FINAL THESIS REPORT

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LIGHTING/ELECTRICAL

DANSKO PHASE III EXPANSION
SPRING 2007

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Executive Summary

This report provides an in-depth study of the lighting and electrical systems and breadth studies in both construction management and mechanical systems of the Dansko Phase III expansion. The first part of this report is the design concept for the Dansko Phase III expansion, a list of design criteria for each space, and a design solution that comes as a result of the mating of the two for four individual spaces. The lighting depth completes a redesign of four spaces. As part of the redesign, a lay-in ceiling was added to a space that was currently exposed structure. This ceiling has a 90% reflectance value, which is 15% higher than the standard ceiling tile found today in most buildings. The electrical redesign consists of resizing the electrical distribution serving these spaces to account for the change in lighting loads. Additionally, an emergency generator was sized to replace the existing batter ballasts, and 25 feeders were resized to be made from aluminum instead of copper, and the price of such a substitution was determined. A coordination study was performed on a path from the main switchboard to load to determine if the circuit breakers were coordinated.

Upon analyzing the tasks to be performed in each of the various spaces chosen for examination, it was determined that the current lighting design is quite adequate and fits well with the aesthetics of the building. However, I see the ability to improve the function of the spaces by changing some aspects of the lighting design. My areas of study will include the entry atrium, a showroom/conference room, a large open office plan with varied tasks, and an exterior façade that has a large sign that is to be viewed from Pennsylvania state route 1, which is adjacent to the Dansko property.

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Introduction and Background

Dansko, Inc. is a shoe manufacturing company based in West Grove, PA, which is located in the south eastern corner of the state. It was started by a European couple that trained horses for a living, but were inspired to change professions after a trip to Denmark in the late 1980s. Mandy Cabot and Peter Kjellerup, the husband and wife team owners, found a Danish clog that changed their lives. After wearing them for two years during rigorous use, Mandy and Peter found these shoes to be extraordinarily comfortable, durable, and attractive enough to wear almost anywhere. They secured the rights to manufacture these clogs and started "Dansko, Inc." in 1991. Their shoes are now available for sale in over 3500 retail locations.

This mixed use building stands three stories tall, having an area of 81,000 square feet. The total cost was estimated at $20,000,000 at the initial design. Following the design-bid-build project delivery method, it is scheduled for completion in September of 2007. It is being built as the existing facility is no longer suitable to hold the growing company. Dansko, Inc. was in the same building as their manufacturing operation, and now is looking to expand to a separate headquarters on the same campus.

The owners of Dansko decided early in the design process to design an environmentally friendly building. Therefore the design incorporates a large percentage of windows to utilize as much daylight as possible. Energy efficient fluorescent T5 lamps were used throughout much of the building, along with compact fluorescents. The lighting design incorporates the use of many products from Armstrong’s architectural ceiling catalog, as desired by the owners.

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Architecture

The exterior of the building is clad in brick with decorative patterns of different color bricks mixed in around the windows. The roof structure has two different components; a standing seam metal roof on the retail space and a green roof on the rest of the building. Sitting atop of the structure are solar collectors which collect the sun's rays through the circulation of water. All of the open offices feature under-floor air distribution for space conditioning. This floor space sits above a 4" composite slab on 2" decking. The structure is then carried through heavy wide flange beams which also support the façade. A steel moment frame lateral resistance system is used atop a spread footing foundation. The southern face is lined with lightshelves to help control daylight from being obtrusive into the building, while at the same time maximizing daylight into the spaces. At the center of the building is an atrium that expands the first and second floors and is capped with clerestories on three sides allowing much daylight to enter the space. Other parts of this building include a cafeteria, a parking garage, and a roof terrace to be used by the employees during breaks throughout the day.

Acknowledgements

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Lighting Depth

Introduction

The lighting design for Dansko is built off of the following concept: Comfort, Style, and Durability. Each of these reflects the philosophy that directs Dansko in their manufacturing of goods. This design focuses on creating a comfortable environment that is pleasant to be in, providing a sleek, integrated style, and presenting a durable product that requires minimal maintenance. The comfort comes from creating a non-uniform environment in the spaces where people will spend much of their day, either when working or when taking a break. The style comes from incorporating the luminaires into the architecture, letting the building and the products be the showcase, having the lighting play a supporting role. The durability comes from using lamps that generally have a long life, and luminaires that require low maintenance. Durability is also manifested in use of as few different of lamp types as possible. The T5 lamp was used throughout; a high-output lamp was specified where higher light levels were required.

Entry Atrium

The atrium is the first room you see when you enter through the front door of the building. It serves as the central circulation hub. From this space you can access the reception desk, retail outlet, product showroom, public restrooms, conference rooms, and general administrative offices. Being the first space you see upon entering the building, this space should be impressive and attractive. The architect did a good job of drawing your eye upwards by making the atrium two stories in height, with a clerestory capping it off. There is a two-story sign adjacent to the stair displaying the name “dansko.” A display wall is located to the left upon entry, before you arrive at the reception desk. This wall features “shoeboxes” recessed into the wall that showcase the newest products from Dansko. A clerestory at the top of the atrium contains 254 square feet of glass, with windows on three sides. The south facing wall does not contain glass.

For the purpose of this report, the entry atrium space is broken up into 5 spaces; the lobby, receptionist’s office, atrium, lounge, and second floor corridor. The lobby is defined by the single-height space that contains the “shoebox” display and the receptionist’s office. It is approximately 40’Lx11’-6”Wx10’H. The receptionist’s office is approximately 8’x9’x10’ and surrounded by 3 walls and the receptionist’s desk. The atrium is defined by the double-height space; the ceiling height is 23’-9” with base dimensions of roughly 25’x25’. The lounge, at 430 square feet, is on the second floor

overlooking the atrium floor; it has a ceiling height of 10'. The second floor corridor leads to the open office from the stairs, at about 6'-4" wide by 10' high.

Materials

Location: Ceiling of Lobby, Atrium, corridor to room 215 on Second Floor

Material: Benjamin Moore Color Preview, Distant Gray
Reflectance: 93%

Location: Wall of Atrium and Lobby

Material: Benjamin Moore Color Preview, Marble White
Reflectance: 84%

Location: Wall of Receptionist's Office

Material: Benjamin Moore Color Preview, Cotton Tail
Reflectance: 90%

Location: Door of Receptionist's Office

Material: Benjamin Moore Color Preview, Golden Straw
Reflectance: 75%

Location: Doors of Atrium and Lobby

Material: Benjamin Moore Color Preview, Danville Tan
Reflectance: 44%

Location: Doors of 2nd Floor Corridor

Material: Benjamin Moore Color Preview, Filtered Sunlight
Reflectance: 83%

Location: Floor of Atrium and Lobby

Material: EnviroGlas – Terrazzo, Benjamin Moore Paint,
Ashen Tan
Reflectance: 54%

Location: Floor of Receptionist's Office

Material: Interface Flooring System
Pattern: Weimar
Color: Acorn
Reflectance: 12%

Location: Floor of Stairs and 2nd Floor Lounge and Corridor

Material: Smith & Fong Plyboo
Pattern: Standard Flooring
Color: Amber prefinished, flat grain
Reflectance: 28%

Location: Ceiling of Receptionist's Office and 2nd Floor Lounge

Material: Armstrong Cirrus, White
Reflectance: 86%

Design Criteria

- *Appearance of Space and Luminaires*
  Appearance of this space is critical. Opinions are often formed from first impressions, and this space is the first thing you see upon entering the building. The luminaires should be concealed in the architecture and not stand out. The architecture of the building and the products on display are the attractions here, and the lighting should emphasize and reinforce that.

- *Color Appearance (Color Contrast)*
  Since this space has products on display, it requires that color rendering be a priority. With the amount of daylight available in the space, objects will appear true to color.

- *Daylighting Integration and Control*
  Atop this two-story space sits a clerestory on three of the four sides. Outside of that there is a parapet that blocks out some direct sun. Daylight will provide most

of the illumination of this space, with some artificial light needed in the areas that are not double-height. Dimming or switching should be provided to maximize daylighting and minimize energy consumption. A photosensor should be included to control clerestory, lobby, lounge, and corridor lighting in proportion to the amount of natural light available in the space. Items not under the control of a photosensor include the receptionist's office luminaire and the product display wall.

- *Direct Glare*
  Glare from luminaires should be avoided in this space. A gentle, pleasing environment is desired, and therefore diffusing lenses would be an appropriate element. Direct sunlight entering the space will provide a dynamic environment but should be controlled as to not be overpowering.

- *Light Distribution on Surfaces*
  Striations and scallops are not desired in this space; lighting should be designed as to avoid shadows, and provide luminance ratios of within 3:1 from the ceiling to the walls.

- *Modeling of Faces or Objects*
  Spatial modeling is important in this space, especially for the products on display. It is important that the lighting system model faces well, as eye socket shadows are unattractive and can leave a bad impression on patrons to the building.

- *Points of Interest*
  The lighting should assist in drawing your attention to the display wall as the primary focus. Secondary areas of focus are the video display, reception desk, and the two-story "dansko" sign.

- *Shadows*
  Shadows can have a very desirable effect in this space. Natural daylighting will take care of creating a constantly changing environment with great contrasts on the walls of the atrium. Linear sources around the receptionist's desk will limit shadows that may fall onto the desk.

- *Sparkle/Desirable Highlights*
  Natural daylight will create highlights in the space independent of the lighting system. The main highlights of the space are the products, so nothing should stand out above the shoe display wall.

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Lighting Design Solution

The entry atrium was a very interesting space to redesign as it has many different areas to consider. Direction through the space was the most important consideration. Most individuals who enter this space will head directly for the receptionist's desk. The lighting in the ceiling along this path not only leads you this way, but it also mimics the footsteps they take to get there. Ribbons of light are recessed into the ceiling in the same pattern as footsteps. Further down this path past the receptionist, the ceiling seems to go on indefinitely through the use of a perimeter wallwash that breaks the connection from wall to ceiling. The luminaire itself is recessed into the ceiling, and the lamp is hidden from view. The ceiling seems as though it is floating, with no definitive edge. This serves as a metaphor to there being no definitive limit to the distance you will travel in your Dansko shoes. As the patron progresses down this path towards the receptionist, his attention is drawn to a series of display boxes recessed into the wall. The boxes seem to glow from an unknown source. The center of each box will showcase a certain Dansko product that is evenly illuminated by the diffuse glowing surfaces that surround it. Following the lines of the building, the luminaires chosen for this space are rectangular. From the 4' slotlight in the lobby space to the 10" square downlight in the lounge and corridor on the second floor, the sharp angles of the architecture are reflected throughout.

The inclusion of a video display screen will add a point of interest to the atrium and help further draw attention to the Dansko products. It was placed on the south wall adjacent to the entrance doors to the showroom. This location will shield it from direct sunlight due to the fact that the ceiling at this point is single-height and extends roughly two feet from the wall before opening up to the double-height atrium.

Equipment

Atrium - Luminaire Schedule

Type	Luminaire Manufacturer and Catalog Number	Description	Lamp	Ballast Manufacturer and Catalog Number	Ballast Watts
A-62	Zumtobel SLRI-E-1545-4	3" wide flangeless slotlight.	54W T5HO	Lutron Hi-lume FDB-T554-277-1	62
B-440	io lighting 0-06-SSP-3-XX-XX-65-3kHO-X-2-I	LED striplight incorporated into handrail with remote transformer.	LED	Included	440
C-62	Elliptipar F109-T155-S-02-X-V00	Elliptical reflector.	54W T5HO	Lutron Hi-lume FDB-T554-277-1	62
D-34	Zumtobel 2LS1D=32GX24Q3-X-FF-SRM	10"x10" square-framed downlight with facetted polycarbonate reflector.	32W CFL	Lutron Compact SE FDB-T432-277-1-S	34
E-26	Litecontrol 20-1-3-T5-CWM-PR-277	Recessed perimeter luminaire with parabolic reflector. Lamp hidden from view.	21W T5	Advance ICN-132-MC@277	26
E-34	Litecontrol 20-1-4-T5-CWM-PR-277	Recessed perimeter luminaire with parabolic reflector. Lamp hidden from view.	28W T5	Advance ICN-132-MC@277	34
H-117	Zumtobel ML4E-14-2545-MD-XXX	Recessed direct/indirect luminaire with light "chamber" and microgrid diffuser.	(2) 54W T5HO	Lutron Hi-lume FDB-T554-277-2	117
S-62	Belfer Lighting 2820-I-54T5HO-2-E-WH	T5H0 Striplight with 86% reflective white coating.	54W T5HO	Advance ICN-2S54-90C@277	62

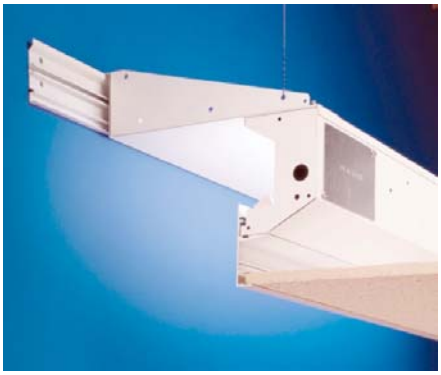
Figure 1 – Atrium Fixture Schedule

Fixture type A: This fixture provides a diffuse lens that spreads light evenly throughout its distribution. It is used in this application to provide illumination in the single-height lobby space, mimicking a footstep pattern.

Fixture type B: Integrated into the handrail, LED strips illuminate the stairs to a level of 10fc. It is used on the main stairwell to the second floor. It is intended to be used on the main stairwell leading to the lower level (outside the scope of this report.)

Fixture type C: Shown here with the wall mounted option, this fixture is mounted on a ledge at the clerestory level. It provides an even wash of light across the ceiling of the atrium utilizing an elliptical reflector.

Fixture type D: This 10” square downlight carries the rectilinear feel to the second floor. Its multifaceted reflector provides optimal photometric performance, providing both diffuse and direct light.



Fixture type E: This perimeter light breaks the connection between the ceiling and the wall in the lobby. It helps define the edge of the space and draws your attention through the space.

Fixture type H: Serving as the lighting in the receptionist's office, this fixture has an integrated "light chamber" and micro louver that helps block lamp image but provides a uniform wash over the surfaces in this space.

Fixture type S: This strip light provides the illumination for the shoe display boxes in the lobby. Its body is painted with high-reflectance paint for maximum light output.

Figure 2 – Atrium Fixture Images

Light Loss Factors

	Type	LLD	LDD	RSDD	BF	LLF
Atrium	A	0.93	0.88	0.97	1.02	0.81
	B	0.3	0.88	0.95	0.96	0.24
	C	0.93	0.85	0.87	1.02	0.70
	D	0.9	0.88	0.97	1	0.77
	H	0.93	0.86	0.95	1.02	0.78
	E-3	0.93	0.89	0.97	1.02	0.82
	E-4	0.93	0.89	0.97	1.02	0.82
	S-62	0.92	0.89	0.99	1.02	0.83

Figure 3 – Atrium Light Loss Factors

Light Loss factors were calculated using a 12-month cleaning cycle. The atrium was considered a clean environment. Lamp lumen depreciation was calculated by dividing the mean lumen output by the initial lumen output, given by the lamp manufacturer. Ballasts were chosen to have the highest ballast factor, as to provide the most light output with the least power input.

Power Densities

Atrium	Area (sf)	Watts	ASHRAE Base Allowance	Additional Allowance	Applied Area (sf)	Description	ASHRAE Total Allowable Watts	ASHRAE Total Allowable LPD	LPD (W/sf)
Atrium Floor	550	1041.28	0.6	0			330	0.6	1.89
Lobby	640	704	0.8	1	640	Display	1152	1.8	1.10
Lounge	430	340	1.2	0			516	1.2	0.79
Corridor	430	272	0.8						0.63
Receptionist	79.5	117	1.2				95.4	1.2	1.47
Total:	2129.5	2474.28							1.16

Figure 4 – Atrium Light Power Density

Lighting Layout and Controls

The atrium lighting will be controlled by time clocks and photosensor switching. The emergency will be controlled from a separate time clock than the normal power that will stay on a few hours later for late-night egress from the building. The lobby, clerestory, and 2nd floor lighting will be controlled by a photosensor during the day, due to the fact that most of the time there will be plenty of daylight to illuminate the space.

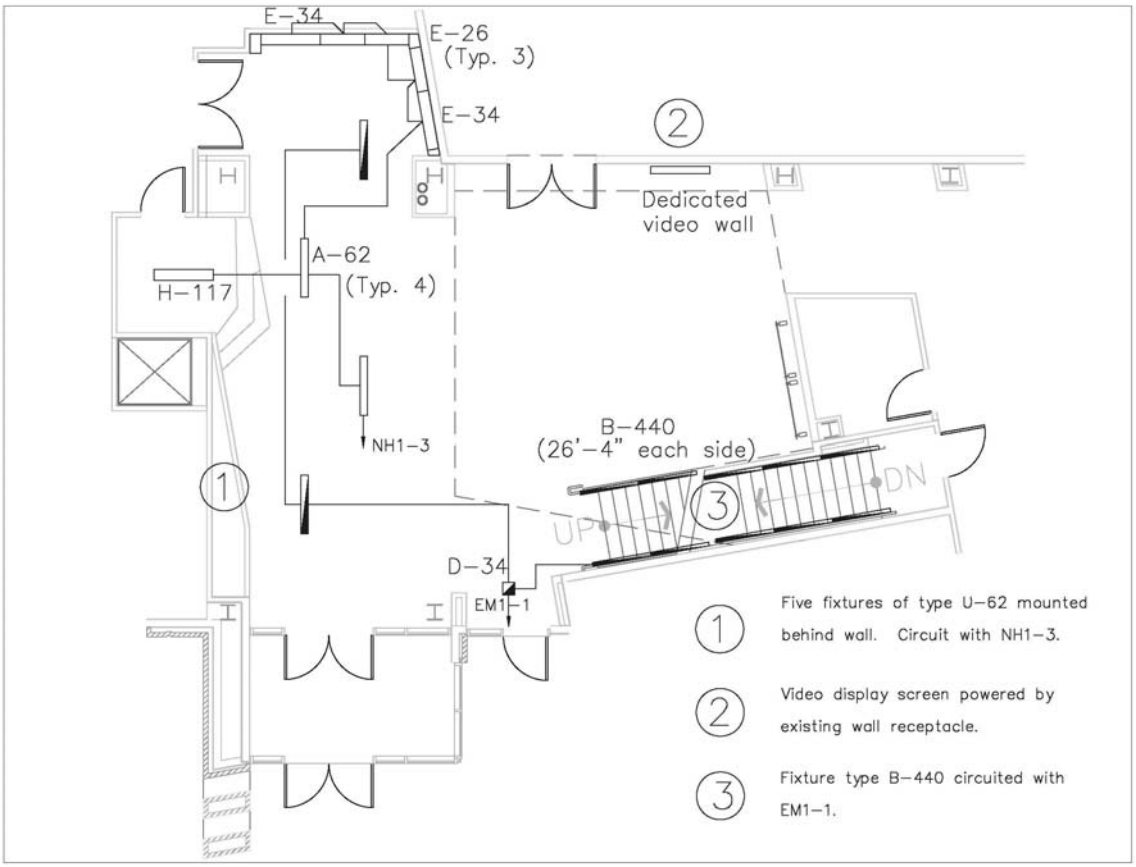


Figure 5 – Atrium – First Floor Lighting Layout and Circuiting

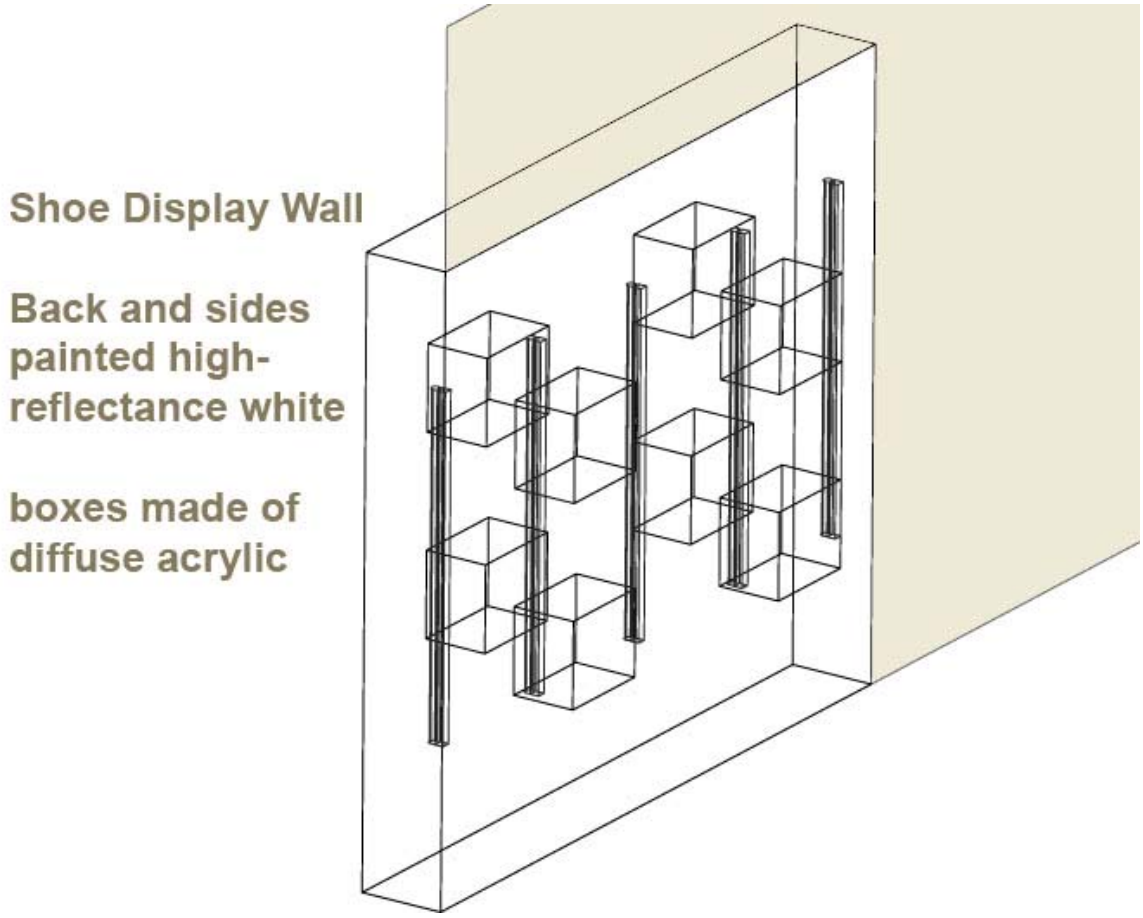


Figure 6 – Cutaway view of the Display Wall

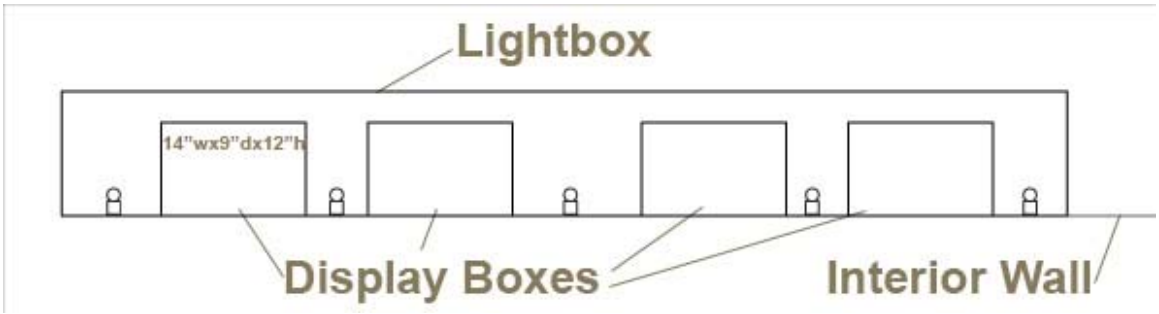


Figure 7 – Top view of the Display Wall

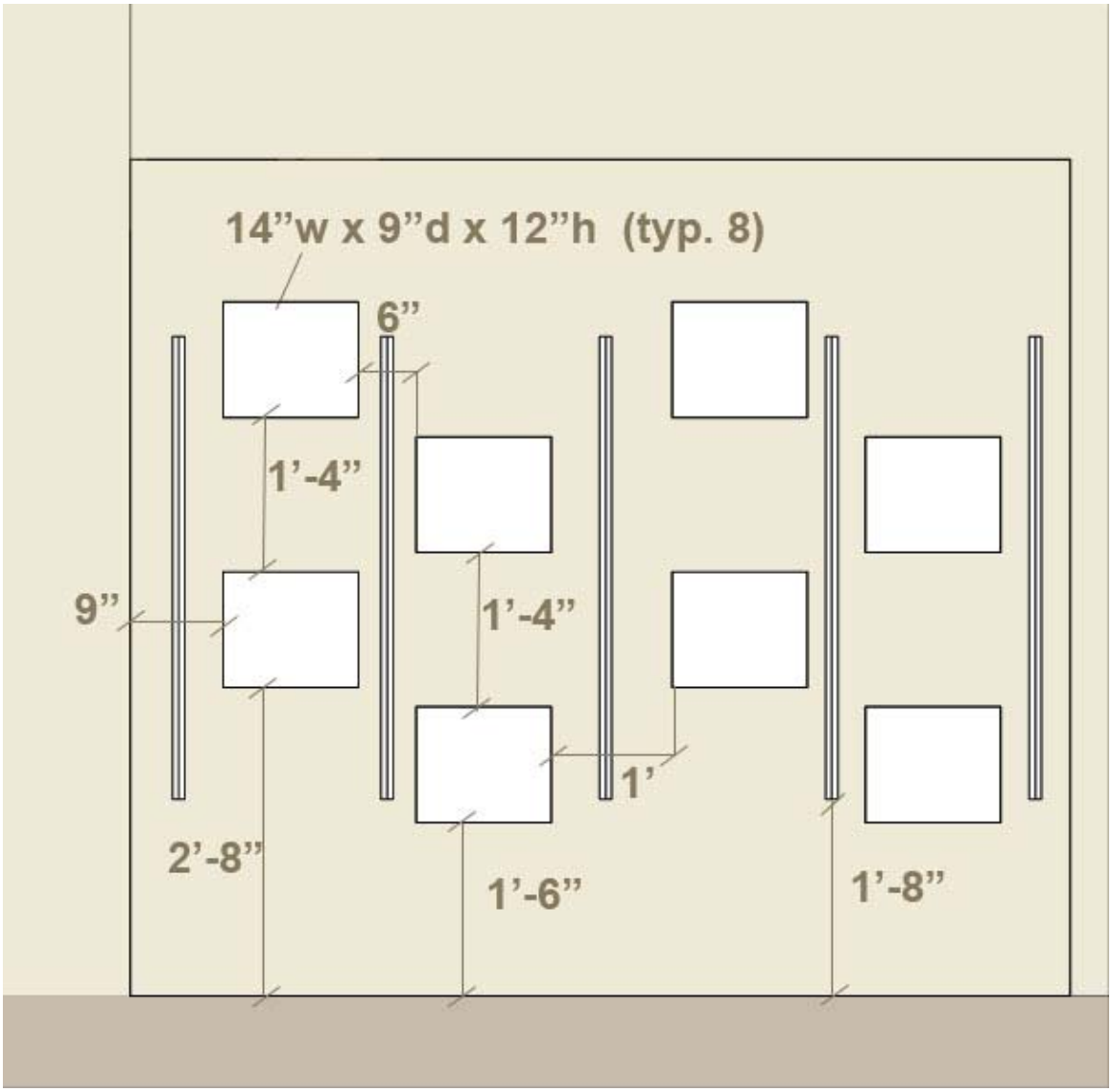


Figure 8 – Front transparent view of the Display Wall

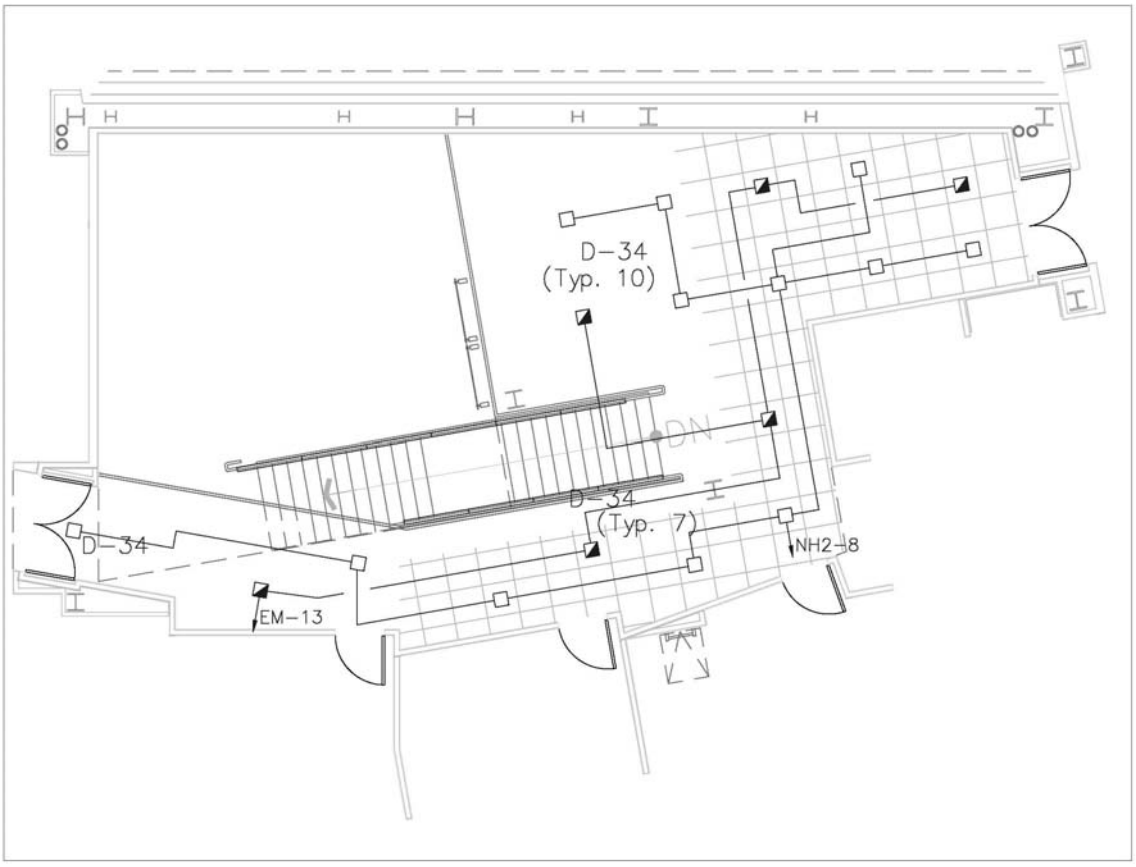


Figure 9 – Atrium – Second Floor Lighting Layout and Circuiting

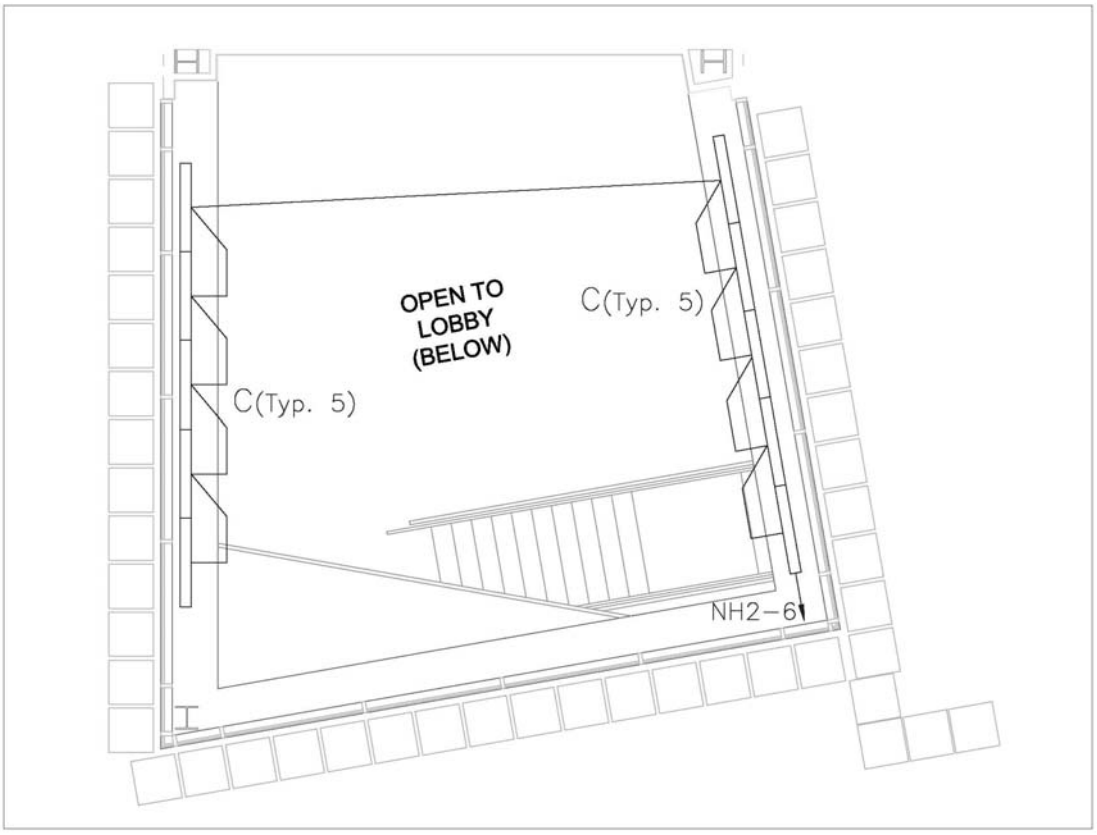


Figure 10 – Atrium – Clerestory Lighting Layout and Circuiting

The clerestory lighting will be mounted on a ledge at the window height. Maintenance will be easy to perform from the roof by accessing the luminaires from the windows. This lighting is generally for aesthetics at night to light the ceiling to prevent a cavernous feeling in the atrium. It will be switched on and off by a time clock, and controlled by a photosensor during the day. The photosensor for the atrium space will be mounted at the clerestory looking out of the window.

The lobby grid in the figure below shows an average illuminance of 15.95 fc, with a maximum/minimum ratio of 3.25:1. This area is uniformly illuminated and meets IESNA recommended value of 10 fc. The atrium space also meets this criterion, with an average illuminance of 11.25 fc and a max/min ratio of 1.58:1.

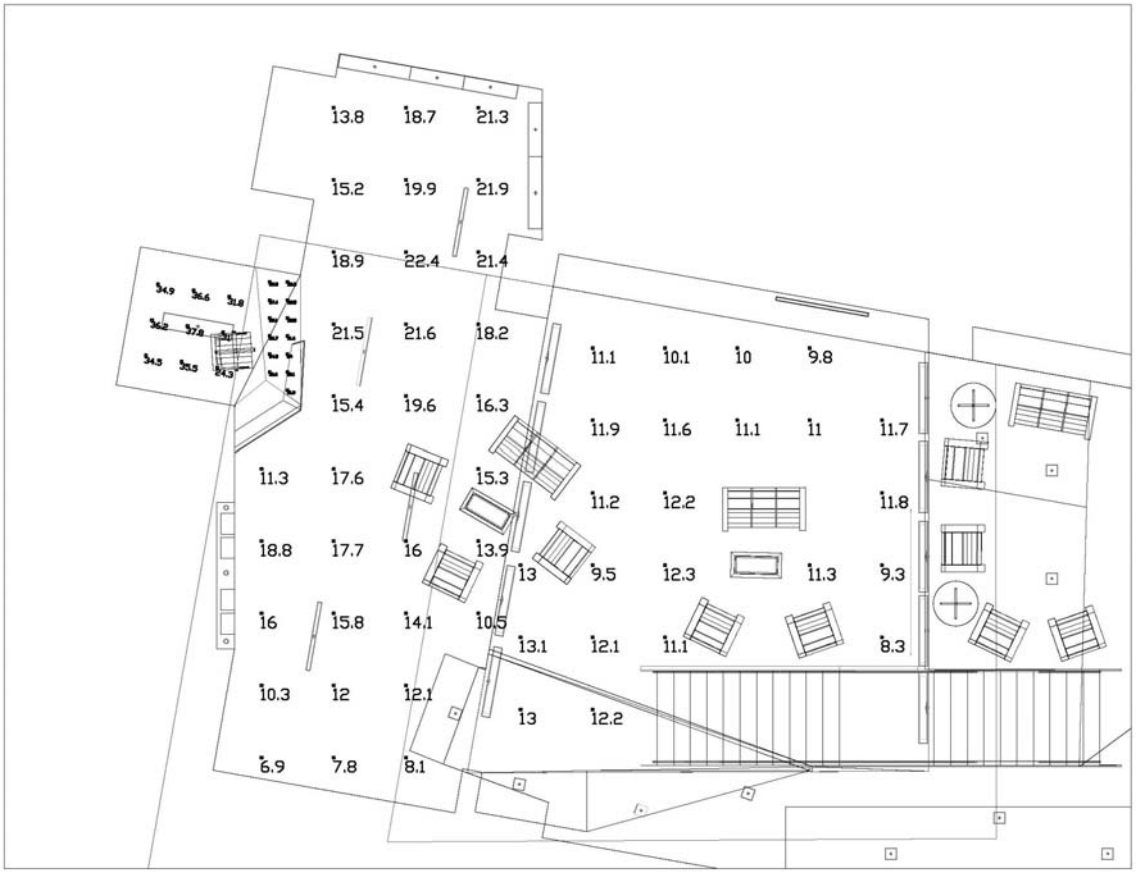


Figure 11 – Atrium Floor Illuminance (fc) – Electric Light

The 11.25 fc average on the floor of the atrium comes from the 10 54W T5HO elliptical luminaires washing the ceiling. This calculation grid, which is approximately 26' off of the floor, shows an average of 37.76 fc, with a max/min ratio of 2.16:1 which is well in range of the IESNA recommended ratio of 3:1.

