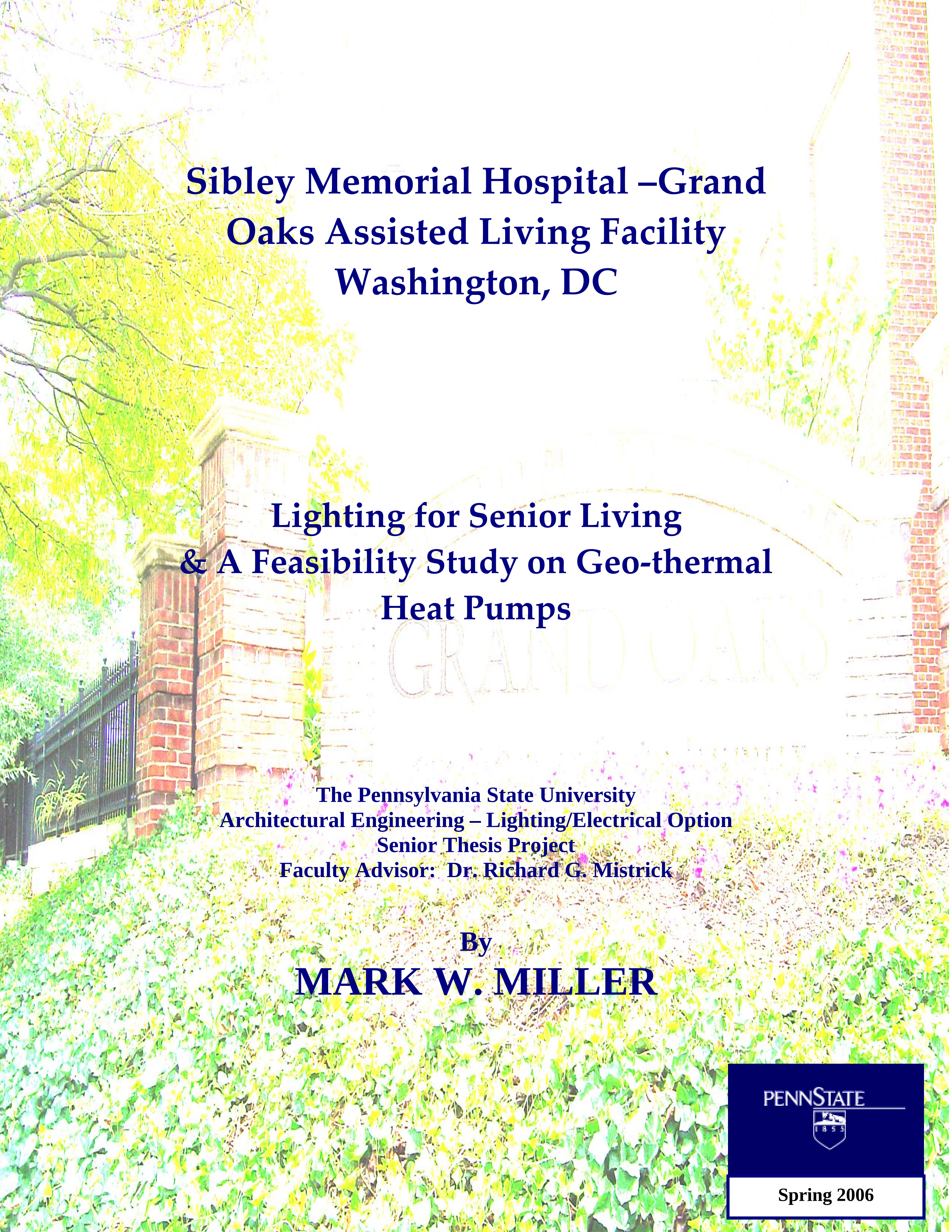

Sibley Memorial Hospital –Grand Oaks Assisted Living Facility
Washington, DC

Lighting for Senior Living & A Feasibility Study on Geo-thermal Heat Pumps

The Pennsylvania State University
Architectural Engineering – Lighting/Electrical Option
Senior Thesis Project
Faculty Advisor: Dr. Richard G. Mistrick

By
MARK W. MILLER

PENNSTATE
1855

Spring 2006

Mark W. Miller

Sibley Memorial Hospital - Grand Oaks
Washington, D.C.

PROJECT INFORMATION

Project Name: Sibley Memeorial Hospital - Grand Oaks Addition
Location: Washington, DC
Size: 60,881 SF New Construction Floor Area
6,883 SF Renovations To Existing Floor Area
Dates of Construction: $17,000,000 Construction Cost, not including finishing cost

PRIMARY PROJECT TEAM

Architect: Wilmot/Sanz Architecture/Planning
General Contractor: Hitt Construction
Mep Engineers: Leach Wallace Associates
Structural Engineers: Smilslovia Kehnemui and Associates
Civil Engineerins: Cervantes and Associates, P.C.

ARCHITECTURE

- Georgian Style with a mixture of brick and stucco on floors 1-3, and prodominately stucco on the 4th floor
- Addition will connect at north east and north west pods of existing building at 2nd floor level
- Parking Garage at first floor of addition, with a facade to match that of entire building

STRUCTURAL

- W14x68 columns on caisson pedestals
- 48x52 grade beams support the upper floors that have reinforced lightweight concrete on metal deck
- Roof structure comprised of W18x40s, supporting Built-up Single Ply Membrame roofing

ELECTRICAL

- Main Distribution panel 480Y/277 volt, 3phase, 4 wire, 800a, Extended from existing switchboard
- Lighting and recptacles fed from dry type transformers and 208Y/120 volt panels
- Onsite diesel fired emergency generator rated at 150 kW

LIGHTING

- 277V Metal halide in parking gararge
- 120 V Compact Fluorescent downlights and wall sconces throughout most of building
- Decorative cove lighting in dining room, lobby, and corridors

MECHANICAL

- Main air distribution via four pipe fan coil units
- Chilled water provided by roof to hermetic helical rotary chiller
- Hot water provided by two steam fired hot water heaters
- 100% outside air provided by centralized energy

Lighting/Electrical Option

CPEP - http://www.arche.psu.edu/thesis/eportfolio/current/portfolio/mwm171

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EXECUTIVE SUMMARY

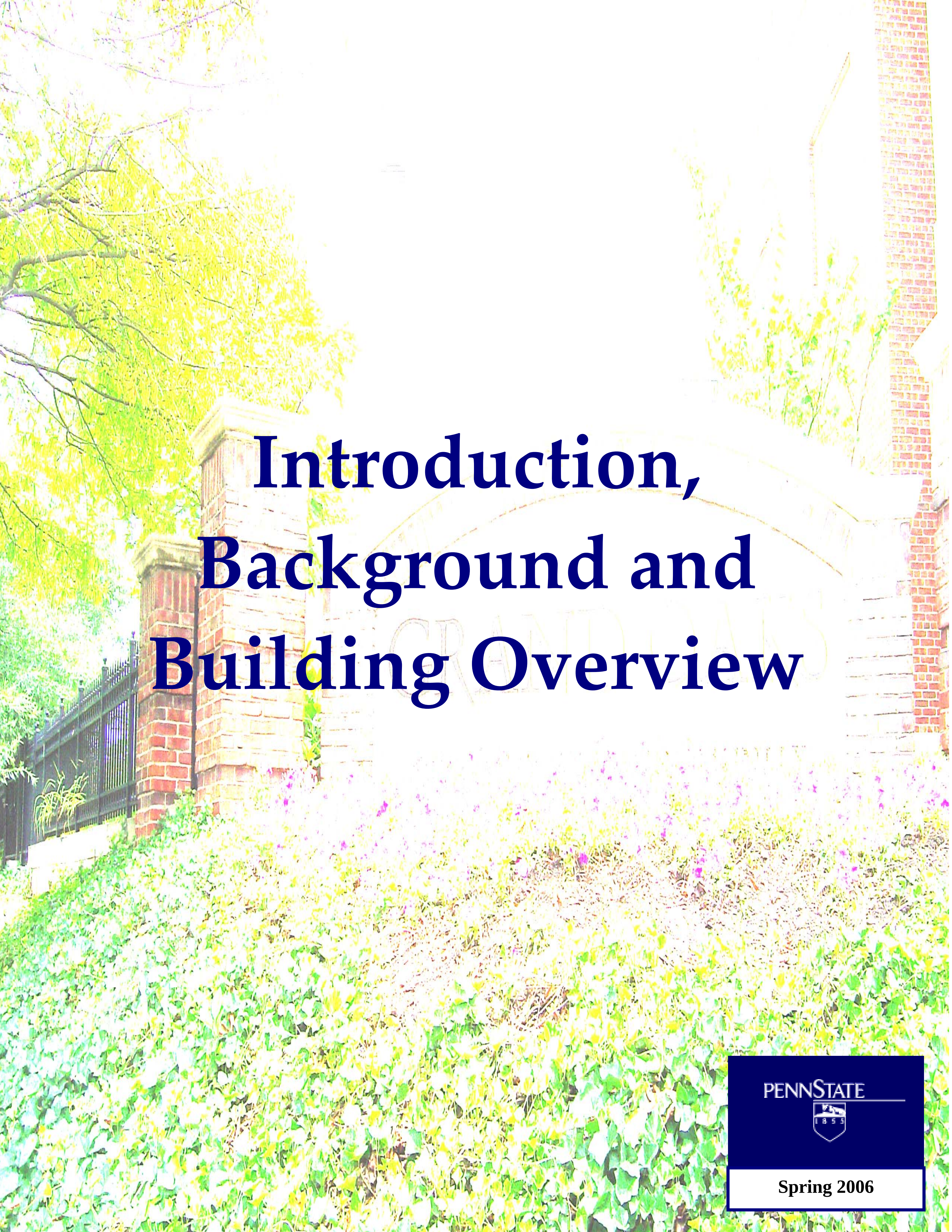
This report contains designs and studies that are proposed for Sibley Memorial Hospital's – Grand Oaks Assisted Living Facility. The Assisted Living facility can be thought of as a two part building; the existing building, which completed construction and began operation in the year 2000, and the new addition that will begin construction in the summer of 2006. The two part building has led to a two part thesis project. The Lighting Depth Study considered various spaces located in the existing building while the Mechanical Feasibility Study, Electrical Depth Study, and Construction Management Breadth Study were the result of study the new addition.

The Lighting Depth Study looked at four different spaces within the existing Assisted Living Facility. These spaces include the Living Room/Library, the Dining Room Addition, the Lobby, and the Building Exterior and Entryway. A design criterion was established with reference to the IESNA, and specifically, Lighting and the Visual Environment for Senior Living (IES RP-28-98). Power density requirements were established by ASHRAE 90.1, and the design of the various spaces complied with this document. In the full report one can find global design criteria, space specific design criteria, design development, and final design layouts and conclusions.

The Mechanical Feasibility Study looked into the implementation of a ground-coupled, closed loop, 2-pipe, geothermal heat pump installation. In this report, the current system and the proposed geothermal system were compared, from which a geothermal heat pump system could be sized and a method for system construction could be developed. The respective power consumptions were tallied based on the size of the current system and the purposed heat pump design. Based on the power consumption of each system, monthly electric bills could be developed.

The Electrical Depth Study looks at a new way of distributing power to the new Assisted Living Facility Addition. Based on the electrical characteristics of the proposed mechanical system outlined in the Mechanical Feasibility Study, I was able to propose a new distribution method for normal power to the new Assisted Living Facility Addition. This new distribution system adds a group mounted, 2000A section protected by a 900 A circuit breaker, to the existing Switchboard located in the existing building's Main Electrical Room, from which (3) sets of normal power feeders can be extend to a 1000A main distribution panel. The main distribution panel supplies power to subsequent distribution panels, as well was the two elevators, Energy Recovery Unit Heat Pumps, etc. A cost comparison is also included to look at the cost savings of this new distribution method.

The Construction Management Breadth is a Cost Analysis of the Geothermal Heat Pump design outlined in the Mechanical Feasibility study. The initial cost of the current design and the one I propose implementing are documented within this report. Based on the monthly energy savings that the Mechanical Feasibility Report suggested; annual energy savings of the current system vs. the one I propose are analyzed, from which a payback period can be established to offset the high initial cost of the Geothermal Heat Pump Design. The high electricity rates that are set to affect the Baltimore/Washington area this summer of 2006; discussed in detail in the Mechanical Feasibility report, are also taken into account when establishing a payback period. The rate structure is scaled to assume the inflated cost that would be associated with a 35%-72% rate increase in utility bills. Obliviously, a 72% rate increase would not be passed by lawmakers, but for demonstrative purposes and to further sell my proposed Geothermal Heat Pump design, I choose to establish payback periods based on these rate increases. Also included is the net present value of the annual energy savings offered by a 25 year projected life of the geothermal heat pump system. The different net present value of the energy savings are shown with the current electrical rates, the 35% rate increase, and the 72% rate increase. Also included is the Rate of Return on the initial investment of this Geothermal Heat Pump System over a 25 year projected life, given present electric rates, a 35% rate increase, and a 72% rate increase.



Introduction, Background and Building Overview

Spring 2006

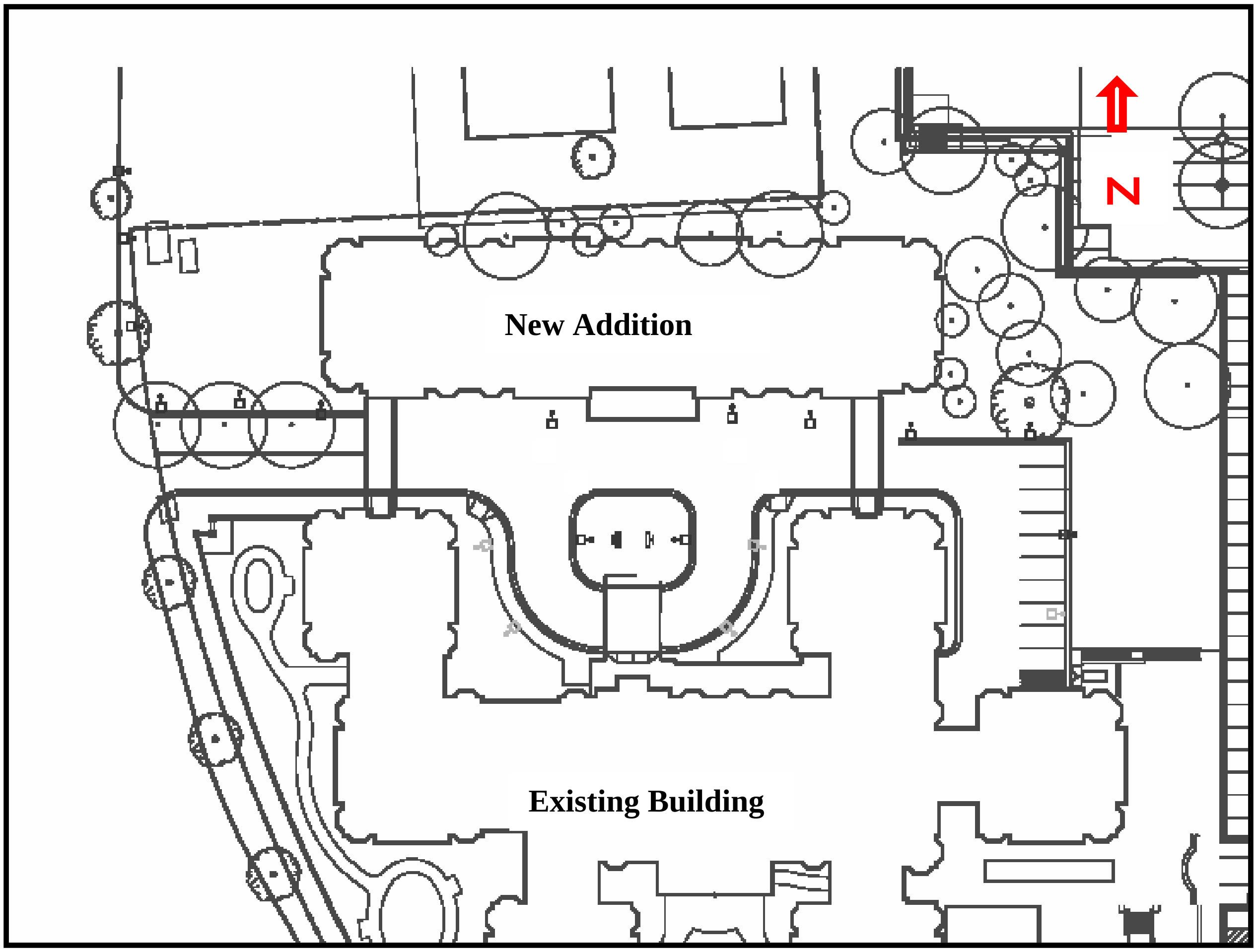
INTRODUCTION AND BACKGROUND

This project looks at Sibley Memorial Hospital's Grand Oaks Assisted Living Facility. The existing building finished construction and began to be operational in the summer of 2000. The existing building was used for the Lighting Depth Study which had a variety of different spaces for which a lighting design program could be developed, these spaces include: The Living Room/Library, The new Dining Room Addition, The Lobby, and the Building Exterior. In the summer of 2006 the facility will be adding a 60,000 square foot addition which will provide additional residential suites and a parking garage on the ground floor. This building addition was studied, from which evolved the Electrical Depth, Mechanical Feasibility Study, and Cost Analysis of Geothermal Heat Pumps.

GENERAL BUILDING OVERVIEW

- **Building Name:** Sibley Memorial Hospital, Grand Oaks Assisted Living Facility Addition.
- **Location and Site:** 5255 Loughboro Road, NW, Washington, DC 20016
- **Building Occupancy Name:** Sibley Memorial Hospital
- **Occupancy or function types:** Assisted Living Residence
- **Size:** New Construction Floor Area – 60,881 SF
  Renovated Existing Floor Area - 6,883 SF
- **Number of stories above grade/total levels:** 4 stories
- **Primary project team:**
  - **Owner:** Sibley Memorial Hospital
    website: www.sibley.org
  - **General Contractor:** Hitt Construction
  - **Architects:** Wilmot/Sanz Architecture/Planning
    website: www.welmot.com
  - **Civil Engineers:** Cervantes and Associates, P.C.
    website: www.vaeng.com/consultants/cervantes--associates/
  - **Food Service:** Culinary Advisors – Food Service Faculty Designers and Consultant, LLC
    website: www.culinaryadvisors.com
  - **M.E.P. Engineers -** Leach Wallace Associates, Inc.
    website: www.leachwallace.com
  - **Structural Engineers –** Smislovia Kehnemui and Associates PA(SK+A)
    website: www.skaengineers.com

- **Dates of Construction (Start-Finish):** 4/18/05-4/14/06 – proposed,
- **Actual Cost Information:** 17 million in contractor cost, not including finishing costs
- **Project Delivery method:** Design-Bid-Build



ARCHITECTURE

Grand Oaks, part of Sibley Memorial Hospital, is an affluent assisted living residence located at the corner of MacArthur Boulevard and Loughboro Road, in Washington D.C. This upper scale living community strives to combine comfortable surroundings, personalized assistance, 24-hour support, and a full range of services and activities. The current facility features 104 apartments, studios, and one-and-two bedroom units, boasting nine-foot ceilings with spacious and bright layouts. The building features sitting rooms with fireplaces; terraces and gardens with European-inspired appointments and furniture provide the finishing touches. Amenities include a comfortable dining room, with an executive chef, clubroom, spa, beauty and barber shop, greenhouse and chapel.[1] The Georgian Style architecture combine the different textures of brick and stucco that provide a classy and elegant look throughout the entire building. Upon arriving to the main entrance, one is greeted with beautiful landscaping and the covered Porte Cochere. The new addition will extend off the two pods, which are at the east and west of the existing building. To maintain traffic flow; the building will connect at floors two through four of the existing building, thus allowing vehicular movement throughout the site. This new addition will sit adjacent to the existing facility on what is currently a parking lot. So as not to loose valuable parking spaces, the new building will maintain a parking area in the first floor level. The exterior façade will be like that of the existing, and floors 2-4 will provide additional tenant space, as well as a day/activity room.

1. www.sibley.org/services/s_grandoaks

MAJOR NATIONAL MODEL CODES

(1) Building: The International Building Code, 2000 and D.C. Supplement 2003
(2) Electrical: NFPA National Electric Code, 1996 and D.C. Supplement 2003
(3) Mechanical: International Mechanical Code, 2000 and D.C. Supplement 2003
(4) Plumbing: International Fire Prevention Code, 2000 and D.C. Supplement 2003
(5) Fire Prevention: International Fire Prevention Code, 2000 and D.C. Supplement 2003

BUILDING ENVELOPE

The Grand Oaks facility is a brick and stucco building with bow windows, Doric columns, and gabled roofing, all of which complement each other in both space and proportion to produce the Georgian Style appearance. The exterior walls consist of three arrangements: one being; face brick, 1-1/2 gypsum sheathing, and 6” metal framing studs, the other; face brick and CMU’s, and last; face brick and poured in place concrete. Wall type depends on the place, load barring need, and above/below grade conditions. The structure of the building is comprised of wide flange columns and grade beams. The roofing system has both sloping gables and a hipped portion in the cent that holds the HVAC equipment. The main penthouse and floor framing plan has 3-1/2” lightweight concrete on 2” metal deck. The roof construction at the sloped areas consists of 1-1/2” x 22 gauge galvanized metal roof deck, wide rib type. The sloped area uses wide flange steel beams ranging in size from W12X15 – W18X40. The girders supporting these sloped areas are W21X50.

CONSTRUCTION

The Grand Oaks facility was designed under a design-bid-build contract. Construction was planned and scheduled to take 52 weeks. The tentative dates of construction were 4/18/05-4/14/06. I visited the site in August 2005, and ground had yet to be broken. The most recent information that I have on this building is that that it is in the submittal process.

ELECTRICAL

The normal power is provided to the existing Assisted Living Facility from a PEPCO owned network transformer vault. The electrical service terminates in a 2000 amp switchboard protected by a fused bolted pressure switch located in the basement of the Assisted Living Facility. The existing Facility receives heating and chilled water service from Sibley’s Central Energy Plant. A main distribution panel rated at 480Y/277 volts, 3 phase, 800A, is extended from the existing Switchboard. Mechanical equipment is served directly from the Main Distribution Panel Board. Lighting and receptacles are served from dry type transformers and 208Y/120 panelboards. Transformers are located at the North East and North West Wings of the addition and feed the panelboards from their respective locations. Emergency power is generated with an on site 300KW diesel-fired emergency generator. This generator provides emergency power to the elevators, egress lighting, and a limited amount of refrigeration in the kitchen.

-Information obtained from bid proposal provided by Leach Wallace Associates.

LIGHTING

The site lighting for Grand Oaks is minimal and served via pole mounted lighting fixtures. The fixtures are served from the existing electrical equipment in the main building and operate at 277V. All other lighting is served via the 208Y/120 panel boards, and is predominately fluorescent fixtures. The parking garage makes use of metal halide downlights, which serve more of a utilitarian function rather than aesthetic one. The 3-story bridges that connect the addition to the main building make use of daylighting via large window on both sides. Both compact fluorescent downlights and wall sconces provide electric lighting to the bridge corridors. The main corridors are also lit with wall sconces and compact fluorescent downlights. Decorative cove lighting is employed at the ends of the corridors and at the entrance to the day/activity room. The day/activity room makes use of downlights as does the renovated dining room. The dinning room also has decorative cove lighting and linear wall washers.

MECHANICAL

The main air distribution of the Grand Oaks addition is achieved via four pipe fan coil units. All units have forward-curved 3-speed centrifugal fans sized at medium speed to minimize fan noise within the space. The FCU in living areas are exposed floor-mounted types with stack-style vertical cabinets. Air is 100% re-circulated. FCU are of the two-coil, four pipe style. Each unit is suitable for chilled water and heating hot water service. The ventilation requirement is provided by either wall or ceiling mounted supply air registers connected to a ducted 100% outside air ventilation distribution system. Exhausted air is removed through ceiling mounted registers located in toilet rooms. A centralized energy recovery air-handling unit serves both the supply and return air to increase the efficiency of the system. Chilled water is provided via an air-cooled roof-mounted chiller. The chiller is a hermetic helical rotary machine, featuring multiple air-cooled condenser fans, modulating compressor unloading, and independent refrigerant circuits. Hot watered is supplied via two instantaneous steam-fired domestic hot water heaters that receive steam from Sibley's Boiler Plant.
-Information obtained from bid proposal provided by Leach Wallace Associates.

STRUCTURAL

The foundation is typical slab on grade, 5" thick, placed on a vapor barrier, over 4 inches of washed gravel reinforced with 6x6 W2.0x2.0 welded wire mesh. The columns serving this area are placed on caisson pedestals and are predominately wide flanged, W14x68. Grade Beams support the upper floors and are of the 48x52 dimension. Floors 2-4 are comprised of reinforced lightweight concrete on metal decking. Grade beams range in size from W12x72-W55x42, while supporting columns range in size from W10x33-W10x60. Typical spans between columns are 26'6"-30' while typical beam spans are 8-1/2" on center. Sloped roof structure is comprised of W18x40 and W12x16, which hold the galvanized metal roof deck.

PLUMBING

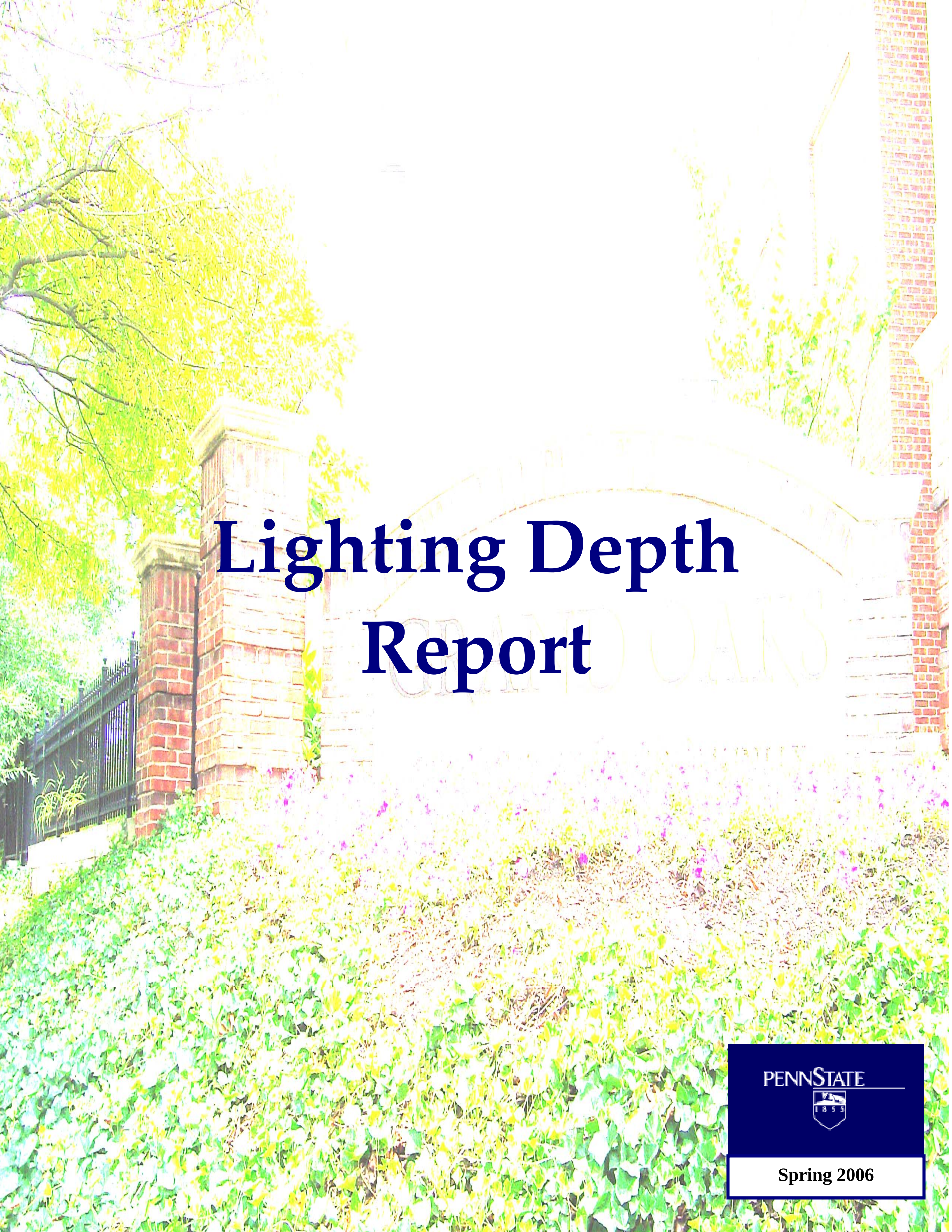
The plumbing system provides domestic cold and hot water, with hot water re-circulation, soil, waste and vent, air conditioning condensate drainage, as well as natural gas. Domestic water service is routed through a pipe chase to a location above the Fourth Floor where a water softener is provided. Cold water is then distributed to other levels with in a series of risers. Domestic hot water is routed form the water heaters, located in the penthouse, down through toilet room chases, and returned to the heaters via inline recirculation pumps.
-Information obtained from bid proposal provided by Leach Wallace Associates.

FIRE PROTECTION

The water for fire protection is obtained from the Domestic Water System. The main fire riser branches into a dry-pipe sprinkler system serving the parking level, and a wet-pipe sprinkler system serving the occupied floors and penthouse spaces. The system is a single zone comprising the entire first level. The sprinkler zone assemblies are contained in the stairwell on each floor and consist of an outside stem and yoke gate valve with tamper switch, check valve and flow switch. All sprinklers are of the quick response type, with recessed heads in all occupied spaces with ceilings.
-Information obtained from bid proposal provided by Leach Wallace Associates.

TRANSPORTATION

Two elevator banks are located in the NW and NE ends of the Grand Oaks addition. Each car is piston driven and operated with 40hp motors that are connected to the emergency branch circuit serving their respective areas.



Lighting Depth Report

Spring 2006

Introduction

Grand Oaks is an Assisted Living Facility in the Washington, D.C. area that gives its residents the support they need while maintaining a home like environment. So, when I set out to develop a lighting program for this facility, I wanted to establish as much of a residential type atmosphere as possible. There are certain challenges given the fact that I am designing for older individuals, which as a result of their age, have issues with vision, of which, poor lighting design can affect. A few of the problems that the affect older individuals are: smaller pupils (which reduce the amount of light entering the eye), loss of ocular transparency (which scatters light and reduces the apparent contrast of objects), yellowing of the ocular media (which changes the colors of the visual field), loss of accommodation (which results in increased blur), and an increase in the prevalence of ocular disease. All of these issues contribute to the need for special attention to the lighting requirements of older persons. (IESNA: Lighting and the Visual Environment for Senior Living RP-28-98) The implementation of good lighting design can be thought of as a preventative medicine, by addressing the visual needs of those older individuals, I provide an environment that is safer for them to live in. With that said, there was some global design criterion that needed to be developed so that the lighting design could begin.

The structure of the Lighting Depth Report is somewhat different than the others, (Mechanical Feasibility Study, Cost Analysis of Geothermal Heat Pumps, and the Electrical Depth Report), such that I am not doing a direct comparison of the existing lighting conditions to new design conditions. In Technical Report #1, I provided a comprehensive existing conditions report that addressed the present issues with the current lighting design. After completing this report, I found that the facility was within code by meeting appropriate illuminance levels and power densities. The reason for not comparing the current design with the one that I am proposing is that lighting design in and of itself is an artistic notion and opinion. This subjective nature of lighting design is in and of itself a matter of opinion. So, in this report, I am going to refrain from making subjective complaints about the existing lighting design. I will base the effectiveness of my design on how well it adheres to the design criteria that I set forth. In the next section, you will find the “global” design criterion that is to be kept in mind for all spaces. Space by space design criteria will also be addressed given the specific needs of the individual spaces.

Design Criteria

- *Source: IES: RP-28-98 – Light and the Visual Environment for Senior Living*
- **The following design criterion is for a Senior Living Facility and the spaces that it includes. This criterion pertains specifically to the aging population and is meant to provide a basic understanding of their needs. Specific space criterion will also be developed in addition to this information.**

Elderly individuals can be divided into two categories:

- Those who suffer from pre-retinal scatter from corneal, lenticular, and citreal opacities. These persons may, and often do, have abnormal retinas. For such persons, increases in light may do more harm that good by increasing the amount of light available to be scattered.
- Those whose vision is limited by retinal dysfunction and whose acuity and contrast sensitivity are reduced. These persons often benefit from significantly higher light levels than are required for the normally sighted.

From the above two categories, it is apparent that special consideration will need to be taken when developing the design criteria and developing a lighting theme/program.

Quality of Lighting

- Freedom from glare (both disability glare and discomfort glare)
  - Reduce the amount of lighting entering the eye from areas within the central 10-15 degrees of the visual field which do not directly contribute to the visibility of the task
  - Avoid sources that are:
    - Bright
    - Large in area
    - Close to the line-of-sight
- Freedom from veiling reflections
- Freedom from flicker
- Adaptation control
  - Transitioning from light to dark is much greater the from dark to light
    - Lobbies must be brighter during the day and dimming during night time hours
- Spectral power distribution
  - “Bluer” produce less glare
  - Filtering the yellow wavelength can also increase the visual performance on contrast sensitivity and acuity tasks.

- Daylight – psychological, physical health, and energy conserving benefits
  - Brightness
    - According to the IES, older individuals need more light given their somewhat sedentary lifestyles. The lack of daylight and high light levels throughout the day can disrupt the circadian rhythms and suppress the brain's nocturnal production of melatonin. This hormone, produced by the pineal gland, is secreted during the dark phase of the daily light/dark cycle, telling the body it is nighttime. As a result, older individuals have disrupted sleeping patterns and rely heavily on sleep medications. Sleep medication can have adverse affects such as memory loss, incoordination, and breathing disorders. The problem is apparent; so much attention will be given to increasing the light levels of the spaces throughout the day. Incorporation of day lighting and electric lighting will need to be integrating to increase light levels and lower energy consumption to comply with ASHRAE and /IESNA Standard 90.1 requirement for power consumption.
  - Depression and Mood Disorders
    - Lack of outdoor light exposure and sedentary lifestyles that keep older individuals indoors are factors that contribute to the depression and mood disorders
    - There is a need for exposure to bright light conditions for both psychological health as well as physical health and a feeling of well-being.
  - Vitamin D
    - Vitamin that is crucial for skeletal health
    - Obtained from both diet and the UVA radiation found in sunlight
    - Many older individuals do not receive enough in either diet or sunlight exposure.
    - Exposure to daylight and dietary supplements could help provide this essential nutrient.
  - Energy Conservation
    - With careful implementation, daylight can considerable lower energy consumption and should be a top priority of the utmost importance

Illuminance Values – *referenced from Health Care Facilities IES*

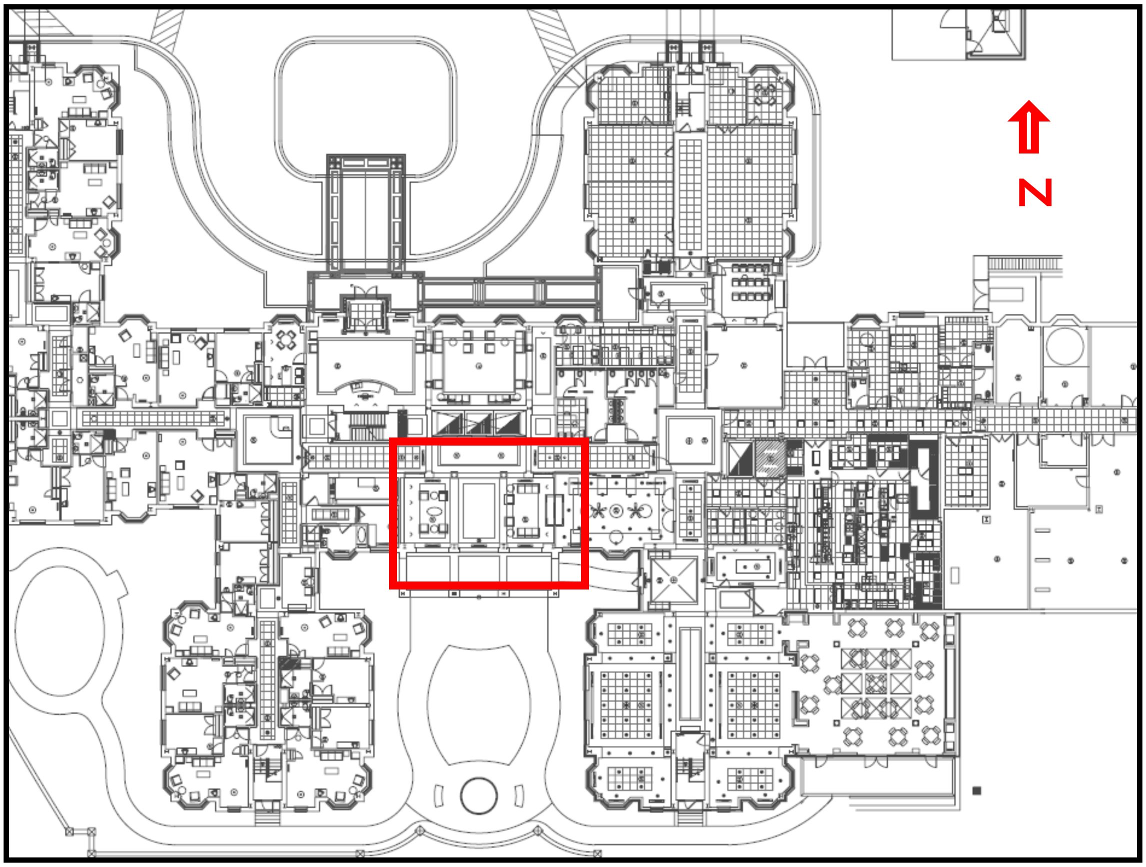
Areas	Ambient Light in Footcandles	Task light in footcandles
Exterior Entrance(Night)	**10**	
Interior Entry (Day)	**100**	
Interior Entry (Night)	**10**	
Exit Stairways and Landings	**30**	
Elevator Interior	**30**	
Parking Garage Entrance	**50**	
Exterior Walkways	**5**	
Administration (Active)	**30**	**50**
Active Area (Day Only)	**30**	**50**
Visitor Waiting (Day)	**30**	
Visitor Waiting (Night)	**10**	
Chapel or Quiet Area (Active)	**30**	
Dining (Active Hours)	**50**	
Hallways(Active Hours)	**30**	
Hallways (Sleeping Hours)	**10**	

Now that the global design criterion is addressed, I can begin to talk about the design of the individual spaces.

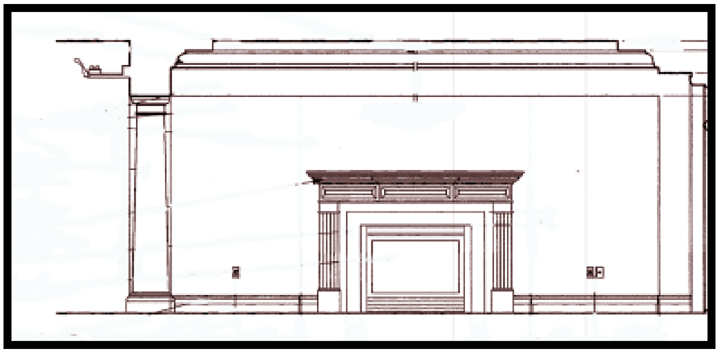
Living Room/Library

The first space that I am going to address in this lighting design is the Living Room. The intent of the lighting design in this space was to provide a warm, cozy, and comfortable environment. The nature of this space allows residents to have intimate conversations or congregate with friends for more of a social time. Some areas of interest are the bookshelves and the fireplace. So, when I developed schematics for the space, I thought of how I wanted to address this pieces and how the light would impact them.

Space Details



The Living Room/Library is situated in the building such that it has a southern exposure. As you can see from the Floor plan, there is a covered porch that one can get to through the French doors, and have pleasant and relaxing view of the court yard area during well temperate days. The figure shown below is an elevation of the French doors on the southern end of the Living Room/Library.



This is a section of the living room that shows the location of the fireplace and some of its details. This fireplace was of importance in the lighting design because it is a focal point in the room, of which attention needed to be drawn towards.

Space Specific Design Criteria

Target Illuminance Levels

Horizontal –	40-50fc
Vertical -	20 fc

Appearance of Space and Luminaires

Given the multipurpose nature of the space, the appearance of the space and luminaries needs to be both aesthetically pleasing and integrated for functionality. The functions of this space are such that residents could be in an intimate conversation or congregating as a group. Luminaries will be integrated as much as possible into the architecture so that there are clean lines throughout the space. The table lamps will be decorative in their given nature and be of a conservative look that fits within the space.

Color Appearance (and color contrast)

Color appearance will be heightened by the use of high CRI lamps so that as much of the visible spectrum as possible, will be recognized. In addition to the color rending of the lamps, I will also implement lamp temperature of 3000K. This warmer lamp temperature will complement the residential feel and intimacy of the space that I am trying to create. Skin tones will appear more healthy and overall look of the space will be warmer given this specified lamp temperature.

Daylight Integration and Control

The ability to use daylight will be considered only as an additive source to the electric lighting that is to be installed. With the large covered porch, direct sunlight penetration will not be an issue. I suggest that the window glass be view glass with a transmittance of 60%. There will be

dimming capabilities in the space, but it will be up to decide the facility to decide when and by how much they want to dim to the electric lighting in the space. The dimming will provide a greater aesthetic to the space rather than being looked at as a potential energy saver. The energy savings will be realized by adhering to ASHRAE 90.1 for power densities in the space.

Direct Glare/reflected

It will be important to avoid direct glare so that different illuminance ratios do not make the residents uncomfortable and potentially disoriented. Both the placement and type of luminaires used will address this concern and be of the variety that results in low levels of direct glare. Reflected Glare will be avoided by the use of matte finishes and furniture.

Power Allowance

ASHRAE/IESNA 90.1 –	1.2 watts/ft^2
Based on space by space method	1.0 watts/ft^2 – for decorative chandelier-type luminaries or sconces or for highlighting art or exhibit

With the listed design criteria, I could begin to develop a schematic design that would eventually be modeled in AGI.32 so that I could calculate the necessary illuminance values.

Schematic Design of the Space

During the brainstorming process I developed some schematic sketches of the living room space to show where I wanted to put the light, by which I could establish a hierarchy of objects within the space and draw a person's attention to any visual areas of interest. My thoughts during the schematic design were to add cove lighting to provide general diffuse, indirect illumination. The columns are highlight with wall sconces to make them more dramatic. The fireplace is washed with light with special highlight for framed artwork that could be placed above the mantel. Table lamps are added to provide that "home-like" environment and give more light at the work plane so that residents have the appropriate foot candle levels present for reading.

Now that I have an idea of what I want the space to look like, how I envision the overall aesthetic properties of the space, and various levels of hierarchy, I could begin my search for the perfect luminaires that could achieve the desired lighting affect. In addition, a 3-dimensional model of the space was created in AGI.32. The reflectance of the ceiling, walls, floor, and the like are provided below. These values as well as assumption went into the program to produce the lighting calculations.

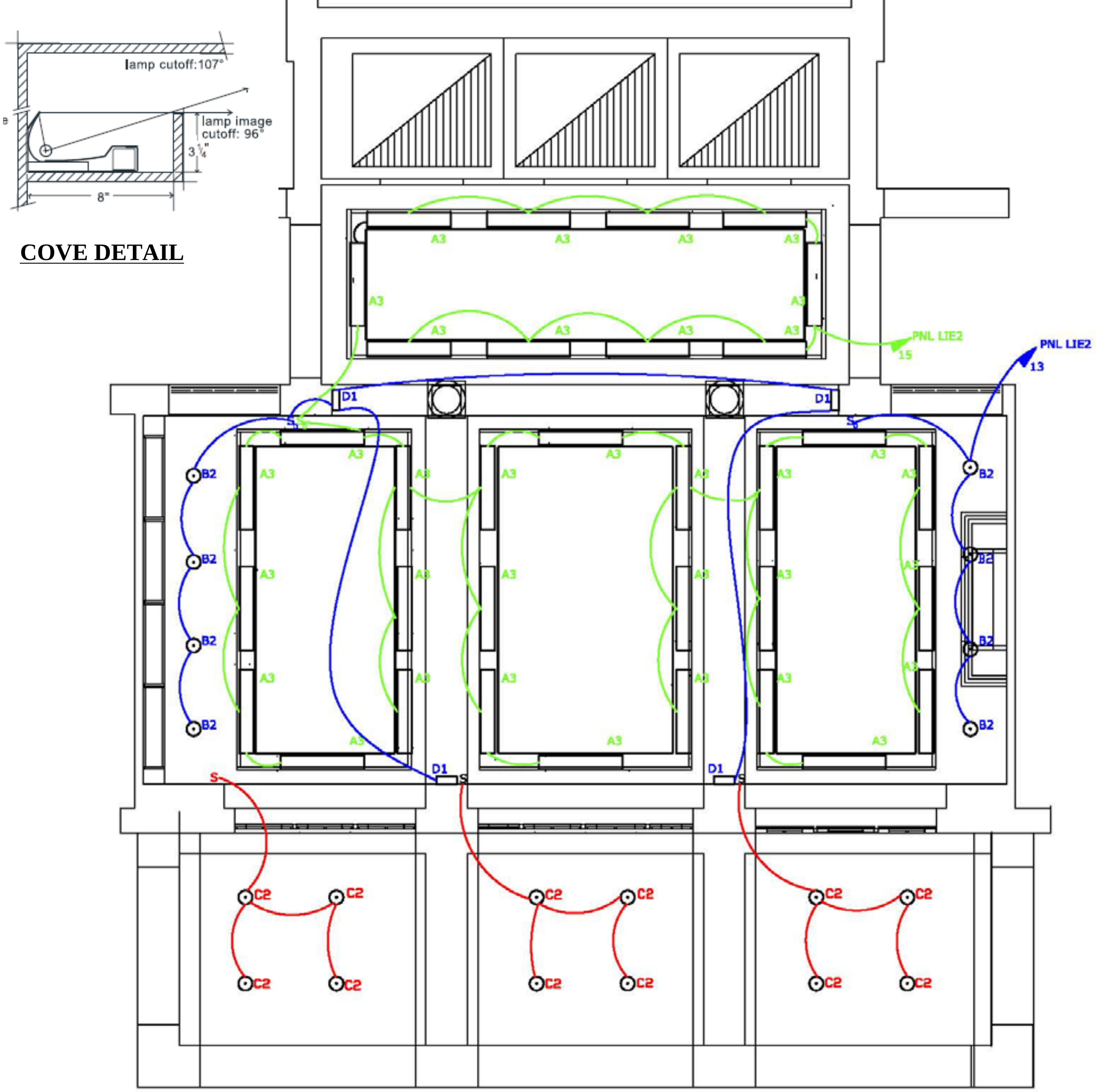
The surface materials of the space include:

▪ vinyl wall covering	reflectance = 50%
▪ Painted Plaster Ceiling	reflectance = 80%
▪ Carpet flooring	reflectance = 20%
▪ doors-painted	reflectance = 80%
▪ windows	reflectance = 10%(night)
	transmittance = 60%

The furnishings of the space include:

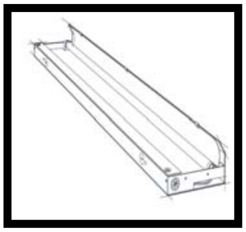
▪ Wooden tables	reflectance = 30%
▪ Leather Furniture	reflectance = 10%
▪ Book Cases – wood stain	reflectance = 10%
▪ Fireplace – wood	reflectance 10%

Lighting Layout



COVE DETAIL

A3 – Prudential



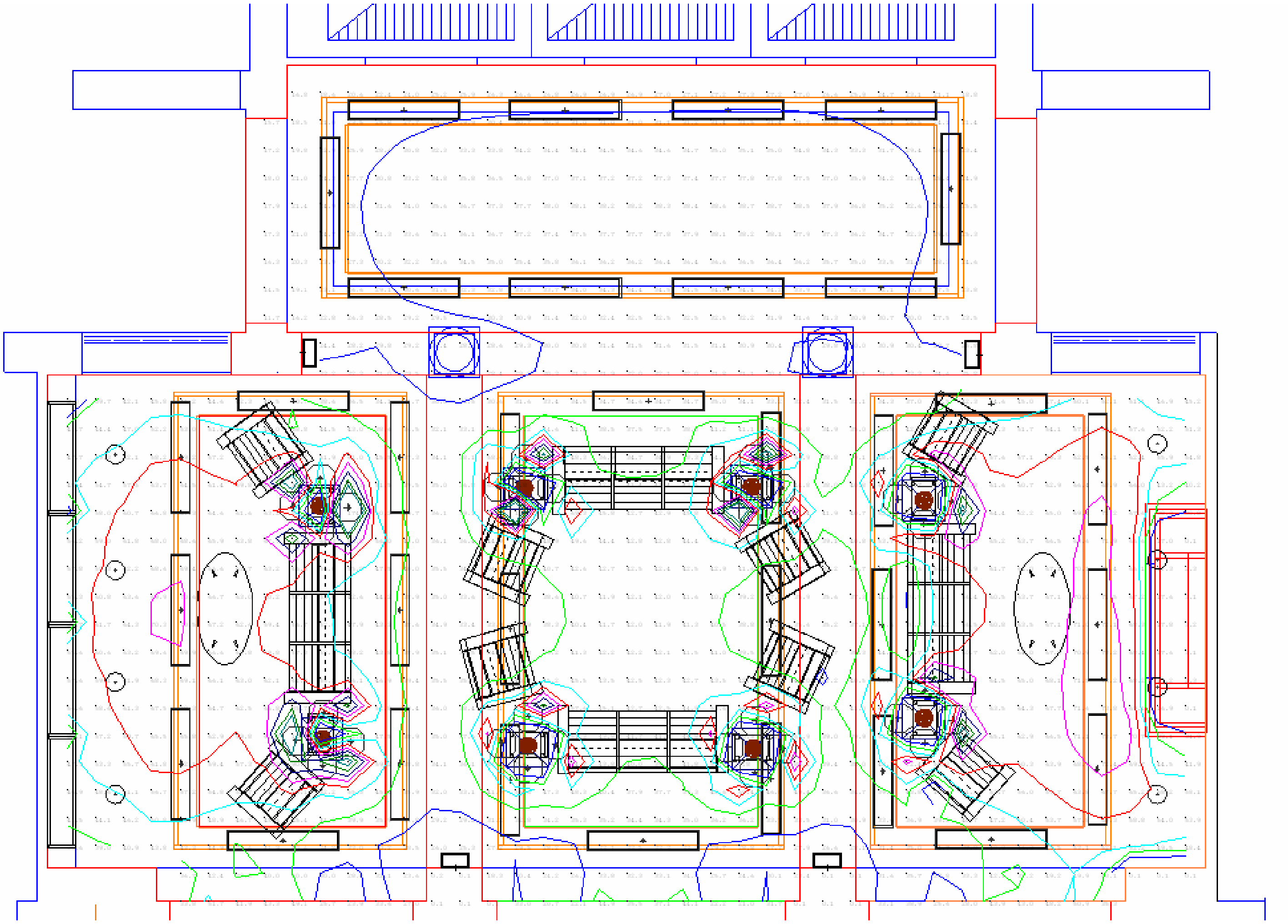
B2 – ERCO

C2 – ERCO

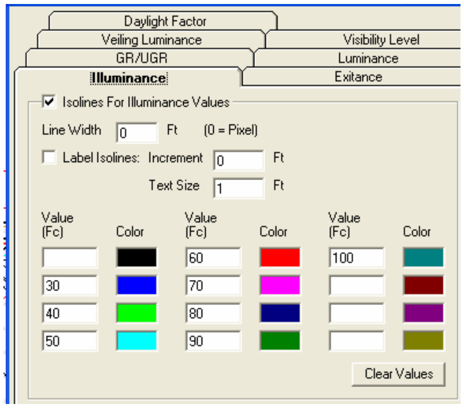
D1 – Spilighting

D2 – Target

ISO-LINES



Average Illuminance ~ 43 fc



☑ Isolines For Illuminance Values

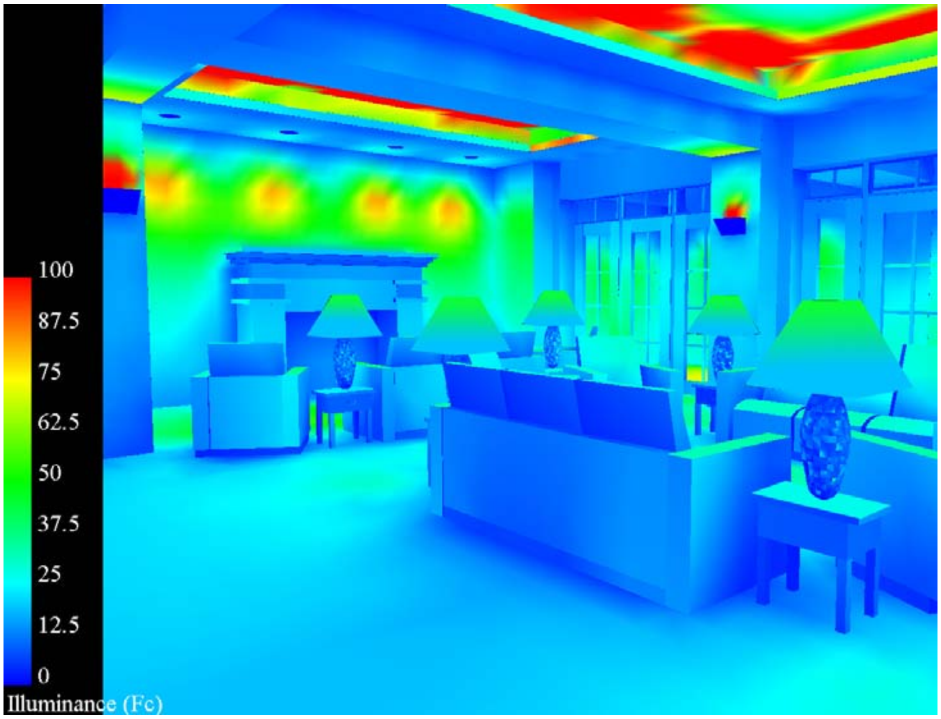
Line Width 0 Ft (0 = Pixel)

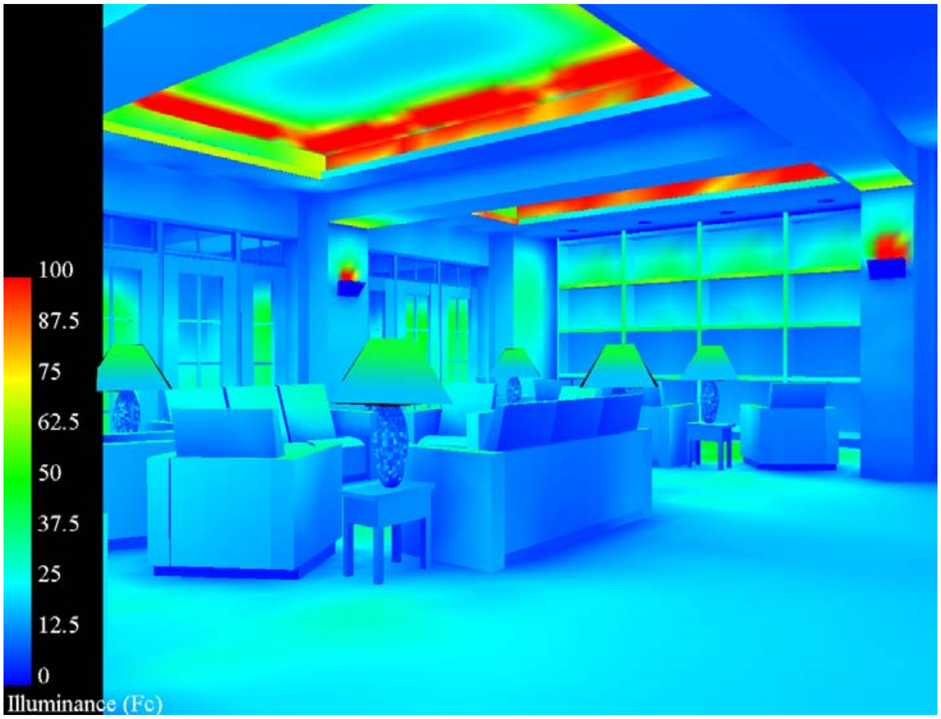
☐ Label Isolines: Increment 0 Ft

Text Size 1 Ft

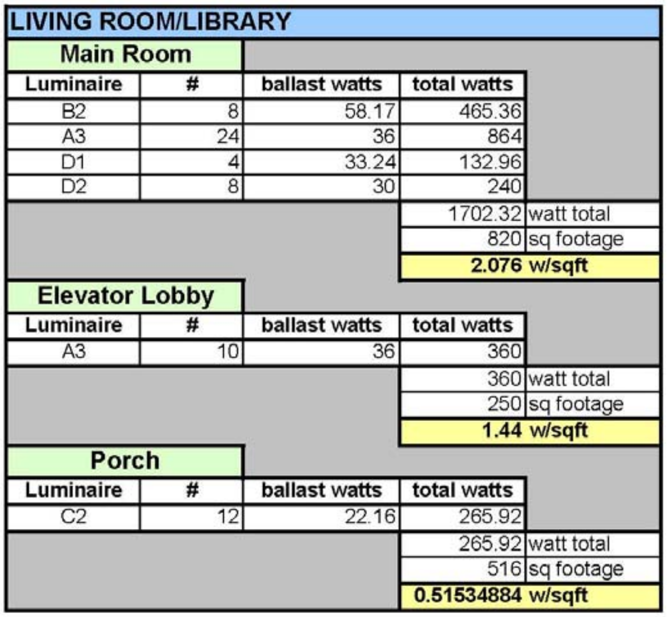
Value (Fc)	Color	Value (Fc)	Color	Value (Fc)	Color
	⬛	60	🟥	100	🟦
30	🟦	70	🟪		🟥
40	🟩	80	🟦		🟪
50	🟦	90	🟩		🟨

PSEUDO COLOR





Power Density



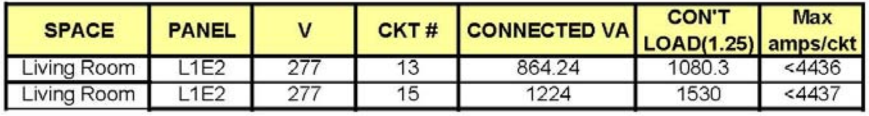
LIVING ROOM/LIBRARY				
Main Room				
Luminaire	**#**	**ballast watts**	**total watts**	
B2	8	58.17	465.36	
A3	24	36	864	
D1	4	33.24	132.96	
D2	8	30	240	
			1702.32	watt total
			820	sq footage
			2.076	**w/sqft**
Elevator Lobby				
Luminaire	**#**	**ballast watts**	**total watts**	
A3	10	36	360	
			360	watt total
			250	sq footage
			1.44	**w/sqft**
Porch				
Luminaire	**#**	**ballast watts**	**total watts**	
C2	12	22.16	265.92	
			265.92	watt total
			516	sq footage
			0.51534884	**w/sqft**

ASHRAE 90.1 – Using the space-by-space method.

1.3 W/ft^2
1.0 W/^{ft2} decorative lighting

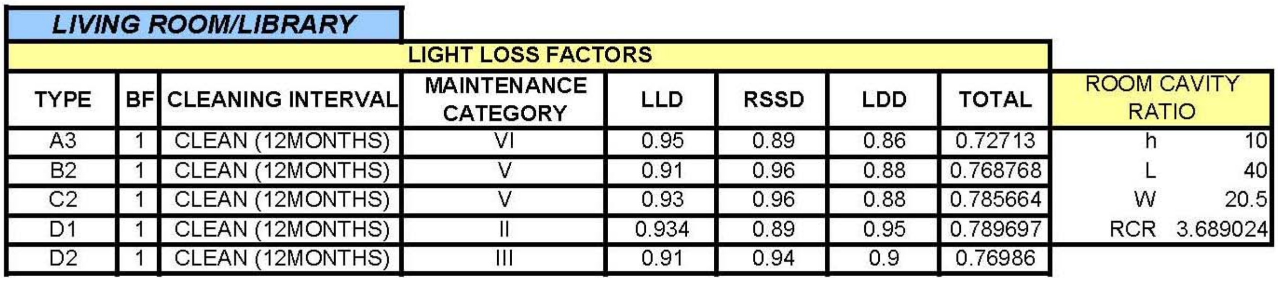
Exceptions to 9.2.2.3
(g) Lighting in spaces specifically designed for use by the visually impaired
9.6.3 Additional Interior Lighting Power
(a) For spaces in which lighting is specified to be installed in addition to the general lighting for the purpose of decorative appearance, such as chandelier-type luminaries or sconces of for highlighting are or exhibits, provided that the additional lighting powers hall not exceed 1.0W/ft^2 of such spaces

Branch Circuit Connect Load



SPACE	PANEL	V	CKT #	CONNECTED VA	CON'T LOAD(1.25)	Max amps/ckt
Living Room	L1E2	277	13	864.24	1080.3	<4436
Living Room	L1E2	277	15	1224	1530	<4437

Light Loss Factors



LIVING ROOM/LIBRARY									
LIGHT LOSS FACTORS									
TYPE	BF	CLEANING INTERVAL	MAINTENANCE CATEGORY	LLD	RSSD	LDD	TOTAL	ROOM CAVITY RATIO	
A3	1	CLEAN (12MONTHS)	VI	0.95	0.89	0.86	0.72713	h	10
B2	1	CLEAN (12MONTHS)	V	0.91	0.96	0.88	0.768768	L	40
C2	1	CLEAN (12MONTHS)	V	0.93	0.96	0.88	0.785664	W	20.5
D1	1	CLEAN (12MONTHS)	II	0.934	0.89	0.95	0.789697	RCR	3.689024
D2	1	CLEAN (12MONTHS)	III	0.91	0.94	0.9	0.76986		

RENDERINGS

The cove lighting in the space provides soft, indirect general illumination. The indirect portion helps to soften shadows and limit harsh contrast ratios. The bookshelf lighting is achieved with (2)-26W-CF wallwashers from ERCO. These luminaires wash the bookshelves with light and provide an average of 30 vertical footcandles. The lamps on the end tables are added to provide additional task lighting that may be needed for reading purposes. These table lamps make use of 30W screw base CF lamps. They will receive power from floor mounted outlets. The comment could be made that screw base CF lamps hurt the power factor on the electric bill. Given the fact that I am only using a total of (8) eight, I do not feel that will be any concern or problem. The wall sconces are implemented to add drama to the space and highlight the columns.

The fireplace is illuminated with the same wall washers that are used for the book cases. You can see that there is scalloping on the wall, and to some, this may be an undesired affect. In this installation I feel that the scallops add romance to the space with the contrast between light and dark. With these wallwashers at their current placement, any artwork that may be hung on the wall will have excellent illumination.

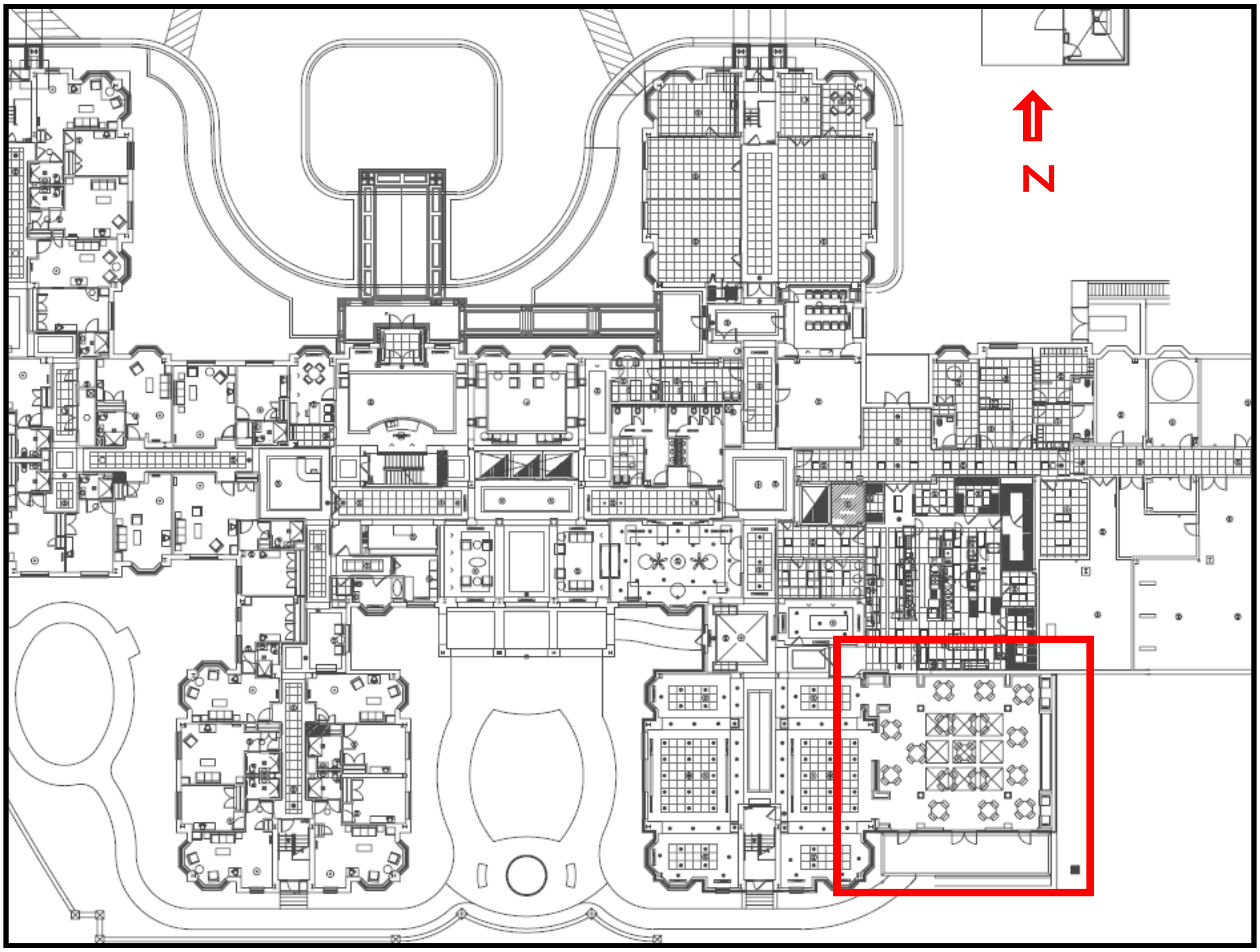
CONCLUSION

After running the various calculations for the space, I found that I met the desired design criteria of maintaining an average horizontal illuminance level of 40 fc. Now, an average is just that, an average, it really does not paint a clear picture of what is happening at a specific location in the room. When the ISO-LINE figures are referred to, one can see that at the location where the residents may need more light for reading or other tasks, i.e. where the furniture is placed, the illuminance levels are well above 40fc. With the use of cove lighting I provide indirect illumination that will limit glare and harsh contrast ratios. All electric light installations have lamp temperatures of 3000K, with CRI's of 80 or higher. With the use of low-e glazing on the doors, I limit the amount of daylight entering the space, thus reducing the luminance ratio issues that could result in discomfort glare for the residents. In addition to the low transmittance of the glazing, the covered porch reduces the direct component of the sunlight. Any light coming through the glass will be reflected light, that has already been converted into a lambertian distribution because of the diffuse surface of which it has been reflected from.

All luminaire cutsheets are provided in Appendix A and referenced by their letter/number designation. Refer to the Lighting Fixture schedule to find lamp specifications and ballast specifications. All lamps will be provided by Sylvania while ballasts are provided by Lutron and Advance Transformer. The lamp and ballast information can be found on the CD provided, of which will include the complete Sylvania lamp catalog for any reference to a specific lamp that may be desired.

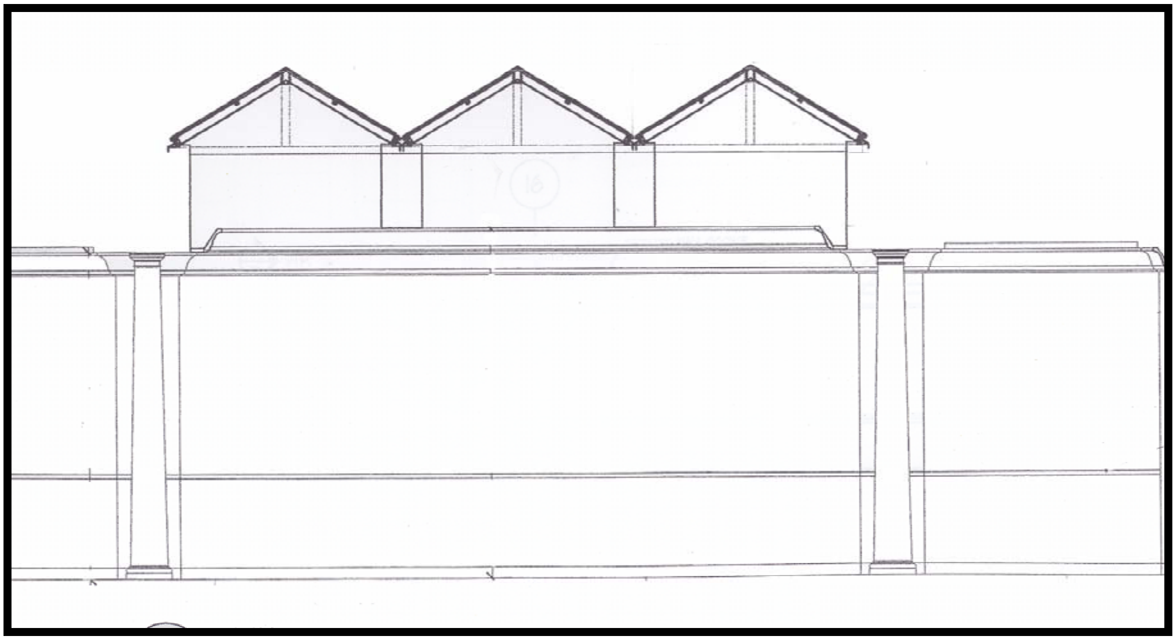
…The next space to be considered will be the **Dining Room.**

SPACE DETAILS



As it was mentioned previously, the Assisted Living Facility will be adding onto its existing structure. This addition will add approximately 56 residential suites. To handle the additional people, a dining room addition was added to the existing facility, adjacent to the current dining room. A few things to consider when thinking about this dining room space: Given the fact that this is an addition, the area adjacent to the existing dining room had to be excavating to make room for the new addition. To decrease the cost of the project, as well as to allow the surrounding areas of the facility to remain the same, the land area excavated was limited to the approximate footprint of the dining room addition. As you can see from the floor plan, a retaining wall had to be added at the east and south ends, this reduces the amount of window space available to the dining room. As a result, the Architects opted for a series of pyramid shaped skylights to make up for the lost day light. The day lit nature of the space was considered when developing the design criteria and in the schematic and final design phases of lighting program.

Sections and Elevations



In this figure one can see the way in which the skylight will be constructed. The ceiling height is 10 feet; the grid beams that support the skylights provide a well height of 2.5 feet plus the height of the skylights themselves, which is another 2 feet.

This figure shows the elevation of exterior entrance that is located on south side of the new dining room. This entrance has an 11 foot wide covered porch which helps to block direct sunlight entering through the door glazing.

