Howard County General Hospital
Columbia, Maryland

Photo Courtesy of Leach Wallace Associates

Casey Schardt

Spring 2004

Lighting/Electrical Option

Faculty Consultant: Dr. Mistrick

Howard County General Hospital

5755 Cedar Lane Columbia, MD 21044

Project Statistics

- 40,000 square foot, 3 story (2 above grade) addition to existing 230,000 square foot facility.
- Project also includes a Renovation of 30,000 square feet of the existing building.
- $20,000,000 Construction cost.
- Constructed between September 2000 and July 2003.

Courtesy of Leach Wallace Associates

Project Team

Owner/Occupant: **Johns Hopkins Hospital System**
Architect: **Wilmot Sanz, Incorporated**
MEP Engineer: **Leach Wallace Associates**
Structural Engineer: **LPJ Qodesh, Incorporated**
Civil Engineer: **Joyce Engineering Group**
General Contractor: **Atlantic Builders Group**

Courtesy of Howard County General Hospital

Structural

- Cast in place concrete foundation with slab on grade on basement floor.
- Cast in place slab on deck with supported by steel columns, girders, and beams for first and second floors, and the roof.
- Roof slab is designed such that a third floor could be added on top it in the future.

Lighting

- Most lighting at 277 volts, with a few applications using 120 volts.
- Continuous glazing down the length of the building allows for utilization of daylight in some spaces.
- Many critical medical tasks require special lighting conditions.

Architecture

- Will allow Howard County General Hospital to increase its capacity to serve the community.
- 47-bay emergency department
- 6-bed pediatric inpatient nursing unit
- a 17-bed neonatal intensive care unit, a 12-bed birthing department
- 16-bed intensive care unit
- Expanded imaging department
- Expanded facilities for maintenance and engineering.
- Upgrades to the mechanical and electrical systems.
- The architecture is intended to clarify the function of the spaces while adding emotion to them. *(courtesy of Wilmot Sanz)*

Mechanical

- Several new air handling units and hot water heating plant as part of a VAV HVAC system with hot water reheat.
- Existing chiller plant is to be expanded by 1,500 tons with three new chillers and cooling towers.
- Medical gas services, including oxygen, vacuum, medical air, and nitrous oxide.

Electrical

- New 2,500 KVA, 480Y/277V substation along with new emergency paralleling switchgear.
- Automatic transfer switching required for segregating emergency power into three branches: life safety, critical, and equipment.
- New fire alarm, nurse call, telecommunications, and security systems, with a complex centralized monitoring system. *(courtesy of Leach Wallace Assoc.)*

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Executive Summary

This report analyzes the design of the addition and renovation to Howard County General Hospital. It focuses primarily on the lighting and electrical portions of the design, but also takes into careful consideration the impact on all other aspects of the design, such as architecture, construction, energy concerns, and HVAC requirements.

The lighting study analyzes in detail three different spaces in the hospital. The lighting in these spaces was completely redesigned. The spaces include a lobby area, a nurse station, and a videoconferencing room. The design criteria were identified for each space, and unique solutions are presented.

The electrical study analyzes the performance of the existing design of the electrical distribution system. Recommendations are made that could improve this design and address certain problems that may arise. For example, an uninterruptible power supply (UPS) was designed to serve sensitive diagnostic imaging equipment, which has been known to shut down due to even very small power disturbances. Parts of the emergency power distribution system are redesigned, including a new generator. The circuits and panels for the second floor labor and delivery unit were analyzed, along with all equipment in the path back to the substation. The protective devices on this path were analyzed for coordination. A motor control center was also redesigned.

The lighting system throughout the building was analyzed and a new fixture is proposed to replace an existing one that will cut down on both construction costs as well as the life-cycle operational costs.

The impacts on the mechanical systems from the new lighting design and the addition of the UPS were analyzed to determine how these changes affect the HVAC system serving those areas.

Acknowledgements

I would like to thank the following people and companies for their help in completing this project, or for offering their support:

My Family

My Roommates, Friends, and Classmates

The Entire Architectural Engineering Faculty and Staff

Rob Banas and Leach Wallace Associates

John Reese of Reese Engineering

Ed Wunderley of Burt Hill Kosar Rittleman Associates

Howard County General Hospital

Wilmot Sanz Architecture/Planning

Background

Howard County General Hospital is located in Columbia, Maryland. This project focuses on the recent addition to the hospital. The characteristics of the design of this project are outlined below.

General Project Data

- Building Name: Howard County General Hospital
- Location and Site: 5755 Cedar Lane, Columbia, MD 21044
- Building Occupant Name: Johns Hopkins Hospital System
- Function: Hospital
- Size: 40,000 square foot addition, 30,000 square foot renovation
- Stories: 3, 2 above grade
- Project Team:
  - Owner: Johns Hopkins Hospital System
  - Architect: Wilmot Sanz, Inc
  - MEP Engineer: Leach Wallace Associates
  - Structural Engineer: LPJ Qodesh, Inc.
  - Civil Engineer: Joyce Engineering Group
  - General Contractor: Atlantic Builders Group
  - Mechanical Contractor: Southern Mechanical
  - Electrical Contractor: Electrico, Inc.
- Dates of Construction: September 2000 – July 2003
- Total Construction Cost: $20,261,000
  - Total Electrical Construction Cost: $2,600,000
  - Total Mechanical Construction Cost: $7,495,000
- Project Delivery Method: Design-Bid-Build

Architecture

The addition and renovation is allow Howard County General Hospital to increase its capacity to serve the community by adding a new 47-bay emergency department, , a 6-bed pediatric inpatient nursing unit, a 17-bed neonatal intensive care unit, a 12-bed birthing department, a new 16-bed intensive care unit, an expanded imaging department, and expanded facilities for maintenance and engineering. The modernization also includes upgrades to the hospitals mechanical and electrical systems. The architecture is intended to clarify the function of the spaces while adding emotion to them.

The 1993 edition of the BOCA National Building Code governs the design of the building, as well as the Howard County Health Department.

The exterior walls are prefabricated concrete curtain walls supported by steel columns, with tinted glazing on both above grade levels. Steel joists support the steel decking on the flat roof.

Fire Protection

Structural steel and metal decking are protected by cementitious spray-on fireproofing. One and two hour rated fire partitions, and fire & smoke partitions are used in critical locations to isolate the spread of fires; for example in exits, stairwells, duct shafts, and corridors. Magnetic hold-open doors that close during a fire alarm are also used in many corridors. Fire retardant or resistant materials are used in many furnishings where possible.

The hospital is fully sprinklered throughout, based on Light Hazard Occupancy requirements. The sprinkler system is a Class I combination wet type automatic sprinkler-standpipe system. There are smoke detectors and dampers installed in the HVAC ductwork. These detectors will shut down the associated air handlers and/or operate the dampers. These detectors, along with sprinkler flow alarm switches, smoke detectors in the rooms, and manual pull stations are all connected to the building evacuation alarm system to alert the occupants in the event of a fire, and to alert the local Fire Department. The building alarm system includes alarm chimes, flashing lights, and indicators on the fire alarm control panel.

Transportation

The addition to the hospital is served by several nearby existing elevators. No new elevators are being installed. The existing building was designed to accommodate an expansion with the elevators located at the edge of the building. With the new addition, the elevators will now be in the core of the building.

Telecommunications

Nearly all rooms in the building feature telephone and data outlets. The telephone lines are integrated into the hospital's in-house telephone system. The data outlets allow computers to connect computers to the hospital's network, which is linked to the Johns Hopkins Hospital System's computer network.

Special Systems: Nurse Call System

Various types of nurse call terminals are provided in all areas where patients may require the assistance of a nurse. They send signals to nurse call control panels, and have an indicator light nearby to alert the nurses as to where the call came from. Some terminals also include intercom stations.

Special Systems: Hospital Paging Systems

Speakers for the paging system are installed in the ceilings throughout the hospital. Some phones, such as those for receptionists, are connected for transmitting over the paging system. Some areas, such as the Diagnostic Imaging Suite also have their own local paging systems.

Special Systems: Medical Gas System

The hospital has a system to distribute medical gases throughout the building to be used in specialized spaces such as operating rooms. These gases include oxygen, nitrous oxide, medical air, vacuum, and anesthesia evacuation.

Existing Electrical System

System Type and Utility Service

A secondary selective system is used to distribute incoming power from the utility. Though more costly than a radial system, this type of system allows for a continuous supply of power to essential systems required for the hospital. If either primary feeder is interrupted, the other can take over. It also allows for regular maintenance to be performed while still operating under normal power from the utility. This is particularly important since an interruption in service could be life-threatening for patients undergoing surgical procedures, or those relying on electrical life-support devices.

The facility is served by Baltimore Gas and Electric Company by a 13.2 kilovolt feeder to an existing outdoor switchgear located on the hospital's campus. The individual buildings are then fed from this switchgear. In the new West Addition, the voltage is stepped down to the building utilization voltage of 480/277 volts by two transformers with a wye configuration. The substation is 3 phase, 4 wires, and rated for 2500 kVA, 4000 Amps.

Emergency Power

The hospital is supplied by emergency power via existing on-site emergency generators. The main building has existing generator paralleling switchgear through which the emergency power is delivered to the building. Automatic transfer switches allow the essential systems to maintain power during an interruption of the power from the utility. The type of switches used are electrically operated and mechanically held. They are in NEMA 1 enclosures with manual operating handles allow for the operator to safely maintain the devices.

There are three different branches of emergency power found in the building: Life Safety Branch, Critical Branch, and Equipment Branch. The Life Safety Branch is to primarily supply power to egress lighting circuits. These circuits are found in all corridors, stairways, lobbies, and other large spaces or those used for egress during an emergency. Nurse call systems, fire alarms and other related devices are also on the Life Safety Branch so that they will remain powered during an emergency. The Critical Branch supplies power to a variety of essential systems in the building required for the hospital to continue to function and treat patients. This includes life-support systems, monitors, some computer systems, and surgical tools. The Critical Branch also includes some lighting circuits. Any switched lighting on emergency power is on the Critical Branch. For example, nurse stations must be provided with ample light at all times. Medical exam and surgical lights also must always be available when needed. Finally, the Equipment Branch contains primarily mechanical systems that need to maintain continuous power, and those essential during emergencies. For example, elevators are needed for use by fire fighters, and may be needed for egress. In addition, many HVAC devices need to remain functional to provide sufficient air quality. This is particularly important in operating room where large amounts of clean airflow are required to maintain a clean and comfortable environment.

Overcurrent Protection

The electrical system is protected from overcurrent by a variety of different devices, including fuses, fused safety switches, and circuit breakers.

Low voltage (600 amps or less) fuses are dual-element, U.L. class RK-5 current limiting time-delay type. Interrupting rating is 200,000 RMS symmetrical amperes. The size is described as NEMA class H. High voltage (601-6000 amps) fuses are NEMA class L, and also have an interrupting rating of 200,000 amperes.

Fused safety switches have current limiting "R" rejection feature fuses. They are rated to withstand a short circuit of at least 100,000 amps RMS. They are in heavy duty NEMA 1 steel enclosures (3R if outdoors), and can be equipped with at least two padlocks.

Enclosed circuit breakers are to be quick make, quick break, trip-free handle and calibrated for 40° C ambient temperature. They are common trip and have handles that indicate whether they are on or off.

Circuit breakers in panelboards are bolt-on type thermal magnetic tripping free of handle.

Layout

The new West Addition Substation is located on the ground (basement floor) of the building in the main electrical room located in the middle of the south side of the west addition. The motor control centers are located in the adjacent main mechanical room where most of the mechanical equipment for the building is located. The main electrical room also houses the automatic transfer switches, several large panelboards distributing power to the floors above, as well as transformers. The remainder of the panelboards and transformers are located in various electrical rooms on each floor of the building.

Lighting Systems

Nearly all of the lighting found in the building operates at 277 volts, with the exception of some specialty lighting, such as surgical task lighting, under-cabinet fixtures, dark room lights, and helicopter obstruction lights, which operate at 120 volts. The lighting fixtures are almost exclusively fluorescent, again with a few exceptions, including both high intensity discharge and incandescent. Metal halide fixtures are used outdoors in the parking area. The fluorescent ballasts found in the fixtures are electronic, Class P with A sound ratings. The ballasts are of high power factor (at least 0.95), ballast factor of at least 85%, and with a maximum total harmonic distortion of 10%. Dimming ballasts are dimmable to 1% for linear fluorescent fixtures, and 5% for compact fluorescent.

Lighting Analysis

The lighting for three different spaces in the hospital was analyzed and redesigned. These spaces include the lobby and reception area for the emergency department, a nurse station for the labor and delivery unit, and a staff conference room.

Before analyzing each space individually, there are a number of important design considerations to be implemented for any health care facility. For example, a major issue for the design is cost. This includes both the initial construction cost, as well as the life cycle cost, including operating and maintenance costs.

Another Important design issue is the age and disabilities of the occupants. The average age of people in the building is significantly higher than for other types of buildings. Visual abilities diminish with age, and many patients may actually have visual impairments, such as glaucoma or other disabilities. Therefore, the illuminance levels become even more critical to be met or exceeded. For the same reasons, direct glare issues also become more critical. Potential glare problems can be improved by increasing uniformity in spaces, and by using sources such as downlights and fixtures with louvers as opposed to lensed fixtures.

The lighting in a hospital should also help to create a comfortable and pleasant atmosphere. Hospitals can be potentially intimidating places; the lighting should be soft and convey a calm mood, but still must provide ample light for the medical staff to do their jobs effectively.

An appearance of cleanliness should also be conveyed. Bright surfaces can help to do this. Despite their actual cleanliness, dim surfaces may seem to be dark and dingy. This would convey a poor image to the patient. Relatively cool light (high color temperature) can also help to convey a clean appearance.

Good color rendering is especially important so the doctors and nurses can recognize potential problems with patients that may be identified by their appearance, such as skin discolorations. The hospital's standard light sources have a correlated color temperature 4100K, and a color rendering index of about 85. Unless otherwise specified in the lighting fixture schedules, these designs all utilized this standard.

The guidelines for illumination of all spaces are taken from the Illumination Society of North America Handbook, edited by Mark S. Rea. Energy consumption requirements are from ASHRAE Standard 90.1-1999. Information regarding specific pieces of equipment was primarily obtained from manufacturers' data. See the appendix for a complete list of references.

Lobby Lighting

Room Layout

The lobby area and waiting room for the emergency department consists of a number of different spaces that are integrated to become one large entry area. There is a work area for the receptionists right at the entrance. There is a large waiting room across from the reception desk. The waiting area includes a children's play area in the corner of the room. Adjacent to the reception desk is a small café area with vending machines and table. There is also a corridor area running between the waiting room and the rest of the space to allow for circulation.

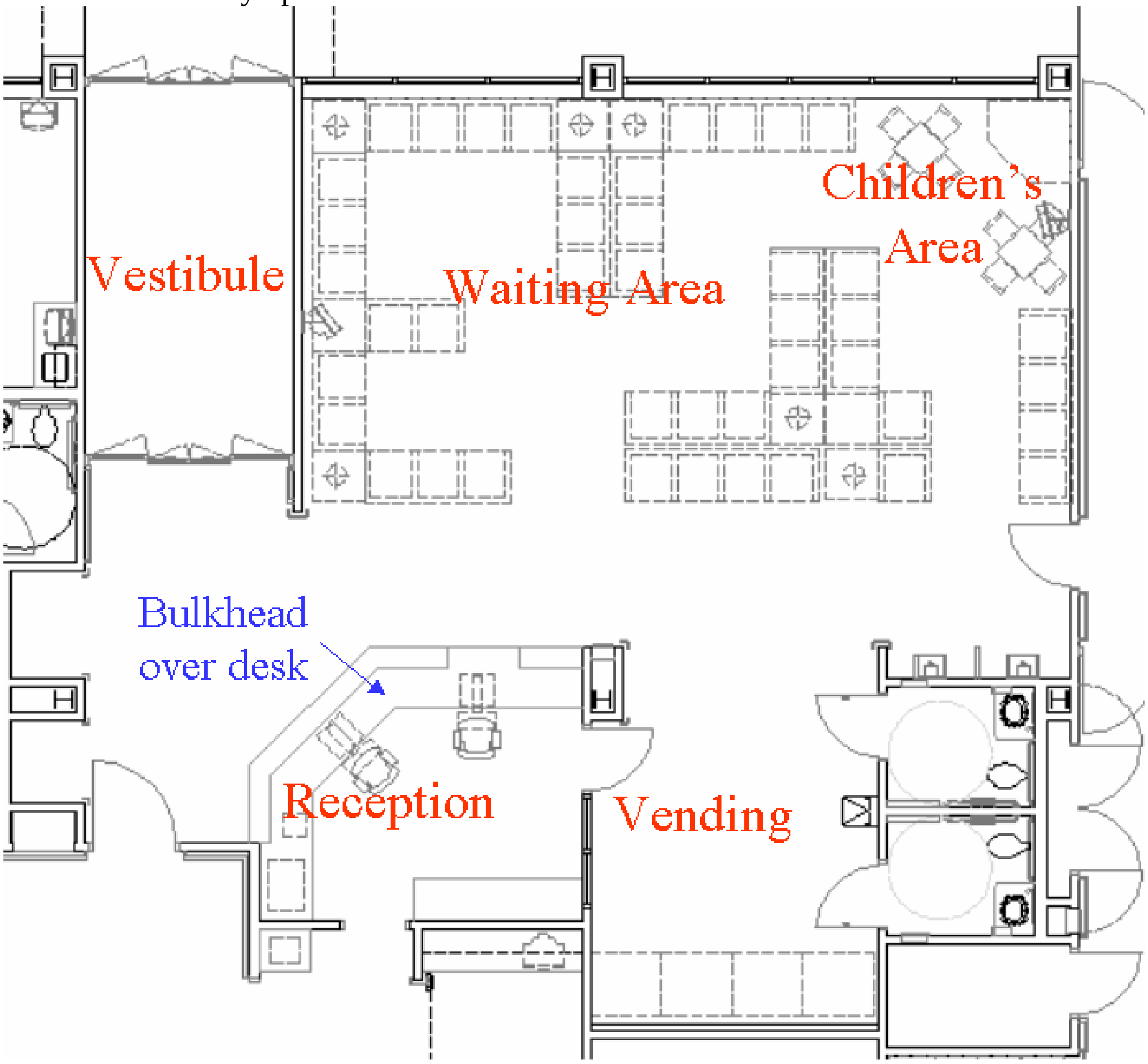
The ceiling in this space is somewhat complicated and presents a design challenge. Throughout much of the space, there is a 2'x2' suspended ceiling tile grid at ten feet above the floor. The orientation of the grid is at 45 degrees to the walls. There is a bulkhead that runs around the perimeter of the space at varying widths. This bulkhead is at nine feet above the floor. The receptionist area has a suspended ceiling tile grid also at a nine height. Another bulkhead separates the entry area from the receptionist area. The bulkhead is directly above the receptionist desk and is at 7'-6" above the floor.

The walls and bulkhead in the space will be of a light cream color with a reflectance of about 65 percent. The work surface of the receptionist's desk is a dark blue matte solid polymer with a reflectance of about 10 percent, and is at 30 inches above the floor. The surface of the part of the desk shared by the receptionists and the patients is 42 inches above the floor. The floor in the waiting area and the reception area is carpeted with a reflectance of about 30%. The remainder of the space is gray and white floor tile with a reflectance of about 50%.

There will be some artwork located on each of the two walls of the waiting area. There will be two pictures hanging on each wall.

The exterior wall of the waiting area is a window to the outside. There is a very limited amount of daylight available here. This glass is tinted, faces a northern exposure, and is shielded by a large overhang in front of the entrance to the emergency department. Also since this is the emergency department, which is in operation both day and night, daylight was not considered for this analysis.

Floor Plan of Lobby Space



Plan Courtesy of Leach Wallace Associates

<u>Design Criteria</u>

The tasks performed at the reception desk include both paper tasks as well as VDT use. The IES recommends a general horizontal illuminance level of 30 footcandles and a local illuminance of 50 footcandles on the desk surface, which should be fairly uniform. A vertical illuminance level of five to ten footcandles is also recommended. Direct glare is an important issue, as well as reflected glare from both the work surface and the VDT screens. With the reception area being open to the surrounding corridor, the source-task-eye geometry must be considered both within the nurse station and from the sources in the corridor. Uniformity of the room surfaces is important as they can also create veiling reflections in the VDT screens. Color and modeling of faces are also important for interaction between nurses and patients.

The tasks in the waiting and vending areas include relaxing and light reading such as magazines. The light levels in this space needs to consider both those who need a higher light level for reading as well as those who may want less light to just relax and pass the time. This space needs to have comfortable lighting because people waiting in the emergency room may already be in discomfort, and may be waiting here a while if the hospital is particularly busy. The IES recommends an illuminance of 30 footcandles for reading in a waiting area.

To give waiting patients some visual interest to help pass the time, the pictures are provided on the walls of the waiting area. These pictures are to be illuminated to accent them and contrast from the surrounding wall.

For the circulation area running down the middle of the space, the IES recommends a horizontal illuminance of ten footcandles in a corridor in a healthcare facility.

Design Solution

A round indirect/direct pendant is placed behind the reception desk to provide the general illumination for the nurses. The indirect light also illuminates the surfaces throughout the space, which provides uniformity to eliminate noticeable VDT reflections.

Local illuminance is delivered to the reception desk by overhead louvered slot fixtures in the bulkhead above the desk that provide light both to the desk and to the counter above the desk, which is shared by both the receptionists and the patients. Since the existing conditions indicate that there were downlights in this bulkhead, and no other drawings show any other equipment in the bulkhead, it was determined that the bulkhead is simply an architectural feature, and placement of these fixtures would not create a conflict with any other systems, and will help to bring attention to this aspect of the architecture.

The slot fixtures along with the pendant at the reception desk will make this the brightest area of the space. This will draw attention to the receptionist area, so that there is no question of where to go first for people entering the emergency department.

With the slots nearly directly above the desk and counter, any potential glare problem is reflected directly back up, and the source-task-eye geometry yields a glare-free condition for anyone on either side of the counter.

The rest of the space, including the entry area, waiting area, café, and circulation space, all share the same ceiling, and it is therefore logical to light them similarly. Due to the complicated nature of the ceiling, downlights were chosen to light this space. Indirect lighting was considered to provide a softer, more comfortable light, but was discounted because it would potentially create odd patterns on the bulkhead, which has a somewhat irregular configuration. Indirect light often helps to open up a room by making it feel more spacious. With a ten foot ceiling over most of the space, and a relatively large room to begin with, this was not necessary.

The target illuminance in both the waiting and vending/café areas is 30 footcandles. Since the corridor area in the middle is in no way isolated and shares a ceiling, a relatively uniform illuminance throughout the space is desired; so similar spacing of the downlights was applied throughout the space. Downlights can also be integrated easily into both the ceiling grid areas and the lower gypsum wallboard bulkhead ceilings.

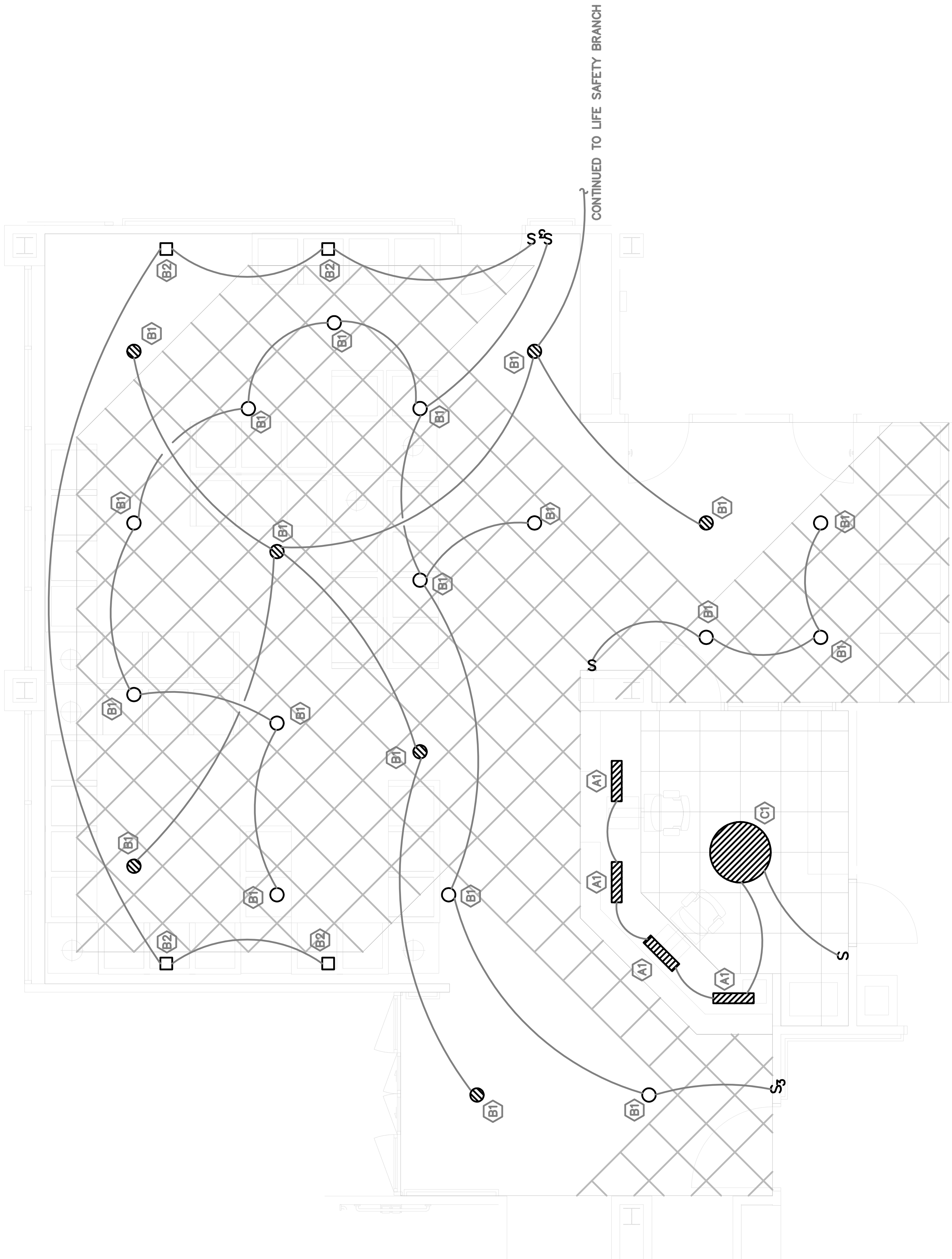
Narrow beam spotlights with T-6 metal halide lamps accent the four photographs on the walls of the waiting area. These accents draw attention to the artwork for patients who may be bored and need something of interest to look at. Metal halide sources were chosen for maintenance reasons. With the lights being on constantly in the emergency room, incandescent sources will burn out too frequently and be difficult to maintain. Fluorescent sources could not be used because the lamps are too large to get a very narrow beam angle from a spotlight. The small size, long life, and good color rendering of metal halide lamps make them ideal for this application.

A challenge in laying out both the downlights and the spotlights is to do so in such a way that they do not project unsightly scallop patterns on the bulkhead, which is a foot lower than the suspended ceiling tiles. Also, for this reason the spotlights were mounted in the bulkhead, rather than in the ceiling tile further from the wall.

The controls in this space are all toggle switches. A large degree of control is trivial here because the condition of the space remains pretty static, and it is in use at all times. Most of the space is operated on normal power. Some of the downlights are connected to the life safety emergency power branch to provide light during a power failure. The lights at the reception desk are connected to the critical emergency power branch as required by the National Electric Code. This is so that the essential services of the hospital can remain functional during a power outage.

Table lamps are provided on the end tables in the waiting room. These are primarily architectural features to give the waiting room a more comfortable residential feel, along with the soft chairs, end tables and carpeting. The lamps will also allow patients to get a slightly higher light level for reading, while conserving energy when not in use by turning them off. Because these lamps only contribute to their localized areas, and because the overall general illuminance is desired to be the full recommended level, these table lamps are shown in the rendering, but were turned off, so their light contribution to the room is neglected for this analysis. Compact fluorescent lamps at 16W will be recommended to conserve energy over an incandescent bulb.

For the actual layout of the lighting system for the lobby, see the lighting plan on the next page. Note that the lighting circuits are not shown to be connected to their power sources, to more clearly depict the switching arrangement.


CONTINUED TO LIFE SAFETY BRANCH
B1
B2
A1
C1
S
S3

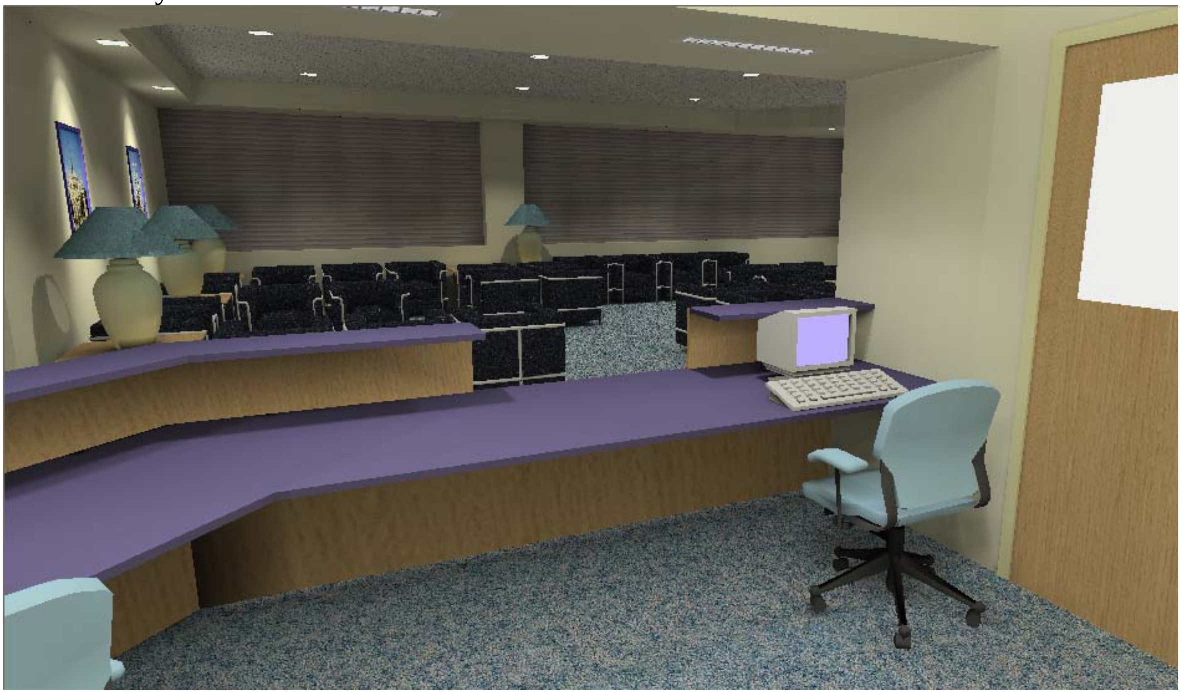
LIGHTING FIXTURE SCHEDULE					
FIXTURE	DESCRIPTION	LAMPS	VOLTAGE	BALLAST	WATTS
A1	COLUMBIA BRIO 4"x2' RECESSED FIXTURE PARABOLIC LOUVERS	(1) F14T5/841	277	ADVANCE ICN-2S28@277	19
B1	LITHONIA AFV DOWNLIGHT VERTICAL LAMP, OPEN REFLECTOR	(1) CF42TRT/841	277	ADVANCE ICF-2S26-H1-LD@277	46
B2	ERCO QUADRA SPOTLIGHT 10 DEGREE REFLECTOR	(1) MH39WT6/827	277	ADVANCE 71A5037J	48
C1	LITECONTROL MANTRA ROUND INDIRECT/DIRECT PENDANT	(3) F40BX/4100K (1) CFS21W/4100K	277	ADVANCE RCN-2TTP40-SC ICF-2S42-M2-LD	117 20

LIGHTING POWER DENSITY			
FIXTURE	WATTS PER FIXTURE	# OF FIXTURES	TOTAL
A1	19	5	95
B1	46	21	966
B2	48	4	192
C1	137	1	137
		TOTAL	1390
AREA: 1352 SQUARE FEET		**DENSITY (W/SF)**	1.0

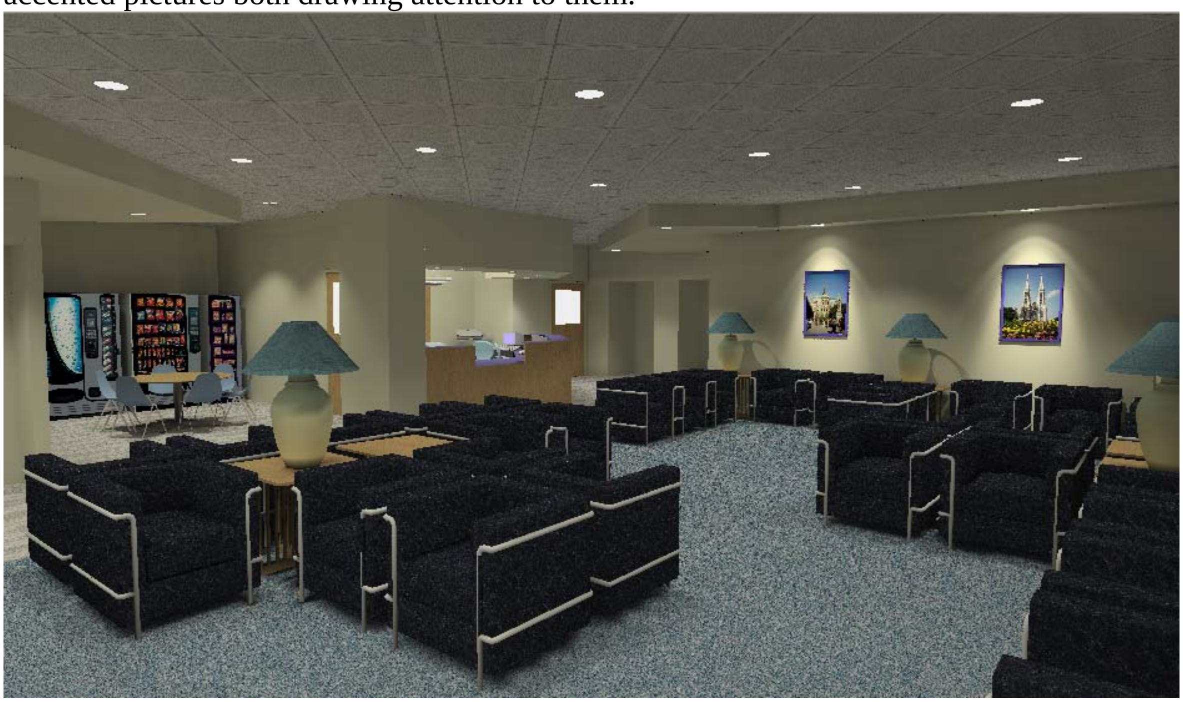
LIGHT LOSS FACTORS								
FIXTURE	TYPE	LDD	RSDD	LLD	BF	TOTAL LLF	INIT LUM	LUMENS
A1	IV	0.94	0.98	0.95	1.07	0.94	8700	8147
B1	IV	0.94	0.98	0.85	1	0.78	2700	2114
B2	IV	0.94	0.98	0.8	1	0.74	1350	995
C1	VI	0.93	0.93	0.9	1	0.78	10800	8407

DIRT CONDITIONS: VERY CLEAN
CLEANING CYLCLE: 12 MONTHS
RCR = 1 FOR SLOT (NO WALLS NEAR IT)
RCR = 3.6 FOR DOWNLIGHTS AND SPOTS
RCR = 7.6 FOR PENDANT BEHIND DESK

This rendering shows the view towards the waiting room from behind the reception desk. It shows that there is relatively uniform light on the desk, with the desk only barely shadowed by the above counter.