Figure 12 – Atrium Ceiling Illuminance (fc) – Electric Light

The recessed direct/indirect fixture provides an even illumination on the work plane. The average illuminance on the desk is 31.18 fc with a max/min ratio of 2.25:1.

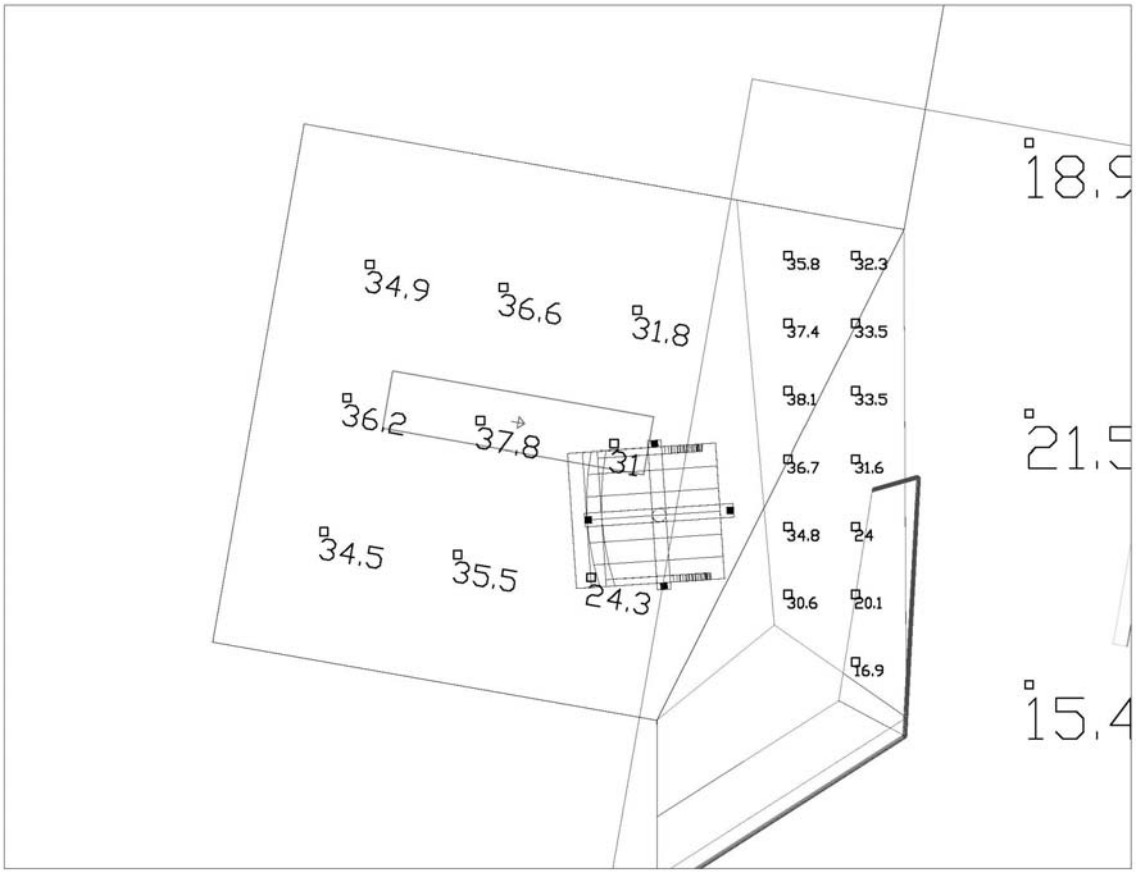


Figure 13 – Receptionist's Office Floor and Desk Illuminance (fc) – Electric Light

Electric lighting alone provides16.56 fc averaged over the corridor and the lounge. The lounge lighting is a bit higher to provide for reading on an employee's break.

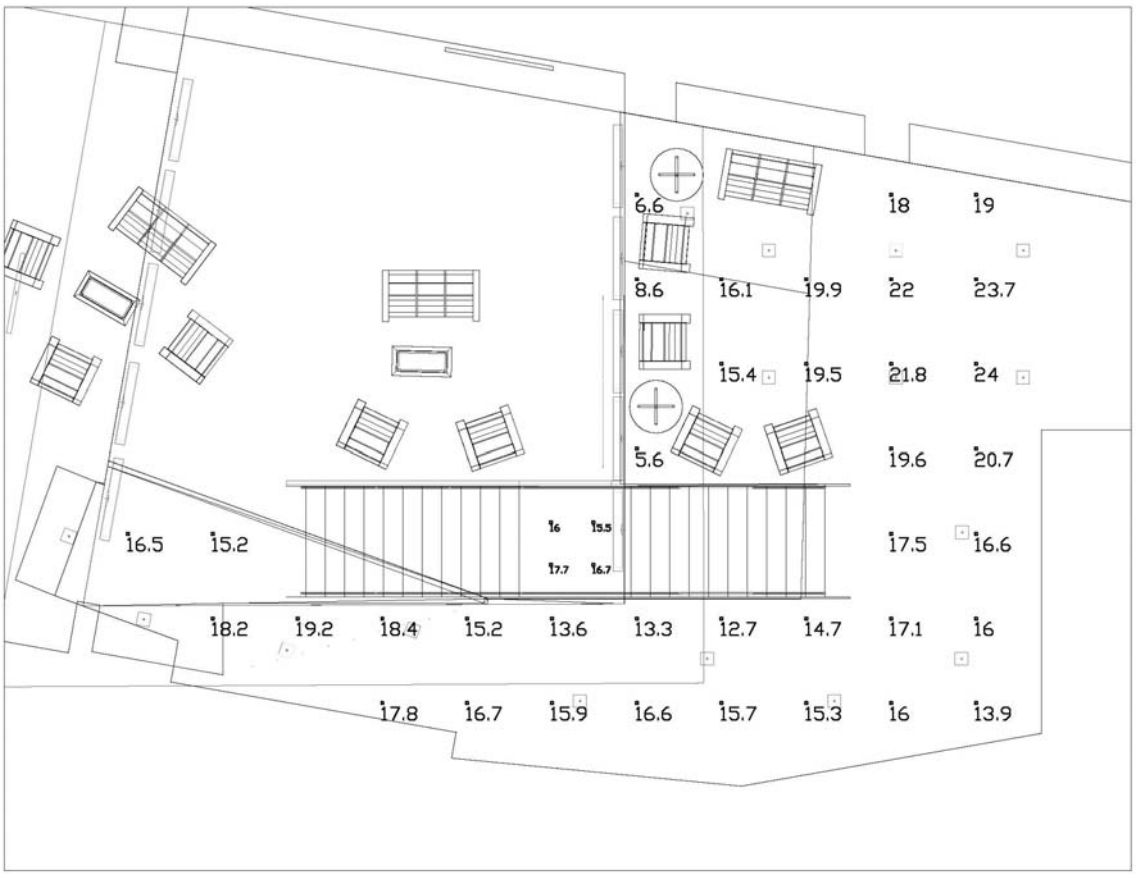


Figure 14 – Second Level Floor Illuminance (fc) – Electric Light

The LED source integrated into the handrail of the stairway provides a fairly uniform illumination on the stairs. For simplicity's sake, the grid was placed on the landing, but similar levels can be found along the entire length of the stairway. The average from this grid is 16.48 fc.

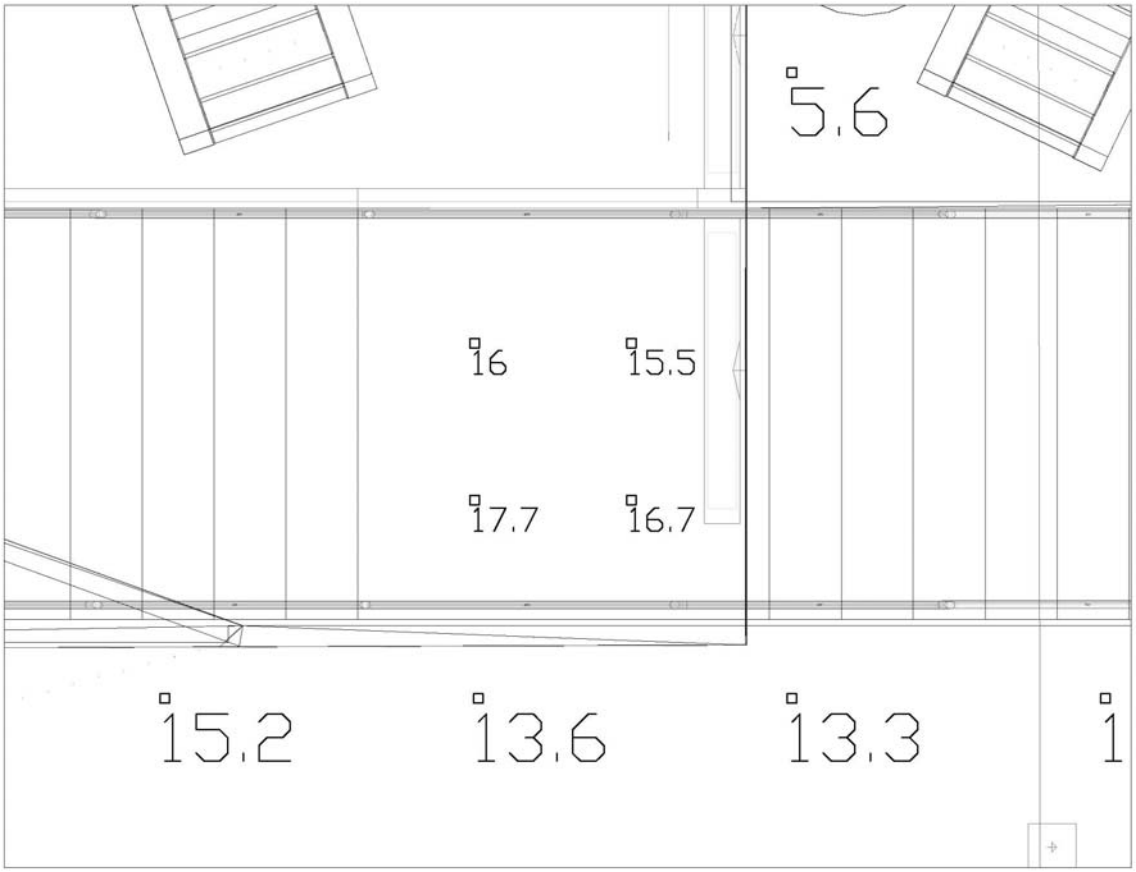


Figure 15 – Stair Illuminance (fc) – Electric Light

On a clear day, this space is illuminated quite sufficiently by natural light. This grid is strictly daylight; electric light was not considered in these calculations. The 3000+ fc reading along the north wall is a result of direct sun penetrating the space. The average illuminance on the floor of the atrium is 379.9 fc, while it is 42.56 on the lobby floor.

Figure 16 – Atrium Floor Illuminance (fc) – Daylight, Clear Sky, March 21st 12pm

For the second floor, the daylight in this condition provides plenty of light to read by when sitting by the edge; since the daylighting does not reach the edge of the lounge, the lighting in this space will likely be on more than the lighting in the other spaces in the atrium. The average level was 54.64 fc.

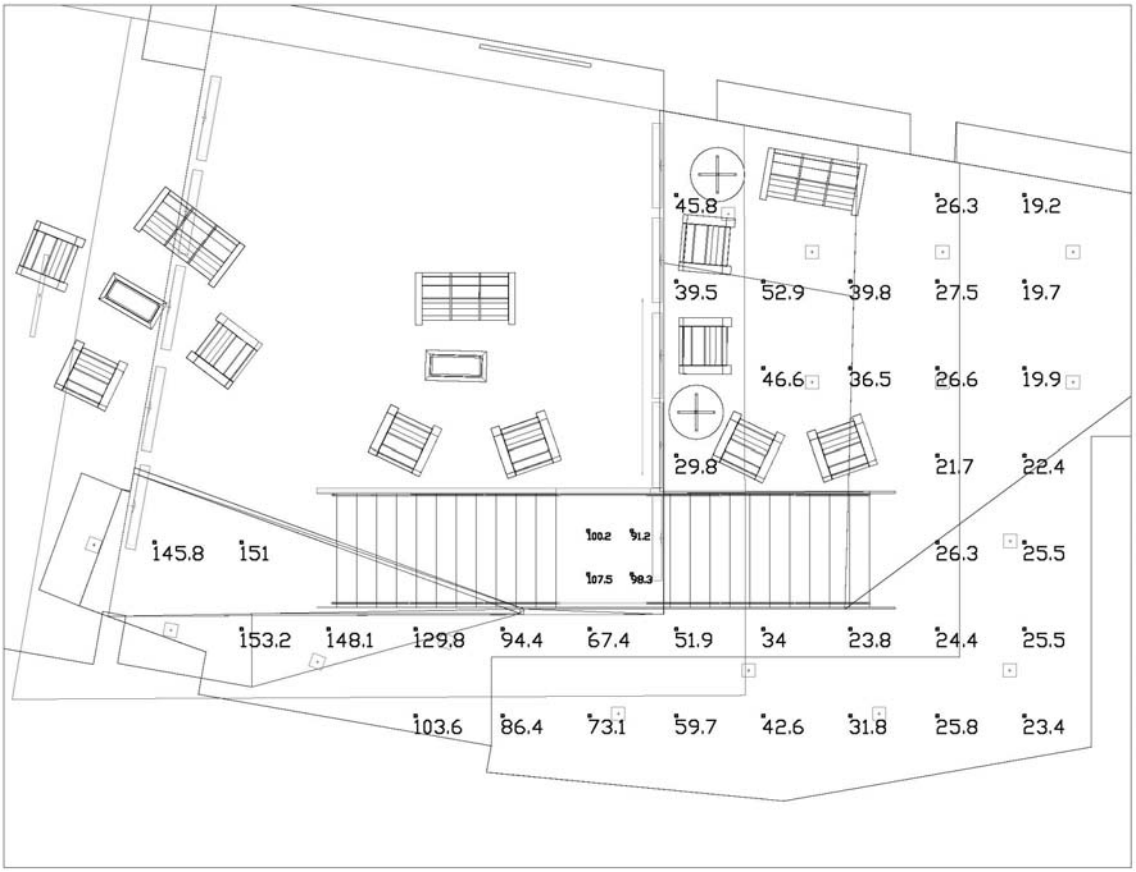


Figure 17 – Second Level Floor Illumination (fc) – Daylight, Clear Sky, March 21st 12pm

Renderings

Figure 18 – Atrium Rendering – Daylight and Electric Light, Clear Sky, March 21st 12pm

Figure 19 – Atrium Rendering – Daylight, Clear Sky, March 21st 12pm

Figure 20 – Atrium – Second Floor Fold-Away Section

Figure 21 – Atrium – First Floor Fold-Away Section

Figure 22 – Atrium, View from Reception Desk – Electric Light

Figure 23 – Atrium Cutaway Section – Electric Light

Lighting Control Plan

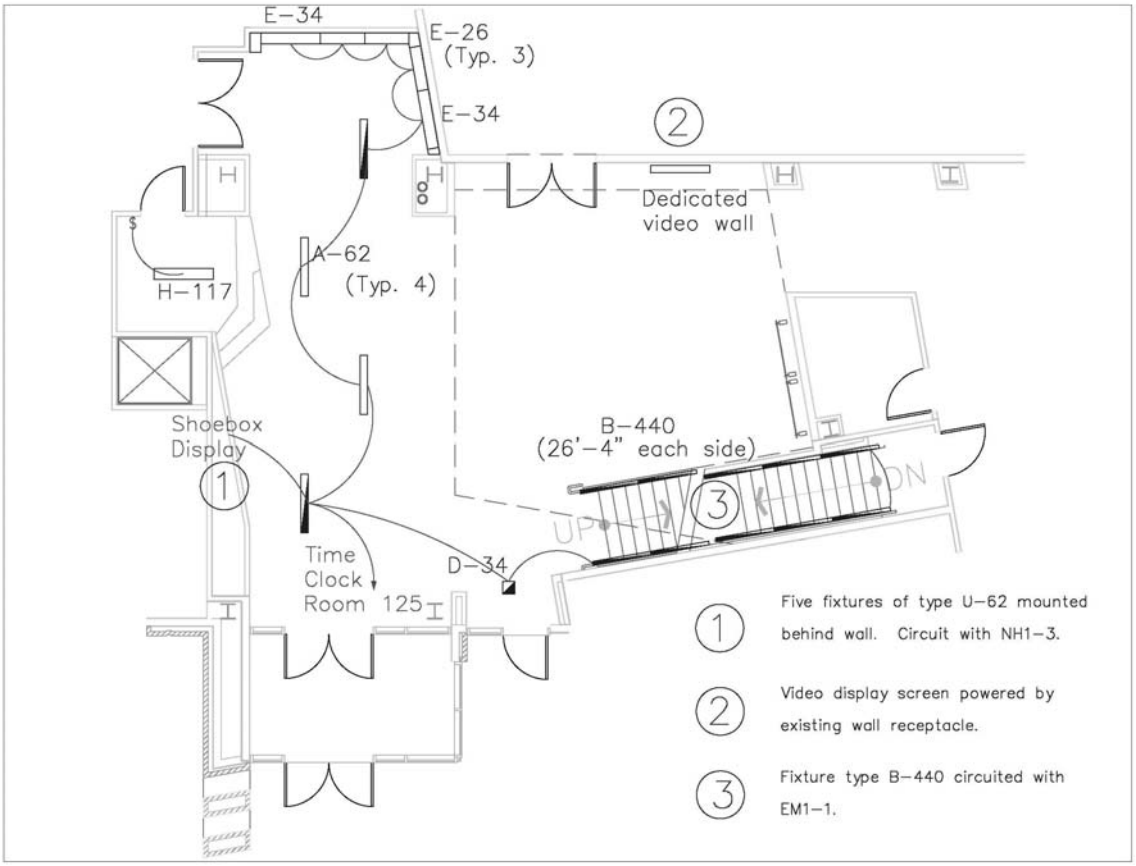


Figure 24 – Atrium First Floor Control Plan

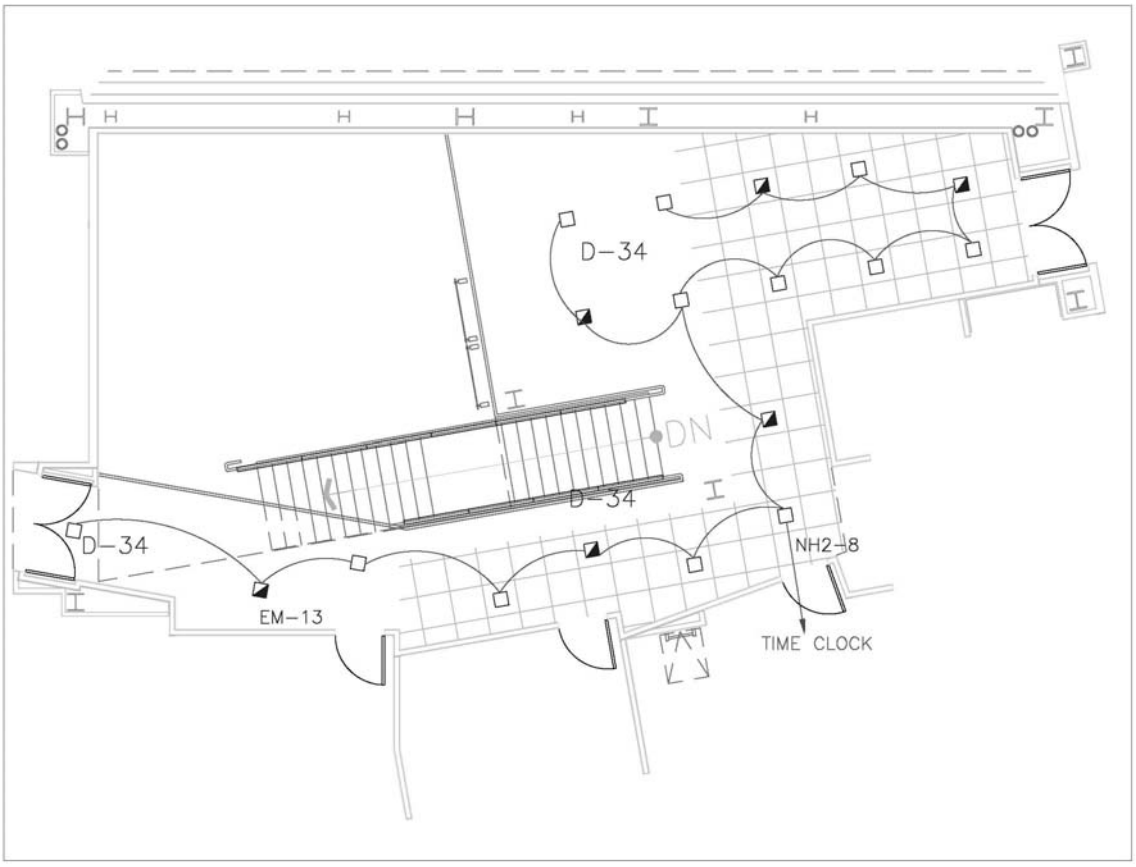


Figure 25 – Atrium Second Floor Control Plan

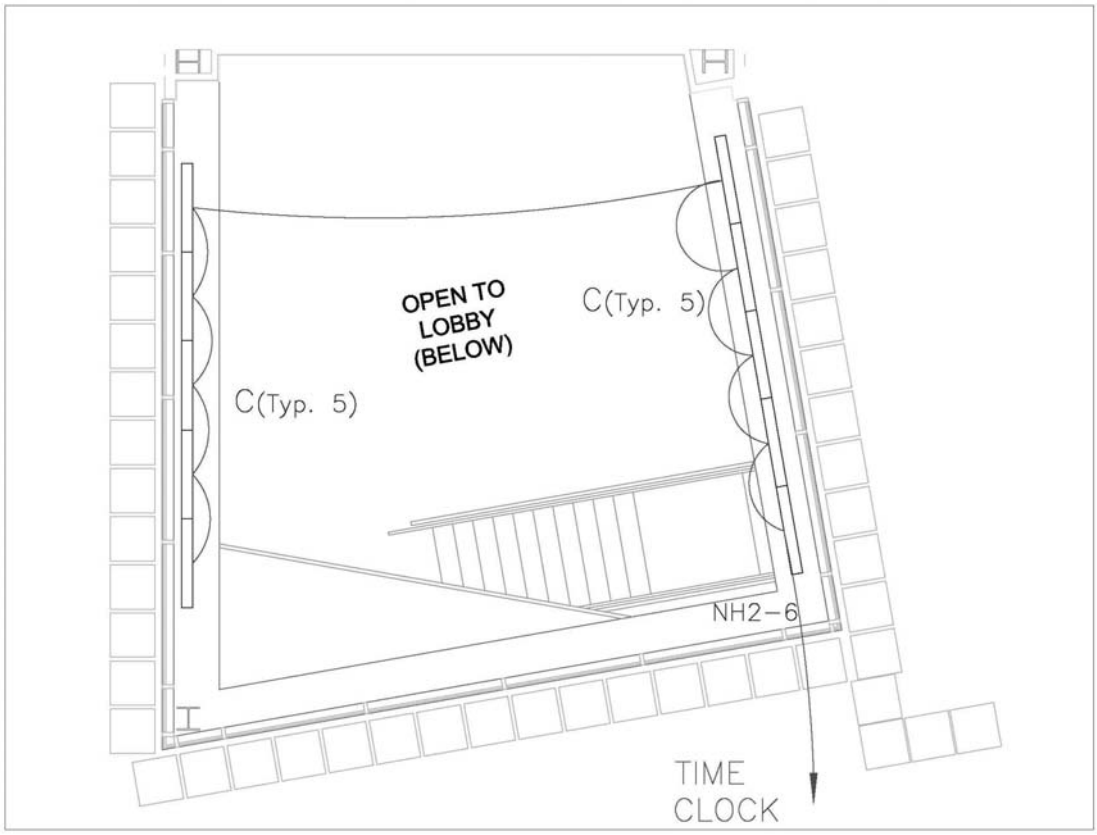


Figure 26 – Atrium Clerestory Control Plan

Summary

The design of this space, while the power density is relatively high, will not consume much energy at all due to daylight harvesting. The main focus of this space, the product display wall, will be the most luminous surface and therefore draw your attention. It advertises the Dansko, Inc. name and helps to push the products, while blending in well with the architecture and subconsciously leading your mind to your feet with the rhythmic placement of the luminaires in the ceiling mimicking footsteps. The entry atrium makes a great first impression for patrons entering the Dansko corporate headquarters.

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Open Office

The open office takes up a good sized portion of the second floor at around 7404 square feet. Comprising the makeup of this room are a marketing collaboration room, a kitchenette, five partitioned offices, a central pin up space, and open office area around the perimeter. Conditioned air is supplied to the space via an under-floor air distribution system, leaving the exposed structure as the ceiling. The most important consideration for this space is providing a glare-free work environment that incorporates the energy saving and health benefits of providing natural daylight to compliment electric lighting.

Materials

Location: Walls of Open Office and Marketing Room

Material: Benjamin Moore Color Preview, Filtered Sunlight
Reflectance: 83%

Location: Walls of Private Offices

Material: Benjamin Moore Color Preview, Monterey White
Reflectance: 80%

Location: Doors of Open Office

Material: Benjamin Moore Color Preview, Straw
Reflectance: 74%

Location: Floor of Open Office and Marketing

Material: Interface Flooring System
Pattern: Psychedelic
Color: Flash Black
Reflectance: 33%

Location: Floor of Private Offices

Material: Interface Flooring System
Pattern: Veneer
Color: Oak
Reflectance: 27%

Design Criteria

- *Appearance of Space and Luminaires*
  This space is entirely open and easily viewed from all corners of the room. A luminaire should be chosen that will not seem overpowering in a large open space. Linear fixtures work well for this application. Some movable, directional lights may also be used, such as track lighting to highlight the presentation boards.

- *Color Appearance*
  Since this is the corporate headquarters of a shoe manufacturer, providing lighting that will render proper colors from fabrics and other materials is very important. Using a high CRI lamp will ensure that colors appear true.

- *Daylighting Integration and Control*
  This space features large windows measuring 8'-6" high by 12' wide to allow the maximum amount of daylight and natural views in the space, staying true to the owner's wishes of providing a healthy working environment. Taking advantage of this daylight is necessary to conserve energy by dimming or switching zones of electric lighting.

- *Light Distribution on Task Plane (Uniformity)*
  Being an open office plan, there is much opportunity for the owner to rearrange furniture at their discretion, although there is a prescribed furniture layout. Therefore, it is necessary to provide a uniformly lit work plane to accommodate any arrangement of office furniture.

- *Modeling of Faces or Objects*
  This is most important in the marketing collaboration room, where advertising materials will be on display and will need to be properly addressed with the lighting system.

- *Horizontal Illuminance*
  General Office: 30 fc
  Kitchenette: 30 fc

- *Vertical Illuminance*
  General Office: 5 fc
  White Boards and Pin-up Space: 30 fc
  Kitchenette: 10 fc

Lighting Design Solution

The design for the open office relied heavily on the layout of the furniture. The exposed structure ceiling was hidden by a lay-in ceiling with a higher reflectance value. In the attempt to maximize the capabilities of this ceiling that was included in this space, an indirect fixture was chosen for use. Since the ceiling sloped towards the middle however, making the ceiling height at this location close to 8', it became impractical to maintain a suspended luminaire throughout the space. Therefore a different solution had to be found; utilize the effects of the high reflectance ceiling by using an indirect distribution but restrict the use of pendant mounted luminaires. This was done by integrating a normally suspended fixture into the backs of the workstations that line the walls in the open office. These fixtures were also placed atop of the shelving units along the north wall to provide ambient light on the north half of the office. Above the tables, where more light was needed, a linear fluorescent fixture was recessed into the ceiling. This fixture provided sufficient light to comply with the IESNA Lighting Handbook recommendation of 30 fc to read by. Around the perimeter on the north side of the building, adjustable MR-16s were used to illuminate the continuous waist-height counter that ran along the windows. This same MR-16 fixture was used in the central pin up space with a higher specified wattage. This provided the appropriate vertical illumination levels to highlight the sketches and drawings that will be hung up for display on the walls in the pin up space. Listed below is the evaluation of the redesign for the open office.

Equipment

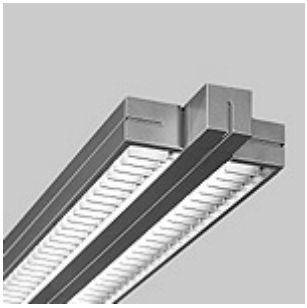
Open Office - Luminaire Schedule

Type	Luminaire Manufacturer and Catalog Number	Description	Lamp	Ballast Manufacturer and Catalog Number	Ballast Watts
J-117	LEDALITE 891-3-H02-E-N-4-1-2-E-W	Indirect 2 lamp T5HO with 95.3% Efficiency	(2) 54W T5HO	Lutron Hi-lume FDB-T554-277-2	117
K-35	LIGHTOLIER F7-3-7-X-WH-9-2-X	Adjustable MR-16 for use with Armstrong Techzone Ceiling System	35W MR16 40D		
L-117	LIGHTOLIER F7-3-4-2-WH-X-2-4-TR	2 lamp T5HO louvered slotlight for use with armstrong techzone ceiling. Top reflector component for 87% downlight	(2) 54W T5	Lutron Hi-lume FDB-T554-277-2	117
M-62	LIGHTOLIER F7-3-4-1-WH-X-2-4-TR	2 lamp T5 louvered slotlight for use with armstrong techzone ceiling. Top reflector component for 87% downlight	(2) 28W T5	Lutron Eco-10 ECO-T528-277-2	62
N-36	LITHONIA UC-42-277	1-3/16" deep undercabinet light with fluorescent lamping.	(2) 14W T5	Advance ICN-2M32-MC@277	36
R-75	LIGHTOLIER F7-3-7-X-WH-9-2-X	Adjustable MR-16 for use with Armstrong Techzone Ceiling System	75W MR16 40		

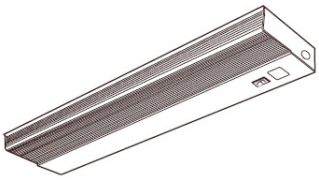
Figure 27 – Open Office Luminaire Schedule

Fixture type J: This 100% indirect fixture is integrated into the office furniture. It was chosen because of its uniform distribution.

Fixture type K and R: This adjustable MR-16 is used in the pin up space and along the north wall. It provides the functionality to easily re-aim depending on the item on display. It is thin enough that it fits into the Armstrong Techzone ceiling technical zone.



Fixture type L and M: This fixture was chosen because it matches fixture type K and R, and is used with a reflector that produces 100% downlight. It is recessed into the ceiling to provide additional lighting over tables and work surfaces, where the ceiling height does not allow for an indirect fixture. It also fits into the technical zone of the Armstrong Ceiling Techzone.



Fixture type N: This lensed fixture is mounted under the upper section of cabinets in the kitchenette. The full wrap-around lens prevents bulb fragments from falling onto the counter surface in the event of lamp breakage.

Figure 28 – Open Office Luminaire Images

Light Loss Factors

	Type	LLD	LDD	RSDD	BF	LLF
Open Office	J	0.93	0.85	0.88	1	0.70
	K	1.00	0.89	0.88	1	0.78
	L	0.93	0.89	0.88	1	0.73
	M	0.93	0.89	0.88	1.02	0.74
	N	0.92	0.88	0.88	1	0.71
	R	1.00	0.89	0.88	1	0.78

Figure 29 – Open Office Light Loss Factors

Light Loss factors were calculated using a 12-month cleaning cycle. The open office was considered a clean environment. Lamp lumen depreciation was calculated by

dividing the mean lumen output by the initial lumen output, given by the lamp manufacturer. Ballasts were chosen to have the highest ballast factor, as to provide the highest light output with the lowest power input.

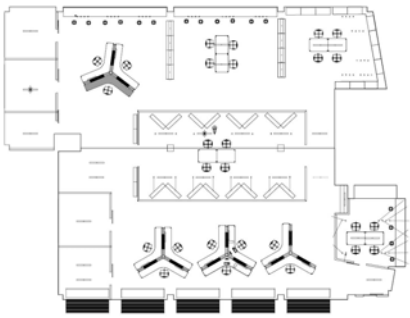
Power Densities

Open Office	Area (sf)	Watts	ASHRAE Base Allowance	Additional Allowance	Applied Area (sf)	Description	ASHRAE Total Allowable Watts	ASHRAE Total Allowable LPD	LPD (W/sf)
	7220	7404	1.1				7942	1.1	1.03

Figure 30 – Open Office Power Density

Layout

Figure 31 – Open Office Lighting Layout and Circuiting



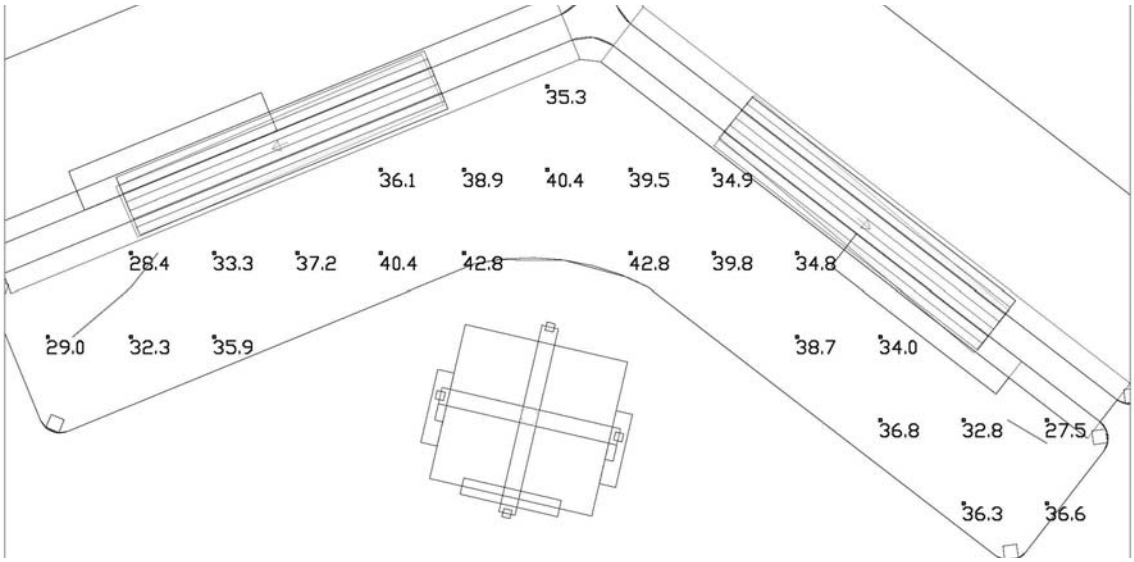
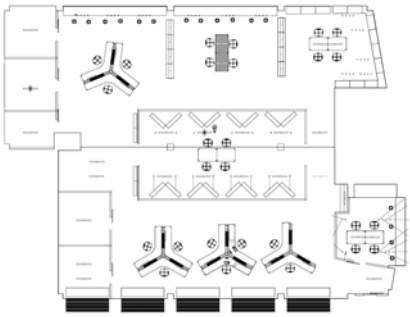


Figure 32 – Open Office – Workstation Work Plane Illuminance (fc) – Electric Light

This workstation faces away from the northern windows, so it sees the least amount of natural daylight out of any of the desks. The average level on the work plane is 36.02 fc



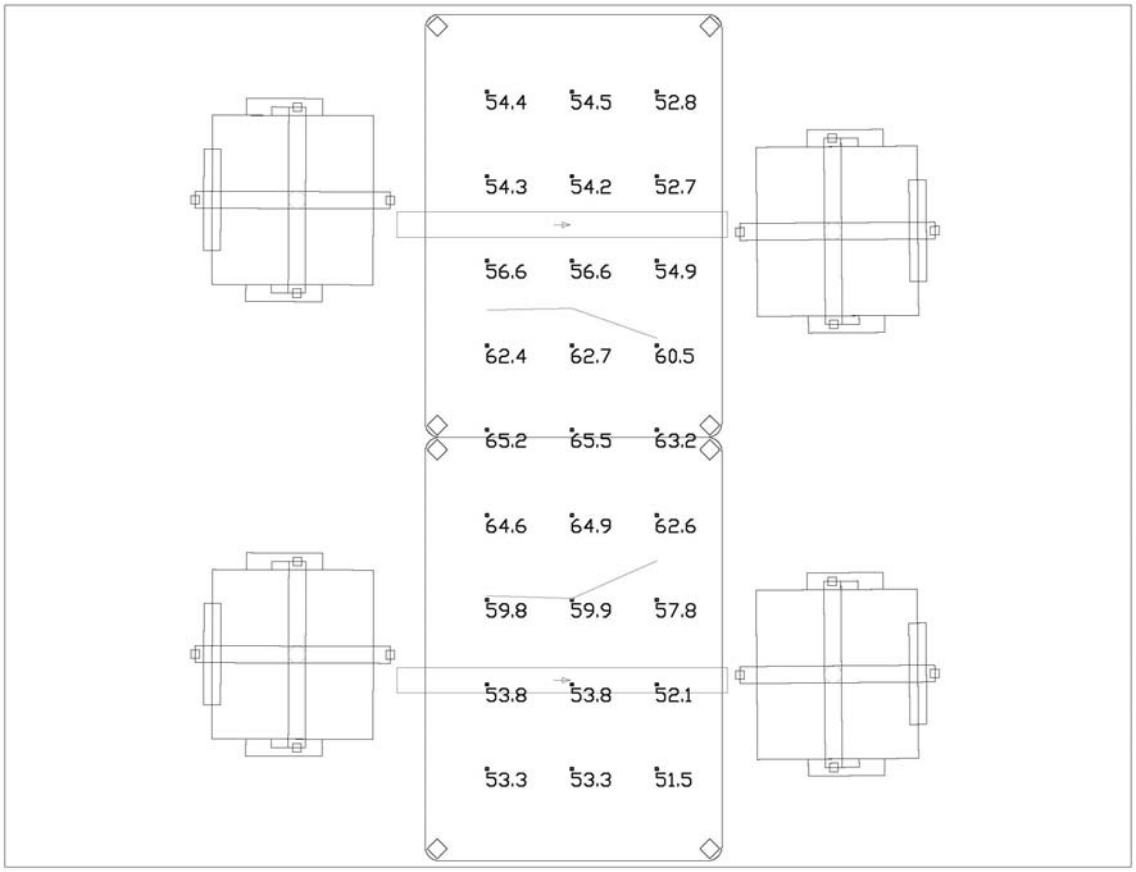


Figure 33 – Open Office – Table Illuminance (fc), Electric Light

The average illuminance on the tables on the north side of the office is 57.70 fc.

