addition of skylights.

Skycalc is an excel program that works by percent area of the roof that is skylights compared to the floor area. Adjusting the location, reflectance values of surfaces, type of space, partition heights, lighting type and controls, skylight properties, and cost of electricity and heating gives a good estimate of the size and number of skylights that would be optimal in the space. I do not have costs of electricity or fuel for my building because they would not release the information to me, so I assumed \$0.10 kWh for electricity and \$0.50/Therm for oil costs. The program does not take into account exterior window openings so this is just estimation. Results are as follows with rest of the analysis in Appendix A:

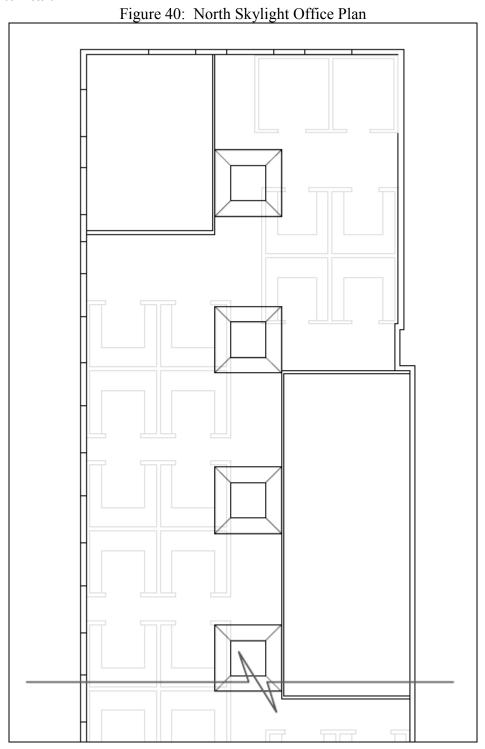


Figure 39: Skycalc Output Results

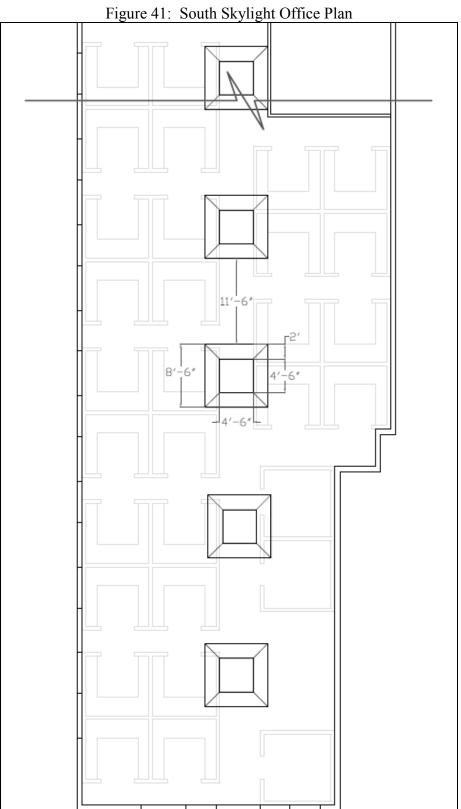
SkyCalc: Skylig		Assistant - T		
Company Name:				
Project Description:		SIGN		
.,				
Electric Lighting Usage	kWh/yr			
tg. Energy without Skylights	17,309	Lighting Fraction S	aved	41%
ighting Energy w/ Skylights	10,279	Full daylighting (h/)	/r)	1,941
	Saving	s from Design Skyli	ghting Sys	tem
		Annual Energ	-	Annual Cost
	Savings	Savings (kWh/	yr) S	avings (\$/yr)
	Lighting	7,03		\$703
	Cooling	-90		-\$90
	Heating	23		\$4
	Total	6,30	55	\$617
Skylighting System Descripti	on	Site Description		
Skylight unit size (ft ²)	20.3	Climate Location	on Frede	ericksburg.wea
Number of Skylights	8	Climate Zor	ne CZ4	(mixed, 3,600
Total Skylight Area (ft ²)	162	Building Typ	be Office	Э
Skylight to Floor Ratio (SFR)	2.7%	Building Are	ea 6,000) (ft ²)
Effective Aperture	1.1%	0		()
Floor Area per Skylight	750	Elecric Lighting S	ystem Des	cription
Skylight U-value	0.410	Lighting Typ	De Direct/Indi	irect fluorescent
Skylight SHGC	68%	Lighting Contr	ol Dimming ı	min 10% light
Skylight T _{vis}	72%	Light Level Setpoi	nt	30 fc
Well Efficiency (WF)	79%	Lighting Densi	tv	0.81 W/f
Dirt and Screen Factor	70%	Connected Loa		4.9 kW
Overall Skylight System Tvis	40%	Fraction Controlle	ed	90%
Skylight CU	80%			
	As compared t	o the design with 8 skyli	ghts but no p	hotocontrols
	Savings fr	om Functioning Pho	otocontrol	System
		Annual Energ	-	Annual Cost
	Savings	Savings (kWh/		avings (\$/yr)
	Lighting	7,03		\$703
	Cooling	1,97		\$197
	Heating		56	-\$1
	Total	8,94	+/	\$899



Skylight Plan



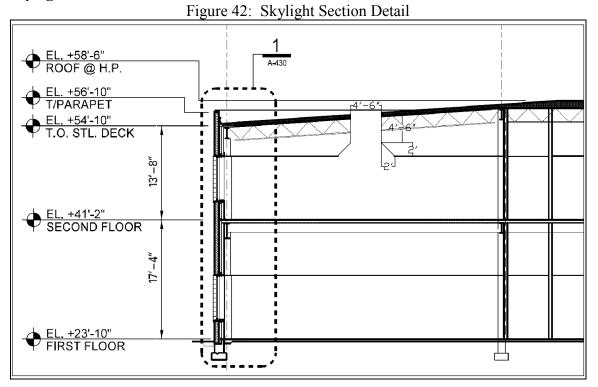




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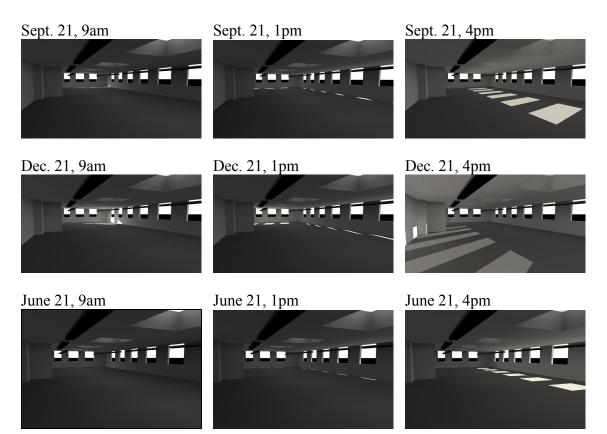


Skylight Section





Daylight



Daylight Integration

To use the added daylight properly, I had to incorporate a dimmed electrical lighting system into the space. In order to find out how much money would be saved each year using the daylight integration, I used the SPOT (Sensor Placement + Optimization Tool) to determine when and for how long the lights could be dimmed. I chose to use a quarter of the office space to do the analysis. The space was in the middle where no light was contributing from the south or north wall windows. Two skylights and four windows were included in the study. For the skylight design, the program could not do the splayed well I have designed so I went with the most conservative and had a square 4.5'x4.5' skylight opening. The depth of the skylight to the ceiling was 5' with a reflectance of 85% in the skylight well. The luminaire used was the same one in my lighting design, mounted at the same height of 2' from the ceiling.

One photocell was used in the space only controlling the two sets of lighting closest to the windows. I am assuming that the lighting on the east side will always be on full output. The photocell has a cosine distribution and sliding setpoint value. The location is on the ceiling between the set of luminaires closest to the window and aimed toward the floor to receive light from the windows and skylights. The target illuminance



value for the space was 30fc on the workplane. The extra levels needed for reading and writing will be supplied by the task luminaires on each cubicle. The results are below, with the rest of the analysis in Appendix A:

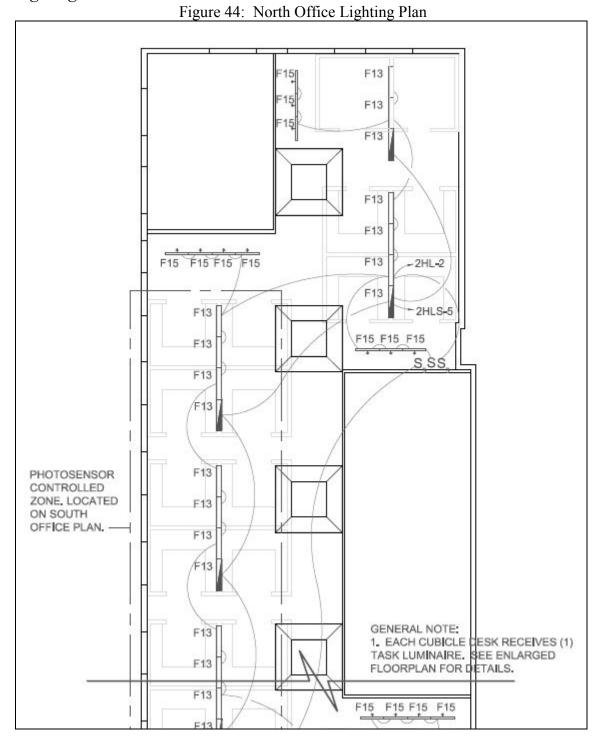
Figure 43: SPOT Analysis Final Results

nual Results		_	_	_	_	_	_	_	_	_	l e	Building /	/ Campus	Informatio	n ——			Build	ing V	Vide R	ocult	0	_	_	_	_	
inual results	_	7.		Zor	- 2	7	-2	7		Tatal	8 L.							Duilu	iliy-i	nue n	esuit	, 	T	4 a 1	0.		Ł
			ne1			Zon	183	Zone	84	Total				illar Space			. 11		E 1		. ,		To		00	sts	Ł
Average Lig			17	1.0	00					0.17				stricity Price						tric Sav				19	\$	452	L
Electric Savings			30							1130		A	werage H	eating Pric	0.50	\$/The	rm			leating				20	\$	7	L
Heating Load			55							355							II	Co	oling L	oad Sav	/ings, [kWh/yr]		86	\$	239	ł
Cooling Load			97	-	_					597														Total	\$	683	l
Average Illumir			45	5						99																	
Minimum Illumir			7	8							4 1																
Maximum Illumin	iance, [t	- 40 - 40	841	13	03					4841																	
vage Workplane Illumi	nance, [fc]	•	< 5	0%	50%-1	100%	> 100)%	Critical E	Day	1						1	1	1		1		1	1	1		
rage Workplane Illumi		•	< 5	0%	50%-1	100%	> 100	1%																			
	1 2	3	< 51 4	5	6	100% 7	8	9	10	11 12	13	14		6 17	18	19	20	21	22	23 24			27	28	29	30	
January	1 2 44 45	3	< 51 4 79	5 76	6	7	8 54	9	10	11 12 74 74	64		50 5	4 87	18 71	86	92		86	43 53	3 85	66	134		29 75	30 54	
January February	1 2 44 45 91 93	3 73 72	< 50 4 79	5 76 61	6 84 80	7	8 54 51	9 44 85	10 45 152	11 12 74 74 87	64 51	109	50 5 78 9	4 87 5 110		86 66	92 78	57	86 52	43 53 92 11	3 85	66 47	134 78	107	75	54	
January February March	1 2 44 45 91 93 107 98	3 73 72 69	4 79	5 76 61 95	6 84 80 119	7 48 122	8 54 51	9 44 85 115	10 45 152 157	11 12 74 74 87 111	64 51 111	109 53	50 5 78 9 102 7	4 87 5 110 6 75	71	86 66 124	92 78 84	57 107	86	43 53 92 11 51 12	3 85 3 2	66 47 141	134 78 108	107 116		54 53	
January February March April	1 2 44 45 91 93 107 98 142	3 73 72 69 123	4 79 152	5 76 61 95 51	6 84 80	7 48 122 124	8 54 51 106	9 44 85 115 61	10 45 152 157 52 1	11 12 74 74 87 111 65 156	64 51 111	109 53 172	50 5 78 9 102 7 1	4 87 5 110 6 75 36 56	71	86 66 124 120	92 78	57 107 63	86 52 97	43 50 92 11 51 12 105 16	3 85 3 2 7 183	66 47 141 2 50	134 78	107 116 182	75 60	54 53 57	
January February March April May	1 2 44 45 91 93 107 98 142 78 55	3 73 72 69	4 79 152 196	5 76 61 95 51 219	6 84 80 119 55	7 48 122 124 195	8 54 51 106 114	9 44 85 115 61 57	10 45 152 157 52 1 204 1	11 12 74 74 87 111 65 156 41 68	64 51 111 50	109 53 172 64	50 5 78 9 102 7 1 158 1	4 87 5 110 6 75 36 56 59 150	71 135 74	86 66 124 120 139	92 78 84 172	57 107 63 144	86 52 97 150	43 53 92 11 51 12 105 16 166 72	3 85 3 2 7 18 2 55	66 47 141 2 50 163	134 78 108 69	107 116 182 72	75 60 141	54 53 57 107	
January February March April May June	1 2 44 45 91 93 107 98 142 78 55 173 94	3 73 72 69 123 167	4 79 152 196 72	5 76 61 95 51 219 95	6 84 80 119 55 115	7 48 122 124 195 49	8 54 51 106	9 44 85 115 61 57 175	10 45 152 157 52 1 204 1	11 12 74 74 87 111 65 156 41 68 28 77	64 51 111 50 132	109 53 172 64 186	50 5 78 9 102 7 11 158 1 94 8	4 87 5 110 6 75 36 56 59 150 1	71 135 74 156	86 66 124 120 139 153	92 78 84 172 167	57 107 63 144 192	86 52 97 150	43 50 92 11 51 12 105 16 166 72 199	3 85 3 2 7 182 2 55 19	66 47 141 2 50 163 5 203	134 78 108 69 161	107 116 182 72 143	75 60	54 53 57 107 68	
January February March April May June June	1 2 44 45 91 93 107 98 142 78 55 73 94 100	3 73 72 69 123 167 116	4 79 152 196 72 120	5 76 61 95 51 219	6 84 80 119 55 115 201	7 48 122 124 195 49 226	8 54 51 106 114 125	9 44 85 115 61 57 175 146	10 45 152 157 52 1 204 1 137	11 12 74 74 87 111 65 156 41 68 28 77 65 187	64 51 111 50 132 198	109 53 172 64 186 199	50 5 78 9 102 7 1 158 1 94 8	4 87 5 110 6 75 36 56 59 150 1 1 139	71 135 74 156 197	86 66 124 120 139	92 78 84 172 167 171	57 107 63 144 192 174	86 52 97 150 155	43 53 92 11 51 12 105 16 166 72 199 17	3 85 3 2 7 18: 2 55 19: 3 18:	66 47 141 2 50 163 5 203 9 152	134 78 108 69 161 118	107 116 182 72 143 68	75 60 141 107	54 53 57 107 68 144	
January February March April May June July August	1 2 44 45 91 93 107 98 142 78 55 173 94 100 133 157	3 73 72 69 123 167 116 153	4 79 152 196 72 120 176	5 76 61 95 51 219 95 85	6 84 80 119 55 115 201 120	7 48 122 124 195 49 226 125	8 54 51 106 114 125 130	9 44 85 115 61 57 175 146 151	10 45 152 157 52 1 204 1 137 134	11 12 74 74 87 111 65 156 41 68 28 77 65 187 93	64 51 111 50 132 198 65	109 53 172 64 186 199 80	50 5 78 9 102 7 158 1 94 6 94 9 129 1	4 87 5 110 6 75 36 56 59 150 1 1 139 25 67	71 135 74 156 197 75	86 66 124 120 139 153 140	92 78 84 172 167 171 42	57 107 63 144 192 174 132	86 52 97 150 155 139	43 53 92 11 51 12 105 16 166 73 199 59 17 121 16	3 85 3 2 7 18: 2 55 19: 3 18: 4 19:	66 47 141 50 163 50 203 9 152	134 78 108 69 161 118 123	107 116 182 72 143 68 114	75 60 141 107 124	54 53 57 107 68	
January February March April May June July Auly August September	1 2 44 45 91 93 107 98 142 78 55 773 94 100 133 157 90	3 73 72 69 123 167 116 153 98	4 79 152 196 72 120 176 129	5 76 61 95 51 219 95 85 85	6 84 80 119 55 115 201	7 48 122 124 195 49 226	8 54 51 106 114 125 130 176	9 44 85 115 61 57 175 146 151	10 45 152 157 52 1 204 1 137 134 115	11 12 74 74 87 111 65 156 41 68 28 77 65 187 93 52 48	64 51 111 50 132 198 65 50	109 53 172 64 186 199	50 5 78 9 102 7 1 158 1 94 6 94 6 94 9 129 1 139	4 87 5 110 6 75 36 56 59 150 1 1 139 25 67 70	71 135 74 156 197 75 115	86 66 124 120 139 153 140 118	92 78 84 172 167 171 42 97	57 107 63 144 192 174	86 52 97 150 155 139 153	43 53 92 11 51 12 105 16 166 73 199 59 17 121 16 68	3 85 3	66 47 141 50 163 5 203 9 152 8 86	134 78 108 69 161 118 123 80	107 116 182 72 143 68	75 60 141 107 124 140	54 53 57 107 68 144 132	
February March April May July July August September October	1 2 44 45 91 93 107 98 142 78 55 173 94 100 133 157	3 73 72 69 123 167 116 153	4 79 152 196 72 120 176	5 76 61 95 51 219 95 85	6 84 80 119 55 115 201 120	7 48 122 124 195 49 226 125	8 54 51 106 114 125 130	9 44 85 115 61 57 175 146 151 97	10 45 152 157 52 1 204 1 137 134 115	11 12 74 74 87 111 65 156 41 68 28 77 65 187 93	64 51 111 50 132 198 65	109 53 172 64 186 199 80	50 5 78 9 102 7 1 158 1 94 6 94 9 129 1 139 9 95 9	4 87 5 110 6 75 36 56 59 150 1 1 139 25 67	71 135 74 156 197 75	86 66 124 120 139 153 140	92 78 84 172 167 171 42	57 107 63 144 192 174 132	86 52 97 150 155 139	43 53 92 11 51 12 105 16 166 73 199 59 17 121 16	3 85 3 2 7 18 2 55 19 3 18 3 18 4 19 5 92 5 42	66 47 141 50 163 5 203 9 152 8 86	134 78 108 69 161 118 123	107 116 182 72 143 68 114	75 60 141 107 124	54 53 57 107 68 144	

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Lighting Plan





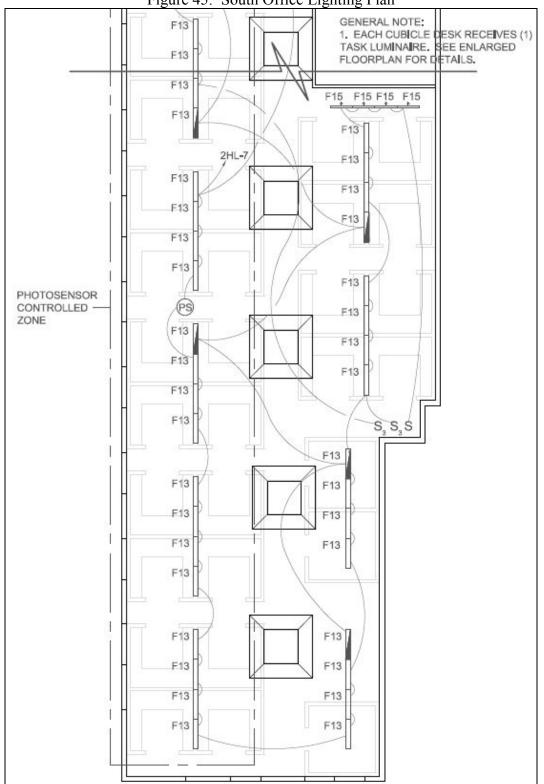
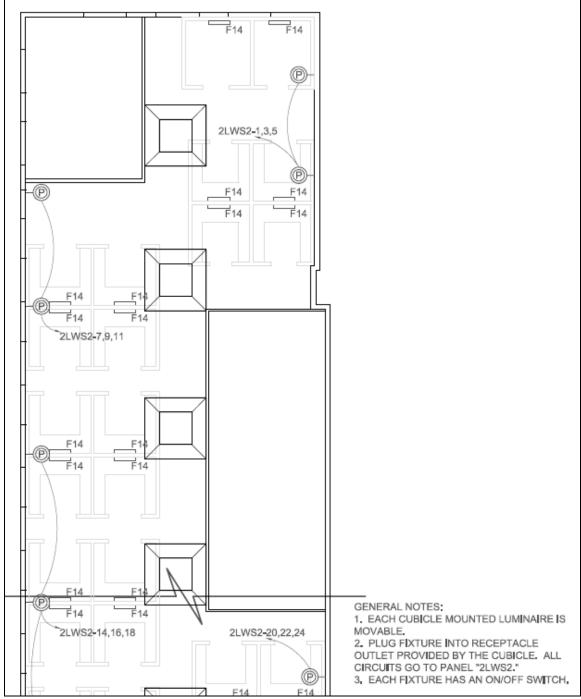


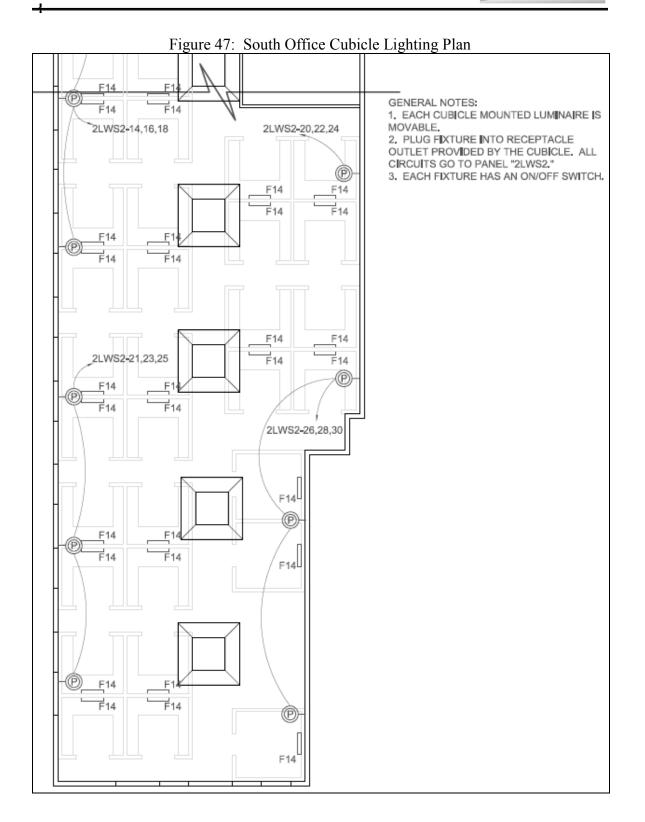
Figure 45: South Office Lighting Plan



Figure 46: North Office Cubicle Lighting Plan





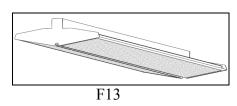


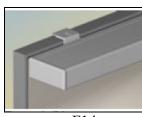


Luminaires

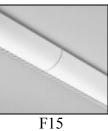
	Table 11		
	LUMINAIRE SCHEDULE		
Туре	Description	Lamping	ССТ
F13	INDIRECT SUSPENDED LINEAR FLUORESCENT, DOUBLE DIFFUSER OPTICAL DESIGN, 96% REFLECTIVE WHITE PAINT. NOMINAL 3.5"x12"x48". CAN BE CONNECTED IN SECTIONS. TYPE 6 SYMMETRICAL DISTRIBUTION.	(1) F54W/T5/841/ECO	4100
F14	WORKSTATION LUMINAIRE FOR INSTALLATION ON OPEN OFFICE FURNITURE PANELS. DESIGNED TO PROVIDE LOW- GLARE TASK LIGHTING FOR HORIZONTAL SURFACES. NOMINAL 6"x2.5"x36". TYPE IV ASYMMETRICAL DISTRIBUTION. PLUG IN CONNECTION TO RECEPTACLE OUTLET.	(1) F21W/T5/841/ECO	4100
F15	SURFACE MOUNTED WALLWASH, ASYMMETRICAL DISTRIBUTION, TYPE IV FIXTURE. NOMINAL 5"x2.5"x36". MATTE WHITE FINISH WITH DECORATIVE ENDPLATES. CAN BE CONNECTED IN SECTIONS.	(1) F21W/T5/841/ECO	4100

*Full Luminaire, Ballast, LLF schedule and cutsheets attached in Appendix A.





F14



LLF's

			Table 1	2			
TYPE	BF	CLEANING	MAINTENANCE	LLD	LDD	RSDD	LLF
F13	0.03/1.00	12 Month	VI	0.92	0.85	0.93	0.73
F14	1	12 Month	III	0.92	0.9	0.97	0.8
F15	1.03	12 Month	III	0.92	0.9	0.97	0.83

*Assuming a clean environment.



Power Density and Illuminance Levels

		Table 13		
TYPE	# LUMINAIRES	# LAMPS/LUMINAIRE	WATTAGE/LAMP	WATTAGE
F13	51	1	125-(2) LAMPS	3187.5
F14	45	1	27	1215
F15	14	1	26	364
-	1 ***	6		

Total Wattage = 4766.5 W

Total Square Ft. = 5900s.f.

Power Density = 0.81 W/sq ft.

Using the Space-by-Space Method in ASHRAE 90.1 Open Office: 1.1 W/sq ft.

This lighting design meets ASHRAE 90.1 for power density for an open office space.

Controls

The office area will be controlled by a photocell and the Base SCADA system. There will be switches on the walls for override control as well. The photocells will control the fixtures along the exterior wall only, circuits "2HL-2" and "2HL-7," shown on the office lighting plan within the boxed out region. The following shows the schematic diagram of the system. It is a Wattstopper system with Photocell, Dimming Module, Power Pack, and wall switches. Occupancy sensors will not be used in this design due to the SCADA system and the open office layout. The cutsheets are available in Appendix A.

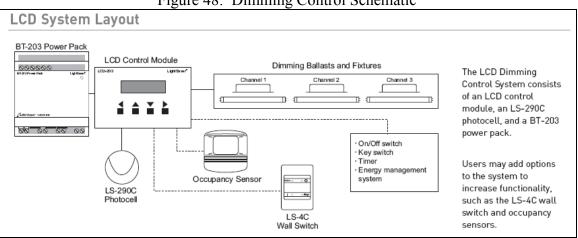


Figure 48: Dimming Control Schematic



Renderings and Calculation Results

Figure 49: Office Rendering



Figure 50: Office Rendering

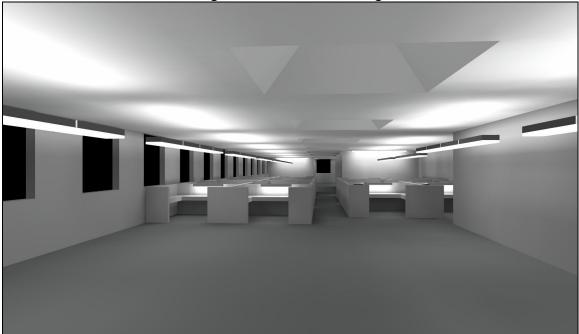




Figure 51: Office Pseudo Rendering

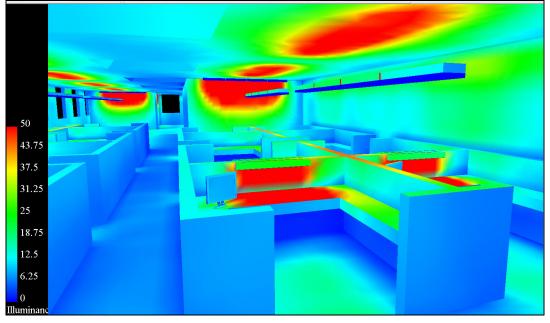
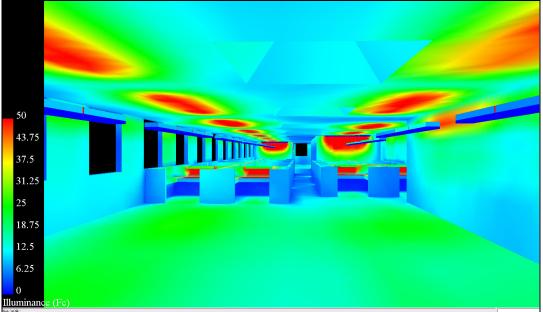


Figure 52: Office Pseudo Rendering



+



Electrical Depth

Background

The electrical system in the Naval Network & Space Operations Command is powered from an existing switchgear unit located outside the adjacent building. The utility service ends at two existing exterior 1750kVA transformers before entering the existing switchgear. This utility comes in parallel to these transformers that step-down the voltage from 13.8KV to 480V. These 480Y/277V feeders enter the existing doubleended switchgear that powers the adjacent building. Two secondary feeders are routed from here to the new building, where they enter double-ended 1600A switchgear located in the first floor electrical room. Each feeder and switchgear panel is designed to carry the entire load of the building. The switchgear's main tie breaker will automatically transfer on the loss of a power to a single feeder in order to keep the entire building powered.

Interior building power will be distributed at 480Y/277V, using a 3-phase and 4wire system. Feeders from the switchgear go to distribution panels for lighting, receptacles and power panels, along with the UPS system and all other loads throughout the building. Step-down transformers are provided for those loads that run off of 208Y/120V service. Panels are located primarily in the first floor and second floor electrical rooms. Exceptions to this are the critical systems and workstation receptacle panels which are located in each specific office area.

Two existing 1250kVA generators are outside and provide redundant standby power if the system goes down. These generators activate upon loss of normal power, and sense the maximum load to the double-ended switchboard (Panel MSBA and MSBB). If the building load is below maximum for the generators, the tie breaker in the generator switchgear stays open and does not activate any shunt trip breakers. If the maximum load is exceeded then the tie breaker stays open and shunt trips are activated on appropriate non-essential loads to maintain facility load. If one generator fails to start the tie breaker in the generator switchgear closes and the appropriate shunt trip breakers are activated to shed non-essential loads across the entire system. The generators are not rated to serve life safety loads so these are served by the standby power system (SPS).

The SPS system provides power for emergency egress lighting, non-egress lighting to maintain essential operations, and essential equipment. The egress lighting also has a 90-minute battery backup via an automatic transfer switch to ensure the emergency lights will stay on. Fire alarm and security systems, along with the UPS system are also run from this SPS.

The UPS system services critical loads in both facilities and has two 625kVA modules to provide N+1 reliability. Each system has a 30-minute battery plant to provide the necessary power to service the present critical loads and 25% spare capacity for future expansion. The UPS system is set up so if one system goes down, critical loads can be transferred to the other UPS module by closing the static transfer switch located between the UPS switchboards and UPS distribution panels.

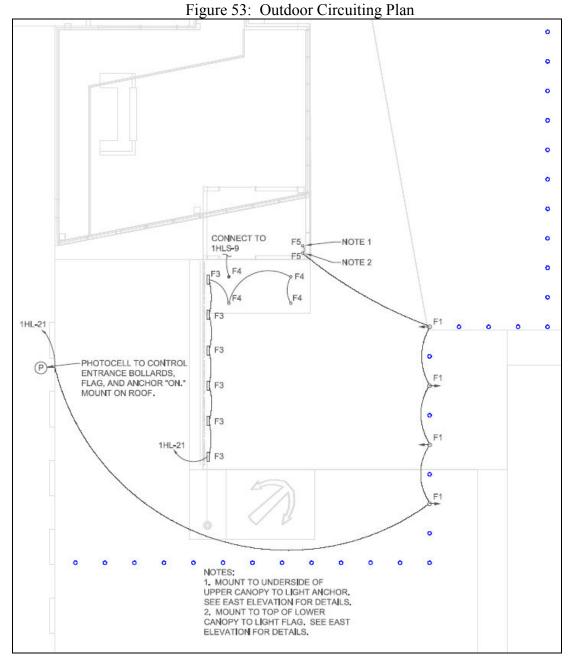
4



Panelboards and Circuiting

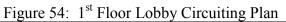
All four lighting spaces are circuited as shown in the following drawings. Following the plans are the panelboards as they originally were designed with the circuits that changed highlighted. Below each original panelboard is the updated panelboard with the new circuits.

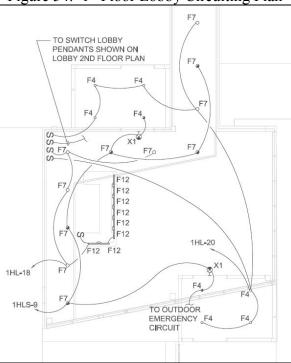
Outdoor Area



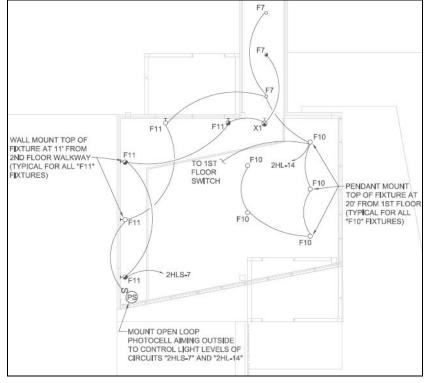


Lobby

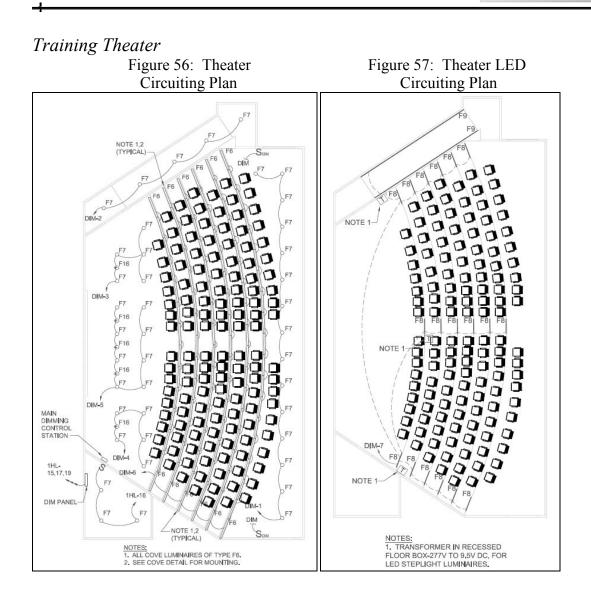








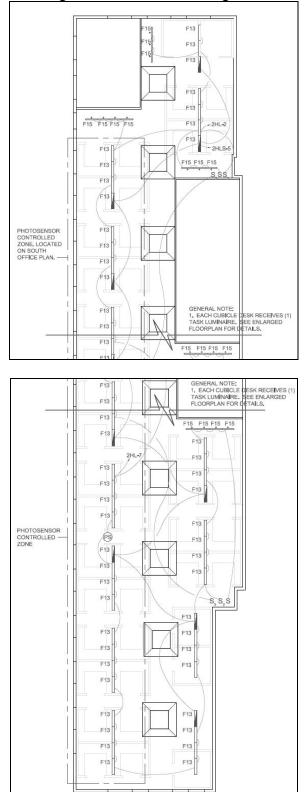






Office

Figure 58: Office Circuiting Plan





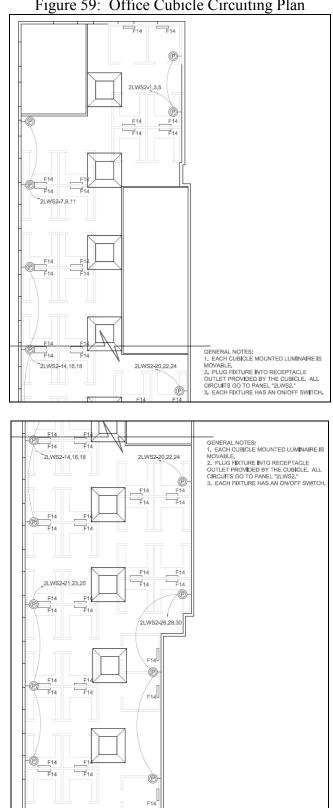


Figure 59: Office Cubicle Circuiting Plan



Original

Table 14: Panel "1HL" Old

		000.00		-			
		N	EUTRAL BUS:	100%	VOLTAGE:	480Y/277V, 3PH, 4W + GND	
PA	NEL "1HL"	G	ROUND BUS:	YES	MAINS:	125A	
(A	UTOMATED	SOLATED G	ROUND BUS:	NO MAIN	CR. BKR.	100A/3P	
LIC	GHTING PANEL)		MOUNTING:	SURFACE A	C RATING	14.000	
CIR.			BREAKER	BREAKER			CIR.
NO.	DESCRIPTION	VA LOAD	amps / poles	amps / poles	VA LOAD	DESCRIPTION	NO.
1	LIGHTS - 156, 139, 154, 127, 118, 106, 125, 126	3,240	20/1	20/1	1,560	LIGHTS - 120, 121, 222, 123	2
3	Lights - 165 (West)	1,500	20/1	20/1	3,060	LIGHTS - 110, 111, 113, 112, 114, 117,118	4
5	LIGHTS - 165 (CENTER)	1,440	20/1	20/1	1,620	Lights - Perimeter 112, with photocell	6
7	LIGHTS - 165 (EAST)	1,500	20/1	20/1	2,980	LIGHTS - 129 (SOUTH), 130, 131, 132, 133	8
9	LIGHTS - 140, 141, 144, 146	3,080	20/1	20/1	3,000	LIGHTS - 129 (NORTH), 134, 135, 136, 137	10
11	Exterior lights (north & West)	2,250	20/1	20/1	2,700	LIGHTS - 103, 103A, 104, 105, 107, 108, 109	12
13	Exterior lights (South & East)	2,250	20/1	20/1	2,730	Lights - 102, 149, 150, 100	14
15	AUDITORIUM DIMMING PANEL	5,000	60/3	20/1	350	Lights - 163	16
17		5,000	*	20/1	1,800	LIGHTS - LOBBY SCONCE	18
19		5,000		20/1	256	LIGHTS - 100A, 100B, 101	20
	LIGHTS - MAIN ENTRY BOLLARDS, FLAG POLE	500	20/1	20/1	481	LIGHTS - FLAG POLE, BLDG. SIGN, OVER HANG	22
23	SPARE		20/1	20/1	3,120	LIGHTS - PARKING LOT (WEST)	24
25	SPARE	-	20/1	20/1	1,695	LIGHTS - SIDEWALK, ROADWAY (NORTH)	26
27	SPARE		20/1	20/1	2,550	LIGHTS - PARK., SIDEWALK (NORTH & WEST)	28
29	SPARE	-	20/1	20/1	(H)	SPARE	30
31	SPARE		20/1	20/1	673	SPARE	32
33	SPACE	-	-	20/1	(1 0)	SPARE	34
35	SPACE			20/1	1.73	SPARE	36
37	SPACE	-	-	40/3		SCADA UNIT	38
39	SPACE	×	-	872	()	-	40
41	SPACE		-	8 - 5	12	-	42
	SUB TOTAL	30,760			27,902	SUB TOTAL	
	LEGEND: ** 6mA GROUND FAULT CIRCUIT BR	eaker	CONNEC	TED LOAD	REMARKS		
	* 30mA GROUND FAULT CIRCUIT B	Reaker	58.7	KVA			
	 LOCK-ON CIRCUIT BREAKER HAN 	DLE	70.6	3 PH. AMPS			
910							8

Redone

Table 15: Panel "1HL" New

	PANELBOARD SCHEDULE												
VOLTAGE: SIZE/TYPE BUS: SIZE/TYPE MAIN:	I,4W+GND		PANEL T. IEL LOCATI EL MOUNTI	ON:	Mai	n El		141	MIN. C/B AIC: OPTIONS:				
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	А	В	С	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION	
Lighting	156139	3522	20A/1P	1	*			2	20A/1P	1696	120121	Lighting	
Lighting	165west	1630	20A/1P	3		*		4	20A/1P	3326	110111	Lighting	
Lighting	165center	1565	20A/1P	5			*	6	20A/1P	1761	112	Lighting	
Lighting	165east	1630	20A/1P	7	*			8	20A/1P	3239	129	Lighting	
Lighting	140141	3348	20A/1P	9		*		10	20A/1P	3261	129	Lighting	
Lighting	Ext. North	2446	20A/1P	11			*	12	20A/1P	2935	103	Lighting	
Lighting	Ext. South	2446	20A/1P	13	*			14	20A/1P	2967	102	Lighting	
Theater DIM PnI	Theater	2118	20A/1P	15		*		16	20A/1P	511	163	Lighting	
Theater DIM PnI	Theater	2118	20A/1P	17			*	18	20A/1P	259	Lobby	Lighting	
Theater DIM PnI	Theater	2118	20A/1P	19	*			20	20A/1P	200	Lobby	Lighting	
Lighting	Outdoor	519	20A/1P	21		*		22	20A/1P	0	-	Spare	
Spare	-	0	20A/1P	23			*	24	20A/1P	3391	Parking	Lighting	
Spare	-	0	20A/1P	25	*			26	20A/1P	1842	Roadway	Lighting	
Spare	-	0	20A/1P	27		*		28	20A/1P	2772	Parking	Lighting	
Spare	-	0	20A/1P	29			*	30	20A/1P	0	-	Spare	
Spare	-	0	20A/1P	31	*			32	20A/1P	0	-	Spare	
Spare	-	0	20A/1P	33		*		34	20A/1P	0	-	Spare	
Spare	-	0	20A/1P	35			*	36	20A/1P	0	-	Spare	
Spare	-	0	20A/1P	37	*			38	40A/3P	0	-	Scada Unit	
Spare	-	0	20A/1P	39		*		40		0	-	Scada Unit	
Spare	-	0	20A/1P	41			*	42		0	-	Scada Unit	
CONNECTED LOAD) (KW) - A	19.66								TOTAL DESIGN	43.36		
CONNECTED LOAD) (KW) - B	17.48								POWER FACTO	0.92		
CONNECTED LOAD) (KW) - C	14.47								TOTAL DESIGN LOAD (AMPS)			



Original

Table 16: Panel "1HLS" Old

			S. J. M. M.			
	N	EUTRAL BUS:	100%	VOLTAGE:	480Y/277V, 3PH, 4W + GND	
PANEL "1HLS"	G	ROUND BUS:	YES	MAINS:	125A	
	ISOLATED G	ROUND BUS:	NO MAIN	CIR. BKR.	30A/3P	
		MOUNTING:	SURFACE A	C RATING:	14,000	
CIR.		BREAKER	BREAKER			CIR.
NO. DESCRIPTION	VA LOAD	amps / poles	amps / poles	VA LOAD	DESCRIPTION	NO.
1 EMG LIGHTS - 140 THRU 146	3,000	20/1	20/1	520	EMG LIGHTS - 110 THRU 117	2
з EMG LIGHTS - С102, С103, С10	6, 108, C139 2,050	20/1	20/1	130	EMG LIGHTS - 120 THRU 124	4
5 EMG LIGHTS - 118, 126, 127, C1	138 710	20/1	20/1	440	EMG LIGHTS - OPS	6
7 EMG LIGHTS - AUDITORIUM	680	20/1	20/1	64	EMG LIGHTS - ELEVATOR MACHINE ROOM	8
9 EMG LIGHTS - LOBYY 100, CO	RR 101 1,058	20/1	20/1	-	SPARE	10
11 SPARE	-	20/1	20/1	-	SPARE	12
13 SPARE	-	20/1	20/1	-	SPARE	14
15 SPARE	-	20/1	20/1	-	SPARE	16
17 SPARE	-	20/1	20/1	•	SPARE	18
19 SPARE	-	20/1	20/1	-	SPARE	20
21 SPARE	-	20/1	20/1	-	SPARE	22
23 SPARE	-	20/1	20/1	-	SPARE	24
25 SPARE	-	20/1	20/1	-	SPARE	26
27 SPARE	-	20/1	20/1	-	SPARE	28
29 SPARE	-	20/1	20/1		SPARE	30
31 SPACE	-	-	-	-	SPACE	32
33 SPACE			-	-	SPACE	34
35 SPACE	-	-	-	-	SPACE	36
37 SPACE	-	-	40/3	-	TVSS UNIT	38
39 SPACE	-	-	-	-	-	40
41 SPACE	-	-	-	-	-	42
	SUB TOTAL 7,498			1,154	SUB TOTAL	
LEGEND: ## 6mA GROUND F	AULT CIRCUIT BREAKER	CONNEC	TED LOAD	REMARKS		
 30mA GROUND 	FAULT CIRCUIT BREAKER	8.7	KVA			
 LOCK-ON CIRCU 	JIT BREAKER HANDLE	10.4	3 PH. AMPS			
				-		

Redone

Table 17: Panel "1HLS" New

	PANELBOARD SCHEDULE													
VOLTAGE: SIZE/TYPE BUS: SIZE/TYPE MAIN:	1,4W+GND		PANEL T IEL LOCATI EL MOUNTI	ON:	Mai	n El		MIN. C/B AIC: 14K OPTIONS: None None						
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	А	В	С	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION		
Emg Lighting	140-146	3261	20A/1P	1	*			2	20A/1P	565	110-117	Emg Lighting		
Emg Lighting	C102,C103	2228	20A/1P	3		*		4	20A/1P	141	120-124	Emg Lighting		
Emg Lighting	118126	772	20A/1P	5			*	6	20A/1P	478	OPS	Emg Lighting		
Emg Lighting	Theater	739	20A/1P	7	*			8	20A/1P	70	Elev. Mach	Emg Lighting		
Emg Lighting	Lobby	251	20A/1P	9		*		10	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	11			*	12	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	13	*			14	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	15		*		16	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	17			*	18	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	19	*			20	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	21		*		22	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	23			*	24	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	25	*			26	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	27		*		28	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	29			*	30	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	31	*			32	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	33		*		34	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	35			*	36	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	37	*			38	30A/3P	0	-	TVSS Unit		
Spare	-	0	20A/1P	39		*		40		0	-	TVSS Unit		
Spare	-	0	20A/1P	41			*	42		0	-	TVSS Unit		
CONNECTED LOAD	0 (KW) - A	4.63							TOTAL DESIGN	LOAD (KW)	10.21			
CONNECTED LOAD	0 (KW) - B	2.62							POWER FACTOR		0.92			
CONNECTED LOAD) (KW) - C	1.25								TOTAL DESIGN	LOAD (AMPS)	13		



Original

Table 18: Panel "DIM" Old

AUDITORIUM SUMMARY LOAD SCHEDULE											
LUTRON ZONE	LOAD TYPE	ACTUAL LOAD(VA)									
A1-1	1	BACK 2 x 2's	277V	FL - HILUME / ECO 10	2720						
A1-2	2	MID 2 x 2's	277V	FL - HILUME / ECO 10	640						
A1-3	3	FRONT 2 x 2's	277V	FL - HILUME / ECO 10	960						
A1-4	4	SPEAKER ACCENTS	277V	MAGNETIC LV	480						
A1-5	5	RAMP DNLT WW	277V	FL - NON-DIM	340						
A1-6	6	RAMP STEP	277V	FL - NON-DIM	188						
A1-7	7	BULL NOSE STEP	277V	MAGNETIC LV	900						

