Final Thesis Report

Date of Submission: April 12, 2011

Faculty Consultants: Dr. Mistrick, Ted Dannerth

http://www.engr.psu.edu/ae/thesis/portfolios/2011/btk5008/index.html

Computer files location: P:\btk5008\Thesis\

Executive Summary

The City of Green Administration Building, which is located in the City of Green, Ohio, houses the employees that are responsible for various aspects of the city government and organization. There are many different departments such as the school board, planning and engineering, as well as the mayor's office. These departments are divided among the three wings of the building and connected by a central lobby and mezzanine space.

The main focus of this thesis report is to re-design the lighting and electrical systems for four spaces of certain types. These new designs consider appropriate design criteria, and strive for improving upon the existing designs that were examined during the first half of the year. The four types of spaces that were required are as follows: An outdoor space, circulation space, special purpose space, and large work space. In addition to creating a new and unique lighting design, one space is required to represent a psychological impression. The space chosen is the Main Lobby (circulation space), which will create a sense of spaciousness. Lighting design criteria was largely derived from the IESNA Lighting Handbook, and energy usage limits were determined from ASHRAE Standard 90.1.

This report will concentrate on the new lighting and electrical designs, and does not discuss the existing design in detail. For an explanation of the existing design, refer to Tech Reports 1 and 2. These can be found on the CPEP website. While not a complete system redesign, branch circuits were altered to accommodate the new lighting fixtures. In addition to this branch circuit redesign, two electrical depths were completed. These electrical depths are an addition of a UPS system to the building electrical system and a panel consolidation study.

Besides the in-option depth topics, two breadth topics were chosen. For the mechanical breadth of this report I investigated incorporating a Variable Refrigerant flow system rather than the existing water loop heat pump system. In addition to this mechanical breadth, an architectural redesign of the entrance structure was considered.

Table of Contents

City of Green Administration Building

1755 Town Park Boulevard
City of Green, Ohio 44216

Brian Koze
Lighting & Electrical

Project Team

Architect: Hasenstab Architects Inc.

Mechanical & Electrical: Scheeser & Buckley Mayfield, LLC

Civil: Floyd Brown Group

Construction Manager: Welty Building Company Limited LTT

Statistics

Occupancy Classification: Type B

53,671 Gross Square Feet

3 Stories

Project Cost: 8.2 Million

Date of Construction: August 2008 – October 2009

Architecture

Steel, brick, and glass facade, aluminum and slate roof.

Covered entranceway and clock tower.

Poured concrete basement wall with steel above grade.

Concrete floor slab on metal deck

Electrical

Underground 15 kV service to an outdoor pad mounted utility owned transformer with integral meter.

Secondary side output is 480 V, 3 Phase, 4 Wire to building central distribution system.

Main power distribution throughout building is 480 V, 3 Phase with centralized stepdown transformers to 208/120 V.

750 kW on site generator provides emergency power.

Mechanical

The building has a dedicated outside air system (DOAS) for ventilation.

Supplementary heating and cooling is provided through a water loop heat pump system (WLHP).

This water loop is heated by two natural gas condensing boilers and cooled by a closed circuit induced draft evaportative cooling tower.

Lighting

Office and workspace lighting provided by two foot by two foot and four foot by two foot ceiling recessed fluorescent luminaires.

Exterior facade is illuminated by in ground metal halide fixtures, compact fluorescent wall washers, and pole mounted metal halides to light the walkway.

Interior spaces conbine fluorescent ceiling recessed, pendant, cove, and sconce luminaires to create a unique yet professional atmosphere.

Building Statistics

Building Name

City of Green Administration Building

Location and Site

1755 Town Park Boulevard, City of Green, Ohio 44216

Building Occupant Name

City of Green Administration

Occupancy or Function Types (Type of Building)

The building's occupancy classification is type "B," or business. The occupancy load is 90 total occupants.

Size (Total Square Feet)

The ground floor is 13,997 gross square feet, while the second floor totals to 13,997 gross square feet. The basement is 19,742 gross square feet. These three stories add to 53,671 gross square feet.

Number of Stories above Grade / Total Levels

There are two stories above grade and a basement, totaling three levels.

Primary Project Team

Owner: The City of Green

General Contractor: Mr. Marty Ganzer

Construction Manager: Welty Bld. Company Limited LTT.

Architect: Hasenstab Architects Inc.

Project Architect of Record: Dennis Check

Mechanical / Electrical Engineer: Scheeser & Buckley Mayfield, LLC

Engineer of Record (HVAC): Jim Kulick, PE

Engineer of Record (L/E): Jim Eckman, PE

Civil / Site Planning: Kevin Noble, PE

Civil Engineer (Structural): Floyd Brown Group

Date of Construction

August 2008 - October 2009

Actual Cost Information:

Detailed budget information has not yet become available. The total building cost given on their website is 8.2 million dollars.

Project Delivery Method

The City of Green Administration Building was built under a multiple prime contract between all the prime contractors and the owner. All prime contracts were a firm lump sum (guaranteed maximum price).

Architecture

The occupancy classification is type B for business, subgroup S-1 and A-3. The construction type is 2-B. The seismic design category is type C and the seismic design site class is type D. The building is full fire suppressed with a zero hour fire rating for all building elements. The actual height of the building to the bottom of the roof structural line is 37 ft, and it is approved for 90 total occupants.

Building Enclosure

The facade is built of two different types of brick, which form interesting patterns on the façade. Large areas of glazing

Sustainability Features

There are few notable sustainability features incorporated into the building. Some control systems including motion sensors for the lighting system are in place but currently fail to function.

Electrical

The electrical distribution system recieves power from a 500 kVA, 3 phase, utility owned stepdown transformer located on site. Conduit from this transformer carries 480/277V WYE into the lower level of the building to a main distribution panel. Power is distributed from this main distribution panel through automatic transfer switches to four distribution panels of various sizes. These distribute power to branch circuit panels located in electrical closets throughout the building. Emergency power is supplied by an on-site 750 KW generator which supplies the same 480/277V WYE connection as the utility owned transformer. It connects to the building's electrical system via the automatic transfer switches off the main distribution panel. Emergency power is connected to all building loads.

Lighting

Exterior lighting for the facade is provided by in ground metal halide luminaires. Metal halide bollards illuminate the pathway leading into the building. The area immedietly outside the entrance is illuminated by recessed fluorescent downlights. The interior spaces use a variety of fluorescent fixtures, including compact and linear fluorescents in various styles of luminaires. Workspaces use four foot by two foot and two foot by two foot linear fluorescents, while more decorative spaces such as the Main Lobby and Council Chambers use recessed CFL cans and CFL pendant fixtures. Linear fluorescent wall sconces are used in the Lobby and Council Chambers spaces as well.

Mechanical

The mechanical system of the building has a dedicated outside air system for ventilation. Supplementary heating and cooling is provided through a water loop heat pump system. This water loop is heated by two natural gas condensing boilers and cooled by a closed circuit induced draft evaporative cooling tower.

Structural

The building foundation utilizes spread footings and interior reinforced concrete slab on grade. Structural steel and steel joists support the building loads. W shaped structural steel is ASTM A992, and M / S / C shapes are ASTM A36 uno. All structural steel plates and angles are ASTM A35 uno as well. Size of the structural steel columns varies throughout the building depending on space use and level, with W16x26 and W18x35 being the most common. Beam to beam connections and beam to column connections are double angle with a thickness of 5/16". High strength steel metal form deck is puddle welded at all steel supports. Wood roof trusses support roof loads.

Communication Systems

Fire alarms with visual and audible signals are used. This is a non-addressable system. A centralized computer lighting control system allows for digital control via relays of each seperate lighting zone throughout the building.

Lighting Design: Entrance Structure (Outdoor Space)

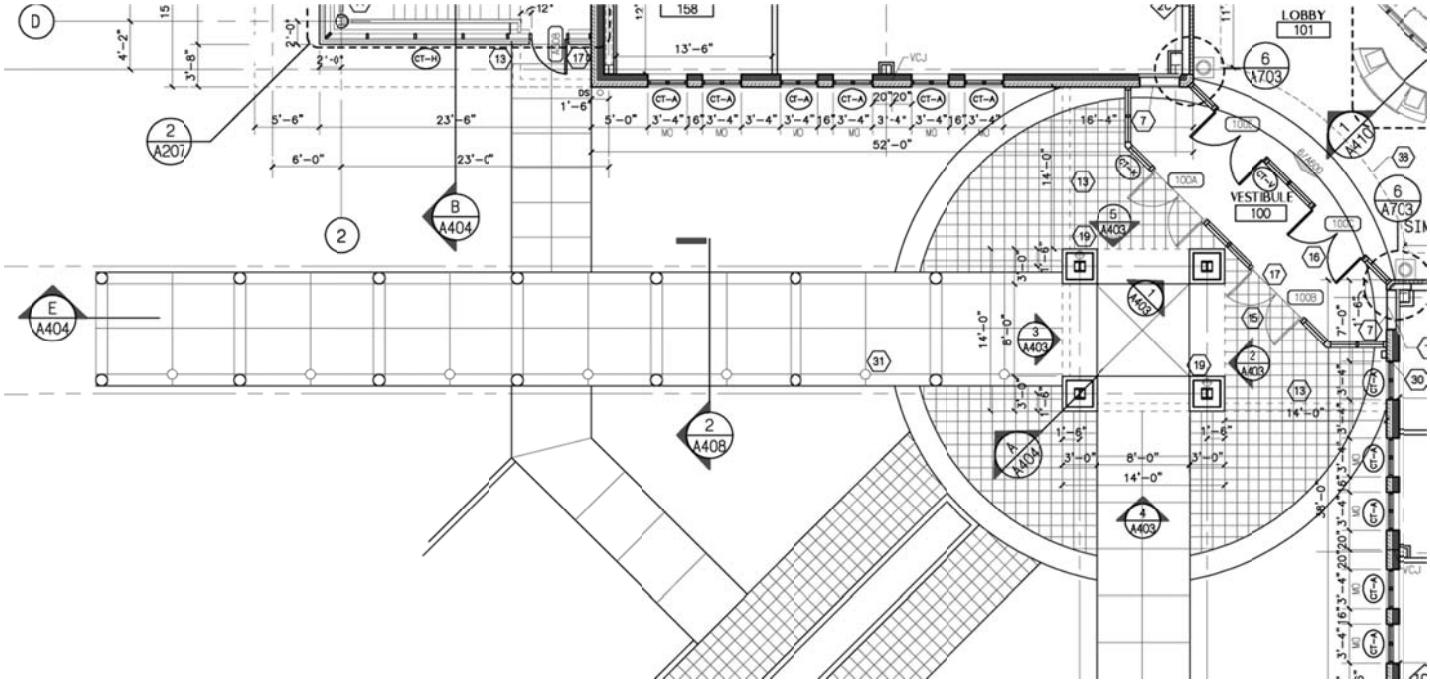
Spatial Description

The Entrance Structure consists of a covered 10 ft. wide walkway parallel to the West wing façade leading to a clock tower. White fiberglass columns line both sides of the walkway and support the aluminum skylight system which provides shelter to occupants as they enter the vestibule. This skylight system is 13'-2" high, and has an 8"/12" slope on each side of the highest point. The supporting columns are spaced 12' on center. A monumental clock tower clearly marks the entrance to the building, standing at 43' from the ground floor. The clock tower itself is not accessible for anybody other than the maintenance crew.

Area: 1248.5 SF Ceiling Height = 9'-4" (Ground Level)

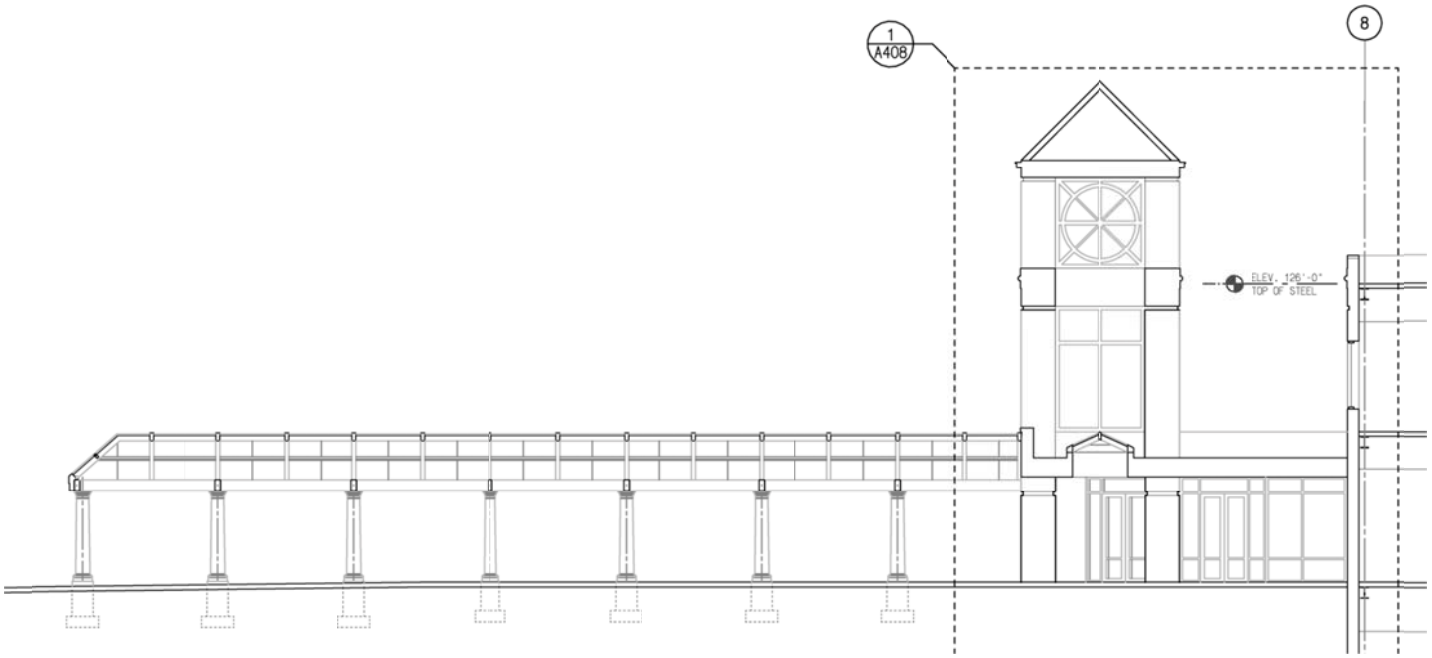
Ceiling Height = 24'-5" (Second Floor Level)