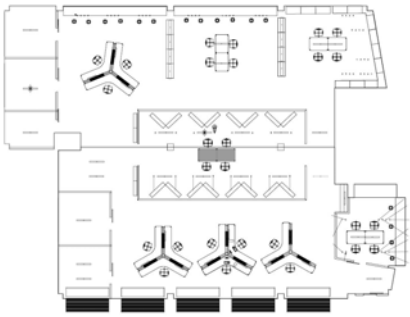
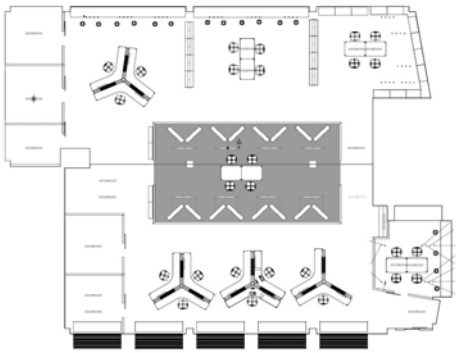


Figure 34 – Open Office – Pin Up Table

The average illuminance value on the pin up table is 38.97 fc.



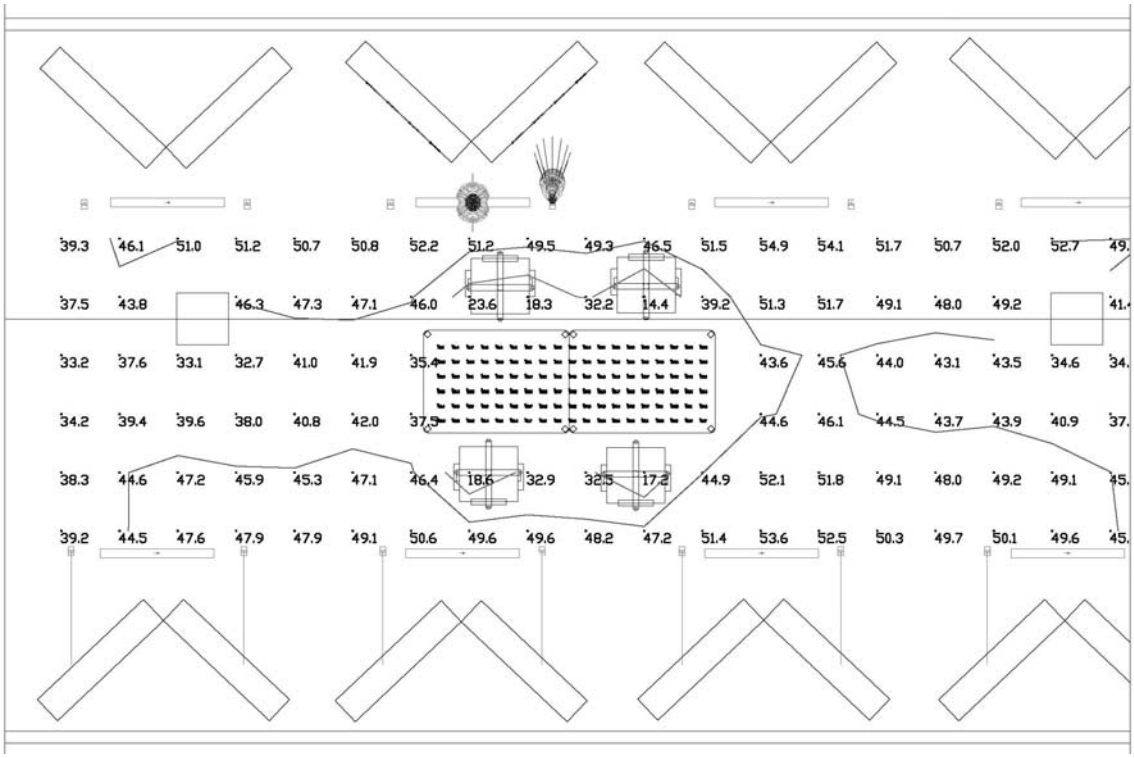
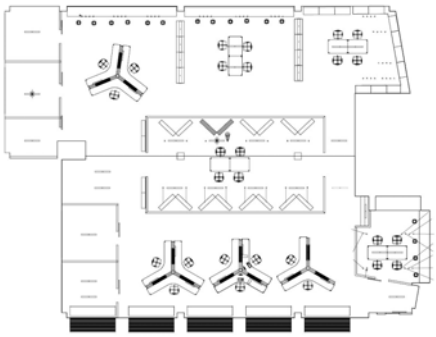


Figure 35 – Open Office – Pin Up Floor

The average illuminance on the floor of the pin up space is 43.72 fc.



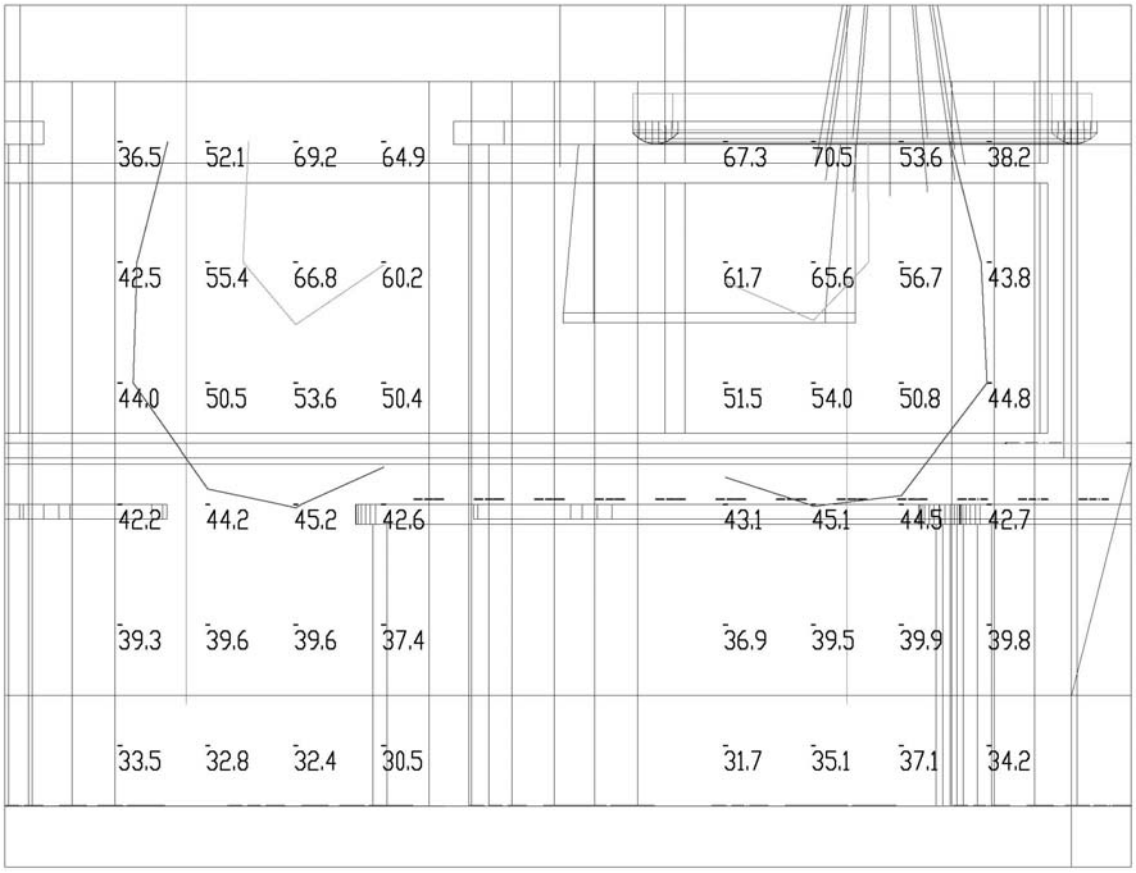
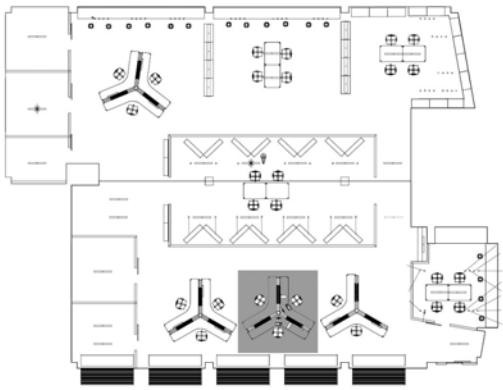


Figure 36 – Open Office – Vertical Pin Up Space

The average illuminance across both vertical surfaces is 46.5 fc.



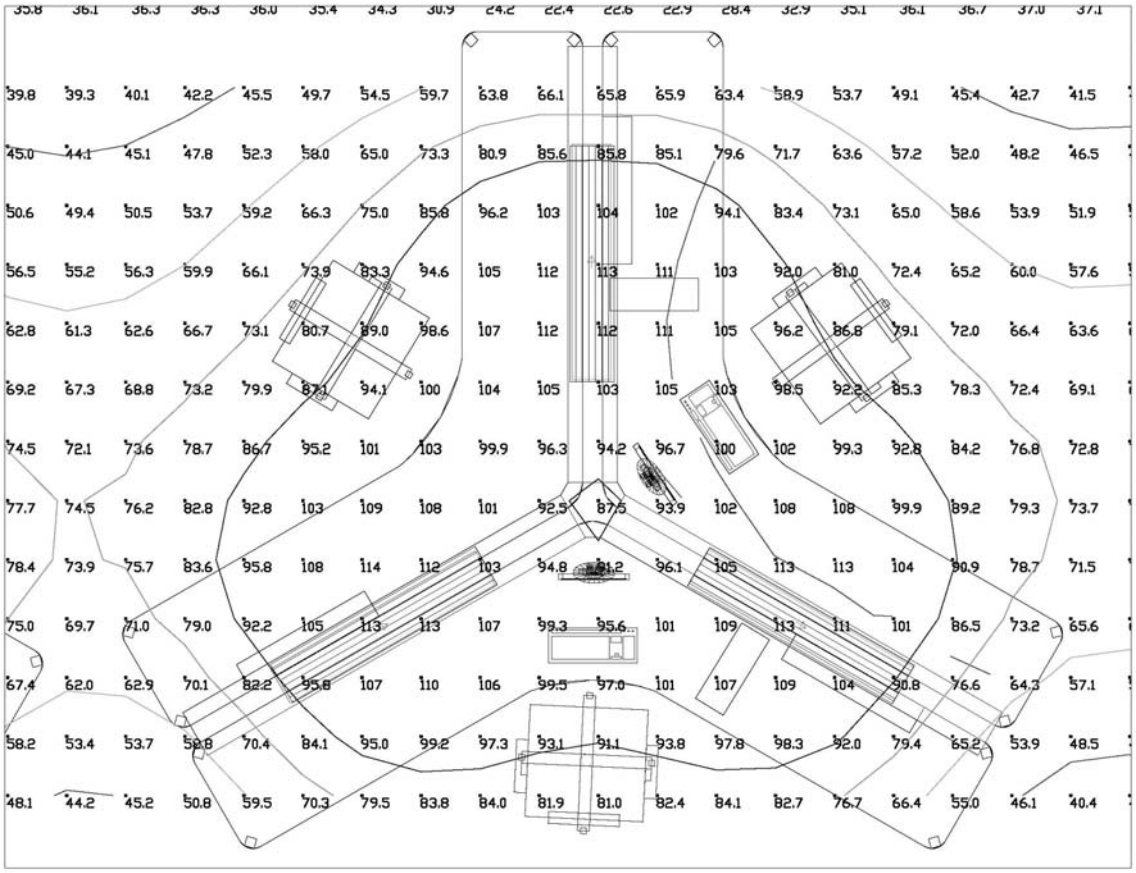


Figure 37 – Open Office – Workstation Ceiling Illuminance

The average illuminance on the ceiling above the middle workstation on the south side was 78.03 fc. The maximum to minimum value ratio is 5.42:1.

Renderings

Figure 38 – Open Office Western View – Electric LIght

Figure 39 - Open Office Workstation View – Electric Light

Figure 40 – Open Office Pin Up Space – Electric Light

Figure 41 – Open Office Northeastern View – Electric Light

Figure 42 – Open Office Northern View – Electric Light

Figure 43 – Open Office Marketing Room – Electric Light

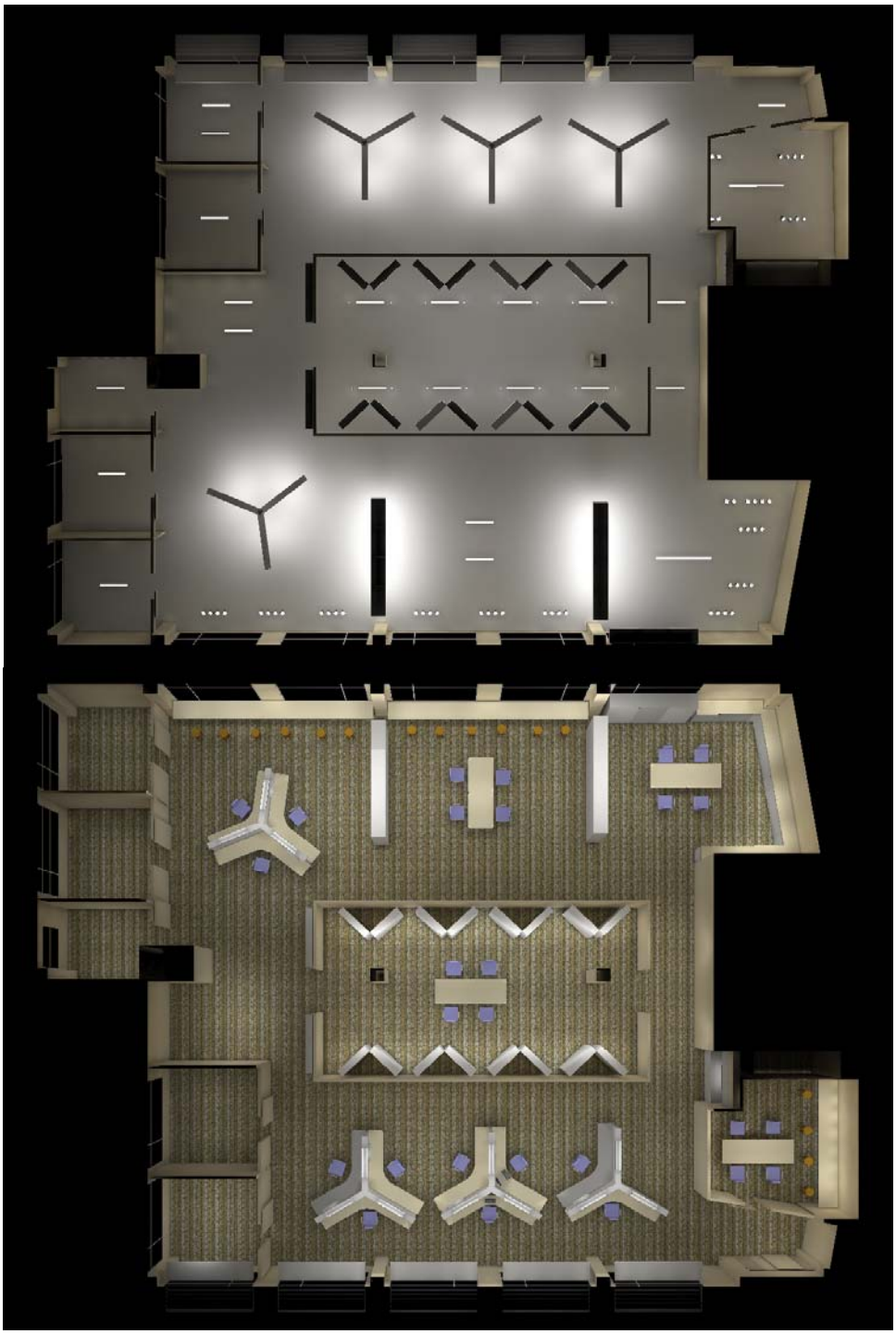


Figure 44 – Open Office Fold-Away Section – Electric Light

Figure 45 – Open Office, East/West Cutaway – Electric Light

Luminaire Control Plan

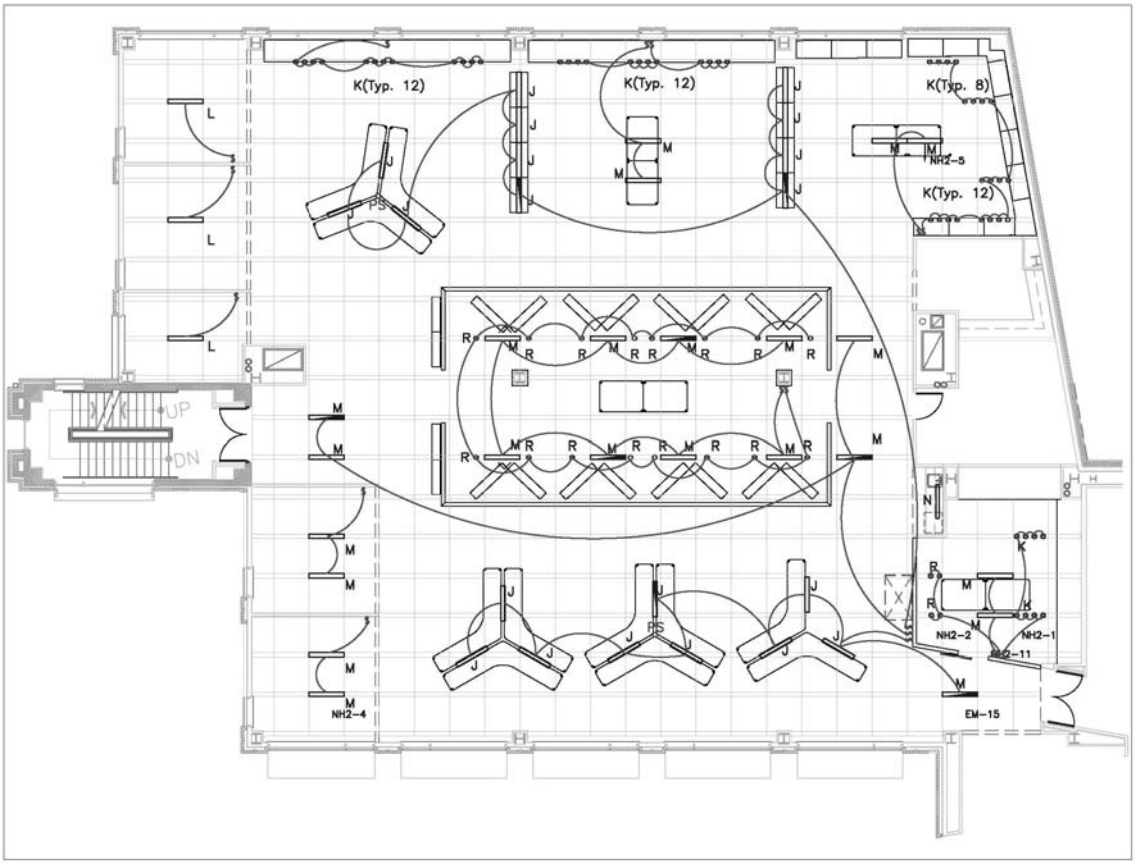


Figure 46 – Open Office Control Plan

There are two photosensors integrated into the workstations to control two different zones of indirect lighting, fixture type J; the north side and the south side. The other lighting is controlled by dimmers placed nearby the point of use for each system of luminaires.

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Lighting/Electrical Option
Dansko Phase III
West Grove, PA
Dr. Mistrick
April 12, 2007

Summary

The open office provided a great opportunity to design for the intended use. The furniture plan gave notice to what activities were taking place in this space and therefore dictated the lighting design. The MR-16s, used on both the countertops and pin-up space, provided directional lighting that was adjustable to account for almost any arrangement of materials on display. Dimming the indirect fixtures made it possible to maintain an appropriate light level on the task plane while maximizing energy savings. Giving control of different lighting systems via wall dimmers made it possible to have light where you need it, and easy to turn off when not in use. Integrating a lighting plan with a layout dictated by a unique ceiling grid posed a slight problem – having a location for a fixture directly above a work surface required that the work surface be moved slightly in a few cases. A ceiling of this nature is intended more for a space that moves furniture around often, but in this case it was used in a space where furniture will be stationary for a long period of time and therefore more precise mounting of fixtures was possible, helping to minimize using more fixtures to light every area evenly.

Showroom

This room plays a major part in the Dansko Corporation. On the walls will be displayed a collection of footwear that Dansko manufacturers. The center of the room will house a runway that will be used to hold fashion shows to showcase their products. Around the runway will be tables and chairs for the prospective distributors and various merchants. The spectators should be provided with enough light to read both handwritten and typed literature, and write down notes. The design of this space allows for 4 different scenes; general/display, conference, runway, and projection. A detailed explanation of each scene can be found on page 65.

Materials

Location: Walls of Showroom
Material: Paint
Manufacturer: Benjamin Moore Color Preview, Rainforest Dew
Reflectance: 78%

Location: Walls of Showroom
Material: Paint
Manufacturer: Benjamin Moore Color Preview, Cream Silk
Reflectance: 88%

Location: Walls of Showroom
Material: Paint
Manufacturer: Benjamin Moore Color Preview, Soft Fern
Reflectance: 60%

Location: Doors of Showroom
Material: Paint
Manufacturer: Benjamin Moore Color Preview, Filtered Sunlight
Reflectance: 83%

Location: Floor of Showroom, Field
Material: Carpet
Manufacturer: Interface Flooring System
Pattern: Cologne
Color: Cirrus
Reflectance: 25%

Location: Floor of Showroom, Border
Material: Carpet
Manufacturer: Interface Flooring System
Pattern: Menagerie
Color: Camel
Reflectance: 18%

Design Criteria

- *Appearance of Space and Luminaires*
  The space should be very attractive and high-end. The focus of this space is the product, so fixtures should not stand out or provide unnecessary spill light. Provide fixtures with integral cut-off attachments.

- *Color Appearance*
  Color appearance is very important in this space. The luminaires should render the materials as realistically as possible. Wall and floor surfaces should be a neutral color to provide a backdrop for the products on display.

- *Direct Glare*
  Luminaire angles should be addressed so that the audience is not blinded by the lights focused on the runway. Provide fixtures with integral cut-off attachments to ensure that direct view of the lamp is not possible.

- *Modeling of Faces or Objects*
  Great care should be taken to wash the entire model on the runway, from the moment they step onto the floor. Providing light from both sides as well as in front of the model will ensure that the face is evenly washed to eliminate unsightly shadows.

- *Source/Task/Eye Geometry*
  Luminaires should be placed in locations that will not cause the audience to see reflections in the runway.

- *System Control and Flexibility*
  The lighting system should be able to provide four different settings: Runway mode, display mode, conference mode, and presentation mode.

- *Horizontal Illuminance*
  Runway Mode:
  Runway: 50 fc
  Tables: 15-20 fc

  General/Display Mode:
  General Floor plane: 10 fc

  Conference Mode:
  Tables: 30 fc

  Projection Mode:
  Tables: 5 fc

- *Vertical Illuminance*

  Runway Mode:
  Runway: 30 fc

  General/Display Mode:
  Display walls: 30 fc

  Conference Mode:
  Tables: 10 fc
  Display walls: 10 fc

Lighting Design Solution

Equipment

Showroom - Luminaire Schedule

Type	Luminaire Manufacturer and Catalog Number	Description	Lamp	Ballast Manufacturer and Catalog Number	Ballast Watts
O-75	LIGHTOLIER 75330.023	Theater style halogen luminaire with barn door accessory. Mounts to Lytespan track.	75W PAR 30 10 DEG		
P-75	LIGHTOLIER 75330.023-75905.000-74820.000	Theater style halogen luminaire with barn door accessory. Mounts to Lytespan track.	75W PAR 30 25 DEG		
Q-117	LIGHTOLIER 75335.023	54W T5HO wallwash. Mounts to Lytespan track.	(2) 54W T5	Lutron Hi-lume FDB-T554-277-2	117
T-68	Kramer Lighting KL12-2X-32PLT-XB-CFF-S-277-B	Surface mounted downlight for emergency use only.	(2) 32W CFL	Lutron Compact SE FDB-T432-277-2-S	68

Figure 47 – Showroom Luminaire Schedule

Fixture type O and P: An incandescent source was chosen for the showroom for its high color rendering index. This particular fixture has integral barn doors that will help cut down on the glare and spill light. The barn doors were not modeled in the renderings, and therefore scallops will be present on the ceiling beams. It is used

Fixture type Q: This T5HO wallwash provides ample illumination for the display of Dansko shoes along the north wall of the showroom. A high CRI lamp will make the shoes appear true-to-color.

Fixture type T: Specified in black to match fixtures O, P, and Q, this two-lamp downlight provides ambient light levels as the first tier of the design of the showroom.

Figure 48 – Showroom Luminaire Images

Light Loss Factors

	Type	LLD	LDD	RSDD	BF	LLF
Showroom	O-75	1.00	0.89	0.97	1	0.86
	P-75	1.00	0.89	0.97	1	0.86
	Q-62	0.93	0.89	0.97	1	0.80
	T-68	0.92	0.89	0.97	0.98	0.78

Figure 49 – Showroom Light Loss Factors

Light Loss factors were calculated using a 12-month cleaning cycle. The open office was considered a clean environment. Lamp lumen depreciation was calculated by dividing the mean lumen output by the initial lumen output, given by the lamp manufacturer. Ballasts were chosen to have the highest ballast factor, as to provide the highest light output with the lowest power input.

Power Densities

Showroom	Area (sf)	Watts	ASHRAE Base Allowance	Additional Allowance	Applied Area (sf)	Description	ASHRAE Total Allowable Watts	ASHRAE Total Allowable LPD	LPD (W/sf)
	2730	7461	1.3	1.6	499	Display	4347.4	1.59	2.73

Figure 50 – Showroom Lighting Power Density

Layout

The showroom lighting is split between 120v and 277v. All runs of track are 120v, while the surface cans (fixture type T-68) run at 277v. This allows for fixture T-68 to be run from an emergency panelboard, which is supplied at 277v. All of the fixtures in this space are run through dimming panels, and controlled by a Lutron Grafik Eye 4000. An enlarged circuiting plan is shown on the next 3 pages.

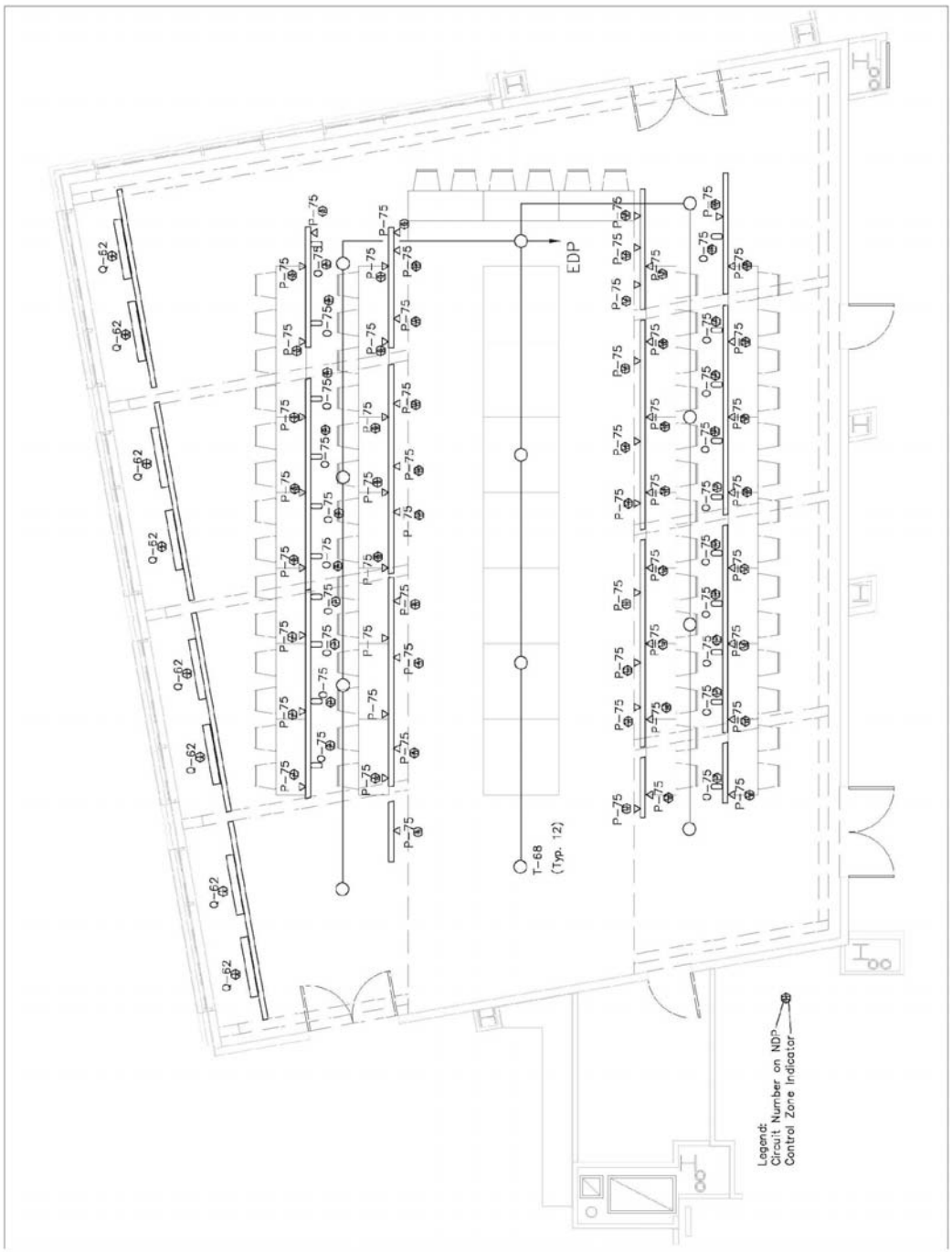

Figure 51 – Showroom Overall Lighting Plan

Figure 52 – Showroom – Lighting Plan Rows 3 and 4

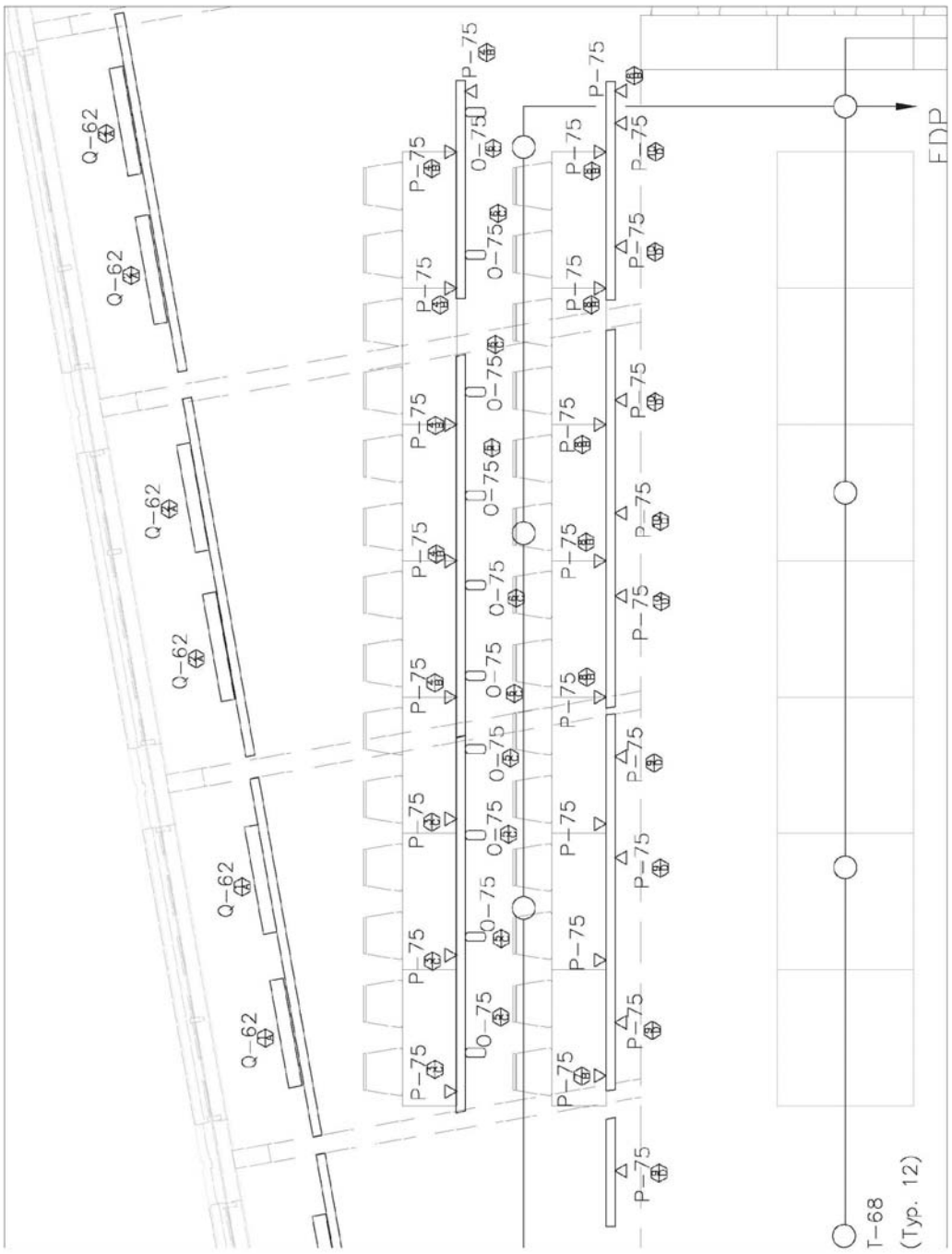

Figure 53 – Showroom – Lighting Plan Rows 1 and 2

Scene 1: General/Display

The goal of this scene is to highlight the display wall and provide enough illumination for the rest of the space for simple navigation. The intended light level for the display wall is 50 fc, and for the rest of the space 10 fc is desired. The calculated values are as follows:

- End Desk: 8.27 fc
- Shoes: 33.27 fc
- Desk Row 1: 21.79 fc
- Desk Row 2: 13.20 fc
- Desk Row 3: 9.15 fc
- Desk Row 4: 7.23 fc
- Floor Left: 14.31 fc
- Runway: 10.44 fc

Figure 54 – Runway under Normal Scene

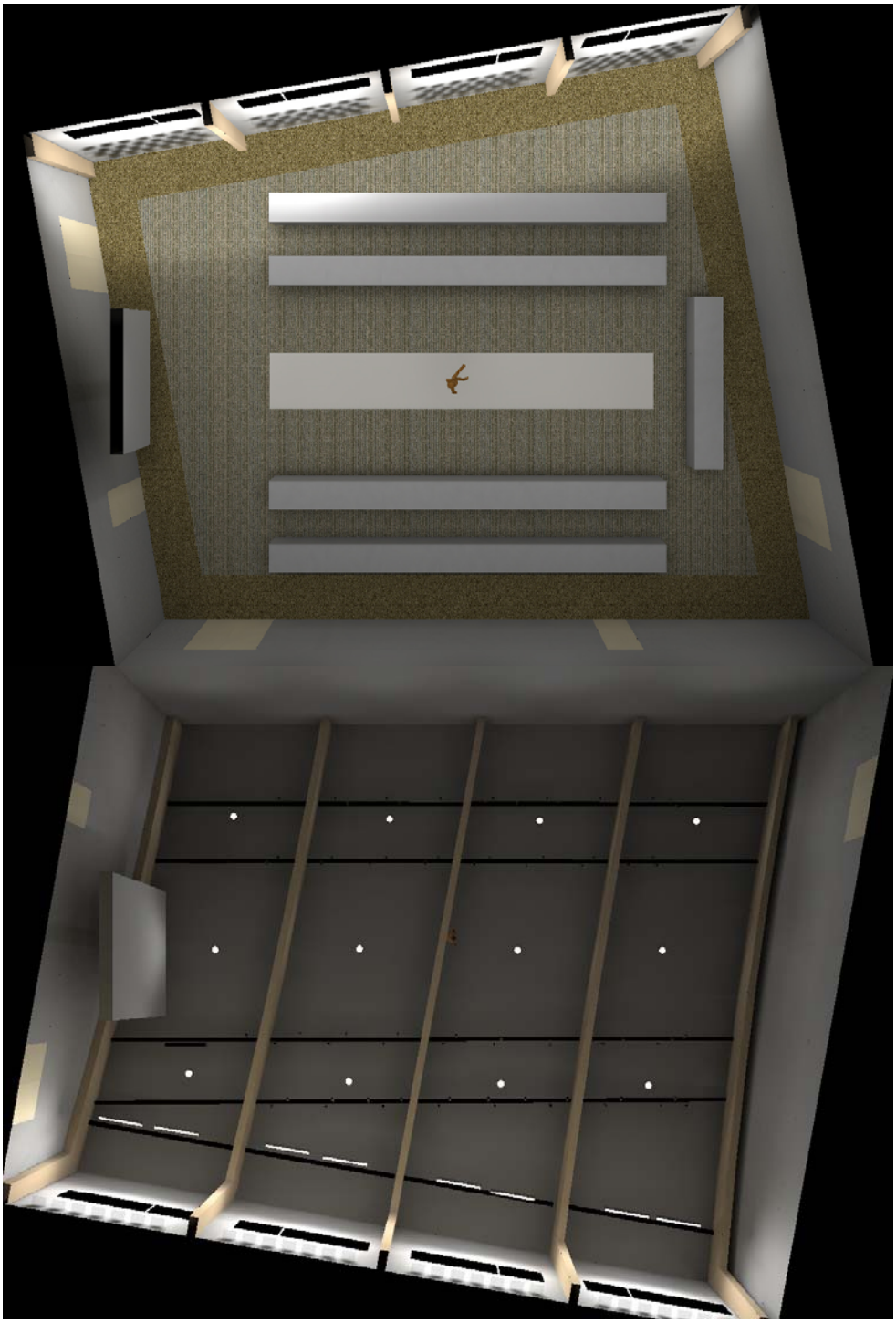

Figure 55 – Showroom – General/Display Conditions Fold-Away Section

Scene 2: Conference

Below is an overall grid layout as calculated in AGI. For enlarged calculation grids, please see Appendix E. From the design criteria listed earlier in this section, for conference mode the intended illumination levels were 30 fc for the tables. Since the grids were broken up into rows, the averages per row are given below.

