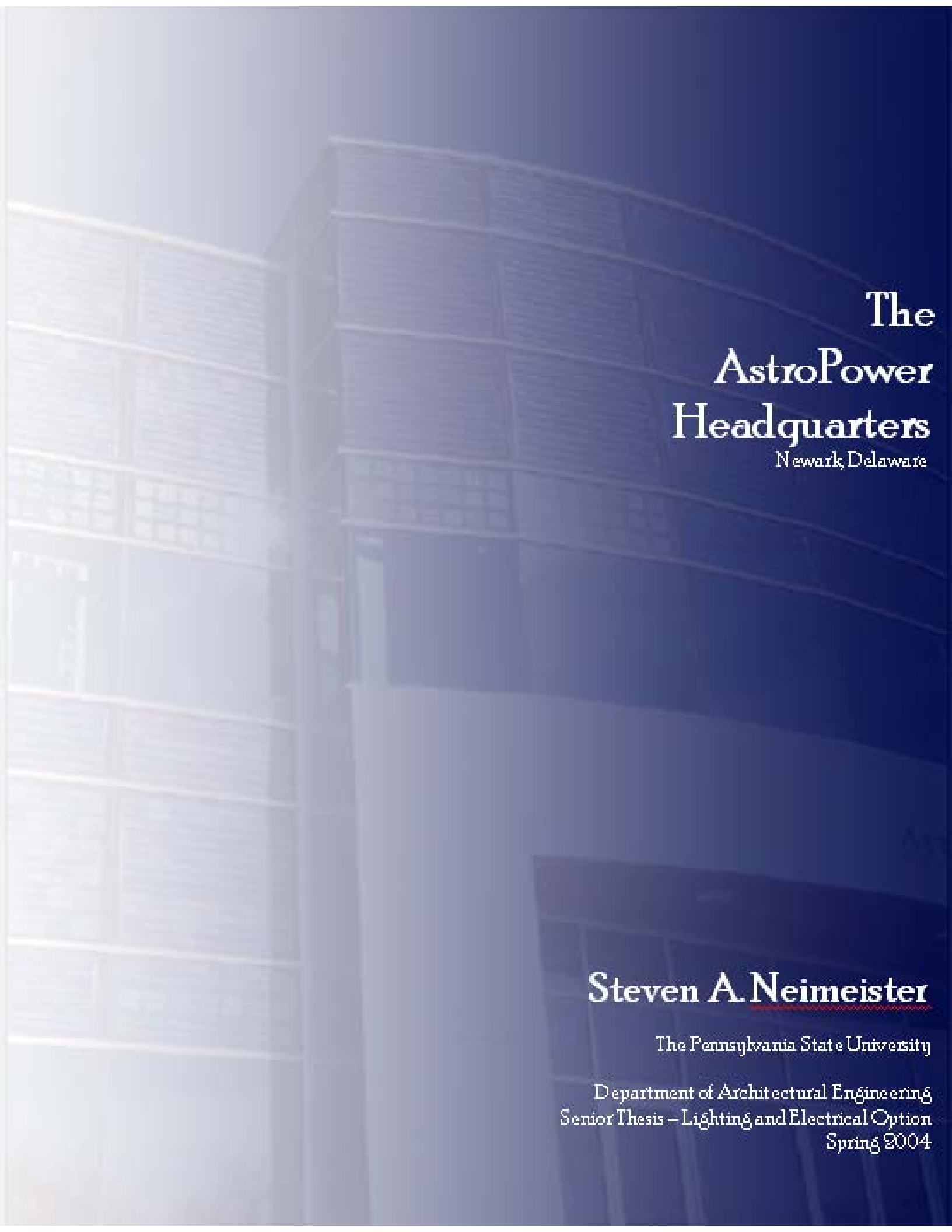

The AstroPower Headquarters

Newark, Delaware

Steven A. Neimeister

The Pennsylvania State University

Department of Architectural Engineering

Senior Thesis – Lighting and Electrical Option

Spring 2004

AstroPower Corporate Headquarters

Newark, Delaware

Project Team

- Owner—AstroPower
- Architect—Bernardon, Haber, Halloway Architecs PC
- Owner/Developer—McConnell Development, Inc.
- Structural Engineer—O'Donnell, Naccarato, & MacIntosh
- Mechanical/Electrical Engineer—Bruce E. Brooks & Associates
- Fire Protection—Bear Industries, Inc.
- General Contractor—Commonwealth Constructive Company

Electrical System

- 30-kilowatt building integrated façade of single-crystal solar cells and Apex™ solar cells (manufactured by AstroPower)
- 310-kilowatt rooftop system with 2400 solar modules

Lighting System

- Flourescent lighting with recessed spotlights
- Skylights and windows to maximize daylight

Building Description

- Office Space—58,000 square feet
- Warehouse—100,000 square feet
- Two story building above grade
- Solar panels line building sides and roof
- Building position provides maximum exposure to sun path while maximizing the preservation of wetlands on site

Structural System

- Concrete footing system
- Steel framing
- Truss system in warehouse
- Glass curtain walls

Mechanical System

- Two boilers
- Forced air system
- Air conditioning throughout

Other Information

- Fast-Track Construction began 2001, completed in March of 2002
- Design-Build Project delivery method
- Many of AstroPower's own solar products were used in construction

Steve Neimeister

Architectural Engineering—Lighting/Electrical Option

http://www.arche.psu.edu/thesis/2004/san141

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1. Executive Summary

Executive Summary

After receiving the qualifications for choosing a Senior Thesis building in mid-June of 2003, many different buildings I was familiar with came into mind. Having worked on numerous buildings around the country for the past five summers, structures that ranged from a new Professional Baseball Ballpark to a 48-story Green high-rise in Times Square mid-town Manhattan, I was unsure of which to choose. Although each of these buildings have many fascinating entities and design components, I felt as though most of them were much too large to focus on lighting and electrical elements. I recruited help from Bernardon, Haber, Halloway Architects PC, a widely known firm in the Philadelphia and Wilmington areas. After providing them with the criteria, they suggested several of their projects. The AstroPower Headquarters in Newark, Delaware was my first choice.

AstroPower is an international company that is a major solar power development firm. They manufacture solar panels that can be used in constructing today's major buildings. In fact, they used their own products in the construction of their Headquarters. With the installation of these solar panels on both the façade and roof of the building, the electrical energy requirements for the structure have been significantly reduced. I thought it would be very interesting to see how a building like this would function, seeing as how Green Building Design is the future of construction.

After taking a look at the building, I was impressed with their use of natural light through the solar panels, and the amount of open space, skylights, and domes. Since their company is based on solar design, it is nice to see them incorporate so much of sun into the design of their Headquarters. It made me think about how much natural light they had to work with when coming up with a lighting scheme during the design process.

The most unique feature on the building is the glass façade. When you approach the curved building and its blue glass curtain wall, you immediately realize that you are looking at a very different type of building. Upon closer inspection, you can see the solar cells embedded in the spandrel glass of the façade. The spectacular 30-kilowatt façade uses a combination of single-crystal solar cells and Apex™ solar cells, which are produced using AstroPower's proprietary Silicon-Film™ process. There are a total of 226 custom-shaped modules, which were manufactured at AstroPower's existing production facility in Newark, as well as the 168 translucent shading modules. A total of 83 different sizes of modules were integrated into the façade and the building's skylight. The BIPV solar installation generates solar electric power for the building, but it also serves as the building envelope as well. The solar modules replaced many of the traditional building elements.

Having a total 160,000 square feet, interesting architecture, a unique electrical system and lighting design, I felt the AstroPower Headquarters far surpassed any requirements for a great Senior Thesis building.

In the Depth portion of the thesis study, five spaces were analyzed for the redesigning of the lighting system. These spaces include a Conference Room, Lunch Room, Lobby Atrium, Open Office Area, and the Front Entranceway. The Open Office area involves an in-depth comparison of two distinct lighting systems; a

direct/indirect system with hanging fluorescent pendants, to a direct system with downlights. The goals in all of the spaces were to develop an energy efficient design that is both visually attractive and adds an element of design to the existing architecture. It was also to incorporate a theme throughout the spaces that united the various building spaces. The calculations used in the analysis were all performed using the AutoDesk Lightscape program. Renderings of the new and existing lighting systems were also made using the AutoDesk Lightscape program, for a realistic view of present versus future design.

Also in the Depth portion is an analysis of the current electrical system in the building. The analysis contains information regarding new ballasts and luminaires that have been implicated in the Lighting redesign. Due to the complexity of the building's electrical system with the solar input from the façade and roof, a resize and redesign of the Panels would have required assistance from an AstroPower representative and a licensed Electrical Engineer. Despite the set back, viewing the existing system was a beneficial learning experience within itself.

The first Breadth portion of the Thesis Portfolio is an analysis and design of the building's telecommunication system. The design will start with placement of new Telecommunications Rooms, layout of the equipment within these rooms, and the distribution of cable over the entire office. Details regarding the new system will include equipment in the rack, cable type, riser information and placement, and other information pertaining to the new system.

The second Breadth portion of the Thesis Portfolio will be a LEED Building Analysis. Seeing as how the building represents everything that should be incorporated into a Green building, I thought it appropriate to do a LEED study to see what rating the AstroPower Headquarters would receive. A listing of all achieved points will be incorporated into a summary, along with improvements the building can make to gain extra points to be as environmentally friendly as possible.

In the end, after all the late nights and long hours, the Senior Thesis project turned out to be a fantastic way to learn more about my future profession, how buildings are put together, and to see how things work in the real world. After it's completion, it was comforting to see how the integration of all building elements, Structural, Electrical, Lighting, Mechanical, Telecommunications, and many more can come together to make sense for a Pennsylvania State University Architectural Engineering student.

Acknowledgments

Thanks and my utmost appreciation goes out to...

Everyone at the AstroPower Headquarters

Art Bernardon, Doug Hertzenberg, and Diana Gonzalez at Bernardon, Haber, Halloway Architects PC

The Architectural Engineering Staff at Penn State University

Architectural Engineering Alumni and other Professionals who were willing to take time out of their busy schedules to aid in this project

My Architectural Engineering peers...

Without whose laughter, friendship, and advice this project would never have been completed.

Shout outs...

Arch Enemies . Butchers . Bratz . Cornbread . Foam . Tacos and Donuts . Jeff Eats Peters . Cheng . Katie T & Bein – mi amigos in LE . Tall Dan . Greg Dub . Keenan OOO . Jake aka Wang . Momo . TimJones . Ashley B . Tate . Donald Darren . Peterson .
Thanks for all the good times – wouldn't have made it without ya!

2. Introduction

Introduction

The Architectural Engineering fifth year Senior Thesis is an investigative and design-oriented project based on a building or building model obtained from an outside sponsor. Throughout the course of this year-long project, the students are required to investigate the background of the project, including the existing design and other engineering related issues. The students are then to redesign in depth one major portion of the building system, depending on their specialized option work. A breadth redesign portion of the project is also required to demonstrate the student's broad knowledge of the architectural engineering field.

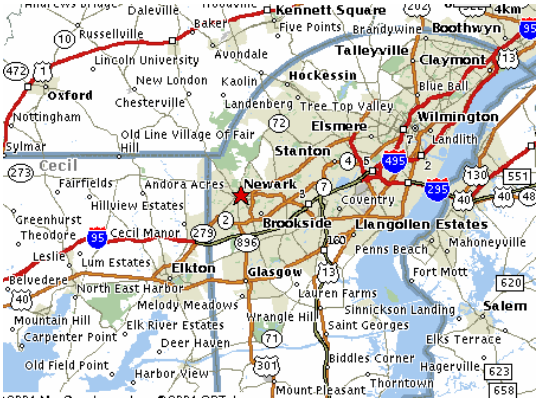
For the analysis of the AstroPower Headquarters, a redesign of the existing lighting systems will be performed on the following spaces: A Conference Room, Lunch Room, Lobby Atrium, an Open Office Space where two different systems are designed and compared, and finally the building's Front Entrance. The main analysis, or depth portion, will also include an analysis of the existing electrical system in the building.

A further requirement of the Senior Thesis project is to explore two different breadth areas of the building. The first is a design of a telecommunications system from start to finish. This will include laying out the system, telecommunications closets, racks, equipments, all the way to the desk terminations. The second breadth topic will be an examination of the building's LEED Certification; what level it is, how it can be better, and other information regarding LEED Design and it's future in the building industry.

Project Background

The AstroPower Headquarters is located in the Pencader Corporate Center, 300 Executive Drive in Newark, Delaware. The building is two stories high, with an Office section of 58,000 square feet and a Manufacturing section of 100,000 square feet. The Manufacturing section is used to create the very products that are sold by AstroPower. The Office section houses the company's chief employees, as well as design technicians and sales associates. A design studio and showcase is also in the Office section to offer perspective buyers a close up view of the quality product that is made at this location. The facility was completed in March of 2002, and has been occupied by the AstroPower company ever since.

Other important information pertaining to the AstroPower Headquarters include the building's placement. Following in line with other Green buildings, the front door faces southeast. The entire office section spans a semi-circular glass curtain wall, which enables every part of the facility to experience natural daylight at all times during the work day. In addition to the glass façade, high open ceilings with numerous skylights offer an abundance of natural light as well.



Project Information

The building I have selected to base my Senior Thesis project on is the AstroPower Headquarters located in the Pencader Corporate Center, 300 Executive Drive in Newark, Delaware. The building is owned by The McConnell Johnson Corporation. At this time, AstroPower is the sole tenant, utilizing both the office space, which consists of 58,000 square feet, along with the warehouse and manufacturing space, which consists of 100,000 square feet. The total building size is around 160,000 square feet. Although only two stories above grade, the manufacturing section offers 30 feet clearance height.

The architect and interior designer for this project was the firm of Bernardon, Haber, Halloway Architects PC (http://www.bernardon.com). The owner and developer of the building is McConnell Development, Inc. (http://www.mcconnelljohnson.com). The structural engineer for the AstroPower Headquarters was the firm of O'Donnell, Naccarato, & MacIntosh (http://www.onmac.com), and the mechanical and electrical engineering was handled by the firm of Bruce E. Brooks & Associates (http://www.brucebrooks.com). The fire protection for the project was taken care of by Bear Industries, Inc., and the General Contractor was the Commonwealth Construction Company.

The AstroPower Headquarters began construction in 2001. Using a Design-Build project delivery method and fast-track construction, client move-in was in March of 2002. The actual cost of the building has not been disclosed at this time.

The architectural features of this building are quite impressive. The positioning of the building provides maximum exposure to the path of the sun while maximizing the preservation of wetlands on the site. There is a 30-kilowatt building-integrated façade of single-crystal solar cells and Apex™ solar cells, which happen to be produced using AstroPower's proprietary Silicon-Film™ process. In addition to the façade, the building also features a 310-kilowatt rooftop system, which incorporates more than 2,400 solar modules. The interior focuses mainly on openness and airiness. Skylights and vision glass embedded with solar cells cast a pattern of shadows on floors and walls. The building is zoned in a corporate building park, with no significant historical elements. The roof is a flat joist system so that it can accommodate the solar panels. The exterior building envelope features a glass curtain wall in the office area, and CMU's around the warehouse.

The following codes were utilized in the construction of this building: Energy Conservation – ASHRAE/IESNA 90.1-1989, Building Construction – 1996 BOCA National Building Code, Fire Protection – 1997 Delaware State Fire Prevention Regulations, Electrical – NFPA 70 National Electric Code, Plumbing – 1996 National Plumbing Code, and the 1991 Americans with Disabilities Guidelines.

Electrical System

The electrical system in the AstroPower Headquarters is very different than most other buildings. Using the solar panels that are on the exterior façade and roof, extra energy is provided within, optimizing the green building ideas for energy consumption. The façade provides a total of 30-kilowatts to the system, while the roof

adds an additional 310-kilowatts. They used branch circuit #12 wire for the 480 convenient power circuits up to 100 feet, and #10 wire for everything over that. The system is a standard 480/277 V system. The emergency back-up is covered by the solar energy that is supplied using the panels. A diesel generator that is 480/277V, 3 phase, four wire system. The average draw is 1050 kVA. There are total of four electrical closets located throughout the building.

Lighting System

The lighting system in the AstroPower Headquarters is rather simple. Using a total six different fluorescent fixtures throughout, with low-energy ballasts, it follows with the building's green concept. Dimmers and motion sensors are used throughout, and with the presence of so much natural daylight from the skylights and glass curtain wall, a complex lighting system was not really necessary. Information regarding the existing Lighting System can be found in the Depth Study, Lighting Analysis sections further along in this Portfolio.

Mechanical System

The mechanical system in the AstroPower Headquarters is also fairly simple. There are cooling towers behind the exterior of the building. There is a centrifugal water chiller that feeds the cooling coils of the Air Handling Units that are located in the building's mechanical rooms. A gas boiler is the source for the required load in the heating coil. The ductwork features acoustic insulation that allows the system to run at a minimal noise level.

Structural System

The structural system used is not very complex, seeing as the structure is only two-stories in height. The glass curtain wall that wraps around fifty percent of the building's exterior provides an attractive structural support. The remainder of the building, which is the manufacturing space, has CMU's and steel beams to support the roof structure. As mentioned above, there is a slab on grade concrete system with footers. The building has steel columns spaced throughout to provide support for the roof structure.

Fire Protection

The AstroPower Headquarters features both active and passive fire protection systems. Sprinkler heads are found in both the office and manufacturing spaces, and the heating and ventilation system features an emergency smoke evacuation mode. All steel that has been installed in the building follows the 1997 Delaware State Fire Prevention Regulations.

Transportation System

Considering the building is not very large and only two-stories, there is only one elevator. It is accessed through the lobby and is in accordance with ADA regulations. There are three separate staircases in the office section of the building.

Telecommunications System

The AstroPower Headquarters features a local area network system throughout the offices and manufacturing side. A copper backbone and Single and Multi-Mode fiber lead back from each termination to a central telecommunications room. In the rack, the cables are cross-connected and patched in from a cable coming in through the building's foundation. Each termination has a capability of have four connections (for example phone, PC, fax, network printer). Equipment in the data rack located in the closet has not been identified at this time, and additional information has been requested from the network consulting firm that designed the system.

Special Systems

The only special system in the AstroPower Headquarters is the usage of the solar cells that AstroPower designed integrated with the electrical system. Information regarding the APex™ solar cells, produced using AstroPower's proprietary Silicon-Film™ process, along with the BIPV solar installation process can be found on AstroPower's web site (http://www.astropower.com).

3. Lighting Analysis
Conference Room

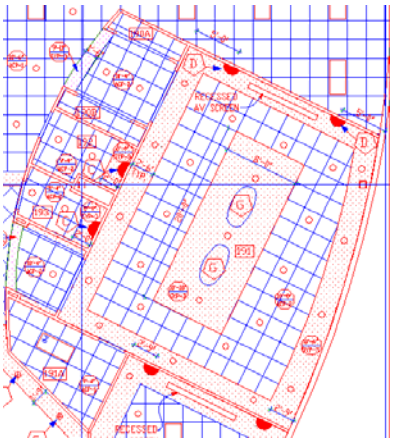
Conference Room

Design Criteria

The Conference Room on the first floor has specific design criteria relating to the space. The appearance of space and luminaires is very important in a room like this. Direct glare can also be a problem, so the effects the fixtures have on the table also should be put into consideration. The new lighting design should also reflect an emphasis on seeing others. The modeling of faces and objects is also a very important part of the room. With these criteria in mind, a redesign was developed for the Conference Room space.

Design Schematic

The existing space only has downlights arranged around the perimeter, with two hanging pendants over the table (not shown in existing Lightscape renderings).



The idea for the redesign is to take advantage of the room's architectural piece, the trayed ceiling. Color will also be added to the space to continue the theme of the outdoors and to mirror the glass curtain wall. Finally solar cells will be added to the walls to attract more attention and to show off the new lights. The cove over the table will be similar to the one shown below to the left, with fluorescent strips along the edges. This will provide a soft light without glare for the table.

Wallwashers will be placed around the exterior walls, adding a clean wash while enhancing the new solar panels that will be placed to give the room a little character. The wallwashers will provide an atmosphere similar to the one shown above to the right. Finally, three downlights will be added over the conference room table, giving the appearance of an abundance of light coming down from the cove, without drawing the room inhabitant's eyes upwards. With these basic luminaires, a clean design will be established, creating an environment that is visually attractive while maintaining a low power density, keeping the concept of green design throughout the space.

New Lighting Equipment

For the wallwash lighting, the Peerless Lightline™ Recessed Wall Wash Fixture is going to be used. The lamp that will be in this fixture is a Philips SILHOUETTE™ Programmed Start T5 Miniature Bipin Fluorescent Lamp. It is a 28-watt bulb, with a Color Rendering Index of 85. The ballast to be used is the Advance VCN-132-MC, with a voltage of 277 volts, 60 Hertz frequency, 28 watts, a ballast factor of 0.98, and a power factor of 0.98.

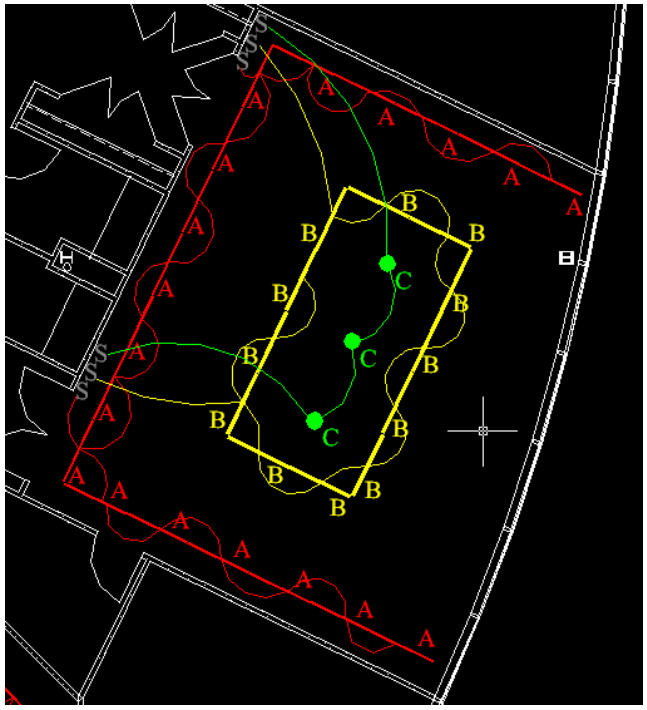
For the cove lighting, the Columbia Lighting CN2 One lamp T5 Narrow Strip Fixture is going to be used. The lamp that will be in this fixture is a Philips SILHOUETTE™ High Output Programmed Start T5 Miniature Bipin Fluorescent Lamp. It is a 39-watt bulb, with a Color Rendering Index of 85. The ballast to be used is the Advance ICN-2S39@277V, with a voltage of 277 volts, 50/60 Hertz frequency, 39 watts, a ballast factor of 1.00, and a power factor of 0.98.

For the downlights, the Erco Lightcast Downlight will be used. The lamp that will be in this fixture is a Philips TC-TEL 18WGx24q-2 compact fluorescent lamp. It is a 18-watt bulb, with a Color Rendering Index of 82. The ballast to be used is the Advance ICF-2S18-M1-BS@277V, with a voltage of 277 volts, 50/60 Hertz frequency, 20 watts, a ballast factor of 1.05, and a power factor of 0.97 (Spec sheets for all the equipment mentioned above can be found in the Appendix).

Control Zones

The Conference Room will feature a Control System that has several different functions. Three predefined settings will be automatically set for the space; the first will be General Meeting Environment, which features all luminaires illuminated, the second will be Audio/Visual Presentation Environment, which is specifically designed for use with a projector, television, or other Audio/Visual output device which would require low light levels, and the third will be Midday Meeting Environment for use when the natural daylight coming through the glass curtain wall is at high levels. The system will also have the ability to have User Defined lighting scenarios. All different types of lights are controlled on different circuits, allowing flexibility and convenience for the occupants of the AstroPower Headquarters building. In addition to the Control System, dimmers and motion sensors will also be added to the space for energy conservation.

Reflected Ceiling Plan



Fixture	Description	Fixture Type	Lamp Type	Lamp Watts	CRI	Ballast Watts	Ballast PF
A	Peerless Lightline Wallwasher	Indirect	Fluorescent	28	85	28	0.98
B	Columbia C2 Narrow Strip	Indirect	Fluorescent	39	85	39	1
C	Erco LC Downlight	Direct	Comp. Fluor.	20	82	20	1.05

Power Summary

After the layout of the new fixtures was determined, a power summary could be put together. Having 12 fluorescent lamps and ballasts in the cove, 18 wall wash fixtures and ballasts, and 3 downlights and ballasts, a power density of 1.31 W/ft^2 was computed. According to the ASHRAE/IESNA Standard 90.1, the recommended power density is 1.5 W/ft^2. This is a very good improvement for the electrical system load.

Conference Room Lighting System					
Fixture	Lamp Watts	# of Lamps	Input Watts	# Used	Total Wattage
A	28	1	28	18	504
B	24	2	24	12	288
C	20	1	20	3	60
			Total Wattage (W)		852
			Total Area (ft^2)		648.8
			Power Density (W/ft^2)		1.313

Light Loss Factors

Several Light Loss Factors that pertain to the Conference Room are the Ballast Factors, Lamp Lumen Depreciation Factor, Room Surface Dirt Depreciation Factor, and the Luminaire Surface Depreciation.

Conference Room Light Loss Factors					
Fixture	Ballast Factor	LLD	RSDD	LSD	LLF
A	0.98	0.95	0.89	0.88	0.73
B	1	0.96	0.89	0.86	0.74
C	1.05	0.95	0.89	0.88	0.78

These final numbers will be applied in the Lightscape Software program when renderings for the new design are completed.

Lighting Analysis

A complete Lighting Analysis for the space has been made using the AutoDesk Lightscape program. Several renderings of the redesigned AstroPower Conference Room are presented below:

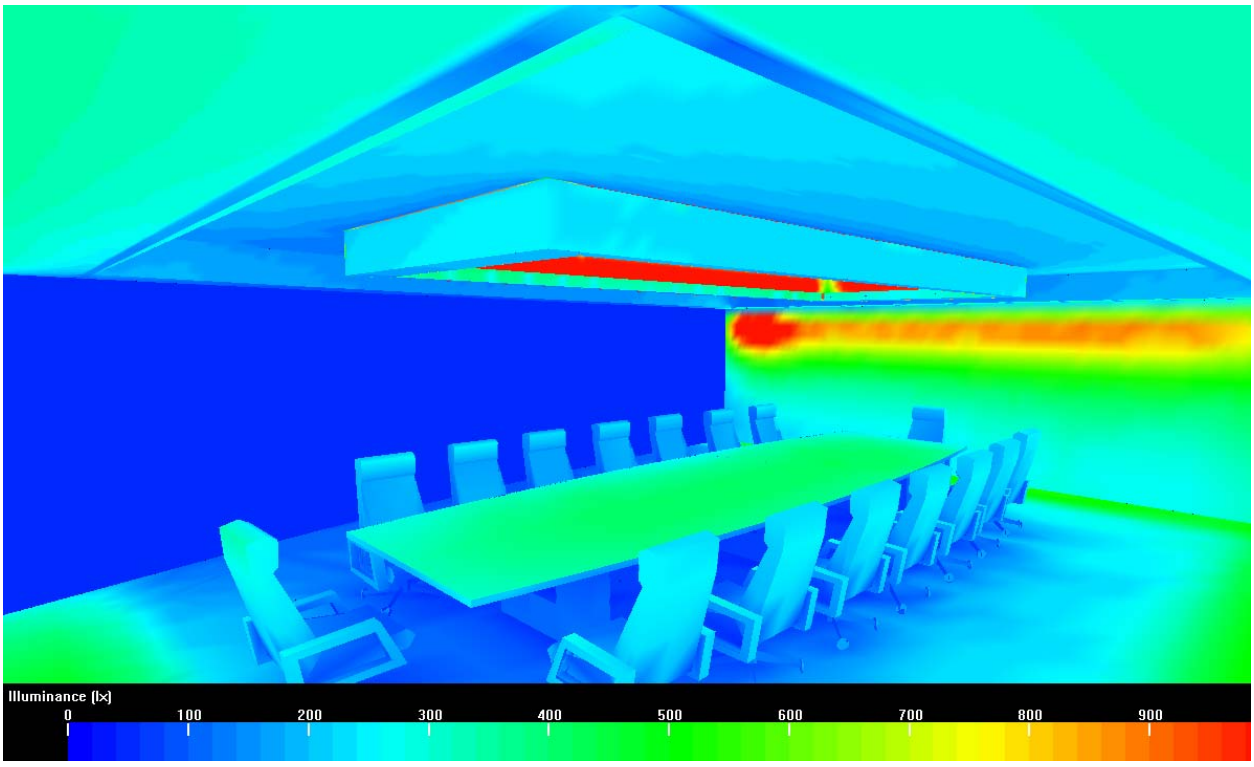
View from the southern corner (Glass curtain wall seen to the right)

View from the table looking south (Glass curtain wall shown to the left)

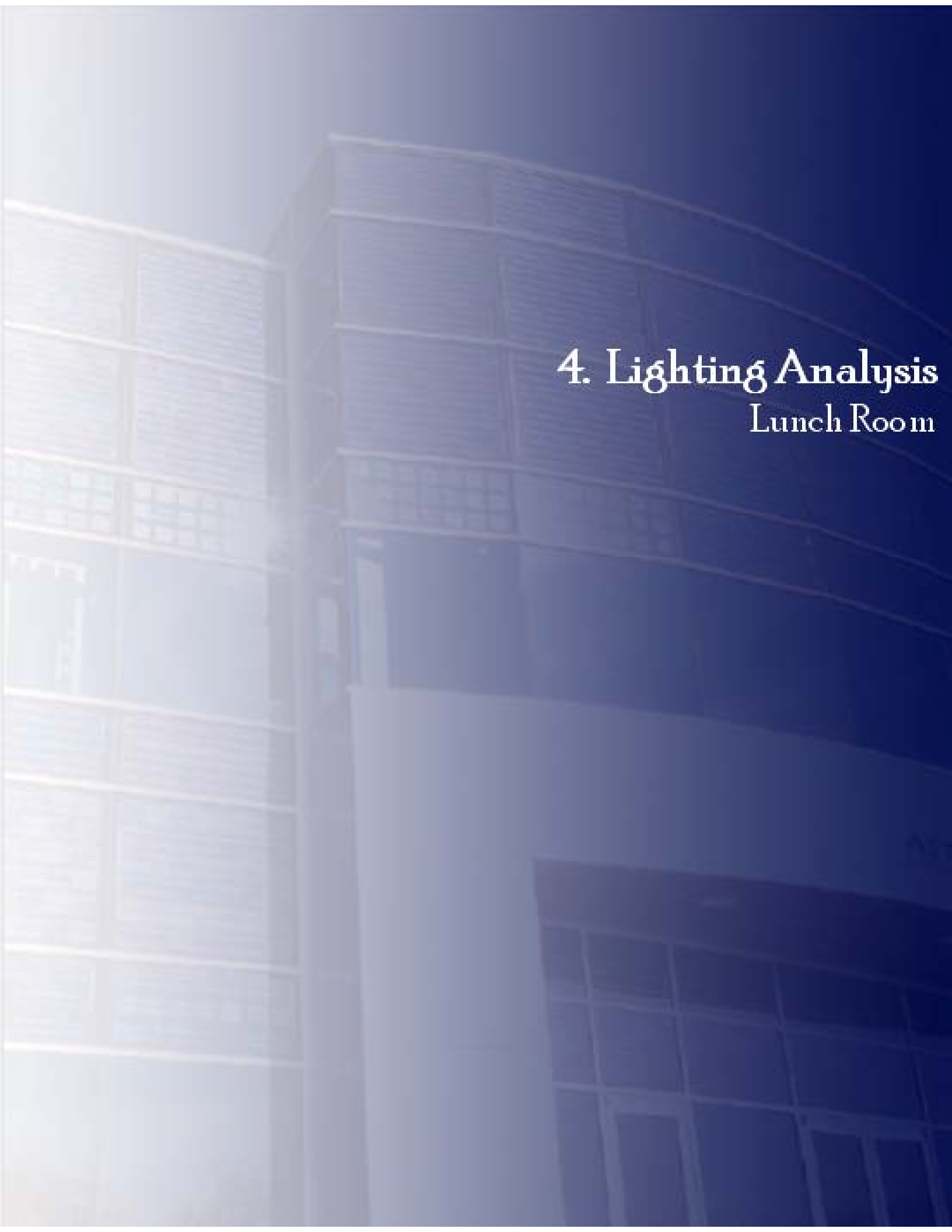
View from southeastern corner

A Photoshop rendering of the Conference Room with Blue tinted Fluorescent wallwashers

Illuminance Rendering



The reason for the high value on the walls is to accentuate the Solar Panel cells that will be placed on the walls at random (not shown in rendering), continuing the theme of solar power and green design throughout the interior of the AstroPower Headquarters.



4. Lighting Analysis
Lunch Room

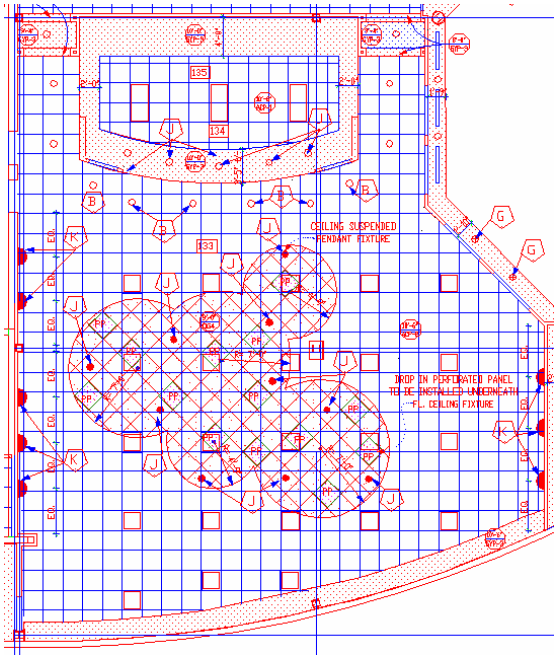
Lunch Room

Design Criteria

The Lunch Room is located off of the Atrium Lobby on the first floor of the AstroPower Headquarters. The room has some specific design criteria to take into consideration with the new lighting design. Each of the tables should be illuminated to a level that anything on the surface can be easily viewed, such as food or papers. On the contrary, faces in the evening should not have direct light shining on them so that lines and imperfections are brought out to those sitting at the same table. In addition to the table lighting, aisles should also have adequate light for walking in between other tables and chairs. The space also needs more of a visually interesting lighting atmosphere that relates to the rest of the AstroPower Headquarters and continues the theme of nature and solar panels throughout.

Design Schematic

The existing space currently consists of two-by-two fluorescent troffers arranged over the tables. In addition to those, there are fluorescent downlights located by the entrance doors and near the curved wall at the north end of the room. A picture and rendered image of the existing room are shown below:



The idea for the redesign is to create a more visually interesting space. In addition to this, color will also be added to bring the theme of the outdoors into the space, and to mirror the glass wall on the south side of the building. Each table will feature a compact fluorescent pendant that hangs above focusing on the surface below. Both the east and west walls will receive a fluorescent wallwash; the curved wall and columns will be lit from below with Blue L.E.D. fixtures mounted in the floor.



With these basic luminaires, a clean and interesting design will be established, creating an environment that is visually attractive while maintaining a low power density, keeping the concept of green design throughout the space.

New Lighting Equipment

For the wallwash lighting, the Peerless Lightline™ Recessed Wall Wash Fixture is going to be used. The lamp that will be in this fixture is a Philips SILHOUETTE™ Programmed Start T5 Miniature Bipin Fluorescent Lamp. It is a 28-watt bulb, with a Color Rendering Index of 85. The ballast to be used is the Advance VCN-132-MC, with a voltage of 277 volts, 60 Hertz frequency, 28 watts, a ballast factor of 0.98, and a power factor of 0.98.