Floor Plan



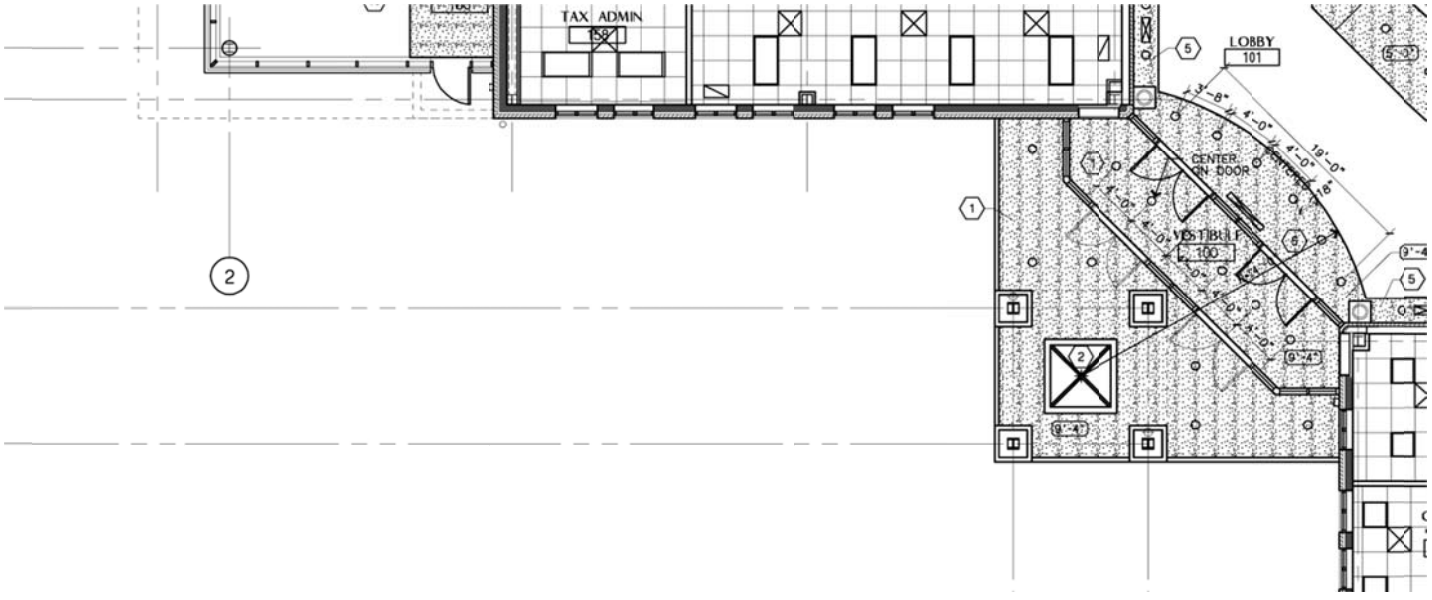
Entrance Structure: Floor Plan

Section

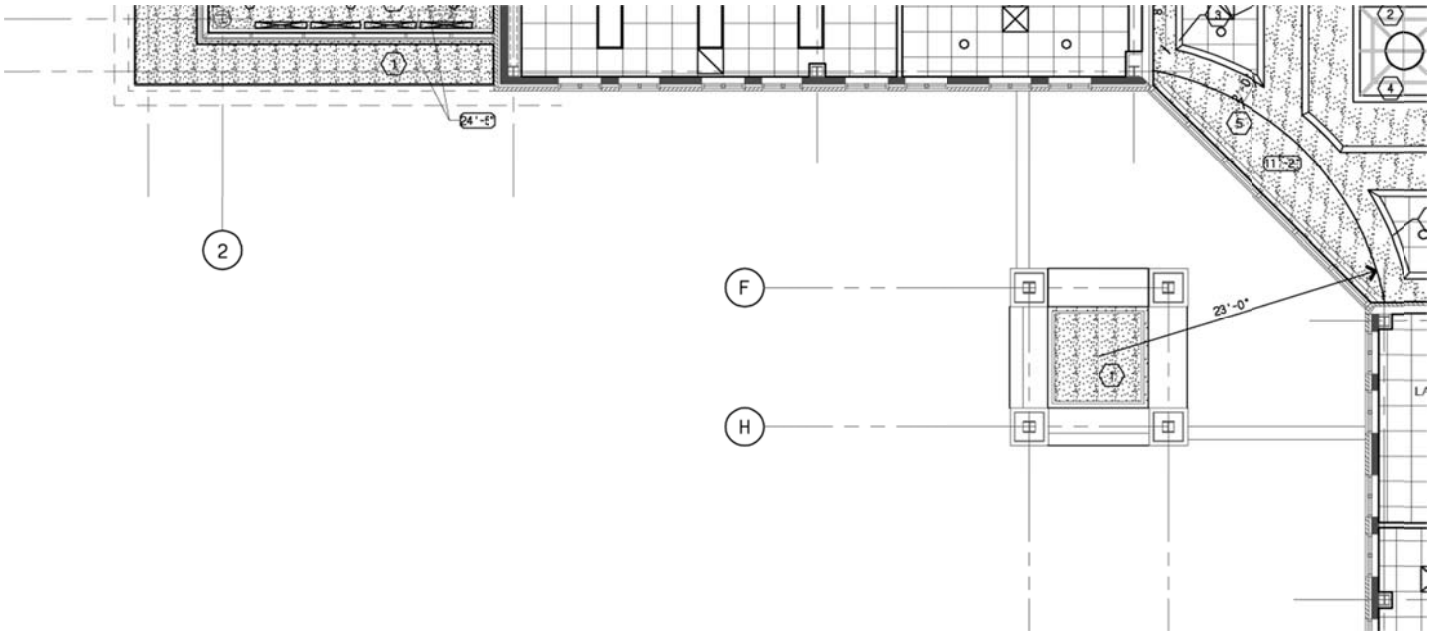


Entrance Structure: Section

Reflected Ceiling Plans



Entrance Structure: Ground Floor RCP



Entrance Structure: Second Floor RCP

Finishes (Materials)

Material	Location	Reflectance
Brick	Wall surfaces	0.35
Metal	Roof	0.6
Aluminum	Walkway Glazing Support	0.7
Fiberglass, White	Walkway Columns	0.8
Glazing	All Glazing	.44 (Transmittance)

Furnishings

No furnishings exist under or surrounding the entrance structure.

Visual Tasks

Because the Main Entrance Structure functions solely as an exterior walkway, the only visual task that applies is general circulation, which falls under the "orientation and simple visual tasks" category.

Design Criteria

Space Types in IESNA Lighting Guide

Building Exteriors, Entrances, Active (Pedestrian / Conveyance)

Appearance of Space and Luminaires

The City of Green Administration Building represents the surrounding population and area. The exterior needs to convey the professional nature of the building to any guests viewing the building at night time. The lighting should enhance the features of the walkway and clock tower without causing visual clutter.

Equipment chosen to illuminate the entrance structure must render the natural colors of the materials in a natural way to not decrease the aesthetic appeal of the building. The spectral power distribution of the lamp should be considered to choose a source that will render colors well. For the majority of offices and institutional workplaces, a CRI of 70 and above will be adequate.

Direct / Reflected Glare and Source-Task-Eye Geometry

Direct and reflected disability glare can be discomforting to occupants. Luminaires must be chosen and placed to eliminate direct glare from the source to the eye. To ensure direct glare is minimized, the beam angle should be less than 70 degrees from the source to observer. Source-task-eye geometry needs to be considered to reduce reflected glare for occupants using the entrance as well as occupants inside the spaces with exterior windows adjacent to the Entrance Structure. Also, luminaire luminance in the direction to the viewer should be minimal to reduce direct glare.

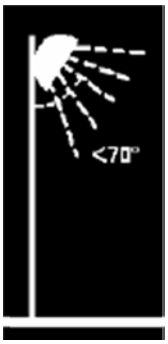


Image Source: ILE Guidance Notes for the Reduction of Obtrusive Light (Page 2)

Light Distribution on Surfaces

Discomfort can be caused by a high contrast between the illuminated surface and surrounding areas. To ensure minimal discomfort glare, luminance ratios of the surfaces on the Entrance Structure should not exceed 20:1.

Light Pollution / Trespass

Reducing the amount of light emitted into the atmosphere and surrounding area is necessary for exterior lighting design. Light pollution will be avoided by reducing light emitted above the horizontal and non-target illumination according to guidelines set by the Institution of Lighting Engineers (ILE) document "Guidance Notes for the Reduction of Obtrusive Light." Minimizing direct upward light, spill light, and light trespass will be a main design goal.

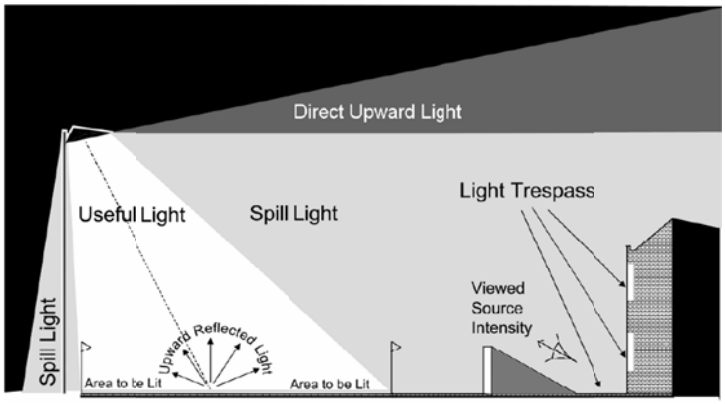


Image Source: ILE Guidance Notes for the Reduction of Obtrusive Light (Page 1)

Environmental Zone: E2, Low District Brightness Area

Sky Glow Upward Light Ratio (ULR) (Max %) = 2.5

This does not apply to ground recessed luminaires, ground mounted floodlights, and festive lighting.

Source Intensity I = 2.5 kcd (Pre-Curfew), 0 kcd (Post-Curfew)

The pre-curfew limit of 2.5 kcd in potentially obtrusive directions (facing away from the building) will be adhered to despite the large current distance between the building and surrounding properties. This will ensure the building will meet the requirements if future development shortens this distance. The 0 kcd limit can always be met by turning off the relevant fixtures.

Building luminance L = 5 cd / m^2 (Average)

Because the general district brightness is unknown, it will not be considered during evaluation. Also, spill light from nearby fixtures not used to directly light the building façade are not included in this average.

Points of Interest

The main point of interest for this space is the clock tower at the end of the walkway. This clock tower should be highlighted, while keeping to the previously mentioned maximum surface luminance ratio and minimizing wasted upward light.

Illuminance Values Based on IESNA Lighting Guide

Horizontal Illuminance: 5 fc

Vertical Illuminance: 3 fc

Power Allowances: ASHRAE Standard 90.1

For "Canopies and Overhangs," the power allowance is 1.25 W / SF. This applies to the area under the covered walkway and canopy.

Area under overhang and walkway = 1346 SF

(1346 SF) * (1.25 W / SF) = 1682.5 W Lighting Power Allowance

For walkways less than 10 ft. wide, the power allowance is 1 W / LF. This applies to the uncovered walkways considered for this space, except for the circular plaza area not covered by the clock tower overhang.

Combined Length of Walkways = 379.05 ft.

(83 LF) * (1 W/LF) = 379.05 W Lighting Power Allowance

For plaza areas, the power allowance is 0.2 W / SF. This applies to the circular area around the clock tower that is not covered by the canopy.

Plaza Area = 628.5 SF

(628.5 SF) * (0.2 W / SF) = 125.7 W

For entrance areas, the power allowance is 30 W / LF of door width.

Door Width = 12 ft.

(12 ft.) * (30 W / LF) = 360 W

Total Lighting Power Allowance = 1682.5 W + 379.05 W + 125.7 W + 360 W = **2547 W**

Shutoff Requirements: ASHRAE Standard 90.1

An astronomical time switch or photosensor is mandatory for dusk-to-dawn exterior lighting.

Summary of Numerical Design Criteria

Horizontal Illuminance	5 fc	
Vertical Illuminance	3 fc	
Total Power Allowance	2547 W	
Max Beam Angle	70 degrees	(Source to Observer)
Max Surface Luminance Ratio	20:1	
ULR (Max %)	2.5	
Source Intensity I	2.5 kcd	(Away from Building)
Building luminance L	5 cd / m^2	(Average)
Lamp CRI	<70	

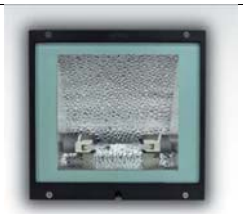
Lighting Solution Overview

The goal of the lighting solution for the entrance structure is to safely illuminate the entrance pathways below and surrounding the clock tower and covered walkway while minimizing direct/indirect/discomfort glare, controlling upward light, and guiding occupants into the space via points of interest. All criteria must be met while adhering to the maximum lighting power allowance. This was done using a combination of bollard, surface mount linear fluorescent, surface mount compact fluorescent, and recessed compact fluorescent luminaires. The bollard fixtures provide the necessary 5 fc of horizontal illumination on the uncovered paths. Surface mounted linear fluorescents mounted to the underside of the walkway covering provide a slightly higher illumination value than the uncovered walkway, and recessed CFLs further increase illumination under the clock tower canopy. This increasing Illuminance gives time for the eye to adapt to higher interior illumination levels as well as guiding nearby occupants into the space.

The clock tower is highlighted with surface mounted wall grazing fixtures on the exterior, and a single high intensity wide beam angle down light mounted to the topmost ceiling. This will guide occupants that are further away from the building using the clock tower as a point of interest. Furthermore, exterior surface illumination is limited to the layers of red brick. This is continued into the lobby to create a sense of connection between the spaces.

Luminaire & Ballast Schedules

Luminaire Images

Type	Image	Type	Image
FC		FD	
FE		FF	
FG			

Luminaire Schedule

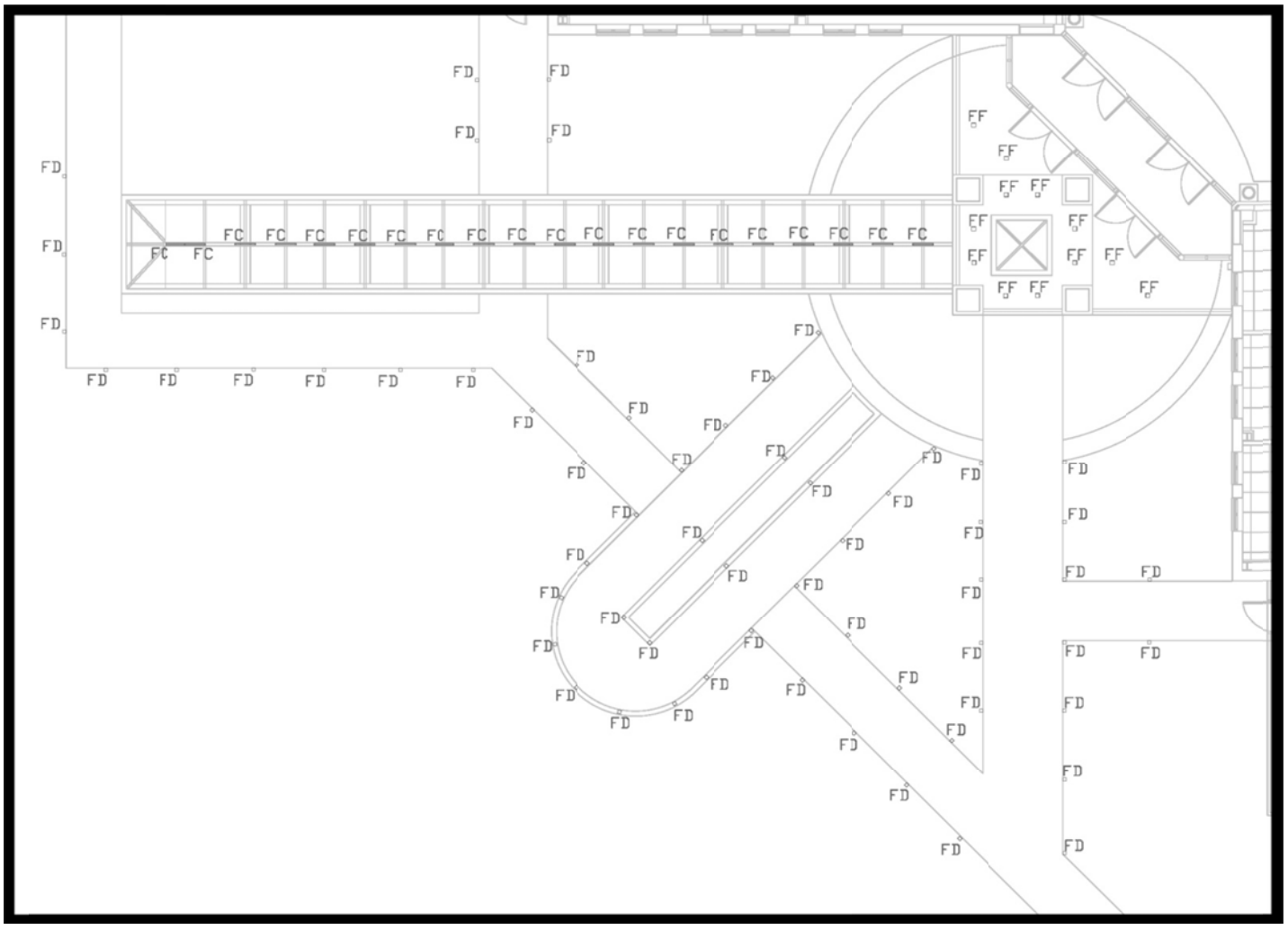
Type	Mfr	Catalog #	Description	Lamp	Fixture Watts	Volts	Quantity
FC	Ligman	30621	Linear Fluorescent, surface mount, black, bi-symmetrical reflector	GE F14W/T5/835/ECO G5 (Bi-Pin) 1350 Initial Lumens	16 W	277	14
FD	Ligman	10592	Metal Halide, Bollard, symmetrical distribution, black	Philips MASTERColour Mini CDM-Tm 20W/830 PGJ5 Base 1615 Initial Lumens	26 W	277	61
FE	Ligman	30569	CFL, surface mount, black, bi-symmetrical wall washer,	TC-TEL 32W DULUX T/E OSRAM Gx24q-4 (4-Pin) 3200 Initial Lumens	37 W	277	8
FF	Bega	6725P	CFL, recessed, symmetrical distribution, black	18 W CFL Triple – 4p Gx24q-2 1200 Initial Lumens	24 W	277	10
FG	Ligman	80157	Metal Halide, surface mount, symmetrical, aluminum reflector	HIS-MP 70W/CL SYLVANIA 4900 Initial Lumens	87 W	277	1