- Desk Row 1: 34.08 fc
- Desk Row 2: 29.92 fc
- Desk Row 3: 25.71 fc
- Desk Row 4: 24.41 fc
- Desk End Row: 24.18 fc

The zones were dimmed at the following levels for the conference setting:

- Zone A: 50%
- Zone B: 100%
- Zone C: Switched Off
- Zone D: 30%
- Zone E: 100%

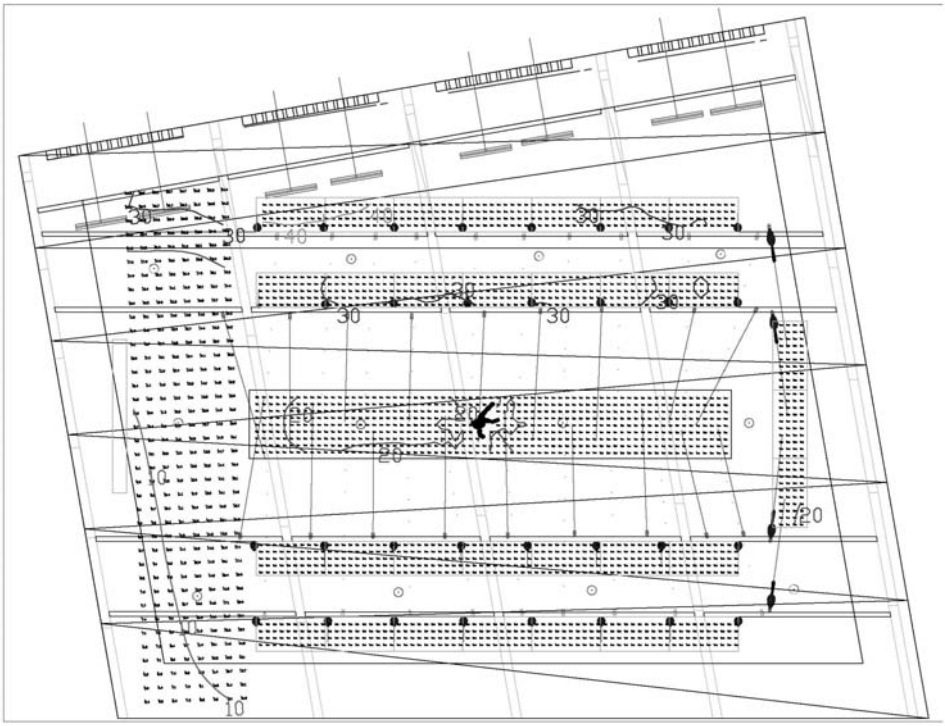

Figure 56 – Showroom – Conference Scene Calculation Grids

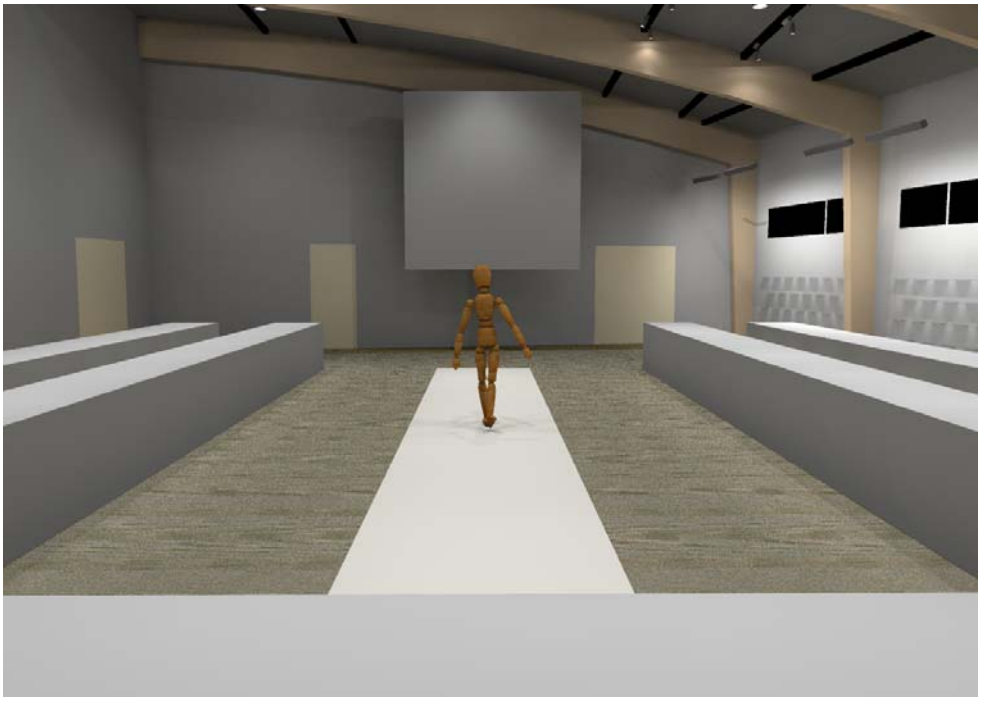

Figure 57 – Showroom – Conference Scene

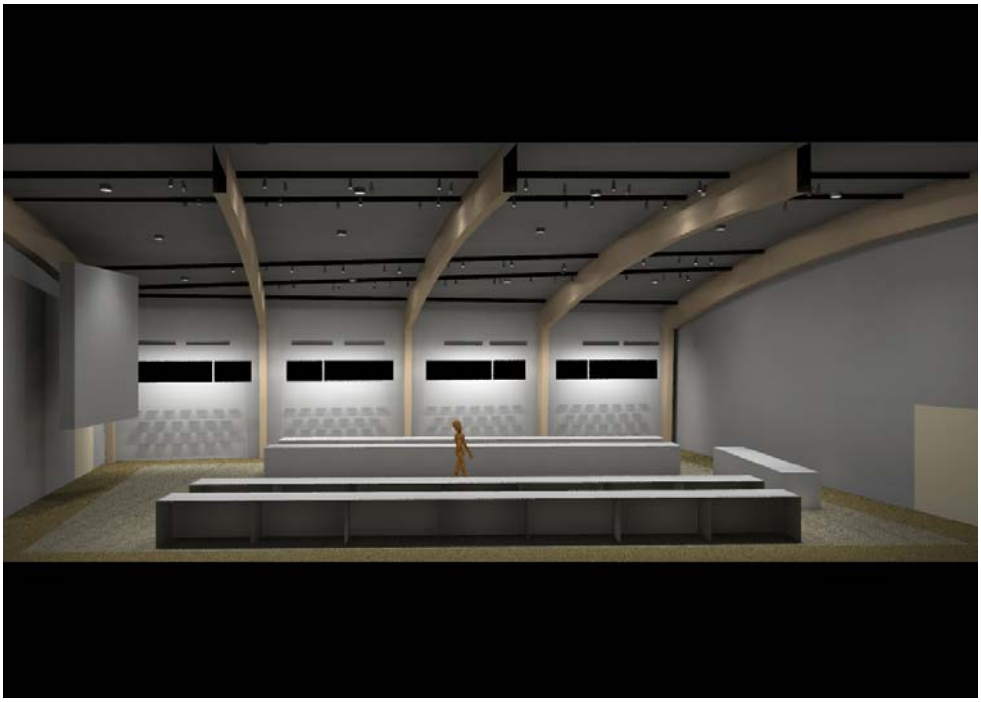

Figure 58 – Showroom – Conference Scene

Scene 3: Runway

For runway purposes, the lighting was dimmed to the following loads:

- Zone A: Switched Off
- Zone B: 70%
- Zone C: 100%
- Zone D: 100%
- Zone E: Switched Off

This level of dimming provided the following averages for the calculation grids for horizontal surfaces:

- Desk Row 1: 16.79 fc
- Desk Row 2: 19.27 fc
- Desk Row 3: 17.68 fc
- Desk Row 4: 15.73 fc
- Desk End Row: 16.73 fc
- Runway: 53.84 fc
- Face-Height Grid: 44.9 fc
- Floor: 6.55 fc

For vertical surfaces, the following levels were obtained:

- Display Wall: 2.62 fc
- Runway North Facing: 27.97 fc
- Runway South Facing: 23.25 fc
- Runway East Facing: 15.48 fc
- Runway West Facing: 14.98 fc

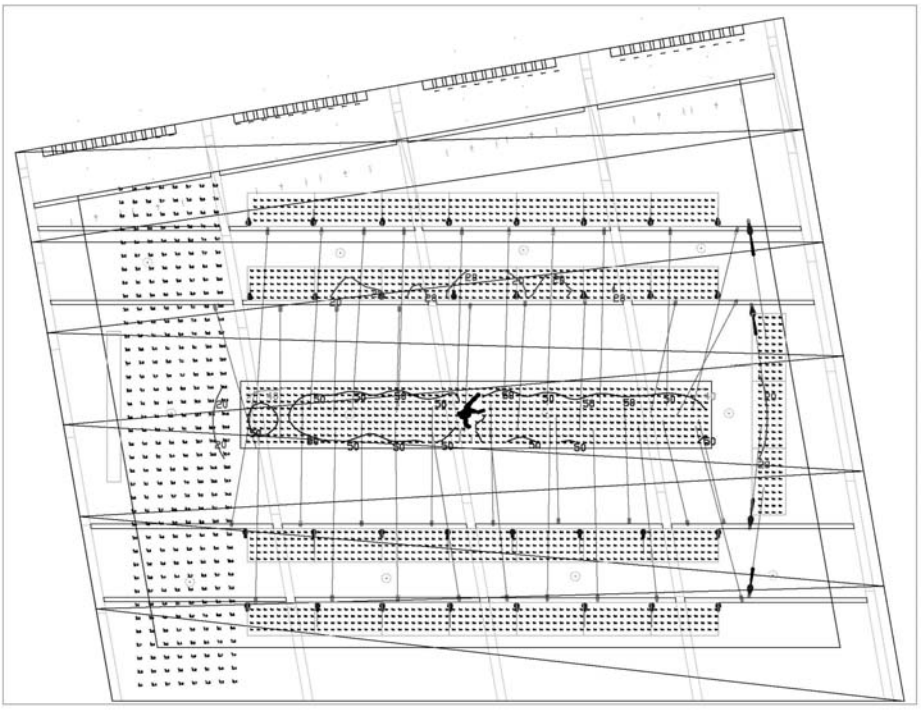

Figure 59 – Showroom – Runway Scene

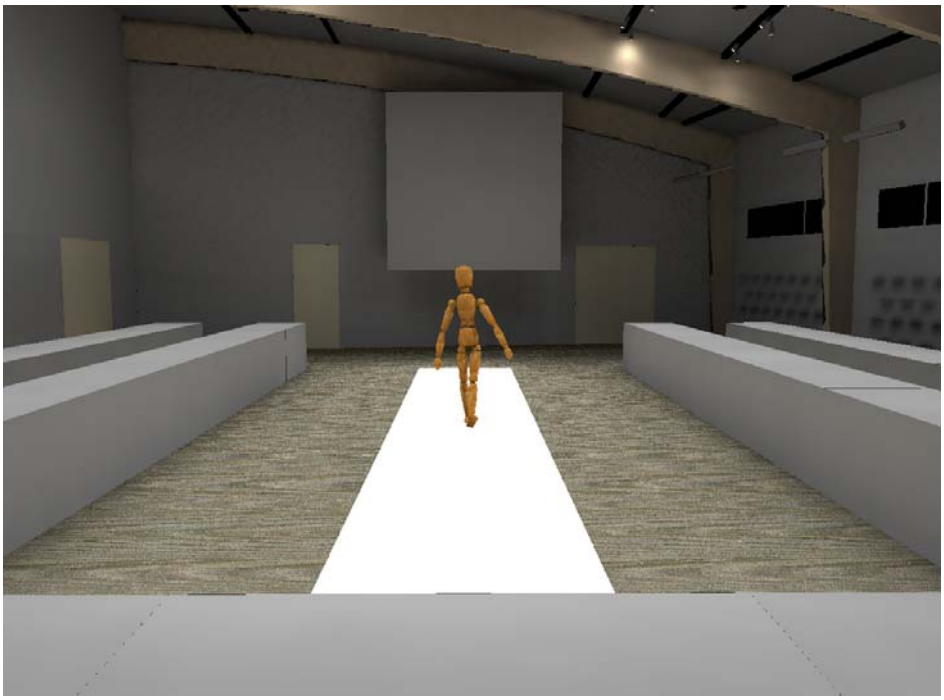

Figure 60 – Showroom – Runway Scene

Figure 61 – Showroom – Runway Scene Fold-Away Section

Scene 4: Projection

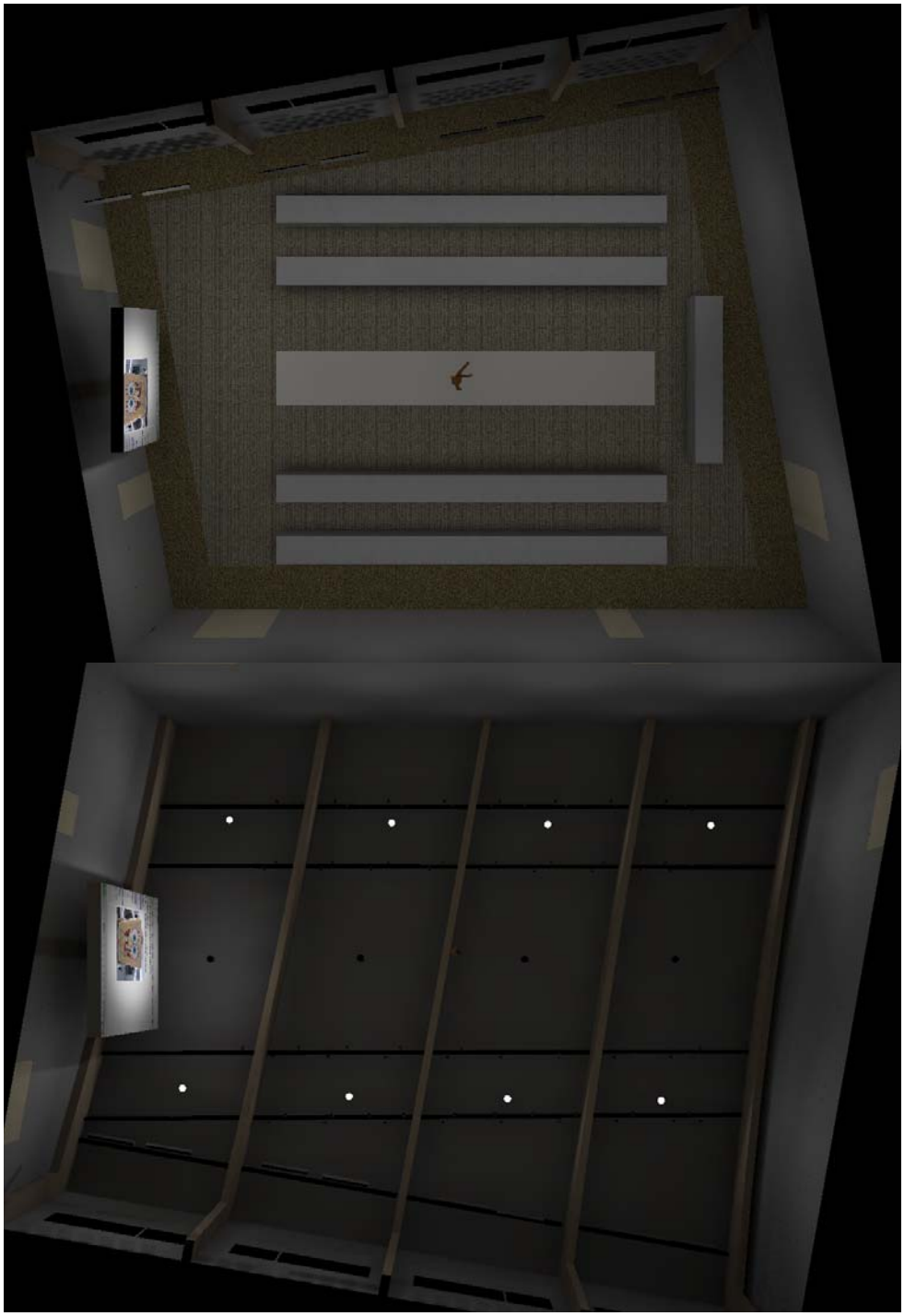

Figure 62 – Showroom – Projection Scene

Figure 63 – Showroom – Projection Screen

Summary

This space was designed to be utilized in four different ways; general shoe display, conference, runway, and projection. The proposed design provides the flexibility to be able to function in each of these ways. It meets or exceeds the criteria for the general/display setting, the conference setting, and the projection setting. The runway setting vertical illuminance on the model initially was aiming for 30 fc, but as this runway is mainly to display footwear, having a lower illumination on the face was determined not to be as important as first anticipated. Therefore, meeting 15 fc instead of the original target of 30 fc for vertical illuminance was still considered acceptable, and in turn the runway setting was also considered a success. The design and layout of the track provides versatility for future uses, and also maintains its anonymity by tucking in between the gluelam arches. Although the entire system power density is above the target set forth by ASHRAE standard 90.1, a limit on the total power consumption is inherent to the design of this space. The scenes set up in this report do not allow the entire system to be used at once. Of course, there is always the possibility of the owner deciding to change the characteristics of each scene and violate the initial intent. The owners of this building, however, are extremely environmentally conscious and would gladly abide by the designers intent.

Exterior Façade

The exterior space chosen for redesign is a portion of a rear wall of the building which is visible from Route 1. Currently there are two floodlights mounted on the hill to wash the entire wall that the sign is mounted on providing contrast to the spotlights mounted at the top of each sign which highlight the lettering. The AGI model is a massing model that shows the wall and the Dansko lettering.

Materials

While the exact properties of the exterior brick were not available for this report, a few assumptions were made regarding the material of this façade. The brick was considered a light color with a reflectance of 50%.

Design Criteria

- *Visual Appearance of Space and Luminaires*
  Luminaires should not be visible. The purpose of having the sign lit is to be draw attention to the name Dansko, and any thing else in the picture would just deter from that effect. The sign should be highlighted and able to draw your attention from nearby Route 1.

- *Light Distribution on Surfaces*
  The façade surrounding the sign should be backlight to provide a backdrop for the signs, but not lit too much that it attracts attention away from the sign itself. A ratio of 3:1 5:1 should be appropriate for light level on the sign to light level on the wall.

- *Points of Interest*
  The Dansko sign is the main focus of this space, with the building façade playing the secondary role.

- *Surface Characteristics*
  The façade is light-colored brick masonry. The sign itself is a perforated metal with the letters colored in.

- *Vertical Illuminance*
  Façade Illuminance: 10 fc

- *Vertical Luminance*
  Sign Luminance: 7 cd/ft^2

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April 12, 2007

Lighting Design Solution

Equipment

Façade - Luminaire Schedule

Type	Luminaire Manufacturer and Catalog Number	Description	Lamp	Ballast Manufacturer and Catalog Number	Ballast Watts
F-55	Hydrel M9710-B-50M-MVOLT-WFL-FLC-34S-ISS-BTR-BZ	Metal Halide Ingrade luminaire with wide flood distribution. Internal Source Shield	50W MH	Advance ICN-2S54-90C@277	55
G-50	Color Kinetics eW FLEX SLX 2700K CLEAR FLAT	Custom internally illuminated sign with string LEDs	LED	Included	50W per 50 nodes

Figure 64 – Façade Luminaire Schedule

Light Loss Factors

	Type	LLD	LDD	RSDD	BF	LLF
Façade	F-55	0.93	0.8		1.02	0.76
	G-50	1	0.8		1	0.80

Figure 65 – Façade Light Loss Factors

Power Densities

	Area (sf)	Watts	ASHRAE Base Allowance	Additional Allowance	Applied Area (sf)	Description	ASHRAE Total Allowable Watts	ASHRAE Total Allowable LPD	LPD (W/sf)
Façade	1580	589	0.2				316	0.2	0.37

Figure 66 – Façade Power Density

Layout

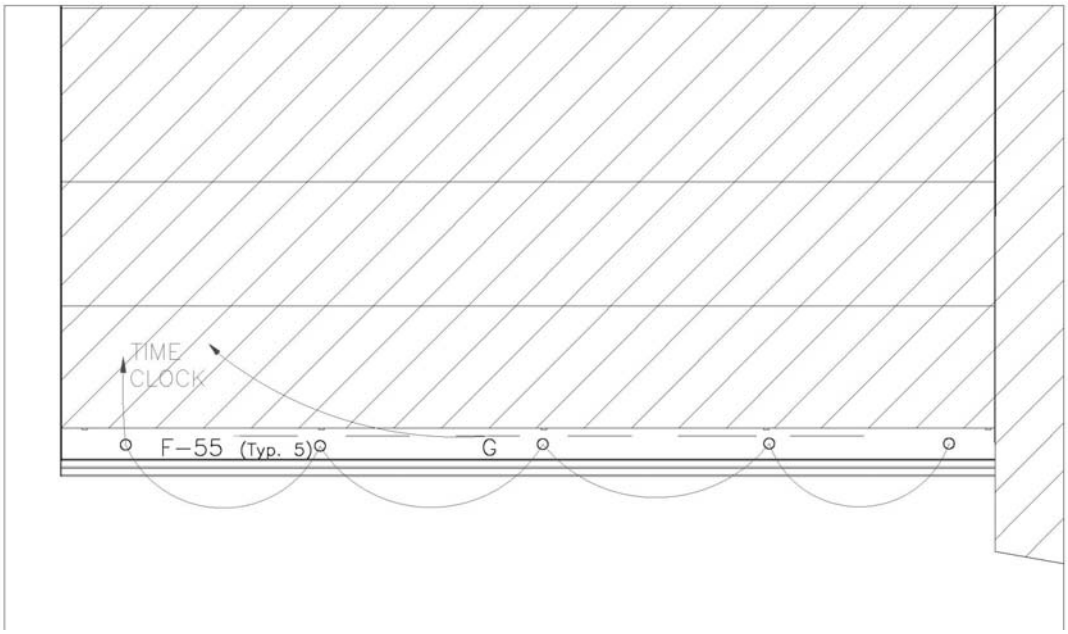


Figure 67 – Façade Luminaire Layout – Version 1 Plan

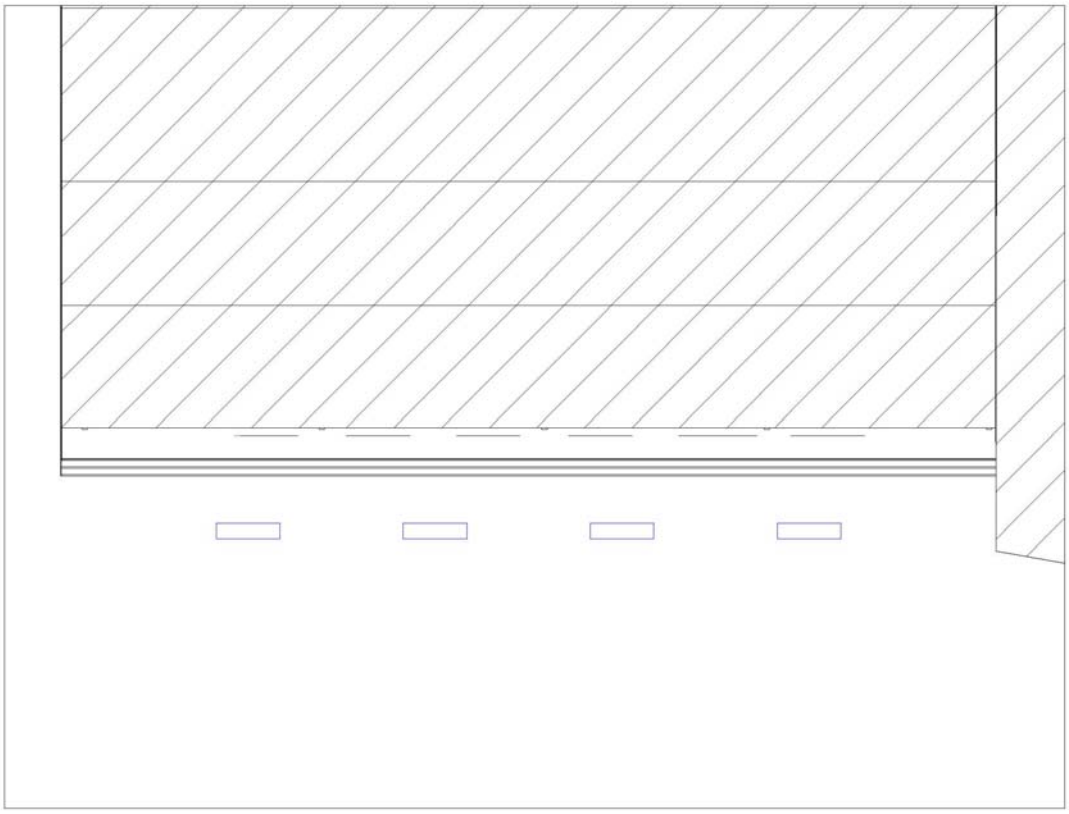


Figure 68 – Façade Luminaire Layout – Version 2 Plan

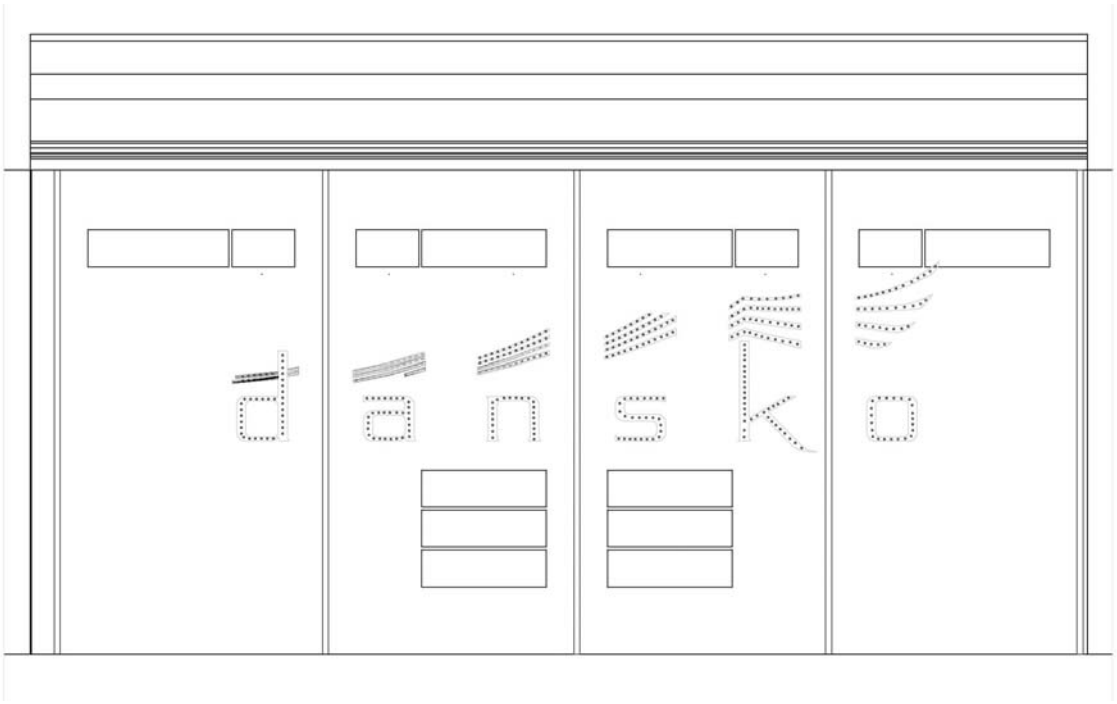


Figure 69 – Façade Luminaire Layout – Version 1 Elevation

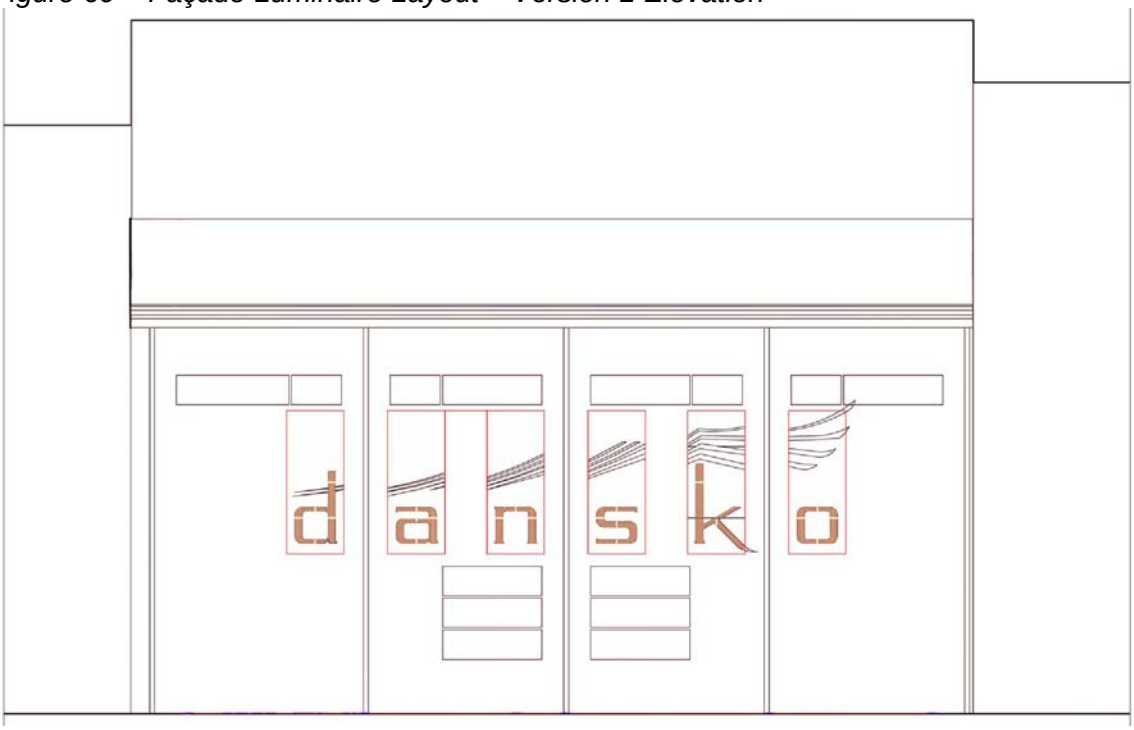


Figure 70 – Façade Luminaire Layout – Version 2 Elevation

Renderings

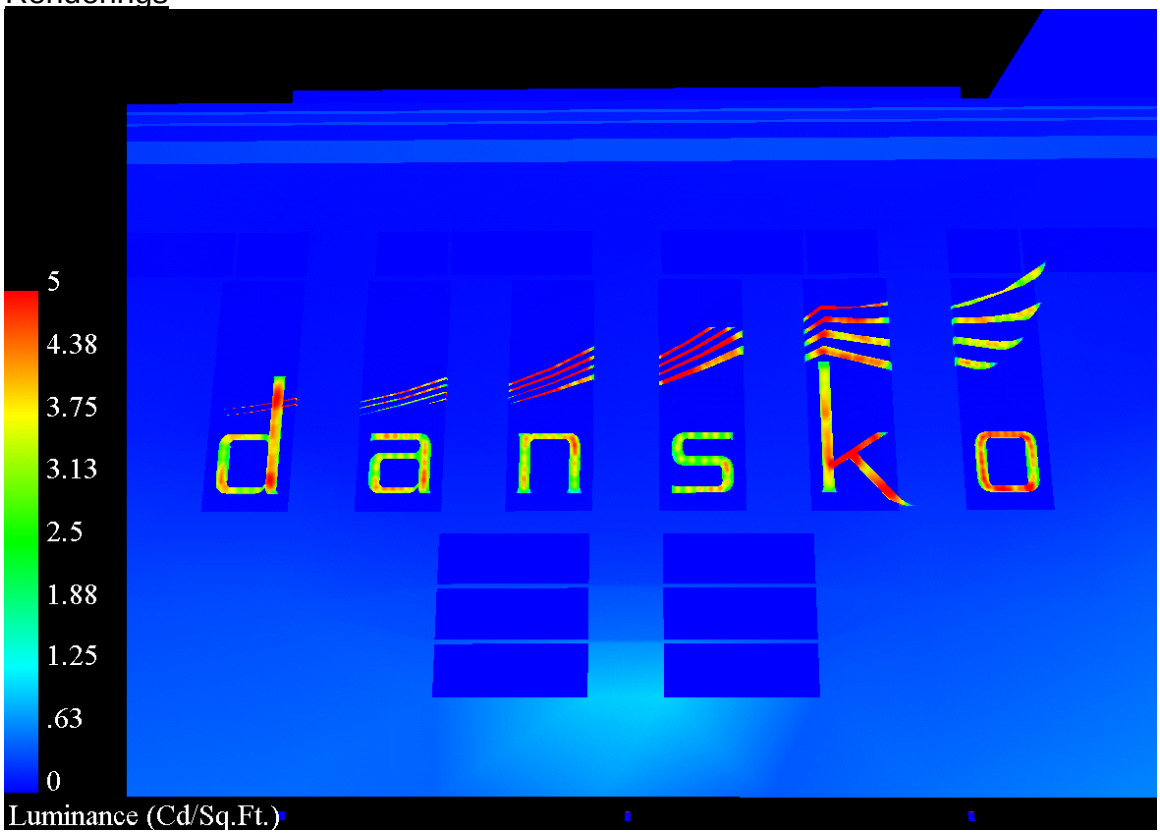
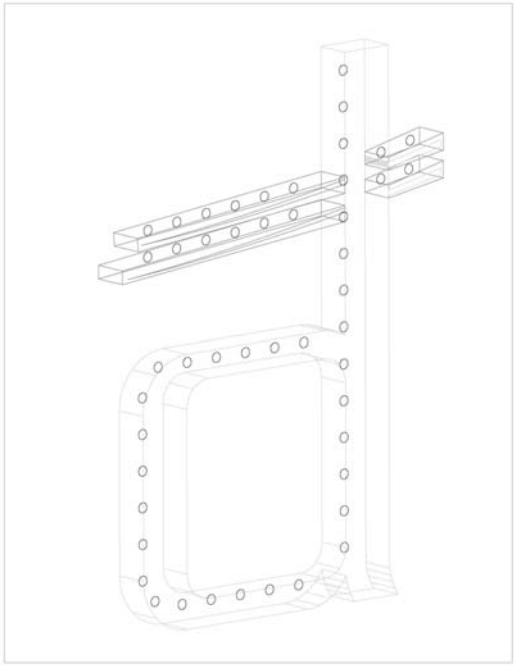


Figure 71 – Façade Psuedocolor Rendering Version 1

Figure 72 – Façade Luminance Map Version 1



This detail shows the general idea for the lighting of the sign. Each letter and wave element above is illuminated internally by a string of LEDs. For the waves that are smaller than the 1.22” width of the LED module, a light box was built. The box consists of a solid surface that has a light color on the inside to reflect the light and colored similar to the brick of the building on the outside to blend into the façade. On the side facing away from the building, there is a diffusing acrylic lens that allows the shape of the wave to be realized.