Space Specific Design Criteria

Target Illuminance Levels

Horizontal – 50 fc
Vertical - 30 fc

Appearance of Space and Luminaires

With the use of the skylights, this dining room space is already segregated from the adjacent dining room by the virtue of having large amounts of daylight present throughout most of the day. With that in mind, the appearance of the space will integrate the daylight in such a way that it has more of a café type feel that one might associate with a place they would go for lunch or an early dinner. There will be a balance between this café type feel and that of a formal dining room space. With the use of warm wall colors and decorative art work, the space will maintain its formalness, while the daylight will provide higher illuminance levels to make the space feel more open. The luminaires used in the space will be integrated into the architecture wherever possible. All downlights will be outfitted with darklight reflectors that will minimize their potential to cause unwanted glare.

Color Appearance (and color contrast)

Color appearance will be achieved with the use of high CRI lamps so that as much of the visible spectrum will be present as possible. In addition to specifying lamps with high CRI values, I am going to spec two different lamp temperatures. It is recommended that for any given space, the color temperature ranges should not exceed 100K. But, given the nature of this space, I am going to argue for my design in that I will use 4100K to create a cooler daylight affect for the skylight wells. Other lamps around the perimeter space will make use of lamp temperatures of 3500K.

Daylight Integration and Control

The skylights provide the greatest opportunity to bring natural daylight into the space. The covered entrance on the south end of the dining room will also contribute daylight, but its contribution will be minimal given the size of the overhang and the retaining wall that is a few feet beyond the termination of the overhang. Any light that is present through the exterior entrance doors will be of the reflected variety and lambertian in its nature given the diffuse surfaces that it will be reflected from. Daylight control will be achieved via a photo sensor that will be located in the skylight well.

Direct Glare/Reflected

It will be important to avoid direct glare so that different luminance ratios do not make the residents uncomfortable and potentially disoriented. Both the placement and type of luminaires used will address this concern and be of the variety that results in low levels of direct glare. Reflected Glare will be avoided by the use of matte finishes and furniture.

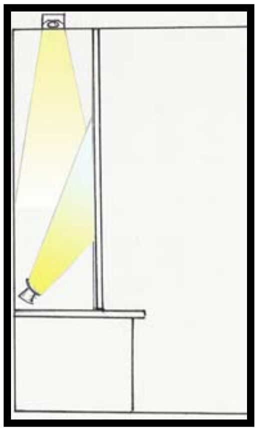
Power Allowance

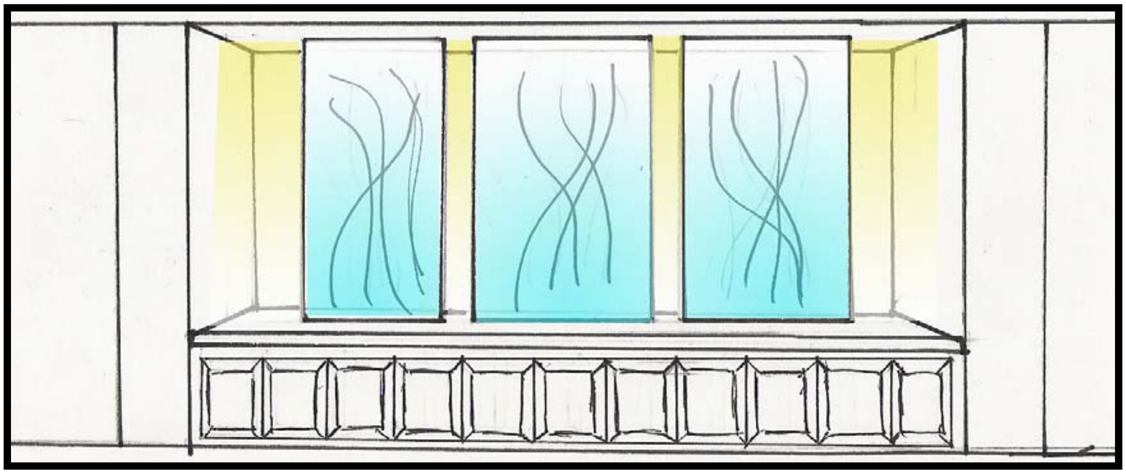
ASHRAE/IESNA 90.1 – 2.1 watts/ft^2
Based on space by space method

With the listed design criteria, I could begin to develop a schematic design that would eventually be modeled in AGI.32 from which I could calculate the necessary illuminance values.

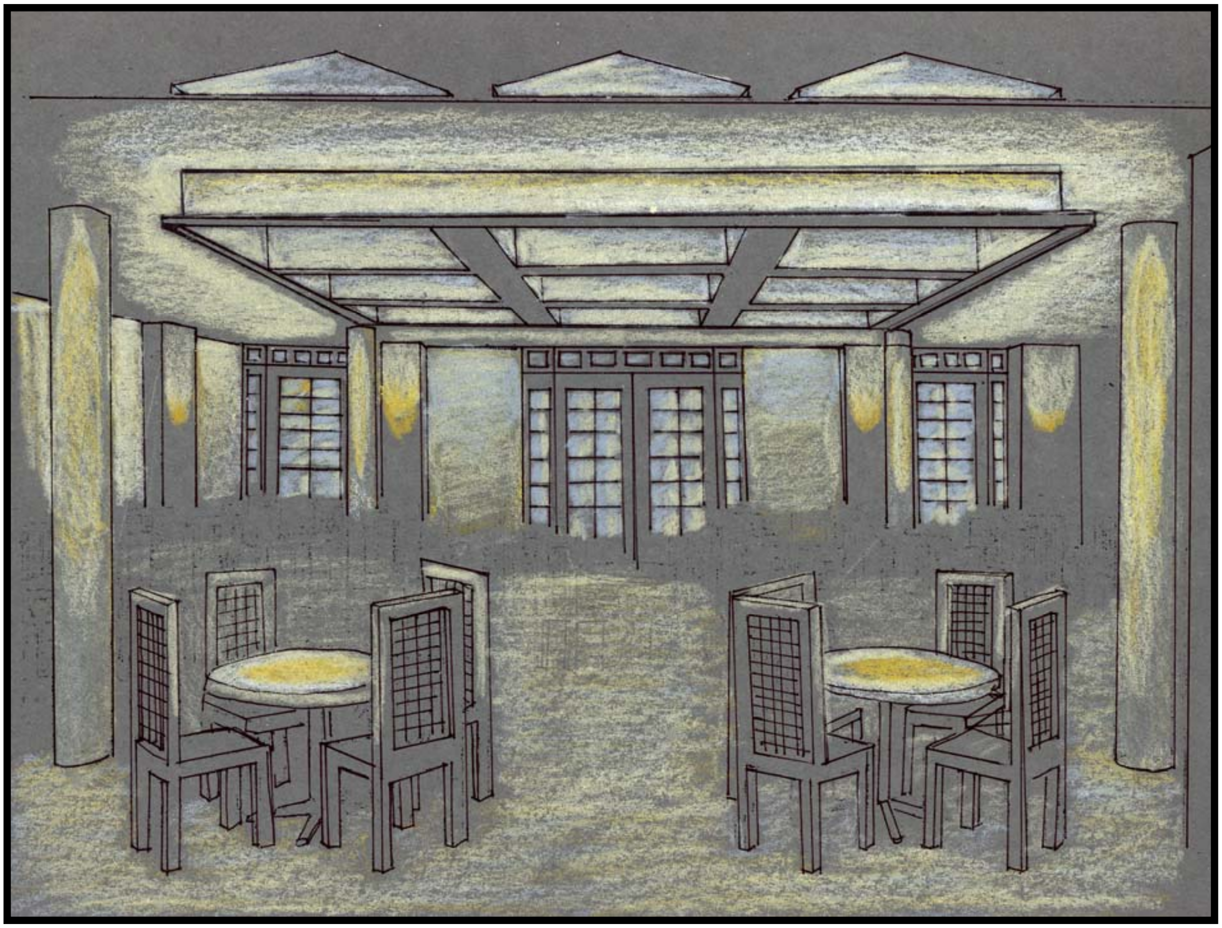
<u>Schematic Design of the Space</u>

The schematic design phase of the project resulted in a brainstorming session where I decided how I wanted the light to integrated into the space. My initial schematic design tried to implement a cove lighting system to balance the luminance ratios between the ceiling and the skylight wells. After getting into the design process and running the calculations, this was a very inefficient way to provide general electric lighting. Another thought that I had during the schematic design phase was to provide a 3 panels of glass that would be back lit by color changing LEDs. After being critiqued by several lighting designers during the Lutron Presentation in December of 2005, I opted against this design as well. But, I have included some of the sketches that I produced with original design concepts because I feel that it gives strength to the design development process that took place by showing that not everything you originally want to do or implement is a good idea or efficient enough for real world installation.





The previous sketches are to illustrate the glass panel design concept and how I was going to back light them. The issue with this idea is that the linear source that I show as providing general back light could have the potential to wash out the color changing LEDs. Without taking the time to mock up this installation, or the ability to accurately model it in AGI.32, I decided to remove this idea from the final design.



This is a sketch that I developed in the schematic design process. My intentions for the space were to illuminate the ceiling to balance the luminance ratios between the skylight wells and the ceiling. In addition, I wanted to wash the walls with light to again provide low contrast ratios but as well as to highlight any artwork that might be present. Downlights over the tables would provide the footcandle levels needed for the given space, while adding some sparkle to the tableware, and enhance facial modeling. If I were to use totally diffuse indirect sources, the space would be very bland and boring. By adding the downlight component, I increase the contrast ratios, but not so much so that there are visibility issues for the residents using the dining room space.

Now with an overall design idea in mind, I could begin to model the space in AGI.32. The AGI.32 model was useful in analyzing the daylight contribution that the skylights made to the space. There were 5 different scenarios that I needed to study to establish how I would control the daylight entering the spaces. These scenarios include:

- March 21 – clear sky condition
- June 21 – clear sky condition
- December 21 – clear sky condition
- Overcast sky – it did not matter what time of year I looked at this condition because an overcast sky is uniform at all times of the year
- Electric light only

The surface materials of the space include:

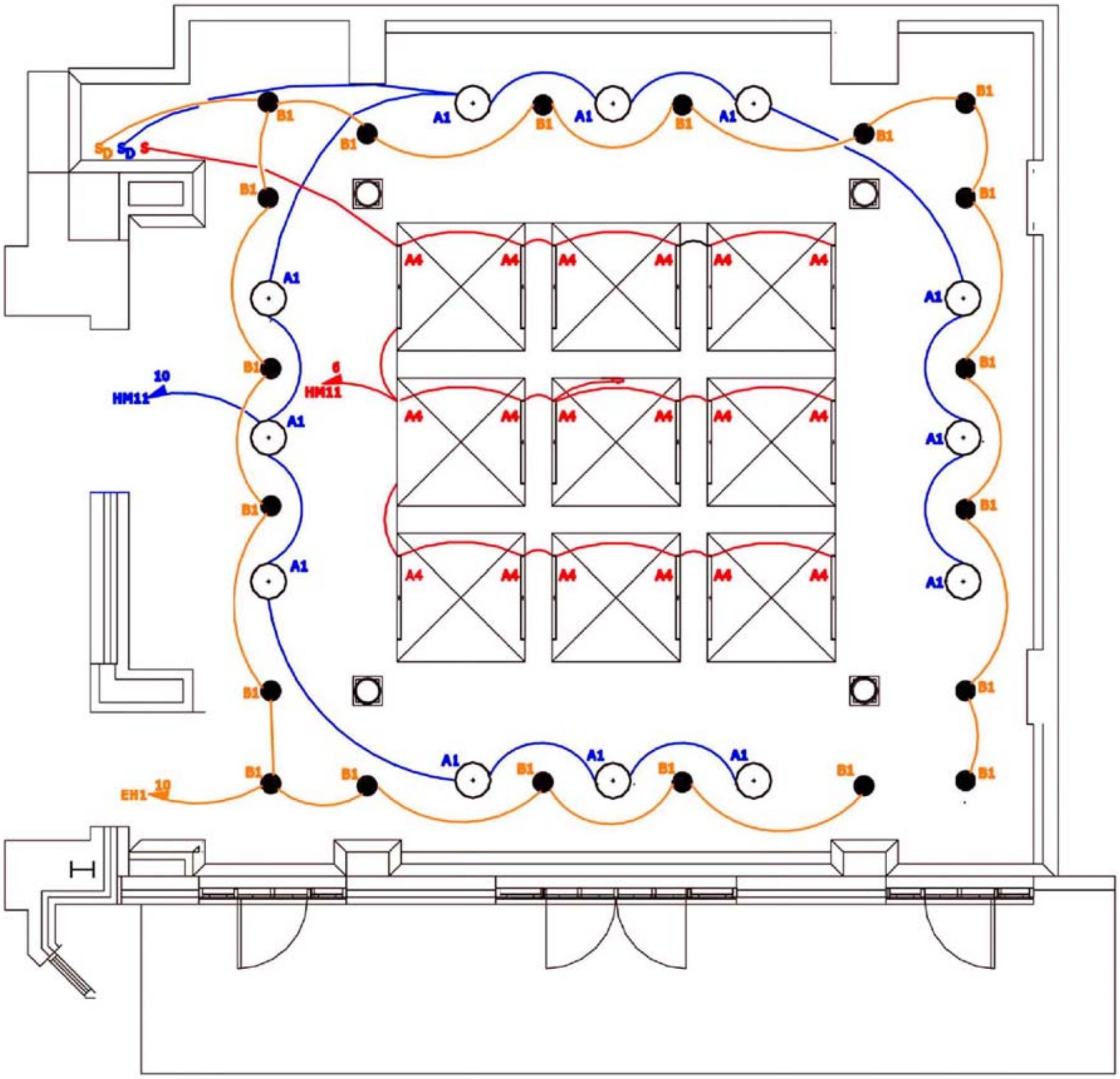
▪ vinyl wall covering	reflectance = 50%
▪ Painted Plaster Ceiling	reflectance = 80%
▪ Carpet flooring	reflectance = 20%
▪ doors-painted	reflectance = 80%
▪ windows	reflectance = 10%(night) transmittance = 55%

The furnishings of the space include:

▪ Wooden tables	reflectance = 10%, low specularity
▪ Wooden Chairs	reflectance = 10%

A calculation plane was added at 2.5 feet to see the various illumination values during different calculation scenarios. In the following section the electric lighting layout is presented. The different output for the various scenarios was used in determining the electric light control for the space during daylight hours.

Lighting Layout

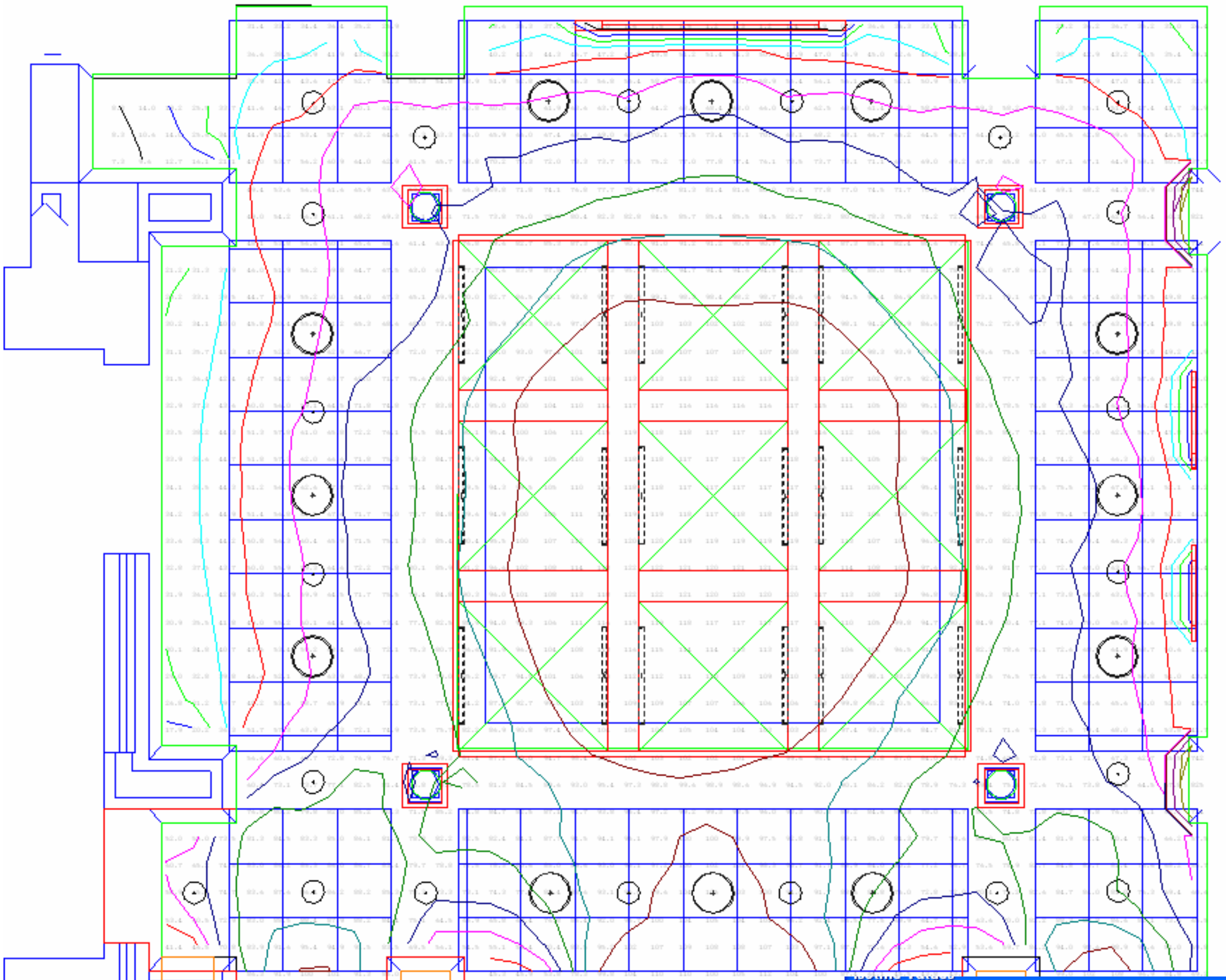


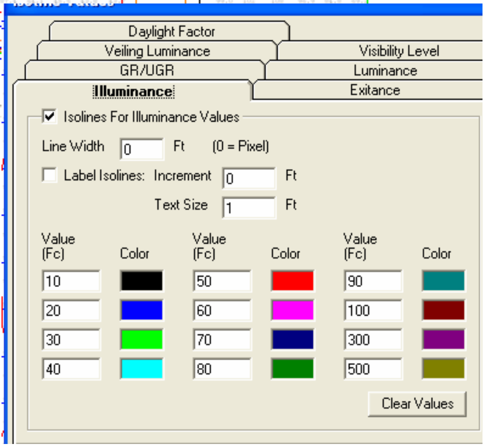
A1 – American Glass

A4 – ERCO

B1 – ERCO

ISO-LINES – Overcast Sky





☑ Isolines For Illuminance Values

Line Width 0 Ft (0 = Pixel)

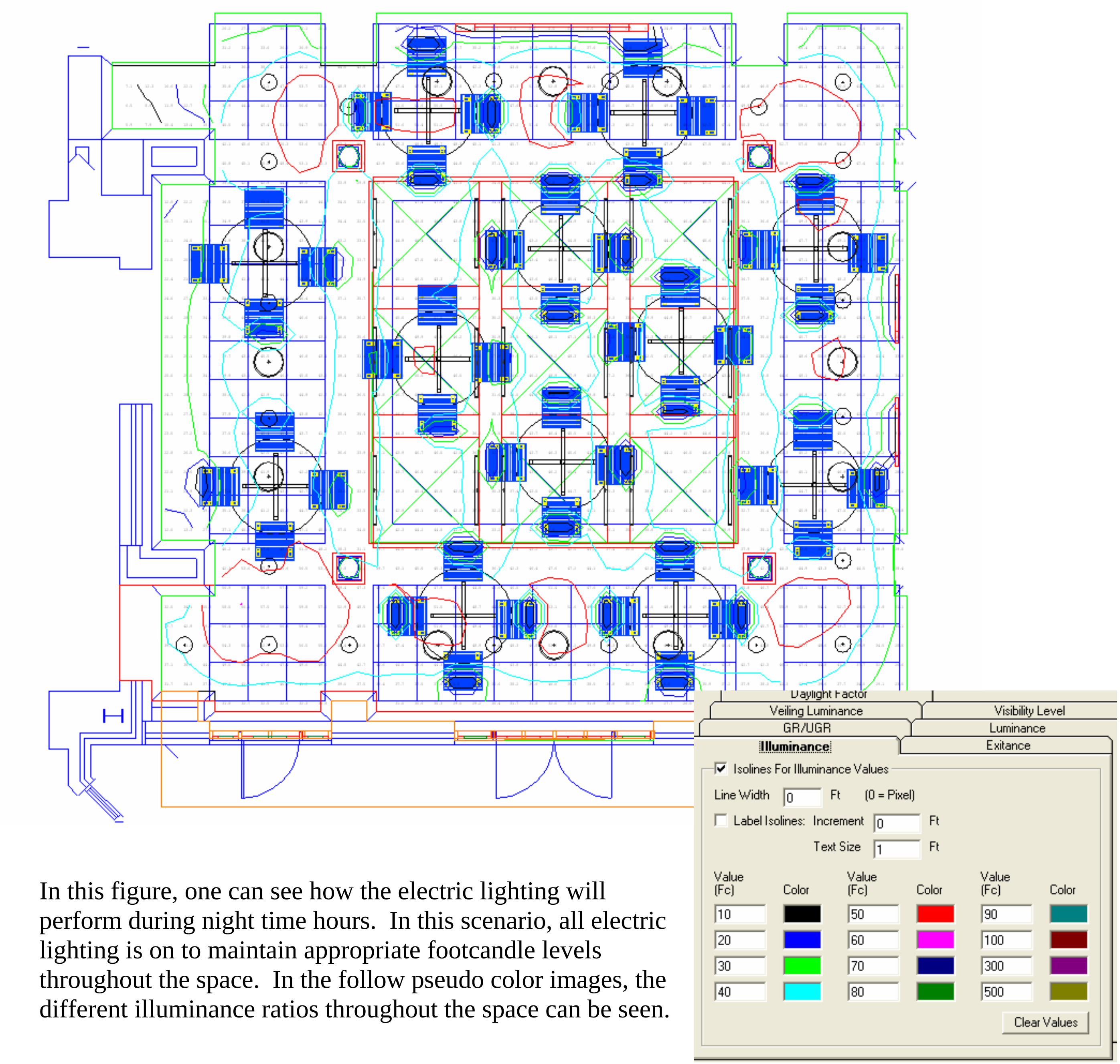
☐ Label Isolines: Increment 0 Ft

Text Size 1 Ft

Value (Fc)	Color	Value (Fc)	Color	Value (Fc)	Color
10	⬛	50	🟥	90	🟦
20	🟦	60	🟪	100	🟫
30	🟩	70	🟦	300	🟪
40	🟦	80	🟩	500	🟨

In this figure, one can see how the illuminance levels vary throughout the space when considering the electric lighting and the daylight that the skylights provide. This iso-line figure has all electric lighting on except those located in the skylight wells. In this condition, there is an **average illuminance of 80fc.**

ISO-LINES – Electric Lighting Only



☑ Isolines For Illuminance Values

Line Width 0 Ft (0 = Pixel)

☐ Label Isolines: Increment 0 Ft

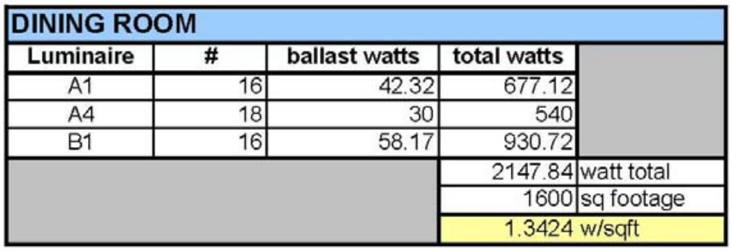
Text Size 1 Ft

Value (Fc)	Color	Value (Fc)	Color	Value (Fc)	Color
10	⬛	50	🟥	90	🟩
20	🟦	60	🟪	100	🟥
30	🟩	70	🟦	300	🟪
40	🟦	80	🟩	500	🟨

In this figure, one can see how the electric lighting will perform during night time hours. In this scenario, all electric lighting is on to maintain appropriate footcandle levels throughout the space. In the follow pseudo color images, the different illuminance ratios throughout the space can be seen.

PSEUDO COLOR

Power Density

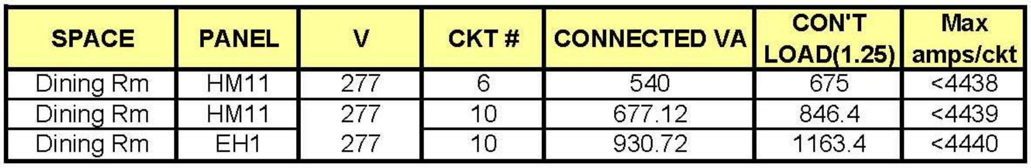


DINING ROOM				
Luminaire	#	ballast watts	total watts	
A1	16	42.32	677.12	
A4	18	30	540	
B1	16	58.17	930.72	
			2147.84	watt total
			1600	sq footage
			1.3424 w/sqft	

ASHRAE 90.1 – Using the space-by-space method

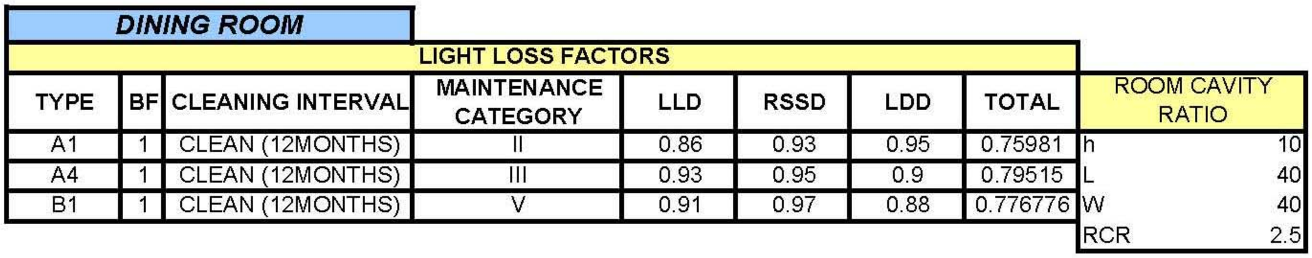
2.1 W/ft^2

Branch Circuit Connecting Load



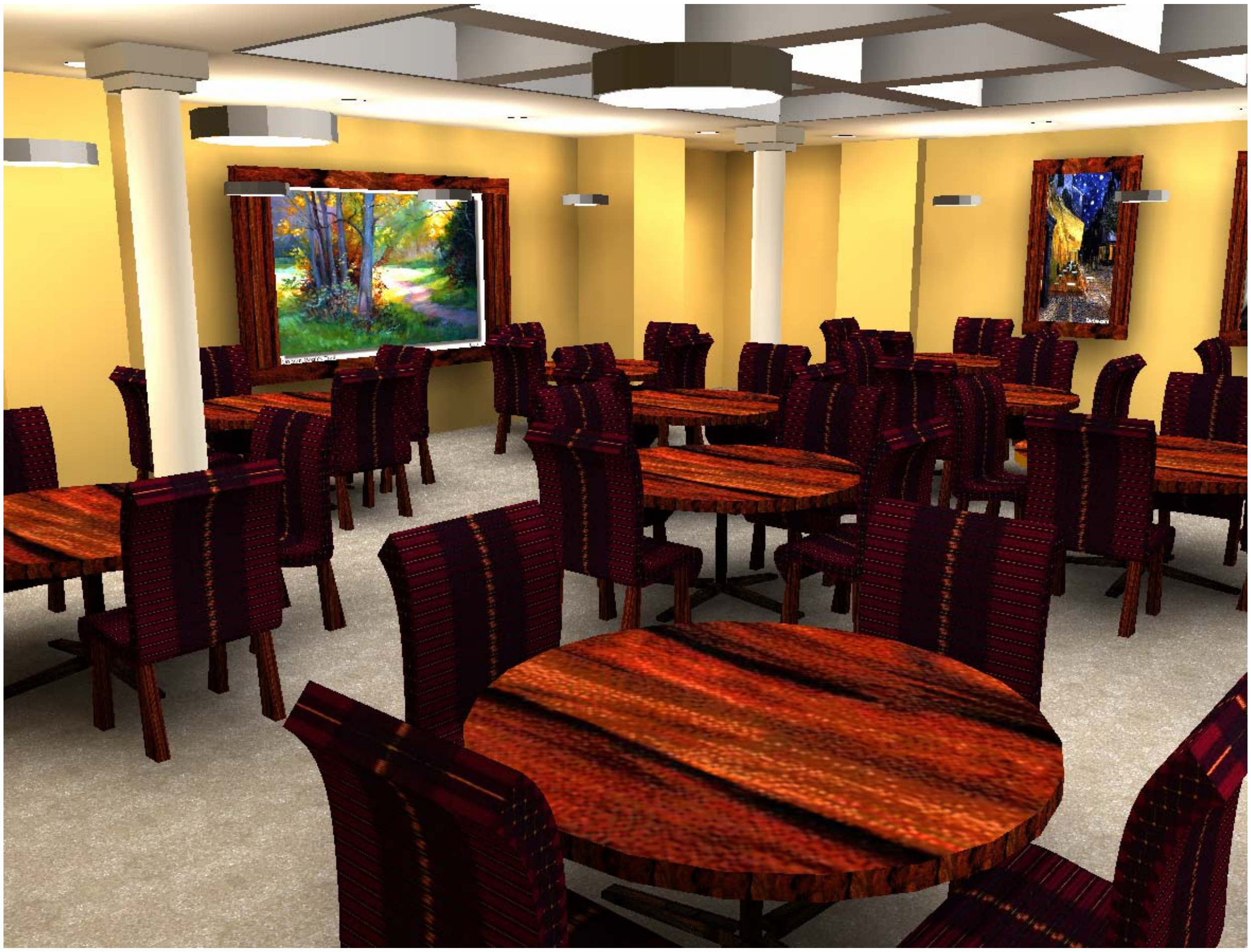
SPACE	PANEL	V	CKT #	CONNECTED VA	CON'T LOAD(1.25)	Max amps/ckt
Dining Rm	HM11	277	6	540	675	<4438
Dining Rm	HM11	277	10	677.12	846.4	<4439
Dining Rm	EH1	277	10	930.72	1163.4	<4440

Light Loss Factors



DINING ROOM									
LIGHT LOSS FACTORS									
TYPE	BF	CLEANING INTERVAL	MAINTENANCE CATEGORY	LLD	RSSD	LDD	TOTAL	ROOM CAVITY RATIO	
A1	1	CLEAN (12MONTHS)	II	0.86	0.93	0.95	0.75981	h	10
A4	1	CLEAN (12MONTHS)	III	0.93	0.95	0.9	0.79515	L	40
B1	1	CLEAN (12MONTHS)	V	0.91	0.97	0.88	0.776776	W	40
								RCR	2.5

RENDERINGS



This rendering gives some idea of what the space may look like given the electric lighting layout. The skylight wells are illuminated with surface mounted wallwashers, which are mounted at a height of 12 feet and fit nicely in the skylight wells. There were several things that I could have done when approaching the skylight wells during night time conditions. There was an idea to not provide any source of electric lighting in this area, but, during the night time hours, the other luminaires did not provide adequate illuminance levels. I also thought about uplighting these wells, but then there would be an issue with the darksky compliance. The skylight wells are a structural member in and of themselves, so there was not a way to recess a luminaire in the well to make a more integrated solution. The surface mounted wallwasher from ERCO were my best solution to this area. The slim profile and white finish make it less noticeable. I do not believe there will be issues with glare given that fixture is mounted in the well itself and at most visual

angles, the luminaire will not be visible. The tables around the perimeter of the space are illuminated by indirect pendants that have (1)42W-triple tube compact fluorescent lamp, and recessed downlights that have (2) 26W compact fluorescent lamps. The mixture of indirect and direct lighting helps to soften the contrast ratios and provide nice levels of illumination on the table surface. The indirect pendants are also helpful during the day to balance the luminance ratios between the ceiling and the skylight wells.

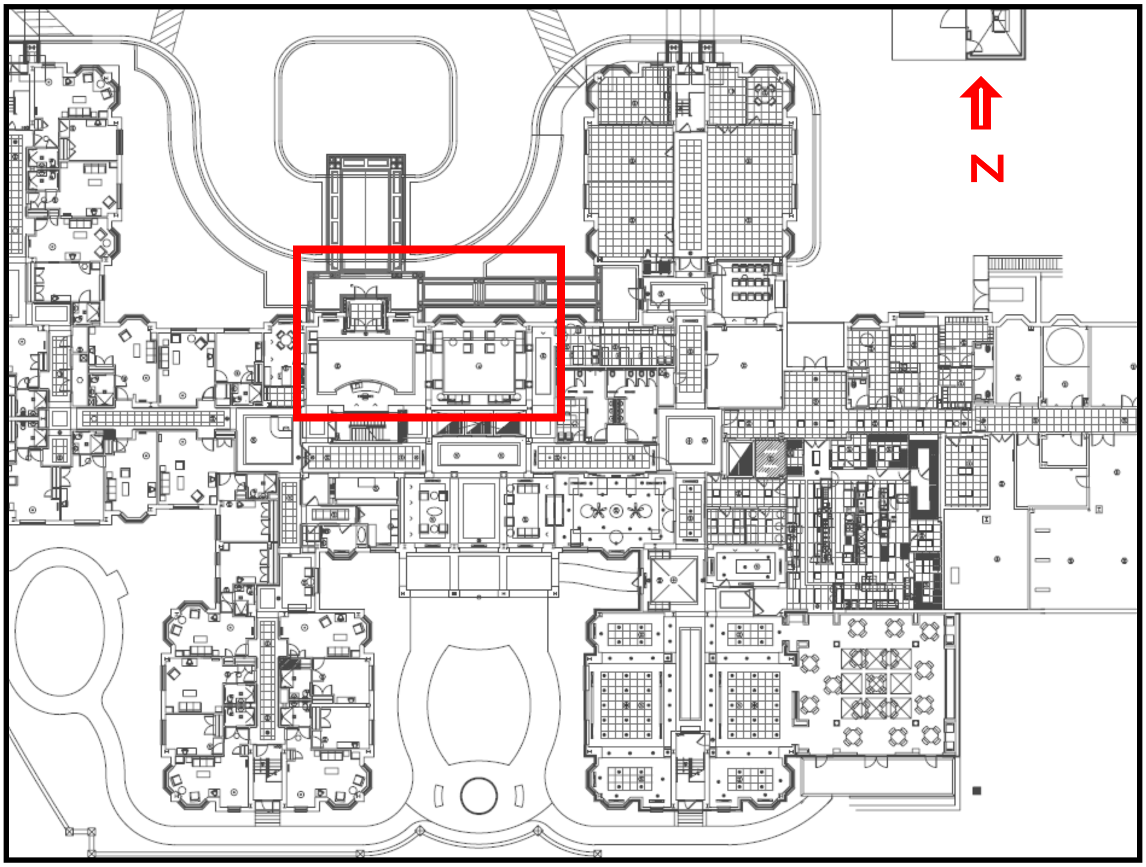
CONCLUSION

After running various calculations for the space, I found that I met the desired design criteria of a horizontal illuminance level of 50 fc with the electric lighting. During the day, these illuminance levels will be much higher due to the skylights in the space. The skylights are great for an Assisted Living Facility setting. Given the changes that can occur in the circadian system as one ages, sleeping disorders can develop, of which can affect mood and health. By providing an area that is brightly illuminated during the daylight hours, residents have the opportunity to correct their internal body clock and hopefully avoid some of the associated health problems associated with sleeping disorders. There is also a reduction in the electric lighting used in the space during daylight hours. The surface mounted wallwashers are connected to photo sensor that is mounted on a skylight well wall. When that sensor sees and illuminance level of 100 fc or more, it turns the associated electric lighting off, thereby saving energy. As it was mentioned earlier, all electric light installations have lamp temperatures of 3500K with the exception to those luminaires mounted in the skylight wells, which have lamp temperatures of 4100K to maintain a cooler daylight appearance when they are in operation. Dimming of either the pendants or downlights can be done at the wall switches. The space falls within ASHRAE 90.1 power density requirements of having less that 2.1W/ft^2

All luminaire cutsheets are provided in Appendix A and referenced by their letter/number designation. Refer to the Lighting Fixture schedule to find lamp specifications and ballast specifications. All lamps will be provided by Sylvania while ballasts are provided by Lutron and Advance Transformer. The lamp and ballast information can be found on the CD provided, of which will include the complete Sylvania lamp catalog for any reference to a specific lamp that may be desired.

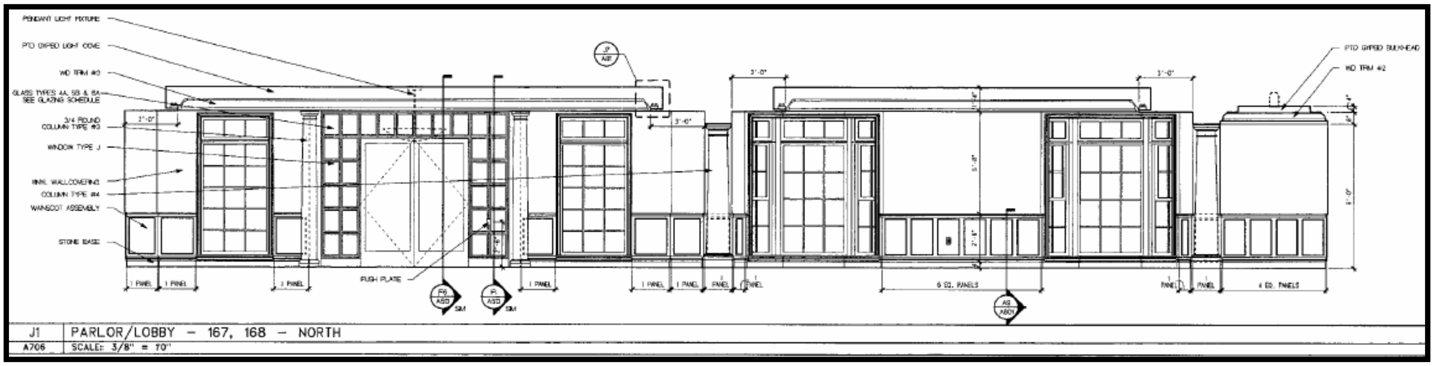
…The next space to be considered will be the **Lobby**.

Space Details



The lobby serves as the main entrance point into the facility for residents and visitors alike. The northeastern windows are shielded by the roof that covers the walkway. Given the northern orientation and covered walkways, there should not be any issue with direct daylight. This space is somewhat challenging given the fact that it is a transition point from indoors to outdoors. As we age, our pupils become smaller and have a decreased ability to change when confronted with the drastic illuminance changes encountered when moving from indoors to outdoors, and vica versa. Therefore, when developing the design criteria and eventually the light design for the space, special consideration was taken for this space.

This figure shows northern elevations of the lobby space. Please disregard any luminaires that are shown in these figures as these are of the previous lighting design and not of my own. In this figure one can see the large expanse of glass along the northern wall. This will aid in bringing daylight into the space, and because it is north facing, it will be relatively consistent throughout the day, with few if any problems of direct sunlight penetration.



Space Specific Design Criteria

Target Illuminance Levels

Horizontal : 100 fc – interior entry (day)
10 fc – interior entry (night)
30 fc – visitor waiting-parlor (day)
10 fc – visitor waiting-parlor (night)
Vertical : 10 fc – interior entry/visitor waiting (day)
3 fc – interior entry/visitor waiting (night)

Appearance of Space and Luminaires

This is the first space that is encountered when entering the space, so the décor and feel of the space should set a standard by which the rest of the facility upholds. The assisted living facility is for long-term residents, and the warmth and comforts of home should be felt within the space. The appearance should be formal and inviting. The luminaries should be integrated into the architecture of the space, and those visible should be tasteful and elegant.

Color Appearance (and color contrast)

The lobby itself is dressed in European inspired seating, carpeting and furniture. The rich and vibrant colors need to be accentuated and brought to life with the use of correct lighting sources. Lamps with high CRI values will be used and architectural highlighting will be done wherever possible.

Daylight Integration and Control

The windows and doors of the lobby face the northern direction. Direct sunlight that could cause unwanted glare and high luminance ratios should not be a problem. In addition to facing north, the windows on the northeastern side are shielding by the roof that covers the walkway. Daylight will be studied and integrated into the space. The possible use of photo sensors and daylight dimming controls will be investigated. The integration of daylight will also help balance the transition from inside to outside light levels, so that adaptation time will be shorter.

Direct/Reflected Glare

Direct glare from daylight should not be an issue. Other potential glare sources are the luminaries themselves. Luminaires with smaller apertures will be used, as well as baffled lenses if it seems necessary. Ceiling luminance ratio will be balanced so that the luminaries and the ceiling beside the luminaires do not exceed a ration of 100:1. The receptionist sits in the lobby area and veiling reflections as well as reflected glare will need to be avoided due to the use of a computer.

Power Allowance

ASHRAE/IESNA 90.1 -	1.3 watts/ft^2
Based on space by space method	1.0 watts/ft^2 – for decorative chandelier-type luminaries or sconces or for highlighting art or exhibits

With the listed design criteria, I could begin to develop a schematic design that would eventually be modeled in AGI.32 from which I could calculate the necessary illuminance values.

Schematic Design of the Space

In the schematic design process, I tried to develop a lighting program that would be implemented in a final design. My initial thoughts were to utilize a cove that would be used to provide indirect general illumination throughout the space. Then, with the use of downlights, I would further increase the illuminance levels to the desired values. The following schematic shows my initial design concept.

In this sketch, I am showing the ceiling illuminated with the use of a cove lighting system. The windows and entry way doors give an opportunity for diffuse daylight to make its way into the space. The walls are washed with light to make the space feel more open. The receptionist area is highlighted to provide a visual cue to where one could find assistance. After developing the design concept, I could see how my idea would perform in AGI.32 and if this would be a realistic design solution for the space. The reflectance of the ceiling, walls, floor, and the like are provided below. These values went into the 3-dimensional model that was used to produce the desired lighting calculations.

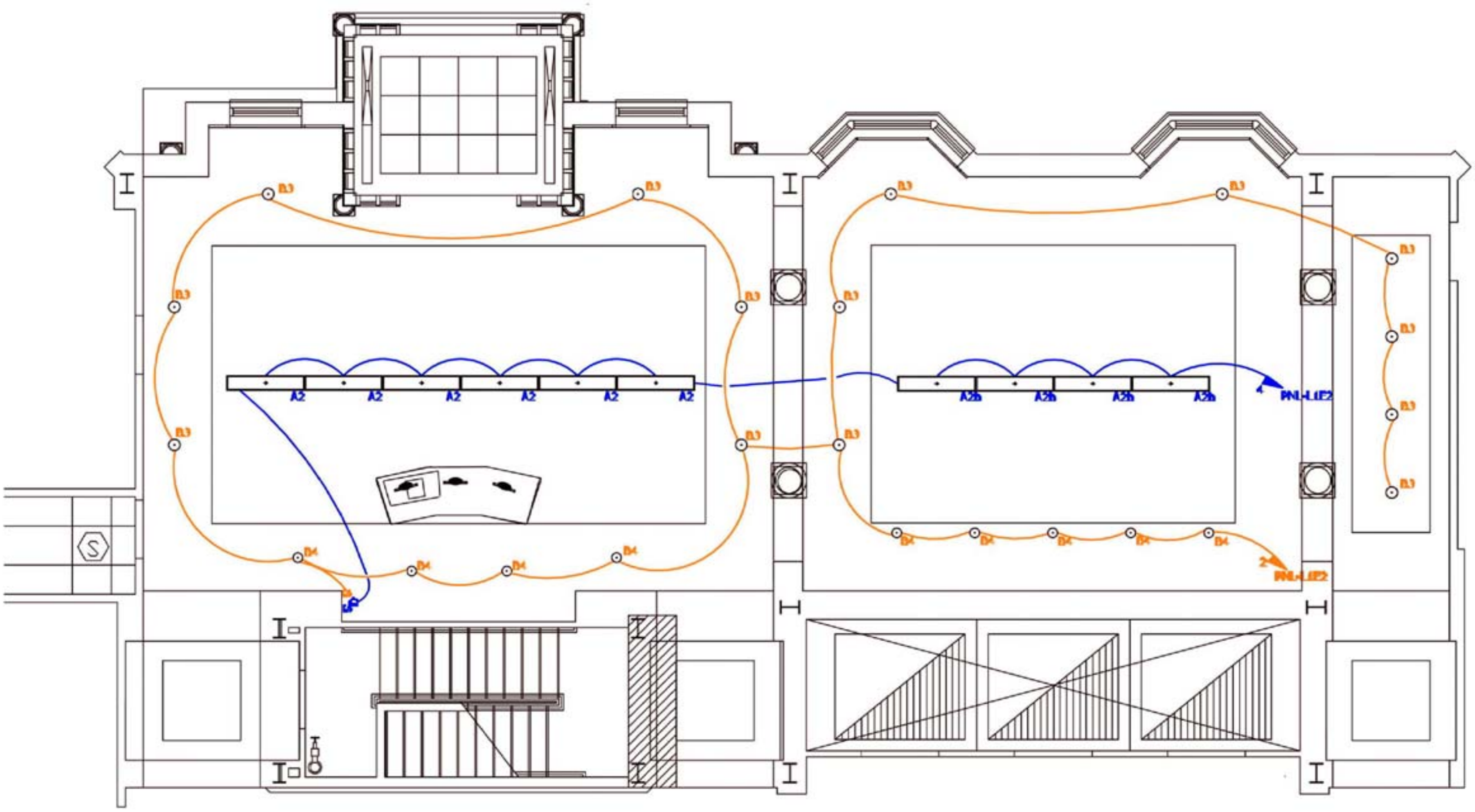
The surfaces of the space include:

▪ vinyl wall covering	reflectance = 50%
▪ ceiling – painted gyp board	reflectance = 70%
▪ marble tile and carpet flooring	reflectance = 20%
▪ wainscot – wood stain	reflectance = 30%
▪ doors – painted	reflectance = 60%
▪ windows	reflectance = 10% (night) transmittance = 60%

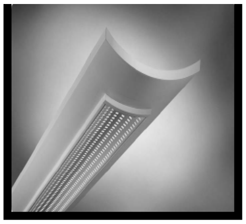
The furnishings of the space include:

▪ European inspired chairs and benches	reflectance = 20%
▪ Reception desk – wood	reflectance = 30%
▪ Wooden tables	reflectance = 20%

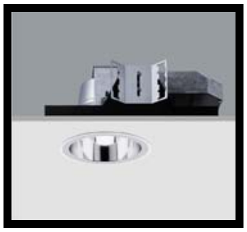
Lighting Layout



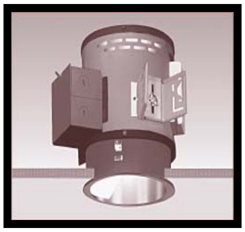
A2 & A2b – Focal Point

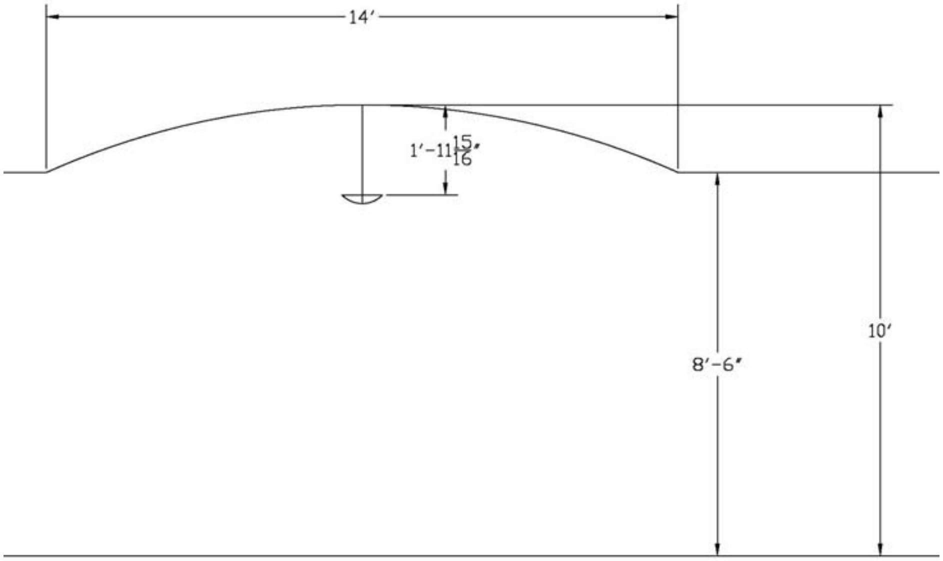


B3 – ERCO

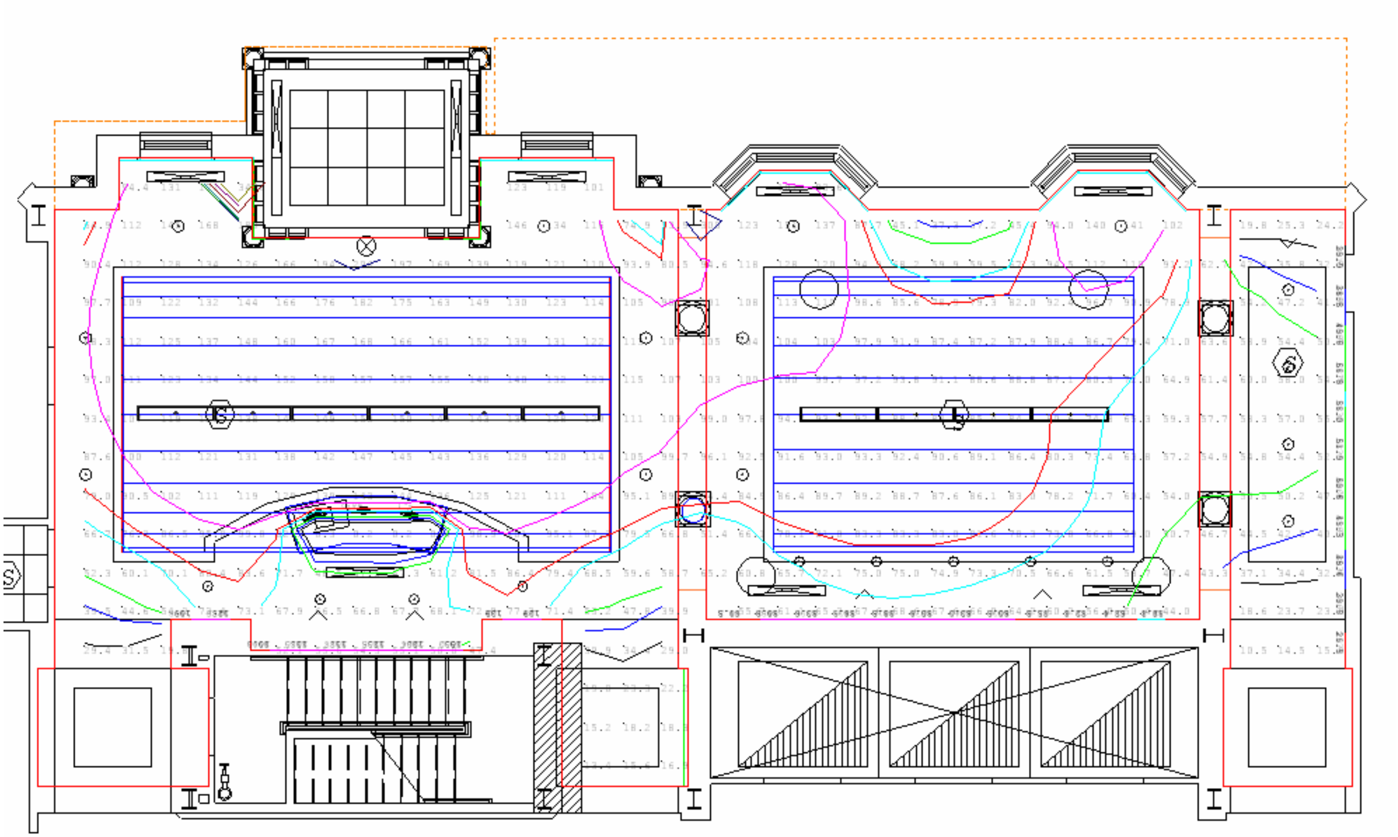


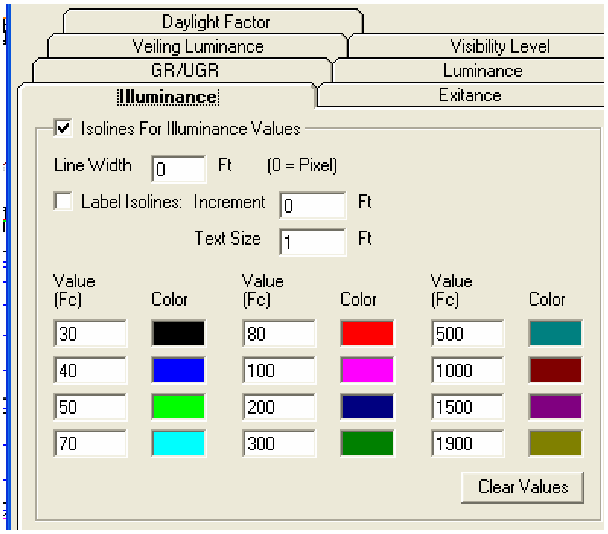
B4 – Focal Point





Barrel Vault Detail





Daylight Factor | Veiling Luminance | Visibility Level | GR/UGR | Luminance | **Illuminance** | Exitance

☑ Isolines For Illuminance Values

Line Width 0 Ft (0 = Pixel)

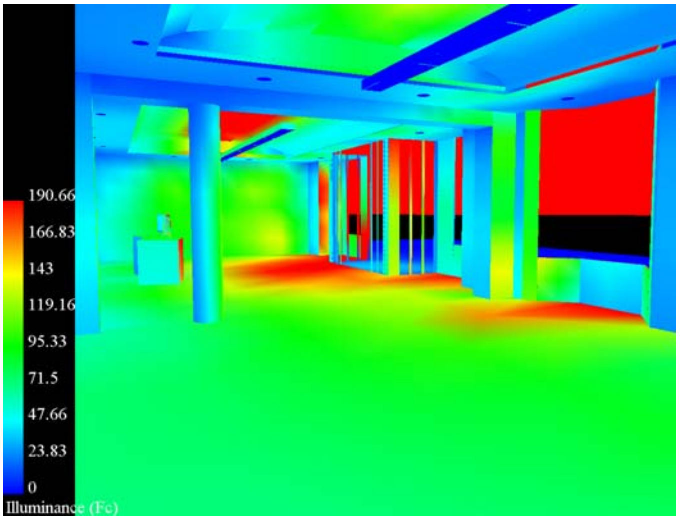
☐ Label Isolines: Increment 0 Ft

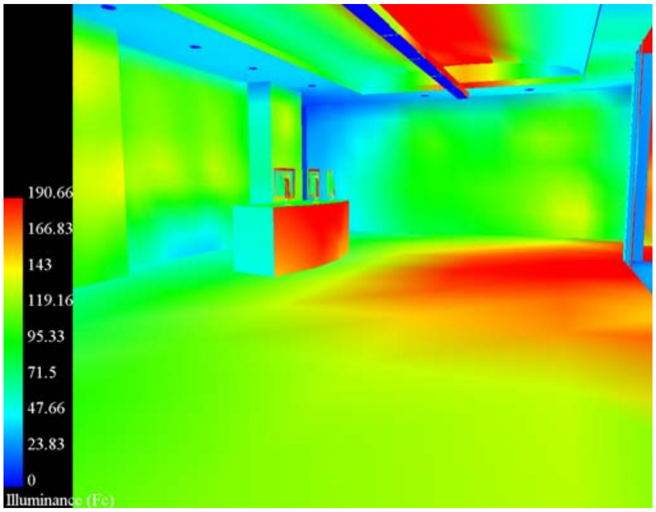
Text Size 1 Ft

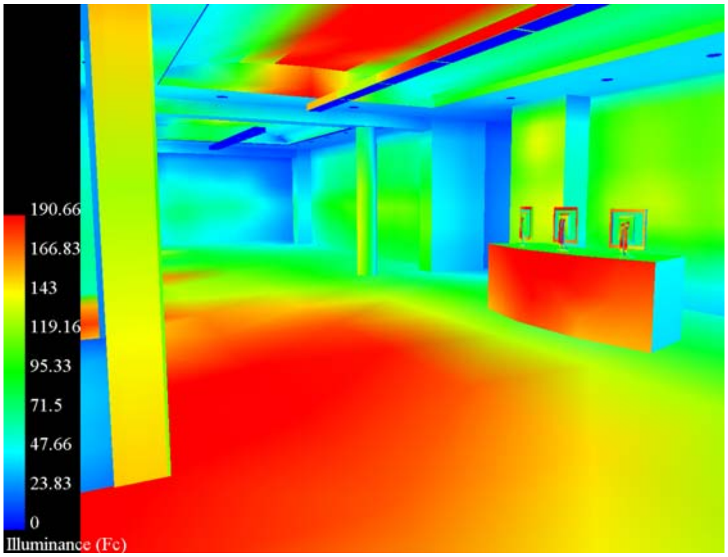
Value (Fc)	Color	Value (Fc)	Color	Value (Fc)	Color
30	■	80	■	500	■
40	■	100	■	1000	■
50	■	200	■	1500	■
70	■	300	■	1900	■

Clear Values

The ISO-LINE diagrams give a nice way of representing where the light is falling within a given area of the space. This ISO-LINE diagram, as well as pseudo color and renderings to follow, consider the electric lighting and daylight. The daylight condition is a clear day on June 21 at 12 noon. I used this day as being the worst case scenario for the lobby acting as a transition space from indoor to outdoor illuminance levels. This time of year is when the sun would be at it highest level, and a time when there would be the greatest illuminance different between indoors and outdoors. By checking the illuminance ratios that the electric light can provide in response to the daylight, I could judge how well I felt the design I suggest implementing performs.

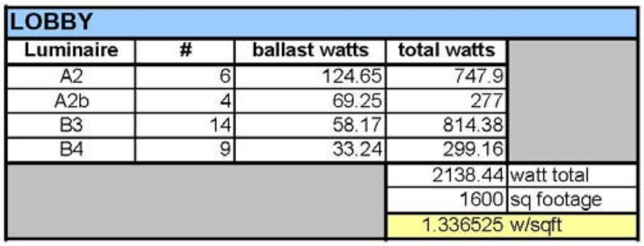






The Pseudo Color Images show illuminance differences that occur throughout the space. I wanted to maintain an illuminance ratio that did not exceed 10:1 between any one of the surfaces. I feel that if the electric light could balance the daylight with that ratio, there would not be a significant issue with contrast sensitivity. As you can see from the linear scale, the illuminance levels are at the upper bound of the design criteria suggested target illuminance level of 100fc. I feel that the design that I suggest provides one of the best solutions in that it is able to achieve the desired illuminance levels during the day that make the transition from indoors to outdoors, and visa versa, more comfortable and safe for the older residents in the facility.

Power Density

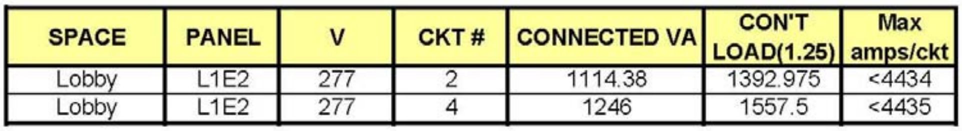


LOBBY				
Luminaire	#	ballast watts	total watts	
A2	6	124.65	747.9	
A2b	4	69.25	277	
B3	14	58.17	814.38	
B4	9	33.24	299.16	
			2138.44	watt total
			1600	sq footage
			1.336525 w/sqft	

ASHRAE 90.1 – Using the space-by-space method.

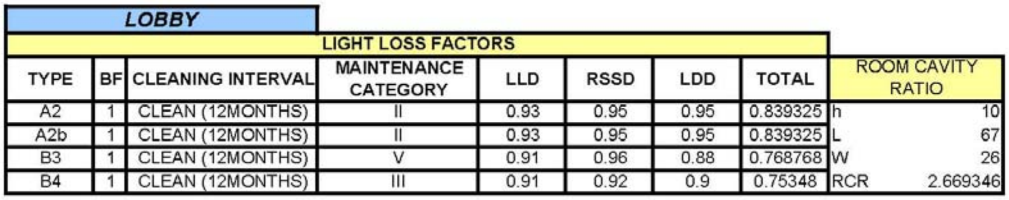
1.3 W/ft^2
1.0 $W/^{ft2}$ decorative lighting

Branch Circuit Connected Load



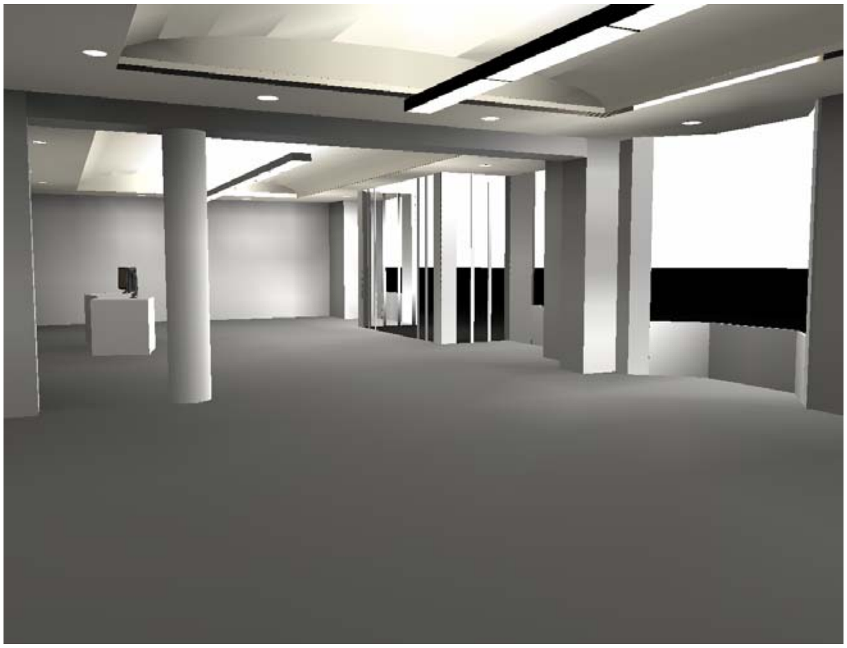
SPACE	PANEL	V	CKT #	CONNECTED VA	CON'T LOAD(1.25)	Max amps/ckt
Lobby	L1E2	277	2	1114.38	1392.975	<4434
Lobby	L1E2	277	4	1246	1557.5	<4435

Light Loss Factors



LOBBY									
LIGHT LOSS FACTORS									
TYPE	BF	CLEANING INTERVAL	MAINTENANCE CATEGORY	LLD	RSSD	LDD	TOTAL	ROOM CAVITY RATIO	
A2	1	CLEAN (12MONTHS)	II	0.93	0.95	0.95	0.839325	h	10
A2b	1	CLEAN (12MONTHS)	II	0.93	0.95	0.95	0.839325	L	67
B3	1	CLEAN (12MONTHS)	V	0.91	0.96	0.88	0.768768	W	26
B4	1	CLEAN (12MONTHS)	III	0.91	0.92	0.9	0.75348	RCR	2.669346

RENDERINGS



The higher illuminance levels needed for better adaptation from indoor to outdoor light conditions during the day were achieved with direct/indirect linear pendants that utilize 54T5HO lamps. These luminaires have an efficiency of 95%. As you can see from the renderings, I choose to incorporate a barrel vaulted ceiling which helps to redirect the reflected light down to the floor. It could be thought of as working along the same lines as a parabolic reflector. I understand that there will be a lambertian distribution of reflected light from the ceiling, but by using the barrel vault, I do not loose light in the corners, as I would if I went with a square cove approach. The cove lighting was completely disregarded in this area. It was not nearly efficient enough; there was no way to provide the necessary illuminance levels without going over power density allowances. The linear pendants in the lobby area, which has the receptionist's desk and the entry to the building, have (2)54T5HO, while the parlor area makes use of only (1)54T5HO. The walls are washed with light and this affect is achieved by recessed-round washlights that use (1)26W-CF lamp. They help to balance the luminance ratio throughout the space and create a more open environment. Other perimeter lighting is achieved with recessed downlights that use (2)26W-CF lamps. The color temperatures of all lamps are 4100K, with CRI

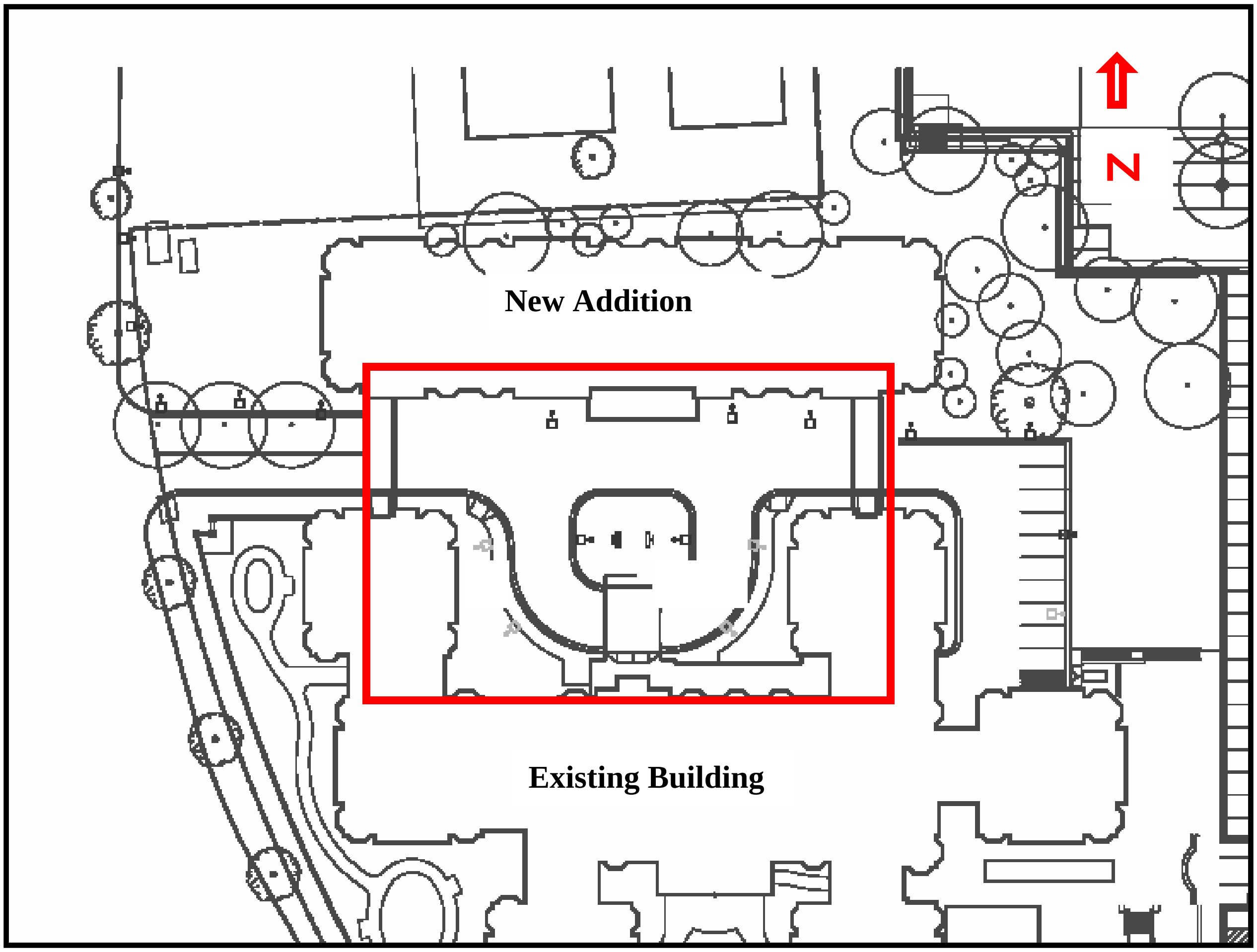
values of 80 or higher. I choose a higher lamp temperature for this area given the transition from daylight to indoor electric lighting. The high lamp temperature will complement the cooler color appearance of the daylight environment.

CONCLUSION

As I have already explained, the nature of this lobby space is such that the transition from outdoors to indoors need to be addressed by provided higher illuminance levels during the day and lower illuminace level during the night time hours. For daylight conditions, all electric light will be on, while at night time hours, the only luminaires that will be on are the linear pendants. They will be outfitted with dimming ballast so that the light levels can be brought down to the desired levels. The receptionist will be in control of this environment and will decide by how much the lights are dimmed during night time operation. It will also be suggest that she/he turn off perimeter lighting during the night to save energy, the linear pendants will be able to provide the desired illuminance levels by themselves. Overall, I am confident with the lighting design that I suggest. It meets the design criteria by reaching proper illuminance levels during daytime operation, and it does this while staying within the power density requirements of ASHRAE 90.1

All luminaire cutsheets are provided in Appendix A and referenced by there letter/number designation. Refer to the Lighting Fixture schedule to find lamp specifications and ballast specifications. All lamps will be provided by Sylvania while ballasts are provided by Lutron and Advance Transformer. The lamp and ballast information can be found on the CD provided, of which will include the complete Sylvania lamp catalog for any reference to a specific lamp that may desired.

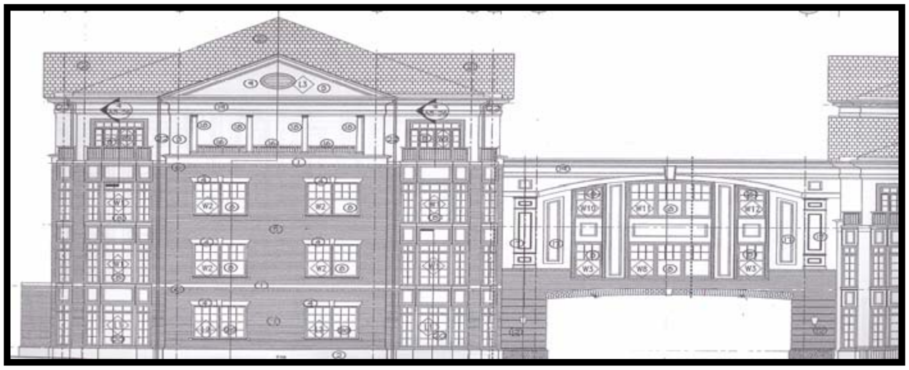
…The next and final space to consider will be the **Outdoor area and Building Entrance**



The main building entry will be considered as well as the walkways. The function of the electric lighting that is provided for this space is to address the needs of outdoor illumination during the night time hours. Given the fact that this is an Assisted Living Facility, there will be no exterior building illumination designed. The reason for this, which is apparent, is that fact that the light could shine in to the resident's rooms and be bothersome during night time hours when they are trying to sleep. As it was discussed earlier, older individuals often have sleeping disorders, so it would not be appropriate to provide a lighting design that could further affect them. In the next section, you will see pictures of the existing building. The new addition will be under construction in the summer of 2006, so no pictures are yet available of that structure. I have included the Architectural Elevation of that addition so that you can get acquainted with the space.