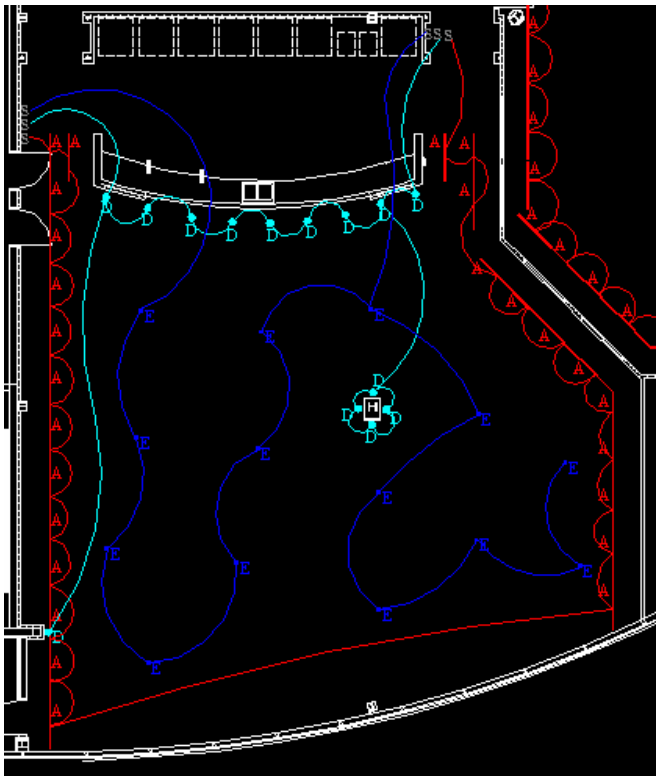
For the luminaires over the tables, the Erco Parabelle Pendant Downlight will be used. The lamp that will be in this fixture is a Philips PL-T Triple 4-Pin Fluorescent Lamp. It is a 26-watt bulb, with a Color Rendering Index of 82. The ballast to be used is the Advance ICF-2S26-H1-LD@120, with a voltage of 277 volts, 50/60 Hertz frequency, 26 watts, a ballast factor of 1.10, and a power factor of 0.98.

For the Blue L.E.D.s, the Erco Tesis Recessed Floor Luminaire is going to be used. The lamp that will be in this fixture is a Philips MasterColor® Tubular Single-Ended T-4 Lamp, a 39-watt bulb.

Control Zones

The Lunch Room will feature a Control System that has several different functions. Three predefined settings will be automatically set for the space; the first will be Morning/Afternoon Dining, for when natural daylight is the strongest, the second will be Evening/Reception Environment, for a more romantic setting and use with little daylight, and the final setting will be Unoccupied/Night Light, for when the space is unoccupied. The system will also have the ability to have User Defined lighting scenarios. All different types of lights are controlled on different circuits, allowing flexibility and convenience for the occupants of the AstroPower Headquarters building. In addition to the Control System, dimmers and motion sensors will also be added to the space for energy conservation.

Reflected Ceiling Plan



Fixture	Description	Fixture Type	Lamp Type	Lamp Watts	CRI	Ballast Watts	Ballast PF
A	Peerless Lightline Wallwasher	Indirect	Fluorescent	28	85	28	0.98
D	Erco Tesis Recessed Luminaire	Direct/Indirect	Blue LED	39	N/A	N/A	N/A
E	Erco Parabelle Pendant	Direct	Comp. Fluor.	26	82	26	1.1

Power Summary

After the layout of the new fixtures was determined, a power summary could be put together. Having 26 wall wash fixtures and ballasts around the perimeter, 14 total Blue L.E.D. lights with ballasts, and 14 fixtures over the tables, a power density of 0.86 W/ft^2 was computed. According to the ASHRAE/IESNA Standard 90.1, the recommended power density is 1.3 W/ft^2. This is a tremendous improvement for the electrical system load.

Lunch Room Lighting System					
Fixture	Lamp Watts	# of Lamps	Input Watts	# Used	Total Wattage
A	28	1	28	26	728
D	39	1	39	14	546
E	26	1	26	14	364
				Total Wattage (W)	1638
				Total Area (ft²)	1900
				Power Density (W/ft²)	0.862

Light Loss Factors

Several Light Loss Factors that pertain to the Conference Room are the Ballast Factors, Lamp Lumen Depreciation Factor, Room Surface Dirt Depreciation Factor, and the Luminaire Surface Depreciation.

Lunch Room Light Loss Factors						
Fixture	Ballast Factor	LLD	RSDD	LSD		LLF
A	0.98	0.95	0.89	0.88		0.73
D	1	0.91	0.89	0.88		0.71
E	1.1	0.95	0.89	0.88		0.82

These final numbers will be applied in the Lightscape Software program when the new renderings for the new design are completed.

Lighting Analysis

A complete Lighting Analysis for the space has been made using the AutoDesk Lightscape program. Several renderings of the redesigned AstroPower Lunch Room are presented below:

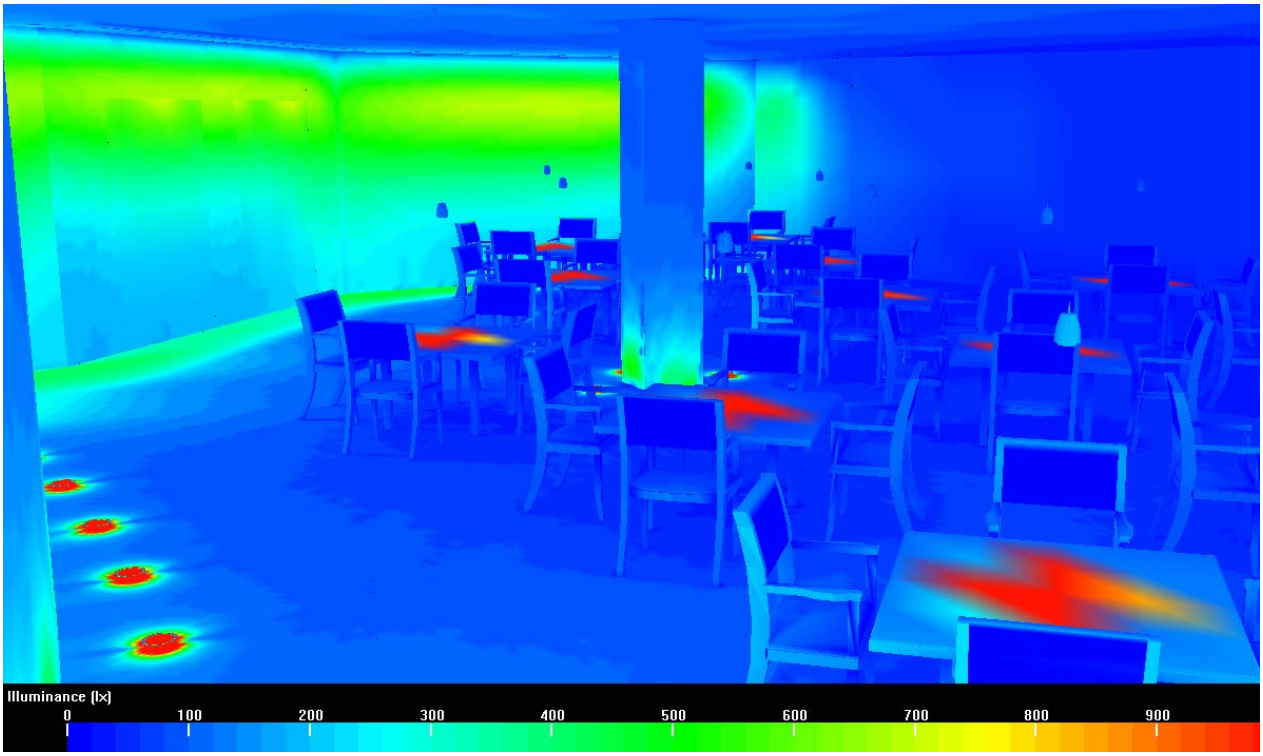
View of the curved north wall illuminated with the Blue L.E.D.s and the east wall

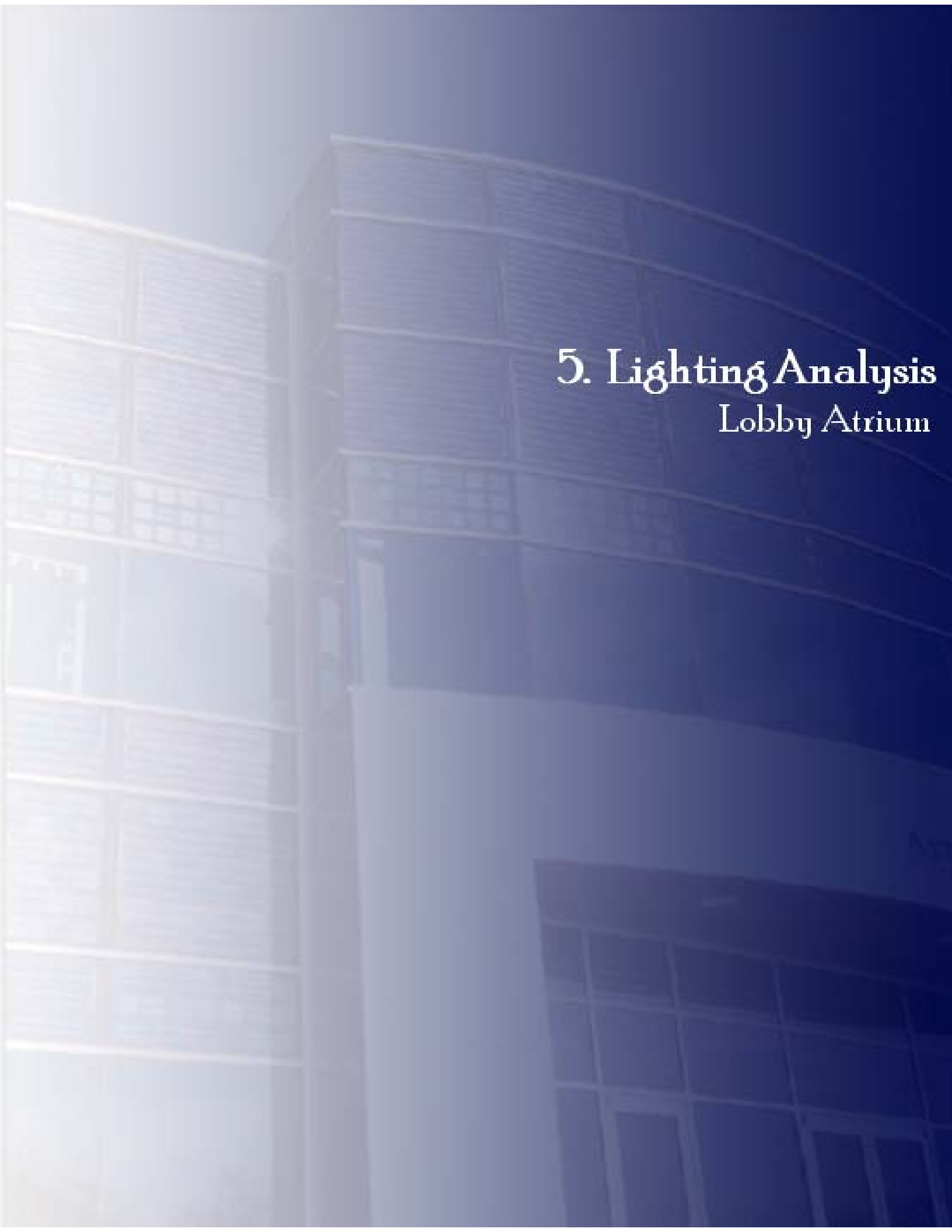
View of table surface

View of the Lunch Room looking north

View looking towards the south glass curtain wall

Illuminance Rendering





5. Lighting Analysis

Lobby Atrium

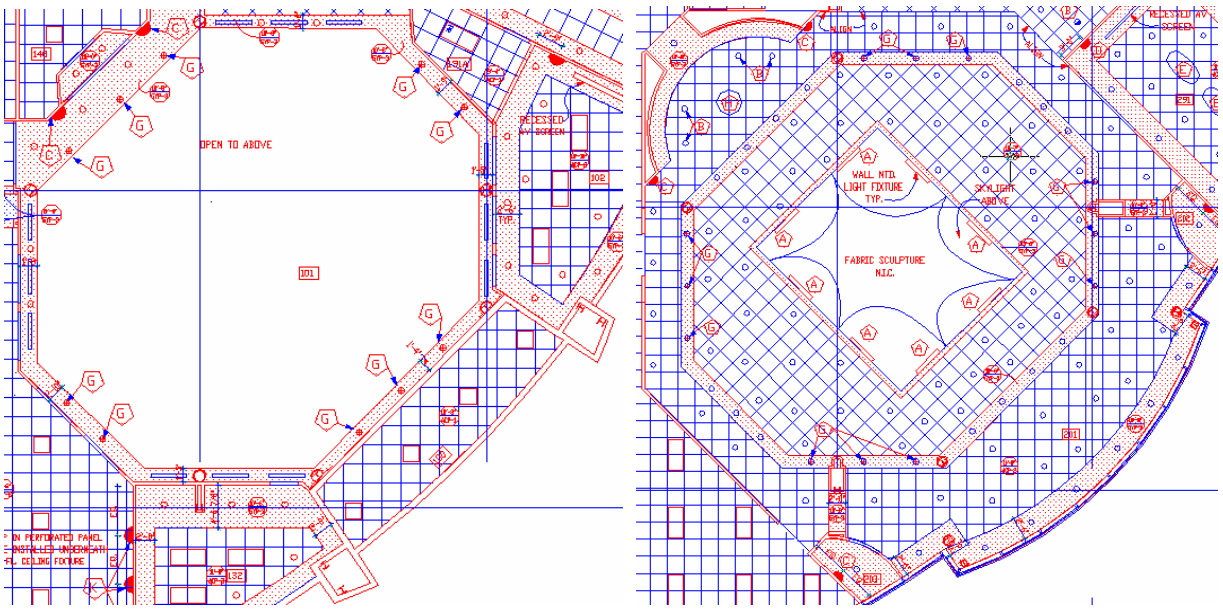
Lobby Atrium

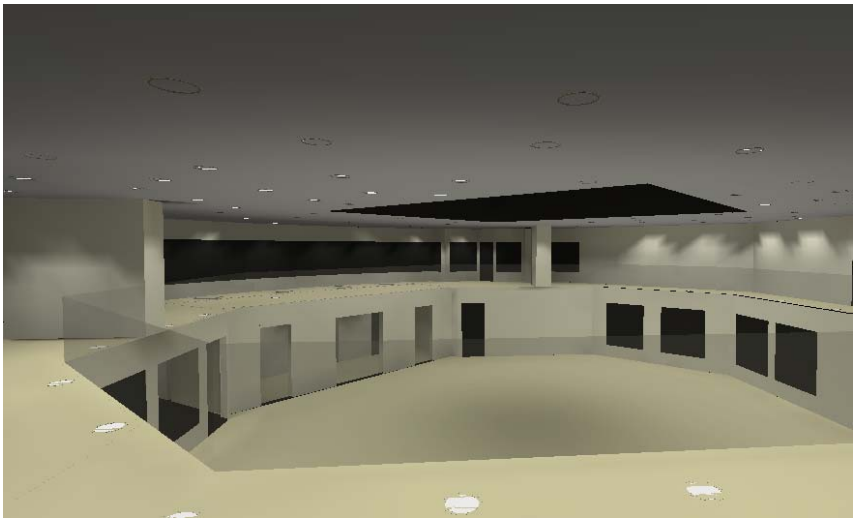
Design Criteria

The Lobby Atrium is by far the most impressive room in the AstroPower Headquarters. Upon entering the building, an immense, octagonal room is bestowed upon you. It rises up above the second floor height to a square raised skylight that sits in the room's center. Naturally, the lighting design of this space is critical. It is the first room people see when they enter, and the last room they see when they leave. Visitors to the building sometimes never see any of the other spaces. The appearance of luminaires is very important in a space like this. There must be enough light on the ground and common spaces so that it is not difficult to see where you are going and others around you. The modeling of faces and objects is also important. With these criteria in mind, a redesign was developed for the Lobby Atrium.

Design Schematic

The existing space consisted of downlights scattered over the second floor ceiling and around the perimeter of the first floor. The fixtures were also placed in the center of the room around the center skylight, to provide light to the ground floor below.





The idea for the redesign is to take advantage of the room's architectural pieces. These include the openness of the room, accentuated by the railings around the second floor balcony, and the skylight in the center of the room. Color will be added to the space to continue the theme of the outdoors and to mirror the glass that surrounds the space. Solar cell panels will also be added to the walls to continue the theme of the building representing solar panels and green design. To achieve these design elements, fluorescent wall washers will be added to both the first and second floor walls, providing a soft indirect source for the space, similar to a window.

For the color element, Blue L.E.D.s will be placed in many different areas of the room. First, they will be placed around the railing to provide an effect similar to the ones pictured below:

This will draw attention upwards when entering from the main doors, in addition to introducing the concept of the blue light to everyone who enters the building. The blue L.E.D.s will also be placed by the front doors, the space opposite the front doors, the second floor tier along the northwestern curved wall, and the southeastern window corridor.

Wallwashers will also be placed along the freshly glazed lower portion of the center skylight. This will help with light levels on the ground floor, as well as attract attention up to the skylight at night, when natural daylight is not entering the space.

With a unique, clean lighting design as this, the entrance to the AstroPower Headquarters will be something those who enter will not soon forget. A clean design is established, creating an environment that is visually attractive and romantic, while maintaining a low power density, keeping the concept of green design throughout the space.

New Lighting Equipment

For the wallwash lighting, the Peerless Lightline™ Recessed Wall Wash Fixture is going to be used. The lamp that will be in this fixture is a Philips SILHOUETTE™ Programmed Start T5 Miniature Bipin Fluorescent Lamp. It is a 28-watt bulb, with a Color Rendering Index of 85. The ballast to be used is the Advance VCN-132-MC, with a voltage of 277 volts, 60 Hertz frequency, 28 watts, a ballast factor of 0.98, and a power factor of 0.98.

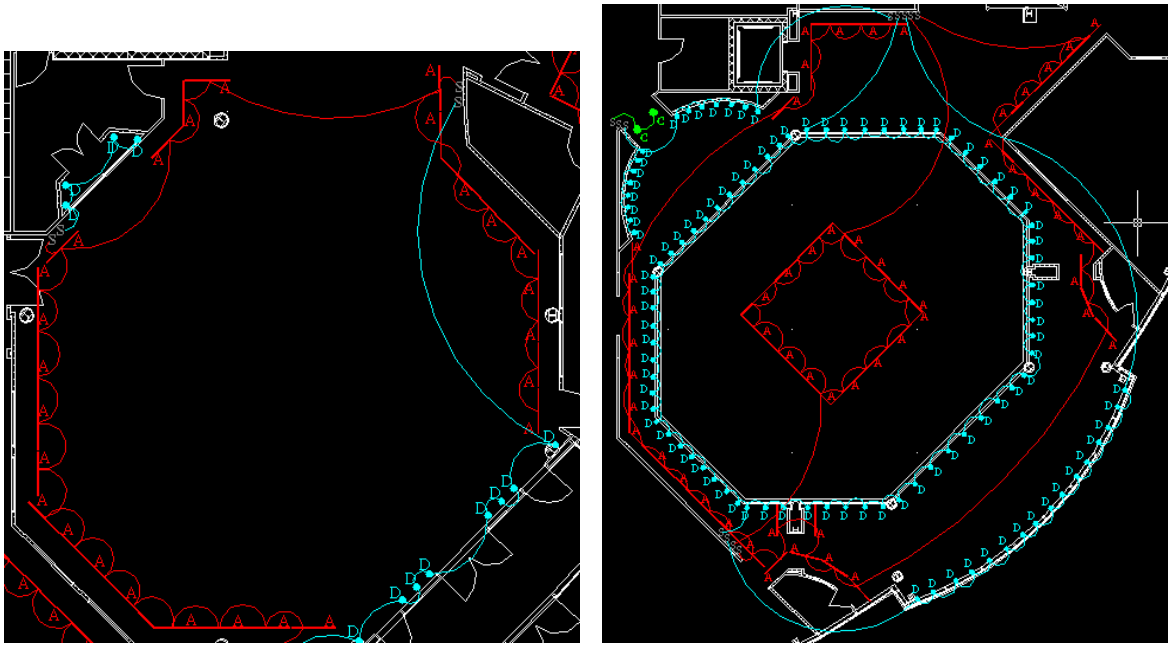
For the downlights above the rear doors on the second level, the Erco Lightcast Downlight will be used. The lamp that will be in this fixture is a Philips TC-TEL 18WGx24q-2 compact fluorescent lamp. It is a 18-watt bulb, with a Color Rendering Index of 82. The ballast to be used is the Advance ICF-2S18-M1-BS@277V, with a voltage of 277 volts, 50/60 Hertz frequency, 20 watts, a ballast factor of 1.05, and a power factor of 0.97.

For the Blue L.E.D.s, the Erco Tesis Recessed Floor Luminaire is going to be used. The lamp that will be in this fixture is a Philips MasterColor® Tubular Single-Ended T-4 Lamp, a 39-watt bulb (Spec sheets for all the equipment mentioned above can be found in the Appendix).

Control Zones

The Lobby Atrium will feature a Control System that has several different functions. Three predefined settings will be automatically set for the space; the first will be Morning/Afternoon Environment, for use with high daylight, the second will be Presentation Environment for use during evening events, and the third will be Unoccupied/Night Light, for when the building is unoccupied. The system will also have the ability to have User Defined lighting scenarios. All different types of lights are controlled on different circuits, allowing flexibility and convenience for the occupants of the AstroPower Headquarters building. In addition to the Control System, dimmers and motion sensors will also be added to the space, for energy conservation.

Reflected Ceiling Plan



Fixture	Description	Fixture Type	Lamp Type	Lamp Watts	CRI	Ballast Watts	Ballast PF
A	Peerless Lightline Wallwasher	Indirect	Fluorescent	28	85	28	0.98
C	Erco LC Downlight	Direct	Comp. Fluor.	20	82	20	1.05
D	Erco Tesis Recessed Luminaire	Direct/Indirect	Blue LED	39	N/A	N/A	N/A

Power Summary

After the layout of the new fixtures was determined, a power summary could be put together. Having a total of 63 wallwashers and ballasts, 2 fluorescent downlights and ballasts, and 111 Blue L.E.D. lights, a power density of 0.73 W/ft^2 was computed. According to the ASHRAE/IESNA Standard 90.1, the recommended power density is 0.7 W/ft^2, with an additional 1.0 W/ft^2 for Decorative and Accent Lighting; a combined total of 1.7 W/ft^2.

Lobby Atrium Lighting System					
Fixture	Lamp Watts	# of Lamps	Input Watts	# Used	Total Wattage
A	28	1	28	63	1764
C	20	1	20	2	40
D	39	1	39	111	4329
			Total Wattage (W)		6133
			Total Area (ft^2)		8400
			Power Density (W/ft^2)		0.73

Light Loss Factors

Several Light Loss Factors that pertain to the Lobby Atrium are the Ballast Factors, Lamp Lumen Depreciation Factor, Room Surface Dirt Depreciation Factor, and the Luminaire Surface Depreciation.

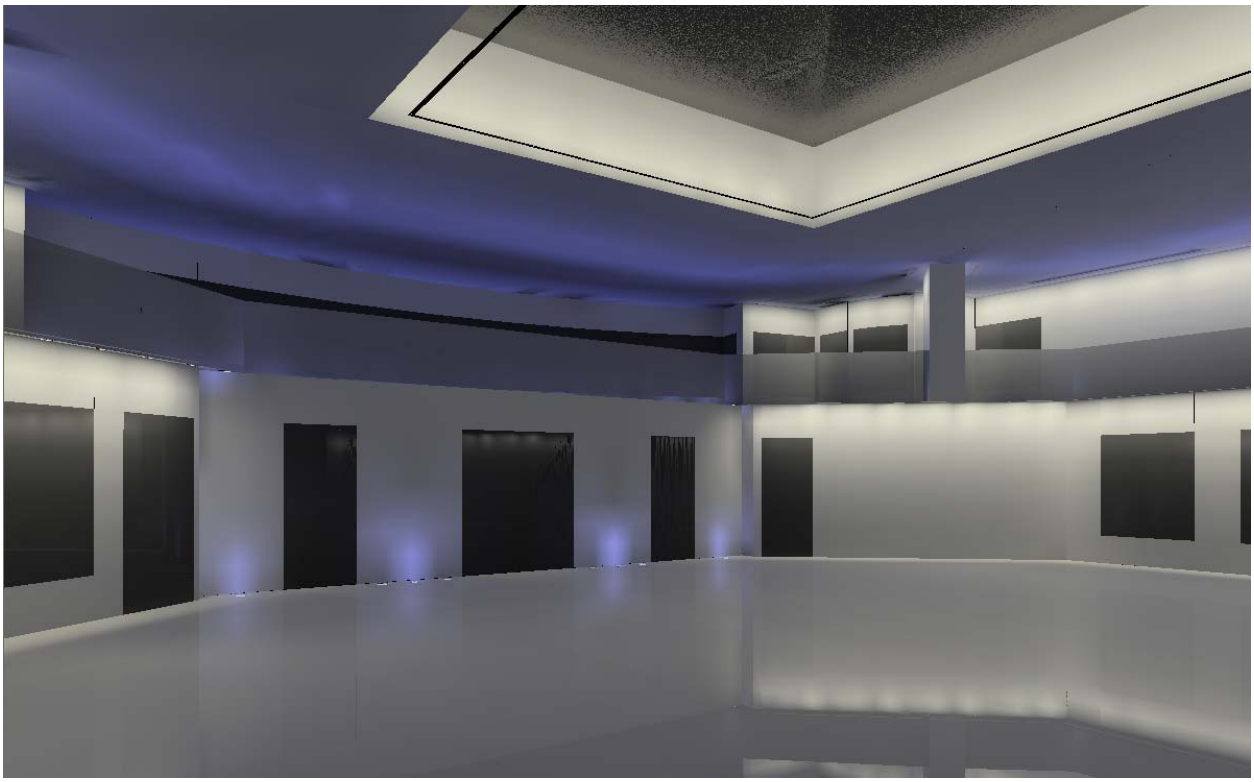
Lobby Atrium Light Loss Factors						
Fixture	Ballast Factor	LLD	RSDD	LSD		LLF
A	0.98	0.95	0.89	0.88		0.73
C	1.05	0.95	0.89	0.88		0.78
D	1	0.91	0.89	0.88		0.72

These final numbers will be applied in the Lightscape Software program when the renderings for the new design are completed.

Lighting Analysis

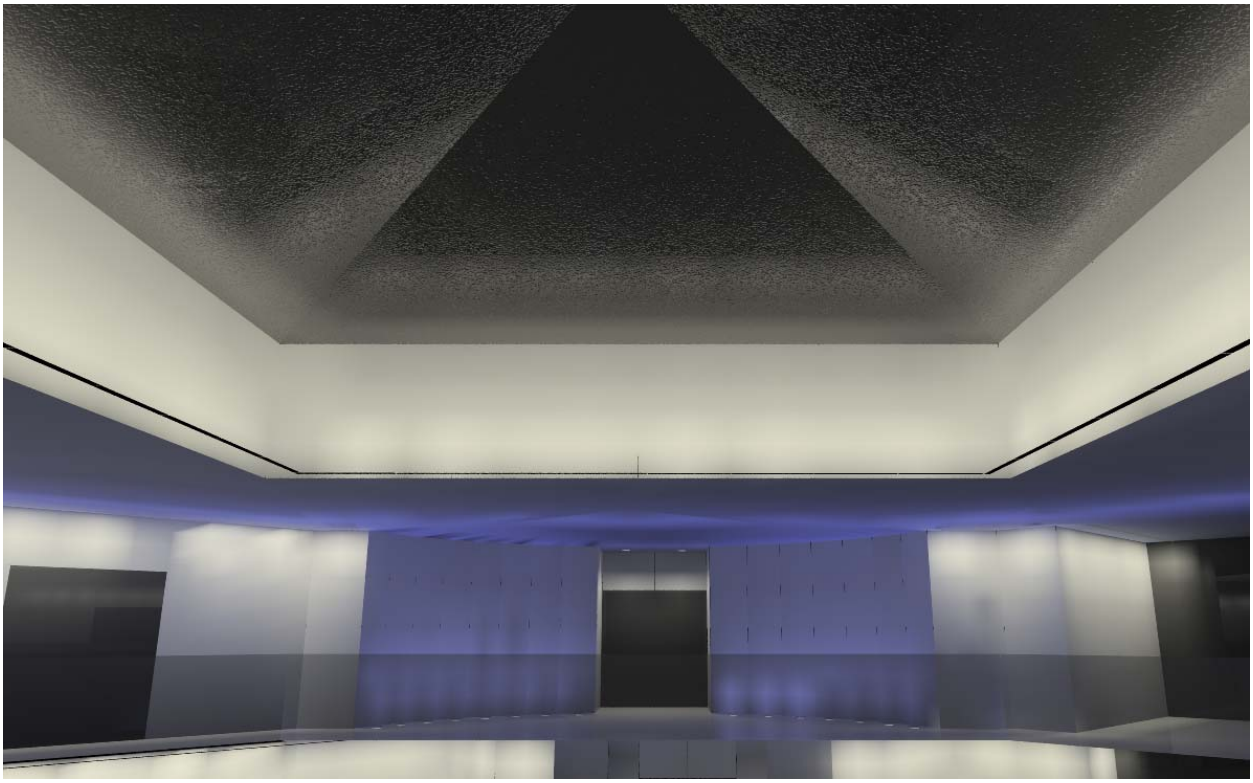
A complete Lighting Analysis for the space has been made using the AutoDesk Lightscape program. Several renderings of the redesigned AstroPower Lobby Atrium are presented below:

View from entering Front Door



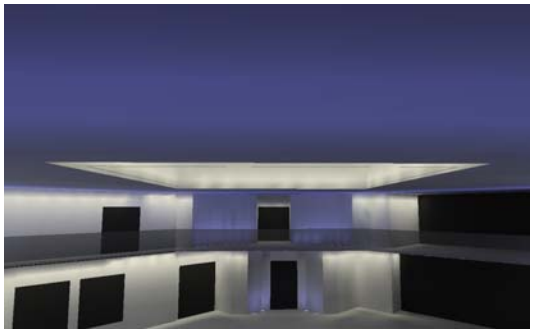
View of Front Door

View of Center Skylight



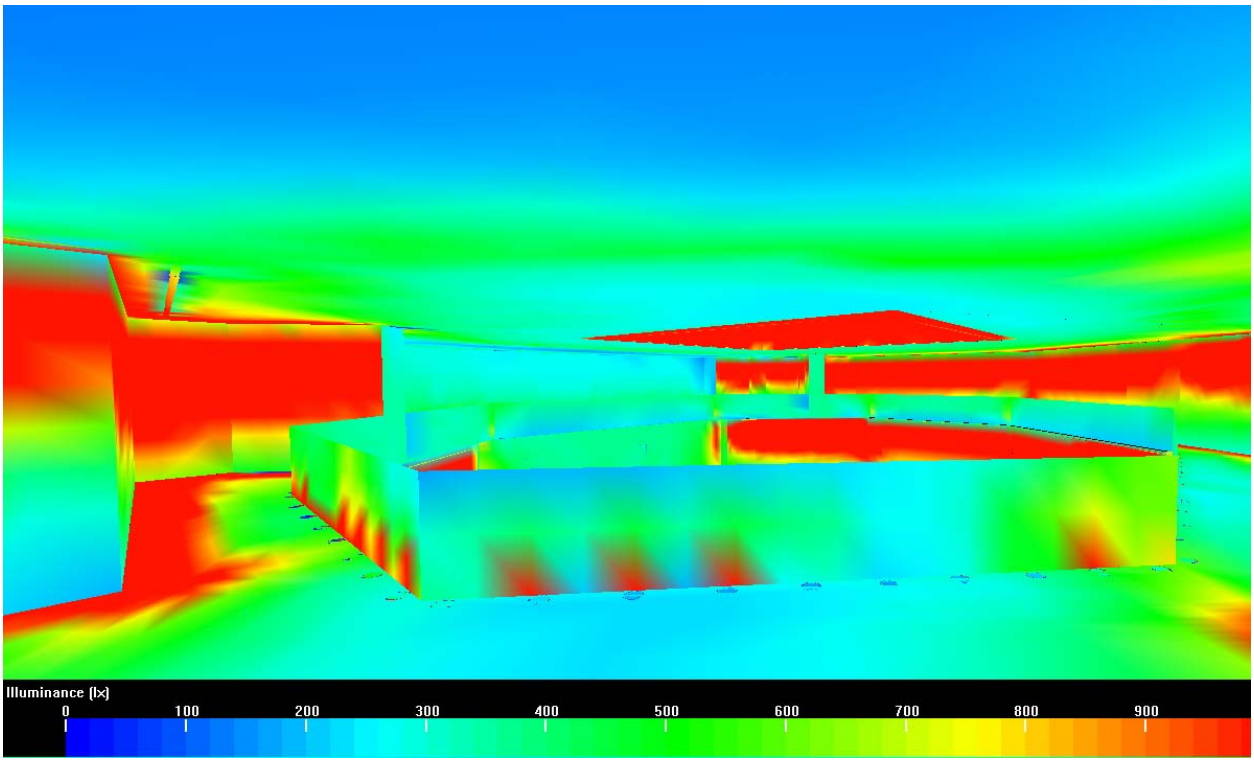
View of ceiling

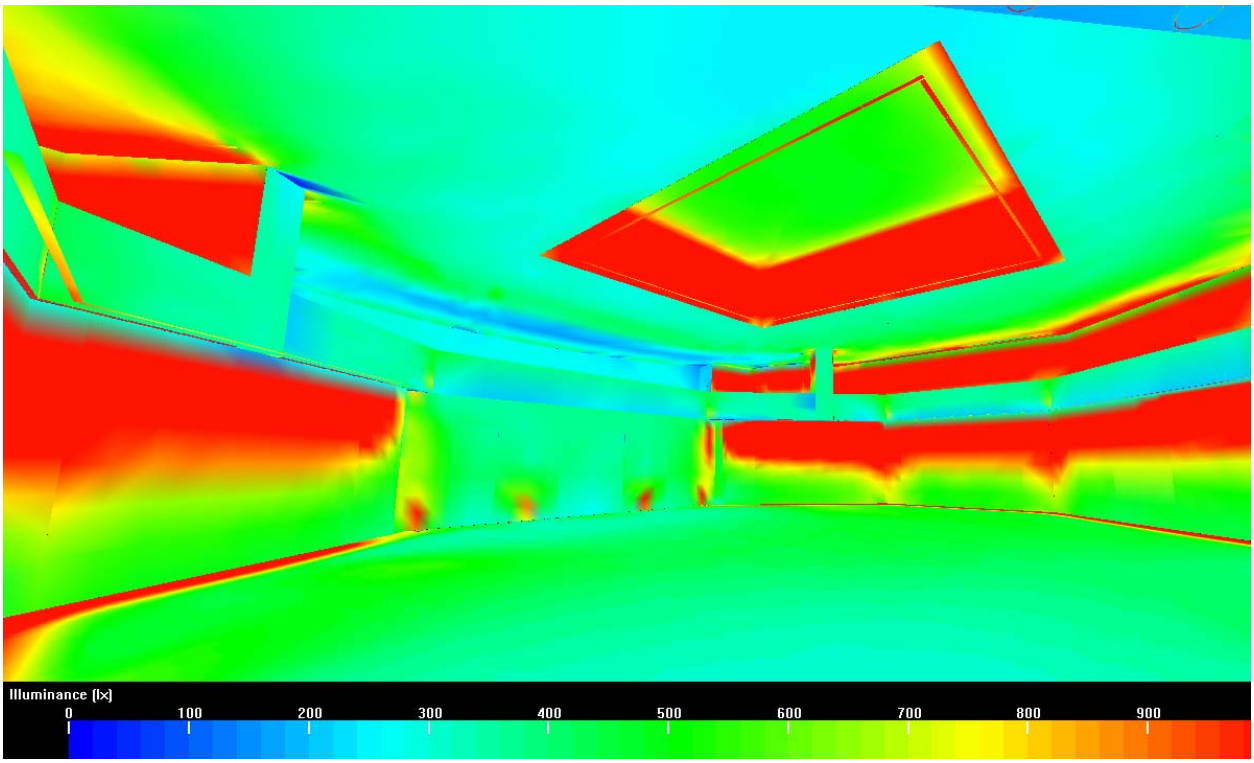
Railing with Blue L.E.D. lights



View from balcony level

Illuminance Renderings





6. Lighting Analysis

Open Office Area

A Comparative Study

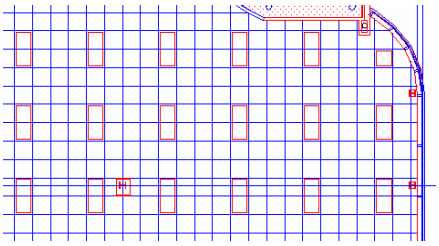
Open Office Space

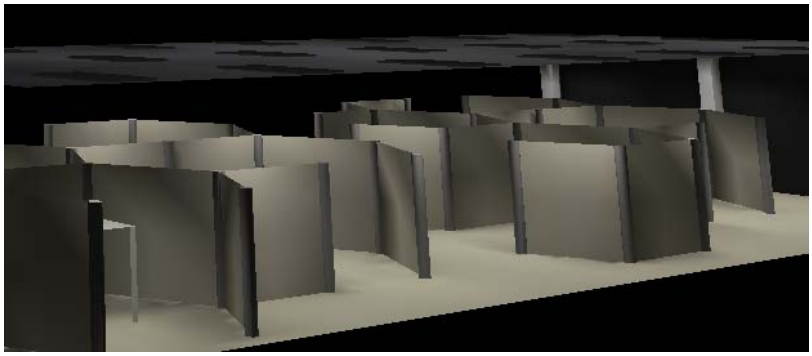
Design Criteria

The Open Office Area on the second floor has specific design criteria relating to the space. The appearance of space and luminaires is very important in an area like this. Direct glare can also be a problem on both the work planes and Computer Monitors, or VDT's, so the effects the fixtures have on these items also should be put into consideration. The new lighting design should also reflect an emphasis on adequate light levels without shadowing. The partitions in the space should also be taken into consideration, as they are very important for luminaire placement. With these design criteria in mind, a redesign was developed for the Open Office space.