Figure 73 – “dansko” Letter Detail

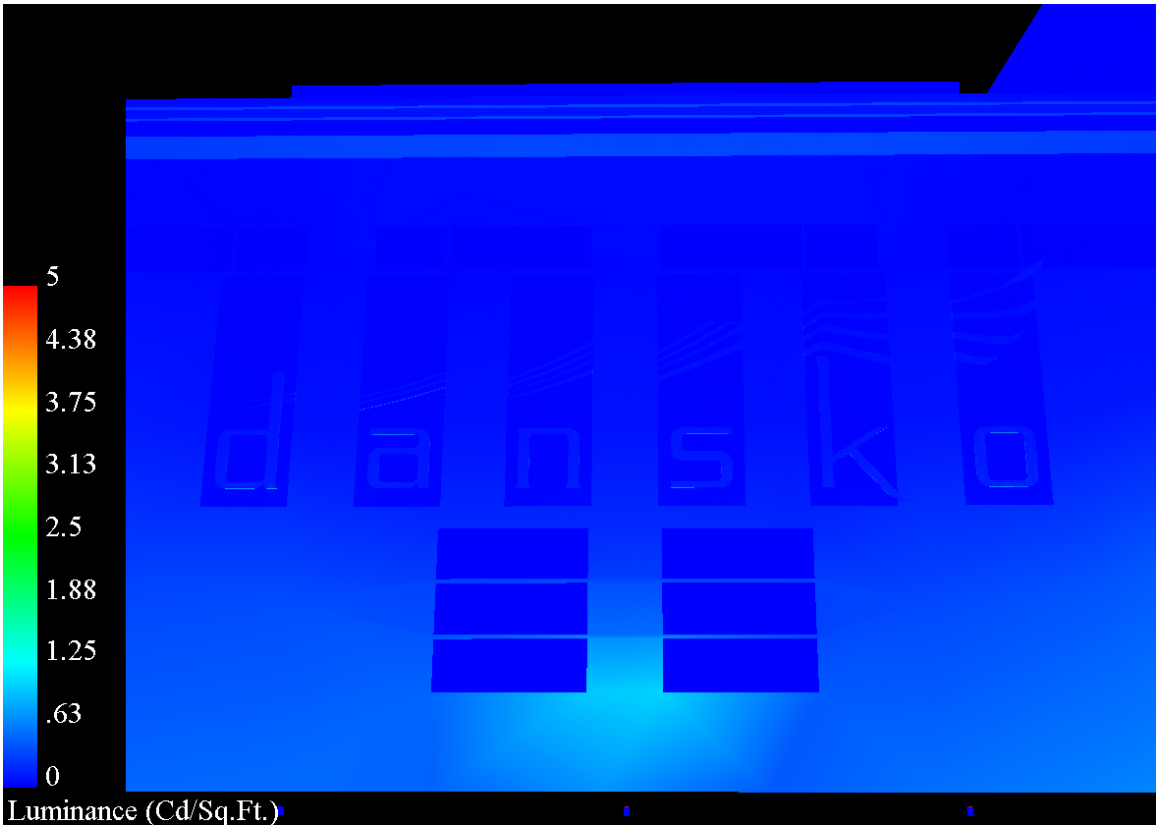


Figure 74 - Façade Psuedocolor Rendering Version 2

Figure 75 – Façade Luminance Map Version 2

Version 1 consists of 5 in-grade metal halide floodlights at 50W each that provide a gentle wash up the façade. The letters themselves are internally lit with LED's. Total watts for this system are 589W.

Version 2 consists of 4 54w T5HO Fluorescent lamps mounted 6' away from the wall and spaced 11'-9" apart.

Summary

Both versions produce exactly the same illumination on the façade. An average of 1.10 fc was calculated in both instances. Version 1, even though it consumes more watts, makes the "dansko" sign stand out much more, and therefore is preferred over version 2. This sign is meant to advertise the Dansko name and draw attention to the building. Version 1 serves both purposes equally well.

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High Light Reflectance Ceiling Study

Recently, Armstrong World Industries, Inc., a leader in commercial ceiling manufacturing, came out with a product called TechZone. This ceiling serves two purposes: to clean up the ceiling appearance by locating the lighting, HVAC, and sprinkler equipment in 6” channels between the ceiling panels, and provide a 90% reflective ceiling surface to maximize task plane illumination. Average ceiling tile today is 75%. Through multiple variations in ceiling height and room layout, the TechZone ceiling averaged around a 22% increase in task plane illuminance, and reduced ceiling uniformity maximum to minimum ratios over the standard 75% reflective ceiling.

Additionally, LEED offers points for the reduction in energy usage as compared to the ASHRAE standard 90.1-2004. In previous years, energy usage was based on ASHRAE standard 90.1-1999, but as the newer standards were published by ASHRAE, LEED raised their standards. As proven in a research study, 1-3 LEED points are available (based on LEED NC v2.2) for the reduction in lighting power density by 10.5% and up. Use of the Armstrong TechZone ceiling system has shown a decrease of 14.1%.

In the same study, the effect of the reduction in lighting power density on HVAC loads was also examined. The results varied, as location and room orientation played a large role in the overall effect. Therefore, the application in the open office room 215 of the Dansko building was modeled to determine the effects on this particular installation. More information can be found in the Mechanical Breadth study on page 113.

Armstrong World Industries, Inc. gave the following approximation of a price quote per square foot installed for their TechZone ceiling with these options:

1. Square Tegular Edge Detail
2. 6” x 48” Optima Tegular Technical Panel
3. 42” x 48” Optima Field Panel

The quote was a range between $4.60-$4.85 per square foot, which is the installed cost. With a square footage of 7220, at the high end this ceiling would cost $35,017. The most equivalent tile listed in RS Means with regards to size and appearance is a 2’x4’x3/4” tegular ceiling tile on a 9/16” grid system cost $4.39 installed, which would cost $31,695.80. The additional $3,321.2 would be offset by the additional savings incurred by using fewer luminaires.

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Electrical Depth

Dansko Phase III gets its power from a transformer at 35KV, where it's stepped down to a useful voltage for the building of 480Y277V. There are also several smaller transformers that step the voltage down to 208Y/120V for receptacles, some mechanical equipment, and a lighting panelboard. The fire pump is powered straight from the transformer before the line gets to the main switchboard. This switchboard powers all panelboards for lighting and receptacles, among the kitchen equipment and various fans and pumps. The mechanical equipment is run off of a distribution panel which is powered by the main switchboard, and has a 1200A circuit breaker.

The first aspect of the depth work is regarding electrical distribution. Due to the changes in lighting loads from the Lighting Depth work, the panelboards and feeders serving those loads had to be resized. The existing panelboards were studied and it was determined which circuits were to be resized. Once the new loads were finalized, the new circuits were sized according to the National Electric Code (NEC) and new panelboard schedules were completed. This report shows the spreadsheets and demonstrates the methodology used in resizing the panelboards and feeders.

The second aspect of the depth work was sizing an emergency generator and determining the location, cost, and overall feasibility. The emergency generator was compared to using emergency ballasts which power individual luminaires for a period of no shorter than 90 minutes.

Thirdly, a cost-analysis was performed on switching the feeder material from copper to aluminum. As the cost of copper rises, alternatives are sought out; aluminum is relatively cheap, and although it has a lesser conductivity than copper, can be used in building installations to save money.

Near the end of this section is a coordination analysis performed on a single-path through the distribution system. In the attempt to evaluate the available short circuit current available at the switchboard, the short circuit current available from the utility had to be determined. The utility company however was unable to provide that information for the Dansko Phase III expansion, and therefore no analysis was able to be completed.

At the end is a summary of the findings of this depth study and the conclusions at which were arrived following this study.

Existing Panelboard Schedule

Below are the existing panelboards which needed to be modified following the completion of the lighting redesign. The branch circuits which were changed are shaded in. The criteria used by the Electrical Engineer to complete the existing panelboards were not available, the spare capacity used in the calculations of the protection and bus size were unknown. It is assumed in this report that the spare capacity requirements were quite large for the original design, and therefore the redesign included spare capacities of 50% or more. The power factors used in both the existing and the new panelboards were approximated conservatively. The values used in this report are as follows:

- Fluorescent: 0.95
- Incandescent: 1.0
- HID: 0.95

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 150A COPPER SIZE/TYPE MAIN: 150A/3P MCB	PANEL TAG: NHB PANEL LOCATION: LOWER LEVEL PANEL MOUNTING: SURFACE	MIN. C/B AIC: 14K OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Ltg. Night/Em West	Room 1	1900	20A/1P	1	*			2	20A/1P	3300	Cafeteria	Ltg. Cafeteria
Ltg. Night/Em East	0	1500	20A/1P	3		*		4	20A/1P	3400	3.4	Ltg. Office SW
Ltg. Common West	0	1900	20A/1P	5			*	6	20A/1P	800	0	Ltg. Office N
Ltg. Common East	0	1300	20A/1P	7	*			8	20A/1P	0	0	Spare
Ltg. Utility West	0	1900	20A/1P	9		*		10	20A/1P	0	0	Spare
Ltg. Utility East	0	2300	20A/1P	11			*	12	20A/1P	0	0	Spare
Ltg. Utility East	0	1800	20A/1P	13	*			14	20A/1P	500	0	Ltg. Ext N/EM West
Spare	0	0	20A/1P	15		*		16	20A/1P	200	0	Ltg. Ext N/E East
Spare	0	0	20A/1P	17			*	18	20A/1P	900	0	Ltg. Ext N/E West
Spare		0	20A/1P	19	*			20	20A/1P	500		Ltg. Ext. Sign
Spare		0	20A/1P	21		*		22	20A/1P	1600		Ltg. Ext. Poles
Spare		0	20A/1P	23			*	24	20A/1P	1600		Ltg. Ext. Poles
Spare		0	20A/1P	25	*			26	20A/1P	1000		Ltg. Ext. Bollards
Spare		0	20A/1P	27		*		28	20A/1P	1600		Ltg. Ext. Poles
Spare		0	20A/1P	29			*	30	20A/1P	0		Spare
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A	10.30	TOTAL DESIGN LOAD (KW)	42.00
CONNECTED LOAD (KW) - B	10.20	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	7.50	TOTAL DESIGN LOAD (AMPS)	53

Figure 76 – Existing Panelboard NHB

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
DESCRIPTION 150A/3P C/B

PANEL TAG: NH1
PANEL LOCATION: FIRST FLOOR
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Ltg. Night/Em West	Lobby 102	1600	20A/1P	1	*			2	20A/1P	3300	132	Ltg. Office NW
Ltg. Night/Em East	126	1600	20A/1P	3		*		4	20A/1P	2600	114	Ltg. Office NW
Ltg. Night/Em S	5	0	20A/1P	5			*	6	20A/1P	3500	104	Ltg. Office SW
Ltg. Common Center	Hallway 128	2100	20A/1P	7	*			8	20A/1P	800	Elec 125	Ltg. Office Center
Ltg. Utility Center	126	300	20A/1P	9		*		10	20A/1P	1700	157	Ltg. Office East
Ltg. Utility South	183	1300	20A/1P	11			*	12	20A/1P	0		Spare
Spare		0	20A/1P	13	*			14	20A/1P	2100	Retail	Ltg. Retail South
Spare		0	20A/1P	15		*		16	20A/1P	2100	Retail	Ltg. Retail South
Spare		0	20A/1P	17			*	18	20A/1P	2100	Retail	Ltg. Retail South
Spare		0	20A/1P	19	*			20	20A/1P	0		Spare
Spare		0	20A/1P	21		*		22	20A/1P	0		Spare
Spare		0	20A/1P	23			*	24	20A/1P	0		Spare
Spare		0	20A/1P	25	*			26	20A/1P	0		Spare
Spare		0	20A/1P	27		*		28	20A/1P	0		Spare
Spare		0	20A/1P	29			*	30	20A/1P	0		Spare
Empty		0	20A/1P	31	*			32	20A/1P	0		Empty
Empty		0	20A/1P	33		*		34	20A/1P	0		Empty
Empty		0	20A/1P	35			*	36	20A/1P	0		Empty
Empty		0	20A/1P	37	*			38	20A/1P	0		Empty
Empty		0	20A/1P	39		*		40	20A/1P	0		Empty
Empty		0	20A/1P	41			*	42	20A/1P	0		Empty

CONNECTED LOAD (KW) - A	9.90	TOTAL DESIGN LOAD (KW)	30.12
CONNECTED LOAD (KW) - B	8.30	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	6.90	TOTAL DESIGN LOAD (AMPS)	38

Figure 77 – Existing Panelboard NH1

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A COPPER
SIZE/TYPE MAIN: 150A/3P MCB

PANEL TAG: NH2
PANEL LOCATION: SECOND FLOOR
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Ltg. Night/Em West	Conf	1200	20A/1P	1	*			2	20A/1P	3400	Room 215	Ltg Office NW
Ltg. Night/Em East	3	1000	20A/1P	3		*		4	20A/1P	3100	Room 215	Ltg Office NW
Ltg. Common East	5	1400	20A/1P	5			*	6	20A/1P	2600	Room 215	Ltg Office SW
Ltg. Utility Center	7	200	20A/1P	7	*			8	20A/1P	3700	Room 215	Ltg Office SW
		0	20A/1P	9		*		10	20A/1P	700	Room 215	Ltg Office Center
		0	20A/1P	11			*	12	20A/1P	1800	Room 215	Ltg Office East
		0	20A/1P	13	*			14	20A/1P	0		
		0	20A/1P	15		*		16	20A/1P	0		
		0	20A/1P	17			*	18	20A/1P	0		
		0	20A/1P	19	*			20	20A/1P	0		
		0	20A/1P	21		*		22	20A/1P	0		
		0	20A/1P	23			*	24	20A/1P	0		
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A	8.50	TOTAL DESIGN LOAD (KW)	22.92
CONNECTED LOAD (KW) - B	4.80	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	5.80	TOTAL DESIGN LOAD (AMPS)	29

Figure 78 – Existing Panelboard NH2

New Panelboard Schedules

The new lighting loads were added to the existing panelboards and a new demand load was determined. The demand factors used for the completion of these panelboards are as follows:

- Receptacles: 0.7
- Computers: 0.8
- Fluorescent Lighting: 1.25
- HID Lighting: 1.25
- Incandescent Lighting: 1.25
- HVAC Fans: 0.8
- Heating: 1.25
- Kitchen Equipment: 0.8

Once the new lighting loads were added, the circuits were rearranged in order to balance the load across the three phases. Four existing panelboards were changed, which resulted in five new lighting panelboards and two new dimming panels. One of each of the new lighting panelboards and new dimming panels was made to be serviced by an emergency generator in the event of a power loss. From there, the circuit breaker protecting the panelboard was sized, and a bus size was determined. The feeder was based on the circuit breaker protecting the panelboard, and finally the conduit was sized. Following the panelboard schedules listed below is the new feeder schedule.

Panelboards NHB, NH1, NH2, and NLB3 will be mounted in the same location as they were previously. Panelboard EM will be located on the first floor in Electrical Closet 125 in the east wing of the building. The two dimming panels, designated NDP and EDP, will be mounted in the AV closet that serves the showroom.

The new panelboards and associated worksheets that were used in their completion can be found below.

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V, 3P, 4W
SIZE/TYPE BUS: 100A COPPER
SIZE/TYPE MAIN: 60A/3P MCB

PANEL TAG: NHB
PANEL LOCATION: LOWER LEVEL
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Ltg. Common East		1300	20A/1P	1	*			2	20A/1P	800		Ltg. Office N
Ltg. Office SW		3400	20A/1P	3		*		4	20A/1P	1375		Ltg. Utility West
Ltg. Common West		1750	20A/1P	5			*	6	20A/1P	3300	Cafeteria	Ltg. Cafeteria
Ltg. Utility East		1975	20A/1P	7	*			8	20A/1P	1600		Ltg. Ext. Poles
Ltg. Ext West		900	20A/1P	9		*		10	20A/1P	1600		Ltg. Ext. Poles
Ltg. Utility East		1800	20A/1P	11			*	12	20A/1P	1000		Ltg. Ext. Bollards
Ltg. Ext. Poles		1600	20A/1P	13	*			14	20A/1P	0		Spare
Ltg. Ext. Sign		0	20A/1P	15		*		16	20A/1P	0		Spare
Spare		0	20A/1P	17			*	18	20A/1P	0		Spare
Spare		0	20A/1P	19	*			20	20A/1P	0		Spare
Spare		0	20A/1P	21		*		22	20A/1P	0		Spare
Spare		0	20A/1P	23			*	24	20A/1P	0		Spare
Spare		0	20A/1P	25	*			26	20A/1P	0		Spare
Spare		0	20A/1P	27		*		28	20A/1P	0		Spare
Empty		0	20A/1P	29			*	30	20A/1P	0		Empty
Empty		0	20A/1P	31	*			32	20A/1P	0		Empty
Empty		0	20A/1P	33		*		34	20A/1P	0		Empty
Empty		0	20A/1P	35			*	36	20A/1P	0		Empty
Empty		0	20A/1P	37	*			38	20A/1P	0		Empty
Empty		0	20A/1P	39		*		40	20A/1P	0		Empty
Empty		0	20A/1P	41			*	42	20A/1P	0		Empty

CONNECTED LOAD (KW) - A	7.28	TOTAL DESIGN LOAD (KW)	42.00
CONNECTED LOAD (KW) - B	7.28	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	7.85	TOTAL DESIGN LOAD (AMPS)	53

Figure 79 – New Panelboard NHB

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 150A
SIZE/TYPE MAIN: 60A/3P MCB

PANEL TAG: NH1
PANEL LOCATION: FIRST FLOOR ROOM 125
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Ltg. Office NW	132	3300	20A/1P	1	*			2	20A/1P	1730	Hallway 128	Ltg. Common Center
Ltg. Lobby	Lobby	494	20A/1P	3		*		4	20A/1P	3500	104	Ltg. Office SW
Ltg. Office NW	114	2600	20A/1P	5			*	6	20A/1P	800	Elec 125	Ltg. Office Center
Spare		0	20A/1P	7	*			8	20A/1P	2100	Retail	Ltg. Retail South
Ltg. Utility South	183	1300	20A/1P	9		*		10	20A/1P	2100	Retail	Ltg. Retail South
Ltg. Office East	157	1700	20A/1P	11			*	12	20A/1P	2100	Retail	Ltg. Retail South
Spare		0	20A/1P	13	*			14	20A/1P	0		Spare
Spare		0	20A/1P	15		*		16	20A/1P	0		Spare
Spare		0	20A/1P	17			*	18	20A/1P	0		Spare
Spare		0	20A/1P	19	*			20	20A/1P	0		Spare
Spare		0	20A/1P	21		*		22	20A/1P	0		Spare
Spare		0	20A/1P	23			*	24	20A/1P	0		Spare
Spare		0	20A/1P	25	*			26	20A/1P	0		Spare
Spare		0	20A/1P	27		*		28	20A/1P	0		Spare
Spare		0	20A/1P	29			*	30	20A/1P	0		Spare
Empty		0	20A/1P	31	*			32	20A/1P	0		Empty
Empty		0	20A/1P	33		*		34	20A/1P	0		Empty
Empty		0	20A/1P	35			*	36	20A/1P	0		Empty
Empty		0	20A/1P	37	*			38	20A/1P	0		Empty
Empty		0	20A/1P	39		*		40	20A/1P	0		Empty
Empty		0	20A/1P	41			*	42	20A/1P	0		Empty

CONNECTED LOAD (KW) - A	7.13	TOTAL DESIGN LOAD (KW)	40.73
CONNECTED LOAD (KW) - B	7.39	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	7.20	TOTAL DESIGN LOAD (AMPS)	52

Figure 80 – New Panelboard NH1

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W
SIZE/TYPE BUS: 100A COPPER
SIZE/TYPE MAIN: 50A/3P C/B

PANEL TAG: NH2
PANEL LOCATION: SECOND FLOOR ROOM 205
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 14K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
35W MR16	Room 215	1820	20A/1P	1	*			2	20A/1P	1500	Room 215	75W MR16
Ltg. Common East	East	340	20A/1P	3		*		4	20A/1P	661	Room 215	Ltg. Office West
Ltg. Office North	Room 215	1301	20A/1P	5			*	6	20A/1P	620	Atrium	Ltg. Clerestory
Spare		0	20A/1P	7	*			8	20A/1P	408	Lounge	Ltg. Lounge
Ltg. Office Center	Room 215	700	20A/1P	9		*		10	20A/1P	1800	Room 215	Ltg. Office East
Ltg. Office South	Room 215	1530	20A/1P	11			*	12	20A/1P	0		Spare
Spare		0	20A/1P	13	*			14	20A/1P	0		Spare
Spare		0	20A/1P	15		*		16	20A/1P	0		Spare
Spare		0	20A/1P	17			*	18	20A/1P	0		Spare
Spare		0	20A/1P	19	*			20	20A/1P	0		Spare
Spare		0	20A/1P	21		*		22	20A/1P	0		Spare
Spare		0	20A/1P	23			*	24	20A/1P	0		Spare
Spare		0	20A/1P	25	*			26	20A/1P	0		Spare
Spare		0	20A/1P	27		*		28	20A/1P	0		Spare
Spare		0	20A/1P	29			*	30	20A/1P	0		Empty
Empty		0	20A/1P	31	*			32	20A/1P	0		Empty
Empty		0	20A/1P	33		*		34	20A/1P	0		Empty
Empty		0	20A/1P	35			*	36	20A/1P	0		Empty
Empty		0	20A/1P	37	*			38	20A/1P	0		Empty
Empty		0	20A/1P	39		*		40	20A/1P	0		Empty
Empty		0	20A/1P	41			*	42	20A/1P	0		Empty

CONNECTED LOAD (KW) - A	3.73	TOTAL DESIGN LOAD (KW)	18.78
CONNECTED LOAD (KW) - B	3.50	POWER FACTOR	0.95
CONNECTED LOAD (KW) - C	3.45	TOTAL DESIGN LOAD (AMPS)	24

Figure 81 – New Panelboard NH2

PANELBOARD SCHEDULE

VOLTAGE: 208Y/120V,3PH,4W
SIZE/TYPE BUS: 100A
SIZE/TYPE MAIN: 80A/3P C/B

PANEL TAG: NLB3
PANEL LOCATION: LOWER LEVEL
PANEL MOUNTING: SURFACE

MIN. C/B AIC: 10K
OPTIONS:

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
NDP	Showroom	1900	20A/1P	1	*			2	20A/1P	1900	Showroom	NDP
NDP	Showroom	1900	20A/1P	3		*		4	20A/1P	1900	Showroom	NDP
NDP	Showroom	1900	20A/1P	5			*	6	20A/1P	1900	Showroom	NDP
NDP	Showroom	1900	20A/1P	7	*			8	20A/1P	1900	Showroom	NDP
NDP	Showroom	1900	20A/1P	9		*		10	20A/1P	1900	Showroom	NDP
NDP	Showroom	1900	20A/1P	11			*	12	20A/1P	1900	Showroom	NDP
Spare		0	20A/1P	13	*			14	20A/1P	0		Spare
Spare		0	20A/1P	15		*		16	20A/1P	0		Spare
Spare		0	20A/1P	17			*	18	20A/1P	0		Spare
Spare		0	20A/1P	19	*			20	20A/1P	0		Spare
Spare		0	20A/1P	21		*		22	20A/1P	0		Spare
Spare		0	20A/1P	23			*	24	20A/1P	0		Spare
		0	20A/1P	25	*			26	20A/1P	0		
		0	20A/1P	27		*		28	20A/1P	0		
		0	20A/1P	29			*	30	20A/1P	0		
		0	20A/1P	31	*			32	20A/1P	0		
		0	20A/1P	33		*		34	20A/1P	0		
		0	20A/1P	35			*	36	20A/1P	0		
		0	20A/1P	37	*			38	20A/1P	0		
		0	20A/1P	39		*		40	20A/1P	0		
		0	20A/1P	41			*	42	20A/1P	0		

CONNECTED LOAD (KW) - A	7.60	TOTAL DESIGN LOAD (KW)	27.36
CONNECTED LOAD (KW) - B	7.60	POWER FACTOR	1.00
CONNECTED LOAD (KW) - C	7.60	TOTAL DESIGN LOAD (AMPS)	76

Figure 82 – New Panelboard NLB3

PANEL NDP : 120V						AV CLOSET 122
DIMMER	ZONE	TYPE	CONTROL	LOAD (W)	VOLTAGE (V)	LOCATION
1	A	FLUOR.	DIMM	1200	120	Shoe Display
2	A	FLUOR.	DIMM	1200	120	Shoe Display
3	B	INCAND.	DIMM	900	120	Desk Row 1-1
4	B	INCAND.	DIMM	1500	120	Desk Row 1-2
5	B	INCAND.	DIMM	900	120	Desk Row 2-1
6	B	INCAND.	DIMM	1500	120	Desk Row 2-2
7	B	INCAND.	DIMM	1200	120	Desk Row 3-1
8	B	INCAND.	DIMM	1500	120	Desk Row 3-2
9	B	INCAND.	DIMM	1200	120	Desk Row 4-1
10	B	INCAND.	DIMM	1500	120	Desk Row 4-2
11	C	INCAND.	DIMM	900	120	Runway Row 1-1
12	C	INCAND.	DIMM	1500	120	Runway Row 1-2
13	D	INCAND.	DIMM	900	120	Runway Row 2-1
14	D	INCAND.	DIMM	1500	120	Runway Row 2-2
15	D	INCAND.	DIMM	1200	120	Runway Row 3-1
16	D	INCAND.	DIMM	1500	120	Runway Row 3-2
17	C	INCAND.	DIMM	1200	120	Runway Row 4-1
18	C	INCAND.	DIMM	1500	120	Runway Row 4-2
19						
20						
21						
22						
23						
24						
		TOTAL LOAD (W)		22800		

Figure 83 – New Dimming Panel NDP

PANELBOARD SCHEDULE

VOLTAGE: 480Y/277V,3PH,4W SIZE/TYPE BUS: 100A SIZE/TYPE MAIN: 50A/3P C/B			PANEL TAG: EM PANEL LOCATION: FIRST FLOOR ROOM 125 PANEL MOUNTING: SURFACE							MIN. C/B AIC: 14K OPTIONS:		
DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Ltg. Ext. N/E East	Lower Level	200	20A/1P	1	*			2	20A/1P	1375	Lower Level	Ltg. Utility West
Ltg. Night/Em East	Lower Level	1500	20A/1P	3		*		4	20A/1P	500	Lower Level	Ltg. Ext. N/E West
Ltg. Night/Em West	Lower Level	1740	20A/1P	5			*	6	20A/1P	421	Lower Level	Ltg. Stairs
Spare		0	20A/1P	7	*			8	20A/1P	1600	First Floor	Ltg. N/E East
Ltg. Utility Center E	First Floor	300	20A/1P	9		*		10	20A/1P	579	First Floor	Ltg. Lobby
Ltg. N/E West	First Floor	1215	20A/1P	11			*	12	20A/1P	790	Second Floor	Ltg. N/E East
Ltg. Lounge	Second Floor	204	20A/1P	13	*			14	20A/1P	200	Second Floor	Ltg. Utility Center E
Ltg. N/E West	Second Floor	731	20A/1P	15		*		16	60A/3P	272	Showroom	EDP
Spare		0	20A/1P	17			*	18		272	Showroom	EDP
Spare		0	20A/1P	19	*			20		272	Showroom	EDP
Spare		0	20A/1P	21		*		22	20A/1P	0		Spare
Spare		0	20A/1P	23			*	24	20A/1P	0		Spare
Spare		0	20A/1P	25	*			26	20A/1P	0		Spare
Spare		0	20A/1P	27		*		28	20A/1P	0		Spare
Spare		0	20A/1P	29			*	30	20A/1P	0		Spare
Empty		0	20A/1P	31	*			32	20A/1P	0		Empty
Empty		0	20A/1P	33		*		34	20A/1P	0		Empty
Empty		0	20A/1P	35			*	36	20A/1P	0		Empty
Empty		0	20A/1P	37	*			38	20A/1P	0		Empty
Empty		0	20A/1P	39		*		40	20A/1P	0		Empty
Empty		0	20A/1P	41			*	42	20A/1P	0		Empty
CONNECTED LOAD (KW) - A		3.85								TOTAL DESIGN LOAD (KW)		22.51
CONNECTED LOAD (KW) - B		3.88								POWER FACTOR		0.95
CONNECTED LOAD (KW) - C		4.44								TOTAL DESIGN LOAD (AMPS)		28

Figure 84 – New Emergency Panel EM

PANEL EDP : 277V						AV CLOSET 122
DIMMER	ZONE	TYPE	CONTROL	LOAD (W)	VOLTAGE (V)	LOCATION
1	A	FLUOR.	DIMM	272	277	Ltg. Showroom Row 1
2	A	FLUOR.	DIMM	272	277	Ltg. Showroom Row 2
3	A	FLUOR.	DIMM	272	277	Ltg. Showroom Row 3
4						
5						
6						
7						
8						
9						
10						
11						
12						
		TOTAL LOAD (W)		816		

Figure 85 – New Emergency Dimming Panel EDP

LIGHTING AND APPLIANCE PANELBOARD SIZING WORKSHEET

Panel Tag---------->				NHB	Panel Location:			LOWER LEVEL			
Nominal Phase to Neutral Voltage------->				277	Phase:			3			
Nominal Phase to Phase Voltage-------->				480	Wires:			4			
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Ltg. Common East	3		1300	w	0.95	1300	1368		
2	A	Ltg. Office N	3		800	w	0.95	800	842		
3	B	Ltg. Office SW	3		3400	w	0.95	3400	3579		
4	B	Ltg. Utility West	3		1375	w	0.95	1375	1447		
5	C	Ltg. Common West	3		1750	w	0.95	1750	1842		
6	C	Ltg. Cafeteria	3	Cafeteria	3300	w	0.95	3300	3474		
7	A	Ltg. Utility East	3		1975	w	0.95	1975	2079		
8	A	Ltg. Ext. Poles	4		1600	w	0.95	1600	1684		
9	B	Ltg. Ext West	4		900	w	0.95	900	947		
10	B	Ltg. Ext. Poles	4		1600	w	0.95	1600	1684		
11	C	Ltg. Utility East	3		1800	w	0.95	1800	1895		
12	C	Ltg. Ext. Bollards	4		1000	w	0.95	1000	1053		
13	A	Ltg. Ext. Poles	4		1600	w	0.95	1600	1684		
14	A	Spare				w	0.95	0	0		
15	B	Ltg. Ext. Sign	3		0	w	0.95	0	0		
16	B	Spare			0	w	1.00	0	0		
17	C	Spare			0	w	1.00	0	0		
18	C	Spare			0	w	1.00	0	0		
19	A	Spare			0	w	1.00	0	0		
20	A	Spare			0	w	1.00	0	0		
21	B	Spare			0	w	1.00	0	0		
22	B	Spare			0	w	1.00	0	0		
23	C	Spare			0	w	1.00	0	0		
24	C	Spare			0	w	1.00	0	0		
25	A	Spare			0	w	1.00	0	0		
26	A	Spare			0	w	1.00	0	0		
27	B	Spare			0	w	1.00	0	0		
28	B	Spare			0	w	1.00	0	0		
29	C	Empty				w	1.00	0	0		
30	C	Empty				w	1.00	0	0		
31	A	Empty				w	1.00	0	0		
32	A	Empty				w	1.00	0	0		
33	B	Empty				w	1.00	0	0		
34	B	Empty				w	1.00	0	0		
35	C	Empty				w	1.00	0	0		
36	C	Empty				w	1.00	0	0		
37	A	Empty				w	1.00	0	0		
38	A	Empty				w	1.00	0	0		
39	B	Empty				w	1.00	0	0		
40	B	Empty				w	1.00	0	0		
41	C	Empty				w	1.00	0	0		
42	C	Empty				w	1.00	0	0		
PANEL TOTAL								22.4	23.6	Amps=	28.4

PHASE LOADING							kW	kVA	%	Amps
PHASE TOTAL		A					7.3	7.7	32%	27.6
PHASE TOTAL		B					7.3	7.7	32%	27.6
PHASE TOTAL		C					7.9	8.3	35%	29.8

LOAD CATAGORIES			Connected			Demand				Ver. 1.01
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0	0.70	0.0	0.0			
2	computers		0.0	0.0	0.90	0.0	0.0			
3	fluorescent lighting		15.7	16.5	1.25	19.6	20.7	0.95		
4	HID lighting		6.7	7.1	1.25	8.4	8.8	0.95		
5	incandescent lighting		0.0	0.0	1.00	0.0	0.0			
6	HVAC fans		0.0	0.0	0.80	0.0	0.0			
7	heating		0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment		0.0	0.0	1.00	0.0	0.0			
Total Demand Loads						28.0	29.5			
Spare Capacity			50%			14.0	14.7			
Total Design Loads						42.0	44.2	0.95	Amps=	53.2

Figure 86 – NHB Worksheet

LIGHTING AND APPLIANCE PANELBOARD SIZING WORKSHEET

Panel Tag---------->				NH1	Panel Location:			FIRST FLOOR ROOM 125			
Nominal Phase to Neutral Voltage------->				277	Phase:			3			
Nominal Phase to Phase Voltage-------->				480	Wires:			4			
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	Ltg. Office NW	3	132	3300	w	0.95	3300	3474		
2	A	Ltg. Common Center	3	Hallway 128	1730	w	0.95	1730	1821		
3	B	Ltg. Lobby	3	Lobby	494	w	0.95	494	520		
4	B	Ltg. Office SW	3	104	3500	w	0.95	3500	3684		
5	C	Ltg. Office NW	3	114	2600	w	0.95	2600	2737		
6	C	Ltg. Office Center	3	Elec 125	800	w	0.95	800	842		
7	A	Spare			0	w	0.95	0	0		
8	A	Ltg. Retail South	4	Retail	2100	w	0.95	2100	2211		
9	B	Ltg. Utility South	3	183	1300	w	0.95	1300	1368		
10	B	Ltg. Retail South	4	Retail	2100	w	0.95	2100	2211		
11	C	Ltg. Office East	3	157	1700	w	0.95	1700	1789		
12	C	Ltg. Retail South	4	Retail	2100	w	0.95	2100	2211		
13	A	Spare			0	w	1.00	0	0		
14	A	Spare			0	w	1.00	0	0		
15	B	Spare			0	w	1.00	0	0		
16	B	Spare			0	w	1.00	0	0		
17	C	Spare			0	w	1.00	0	0		
18	C	Spare			0	w	1.00	0	0		
19	A	Spare			0	w	1.00	0	0		
20	A	Spare			0	w	1.00	0	0		
21	B	Spare			0	w	1.00	0	0		
22	B	Spare			0	w	1.00	0	0		
23	C	Spare			0	w	1.00	0	0		
24	C	Spare			0	w	1.00	0	0		
25	A	Spare			0	w	1.00	0	0		
26	A	Spare			0	w	1.00	0	0		
27	B	Spare			0	w	1.00	0	0		
28	B	Spare			0	w	1.00	0	0		
29	C	Spare			0	w	1.00	0	0		
30	C	Spare			0	w	1.00	0	0		
31	A	Empty			0	w	1.00	0	0		
32	A	Empty			0	w	1.00	0	0		
33	B	Empty			0	w	1.00	0	0		
34	B	Empty			0	w	1.00	0	0		
35	C	Empty			0	w	1.00	0	0		
36	C	Empty			0	w	1.00	0	0		
37	A	Empty			0	w	1.00	0	0		
38	A	Empty			0	w	1.00	0	0		
39	B	Empty			0	w	1.00	0	0		
40	B	Empty			0	w	1.00	0	0		
41	C	Empty			0	w	1.00	0	0		
42	C	Empty			0	w	1.00	0	0		
PANEL TOTAL								21.7	22.9	Amps=	27.5