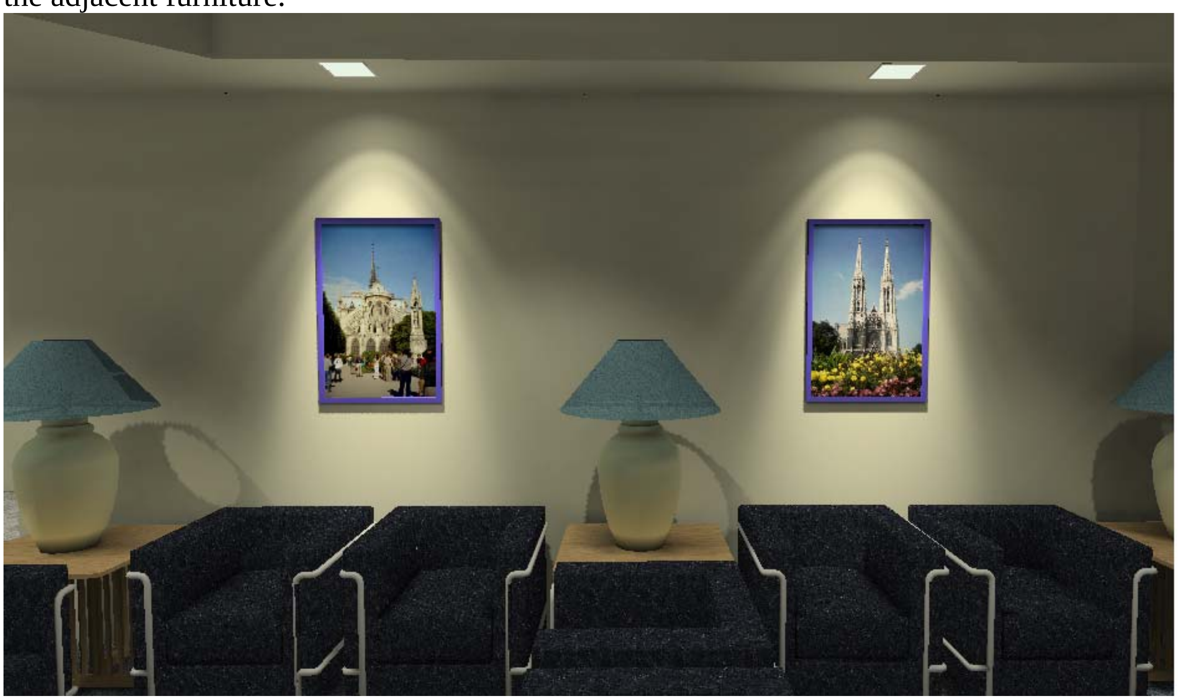


The following rendering is a view of the waiting area with the reception desk (center) and the café/vending area (left) in the background. This image shows uniformity in the waiting area, and shows the visual hierarchy with the brightness of the reception area and the accented pictures both drawing attention to them.

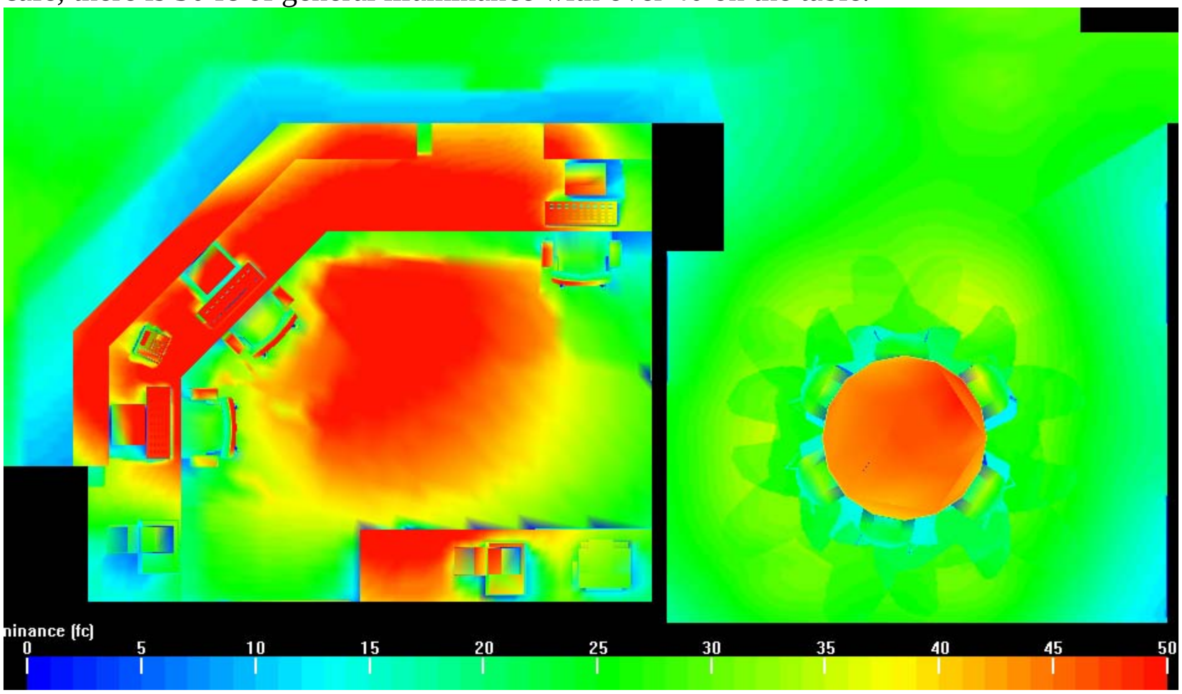


This rendering shows the café/vending area as well a view into the reception desk. Note that in all of these renderings, the bulkhead remains uniform and is not subject to bright scallops from the downlights.

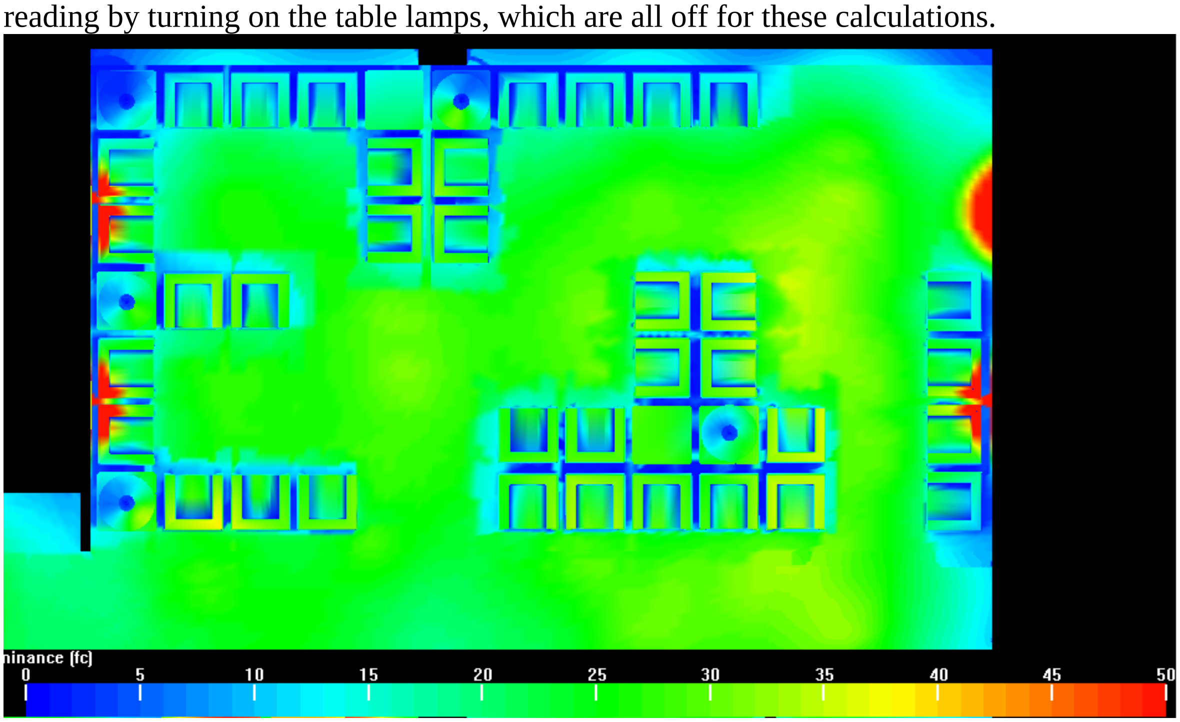
This rendering is a close-up of the accented pictures. The tight candela distribution of the spotlights casts light on the pictures, and limits the spill light onto the rest of the wall and the adjacent furniture.



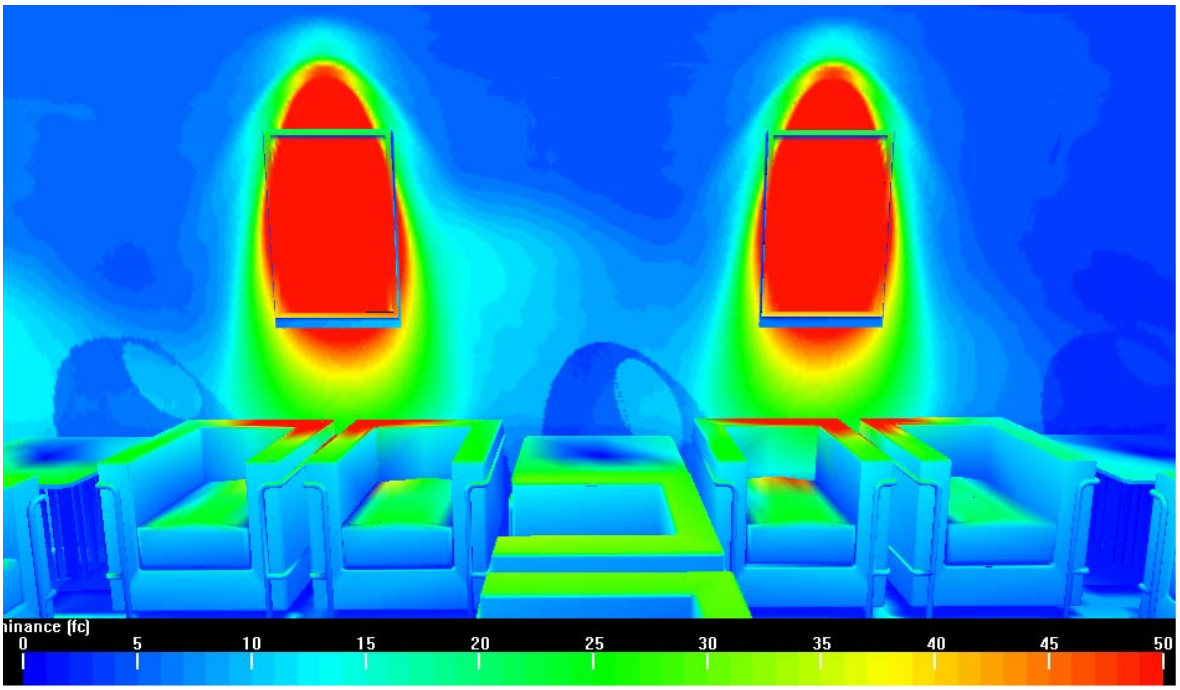
This false color image shows that the desired illuminance levels have been met for both the reception desk and the café area. The intended general illuminance behind the reception exceeds the recommended 30 fc. 50 fc is achieved on both the desk and counter. In the café, there is 30 fc of general illuminance with over 40 on the table.



This false color image shows that the illuminances throughout the waiting area and the circulation space are all around the desired 30 fc. Additional can also be acquired for reading by turning on the table lamps, which are all off for these calculations.



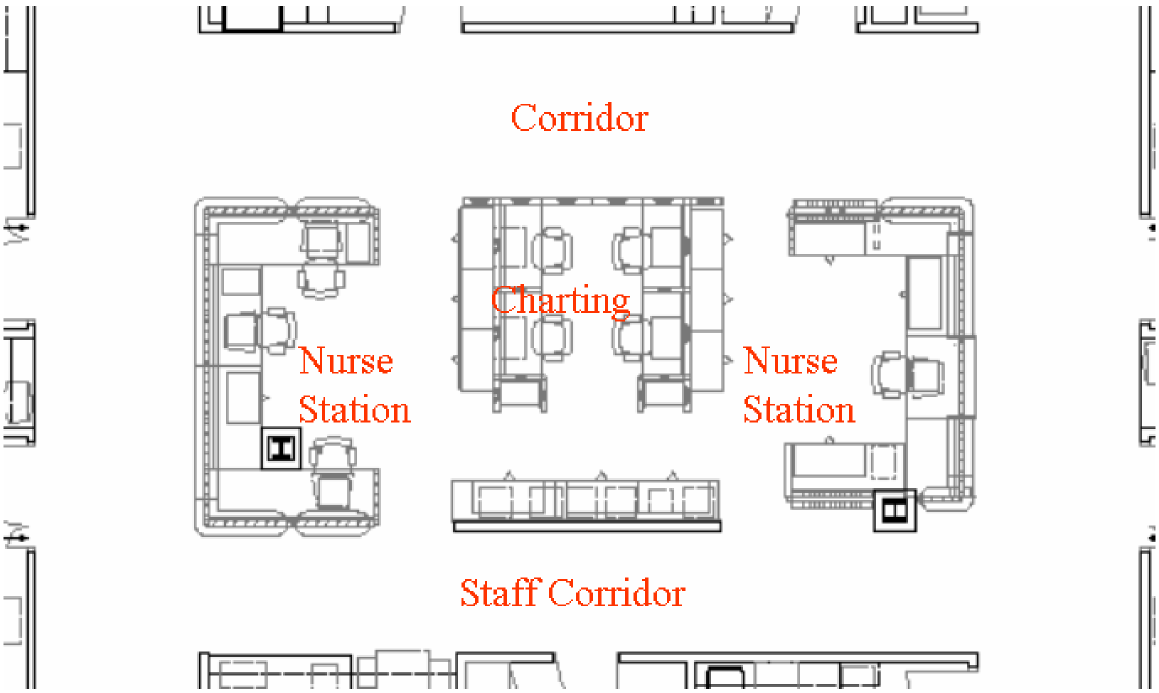
This false color image again depicts the accenting on the artwork in the waiting area, showing the very bright center of the 10 degree spotlights is focused directly on the pictures with little spill light. The biggest spill light issue is the added horizontal illuminance on the chairs, from about the typical 30 fc to about 50 fc. The only way to prevent this would be to move the spotlights further away from the wall. This would be impractical, because they would create scallops on the bulkhead. These are mounted in the bulkhead to prevent this. Their geometry and orientation also integrates better architecturally with the bulkhead than with the grid ceiling.



Nurse Station Lighting

Room Layout

The nurse station space for the Labor and Delivery Unit also consists of several different areas. There are two sets of nurses' desks that flank both sides of the central charting area. A corridor surrounds these three spaces with the nurses' desks being open to the corridor. The desks along with a bulkhead above them separates the nurse stations from the corridor. The charting area does have full height walls on all four of its sides.



Plan Courtesy of Leach Wallace Associates

The ceiling of the corridor is a 2'x2' suspended ceiling tile grid with an 80 percent reflectance. The grid is suspended nine feet above the floor. An 8-inch wide gypsum wallboard bulkhead with an 80 percent reflectance runs along the walls on both sides of the corridors at eight feet above the floor, with the nine-foot grid ceiling on the interior of the bulkhead. Another bulkhead that is three feet wide surrounds the nurse station at 7'-2". Inside of this bulkhead, where the workspaces are, is another 2'x2' ceiling tile grid at nine feet above the floor.

The walls will be painted a neutral light cream color with a reflectance of about 65 percent. The work surface of the nurses' desks is a light colored matte solid polymer with a reflectance of about 40 percent, and is at 30 inches above the floor. The counter above the desk is a dark colored semi-specular wood finish with a reflectance of about 15 percent, and this work surface is at 42 inches above the floor.

Design Criteria

The tasks performed at the nurse station include both paper tasks as well as VDT use. The IES recommends a general horizontal illuminance level of 30 footcandles and a local illuminance of 50 footcandles on the desk surface, which should be fairly uniform. A vertical illuminance level of five to ten footcandles is also recommended. Direct glare is an important issue, as well as reflected glare from both the work surface and the VDT screens. With the nurse station being open to the surrounding corridor, the source-task-eye geometry must be considered both within the nurse station and from the sources in the corridor. Uniformity of the room surfaces is important as they can also create veiling reflections in the VDT screens. Color and modeling of faces are also important for interaction between nurses and patients.

The central charting area is surrounded by walls, and the tasks here are similar, but feature more extensive VDT use. The IES recommends an illuminance of 30 footcandles for such tasks. The horizontal illuminance is less important here, but VDT considerations are of high importance. Due the geometry of this small room, glare from veiling reflections due to ceiling light sources will not be a problem. Relative uniformity of light in the space is the primary issue regarding light reflected by VDT screens.

For the surrounding corridor area, the recommended illuminance is only ten footcandles. While little vertical illuminance is required for the corridor space, brighter surfaces will make the space appear less confined and less dreary. To make the corridors of a hospital even more comfortable for patients, light sources can be selected that provide ample light, but have some diffuseness, so that a patient who is lying on their back, being wheeled along on a bed, will not have to be looking up directly at bare lamps, which could cause discomfort due to their glare. As with any space in a hospital, a pleasant overall appearance is important to make a potentially depressing place as comfortable as possible. Controls for this space are also an issue as energy can be saved when the nurse station is not fully staffed, and at night, when the corridor is not continuously occupied.

Design Solution

A round indirect/direct pendant is placed over each of the nurse station desk areas to provide the necessary general illumination. The indirect light also helps to provide uniformity to the space, and by giving the space a larger feel by brightening all surfaces in the room. Without a bright ceiling, the space may feel very confined if it was dark overhead and the surrounding walls in the corridor were bright.

Local illuminance is delivered to the nurses’ desks by overhead slot fixtures in the bulkhead above the desk that provide light both to the nurses’ desks and to the counter above the desk, which is shared by both the nurses and the patients. As with the slot fixtures in the bulkhead above the reception desk in the lobby area, this bulkhead is empty, except for the lights, which therefore do not pose any coordination problems.

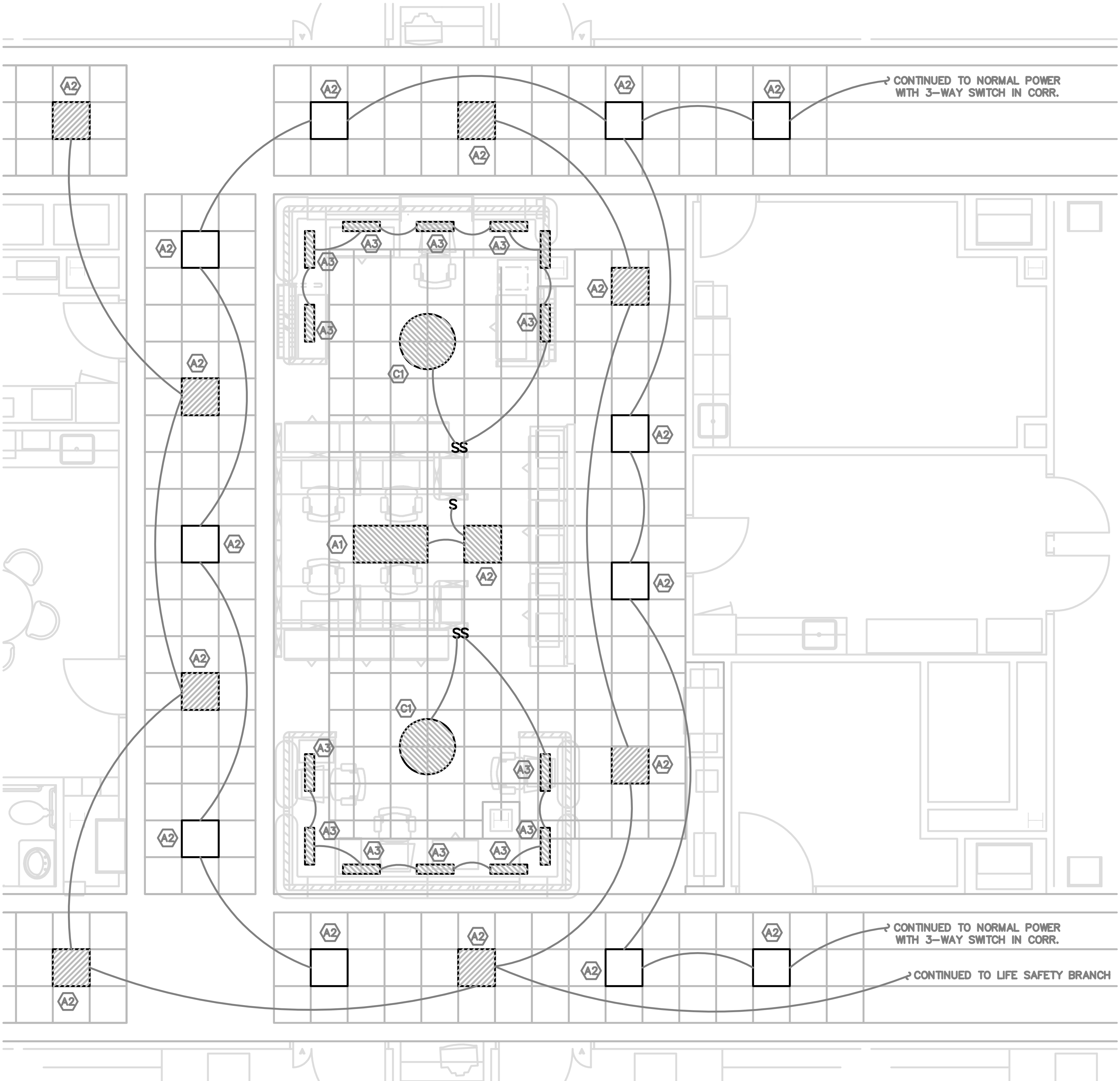
The charting area is illuminated simply by a 2'x4' lensed troffer. The lens serves to diffuse the light and provide more light to the upper parts of the wall surfaces so that with the brighter surfaces, this small area feels less cramped, especially if there are people occupying all four seats in this small room. Because of the geometry of this space, the lensed troffer will not cause any veiling reflection problems in the VDT screens. Its relatively diffuse distribution will also help to provide uniformity to further prevent veiling reflections.

With bulkheads running down the center of the corridor, this space was somewhat of a challenge to find fixtures that would not create odd patterns. For example, indirect fixtures that deliver a lot of light to the ceiling may create a very dark underside to the bulkheads. Other sources may create harsh shadows on the upper walls cast by the bulkhead. The fixtures chosen were 2'x2' recessed direct/indirect luminaires typically spaced eight feet on center. These fixtures provide plenty of light to the floor for orientation. They prevent a patient, who is lying on his back while being wheeled through the corridor, from having to look up directly into a bare lamp as they might with parabolic louvers or with downlights. The fixtures are also oriented to provide light as high as possible on the wall surfaces. This orientation also looks better because it has the fixture positioned so that the side baskets containing the lamps are aligned with the corridor.

The calculation grids below show that the target illuminances established by the design criteria have been met. Note that due to the symmetry of the space the calculations are not shown for every redundant area.

The controls for this area will all be toggle switches. The corridor will naturally have bi-level switching because there will be some lights on the normal power branch, which can be switched, and some will be on the life safety emergency power branch, which will always be on. At night, when most patients are likely to be sleeping, the lights could be turned down. A switch will control each side of the nurse station and the charting area will each be switched separately, so that energy can be saved when the nurse station is not fully staffed, and some areas are not in use. By code, the lights in the nurse station are connected to the critical emergency power branch, which can be switched off when not in use (as opposed to the life safety branch). The lighting plan is shown below.

The power density for this space is only 0.77 watts per square foot, which falls well below the requirements of ASHRAE/IESNA Standard 90.1-1999.


CONTINUED TO NORMAL POWER
WITH 3-WAY SWITCH IN CORR.
A2
A3
C1
A1
SS
S
CONTINUED TO NORMAL POWER
WITH 3-WAY SWITCH IN CORR.
CONTINUED TO LIFE SAFETY BRANCH

LIGHTING FIXTURE SCHEDULE

FIXTURE	DESCRIPTION	LAMPS	VOLTAGE	BALLAST	WATTS
A1	COLUMBIA BRIO 4'x2' RECESSED FIXTURE PARABOLIC LOUVERS	(1) F14T5/841	277	ADVANCE ICN-2S28@277	19
B1	LITHONIA AFV DOWNLIGHT VERTICAL LAMP, OPEN REFLECTOR	(1) CF42TRT/841	277	ADVANCE ICF-2S26-H1-LD@277	46
B2	ERCO QUADRA SPOTLIGHT 10 DEGREE REFLECTOR	(1) MH39W T6/827	277	ADVANCE 71A5037J	48
C1	LITECONTROL MANTRA ROUND INDIRECT/DIRECT PENDANT	(3) F40BX/4100K (1) CFS21W/4100K	277	ADVANCE RCN-2TTP40-SC ICF-2S42-M2-LD	117 20

LIGHTING POWER DENSITY

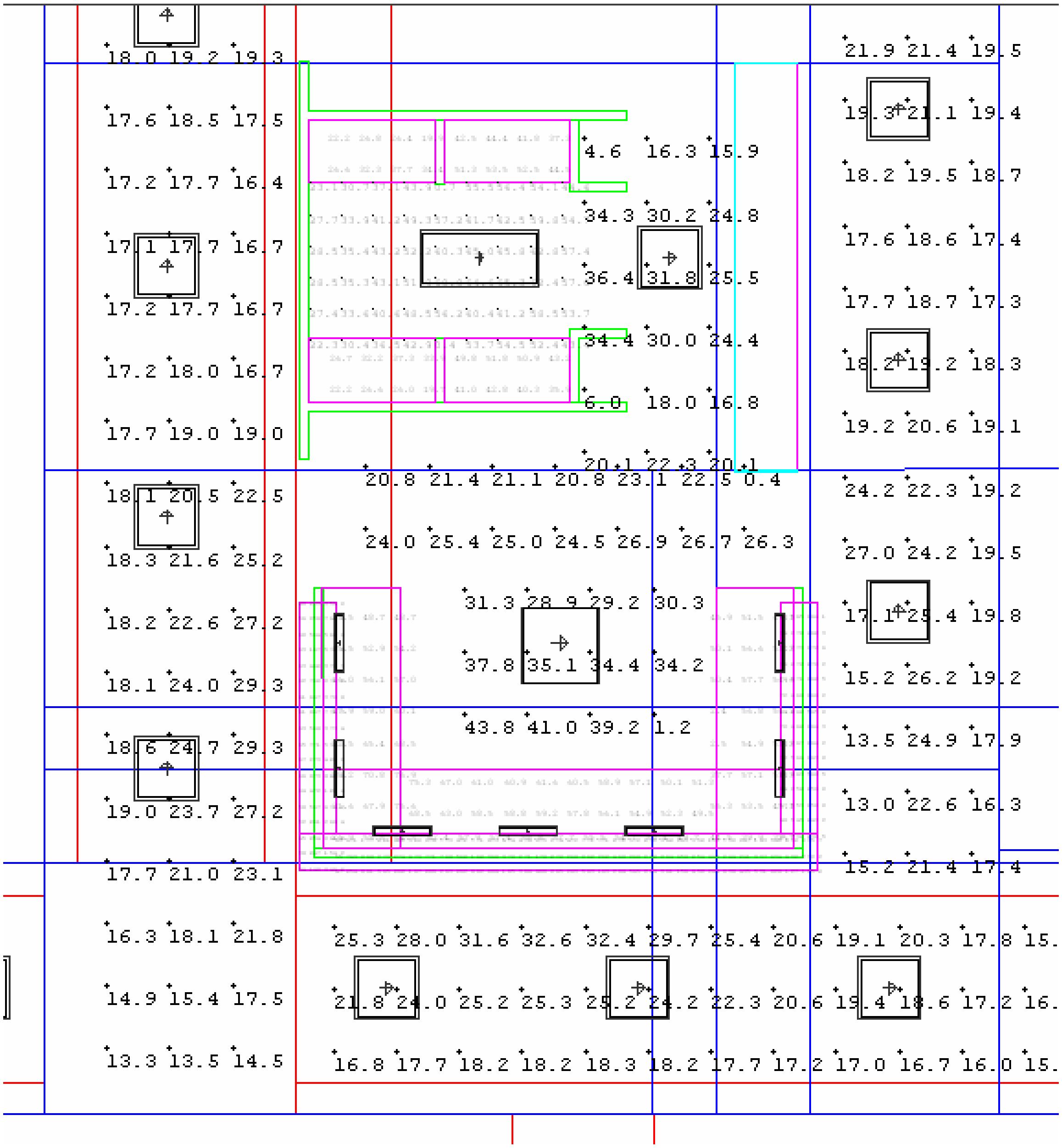
FIXTURE	WATTS PER FIXTURE	# OF FIXTURES	TOTAL
A1	19	5	95
B1	46	21	966
B2	48	4	192
C1	137	1	137
TBLL	16	6	96
		TOTAL	1486
AREA: 1352 SQUARE FEET		DENSITY (W/SF)	1.1

LIGHT LOSS FACTORS

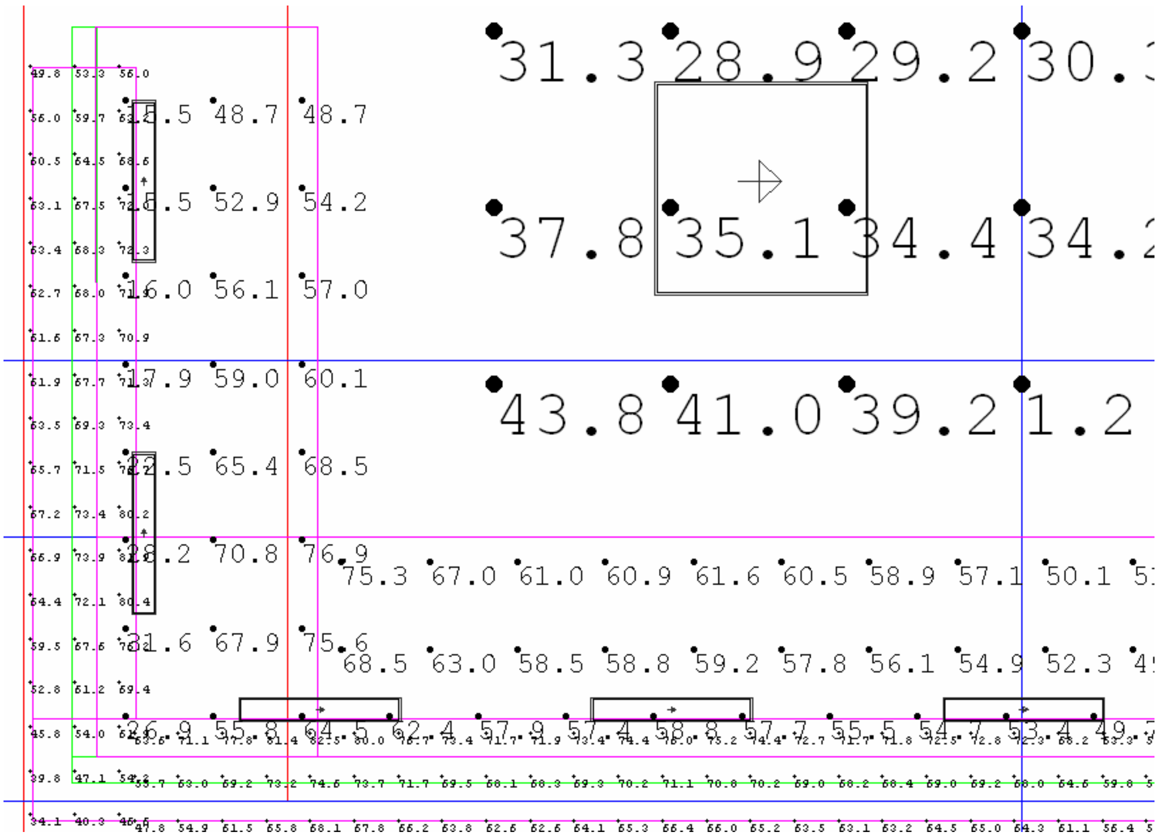
FIXTURE	TYPE	LDD	RSDD	LLD	BF	TOTAL LLF	INIT LUM	LUMENS
A1	V	0.93	0.97	0.9	0.88	0.71	8700	6216
A2	IV	0.94	0.97	0.9	1	0.82	2700	2216
A3	IV	0.94	0.97	0.95	1.07	0.93	1350	1251
B1	VI	0.94	0.98	0.9	0.95	0.79	10800	8506

DIRT CONDITIONS: VERY CLEAN
CLEANING CYLCLE: 12 MONTHS
RCR = 7.7 FOR LENSED TROFFER IN CHARTING
RCR = 6.5 FOR CORRIDOR
RCR = 1 FOR SLOT (NO WALLS NEAR IT)
RCR = 4.3 FOR PENDANTS BEHIND NURSE DESKS

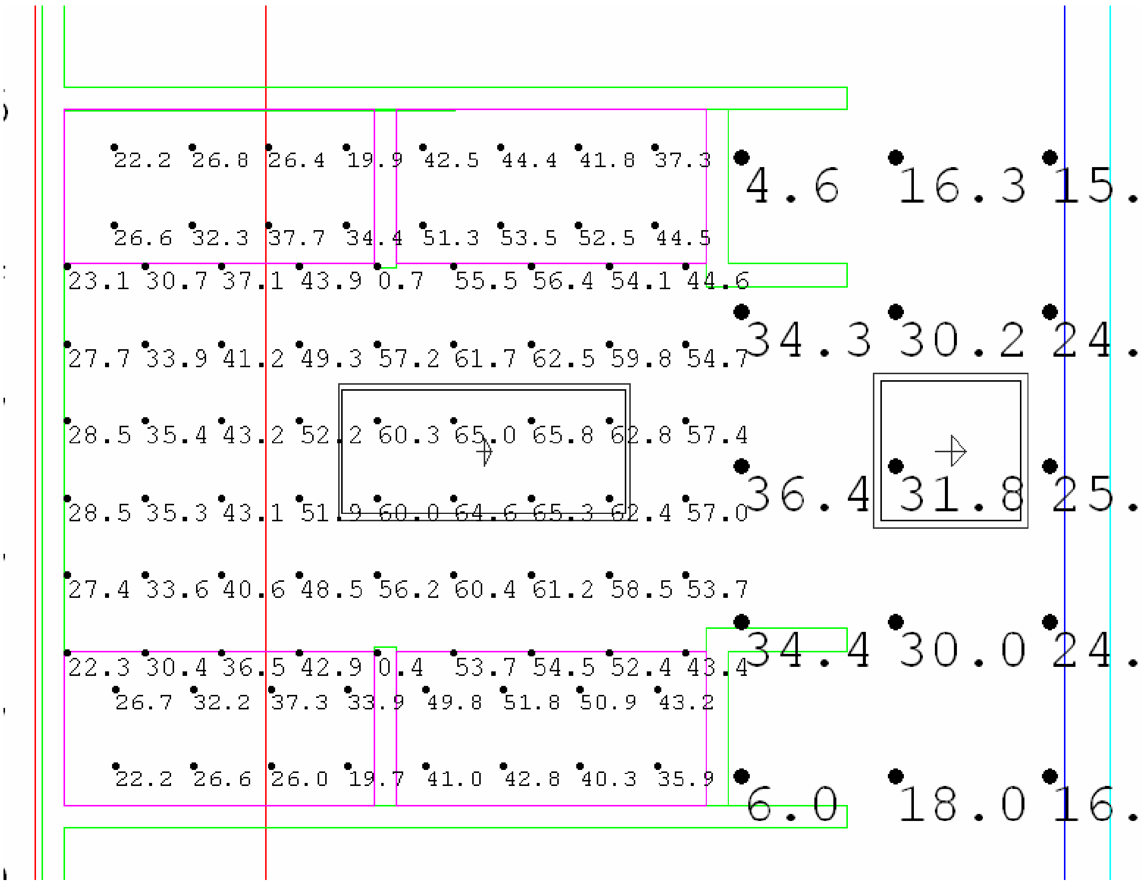
This illuminance grid shows the illuminances in the corridor are relatively uniform and are well above the recommended level of 10 footcandles.