Pictures

These pictures show the existing building entrance, as well as the brick paved walkways, and the covered walkway that is along the northern façade of the lobby space.



This is an Architectural Elevation of the new addition. Bridged walkways will connect at the northwestern and northeastern pods at the second floor levels. This new addition provides additional tenant rooms as well as a parking

garage on the first floor level. The addition is where the remainder of this thesis project focuses and can be found in the different sections following the light depth report.

Space Specific Design Criteria

Task

The main task the exterior lighting has to serve is somewhat two fold. The pole mounted lights need to provide general illumination on the roadway and walkway so that pedestrians can move about safely and have enough light to see. Given the older population of people residing in this building, the overall illumination must be higher. As it is stated in the *General Design Criteria*, higher illuminance levels are needed to distinguish contrast, depth perception, and adaptation time. With that said, the overall lighting levels need to be high as well as the entry to the building.

Illuminance Values

Horizontal :	5 fc – suggested for walkways
	10 fc – exterior entrance
Vertical :	1 fc – facial recognition

Appearance of space of Luminaires

The pole lights should remain elegant and prominent as they lay against the building background. The look of the luminaire should compliment the architecture and not look industrial. The entrance to the building should be inviting, and the luminaries should be integrated within the architecture.

Color Appearance (and Color Contrast)

Lamp color temperature should be warm, somewhere around 3000K to look similar to other lighting throughout the building. When vegetation is illuminated, lamp choice will be critical so that the colors are accentuated and well represented. Contrast is important so that residents can differentiate differences in elevation.

Direct Glare and Reflected Glare

Residents' rooms will be in view of the outdoor lighting, as a result, the pole-mounted luminaries should have sharp cut off so that direct light does not spill into their rooms. The orientation and location of these luminaries will be addressed. Reflected glare should not be an issue given the low reflectance of the building materials.

Power Allowance

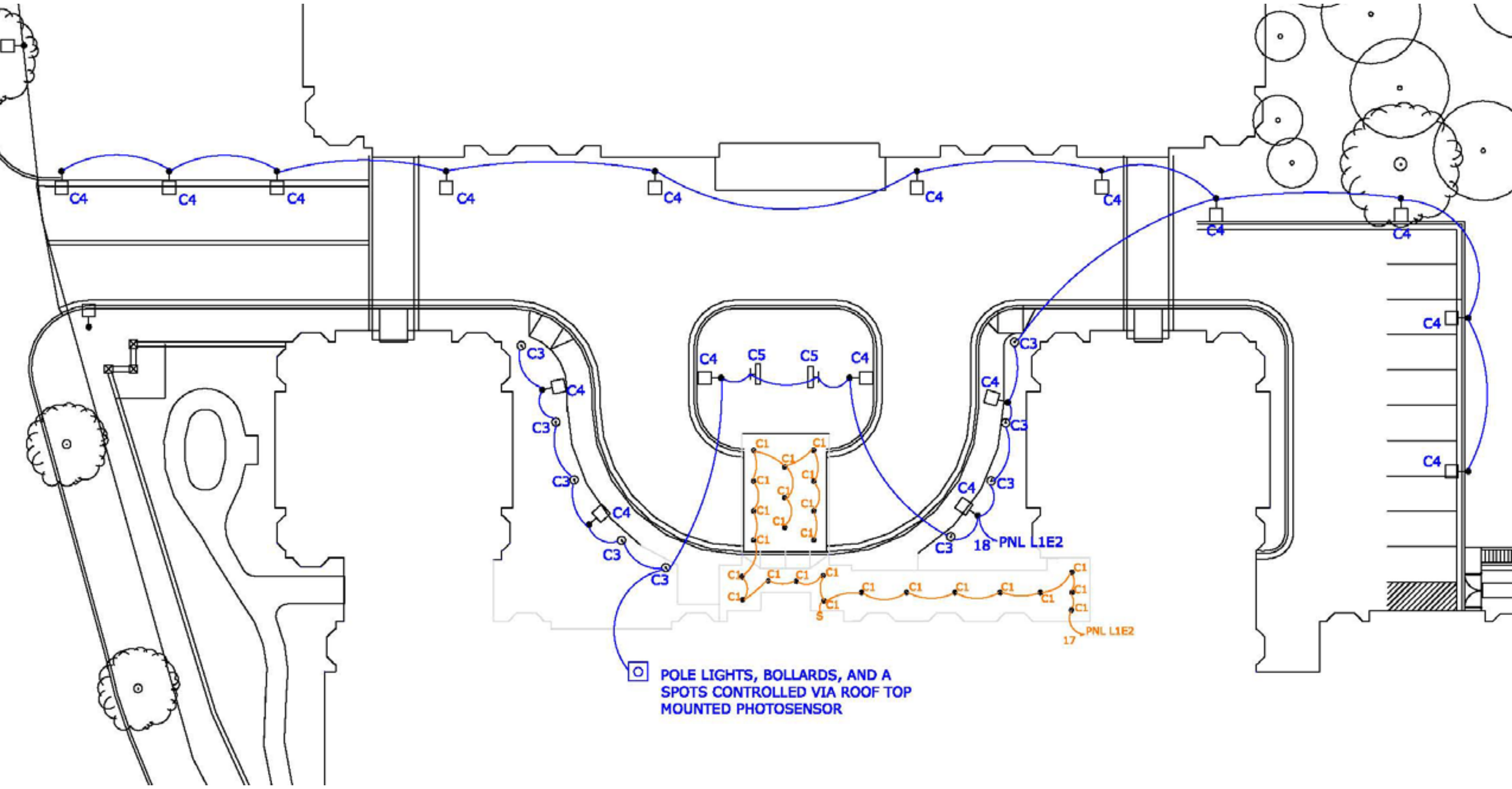
ASRAE 90.1 – 9.4.5 **Exterior Building Lighting Power.** The total exterior lighting power allowance for all exterior building applications is the sum of the individual lighting power densities permitted in Table 9.4.5 for these applications plus additional unrestricted allowance of 5% of that sum. Trade-offs are allowed only among exterior lighting applications listed in the Table 9.4.5 "Tradable Surfaces" section.

Schematic Design of the Space

The lighting design of this space is more for function than for aesthetics. As the design criteria mentions, the luminaire choices will be such that they compliment the architecture, but the over all design theme will be one of function in that it will provide the required illuminance levels. With that said, I used AGI.32 to perform calculations of the different design scenarios. 3-dimensional building models were used to see how the luminaires behaved with the surrounding building structure. The reflectance values shown below were applied when developing the calculations.

The surface materials of the space include:

▪ red brick	reflectance = 20%
▪ white wood trim	reflectance = 40%
▪ painted stucco	reflectance = 30%
▪ asphalt	reflectance = 15%
▪ red brick pavers	reflectance = 20%



POLE LIGHTS, BOLLARDS, AND A SPOTS CONTROLLED VIA ROOF TOP MOUNTED PHOTOSENSOR

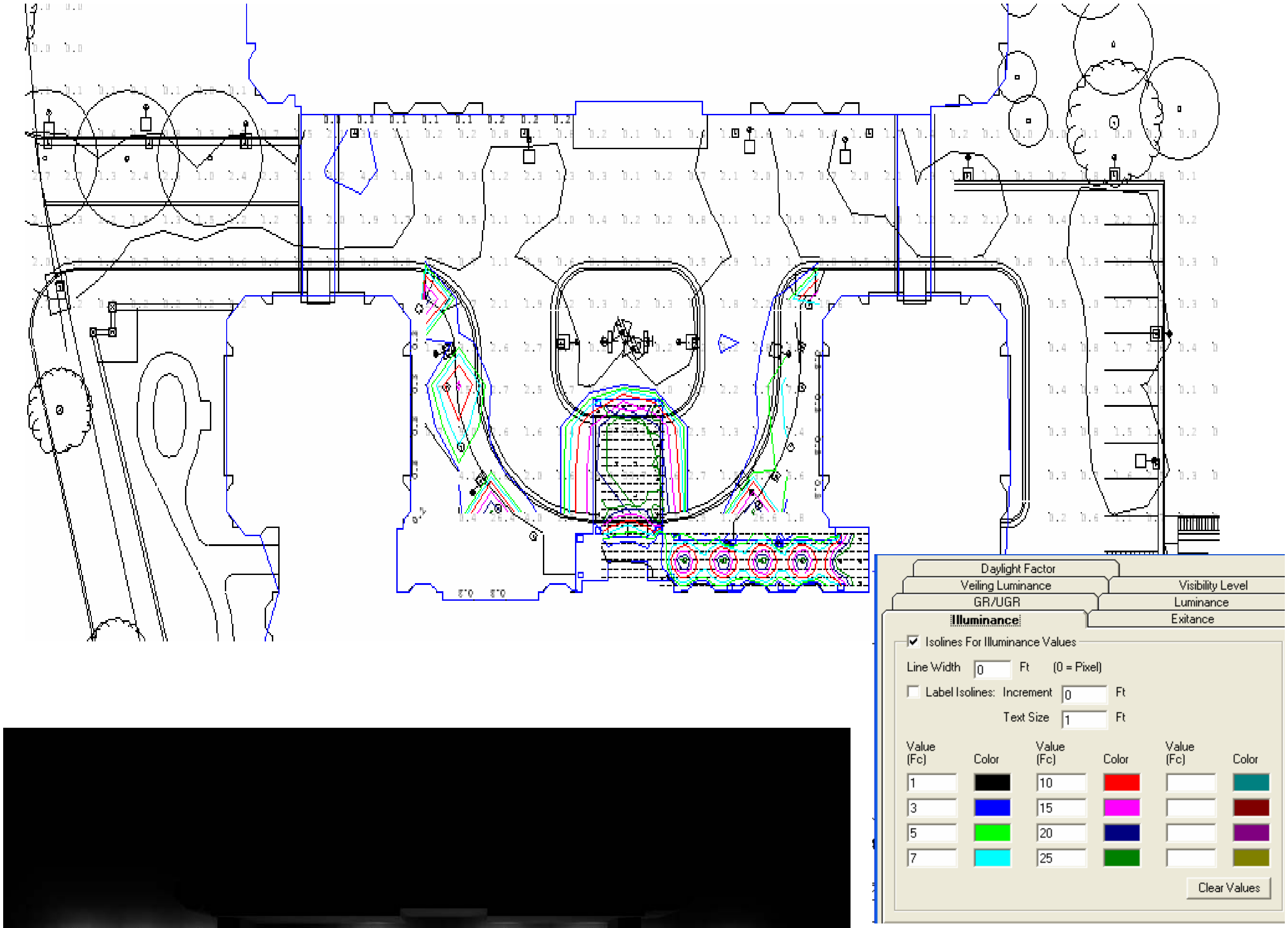
C1 - ERCO

C3 - Bysted

C5 - ERCO

C4 - Providence

Cut-off Sheild



Daylight Factor | Veiling Luminance | Visibility Level | GR/UGR | Luminance | **Illuminance** | Exitance

☑ Isolines For Illuminance Values

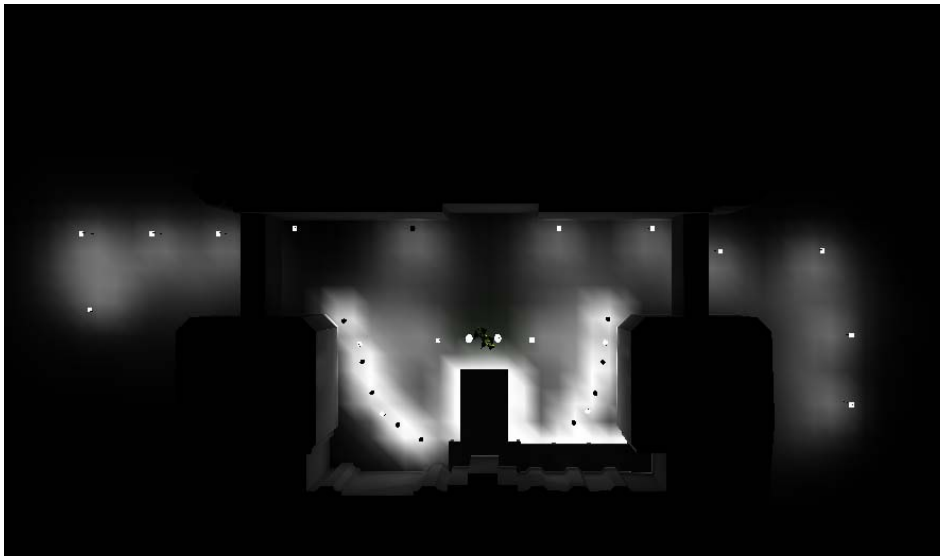
Line Width 0 Ft (0 = Pixel)

☐ Label Isolines: Increment 0 Ft

Text Size 1 Ft

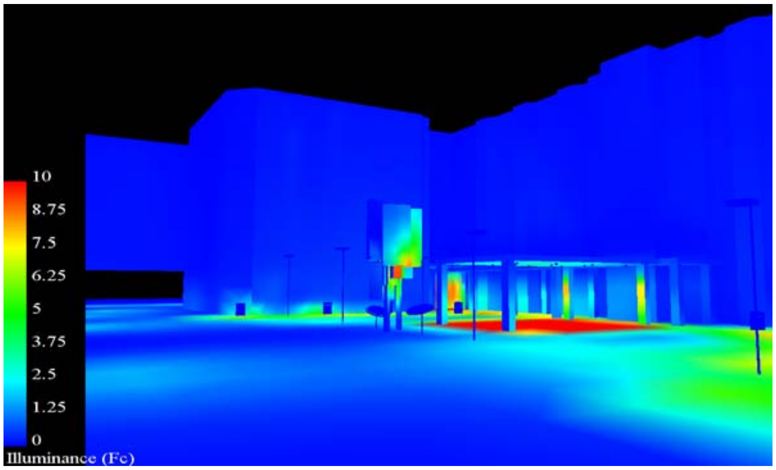
Value (Fc)	Color	Value (Fc)	Color	Value (Fc)	Color
1	⬛	10	🟥		🟦
3	🟦	15	🟪		🟥
5	🟩	20	🟦		🟪
7	🟦	25	🟩		🟨

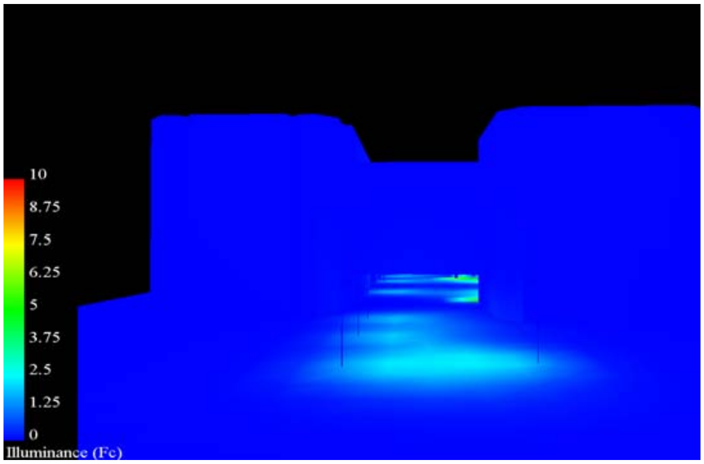
Clear Values

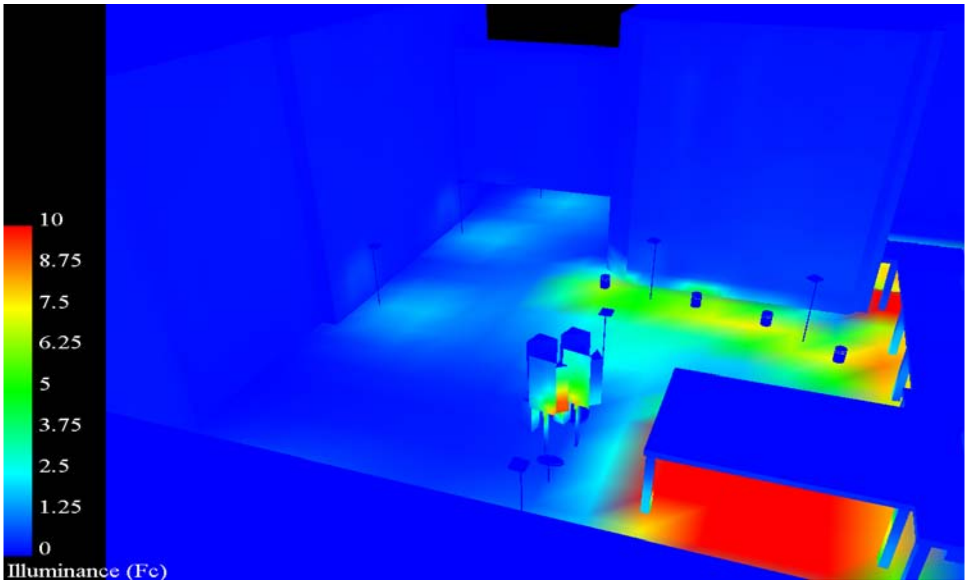


The Isolines and renderings show different illuminance levels that are achieved with the various luminaire selections. Higher illuminance levels are achieved with bollards for the brick walkways.

PSEUDO COLOR

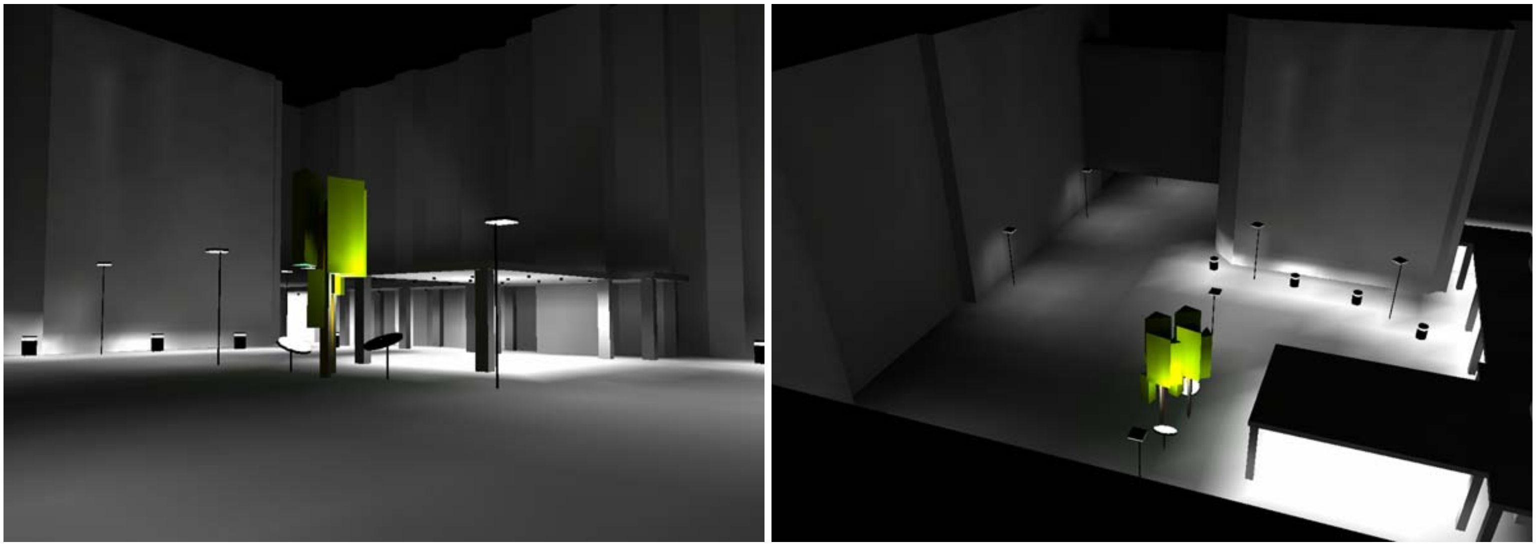






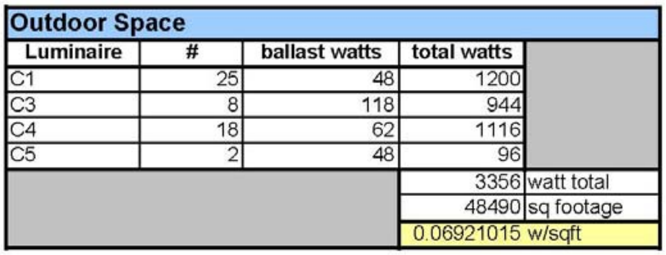
These Pseudo Color images show the various illuminance levels that are achieve with the electric lighting. It was important to have higher illuminance levels on the walkway and at the entry to the building. The Porte Cochere acts as another buffer zone of light to help with adaptation from outdoor illuminance levels to indoor levels. Refer to the Iso-line diagram for approximate foot candle levels in any specific area. The scale was set so that all of the electric lighting would be shown in the pseudo color image. The red area in the birds eye view is has an illuminance level around 20-30 fc, the brick covered walkways have approximately 5-10, and the general roadway has an average of 1-2 fc.

RENDERINGS



The renderings, although very basic in nature, further illustrate how the selected luminaires perform, and what, if any, light falls on the buildings. As you can see from the renderings, spill light is minimal, and with the pole light fixture that I have specified, there should be no issues with light entering the resident rooms.

Power Density



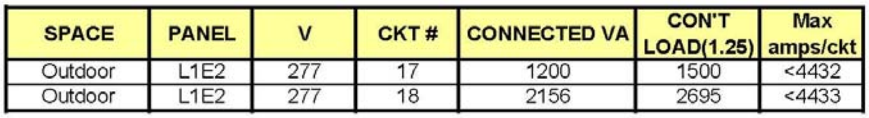
Outdoor Space

Luminaire	#	ballast watts	total watts	
C1	25	48	1200	
C3	8	118	944	
C4	18	62	1116	
C5	2	48	96	
			3356	watt total
			48490	sq footage
			0.06921015	w/sqft

ASHRAE 90.1 – Using the space-by-space method.

ASRAE 90.1 – 9.4.5 **Exterior Building Lighting Power.** The total exterior lighting power allowance for all exterior building applications is the sum of the individual lighting power densities permitted in Table 9.4.5 for these applications plus additional unrestricted allowance of 5% of that sum. Trade-offs are allowed only among exterior lighting applications listed in the Table 9.4.5 “Tradable Surfaces” section.

Branch Circuit Connected Load



SPACE	PANEL	V	CKT #	CONNECTED VA	CON'T LOAD(1.25)	Max amps/ckt
Outdoor	L1E2	277	17	1200	1500	<4432
Outdoor	L1E2	277	18	2156	2695	<4433

Light Loss Factors

BUILDING EXTERIOR

			LIGHT LOSS FACTORS				
TYPE	BF	CLEANING INTERVAL	MAINTENANCE CATEGORY	LLD	RSSD	LDD	TOTAL
C1	1	CLEAN (12MONTHS)	V	0.8		0.9	0.72
C3	1	CLEAN (12MONTHS)	V	0.85		0.9	0.765
C4	1	CLEAN (12MONTHS)	III	0.55		0.9	0.495
C5	1	CLEAN (12MONTHS)	V	0.8		0.9	0.72

IESNA:22-25
LDD exposure

IESNA 22-25: Luminaire Surface Depreciation: Experience is the best predictor; no factors are available at present

- therefore, I am going to omit this factor
- reason being: the associated surface dirt would be encountered under the assumed reflectance for the various surfaces...therefore, it's already accounted for

CONCLUSION

After running the various calculations for this area, I found that I met the desired criteria on a numerical basis of providing appropriate illuminance levels and staying within the allotted power density specified by ASHRAE 90.1. As you can see from the images contained with the Outdoor Section of the report, there are different illuminance levels for different areas of the building exterior. You can think of it as three layers of light. The first general layer is provided by the pole mounted fixtures that use (1)50W-MH lamp. This fixture provides the necessary roadway illumination for vehicular movement and walking to and from buildings. The next layer of light is provided by the bollards that are used to illuminate the brick walkways. This fixture use (1) 100W-MH lamp to provide higher illuminance levels on the walkways. There were two reasons for choosing this higher wattage lamp for the bollards. One, I really wanted to increase the light levels on the walkways to accentuate the brick pavers and the neighboring vegetation. The fact that the light source for the bollard is 4’ off the ground provides good amounts of spill light to the neighboring vegetation and walkway, but without being a source by which light could infiltrate the residents’ rooms. The second reason is given the light loss factors associated with metal halide sources; I wanted to make sure I was maintaining increased illuminance levels after the associated lumen losses went into effect. The next layer of light is provided by the recessed downlights that are in the Porte Cochere and Covered Walkway. These fixtures are outfitted with (1) 39W Metal Halide Lamp that has better efficacy and lamp life than a comparable compact fluorescent source. With this design, I want the outdoor lighting to be on for all hours of the night. A roof-top photo sensor mounted on a 3 foot pole (to keep in view in case of snow fall or debris), will turn the pole mounted fixture and bollards on as night falls. The downlights in the Porte Cochere are controlled by a wall switch, and as I said, I want those fixtures to be on for all hours of the night, so there should not be issue with re-strike time due to switching.

All luminaire cutsheets are provided in Appendix A and referenced by there letter/number designation. Refer to the Lighting Fixture schedule to find lamp specifications and ballast specifications. All lamps will be provided by Sylvania while ballasts are provided by Lutronand Advance Transformer. The lamp and ballast information can be found on the CD provided, of which will include the complete Sylvania lamp catalog for any reference to a specific lamp that may be desired.

This concludes the Lighting Depth Report. The remainder of the report focuses solely on the new addition, of which you can find designs and feasibility studies for the mechanical and electrical equipment. Enjoy!

Mechanical Feasibility Study

PENNSTATE

1855

Spring 2006

INTRODUCTION

This Mechanical Feasibility Study will address the current mechanical system and try and suggest an alternative approach for a mechanical system design. The Grand Oaks assisted living facility, although different in aesthetics and overall purpose of care; is associated with and owned by, Sibley Memorial Hospital. In the year 2000, the existing building finished construction and began operation. Sibley Memorial Hospital has a central plant facility that serves the Hospital, Skilled Nursing Facility, and Existing Assisted Living Facility. The existing facility receives cold water for cooling, as well as medium pressure steam for heating hot water, and domestic hot water, via underground extension lines from the central plant. Essentially, the existing facility is not paying to produce cold water for cooling or hot water, for heating hot water and domestic hot water. They are charged a marginal fee for the energy they consume, but the building does not have onsite capabilities to produce cold or hot water for cooling and heating. With that said, it is no wonder they have relatively low electric bills. So, when trying to compare the needs and consumption of the existing facility and extrapolate a reasonable value for the energy needs of the new addition, there are some large assumptions that need to be made. Specifically, when trying to determine a demand charge associated with a building that is not currently built, (i.e., the new addition from which my Mechanical Feasibility Study addresses). This will be addressed in more detail later in this report.

EXISTING SYSTEM

The main air distribution of the Grand Oaks addition is achieved via four pipe fan coil units. All units have forward-curved 3-speed centrifugal fans sized at medium speed to minimize fan noise within the space. The FCU in living areas are exposed floor-mounted types with stack-style vertical cabinets. Air is 100% re-circulated. FCU are of the two-coil, four pipe style, suitable for chilled water and heating hot water service, with chilled water supply and return piping, and hot water supply and return piping. The ventilation requirement is provided by either wall or ceiling mounted supply air registers connected to a ducted 100% outside air ventilation distribution system. Exhausted air is removed through ceiling mounted registers located in toilet rooms. A centralized energy recovery air-handling unit serves both the supply and return air to increase the efficiency of the system. Chilled water is provided via an air-cooled roof-mounted chiller. The chiller is a hermetic helical rotary machine, featuring multiple air-cooled condenser fans, modulating compressor unloading, and independent refrigerant circuits. Hot watered is supplied via two instantaneous steam-fired domestic hot water heaters that receive medium pressure steam from Sibley's Boiler Plant.

ISSUES WITH CURRENT SYSTEM

The main concern with this system is the roof mounted air-to-water chiller that has a nominal cooling capacity of 140 tons and a maximum input power of 182 kw. Given that the chiller has multi-stages of air cooled condensing fans, and independent refrigerant circuits, certainly helps with the system efficiency. But it is still a unit that has the potential to consume large amounts of electricity and add to the life-cycle operating cost of the building. Electricity is becoming more of a volatile commodity of which, the Baltimore/Washington area will realize in the not to distant future.

ELECTRICITY RATES

In an article found in the Washington Post(referenced in Appendix B): “Customers in the Baltimore/Washington area receiving utility service from either Potomac Electric Power Company(Pepco) or Baltimore Gas and Electric (BGE), are expected to see large increases in utility rates effective the summer of 2006. In an article from the Washington times, the Maryland Public Service Commission was quoted at saying customers could expect rate increases in the range of 37-72% increases over current utility rates. The reason for this large rate increase is by in large to a two part problem. In 1999, Maryland deregulated its electric utilities requiring them to segregate their supply and distribution services. In 1993, law makers put a cap on utility rates and set them 6.5% below the current 1993 utility rates. Since then utility company rates have continued to rise due to inflation and the stresses placed on generation plants to meet demands. The overall volatility of the price of energy is further escalated due to the “War Against Terror” and struggles with Western Oil production, and the horrific Hurricanes that swept through the Southern United States in the Summer of 2005. The hurricanes severely damaged the Gulf Coast infrastructure, of which about 1/3 of the nations energy runs through. When taking into consideration energy on a global and national level, as well was at the local sector, electricity rates could not help but be affected.”

POSSIBLE SOLUTION

With all that said, I looked to a Mechanical System that could be implemented that would eliminate the chiller unit, while still operating along the same lines as the current fan-coil units. After talking with some individuals in the industry, I decided to explore the possibility of water-to-air heat pumps with a ground couple closed-loop. In this application, I will have a closed horizontal loop throughout the building that will have a variable rate pump and a 3-way diverting valve. If this horizontal loop falls outside the set point range of 40-70 degree F, the diverting valve opens, allowing a side stream straight pump to send the water/antifreeze solution down into the ground to recondition the loop. This ground loop will consist of a series “wells” made up of vertical bore holes filled with U-bed pipes. Well depth can range from 100-250 feet, I will

suggest using well depth of 160 feet. Long hair-pin shaped loops with U-bend pipes are put into the wells, then plugged or grouted, and connected to headers in a trench leading back to the building. It is my suggestion to place the series of vertical loops under the building foundation. All the drilling and pipe runs can be done prior to building construction, and by utilizing the space under the building, I am not affecting the ground area outside the building.

ADVANTAGES OF GEOTHERMAL SYSTEM

The main advantage of this system is the energy savings that it can provide when compared to the current mechanical system. As long as the horizontal loop is within its set point range, the side stream pump is not running, thereby saving energy. Given the nature of this building, assisted living; with residents having individual heat pumps in their bedrooms and living areas, this particular heat pump configuration is ideal. The heat pumps are completely independent of one another; one could be in cooling mode while the other is heating mode. So, the only electricity that is used while the horizontal loop is within its set range is to move BTUs throughout the building. Individual heat pumps are either taking BTUs out of the loop or putting BTUs into the loop. Another advantage of this system is that all the equipment is inside the building, unexposed to outside whether conditions. This closed loop system also uses limited amounts of water compared to an open loop system, which needs a large supply of clean, fresh water.

EQUIPMENT ELIMINATION

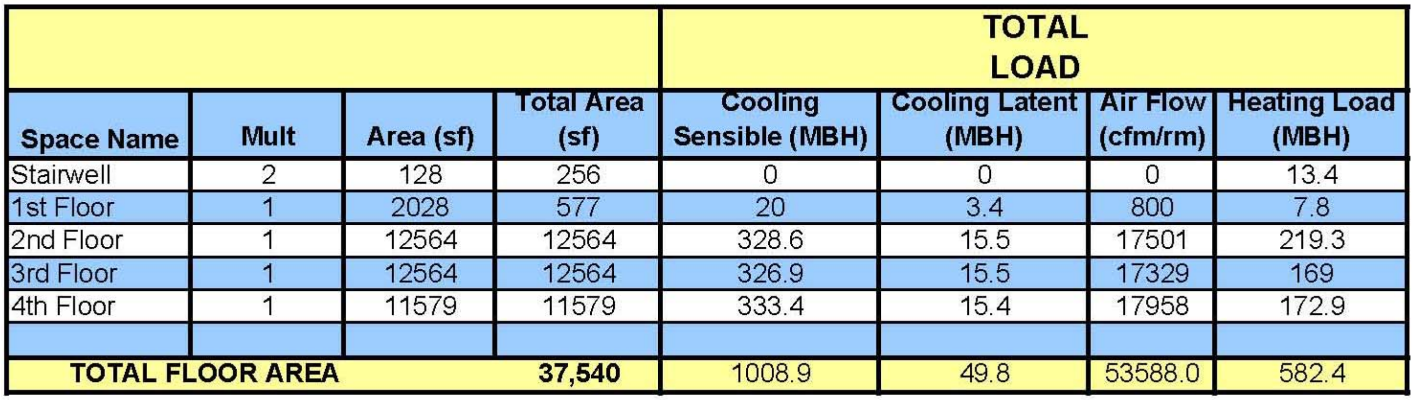
With this proposed installation if geothermal heat-pumps, several pieces of the current mechanical design can be eliminated.

- (1) Air- Cooled Helical Rotary Screw Chiller
- (2) Shell & Tube Steam-to-Water Converters
- (1) Duplex Condensate Receiver Pumpset
- (63) – 1 ton – 4 pipe fan coil units
- (26) – 2 ton – 4 pipe fan coil units
- (2) Heating Hot Water Pumps
- (1) Heating Hot Water Expansion Tank
- (1) Heating Hot Water System Bypass Water Filter
- (1) Heating Hot Water Filter
- (1) Cold Water Expansion Tank
- (1) Cold Water System Bypass Filter
- (1) Cold Water System Shot Feeder
- (650) ft - *approx(from rough take-off)* of Heating Hot Water Supply Piping
- (650) ft - *approx(from rough take-off)* of Heating Hot Water Return Piping

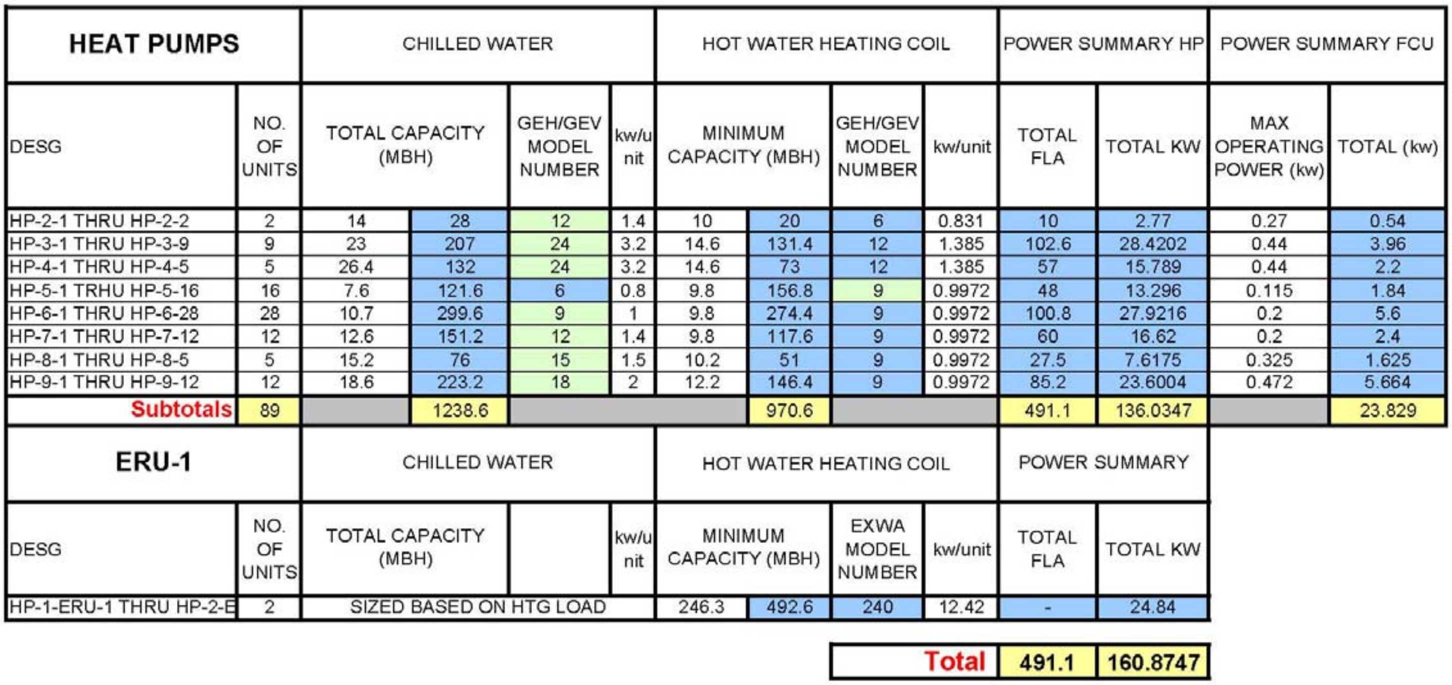
Immediately one can see that by stepping down to a 2-pipe closed loop system from that of a 4-pipe system simplifies the Mechanical Equipment needed. After assuming that these were the pieces of equipment that could be theoretically eliminated, I sought out to find a combination of heat pumps that would satisfy the load requirements for the building.

HEAT PUMP SIZING

Based on the load summary provided by the Mechanical Engineering Firm, there is a total load of 1008.9 MBH sensible cooling, 49.8 MBH latent cooling, and 582.4 MBH heating. So, if I sized the Geothermal Heat Pumps in accordance with this, seeing that the cooling load is the largest, I would need the capacity to handle 1058.7 MBH/12 = about an 89 ton system. Refer to the chart below for the Total Load Summary. I was not confident that this was the "magic" number I was looking for because I was uncertain as to what context, other than square footage that went into the making of this number. I then looked at the characteristics of the current fan-coil units, which are referenced in full detail in Appendix B. After doing this, I saw that again there was a need for a larger cooling capacity than heating capacity. The total MBH from the summation of the individual fan-coil units was 1238.6 MBH. Assuming that these units were sized correctly, I began to find water-to-air heat pumps with similar operating characteristics and the same MBH rating. After doing this I was able to quantify the energy associated with the fan-coil units operation to that of the heat pumps.



				TOTAL LOAD			
Space Name	Mult	Area (sf)	Total Area (sf)	Cooling Sensible (MBH)	Cooling Latent (MBH)	Air Flow (cfm/rm)	Heating Load (MBH)
Stairwell	2	128	256	0	0	0	13.4
1st Floor	1	2028	577	20	3.4	800	7.8
2nd Floor	1	12564	12564	328.6	15.5	17501	219.3
3rd Floor	1	12564	12564	326.9	15.5	17329	169
4th Floor	1	11579	11579	333.4	15.4	17958	172.9
TOTAL FLOOR AREA			**37,540**	1008.9	49.8	53588.0	582.4



HEAT PUMPS		CHILLED WATER				HOT WATER HEATING COIL				POWER SUMMARY HP		POWER SUMMARY FCU	
DESG	NO. OF UNITS	TOTAL CAPACITY (MBH)		GEH/GEV MODEL NUMBER	kw/unit	MINIMUM CAPACITY (MBH)		GEH/GEV MODEL NUMBER	kw/unit	TOTAL FLA	TOTAL KW	MAX OPERATING POWER (kw)	TOTAL (kw)
HP-2-1 THRU HP-2-2	2	14	28	12	1.4	10	20	6	0.831	10	2.77	0.27	0.54
HP-3-1 THRU HP-3-9	9	23	207	24	3.2	14.6	131.4	12	1.385	102.6	28.4202	0.44	3.96
HP-4-1 THRU HP-4-5	5	26.4	132	24	3.2	14.6	73	12	1.385	57	15.789	0.44	2.2
HP-5-1 TRHU HP-5-16	16	7.6	121.6	6	0.8	9.8	156.8	9	0.9972	48	13.296	0.115	1.84
HP-6-1 THRU HP-6-28	28	10.7	299.6	9	1	9.8	274.4	9	0.9972	100.8	27.9216	0.2	5.6
HP-7-1 THRU HP-7-12	12	12.6	151.2	12	1.4	9.8	117.6	9	0.9972	60	16.62	0.2	2.4
HP-8-1 THRU HP-8-5	5	15.2	76	15	1.5	10.2	51	9	0.9972	27.5	7.6175	0.325	1.625
HP-9-1 THRU HP-9-12	12	18.6	223.2	18	2	12.2	146.4	9	0.9972	85.2	23.6004	0.472	5.664
Subtotals	89		1238.6				970.6			491.1	136.0347		23.829

ERU-1		CHILLED WATER				HOT WATER HEATING COIL				POWER SUMMARY	
DESG	NO. OF UNITS	TOTAL CAPACITY (MBH)			kw/unit	MINIMUM CAPACITY (MBH)		EXWA MODEL NUMBER	kw/unit	TOTAL FLA	TOTAL KW
HP-1-ERU-1 THRU HP-2-E	2	SIZED BASED ON HTG LOAD				246.3	492.6	240	12.42	-	24.84
								Total		**491.1**	**160.8747**

The main power consumption for a fain coil unit comes from the motor, which operates a blower, that is responsible for pulling air through the unit so that it can be conditioned by either the heating coils or cooling coils, depending on the need of the space. These units themselves are not consuming large amounts of electricity to produce the heating and cooling requirements, the Mechanical Equipment that is supplying the chilled water or hot water is where the real energy consumption takes place. So when addressing the energy consumption of the fan coil units, I assumed that the kw rating on the motor was at maximum efficiency, therefore that was the kw I used to find their power consumption. Since there is no direct efficiency factor associated with the FCU, the efficiency of the equipment serving these units will be taken into consideration when that equipment kw are quantified.

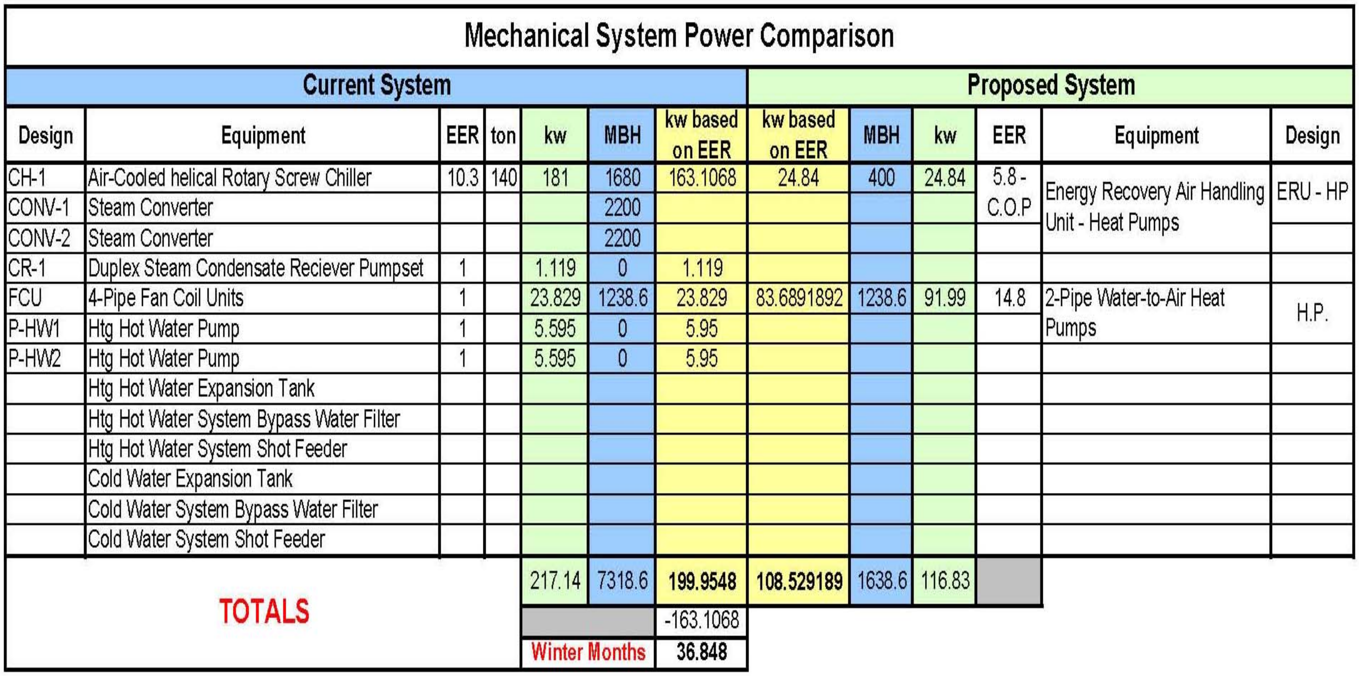
The main power consumption for the heat pumps actually does occur at the unit itself. Some of the instrumental pieces of the heat pump are: a reciprocating compressor, Coaxial Water-to-Refrigerant Coil, Expansion Valve and Reversing Valve, Blower Motor, Air-to-Refrigerant Coil. The Expansion valve plays an important role in monitoring the refrigerant flow through the circuitry to achieve desired heating or cooling. The expansion valve device allows the exact amount of refrigerant required to meet the coil load demands, which increases the efficiency of the unit. (www.trane.com)

As it can be seen by the rather lengthy list, the heat pumps are slightly more complex than the fan coil units. But with all these components working in unison, the efficiency is quite high. For the purpose of this study, I have used an E.E.R for the heat pumps of, 14.8, which corresponds to the average E.E.R. for the different heat pumps I selected to take the place of the fan coil units.

Another thing to consider by comparing the current mechanical system to that of the geothermal heat pump system I propose is the Energy Recover Air Handling Unit, denoted ERU-1, that provides the outdoor air requirements for the building. This unit is located on the roof and works by mixing outside/supply air with return/exhaust air, whereby it can save energy by not conditioning 100% outside air. The unit still needs chilled water and hot water to service its cooling coils and heating coils. I did not look into an air handling unit that uses only one water source. Instead I made some assumptions based on the chilled water cooling coil needs and the hot water heating coil needs. The cooling coil has a total capacity of providing 300 MBH, while the heating coil has a minimum capacity of providing 400 MBH, (please refer to Appendix B for a schedule of this piece of equipment). So, I sized two water-to-water heat pumps that could satisfy the 400 MBH requirement of the heating coil. I found that a Trane model EXWA-240 could provide 246.3 MBH, so I assume that two of these units would satisfy the 400 MBH requirement of the ERU-1. Because I sized this unit for heating, the efficiency rating is based on C.O.P. rather than E.E.R. I assumed the kw associated with these particular heat pump units already took into consideration the efficiency of the heat pump.

POWER COMPARISON OF TWO SYSTEMS

After I found the number of heat pumps needed to satisfy the MBH needs that the current system specifies, I could begin to compare the power consumption of current system; with all of its associate equipment, to that of the geothermal heat pumps I propose implementing. One thing to note: I am still maintaining the chilled water pumps that have the capacity to push 360 GPM. I mentioned earlier that for the horizontal loop, I would need a variable rate pump, and a side stream straight pump for when I need to call on the ground for either heat sinking or heat extracting purposes. For the sake of simplification, I am assuming that that these two cold water pumps have the capacity needed to push the fluid through my closed loop system. That is the reason that I am only considering the power that the hot water pumps consume in the Current System Comparison.



Mechanical System Power Comparison

Current System							Proposed System					
Design	**Equipment**	**EER**	**ton**	**kw**	**MBH**	**kw based on EER**	**kw based on EER**	**MBH**	**kw**	**EER**	**Equipment**	**Design**
CH-1	Air-Cooled helical Rotary Screw Chiller	10.3	140	181	1680	163.1068	24.84	400	24.84	5.8 - C.O.P	Energy Recovery Air Handling Unit - Heat Pumps	ERU - HP
CONV-1	Steam Converter				2200							
CONV-2	Steam Converter				2200							
CR-1	Duplex Steam Condensate Reciever Pumpset	1		1.119	0	1.119						
FCU	4-Pipe Fan Coil Units	1		23.829	1238.6	23.829	83.6891892	1238.6	91.99	14.8	2-Pipe Water-to-Air Heat Pumps	H.P.
P-HW1	Htg Hot Water Pump	1		5.595	0	5.95						
P-HW2	Htg Hot Water Pump	1		5.595	0	5.95						
	Htg Hot Water Expansion Tank											
	Htg Hot Water System Bypass Water Filter											
	Htg Hot Water System Shot Feeder											
	Cold Water Expansion Tank											
	Cold Water System Bypass Water Filter											
	Cold Water System Shot Feeder											
TOTALS				217.14	7318.6	**199.9548**	**108.529189**	1638.6	116.83			
						-163.1068						
				Winter Months		**36.848**						

PURPOSE OF THIS STUDY

Ultimately, the goal of this feasibility study is see if there is an energy savings among the two systems. So based on the MBH and EER(which tells me the amount of electricity required by an air conditioning unit to provide the desired cooling level in BTUs. The higher an EER, the more energy efficient a unit is.), I was able to associate a kw rating with a specific piece of equipment. Because the chiller is a very important piece of equipment in this comparison, I wanted to be as accurate as possible when determining the kw it consumes. From the documents and working drawings that I have, no specific manufacturer was specified as the provider of the Chiller unit. I found a model from TRANE that served the specified cooling requirements of 140 ton capacity; which has a standard high efficiency E.E.R rating of 10.3. The addition utilizes a medium pressure steam service that is receives from Sibley Memorial Hospital's Central Plant. After talking with Dave Bracket, a Mechanical Engineer at Leach Wallace, I learned that the steam this building receives, as well as the existing building, is excess steam. The central plant does not change its boiler operations based on these buildings, the boilers are going to produce the same amount of steam whether these building exist of not. That, in and of itself, makes a dollar-to-dollar energy savings comparison hard because they are not operating with the same cost of production. I thought about trying to convert the steam consumption into a kw number, and then associate a marginal price with that kw rating. But I wanted to keep the comparison as realistic

as possible, so I decided to completely exclude the energy associated with generating the steam, and see how the numbers worked.

As one can see looking at the numbers, the Current Mechanical System with a the chiller unit and all associated equipment has a total kw consumption based on E.E.R. of 199.95 kw, and the heat pump system I propose has a kw consumption of 108.53 kw. Keep in mind, this is a "Feasibility Study", so I am not saying these are the exact numbers these two installations have associated with them, but I feel that I am making conservative assumptions and decisions, and these are the numbers I was able to generate based on my assumptions.

ENERGY COMPARISON

Now that I have the "magic" KW numbers, I can compare the annual electrical bills of the two systems, the current vs. the proposed, and see if there is a savings with the geothermal heat pump units. As I mentioned before, this building has yet to be constructed, so there are no previous electric bills that I can use to find kwh usage, or a kw demand. So, when making the comparison, I assumed that all systems were running 24 hours a day. This building will receive electrical service from PEPCO (Potomac Electric and Power Company), and will be classified under the rate structure of, Time Metered General Service-Low Voltage Schedule "GT-LV". Refer to Appendix B for this particular Rate Schedule.

TARIFF AGREEMENT

-see following page

From the tariff agreement for PEPCO, service DC-GT LV:

Rating Periods
Weekdays - (Excluding Holidays)

On-Peak Period	12:00 noon to 8:00 p.m. (8)
Intermediate Period	8:00 am to 12:00 noon
and	8:00 pm to 12:00 midnight (8)
Off-Peak	12:00 midnight to 8:00 a.m (8)
Saturdays, Sundays and Holidays	
Off-Peak Period	All Hours

For a 7 day week	
On-Peak	40hrs
Intermediate	40hrs
Off-Peak	88hrs

Billing Demands - (270kw) for Existing Building
On-Peak (Summer Billing Months Only) - The billing demand shall be the maximum thirty (30) minute demand recorded during the on-peak period of the billing month (**202.5**)

Maximum (All Months) - The billing demand shall be the maximum thirty (30) minute demand recorded during the billing month **(202.5)**

ASSUMPTIONS WITH ENERGY COMPARISONS

Because the Addition has not yet been built, I could not look to past electrical bills to find a reasonable Demand Charge, so I looked at what the past electrical bills of the existing building, and saw that they had a demand charge of 270kw. As was mentioned previously, the existing building receives all chilled water for cooling and all steam for heating from Sibley Memorial Hospital's Central Plant. So, they are not locally (on-site) seeing an electrical charge for producing chilled water and hot water. So, I am going to use 75% of that kw demand charge for this building, this is where the 202.5 kw number comes from in the figure above. I am assuming that because I am using a geothermal system, the demand charge will be lower because the heat pumps can move BTUs throughout the building. Also the fact that the ground temperature is a relatively constant temperature, there is not a large energy use associated with producing the horizontal loop temperature. With the air cooled chiller, there could be a temperature differential

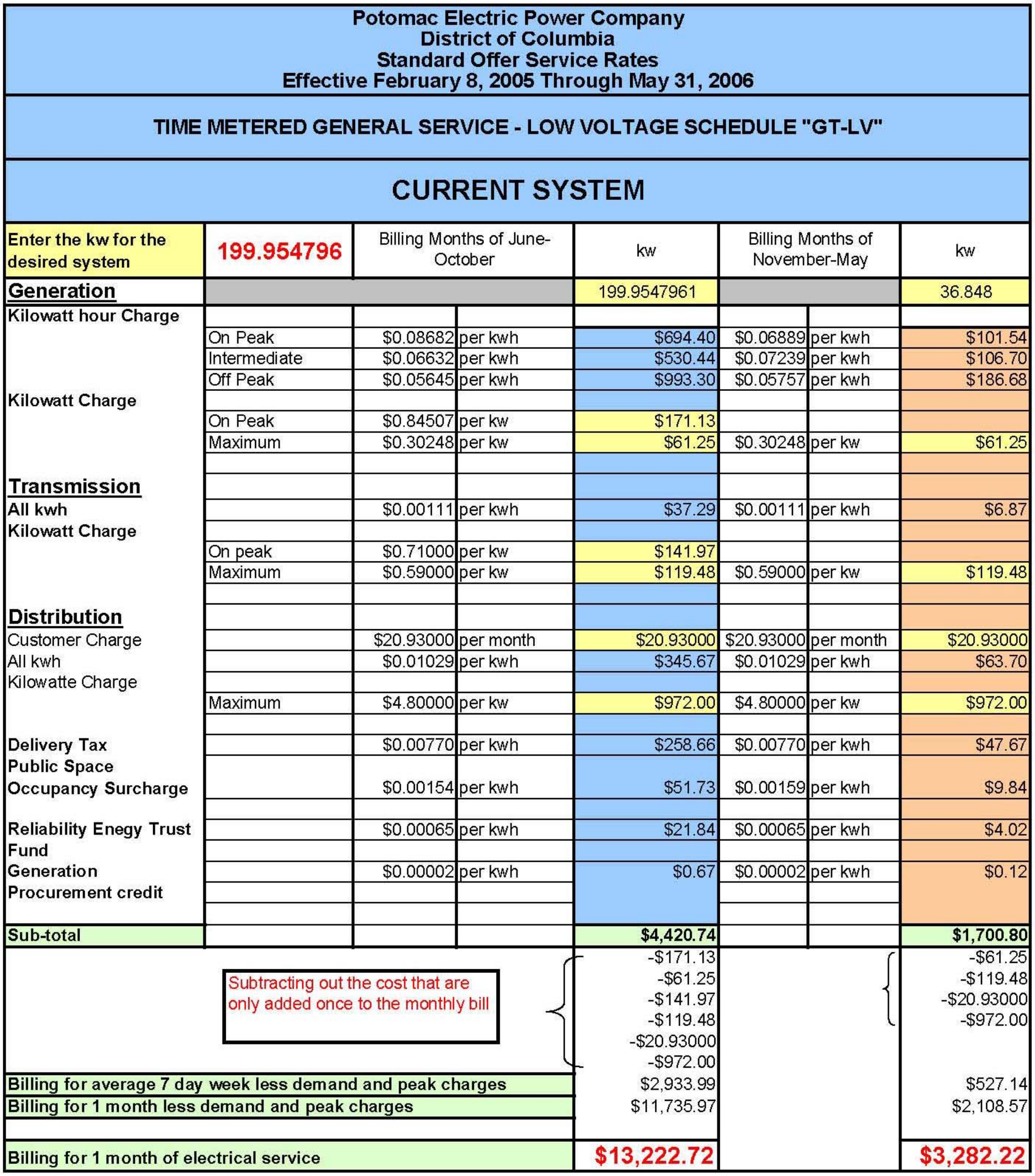
of outside air to a conditioned chilled water temperature of 35 degrees F, but for the purpose of keeping the comparisons the same; I used the same demand for each electric bill.

Another assumption that I am making is that the chiller is operating at full capacity to produce chilled water, so the kw I use in the electric bill is the one documented in the Mechanical System Power Comparison Chart. Also, the FCU operation explained previously allowed me to make the assumption that the kw consumed by a FCU is soley from the motor, so if the unit is on, its using the specified number of kw. The FCU does not influence the chilled water loop or the heating hot water loop temperature, it is only running that water through heating or cooling coils, depending on the service need.

For the heat pumps: Given the fact that I am using a ground-couple closed loop system to produce my horizontal loop temperature a diversity factor of 60% will be applied to the kw rating that I calculated. This is because I am not using fossil fuels or electricity to charge my loop, I am using the ground as a heat exchanger; and the fact that the heat pumps have the ability to take BTU's from or put BTU's into the loop, de-rating the kw makes sense.

Based on these assumptions and the rate structure of Time Metered General Service – Low Voltage Schedule “GT-LV”, I developed a monthly energy bill for the Current Mechanical System, and one for my Proposed Mechanical System. From these two comparisons one can see the cost savings of using the heat pump system that I propose verses the current system.

CURRENT SYSTEM ELECTRIC BILL



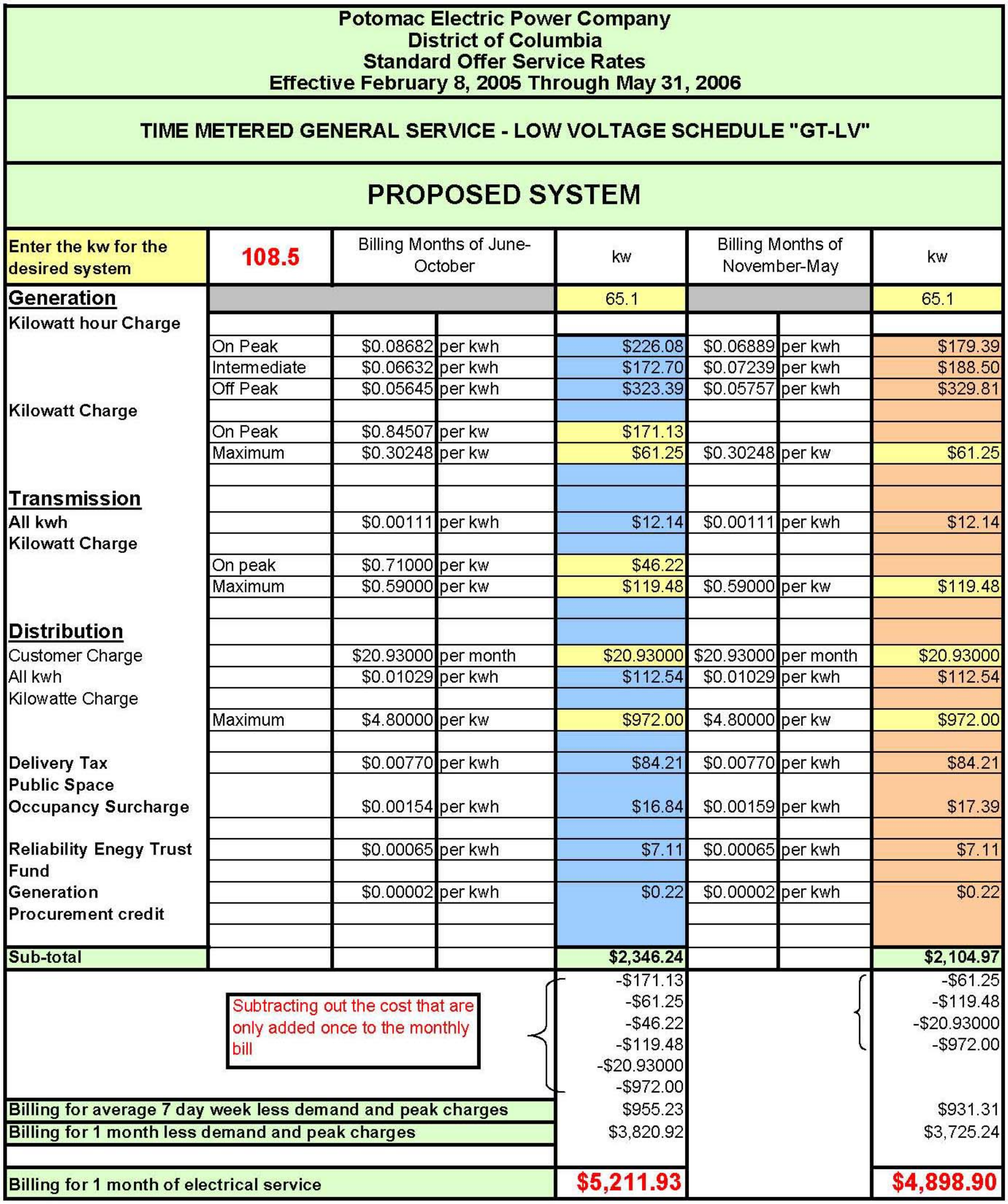
Potomac Electric Power Company
District of Columbia
Standard Offer Service Rates
Effective February 8, 2005 Through May 31, 2006

TIME METERED GENERAL SERVICE - LOW VOLTAGE SCHEDULE "GT-LV"

CURRENT SYSTEM

Enter the kw for the desired system	199.954796	Billing Months of June-October		kw	Billing Months of November-May		kw
Generation				199.9547961			36.848
Kilowatt hour Charge							
	On Peak	$0.08682	per kwh	$694.40	$0.06889	per kwh	$101.54
	Intermediate	$0.06632	per kwh	$530.44	$0.07239	per kwh	$106.70
	Off Peak	$0.05645	per kwh	$993.30	$0.05757	per kwh	$186.68
Kilowatt Charge							
	On Peak	$0.84507	per kw	$171.13			
	Maximum	$0.30248	per kw	$61.25	$0.30248	per kw	$61.25
Transmission							
All kwh		$0.00111	per kwh	$37.29	$0.00111	per kwh	$6.87
Kilowatt Charge							
	On peak	$0.71000	per kw	$141.97			
	Maximum	$0.59000	per kw	$119.48	$0.59000	per kw	$119.48
Distribution							
Customer Charge		$20.93000	per month	$20.93000	$20.93000	per month	$20.93000
All kwh		$0.01029	per kwh	$345.67	$0.01029	per kwh	$63.70
Kilowatte Charge							
	Maximum	$4.80000	per kw	$972.00	$4.80000	per kw	$972.00
Delivery Tax		$0.00770	per kwh	$258.66	$0.00770	per kwh	$47.67
Public Space Occupancy Surcharge		$0.00154	per kwh	$51.73	$0.00159	per kwh	$9.84
Reliability Enegy Trust Fund		$0.00065	per kwh	$21.84	$0.00065	per kwh	$4.02
Generation Procurement credit		$0.00002	per kwh	$0.67	$0.00002	per kwh	$0.12
Sub-total				$4,420.74			$1,700.80
	Subtracting out the cost that are only added once to the monthly bill			-$171.13 -$61.25 -$141.97 -$119.48 -$20.93000 -$972.00			-$61.25 -$119.48 -$20.93000 -$972.00
Billing for average 7 day week less demand and peak charges				$2,933.99			$527.14
Billing for 1 month less demand and peak charges				$11,735.97			$2,108.57
Billing for 1 month of electrical service				$13,222.72			$3,282.22

PROPOSED SYSTEM ELECTRIC BILL



Potomac Electric Power Company
District of Columbia
Standard Offer Service Rates
Effective February 8, 2005 Through May 31, 2006

TIME METERED GENERAL SERVICE - LOW VOLTAGE SCHEDULE "GT-LV"

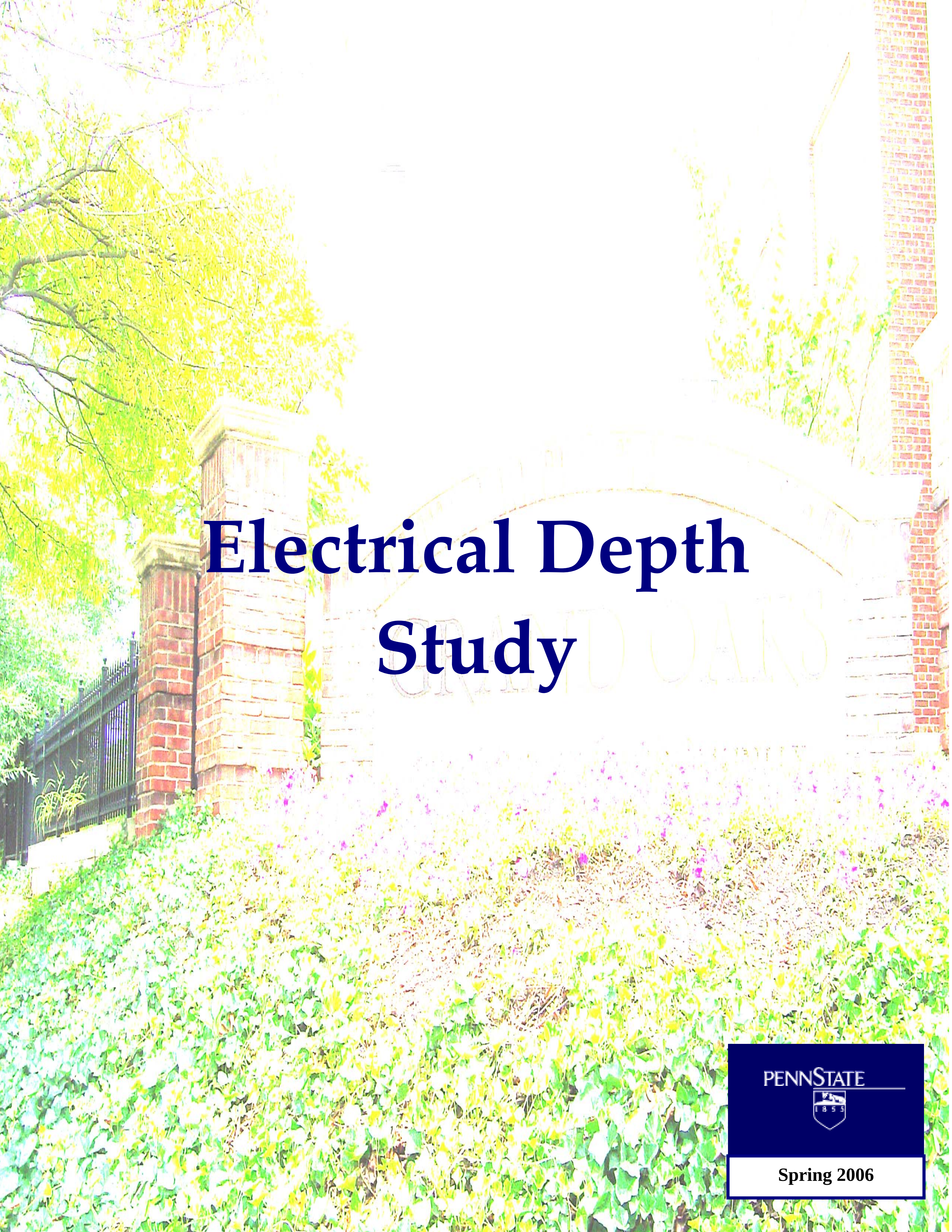
PROPOSED SYSTEM

Enter the kw for the desired system	108.5	Billing Months of June-October		kw	Billing Months of November-May		kw
Generation				65.1			65.1
Kilowatt hour Charge							
	On Peak	$0.08682	per kwh	$226.08	$0.06889	per kwh	$179.39
	Intermediate	$0.06632	per kwh	$172.70	$0.07239	per kwh	$188.50
	Off Peak	$0.05645	per kwh	$323.39	$0.05757	per kwh	$329.81
Kilowatt Charge							
	On Peak	$0.84507	per kw	$171.13			
	Maximum	$0.30248	per kw	$61.25	$0.30248	per kw	$61.25
Transmission							
All kwh		$0.00111	per kwh	$12.14	$0.00111	per kwh	$12.14
Kilowatt Charge							
	On peak	$0.71000	per kw	$46.22			
	Maximum	$0.59000	per kw	$119.48	$0.59000	per kw	$119.48
Distribution							
Customer Charge		$20.93000	per month	$20.93000	$20.93000	per month	$20.93000
All kwh		$0.01029	per kwh	$112.54	$0.01029	per kwh	$112.54
Kilowatte Charge							
	Maximum	$4.80000	per kw	$972.00	$4.80000	per kw	$972.00
Delivery Tax		$0.00770	per kwh	$84.21	$0.00770	per kwh	$84.21
Public Space Occupancy Surcharge		$0.00154	per kwh	$16.84	$0.00159	per kwh	$17.39
Reliability Enegy Trust Fund		$0.00065	per kwh	$7.11	$0.00065	per kwh	$7.11
Generation Procurement credit		$0.00002	per kwh	$0.22	$0.00002	per kwh	$0.22
Sub-total				$2,346.24			$2,104.97
	Subtracting out the cost that are only added once to the monthly bill			-$171.13 -$61.25 -$46.22 -$119.48 -$20.93000 -$972.00			-$61.25 -$119.48 -$20.93000 -$972.00
Billing for average 7 day week less demand and peak charges				$955.23			$931.31
Billing for 1 month less demand and peak charges				$3,820.92			$3,725.24
Billing for 1 month of electrical service				$5,211.93			$4,898.90

CONCLUSION

The purpose of this "Feasibility Study" was to look at the energy savings that might be realized by installing a 2-pipe geothermal heat pump system in place of the Current System, which utilizes 4-pipe fan coil units that receive chilled water supply from a roof-top air cooled chilling unit, and heating hot water supply from two medium pressure steam-to-water converters. The theory behind the geothermal system makes it something of interest to study. The ability to use the relatively constant temperature of the ground as a source of energy makes a strong case when looking at the energy savings a system of this type could afford. As noted, several assumptions had to be made, but with the support and reasons that I gave for making these assumptions, I feel that they are sound, and at times conservative. The final design that I propose will make use of (89) water-to-air heat pumps that are of the size of 1-2 tons, and (2) 20 ton water-to-water heat pumps that satisfy the needs of the Energy Recovery Air Handling Unit. The ground loop will consist of 200 vertically drilled wells, assuming 1-ton capacity per well, spaced 12-feet apart and located under the building foundation. Each well will be filled with U-bent Polyethylene pipe and then back filled with a grouting material. The 2-pipe horizontal loop will be housed on the fourth floor with vertical pipe risers supplying the subsequent lower floors where the various heat pumps are located in individual tenant suites. The current design for condensate return piping will be maintained, and heat pumps will be outfitted with a condensate pipe connection. To avoid any mold or bacteria build up during summer months, when there may be a constant moisture condition present in the condensate pan, the heat pumps will have 13 watt - ultraviolet light that turns on for 15 minutes a day, thereby killing any mold or bacteria spores.

After comparing the two energy bills, it can be seen that the Geothermal System that I propose has the potential to save around $3900/month during the summer billing rate structure, while in the winter month, it could cost around $1600/month more to operate. The geothermal heat-pump design is likely to have a higher initial cost than the current system, but with the suggested energy savings this high initial cost could be offset by annual energy savings afforded by my proposed system. The cost analysis for this system can be found in the Construction Management Report found in the pages to follow. The implications of my proposed mechanical system offer the opportunity to explore a different electrical distribution method to the Assisted Living Facility Addition. With the elimination of the roof top chiller, I eliminate a major piece of equipment that previously influenced the electrical distribution system.