Refer to Appendix X for Cut sheets

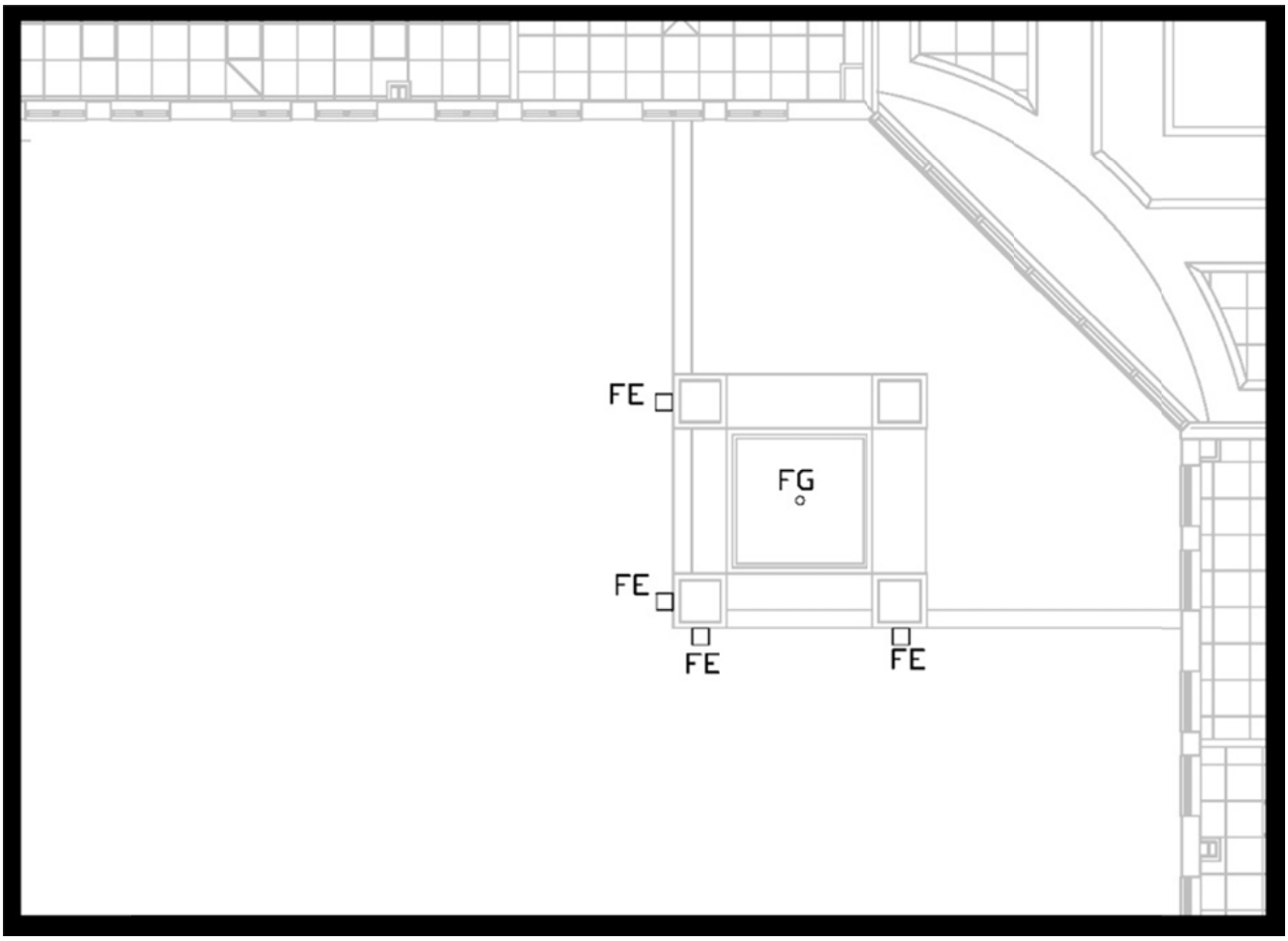
Ballast Schedule

Type	Description	Input Watts	BF	Other
FC	GE228MVPS-A	16 W	1	
FD	Philips EH-Sm 20W/S 220-240 50/60 Hz (9137 006 014)	26 W	1	
FE	VS / TC-TEL 25-42W / TC-DEL 220V 50Hz	37 W	1	
FF	Electronic ballast universal voltage 120V – 277V	24 W	1	
FG	GATA N70 220V / 50 Hz	87 W	1	

Lighting Plan



Entrance Structure Ground Lighting Plan: See Appendix X for Full Size Drawing and Scale



Entrance Structure Second Floor Lighting Plan: See Appendix X for Full Size Drawing and Scale

Control System

Requirements: ASHRAE Standard 90.1

Standard 90.1 requires automatic lighting shutoff for interior lighting in buildings larger than 5000 SF

Space Control Scheme

All outdoor luminaires will operate via a time clock for simplicity, which will turn all outdoor lights off at a pre-set time. There will be no need for a photosensor.

Performance Summary

Light Loss Factors

Luminaire Type	LDD	LLD	BF	Total LLF
FC	.95	.92	1	.874
FD	.95	.91	1	.865
FE	.95	.87	1	.82
FF	.95	.92	1	.87
FG	.95	.9	1	.855

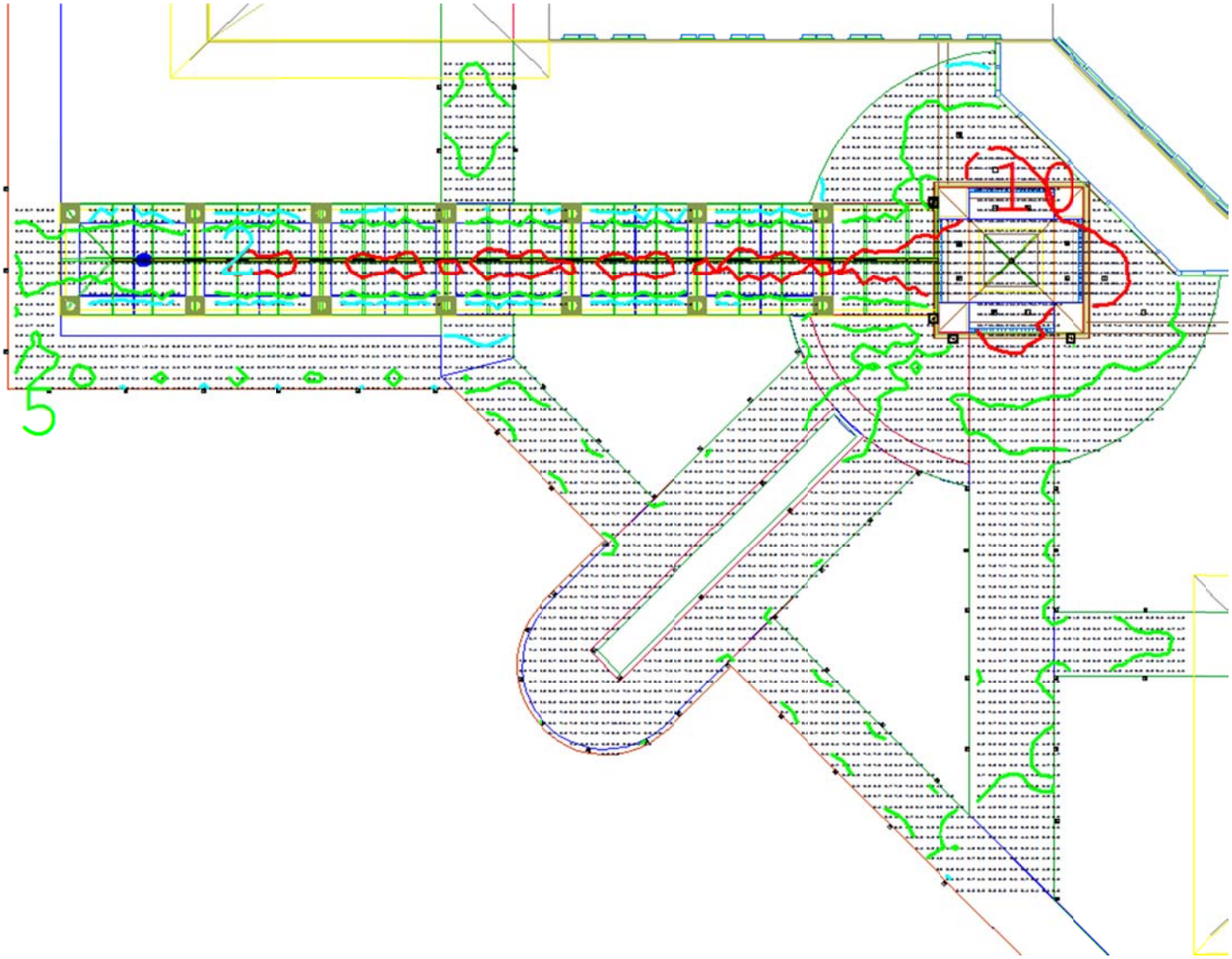
Energy Calculations

Luminaire Type	Input Watts	Quantity	Total Watts
FC	16 W	14	224 W
FD	26 W	61	1586 W
FE	37 W	8	296 W
FF	24 W	10	240 W
FG	87 W	1	87 W
Lighting Power Allowance = 2547 W			**2477 W**

The space meets lighting power density requirements set by ASHRAE 90.1. This was possible because all of the energy calculations done to figure out the components of this LPD are tradable amongst each other.

AGI Calculations

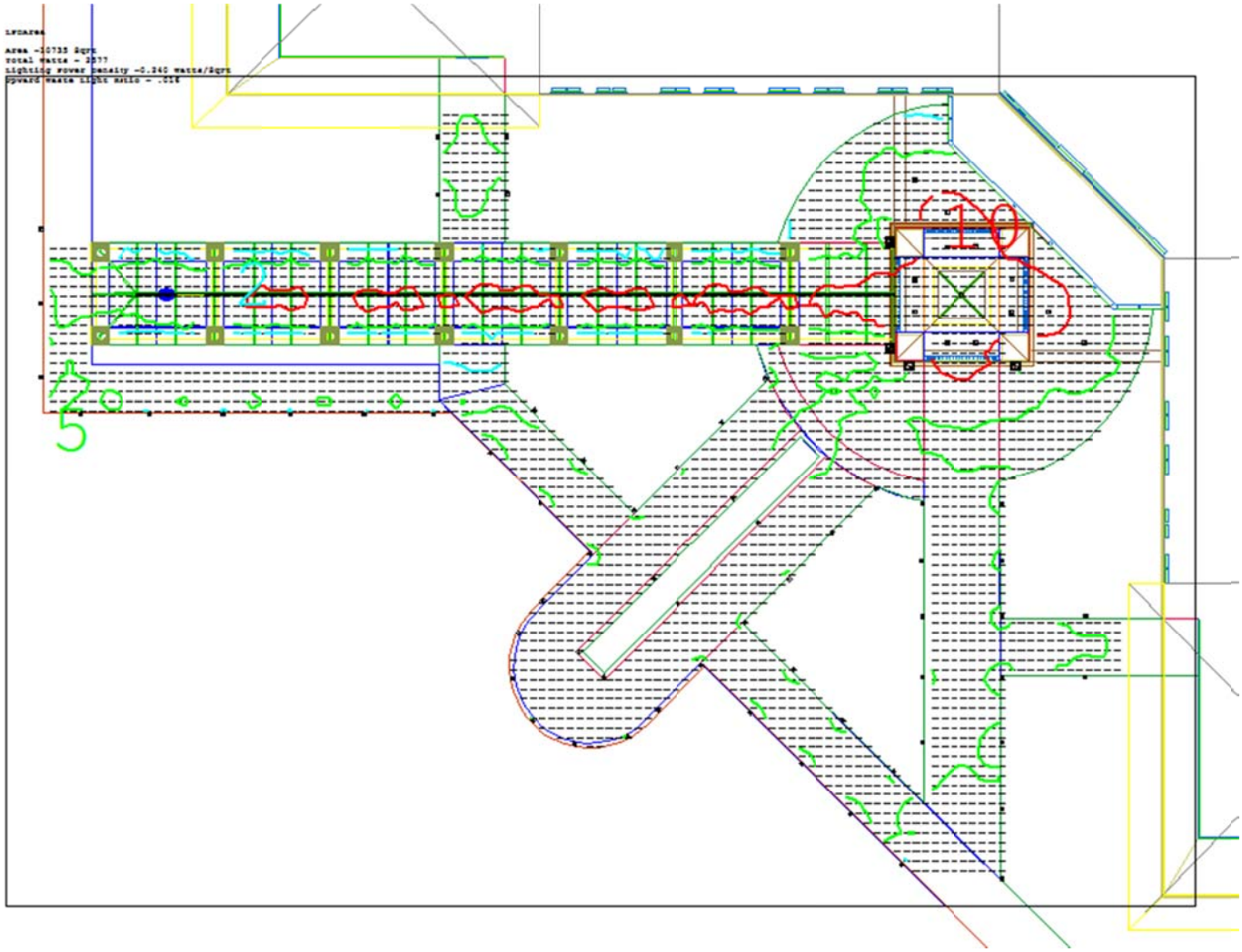
(Calc. 1) Entrance Structure: Ground Level Illuminance



Average = 6.40 fc	Maximum = 18.7 fc	Minimum = 0.5 fc
Ave / Min = 12.80	Max / Min = 37.40	

For the ground level calculation, the majority of the uncovered walkway is illuminated to 5 fc. If the areas existing ambient light level was known, it would have been included in the calculation. This will bring these areas up to the required 5 fc because parking lot luminaires are located nearby the entranceway.

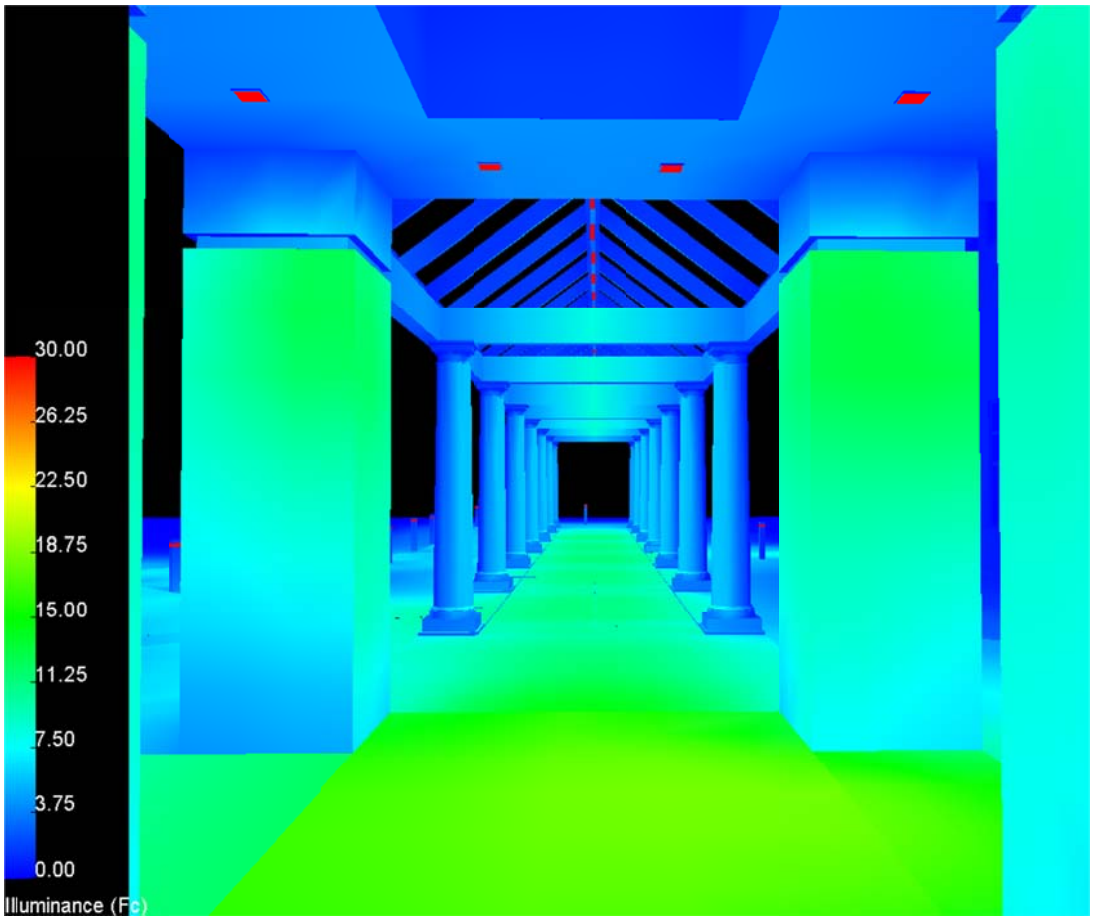
(Calc. 2) Entrance Structure: Upward Wasted Light Ratio (UWLR)