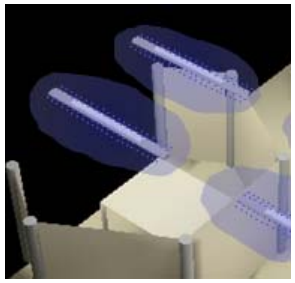
Design Schematic I – Direct/Indirect Fixture Approach

The existing space only has two-by-four troffers arranged over top of the octagonal shaped cubicles. A rendered image of the existing area is shown below to the right:





The idea for the redesign is to create a more visually interesting space. In addition to this, color will also be added to bring the theme of the outdoors into the space, and to mirror the glass wall on the east side of the building, along with the skylights over top of the atrium space located to the left. Each cubicle will feature a hanging pendant, with fluorescent downlight and blue L.E.D. uplights. The uplights will provide an "air-like" atmosphere when being viewed from other areas.



In addition to the hanging fluorescent fixtures, fluorescent downlights will be placed in walking areas between cubicles, where seeing others might be important. With these basic luminaires, a clean design will be established, creating an environment that is visually attractive while maintaining a low power density, keeping the concept of green design throughout the space.

New Lighting Equipment

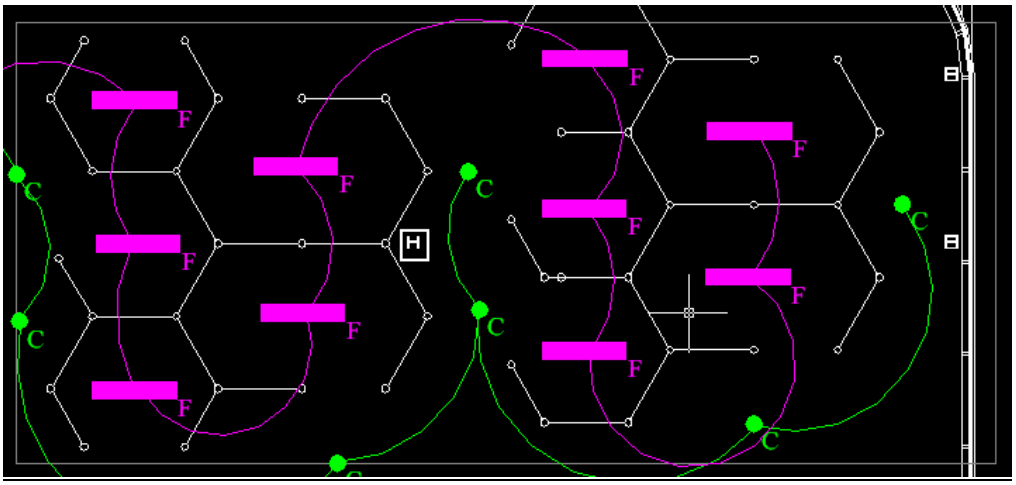
For the hanging fluorescent fixtures, the Orgatech LightStar L.E.D. will be used. The lamp that will be in this fixture is a Philips ALTO® SILHOUETTE™ High Output Programmed Start T5 Miniature Bipin Fluorescent Lamp. It is a 54-watt bulb, with a Color Rendering Index of 85. The ballast to be used is the Advance ICN-2S54-90C@277, with a voltage of 277 volts, 50/60 Hertz frequency, 54 watts, a ballast factor of 1.02, and a power factor of 0.96.

For the downlights, the Erco Lightcast Downlight will be used. The lamp that will be in this fixture is a Philips TC-TEL 18WGx24q-2 compact fluorescent lamp. It is an 18-watt bulb, with a Color Rendering Index of 82. The ballast to be used is the Advance ICF-2S18-M1-BS@277V, with a voltage of 277 volts, 50/60 Hertz frequency, 20 watts, a ballast factor of 1.05, and a power factor of 0.97 (Spec sheets for all the equipment mentioned above can be found in the Appendix).

Control Zones

The portion of the Open Office area that is represented in this analysis will be one control zone. The Fluorescent downlights will be on one circuit, the downlights in the aisles will be on another. There will be two sets of switches located near the north and south sides of the space. Each zone will feature motion sensors, to automatically turn off the lights if the space is unoccupied. There will also be dimmers on the switches to compensate for the amount of natural daylight in the space. A complex Control System will not be required.

Reflected Ceiling Plan



Fixture	Description	Fixture Type	Lamp Type	Lamp Watts	CRI	Ballast Watts	Ballast PF
C	Erco LC Downlight	Direct	Comp. Fluor.	20	82	20	1.05
F	Orgatech LightStar LED	Direct/Indirect	Fluor./LED	54	N/A	54	1.02

Power Summary

After the layout of the new fixtures was determined, a power summary could be put together. Having 10 fluorescent lamps and ballasts over the cubicles, and 9 downlights and ballasts, a power density of 0.96 W/ft^2 was computed. According to the ASHRAE/IESNA Standard 90.1, the recommended power density is 1.5 W/ft^2. This is a tremendous improvement for the electrical system load.

Open Office Lighting System - Schematic I					
Fixture	Lamp Watts	# of Lamps	Input Watts	# Used	Total Wattage
C	20	1	20	9	180
F	54	2	54	10	1080
			Total Wattage (W)		1260
			Total Area (ft^2)		1320
			Power Density (W/ft^2)		0.96

Light Loss Factors

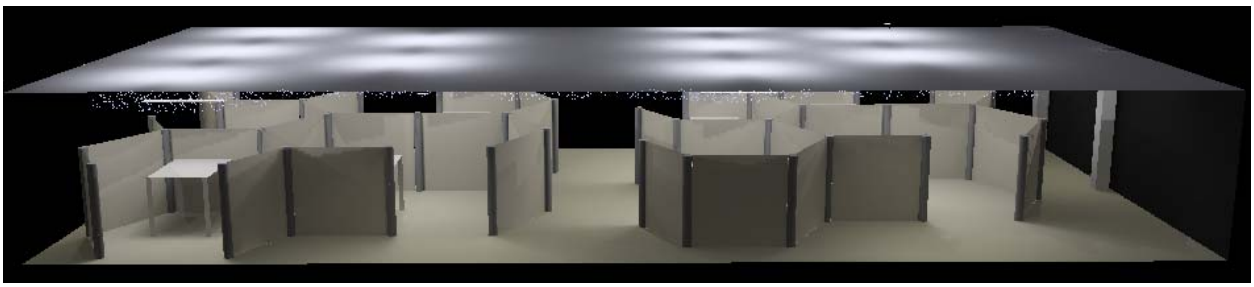
Several Light Loss Factors that pertain to the Conference Room are the Ballast Factors, Lamp Lumen Depreciation Factor, Room Surface Dirt Depreciation Factor, and the Luminaire Surface Depreciation.

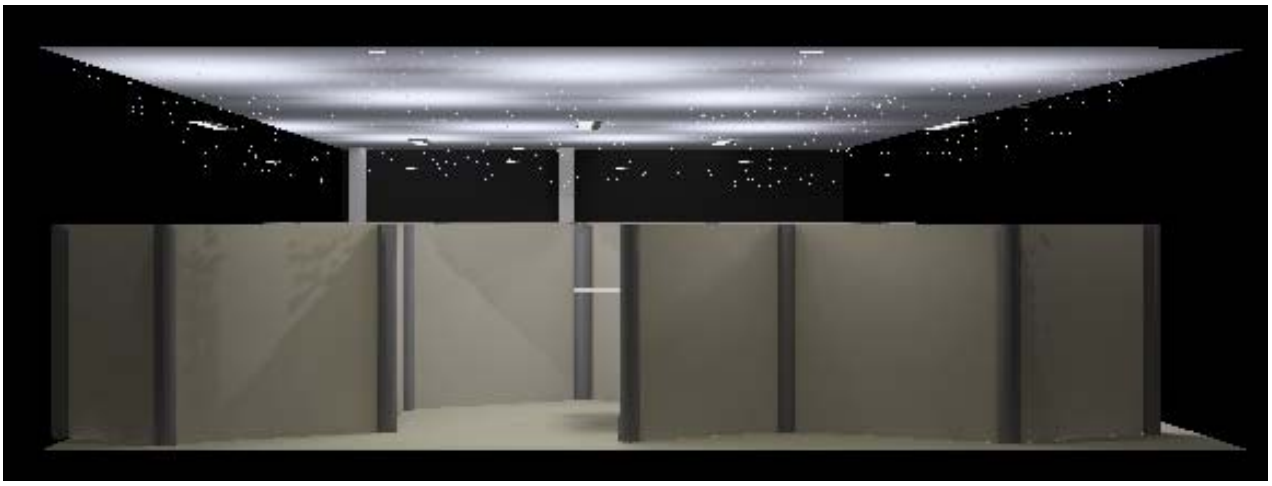
Open Office Schematic I Light Loss Factors						
Fixture	Ballast Factor	LLD	RSDD	LSD		LLF
C	1.05	0.95	0.89	0.88		0.78
E	1.02	0.95	0.88	0.87		0.74

These final numbers will be applied in the Lightscape Software program when the renderings for the new design are completed.

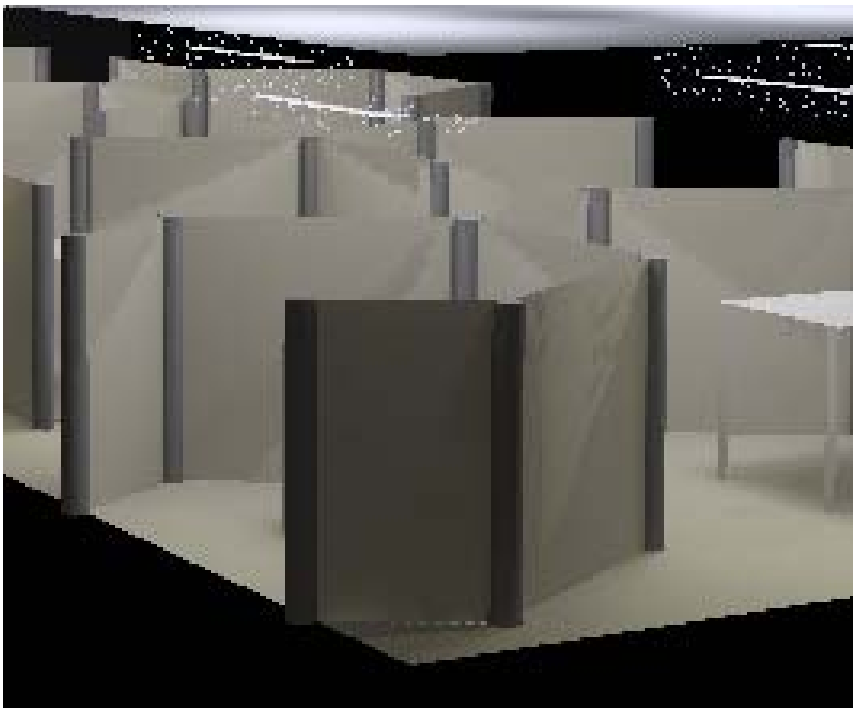
Lighting Analysis

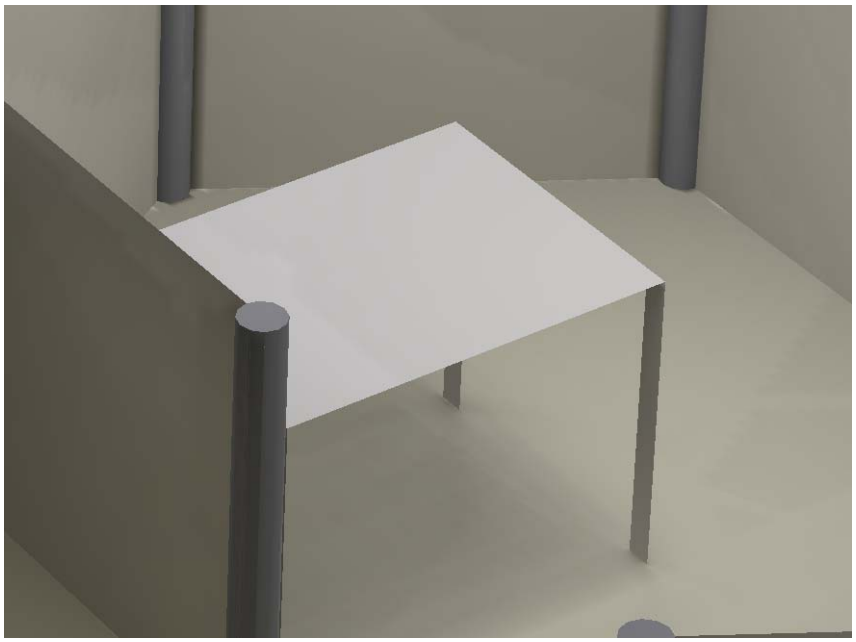
A complete Lighting Analysis for the space has been made using the AutoDesk Lightscape and Adobe Photoshop programs. Several renderings of the redesigned AstroPower Conference Room are presented below:





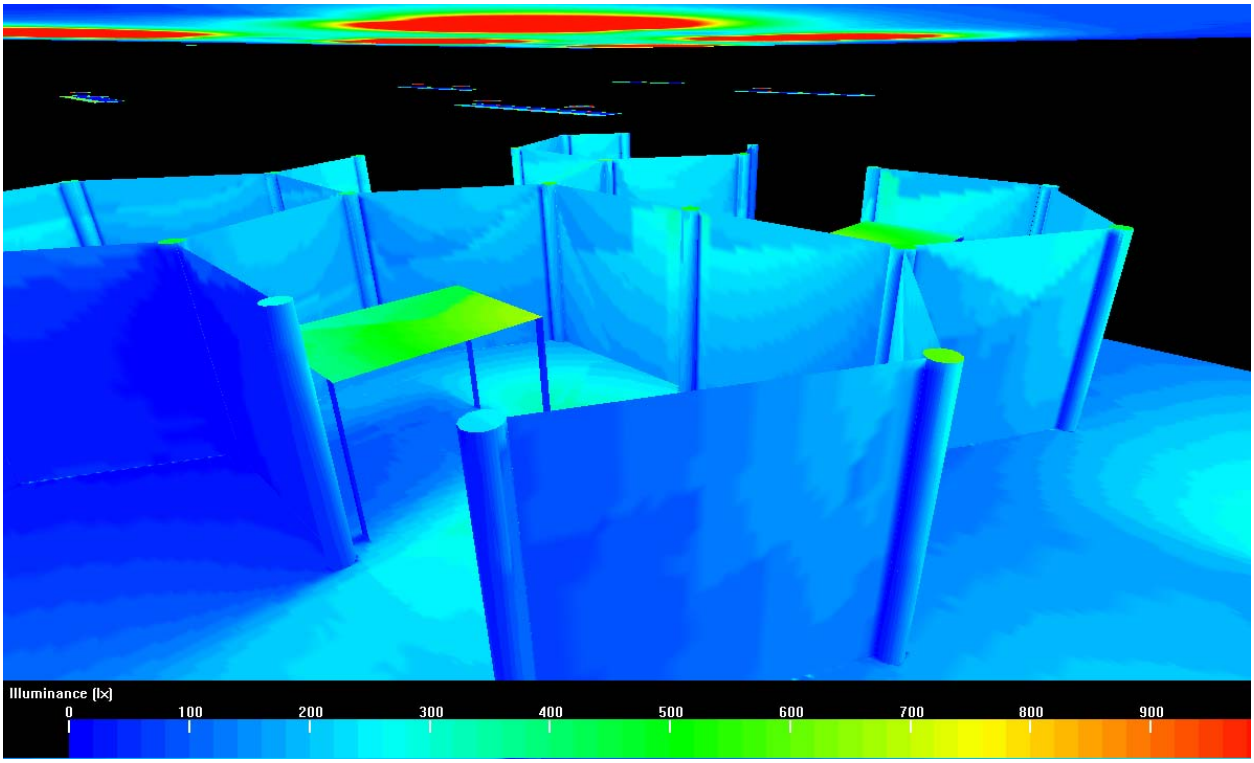
(A cloud-like image was added to where the Orgatech Luminaires will be hanging)





Even light distribution on the work surface with no shadows

Illuminance Rendering



Design Schematic II – Direct Fixture Approach

For an alternative approach to lighting the Open Office Area, a direct lighting design will be used. A more visually interesting could be achieved using pendant downlight fixtures, however the price and function ability is not appropriate for an Open Office area. In addition, direct color on the work surface would also be inappropriate for the work environment. Therefore, the second lighting design will feature stronger fluorescent downlights overtop of the hexagonal cubicles. Once again in the walkways the regular fluorescent downlights will be used to provide ample lighting for walking. The clean design of these fixtures will be consistent with the rest of the new lighting scheme. The power density will also remain low with the usage of fluorescent lamps, keeping the concept of green design throughout the space.

New Lighting Equipment

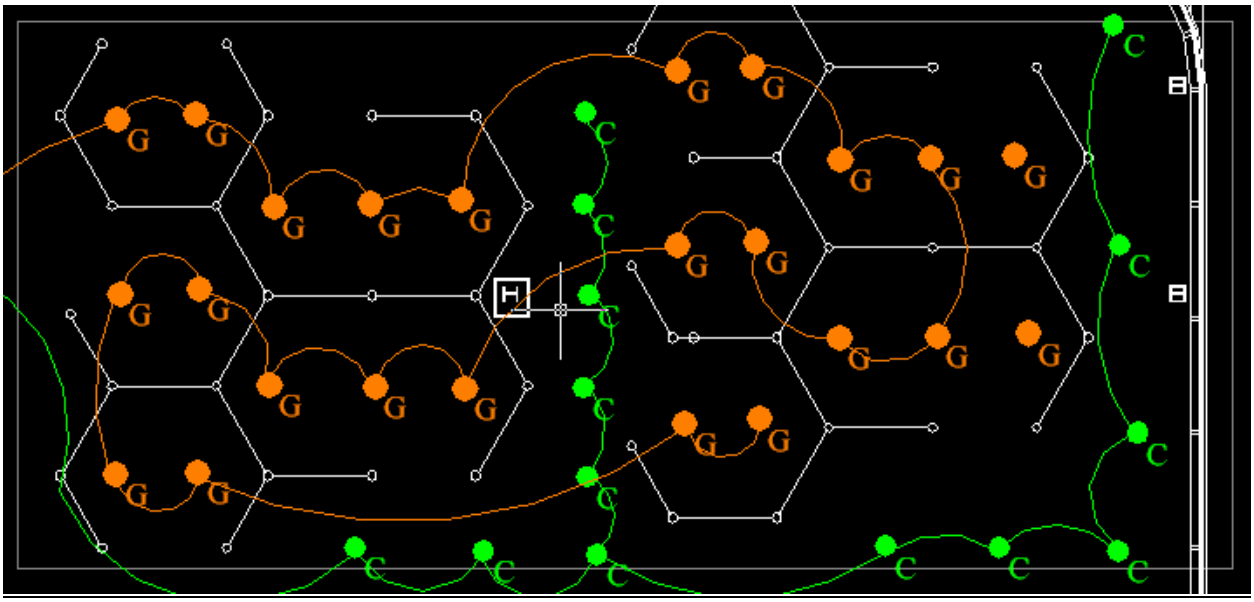
For the walkway downlights, the Erco Lightcast Downlight will be used. The lamp that will be in this fixture is a Philips TC-TEL 18WGx24q-2 compact fluorescent lamp. It is an 18-watt bulb, with a Color Rendering Index of 82. The ballast to be used is the Advance ICF-2S18-M1-BS@277V, with a voltage of 277 volts, 50/60 Hertz frequency, 20 watts, a ballast factor of 1.05, and a power factor of 0.97.

For the downlights over the work stations, the Erco Lightcast Downlight will also be used, however in a larger size. The lamp that will be in this fixture is a Philips PL-T Triple 4-Pin Fluorescent Lamp. It is a 32-watt bulb, with a Color Rendering Index of 82. The ballast to be used is the Advance ICF-2S26-HI-LD@277V, with a voltage of 277 volts, 50/60 Hertz frequency, 32 watts, a ballast factor of 0.98, and a power factor of 0.98 (Spec sheets for all the equipment mentioned above can be found in the Appendix).

Control Zones

The portion of the Open Office area that is represented in this analysis will be one control zone. The stronger Fluorescent downlights over the cubicles will be on one circuit, the smaller downlights in the aisles will be on another. There will be two sets of switches located near the north and south sides of the space. Each zone will feature motion sensors, to automatically turn off the lights if the space is unoccupied. There will also be dimmers on the switches to compensate for the amount of natural daylight in the space. A complex Control System will not be required.

Reflected Ceiling Plan



Fixture	Description	Fixture Type	Lamp Type	Lamp Watts	CRI	Ballast Watts	Ballast PF
C	Erco LC Downlight	Direct	Comp. Fluor.	20	82	20	1.05
G	Erco LC Downlight - Large	Direct	Comp. Fluor.	32	82	32	0.98

Power Summary

After the layout of the new fixtures was determined, a power summary could be put together. Having 14 walkway fluorescent downlights and ballasts, along with 22 work surface fluorescent downlights and ballasts, a power density of 1.35W/ft^2 was computed. According to the ASHRAE/IESNA Standard 90.1, the recommended power density is 1.5 W/ft^2. Although this is an improvement from the existing design, it is still far from the power density achieved by using the Direct/Indirect system.

Open Office Lighting System - Schematic II					
Fixture	Lamp Watts	# of Lamps	Input Watts	# Used	Total Wattage
C	20	1	20	14	280
G	32	2	68	22	1496
			Total Wattage (W)		1776
			Total Area (ft²)		1320
			Power Density (W/ft²)		1.35

Light Loss Factors

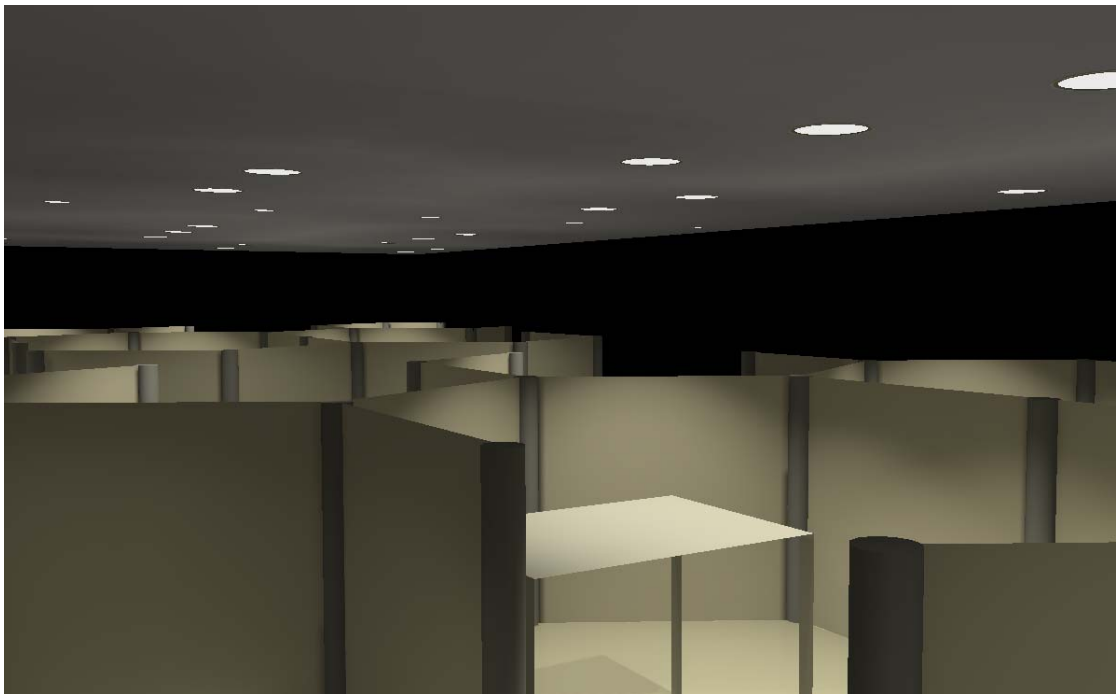
Several Light Loss Factors that pertain to the Open Office Area are the Ballast Factors, Lamp Lumen Depreciation Factor, Room Surface Dirt Depreciation Factor, and the Luminaire Surface Depreciation.

Open Office Schematic II Light Loss Factors						
Fixture	Ballast Factor	LLD	RSDD	LSD		LLF
C	1.05	0.95	0.89	0.88		0.78
G	0.98	0.95	0.89	0.88		0.73

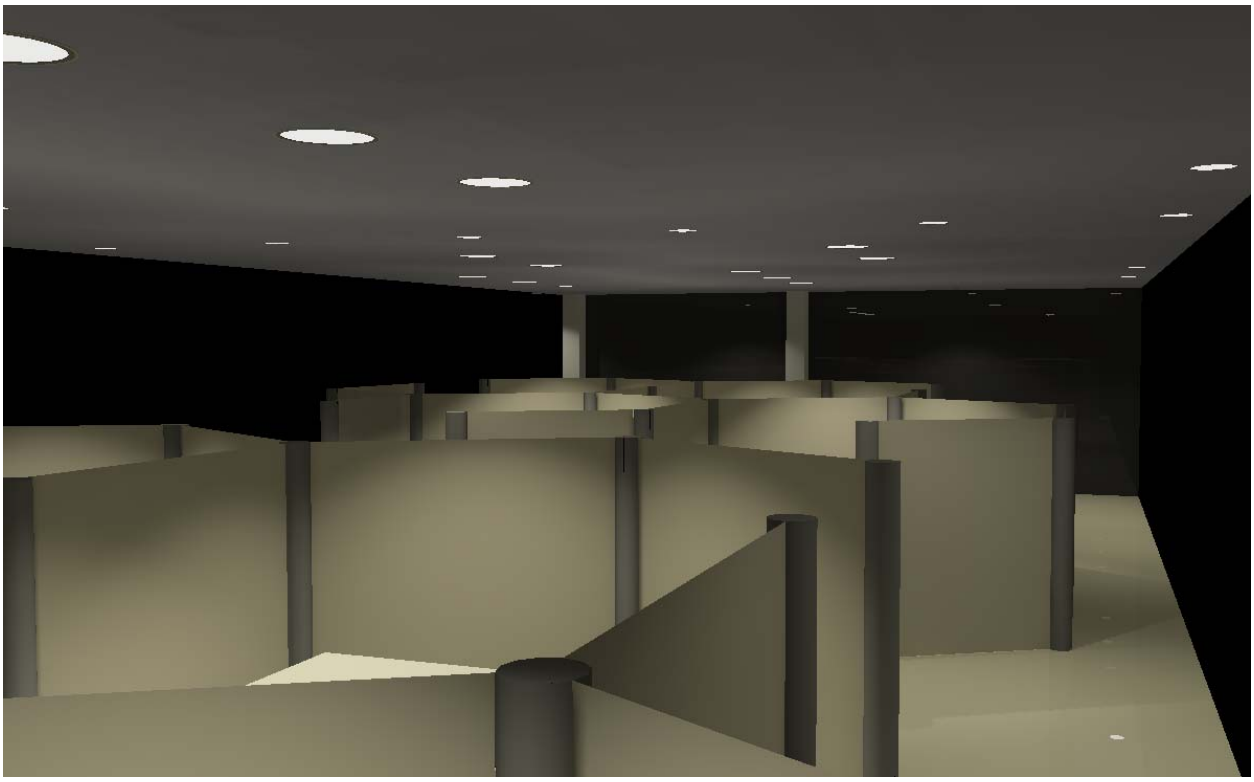
These final numbers will be applied in the Lightscape Software Program when the renderings for the new design are completed.

Lighting Analysis

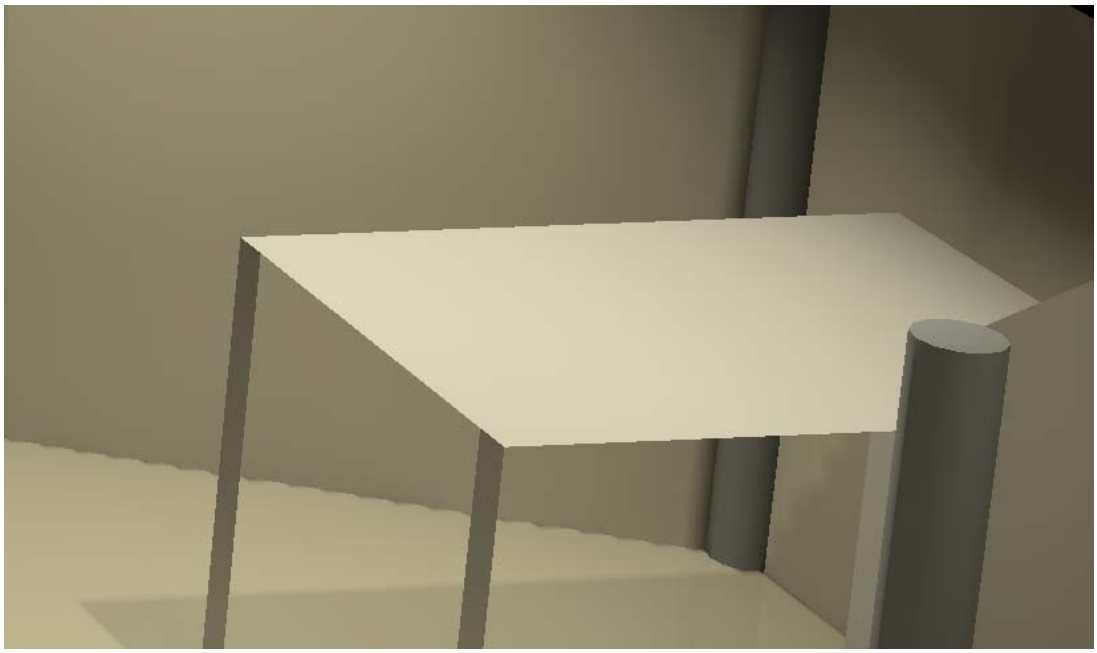
A complete Lighting Analysis for the space has been made using the AutoDesk Lightscape program. Several renderings of the redesigned AstroPower Open Office Area are presented below:



(A view of the Open Office area facing west)

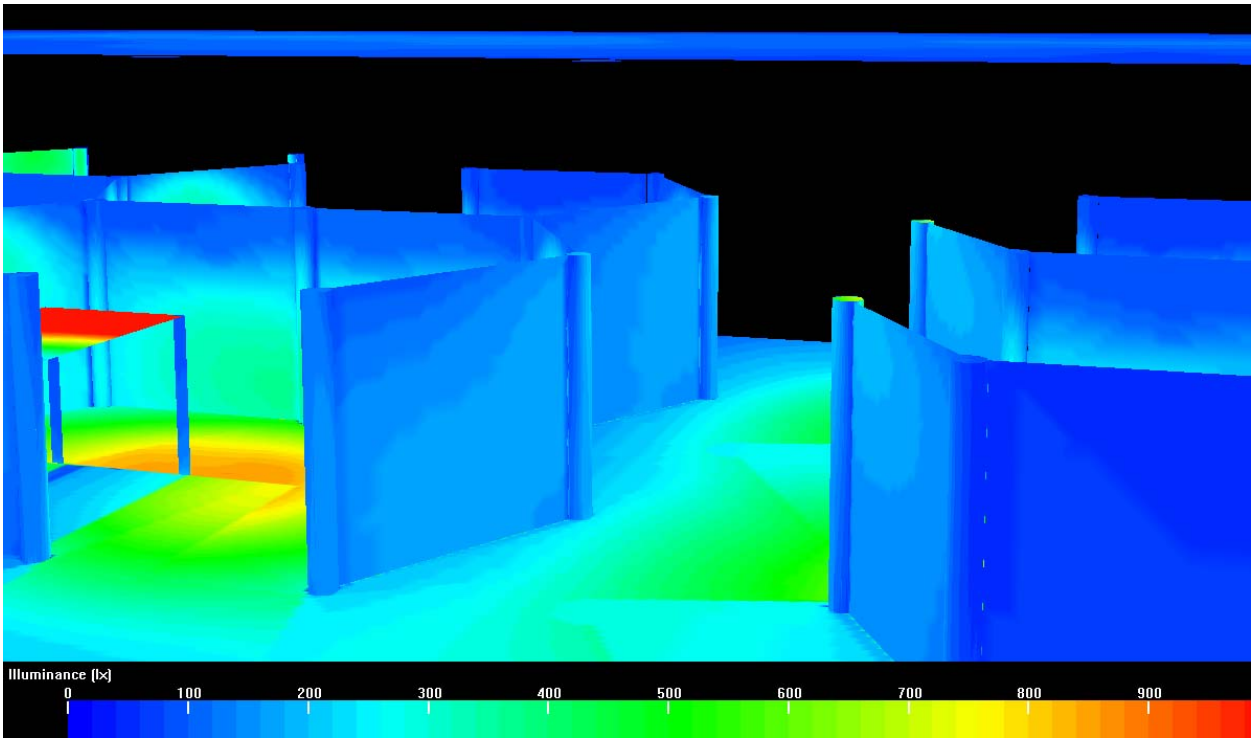


(A view of the Open Office facing the east glass façade wall)



(An illuminated work surface)

Illuminance Rendering



System Comparisons

After inspecting the results of the first Design Schematic with the second Design Schematic, a final recommendation has been developed. In addition to the fact that the power density is lower, it meets all of the design criteria, including the usage of color and visually interesting luminaires and the illuminances values are higher on the work surface, the first Design Schematic (Indirect/Direct fixtures) is clearly the way to go with the redesign.

7. Lighting Analysis

Front Entranceway

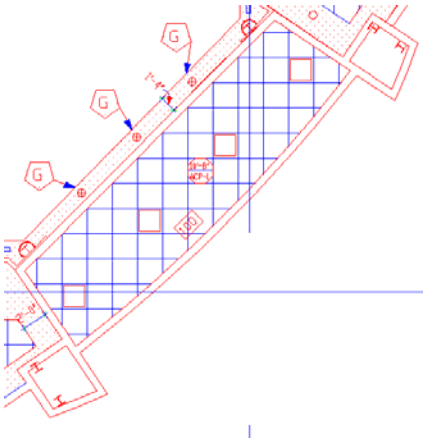
Front Entranceway

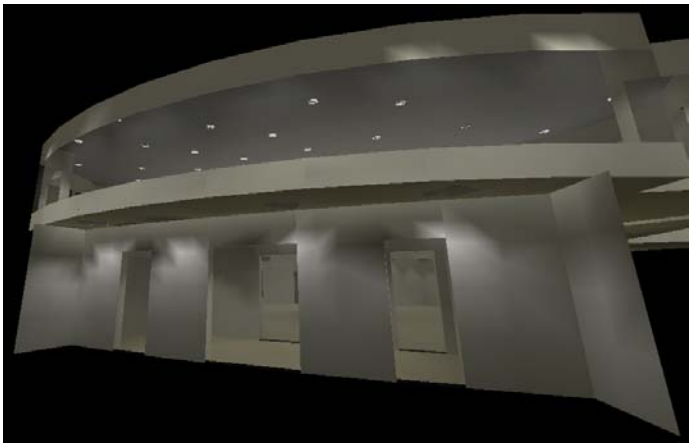
Design Criteria

The Front Entranceway has very specific design criteria when a new lighting design is developed. It is important that the luminaires are visually appealing to those who enter, along with the color of the lamps and the color contrast. It is also important to not have light pollution, but to light the space adequately enough so that people and their faces are easily seen without shadows or glare. To incorporate the design of the interior with the exterior is a challenging task, but one that can be accomplished. With these criteria in mind, a redesign was developed for the Front Entranceway.