This illuminance grid shows that the lighting system achieves the recommended general illuminance of 30 footcandles in the area behind the nurses' desk. It also shows that the recommended local level of 50 footcandles is reached on the desk surfaces with a high degree of uniformity.



This illuminance grid shows the recommended 30 footcandles is more than achieved with the lensed troffer. The recessed direct-indirect fixture in the circulation area within the nurse station also delivers well over the 10 footcandles needed for circulation.



Conference Room Lighting

Room Layout

The walls of this small room are a light cream color with a reflectance of 65 percent. The surface of the table in the center is a matte white solid polymer with a reflectance of about 80 percent. There is room for eight chairs around the table. There will also be small dark wood tables in two corners of the room, one with a television on top of it, the other with a personal computer monitor for use in video conferencing. The camera will be mounted on top of the monitor. Due to the orientation of the camera and table, not all of the seats will be occupied during video conferencing. A four foot by five foot projection screen hangs from one wall above a low dark wood bookcase. When in use, the projector will rest in the center of the table. There is also a white four foot square marker board on the wall opposite the projection screen. The ceiling is a 2'x2' suspended ceiling grid hung at 8'-6" above the floor. The ceiling tiles are white with an 80 percent reflectance.

Design Criteria

Though this is a relatively small space, visual tasks will vary widely for the conference room. This will require a versatile lighting system to accommodate these different activities. It can be used for meetings involving the reading from paper, it may include use of the marker board. Presentations may be projected on the screen. The television will also be used for video presentations.

For general meeting situations, the IES recommends a horizontal illuminance of 30 footcandles and a vertical illuminance of 5 footcandles. For video conferences, higher levels are required for quality video renderings by the camera. The recommended levels are 50 footcandles of horizontal illuminance and 30 footcandles of vertical illuminance. Other considerations are also important for video conferencing, such as a maximum luminance uniformity ratio on the face of three to one. The vertical illuminance is extremely important to prevent harsh shadows on peoples' faces. A target of 30 footcandles of vertical illuminance will also be applied to the white marker board. As with any meeting space, color and modeling of faces is an important design consideration, and is even more important for the video camera. Glare is also an issue, from direct and reflected components, most notably in the VDT screens and possible the marker board. In addition, luminance uniformity of the surfaces will also prevent veiling reflections in these surfaces and will improve the video renderings. With all of these different tasks that may take place in this space on a regular basis, it will be important to have a convenient control system that provides the proper light quality and quantity for each task. This will improve the functionality of the space and can help to conserve energy.

Being a very small space which may be occupied by several people at one time during meetings, it is important for the surfaces in the room to be bright to convey a feeling of spaciousness. This can be achieved through the application of indirect lighting to the space which will brighten the walls and ceiling while delivering the proper amount of illumination to tasks and faces.

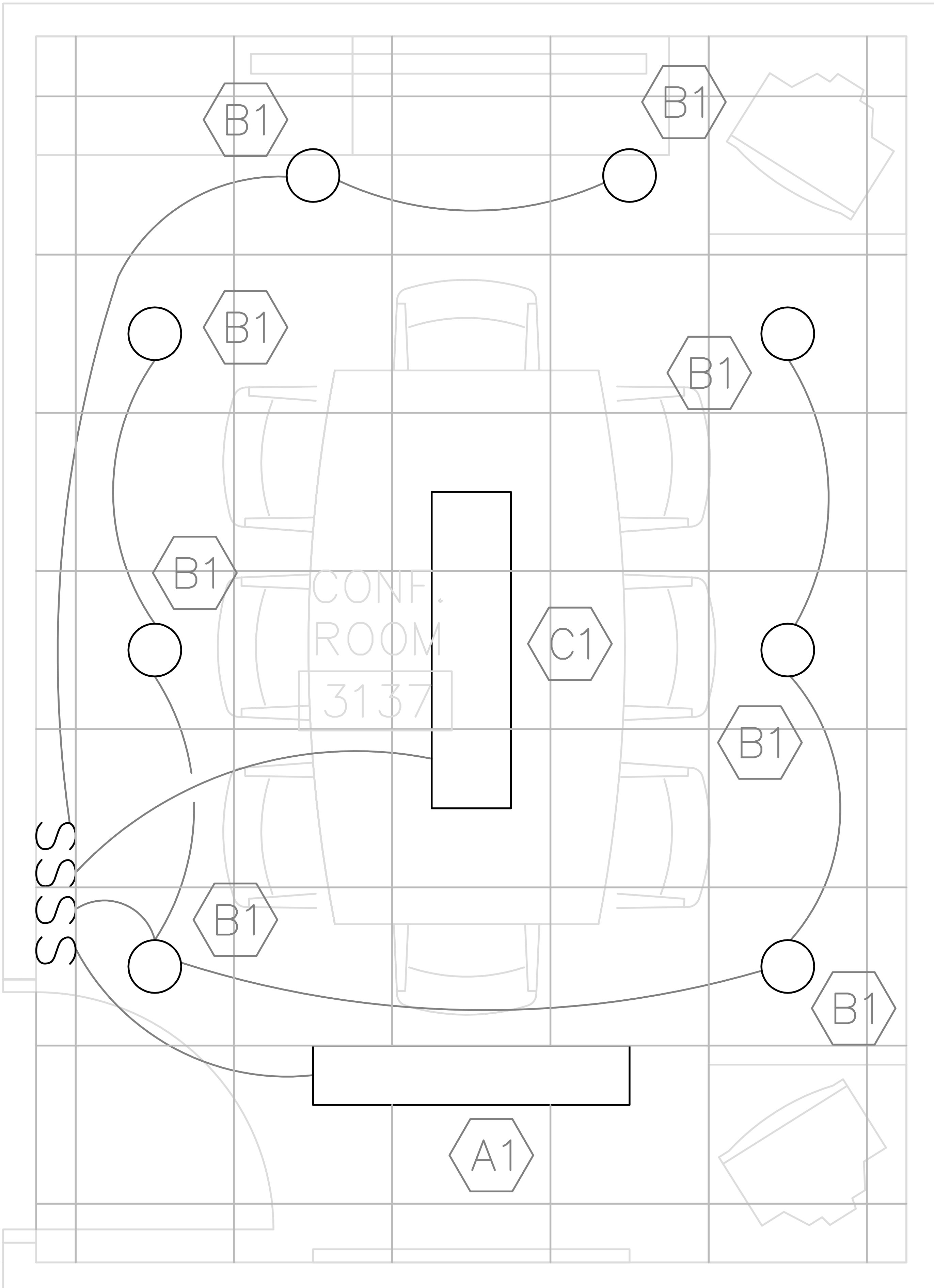
According to ASHRAE/IESNA Standard 90.1-1999, the maximum allowable power density for a typical conference room is 1.5 watts per square foot.

Design Solution

An indirect-direct pendant in the center of the room delivers light to the ceiling which provides relatively uniform direct light to the entire space. It creates a bright ceiling and walls and provides ample light to the table. Wallwash downlights illuminate the walls to create bright surrounding surfaces in the space for a more spacious appearance. Their light distribution also allows them to provide a direct light component towards the center of the room to help model faces. The surface of the table has a relatively high reflectance (60%) to help reflect light off table to provide light to the lower parts of the faces to increase uniformity. Finally a wall slot fixture above the white marker board provides the necessary illumination to the marker board. It also serves to provide indirect light to the space and brightens the wall, but can be turned off to conserve energy when the light is not needed.

Controls for this space are important to facilitate versatility. Though this is a very small room, to there will be four toggle wall switches. For meetings, the pendant will be switched on. The wallwashers will likely be left off, as their contribution is trivial for most situations. The light for the marker board can be switched on or off as necessary. For audiovisual presentations, the wallwash downlights away from the projector screen will be switched on to provide some direct light to the table, if necessary for jotting down notes, and the pendant will be turned off. Those downlights in front of the projector screen will be turned off so that they do not wash out the projected screen image. For videoconferencing, all of the lights will be switched on. An occupancy sensor will also be provided in the room to automatically shut off the lights when the room is not in use. For further clarification on the layout of the lighting system and the switching configuration, see the lighting plan on the next page. This versatility of the lighting system will enhance the various tasks performed here as well as conserve energy when possible. Dimming of some or all of these lights is another option, but was not implemented because there is plenty of switching control to be more than adequate, and dimming adds considerable construction expense.

The lighting power density is 1.7 watts per square foot. This is slightly above the 1.5 watts per square foot allowed by ASHRAE/IESNA Standard 90.1-1999. The high design levels recommended for video conferencing can account for this discrepancy. It will be rare that all lights in this space will be on at all times. The only time that this condition was designed is for video conferencing. For general meetings, the power consumption will fall into compliance. ASHRAE/IESNA Standard 90.1-1999 also allows the excess energy to be recovered in other spaces, which it is more than made up in the other two spaces designed in this report.


B1
B1
B1
B1
B1
C1
CONF.
ROOM
3137
B1
B1
B1
SSSS
A1

LIGHTING FIXTURE SCHEDULE					
FIXTURE	DESCRIPTION	LAMPS	VOLTAGE	BALLAST	WATTS
A1	LITECONTROL WALL/SLOT-2000 PR WALL SLOT FIXTURE WITH PARABOLIC REFLECTOR	(1) F54T5HO/4100K	277	ADVANCE ICN-2S54-90C@277	62
B1	LITHONIA AFVW WALLWASH DOWNLIGHT VERTICAL LAMP, OPEN REFLECTOR	(1) CF13DTT	277	ADVANCE ICF-2S13-H1-LD@277	16
C1	LITECONTROL CLASSICA ID (P-ID-5500) 4' INDIRECT-DIRECT PENDANT	(2) F32T8/4100K (1) F40BX/4100K	277	ADVANCE VCN-2S32-SC ADVANCE VCN-2TTP40-SC	32 44

LIGHTING POWER DENSITY			
FIXTURE	WATTS PER FIXTURE	# OF FIXTURES	TOTAL
A1	62	1	62
B1	16	8	128
C1	108	1	108
		TOTAL	298
AREA: 170.5 SQUARE FEET		**DENSITY (W/SF)**	1.7

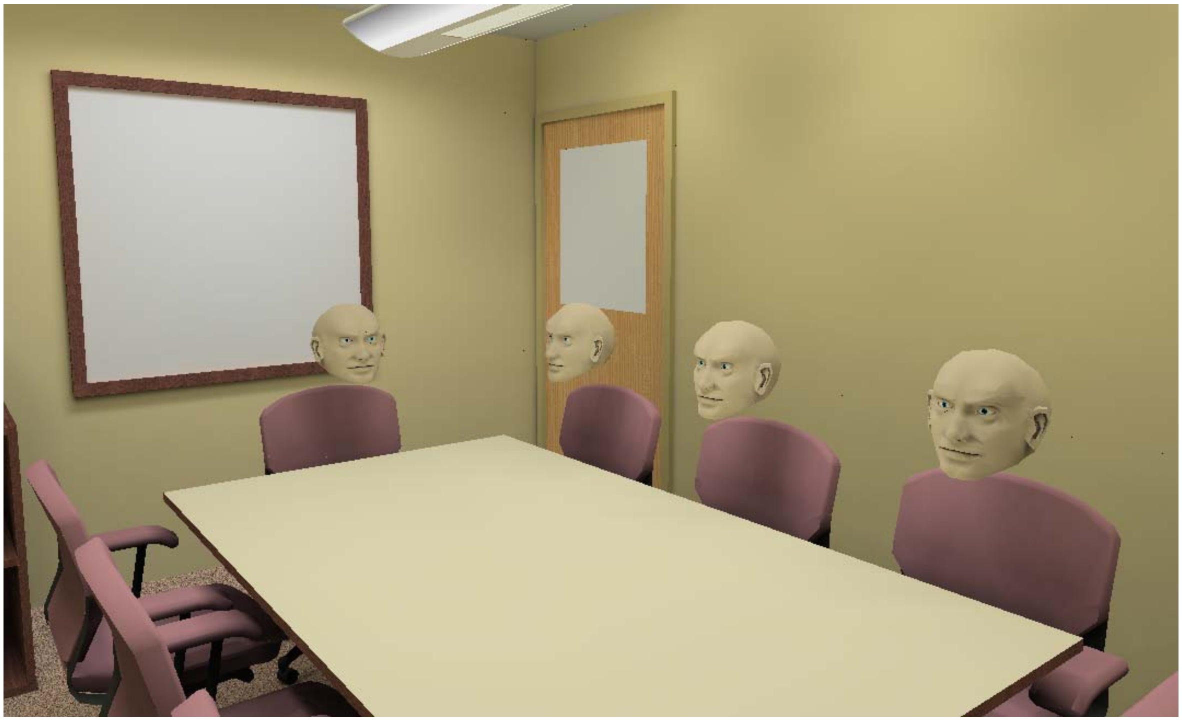
LIGHT LOSS FACTORS								
FIXTURE	TYPE	LDD	RSDD	LLD	BF	TOTAL LLF	INIT LUM	LUMENS
A1	IV	0.94	0.98	0.95	1.02	0.89	5000	4463
B1	IV	0.94	0.98	0.85	1	0.78	900	705
C1	II	0.97	0.94	0.9	0.92	0.75	8950	6757

DIRT CONDITIONS: VERY CLEAN
CLEANING CYLCLE: 12 MONTHS
RCR = 6.6

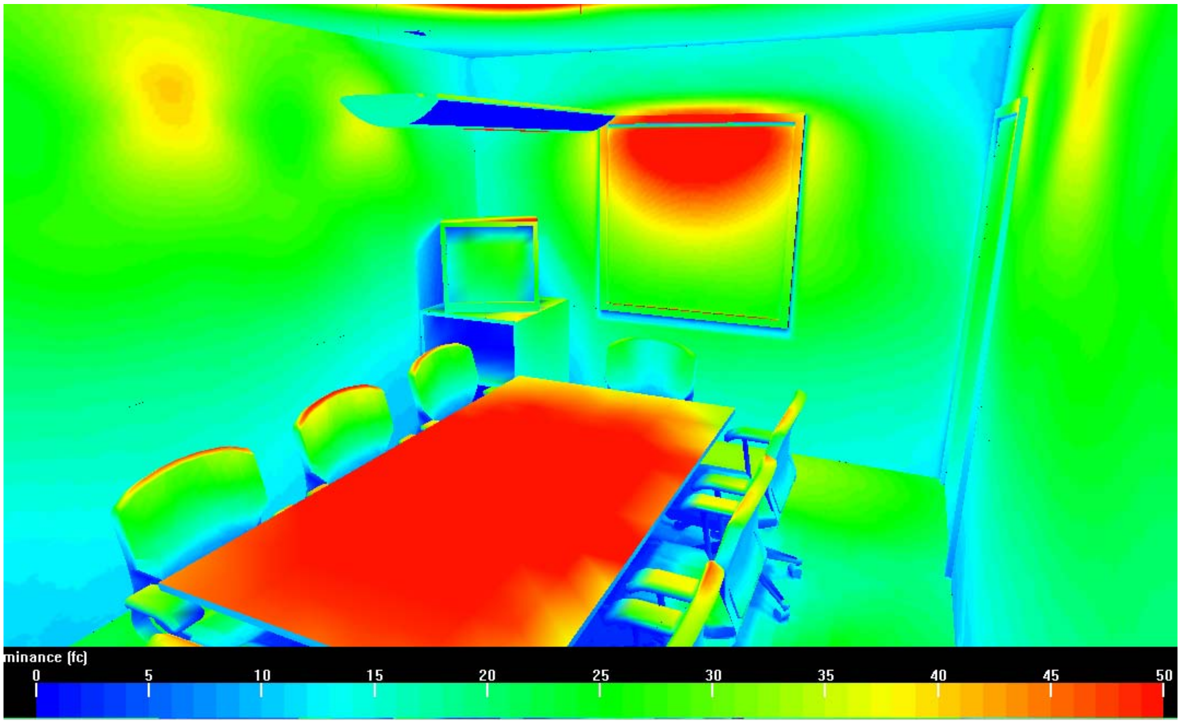
The following renderings show the appearance of the space, with it's bright surfaces to help the room feel larger. The lighting system provides a comfortable environment for face-to-face communication, reading, and audiovisual presentations.

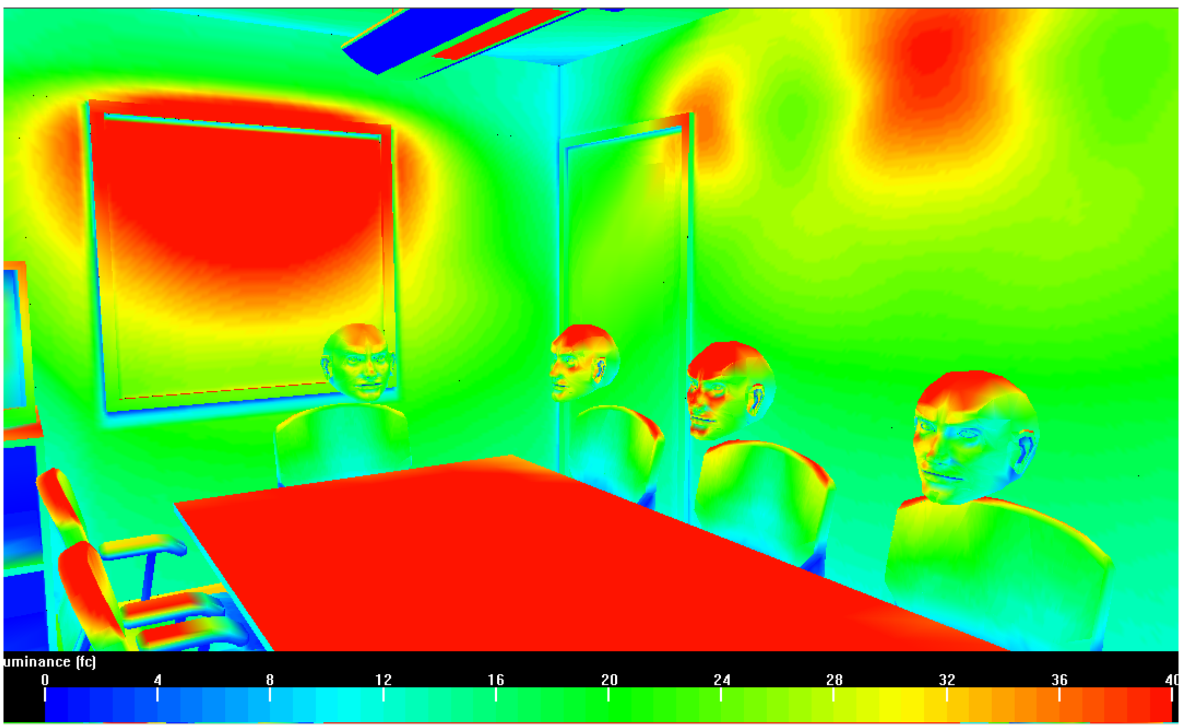
This rendering shows the view of the conference room looking towards the position of the camera and videoconferencing monitor as well as where the projector screen will be for audiovisual presentations.

This rendering shows the view of the conference room as seen from the camera. Faces were inserted into the room to examine the effectiveness of the lighting system for facial rendering. This view also shows how the slot fixture effectively illuminates the marker board.

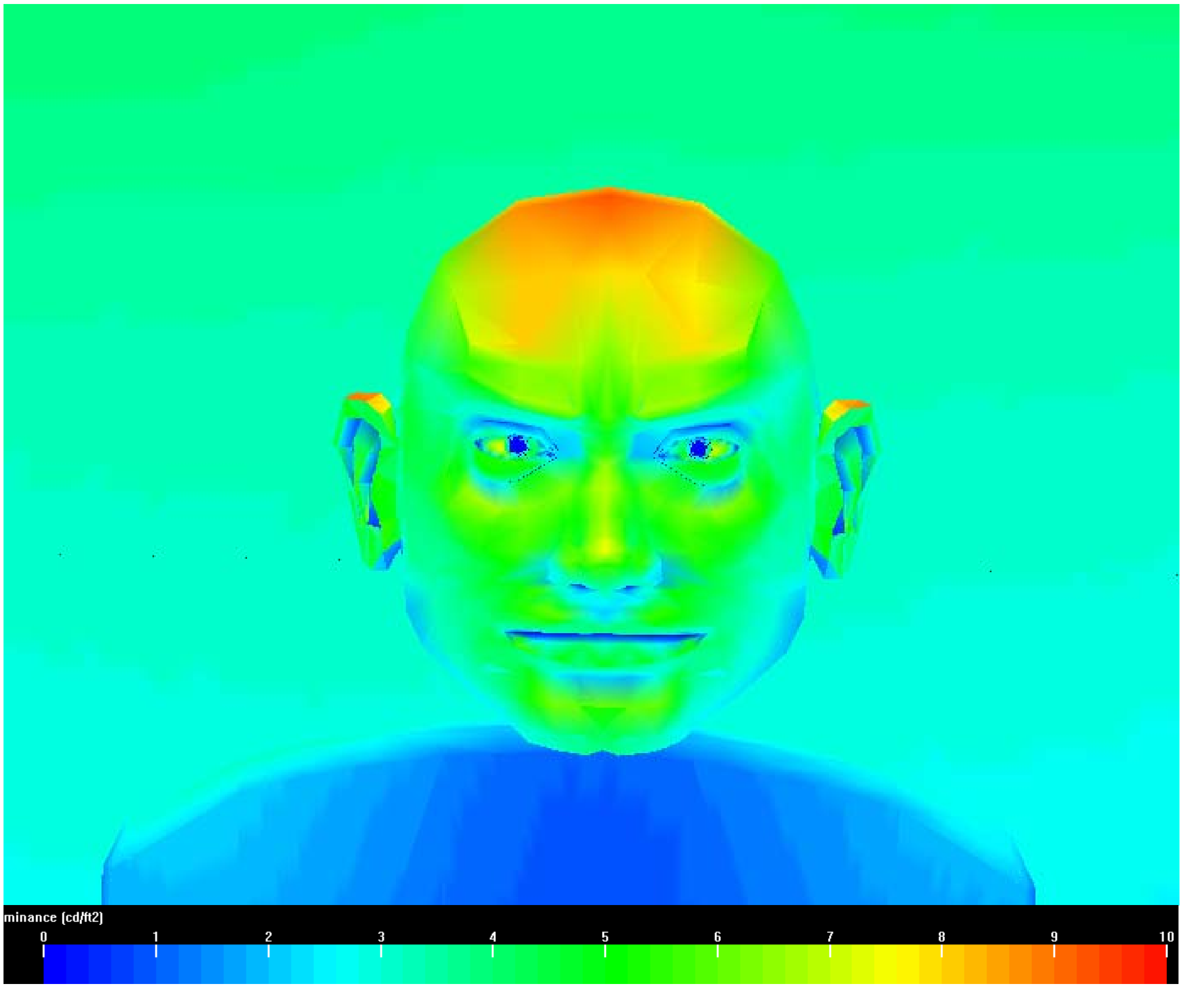


As can be seen in the illuminance false color image, the necessary illumination levels have been achieved for the table (50 fc), marker board (50 fc), and faces (30 fc vertical). In addition, the surfaces throughout the room are very uniform, which is helpful for videoconferencing. Note that the first image has a maximum of 50 fc, while the second has a maximum of 40 fc to better depict the facial illuminances.





The luminance false color image below shows that faces are modeled well with some gradient, but falling within the 3:1 ratio. It is important that there is some variation within the allowable ratio so the faces have three dimensional character and do not appear flat under too severe uniformity. This image brings out facial feature by highlighting the top of the head, ears and nose, and slightly shadowing under the eyebrows, nose, lips, and chin.



Electrical Analysis

Many aspects of the electrical distribution system were analyzed to size various pieces of equipment, determine if there are improvements that can be made, and verify code compliance.

This study analyzed the impact of adding an uninterruptible power supply to serve critical medical equipment. An emergency generator was sized to serve the emergency power needs of the facility. The power distribution for the labor and delivery unit on the second floor was studied in detail, with the distribution equipment being sized to serve the loads. Based on this analysis, the emergency power configuration was also redesigned based on NEC guidelines. A protective device coordination study was performed to check the short circuit ratings through a path through the distribution system from the substation to a second floor critical power panel. A motor control center was also redesigned, including starter sizing, protective devices, feeder and conduit sizes, and short circuit requirements.

The power distribution in a hospital differs from most buildings in its emergency power requirements. With a large amount of critical services relying on electric power, it is literally a life-and-death issue that ample power is always available. The NEC requires that the emergency power to be served by an on-site generator is segregated into at least three branches. The life safety branch includes the lighting in corridors, stairways, and other areas requiring light for building egress in case of an emergency. These lights are always on and cannot be switched off. This also includes elevators and automatic doors, which may need to be operated during a power failure. The fire alarm system is also on the life safety branch. The critical branch serves equipment that patient's lives may depend on. It also includes any equipment necessary to keep the hospital functioning properly, such as computer systems, nurse call devices, surgical equipment, etc. Some lighting is also on critical power, such as exam lights, surgical lights, and lights serving nurse stations. The equipment branch serves mechanical equipment that may need to be in operation during a failure of the utility electric service, such as some of the HVAC devices. This hospital also employs a fourth branch of emergency power, the X-ray branch. This includes the hospital's diagnostic imaging equipment, such as CAT Scans and MRI machines.

The safety guidelines for much of the power distribution design were obtained from the <u>National Electric Code 2002</u>, published by the National Fire Protection Association. Most of the calculation methods were obtained from <u>Electrical Systems in Buildings</u>, by S. David Hughes. Information on specific equipment was gathered from manufacturers' data. See the appendix for a complete list of references.

UPS System

A problem that occurs with the existing design for the hospital is that there is some very sensitive equipment that can be disrupted by very slight disturbances in their electric service. For example, during a failure of normal power, when the automatic transfer switch serving the X-ray power branch is flipped, the very short time period that the power is interrupted can cause the diagnostic imaging machines to fail. Even small blips in the utility service can cause them to shut and have to reboot. This is a serious problem, because when this occurs, any information from a procedure in progress is lost, and the procedure must be started over. These procedures can cost as much as $10,000, so the hospital takes on a very significant financial loss anytime this happens.

This problem can be remedied by the addition of an uninterruptible power supply (UPS). A UPS can maintain power service to equipment during a power failure. It also cleans up the slight variations in power service from the electric utility. A UPS operates by taking the incoming AC power from the utility and converting it to DC through an inverter. A rectifier then converts the DC power back to AC. This cleaner, uninterrupted AC power is then delivered to the equipment. In the case of a loss of power to the UPS, it is equipped with a battery, which then takes over to supply the DC power to the rectifier. A power loss is recovered by the UPS within about a quarter of a cycle (1/240th of a second), which is too short to affect even extremely sensitive equipment. This constant supply of AC power will keep the equipment running regardless of problems with the electrical service.

The first step in designing the UPS system was to identify which pieces of equipment will benefit from uninterrupted power. There were five pieces of diagnostic imaging equipment that were taken to be served by the UPS. Three of them were served by the emergency power panel EXRDP-GW1, and two served by the normal power panel XRDP-GW1. These two panels served only this equipment. The equipment was a CAT Scan, two radiology units, and two radio/fluoroscopy (R/F) units.

This design will take these five pieces of equipment and serve them all from the emergency generator. The two panels are to be combined into one emergency panel, it will be the sole panel to be served by the X-Ray emergency branch. This new panel was resized to accommodate all five loads.

There are different options for serving this equipment with a UPS system. One UPS unit could serve the distribution panel, which in turn, serves all five devices. An alternative is to supply each device with its own individual UPS. There are problems inherent with each solution. If all the equipment is served from the same unit, if the unit fails or when it requires routine maintenance, the entire panel will be unprotected. The advantage is that maintenance is easier and cheaper to with a centralized system. With five separate UPS units, the initial cost is a lot higher, and they will take up a lot more space. The method selected for this analysis was the single large UPS. This decision was made primarily due to cost considerations, and the fact that the equipment being served is all in adjacent areas, so the UPS can be local to all of the devices. For a more details on the cost analysis, refer to the construction management study.

The next step is to design the size of the UPS unit. This was done based on the apparent power loads of the five devices. These were obtained from the breaker sizes that serve the equipment on the original panels. The apparent power was then calculated from the amperage of the breaker and the voltage. A 500 KVA UPS was chosen. The sizing calculations are below.

UPS SIZING						
EQUIPMENT	**V**	**P**	**BRKR**	**KVA**	**PANEL**	**CKT**
CAT SCAN	480	3	150	125	EXRDP-GW1	9
RADIOLOGY #1	480	3	100	83	EXRDP-GW1	3
R/F #4	480	3	100	83	EXRDP-GW1	4
RADIOLOGY #2	480	3	100	83	XRDP-GW1	3
R/F #3	480	3	100	83	XRDP-GW1	4
			TOTAL:	457		

With most electrical equipment, a 25% growth factor is typically incorporated into the size design. In most cases an oversize cannot cause any problems. With UPS systems, they run most efficiently at their rated load. The loads were obtained from breaker sizes, which already must include a 25% safety factor, and this total does not account for any demand factor. Therefore there is some room for growth, but the UPS will be sized to be close to the actual load condition.

The battery for the UPS must also be sized. The standard ten-minute battery was chosen. Since the equipment is served by the emergency generator, a utility power failure will mean that the emergency generator will be operating within a second or two, so the ten minutes of power is more than enough time. In the event that the emergency generator fails, the ten minutes is enough time to shut down the equipment in an organized fashion to retain the data on the machines.

Another component of the design is to find a place for the UPS. The physical size of the unit is 72 by 39 inches by 78 inches high. Since the initial architectural design did not account for this equipment, the only logical place for the unit is in the large mechanical room in the basement. Ideally, it would be located in an electrical room nearby the diagnostic imaging suite, so that the losses in the feeders could be minimized.

With all five pieces of equipment coming from two panels being integrated on one panel, the new panel had to be sized. The new panel design is shown in the schedule below.

UPS-GW1

WIRING PANEL SCHEDULE

PANEL: EXRDP-GW1 | MAINS: MLO | AMPS: 800 | AIC: 65,000

VOLTAGE: 480Y/277 | WIRES: 4 | PHASE: 3 | MOUNTING: SURFACE | LOC: ELEC RM 114

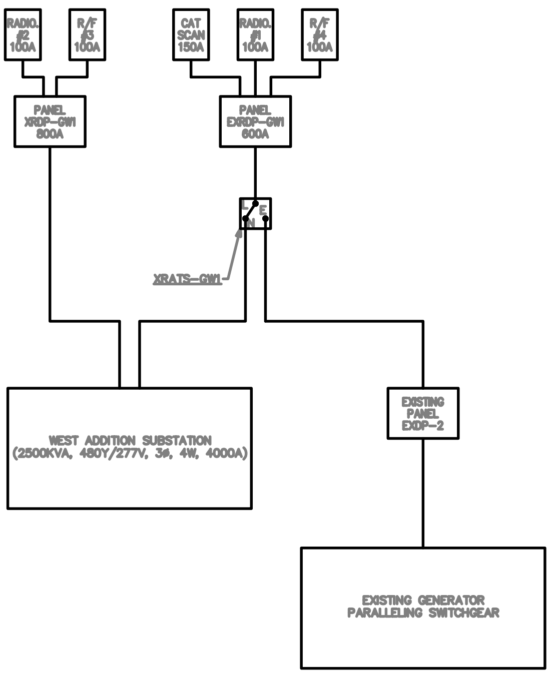
CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT	CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT
1	-	-	-	-	2	-	-	-	-
3	X-RAY EQUIP: RAD #1	3	100	2"C.W/4#1/O+1#2GRD.	4	X-RAY EQUIP: RAD #2	3	100	2"C.W/4#1/O+1#2GRD.
5	-	-	-	-	6	-	-	-	-
7	-	-	-	-	8	-	-	-	-
9	X-RAY EQUIP: R/F #3	3	100	2"C.W/4#1/O+1#2GRD.	10	X-RAY EQUIP: R/F #4	3	100	2"C.W/4#1/O+1#2GRD.
11	-	-	-	-	12	-	-	-	-
13					14	-	-	-	-
15	CAT SCAN EQUIP	3	150	2"C.W/4#3/O+1#2GRD.	16	SPACE	3	-	-
17	-	-	-	-	18	-	-	-	-
19	-	-	-	-	20	-	-	-	-
21	SPACE	3	-	-	22	SPACE	3	-	-
23	-	-	-	-	24	-	-	-	-
25	-	-	-	-	26	-	-	-	-
27	SPACE	3	-	-	28	SPACE	3	-	-
29	-	-	-	-	30	-	-	-	-

TOTAL BRKR A: 550
25% GROWTH: 137.5
TOTAL A: 687.5
PANEL SIZE: 800

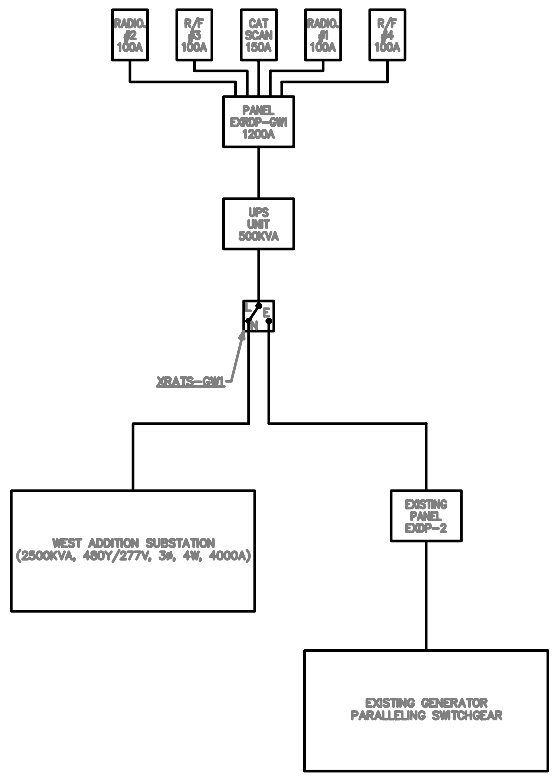
A bypass switch was also specified for the UPS. This increases the initial cost of the system by about $10,000, but it allows the UPS unit to be disconnected and bypassed during maintenance or other problems with the UPS. This bypass is essential so that the equipment served by the UPS will always be available for use, such as in the case of emergencies.