Electrical Depth Study

PENNSTATE

1855

Spring 2006

CURRENT SYSTEM

The current electrical system can best be described as star; one main switchboard that feeds to the main distribution panel, which then feeds the other panels. The normal power is provided to the existing Assisted Living Facility from a PEPCO owned network transformer vault. The electrical service terminates in a 2000 amp, Square-D switchboard protected by a fused bolted pressure switch located in the basement of the Assisted Living Facility. From the switchboard, power is fed to the distribution panel board, designated Panel MDP, rated 480Y/277 volts, 3 phase, 600A. Mechanical equipment is served directly from Panel MDP. Lighting and receptacle loads are served by dry-type transformers and 208Y/120 panelboards. The distribution panels are located in the Penthouse area of the Assisted Living Facility and panelboards are fed down from that location.

The emergency power is generated via and on-site, 150 KW diesel-fired emergency generator. The generator is located outside on grade, and provides emergency power to the egress lighting and a limited amount of refrigeration in the kitchen. Emergency power for the addition is provided for the egress lighting, and is received from the existing emergency distribution panel EH1. Emergency power is stepped down to 208Y/120 voltage and distributed to life safety panels on floors 2 and 4 of the addition.

A calculation of the NEC building design load was performed to check the existing wire sizes and over current protection devices for the main feeders and distribution panels. Look at Technical Assignment #1, located on the course website for these calculations. The addition will be built and metered under the rate schedule of “GT-LV”, Time Metered General Service – Low Voltage Service Schedule, which is a different rate structure than that of the existing building.

NEW DESIGN CONSIDERATION

The existing Assisted Living Facility receives chilled water for cooling and medium pressure steam for heating from Sibley Memorial Hospital’s center plant. It is the intent of both the electrical and mechanical design that I suggest implementing, to make this addition a stand alone facility. One way to help make this addition a stand alone facility electrically is to segregate the electricity it receives and make it somewhat independent of the existing building. There were two options that I first considered. The first would have been to provide another PEPCO owned transformer, from which the new addition would be served. After preliminary talks with an electrical engineer, I opted against this due to a high initial cost of acquiring a new service, and the fact that it would increase the electric bill given that the two buildings would have separate meters, and incur several duplicate charges with such an option.

The option for my design was to add a section to the existing switchboard, and extend one normal power feeder over to the addition, that would serve a Main Distribution Panel, denoted MDP, from which all subsequent distribution panels would be served, in addition to the two elevators and the water-to-water heat pumps associated with the Energy Recovery Air Handling Unit. One reason this was not done in the current design was because of the strain that the starting load of the roof-top chiller would put on the electrical system. Every time the chiller turned on, there could be a dip in the voltage supplied resulting in a flicker in the lights and other electrical devices in the addition. Obviously, if the feeders were oversized considerable to handle the starting load, it would not be a problem, but that would not be cost effective. This does make sense in my design given the fact that I have eliminated the roof top chiller as the cold water provided. With the use of water-to-air heat pumps in the tenant suites and water-to-water heat pumps for the Energy Recover Air Handling Unit, I will eliminate the inrush current that the chiller would have provided. Another reason for this design consideration is to explore the cost savings that could be realized by reducing the number of feeders and underground duct bank that would need to be installed to extend service from the existing building to the addition.

In my mechanical feasibility study, I considered replacing the 4-pipe fan coil units with 2-pipe water-to-air heat pumps. The fan-coil units are served from 480Y/277V, 3-phase, 4-wire, 100 A panels, located on floors 2-4. The first thing I had to do for the electrical design was to check the connected load that the heat-pumps would put on these panels and make sure that the connected load did not exceed the allowable load for these given panels, as well as making sure there was room for system growth. I did two calculations to make sure the panels are sized appropriately for the heat-pump loads. First, I found the total kw that 89 heat-pumps produced, and assuming that each of the three paneboards would have about equal connected load, I could see if they were sized appropriately. I also looked at the individual panelboards; H2-NE, H3-NE, H4-NE, and gave each of the 89 heat pumps their own circuit, spread over the 3 panels, to make sure the general calculation was acceptable. The electrical characteristics of the heat-pumps are referenced in Appendix B. The panel boards; H2-NE, H3-NE, and H4-NE, are referenced in Appendix C, which show the respective connected loads that the heat pumps place on the panels.

GENERAL CALCULATION FOR LOAD ON PANELS H2-NE, H3-NE, H4-NE

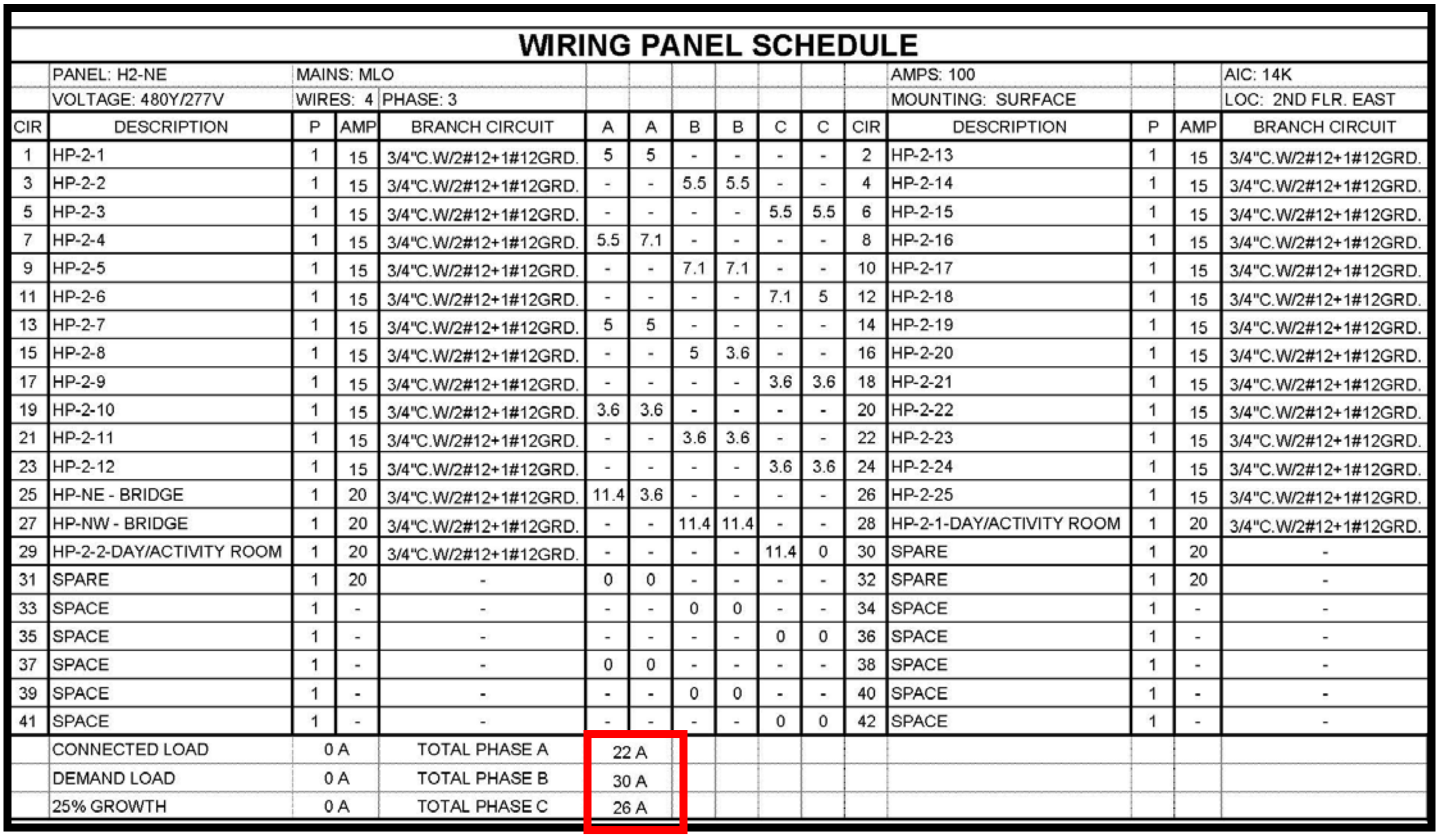
Total of 136.0347 kw from heat pumps serving tenant suites and additional spaces.

- 136.0347 kw = $\sqrt{3}$ * (480)*A
- Amps = 163.624 A
- Assuming about an equal load on each floor
- 163.624/3 = 54.54 A per panel @ 480 V - 3θ
- 100 amp panel can hold 80 amps of load
- 54.54*1.25(growth) = 68.175 A

- 68.175*1.25(Ckt Bkr) = 85.21875 – use 100 A circuit breaker
- Therefore, you can use the 100 amp panels that are currently serving these floors
- Using 4#3 + 1#8 GRND/ panel
    - #3 = 100 amps of allowable ampacity
    - *This calculation tells me that I can maintain the panels as they are and connect the Heat-Pump loads in place of the Fan-Coil Units*

An example of the calculation to check for panel and wire size is provided below. For each panel, the largest load on any single phase was chosen for analysis, and if this complied, by default, the other two phase loads were acceptable.

EXAMPLE CALCULATION: CHECKING PANEL H2-NE



WIRING PANEL SCHEDULE

	PANEL: H2-NE	MAINS: MLO										AMPS: 100			AIC: 14K
	VOLTAGE: 480Y/277V	WIRES: 4		PHASE: 3								MOUNTING: SURFACE			LOC: 2ND FLR. EAST
CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT	A	A	B	B	C	C	CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT
1	HP-2-1	1	15	3/4"C.W/2#12+1#12GRD.	5	5	-	-	-	-	2	HP-2-13	1	15	3/4"C.W/2#12+1#12GRD.
3	HP-2-2	1	15	3/4"C.W/2#12+1#12GRD.	-	-	5.5	5.5	-	-	4	HP-2-14	1	15	3/4"C.W/2#12+1#12GRD.
5	HP-2-3	1	15	3/4"C.W/2#12+1#12GRD.	-	-	-	-	5.5	5.5	6	HP-2-15	1	15	3/4"C.W/2#12+1#12GRD.
7	HP-2-4	1	15	3/4"C.W/2#12+1#12GRD.	5.5	7.1	-	-	-	-	8	HP-2-16	1	15	3/4"C.W/2#12+1#12GRD.
9	HP-2-5	1	15	3/4"C.W/2#12+1#12GRD.	-	-	7.1	7.1	-	-	10	HP-2-17	1	15	3/4"C.W/2#12+1#12GRD.
11	HP-2-6	1	15	3/4"C.W/2#12+1#12GRD.	-	-	-	-	7.1	5	12	HP-2-18	1	15	3/4"C.W/2#12+1#12GRD.
13	HP-2-7	1	15	3/4"C.W/2#12+1#12GRD.	5	5	-	-	-	-	14	HP-2-19	1	15	3/4"C.W/2#12+1#12GRD.
15	HP-2-8	1	15	3/4"C.W/2#12+1#12GRD.	-	-	5	3.6	-	-	16	HP-2-20	1	15	3/4"C.W/2#12+1#12GRD.
17	HP-2-9	1	15	3/4"C.W/2#12+1#12GRD.	-	-	-	-	3.6	3.6	18	HP-2-21	1	15	3/4"C.W/2#12+1#12GRD.
19	HP-2-10	1	15	3/4"C.W/2#12+1#12GRD.	3.6	3.6	-	-	-	-	20	HP-2-22	1	15	3/4"C.W/2#12+1#12GRD.
21	HP-2-11	1	15	3/4"C.W/2#12+1#12GRD.	-	-	3.6	3.6	-	-	22	HP-2-23	1	15	3/4"C.W/2#12+1#12GRD.
23	HP-2-12	1	15	3/4"C.W/2#12+1#12GRD.	-	-	-	-	3.6	3.6	24	HP-2-24	1	15	3/4"C.W/2#12+1#12GRD.
25	HP-NE - BRIDGE	1	20	3/4"C.W/2#12+1#12GRD.	11.4	3.6	-	-	-	-	26	HP-2-25	1	15	3/4"C.W/2#12+1#12GRD.
27	HP-NW - BRIDGE	1	20	3/4"C.W/2#12+1#12GRD.	-	-	11.4	11.4	-	-	28	HP-2-1-DAY/ACTIVITY ROOM	1	20	3/4"C.W/2#12+1#12GRD.
29	HP-2-2-DAY/ACTIVITY ROOM	1	20	3/4"C.W/2#12+1#12GRD.	-	-	-	-	11.4	0	30	SPARE	1	20	-
31	SPARE	1	20	-	0	0	-	-	-	-	32	SPARE	1	20	-
33	SPACE	1	-	-	-	-	0	0	-	-	34	SPACE	1	-	-
35	SPACE	1	-	-	-	-	-	-	0	0	36	SPACE	1	-	-
37	SPACE	1	-	-	0	0	-	-	-	-	38	SPACE	1	-	-
39	SPACE	1	-	-	-	-	0	0	-	-	40	SPACE	1	-	-
41	SPACE	1	-	-	-	-	-	-	0	0	42	SPACE	1	-	-
	CONNECTED LOAD	0 A		TOTAL PHASE A	22 A										
	DEMAND LOAD	0 A		TOTAL PHASE B	30 A										
	25% GROWTH	0 A		TOTAL PHASE C	26 A										

A 100A – 3-phase can have up to 100 amps connected on any single phase. It is design practice to connect a maximum load of 80% of what the panel is rated.

- *30A*1.25(demand)*1.25(growth) = 46.875A < 100A per phase*
-

The panels are served by 4#3+1#8GRND, check to make sure wires have enough ampacity

- *Ampacity of #3THW, 75°C = 100 A*
- *De-rate the wire – 100*0.8 = 80 A >46.875 therefore, panel can handle the connected load of the Heat-Pumps*
- *Remaining two panels loads were also sized appropriately to handle heat-pump loads.*

SIZING A MAIN DISTRIBUTION PANEL

1.) I need to find the amps associated with the existing Main Distribution Panel (MDP). From the previous check of adding the heat-pumps in place of the fan-coil units to the existing panel boards, I know that I am not exceeding the VA allocated for those panels, and I have not added any additional load to the existing MDP, therefore…

  - Existing 600A panel
  - De-rate to find ampacity

600A*0.8 = 480 A

  - 480A + 128A + 80A = 688 A

Elevators FLA given from cutsheet data from manufacturer – provided by electrical engineer – 64 FLA/Elevator motor

FLA from Heat Pumps associated with Energy Recovery Unit. These are provided to give additional capacity to the horizontal loop when heating and coiling coils are needed to condition the outdoor air to appropriate temperatures and

  - Circuit Breaker Size = **1.25*688 = 860 A** – this is not a standard size, so step up to a **900A breaker, -** it will have a 900 A trip mechanism, but fits in a 100A frame.
  - Provide a Square-D I-line **1000A Panelboard**

FEEDER SIZING

- Find an insulated conductor with **900A** allowable ampacity
- Use (**3) sets of 350 MCM** – [table 310.16 NEC 2002]
    - **350MCM** has an ampacity of **310A*3 = 930A>900A O.K.**
- Provide **1#2/0 Ground** for each set of **350 MCM** [table 250.122 NEC 2002]

VOLTAGE DROP

- Distance = 310 feet from duct bank take-off, round up to **400 feet** to be conservative
- To be conservative, using full load as **80%*900A** ckt bkr = 720 FLA

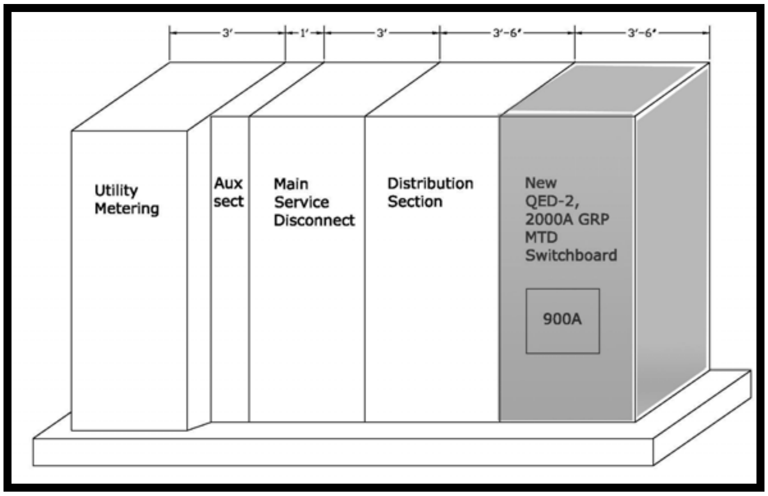
$$VD = \frac{(720)(400)(106)}{(3)(480)(10,000)}$$

Chart value

VD = 2.1% < 3% O.K [article 215.2 FPN No.2]

DISTRIBUTION SECTION

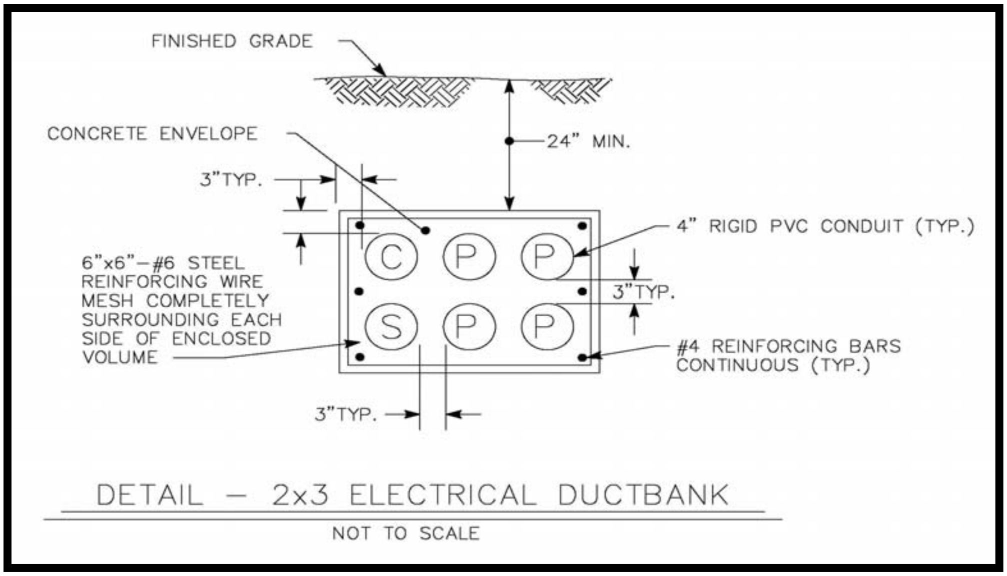
- Currently there is a **2000A** Switchboard with **2000A** horizontal bus, and **2000A** vertical bus
- Need to add a **2000A** section to existing Square-D Switchboard
- Provide **QED-2, 2000A** Group Mounted Switchboard, Floor Mounted, **480Y/277V**
- Install **900A** circuit breaker



Schematic of new 2000A Group Mounted Switchboard.

DUCTBANK

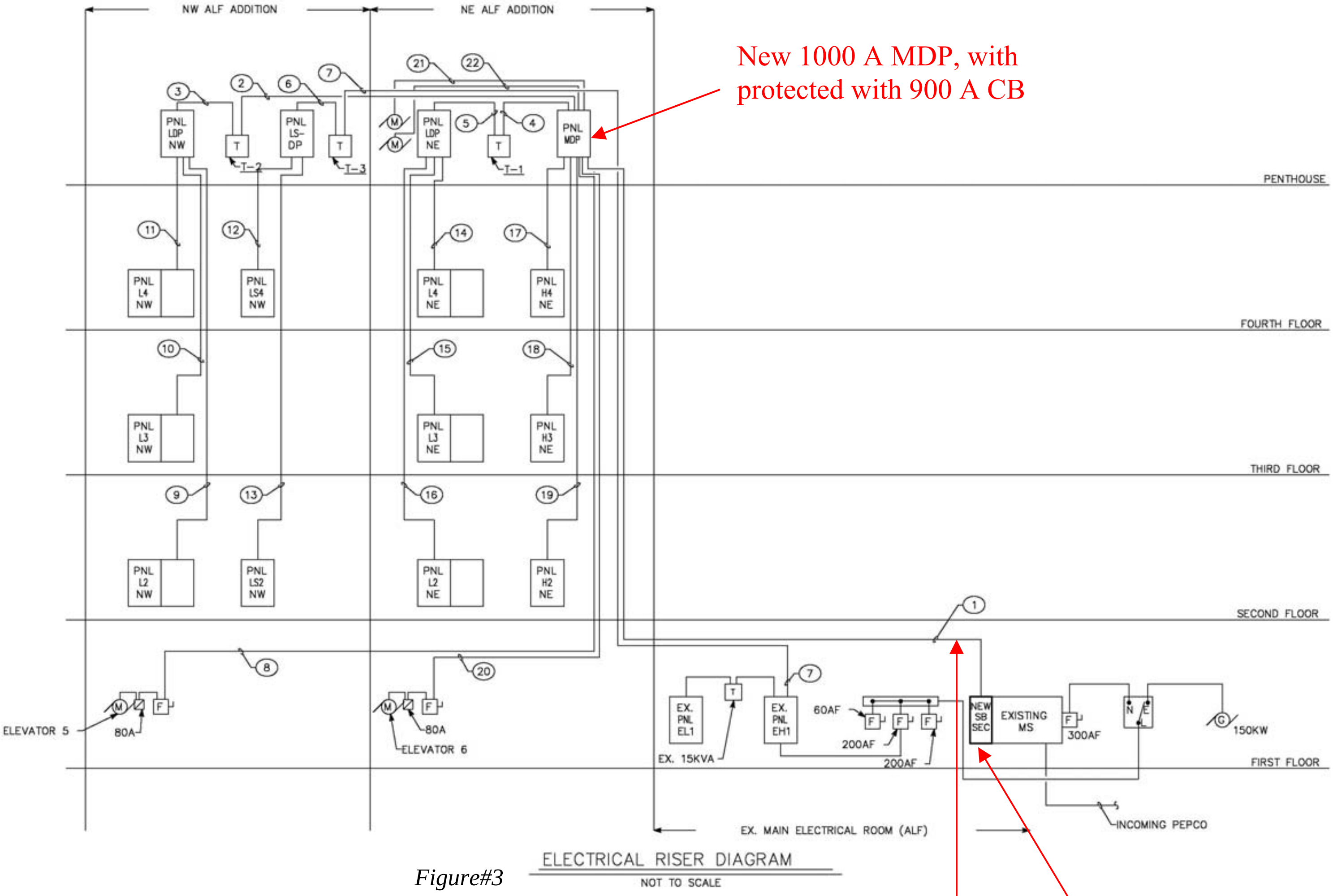
- Provide (6) – 4” conduits, 2 rows of 3 stacked
    - NEC says that you could use 3”, but 4” is the standard used in industry, therefore that is what will be specified
- 3 normal power conduits to house (3)sets of 4#350MCM + 1#2/0GRND
- 1 emergency power conduit to house 4#1+1#8



Schematic of electrical ductbank

Now that all items are sized and specified, a new riser diagram can be developed to show the implementation of the new design.

New Electrical Riser Diagram



New 1000 A MDP, with protected with 900 A CB

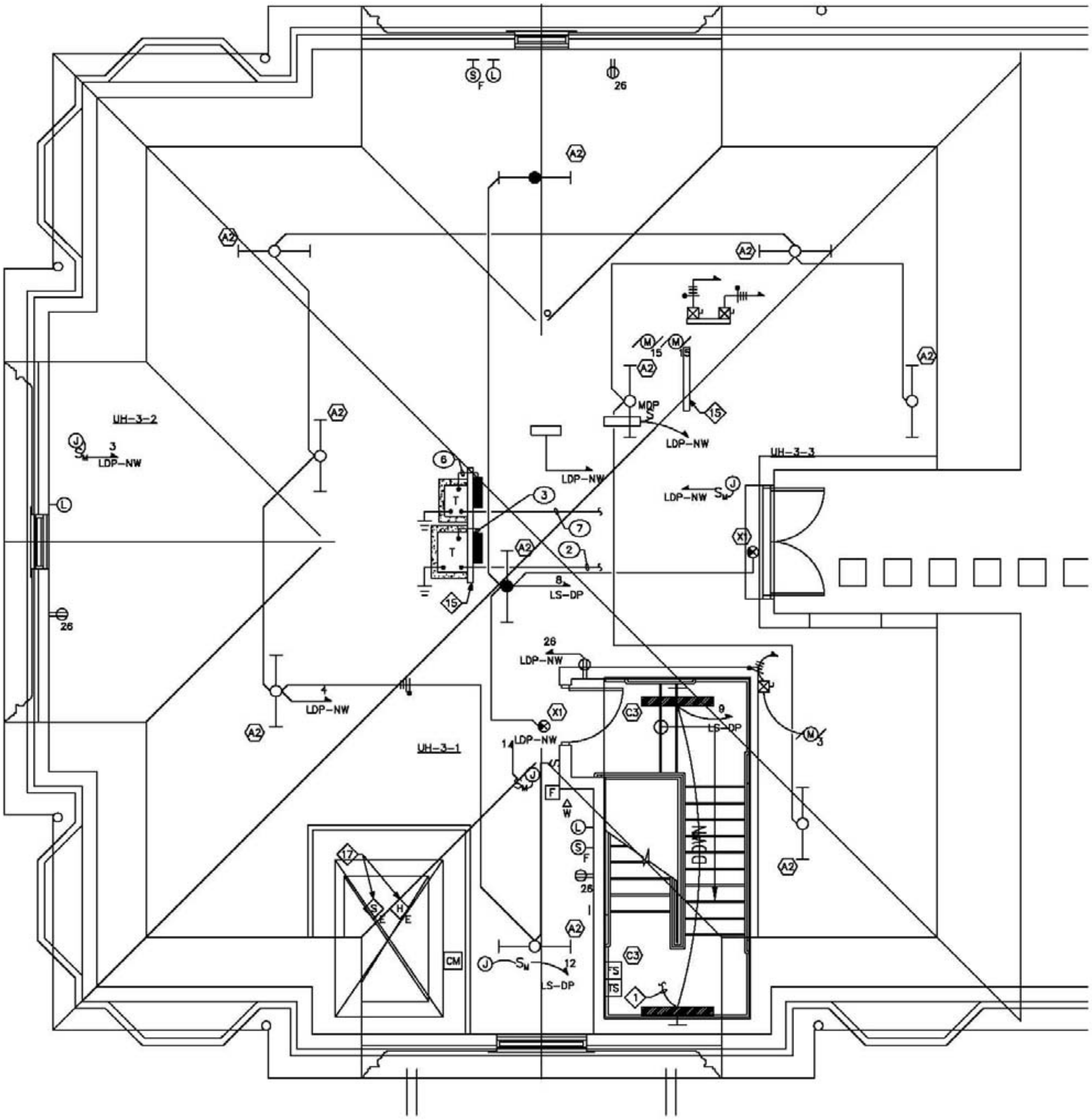
Figure#3

New 1000A, group mounted, Switchboard Section

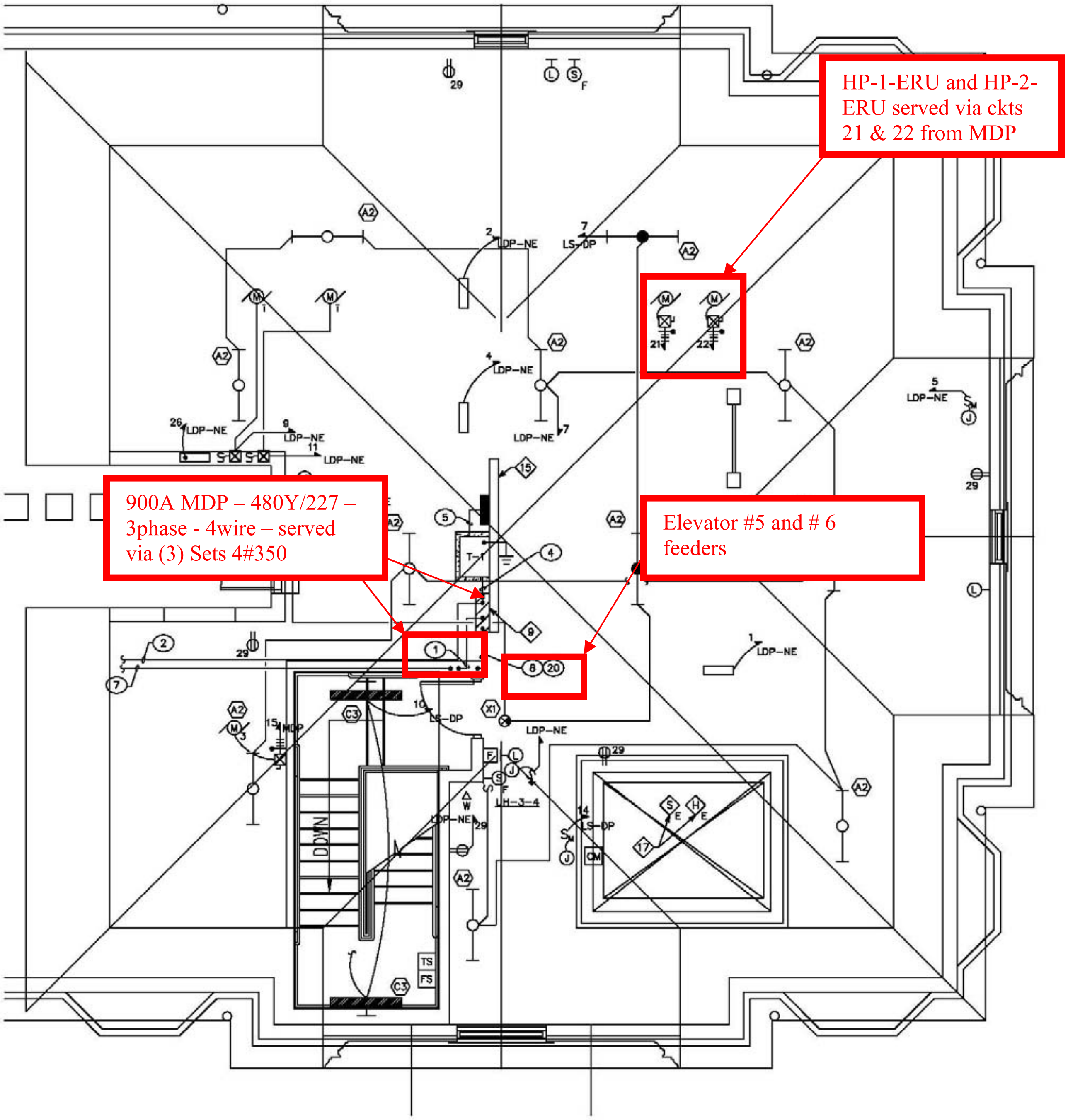
NOTE: Refer to Feeder Schedule in Appendix C for associated changes with this new distribution section; the highlighted numbers are the feeders that differ from the original design.

Single Feeder Extended to New Building Addition – (3) sets – 350 MCM in underground duct bank

NW – Penthouse Electrical Plan



NW – Penthouse Electrical Plan



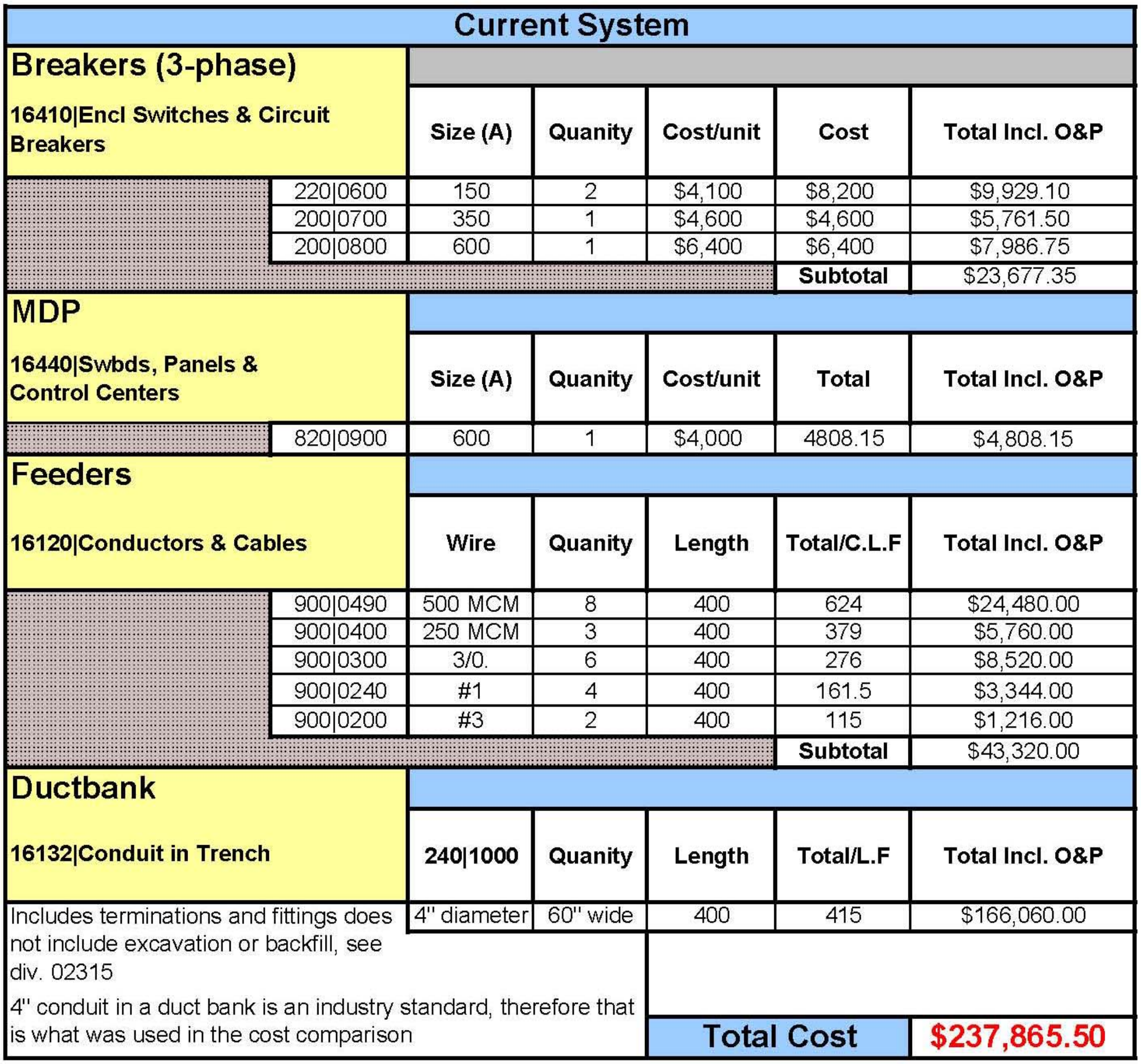
HP-1-ERU and HP-2-ERU served via ckts 21 & 22 from MDP

900A MDP – 480Y/227 – 3phase - 4wire – served via (3) Sets 4#350

Elevator #5 and # 6 feeders

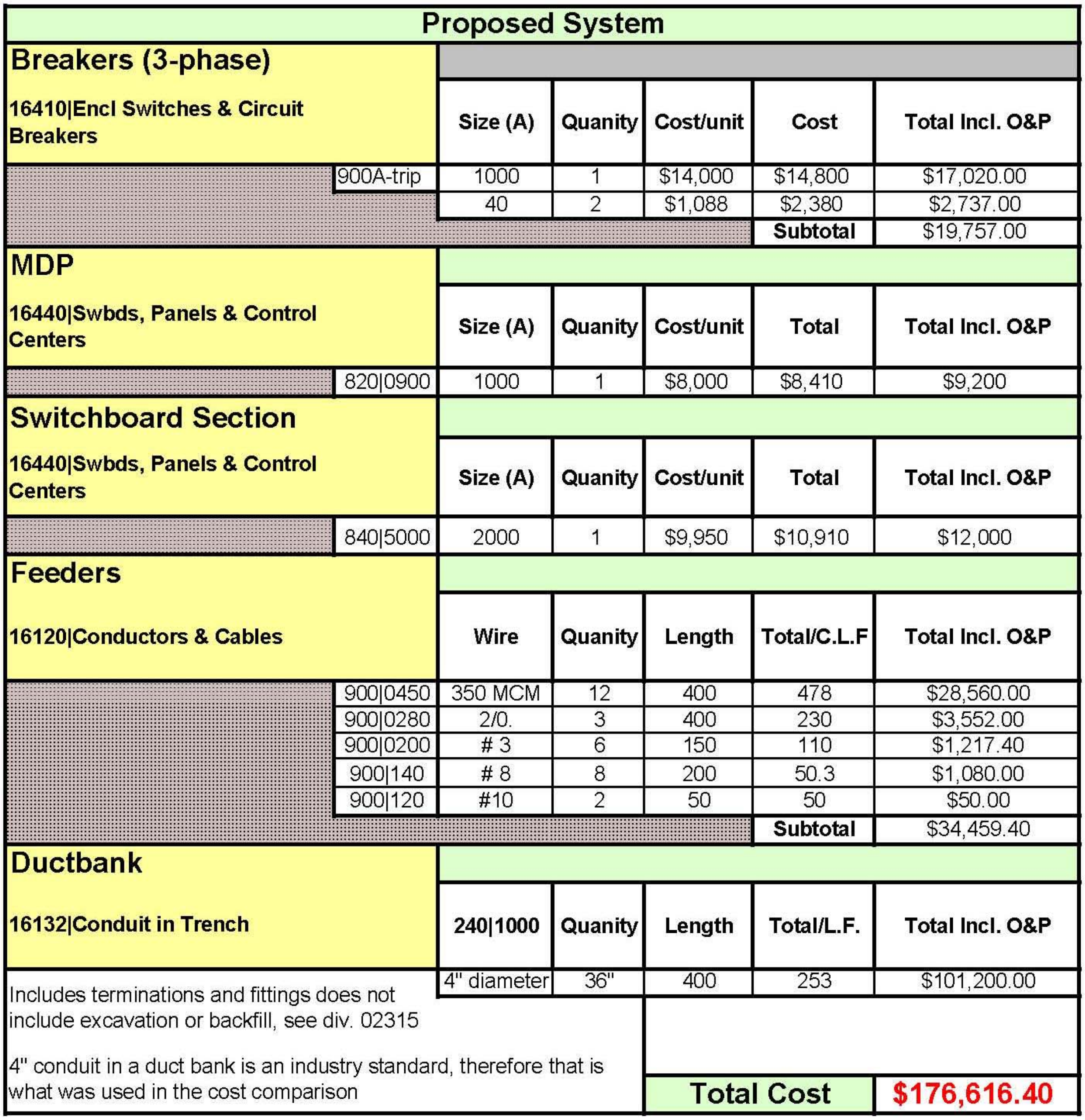
The purpose of this new electrical distribution plan is to see what if any cost savings can be associated with this design, based on a new configuration that was made possible by geothermal heat pump installation that was suggested in the Mechanical Feasibility Study Report. As well as provide another way to segregate the addition from the existing building. Below are the cost comparisons of the two systems. It summarizes and depicts the differences in cost of the circuit breakers, Main Distribution panels, feeders, etc.

COST COMPARISON – CURRENT DISTRIBUTION SYSTEM



Current System						
Breakers (3-phase) **16410|Encl Switches & Circuit Breakers**		**Size (A)**	**Quanity**	**Cost/unit**	**Cost**	**Total Incl. O&P**
	220|0600	150	2	$4,100	$8,200	$9,929.10
	200|0700	350	1	$4,600	$4,600	$5,761.50
	200|0800	600	1	$6,400	$6,400	$7,986.75
					Subtotal	$23,677.35
MDP **16440|Swbds, Panels & Control Centers**		**Size (A)**	**Quanity**	**Cost/unit**	**Total**	**Total Incl. O&P**
	820|0900	600	1	$4,000	4808.15	$4,808.15
Feeders **16120|Conductors & Cables**		**Wire**	**Quanity**	**Length**	**Total/C.L.F**	**Total Incl. O&P**
	900|0490	500 MCM	8	400	624	$24,480.00
	900|0400	250 MCM	3	400	379	$5,760.00
	900|0300	3/0.	6	400	276	$8,520.00
	900|0240	#1	4	400	161.5	$3,344.00
	900|0200	#3	2	400	115	$1,216.00
					Subtotal	$43,320.00
Ductbank **16132|Conduit in Trench**		**240|1000**	**Quanity**	**Length**	**Total/L.F**	**Total Incl. O&P**
Includes terminations and fittings does not include excavation or backfill, see div. 02315		4" diameter	60" wide	400	415	$166,060.00
4" conduit in a duct bank is an industry standard, therefore that is what was used in the cost comparison					**Total Cost**	**$237,865.50**

COST COMPARISON –PROPOSED DISTRIBUTION SYSTEM



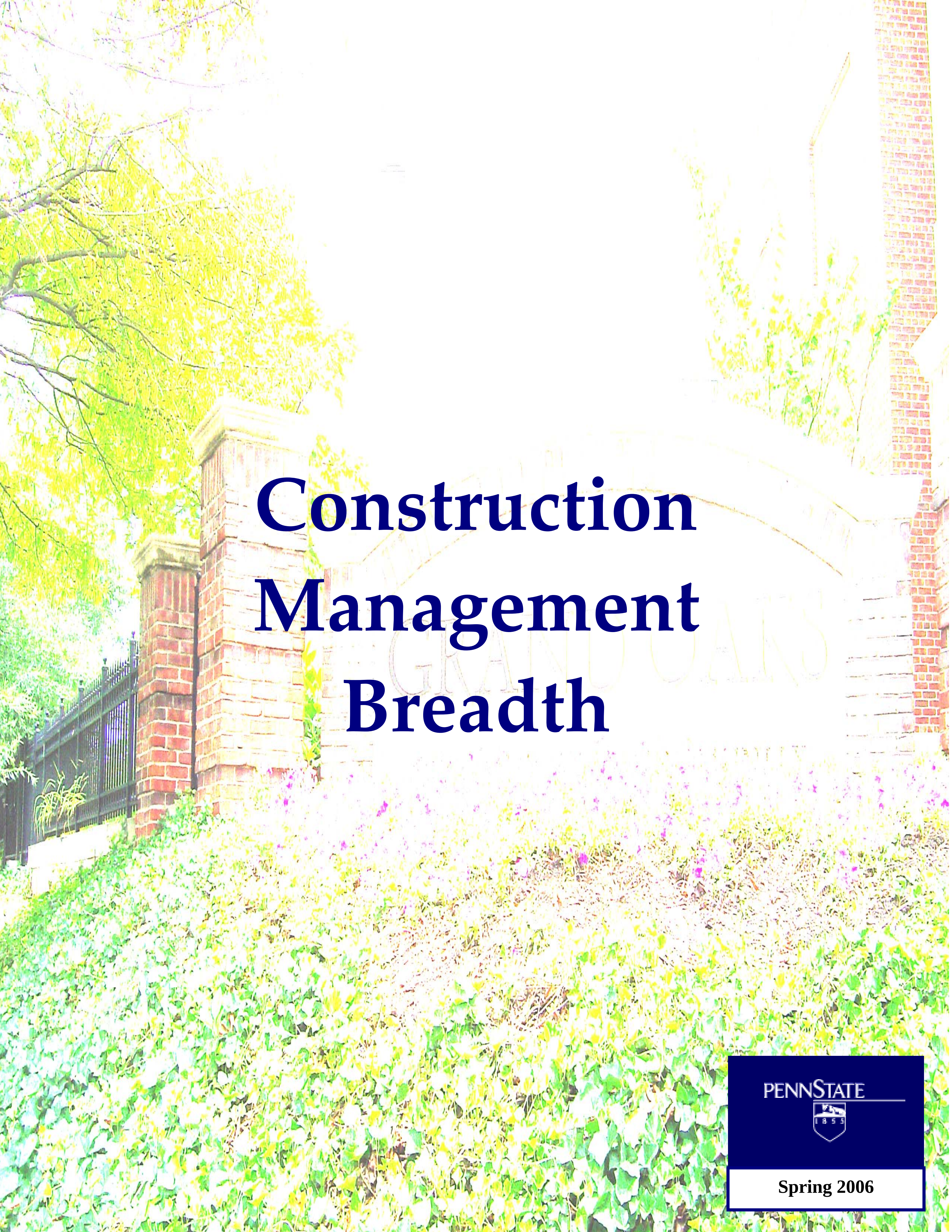
Proposed System						
Breakers (3-phase) **16410|Encl Switches & Circuit Breakers**		**Size (A)**	**Quanity**	**Cost/unit**	**Cost**	**Total Incl. O&P**
	900A-trip	1000	1	$14,000	$14,800	$17,020.00
		40	2	$1,088	$2,380	$2,737.00
					Subtotal	$19,757.00
MDP **16440|Swbds, Panels & Control Centers**		**Size (A)**	**Quanity**	**Cost/unit**	**Total**	**Total Incl. O&P**
	820|0900	1000	1	$8,000	$8,410	$9,200
Switchboard Section **16440|Swbds, Panels & Control Centers**		**Size (A)**	**Quanity**	**Cost/unit**	**Total**	**Total Incl. O&P**
	840|5000	2000	1	$9,950	$10,910	$12,000
Feeders **16120|Conductors & Cables**		**Wire**	**Quanity**	**Length**	**Total/C.L.F**	**Total Incl. O&P**
	900|0450	350 MCM	12	400	478	$28,560.00
	900|0280	2/0.	3	400	230	$3,552.00
	900|0200	# 3	6	150	110	$1,217.40
	900|140	# 8	8	200	50.3	$1,080.00
	900|120	#10	2	50	50	$50.00
					Subtotal	$34,459.40
Ductbank **16132|Conduit in Trench**		**240|1000**	**Quanity**	**Length**	**Total/L.F.**	**Total Incl. O&P**
Includes terminations and fittings does not include excavation or backfill, see div. 02315 4" conduit in a duct bank is an industry standard, therefore that is what was used in the cost comparison		4" diameter	36"	400	253	$101,200.00
					Total Cost	**$176,616.40**

In this cost comparison, the electrical distribution system that I propose will save around **$61,250**. The numbers for associated cost were found in R.S. Means. The way in which the

numbers were quantified was kept consistent between the two comparisons so that if any one item has a discrepancy, the one in which it is being compared to has the same discrepancy, hence maintaining the same margin of error for each comparison comparison. As one can see by looking at the two cost comparisons, the biggest difference occurs when comparing the size of the duct bank, which is priced per linear foot based on the size of the duct. By reducing the number of feeders that are extended over to the addition from the Main Electrical Room in the existing building, I can reduce the number of conduits needed, thereby reducing the size of the ductbank to carry those feeders.

Conclusion

To conclude, the existing design extended four normal power feeders from the existing, 2000 amp Switchboard, two of those feeders served Elevators #4 and #5, one of those feeders served a 180kw Roof Top Rotary Screw Chilling Unit, and one served the 600A MDP. With my proposed mechanical design, the Roof Top Chiller was eliminated, thereby removing any concern for a sage in the electrical voltage seen by other equipment in the building during the Chiller start-up period. It is assumed based on the characteristics of the heat-pumps, which were thoroughly explain in the Mechanical Feasibility Study, that at no time will they *all* be operating, starting, or stopping. However, with the Chiller running at full capacity during the extreme design days, i.e. – a very hot and humid day, pulling 180kw of power, a large strain would have been placed on my design by only extending one normal power feeder to a MDP. Therefore, by re-evaluating the Mechanical System and suggesting an alternative method for heating and cooling, I was able to reduce the cost associated with the Electrical Distribution System, and save approximately $61,250.



Construction Management Breadth

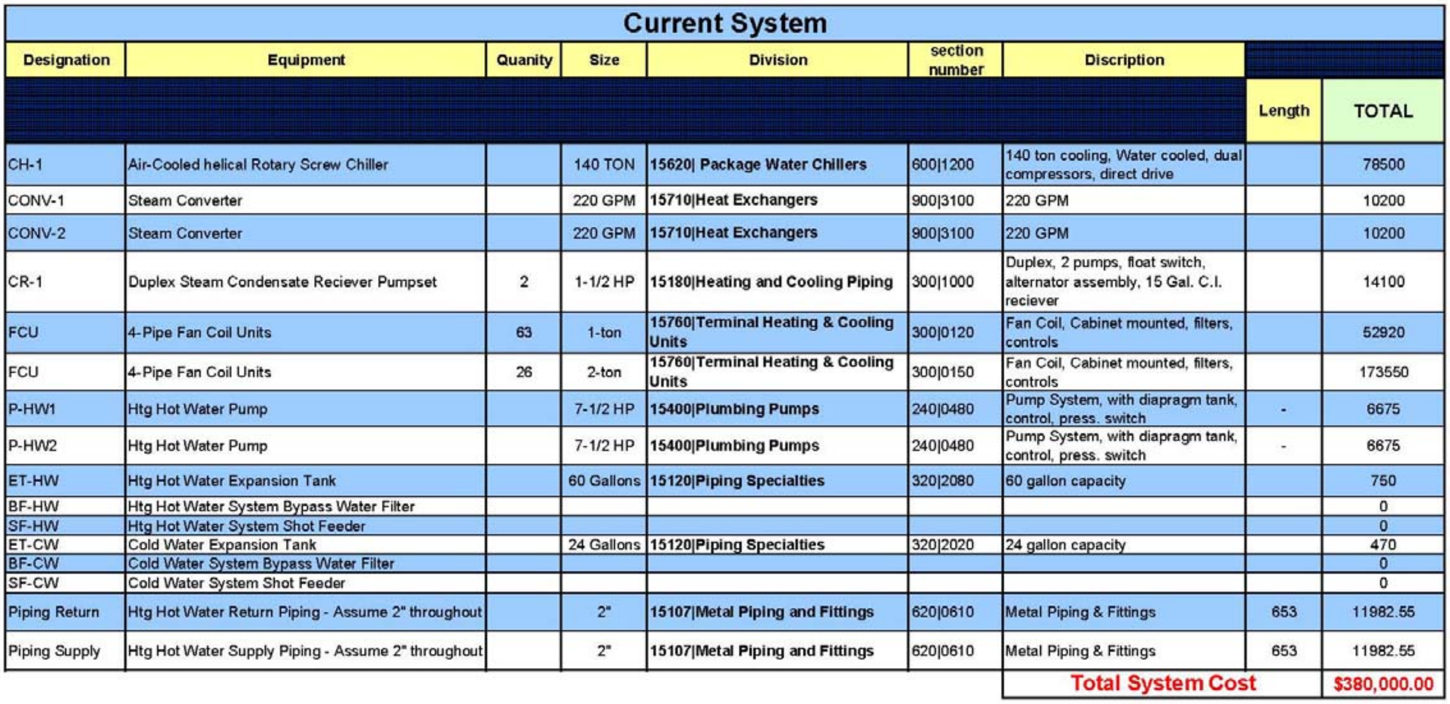
Spring 2006

COST ANALYSIS OF GEOTHERMAL HEAT PUMPS

INTRODUCTION

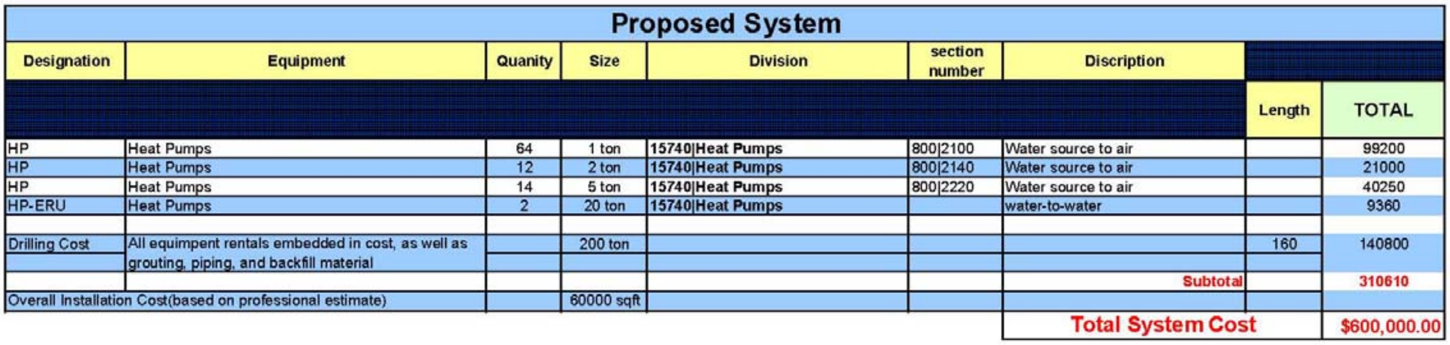
In this section of the report, we can see what, if any cost savings occur based on the proposed mechanical system design which implements geothermal heat pumps, of the ground-coupled closed loop type, to satisfy the HVAC needs of Sibley Memorial Hospital's – Grand Oaks Assisted Living Facility Addition. The initial cost of the current design and the one I propose implementing are documented within this report. Based on the monthly energy savings that the Mechanical Feasibility Report suggested; annual energy savings of the current system vs. the one I propose are analyzed, from which a payback period can be established to offset the high initial cost of the Geothermal Heat Pump Design. The high electricity rates that are set to affect the Baltimore/Washington area this summer of 2006; discussed in detail in the Mechanical Feasibility report, are also taken into account when establishing a payback period. The rate structure is scaled to assume the inflated cost that would be associated with a 35%-72% rate increase in utility bills. Obliviously, a 72% rate increase would not be passed by lawmakers, but for demonstrative purposes and to further sell my proposed Geothermal Heat Pump design, I choose to establish payback periods based on these rate increases. Also included is the net present value of the annual energy savings offered by a 25 year projected life of the geothermal heat pump system. The different net present value of the energy savings are shown with the current electrical rates, the 35% rate increase, and the 72% rate increase. Also included is the Rate of Return on the initial investment of this Geothermal Heat Pump System over a 25 year projected life, given present electric rates, a 35% rate increase, and a 72% rate increase.

EQUIPMENT COST COMPARISON OF CURRENT SYSTEM VS. PROPOSED



Current System

Designation	Equipment	Quanity	Size	Division	section number	Discription	Length	TOTAL
CH-1	Air-Cooled helical Rotary Screw Chiller		140 TON	**15620| Package Water Chillers**	600|1200	140 ton cooling, Water cooled, dual compressors, direct drive		78500
CONV-1	Steam Converter		220 GPM	**15710|Heat Exchangers**	900|3100	220 GPM		10200
CONV-2	Steam Converter		220 GPM	**15710|Heat Exchangers**	900|3100	220 GPM		10200
CR-1	Duplex Steam Condensate Reciever Pumpset	2	1-1/2 HP	**15180|Heating and Cooling Piping**	300|1000	Duplex, 2 pumps, float switch, alternator assembly, 15 Gal. C.I. reciever		14100
FCU	4-Pipe Fan Coil Units	63	1-ton	**15760|Terminal Heating & Cooling Units**	300|0120	Fan Coil, Cabinet mounted, filters, controls		52920
FCU	4-Pipe Fan Coil Units	26	2-ton	**15760|Terminal Heating & Cooling Units**	300|0150	Fan Coil, Cabinet mounted, filters, controls		173550
P-HW1	Htg Hot Water Pump		7-1/2 HP	**15400|Plumbing Pumps**	240|0480	Pump System, with diapragm tank, control, press. switch	-	6675
P-HW2	Htg Hot Water Pump		7-1/2 HP	**15400|Plumbing Pumps**	240|0480	Pump System, with diapragm tank, control, press. switch	-	6675
ET-HW	Htg Hot Water Expansion Tank		60 Gallons	**15120|Piping Specialties**	320|2080	60 gallon capacity		750
BF-HW	Htg Hot Water System Bypass Water Filter							0
SF-HW	Htg Hot Water System Shot Feeder							0
ET-CW	Cold Water Expansion Tank		24 Gallons	**15120|Piping Specialties**	320|2020	24 gallon capacity		470
BF-CW	Cold Water System Bypass Water Filter							0
SF-CW	Cold Water System Shot Feeder							0
Piping Return	Htg Hot Water Return Piping - Assume 2" throughout		2"	**15107|Metal Piping and Fittings**	620|0610	Metal Piping & Fittings	653	11982.55
Piping Supply	Htg Hot Water Supply Piping - Assume 2" throughout		2"	**15107|Metal Piping and Fittings**	620|0610	Metal Piping & Fittings	653	11982.55
						Total System Cost		**$380,000.00**



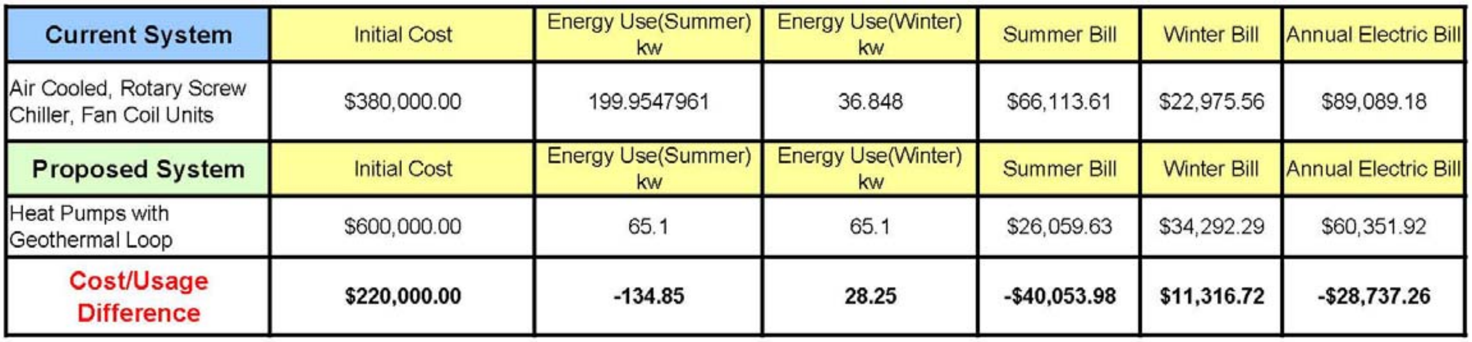
Proposed System

Designation	Equipment	Quanity	Size	Division	section number	Discription	Length	TOTAL
HP	Heat Pumps	64	1 ton	**15740|Heat Pumps**	800|2100	Water source to air		99200
HP	Heat Pumps	12	2 ton	**15740|Heat Pumps**	800|2140	Water source to air		21000
HP	Heat Pumps	14	5 ton	**15740|Heat Pumps**	800|2220	Water source to air		40250
HP-ERU	Heat Pumps	2	20 ton	**15740|Heat Pumps**		water-to-water		9360
Drilling Cost	All equipment rentals embedded in cost, as well as grouting, piping, and backfill material		200 ton				160	140800
						Subtotal		**310610**
Overall Installation Cost(based on professional estimate)			60000 sqft					
						Total System Cost		**$600,000.00**

A few things to make note of when looking at the cost comparison of the two systems: The total cost associated with any piece of equipment is from R.S. Means. The cold water pumps are not considered in the Current System total cost because I am assuming that the cost of those pumps are similar to the cost of the variable rate, and side straight pump in the Proposed System. Also, the Proposed System is a two pipe system, thereby I account for the heating hot water piping in the cost associated with the Current System cost. The total cost of the Proposed Geothermal System is based off a ($20,000/2000 sqft) figure given to me by Mr. Dave Feyock, a consultant

for Somerset Rural Electric, who specializes in the design and construction of geothermal heat pump systems. So based on the approximate building square footage, I was able to estimate a total installation cost of the proposed geothermal system. The next section address the initial costs associated with the two systems and an annual electric bill that each system might see.

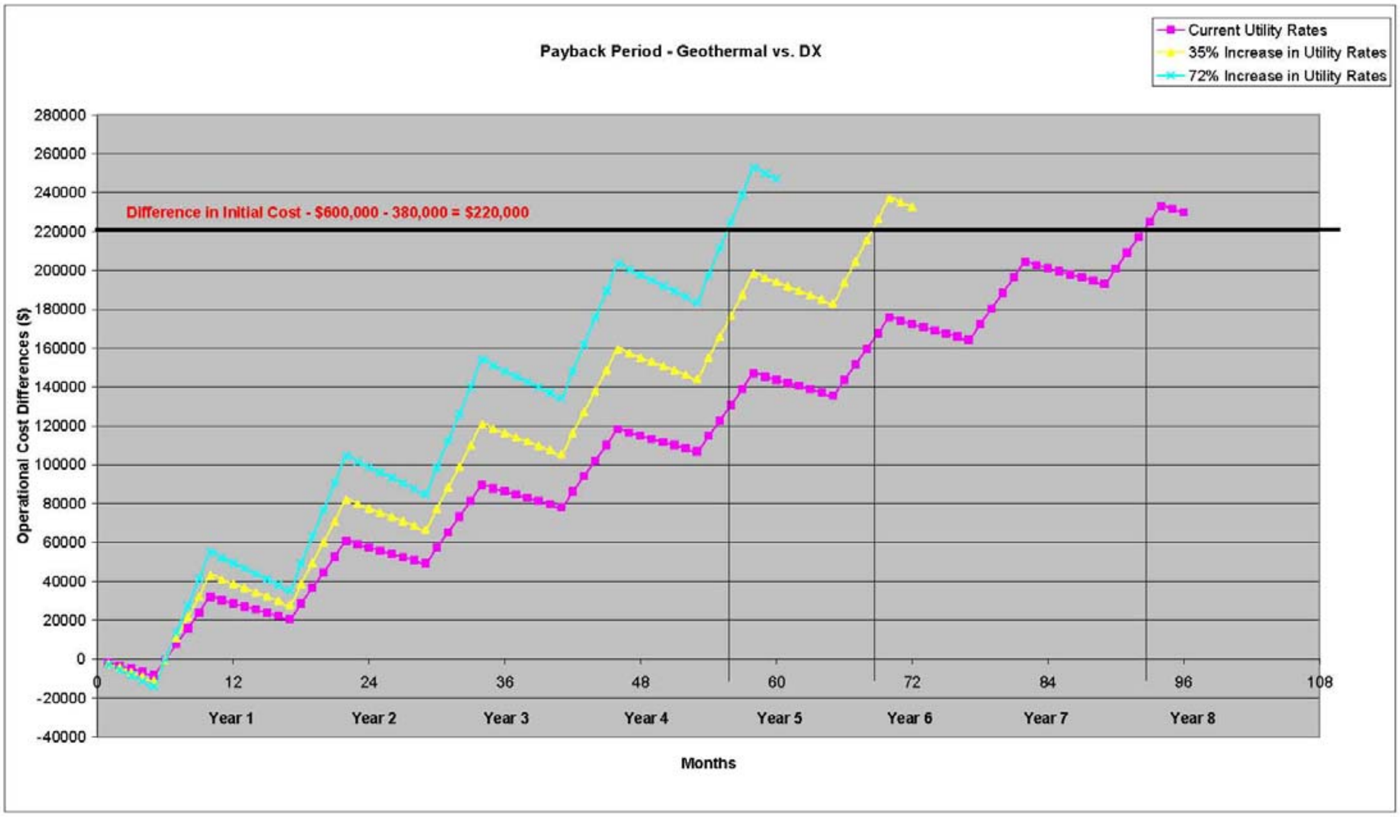
INITIAL COST COMPARISON VS. ANNUAL ELECTRIC BILL



Current System	Initial Cost	Energy Use(Summer) kw	Energy Use(Winter) kw	Summer Bill	Winter Bill	Annual Electric Bill
Air Cooled, Rotary Screw Chiller, Fan Coil Units	$380,000.00	199.9547961	36.848	$66,113.61	$22,975.56	$89,089.18
Proposed System	Initial Cost	Energy Use(Summer) kw	Energy Use(Winter) kw	Summer Bill	Winter Bill	Annual Electric Bill
Heat Pumps with Geothermal Loop	$600,000.00	65.1	65.1	$26,059.63	$34,292.29	$60,351.92
Cost/Usage Difference	**$220,000.00**	**-134.85**	**28.25**	**-$40,053.98**	**$11,316.72**	**-$28,737.26**

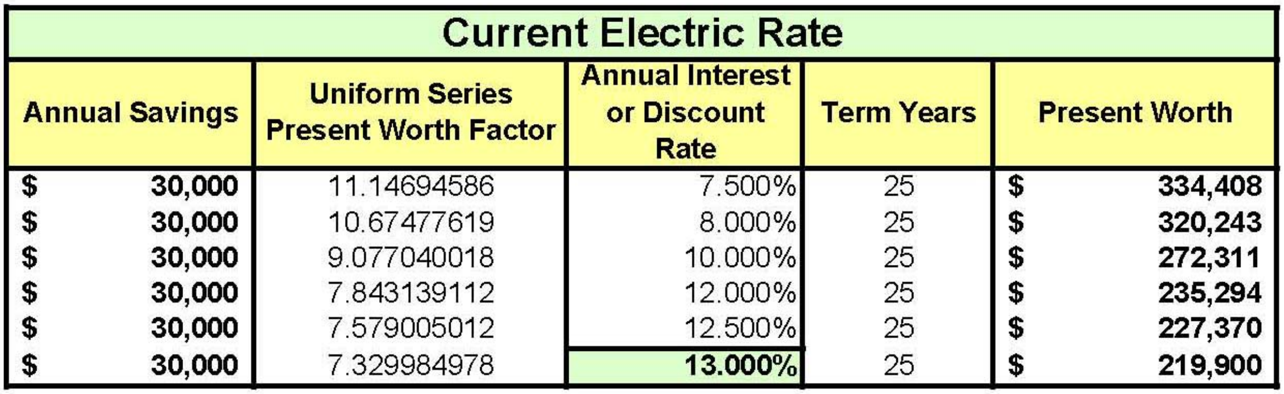
As the chart indicates there is a higher initial cost for the Proposed System, but from the Mechanical Feasibility study, based on the kilo-watts that each system consumes, and the expected electric bills for summer and winter months, the Proposed System could offer an annual energy savings of almost **$30,000.00.** In the building industry, initial cost seems to be the driving force, so to make the case for my proposed Geothermal Heat Pump System, I want to establish a payback period based on the annual electric savings that my system could offer, and show that it could be a wise decision to go with a higher first cost capital investment given the projected life of the system and the volatility of electricity rates.

PAYBACK PERIOD OF GEOTHERMAL HEAT PUMP SYSTEM



As this graph indicates, and what one would assume, the higher the electric rates get, the faster the initial cost of the Geothermal Heat Pump System is offset. As it was already mentioned, Baltimore/Washington customers will probably not see an electricity rate increase of 72%. But this graph does makes a strong case: Given the local situation of electricity rates in the Baltimore/Washington area, and the ever growing national demand for electricity, the payback on an energy efficient system could be worth the higher initial first cost. Another way of looking at the annual energy savings offered by the Geothermal Heat Pump System is to compare the Net Present Value of the annual electrical cost savings over a 25 year projected life.

Net Present Value and Rate of Return



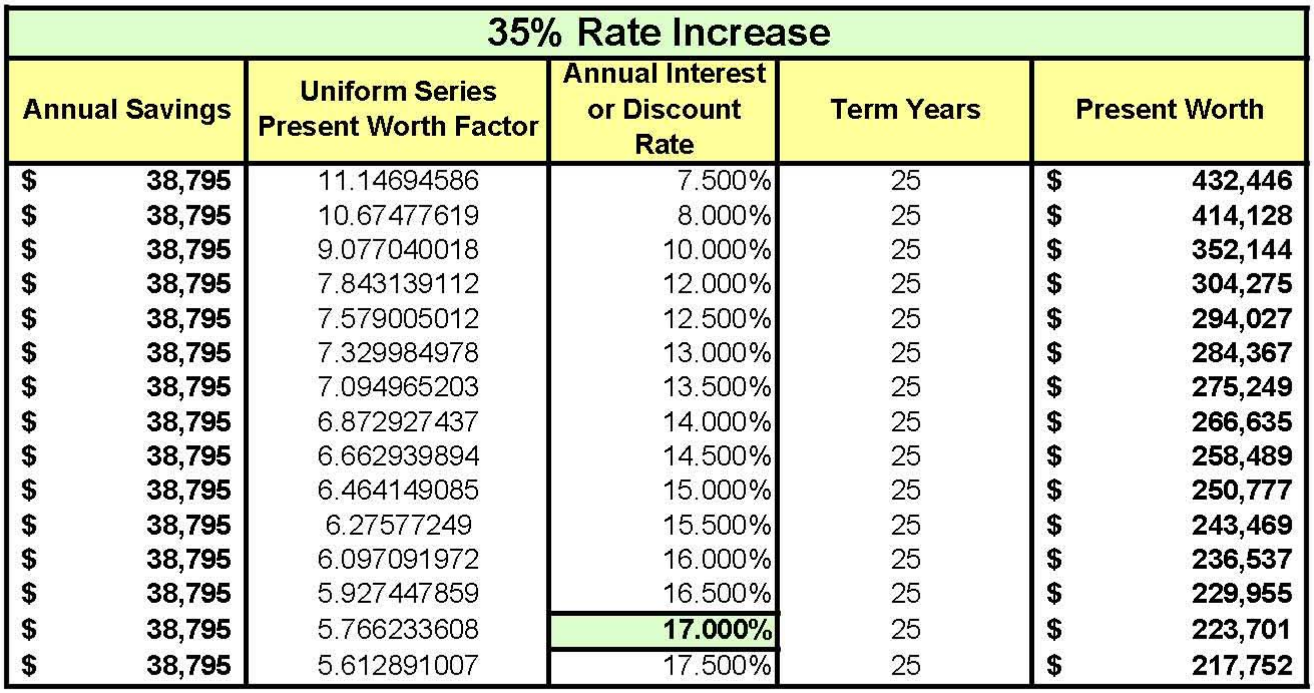
Current Electric Rate

Annual Savings	Uniform Series Present Worth Factor	Annual Interest or Discount Rate	Term Years	Present Worth
$ 30,000	11.14694586	7.500%	25	**$ 334,408**
$ 30,000	10.67477619	8.000%	25	**$ 320,243**
$ 30,000	9.077040018	10.000%	25	**$ 272,311**
$ 30,000	7.843139112	12.000%	25	**$ 235,294**
$ 30,000	7.579005012	12.500%	25	**$ 227,370**
$ 30,000	7.329984978	**13.000%**	25	**$ 219,900**

Assuming that the Assisted Living Facility could borrow money at the current “Prime-Rate” of 7.5%, an investment of $220,000 (the initial cost difference) in the Geothermal System provides an annual savings at current electric rates of approximately $30,000. Therefore the “Net Present Value” of the Geothermal System over its projected life of 25 years would be:

Present Value of Savings	**$334,408.00**
Less Initial Investment	**<u>$220,000.00</u>**
Net Present Value	**$114,408.00**

Also over this 25 year projected life, at current electric rates, the investment in my proposed Geothermal System would yield a **“Rate of Return”** of approximately**13%.** As I had mentioned before, the current PEPCO electric rates have been held artificially low due to rate caps, which are due to expire in the summer of 2006. The utility has, in fact, already filed for 35%-72% rate increases. Given present and future projections that global demand for energy will continue to exceed supply, electric rates are also expected to escalate. Therefore, the calculated Net Present Value as well as the Rate of Return provided by the energy cost savings of the Geothermal installation can be considered quite conservative. But, to further illustrate with numbers the potential energy savings, I considered the Net Present Value and Rates of Return with a 35% and a 72% rate increase.