Redone

Table 19: Panel "DIM" New

	Training Theater Summary Load Schedule										
Lutron Zone	DIM Zone	Zone/Circuit Description	Voltage	Load Type	Wattage						
DIM 1	1	Back Downlights	277	Mark 7 0-10V	563						
DIM 2	2	Ramp Downlights	277	Mark 7 0-10V	188						
DIM 3	3	Left Front Downlights	277	Mark 7 0-10V	288						
DIM 4	4	Right Front Downlights	277	Mark 7 0-10V	288						
DIM 5	5	Middle Front Downlights	277	Mark 7 0-10V	600						
DIM 6	6	Cove Lighting	277	Mark 7 0-10V	2871						
DIM 7	7	Steplights	277	Magnetic LV	31.6						



Original

Table 20: Panel "2HL" Old

	N	EUTRAL BUS:	10	00%	VOLTAGE:	480Y/277V, 3PH, 4W + GND			
PANEL "2HL"	G	ROUND BUS:	Y	ΈS	MAINS:	125A			
(AUTOMATED	SOLATED G	ROUND BUS:	N	0 MAIN	CR. BKR.	100A/3P			
LIGHTING PANEL)		MOUNTING:	S	SURFACE A	C RATING:	14.000			
CIR.		BREAKER		BREAKER			CIR.		
NO. DESCRIPTION	VA LOAD	amps / poles		amps / poles	VA LOAD	DESCRIPTION	NO.		
1 LIGHTS - 202, 204, 250, 254	3,324	20/1		20/1	2,200	LIGHTS - 236 (PERIMETER), 240, 241	2		
3 LIGHTS - 232, 242	1,446	20/1		20/1	2,500	LIGHTS - 236, 237, 238, 239	4		
5 LIGHTS - 274, 275, 270, 271, 268, 269	2,711	20/1		20/1	2,310	LIGHTS - 253, 249, 248	6		
7 LIGHTS - 235, 234	2,326	20/1		20/1	815	Lights - 244	8		
9 LIGHTS - 208, 209, 210, 211, 212, 213	2,683	20/1		20/1	3,058	LIGHTS - 214, 220, 222, 224, 226, 228	10		
11 LIGHTS - 203, 206, 207	1,460	20/1		20/1	2,079	LTS-215-17, 219, 221, 223, 225, 227, 229-31	12		
13 LIGHTS - 256, 257, 258, 259, 260, 261	2,336	20/1		20/1	2,100	LIGHTS - BRIDGE 200, SCONCES	14		
15 LIGHTS - 255, 263, 264, 266, 267	3,114	20/1		20/1	256	Lights - Bridge 201, Lobby	16		
17 SPARE	-	20/1		20/1	-	SPARE	18		
19 SPARE	-	20/1		20/1	-	SPARE	20		
21 SPARE	-	20/1		20/1	-	SPARE	22		
23 SPARE	-	20/1		20/1	-	SPARE	24		
25 SPARE	-	20/1		20/1	-	SPARE	26		
27 SPARE	-	20/1		20/1	-	SPARE	28		
29 SPARE	-	20/1		20/1	-	SPARE	30		
31 SPACE	-	-		-	-	SPACE	32		
33 SPACE		-		-	-	SPACE	34		
35 SPACE	-	-		-	-	SPACE	36		
37 SPACE	-	-		40/3	-	SCADA UNIT	38		
39 SPACE	-	-		-	-	-	40		
41 SPACE	-	-		-	-	-	42		
SUB TOTAL					15,318	SUB TOTAL			
LEGEND: ** 6mA GROUND FAULT CIRCUIT B	Reaker	CONNEC	ст	ED LOAD	REMARKS:				
* 30mA GROUND FAULT CIRCUIT	Breaker	34.7		KVA					
 LOCK-ON CIRCUIT BREAKER HAD 	NDLE	4 1.8		3 PH. AMPS					

Redone

Table 21: Panel "2HL" New

	PANELBOARD SCHEDULE														
VOLTAGE: SIZE/TYPE BUS: SIZE/TYPE MAIN:		1,4W+GND		PANEL T IEL LOCATI EL MOUNTI	ON:	Ele	ctric			OPTIONS:	MIN. C/B AIC: 14K OPTIONS: None None				
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	А	в	С	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION			
Lighting	202+	3613	20A/1P	1	*			2	20A/1P	1170	234	Lighting			
Lighting	232242	1572	20A/1P	3		*		4	20A/1P	2717	236+	Lighting			
Lighting	274+	2947	20A/1P	5			*	6	20A/1P	2511	253+	Lighting			
Lighting	234	1911	20A/1P	7	*			8	20A/1P	886	244	Lighting			
Lighting	208+	2916	20A/1P	9		*		10	20A/1P	3324	214+	Lighting			
Lighting	203+	1587	20A/1P	11			*	12	20A/1P	2260	215+	Lighting			
Lighting	256+	2539	20A/1P	13	*			14	20A/1P	988	Bridge Lobby	Lighting			
Lighting	255+	3385	20A/1P	15		*		16	20A/1P	0	-	Spare			
Spare	-	0	20A/1P	17			*	18	20A/1P	0	-	Spare			
Spare	-	0	20A/1P	19	*			20	20A/1P	0	-	Spare			
Spare	-	0	20A/1P	21		*		22	20A/1P	0	-	Spare			
Spare	-	0	20A/1P	23			*	24	20A/1P	0	-	Spare			
Spare	-	0	20A/1P	25	*			26	20A/1P	0	-	Spare			
Spare	-	0	20A/1P	27		*		28	20A/1P	0	-	Spare			
Spare	-	0	20A/1P	29			*	30	20A/1P	0	-	Spare			
Spare	-	0	20A/1P	31	*			32	20A/1P	0	-	Spare			
Spare	-	0	20A/1P	33		*		34	20A/1P	0	-	Spare			
Spare	-	0	20A/1P	35			*	36	20A/1P	0	-	Spare			
Spare	-	0	20A/1P	37	*			38	40A/3P	0	-	Scada Unit			
Spare	-	0	20A/1P	39		*		40		0	-	Scada Unit			
Spare	-	0	20A/1P	41			*	42		0	-	Scada Unit			
CONNECTED LOAD	D (KW) - A	11.11							TOTAL DESIGN	LOAD (KW)	28.83				
CONNECTED LOAD	D (KW) - B	13.91							POWER FACTOR		0.93				
CONNECTED LOAD	D (KW) - C	9.30								TOTAL DESIGN	LOAD (AMPS)	37			