Another design consideration with UPS systems is the significant amount of heat that they can generate, which must be removed through the HVAC system. For details on the impact on the HVAC design, refer to the mechanical analysis.

On the following page are schematic riser diagrams showing the portion of the electrical distribution system that is affected by the addition of this UPS. The original design is shown without the UPS, followed by schematic diagram of the redesign.



ORIGINAL DESIGN



REDESIGN FEATURING UPS SYSTEM

Emergency Generator

The existing design does not feature a new generator. Since the project is an addition to an existing hospital, a new generator was not necessary. This redesign includes the design for a new generator to serve the emergency power needs for the addition.

Hospitals require a large amount of emergency power because lives depend on the ability of many services in the hospital to remain functional at all times. As described previously, code requires that the emergency power is segregated into four different branches. When the generator starts up, the power branches are started sequentially to prevent the generator from being overloaded by all systems starting at once. The life safety branch starts first, followed by the critical power, the equipment, and finally the X-ray branch. Now that the X-Ray is served by a UPS, there will be no problems with starting this last.

The loads on each of these four branches were tabulated to determine the necessary generator size. The procedure for sizing the generator was presented by Ed Wunderle of Burt Hill Kosar Rittelmann Associates on February 27, 2004. The KW and KVA loads for lighting and receptacles were simply calculated from the total wattage of the lights and assuming 180 KV for receptacles. For the life safety and the critical branches, the running and starting loads are identical. A 0.8 power factor was assumed for these loads. For the loads from mechanical equipment, the horsepower ratings were used to estimate their starting and running KVAs and KWs.

First the starting loads for the life safety branch were totaled to find the load when this branch starts up. Then the critical branch starts: this starting load is added to the running load of the life safety branch. The equipment branch is next. It is further broken down into two different steps due to the high starting loads. The loads for the equipment was estimated based on the horsepower ratings, which were converted to starting and running KVAs and KWs. For each step, the starting KVA was adding to running KVAs of all previous steps. Finally, the X-ray branch was added in. To determine the critical ratings, the highest KVA and KW totals were found, which including the starting KVA of that critical step in addition to the running KVAs of the previous steps.

The calculations for generator size are shown below. Based on this analysis, a 600 KW generator was selected.

GENERATOR SIZING								
	HP	KW	SKVA	RKVA	SKW	RKW	KVA	KW
LIFE SAFETY BRANCH	-	9.6	12	12	9.6	12	12	10
CRITICAL BRANCH	-	90	113	113	90	90	125	100
MECHANICAL-1	115	-	690	115	230	98	815	332
MECHANICAL-2	109	-	654	109	218	93	894	418
X-RAY	-	70	88	88	70	70	437	362

	KVA	KW
Critical Condition:	894	418
25% Growth:	223.5	104.5
Design:	1117.5	522.5

In addition to sizing the electrical generation capacity, the fuel tank must also be sized. Based on Generac's manufacturer's data, at full load, the generator selected burns diesel fuel at a rate of 46.2 gallons per hour. Since it is absolutely critical that a hospital has power at all times, even in the event of a long-term power outage, the code in the state of Maryland requires that 64 hours of generator fuel storage is available on site. 46.2 gallons per hour over 64 hours is 2957 gallons. There for a 3000 gallon diesel fuel tank was sized.

The location of the generator is on the site across the parking lot from the building. This placement reduces any noise and heat impacts the generator may have on the building.

The schematic riser diagram for the UPS shows how the generator is connected into the X-ray power branch through the use of an automatic transfer switch (ATS). For the generator, this configuration is simply repeated with a separate ATS for each branch. This ATS then feeds the main distribution panel for that branch.

Analysis of Labor and Delivery Unit

The power distribution for the labor and delivery unit on the second floor was analyzed for code compliance and to identify potential improvements to the system.

First the circuiting was analyzed to ensure that no more than 16 amps were any of the 20 amp lighting circuits. The wattages for the lamps and ballasts were added up on each circuit. For a 277-volt circuit (most lighting in the building is at 277 V), the maximum allowable KVA is 4432. The life safety branch, critical branch, and normal power all served 277-volt lighting circuits. Many of the lighting circuits approached the allowable 4432 KVA, which allowed little room for future additions to the circuits. Since there are plenty of spare breakers on the lighting panels, and it is unlikely for power to be added, this is of little concern.

Next, the 120-volt power circuits were analyzed. For a 20 amp, 120-volt circuit, the maximum allowable current is again 16 amps, but the allowable power is only 1920 VA. These circuits were found on both normal power and the critical branch. General receptacles were considered to have a typical load of about 180 VA. The design for these circuits was much more conservative than for lighting. This is because it is much more likely that these receptacles will be loaded above the assumed design condition. Since the health of people may rely on uninterrupted power service, especially on the critical branch, it makes sense to design very conservatively.

This analysis yielded on discrepancy with the National Electric Code. The automatic door controls and the fire alarm system were all served from the critical power branch. The code specifies that this equipment should be served by the life safety branch. An explanation for the design is that this equipment operates at 120 volts. The life safety branch is principally lighting, and therefore only 277-volt circuits on life safety power. Another explanation is that this is simply complying with the way the existing part of the hospital was built. This redesign addresses this discrepancy, by adding two 208-volt, 225-amp, 2-section panels, one on the first floor, and one on the second. Each would also require a 45-KVA dry-type transformer. The life safety power distribution panel ELDP-GW1 will also have to be resized from 225 amps to 400 amps.

On the next page is an example of one the panels analyzed. It is the critical 2-section panel ECPP-2W1. The calculated loads are shown for each circuit on their proper phase. The highlighted circuits are those that were originally designed on the panel, but are to be moved to the new 208-volt life safety panels.

On the page following the panel schedule is the portion of the new redesigned portion of the schematic riser diagram showing the additional panels required to bring the design into compliance with the National Electric Code.

WIRING PANEL SCHEDULE

PANEL: ECPP-2W1 (SECTION 1) MAINS: MCB (THRU-FEED) AMPS: 225 AIC: 10,000
VOLTAGE: 208Y/120 WIRES: 4 PHASE: 3 MOUNTING: RECESSED LOC: CORRIDOR 2138

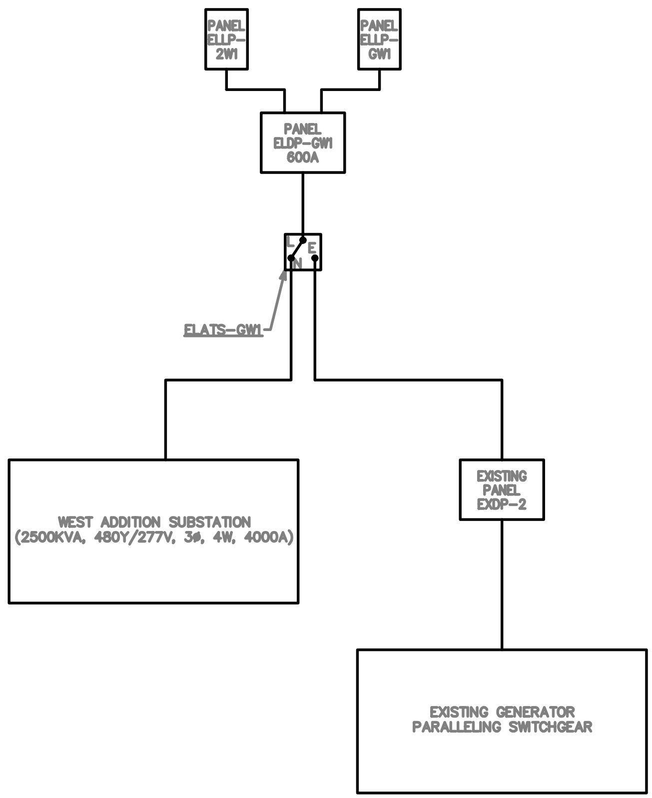
CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT	A	A	B	B	C	C	CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT
1	DOOR CONTROL: 2120	1	20	-	0	0	-	-	-	-	2	MED GAS ALARM: CORR 2150	1	20	2-#12 THW + 1#12 GRD.
3	REC: 2176	1	20	2-#12 THW + 1#12 GRD.	-	-	1.5	0	-	-	4	MED GAS ALARM: CORR 2150	1	20	2-#12 THW + 1#12 GRD.
5	REC: 2176	1	20	2-#12 THW + 1#12 GRD.	-	-	-	-	3	0	6	DOOR CONTROL: 2150	1	20	2-#12 THW + 1#12 GRD.
7	REC: 2122	1	20	2-#12 THW + 1#12 GRD.	3	0	-	-	-	-	8	DOOR CONTROL: 2150	1	20	2-#12 THW + 1#12 GRD.
9	REC: 2122	1	20	2-#12 THW + 1#12 GRD.	-	-	4.5	0	-	-	10	DOOR CONTROL: 2186	1	20	2-#12 THW + 1#12 GRD.
11	BED LOCATOR: 2122	1	20	2-#12 THW + 1#12 GRD.	-	-	-	-	9	0	12	DOOR CONTROL: 2186	1	20	2-#12 THW + 1#12 GRD.
13	SCRUB SINK: 2149	1	20	2-#12 THW + 1#12 GRD.	6	3	-	-	-	-	14	REC: 2160	1	20	2-#12 THW + 1#12 GRD.
15	REC: 2152, 55, 60, 62	1	20	2-#12 THW + 1#12 GRD.	-	-	6	6	-	-	16	REC: 2160	1	20	2-#12 THW + 1#12 GRD.
17	SPARE	1	20	-	-	-	-	-	0	3	18	REC: 2162	1	20	2-#12 THW + 1#12 GRD.
19	REC: 2151	1	20	2-#12 THW + 1#12 GRD.	6	6	-	-	-	-	20	REC: 2162	1	20	2-#12 THW + 1#12 GRD.
21	REC: 2151	1	20	2-#12 THW + 1#12 GRD.	-	-	6	3	-	-	22	BASSINET REC: 2118	1	20	2-#12 THW + 1#12 GRD.
23	PYXIS: CORR. 2158	1	20	2-#12 THW + 1#12 GRD.	-	-	-	-	8	4.5	24	REC: 2130	1	20	2-#12 THW + 1#12 GRD.
25	REC: 2120	1	20	2-#12 THW + 1#12 GRD.	4.5	3	-	-	-	-	26	BASSINET REC: 2120	1	20	2-#12 THW + 1#12 GRD.
27	REC: 2120	1	20	2-#12 THW + 1#12 GRD.	-	-	6	10	-	-	28	REFRIG REC: 2159	1	20	2-#12 THW + 1#12 GRD.
29	BED LOCATOR: 2120	1	20	2-#12 THW + 1#12 GRD.	-	-	-	-	9	6	30	REC: 2159, 2165	1	20	2-#12 THW + 1#12 GRD.
31	REC: 2118	1	20	2-#12 THW + 1#12 GRD.	6	0	-	-	-	-	32	DOOR CONTROL: 2211	1	20	2-#12 THW + 1#12 GRD.
33	BED LOCATOR: 2118	1	20	2-#12 THW + 1#12 GRD.	-	-	9	1.5	-	-	34	REC:ELEC. CLOSET	1	20	2-#12 THW + 1#12 GRD.
35	REC: 2118	1	20	2-#12 THW + 1#12 GRD.	-	-	-	-	4.5	0	36	DOOR CONTROL: 2117	1	20	2-#12 THW + 1#12 GRD.
37	REC: 2152	1	20	2-#12 THW + 1#12 GRD.	3	6	-	-	-	-	38	REC: 2155	1	20	2-#12 THW + 1#12 GRD.
39	REC: 2152	1	20	2-#12 THW + 1#12 GRD.	-	-	6	3	-	-	40	REC: 2155	1	20	2-#12 THW + 1#12 GRD.
41	REC: 2166	1	20	2-#12 THW + 1#12 GRD.	-	-	-	-	1.5	4.5	42	REC: 2124	1	20	2-#12 THW + 1#12 GRD.

PANEL: ECPP-2W1 (SECTION 2)

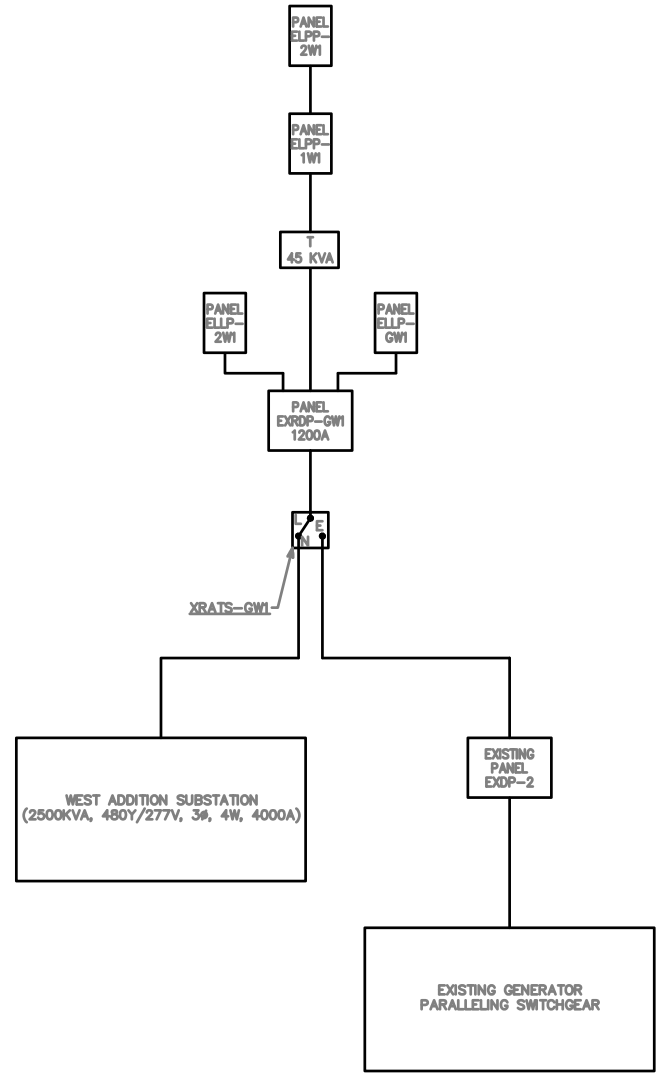
CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT	A	A	B	B	C	C	CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT
43	SURGICAL LTS: 2168, 2170	1	20	%%223"C.W/2#12+1#12GRD	12	0	-	-	-	-	44	SPARE	1	20	-
45	SURGICAL LTS: 2130, 2128	1	20	%%223"C.W/2#12+1#12GRD	-	-	12	0	-	-	46	SPARE	1	20	-
47	GFI SINK REC: 2118, 2120	1	20	%%223"C.W/2#12+1#12GRD	-	-	-	-	6	0	48	SPARE	1	20	-
49	REC: 2114	1	20	%%223"C.W/2#12+1#12GRD	1.5	0	-	-	-	-	50	SPARE	1	20	-
51	ICE MACH: 2221	1	20	%%223"C.W/2#12+1#12GRD	-	-	10	0	-	-	52	SPARE	1	20	-
53	INSTAHOT: 2221	1	20	%%223"C.W/2#12+1#12GRD	-	-	-	-	8	0	54	SPARE	1	20	-
55	EXAM LT: 2118, 2120	1	20	%%223"C.W/2#12+1#12GRD	12	0	-	-	-	-	56	SPARE	1	20	-
57	EXAM LT: 2122, 2124	1	20	%%223"C.W/2#12+1#12GRD	-	-	12	0	-	-	58	SPARE	1	20	-
59	EXAM LT: 2155	1	20	%%223"C.W/2#12+1#12GRD	-	-	-	-	8	0	60	SPARE	1	20	-
61	EXAM LT: 2152	1	20	%%223"C.W/2#12+1#12GRD	8	0	-	-	-	-	62	SPARE	1	20	-
63	EXAM LT: 2160	1	20	%%223"C.W/2#12+1#12GRD	-	-	8	0	-	-	64	SPARE	1	20	-
65	EXAM LT: 2162	1	20	%%223"C.W/2#12+1#12GRD	-	-	-	-	8	0	66	SPARE	1	20	-
67	DOOR CTRL: 2116	1	20	%%223"C.W/2#12+1#12GRD	0	0	-	-	-	-	68	SPARE	1	20	-
69	ATC XFMR: 2210	1	20	%%223"C.W/2#12+1#12GRD	-	-	10	0	-	-	70	SPARE	1	20	-
71	REC: EXAM/OBS 2156	1	20	%%223"C.W/2#12+1#12GRD	-	-	-	-	3	0	72	SPARE	1	20	-
73	REC: EXAM/OBS 2156	1	20	%%223"C.W/2#12+1#12GRD	4.5	50	-	-	-	-	74	-	-	-	-
75	REC: 2133	1	20	%%223"C.W/2#12+1#12GRD	-	-	3	50	-	-	76	PANEL ECPP-2W2	3	80	3-#4 THW + 1#8 GRD.
77	BASSINET REC: 2122	1	20	%%223"C.W/2#12+1#12GRD	-	-	-	-	3	50	78	-	-	-	-
79	GFI SINK REC: 2122, 2124	1	20	%%223"C.W/2#12+1#12GRD	6	30	-	-	-	-	80	-	-	-	-
81	EXAM LT: EXAM/OBS 2156	1	20	%%223"C.W/2#12+1#12GRD	-	-	6	30	-	-	82	PANEL ECPP-2W3	3	80	3-#4 THW + 1#8 GRD.
83	SPARE	1	20	-	-	-	-	-	0	30	84	-	-	-	-

TOTAL PHASE A	99 A
TOTAL PHASE B	107 A
TOTAL PHASE C	102 A

HIGHEST PHASE TOTAL:	107 A
25% GROWTH	27 A
TOTAL	134 A
NEXT PANEL SIZE	225 A



ORIGINAL DESIGN



REDESIGN FEATURING
NEW LIFES SAFETY PANELS

This analysis was continued down through the system to the substation; including panels ECPP-2W1, ECLP-2W1, ECDP-GW1, transformer T-6, automatic transfer switch ECATS-GW1, and the West Addition Substation. The tables on the following two pages show an example of the load calculations—specifically those related to the sizing of the substation.

ELECTRICAL LOADS - MECHANICAL EQUIPMENT (3-PHASE)						
EQUIPMENT NAME	NORMAL POWER		EQUIPMENT BRANCH		TOTAL LOAD (DEMAND KVA)	
	HP	AMPS	HP	AMPS	NORMAL	EQUIP.
CHILLER CH-3		367			305.1	0.0
CHILLER CH-4		367			305.1	0.0
CHILLER CH-5		606			503.8	0.0
STORM SUMP SET SWP-1/2			2 @ 3	9.6	0.0	8.0
PUMP P-HS-1			30	40	0.0	33.3
PUMP P-HW-1			7.5	11	0.0	9.1
PUMP P-HW-2			7.5	11	0.0	9.1
PUMP P-PH-1W-1			1.5	3	0.0	2.5
PUMP P-PH-2W-1			1.5	3	0.0	2.5
FAN SF-2W-1			75	96	0.0	79.8
FAN SF-1W-1			75	96	0.0	79.8
FAN EF-RP-1			3	4.8	0.0	4.0
PUMP P-PH-E-1			3/4	1.6	0.0	1.3
PANEL EEPP-GW1 VIA T-19			-	54	0.0	44.9
SEWAGE PUMP SET SP-1/2			2 @ 3	9.6	0.0	8.0
AIR COMPRESSOR AC-1			2 @ 5	15.2	0.0	12.6
FAN SF-1W-2	75	96			79.8	0.0
FAN RF-1W-1	60	77			64.0	0.0
FAN SF-2W-2	75	96			79.8	0.0
FAN RF-2W-1	60	77			64.0	0.0
COOLING TOWER CT-3	30	40			33.3	0.0
COOLING TOWER CT-4	25	34			28.3	0.0
COOLING TOWER CT-5 (A)	25	34			28.3	0.0
FAN SF-E-1	25	34			28.3	0.0
COOLING TOWER CT-5 (B)	25	34			28.3	0.0
BASIN HEATERS CT-3	(18KW)	22			18.3	0.0
BASIN HEATERS CT-4	(18KW)	22			18.3	0.0
BASIN HEATERS CT-5	(24KW)	29			24.1	0.0
PUMP P-HS-2	30	40			33.3	0.0
CONDENSATE RECEIVER CR-1	2 @ 10	28			23.3	0.0
PUMP P-P-5	20	27			22.4	0.0
PUMP P-DW-1	5	7.6			6.3	0.0
PUMP P-S-3	100	124			103.1	0.0
PUMP P-C-5	60	77			64.0	0.0
PUMP P-P-4	10	14			11.6	0.0
PUMP P-DW-2	2	3.4			2.8	0.0
PUMP P-S-4	100	124			103.1	0.0
PUMP P-C-4	40	52			43.2	0.0
PUMP P-P-3	10	14			11.6	0.0
PUMP P-DW-3	2	3.4			2.8	0.0
PUMP P-S-5	100	124			103.1	0.0
PUMP P-C-3	40	52			43.2	0.0
PUMP P-HW-3	7.5	11			9.1	0.0
FAN EF-2W	5	7.6			6.3	0.0
FAN EF-1W	3	4.8			4.0	0.0

TOTALS: 2202 KVA 295 KVA

Receptacle Load				
	Normal	**Critical**	**Norm KVA**	**Crit KVA**
Ground Floor	64	13	12	2
First Floor	640	490	115	88
Second Floor	547	406	98	73
Total	1251	909	225	164
With Demand Factor:			162	132

FEEDER SIZING					
SERVING	**LOAD (A)**	**WITH 1.25 DES. FAC.**	**FEEDER**	**FEEDER CAPACITY**	**OVERSIZE FACTOR**
Chiller CH-3	367	459	(2) 4#4/0	460	1.00
Chiller CH-4	367	459	(2) 4#4/0	460	1.00
Chiller CH-5	606	758	(2) 4#500 MCM	760	1.00
MCC-N-GW1	714	893	(4) 3#350 MCM	1200	1.34
MCCN-GW2	595	744	(3) 3#400 MCM	1000	1.34
Pnl MDP-GW1	590	738	(3) 4#350 MCM	800	1.08
Pnl ECDP-GW1	470	588	(2) 4#350 MCM	600	1.02
Pnl MCC-E-GW1	395	494	(2) 4#350 MCM	600	1.22
Pnl ELDP-GW1	110	138	4#4/0	225	1.64
Pnl EXRDP-GW1	350	438	(2) 4#350 MCM	600	1.37
Pnl XRDP-GW1	160	200	(3) 4#350 MCM	800	4.00
SUBSTA. XFMR	92	115	3#2/0	175	1.52
			Breaker Size:	150	1.30

	LOAD (KVA) W/ DEM. FAC.	**WITH 1.25 DES. FAC.**	**RATED KVA**	**OVERSIZE FACTOR**
MAIN XFMRS	1217	1521	2500	1.64
SUBSTATION	1217	1521	3200	2.10

Protective Device Coordination Study (Short Circuit Analysis)

The short circuit ratings were analyzed for a single path through the building distribution system, from the substation to the double-section critical power panel ECPP-2W1, serving the second floor.

The calculations are shown below. The analysis begins at the substation transformer, where the largest available fault current will occur. From the utility (Baltimore Gas and Electric), the available short circuit KVA is 750000. Using this data and information from the drawings, the fault currents were calculated through the path. The calculation methods were taken from Electrical Systems in Buildings, by S. David Hughes. The feeder sizes were taken from the construction drawings. The lengths of the feeders were estimated by measuring the distances between equipment. Based on these feeder sizes and lengths, the feeder impedances were calculated from Table 9-9 in the NEC 2002 Code. Transformer impedances were obtained from the design documents.

Available Utility Short Circuit KVA: 750000 KVA
Substation Rated KVA: 2500 KVA
Utility Transformer Impedence: 5.7%

$$\text{Rated Secondary I} = \frac{\text{KVA*1000}}{\text{1.73*VL}} = \frac{2500*1000}{1.73*480} = 3007\text{ A}$$

Epu=1
Itpu = Epu / Zpu = 1 / 0.057 = 17.5
It = Itpu * Isec = 17.5 * 3007 = 52.8 KAIC
Zb = Vph / Isec = 277 / 3007 = 0.092 ohms

Subsequent Equipment

Equip	Irated	Isco	Feeder	Length	Z/1000'	Z	Zpu	Iscpu	Isc	Eq. Rtg
ECDP-GW1	3007	52.8	(2) #350MCM	100	0.03578	0.007156	0.169783	5.889885	17.71	65K
ECLP-2W1	3007	17.71	#4/0	120	0.10183	0.031595	0.343426	2.911835	8.76	25K
T-6 PRI	3007	8.76	#2	5	0.28284	0.034424	0.37417	2.672585	8.04	25K
T-6 SEC	1303	8.04	-	-	-	-	0.42417	1.020818	3.07	10K
ECPP-2W1	1303	3.07	#4/0	5	0.10183	0.040042	0.435238	0.994858	2.99	10K

Motor Control Center Design

The building's normal power motor control center (MCC) MCC-N-GW1 was redesigned to serve the necessary loads. This includes 17 motor circuits, as well as six other circuits, which are designated for specific future equipment. All of these circuits were designed as if they were new. The calculation methods were taken primarily from Electrical Systems in Buildings, by S. David Hughes.

The first step was to get the characteristics of all the equipment, such as the horsepower ratings, voltage, and starter type. Using the horsepower ratings, the full load current was calculated for each motor from NEC table 430-150. The maximum circuit breaker rating for a full voltage non-reversing starter is 250% of the full load amps (from NEC table 430-152). This current is then sized up to the next highest available breaker size. Based on this circuit breaker rating, the NEMA size for the starter/breaker was determined from manufacturer's data from Eaton Cutler-Hammer. Using the technical data for Eaton Cutler-Hammer's Freedom Motor Control Center, the size of the space required was determined based on the NEMA size. Using NEC table 310-16, the feeders were sized based on the circuit breaker rating. Then the conduit was sized to carry these feeders using NEC table 9-3A. The feeder length was estimated by measuring the distance between the equipment and the MCC. The last calculation was the short circuit fault current. For the complete procedure for these, refer to the previous section addressing short circuit calculations.

These calculations were carried out for all 23 motor circuits. These results are on the next page.

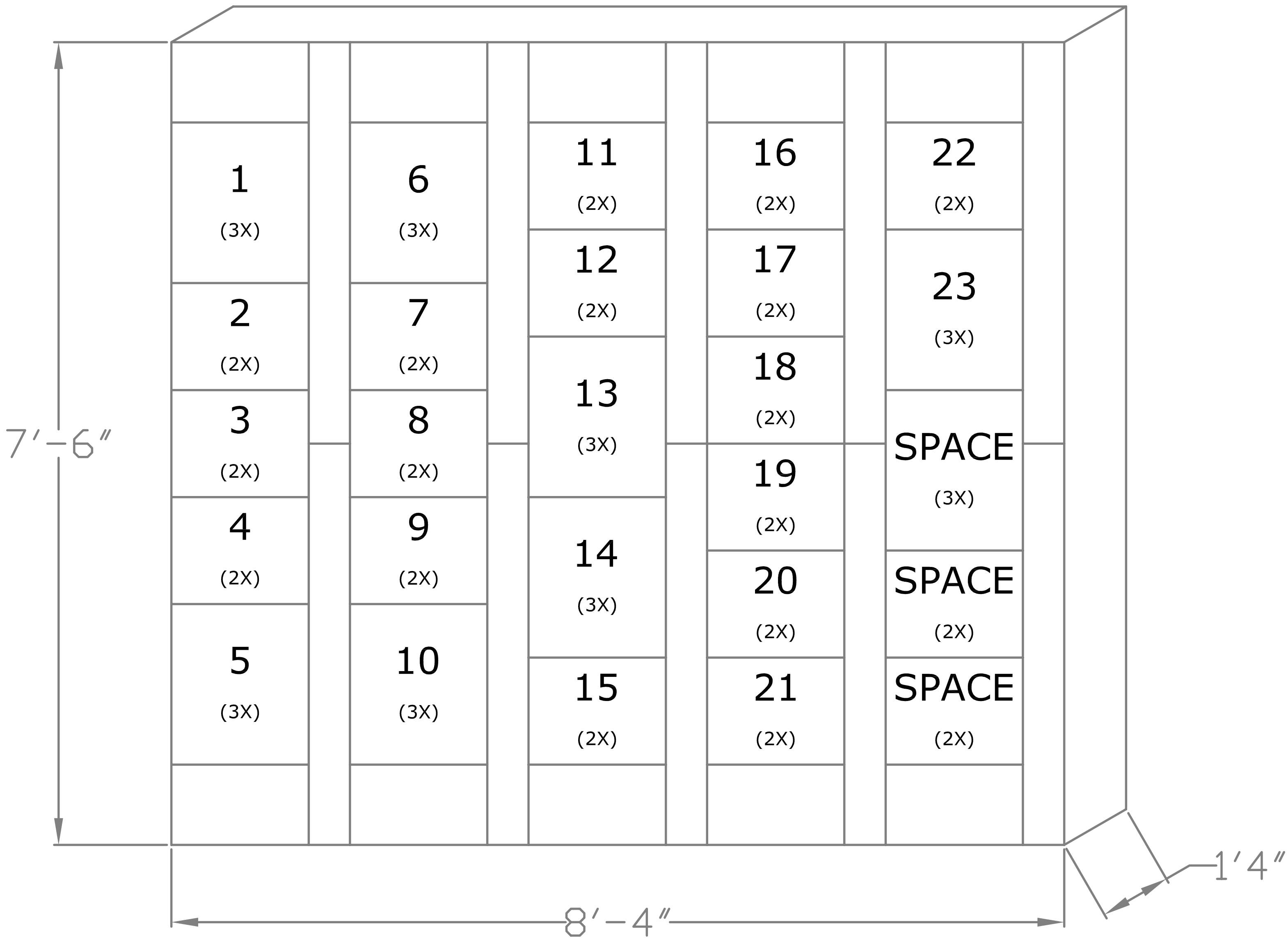
The last aspect to be designed is the actual layout of the MCC. Based on the configurations of Eaton Cutler-Hammer's Freedom MCC, the spaces were filled in appropriately. An elevation of the MCC is on the page following the MCC calculations.

MOTOR CONTROL CENTER SIZING (MCC-N-GW1)

#	EQUIPMENT	HP	FLA	MAX A	CB SIZE	STR TYPE	NEMA SIZE	SPACE SIZE	DISCON SW. SIZE	FEEDER	CONDUIT	FEEDER LENGTH	I (SC) KAIC
1	PUMP P-HS-2	30	40	100	100	FVNR	3	3X	60	3-#3 THW + 1#8 GRD.	1.25"	100	20.7
2	CONDENSATE RECEIVER CR-1	20	27	67.5	80	FVNR	2	2X	60	3-#4 THW + 1#8 GRD.	1.25"	90	19.6
3	PUMP P-P-5	20	27	67.5	80	FVNR	2	2X	60	3-#4 THW + 1#8 GRD.	1.25"	55	24.4
4	PUMP P-DW-1	5	7.6	19	20	FVNR	1	2X	30	3-#12 THW + 1#12 GRD.	0.75"	75	6.4
5	PUMP P-S-3	100	124	310	350	FVNR	4	3X	200	(2) 3-#2/0 THW + 1#3 GRD.	2.5"	15	38.4
6	PUMP P-C-5	60	77	192.5	200	FVNR	4	3X	100	3-#3/0 THW + 1#6 GRD.	2"	75	29.9
7	PUMP P-P-4	10	14	35	35	FVNR	1	2X	30	3-#8 THW + 1#10 GRD.	1"	55	15.7
8	PUMP P-DW-2	2	3.4	8.5	15	FVNR	1	2X	30	3-#12 THW + 1#12 GRD.	0.75"	75	6.4
9	PUMP P-S-4	100	124	310	250	FVNR	4	2X	200	(2) 3-#2/0 THW + 1#3 GRD.	2.5"	15	38.4
10	PUMP P-C-4	40	52	130	150	FVNR	3	3X	100	3-#1/0 THW + 1#6 GRD.	2"	75	27.9
11	PUMP P-P-3	10	14	35	35	FVNR	1	2X	30	3-#8 THW + 1#10 GRD.	1"	55	15.7
12	PUMP P-DW-3	2	3.4	8.5	15	FVNR	1	2X	30	3-#12 THW + 1#12 GRD.	0.75"	75	6.4
13	PUMP P-S-5	100	124	310	350	FVNR	4	3X	200	(2) 3-#2/0 THW + 1#3 GRD.	2.5"	15	38.4
14	PUMP P-C-3	40	52	130	150	FVNR	3	3X	100	3-#1/0 THW + 1#6 GRD.	2"	75	27.9
15	PUMP P-HW-3	7.5	11	27.5	30	FVNR	1	2X	30	3-#10 THW + 1#10 GRD.	0.75"	100	7.5
16	FAN EF-2W	5	7.6	19	20	FVNR	1	2X	30	3-#12 THW + 1#12 GRD.	0.75"	65	7.2
17	FAN EF-1W	3	4.8	12	15	FVNR	1	2X	30	3-#12 THW + 1#12 GRD.	0.75"	65	7.2
18	PUMP P-DW-3 (FUTURE)	2	3.4	8.5	15	FVNR	1	2X	30	3-#12 THW + 1#12 GRD.	0.75"	75	6.4
19	PUMP P-HW-5 (FUTURE)	5	7.6	19	20	FVNR	1	2X	30	3-#12 THW + 1#12 GRD.	0.75"	100	5.0
20	PUMP P-HW-4 (FUTURE)	5	7.6	19	20	FVNR	1	2X	30	3-#12 THW + 1#12 GRD.	0.75"	100	5.0
21	PUMP P-C-6 (FUTURE)	30	40	100	100	FVNR	3	3X	60	3-#3 THW + 1#8 GRD.	1.25"	75	21.7
22	PUMP P-P-6 (FUTURE)	15	21	52.5	60	FVNR	2	2X	30	3-#6 THW + 1#10 GRD.	1"	55	20.2
23	PUMP P-HS-3 (FUTURE)	30	40	100	100	FVNR	3	3X	60	3-#3 THW + 1#8 GRD.	1.25"	100	20.7

Total FLA:	832.4
25% of Largest	31
25% Growth:	215.85
Total:	1079.3

MCC Size: 1200 A



MOTOR CONTROL CENTER: MCC-E-GW1

Construction Management Analysis

Analysis of Lighting Costs and Energy Savings

The lighting system was analyzed to determine if there were any ways to save on the costs related to either initial construction cost, or to the life cycle cost of the system.