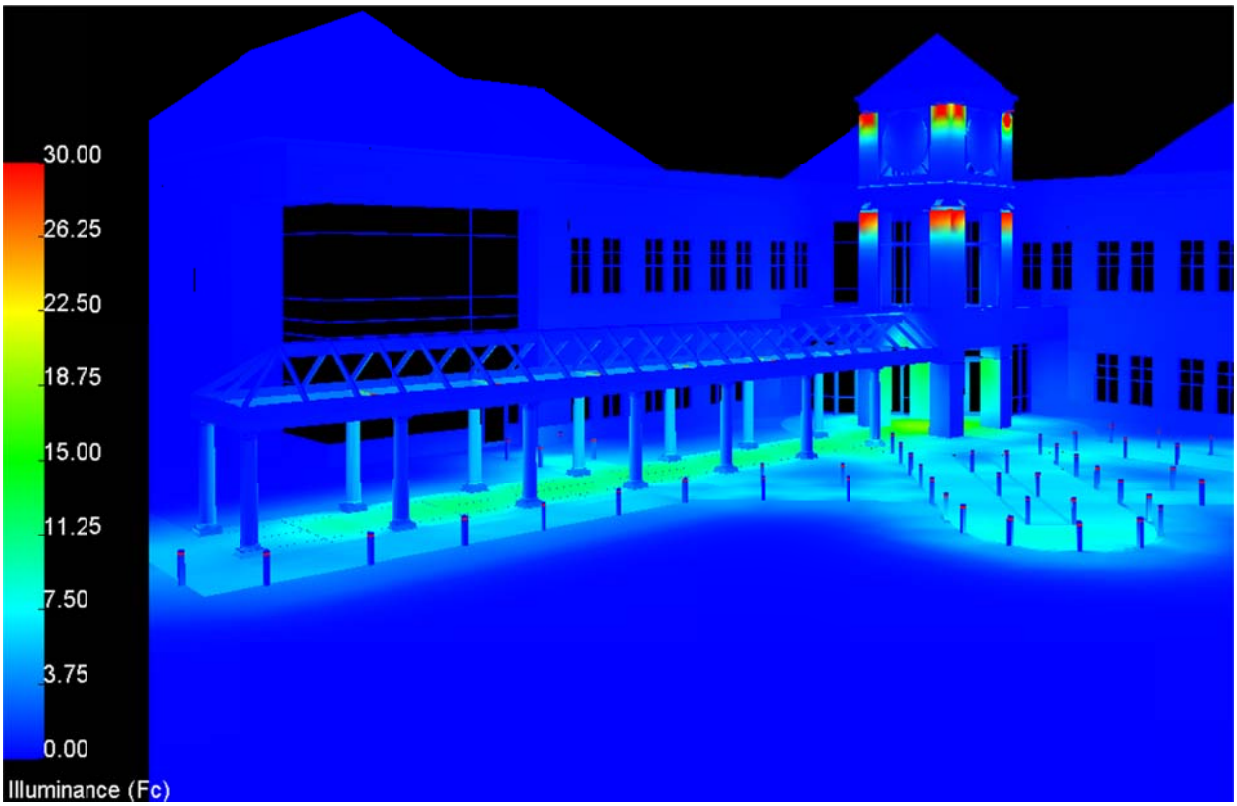


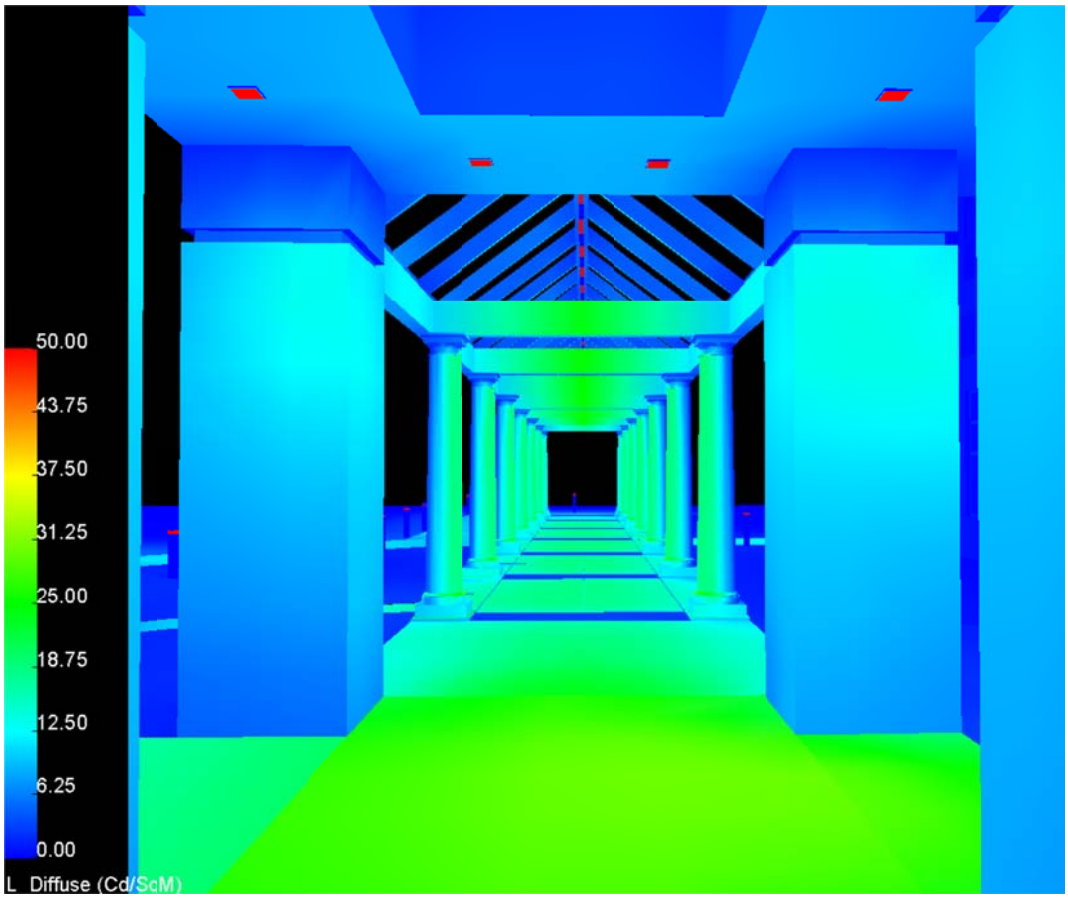
Area = 10735 SF	Total Watts = 2477 W	LPD = 0.240 W / SF
UWLR = 0.016		

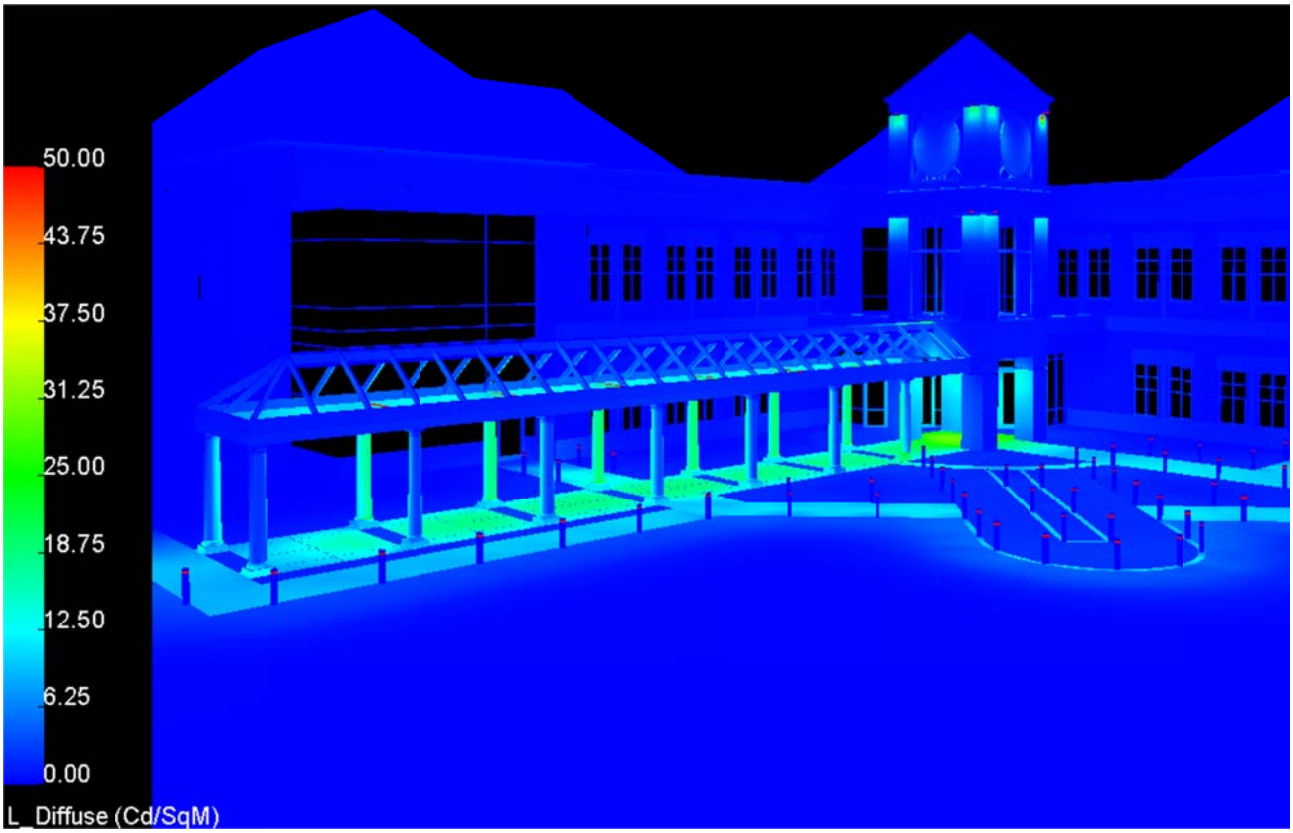
This upward wasted light ratio is below the 2.5% set by the design criteria for this space. It is important to note that the UWLR only includes luminaires specified for this section of the report, and does not represent the site total UWLR due to additional parking lot and façade lighting which illuminate the building.

Renderings


30.00
26.25
22.50
18.75
15.00
11.25
7.50
3.75
0.00
Illuminance (Fc)


30.00
26.25
22.50
18.75
15.00
11.25
7.50
3.75
0.00
Illuminance (Fc)


50.00
43.75
37.50
31.25
25.00
18.75
12.50
6.25
0.00
L_Diffuse (Cd/SqM)


50.00
43.75
37.50
31.25
25.00
18.75
12.50
6.25
0.00
L_Diffuse (Cd/SqM)

Lighting Design: Main Lobby (Circulation Space)

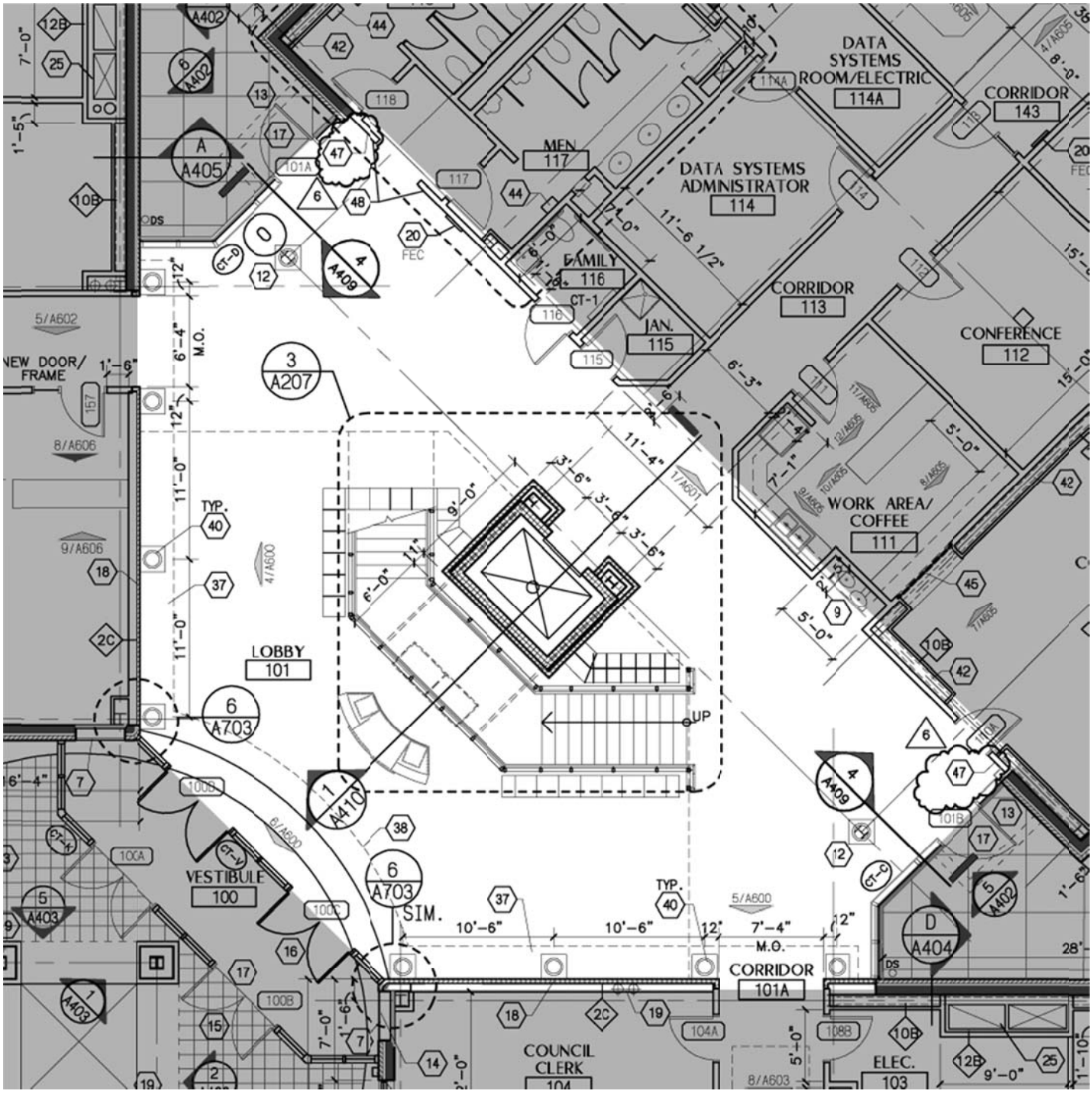
Spatial Description

The Main Lobby introduces occupants to the interior space and pulls together the three main wings of the building. Its central location makes it the meeting point of the three wings, as well as the main point of access to all major spaces. Notable features of the lobby include the secretary's desk directly in front of the entrance point, a central staircase wrapping around the main elevator, seating throughout the space, hanging artwork, and coves on the ceilings of both lobby floors. High quality materials used in construction are detailed below, and must be considered in the lighting design.

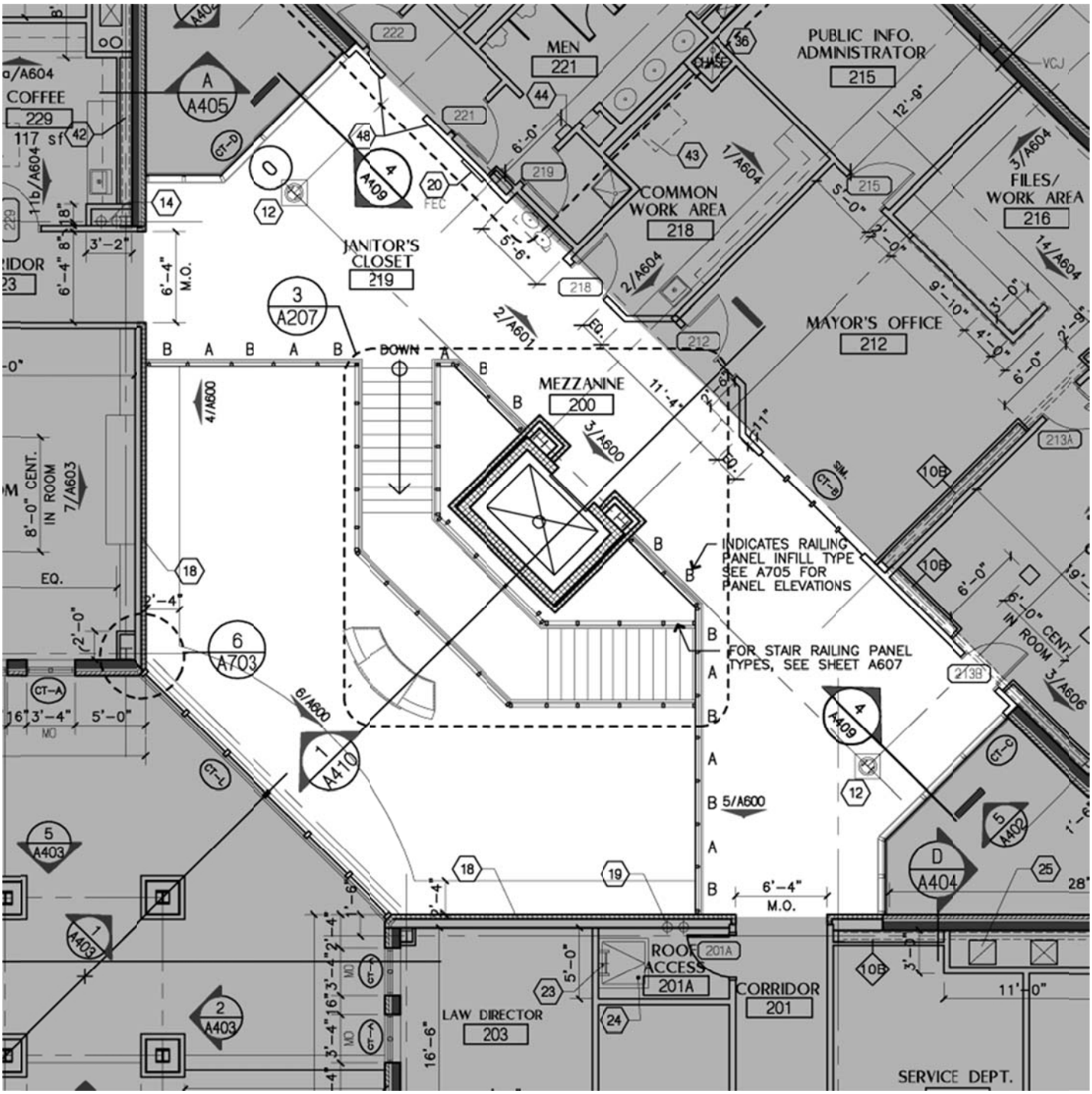
Various architectural features of the Lobby tie it to surrounding spaces. The recessed coves on the ceiling are shown in the reflected ceiling plan. These coves are of architectural importance because they are the main feature which ties the Lobby to the Council Chambers, two of the most used and luxurious spaces in the building. The decorative columns located around the perimeter match the structural columns supporting the entrance structure, successfully tying the two together architecturally. These matching features ease circulation through the building in some cases, and should be supported by the lighting.