Original

Table 22: Panel "2HLS" Old

		N	EUTRAL BUS:	100	0%	VOLTAGE:	480Y/277V, 3PH, 4W + 2GND	
PA	NEL "2HLS"	G	ROUND BUS:	YE	S	MAINS:	125A	
	I:	SOLATED G	ROUND BUS:	NC) MAIN	CIR. BKR.	30A/3P	
			MOUNTING:	SU	IRFACE A	C RATING:	14,000	
CR.			BREAKER	Γ	BREAKER			CIR.
NO.	DESCRIPTION	VA LOAD	amps / poles		amps / poles	VA LOAD	DESCRIPTION	NO.
1	EMG LTS-202,204,206,207,242,243,232,234	2,170	20/1		20/1	295	EMG LTS-270, 271, 272A, 268, 273, 274, 275	2
3	EMG LIGHTS - 244, 245, 246, 247, 248, 249	2,160	20/1		20/1	515	EMG LIGHTS - 255, 258, 263	4
5	EMG LIGHTS - 236	425	20/1		20/1	360	EMG LIGHTS - 214, 220	6
	EMG LIGHTS - BRIDGE 200	406	20/1		20/1	205	EMG LIGHTS - 208	8
<u> </u>	SPARE	-	20/1		20/1	-	SPARE	10
<u> </u>	SPARE	-	20/1		20/1	-	SPARE	12
	SPARE	-	20/1		20/1	-	SPARE	14
	SPARE	-	20/1		20/1	-	SPARE	16
	SPARE	-	20/1	╵┟	20/1	-	SPARE	18
10	SPARE	-	20/1		20/1	-	SPARE	20
~ .	SPARE	-	20/1		20/1	-	SPARE	22
	SPARE	-	20/1	╵┟	20/1	-	SPARE	24
	SPARE	-	20/1	╵┟	20/1	-	SPARE	26
	SPARE	-	20/1		20/1	-	SPARE	28
~~~	SPARE	-	20/1		20/1	-	SPARE	30
	SPACE	-	-	╵┟	-	-	SPACE	32
	SPACE	-	-		-	-	SPACE	34
35	SPACE	-	-		-	-	SPACE	36
37	SPACE	-	-	╽╽	40/3	-	TVSS UNIT	38
	SPACE	-	-	╽╽	-	-	-	40
41	SPACE	-	-		-	-	-	42
	SUB TOTAL	5,161				1,375	SUB TOTAL	
	LEGEND: ** 6mA GROUND FAULT CIRCUIT BR		CONNEC			REMARKS	:	
	30mA GROUND FAULT CIRCUIT B		6.5		KVA			
	LOCK-ON CIRCUIT BREAKER HAN	DLE	7.9	;	3 PH. AMPS			

# Redone

## Table 23: Panel "2HL" New

	PANELBOARD SCHEDULE													
VOLTAGE: SIZE/TYPE BUS: SIZE/TYPE MAIN:		I,4W+2GND		PANEL T IEL LOCATI EL MOUNTI	ON:	Elec	ctric		MIN. C/B AIC: 14K OPTIONS: None None					
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	А	в	С	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION		
Emg Lighting	202+	2284	20A/1P	1	*			2	20A/1P	311	270+	Emg Lighting		
Emg Lighting	244+	2274	20A/1P	3		*		4	20A/1P	542	255+	Emg Lighting		
Emg Lighting	236	593	20A/1P	5			*	6	20A/1P	379	214220	Emg Lighting		
Emg Lighting	Bridge Lobby	204	20A/1P	7	*			8	20A/1P	209	208	Emg Lighting		
Spare	-	0	20A/1P	9		*		10	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	11			*	12	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	13	*			14	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	15		*		16	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	17			*	18	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	19	*			20	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	21		*		22	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	23			*	24	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	25	*			26	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	27		*		28	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	29			*	30	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	31	*			32	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	33		*		34	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	35			*	36	20A/1P	0	-	Spare		
Spare	-	0	20A/1P	37	*			38	40A/3P	0	-	TVSS Unit		
Spare	-	0	20A/1P	39		*		40		0	-	TVSS Unit		
Spare	-	0	20A/1P	41			*	42		0	-	TVSS Unit		
CONNECTED LOAD	D (KW) - A	3.01								TOTAL DESIGN	LOAD (KW)	8.1		
CONNECTED LOAD	D (KW) - B	2.82								POWER FACTOR		0.9		
CONNECTED LOAD	) (KW) - C	0.97								TOTAL DESIGN	LOAD (AMPS)	1		



#### Original

#### Table 24: Panel "2LWS2" Old

		N	EUTRAL BUS; 2	200%	VOLTAGE;	208Y/120V, 3PH, 5W + 2GND			
PA	NEL "2LWS2"	G	ROUND BUS: Y	FS	MAINS	225A			
					CIR. BKR.				
	ı i	SOLATED G	ROUND BUS: Y						
			MOUNTING:		C RATING	10,000			
CIR.			BREAKER	BREAKER			CIR.		
NO.	DESCRIPTION		amps / poles	amps / poles		DESCRIPTION	NO.		
1	SYSTEM FURN., OPEN OFFICE N5 RM 23603	720	20/1	20/1	1,080	OFFICE RECEPTACLES, RM 24001, 24101	2		
3	SYSTEM FURN., OPEN OFFICE N5 RM 23603	720	20/1	20/1	1,080	CONFERENCE RM RECEPTS, RM 239A1	4		
5	SYSTEM FURN., OPEN OFFICE N5 RM 23603	720	20/1	20/1	1,080	OFFICE RECEPTS, RM 24001, 23603, 238A1	6		
7	SYSTEM FURN., OPEN OFFICE N5 RM 23603	720	20/1	20/1	300	CONFERENCE RM CATV RECEPT., RM 239A1	8		
9	SYSTEM FURN., OPEN OFFICE N5 RM 23603	720	20/1	20/1	240	CONFERENCE RM RECEPT., RM 239A1	10		
-	SYSTEM FURN., OPEN OFFICE N5 RM 23603	360	20/1	20/1	240	CONFERENCE RM RECEPT., RM 239A1	12		
	COPIER, RM 23704	1,200	20/1	20/1	1,440	SYSTEM FURN., OPEN OFFICE N5 RM 23603	14		
	PRINTER, RM 23704	940	20/1	20/1	1,440	SYSTEM FURN., OPEN OFFICE N5 RM 23603	16		
	FAX MACHINE, RM 23704	940	20/1	20/1	1,440	SYSTEM FURN., OPEN OFFICE N5 RM 23603	18		
-	RECEPTS, OPEN OFFICE N5 RM 23603, 23704	1,260	20/1	20/1	720	SYSTEM FURN., OPEN OFFICE N5 RM 23603	20		
	SYSTEM FURN., OPEN OFFICE N5 RM 23603	1,440	20/1	20/1	720	SYSTEM FURN., OPEN OFFICE N5 RM 23603	22		
23	SYSTEM FURN., OPEN OFFICE N5 RM 23603	1,440	20/1	20/1		SYS. FURN., OPEN OFF. N5 RM 23603(SPARE)	24		
25	SYSTEM FURN., OPEN OFFICE N5 RM 23603	1,440	20/1	20/1	1,440	SYSTEM FURN., OPEN OFFICE N5 RM 23603	26		
27	SPARE	-	20/1	20/1	1,080	SYSTEM FURN., OPEN OFFICE N5 RM 23603	28		
29	SPARE	-	20/1	20/1	720	SYSTEM FURN., OPEN OFFICE N5 RM 23603	30		
31	SPARE	-	20/1	20/1	100	SOUND GENERATOR 237	32		
33	SPARE	-	20/1	20/1	-	SPARE	34		
35	SPARE	. · ·	20/1	20/1	<b>.</b>	SPARE	36		
37	SPARE	-	20/1	40/3		TVSS UNIT	38		
39	SPARE		20/1			-	40		
41	SPARE		20/1	-		-	42		
	SUB TOTAL	12,620			13,120	SUB TOTAL			
2	LEGEND: ** 6mA GROUND FAULT CIRCUIT BR	eaker	CONNEC	TED LOAD	REMARKS:				
	30mA GROUND FAULT CIRCUIT E	Reaker	25.74	KVA	FEED-THRU LUGS				
	<ul> <li>LOCK-ON CIRCUIT BREAKER HAN</li> </ul>	DLE	71.50 3 PH. AMPS						
10.00			97				7.4		

#### Redone

#### Table 25: Panel "2LWS2" New

		P	A N E I	вои	A F	ק ב	)	SCH	EDU	LE		
VOLTAGE: SIZE/TYPE BUS: SIZE/TYPE MAIN:	1,5W+2GND		PANEL T IEL LOCATI EL MOUNTI	ON:	Ope	en C	office 236		MIN. C/B AIC: 10K OPTIONS: None None			
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	А	В	С	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Systems Furniture	Open Office	858	20A/1P	1	*			2	20A/1P	1200	Open Office	Systems Furniture
Systems Furniture	Open Office	858	20A/1P	3		*		4	20A/1P	1200	Open Office	Systems Furniture
Systems Furniture	Open Office	858	20A/1P	5			*	6	20A/1P	1200	Open Office	Systems Furniture
Systems Furniture	Open Office	858	20A/1P	7	*			8	20A/1P	333	Open Office	Systems Furniture
Systems Furniture	Open Office	858	20A/1P	9		*		10	20A/1P	267	Open Office	Systems Furniture
Systems Furniture	Open Office	487	20A/1P	11			*	12	20A/1P	267	Open Office	Systems Furniture
Systems Furniture	Open Office	1333	20A/1P	13	*			14	20A/1P	1658	Open Office	Systems Furniture
Systems Furniture	Open Office	1044	20A/1P	15		*		16	20A/1P	1687	Open Office	Systems Furniture
Systems Furniture	Open Office	1044	20A/1P	17			*	18	20A/1P	1687	Open Office	Systems Furniture
Systems Furniture	Open Office	1400	20A/1P	19	*			20	20A/1P	916	Open Office	Systems Furniture
Systems Furniture	Open Office	1716	20A/1P	21		*		22	20A/1P	916	Open Office	Systems Furniture
Systems Furniture	Open Office	1716	20A/1P	23			*	24	20A/1P	0	Open Office	Spare
Systems Furniture	Open Office	1716	20A/1P	25	*			26	20A/1P	1600	Open Office	Systems Furniture
Systems Furniture	-	0	20A/1P	27		*		28	20A/1P	1316	Open Office	Systems Furniture
Systems Furniture	-	0	20A/1P	29			*	30	20A/1P	916	Open Office	Systems Furniture
Spare	-	0	20A/1P	31	*			32	20A/1P	111	237	Sound Generator
Spare	-	0	20A/1P	33		*		34	20A/1P	0	-	Spare
Spare	-	0	20A/1P	35			*	36	20A/1P	0	-	Spare
Spare	-	0	20A/1P	37	*			38	40A/3P	0	-	TVSS Unit
Spare	-	0	20A/1P	39		*		40		0	-	TVSS Unit
Spare	-	0	20A/1P	41			*	42		0	-	TVSS Unit
CONNECTED LOAD	ONNECTED LOAD (KW) - A 11.98			3					TOTAL DESIGN LOAD (KW)		25.21	
CONNECTED LOAD	ONNECTED LOAD (KW) - B 9.86		6						POWER FACTOR		0.90	
CONNECTED LOAD	0 (KW) - C	8.17								TOTAL DESIGN	LOAD (AMPS)	78

Chris Ankeny NNSOC Dahlgren, VA

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#### **Feeder and Overcurrent Protection**

The panelboard layouts were all standardized for the type of load that was placed on them. All the lighting loads were circuited by the two lighting panels or the two emergency lighting panels. Each receptacle panelboard was sized the same regardless if the panel was oversized for its load. Because of this I did the feeder sizing and overcurrent protection but left the panels the same as the existing because the loads hardly changed with my additions and I wanted to keep them uniform with the rest of the building. There were no loads that I added to any panel that required me to size up the feeder or circuit breaker.

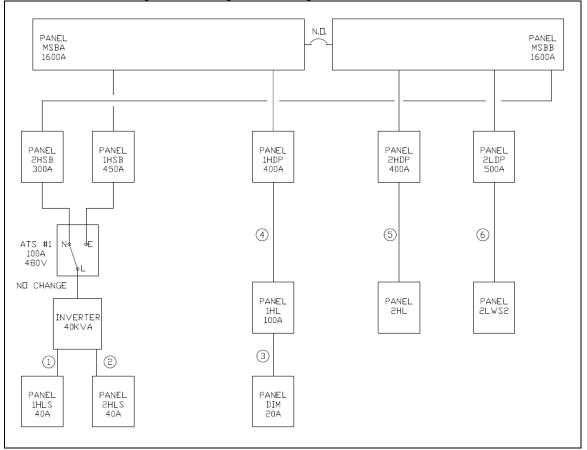


Figure 60: Single Line Diagram of Redone Panels

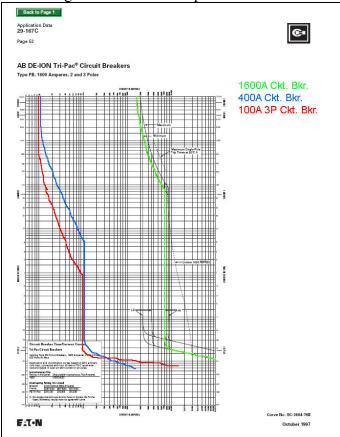


Table 26:	Feeder	Schedule
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								FEEDER	SCHED	ULE						
CONDUIT CONDUCTORS (PER SET)										SIZE OF	FRAME OR					
	NO. OF (PER SET) PHASE CONDUCTORS NEUTRAL CONDUCTORS GROUND CONDUCTORS										ICTORS	OVERCURRENT	SWITCH			
TAG	FROM	то	SETS	SIZE	TYPE	No.	SIZE	TYPE	No.	SIZE	TYPE	No.	SIZE	TYPE	PROTECTION	SIZE
1	1HLS	ATS-1	1	3/4"	EMT	3	8AWG	CU THWN	1	8AWG	CU THWN	1	10AWG	CU THWN	30	40A/3P
2	2HLS	ATS-1	1	3/4"	EMT	3	8AWG	CU THWN	1	8AWG	CU THWN	1	10AWG	CU THWN	30	40A/3P
3	DIM	1HLS	1	1/2"	EMT	3	12AWG	CU THWN	1	12AWG	CU THWN				20	20A/3P
4	1HLS	1HDP	1	1 3/4"	EMT	3	3AWG	CU THWN	1	3AWG	CU THWN	1	8AWG	CU THWN	100	125A/3P
5 2HL 2HDP 1 13/4" EMT 3 3AWG CUTHWN 1 3AWG CUTHWN 1 8AWG CUTHW											CU THWN	100	125A/3P			
6	2LWS2	2LDP	1	2"	EMT	3	1/0AWG	CU THWN	1	1/0AWG	CU THWN	2	6AWG	CU THWN	150	225A/3P

Full Feeder table and trip devices are in Appendix B. Below are the electrical device coordination trip breakers for a 100A, 400A, and 1600A panelboard. These devices are coordinated properly.

I could not do the short circuit calculation because the available incoming shortcircuit rating was not given to me. My building is powered from existing switchgear which is rated at 30,000AIC. The main double-ended switchboard is rated at 30,000AIC.



#### Figure 61: Device Trip Coordination



#### **Rotary UPS-vs.-Static UPS**

#### Background

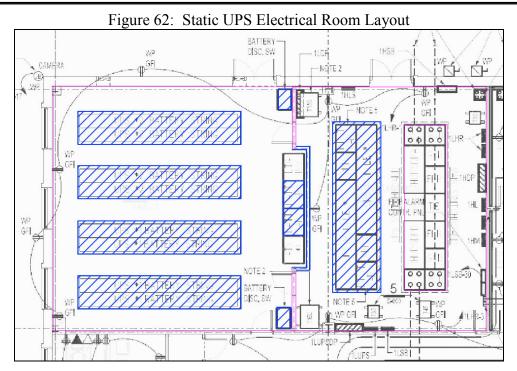
Currently the UPS system services critical loads in both facilities and has two 625kVA modules to provide N+1 reliability. Each system has a 30-minute battery plant to provide the necessary power to service the present critical loads and 25% spare capacity for future expansion. The UPS system is set up so if one system goes down, critical loads can be transferred to the other UPS module by closing the static transfer switch located between the UPS switchboards and UPS distribution panels. These transfer switches allow power to be delivered to either UPS distribution panel which in turn delivers power to the end panels and loads. Once the two 1000KW generators start, they will power the loads until the main electrical system is up and running again. The main advantage of the Static system is that the 30 minutes of available power allow for all systems to properly shut down if the generators fail to start.

#### Analysis

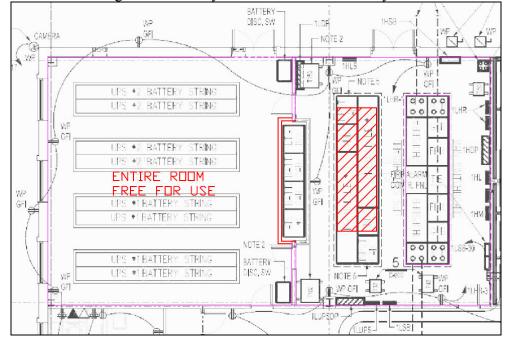
The current design of the uninterruptible power system is first cost efficient, but appears to require a lot of space inside the building due to the need for a battery room and the Static UPS system. The battery room takes up an area of roughly 1300 square feet while the Static UPS equipment requires an area of 180 square feet.

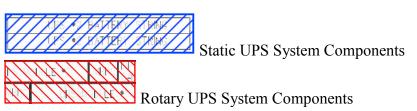
Replacing the Static UPS system with a Rotary UPS system will create more space in the building by removing the batteries and additional HVAC equipment required for them. The rotary system does not need to be conditioned and works in temperatures up to 104 degrees. Batteries have specific operating temperatures and degrade faster when not properly conditioned. Removing the batteries also takes away the environmental and safety issues that need to be accounted for in battery installations. The Rotary UPS system generally has a higher first cost, but can be better in the long run with longer life and simpler maintenance. The space for the system requires the same footprint as the Static UPS system without the battery bank room, so about 1300 square feet of space will be freed up in this building. The cost of the building was \$17,000,000 and the square footage was 75,000s.f. That ends up being 17,000,000 / 75000 = \$227/s.f. So putting in the rotary system would save 1300s.f.* \$227/s.f. = \$295,100 of the building cost. Figure 2.8 and Figure 2.9 show the comparison between both system layouts in the electrical room.





#### Figure 63: Rotary UPS Electrical Room Layout





Chris Ankeny NNSOC Dahlgren, VA

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The downside of using a Rotary UPS system is the fact that it only works for seconds whereas the Static UPS with battery system can last for minutes. This building is set up for 30 minutes of backup battery reliability once the system starts. The Caterpillar UPS 300 Series Multi Module System that I have chosen to use will only provide 13 seconds of power at 100% capacity. This level of time is sufficient since the majority of power disruptions last less than 5 seconds, and the standby generators are rated to start in 10 seconds or less. If the standby generators fail to start and the electrical outage lasts, then the critical equipment in the building will not shut down properly and information may be lost. This is the major concern of using rotary technology.

Rotary UPS can be coupled with battery backup but I am not using this approach in my design. The advantage of that system is to allow longer life on the batteries by letting the rotary unit handle the 5 second outages and allow the batteries to be used in the longer outages. Batteries degrade when used, so only using them for longer outages will increase their lifespan. The batteries also allow the critical system loads to shut down properly if both generators fail to come online. I am not using this system because each standby generator for my building has the capacity to power the entire UPS load on just one generator. With all of the redundancy (two utilities, two parallel switchboards, two parallel UPS systems, two parallel standby generators) in the electrical system, I am willing to live with the slim chance of both generators failing to start when a power outage occurs.

#### System Comparison

For my life cycle cost comparison, I will be using the Caterpillar UPS 300 600kVA and 900kVA Series Multi Module Systems against the MGE UPS EPS 8000 750kVA Static System. Sadly, the rotary system only comes in 600kVA or 900kVA while the cost information I have for the static system is for a 750kVA unit, so the comparisons will not be same size unit to same size unit. Instead of comparing the rotary system to 30 minutes of battery backup, I will be comparing them with 7 minutes of battery backup. Seven minutes of battery power would require the generator startup immediately just as the rotary system does, which would give a better overall comparison of the two systems. With the 30 minutes of battery backup the generators would not need to carry the full UPS load on startup and therefore be an unfair comparison of the systems(due to the increased cost of 30 minutes of battery backup). The cost of displaced space is only relevant to the two systems being compared, not the space required by the 30 minutes of batteries in the actual building.

#### Assumptions

- I am not comparing the air conditioning cost savings in this analysis because the gained area from the rotary system can be usable space which requires conditioning as well.
- Cost of space = \$17,000,000 for building / 75,000 square feet of building floor area: \$227/s.f.
- Life cycle duration analysis of 10 years.

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- Interest rate of 6% a year for the life cycle cost analysis.
- Cost of electricity of \$0.10/kwh.
- Total load on system of 500kw. Full load efficiency on all equipment
- Energy losses = System output*(1-efficiency)/efficiency
- Energy Cost = Energy losses  $(kw)^*$  24  $(hrs)^*$  365  $(days)^*$  \$0.10/kwh
- Present Worth = Annual cost  $((1 + i)^n 1)/(i(1+i)^n)$
- Present Value =  $Cost^* ((1+i)^{-n})$

#### Rotary UPS Cost, one system

The budgetary figure for the 600kVA system is \$230,000.00. The budgetary figure for the 900kVA system is \$340,000.00.

• Cost includes equipment, freight to site, startup and commissioning and owner's instructions.

An estimated installation cost of 25% of the equipment cost was the number given to me, so \$57,500 for the 600kVA unit and \$85,000 for the 900kVA unit.

The only wear items in the system are two flywheel bearings which are constantly monitored by the unit over time. The monitoring equipment determines when the bearings need to be replaced, typical every 3-5 years. The replacement cost and two days of technician time are about \$6,000 for the 600kVA unit and \$9000 for the 900kVA unit.

- Assuming Present Value replacement in the 5th year: \$6000* ((1+0.06)⁻⁵) = \$4,483.55 (600kVA unit) \$9000* ((1+0.06)⁻⁵) = \$6,725.32 (900kVA unit)
- Assuming Present Value replacement in the 10th year: \$6000* ((1+0.06)⁻¹⁰) = \$3,350.37 (600kVA unit) \$9000* ((1+0.06)⁻¹⁰) = \$5,025.55 (900kVA unit)

Each year the oil for a vacuum pump needs to be changed in the system. The oil used is vegetable oil and can be changed by the owner or contractor will do it for \$600/year for the 600kVA unit and \$900/year for the 900kVA unit. There is no yearly maintenance contract for this system.

• Assuming Present Worth:  $600^{(1+0.06)^{10}-1} (0.06(1+0.06)^{10}) = 44,416.05 (600 \text{kVA unit})$  $900^{((1+0.06)^{10}-1)} (0.06(1+0.06)^{10}) = 6,624.08 (900 \text{kVA unit})$ 

Energy Cost:

Efficiency of system is 97% at full output, with assumed load of 500kw Energy losses = 500*(1-0.97)/0.97 = 15.46kw Energy Cost = 15.46/ww*24/mx*265.dows*0.10/wwb = \$12.542.06/ww

Energy Cost = 15.46kw*24hrs*365days*\$0.10/kwh = \$13,542.96/yr

• Assuming Present Worth:  $13,542.96*((1+0.06)^{10}-1)/(0.06(1+0.06)^{10}) = $99,677.36$  Chris Ankeny NNSOC Dahlgren, VA

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#### Dimensions:

The 600kVA unit is 34" deep, 170" wide, and 96" high. 40 square feet The 900kVA unit is 34" deep, 213" wide, and 96" high. 50 square feet

Cost of Space: 600kVA unit: 40s.f.*\$227/s.f. = \$9,080 900kVA unit: 50s.f.*\$227/s.f. = \$11,350

• Assuming Present Worth:  $9,080*((1+0.06)^{10}-1)/(0.06(1+0.06)^{10}) = 66,829.59 (600kVA unit)$  $11,350*((1+0.06)^{10}-1)/(0.06(1+0.06)^{10}) = 883,536.99 (900kVA unit)$ 

#### Static UPS Cost, one system

The budgetary figure for the 750kVA system is \$200,000.00.

• Cost includes equipment, battery cabinets, Factory startup and training, load bank testing at site, and one year warranty parts and labor.

An estimated installation cost of \$60,000 for the unit and batteries.

A maintenance contract which includes 24/7 coverage, parts, labor and two preventative maintenances on the UPS and batteries has a budget cost of \$25,000 per year.

• Assuming Present Worth:  $25,000*((1+0.06)^{10}-1)/(0.06(1+0.06)^{10}) = $184,002.18$ 

Every five years is the recommended time to change the battery system. The total cost of batteries, installation, and removal of old batteries is \$60,000.

- Assuming Present Value replacement in the 5th year:  $(1+0.06)^{-5} = 44.835.49$
- Assuming Present Value replacement in the  $10^{\text{th}}$  year:  $(1+0.06)^{-10} = 333,503.69$

Energy Cost:

Efficiency of system is 93% at full output, with assumed load of 500kw Energy losses = 500*(1-0.93)/0.93 = 37.63kw Energy Cost = 37.63kw*24hrs*365days*\$0.10/kwh = \$32,963.88/year

• Assuming Present Worth:  $32,963.88*((1 + 0.06)^{10}-1)/(0.06(1+0.06)^{10}) = $242,617.03$ 

Dimensions:

The 750kVA unit is 39" deep, 122" wide, and 82" high. The Maintenance Bypass Cabinet is 39' deep, 23" wide, and 82" high. The 4 Battery Cabinets are 33" deep, 50" wide, and 75" high each. 85 total square feet Chris Ankeny NNSOC Dahlgren, VA

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Cost of Space: 85s.f.*\$227/s.f. = \$19,295 • Assuming Present Worth:

 $19,295*((1+0.06)^{10}-1)/(0.06(1+0.06)^{10}) = 142,012.88$ 

#### Comparison

Table 2'	7: Total Life Cycl	e Costs	
Present Worth	n Costs (\$) Over	10 Year Span	
	600kVA Rotary UPS	900kVA Rotary UPS	750kVA Static UPS
First Cost Equipment	\$230,000	\$340,000	\$200,000
Installation	\$57,500	\$85,000	\$60,000
Total First Costs	\$287,500	\$425,000	\$260,000
Total Savings of each Rotary system compared to the Static System. First Costs, Single System.	-\$27,500	-\$165,000	\$0
Maintenance	\$4,416	\$6,624	\$184,002
Replace Equipment (5,10th year)	\$7,834	\$11,751	\$78,339
Energy Cost	\$99,677	\$99,677	\$242,617
Cost of Space	\$66,830	\$83,537	\$142,013
Present Worth Total 10 Year Cost	\$466,257	\$626,589	\$906,971
Total cost of all Equipment (2 systems)	\$932,514	\$1,253,178	\$1,813,943
Total Savings of each Rotary system compared to the Static System. 10 Year.	\$881,429	\$560,765	\$0

## Conclusion

I am very pleased with the results of the analysis. The few values that I am unsure of are the energy costs due to the fact that the sizes of the systems are different and I assumed the full load efficiency of each system. The units would not be running at full load at the 500kw assumed load but I had no other values to use. Also, manufacturers sometimes make most of their money with yearly maintenance contracts with owners, which might explain the \$25,000/year contract with the static system, but there was no maintenance contract on the rotary system. Then again, the batteries are more dangerous and require more maintenance so perhaps this is a fairly accurate representation. First cost is a big deal but the values are not that different. It costs only \$55,000 more for (2) 600kVA rotary systems and \$330,000 more for (2) 900kVA rotary systems, compared to (2) 750kVA static systems. In the long term both rotary systems use less money than the static system, are safer with the respect to batteries and environment, and easier to maintain over time. I would recommend using either rotary system over the static system for this building.



#### **Photovoltaic Array Analysis**

#### Introduction

The following photovoltaic analysis is used to determine whether it is viable to install a PV array on the roof of the NNSOC. I will be using the RETScreen photovoltaic analysis tool to determine energy production and the payback period of a PV array. The energy usage of my building is much higher than anything a PV array can produce within the area of the roof. Since I plan on using all the energy produced, the system will be ongrid with the utility and no battery storage system. If by chance the PV array is producing more energy than the building is using, then it will send this energy back to the utility.

For a lot of states there are programs designed to help financially with the costs of a photovoltaic array for a home or business. However, currently in the state of Virginia, there are no tax incentives or credits for installation of PV systems. There is a federal tax credit of 30% for business installations that I will be using in my design.

#### Design Concept

I chose BP Solar's 3160 photovoltaic module for my base unit. Pricing data for the PV modules and inverter came from AdvancedEnergyOnline.com. The cost of the BP 3160 module is \$800/module and the cost of a 225kW 480V inverter is \$208,073. The inverter is rated at 480V so my PV modules should be connected to half of this voltage. Each module is 160 watts at 35.1 volts and 4.55 amps at full output. So connecting the modules in series to around 240 volts requires 7 modules, with the rest of the modules in parallel. The total roof area is 34,875s.f, but not all of this space is usable. Figure 2.11 shows the proposed layout for the system. With this layout and the proper wiring design, 1,456 modules fit the layout. +



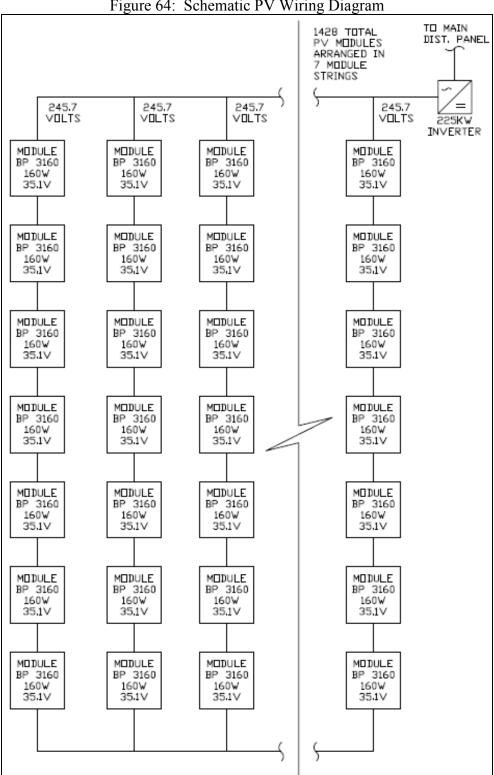


Figure 64: Schematic PV Wiring Diagram



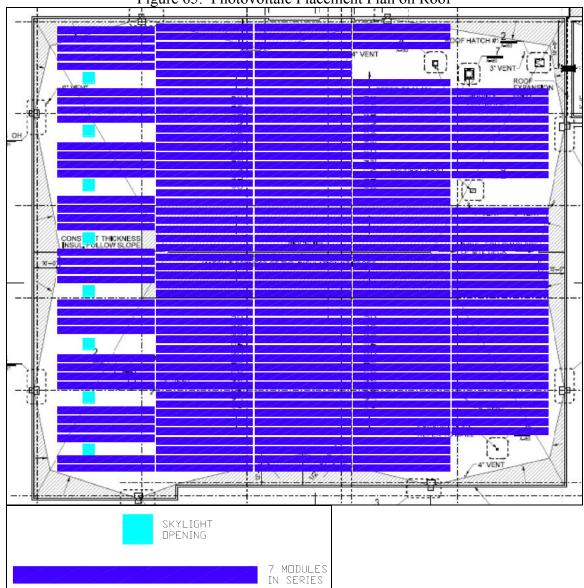


Figure 65: Photovoltaic Placement Plan on Roof

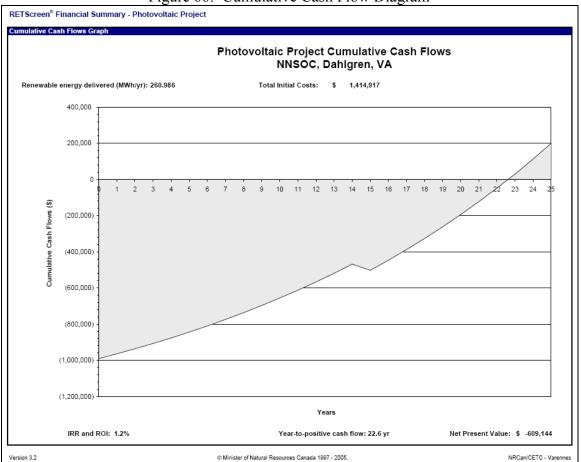
#### Assumptions

- Project life of 25 years
- Energy cost of \$0.10/kWh with escalation rate at 5.0%
- 30% Federal tax credit for new installations
- Inverter repair every 15 years

#### Analysis

The RETScreen tool was used to determine the basic cost and payback of the system, along with the maximum energy it can produce. The results are below in Figure 65 with the rest of the analysis in Appendix B.





#### Figure 66: Cumulative Cash Flow Diagram

#### Conclusion

The net payback period on implementing a Photovoltaic array on the roof of the NNSOC does not seem to be worth while. It will take at least 22.5 years to reach the break even point. Unless the client would really want a PV system I would recommend against it at this point in time. If Virginia had some type of tax relief or credit program to help offset the costs of PV arrays then this analysis might have been possible. Also, in the next few years I expect PV arrays to become more popular due to our current energy situation and people wanting to be more environmental friendly. If PV panel manufacturers improve their production efficiency due to public demand then the price per panel should fall and become a better alternative energy source for consumers. This would be an option the building owners could look into for a future retrofit to help with energy costs.

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## **Mechanical Breadth**

#### HVAC affect on Skylight Design

#### Background

After my proposed daylight redesign for the office is complete, I will be analyzing the affects of the glazing area added on the roof with the HVAC design. The added glazing may affect ASHRAE Standard 90.1 as well as the designed heating and cooling loads of the space. I will compare the increase in HVAC loads to the original building using E-Quest 3-61 (Quick Energy Simulation Tool) for the analysis. Using E-Quest, I will run a base building HVAC load simulation with no skylights, and then run a simulation with the added skylights to determine the difference in the loads for each design. This value will be how much more HVAC load is needed for the building with the added skylights.

#### Assumptions

- E-Quest building model remains unchanged except for the skylights in each simulation
- Skylight glazing is Double Polycarbonate White Translucent
- Skylight to area of roof is 2.7% which is what the Skycalc tool showed to be the most efficient design
- Electricity cost is \$0.10/kWh
- Thermal cost is \$0.50/Therm

#### Analysis

I designed a generic model of my building in order to run this analysis. Placing in the mechanical loads from the schedules gave me the right size units for the building along with the efficiencies of each unit. The analysis was run twice with only the skylights changing in the design. Only changing the skylights should give me an accurate model of how much energy the extra skylights would use. The charts below show the monthly cost of energy for the electrical and thermal loads.



	SOC_no skylig	hts - Fan F		EEM		e Buil				2012/2017	ate/Time:	04/05/07	@ 22:02
(000)	lectric Co	onsum	ption (	kWh)	]	- A-82.9	0,000) 60 <del></del>	Gas	Consu	mptior	ı (Btu)	]	
120 100 60 40 20							50 40 30 20						
Ar	eb Mar Apr ea Lighting ask Lighting	9	Mis	Sep Oct M c. Equip	ment		Jan f Jan f Oumps & /entilatio	Aux.	Apr May J	Water H	leating Supp.	Oct Nov C	Space H Refrigera
ectric Consu	mption (k) Jan	Wh x000 Feb	) Mar	Apr	Мау	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
ace Cool	10.4	9.8	15.4	15.1	17.3	19.4	22.6	23.6	17.4	16.6	14.3	12.4	194.3
eat Reject.		0.0	0.0	0.0	0.1	0.2	0.4	0.3	0.2	0.1	0.0	0.0	1.4
frigeration	-	-		-	-	-	-	•	-		-	-	-
ace Heat	-				-	-	-	-			-	-	-
Supp.		1	1.5	-	- 26	5	-	-		÷.,			-
t Water	- 20	-				- 7.2		- 8.6	-		-	- 27	
nt. Fans	3.9	3.3	4.5	5.3	6.4	7.2	7.9	8.6	6.4	6.1	4.4	3.7	67.7
nt. Fans mps & Aux.	3.9 3.8	3.3 3.5	4.5 4.2	5.3 4.1	6.4 4.3	7.2 4.1	7.9 4.1	8.6 4.4	6.4 3.7	6.1 4.3	4.4 3.9	3.7 3.8	67.7 47.9
nt. Fans mps & Aux. t. Usage	3.9 3.8 4.6	3.3 3.5 3.5	4.5 4.2 3.9	5.3 4.1 3.8	6.4 4.3 2.7	7.2 4.1 2.6	7.9 4.1 2.7	8.6 4.4 4.4	6.4 3.7 4.2	6.1 4.3 4.4	4.4 3.9 4.4	3.7 3.8 4.6	67.7 47.9 45.7
nt. Fans mps & Aux. t. Usage sc. Equip.	3.9 3.8	3.3 3.5	4.5 4.2	5.3 4.1	6.4 4.3	7.2 4.1	7.9 4.1	8.6 4.4	6.4 3.7	6.1 4.3	4.4 3.9	3.7 3.8	67.7 47.9
nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights	3.9 3.8 4.6 46.6	3.3 3.5 3.5 42.1	4.5 4.2 3.9	5.3 4.1 3.8 46.4	6.4 4.3 2.7 48.5	7.2 4.1 2.6 46.4	7.9 4.1 2.7 46.6	8.6 4.4 4.4 50.5	6.4 3.7 4.2 42.5	6.1 4.3 4.4 48.5	4.4 3.9 4.4 44.5	3.7 3.8 4.6 44.6	67.7 47.9 45.7
nt. Fans mps & Aux. t. Usage ac. Equip. sk Lights a Lights	3.9 3.8 4.6 46.6	3.3 3.5 3.5 42.1	4.5 4.2 3.9 48.5	5.3 4.1 3.8 46.4 -	6.4 4.3 2.7 48.5	7.2 4.1 2.6 46.4	7.9 4.1 2.7 46.6	8.6 4.4 4.4 50.5	6.4 3.7 4.2 42.5	6.1 4.3 4.4 48.5	4.4 3.9 4.4 44.5	3.7 3.8 4.6 44.6	67.7 47.9 45.7 555.8
nt. Fans mps & Aux. t. Usage ac. Equip. sk Lights ea Lights <b>tal</b>	3.9 3.8 4.6 46.6 - 14.7 83.9	3.3 3.5 3.5 42.1 - 13.3 75.5	4.5 4.2 3.9 48.5 - 15.3 92.0	5.3 4.1 3.8 46.4 - 14.6	6.4 4.3 2.7 48.5 - 15.3	7.2 4.1 2.6 46.4 - 14.6	7.9 4.1 2.7 46.6 - 14.7	8.6 4.4 50.5 - 16.0	6.4 3.7 4.2 42.5 - 13.3	6.1 4.3 4.4 48.5 - 15.3	4.4 3.9 4.4 44.5 - 14.0	3.7 3.8 4.6 44.6 - 14.0	67.7 47.9 45.7 555.8 - 175.2
nt. Fans mps & Aux. t. Usage ac. Equip. sk Lights ea Lights tal s Consumpl	3.9 3.8 4.6 46.6 - 14.7 83.9 tion (Btu xt	3.3 3.5 42.1 - 13.3 75.5 000,000) Feb	4.5 4.2 3.9 48.5 - 15.3 92.0	5.3 4.1 3.8 46.4 - 14.6 89.3 Apr	6.4 4.3 2.7 48.5 - 15.3	7.2 4.1 2.6 46.4 - 14.6 94.5	7.9 4.1 2.7 46.6 - 14.7 99.0	8.6 4.4 50.5 - 16.0	6.4 3.7 4.2 42.5 - 13.3 87.8 <b>Sep</b>	6.1 4.3 4.4 48.5 - 15.3 95.2 Oct	4.4 3.9 4.4 44.5 - 14.0 85.4 Nov	3.7 3.8 4.6 44.6 - 14.0 83.1 Dec	67.7 47.9 45.7 555.8 - 175.2
nt. Fans mps & Aux. t. Usage ac. Equip. sk Lights ea Lights tal s Consumpl ace Cool	3.9 3.8 4.6 46.6 - 14.7 83.9 tion (Btu x)	3.3 3.5 3.5 42.1 - 13.3 75.5	4.5 4.2 3.9 48.5 - 15.3 92.0	5.3 4.1 3.8 46.4 - 14.6 89.3	6.4 4.3 2.7 48.5 - 15.3 94.6	7.2 4.1 2.6 46.4 - 14.6 94.5	7.9 4.1 2.7 46.6 - 14.7 99.0	8.6 4.4 50.5 - 16.0 107.8	6.4 3.7 4.2 42.5 - 13.3 87.8	6.1 4.3 4.4 48.5 - 15.3 95.2	4.4 3.9 4.4 44.5 - 14.0 85.4	3.7 3.8 4.6 44.6 - 14.0 83.1	67.7 47.9 45.7 555.8 - 175.2 1,088.0
nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights tal s Consumpl ace Cool at Reject.	3.9 3.8 4.6 46.6 - 14.7 83.9 tion (Btu xt	3.3 3.5 42.1 - 13.3 75.5 000,000) Feb	4.5 4.2 3.9 48.5 - 15.3 92.0	5.3 4.1 3.8 46.4 - 14.6 89.3 Apr	6.4 4.3 2.7 48.5 - 15.3 94.6	7.2 4.1 2.6 46.4 - 14.6 94.5	7.9 4.1 2.7 46.6 - 14.7 99.0	8.6 4.4 50.5 - 16.0 107.8	6.4 3.7 4.2 42.5 - 13.3 87.8 <b>Sep</b>	6.1 4.3 4.4 48.5 - 15.3 95.2 Oct	4.4 3.9 4.4 44.5 - 14.0 85.4 Nov	3.7 3.8 4.6 44.6 - 14.0 83.1 Dec	67.7 47.9 45.7 555.8 - 175.2 1,088.0
nt. Fans mps & Aux. t. Usage ac. Equip. sk Lights ea Lights tal ace Cool at Reject. frigeration	3.9 3.8 4.6 46.6 - 14.7 83.9 cion (Btu xl Jan -	3.3 3.5 42.1 - 13.3 75.5 000,000) Feb -	4.5 4.2 3.9 48.5 - 15.3 92.0 Mar	5.3 4.1 3.8 46.4 - 14.6 89.3 Apr -	6.4 4.3 2.7 48.5 - 15.3 94.6 May	7.2 4.1 2.6 46.4 - 14.6 94.5 Jun	7.9 4.1 2.7 46.6 - 14.7 99.0 Jul	8.6 4.4 50.5 - 16.0 107.8	6.4 3.7 4.2 42.5 - 13.3 87.8 <b>Sep</b>	6.1 4.3 4.4 48.5 - 15.3 95.2 Oct	4.4 3.9 4.4 44.5 - 14.0 85.4 Nov	3.7 3.8 4.6 44.6 - 14.0 83.1 <b>Dec</b> -	67.7 47.9 45.7 555.8 - 175.2 1,088.0
nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights ea Lights tal s Consumpt ace Cool at Reject. frigeration ace Heat "Supp.	3.9 3.8 4.6 14.7 83.9 cion (Btu xt Jan - - 50.16	3.3 3.5 42.1 - 13.3 75.5 000,000) Feb - - - 11.87 -	4.5 4.2 3.9 48.5 - 15.3 92.0 Mar - - -	5.3 4.1 3.8 46.4 14.6 89.3 Apr	6.4 4.3 2.7 48.5 - 15.3 94.6 <b>May</b> - - -	7.2 4.1 2.6 46.4 - 14.6 94.5 Jun - - -	7.9 4.1 2.7 46.6 - 14.7 99.0 <b>Jul</b> - - - - -	8.6 4.4 50.5 - 16.0 107.8 <b>Aug</b> - - -	6.4 3.7 4.2 42.5 - 13.3 87.8 <b>Sep</b> - - -	6.1 4.3 4.4 48.5 15.3 95.2 <b>Oct</b>	4.4 3.9 4.4 44.5 - 14.0 85.4 Nov - - 0.80	3.7 3.8 4.6 44.6 14.0 83.1 <b>Dec</b> 7.76	67.7 47.9 45.7 555.8 - 175.2 1,088.0 <b>Total</b> - - 70.59
nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights ea Lights tal s Consumpl ace Cool at Reject. frigeration ace Heat Supp. t Water	3.9 3.8 4.6 46.6 14.7 83.9 tion (Btu xt Jan - - 50.16 - 8.58	3.3 3.5 42.1 - 13.3 75.5 000,000) Feb - - - 11.87 - 8.03	4.5 4.2 3.9 48.5 - 15.3 92.0 Mar	5.3 4.1 3.8 46.4 - 14.6 89.3 <b>Apr</b> - - - 8.68	6.4 4.3 2.7 48.5 - 15.3 94.6 <b>May</b> - - - 8.44	7.2 4.1 2.6 46.4 14.6 94.5 Jun	7.9 4.1 2.7 46.6 - 14.7 99.0 <b>Jul</b> - - - - - - - - - - - - - - - - - -	8.6 4.4 50.5 - 16.0 107.8 <b>Aug</b> - -	6.4 3.7 4.2 42.5 - 13.3 87.8 <b>Sep</b> - - - - - - - - - - - - - - - - - - -	6.1 4.3 4.4 48.5 - 15.3 95.2 <b>Oct</b> - - - - 7.19	4.4 3.9 4.4 44.5 - 14.0 85.4 Nov - - 0.80 - 7.09	3.7 3.8 4.6 44.6 14.0 83.1 <b>Dec</b> 7.76 7.68	67.7 47.9 45.7 555.8 175.2 1,088.0 <b>Total</b>
nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights tal s Consumpl ace Cool at Reject. frigeration ace Heat 'Supp. t Water nt. Fans	3.9 3.8 4.6 46.6 14.7 83.9 tion (Btu x) Jan 50.16 - 8.58	3.3 3.5 42.1 - 13.3 75.5 000,000) Feb - - - 11.87 -	4.5 4.2 3.9 48.5 - 15.3 92.0 Mar - - -	5.3 4.1 3.8 46.4 14.6 89.3 <b>Apr</b> 8.68	6.4 4.3 2.7 48.5 - 15.3 94.6 <b>May</b> - - -	7.2 4.1 2.6 46.4 - 14.6 94.5 Jun - - -	7.9 4.1 2.7 46.6 - 14.7 99.0 <b>Jul</b> - - - - -	8.6 4.4 50.5 - 16.0 107.8 <b>Aug</b> - - -	6.4 3.7 4.2 42.5 - 13.3 87.8 <b>Sep</b> - - -	6.1 4.3 4.4 48.5 15.3 95.2 <b>Oct</b>	4.4 3.9 4.4 44.5 - 14.0 85.4 Nov - - 0.80	3.7 3.8 4.6 44.6 14.0 83.1 <b>Dec</b>	67.7 47.9 45.7 555.8 - 175.2 1,088.0 <b>Total</b> - - 70.59
nt. Fans mps & Aux. t. Usage acc. Equip. sk Lights tal s Consumpl ace Cool at Reject. frigeration ace Heat Supp. t Water nt. Fans mps & Aux.	3.9 3.8 4.6 46.6 - 14.7 83.9 tion (Btu xt Jan - 50.16 - - 8.58 - -	3.3 3.5 42.1 13.3 75.5 000,000) Feb	4.5 4.2 3.9 48.5 - 15.3 92.0 Mar - - - 9.25 - -	5.3 4.1 3.8 46.4 - 14.6 89.3 <b>Apr</b> - - - - 8.68 - -	6.4 4.3 2.7 48.5 - 15.3 94.6 - - - - - - - - - - - - - - - - - - -	7.2 4.1 2.6 46.4 94.5 <b>Jun</b> - - - 7.47 - -	7.9 4.1 2.7 46.6 14.7 99.0 <b>Jul</b> - - - - - - - - - - - - - - - - - - -	8.6 4.4 50.5 16.0 107.8 <b>Aug</b> - - - 7.20 - -	6.4 3.7 4.2 42.5	6.1 4.3 4.4 48.5 15.3 95.2 <b>Oct</b>	4.4 3.9 4.4 44.5 - - - - - - - - - - - - - - - - - - -	3.7 3.8 4.6 44.6 - 14.0 83.1 <b>Dec</b> - 7.76 - 7.76 - 7.68 - -	67.7 47.9 45.7 555.8 - 175.2 1,088.0 <b>Total</b> - - 70.59
nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights ea Lights tal s Consumpt scce Cool tat Reject. frigeration acce Heat > Supp. t Water int. Fans mps & Aux. t. Usage	3.9 3.8 4.6 46.6 14.7 83.9 tion (Btu x) Jan 50.16 - 8.58	3.3 3.5 42.1 - 13.3 75.5 000,000) Feb - - - 11.87 - 8.03	4.5 4.2 3.9 48.5 - 15.3 92.0 Mar - - -	5.3 4.1 3.8 46.4 14.6 89.3 <b>Apr</b> 8.68	6.4 4.3 2.7 48.5 - 15.3 94.6 <b>May</b> - - - 8.44	7.2 4.1 2.6 46.4 - 14.6 94.5 Jun - - -	7.9 4.1 2.7 46.6 - 14.7 99.0 <b>Jul</b> - - - - - - - - - - - - - - - - - -	8.6 4.4 50.5 - 16.0 107.8 <b>Aug</b> - - -	6.4 3.7 4.2 42.5 - 13.3 87.8 <b>Sep</b> - - - - - - - - - - - - - - - - - - -	6.1 4.3 4.4 48.5 - 15.3 95.2 <b>Oct</b> - - - - 7.19	4.4 3.9 4.4 44.5 - 14.0 85.4 Nov - - 0.80 - 7.09	3.7 3.8 4.6 44.6 14.0 83.1 <b>Dec</b>	67.7 47.9 45.7 555.8 - 175.2 1,088.0 <b>Total</b> - - 70.59
nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights ea Lights tal sconsumpt scc Cool sat Reject. frigeration sace Heat Supp. t Water int. Fans mps & Aux. t. Usage sc. Equip.	3.9 3.8 4.6 14.7 83.9 cion (Btu xt Jan - - 50.16 - 8.58 - - - 8.58 - - - - -	3.3 3.5 42.1 - 13.3 75.5 0000,000) Feb - - - 11.87 - 8.03 - - - - - - -	4.5 4.2 3.9 48.5 15.3 92.0 Mar - - - 9.25 - - - - - - - - - - - - - - -	5.3 4.1 3.8 46.4 - 14.6 89.3 - - - - - - - - - - - - - - - - - - -	6.4 4.3 2.7 48.5 - 15.3 94.6 - - - - - - - - - - - - - - - - - - -	7.2 4.1 2.6 46.4 14.6 94.5 <b>Jun</b>	7.9 4.1 2.7 46.6 - - 14.7 99.0 <b>Jul</b> - - - - - - - - - - - - - - - - - - -	8.6 4.4 4.4 50.5 - 16.0 107.8 - - - - - - - - - - - - - - - - - - -	6.4 3.7 4.2 42.5 13.3 87.8 <b>Sep</b> - - - - - - - - - - - - - - - - - - -	6.1 4.3 4.4 48.5 - - - - - - - - - - - - - - - - - - -	4.4 3.9 4.4 44.5 - 14.0 85.4 Nov - - 0.80 - 7.09 - - - - - - -	3.7 3.8 4.6 44.6 14.0 83.1 <b>Dec</b> 7.68 7.68	67.7 47.9 45.7 555.8 - 175.2 1,088.0 <b>Total</b> - - 70.59
nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights ea Lights tal s Consumpl ace Cool at Reject. frigeration ace Heat Supp. t Water nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights	3.9 3.8 4.6 46.6 14.7 83.9 tion (Btu xt Jan - - 50.16 - 8.58 - - - - - - - - - - - - - - - - - - -	3.3 3.5 42.1 13.3 75.5 0000,000) Feb - - - - - - - - - - - - - - - - - - -	4.5 4.2 3.9 48.5 15.3 92.0 Mar	5.3 4.1 3.8 46.4 14.6 89.3 <b>Apr</b>	6.4 4.3 2.7 48.5 - 15.3 94.6 - - - - - - - - - - - - - - - - - - -	7.2 4.1 2.6 46.4 - 14.6 94.5 Jun - - - 7.47 - - - - - - - - - - - - - - - - - - -	7.9 4.1 2.7 46.6 - 14.7 99.0 <b>Jul</b> - - - - - - - - - - - - - - - - - - -	8.6 4.4 4.4 50.5 - 16.0 107.8 - - - - - - - - - - - - - - - - - - -	6.4 3.7 4.2 42.5 13.3 87.8 <b>Sep</b>	6.1 4.3 4.4 48.5 - 15.3 95.2 Oct - - - - - - - - - - - - - - - - - - -	4.4 3.9 4.4 44.5 - 14.0 85.4 Nov - - - - - - - - - - - - - - - - - - -	3.7 3.8 4.6 44.6	67.7 47.9 45.7 555.8 - 175.2 1,088.0 <b>Total</b> - - 70.59
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nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights ea Lights tal s Consumpl sce Cool sat Reject. frigeration sece Heat 5 Supp. st Water int. Fans mps & Aux.	3.9 3.8 4.6 46.6 - 14.7 83.9 tion (Btu x) Jan - - 50.16 - - 8.58 - - - - - - - - - - - - - - - - - - -	3.3 3.5 3.5 42.1 13.3 75.5 000,000) Feb	4.5 4.2 3.9 48.5 - 15.3 92.0 Mar - - - - - - - - - - - - - - - - - - -	5.3 4.1 3.8 46.4 - 14.6 89.3 - - - - 8.68 - - - - - - - - - - - - - - - - - - -	6.4 4.3 2.7 48.5 - 15.3 94.6 - - - - - - - - - - - - - - - - - - -	7.2 4.1 2.6 46.4 14.6 94.5 <b>Jun</b>	7.9 4.1 2.7 46.6 - 14.7 99.0 <b>Jul</b> - - - - - - - - - - - - - - - - - - -	8.6 4.4 50.5 16.0 107.8 <b>Aug</b> - - - 7.20 - - - - - - - - - - - - - - - - - - -	6.4 3.7 4.2 42.5 13.3 87.8 <b>Sep</b> - - - - - - - - - - - - - - - - - - -	6.1 4.3 4.4 48.5 5.2 <b>Oct</b> - - - - - - - - - - - - - - - - - - -	4.4 3.9 4.4 44.5 14.0 85.4 Nov - - - - - - - - - - - - - - - - - - -	3.7 3.8 4.6 44.6 14.0 83.1 <b>Dec</b>	67.7 47.9 45.7 555.8 175.2 1,088.0 <b>Total</b> - - - 92.64 - - - - - -

Ei. D :14: N/ dal P 11+4 n