First, all of the light fixtures in the project were counted, to determine what fixture types impact cost the most. There was a particular downlight, Lithonia's AFZ-8, denoted as B1 on the lighting fixture schedule, that was used 434 times throughout the building, for various applications, especially in corridors and nurse stations. This count was higher by far than any other fixture.

After identifying this fixture, as well as others that are frequently used, the efficiencies of these fixtures were obtained from the photometric data provided by the manufacturer. The AFZ downlight is one with two horizontally oriented 26-watt compact fluorescent lamps. Horizontal lamps typically have a lower efficiency, especially with two lamps, because the lamps disrupt the light from each other. A single vertically oriented lamp in a downlight is usually a more efficient fixture. It was expected that the same light output could be achieved with a single lamp, which is less than the 52 watts per fixture, as originally designed.

The Lithonia AFV-8, is another downlight with the same size ceiling opening (8 inches), and very similar characteristics to the AFZ-8, except that it features one vertical lamp as opposed to two horizontal lamps. The efficiencies of various lamp configurations and wattages were compared.

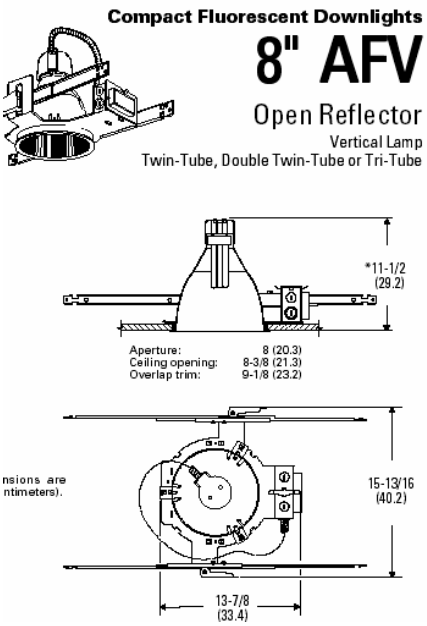
A comparison of fixture efficiencies is shown below.

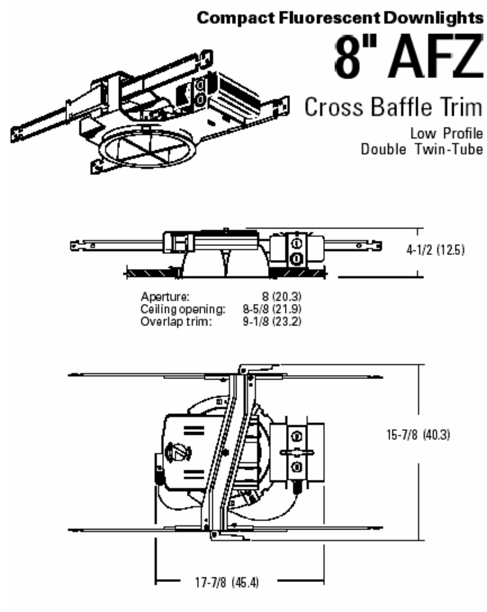
Fixture Efficiency

Fixture	# of lamps	Lamp	Lamp Orient.	Fixture W	Tot Lamp Lumens	Efficiency	Fixt. Lumens
Lithonia AFZ-8	2	13W DTT	Horizontal	36	1720	35.6%	612
Lithonia AFZ-8	2	18W DTT	Horizontal	52	3600	37.1%	1336
Lithonia AFV-8	1	13W TRT	Vertical	13	900	60.8%	547
Lithonia AFV-8	1	18W TRT	Vertical	18	1250	59.3%	741
Lithonia AFV-8	1	26W TRT	Vertical	26	1800	74.2%	1336
Lithonia AFV-8	1	32W TRT	Vertical	32	2400	69.0%	1656
Lithonia AFV-8	1	42W TRT	Vertical	42	3200	56.8%	1818

The AFV-8 fixture with one 26-watt lamp yields exactly the same light output as the AFZ-8 fixture with two 26-watt lamps.

Based on this analysis, the redesign is to include the AFV-8 downlight for all applications where the AFZ-8 is specified. The only disadvantage is that the AFV-8 is taller than the AFZ-8, as shown in the cross-sections of the fixtures below. This could potentially pose a coordination problem with the mechanical layout in the space. This building has a twenty foot floor-to-floor height, and a plenum space of ten to twelve feet in most areas. Therefore there is plenty of space for the ductwork to work with. In addition, these downlights occupy little space in plan, as compared to a 2'x4' troffer for example.





Sections from www.gothamlighting.com

In order to analyze the actual cost impact of making this change, cost data had to be obtained for the ballasts, the lamps, and the electrical power consumption. Since the fixture itself is only changing slightly, there will be little or no change in fixture cost and labor cost.

The electrical rates were obtained from the hospital's electric bills for both power generation from Pepco and power transmission and distribution from Baltimore Gas and Electric (note—electricity generation in Maryland is deregulated). The bills are from an entire year, so that the costs per kilowatt hour can be found for summer and winter, as well as peak times and off-peak. The delivery service demand cost per KW is also listed.

To find the difference in initial cost, the costs for each of the lamps was found as well as the costs for the ballast. These were obtained from www.saveonlighting.com, based on their bulk pricing. The lamp cost is $7.95 per lamp. The two-lamp ballasts cost $56.03. Since the ballasts allow a ten foot distance between ballast and lamp, and most of the fixtures are spaced at about six or eight feet, the two-lamp ballasts can still be used.

Because the new fixtures have the same light output as those in the original design, there is no need to change their layout.

Below are tables used to compare the old system versus the new system.

Fix Type	#	Old Fixture	#	Lamps	LLife (h)	Ballast	L/B	BLife	BW
B1	434	Lithonia AFZ-8	2	CF26DTT	20000	Universal C213UNVBE000C	2	60000	56

New Fixture	#	Lamps	LLife (h)	Ballast	L/B	BLife	BW
Lithonia AFV-8	1	CF26TRT	20000	Universal C213UNVBE000C	2	60000	56

Old Lamp $	Bal $	Energy	Savings Lamp $	Bal $	Energy
7.95	56.03	24304	7.95	56.03	12152

This analysis shows that the system saves 50 percent on energy consumption, initial cost and operational cost.

Knowing all of the associated costs and the available savings, a total dollar figure can be calculated each for initial cost, and operational cost per year. The initial cost is simple to determine. Half of the ballasts and half of the lamps are required. Multiply the number of lamps and ballasts eliminated in the initial installation, and add them together to determine the total initial cost savings.

The operational costs can be determined by taking all of the cost data from the electrical bills and finding an average energy cost per kilowatt-hour, and an average demand cost per KW per month. Since the hospital is in operation at all times, and most of these lights are found in places that are typically always occupied (corridors and nurse stations), it is safe to assume that these downlights will be on all day, every day. To find the average electricity cost, the average cost per KWH can be determined by a weighted average, taking into account how many hours out of the year (8760 hours total), each part of the rate schedule is in effect. The demand charge per KW has remained constant throughout the year, so this is the same every month.

The yearly average operational cost savings from replacing the lamps and ballasts can also be calculated by taking into account the rated life of each item. Assuming that the fixtures will all be re-lamped together, the labor cost associated with replacing them is negligible, since the number of fixtures does not change.

Below is a table showing the total calculated savings, including both the initial cost savings during construction, and the savings per year.

Avg. Energy Cost (per kWh)				$0.0422	
Demand Cost (per KW, per month)				$2.3300	

	Lamp Sav	Bal Sav	Energy Sav	Demand Sav	Init Sav	Sav/Yr
B1	$3,450	$12,159	$4,489	$340	**$15,609**	**$8,116**

Since there is cost savings from the beginning, with no additional investment, there is no need to analyze a payback period. The redesigned system begins paying off before the project is even completed.

The one downside to having one lamp per fixture as opposed to two, is that if one lamp dies, there is still another one producing light in a two-lamp fixture. Assuming group-relamping, this problem will rarely arise, because the lights will typically be replaced before they fail.

UPS Cost Analysis

The costs of the new UPS system to be added through the redesign to determine the cost differences in installing one large UPS, or five smaller ones. The large UPS was sized to be 500 KVA. The five individual systems would consist of a 150 KVA unit and four 100 KVA units.

The cost data was obtained from Liebert, through Reese Engineering. The price quoted includes the desired 10-minute battery, and well as a bypass switch. The cost for the 100 KVA unit is $86,000. The cost for the 150 KVA unit is $100,000. And the cost for the 500 KVA unit is $182,000.

The total cost for the five individual units would be $444,000, compared to the single unit cost of $182,000. The single unit was chosen for the redesign. R.S. Means was consulted to determine the difference in labor, but the UPS units listed only go up to 15 KVA.

Mechanical Analysis

UPS Impact on HVAC

A major design consideration regarding the addition of the uninterruptible power supply system is its impact on the HVAC system. The UPS generates a lot of heat, which must be removed from the building.

Assuming that the UPS would have been considered in the architectural design of the layout of the major electrical distribution equipment, the UPS should be placed in the electrical room near the diagnostic imaging department, which houses all of the equipment being served by the UPS. This electrical room is small, but there is an adjacent storage room that could possibly be converted to accommodate the UPS.

The heat dissipation of the 500 KVA UPS unit was obtained from the specifications provided in Liebert's manufacturer's data. The full load heat dissipation is 98,050 BTU/hour when operated at full load.

To find the impact on the CFM capacity in the room, the BTU/hr must be related to the required additional CFM. Currently, the electrical room and storage room together combine for 325 CFM. The additional CFM required is calculated below.

$Q = 1.08\ (CFM)\ (dT)$
$(98{,}050\ BTU/hr) = 1.08\ (CFM)\ (75-55)$
$CFM = 4539\ CFM$

This is a significant impact on the HVAC service to this room, and therefore the ducts leading to this space will have to be sized up to deliver this air flow.

The additional load due to the UPS will also impact the chiller. The calculations below show how the dissipated heat gain is converted to tonnage of cooling load added onto the chiller.

$(98050\ BTU/hr) \times (ton)/(12000\ BTU/hr) = 8.17\ tons$

This is only a small fraction on the loads of the 500-ton chillers, of which there are five. This impact is not significant enough to change the sizes of the chillers.

Impact of Lighting Changes on HVAC

The reduction in lighting energy consumed by the redesigned system using more efficient light fixtures, will reduce the load on the mechanical system, and will reduce the energy required to run the cooling system.

The light fixtures that were changed are scattered throughout the building and therefore will not have significant impacts on the air flow requirements to the spaces affected by the redesign.

The reduction in lighting power is 12.152 KW. This reduction in electrical power is equivalent to the reduction in heat dissipated by the lighting system, and therefore equivalent to the reduction in cooling load. The calculation below shows the lighting energy in kilowatts converted to the reduction in tons of cooling on the chiller.

(12.152 KW) x (3412 BTU/hr/KW) x (1 ton/12000 BTU/hr) = 3.455 tons

Like the UPS system, this impact on the large chillers is relatively insignificant, but it does help to offset the added load of the UPS.

To convert this to a cost savings, the savings in kWh of electricity from the chiller through the course of a year must be found, based on the known chiller characteristics of 500 tons and 272 KW.

(3.455 tons) x (272 KW / 500 tons) x (8760 hr/yr) = 16466 kWh / yr

Finally, this is converted to annual savings and added to the previously calculated savings from the lighting redesign. This includes both the energy usage and the demand charge.

		KWh	KW		
		16466	1.9		
Lighting					
Init Sav	Sav/Yr	Mech Sav	M Dem S	Tot Mech	Tot Sav/Yr
$15,609	**$8,116**	694.4371	53.124	747.5611	8863.191

Conclusion

The designs presented offer detailed analyses for many different systems found throughout the building. Although, it is impossible for such a report to address all issues faced when designing a building, this project represents many of the processes and considerations that go into designing a building.

These analyses address various building systems, such as lighting, normal and emergency power distribution, and HVAC. Other considerations such as costs and appearance are also addressed for various aspects of the design.

The addition of the UPS system represents an opportunity where paying some extra money during construction can prevent major problems later and end up saving money. The analysis of lighting fixture efficiency demonstrates that there are often minor changes that can be made to a design that can drastically improve the results.

The mechanical analyses are one example that shows how changes to one building system can have effects on others and all of the architects, engineers, and other designers working on large project such as this one need to communicate with each other and understand the issues that their colleagues face are intimately integrated with everyone else's design. There also must be careful attention paid to the needs of the owner and the issues that will face those who are to eventually take the design and construct the building.

Appendix

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www.lithonia.com

www.philips.com

www.saveonlighting.com

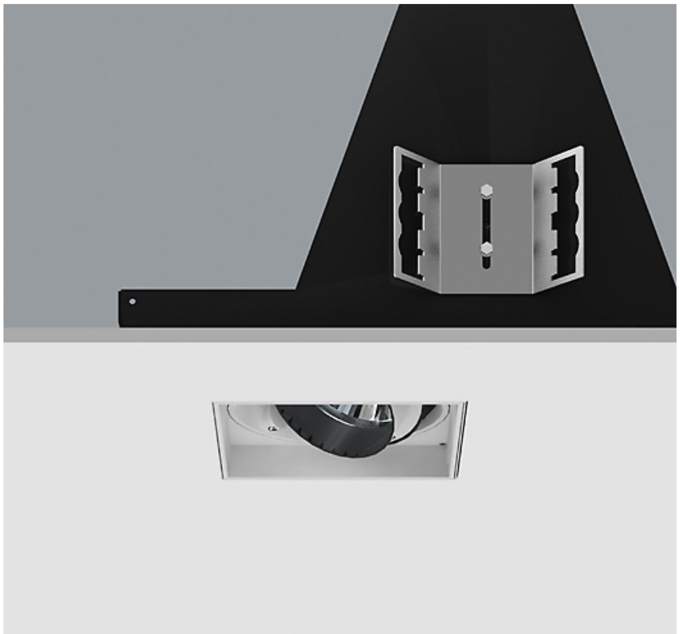
www.sylvania.com

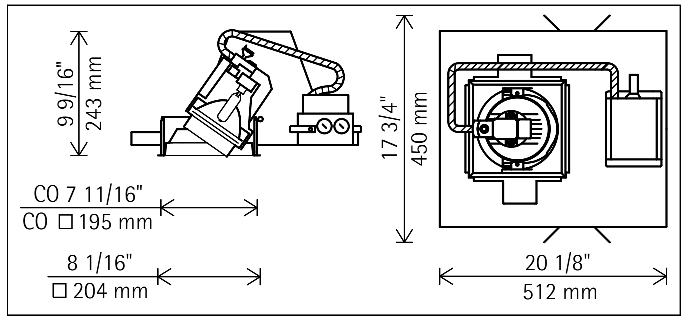
www.universalballast.com

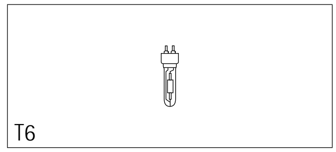
www.wilmot.com

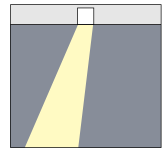
Quadra Directional spotlight

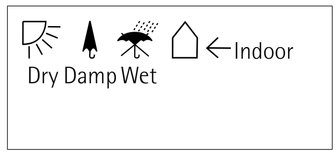
for metal halide lamps

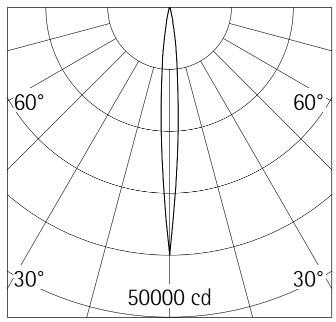












88055.023
Reflector color Silver
T6 39W G12 3400lm
ECG

Product description
Mounting plate: plastic, white. Mounting ring for lampholder carrier: cast aluminum, white (RAL9002) powder-coated. 360° rotation.
Lampholder carrier: cast aluminum, black powder-coated, designed as heat sink. 40° tilt.
Double-sided, reversible mounting frame to cover the ceiling aperture or for use as flush ceiling, trim detail: aluminum, white (RAL9002) powder-coated. Mounting bracket: metal.
Mounting plate for preinstallation with junction box for through-wiring, black powder-coated. Electronic control gear 120V, 60Hz on top of junction box. Snap-in plug for connection between junction box and luminaire.
Anti-glare ring: cast aluminum, internal black lacquered, external white (RAL9002) powder-coated.
Spot reflector: aluminum, anodized, specular. UV filter as safety glass.
Type Non IC luminaire.
Insulation materials must be kept away from the luminaire by a minimum of 3". Thermally protected luminaire. Luminaires protected with disconnecting switch. Suitable for wet location. Removal of luminaire allows access to junction box from below.
Max. ceiling thickness 3/4".
Weigth: 10.36 lbs / 4.70 kg

T6 39W G12 3400lm

h(ft)	E(fc)	D(ft)
		8°
3	4576	0'5"
6	1144	0'10"
9	508	1'3"
12	286	1'8"
15	183	2'1"

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: 04.03.2004
Please download latest version from
www.erco.com/88055.023

FEATURES

OPTICAL SYSTEM
- Reflector - Self-flanged, specular clear or semi-diffuse reflector.
- Baffle - Specular clear upper reflector. Microgroove baffle with white painted flange.
- Vertisys optical system patented. US Patent #5,800,050.
- Lamp is visible before lamp image. Lamp image reflects smoothly from top of reflector to bottom for aperture appearance similar to incandescent.
- Brightness control and high efficiency are optimally balanced.
- Controlled anodized coating suppresses iridescence.

HOUSING
- 16-gauge galvanized steel mounting/plaster frame with friction support springs to retain optical system. Maximum 7/8" ceiling thickness.
- Expandable, self-locking mounting bars provide horizontal and vertical adjustment.
- Galvanized steel junction box with bottom-hinged access covers and spring latches. Two combination 1/2"–3/4" and four 1/2" knockouts for straight-through conduit runs. Capacity: 8 (4 in, 4 out) No. 12 AWG conductors, rated for 75°C.

ELECTRICAL SYSTEM
- Rugged aluminum lampholder housing designed for positive lamp positioning.
- Vertically-mounted, positive-latch, thermoplastic socket.
- Class P (thermally-protected), high power factor ballast mounted to the junction box.

LISTING
- Fixtures are UL listed for thru-branch wiring, recessed mounting and damp locations. Listed and labeled to comply with Canadian Standards (see Options).

Type .... Catalog number ....

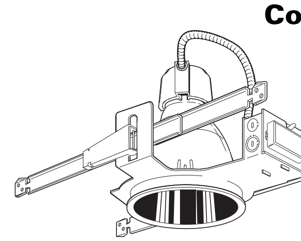
....

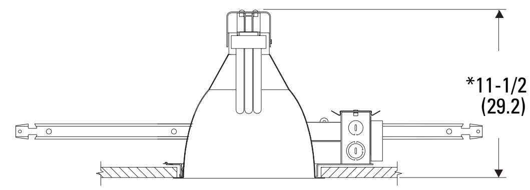
Compact Fluorescent Downlights

8" AFV

Open Reflector

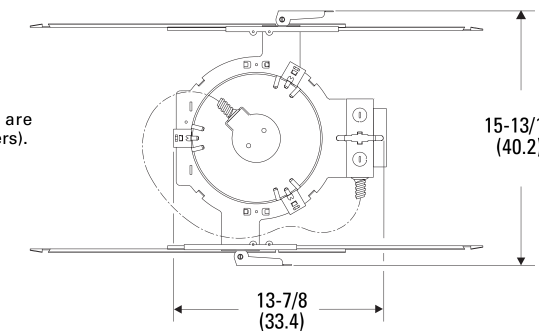
Vertical Lamp
Twin-Tube, Double Twin-Tube or Tri-Tube





Aperture:	8 (20.3)
Ceiling opening:	8-3/8 (21.3)
Overlap trim:	9-1/8 (23.2)

All dimensions are inches (centimeters).



*Maximum height depends on lamp wattage/type, dimensions range from 9-3/4 to 11-1/2

ENERGY

LER.DOH	Annual Energy Cost	Lamps	Lamp Lumens	Ballast Factor	Input Watts
49	$4.90	(1)26TRT	1800	.98	27

Calculated in accordance with NEMA standard LE-5.

ORDERING INFORMATION

Example: **AFV 26DTT 8AR 120 GEB10 WLP**

Choose the boldface catalog nomenclature that best suits your needs and write it on the appropriate line. Order accessories as separate catalog numbers (shipped separately).

AFV

Series
- **AFV**

Wattage/lamp
- **9TT**[1] One 9W twin-tube
- **13TT**[1] One 13W twin-tube
- **13DTT**[2] One 13W double twin-tube
- **18DTT**[2] One 18W double twin-tube
- **26DTT**[2] One 26W double twin-tube
- **18TRT**[3] One 18W tri-tube
- **26TRT**[3] One 26W tri-tube
- **32TRT**[3] One 32W tri-tube
- **42TRT**[3] One 42W tri-tube

NOTES:
1. Available with magnetic ballast only.
2. Available with magnetic or electronic ballast.
3. Available with electronic ballast.
4. Not recommended for use with compact fluorescent lamp; consult factory.
5. Not available with finishes.
6. Refer to options and accessories tab for additional ballast types.
7. For compatible Reloc systems, refer to options and accessories tab.
8. Not available wtih ELR option.

Reflector Type
- **8AR** Clear
- **8PR** Pewter
- **8UBR** Umber
- **8WTR** Wheat
- **8CR**[4] Champagne Gold
- **8GR**[4] Gold
- **8MB**[5] Black Baffle
- **8WB** White Baffle
- **8MWR** White Reflector

Lens Type[5]
- **(blank)** no lens
- **CGL** Clear lens
- **PCL** Clear Polycarbonate Lens
- **CAL** Clear acrylic lens

Finish
- **(blank)** Specular low iridescent
- **LD** Semi-diffuse low iridescent

Voltage
- **120**
- **277**
- **347**
- **MVOLT**

Ballast[6]
- **EMB** Electromagnetic ballast. Requires two-pin lamp.
- **GEB10** Electronic ballast. Requires four-pin lamp.
- **DMHL** Lutron Hi-lume® electronic dimming ballast, 120V or 277V, 18DTT, 26DTT, 26TRT, 32TRT and 42TRT only. Requires four-pin lamp. Minimum dimming level 5%.
- **ADEZ** Advance Mark X electronic dimming ballast. (120V or 277V; 26DTT, 26TRT, 32TRT and 42TRT only.) Requires four-pin lamp. Minimum dimming level 5%.

Options
- **WLP** With 35°K lamp (shipped separately).
- **TRW** White painted flange (6WR)
- **LRC**[7] Provides compatibility with Lithonia Reloc System.
- **GMF** Single slow-blow fuse.
- **RIF** Radio interference filter.
- **ELR** Emergency battery pack. Access above ceiling required. Remote test switch provided. (Consult factory for dimensional changes.)
- **GSKT** 1/8" x 3/8" foam gasketing.
- **QDS**[8] Quick-disconnect for easy ballast replacement.
- **CSA** Listed and labeled to comply with Canadian Standards.
- **EL**[9] Emergency battery pack. Integral test switch provided.

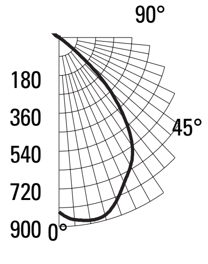
Accessories

Order as separate catalog numbers.
- **SC8** Sloped ceiling adaptor. Degree of slope must be specified (10D, 15D, 20D, 25D, 30D). Ex: SC8 **10D**.
- **CTA8** Ceiling thickness adaptor. (Extends mounting frame to accommodate ceiling thickness up to 2".)

8" AFV Open Reflector

Distribution curve | Distribution data | Output data | Coefficient of utilization | Illuminance Data at 30" Above Floor for a Single Luminaire

AFV 26TRT 8AR, (1) PL-T 26W/30/4P lamp, 1800 rated lumens, 1.3 s/mh, test no. 2194021601



From 0°	cp.	Lumens
0°	830	
5°	870	84
15°	876	247
25°	762	353
35°	630	390
45°	354	255
55°	5	24
65°	0	1
75°	0	1
85°	0	1
90°	0	

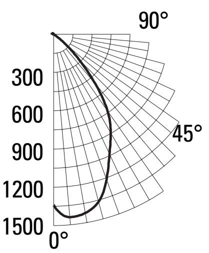
Zone	Lumens	%lamp
0°-30°	682	37.9
0°-40°	1071	59.5
0°-60°	1349	75.0
0°-90°	1349	75.0
90°-180°	0	0.0
0°-180°	1349	75.0*

*Efficiency

ρf	20%					
ρc	80%		70%		50%	
ρw	50%	30%	50%	30%	50%	30%
1	83	81	82	80	78	77
2	78	75	76	74	74	72
3	72	68	71	68	69	66
4	67	63	66	63	65	62
5	63	58	62	58	60	57
6	58	54	58	53	56	53
7	54	49	53	49	52	48
8	50	45	49	45	48	44
9	46	41	45	43	45	40
10	42	37	42	37	41	37

		50% beam angle 64.0°		10% beam angle 93.8°	
Mount height	Initial fc at beam center	Beam diameter	fc at beam edge	Beam diameter	fc at beam edge
8'	27.5	6.9'	13.7	11.8'	2.7
10'	14.8	9.4'	7.4	16.0'	1.5
12'	9.2	11.9'	4.6	20.3'	0.9
14'	6.3	14.4'	3.1	24.6'	0.6
16'	4.6	16.9'	2.3	28.9'	0.5

AFV 32TRT 8AR, (1) PL-T 32W/30/4P lamp, 2400 rated lumens, 1.1 s/mh, test no. 2194021402



From 0°	cp.	Lumens
0°	1344	
5°	1440	137
15°	1360	382
25°	1036	481
35°	737	460
45°	280	219
55°	4	7
65°	1	1
75°	0	1
85°	0	1
90°	0	

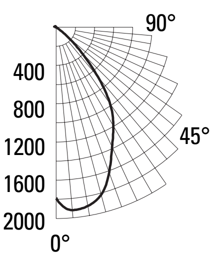
Zone	Lumens	%lamp
0°-30°	998	41.6
0°-40°	1457	60.7
0°-60°	1682	70.1
0°-90°	1683	70.1
90°-180°	0	0.0
0°-180°	1683	70.1*

*Efficiency

ρf	20%					
ρc	80%		70%		50%	
ρw	50%	30%	50%	30%	50%	30%
1	78	77	77	75	74	73
2	73	71	72	70	70	68
3	69	66	68	65	66	64
4	65	61	64	61	63	60
5	61	57	60	56	59	56
6	57	53	57	53	55	52
7	53	49	53	49	52	49
8	50	46	49	46	49	45
9	47	43	46	42	46	42
10	43	39	43	39	43	39

		50% beam angle 55.3°		10% beam angle 87.6°	
Mount height	Initial fc at beam center	Beam diameter	fc at beam edge	Beam diameter	fc at beam edge
8'	44.5	5.8'	22.2	10.5'	4.4
10'	23.9	7.9'	12.0	14.4'	2.4
12'	14.9	9.9'	7.4	18.2'	1.5
14'	10.2	12.0'	5.1	22.1'	1.0
16'	7.4	14.1'	3.7	25.9'	0.7

AFV 42TRT 8AR, (1) PL-T 42W/30/4P lamp, 3200 rated lumens, 1.0 s/mh, test no. 2195121902



From 0°	cp.	Lumens
0°	1568	
5°	1705	162
15°	1467	407
25°	1145	527
35°	821	505
45°	244	198
55°	10	8
65°	4	4
75°	2	3
85°	2	2
90°	0	

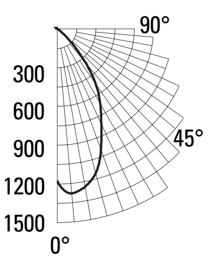
Zone	Lumens	%lamp
0°-30°	1097	34.3
0°-40°	1602	50.1
0°-60°	1808	56.5
0°-90°	1817	56.8
90°-180°	0	0.0
0°-180°	1817	56.8*

*Efficiency

ρf	20%					
ρc	80%		70%		50%	
ρw	50%	30%	50%	30%	50%	30%
1	63	61	61	60	59	58
2	58	55	57	55	55	53
3	54	51	53	50	51	49
4	50	46	49	46	48	45
5	46	43	46	42	45	42
6	43	40	43	39	42	39
7	40	37	40	36	39	36
8	38	34	37	34	37	34
9	35	32	35	32	34	31
10	33	30	33	30	32	29

		50% beam angle 53.7°		10% beam angle 85.6°	
Mount height	Initial fc at beam center	Beam diameter	fc at beam edge	Beam diameter	fc at beam edge
8'	51.8	5.6'	25.9	10.2'	5.2
10'	27.9	7.6'	13.9	13.9'	2.8
12'	17.4	9.6'	8.7	17.6'	1.7
14'	11.9	11.7'	5.9	21.3'	1.2
16'	8.6	13.7	4.3	25.0'	0.9

AFV 32TRT 8MB, (1) PL-T 32W/30/4P lamp, 2400 rated lumens, 1.0 s/mh, test no. 2196071102



From 0°	cp.	Lumens
0°	1182	
5°	1279	120
15°	1157	322
25°	812	378
35°	525	329
45°	176	141
55°	2	4
65°	0	1
75°	0	1
85°	0	1
90°	0	

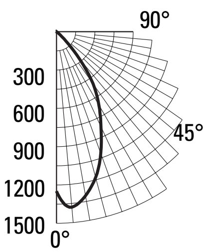
Zone	Lumens	%lamp
0°-30°	819	34.1
0°-40°	1147	47.8
0°-60°	1291	53.8
0°-90°	1291	53.8
90°-180°	0	0.0
0°-180°	1291	53.8*

*Efficiency

ρf	20%					
ρc	80%		70%		50%	
ρw	50%	30%	50%	30%	50%	30%
1	60	59	59	58	57	56
2	57	55	56	54	54	53
3	53	51	53	50	51	49
4	50	48	50	47	49	47
5	47	44	47	44	46	44
6	45	42	44	42	44	41
7	42	39	42	39	41	38
8	39	37	39	36	39	36
9	37	34	37	34	36	34
10	35	32	35	32	34	31

		50% beam angle 50.8°		10% beam angle 84.2°	
Mount height	Initial fc at beam center	Beam diameter	fc at beam edge	Beam diameter	fc at beam edge
8'	39.1	5.2'	19.5	9.9'	3.9
10'	21.0	7.1'	10.5	13.6'	2.1
12'	13.1	9.0'	6.6	17.2'	1.3
14'	8.9	10.9'	4.5	20.8'	0.9
16'	6.5	12.8'	3.2	24.4'	0.6

AFV 42TRT 8MB, (1) PL-T 42W/30/4P lamp, 3200 rated lumens, 1.0 s/mh, test no. 2197011701



From 0°	cp.	Lumens
0°	1498	0
5°	1655	158
15°	1419	402
25°	990	458
35°	598	376
45°	126	97
55°	1	1
65°	0	0
75°	0	0
85°	0	0
90°	0	0

Zone	Lumens	%lamp
0°-30°	1018	31.8
0°-40°	1394	43.6
0°-60°	1493	46.6
0°-90°	1493	46.6
90°-180°	0	0.0
0°-180°	1493	46.6*

*Efficiency

ρf	20%					
ρc	80%		70%		50%	
ρw	50%	30%	50%	30%	50%	30%
1	51	50	49	47	47	46
2	48	46	47	44	44	43
3	44	42	45	41	41	40
4	41	39	43	38	39	37
5	39	36	40	35	37	35
6	36	33	33	33	35	32
7	34	31	37	31	33	30
8	32	29	35	29	31	29
9	30	27	33	27	29	27
10	28	26	32	25	27	25

		50% beam angle 50.8°		10% beam angle 84.2°	
Mount height	Initial fc at beam center	Beam diameter	fc at beam edge	Beam diameter	fc at beam edge
8'	49.5	5.1'	24.8	9.5'	4.9
10'	26.6	6.9'	13.3	13.0'	2.6
12'	16.6	8.8'	8.3	16.4'	1.6
14'	11.3	10.6'	5.7	19.9'	1.1
16'	8.2	12.4'	4.1	23.3'	0.8

NOTES:
1. For electrical characteristics consult technical data tab.
2. Tested to current IES and NEMA standards under stabilized laboratory conditions. Various operating factors can cause differences between laboratory data and actual field measurements. Dimensions and specifications are based on the most current available data and are subject to change without notice.

gotham
An Acuity Brands Company

GOTHAM ARCHITECTURAL DOWNLIGHTING
A DIVISION OF ACUITY LIGHTING GROUP, INC.
1400 Lester Road Conyers Georgia 30012
P 800 315 4982 F 770 860 3129
www.gothamlighting.com

SP8

Static

Intended Use

Specification premium, high performance, static T8 luminaires provide general illumination for recessed applications; ideal for restricted plenum spaces.

Features

Innovative low-profile design optimized around T8 lamps, low-profile electronic ballasts and T8 compact sockets.

Hemmed sides provide smooth edges for easy handling during installation.

Standard steel door frame features precise flush-mitered corners.

Unique door frame design delivers a premium extruded appearance.

Housing and door frame interface provides a superior mechanical light seal without the use of foam gasketing.

Standard latch provides spring action. Door latches and hinges from either side.

Improved performance – higher fixture efficiency and reduced lamp image.

Integral T-bar safety clips are standard – no need to install separate clips.

Aluminum door frames available, flush or regressed.

Compatible with virtually all ceiling types. Field trim modification kits also available. See page 48.

U.S. patents – 6,210,025; 6,231,213; 6,213,625; 2,288,471.

Listings – UL Listed (standard). CSA Certified or NOM Certified (see Options).

Ordering Information

Example: **2SP8 G 3 32 A12 120 1/3 GEB**

Series

2SP8 2' wide

Trim type

- **G** Grid
- **F** Flanged
- **MT** Modular fit-in

Number of lamps

2, 3, 4[1], 6[1]

Not included.