Area: 3331 SF Ceiling Height = Varies, see reflected ceiling plan

Floor Plans

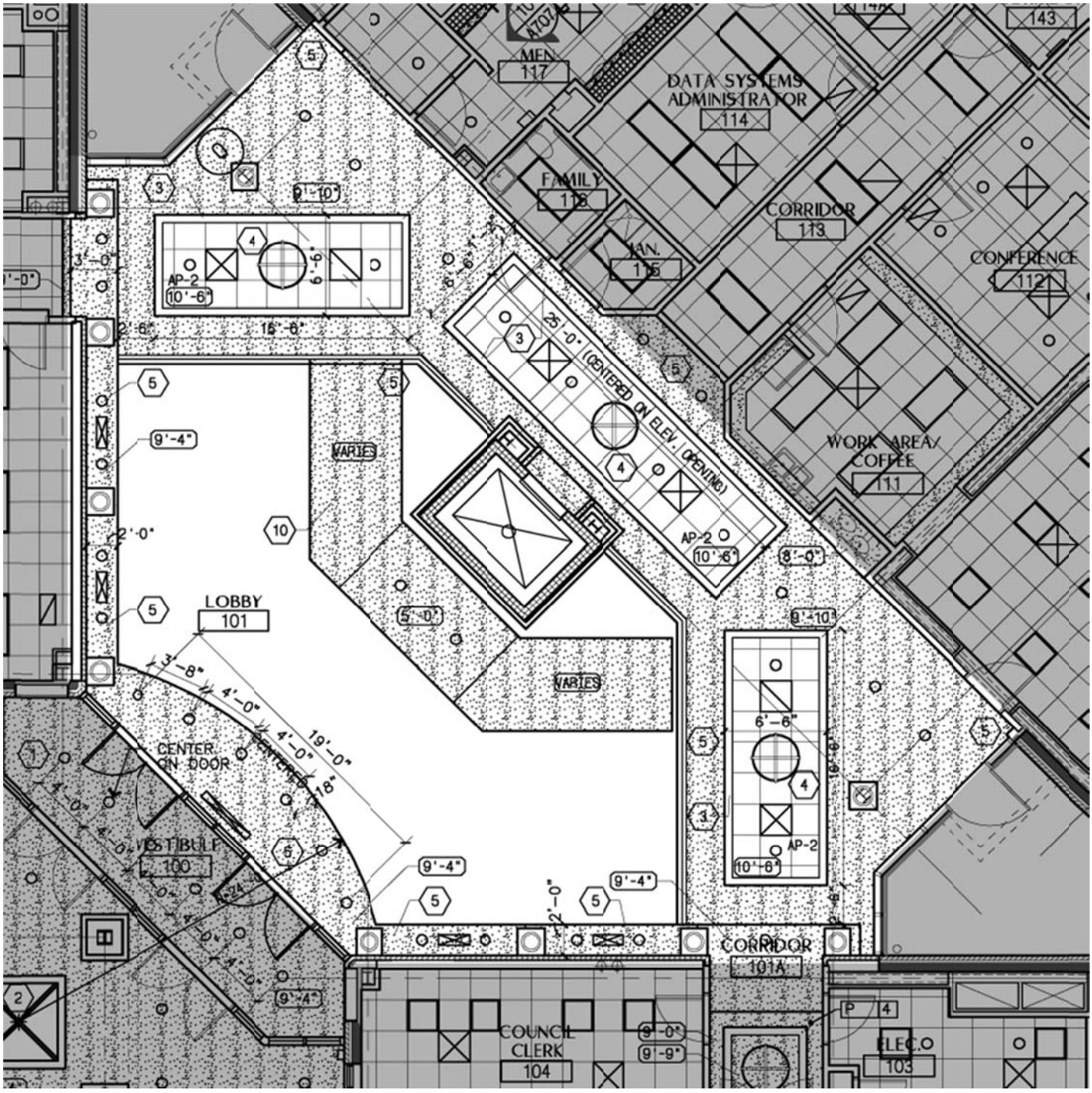


Main Lobby: Ground Floor Plan

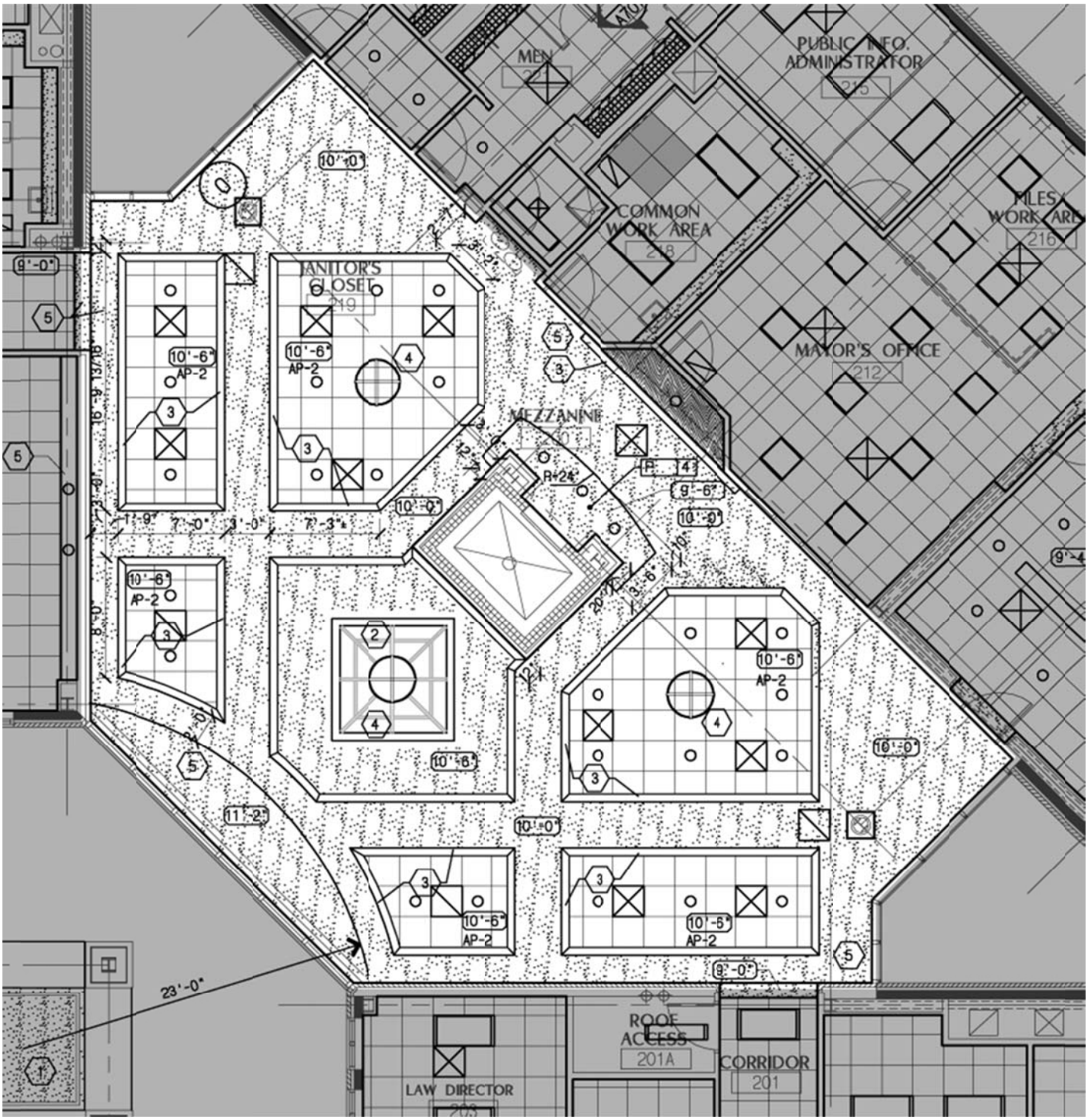


Main Lobby: Second Floor Plan

Reflected Ceiling Plans



Main Lobby: Ground Floor Reflected Ceiling Plan



Main Lobby: Second Floor Reflected Ceiling Plan

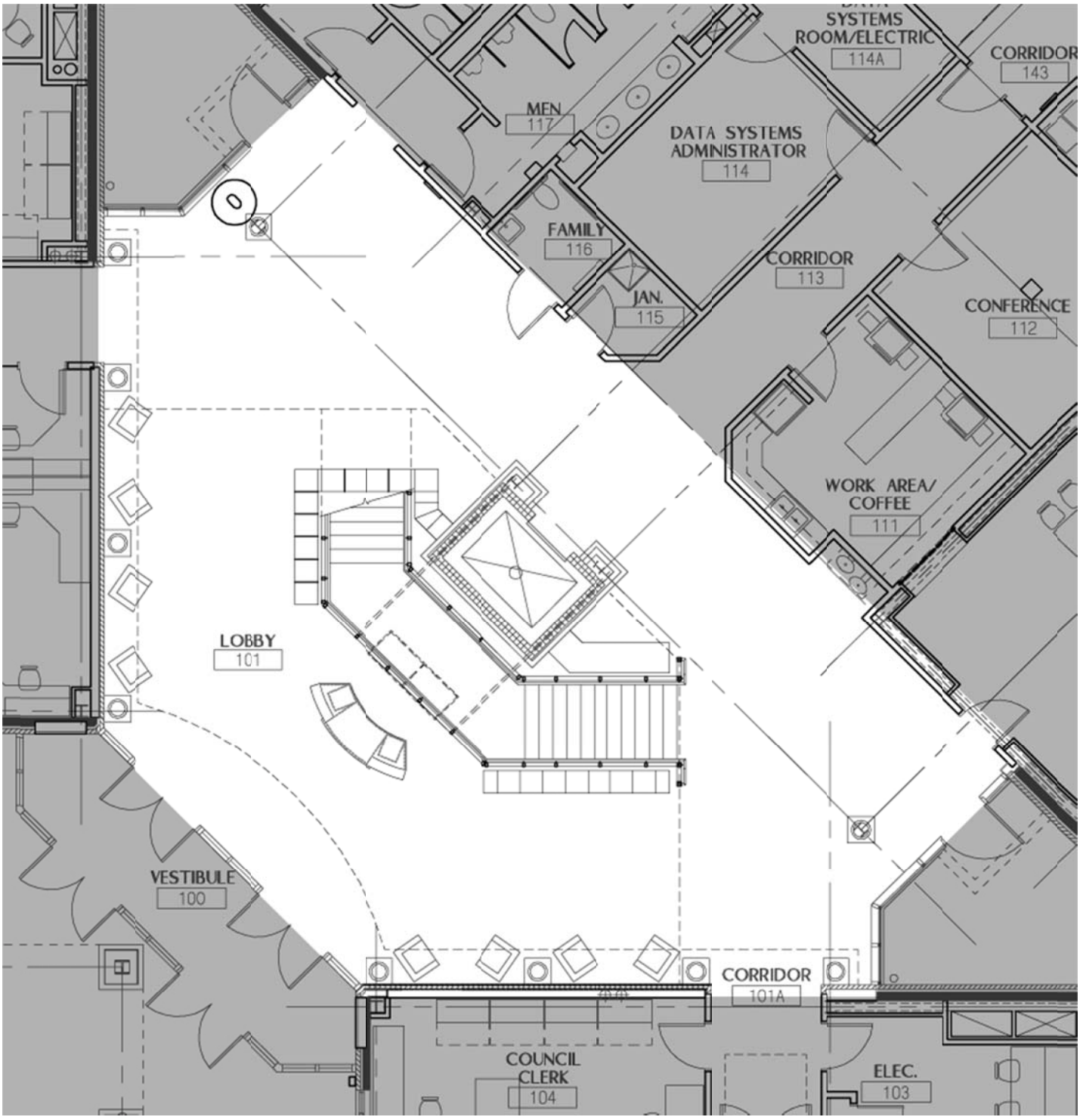
Finishes (Materials)

Material	Location	Reflectance
Tile, Ergon Color "Naturale Rettificato"	Floor	0.35
Vinyl Wall Covering, Essex Color "Trust Fund"	Walls	0.7
Fiberglass, Painted White	Columns	0.8
Nylon Scaper Yarn, Leed Color Unknown	Floor inside of entrance doors	0.4
Carpet, Bolyu Color "Array"	Border of 2nd floor	0.25
Carpet, Bolyu Color "#DEF27"	Outside Elevator, 2nd Floor	0.2
Glazing	All Glazing	.44 (Transmittance)

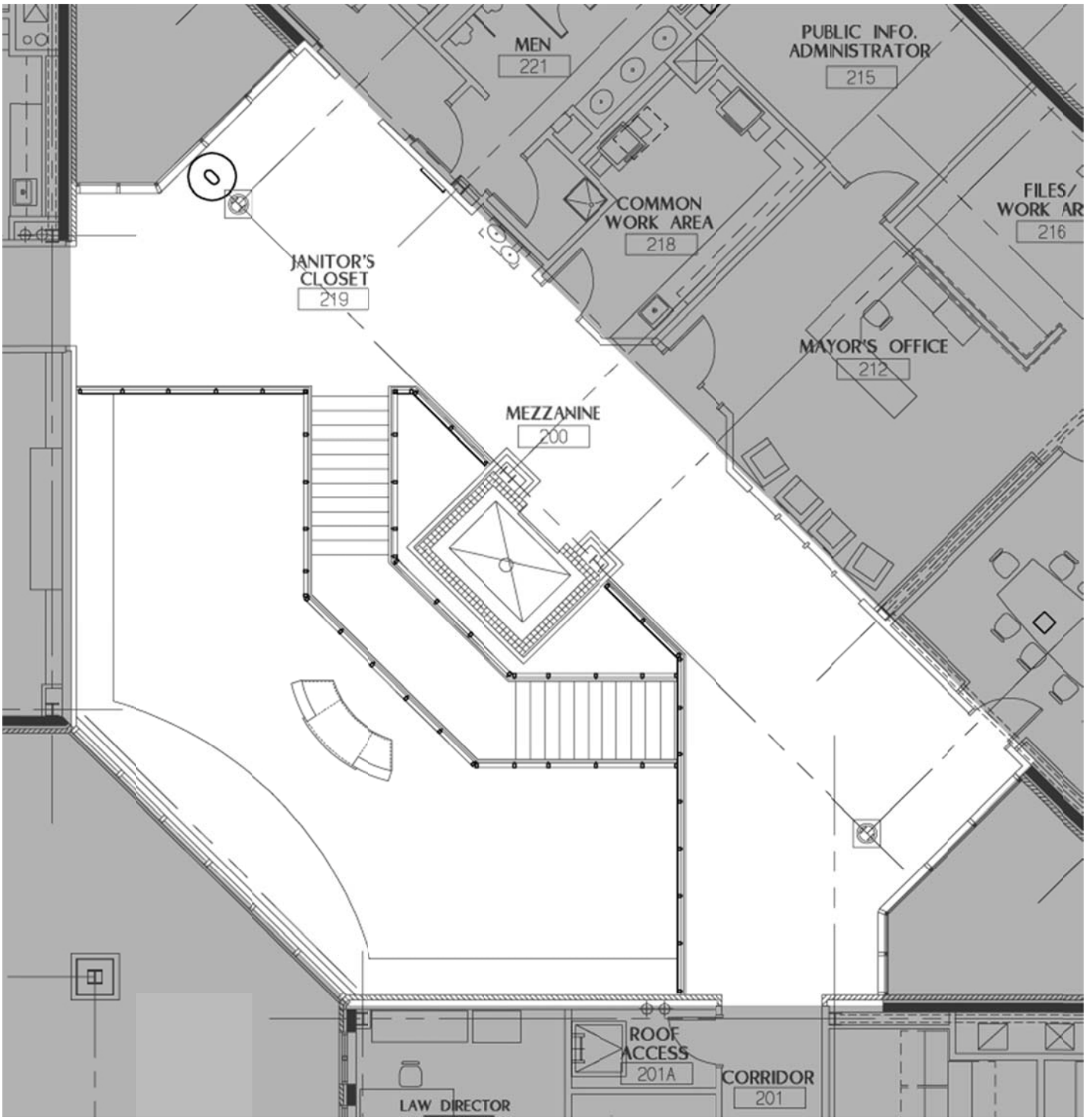
Furnishings

The Main Lobby has seating around part of the perimeter wall and staircase of the first floor. Also, the secretary's desk is located next to the staircase in front of the main entrance. There are eight large armchairs on the perimeter wall near the entrance, and continuous bench seating surrounding the central stairs. The second floor is devoid of furniture. Exact locations of furnishings can be viewed on the furniture plans below.