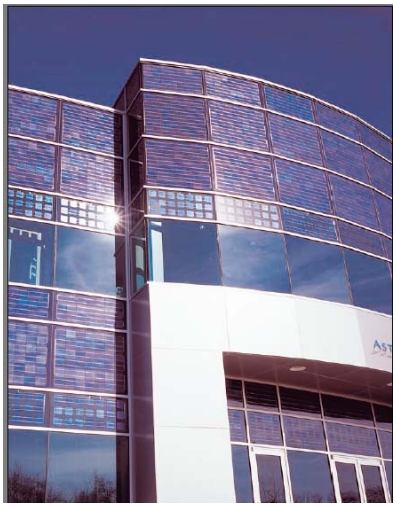
Design Schematic

The existing space has four two-by-two troffers arranged over the front canopy entranceway.





The idea for the redesign is to make the area stand out dramatically from far away. It is to invite people in to the building, making it a place they would go to even if they did not need to. The exterior of the building is covered with the blue/green solar panels, and a blue tinted glass on all other places. With an abundance of light shining on the surface, a blue reflection appears. This will keep the design continuous with the rest of the building.



To achieve these ideas, soft fluorescent downlights will be added in abundance. Due to the low power requirements, more can be added at the entranceway., for an outcome like the one in the picture below.

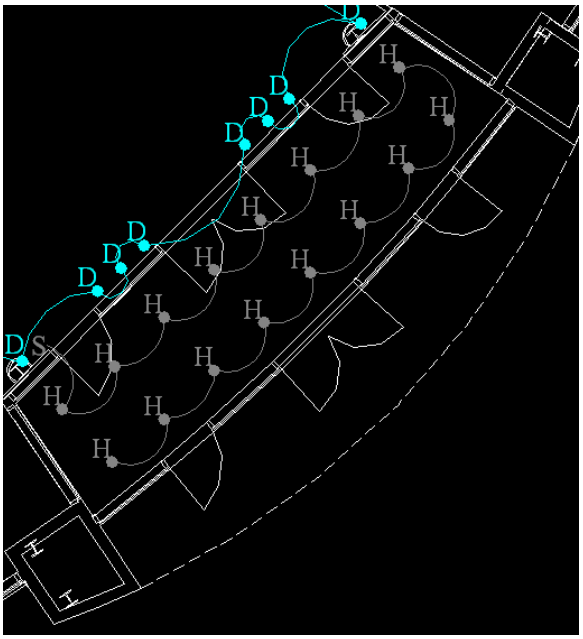
New Lighting Equipment

The downlights that are to be used are the Erco Lightcast Downlight for Outdoors. The lamp for these fixtures is the Philips PL-T Triple 4-Pin Compact Fluorescent Lamp. It is an 18-watt bulb, with a Color Rendering Index of 82. The ballast to be used with this luminaire is the Advance ICF-2S18-H1-LD@277V, with a voltage of 277 volts, 50/60 Hertz frequency, 20-watts, a ballast factor of 1.05, and a power factor of 0.97.

Control Zones

The Front Entranceway will feature a Control System that has several different functions. Three predefined settings will be automatically set for the Entranceway; the first will be Evening/Nighttime Environment, where all of lights will be on at full strength. The second will be Early Morning, to be used when the building is unoccupied. It will dim the lights to a level that is still bright enough to maintain visual acuity when coming and going from the building, but the "awe" that is created from full strength is not necessary when the building is empty. The third is manual control, where the lights can be turned on or off, at any strength desired by the building occupant. With these control options, saving on electricity will be easier for the AstroPower Company.

Reflected Ceiling Plan



Fixture	Description	Fixture Type	Lamp Type	Lamp Watts	CRI	Ballast Watts	Ballast PF
H	Erco Lightcast Downlight	Direct	Comp. Fluor.	18	82	20	1.05

Power Summary

After the layout of the new fixtures was determined, a power summary could be put together. Having 16 fluorescent downlights and ballasts, a power density of 10.01 W/linear foot was computed. According to the ASHRAE/IESNA Standard 90.1, the recommended power density is 33 W/linear foot. This is still a tremendous improvement from the existing design.

Front Entranceway Lighting System					
Fixture	Lamp Watts	# of Lamps	Input Watts	# Used	Total Wattage
H	18	1	20	16	320
			Total Wattage (W)		320
			Total Linear Feet (ft)		31.95
			Power Density (W/ln.ft)		10.01

Light Loss Factors

Several Light Loss Factors that pertain to the Conference Room are the Ballast Factors, Lamp Lumen Depreciation Factor, Room Surface Dirt Depreciation Factor, and the Luminaire Surface Depreciation.

Front Entranceway Light Loss Factors					
Fixture	Ballast Factor	LLD	RSDD	LSD	LLF
H	1.05	0.95	0.9	0.92	0.83

Lighting Analysis

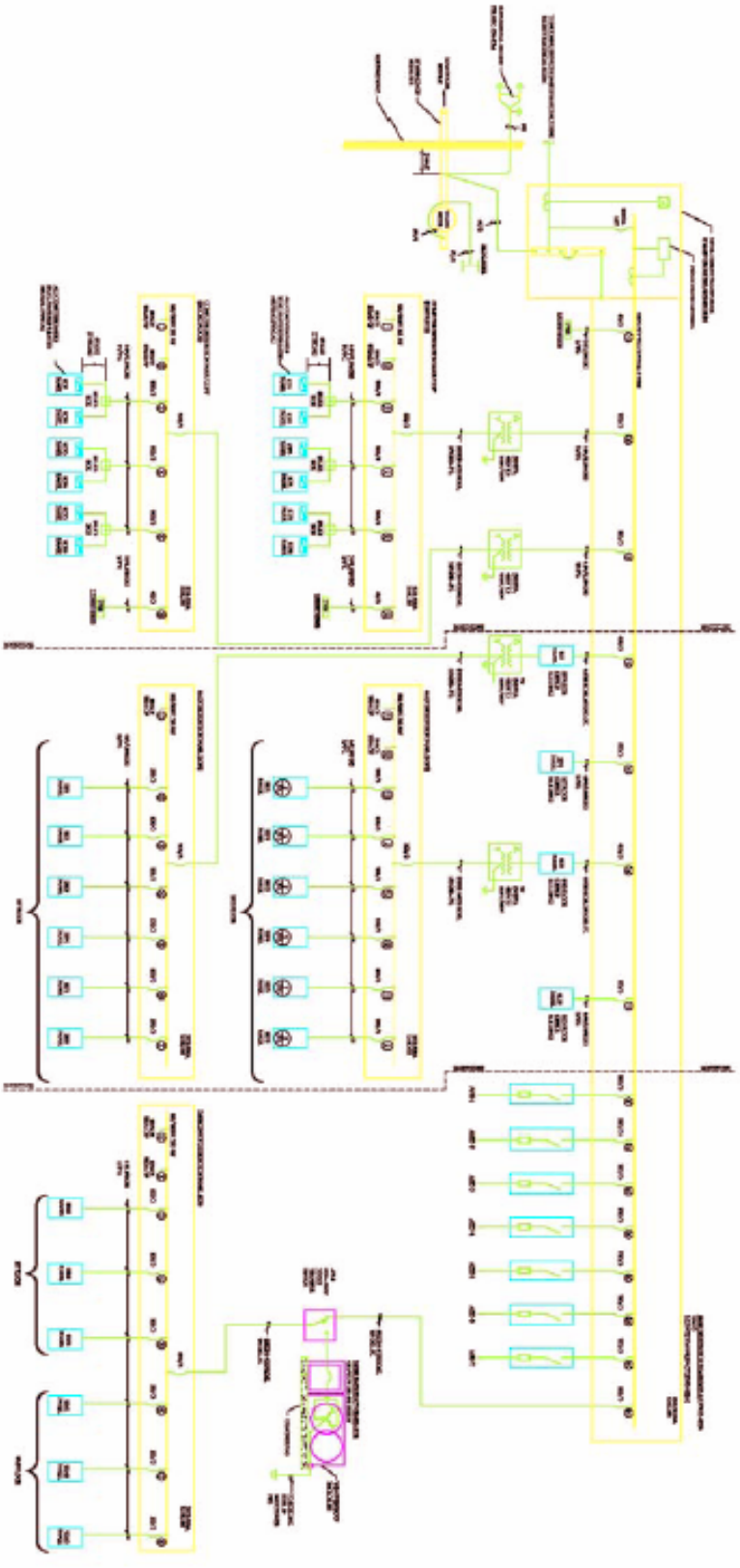
Although the Front Entranceway was not rendered in a computer program such as AutoDesk Lightscape, however the new design is considered to be successful. With the addition of many fixtures, while maintaining a minimal power density, the new design will surely draw attention to the space while providing ample light for those entering and exiting.

8. Electrical Analysis

Electrical Analysis

The AstroPower Headquarters building was constructed a few years ago to act as both a Headquarters and to be a display of what the product they manufacture can accomplish when put to work. The building features both office and manufacturing areas, requiring ample power in both spaces to attend to the research and professional sides of their corporation. The electrical system for a building like this must be designed to suit the use of the building, and also be able to provide flexibility for future additions the building might encounter. This report will go into the different aspects of the existing electrical system while providing information related to power usage, power distribution throughout the building, and other electrical load calculations.

Part I – Single Line Diagram



(A magnified version of the Single Line Diagram can be found in the Appendix)

Part II – Electrical Systems Existing Conditions

The following is a compilation of information pertaining to the building electrical system that currently exists in the AstroPower Headquarters building.

System Type

The AstroPower Headquarters building features a Load-center system using radial-type circuit arrangement. This design allows the power to be distributed at the highest economical voltage level to areas of concentrated load where the voltage is transferred down to the utilization level. The utilization equipment is then supplied using relatively short low-voltage feeders.

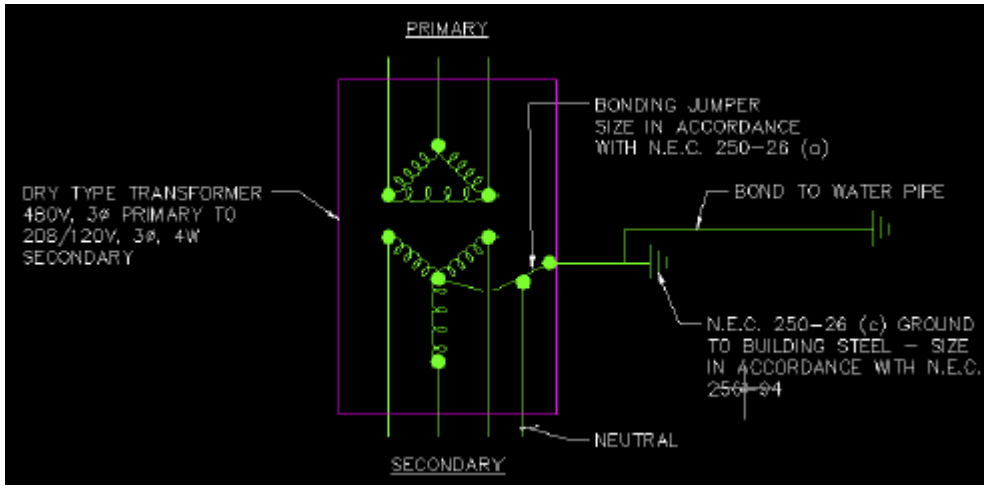
The load-center type of distribution has been made possible by the development of drytype medium-voltage switchgear and transformers that do not require expensive fireproof vaults and by the development of lower-cost medium-voltage feeder cables. The primary distribution switchgear is the metal-clad type using medium-voltage air circuit breakers.

Building Utilization Voltage

Incoming electrical power is provided at 12kV, which is then transferred into 480Y/277V to be distributed to the different distribution panels and air handling units for the lighting and mechanical systems. The lines are transferred again into 120/208V for receptacles and other power loads.

Transformer Configuration

All transformers used in the electrical distribution system are dry energy saving units square "D" T3HB series. The transformers convert three phase, three wire 460 volt delta primary to three phase, four wire 208/120V grounded wye secondary. The transformers also have a 220° insulation and 80° rise temperature rating, with 2 ½ % FCAN and 4 – 2 ½ % FCBN taps. For the computer distribution panels the TC-1 transformers are used. They are K-rated, electrostatically shielded, square D and Class 7400.



Emergency Power Systems

Emergency power in the AstroPower Headquarters is provided by a Diesel Emergency Generator located outside the building. It is underneath a weatherproof enclosure and on top of a concrete pad. The generator is a 480/277V three phase, four wire system that provides 200 kilowatts of power. When the Emergency Generator is not in use, the Emergency Distribution panel is powered by a line coming in from the Main Distribution Board. Upon power shut down, a three pole transfer switch connects to the generator providing 600 volts to the Emergency Distribution panel. This panel is equipped with 120/208V, three phase four wire connections to power the emergency lighting, exhaust fans, and other equipment located in the building.

Over-current Protective Devices

The AstroPower Headquarters uses several measures for over-current protection. After the transformer steps down the power from 12 kV to 480/277V, circuit breakers are located on each line out to the individual distribution panels. On the main distribution board, the circuit breakers are listed as three pole 80, 125, 200, 225, 400, or 600 amp circuit breakers. On the computer distribution panels, three pole 200 amp and 40 amp circuit breakers are used. On the main distribution panels, three pole 100 amp circuit breakers are used. Finally, the emergency distribution panel uses three pole 100 amp circuit breakers.

The air handling units are equipped with fuses and fused switches. They lead off the main distribution board with three pole 225 amps circuit breakers. There are a total of seven air handling units.

Finally, off of the main distribution board and the two computer distribution panels there are Libert Interceptor series transient voltage surge suppressors. They lead off the main lines with three pole 40 amp circuit breakers. With these protective devices, any type of damage will hopefully be prevented.

Location of Electrical Rooms and Equipment

A main electrical room, number 154, is located between columns L and M and line six, on the first floor in the office area. It is approximately twenty feet deep by eight feet wide. The room has the following panels and equipment: two 150kVA transformers, a security panel, and emergency distribution panel, a fire alarm panel, a 600A transfer switch, along with the panels 1EM1, 1EM2, 1CP1, 1CP2, 1CP3, 1RP1, 1RP2, 1RP3, MDP1, 1LP1, and CDP.

A secondary electrical room, number 174, is located between columns K and L and line three, on the first floor in the office area. It is approximately ten feet deep by six feet wide. The room has the following panels: 1LP2, 1RP4, 1RP5, 1RP6, 1CP4, 1CP5, 1CP6, 1EM3.

Another main electrical room, number 244, is located between columns L and M and line six, on the second floor in the office area. It is approximately sixteen feel deep by eight feet wide. The room has the following panels and equipment: two 150kVA transformers, along with panels 2EM1, 2EM2, 2CP1, 2CP2, 2CP3, CDP2, 2RP1, 2RP2, 2RP3, MDP2, and 2LP1.

Another secondary electrical room, number 272, is located between columns K and L and line three, on the second floor in the office area. It is approximately ten feet deep by six feet wide. The room has the following panels: 2LP2, 2RP4, 2RP5, 2RP6, 2CP4, 2CP5, 2CP6, and 2EM3.

Typical Lighting Systems

The lighting used in the AstroPower Headquarters is categorized as being fluorescent and L.E.D. All fluorescent and L.E.D. fixtures in the building are to have an input of 277V and a frequency of 60 Hz. The THD shall be less than 20% for the main lamp design, and the Lamp Current Crest factor shall not exceed 1.7. The power factor must be greater than 98%, but for most lamps is assumed to be 1.0. For the fluorescent fixtures, the ballasts must be CSA approved and UL listed class P.

Important Design Requirements

Since two of the four electrical panels feed the computer areas, a Leibert Interceptor Series transient voltage surge suppressor is connected. There is also one off the main line on the main distribution board after the transformer steps down the 12kV line in. There are also four additional transformers from the main distribution board to the four other panels that step down the voltage from 150 kVA 480V to 208Y/120V.

Part III – Lighting and Mechanical Systems Information

The following tables list the primary lamps and ballasts that are used in the AstroPower Headquarters building:

Lamps

Fixture	Manufacturer	Model	Feature	Watts	Bulb	Base	CRI	CCT	Des. Lumens	Init. Lumens
A	Philips Lighting	SILHOUTTE™ Programmed Start	T5 Miniature Bipin Fluorescent Lamps	28	T5	Min. Bipin	85	4100 K	2750	2900
B	Philips Lighting	SILHOUTTE™ High Output Prog. Start	T5 Miniature Bipin Fluorescent Lamps	24	T5	Min. Bipin	85	4100 K	1895	2000
C	Philips Lighting	PL-T Triple 4-Pin Fluorescent Lamp	ALTO® Lamp Technology	18	PL-T	GX24q-2	82	4100 K	1020	1200
D	Philips Lighting	MasterColor® Tubular Single-Ended T-4	Lifetime Color Stability	39	T-4	G8.5	N/A	N/A	2640	3300
E	Philips Lighting	PL-T Triple 4-Pin Fluorescent Lamp	ALTO® Lamp Technology	26	PL-T	GX24q-3	82	4100 K	1530	1800
F	Philips Lighting	ALTO® SILHOUTTE™ High Output Prog. Start	T5 Miniature Bipin Fluorescent Lamps	54	T5	Min. Bipin	85	4100 K	4750	5000
G	Philips Lighting	PL-T Triple 4-Pin Fluorescent Lamp	ALTO® Lamp Technology	32	PL-T	GX24q-3	82	4100 K	2040	2400
H	Philips Lighting	PL-T Triple 4-Pin Fluorescent Lamp	ALTO® Outdoor Lamp Technology	18	PL-T	GX24q-2	82	4100 K	1020	1200

Ballasts

Fixture	Manufacturer	Model	Brand Name	Type	Starting Method	Volts	Frequency	Input Power	Ballast Factor	Power Factor
A	Advance	VCN-132-MC	CENTIUM	Electronic	Instant Start	277	60	30 W	0.98	0.99
B	Advance	ICN-2S24@277V	CENTIUM	Electronic	Prog. Start	277	50/60	52 W	1	0.98
C	Advance	ICF-2S18-M1-BS@277	ADVANCE CFL	Electronic	Prog. Start	120-277	50/60	20 W	1.05	0.98
D	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
E	Advance	ICF-2S26-H1-LD@120	ADVANCE CFL	Electronic	Prog. Start	120-277	50/60	29 W	1.1	0.98
F	Advance	ICN-2S54-90C@277	CENTIUM	Electronic	Prog. Start	277	50/60	62 W	1.02	0.98
G	Advance	ICF-2S24-M2-BS@120	ADVANCE CFL	Electronic	Prog. Start	120-277	50/60	68 W	0.98	0.98
H	Advance	ICF-2S18-H1-LD@120	ADVANCE CFL	Electronic	Prog. Start	120-277	50/60	20 W	1.05	0.98

The following tables list the mechanical equipment that is used in the AstroPower Headquarters building:

Roof Top Units

Symbol	Description	Tot. CFM	Min. O.A. CFM	Net Cooling Capacity	Mixed Air Ent.		Capacity (MBH)		Net Heating Capacity			Power
				Amb D.B. Temp.	D.B.	W.B.	Tot.	Sens.	Ent. Air Temp.	Input (MBH)	Output (MBH)	V/PH/Hz
RTU-1	1Fl.Perim.	12,000	1,020	93	76.5	64	361	328	69.5	500	240	460/3/60
RTU-2	1Fl.North	12,000	1,520	93	77.3	64.5	360	292	66.8	500	170	460/3/60
RTU-3	2Fl.North	16,000	1,520	93	76.7	64.1	436	395	68.8	850	216	460/3/60
RTU-4	2Fl.South	16,000	1,520	93	76.7	64.1	436	395	68.8	850	216	460/3/60
RTU-5	1Fl.South	12,000	1,520	93	77.3	64.5	360	292	66.8	500	170	460/3/60
RTU-6	2Fl.Perim.	14,000	1,020	93	76.3	63.9	436	395	70.3	500	224	460/3/60
RTU-7	Air Hand Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60
RTU-8	Air Hand Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60
RTU-9	Air Hand Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60
RTU-10	Air Hand Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60
RTU-11	Air Hand Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60
RTU-12	Air Hand Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60
RTU-13	Air Hand Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60
RTU-14	Air Hand Unit	30,000	7,500	93	81.8	67.5	920	465	56.5	-	410	460/3/60

Symbol	Basis
RTU-1	Trane SFHFC4OP, 40 ton nom.
RTU-2	Trane SFHFC4OP, 40 ton nom.
RTU-3	Trane SFHFC4OP, 40 ton nom.
RTU-4	Trane SFHFC4OP, 40 ton nom.
RTU-5	Trane SFHFC4OP, 40 ton nom.
RTU-6	Trane SFHFC4OP, 40 ton nom.
RTU-7	Trane SFHFC75P, 75 ton nom.
RTU-8	Trane SFHFC75P, 75 ton nom.
RTU-9	Trane SFHFC75P, 75 ton nom.
RTU-10	Trane SFHFC75P, 75 ton nom.
RTU-11	Trane SFHFC75P, 75 ton nom.
RTU-12	Trane SFHFC75P, 75 ton nom.
RTU-13	Trane SFHFC75P, 75 ton nom.
RTU-14	Trane SFHFC75P, 75 ton nom.

Exhaust Fans

Symbol	Description	Location	C.F.M.	E.S.P.	Fan R.P.M.	Motor H.P.	Sones	V/PH/Hz	Basis
EF-1	1Fl. Core	Roof	1,800	1.5	1445	1	13.9	208/3/60	Penn Ventilator Domex DX14B
EF-2	2Fl. Core	Roof	1,000	1	1282	0.5	9.6	208/3/60	Penn Ventilator Domex DX11B
EF-3	Machine Rm.	Roof	400	1	1223	0.25	9.1	115/1/60	Penn Ventilator Domex DX11B
EF-4	Elec. RMS	Roof	400	1	1223	0.25	9.1	115/1/60	Penn Ventilator Domex DX11B
EF-5	Elec. RMS	Roof	400	1	1223	0.25	9.1	115/1/60	Penn Ventilator Domex DX11B

Part IV – Building Load Calculations

The total building loads were tabulated for the AstroPower Headquarters building. Listed below are the total loads from the lighting and receptacle load. The mechanical load has not been included in the final building total.

Receptacle Load

Location	Square Feet	Number of Receptacles
Warehouse	100,909	2,019
Office - Fl. 1	29,645	593
Office - Fl. 2	29,563	589
Total Number of Receptacles		3,201
x 180 VA / Receptacle =		x 180
Receptacle Load (VA)		576,180
First 10,000 VA at 100%		10,000
Remaining 566,180 at 50%		283,090
TOTAL Computed Load (VA)		293,090
(kVA)		293.09

Total Receptacle Load = 293,090 = **293.03 kVA**

Lighting Load

Data taken from NEC 2002 Table 220-3(a) General Lighting Load by occupancy:

Warehouse/Manufacturing: 100,909 ft.^{2} x 2 VA = **201,818 VA**
Office Area: 59,208 ft.^{2} x 3 ½ VA = **207,228 VA**

Total Lighting Load = 409,046 VA = **409.046 kVA**

Demand Factor

Data taken from NEC 2002 Table 220-11 Lighting Load Demand Factors:

All Others – Total volt-amperes = 100%

Total Building Load (for Lighting and Receptacles)

The total building load for Lighting and Receptacles (excluding Mechanical) is **702.136 kVA**.

9. Telecommunications System Design

Telecommunications System Design

The AstroPower Headquarters represents the advancement of solar design in our world today. The building itself is an example of this. A Headquarters this dedicated to moving into the future should have a Telecommunications system just as advanced. A new Telecommunications system has been developed for the AstroPower Headquarters.

The new design will feature the addition of two new rooms to the building. On the first floor, a 16'-8" by 8'-6" room will be built off of the existing electrical room in the northwestern part of the building. The second floor room will be directly above the first floor room. It will measure 16'-8" by 17'-2" and is located directly off the existing electrical closet on the second floor. It is also located in the northwestern part of the building.

Telecommunications Rooms

The second floor telecommunications room, which will double as the building's Data Center, will contain all file servers, PBX, main UPS, OCTEL, and all related peripherals associated with the successful operation of the firm's technology needs. All cable distribution will originate in the new room, with a significant amount of fiber cable to be installed in accordance with infrastructure design. The new room will be constructed on a raised access floor. The floor will have a slab to tile depth of 12". All power and HVAC distribution will be accommodated within the cavity of the new floor. Communications cable requirements for the room will be routed overhead via an overhead ladder rack/cable tray system. Cabinet cables (fiber and copper) for both the data and voice systems, as well as riser and backbone cables will utilize this overhead system.

Power and HVAC for the room will be provided using the existing systems that are already in place in the AstroPower Headquarters. A pre-action fire suppression system will be installed in the new room. Access to the room will be controlled using the existing pass card security system already implemented in the building.

There will be no ceiling in the room, with the under slab surface from the second floor repaired, sealed, and painted according to the firm's preferences. Leak detection and grounding will be provided under the floor, with grounding also provided to all cabinets.

The room will be constructed to house only elements of the technology infrastructure. An estimated five new cabinets will be installed to house servers. They will measure approximately 24" wide, 42" deep, and seven feet tall. The telephone switch (PBX) will be relocated into the room as well. The configuration of the moved switch will require two individual spaces within the room. PBX connections to the service provider network(s) as well as to the individual work area outlets will occur at the Voice Main Distribution Facility. A new Local Area Network system will also be installed. The LAN will consist of core equipment servicing all of the file, print, and applications servers via the Data Main Distribution Facility. In addition, all work area outlets will be connected to the LAN via individual fiber connections collapsed into the Data Center. All LAN equipment will be mounted using open frame racks rather than cabinets. A new Keyboard/Mouse/Monitor, or KVM, will be installed which will also interface with the cabinets and servers using the Data Main Distribution Facility at the cross connection point. The

KVM hardware will be located with the core LAN switching equipment. Other equipment to be added to the room will be relocated from the existing network.

The first floor telecommunications room is intended to be used strictly for passive connectivity between the horizontal (Work Area Outlet) system and the vertical (riser/backbone) system. The room will consist of a riser up to the second level. There will also be a ladder rack/cable tray system implemented in the room from the riser to the free standing rack. The room will mirror the characteristics of the second floor telecommunications room, in exception of the raised floor system.

Vertical Subsystem

The vertical component of the cable infrastructure will consist of high pair count copper cables for the voice requirements, and high fiber count backbone cables for the data requirements. All vertical subsystem component cables will originate in the second floor Telecommunications Room and extend to the first floor Telecommunications Room below.

The voice riser cable system consists of multiple 300 pair high pair count copper cables. Cable sizing has been developed based on input from the AstroPower Voice Technology staff. All cable used as riser cable will meet or exceed Category 3 performance standards.

The Voice Main Distribution Facility will consist of wall mounted BIX style termination blocks arranged in order by floor and PBX Peripheral Equipment Cabinet. Riser cables will be terminated on separate and separated block fields within the Voice Main Distribution Facility.

Riser cables will be terminated on separate 300 pair block assemblies in the telecommunications rooms. They will be wall mounted. Each pair of riser cable will be color coded and identified. Color coding will utilize standard communications coding schedule within individual 25 pair binder groups. Pair identification will consist of floor number-serial number (ex. 01-001, 01-002W for wall phones). Specific pair usage will be defined for the riser cables. Each work area outlet will have two individual cross connections installed in the telecommunications room from the voice cable to pairs on the riser cable.

The system is also implemented with significant expansion possibilities in place.

Data System

The data backbone system will consist of multiple 144 strand, 50 micron, laser optimized, multi-mode fiber cables. Cable size to each individual floor has been developed to provide adequate day one connectivity, reasonable expansion provisions, maximum utilization of standard accessories and termination equipment, and economical practice to minimize costs.

Each data connection will require use of two individual fiber optic stands. Adequate fiber stands will be installed to support minimally 1 connection to every work area outlet on each floor with a minimum of 100% expansion. The fiber optic racks in the Data Center will support multiple fiber optic termination cabinets.

Horizontal Subsystem

The horizontal subsystem of the Infrastructure consists of the cables originating in the telecommunications rooms and extending to the individual Work Area Outlet. Two individual style Work Area Outlets have been designed for the AstroPower Headquarters:

Full Compliment

Wall Phone

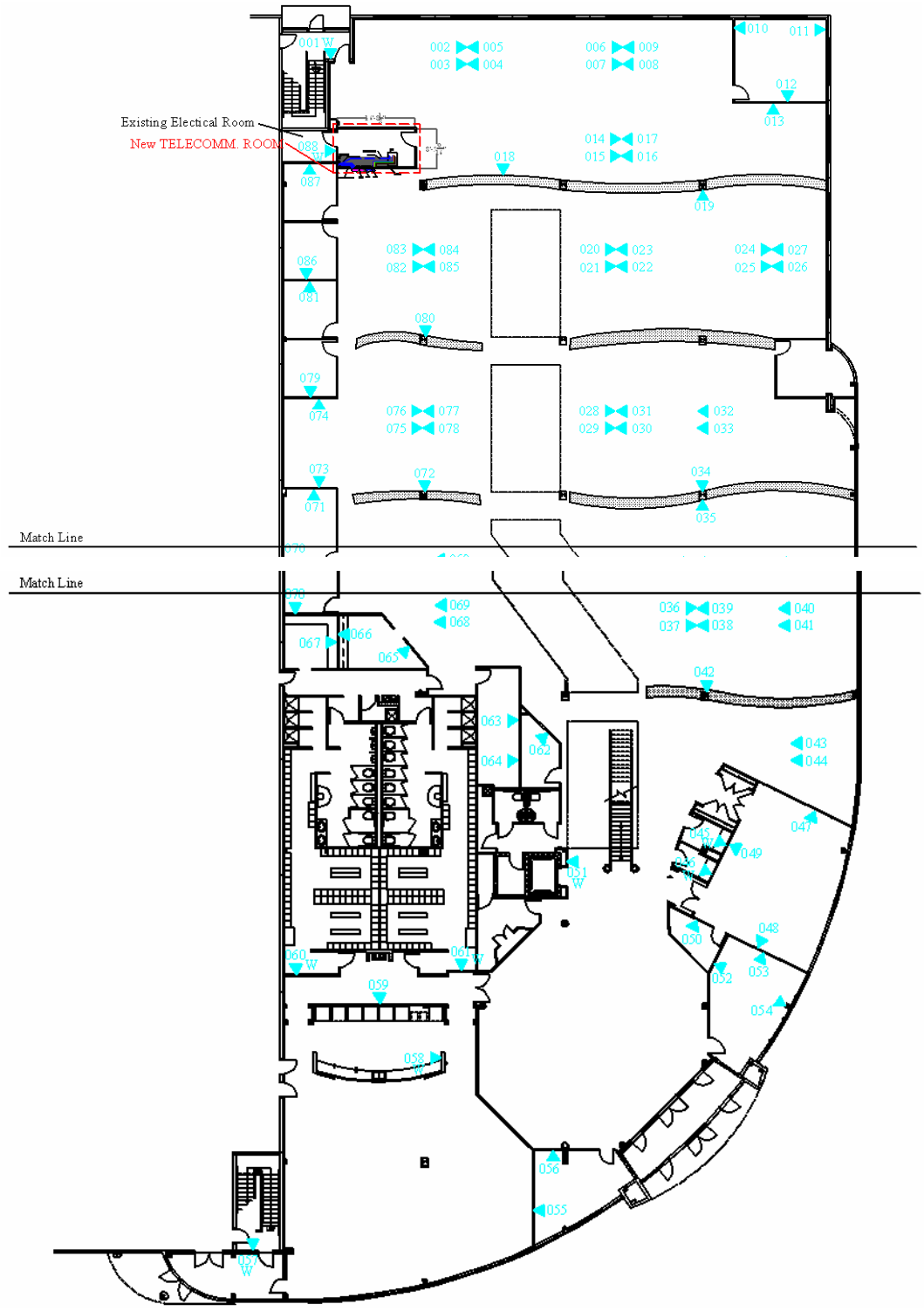
Full compliment Work Area Outlet locations will be furnished with both a copper complement (2 cables) and a Fiber component (4 strands). Wall phone locations will be furnished with just the copper component of the system.

Copper Component

The copper component of the horizontal subsystem will consist of two individual, Category 6 compliant, plenum rated, 4 pair cables. Copper cables will extend to the Work Area Outlet locations to be detailed on the drawings. Within the telecommunications room, each individual copper cable will be fully terminated using BIX style punch down blocks designated to provide Category 6 performance characteristics both at the cable level as well as at the cross connection level. Each of the two cables will be uniquely colored. Each cable will be fully terminated at the Work Area Outlet.

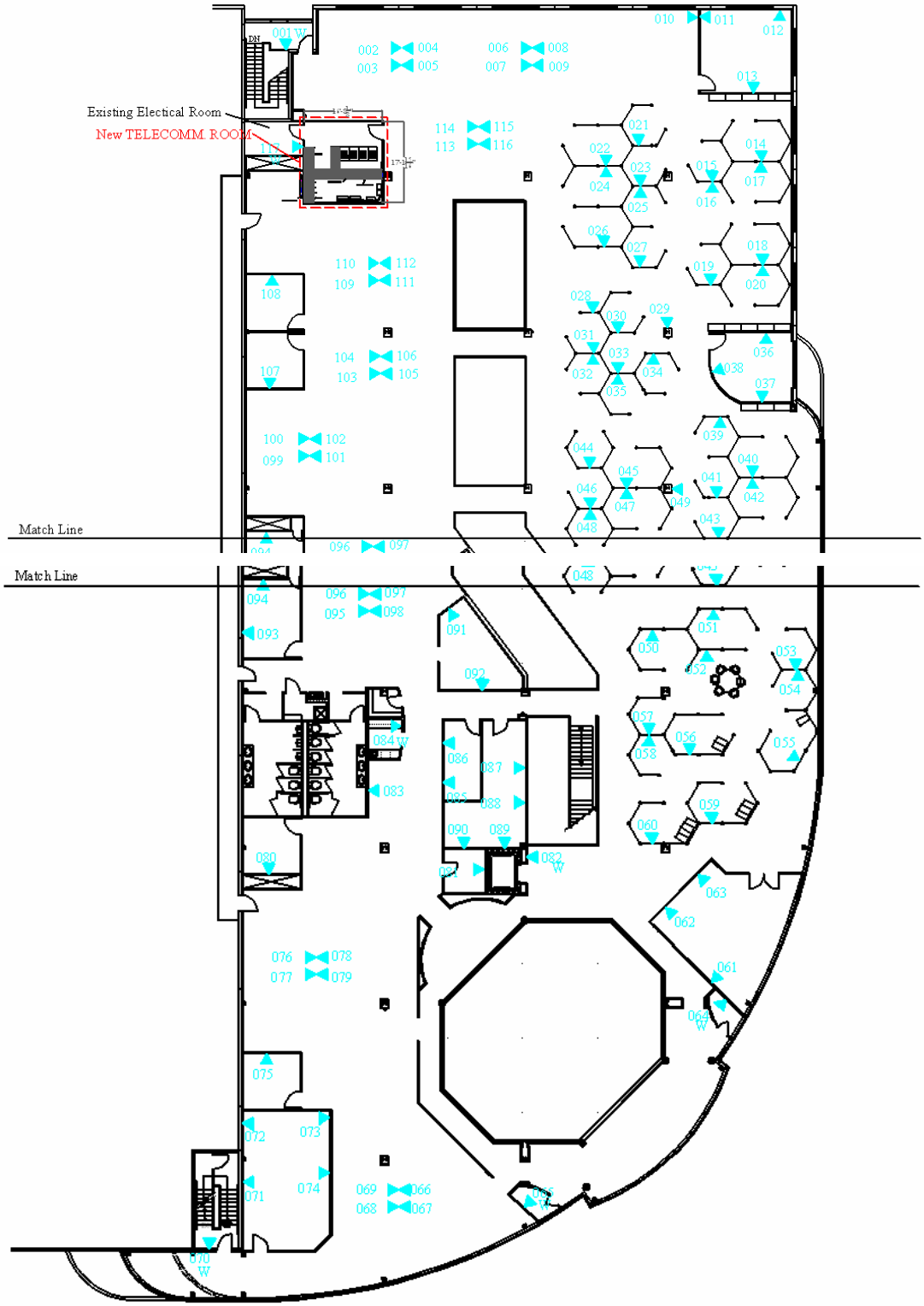
Cable 1 will be terminated in a split fashion using two individual 6-position jacks, each jack having 2 of the 4 cable pairs terminated. Terminations at each jack will utilize USOC termination schemes. Cable 2 will be terminated using a single, 8-postion, modular, Category 6 compliant connector. Termination at the jack will utilize EIA/TIA 568-B termination schemes. Each cable installed will be identified at the jacket with the number of the Work Area Outlet it is installed to.