		no unini	ig - Pan Po	wer Ctrl	EEM					Run D	ate/Time:	04/05/07	@ 21:57	
×000)	lectric C	onsum	ption (	(kWh)	]	12.00	0,000) 70 <del>-</del>	Gas	Consu	mption	ı (Btu)	]		
_	eb Mar Apr			Sep Oct I			60		Apr May 1	Jun Jul A Water H		Oct Nov I	Dec	- Hea
	ask Lighting	9	Ext	terior Us			entilatio			Ht Pum			Refrig	
	Jan	Feb	Mar	Apr	Мау	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total	
				15.4	17.6	19.7	22.9	23.9	17.6	16.8	14.6	12.6	197.7	
ace Cool	10.7	10.1	15.7											
at Reject.	10.7	0.0	0.0	0.0	0.1	0.2	0.4	0.3	0.2	0.1	0.0	0.0	1.4	
at Reject. frigeration	2	0.0				0.2								
at Reject. frigeration ace Heat Supp.	-	0.0 - -	0.0 - - -	0.0 - -	0.1	0.2	0.4 - -	0.3 - -	0.2 - -	0.1	0.0 - -	0.0 - -	1.4	
at Reject. frigeration ace Heat Supp. t Water		0.0 - - -	0.0 - - -	0.0 - - -	0.1	0.2 - - -	0.4 - - -	0.3 - - -	0.2	0.1	0.0 - - -	0.0 - - -	1.4	
at Reject. frigeration ace Heat Supp. t Water nt. Fans	-	0.0 - -	0.0 - - -	0.0 - -	0.1	0.2 - -	0.4 - -	0.3 - -	0.2 - -	0.1	0.0 - -	0.0 - -	1.4	
at Reject. frigeration ace Heat Supp. t Water nt. Fans mps & Aux.	- - - 4.0	0.0 - - - 3.4	0.0 - - - 4.6	0.0 - - - 5.3	0.1	0.2 - - - 7.3	0.4 - - - 8.1	0.3 - - - 8.7	0.2 - - - 6.5	0.1 - - - 6.1	0.0 - - - 4.3	0.0 - - - 3.8	1.4 - - - 68.3	
at Reject. frigeration ace Heat Supp. t Water nt. Fans mps & Aux. t. Usage sc. Equip.	- - - 4.0 3.9 4.6 46.6	0.0 - - - 3.4 3.5 3.5 3.5 42.1	0.0 - - 4.6 4.3 3.9 48.5	0.0 - - 5.3 4.1	0.1 - - - 6.5 4.3	0.2 - - 7.3 4.1 2.6 46.4	0.4 - - 8.1 4.1 2.7 46.6	0.3 - - 8.7 4.5 4.4 50.5	0.2 - - 6.5 3.7	0.1 - - 6.1 4.3 4.4 48.5	0.0 - - 4.3 3.9	0.0 - - 3.8 3.8	1.4 - - - 68.3 48.5	
at Reject. frigeration ace Heat Supp. t Water nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights	- - 4.0 3.9 4.6 46.6	0.0 - - 3.4 3.5 3.5 42.1 -	0.0 - - 4.6 4.3 3.9 48.5	0.0 - - 5.3 4.1 3.8 46.4 -	0.1 - - 6.5 4.3 2.7 48.5	0.2 - - 7.3 4.1 2.6 46.4	0.4 - - 8.1 4.1 2.7 46.6	0.3 - - 8.7 4.5 4.4 50.5	0.2 - - 6.5 3.7 4.2 42.5 -	0.1 - - 6.1 4.3 4.4 48.5	0.0 - - 4.3 3.9 4.4 44.5 -	0.0 - - 3.8 3.8 4.6 44.6 -	1.4 - - 68.3 48.5 45.7 555.8	
eat Reject. frigeration lace Heat P Supp. It Water Int. Fans mps & Aux. I. Usage sc. Equip. sk Lights ea Lights	- - - 4.0 3.9 4.6 46.6	0.0 - - - 3.4 3.5 3.5 3.5 42.1	0.0 - - 4.6 4.3 3.9 48.5	0.0 - - 5.3 4.1 3.8 46.4	0.1 - - 6.5 4.3 2.7 48.5	0.2 - - 7.3 4.1 2.6 46.4	0.4 - - 8.1 4.1 2.7 46.6	0.3 - - 8.7 4.5 4.4 50.5	0.2 - - 6.5 3.7 4.2 42.5	0.1 - - 6.1 4.3 4.4 48.5	0.0 - - 4.3 3.9 4.4 44.5	0.0 - - 3.8 3.8 4.6 44.6	1.4 - - - 68.3 48.5 45.7 555.8	
at Reject. frigeration ace Heat ' Supp. t Water nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights ea Lights tal	- - 4.0 3.9 4.6 46.6 - 14.7 84.3 tion (Btu x	0.0 - - 3.4 3.5 3.5 42.1 - 13.3 75.9	0.0 - - 4.6 4.3 3.9 48.5 - 15.3 92.3	0.0 - - 5.3 4.1 3.8 46.4 - 14.6 89.7	0.1 - - 6.5 4.3 2.7 48.5 - 15.3 95.0	0.2 - - 7.3 4.1 2.6 46.4 - 14.6 94.9	0.4 - - 8.1 4.1 2.7 46.6 - 14.7 99.4	0.3 - - 8.7 4.5 4.4 50.5 - 16.0 108.3	0.2 - - 6.5 3.7 4.2 42.5 - 13.3 88.1	0.1 - - 6.1 4.3 4.4 48.5 - 15.3 95.5	0.0 - - 4.3 3.9 4.4 44.5 - 14.0 85.7	0.0 - - 3.8 3.8 4.6 44.6 - 14.0 83.5	1.4 - - 68.3 48.5 45.7 555.8 - 175.2 1,092.6	
eat Reject. frigeration leace Heat > Supp. It Water Int. Fans mps & Aux. t. Usage sc. Equip. sk Lights ea Lights tal s Consump	- - 4.0 3.9 4.6 46.6 - 14.7 84.3	0.0 - - 3.4 3.5 3.5 42.1 - 13.3 75.9	0.0 - - 4.6 4.3 3.9 48.5 - 15.3 92.3	0.0 - - 5.3 4.1 3.8 46.4 - 14.6	0.1 - - 6.5 4.3 2.7 48.5 - 15.3	0.2 - - 7.3 4.1 2.6 46.4 - 14.6	0.4 - - 8.1 4.1 2.7 46.6 - 14.7	0.3 - - 8.7 4.5 4.4 50.5 - 16.0	0.2 - - - - - - - - - - - - - - - - - - -	0.1 - - 6.1 4.3 4.4 48.5 - 15.3	0.0 - - 4.3 3.9 4.4 44.5 - 14.0	0.0 - - 3.8 3.8 4.6 44.6 - 14.0	1.4 - - 68.3 48.5 45.7 555.8 - 175.2	
at Reject. frigeration ace Heat 5 Supp. t Water nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights ea Lights tal s Consump ace Cool at Reject.	- - 4.0 3.9 4.6 46.6 - 14.7 84.3 tion (Btu xi Jan	0.0 - - 3.4 3.5 3.5 42.1 - 13.3 75.9 000,000) Feb	0.0 - - 4.6 4.3 3.9 48.5 - 15.3 92.3 ) Mar	0.0 - - 5.3 4.1 3.8 46.4 - 14.6 89.7	0.1 - - 6.5 4.3 2.7 48.5 - 15.3 95.0	0.2 - - 7.3 4.1 2.6 46.4 - 14.6 94.9 Jun	0.4 - - 8.1 4.1 2.7 46.6 - 14.7 99.4 Jul	0.3 - - 8.7 4.5 4.4 50.5 - 16.0 108.3	0.2 - - - - - - - - - - - - - - - - - - -	0.1 - - - - - - - - - - - - - - - - - - -	0.0 - - 4.3 3.9 4.4 44.5 - 14.0 85.7 Nov	0.0 - - 3.8 3.8 4.6 44.6 - 14.0 83.5 Dec	1.4 - - 68.3 48.5 45.7 555.8 - 175.2 1,092.6	
at Reject. frigeration ace Heat Supp. t Water nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights sk Lights tal s Consump ace Cool at Reject. frigeration	- - - 4.0 3.9 4.6 46.6 - 14.7 84.3 tion (Btu xi Jan - -	0.0 - - 3.4 3.5 3.5 42.1 - 13.3 75.9 000,000) Feb - - -	0.0 - - 4.6 4.3 3.9 48.5 - 15.3 92.3 ) Mar	0.0 - - 5.3 4.1 3.8 46.4 - 14.6 89.7	0.1 - - 6.5 4.3 2.7 48.5 - 15.3 95.0	0.2 - - 7.3 4.1 2.6 46.4 - 14.6 94.9 Jun	0.4 - - 8.1 4.1 2.7 46.6 - 14.7 99.4 Jul	0.3 - - 8.7 4.5 4.4 50.5 - 16.0 108.3	0.2 - - - - - - - - - - - - - - - - - - -	0.1 - - - - - - - - - - - - - - - - - - -	0.0 - - 4.3 3.9 4.4 44.5 - 14.0 85.7 Nov	0.0 - - 3.8 3.8 4.6 44.6 - 14.0 83.5 <b>Dec</b> - -	1.4 - - - - - - - - - - - - - - - - - - -	
at Reject. frigeration ace Heat Supp. t Water nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights ac Lights tal s Consump ace Cool at Reject. frigeration ace Heat	- - 4.0 3.9 4.6 46.6 - 14.7 84.3 tion (Btu x) Jan - -	0.0 - - 3.4 3.5 3.5 42.1 - 13.3 75.9 0000,000) Feb - -	0.0 - - 4.6 4.3 3.9 48.5 - 15.3 92.3 ) Mar - -	0.0 - - 5.3 4.1 3.8 46.4 - 14.6 89.7	0.1 - - 6.5 4.3 2.7 48.5 - 15.3 95.0	0.2 - - 7.3 4.1 2.6 46.4 - 14.6 94.9 Jun -	0.4 - - - 8.1 4.1 2.7 46.6 - - 14.7 99.4 Jul - -	0.3 - - 8.7 4.5 4.4 50.5 - 16.0 108.3 <b>Aug</b> - -	0.2 - - - - - - - - - - - - - - - - - - -	0.1 - - 6.1 4.3 4.4 48.5 - 15.3 95.5 Oct	0.0 - - 4.3 3.9 4.4 44.5 - 14.0 85.7 Nov -	0.0 - - 3.8 3.8 4.6 44.6 - 14.0 83.5 Dec	1.4 - - - - - - - - - - - - - - - - - - -	
at Reject. frigeration ace Heat Supp. t Water nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights tal s Consump ace Cool at Reject. frigeration ace Heat Supp.	- - - 4.0 3.9 4.6 46.6 - 14.7 84.3 tion (Btu xi Jan - -	0.0 - - 3.4 3.5 3.5 42.1 - 13.3 75.9 000,000) Feb - - -	0.0 - - 4.6 4.3 3.9 48.5 - 15.3 92.3 ) Mar - -	0.0 - - 5.3 4.1 3.8 46.4 - 14.6 89.7	0.1 - - 6.5 4.3 2.7 48.5 - 15.3 95.0	0.2 - - - - - - - - - - - - - - - - - - -	0.4 - - - 8.1 4.1 2.7 46.6 - 14.7 99.4 Jul - - - -	0.3 - - 8.7 4.5 4.4 50.5 - 16.0 108.3 <b>Aug</b> - - -	0.2 - - - - - - - - - - - - - - - - - - -	0.1 - - 6.1 4.3 4.4 48.5 - 15.3 95.5 Oct	0.0 - - 4.3 3.9 4.4 44.5 - 14.0 85.7 Nov	0.0 - - 3.8 3.8 4.6 44.6 - 14.0 83.5 <b>Dec</b> - -	1.4 - - - - - - - - - - - - - - - - - - -	
at Reject. frigeration ace Heat Supp. t Water nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights tal s Consump ace Cool at Reject. frigeration ace Heat Supp. t Water nt. Fans	- - 4.0 3.9 4.6 46.6 - 14.7 84.3 tion (Btu xt Jan - - - 54.03	0.0 - - 3.4 3.5 42.1 - 13.3 75.9 000,000 Feb - - - - - - - - - - - - - - - - - - -	0.0 - - 4.6 4.3 3.9 48.5 - 15.3 92.3 92.3 Mar - - - - -	0.0 - - 5.3 4.1 3.8 46.4 - 14.6 89.7 <b>Apr</b> - - - - - -	0.1 - - - - - - - - - - - - - - - - - - -	0.2 - - 7.3 4.1 2.6 46.4 - 14.6 94.9 <b>Jun</b> - -	0.4 - - - 8.1 4.1 2.7 46.6 - - 14.7 99.4 Jul - - - -	0.3 - - 8.7 4.5 4.4 50.5 - 16.0 108.3 <b>Aug</b> - - -	0.2 - - - - - - - - - - - - - - - - - -	0.1 - - 6.1 4.3 4.4 48.5 - 15.3 95.5 <b>Oct</b> - - - -	0.0 - - 4.3 3.9 4.4 44.5 - 14.0 85.7 <b>Nov</b> - - - - - - - - - - - - - - - - - - -	0.0 - - 3.8 3.8 4.6 44.6 - 14.0 83.5 <b>Dec</b> - - - - - - - - - - - - - - - - - - -	1.4 - - - - - - - - - - - - - - - - - - -	
at Reject. frigeration ace Heat 5 Supp. t Water nt. Fans mps & Aux. t. Usage sc. Equip. sk Lights ace Lights stal s Consump ace Cool at Reject. frigeration ace Heat 5 Supp. t Water nt. Fans mps & Aux.	- - 4.0 3.9 4.6 46.6 - 14.7 84.3 tion (Btu x) Jan - 54.03 - 54.03 - - 54.03 - - - - - - - - - - - - - - - - - - -	0.0 - - 3.4 3.5 3.5 42.1 - 13.3 75.9 000,000) Feb - - - 15.05 - 8.03 - - -	0.0 - - 4.6 4.3 3.9 48.5 - 15.3 92.3 ) Mar - - - - - - - - - - - - - - - - - - -	0.0 - - 5.3 4.1 3.8 46.4 - 14.6 89.7 <b>Apr</b> - - - - - 8.68 - - - - - - - - - - - - - - -	0.1 - - - - - - - - - - - - - - - - - - -	0.2 - - - - - - - - - - - - - - - - - - -	0.4 - - 8.1 2.7 46.6 - 14.7 99.4 <b>Jul</b> - - - - - - - - - - - - - - - - - - -	0.3 - - - - - - - - - - - - - - - - - - -	0.2 - - - - - - - - - - - - - - - - - - -	0.1 - - - - - - - - - - - - - - - - - - -	0.0 - - 4.3 3.9 4.4 44.5 - 14.0 85.7 Nov - - - 0.89 - 7.09 - - -	0.0 - - 3.8 3.8 4.6 44.6 - 14.0 83.5 <b>Dec</b> - - - 9.89 - - 7.69 - - - -	1.4 - - - - - - - - - - - - - - - - - - -	
eat Reject. frigeration leace Heat > Supp. It Water Int. Fans mps & Aux. t. Usage sk Lights ea Lights ea Lights it al s Consump leace Cool leat Reject. frigeration leace Heat > Supp. It Water Int. Fans mps & Aux. t. Usage	- - 4.0 3.9 4.6 46.6 - 14.7 84.3 tion (Btu x) - - - - - - - - - - - - - - - - - - -	0.0 - - 3.4 3.5 42.1 - 13.3 75.9 000,000) Feb - - - - - - - - - - - - - - - - - - -	0.0 - - 4.6 4.3 3.9 48.5 - 15.3 92.3 92.3 <b>Mar</b> - - - - - - - - - - - - - - - - - - -	0.0 - - 5.3 4.1 3.8 46.4 - 14.6 89.7 <b>Apr</b> - - - - - - - - - - - - - - - - - - -	0.1 - - - - - - - - - - - - - - - - - - -	0.2 - - - 7.3 4.1 2.6 46.4 - - 46.4 - - - - - - - - - - - - - - - - - - -	0.4 - - 8.1 4.1 2.7 46.6 - 14.7 99.4 <b>Jul</b> - - - - - - - - - - - - - - - - - - -	0.3 - - 8.7 4.5 50.5 - 16.0 108.3 <b>Aug</b> - - - - - - - - - - - - - - - - - - -	0.2 - - - - - - - - - - - - - - - - - - -	0.1 - - - - - - - - - - - - - - - - - - -	0.0 - - 4.3 3.9 4.4 44.5 - 14.0 85.7 Nov - - - - - - - - - - - - - - - - - - -	0.0 - - - 3.8 3.8 4.6 44.6 44.6 44.6 - - - - - - - - - - - - - - - - - - -	1.4 - - - - - - - - - - - - - - - - - - -	
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eat Reject. frigeration bace Heat > Supp. bt Water ent. Fans imps & Aux. t. Usage c. Equip. isk Lights ea Lights btal es Consump bace Cool eat Reject. ifrigeration bace Heat > Supp. bt Water ent. Fans imps & Aux. t. Usage	- - 4.0 3.9 4.6 46.6 - 14.7 84.3 tion (Btu xi Jan - - 54.03 - 8.58 - - - - - - - - - - - - - - - - - - -	0.0 - - 3.4 3.5 42.1 - 13.3 75.9 000,000) Feb - - - - - - - - - - - - - - - - - - -	0.0 - - 4.6 4.3 3.9 48.5 - 15.3 92.3 92.3 <b>Mar</b> - - - - - - - - - - - - -	0.0 - - 5.3 4.1 3.8 46.4 - 14.6 89.7 <b>Apr</b> - - - - - - 8.68 - - - - - - - -	0.1 - - - - - - - - - - - - - - - - - - -	0.2 - - - - - - - - - - - - - - - - - - -	0.4 - - - 8.1 4.1 2.7 46.6 - - 14.7 99.4 <b>Jul</b> - - - - - - - - - - - - - - - - - -	0.3 - - 8.7 4.5 50.5 - 16.0 108.3 - - - - - - - - - - - - - - - - - - -	0.2 - - - - - - - - - - - - - - - - - - -	0.1 - - - - - - - - - - - - - - - - - - -	0.0 - - 4.3 3.9 4.4 4.4 5.7 14.0 85.7 Nov - - - - - - - - - - - - - - - - - - -	0.0 - - 3.8 3.8 4.6 44.6 44.6 - 14.0 83.5 <b>Dec</b> - - - 9.89 - 9.89 - 7.69 - - - - -	1.4 - - - - - - - - - - - - - - - - - - -	

#### 69. Studiabt Additio Model D aulte Ei.



#### Comparison

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	Table 2	8							
HVAC	Load Comparison of	Additional Skylights							
HVAC Equipment Lighting Equipment									
	Electrical	Electrical	Gas						
	Consumption/yr	Consumption/yr	Consumption/yr						
	(kWh)	(kWh)	(Btu)						
Original Design	912,800	175,200	163,230,000						
Skylight Addition	917,400	175,200	172,510,000						
Difference	4,600	0	9,280,000						
Btu to kWh Conversion	-	-	2,719.70						
True Load in kWh	4,600.00	0.00	2,719.70						
Cost at \$0.10/kWh	\$460.00	\$0.00	\$271.97						

#### Conclusion

In the analysis it shows that adding in the 8 skylights will add an extra \$731.97 a year to the energy cost of the building. Strictly on cost, the daylight integration with the skylights and dimmed lighting have a conservative energy savings of \$680.00 but probably higher (See SPOT analysis Figure 43). The two costs are fairly similar for the most part, but having daylight integration within an office atmosphere has shown to enhance productivity among employees. Employee comfort should be a main priority and having daylight in a space helps to achieve that. Also, with the west wall oriented like it is, there is a good chance the manual blinds will be pulled down most afternoons so having the skylights in the middle of the space can still provide a good daylight solution. When the blinds are closed the lights still can be dimmed providing enough light is coming through the skylights. Even though it might be a larger upfront cost to install the skylights and dimming ballasts, the system almost balances itself out annually and employee comfort is enhanced so I would recommend using this skylight design and daylight integration within the open office space.

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## **Construction Management Breadth**

#### Skylight Integration with Building Systems

#### Background

The skylights that I have added into the open office area take up a lot of space in the ceiling grid. Coordination of the structural, architectural, and MEP systems needs to be coordinated together to make sure they do not conflict with each other.

#### Structural

The skylights need to be fit in-between the roof trusses and be framed in to properly install each skylight. The rough-in frame should extend to the ceiling grid which includes the splayed well too. Without having this area framed out, the chance of adding MEP equipment in these skylight spaces is higher.

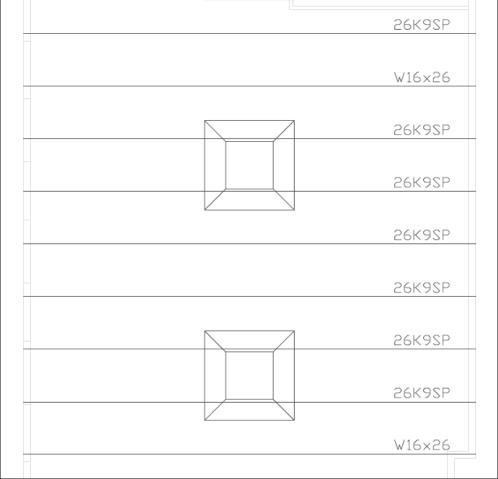


Figure 69: Skylight Integration between Roof Trusses

#### Mechanical

Mechanical ducts pose a problem for the skylight design. The main branch duct was running right through the skylight design. I moved it 6' further into the office area so it wouldn't interfere with the skylights. The little amount that it moved should not affect the mechanical design at all. Below in Figure 69 is the new mechanical duct plan.

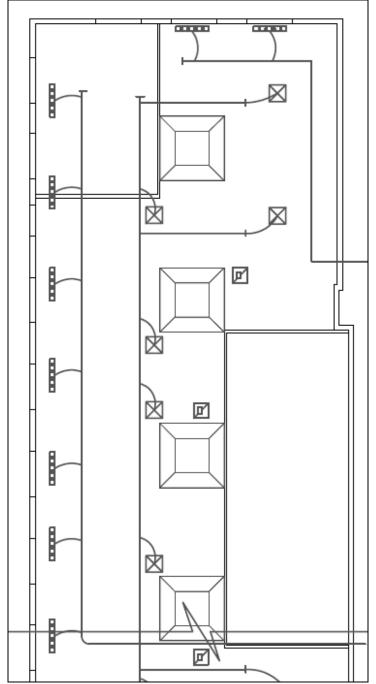
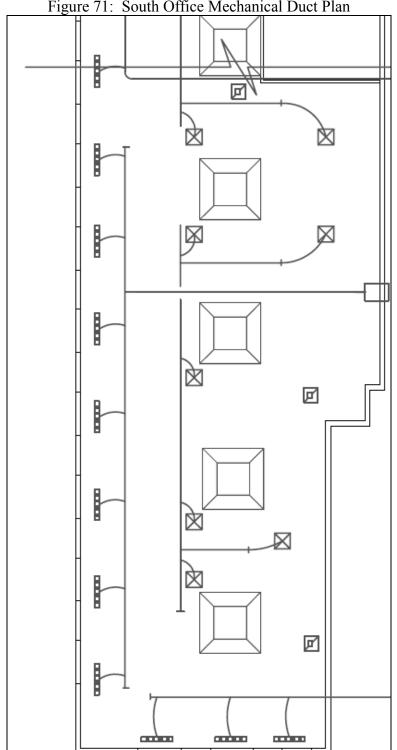
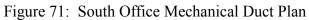


Figure 70: North Office Mechanical Duct Plan









#### Plumbing

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The sprinkler system is only in select areas of the NNSOC. The open office area is a space that does not have fire suppression, just audio and visual alarms. Therefore no coordination needs to take place for plumbing.

#### *Telecommunication*

All telecommunication wiring goes through the cubicle furniture to the hallway where it is routed above the acoustical tile ceiling. No need for coordination with the skylights.

#### Conclusion

The addition of skylights to the office space has minimal effect on the other systems in the building. The mechanical coordination had the largest impact but could be changed rather quickly with a simple move of the main branch duct in the space. Designing the skylight to fit between trusses also simplified the structural design of the roof system allowing for a quick integration of the overall skylight system into the office area. Chris Ankeny NNSOC Dahlgren, VA

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### Conclusions

The Naval Network Space & Operations Command redesign was a success. The goals I set forth for the lighting and electrical redesign I feel were met. For lighting, the daylight integration seemed to make the office space more comfortable for the employees while limiting the increase in cost. All the lighting spaces seemed to fit within the architecture of a Naval Office, yet still be aesthetically pleasing and successful in lowering the power density in all redesigned spaces.

The NNSOC relies heavily on a reliable emergency power system for their critical loads that must have continuous power. The alternate design of the rotary UPS system instead of the static UPS system concluded that the rotary system would save more money in a 10 year life cycle analysis. The rotary system is also safer for the environment with the lack of lead acid batteries the need for air conditioning to them. From my results I would recommend using the rotary UPS system over a static UPS system.

The Photovoltaic analysis had shown that at this point in time adding a PV array to the building for solar power is not a viable solution for energy production. The good news is there is starting to be a push toward PV energy production from consumers and the price for a system like this may go down. State and federal incentives and tax credits are also developing to help with costs around the country so PV energy production may be worth while in the coming years. This analysis would provide a good start to a future installation of photovoltaic panels on this building.

In this thesis project, I was able to create an efficient lighting design while maintaining the look of a naval facility. The emergency power alternative solution was a success and can show a rotary system can be just as reliable as a static system, with cheaper cost and maintenance in the lifetime of the equipment. Overall, the entire project should provide some good ideas for future alternative designs of lighting and electrical systems for buildings. Chris Ankeny NNSOC Dahlgren, VA

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## Acknowledgments

Where to begin with this list of people who have helped me? So many people have been kind, patient and most importantly helpful throughout this entire year. Starting off with my family because without them I would never have gotten through school, and my brother who has supported me in everything I've done.

The employees at Kling in Washington D.C. who helped find a great building to use for my thesis and provided me with countless amounts of information as well as the drawing sets and specs. Special thanks needs to go to John Turner, Michael Kang, Ray Doyle and Diane Evans for their helping hands last summer and this year.

Brian Guthrie at the NAVFAC Washington for his prompt email responses regarding on site information as well as getting the owner's permission form signed and turned in.

The entire A/E Facility with special thanks to Dr. Mistrick for his teaching throughout the years and Ted Dannerth for the electrical help with my system design and understanding of the material.

Finally, thanks to all my friends and AE classmates. We have had some great times and school would have been impossible to complete without them. Special thanks to the lighting option and my roommates.



## References

#### General

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A/E firm Kling for providing the drawings, Specs, RFP report and Proposal

Advisor – Dr. Mistrick

Electrical Consultant – Mr. Ted Dannerth

#### Lighting

IESNA Handbook 9th Addition

ASHRAE 90.1

#### Electrical

National Electric Code 2005

Renmark - Renaissance Electrical Marketing, Inc.

Caterpillar

MGE UPS Systems

U.S. Department of Energy, Energy Efficiency and Renewable Energy www.eere.energy.gov/femp/

## **Appendix A**

*Luminaire, Ballast, LLF Schedules

*Luminaire Cutsheets

*Ballast Cutsheets

*Lamp Cutsheets

*Daylight Analysis

- Skycalc Inputs
- SPOT Inputs

*Lighting Equipment Cutsheets

C=CEILING: P=PENDANT: R=RECESSED: 8	S=SURFACE: T=TRACK: W=WALI LUMINAIRE SC	HEDU	CONCRETE BASE ULE Lamping	Volts	Watts	Ballast	Location	Notes
"GREENLEE" HYPR 70CMH/T6 MT OptX BLK DT H42 PCH	', 360 SH x S.		(1) CMH70TU/942/G12	277	77	B1	OUTDOOR	
"LITHONIA" KSF1 150M R3 277 RP04 SF DBL LP1	ONE(1) POLE MOUNT HID SHOEBOX LUMINAIRE, NOMINAL 21.25" x 7.25" DEPTH, ANODIZED, SEGMENTED TYPE III OPTICS, SEAM WELDED ALUMINUM HOUSING, FINISHED DARK BRONZE, FLAT TEMPERED GLASS LENS, HORIZONTAL LAMP ORIENTATION, MOUNT UNDERSIDE OF LUMINAIRE AT 30' A.F.G.	CB (1	(1) MVR150/U/WM	277	173	B2	PARKING LOT	SAME AS ORIGINALLY DESIGNED
"LITHONIA" KSF1 150M R3 277 RP04 SF DBL LPI	SIMILAR TO TYPE "F2" EXCEPT MOUNT UNDERSIDE OF LUMINAIRE AT 20' A.F.G.	CB (1	(1) MVR150/U/WM	277	173	B2	PARKING LOT	SAME AS ORIGINALLY DESIGNED
"LITHONIA" KSF1 150M R3 277 RP04 SF DBL LPI	SIMILAR TO TYPE "F2" EXCEPT WITH TWO SHOEBOX LUMINAIRES OPPOSED 180 DEGREES FROM EACH OTHER.	CB (1	(1) MVR150/U/WM	277	346	B2	PARKING LOT	SAME AS ORIGINALLY DESIGNED
"EXTERIEUR VERT" M2 RMA 7	RECESSED PROJECTOR, TYPE VI, FIXED REFLECTOR LUMINAIRE, NOMINAL 19" x 3.6". DRIVE OVER RATED, WATERPROOF.	я <u>г р</u>	(1) FM 11W/760 W4,3 UNV1	277	11	INTEGRAL	INTEGRAL OUTDOOR	
'ERCO" TC-TEL 18W GX24q-2	CAST ALUMINUM, SILVER POWDER-COATED TYPE V DOWNLIGHT, NOMINAL 8" DIAMETER x 9" DEPTH. CUT-OFF ANGLE 30 DEGREES. WATER-JET PROOF.	R (1	(1) F18TBX/SPX41/A/4	277	19.5	B3	оитроок	
"ERCO" HIT-CE 35W G12	CORROSION-RESISTANT CAST ALUMINUM TYPE V BEAMER II PROJECTOR, NOMINAL 12" HIGH x 6.25" DIAMETER. 130 DEGREE TILT, MOUNTING PLATE FOR METAL HALIDE LAMPS. CUT-OFF ANGLE 50 DEGREES. WATER-JET PROOF.	S CI 2	(1) CMH35/T/UVC/U/830/G1 2	277	35	ON	OUTDOOR	
"LEDALITE" 280 8 T01 E N 04 7 2 E W	DIE-FORMED 24 GAUGE METAL PAINTED WHITE COVE LUMINAIRE. NOMINAL 6" × 48" × 1.5" DEPTH, TYPE VI ASYMMETRIC DISTRIBUTION.	s (1	(1) F32T8XLSPX41HLEC	277	35	B4	THEATER	
"ERCO" TC-TEL 32W GX24q-3 ECG 1-10V	CAST ALUMINUM DOWNLIGHT, WHITE POWDER COATED TYPE V SYMMETRIC DISTRIBUTION. NOMINAL 8" DIAMETER x 7" DEPTH	R (1	(1) F32TBX/841/A/ECO	277	37.5	B5	ТНЕАТЕR, LOBBY	
"CELESTIAL LIGHTING" LF5000 RO W 4	"   DELINEATED STAIRNOSE LED LUMINAIRE, LOW VOLTAGE, COMPLIES WITH NFPA'S LIFE SAFETY CODE (0.2 FC) WHEN INSTALLED AS RECOMMENDED.	<u>ר צ</u> א	INCLUDED IN LUMINAIRE	9.5V DC	0.2	TRANSFOR THEATER MER	THEATER	
"CELESTIAL LIGHTING" LF2000 S W 12		s S	INCLUDED IN LUMINAIRE	9.5V DC	0.2	TRANSFOR THEATER MER	THEATER	
"DELRAYLIGHTING" 6320.2.BLC.57	KONE PENDANT CYLINDER WITH DOWNLIGHT COMPONENT, EXTRUDED ALUMINUM CENTER TUBE IS LAMP HOLDER AND ELECTRONIC BALLAST. TYPE V SYMMETRIC DISTRIBUTION, TOP AND BOTTOM CYLINDER IS 1/4" THICK WITH ALUMINUM COVER PLATES WITH SILVER POWDER COAT FINISH.	P (3) F3(	(3) F32T8SP30ISWMECO (1) CMH39UPAR20FL25	277	155	B6,B7	ГОВВУ	

BY	BY	ICE	E CE	OFFICE	ATER
B8 LOBBY	в9 совву	B10 OFFICE	INTEGRAL OFFICE	B9 OFF	TRANSFOR THEATER MER
54	26	62.5	27	26	100
277	277	277	120	277	12V
W (3) F17T8XL/SPX41ECO	(1) F21W/T5/841/ECO	(1) F54W/T5/841/ECO	(1) F21W/T5/841/ECO	(1) F21W/T5/841/ECO	(1) Q100T3/12V/CL
M	S	Ч	S	S	к
KONE PENDANT CYLINDER, EXTRUDED ALUMINUM CENTER TUBE IS LAMP HOLDER AND ELECTRONIC BALLAST. TYPE V SYMMETRIC DISTRIBUTION, TOP AND BOTTOM CYLINDER IS 1/4" THICK WITH ALUMINUM COVER PLATES WITH SILVER POWDER COAT FINISH. SPECIAL WALL MOUNT ADAPTER.	LINEAR DIRECT FLUORESCENT LOW-PROFILE FIXTURE. NOMINAL 2"x2"x22.5". HIGH GLOSS, BAKED WHITE ENAMEL FINISH. TYPE IV SYMMETRIC DISTRIBUTION.	"FINELITE" INDIRECT SUSPENDED LINEAR FLUORESCENT, DOUBLE S15-32'-115-SC-277-FA DIFFUSER OPTICAL DESIGN, 96% REFLECTIVE WHITE PAINT. NOMINAL 3.5"x12"x48". CAN BE CONNECTED IN SECTIONS. TYPE 6 SYMMETRICAL DISTRIBUTION.	WORKSTATION LUMINAIRE FOR INSTALLATION ON OPEN OFFICE FURNITURE PANELS. DESIGNED TO PROVIDE LOW- GLARE TASK LIGHTING FOR HORIZONTAL SURFACES. NOMINAL 6"x2.5"x36". TYPE IV ASYMMETRICAL DISTRIBUTION. PLUG IN CONNECTION TO RECEPTACLE OUTLET.	SURFACE MOUNTED WALLWASH, ASYMMETRICAL DISTRIBUTION, TYPE IV FIXTURE. NOMINAL 5"x2.5"x36". MATTE WHITE FINISH WITH DECORATIVE ENDPLATES. CAN BE CONNECTED IN SECTIONS.	LOW VOLTAGE, RECESSED DIRECTIONAL SPOTLIGHT. BLACK POWDER-COATED, 0-40 DEGREE TILT. NOMINAL 7" DIAMETER × 6" DEPTH, TYPE V SYMMETRIC DISTRIBUTION.
"DELRAYLIGHTING" 6331.2.BLA.33	"LITHONIA" MS5 1 21T5 GEB10PS	"FINELITE" 815-32'-1T5-SC-277-FA	"TAMBIENT" STYLE P201	"ELLIPTIPAR" F144-T121-S-22-2-000	"ERCO" QT12-AX 100W 12V GYG.35
F11	F12	F13	F14	F15	F16

		BALLAST SC	HEDULE				
Туре	Luminaire	Description	BF	Input Watt	PF	THD	#Lamps
B1	F1	GE HID ULTRAMAX GEMH70-SLJ-MV	1.00	77	0.97	0.10	1
B2	F2, F2A, F2B	ADVANCE 150W M102 60HZ R-HPF	0.99	173	0.90	0.10	1
B3	F4	ADVANCE CFM18W/GX24q	1.05	39	0.99	0.10	2
B4	F6	ADVANCE MARK 7 0-10V F32T8 VZT-4S32-4	0.05/0.88	25/116	0.99	0.10	4
B5	F7	ADVANCE MARK 7 0-10V CFM32W/GX24Q	0.05/1.00	19/75	0.98	0.10	2
B6	F10	ADVANCE MARK 10 POWERLINE VEZ- 3S32-SC	0.05/1.00	20/102	0.99	0.10	3
B7	F10	ADVANCE 39W M130 60HZ HX-HPF	0.99	53	0.90	0.10	1
B8	F11	ADVANCE MARK 7 0-10V F17T8 IZT-3S32-SC	0.03/1.00	16/54	0.99	0.10	3
B9	F12,F15	ADVANCE CENTIUM ICN-2S28	1.03	26	0.95	0.15	1
B10	F13	ADVANCE ROVR IDA-2S54	0.03/1.00	24/125	0.98	0.10	2

			LIGHT LOSS F.	ACTORS			
TYPE	BF	CLEANING	MAINTENANCE	LLD	LDD	RSDD	LLF
F1	1.00	12 Month	V	0.77	0.87	-	0.67
F2	0.99	12 Month	V	0.75	0.87	-	0.65
F2A	0.99	12 Month	V	0.75	0.87	-	0.65
F2B	0.99	12 Month	V	0.75	0.87	-	0.65
F3	1.00	12 Month	VI	0.92	0.85	-	0.78
F4	1.05	12 Month	V	0.85	0.87	0.97	0.75
F5	1.00	12 Month	V	0.80	0.87	-	0.70
F6	0.88	12 Month	VI	0.94	0.85	0.85	0.60
F7	1.00	12 Month	V	0.84	0.87	0.97	0.71
F8	1.00	12 Month	V	0.90	0.87	0.94	0.74
F9	1.00	12 Month	V	0.90	0.87	0.94	0.74
F10	0.99	12 Month	V	0.90	0.87	0.92	0.71
F11	1.00	12 Month	V	0.95	0.87	0.92	0.76
F12	1.03	12 Month	II	0.92	0.94	0.97	0.86
F13	1.00	12 Month	VI	0.92	0.85	0.93	0.73
F14	1.00	12 Month	III	0.92	0.90	0.97	0.80
F15	1.03	12 Month	III	0.92	0.90	0.97	0.83
F16	1.00	12 Month	V	0.85	0.87	0.97	0.72

Assuming a 12 month cleaning cycle within a clean environment. rcr=(2.5 x cavity height x cavity perimeter)/area of cavity base

	Area of Base	Cavity Height (ft)	Cavity Perimeter (ft)	RCR
Theater	3000	11	240	2.2
Lobby	1600	35	200	10.9
Office	6000	10	465	1.9

## **GREENLEE HYPERION SERIES**

F1 Luminaire

LAMP TYPE: Standard or Ceramic Metal Halide

HOUSING: One-piece, heavy-walled, extruded aluminum, .322" thick for vandal resistance.

- **CROWN ASSEMBLY:** Flat or domed, heavy cast aluminum. For added security against vandals, crown attaches to lower housing with four captive, concealed 1/4" x 20 Allenhead screws.
- **LENS:** One-piece, heavy-walled borosilicate lens is recessed .764" and protected by three cast ribs for vandal resistance. Exposed portion of the lens is only .671" tall.
- **OPTICS:** Patented OptX[™] optical assembly uses Constructive OcclusionTM technology. A precisely positioned clear lamp in a Cavity and FanTM assembly projects radiant energy into selective zones. Proprietary coating on the cavity is 96% reflective.
- **BALLAST**: High Power Factor, multi-tap ballast designed for -20°F operation is standard. Universal electronic ballast for 120-277V, 50 or 60 HZ operation is available.
- LAMPHOLDER: Matched to lamp. Glazed porcelain, medium base, 4KV pulse rated with spring center contact.
- **ANCHOR BOLTS:** Anchor bolts are 3/8" x 10" heavy-duty galvanized steel. Four (4) are furnished.

FINISH: Available in metallic silver, satin verde green, black, bronze, white, and buff.

#### EXTRA VALUE FEATURES:

- Unique OptXTM optical assembly
- Tailored, uniform distribution over greater distances.
- · Increased spacing between luminaires
- Vandal Resistant Aperture
- Heavy Duty Construction
- Premium Materials

Bollards are subjected to extreme environments – from severe weather to pedestrian wear-and-tear, and senseless vandalism. The Hyperion Bollard Series was designed with this harsh reality in mind, and that's why its materials are of the highest quality, ruggedly durable, and feature superior vandal resistant construction.

OPTICS – OptX optics are the heart of this luminaire. A clear lamp is precisely positioned in a highly engineered, and patented, Cavity and Fan assembly that functions like an integrating sphere. Known as Constructive Occlusion technology, this sphere uses a proprietary internal coating that realizes 96% reflectance. The lamp's radiant energy is distributed by this finely tuned, reflective surface to desired zones.
 VANDAL RESISTANT APERTURE – Hyperion features the narrowest aperture of any

bollard on the market, a mere 1.167" wide, which gives the luminaire a sleek and elegant appearance while minimizing the target area available to vandals.

**VANDAL RESISTANT LENS** – The one-piece, heavy-walled borosilicate lens is recessed a full .764" and protected by three cast ribs. The exposed portion of the lens is only .671" tall. These design features and premium materials provide superior vandal resistance.

**LAMPS** – Standard and Ceramic Metal Halide

**HEAVY-WALL HOUSING** – One-piece, heavy-wall extruded aluminum, .322" thick for vandal resistance.

**CROWN** – Flat or domed heavy-wall cast aluminum. One-piece castings provide for greater impact strength.

**CONCEALED ACCESS** – Added security against vandals, crown attaches to lower housing with four captive, concealed 1/4" x 20 Allen-head screws.

- **3** SEALING AND GASKETS Silicone gaskets and seals ensure Hyperion is as dependable as it is rugged.
- **BALLASTS** Standard ballast is high power factor, designed for -20° operation. Universal electronic ballast available.

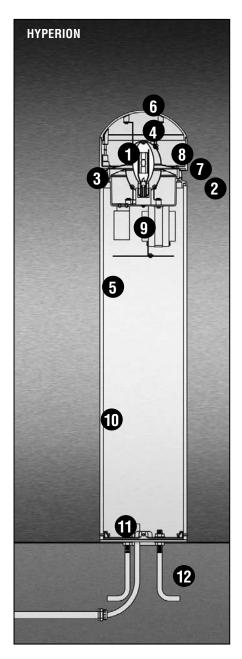
**FINISHES** – Metallic Silver, Satin Verde Green, Black, Bronze, White or Platinum Plus polyester powder coating.

**MOUNTING BASE** – Extra thick, 1/2" cast aluminum (cromate converted and powder coat finished in black standard).

**ANCHOR BOLTS**  $- 3/8^{\circ}$  x 10" heavy-duty galvanized steel; four (4) furnished.







Greenlee Lighting™

5

6

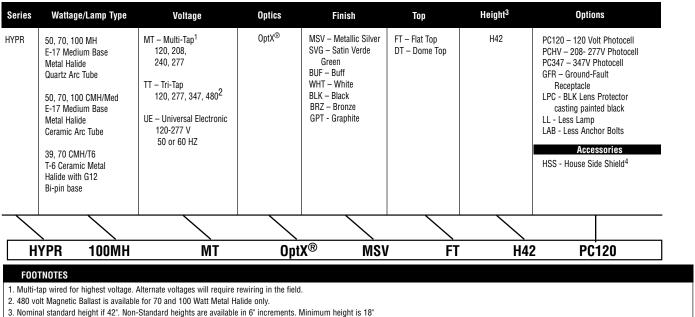
Project Name_

Catalog #

____ Fixture Type ____

 $\ensuremath{\textcircled{}^{\odot}}$  2006 LSI INDUSTRIES INC.

## **GREENLEE HYPERION SERIES**

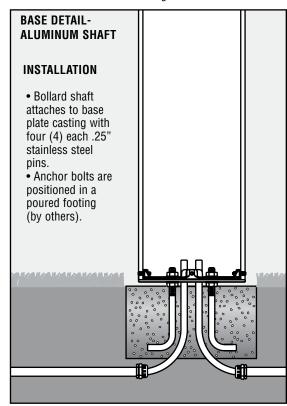


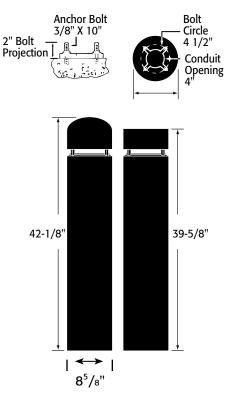
4. House Side Shield provides 1800 shielding. Maximum fixture rating with HSS is 70 watts. HSS is NOT available for 100 watt fixtures.

#### **HYPERION BOLLARDS**

#### DIMENSIONS

All Hyperion Bollards are shipped with lamps installed and 38" leads to facilitate wiring.





#### FINISHES

Each Hyperion Bollard has a tough polyester powder coat finish, which is guaranteed for two years and is available in six standard colors: metallic silver, satin verde green, black, bronze, white, graphite, and buff.



Greenlee Lighting™

Project Name

Catalog #

___ Fixture Type _____

© 2006 LSI INDUSTRIES INC.



#### Projector body

- Drive over rated

- Waterproof IP67
- Available in anodized black cast aluminum.
- Integral electronic ballast.
- 3.5 Metric tons / 7600 Lbs.

#### Lamp / Optics

- Fluorescent lamp T2 11W /120/277V
- Lamp holder W4,3 .
- Choice of 3 fixed reflectors:
- Symetrical Spot reflector
- Symetrical Flood reflector
- Asymetrical reflector

#### Trim

- Black anodised cast aluminium.
- Heat treated glass.
- 8 stainless steel securing screws.

#### Rough-In Components

- Fixture is pre-wired with 2ft of SJOOW cord.
  Sleeve is ordered separately (see accessories).
- Installation Recomendations
- In all potentially wet/damp locations, a waterproof junction box must be used.
  Provisions for effective drainage are
- Provisions for effective arainage are necessary.

#### Applications

- Public spaces
- Walkways
- Commercial facilities

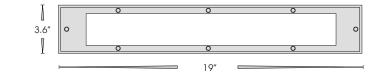


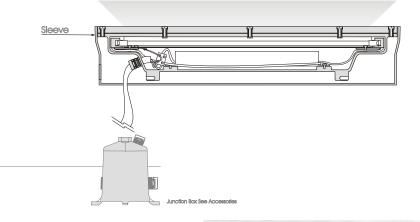


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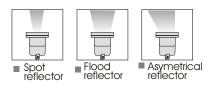






J-Box Access Hole







TARGETTI NORTH AMERICA

a division of

1513 E. Saint Gertrude Place **Tel** 714 957-4960 Santa Ana, Ca 92705 **Fax** 714 957-4965

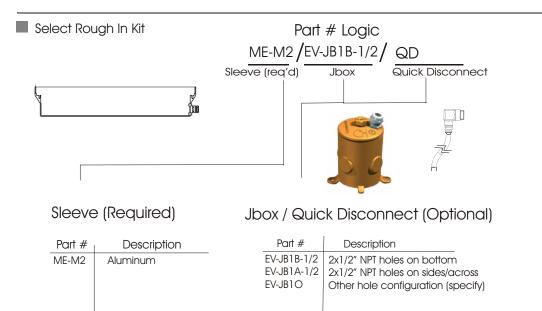


Part # Logic

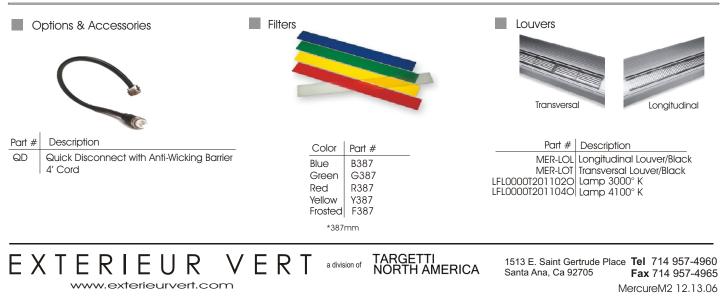


## MERCURE

-	<u>M2</u> > Part #	<u>R</u> Refle	<u>MP</u> ector	<u>]</u> Voltc	ige	
T2 Fluoresent Projector	RMP=Sym RMS=Sym RMA=Asy	netrical	Flood R	eflector	1 = 1 7=2	



Accessories



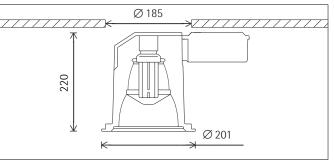


## Lightcast Downlight

for compact fluorescent lamps













81029.000 Reflector silver TC-TEL 18W GX24q-2 1200lm ECG

#### Product description

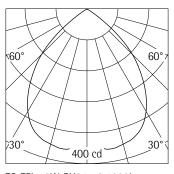
Housing: cast aluminium, silver powder-coated. Mounting with 3point support and screw-tightening. Side-mounted control gear: plastic, black.

Electronic control gear. 2 cable entries. Through-wiring possible. 5pole terminal block. Darklight reflector: aluminium, bright anodised. Cut-off angle 30°.

bright anodised. Cut-off angle 30°. Diffuser as lamp cover: plastic, translucent.

Screw-fastened cover ring with safety glass: corrosion-resistant, cast aluminium, No-rinse surface treatment. Silver double powdercoated. To be removed together with Darklight reflector for lamp replacement.

Protection mode IP65: dust-proof and water-jet proof. Weight 2.40kg



TC-TEL 18W GX24q-2 1200lm

h(m)	E(Ix)	D(m) 87°
1	359	1.90
2	90	3.80
3	40	5.69
4	22	7.59
5	14	9.49

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 Edition: 16.11.2006 Please download the current version from www.erco.com/81029.000



## Lightcast Downlight Planning data

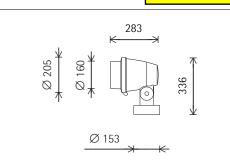
Cleaning (a) Ambient conditions LMF RSMF	1 P 0.98 0.99	C 0.94 0.98	N 0.90 0.96	D 0.86 0.95	2 P 0.95 0.97	C 0.91 0.96	N 0.86 0.95	D 0.81 0.94	3 P 0.94 0.97	C 0.90 0.96	N 0.84 0.95	D 0.79 0.94
Hours of operation (h) LLMF LSF	2000 0.92 1	6000 0.85 1	10000 0.83 1	1000 0.97 1	4000 0.88 1	8000 0.83 1						
MF LMFxRSMFxLLM MF Maintainance F LMF Lumiaire Maint RSMF Room Surface I LLMF Lamp Lumens M LSF Lamp Survival f P Room pure C Room clean N Room normal D Room dirty	actor enance Mainten Vainten	ance Fa										



## **Beamer II Projector**

with mounting plate for metal halide lamps





60°

30

HIT-CE

60°





F

**34004.000** Graphit m HIT-CE 35W G12 3300lm

#### **Product description**

Housing, hinge and mounting plate: corrosion-resistant cast aluminium, No-Rinse surface treatment. Double powder-coated. Optimised surface for reduced accumulation of dirt. Hinge with internal wiring, 130° tilt. Graduated disc: corrosion-resistant aluminium. Mounting plate rotatable through 240° Control gear with temperature control gear with temperature controller, timer-ignitor, capacitor. 2 cable entries. Through-wiring possible. 3-pole terminal block. Spot reflector: aluminium, silver anodised, mirror-finish. Screw-fastened snoot with safety glass: corrosion-resistant cast aluminium, double powder-coated. Cross-baffle: metal, black lac-

quered. Cut-off angle 50°. Without spill light. Protection mode IP65: dust-proof

Weight 7.00kg Maximum wind load area 0.06m² 230° 60000 cd HIT-CE 35W G12 3300lm

h(m)	E(lx)	D(m) 9°
2	12753	0.31
4	3188	0.63
6	1417	0.94
8	797	1.26
10	510	1.57

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 Edition: 16.11.2006 Please download the current version from www.erco.com/34004.000



# **Beamer II Projector**

Planning data

Cleaning (a) Ambient conditions LMF RSMF	1 P 0.98 0.99	C 0.94 0.98	N 0.90 0.96	D 0.86 0.95	2 P 0.95 0.97	C 0.91 0.96	N 0.86 0.95	D 0.81 0.94	3 P 0.94 0.97	C 0.90 0.96	N 0.84 0.95	D 0.79 0.94
Hours of operation (h) LLMF LSF	1000 0.89 1	2000 0.84 1	4000 0.81 1	6000 0.79 1	8000 0.77 1	10000 0.76 1	12000 0.75 1					

MF

LMFxRSMFxLLMFxLSF Maintainance Factor Lumiaire Maintenance Factor Room Surface Maintenance Factor Lamp Lumens Maintenance Factor Lamp Survival Factor Room pure Room clean Room normal Room dirty

MF LMF RSMF LLMF LSF P C N D

F6 Luminaire

	1 T5H
	Asymmetri
In-Cove LP	 2808H0

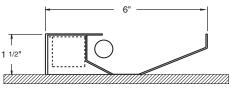
 Virtually eliminates the socket shadows found when using traditional strip lights.	
Inter-locking modules allow for fast easy installation.	
Factory pre-wired with quick-wire connectors.	
Ultra slim profile for small coves.	

Adjustable mounting positions allow beam pattern to be coordinated with architecture.

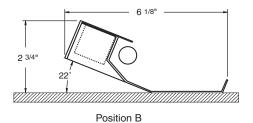
## Order Number Guide

280	8	H01	E	N				E	W
<i>Series</i> In-Cove LP	<i>Type</i> Wall mount Indirect	<i>Lamps</i> 1 T5HO	<i>Lower Optics</i> E - None	<i>Upper Optics</i> N - Standard	Length 02 - 2ft* 03 - 3ft* 04 - 4ft* 06 - 6ft* 08 - 8ft*	Wiring Options 1 - 1cct 3 - 1cct w/ Emergency cct 5 - 1cct w/ Battery Pack 7 - 1cct w/ Dimming* 8 - 1cct w/Thru Wire	Voltage 1 - 120V 2 - 277V 3 - 347V* X - Custom	<i>Ballast</i> Electronic	<i>Finish</i> W - Standard White
						Consult factory for complete list of standard wiring options.	* Consult factory for availability		

## **Cross** Section

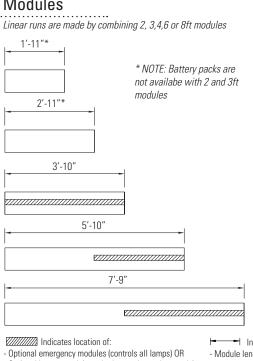


Position A



Weight 2.7 lb/ft





- Optional battery pack (standard controls one lamp only)

Indicates:

- Module length / Mounting distance *Module length does not include endcaps



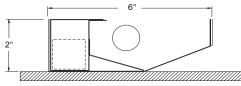
Cove mount	
1 T8	
Asymmetric	
2808T01	 In-Cove LP

Exceptional forward-throw distribution allows close mounting to ceiling with excellent uniformity. Virtually eliminates the socket shadows found when using traditional strip lights. Inter-locking modules allow for fast easy installation. Factory pre-wired with quick-wire connectors. Ultra slim profile for small coves. Adjustable mounting positions allow beam pattern to be coordinated with architecture.

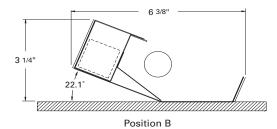
#### Order Number Guide

280	8	T01	E	Ν				E	W
<i>Series</i> In-Cove LP	<i>Type</i> Wall mount Indirect	<i>Lamps</i> 1 T8	<i>Lower Optics</i> E - None	<i>Upper Optics</i> N - Standard	Length 02 - 2ft 03 - 3ft 04 - 4ft 06 - 6ft 08 - 8ft	Wiring Options 1 - 1cct 3 - 1cct w/ Emergency cct 5 - 1cct w/ Battery Pack 7 - 1cct w/ Dimming* 8 - 1cct w/ Thru Wire	Voltage 1 - 120V 2 - 277V 3 - 347V* X - Custom	<i>Ballast</i> Electronic	<i>Finish</i> W - Standard White
						Consult factory for complete list of standard wiring options	* Consult factory for availability		

## Cross Section



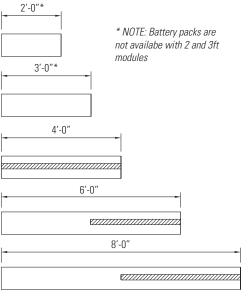
Position A



Weight 2.7 lb/ft

### Modules

Linear runs are made by combining 2, 3,4,6 or 8ft modules



Indicates location of:

- Optional emergency modules (controls all lamps) OR - Optional battery pack (standard controls one lamp only) Indicates:
 Module length / Mounting distance
 *Module length does not include endcaps





0

Asymmetric

## Photometry

1 T 8

#### Specifications

#### Housing

Die-formed 24 gauge metal painted white. Note: NYC version available. Please consult factory.

#### **Optical System**

Constructed of highly specular aluminum and highly reflective 24 gauge metal to produce an asymmetric distribution.

#### Joints

Integral with each module. Luminaire shall have an alignment tab to allow sections to be easily configured, saving installation time.

#### Electrical

All luminaires shall be factory pre-wired to section ends with quick-wire connectors.

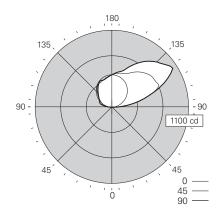
#### Ballast

Electronic.

#### Approvals

Certified to UL & CSA standards.

Due to continuing product improvments, Ledalite reserves the right to change specifications without notice.



Report#
2101275
Efficiency
Peak Candela Value