The space has enough seating for approximately twenty people, in addition to the secretary. This implies that the lobby could function as a waiting room during busy times of the day, which will affect some aspects of the lighting design. Guests will want to be able to do read or work on their laptops while waiting so appropriate illumination levels must be selected for the work plane. Much of the lobby contains no seating, and essentially acts as a large hallway in front of the elevator.



Furniture Plan: Ground Floor



Furniture Plan: Second Floor

Visual Tasks

The main visual task to consider for the main lobby is circulation of people, especially for the transition from the exterior to interior of the building and the central staircase. The lighting must ensure a safe transition into the building as well as use of the interior staircase. Dimming the interior luminaires during night time will ensure the visual system will be able to adapt to the difference. The secretary will be performing visual tasks that most guests will not. He or She must use a computer, or perform simple reading and writing tasks. The guests who will be using the seating area on the lower level may also be reading, writing, or using a personal electronic device. For the areas of the lobby space away from the seating and desk area, the only visual task will be circulation. Because the visual tasks differ through the lobby, the lighting will need to be designed accordingly. The four main spaces are the Secretary's Desk, Waiting Area, Elevator Corridors, and Corridors.

Design Criteria

Space Type in IESNA Lighting Guide

Offices: Lobbies, lounges, and reception areas

Appearance of Space and Luminaires

The Main Lobby is the first space new occupants see upon entering the building, so it must be visually pleasing and memorable. The lighting must complement the architectural elements, such as the ceiling coves and perimeter decorative columns. Achieving a psychological impression of spaciousness will improve the appearance of the lobby, and create a general sense of awe. Luminaires should be chosen to enhance but not distract from the space.

Reflected Glare and Source-Task-Eye Geometry

Surface materials used in construction must be carefully considered to reduce reflected glare off specular surfaces. Indirect glare from luminaires can cause a veiling reflectance on the secretary's (and guest) computer screen. Source-task-eye geometry is important for the areas of the lobby where tasks other than circulation will be performed, such as the waiting area and secretary's desk. It is also crucial to prevent glare in the staircase area for safe movement between floors.

Light Distribution on Task Plane

A uniform distribution of light on the task plane is necessary for the secretary's desk and guest waiting areas. For other parts of the space the task plane is not a great concern, however the illumination of all corridor spaces must be at least one fifth the illumination in adjacent areas.

Modeling of Faces and Objects

The secretary will be welcoming people to the building. This is a circulation space where a lot of people will be moving through so the lighting should be able to render faces accurately and well.

Illuminance Values Based on IESNA Lighting Guide

Corridor Spaces

Horizontal Illuminance: 10 fc

Vertical Illuminance: 3 fc

Secretary's Desk

Horizontal Illuminance: 30 fc

Vertical Illuminance: 10 fc

Guest Waiting Area

Horizontal Illuminance: 30 fc

Vertical Illuminance: 10 fc

Power Allowances: ASHRAE Standard 90.1

Using the Space-by-Space method for a Lobby and Table 9.6.1, the power allowance is equal to 1.3 W/SF (conference/meeting/multipurpose space).

Area = 3331 SF

(3331 SF)*(1.3 W/SF) = 4330 W Lighting Power Allowance

Summary of Numerical Design Criteria

Horizontal Illuminance	10 fc (Corridor Spaces)
	30 fc (Secretary's Desk)
	30 fc (Guest Waiting Area)
Vertical Illuminance	3 fc (Corridor Spaces)
	10 fc (Secretary's Desk)
	10 fc (Guest Waiting Area)
Power Allowance	4330 W
Lamp CRI	<70

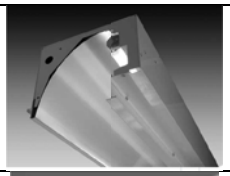
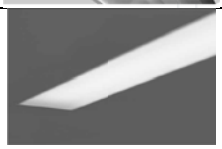
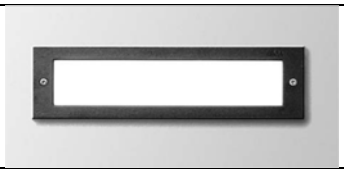
Lighting Solution Overview

The luminaires and their placement were chosen to create a psychological impression of spaciousness, meet the previously described design criteria, and support the buildings architecture in a way which provides a visual relation between the lobby and spaces which it connects. Many architectural elements in the space can be seen throughout the three wings, but the lobby is the only area which has them all. The columns and red brick from the entrance structure continue into the lobby and line both perimeter walls directly inside the entrance. Coves on both the ground level of the lobby and the ceiling above the mezzanine are nearly the same as the coves in the Council Chambers, and the skylight over the secretary's desk is a larger version of the one inside the clock tower.

The lighting design relates these spaces together in several ways. Firstly, linear fluorescent asymmetrical fixtures wash the brick behind the white fiberglass columns and surrounding the central elevator. This is done for both levels in a similar way the exterior columns of the entrance structure were highlighted. The coves in the Lobby and Council Chambers are related by using a recessed, thin, seamless fluorescent luminaire to create continuous squares of light within the cove with the sides parallel to the cove edges when possible. This solution supplies adequate illumination, creates visual interest, and eliminates the challenge of lighting the two coves of different depths in a similar fashion. Cove fixtures were used inside the skylight to illuminate the skylight at night. Also, recessed down lights provide additional light on the secretaries desk and near the entrance doors, and low wattage recessed fixtures illuminate the stairs.

Luminaire and Ballast Schedules

Luminaire Images

Type	Image	Type	Image
FH		FI	
FJ		FK	
FF			

Luminaire Schedule

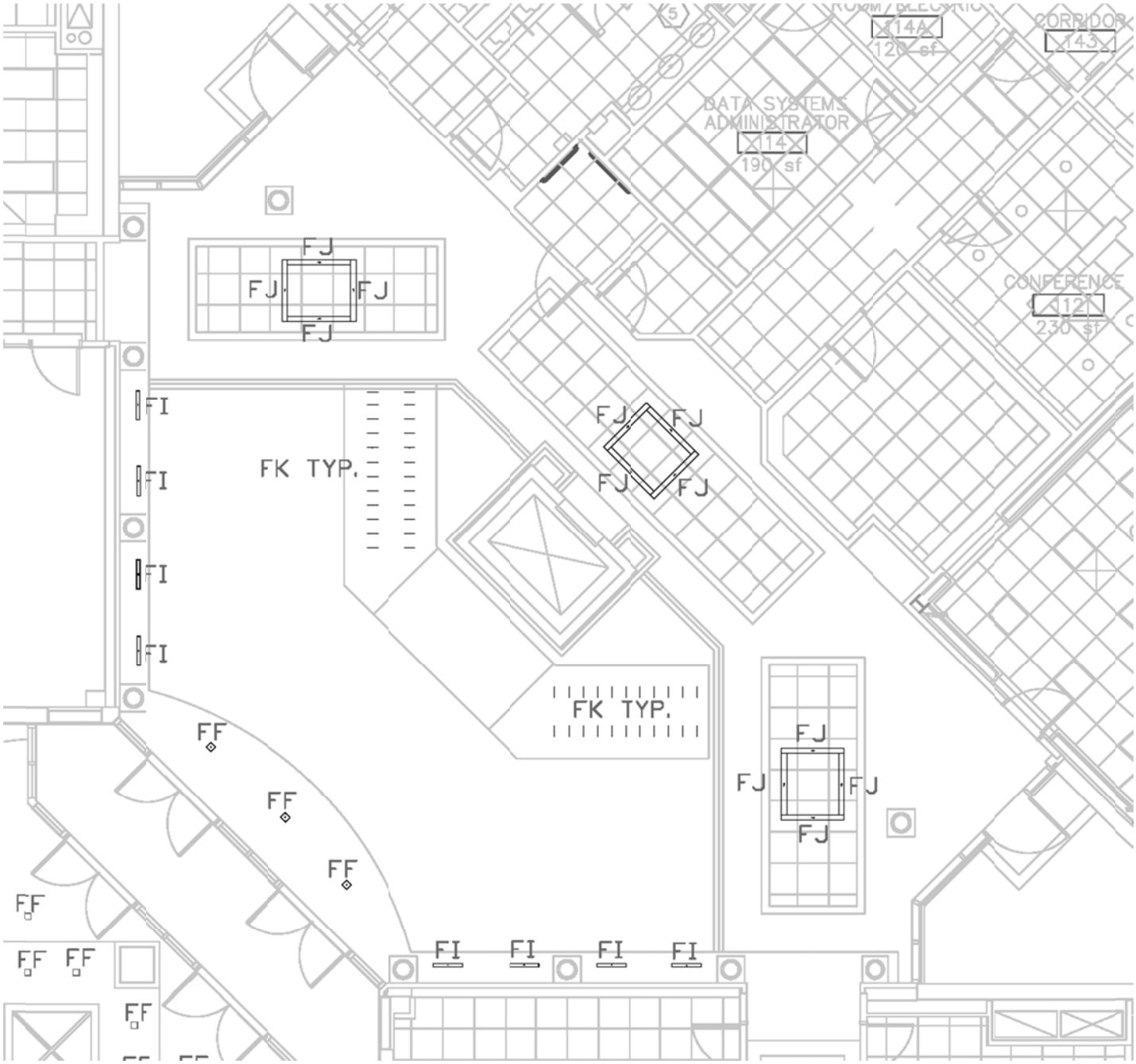
Type	Mfr	Catalog #	Description	Lamp	Fixture Watts	Volts	Quantity
FH	Focal Point	FW3-NS-1T5-1C-120-E-RC-HW-3'	Cove luminaire	F32T8	35 W	277	8
FI	Bega	6813P	Linear Fluor. Wall Washer	24 W FL T5	27 W	277	20
FJ	Focal Point	FSM4-FL-1T5-1C-120-S-G1-WH-4'	Seamless, must be installed before ceiling	F28W T5	32 W	277	52
FK	Bega	2289P	Stair recessed	9 W CF twin-2p	13 W	277	43
FF	Bega	6725P	CFL, recessed, symmetrical distribution, black	18 W CFL Triple – 4p Gx24q-2 1200 Initial Lumens	24 W	220	6

Refer to Appendix X for Cut sheets

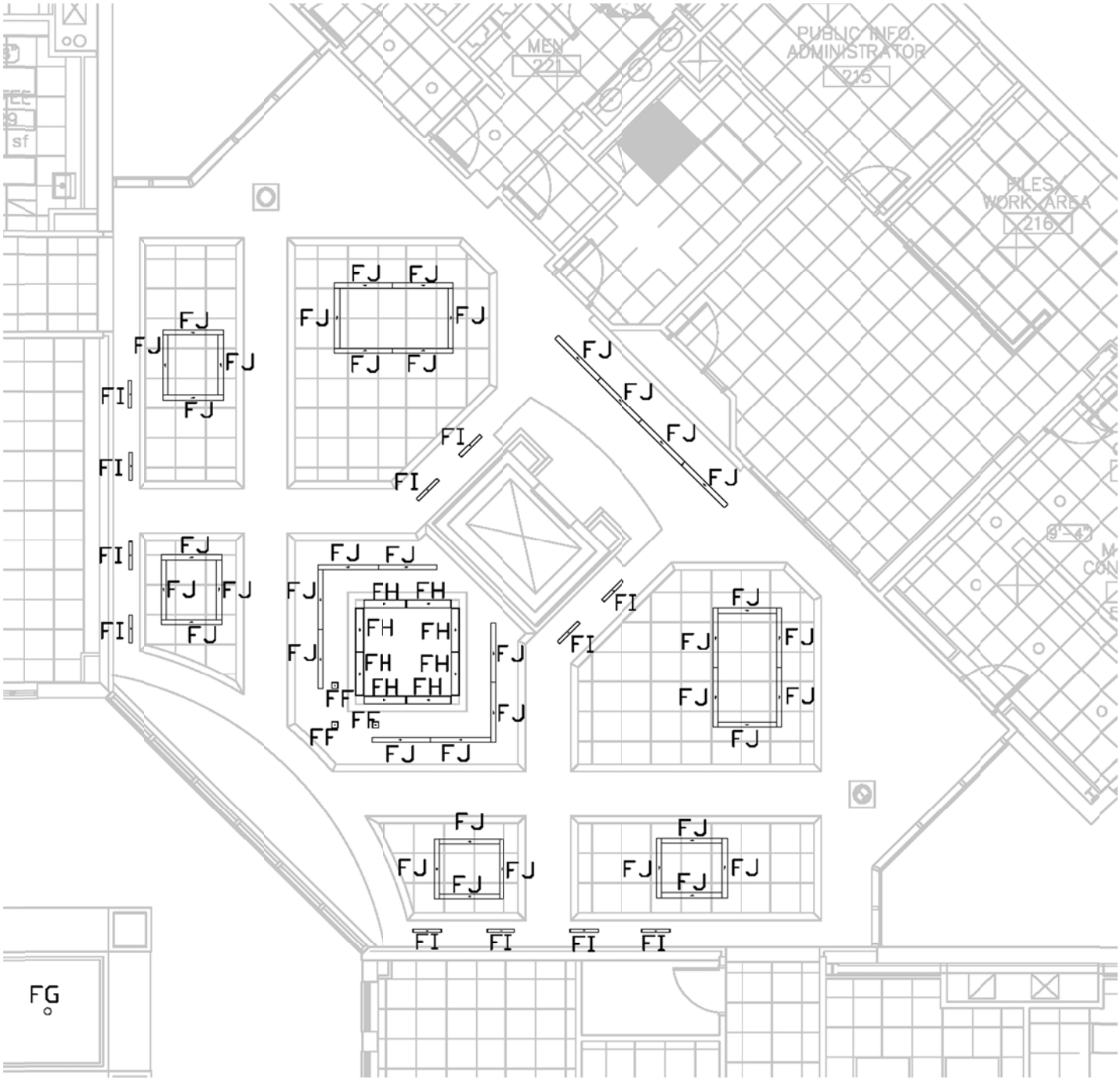
Ballast Schedule

Type	Description	Input Watts	BF	Other
FH		35 W	1	
FI	Integral electronic universal voltage ballast	27 W	1	
FJ	Electronic ballast	32 W	1	
FK		13 W	1	
FF	Electronic ballast universal voltage 120V – 277V	24 W	1	

Lighting Plans



Main Lobby: Ground Floor Lighting Plan



Main Lobby: Second Floor Lighting Plan

Control System

Requirements: ASHRAE Standard 90.1

Standard 90.1 requires automatic lighting shutoff for interior lighting in buildings larger than 5000 SF

Space Control Scheme

Because the lobby is the main space in the building, the lighting system will be simple on/off switching, and will not have multiple zones. The non-emergency fixtures will be on a clock timer to ensure they shut off at the appropriate, pre-set time.