35% Rate Increase				
Annual Savings	**Uniform Series Present Worth Factor**	**Annual Interest or Discount Rate**	**Term Years**	**Present Worth**
$ **38,795**	11.14694586	7.500%	25	$ **432,446**
$ **38,795**	10.67477619	8.000%	25	$ **414,128**
$ **38,795**	9.077040018	10.000%	25	$ **352,144**
$ **38,795**	7.843139112	12.000%	25	$ **304,275**
$ **38,795**	7.579005012	12.500%	25	$ **294,027**
$ **38,795**	7.329984978	13.000%	25	$ **284,367**
$ **38,795**	7.094965203	13.500%	25	$ **275,249**
$ **38,795**	6.872927437	14.000%	25	$ **266,635**
$ **38,795**	6.662939894	14.500%	25	$ **258,489**
$ **38,795**	6.464149085	15.000%	25	$ **250,777**
$ **38,795**	6.27577249	15.500%	25	$ **243,469**
$ **38,795**	6.097091972	16.000%	25	$ **236,537**
$ **38,795**	5.927447859	16.500%	25	$ **229,955**
$ **38,795**	5.766233608	**17.000%**	25	$ **223,701**
$ **38,795**	5.612891007	17.500%	25	$ **217,752**

Present Value of Savings	**$432,446.00**
Less Initial Investment	**$220,000.00**
Net Present Value	**$212,446.00**
Rate of Return	**17-17.5%**

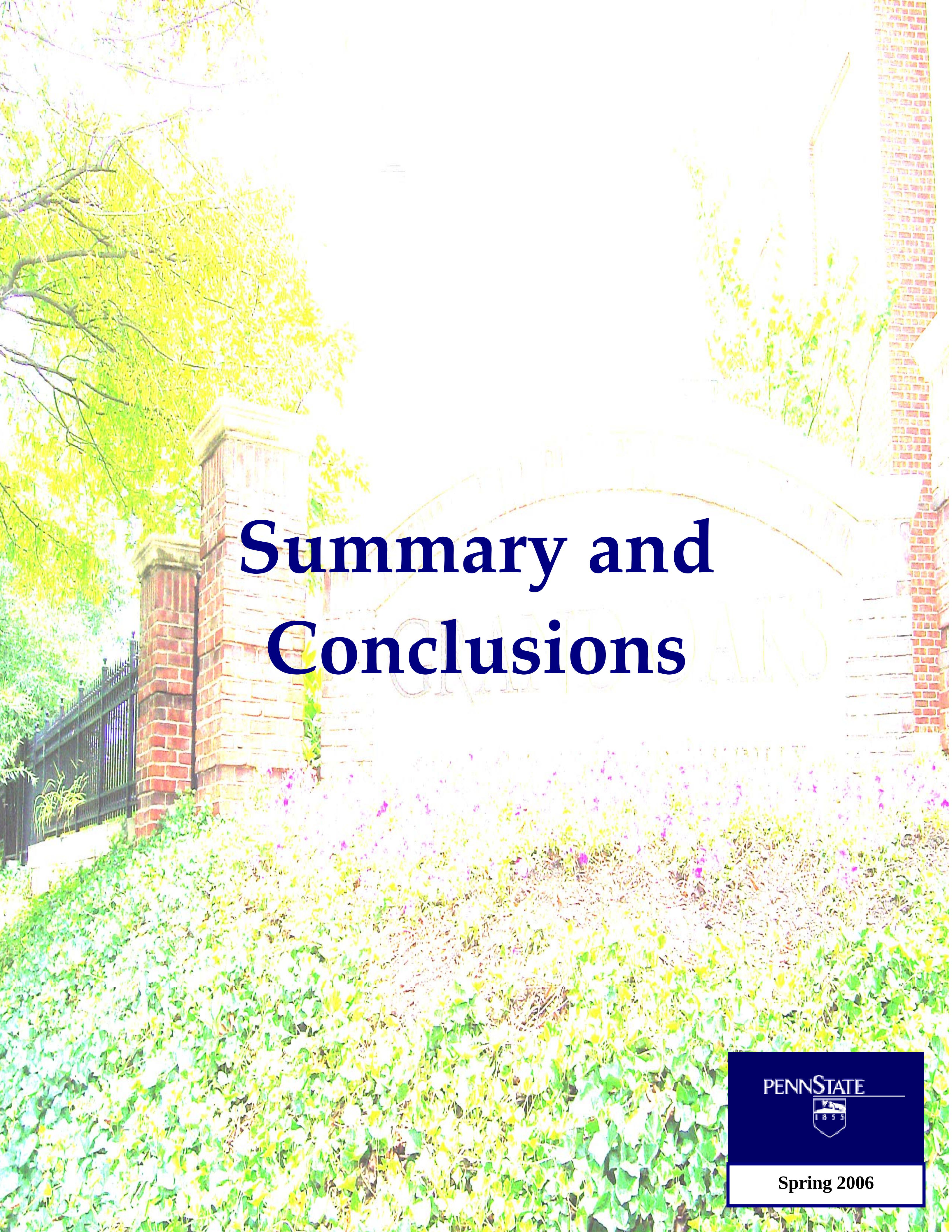
72% Rate Increase

Annual Savings	Uniform Series Present Worth Factor	Annual Interest or Discount Rate	Term Years	Present Worth
$ 49,428	11.14694586	7.500%	25	$ 550,972
$ 49,428	10.67477619	8.000%	25	$ 527,634
$ 49,428	9.077040018	10.000%	25	$ 448,661
$ 49,428	7.843139112	12.000%	25	$ 387,671
$ 49,428	7.579005012	12.500%	25	$ 374,616
$ 49,428	7.329984978	13.000%	25	$ 362,307
$ 49,428	7.094965203	13.500%	25	$ 350,691
$ 49,428	6.872927437	14.000%	25	$ 339,716
$ 49,428	6.662939894	14.500%	25	$ 329,336
$ 49,428	6.464149085	15.000%	25	$ 319,510
$ 49,428	6.27577249	15.500%	25	$ 310,199
$ 49,428	6.097091972	16.000%	25	$ 301,368
$ 49,428	5.927447859	16.500%	25	$ 292,982
$ 49,428	5.766233608	17.000%	25	$ 285,014
$ 49,428	5.612891007	17.500%	25	$ 277,434
$ 49,428	5.466905847	18.000%	25	$ 270,219
$ 49,428	5.327804013	18.500%	25	$ 263,343
$ 49,428	5.195147959	19.000%	25	$ 256,786
$ 49,428	5.068533518	19.500%	25	$ 250,528
$ 49,428	4.94758702	20.000%	25	$ 244,550
$ 49,428	4.83196268	20.500%	25	$ 238,835
$ 49,428	4.721340232	21.000%	25	$ 233,367
$ 49,428	4.615422787	21.500%	25	$ 228,132
$ 49,428	4.513934883	**22.000%**	25	$ 223,115
$ 49,428	4.41662072	22.500%	25	$ 218,305
$ 49,428	4.323242549	23.000%	25	$ 213,690

Present Value of Savings	**$550,972.00**
Less Initial Investment	**$220,000.00**
Net Present Value	**$330,972.00**
Rate of Return	**22-22.5%**

CONCLUSION

As the numbers and graphs indicate, the higher initial cost of the Geothermal System can be offset by the amount of money it saves in electricity cost on a yearly basis. With the assumptions I made in the Mechanical Feasibility Study, two annual electric bills could be developed from which I could suggest a possible payback period of 4 ½ - 7 ½ years on the higher initial investment in the Geothermal System. I also found that the Net Present Value of the electric savings could be from $115,000 - $331,000 over a 25 year projected life; and that the investment in the Geothermal System could yield a 13% - 22.5% Rate of Return. Because the Assisted Living Facility Addition has yet to be built, I had to make some assumptions about the electric bills that each of the two mechanical systems might produce. But, given my assumptions, I feel that this cost analysis demonstrates the potential savings that could be offered by the proposed Geothermal System.



Summary and Conclusions

Spring 2006

The Lighting Depth Study looked at the redesign of four main spaces in the existing Grand Oaks Assisted Living Facility. All space met the design criteria that was established and referenced from the IESNA and ASHRA 90.1. The overall lighting program provides an atmosphere that maintains and elegant residential ambiance to the given spaces. The lighting control scheme provides system flexibility while giving personal control, something which one has at their own home. The ISO-LINE figures, Pseudo Color, and Renderings show how the lighting design performs and gives an artistic representation of what the spaces could look like if the design were to be implemented.

The Mechanical Feasibility Study's purpose was to look at the energy savings that might be realized by installing a 2-pipe geothermal heat pump system in place of the Current System, which utilizes 4-pipe fan coil units that receive chilled water supply from a roof-top air cooled chilling unit, and heating hot water supply from two medium pressure steam-to-water converters. The theory behind the geothermal system makes it something of interest to study. The ability to use the relatively constant temperature of the ground as a source of energy makes a strong case when looking at the energy savings a system of this type could afford. As noted, several assumptions had to be made, but with the support and reasons that I gave for making these assumptions, I feel that they are sound, and at times conservative. The final design that I propose will make use of (89) water-to-air heat pumps that are of the size of 1-2 tons, and (2) 20 ton water-to-water heat pumps that satisfy the needs of the Energy Recovery Air Handling Unit. The ground loop will consist of 200 vertically drilled wells, assuming 1-ton capacity per well, spaced 12-feet apart and located under the building foundation. Each well will be filled with U-bent Polyethylene pipe and then back filled with a grouting material. The 2-pipe horizontal loop will be housed on the fourth floor with vertical pipe risers supplying the subsequent lower floors where the various heat pumps are located in individual tenant suites. The current design for condensate return piping will be maintained, and heat pumps will be outfitted with a condensate pipe connection. To avoid any mold or bacteria build up during summer months, when there may be a constant moisture condition present in the condensate pan, the heat pumps will have 13 watt - ultraviolet light that turns on for 15 minutes a day, thereby killing any mold or bacteria spores.

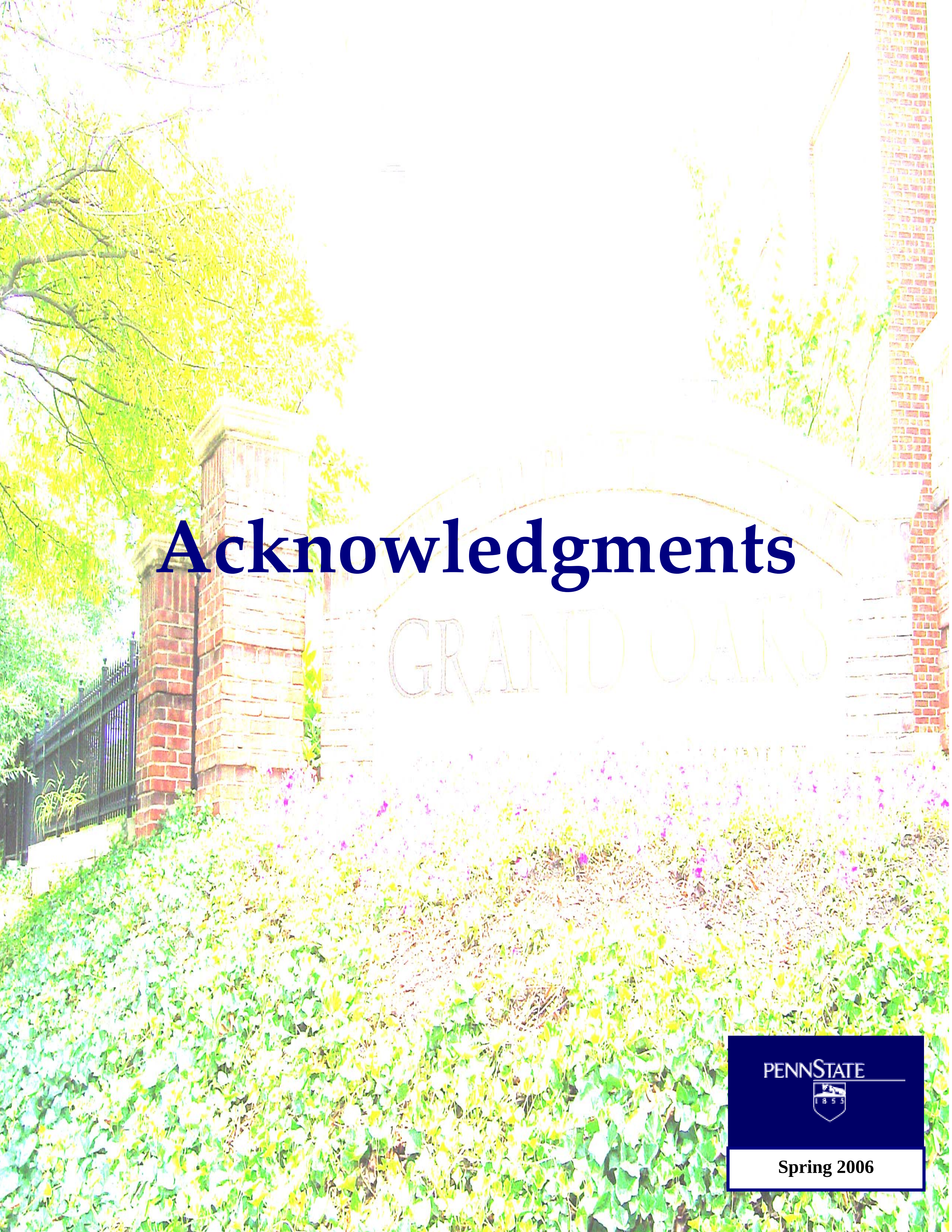
After comparing the two energy bills, it can be seen that the Geothermal System that I propose has the potential to save around $3900/month during the summer billing rate structure, while in the winter month, it could cost around $1600/month more to operate. The geothermal heat-pump design is likely to have a higher initial cost than the current system, but with the suggested energy savings this high initial cost could be offset by annual energy savings afforded by my proposed system. The cost analysis for this system can be found in the Construction Management Report found in the pages to follow. The implications of my proposed mechanical

system offer the opportunity to explore a different electrical distribution method to the Assisted Living Facility Addition. With the elimination of the roof top chiller, I eliminate a major piece of equipment that previously influenced the electrical distribution system.

The Electrical Depth Study: The existing design extended four normal power feeders from the existing, 2000 amp Switchboard, two of those feeders served Elevators #4 and #5, one of those feeders served a 180kw Roof Top Rotary Screw Chilling Unit, and one served the 600A MDP. With my proposed mechanical design, the Roof Top Chiller was eliminated, thereby removing any concern for a sage in the electrical voltage seen by other equipment in the building during the Chiller start-up period. It is assumed based on the characteristics of the heat-pumps, which were thoroughly explain in the Mechanical Feasibility Study, that at no time will they *all* be operating, starting, or stopping. However, with the Chiller running at full capacity during the extreme design days, i.e. – a very hot and humid day, pulling 180kw of power, a large strain would have been placed on my design by only extending one normal power feeder to a MDP. Therefore, by re-evaluating the Mechanical System and suggesting an alternative method for heating and cooling, I was able to reduce the cost associated with the Electrical Distribution System, and save approximately $61,250.

The Construction Management Breadth Study found the higher initial cost of the Geothermal System can be offset by the amount of money it saves in electricity cost on a yearly basis. With the assumptions I made in the Mechanical Feasibility Study, two annual electric bills could be developed from which I could suggest a possible payback period of 4 ½ - 7 ½ years on the higher initial investment in the Geothermal System. I also found that the Net Present Value of the electric savings could be from $115,000 - $331,000 over a 25 year projected life; and that the investment in the Geothermal System could yield a 13% - 22.5% Rate of Return. Because the Assisted Living Facility Addition has yet to be built, I had to make some assumptions about the electric bills that each of the two mechanical systems might produce. But, given my assumptions, I feel that this cost analysis demonstrates the potential savings that could be offered by the proposed Geothermal System.

Acknowledgments



Spring 2006

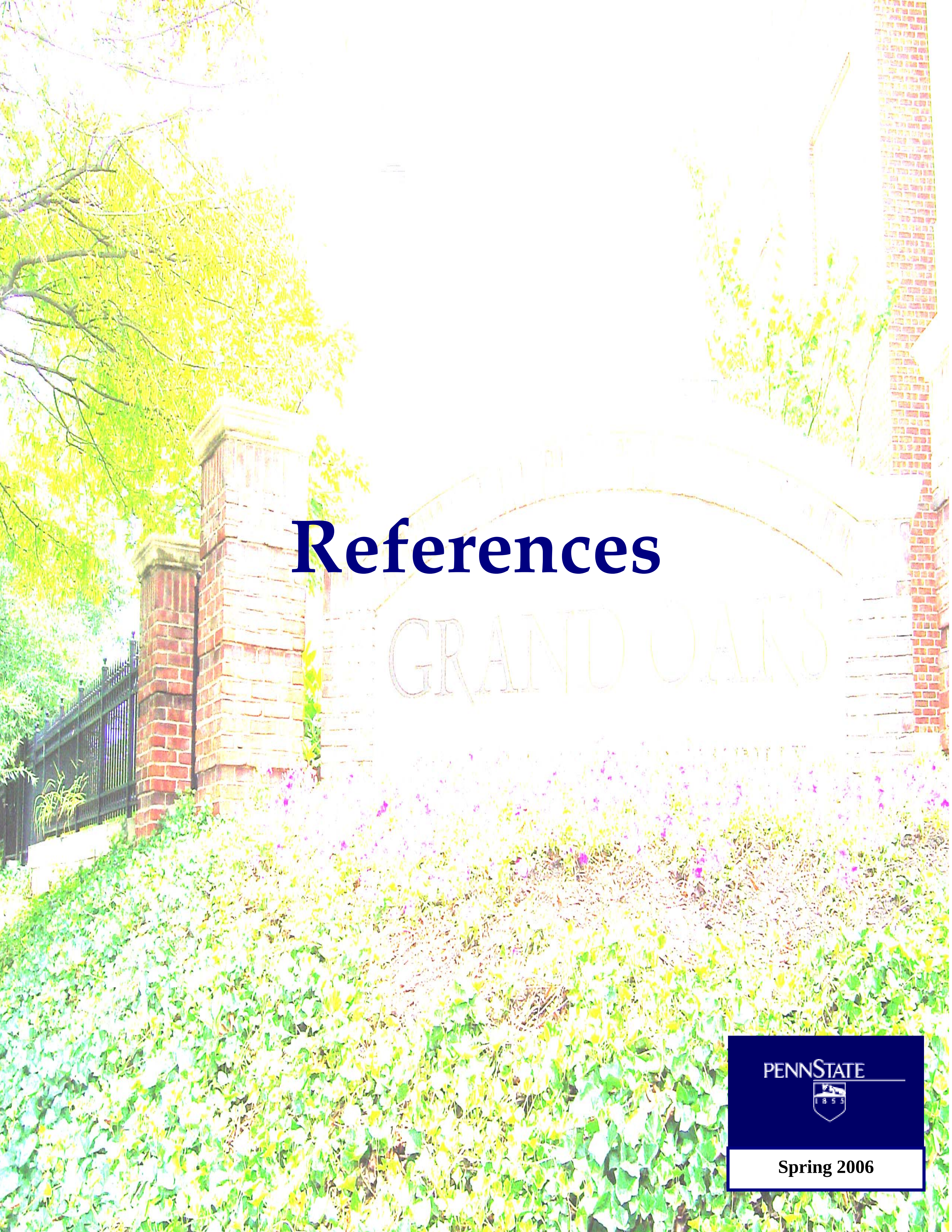
ACKNOWLEDGEMENTS

This my opportunity to thank the many people that have helped me through this senior thesis experience. The first two people to thank are my Mom and Dad, for always being a rock of which I could rely on for anything. Throughout my entire college career they have been the voice of reason and reassurance, guidance and structure, and have been two amazing role models who have given me amazing opportunities to succeed.

I would also like to thank the Architectural Engineering Faculty for providing a great education which is unmatched anywhere in the nation. A special thanks to those faculty members directly involved in making this project a success; Dr. Mistrick and Dr. Moeck for their help with my lighting and electrical needs, Dr. Friehaut for his Mechanical Advising, and Professor Parfitt for his management of the "senior thesis experience".

I would like to thank Leach Wallace Associates for sponsoring this project. A special thanks to Jacek Grabowski from Leach Wallace Associates for provided outstanding electrical engineering support and patience. I appreciate the hours that he took out of his day to answer any of my countless questions, and for making sure that I was learning the reason why things are done the way that they are. Thanks to Dave Brackett from Leach Wallace for his Mechanical support. Another special thanks to Dave Feyock from Somerset Rural Electric for his knowledge in the implementation of Geo-Thermal Heat Pumps.

Thanks to all my friends who have been there for me through this year long project. They have been there for an occasional pep talk or quite a few nights out on the town, whatever the need may have been, I could count on them.



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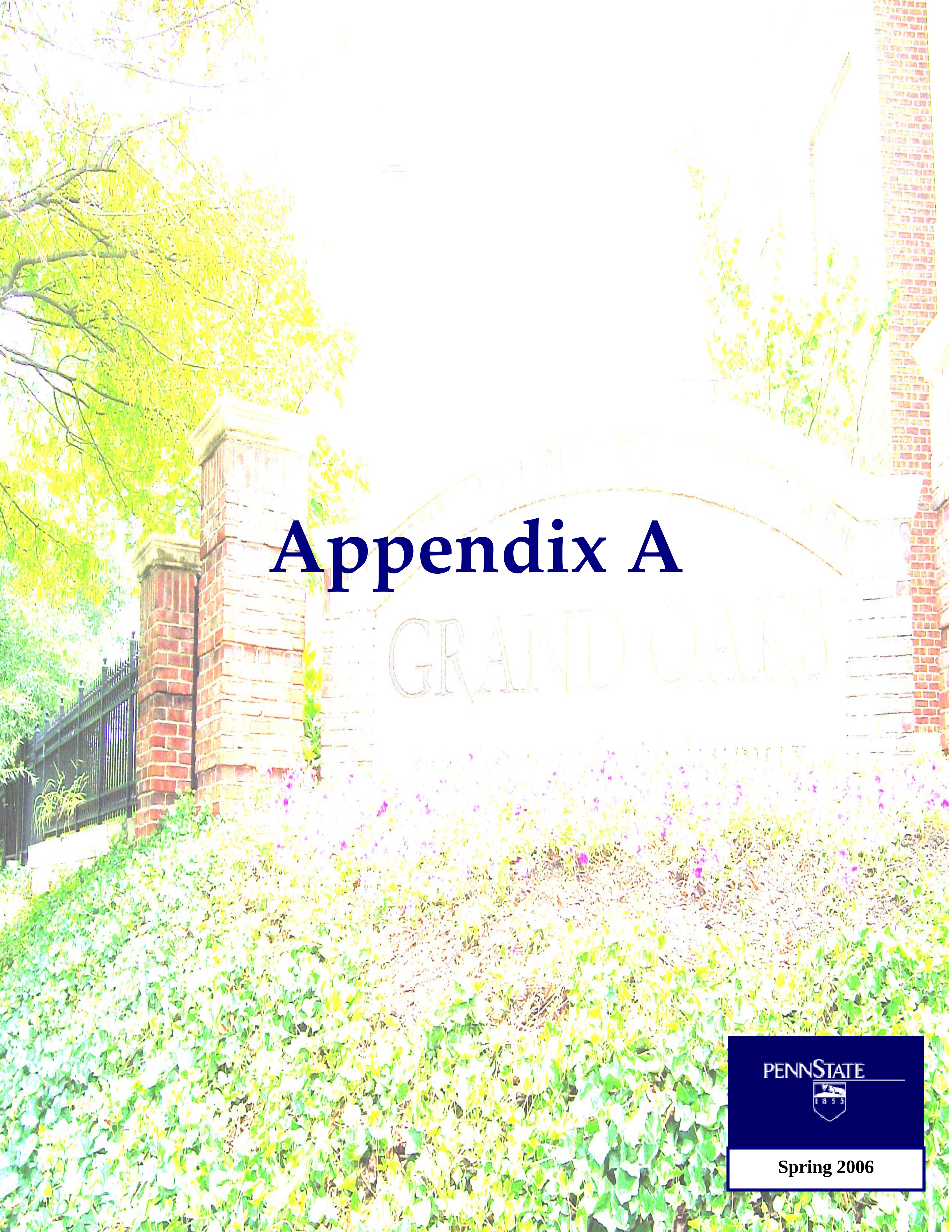
Appendix A



Spring 2006

LIGHTING FIXTURE SCHEDULE

TYPE	DESCRIPTION	MANUFACTURER / CATALOG NO.	LAMPS	VOLTAGE	NOTES
A1	DECORATIVE PENDANT	LIGHTOLIER 40740 PBUC	(1) CF42TT/835	277	DIMMING ☐
A2	LINEAR PENDANT INDIRECT CONCAVE SHEILDING	FOCAL POINT FV3S	(2) F54T5HO/841	277	DIMMING
A2b	LINEAR PENDANT INDIRECT CONCAVE SHEILDING	FOCAL POINT FV3S	(1) F54T5HO/841	277	DIMMING
A3	4' COVE LIGHT 95% SPECULAR ALLUMINUM REFLECTOR WHITE ENAMAL FINISH	PRUDENTIAL SC	(1)F32T8/830	277	DIMMING
A4	SURFACE MTD WALLWASH ALUMINUM REFLECTOR SILVER, SATIN MATT ANODISED	ERCO 65043.000	(1)F28T5/841	277	
B1	8" DOWNLIGHT, HORIZONTAL LAMP DARKLIGHT REFLECTOR ALUMINUM BRIGHT ANODISED	ERCO 22225.023	(2) CFQ26W/G24Q/835	277	DIMMING
B2	LIGHTCAST WALLWASHER DARKLIGHT REFLECTOR ALUMINUM MIRROR VAPORISED FINISH	ERCO 83855.000	(2) CFQ26W/G24Q/830	277	DIMMING
B3	8" DOWNLIGHT, HORIZONTAL LAMP DARKLIGHT REFLECTOR ALUMINUM BRIGHT ANODISED	ERCO 22225.023	(2) CFQ26W/G24Q/841	277	
B4	8" WALLWASHER	KURT VERSEN - P905	(1) CFQ26W/G24Q/841	277	
C1	8" DOWNLIGHT/VERTICAL LAMP LOW BRIGHTNESS REFLECTOR OUTDOOR	ERCO - 81022.023	(1)MH39W/830	277	
C2	8" DOWNLIGHT/VERTICAL LAMP DARKLIGHT REFLECTOR OUTDOOR	ERCO - 81029.000	(1)CFQ18W/G24Q/830	277	
C3	3' BOLLARD	LOUIS POLLSEN - BYS	(1)MH100W/830	277	
C4	POLE LIGHT ASYMMETRIC INDIRECT INDIRECT REFLECTIVE OPTICAL SYSTEM	PROVIDENCE - PROV-INDA	(1) MH50W/830	277	
C5	OUTD00R SPOT SPHEROLIT REFLECTOR SILVER, SPECULAR ANODIZED	ERCO - 34028.023	(1)MH39W/830	277	
D1	SCONCE	SPILIGHITNG P1W1016	(1)CFQ18W/830	277	DIMMING
D2	TABLE LAMP	CUSTOM	(1) CFQ13W/G24Q/830	120	outlet

Type: **A1**

Lamp: **(1)CF42TT/835**

THE AMERICAN GLASS LIGHT COMPANY®

PENDANT FIXTURES

Inca Plain Uplight

Catalog # 5826-PU

SPECIFICATIONS

Please select the specifications from the fields below. Whe
finished, print a spec sheet or save to your project file.

Width/Diameter/Length: 26"

Overall Height: Select Second

Lamping: Select Lamping

Glass/Panel: White Sandblasted Glass (std.)

Finish: Select Finish

Enter Your Notes Here:

Additional Details

Fixtures use
stainless st
aircraft cab

Weight stand

Sign-in to save P

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Type: **A2**
Lamp: **(2)F54T5HO/841**

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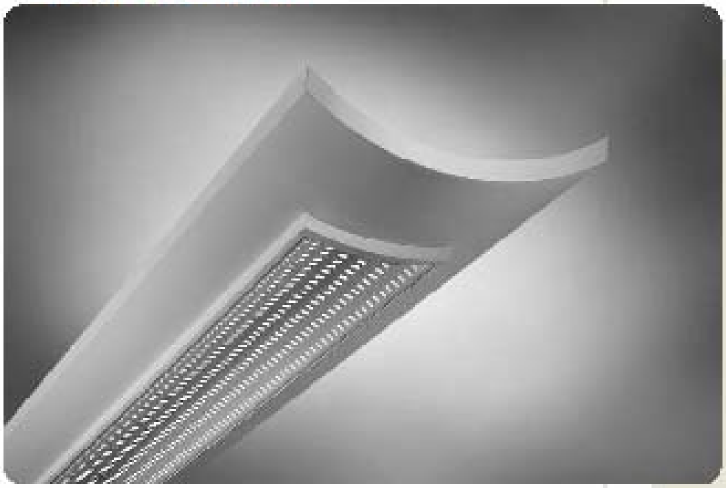


Covered by the following U.S. Patents: D491,624; D480,499; D491,620.

FEATURES

Suspend linear indirect fluorescent with concave shielding.

Verve™ III is an excellent choice for open areas, small offices, lobbies, corridors and educational facilities.

shielding options


square


slotted


round

color options


cherry red


kelly green

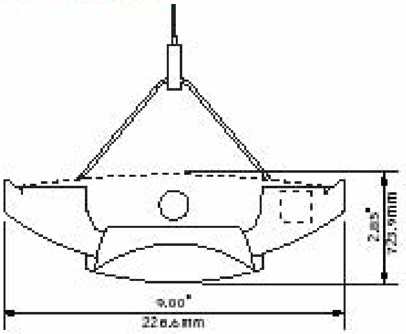

sky blue

companion luminaire


wall mount

august 2005

DIMENSIONAL DATA



lamping options


T5HO LAMPS


T5 LAMPS

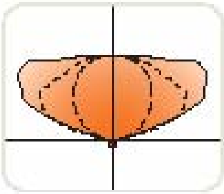

T8 LAMPS

fixture information

4' (4' 10")

8' (8' 10")

PERFORMANCE



Square Shielding
1-Lamp T5HO
94.5% Efficiency
1392 cd @ 125°

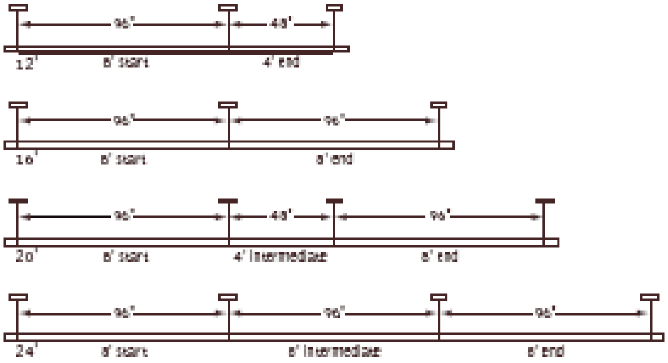
95%	Indirect
5%	Direct

See Photometric section for additional performance data.

fixture type:

project name:

MOUNTING INFORMATION



Consult factory for additional row length information.

SPECIFICATIONS

construction

One-piece 20 Ga. steel housing.

20 Ga. concave shield available with round, square or slotted perforations.

Concave shield includes white acrylic insert.

Optional red, green or blue color gel may be specified.

Ends of concave shielding is finished with specular aluminum insert and die-cast trim piece.

Die-cast 5" end cap fastened to housing.

For row installation, internal brackets form hairline joint.

All luminaires are provided with a Y-cable suspension system and are mounted on 48" or 96" centers.

4' unit weight:	22 lbs.
8' unit weight:	32 lbs.

optic

Reflector fabricated of low iridescent, semi specular premium grade aluminum.

electrical

Luminaires include factory installed branch circuit wiring with over-molded quick connects.

Electronic ballasts are thermally protected and have a Class "P" rating.

Factory installed SJT power cord at feed location is included.

Optional DALI and other dimming ballasts available.

Consult factory for dimming specifications and availability.

UL and cUL listed.

emergency

Emergency battery packs provide 90 minutes of one lamp illumination.

Initial lumen output for lamp types are as follows:

T8 Lamp:	Up to 425 lumens
T5 Lamp:	Up to 500 lumens
T5HO Lamp:	Up to 625 lumens

Battery pack requires unswitched hot from same branch circuit as AC ballast.

finish

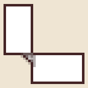
Polyester powder coat applied over a 5-stage pretreatment.

Standard luminaire housing finished in Matte Satin White or Titanium Silver.

Canopy finished in Matte Satin White.

ORDERING

luminaire series		FV3S
Verve III	FV3S	
shielding (Includes white diffuser)		______
Round Perforated Shielding (3-lamp T8, T5, T5HO only)	PS	
Square Shielding	SQ	
Slotted Shielding	SL	
optional color gel (Leave blank for no color)		______
Cherry Red Gel	R	
Kelly Green Gel	G	
Sky Blue Gel	B	
lamping		______
2 Lamp T5	2T5	
3 Lamp T5	3T5	
1 Lamp T5HO	1T5HO	
2 Lamp T5HO	2T5HO	
3 Lamp T5HO	3T5HO	
2 Lamp T8	2T8	
3 Lamp T8	3T8	
circuit		______
Single Circuit	1C	
Dual Circuit (Multiple lamp fixtures only)	2C	
voltage		______
120 Volt	120	
277 Volt	277	
347 Volt (Consult factory for availability)	347	
ballast		______
Electronic Instant Start <20% THD (T8 Only)	E	
Electronic Program Start <10% THD	S	
Electronic Dimming Ballast (Consult factory for dimming availability)	D	
mounting		______
24" Cable Suspension	C24	
48" Cable Suspension	C48	
96" Cable Suspension (Specify "J" in place of "C" for 5" dia. canopies at power feed and 2" dia. canopies at non-feed locations) (Consult factory for sloped ceiling applications)	C96	
factory options		______
Emergency Circuit	EC	
Emergency Battery Pack	EM	
HLR/GLR Fuse	FU	______
Include 3000K Lamp	L830	______
Include 3500K Lamp	L835	
Include 4100K Lamp	L841	
finish		______
Matte Satin White	WH	
Titanium Silver	TS	
luminaire run length		______
4'	4'	
8'	8'	
12' (8'+4')	12'	
16' (8'+8')	16'	
20' (8'+4'+8')	20'	
24' (8'+8'+8')	24'	
integrator options		______
90-degree Corner	FV3-90	

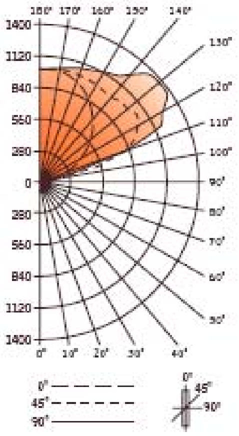


concave

verve™ III

Filename: FV3SSQ1T5H.IES
Catalog #: FV3S-SQ-1T5HO-1C-120-S-C24-WH-4'
Efficiency: 94.5%
Test #: 11588.0

CANDLEPOWER DISTRIBUTION



Vertical Angle	Horizontal Angle 0°	22.5°	45°	67.5°	90°	Zonal Lumens
0°	83	83	83	83	83	
5°	84	82	82	84	82	8
15°	84	84	84	84	84	24
25°	77	77	79	79	79	36
35°	71	74	74	74	73	46
45°	55	56	56	56	56	43
55°	40	42	42	42	42	38
65°	24	25	25	24	24	24
75°	8	11	9	11	9	10
85°	0	0	1	1	1	7
90°	0	1	1	1	1	
95°	40	40	11	11	11	24
105°	178	444	530	361	305	417
115°	350	621	948	1149	1196	866
125°	516	693	1060	1321	1392	903
135°	676	788	1030	1277	1376	798
145°	806	866	999	1121	1168	624
155°	923	951	1021	1082	1110	471
165°	996	1005	1029	1054	1064	292
175°	1017	1019	1021	1022	1024	97
180°	1020	1020	1020	1020	1020	

Spacing Criterion: 1.3 1.4

LUMEN SUMMARY

	Zone	Lumens	% Lamp	% Fixt
	0°-30°	68	1.4	1.4
	0°-90°	230	4.6	4.9
	90°-130°	2211	44.2	46.8
	90°-180°	4493	89.9	95.1
Total Luminaire	0°-180°	4723	94.5	100.0

LUMINANCE DATA (CD/M²)

Vertical Angle	0°	45°	90°
45°	277	282	282
55°	248	261	261
65°	202	211	202
75°	110	124	124
85°	0	41	41

CO–EFFICIENTS OF UTILIZATION

Floor								20						
Ceiling	80				70			50		30		10		00
Wall	70	50	30	10	70	50	10	50	10	50	10	50	10	00
RCR 0	91	91	91	91	78	78	78	55	55	34	34	14	14	05
1	83	79	75	72	71	68	63	48	45	29	28	12	12	04
2	75	69	63	59	65	60	51	42	37	26	23	11	10	03
3	69	60	54	49	59	52	43	37	31	23	19	10	08	03
4	63	53	46	41	54	46	36	33	26	20	17	09	07	03
5	57	47	40	35	49	41	31	29	22	18	14	08	06	02
6	53	42	35	30	45	37	27	26	19	16	12	07	05	02
7	49	38	31	26	42	33	25	24	17	15	11	06	05	02
8	45	35	28	23	39	30	21	21	15	13	10	06	04	01
9	42	31	25	21	36	27	18	19	13	12	08	05	04	01
10	39	29	23	19	34	25	16	18	12	11	08	05	03	01

Numbers indicate percentage values of reflectivity.

Go to www.focalpointlights.com for additional photometric data.

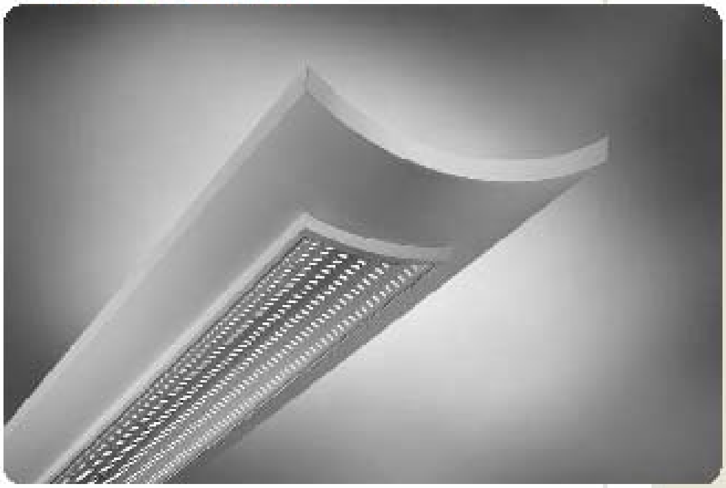
Type: **A2b**

Lamp: **(1)F54T5HO/841**

FOCAL POINT®

concave

verve™ III



Covered by the following U.S. Patents: D481,624; D480,499; D481,620.

FEATURES

Suspend linear indirect fluorescent with concave shielding.

Verve™ III is an excellent choice for open areas, small offices, lobbies, corridors and educational facilities.

shielding options

square

slotted

round

color options

cherry red

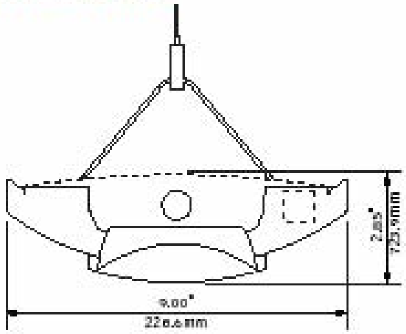
kelly green

sky blue

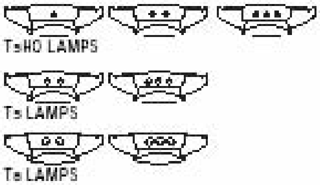
companion luminaire

wall mount

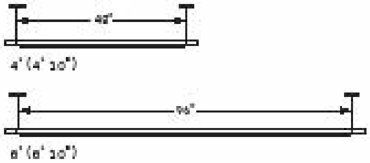
DIMENSIONAL DATA



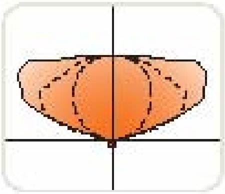
lamping options



fixture information



PERFORMANCE



Square Shielding
1-Lamp T5HO
94.5% Efficiency
1392 cd @ 125°

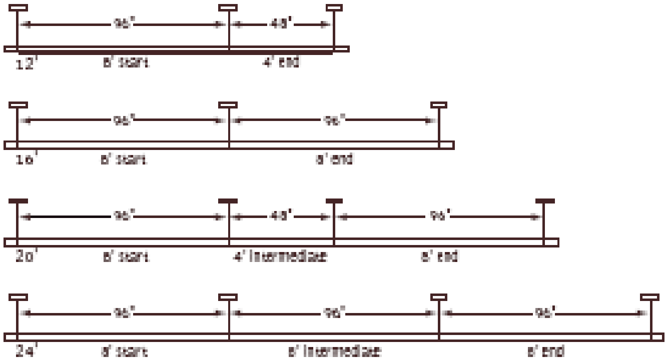
95% Indirect
5% Direct

See Photometric section for additional performance data.

fixture type:

project name:

MOUNTING INFORMATION



Consult factory for additional row length information.

SPECIFICATIONS

construction

One-piece 20 Ga. steel housing.

20 Ga. concave shield available with round, square or slotted perforations.

Concave shield includes white acrylic insert.

Optional red, green or blue color gel may be specified.

Ends of concave shielding is finished with specular aluminum insert and die-cast trim piece.

Die-cast 5" end cap fastened to housing.

For row installation, internal brackets form hairline joint.

All luminaires are provided with a Y-cable suspension system and are mounted on 48" or 96" centers.

4' unit weight: 22 lbs.
8' unit weight: 32 lbs.

optic

Reflector fabricated of low iridescent, semi specular premium grade aluminum.

electrical

Luminaires include factory installed branch circuit wiring with over-molded quick connects.

Electronic ballasts are thermally protected and have a Class "P" rating.

Factory installed SJT power cord at feed location is included.

Optional DALI and other dimming ballasts available.

Consult factory for dimming specifications and availability.

UL and cUL listed.

emergency

Emergency battery packs provide 90 minutes of one lamp illumination.

Initial lumen output for lamp types are as follows:

T8 Lamp:	Up to 425 lumens
T5 Lamp:	Up to 500 lumens
T5HO Lamp:	Up to 825 lumens

Battery pack requires unswitched hot from same branch circuit as AC ballast.

finish

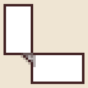
Polyester powder coat applied over a 5-stage pretreatment.

Standard luminaire housing finished in Matte Satin White or Titanium Silver.

Canopy finished in Matte Satin White.

ORDERING

luminaire series		FV3S
Verve III	FV3S	
shielding (Includes white diffuser)		______
Round Perforated Shielding (3-lamp T8, T5, T5HO only)	PS	
Square Shielding	SQ	
Slotted Shielding	SL	
optional color gel (Leave blank for no color)		______
Cherry Red Gel	R	
Kelly Green Gel	G	
Sky Blue Gel	B	
lamping		______
2 Lamp T5	2T5	
3 Lamp T5	3T5	
1 Lamp T5HO	1T5HO	
2 Lamp T5HO	2T5HO	
3 Lamp T5HO	3T5HO	
2 Lamp T8	2T8	
3 Lamp T8	3T8	
circuit		______
Single Circuit	1C	
Dual Circuit (Multiple lamp fixtures only)	2C	
voltage		______
120 Volt	120	
277 Volt	277	
347 Volt (Consult factory for availability)	347	
ballast		______
Electronic Instant Start <20% THD (T8 Only)	E	
Electronic Program Start <10% THD	S	
Electronic Dimming Ballast (Consult factory for dimming availability)	D	
mounting		______
24" Cable Suspension	C24	
48" Cable Suspension	C48	
96" Cable Suspension (Specify "J" in place of "C" for 5" dia. canopies at power feed and 2" dia. canopies at non-feed locations) (Consult factory for sloped ceiling applications)	C96	
factory options		______
Emergency Circuit	EC	
Emergency Battery Pack	EM	
HLR/GLR Fuse	FU	______
Include 3000K Lamp	L830	______
Include 3500K Lamp	L835	
Include 4100K Lamp	L841	
finish		______
Matte Satin White	WH	
Titanium Silver	TS	
luminaire run length		______
4'	4'	
8'	8'	
12' (8'+4')	12'	
16' (8'+8')	16'	
20' (8'+4'+8')	20'	
24' (8'+8'+8')	24'	
integrator options		______
90-degree Corner	FV3-90	

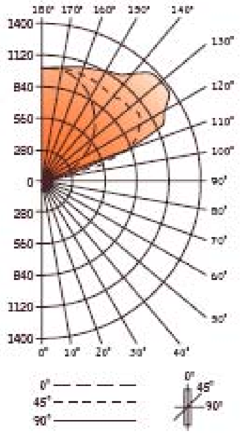


concave

verve™ III

Filename: FV3SSQ1T5H.IES
Catalog #: FV3S-SQ-1T5HO-1C-120-S-C24-WH-4'
Efficiency: 94.5%
Test #: 11588.0

CANDLEPOWER DISTRIBUTION



Vertical Angle	0°	22.5°	45°	67.5°	90°	Zonal Lumens
	Horizontal Angle					
0°	83	83	83	83	83	
5°	84	82	82	84	82	8
15°	84	84	84	84	84	24
25°	77	77	79	79	79	36
35°	71	74	74	74	73	46
45°	55	56	56	56	56	43
55°	40	42	42	42	42	38
65°	24	25	25	24	24	24
75°	8	11	9	11	9	10
85°	0	0	1	1	1	7
90°	0	1	1	1	1	
95°	40	40	11	11	11	24
105°	178	444	530	361	305	417
115°	350	621	948	1149	1196	866
125°	516	693	1060	1321	1392	903
135°	676	788	1030	1277	1376	798
145°	806	866	999	1121	1168	624
155°	923	951	1021	1082	1110	471
165°	996	1005	1029	1054	1064	292
175°	1017	1019	1021	1022	1024	97
180°	1020	1020	1020	1020	1020	

Spacing 1.3
Criterion: 1.4

LUMEN SUMMARY

	Zone	Lumens	% Lamp	% Fixt
	0°-30°	68	1.4	1.4
	0°-90°	230	4.6	4.9
	90°-130°	2211	44.2	46.8
	90°-180°	4493	89.9	95.1
Total Luminaire	0°-180°	4723	94.5	100.0

LUMINANCE DATA (CD/M²)

Vertical Angle	0°	45°	90°
45°	277	282	282
55°	248	261	261
65°	202	211	202
75°	110	124	124
85°	0	41	41

CO–EFFICIENTS OF UTILIZATION

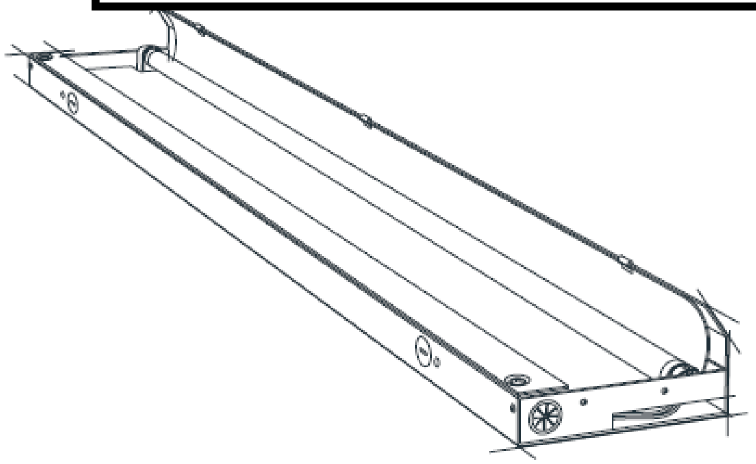
Floor								20						
Ceiling	80				70			50		30		10		00
Wall	70	50	30	10	70	50	10	50	10	50	10	50	10	00
RCR 0	91	91	91	91	78	78	78	55	55	34	34	14	14	05
1	83	79	75	72	71	68	63	48	45	29	28	12	12	04
2	75	69	63	59	65	60	51	42	37	26	23	11	10	03
3	69	60	54	49	59	52	43	37	31	23	19	10	08	03
4	63	53	46	41	54	46	36	33	26	20	17	09	07	03
5	57	47	40	35	49	41	31	29	22	18	14	08	06	02
6	53	42	35	30	45	37	27	26	19	16	12	07	05	02
7	49	38	31	26	42	33	25	24	17	15	11	06	05	02
8	45	35	28	23	39	30	21	21	15	13	10	06	04	01
9	42	31	25	21	36	27	18	19	13	12	08	05	04	01
10	39	29	23	19	34	25	16	18	12	11	08	05	03	01

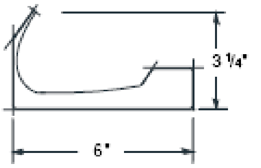
Numbers indicate percentage values of reflectivity.

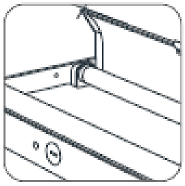
Go to www.focalpointlights.com for additional photometric data.

Type
Job Name
Catalog Number

Type: A3
Lamp: (1)F32T8/830







ordering

series	lamp rows	nominal length	voltage	options
SC				
	1T8	02'	120	PAF
	1T5	03'	277	EML*
	1T5HO	04'	347*	EMH*
		06'	*T8 & T5HO only	DM
		08'		RSE*†
		R__*		10THD†
		*row length		B__
				FH
				QC
				*consult factory for fixture lengths < 4' †T8 only

Applications Coves, retail, lobbies, small offices, conference rooms.

Features A low-profile cove lighting system designed for T5/HO or T8 lamps with a unique 3-piece optical system. Formed 95 percent reflective specular aluminum reflector throws light at low angles. Galvanized steel bottom reflector directs and diffuses light on ceiling to eliminate striations while limiting uplight. White backlight reflector fills the cove cavity with light, limiting socket shadow.

Construction The housing, available in 2-, 3-, 4-, 6- or 8-foot standard lengths, and end plates are made of die-formed, 20-gauge steel. The three part reflector system is die-formed from 95 percent reflective specular aluminum, 20-gauge steel and galvanized steel.

Finish The standard exterior body color is white enamel.

Electrical T8 fixtures have instant-start electronic ballasts with less than 20% THD. T5/HO fixtures have programmed-start electronic ballasts with less than 10% THD. Fixtures are U.L. Damp labeled (non-emergency) and I.B.E.W. manufactured. Maximum ballasts size available: 1 5/8" width x 1 1/4" height.

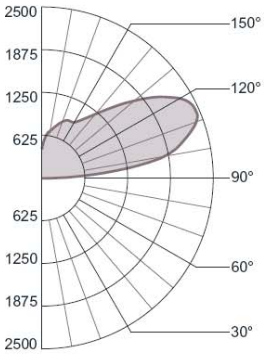
Mounting Fixture is to be surface-mounted within concealed coves.

Options **PAF**: painted after fabrication; **EML**: emergency battery (T5/HO=700 lumens; T8=600 lumens); **EMH**: emergency battery (T5/HO=1200 lumens; T8=1200 lumens); **DM**: dimming (consult factory); **RSE**: rapid-start electronic (T8 only); **10THD**: ballast with < 10% total harmonic distortion; (T8 only); **B_**: specific ballast, specify manufacturer and catalog number (consult factory); **FH**: fixture fusing (slow blow); **QC**: quick-connect circuit assemblies.

photometric data

SC-1T5HO-04

Report # LSI16391 D=0.0% I=100.0%
Lamp Lumens: 4500 Input Watts: 58



Candlepower Summary

Vertical	Horizontal Angle					Output
Angle	0°	22.5°	45°	67.5°	90°	Lumens
90	0	48	35	79	39	
95	10	584	840	1069	911	385
100	37	821	1350	1858	1802	
105	74	753	1615	2064	2149	723
110	111	633	1686	2253	2400	
115	147	567	1557	2225	2455	694
120	183	543	1356	2027	2335	
125	222	564	1154	1759	2076	519
130	256	616	1001	1492	1764	
135	290	646	892	1257	1473	359
140	323	660	835	1082	1230	
145	349	652	838	938	1056	249
150	374	652	848	916	946	
155	395	644	810	905	933	174
160	413	646	761	838	881	
165	427	616	707	756	788	96
170	439	564	671	690	701	
175	446	499	564	575	603	28
180	429	429	429	429	429	

Zonal Lumen Summary

Zone	% Lamp	% Luminaire
0-90	0.00	0.00
0-180	75.74	100.00

Efficiency = 75.7%

Peak Candela = 2458 @ 112.5°
Peak : Zenith Ratio = 5.7 : 1

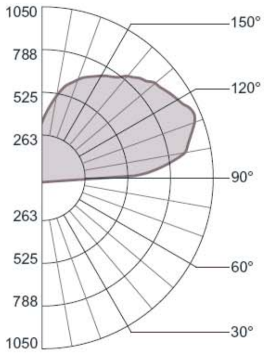
Coefficients of Utilization (%)

Floor	effective floor cavity reflectance = .20										
Ceiling	80				70				50		
Wall	**70**	**50**	**30**	**10**	**70**	**50**	**30**	**10**	**50**	**30**	**10**
RCR **0**	72	72	72	72	62	62	62	62	42	42	42
1	66	63	60	57	56	53	51	49	37	35	34
2	60	54	50	47	51	47	43	40	32	30	28
3	54	48	43	39	46	41	37	34	28	26	24
4	50	42	37	33	42	36	32	28	25	22	20
5	45	37	32	28	39	32	27	24	22	19	17
6	42	33	28	24	35	28	24	21	20	17	15
7	38	30	24	20	32	25	21	18	18	15	12
8	35	27	21	18	30	23	18	15	16	13	11
9	32	24	19	15	28	21	16	13	14	12	09

photometric data

SC-1T8-04

Report # LSI16088 D=0.0% I=100.0%
Lamp Lumens: 2950 Input Watts: 31



Candlepower Summary

Vertical	Horizontal Angle					Output
Angle	0°	22.5°	45°	67.5°	90°	Lumens
90	2	138	316	518	556	
95	17	258	493	704	757	248
100	44	360	605	855	917	
105	81	373	695	903	974	328
110	118	382	717	959	1042	
115	156	399	699	934	1044	325
120	192	422	685	887	986	
125	227	451	672	852	937	287
130	260	481	669	820	897	
135	292	509	653	798	857	245
140	319	530	660	756	827	
145	349	547	663	739	778	197
150	373	545	664	725	759	
155	393	536	652	709	734	142
160	410	520	637	679	703	
165	424	502	592	635	660	90
170	434	483	538	560	584	
175	440	460	485	486	500	24
180	430	430	430	430	430	

Zonal Lumen Summary

Zone	% Lamp	% Luminaire
0-90	0.00	0.00
0-180	71.58	100.00

Efficiency = 71.6%

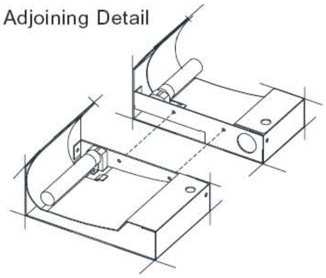
Peak Candela = 1053 @ 112.5°
Peak : Zenith Ratio = 2.4 : 1

Coefficients of Utilization (%)

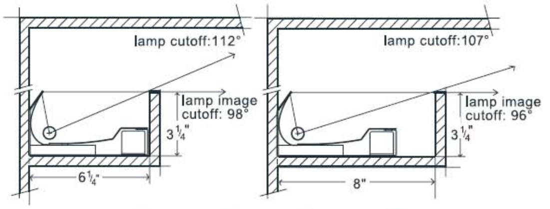
Floor	effective floor cavity reflectance = .20										
Ceiling	80				70				50		
Wall	**70**	**50**	**30**	**10**	**70**	**50**	**30**	**10**	**50**	**30**	**10**
RCR **0**	68	68	68	68	58	58	58	58	40	40	40
1	62	59	57	54	53	51	49	46	35	33	32
2	56	51	47	44	48	44	41	38	30	28	26
3	51	45	41	37	44	39	35	32	27	24	22
4	47	40	35	31	41	34	30	27	23	21	19
5	43	35	30	26	36	30	26	23	21	18	16
6	39	31	26	22	33	27	23	19	19	16	14
7	36	28	23	19	31	24	20	17	17	14	12
8	33	25	20	17	28	22	17	14	15	12	10
9	31	23	18	14	26	20	15	13	14	11	09

installation

Adjoining Detail



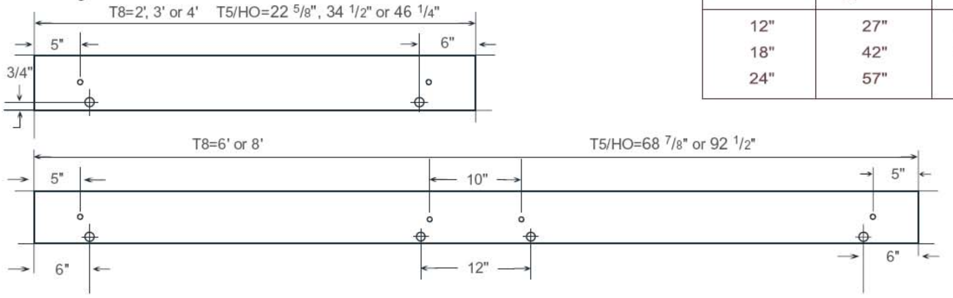
Mounting Details



Distance from wall along ceiling

cove to ceiling	Peak Candela @ 112.5°	6 ¼" cove		8" cove	
		lamp	lamp image	lamp	lamp image
12"	27"	27"	70"	37"	91"
18"	42"	42"	112"	57"	148"
24"	57"	57"	155"	77"	205"

Mounting Locations

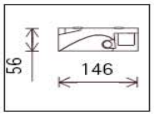


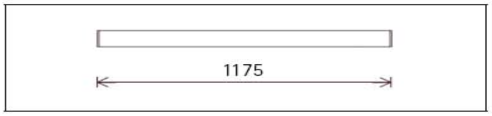
Type: A4
Lamp: (1)F28T5/841

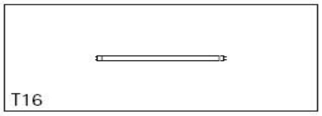
ERCO

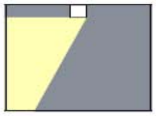
TFL Wallwasher

for fluorescent lamps









65043.000 White (RAL9002)
T16 28W G5 2600lm
ECG

Product description
Housing: aluminium profile, powder-coated.
1 cable entries. Through-wiring possible. 3-pole terminal block.
Electronic control gear.
Wallwasher reflector: aluminium, silver, satin matt anodised. Hinged cover for lamp replacement.
Weight 4.00kg

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Germany
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Fax.:+49 2351 551-300
info@erco.com

Technical Region: 230V/50Hz
Edition: December 16, 2005
Please download the current version from
www.erco.com/65043.000

ERCO

TFL Wallwasher

Planning data

Cleaning (a)	1				2				3			
Ambient conditions	P	C	N	D	P	C	N	D	P	C	N	D
LMF	0.94	0.89	0.81	0.72	0.88	0.80	0.69	0.59	0.84	0.74	0.61	0.52
RSMF	0.99	0.98	0.96	0.95	0.97	0.96	0.95	0.94	0.97	0.96	0.95	0.94

Hours of operation (h)	2000	4000	6000	8000	10000	12000	14000	16000	18000	20000
LLMF	0.96	0.95	0.94	0.93	0.92	0.91	0.90	0.89	0.88	0.88
LSF	1	1	1	1	1	1	1	1	1	1

MF	LMFxRSMFxLLMFxLSF
MF	Maintainance Factor
LMF	Lumiaire Maintenance Factor
RSMF	Room Surface Maintenance Factor
LLMF	Lamp Lumens Maintenance Factor
LSF	Lamp Survival Factor
P	Room pure
C	Room clean
N	Room normal
D	Room dirty

Illuminance E_n (lx)
Specifications:
Number of luminaires n > 5
Wall height (m) 3
T16 28W G5 2600lm

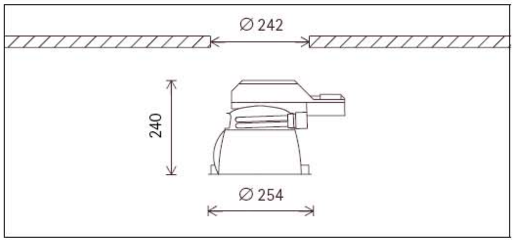
Offset from wall (m)	1.00		1.00		1.25		1.25	
Luminaire spacing (m)	1.25		1.50		1.25		1.75	
	below the luminaire	between the luminaires	below the luminaire	between the luminaires	below the luminaire	between the luminaires	below the luminaire	between the luminaires
0.250	285	228	258	176	123	117	93	79
0.500	624	559	559	430	396	382	313	252
0.750	619	579	540	463	506	488	390	331
1.000	510	490	439	401	460	450	348	315
1.250	412	403	352	335	394	389	297	278
1.500	333	327	284	275	333	329	250	240
1.750	269	265	230	225	280	277	211	205
2.000	217	213	185	182	235	233	178	174
2.250	176	172	151	149	197	194	150	147
2.500	144	140	125	122	164	162	126	124
2.750	118	116	104	101	137	135	107	105

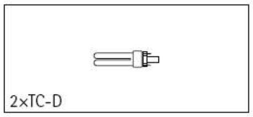
Type: B1
Lamp: (2)CF26W/835

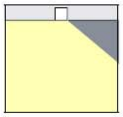
ERCO

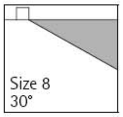
Lightcast Washlight

for TC-D lamps









22215.000 Reflector silver
2×TC-D 26W G24d-3 1800lm

Product description
Housing: cast aluminium, designed as heat sink.
Mounting ring: cast aluminium, white (RAL9002) powder-coated.
Tools not required for mounting with 4-point support and screw fixing.
Junction box for through-wiring, 5-pole terminal block, integrated cable clamp.
2 sets of low-loss control gear.
Darklight reflector: aluminium, bright anodised. Cut-off angle 30°.
Weight 3.70kg

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Technical Region: 230V/50Hz
Edition: December 16, 2005
Please download the current version from
www.erco.com/22215.000

ERCO

Lightcast Washlight

Planning data

Cleaning (a)	1				2				3			
Ambient conditions	P	C	N	D	P	C	N	D	P	C	N	D
LMF	0.94	0.89	0.81	0.72	0.88	0.80	0.69	0.59	0.84	0.74	0.61	0.52
RSMF	0.99	0.98	0.96	0.95	0.97	0.96	0.95	0.94	0.97	0.96	0.95	0.94

Hours of operation (h)	1000	2000	4000	6000	8000	10000
LLMF	0.97	0.92	0.88	0.85	0.83	0.83
LSF	1	1	1	1	1	1

MF	LMFxRSMFxLLMFxLSF
MF	Maintainance Factor
LMF	Lumiaire Maintenance Factor
RSMF	Room Surface Maintenance Factor
LLMF	Lamp Lumens Maintenance Factor
LSF	Lamp Survival Factor
P	Room pure
C	Room clean
N	Room normal
D	Room dirty

Illuminance E_n (lx)
Specifications:
Number of luminaires n > 5
Wall height (m) 3
TC-D 26W G24d-3 1800lm

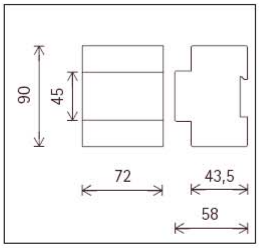
Offset from wall (m)	0.90		0.90		1.20		1.20	
Luminaire spacing (m)	0.90		1.20		1.20		1.50	
	below the luminaire	between the luminaires	below the luminaire	between the luminaires	below the luminaire	between the luminaires	below the luminaire	between the luminaires
0.250	184	185	141	133	90	91	74	71
0.500	239	245	185	175	123	122	101	96
0.750	250	270	184	222	137	143	113	111
1.000	277	260	218	197	141	152	108	131
1.250	256	266	200	193	163	143	129	118
1.500	253	248	190	194	148	156	124	115
1.750	215	226	182	173	147	147	115	122
2.000	192	194	153	157	142	140	112	114
2.250	165	163	130	138	125	131	109	106
2.500	140	140	115	118	114	118	98	99
2.750	118	120	100	101	104	105	85	90

ERCO

Lightcast Washlight

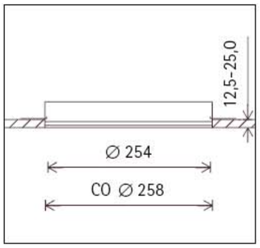
Accessories

83816.000
DALI switching actuator, double, 16A
Two voltage-free contacts for switching ohmic, inductive and capacitive loads max 16A.
DALI interface with two independent addresses.
Mounting on DIN rail.
Weight 0.21kg

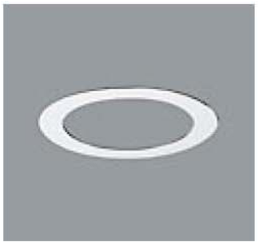


83955.000
Plaster ring
Metal, white.
Height 20mm.

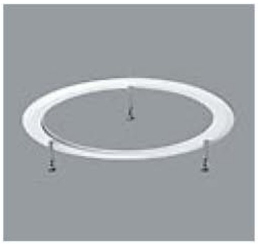
83777.000
Mounting ring
Metal, white powder-coated. For flush-mounting installation in plasterboard ceilings.



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



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



83973.000
Fixture
For decorative disc size 8.
Metal ring, white. 3 spacer sleeves, metal chrome-plated.

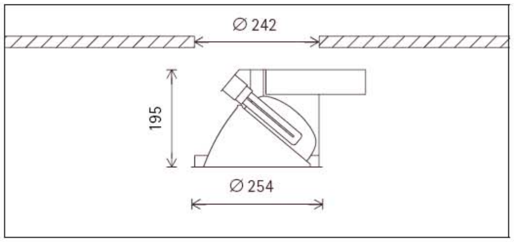
83943.000
Decorative circular disc
Size 8
Plastic white, translucent, mirror-finish.
Only in conjunction with:
83973.000

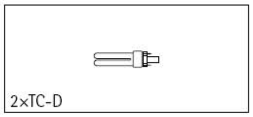
Type: **B2**
Lamp: **(2)CF26W/830**

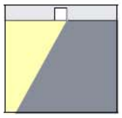
ERCO

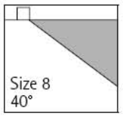
Lightcast Wallwasher

for TC-D lamps









83885.000 Reflector silver
2×TC-D 26W G24d-3 1800lm

Product description
Housing: metal, black powder-coated.
Mounting ring: cast aluminium, white (RAL9002) powder-coated.
2 cable entries, through-wiring possible. 5-pole terminal block.
2 sets of low-loss control gear.
Upper reflector: aluminium, silver anodised.
Darklight reflector: plastic, mirror-finish aluminium vaporised, outside white. Scratch resistant special coating. Cut-off angle 40°.
Weight 2.70kg

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Technical Region: 230V/50Hz
Edition: December 16, 2005
Please download the current version from
www.erco.com/83885.000

ERCO

Lightcast Wallwasher

Planning data

Cleaning (a)	1				2				3			
Ambient conditions	P	C	N	D	P	C	N	D	P	C	N	D
LMF	0.94	0.89	0.81	0.72	0.88	0.80	0.69	0.59	0.84	0.74	0.61	0.52
RSMF	0.99	0.98	0.96	0.95	0.97	0.96	0.95	0.94	0.97	0.96	0.95	0.94

Hours of operation (h)	1000	2000	4000	6000	8000	10000
LLMF	0.97	0.92	0.88	0.85	0.83	0.83
LSF	1	1	1	1	1	1

MF	LMFxRSMFxLLMFxLSF
MF	Maintainance Factor
LMF	Lumiaire Maintenance Factor
RSMF	Room Surface Maintenance Factor
LLMF	Lamp Lumens Maintenance Factor
LSF	Lamp Survival Factor
P	Room pure
C	Room clean
N	Room normal
D	Room dirty

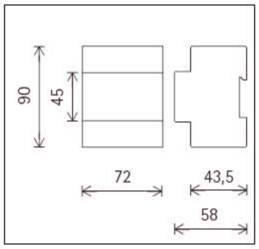
Illuminance E_n (lx)
Specifications:
Number of luminaires n > 5
Wall height (m) 3
TC-D 26W G24d-3 1800lm

Offset from wall (m)	0.90		0.90		1.20		1.20	
Luminaire spacing (m)	0.90		1.20		1.20		1.50	
	below the luminaire	between the luminaires	below the luminaire	between the luminaires	below the luminaire	between the luminaires	below the luminaire	between the luminaires
0.250	132	127	117	74	44	34	42	21
0.500	438	480	348	332	156	167	133	122
0.750	612	675	463	496	284	311	231	240
1.000	601	658	437	507	344	380	277	302
1.250	521	556	375	446	346	379	273	309
1.500	431	443	311	361	317	344	248	287
1.750	348	347	259	286	280	297	220	251
2.000	278	276	215	228	242	249	191	213
2.250	223	221	178	183	207	207	166	178
2.500	179	178	147	150	175	174	144	150
2.750	147	144	122	124	148	147	124	126

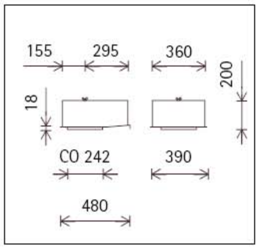
Lightcast Wallwasher

Accessories

83816.000
DALI switching actuator, double, 16A
Two voltage-free contacts for switching ohmic, inductive and capacitive loads max 16A.
DALI interface with two independent addresses.
Mounting on DIN rail.
Weight 0.21kg

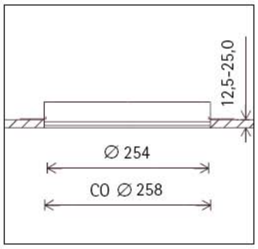


83590.000
Concrete housing
Metal, powder-coated.
Recommended aggregate grain size of the concrete is 0-8mm.
Weight 5.20kg



83955.000
Plaster ring
Metal, white.
Height 20mm.

83777.000
Mounting ring
Metal, white powder-coated. For flush-mounting installation in plasterboard ceilings.



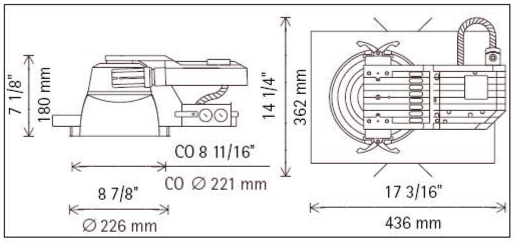
82950.000
Mounting plate for panelled ceilings
Metal, white (RAL9002) powder-coated. Individual design of mounting plates according to ceiling type and luminaire. Quote ceiling type and dimensions.

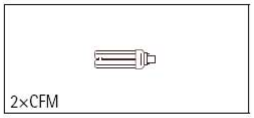
83980.000
Cover ring
Metal, white. For covering the gap where ceiling cut-outs are too big. Inner and outer diameter to be specified when placing order.