Peak: Zenith Ratio
RP-1 Compliant

74.9%	
1030 @	122.5°
2.2:1	

CAN	DELA	DIST	RIBL		1	
Vert.		Horizo	ntal An	gle		Zonal
Angle						Lumens
	0	45	90	135	180	
0	0	0	0	0	0	
5	0	0	0	0	0	0
15	0	0	0	0	0	0
25	0	0	0	0	0	0
35	0	0	0	0	0	0
45	0	0	0	0	0	0
55	0	0	0	0	0	0
65	0	0	0	0	0	0
75	0	0	0	0	0	0
85	0	0	0	0	0	0
90	24	22	2	3	1	
95	153	153	28	48	46	93
105	477	472	97	134	157	271
115	825	742	172	166	193	386
125	1021	724	247	221	222	408
135	912	685	314	292	272	362
145	796	616	371	363	341	298
155	652	532	416	388	406	217
165	532	504	446	414	409	131
175	485	479	461	447	442	46
180	463	463	463	463	463	

COEFFI	CIEN	NTS	OF	UTIL	IZA	TIO	۷ (%	6)			
Ceiling		80				70			50		0
Wall	70	50	30	10	70	50	30	50	30	10	0
RCR											
0	71	71	71	71	61	61	61	41	41	41	0
1	65	62	59	56	55	53	50	36	35	33	0
2	59	54	49	46	50	46	42	31	29	27	0
3	53	47	42	38	45	40	36	27	25	23	0
4	49	41	36	32	41	35	31	24	21	19	0
5	44	36	31	27	38	31	27	21	19	16	0
6	41	32	27	23	35	28	23	19	16	14	0
7	37	29	24	20	32	25	20	17	14	12	0
8	34	26	21	17	29	22	18	15	12	10	0
9	32	23	18	15	27	20	16	14	11	9	0
10	30	21	16	13	25	18	14	13	10	8	0
Based	on a	floor	refle	ctan	ce of	0.2					

Note : IES photometric files available for download at www.ledalite.com

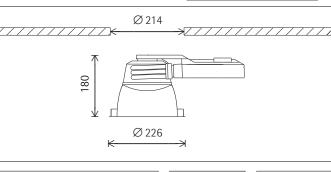




# Lightcast Downlight

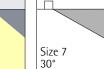
for TC-T lamps





TC-TEL





22134.000 Reflector silver TC-TEL 32W GX24q-3 2400lm ECG 1-10V

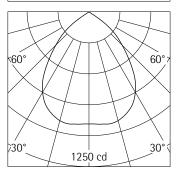
#### Product description

Housing: cast aluminium, designed as heat sink.

Mounting ring: cast aluminium, white (RAL9002) powder-coated. Tools not required for mounting with 4-point support and screw fixing.

Junction box for through-wiring, 5-pole terminal block, integrated cable clamp. Electronic control gear.

gear. Darklight reflector: aluminium, bright anodised. Cut-off angle 30°. Diffuser as lamp cover: plastic, translucent, can be removed for lamp replacement without tools. Weight 1.90kg



TC-TEL 32W GX24q-3 2400lm

LOR 0.64 UGR 19.5 65° < 200 cd/m²

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 Edition: 16.11.2006 Please download the current version from www.erco.com/22134.000



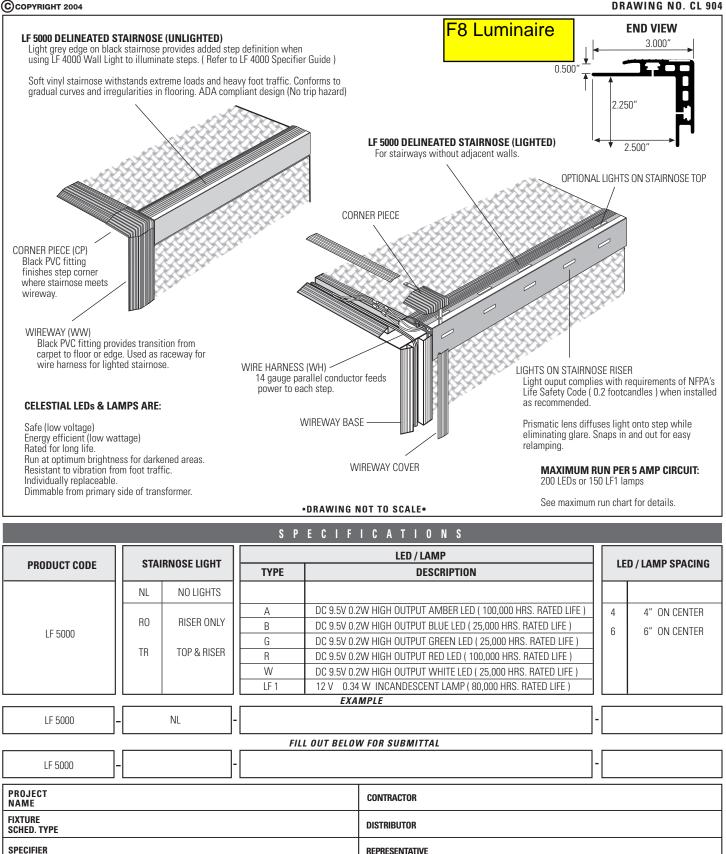
# Lightcast Downlight Planning data

22134.000 Connected load Connected load per 100 Number of luminaires p	P: Dix P*:		n²	3 2400	m						
22134.000 Number of luminaires p	per 100m² for	TC-TEL : 100lx 7		24q-3 2 300lx 20							
$\begin{array}{llllllllllllllllllllllllllllllllllll$											
Cleaning (a) Ambient conditions LMF RSMF	1 P C 0.94 0.89 0.99 0.98	N 0.81 0.96	D 0.72 0.95	2 P 0.88 0.97	C 0.80 0.96	N 0.69 0.95	D 0.59 0.94	3 P 0.84 0.97	C 0.74 0.96	N 0.61 0.95	D 0.52 0.94
Hours of operation (h) LLMF LSF	2000 6000 0.92 0.85 1 1	) 10000 0.83 1	1000 0.97 1	4000 0.88 1	8000 0.83 1						
MF LMFxRSMFxLLM MF Maintainance F LMF Lumiaire Maint RSMF Room Surface I LLMF Lamp Lumens M LSF Lamp Survival I P Room pure C Room clean	actor enance Factor Maintenance Maintenance I	Factor									

- Room normal Room dirty N D

Co	Correction table												
Ce	iling	0.70	0.70	0.70	0.50	0							
Wall		0.70	0.50	0.20	0.20	0							
Flo	or	0.50	0.20	0.20	0.10	0							
k	0.6	79	60	51	51	47							
k	1.0	101	78	70	68	65							
k	1.5	117	91	84	81	78							
k	2.5	129	100	95	90	86							
k	3.0	133	103	99	93	89							





	-
<b>celestial</b> [[g]ht]ng	

*visit us at :* www.celestiallighting.com *e•mail :* info @ celestiallighting.com

## SPECIFIER GUIDE

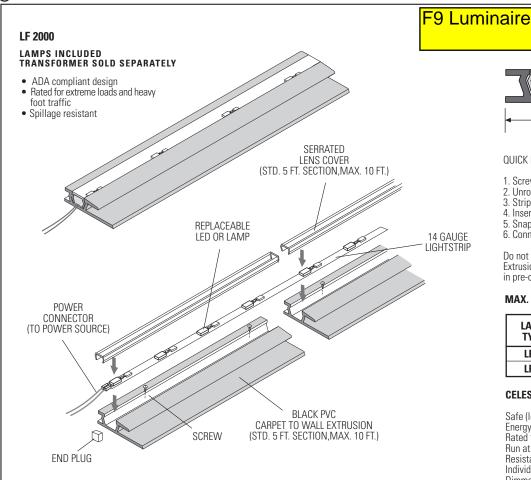
#### LISTED PRODUCT DESCRIPTION PRODUCT CODE

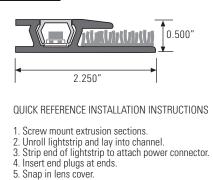
## CARPET-TO-WALL PATH LIGHT

LITEFORM LF 2000

DRAWING NO. CL 1004

#### COPYRIGHT 2004





**END VIEW** 

6. Connect to power source.

Do not exceed maximum run length per circuit. Extrusion, lens cover and lightstrip are available in pre-cut sections or can be field cut.

#### MAX. RUN PER CIRCUIT (5 AMPS)

LAMP	LAMP SPACING						
TYPE	6″	12″					
LED	112 FT.	200 FT.					
LF1	79 FT.	158 FT.					

#### **CELESTIAL LEDs & LAMPS ARE:**

Safe (low voltage) Energy efficient (low wattage) Rated for long life. Run at optimum brightness for darkened areas. Resistant to vibration from foot traffic. Individually replaceable. Dimmable from primary side of transformer.

**•DRAWING NOT TO SCALE** 

			S	PECIFI	CATION S			
PRODUCT CODE		LENS COLOR			LED / LAMP			LED / LAMP SPACING
			ТҮРЕ		DESCRIPTION			
LF 2000	C A B G B	CLEAR AMBER BLUE GREEN BED	A B G R W	DC9.5V 0. 2 W         AMBER LED ( 100,000 HRS. RATED LIFE )           DC9.5V 0. 2 W         BLUE LED ( 25,000 HRS. RATED LIFE )           DC9.5V 0. 2 W         GREEN LED ( 25,000 HRS. RATED LIFE )           DC9.5V 0. 2 W         RED LED ( 100,000 HRS. RATED LIFE )           DC9.5V 0. 2 W         RED LED ( 100,000 HRS. RATED LIFE )           DC9.5V 0. 2 W         WHITE LED ( 25,000 HRS. RATED LIFE )           DC9.5V 0. 2 W         WHITE LED ( 25,000 HRS. RATED LIFE )           12V 0.34W INCANDESCENT LAMP ( 80,000 HRS. RATED LIFE )				6" ON CENTER 12" ON CENTER
	S	SMOKE	LF1		EAR LENS WITH LEDS		OR SPECIFY OTHER SPACING	
		1	·	EXA	MPLE			
LF 2000 - C -					А			6
				FILL OUT BELOV	V FOR SUBMITTAL		_	
LF 2000 -			-					
PROJECT NAME					CONTRACTOR			
FIXTURE SCHED. TYPE					DISTRIBUTOR			
SPECIFIER					REPRESENTATIVE			
<i>celes</i> i	<b>ia</b>	<u>Ighti</u>	IJ	e•mail :	iallighting.com tiallighting.com	14009 Dinard Av Santa Fe Spring CA 90670		PH (562) • 802 • 8811 (800) • 233 • 3563 FX (562) • 802 • 2882

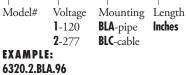
#### **BIG LIGHT OPAL CYLINDER WITH DOWNLIGHT**

#### TYPE:

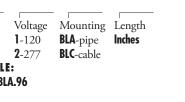
## **PROJECT:**

F10, F11 Luminaire

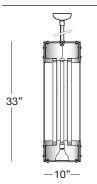




and length of suspension must be specified, see back page for details. Fixtures use 3- T8 lamps wrapped by a seamless cylindrical Acrylic diffuser. See order info for downlight options. Separate switch leg for downlight is standard. PAR lamps are replaceable without removing cover. U.L. Listed for damp locations.







6301 3-17w T8 lamps with 1-75w PAR30S 120V only

#### 6321

3-17w T8 lamps with 1-39w Metal Halide PAR20

#### 6331

3-17w T8 lamps with no downlight

#### 6300

57"

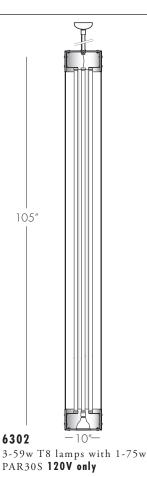
3-32w T8 lamps with 1-75w PAR30S 120V only

#### 6320

3-32w T8 lamps with 1-39w Metal Halide PAR20

#### 6330

3-32w T8 lamps with no downlight



6322

6332

3-59w T8 lamps with 1-39W

3-59w single pin T8 lamps

Metal Halide PAR20

with no downlight

#### BURBANK,

CALIFORNIA, 91505 WWW. DELRAY LIGHTING. COM

## 3-17 WATT





Ħ



#### 3-59W T8 A

#### **MOUNTING OPTIONS**

#### PIPE MOUNT

#### BLA

Order **BLA** mount for 1/2" pipe, length must be specified. Pipe comes with ball aligner canopy rated for 75 lbs. and mounts to standard J-boxes.



#### CABLE MOUNT

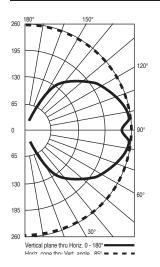
#### BLC

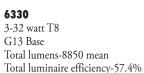
Order **BLC** mount for any length, must be specified. 3/32" stainless steel aircraft cable adjusts with push button cable grippers for easy field adjustment. Not for use in windy areas



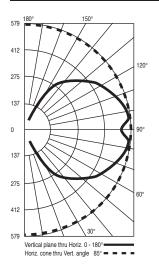
3-17 watt T8 Total lumens-4200 mean Total luminaire efficiency-57.3%

#### <u>CP DISTRIBUTION</u>





#### **CP DISTRIBUTION**



#### COEFFICIENTS OF UTILIZATION

% CEI	LING 80	(20%	FLOOR)	% CE	LING 80	(20%	FLOOR)	% CEI	LING 80	(20%	FLOOR)
% W#	ALL 70	50	30	% W/	ALL 70	50	30	% WA	LL 70	50	30
0	61	61	61	0	61	61	61	0	61	61	61
1	52	47	43	1	52	47	43	1	52	47	43
2	45	39	34	2	45	39	34	2	45	39	34
3	41	33	28	3	41	33	28	3	41	33	28
4	37	29	23	4	37	29	23	4	37	29	23
5	33	25	19	5	33	25	19	5	33	25	19
6	31	22	17	6	31	22	17	6	31	22	17
7	28	20	15	7	28	20	15	7	28	20	15
8	26	18	13	8	26	18	13	8	26	18	13
9	24	16	11	9	24	16	11	9	24	16	11
10	22	15	10	10	22	15	10	10	22	15	10



6332

1098

824

549

275

0

275

549

824

1098

Vertical plane thru Horiz. 0 - 180°

Horiz. cone thru Vert. angle 85° = = =

Fa8 Base

3-59 watt T8

Total lumens-17700 mean

Total luminaire efficiency-57.3%

**CP DISTRIBUTION** 

20

-



6331

G13 Base



## **FEATURES & SPECIFICATIONS**

#### INTENDED USE

T5 linear direct fluorescent intended for use in low-profile commercial, retail, manufacturing, warehouse, cove and display applications.

#### ATTRIBUTES

Designed exclusively for use with T5 lamps, T5 sockets and T5 electronic ballasts.

#### CONSTRUCTION

Housing formed from cold-rolled steel. No asbestos is used in this product. Heavy-duty 20-gauge channel.

Extended-height end caps retain and support sockets. Compact T5 socket features rotating collar and enclosed contacts.

#### FINISH

High-gloss, baked white enamel finish. Five-stage iron-phosphate pretreatment ensures superior paint adhesion and rust resistance.

#### **OPTICAL SYSTEM**

A variety of optical assemblies are available. See the MS5-Reflector or MS5-Louver spec sheets.

#### ELECTRICAL SYSTEM

Thermally protected, resetting, Class P, HPF, non-PCB, UL Listed.

Suitable for damp locations. AWM, TFN or THHN wire used throughout, rated for required temperatures.

#### INSTALLATION

Labor-saving coupler supplied for row mounting. Numerous knockouts for easy installation. Surface-mount or suspended.

#### LISTING

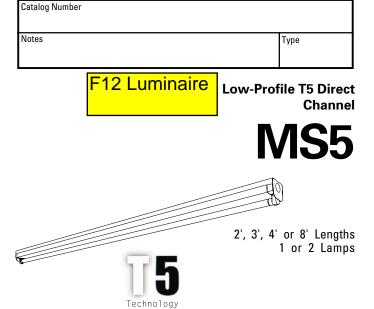
UL Listed and CSA Certified (see Options).

**ORDERING INFORMATION** 

#### WARRANTY

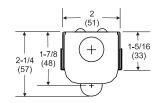
Guaranteed for one year against mechanical defects in manufacture.

Specifications subject to change without notice.



#### Specifications

Length: 22-7/16 (569), 34-1/4 (869), 46-1/16 (1169) or 92-1/16 (2337) Width: 2 (51) Depth: 2-1/4 (57) Weight: 4.8 lbs (2.2 kg)



#### Example: MS5 1 54T5H0 MVOLT GEB10PS

#### MS5 Series Number Voltage Options Lamp type of lamps MS5 T5 low-profile 14T5 14W T5 (22") 3472 GEB10PS Electronic ballast, ≤10% THD, **MVOLT**³ Program Start direct 1, 2 21T5 21W T5 (34") Others Not included. **GLR** Internal fast-blow fuse⁴ 24T5H0 24W T5 H0 (22") available. GMF Internal slow-blow fuse⁴ For tandem 28T5 28W T5 (46") double-length unit, add PLF_ Plug-in wiring, specify 1, 2 or 3 39T5HO 39W T5 HO (34") branch circuits and hot wires prefix T.1 54T5H0 54W T5 H0 (46") (A=black, B=red, C=blue, AB or AC) Éxample: TMS5 **EL55** Emergency battery pack (nominal 390-700 lumens; see Fluorescent Battery Packs tab)^{1, 4} **CSA** CSA Certified Accessories Order as separate catalog number.

WGMS5Z Wireguard, 4', zinc

THMS5 Tong hanger

1B Ceiling spacer (adjusts from 1-1/2" to 2-1/2" from ceiling)

**SQ_** Swivel stem hanger (specify length in 2" increments)

NOTES:

1 Only available with 28W and 54W.

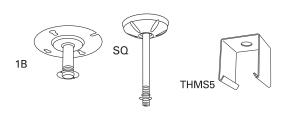
2 Only available with 54W.

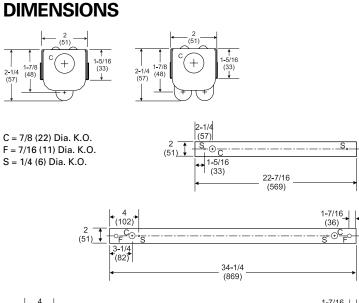
3 Available with GEB10PS only.

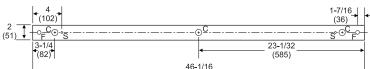
4 Specify voltage.

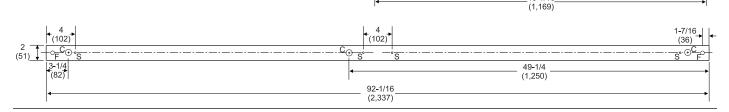
## **MOUNTING DATA**

For unit or row installation, surface or stem mounting. Unit installation — Minimum of two hangers required. Row installation — One hanger per channel plus one per row required. Hanging devices illustrated below.









## PHOTOMETRICS

Calculated using the zonal cavity method in accordance with IESNA LM41 procedure. Floor reflectances are 20%. Lamp configurations shown are typical. All data based on 25°C. Full photometric data on these and other configurations available upon request.

#### MS5 1 54T5H0 120 GEB10PS

Report LTL 8568

Lumana nar Jama 1/100 Lum off 00 60	
Lumens per lamp - 4400 - Lum. eff 98.69	6

#### S/MH (along) 1.2 (across) 1.6

**Coefficient of Utilization** 

Ceiling		80%			70%			50%	
Wall	70%	50%	30%	70%	50%	30%	50%	30%	10%
0	113	113	113	109	109	109	100	100	100
1	99	93	87	95	89	84	81	77	73
2 3	89	79	71	84	75	68	69	63	57
3	80	68	58	76	65	56	59	52	46
4	73	59	50	69	57	48	52	44	38
5	66	52	43	63	50	41	46	38	32
6	61	47	37	58	45	36	41	34	28
7	56	42	33	53	40	32	37	30	24
8	52	38	29	50	37	28	34	27	21
9	49	35	26	46	34	26	31	24	19
10	45	32	24	43	31	23	29	22	17
Zona	l Lur	nens	s Su	mmar	y				

Zone	Lumens	%Lamp	%Fixture
0-30	640	14.5	14.8
0-40	1089	24.7	25.1
0-60	2159	49.1	49.8
0-90	3583	81.4	82.6
90-180	755	17.2	17.4
0-180	4338	98.6	100.0



Lithonia Lighting Fluorescent One Lithonia Way, Conyers, GA 30012-3957 Phone: 800-858-7763 Fax: 770-929-8789 In Canada: 1100 50th Ave., Lachine, Quebec H8T 2V3 www.lithonia.com

Sheet # MS5

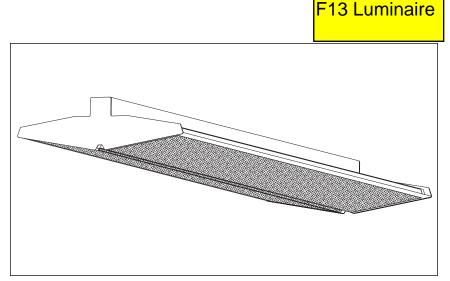
MS5.p65 ©2001 Lithonia Lighting, 9/01

# FINELITE

## Series 15 - Technical Sheet

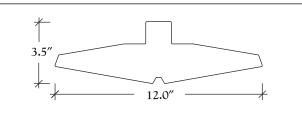
**Finelite Series 15** represents an advancement in the art of indirect lighting. The slim, attractive profile delivers unsurpassed performance in low ceiling applications. Available in 1 or 2 T8, T5 or T5HO lamp cross sections, and 2', 3', 4' or 8' lengths.

Series 15 combines a unique open cavity, double diffuser optical design (Patent Pending) with 96% reflective white paint in order to maximize fixture efficiency and performance.



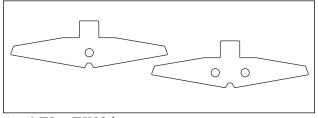
The unique optical design generates high performance in low ceiling areas.

#### DIMENSIONS



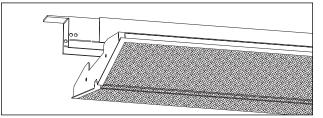
The height of the fixture body is 3.5", width 12.0".

#### T5 / T5HO LAMPS



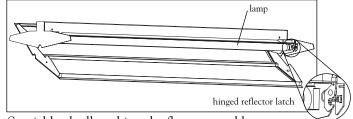
1 or 2 T5 or T5HO lamps.

#### DIE-FORMED JOINER PLATE



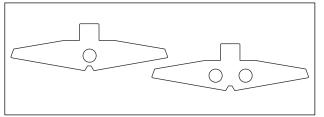
Die-formed aligner plate comes factory installed for smooth joints. Plug-together wiring ensures electrical connections are right every time.

#### **REFLECTOR ASSEMBLY**



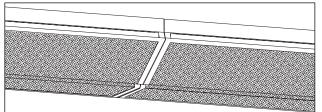
Special latch allows hinged reflector assembly to rotate or be removed for easy maintenance and lamp access.

#### T8 LAMPS



 $1 \mbox{ or } 2 \mbox{ T8 lamps}.$ 

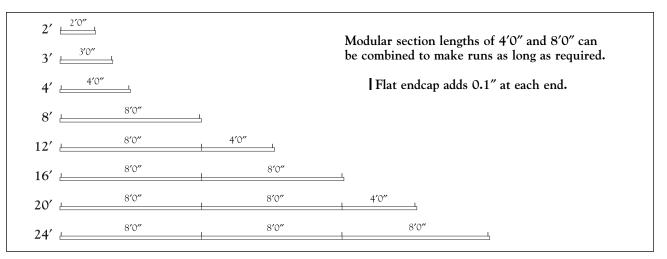
#### STRONG, TIGHT JOINTS



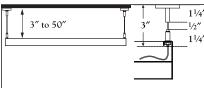
Fixtures slide together tightly and die-formed internal aligner plate ensures strong joints with no light leaks.

# FINELITE

## Series 15 - Technical Sheet



#### STANDARD FA CABLE



Standard fully adjustable aircraft cable (FA) allows suspension from 3.0" to 50". Depress the head of the fitting to allow continuous adjustment of the cable length.

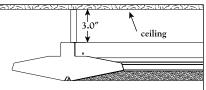
#### SPECIFICATIONS

**CONSTRUCTION:** 18 gauge die-formed steel body. All components hard tooled to tolerances of 0.005".

Die-formed 0.062" perforations cover the surface of the steel downlight shielding.

ENDCAPS: (FE) Flat Endcap standard, dieformed steel, painted to match fixture, adds 0.1''at each end. No exposed fasteners, holes or knockouts.

#### **OPTIONAL STEM MOUNT**



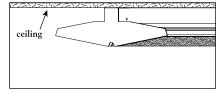
Optional Stem Mount (SS) positions the top of the fixture 3" from the ceiling. Additional stem lengths available for hard ceilings. Consult factory for additional requirements.

ELECTRICAL: 120 or 277 volt prewired. Fixture and electrical components UL/C-UL listed and fixture will bear UL/C-UL labels. Optional Adders: 347 volt prewired, dual circuit, low profile emergency battery packs.

LAMPING: 1 or 2 T8, T5 or T5HO cross sections.

BALLAST: Electronic low profile instant start ballasts <20%THD standard. Optional Adders: Rapid Start, low profile dimming ballasts (controls by others), low profile emergency battery packs. Consult factory. 347volt ballast available for selected lamps - Consult Factory.

#### **OPTIONAL SURFACE MOUNT**



Optional Surface Mount (SM) fixture mounts directly to ceiling with no exposed hardware.

stem lengths available for hard ceilings ONLY. Consult Factory.

SUPPORT CABLES: Stainless steel with plated hardware.

FEED: Pendant: 18 gauge straight cord. 14 gauge feed cord used when fixture current exceeds 6 amps. Feed is 1.5" from end of fixture.

FINISHES: Finelite brite white standard. (NOTE: this finish is 96% reflective.)

<b>OPTICAL SYSTEM:</b> Finelite innovation Series 15 open cavity double diffuser optical system with 96% reflective white paint, PATENT TENDING. This product uses patented Constructive Occlusion® technology. <b>REFLECTORS:</b> (96W) Standard—96 White painted high reflectance reflectors.	Consult factory. 347volt ballast available for selected lamps - Consult Factory. <b>MOUNTING OPTIONS:</b> Standard pendant mounting is fully adjustable aircraft cable (FA), adjusts suspension from 3" to 50". Optional Adders: Adjustable aircraft cable (AC) lengths from 51" to 150"; Stem Mount (SS) 3" metal stem; Surface Mount (SM) flush to ceiling. Additional	<ul> <li>LENGTHS: 4' and 8' section lengths can be combined to make longer runs. <i>Consult factory for 2' and 3' lengths</i>.</li> <li>WEIGHT: Fixture weight = 2.0 lb/ft.</li> <li>WALL MOUNT: Matching Series 15 Wall Mount available. See S15WM Technical Sheet.</li> </ul>
ORDERING INFORMATION	(2) - S15 - 32'	– 1T5HO – SC – 277 – FA
Circuiting (SC-single circuit, DC-dual circu Voltage (120, 277, 347 Volt) ————		

F14 Luminaire

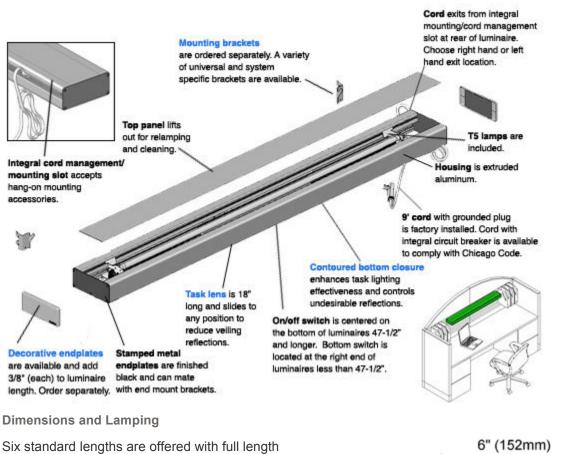
Click to print

## Task Lighting - Style P201



Features

**Style P201** workstation luminaires feature an integral hang-on mounting channel that facilitates installation on open office furniture panels. They are designed to provide low-glare task lighting for horizontal worksurfaces. Where privacy partitions occur, these luminaires also reduce workstation luminance ratios by softly lighting the panel in front of the user.

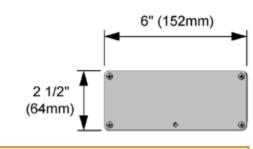


Six standard lengths are offered with full length lamping. Non-standard lengths from 35-3/4" to 95-3/4" at 1" increments are available at an additional cost.

#### Design Tip:

Mounting methods that engage system furniture support features may dictate a non-standard luminaire length.

Each luminaire is provided with one T5 fluorescent lamp or two tandem mounted T5 lamps according to the overall luminaire length. To limit the luminance of workstation surfaces, only standard output lamps are offered. The use of high-output T5 lamps is not recommended.



Length		Lamps	Input
35 3/4 "	(908 mm)	1xF21T5	27 watts
47 1/2 "	(1206 mm)	1xF28T5	34 watts
59"	(1499mm)	1xF35T5	40 watts
70-3/4″	(1797mm)	2xF21T5	52 watts
82 1/2″	(2096mm)	1xF21T5 + 1xF28T5	61 watts
94 1/4"	(2394mm)	1xF28T5	66 watts

#### 3000K lamps are included. 3500K and 4100K lamps are available upon request.

Non-standard lamp configurations are available on large quantity orders (e.g. 71" luminaire with 1xF35T5 lamp). Consult factory.

#### **Mounting Height**

Recommended mounting height is 48" to 50" A.F.F. for 24" deep worksurfaces and 48" to 52" for 30" deep worksurfaces (based on a worksurface height of 28-1/2" and a minimum seated eye height of 40-1/2"). When a standard desk clamp stanchion is used, top of the luminaire is at 48" A.F.F. (19-1/2" above the worksurface).

Tambient can provide non-standard task lighting optics for certain other workstation geometries. Contact Tambient for details.

#### Mounting Accessories

**Universal hang-on panel clamps** are available for mounting workstation luminaires on partitions from 1-1/2" to 3-1/2" thick. Order panel clamps separately.

**Universal desk clamp stanchions** are available for mounting to worksurfaces from 1" to 2" thick. Order desk clamp stanchions separately.

**Wall mount brackets** are available for mounting to stud walls and rigid wall panels. Order seperately.

Tambient can supply mounting brackets for use with specific commercial office furniture systems and custom brackets for unique mounting conditions. Contact Tambient for details.

#### Ballasts

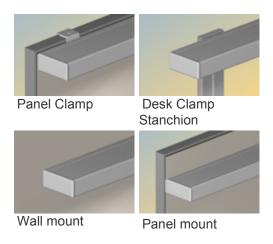
Luminaires are supplied with integral 120 volt, high power factor electronic ballasts for energy efficiency.

Programmed start ballasts are standard to maximize lamp life and minimize energy use.

Manufacturer/model of furnished ballast(s) may vary. However, all ballasts furnished meet or exceed the following criteria:



Caution: To avoid discomfort glare, do not install these units above 52" A.F.F. (50" for 24" deep worksurfaces).



- Total Harmonic Distortion (THD) < 10%
- Power Factor (PF) > 97%
- Ballast Factor* (BF) > 98%
- Current Crest Factor (CF) < 1.7</p>
- Sound Rating A or better
- ANSI, IEEE, and FCC compliant
- UL listed (United States and Canada)
   *Primary lamp application

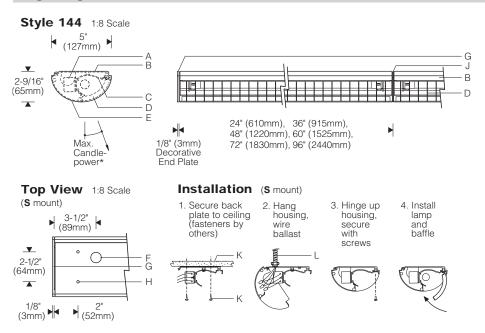
#### Cords

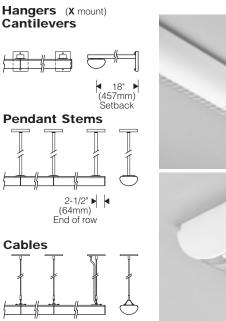
Cords are factory installed, 18 gauge, 3-conductor, Type SJT with grounded plug in accordance with UL153 (*Standard for Portable Electric Luminaires*) and the associated *Supplementary Requirements for Units for Use with Office Furnishings*.

Furnished cord length is 9 feet; the maximum length allowed by the standard. Standard cords are black. Gray and beige cords are available at an additional cost.

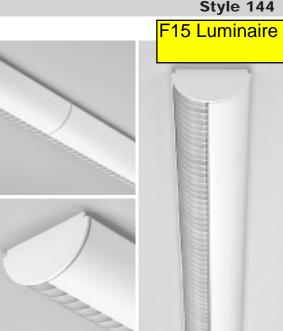
For installations in the City of Chicago, we offer cords with a

#### Lighting the Wall Xtra small enclosed semi-elliptical, one-way





T5 Fluorescent



* Aiming is field adjustable from 25° to 35° above nadir (factory setting is 25°).

#### **Specifications**

- A Electronic ballast
- B Extruded aluminum back plate
- C Specular extruded aluminum reflector (adjustable aiming)
- **D** High-impact polycarbonate baffle, 25° shielding (matte gray)
- E Extruded aluminum housingF Conduit entry, 7/8"
- (22mm) dia. (**S** mount)
- G Aluminum decorative end plates (order separately)
   H Mounting balas
- H Mounting holes, 9/32" (7mm) dia.
- J Aluminum joiner/reveal plates (matte gray)
- K Structure and fasteners (by others)
- L Conduit and connector (by others)
- Ideal for corridors, art walls, displays, chalkboards, signs

#### Performance

Features

Two parabolic reflector sections drive light to the bottom of the vertical surface. An elliptical section redirects light that is normally wasted back to a parabola. Glare is minimized and asymmetry of the beam is maximized resulting in high beam efficiency and superior surface uniformity.

■ T5/T5HO for precise optical control - adjustable aiming

matte gray baffle nearly matches housing when lighted

Designed to be inconspicuous - lights entire wall evenly

without amplifying surface imperfections (unlike slots)

Matte white elliptical housing blends with ceiling -

#### 1x55W T5 HO T5 HO

For complete photometrics, visit www.elliptipar.com.

elliptipar

#### Finish:

Matte white housing and decorative end plates. Joiner/reveal plates and baffle finished matte gray.

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:

**S** mount - back plate mounts flush to ceiling.

X mount - cantilevers, stems or cables ordered separately.

Cantilever - 1" x 2" steel arm, suitable support structure required. Adjustable interface plate (concealed under canopy) allows leveling of arms  $+/-5^{\circ}$ .

Pendant stem - 11/16" O.D. aluminum, internally threaded.

Cable - 1/16" dia. 7x7 aircraft cable, field adjustable length.

Hangers at ends of row (or single) are located 2-1/2" (64mm) from end. Intermediate hangers are centered on joint.

#### Electrical:

**S** mount - 7/8" (22mm) diameter knockouts located at each end of back plate for conduit feed (by others). Use 90°C wire for supply connections and through wire.

**X** mount - electrical feed hanger mounts over recessed outlet box (by others). Cantilever and stem electrical feeds supplied with #14 AWG leads (must be located at end of row). Cable feed includes 18/3 cord (can be located at end or joint).

Housing hinges down for access to ballast and wiring. Optional #14 AWG prewired modular through wiring with quick connectors.

Integral electronic HPF thermally protected class P ballast with end-of-life protection.

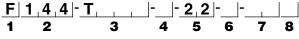
Optional electronic dimming ballast dims to 1% of full light output. Compatible dimming control is required (by others). Consult sales representative for specifications.

Optional integral emergency battery operates one lamp. Separate unswitched supply is required.

Standard: UL listed or CSA certified.



#### To form a Catalog Number



#### **1** Source

F = Linear fluorescent

#### 2 Style

144 = Xtra small enclosed semi-elliptical, one-way, integral ballast

#### 3 Lamp

**Note:** To order by overall row length, enter **ROW CODE** in place of Lamp Code below (see Row Charts on page 16-3a). Row Codes specifiy a row complete with all necessary luminaires and end plates. **Hangers are ordered separately.** 

#### 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

	Longth		T5	Т5НО				
	Length	Code	Lamp(s)	Code	Lamp(s)			
	T5 Fluorescent		α		0			
	24" (610mm)	T114	1 x F14T5	T124	1 x F24T5/HO			
	36" (915mm)	T121	1 x F21T5	T139	1 x F39T5/HO			
3	48" (1220mm)	T128	1 x F28T5	T155	1 x F55T5/HO			
<b>_</b>	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 F55T5/HO			

For complete lamp and ballast information, see Accessories Section. Standard T5 lamp color is 3000K / 80+ CRI.

#### **4** Mounting

- **S** = Ceiling mount
- **X** = For use with cantilevers, pendant stems or cable hangers (order separately)

#### 5 Finish

- 22 = Matte white
- **99** = Custom RAL or computer matched color to be specified, consult sales representative

#### Project:

#### **6** Voltage/Ballast

*Electronic* **1** = 120V

1 = 120V2 = 277V

2 = 277V3 = 347V (Canada)

* Consult sales representave for dimming 5' lamps (lamp codes **Tx35**, **Tx80**).

Dimming*

T = 120V

V = 277V

Note: When dimming  $\mathbf{X}$  mount luminaires, order two (2) electrical feeds to accommodate the control circuit.

Max. Row Length per Feed (4' lamps)								
Voltage	Lamp	Cable **						
120V	T5	228' (69.5m)	140' (42.7m)					
1200	T5HO	124' (37.8m)	76' (23.2m)					
277V	T5	532' (162.2m)	332' (101.2m)					
2//V	T5HO	296' (90.2m)	184' (56.1m)					

Based on 16A branch circuit capacity (20A max allowed for #14 AWG thru wire).

** Based on 10A capacity of 18/3 cord.

#### **7 Option** (See Accessories Section for specifications)

#### **00** = No option

- OE = Integral emergency battery pack with indicator lamp and test button. Available in 4', 5', 6' and 8' units (lamp codes T128, T135, T221, T228, T155, T239 and T255). Operates one lamp. Note: For X mount, order two (2) electrical feed cantilevers, stems or cables to accomodate unswitched feed to battery.
- **0K** = Prewired modular #14 AWG through wiring with quick connectors.
- EK = Combination of emergency battery pack and prewired modular through wiring as described above.
   Note: Modular wiring does NOT accomodate unswitched supply to battery. Feed unswitched circuit directly to this unit.
- **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

#### F144 - T155 - X - 22 - T - 000

Xtra small enclosed semi-elliptical, one-way series for use with one 4' F54T5HO lamp, 48" long housing (not including decorative end plates). For use with cantilever, pendant stem or cable hangers (order separately). Matte white. Integral 120V dimming ballast. Vertical straight blade baffles finished matte gray. UL. Order decorative end plates separately.

#### elliptipar

elliptipar

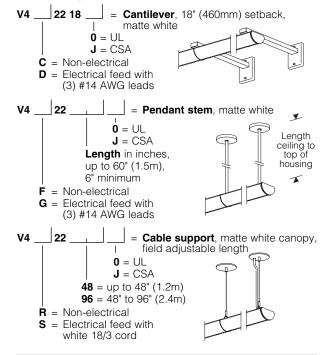
114 Boston Post Road, West Haven, Connecticut 06516, USA Voice 203.931.4455 • Fax 203.931.4464 • www.elliptipar.com Type:

#### Hangers

Order separately. See Accessories Section for specifications. Singles - order one non-electrical and one electrical feed hanger for each module (**X** mount).

Rows - order one non-electrical hanger for each module (**X** mount) plus one electrical feed for each row. See Voltage/Ballast for maximum row length per electrical feed. Note: For each single or row with dimming (voltage/ballast code **T** or **V**) or for each module with emergency battery (option code **OE**), order one additional electrical feed and subtract one non-electrical hanger.

Cantilever and stem electrical feeds must be located at an end of row. Cable feed can be located at ends or intermediate joints.



#### Accessories

Order separately. See Accessories Section for specifications.

ADE44220 = Decorative end plates, pair, matte white, or custom color to match housing (see 5 Finish) Note: adds 1/4" (6mm) to length

**ABK** = **Blank-Out Cover** for non-lighted module. Extruded cover replaces baffle, reflector and lamp(s). Painted to match housing. Consult factory for assistance.

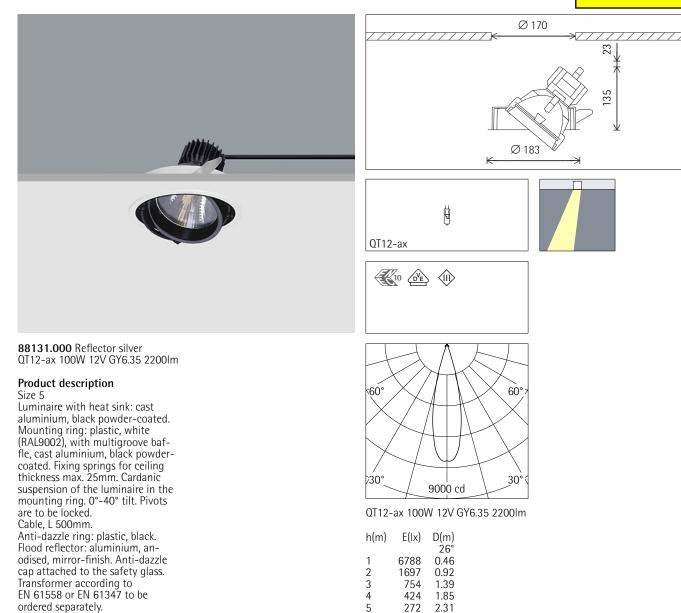
The external shapes of the asymmetric reflectors are trademarks of **elliptipar**. Certain products illustrated may be covered by applicable patents and patents pending. For a list of patents, see Contents pages. These specifications supersede all prior publications and are subject to change without notice. ©2006 **elliptipar**.



# **Gimbal Directional spotlight**

for low-voltage halogen lamps

F16 Luminaire



5

272

2.31

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

Weight 0.95kg

Technical Region: 230V/50Hz Edition: 16.11.2006 Please download the current version from www.erco.com/88131.000



# **Gimbal Directional spotlight**

Planning data

Cleaning (a) Ambient conditions LMF RSMF	1 P 0.94 0.99	C 0.88 0.98	N 0.82 0.96	D 0.77 0.95	2 P 0.89 0.97	C 0.83 0.96	N 0.77 0.95	D 0.71 0.94	3 P 0.85 0.97	C 0.79 0.96	N 0.73 0.95	D 0.65 0.94
Hours of operation (h) LLMF LSF	1000 0.98 1	2000 0.95 1										
MF LMFxRSMFxLLM MF Maintainance f LMF Lumiaire Maint RSMF Room Surface LLMF Lamp Lumens I LSF Lamp Survival P Room pure C Room clean N Room normal D Room dirty	actor enance Mainter Vainter	nance Fa										

WORLDWIDE PART	GE Lighting	F1 Lamp Commercial Products & Solutions
SIT	E SEARCH > HOME	* PRODUCTS > EDUCATION / RESOURCES > LIGHTING APPLICATIONS
20023 – CMH70T GE ConstantColor® P	<b>'U/942/G12</b> 'ulseArc® CMH® Ceramic N	Where to Buy   FAQs   Contact Us   EliteNet
		Bulb Base
GENERAL CHARAC	TERISTICS High Intensity Discharge Ceramic Metal Halide	
Bulb	T6	T.T. U U
		View Larger
Base	Bi-Pin (G12)	
Wattage	70	ADDITIONAL RESOURCES
Rated Life	15000 hrs	<u>Catalogs</u>
Bulb Material Lamp Enclosure Type	Quartz Enclosed fixtures only	Testimonials
(LET)	-	Brochures Product Brochures
Additional Info	UV control	Ceramic Metal Halide     Application/Segment Brochures     Centraster Listering
PHOTOMETRIC CHA	RACTERISTICS	<u>Contractor Lighting</u> MSDS (Material Safety Data Shoets)
Initial Lumens	6000	MSDS (Material Safety Data Sheets) Disposal Policies & Recycling Information
Mean Lumens	4600	
Nominal Initial Lumen per Watt	s 85	
Color Temperature	4200 K	
Color Rendering Index (CRI)	< 93	
ELECTRICAL CHAR	ACTERISTICS	
Burn Position	Universal burning positio	n
Warm Up Time to 90% (MAX)	6 2 min/3	
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 INFORMA	TION	
Product Code	20023	
Description	CMH70TU/942/G12	
ANSI Code	M139/M85/M98	
Standard Package	Case	
Standard Package GTIN	10043168200230	

Standard Package

Quantity

12

Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	12
UPC	043168200233

#### **COMPATIBLE GE BALLASTS**

Product Code	Description	# of Bulbs	Power Factor	Ballast Factor
87531	GEMH70-MSF-120	1	99.0	1.0
87546	GEMH70-SLJ-MV	1	99.0	1.0
86847	M70MLTLC3M500K	1	90.0	1.0
86576	11210277CTC000C		90.0	1.0
<u>86578</u>	11210506CTC000C	1	90.0	1.0
<u>86839</u>	M7048TLC3M500K	1	90.0	1.0

#### **A** CAUTIONS & WARNINGS

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

#### See list of cautions & warnings.

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**Product Details** 





Product description: EAN/ Product : Quantity:

FM 11W/760 W4,3 UNV1 4050300579979 Unpacked (UNV) contains 1 Piece (PC)

You can find this product in the eCatalog: http://catalog.myosram.com?~language=EN&~country=&it_p=4050300579979

General Description	
Base	W4.3
Energy label	В
ILCOS	FDH-11/60/2A-L/P-W4,3
Recycling (WEEE)	yes
Technical - Electrical Data	
Luminous Efficacy in Im/W	52 lm/W
Rated wattage in Watts	11 W
Technical - Light Technical Data	
Luminous output in lumen	570 lm
Technical - Colors	
Colour appearance	LUMILUX Daylight
Colour rendering group	2A
Colour rendering index (Ra)	Min. 70 Max. 79
Colour temperature in Kelvin	6000 K
Technical - Geometries	
Length in mm	421.6 mm
Tube diameter in mm	7 mm
Technical - Life	
Average lamp life in hours	8000 h ¹⁾
Economic life in hours	6000 h ²⁾

Packaging units							
EAN	Packaging type and content	Dimensions in h x w x l	Gross weight	Volume			
4050300579979	Unpacked contains 1 Piece	0,000 mm x 0,000 mm x 0,000 mm	0,000 kg (0,019 kg)	0,000 Cubic dec.			
4050300579986	Shipping carton box contains 20 Piece	40,000 mm x 103,000 mm x 439,000 mm	0,456 kg (0,380 kg)	1,809 Cubic dec.			

²⁾ with preheat ECG

		ghting	r & Industrial			
WORLDWIDE PART	NER				Commercio	l Products & Solutions
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,				Wh	ere to Buy   FA	AQs   Contact Us   EliteNe
34385 – F18TBX/ GE Ecolux® Biax® T4 Wigh Color Rendering Energy Savings			pitality; Office; Resta		Base	PRINT
GENERAL CHARACT	ERISTICS			State and State		
Lamp type		iorescent - Plug-li	 n	2.7		
Bulb	T4			2	View Larger	
Base	GX24q-2					
Wattage	18		ADDITIONAL	RESOURCES		
Voltage	120/100		Catalogs			
Rated Life	12000 hrs		Testimonials			
Starting Temperature	0 °C (32 °F)		Brochures     Product Bro     Ecolux	chures		
Cathode Resistance	6.050 Ohm		Ecolux (E	Environmental)		
Additional Info	Dimmable w dimming bal Protection (E compliant	ith appropriate last., End of Life EOL), TCLP	Sell Sheets <ul> <li>Fast Warmi</li> </ul> Disposal Policy	ng cies & Recycling Information		
Primary Application	Facilities; Re	etail Display; Office; Restaurant	;			
PHOTOMETRIC CHA	RACTERISTIC	CS				
nitial Lumens	1200					
Mean Lumens	1020					
Nominal Initial Lumens per Watt	66					
Color Temperature	4100 K					
Color Rendering Index (CRI)	82					
	CTERISTICS	·				
Current (max)	5.2500 A					
Open Circuit Voltage (after preheating) (MAX)	250 V					
Open Circuit Voltage (after preheating) Min @ Temperature	550 V @ 10	°C, 550 V @ 15 °	C			
Open Circuit Voltage Across Starter (MIN)	198 V					
_amp Current	0.225 A					
Preheat Voltage (MIN)	4 V					
Current Crest Factor (MAX)	1.7					
Supply Current Frequency	60 Hz					

#### DIMENSIONS

Maximum Overall Length (MOL)	4.8000 in (121.9 mm)
Nominal Length	4.800 in (121.9 mm)
Base Face to Top of Lamp	4.250 in (107.9 mm)

#### PRODUCT INFORMATION

Product Code	34385
Description	F18TBX/SPX41/A/4
ANSI Code	60901-IEC-3418-1
Standard Package	Case
Standard Package GTIN	10043168343852
Standard Package Quantity	10
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	10
UPC	043168343855

#### **COMPATIBLE GE BALLASTS**

Product Code	Description	# of Bulbs	Power Factor	Ballast Factor
80675	C218UNVBEIP	1	95.0	1.05
<u>80677</u>	C218UNVBES- IP	1	95.0	1.05
<u>80679</u>	C218UNVSE- IP	1	95.0	1.05

#### A CAUTIONS & WARNINGS

See list of cautions & warnings.

#### NOTES

- 4-Pin lamp minimum starting temperature is a function of the ballast. Most ballasts are rated with a minimum starting temperature of 50 degrees F (10 C). Ballasts are also available that provide reliable starting to 0 degrees F (-18C) and -20 F (-29C).
- Amalgam product experience stable brightness over a wider temperature range and in various operating positions.
- Based on 60Hz reference circuit.
- Fluorescent lamp lumens decline during life

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the following notice applies: WARNING: This lamp can cause serious skin burn and eye inflammation from shortwave ultraviolet radiation if the outer envelope of the lamp is broken or punctured, and the arc tube continues to operate. Do not use where people will remain more than a few minutes unless adequate shielding or other safety precautions are used. Certain types of lamp that will automatically extinguish when

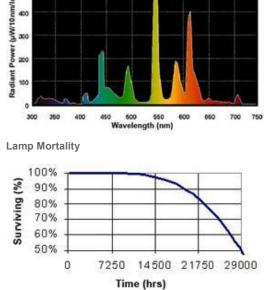
	192-1	Consume	er & Industrial		F5 Lamp
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				M	Vhere to Buy   FAQs   Contact Us   EliteN
38696 – CMH3 GE PulseArc® Sho			Stage & Studio		
GENERAL CHAR	ACTERISTICS			1	
Lamp type	High Intensity I Metal Halide	Discharge - Cera	amic	MDC	
Bulb	T6		144	ses.	
Base	Bi-Pin (G12)				
Wattage	35			. [ ]	
Rated Life (Vert)	10000 hrs		U U_	- 11 - Ju	
Primary Applicatior	Stage & Studio	)		Bulb	Base
PHOTOMETRIC C	HARACTERISTIC	S			
Initial Lumens	3400				
Nominal Initial Lumens per Watt	97			ΥΥ.	<u>View Larger</u>
Color Temperature	3000 K				
ELECTRICAL CHA	ARACTERISTICS		ADDITIONAL	RESOURCES	
Burn Position	Universal burni	na position	Catalogs		
DIMENSIONS			<u>Testimonials</u> MSDS (Materi	al Safety Data Sheets)	
Light Center Lengtl	b 2 170 in (EE 1 )	~~)	Disposal Polic	cies & Recycling Information	<u>n</u>
(LCL)	2.170 III (55.11	1111)			
PRODUCT INFOR	MATION		GRAPHS & CI Spectral Powe	HARTS er Distribution	
Product Code	38696		0.40		
Description	CMH35/T/UVC	/U/830/G12	(12)		
ANSI Code	No CMH35 AN		0.30		
Standard Package Quantity	12		0.25		
Sales Unit	Unit		0.15		
A CAUTIONS & V	WARNINGS		Badjant P		
See list of cautions	& warnings.		300 360		50 700 750
NOTES				Wavelength (nm)	
	only, per UL Stan	dard 1570 lp			

	GE Lighting	F6 Lamp
WORLDWIDE PARTNER	Lighting	Commercial Products & Solution
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<b>10322 – F32T8XLSPX4</b> GE Ecolux® Starcoat® T8	1HLEC	
<ul> <li>Passes TCLP, which can low</li> <li>High Color Rendering Energy Savings</li> </ul>	ver disposal costs.	
GENERAL CHARACTERIST		20)
Lamp type	Linear Fluorescent - Straight Linear	
Bulb	Т8	—
Base	Medium Bi-Pin (G13)	Bulb Base
Wattage	32	
Voltage	137	
Rated Life	24000 hrs	
Rated Life (instant start) @ Time	29000 h @ 12 h 24000 h @ 3 h	View Larger
Rated Life (rapid start) @ Time	29000 h @ 12 h	
Bulb Material	Soda lime	ADDITIONAL RESOURCES
Starting Temperature (MIN)	10 °C (50 °F)	<u>Catalogs</u>
Additional Info	TCLP compliant	<ul> <li><u>Testimonials</u></li> <li>Brochures</li> </ul>
		Application/Segment Brochures
PHOTOMETRIC CHARACTE	RISTICS	Contractor Lighting
Initial Lumens	3100	Healthcare Lighting     Office Lighting
Mean Lumens	2915	Retail Lighting
Nominal Initial Lumens per Watt	96	Product Brochures
Color Temperature	4100 K	<ul> <li>Ecolux (Environmental)</li> <li>Industrial Lighting</li> </ul>
Color Rendering Index (CRI)	82	ULTRA Linear Fluorescent
S/P Ratio (Scotopic/Photopic Ratio)	1.8	Sell Sheets <ul> <li>F32T8 High Lumen Linear Fluorescent System</li> </ul>
ELECTRICAL CHARACTERI	STICS	MSDS (Material Safety Data Sheets) Disposal Policies & Recycling Information
Open Circuit Voltage (rapid start) Min @ Temperature	315 V @ 10 °C	GRAPHS & CHARTS
Cathode Resistance Ratio - Rh/Rc (MIN)	4.25	Spectral Power Distribution
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)	

Bulb Diameter (DIA) (MIN)	0.940 in (23.8 mm)