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL		A				7.1	7.5	33%	27.1
PHASE TOTAL		B				7.4	7.8	34%	28.1
PHASE TOTAL		C				7.2	7.6	33%	27.4

LOAD CATAGORIES			Connected			Demand				Ver. 1.01
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0	0.70	0.0	0.0			
2	computers		0.0	0.0	0.80	0.0	0.0			
3	fluorescent lighting		15.4	16.2	1.25	19.3	20.3	0.95		
4	HID lighting		6.3	6.6	1.25	7.9	8.3	0.95		
5	incandescent lighting		0.0	0.0	1.00	0.0	0.0			
6	HVAC fans		0.0	0.0	0.80	0.0	0.0			
7	heating		0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment		0.0	0.0	0.80	0.0	0.0			
Total Demand Loads						27.2	28.6			
Spare Capacity			50%			13.6	14.3			
Total Design Loads						40.7	42.9	0.95	Amps=	51.6

Figure 87 – NH1 Worksheet

LIGHTING AND APPLIANCE PANELBOARD SIZING WORKSHEET

Panel Tag---------->				NH2	Panel Location:			SECOND FLOOR ROOM 205			
Nominal Phase to Neutral Voltage------->				277	Phase:			3			
Nominal Phase to Phase Voltage-------->				480	Wires:			4			
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks	
1	A	35W MR16	5	Room 215	1820	w	0.95	1820	1916		
2	A	75W MR16	5	Room 215	1500	w	0.95	1500	1579		
3	B	Ltg. Common East	3	East	340	w	0.95	340	358		
4	B	Ltg. Office West	3	Room 215	661	w	0.95	661	696		
5	C	Ltg. Office North	3	Room 215	1301	w	0.95	1301	1369		
6	C	Ltg. Clerestory	3	Atrium	620	w	0.95	620	653		
7	A	Spare	3		0	w	0.95	0	0		
8	A	Ltg. Lounge	3	Lounge	408	w	0.95	408	429		
9	B	Ltg. Office Center	3	Room 251	700	w	0.95	700	737		
10	B	Ltg. Office East	3	Room 251	1800	w	0.95	1800	1895		
11	C	Ltg. Office South	3	Room 215	1530	w	0.95	1530	1611		
12	C	Spare			0	w	1.00	0	0		
13	A	Spare			0	w	1.00	0	0		
14	A	Spare			0	w	1.00	0	0		
15	B	Spare			0	w	1.00	0	0		
16	B	Spare			0	w	1.00	0	0		
17	C	Spare			0	w	1.00	0	0		
18	C	Spare			0	w	1.00	0	0		
19	A	Spare			0	w	1.00	0	0		
20	A	Spare			0	w	1.00	0	0		
21	B	Spare			0	w	1.00	0	0		
22	B	Spare			0	w	1.00	0	0		
23	C	Spare			0	w	1.00	0	0		
24	C	Spare			0	w	1.00	0	0		
25	A	Spare			0	w	1.00	0	0		
26	A	Spare			0	w	1.00	0	0		
27	B	Spare			0	w	1.00	0	0		
28	B	Spare			0	w	1.00	0	0		
29	C	Spare			0	w	1.00	0	0		
30	C	Empty			0	w	1.00	0	0		
31	A	Empty			0	w	1.00	0	0		
32	A	Empty			0	w	1.00	0	0		
33	B	Empty			0	w	1.00	0	0		
34	B	Empty			0	w	1.00	0	0		
35	C	Empty			0	w	1.00	0	0		
36	C	Empty			0	w	1.00	0	0		
37	A	Empty			0	w	1.00	0	0		
38	A	Empty			0	w	1.00	0	0		
39	B	Empty			0	w	1.00	0	0		
40	B	Empty			0	w	1.00	0	0		
41	C	Empty			0	w	1.00	0	0		
42	C	Empty			0	w	1.00	0	0		
PANEL TOTAL								10.7	11.2	Amps=	13.5

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					3.7	3.9	35%	14.2
PHASE TOTAL	B					3.5	3.7	33%	13.3
PHASE TOTAL	C					3.5	3.6	32%	13.1

LOAD CATAGORIES			Connected			Demand				Ver. 1.01
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0	0.70	0.0	0.0			
2	computers		0.0	0.0	0.80	0.0	0.0			
3	fluorescent lighting		7.4	7.7	1.25	9.2	9.7	0.95		
4	HID lighting		0.0	0.0	1.25	0.0	0.0			
5	incandescent lighting		3.3	3.5	1.00	3.3	3.5	0.95		
6	HVAC fans		0.0	0.0	0.80	0.0	0.0			
7	heating		0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment		0.0	0.0	0.80	0.0	0.0			
Total Demand Loads						12.5	13.2			
Spare Capacity			50%			6.3	6.6			
Total Design Loads						18.8	19.8	0.95	Amps=	23.8

Figure 88 - NH2 Worksheet

LIGHTING AND APPLIANCE PANELBOARD SIZING WORKSHEET

Panel Tag---------->				NLB3	Panel Location:			LOWER LEVEL				
Nominal Phase to Neutral Voltage------->				120	Phase:			3				
Nominal Phase to Phase Voltage-------->				208	Wires:			4				
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks		
1	A	NDP	5	Showroom	1900	w	1.00	1900	1900			
2	A	NDP	5	Showroom	1900	w	1.00	1900	1900			
3	B	NDP	5	Showroom	1900	w	1.00	1900	1900			
4	B	NDP	5	Showroom	1900	w	1.00	1900	1900			
5	C	NDP	5	Showroom	1900	w	1.00	1900	1900			
6	C	NDP	5	Showroom	1900	w	1.00	1900	1900			
7	A	NDP	5	Showroom	1900	w	1.00	1900	1900			
8	A	NDP	5	Showroom	1900	w	1.00	1900	1900			
9	B	NDP	5	Showroom	1900	w	1.00	1900	1900			
10	B	NDP	5	Showroom	1900	w	1.00	1900	1900			
11	C	NDP	5	Showroom	1900	w	1.00	1900	1900			
12	C	NDP	5	Showroom	1900	w	1.00	1900	1900			
13	A	Spare			0	w	1.00	0	0			
14	A	Spare			0	w	1.00	0	0			
15	B	Spare			0	w	1.00	0	0			
16	B	Spare			0	w	1.00	0	0			
17	C	Spare			0	w	1.00	0	0			
18	C	Spare			0	w	1.00	0	0			
19	A	Spare			0	w	1.00	0	0			
20	A	Spare			0	w	1.00	0	0			
21	B	Spare			0	w	1.00	0	0			
22	B	Spare			0	w	1.00	0	0			
23	C	Spare			0	w	1.00	0	0			
24	C	Spare			0	w	1.00	0	0			
25	A				0	w	1.00	0	0			
26	A				0	w	1.00	0	0			
27	B				0	w	1.00	0	0			
28	B				0	w	1.00	0	0			
29	C				0	w	1.00	0	0			
30	C				0	w	1.00	0	0			
31	A				0	w	1.00	0	0			
32	A				0	w	1.00	0	0			
33	B				0	w	1.00	0	0			
34	B				0	w	1.00	0	0			
35	C				0	w	1.00	0	0			
36	C				0	w	1.00	0	0			
37	A				0	w	1.00	0	0			
38	A				0	w	1.00	0	0			
39	B				0	w	1.00	0	0			
40	B				0	w	1.00	0	0			
41	C				0	w	1.00	0	0			
42	C				0	w	1.00	0	0			
PANEL TOTAL								22.8	22.8	Amps=	63.3	

PHASE LOADING							kW	kVA	%	Amps
PHASE TOTAL		A					7.6	7.6	33%	63.3
PHASE TOTAL		B					7.6	7.6	33%	63.3
PHASE TOTAL		C					7.6	7.6	33%	63.3

LOAD CATAGORIES			Connected			Demand				Ver. 1.01
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0	0.70	0.0	0.0			
2	computers		0.0	0.0	0.80	0.0	0.0			
3	fluorescent lighting		0.0	0.0	1.25	0.0	0.0			
4	HID lighting		0.0	0.0	1.25	0.0	0.0			
5	incandescent lighting		22.8	22.8	1.00	22.8	22.8	1.00		
6	HVAC fans		0.0	0.0	1.00	0.0	0.0			
7	heating		0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment		0.0	0.0	1.00	0.0	0.0			
Total Demand Loads						22.8	22.8			
Spare Capacity			20%			4.6	4.6			
Total Design Loads						27.4	27.4	1.00	Amps=	76.0

Figure 89 – NLB3 Worksheet

LIGHTING AND APPLIANCE PANELBOARD SIZING WORKSHEET

Panel Tag---------->				EM	Panel Location:			FIRST FLOOR ROOM 125				
Nominal Phase to Neutral Voltage------->				277	Phase:			3				
Nominal Phase to Phase Voltage-------->				480	Wires:			4				
Pos	Ph.	Load Type	Cat.	Location	Load	Units	I. PF	Watts	VA	Remarks		
1	A	Ltg. Ext. N/E East	3	Lower Level	200	w	0.95	200	211			
2	A	Ltg. Utility West	3	Lower Level	1375	w	0.95	1375	1447			
3	B	Ltg. Night/Em East	3	Lower Level	1500	w	0.95	1500	1579			
4	B	Ltg. Ext. N/E West	3	Lower Level	500	w	0.95	500	526			
5	C	Ltg. Night/Em West	3	Lower Level	1740	w	0.95	1740	1832			
6	C	Ltg. Stairs	3	Lower Level	421	w	0.95	421	443			
7	A	Spare			0	w	0.95	0	0			
8	A	Ltg. N/E East	3	First Floor	1600	w	0.95	1600	1684			
9	B	Ltg. Utility Center E	3	First Floor	300	w	0.95	300	316			
10	B	Ltg. Lobby	3	First Floor	579	w	0.95	579	609			
11	C	Ltg. N/E West	3	First Floor	1215	w	0.95	1215	1279			
12	C	Ltg. N/E East	3	Second Floo	790	w	0.95	790	832			
13	A	Ltg. Lounge	3	Second Floo	204	w	0.95	204	215			
14	A	Ltg. Utility Center E	3	Second Floo	200	w	0.95	200	211			
15	B	Ltg. N/E West	3	Second Floo	731	w	0.95	731	769			
16	B	EDP	5	Showroom	272	w	1.00	272	272			
17	C	Spare			0	w	1.00	0	0			
18	C	EDP	5	Showroom	272	w	1.00	272	272			
19	A	Spare			0	w	1.00	0	0			
20	A	EDP	5	Showroom	272	w	1.00	272	272			
21	B	Spare			0	w	1.00	0	0			
22	B	Spare			0	w	1.00	0	0			
23	C	Spare			0	w	1.00	0	0			
24	C	Spare			0	w	1.00	0	0			
25	A	Spare			0	w	1.00	0	0			
26	A	Spare			0	w	1.00	0	0			
27	B	Spare			0	w	1.00	0	0			
28	B	Spare			0	w	1.00	0	0			
29	C	Spare			0	w	1.00	0	0			
30	C	Spare			0	w	1.00	0	0			
31	A	Empty			0	w	1.00	0	0			
32	A	Empty			0	w	1.00	0	0			
33	B	Empty			0	w	1.00	0	0			
34	B	Empty			0	w	1.00	0	0			
35	C	Empty			0	w	1.00	0	0			
36	C	Empty			0	w	1.00	0	0			
37	A	Empty			0	w	1.00	0	0			
38	A	Empty			0	w	1.00	0	0			
39	B	Empty			0	w	1.00	0	0			
40	B	Empty			0	w	1.00	0	0			
41	C	Empty			0	w	1.00	0	0			
42	C	Empty			0	w	1.00	0	0			
PANEL TOTAL								12.2	12.8	Amps=	15.4	

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					3.9	4.0	32%	14.6
PHASE TOTAL	B					3.9	4.1	32%	14.7
PHASE TOTAL	C					4.4	4.7	36%	16.8

LOAD CATAGORIES			Connected			Demand				Ver. 1.01
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0	0.70	0.0	0.0			
2	computers		0.0	0.0	0.80	0.0	0.0			
3	fluorescent lighting		11.4	12.0	1.25	14.2	14.9	0.95		
4	HID lighting		0.0	0.0	1.25	0.0	0.0			
5	incandescent lighting		0.8	0.8	1.00	0.8	0.8	1.00		
6	HVAC fans		0.0	0.0	0.80	0.0	0.0			
7	heating		0.0	0.0	1.25	0.0	0.0			
8	kitchen equipment		0.0	0.0	0.80	0.0	0.0			
Total Demand Loads						15.0	15.8			
Spare Capacity			50%			7.5	7.9			
Total Design Loads						22.5	23.6	0.95	Amps=	28.4

Figure 90 – EM Worksheet

FEEDER SCHEDULE

TAG	FROM	TO	NO. OF SETS	CONDUIT (PER SET) SIZE	CONDUIT (PER SET) TYPE	PHASE CONDUCTORS No.	PHASE CONDUCTORS SIZE	PHASE CONDUCTORS TYPE	NEUTRAL CONDUCTORS No.	NEUTRAL CONDUCTORS SIZE	NEUTRAL CONDUCTORS TYPE	GROUND CONDUCTORS No.	GROUND CONDUCTORS SIZE	GROUND CONDUCTORS TYPE	SIZE OF OVERCURRENT PROTECTION	FRAME OR SWITCH SIZE
1	MSB	NHB	1	3/4"	EMT	3	8AWG	CU THWN	1	8AWG	CU THWN	1	10AWG	CU THWN	60	100A/3P
2	MSB	NH1	1	3/4"	EMT	3	8AWG	CU THWN	1	8AWG	CU THWN	1	10AWG	CU THWN	60	100A/3P
3	MSB	EM	1	3/4"	EMT	3	8AWG	CU THWN	1	8AWG	CU THWN	1	10AWG	CU THWN	50	100A/3P
4	MSB	NH2	1	3/4"	EMT	3	8AWG	CU THWN	1	8AWG	CU THWN	1	10AWG	CU THWN	60	100A/3P
5	EM	EDP	1	3/4"	EMT	3	14AWG	CU THWN	1	14AWG	CU THWN	1	14AWG	CU THWN	20	100A/3P
6	NLB3	NDP	1	3/4"	EMT	3	14AWG	CU THWN	1	14AWG	CU THWN	1	14AWG	CU THWN	20	100A/3P
7	MSB	NLB1	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
8	MSB	NLB2	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
9	MSB	NLB3	1	1 1/4"	EMT	3	4AWG	CU THWN	1	4AWG	CU THWN	1	8AWG	CU THWN	80	150A/3P
10	MSB	NL1	1	2 1/2"	EMT	3	4/0AWG	CU THWN	1	4/0AWG	CU THWN	1	6AWG	CU THWN	225	225A/3P
11	MSB	CH-1	2	2 1/2"	EMT	3	350KCMIL	CU THWN	1	350KCMIL	CU THWN	1	1AWG	CU THWN	600	600A/3P
12	MSB	NL1A	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
13	MSB	NL2	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
14	MSB	NLC2A	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
15	MSB	NLCB	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
16	MSB	NLC1	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
17	MSB	NLC2	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
18	MSB	NL2A	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
19	MSB	NLKIT	1	2 1/2"	EMT	3	4/0AWG	CU THWN	1	4/0AWG	CU THWN	1	4AWG	CU THWN	225	225A/3P
20	DSB	SF-1	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
21	DSB	SF-2	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
22	DSB	B-1	1	2"	EMT	3	3/0AWG	CU THWN	1	3/0AWG	CU THWN	1	6AWG	CU THWN	175	175A/3P
23	DSB	B-2	1	2"	EMT	3	3/0AWG	CU THWN	1	3/0AWG	CU THWN	1	6AWG	CU THWN	175	175A/3P
24	DSB	RF-1	1	1 1/2"	EMT	3	1/0AWG	CU THWN	1	1/0AWG	CU THWN	1	6AWG	CU THWN	100	100A/3P
25	MSB	DSB	4	3"	EMT	3	350KCMIL	CU THWN	1	350KCMIL	CU THWN	1	3/0AWG	CU THWN	1200	1200A/3P

NOTES:
1. REFER TO RISER DIAGRAM FOR FEEDER TAGS

AL=ALUMINUM
CU=COPPER

Figure 91 – New Feeder Schedule

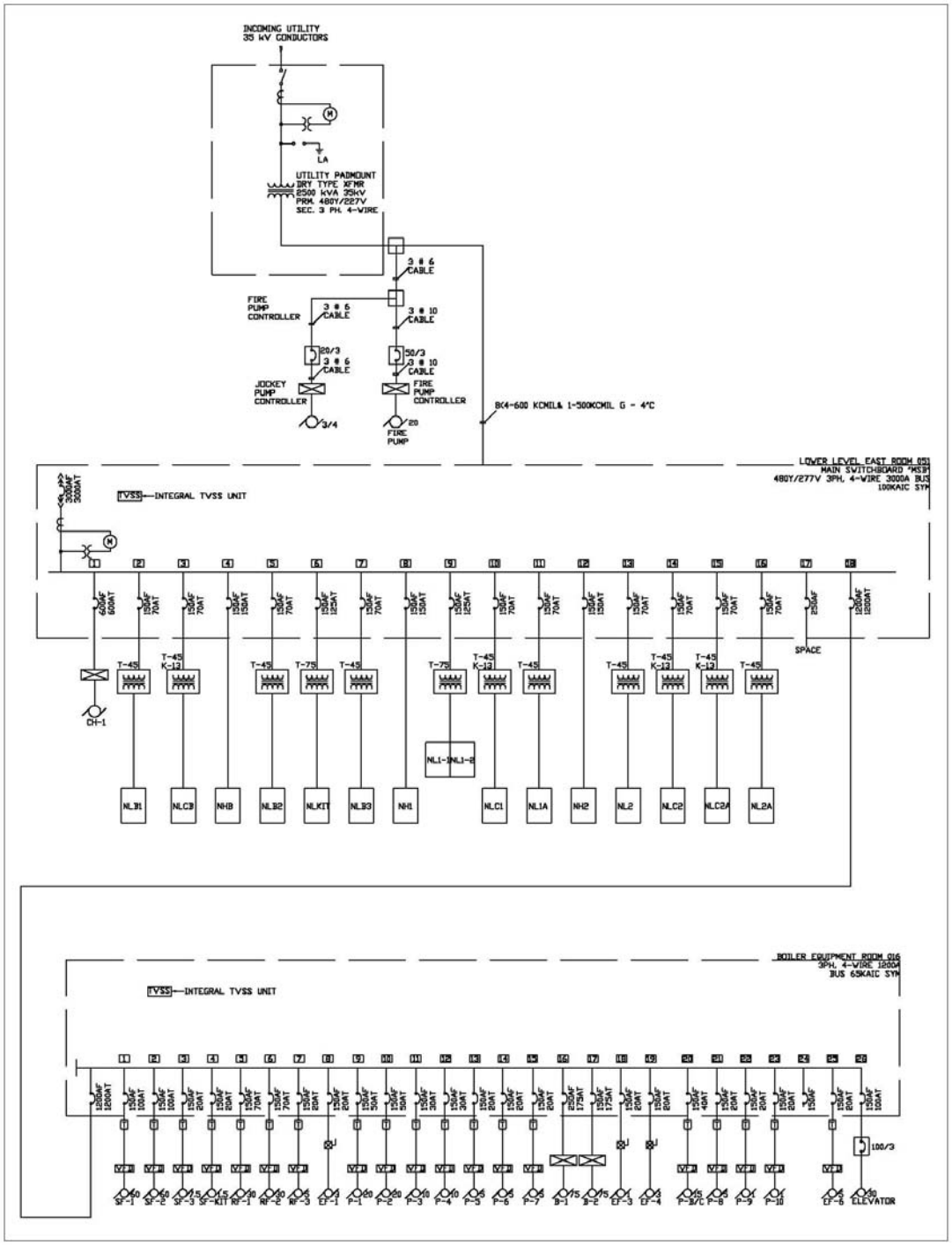


Figure 92– Existing Single- Line Diagram

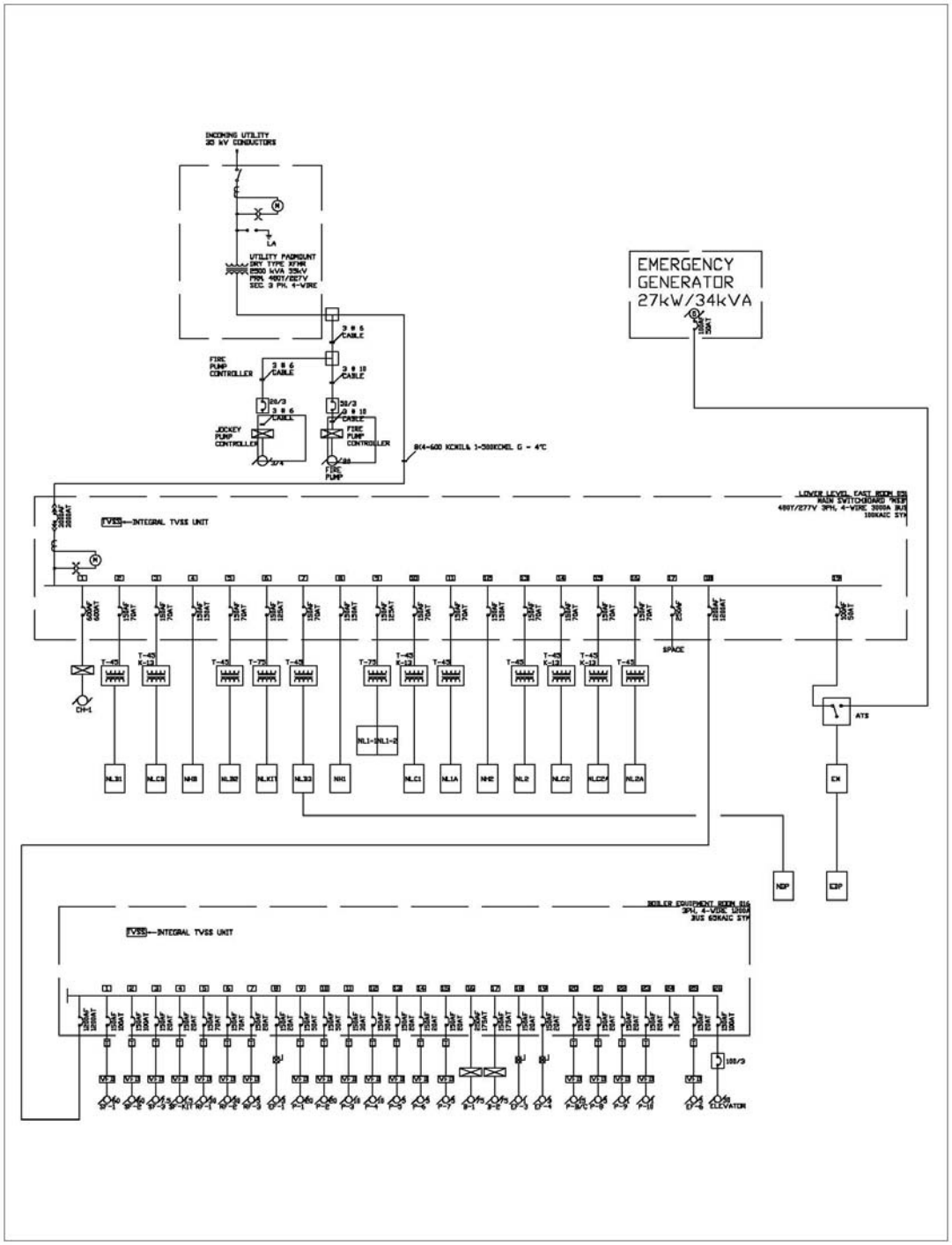


Figure 93 – New Single-Line Diagram

David Rosenberger
Lighting/Electrical Option
Dansko Phase III
West Grove, PA
Dr. Mistrick
April 12, 2007

Emergency Generator

Following the evaluation of the existing emergency lighting system, it was found that battery ballasts were used. These specialized ballasts are located within each emergency fixture, and are made to provide power in the event that the utility supplied power is interrupted. NEC specifies that battery ballasts must provide operation for no less than 90 minutes. It also specifies that each battery ballast be checked for operation once a year, which can be come quite a maintenance headache. Additionally, after a time the battery ballasts will lose their ability to hold a charge and will need to be replaced. In comparison, checking the operation of a single emergency generator requires much less time, and generators (with proper maintenance) can potentially last the lifetime of the building.

The entire building was examined and the emergency loads were determined. The existing emergency loads were designated Night/Emergency, meaning they were to stay on at night. Although the lengths were not noted in the drawings, they were estimated using building lines and corridors. A voltage drop calculation was made for the longer loads and found to be within acceptance. After summing all of the existing emergency loads and the new emergency loads, a total demand of approximately 23kW was determined.

A generator from Kohler Power Systems was selected that provides a standby rating of 30-35kW and a prime rating of 27-33kW, which is enough to power the lighting loads. Had more devices considered to be powered by the emergency generator, a large one would be required. There is enough space in the lower level east electrical room 051 for the generator to be placed. Additionally, it would be easy to provide the necessary exhaust because the electrical room adjoins an exterior wall. Although it is below grade, it would be possible to excavate the area at the wall to install a supply/exhaust vent.

The dimensions of the generator are 78.71”L x 40.94”W x 50.15”H, and it weighs 1560lbs. Based on the weight of the generator and the location, it would not have an effect on the structure of the building.

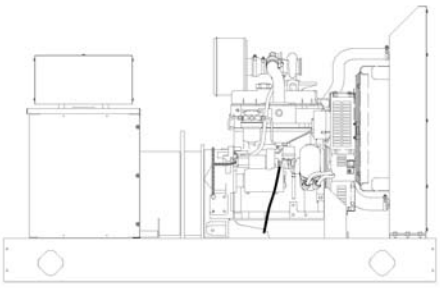
Model: 30REOZJB

KOHLER POWER SYSTEMS | **190–600 V** | **Diesel**

ISO 9001 KOHLER POWER SYSTEMS NATIONALLY REGISTERED

Ratings Range

		60 Hz	50 Hz
Standby:	**kW**	30–35	25–29
	kVA	30–44	25–36
Prime:	**kW**	27–33	23–26
	kVA	27–41	23–33



Generator Set Ratings

Alternator	Voltage	Ph	Hz	130°C Rise Standby Rating kW/kVA	130°C Rise Standby Rating Amps	105°C Rise Prime Rating kW/kVA	105°C Rise Prime Rating Amps
4P5W/ 4P5	120/208	3	60	35/44	121	33/41	115
	127/220	3	60	34/43	112	31/39	102
	120/240	3	60	35/44	105	33/41	99
	120/240	1	60	33/33	138	30/30	125
	139/240	3	60	34/43	102	31/39	93
	220/380	3	60	35/44	66	32/40	61
	240/416	3	60	35/44	61	33/41	57
	277/480	3	60	34/43	51	31/39	47
	347/600	3	60	33/41	40	30/38	36
	110/190	3	50	27/34	103	26/33	97
	115/200	3	50	26/33	95	24/30	87
	120/208	3	50	26/33	92	23/29	80
	110/220	3	50	29/36	94	26/33	87
	110/220	1	50	26/26	118	24/24	109
	220/380	3	50	27/34	52	26/33	49
	230/400	3	50	26/33	48	24/30	43
	240/416	3	50	26/33	46	23/29	40
4Q4W/ 4Q4	120/240	1	60	30/30	125	27/27	113
	110/220	1	50	25/25	114	23/23	105

RATINGS: All three-phase units are rated at 0.8 power factor. All single-phase units are rated at 1.0 power factor. *Standby Ratings:* Standby ratings apply to installations served by a reliable utility source. The standby rating is applicable to varying loads for the duration of a power outage. There is no overload capability for this rating. Ratings are in accordance with ISO-3046/1, BS 5514, AS 2789, and DIN 6271. *Prime Power Ratings:* Prime power ratings apply to installations where utility power is unavailable or unreliable. At varying load, the number of generator set operating hours is unlimited. A 10% overload capacity is available for one hour in twelve. Ratings are in accordance with ISO-8528/1, overload power in accordance with ISO-3046/1, BS 5514, AS 2789, and DIN 6271. For limited running time and base load ratings, consult the factory. Obtain the technical information bulletin (TIB-101) on ratings guidelines for the complete ratings definitions. The generator set manufacturer reserves the right to change the design or specifications without notice and without any obligation or liability whatsoever. GENERAL GUIDELINES FOR DERATION: *Altitude:* Derate 1.3% per 100 m (328 ft.) elevation above 2000 m (6560 ft.). *Temperature:* Derate 1.0% per 10°C (18°F) temperature above 40°C (104°F).

Standard Features

- Kohler Co. provides one-source responsibility for the generating system and accessories.
- The generator set and its components are prototype-tested, factory-built, and production-tested.
- The 60 Hz generator set offers a UL 2200 listing.
- The generator set accepts rated load in one step.
- The generator set complies with ISO 8528-5, Class G2, requirements for transient performance in all generator set configurations. Select the Decision-Maker™ 550 controller for improved voltage regulation and ISO 8528-5, Class G3, compliance.
- A one-year limited warranty covers all systems and components. Two-, five-, and ten-year extended warranties are also available.
- Alternator features:
  - Kohler's Fast-Response™ III wound field (WF) design alternator provides excellent voltage response and short-circuit capability using an auxiliary power brushless exciter.
  - Kohler's unique Fast-Response™ II excitation system delivers excellent voltage response and short circuit capability using a permanent magnet (PM)-excited alternator.
  - The brushless, rotating-field alternator has broadrange reconnectability.
- Other features:
  - Controllers are available for all applications. See controller features inside.
  - The low coolant level shutdown prevents overheating (standard on radiator models only).
  - Integral vibration isolation eliminates the need for under-unit vibration spring isolators.

Available Option

- The 3029TF270 engine is certified by the Environmental Protection Agency (EPA) to conform to Tier 2 nonroad emissions regulations.

G5-203 (30REOZJB) 3/06k

Figure 94 – Generator Page 1

Alternator Specifications

Specifications	Alternator
Manufacturer	Kohler
Type	4-Pole, Rotating-Field
Exciter type	
Wound field (WF)	Wound Exciter Field with Separate Excitation Power Winding
Permanent magnet (PM)	Brushless, Permanent-Magnet
Leads: quantity, type	12, Reconnectable
Voltage regulator	Solid State, Volts/Hz
Insulation:	NEMA MG1
Material	Class H
Temperature rise	130°C, Standby
Bearing: quantity, type	1, Sealed
Coupling	Flexible Disc
Amortisseur windings	Full
Voltage regulation, no-load to full-load	
Wound field (WF) alternator	±0.25% Average
Permanent magnet (PM) alternator	±2% Average
550 controller (with 0.5% drift due to temperature variation)	3-Phase Sensing, ±0.25%
One-step load acceptance	100% of Rating
Unbalanced load capability	100% of Rated Standby Current
Peak motor starting kVA:	(35% dip for voltages below)
480 V, 380 V 4P5W/4P5 (12 lead)	140 (60 Hz), 98 (50 Hz)
240 V, 220 V 4Q4W/4Q4 (4 lead)	72 (60 Hz), 88 (50 Hz)

- NEMA MG1, IEEE, and ANSI standards compliance for temperature rise and motor starting.
- Sustained short-circuit current of up to 300% of the rated current for up to 10 seconds.
- Sustained short-circuit current enabling downstream circuit breakers to trip without collapsing the alternator field.
- Self-ventilated and dripproof construction.
- Vacuum-impregnated windings with fungus-resistant epoxy varnish for dependability and long life.
- Superior voltage waveform from a two-thirds pitch stator and skewed rotor.
- Fast-Response™ III wound field (WF) brushless alternator with auxiliary power brushless exciter for excellent load response.
- Fast-Response™ II brushless alternator with brushless exciter for excellent load response.

Application Data

Engine

Engine Specifications	60 Hz	50 Hz
Manufacturer	John Deere	
Engine model, non-emissions certified	3029TF150	3029TF120
Engine model, EPA certified	3029TF270	—
Engine type	4-Cycle, Turbocharged	
Cylinder arrangement	3 Inline	
Displacement, L (cu. in.)	2.9 (177)	
Bore and stroke, mm (in.)	106 x 110 (4.17 x 4.33)	
Compression ratio	17.2:1	
Piston speed, m/min. (ft./min.)	396 (1299)	330 (1083)
Main bearings: quantity, type	4, Replaceable Insert	
Rated rpm	1800	1500
Max. power at rated rpm, kWm (BHP)	48 (64)	42 (56)
Cylinder head material	Cast Iron	
Crankshaft material	Forged Steel	
Valve material:		
Intake	Chromium-Silicon Steel	
Exhaust	Stainless Steel	
Governor: type, make/model	Mechanical, Stanadyne/DB2	
Frequency regulation, no-load to full-load	3-5%	
Frequency regulation, steady state	±0.33% (mech. governor) ±0.25% (elect. isoch. gov.)	
Frequency	Fixed	
Air cleaner type, all models	Dry	

Exhaust

Exhaust System	60 Hz	50 Hz
Exhaust manifold type	Dry	
Exhaust flow at rated kW, non-emissions certified, m^3/min. (cfm)	8.4 (295)	6.2 (220)
Exhaust flow at rated kW, EPA certified, m^3/min. (cfm)	9.1 (320)	—
Exhaust temperature at rated kW, dry exhaust, non-emissions certified, °C (°F)	474 (885)	510 (950)
Exhaust temperature at rated kW, dry exhaust, EPA certified, °C (°F)	498 (928)	—
Maximum allowable back pressure, kPa (in. Hg)	7.5 (2.2)	
Exhaust outlet size at engine hookup, mm (in.)	63.5 (2.5)	

Engine Electrical

Engine Electrical System	60 Hz	50 Hz
Battery charging alternator:	12 Volt	
Ground (negative/positive)	Negative	
Volts (DC)	12	
Ampere rating	55	
Starter motor rated voltage (DC)	12	
Battery, recommended cold cranking amps (CCA):		
Quantity, CCA rating	One, 640	
Battery voltage (DC)	12	

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Figure 95 – Generator Sheet 2

Application Data

Fuel

Fuel System	60 Hz	50 Hz
Fuel supply line, min. ID, mm (in.)	11.0 (0.44)	
Fuel return line, min. ID, mm (in.)	6.0 (0.25)	
Max. lift, fuel pump: type, m (ft.)	Engine-Driven, 1.8 (6.0)	
Max. fuel flow, Lph (gph)	112 (29.6)	108 (28.6)
Fuel prime pump	Manual	
Fuel filter		
Secondary	8 Microns @ 98% Efficiency	
Water Separator	Yes	
Recommended fuel	#2 Diesel	

Lubrication

Lubricating System	60 Hz	50 Hz
Type	Full Pressure	
Oil pan capacity, L (qt.)	7.6 (8.0)	
Oil pan capacity with filter, L (qt.)	8.5 (9.0)	
Oil filter: quantity, type	1, Cartridge	
Oil cooler	Water-Cooled	

Cooling

Radiator System	60 Hz	50 Hz
Ambient temperature, °C (°F)	50 (122)	
Engine jacket water capacity, L (gal.)	5.7 (1.5)	
Radiator system capacity, including engine, L (gal.)	13.6 (4.6)	
Engine jacket water flow, Lpm (gpm)	110 (29)	91 (24)
Heat rejected to cooling water at rated kW, dry exhaust, EPA certified, kW (Btu/min.)	24.3 (1380)	19.1 (1085)
Heat rejected to cooling water at rated kW, dry exhaust, certified, kW (Btu/min.)	26.9 (1530)	—
Water pump type	Centrifugal	
Fan diameter, including blades, mm (in.)	483 (19)	
Fan, kWm (HP)	2.1 (2.8)	1.5 (2.0)
Max. restriction of cooling air, intake and discharge side of radiator, kPa (in. H_2O)	0.125 (0.5)	

Remote Radiator System†	60 Hz	50 Hz
Exhaust manifold type	Dry	
Connection sizes:		
Water inlet, ID hose, mm (in.)	48 (1.88)	
Water outlet, ID hose, mm (in.)	38 (1.50)	
Static head allowable above engine, kPa (ft. H_2O)	63 (21)	

† Contact your local distributor for cooling system options and specifications based on your specific application.