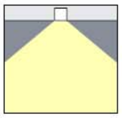
Type: B3
Lamp: (2)CF26W/841

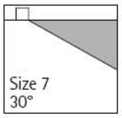
ERCO

LC Downlight
for compact fluorescent lamps

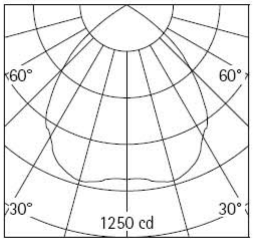








cULus
Dry Damp Wet
← Indoor



2×CFM 26W GX24q-3 1800lm

Efficiency: 49%

22225.023 Reflector silver
2×CFM 26W GX24q-3 1800lm
ECG

Product description
Housing: cast aluminum, designed as heat sink.
Mounting ring: cast aluminum, white (RAL9002) powder-coated.
4-point support and screw tightening for fixing to mounting plate.
Electronic control gear 120V/277V, 60Hz, class P inside cast housing.
Mounting plate for preinstallation with junction box for through-wiring. Snap-in plug for connection between junction box and luminaire.
Low brightness reflector: aluminum, specular anodized. Cut-off angle 30° from horizontal.
Diffuser as lamp cover: plastic, translucent, for lamp replacement removable without tools.
Type Non IC luminaire.
Insulation materials must be kept away from the luminaire by a minimum of 3". Suitable for damp location. Removal of reflector allows access to junction box from below.
Max. ceiling thickness 3/4".
Weight 9.26lbs / 4.20kg

ERCO

LC Downlight

Planning Data

22225.023	CFM 26W GX24q-3 1800lm	
Connected load	P:	52 W
Connected load per 10fc	P*:	0.4 W/ft^2
Number of luminaires per 10fc	n*:	7.0 1/1000ft^2

22225.023	CFM 26W GX24q-3 1800lm			
Number of luminaires per 1000ft^2 for	10fc	20fc	30fc	50fc
	7	14	22	36

22225.023	CFM 26W GX24q-3 1800lm			
Module (ft)	4x6	6x6	6x8	8x8
Illuminance (fc)	59	40	30	22

Correction table

Ceiling	0.70	0.70	0.70	0.50	0
Wall	0.70	0.50	0.20	0.20	0
Floor	0.50	0.20	0.20	0.10	0
k 0.6	77	58	49	49	45
k 1.0	100	77	69	67	63
k 1.5	116	91	84	81	77
k 2.5	129	100	95	90	86
k 3.0	133	103	99	93	89

ERCO

LC Downlight

Photometric report

Lamp Information

CFM 26W GX24q-3 1800lm
Note:
Photometric data may change when using different lamps.
These guide values are based on 10ft ceiling height in a square room of 1000ft² and mean reflectances (ceiling 70 %, walls 50 % and floor 20 %). Other room shapes or reflectances should be converted accordingly. The values include the light loss factor of 0.8.

Coefficiants of Utilisation

Reflectances																
Ceiling	80	80	80	70	70	70	50	50	50	30	30	30	10	10	10	0
Wall	50	30	10	50	30	10	50	30	10	50	30	10	50	30	10	0
Floor	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
Room Cavity Ratio																
0	62	62	62	60	60	60	56	56	56	53	53	53	50	50	50	49
1	54	54	54	53	53	52	51	51	50	48	48	48	47	46	46	45
2	50	49	48	49	48	47	47	46	45	45	45	44	44	43	43	42
3	46	44	43	45	44	42	43	42	41	42	41	40	41	40	39	38
4	42	40	38	42	40	38	40	39	37	39	38	37	38	37	36	35
5	39	37	35	39	36	34	37	36	34	36	35	33	35	34	33	32
6	36	33	31	36	33	31	35	32	30	34	32	30	33	31	30	29
7	33	30	28	33	30	28	32	29	27	31	29	27	30	28	27	26
8	31	27	25	30	27	25	29	27	25	29	26	24	28	26	24	23
9	28	25	22	28	25	22	27	24	22	26	24	22	26	23	22	21
10	26	23	20	26	22	20	25	22	20	24	22	20	24	21	19	19

Candlepower distribution

Vertical Angle	Candelas		
	0°	45°	90°
0°	939	939	939
10°	965	965	965
20°	953	953	953
30°	819	819	819
40°	623	623	623
50°	347	347	347
60°	4	4	4
70°	0	0	0
80°	0	0	0
90°	0	0	0

Zonal Lumen Summery

Zone	Lumens	%Lamp	%Fixture
0°	0	0	0
10°	91	3	5
20°	365	10	21
30°	778	22	44
40°	1239	34	70
50°	1610	45	91
60°	1761	49	100
70°	1762	49	100
80°	1762	49	100
90°	1762	49	100

Luminance Data

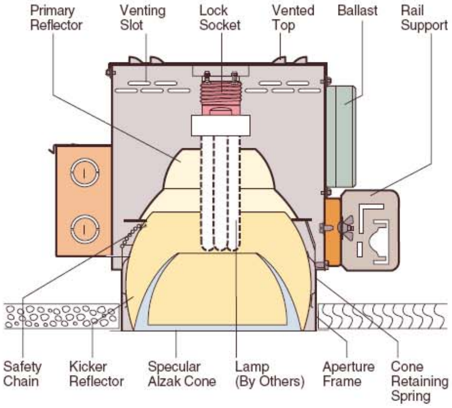
Vertical Angle	Footlamberts		
	0°	45°	90°
45°	7995	7995	7995
50°	6334	6334	6334
55°	3445	3445	3445
60°	95	95	95
65°	0	0	0
70°	0	0	0
75°	0	0	0
80°	0	0	0
85°	0	0	0

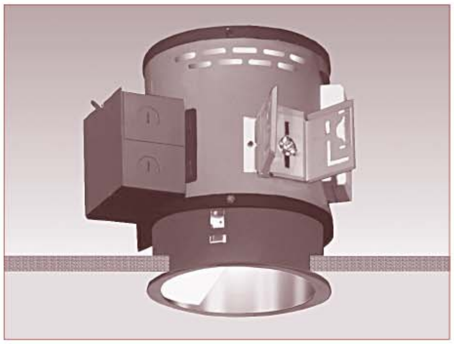
Type: B4

Lamp: (1)CF26W/841

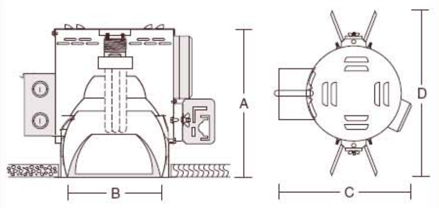
P905 One 26W or 32W Triple Tube Lamp
P915 One 42W Triple Tube Lamp

Wall Washers
5⁷/₈" Conoid Aperture





Dimensions and Lamps



Number	A Depth*	B Aperture	C Width	D Length	Lamp**
P905	9³/₄" 248mm	5⁷/₈" 149mm	10¹/₂" 267mm	13¹/₄" 337mm	26W or 32W Triple Tube
P915	10¹/₄" 260mm	5⁷/₈" 149mm	10¹/₂" 267mm	13¹/₄" 337mm	42W Triple Tube

* Recess depth increases to 12¹/₂" with EM and DM accessories.

**For proper focal position for 26W lamps, add 26W to catalog number.

Matching Units

Medium beam downlight	Page P51
Medium wide beam downlight	Page P52
Wall washers	Pages P61, P62

** Click for link to pages in blue.

Optics and Applications

Full circle kicker reflectors direct a uniform wash light to adjacent walls. The pattern is free from spikes, striations or dropouts and features wide lateral distribution. The downlight component is uniform with a soft edge to blend with nearby units. Use in low to medium height ceilings.

Design Features

Steel housings protect the reflectors which are joined to each other for predictable performance. The turn and lock socket prevents the lamp from falling if it is not properly engaged. It is a dependable fail safe mechanism to prevent injury and litigation. Cone and window assembly may be rotated 360˚ after installation. Vented air flow design assures cool fixture temperature for optimal lamp performance. Maximum ceiling thickness 2". Ballast and lamp service from below.

Finish

Specular clear Alzak cones are standard. Optional colors and Softglow® finishes are available. Housings and structural parts are painted optical matte black to suppress stray light leaks. Steel parts are phosphate conditioned for corrosion resistance before painting.

Ballasts

Fully electronic, microprocessor controlled with variable starting current for inrush protection to assure rated lamp life. Input voltage ranges from 120V through 277V. Power factor .98, starting temperature 0° F (-18° C), THD < 10%. Pre-heat start < 1.0 second. End of lamp life protection. Rated for > 50,000 starts.

General

Fixtures are pre-wired, UL and C-UL listed for eight wire 75°C branch circuit wiring. Union made IBEW. Luminaire Efficiency Ratings (LER) do not apply to wall washers.

Accessories

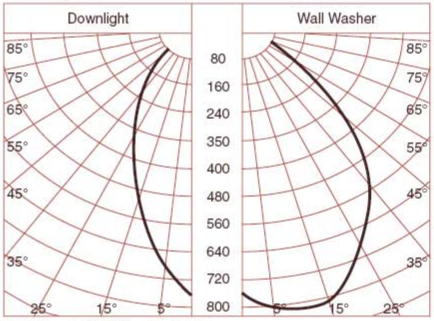
G	Gold cone.
H	Mocha cone.
P	Graphite cone.
T	Titanium cone.
W	Wheat cone.
Y	Pewter cone.
Z	Bronze cone.
R2	26" support rails.
R5	52" support rails.
WT	White trim flange.
WHT	White complete trim.
V347	347 volt ballast.
F	Fuse.
S	Softglow® finishes: add S before color letters. e.g. SW for Softglow® wheat cone, SC for Softglow® clear cone.
DM	Dimming ballast. Specify watts and volts.
EM	Emergency power includes integral charger light and test switch visible through aperture. Single lamp operation for 90 minutes. Specify volts.
WRL	Wattage restriction label, specify wattage.
L	◕ Limited wall wash.
D	⦶ Double wall wash.
C	◔ 250° corner wall wash.

kurt versen

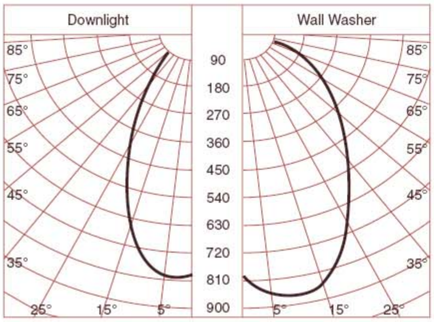
Kurt Versen Company
Point Source Lighting
Westwood, New Jersey 07675

P63 P905 P915

Candlepower Distribution Curves



P905 One 32W Philips Triple Tube



P915 One 42W Philips Triple Tube

Notes

1 Data by IES methods. Compact fluorescent data vary due to lamp lumen differences, power input, burning position, ambient temperature and ballast characteristics. A modification factor should be applied.

2 Above data measure output of the wall washers only. No contribution from adjacent downlights or ceiling, floor or wall reflectances is included. Total illumination on the wall will increase with the contri-bution from other sources.

3 Data are cosine corrected to the plane of the wall. Uncorrected data would be substantially higher and depend upon the angle of incidence to the wall which varies with the mounting distance from the wall.

4 Kurt Versen wall washers are designed to minimize hard shadow lines at the ceiling. Light intensity increases gradually to the maximum area, just above eye level. The field is uniform, devoid of hot spots, striations and spikes.

5 If colored cones are required, only the downlight cone will be tinted. The kicker reflector is always clear Alzak for maximum output and true color rendition.

6 Specular cone multipliers: Use for downlight and brightness data only: Gold x .93, Wheat x .89, Pewter x .81, Mocha x .79, Graphite x .76, Titanium x .76, Bronze x .73.

7 Softglow® cone multipliers: Use for downlight and brightness data only: Clear x .98, Gold x .90, Wheat x .89, Pewter x .74, Mocha x .77, Graphite x .72, Titanium x .72, Bronze x .70.

8 Brightness data from the Average Luminance Method are inaccurate for small aperture downlights. They are theoretical calculations derived for large surfaces such as troffers. For a complete discussion refer to section Z brochure Z1.

Multiple Units Footcandles

From Ceiling	2' from wall				3' from wall				4' from wall			
	2' Centers		3' Centers		3' Centers		4' Centers		4' Centers		6' Centers	
	CL	Mid	CL	Mid	CL	Mid	CL	Mid	CL	Mid	CL	Mid
1'	26	26	20	16	8	8	6	5	3	3	2	2
2'	48	43	38	27	15	14	12	10	7	7	5	4
3'	43	42	31	27	22	20	18	13	9	9	7	5
4'	32	32	23	21	21	20	17	15	12	11	10	6
5'	24	24	16	16	18	18	14	13	12	12	9	7
6'	18	18	12	12	15	15	11	11	11	11	8	7
7'	14	14	9	9	12	12	9	9	10	9	7	6
8'	11	11	7	7	10	10	7	7	8	8	6	5
10'	7	7	5	5	7	7	5	5	6	6	4	4
12'	5	5	3	3	5	5	4	4	4	4	3	3

P905 One 32W Philips Triple Tube
P905 One 32W Osram Sylvania x .85

From Ceiling	2' from wall				3' from wall				4' from wall			
	2' Centers		3' Centers		3' Centers		4' Centers		4' Centers		6' Centers	
	CL	Mid	CL	Mid	CL	Mid	CL	Mid	CL	Mid	CL	Mid
1'	51	46	40	28	15	14	12	9	6	5	5	3
2'	60	56	45	35	26	25	21	17	13	12	10	6
3'	47	47	33	30	27	25	22	17	15	14	11	9
4'	35	36	24	23	23	23	18	16	15	14	11	8
5'	27	27	18	18	19	19	15	14	14	13	10	8
6'	20	21	13	13	16	15	12	12	12	12	8	7
7'	16	16	10	10	13	13	10	10	10	10	7	7
8'	12	12	8	8	11	10	8	8	9	9	6	6
10'	8	8	5	5	7	7	6	6	6	6	4	4
12'	5	5	3	3	5	5	4	4	5	5	3	3

P915 One 42W Philips Triple Tube
P915 One 42W Osram Sylvania x .85

Brightness

Number	Lamps	85°	75°	65°	55°	45°
P905	One 32W Philips Triple Tube	9	18	42	2748	11404
	One 32W Osram Triple Tube	11	27	55	6727	13651
P915	One 42W Philips Triple Tube	11	23	57	3685	15394
	One 42W Osram Triple Tube	12	24	60	7376	14970

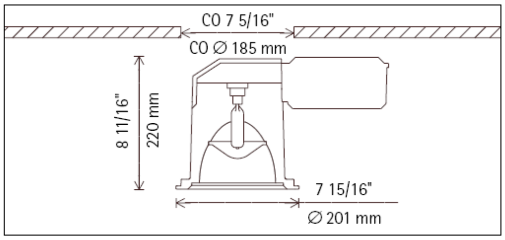
Data in footlamberts. Photometer readings, Maximum Brightness Method. See note 8.

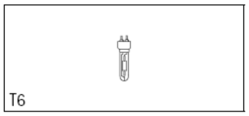
Type: C1
Lamp: (1)MH39W/830

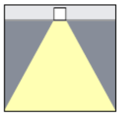
ERCO

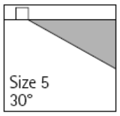
LC Downlight

for metal halide lamps

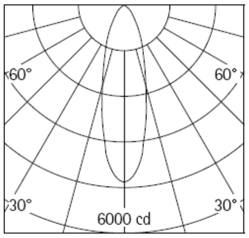








c UL us
Dry Damp Wet
→ Outdoor



T6 39W G12 3400lm

h(ft)	E(fc)	D
		29°
3	518	1'7"
6	129	3'1"
9	58	4'8"
12	32	6'2"
15	21	7'9"

81022.023 Reflector silver
T6 39W G12 3400lm
ECG

Product description

Housing: cast aluminum, silver powder-coated. Mounting with 3-point support and screw-tightening. Side-mounted control gear: cast aluminum, black powder-coated.
Electronic control gear 120V/277V, 60Hz. Through-wiring possible.
Low brightness reflector: aluminum, specular anodized. Cut-off angle 30° from horizontal. Diffuser as lamp cover: glass, frosted.
Screw-fastened cover ring with safety glass: corrosion-resistant, cast aluminum, No-rinse surface treatment. Silver, double powder-coated. To be removed together with low-brightness reflector for lamp replacement.
Suitable for wet location (IP65): dust-proof and water jet-proof.
Weight 9.26lbs / 4.20kg

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

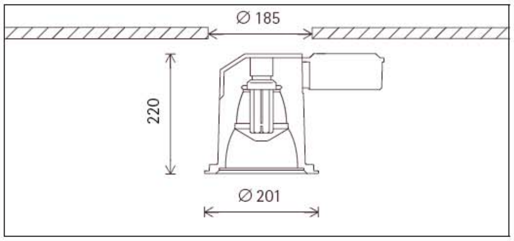
TechnischeUmgebung
Edition: December 21, 2005
Please download latest version from
www.erco.com/Artikelnummer

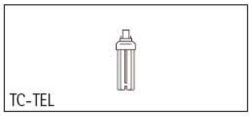
Type: C2
Lamp: (1)CF18W/830

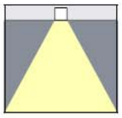
ERCO

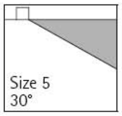
Lightcast Downlight

for compact fluorescent lamps

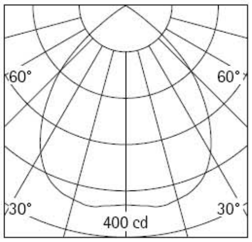








IP65



TC-TEL 18W GX24q-2 1150lm

h(m)	E(lx)	D(m) 87°
1	344	1.90
2	86	3.80
3	38	5.69
4	22	7.59
5	14	9.49

81029.000 Reflector silver
TC-TEL 18W GX24q-2 1150lm
ECG

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

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

Technical Region: 230V/50Hz
Edition: December 16, 2005
Please download the current version from
www.erco.com/81029.000

Lightcast Downlight

Planning data

Cleaning (a)	1				2				3			
Ambient conditions	P	C	N	D	P	C	N	D	P	C	N	D
LMF	0.98	0.94	0.90	0.86	0.95	0.91	0.86	0.81	0.94	0.90	0.84	0.79
RSMF	0.99	0.98	0.96	0.95	0.97	0.96	0.95	0.94	0.97	0.96	0.95	0.94

Hours of operation (h)	1000	2000	4000	6000	8000	10000
LLMF	0.97	0.92	0.88	0.85	0.83	0.83
LSF	1	1	1	1	1	1

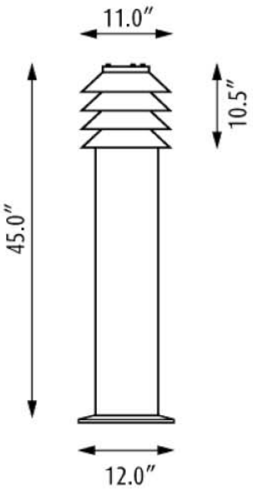
MF	LMFxRSMFxLLMFxLSF
MF	Maintainance Factor
LMF	Lumiaire Maintenance Factor
RSMF	Room Surface Maintenance Factor
LLMF	Lamp Lumens Maintenance Factor
LSF	Lamp Survival Factor
P	Room pure
C	Room clean
N	Room normal
D	Room dirty

Type: C3

Lamp: (1)MH100W/830

Bysted

Design: Peter Bysted



Bysted provides downward illumination. The louver shades are painted white on the inside, to optimize the reflected light and creates a distinct circular pattern of light on the ground. Bysted has a ruggedness that makes it suitable for use in public areas. The Cor-Ten steel and cast iron will oxidize with a thin layer of uniform rust.

Finish
Cor-Ten steel, raw.

Material
Housing: Die cast iron. Post: Cor-Ten steel.
Base plate: Cor-Ten steel.

Mounting
Base plate: Mounted to a concrete base with 4 anchor bolts. Base plate dimension: 12.0" dia.

Weight
Max. 94 lbs.

Label
cUL, Wet location. IBEW.

Specification

1 | **Product code**
BYS

2 | **Light source**
1/100W/A-21/CL medium
1/100W/HPS/ED-17 medium
1/100W/MH/ED-17 medium

3 | **Voltage**
120/277V
120V

4 | **Finish**
COR-TEN

Specification notes:
a. HID variants are provided with one 120/277V F-can style ballast.
b. Incandescent variant is only available in 120V.

Info notes:
I. Cor-Ten steel contains copper and carbon steel. After weathering, a thin, uniform layer of rust appears and acts to self-protect the surface from further corrosion thus eliminating the need for future maintenance. The process of oxidation causes the surface to bleed. Care must be taken to install the bysted fixture in a drainage pit or in grass to prevent surface staining. II. The comparable EU version has the following application: Ingress Protection Code: IP44.

Type: **C4**
Lamp: **(1)MH50W/830**

- Die cast aluminum construction for corrosion resistance.
- Tool-less access and removal of the reflector, lamp and ballast.
- Type 2, 3, 4 and 5 full cutoff, horizontal reflectors.
- Type 3 and type 5 vertical lamp cutoff reflectors.
- Asymmetric and symmetric indirect, cutoff optical system.
- 50 to 175 watts HID including T-6 CDM lamps and electronic ballasts for metal halide lamps.
- Separate die cast aluminum ballast module for cooler operation and extended component life.
- Powder coat finish in ten standard colors with a polychrome primer.
- Slips over a 4 inch tenon for arm or pole mounting.

Providence™

page 2 of 6 DATE TYPE

PROV / / / / /

FIXTURE 1	LAMP/BALLAST 2	COLOR 3	OPTIONS 4	DECORATIVE ARMS 5	POLE/BASE 6

1 Fixture

Reset Print

☐	**PROV-H2**	type 2 horizontal reflector, flat tempered clear glass lens
☐	**PROV-H3**	type 3 horizontal reflector, flat tempered clear glass lens
☐	**PROV-H4**	type 4 horizontal reflector, flat tempered clear glass lens
☐	**PROV-H5**	type 5 horizontal reflector, flat tempered clear glass lens
☐	**PROV-V3**	type 3 vertical reflector, tempered clear sag glass lens
☐	**PROV-V5**	type 5 vertical reflector, tempered clear sag glass lens
☐	**PROV-INDA**	asymmetric indirect, indirect reflective optical system, metal halide lamps only.
☐	**PROV-INDS**	symmetric indirect, indirect reflective optical system, metal halide lamps only.

2 Lamp/Ballast

☐	**50MH**	50 watt metal halide 120/277 volt ballast. Use a medium base, clear ED-17 lamps.
☐	**50MHEB**	50 watt electronic metal halide ballast, 120 thru 277 volt. Use a medium base, clear ED-17 lamp.
☐	**70MH**	70 watt metal halide 120/208/240/277 volt ballast. Use a medium base, clear ED-17 lamps.
☐	**70MHEB**	70 watt electronic metal halide ballast, 120 thru 277 volt. Use a medium base, clear ED-17 lamp.
☐	**70MHT6**	70 watt metal halide 120/277 volt ballast. Use a G12 base, clear T-6 ceramic lamp.
☐	**70MHT6EB**	70 watt electronic metal halide ballast, 120 thru 277 volt. Use a G12 base, clear T-6 ceramic lamp.
☐	**100MH**	100 watt metal halide 120/208/240/277 volt ballast. Use a medium base, clear ED-17 lamps.
☐	**150MH**	150 watt metal halide 120/208/240/277 volt ballast. Use a medium base, clear ED-17 lamps.
☐	**150MHEB**	150 watt electronic metal halide ballast, 120 thru 277 volt. Use a medium base, clear ED-17 lamp.
☐	**150MHT6**	150 watt metal halide 120/208/240/277 volt ballast. Use a G12 base, T-6 ceramic MH lamp.
☐	**150MHT6EB**	150 watt electronic metal halide ballast, 120 thru 277 volt. Use a G12 base, T-6 ceramic MH lamp.
☐	**175MH**	175 watt metal halide 120/208/240/277 volt ballast. Use a medium base, clear ED-17 lamps.
☐	**70HPS**	70 watt high pressure sodium 120/208/240/277 volt ballast. Use a medium base, clear ED-17 lamps
	100HPS	100 watt high pressure sodium 120/208/240/277 volt ballast. Use a medium base, clear ED-17 lamps.
	150HPS	150 watt high pressure sodium 120/208/240/277 volt ballast. Use a medium base, clear ED-17 lamps.

All HID ballasts are multi-tap, prewired for 277 volts. Lamps not included.

☐	**CF**	Electronic transformer for 26, 32 or 42 watt compact fluorescent lamp 120 through 277 volt.

For Horizontal reflectors only.

3 Color

☐	**WHT**	White
☐	**LGY**	Light Grey
☐	**MAL**	Matte Aluminum
☐	**MDG**	Medium Grey
☐	**ATG**	Antique Green
☐	**VGR**	Verde Green
☐	**WRZ**	Weathered Bronze

☐	**DGN**	Dark Green
☐	**CRT**	Corten
☐	**BRM**	Metallic Bronze
☐	**DBZ**	Dark Bronze
☐	**BLK**	Black
☐	**MTB**	Matte Black
☐	**RAL #**	
☐	**CUSTOM**	

SOLD TO PO # JOB NAME

/ /

Approvals

Architectural Area Lighting
14249 Artesia Blvd / La Mirada, CA 90638
714.994.2700 / fax 714.994.0522 / www.aal.net

Options

☐ **SPK**

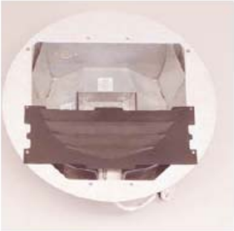
Decorative cast aluminum spikes on the top and bottom of the four vertical struts.

☐ **PFN**

Cast aluminum finial painted a brass color.

☐ **PCA-T**

Rotatable photocell housing.
The housing slips over a 4"/100mm o.d. pole, a fixture slips over the 4"/100mm o.d. tenon. Includes an internal twist lock receptacle, and an access cover with integral lens. Photocell by others.



☐ **HSS**

HOUSE SIDE SHIELD
For horizontal and vertical reflector models. House side shield to cut off light behind the pole and shield the lamp from view.

☐ **LDL**

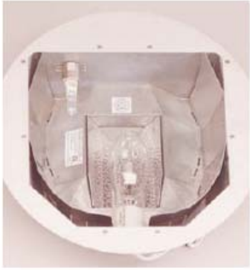
LOW BRIGHTNESS LENS
Frosted, flat tempered glass lens has a lightly diffused finish to minimize the lamp and reflector brightness. For horizontal reflector models.

EGRESS AND EMERGENCY OPTIONS

Egress lighting codes require an illuminated path to allow occupants to get a safe distance from the building during a power failure or other emergency. In conjunction with the proper wiring, these two options can be implemented to provide egress lighting.

☐ **QRS**

RESTRIKE CONTROLLER
Quartz restrike controller and socket for a T-4 mini-cand halogen lamp, maximum 150 watt. Not for use with electronic metal halide ballasts. Not available for indirect models.

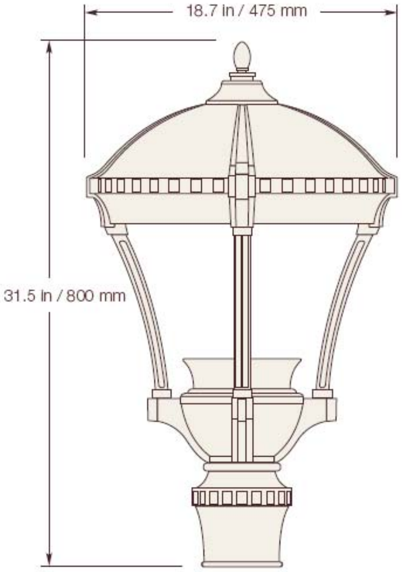


☐ **QL**

HALOGEN LAMP CIRCUIT
Socket for a T-4 mini-cand halogen lamp, maximum 150 watt. Must be field wired to a separate 120 volt circuit.
Not available for indirect models.

Specifications

Weight: 29lbs. EPA: 1.30



REFLECTOR MODELS - REFLECTOR/LAMP

The upper lamp housing shall be die cast aluminum. The internal reflector module is sealed from the outer housing with a molded silicone gasket. The tempered glass lens shall be sealed to the housing with a silicone gasket. One stainless steel latch shall release the door to allow access the lamp.

The reflector module shall be composed of faceted, specular and semi specular anodized aluminum panels rigidly attached in a die cast aluminum housing. The reflector shall be removed without tools by lifting it out of the four spring loaded posts. The reflector tray shall be rotatable on 90° centers for orienting the light distribution. The horizontal and vertical lamp reflectors shall meet ANSI-IES standards for full cutoff reflector systems.

REFLECTOR MODELS - BALLAST

The lower ballast housing shall be die cast aluminum. The tool-less ballast access for servicing is accomplished by a quarter turn motion of the top cover. The ballast shall be mounted on a prewired tray with a quick disconnect plug attached to the underside of the cover. HID ballasts are high power factor, rated for -30°F starting. Electronic ballasts for metal halide lamps are sound rated A. Sockets are medium base for ED-17 lamps, G12 for use with T6 lamps, All sockets are pulse rated porcelain. Ballasts are multi-tap, wired at the factory for 277 volts. Compact fluorescent transformers shall accept 120 to 277 volt input and rated for 0°F starting.

INDIRECT MODELS - LOWER LAMP MODULE

The lower housing shall contain the lamp module. The cover shall be die cast aluminum with a tempered glass lens. The lamp shall be accessed by turning the lamp housing cover a quarter turn. The reflector shall be polished, anodized aluminum with an extremely narrow beam for directing the light to the upper reflector. Sockets are medium base for ED-17 lamps or G12 for use with T6 lamps, All sockets are pulse rated porcelain.

INDIRECT MODELS - UPPER REFLECTOR/BALLAST

The die cast aluminum upper housing shall contain the ballast assembly and the indirect reflector. The tool-less ballast access for servicing is accomplished single flip up latch and hinged top cover. The ballast shall be mounted on a prewired tray with a quick disconnect plug. The HID ballasts are high power factor, rated for -30°F starting. Ballasts are multi-tap, wired at the factory for 277 volts. The indirect reflector is mounted to the underside of the upper housing. The reflector shall be die cast aluminum, finished in a high reflectance white. The indirect reflector models shall be IES classified as cutoff with less than 1% lumen output above 90 degrees.

INSTALLATION & MOUNTING

The Providence series shall be factory supplied as a complete, prewired assembly. The fitter shall slip over a 4"/100mm open top pole or arm and be secured and leveled with three stainless steel set screws.

FINISH

Fixture finish consists of a five stage pretreatment regimen with a polymer primer sealer, oven dry off and top coated with a thermoset super TGIC polyester powder coat finish. The finish shall meet the AAMA 605.2 performance specification which includes passing a 3000 hour salt spray test for corrosion resistance.

CERTIFICATION

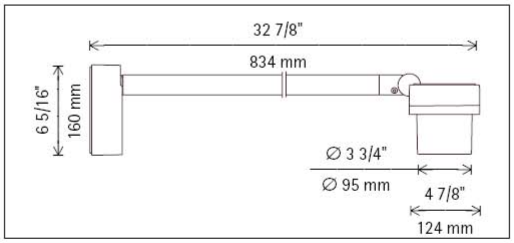
The fixture shall be listed with ETL for outdoor, wet location use, UL1598 and Canadian CSA Std. C22.2 no.250. IP=55.

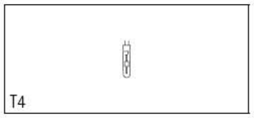
Type: C5
Lamp: (1)MH39W/830

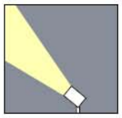
ERCO

Grasshopper Projector

with cantilever for metal halide lamps





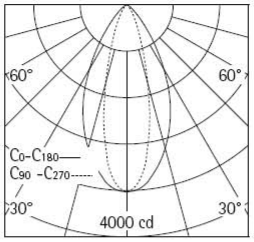


Dry Damp Wet ⌂ → Outdoor

34028.023 Graphit m
T4 39W G8.5 3300lm
ECG

Product description

Housing, hinge and mounting plate: corrosion-resistant, cast aluminum, No-Rinse surface treatment. Double powder-coated. Optimized surface for reduced accumulation of dirt. Hinge with graduations and internal wiring, 80° tilt. Mounting plate rotatable through 360°.
Cantilever: corrosion-resistant aluminum tube.
Electronic control gear 120V, 60Hz. 2 cable entries. Through-wiring possible. 3-pole terminal block.
Spherolit reflector, spot: aluminum, silver, specular anodized. Sculpture lens for uniform illumination of close proximity areas.
Compact lamp head with improved lamp screening for optimum visual comfort. Corrosion-resistant cast aluminum, double powder-coated.
Suitable for wet location (IP65): dust-proof and water jet-proof.
Weight 7.83lbs / 3.55kg



T4 39W G8.5 3300lm

h(ft)	E(fc)	D	
		C0	C90
		53°	27°
3	358	2'12"	1'5"
6	89	5'12"	2'11"
9	40	8'12"	4'4"
12	22	11'12"	5'9"
15	14	14'11"	7'2"

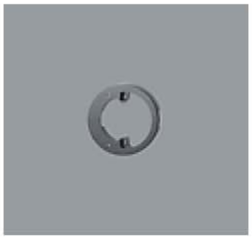
ERCO Lighting, Inc.
160 Raritan Center Parkway
Suite 10
Edison, NJ 08837
USA
Tel.: +1 732 225 8856
Fax: +1 732 225 8857
info.us@erco.com

Technical Region: 120V/60Hz
Edition: December 21, 2005
Please download latest version from
www.erco.com/34028.023

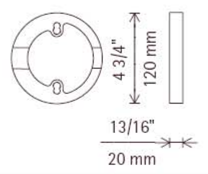
Grasshopper Projector

Accessories

33973.000
Ground spike
Metal, hot-dip galvanized.
Cable entry.

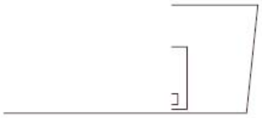


34990.000
Spacer
for cables mounted on top of plaster.
Corrosion-resistant, cast aluminum, No-Rinse surface treatment. Graphit m double powder-coated.
Weight 0.35lbs / 0.16kg



Type: **D1**

Lamp: **(1)CF18W/830**



PIW1000
Painted–White

PIW1002
Painted–White

PIW1004
Painted–White

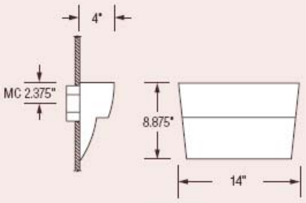
PIW1006
Painted–White with Brushed Brass Over Steel Accent

Scoop Surface Mount Sconce

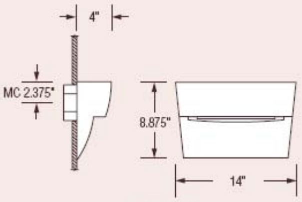
PHACES

14"

Stepped

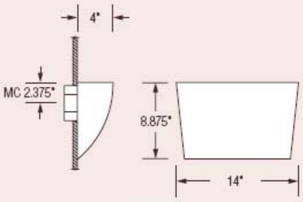


PIW1010
ADA



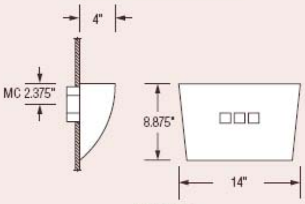
PIW1012
ADA

Scoop



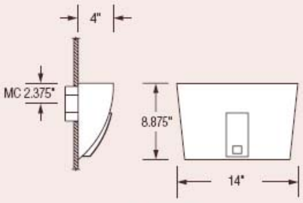
PIW1014
ADA

Scoop with Window



PIW1016
ADA

Scoop with Accent



PIW1018
ADA

MC = Mounting Center

Specifications:

- 18 gauge formed cold-rolled steel housing
- ADA compliant
- Integral ballast
- Ballast thermally protected
- Universal mounting holes and direct access to a standard 4" octagonal junction box.
- UL listed for damp locations. (Not recommended for exterior use.)

Design modification rights reserved.

Complete photometric data
on page 254

Sample model number: PIW1012 (STYLE) - 1F42 (LAMPING) - 120 (VOLTAGE) - PT03 (FINISH) - PBST (ACCENT FINISH) - TL (OPTION)

Select Style

- PIW1010
- PIW1012
- PIW1014
- PIW1016
- PIW1018

Select any Lamping
(indirect/bowl illumination)

	Lamping Detail (indirect - bowl illumination)	Optical Pkg.	Photometry
1N150	(1) 150W A21 INC	A	NA
1F13	(1) CFQ13W/G24q	B	E14-2
1F26	(1) CFQ26W/G24q	B	E14-2
1F26DM	(1) CFQ26W/G24q	B	E14-2
1F32	(1) CFTR32W/G24q	B	E14-2
1F32DM	(1) CFTR32W/G24q	B	E14-2
1F42	(1) CFTR42W/G24q	B	E14-2
1F42DM	(1) CFTR42W/G24q	B	E14-2
2N75	(2) 75W A19 INC	C	NA
2F13	(2) CFQ13W/G24q	D	E14-2
2F26	(2) CFQ26W/G24q	D	E14-2

DM = Dimming ballast(s) provided
(Requires **RAB** option.)

If Photometry is not available, consult factory for further details.

Select Voltage

- 120
- 277

Select Finish

PT__	Painted. (Include Paint Number.)

Select Accent Finish*

PT__	Painted. (Include Paint Number.)
ABST	Antique brass over steel
BBST	Brushed brass over steel
CPST	Polished chrome over steel
PBST	Polished brass over steel

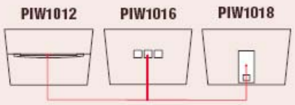
See Finish Selection Guide, pages 268-269.

****Not required for PIW1010 and 1014.***

Select Options

TL	Top Lens. Clear tempered glass. Standard on 1T150 lamping.
F	Fuse option. Factory installed.
EMI	Integral Emergency Lighting. Use with **RAB** - recessed accessory box. Fluorescent only. Battery lumen packages 650 and below.
EMR	Remote Emergency Lighting. Fluorescent only. Required for battery lumen packages greater than 650.
RAB	Recessed Accessory Box. Required with **DM** and **EMI** options.

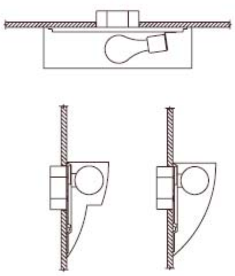
For further detail on options, see Technical Notes on page 266.



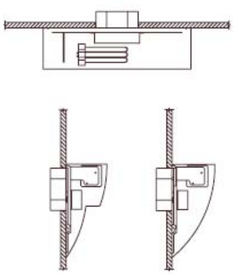
Add **Accent Finish** to specify finish of accent element.

OPTICAL PACKAGES

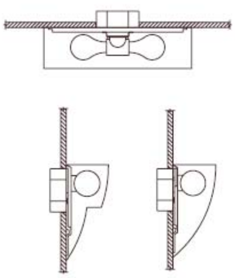
A



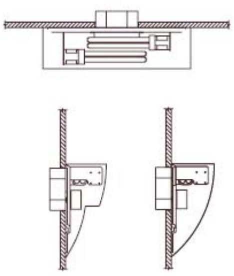
B



C

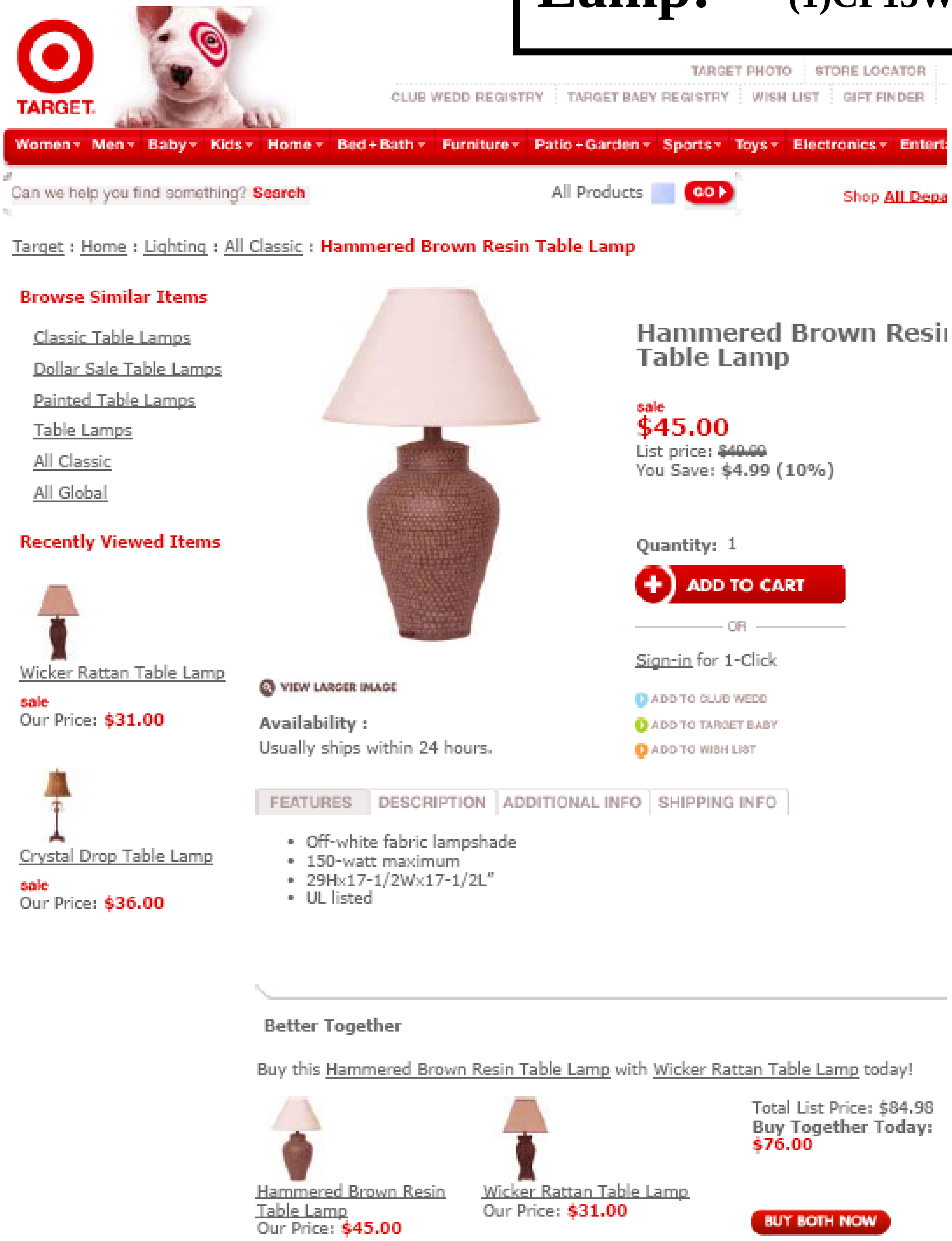


D



Type: D2

Lamp: (1)CF13W/830



Target : Home : Lighting : All Classic : Hammered Brown Resin Table Lamp

Browse Similar Items

- Classic Table Lamps
- Dollar Sale Table Lamps
- Painted Table Lamps
- Table Lamps
- All Classic
- All Global

Recently Viewed Items

Wicker Rattan Table Lamp
sale
Our Price: $31.00

Crystal Drop Table Lamp
sale
Our Price: $36.00

**Hammered Brown Resi
Table Lamp**

sale
$45.00
List price: ~~$49.99~~
You Save: $4.99 (10%)

Quantity: 1

Sign-in for 1-Click

Availability :
Usually ships within 24 hours.

- Off-white fabric lampshade
- 150-watt maximum
- 29Hx17-1/2Wx17-1/2L"
- UL listed

Better Together

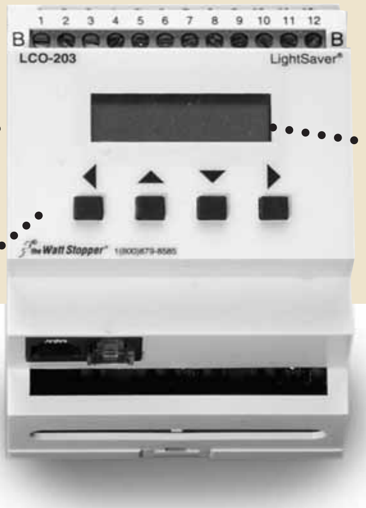
Buy this Hammered Brown Resin Table Lamp with Wicker Rattan Table Lamp today!

Hammered Brown Resin Table Lamp
Our Price: $45.00

Wicker Rattan Table Lamp
Our Price: $31.00

Total List Price: $84.98
Buy Together Today:
$76.00

LightSaver® LCO-203 ON/OFF Switching



Automatic ON/OFF daylighting control module

Multi-level switching

Pushbutton programming and automated setup

Five individually programmable adjustments for each control channel

LCD display of light level readings

Open loop control

PROJECT

LOCATION/TYPE

Product Overview

Description

Watt Stopper/Legrand's LightSaver LCO-203 provides automatic ON/OFF switching control for fluorescent and HID fixtures. It is an open loop controller providing up to three zones of control from a single photocell.

Operation

The LCO controller is part of a system that includes the LS-290C photocell and the BT-203 Power Pack. Each of the LCO controller's three channels connects directly with its own dedicated relay in the power pack. The photocell measures daylight and transmits these data to the LCO controller. When daylight is adequate, the LCO controller switches lighting off. When daylight diminishes below the desired setpoint, the LCO controller switches lighting back on. The ON and OFF delays for each channel are individually adjustable. The LCO controller integrates with occupancy sensors as well as an optional wall switch for manual overrides.

Multiple Channel Control

Multi-channel control enables gradual, multi-level switching of electric lighting as the daylight contribution increases. The LCO can be used to either switch off individual rows of lamps in a luminaire or entire luminaires. This gradual reduction is likely to provide more balanced lighting while being less distracting to occupants.

Applications

Spaces such as warehouses, storage areas, atriums, lobbies, and open office areas will benefit from use of the LCO controller.

Features

- Simplified setup and calibration
- Optional wall switch (LS-4C) provides ON/OFF control so users can adjust lighting
- Five individually adjustable parameters for each channel: ON delay, OFF delay, deadband, setpoint, load shed setpoint
- Menu-driven, pushbutton programming without special tools
- Automatic internal calculation of daylight contribution for each channel for simplified setup
- DIN rail mounting
- Suitable for mounting in low voltage section in control panel
- California Title 24-2005 compliant

www.wattstopper.com
800.879.8585

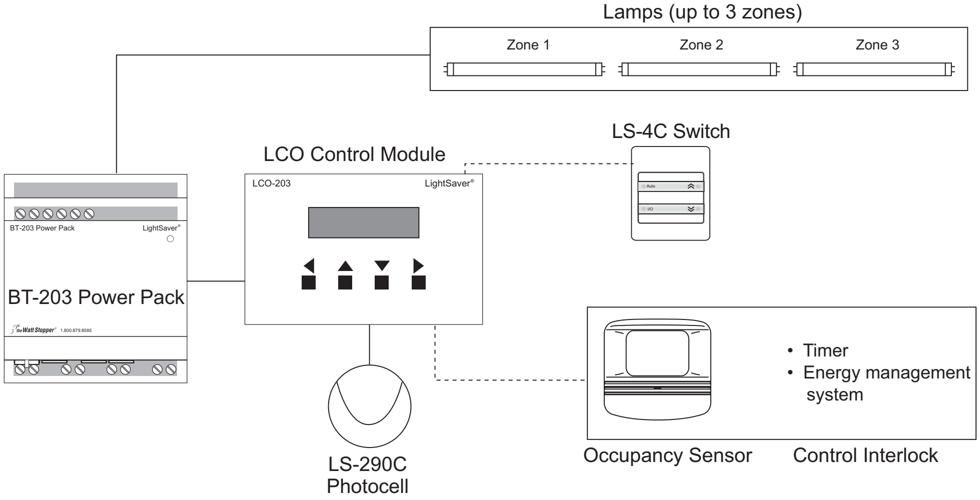
LCO-203 Technical Information

Specifications

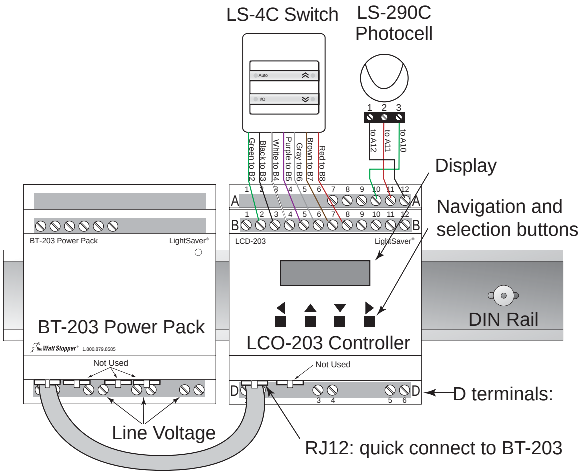
- Class 2 low voltage device
- Photocell range from 3 - 6,000 footcandles
- Setpoint range from 5-60 fc
- Programmable deadband from 10%-80%
- Adjustable ON delay from 5-60 seconds
- Adjustable OFF delay from 3-60 minutes
- Load shed setpoint from 5-60 fc
- 24VDC supply voltage provided by BT-203
- Dimensions: 3.5” x 2.81” x 2.5” (89mm x 71mm x 64mm) LxWxD
- UL and CUL listed; five year warranty

System Layout & Wiring

System Layout



LCO-203 Wiring and Settings



Ordering Information

Catalog No.	Description	Voltage	Channels
☐ LCO-203	ON/OFF switching control module	24 VDC	three
☐ LS-290c	Photocell		
☐ BT-203	Power Pack		

ON/OFF control system options:

Product group	Catalog No.	Description
Switch	☐ LS-4C	Wall Switch
Enclosure	☐ LS-E8	Screw-cover enclosure 8” x 8” x 4” (203.2mm x 203.2mm x 101.6mm)
	☐ LS-E12	Screw-cover enclosure 12” x 12” x 4” (304.8mm x 308.8mm x 101.6mm)

WIRING PANEL SCHEDULE

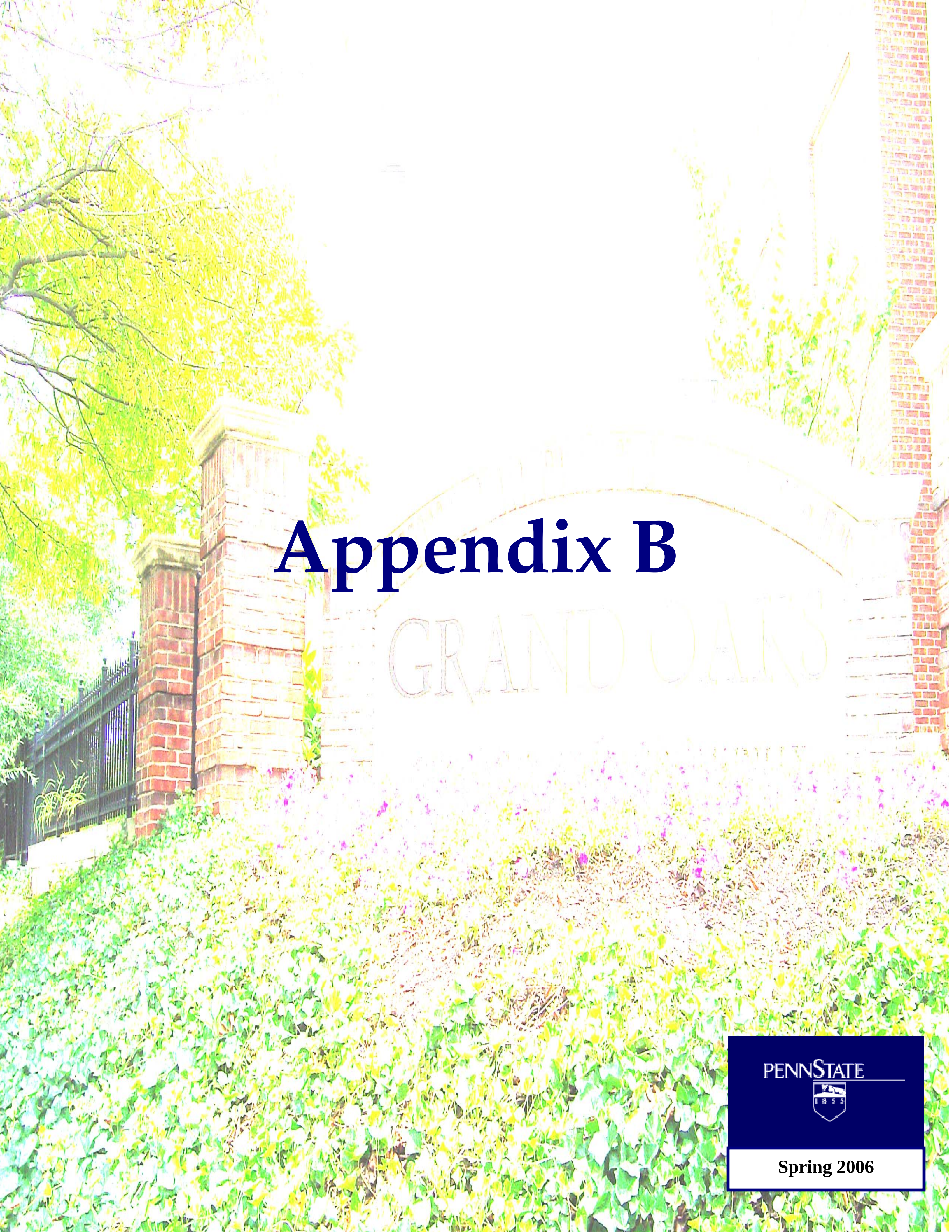
PANEL: EH1	MAINS: MLO				AMPS: 400			AIC: 25K
VOLTAGE: 480Y/277	WIRES: 4		PHASE: 3		MOUNTING: SURFACE			LOC: MAIN ELECTRICAL ROOM
DESCRIPTION	P	AMP	BRANCH CIRCUIT	CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT
SPARE	-	-	-	2	LIGHTING	1	20	3/4"C.W/2#12+1#12GRND
LIGHTING	1	20	3/4"C.W/2#12+1#12GRND	4	LIGHTING	1	20	3/4"C.W/2#12+1#12GRND
LIGHTING	1	20	3/4"C.W/2#12+1#12GRND	6	LIGHTING	1	20	3/4"C.W/2#12+1#12GRND
LIGHTING	1	20	3/4"C.W/2#12+1#12GRND	8	LIGHTING	1	20	3/4"C.W/2#12+1#12GRND
LIGHTING	1	20	3/4"C.W/2#12+1#12GRND	10	LIGHTING	1	20*	3/4"C.W/2#12+1#12GRND
LIGHTING	1	20	3/4"C.W/2#12+1#12GRND	12	SPARE	1	20	-
LIGHTING	1	20	3/4"C.W/2#12+1#12GRND	14	SPARE	1	20	-
SPARE	1	20	-	16	SPARE	1	20	-
SPARE	1	20	-	18	SPARE	1	20	-
SPARE	1	20	-	20	SPARE	1	20	-
SPARE	1	20	-	22	SPARE	1	20	-
SPARE	1	20	-	24	SPARE	1	20	-
SPARE	1	20	-	26	SPACE	-	-	-
SPARE	1	20	-	28	SPACE	-	-	-
SPARE	1	20	-	30	SPACE	-	-	-
-	-	-	-	32	SPACE	-	-	-
XFMR/PANEL EL1	3	45	3/4"C.W/3#8+1#10GRND	34	SPACE	-	-	-
-	-	-	-	36	SPACE	-	-	-
-	1	-	-	38	SPACE	-	-	-
PANEL EMP	1	225	2-1/2"C.W/3#4/0+1#4/0GRND	40	SPACE	-	-	-
-	1	-	-	42	SPACE	-	-	-
CONNECTED LOAD	16731 VA		TOTAL PHASE A		7750 VA			
DEMAND LOAD	20914 VA		TOTAL PHASE B		4261 VA			
25% GROWTH	26142 VA		TOTAL PHASE C		4720 VA			

WIRING PANEL SCHEDULE

	PANEL: HM11	MAINS: MLO				AMPS: 100			AIC: 25K
	VOLTAGE: 480Y/277	WIRES: 4		PHASE: 3		MOUNTING: SURFACE			LOC: MAIN ELECTRICAL ROOM
CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT	CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT
1	LIGHTING	1	20	3/4"C.W/2#12+1#12GRND	2	GEN BLOCK HTR	2	20	3/4C.W/3#12+1#12GRND
3	LIGHTING	1	20	3/4"C.W/2#12+1#12GRND	4	-	-	-	-
5	LIGHTING	1	20*	3/4"C.W/2#12+1#12GRND	6	LIGHTING	1	20*	3/4"C.W/2#12+1#12GRND
7	SPARE	1	20	-	8	SPARE	1	20	-
9	SPARE	1	20	-	10	SPARE	1	20	-
11	SPARE	1	20	-	12	SPARE	1	20	-
13	SPARE	1	20	-	14	SPARE	1	20	-
15	SPARE	1	20	-	16	SPARE	1	20	-
17	SPARE	1	20	-	18	SPARE	1	20	-
19	SPARE	1	20	-	20	SPARE	1	20	-
21	SPARE	1	20	-	22	SPARE	1	20	-
23	SPARE	1	20	-	24	SPARE	1	20	-
25	SPARE	1	20	-	26	SPARE	1	20	-
27	SPARE	1	20	-	28	SPARE	1	20	-
29	SPARE	1	20	-	30	SPARE	1	20	-
31	SPARE	1	20	-	32	SPARE	1	20	-
33	SPARE	1	20	-	34	SPARE	1	20	-
35	SPARE	1	20	-	36	SPARE	1	20	-
37	SPARE	1	20	-	38	SPARE	1	20	-
39	SPARE	1	20	-	40	SPARE	1	20	-
41	SPARE	1	20	-	42	SPARE	1	20	-
	CONNECTED LOAD	8500 VA		TOTAL PHASE A		5600 VA			
	DEMAND LOAD	10625 V A		TOTAL PHASE B		3900 VA			
	25% GROWTH	13282 VA		TOTAL PHASE C		8500 VA			

WIRING PANEL SCHEDULE

	PANEL: LIE2	MAINS: MLO				AMPS: 225			AIC: 14K
	VOLTAGE: 480Y/277V	WIRES: 4		PHASE: 3		MOUNTING: SURFACE			LOC: MAIN ELEC. RM
CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT	CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT
1	LIGHTING	1	20	3/4"C.W/2#12+1#12GRD.	2	LIGHTING	1	20**	3/4"C.W/2#12+1#12GRD
3	LIGHTING	1	20	3/4"C.W/2#12+1#12GRD.	4	LIGHTING	1	20**	3/4"C.W/2#12+1#12GRD
5	LIGHTING	1	20	3/4"C.W/2#12+1#12GRD.	6	LIGHTING XFMR	1	20	3/4"C.W/2#12+1#12GRD
7	FANS	1	20	3/4"C.W/2#12+1#12GRD.	8	LIGHTING XFMR	1	20	3/4"C.W/2#12+1#12GRD
9	LIGHTING	1	20	3/4"C.W/2#12+1#12GRD.	10	LIGHTING	1	20	3/4"C.W/2#12+1#12GRD
11	LIGHTING	1	20	3/4"C.W/2#12+1#12GRD.	12	LIGHTING	1	20	3/4"C.W/2#12+1#12GRD
13	LIGHTING	1	20*	3/4"C.W/2#12+1#12GRD.	14	LIGHTING	1	20	3/4"C.W/2#12+1#12GRD
15	LIGHTING	1	20*	3/4"C.W/2#12+1#12GRD.	16	LIGHTING	1	20	3/4"C.W/2#12+1#12GRD
17	OUTDOOR DOWNLIGHT	1	20	3/4"C.W/2#12+1#12GRD.	18	OUTDOOR POLE/BOLLARD	1	20	1.5"C.W/2#8+1#10GRD.
19	SPARE	1	20	-	20	SPARE	1	20	-
21	SPARE	1	20	-	22	SPARE	1	20	-
23	SPARE	1	20	-	24	SPARE	1	20	-
25	SPARE	1	20	-	26	SPARE	1	20	-
27	SPACE	1	-	-	28	SPACE	1	-	-
29	SPACE	1	-	-	30	SPACE	1	-	-
31	SPACE	1	-	-	32	SPACE	1	-	-
33	SPACE	1	-	-	34	SPACE	1	-	-
35	SPACE	1	-	-	36	SPACE	1	-	-
37	SPACE	1	-	-	38	SPACE	1	-	-
39	SPACE	1	-	-	40	SPACE	1	-	-
41	SPACE	1	-	-	42	SPACE	1	-	-
	CONNECTED LOAD	12144 VA		TOTAL PHASE A	3172 VA				
	DEMAND LOAD	13905 VA		TOTAL PHASE B	4536 VA				
	25% GROWTH	17381 A		TOTAL PHASE C	4436 VA				



Appendix B

Spring 2006

Air-Cooled Series R™ Rotary Liquid Chiller

Model RTAC

140 to 500 Tons (60 Hz)

140 to 400 Tons (50 Hz)

Built For the Industrial and Commercial Markets

May 2005

RLC-PRC006-EN

Features and Benefits

Table 1. RTAC efficiency vs Ashrae 90.1

RTAC - Exceeding the Efficiency Standard						
	Full Load Efficiency (EER*)			Part Load Efficiency (EER*)		
Tonnage	**ASHRAE 90.1**	Standard Efficiency	High Efficiency	**ASHRAE 90.1**	Standard Efficiency	High Efficiency
140	9.6	9.7	10.3	10.4	13.5	14.0
155	9.6	9.8	10.4	10.4	13.6	14.1
170	9.6	9.9	10.4	10.4	13.9	14.4
185	9.6	9.7	10.3	10.4	13.7	14.2
200	9.6	9.6	10.1	10.4	13.3	13.9
225	9.6	9.6	10.2	10.4	13.4	14.0
250	9.6	9.6	10.1	10.4	13.6	13.8
275	9.6	9.8	10.5	10.4	13.3	13.7
300	9.6	9.6	10.2	10.4	13.3	13.6
350	9.6	9.6	10.5	10.4	13.1	15.3
400	9.6	9.6	10.1	10.4	14.6	14.5
450	9.6	9.6	n/a	10.4	14.7	
500	9.6	9.6	n/a	10.4	14.9	

COP = EER/3.414.
Efficiencies given for 60 Hz units

ASHRAE Standard 90.1 and RTAC World Class Energy Efficiency…

The importance of energy efficiency cannot be understated. Fortunately, ASHRAE has created a guideline emphasizing its importance. Nonetheless, energy is often dismissed as an operational cost over which the owner has little control. That perception results in missed opportunities for energy efficiency, reduced utility bills, and higher profits. Lower utility bills directly affect profitability. Every dollar saved in energy goes directly to the bottom line. Trane's RTAC is one way to maximize your profits.

ASHRAE Standard 90.1 & Executive Order - New technology applied to the design, controls, and manufacturing have created excellent efficiency levels in the RTAC that are helping to push industry minimums to new heights. All Trane air-cooled chillers meet the new efficiency levels mandated by ASHRAE Standard 90.1. This new standard requires higher efficiencies than past technologies can deliver. The US Federal Government has adopted standard 90.1 and, in some cases, requires even higher efficiencies. Federal Executive Order mandates energy consuming devices procured must be in the top 25% of their class. In the case of chillers, that product standard is ASHRAE 90.1. Trane's RTAC meets and exceeds the efficiency requirements of 90.1, while the high efficiency RTAC can meet the "stretch goals" of Executive Order.

Precise Capacity Control. Trane's patented unloading system allows the compressor to modulate infinitely and exactly match building loads. At the same time chilled water temperatures will be maintained within +/- 1/2ºF [0.28°C] of setpoint. Reciprocating and screw chillers with stepped capacity control do well to maintain chilled water temperatures within 2ºF [1.1°C] of setpoint. Stepped control also results in overcooling your space because rarely does the capacity of the machine match the building load. The result can be 10% higher energy bills. Trane's RTAC optimizes the part load performance of your machine for energy efficiency, precise control for process applications, and your personal comfort regardless of the weather outside.

High Efficiency Horizontal and Vertical Water-Source Comfort System

Axiom™
1/2 - 5 Tons — 60 HZ— Model GEH/GEV

March 2005

WSHP-PRC001-EN

Performance Data
006-Cooling

Table P2: GEH/GEV 006 Cooling Performance

Cooling performance data is tabulated at 80.6 F DB/66.2 F WB entering air at ARI/ISO 13256-1 rated CFM. For ARI/ISO 13256-1 certified ratings, see Table P1. See Performance correction tables to correct performance at conditions other than those tabulated. Data shown is for unit performance only. Interpolation is permissible. Extrapolation is not.

Rated GPM: 1.5 **Maximum CFM: 152**
Rated CFM: 190 **Maximum CFM: 228**

EWT	GPM	Total Mbtuh	Sen Mbtuh	SHR	Power kW	EER	Reject Mbtuh	LWT	Feet Head
45	1.0	8.4	5.5	0.66	0.46	18.3	10.0	65.0	1.5
45	1.2	8.4	5.6	0.66	0.45	18.8	10.0	61.6	2.1
45	1.4	8.5	5.6	0.66	0.45	18.8	10.0	59.3	2.7
45	1.5	8.5	5.6	0.66	0.44	19.3	10.0	58.3	3.0
45	1.6	8.5	5.6	0.66	0.44	19.3	10.0	57.5	3.4
45	1.7	8.5	5.6	0.66	0.43	19.7	10.0	56.7	3.7
45	1.8	8.5	5.6	0.66	0.43	19.8	10.0	56.1	4.1
55	1.0	8.0	5.4	0.68	0.46	17.3	9.5	74.1	1.4
55	1.2	8.0	5.4	0.68	0.45	17.8	9.5	70.9	2.0
55	1.4	8.0	5.5	0.68	0.45	17.9	9.6	68.7	2.6
55	1.5	8.1	5.5	0.68	0.44	18.3	9.6	67.8	2.9
55	1.6	8.1	5.5	0.68	0.44	18.4	9.6	67.0	3.2
55	1.7	8.1	5.5	0.68	0.44	18.4	9.6	66.3	3.5
55	1.8	8.1	5.6	0.69	0.43	18.8	9.6	65.6	3.9
68	1.0	7.4	5.3	0.71	0.50	14.9	9.2	86.3	1.4
68	1.2	7.5	5.3	0.71	0.49	15.3	9.2	83.3	1.9
68	1.4	7.6	5.4	0.71	0.48	15.7	9.2	81.1	2.4
68	1.5	7.6	6.0	0.80	0.48	15.8	9.2	80.3	2.7
68	1.6	7.6	5.4	0.71	0.47	16.2	9.2	79.5	3.0
68	1.7	7.6	5.4	0.71	0.47	16.2	9.2	78.9	3.3
68	1.8	7.7	5.5	0.71	0.47	16.3	9.3	78.3	3.6
77	1.0	7.1	5.2	0.73	0.55	12.9	9.0	95.0	1.3
77	1.2	7.2	5.2	0.73	0.54	13.3	9.0	92.1	1.8
77	1.4	7.3	5.3	0.73	0.53	13.7	9.1	90.0	2.3
77	1.5	7.3	5.3	0.73	0.53	13.7	9.1	89.2	2.6
77	1.6	7.3	5.3	0.73	0.52	14.1	9.1	88.4	2.9
77	1.7	7.3	5.4	0.73	0.52	14.1	9.1	87.8	3.1
77	1.8	7.4	5.4	0.73	0.52	14.2	9.1	87.2	3.4
86	1.0	6.8	5.1	0.74	0.61	11.2	8.9	103.9	1.3
86	1.2	6.9	5.2	0.75	0.60	11.5	8.9	101.0	1.7
86	1.4	7.0	5.2	0.75	0.59	11.8	9.0	98.9	2.2
86	1.5	7.0	5.3	0.75	0.59	11.9	9.0	98.1	2.5
86	1.6	7.0	5.3	0.75	0.59	11.9	9.1	97.4	2.7
86	1.7	7.1	5.3	0.75	0.58	12.2	9.1	96.7	3.0
86	1.8	7.1	5.3	0.75	0.58	12.2	9.1	96.1	3.3
95	1.0	6.5	5.0	0.76	0.67	9.8	8.8	112.8	1.2
95	1.2	6.6	5.1	0.77	0.67	9.9	8.9	109.9	1.6
95	1.4	6.7	5.2	0.77	0.66	10.2	9.0	107.9	2.1
95	1.5	6.7	5.2	0.77	0.65	10.4	9.0	107.0	2.4
95	1.6	6.8	5.2	0.77	0.65	10.4	9.0	106.3	2.6
95	1.7	6.8	5.3	0.77	0.65	10.5	9.0	105.7	2.9
95	1.8	6.9	5.3	0.77	0.64	10.7	9.0	105.1	3.2
105	1.0	6.2	4.9	0.79	0.74	8.4	8.8	122.7	1.2
105	1.2	6.3	5.0	0.79	0.74	8.6	8.9	119.9	1.6
105	1.4	6.4	5.1	0.79	0.73	8.8	8.9	117.8	2.0
105	1.5	6.5	5.1	0.79	0.72	9.0	8.9	117.0	2.2
105	1.6	6.5	5.2	0.79	0.72	9.1	9.0	116.3	2.5
105	1.7	6.6	5.2	0.79	0.72	9.1	9.0	115.7	2.8
105	1.8	6.6	5.2	0.79	0.71	9.3	9.0	115.1	3.0
115	1.0	6.0	4.9	0.81	0.84	7.1	8.8	132.9	1.1
115	1.2	6.1	5.0	0.82	0.83	7.3	8.9	130.0	1.5
115	1.4	6.2	5.1	0.82	0.82	7.5	9.0	128.0	1.9
115	1.5	6.2	5.1	0.82	0.82	7.6	9.0	127.2	2.2
115	1.6	6.3	5.1	0.82	0.81	7.7	9.0	126.4	2.4
115	1.7	6.3	5.2	0.82	0.81	7.8	9.1	125.8	2.7
115	1.8	6.4	5.2	0.82	0.81	7.9	9.1	125.2	3.0
120	1.0	5.8	4.8	0.82	0.91	6.4	9.0	138.1	1.0
120	1.2	6.0	4.9	0.83	0.90	6.6	9.0	135.2	1.4
120	1.4	6.1	5.0	0.83	0.90	6.7	9.1	133.2	1.9
120	1.5	6.1	5.1	0.83	0.89	6.9	9.1	132.3	2.1
120	1.6	6.2	5.1	0.83	0.89	6.9	9.2	131.6	2.4
120	1.7	6.2	5.2	0.83	0.88	7.0	9.2	131.0	2.6
120	1.8	6.2	5.2	0.83	0.88	7.1	9.3	130.4	2.9

Performance Data
006-Heating

Table P3: GEH/GEV 006 Heating Performance

Heating performance data is tabulated at 68 F DB entering air at ARI/ISO 13256-1 rated CFM. For ARI/ISO 13256-1 certified ratings, see Table P1. See Performance correction tables to correct performance at conditions other than those tabulated. Data shown is for unit performance only. Interpolation is permissible. Extrapolation is not.