Performance Summary

Light Loss Factors

Luminaire Type	LDD	LLD	BF	Total LLF
FH	.95	.91	1	.865
FI	.95	.91	1	.865
FJ	.95	.92	1	.874
FK	.95	.92	1	.87

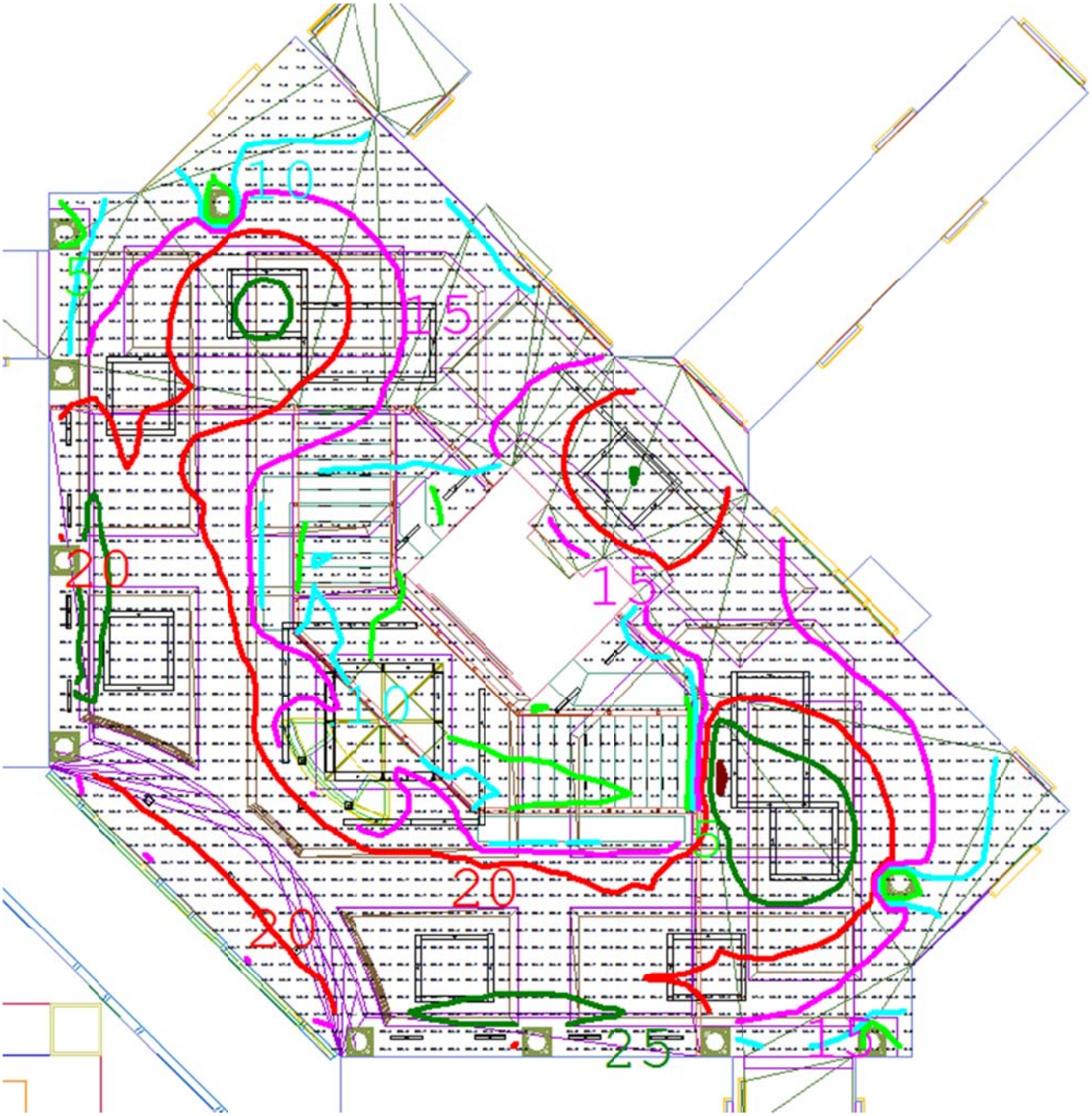
Energy Calculations

Luminaire Type	Input Watts	Quantity	Total Watts
FH	35 W	14	490 W
FI	27 W	61	1647 W
FJ	32 W	8	256 W
FK	13 W	10	130 W
FF	24 W	6	144 W
Lighting Power Allowance = 4330 W			**2,667 W**

After totaling the quantity of fixtures and considering their input watts rather than their lamp wattage, the new design falls well under the lighting power allowance for the space. This will result in energy savings throughout the year.

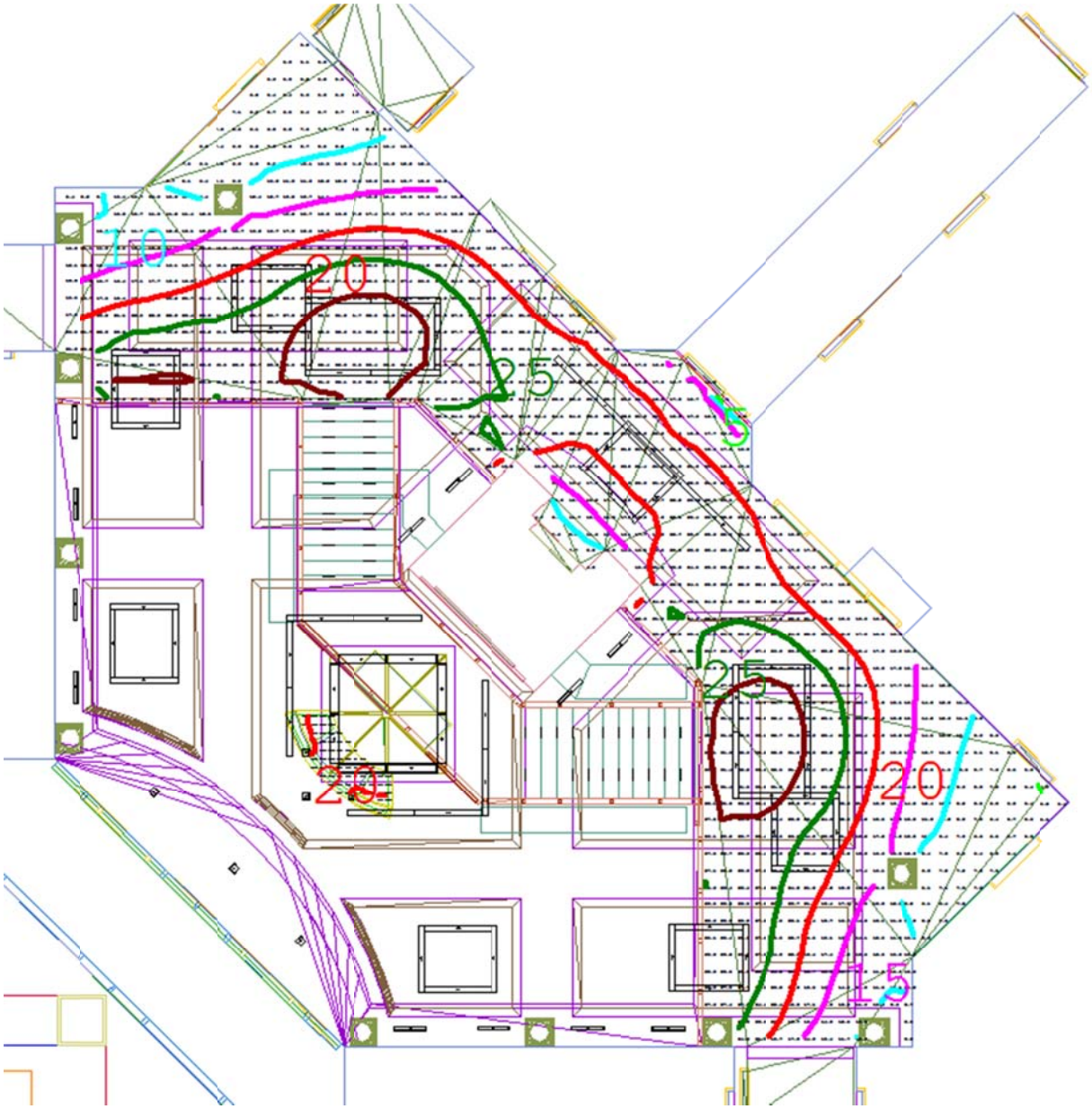
AGI Calculations

(Calc. 1) Main Lobby: Ground Floor Illuminance Levels



Average = 16.83 fc	Maximum = 30.5 fc	Minimum = 0.0 fc
Ave / Min = N/A	Max / Ave = 1.81	

(Calc. 2) Main Lobby: Mezzanine and Secretary's Desk Illuminance Levels



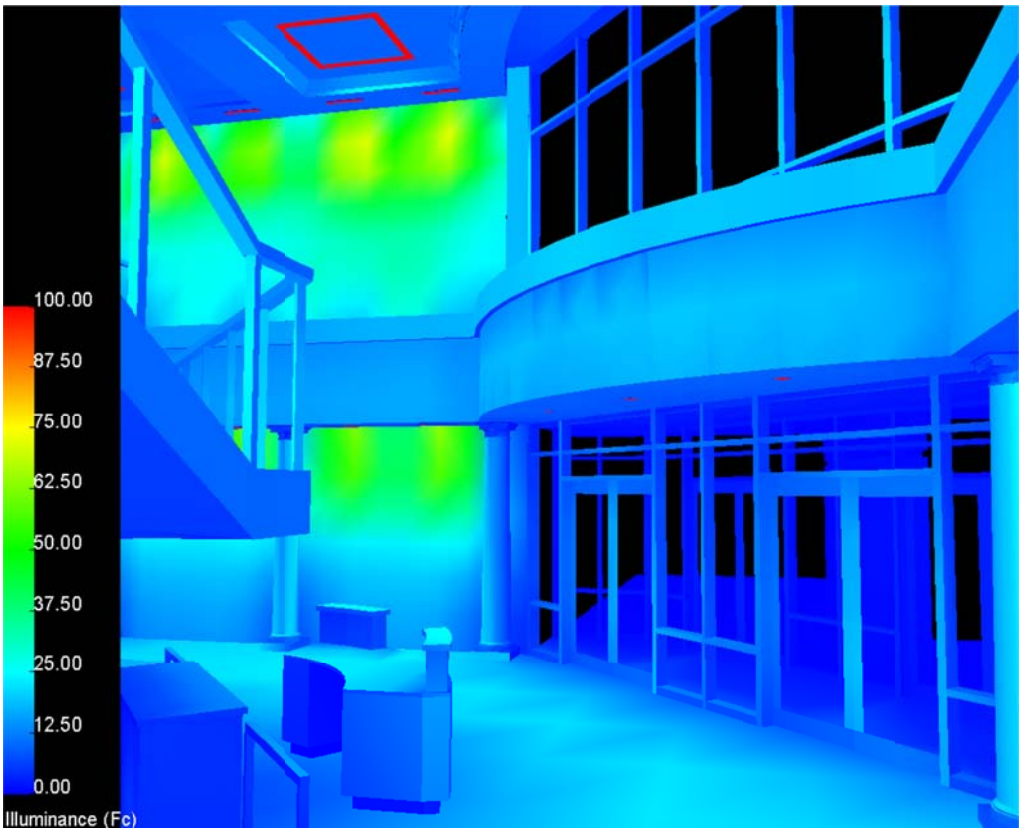
Mezzanine

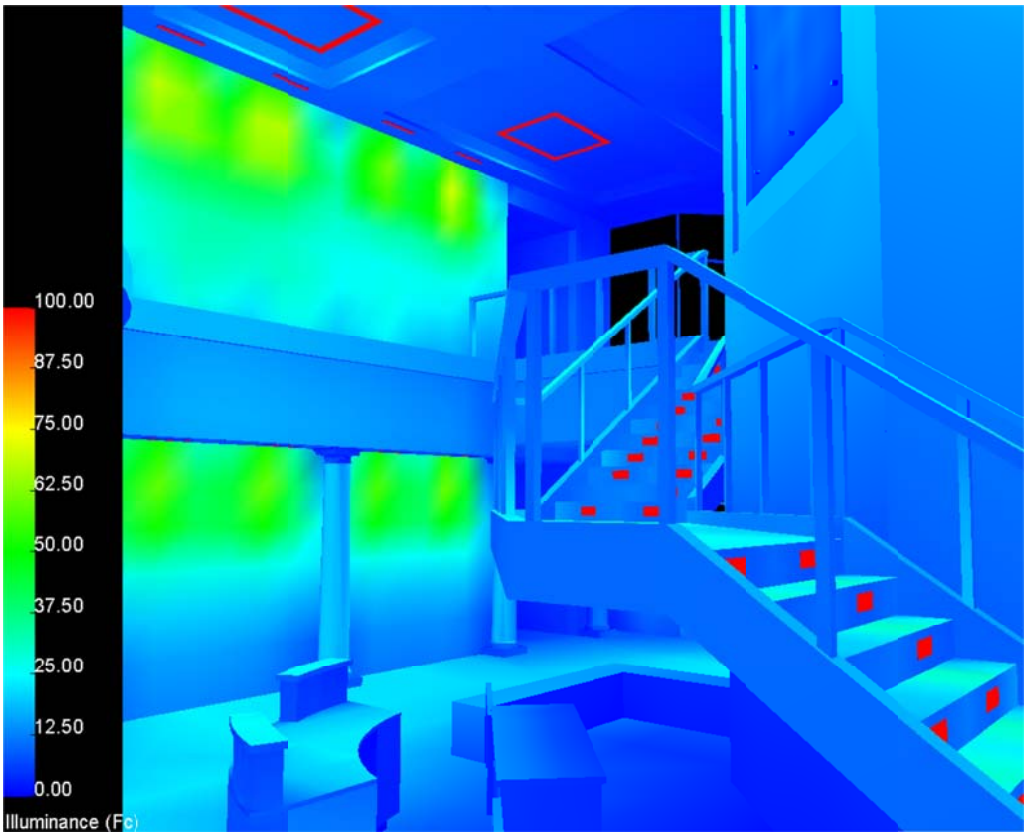
Average = 19.99 fc	Maximum = 33.7 fc	Minimum = 0.1 fc

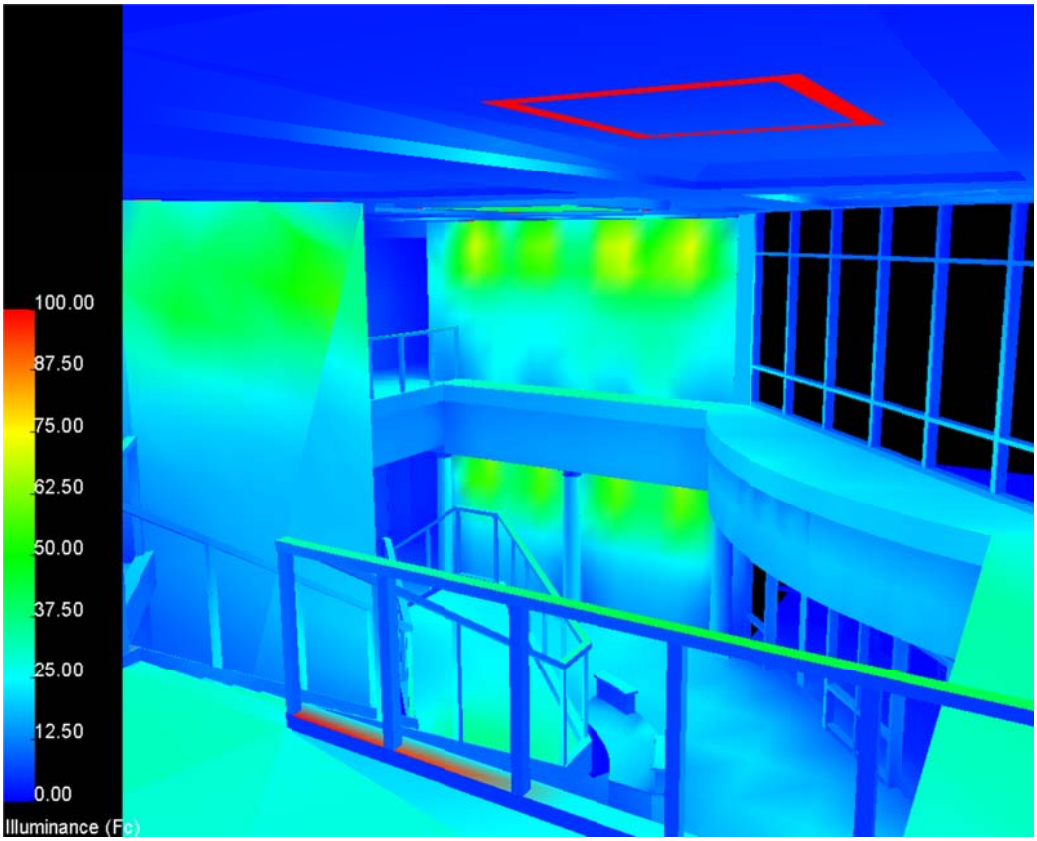
Secretary's Desk

Average = 22.24 fc	Maximum = 25.0 fc	Minimum = 16.3 fc

Renderings




100.00
87.50
75.00
62.50
50.00
37.50
25.00
12.50
0.00
Illuminance (Fc)


100.00
87.50
75.00
62.50
50.00
37.50
25.00
12.50
0.00
Illuminance (Fc)

Lighting Design: Council Chambers (Special Purpose Space)