Lamp type

- **17** 17W T8 (24")
- **U31** 31W T8 U (1⁵/₈" leg)
- **U316** 31W T8 U (6" leg)[2]
- **32** 32W T8 (48")
- **CF39** 39W TT5 (16")
- **CF40** 40W TT5 (24")
- **CF50** 50W TT5 (24")
- **CF55** 55W TT5 (24")

Frame type

- (blank) Flush steel, white
- **FN** Flush aluminum, natural
- **FM** Flush aluminum, matte black
- **FW** Flush aluminum, white
- **RN** Regressed aluminum, natural
- **RM** Regressed aluminum, matte black
- **RW** Regressed aluminum, white

Diffuser type

- **A12** #12 pattern acrylic[3]
- **A12125** #12 pattern acrylic, .125" thick
- **RA125** #12 pattern acrylic, .125" thick (reverse apex)
- **A19** #19 pattern acrylic, .156" thick
- **K20** #20 pattern acrylic, .140" thick
- **84Y** Holophane 8224 with overlay
- **PC1S** ½"x½"x½" plastic cube louver, silver
- **PC2S** 1½"x1½"x1" plastic cube louver, silver with flange
- **PC3S** ¾"x¾"x½" plastic cube louver, silver

Voltage

- **120**
- **277**
- **347**
- **MVOLT***

Others available.

* 120-277V. Must specify GEB10IS.

Options

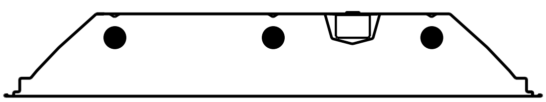
- **1/3** One 3-lamp ballast
- **1/4** One 4-lamp ballast
- **GEB** Electronic ballast, ≤20% THD
- **GEB10IS** T8 electronic ballast, ≤10% THD, instant start
- **GEB10RS** T8 electronic ballast, ≤10% THD, rapid start
- **CSA** CSA Certified
- **NOM** NOM Certified

See pages 90 & 91 for others.

NOTES:
1 4- and 6-lamp models available with 17W and 32W straight tubes only.
2 Not available on 3-lamp fixtures. Use U31.
3 Standard A12 diffuser has reverse apex technology.

Availability and Dimensions

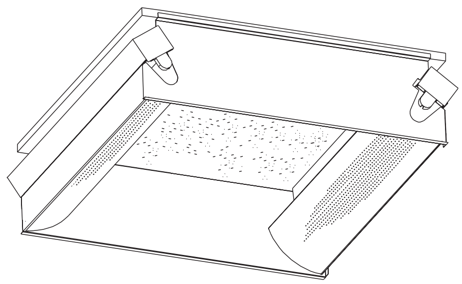
Nominal Size	Series	Number of Lamps	Lamp Type	Height in.(cm)
	2SP8	2	17, U31, U316, CF39	3¹¹/₁₆ (9.3)
	2SP8	2	CF40, CF50, CF55	3¹¹/₁₆ (9.3)
2x2	2SP8	3	17, U31, CF39	3¹¹/₁₆ (9.3)
	2SP8	3	CF40, CF50, CF55	3¹¹/₁₆ (9.3)
	2SP8	4	17	3¹¹/₁₆ (9.3)
2x4	2SP8	2, 3, 4, 6	32	3¹¹/₁₆ (9.3)



Day-Brite® Lighting

Tenuto™

2' x 2'
2 Lamp
Side Basket
Recessed Direct/Indirect



APPLICATION

- Recessed direct/indirect luminaire for glare-free illumination.
- Fits standard 2' x 2' inverted T-grid (NEMA "G") opening.
- Fully recessed mounting, suitable for row mounting.
- Uses standard 2' x 2' ceiling tile (by others) as top cover/reflector.
- Ceiling tile identical to surrounding ceiling can be used to provide a very integrated appearance.
- Different materials, pattern, or colors can be used to create accents or architectural features.
- Economical alternative to traditional recessed direct/indirect luminaires.

CONSTRUCTION/FINISH

- Delivered assembled with ballast channels, end panels, and perforated lamp covers. Ceiling tile to be supplied by others and installed on site.
- Ballast channels made of code gauge die formed steel.
- Multi-stage phospate treated for maximum corrosion resistance and finish coat is baked white enamel.
- Micro-perforated, side mounted lamp covers provide soft awareness to light sources.
- Soft white overlays on inside of lamp covers conceal lamp images and balance between direct and reflected light.
- Easy ballast access through lamp compartment.
- Swing down lamp covers for easy relamping.
- Built-in grid clips.

ELECTRICAL

- UL listed for damp locations.
- Class P, HPF ballasts comply with Ⓔ Federal Ballast Law (public law 100-357, 1988).
- Self contained emergency power pack can be incorporated. UL listed for dry locations.
- Power-Connect modular wiring option available for continuous row applications (see sheet 1604-OA).
- Electronic ballast standard for maximum efficiency.

CATALOG NUMBER

2 | TO | S | G | 2 | ___ – PMW – ___ – ___ – ___

WIDTH
2'

FIXTURE FAMILY
TO– Tenuto

BASKET LOCATION
S – Side

CEILING TYPE
G - Grid

NO. OF LAMPS
(not included)
2

LAMP TYPE/WATTAGE
14 – 14wT5 (22")
17 – 17wT8 (24")
24HO – 24wT5HO (22")
CF40 – 40wTT5 (22-1/2")
CF50 – 50wTT5 (22-1/2")
CF55 – 55wTT5 (22-1/2")

SHIELDING
PMW – Perforated Metal with White Overlay

VOLTAGE
120
277
347 (consult factory for availability)
UNV - Universal voltage, 120-277 volt (T8 and 40wTT5 only)

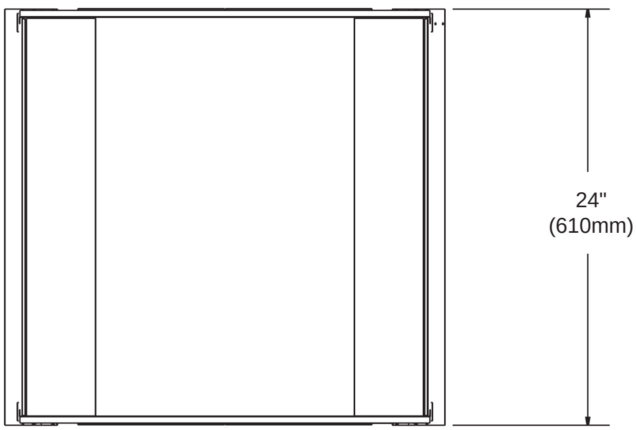
BALLAST
Generic Electronic Ballasts (Brand selected by Day-Brite)
Suffix Catalog # with
– Ballast Quantity – __ / __ -EB Lamps Per Ballast.

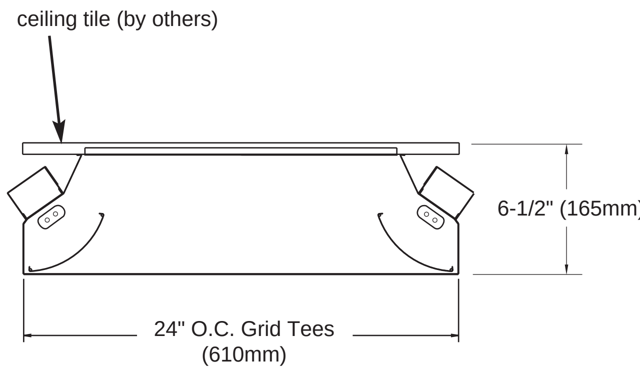
Example: –1/2-EB = One 2 Lamp Electronic Ballast.

OPTIONS
CM – Canadian Market

JOB INFORMATION

DIMENSIONS





PHOTOMETRIC DATA

CATALOG # 2TOSG2CF40-PMW-1/2-EB **LAMPS =** 40wTT5 **INPUT WATTS =** 69
TEST #22253 **S/MH=** 1.3 **BALLAST =** ELECTRONIC **BALLAST FACTOR =** .88

LER = 52

COMPARATIVE YEARLY LIGHTING ENERGY COST PER 1000 LUMENS = **$4.62** BASED ON 3000 HRS. AND $.08 PER KWH.

FIXTURE EFFICIENCY= 65.2%

CANDLEPOWER

Angle	End	45	Cross
0	1342	1342	1342
5	1332	1333	1338
10	1314	1316	1325
15	1279	1287	1304
20	1232	1252	1265
25	1177	1198	1221
30	1114	1131	1160
35	1036	1063	1081
40	956	974	1010
45	864	880	947
50	766	790	886
55	662	707	826
60	559	618	762
65	458	529	696
70	363	438	617
75	278	338	510
80	191	223	343
85	123	103	135

MAINTAINED ILLUMINATION TABLE- Square Feet/Fixture*

- 80-50-20 Reflectances (Ceiling-Wall-Floor)
- LLF = 0.73 3150 Lumens/Lamp very clean
- Room width divided by room height = 5 or more, 2 or 1

Fixture Size & # of Lamps	Room Width / Room Height =	Approx. Area (sq. ft.) per Fixture				
		10 ft-c	30 ft-c	50 ft-c	70 ft-c	100 ft-c
2' x 2' 2 Lamp	5	-	103	62	44	30
	2	-	68	41	-	-
	1	-	49	29	-	-

*Observe Fixture S/MH Requirements for Specific Applications

AVERAGE LUMINANCE CD/SQ.M WITH 3150 LUMEN LAMPS

ANGLE	END	45°	CROSS
45	3288	3349	3604
55	3106	3317	3875
65	2916	3368	4432
75	2890	3514	5303
85	3798	3180	4168

TYPICAL V.C.P.'s

Room Size	Mounting Height Lengthwise		Mounting Height Crosswise	
	8.5	10	8.5	10
30x30	41	47	33	39
40x40	37	41	30	33
60x30	42	47	37	42
60x60	34	37	29	30
100x100	32	34	29	30

COEFFICIENT OF UTILIZATION

pfc	20							
pcc	80			70			50	
pw	70	50	30	70	50	30	50	30
RCR								
0	78	78	78	76	76	76	71	71
1	69	67	64	68	65	61	61	59
2	63	57	53	61	56	52	54	50
3	57	50	45	56	48	44	46	42
4	53	44	38	51	44	38	41	36
5	47	40	34	46	39	33	36	32
6	45	35	29	42	34	28	34	28
7	40	32	26	40	32	26	30	26
8	38	28	23	36	28	23	28	23
9	35	27	20	34	27	20	26	20
10	34	25	20	33	25	19	23	19

LIGHT DISTRIBUTION

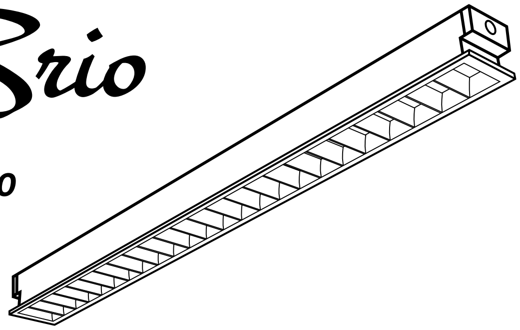
DEGREES	LUMENS	% LAMP	% FIXTURE
0-30	1044	16.6	25.4
0-40	1708	27.1	41.6
0-60	3048	48.4	74.2
0-90	4105	65.2	100.0

LLF = .73 LLF = LIGHT LOSS FACTOR LLF = LDD X LLD X BF LDD = VERY CLEAN 0.94 CLEAN 0.90
LLD = 0.88 @ 40% RATED LAMP LIFE BF = .88 ELECTRONIC BALLAST & 40wTT5 LAMP (RELAMP AT 70% LAMP LIFE)

DAY-BRITE LIGHTING • www.daybritelighting.com
776 South Green Street • Tupelo, Mississippi 38804 • PH: (662) 842-7212 • FAX: (662) 841-5501
CANADIAN DIVISION
189 Bullock Drive • Markham, Ontario L3P 1W4 • PH: (905) 294-9570 • FAX: (905) 294-9811

Brio

Stretto



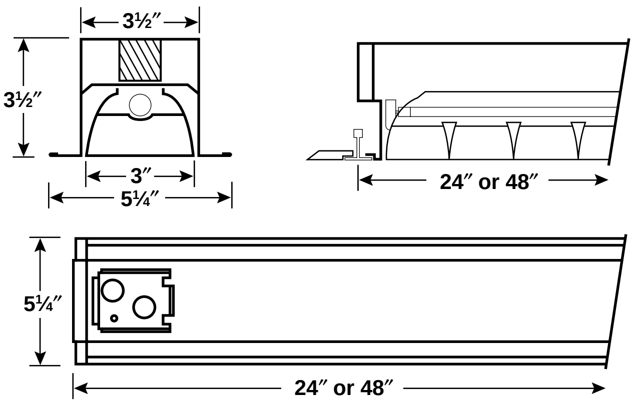
BR042-1, BR044-1

4″x 2′ or 4″x 4′ Parabolic
1 T5 or T5 HO Lamp

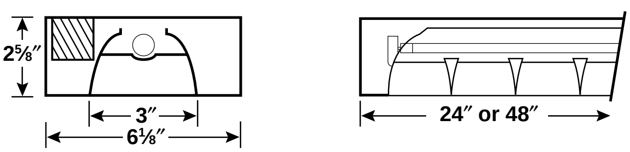
Type: ______________________________

Job Description: ______________________________

Recessed

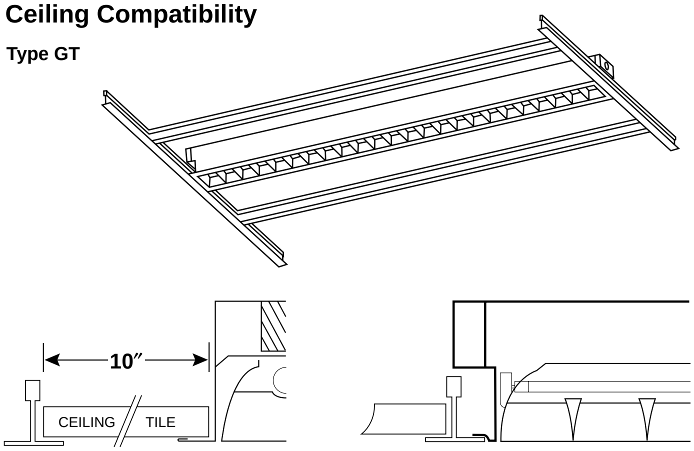


Surface/Pendant



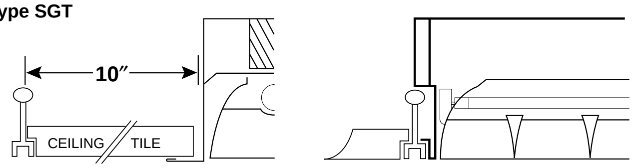
Ceiling Compatibility

Type GT



For lay-in installation in exposed grid ceilings. Maximum tee widths of 1″ and maximum tee heights of 1½″ allowed.

Type SGT



For 9⁄16″ slot grid type ceilings. Louver will be level with the ceiling plane. Shoulder heights of tee or exact slot grid must be specified.

Features

- Narrow aperture dedicated louver for single or row mounting.
- RP-1 compliant with superior glare control for areas with computers.
- T5 or T5 HO technology provides an excellent lumen package.
- 3½″ deep, low profile housing.
- Integral cross tee trim (GT) supports ceiling tile for easy installation.

Construction

Luminaire housing and endcaps are die formed code gauge cold rolled steel. Lamps are accessible from below the ceiling. Anodized aluminum louver securely snaps into position without tools. Safety tethers are standard, allowing hands-free maintenance.

Finish

Painted parts are treated with a five stage phosphate bonding process and are finished with a high reflectance baked white enamel. Louver is standard low iridescence specular (LS) natural anodized aluminum.

Installation

An access plate is furnished with each recessed fixture for fast wiring connections without the necessity to open the fixture or wireway. In-row wiring is available for end-to-end or tandem spacing.

Ceiling Compatibility

Standard integral cross tee trim (GT) allows installation into a 2′x2′ or 2′x4′ 15⁄16″ lay-in exposed grid ceiling without the need to frame with additional T-bar. GT trim acts as integral cross tee to support ceiling tile along the length of the unit. Cut tile to 10″ each side. For Slot Grid T-bar, use Slot Grid integral cross tee (SGT) trim. Grid (G) trim is available for use with FK04 flange kit to install grid (G) trim into hard ceiling application. Grid (G) trim may also be used for traditional T-bar installations (requires full framing of unit). If flange with wing hangers or surface mount is desired, contact factory.

Labels & Electrical

All luminaires are UL listed 1598 and bear UL recessed fixture labels. CUL label optional. Completely wired with standard class “P”, thermally protected, autoresetting, HPF, CBM ballasts. Sound rated A. All ballast leads extend a minimum of 6″ through access opening.

Complete ordering information on back. Dimensions and specifications subject to change without notice.

HUBBELL® Hubbell Lighting, Inc.

www.columbialighting.com • 3808 N Sullivan Rd, Bldg 29 • Spokane, WA 99216 • (509) 924-7000

Columbia LIGHTING

Photometric Report No. 12831

Columbia LIGHTING

Tel 509 924 7000
PO Box 2767 (99220) 3808 North Sullivan Road Spokane WA 99216

Environmental Laboratories

REPORT # 12831
DATE: 5/15/ 1

LUMINAIRE: BR044-154G-LS-EB5-PAF

4" X 48" 1 LAMP WITH 24 CELL SPECULAR LOUVER
BAL.: QT2X54/120PHO; LAMP: F54T5: BAL. FAC.: 1.00: WATTS: 60
LAMPS RATED AT 4400 LUMENS EACH
LUMINOUS AREA: 45.8 X 3.1

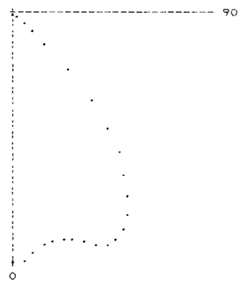
REFLECTANCE: PCW .93 MOUNTING: RECESSED

S/MH: PARL 1.21 NORM 1.33

PLOT OF NORMAL PLANE
SHIELDING: PARL 32 NORM 34

CANDLEPOWER

DEG	0	22.5	45	67.5	90
0	1975.	1975.	1975.	1775.	1975.
5	1960.	1971.	1957.	1921.	1904.
10	1937.	1921.	1847.	1832.	1829.
15	1888.	1825.	1824.	1851.	1860.
20	1808.	1735.	1827.	1923.	1946.
25	1707.	1673.	1834.	1965.	1970.
30	1590.	1596.	1786.	1860.	1841.
35	1454.	1490.	1609.	1602.	1559.
40	1291.	1328.	1364.	1247.	1186.
45	1034.	1072.	1004.	798.	614.
50	543.	697.	614.	311.	201.
55	191.	263.	241.	95.	25.
60	30.	73.	59.	19.	5.
65	4.	4.	9.	9.	4.
70	2.	2.	2.	2.	1.
75	0.	1.	0.	0.	0.
80	0.	0.	0.	0.	0.
85	0.	0.	0.	0.	0.
90	0.	0.	0.	0.	0.



ZONAL SUMMARY

ZONE	LUMENS	LAMP	FIXT
0- 30	1543.	35.1	45.2
0- 40	2503.	56.9	73.3
0- 60	3399.	77.2	99.6
0- 90	3413.	77.6	100.0
90-180	0.	0.0	0.0
0 180	3413.	77.6	100.0

This photometric test was performed using a specific ballast / lamp combination. Extrapulation of these data for other ballast / lamp combinations may produce erroneous results. The ballast factor must be applied to the lumen output rating assigned to the lamp(s) or to the candlepower values shown.

Luminaire efficacy rating (LER) per NEMA LE5-1993.

LER = 57

TESTED BY: S.T. APPROVED BY: [signature]

TEST RUN IN ACCORDANCE TO CURRENT I.E.S. PUBLISHED PROCEDURES

Coefficients of Utilization

Coefficients of Utilization

Zonal Cavity Method — Floor Reflectance - .20

RC	80				70				50			0
RW	70	50	30	10	70	50	30	10	50	30	10	0
1	88	85	83	81	86	83	82	80	80	79	77	72
2	83	78	75	72	81	77	74	71	75	72	70	66
3	78	72	68	64	76	71	67	64	69	66	63	60
4	73	66	61	58	71	65	61	57	64	60	57	54
5	68	61	55	52	67	60	55	51	58	54	51	49
6	64	56	50	47	63	55	50	46	54	49	46	44
7	59	51	46	42	58	50	45	42	49	45	41	40
8	55	46	41	37	54	46	41	37	45	40	37	35
9	51	42	36	33	50	41	36	33	41	36	32	31
10	47	38	33	29	46	38	33	29	37	32	29	28

Visual Comfort Probability

Reflectance - 80, 50, 20
Work Plane Illumination - 100 FC@ 2.5 ft.

VCP

Room Dimensions W	L	Luminaires Lengthwise Ht. 8.5	10.0	13.0	16.0	Luminaires Crosswise Ht. 8.5	10.0	13.0	16.0
20	20	84	76	62	46	95	86	79	60
20	40	88	83	75	59	95	87	87	73
30	30	91	85	76	58	96	91	87	69
30	60	91	87	83	68	97	91	89	74
40	40	91	89	84	69	98	93	91	77
40	60	91	89	86	73	98	93	91	77
60	30	91	88	83	67	98	94	91	76
60	40	91	89	86	73	98	94	92	81
60	60	91	89	88	76	98	94	93	81

Energy Data

LER: 57 **Energy Cost: $4.21***

Input Watts: 60 **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: BR044-154GT-LS-EB5120-1WW

BR ___ - 1 ___ ___ - LS - EB5 ___ - ___

Model
BR - Brio

Fixture Size
042 - 4″ x 2′ (Recessed)
044 - 4″ x 4′ (Recessed)
062 - 6″ x 2′ (Surface)
064 - 6″ x 4′ (Surface)

No. of Lamps
1 - One

Lamp Type
14 - 2′, Linear T5
24 - 2′, Linear T5 HO
28 - 4′, Linear T5
54 - 4′, Linear T5 HO

Ceiling Type
GT - Integral Cross Tee (Grid ends lay into T-bar, sides act as integral cross-tee to support ceiling tile)
SGT - Slot Grid Integral Cross Tee (Ends lay into slot grid T-bar, sides act as integral cross-tee to support tile)
G - Grid (Standard 15⁄16″ flat lay-in T-bar)
SM - Surface Mount

Louver Finish
LS - Low Iridescence Specular

Ballast
EB5 - Electronic Linear T5
Lamp type will determine ballast installed. For example, BR042-124GT-LS-EB5277 will ship with T5 HO electronic ballast suitable for (1) 24W T5 HO lamp.

Voltage
120 - 120V
277 - 277V

Options
1WW - Asymmetric Wall Wash
2WW - Double Wall Wash
F5830 - T5 Standard or T5 HO Linear Lamp Installed, 80 CRI, 3000 K**
F5835 - T5 Standard or T5 HO Linear Lamp Installed, 80 CRI, 3500 K**
F5841 - T5 Standard or T5 HO Linear Lamp Installed, 80 CRI, 4100 K**
FK042 - 4″ x 2′ Single Flange Kit
FK044 - 4″ x 4′ Single Flange Kit
DL - Damp Label
GLR - Fast Blow Fuse
GMF - Slow Blow Fuse
EL - Emergency Battery Pack
C388 - 3-Wire Flex
MSEE - Master/Satellite End-to-End (Allows two units to share one ballast when placed end-to-end)
MS6 - Master/Satellite with 6′ Harness
PAF - Paint After Fabrication

**Lamp type will determine lamp installed. For example, BR044-154HOGT-LS-EB5120-F5835 will ship with (1) 54 Watt T5 Hight Output 80 CRI, 3500 K lamp installed.

CO 3/03

Columbia LIGHTING
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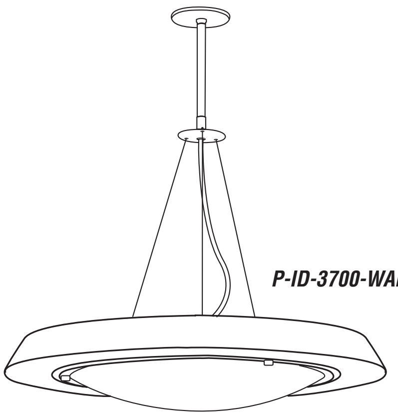
LITECONTROL

Mantra™
P-I-3700, P-ID-3700

PENDANT INDIRECT
PENDANT INDIRECT/DIRECT

TYPE:
PROJECT:

SPECIFICATIONS



P-ID-3700-WAB

See Page 4 for dimensioned cross-sections

HOUSING. Bottom housing is 31 7/8" in diameter, 16-gauge spun steel, with a 12 1/2" diameter opening in the middle. Recessed chassis is 20-gauge spun steel.

REFLECTOR. Die-formed .025" thick specular hammertone aluminum.

INDIRECT ONLY VERSION. P-I-3700 is the baseline indirect-only fixture with solid bottom housing.

INDIRECT/DIRECT VERSION. P-ID-3700 incorporates a 2D direct lamp in the center of the fixture and a 23 1/4" diameter 1/8" thick white acrylic bowl **(WAB)** as down-light shield.

LAMPING. The up-light component can accommodate three or six 39-, 40-, 50-, or 55-watt compact fluorescent lamps. The optional down-light component can accommodate one 21- or 38-watt 2D lamp.

BALLAST. Electronic, high power factor, thermally protected Class P, Sound Rated A, manufactured by a UL Listed manufacturer, as available, determined by Litecontrol. The minimum number of ballasts will be used.

SUSPENSION. Each fixture is suspended with one P6S stem (5/8" dia., 3/8" NPT), three aircraft cables, and an intermediate retaining plate. The minimum recommended suspension height is 24".

CERTIFICATION. Fixture and electrical components shall be UL and/or CUL Listed and shall bear the I.B.E.W., A.F. of L. label

Note: Litecontrol reserves the right to change specifications without notice for product development and improvement..

UL LISTED

ORDERING GUIDE

Section	Mounting	-	Distribution	-	Series	Lamp Count	-	Lamp Type	-	Diffuser	-	Finish	-	Ballast	-	Option	-	Volts	Indirect Lamps	Diameter in. (mm)
	P		I		37	3	0	BX39		--				ELB					3-FT36W	31 7/8 (810)
	P		I		37	3	0	BX40		--				ELB					3-FT40W	31 7/8 (810)
	P		I		37	3	0	BX50		--				ELB					3-FT50W	31 7/8 (810)
	P		I		37	3	0	BX55		--				ELB					3-FT55W	31 7/8 (810)
	P		I		37	6	0	BX39		--				ELB					6-FT36W	31 7/8 (810)
	P		I		37	6	0	BX40		--				ELB					6-FT40W	31 7/8 (810)
	P		I		37	6	0	BX50		--				ELB					6-FT50W	31 7/8 (810)
	P		I		37	6	0	BX55		--				ELB					6-FT55W	31 7/8 (810)
	P		ID		37	3	0	BX39/21		WAB				ELB					3-FT36W	31 7/8 (810)
	P		ID		37	3	0	BX40/21		WAB				ELB					3-FT40W	31 7/8 (810)
	P		ID		37	3	0	BX50/21		WAB				ELB					3-FT50W	31 7/8 (810)
	P		ID		37	3	0	BX55/21		WAB				ELB					3-FT55W	31 7/8 (810)
	P		ID		37	6	0	BX39/21		WAB				ELB					6-FT36W	31 7/8 (810)
	P		ID		37	6	0	BX40/21		WAB				ELB					6-FT40W	31 7/8 (810)
	P		ID		37	6	0	BX50/21		WAB				ELB					6-FT50W	31 7/8 (810)
	P		ID		37	6	0	BX55/21		WAB				ELB					6-FT55W	31 7/8 (810)

P-I-3730BX40-TCWM-ELB-120 is a typical catalog number for a three-lamp indirect BX40 fixture, painted Textured Matte White, with electronic ballast, 120 volts.

P-ID-3730BX40/21-WAB-TCWM-ELB-120 is a typical catalog number for a three-lamp indirect/direct, BX40 (indirect) and 21 W (direct) fixture, painted Textured Matte White, with electronic ballast and acrylic down-light bowl, 120 volts.

For direct 38W 2D lamp, specify **BX39/38**, **BX40/38**, **BX50/38** or **BX55/38** in place of BX39/21, BX40/21, BX50/21, or BX55/21 respectively.

Finish: TCWM (Textured Matte White) is standard. For other finishes, see *LiteColors*™ brochure.

OPTIONS

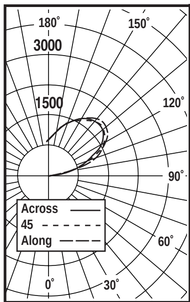
EF Emergency fluorescent ballast. Battery-powered ballast from a UL Listed manufacturer will operate one compact fluorescent lamp for 1 1/2 hours. Some lamping combinations cannot accommodate an EF ballast. Check with factory for availability.

F Fuse. Slow or fast blow, determined by Litecontrol.

WL Fixture supplied with one down-light lamp (P-ID-3700 series only). Lamps are shipped separately. Contact factory for lamp availability.

LITECONTROL . . . an employee owned company
100 HAWKS AVENUE HANSON MA 02341 781 294 0100 FAX 781 293 2849 info@litecontrol.com www.litecontrol.com

PHOTOMETRIC DATA: Indirect



CANDLEPOWER SUMMARY

ANGLE	0	22.5	45	67.5	90	OUTPUT LUMENS
180	847	847	847	847	847	
175	885	886	879	885	889	87
170	993	995	986	994	1009	
165	1144	1133	1124	1143	1160	323
160	1301	1268	1267	1301	1316	
155	1454	1396	1407	1456	1461	661
150	1598	1518	1539	1600	1592	
145	1721	1625	1654	1720	1699	1051
140	1828	1710	1748	1820	1776	
135	1904	1769	1812	1886	1825	1407
130	1916	1767	1811	1881	1810	
125	1859	1720	1776	1843	1748	1587
120	1734	1592	1676	1745	1599	
115	1556	1397	1482	1556	1377	1456
110	1344	1172	1244	1310	1151	
105	1035	914	990	1036	914	1024
100	694	635	673	717	627	
95	317	294	332	361	303	371
90	24	32	38	45	44	

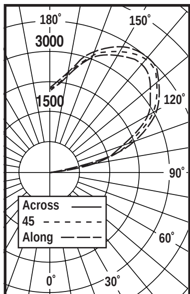
P-I-3730BX40 84.3% Efficiency
Litecontrol Certified Test Report #26530000

RCC	80				70				50			30			10			0
RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
RCR																		
0	.80	.80	.80	.80	.69	.69	.69	.69	.47	.47	.47	.27	.27	.27	.09	.09	.09	.00
1	.73	.70	.67	.64	.62	.59	.57	.54	.41	.39	.38	.23	.23	.22	.07	.07	.07	.00
2	.66	.60	.56	.52	.56	.52	.48	.45	.36	.33	.31	.20	.19	.18	.07	.06	.06	.00
3	.60	.53	.48	.43	.51	.46	.41	.37	.31	.29	.26	.18	.17	.16	.06	.05	.05	.00
4	.55	.47	.41	.36	.47	.40	.35	.31	.28	.25	.22	.16	.14	.13	.05	.05	.04	.00
5	.50	.41	.35	.31	.43	.36	.30	.27	.25	.21	.19	.14	.12	.11	.05	.04	.04	.00
6	.46	.37	.31	.26	.39	.32	.27	.23	.22	.19	.16	.13	.11	.10	.04	.04	.03	.00
7	.42	.33	.27	.22	.36	.28	.23	.20	.20	.16	.14	.11	.10	.08	.04	.03	.03	.00
8	.39	.30	.24	.20	.33	.25	.20	.17	.18	.14	.12	.10	.09	.07	.03	.03	.02	.00
9	.36	.27	.21	.17	.31	.23	.18	.15	.16	.13	.11	.09	.08	.06	.03	.02	.02	.00
10	.34	.24	.19	.15	.29	.21	.16	.13	.15	.11	.09	.09	.07	.06	.03	.02	.02	.00

Floor Cavity Reflectance .20

ZONAL LUMEN SUMMARY

ZONE	LUMENS	% LAMP	% LUMINAIRE
180-90°	7961	84.25	100
90-0°	0	.00	0.0
180-0°	7961	84.25	100



CANDLEPOWER SUMMARY

ANGLE	0	22.5	45	67.5	90	OUTPUT LUMENS
180	2137	2137	2137	2137	2137	
175	2264	2260	2237	2214	2235	218
170	2562	2536	2499	2474	2503	
165	2901	2852	2828	2799	2803	801
160	3191	3114	3127	3098	3061	
155	3429	3301	3360	3335	3258	1538
150	3622	3437	3537	3526	3411	
145	3762	3537	3650	3651	3515	2265
140	3812	3568	3712	3737	3548	
135	3757	3508	3699	3716	3503	2787
130	3571	3290	3517	3527	3308	
125	3337	3025	3276	3310	3051	2862
120	3088	2743	2963	3012	2778	
115	2703	2391	2577	2635	2394	2505
110	2238	1976	2149	2188	1967	
105	1669	1479	1617	1634	1476	1659
100	1060	957	1042	1060	944	
95	447	417	463	483	410	540
90	50	64	68	72	63	

P-I-3760BX40 80.3% Efficiency
Litecontrol Certified Test Report #26560002

RCC	80				70				50			30			10			0
RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
RCR																		
0	.76	.76	.76	.76	.65	.65	.65	.65	.45	.45	.45	.26	.26	.26	.08	.08	.08	.00
1	.70	.66	.63	.61	.59	.57	.54	.52	.39	.37	.36	.22	.22	.21	.07	.07	.07	.00
2	.63	.58	.53	.49	.54	.49	.46	.43	.34	.32	.30	.20	.18	.17	.06	.06	.06	.00
3	.58	.51	.45	.41	.49	.43	.39	.36	.30	.27	.25	.17	.16	.15	.06	.05	.05	.00
4	.52	.45	.39	.35	.45	.38	.34	.30	.26	.23	.21	.15	.14	.12	.05	.04	.04	.00
5	.48	.39	.34	.29	.41	.34	.29	.25	.23	.20	.18	.14	.12	.11	.04	.04	.04	.00
6	.44	.35	.29	.25	.37	.30	.25	.22	.21	.18	.15	.12	.10	.09	.04	.03	.03	.00
7	.40	.31	.26	.21	.34	.27	.22	.19	.19	.15	.13	.11	.09	.08	.04	.03	.03	.00
8	.37	.28	.22	.19	.32	.24	.20	.16	.17	.14	.11	.10	.08	.07	.03	.03	.02	.00
9	.34	.25	.20	.16	.29	.22	.17	.14	.15	.12	.10	.09	.07	.06	.03	.02	.02	.00
10	.32	.23	.18	.14	.27	.20	.15	.12	.14	.11	.09	.08	.06	.05	.03	.02	.02	.00

Floor Cavity Reflectance .20

ZONAL LUMEN SUMMARY

ZONE	LUMENS	% LAMP	% LUMINAIRE
180-90°	15170	80.27	100
90-0°	0	.00	0.0
180-0°	15170	80.27	100

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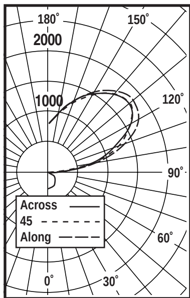
PHOTOMETRIC DATA: Indirect/Direct