First Floor – Telecommunications Technology Infrastructure Plan



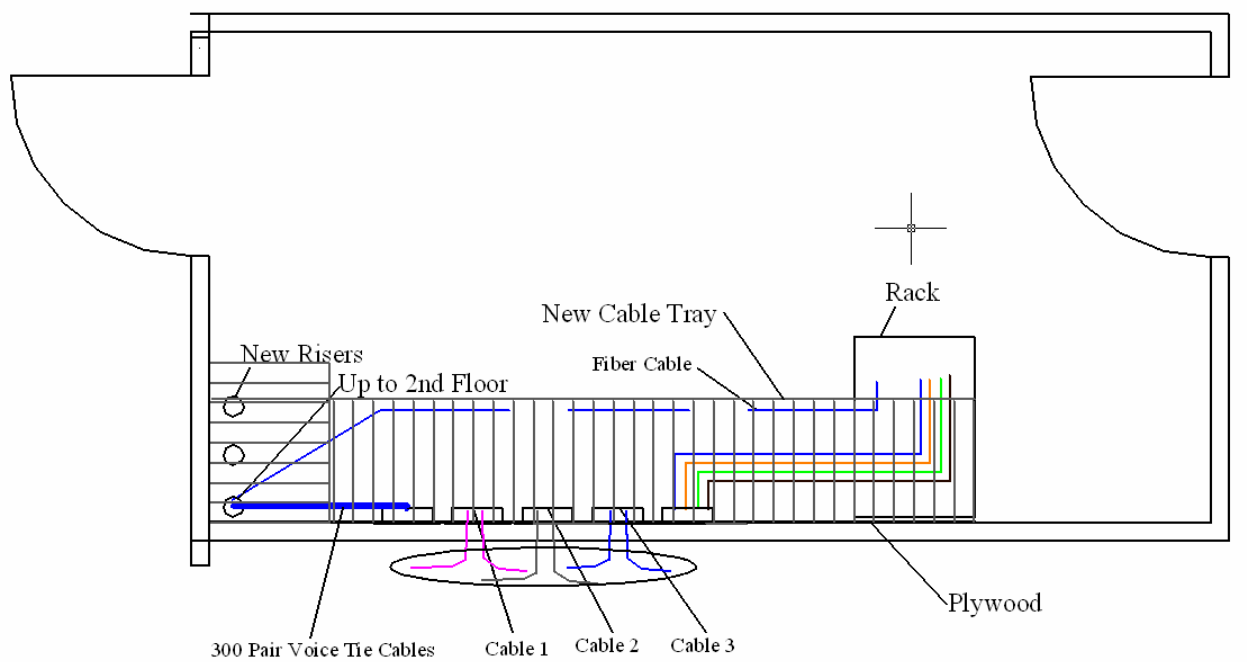
(An enlarged version of this plan can be viewed in the Appendix)

Second Floor – Telecommunications Technology Infrastructure Plan

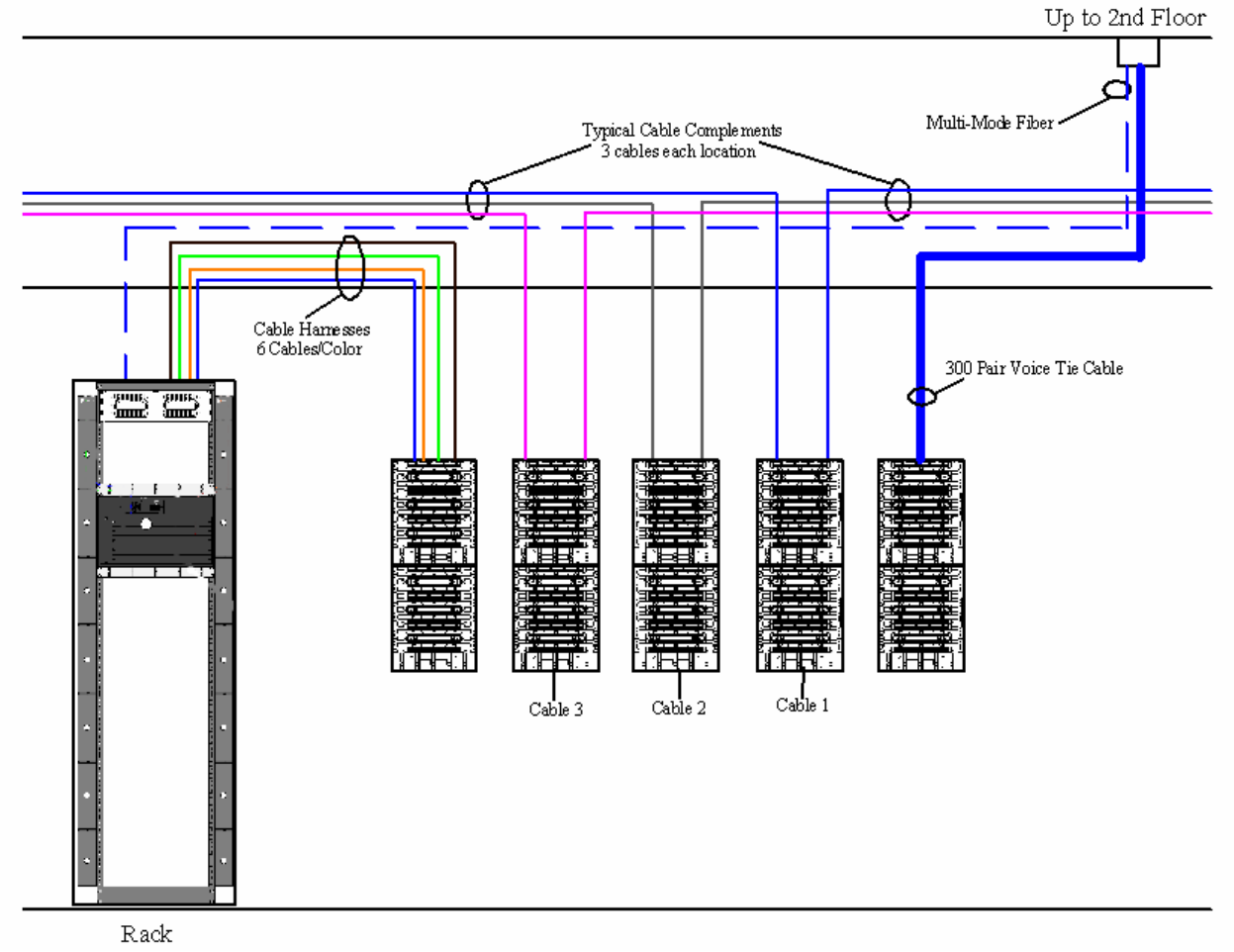


(An enlarged version of this plan can be viewed in the Appendix)

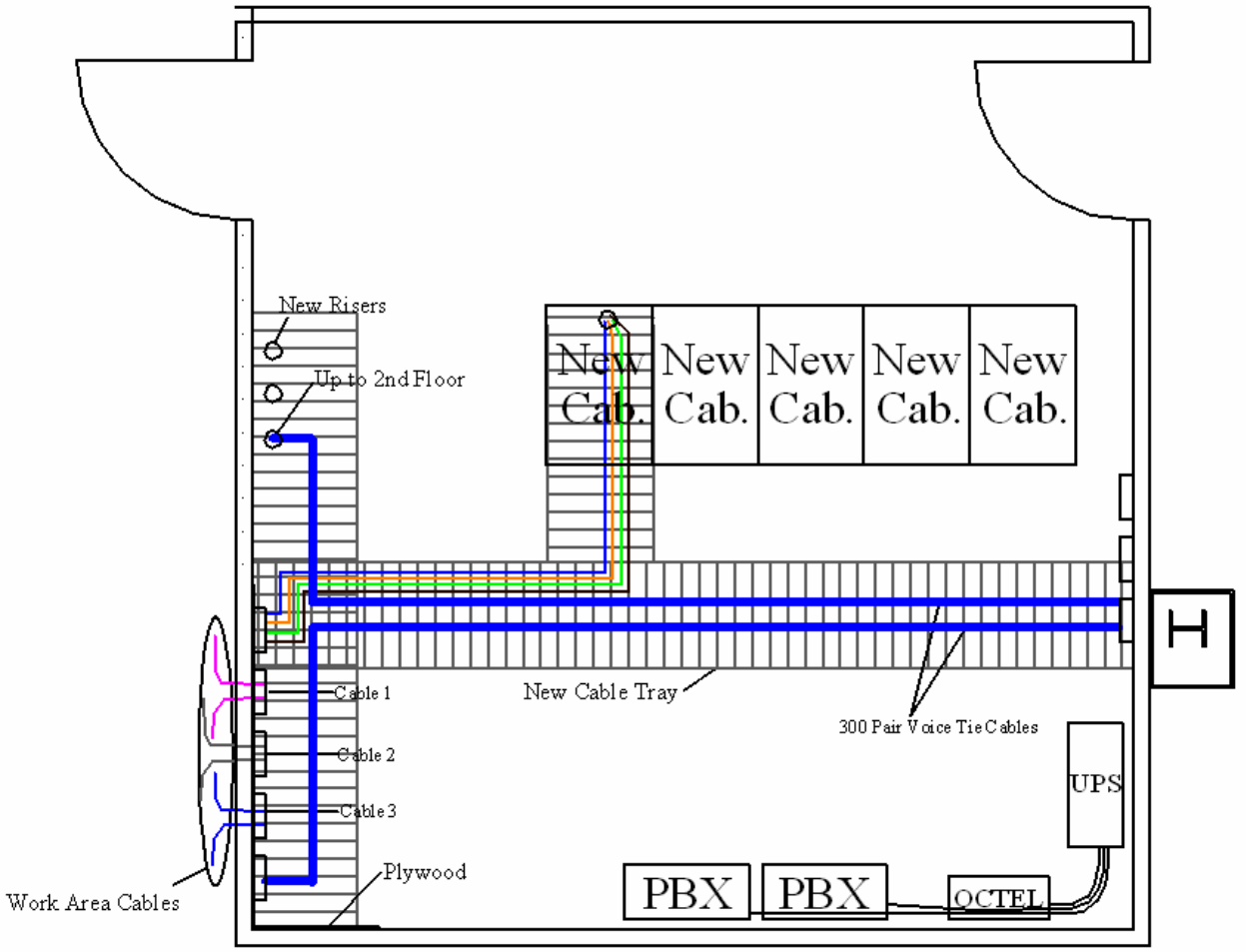
Telecommunications Room Plan – First Floor



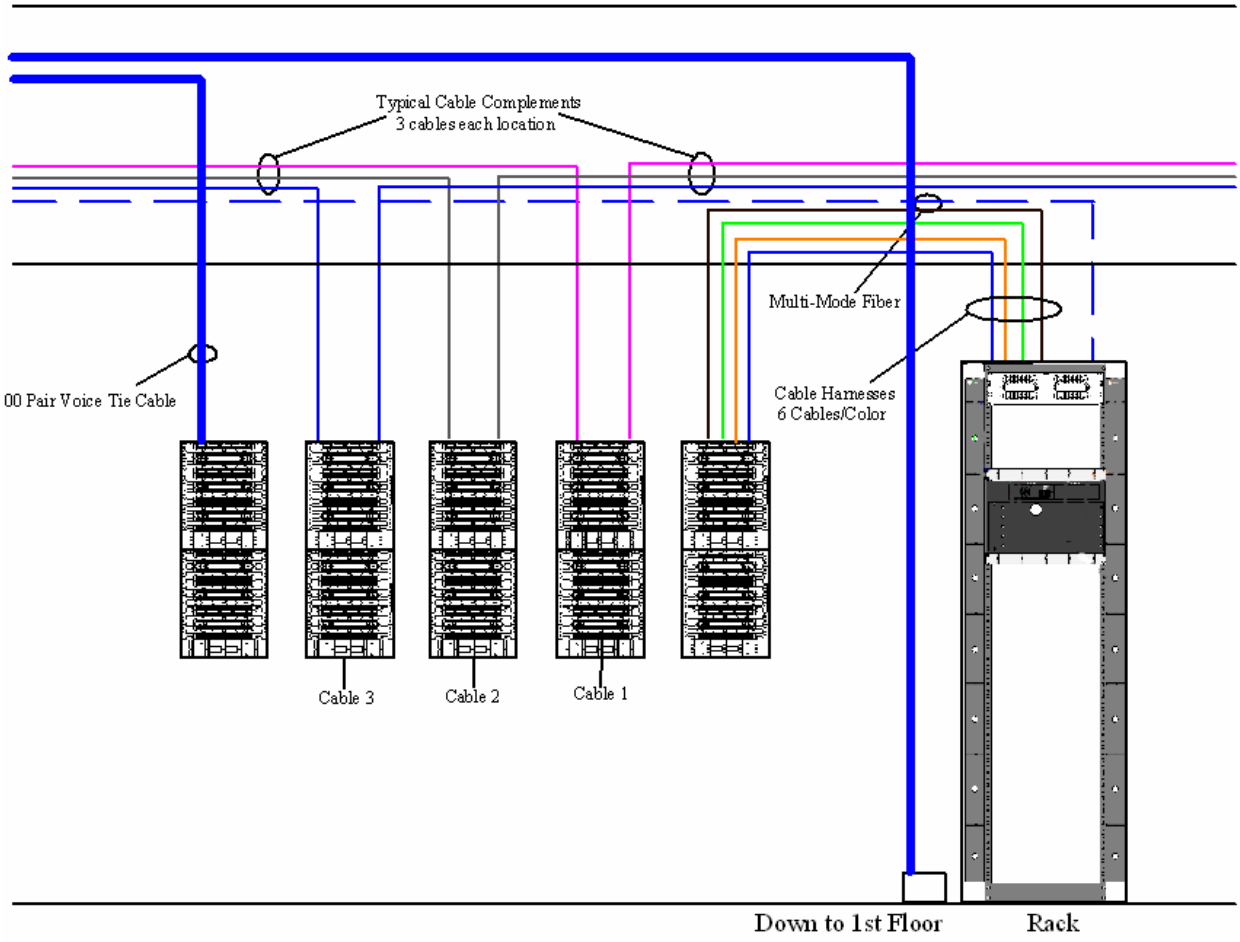
Telecommunications Room Elevation – First Floor



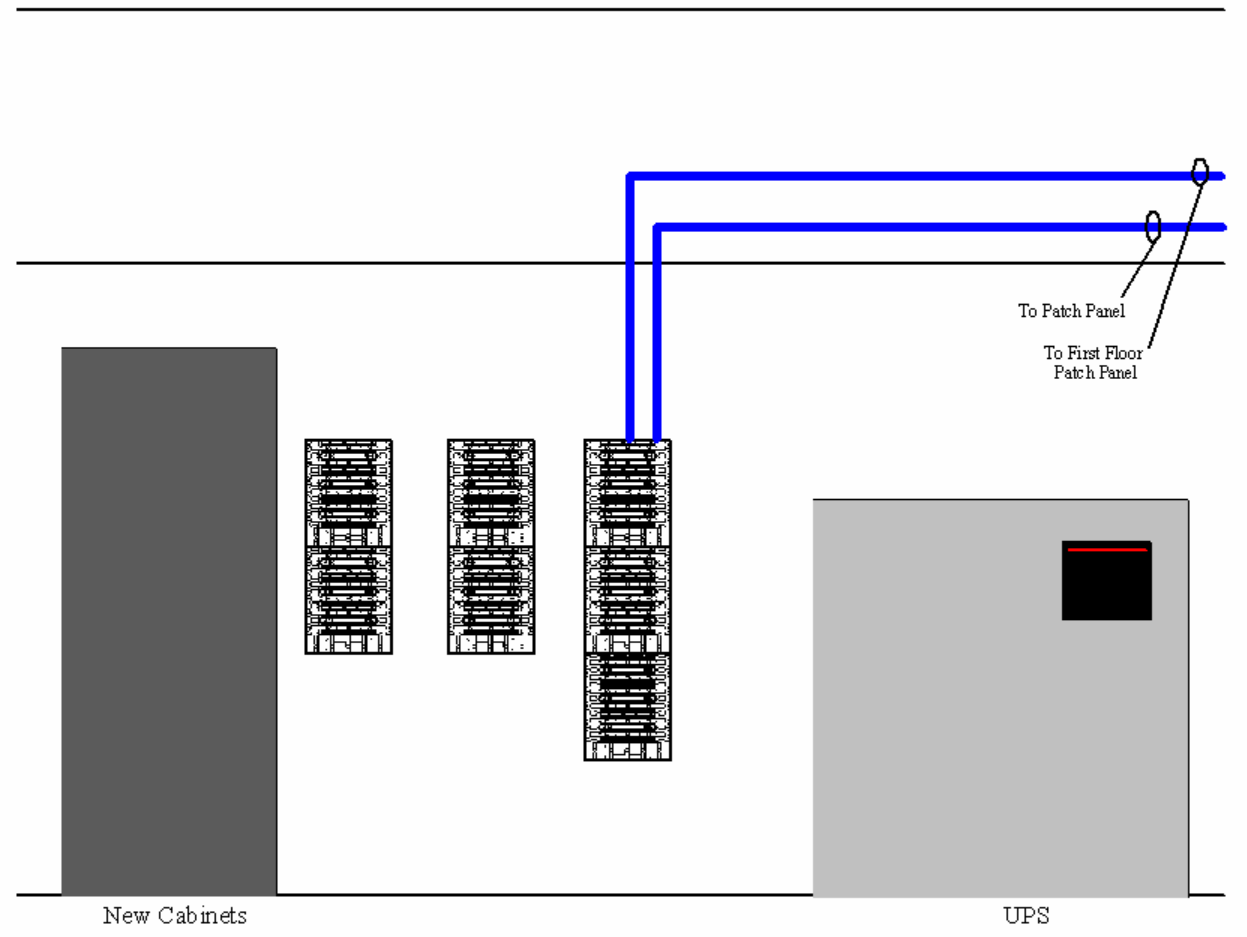
Telecommunications Room Plan – Second Floor



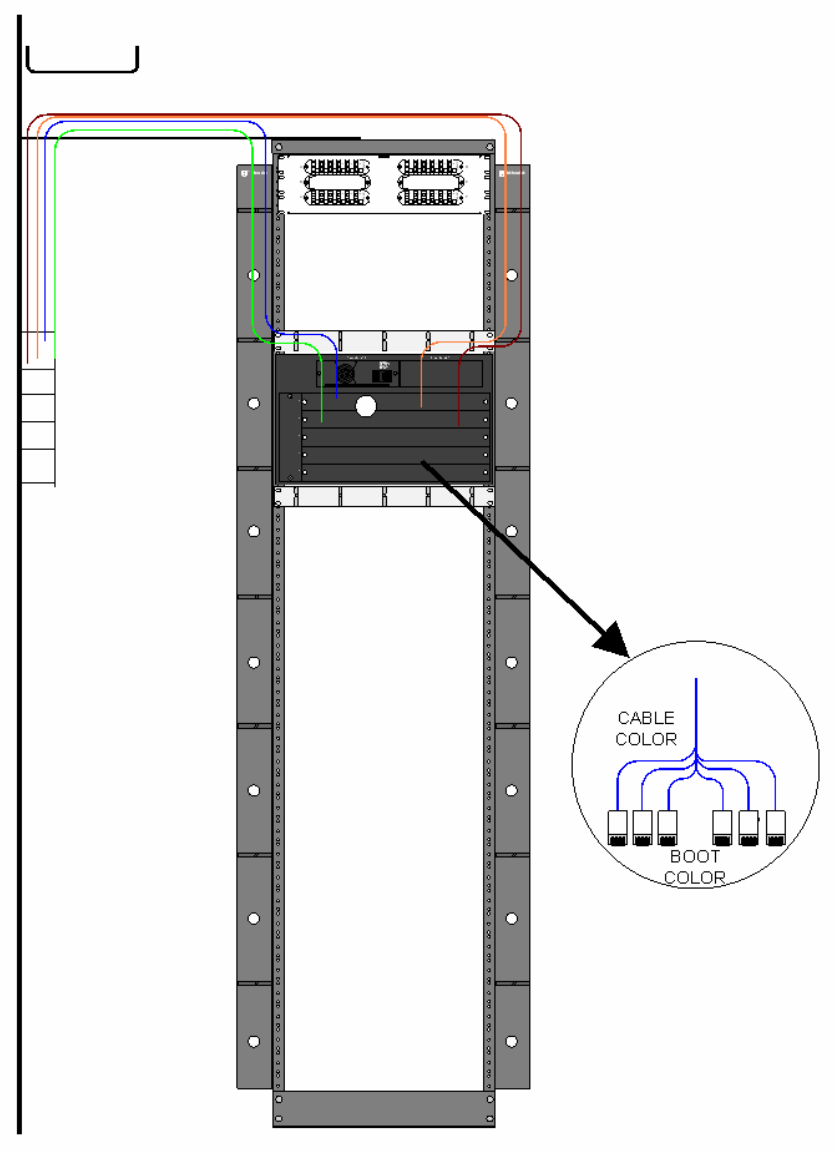
Telecommunications Room Elevation – Second Floor – West Wall



Telecommunications Room Elevation – Second Floor – East Wall



Telecommunications Room – Typical Rack Detail



Cable harnesses are to be installed from the ports of the switch to the wall field and terminated on the blocks for cross connection to the Data workarea cable.

Each harness shall consist of six (6) category 5 cable, each cable numbered 1 thru 6, with appropriate colored boot covering the 8 position modular jack.

Each cable color shall be used with each boot color in order. That is, harness 1 will consist of six blue cables with white boots; harness 2 will consist of six orange cables with white boots; harness 3 will consist of six green cables with white boots; harness 4 will consist of six brown (or alternately grey) cables with white boots; harness 5 will consist of six blue cables with red boots, etc.

A minimum of ninety six cables shall be installed from the switch ports to the wall field.

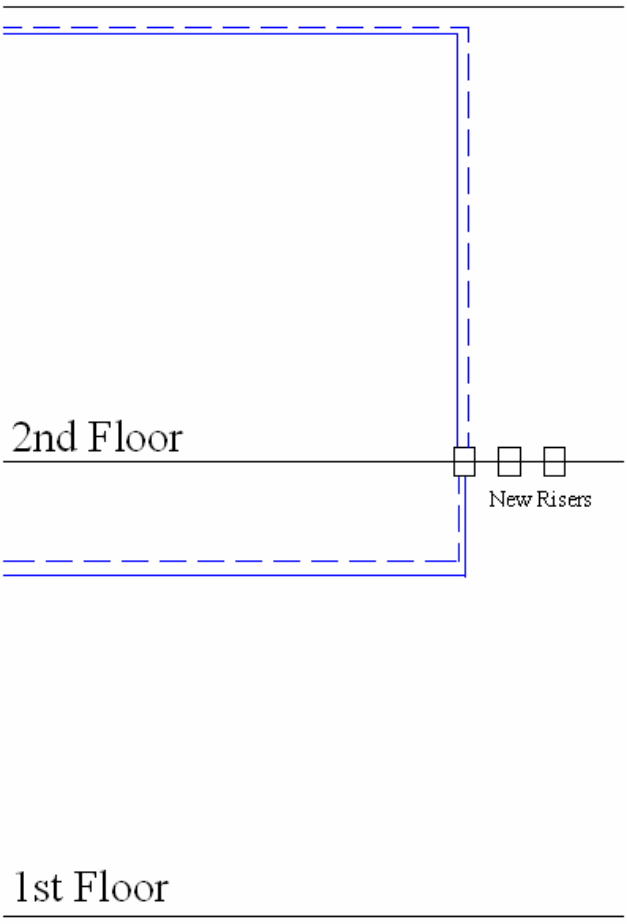
All harnesses shall be separately bundled, neatly routed, and able to be plugged into the switch equipment furnished and installed by others.

Each harness shall be terminated in order on a single row of the 110 blocks on the wall field.

Specific orientation and position of harnesses to be dependant on electronics to be installed

Cable Colors	Boot Colors
Blue	White
Orange	Red
Green	Black
Brown (Grey)	Yellow

Telecommunications Riser Diagram



10. LEED Building Analysis

LEED Building Analysis

The concept of Green Building design is the future of design and construction. LEED, or Leadership in Energy and Environmental Design, has composed a checklist of guidelines and restrictions that are applied to new buildings in order receive the honor of being a Green Building.

The pre-certification estimates range from Certified, which is 26 – 32 points; Silver, which is 33 – 38 points; Gold, which is 39 – 51 points; and Platinum, which is 52 – 69 points.

By using the U.S. Green Building Council, Leadership in Energy and Environmental Design Green Building Rating System for New Construction and Major Renovations, (LEED-NC) Version 2.1, November 2002, an analysis of the AstroPower Headquarters was completed. This report will show the outcome of this analysis, what sections AstroPower received points for, what sections they did not receive points for, and different ways to improve their current rating.

LEED Version 2.1 Registered Project Checklist

AstroPower Headquarters
Newark, Delaware

Yes	?	No			
10		**4**	**Sustainable Sites**		**14** Points
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
1			Credit 1	**Site Selection**	1
1			Credit 2	**Urban Redevelopment**	1
		1	Credit 3	**Brownfield Redevelopment**	1
1			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
1			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
		1	Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
1			Credit 4.4	**Alternative Transportation**, Parking Capacity and Carpooling	1
1			Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1			Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
1			Credit 6.1	**Stormwater Management**, Rate and Quantity	1
		1	Credit 6.2	**Stormwater Management**, Treatment	1
1			Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1
		1	Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
1			Credit 8	**Light Pollution Reduction**	1

Yes	?	No			
2		**3**	**Water Efficiency**		**5** Points
		1	Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
		1	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
1			Credit 3.1	**Water Use Reduction**, 20% Reduction	1
1			Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Yes	?	No			
10			**Energy & Atmosphere**		**17** Points
Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
3			Credit 1	**Optimize Energy Performance**	1 to 10
1			Credit 2.1	**Renewable Energy**, 5%	1
1			Credit 2.2	**Renewable Energy**, 10%	1
1			Credit 2.3	**Renewable Energy**, 20%	1
1			Credit 3	**Additional Commissioning**	1
1			Credit 4	**Ozone Depletion**	1
1			Credit 5	**Measurement & Verification**	1
1			Credit 6	**Green Power**	1

Yes	?	No			
5		**8**	**Materials & Resources**		**13** Points
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
1			Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
		1	Credit 1.2	**Building Reuse**, Maintain 100% of Shell	1
		1	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
		1	Credit 2.1	**Construction Waste Management**, Divert 50%	1
		1	Credit 2.2	**Construction Waste Management**, Divert 75%	1
1			Credit 3.1	**Resource Reuse**, Specify 5%	1
1			Credit 3.2	**Resource Reuse**, Specify 10%	1
		1	Credit 4.1	**Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)	1
		1	Credit 4.2	**Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)	1
1			Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
1			Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
		1	Credit 6	**Rapidly Renewable Materials**	1
		1	Credit 7	**Certified Wood**	1

Yes	?	No			
11		**4**	**Indoor Environmental Quality**		**15** Points
Y			Prereq 1	**Minimum IAQ Performance**	Required
Y			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
1			Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1
1			Credit 2	**Ventilation Effectiveness**	1
		1	Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
1			Credit 4.2	**Low-Emitting Materials**, Paints	1
1			Credit 4.3	**Low-Emitting Materials**, Carpet	1
1			Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber	1
		1	Credit 5	**Indoor Chemical & Pollutant Source Control**	1
1			Credit 6.1	**Controllability of Systems**, Perimeter	1
1			Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
		1	Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
		1	Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
1			Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
1			Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

Yes	?	No			
1		**4**	**Innovation & Design Process**		**5** Points
		1	Credit 1.1	**Innovation in Design**: Provide Specific Title	1
		1	Credit 1.2	**Innovation in Design**: Provide Specific Title	1
		1	Credit 1.3	**Innovation in Design**: Provide Specific Title	1
		1	Credit 1.4	**Innovation in Design**: Provide Specific Title	1
1			Credit 2	**LEED™ Accredited Professional**	1

Yes	?	No		
39		**23**	**Project Totals** (pre-certification estimates)	**69** Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

Point Accumulation

The following is where the AstroPower Headquarters gained points in the pre-certification estimate:

Sustainable Sites

PreReq1 – Erosion & Sedimentation Control

Intent

Control erosion to reduce negative impacts on water and air quality.

Requirements

Design a sediment and erosion control plan, specific to the site, that conforms to United States Environmental Protection Agency (EPA) Document No. EPA 832/R-92-005 (September 1992), Storm Water Management for Construction Activities, Chapter 3, OR local erosion and sedimentation control standards and codes, whichever is more stringent. The plan shall meet the following objectives:

- Prevent loss of soil during construction by stormwater runoff and/orwind erosion, including protecting topsoil by stockpiling for reuse.
- Prevent sedimentation of storm sewer or receiving streams.
- Prevent polluting the air with dust and particulate matter.

Credit 1 – Site Selection

Intent

Avoid development of inappropriate sites and reduce the environmental impact from the location of a building on a site.

Requirements

Do not develop buildings, roads or parking areas on portions of sites that meet any one of the following criteria:

- Prime farmland as defined by the United States Department of Agriculture in the United States Code of Federal Regulations, Title 7, Volume 6, Parts 400 to 699, Section 657.5 (citation 7CFR657.5).
- Land whose elevation is lower than 5 feet above the elevation of the 100-year flood as defined by the Federal Emergency Management Agency (FEMA).
- Land which is specifically identified as habitat for any species on Federal or State threatened or endangered lists.
- Within 100 feet of any water including wetlands as defined by United States Code of Federal Regulations 40 CFR, Parts 230-233 and Part 22, and isolated wetlands or areas of special concern identified by state or local rule, OR greater than distances given in state or local regulations as defined by local or state rule or law, whichever is more stringent.
- Land which prior to acquisition for the project was public parkland, unless land of equal or greater value as parkland is accepted in trade by the public landowner (Park Authority projects are exempt).

Credit 2 – Development Density

Intent

Channel development to urban areas with existing infrastructure, protect greenfields and preserve habitat and natural resources.

Requirements

Increase localized density to conform to existing or desired density goals by utilizing sites that are located within an existing minimum development density of 60,000 square feet per acre (two story downtown development).

Credit 4.1 – Alternative Transportation: Public Transportation Access

Intent

Reduce pollution and land development impacts from automobile use.

Requirements

Locate project within 1/2 mile of a commuter rail, light rail or subway station or 1/4 mile of two or more public or campus bus lines usable by building occupants.

Credit 4.2 – Alternative Transportation

Bicycle Storage & Changing Rooms

Intent

Reduce pollution and land development impacts from automobile use.

Requirements

For commercial or institutional buildings, provide secure bicycle storage with convenient changing/shower facilities (within 200 yards of the building) for 5% or more of regular building occupants. For residential buildings, provide covered storage facilities for securing bicycles for 15% or more of building occupants in lieu of changing/shower facilities.

Credit 4.4 – Alternative Transportation: Parking Capacity
Intent
Reduce pollution and land development impacts from single occupancy vehicle use.
Requirements
Size parking capacity to meet, but not exceed, minimum local zoning requirements AND provide preferred parking for carpools or vanpools capable of serving 5% of the building occupants; OR add no new parking for rehabilitation projects AND provide preferred parking for carpools or vanpools capable of serving 5% of the building occupants.

Credit 5.1 – Reduced Site Disturbance: Protect or Restore Open Space
Intent
Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.
Requirements
On greenfield sites, limit site disturbance including earthwork and clearing of vegetation to 40 feet beyond the building perimeter, 5 feet beyond primary roadway curbs, walkways and main utility branch trenches, and 25 feet beyond constructed areas with permeable surfaces (such as pervious paving areas, stormwater detention facilities and playing fields) that require additional staging areas in order to limit compaction in the constructed area;
OR, on previously developed sites, restore a minimum of 50% of the site area (excluding the building footprint) by replacing impervious surfaces with native or adapted vegetation.

Credit 5.2 – Reduced Site Disturbance: Development Footprint
Intent
Conserve existing natural areas and restore damaged areas to provide habitat and promote biodiversity.
Requirements
Reduce the development footprint (defined as entire building footprint, access roads and parking) to exceed the local zoning's open space requirement for the site by 25%. For areas with no local zoning requirements (e.g., some university campuses and military bases), designate open space area adjacent to the building that is equal to the development footprint.

Credit 6.1 – Stormwater Management: Rate and Quantity
Intent
Limit disruption and pollution of natural water flows by managing stormwater runoff.
Requirements
If existing imperviousness is less than or equal to 50%, implement a stormwater management plan that prevents the post-development 1.5 year, 24 hour peak discharge rate from exceeding the pre-development 1.5 year, 24 hour peak discharge rate.
OR, If existing imperviousness is greater than 50%, implement a stormwater management plan that results in a 25% decrease in the rate and quantity of stormwater runoff.

Credit 7.1 – Heat Island Effect: Non-Roof
Intent
Reduce heat islands (thermal gradient differences between developed and undeveloped areas) to minimize impact on microclimate and human and wildlife habitat.
Requirements
Provide shade (within 5 years) and/or use light-colored/high-albedo materials (reflectance of at least 0.3) and/or open grid pavement for at least 30% of the site's non-roof impervious surfaces, including parking lots, walkways, plazas, etc.;
OR place a minimum of 50% of parking spaces underground or covered by structured parking; OR use an open-grid pavement system (less than 50% impervious) for a minimum of 50% of the parking lot area.

Credit 8 – Light Pollution Reduction
Intent
Eliminate light trespass from the building and site, improve night sky access and reduce development impact on nocturnal environments.
Requirements
Meet or provide lower light levels and uniformity ratios than those recommended by the Illuminating Engineering Society of North America (IESNA) *Recommended Practice Manual: Lighting for Exterior Environments* (RP-33-99). Design exterior lighting such that all exterior luminaires with more than 1000 initial lamp lumens are shielded and all luminaires with more than 3500 initial lamp lumens meet the Full Cutoff IESNA Classification. The maximum candela value of all interior lighting shall fall within the building (not out through windows) and the maximum candela value of all exterior lighting shall fall within the property. Any luminaire within a distance of 2.5 times its mounting height from the property boundary shall have shielding such that no light from that luminaire crosses the property boundary.

Water Efficiency

Credit 3.1 – Water Use Reduction: 20% Reduction

Intent

Maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

Requirements

Employ strategies that in aggregate use 20% less water than the water use baseline calculated for the building (not including irrigation) after meeting the Energy Policy Act of 1992 fixture performance requirements.

Credit 3.2 – Water Use Reduction: 30% Reduction

Intent

Maximize water efficiency within buildings to reduce the burden on municipal water supply and wastewater systems.

Requirements

Employ strategies that in aggregate use 30% less water than the water use baseline calculated for the building (not including irrigation) after meeting the Energy Policy Act of 1992 fixture performance requirements.

Energy & Atmosphere

PreReq 1 – Fundamental Building Systems Commissioning

Intent

Verify and ensure that fundamental building elements and systems are designed, installed and calibrated to operate as intended.

Requirements

Implement or have a contract in place to implement the following fundamental best practice commissioning procedures.

- Engage a commissioning team that does not include individuals directly responsible for project design or construction management.
- Review the design intent and the basis of design documentation.
- Incorporate commissioning requirements into the construction documents.
- Develop and utilize a commissioning plan.
- Verify installation, functional performance, training and operation and maintenance documentation.
- Complete a commissioning report.

PreReq 2 – Minimum Energy Performance

Intent

Establish the minimum level of energy efficiency for the base building and systems.

Requirements

Design the building to comply with ASHRAE/IESNA Standard 90.1-1999 (without amendments) or the local energy code, whichever is more stringent.

PreReq 3 – CFC Reduction in HVAC&R Equipment

Intent

Reduce ozone depletion.

Requirements

Zero use of CFC-based refrigerants in new base building HVAC&R systems. When reusing existing base building HVAC equipment, complete a comprehensive CFC phase-out conversion.

Credit 1 – Optimize Energy Performance

Intent

Achieve increasing levels of energy performance above the prerequisite standard to reduce environmental impacts associated with excessive energy use.

Requirements

Reduce design energy cost compared to the energy cost budget for energy systems regulated by ASHRAE/IESNA Standard 90.1-1999 (without amendments), as demonstrated by a whole building simulation using the Energy Cost Budget Method described in Section 11 of the Standard.