Operation Requirements

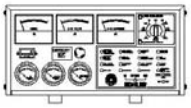
Air Requirements	60 Hz	50 Hz
Radiator-cooled cooling air, m^3/min. (scfm)‡	91 (3200)	76 (2700)
Cooling air required for generator set when equipped with city water cooling or remote radiator, based on 14°C (25°F) rise and ambient temp. of 29°C (85°F), m^3/min. (cfm)	54 (1900)	43 (1500)
Combustion air, m^3/min. (cfm)	3.5 (123)	2.7 (97)
Heat rejected to ambient air:		
Engine, kW (Btu/min.)	8.8 (500)	7.0 (400)
Alternator, kW (Btu/min.)	5.6 (320)	4.7 (270)

‡ Air density = 1.20 kg/m^3 (0.075 lbm/ft^3)

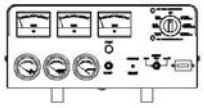
Fuel Consumption, Non-Emissions Certified	60 Hz		50 Hz	
Diesel, Lph (gph) at % load	Standby Rating			
100%	11.0	(2.9)	8.5	(2.2)
75%	8.5	(2.2)	6.6	(1.7)
50%	6.2	(1.6)	5.1	(1.3)
25%	3.9	(1.0)	3.7	(1.0)
Diesel, Lph (gph) at % load	Prime Rating			
100%	10.0	(2.6)	8.3	(2.2)
75%	7.8	(2.1)	6.4	(1.7)
50%	5.6	(1.5)	4.8	(1.3)
25%	3.9	(1.0)	3.5	(0.9)
Fuel Consumption, EPA Certified	**60 Hz**		**50 Hz**	
Diesel, Lph (gph) at % load	Standby Rating			
100%	11.6	(3.1)	—	—
75%	9.0	(2.4)	—	—
50%	6.6	(1.7)	—	—
25%	4.0	(1.1)	—	—
Diesel, Lph (gph) at % load	Prime Rating			
100%	10.6	(2.8)	—	—
75%	8.3	(2.2)	—	—
50%	6.1	(1.6)	—	—
25%	3.8	(1.0)	—	—

Controllers

Decision-Maker™ 550 Controller
Audiovisual annunciation with NFPA 110 Level 1 capability.
Programmable microprocessor logic and digital display features.
Alternator safeguard circuit protection.
12- or 24-volt engine electrical system capability.
Remote start, remote annunciation, and remote communication options.
Refer to G6-46 for additional controller features and accessories.



Decision-Maker™ 3+, 16-Light Controller
Audiovisual annunciation with NFPA 110 Level 1 capability.
Microprocessor logic, AC meters, and engine gauge features.
12- or 24-volt engine electrical system capability.
Remote start, prime power, and remote annunciation options.
Refer to G6-30 for additional controller features and accessories.



Decision-Maker™ 1 Controller
Single-light annunciation and basic controls with NFPA capability.
Relay logic, AC meters, and engine gauge features.
12-volt engine electrical system capability only.
Remote or automatic start options.
Refer to G6-29 for additional controller features and accessories.
Note: Not available with 600-volt alternator.

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Figure 96 – Generator Sheet 3

KOHLER CO., Kohler, Wisconsin 53044 USA
Phone 920-565-3381, Fax 920-459-1646
For the nearest sales and service outlet in the
US and Canada, phone 1-800-544-2444
KohlerPowerSystems.com

Kohler Power Systems
Asia Pacific Headquarters
7 Jurong Pier Road
Singapore 619159
Phone (65) 6264-6422, Fax (65) 6264-6455

Additional Standard Features

- Alternator Protection (standard with 550 controller)
- Battery Rack and Cables
- Integral Vibration Isolation
- Oil Drain Extension
- Operation and Installation Literature

Available Accessories

Enclosed Unit
- ❑ Sound Enclosure (with enclosed critical silencer)
- ❑ Weather Enclosure (with enclosed critical silencer)
- ❑ Weather Housing (with roof-mounted critical silencer)

Open Unit
- ❑ Exhaust Silencer, Critical (kit: PA-352663)
- ❑ Exhaust Silencer, Hospital (kit: GM32386-KP1)
- ❑ Flexible Exhaust Connector, Stainless Steel

Cooling System
- ❑ Block Heater (recommended for ambient temperatures below 0°C [32°F])
- ❑ Radiator Duct Flange
- ❑ Remote Radiator Cooling

Fuel System
- ❑ Auxiliary Fuel Pump
- ❑ Flexible Fuel Lines
- ❑ Fuel Pressure Gauge
- ❑ Subbase Fuel Tanks
- ❑ Subbase Fuel Tank with Day Tank

Electrical System
- ❑ Battery
- ❑ Battery Charger, Equalize/Float Type
- ❑ Battery Heater

Engine and Alternator
- ❑ Alternator, Wound Field (WF)
- ❑ Alternator, Permanent Magnet (PM)
- ❑ Air Cleaner, Heavy Duty
- ❑ Air Cleaner Restriction Indicator
- ❑ Alternator Strip Heater
- ❑ Bus Bar Kits
- ❑ Closed Crankcase Vent
- ❑ CSA Certification
- ❑ Current Transformer Kit
- ❑ Electronic Isochronous Governor (±0.25% freq. reg. steady state)
- ❑ EPA Certified Engine for Tier 2
- ❑ Line Circuit Breaker (NEMA type 1 enclosure)
- ❑ Line Circuit Breaker with Shunt Trip (NEMA type 1 enclosure)
- ❑ Optional Alternators
- ❑ Rated Power Factor Testing
- ❑ Rodent Guards
- ❑ Safeguard Breaker (not available with 550 controller)
- ❑ Skid End Caps

Paralleling System
- ❑ Reactive Droop Compensator
- ❑ Voltage Adjust Control
- ❑ Voltage Regulator Relocation Kit

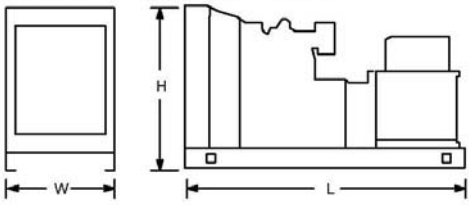
Maintenance
- ❑ General Maintenance Literature Kit
- ❑ Maintenance Kit (includes standard air, oil, and fuel filters)
- ❑ NFPA 110 Literature
- ❑ Overhaul Literature Kit
- ❑ Production Literature Kit

Controller (550 and 16-Light Controllers)
- ❑ Common Failure Relay Kit
- ❑ Communication Products and PC Software (550 controller only)
- ❑ Customer Connection Kit
- ❑ Dry Contact Kit (isolated alarm)
- ❑ Engine Prealarm Sender Kit
- ❑ Prime Power Switch (550 controller only)
- ❑ Remote Annunciator Panel
- ❑ Remote Audiovisual Alarm Panel
- ❑ Remote Emergency Stop Kit
- ❑ Remote Mounting Cable
- ❑ Run Relay Kit

Miscellaneous Accessories
- ❑ _____
- ❑ _____
- ❑ _____
- ❑ _____

Dimensions and Weights

Overall Size, L x W x H, mm (in.):
Wide Skid: 2000 x 1040 x 1274 (78.74 x 40.94 x 50.15)
Narrow Skid: 2000 x 864 x 1274 (78.74 x 34.02 x 50.15)
Weight (radiator model), wet, kg (lb.): 708 (1560)



NOTE: This drawing is provided for reference only and should not be used for planning installation. Contact your local distributor for more detailed information.

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Figure 97 – Generator Sheet 4

Comparing Feeder Material: Copper vs. Aluminum

This section determines the cost savings in switching 25 copper feeders to aluminum. Electrical wiring in a building accounts for a large cost. Switching from a more expensive copper feeder to an aluminum feeder has the potential, depending on the size of the project, for significant savings. While this study focuses on 25 feeders, it would be acceptable to say that the savings would be proportionate to the rest of the building encompassing all of the feeders. Through research into copper vs. aluminum feeders, it was found that using aluminum wiring inside buildings is ill-advised, due to the difference in the thermal properties of aluminum as compared to copper. Using aluminum for the feeder from utility into the building is the only recommended application for aluminum since this application has a steady temperature. This study, however, will determine the cost savings *in theory* in switching from copper to aluminum wiring for feeders inside the building. Figure 98 shows the feeder calculations for copper wiring, while figure 99 shows the feeder calculations for aluminum wiring.

In this example, it was found that copper feeders would cost $149,232.92. The Aluminum feeders cost $118,232.56. For this particular comparison, a savings of $31,000.36 is possible.

FEEDER SCHEDULE

				CONDUIT (PER SET)		CONDUCTORS (PER SET)									SIZE OF OVERCURRENT PROTECTION	FRAME OR SWITCH SIZE
						PHASE CONDUCTORS			NEUTRAL CONDUCTORS			GROUND CONDUCTORS				
TAG	FROM	TO	NO. OF SETS	SIZE	TYPE	No.	SIZE	TYPE	No.	SIZE	TYPE	No.	SIZE	TYPE		SIZE
1	MSB	NHB	1	3/4"	EMT	3	8AWG	CU THWN	1	8AWG	CU THWN	1	10AWG	CU THWN	60	60A/3P
2	MSB	NH1	1	3/4"	EMT	3	8AWG	CU THWN	1	8AWG	CU THWN	1	10AWG	CU THWN	60	60A/3P
3	MSB	EMB	1	3/4"	EMT	3	12AWG	CU THWN	1	12AWG	CU THWN	1	14AWG	CU THWN	30	30A/3P
4	MSB	NH2	1	3/4"	EMT	3	8AWG	CU THWN	1	8AWG	CU THWN	1	10AWG	CU THWN	60	60A/3P
5	EMB	EM1	1	3/4"	EMT	3	14AWG	CU THWN	1	14AWG	CU THWN	1	14AWG	CU THWN	20	20A/3P
6	EM1	EM2	1	3/4"	EMT	3	14AWG	CU THWN	1	14AWG	CU THWN	1	14AWG	CU THWN	20	20A/3P
7	MSB	NLB1	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
8	MSB	NLB2	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
9	MSB	NLB3	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
10	MSB	NL1 (1)	1	2 1/2"	EMT	3	4/0AWG	CU THWN	1	4/0AWG	CU THWN	1	6AWG	CU THWN	225	225A/3P
11	MSB	NL1 (2)	1	2 1/2"	EMT	3	4/0AWG	CU THWN	1	4/0AWG	CU THWN	1	4AWG	CU THWN	225	225A/3P
12	MSB	NL1A	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
13	MSB	NL2	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
14	MSB	NLC2A	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
15	MSB	NLCB	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
16	MSB	NLC1	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
17	MSB	NLC2	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
18	MSB	NL2A	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
19	MSB	NLKIT	1	2 1/2"	EMT	3	4/0AWG	CU THWN	1	4/0AWG	CU THWN	1	4AWG	CU THWN	225	225A/3P
20	DSB	SF-1	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
21	DSB	SF-2	1	2"	EMT	3	2/0AWG	CU THWN	1	2/0AWG	CU THWN	1	6AWG	CU THWN	150	150A/3P
22	DSB	B-1	1	2"	EMT	3	3/0AWG	CU THWN	1	3/0AWG	CU THWN	1	6AWG	CU THWN	175	175A/3P
23	DSB	B-2	1	2"	EMT	3	3/0AWG	CU THWN	1	3/0AWG	CU THWN	1	6AWG	CU THWN	175	175A/3P
24	DSB	RF-1	1	1 1/2"	EMT	3	1/0AWG	CU THWN	1	1/0AWG	CU THWN	1	6AWG	CU THWN	100	100A/3P
25	DSB	RF-2	1	1 1/2"	EMT	3	1/0AWG	CU THWN	1	1/0AWG	CU THWN	1	6AWG	CU THWN	100	100A/3P

NOTES:
1. REFER TO RISER DIAGRAM FOR FEEDER TAGS

AL=ALUMINUM
CU=COPPER

Figure 98 – Copper Feeder Schedule

FEEDER SCHEDULE

				CONDUIT (PER SET)		CONDUCTORS (PER SET)									SIZE OF OVERCURRENT PROTECTION	FRAME OR SWITCH SIZE
						PHASE CONDUCTORS			NEUTRAL CONDUCTORS			GROUND CONDUCTORS				
TAG	FROM	TO	NO. OF SETS	SIZE	TYPE	No.	SIZE	TYPE	No.	SIZE	TYPE	No.	SIZE	TYPE		
1	MSB	NHB	1	1 1/4"	EMT	3	4AWG	AL THWN	1	4AWG	AL THWN	1	8AWG	AL THWN	60	60A/3P
2	MSB	NH1	1	1 1/4"	EMT	3	4AWG	AL THWN	1	4AWG	AL THWN	1	8AWG	AL THWN	60	60A/3P
3	MSB	EMB	1	3/4"	EMT	3	8AWG	AL THWN	1	8AWG	AL THWN	1	8AWG	AL THWN	30	30A/3P
4	MSB	NH2	1	1 1/4"	EMT	3	4AWG	AL THWN	1	4AWG	AL THWN	1	8AWG	AL THWN	60	60A/3P
5	EMB	EM1	1	3/4"	EMT	3	10AWG	AL THWN	1	10AWG	AL THWN	1	10AWG	AL THWN	20	20A/3P
6	EM1	EM2	1	3/4"	EMT	3	10AWG	AL THWN	1	10AWG	AL THWN	1	10AWG	AL THWN	20	20A/3P
7	MSB	NLB1	1	2"	EMT	3	3/0AWG	AL THWN	1	3/0AWG	AL THWN	1	4AWG	AL THWN	150	150A/3P
8	MSB	NLB2	1	2"	EMT	3	3/0AWG	AL THWN	1	3/0AWG	AL THWN	1	4AWG	AL THWN	150	150A/3P
9	MSB	NLB3	1	2"	EMT	3	3/0AWG	AL THWN	1	3/0AWG	AL THWN	1	4AWG	AL THWN	150	150A/3P
10	MSB	NL1 (1)	1	2 1/2"	EMT	3	300KCMIL	AL THWN	1	300KCMIL	AL THWN	1	2AWG	AL THWN	225	225A/3P
11	MSB	CH-1	2	3"	EMT	3	400KCMIL	AL THWN	1	400KCMIL	AL THWN	1	2/0AWG	AL THWN	600	600A/3P
12	MSB	NL1A	1	2"	EMT	3	3/0AWG	AL THWN	1	3/0AWG	AL THWN	1	4AWG	AL THWN	150	150A/3P
13	MSB	NL2	1	2"	EMT	3	3/0AWG	AL THWN	1	3/0AWG	AL THWN	1	4AWG	AL THWN	150	150A/3P
14	MSB	NLC2A	1	2"	EMT	3	3/0AWG	AL THWN	1	3/0AWG	AL THWN	1	4AWG	AL THWN	150	150A/3P
15	MSB	NLCB	1	2"	EMT	3	3/0AWG	AL THWN	1	3/0AWG	AL THWN	1	4AWG	AL THWN	150	150A/3P
16	MSB	NLC1	1	2"	EMT	3	3/0AWG	AL THWN	1	3/0AWG	AL THWN	1	4AWG	AL THWN	150	150A/3P
17	MSB	NLC2	1	2"	EMT	3	3/0AWG	AL THWN	1	3/0AWG	AL THWN	1	4AWG	AL THWN	150	150A/3P
18	MSB	NL2A	1	2"	EMT	3	3/0AWG	AL THWN	1	3/0AWG	AL THWN	1	4AWG	AL THWN	150	150A/3P
19	MSB	NLKIT	1	2 1/2"	EMT	3	300KCMIL	AL THWN	1	300KCMIL	AL THWN	1	2AWG	AL THWN	225	225A/3P
20	DSB	SF-1	1	2"	EMT	3	3/0AWG	AL THWN	1	3/0AWG	AL THWN	1	4AWG	AL THWN	150	150A/3P
21	DSB	SF-2	1	2"	EMT	3	3/0AWG	AL THWN	1	3/0AWG	AL THWN	1	4AWG	AL THWN	150	150A/3P
22	DSB	B-1	1	2 1/2"	EMT	3	4/0AWG	AL THWN	1	4/0AWG	AL THWN	1	4AWG	AL THWN	175	175A/3P
23	DSB	B-2	1	2 1/2"	EMT	3	4/0AWG	AL THWN	1	4/0AWG	AL THWN	1	4AWG	AL THWN	175	175A/3P
24	DSB	RF-1	1	1 1/2"	EMT	3	1AWG	AL THWN	1	1AWG	AL THWN	1	6AWG	AL THWN	100	100A/3P
25	MSB	DSB	4	3"	EMT	3	500KCMIL	AL THWN	1	500KCMIL	AL THWN	1	250KCMIL	AL THWN	1200	1200A/3P

NOTES:
1. REFER TO RISER DIAGRAM FOR FEEDER TAGS

AL=ALUMINUM
CU=COPPER

Figure 99 – Aluminum Feeder Schedule

Comparing Feeder Material: Copper vs. Aluminum																		
Feeder Tag	From	To	Length (ft)	Design Load (A)	Protection	No. of Sets	Phase/Neutral Size		Cost per foot		Ground Size		Cost per Foot		Conduit Size	Conduit Cost	Cost	
							Copper	Aluminum	Copper	Aluminum	Copper	Aluminum	Copper	Aluminum			Copper	Aluminum
3	MSB	EM	168	28	60	1	8AWG	6AWG	1.15	0.935	10AWG	6AWG	0.82	0.935	0.75	8.4	$2,321.76	$2,196.60
1	MSB	NHB	130	53	60	1	8AWG	6AWG	1.15	0.935	10AWG	6AWG	0.82	0.935	0.75	8.4	$1,796.60	$1,699.75
2	MSB	NH1	168	51	60	1	8AWG	6AWG	1.15	0.935	10AWG	6AWG	0.82	0.935	0.75	8.4	$2,321.76	$2,196.60
4	MSB	NH2	160	24	60	1	8AWG	6AWG	1.15	0.935	10AWG	6AWG	0.82	0.935	0.75	8.4	$2,211.20	$2,092.00
22	DSB	RF-1	78	40	70	1	6AWG	4AWG	1.63	1.15	8AWG	6AWG	1.15	0.935	1	11.1	$1,464.06	$1,297.53
25	DSB	RF-2	68	40	70	1	6AWG	4AWG	1.63	1.15	8AWG	6AWG	1.15	0.935	1	11.1	$1,276.36	$1,131.18
5	MSB	NLB1	26	42.67	150	1	1/0AWG	2/0AWG	4.5	2.78	6AWG	4AWG	1.63	2.78	1.5	14.4	$884.78	$735.80
6	MSB	NLB2	130	125.33	150	1	1/0AWG	2/0AWG	4.5	2.78	6AWG	4AWG	1.63	2.78	1.5	14.4	$4,423.90	$3,679.00
7	MSB	NLB3	130	112.67	150	1	1/0AWG	2/0AWG	4.5	2.78	6AWG	4AWG	1.63	2.78	1.5	14.4	$4,423.90	$3,679.00
10	MSB	NL1A	168	114.17	150	1	1/0AWG	2/0AWG	4.5	2.78	6AWG	4AWG	1.63	2.78	1.5	14.4	$5,717.04	$4,754.40
11	MSB	NL2	160	113.33	150	1	1/0AWG	2/0AWG	4.5	2.78	6AWG	4AWG	1.63	2.78	1.5	14.4	$5,444.80	$4,528.00
12	MSB	NLC2A	160	18.67	150	1	1/0AWG	2/0AWG	4.5	2.78	6AWG	4AWG	1.63	2.78	1.5	14.4	$5,444.80	$4,528.00
13	MSB	NLCB	26	28	150	1	1/0AWG	2/0AWG	4.5	2.78	6AWG	4AWG	1.63	2.78	1.5	14.4	$884.78	$735.80
14	MSB	NLC1	168	51.67	150	1	1/0AWG	2/0AWG	4.5	2.78	6AWG	4AWG	1.63	2.78	1.5	14.4	$5,717.04	$4,754.40
15	MSB	NLC2	160	36	150	1	1/0AWG	2/0AWG	4.5	2.78	6AWG	4AWG	1.63	2.78	1.5	14.4	$5,444.80	$4,528.00
16	MSB	NL2A	160	85.53	150	1	1/0AWG	2/0AWG	4.5	2.78	6AWG	4AWG	1.63	2.78	1.5	14.4	$5,444.80	$4,528.00
18	DSB	SF-1	78	77	150	1	1/0AWG	2/0AWG	4.5	2.78	6AWG	4AWG	1.63	2.78	1.5	14.4	$2,654.34	$2,207.40
19	DSB	SF-2	68	77	150	1	1/0AWG	2/0AWG	4.5	2.78	6AWG	4AWG	1.63	2.78	1.5	14.4	$2,314.04	$1,924.40
20	DSB	B-1	152	96	175	1	2/0AWG	3/0AWG	5.45	3.05	6AWG	4AWG	1.63	3.05	2	17.85	$6,274.56	$5,031.20
21	DSB	B-2	152	96	175	1	2/0AWG	3/0AWG	5.45	3.05	6AWG	4AWG	1.63	3.05	2	17.85	$6,274.56	$5,031.20
8	MSB	NL1-1	168	203	225	1	3/0AWG	250KCMIL	6.7	4.2	4AWG	2AWG	2.29	4.2	2	17.85	$7,885.92	$6,526.80
17	MSB	NLKIT	130	89.33	225	1	3/0AWG	250KCMIL	6.7	4.2	4AWG	2AWG	2.29	4.2	2	17.85	$6,102.20	$5,050.50
24	MSB	NL1-2	168	93	225	1	3/0AWG	250KCMIL	6.7	4.2	4AWG	2AWG	2.29	4.2	2	17.85	$7,885.92	$6,526.80
9	MSB	CH-1	150	339.2	600	2	350KCMIL	500KCMIL	12.25	6.5	1AWG	2/0AWG	3.9	6.5	2	17.85	$21,225.00	$15,105.00
23	MSB	DSB	118	780	1200	4	350KCMIL	500KCMIL	12.25	6.5	1AWG	2/0AWG	3.9	6.5	2	17.85	$33,394.00	$23,765.20
																	$149,232.92	$118,232.56

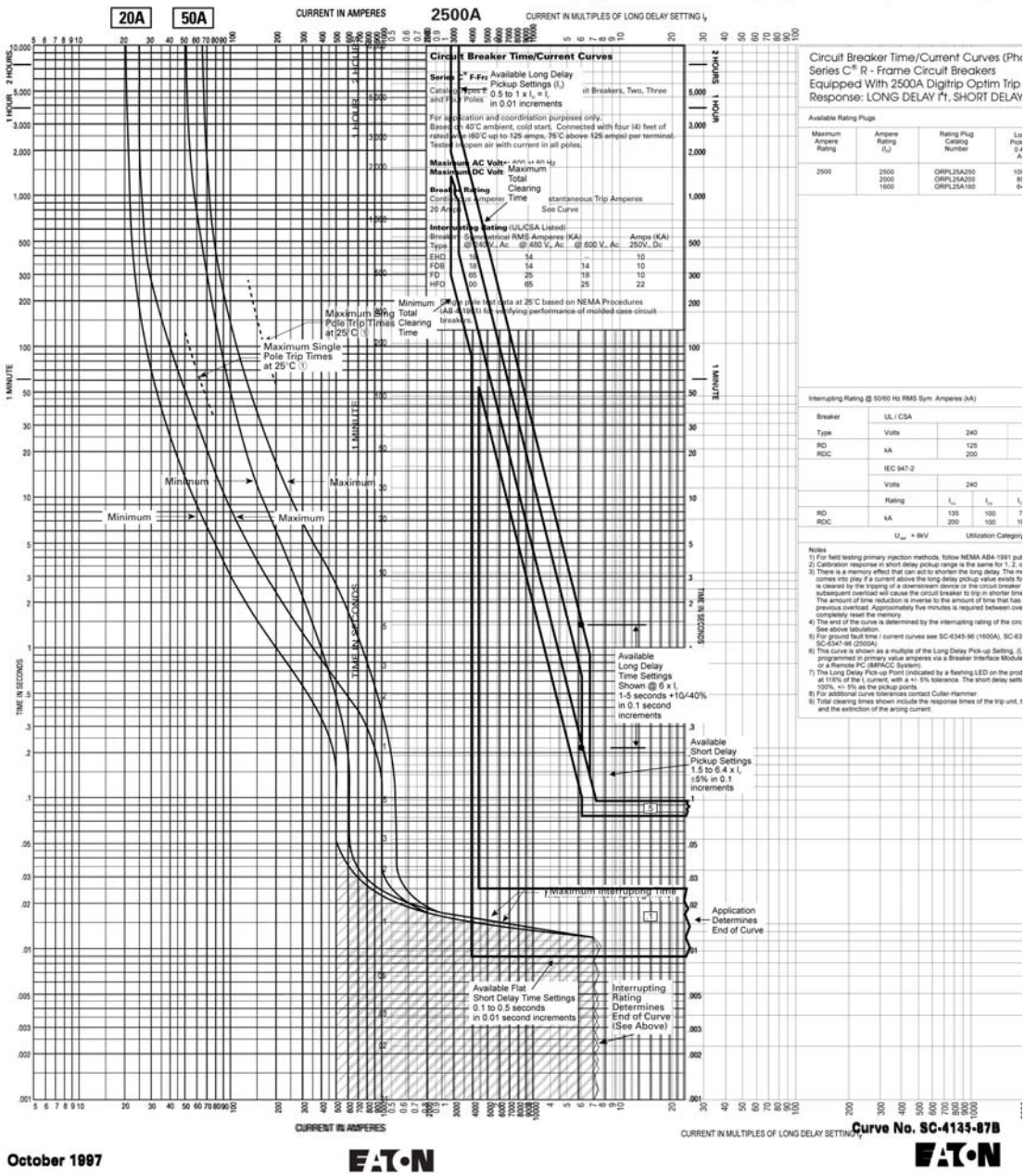
Figure 100 – CU vs. AL

AB DE-ION Circuit Breakers

Types EHD, FDB, FD and HFD 80 Amperes

AB DE-ION Circuit Breakers

R-Frame Circuit Breakers Equipped with 2500A Digitrip OPTIM Trip Units; Long De



October 1997

Figure 101 – Circuit Breaker Coordination

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Summary

The new lighting design prompted three new panelboards. A separate emergency panel was sized and run through an automatic transfer switch that would automatically switch the power from utility to emergency generator in the event that the utility feed goes down. This generator fits in electrical room 051 in the lower level, and with minor modification to the exterior wall, can be set up for ventilation to the outside.

When sizing wire for both copper and aluminum, copper was considerably more expensive, and this was expected. The savings when taken over a much larger building could yield much higher savings, but more research would have to be given to determine the effects on expansion and shrinkage due to the thermal properties of aluminum.

The circuit breaker coordination was done for a path from the circuit breaker on the main switchboard to panelboard NH1 to circuit number 1. Circuit 1 is protected by a 20A breaker, panelboard NH1 is protected by a 150A breaker, and the main switchboard is protected by a 3000A breaker. A 3000A breaker was not available in the Cutler Hammer 2006 Consulting Application Guide & Product Specification Guide. The largest breaker available is 2500A, so that was used to approximate the coordination as much as possible. The circuits that were analyzed were in fact coordinated.

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Construction Management Breadth

Luminaire Integration

The lighting design calls for two different luminaires to be modified. Each luminaire is already in production, but currently unavailable with the desired options. A custom modification is needed for fixture type J and fixture types K, L, M, and R. Fixture type J is currently a pendant mounted indirect, which will be modified to mount to the workstations in the open office space on the west side of the second level. Fixture types M and L are the same luminaire, as are K and R, with different lamping options, but the modification is the same for both. Currently, they mount as pendants also, with L and M having a direct/indirect distribution and K and R having a direct distribution. M and L will be modified to have a 100% direct distribution recessed into the Armstrong TechZone ceiling.

The mounting for fixture type J is designed to be as simple as possible; the existing body, which is solid die-formed 20 gauge cold-rolled steel, will have two short stanchion mounts attached, spacing it about an inch off of the mounting surface. The fixture is to be mounted into the divider between work stations. There will be a box surrounding it shielding it from view from 58” inches and below. This number was chosen as it is the average height of a person’s eyes. Power comes to these fixtures from under the floor which are hard wired into the electrical distribution system. Figure 102 shows a detail of the mounting.

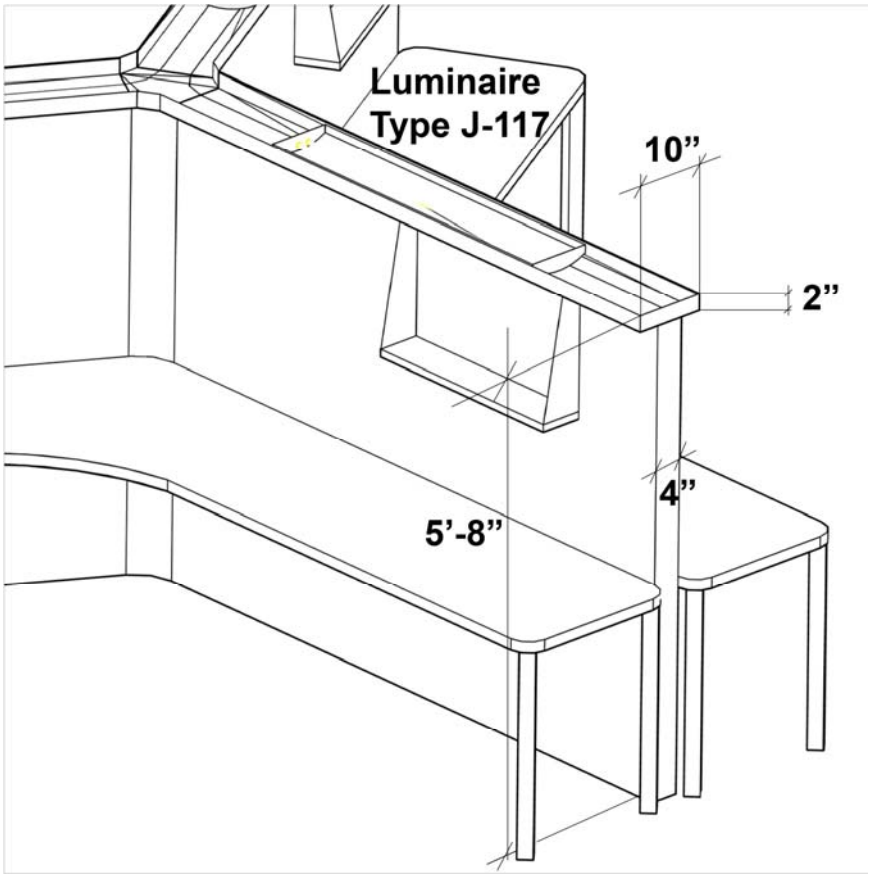

Figure 102 – Detail of Office Furniture Integration

From contacting a fixture manufacturer, I was informed that this type of custom application would take an additional 4-5 weeks of time to incorporate. With the planned completion date of September 2007, it is imperative that the custom luminaires be ordered leaving enough time for their custom mounting to the workstations. Due to the fact that the furniture will be going in after the lights, as long as the fixtures are ordered 4-5 weeks ahead of the other lights, there will be sufficient time to mount them to the furniture before their installation. The only condition will be wiring, where there will need to be a junction box at each workstation location to wire in the fixtures.

Fixture types K, L, M, and R will be modified to mount to a lay-in ceiling. The existing width of the body is 5.77”, and the space it needs to fit into is 6”. Therefore it is foreseeable that the application is possible with some modification. Fixtures L and M currently come with a top reflector option that provides 87% downlight. This reflector comes as a solid piece of cold-rolled steel with punchouts to provide 13% uplight. This fixture has not previously been tested by UL with a reflector that provides 100% downlight, which will cause a longer lead time. Underwriter’s Laboratory quoted a time frame of 10-12 weeks to have a luminaire be tested. In the event that the timeframe

does not allow for UL testing, a technician from UL can come to the site after installation to perform a field evaluation of its compliance, and if satisfactory will designate it with a "Field Evaluated Product Mark."

Two different manufacturers were contacted in figuring out the lead time associated with such modifications. The basis for each was about 4-5 weeks will be needed to modify each fixture. Fixtures L and M will need an additional 10-12 weeks to be UL certified once they are manufactured. Therefore, they should be ordered 14-17 weeks prior to the scheduled installation of the lay-in ceiling in the open office. K and R need only be ordered 4-5 weeks prior to the installation of the ceiling. Fixture J will likely not need an additional lead time due to the fact that the furniture will be installed after the rest of the space is completed. Ordering fixture J at the same time as all of the other lighting for this area and having them sent to the furniture manufacturer should provide enough time for the mounting to be completed and the furniture to arrive on site as scheduled. With a project time frame in hand and the furniture manufacturer's information present, an exact schedule could be determined. Consequently, an electrician will need to be on hand when the furniture arrives to wire these 19 fixtures. Based on the 2002 version of RS Means Building Construction Cost Data 60th Edition, each luminaire would take 1.143 hours to complete, and there are 19 luminaires which will need to be wired. Based on these numbers, it would take one electrician 21.717 hours, or roughly 3 days. This value for hourly output is based on the following: material receiving and handling, mobilization at site, site movement, breaks, and cleanup, in addition to the actual wiring. Since each fixture will already be in place and located within close proximity to each other, it is safe to say that the electrician's productivity would be increased compared to the RS Means numbers. Based on the conservative assumption that the actual wiring time comprises 60% of the electrician's time, his new productivity becomes 0.6858 units per hour. It would now take two electricians 6.5 hours to wire all 19 luminaires, at a cost of $527.72. Please see figure 102 for a detailed breakdown of this cost.

Custom Luminaire Integration Analysis						
Number of Luminaires	Labor - Hours	Number of Electricians	Labor Cost	Total Time	Cost per Electrician	Total Cost
19	1.143	1	$40.50	21.717	$879.54	$879.54
19	0.6858	1	$40.50	13.0302	$527.72	$527.72
19	0.6858	2	$40.50	6.5151	$263.86	$527.72

Figure 102 – Cost estimate for wiring of fixture type J

Summary

Ordered by the time frames listed above, these luminaires would be possible to have installed on time. The savings incurred by using fewer luminaires would be enough to offset the cost of the additional testing required and modifications to the luminaires.

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Mechanical Breadth

The inclusion of a high light reflecting ceiling, although it will cost more initially, enables savings down the line. As shown in previous studies, the Armstrong TechZone ceiling increases the amount of light on the task plane by 22% as compared to standard ceiling tile. This provides the opportunity to reduce the number of luminaires in a space, which will lower the overall lighting power density. To determine the effects of this ceiling system and redesigned lighting system on this space, an energy analysis was performed.

Hourly Analysis Program version 4.31 made by Carrier was used to simulate the effects of this system on energy usage over the span of a year. The variables involved in this kind of analysis are plentiful, and not all of the information needed was available to perform an exact simulation of how the building would perform in reality. What *was* able to be done, however, was a comparison of two different scenarios holding the unknown variables constant. The variables that changed in this model were:

1. Average ceiling height
2. Lighting power density

The factors that were held constant through this analysis were:

1. Building occupancy
2. Thermal properties of the walls, windows, and roof structure
3. Heating and cooling requirements
4. Electric utility price rate
5. Natural gas price rate
6. Room area dimensions
7. Building orientation

Also, it should be noted that while the following comparison shows a different floor area between the original and the new designs, this was necessary in order to gain accurate results since the simulation depends on how the luminaires are mounted. The following tables and graphs show that a savings was possible with the installation of this ceiling in regards to electricity consumption of the lighting, but when taking heating costs into account, a net loss was determined. The difference for this space was only $463 for a year, which in the general scope of things is minimal; however, it is still an additional cost that the owner will likely be unwilling to pay, especially when the additional initial cost of the ceiling is taken into account.

The following tables and graphs show the values obtained from HAP43 for the existing design:

Table 1. Annual Costs

Component	Original Building ($)
Air System Fans	881
Cooling	1,448
Heating	1,336
Pumps	0
Cooling Tower Fans	0
HVAC Sub-Total	**3,666**
Lights	3,337
Electric Equipment	0
Misc. Electric	0
Misc. Fuel Use	0
Non-HVAC Sub-Total	**3,337**
Grand Total	**7,002**

Table 2. Annual Cost per Unit Floor Area

Component	Original Building ($/ft²)
Air System Fans	0.122
Cooling	0.201
Heating	0.185
Pumps	0.000
Cooling Tower Fans	0.000
HVAC Sub-Total	**0.508**
Lights	0.462
Electric Equipment	0.000
Misc. Electric	0.000
Misc. Fuel Use	0.000
Non-HVAC Sub-Total	**0.462**
Grand Total	**0.970**
Gross Floor Area (ft²)	7220.0
Conditioned Floor Area (ft²)	7220.0

Note: Values in this table are calculated using the Gross Floor Area.