CANDLEPOWER SUMMARY

ANGLE	0	22.5	45	67.5	90	OUTPUT LUMENS
180	807	807	807	807	807	
170	950	948	940	951	955	391
160	1241	1221	1210	1241	1244	
150	1526	1478	1467	1522	1502	1638
140	1745	1678	1668	1733	1680	
130	1820	1739	1735	1815	1731	2886
120	1692	1599	1571	1652	1539	
110	1295	1169	1180	1287	1086	2391
100	669	633	619	666	570	
90	58	51	45	42	43	452
80	110	102	95	89	88	
70	118	110	99	96	97	219
60	139	133	128	125	125	
50	165	163	161	158	157	267
40	192	191	190	188	187	
30	217	216	215	214	213	232
20	235	235	233	234	233	
10	248	247	246	246	246	93
0	243	243	243	243	243	

P-ID-3730BX40/21-WAB 79.3% Efficiency
Litecontrol Certified Test Report #26540020

RCC	80				70				50			30			10			0
RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
RCR																		
0	.77	.77	.77	.77	.67	.67	.67	.67	.49	.49	.49	.31	.31	.31	.16	.16	.16	.08
1	.70	.67	.64	.61	.61	.58	.56	.53	.42	.41	.39	.27	.26	.25	.13	.13	.13	.06
2	.64	.58	.53	.49	.55	.51	.47	.43	.37	.34	.32	.24	.22	.21	.12	.11	.10	.05
3	.58	.51	.46	.41	.50	.44	.40	.36	.32	.29	.27	.21	.19	.18	.10	.09	.09	.04
4	.53	.45	.39	.35	.46	.39	.34	.31	.28	.25	.23	.18	.17	.15	.09	.08	.08	.04
5	.48	.39	.34	.29	.42	.35	.30	.26	.25	.22	.19	.16	.14	.13	.08	.07	.06	.03
6	.44	.35	.29	.25	.38	.31	.26	.22	.23	.19	.17	.15	.13	.11	.07	.06	.06	.03
7	.41	.32	.26	.22	.35	.28	.23	.19	.20	.17	.14	.13	.11	.09	.07	.06	.05	.02
8	.38	.28	.23	.19	.33	.25	.20	.17	.18	.15	.12	.12	.10	.08	.06	.05	.04	.02
9	.35	.26	.20	.16	.30	.22	.18	.14	.16	.13	.11	.11	.09	.07	.05	.04	.04	.02
10	.32	.23	.18	.14	.28	.20	.16	.13	.15	.12	.09	.10	.08	.06	.05	.04	.03	.01

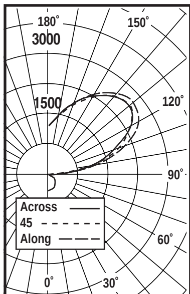
Floor Cavity Reflectance .20

ZONAL LUMEN SUMMARY

ZONE	LUMENS	% LAMP	% LUMINAIRE
180-90°	7660	70.93	89.49
90-0°	899	8.33	10.51
180-0°	8559	79.26	100.00

LUMINANCE SUMMARY (fL)

ANGLE	0	45	90
45	460	435	414
55	484	433	409
65	549	435	410
75	784	553	498



CANDLEPOWER SUMMARY

ANGLE	0	22.5	45	67.5	90	OUTPUT LUMENS
180	1991	1991	1991	1991	1991	
170	2363	2365	2392	2425	2429	975
160	3000	2930	2981	3085	3053	
150	3469	3287	3344	3516	3361	3682
140	3628	3464	3543	3667	3494	
130	3440	3269	3323	3420	3185	5464
120	2981	2737	2808	2945	2582	
110	2070	1958	2016	2100	1813	3958
100	967	897	897	934	805	
90	58	51	45	42	43	555
80	110	102	95	89	88	
70	118	110	99	96	97	219
60	139	133	128	125	125	
50	165	163	161	158	157	267
40	192	191	190	188	187	
30	217	216	215	214	213	232
20	235	235	233	234	233	
10	248	247	246	246	246	93
0	243	243	243	243	243	

P-ID-3760BX40/21-WAB 76.2% Efficiency
Litecontrol Certified Test Report #26670021

RCC	80				70				50			30			10			0
RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
RCR																		
0	.74	.74	.74	.74	.64	.64	.64	.64	.45	.45	.45	.28	.28	.28	.12	.12	.12	.04
1	.67	.64	.61	.58	.58	.55	.53	.50	.39	.37	.36	.24	.23	.22	.10	.10	.10	.03
2	.61	.55	.51	.47	.52	.48	.44	.41	.34	.32	.30	.21	.20	.19	.09	.08	.08	.03
3	.55	.49	.44	.39	.48	.42	.38	.35	.30	.27	.25	.18	.17	.16	.08	.07	.07	.02
4	.50	.43	.37	.33	.43	.37	.32	.29	.26	.23	.21	.16	.15	.13	.07	.06	.06	.02
5	.46	.37	.32	.28	.40	.33	.28	.24	.23	.20	.18	.14	.13	.11	.06	.05	.05	.02
6	.42	.34	.28	.24	.36	.29	.24	.21	.21	.18	.15	.13	.11	.10	.06	.05	.04	.01
7	.39	.30	.24	.21	.33	.26	.21	.18	.19	.15	.13	.12	.10	.08	.05	.04	.04	.01
8	.36	.27	.22	.18	.31	.23	.19	.16	.17	.14	.11	.11	.09	.07	.04	.04	.03	.01
9	.33	.24	.19	.16	.28	.21	.17	.14	.15	.12	.10	.09	.08	.06	.04	.03	.03	.01
10	.31	.22	.17	.14	.26	.19	.15	.12	.14	.11	.09	.09	.07	.06	.04	.03	.02	.01

Floor Cavity Reflectance .20

ZONAL LUMEN SUMMARY

ZONE	LUMENS	% LAMP	% LUMINAIRE
180-90°	14535	71.78	94.17
90-0°	899	4.44	5.83
180-0°	15434	76.22	100.00

LUMINANCE SUMMARY fL)

ANGLE	0	45	90
45	460	435	414
55	484	433	409
65	549	435	410
75	784	553	498

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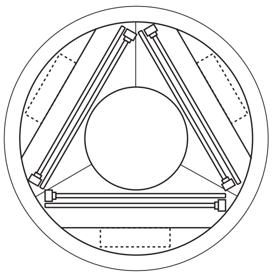
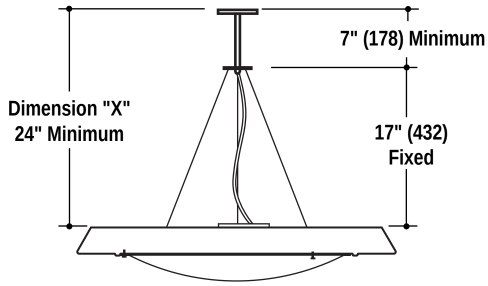
PLANNING FOR INSTALLATION

PLAN VIEW





SUSPENSION ASSEMBLY & MOUNTING:
Provided with a combination P6S (5/8" diameter) stem and three-cable 3/32" diameter aircraft cable assembly. The stem mounts to a 3 1/2" octagonal x 2 1/8" deep outlet box independently supported above the ceiling plane*. The outlet box is then covered by a 5" diameter x 1/4" deep canopy (provided).

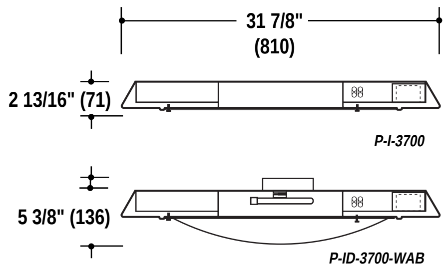
SUSPENSION LENGTH:
Per the diagram above, specify the dimension "X" for ceiling-to-top-of-fixture suspension length. Standard lengths for dimension "X" available for Mantra are: 18", 24", and 36".

The standard length of the aircraft portion of the suspension is 17", and the stem length will be determined by Litecontrol to complete the specified total suspension dimension "X". The aircraft cable attachments provide vertical adjustment to the overall suspension of about 1". For special suspension requirements, including dimensions "X", other than those listed above, contact factory.

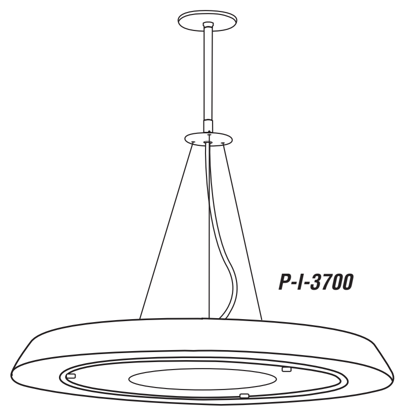
***NOTE:** Fixture assemblies weigh from 41 to 51 lbs. The National Electric Code requires that any fixture weighing more than 50 lbs. be supported independently from an outlet box.

QUESTIONS TO ASK
1. 120 or 277 volt?
2. White, LiteColor, or special color?
3. Dimension “X”: advise length.
4. Other options?

DIMENSIONED CROSS-SECTIONS



ISOMETRIC VIEW - INDIRECT



FEATURES

Type | Catalog number

OPTICAL

- Reflector – Self-flanged, specular clear or semi-diffuse reflector. Bounding Ray Optical Principle design provides lamp before lamp image and smooth transition from top of reflector to bottom. Hybrid kicker reflector for wallwash. Minimum flange matches reflector finish. White painted flange optional. (Vertisys optical system patented – US Patent #5,800,050)
- Hybrid kicker reflector has highly specular finish on bottom ¾" and transitions to diffuse on the rest of the kicker reflector.
- 1/8" clear glass or clear polycarbonate lens available.

MECHANICAL

- 16-gauge galvanized steel mounting/plaster frame with with integral yoke to retain reflector system. Yoke is 16 gauge galvanized steel with tempered steel flat spring and is adjustable for up to 1-5/8" thick ceiling with no additional parts or modifications.
- Mounting bars are 16-gauge galvanized steel with continuous 4" vertical adjustment, held in place with tool-less, cam-action locking system. Post installation adjustment possible without the use of tools from above or below the ceiling. Shipped pre-installed.
- Galvanized steel junction box with bottom-hinged access covers and spring latches. Two combination ½"-3/4" and three ½" knockouts for straight-through conduit runs. Capacity: 8 (4 in, 4 out) No. 12 AWG conductors rated for 90°C.

ELECTRICAL SYSTEM

- Rugged aluminum lampholder housing designed for positive lamp center positioning.
- Vertically mounted, positive-latch thermoplastic socket.
- Class P, thermally-protected, high power factor ballast mounted to the junction box.

LISTING

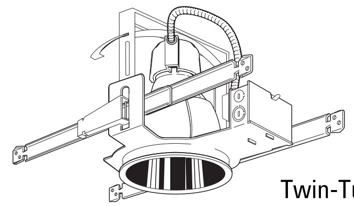
- Fixtures are UL Listed for thru-branch wiring, recessed mounting and damp locations. Listed and labeled to comply with Canadian Standards (see Options).

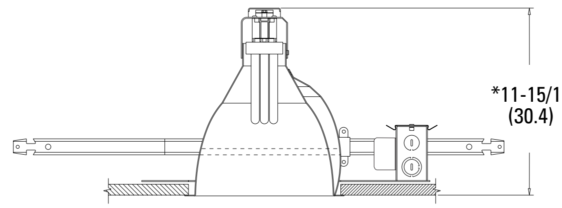
Compact Fluorescent Downlights

8" AFVW

Open Wallwash

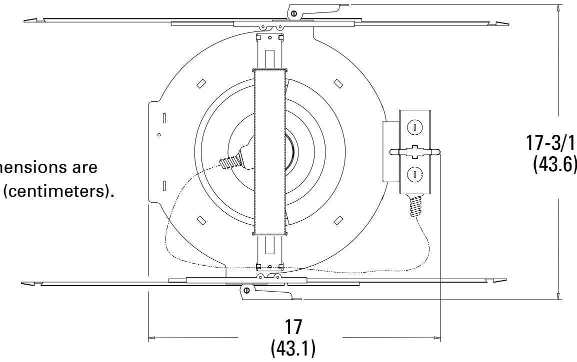
Vertical Lamp
Twin-Tube, Double Twin-Tube or Tri-Tube





Aperture:	8 (20.3)
Ceiling opening:	8-5/8 (21.9)
Overlap trim:	9-1/8 (23.2)
Lens recess:	3-1/4 (8.3)

All dimensions are inches (centimeters).



*Maximum height depends on lamp wattage/type, dimensions may be from 10-3/16 to 11-15/16

ORDERING INFORMATION

Example: **AFVW 1/26DTT 8AR 120 GEB10 WLP**

Choose the boldface catalog nomenclature that best suits your needs and write it on the appropriate line.

AFVW

Series

AFVW	

Wattage/lamp

9TT[1]	One 9W twin-tube
13TT[1]	One 13W twin-tube
13DTT[2]	One 13W double twin-tube
18DTT[2]	One 18W double twin-tube
26DTT[2]	One 26W double twin-tube
18TRT[3]	One 18W tri-tube
26TRT[3]	One 26W tri-tube
32TRT[3]	One 32W tri-tube
42TRT[3]	One 42W tri-tube

Reflector Type

8AR	Clear
8PR	Pewter
8UBR	Umber
8WTR	Wheat
8CR[4]	Champagne Gold
8GR[4]	Gold
8WR	White Reflector

Lens Type[5]

(blank)	no lens
CGL	Clear Lens
PCL	Clear Polycarbonate Lens

Finish

(blank)	no lens
CGL	Clear lens
PCL	Clear Polycarbonate Lens
CAL	Clear acrylic lens

Voltage

120
277
347

Ballast[6]

EMB	Electromagnetic ballast.
GEB10	Electronic ballast.
DMHL	Lutron Hi-lume[0] electronic dimming ballast, 120V or 277V, 18DTT, 26DTT, 26TRT, 32TRT and 42TRT only.
ADEZ	Advance Mark X electronic dimming ballast. (120V or 277V; 26DTT, 26TRT, 32TRT and 42TRT only.)

Options

WLP	With 35°K lamp (shipped separately).
TRW	White painted flange (6WR)
LRC[7]	Provides compatibility with Lithonia Reloc System.
GMF	Single slow-blow fuse.
RIF	Radio interference filter.
ELR	Emergency battery pack. Access above ceiling required. Remote test switch provided. (Consult factory for dimensional changes.)
GSKT	1/8" x 3/8" foam gasketing.
QDS[8]	Quick-disconnect for easy ballast replacement.
CSA	Listed and labeled to comply with Canadian Standards.
EL[9]	Emergency battery pack. Integral test switch provided.

NOTES:
1 Available with magnetic ballast only.
2 Available with magnetic or electronic ballast.
3 Available with electronic ballast only.
4 Not recommended for use with compact fluorescent lamp; consult factory.
5 For additional lens types, consult factory.
6 Refer to options and accessories tab for additional ballast types.
7 For compatible Reloc systems, refer to options and accessories tab.
8 Not available with ELR option.
9 N/A with lenses

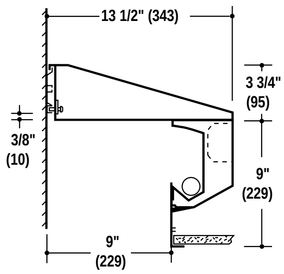
Wall/Slot®-2000
Wall/Slot®-2000 PR

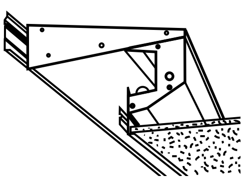
TYPE:
PROJECT:

LITECONTROL

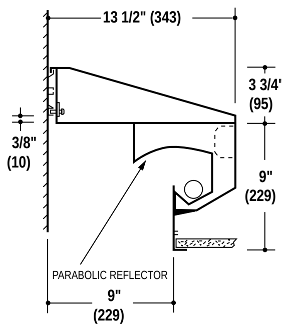
SPECIFICATIONS

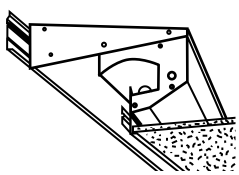
Wall/Slot-2000





Wall/Slot-2000PR





U.S. Patent No. D329,299

FIXTURE SUPPORT RAIL. Extruded white aluminum, wall-mounted rail provides continuous support and true alignment of fixtures and components. Rail is designed to provide reveal and compensate for irregularities in wall construction. Galvanized spline keys are included for continuous alignment.

FIXTURE HOUSING. Die-formed and welded 20-gauge steel. Plenum cover/wall bracket is a one-piece assembly of 20-gauge steel and heavy-gauge steel brackets with leveling screws to provide adjustment. Brackets are spaced approximately every two feet for 2-, 4-, and 8-foot fixtures, and 1 1/2 feet for 3-foot and 6-foot fixtures. Plenum cover has a continuous hook-and-lock feature for quick installation.

REFLECTOR. 2000 Curved reflector is die-formed .025" thick specular hammertone aluminum, precisely shaped for maximum downward light projection. Straight reflector portions are steel, finished in high-reflectance white for uniform light distribution. **2000PR** Parabolic reflector (PR) is die-formed .025" thick low-iridescence semi-specular aluminum, precisely shaped for maximum downward light projection. It is shielded from all viewing angles from 0° to 60° below horizontal. Straight reflector portions are steel, finished in high-reflectance white for uniform light distribution.

CEILING TRIM/LUMINANCE CONTROL DEFLECTOR. Extruded aluminum with internal aligner splines. LCD shields lamps from direct view and eliminates socket shadows on wall. Paint finish is CWM (Matte White) baked enamel.

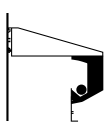
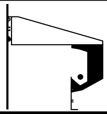
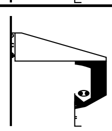
BALLAST. Electronic, high power factor, thermally protected Class P, Sound Rated A, manufactured by a UL Listed manufacturer, as available, determined by Litecontrol. The minimum number of ballasts will be used.

CEILING TYPE. Compatible with most types of ceiling systems, including grid and plaster. Fixture system must be installed prior to installation of ceiling. Finish of wall should extend 13" above finished ceiling height. See *Wall/Slot-2000 Pre-Installation Manual* for specific ceiling type details.

CERTIFICATION. Fixture and electrical components shall be UL and/or CUL Listed and shall bear the I.B.E.W., A.F. of L. label. UL LISTED

Note: Litecontrol reserves the right to change specifications without notice for product development and improvement.

ORDERING GUIDE

Section	Series	Lamp Count	Nominal Length (ft.)	Lamp Type	Finish	Ballast	Option	Volts	Lamps	Length in. (mm)
	20	1	2	T8	CWM	ELB			1-F17T8	24 (610)
	20	1	3	T8	CWM	ELB			1-F25T8	36 (914)
	20	1	4	T8	CWM	ELB			1-F32T8	48 (1219)
	20	2	6	T8	CWM	ELB			2-F25T8	72 (1829)
	20	2	8	T8	CWM	ELB			2-F32T8	96 (2438)
	20	1	3	T5HO	CWM	ELB			1-F39T5HO	36 (914)
	20	1	4	T5HO	CWM	ELB			1-F54T5HO	48 (1219)
	20	2	6	T5HO	CWM	ELB			2-F39T5HO	72 (1829)
	20	2	8	T5HO	CWM	ELB			2-F54T5HO	96 (2438)
	20	1	2	BX40	CWM	ELB			1-FT40W	24 (610)
	20	2	3	BX39	CWM	ELB			2-FT36W	36 (914)
	20	2	4	BX40	CWM	ELB			2-FT40W	48 (1219)
	20	4	6	BX39	CWM	ELB			4-FT36W	72 (1829)
	20	4	8	BX40	CWM	ELB			4-FT40W	96 (2438)

2014T8-CWM-ELB-120 is a typical catalog number for a one-lamp, 4-foot long T8 fixture, painted Matte White, 120 volts.
2014T8-CWM-ELB-PR-120 is a typical catalog number for a one-lamp, 4-foot long T8 fixture with parabolic reflector, painted Matte White, 120 volts.
Finish: CWM (Matte White) is standard.
For standard T5 lamps in place of high-output T5, specify **T5** in place of T5HO. Lamps are F28T5 (4').

BALLAST OPTIONS

Specify in place of **ELB**, contact factory for availability:

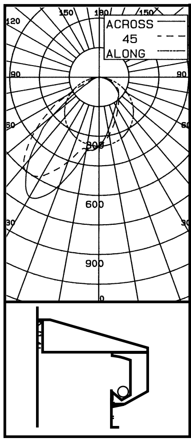
- **ELB10** Electronic ballast, same specification as above, except less than 10% THD.
- **MKV/ELB** Advance Mark V electronic ballast.
- **DA-ELB** Advance Mark VII dimming ballast.
- **HEL/ELB** Motorola Helios dimming ballast.
- **ECO/ELB** Lutron ECO-10 dimming ballast.

OTHER OPTIONS

- **EF** Emergency fluorescent ballast. Battery-powered ballast from a UL Listed manufacturer will operate one T8 lamp in a 4' or 8' fixture for 1 1/2 hours.
- **F** Fuse. Slow or fast blow, determined by Litecontrol.
- **RF** Radio frequency interference filter. Advance RIF-1, unless otherwise specified.
- **SDS** A shallow-depth fixture of 10 1/2" height is available for areas where obstructions occur. Contact factory.
- **PR** Parabolic Reflector. Larger specular hammertone aluminum reflector for additional downward light projection.

LITECONTROL
100 HAWKS AVENUE HANSON MA 02341 781 294 0100 FAX 781 293 2849 info@litecontrol.com www.litecontrol.com

PHOTOMETRIC DATA: Wall/Slot-2000



CANDLEPOWER SUMMARY

ANGLE	0	45	90	135	180	OUTPUT LUMENS
90	0	0	1	1	1	
85	6	7	14	15	13	14
80	16	16	41	29	27	
75	25	29	71	46	41	49
70	36	43	103	64	57	
65	49	87	133	82	73	103
60	85	187	164	102	90	
55	166	305	193	118	108	176
50	301	413	220	129	127	
45	424	511	245	142	139	228
40	543	589	267	155	147	
35	642	604	287	170	156	225
30	701	580	303	189	169	
25	667	520	318	212	185	169
20	582	457	330	235	207	
15	482	390	339	265	236	97
10	383	370	345	297	272	
5	372	368	349	328	315	33
0	349	349	349	349	349	

2014T8-120 70% wall reflectance
Litecontrol Certified Test Report #14711001

RCC	80				70				50			30			10			0
RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
RCR																		
0	.45	.45	.45	.45	.44	.44	.44	.44	.42	.42	.42	.40	.40	.40	.38	.38	.38	.38
1	.42	.40	.39	.37	.41	.39	.38	.37	.38	.37	.36	.36	.35	.35	.35	.34	.33	.33
2	.38	.36	.33	.31	.37	.35	.33	.31	.33	.32	.30	.32	.31	.30	.31	.30	.29	.28
3	.35	.32	.29	.27	.34	.31	.29	.27	.30	.28	.26	.29	.27	.26	.28	.27	.25	.24
4	.32	.28	.25	.23	.32	.28	.25	.23	.27	.24	.22	.26	.24	.22	.25	.23	.22	.21
5	.30	.25	.22	.19	.29	.25	.22	.19	.24	.21	.19	.23	.21	.19	.22	.20	.19	.18
6	.27	.22	.19	.17	.27	.22	.19	.17	.21	.19	.17	.21	.18	.17	.20	.18	.16	.16
7	.25	.20	.17	.15	.24	.20	.17	.15	.19	.16	.15	.19	.16	.14	.18	.16	.14	.14
8	.23	.18	.15	.13	.22	.18	.15	.13	.17	.14	.12	.17	.14	.12	.16	.14	.12	.12
9	.21	.16	.13	.11	.21	.16	.13	.11	.15	.13	.11	.15	.12	.11	.15	.12	.10	.10
10	.19	.15	.11	.09	.19	.14	.11	.09	.14	.11	.09	.14	.11	.09	.13	.11	.09	.09

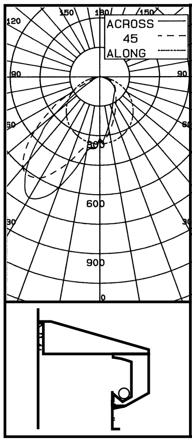
Floor Cavity Reflectance .20

ZONAL LUMEN SUMMARY

ZONE	LUMENS	% LAMP	% LUMINAIRE
180-90°	0	0.0	0.0
90-0°	1090	37.61	100
180-0°	1090	37.61	100

LUMINANCE SUMMARY (fL)

ANGLE	0°	45°	90°	135°	180°
45°	630	759	362	210	206
55°	304	559	353	216	198
65°	123	216	330	205	183
75°	103	118	289	186	167
85°	69	80	174	181	151



CANDLEPOWER SUMMARY

ANGLE	0	45	90	135	180	OUTPUT LUMENS
90	0	1	1	2	1	
85	4	5	13	12	10	12
80	13	14	38	24	21	
75	21	24	68	39	33	44
70	30	36	98	56	47	
65	41	79	129	70	61	95
60	73	182	159	84	75	
55	150	304	187	93	88	166
50	286	423	214	102	101	
45	418	528	237	113	108	221
40	551	602	260	126	114	
35	656	615	279	143	124	220
30	709	593	296	163	137	
25	676	532	310	187	156	165
20	595	466	321	215	181	
15	490	393	330	248	214	95
10	385	365	336	283	256	
5	367	361	340	319	305	32
0	308	308	308	308	308	

2014T8-120 50% wall reflectance
Litecontrol Certified Test Report #14711000

RCC	80				70				50			30			10			0
RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
RCR																		
0	.43	.43	.43	.43	.42	.42	.42	.42	.40	.40	.40	.38	.38	.38	.37	.37	.37	.36
1	.40	.38	.37	.36	.39	.38	.36	.35	.36	.35	.34	.35	.34	.33	.33	.33	.32	.32
2	.37	.34	.32	.30	.36	.34	.32	.30	.32	.31	.29	.31	.30	.29	.30	.29	.28	.27
3	.34	.30	.28	.26	.33	.30	.28	.26	.29	.27	.25	.28	.26	.25	.27	.26	.24	.24
4	.31	.27	.24	.22	.30	.27	.24	.22	.26	.24	.22	.25	.23	.21	.24	.23	.21	.20
5	.29	.24	.21	.19	.28	.24	.21	.19	.23	.21	.19	.22	.20	.18	.22	.20	.18	.18
6	.26	.22	.19	.16	.26	.21	.18	.16	.21	.18	.16	.20	.18	.16	.20	.17	.16	.15
7	.24	.19	.16	.14	.24	.19	.16	.14	.19	.16	.14	.18	.16	.14	.18	.15	.14	.13
8	.22	.17	.14	.12	.22	.17	.14	.12	.17	.14	.12	.16	.14	.12	.16	.14	.12	.11
9	.20	.16	.13	.10	.20	.15	.12	.10	.15	.12	.10	.14	.12	.10	.14	.12	.10	.10
10	.19	.14	.11	.09	.18	.14	.11	.09	.13	.11	.09	.13	.11	.09	.13	.11	.09	.08

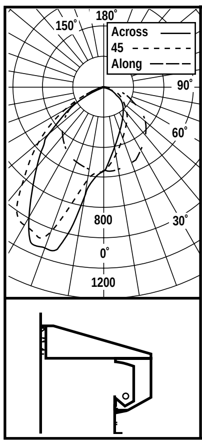
Floor Cavity Reflectance .20

ZONAL LUMEN SUMMARY

ZONE	LUMENS	% LAMP	% LUMINAIRE
180-90°	0	0.0	0.0
90-0°	1045	36.05	100
180-0°	1045	36.05	100

LUMINANCE SUMMARY (fL)

ANGLE	0°	45°	90°	135°	180°
45°	622	785	351	167	160
55°	275	558	342	171	162
65°	102	196	319	174	151
75°	83	97	274	160	135
85°	51	61	160	144	126



CANDLEPOWER SUMMARY

ANGLE	0	45	90	135	180	OUTPUT LUMENS
90	0	2	1	0	0	
85	7	12	20	11	7	16
80	25	28	64	25	22	
75	39	44	109	48	38	70
70	57	94	162	76	59	
65	81	174	210	99	82	158
60	176	349	259	131	105	
55	283	447	307	159	130	270
50	479	573	352	181	154	
45	568	706	392	205	182	340
40	698	863	428	228	201	
35	841	1015	459	252	220	352
30	1019	1038	486	283	242	
25	1139	1075	507	314	265	288
20	1128	968	522	352	300	
15	1033	722	539	394	345	166
10	679	620	545	439	397	
5	578	578	551	491	462	52
0	546	546	546	546	546	

2014T5HO 50% wall reflectance
Litecontrol Certified Test Report #14716000

RCC	80				70				50			30			10			0
RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
RCR																		
0	.41	.41	.41	.41	.40	.40	.40	.40	.38	.38	.38	.36	.36	.36	.35	.35	.35	.34
1	.38	.36	.35	.34	.37	.36	.35	.34	.34	.33	.32	.33	.32	.31	.32	.31	.31	.30
2	.35	.32	.30	.29	.34	.32	.30	.28	.31	.29	.28	.30	.28	.27	.29	.28	.27	.26
3	.32	.29	.27	.25	.31	.28	.26	.24	.27	.26	.24	.27	.25	.24	.26	.24	.23	.22
4	.30	.26	.23	.21	.29	.25	.23	.21	.25	.22	.21	.24	.22	.20	.23	.22	.20	.20
5	.27	.23	.20	.18	.26	.23	.20	.18	.22	.20	.18	.21	.19	.18	.21	.19	.17	.17
6	.25	.21	.18	.16	.24	.20	.18	.16	.20	.17	.16	.19	.17	.15	.19	.17	.15	.15
7	.23	.19	.16	.14	.22	.18	.16	.14	.18	.15	.14	.17	.15	.13	.17	.15	.13	.13
8	.21	.17	.14	.12	.21	.16	.14	.12	.16	.13	.12	.16	.13	.12	.15	.13	.12	.11
9	.19	.15	.12	.10	.19	.15	.12	.10	.14	.12	.10	.14	.12	.10	.14	.11	.10	.09
10	.18	.13	.11	.09	.18	.13	.11	.09	.13	.11	.09	.13	.10	.09	.12	.10	.09	.08

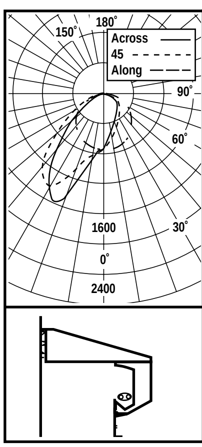
Floor Cavity Reflectance .20

ZONAL LUMEN SUMMARY

ZONE	LUMENS	% LAMP	% LUMINAIRE
180-90°	0	0.0	0.0
90-0°	1706	34.14	100.00
180-0 °	1706	34.14	100.00

LUMINANCE SUMMARY (fL)

ANGLE	0°	45°	90°	135°	180°
45°	845	1050	580	304	270
55°	519	819	560	291	238
65°	200	434	520	246	205
75°	159	178	440	196	154
85°	82	139	245	131	82



CANDLEPOWER SUMMARY

ANGLE	0	45	90	135	180	OUTPUT LUMENS
90	3	1	2	3	3	
85	14	8	27	8	8	19
80	25	34	85	36	25	
75	47	57	149	63	47	89
70	68	111	214	96	74	
65	96	200	279	129	96	198
60	195	398	341	168	128	
55	305	570	409	205	161	341
50	523	797	465	234	200	
45	704	1005	523	264	233	446
40	972	1238	570	296	255	
35	1193	1361	613	333	271	464
30	1448	1394	650	374	310	
25	1548	1257	680	419	348	374
20	1448	1058	704	474	398	
15	1129	901	723	530	457	210
10	884	791	734	597	534	
5	769	765	738	667	616	69
0	729	729	729	729	729	

2024BX40 50% wall reflectance
Litecontrol Certified Test Report #14720000

RCC	80				70				50			30			10			0
RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
RCR																		
0	.42	.42	.42	.42	.41	.41	.41	.41	.39	.39	.39	.37	.37	.37	.36	.36	.36	.35
1	.39	.37	.36	.35	.38	.37	.35	.34	.35	.34	.33	.34	.33	.32	.33	.32	.31	.31
2	.36	.33	.32	.30	.35	.33	.31	.29	.32	.30	.29	.31	.29	.28	.30	.28	.28	.27
3	.33	.30	.27	.25	.32	.29	.27	.25	.28	.26	.25	.27	.26	.24	.27	.25	.24	.23
4	.31	.27	.24	.22	.30	.27	.24	.22	.26	.23	.22	.25	.23	.22	.24	.23	.21	.21
5	.28	.24	.21	.19	.27	.24	.21	.19	.23	.21	.19	.22	.20	.19	.22	.20	.19	.18
6	.26	.22	.19	.17	.25	.21	.19	.17	.21	.18	.17	.20	.18	.16	.20	.18	.16	.16
7	.24	.19	.17	.15	.23	.19	.16	.14	.19	.16	.14	.18	.16	.14	.18	.16	.14	.14
8	.22	.18	.15	.13	.22	.17	.15	.13	.17	.14	.13	.16	.14	.13	.16	.14	.13	.12
9	.20	.16	.13	.11	.20	.16	.13	.11	.15	.13	.11	.15	.13	.11	.15	.13	.11	.10
10	.19	.14	.12	.10	.19	.14	.12	.10	.14	.11	.10	.14	.11	.10	.13	.11	.10	.09

Floor Cavity Reflectance .20

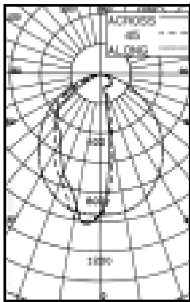
ZONAL LUMEN SUMMARY

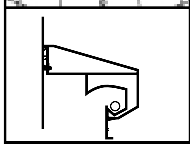
ZONE	LUMENS	% LAMP	% LUMINAIRE
180-90°	0	0.0	0.0
90-0°	2204	35.00	100.00
180-0°	2204	35.00	100.00

LUMINANCE SUMMARY (fL)

ANGLE	0°	45°	90°	135°	180°
45°	1046	1495	775	393	346
55°	560	1045	746	376	295
65°	238	497	691	320	238
75°	191	231	605	256	189
85°	166	98	323	98	98

PHOTOMETRIC DATA: Wall/Slot-2000PR





CANDLEPOWER SUMMARY

ANGLE	0	45	90	135	180	OUTPUT LUMENS
90	0	0	0	0	0	
85	1	3	12	10	8	9
80	10	12	37	21	20	
75	19	22	79	35	32	46
70	28	34	151	49	43	
65	38	133	228	63	56	107
60	90	245	311	75	70	
55	233	332	397	86	83	189
50	341	363	482	90	96	
45	433	393	563	90	102	230
40	453	448	640	93	102	
35	469	526	713	92	100	231
30	525	614	777	92	98	
25	613	694	835	94	95	219
20	716	759	884	102	93	
15	781	858	920	223	95	177
10	906	989	942	457	246	
5	1014	996	951	769	625	83
0	954	954	954	954	954	