New Bldgs.	Existing Bldgs.	Points
15%	5%	1
20%	10%	2
25%	15%	3
30%	20%	4
35%	25%	5
40%	30%	6
45%	35%	7
50%	40%	8
55%	45%	9
60%	50%	10

Regulated energy systems include HVAC (heating, cooling, fans and pumps), service hot water and interior lighting. Non-regulated systems include plug loads, exterior lighting, garage ventilation and elevators (vertical transportation). Two methods may be used to separate energy

consumption for regulated systems. The energy consumption for each fuel may be prorated according to the fraction of energy used by regulated and non-regulated energy. Alternatively, separate meters (accounting) may be created in the energy simulation program for regulated and non-regulated energy uses. If an analysis has been made comparing the proposed design to local energy standards and a defensible equivalency (at minimum) to ASHRAE/IESNA Standard 90.1-1999 has been established, then the comparison against the local code may be used in lieu of the ASHRAE Standard. Project teams are encouraged to apply for innovation credits if the energy consumption of non-regulated systems is also reduced.

Credit 2.1 – Renewable Energy: 5%

Intent

Encourage and recognize increasing levels of on-site renewable energy self supply in order to reduce environmental impacts associated with fossil fuel energy use.

Requirements

Supply at least 5% of the building's total energy use (as expressed as a fraction of annual energy cost) through the use of on-site renewable energy systems.

Credit 2.2 – Renewable Energy: 10%

Intent

Encourage and recognize increasing levels of self-supply through renewable technologies to reduce environmental impacts associated with fossil fuel energy use.

Requirements

Supply at least 10% of the building's total energy use (as expressed as a fraction of annual energy cost) through the use of on-site renewable energy systems.

Credit 2.3 – Renewable Energy: 20%

Intent

Encourage and recognize increasing levels of self-supply through renewable technologies to reduce environmental impacts associated with fossil fuel energy use.

Requirements

Supply at least 20% of the building's total energy use (as expressed as a fraction of annual energy cost) through the use of on-site renewable energy systems.

Credit 3 – Additional Commissioning

Intent

Verify and ensure that the entire building is designed, constructed and calibrated to operate as intended.

Requirements

In addition to the Fundamental Building Commissioning prerequisite, implement or have a contract in place to implement the following additional commissioning tasks:

1. A commissioning authority independent of the design team shall conduct a review of the design prior to the construction documents phase.
2. An independent commissioning authority shall conduct a review of the construction documents near completion of the construction document development and prior to issuing the contract documents for construction.
3. An independent commissioning authority shall review the contractor submittals relative to systems being commissioned.
4. Provide the owner with a single manual that contains the information required for re-commissioning building systems.
5. Have a contract in place to review building operation with O&M staff, including a plan for resolution of outstanding commissioning-related issues within one year after construction completion date.

Credit 4 – Ozone Protection

Intent

Reduce ozone depletion and support early compliance with the Montreal Protocol.

Requirements

Install base building level HVAC and refrigeration equipment and fire suppression systems that do not contain HCFCs or Halons.

Credit 5 – Measurement and Verification

Intent

Provide for the ongoing accountability and optimization of building energy and water consumption performance over time.

Requirements

Install continuous metering equipment for the following end-uses:

- Lighting systems and controls
- Constant and variable motor loads
- Variable frequency drive (VFD) operation
- Chiller efficiency at variable loads (kW/ton)
- Cooling load
- Air and water economizer and heat recovery cycles
- Air distribution static pressures and ventilation air volumes

- Boiler efficiencies
- Building-related process energy systems and equipment
- Indoor water risers and outdoor irrigation systems

Develop a Measurement and Verification plan that incorporates the monitoring information from the above end-uses and is consistent with Option B, C or D of the 2001 *International Performance Measurement & Verification Protocol (IPMVP) Volume I: Concepts and Options for Determining Energy and Water Savings.*

Credit 6 – Green Power

Intent

Encourage the development and use of grid-source, renewable energy technologies on a net zero pollution basis.

Requirements

Provide at least 50% of the building's electricity from renewable sources by engaging in at least a two-year renewable energy contract. Renewable sources are as defined by the Center for Resource Solutions (CRS) Green-e products certification requirements.

Materials & Resources

PreReq 1 – Storage & Collection of Recyclables

Intent

Facilitate the reduction of waste generated by building occupants that is hauled to and disposed of in landfills.

Requirements

Provide an easily accessible area that serves the entire building and is dedicated to the separation, collection and storage of materials for recycling including (at a minimum) paper, corrugated cardboard, glass, plastics and metals.

Credit 1.1 – Building Reuse: Maintain 75% of Existing Walls, Floors and Roof

Intent

Extend the life cycle of existing building stock, conserve resources, retain cultural resources, reduce waste and reduce environmental impacts of new buildings as they relate to materials manufacturing and transport.

Requirements

Maintain at least 75% of existing building structure and shell (exterior skin and framing, excluding window assemblies and non-structural roofing material).

Credit 3.1 – Resource Reuse: 5%

Intent

Reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources.

Requirements

Use salvaged, refurbished or reused materials, products and furnishings for at least 5% of building materials.

Credit 3.2 – Resource Reuse: 10%

Intent

Reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources.

Requirements

Use salvaged, refurbished or reused materials, products and furnishings for at least 10% of building materials.

Credit 5.1 – Regional Materials: 20% manufactured regionally

Intent

Increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the regional economy and reducing the environmental impacts resulting from transportation.

Requirements

Use a minimum of 20% of building materials and products that are manufactured* regionally within a radius of 500 miles.

*Manufacturing refers to the final assembly of components into the building product that is furnished and installed by the tradesmen. For example, if the hardware comes from Dallas, Texas, the lumber from Vancouver, British Columbia, and the joist is assembled in Kent, Washington; then the location of the final assembly is Kent, Washington.

Credit 5.2 – Regional Materials: 50% extracted regionally

Intent

Increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the regional economy and reducing the environmental impacts resulting from transportation.

Requirements

Of the regionally manufactured materials documented for MR Credit 5.1, use a minimum of 50% of building materials and products that are extracted, harvested or recovered (as well as manufactured) within 500 miles of the project site.

Indoor Environmental Quality

PreReq 1 – Minimum IAQ Performance

Intent

Establish minimum indoor air quality (IAQ) performance to prevent the development of indoor air quality problems in buildings, thus contributing to the comfort and well-being of the occupants.

Requirements

Meet the minimum requirements of voluntary consensus standard ASHRAE 62-1999, Ventilation for Acceptable Indoor Air Quality, and approved Addenda (see ASHRAE 62-2001, Appendix H, for a complete compilation of Addenda) using the Ventilation Rate Procedure.

PreReq 2 – Environmental Tobacco Smoke (ETS) Control

Intent

Prevent exposure of building occupants and systems to Environmental Tobacco Smoke (ETS).

Requirements

Zero exposure of non-smokers to ETS by EITHER:

- prohibiting smoking in the building and locating any exterior designated smoking areas away from entries and operable windows;

  OR

- providing a designated smoking room designed to effectively contain, capture and remove ETS from the building. At a minimum, the smoking room must be directly exhausted to the outdoors with no recirculation of ETS-containing air to the non-smoking area of the building, enclosed with impermeable deck-to-deck partitions and operated at a negative pressure compared with the surrounding spaces of at least 7 PA (0.03 inches of water gauge).
- Performance of the smoking rooms shall be verified by using tracer gas testing methods as described in the ASHRAE Standard 129-1997. Acceptable exposure in non-smoking areas is defined as less than 1% of the tracer gas concentration in the smoking room detectable in the adjoining non-smoking areas. Smoking room testing as described in ASHRAE Standard 129-1997 is required in the contract documents and critical smoking facility systems testing results must be included in the building commissioning plan and report or as a separate document.

Credit 1 – Carbon Dioxide (CO2) Monitoring

Intent

Provide capacity for indoor air quality (IAQ) monitoring to help sustain long-term occupant comfort and well-being.

Requirements

Install a permanent carbon dioxide (CO2) monitoring system that provides feedback on space ventilation performance in a form that affords operational adjustments. Refer to the CO2 differential for all types of occupancy in accordance with ASHRAE 62-2001, Appendix D.

Credit 2 – Ventilation Effectiveness

Intent

Provide for the effective delivery and mixing of fresh air to support the safety, comfort and well-being of building occupants.

Requirements

For mechanically ventilated buildings, design ventilation systems that result in an air change effectiveness (Eac) greater than or equal to 0.9 as determined by ASHRAE 129-1997. For naturally ventilated spaces demonstrate a distribution and laminar flow pattern that involves not less than 90% of the room or zone area in the direction of air flow for at least 95% of hours of occupancy.

Credit 3.2 – Construction IAQ Management Plan: Before Occupancy

Intent

Prevent indoor air quality problems resulting from the construction/renovation process in order to help sustain the comfort and well-being of construction workers and building occupants.

Requirements

Develop and implement an Indoor Air Quality (IAQ) Management Plan for the pre-occupancy phase as follows:

- After construction ends and prior to occupancy conduct a minimum two-week building flush-out with new Minimum Efficiency Reporting Value (MERV) 13 filtration media at 100% outside air. After the flushout, replace the filtration media with new MERV 13 filtration media, except the filters solely processing outside air.

  OR

- Conduct a baseline indoor air quality testing procedure consistent with the United States Environmental Protection Agency's current *Protocol for Environmental Requirements, Baseline IAQ and Materials, for the Research Triangle Park Campus, Section 01445.*

Credit 4.1 – Low-Emitting Materials: Adhesives & Sealants

Intent

Reduce the quantity of indoor air contaminants that are odorous, potentially irritating and/or harmful to the comfort and well-being of installers and occupants.

Requirements

The VOC content of adhesives and sealants used must be less than the current VOC content limits of South Coast Air Quality Management District (SCAQMD) Rule #1168, AND all sealants used as fillers must meet or exceed the requirements of the Bay Area Air Quality Management District Regulation 8, Rule 51.

Credit 4.2 – Low-Emitting Materials: Paints and Coatings
Intent
Reduce the quantity of indoor air contaminants that are odorous, potentially irritating and/or harmful to the comfort and well-being of installers and occupants.
Requirements
VOC emissions from paints and coatings must not exceed the VOC and chemical component limits of Green Seal's Standard GS-11 requirements.

Credit 4.3 – Low-Emitting Materials: Carpet
Intent
Reduce the quantity of indoor air contaminants that are odorous, potentially irritating and/or harmful to the comfort and well-being of installers and occupants.
Requirements
Carpet systems must meet or exceed the requirements of the Carpet and Rug Institute's Green Label Indoor Air Quality Test Program.

Credit 4.4 – Low-Emitting Materials: Composite Wood
Intent
Reduce the quantity of indoor air contaminants that are odorous, potentially irritating and/or harmful to the comfort and well-being of installers and occupants.
Requirements
Composite wood and agrifiber products must contain no added urea-formaldehyde resins.

Credit 6.1 – Controllability of Systems: Perimeter Spaces
Intent
Provide a high level of thermal, ventilation and lighting system control by individual occupants or specific groups in multi-occupant spaces (i.e. classrooms or conference areas) to promote the productivity, comfort and wellbeing of building occupants.
Requirements
Provide at least an average of one operable window and one lighting control zone per 200 square feet for all regularly occupied areas within 15 feet of the perimeter wall.

Credit 6.2 – Controllability of Systems: Non-Perimeter Spaces
Intent
Provide a high level of thermal, ventilation and lighting system control by individual occupants or specific groups in multi-occupant spaces (i.e. classrooms or conference areas) to promote the productivity, comfort and wellbeing of building occupants.
Requirements
Provide controls for each individual for airflow, temperature and lighting for at least 50% of the occupants in non-perimeter, regularly occupied areas.

Credit 8.1 – Daylight and Views: Daylight 75% of Spaces
Intent
Provide for the building occupants a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.
Requirements
Achieve a minimum Daylight Factor of 2% (excluding all direct sunlight penetration) in 75% of all space occupied for critical visual tasks. Spaces excluded from this requirement include copy rooms, storage areas, mechanical plant rooms, laundry and other low occupancy support areas. Other exceptions for spaces where tasks would be hindered by the use of daylight will be considered on their merits.

Credit 8.2 – Daylight and Views: Views for 90% of Spaces
Intent
Provide for the building occupants a connection between indoor spaces and the outdoors through the introduction of daylight and views into the regularly occupied areas of the building.
Requirements
Achieve direct line of sight to vision glazing for building occupants in 90% of all regularly occupied spaces. Examples of exceptions include copy rooms, storage areas, mechanical, laundry and other low occupancy support areas. Other exceptions will be considered on their merits.

Innovation & Design Process

Credit 2 – LEED Accredited Professional
Intent
To support and encourage the design integration required by a LEED Green Building project and to streamline the application and certification process.
Requirement
At least one principal participant of the project team that has successfully completed the LEED Accredited Professional exam

Summary

After the completion of the Pre-Certification Estimates Checklist, it has been determined that the AstroPower Headquarters should receive a rating of Gold. This is a huge accomplishment for the design professionals involved in the project.

Several other points can be achieved by offering Alternative Fuel Vehicles for some of their employees. In addition to that several other points can be added by improving their Water Efficiency. By the addition of purifiers and other water efficient devices, their impressive point total can rise even more.

In the end, the AstroPower Headquarters would be an excellent example for what a design developer should strive for in an energy efficient building.

11. Conclusions

Conclusions

Lighting

The overall lighting redesign has accomplished all of the goals set out in the beginning of the project. The new fixtures are clean and simple, and very energy efficient due to the fact they use fluorescent and L.E.D. bulbs. The color concept of using blue to mimic the sky and outdoors ties in to all spaces. The idea of relating solar cells to the space to act as a theme works with the placement of solar panels on the interior walls to diffuse the light, creating art in the spaces as well. The relationship between building functionality and appearance is now noticeable and striking to all that enter.

Electrical

The overview of the Electrical system at the AstroPower Headquarters was extremely beneficial in seeing how different systems come together. To see how the solar panels contribute to the building's system was also a beneficial learning experience. It was important to see how technology is affecting designs that we are used to seeing.

Telecommunications

The telecommunications infrastructure of the AstroPower Headquarters is now available to help the company move forward through the twenty-first century. By using the combination of copper and fiber, and the installation of new telecommunications rooms and risers, a well organized, easily updateable system is now in place. Every work area outlet is now customizable to those who sit around it, making the system both convenient and effective.

LEED Analysis

With the completion of the LEED Building Criteria Checklist, is was found that the AstroPower Headquarters would receive a rating of Gold, the second highest honor bestowed upon a Building from the U.S. Green Building Council. This building can now be viewed as an example in how the design and development of the future should be based.

Summary

In the end, I believe that the final thesis presentation that has just been viewed far surpassed any expectations I could have ever hoped for. Not only did I have the opportunity to explore in depth the current systems of the building, but actually was able to contribute my own thoughts and ideas to an already existing structure. This senior thesis has been a valuable experience unlike any other, and will take it with me as I go out into the world as a Penn State Architectural Engineering graduate.

12. References

References

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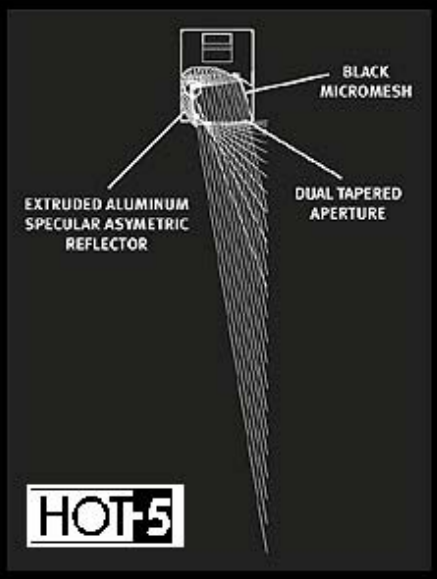
●The Telecommunications Industry Association, 2002. www.tiaonline.com

13. Appendix

Fixture A



Lightline™ Recessed Wall Wash

Want to light merchandise, or artwork, or are you simply looking to add some volumetric brightness to a room? Lightline Wall Wash from Peerless brings HOT-5® technology to a recessed environment. Built with a precise specular, asymmetric, extruded aluminum reflector, Lightline Wall Wash tames the powerful T5HO lamp and the result is a wall bathed with soft, comfortable light.

Room occupants are unaware of the source because of its narrow 2" line-like aperture and tuned brightness balanced with the luminance of the ceiling.

Lightline Wall Wash is part of the Lightline family of products. Designed around ultra-slim T5HO lamps, Lightline luminaires bring a discrete narrow aesthetic to a variety of architecture.

Fixture A Lamp

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  - MasterColor®
  - DuraMax®
  - Halogená®
  - Marathon™
  - Tanning

Contact Philips Lighting
1.800.555.0050

SILHOUETTE™ Programmed Start

Feature: T5 Miniature Bipin Fluorescent Lamps
Watts: 28
Bulb: T5
Base: Min. Bipin
Product Number: 046677-23086-2
Ordering Code: F28T5/841
Package Quantity: 40
Description: TL 841, 4100K
CRI: 85
Rated Avg. Life (Hrs.): 20,000
Design Lumens: 2750
Nominal Length: 46
Approximate Initial Lumens: 2900
View Compatible Ballasts
This Bulb Meets US Federal Minimum Efficiency Standard

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Compatible Ballasts

Energy Saving Product

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Literature
MSDS S06-99001
Product Brochure
Product Bulletin

Fixture A Ballast

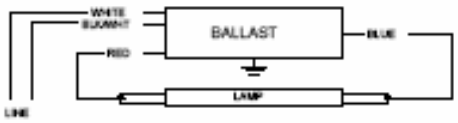
ADVANCE™

VCN-132-MC	
Brand Name	CENTIUM
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Series
Input Voltage	277
Input Frequency	60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
F21T5	1	21	50/10	0.10	27	1.10	10	0.98	1.7	4.07
F25T8	1	25	0/-18	0.09	25	0.98	10	0.98	1.7	3.92
* F28T5	1	28	50/10	0.11	30	0.98	10	0.99	1.7	3.27
F32T8	1	32	0/-18	0.11	30	0.98	10	0.98	1.7	3.27
F32T8/ES (30W)	1	30	60/16	0.10	28	0.98	10	0.98	1.7	3.50

Wiring Diagram



Diag. 63

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	Yellow/Blue		0
White	25L	63.5	Blue/White		0
Blue	31R	78.7	Brown		0
Red	37L	94	Orange		0
Yellow		0	Orange/Black		0
Gray		0	Black/White	25L	63.5
Violet		0	Red/White		0

Enclosure

Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
9.50 "	1.08 "	1.05 "	8.91 "
9 1/2	1 2/25	1 1/20	8 91/100
24.1 cm	2.7 cm	2.7 cm	22.6 cm

Revised 08/28/2002

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

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Fixture A Ballast (Cont.)

VCN-132-MC	
Brand Name	CENTIUM
Ballast Type	Electronic
Starting Method	Instant Start
Lamp Connection	Series
Input Voltage	277
Input Frequency	60 HZ
Status	Active

Electrical Specifications

Notes:

1 Physical Requirements

1.1 Ballast must be physically interchangeable with a magnetic core & coil ballast.
1.2 Ballast must have permanently connected leads integral to the ballast or poke-in connectors, color coded to ANSI C82.11 (latest version).
1.3 Ballast must be formed from recyclable steel painted in accordance with UL 935 standards. Plastic products with gaseous discharges are not allowed.

2 Lighting Performance Requirements

2.1 Ballast must have a ballast factor of:
- 2.1.1 .75-.78 for a low wattage design (LW).
- 2.1.2 .85-.92 for a normal light output design.

2.2 Ballast must have a maximum input wattage (ANSI) as indicated on the data sheet.
2.3 Ballast must have a Ballast Efficacy Factor greater than or equal to as indicated on the data sheet.
2.4 Ballast must be able to start and operate the specified lamps at a minimum temperature of (-20,0,32,50,60) degrees Fahrenheit as indicated on the data sheet and shall be in accordance with lamp manufacturer recommendations.
2.5 Ballast must be sound rated A. (T12/HO and T12/Slimline rated B).
2.6 Ballast must be designed and UL listed to operate the number of lamps as indicated on the data sheet.

3 Electrical Performance Requirements

3.1 Ballast THD shall be less than 10% for the main lamp desing (as indicated on the data sheet).
3.2 Lamp Current Crest Factor shall not exceed 1.7 for the main lamp design.
3.3 Ballast Power Factor must be greater than 98% for the main lamp design.
3.4 Ballast output frequency shall be greater than 20kHz and less than 30kHz or greater than 42kHz. Ballast output shall not be between 30 and 42kHz for any lamp combination.
3.5 Ballast must operate between 108-132V(120V), 249-305V(277V), 312-382V(347V), or 432-528V (480V) 60 Hz.
3.6 Ballast must maintain light output at +/- 10% during a voltage fluctuation of +/- 10%.
3.7 Ballast shall be (Instant Start Parallel, Rapid Start Series, Programmed Rapid Start Series) as indicated on the data sheet.
3.8 All ballasts for Compact Fluorescent Lamps (CFL) and T5 diameter lamps must contain a lamp End-Of-Life (EOL) detection and shut down circuit in accordance with ANSI/IEC proposed standards and must be operated on a rapid start ballast. Compact Fluorescent lamps shall not be operated on an instant start circuit.

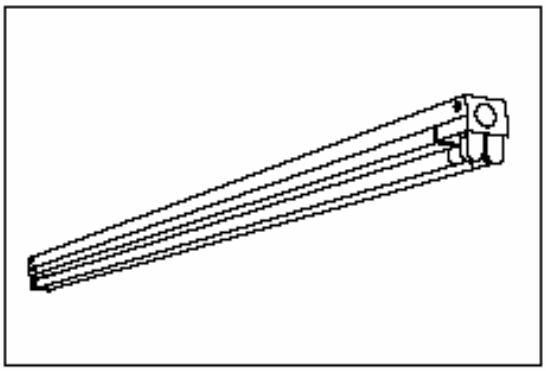
4 Regulatory Requirements

4.1 Ballast shall meet ANSI C82.11 limits for Total Harmonic Distortion (THD).
4.2 Ballast shall meet FCC Part 18 non-consumer standards for electrical equipment (Class A).
4.3 Ballast shall meet ANSI 62.41 Category A standards for Transient Voltage protection.
4.4 Ballast shall meet UL 935 standards and be UL listed and CSA approved.
4.5 Ballast shall be UL Class P and Type 1 Outdoor.
4.6 Ballast shall contain no Polychlorinated Biphenyl (PCBs) in accordance with US law.
4.7 Ballast shall meet all US state and federal efficacy laws and all Canadian provincial and federal efficacy laws.

5 Other

5.1 Ballast shall carry a 5 year warranty (from date of manufacture) with PLUS 90 system protection warranty (must register). Warranty shall be valid at case temperatures of 70C or less. For 90C rated ballasts, warranty shall be 3 years for ballast case temperatures between 70C and 90C.
5.2 Manufacturer must have a 15 year history of designing and manufacturing electronic ballasts for the North American market.
5.3 Ballast must be manufactured in a facility Certified to ISO 9002 Quality System Standards.
5.4 Ballast must be ordered and shipped from a distribution center Certified to ISO 9002 Quality System Standards.
5.5 Ballast must be Advance Transformer Co. _____brand, part # _____. All proposed substitutes must be submitted to the specifying authority two weeks prior to bid due date. Submittal does not guarantee acceptance.

Fixture B



CN2
CN3
CN4

ONE OR TWO LAMP T5 OR T5 HO NARROW STRIP

Type: _____

Job Description: _____

FEATURES:

- Available nominal 2', 3' or 4'.
- Heavy die formed steel channel.
- Rotary lock lampholders for positive lamp contact.
- Individual or row mounting. Surface or suspended.
- Specially designed for use with T5 or T5 HO lamps.
- Narrow 2" strip.
- KO's in end cap or back of housing for easier power hook up.

SPECIFICATIONS:

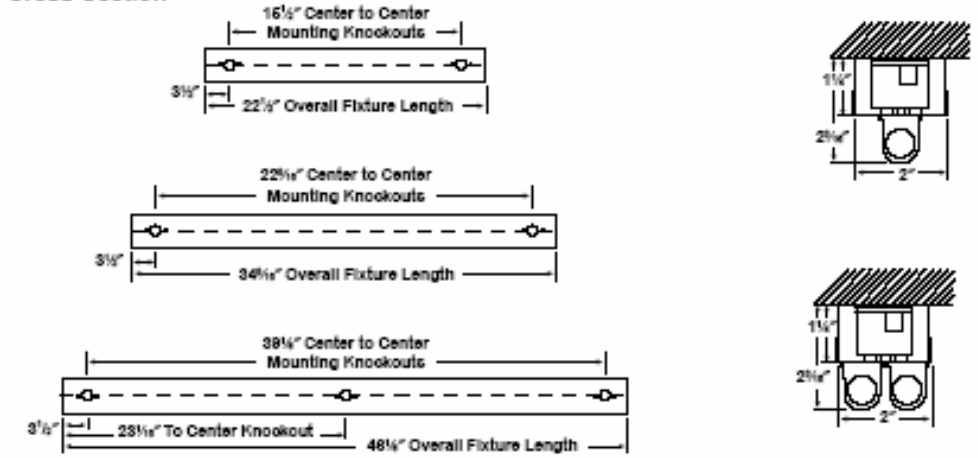
Ballasts
Programmed start, electronic, high power factor, low harmonic, sound rated A. All are UL listed.

Housing
Die formed steel suitable for surface or stem mounting.

Finish
All parts pre-painted with high gloss baked white enamel, minimum reflectance 86%, applied over iron phosphate pre-treatment for maximum adhesion and rust resistance. For post painted housng and reflector suffix catalog number with PAF.

Labels
All fixtures carry the UL label. (CSA approval available. Use Suffix "CSA").

Cross Section



A - ⅞" Diameter Knockout
Note: All dimensions are in inches; dimensions are subject to change without notice. Please consult factory or check sample for verification.

C41

CO 02/02

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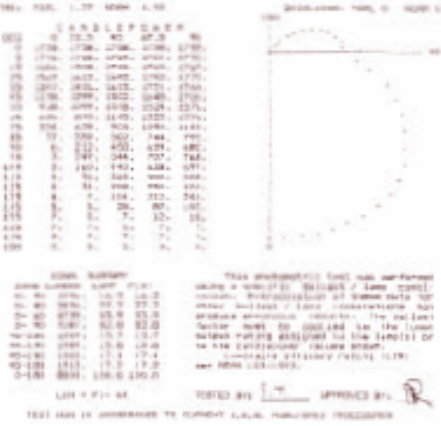
Columbia LIGHTING

Fixture B (Cont.)

Photometric Report No. 12789

Columbia LIGHTING

Environmental Laboratories



Coefficients of Utilization

Coefficients of Utilization

Zonal Cavity Method — Floor Reflectance - .20

RC	80				70				60			0
RW	70	50	30	10	70	50	30	10	50	30	10	0
1	103	97	92	88	98	93	89	85	86	82	79	66
2	92	83	76	69	88	80	73	67	73	68	63	52
3	84	72	64	57	80	70	62	55	64	57	52	43
4	76	64	54	47	73	61	53	46	56	49	44	36
5	69	56	46	39	66	54	45	38	49	42	36	30
6	63	49	40	33	60	48	39	33	44	36	31	25
7	58	44	35	29	55	43	34	28	39	32	27	22
8	54	40	31	25	51	38	30	24	35	28	23	18
9	49	35	27	21	47	34	26	20	32	25	19	15
10	45	32	24	18	44	31	23	18	29	22	17	13

Energy Data

LER: FI-68 — Energy Cost: $3.53*
Input Watts: 129 — BF: 1.00

The above energy calculations were conducted using a specific lamp/ballast combination. Actual results may vary depending upon the lamp and ballast used. Lamp and ballast specifications are subject to change without notice.

*Comparative annual lighting energy cost per 1000 lumens based on 3000 hours and $0.08 per KWH.

Ordering Information

Example: CN4-254-EB5120

CN - - - - - -

Series
CN

Size
2 - 2'
3 - 3'
4 - 4'

No. of Lamps In Cross Section
1 - One
2 - Two

Lamp Type
14 - T5 (2' Nominal)
24 - T5 HO (2' Nominal)
21 - T5 (3' Nominal)
39 - T5 HO (3' Nominal)
28 - T5 (4' Nominal)
54 - T5 HO (4' Nominal)

Ballast
EB6 - T5 or T5 HO Electronic Ballast (Ballast will be determined by lamp type.)
For a specific ballast vendor, show as option.

Voltage
120 - 120V
277 - 277V
347 - 347V

Channel Options
GLR - Fast Blow Fuse
GMF - Slow Blow Fuse
CSA - Approved, Canadian Standards Association
PAF - Paint After Fabrication
C&P - Cord and Plug

Channel Accessories
CNR - Symmetric Reflector for 2', 3', 4'
CNRA - Asymmetric Reflector for 2', 3', 4'
CNSAR - Specular Symmetric Reflector for 2', 3', 4'
CNSARA - Specular Asymmetric Reflector for 2', 3', 4'
For additional options and accessories contact factory.

C41

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Fixture B Lamp

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  - QL Induction
  - ALTO®
  - MasterColor®
  - DuraMax®
  - Halogená®
  - Marathon™
  - Tanning

SILHOUETTE™ High Output Programmed Start

Feature: T5 Miniature Bipin Fluorescent Lamps
Watts: 24
Bulb: T5
Base: Min. Bipin
Product Number: 046677-29021-3
Ordering Code: F24T5/841/HO
Package Quantity: 40
Description: TL 841, 4100K
CRI: 85
Rated Avg. Life (Hrs.): 20,000
Design Lumens: 1895
Nominal Length: 22
Approximate Initial Lumens: 2000
View Compatible Ballasts

Energy Saving Product

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Compatible Ballasts

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Fixture B Ballast

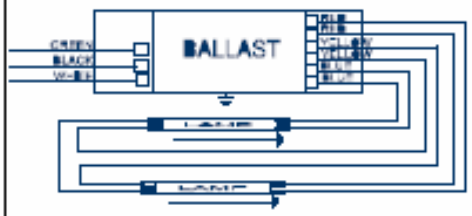
ADVANCE

ICN-2S24@277V	
Brand Name	CENTIUM
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
F24T5/HO	1	0	0/-18	0.10	27	1.02	10	0.98	1.7	3.78
* F24T5/HO	2	0	0/-18	0.19	52	1.00	10	0.98	1.7	1.92
F39T5/HO	1	39	0/-18	0.15	40	0.90	10	0.98	1.7	2.25
FC12T5	1	40	0/-18	0.15	40	0.84	10	0.98	1.7	2.10
FC9T5	1	22	0/-18	0.10	27	1.02	10	0.98	1.7	3.78
FC9T5	2	22	0/-18	0.19	52	1.00	10	0.98	1.7	1.92
FT24W/2G11	1	24	0/-18	0.10	27	1.02	10	0.98	1.7	3.78
FT24W/2G11	2	24	0/-18	0.19	52	1.00	10	0.98	1.7	1.92
FT35W/2G11	1	35	0/-18	0.13	34	0.90	10	0.98	1.7	2.65
FT40W/2G11	1	40	0/-18	0.17	47	1.00	10	0.98	1.7	2.13

Wiring Diagram

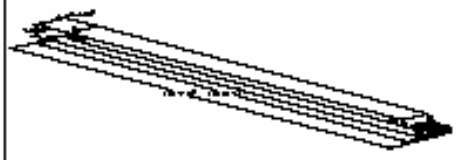


The wiring diagram that appears above is for the lamp type denoted by the asterisk (*)

Standard Lead Length (Inches)

	In.	cm.		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



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 01/25/2002

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

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Corporate Offices: Phone: 800-322-2086

Fixture B Ballast (Cont.)

ICN-2S24@277V	
Brand Name	CENTIUM
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Notes:

1 Physical Requirements

1.1 Ballast must be physically interchangeable with a magnetic core & coil ballast.
1.2 Ballast must have permanently connected leads integral to the ballast or poke-in connectors, color coded to ANSI C82.11 (latest version).
1.3 Ballast must be formed from recyclable steel painted in accordance with UL 935 standards. Plastic products with gaseous discharges are not allowed.

2 Lighting Performance Requirements

2.1 Ballast must have a ballast factor of:
- 2.1.1 .75-.78 for a low wattage design (LW).
- 2.1.2 .85-.92 for a normal light output design.

2.2 Ballast must have a maximum input wattage (ANSI) as indicated on the data sheet.
2.3 Ballast must have a Ballast Efficacy Factor greater than or equal to as indicated on the data sheet.
2.4 Ballast must be able to start and operate the specified lamps at a minimum temperature of (-20,0,32,50,60) degrees Fahrenheit as indicated on the data sheet and shall be in accordance with lamp manufacturer recommendations.
2.5 Ballast must be sound rated A. (T12/HO and T12/Slimline rated B).
2.6 Ballast must be designed and UL listed to operate the number of lamps as indicated on the data sheet.

3 Electrical Performance Requirements

3.1 Ballast THD shall be less than 10% for the main lamp desing (as indicated on the data sheet).
3.2 Lamp Current Crest Factor shall not exceed 1.7 for the main lamp design.
3.3 Ballast Power Factor must be greater than 98% for the main lamp design.
3.4 Ballast output frequency shall be greater than 20kHz and less than 30kHz or greater than 42kHz. Ballast output shall not be between 30 and 42kHz for any lamp combination.
3.5 Ballast must operate between 108-132V(120V), 249-305V(277V), 312-382V(347V), or 432-528V (480V) 60 Hz.
3.6 Ballast must maintain light output at +/- 10% during a voltage fluctuation of +/- 10%.
3.7 Ballast shall be (Instant Start Parallel, Rapid Start Series, Programmed Rapid Start Series) as indicated on the data sheet.
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4 Regulatory Requirements

4.1 Ballast shall meet ANSI C82.11 limits for Total Harmonic Distortion (THD).
4.2 Ballast shall meet FCC Part 18 non-consumer standards for electrical equipment (Class A).
4.3 Ballast shall meet ANSI 62.41 Category A standards for Transient Voltage protection.
4.4 Ballast shall meet UL 935 standards and be UL listed and CSA approved.
4.5 Ballast shall be UL Class P and Type 1 Outdoor.
4.6 Ballast shall contain no Polychlorinated Biphenyl (PCBs) in accordance with US law.
4.7 Ballast shall meet all US state and federal efficacy laws and all Canadian provincial and federal efficacy laws.

5 Other

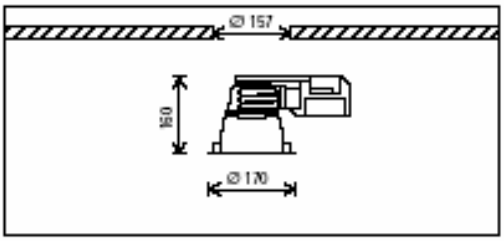
5.1 Ballast shall carry a 5 year warranty (from date of manufacture) with PLUS 90 system protection warranty (must register). Warranty shall be valid at case temperatures of 70C or less. For 90C rated ballasts, warranty shall be 3 years for ballast case temperatures between 70C and 90C.
5.2 Manufacturer must have a 15 year history of designing and manufacturing electronic ballasts for the North American market.
5.3 Ballast must be manufactured in a facility Certified to ISO 9002 Quality System Standards.
5.4 Ballast must be ordered and shipped from a distribution center Certified to ISO 9002 Quality System Standards.
5.5 Ballast must be Advance Transformer Co. _____brand, part # _____. All proposed substitutes must be submitted to the specifying authority two weeks prior to bid due date. Submittal does not guarantee acceptance.

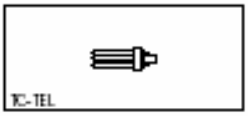
Fixture C

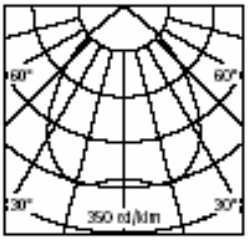
ERCO

Lightcast Downlight

for TC-T lamps







22271.000
Reflector colour Silver
TC-TEL 18W G24q-2 1150lm
ECG 1W-10W

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.
Darklight reflector: aluminium, bright anodised. Cut-off angle 40°.
Diffuser as lamp cover: plastic, translucent, can be removed for lamp replacement without tools.
Weight: 1,40kg

TC-TEL 18W G24q-2 1150lm

η:	0.46
DIN:	A60
UTE:	0.46 B
NBN:	BZ 1
CIBSE	
TM5:	BZ 1
CIE:	79/100/100/100/46
UGR:	17.6

ERCO Leuchten GmbH
Postfach 24 60
58505 Lüdenscheid
Deutschland
Tel.: +49 2351 551-0
Fax: +49 2351 551-300
info@erco.com

Technical Region: 230V/50Hz
Edition: 10.12.2003
Please download the current version from
www.erco.com/22271.000

Fixture C (Cont.)