Bulb Diameter (DIA) (MAX)	1.100 in (27.9 mm)
Max Base Face to Base Face (A)	47.220 in (1199.3 mm)
Face to End of Opposing Pin (B) (MIN)	47.400 in (1203.9 mm)
Face to End of Opposing Pin (B) (MAX)	47.500 in (1206.5 mm)
End of Base Pin to End of Opposite Pin End (C)	47.670 in (1210.8 mm)

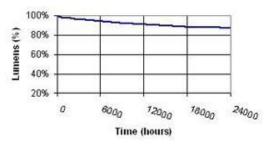
#### PRODUCT INFORMATION

Product Code	10322
Description	F32T8XLSPX41HLEC
ANSI Code	1005-2
Standard Package	Case
Standard Package GTIN	10043168103227
Standard Package Quantity	36
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	36
UPC	043168103220



#### Lumen Maintenance

500



#### COMPATIBLE GE BALLASTS

Product		# of	Power	Ballast
Code	Description	Bulbs	Factor	Factor
<u>49772</u>	GE232MAX- N/ULTRA	1	99.0	0.87
<u>80353</u>	B132R120V5	1	90.0	0.05
<u>49774</u>	GE432MAX- N/ULTRA	3	99.0	0.87
<u>49709</u>	GE432MAX- L/ULTRA	3	99.0	0.77
<u>49776</u>	GE332MAX- H/ULTRA	2	99.0	1.15
<u>97656</u>	GE232MAX- N/CTR	1	99.0	0.87
<u>97709</u>	GE-232MV-N-DIY	1	99.0	1.02
80358	B332SR277V5		90.0	0.05
<u>97711</u>	GE-432MV-N-DIY	3	99.0	0.93
80356	B232SR277V5	2		0.05
<u>30198</u>	GE-232-MV-H	1	99.0	1.34
<u>30192</u>	GE-332-MV-N	2	99.0	0.96
29656	GE-332-MV-PS- H-T	2	98.0	1.28
<u>29666</u>	GE-332-MVPS- XL-T	2	98.0	0.64
<u>30189</u>	GE-132-MV-N	1	99.0	0.87
29632	GE-232-277PS-N- T	1	95.0	1.03
<u>29672</u>	GE-332-MVPS-XL	2	98.0	0.64
<u>29676</u>	GE-332-MVPS-H	2	98.0	1.28
<u>29625</u>	GE-432-120-PS-N	3	99.0	0.96
<u>29623</u>	GE-332-120-PS-N	2	99.0	1.0
<u>49707</u>	GE232MAX- L/ULTRA	1	99.0	0.77
24161	GE-132-120-N-	1	99.0	0.87

WORLDWIDE PAR			F7 Lamp
<u>S</u>	ITE SEARCH > HOME	PRODUCTS > EDUCATION / RESOURCE	CES > LIGHTING APPLICATIONS
<b>97632 – F32TB</b> ) GE Ecolux® Biax® ⁻	<b>X/841/A/ECO</b> T4 - Facilities; Retail Display; Hospita	lity; Office; Restaurant; Warehouse	Where to Buy   FAQs   Contact Us   EliteNe
High Color Renderin Energy Savings	g	- Bulb	Base
GENERAL CHARA	CTERISTICS		
Lamp type	Compact Fluorescent - Plug-In	-	
Bulb	Τ4	_	View Larger
Base	GX24q-3		
Wattage	32	ADDITIONAL RESOURCES	
Voltage	120/100	<u>Catalogs</u>	
Rated Life	12000 hrs	<u>Testimonials</u> Brochures	
Starting Temperature (MIN)	0 °C (32 °F)	Product Brochures	
Cathode Resistance	2.700 Ohm	Ecolux (Environmental) Sell Sheets	
Rated Life (rapid start) @ Time	12000 h @ 3 h 20000 h @ 12 h	<ul> <li>Fast Warming</li> <li>Biax® T/E 32W with Amalgam</li> </ul>	
Additional Info	Dimmable with appropriate dimming ballast., End of Life Protection (EOL), TCLP compliant	Disposal Policies & Recycling Informatio	<u>on</u>
Primary Application	Facilities; Retail Display; Hospitality; Office; Restaurant; Warehouse	-	
PHOTOMETRIC CH	IARACTERISTICS		
Initial Lumens	2200	_	
Mean Lumens	1850	_	
Nominal Initial Lumens per Watt	68	-	
Color Temperature	4100 K	_	
Color Rendering Index (CRI)	82	-	
	RACTERISTICS		
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	-	

(MIN) Current Crest

Factor (MAX)
Supply Current

Frequency

1.7

20000 Hz

#### DIMENSIONS

Maximum Overall Length (MOL)	5.5000 in (139.7 mm)
Nominal Length	5.500 in (139.7 mm)
Base Face to Top of Lamp	4.900 in (124.4 mm)

#### **PRODUCT INFORMATION**

Product Code	97632
Description	F32TBX/841/A/ECO
ANSI Code	60901-IEC-7432-2
Standard Package	Case
Standard Package GTIN	10043168976326
Standard Package Quantity	10
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	10
UPC	043168976329

#### **COMPATIBLE GE BALLASTS**

Product Code	Description	# of Bulbs	Power Factor	Ballast Factor
<u>80689</u>	C2642UNVSE- IP	1	98.0	1.0
<u>47506</u>	C242UNVBES- IP	2	98.0	1.0
<u>80685</u>	C2642UNVBE- IP	1	98.0	1.0
80687	C2642UNVBES- IP	1	98.0	1.0
<u>47509</u>	C242UNVSE-IP	2	98.0	1.0

#### A CAUTIONS & WARNINGS

#### See list of cautions & warnings.

#### NOTES

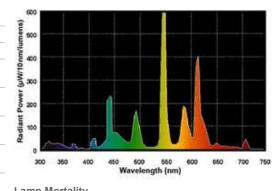
- 4-Pin lamp minimum starting temperature is a function of the ballast. Most ballasts are rated with a minimum starting temperature of 50 degrees F (10 C). Ballasts are also available that provide reliable starting to 0 degrees F (-18C) and -20 F (-29C).
- Amalgam product experience stable brightness over a wider temperature range and in various operating positions.
- Based on 60Hz reference circuit.
- Fluorescent lamp lumens decline during life

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27621 – F32T8XL/SPX4 GE Ecolux® Starcoat® T8	I1ECO	
Passes TCLP, which can low	ver disposal costs.	
<ul> <li>Provides significantly longer l helping to reduce maintenance</li> </ul>		
High Color Rendering		
GENERAL CHARACTERISTI	CS	
Lamp type	Linear Fluorescent - Straight Linear	
Bulb	Т8	Bulb Base
Base	Medium Bi-Pin (G13)	
Wattage	32	
Voltage	137	
Rated Life	24000 hrs	
Rated Life (instant start) @ Time	29000 h @ 12 h 24000 h @ 3 h	View Larger
Rated Life (rapid start) @ Time	29000 h @ 12 h	ADDITIONAL RESOURCES
Bulb Material	Soda lime	Catalogs
Starting Temperature (MIN)	10 °C (50 °F)	Testimonials     Brochures
Additional Info	TCLP compliant	Product Brochures • Color
PHOTOMETRIC CHARACTE	RISTICS	• Ecolux
Initial Lumens	2950	<ul> <li><u>Ecolux (Environmental)</u></li> <li>Industrial Lighting</li> </ul>
Mean Lumens	2800	Linear Fluorescent Lamps
Nominal Initial Lumens per Watt	92	XL Brochure     Application/Segment Brochures     Contractor Lighting
Color Temperature	4100 K	Healthcare Lighting
Color Rendering Index (CRI)	86	Office Lighting     Retail Lighting
S/P Ratio (Scotopic/Photopic Ratio)	1.8	MSDS (Material Safety Data Sheets) Disposal Policies & Recycling Information
	STICS	
Open Circuit Voltage (rapid start) Min @ Temperature	315 V @ 10 °C	GRAPHS & CHARTS  Spectral Power Distribution
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)	 1)
<u> </u>		

Bulb Diameter (DIA)	1.000 in (25.4 mm)
Bulb Diameter (DIA) (MIN)	0.940 in (23.8 mm)
Bulb Diameter (DIA) (MAX)	1.100 in (27.9 mm)
Max Base Face to Base Face (A)	47.220 in (1199.3 mm)
Face to End of Opposing Pin (B) (MIN)	47.400 in (1203.9 mm)
Face to End of Opposing Pin (B) (MAX)	47.500 in (1206.5 mm)
End of Base Pin to End of Opposite Pin End (C)	47.670 in (1210.8 mm)



#### **PRODUCT INFORMATION**

Product Code	27621
Description	F32T8XL/SPX41ECO
ANSI Code	1005-2
Standard Package	Case
Standard Package GTIN	10043168276211
Standard Package Quantity	36
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	36
UPC	043168276214



Lumen Maintenance



#### COMPATIBLE GE BALLASTS

Product Code	Description	# of Bulbs	Power Factor	Ballast Factor
<u>49772</u>	GE232MAX- N/ULTRA	1	99.0	0.87
80353	B132R120V5	1	90.0	0.05
<u>49774</u>	GE432MAX- N/ULTRA	3	99.0	0.87
<u>49709</u>	GE432MAX- L/ULTRA	3	99.0	0.77
<u>49776</u>	GE332MAX- H/ULTRA	2	99.0	1.15
<u>97656</u>	GE232MAX- N/CTR	1	99.0	0.87
97709	GE-232MV-N-DIY	1	99.0	1.02
80358	B332SR277V5	3	90.0	0.05
<u>97711</u>	GE-432MV-N-DIY	3	99.0	0.93
80356	B232SR277V5	2		0.05
<u>30198</u>	GE-232-MV-H	1	99.0	1.34
<u>30192</u>	GE-332-MV-N	2	99.0	0.96
<u>29656</u>	GE-332-MV-PS- H-T	2	98.0	1.28
<u>29666</u>	GE-332-MVPS- XL-T	2	98.0	0.64
<u>30189</u>	GE-132-MV-N	1	99.0	0.87
29632	GE-232-277PS-N- T	1	95.0	1.03
29672	GE-332-MVPS-XL	2	98.0	0.64
<u>29676</u>	GE-332-MVPS-H	2	98.0	1.28
<u>29625</u>	GE-432-120-PS-N	3	99.0	0.96
<u>29623</u>	GE-332-120-PS-N	2	99.0	1.0
<u>49707</u>	GE232MAX- L/ULTRA	1	99.0	0.77

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42068 – CMH39UF			D
	seArc® CMH® Ceramic Metal H	lalide PAR20	
GENERAL CHARACTE	RISTICS		
Lamp type	High Intensity Discharge - Ceramic Metal Halide		
Bulb	PAR20	MOL (	
Base	Medium Screw (E26)		
Wattage	39		
Rated Life	10000 hrs		
Bulb Material	Hard glass	Bulb Ba	ase
_amp Enclosure Type (LET)	Open or enclosed fixtures		
Additional Info	Ballast thermal protection, U control	v J	
PHOTOMETRIC CHAR	ACTERISTICS	Vi	iew Larger
Initial Lumens	2100		
Nominal Initial Lumens per Watt	53	ADDITIONAL RESOURCES Catalogs	
Beam Spread	25 °	<u>Testimonials</u>	
Center Beam Candlepower (CBCP)	7500	Brochures Product Brochures Ceramic Metal Halide	
Color Temperature	3000 K	Ceramic Metal Halide     Color	
Color Rendering Index (CRI)	86	HID Lamps     Application/Segment Brochures	
ELECTRICAL CHARAC	CTERISTICS	Contractor Lighting     Restaurant Lighting     Sell Sheets	
Burn Position	Universal burning position	GE ConstantColor® CMH® Lamps	
Open Circuit Voltage (peak lead ballast) (MIN	280 V )	IES/Photometric Download MSDS (Material Safety Data Sheets)	
Open Circuit Voltage (RMS lag ballast) (MIN)	198 V	Disposal Policies & Recycling Information	
Warm Up Time to 90% (MAX)	2 min/3		
Hot Restart Time to 90% (MIN)	6 10 min		
Hot Restart Time to 90% (MAX)	6 15 min		

DIMENSIONS	
Maximum Overall Length (MOL)	3.5000 in (88.9 mm)
Nominal Length	3.500 in (88.9 mm)
Bulb Diameter (DIA)	2.500 in (63.5 mm)

#### PRODUCT INFORMATION

Product Code 42068

http://genet.gelighting.com/LightProducts/Dispatcher?REQUEST=COMMERCIALSPEC... 3/29/2007

Description	CMH39UPAR20FL25
ANSI Code	M130
Standard Package	Case
Standard Package GTIN	10043168420683
Standard Package Quantity	15
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	15
UPC	043168420686

#### COMPATIBLE GE BALLASTS

Product	Description	# of	Power	Ballast
Code		Bulbs	Factor	Factor
<u>87501</u>	GEMH39- MSF-120	1	99.0	1.0

#### A CAUTIONS & WARNINGS

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

#### See list of cautions & warnings.

#### NOTES

• Rated life based on 11 hours per start

 Use electronic ballast, peak lead ballast, or system which can shut itself off if ballast overheating occurs

Return To Top

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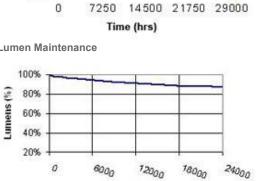
	GE Lighting			F11 Lamp
WORLDWIDE PARTNER				Commercial Products & Solutions
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<b>15484 – F17T8XL/SPX</b> GE Ecolux® Starcoat® T8	1ECO		<u>What</u>	ere to Buy   FAQs   Contact Us   EliteNet
• Passes TCLP, which can low	ver disposal costs.			
Provides significantly longer     helping to reduce maintenance				
High Color Rendering				
GENERAL CHARACTERISTI	cs			
Lamp type	Linear Fluorescent - Straight Linear			
Bulb	Т8		Bulb	ase
Base	Medium Bi-Pin (G13)			
Wattage	17			
Voltage	70			
Rated Life	24000 hrs			
Rated Life (instant start) @ Time	24000 h @ 12 h 20000 h @ 3 h		<u>\</u>	/iew Larger
Rated Life (rapid start) @ Time	29000 h @ 12 h	ADDITIONAL I	RESOURCES	
Bulb Material	Soda lime	<u>Catalogs</u>		
Starting Temperature (MIN)	10 °C (50 °F)	<ul> <li><u>Testimonials</u></li> <li>Brochures</li> </ul>		
Additional Info	TCLP compliant	Application/S	Segment Brochures	
		Contracto     Healthcar		
PHOTOMETRIC CHARACTE		Office Lig		
Initial Lumens	1350 1280	<ul> <li><u>Retail Lig</u></li> <li>Product Brod</li> </ul>		
Mean Lumens Nominal Initial Lumens per	79	Industrial		
Watt	15		al Safety Data Sheets)	
Color Temperature	4100 K	Disposal Polic	cies & Recycling Information	
Color Rendering Index (CRI)	86			
S/P Ratio (Scotopic/Photopic Ratio)	1.8	GRAPHS & CH Spectral Powe		
ELECTRICAL CHARACTERI		600 (seus)		
Open Circuit Voltage (rapid start) (MAX)	285 V	(W/10 nm/lumens) 00 00 00		
Open Circuit Voltage (rapid start) Min @ Temperature	210 V @ 10 °C			
Cathode Resistance Ratio - Rh/Rc (MIN)	4.25	Radiant Power		
Cathode Resistance Ratio - Rh/Rc (MAX)	6.5	Radia		
Current Crest Factor (MAX)	1.7	300 350	400 450 <mark>500 550 600 650</mark> Wavelength (nm)	700 750
DIMENSIONS		Lamp Mortalit	у	
Maximum Overall Length (MOL)	23.7800 in (604.0 mm)			

Minimum Overall Length	23.6700 in (601.2 mm)	100%	_
Nominal Length	24.000 in (609.6 mm)	\$ 90%	>
Bulb Diameter (DIA)	1.000 in (25.4 mm)	<b>2</b> 80%	
Bulb Diameter (DIA) (MIN)	0.940 in (23.8 mm)	<u>≩</u> 70%	-
Bulb Diameter (DIA) (MAX)	1.100 in (27.9 mm)	J 60%	-
Max Base Face to Base Face (A)	23.220 in (589.7 mm)	50%       0 7250 14500	217
Face to End of Opposing Pin (B) (MIN)	23.400 in (594.3 mm)	Time (hrs)	
Face to End of Opposing Pin (B) (MAX)	23.500 in (596.9 mm)	Lumen Maintenance	
End of Base Pin to End of	23 670 in (601 2 mm)	100%	-



#### PRODUCT INFORMATION

Product Code	15484
Description	F17T8XL/SPX41ECO
ANSI Code	1001-1
Standard Package	Case
Standard Package GTIN	10043168154847
Standard Package Quantity	24
Sales Unit	Unit
No Of Items Per Sales Unit	1
No Of Items Per Standard Package	24
UPC	043168154840

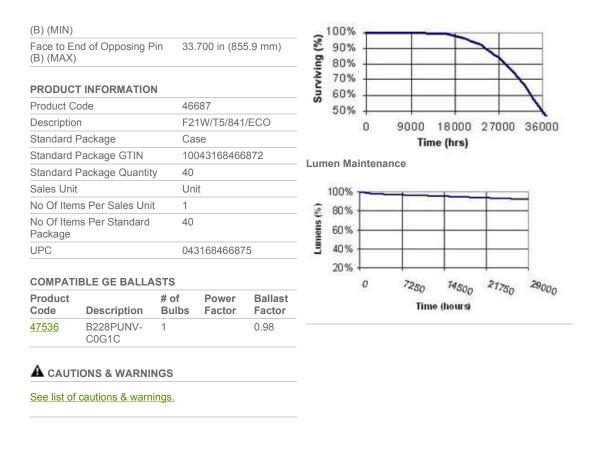




#### **COMPATIBLE GE BALLASTS**

Product Code	Description	# of Bulbs	Power Factor	Ballast Factor
				Factor
<u>47550</u>	GE432MAX-H- 42T	3	99.0	
<u>49772</u>	GE232MAX- N/ULTRA	1	99.0	
<u>49707</u>	GE232MAX- L/ULTRA	1	98.0	
<u>47548</u>	GE232MAX-H- 42T	1	99.0	
<u>49709</u>	GE432MAX- L/ULTRA	3	99.0	
<u>97656</u>	GE232MAX- N/CTR	1	99.0	
<u>97709</u>	GE-232MV-N-DIY	1	99.0	1.0
<u>49776</u>	GE332MAX- H/ULTRA	2	99.0	
<u>97711</u>	GE-432MV-N-DIY	3	99.0	0.91
<u>49774</u>	GE432MAX- N/ULTRA	3	99.0	
<u>30192</u>	GE-332-MV-N	2	99.0	0.92
<u>30189</u>	GE-132-MV-N	1	99.0	0.88
<u>29632</u>	GE-232-277PS-N- T	1	88.0	1.02
<u>29656</u>	GE-332-MV-PS- H-T	2	98.0	1.25
29676	GE-332-MVPS-H	2	98.0	1.25
29625	GE-432-120-PS-N	3	99.0	0.96
29666	GE-332-MVPS- XL-T	2	98.0	0.65
<u>29672</u>	GE-332-MVPS-XL	2	98.0	0.65

	GE Lighting	F12, F14, F15 Lamp
WORLDWIDE PARTNER	99	Commercial Products & Solutio
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46687 – F21W/T5/841/	ECO	PRINT
GE Ecolux® Starcoat® T5		
Passes TCLP, which can lov	ver disposal costs.	
GENERAL CHARACTERIST	ICS	
Lamp type	Linear Fluorescent - Straight Linear	
Bulb	T5	
Base	Miniature Bi-Pin (G5)	—
Wattage	21	Bulb Base
Voltage	123	
Rated Life	30000 hrs	- q
Rated Life (rapid start) @ Time	30000 h @ 3 h 36000 h @ 12 h	d_
Bulb Material	Soda lime	View Larger
Starting Temperature (MIN)	-20 °C (-4 °F)	
Additional Info	TCLP compliant	ADDITIONAL RESOURCES
		Catalogs
PHOTOMETRIC CHARACTE	RISTICS	Testimonials
Initial Lumens	2100	Brochures
Mean Lumens	1930	Application/Segment Brochures  Contractor Lighting
Nominal Initial Lumens per Watt	100	Healthcare Lighting     Product Brochures
Color Temperature	4100 K	• Ecolux
Color Rendering Index (CRI)	85	Ecolux (Environmental)
S/P Ratio (Scotopic/Photopic Ratio)	1.7	Disposal Policies & Recycling Information
ELECTRICAL CHARACTER	ISTICS	GRAPHS & CHARTS Spectral Power Distribution
Open Circuit Voltage (rapid start) Min @ Temperature	340 V @ 10 °C	
Cathode Resistance Ratio - Rh/Rc (MIN)	4.25	Biddiant Power (pWi10) multimension
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)	300 350 400 450 600 550 600 650 700 750 Wavelength (nm)
Bulb Diameter (DIA)	0.625 in (15.8 mm)	
Bulb Diameter (DIA) (MAX)	0.670 in (17.0 mm)	Lamp Mortality
Max Base Face to Base Face (A)	, ,	



Return To Top

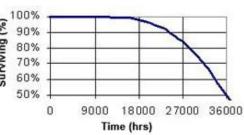
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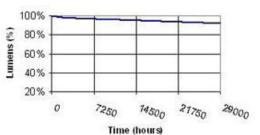
<u> </u>	GE Lighting		F13 Lamp
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46761 – F54W/T5/841/E	<u> </u>		D
GE Ecolux® Starcoat® T5	00		
Passes TCLP, which can lowe	er disposal costs.		
High Color Rendering			
GENERAL CHARACTERISTIC	2S	Ξ=	
Lamp type	Linear Fluorescent -		
	Straight Linear	_	
Bulb Base	T5 Miniature Bi-Din (G5)	_	
Base Wattage	Miniature Bi-Pin (G5) 54	-	
Vattage	117	Bulb Bas	e
Rated Life	30000 hrs	-	
Rated Life (rapid start) @	30000 h @ 3 h 36000 h @ 12 h	C	t.
Bulb Material	Soda lime		w Larger
Starting Temperature (MIN)	-20 °C (-4 °F)		
Additional Info	TCLP compliant	ADDITIONAL RESOURCES	
PHOTOMETRIC CHARACTER	RISTICS	<u>Catalogs</u> Testimonials	
nitial Lumens	5000	Brochures	
Mean Lumens	4600	Product Brochures	
Nominal Initial Lumens per Watt	92	<ul> <li>Ecolux</li> <li>Ecolux (Environmental)</li> <li>Application/Segment Brochures</li> </ul>	
Color Temperature	4100 K	Healthcare Lighting	
Color Rendering Index (CRI)	85	Contractor Lighting	
S/P Ratio (Scotopic/Photopic	1.7	<ul> <li>Fluorescent</li> <li>Starcoat® T5 Linear Fluorescent Lamps</li> </ul>	
Ratio)		Disposal Policies & Recycling Information	
ELECTRICAL CHARACTERIS	TICS		
Open Circuit Voltage (rapid start) Min @ Temperature	520 V @ 10 °C	GRAPHS & CHARTS Spectral Power Distribution	
Cathode Resistance Ratio - Rh/Rc (MIN)	4.25	2000 20	
Cathode Resistance Ratio - Rh/Rc (MAX)	6.5	(sueemn), Auto (sueemn), Auto	
Lamp Current	460 mA	W10*	
Current Crest Factor (MAX)	1.7	3 300	
DIMENSIONS		2000 1000	
Maximum Overall Length (MOL)	45.8000 in (1163.3 mm)	The second secon	
Nominal Length	45.200 in (1148.0 mm)	300 350 400 450 500 550 600 650 7	00 750
Bulb Diameter (DIA)	0.625 in (15.8 mm)	Wavelength (nm)	
Bulb Diameter (DIA) (MAX)	0.670 in (17.0 mm)	Lamp Mortality	
Max Base Face to Base Face	45.240 in (1149.0 mm)	—	

Face to End of Opposing Pin (B) (MIN)	45.420 in (1153.6 mm)	2 100% 2 90%
Face to End of Opposing Pin (B) (MAX)	45.520 in (1156.2 mm)	60 80% -
PRODUCT INFORMATION		50% -
Product Code	46761	
Description	F54W/T5/841/ECO	- 0
Standard Package	Case	-
Standard Package GTIN	10043168467619	Lumen Maint
Standard Package Quantity	40	100%
Sales Unit	Unit	-
No Of Items Per Sales Unit	1	° 80% −
No Of Items Per Standard	40	■ 60% +

043168467612



ntenance



#### **COMPATIBLE GE BALLASTS**

Package

UPC

Product Code	Description	# of Bulbs	Power Factor	Ballast Factor
<u>29717</u>	GE454MVPSN1- B	1	99.0	1.0
<u>87666</u>	GE-254-MV-PS- NLB	1	99.0	1.02
<u>47542</u>	B254PUNV- DGE1C	1	99.0	1.02
87636	B254PUNV-DL	1	98.0	1.1
<u>87651</u>	GE-454-MV-PS- NLB	1	99.0	1.0
<u>87621</u>	GE-454-MV-PS- NL	1	99.0	1.0
<u>29726</u>	GE454MVPSN1	1	99.0	1.0

#### **A** CAUTIONS & WARNINGS

See list of cautions & warnings.

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34676 – Q100T3/12V/CL				
GE T3		_		
GENERAL CHARACTERISTICS	i	4		
Lamp type	Halogen - Single- Ended	5		
Bulb	T3	3		
Base	2-Pin (GY6.35)	E		
Filament	CC-6			
Wattage	100			
Voltage	12	_	Bulb Filament	
Voltage (MIN)	100	_		
Rated Life	2000 hrs	_	Ц Ц Ц	
Rated Life (Vert)	2000 hrs		H M	
PHOTOMETRIC CHARACTERIS	STICS		View Large	-
Initial Lumens	2350			-
Initial Lumens (Hor)	23.5	ADDITIONAL RESOU	RCES	
Initial Lumens (Vert)	2350	Catalogs		
Nominal Initial Lumens per Watt	23	<b>Testimonials</b>		
DIMENSIONS		MSDS (Material Safet	<u>ty Data Sheets)</u> Recycling Information	
Maximum Overall Length (MOL)	1.7500 in (44.4 mm)			-
Bulb Diameter (DIA)	0.375 in (9.5 mm)	-		
PRODUCT INFORMATION Product Code	34676	_		
Description	Q100T3/12V/CL	_		
Standard Package	BUNDLE	_		
Standard Package GTIN	30043168346765	_		
Standard Package Quantity	100			
Sales Unit	Unit	-		
No Of Items Per Sales Unit	1			
No Of Items Per Standard Package	100			
UPC	043168346764	-		
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<b>87546 – GEMH70-</b> GE HID UltraMax™ Ele		ncy Ballast					
GENERAL CHARACTE	RISTICS						
Category	High Intensity Dis	charge	1.27				
Ballast Type	Electronic - Low F	-	A Start Barrier	1-		1000 00.001	
Line Voltage Regulation (+/-)	10 %			ſ	0		
Ambient Temperature (MAX)	55 °C (131 °F)		100-100-100 B				
Case Temperature (MAX)	90 °C (194 °F)						_
Ballast Factor	Normal					View Large	<u>_</u>
Sound Rating	A (20-24 decibels	)	DIMENSIONO				
Enclosure Type	Metal		DIMENSIONS				
Distance to Lamp	8 ft		Case dimensions	70:	m (104	01 mama)	
(MAX)			Length (L)			91 mm)	
Additional Info End of Life Protection Thermally protected			Width (W) Height (H)		n (65.5 n (55.8		_
			Mounting dimensions	2.21	11 (55.0	0 11111)	_
ELECTRICAL CHARAG	CTERISTICS		Mount Length (M)	0.4 i	n (10.9	2 mm)	_
Lamp Operating	130 Hz		Weight	0.38		<u> </u>	
Frequency			Exit Type		Bottom Leads with Studs		
			Remote mounting distance to				_
			— lamp				_
Product Code	87546	/	Remote Mounting Wire	18 A	WG		
Description	GEMH70-SLJ-MV	1	Gauge	<u> </u>	E	1 0 . 7 4	-
Standard Package Standard Package	Case 10043168875469		Lead lengths	Qty	Exit	Length (± 1 in.)	
GTIN Standard Package	10		Black	1	Left	10 in (254 mm)	
Quantity	10		Brown	1	Right	10 in (254	_
Sales Unit	Case					mm)	-
No Of Items Per Sales Unit	1		Red	1	Right	10 in (254 mm)	-
No Of Items Per Standard Package	10		White	1	Left	10 in (254 mm)	
UPC	043168875462						

View Larger

Lamp	# of Lamps	Specifications by Line Vo	oltage			
И98	1		120		277	
		System Wattage (W)	77		77	
70 W Cerai	mic Metal	Nominal Current	0.66 A		0.3 A	
∃alide) 70 W Quarl	tz Metal	Ballast Factor	1		1	
Halide)		Ballast Efficiency Factor	0.91		0.91	
		Drop Out Voltage	96 V		96 V	
		Power factor (>=) %	99		97	
		Crest factor (<)	1.4		1.4	
		THD % (<)	4.9		7.7	
	Min. starting temperature	0 °F (-18	°C)	0 °F (-18 °C)		
	Fuse rating	3		3		
			System specs		System specs	
/143	1		120		277	
		System Wattage (W)	77		77	
70 W Ceraı -lalide)	mic Metal	Nominal Current	0.66 A		0.3 A	
lanue)		Ballast Factor	1		1	
		Ballast Efficiency Factor	0.91		0.91	
		Drop Out Voltage	96 V		96 V	
		Power factor (>=) %	99		97	
		Crest factor (<)	1.4		1.4	
		THD % (<)	4.9		7.7	
-	Min. starting temperature	0 °F (-18	°C)	0 °F (-18 °C)		
	Fuse rating	3		3		
			System specs		System specs	
2143	1		120		277	
		System Wattage (W)	77		77	
		Nominal Current	0.66 A		0.3 A	
		Ballast Factor	1		1	
		Ballast Efficiency Factor	0.91			
		Drop Out Voltage	96 V		96 V	
		Power factor (>=) %	99		97	
		Crest factor (<)	1.4		1.4	
		THD % (<)	4.9		7.7	
		Min. starting temperature	0 °F (-18	°C)	0 °F (-18 °C)	
		Fuse rating	3		3	
0.64.0		Fuse rating				
-	erformance			ARRANTY INFORMA	-	
RoHs Con UL Type 1 ANSI - C6 UL 1029 L	Outdoor 2.41	sumer	wil per dat	be free from defects to as defined in the	the purchaser that each ballas in material or workmanship for attached documents from the en properly installed and under e.	
cUL Listed			<u>Do</u>	wnload full warranty		
NOTES			AD	DITIONAL RESOUR	CES	
	ed lead wires			talogs		
Do not co	onnect browr	or red wires to ground	Те	Testimonials		

#### SPECIFICATIONS BY LAMP & LINE VOLTAGE

Return To Top

**Disposal Policies & Recycling Information** 

**B3** Ballast

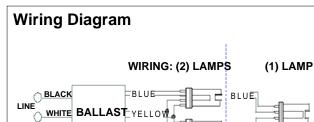


### **Electrical Specifications**

## ICF-2S18-H1-LD@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.
CFM18W/GX24Q	1	18	0/-18	0.08	20	1.05	10	0.97	1.5	5.25
* CFM18W/GX24q	2	18	0/-18	0.14	39	1.05	10	0.99	1.5	2.69
CFQ18W/G24q	1	18	0/-18	0.07	19	1.00	10	0.97	1.5	5.26
CFQ18W/G24q	2	18	0/-18	0.13	35	0.95	10	0.99	1.5	2.71
CFS16W/GR10q	2	16	0/-18	0.13	37	1.00	09	0.99	1.5	2.70
CFS21W/GR10Q	1	21	0/-18	0.07	20	0.90	15	0.97	1.5	4.50
CFS21W/GR10Q	2	21	0/-18	0.14	40	0.91	10	0.99	1.5	2.28



FIIOW∜

RED

REL

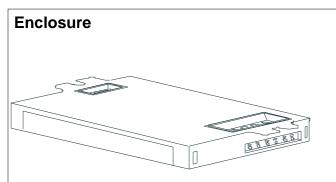
#### Green Terminal must be Grounded

GREE

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

#### Standard Lead Length (inches)

in.	cm.		in.	cm.
0.0		Yellow/Blue		
0.0		Blue/White		
0.0				
0.0		Orange		
0		v		
	0.0 0.0 0.0	0.0 0.0 0.0	0.0Yellow/Blue0.0Blue/White0.0Brown	0.0         Yellow/Blue           0.0         Blue/White           0.0         Brown           0.0         Orange           0         Orange/Black           Black/White         Black/White



#### **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 08/15/2006



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#### **ADVANCE**

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#### **Electrical Specifications**

#### Notes:

Section I - Physical Characteristics

1.1 Ballast shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.

1.2 Ballast shall be available in a plastic/metal can or all metal can construction to meet all plenum requirements.

1.3 Ballast shall be provided with poke-in wire trap connectors color coded per ANSI C82.11.

#### Section II - Performance Requirements

2.1 Ballast shall be Programmed Start except for ballasts with -QS suffix, which shall be Rapid Start.

2.2 Ballast shall contain auto restart circuitry in order to restart lamps without resetting power.

2.3 Ballast shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the IntelliVolt ballast. RCF models shall operate from 60 Hz input source of 120V with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast.

2.4 Ballast shall be high frequency electronic type and operate lamps at a frequency above 42 kHz to avoid interference with infrared devices and eliminate visible flicker.

2.5 Ballast shall have a Power Factor greater than 0.98 for primary lamp.

2.6 Ballast shall have a minimum ballast factor of 1.00 for primary lamp application.

2.7 Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less in accordance with lamp manufacturer recommendations.

2.8 Ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp. 2.9 Ballast shall have a Class A sound rating.

2.10 Ballast shall have a minimum starting temperature of -18C (0F) for primary lamp. Ballasts for PL-H lamps shall have a minimum starting temperature of -30C (-20F) for primary lamp.

2.11 Ballast shall provide Lamp EOL Protection Circuit.

2.12 Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.

Section III - Regulatory Requirements

3.1 Ballast shall not contain any Polychlorinated Biphenyl (PCB).

3.2 Ballast shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified where applicable.

3.3 Ballast shall be Underwriters Laboratories (UL) rated for use in air-handling spaces.

3.4 Ballast shall comply with ANSI C62.41 Category A for Transient protection.

3.5 Ballast shall comply with ANSI C82.11 where applicable.

3.6 Ballast shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated) except for RCF models which shall be Consumer (Class B).

#### Section IV - Other

4.1 Ballast shall be manufactured in a factory certified to ISO 9002 Quality System Standards.

4.2 Ballast shall carry a five-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 75C and three-years for a maximum case temperature of 85C (90C 3year warranty for ICF1H120-M4-XX, ICF2S42-90C-M2-XX and ICF2S70-M4-XX modesls).

4.3 Manufacturer shall have a fifteen-year history of producing electronic ballasts for the North American market.

4.4 Ballast shall be Advance part # _____ or approved equal.

Revised 08/15/2006



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## ICF-2S18-H1-LD@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

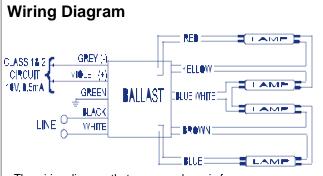
**B4 Ballast** 



#### **Electrical Specifications**

VZT-4S32-4				
Brand Name	MARK 7 0-10V			
Ballast Type	Electronic Dimming			
Starting Method	Programmed Start			
Lamp Connection	Series			
Input Voltage	277			
Input Frequency	50/60 HZ			
Status	Active			

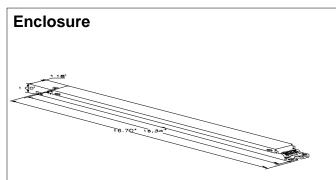
Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (Watts) (min/max)	Ballast Factor (min/max)	MAX THD %	Power Factor	Lamp Current Crest Factor	B.E.F.
F17T8	4	17	50/10	0.25	18/69	0.05/0.88	10	0.99	1.6	1.28
F25T8	4	25	50/10	0.35	22/96	0.05/0.88	10	0.99	1.7	0.92
* F32T8	4	32	50/10	0.42	25/116	0.05/0.88	10	0.99	1.6	0.76



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

#### **Standard Lead Length (inches)**

	in.	cm.		in.	cm.
Black	0	0	Yellow/Blue	0	0
White	0	0	Blue/White	0	0
Blue	0	0	Brown	0	0
Red	0	0	Orange	0	0
Yellow	0	0	ŭ	0	0
Gray	0	0	ŭ	0	0
Violet	0	0		0	0
	White Blue Red Yellow Gray	Black0White0Blue0Red0Yellow0Gray0	Black         0         0           White         0         0           Blue         0         0           Red         0         0           Yellow         0         0           Gray         0         0	Black00White00Blue00Blue00Red00Yellow00OrangeOrange/BlackGray00	Black00White00White00Blue00Blue00Red00Yellow00Orange0Gray00Winite0Black/White0



#### **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 06/17/2003



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#### **Electrical Specifications**

## IZT-2T42-M3-BS@277

Brand Name	MARK 7 0-10V
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.
* CFM32W/GX24Q	2	32	50/10	0.27	19/75	0.05/1.00	10	0.98	1.4	1.33
CFM42W/GX24Q	2	42	50/10	0.35	18/96	0.05/1.00	10	0.99	1.4	1.04
CFTR57W/GX24C	1	57	50/10	0.24	18/66	0.05/1.00	10	0.99	1.6	1.52
CFTR70W/GX24C	1	70	50/10	0.29	18/80	0.05/1.00	10	0.99	1.6	1.25

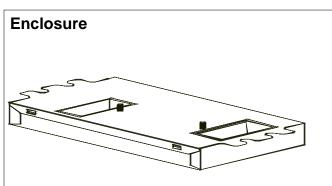
### Wiring Diagram



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

#### **Standard Lead Length (inches)**

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



#### **Enclosure Dimensions**

OverAll (L)	Width (W)	Height (H)	Mounting (M)
6.28 "	3.00 "	1.29 "	2.00 "
6 7/25	3	1 29/100	2
16 cm	7.6 cm	3.3 cm	5.1 cm

#### Revised 08/27/2003



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#### ADVANCE

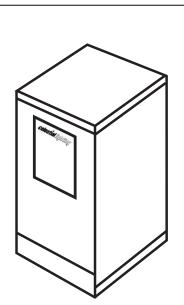
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### **TRANSFORMERS**

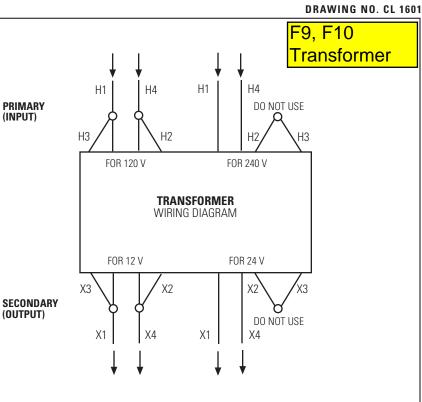
CLTF

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0211



SPECIFIER GUIDE



Primary Voltage 120V or 240V Secondary Voltage 12V or 24V NEMA Type 3 enclosure rated for outdoor use. Minimum starting temperature - 40°C ANSI/NEMA sound rating under 40 db UL and CSA Listed.

•DRAWING NOT TO SCALE•

PRODUCT DESCRIPTION

PRODUCT CODE

LISTED

S P E C I F I C A T I O N S						
PRODUCT CODE	CAPACITY (W = VA)	DIMENSIONS (H X W X D)	WEIGHT			
CLTF 50	50 VA	6.4" X 3.2" X 3.1"	4 LBS.			
CLTF 100	100 VA	7.2" X 3.9" X 3.7"	5 LBS.			
CLTF 150	150 VA	7.2" X 3.9" X 3.7"	7 LBS.			
CLTF 250	250 VA	8.7" X 4.1" X 3.9"	10 LBS.			
CLTF 500	500 VA	9.1" X 4.4" X 4.2"	15 LBS.			
CLTF 750	750 VA	9.7" X 4.8" X 4.6"	19 LBS.			
CLTF 1000	1000 VA	10.5" X 5.5" X 5.2"	24 LBS.			
CLTF 1500	1500 VA	11.7" X 5.5" X 5.2"	30 LBS.			
CLTF 2000	2000 VA	13.0" X 5.5" X 5.2"	38 LBS.			
CLTF 3000	3000 VA	11.5" X 10.4"X 7.2"	55 LBS.			
	1	FILL OUT QUANTITIES	I			

CLTF50	CLTF100	CLTF150		CLTF250	CLTF500
CLTF750	CLTF1000	CLTF1500		CLTF2000	CLTF3000
PROJECT NAME			CONTRACTOR		
FIXTURE SCHED. TYPE			DISTRIBUTOR		
SPECIFIER			REPRESENTATIVE		
<i>celestia</i>	lighting	e•mail :	iallighting.com tiallighting.com	14009 Dinard Ave. Santa Fe Springs, CA 90670	PH (562) • 802 • 8811 (800) • 233 • 3563 FX (562) • 802 • 2882

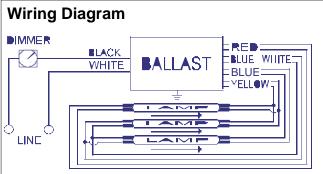
**B6** Ballast



### **Electrical Specifications**

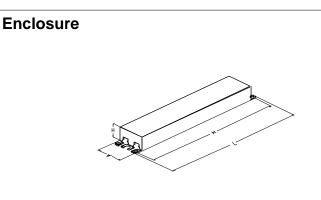
Brand Name	MARK 10 POWERLINE
Ballast Type	Electronic Dimming
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	277
Input Frequency	50/60 HZ
Status	Active

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.
F17T8	3	17	50/10	0.21	18/56	0.05/1.05	10	0.99	1.6	1.88
F25T8	3	25	50/10	0.29	19/79	0.05/1.05	10	0.99	1.6	1.33
* F32T8	3	32	50/10	0.37	20/102	0.05/1.00	10	0.99	1.6	0.98



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

#### **Standard Lead Length (inches)**



#### **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

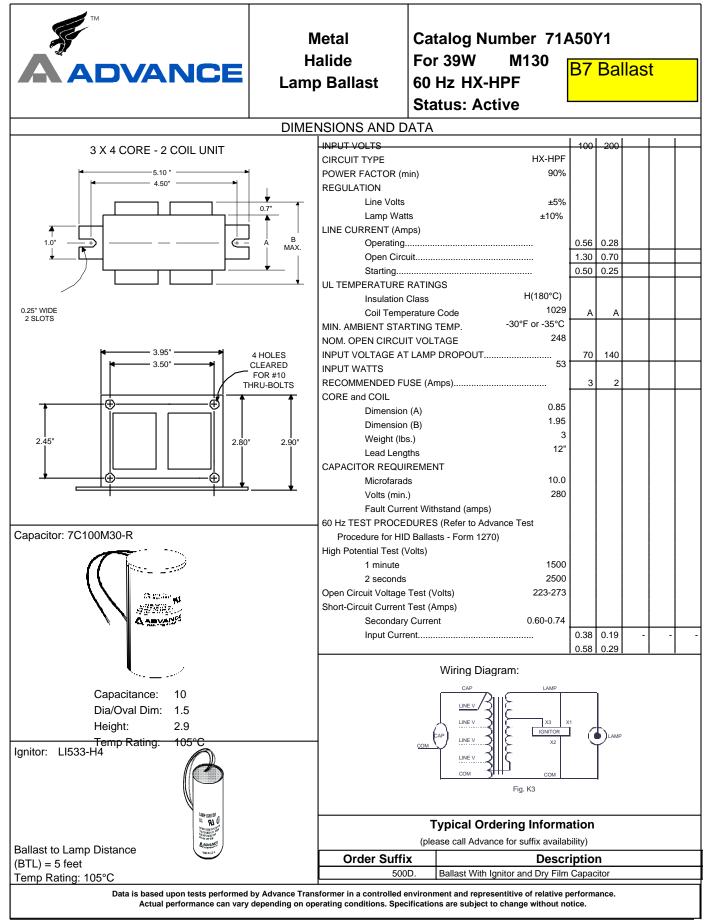
Revised 10/28/2005



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**B8** Ballast



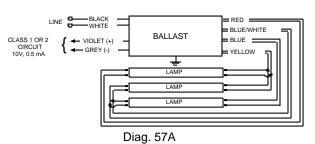
#### **Electrical Specifications**

IZT-3S32-SC@277V
------------------

Brand Name	MARK 7 0-10V
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.
* F17T8	3	17	50/10	0.20	16/54	0.03/1.00	10	0.99	1.7	1.85
F25T8	3	25	50/10	0.28	16/76	0.03/1.00	10	0.99	1.7	1.32
F32T8	3	32	50/10	0.34	18/93	0.03/1.00	10	0.99	1.7	1.08

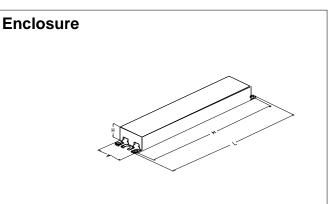




The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

#### Standard Lead Length (inches)

in.	cm.	in.	cm.
22	55.9	Yellow/Blue	0
22	55.9	Blue/White 46	116.8
26	66	Brown	0
46	116.8	Orange	0
26	66	Orange/Black	0
36	91.4	Black/White	0
36	91.4	Red/White	0
	22 22 26 46 26 36	22         55.9           22         55.9           26         66           46         116.8           26         66           36         91.4	22         55.9         Yellow/Blue           22         55.9         Blue/White         46           26         66         Brown         46           26         66         Orange         0           26         66         Black/White         46



#### **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 05/27/2004



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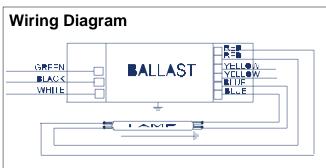
**B9 Ballast** 



### **Electrical Specifications**

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					

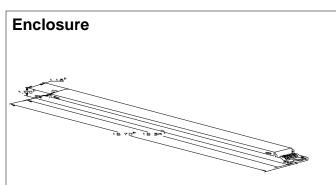
Lamp Type	Num. of Lamp s	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
F14T5	1	14	0/-18	0.07	19	1.07	20	0.90	1.7	5.63
F14T5	2	14	0/-18	0.13	34	1.06	10	0.98	1.7	3.12
* F21T5	1	21	0/-18	0.10	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



For 1 lamp operation, do not use yellow leads The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

#### **Standard Lead Length (inches)**

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



#### **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



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#### **Electrical Specifications**

#### Notes:

Section I - Physical Characteristics

1.1 Ballast shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.

1.2 Ballast shall be provided with integral leads or poke-in wire trap connectors color-coded per ANSI C82.11.

Section II - Performance Requirements

2.1 Ballast shall be Programmed Start.

2.2 Ballast shall contain auto restart circuitry in order to restart lamps without resetting power.

2.3 Ballast shall operate from 50/60 Hz input source of ______ (120V through 277V or 347V through 480V) with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast.

2.4 Ballast shall be high frequency electronic type and operate lamps at a frequency above 42 kHz to avoid interference with infrared devices and eliminate visible flicker.

2.5 Ballast shall have a Power Factor greater than 0.98 for primary lamp.

2.6 Ballast shall have a minimum ballast factor of 1.00 for primary lamp application.

2.7 Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less in accordance with lamp manufacturer recommendations.

2.8 Ballast input current shall have Total Harmonic Distortion (THD) of less than 20% for Standard models and THD of less than 10% for Centium models when operated at nominal line voltage with primary lamp.

2.9 Ballast shall have a Class A sound rating.

2.10 Ballast shall have a minimum starting temperature of ______ {-18C (0F) or -28C (-20F)} for primary lamp. Consult lamp manufacturer for temperature versus light output characteristics.

2.11 Ballast shall provide Lamp EOL Protection Circuit.

2.12 Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.

2.13 Ballast shall have a hi-low switching option when operating (4) F54T5/HO lamps to allow switching from 4-2 lamps, 3-2 lamps or 3-1 lamp.

2.14 Four-lamp ballast shall have semi-independent lamp operation.

Section III - Regulatory Requirements

3.1 Ballast shall not contain any Polychlorinated Biphenyl (PCB).

3.2 Ballast shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified where applicable.

3.3 Ballast shall comply with ANSI C62.41 Category A for Transient protection.

3.4 Ballast shall comply with ANSI C82.11 where applicable.

3.5 Ballast shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

3.6 Ballast shall comply with UL Type CC rating.

#### Section IV - Other

4.1 Ballast shall be manufactured in a factory certified to ISO 9002 Quality System Standards.

4.2 Ballast shall carry a five-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 70C. Ballasts with a "90C" designation in their catalog number shall also carry a three-year warranty at a maximum case temperature of 90C.

4.3 Manufacturer shall have a fifteen-year history of producing electronic ballasts for the North American market.

4.4 Ballast shall be Advance part # _____ or approved equal.

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 TRANSFORMER CO. O'HARE INTERNATIONAL CENTER - 10275 WEST HIGGINS ROAD ROSEMONT, ILLINOIS 60018 TELEPHONE: (847) 390-5000 FAX: (847) 390-5109

## 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

**B10** Ballast

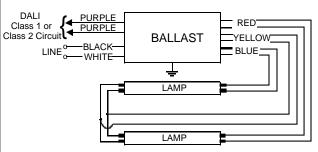


### **Electrical Specifications**

IDA-2S	54@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 Lamp s	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.
* F54T5/HO	2	54	50/10	0.45	24/125	0.03/1.00	10	0.98	1.7	0.80
FC12T5/HO	2	55	50/10	0.42	24/114	0.03/0.90	10	0.98	1.7	0.79
FT55W/2G11	2	55	50/10	0.42	24/114	0.03/0.90	10	0.98	1.7	0.79

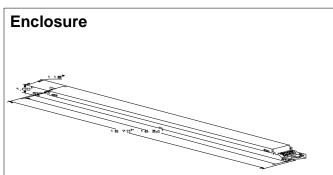




The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

#### Standard Lead Length (inches)

	in.	cm.		in.	cm.
Black	0	0	Yellow/Blue		0
White	0	0	Blue/White		0
Blue	0	0	Brown		0
Red	0	0	Orange		0
Yellow	0	0	Orange/Black		0
Gray		0	Black/White		0
Violet		0	Red/White		0
	White Blue Red Yellow Gray	Black0White0Blue0Red0Yellow0Gray1	Black         0         0           White         0         0           Blue         0         0           Red         0         0           Yellow         0         0           Gray         0         0	Black00White00Blue00Blue00Red00Yellow00Gray00Minite0	Black00White00Blue00Blue00Red00Yellow00Gray00Visite0



#### **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 01/16/2004



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



#### **Electrical Specifications**

#### Notes:

Section I - Physical Characteristics

1.1 Ballast shall be physically interchangeable with standard electromagnetic or standard electronic ballasts, where applicable.

1.2 Ballast shall be available in a plastic/metal can or all metal can construction to meet all plenum requirements.

1.3 Ballast shall be provided with poke-in wire trap connectors or integral leads color coded per ANSI C82.11.

#### Section II - Performance Requirements

2.1 Ballast shall be Programmed Start.

2.2 Ballast shall be provided with integral protection circuitry to withstand connection of low voltage control leads to mains power supply. In this event, ballast shall default to maximum light output.

2.3 Ballast shall contain auto restart circuitry in order to restart lamps without resetting power.

2.4 Ballast shall operate from 50/60 Hz input source of 120V or 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast. IntelliVolt models shall operate from 50/60 Hz input source of 120V through 277V with sustained variations of +/- 10% (voltage and frequency) with no damage to the ballast.

2.5 Ballast shall be high frequency electronic type and operate lamps at a frequency above 42 kHz to avoid interference with infrared devices and eliminate visible flicker.

2.6 Ballast shall have a Power Factor greater than 0.98 at full light output and greater than 0.90 throughout the dimming range for primary lamp.

2.7 Ballast shall have a minimum ballast factor of 1.00 at maximum light output and 0.03 at minimum light output for primary lamp application.2.8 Ballast shall provide for a Lamp Current Crest Factor of 1.7 or less throughout the dimming range in accordance with lamp manufacturer recommendations.

2.9 Ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage with primary lamp. 2.10 Ballast shall have a Class A sound rating.

2.11 Ballast shall have a minimum starting temperature of 10C (50F) for primary lamp.