2014T8-PR 70% wall reflectance
Litecontrol Certified Test Report #24311001

RCC	80				70				50			30			10			0
RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
RCR																		
0	.53	.53	.53	.53	.52	.52	.52	.52	.49	.49	.49	.47	.47	.47	.45	.45	.45	.44
1	.49	.48	.46	.45	.48	.47	.45	.44	.45	.44	.43	.43	.42	.41	.42	.41	.40	.39
2	.46	.43	.40	.38	.45	.42	.40	.38	.40	.39	.37	.39	.38	.36	.38	.37	.35	.35
3	.42	.39	.36	.33	.41	.38	.35	.33	.37	.34	.32	.36	.34	.32	.34	.33	.31	.30
4	.39	.35	.32	.29	.38	.34	.31	.29	.33	.31	.28	.32	.30	.28	.31	.29	.28	.27
5	.36	.31	.28	.25	.35	.31	.27	.25	.30	.27	.25	.29	.27	.25	.28	.26	.24	.23
6	.34	.28	.25	.22	.33	.28	.25	.22	.27	.24	.22	.27	.24	.22	.26	.23	.22	.21
7	.31	.26	.22	.20	.31	.25	.22	.20	.25	.22	.20	.24	.21	.19	.24	.21	.19	.19
8	.29	.23	.20	.18	.28	.23	.20	.17	.23	.20	.17	.22	.19	.17	.22	.19	.17	.16
9	.27	.21	.18	.16	.26	.21	.18	.16	.21	.18	.15	.20	.17	.15	.20	.17	.15	.14
10	.25	.20	.16	.14	.25	.19	.16	.14	.19	.16	.14	.18	.16	.14	.18	.16	.14	.13

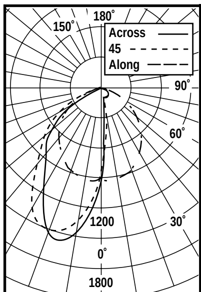
Floor Cavity Reflectance .20

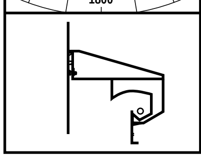
ZONAL LUMEN SUMMARY

ZONE	LUMENS	% LAMP	% LUMINAIRE
180-90°	0	.00	.00
90-0°	1286	44.35	100
180-0°	1286	44.35	100

LUMINANCE SUMMARY (fL)

ANGLE	0°	45°	90°	135°	180°
45°	644	584	834	134	151
55°	428	608	724	157	151
65°	94	331	564	158	138
75°	76	90	320	140	130
85°	16	38	149	117	101





CANDLEPOWER SUMMARY

ANGLE	0	45	90	135	180	OUTPUT LUMENS
90	0	0	1	1	2	
85	5	8	21	10	4	13
80	7	20	53	25	19	
75	24	31	89	44	26	63
70	33	77	149	62	51	
65	44	265	223	81	67	163
60	191	441	305	90	84	
55	432	597	393	98	95	300
50	613	687	476	104	103	
45	760	809	564	103	109	375
40	829	973	642	100	113	
35	941	1154	710	103	99	390
30	1113	1337	774	99	99	
25	1319	1448	826	107	101	353
20	1498	1492	875	136	98	
15	1558	1465	900	202	117	240
10	1478	1357	916	348	211	
5	1259	1164	922	579	449	84
0	888	888	888	888	888	

2014T5HO-PR 50% wall reflectance
Litecontrol Certified Test Report #24316000

RCC	80				70				50			30			10			0
RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
RCR																		
0	.47	.47	.47	.47	.46	.46	.46	.46	.44	.44	.44	.42	.42	.42	.40	.40	.40	.40
1	.44	.42	.41	.40	.43	.42	.40	.39	.40	.39	.38	.38	.38	.37	.37	.36	.36	.35
2	.41	.38	.36	.34	.40	.37	.35	.34	.36	.34	.33	.35	.33	.32	.34	.32	.31	.31
3	.38	.34	.31	.29	.37	.34	.31	.29	.33	.30	.29	.31	.30	.28	.31	.29	.28	.27
4	.35	.31	.28	.25	.34	.30	.28	.25	.29	.27	.25	.28	.26	.25	.28	.26	.24	.24
5	.32	.28	.24	.22	.31	.27	.24	.22	.26	.24	.22	.26	.23	.21	.25	.23	.21	.20
6	.30	.25	.22	.19	.29	.24	.21	.19	.24	.21	.19	.23	.21	.19	.23	.20	.19	.18
7	.27	.22	.19	.17	.27	.22	.19	.17	.22	.19	.17	.21	.19	.17	.21	.18	.17	.16
8	.25	.20	.17	.15	.25	.20	.17	.15	.19	.17	.15	.19	.16	.15	.19	.16	.15	.14
9	.23	.18	.15	.13	.23	.18	.15	.13	.18	.15	.13	.17	.15	.13	.17	.14	.13	.12
10	.22	.17	.14	.12	.21	.16	.14	.12	.16	.13	.11	.16	.13	.11	.15	.13	.11	.11

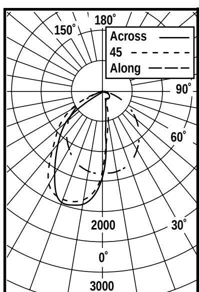
Floor Cavity Reflectance .20

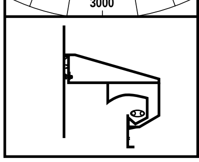
ZONAL LUMEN SUMMARY

ZONE	LUMENS	% LAMP	% LUMINAIRE
180-90°	0	.00	.00
90-0°	1977	39.55	100.00
180-0°	1977	39.55	100.00

LUMINANCE SUMMARY (fL)

ANGLE	0°	45°	90°	135°	180°
45°	1130	1203	835	152	163
55°	792	1094	717	179	174
65°	109	658	553	200	166
75°	96	126	360	179	107
85°	63	97	249	119	43





CANDLEPOWER SUMMARY

ANGLE	0	45	90	135	180	OUTPUT LUMENS
90	3	1	2	3	1	
85	3	8	28	12	7	16
80	15	21	71	31	26	
75	27	37	128	53	41	80
70	30	77	250	79	63	
65	52	310	346	97	85	206
60	196	572	460	118	101	
55	518	775	581	132	119	393
50	808	940	700	140	133	
45	1010	1136	819	135	146	511
40	1187	1343	928	138	140	
35	1384	1591	1030	140	140	538
30	1587	1804	1118	151	138	
25	1835	1882	1200	161	135	475
20	1963	1903	1262	186	145	
15	1953	1897	1311	226	169	316
10	1895	1805	1336	385	223	
5	1713	1652	1348	747	539	117
0	1310	1310	1310	1310	1310	

2024BX40-PR 50% wall reflectance
Litecontrol Certified Test Report #24320000

RCC	80				70				50			30			10			0
RW	70	50	30	10	70	50	30	10	50	30	10	50	30	10	50	30	10	0
RCR																		
0	.50	.50	.50	.50	.49	.49	.49	.49	.47	.47	.47	.45	.45	.45	.43	.43	.43	.42
1	.47	.45	.44	.43	.46	.44	.43	.42	.42	.41	.41	.41	.40	.39	.39	.39	.38	.37
2	.43	.41	.39	.37	.43	.40	.38	.36	.39	.37	.35	.37	.36	.35	.36	.35	.34	.33
3	.40	.37	.34	.32	.39	.36	.34	.31	.35	.33	.31	.34	.32	.30	.33	.31	.30	.29
4	.37	.33	.30	.28	.37	.33	.30	.28	.32	.29	.27	.31	.29	.27	.30	.28	.27	.26
5	.35	.30	.27	.24	.34	.30	.27	.24	.29	.26	.24	.28	.26	.24	.27	.25	.24	.23
6	.32	.27	.24	.22	.31	.27	.24	.22	.26	.23	.21	.25	.23	.21	.25	.23	.21	.20
7	.30	.25	.21	.19	.29	.24	.21	.19	.24	.21	.19	.23	.20	.19	.23	.20	.18	.18
8	.28	.22	.19	.17	.27	.22	.19	.17	.22	.19	.17	.21	.19	.17	.21	.18	.17	.16
9	.26	.20	.17	.15	.25	.20	.17	.15	.20	.17	.15	.19	.17	.15	.19	.16	.15	.14
10	.24	.19	.16	.13	.23	.18	.16	.13	.18	.15	.13	.18	.15	.13	.17	.15	.13	.13

Floor Cavity Reflectance .20

ZONAL LUMEN SUMMARY

ZONE	LUMENS	% LAMP	% LUMINAIRE
180-90°	0	.00	.00
90-0	2647	42.02	100.00
180-0	2647	42.02	100.00

LUMINANCE SUMMARY (fL)

ANGLE	0°	45°	90°	135°	180°
45°	1502	1689	1212	201	218
55	948	1420	1062	242	218
65	130	770	857	242	211
75	108	150	520	216	166
85	34	98	333	142	81

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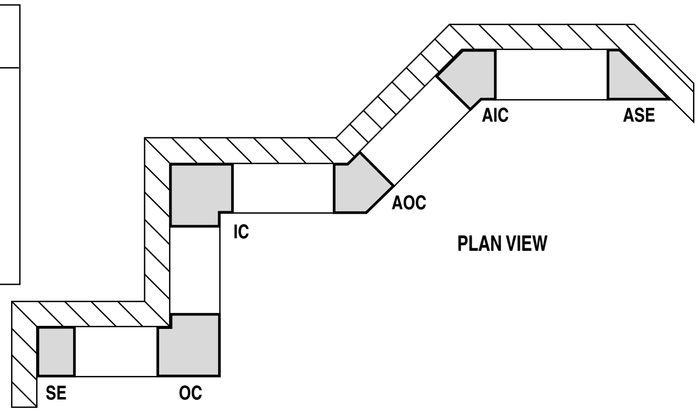
SYSTEM CONNECTORS and ACCESSORIES

Catalog Number

Series	Connector	Finish	Description (Minimum/Maximum along wall in parenthesis)
2000	EC	CWM	End Cap
2000	SE	CWM	Straight Extension (2"-12")
2000	IC	CWM	Inside Corner - 90° (14"-21")
2000	OC	CWM	Outside Corner - 90° (2"-11")
2000	ASE	CWM	Angular Straight Extension - 135° (2"-11")
2000	AIC	CWM	Angular Inside Corner - 135° (6"-15")
2000	AOC	CWM	Angular Outside Corner - 135° (2"-11")

2000-AOC-CWM is a typical catalog number for an angular outside corner connector. Corners, extensions, and end caps, when added to fixtures, permit continuous wall-to-wall installation. Lengths are field cut.

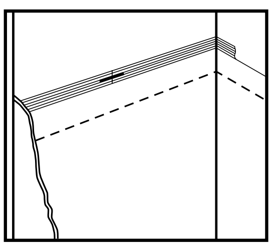
NOTE: Parabolic reflector is positioned above lamps only, and does not extend through system connectors.



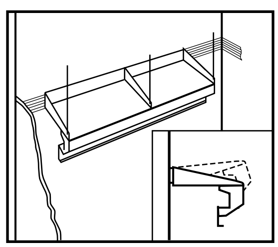
PLANNING FOR INSTALLATION

Finished wall should extend 13" above ceiling. Locate bottom of Fixture Support Rail 9 3/8" up from bottom of ceiling for Lay-in Grid T-bar ceilings. Extruded trim of fixtures supports ceiling tiles at perimeter; elsewhere ceiling construction must be supported independently of the lighting system.

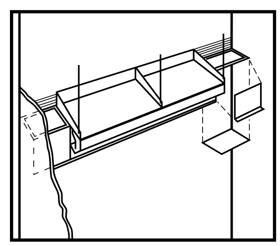
1. Install Fixture Support Rails on wall.

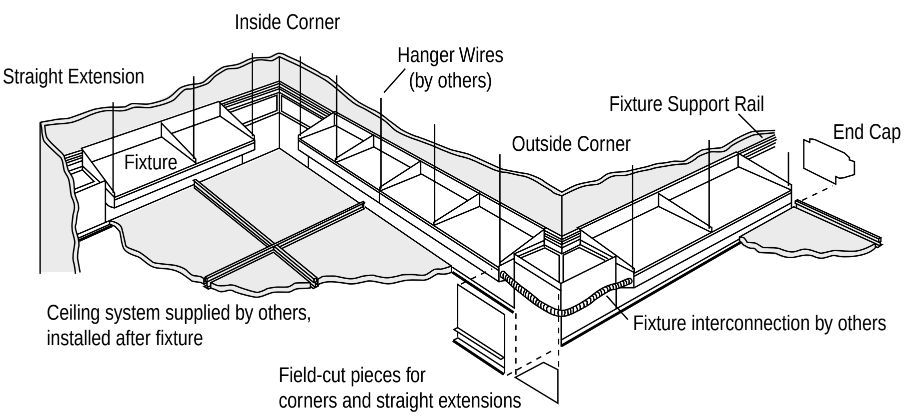


2. Hook fixtures on rail and slide into position. Attach hanger wires.



3. Install extensions and corners.

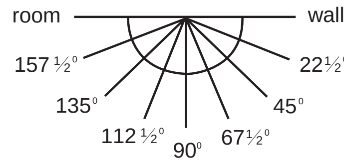




QUESTIONS TO ASK

1. 120 or 277 volt?
2. Row information, including desired fixture lengths?
3. Verify ceiling type?
4. Other options?

TECHNICAL INFORMATION



Footcandle values are initial and tables are based on minimum of six units. For fixture-to-wall distance other than those shown, use maximum of one-to-one spacing (distance between fixtures not more than distance to wall) for best results.

Fixture/lamp | **Candlepower data** | **Footcandle values**

AFVW 32TRT 8AR

PL-T 32/30/4P lamp
2400 rated lumen
Test no. 2195091202

Vertical angle	Plane angle: Room side					Wall side			
	Room	157½°	135°	112½°	90°	67½°	45°	22½°	Wall
0°	1203	1203	1203	1203	1203	1203	1203	1203	1203
5°	1262	1276	1332	1356	1336	1250	1186	1138	1126
15°	1336	1325	1336	1365	1245	1139	994	887	857
25°	1039	1068	1028	1096	1030	934	828	790	733
35°	716	720	706	764	757	689	617	604	571
45°	260	228	216	182	172	196	339	392	354
55°	0	5	4	0	4	50	213	219	195
65°	0	0	0	0	0	21	107	120	97
75°	0	0	0	0	0	3	62	45	49
85°	0	0	0	0	0	0	9	6	0
90°	0	0	0	0	0	0	0	0	0

	Luminaire 3' from wall on 3' centers			Luminaire 3' from wall on 4' centers		
1	11	10	11	8	8	8
2	21	22	21	15	16	15
3	28	27	28	20	19	20
4	27	29	27	20	22	20
5	26	25	26	18	20	18
6	22	24	22	18	17	18
7	21	21	21	16	16	16
8	19	18	19	14	15	14
9	16	15	16	13	13	13
10	13	13	13	12	11	12

AFVW 42TRT 8AR

PL-T 42/30/4P lamp
3200 rated lumen
Test no. 2196070601

Vertical angle	Plane angle: Room side					Wall side			
	Room	157½°	135°	112½°	90°	67½°	45°	22½°	Wall
0°	1186	1186	1186	1186	1186	1186	1186	1186	1186
5°	1277	1304	1365	1370	1325	1226	1153	1092	1044
15°	1326	1321	1280	1314	1200	1056	899	766	696
25°	1096	1138	1095	1162	1063	947	902	817	748
35°	795	781	759	806	782	693	732	734	686
45°	174	155	121	134	130	195	389	494	442
55°	0	6	14	3	0	34	237	260	241
65°	0	0	4	0	0	28	137	131	116
75°	0	0	0	0	0	0	67	62	65
85°	0	0	0	0	0	0	3	14	15
90°	0	0	0	0	0	0	0	0	0

	Luminaire 3' from wall on 3' centers			Luminaire 3' from wall on 4' centers		
1	13	12	13	10	9	10
2	26	26	26	19	19	19
3	33	33	33	24	23	24
4	32	34	32	23	26	24
5	29	30	30	20	24	21
6	24	26	25	19	20	19
7	20	22	22	16	17	17
8	17	18	19	14	15	14
9	14	16	16	12	13	13
10	12	13	13	10	11	12

AFVW 32TRT 8AR CGL

PL-T 32/30/4P lamp
2400 rated lumen
Test no. LTL7726

Vertical angle	Plane angle: Room side					Wall side			
	Room	157½°	135°	112½°	90°	67½°	45°	22½°	Wall
0°	1107	1107	1107	1107	1107	1107	1107	1107	1107
5°	1161	1174	1225	1248	1229	1150	1091	1047	1036
15°	1229	1219	1229	1256	1145	1048	914	816	788
25°	956	983	946	1008	948	859	762	727	674
35°	659	662	650	703	696	634	568	556	525
45°	239	210	199	167	158	180	312	361	326
55°	0	5	4	0	4	46	196	201	179
65°	0	0	0	0	0	19	98	110	89
75°	0	0	0	0	0	3	57	41	45
85°	0	0	0	0	0	0	8	6	0
90°	0	0	0	0	0	0	0	0	0

	Luminaire 3' from wall on 3' centers			Luminaire 3' from wall on 4' centers		
1	10	9	10	7	7	7
2	19	20	19	14	15	14
3	25	25	26	19	18	19
4	25	26	25	18	21	18
5	23	23	24	17	19	17
6	20	22	21	16	16	17
7	17	19	19	14	15	14
8	15	16	17	12	14	13
9	12	14	15	11	12	12
10	11	12	12	9	10	11

AFVW 42TRT 8AR CGL

PL-T 42/30/4P lamp
3200 rated lumen
Test no. LTL7727

Vertical angle	Plane angle: Room side					Wall side			
	Room	157½°	135°	112½°	90°	67½°	45°	22½°	Wall
0°	1091	1091	1091	1091	1091	1091	1091	1091	1091
5°	1175	1200	1256	1260	1219	1128	1061	1005	960
15°	1220	1215	1178	1209	1104	972	827	705	640
25°	1008	1047	1007	1069	978	871	830	752	688
35°	731	719	698	742	719	638	673	675	631
45°	160	143	111	123	120	179	358	454	407
55°	0	6	13	3	0	31	218	239	222
65°	0	0	4	0	0	26	126	121	107
75°	0	0	0	0	0	0	62	57	60
85°	0	0	0	0	0	0	3	13	14
90°	0	0	0	0	0	0	0	0	0

	Luminaire 3' from wall on 3' centers			Luminaire 3' from wall on 4' centers		
1	12	11	12	9	9	9
2	24	24	24	17	17	17
3	30	30	31	22	22	22
4	29	31	30	22	24	22
5	26	27	27	19	22	19
6	22	24	23	18	18	18
7	19	20	20	15	16	15
8	15	17	18	13	14	13
9	13	14	15	11	12	12
10	11	12	12	9	10	11

NOTES:
1. For electrical characteristics consult technical data tab.
2. Tested to current IES and NEMA standards under stabilized laboratory conditions. Various operating factors can cause differences between laboratory data and actual field measurements. Dimensions and specifications are based on the most current available data and are subject to change without notice.

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An Acuity Brands Company

GOTHAM ARCHITECTURAL DOWNLIGHTING
A DIVISION OF ACUITY LIGHTING GROUP, INC.
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www.gothamlighting.com

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Product Number: 50431

Order Abbreviation: QTP3X32T8/277RSN A NL

General Description: 3-lamp 277V <10%THD rapid start normal ballast factor electronic ballast in an A enclosure size without leads for 32W T8 lamp

Product Information	
Abbrev. With Packaging Info.	QTP3X32T8277RSNANL
Ballast Factor	0.88
Ballast Height H (in)	1.5000
Ballast Length L (in)	9.5000
Ballast Width W (in)	2.3800
Circuit Type	Series
Family Brand Name	QUICKTRONIC Professional
Input Wattage (W)	90.00
Input Current (Amps)	0.33
Nominal Voltage (V)	277.00
Nominal Voltage (V)	277
Number of Lamps	3
Power Factor	>0.99
Primary Lamp Type	FO32/XP
Sound Rating	A
Starting Method	Rapid Start
Starting Temperature - Fahrenheit	50
Starting Temperature - Celsius	10
Total Harmonic Distortion (THD)	<10%
Wiring Method	Wiretrap Connectors

Additional Product Information

Product Documents, Graphs, and Images

Compatible Lamps

Packaging Information

Footnotes

- Data based on primary lamp types. See OSRAM SYLVANIA System Performance Guide for data on other lamp combinations.
- 70C Max Case Temperature
- UL Listed Class P, Type 1 Outdoor
- Ground ballast case
- Install in accordance with National Electric Codes
- Complies with FCC 47 CFR Part 18, Non-Consumer
- ANSI 62.41 Cat. A Transient Protection
- Class A Sound Rating.
- Input Frequency: 60Hz.
- Minimum Starting Temperature: 50F/10C.
- Remote Mounting up to 19 feet (keep red wires short for 1&2 lamp models).

Print Page

SPECIFICATIONS

Series 600T

UPS RATING kVA	kW	LOAD POWER FACTOR	AC INPUT/ OUTPUT VOLTAGE	%EFFICIENCY AT VARIOUS LOADS[1] 50%	75%	100%	NOMINAL BATTERY REQUIREMENTS (CELLS)	MAXIMUM HEAT DISSIPATION (BTU/HR) FULL LOAD	DIMENSIONS WxDxH[2] (INCHES) TOP ENTRY ONLY	TOP & BOTTOM ENTRY	APPROXIMATE WEIGHT[2] SMS	MMU
65	52	0.8	480/480	92.5%	93.5%	93.5%	240	12,350	N/A	34x32x68	1,500	1,470
65	52	0.8	480/208	92.5%	93.0%	93.0%	240	13,350	N/A	34x32x68	1,700	1,670
65	52	0.8	208/208	92.0%	92.0%	92.0%	240	15,450	N/A	34x32x68	1,900	1,870
80	64	0.8	480/480	92.5%	93.5%	93.5%	240	15,200	N/A	34x32x68	1,700	1,670
80	64	0.8	480/208	92.5%	93.0%	93.0%	240	16,450	N/A	34x32x68	1,950	1,920
80	64	0.8	208/208	92.0%	92.0%	92.0%	240	19,000	N/A	34x32x68	2,100	2,070
100	80	0.8	480/480	92.5%	93.5%	93.5%	240	19,000	48x33x78	56x33x78	2,500	2,465
100	80	0.8	480/208	92.5%	93.0%	93.0%	240	20,550	48x33x78	56x33x78	2,800	2,765
100	80	0.8	208/208	92.0%	92.0%	92.0%	240	23,750	48x33x78	56x33x78	3,100	3,065
125	100	0.8	480/480	92.5%	93.5%	93.5%	240	23,750	48x33x78	56x33x78	2,600	2,565
125	100	0.8	480/208	92.5%	93.0%	93.0%	240	25,700	48x33x78	56x33x78	2,900	2,865
125	100	0.8	208/208	92.0%	92.0%	92.0%	240	29,700	48x33x78	56x33x78	3,250	3,215
150	120	0.8	480/480	93.0%	94.0%	94.0%	240	26,150	48x33x78	56x33x78	2,850	2,800
150	120	0.8	480/208	93.0%	93.5%	93.5%	240	28,450	N/A	56x33x78	3,050	3,000
150	120	0.8	208/208	93.0%	92.5%	92.5%	240	33,200	N/A	56x33x78	3,320	3,270
225	180	0.8	480/480	93.0%	94.0%	94.0%	240	39,200	48x33x78	56x33x78	3,190	3,140
225	180	0.8	480/208	93.0%	93.5%	93.5%	240	42,700	N/A	56x33x78	3,475	3,425
225	180	0.8	208/208	93.0%	92.5%	92.5%	240	49,800	N/A	56x33x78	3,870	3,820
300	240	0.8	480/480	93.0%	94.0%	94.0%	240	52,300	N/A	72x35x78	4,200	4,150
300	240	0.8	480/208	93.0%	93.5%	93.5%	240	56,950	N/A	72x35x78	4,450	4,400
300	240	0.8	208/208	93.0%	92.5%	92.5%	240	66,400	N/A	72x35x78	5,400	5,350
400	320	0.8	480/480	93.0%	94.0%	94.0%	240	69,700	N/A	72x35x78	4,900	4,850
400	320	0.8	480/208	93.0%	93.5%	93.5%	240	75,950	N/A	72x35x78	5,150	5,100
400	320	0.8	208/208	92.5%	92.0%	92.0%	240	94,950	N/A	96x35x78	8,400	8,350
400	360	0.9	480/480	93.0%	94.0%	94.0%	240	78,450	N/A	72x35x78	5,100	5,050
450	360	0.8	480/480	93.0%	94.0%	94.0%	240	78,450	N/A	72x35x78	5,100	5,050
500	400	0.8	480/480	93.0%	94.0%	94.0%	240	87,150	N/A	72x39x78	5,775	5,710
500	450	0.9	480/480	93.0%	94.0%	94.0%	240	98,050	N/A	72x39x78	5,795	5,730
625 (6P)	500	0.8	480/480	93.5%	94.5%	94.5%	240	99,300	N/A	108x39x78	7,500	7,405
625 (12P)	500	0.8	480/480	93.0%	93.5%	93.5%	240	118,650	N/A	120x39x78	10,580	10,485
750 (6P)	600	0.8	480/480	93.5%	94.5%	94.5%	240	119,200	N/A	108x39x78	8,100	8,005
750 (12P)	600	0.8	480/480	93.0%	93.5%	93.5%	240	142,350	N/A	120x39x78	11,580	11,485
750 (12P)	675	0.9	480/480	93.0%	93.5%	93.5%	240	160,150	N/A	120x39x78	11,880	11,785

1 Efficiency measured at rated power factor and non-linear load. Input filter loss is less than 0.35%.

2 Dimensions and weights do not include System Control Cabinet furnished with Multi-Module Systems. Weights are for the standard configurations; top-entry models will be 200 pounds less.

Input

- Voltage: 208, 400 or 600 VAC, 3-phase, 3-wire plus ground
- Voltage Range: +10, -15% (no battery discharge at -20%)
- Power Factor: 0.85 lagging; 0.92 lagging with optional input filter.
- Frequency Range: 60 Hz, ±5%. Frequency change models available (50 Hz in/ 60 Hz out or 60 Hz in/ 50 Hz out)
- Current Distortion: 7% reflected THD at full load with optional input filter. 4% reflected THD at full load with optional 12-pulse rectifier and input filter.
- Subcycle Magnetizing Inrush: 2-3 times normal full load current; 5-8 times normal for units with optional input isolation transformer or 12-pulse rectifier. Walk-in of 20% to 100% over 15 seconds.

Output and Bypass

- Voltage: 200, 480 or 600 VAC, 3-phase, 3-wire or 4-wire.
- Voltage Adjustment: ±5%
- Voltage Regulation: ±0.5% for balanced load; ±2% for 50% unbalanced load.
- Dynamic Regulation: ±5% deviation for 100% load step. ±4% deviation for 50% load step. ±1% for loss or return of AC input. Manual return of load to UPS: ±4%.
- Transient Response Time: Recover to ±1% of steady state within 16 milliseconds (1 cycle).
- Voltage Distortion: For linear loads, less than 4% THD. Maximum of 2% RMS for any single harmonic. Less than 5% THD for 100% nonlinear loads without kVA/kW derating.
- Phasing Balance: 120° ±1° for balanced load. 120° ±3° for 50% unbalanced load.
- Frequency Regulation: ±0.1%
- Load Power Factor Range: 1.0 to 0.7 lagging without derating.
- Overload: 125% of full load for ten minutes. 150% for 30 seconds. 104% continuous.
- Fault-Clearing Current: Up to 1,000% for 16 milliseconds. Up to 500% for 40 milliseconds.

Environmental

- Operating Temperature: 0° to 40°C without derating.
- Non-Operating Temperature: -20°C to 70°C.
- Humidity: 0-95% relative humidity without condensation.
- Operating Altitude: Up to 1,200 meters without derating.
- Non-Operating Altitude: Up to 15,000 meters.

Standard Features

- LCD 80-character x 25 line monitor/control panel
- Self-diagnostics
- 2-stage battery charge current limit
- 2-stage input AC current limit
- Internal maintenance bypass
- Programmable automatic retransfer
- Automatic line-drop compensation
- Battery overdischarge protection
- Battery-time-remaining display
- Automatic equalize charge timer
- Emergency Power Off
- Output isolation transformer

Options and Accessories

- Input filter/power factor correction
- 12-pulse rectifier input
- Power-Tie® Dual-Bus System
- Load Bus Sync™ (for dual load bus systems)
- Input isolation transformer
- Bypass isolation transformer
- Maintenance bypass cabinet
- Power distribution unit (single or dual input)
- Standard and custom switchgear packages
- Valve-regulated lead-acid battery packs
- Flooded rack-mounted battery systems
- SNMP capabilities
- SiteScan centralized monitoring system
- Remote monitor panel
- Communications interfaces
- Alarm status contacts
- Customer alarm inputs
- Frequency-change models (50 Hz in/60 Hz out, or 60 Hz in/50 Hz out)
- Flywheel Energy Storage System interface

2100 Series Motor Control Center

Freedom and Advantage Motor Control Center

General Description

Introduction

Eaton's Cutler-Hammer Freedom™ and Advantage™ MCCs provide a convenient method for grouping motor control as well as associated distribution equipment. Both Freedom and Advantage 2100 Series MCCs may be applied on electrical systems up to 600V, 50 or 60 Hz, having available fault currents of up to 100,000 amperes rms. Enclosure designs include NEMA® 1 gasketed, NEMA 2, 12 and NEMA 3R. All controllers are assembled with Cutler-Hammer components of proven safety, quality and reliability. All components are wired in accordance with NEC® and UL® standards.

Features

- UL label.
- 42, 65 and 100 kAIC ratings.
- Molded Case, Insulated Case and Air Power Circuit Breakers.
- Across-the-line, reduced voltage, and solid-state starters.
- Variable frequency drives and VFD options.

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Technical Data

Table 24.1-1. Short Circuit Ratings for Motor Control (480 Volt)

Short Circuit Protective Device	Combination Starter FV and RV (kA)	Solid-State Reduced Voltage	Adjustable Frequency Drives
HMCP Motor Circuit Protector (Standard Rating) HMCP Motor Circuit Protector (Optional Rating)	65 100	65 100	65 100
MCCB Molded Case Circuit Breaker (Standard Rating) MCCB Molded Case Circuit Breaker (Optional Rating) Fusible Switch	65 100 100	65 — 100	65 100 100

Table 24.1-2. Combination Starters with Series C Motor Circuit Protectors or Molded Case Circuit Breakers — Dimensions in Inches (mm)

Motor Circuit Protector Ratings are suitable for both NEMA Design B and NEMA Design E (high efficiency) motors. Per NEC, the motor circuit protectors may be adjusted to 17X motor FLA.

NEMA Size	Maximum Horsepower					HMCP Frame [1]	MCCB Frame [2]	Freedom		Advantage	
								Unit Size		Unit Size	
	208V	240V	380V	480V	600V			Inches (mm)	X Space	Inches (mm)	X Space
Full Voltage Non-Reversing								**Type F206**		**Type W206**	
1	7.5	7.5	10	10	10	150	 HFD/FDC HFD/FDC	6 (152.4) [3] 12 (304.8) [4] 18 (457.2)	1X [3] 2X [4] 3X	6 (152.4) [3] 12 (304.8) [4] 18 (457.2)	1X [3] 2X [4] 3X
2	10	15	25	25	25	150	 HFD/FDC HFD/FDC	 12 (304.8) [4] 18 (457.2)	 2X [4] 3X	6 (152.4) [3] 12 (304.8) [4] 18 (457.2)	1X [3] 2X [4] 3X
3	25	30	50	50	50	150	HFD/FDC HFD/FDC HFD/FDC	 18 (457.2) [5] 24 (609.6)	 3X [5] 4X	12 (304.8) [3] 18 (457.2) [5] 24 (609.6)	2X [3] 3X [5] 4X
4	40	50	75	100	100	150	HFD/FDC HFD/FDC HJD/JDC	 18 (457.2) [5][6] 24 (609.6) [6]	 3X [5] 4X	12 (304.8) [6] 18 (457.2) [5][6] 24 (609.6) [6]	2X 3X [5] 4X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	 36 (914.4)	 6X	 36 (914.4)	 6X
6	25 150	100 200	250 300	300 350 400	400 — —	600 1200	HLD/LDC [11] HND	48 (1219.2) 72 (1828.8) [7]	8X 12X	42 (1066.8) 60 (1524.0)	7X [10] 10X
7	—	300	—	600	600	1200	HND	72 (1828.8) [7]	12X	72 (1828.8) [7]	12X
Full Voltage Non-Reversing — Dual Unit [8]								**Type F246**		**Type W246**	
1	7.5	7.5	10	10	10	150	HFD/FDC	18 (457.2)	3X	18 (457.2)	3X
2	10	15	25	25	25	150	HFD/FDC	18 (457.2)	3X	18 (457.2)	3X
Full Voltage Reversing								**Type F216**		**Type W216**	
1	7.5	7.5	10	10	10	150	HFD/FDC	18 (457.2) [5] 24 (609.6)	3X [5] 4X	18 (457.2) [5] 24 (609.6)	3X [5] 4X
2	10	15	25	25	25	150	HFD/FDC	18 (457.2) [5] 24 (609.6)	3X [5] 4X	18 (457.2) [5] 24 (609.6)	3X [5] 4X
3	25	30	50	50	50	150	HFD/FDC	24 (609.6) [9]	4X	24 (609.6) [9]	6X
4	40	50	75	100	100	150	HJD/JDC	30 (762.0) [9]	5X	30 (762.0) [9]	5X
5	50 75	60 100	100 150	125 200	150 200	250 400	HJD/JDC HKD/KDC	 60 (1524.0)	 10X	 60 (1524.0)	10X
6	125 150	100 200	250 300	300 400	400 —	600 1200	HLD/LDC HND [12]	72 (1828.8) [7] 72 (1828.8) [12]	12X 12X [12]	72 (1828.8) 72 (1828.8) [13]	12X 12X [13]

[1] Standard Combination Starter Units with HMCP Magnetic Only disconnect have short circuit ratings of 65,000 amperes at 480 volts. Optional HMCP combination starter units are available with 100,000 amperes at 480 volts.
[2] Optional Combination Starter Units with Thermal-Magnetic breaker disconnects are available with either 65,000 amperes or 100,000 amperes at 480 volts.
[3] Maximum of (3) pilot devices, (2) auxiliary contacts; 100VA CPT maximum. Standard lugs only.
[4] 12-inch (304.8 mm)/2X unit is standard.
[5] 18-inch (457.2 mm)/3X unit is standard.
[6] Minimum 30-inch (762.0 mm) space needed with Thermal-Magnetic Circuit Breaker.
[7] Requires 28-inch (711.2 mm) wide structure.
[8] Limited options. Two starter units share common door.
[9] 30-inch (762.0 mm) space needed for Thermal-Magnetic Circuit Breaker.
[10] For top entry, 8X space required.
[11] 1200A HMCP frame available in 11X 66-inch (1676.4 mm).
[12] Requires 36-inch (914.4 mm) wide structure.
[13] Requires 28-inch (711.2 mm) wide structure.

Note: For HMCP continuous ampere ratings by Motor hp, see **Table 24.1-81** on **Page 24.1-38**.