Rated GPM: 1.5 **Maximum CFM: 152**
Rated CFM: 190 **Maximum CFM: 228**

EWT	GPM	Htg Cap Mbtuh	Absorb Mbtuh	Power kW	COP	LWT	Feet Head
25	1.0	5.0	3.2	0.52	2.8	18.5	1.5
25	1.2	5.2	3.4	0.52	2.9	19.4	2.2
25	1.4	5.2	3.4	0.53	2.9	20.2	3.0
25	1.5	5.2	3.4	0.53	2.9	20.5	3.4
25	1.6	5.2	3.3	0.53	2.8	20.8	3.8
25	1.7	5.2	3.4	0.53	2.9	21.1	4.2
25	1.8	5.2	3.4	0.53	2.9	21.2	4.6
32	1.0	5.5	3.6	0.54	3.0	24.7	1.5
32	1.2	5.7	3.8	0.54	3.1	25.6	2.1
32	1.4	5.7	3.9	0.54	3.1	26.5	2.9
32	1.5	5.7	3.8	0.55	3.0	26.9	3.2
32	1.6	5.7	3.8	0.55	3.0	27.2	3.6
32	1.7	5.7	3.8	0.55	3.0	27.5	4.0
32	1.8	5.8	3.9	0.55	3.1	27.7	4.5
45	1.0	6.5	4.6	0.57	3.3	35.9	1.5
45	1.2	6.7	4.8	0.57	3.5	37.0	2.1
45	1.4	6.8	4.9	0.57	3.5	38.0	2.7
45	1.5	6.8	4.9	0.57	3.5	38.5	3.0
45	1.6	6.8	4.9	0.58	3.5	38.9	3.4
45	1.7	6.9	4.9	0.58	3.5	39.2	3.7
45	1.8	6.9	5.0	0.58	3.5	39.5	4.1
55	1.0	7.4	5.4	0.59	3.7	44.3	1.4
55	1.2	7.6	5.6	0.60	3.7	45.7	2.0
55	1.4	7.7	5.7	0.60	3.8	46.9	2.6
55	1.5	7.8	5.7	0.60	3.8	47.4	2.9
55	1.6	7.8	5.7	0.60	3.8	47.8	3.2
55	1.7	7.8	5.8	0.60	3.8	48.2	3.5
55	1.8	7.9	5.8	0.60	3.8	48.5	3.9
68	1.0	8.5	6.4	0.62	4.0	55.2	1.4
68	1.2	8.8	6.6	0.63	4.1	56.9	1.9
68	1.4	8.9	6.7	0.63	4.1	58.4	2.4
68	1.5	8.9	6.8	0.63	4.1	59.0	2.7
68	1.6	8.9	6.8	0.63	4.2	59.5	3.0
68	1.7	9.0	6.8	0.63	4.2	60.0	3.3
68	1.8	9.0	6.9	0.63	4.2	60.4	3.6
75	1.0	9.1	6.9	0.64	4.1	61.2	1.4
75	1.2	9.3	7.2	0.64	4.3	63.0	1.8
75	1.4	9.4	7.3	0.64	4.3	64.6	2.3
75	1.5	9.5	7.3	0.64	4.3	65.3	2.6
75	1.6	9.5	7.3	0.65	4.3	65.9	2.9
75	1.7	9.5	7.3	0.65	4.3	66.4	3.2
75	1.8	9.6	7.3	0.65	4.3	66.8	3.5
86	1.0	9.8	7.5	0.66	4.3	70.9	1.3
86	1.2	10.1	7.8	0.66	4.5	72.9	1.7
86	1.4	10.2	7.9	0.67	4.4	74.7	2.2
86	1.5	10.2	7.9	0.67	4.5	75.4	2.5
86	1.6	10.2	7.9	0.67	4.5	76.1	2.7
86	1.7	10.2	7.9	0.67	4.5	76.6	3.0
86	1.8	10.2	8.0	0.67	4.5	77.1	3.3

Table P4: 006 Fan Correction Factors

Entering CFM	Cooling Capacity	Sensible Capacity	Cooling Input Watts	Heating Capacity	Heating Input Watts
152	0.974	0.892	0.965	0.972	1.032
162	0.981	0.920	0.973	0.979	1.023
171	0.987	0.945	0.981	0.986	1.016
181	0.994	0.973	0.991	0.993	1.008
190	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
209	1.012	1.051	1.020	1.013	0.984
218	1.018	1.077	1.030	1.020	0.977
228	1.025	1.105	1.042	1.027	0.968

Performance Data 009-Cooling

Table P5: GEH/GEV 009 Cooling Performance

Cooling performance data is tabulated at 80.6 F DB/66.2 F WB entering air at ARI/ISO 13256-1 rated CFM. For ARI/ISO 13256-1 certified ratings, see Table P1. See Performance correction tables to correct performance at conditions other than those tabulated. Data shown is for unit performance only. Interpolation is permissible. Extrapolation is not.

Rated GPM: 2.1	**Maximum CFM: 228**
Rated CFM: 285	**Maximum CFM: 342**

EWT	GPM	Total Mbtuh	Sen Mbtuh	SHR	Power kW	EER	Reject Mbtuh	LWT	Feet Head
45	1.4	10.6	7.4	0.70	0.56	18.9	12.5	62.9	2.7
45	1.7	10.6	7.4	0.70	0.54	19.6	12.4	59.6	3.8
45	1.9	10.7	7.3	0.68	0.53	20.2	12.5	58.2	4.5
45	2.1	10.7	7.3	0.68	0.52	20.6	12.5	56.9	5.4
45	2.2	10.7	7.3	0.68	0.52	20.6	12.5	56.3	5.8
45	2.3	10.7	7.3	0.68	0.52	20.6	12.5	55.8	6.2
45	2.5	10.7	7.3	0.68	0.52	20.6	12.5	55.0	7.1
55	1.4	10.1	7.1	0.70	0.56	18.0	12.0	72.2	2.6
55	1.7	10.2	7.1	0.70	0.54	18.9	12.0	69.2	3.6
55	1.9	10.2	7.1	0.70	0.53	19.2	12.0	67.6	4.3
55	2.1	10.2	7.1	0.70	0.52	19.6	12.0	66.4	5.0
55	2.2	10.2	7.1	0.70	0.52	19.6	12.0	65.9	5.4
55	2.3	10.2	7.1	0.70	0.52	19.6	12.0	65.4	5.9
55	2.5	10.2	7.1	0.70	0.52	19.6	12.0	64.6	6.7
68	1.4	9.4	6.8	0.72	0.62	15.2	11.5	84.5	2.4
68	1.7	9.5	6.9	0.73	0.60	15.8	11.6	81.6	3.3
68	1.9	9.5	6.9	0.73	0.59	16.1	11.5	80.1	4.0
68	2.1	9.5	6.9	0.73	0.58	16.4	11.5	78.9	4.7
68	2.2	9.5	6.9	0.73	0.57	16.7	11.5	78.4	5.0
68	2.3	9.5	6.9	0.73	0.57	16.7	11.5	78.0	5.4
68	2.5	9.5	6.9	0.73	0.57	16.7	11.5	77.2	6.2
77	1.4	8.9	6.6	0.74	0.68	13.1	11.2	93.1	2.3
77	1.7	9.0	6.7	0.74	0.66	13.6	11.3	90.3	3.1
77	1.9	9.0	6.7	0.74	0.65	13.8	11.2	88.8	3.7
77	2.1	9.0	6.7	0.74	0.64	14.1	11.2	87.7	4.4
77	2.2	9.0	6.7	0.74	0.64	14.1	11.2	87.2	4.8
77	2.3	9.1	6.7	0.74	0.63	14.4	11.3	86.8	5.2
77	2.5	9.0	6.7	0.74	0.63	14.3	11.2	85.9	5.9
86	1.4	8.5	6.4	0.75	0.76	11.2	11.1	101.9	2.2
86	1.7	8.5	6.5	0.76	0.74	11.5	11.0	99.0	3.0
86	1.9	8.5	6.5	0.76	0.73	11.6	11.0	97.6	3.6
86	2.1	8.6	6.5	0.76	0.72	11.9	11.1	96.6	4.2
86	2.2	8.6	6.5	0.76	0.71	12.1	11.0	96.1	4.6
86	2.3	8.6	6.5	0.76	0.71	12.1	11.0	95.6	4.9
86	2.5	8.6	6.5	0.76	0.71	12.1	11.0	94.9	5.7
95	1.4	8.0	6.2	0.78	0.84	9.5	10.9	110.6	2.0
95	1.7	8.1	6.3	0.78	0.82	9.9	10.9	107.9	2.8
95	1.9	8.1	6.3	0.78	0.81	10.0	10.9	106.5	3.4
95	2.1	8.1	6.3	0.78	0.80	10.1	10.8	105.4	4.1
95	2.2	8.1	6.3	0.78	0.80	10.1	10.8	104.9	4.4
95	2.3	8.1	6.3	0.78	0.79	10.3	10.8	104.4	4.7
95	2.5	8.1	6.3	0.78	0.79	10.3	10.8	103.7	5.5
105	1.4	7.5	6.0	0.80	0.93	8.1	10.7	120.4	2.0
105	1.7	7.5	6.0	0.80	0.92	8.2	10.6	117.6	2.7
105	1.9	7.6	6.0	0.79	0.90	8.4	10.7	116.3	3.3
105	2.1	7.6	6.0	0.79	0.89	8.5	10.6	115.2	3.9
105	2.2	7.6	6.0	0.79	0.89	8.5	10.6	114.7	4.2
105	2.3	7.6	6.0	0.79	0.88	8.6	10.6	114.3	4.6
105	2.5	7.6	6.0	0.79	0.88	8.6	10.6	113.5	5.3
115	1.4	6.8	5.7	0.84	1.01	6.7	10.3	129.8	1.9
115	1.7	6.8	5.7	0.84	1.00	6.8	10.2	127.1	2.7
115	1.9	6.9	5.7	0.83	0.98	7.0	10.2	125.9	3.2
115	2.1	6.9	5.7	0.83	0.97	7.1	10.2	124.8	3.8
115	2.2	6.9	5.7	0.83	0.97	7.1	10.2	124.4	4.2
115	2.3	6.9	5.7	0.83	0.97	7.1	10.2	124.0	4.5
115	2.5	6.9	5.7	0.83	0.96	7.2	10.2	123.2	5.2
120	1.4	6.2	5.6	0.90	1.04	6.0	9.8	134.1	1.9
120	1.7	6.3	5.5	0.87	1.03	6.1	9.8	131.7	2.6
120	1.9	6.3	5.5	0.87	1.02	6.2	9.8	130.4	3.2
120	2.1	6.4	5.5	0.86	1.01	6.3	9.9	129.5	3.8
120	2.2	6.4	5.5	0.86	1.00	6.4	9.8	129.0	4.2
120	2.3	6.4	5.5	0.86	1.00	6.4	9.8	128.6	4.5
120	2.5	6.4	5.5	0.86	1.00	6.4	9.8	127.9	5.2

Performance Data
009-Heating

Table P6: GEH/GEV 009 Heating Performance

Heating performance data is tabulated at 68 F DB entering air at ARI/ISO 13256-1 rated CFM. For ARI/ISO 13256-1 certified ratings, see Table P1. See Performance correction tables to correct performance at conditions other than those tabulated. Data shown is for unit performance only. Interpolation is permissible. Extrapolation is not.

Rated GPM: 2.1 **Maximum CFM: 228**
Rated CFM: 285 **Maximum CFM: 342**

EWT	GPM	Htg Cap Mbtuh	Absorb Mbtuh	Power kW	COP	LWT	Feet Head
25	1.4	6.7	4.7	0.60	3.3	18.4	3.0
25	1.7	6.7	4.7	0.60	3.3	19.5	4.2
25	1.9	6.7	4.6	0.61	3.2	20.1	5.1
25	2.1	6.7	4.6	0.61	3.2	20.6	6.0
25	2.2	6.8	4.7	0.61	3.3	20.7	6.5
25	2.3	6.8	4.7	0.61	3.3	20.9	7.0
25	2.5	6.8	4.7	0.61	3.3	21.2	8.1
32	1.4	6.9	4.8	0.62	3.3	25.2	2.9
32	1.7	7.0	4.9	0.62	3.3	26.3	4.1
32	1.9	7.0	4.9	0.63	3.3	26.9	4.9
32	2.1	7.1	5.0	0.63	3.3	27.3	5.8
32	2.2	7.1	5.0	0.63	3.3	27.5	6.3
32	2.3	7.2	5.1	0.63	3.3	27.6	6.7
32	2.5	7.2	5.1	0.63	3.3	28.0	7.7
45	1.4	8.1	5.9	0.66	3.6	36.6	2.7
45	1.7	8.3	6.1	0.66	3.7	37.9	3.8
45	1.9	8.4	6.2	0.66	3.7	38.5	4.5
45	2.1	8.5	6.2	0.67	3.7	39.1	5.4
45	2.2	8.5	6.2	0.67	3.7	39.4	5.8
45	2.3	8.5	6.2	0.67	3.7	39.6	6.2
45	2.5	8.6	6.3	0.67	3.8	40.0	7.1
55	1.4	9.2	6.9	0.68	4.0	45.2	2.6
55	1.7	9.4	7.1	0.69	4.0	46.7	3.6
55	1.9	9.5	7.2	0.69	4.0	47.5	4.3
55	2.1	9.6	7.3	0.69	4.1	48.1	5.0
55	2.2	9.7	7.4	0.69	4.1	48.3	5.4
55	2.3	9.7	7.4	0.69	4.1	48.6	5.9
55	2.5	9.8	7.5	0.69	4.2	49.0	6.7
68	1.4	10.6	8.1	0.72	4.3	56.4	2.4
68	1.7	10.9	8.4	0.72	4.4	58.1	3.3
68	1.9	11.0	8.5	0.72	4.5	59.0	4.0
68	2.1	11.1	8.6	0.73	4.5	59.8	4.7
68	2.2	11.1	8.6	0.73	4.5	60.2	5.0
68	2.3	11.2	8.7	0.73	4.5	60.4	5.4
68	2.5	11.2	8.7	0.73	4.5	61.0	6.2
75	1.4	11.4	8.9	0.73	4.6	62.2	2.3
75	1.7	11.6	9.1	0.74	4.6	64.3	3.2
75	1.9	11.7	9.2	0.74	4.6	65.3	3.8
75	2.1	11.8	9.3	0.74	4.7	66.2	4.5
75	2.2	11.8	9.3	0.74	4.7	66.6	4.8
75	2.3	11.9	9.4	0.74	4.7	66.8	5.2
75	2.5	12.0	9.4	0.75	4.7	67.4	6.0
86	1.4	12.4	9.8	0.76	4.8	71.9	2.2
86	1.7	12.6	10.0	0.76	4.9	74.2	3.0
86	1.9	12.7	10.1	0.76	4.9	75.3	3.6
86	2.1	12.8	10.2	0.76	4.9	76.2	4.2
86	2.2	12.9	10.3	0.77	4.9	76.6	4.6
86	2.3	12.9	10.3	0.77	4.9	77.0	4.9
86	2.5	13.0	10.4	0.77	4.9	77.7	5.7

Table P7: 009 Fan Correction Factors

Entering CFM	Cooling Capacity	Sensible Capacity	Cooling Input Watts	Heating Capacity	Heating Input Watts
228	0.974	0.892	0.965	0.972	1.032
242	0.980	0.918	0.972	0.979	1.024
257	0.987	0.946	0.982	0.986	1.016
271	0.993	0.972	0.991	0.993	1.008
285	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
314	1.013	1.052	1.020	1.014	0.984
328	1.019	1.078	1.030	1.020	0.976
342	1.025	1.105	1.042	1.027	0.968

Performance Data
012-Cooling

Table P8: GEH/GEV 012 Cooling Performance

Cooling performance data is tabulated at 80.6 F DB/66.2 F WB entering air at ARI/ISO 13256-1 rated CFM. For ARI/ISO 13256-1 certified ratings, see Table P1. See Performance correction tables to correct performance at conditions other than those tabulated. Data shown is for unit performance only. Interpolation is permissible. Extrapolation is not.

Rated GPM: 2.8 **Maximum CFM: 304**
Rated CFM: 380 **Maximum CFM: 456**

EWT	GPM	Total Mbtuh	Sen Mbtuh	SHR	Power kW	EER	Reject Mbtuh	LWT	Feet Head
45	1.8	14.3	10.4	0.73	0.88	16.3	17.3	64.2	4.7
45	2.2	14.4	10.4	0.72	0.85	16.9	17.3	60.7	6.5
45	2.5	14.4	10.5	0.73	0.84	17.1	17.3	58.8	8.0
45	2.8	14.5	10.5	0.72	0.83	17.5	17.3	57.4	9.6
45	2.9	14.5	10.5	0.72	0.82	17.7	17.3	56.9	10.1
45	3.1	14.5	10.5	0.72	0.82	17.7	17.3	56.2	11.2
45	3.4	14.5	10.5	0.72	0.80	18.1	17.2	55.1	13.0
55	1.8	13.9	10.0	0.72	0.80	17.4	16.6	73.5	4.4
55	2.2	13.9	10.0	0.72	0.77	18.1	16.5	70.0	6.1
55	2.5	14.0	10.0	0.71	0.77	18.2	16.6	68.3	7.4
55	2.8	14.1	10.1	0.72	0.75	18.8	16.7	66.9	8.9
55	2.9	14.1	10.1	0.72	0.75	18.8	16.7	66.5	9.4
55	3.1	14.1	10.1	0.72	0.75	18.8	16.7	65.8	10.5
55	3.4	14.1	10.0	0.71	0.72	19.6	16.6	64.7	12.2
68	1.8	13.1	9.6	0.73	0.91	14.4	16.2	86.0	4.1
68	2.2	13.2	9.6	0.73	0.88	15.0	16.2	82.7	5.6
68	2.5	13.2	9.6	0.73	0.88	15.0	16.2	81.0	6.9
68	2.8	13.3	9.7	0.73	0.86	15.5	16.2	79.6	8.3
68	2.9	13.3	9.7	0.73	0.86	15.5	16.2	79.2	8.8
68	3.1	13.3	9.6	0.72	0.86	15.5	16.2	78.5	9.8
68	3.4	13.3	9.6	0.72	0.83	16.0	16.1	77.5	11.3
77	1.8	12.5	9.3	0.74	1.00	12.5	15.9	94.7	3.9
77	2.2	12.6	9.3	0.74	0.97	13.0	15.9	91.5	5.3
77	2.5	12.7	9.4	0.74	0.96	13.2	16.0	89.8	6.6
77	2.8	12.7	9.4	0.74	0.95	13.4	15.9	88.4	7.9
77	2.9	12.8	9.4	0.73	0.95	13.5	16.0	88.1	8.4
77	3.1	12.8	9.4	0.73	0.94	13.6	16.0	87.4	9.4
77	3.4	12.8	9.4	0.73	0.92	13.9	15.9	86.4	10.9
86	1.8	12.0	9.1	0.76	1.08	11.1	15.7	103.5	3.7
86	2.2	12.1	9.1	0.75	1.05	11.5	15.7	100.3	5.1
86	2.5	12.1	9.1	0.75	1.05	11.5	15.7	98.6	6.3
86	2.8	12.2	9.2	0.75	1.03	11.8	15.7	97.3	7.6
86	2.9	12.2	9.2	0.75	1.03	11.8	15.7	96.9	8.1
86	3.1	12.2	9.2	0.75	1.03	11.8	15.7	96.2	9.0
86	3.4	12.2	9.1	0.75	1.00	12.2	15.6	95.2	10.5
95	1.8	11.3	8.8	0.78	1.19	9.5	15.4	112.2	3.5
95	2.2	11.4	8.8	0.77	1.16	9.8	15.4	109.0	4.9
95	2.5	11.5	8.9	0.77	1.15	10.0	15.4	107.4	6.1
95	2.8	11.5	8.9	0.77	1.14	10.1	15.4	106.1	7.4
95	2.9	11.5	8.9	0.77	1.13	10.2	15.4	105.7	7.8
95	3.1	11.6	8.9	0.77	1.13	10.3	15.5	105.0	8.8
95	3.4	11.6	8.9	0.77	1.11	10.5	15.4	104.1	10.2
105	1.8	10.5	8.5	0.81	1.35	7.8	15.1	121.9	3.4
105	2.2	10.6	8.5	0.80	1.31	8.1	15.1	118.8	4.8
105	2.5	10.6	8.6	0.81	1.31	8.1	15.1	117.2	5.9
105	2.8	10.7	8.6	0.80	1.30	8.2	15.1	115.9	7.1
105	2.9	10.7	8.6	0.80	1.29	8.3	15.1	115.5	7.6
105	3.1	10.7	8.6	0.80	1.29	8.3	15.1	114.8	8.5
105	3.4	10.8	8.6	0.80	1.27	8.5	15.1	114.0	9.9
115	1.8	9.6	8.1	0.84	1.49	6.4	14.7	131.5	3.3
115	2.2	9.7	8.1	0.84	1.46	6.6	14.7	128.5	4.6
115	2.5	9.8	8.2	0.84	1.45	6.8	14.8	126.9	5.7
115	2.8	9.9	8.2	0.83	1.44	6.9	14.8	125.7	6.9
115	2.9	9.9	8.2	0.83	1.44	6.9	14.8	125.3	7.4
115	3.1	9.9	8.2	0.83	1.44	6.9	14.8	124.7	8.3
115	3.4	9.9	8.2	0.83	1.41	7.0	14.7	123.7	9.7
120	1.8	9.3	7.9	0.85	1.50	6.2	14.4	136.2	3.2
120	2.2	9.4	7.9	0.84	1.47	6.4	14.4	133.3	4.5
120	2.5	9.5	7.9	0.83	1.46	6.5	14.5	131.7	5.6
120	2.8	9.5	8.0	0.84	1.45	6.6	14.5	130.4	6.8
120	2.9	9.5	8.0	0.84	1.45	6.6	14.5	130.1	7.3
120	3.1	9.6	7.9	0.82	1.44	6.7	14.5	129.5	8.2
120	3.4	9.6	7.9	0.82	1.42	6.8	14.5	128.6	9.6

Performance Data
012-Heating

Table P9: GEH/GEV 012 Heating Performance

Heating performance data is tabulated at 68 F DB entering air at ARI/ISO 13256-1 rated CFM. For ARI/ISO 13256-1 certified ratings, see Table P1. See Performance correction tables to correct performance at conditions other than those tabulated. Data shown is for unit performance only. Interpolation is permissible. Extrapolation is not.

Rated GPM: 2.8 **Maximum CFM: 304**
Rated CFM: 380 **Maximum CFM: 456**

EWT	GPM	Htg Cap Mbtuh	Absorb Mbtuh	Power kW	COP	LWT	Feet Head
25	1.8	8.0	5.2	0.83	2.8	19.3	5.6
25	2.2	8.2	5.4	0.83	2.9	20.1	7.7
25	2.5	8.3	5.4	0.84	2.9	20.7	9.4
25	2.8	8.4	5.5	0.84	2.9	21.1	11.2
25	2.9	8.4	5.5	0.84	2.9	21.2	11.8
25	3.1	8.5	5.6	0.84	3.0	21.4	13.1
25	3.4	8.5	5.6	0.84	3.0	21.7	15.0
32	1.8	9.2	6.3	0.85	3.2	25.0	5.3
32	2.2	9.3	6.4	0.86	3.2	26.2	7.3
32	2.5	9.4	6.5	0.86	3.2	26.8	8.9
32	2.8	9.5	6.6	0.86	3.2	27.3	10.6
32	2.9	9.6	6.7	0.86	3.3	27.4	11.2
32	3.1	9.6	6.7	0.86	3.3	27.7	12.4
32	3.4	9.7	6.7	0.87	3.3	28.0	14.3
45	1.8	11.0	7.9	0.90	3.6	36.2	4.7
45	2.2	11.2	8.1	0.91	3.6	37.6	6.5
45	2.5	11.3	8.2	0.92	3.6	38.5	8.0
45	2.8	11.4	8.3	0.92	3.6	39.1	9.6
45	2.9	11.4	8.3	0.92	3.6	39.3	10.1
45	3.1	11.4	8.3	0.92	3.6	39.7	11.2
45	3.4	11.5	8.4	0.92	3.7	40.1	13.0
55	1.8	12.1	8.9	0.93	3.8	45.1	4.4
55	2.2	12.3	9.1	0.93	3.9	46.7	6.1
55	2.5	12.4	9.2	0.94	3.9	47.6	7.4
55	2.8	12.4	9.2	0.94	3.9	48.4	8.9
55	2.9	12.5	9.3	0.94	3.9	48.6	9.4
55	3.1	12.5	9.3	0.94	3.9	49.0	10.5
55	3.4	12.6	9.4	0.94	3.9	49.5	12.2
68	1.8	13.2	10.0	0.95	4.1	56.9	4.1
68	2.2	13.4	10.1	0.96	4.1	58.8	5.6
68	2.5	13.5	10.2	0.96	4.1	59.8	6.9
68	2.8	13.5	10.2	0.96	4.1	60.7	8.3
68	2.9	13.6	10.3	0.96	4.2	60.9	8.8
68	3.1	13.6	10.3	0.96	4.2	61.3	9.8
68	3.4	13.7	10.4	0.97	4.1	61.9	11.3
75	1.8	13.7	10.4	0.97	4.1	63.4	3.9
75	2.2	13.9	10.6	0.97	4.2	65.4	5.4
75	2.5	14.0	10.7	0.98	4.2	66.5	6.6
75	2.8	14.1	10.8	0.98	4.2	67.3	8.0
75	2.9	14.1	10.8	0.98	4.2	67.6	8.5
75	3.1	14.2	10.9	0.98	4.2	68.0	9.5
75	3.4	14.3	10.9	0.99	4.2	68.6	11.0
86	1.8	14.6	11.2	0.99	4.3	73.5	3.7
86	2.2	14.8	11.4	1.00	4.3	75.6	5.1
86	2.5	14.9	11.5	1.01	4.3	76.8	6.3
86	2.8	14.9	11.5	1.01	4.3	77.8	7.6
86	2.9	15.0	11.6	1.01	4.4	78.0	8.1
86	3.1	15.0	11.6	1.00	4.4	78.5	9.0
86	3.4	15.1	11.7	1.01	4.4	79.1	10.5

Table P10: 012 Fan Correction Factors

Entering CFM	Cooling Capacity	Sensible Capacity	Cooling Input Watts	Heating Capacity	Heating Input Watts
304	0.974	0.892	0.965	0.972	1.032
323	0.980	0.919	0.973	0.979	1.024
342	0.987	0.945	0.981	0.986	1.016
361	0.993	0.972	0.990	0.993	1.008
380	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
418	1.012	1.051	1.020	1.013	0.984
437	1.019	1.078	1.030	1.020	0.976
456	1.025	1.105	1.042	1.027	0.968

Performance Data
015-Cooling

Table P11: GEH/GEV 015 Cooling Performance

Cooling performance data is tabulated at 80.6 F DB/66.2 F WB entering air at ARI/ISO 13256-1 rated CFM. For ARI/ISO 13256-1 certified ratings, see Table P1. See Performance correction tables to correct performance at conditions other than those tabulated. Data shown is for unit performance only. Interpolation is permissible. Extrapolation is not.

Rated GPM: 3.5 **Maximum CFM: 368**
Rated CFM: 460 **Maximum CFM: 552**

EWT	GPM	Total Mbtuh	Sen Mbtuh	SHR	Power kW	EER	Reject Mbtuh	LWT	Feet Head
45	2.2	17.0	11.9	0.70	0.78	21.8	19.7	62.9	3.9
45	2.8	17.1	12.0	0.70	0.74	23.1	19.6	59.0	5.7
45	3.1	17.1	11.9	0.70	0.73	23.4	19.6	57.6	6.7
45	3.5	17.1	11.9	0.70	0.72	23.8	19.6	56.2	8.2
45	3.6	17.1	11.8	0.69	0.71	24.1	19.5	55.8	8.5
45	3.8	17.1	11.8	0.69	0.71	24.1	19.5	55.3	9.3
45	4.2	17.1	11.8	0.69	0.72	23.8	19.6	54.3	10.9
55	2.2	16.1	11.4	0.71	0.83	19.4	18.9	72.2	3.7
55	2.8	16.2	11.6	0.72	0.79	20.5	18.9	68.5	5.4
55	3.1	16.3	11.6	0.71	0.78	20.9	19.0	67.2	6.3
55	3.5	16.3	11.5	0.71	0.77	21.2	18.9	65.8	7.7
55	3.6	16.3	11.5	0.71	0.77	21.2	18.9	65.5	8.1
55	3.8	16.3	11.5	0.71	0.77	21.2	18.9	65.0	8.8
55	4.2	16.3	11.5	0.71	0.78	20.9	19.0	64.0	10.3
68	2.2	15.2	10.9	0.72	0.93	16.3	18.4	84.7	3.4
68	2.8	15.3	11.1	0.73	0.90	17.0	18.4	81.1	5.0
68	3.1	15.4	11.1	0.72	0.89	17.3	18.4	79.9	5.9
68	3.5	15.4	11.1	0.72	0.88	17.5	18.4	78.5	7.2
68	3.6	15.3	11.1	0.73	0.88	17.4	18.3	78.2	7.5
68	3.8	15.3	11.1	0.73	0.88	17.4	18.3	77.6	8.2
68	4.2	15.4	11.1	0.72	0.88	17.5	18.4	76.8	9.6
77	2.2	14.5	10.6	0.73	1.02	14.2	18.0	93.4	3.2
77	2.8	14.6	10.8	0.74	1.00	14.6	18.0	89.9	4.7
77	3.1	14.6	10.8	0.74	0.99	14.7	18.0	88.6	5.6
77	3.5	14.6	10.8	0.74	0.98	14.9	17.9	87.3	6.8
77	3.6	14.6	10.8	0.74	0.98	14.9	17.9	87.0	7.2
77	3.8	14.6	10.8	0.74	0.98	14.9	17.9	86.5	7.8
77	4.2	14.6	10.9	0.75	0.98	14.9	17.9	85.6	9.2
86	2.2	13.7	10.4	0.76	1.13	12.1	17.6	102.0	3.0
86	2.8	13.8	10.5	0.76	1.11	12.4	17.6	98.6	4.5
86	3.1	13.8	10.5	0.76	1.10	12.5	17.6	97.4	5.3
86	3.5	13.8	10.3	0.75	1.09	12.7	17.5	96.1	6.5
86	3.6	13.8	10.5	0.76	1.09	12.7	17.5	95.8	6.8
86	3.8	13.8	10.5	0.76	1.08	12.8	17.5	95.2	7.5
86	4.2	13.8	10.5	0.76	1.08	12.8	17.5	94.4	8.8
95	2.2	12.8	10.1	0.79	1.25	10.2	17.1	110.6	2.9
95	2.8	12.9	10.2	0.79	1.23	10.5	17.1	107.3	4.2
95	3.1	13.0	10.2	0.78	1.22	10.7	17.2	106.1	5.1
95	3.5	13.0	10.2	0.78	1.20	10.8	17.1	104.8	6.2
95	3.6	13.0	10.2	0.78	1.20	10.8	17.1	104.6	6.5
95	3.8	12.9	10.2	0.79	1.19	10.8	17.0	104.0	7.1
95	4.2	13.0	10.2	0.78	1.18	11.0	17.0	103.2	8.4
105	2.2	11.9	9.9	0.83	1.39	8.6	16.6	120.2	2.7
105	2.8	12.0	9.9	0.83	1.37	8.8	16.7	117.0	4.0
105	3.1	12.1	9.9	0.82	1.35	9.0	16.7	115.9	4.8
105	3.5	12.1	9.8	0.81	1.33	9.1	16.6	114.6	5.9
105	3.6	12.1	9.8	0.81	1.33	9.1	16.6	114.3	6.2
105	3.8	12.1	9.8	0.81	1.32	9.2	16.6	113.8	6.8
105	4.2	12.1	9.8	0.81	1.30	9.3	16.5	112.9	8.0
115	2.2	11.0	9.7	0.88	1.53	7.2	16.2	129.9	2.6
115	2.8	11.1	9.6	0.86	1.50	7.4	16.2	126.7	3.9
115	3.1	11.2	9.5	0.85	1.49	7.5	16.3	125.6	4.6
115	3.5	11.2	9.4	0.84	1.46	7.7	16.2	124.3	5.7
115	3.6	11.1	9.4	0.85	1.46	7.6	16.1	124.0	6.0
115	3.8	11.1	9.3	0.84	1.44	7.7	16.0	123.5	6.5
115	4.2	11.2	9.3	0.83	1.42	7.9	16.1	122.7	7.7
120	2.2	10.5	9.6	0.91	1.60	6.6	16.0	134.7	2.5
120	2.8	10.6	9.5	0.90	1.57	6.8	16.0	131.5	3.8
120	3.1	10.6	9.4	0.89	1.55	6.8	15.9	130.4	4.5
120	3.5	10.6	9.2	0.87	1.53	6.9	15.8	129.1	5.6
120	3.6	10.6	9.2	0.87	1.52	7.0	15.8	128.9	5.9
120	3.8	10.6	9.1	0.86	1.50	7.1	15.7	128.4	6.4
120	4.2	10.6	9.0	0.85	1.47	7.2	15.6	127.5	7.6

Performance Data
015-Heating

Table P12: GEH/GEV 015 Heating Performance

Heating performance data is tabulated at 68 F DB entering air at ARI/ISO 13256-1 rated CFM. For ARI/ISO 13256-1 certified ratings, see Table P1. See Performance correction tables to correct performance at conditions other than those tabulated. Data shown is for unit performance only. Interpolation is permissible. Extrapolation is not.

Rated GPM: 3.5 **Maximum CFM: 368**
Rated CFM: 460 **Maximum CFM: 552**

EWT	GPM	Htg Cap Mbtuh	Absorb Mbtuh	Power kW	COP	LWT	Feet Head
25	2.2	9.4	6.5	0.86	3.2	19.1	4.3
25	2.8	9.7	6.7	0.89	3.2	20.2	6.3
25	3.1	9.8	6.8	0.89	3.2	20.6	7.4
25	3.5	9.9	6.9	0.89	3.3	21.1	9.1
25	3.6	10.0	7.0	0.89	3.3	21.1	9.5
25	3.8	10.0	7.0	0.89	3.3	21.3	10.3
25	4.2	10.1	7.0	0.90	3.3	21.7	12.1
32	2.2	10.6	7.5	0.91	3.4	25.2	4.2
32	2.8	10.8	7.6	0.93	3.4	26.6	6.1
32	3.1	11.0	7.8	0.93	3.5	27.0	7.2
32	3.5	11.1	7.9	0.94	3.5	27.5	8.7
32	3.6	11.2	8.0	0.94	3.5	27.6	9.1
32	3.8	11.2	8.0	0.94	3.5	27.8	10.0
32	4.2	11.3	8.1	0.94	3.5	28.1	11.6
45	2.2	12.9	9.6	0.98	3.9	36.3	3.9
45	2.8	13.2	9.8	1.00	3.9	38.0	5.7
45	3.1	13.4	10.0	1.01	3.9	38.6	6.7
45	3.5	13.5	10.1	1.01	3.9	39.3	8.2
45	3.6	13.6	10.2	1.01	3.9	39.4	8.5
45	3.8	13.6	10.2	1.01	3.9	39.7	9.3
45	4.2	13.7	10.2	1.02	3.9	40.1	10.9
55	2.2	14.7	11.2	1.04	4.1	44.9	3.7
55	2.8	15.1	11.5	1.06	4.2	46.8	5.4
55	3.1	15.2	11.6	1.06	4.2	47.5	6.3
55	3.5	15.4	11.8	1.07	4.2	48.3	7.7
55	3.6	15.4	11.8	1.07	4.2	48.5	8.1
55	3.8	15.5	11.9	1.07	4.2	48.8	8.8
55	4.2	15.6	12.0	1.07	4.3	49.3	10.3
68	2.2	16.9	13.2	1.10	4.5	56.0	3.4
68	2.8	17.2	13.4	1.12	4.5	58.4	5.0
68	3.1	17.4	13.5	1.13	4.5	59.3	5.9
68	3.5	17.5	13.6	1.13	4.5	60.2	7.2
68	3.6	17.5	13.6	1.13	4.5	60.4	7.5
68	3.8	17.6	13.7	1.13	4.6	60.8	8.2
68	4.2	17.6	13.7	1.14	4.5	61.5	9.6
75	2.2	17.8	13.9	1.13	4.6	62.3	3.2
75	2.8	18.1	14.2	1.15	4.6	64.8	4.8
75	3.1	18.3	14.4	1.15	4.7	65.7	5.6
75	3.5	18.4	14.4	1.16	4.6	66.7	6.9
75	3.6	18.4	14.4	1.16	4.6	67.0	7.2
75	3.8	18.5	14.5	1.16	4.7	67.3	7.9
75	4.2	18.5	14.5	1.16	4.7	68.1	9.3
86	2.2	18.8	14.9	1.13	4.9	72.4	3.0
86	2.8	19.1	15.2	1.15	4.9	75.1	4.5
86	3.1	19.2	15.2	1.16	4.8	76.1	5.3
86	3.5	19.3	15.3	1.16	4.9	77.2	6.5
86	3.6	19.3	15.3	1.16	4.9	77.4	6.8
86	3.8	19.3	15.3	1.16	4.9	77.9	7.5
86	4.2	19.4	15.4	1.17	4.9	78.6	8.8

Table P13: 015 Fan Correction Factors

Entering CFM	Cooling Capacity	Sensible Capacity	Cooling Input Watts	Heating Capacity	Heating Input Watts
368	0.974	0.892	0.965	0.972	1.032
391	0.980	0.919	0.973	0.979	1.024
414	0.987	0.945	0.981	0.986	1.016
437	0.993	0.972	0.990	0.993	1.008
460	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
506	1.012	1.051	1.020	1.013	0.984
529	1.019	1.078	1.030	1.020	0.976
552	1.025	1.105	1.042	1.027	0.968

Performance Data
018-Cooling

Table P14: GEH/GEV 018 Cooling Performance

Cooling performance data is tabulated at 80.6 F DB/66.2 F WB entering air at ARI/ISO 13256-1 rated CFM. For ARI/ISO 13256-1 certified ratings, see Table P1. See Performance correction tables to correct performance at conditions other than those tabulated. Data shown is for unit performance only. Interpolation is permissible. Extrapolation is not.

Rated GPM: 4.2 **Maximum CFM: 456**
Rated CFM: 570 **Maximum CFM: 684**

EWT	GPM	Total Mbtuh	Sen Mbtuh	SHR	Power kW	EER	Reject Mbtuh	LWT	Feet Head
45	2.7	22.4	15.7	0.70	1.11	20.2	26.2	64.4	4.7
45	3.3	22.7	15.9	0.70	1.06	21.4	26.3	60.9	6.4
45	3.7	22.8	15.8	0.69	1.04	21.9	26.4	59.2	7.5
45	4.2	22.8	15.9	0.70	1.03	22.1	26.3	57.5	9.1
45	4.4	22.9	15.9	0.69	1.02	22.5	26.4	57.0	9.8
45	4.6	22.9	16.0	0.70	1.01	22.7	26.4	56.5	10.4
45	5.0	22.9	16.0	0.70	1.01	22.7	26.4	55.5	11.8
55	2.7	21.6	15.6	0.72	1.21	17.9	25.7	74.1	4.3
55	3.3	22.0	15.7	0.71	1.17	18.8	26.0	70.8	5.8
55	3.7	22.0	15.7	0.71	1.14	19.3	25.9	69.0	6.9
55	4.2	22.1	15.8	0.71	1.13	19.6	26.0	67.4	8.3
55	4.4	22.1	15.8	0.71	1.12	19.7	25.9	66.8	8.9
55	4.6	22.1	15.9	0.72	1.12	19.7	25.9	66.3	9.6
55	5.0	22.2	15.9	0.72	1.11	20.0	26.0	65.4	10.9
68	2.7	19.9	15.1	0.76	1.34	14.9	24.5	86.2	3.8
68	3.3	20.3	15.2	0.75	1.30	15.6	24.7	83.0	5.2
68	3.7	20.3	15.2	0.75	1.28	15.9	24.7	81.4	6.2
68	4.2	20.4	15.3	0.75	1.26	16.2	24.7	79.8	7.6
68	4.4	20.4	15.3	0.75	1.26	16.2	24.7	79.2	8.2
68	4.6	20.4	15.3	0.75	1.25	16.3	24.7	78.7	8.8
68	5.0	20.5	15.3	0.75	1.24	16.5	24.7	77.9	10.0
77	2.7	19.0	14.5	0.76	1.47	12.9	24.0	94.8	3.6
77	3.3	19.3	14.7	0.76	1.43	13.5	24.2	91.7	4.9
77	3.7	19.3	14.7	0.76	1.40	13.8	24.1	90.0	5.9
77	4.2	19.4	14.7	0.76	1.39	14.0	24.1	88.5	7.2
77	4.4	19.5	14.7	0.75	1.38	14.1	24.2	88.0	7.8
77	4.6	19.5	14.8	0.76	1.38	14.1	24.2	87.6	8.3
77	5.0	19.5	14.8	0.76	1.37	14.2	24.2	86.7	9.5
86	2.7	18.2	13.9	0.76	1.62	11.2	23.7	103.6	3.3
86	3.3	18.5	14.0	0.76	1.57	11.8	23.9	100.5	4.7
86	3.7	18.5	14.0	0.76	1.55	11.9	23.8	98.9	5.6
86	4.2	18.6	14.1	0.76	1.54	12.1	23.9	97.4	6.9
86	4.4	18.6	14.1	0.76	1.53	12.2	23.8	96.9	7.4
86	4.6	18.7	14.2	0.76	1.52	12.3	23.9	96.4	8.0
86	5.0	18.7	14.2	0.76	1.52	12.3	23.9	95.6	9.1
95	2.7	17.3	13.3	0.77	1.77	9.8	23.3	112.4	3.2
95	3.3	17.6	13.4	0.76	1.73	10.2	23.5	109.3	4.4
95	3.7	17.7	13.4	0.76	1.71	10.4	23.5	107.8	5.4
95	4.2	17.8	13.5	0.76	1.70	10.5	23.6	106.3	6.6
95	4.4	17.8	13.5	0.76	1.69	10.5	23.6	105.8	7.1
95	4.6	17.8	13.5	0.76	1.68	10.6	23.5	105.3	7.7
95	5.0	17.8	13.5	0.76	1.68	10.6	23.5	104.5	8.8
105	2.7	16.1	12.8	0.80	1.96	8.2	22.8	122.0	3.0
105	3.3	16.5	13.0	0.79	1.92	8.6	23.1	119.1	4.2
105	3.7	16.5	12.9	0.78	1.89	8.7	23.0	117.5	5.1
105	4.2	16.6	13.0	0.78	1.88	8.8	23.0	116.0	6.4
105	4.4	16.6	13.0	0.78	1.87	8.9	23.0	115.5	6.9
105	4.6	16.6	13.1	0.79	1.87	8.9	23.0	115.1	7.4
105	5.0	16.7	13.1	0.78	1.86	9.0	23.1	114.3	8.5
115	2.7	15.2	12.8	0.84	2.16	7.0	22.6	131.9	2.8
115	3.3	15.5	12.9	0.83	2.12	7.3	22.7	128.9	4.1
115	3.7	15.5	12.9	0.83	2.09	7.4	22.6	127.4	4.9
115	4.2	15.6	13.0	0.83	2.08	7.5	22.7	125.9	6.1
115	4.4	15.6	13.0	0.83	2.07	7.5	22.7	125.4	6.6
115	4.6	15.6	13.1	0.84	2.07	7.5	22.7	125.0	7.2
115	5.0	15.7	13.1	0.83	2.06	7.6	22.7	124.2	8.3
120	2.7	15.1	13.1	0.87	2.28	6.6	22.9	137.1	2.8
120	3.3	15.4	13.2	0.86	2.24	6.9	23.1	134.1	4.0
120	3.7	15.5	13.2	0.85	2.21	7.0	23.0	132.6	4.9
120	4.2	15.6	13.2	0.85	2.20	7.1	23.1	131.1	6.0
120	4.4	15.6	13.3	0.85	2.19	7.1	23.1	130.6	6.6
120	4.6	15.6	13.3	0.85	2.19	7.1	23.1	130.1	7.1
120	5.0	15.6	13.3	0.85	2.18	7.2	23.0	129.3	8.1

Performance Data
018-Heating

Table P15: GEH/GEV 018 Heating Performance

Heating performance data is tabulated at 68 F DB entering air at ARI/ISO 13256-1 rated CFM. For ARI/ISO 13256-1 certified ratings, see Table P1. See Performance correction tables to correct performance at conditions other than those tabulated. Data shown is for unit performance only. Interpolation is permissible. Extrapolation is not.

Rated GPM: 4.2
Rated CFM: 570

Maximum CFM: 456
Maximum CFM: 684

EWT	GPM	Htg Cap Mbtuh	Absorb Mbtuh	Power kW	COP	LWT	Feet Head
25	2.7	12.5	8.2	1.26	2.9	18.9	5.4
25	3.3	12.7	8.4	1.27	2.9	19.9	7.6
25	3.7	12.9	8.6	1.27	3.0	20.4	9.2
25	4.2	13.0	8.7	1.27	3.0	20.9	11.2
25	4.4	13.0	8.7	1.27	3.0	21.1	12.1
25	4.6	13.1	8.8	1.27	3.0	21.2	12.9
25	5.0	13.1	8.8	1.27	3.0	21.5	14.7
32	2.7	13.6	9.2	1.29	3.1	25.2	5.3
32	3.3	13.9	9.5	1.30	3.1	26.3	7.2
32	3.7	14.1	9.6	1.31	3.2	26.8	8.6
32	4.2	14.2	9.7	1.31	3.2	27.4	10.4
32	4.4	14.3	9.8	1.31	3.2	27.5	11.2
32	4.6	14.3	9.8	1.31	3.2	27.7	11.9
32	5.0	14.3	9.8	1.31	3.2	28.1	13.5
45	2.7	16.2	11.5	1.37	3.5	36.5	4.7
45	3.3	16.5	11.8	1.38	3.5	37.9	6.4
45	3.7	16.7	12.0	1.38	3.5	38.5	7.5
45	4.2	16.9	12.2	1.39	3.6	39.2	9.1
45	4.4	17.0	12.3	1.39	3.6	39.4	9.8
45	4.6	17.0	12.3	1.39	3.6	39.7	10.4
45	5.0	17.1	12.4	1.39	3.6	40.1	11.8
55	2.7	18.3	13.4	1.43	3.7	45.1	4.3
55	3.3	18.7	13.8	1.44	3.8	46.6	5.8
55	3.7	18.9	14.0	1.44	3.8	47.4	6.9
55	4.2	19.2	14.3	1.45	3.9	48.2	8.3
55	4.4	19.2	14.3	1.45	3.9	48.5	8.9
55	4.6	19.3	14.4	1.45	3.9	48.8	9.6
55	5.0	19.3	14.3	1.46	3.9	49.3	10.9
68	2.7	21.2	16.1	1.51	4.1	56.1	3.8
68	3.3	21.6	16.4	1.52	4.2	58.0	5.2
68	3.7	21.9	16.7	1.53	4.2	59.0	6.2
68	4.2	22.1	16.8	1.54	4.2	60.0	7.6
68	4.4	22.2	16.9	1.54	4.2	60.3	8.2
68	4.6	22.2	16.9	1.54	4.2	60.6	8.8
68	5.0	22.3	17.0	1.54	4.2	61.2	10.0
75	2.7	22.7	17.4	1.55	4.3	62.1	3.6
75	3.3	23.1	17.7	1.57	4.3	64.2	5.0
75	3.7	23.3	17.9	1.57	4.3	65.3	6.0
75	4.2	23.6	18.2	1.58	4.4	66.3	7.3
75	4.4	23.7	18.3	1.58	4.4	66.7	7.8
75	4.6	23.7	18.3	1.59	4.4	67.0	8.4
75	5.0	23.8	18.4	1.59	4.4	67.6	9.6
86	2.7	24.6	19.1	1.62	4.4	71.8	3.3
86	3.3	25.1	19.5	1.64	4.5	74.1	4.7
86	3.7	25.4	19.8	1.64	4.5	75.3	5.6
86	4.2	25.6	20.0	1.65	4.5	76.5	6.9
86	4.4	25.7	20.1	1.65	4.6	76.8	7.4
86	4.6	25.7	20.0	1.66	4.5	77.3	8.0
86	5.0	25.8	20.1	1.66	4.6	77.9	9.1

Table P16: 018 Fan Correction Factors

Entering CFM	Cooling Capacity	Sensible Capacity	Cooling Input Watts	Heating Capacity	Heating Input Watts
456	0.974	0.892	0.965	0.972	1.032
485	0.981	0.919	0.973	0.979	1.024
513	0.987	0.945	0.981	0.986	1.016
542	0.993	0.972	0.991	0.993	1.008
570	**1.000**	**1.000**	**1.000**	**1.000**	**1.000**
627	1.012	1.051	1.020	1.013	0.984
656	1.019	1.078	1.030	1.020	0.976
684	1.025	1.105	1.042	1.027	0.968

Performance Data
024-Cooling

Table P17: GEH/GEV 024 Cooling Performance

Cooling performance data is tabulated at 80.6 F DB/66.2 F WB entering air at ARI/ISO 13256-1 rated CFM. For ARI/ISO 13256-1 certified ratings, see Table P1. See Performance correction tables to correct performance at conditions other than those tabulated. Data shown is for unit performance only. Interpolation is permissible. Extrapolation is not.

Rated GPM: 5.5 **Maximum CFM: 608**
Rated CFM: 760 **Maximum CFM: 912**

EWT	GPM	Total Mbtuh	Sen Mbtuh	SHR	Power kW	EER	Reject Mbtuh	LWT	Feet Head
45	3.6	30.4	21.8	0.72	1.69	18.0	36.2	65.1	4.7
45	4.4	30.7	21.7	0.71	1.65	18.6	36.3	61.5	6.4
45	5.0	30.9	21.8	0.71	1.62	19.1	36.4	59.6	7.9
45	5.5	31.0	21.7	0.70	1.61	19.3	36.5	58.3	9.1
45	5.8	31.0	21.7	0.70	1.60	19.4	36.5	57.6	9.9
45	6.1	31.1	21.7	0.70	1.59	19.6	36.5	57.0	10.7
45	6.6	31.2	21.6	0.69	1.58	19.7	36.6	56.1	12.0
55	3.6	29.6	20.8	0.70	1.79	16.5	35.7	74.8	4.5
55	4.4	29.9	20.8	0.70	1.74	17.2	35.8	71.3	6.1
55	5.0	30.0	20.9	0.70	1.72	17.4	35.9	69.4	7.4
55	5.5	30.1	21.0	0.70	1.70	17.7	35.9	68.1	8.6
55	5.8	30.2	21.0	0.70	1.69	17.9	36.0	67.4	9.3
55	6.1	30.2	21.0	0.70	1.68	18.0	35.9	66.8	10.1
55	6.6	30.3	21.0	0.69	1.67	18.1	36.0	65.9	11.3
68	3.6	27.5	20.0	0.73	1.97	14.0	34.2	87.0	4.1
68	4.4	27.8	20.0	0.72	1.92	14.5	34.4	83.6	5.6
68	5.0	28.0	20.1	0.72	1.89	14.8	34.5	81.8	6.8
68	5.5	28.1	20.2	0.72	1.88	14.9	34.5	80.6	7.9
68	5.8	28.1	20.2	0.72	1.87	15.0	34.5	79.9	8.6
68	6.1	28.2	20.3	0.72	1.86	15.2	34.6	79.3	9.3
68	6.6	28.3	20.3	0.72	1.85	15.3	34.6	78.5	10.5
77	3.6	26.2	19.4	0.74	2.11	12.4	33.4	95.6	3.8
77	4.4	26.5	19.4	0.73	2.07	12.8	33.6	92.3	5.3
77	5.0	26.7	19.5	0.73	2.04	13.1	33.7	90.5	6.4
77	5.5	26.8	19.6	0.73	2.02	13.3	33.7	89.3	7.5
77	5.8	26.8	19.7	0.74	2.02	13.3	33.7	88.6	8.1
77	6.1	26.9	19.7	0.73	2.01	13.4	33.8	88.1	8.8
77	6.6	27.0	19.7	0.73	1.99	13.6	33.8	87.3	10.0
86	3.6	24.6	18.8	0.76	2.26	10.9	32.3	104.0	3.6
86	4.4	24.9	18.8	0.76	2.22	11.2	32.5	100.8	4.9
86	5.0	25.1	18.9	0.75	2.20	11.4	32.6	99.1	6.1
86	5.5	25.2	19.0	0.75	2.18	11.6	32.6	97.9	7.1
86	5.8	25.2	19.0	0.75	2.17	11.6	32.6	97.3	7.7
86	6.1	25.3	19.1	0.75	2.17	11.7	32.7	96.8	8.3
86	6.6	25.3	19.1	0.75	2.15	11.8	32.6	95.9	9.5
95	3.6	22.8	18.2	0.80	2.41	9.5	31.0	112.3	3.3
95	4.4	23.1	18.1	0.78	2.38	9.7	31.2	109.3	4.6
95	5.0	23.2	18.2	0.78	2.36	9.8	31.3	107.6	5.7
95	5.5	23.3	18.3	0.79	2.34	10.0	31.3	106.4	6.7
95	5.8	23.4	18.4	0.79	2.33	10.0	31.4	105.9	7.3
95	6.1	23.4	18.4	0.79	2.32	10.1	31.3	105.3	7.9
95	6.6	23.5	18.4	0.78	2.31	10.2	31.4	104.6	9.0
105	3.6	20.7	17.5	0.85	2.57	8.1	29.5	121.5	3.1
105	4.4	21.0	17.4	0.83	2.54	8.3	29.7	118.6	4.4
105	5.0	21.2	17.5	0.83	2.52	8.4	29.8	117.0	5.4
105	5.5	21.3	17.6	0.83	2.50	8.5	29.8	115.9	6.4
105	5.8	21.3	17.7	0.83	2.50	8.5	29.8	115.4	6.9
105	6.1	21.4	17.7	0.83	2.49	8.6	29.9	114.9	7.6
105	6.6	21.4	17.7	0.83	2.48	8.6	29.9	114.1	8.6
115	3.6	18.8	16.9	0.90	2.70	7.0	28.0	130.7	2.9
115	4.4	19.1	16.7	0.87	2.67	7.2	28.2	128.0	4.2
115	5.0	19.2	16.9	0.88	2.66	7.2	28.3	126.4	5.2
115	5.5	19.3	16.9	0.88	2.64	7.3	28.3	125.4	6.1
115	5.8	19.4	17.0	0.88	2.64	7.3	28.4	124.9	6.7
115	6.1	19.4	17.0	0.88	2.63	7.4	28.4	124.4	7.3
115	6.6	19.5	17.1	0.88	2.62	7.4	28.4	123.7	8.3
120	3.6	17.9	16.5	0.92	2.74	6.5	27.3	135.3	2.9
120	4.4	18.2	16.4	0.90	2.73	6.7	27.5	132.7	4.1
120	5.0	18.4	16.5	0.90	2.71	6.8	27.7	131.2	5.1
120	5.5	18.5	16.6	0.90	2.70	6.9	27.7	130.2	6.0
120	5.8	18.5	16.7	0.90	2.70	6.9	27.7	129.7	6.6
120	6.1	18.6	16.7	0.90	2.69	6.9	27.8	129.2	7.2
120	6.6	18.6	16.7	0.90	2.68	6.9	27.8	128.5	8.2

Performance Data
Electrical

E1-Electrical performance

Model No.	Volts	Total FLA	Comp RLA (ea)	Comp LRA (ea)	No. of Compres.	Cmp MCC	Blower Motor FLA	Blower Motor HP	Fan Motor Num	Minimum Circuit Ampacity	Maximum Overcur-rent Protec-tive Device	Electric Heat kW	Electric Heat Amps
006	115/60/1	6.8	5.70	36.2	1	9.1	1.20	1/12	1	8.3	15	0	0
	208/60/1	3.4	2.80	17.7	1	4.6	0.60	1/12	1	4.1	15	0	0
	208/60/1	4.48	2.8	17.7	1	4.6	0.60	1/12	1	5.6	15	0.82	3.9
	230/60/1	3.4	2.80	17.7	1	4.6	0.60	1/12	1	4.1	15	0	0
	230/60/1	4.88	2.8	17.7	1	4.6	0.60	1/12	1	6.1	15	1.00	4.3
	220-240/50/1	3.6	3.10	18.8	1	5.2	0.52	1/12	1	4.4	15	0	0
	220-240/50/1	7.3	3.1	18.8	1	5.2	0.52	1/12	1	9.2	15	1.64	6.8
	265/60/1	3.0	2.45	15.0	1	3.9	0.52	1/12	1	3.6	15	0	0
	265/60/1	5.5	2.5	15.0	1	3.9	0.52	1/12	1	6.9	15	1.33	5.0
009	115/60/1	8.3	7.20	45.6	1	10.9	1.20	1/12	1	10.2	15	0	0
	208/60/1	4.0	3.40	22.2	1	6.4	0.60	1/12	1	4.9	15	0	0
	208/60/1	6.48	3.4	22.2	1	6.4	0.60	1/12	1	8.1	15	1.23	5.9
	230/60/1	4.0	3.40	22.2	1	6.4	0.60	1/12	1	4.9	15	0	0
	230/60/1	7.08	3.4	22.2	1	6.4	0.60	1/12	1	8.9	15	1.50	6.5
	220-240/50/1	5.0	4.30	22.2	1	6.6	0.72	1/8	1	6.1	15	0	0
	220-240/50/1	9.72	4.3	22.2	1	6.6	0.72	1/8	1	12.2	15	2.17	9.0
	265/60/1	3.6	3.10	18.8	1	5.2	0.52	1/12	1	4.4	15	0	0
	265/60/1	8.0	3.1	18.8	1	5.2	0.52	1/12	1	10.0	15	2.00	7.5
012	115/60/1	12.2	10.60	56.7	1	16.0	1.57	1/8	1	14.8	25	0	0
	208/60/1	5.7	5.00	27.9	1	8.3	0.70	1/8	1	7.0	15	0	0
	208/60/1	8.5	5.0	27.9	1	8.3	0.70	1/8	1	10.6	15	1.63	7.8
	230/60/1	5.7	5.00	27.9	1	8.3	0.70	1/8	1	7.0	15	0	0
	230/60/1	9.4	5.0	27.9	1	8.3	0.70	1/8	1	11.8	15	2.00	8.7
	220-240/50/1	5.5	4.80	27.0	1	8.5	0.72	1/8	1	6.7	15	0	0
	220-240/50/1	12.02	4.8	27.0	1	8.5	0.72	1/8	1	15.0	15	2.70	11.3
	265/60/1	5.0	4.30	22.2	1	6.6	0.72	1/8	1	6.1	15	0	0
	265/60/1	10.72	4.3	22.2	1	6.6	0.72	1/8	1	13.4	15	2.65	10.0
015 - Std Static	220-240/50/1	7.1	6.3	32.0	1	10.0	0.80	1/8	1	8.7	15	0	0
	220-240/50/1	14.5	6.3	32.0	1	10.0	0.80	1/8	1	18.1	20	3.28	13.7
015 - Hi Static	208/60/1	6.1	5.40	29.0	1	9.2	0.70	1/8	1	7.5	15	0	0
	208/60/1	10.3	5.4	29.0	1	9.2	0.70	1/8	1	12.9	15	2.00	9.6
	230/60/1	6.1	5.40	29.0	1	9.2	0.70	1/8	1	7.5	15	0	0
	230/60/1	11.6	5.4	29.0	1	9.2	0.70	1/8	1	14.5	15	2.50	10.9
	220-240/50/1	7.8	6.30	32.0	1	10.0	1.53	1/3	1	9.4	15	0	0
	220-240/50/1	15.23	6.3	32.0	1	10.0	1.53	1/3	1	19.0	20	3.28	13.7
	265/60/1	5.5	4.80	27.0	1	8.5	0.72	1/8	1	6.7	15	0	0
	265/60/1	13.22	4.8	27.0	1	8.5	0.72	1/8	1	16.5	20	3.30	12.5
018 - Std Static	208/60/1	8.5	7.6	45.0	1	13.0	0.9	1/8	1	10.4	15	0	0
	208/60/1	12.7	7.6	45.0	1	13.0	0.90	1/8	1	15.9	20	2.46	11.8
	230/60/1	8.5	7.6	45.0	1	13.0	0.90	1/8	1	10.4	15	0	0
	230/60/1	13.9	7.6	45.0	1	13.0	0.90	1/8	1	17.4	20	3.0	13.0
	265/60/1	7.1	6.3	32.0	1	10.0	0.80	1/8	1	8.7	15	0	0
	265/60/1	15.9	6.3	32.0	1	10.0	0.80	1/8	1	19.9	20	4.00	15.1
018 - Hi Static	208/60/1	9.4	7.60	45.0	1	13.0	2.10	1/3	1	11.6	15	0	0
	208/60/1	13.6	7.6	45.0	1	13.0	2.10	1/3	1	17.4	20	2.46	11.8
	230/60/1	9.4	7.60	45.0	1	13.0	2.10	1/3	1	11.6	15	0	0
	230/60/1	14.8	7.6	45.0	1	13.0	2.10	1/3	1	18.9	20	3.00	13.0
	220-240/50/1	11.4	9.90	55.0	1	13.8	1.53	1/3	1	13.9	20	0	0
	220-240/50/1	19.63	9.9	55.0	1	13.8	1.53	1/3	1	24.5	25	4.35	18.1
	265/60/1	7.8	6.30	32.0	1	10.0	1.53	1/3	1	9.4	15	0	0
	265/60/1	16.63	6.3	32.0	1	10.0	1.53	1/3	1	20.8	25	4.00	15.1
	380-415/50/3	4.9	3.90	25.0	1	5.4	0.95	1/3	1	5.8	15	0	0
	380-415/50/3	11.45	3.9	25.0	1	5.4	0.95	1/3	1	14.3	15	4.35	10.5

Performance Data
Electrical

E2-Electrical performance *(continued)*

Model No.	Volts	Total FLA	Comp RLA (ea)	Comp LRA (ea)	No. of Compres.	Cmp MCC	Blower Motor FLA	Blower Motor HP	Fan Motor Num	Minimum Circuit Ampacity	Maximum Overcur-rent Protec-tive Device	Electric Heat kW	Electric Heat Amps
024	208/60/1	12.7	10.90	56.0	1	15.3	2.10	1/3	1	15.7	25	0	0
	208/60/1	17.5	10.9	56.0	1	15.3	2.10	1/3	1	22.3	25	3.26	15.7
	230/60/1	12.7	10.90	56.0	1	15.3	2.10	1/3	1	15.7	25	0	0
	230/60/1	19.2	10.9	56.0	1	15.3	2.10	1/3	1	24.0	25	4.00	17.4
	220-240/50/1	12.4	10.90	58.0	1	15.3	1.53	1/3	1	15.2	25	0	0
	220-240/50/1	24.03	10.9	58.0	1	15.3	1.53	1/3	1	30.0	35	5.40	22.5
	265/60/1	11.4	9.90	55.0	1	13.8	1.53	1/3	1	13.9	20	0	0
	265/60/1	21.53	9.9	55.0	1	13.8	1.53	1/3	1	26.9	30	5.30	20.0
	208/60/3	9.3	7.50	51.0	1	10.5	1.80	1/3	1	11.2	15	0	0
	208/60/3	10.8	7.5	51.0	1	10.5	1.80	1/3	1	13.5	15	3.26	9.0
	230/60/3	9.3	7.50	51.0	1	10.5	1.80	1/3	1	11.2	15	0	0
	230/60/3	11.8	7.5	51.0	1	10.5	1.80	1/3	1	14.8	15	4.00	10.0
	380-415/50/3	5.0	4.00	28.0	1	5.6	0.95	1/3	1	6.0	15	0	0
	380-415/50/3	8.45	4.0	28.0	1	5.6	0.95	1/3	1	10.6	15	5.40	7.5
	460/60/3	4.9	3.90	25.0	1	5.4	0.95	1/3	1	5.8	15	0	0
	460/60/3	7.65	3.9	25.0	1	5.4	0.95	1/3	1	9.6	15	5.30	6.7
030	208/60/1	14.2	12.40	61.0	1	17.4	2.10	1/3	1	17.6	30	0	0
	208/60/1	21.5	12.4	61.0	1	17.4	2.10	1/3	1	27.3	30	4.10	19.7
	230/60/1	14.2	12.40	61.0	1	17.4	2.10	1/3	1	17.6	30	0	0
	230/60/1	23.5	12.4	61.0	1	17.4	2.10	1/3	1	29.8	30	5.00	21.7
	220-240/50/1	16.4	13.60	64.0	1	19.1	2.77	1/2	1	19.8	30	0	0
	220-240/50/1	29.97	13.6	64.0	1	19.1	2.77	1/2	1	37.5	40	6.52	27.2
	265/60/1	12.4	10.90	58.0	1	15.3	1.53	1/3	1	15.2	25	0	0
	265/60/1	26.43	10.9	58.0	1	15.3	1.53	1/3	1	33.0	35	6.60	24.9
	208/60/3	9.5	7.70	55.0	1	10.8	1.80	1/3	1	11.4	15	0	0
	208/60/3	13.2	7.7	55.0	1	10.8	1.80	1/3	1	16.5	20	4.10	11.4
	230/60/3	9.5	7.70	55.0	1	10.8	1.80	1/3	1	11.4	15	0	0
	230/60/3	14.4	7.7	55.0	1	10.8	1.80	1/3	1	18.0	20	5.00	12.6
	380-415/50/3	6.6	4.90	33.0	1	6.9	1.70	1/2	1	7.8	15	0	0
	380-415/50/3	10.8	4.9	33.0	1	6.9	1.70	1/2	1	13.5	15	6.52	9.1
	460/60/3	5.0	4.00	28.0	1	5.6	0.95	1/3	1	6.0	15	0	0
	460/60/3	9.25	4.0	28.0	1	5.6	0.95	1/3	1	11.6	15	6.60	8.3
036	208/60/1	19.3	16.00	82.0	1	22.4	3.60	1/2	1	23.6	35	0	0
	208/60/1	26.87	16.0	82.0	1	22.4	3.60	1/2	1	34.0	35	4.90	23.6
	230/60/1	19.3	16.00	82.0	1	22.4	3.60	1/2	1	23.6	35	0	0
	230/60/1	29.37	16.0	82.0	1	22.4	3.60	1/2	1	37.1	40	6.00	26.1
	265/60/1	16.4	13.60	64.0	1	19.1	2.77	1/2	1	19.8	30	0	0
	265/60/1	32.77	13.6	64.0	1	19.1	2.77	1/2	1	41.0	45	7.95	30.0
	208/60/3	13.7	10.40	65.5	1	14.6	3.60	1/2	1	16.6	25	0	0
	208/60/3	16.87	10.4	65.5	1	14.6	3.60	1/2	1	21.5	25	4.90	13.6
	230/60/3	13.7	10.40	65.5	1	14.6	3.60	1/2	1	16.6	25	0	0
	230/60/3	18.37	10.4	65.5	1	14.6	3.60	1/2	1	23.4	25	6.00	15.1
	380-415/50/3	6.5	4.80	40.0	1	6.7	1.70	1/2	1	7.7	15	0	0
	380-415/50/3	11.6	4.8	40.0	1	6.7	1.70	1/2	1	14.5	15	7.15	9.9
	460/60/3	6.6	4.90	33.0	1	6.9	1.70	1/2	1	7.8	15	0	0
	460/60/3	11.7	4.9	33.0	1	6.9	1.70	1/2	1	14.6	15	7.95	10.0
GEV 040	208/60/1	19.4	16.1	82.0	1	22.5	3.60	1/2	1	23.7	35	0	0
	208/60/1	29.27	16.1	82.0	1	22.5	3.60	1/2	1	37.0	40	5.40	26.0
	230/60/1	19.4	16.1	82.0	1	22.5	3.60	1/2	1	23.7	35	0	0
	230/60/1	31.97	16.1	82.0	1	22.5	3.60	1/2	1	40.4	45	6.60	28.7
	265/60/1	17.8	15.0	83.0	1	21.0	2.77	1/2	1	21.5	35	0	0
	265/60/1	35.97	15.0	83.0	1	0.0	2.77	1/2	1	45.0	45	8.80	33.2
	208/60/3	13.3	10.0	70.0	1	14.0	3.60	1/2	1	16.1	25	0	0
	208/60/3	18.27	10.0	70.0	1	14.0	3.60	1/2	1	23.3	25	5.40	15.0
	230/60/3	13.3	10.0	70.0	1	14.0	3.60	1/2	1	16.1	25	0	0
	230/60/3	19.87	10.0	70.0	1	14.0	3.60	1/2	1	25.3	30	6.60	16.6
	460/60/3	6.8	5.1	33.0	1	7.1	1.70	1/2	1	8.1	15	0	0
	460/60/3	12.7	5.1	33.0	1	7.1	1.70	1/2	1	15.9	20	8.80	11.0

High Efficiency Water-to-Water Water-Source Comfort System

2 through 6 Tons – 60 HZ
20 Tons – 60 HZ

WSHP-PRC009-EN

Performance Data
EXWA 240-Heating

Table P-13: 240 Heating Performance

Performance data is tabulated under ARI/ISO 13256-2.

Antifreeze correction factors may be found on page 47.