2.12 Ballast shall provide Lamp EOL Protection Circuit for all T5, T5/HO, CFL lamps, and T8 lamps operating on 4-lamp ballast.

2.13 Ballast shall control lamp light output from 100% - 3% relative light output for T8 and CFL lamps and 100% - 1% relative light output for T5/HO lamps.

2.14 Ballast shall ignite the lamps at any light output setting without first going to another output setting.

2.15 Ballast shall tolerate sustained open circuit and short circuit output conditions without damage.

Section III - Regulatory Requirements

3.1 Ballast shall not contain any Polychlorinated Biphenyl (PCB).

3.2 Ballast shall be Underwriters Laboratories (UL) listed, Class P and Type 1 Outdoor; and Canadian Standards Association (CSA) certified where applicable.

3.3 Ballast shall comply with ANSI C62.41 Category A for Transient protection.

3.4 Ballast shall comply with ANSI C82.11 where applicable.

3.5 Ballast shall comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).

Section IV - Other

4.1 Ballast shall be manufactured in a factory certified to ISO 9002 Quality System Standards.

4.2 Ballast shall carry a five-year warranty from date of manufacture against defects in material or workmanship, including replacement, for operation at a maximum case temperature of 70C.

4.3 Manufacturer shall have a fifteen-year history of producing electronic ballasts for the North American market.

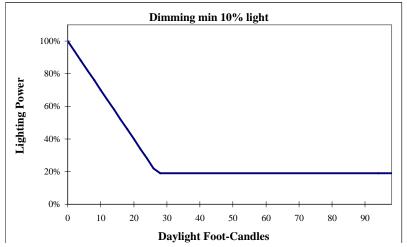
IDA-2S	54@277
Brand Name	ROVR
Ballast Type	Electronic Dimming
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

## SkyCalc Analysis

#### Version 3.0

skycalc office.xls

	n: OFFICE DESIG		Design Skylight to I	Floor Ratio = 2.7	7%
Select Location	User Generated w/ e-QU	EST 🔻	Skylights:		
Climate data loaded	ļ		Number of skylights	s 8	
Climate data needed	•		Skylight width	4.5	– ft
			Skylight length	4.5	– ft
			At least 30 skylights ne	eded for uniform o	daylighting
			Max skylight spacin		
			Skylight Descripti		
Building			Glazing type	Polycarbonate	Э
Building type	Office		Glazing layers	Double glazed	b
Bldg area	6,000	ft ²	Glazing color	Medium White	e
Ceiling height	10	ft			
Wall color	Off-white paint		Skylight Well		
			Light well height	5	feet
Shelving/Racks o	r Partitions?		Well color	Off-white pain	it
Partitions, O Shelve	es/Racks, O None/Ope	en	Safety grate or scre	een O Yes,	No No
Partition height	4	ft			
No data required	8	ft	Heating and Air C	onditioning Sy	ystems
Cubical width	8	ft	Air Conditioning	Mechanical A	/C
Cubical length	8	ft	Heating System	Gas/Oil Boiler	
Check Lighting Power De	ensity on Optional_Input	tab			
Electric Lighting			Utilities		
Lighting system	Direct/Indirect fluore	scent	Average Elec Cost	\$0.100	<u>)</u> kWh
Fixture height	8	_ ft	Heating Fuel Units		
Lighting control	Dimming min 10% li	ght	Heating Fuel Cost	\$0.500	) /Therm



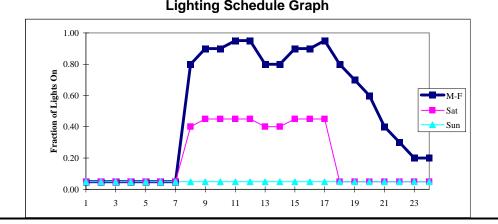
## SkyCalc: Skylight Design Assistant - Optional Inputs Company Name: NNSOC

Project Description: OFFICE DESIGN

Skylights	Default	User Revisions	Design Input
Skylight shape	Dome	Dome	Dome
Height of dome (Rise) (ft)	1.125		1.125
Visible transmittance	49%	72%	72%
Solar heat gain coefficient	54%	68%	68%
Curb type	Wood	Integral frame	Integral frame
Frame type	Metal w/ thermal brk	Metal w/ thermal brk	Metal w/ thermal brk
Unit U-value (Btu/h•°F•ft2)	1.100	0.410	0.410
Dirt light loss factor	70%		70%
Screen or safety grate factor	100%		100%
Light well reflectance	70%	85%	85%
Well factor (WF)	#NAME?		#NAME?
Bottom of light well:			
Width (ft)	4.50	8.50	8.50
Length (ft)	4.50	8.50	8.50
Diffuser on bottom of well?	No	O Yes, O No	No

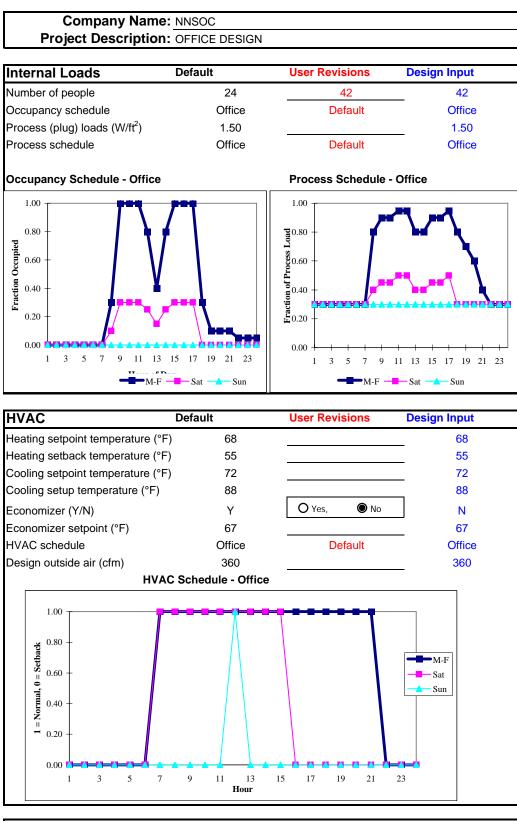
Building	Default	User Revisions	Design Input
Building width (ft)	55	43	43
Building length (ft)	110	Change width or area	140
Wall reflectance	70%		70%
Ceiling reflectance	70%	85%	85%
Floor reflectance	20%		20%
Shelving reflectance	40%		40%
Roof U-value (Btu/h•°F•ff)	0.063		0.063

Electric Lighting	Default	User Revisions	Design Input
Lighting setpoint (fc)	50	30	30
Task height (ft)	2.50		2.50
Lighting power density (W/ft ² )	#NAME?	0.81	0.81
Fraction lighting uncontrolled	10%		0.10
Lighting schedule	Office	Office	Office
Room and luminaire depreciation	80%	75%	75%



Lighting Schedule Graph

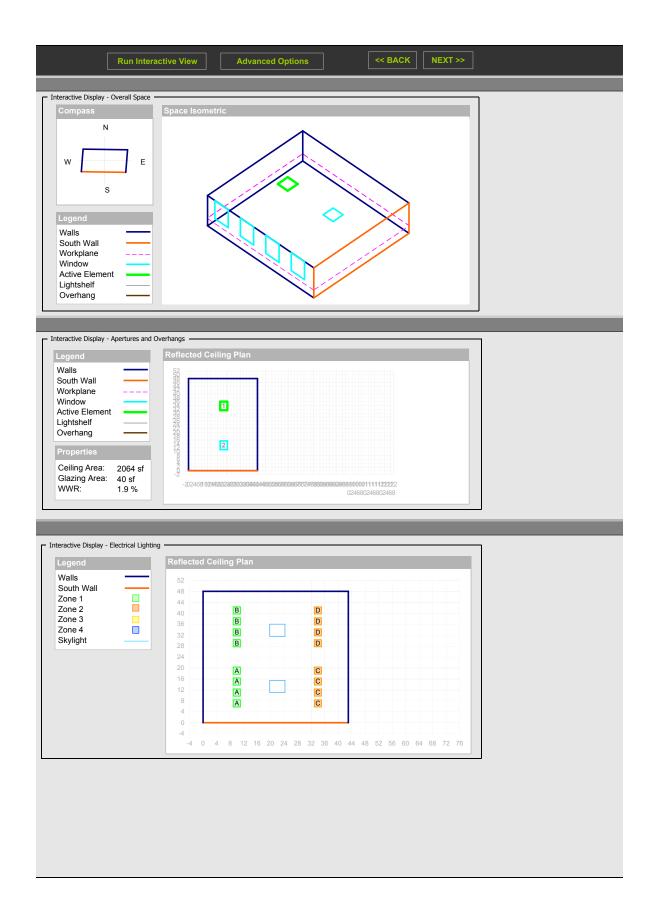
#### **SkyCalc: Skylight Design Assistant - Optional Inputs**



Annual Schedule	Default	User Revisions	Design Input
Starting Month	1		1



#### Input Geometry s<mark>pøt</mark>y **Spatial Characteristics** - Dimensions · Width 48 ft Length 43 ft Height 10 ft Workplane Height 2.5 ft Wall Thickness 10 in Skylight Depth 5 2 ft Orientation deg Surface Reflectances -Floor 20% Walls 60% Ceiling 85% Ground 15% Mullions 50% Lightshelves 80% Överhangs 70% Apertures and Overhangs Architectural Element Specification Architectural Element Ceiling ▼ Element Type Skylight ▼ - 0 Skylight Number 1 🔻 copy... 19.75 31.5 ft Dist From West Wall Dist from South Wall Skylight Length 4.5 ft Skylight Width Transmittance 4.5 ft 60 % Window Treatment t Electrical Lighting Electric Lighting Layout -0 Electric Lighting Array D 💌 copy... finelite_S15_LSIT18033t -Add Auto-Center Off ▼ Zone 2 Mounting Suspension 2 ft Row Starf 29 ft Column Start 34 ft Number of Rows 4 Number of Columns 1 Row Spacing 4 ft Column Spacing 1 ft Orientation 90 deg



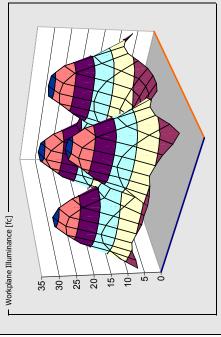
Site and Usage Input	Shade Control
Site Selection	Site Information       Latitude       37.5°         Latitude       37.5°       Veekly         Longitude       77.3°       Load < 33%
Weekly Schedule           Hour         Mon         Tues         Wed         Thurs         Fri         Sat         Sun           1am         0.0         0.0         0.0         0.0         0.0         0.0         0.0           2am         0.0         0.0         0.0         0.0         0.0         0.0         0.0           3am         0.0         0.0         0.0         0.0         0.0         0.0         0.0           4am         0.0         0.0         0.0         0.0         0.0         0.0         0.0           5am         0.0         0.0         0.0         0.0         0.0         0.0         0.0           6am         0.0         0.0         0.0         0.0         0.0         0.0         0.0           9am         1.0         1.0         1.0         1.0         1.0         0.0         0.0           9am         1.0         1.0         1.0         1.0         1.0         0.0         0.0           9am         1.0         1.0         1.0         1.0         1.0         0.0         0.0           9am         1.0         1.0         1.0         1.0	Annual Schedule         Day         Jan         Feb         Mar         Apr         May         Jun         Jul         Aug         Sep         Oct         Nov         Dec           1         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0
	25       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0

seet Electric Lighting Results

<< BACK

Nighttime Workplane Illuminance, [fc]

	Average	Мах	Min	Max/Min	LPD	
Zone 1	15.8	31.4	6.1	5.1	0.48	
Zone 2	16.5	31.4	6.4	4.9	0.48	
Total	16.2	31.4	6.1	5.2	0.48	
						[11]
	Light L	Light Loss Factor 0.78	0.78			ʻqtp
	Design I	Design Illuminance	30	fc		.Wi



ი	11	13	13	13	12	12	11	12	13	14	13	12	0	7	42	
	•	-	-	-						-	-	-				
13	19	22	23	22	20	17	16	19	22	23	22	20	15	10	39	
17	25	30	31	31	28	21	20	26	31	31	31	28	20	1	36	
16	23	28	30	28	25	20	19	24	28	29	28	25	18	7	33	
12	16	18	19	19	18	15	13	17	19	19	19	17	13	6	8	
∞	9	÷	12	12	£	£	£	÷	12	12	£	9	6	7	27	
7	6	10	10	10	10	10	10	10	10	10	10	6	∞	9	24	E
7	6	10	10	10	10	10	10	10	10	10	10	6	∞	9	21	Length
6	÷	12	13	13	12	÷	÷	12	13	13	13	÷	6	7	18	
13	18	21	22	22	20	17	16	19	22	23	22	19	15	10	15	
16	25	30	31	30	27	20	19	25	30	31	31	27	19	1	12	
15	23	27	28	28	24	19	18	23	27	28	28	25	17	10	ი	
1	4	17	19	8	16	4	42	16	8	19	8	16	42	œ	9	
7	ω	10	£	9	6	6	6	6	10	£	10	6	7	9	ო	
45	42	39	36	33	30	27	24	21	18	15	12	0	9	ю		
						[1]	'цр	νi								

The data on this sheet represents the electric lighting (nighttime) workplane illuminance. Ideally, the nighttime workplane illuminance, scaled by an appropriate Light Loss Factor, will be a good estimate of the intended design illuminance of the space. Workplane zoning, the points on the workplane grid that are dominantly lit by a given electric lighting zone, is automatically determined from the luminaire zone layout.

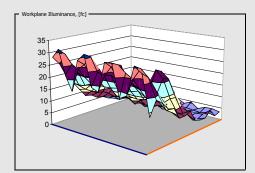
## Daylighting Results

 Interactive View
 View Report
 View Climate Specific Illuminance
 << BACK</td>
 NEXT>>

Annual Daylight Workplane Illuminance, [fc]

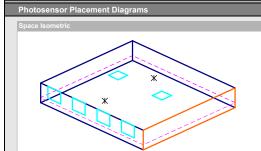
	-								
	Design Cond	lition	Avg	Zone 1 Max	Min	Avg	Zone 2 Max	Min	Shades?
	Clear Sky	anion	Avy	IVIAX	IVIIII	Avg	WIGA	WIIII	Shaues
۲	Winter	8:00 AM	18	32	7	6	23	2	
0		10:00 AM	45	130	16	25	126	5	
0		12:00 PM	66	178	22	33	184	6	
0		2:00 PM	227	1835	26	33	148	9	
0		4:00 PM	124	392	18	74	344	9	
0	Equinox	7:00 AM	22	37	8	8	34	3	
0		8:00 AM	39	116	18	22	113	5	
0		10:00 AM	68	241	25	43	238	8	
0		12:00 PM	97	287	33	54	305	8	
0		2:00 PM	349	3952	38	54	272	10	
0		4:00 PM	582	2605	50	53	211	16	
0		6:00 PM	38	63	16	26	64	10	
0	Summer	5:00 AM	11	20	4	4	14	2	
0		6:00 AM	27	56	9	12	55	3	
0		8:00 AM	58	202	22	37	204	7	
0		10:00 AM	88	303	34	56	326	9	
0		12:00 PM	114	376	39	65	380	10	
0		2:00 PM	509	4977	48	65	338	12	
0		4:00 PM	1015	3953	66	58	252	16	
0		6:00 PM	513	1235	48	129	1202	23	
0		7:00 PM	61	180	18	57	194	8	
~	Overcast Sk								
0	Winter	8:00 AM	8	25	2	2	9	1	
0		10:00 AM	27	85	8	7	29	2	
0		12:00 PM	35	109	10	8	37	3	
õ		2:00 PM	29	90	8	7	30	3	
õ	E autim aut	4:00 PM	11	34	3	3	11	1	
õ	Equinox	7:00 AM	11 25	34	3 7	3 6	12 26	1	
õ		8:00 AM 10:00 AM	25 46	77 145	13	0 11	20 49	2 4	
õ		12:00 PM	40 56	145	16	14	49 59	4 5	
õ		2:00 PM	50	158	15	14	53	4	
õ		4:00 PM	32	99	9	8	34	3	
õ		6:00 PM	5	15	1	1	5	0	
	Summer	5:00 AM	2	8	1	1	3	0	
0 0		6:00 AM	15	48	5	4	16	1	
0		8:00 AM	41	128	12	10	43	4	
0		10:00 AM	60	189	18	15	64	5	
0		12:00 PM	68	214	20	17	72	6	
0		2:00 PM	63	196	18	15	66	6	
0		4:00 PM	45	141	13	11	48	4	
0		6:00 PM	20	63	6	5	21	2	
0		7:00 PM	7	22	2	2	7	1	
0	Annu	al Average	151			36			
0		Maximum		4840			1376		
0		Avg DA	0.87	0.95	0.67	0.58	0.95	0.29	
0	A	vg MaxDA	0.09	0.35	0.00	0.01	0.09	0.00	

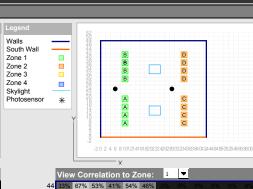
				1		1									
			3%		-66%		100%		00%						
Workplane A	Area	46	6%	33	3%	18	3%	3	%						
	45	28	24	19	15	12	8	7	5	5	3	3	3	3	3
	42	32	29	21	15	12	11	9	9	7	5	3	3	2	5
	39	22	26	21	15	15	13	17	15	10	6	4	3	3	4
	36	16	24	20	17	15	17	24	21	15	6	4	4	3	5
	33	29	26	21	17	16	16	23	22	15	7	3	3	4	4
	30	32	30	21	17	16	16	16	16	11	6	4	3	3	4
Width, [ft]	27	19	24	23	17	13	11	10	9	7	4	5	3	4	4
	24	18	24	23	17	13	12	8	9	6	4	5	3	4	5
	21	30	28	22	17	14	13	11	10	6	6	3	5	2	6
	18	30	29	23	17	13	15	18	18	10	6	4	4	3	4
	15	18	26	22	18	14	17	24	23	15	7	5	3	4	5
	12	19	25	20	16	15	16	21	21	15	6	5	4	3	3
	9	31	29	20	16	14	13	14	14	9	7	3	4	3	4
	6	29	27	22	17	12	10	9	8	6	3	3	4	4	5
	3	13	19	17	14	13	8	8	10	5	4	4	6	3	4
		3	6	9	12	15	18	21	24	27	30	33	36	39	42
								Length	n, [ft]						



## Photosensor Generator

### << BACK NEXT >>

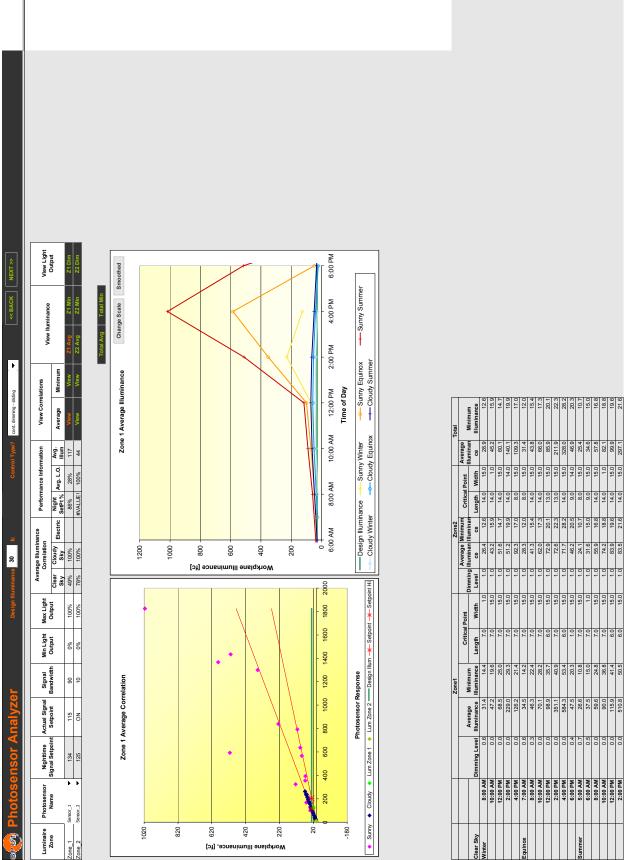




Photosenso	r Placeme	nt			Rever	t to Generated	Points
Photosensor	Mounting	L	ocatio	n	Aiming	Photosensor	Rotation
Name		Х	Y	Ζ		Туре	
Sensor_1	С	6	24	10	D	Cosine	0
Sensor_2	С	29	24	10	D	Cosine	0

View         View <th< th=""><th></th><th></th><th></th><th>-</th><th>2 -2 0 1</th><th>2468</th><th>101214</th><th>6182022</th><th>242628</th><th>3032343</th><th>5384042</th><th>4446485</th><th>0525456</th><th>586062</th><th>466687</th><th>727476</th></th<>				-	2 -2 0 1	2468	101214	6182022	242628	3032343	5384042	4446485	0525456	586062	466687	727476
44         33%         67%         53%         47%         54%         67%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07% <th07%< th="">         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%         07%</th07%<>						— x										
1         263         754         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874         874			Viev	v Co	rrela	tion	to Z	one:	1	▼						
No.         No. <th></th> <th>44</th> <th>33%</th> <th>67%</th> <th>53%</th> <th>41%</th> <th>54%</th> <th>46%</th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th> <th></th>		44	33%	67%	53%	41%	54%	46%								
1         6         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%         78%		41	32%	76%	23%		37%	47%								
1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000         1000 <th< th=""><th></th><th>38</th><th>73%</th><th>64%</th><th></th><th></th><th>31%</th><th>44%</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></th<>		38	73%	64%			31%	44%								
1         38%         65%         7.%         3.%         3.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%         0.%		35	78%	57%			28%	43%								
16         76%         74%         84%         86%         86%         87%         86%         87%         86%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%         87%		32	51%	64%			28%	43%								
Width, [th]         23         88%         7%         60%         52%         36%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         60%         6		29	38%	65%	17%	7%	34%	41%								
20         33%         74%         22%         11%         37%         38%         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5 <th0.5< th="">         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         0.5         <th0.5< th=""> <th0.5< th=""> <th0.5< th=""></th0.5<></th0.5<></th0.5<></th0.5<>		26	76%	74%	41%	34%	46%	39%								
38%         66%         5%         6%         30%         40%         or         or <th< th=""><th>Width, [ft]</th><th>23</th><th>68%</th><th>79%</th><th>60%</th><th>51%</th><th>52%</th><th>36%</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></th<>	Width, [ft]	23	68%	79%	60%	51%	52%	36%								
14         75%         60%         13%         7%         27%         39%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0% <t< th=""><th></th><th>20</th><th>33%</th><th>74%</th><th>22%</th><th>11%</th><th>37%</th><th>38%</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></t<>		20	33%	74%	22%	11%	37%	38%								
69%         58%         1%         7%         28%         40%         1%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0% <th< th=""><th></th><th>17</th><th>38%</th><th>66%</th><th></th><th></th><th>30%</th><th>40%</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></th<>		17	38%	66%			30%	40%								
8         35%         70%         17%         7%         29%         42%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0% <th< th=""><th></th><th>14</th><th>75%</th><th>60%</th><th>13%</th><th></th><th>27%</th><th>39%</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></th<>		14	75%	60%	13%		27%	39%								
5         37%         75%         32%         17%         44%         43%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0%         0% <t< th=""><th></th><th>11</th><th>69%</th><th>58%</th><th></th><th></th><th>28%</th><th>40%</th><th></th><th></th><th></th><th></th><th></th><th></th><th></th><th></th></t<>		11	69%	58%			28%	40%								
2 79% 72% 79% 74% 61% 38% 0% 0% 0% 0% 0% 0% 0% 0%		8	35%	70%	17%		29%	42%								
		5	37%	75%	32%	17%	44%	43%								
		2	79%	72%	79%	74%	61%	38%	0%	0%	0%	0%	0%	0%	0%	0%
2 5 8 11 14 17 20 23 26 29 32 35 38 41			2	5	8	11	14	17	20	23	26	29	32	35	38	41

Length, [ft]



				Zone1					Zonez				Total
					Critical Point	I Point		Average Minimu		Critical Point	Point	Average	
Clear Skv		Dimmina Level	Average Illuminance	Illuminance	Lenath	Width	Level ce	ce	ce	Lenath	Width	ce	Illuminance
Winter	8:00 AM	0.6	31.4	14.4	7.0	1.0		26.4	12.6		15.0	28.9	12.6
	10:00 AM	0.0	47.2	19.6	7.0	15.0	1.0	43.2	15.9	14.0	1.0	45.2	15.9
	12:00 PM	0.0	68.5	25.0	7.0	15.0	1.0	51.6	14.7	14.0	15.0	60.1	14.7
	2:00 PM	0.0	229.0	29.3	7.0	15.0	1.0	51.2	19.9	14.0	14.0	140.1	19.9
	4:00 PM	0.0	126.2	21.4	7.0	15.0	1.0	92.3	17.0	8.0	15.0	109.3	17.0
Equinox	7:00 AM	0.6	34.5	14.2	7.0	15.0	1.0	28.3	12.0	8.0	15.0	31.4	12.0
	8:00 AM	0.3	46.3	22.4	7.0	15.0	1.0	41.3	15.4	14.0	15.0	43.8	15.4
	10:00 AM	0.0	70.1	28.2	7.0	15.0	1.0	62.0	17.3	14.0	15.0	66.0	17.3
	12:00 PM	0.0	98.9	35.7	6.0	15.0	1.0	72.9	20.1	13.0	15.0	85.9	20.1
	2:00 PM	0.0	351.1	40.9	7.0	15.0	1.0	72.6	22.3	13.0	15.0	211.9	22.3
	4:00 PM	0.0	584.3	53.4	6.0	15.0	1.0	7.1.7	28.2	14.0	15.0	328.0	28.2
	6:00 PM	0.4	47.5	20.3	1.0	15.0	1.0	46.2	20.5	9.0	14.0	46.9	20.3
Summer	5:00 AM	0.7	26.6	10.8	7.0	15.0	1.0	24.1	10.7	8.0	15.0	25.4	10.7
	6:00 AM	0.5	37.5	15.0	7.0	1.0	1.0	31.6	15.0	9.0	15.0	34.6	15.0
	8:00 AM	0.0	59.6	24.8	7.0	15.0	1.0	55.9	16.8	14.0	15.0	57.8	16.8
	10:00 AM	0.0	90.0	36.8	7.0	15.0	1.0	74.2	18.8	14.0	1.0	82.1	18.8
	12:00 PM	0.0	115.9	41.4	6.0	15.0	1.0	83.9	19.6	14.0	15.0	99.9	19.6
	2:00 PM	0.0	510.8	50.5	6.0	15.0	1.0	83.5	21.6	14.0	15.0	297.1	21.6

		0.0	1016.9	69.69	1.0	1.0	1.0	77.0	27.7	14.0	15.0	546.9	27.7
	6:00 PM	0.0	515.0	51.5	7.0	1.0	1.0	147.9	37.1	14.0	1.0	331.4	37.1
	7:00 PM	0.1	65.7	21.9	7.0	1.0	1.0	76.1	20.1	9.0	1.0	70.9	20.1
Overcast Sky													
Winter	8:00 AM	0.8	24.1	9.4	7.0	15.0	1.0	22.5	9.0	8.0	15.0	23.3	9.0
	10:00 AM	0.4	36.9	13.2	7.0	15.0	1.0	26.3	11.1	14.0	15.0	31.6	11.1
	12:00 PM	0.3	42.0	14.8	7.0	15.0	1.0	27.9	11.7	14.0	15.0	34.9	11.7
	2:00 PM	0.4	38.0	13.6	7.0	15.0	1.0	26.7	11.2	14.0	15.0	32.3	11.2
	4:00 PM	0.7	26.0	10.0	7.0	15.0	1.0	23.1	9.4	8.0	15.0	24.5	9.4
Equinox	7:00 AM	0.7	26.1	10.0	7.0	15.0	1.0	23.1	9.4	8.0	15.0	24.6	9.4
	8:00 AM	0.5	35.2	12.7	7.0	15.0	1.0	25.8	10.9	14.0	15.0	30.5	10.9
	10:00 AM	0.1	49.7	17.1	7.0	15.0	1.0	30.2	12.5	14.0	15.0	40.0	12.5
	12:00 PM	0.0	57.6	19.4	7.0	15.0	1.0	32.3	13.3	14.0	15.0	45.0	13.3
	2:00 PM	0.0	52.5	17.9	7.0	15.0	1.0	31.0	12.8	14.0	15.0	41.8	12.8
	4:00 PM	0.3	40.0	14.2	7.0	15.0	1.0	27.3	11.4	14.0	15.0	33.6	11.4
	6:00 PM	0.8	21.9	8.7	7.0	15.0	1.0	21.9	8.6	8.0	15.0	21.9	8.6
Summer	5:00 AM	0.9	20.4	8.3	7.0	15.0	1.0	21.4	8.3	8.0	15.0	20.9	8.3
	6:00 AM	0.6	29.1	10.9	7.0	15.0	1.0	24.0	10.1	8.0	15.0	26.6	10.1
	8:00 AM	0.2	46.3	16.0	7.0	15.0	1.0	29.1	12.1	14.0	15.0	37.7	12.1
	10:00 AM	0.0	62.4	20.8	7.0	15.0	1.0	33.5	13.7	14.0	15.0	47.9	13.7
	12:00 PM	0.0	70.3	23.1	7.0	15.0	1.0	35.4	14.5	14.0	15.0	52.8	14.5
	2:00 PM	0.0	64.7	21.5	7.0	15.0	1.0	34.0	14.0	14.0	15.0	49.4	14.0
	4:00 PM	0.1	49.0	16.9	7.0	15.0	1.0	30.0	12.4	14.0	15.0	39.5	12.4
	6:00 PM	0.6	32.2	11.8	7.0	15.0	1.0	24.9	10.6	14.0	15.0	28.6	10.6
	7:00 PM	0.8	23.4	9.2	7.0	15.0	1.0	22.3	8.9	8.0	15.0	22.9	8.9

## **জ্**তন Analysis Tool - Annual Analysis

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		Zor	01	Zor	2	Zon		Zor	04	Tot			h la sere		0::!	Spaces	4									To	otal	Co	osts
		_				2011	ieu	201	104														<u> </u>						
Average Light				1.0	00					0.1						ity Price						ectric					519	\$	452
Electric Savings, [k										113			A	Average	e Heatir	ng Price	0.50	\$/The	erm			I Heati					20	\$	7
Heating Load, [k										35										Co	ooling	Load	Savin	gs, [kV	Vh/yr]	23	86	\$	239
Cooling Load, [k										59																	Total	\$	683
Average Illuminan		14		5						99	9																		
Minimum Illuminan				8						7																			
Maximum Illuminan	ce, [fc]	48	41	13	83					484	11																		
ly Results																													
				0.07	500/			2001	0.11	10.																			
rage Workplane Illuminand	e, [fc]	•	< 5	D%	50%-	100%	> 10	00%	Critica	I Day																			
age Workplane Illuminan	e, [fc]	•	< 5	0%	50%-	100%	> 10	00%	Critica	I Day																			
rage Workplane Illuminand	e, [fc] 2	<b>▼</b>	< 51 4	<mark>0%</mark> 5	50%-*	100% 7	<mark>&gt; 10</mark> 8	9	Critica 10	I <mark>l Day</mark> 11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
January 44	2 45		< 5 4 79		6 84			9	10 45		12 74	64		50	54	17 87	18 71	19 86	20 92	21	86	43	53	25 85	26 66	134		29 75	30 54
1 January 44 February 91	2	3	4	5	6		8	9	10	11			14 109				-		-	21							28 107		
1 January 44 February 91 March 107	2 45	3 73	4	5 76	6 84	7	8 54	9	10 45	11	74 87	64		50	54	87	-	86	92		86	43	53		66	134			54
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# LightSaver® LCD-203 Dimming Controller

Low voltage automatic dimming control module

Three control channels with individually programmable settings

Pushbutton programming and automated setup



LCD display of photocell readings

Optional wall switch override for manual control

Open loop control

PROJECT

LOCATION/TYPE

### Product Overview

#### Description

Watt Stopper/Legrand's LightSaver LCD-203 daylighting controller provides automatic dimming control for fluorescent and HID fixtures. It is an open loop controller providing up to three zones of control from a single photocell. It also integrates with occupancy sensors and accommodates individual occupant overrides via an optional wall switch.

#### Operation

The LCD controller is part of a system that includes the LS-290C photocell and the BT-203 Power Pack. Each of the LCD controller's three channels has a 0-10 VDC output and connects to its own dedicated relay in the power pack. The photocell measures daylight and transmits the data to the controller. Each channel in the controller raises or lowers light levels, while the respective relays in the power pack switch lighting on or off. When daylight is adequate for a channel to fully dim, lights switch off after an adjustable time delay. This capability can be disabled for zones where lighting should remain on.

### Features

- Simplified setup and calibration
- Optional dimming wall switch (LS-4C) provides manual dimming and ON/OFF control so users can adjust lighting as desired
- Seven individually adjustable parameters for each channel: setpoint, minimum output, maximum output, ramp rate, fade rate, cutoff time delay, load shed limit

#### Multiple Channel Control

To achieve balanced dimming control, users group fixtures receiving comparable daylight levels into up to three control groups or zones. Zones closest to the daylight source are dimmed the most, while zones further away from the daylight source dim less. Unused channels may be disabled.

#### Applications

The LCD controller is suitable for a wide range of applications, such as open office areas, classrooms, retail stores, and any application with skylights. It is particularly suitable for applications that require independently dimming fixtures in adjoining zones. The load shedding capability can further reduce light levels during critical periods or during periods of reduced occupancy. If an occupancy sensor is used, its non-occupancy signal initiates dimming by the LCD controller prior to turning lighting off.

- Menu-driven, pushbutton programming without special tools
- Automatic internal calculation for dimming requirements of individual channels for simplified setup
- DIN rail mounting
- California Title 24-2005 compliant

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S Watt Stopper



## LCD Technical Information

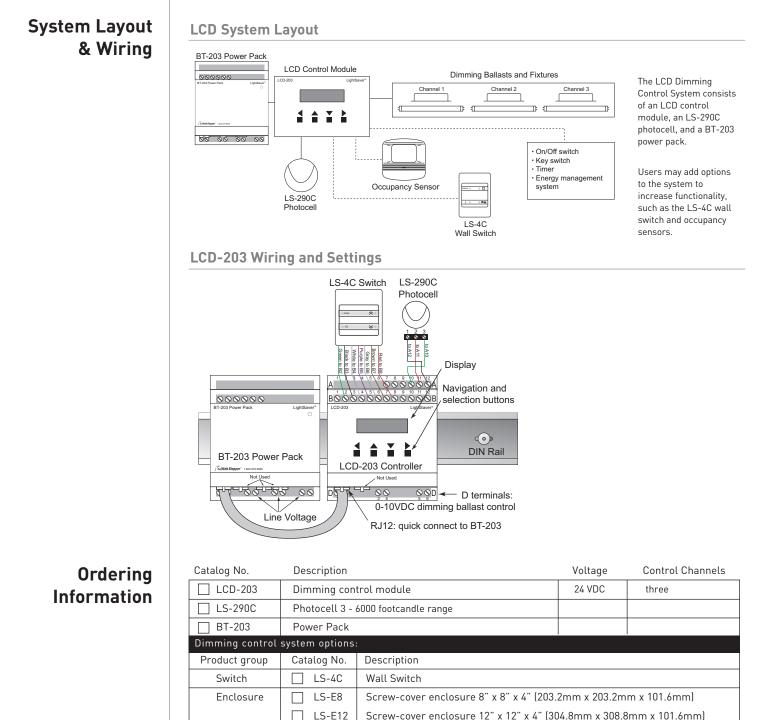
## **Specifications**

- Class 2 low voltage device
- Compatible with standard 0-10 volt dimming ballasts
- Controls up to 50 0-10 VDC ballasts per dimming channel
- Photocell range from 3 6,000 footcandles
- Programmable dimming and fade rates from 5-60 seconds

LS-E12

• Selectable cut off delay from 0-20 minutes or can be disabled

- Programmable minimum output from 0-4VDC
- Programmable maximum output from 6-10VDC
- Load shed output from 0-10 VDC •
- Setpoint range from 5-60 fc •
- 24VDC supply voltage provided by BT-203 •
- Control output voltage to ballasts 0-10VDC •
- Dimensions: 3.5" x 2.81" x 2.5" (89mm x 71mm x • 64mm) LxWxD
- UL and CUL listed; five year warranty





## LightSaver[®] LS-290C Photocell

Photocell for LightSaver LCD-203 and LCO-203 controllers

**Footcandle range** 

from 3 - 6000

Mounts vertically or horizontally

•••• Architecturally attractive design

PROJECT

LOCATION/TYPE

## Product Overview

#### Description

Watt Stopper/Legrand's LightSaver LS-290C photocell provides the daylight data necessary for operation of the LCD-203 and LCO-203 daylighting control systems.

•••••••••

#### Operation

Utilizing a photodiode element, the LS-290C continuously measures ambient light levels. The sensor is positioned to "see" incoming daylight from either a window or skylight without seeing electrical light. Users select the applicable footcandle range by a jumper beneath the front cover.

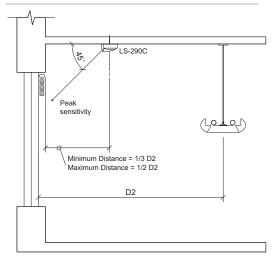
#### **Specifications**

- Three jumper-selectable footcandle ranges: 3-300 fc, 30-3000 fc, 60-6000 fc
- Low voltage, Class 2 device
- Protective hard plastic cover
- 3 conductor 22 AWG twisted cable equal to Belden 8443
- Maximum wire length is 250 feet (76.2m)
- Dimensions: 2" diameter x 1.2" deep (50.8mm diameter x 30.5mm deep)
- UL and CUL listed, five year warranty

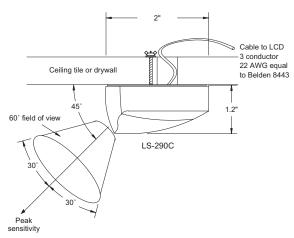
#### Ordering Information

Catalog No.	Description	Footcandle range
LS-2900	Photocell	3 - 6000 (32 - 64,000 lux)

#### **Photocell Placement**



#### **Installation and Wiring**



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## LightSaver® BT-203 Power Pack

Power pack for LightSaver LCO-203 and LCD-203 controllers

Three relays for switching line voltage

120/230/277 VAC transformer

Quick connect to LCD-203 and LCO-203 control modules

•••••• DIN rail mount

### Product Overview

#### Description

Watt Stopper/Legrand's LightSaver BT-203 Power Pack powers the LightSaver LCO-203 and LCD-203 control modules.

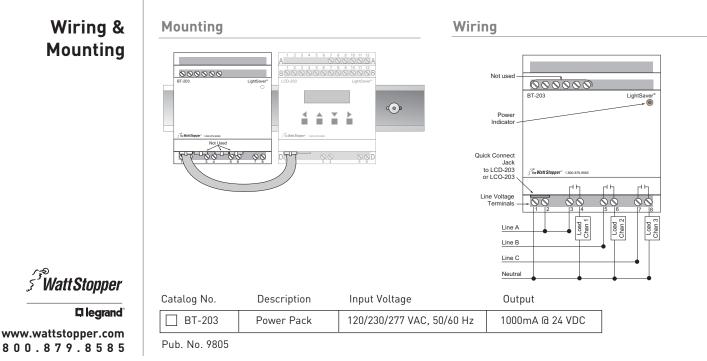
#### Specifications

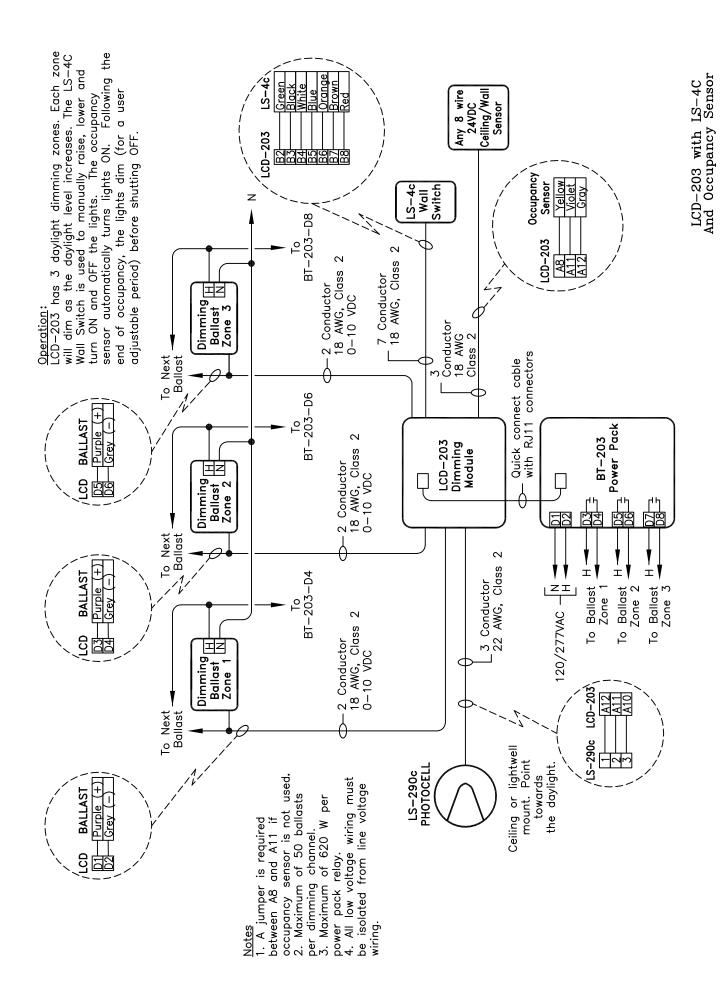
- Voltages: 120/230/277 VAC, 50/60 Hz
- Secondary power: 1000 mA @ 24 VDC (for control of larger loads, contact technical support)
- 3 normally open relays, 620 Va @ 120 or 277 VAC
- Dimensions: 2.76" x 3.57" x 2.36" (70.0mm x 90.5mm x 60.0mm) LxWxD
- UL and CUL listed, five year warranty

#### Operation

PROJECT Location/type

The BT-203 supplies low voltage power to LCO and LCD controllers. It connects via a quick connect cable. It has three normally open relays used to switch line voltage in response to signals from the connected controller. In addition, the power pack has an automatically resetting fuse. If the current drawn from the BT-203 exceeds the specifications, the +24VDC output will turn off and the LED will turn off. Upon removal of the fault condition and primary power, the BT-203 will restore the power.





## **EM Photocell**

Low voltage photocell automatically turns lighting on and off

Mounts on building exterior or roof

Raintight gray plastic enclosure

### Product Overview

### Description

The EM is a low voltage photocell used for controlling exterior lighting. It works with Watt Stopper power packs and lighting control panels (Lighting Integrator and LP series panels) by signalling a change in light levels to the panel.

### Operation

Typically mounted so the light level window faces the northern sky, the EM photocell provides an ON signal when the ambient light level drops below a preset "dark" setpoint. It then provides a signal OFF as the ambient light level rises above the preset "light" setpoint. The setpoint can be changed for specific applications by opening and closing the photocell's aperture window. Normally, a lighting control panel or a power pack supplies power to the photocell. The photocell's relay contact red wires are connected to the panel or to a low voltage controlled load.

### **Specifications**

- 1 15 footcandle range (10.8 161.5 lux)
- Isolated relay contacts 1 amp @ 30 VAC/VDC
- Power input: 24 VAC, 1 VA or 24 VDC, 1 VA
- Dimensions: 2.64" x 1.57" x 1.89" (67.1mm x 39.9mm x 48.0mm)
- One year warranty

Catalog No.	Description	Voltage
EM-24A2	Exterior photocell	24 VAC
EM-24D2	Exterior photocell	24 VDC

Compatible with all Watt Stopper lighting control panels and power packs

Simple to wire and install

Adjustable aperture window for varying ON setpoint

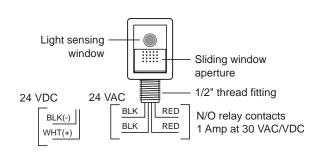
PROJECT

LOCATION/TYPE

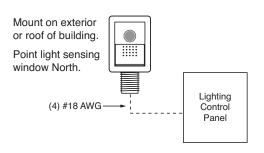
### Features

- One set of normally open, isolated relay contacts; contacts are closed when sensed light level is below dark setpoint, open when light level is above light setpoint
- 8-second time delay and built-in setpoint deadband prevent cycling
- 1/2" threaded male conduit base for easy mounting on conduit fittings or junction boxes.

### **Accessory Enclosure Interior**



### **Accessory Enclosure Interior**



### Ordering Information

*SWatt Stopper* 

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### GR∧FIK Eye.∞

#### PRESET DIMMING CONTROLS

#### GRX-4000 Control Units

#### ney 4000-1a 7,20,00

### GRX-4000 Control Units



#### DESCRIPTION

- Provide pushbutton recall of four preset lighting scenes.
- Control virtually any light source.
- Provide lockout options to prevent accidental changes.
- Include built-in infrared receiver for operation with an optional remote control.

#### Models available to:

- Control two to 24 zones of lighting.
- Provide easy setup of preset lighting scenes: GRX-4100 Control Units provide standard setup via pushbuttons on the Control Unit. GRX-4500 Control Units provide optional setup via a PC, including setting lighting levels in 1% increments.

#### GRX-4000 Control Units work with:

- GRAFIK Eye Wallstations
- GP and LP Dimming Panels
- XP Softswitchn Panels

JOB HUMBER: 4-11-07

### SPECIFICATIONS

#### Operating Voltage

- Low-voltage type Class 2 (PELV), 12VDC to 24VFW.
- Lightning Strike Protection: Meets ANSI/IEEE standard 62.41-1980. Can withstand voltage surges of up to 6000V and current surges up to 3000A.

#### Sources/Load Types

Operates sources with a smooth continuous Square Law dimming curve or on a full conduction non-dim basis via GP and LP Dimming Panels and XP Softswitchm Panels.

JOB HAME:

#### CLUTRON. SPECIFICATION SUBMITTAL Page MODEL NUMBERS: NNSOC GRX-4108-T-WH

#### scenes. Fade time: 0-59 seconds or 1-60 minutes. Can be set differently for each

· 4 preset lighting scenes and off for up to 24 zones, accessible from Control

 12 additional scenes stored in Control Unit, accessible via Wallstations and/or

Light levels fade smoothly between

#### Key Design Features

scene.

Preset Controls

Unit faceplate.

Control Interfaces.

- Meets IEC 801-2. Tested to withstand 15kV electrostatic discharge without damage or memory loss.
- Provides power failure memory: Automatically restores lighting to scene selected prior to power interruption.
- Has faceplate that snaps on with no visible means of attachment.

System Communications and Capacities Low-voltage type Class 2 (PELV) wiring connects Control Units, Wallstations, and Control Interfaces:

- You can link up to 8 Control Units to control up to 64 zones.
- You can add up to 16 total Wallstations and Control Interfaces for a total of 24 control points.

#### Environment

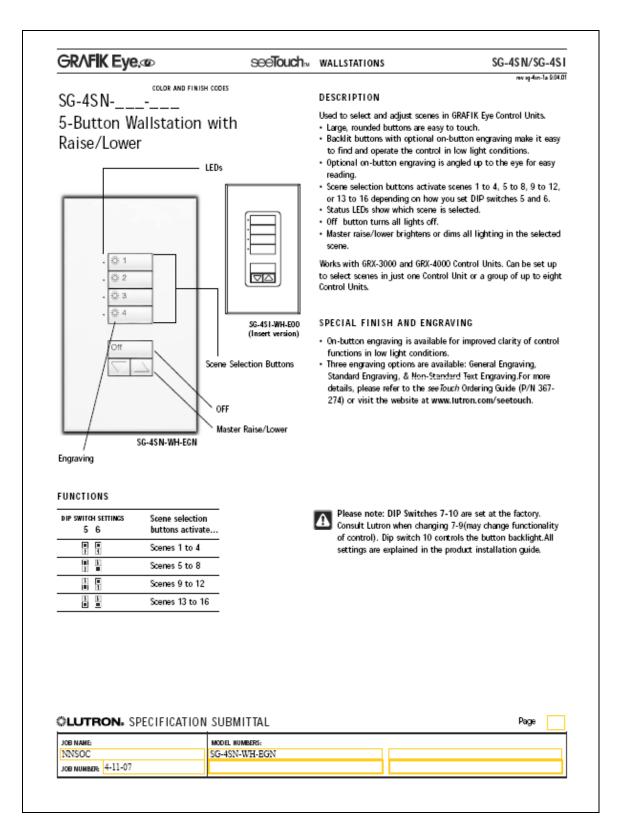
 32-104°F (0-40°C). Relative humidity less than 90% non-condensing.



#### PRESET DIMMING CONTROLS

GRX-4000 Control Units

DIMENSIONS AND MOUNTING WALLBOX¹ U.S. SIZE SIDE VIEW А В С MODEL DEPTH 2-Zone: 4 5/16" 1 13/16 5.56 2 Gang 3.5' GRX-4102 (123mm) (46mm) (141mm) (89mm) GRX-4502 3-Zone: 6 11/16" 3 5/8" 7.25" 3.5' 3 Gang 5/16" 1 15/16" GRX-4103 (184mm) (168mm) (92mm) (89mm) (8mm) (49mm) GRX-4503 4-Zone: 8 5/16" 5 7/16" 8.94″ 4 Gang 3.5 GRX-4104 (208mm) (138mm) (227mm) (89mm) GRX-4504 6-Zone: 8.94″ 3.5 8 5/16" 5 7/16" 4 Gang 4 9/16" GRX-4106 (116mm) (208mm) (138mm) (227mm) (89mm) GRX-4506 5 7/16" 8.94″ 4 Gang 3.5' 8-Zone: 8 5/16" GRX-4108 (208mm) (138mm) (227mm) (89mm) GRX-4508 8.94″ 16-Zone: 8 5/16" 5 7/16" 4 Gang 3.5 (227mm) GRX-4116 (208mm) (138mm) (89mm) GRX-4516 24-Zone: 8 5/16" 5 7/16" 8.94″ 4 Gang 3.5 GRX-4124 (208mm) (138mm) (227mm) (89mm) GRX-4524 ¹ Can be ordered from Lutron as Part Number 241-519 (1 Gang gangable boxes). А è 0 В 00 191919191919199 00 00 3 5/16" (85mm) 8 8 -0 **CLUTRON**, SPECIFICATION SUBMITTAL Page JOB HAME: MODEL NUMBERS: NNSOC GRX-4108-T-WH JOB NUMBER: 4-11-07



GRAFIK Systems	POWER PANELS		GP Dimming Pane
			nev gp-1a 7.20
GP Dimming Panels			
and the second se	and the second second		
		and the second second	
Gillinnatiation			
		March 1	
GP3/4		Limming.	minuma
Mini Panels			
GP8-24	1. Philippen and a second second second	manantootseedin	IT STUDE TO A DESCRIPTION OF THE OWNER OF THE
Standard-Size Panels			
	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1		
DESCRIPTION	umminum	inimine I	1000000
<ul> <li>Provide power and dimming for up to</li> </ul>			
144 load circuits. • Control any light source,	autorrange companyation and a second s	untermananan	n turonnannann mar an thu
<ul> <li>Control any light source, including full-conduction non-dim.</li> </ul>			
Models available for:			
<ul> <li>100-127V, 220-240V (non CE), 230V (CE), and 277V.</li> </ul>		Hinning	intimititi
<ul> <li>3 to 144 circuits.</li> <li>Different feed types and breakers.</li> </ul>	ALTERNATION OF THE OWNER		
GP Dimming Panels work with:	STOCKED BOOK STOCKED S		TAXABLE PARTY AND ADDRESS OF A DOLLAR DESIDE
<ul> <li>GRX-4000 Control Units</li> </ul>	GP36 Large-Size Panels		48-144 Size Panels
<ul> <li>GRAFIK 5000 and 6000 Systems</li> <li>LP Dimming Panels</li> </ul>			
<ul> <li>XP Softswitch₃ Panels</li> <li>DMX512 dimming systems via the</li> </ul>			
2LINK _M option.			
			. –
de la companya de la	MITAL		Page
CLUTRON. SPECIFICATION SUB			
JOB NAME: MODEL	NUMBERS: 2774T6-ML-20-CGP-344		

#### GRAFIK Systems

#### POWER PANELS

**GP Dimming Panels** 

nev gp-4a 7.20.00

Page

#### GP8-24 STANDARD-SIZE MODELS (100-127V AND 277V)

Only standard panels listed. Consult Lutron for options.

#### 100-127V Power

	WOOBLS AVAIL	ABLE FOR		Banco ciberra
NUMBER OF CIRCUITS	FEED TYPE	PAHEL FEED	MAXINUM Feed	BRANCH CIRCUIT Breaker ¹
	1Ø, 2W	10, 2W Main Lugs Only		15A
	10, 20	noni cogo enty	175A	20A
		Main Lugs Only	60A	15A
	1Ø, 3W	Main Logs only	80A	20A
GP 8	10, 54	60A Main Breaker	60A	15A
		80A Main Breaker	80	20A
		Main Lugs Only	50A	15A
	3Ø, 4W	Main Logs Only	60A	20A
	50, 4W	50A Main Breaker	50A	15A
		60A Main Breaker	60A	20A
	1Ø, 3W	Main Lugs Only	100A	15A
	10, 5%	Main Logs Only	125A	20A
GP 12	20 JW	Main Luca Only	60A	15A
GF 12	30, 4W Main Lugs Only	80A	20A	
		60A Main Breaker	60A	15A
		80A Main Breaker	80A	20A
		Main Lugs Only	125A	15A
	4/3 oW		175A	20A
	1Ø, 3W	125A Main Breaker	125A	15A
GP 16		175A Main Breaker	175A	20A
GF 10		Main Lucz Only	100A	15A
	-0.00	Main Lugs Only	125A	20A
	3Ø, 4W	100A Main Breaker	100A	15A
		125A Main Breaker	125A	20A
		Main Lunz Only	110A	15A
CP 20	20 114	Main Lugs Only	150A	20A
GP 20	3Ø, 4W	110A Main Breaker	110A	15A
		150A Main Breaker	150A	20A
		Maio Luor Ook:	125A	15A
CD 24	20 AV	Main Lugs Only	175A	20A
GP 24	3Ø, 4W	125A Main Breaker	125A	15A
		175A Main Breaker	175A	20A

	MODELS AWAIT	LABLE FOR		
NUMBER OF CIRCUITS	REED TYPE	PANEL FEED	MAXIMUM Feed	BRANCH CIRCUIT Breaker ¹
	1Ø, 2W	Main Lugs Only	175A	
GP 8	20 (11)	Main Lugs Only	60A	-
30,	3Ø, 4W	60A Main Breaker	60A	-
GP 12	3Ø, 4W	Main Lugs Only	80A	20A
GF 12 - 50, 4W	80A Main Breaker	80A	-	
GP 16 30.4	3Ø, 4W	Main Lugs Only	125A	-
01 10	50, 41	125A Main Breaker	125A	-

### WIRE SIZES

277V Power

#### Feed Wiring

PANEL FEED	WIRE SIZES
Main Lugs Only	#14 AWG (2.0mm ² ) to #2/0 AWG (50mm ² )
50A-100A Main Breakers	#14 AWG (2.0mm²) to #1/0 AWG (50mm²)
125A-175A Main Breakers	#4 AWG (25mm²) to 350 KCMIL(MCM)

#### Load Circuit Wiring

Connect to Terminal Blocks.

#14 AWG (2.0mm²) to #10 AWG (4.0mm²)

¹ 20/16A, 15/12A continuous load rating.

### **CLUTRON**, SPECIFICATION SUBMITTAL

JOB NAME:	MODEL NUMBERS:	
NNSOC	GP8-2774T6-ML-20-CGP-344	
JOB HUMBER: 4-11-07		

## Appendix B

***UPS Equipment Cutsheet** 

*Photovoltaic Equipment and Analysis

*Trip Graphs

### UNINTERRUPTIBLE POWER SUPPLY (UPS)

## CATERPILLAR®



## **UPS 300 SERIES** Equipment MULTI MODULE SYSTEMS

300 kVA/240 kW, 60 Hz 600 kVA/480 kW, 60 Hz 900 kVA/720 kW, 60 Hz

Caterpillar[®] is leading the power generation marketplace with Power Quality Solutions engineered to deliver unmatched flexibility, expandability, reliability, and cost effectiveness.

### FEATURES PRODUCT FEATURES

- Smallest available footprint
- High system efficiency
- Harmonic cancellation
- Transient protection
- High-speed voltage regulation
- Power factor improvement
- Top and bottom cable entry
- 40° C rating on entire system
- Low input current distortion
- Utilizes kinetic power cell technology
- Simple installation
- Low maintenance
- Quiet operation
- Optional redundant energy storage
- Expandable for future capacity growth
- Optional generator set start module

## RELIABLE POWER PROTECTION FOR CRITICAL APPLICATIONS

Cat[®] UPS systems provide constant power protection against surges, sags, and power interruptions that can disrupt operations or cause loss of valuable data or system capacity. Additionally, the use of the optional generator set start module can dramatically increase generator set starting reliability in a continuous power configuration.

### SUPERIOR DESIGN

Superior system design and the use of robust digital components throughout the system yield the most reliable and trouble-free UPS system on the market. Protection is delivered in the industry's smallest package with the highest efficiency and superior performance.

### LOWER TOTAL COST

The high operating efficiency means yearly savings versus traditional battery UPS products. In addition, lower Cat UPS heat rejection reduces up front HVAC costs and electrical consumption over the life of the product.

### **GENERATOR SET INTEGRATION**

By cancelling harmonic distortion, the 300 Series operates seamlessly with generator sets to provide a higher total electrical load capacity without oversizing the generator set. The 300 Series effectively insulates the generator set from block loads and transient, and can improve its fault clearing capabilities. Programmable integration with standby generator sets assures greater system reliability and improves the total system operation.

### WORLDWIDE PRODUCT SUPPORT

- Parts Distribution Centers are located worldwide with available service support through Caterpillar and the Cat Dealer Network.
- Factory certified service and technicians are trained to support every aspect of your Cat UPS system.



### FACTORY INSTALLED STANDARD AND OPTIONAL EQUIPMENT

Standard Features	Optional Features
Battery free, flywheel energy storage	24-volt DC, generator set starting power
IGBT Based Bi-directional converter	Integral modem – remote communication
Local Emergency Power Off (EPO)	Remote notification and monitoring via Ethernet and e-mail