ERCO Lightcast Downlight

Planning data

Connected load of luminaire incl. control gear
TC-TEL 18W G24q-2 1150lm — PL: 20 W

Connected load per 100lx
TC-TEL 18W G24q-2 1150lm — P*: 4.7 W/m²

Number of luminaires per 100lx
TC-TEL 18W G24q-2 1150lm — n*: 23.3 1/100 m²

Number of luminaires per 100m² for

TC-TEL 18W G24q-2 1150lm	100lx	200lx	300lx	500lx
	23	47	70	116

Illuminances (lx) for module (m)

TC-TEL 18W G24q-2 1150lm	1.2x1.8	1.8x1.8	1.8x2.4	2.4x2.4
	199	133	99	75

Correction table

Ceiling	0.7	0.7	0.7	0.5	0
Wall	0.7	0.5	0.2	0.2	0
Floor	0.5	0.2	0.2	0.1	0
k 0.6	80	61	53	52	49
k 1.0	102	79	71	69	66
k 1.5	117	91	85	82	78
k 2.5	129	100	95	90	86
k 3.0	133	103	99	93	89

Blendungsbewertung nach UGR
S/H=0.25 127cd/m²klm
TC-TEL 18W G24q-2 1150lm

Ceiling [%]	0.70	0.70	0.50	0.50	0.30
Wall [%]	0.50	0.30	0.50	0.30	0.30
Floor [%]	0.20	0.20	0.20	0.20	0.20

Room size X	Y	View looking perpendicular to the lamp axis				View looking parallel to the lamp axis
2H	2H	18.2	19.1	18.4	19.3	19.5
	3H	18.0	18.9	18.3	19.1	19.4
	4H	17.9	18.8	18.3	19.0	19.3
	6H	17.9	18.6	18.2	18.9	19.2
	8H	17.8	18.6	18.2	18.8	19.2
	12H	17.8	18.5	18.2	18.8	19.1
4H	2H	18.0	18.8	18.3	19.0	19.3
	3H	17.8	18.5	18.2	18.8	19.1
	4H	17.7	18.3	18.1	18.7	19.0
	6H	17.7	18.2	18.1	18.6	18.9
	8H	17.6	18.1	18.0	18.5	18.9
	12H	17.6	18.0	18.0	18.4	18.9
8H	4H	17.6	18.1	18.0	18.5	18.9
	6H	17.5	17.9	18.0	18.4	18.8
	8H	17.5	17.8	18.0	18.3	18.8
	12H	17.4	17.7	17.9	18.2	18.7
12H	4H	17.6	18.0	18.0	18.4	18.9
	6H	17.5	17.8	18.0	18.3	18.8
	8H	17.4	17.7	17.9	18.2	18.7

Variation of observer's position for luminaire spacing S

S=		
1.0H	1.9/-11.0	
1.5H	3.7/-29.2	
2.0H	5.7/-30.6	

Standard table BK00/-3.2 — Standard table -/-

Corrected glare index w.r.t. 1150lm total luminous flux

Fixture C (Cont.)

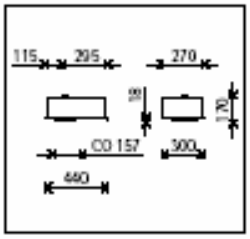
ERCO

Lightcast Downlight

Accessories

83582.000
Concrete housing
Metal, powder-coated.
L 440mm, W 300mm.
Recessed depth 170mm.
Ceiling aperture ø 157mm.

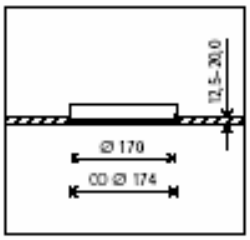
82952.000
Mounting plate for panelled ceilings
Metal, white (RAL9002) powder-coated. Module 100 (85/15, 84/16).
For downlights with ceiling aperture ø 157mm.
Recessing dimension 187x187mm.



83980.000
Cover ring
Metal, white. For covering the gap where ceiling cut-outs are too big.
Inner and outer diameter to be specified when placing order.

83951.000
Plaster ring
Metal, white.
Height 20mm.

83774.000
Mounting ring
Metal, white powder-coated. For flush-mounting installation in plasterboard ceilings.
Diameter 170mm.
Ceiling aperture ø 174mm.



82950.000
Mounting plate for panelled ceilings
Metal, white (RAL9002) powder-coated. Individual design of mounting plates according to ceiling type and luminaire. Quote ceiling type and dimensions.

Fixture C Lamp

PHILIPS

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  - DuraMax®
  - Halogená®
  - Marathon™
  - Tanning

PL-T Triple 4-Pin Fluorescent Lamp

Feature: High color rendering, high efficacy lamps feature 4-pin base for use with preheat, rapid start, electronic and dimming circuits. Featuring
ALTO® Lamp Technology
Watts: 18
Bulb: PL-T
Base: GX24q-2
Product Number: 046677-26822-7
Ordering Code: PL-T 18W/841/4P/ALTO
Generic Designation: CFTR18W/GX24q/841
Package Quantity: 12
Description: 4100K
M.O.L. (in.): 4 5/8
CRI: 82
Approximate life (hrs): 10,000
Lumens: 1200
Design Lumens: 1020
View Compatible Ballasts

Energy Saving Product

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Compatible Ballasts

Fixture C Ballast

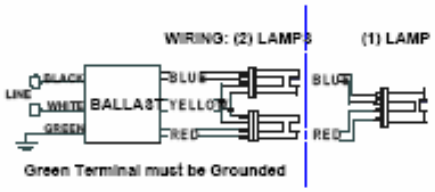
ADVANCE

ICF-2S18-M1-BS@277	
Brand Name	ADVANCE CFL
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
* 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	13	0.97	1.5	4.50
CFS21W/GR10q	2	21	0/-18	0.14	40	0.91	08	0.99	1.5	2.28

Wiring Diagram



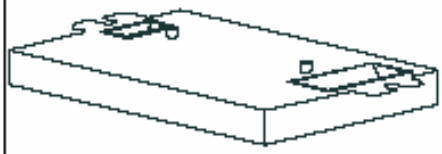
Green Terminal must be Grounded

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		
White	0.0		Blue/White		
Blue	0.0		Brown		
Red	0.0		Orange		
Yellow	0		Orange/Black		
Gray			Black/White		
Violet			Red/White		

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
4.20 "	2.40 "	0.98 "	2.00 "
4 1/5	2 2/5	0 49/50	2
10.7 cm	6.1 cm	2.5 cm	5.1 cm

Revised 08/29/2001

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

ADVANCE TRANSFORMER CO.
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

Fixture C Ballast (Cont.)

ICF-2S18-M1-BS@277	
Brand Name	ADVANCE CFL
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Notes:

Section I - Physical Characteristics

1.1 The electronic ballast shall be furnished with poke-in wire trap connectors, color-coded to ANSI standard C82.11.

Section II - Performance Requirements

2.1 The electronic ballast shall be IntelliVolt (TM) and shall operate from a line voltage range of 108 - 305 volts, 50/60 Hz.

2.2 The electronic ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage (120 - 277 volts) with primary lamps.

2.3 The electronic ballast shall have a Power Factor greater than 95%.

2.4 The electronic ballast shall have a Programmed-Start type system.

2.5 The electronic ballast shall have a lamp end-of-life detection and shutdown circuit.

2.6 The electronic ballast shall be Sound Rated A.

2.7 The electronic ballast output frequency to the lamps shall be above 42kHz to minimize interference with infrared control systems and eliminate visible flicker.

2.8 The electronic ballast shall meet ANSI C82.11, where applicable.

2.9 The electronic ballast shall withstand transients specified in ANSI C62.41, Location Category A3.

Section III - Regulatory Requirements

3.1 The electronic ballast shall meet the requirements of the Federal Communications Commission rules and regulations, Title 47 CFR part 18, for Non-Consumer equipment.

3.2 The electronic ballast shall comply with all applicable state and federal efficiency standards.

3.3 The electronic ballast shall be Underwriters Laboratories (UL) Listed (Class P) and CSA Certified where applicable.

3.4 The electronic ballast shall be Underwriters Laboratories (UL) rated for use in air handling spaces

Section IV - Other

4.1 The electronic ballast shall not contain Polychlorinated Biphenyl (PCBs).

4.2 The electronic ballast shall carry a five-year warranty from the date of manufacture when operated at a case temperature of 75°C or less. When operated at a case temperature between 75°C and 85°C, the warranty shall be 3 years from the date of manufacture.

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

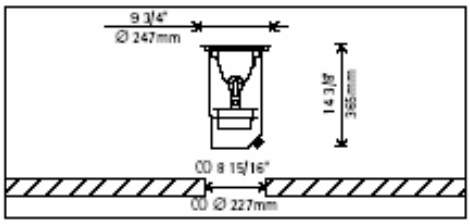
4.4 The electronic ballast shall be produced in a factory certified to ISO 9002 Quality System Standards.

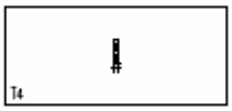
Fixture D

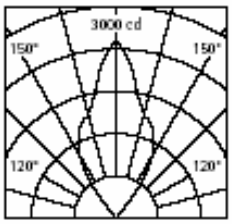
ERCO

Tesis Recessed floor luminaire

Uplight for metal halide lamps







T4 39W G8,5 3300lm

33713.023
Reflector color Silver
T4 39W G8,5 3300lm
ECG

Product description
Housing: corrosion-resistant, cast aluminum, No-rinse surface treatment. Black double powder-coated.
Mounting by means of an adjustable Bat Clamp extension up to 1 3/8" / 35mm.
Electronic control gear 120V, 60Hz. Cable, L 39" / 1m.
Low brightness reflector: aluminum, silver, specular anodized. Cut-off angle 50° from horizontal. Diffuser: glass, frosted. Without spill light.
Screw-mounted cover ring with flush safety glass: corrosion resistant stainless steel.
Safety glass: 1/2" / 12mm, clear. Surface temperature 158°F / 70°C.
Can be driven over by vehicles with pneumatic tyres. Load 9890lb.wt / 44kN.
Suitable for wet location (IP68): dust-proof.
Weigth: 13.23 lbs / 6.00 kg

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

Technical Region: 120V/60Hz
Edition: 04.05.2004
Please download latest version from
www.erco.com/33713.023

Fixture D Ballast

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  - Halogená®
  - Marathon™
  - Tanning

Contact Philips Lighting
1.800.555.0050

MasterColor® Tubular Single-Ended T-4 Lamps

Feature: Single-Ended T-4 Style. Enclosed Luminaires Only. Lifetime Color Stability Within +/- 200K
Watts: 39
Bulb: T-4
Base: G8.5
Product Number: 046677-37372-0
Ordering Code: CDM35/TC/830
ANSI Code/Ballast Ref.: M130/E
Package Quantity: 12
Description: G, Clear, FadeBlock
M.O.L. (in.): 3 11/32
L.C.L. (in.): 2
Rated Avg. Life (Hrs.): 9000
Approximate Initial Lumens: 3300
Approximate Mean Lumens: 2640
CRI: 81
CCT (K): 3000

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Compatible Ballasts

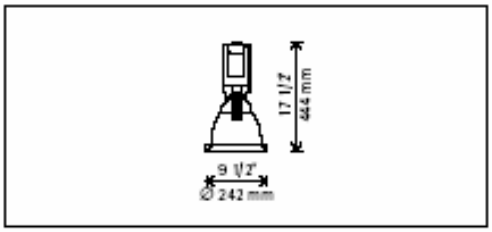
View Compatible Ballasts

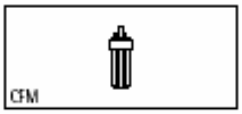
Fixture E

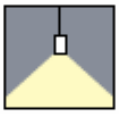
ERCO

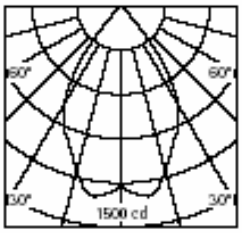
Parabelle Pendant downlight

for compact fluorescent lamps









87607.023 Silver
CFM 26W GX24q-3 1800lm
ECG

Product description
Housing: aluminum profile, powder-coated, designed as heat sink. Mounting bush, ø 1/2" / 13mm, for pendant tube or wire rope suspension.
Electronic control gear 120V/277V, 60Hz.
Low brightness reflector: aluminum, silver, specular anodized, externally silver lacquered. Cut-off angle 40° from horizontal.
Fixing ring: plastic, internally black, externally silver.
Suspension to be ordered separately.
Weigth: 3.53lbs / 1.60kg

CFM 26W GX24q-3 1800lm

Efficiency: 69%

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

Technical Region: 120V/60Hz
Edition: 04.03.2004
Please download latest version from
www.erco.com/87607.023

Fixture E (Cont.)

ERCO

Parabelle Pendant downlight

Planning Data

Connected load of luminaire				
CRM 26W GX24q-3 1800lm	PL: 28 W			
Connected load per 100fc				
CRM 26W GX24q-3 1800lm	P*: 0.3 W/ft²			
Number of luminaires per 100fc				
CRM 26W GX24q-3 1800lm	n*: 9.7 1/1000 ft²			
Number of luminaires per 1000ft² for	10fc	20fc	30fc	50fc
CRM 26W GX24q-3 1800lm	9	18	27	45
Illuminances (fc) for module (ft)	4x6	6x6	6x8	8x8
CRM 26W GX24q-3 1800lm	43	29	22	16

Fixture E (Cont.)

ERCO

Parabelle Pendant downlight

Photometric report

Candlepower distribution

Vertical Angle	Candelas
0°	1223
10°	1292
20°	1016
30°	769
40°	239
50°	0
60°	0
70°	0
80°	0
90°	0

Zonal Lumen Summery

Zone	Lumens	%Lamp	%Fixture
0°	0	0	0
10°	123	7	10
20°	446	25	36
30°	861	48	70
40°	1187	66	96
50°	1237	69	100
60°	1237	69	100
70°	1237	69	100
80°	1237	69	100
90°	1237	69	100

Lamp information
CFM 26W GX24q-3 1800lm

Note:
Photometric data may change when using different lamps.

These guide values are based on 10ft ceiling height in a square room of 1000ft² and mean reflectances (ceiling 70%, walls 50 % and floor 20 %). Other room shapes or reflectances should be converted accordingly. The values include the light loss factor of 0.8.

Coefficiants of Utilisation

Reflectances																
Ceiling	80	80	80	70	70	70	50	50	50	30	30	30	10	10	10	0
Walls	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	0
Floor	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Room Cavity Ratio																
0	82	82	82	80	80	80	76	76	76	73	73	73	70	70	70	69
1	77	75	74	75	74	73	73	72	71	70	69	69	68	67	67	65
2	73	70	69	72	70	68	69	68	66	67	66	65	66	65	64	62
3	69	66	64	68	65	63	66	64	62	65	63	61	63	62	60	59
4	65	62	60	65	62	59	63	61	59	62	60	58	61	59	57	57
5	62	58	56	61	58	56	60	57	55	59	57	55	58	56	54	53
6	59	55	53	58	55	53	57	54	52	56	54	52	56	53	52	51
7	56	52	50	55	52	49	54	51	49	54	51	49	53	50	49	48
8	53	49	47	52	49	46	52	48	46	51	48	46	50	48	46	45
9	50	46	44	49	46	43	49	46	43	48	45	43	48	45	43	42
10	47	43	41	47	43	41	46	43	41	46	43	41	45	42	41	40

Luminance Data

Vertical Angle	Footlamberts
45°	5924
50°	0
55°	0
60°	0
65°	0
70°	0
75°	0
80°	0
85°	0
90°	0

Fixture E (Cont.)

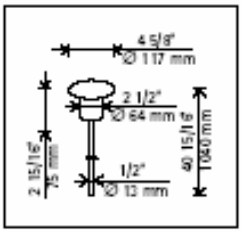
ERCO

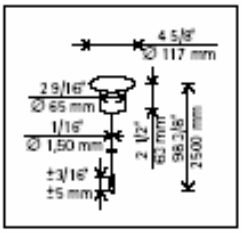
Parabelle Pendant downlight

Accessories

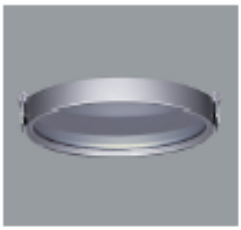
79944.023
Pendant tube suspension
Tube: metal, white powder-coated, ø 1/2" / 13mm, L 40 15/16" / 1040mm.
Canopy: plastic, white, ø 4 5/8" / 117mm, H 2 15/16" / 75mm.
Feeding possible.
Load 44lbs / 20kg.
Approval: c UL us listed.

79948.023
Wire rope suspension
Wire rope with mounting bush: ø 1/16" / 1.50mm, L 98 3/8" / 2500mm.
Canopy: plastic, white, ø 4 5/8" / 117mm, H 2 1/2" / 63mm.
Ceiling fixture: cast aluminum/metal, white powder-coated.
Mounting components: metal.
Cable entry cable clamp, terminal block.
Feeding possible.
Load 44lbs / 20kg.
Approval: c UL us listed.

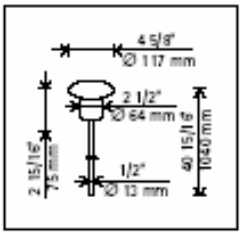




79946.023
Pendant tube suspension
Tube: metal, silver powder-coated, ø 1/2" / 13mm, L 40 15/16" / 1040mm.
Canopy: plastic, silver, ø 4 5/8" / 117mm, H 2 15/16" / 75mm.
Feeding possible.
Load 44lbs / 20kg.
Approval: c UL us listed.



83910.000
Safety glass
Plastic ring, silver. Rapid locking clips.
Height 1 11/16" / 43mm.
Diameter 10" / 252mm.
Weight 1.76lbs / 0.80kg.



Fixture E Lamp

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  - Marathon™
  - Tanning

Contact Philips Lighting
1.800.555.0050

PL-T Triple 4-Pin Fluorescent Lamp

Feature: High color rendering, high efficacy lamps feature 4-pin base for use with preheat, rapid start, electronic and dimming circuits. Featuring
ALTO® Lamp Technology
Watts: 26
Bulb: PL-T
Base: GX24q-3
Product Number: 046677-26825-0
Ordering Code: PL-T 26W/841/4P/ALTO
Generic Designation: CFTR26W/GX24q/841
Package Quantity: 12
Description: 4100K
M.O.L. (in.): 5
CRI: 82
Approximate life (hrs): 10,000
Lumens: 1800
Design Lumens: 1530
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Compatible Ballasts

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Product Photo

Fixture E Ballast

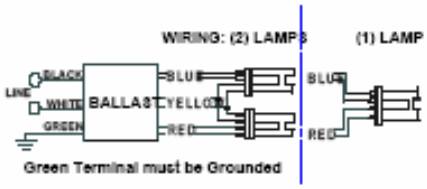
ADVANCE

ICF-2S26-H1-LD@120	
Brand Name	ADVANCE CFL
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
* CFM26W/GX24Q	1	26	0/-18	0.24	29	1.10	10	0.98	1.5	3.79
CFM26W/GX24q	2	26	0/-18	0.45	54	1.00	10	0.99	1.5	1.85
CFM32W/GX24q	1	32	0/-18	0.31	36	0.98	10	0.98	1.5	2.72
CFM42W/GX24q	1	42	0/-18	0.38	46	0.98	10	0.98	1.5	2.13
CFQ26W/G24q	1	26	0/-18	0.23	27	1.00	10	0.98	1.5	3.70
CFQ26W/G24q	2	26	0/-18	0.43	51	1.00	10	0.99	1.5	1.96
CFS21W/GR10q	2	21	0/-18	0.42	51	1.12	10	0.99	1.5	2.20
FT24W/2G11	2	24	0/-18	0.41	48	0.93	10	0.99	1.5	1.94

Wiring Diagram



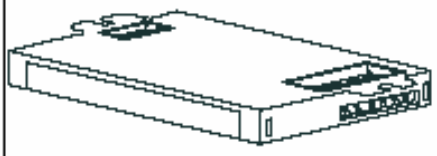
Green Terminal must be Grounded

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		
White	0.0		Blue/White		
Blue	0.0		Brown		
Red	0.0		Orange		
Yellow	0		Orange/Black		
Gray			Black/White		
Violet			Red/White		

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
4.98 "	2.4 "	1.0 "	4.6 "
4 49/50	2 2/5	1	4 3/5
12.6 cm	6.1 cm	2.5 cm	11.7 cm

Revised 06/28/2003

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, IL 60018
Customer Support/Technical Service: Phone: 800-372-3331 · Fax: 630-307-3071
Corporate Offices: Phone: 800-322-2086

Fixture E Ballast (Cont.)

ICF-2S26-H1-LD@120	
Brand Name	ADVANCE CFL
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Notes:

Section I - Physical Characteristics

1.1 The electronic ballast shall be furnished with poke-in wire trap connectors, color-coded to ANSI standard C82.11.

Section II - Performance Requirements

2.1 The electronic ballast shall be IntelliVolt (TM) and shall operate from a line voltage range of 108 - 305 volts, 50/60 Hz.

2.2 The electronic ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage (120 - 277 volts) with primary lamps.

2.3 The electronic ballast shall have a Power Factor greater than 95%.

2.4 The electronic ballast shall have a Programmed-Start type system.

2.5 The electronic ballast shall have a lamp end-of-life detection and shutdown circuit.

2.6 The electronic ballast shall be Sound Rated A.

2.7 The electronic ballast output frequency to the lamps shall be above 42kHz to minimize interference with infrared control systems and eliminate visible flicker.

2.8 The electronic ballast shall meet ANSI C82.11, where applicable.

2.9 The electronic ballast shall withstand transients specified in ANSI C62.41, Location Category A3.

Section III - Regulatory Requirements

3.1 The electronic ballast shall meet the requirements of the Federal Communications Commission rules and regulations, Title 47 CFR part 18, for Non-Consumer equipment.

3.2 The electronic ballast shall comply with all applicable state and federal efficiency standards.

3.3 The electronic ballast shall be Underwriters Laboratories (UL) Listed (Class P) and CSA Certified where applicable.

3.4 The electronic ballast shall be Underwriters Laboratories (UL) rated for use in air handling spaces

Section IV - Other

4.1 The electronic ballast shall not contain Polychlorinated Biphenyl (PCBs).

4.2 The electronic ballast shall carry a five-year warranty from the date of manufacture when operated at a case temperature of 75°C or less. When operated at a case temperature between 75°C and 85°C, the warranty shall be 3 years from the date of manufacture.

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

4.4 The electronic ballast shall be produced in a factory certified to ISO 9002 Quality System Standards.

Fixture F

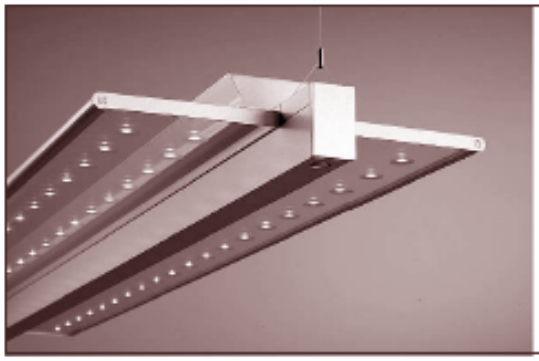
ORGATECH

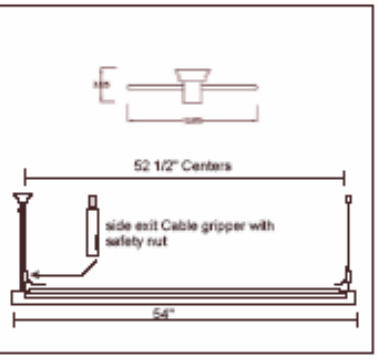
LIGHTSTAR L.E.D.

TYPE

333-0010 /20
2-54W/T5HO 54"
INDIRECT/DIRECT

Project :





SPECIFICATIONS:

CONSTRUCTION: Sculptured, extruded aluminum body, only 3.625" high, sandwiching laminated clear tempered glass panels.
80 minature blue or white L.E.Ds are embedded within the panels, and are energized from an invisible low voltage power supply.
Aluminum trims protect glass edges.

REFLECTOR: Die formed semi specular aluminum reflector for high performance indirect lighting.

OPTICAL EFFECT: Dimmable, high output glare free indirect illumination, with decorative downlighting from colored L.E.DS, which can be seperately controlled to remain illuminated when the fluoresoent lamps are off. LEDs operate without any visible power source creating a floating light sculpture.

LAMPS: - INCLUDED -2 - 54W T5 High Output (5,000Lum.ea) (16,000Hrs)
Option - 28W T5 (2900Lum ea.) by special request.
L.E.Ds are rated for 150,000 hours. (Approx 50 years at 8 hours per day)

MOUNTING: Single steel cable suspension to each end of the fixture, with adjustable cable grippers with side cable exit enable quick, secure leveling. Fixtures are fully assembled for easy installation. Canopies and hardware supplied.
Standard 48" cable provided, other lengths available on request.
Stem supports are available on request.

ELECTRICAL: 120V or 240V only, Prewired ready for installation. Decorative quality cord provides power and dimming control to the fluoresoent lamps. Internal minature low voltage 20V D/C driver controls the LEDs.

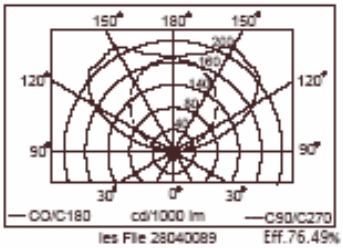
BALLAST: Electronic slim profile 2 lamp T5 low <10% THD. Dimmable ballasts.

LABEL: UL Listed

FINISH: RAL colors 9001-Creme White, 9002-Grey White, 9010-Bright White, 9011 Graphite, 9006-Silver
Option- Custom colors- adder.

WEIGHT: 46lbs.

Ordering Guide		Color
Blue LED Model	333-0020 - _____ - 120V	9001 9002 9010 9011 9006
White LED Model	333-0020 - _____ - 120V	



Orgatech Omegalux 511 N. Virginia Ave; Azusa, Ca. 91702. 626.969.6820 / fax 6830
www.orgatechomegalux.com

Fixture F (Cont.)

ORGATECH

LIGHTGUIDE INSTALLATION:

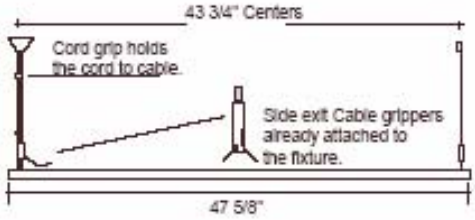
Applies to Lightwing / Lightplane / Prisma, Cable suspended fixtures.
Fixtures are supplied prewired with lamps installed for quick installation, by a qualified electrician.

Before installing: - Disconnect power.
Check the label on the top of the fixture to ensure that the fixture is suitable for the Voltage you intend to use. If the label indicates Universal *120 to 277 Volt* the ballast will automatically sense the voltage applied to ensure correct operation.

Mounting:
Ceiling Couplers attach the steel cable to 1/4-20 studs. - (Crossbars with studs are provided to fix to standard octagonal boxes).

Install the steel cables to the ceiling at 43 3/4" Centers. Decorative Flat or Conical Canopy Covers are provided for the cord- side suspension, with cord retainers which attach to the cable to hold the cord.

Electrical: Line and Neutral inputs to the ballast are universal and it is not necessary to differentiate for connection to the supply. Green must be connected for proper operation.



Canopy cover with snap-in cable or cable & cord grip

Fixture weight 20 Lbs.

Parts

Octagonal box - by others
Canopy bar with 1/4-20 Stud
Ceiling Coupler - 1/4-20
Cone Canopy cover
Snap-in Cable/Cord grip
Adjustable Cable gripper with side exit & Y cable - Ready ssembled on the fixture

Decorative Flat or Conical Canopy Covers are provided, with cord retainers which attach the cord to the cable.

FIXTURES ARE PRE WIRED - LAMPS INSTALLED - NO DISMANTLING REQUIRED

Orgatech Omegalux 511 N. Virginia Ave; Azusa, Ca. 91702. 626.969.6820 / fax 6830

Fixture F Lamp

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  - Tanning

Contact Philips Lighting
1.800.555.0050

MasterColor® Tubular Single-Ended T-4 Lamps

Feature: Single-Ended T-4 Style. Enclosed Luminaires Only. Lifetime Color Stability Within +/- 200K
Watts: 39
Bulb: T-4
Base: G8.5
Product Number: 046677-37372-0
Ordering Code: CDM35/TC/830
ANSI Code/Ballast Ref.: M130/E
Package Quantity: 12
Description: G, Clear, FadeBlock
M.O.L. (in.): 3 11/32
L.C.L. (in.): 2
Rated Avg. Life (Hrs.): 9000
Approximate Initial Lumens: 3300
Approximate Mean Lumens: 2640
CRI: 81
CCT (K): 3000

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Compatible Ballasts

View Compatible Ballasts

Fixture F Ballast

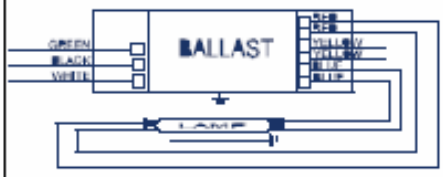
ADVANCE

ICN-2S54-90C@277	
Brand Name	CENTIUM
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
* F54T5/HO	1	54	0/-18	0.23	62	1.02	10	0.96	1.7	1.65
F54T5/HO	2	54	0/-18	0.43	117	1.00	10	0.98	1.7	0.85
FC12T5/HO	1	55	0/-18	0.21	55	0.87	15	0.96	1.7	1.58
FC12T5/HO	2	55	0/-18	0.38	103	0.85	10	0.98	1.7	0.83
FT36W/2G11	1	36	0/-18	0.18	46	1.22	20	0.96	1.7	2.65
FT36W/2G11	2	36	0/-18	0.32	86	1.20	10	0.98	1.7	1.40
FT50W/2G11	1	50	0/-18	0.23	61	1.12	15	0.96	1.7	1.84
FT50W/2G11	2	50	0/-18	0.43	115	1.10	10	0.98	1.7	0.96
FT55W/2G11	1	55	0/-18	0.22	58	0.92	15	0.96	1.7	1.59
FT55W/2G11	2	55	0/-18	0.41	109	0.90	10	0.98	1.7	0.83

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	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

Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
16.70 "	1.18 "	1.00 "	15.34 "
16 7/10	1 9/50	1	16 17/50
42.4 cm	3 cm	2.5 cm	41.5 cm

Revised 08/09/2003

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, IL 60018
Customer Support/Technical Service: Phone: 800-372-3331 · Fax: 630-307-3071
Corporate Offices: Phone: 800-322-2086

Fixture F Ballast (Cont.)

ADVANCE

ICN-2S54-90C@277	
Brand Name	CENTIUM
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Notes:

1 Physical Requirements

1.1 Ballast must be physically interchangeable with a magnetic core & coil ballast.
1.2 Ballast must have permanently connected leads integral to the ballast or poke-in connectors, color coded to ANSI C82.11 (latest version).
1.3 Ballast must be formed from recyclable steel painted in accordance with UL 935 standards. Plastic products with gaseous discharges are not allowed.

2 Lighting Performance Requirements

2.1 Ballast must have a ballast factor of:
- 2.1.1 .75-.78 for a low wattage design (LW).
- 2.1.2 .85-.92 for a normal light output design.

2.2 Ballast must have a maximum input wattage (ANSI) as indicated on the data sheet.
2.3 Ballast must have a Ballast Efficacy Factor greater than or equal to as indicated on the data sheet.
2.4 Ballast must be able to start and operate the specified lamps at a minimum temperature of (-20,0,32,50,60) degrees Fahrenheit as indicated on the data sheet and shall be in accordance with lamp manufacturer recommendations.
2.5 Ballast must be sound rated A. (T12/HO and T12/Slimline rated B).
2.6 Ballast must be designed and UL listed to operate the number of lamps as indicated on the data sheet.

3 Electrical Performance Requirements

3.1 Ballast THD shall be less than 10% for the main lamp desing (as indicated on the data sheet).
3.2 Lamp Current Crest Factor shall not exceed 1.7 for the main lamp design.
3.3 Ballast Power Factor must be greater than 98% for the main lamp design.
3.4 Ballast output frequency shall be greater than 20kHz and less than 30kHz or greater than 42kHz. Ballast output shall not be between 30 and 42kHz for any lamp combination.
3.5 Ballast must operate between 108-132V(120V), 249-305V(277V), 312-382V(347V), or 432-528V (480V) 60 Hz.
3.6 Ballast must maintain light output at +/- 10% during a voltage fluctuation of +/- 10%.
3.7 Ballast shall be (Instant Start Parallel, Rapid Start Series, Programmed Rapid Start Series) as indicated on the data sheet.
3.8 All ballasts for Compact Fluorescent Lamps (CFL) and T5 diameter lamps must contain a lamp End-Of-Life (EOL) detection and shut down circuit in accordance with ANSI/IEC proposed standards and must be operated on a rapid start ballast. Compact Fluorescent lamps shall not be operated on an instant start circuit.

4 Regulatory Requirements

4.1 Ballast shall meet ANSI C82.11 limits for Total Harmonic Distortion (THD).
4.2 Ballast shall meet FCC Part 18 non-consumer standards for electrical equipment (Class A).
4.3 Ballast shall meet ANSI 62.41 Category A standards for Transient Voltage protection.
4.4 Ballast shall meet UL 935 standards and be UL listed and CSA approved.
4.5 Ballast shall be UL Class P and Type 1 Outdoor.
4.6 Ballast shall contain no Polychlorinated Biphenyl (PCBs) in accordance with US law.
4.7 Ballast shall meet all US state and federal efficacy laws and all Canadian provincial and federal efficacy laws.

5 Other

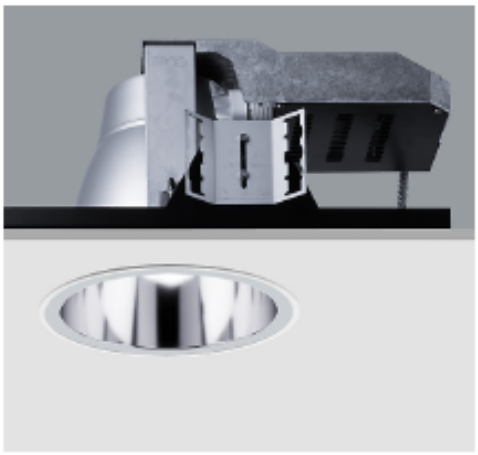
5.1 Ballast shall carry a 5 year warranty (from date of manufacture) with PLUS 90 system protection warranty (must register). Warranty shall be valid at case temperatures of 70C or less. For 90C rated ballasts, warranty shall be 3 years for ballast case temperatures between 70C and 90C.
5.2 Manufacturer must have a 15 year history of designing and manufacturing electronic ballasts for the North American market.
5.3 Ballast must be manufactured in a facility Certified to ISO 9002 Quality System Standards.
5.4 Ballast must be ordered and shipped from a distribution center Certified to ISO 9002 Quality System Standards.
5.5 Ballast must be Advance Transformer Co. _____brand, part # _____. All proposed substitutes must be submitted to the specifying authority two weeks prior to bid due date. Submittal does not guarantee acceptance.

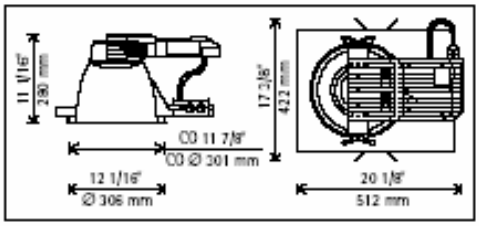
Fixture G

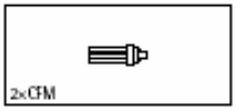
ERCO

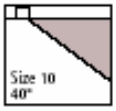
LC Downlight

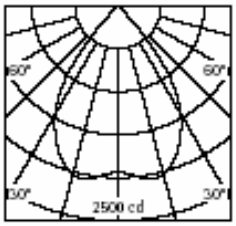
for compact fluorescent lamps











22234.023
Reflector color Silver
2xCFM 32W GX24q-3 2400lm
ECG

Product description
Housing: cast aluminum, designed as heat sink.
Mounting ring: cast aluminum, white (RAL9002) powder-coated. 4-point support and screw tightening for fixing to mounting plate.
Electronic control gear 120V/277V, 60Hz, class P inside cast housing.
Mounting plate for preinstallation with junction box for through-wiring, black powder-coated. Snap-in plug for connection between junction box and luminaire.
Low brightness reflector: aluminum, specular anodized. Cut-off angle 40° from horizontal.
Diffuser as lamp cover: plastic, translucent, for lamp replacement removable without tools.
Type Non IC luminaire.
Insulation materials must be kept away from the luminaire by a minimum of 3". Suitable for wet location. Removal of reflector allows access to junction box from below.
Max. ceiling thickness 3/4".
Weigth: 12.79 lbs / 5.80 kg

2xCFM 32W GX24q-3 2400lm

Efficiency: 48%

ERCO Lighting, Inc.
160 Raritan Center Parkway
Suite 10
Edison, NJ 08837
USA
Tel.: +1 732 225 8866
Fax: +1 732 225 8857
info.us@erco.com

Technical Region: 120V/60Hz
Edition: 04.05.2004
Please download latest version from
www.erco.com/22234.023

Fixture G (Cont.)