Figure 103.1

Table 3. Component Cost as a Percentage of Total Cost

Component	Original Building (%)
Air System Fans	12.6
Cooling	20.7
Heating	19.1
Pumps	0.0
Cooling Tower Fans	0.0
HVAC Sub-Total	**52.3**
Lights	47.7
Electric Equipment	0.0
Misc. Electric	0.0
Misc. Fuel Use	0.0
Non-HVAC Sub-Total	**47.7**
Grand Total	**100.0**

Table 1. Annual Costs

Component	Original Building ($)
HVAC Components	
Electric	2,329
Natural Gas	1,336
Fuel Oil	0
Propane	0
Remote HW	0
Remote Steam	0
Remote CW	0
HVAC Sub-Total	**3,666**
Non-HVAC Components	
Electric	3,337
Natural Gas	0
Fuel Oil	0
Propane	0
Remote HW	0
Remote Steam	0
Non-HVAC Sub-Total	**3,337**
Grand Total	**7,002**

Figure 103.2

Table 2. Annual Energy Consumption

Component	Original Building
HVAC Components	
Electric (kWh)	28,405
Natural Gas (Therm)	182
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Remote CW (na)	0
Non-HVAC Components	
Electric (kWh)	40,690
Natural Gas (Therm)	0
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Totals	
Electric (kWh)	69,096
Natural Gas (Therm)	182
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Remote CW (na)	0

Figure 103.3

Table 4. Annual Cost per Unit Floor Area

Component	Original Building ($/ft²)
HVAC Components	
Electric	0.323
Natural Gas	0.185
Fuel Oil	0.000
Propane	0.000
Remote HW	0.000
Remote Steam	0.000
Remote CW	0.000
HVAC Sub-Total	**0.508**
Non-HVAC Components	
Electric	0.462
Natural Gas	0.000
Fuel Oil	0.000
Propane	0.000
Remote HW	0.000
Remote Steam	0.000
Non-HVAC Sub-Total	**0.462**
Grand Total	**0.970**
Gross Floor Area (ft²)	7220.0
Conditioned Floor Area (ft²)	7220.0

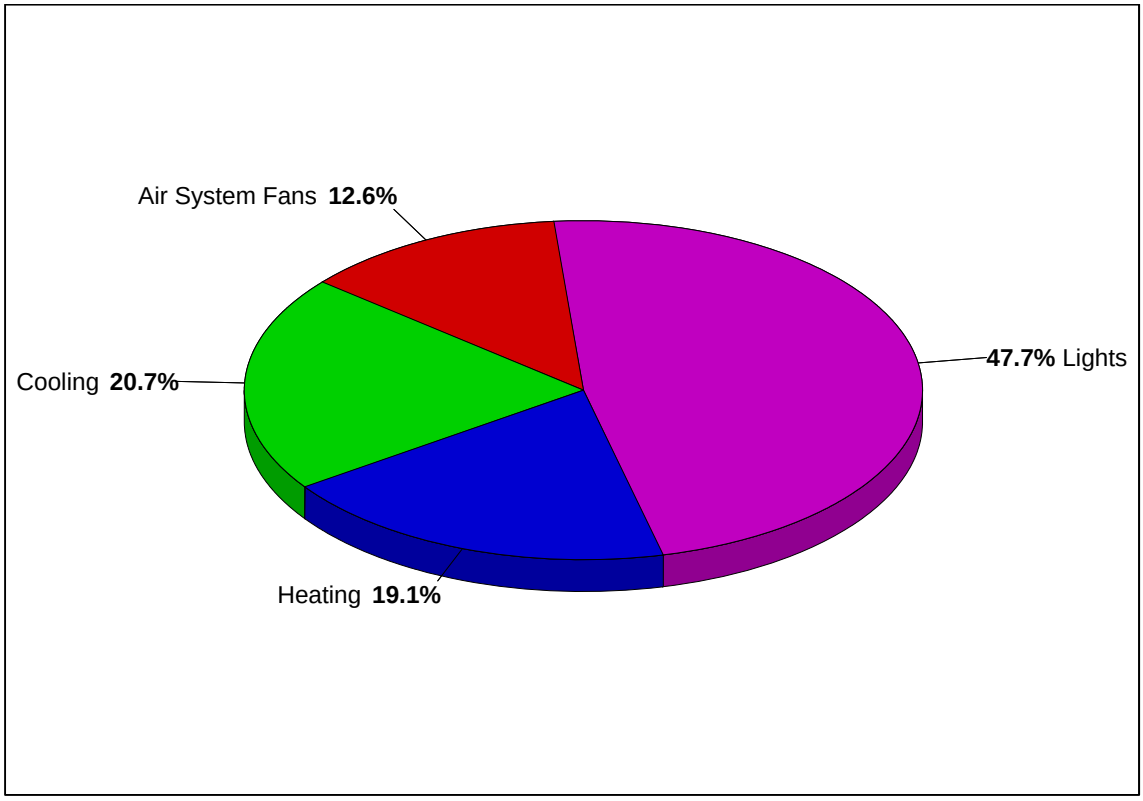
Note: Values in this table are calculated using the Gross Floor Area.

Figure 103.4

Table 5. Component Cost as a Percentage of Total Cost

Component	Original Building (%)
HVAC Components	
Electric	33.3
Natural Gas	19.1
Fuel Oil	0.0
Propane	0.0
Remote HW	0.0
Remote Steam	0.0
Remote CW	0.0
HVAC Sub-Total	**52.3**
Non-HVAC Components	
Electric	47.7
Natural Gas	0.0
Fuel Oil	0.0
Propane	0.0
Remote HW	0.0
Remote Steam	0.0
Non-HVAC Sub-Total	**47.7**
Grand Total	**100.0**

Figure 103.5



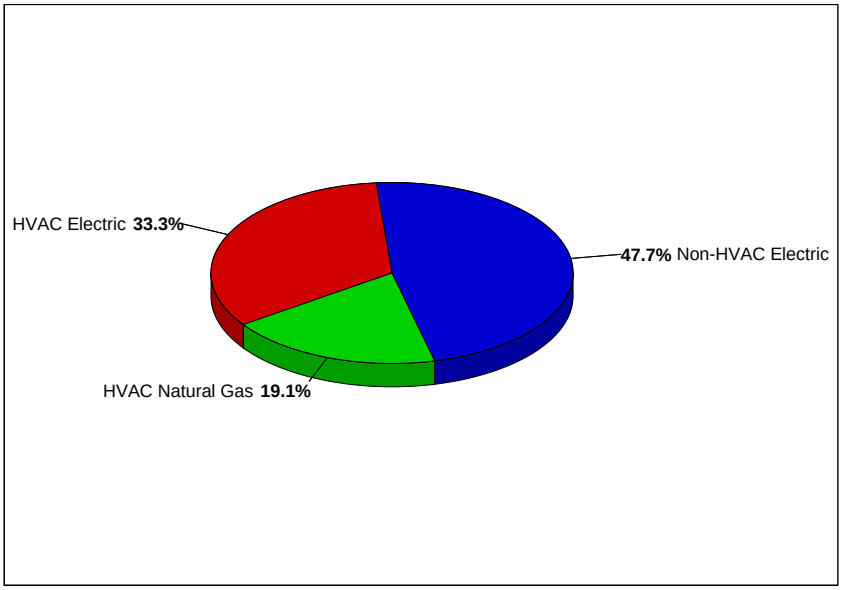
1. Annual Costs

Component	Annual Cost ($)	($/ft²)	Percent of Total (%)
Air System Fans	881	0.122	12.6
Cooling	1,448	0.201	20.7
Heating	1,336	0.185	19.1
Pumps	0	0.000	0.0
Cooling Tower Fans	0	0.000	0.0
HVAC Sub-Total	**3,666**	**0.508**	**52.3**
Lights	3,337	0.462	47.7
Electric Equipment	0	0.000	0.0
Misc. Electric	0	0.000	0.0
Misc. Fuel Use	0	0.000	0.0
Non-HVAC Sub-Total	**3,337**	**0.462**	**47.7**
Grand Total	**7,002**	**0.970**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area ..... **7220.0** ft²
Conditioned Floor Area ..... **7220.0** ft²

Figure 103.6



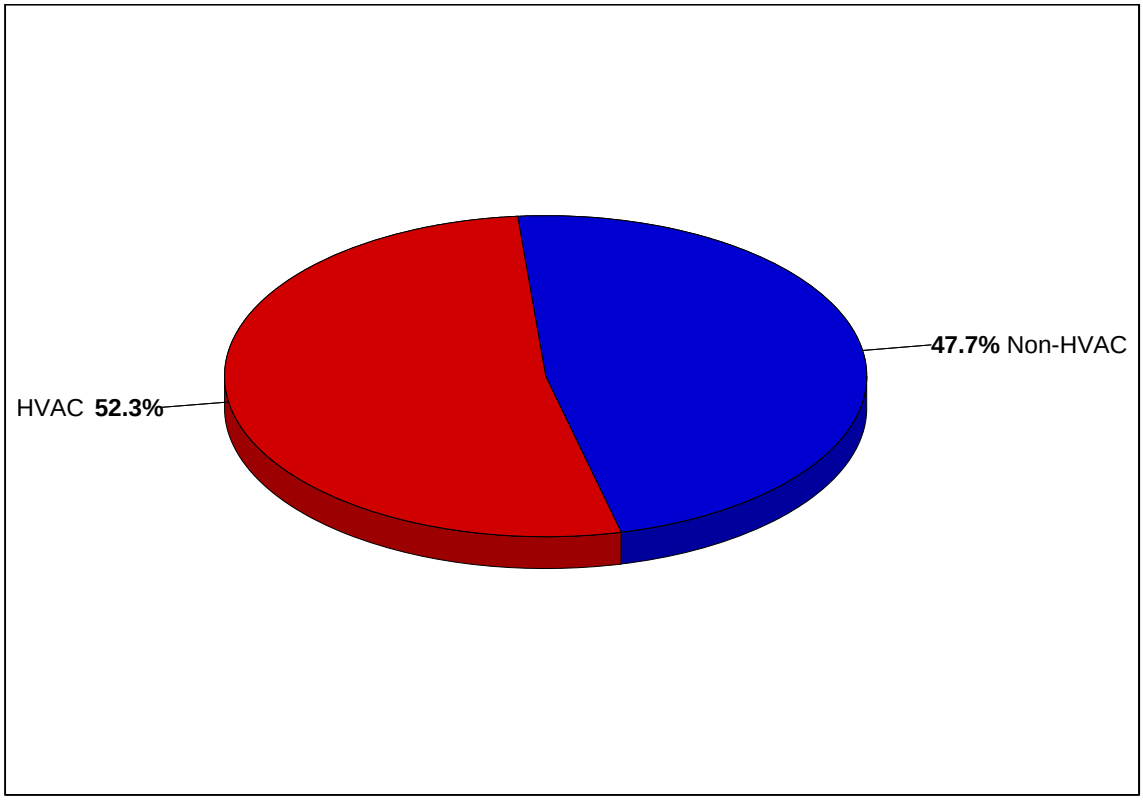
1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC Components			
Electric	2,329	0.323	33.3
Natural Gas	1,336	0.185	19.1
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Remote Chilled Water	0	0.000	0.0
HVAC Sub-Total	**3,666**	**0.508**	**52.3**
Non-HVAC Components			
Electric	3,337	0.462	47.7
Natural Gas	0	0.000	0.0
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Non-HVAC Sub-Total	**3,337**	**0.462**	**47.7**
Grand Total	**7,002**	**0.970**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area ..... **7220.0** ft²
Conditioned Floor Area ..... **7220.0** ft²

Figure 103.7



1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC	3,666	0.508	52.3
Non-HVAC	3,337	0.462	47.7
Grand Total	**7,002**	**0.970**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area ..... **7220.0** ft²
Conditioned Floor Area ..... **7220.0** ft²

Figure 103.8

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1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	165,201	22.881
Heating Coil Loads	14,545	2.015
Grand Total	**179,746**	**24.896**

2. Energy Consumption by System Component

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
Air System Fans	36,669	5.079	130,962	18.139
Cooling	60,249	8.345	215,176	29.803
Heating	18,182	2.518	18,182	2.518
Pumps	0	0.000	0	0.000
Cooling Towers	0	0.000	0	0.000
HVAC Sub-Total	**115,101**	**15.942**	**364,320**	**50.460**
Lights	138,835	19.229	495,841	68.676
Electric Equipment	0	0.000	0	0.000
Misc. Electric	0	0.000	0	0.000
Misc. Fuel Use	0	0.000	0	0.000
Non-HVAC Sub-Total	**138,835**	**19.229**	**495,841**	**68.676**
Grand Total	**253,936**	**35.171**	**860,161**	**119.136**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area ..... **7220.0** ft²
   Conditioned Floor Area ..... **7220.0** ft²

Figure 103.9

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The information provide by HAP43 for the design including the Armstrong TechZone ceiling is listed below:

Table 1. Annual Costs

Component	Original Building ($)
Air System Fans	724
Cooling	1,074
Heating	3,998
Pumps	0
Cooling Tower Fans	0
HVAC Sub-Total	**5,796**
Lights	1,668
Electric Equipment	0
Misc. Electric	0
Misc. Fuel Use	0
Non-HVAC Sub-Total	**1,668**
Grand Total	**7,465**

Table 2. Annual Cost per Unit Floor Area

Component	Original Building ($/ft²)
Air System Fans	0.050
Cooling	0.074
Heating	0.277
Pumps	0.000
Cooling Tower Fans	0.000
HVAC Sub-Total	**0.402**
Lights	0.116
Electric Equipment	0.000
Misc. Electric	0.000
Misc. Fuel Use	0.000
Non-HVAC Sub-Total	**0.116**
Grand Total	**0.517**
Gross Floor Area (ft²)	14440.0
Conditioned Floor Area (ft²)	14440.0

Note: Values in this table are calculated using the Gross Floor Area.

Figure 104.1

Table 3. Component Cost as a Percentage of Total Cost

Component	Original Building (%)
Air System Fans	9.7
Cooling	14.4
Heating	53.6
Pumps	0.0
Cooling Tower Fans	0.0
HVAC Sub-Total	**77.7**
Lights	22.3
Electric Equipment	0.0
Misc. Electric	0.0
Misc. Fuel Use	0.0
Non-HVAC Sub-Total	**22.3**
Grand Total	**100.0**

Table 1. Annual Costs

Component	Original Building ($)
HVAC Components	
Electric	1,798
Natural Gas	3,998
Fuel Oil	0
Propane	0
Remote HW	0
Remote Steam	0
Remote CW	0
HVAC Sub-Total	**5,796**
Non-HVAC Components	
Electric	1,668
Natural Gas	0
Fuel Oil	0
Propane	0
Remote HW	0
Remote Steam	0
Non-HVAC Sub-Total	**1,668**
Grand Total	**7,465**

Figure 104.2

Table 2. Annual Energy Consumption

Component	Original Building
HVAC Components	
Electric (kWh)	21,929
Natural Gas (Therm)	544
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Remote CW (na)	0
Non-HVAC Components	
Electric (kWh)	20,345
Natural Gas (Therm)	0
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Totals	
Electric (kWh)	42,275
Natural Gas (Therm)	544
Fuel Oil (na)	0
Propane (na)	0
Remote HW (na)	0
Remote Steam (na)	0
Remote CW (na)	0

Figure 104.3

Table 4. Annual Cost per Unit Floor Area

Component	Original Building ($/ft²)
HVAC Components	
Electric	0.125
Natural Gas	0.277
Fuel Oil	0.000
Propane	0.000
Remote HW	0.000
Remote Steam	0.000
Remote CW	0.000
HVAC Sub-Total	**0.401**
Non-HVAC Components	
Electric	0.116
Natural Gas	0.000
Fuel Oil	0.000
Propane	0.000
Remote HW	0.000
Remote Steam	0.000
Non-HVAC Sub-Total	**0.116**
Grand Total	**0.517**
Gross Floor Area (ft²)	14440.0
Conditioned Floor Area (ft²)	14440.0

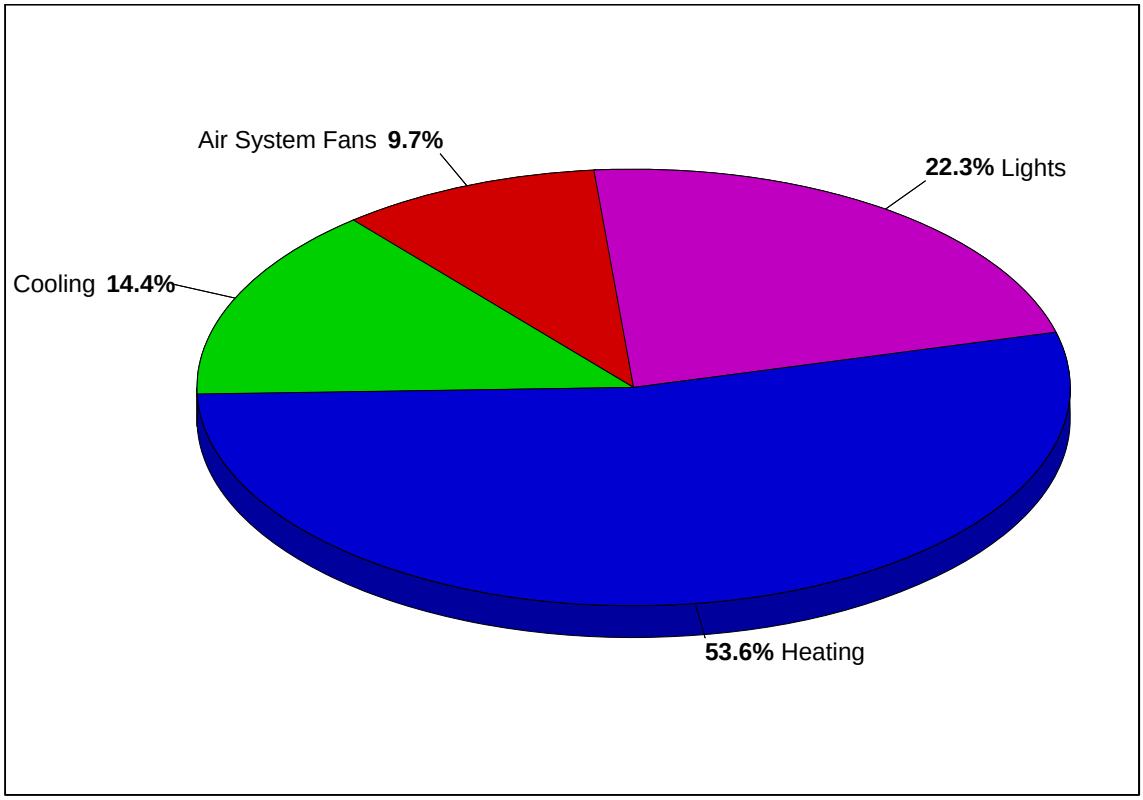
Note: Values in this table are calculated using the Gross Floor Area.

Figure 104.4

Table 5. Component Cost as a Percentage of Total Cost

Component	Original Building (%)
HVAC Components	
Electric	24.1
Natural Gas	53.6
Fuel Oil	0.0
Propane	0.0
Remote HW	0.0
Remote Steam	0.0
Remote CW	0.0
HVAC Sub-Total	**77.7**
Non-HVAC Components	
Electric	22.3
Natural Gas	0.0
Fuel Oil	0.0
Propane	0.0
Remote HW	0.0
Remote Steam	0.0
Non-HVAC Sub-Total	**22.3**
Grand Total	**100.0**

Figure 104.5



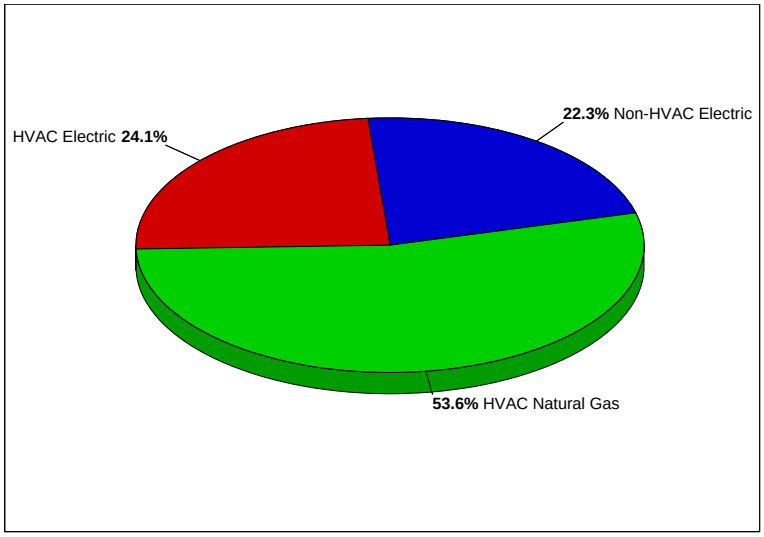
1. Annual Costs

Component	Annual Cost ($)	($/ft²)	Percent of Total (%)
Air System Fans	724	0.050	9.7
Cooling	1,074	0.074	14.4
Heating	3,998	0.277	53.6
Pumps	0	0.000	0.0
Cooling Tower Fans	0	0.000	0.0
HVAC Sub-Total	**5,796**	**0.402**	**77.7**
Lights	1,668	0.116	22.3
Electric Equipment	0	0.000	0.0
Misc. Electric	0	0.000	0.0
Misc. Fuel Use	0	0.000	0.0
Non-HVAC Sub-Total	**1,668**	**0.116**	**22.3**
Grand Total	**7,465**	**0.517**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area ..... **14440.0** ft²
Conditioned Floor Area ..... **14440.0** ft²

Figure 104.6



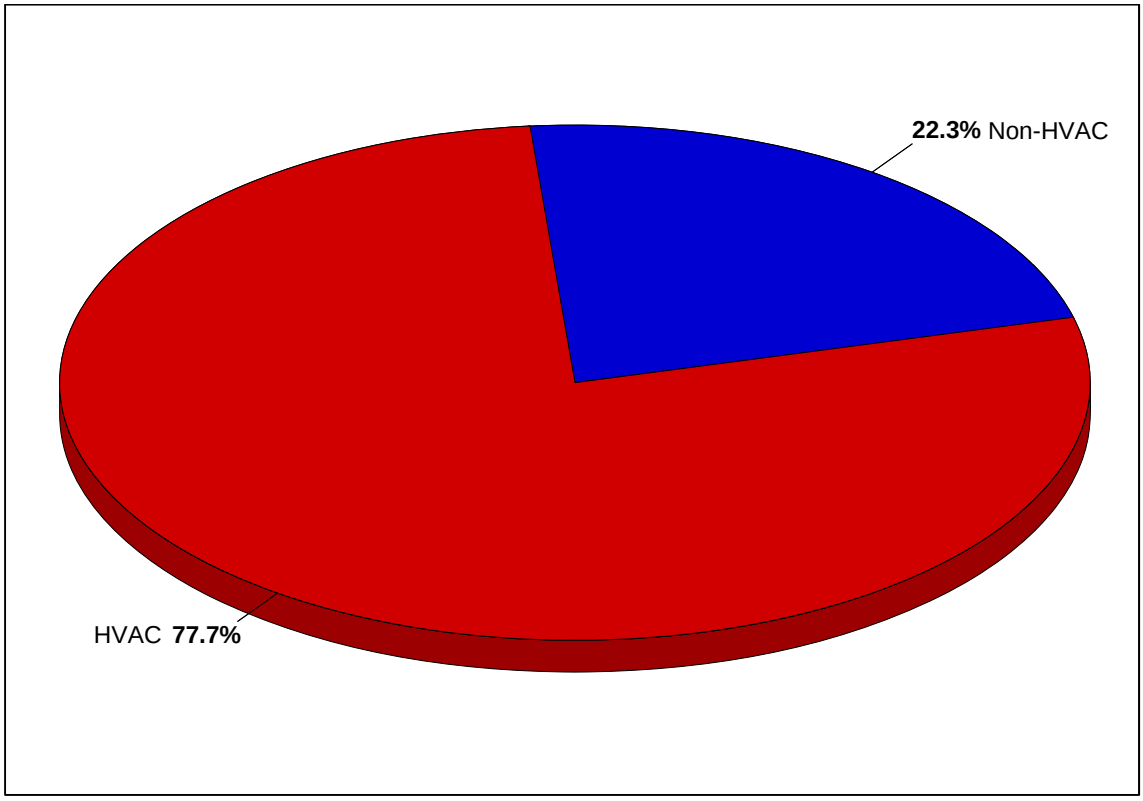
1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC Components			
Electric	1,798	0.125	24.1
Natural Gas	3,998	0.277	53.6
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Remote Chilled Water	0	0.000	0.0
HVAC Sub-Total	**5,796**	**0.401**	**77.7**
Non-HVAC Components			
Electric	1,668	0.116	22.3
Natural Gas	0	0.000	0.0
Fuel Oil	0	0.000	0.0
Propane	0	0.000	0.0
Remote Hot Water	0	0.000	0.0
Remote Steam	0	0.000	0.0
Non-HVAC Sub-Total	**1,668**	**0.116**	**22.3**
Grand Total	**7,465**	**0.517**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area ..... **14440.0** ft²
Conditioned Floor Area ..... **14440.0** ft²

Figure 104.7



1. Annual Costs

Component	Annual Cost ($/yr)	($/ft²)	Percent of Total (%)
HVAC	5,796	0.401	77.7
Non-HVAC	1,668	0.116	22.3
Grand Total	**7,465**	**0.517**	**100.0**

Note: Cost per unit floor area is based on the gross building floor area.

Gross Floor Area ..... **14440.0** ft²
Conditioned Floor Area ..... **14440.0** ft²

Figure 104.8

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April 12, 2007

1. Annual Coil Loads

Component	Load (kBTU)	(kBTU/ft²)
Cooling Coil Loads	120,630	8.354
Heating Coil Loads	43,517	3.014
Grand Total	**164,147**	**11.368**

2. Energy Consumption by System Component

Component	Site Energy (kBTU)	Site Energy (kBTU/ft²)	Source Energy (kBTU)	Source Energy (kBTU/ft²)
Air System Fans	30,140	2.087	107,644	7.455
Cooling	44,683	3.094	159,581	11.051
Heating	54,396	3.767	54,396	3.767
Pumps	0	0.000	0	0.000
Cooling Towers	0	0.000	0	0.000
HVAC Sub-Total	**129,219**	**8.949**	**321,621**	**22.273**
Lights	69,418	4.807	247,921	17.169
Electric Equipment	0	0.000	0	0.000
Misc. Electric	0	0.000	0	0.000
Misc. Fuel Use	0	0.000	0	0.000
Non-HVAC Sub-Total	**69,418**	**4.807**	**247,921**	**17.169**
Grand Total	**198,637**	**13.756**	**569,541**	**39.442**

Notes:
1. 'Cooling Coil Loads' is the sum of all air system cooling coil loads.
2. 'Heating Coil Loads' is the sum of all air system heating coil loads.
3. Site Energy is the actual energy consumed.
4. Source Energy is the site energy divided by the electric generating efficiency (28.0%).
5. Source Energy for fuels equals the site energy value.
6. Energy per unit floor area is based on the gross building floor area.
   Gross Floor Area ..... **14440.0** ft²
   Conditioned Floor Area ..... **14440.0** ft²

Figure 104.9

The information found through this simulation show that a reduction in lighting does not always guarantee a reduction in total cost. The total energy cost per year in this case increased by $463. Because lighting in commercial buildings give off large amounts of heat in converting electricity into visible light, the reduction in this heat affects the HVAC system greatly. The graphs below were obtained from the 2006 Buildings Energy Data Book, which is published by the U.S. Department of Energy, and help reinforce this explanation. Figure 105 shows the sources of heat in a building in red in the top half of the graph, while the lower half illustrates the ways that heat escapes a building. The remainder, shown highlighted in yellow, must be made up by the HVAC equipment. Figure 106 shows the opposite, with causes of heat loss above and sources of heat below.

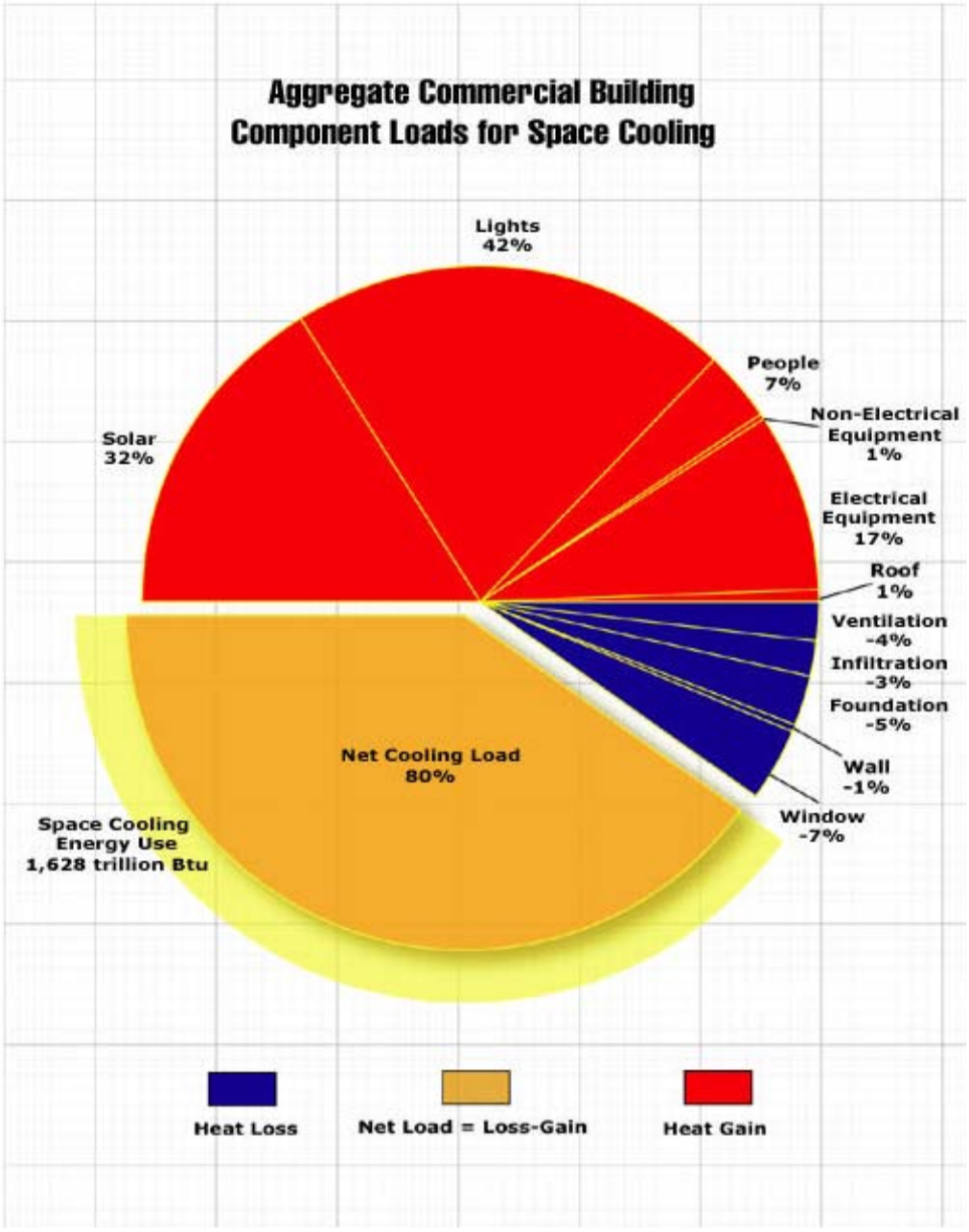

Figure 105 – Space Cooling Loads

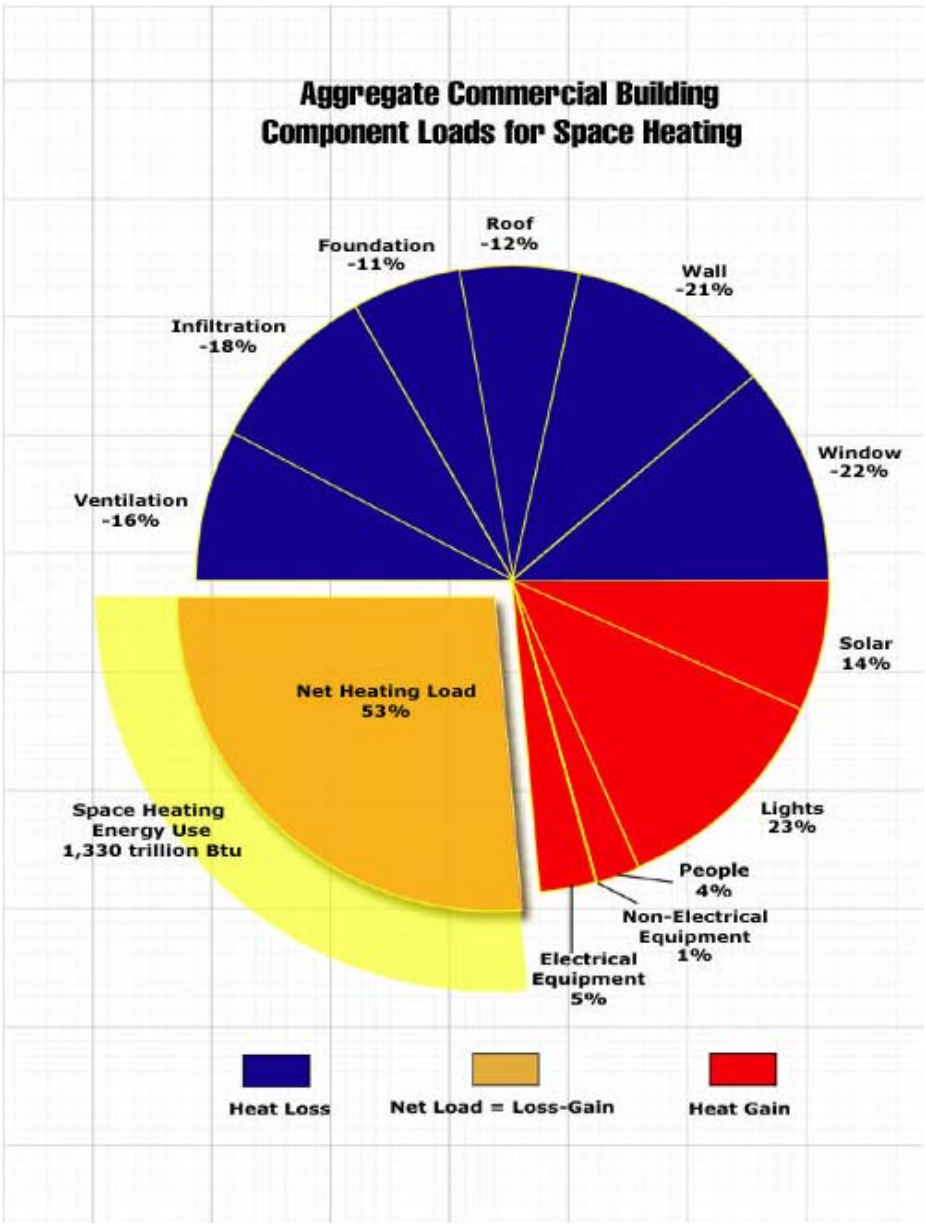

Figure 106 – Space Heating Loads

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Summary

The lighting in the average commercial building accounts for 23% of the heating. For buildings which are in cooling mode year round, which most large office buildings are, a reduction in lighting power density would be very beneficial. The open office in this application showed that the cooling costs decreased by $375, but the heating costs increased by more than double, at $2,662. Therefore the reduction in lighting power density was not advantageous to help save energy. This model would work, however, if one of two variables were changed. Either the building was relocated to a warmer climate, or a building that runs in cooling mode year round was chosen. This way the reduction in lighting power density from the ballasts and lamps would put less of a strain on the cooling equipment, thereby saving energy that way.

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Summary

The redesign of this project proved to be quite the experience. Redesigning spaces with the exact uses in mind made it possible to design for a much lower power density in the case of the open office. The entry atrium supplied plentiful daylight to the spaces fed by it which allows for lower daytime operating costs. The showroom, although by code would be much to high over the recommended limit, provides a versatility that accounts for all of the uses of the space. The “dansko” sign on the north façade of the showroom, while it consumes almost twice the recommended wattage, provides a beacon of interest for motorists along route 1 who will see the name and make the building noticed. Advertising is extremely costly these days, and having a sign that lights up against the darker surround will in turn provide more revenue for Dansko, Inc. Initially, a high light reflectance ceiling was intended to help conserve energy by using the newest technologies and methods, but as it turns out, in this application it did not live up to expectations. Using this system under different conditions can provide a worthwhile savings. While it is not recommended, copper feeders inside the building could be changed go aluminum to save money. The savings from this could possibly be $31,000. As for the effects of custom luminaires on the project schedule, it was determined to have minimal impact on the completion date.

References

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ASHRAE 90.1-1999

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Electrical Systems in Buildings by S. David Hughes