RS232 or RS485 serial connection	UPS View – real-time monitoring software
LCD monitor/control user interface panel	SNMP
Programmable input and output contacts	MODBUS (RTU or TCP/IP)
Redundant cooling fans	Remote Status Panel (8 status LED's)
Top/Bottom cable entry	Maintenance bypass
Back feed protection	Seismic mounting
Monitoring and alarms for all critical components w/self-diagnostics	4-wire input and output
Voltage regulation and power factor improvement	Remote EPO
Harmonic cancellation	N+1 flywheel energy storage
Static Bypass Switch	Field expandable for future capacity increases
	External synchronizing input

### **SPECIFICATIONS**

П

INPUT	
Voltage	480 VAC 3-phase, 3-wire plus ground from grounded wye source (4-wire – optional)
Voltage Range	+ 10%/-15% (programmable)
Frequency	60Hz (± 10% max. – programmable)
Power Factor	0.99 at rated load and nominal voltage
Harmonic Current Disto	ortion
Linear load	< 3% at 100% resistive load
Non-linear load	< 8% with 100% non-linear load
Surge Withstand	Meets IEEE 587/ANSI C62.41
Walk-in	1 to 15 seconds (programmable)
Bypass Source	Same as input source – Synchronized frequency, phase and voltage
Bypass Voltage Window	+ 10%/-15% (programmable within range)
OUTPUT	
Voltage	480 VAC, 3-phase, 3-wire plus ground (4-wire with optional 4-wire input)
Voltage regulation	
Steady-state	± 2% of nominal for ± 10% input and balanced or unbalanced load
Transient	± 5% of nominal for 100% load step; or loss/return of input
Recovery Time	50 millisecond maximum
Bypass Trigger	Programmable up to ± 10%

Frequency Regulation	
Normal Operation	Synchronized to input
Free Running	± 0.2% free running
Synch Window	Adjustable over a range of at least 0.3 Hz to 3 Hz
Resynchronization Slew Rate	Adjustable over a range 0.3 Hz/second to 1 Hz/second
Load Power Factor	0.8 lag to 0.9 lead for specified regulation and rating. 0.4 lag to 0.7 lead with reduced regulation or load
Voltage Unbalance & D	istortion
Balanced Load	< 1% voltage unbalance and < 1° phase displacement
50% Unbalanced Load	< 3% voltage unbalance and < 3° phase displacement
Linear Load	< 3% THD, < 2% SHD
100% Non Linear Load ⁽¹⁾	< 5% THD
Load Imbalance	The UPS is capable of supporting any combination of unbalanced load that does not exceed the maximum phase currents and the total output limitations of the UPS
Overload Capability (no	rmal operation)
10 Minutes	Up to 125%
30 Seconds	Up to 200%
1 seconds	500%
10 milliseconds	1000%

¹ In accordance with EN 50091-3

### UPS 300 SERIES MULTI MODULE SYSTEMS 300 kVA/240 kW, 60 Hz 600 kVA/480 kW, 60 Hz 900 kVA/720 kW, 60 Hz

## CATERPILLAR®

### **TECHNICAL DATA**

		UPS300E	UPS600	UPS900
Maximum kVA		300	600	900
Maximum kW		240	480	720
Input Voltage (nominal)			480	
Output Voltage (nominal)			Same as input	
Input Current (amps)				
Nominal		297	595	892
Maximum Continuous		400	800	1200
Maximum Including Recharge		440	880	1320
Output Current		361	722	1084
System Efficiency		97%	97%	97%
System Withstand Rating			65,000 A	
Heat Rejection				
Nominal	BTU/Hr kW	25,300 7.5	50,600 14.8	75,900 22.3
Worst Case	BTU/Hr kW	52,200 15.3	104,500 30.6	156,700 45.9

### DIMENSIONS AND WEIGHTS

UPS300E		
Depth	865 mm	34.0 in
Width	3,226 mm	127 in
Height	2,438 mm	96.0 in
Weight (3-wire)	3,199 kg	7,050 lb
Weight (4-wire)	3,494 kg	7,700 lb
UPS600		
Depth	865 mm	34.0 in
Width	4,318 mm	170 in
Height	2,438 mm	96.0 in
Weight (3-wire)	5,241 kg	11,550 lb
Weight (4-wire)	5,536 kg	12,200 lb
UPS900		
Depth	865 mm	34.0 in
Width	5,410 mm	213.0 in
Height	2,438 mm	96.0 in
Weight (3-wire)	7,282 kg	16,050 lb
Weight (4-wire)	7,577 kg	16,700 lb

### ENVIRONMENTAL

Acoustical Noise	< 75dBA at 1m (3.28 ft)
Temperature	
Operating	0° C to 40° C (4° F to 104° F)
Storage	-25° C to 70° C (-13° F to 158° F)
Humidity	5% to 95% (non-condensing)
Altitude	Up to 914.4 m (3,000 ft); (de-rate operating temperature range for higher elevation)
Emissions and Immunity	FCC Class A, Subpart J of 1Part 5/EN 50091-2

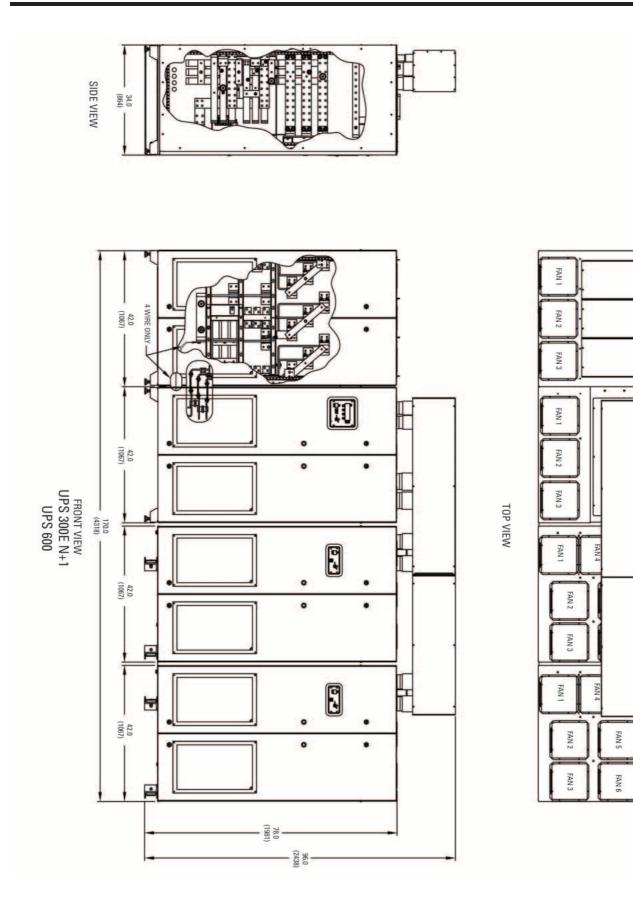
### CERTIFICATIONS

UL 1778 listed
CUL CAN/CSA 22.2 No. 107.1 listed
EN50091-1-1
CE Mark

### RIDE THROUGH TIMES (SEC)

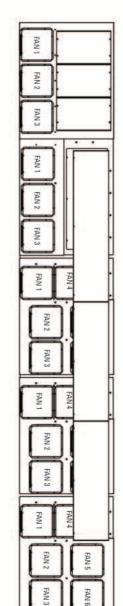
Model	100% load	75% load	50% load	25% load
UPS300E				
UPS600	13	17	25	50
UPS900				

### UPS 300 SERIES MULTI MODULE SYSTEMS 300 kVA/240 kW, 60 Hz 600 kVA/480 kW, 60 Hz 900 kVA/720 kW, 60 Hz



## CATERPILLAR®

••••• SIDE VIEW 34.0 ..... 4 WIRE ONLY 42.0 (1067) . Π 0 . 42.0 0 . FRONT VIEW UPS 600 N+1 UPS 900 -42.0 (1067) 213.0 (5410) TOP VIEW 0 . . -42.0 (1067) • -42.0 • . 78.0 96.0 (2438)



CATERPILLAR®



The EPS 8000 specifications read like a list of ideal answers to today's critical power user requirements. Featuring a true IGBT PWM inverter that feeds up to 720 kW per UPS of computer grade power (<4% THD) to your critical loads, the **EPS 8000** meets all your high power requirements in a compact footprint.

**EPS 8000** user's will enjoy substantial cost savings as MGE's Digital Power Quality logic keeps the inverter efficiency high even when the UPS is lightly loaded. On the input side, a 12 pulse rectifier combined with MGE's data grade input filter boasts very low THD, low kVAR, and no leading power factor; making the **EPS 8000** ideal for generators. All of these features and more make the **EPS 8000** the best choice for high availability critical power systems.

### **MGE UPS SYSTEMS** the chosen solution for **95%** of Fortune 100 companies

THE UNINTERRUPTIBLE POWER PROVIDER

MGE UPS SYSTEMS

EPS 8000 555/625/750/800 kVA

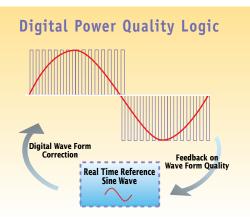
Static UPS Equipment

### Where Power and Reliability Converge

### **Advanced Features**

- 0.9 output Power Factor
- Space saving footprint/highest kW per square foot
- High energy efficiency
- Large graphical user interface*
- 12 pulse rectifier
- Ultra low kVAR data grade input filter
- Excellent generator compatibility
- Non-linear load optimized
- IGBT PWM inverter with Digital Power Quality logic
- Precision output voltage regulation
- Advanced battery management system
- 100% step load enabled
- Integrated isolation transformer
- True front access
- Fault tolerant output
- Easy integration with most monitoring systems
   * optional

M G E UPS SYSTEMS



### Active Harmonic Conditioning

Most loads protected by the UPS are non-linear loads, such as computer power supplies, which reflect large amounts of harmonic distortion onto the critical bus disturbing other equipment. The EPS 8000's DQP logic dynamically adjusts the output load side voltage distortion resulting in clean, distortion free (<3.5% THD) power on the critical bus.

### Fault Tolerant Circuitry

Even when protected by a breaker, a fault may take up to six or more cycles to clear and are common over the life of a UPS system. Most UPS inverters cannot respond fast enough and continue to supply the fault with inverter power overloading the power semi-conductors

### The **EPS 8000's** superior inverter performance is a result of **MGE's Digital Power Quality (DPQ) logic.**

By creating the waveform from hundreds of precisely controlled pulses, the DPQ logic system continuously compares the output power to a reference sine wave applying sub cycle correction pulses to maintain precise voltage regulation. The speed, precision, and dynamic response of the DPQ logic allow the inverter to have the following truly unique performance characteristics.

and causing critical component failure. The EPS 8000 inverter has a micro sub-cycle response time allowing the inverter to rapidly and safely transfer the inverter from a faulted load to the bypass source.

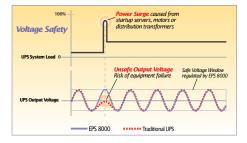
The added fault clearing capacity of the bypass source (typically fed by the utility), along with a robust static transfer switch that can handle up to 22 times the nominal



current safely, clears the fault and instantly returns to protected inverter power.

#### Outstanding Dynamic Load Response

UPSs are frequently exposed to rapid load changes caused from starting motors, distribution transformers, and even large banks of servers. These step loads can cause a significant voltage decay on the output of most UPSs. Even when exposed to a 100% step load, the EPS 8000 maintains precise output voltage regulation, limiting voltage transients to under 5%.



### Space saving footprint with true front access

*Fitting into a space as little as 120" wide,* the EPS 8000 has one of the highest power densities of any UPS. The integrated input isolation transformer and input filter eliminate the need for bulky auxiliary cabinets. All EPS 8000 components, including the transformers, are truly front accessible with no rear access requirements, *saving even more footprint.* 

- True Front Access/No rear or side access required
- 23 kW/square foot high power density (750/800 kVA models)
- 121" wide including input isolation transformer and filter (multi-module/135" single module w/ bypass)
- Easy front thermal scanning with terminal viewing ports



### **Proven Data Center Power Protection**

### **Generator Friendly Technology**

By combining a low distortion 12 pulse rectifier with a passive inductive filter, the EPS 8000 limits input distortion to around 5% while minimizing kVARs to a negligible level. Even when lightly loaded, the UPS input power factor is not leading. Together, these conditions are ideal for generators and limit oversizing requirements.



Advantage MGE MGE Input Filters Feature: Low Input Distortion Very Low kVAR No Leading Power Factor No mechanical switching of filters



Rapid, expert Service means equals maximum uptime. MGE's 150 factory trained field technicians are strategically located throughout North America ensuring a rapid response with 7 x 24 service for customers with mission critical applications. Regular preventive maintenance visits and computer aided diagnostics assist our

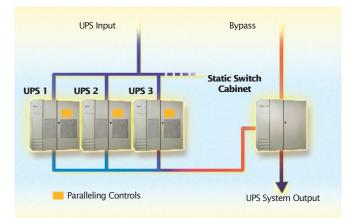
technicians in detecting issues before they have a chance to compromise UPS performance. MGE's dedicated Customer Care Center ensures a prompt and attentive response whatever your need may be. From scheduling maintenance visits to dispatching field technicians in the event of an emergency, a Customer Care Representative is ready to respond.

### Large Power Systems Solutions

### Why use the MGE Power Systems?

- Unique paralleling technology with controls/no single points of failure
- Critical Bus Synchronization for dual bus systems
- Complete product line to satisfy all project requirements
- Experienced Power Systems Design Team
- Proven track record on the world's largest projects

### MGE's complete line of power system products offer the efficiency of a single vendor and benefit of a single source of project accountability!



### Advanced Graphical User Interface:

An optional large LCD **touch screen** comple-

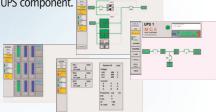
ments the EPS 8000 controls to provided features including active mimic diagrams, alarm/event logs and more. The



simplicity of the display allows operators of all knowledge levels to understand UPS status and operation at a glance, limiting operator errors.

### Details you can understand!

**Component level screens** like the battery management page and the output power page provide a very detailed view of the status of each UPS component.



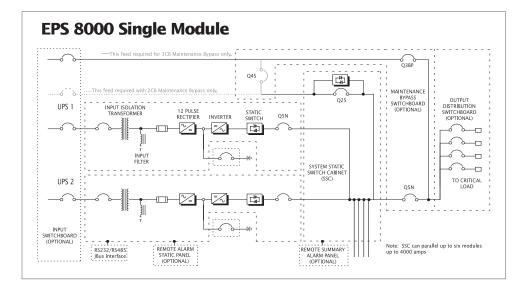
**The GUI's alarm and event log** *tracks all changes in UPS status, along with a corresponding time stamp. This, along with a trending record of key parameters, aids in keeping an accurate measurement of UPS performance.* 

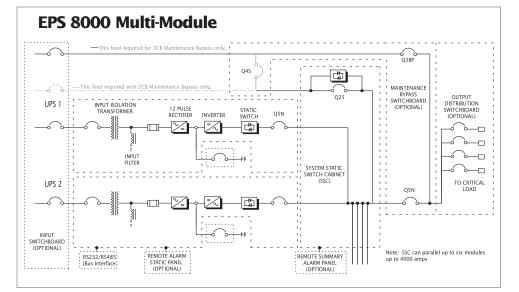
710

**MGE UPS SYSTEMS is the industry leader in design of large power systems.** With thousands of installations worldwide, MGE consistently delivers the ultimate in reliability, availability and maintainability.

MGE UPSs can be paralleled with up to six modules for redundancy or capacity. MGE's unique Shared Parallel system places intelligence for paralleling in each individual UPS module eliminating a centralized single point of failure. The output of each UPS is centrally bussed through a Static Switch Cabinet (SSC), which also provides a seamless system transfer to a bypass source when needed.

Technical Specifications	555kVA/500kW	555kVA/500kW	625kVA/562kW	625kVA/562kW	750kVA/675kW	800kVA/720kW
Input/Output Voltage ¹ (V)	480/480	600/600	480/480	600/600	480/480	480/480
Nominal Input (A)	719	575	817	654	907	1061
Max Input (A)	825	663	923	741	1,043	1,134
Input CB (kAIC)	100	100	100	100	100	100
Trip/Frame Size (A)	2,000/1,200	2,000/1,000	2,000/1,200	2,000/1,000	2,000/1,600	2,000/1,600
Nominal Bypass Current (A)	668	753	752	601	900	960
Maint. Bypass CB ² (KAIC)	65	65	65	65	65	65
Trip/Frame Size (A)	1,000/1,200	800/1,200	1,000/1,200	800/1,200	1,200/1,200	1,200/1,200
UPS Output Isolation CB ² (KAIC)	65	65	65	65	65	65
Trip/Frame Size (A)	1,000/1,200	800/1,200	1,000/1,200	800/1,200	1,200/1,200	1,200/1,200
Max Output Current (A)	668	534	752	601	900	960
Max DC Current (A)	1,533	1,533	1,533	1,533	1,766	1,884
DC Breaker						
Trip/Frame Size (A)	1,600/2,000	1,600/2,000	1,600/2,000	1,600/2,000	2,000/2,000	2,000/2,000
System Efficiency (100%-25% load)	93%	93%	93%	93%	93%	93%
Full Load Heat Rejection (BTUs)	125,970	125,970	133,300	133,300	173,000	190,000
Multi Module Width ³ (39"Dx82"H)	121"	121"	121"	121"	121"	121"
Single Module Width ³ -Top Entry (39"Dx82"H)	121"	121"	121"	121"	135"	135"
Maintenance Bypass for single module	22"	22"	`22"	22"	8"	8"
Bottom Entry	36"	36"	36"	36"	36"	36"
Battery Disconnect Width (28"Dx90H)	36"	36"	36"	36"	36"	36"
Max. Shipping Split Width	61"	61"	61"	61"	61"	61
UPS Cabinet Weight ⁴ (lbs)	12,200	12,200	12,200	12,200	14,000	14,000





### **Standard Features** Input isolation transformer I ow k\∕AR input filter

Low kVAR input filter									
IGBT PWM inverter w/Digital Power Quality logic									
12 pulse rectifier									
Serial and dry contact communications interface									
Computer aided diagnostics									
Advanced battery management									
	No rear access								
Redundant fan as	semblies								
Input									
Input Voltage	480 or 600 VAC (3ph,3/4W + GRD)								
	+10/-15% 60 Hz ±10%								
<ul> <li>Frequency (Hz)</li> <li>Power Factor</li> </ul>									
Power Factor	0.9 lagging, .95 with filter 4 kVAR max leading								
Input Current	4 KVAR Max leading								
Distortion	5% max. THD at full load								
_									
Output Dewer Factor	0.9								
Voltage	480 or 600 VAC (3ph, 3/4W+GRD)								
Frequency	$60 \text{ Hz} (\text{selectable} \pm 5\%)$								
Friequency	0.1% free running								
Voltage	0.170 nee fulling								
Regulation	+/- 0.5% steady state								
5	(±2.5% 100% step load)								
Voltage Distortion	4% max for non-linear loads								
	w/crest factor of 3.5								
New years of the second	2% max linear load								
Inverter Overload	125% for 10 minutes,								
Unbalanced Load	150% for 1 minute, Up to 100% 120° ±3%								
	(unbalanced load) max. angle								
	displacement, $\pm 2.5\%$ max.								
	voltage deviation								
Bypass Input									
Voltage	+10/-15% UPS output								
	voltage (3ph, 3/4W+GRD)								
▶ Frequency	60Hz (±0.25 Hz up to 2 Hz)								
DC Rating									
Nominal Voltage	480 VDC								
5									
Environmental Operating	specifications								
Temperature	0°C to 40°C (32°F to 104°F)								
Non-operating: $-20^{\circ}$ C to $+45^{\circ}$ C ( $-4^{\circ}$ to $113^{\circ}$ F)									
Audible Noise	75 dB @ 5'								
<ul><li>Audible Noise</li><li>Relative Humidity</li></ul>									
<ul> <li>Audible Noise</li> <li>Relative Humidity</li> <li>Options</li> </ul>	75 dB @ 5' 0-90% non-condensing								
<ul> <li>Audible Noise</li> <li>Relative Humidity</li> <li>Options</li> <li>Graphical User Integration</li> </ul>	75 dB @ 5' 0–90% non-condensing terface with Network Connection								
<ul> <li>Audible Noise</li> <li>Relative Humidity</li> <li>Options</li> <li>Graphical User Int</li> <li>Battery Disconneed</li> </ul>	75 dB @ 5' 0–90% non-condensing terface with Network Connection								
<ul> <li>Audible Noise</li> <li>Relative Humidity</li> <li>Options</li> <li>Graphical User Inti</li> <li>Battery Disconnee</li> <li>External Maintena</li> </ul>	75 dB @ 5' 0–90% non-condensing terface with Network Connection ct ance Bypass								
<ul> <li>Audible Noise</li> <li>Relative Humidity</li> <li>Options</li> <li>Graphical User Int</li> <li>Battery Disconnee</li> <li>External Maintena</li> <li>Critical Bus Synch</li> </ul>	75 dB @ 5' 0–90% non-condensing terface with Network Connection ct ance Bypass ironization Module								
<ul> <li>Audible Noise</li> <li>Relative Humidity</li> <li>Options</li> <li>Graphical User Int</li> <li>Battery Disconnee</li> <li>External Maintena</li> <li>Critical Bus Synch</li> <li>Remote Alarm Sta</li> </ul>	75 dB @ 5' 0–90% non-condensing terface with Network Connection ct ance Bypass ironization Module atus Panel								
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POWER

#### MGE UPS SYSTEMS

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U N I N T E R R U P T I B L E

www.mgeups.com info@mgeups.com EPS 8k

Revision 104 Effective: October 2006

PROVIDER

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# **BP Solar Modules -**

## **Photovoltaic Power Modules**

Founded in 1973, Solarex is the first organization to have applied photovoltaic technology to commercial needs on Earth. As a wholly owned subsidiary of BP Amoco, Solarex (now called BP Solar) is the largest manufacturer of polycrystalline silicon PV modules and cells and the leader in the manufacture and commercialization of single and tandem junction thin film silicon technology and modules. BP Solar has ISO 9001-certified manufacturing facilities in Australia and the U.S., and power systems operating on every continent. BP Solar has over twentyfive years of research, development and manufacturing experience in advanced polycrystalline silicon technology. BP Solar's polycrystalline solar cells are manufactured with SEMIXTM process cast silicon which gives them attractive large crystal grains and low impurities. The cells are covered with a highly conductive silver paste grid, backed with a strong, conductive aluminum layer and topped with an anti-reflective coating to enhance efficiency. Every cell is tested and categorized by its output current at a reference voltage. Power losses in modules due to mismatched cells are virtually eliminated.



The BP275 75 watt modules are made with 36 conventional single-crystal silicon cells.

The BP585 85 watt modules are made with 36 laser-grooved buried-grid single-crystal silicon cells, which are currently the most efficient

commercially available cell in the world. Their efficiency is 20% higher than other typical single crystal cells in full sun, and they give significantly better performance in low light and overcast conditions. This high efficiency translates into cost savings on mounting structures, especially on trackers. Both panels have in each conduit-ready junction box has two waterproof cable clamps and by-pass diodes, so no special module interconnects are required. The face of these modules are tempered, high light transmission glass and the rear is a triple lamination of PVF, polyester and PVF. Output is 12 volts. Dimensions: 46.8" x 20.9" x 1.5". 20 year warranty. UL Listed.

#### **Solarex SX Series**

· 36 polycrystalline silicon solar cells.

· Engineered for industrial use.

· Dual voltage capability at 6 and 12VDC. (SX-5 & 10 available in 12VDC only).

• Rugged Universal frames. (SX-5 & SX-10 offered with the "multimount " frame only.) • Conduit-ready, high-capacity junction box with six terminal connection. (SX-5 & SX-10 have an epoxy-potted junction box and come with 15' of cable.)

 $\cdot$  20 year power warranty on 40 to 85 Watt modules. (10 year on 5 to 30 Watt modules.)

· UL Listed / FM approved / IEC61215 / TÜV. Class C fire rating on 40 to 85 watt modules.

 $\cdot$  M, D and U refer to the frame style. M is multimount, D is direct and U is universal.

#### **BP Solar Modules**

Prices are all list. Contact us for sale prices.

Name	Wattage Peak ( watts )	Item Number	Price
SX20U	20	11.3523	\$300
SX30U	30	11.3525	\$325
<b>SX60</b> U	60	11.3529	\$400
BP-275	75	11.3580	\$450
BP-585	85	11.3585	\$550
BP3150	150	11.3617	\$750
BP3160	160	11.3619	\$800

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Lighting	<b>Batteries</b>	Fans - AC - Heating	Large Appliances	Small Appliances	Miscellaneous

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### **Utility Intertie 3-Phase Inverters**

### **Trace 3-Phase Power Module Systems**

The TRACE Power Module System is a "balance of system" package designed to permit seamless system integration. Aimed at meeting a broad range of applications, the modular design facilitates installation standardization while permitting maximum flexibility. It allows isolation of components, wiring and safety circuitry in a lockable cabinet while maintaining access to all the breakers.

These Power Modules are a three-phase configuration of three Sine-Wave inverters in a stacked, three module, pre-wired system. Includes three phase monitoring software, SWCA Communications Adapter, 3-stage battery charger, and automatic AC transfer relay. For stand-alone or utility-interactive applications. Floor Mount: 19" deep (48 cm), 34" wide (85 cm), 57" high (143 cm) Unit weight: 527 or 560 lbs (240 or 255 kg.) Depending on Model.

Name	Wattage ( watts )		Input Voltage ( volts )	Output Voltage ( volts )	Weight ( LBS )	Price
PM- SW4048/3PH	12000.	60	48	/240	7173	\$15,457.00
PM- SW5548/3PH	16000.	60	48	/240	8226	\$17,125.00

### **Trace Technologies PV Series Grid-Tied 3-Phase Inverters**

The Trace Technologies PV Series of Utility interactive photovoltaic inverters have quickly set the standard for grid tied solar power systems from 10 kW and up. Reliability, efficiency and performance are among the reasons that increasing numbers of electric utilities and other energy producers and users are looking to Trace Technologies for their photovoltaic power conversion needs. Features: automatic morning wakeup and evening shutdown, peak power tracking, power limiting during enhanced irradiance conditions, and full instrumentation of input and output parameters displayed locally or remotely. Each model complies with the applicable industry standards, including IEEE 519, IEEE 929 and the National Electrical Code. The flexibility of the many user programmable protective function set-points allows the inverter to be paralleled with most utility distribution systems with little or no additional protective hardware required. Peak power tracking is 300-600 VDC for this line. All these inverters are 208 VAC and 60 Hz units.

Name	Wattage ( watts )	Length (IN)	Width (IN)	Height (IN)	Weight (LB)	Price
PV-100208	100000.	31	27	68	1700	\$51,795.00
PV-150208	150000.	40	27	86	3700	\$67,595.00
PV-20208	20000.	14	14	28	175	\$13,134.00
PV-225208	225000.	40	27	86	3900	\$81,295.00
PV-30208	30000.	27	20	68	1000	\$17,155.00
PV-300208	300000.	40	27	86	3900	\$89,895.00
PV-50208	50000.	27	20	68	1300	\$28,485.00
PV-10208	10000.	16	12	26	75	\$6,925.00
PV-15208	15000.	24	14	28	175	\$10,387.00
PV-500208	500000.	40	27	86	3700	\$150,298.00

PV Series Grid-Tied Inverters (for systems without batteries)

### **Trace Technologies PV/Hybrid Series 3-Phase Inverters**

The Trace Technologies PV/Hybrid series of power processing systems provide complete power conversion and system control solutions. For applications from 30 kVA to 300 kVA, the PV/Hybrid series offers the reliability, efficiency and performance necessary for truly autonomous power system operation. The PV/Hybrid series delivers a unique combination of features available only from Trace Technologies. PV array peak power tracking, battery charge control, engine load management and synchronous load transfers between the inverter and the generator are integrated into a single unit. Connect your battery bank, PV array, standby generator and load to the PV/Hybrid, and your power system is up and running. For most loads, the inverter's voltage regulation, frequency regulation and voltage waveform characteristics significantly exceed that delivered by the standby generator, even in the presence of severe phase imbalance. Peak power tracking is 300-600 VDC for these inverters. All these inverters are 480 VAC, 3 phase, 3 wire, 60 Hz units.

#### **PV/Hybrid Series Inverters**

Name	Wattage ( watts )	Length (IN)	Width (IN)	Height (IN)	Weight (LB)	Price
HY-100	100000.	40	27	86	1700	\$112,495.00
HY-150	150000.	80	27	86	3700	\$152,993.20
HY-225	225000.	80	27	86	3900	\$208,073.20
HY-30	30000.	27	20	68	1000	\$50,993.20
HY-300	300000.	80	27	86	3900	\$244,793.20
HY-50	50000.	27	20	68	1300	\$64,729.20

Sun Power	Water Power	Wind Power	System Components	Design Resources	Water Pumps
Lighting	<b>Batteries</b>	Fans - AC - Heating	Large Appliances	Small Appliances	Miscellaneous

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High-efficiency photovoltaic module using silicon nitride multicrystalline silicon cells.

### Performance

Rated power (P _{max} )	160W
Power tolerance	± 5%
Nominal voltage	24V
Limited Warranty ₁	25 years

### Configuration

Bronze frame with output cables and
polarized Multicontact (MC) connectors
Clear universal frame with output cables and
polarized Multicontact (MC) connectors
Unframed laminate version of BP 3160S
Clear universal frame with standard junction box

Electrical Characteristics ²	BP 3160
Maximum power (P _{max} ) ³	160W
Voltage at Pmax (V _{mp} )	35.1V
Current at Pmax (I _{mp} )	4.55A
Warranted minimum P _{max}	152W
Short-circuit current (I _{sc} )	4.8A
Open-circuit voltage (V _{oc} )	44.2V
Temperature coefficient of I _{sc}	(0.065±0.015)%/°C
Temperature coefficient of V _{oc}	-(160±20)mV/°C
Temperature coefficient of power	-(0.5±0.05)%/ °C
NOCT (Air 20°C; Sun 0.8kW/m ² ; wind 1m/s)	47±2°C
Maximum series fuse rating	15A (S, L); 20A (U)
Maximum system voltage	600V (U.S. NEC & IEC 61215 rating) 1000V (TÜV Rheinland rating)



BP 3160

### **Mechanical Characteristics**

Dimensions	B,S,U L	Length: 1593mm (62.8")Width: 790mm (31.1")Depth: 50mm (1.97")Length: 1580mm (62.2")Width: 783mm (30.8")Depth: 19mm (0.75")								
Weight	B,S,U L	15.0 kg (33.1 pounds) 12.4 kg (27.3 pounds)								
Solar Cells	B,S,L,U	72 cells (125mm x 125mm) in a 6x12 matrix connected in series								
Output Cables	B,S,L	RHW AWG# 12 (4mm ² ) cable with polarized weatherproof DC rated Multicontact connectors; asymmetrical lengths - 1250mm (-) and 800mm (+)								
Junction Box	U	Standard junction box with 6-terminal connection block; IP 54, accepts PG 13.5, M20, ½ inch conduit, or cable fittings accepting 6-12mm diameter cable. Terminals accept 2.5 to 10mm ² (8 to 14 AWG) wire.								
Diodes	B,S,L,U	Three 9A, 45V Schottky by-pass diodes included								
Construction	B,S,L,U	Front: High-transmission 3mm (1/8 th inch) tempered glass; Back: Tedlar; Encapsulant: EVA								
Frame	B,S,U	Anodized aluminum alloy type 6063T6 Universal frame; Color: bronze (B); silver (S,U)								

1. Warranty: Power output for 25 years. Freedom from defects in materials and workmanship for 5 years. See our website or your local representative for full terms of these warranties.

2. These data represent the performance of typical BP 3160 products, and are based on measurements made in accordance with ASTM E1036 corrected to SRC (STC.)

3. During the stabilization process that occurs during the first few months of deployment, module power may decrease by up to 3% from typical P_{max}.

### **Quality and Safety**

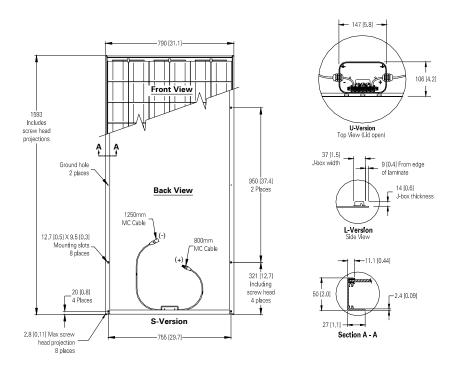
ESTI	Module power measurements calibrated to World Radiometric Reference through ESTI (European Solar Test Installation at Ispra, Italy)	
CE	Manufactured in ISO 9001-certified factories; conforms to European Community Directives 89/33/EEC, 73/23/EEC, 93/68/EEC; certified to IEC 61215	<b>BP 3160 I-V Curves</b>
TÜV	Framed modules certified by TÜV Rheinland as Safety Class II (IEC 60364) equipment for use in systems up to 1000 VDC	5.0
	Listed by Underwriter's Laboratories for electrical and fire safety (Class C fire rating)	$4.0 - \boxed{-\frac{t=0C}{t=25C}}$
FM	Approved by Factory Mutual Research in NEC Class 1, Division 2, Groups C & D hazardous locations (U)	
		2.0

#### **Qualification Test Parameters**

Temperature cycling range	-40°C to +85°C (-40°F to 185°F)
Humidity freeze, damp heat	85% RH
Static load front and back (e.g. wind)	50psf (2400 pascals)
Front loading (e.g. snow)	113psf (5400 pascals)
Hailstone impact	25mm (1 inch) at 23 m/s (52mph)

2.0 1.0 0.0 0 20 40 60 Voltage (V)

Dimensions in brackets are in inches. Unbracketed dimensions are in millimeters. Overall tolerances ±3mm (1/8")



Included with each module: self-tapping grounding screws, instruction sheet, and warranty document.

Note: This publication summarizes product warranty and specifications, which are subject to change without notice.





### Frequently Asked Questions on the New Federal Solar Tax Credits

This FAQ sheet should answer many of the questions facing companies in the solar energy industry about the federal solar tax credits. *While we have to be very clear that SEIA cannot offer you tax advice, which can ultimately only come from your tax professional*, this document should provide some initial guidance based on the legislative text.

In the coming weeks, SEIA will be working with the IRS to obtain formal guidance on these issues, and will keep you informed about the forms and procedures you will need to claim this valuable credit.

We encourage you to send questions to us at info@seia.org, so that we can obtain clarity on these key issues for you as soon as possible.

	Old Incentive	New Incentive	Credit window	Сар	Eligible technologies
Business credit	10%	30%	1/1/06 - 12/31/07 at 30%; reverts to permanent 10% thereafter	No cap	PV, CSP, solar hybrid lighting, solar domestic water heating (excluding pool heating)
Residential credit	None	30%	1/1/06 - 12/31/07	\$2,000 per system/ for each solar technology	PV, solar domestic water heating (excluding pool heating)

### **Business Credit vs. Residential Credit**

## 1. What are the dates of the credit? Is it applicable to existing systems?

The credits become available for systems that are "placed in service" - activated between January 1, 2006, and December 31, 2007. If the installation is on a new home, the "placed in service" date is the date of occupancy by the homeowner.

Systems that have already been installed are not eligible.

### 2. What about systems that have been purchased but not installed?

Should you sell / buy a system and even start work this year, but do not complete "original installation" of the system or "place it in service" until Jan. 1, it will qualify for the credit.

SOLAR ENERGY INDUSTRIES ASSOCIATION 805 15TH ST., NW # 510 WASHINGTON, DC 20005 (202) 682 – 0556 (P) (202) 682 – 0559 (F) HTTP://WWW.SEIA.ORG

# 3. Can this credit be applied to capacity additions? (i.e. I have a 1.5 kW system and I want to add 1.5 kW more.) Similarly, can I apply this credit to used equipment going into a new installation?

This is not entirely clear at present. However, the language would suggest that both scenarios are allowed - the credits apply to the amount of expenditure on solar energy property in a given year. SEIA will work with the IRS to develop regulations favorable to the solar industry. We will pass on additional information as it becomes available.

### 4. How does the residential cap on expenditures operate?

An individual can take the 30% credit up to a \$2,000 cap for photovoltaics, while also taking the credit up to a separate \$2,000 cap for solar water heating. The credit may be carried over to future years.

Business entities have no cap on the total credit amount, provided they have a sufficient tax liability. Businesses have 2 years in which to take the credit.

## 5. How does the credit work with existing state credits or utility incentives?

The credit applies to the basis remaining after any state or utility incentives available to the taxpayer have been taken.

Example: a \$10,000 system that receives \$5,000 in state incentives would be eligible for a \$1,500 Federal credit.

## 6. Are there any changes to the business solar tax credit other than percent?

The business solar tax credit will continue to be administered as before; all that has changed is the percentage increase to 30%. Operation and legal technicalities of the business credit are well established. An accountant or tax professional familiar with these rules should be able to inform you on any specific issues.

Contact: Rhone Resch, rresch@seia.org or Noah Kaye, nkaye@seia.org

### **Congress Extends Federal Solar Energy Tax Credits Through End of 2008**

(WASHINGTON, DC) - In its waning hours, the 109th Congress today passed legislation that would extend the 30% solar energy investment tax credit (ITC) for homeowners and businesses for one additional year, through the end of 2008.

The Solar Energy Industries Association (SEIA) applauded the one-year extension of the solar ITC in H.R. 6111, the "Tax Relief and Health Care Act of 2006." At the same time, the industry cautioned that the lifespan of the credits is too short to encourage significant industry growth and cost reductions.

"While this bill does not constitute a long-term solar growth policy, it does provide some breathing room for solar projects in the 12- to 18-month pipeline," said Rhone Resch, SEIA President. "It ensures that the solar industry will continue to grow at a record rate in 2007. The passage of this bill with an extension of the solar ITC is recognition by Congress that solar is indispensable to our clean energy future."

An eight-year extension of the ITC will remain the solar industry's top legislative priority in 2007. A long-term extension is essential to reducing the cost of solar energy, as it would create market conditions that allow solar companies to make investments and drive down costs through economies of scale. A longer duration will also be needed to help stimulate the development of large-scale concentrating solar power projects.

SEIA's Resch expressed optimism that the 110th Congress would enact an eight-year extension as contained in S. 2677 and H.R. 5206, the "Securing America's Energy Independence Act," a bill which gained a bipartisan group of 80 House and 15 Senate cosponsors this year.

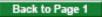
"This bill is a patch, and emphasizes the importance for Congress to enact long-term, comprehensive clean energy legislation when they return in January," said Resch. "We look forward to working with the next Congress, to craft a comprehensive and effective policy blueprint for a self-sustaining clean energy infrastructure in the United States."

### *****

The bill contains the following provisions:

Residential Solar Tax Credit: Extends a 30-percent tax credit, created in the Energy Policy Act of 2005, for the purchase of residential solar water heating, photovoltaic equipment, and fuel cell property. Expires after December 31, 2008.

Business Solar Tax Credit and Fuel Cell Tax Credit: Extends a 30-percent business credit, established in the Energy Policy Act of 2005, for the purchase of fuel cell power plants, solar energy property, and fiber-optic property used to illuminate the inside of a structure. After December 31, 2008, the credit reverts to a permanent 10-percent level.



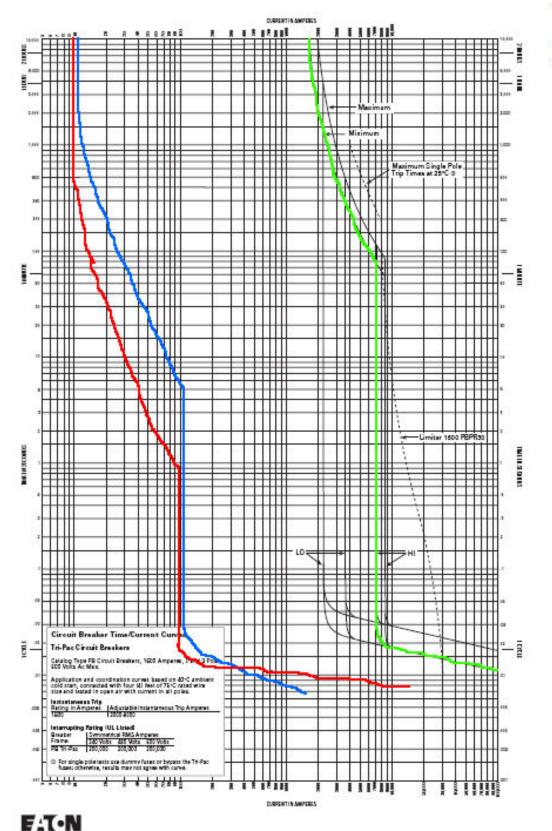
Application Data 29-167C

Page 52



### AB DE-ION Tri-Pac® Circuit Breakers

Type PB, 1600 Amperes, 2 and 3 Poles

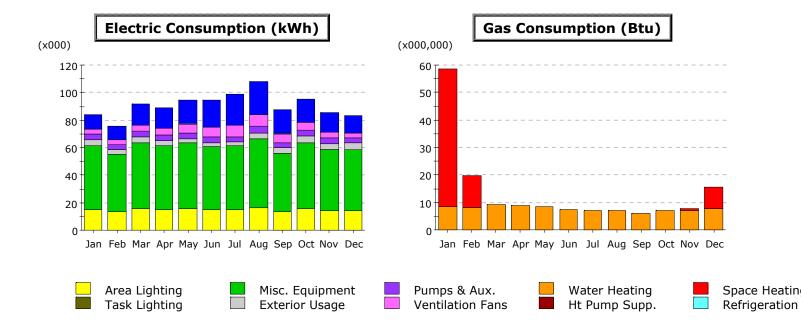


### 1600A Ckt. Bkr. 400A Ckt. Bkr. 100A 3P Ckt. Bkr.

Curve No. SC-3604-76B

## **Appendix C**

*E-Quest Analysis Results

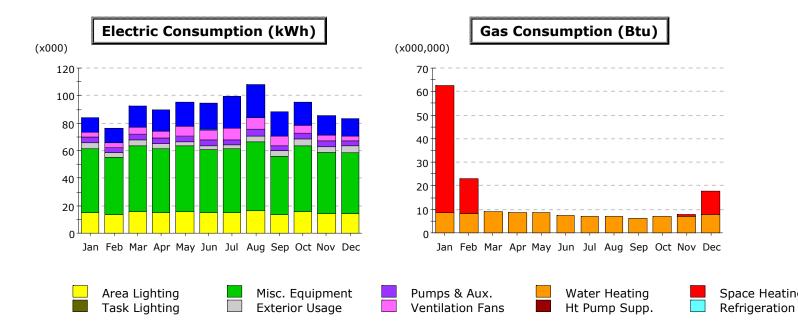


### Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	10.4	9.8	15.4	15.1	17.3	19.4	22.6	23.6	17.4	16.6	14.3	12.4	194.3
Heat Reject.	-	0.0	0.0	0.0	0.1	0.2	0.4	0.3	0.2	0.1	0.0	0.0	1.4
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	3.9	3.3	4.5	5.3	6.4	7.2	7.9	8.6	6.4	6.1	4.4	3.7	67.7
Pumps & Aux.	3.8	3.5	4.2	4.1	4.3	4.1	4.1	4.4	3.7	4.3	3.9	3.8	47.9
Ext. Usage	4.6	3.5	3.9	3.8	2.7	2.6	2.7	4.4	4.2	4.4	4.4	4.6	45.7
Misc. Equip.	46.6	42.1	48.5	46.4	48.5	46.4	46.6	50.5	42.5	48.5	44.5	44.6	555.8
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	14.7	13.3	15.3	14.6	15.3	14.6	14.7	16.0	13.3	15.3	14.0	14.0	175.2
Total	83.9	75.5	92.0	89.3	94.6	94.5	99.0	107.8	87.8	95.2	85.4	83.1	1,088.0

#### Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	50.16	11.87	-	-	-	-	-	-	-	-	0.80	7.76	70.59
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	8.58	8.03	9.25	8.68	8.44	7.47	6.97	7.20	6.04	7.19	7.09	7.68	92.64
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	58.75	19.90	9.25	8.68	8.44	7.47	6.97	7.20	6.04	7.19	7.88	15.45	163.23



#### Electric Consumption (kWh x000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	10.7	10.1	15.7	15.4	17.6	19.7	22.9	23.9	17.6	16.8	14.6	12.6	197.7
Heat Reject.	-	0.0	0.0	0.0	0.1	0.2	0.4	0.3	0.2	0.1	0.0	0.0	1.4
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	-	-	-	-	-	-	-	-	-	-	-	-	-
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	-	-	-	-	-	-	-	-	-	-	-	-	-
Vent. Fans	4.0	3.4	4.6	5.3	6.5	7.3	8.1	8.7	6.5	6.1	4.3	3.8	<u>68.3</u>
Pumps & Aux.	3.9	3.5	4.3	4.1	4.3	4.1	4.1	4.5	3.7	4.3	3.9	3.8	48.5
Ext. Usage	4.6	3.5	3.9	3.8	2.7	2.6	2.7	4.4	4.2	4.4	4.4	4.6	45.7
Misc. Equip.	46.6	42.1	48.5	46.4	48.5	46.4	46.6	50.5	42.5	48.5	44.5	44.6	555.8
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	14.7	13.3	15.3	14.6	15.3	14.6	14.7	16.0	13.3	15.3	14.0	14.0	175.2
Total	84.3	75.9	92.3	89.7	95.0	94.9	99.4	108.3	88.1	95.5	85.7	83.5	1,092.6

#### Gas Consumption (Btu x000,000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Space Cool	-	-	-	-	-	-	-	-	-	-	-	-	-
Heat Reject.	-	-	-	-	-	-	-	-	-	-	-	-	-
Refrigeration	-	-	-	-	-	-	-	-	-	-	-	-	-
Space Heat	54.03	15.05	-	-	-	-	-	-	-	-	0.89	9.89	79.86
HP Supp.	-	-	-	-	-	-	-	-	-	-	-	-	-
Hot Water	8.58	8.03	9.25	8.68	8.45	7.47	6.97	7.20	6.04	7.19	7.09	7.69	92.65
Vent. Fans	-	-	-	-	-	-	-	-	-	-	-	-	-
Pumps & Aux.	-	-	-	-	-	-	-	-	-	-	-	-	-
Ext. Usage	-	-	-	-	-	-	-	-	-	-	-	-	-
Misc. Equip.	-	-	-	-	-	-	-	-	-	-	-	-	-
Task Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Area Lights	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	62.62	23.08	9.25	8.68	8.45	7.47	6.97	7.20	6.04	7.19	7.98	17.58	172.51