				Load 30.0 GPM							Load 55.0 GPM							Load 70.0 GPM						
Source EWT	Load EWT	Source GPM	Source WPD Ft Head	Source LWT	Heat Cap Mbtuh	Power kW	Heat Of Absorb	COP	Load LWT	Load WPD Ft Head	Source LWT	Heat Cap Mbtuh	Power kW	Heat Of Absorb	COP	Load LWT	Load WPD Ft Head	Source LWT	Heat Cap Mbtuh	Power kW	Heat Of Absorb	COP	Load LWT	Load WPD Ft Head
30.0	60.0	30.0	4.6	21.5	165.3	10.88	128.2	4.5	71.0	3.4	21.3	165.3	9.95	131.3	4.9	66.0	9.2	21.2	165.3	9.65	132.4	5.0	64.7	13.9
30.0	60.0	55.0	12.6	24.8	180.9	11.02	143.3	4.8	72.1	3.4	24.7	180.9	10.07	146.5	5.3	66.6	9.2	24.6	180.9	9.77	147.6	5.4	65.2	13.9
30.0	60.0	70.0	18.9	25.9	183.5	11.19	145.3	4.8	72.2	3.4	25.8	183.5	10.23	148.6	5.3	66.7	9.2	25.7	183.5	9.92	149.6	5.4	65.2	13.9
30.0	80.0	30.0	4.6	22.3	163.1	14.06	115.1	3.4	90.9	2.9	22.1	163.1	12.85	119.2	3.7	85.9	8.1	22.0	163.1	12.46	120.6	3.8	84.7	12.2
30.0	80.0	55.0	12.6	25.3	178.5	14.23	129.9	3.7	91.9	2.9	25.1	178.5	13.00	134.1	4.0	86.5	8.1	25.1	178.5	12.61	135.5	4.1	85.1	12.2
30.0	80.0	70.0	18.9	26.2	181.0	14.45	131.7	3.7	92.1	2.9	26.1	181.0	13.21	135.9	4.0	86.6	8.1	26.1	181.0	12.82	137.3	4.1	85.2	12.2
30.0	100.0	30.0	4.6	23.4	160.9	18.07	99.2	2.6	110.8	2.6	23.0	160.9	16.51	104.6	2.9	105.9	7.3	22.9	160.9	16.02	106.2	2.9	104.6	11.0
30.0	100.0	55.0	12.6	25.9	176.1	18.29	113.7	2.8	111.8	2.6	25.7	176.1	16.71	119.1	3.1	106.4	7.3	25.6	176.1	16.21	120.8	3.2	105.1	11.0
30.0	100.0	70.0	18.9	26.7	178.6	18.58	115.2	2.8	112.0	2.6	26.6	178.6	16.98	120.7	3.1	106.5	7.3	26.5	178.6	16.47	122.4	3.2	105.1	11.0
30.0	120.0	30.0	4.6	24.6	158.7	22.98	80.3	2.0	130.7	2.4	24.2	158.7	21.00	87.0	2.2	125.8	6.7	24.1	158.7	20.38	89.1	2.3	124.6	10.1
30.0	120.0	55.0	12.6	26.6	173.7	23.26	94.3	2.2	131.7	2.4	26.3	173.7	21.25	101.2	2.4	126.4	6.7	26.2	173.7	20.62	103.3	2.5	125.0	10.1
30.0	120.0	70.0	18.9	27.3	176.2	23.63	95.6	2.2	131.9	2.4	27.1	176.2	21.59	102.5	2.4	126.5	6.7	27.0	176.2	20.95	104.7	2.5	125.1	10.1
40.0	60.0	30.0	4.1	29.7	193.2	11.51	153.9	4.9	72.9	3.4	29.5	193.2	10.52	157.3	5.4	67.0	9.2	29.4	193.2	10.21	158.4	5.5	65.5	13.9
40.0	60.0	55.0	11.1	33.8	211.4	11.65	171.6	5.3	74.1	3.4	33.6	211.4	10.64	175.1	5.8	67.7	9.2	33.6	211.4	10.33	176.1	6.0	66.0	13.9
40.0	60.0	70.0	16.7	35.0	214.5	11.84	174.1	5.3	74.3	3.4	34.9	214.5	10.81	177.6	5.8	67.8	9.2	34.9	214.5	10.49	178.7	6.0	66.1	13.9
40.0	80.0	30.0	4.1	30.7	189.7	14.62	139.8	3.8	92.7	2.9	30.4	189.7	13.36	144.1	4.2	86.9	8.1	30.3	189.7	12.97	145.4	4.3	85.4	12.2
40.0	80.0	55.0	11.1	34.3	207.5	14.80	157.0	4.1	93.9	2.9	34.1	207.5	13.52	161.4	4.5	87.6	8.1	34.1	207.5	13.12	162.7	4.6	85.9	12.2
40.0	80.0	70.0	16.7	35.5	210.5	15.04	159.2	4.1	94.1	2.9	35.3	210.5	13.74	163.6	4.5	87.7	8.1	35.3	210.5	13.33	165.0	4.6	86.0	12.2
40.0	100.0	30.0	4.1	31.8	186.1	18.61	122.6	2.9	112.5	2.6	31.5	186.1	17.00	128.1	3.2	106.8	7.3	31.3	186.1	16.50	129.8	3.3	105.4	11.0
40.0	100.0	55.0	11.1	34.9	203.7	18.83	139.4	3.2	113.7	2.6	34.7	203.7	17.21	145.0	3.5	107.5	7.3	34.7	203.7	16.69	146.7	3.6	105.9	11.0
40.0	100.0	70.0	16.7	36.0	206.6	19.13	141.3	3.2	113.9	2.6	35.8	206.6	17.48	146.9	3.5	107.6	7.3	35.8	206.6	16.96	148.7	3.6	105.9	11.0
40.0	120.0	30.0	4.1	33.2	182.6	23.52	102.3	2.3	132.3	2.4	32.7	182.6	21.49	109.3	2.5	126.7	6.7	32.6	182.6	20.85	111.4	2.6	125.3	10.1
40.0	120.0	55.0	11.1	35.7	199.8	23.81	118.5	2.5	133.5	2.4	35.4	199.8	21.75	125.6	2.7	127.4	6.7	35.4	199.8	21.11	127.8	2.8	125.8	10.1
40.0	120.0	70.0	16.7	36.6	202.7	24.19	120.1	2.5	133.7	2.4	36.4	202.7	22.10	127.3	2.7	127.5	6.7	36.3	202.7	21.44	129.5	2.8	125.9	10.1
50.0	60.0	30.0	3.7	38.0	221.9	12.08	180.7	5.4	74.8	3.4	37.7	221.9	11.04	184.2	5.9	68.1	9.2	37.6	221.9	10.71	185.4	6.1	66.3	13.9
50.0	60.0	55.0	10.1	42.7	242.8	12.23	201.1	5.8	76.2	3.4	42.6	242.8	11.17	204.7	6.4	68.8	9.2	42.5	242.8	10.84	205.8	6.6	66.9	13.9
50.0	60.0	70.0	15.1	44.2	246.3	12.42	203.9	5.8	76.4	3.4	44.1	246.3	11.35	207.6	6.4	69.0	9.2	44.0	246.3	11.01	208.7	6.6	67.0	13.9
50.0	80.0	30.0	3.7	39.0	217.0	15.14	165.3	4.2	94.5	2.9	38.7	217.0	13.84	169.8	4.6	87.9	8.1	38.6	217.0	13.42	171.2	4.7	86.2	12.2
50.0	80.0	55.0	10.1	43.3	237.4	15.32	185.1	4.5	95.9	2.9	43.1	237.4	14.00	189.6	5.0	88.7	8.1	43.1	237.4	13.59	191.0	5.1	86.8	12.2
50.0	80.0	70.0	15.1	44.6	240.9	15.57	187.8	4.5	96.1	2.9	44.5	240.9	14.23	192.3	5.0	88.8	8.1	44.5	240.9	13.80	193.8	5.1	86.9	12.2
50.0	100.0	30.0	3.7	40.2	212.1	19.11	146.9	3.3	114.2	2.6	39.8	212.1	17.46	152.5	3.6	107.8	7.3	39.7	212.1	16.94	154.3	3.7	106.1	11.0
50.0	100.0	55.0	10.1	44.0	232.1	19.34	166.1	3.5	115.6	2.6	43.8	232.1	17.67	171.8	3.8	108.5	7.3	43.7	232.1	17.14	173.6	4.0	106.7	11.0
50.0	100.0	70.0	15.1	45.2	235.4	19.64	168.4	3.5	115.8	2.6	45.0	235.4	17.95	174.1	3.8	108.6	7.3	45.0	235.4	17.42	176.0	4.0	106.8	11.0
50.0	120.0	30.0	3.7	41.7	207.2	24.04	125.2	2.5	134.0	2.4	41.2	207.2	21.96	132.3	2.8	127.6	6.7	41.0	207.2	21.31	134.5	2.8	126.0	10.1
50.0	120.0	55.0	10.1	44.8	226.7	24.33	143.7	2.7	135.3	2.4	44.5	226.7	22.23	150.8	3.0	128.3	6.7	44.4	226.7	21.57	153.1	3.1	126.6	10.1
50.0	120.0	70.0	15.1	45.8	230.0	24.71	145.7	2.7	135.5	2.4	45.6	230.0	22.58	152.9	3.0	128.5	6.7	45.6	230.0	21.91	155.2	3.1	126.6	10.1
60.0	60.0	30.0	3.4	46.1	251.3	12.60	208.3	5.8	76.8	3.4	45.9	251.3	11.51	212.0	6.4	69.1	9.2	45.8	251.3	11.17	213.2	6.6	67.2	13.9
60.0	60.0	55.0	9.2	51.6	275.0	12.75	231.5	6.3	78.3	3.4	51.4	275.0	11.65	235.2	6.9	70.0	9.2	51.4	275.0	11.30	236.4	7.1	67.9	13.9
60.0	60.0	70.0	13.9	53.3	278.9	12.95	234.7	6.3	78.6	3.4	53.2	278.9	11.84	238.5	6.9	70.1	9.2	53.1	278.9	11.49	239.7	7.1	68.0	13.9
60.0	80.0	30.0	3.4	47.2	245.1	15.62	191.8	4.6	96.4	2.9	46.9	245.1	14.27	196.4	5.0	88.9	8.1	46.8	245.1	13.85	197.8	5.2	87.0	12.2
60.0	80.0	55.0	9.2	52.2	268.1	15.81	214.1	5.0	97.9	2.9	52.0	268.1	14.44	218.8	5.4	89.8	8.1	52.0	268.1	14.01	220.3	5.6	87.7	12.2
60.0	80.0	70.0	13.9	53.8	272.0	16.06	217.2	5.0	98.2	2.9	53.7	272.0	14.67	221.9	5.4	89.9	8.1	53.6	272.0	14.24	223.4	5.6	87.8	12.2
60.0	100.0	30.0	3.4	48.5	238.8	19.58	172.0	3.6	116.0	2.6	48.1	238.8	17.89	177.7	3.9	108.7	7.3	48.0	238.8	17.35	179.6	4.0	106.9	11.0
60.0	100.0	55.0	9.2	53.0	261.3	19.81	193.7	3.9	117.5	2.6	52.7	261.3	18.10	199.5	4.2	109.6	7.3	52.7	261.3	17.56	201.4	4.4	107.5	11.0
60.0	100.0	70.0	13.9	54.4	265.1	20.13	196.4	3.9	117.8	2.6	54.2	265.1	18.39	202.3	4.2	109.7	7.3	54.2	265.1	17.84	204.2	4.4	107.6	11.0
60.0	120.0	30.0	3.4	50.1	232.5	24.53	148.8	2.8	135.7	2.4	49.6	232.5	22.41	156.0	3.0	128.6	6.7	49.4	232.5	21.75	158.3	3.1	126.7	10.1
60.0	120.0	55.0	9.2	53.8	254.4	24.82	169.7	3.0	137.2	2.4	53.6	254.4	22.68	177.0	3.3	129.4	6.7	53.5	254.4	22.01	179.3	3.4	127.4	10.1
60.0	120.0	70.0	13.9	55.1	258.1	25.22	172.0	3.0	137.4	2.4	54.9	258.1	23.04	179.5	3.3	129.5	6.7	54.8	258.1	22.36	181.8	3.4	127.5	10.1

Performance Data
Electrical

Table E-1: Electrical performance WPWD/EXWA

Model/MBH	VOLTS-AC/HZ/PH	Min. Util. Volt	Max Util. Volt	Compressor Each RLA	LRA	No. of Comp	Without Desup		With Desup		
							MCA	Max Fuse	Desup RLA	MCA	Max Fuse
WPWD024	208-230/60/1	197	253	11.4	56.0	1	14.3	25	0.4	14.7	25
	220-240/50/1	198	264	9.6	47.0	1	12.0	20	0.4	12.4	20
	265/60/1	239	292	9.6	47.0	1	12.0	20	0.4	12.4	20
WPWD036	208-230/60/1	197	253	15.0	73.0	1	18.8	30	0.4	19.2	30
	208-230/60/3	197	253	10.7	63.0	1	13.4	20	0.4	13.8	20
	220-240/50/1	198	264	14.3	71.0	1	17.9	30	0.4	18.3	30
	265/60/1	239	292	14.3	71.0	1	17.9	30	0.4	18.3	30
	380-415/50/3	342	456	5.0	31.0	1	6.3	15.0	0.4	6.7	15.0
	460/60/3	414	506	5.0	31.0	1	6.3	15	0.4	6.7	15
WPWD042	208-230/60/1	197	253	18.4	95.0	1	23.0	40	0.4	23.4	40
	208-230/60/3	197	253	11.4	77.0	1	14.3	25	0.4	14.7	25
	220-240/50/1	198	264	16.4	83.0	1	20.5	35	0.4	20.9	35
	265/60/1	239	292	16.4	83.0	1	20.5	35	0.4	20.9	35
	380-415/50/3	342	456	5.7	39.0	1	7.1	15.0	0.4	7.5	15.0
	460/60/3	414	506	5.7	39.0	1	7.1	15	0.4	7.5	15
WPWD048	208-230/60/1	197	253	20.4	109.0	1	25.5	45	0.4	25.9	45
	208-230/60/3	197	253	13.9	88.0	1	17.4	30	0.4	17.8	30
	380-415/50/3	342	456	7.1	44.0	1	8.9	15.0	0.4	9.3	15.0
	460/60/3	414	506	7.1	44.0	1	8.9	15	0.4	9.3	15
WPWD060	208-230/60/1	197	253	28.0	169.0	1	35.0	60	0.4	35.4	60
	208-230/60/3	197	253	20.0	123.0	1	25.0	45	0.4	25.4	45
	380-415/50/3	342	456	7.5	49.5	1	9.4	15.0	0.4	9.8	15.0
	460/60/3	414	506	7.5	49.5	1	9.4	15	0.4	9.8	15
	575/60/3	517	633	6.4	40.0	1	8.0	15	0.4	8.4	15
WPWD072	208-230/60/1	197	253	32.1	169.0	1	40.1	70	0.4	40.5	70
	208-230/60/3	197	253	19.3	137.0	1	24.1	40	0.4	24.5	40
	380-415/50/3	342	456	10.0	62.0	1	12.5	20.0	0.4	12.9	20.0
	460/60/3	414	506	10.0	62.0	1	12.5	20	0.4	12.9	20
	575/60/3	517	633	7.8	50.0	1	9.8	15	0.4	10.2	15
EXWA240	208/60/3	197	229	31.7	232.0	2	71.39	100			
	230/60/3	207	253	31.7	261.0	2	71.39	100			
	460/60/3	414	506	14.1	112.0	2	31.73	45			
	575/60/3	518	633	11.2	92.0	2	25.24	35			

pepco

A PHI Company

DISTRICT OF COLUMBIA
TIME METERED GENERAL SERVICE – LOW VOLTAGE SERVICE
SCHEDULE GT LV
UPDATED METERS READ ON AND AFTER MARCH 1, 2006

	Billing Months of June – October (Summer)	**Billing Months of November – May (Winter)**
Generation[1]		
Kilowatt-hour Charge		
On Peak	$ 0.08682 per kwh	$ 0.06889 per kwh
Intermediate	$ 0.06632 per kwh	$ 0.07239 per kwh
Off Peak	$ 0.05645 per kwh	$ 0.05757 per kwh
Kilowatt Charge		
On Peak	$ 0.84507 per kw	
Maximum	$ 0.30248 per kw	$ 0.30248 per kw
Procurement Cost Adjustment	**www.pepco.com for monthly rate**	
Transmission[2]		
All kwh	$ 0.00111 per kwh	$ 0.00111 per kwh
Kilowatt Charge		
On Peak	$ 0.71 per kw	
Maximum	$ 0.59 per kw	$ 0.59 per kw
Distribution[3]		
Customer Charge	$ 20.93 per month	$ 20.93 per month
All kwh	$ 0.01029 per kwh	$ 0.01029 per kwh
Kilowatt Charge		
Maximum	$ 4.80 per kw	$ 4.80 per kw
Delivery Tax[4]	$ 0.0077 per kwh	$ 0.0077 per kwh
Public Space Occupancy Surcharge[5]	$ 0.00154 per kwh	$ 0.00154 per kwh
Administrative Credit	**www.pepco.com for monthly rate**	
Reliability Energy Trust Fund[6]	$ 0.00065 per kwh	$ 0.00065 per kwh
Generation Procurement Credit[7]	$ 0.00002 per kwh	$ 0.00002 per kwh

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[1] Effective February 8, 2005
[2] Effective February 8, 2005
[3] Effective February 8, 2005
[4] Effective January 1, 2005
[5] Effective March 1, 2006
[6] Effective with the Billing Month of June, 2005
[7] Effective Billing Month of November, 2005, Rendition Group 11

TIME METERED GENERAL SERVICE - LOW VOLTAGE

SCHEDULE "GT LV"

AVAILABILITY
Shall be applicable for either Standard Offer Service when modified by Rider “SOS” or Distribution Service when modified by Rider “SOS” in the District of Columbia portion of the Company's service area to customers whose maximum thirty (30) minute demand equals or exceeds one hundred (100) kilowatts during two (2) or more billing months within twelve (12) consecutive billing months. New customers will be qualified for Schedule "GT LV" based on estimated load and energy consumption using the above criteria. Once a customer's account is established it will remain on Schedule "GT LV" even if the party responsible for the account should change. Removal from Schedule "GT LV" is based solely on the criteria stated in the following paragraph.

Any customer presently on Schedule "GT LV" whose maximum thirty (30) minute demand is less than eighty (80) kilowatts for twelve (12) consecutive billing months, may at the customer's option elect to continue service on this schedule or elect to be served under any other available schedule. If the customer elects to stay on Schedule "GT LV", the customer will remain on Schedule "GT LV" for at least twelve (12) billing months. Rate schedule transfers will be made annually and become effective with the billing month of June.

Available for low voltage electric service at sixty hertz.

Available for standby service when modified by Schedule "S".

Not available for temporary service.

Not available for multiple application to master-metered apartment buildings except for those master-metered apartments served under Schedule "GT LV" prior to December 31, 1982 which will continue to be served under Schedule "GT LV".

CHARACTER OF SERVICE
The service supplied under this schedule normally will be alternating current, sixty hertz, either (i) single phase, three wire, 120/240 volts or 120/208 volts, or (ii) three phase, four wire, 120/208 volts or 265/460 volts.

MONTHLY RATE

	Summer	**Winter**
Distribution Service Charge		
Customer Charge	$ 20.93 per month	$ 20.93 per month
Kilowatt-hour Charge	$ 0.01029 per kwhr	$ 0.01029 per kwhr
Kilowatt Charge		
Maximum	$ 4.80 per kw	$ 4.80 per kw

Generation and Transmission Service Charges – Customers who do not receive service from an alternative Electric Supplier as defined in the Company’s General Terms and Conditions will receive Generation and Transmission Services from the Company under the provisions of Rider “SOS” – Standard Offer Service.

Billing Credit - A monthly billing credit in the amount of $0.75 per bill will be applied to the bill of each customer receiving generation services from an alternative supplier for each month that the alternative supplier renders a bill to the customer on a consolidated basis for services provided both by Pepco and by the alternative supplier.

BILLING MONTHS

Summer – Billing months of June through October.
Winter – Billing months of November through May.

RATING PERIODS

Weekdays - (Excluding Holidays)

On-Peak Period	12:00 noon	to	8:00 p.m.
Intermediate Period	8:00 a.m.	to	12:00 noon
		and	
	8:00 p.m.	to	12:00 midnight
Off-Peak Period	12:00 midnight	to	8:00 a.m.

Saturdays, Sundays and Holidays

Off-Peak Period	All Hours

Holidays

For the purpose of this tariff, holidays will be New Year's Day, Rev. Martin Luther King's Birthday, Presidents' Day, Memorial Day, Independence Day, Labor Day, Columbus Day, Veterans' Day, Thanksgiving Day, and Christmas Day, as designated by the Federal Government.

BILLING DEMANDS

<u>On-Peak</u> (Summer Billing Months Only) - The billing demand shall be the maximum thirty (30) minute demand recorded during the on-peak period of the billing month.

<u>Maximum</u> (All Months) - The billing demand shall be the maximum thirty (30) minute demand recorded during the billing month.

METER READING

Watt-hour meters will be read to the nearest multiple of the meter constant and bills rendered accordingly.

GENERAL TERMS AND CONDITIONS

This schedule is subject in all respects to the Company's "General Terms and Conditions for Furnishing Electric Service" and the Company's "Electric Service Rules and Regulations".

APPLICABLE RIDERS

Standard Offer Service – Large Commercial
Administrative Credit
Reliable Energy Trust Fund
Generation Procurement Credit
Power Factor
Delivery Tax
Public Space Occupancy Surcharge
Excess Facilities
Divestiture Sharing Credit – Non-Residential

Business

Maryland electricity rates to skyrocket

By Kara Rowland
THE WASHINGTON TIMES
March 8, 2006

Electricity rates for Maryland residents will soar this summer, according to the Maryland Public Service Commission.

The commission, which oversees state utilities, announced yesterday that customers served by Potomac Electric Power Co. (Pepco), Baltimore Gas and Electric Co. (BGE) and Delmarva Power will see annual rate increases between 35 percent and 72 percent.

A typical electricity bill for Pepco residential customers will jump by 39 percent, or an average of $468 a year, starting June 1 under the newly set prices. For DPL customers, the price will rise by 35 percent, or $464, also on June 1. BGE customers will see an increase of 72 percent, or $743 annually, starting July 1.

The increases are a result of a competitive bidding process among electricity suppliers to provide what is called "standard offer service," which is set at market rates as utilities buy power from wholesalers. The process is monitored by the Public Service Commission as well as the Office of the People's Counsel, a state utilities watchdog group.

While the Public Service Commission expects the increases based on the bidding process, the agency still must approve the utilities' requests.

Maryland deregulated its electric utilities in 1999, requiring full-service energy providers to separate their supply and distribution businesses. At the time, lawmakers cut residential electricity rates by 6.5 percent below 1993 levels and capped them for six years.

Since then, costs of fuels used to produce electricity, such as oil and natural gas, have increased, touching record-high levels in the days after Hurricane Katrina hit the Gulf Coast on Aug. 29. About one-third of the nation's energy runs through the area's damaged infrastructure.

"Unfortunately, high fuel prices resulting from the recent hurricanes in the Gulf region, terrorist threats and pressure from the global energy market have impacted the price of electricity," Kenneth D. Schisler, chairman of the Public Service Commission, said yesterday.

Electricity rate caps expired for Pepco and Delmarva in 2004, with prices climbing both in 2004 and 2005. The caps will expire for BGE in July.

This is the first year since 1999 that standard offer service prices are being set without the caps.

"BGE does not control the commodity price and so this 72 percent is outside of BGE's control," BGE spokesman Rob Gould said. "The fact is we have not made one cent of profit since 1999 -- it's been strictly a pass through."

BGE's 1.2 million customers in the Baltimore area won't necessarily feel the full impact of the increase. On Monday, the Public Service Commission announced a plan to spread the company's electricity costs over a two-year period, during which time residential customers will see a portion of that increase -- 21 percent -- on their bills.

http://www.washingtontimes.com/business/20060308-121849-8599r.htm

ENERGY INFORMATION ADMINISTRATION

EIA Reports

U.S. DEPARTMENT OF ENERGY
WASHINGTON DC 20585

FOR IMMEDIATE RELEASE
December 18, 1997

Natural Gas Key Factor in Future Electricity Price Reductions; Rapid Technological Advances Able to Slow Carbon Emissions

While increased competition in the electricity generation industry could lower the average price of electricity well into the next century, the Energy Information Administration said today that the amount of future reductions depends on the price of the marginal fuel for generation natural gas. Expanding on baseline projections released last month, EIA's full *Annual Energy Outlook 1998* released today analyzes changes that result from varying economic and market conditions. EIA's latest projections also show that more rapid penetration of more efficient technologies in end-use markets than assumed in the reference case slows growth in energy demand and carbon emissions through 2020.

Increased Competition in Electricity Markets

EIA's latest analysis shows that competition in electricity markets will be a key factor in lowering electricity prices. In addition to improvements in operating efficiency, lower production costs, and retirement of high-cost plants throughout the United States attributable to ongoing restructuring of the electricity industry, competitive pricing practices based on marginal operating costs, including fuel costs, are being introduced in some areas.

EIA's reference case includes ongoing cost reductions attributable to restructuring as well as the transition to competitive pricing in California, New York, and New England where plans to implement restructuring are currently in place. Today's report shows that nationwide, over a 10-year phase-in period, competitive electricity prices would fall below the traditional, regulated average-cost prices through most of the projection period to 2020. Because electricity prices based on marginal costs are more sensitive to changes in the operating costs of the marginal generating units than average-cost electricity prices, how much lower competitive electricity prices would be largely depends on operating costs, including fuel costs.

Assuming slower improvement in natural gas discovery and production technologies than in the reference case, EIA projects natural gas wellhead prices 29 percent higher in 2020 than in the reference case. In contrast, faster improvement *reduces* gas prices 24 percent from the reference case. Higher natural gas prices are reflected in a competitive price of electricity 8 percent higher in 2020 than projected in the reference case; lower gas prices lead to a competitive electricity price 9 percent lower than the reference case price for a range of 1 cent per kilowatthour (Figure 1).

Renewable Portfolio Standards

A competitive electricity market may slow the penetration of generation technologies with high capital costs, including renewable technologies. Renewable portfolio standards mandating a percentage of electricity generation to come from qualifying renewable sources have been proposed at both the Federal and State level to encourage use of renewable technologies.

In EIA's analysis, standards that specify 2 percent of generation from nonhydroelectric renewable technologies in 2000, increasing to 5 percent in 2020, boost renewable generation by 32 percent over the reference case in 2020 (Figure 2), leading to electricity prices 2 percent higher, on average, than in the reference case. Total carbon emissions in the 5-percent standard case are 1 percent lower in 2020.

With a 10-percent renewable standard, renewable generation increases by 79 percent from the reference case in 2020. As a result of the higher renewable generation, electricity prices are higher by 5 percent in 2020 than in the reference case, adding about $3 to the average residential monthly electric bill. Carbon emissions in the 10-percent case are reduced by 3 percent, or 62 million metric tons, in 2020. In either renewable standard case, the price of electricity, in 1996 dollars, would be less than current levels.

Carbon Emissions

EIA's *Outlook* analysis shows that rapid penetration of more efficient technologies in end-use markets can lower energy consumption in 2020 to 111 quadrillion Btu, 7 percent below the reference case projection. As a result, carbon emissions would be 7 percent, or 140 million metric tons, lower than in the reference case (Figure 3). Even with more rapid technology penetration, the carbon emissions in 2020 are 24 percent higher than the 1996 level. Slower technology penetration, characterized by freezing all future end-use technology choices at the efficiency levels available in 1998, results in energy consumption that is 3 percent higher than in the reference case, while carbon emissions are 4 percent, or 73 million metric tons, higher.

EIA's analysis also shows the effects of other assumptions on carbon emissions:

- Extending the life of nuclear generating plants 10 years beyond the retirement dates assumed in the reference case reduces generation from fossil-fired plants and reduces total carbon emissions in 2020 by 2 percent, or 42 million metric tons. Conversely, retiring nuclear plants 10 years before the end of their 40-year license periods could increase emissions by 4 percent, or 74 million metric tons.

- Using more optimistic assumptions on capital, operating, and maintenance costs and capacity factors for renewable generating technologies from the Department of Energy Office of Energy Efficiency and Renewable Energy, increases projected renewable generation and reduces total projected carbon emissions in 2020 by 2 percent, or 30 million metric tons.

- Lower or higher economic growth than assumed in the *Outlook* reference case leads to a range in energy consumption in 2020, from 9 percent below the reference case level of 119 quadrillion Btu to 8 percent above, resulting in carbon emissions that are 10 percent (186 million metric tons) lower or 9 percent (178 million metric tons) higher (Figure 4). (The reference case assumes an average annual growth in the gross domestic product of 1.9 percent; the low and high growth cases assume 1.3 and 2.4 percent annual growth.)

The *Annual Energy Outlook 1998* presents the results of EIA's analysis of the impacts of lower and higher world oil prices, higher electricity demand, variations in the costs of generating technologies, changes in oil and gas resource base assumptions, and variations in coal mining costs. It also includes a discussion of recent and proposed regulatory changes, including air quality and appliance efficiency standards.

The full report can be accessed immediately on EIA's World Wide Web Site (http://www.eia. doe.gov). The direct Internet address is: http://www.eia.doe.gov/oiaf/aeo98/homepage.html. Assumptions underlying the projections in the *Outlook* and more detailed, regional projections are also available on EIA's Web Site. Published copies of the *Outlook* are available from the U.S. Government Printing Office 202/512-1800 or through EIA's National Energy Information Center, Forrestal Building, Washington, DC 20585, 202/586-8800.

The figures referenced above may be viewed, together with this press release and the November 12, 1997, press release presenting the reference case results, on EIA's Web Site. Copies may also be obtained from EIA's press contact.

The report described in this press release was prepared by the Energy Information Administration, the independent statistical and analytical agency within the U.S. Department of Energy. The information contained in the report and the press release should be attributed to the Energy Information Administration and should not be construed as advocating or reflecting any policy position of the Department of Energy or any other organization.

-EIA-

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EIA-97-37

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File Last Modified: December 18, 1997

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Energy Information Administration

4–PIPE FAN COIL UNITS

GENERAL							CHILLED WATER (30% ETG) COOLING COIL				HOT WATER HEATING COIL				ELECTRICAL			
DESIG	LOCATION AND/OR SERVICE	CONFIGURATION	TYPE (REFER TO SPEC)	NOMINAL UNIT SIZE	AIRFLOW AT MEDIUM SPEED (CFM)	TSP ACROSS FCU (IN W.G.)	MINIMUM SENSIBLE / TOTAL CAPACITY (MBH)	WATER FLOWRATE (GPM)	MAXIMUM WPD (FT HEAD)	No. OF ROWS	MINIMUM CAPACITY (MBH)	WATER FLOWRATE @180°F EWT (GPM)	MAXIMUM WPD (FT HEAD)	No. OF ROWS	NOMINAL MOTOR SIZE (HP)	MAXIMUM OPERATING POWER (WATTS)	VOLTS / PHASE / Hz	FCU MODEL No. (NOTE 1)
FCU–1–1 THRU FCU–1–4	DINING ROOM EXPANSION (EX ALF)	VERTICAL FLR–MTD FURRED STACK	STACK	10	850	0.15	21.0 / 29.0	6	12	3	15.0	1.5	10	1	1/4	325	277 / 1 / 60	MODEL 42SG
FCU–2–1 THRU FCU–2–2	ELEVATOR MACHINE ROOMS	HORIZONTAL CABINET	HOR–A	10	500	FREE	10.1 / 14.0	5	5	3	10.0	1	5	1	2 @ 1/15	270	277 / 1 / 60	MODEL 42CG
FCU–3–1 THRU FCU–3–9	LOWER BRIDGES, DAYROOMS	HORIZONTAL CEILING–MTD (HIDDEN)	HOR–B	12	700	0.15	16.1 / 23.1	7	10	3	14.6	1.5	5	1	2 @ 1/8	440	277 / 1 / 60	MODEL 42CE
FCU–4–1 THRU FCU–4–5	UPPER BRIDGES, STAFF ROOMS	HORIZONTAL CEILING–MTD (HIDDEN)	HOR–B	12	700	0.15	18.4 / 26.4	8	10	3	14.6	1.5	5	1	2 @ 1/8	440	277 / 1 / 60	MODEL 42CE
FCU–5–1 THRU FCU–5–16	RESIDENT BEDROOM OR LIVING RM	VERTICAL FLR–MTD FURRED STACK	STACK	4	300	0.15	6.7 / 7.6	1	8	3	9.8	1	5	1	1/20	115	277 / 1 / 60	MODEL 42SG
FCU–6–1 THRU FCU–6–28	RESIDENT BEDROOM OR LIVING RM	VERTICAL FLR–MTD FURRED STACK	STACK	8	500	0.15	10.0 / 10.7	1.5	5	3	9.8	1	5	1	1/6	200	277 / 1 / 60	MODEL 42SG
FCU–7–1 THRU FCU–7–13	RESIDENT BEDROOM OR LIVING RM	VERTICAL FLR–MTD FURRED STACK	STACK	8	500	0.15	11.1 / 12.6	2	5	3	9.8	1	5	1	1/6	200	277 / 1 / 60	MODEL 42SG
FCU–8–1 THRU FCU–8–5	RESIDENT BEDROOM OR LIVING RM	VERTICAL FLR–MTD FURRED STACK	STACK	10	850	0.15	13.7 / 15.2	2	5	3	10.2	1	5	1	1/5	325	277 / 1 / 60	MODEL 42SG
FCU–9–1 THRU FCU–9–12	RESIDENT BEDROOM OR LIVING RM	VERTICAL FLR–MTD FURRED STACK	STACK	12	850	0.15	17.2 / 18.6	3	5	3	12.2	1	5	1	1/4	420	277 / 1 / 60	MODEL 42SG

NOTES:

1. FCU MODEL NUMBERS ARE BASIS OF DESIGN AND ARE CARRIER UNLESS OTHERWISE NOTED IN SCHEDULE.
2. BASE ALL SELECTIONS ON EAT = 80°F dB, 67°F wB, CHILLED WATER EWT=45°F, HEATING WATER EWT=180°F. PERFORMANCE SHALL BE DERATED FOR STATIC PRESSURE DROP SCHEDULED, FOR MEDIUM SPEED FAN OPERATION, AND FOR CHILLED WATER WITH 30% ETHYLENE GLYCOL MIXTURE.
3. WHERE TSP IS INDICATED AS "FREE", TSP INCLUDES PRESSURE DROP ACROSS FILTER, COILS AND STAMPED GRILLES, AND SHALL NOT EXCEED 0.10" W.G. WHERE TSP VALUES ARE GIVEN, TSP INCLUDES COILS, FILTER, FIELD INSTALLED GRILLES, DUCTWORK AND ACCESSORIES.
4. AIR FLOWRATES AND MINIMUM COIL DUTIES ARE INDICATED FOR OPERATION AT MEDIUM FAN SPEED; UNITS SHALL MEET THIS MINIMUM CRITERIA AT THAT SPEED. MINIMUM ELECTRICAL POWER REQUIREMENTS INDICATED ARE CRITERIA FOR OPERATION AT HIGH FAN SPEED; UNITS SHALL BE WIRED TO MEET THIS MINIMUM CRITERIA AT THAT SPEED.
5. PROVIDE THE FOLLOWING FACTORY–FURNISHED OPTIONS:

AIR-COOLED CHILLERS

GENERAL (REFER TO NOTES 1, 2, & 3)

DESIGNATION:	CH-1
LOCATION:	ALF ADDITION ROOF
TYPE:	AIR-COOLED HELICAL ROTARY (SCREW)
REFRIGERANT:	R-134a

CAPACITY (REFER TO NOTE 4)

NOMINAL COOLING CAPACITY (TONS):	140
MIN CAPACITY AT DESIGN CONDITIONS (TONS):	136
QUANTITY OF COMPRESSORS:	2
QUANTITY OF INDEPENDENT REFRIGERATION CKTS:	2
MIN UNLOADING STEPS (EACH COMPRESSOR):	INFINITELY VARIABLE
MIN CHILLER COP:	2.65

EVAPORATOR PERFORMANCE (REFER TO NOTES 5 & 6)

FLUID TYPE:	30% ETHYLENE GLYCOL SOLUTION
ENTERING FLUID TEMPERATURE (°F):	56
LEAVING FLUID TEMPERATURE (°F):	45
FLUID FLOWRATE (GPM):	325
MAXIMUM WATER PRESSURE DROP (FT HEAD):	15
FOULING FACTOR:	.00010

CONDENSER PERFORMANCE

DESIGN AMBIENT TEMPERATURE (°F):	105
AMBIENT TEMPERATURE RANGE (°F):	0 – 115
QUANTITY OF CONDENSER FANS (PER CKT / TOTAL):	5 / 10
FAN MOTOR SIZE (HP, EACH):	2
FAN MOTOR TYPE:	ODP
FIN TYPE:	ALUMINUM SLIT

ELECTRICAL CHARACTERISTICS

MAX POWER INPUT (kW):	181
VOLTS / PHASE / Hz:	460 / 3 / 60 (SINGLE POINT POWER)
FULL LOAD MCA (AMPS PER CKT):	282
STARTER TYPE:	WYE-DELTA

APPROXIMATE PHYSICAL CHARACTERISTICS
(REFER TO NOTE 7)

LENGTH:	16' – 4"
WIDTH:	7' – 5"
HEIGHT:	7' – 9"
OPERATING WEIGHT (LBS, INCL STARTER):	13,000

NOTES:

1. REFER TO CHILLED WATER SCHEMATIC FOR REQUIRED COMMUNICATION POINTS TO BE REPORTED TO THE CCMS.
2. PROVIDE CHILLER WITH LOW AMBIENT HEAD PRESSURE CONTROL, FLOW SWITCH, CONDENSER COIL GUARD, ELECTRONIC EXPANSION VALVE, MINIMUM STEP UNLOADING VALVE, NON-FUSED DISCONNECT SWITCH, SINGLE-POINT POWER CONNECTIONS, COMPRESSOR SOUND ATTENUATION PACKAGE, AND MICROPROCESSOR CONTROLLER WITH DATA LOGGING CAPABILITY. REFER TO SPECIFICATION SECTION 15600 FOR ADDITIONAL REQUIREMENTS.
3. CHILLER EFFICIENCY (C.O.P.) SHALL COMPLY WITH ASHRAE 90.1A GUIDELINES, LATEST EDITION WITH ALL ADDENDA.
4. PROVIDE CHILLER WITH A MINIMUM NUMBER OF REFRIGERATION CIRCUITS AS SCHEDULED. EACH CIRCUIT SHALL BE COMPLETELY INDEPENDENT.
5. SELECT CHILLER WITH ADJUSTED PERFORMANCE FOR USE WITH 30% ETHYLENE GLYCOL MIXTURE. MANUFACTURER DATA INCLUDED WITH SHOP DRAWINGS SHALL INDICATE GLYCOL PERFORMANCE FOR THE CHILLER SUBMITTED.
6. PERFORMANCE INDICATED IS FOR CHILLER SELECTION AT SEA LEVEL WITH STANDARD EVAPORATOR TEMPERATURE RANGE.
7. WHERE SELECTED CHILLER DIMENSIONS EXCEED DIMENSIONS INDICATED IN SCHEDULE, CONTRACTOR SHALL ASSUME RESPONSIBILITY FOR ALL CHANGES IN COST AND SCOPE RELATED TO SUPPORTS, ISOLATION MEASURES AND COORDINATION OF PLACEMENT.

SEMI–INSTANTANEOUS STEAM–FIRED DOMESTIC WATER HEATERS

DESIG	LOCATION	SERVICE	DOMESTIC WATER–SIDE						STEAM–SIDE HEATING				REMARKS
			WATER FLOWRATE (GPM)	EWT (°F)	LWT (°F)	WPD (FT W.G.)	TUBE FOULING FACTOR	STORAGE TANK CAPACITY (GALS)	STM PRESSURE TO CONTROL VALVE (PSIG)	MAX PRESSURE DROP AT VALVE (PSIG)	STEAM FLOWRATE @ 50 PSIG (LB/HR)	MAIN TRAP (LB/HR)	
DWH–1	EAST PENTHOUSE	DOMESTIC HOT WATER SYSTEM	55	40	140	–––	0.0005	45	10	6	2850	8550	MODEL V45SSH1036
DWH–2	EAST PENTHOUSE	DOMESTIC HOT WATER SYSTEM	55	40	140	–––	0.0005	45	10	6	2850	8550	MODEL V45SSH1036

NOTES:

1. HEATER MODEL NUMBERS SCHEDULED ARE BASIS OF DESIGN AND ARE CEMLINE UNLESS OTHERWISE NOTED IN SCHEDULE.
2. ALL UNITS SHALL BE A COMPLETE HORIZONTAL SKID–MOUNTED FACTORY PACKAGE. UNITS SHALL BE FACTORY–FURNISHED WITH PILOT–OPERATED TEMPERATURE REGULATOR, STAINLESS STEEL TANK, TUBES AND THREADED OPENINGS, MAIN AND AUXILIARY F&T STEAM TRAPS, STEAM AND CONDENSATE STRAINERS, VACUUM BREAKER, COPPER TUBE SHEET, DOUBLE SOLENOID SAFETY SYSTEM, AND FIELD PROGRAMMABLE DIGITAL ELECTRONIC CONTROL PANEL (120–VOLT).

SHELL & TUBE STEAM–TO–WATER CONVERTERS

DESIG	LOCATION	SERVICE	PHYSICAL CHARACTERISTICS			TUBE–SIDE (WATER)						SHELL–SIDE (STEAM)			REMARKS
			APPROX SIZE, DIA x LTH (INCHES)	NUMBER OF TUBE PASSES	HEATING SURFACE AREA (SF)	MINIMUM HEATING CAPACITY (MBH)	WATER FLOWRATE (GPM)	EWT (°F)	LWT (°F)	MAX WPD (FT W.G.)	TUBE FOULING FACTOR	STM PRESS TO CTRL VALVE (PSIG)	STEAM FLOWRATE @ 10 PSIG (LB/HR)	TRAP CAPACITY (LB/HR)	
CONV–1	EAST PENTHOUSE	HEATING WATER SYSTEM	24 x 50	2	324	2200	220	160	180	2.0	.005	10	2300	6900	MODEL E24208–S
CONV–2	EAST PENTHOUSE	HEATING WATER SYSTEM	24 x 50	2	324	2200	220	160	180	2.0	.005	10	2300	6900	MODEL E24208–S

NOTES:

1. MODEL NUMBERS ARE BASIS OF DESIGN AND ARE TACO UNLESS OTHERWISE NOTED IN SCHEDULE. REFER TO SPECIFICATION SECTION 15600 AND TO DETAILS FOR ADDITIONAL REQUIREMENTS.
2. PROVIDE ALL UNITS WITH FLANGED CONNECTIONS.
3. PERFORMANCE BASED ON 3/4–INCH O.D. COPPER TUBES, 0.035–INCH THICKNESS.

DUPLEX STEAM CONDENSATE RECEIVER PUMPSET

DESIG	LOCATION	SERVICE	PUMPS & MOTORS							RECEIVER			REMARKS
			PUMP / MOTOR QUANTITY	CAPACITY, EACH PUMP			MOTOR, EACH PUMP			MATERIAL	CAPACITY (GALLONS)	INLET SIZE (INCHES)	
				CONDENSATE (GPM)	DISCHARGE PRESSURE (PSIG)	DISCHARGE SIZE (INCHES)	MOTOR HP	SPEED (RPM)	VOLTS / PHASE / Hz				
CR–1	STEAM PIT (BFP ROOM)	ALF ADDITION	2	45	30	2	1–½	1750	460 / 3 / 60	CAST IRON	45	2–½	MODEL VES–303

NOTES:

1. MODEL NUMBERS ARE BASIS OF DESIGN AND ARE SKIDMORE UNLESS OTHERWISE NOTED IN SCHEDULE. REFER TO SPECIFICATION SECTION 15600 AND TO DETAILS FOR ADDITIONAL REQUIREMENTS.
2. PROVIDE PACKAGE WITH UNIT–MOUNTED CONTROL PANEL WITH STARTERS, DISCONNECT, AND MECHANICAL ALTERNATOR FOR LEAD/LAG CONTROL. ALL POWER AND CONTROL WIRING SHALL BE PRE–WIRED AT THE FACTORY.

ENERGY RECOVERY AIR HANDLING UNIT SCHEDULE

GENERAL											TOTAL ENERGY RECOVERY WHEEL									
DESIG	LOCATION	SERVICE	DUTY TYPE	ESP / TSP (IN W.G.)	FANS (REFER TO FAN SCHEDULE FOR DUTY)	FILTERS (REFER TO FILTER SCHEDULE FOR DUTY)	AIR VOLUMES (CFM)				DESICCANT TYPE	OVERALL MINIMUM EFFICIENCY (%)	MAX APD (IN W.G.)	DUTY TYPE	SUMMER				WINTER	
							AHU TO BUILDING	WHEEL PURGE	TOTAL (FAN)	OA / EA VOLUME					EAT		LAT		EAT (°F)	LAT (°F)
															dB (°F)	wB (°F)	dB (°F)	wB (°F)		
ERU-1	CENTER ROOF	VENTILATION/MAKEUP AIR	OUTSIDE / SUPPLY AIR	2.0 / 7.0	SF-ERU1	FB-ERU1-SA	7500	900	8400	8400	3A SIEVE	50	1.0	OUTSIDE / SUPPLY AIR	95	78	85	71	10	40
			RETURN / EXHAUST AIR	2.0 / 5.0	EF-ERU1	FB-ERU1-EA	7000	900	7900	7900				RETURN / EXHAUST AIR	75	50	---	---	70	---

CHILLED WATER (30% ETG) COOLING COIL													HOT WATER HEATING COIL													REMARKS
COOLING AIRFLOW (CFM)	MIN SENSIBLE / TOTAL CAP (MBH)	MIN ROWS / MAX FPI	EAT		LAT		APPROX SIZE, L x H (INCHES)	MAXIMUM FACE VEL (FPM)	MAX APD (IN W.G.)	EWT (°F)	LWT (°F)	WATER FLOWRATE (GPM)	MAX WPD (FT HEAD)	HEATING AIRFLOW (CFM)	MINIMUM CAPACITY (MBH)	MIN ROWS / MAX FPI	EAT (°F)	LAT (°F)	APPROX SIZE, L x H (INCHES)	MAXIMUM FACE VEL (FPM)	MAX APD (IN W.G.)	EWT (°F)	LWT (°F)	WATER FLOWRATE (GPM)	MAX WPD (FT HEAD)	
			dB (°F)	wB (°F)	dB (°F)	wB (°F)																				
7500	202.5 / 300	6 / 10	85.0	71.0	60.0	59.5	54 x 42	480	1.0	45	57	55	15	7500	400	2 / 7	10	59.4	54 x 42	480	0.3	180	160	40	5	REFER TO NOTES 1 THRU 5 AND TO SECTION 15600

NOTES:

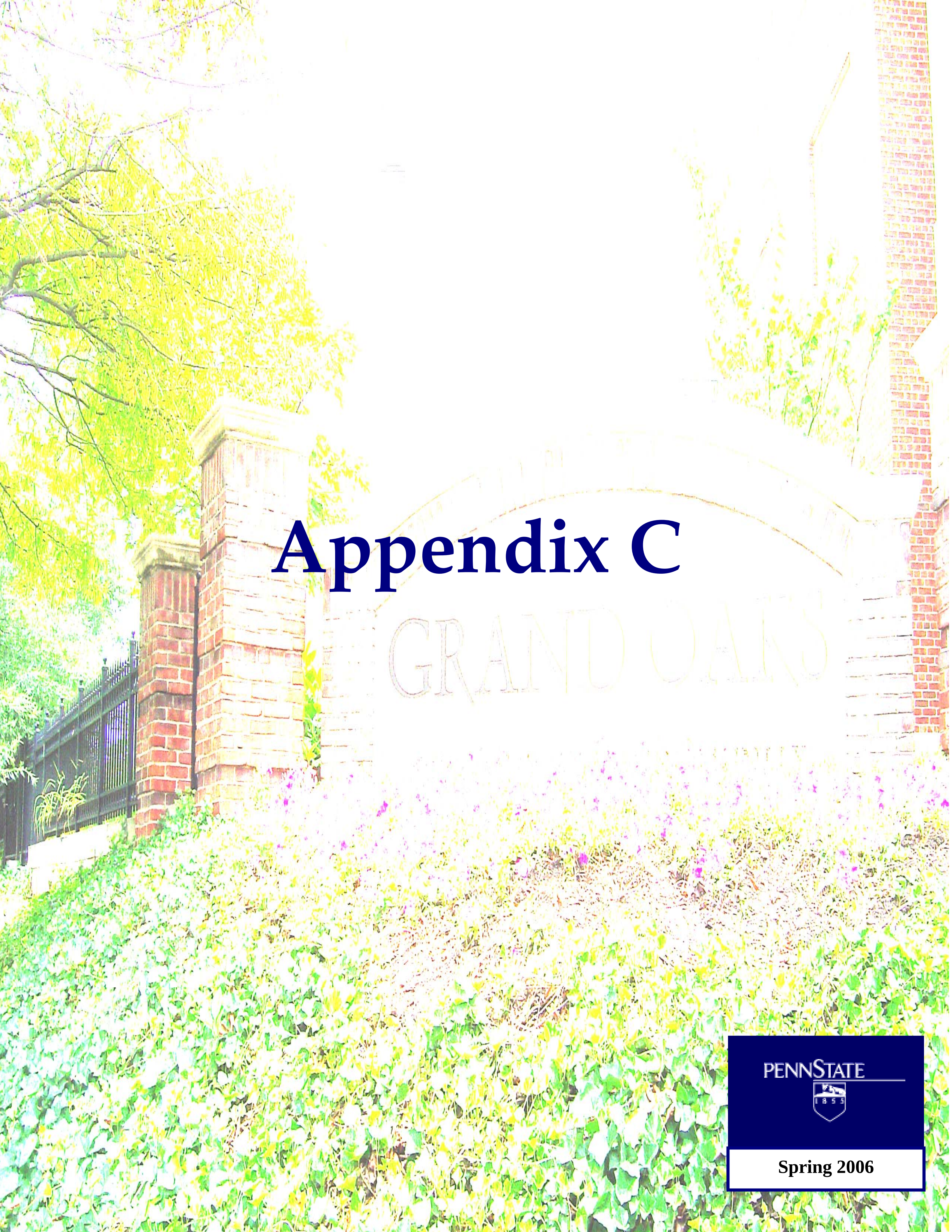
1. BASIS OF DESIGN: SEMCO PACKAGED ROOFTOP AHU MODEL EPHC. PACKAGE SUPPLY AIRSTREAM SHALL INCLUDE OUTSIDE AIR INTAKE HOOD AND AUTOMATIC CONTROL DAMPER, BLOW-THRU SUPPLY AIR FAN, PLEATED PREFILTERS, FINAL CARTRIDGE FILTERS, TOTAL ENERGY RECOVERY WHEEL, HOT WATER PREHEAT COIL, AND CHILLED WATER COOLING COIL. PACKAGE RETURN AIRSTREAM SHALL INCLUDE PLEATED FILTERS UPSTREAM OF WHEEL AND EXHAUST AIR FAN DOWNSTREAM OF WHEEL.
2. REFER TO FAN AND FILTER SCHEDULES FOR ADDITIONAL SELECTION REQUIREMENTS. REFER TO SPECIFICATION SECTION 15600 FOR COMPLETE AHU REQUIREMENTS.
3. PROVIDE AHU WITH THE FOLLOWING OPTIONS: 12-INCH HIGH PREFABRICATED ROOF CURB AND DIGITAL CONTROL PANEL BY AHU MANUFACTURER, OSHA SAFETY CAGE AROUND BOTH FAN AND MOTOR, ENERGY WHEEL FREEZE PROTECTION THRU VFC CONTROL, ALL ACCESS DOORS 18 INCHES WIDE, ADDITIONAL ACCESS DOORS AS INDICATED ON PLANS, SECONDARY SUPPLY FILTERS AS SCHEDULED, AND ADDITIONAL OPTIONS AS SPECIFIED.
4. FAN SELECTIONS SHALL BE BASED ON DIRTY FILTER PRESSURE DROPS SCHEDULED (REFER TO FILTER SCHEDULE). SUPPLY AND RETURN FAN PRESSURE DROPS INCLUDE ADDITIONAL LOSSES OF 0.3" W.G. FOR INTERNAL CASINGS, 0.2" W.G. FOR ATC DAMPER, AND 0.2" W.G. (SUPPLY) OR 0.6" W.G. (RETURN) FOR AIR OPENINGS / DUCT CONNECTIONS. PROVIDE MINIMUM FAN SIZES AND CAPACITIES SCHEDULED REGARDLESS OF INTERNAL AHU PERFORMANCE SUBMITTED.
5. HEATING COIL SHALL BE "INCREASED CAPACITY" COIL; MINIMUM REQUIRED DUTY INDICATED IS FOR OPERATION WITHOUT ENERGY WHEEL. COOLING COIL SHALL BE "STANDARD CAPACITY" COIL, WITH ADJUSTED PERFORMANCE FOR USE WITH 30% ETHYLENE GLYCOL MIXTURE. BOTH COILS SHALL BE CONSTRUCTED WITHOUT ENHANCEMENT DEVICES TO ACHIEVE THE SCHEDULED DUTIES.

PUMPS

DESIG	LOCATION	SERVICE	TYPE (REFER TO SPEC)	WATER FLOWRATE (GPM)	HEAD (FEET)	APPROX IMPELLER DIA (INCHES)	SUCTION x DISCHARGE (IN x IN)	MIN PUMP EFFICIENCY (%)	PUMP SPEED (RPM)	BHP / MOTOR HP	VOLTS / PHASE / Hz	REMARKS
P-CH1	WEST PENTHOUSE	CHILLED WATER SYSTEM	C	360	90	10.1	4 x 4	74	1750	11.4 / 15	460 / 3 / 60	SERIES 4300 MODEL 4x4x11.5 (NOTES 1, 2, 3 & 4)
P-CH2	WEST PENTHOUSE	CHILLED WATER SYSTEM	C	360	90	10.1	4 x 4	74	1750	11.4 / 15	460 / 3 / 60	SERIES 4300 MODEL 4x4x11.5 (NOTES 1, 2, 3 & 4)
P-HW1	EAST PENTHOUSE	HEATING WATER SYSTEM	C	220	70	8.8	3 x 3	72	1750	5.8 / 7-1/2	460 / 3 / 60	SERIES 4300 MODEL 3x3x10 (NOTES 1, 2, & 5)
P-HW2	EAST PENTHOUSE	HEATING WATER SYSTEM	C	220	70	8.8	3 x 3	72	1750	5.8 / 7-1/2	460 / 3 / 60	SERIES 4300 MODEL 3x3x10 (NOTES 1, 2, & 5)
P-DW1	EAST PENTHOUSE	DOMESTIC HOT WATER SYSTEM	B	21	30	6.0	1-1/2 x 1-1/2	47	1750	--- / 1/2	120 / 1 / 60	SERIES 4380 MODEL 1.5x1.5x6 (NOTES 1 & 2); ALL-BRONZE CONSTRUCTION
P-DW2	EAST PENTHOUSE	DOMESTIC HOT WATER SYSTEM	B	21	30	6.0	1-1/2 x 1-1/2	47	1750	--- / 1/2	120 / 1 / 60	SERIES 4380 MODEL 1.5x1.5x6 (NOTES 1 & 2); ALL-BRONZE CONSTRUCTION
P-ERU1	DAYROOM 412	ERU-1 PHC CIRCULATOR	B	40	12	5.5	2 x 2	64	1150	--- / 1/3	120 / 1 / 60	SERIES 4380 MODEL 2x2x6 (NOTES 1 & 2)

NOTES:

1. PUMP MODEL NUMBERS SCHEDULED ARE BASIS OF DESIGN AND ARE ARMSTRONG UNLESS OTHERWISE NOTED IN SCHEDULE.
2. REFER TO SYSTEM PIPING SCHEMATICS AND TO SPECIFICATION SECTIONS 15300 & 15600 FOR ADDITIONAL INFORMATION AND REQUIREMENTS.
3. SELECT CHILLED WATER PUMPS WITH ADJUSTED PERFORMANCE FOR USE WITH 30% ETHYLENE GLYCOL MIXTURE. PUMP MANUFACTURER CURVE PRINTOUT INCLUDED WITH SHOP DRAWINGS SHALL INDICATE GLYCOL PERFORMANCE FOR THE PUMP SUBMITTED.
4. THE SCHEDULED CHILLED WATER PUMP FLOWRATE INCLUDES AN ADDITIONAL 35 GPM WHICH SHALL BE BYPASSED THROUGH ITS RESPECTIVE SYSTEM BYPASS FILTER. REFER TO SPECIFICATION SECTION 15050 FOR FILTER REQUIREMENTS.
5. THE SCHEDULED HEATING WATER PUMP FLOWRATE INCLUDES AN ADDITIONAL 20 GPM WHICH SHALL BE BYPASSED THROUGH ITS RESPECTIVE SYSTEM BYPASS FILTER. REFER TO SPECIFICATION SECTION 15050 FOR FILTER REQUIREMENTS.



Appendix C

Spring 2006

WIRING PANEL SCHEDULE

PANEL: MDP MAINS: MLO AMPS: 1000 AIC: 22K
VOLTAGE: 480Y/277V WIRES: 4 PHASE: 3 MOUNTING: SURFACE LOC: PENTHOUSE

CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT	CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT
1	-	-	-	-	2	-	-	-	-
3	ELEVATOR #5	3	80	1-1/4"C.W/3#3+1# 8GRD.	4	ELEVATOR #6	3	80	1-1/4"C.W/3#3+1# 8GRD.
5	-	-	-	-	6	-	-	-	-
7	-	-	-	-	8	-	-	-	-
9	HP-1-ERU	3	40	3/4"C.W/3#10+1#10GRD.	10	HP-2-ERU	3	40	3/4"C.W/3#10+1#10GRD.
11	-	-	-	-	12	-	-	-	-
13	-	-	-	-	14	-	-	-	-
15	EXHAUST FAN: EF-1	3	15	3/4"C.W/3#12+1#12GRD.	16	PUMP: P-CH1	3	40	3/4"C.W/3#10+1#10GRD.
17	-	-	-	-	18	-	-	-	-
19	-	-	-	-	20	-	-	-	-
21	EXHAUST FAN: EF-2	3	15	3/4"C.W/3#12+1#12GRD.	22	PUMP: P-CH2	3	40	3/4"C.W/3#10+1#10GRD.
23	-	-	-	-	24	-	-	-	-
25	-	-	-	-	26	-	-	-	-
27	PANEL H4-NE	3	100	FEEDER 17	28	PANEL H2-NE	3	100	FEEDER 19
29	-	-	-	-	30	-	-	-	-
31	-	-	-	-	32	-	-	-	-
33	PANEL H3-NE	3	100	FEEDER 18	34	XFMR: T-1	3	200	FEEDER 3
35	-	-	-	-	36	-	-	-	-
37	-	-	-	-	38	-	-	-	-
39	XFMR: T-2	3	200	FEEDER 5	40	ENERGY REC. UNIT: ERU-1	3	80	1 1/4"C.W/3#3+1#8GRD.
41	-	-	-	-	42	-	-	-	-
43	-	-	-	-	44	-	-	-	-
45	SPACE (225AF)	3	-	-	46	SPACE (150AF)	3	-	-
47	-	-	-	-	48	-	-	-	-

EX. DEMAND LOAD TOTAL PHASE A PROPOSED DEMAND LOAD TOTAL PHASE A
EX. DEMAND LOAD TOTAL PHASE B PROPOSED DEMAND LOAD TOTAL PHASE B
EX. DEMAND LOAD TOTAL PHASE C PROPOSED DEMAND LOAD TOTAL PHASE C

FEEDER SCHEDULE

FEEDER NUMBER	SERVING	SERVED FROM	CONDUIT	WIRE	GROUND	AMPS
1	PANEL MDP	NEW DISTRIBUTION SECTION	(3) 3"	3 SETS 4#350 MCM	3#2/0	600
2	T-1	PANEL MDP	2"	4#3/0	1#6	200
3	PANEL LDP-NW	T-1	(2) 2"	2 SETS 4#3/0	(2) 1#3	400
4	T-2	PANEL MDP	2"	4#3/0	1#6	200
5	PANEL LDP-NE	T-2	(2) 2"	2 SETS 4#3/0	(2) 1#3	400
6	PANEL LS-DP	T-3	2"	4#1/0	1#6	150
7	T-3	EX. PANEL EH1	1 1/2"	3#1	1#8	70
8	ELEVATOR #5	PANEL MDP	1-1/4"	3#3	1#8	80
9	PANEL L2-NW	PANEL MDP-NW	2"	4#1/0	1#1	150
10	PANEL L3-NW	PANEL MDP-NW	2"	4#1/0	1#1	150
11	PANEL L4-NW	PANEL MDP-NW	2"	4#1/0	1#1	150
12	LS-4NW	PANEL LS-DP	1 1/4"	4#4	1#10	60
13	LS-2NW	PANEL LS-DP	1 1/4"	4#4	1#10	60
14	PANEL L4-NE	PANEL MDP-NE	2"	4#1/0	1#1	150
15	PANEL L3-NE	PANEL MDP-NE	2"	4#1/0	1#1	150
16	PANEL L2-NE	PANEL MDP-NE	2"	4#1/0	1#1	150
17	PANEL H4-NE	PANEL MDP	1 1/4"	4#3	1#8	100
18	PANEL H3-NE	PANEL MDP	1 1/4"	4#3	1#8	100
19	PANEL H2-NE	PANEL MDP	1 1/4"	4#3	1#8	100
20	ELEVATOR #6	PANEL MDP	1-1/4"	3#3	1#8	80
21	HP-1-ERU	PANEL MDP	3/4"	3#8	1#10	40
22	HP-2-ERU	PANEL MDP	3/4"	3#8	1#10	40

WIRING PANEL SCHEDULE

	PANEL: H2-NE	MAINS: MLO										AMPS: 100			AIC: 14K
	VOLTAGE: 480Y/277V	WIRES: 4		PHASE: 3								MOUNTING: SURFACE			LOC: 2ND FLR. EAST
CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT	A	A	B	B	C	C	CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT
1	HP-2-1	1	15	3/4"C.W/2#12+1#12GRD.	5	5	-	-	-	-	2	HP-2-13	1	15	3/4"C.W/2#12+1#12GRD.
3	HP-2-2	1	15	3/4"C.W/2#12+1#12GRD.	-	-	5.5	5.5	-	-	4	HP-2-14	1	15	3/4"C.W/2#12+1#12GRD.
5	HP-2-3	1	15	3/4"C.W/2#12+1#12GRD.	-	-	-	-	5.5	5.5	6	HP-2-15	1	15	3/4"C.W/2#12+1#12GRD.
7	HP-2-4	1	15	3/4"C.W/2#12+1#12GRD.	5.5	7.1	-	-	-	-	8	HP-2-16	1	15	3/4"C.W/2#12+1#12GRD.
9	HP-2-5	1	15	3/4"C.W/2#12+1#12GRD.	-	-	7.1	7.1	-	-	10	HP-2-17	1	15	3/4"C.W/2#12+1#12GRD.
11	HP-2-6	1	15	3/4"C.W/2#12+1#12GRD.	-	-	-	-	7.1	5	12	HP-2-18	1	15	3/4"C.W/2#12+1#12GRD.
13	HP-2-7	1	15	3/4"C.W/2#12+1#12GRD.	5	5	-	-	-	-	14	HP-2-19	1	15	3/4"C.W/2#12+1#12GRD.
15	HP-2-8	1	15	3/4"C.W/2#12+1#12GRD.	-	-	5	3.6	-	-	16	HP-2-20	1	15	3/4"C.W/2#12+1#12GRD.
17	HP-2-9	1	15	3/4"C.W/2#12+1#12GRD.	-	-	-	-	3.6	3.6	18	HP-2-21	1	15	3/4"C.W/2#12+1#12GRD.
19	HP-2-10	1	15	3/4"C.W/2#12+1#12GRD.	3.6	3.6	-	-	-	-	20	HP-2-22	1	15	3/4"C.W/2#12+1#12GRD.
21	HP-2-11	1	15	3/4"C.W/2#12+1#12GRD.	-	-	3.6	3.6	-	-	22	HP-2-23	1	15	3/4"C.W/2#12+1#12GRD.
23	HP-2-12	1	15	3/4"C.W/2#12+1#12GRD.	-	-	-	-	3.6	3.6	24	HP-2-24	1	15	3/4"C.W/2#12+1#12GRD.
25	HP-NE - BRIDGE	1	20	3/4"C.W/2#12+1#12GRD.	11.4	3.6	-	-	-	-	26	HP-2-25	1	15	3/4"C.W/2#12+1#12GRD.
27	HP-NW - BRIDGE	1	20	3/4"C.W/2#12+1#12GRD.	-	-	11.4	11.4	-	-	28	HP-2-1-DAY/ACTIVITY ROOM	1	20	3/4"C.W/2#12+1#12GRD.
29	HP-2-2-DAY/ACTIVITY ROOM	1	20	3/4"C.W/2#12+1#12GRD.	-	-	-	-	11.4	0	30	SPARE	1	20	-
31	SPARE	1	20	-	0	0	-	-	-	-	32	SPARE	1	20	-
33	SPACE	1	-	-	-	-	0	0	-	-	34	SPACE	1	-	-
35	SPACE	1	-	-	-	-	-	-	0	0	36	SPACE	1	-	-
37	SPACE	1	-	-	0	0	-	-	-	-	38	SPACE	1	-	-
39	SPACE	1	-	-	-	-	0	0	-	-	40	SPACE	1	-	-
41	SPACE	1	-	-	-	-	-	-	0	0	42	SPACE	1	-	-
	CONNECTED LOAD	0 A		TOTAL PHASE A	22 A										
	DEMAND LOAD	0 A		TOTAL PHASE B	30 A										
	25% GROWTH	0 A		TOTAL PHASE C	26 A										

WIRING PANEL SCHEDULE

	PANEL: H3-NE	MAINS: MLO										AMPS: 100			AIC: 14K
	VOLTAGE: 480Y/277V	WIRES: 4		PHASE: 3								MOUNTING: SURFACE			LOC: 3RD FLR. EAST
CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT	A	A	B	B	C	C	CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT
1	HP-3-1	1	15	3/4"C.W/2#12+1#12GRD.	7.1	7.1	-	-	-	-	2	HP-3-14	1	15	3/4"C.W/2#12+1#12GRD.
3	HP-3-2	1	15	3/4"C.W/2#12+1#12GRD.	-	-	7.1	7.1	-	-	4	HP-3-15	1	15	3/4"C.W/2#12+1#12GRD.
5	HP-3-3	1	15	3/4"C.W/2#12+1#12GRD.	-	-	-	-	5	5	6	HP-3-16	1	15	3/4"C.W/2#12+1#12GRD.
7	HP-3-4	1	15	3/4"C.W/2#12+1#12GRD.	5	5	-	-	-	-	8	HP-3-17	1	15	3/4"C.W/2#12+1#12GRD.
9	HP-3-5	1	15	3/4"C.W/2#12+1#12GRD.	-	-	5	3.6	-	-	10	HP-3-18	1	15	3/4"C.W/2#12+1#12GRD.
11	HP-3-6	1	15	3/4"C.W/2#12+1#12GRD.	-	-	-	-	3.6	3.6	12	HP-3-19	1	15	3/4"C.W/2#12+1#12GRD.
13	HP-3-7	1	15	3/4"C.W/2#12+1#12GRD.	3.6	3.6	-	-	-	-	14	HP-3-20	1	15	3/4"C.W/2#12+1#12GRD.
15	HP-3-8	1	15	3/4"C.W/2#12+1#12GRD.	-	-	3.6	3.6	-	-	16	HP-3-21	1	15	3/4"C.W/2#12+1#12GRD.
17	HP-3-9	1	15	3/4"C.W/2#12+1#12GRD.	-	-	-	-	3.6	3.6	18	HP-3-22	1	15	3/4"C.W/2#12+1#12GRD.
19	HP-3-10	1	15	3/4"C.W/2#12+1#12GRD.	3.6	3.6	-	-	-	-	20	HP-3-23	1	15	3/4"C.W/2#12+1#12GRD.
21	HP-3-11	1	15	3/4"C.W/2#12+1#12GRD.	-	-	3	3	-	-	22	HP-3-24	1	15	3/4"C.W/2#12+1#12GRD.
23	HP-3-12	1	15	3/4"C.W/2#12+1#12GRD.	-	-	-	-	3	3	24	HP-3-25	1	15	3/4"C.W/2#12+1#12GRD.
25	HP-3-13	1	15	3/4"C.W/2#12+1#12GRD.	3	11.4	-	-	-	-	26	HP-3-3-DAY/ACTIVITY ROOM	1	20	3/4"C.W/2#12+1#12GRD.
27	HP-3-NE - BRIDGE	1	20	3/4"C.W/2#12+1#12GRD.	-	-	11.4	11.4	-	-	28	HP-3-3-DAY/ACTIVITY ROOM	1	20	3/4"C.W/2#12+1#12GRD.
29	HP-3-NW - BRIDGE	1	20	3/4"C.W/2#12+1#12GRD.	-	-	-	-	11.4	11.4	30	HP-3-CORRIDOR	1	20	3/4"C.W/2#12+1#12GRD.
31	HP-3-26	1	15	3/4"C.W/2#12+1#12GRD.	3	0	-	-	-	-	32	SPACE	1	-	-
33	SPACE	1	-	-	-	-	0	0	-	-	34	SPACE	1	-	-
35	SPACE	1	-	-	-	-	-	-	0	0	36	SPACE	1	-	-
37	SPACE	1	-	-	0	0	-	-	-	-	38	SPACE	1	-	-
39	SPACE	1	-	-	-	-	0	0	-	-	40	SPACE	1	-	-
41	SPACE	1	-	-	-	-	-	-	0	0	42	SPACE	1	-	-
	CONNECTED LOAD	0 A		TOTAL PHASE A	25 A										
	DEMAND LOAD	0 A		TOTAL PHASE B	29 A										
	25% GROWTH	0 A		TOTAL PHASE C	36 A										

WIRING PANEL SCHEDULE

	PANEL: H4-NE	MAINS: MLO										AMPS: 100			AIC: 14K
	VOLTAGE: 480Y/277V	WIRES: 4		PHASE: 3								MOUNTING: SURFACE			LOC: 4TH FLR. EAST
CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT	A	A	B	B	C	C	CIR	DESCRIPTION	P	AMP	BRANCH CIRCUIT
1	HP-4-1	1	15	3/4"C.W/2#12+1#12GRD.	7.1	7.1					2	HP-4-14	1	15	3/4"C.W/2#12+1#12GRD.
3	HP-4-2	1	15	3/4"C.W/2#12+1#12GRD.			7.1	7.1			4	HP-4-15	1	15	3/4"C.W/2#12+1#12GRD.
5	HP-4-3	1	15	3/4"C.W/2#12+1#12GRD.					5	5	6	HP-4-16	1	15	3/4"C.W/2#12+1#12GRD.
7	HP-4-4	1	15	3/4"C.W/2#12+1#12GRD.	5	5					8	HP-4-17	1	15	3/4"C.W/2#12+1#12GRD.
9	HP-4-5	1	15	3/4"C.W/2#12+1#12GRD.			3.6	3.6			10	HP-4-18	1	15	3/4"C.W/2#12+1#12GRD.
11	HP-4-6	1	15	3/4"C.W/2#12+1#12GRD.					3.6	3.6	12	HP-4-19	1	15	3/4"C.W/2#12+1#12GRD.
13	HP-4-7	1	15	3/4"C.W/2#12+1#12GRD.	3.6	3.6					14	HP-4-20	1	15	3/4"C.W/2#12+1#12GRD.
15	HP-4-8	1	15	3/4"C.W/2#12+1#12GRD.			3.6	3.6			16	HP-4-21	1	15	3/4"C.W/2#12+1#12GRD.
17	HP-4-9	1	15	3/4"C.W/2#12+1#12GRD.	-	-	-	-	3	3	18	HP-4-22	1	15	3/4"C.W/2#12+1#12GRD.
19	HP-4-10	1	15	3/4"C.W/2#12+1#12GRD.	3	3	-	-	-	-	20	HP-4-23	1	15	3/4"C.W/2#12+1#12GRD.
21	HP-4-11	1	15	3/4"C.W/2#12+1#12GRD.	-	-	3	3	-	-	22	HP-4-24	1	15	3/4"C.W/2#12+1#12GRD.
23	HP-4-12	1	15	3/4"C.W/2#12+1#12GRD.	-	-	-	-	3	3	24	HP-4-25	1	15	3/4"C.W/2#12+1#12GRD.
25	HP-4-13	1	15	3/4"C.W/2#12+1#12GRD.	3	11.4	-	-	-	-	26	HP-4-1-DAY/ACTIVITY ROOM	1	20	3/4"C.W/2#12+1#12GRD.
27	HP-4-2-DAY/ACTIVITY ROOM	1	20	3/4"C.W/2#12+1#12GRD.	-	-	11.4	11.4	-	-	28	HP-4-NE BRIDGE	1	20	3/4"C.W/2#12+1#12GRD.
29	HP-4-NW BRIDGE	1	20	3/4"C.W/2#12+1#12GRD.	-	-	-	-	11.4	11.4	30	HP-4-NE COORIDOR	1	20	3/4"C.W/2#12+1#12GRD.
31	SPACE	1	-	-	0	0	-	-	-	-	32	SPACE	1	-	-
33	SPACE	1	-	-	-	-	0	0	-	-	34	SPACE	1	-	-
35	SPACE	1	-	-	-	-	-	-	0	0	36	SPACE	1	-	-
37	SPACE	1	-	-	0	0	-	-	-	-	38	SPACE	1	-	-
39	SPACE	1	-	-	-	-	0	0	-	-	40	SPACE	1	-	-
41	SPACE	1	-	-	-	-	-	-	0	0	42	SPACE	1	-	-
	CONNECTED LOAD	0 A		TOTAL PHASE A	20 A										
	DEMAND LOAD	0 A		TOTAL PHASE B	29 A										
	25% GROWTH	0 A		TOTAL PHASE C	35 A										