ERCO

LC Downlight

Planning Data

Connected load of luminaire 2xCFM 32W GX24q-3 2400lm	PL: 66 W			
Connected load per 100fc 2xCFM 32W GX24q-3 2400lm	P*: 0.3 W/ft²			
Number of luminaires per 100fc 2xCFM 32W GX24q-3 2400lm	n*: 5.1 1/1000 ft²			
Number of luminaires per 1000ft² for 2xCFM 32W GX24q-3 2400lm	10fc 5	20fc 10	30fc 14	50fc 24
Illuminances (fc) for module (ft) 2xCFM 32W GX24q-3 2400lm	4x6 81	6x6 54	6x8 41	8x8 30

Fixture G (Cont.)

ERCO

LC Downlight

Photometric report

Candlepower distribution

Vertical Angle	Candelas
0°	1927
10°	2045
20°	1907
30°	1456
40°	559
50°	3
60°	1
70°	0
80°	0
90°	0

Zonal Lumen Summery

Zone	Lumens	%Lamp	%Fixture
0°	0	0	0
10°	191	4	8
20°	759	16	33
30°	1539	32	67
40°	2198	46	96
50°	2297	48	100
60°	2300	48	100
70°	2301	48	100
80°	2301	48	100
90°	2301	48	100

Lamp information
2xCFM 32W GX24q-3 2400lm

Note:
Photometric data may change when using different lamps.

These guide values are based on 10ft ceiling height in a square room of 1000ft² and mean reflectances (ceiling 70 %, walls 50 % and floor 20 %). Other room shapes or reflectances should be converted accordingly. The values include the light loss factor of 0.8.

Coefficiants of Utilisation

Reflectances																
Ceiling	80	80	80	70	70	70	50	50	50	30	30	30	10	10	10	0
Walls	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	0
Floor	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Room Cavity Ratio																
0	57	57	57	56	56	56	53	53	53	51	51	51	49	49	49	48
1	54	53	52	53	52	51	51	50	49	48	48	48	47	47	46	46
2	51	49	48	50	48	47	48	47	46	47	46	45	46	45	44	43
3	48	46	44	47	45	44	46	44	43	45	44	42	44	43	42	41
4	45	43	41	45	43	41	44	42	40	43	41	40	42	41	40	39
5	43	40	38	42	40	38	41	39	38	41	39	38	40	38	37	37
6	40	38	36	40	38	36	39	37	36	39	37	36	38	37	35	35
7	38	36	34	38	35	34	37	35	33	37	35	33	36	34	33	33
8	36	33	32	36	33	31	35	33	31	35	33	31	34	32	31	31
9	34	31	29	34	31	29	33	31	29	33	31	29	32	30	29	28
10	32	29	27	32	29	27	31	29	27	31	29	27	31	29	27	27

Luminance Data

Vertical Angle	Footlamberts
45°	4137
50°	355
55°	228
60°	131
65°	135
70°	27
75°	11
80°	31
85°	73
90°	0

Fixture G (Cont.)

ERCO

LC Downlight

Accessories

83980.000
Cover ring
Metal, white. For covering the gap where ceiling cut-outs are too big. Inner and outer diameter to be specified when placing order.

Fixture G Lamp

PHILIPS

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  - MasterColor®
  - DuraMax®
  - Halogená®
  - Marathon™
  - Tanning

Contact Philips Lighting
1.800.555.0050

PL-T Triple 4-Pin Fluorescent Lamp

Feature: High color rendering, high efficacy lamps feature 4-pin base for use with preheat, rapid start, electronic and dimming circuits. Featuring
ALTO® Lamp Technology
Watts: 32
Bulb: PL-T
Base: GX24q-3
Product Number: 046677-26872-2
Ordering Code: PL-T 32W/841/4P/ALTO
Generic Designation: CFTR32W/GX24q/841
Package Quantity: 12
Description: 4100K
M.O.L. (in.): 5 5/8
CRI: 82
Approximate life (hrs): 10,000
Lumens: 2400
Design Lumens: 2040
View Compatible Ballasts

Energy Saving Product

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Compatible Ballasts

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ALTO Product Logo
Product Photo
Family Photo

Fixture G Ballast

ADVANCE

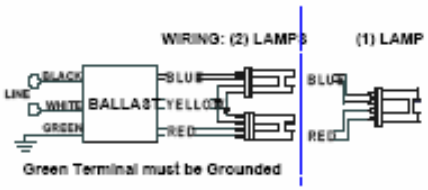
ICF-2S42-M2-BS@120	
Brand Name	ADVANCE CFL
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
(1) FC9T5 & (1) FC12T5	2	0	0/-18	0.51	61	0.85	10	0.98	1.5	1.39
CFM26W/GX24Q	2	26	0/-18	0.46	55	1.00	10	0.98	1.5	1.82
* CFM32W/GX24q	2	32	0/-18	0.57	68	0.98	10	0.98	1.5	1.44
CFM42W/GX24q	2	42	0/-18	0.78	93	0.97	10	0.99	1.5	1.04
CFM57W/GX24Q	1	57	32/00	0.50	59	0.94	10	0.98	1.5	1.59
CFM70W/GX24Q	1	70	14/-10	0.63	75	0.96	10	0.98	1.5	1.28
CFQ26W/G24q	2	26	0/-18	0.43	52	1.00	10	0.98	1.5	1.92
CFS28W/GR10q	2	28	0/-18	0.48	57	1.00	10	0.98	1.5	1.75
CFS38W/GR10q	2	38	0/-18	0.55	62	0.80	10	0.98	1.5	1.29
FT24W/2G11	2	24	0/-18	0.40	48	0.93	15	0.98	1.5	1.94

1-10 Continued...

Wiring Diagram



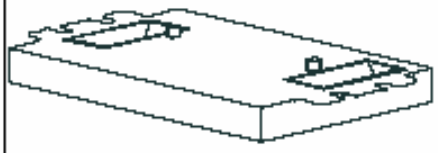
Green Terminal must be Grounded

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		
White	0.0		Blue/White		
Blue	0.0		Brown		
Red	0.0		Orange		
Yellow	0		Orange/Black		
Gray			Black/White		
Violet			Red/White		

Enclosure



Enclosure Dimensions

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

Revised 07/01/2003

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, IL 60018
Customer Support/Technical Service: Phone: 800-372-3331 · Fax: 630-307-3071
Corporate Offices: Phone: 800-322-2086

Fixture G Ballast (Cont.)

ADVANCE

ICF-2S42-M2-BS@120	
Brand Name	ADVANCE CFL
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Continued...11 - 11

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.
FT40W/2G11	2	40	0/-18	0.66	78	0.95	10	0.99	1.5	1.22

Revised 07/01/2003

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Corporate Offices: Phone: 800-322-2086

Fixture G Ballast (Cont.)

ICF-2S42-M2-BS@120	
Brand Name	ADVANCE CFL
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Notes:

Section I - Physical Characteristics

1.1 The electronic ballast shall be furnished with poke-in wire trap connectors, color-coded to ANSI standard C82.11.

Section II - Performance Requirements

2.1 The electronic ballast shall be IntelliVolt (TM) and shall operate from a line voltage range of 108 - 305 volts, 50/60 Hz.

2.2 The electronic ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage (120 - 277 volts) with primary lamps.

2.3 The electronic ballast shall have a Power Factor greater than 95%.

2.4 The electronic ballast shall have a Programmed-Start type system.

2.5 The electronic ballast shall have a lamp end-of-life detection and shutdown circuit.

2.6 The electronic ballast shall be Sound Rated A.

2.7 The electronic ballast output frequency to the lamps shall be above 42kHz to minimize interference with infrared control systems and eliminate visible flicker.

2.8 The electronic ballast shall meet ANSI C82.11, where applicable.

2.9 The electronic ballast shall withstand transients specified in ANSI C62.41, Location Category A3.

Section III - Regulatory Requirements

3.1 The electronic ballast shall meet the requirements of the Federal Communications Commission rules and regulations, Title 47 CFR part 18, for Non-Consumer equipment.

3.2 The electronic ballast shall comply with all applicable state and federal efficiency standards.

3.3 The electronic ballast shall be Underwriters Laboratories (UL) Listed (Class P) and CSA Certified where applicable.

3.4 The electronic ballast shall be Underwriters Laboratories (UL) rated for use in air handling spaces

Section IV - Other

4.1 The electronic ballast shall not contain Polychlorinated Biphenyl (PCBs).

4.2 The electronic ballast shall carry a five-year warranty from the date of manufacture when operated at a case temperature of 75°C or less. When operated at a case temperature between 76°C and 85°C, the warranty shall be 3 years from the date of manufacture.

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

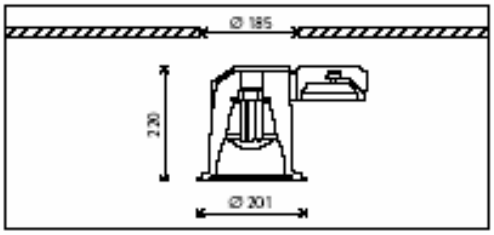
4.4 The electronic ballast shall be produced in a factory certified to ISO 9002 Quality System Standards.

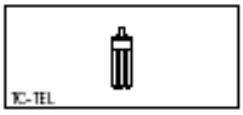
Fixture H

ERCO

Lightcast Downlight

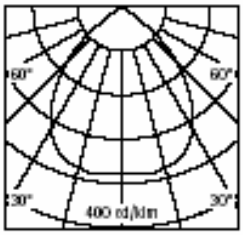
for compact fluorescent lamps





81029.000
Reflector colour Silver
TC-TEL 18W G24q-2 1150lm
ECG

Product description
Housing: cast aluminium, silver powder-coated. Mounting with 3-point support and screw-tightening. Side-mounted control gear: plastic, black.
2 cable entries. Through-wiring possible. 5-pole terminal block.
Electronic control gear.
Darklight reflector: aluminium, bright anodised. Cut-off angle 30°.
Diffuser as lamp cover: plastic, translucent.
Screw mounted cover frame with safety glass: corrosion-resistant, cast aluminium, No-rinse surface treatment. Silver double powder-coated. To be removed together with Darklight reflector for lamp replacement.
Protection mode IP65: dust-proof and water-jet proof.
Weight: 2.40kg



TC-TEL 18W G24q-2 1150lm

h(m)	E(lx/klm)	D(m) 87°
1	299	1.90
2	75	3.80
3	33	5.69
4	19	7.59
5	12	9.49

ERCO Leuchten GmbH
Postfach 24 60
58505 Lüdenscheid
Deutschland
Tel.: +49 2351 551-0
Fax: +49 2351 551-300
info@erco.com

Technical Region: 230V/50Hz
Edition: 03.03.2004
Please download the current version from
www.erco.com/81029.000

Fixture H Lamp

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  - MasterColor®
  - DuraMax®
  - Halogená®
  - Marathon™
  - Tanning

Contact Philips Lighting
1.800.555.0050

PL-T Triple 4-Pin Fluorescent Lamp

Feature: High color rendering, high efficacy lamps feature 4-pin base for use with preheat, rapid start, electronic and dimming circuits. Featuring
ALTO® Lamp Technology
Watts: 18
Bulb: PL-T
Base: GX24q-2
Product Number: 046677-26822-7
Ordering Code: PL-T 18W/841/4P/ALTO
Generic Designation: CFTR18W/GX24q/841
Package Quantity: 12
Description: 4100K
M.O.L. (in.): 4 5/8
CRI: 82
Approximate life (hrs): 10,000
Lumens: 1200
Design Lumens: 1020
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Compatible Ballasts

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Fixture H Ballast

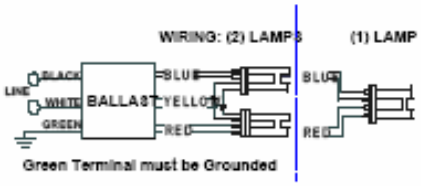
ADVANCE

ICF-2S18-H1-LD@120	
Brand Name	ADVANCE CFL
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Lamp Type	Num. of Lamps	Rated Lamp Watts	Min. Start Temp (°F/C)	Input Current (Amps)	Input Power (ANSI Watts)	Ballast Factor	MAX THD %	Power Factor	MAX Lamp Current Crest Factor	B.E.F.
* CFM18W/GX24Q	1	18	0/-18	0.17	20	1.05	10	0.97	1.5	5.25
CFM18W/GX24q	2	18	0/-18	0.33	39	1.05	10	0.99	1.5	2.69
CFQ18W/G24q	1	18	0/-18	0.16	19	1.00	10	0.97	1.5	5.26
CFQ18W/G24q	2	18	0/-18	0.30	35	0.96	10	0.99	1.5	2.71
CFS16W/GR10q	2	16	0/-18	0.31	37	1.00	09	0.99	1.5	2.70
CFS21W/GR10q	1	21	0/-18	0.16	20	0.90	13	0.97	1.5	4.50
CFS21W/GR10q	2	21	0/-18	0.33	40	0.91	08	0.99	1.5	2.28

Wiring Diagram



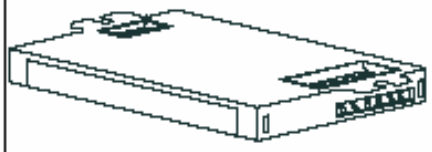
Green Terminal must be Grounded

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		
White	0.0		Blue/White		
Blue	0.0		Brown		
Red	0.0		Orange		
Yellow	0		Orange/Black		
Gray			Black/White		
Violet			Red/White		

Enclosure



Enclosure Dimensions

OverAll (L)	Width (W)	Height (H)	Mounting (M)
4.98 "	2.4 "	1.0 "	4.6 "
4 49/50	2 2/5	1	4 3/5
12.6 cm	6.1 cm	2.5 cm	11.7 cm

Revised 08/05/2002

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

ADVANCE TRANSFORMER CO.
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

Fixture H Ballast (Cont.)

ICF-2S18-H1-LD@120	
Brand Name	ADVANCE CFL
Ballast Type	Electronic
Starting Method	Programmed Start
Lamp Connection	Series
Input Voltage	120-277
Input Frequency	50/60 HZ
Status	Active

Electrical Specifications

Notes:

Section I - Physical Characteristics

1.1 The electronic ballast shall be furnished with poke-in wire trap connectors, color-coded to ANSI standard C82.11.

Section II - Performance Requirements

2.1 The electronic ballast shall be IntelliVolt (TM) and shall operate from a line voltage range of 108 - 305 volts, 50/60 Hz.

2.2 The electronic ballast input current shall have Total Harmonic Distortion (THD) of less than 10% when operated at nominal line voltage (120 - 277 volts) with primary lamps.

2.3 The electronic ballast shall have a Power Factor greater than 96%.

2.4 The electronic ballast shall have a Programmed-Start type system.

2.5 The electronic ballast shall have a lamp end-of-life detection and shutdown circuit.

2.6 The electronic ballast shall be Sound Rated A.

2.7 The electronic ballast output frequency to the lamps shall be above 42kHz to minimize interference with infrared control systems and eliminate visible flicker.

2.8 The electronic ballast shall meet ANSI C82.11, where applicable.

2.9 The electronic ballast shall withstand transients specified in ANSI C62.41, Location Category A3.

Section III - Regulatory Requirements

3.1 The electronic ballast shall meet the requirements of the Federal Communications Commission rules and regulations, Title 47 CFR part 18, for Non-Consumer equipment.

3.2 The electronic ballast shall comply with all applicable state and federal efficiency standards.

3.3 The electronic ballast shall be Underwriters Laboratories (UL) Listed (Class P) and CSA Certified where applicable.

3.4 The electronic ballast shall be Underwriters Laboratories (UL) rated for use in air handling spaces

Section IV - Other

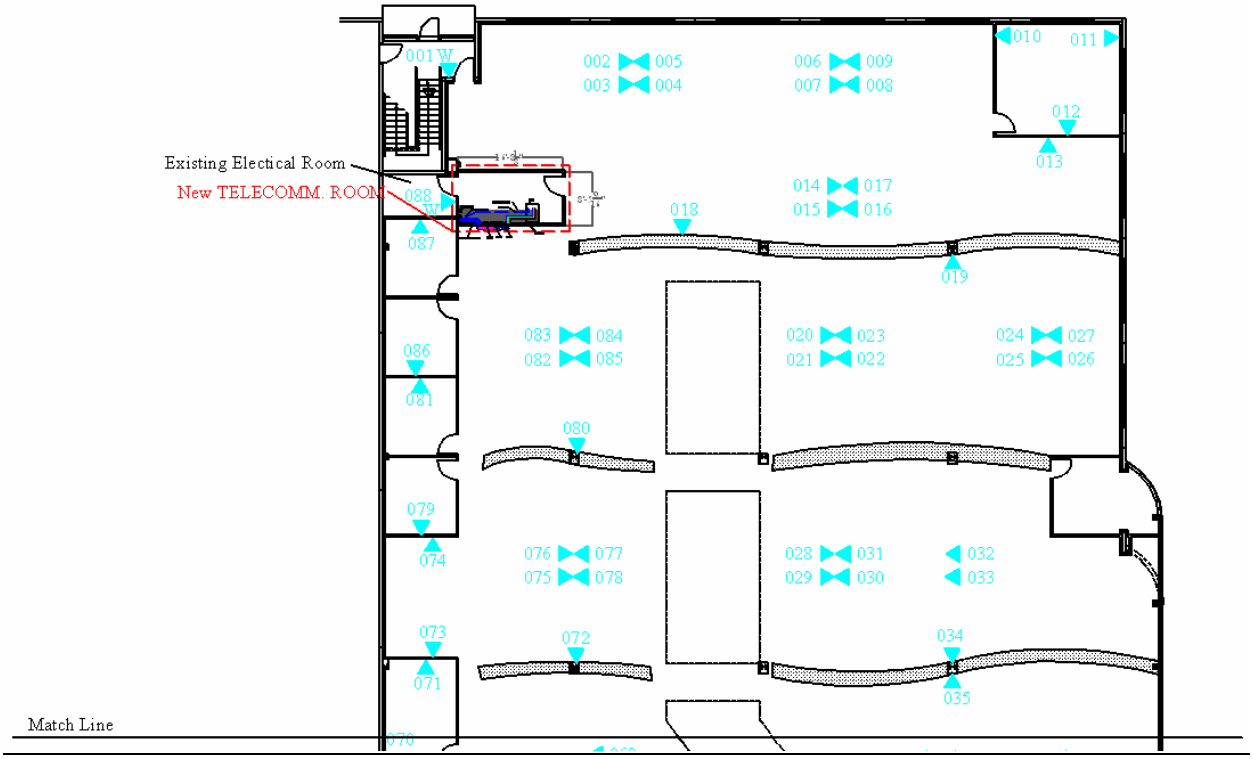
4.1 The electronic ballast shall not contain Polychlorinated Biphenyl (PCBs).

4.2 The electronic ballast shall carry a five-year warranty from the date of manufacture when operated at a case temperature of 75°C or less. When operated at a case temperature between 76°C and 85°C, the warranty shall be 3 years from the date of manufacture.

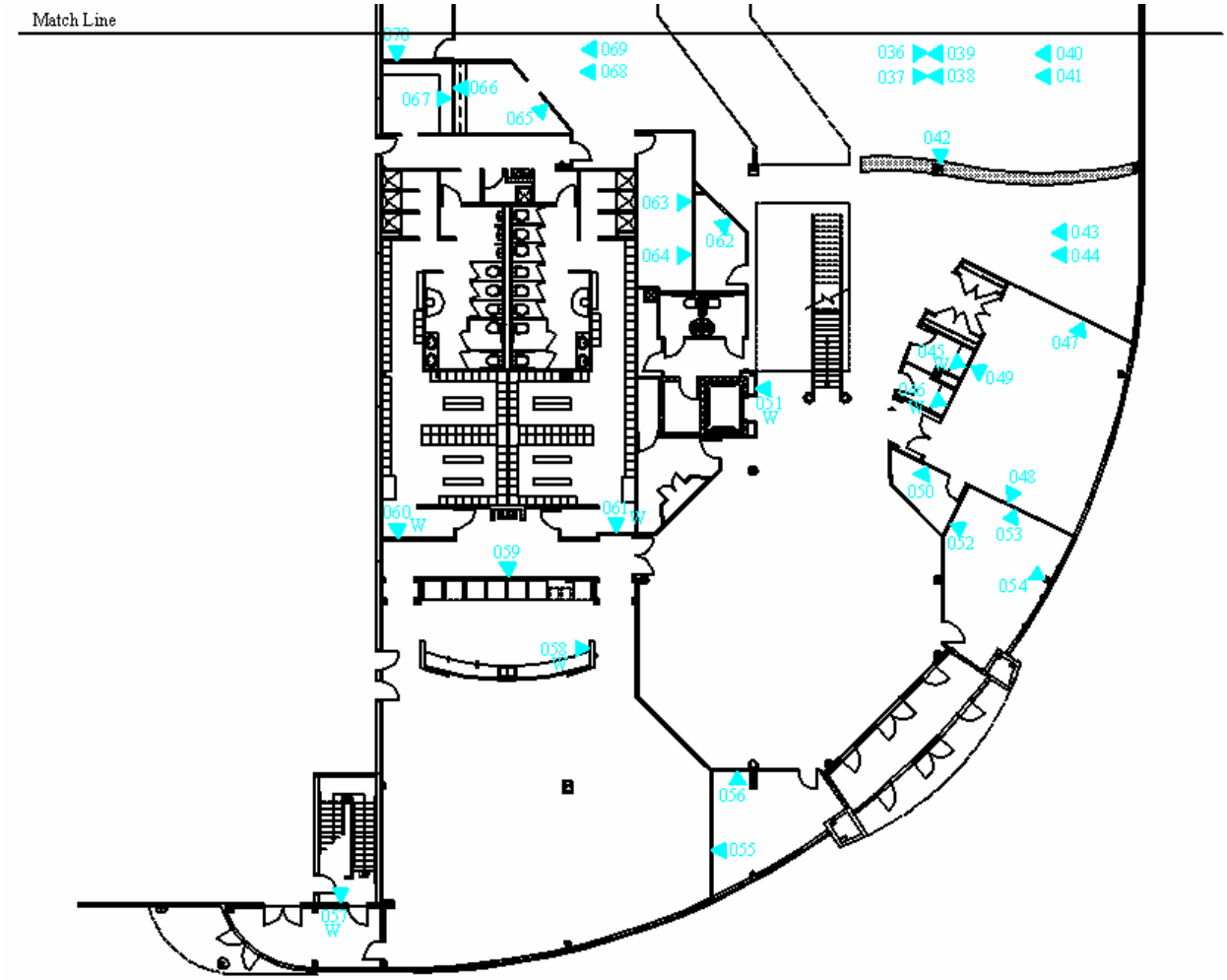
4.3 The manufacturer shall have a fifteen-year history of producing electronic ballasts for the North American market.

4.4 The electronic ballast shall be produced in a factory certified to ISO 9002 Quality System Standards.

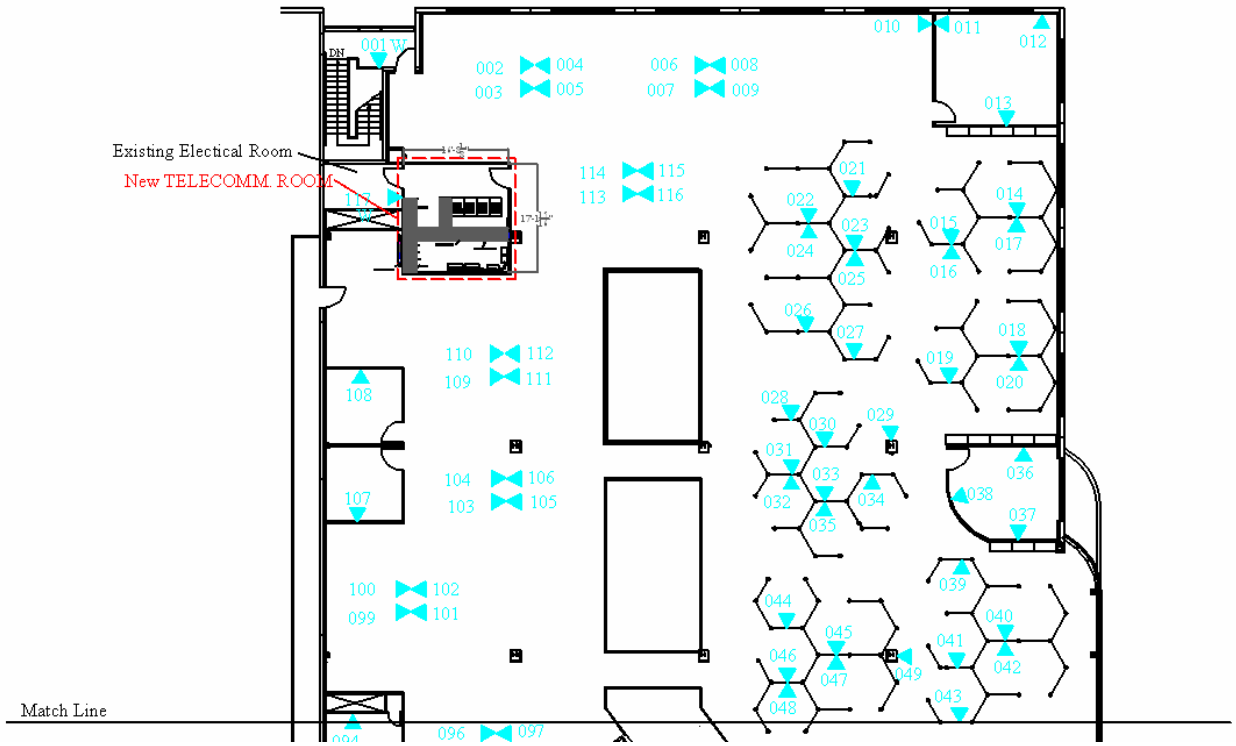
Telecommunications Plan – Floor 1 North



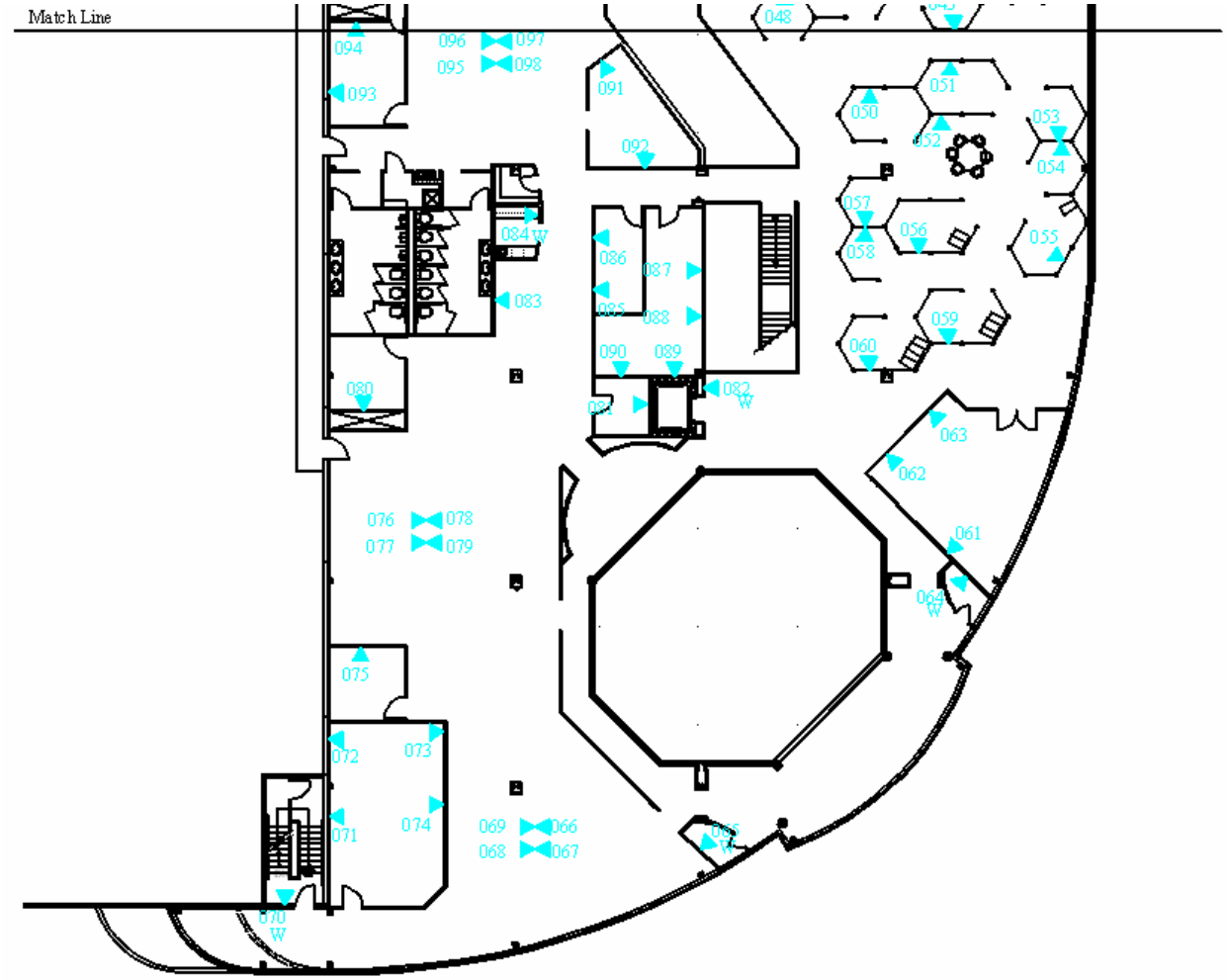
Telecommunications Plan – Floor 1 South



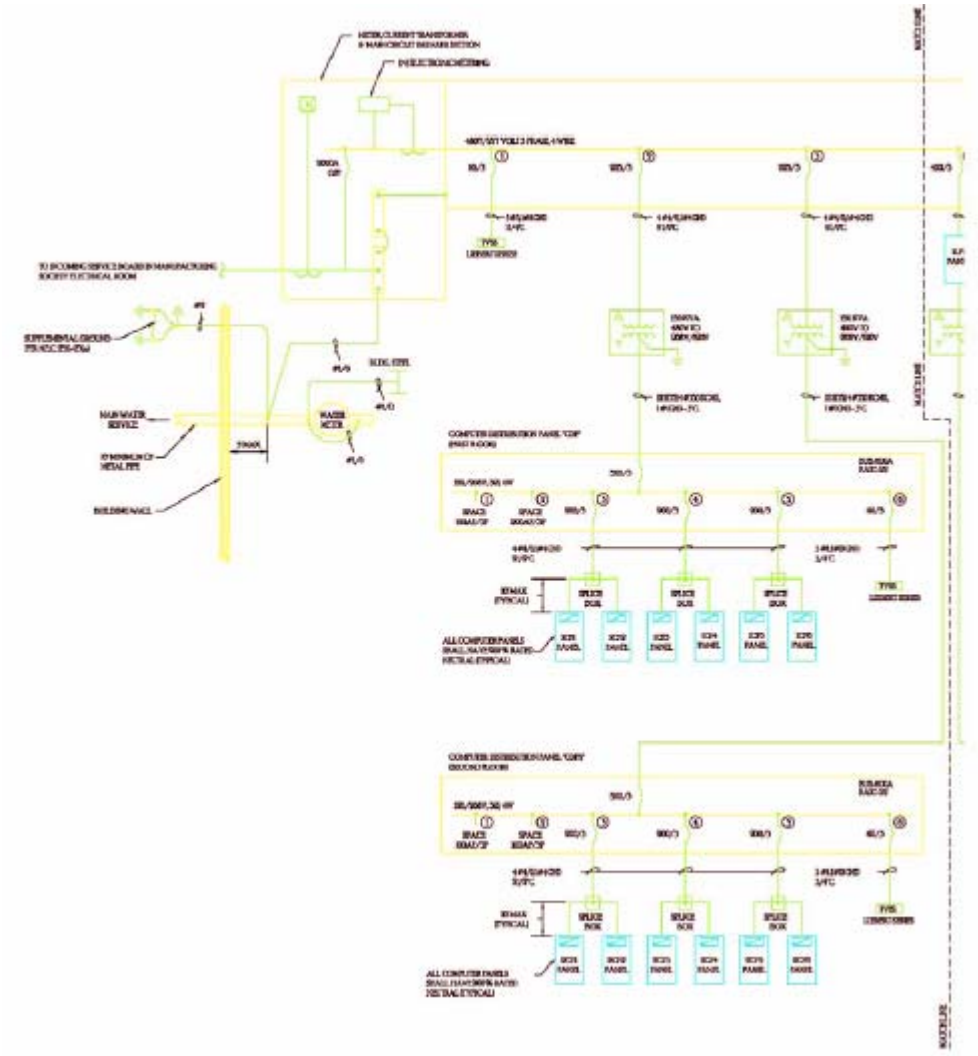
Telecommunications Plan – Floor 2 North



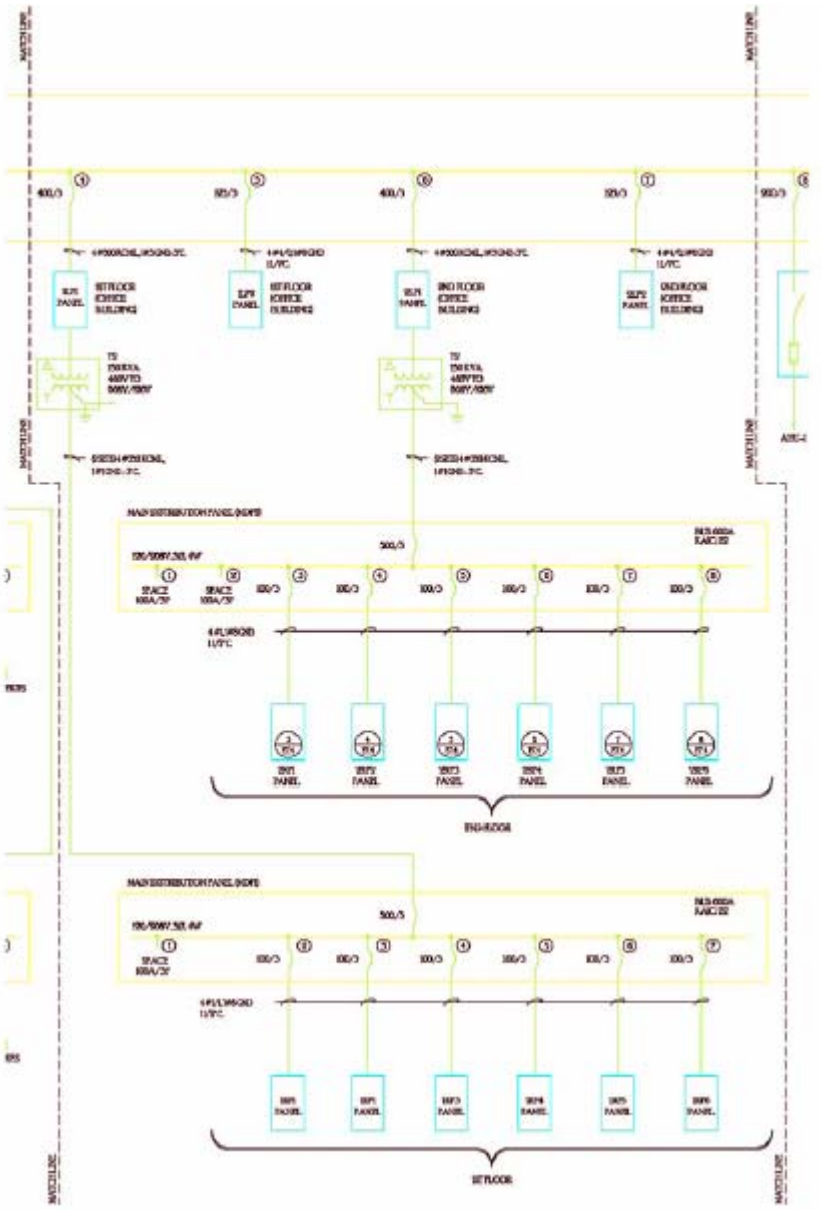
Telecommunications Plan – Second Floor South



Electrical Line Diagram – Part I



Electrical Line Diagram – Part II



Electrical Line Diagram – Part III