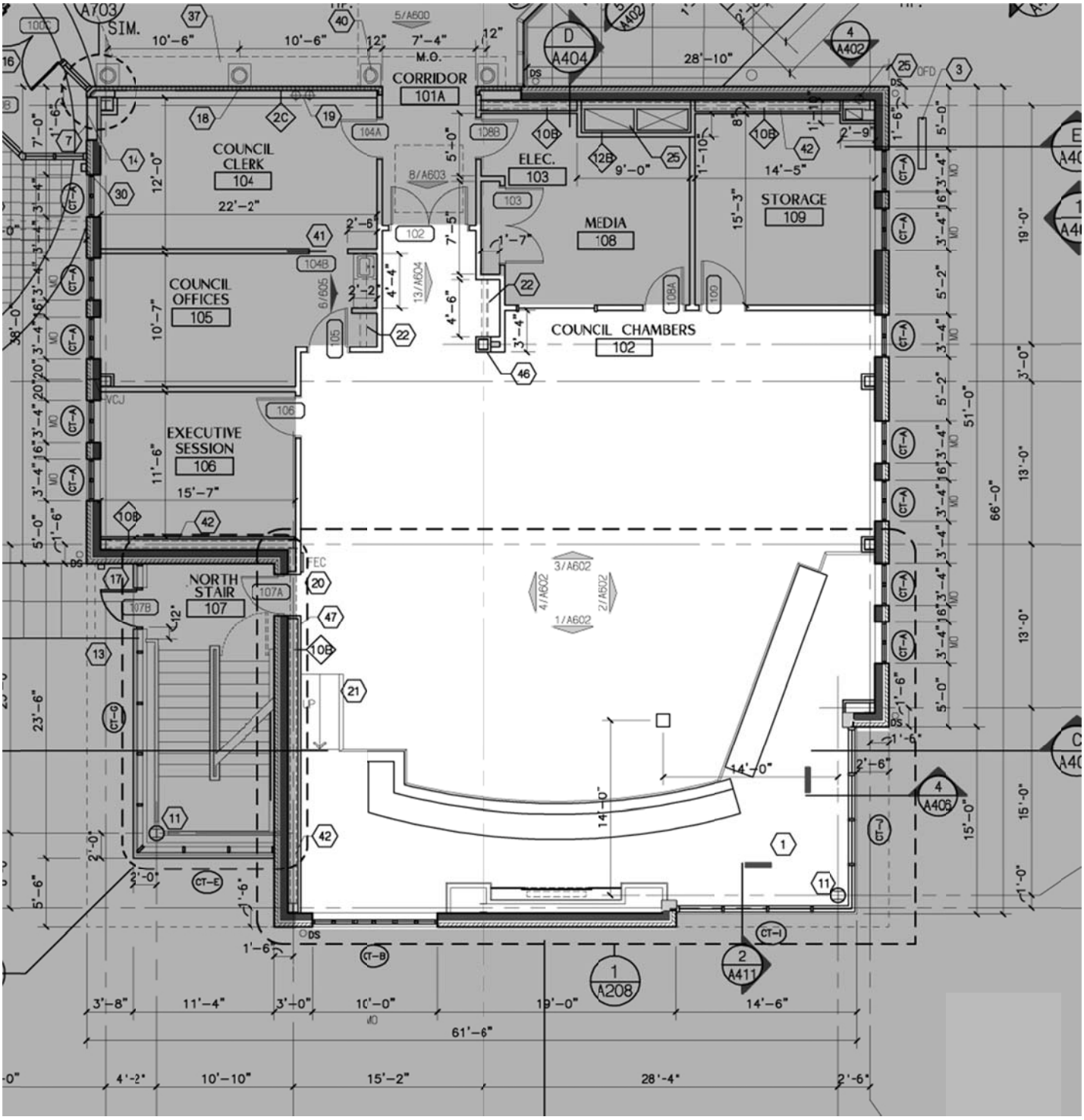
Spatial Description

The Council Chambers is located directly through the Main Lobby and is where major city officials hold large, often televised meetings. The main meeting space occupies the majority of space on the ground floor of the East wing and is surrounded by various supporting rooms such as the media room and smaller conference rooms. The almost rectangular floor plan can be divided up into two major areas; audience seating and council member seating. The council member's seating is positioned on a 6 inch raised platform and has two desks facing the audience with seating for 17 city officials. The space has seating for 109 not including the council.

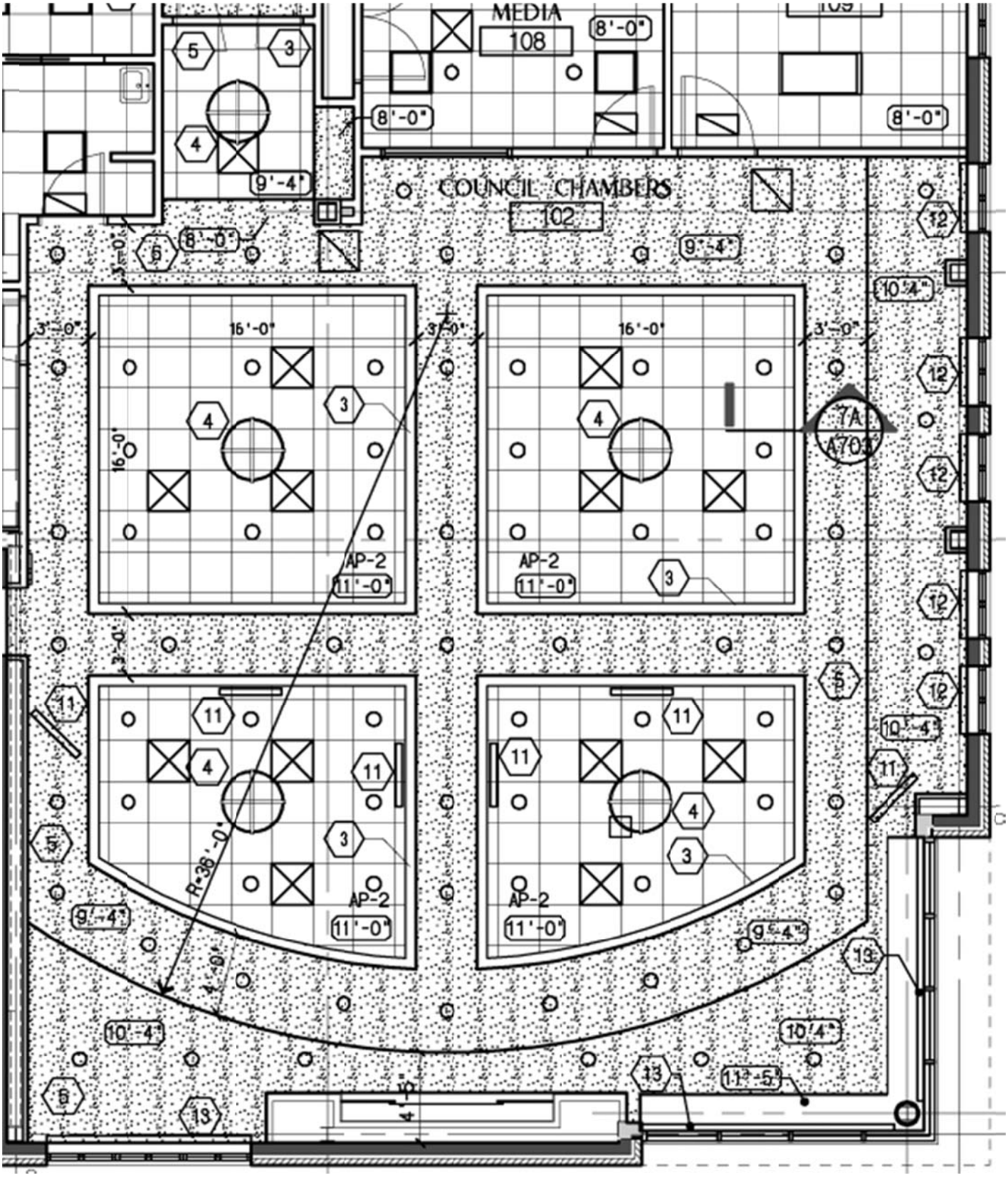
A drop ceiling forms a grid pattern over the audience. There are three ceiling levels in the space as represented in the following plans. Natural, warm wood toned materials are used throughout the space. Wood laminate borders the lower section of the perimeter. Above this is a layer of vinyl wall covering followed by painted GWB starting at the lowest ceiling elevation. The ceilings of the four coves formed by the drop ceiling are made of camel colored acoustic ceiling tile. Two large windows are located behind the council, one of which continues up through the second floor.

Area: 2062 SF Ceiling Height = Varies, see reflected ceiling plan

Floor Plan


CORRIDOR
101A
COUNCIL CLERK
104
COUNCIL OFFICES
105
EXECUTIVE SESSION
106
NORTH STAIR
107
ELEC.
103
MEDIA
108
STORAGE
109
COUNCIL CHAMBERS
102
22'-2"
15'-7"
61'-6"

Reflected Ceiling Plan



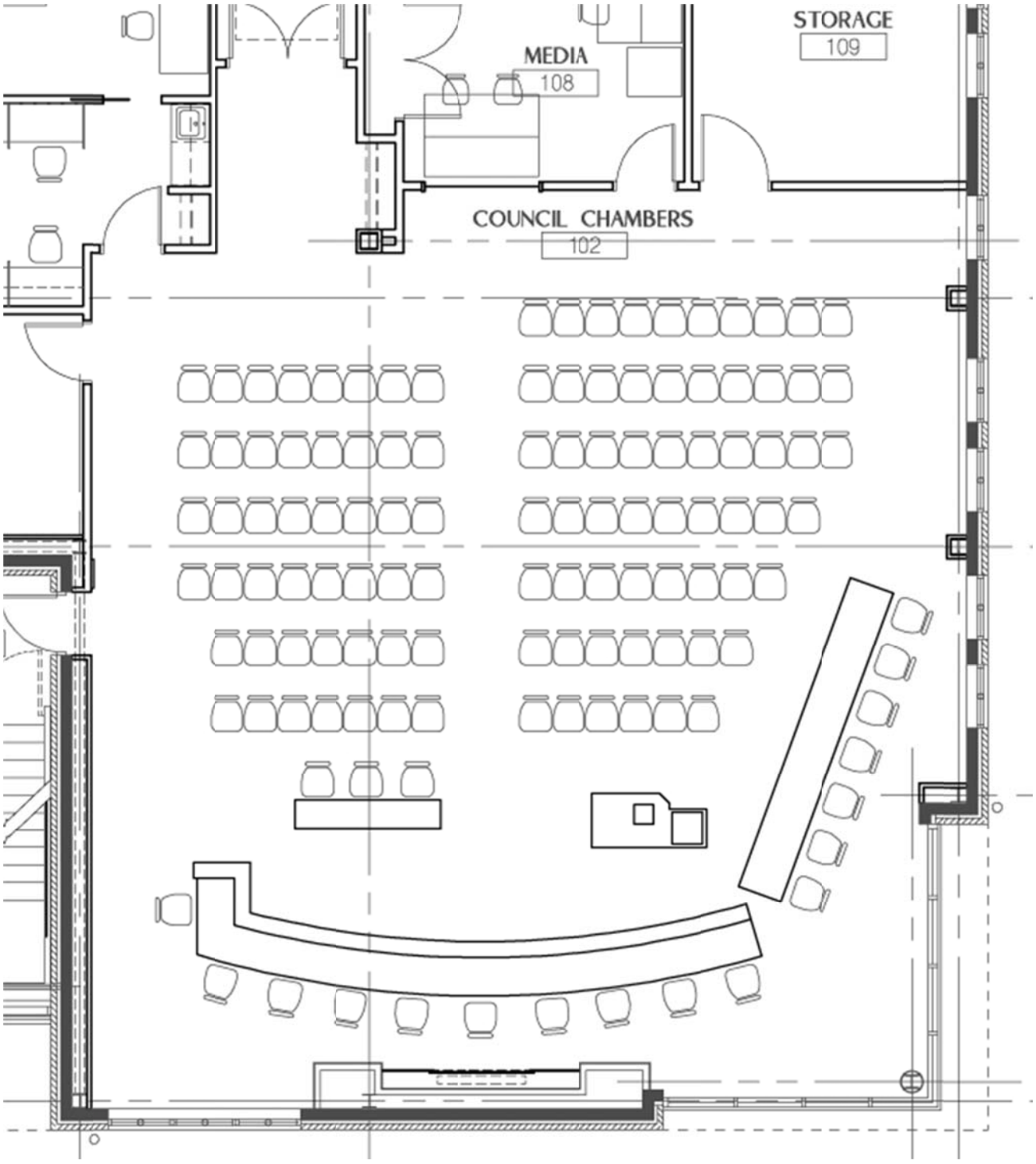
Finishes (Materials)

Material	Location	Reflectance
Carpet, Designweave Color "Ripple #00578"	Floor	0.2
Wood Laminate, Wilsonart Color "Biltmore Cherry #7924-07"	Doors, Walls from 0' to 2'-9"	0.24
Wood Laminate, Wilsonart Color "Huntington Apple #7929-78"	Desks	0.4
Vinyl Wall Covering, MDC Wallcoverings Color "Lush Bottoms # BBG015/4731"	Walls from 2'-9" to 8"-10"	0.64
Painted GWB, Benjamin Moore Color "White Dove #OC-17"	Walls Above 8'-10", Drop Ceiling	0.93
Acoustic Ceiling Tile, Armstrong "Cirrus Tegular #589"	Cove Ceilings	0.86
Glazing	All Glazing	.44 (Transmittance)

Furnishings

The furniture in the Council Chambers space consists of 109 moveable chairs in the audience area facing the council. These are typically arranged in uniform rows as shown in the furniture plan below, but may be changed based on the number of audience members expected or space use at the time. There is also a small table and podium at the front of the audience directly before the Council desks. On the 6" elevated platform where the council sits, there are two unusually shaped desks. They are coated with a semi-specular wood laminate. The desk that runs parallel to the rows of audience seating has a small elevated piece that is 6" higher than the work plane (2'-6") while the other has a flat surface at 2'-6". The furnishings in the room dictate where light will be during different functions in the space.

Television monitors are located throughout the space. One large monitor is mounted on the wall within a cabinet behind the council desk as shown in the furniture plan. The remaining monitors are small, and are mounted to the ceiling in various places. You can see these ceiling mounted monitors in the reflected ceiling plan above. Locations of the monitors will be important when considering source task eye geometry and reflected glare in the final lighting design.


STORAGE
109
MEDIA
108
COUNCIL CHAMBERS
102

Visual Tasks

The Council Chambers is primarily a meeting room that functions similar to a courtroom or lecture hall. Standard tasks include reading and writing, reading information or images from monitors, viewing of people (from Council and Audience perspective), recording meetings for television or live broadcast and simple navigation through space. Depending on the use of the room at the time, some or all of these visual tasks may be important. For example, the audience may not be reading or writing if the presentation is spoken with no visual aids or if they are watching a video on the large monitor behind the council. The lighting design needs to be flexible to allow for the occupants to choose which visual tasks will be needed at the time and what illumination levels should be used.

Design Criteria

Space Types in IESNA Lighting Guide

- Conference Rooms (Meeting and Video Conference)
- Court Room
- Lecture Hall

While the space is not a court room or lecture hall, its layout and function are similar to one. A combination of the relevant portions of these spaces' criteria was used to define the Council Chambers lighting criteria below.

Appearance of Space and Luminaires

The Council Chambers is the most publically viewed space in the building because of frequent television exposure. The lighting will need to reinforce the professional atmosphere of the space while providing visually pleasing yet functional distributions of light. The construction of the luminaires should complement the architectural coves and space materials as well as relate the chambers to the rest of the building.

Direct Glare

Direct glare from the luminaires would decrease functionality of the space and cause presentation issues for the council as well as viewing issues for the audience, and must be prevented.

Reflected Glare and Source-Task-Eye Geometry

Consider source-task-eye geometry to reduce reflected glare (veiling reflections) on the ceiling and wall mounted monitors. The reflection values of desk materials may cause reflected glare for the council. These must be considered when selecting and placing fixtures.

System Control and Flexibility

The Council Chambers lighting system needs to provide flexible control so occupants can easily alter the appearance based on the current application. Some lighting requirements will vary, such as illumination values, depending on the current use of the space. Consider different needs for a video conference, non-televised meeting, and when the space is not occupied. Automatic shutoff should be used to ensure electricity savings when not occupied.

Light Distribution on Task Plane

Light should be uniformly distributed on all task planes to increase ease of visual tasks such as reading and writing. The task plane is not consistent throughout the space because the council is six inches higher than the audience. Also, the illuminance value of this uniform task plane distribution will vary depending on the current use of the space. The audience may not need to be able to read during a televised meeting, but will need to read hand outs when they are used. The uniformity of light on the task plane is important regardless of the desired illumination value.

Modeling of Faces and Objects

Modeling the faces of the council will be very important during video conferences and televised meetings. Proper vertical illuminance values as defined below will ensure that the people occupying the chambers will be modeled in an aesthetically pleasing way. The distribution of this vertical illuminance must be consistent to avoid shadows on the faces of the council.

Daylight Control

All windows in the space are equipped with MechoShade “Mecho 5” chain driven roller shades. The two larger windows behind the council are motor controlled via a switch.

Illuminance Values Based on IESNA Lighting Guide

Audience Seating Area: Video Conference

Horizontal Illuminance: 10 fc Vertical Illuminance: 3 fc

Council Seating Area: Video Conference

Horizontal Illuminance: 50 fc Vertical Illuminance: 30 fc

Audience Seating Area: Standard Meeting (No Video)

Horizontal Illuminance: 30 fc Vertical Illuminance: 5 fc

Council Seating Area: Standard Meeting (No Video)

Horizontal Illuminance: 30 fc Vertical Illuminance: 5 fc

Power Allowances: ASHRAE Standard 90.1

Using the Space-by-Space method for an open office plan and Table 9.6.1, the power allowance is equal to 1.3 W/SF (conference/meeting/multipurpose space).

Area = 2062 SF

(2062 SF)*(1.3 W/SF) = 2680.6 W Lighting Power Allowance

Summary of Numerical Design Criteria

Horizontal Illuminance	10 fc (Audience, Video)
	50 fc (Council, Video)
	30 fc (Audience, No Video)
	30 fc (Council, No Video)
Vertical Illuminance	3 fc (Audience, Video)
	30 fc (Council, Video)
	5 fc (Audience, No Video)
	5 fc (Council, No Video)
Power Allowance	2680 W
Lamp CRI	<70

Lighting Solution Overview

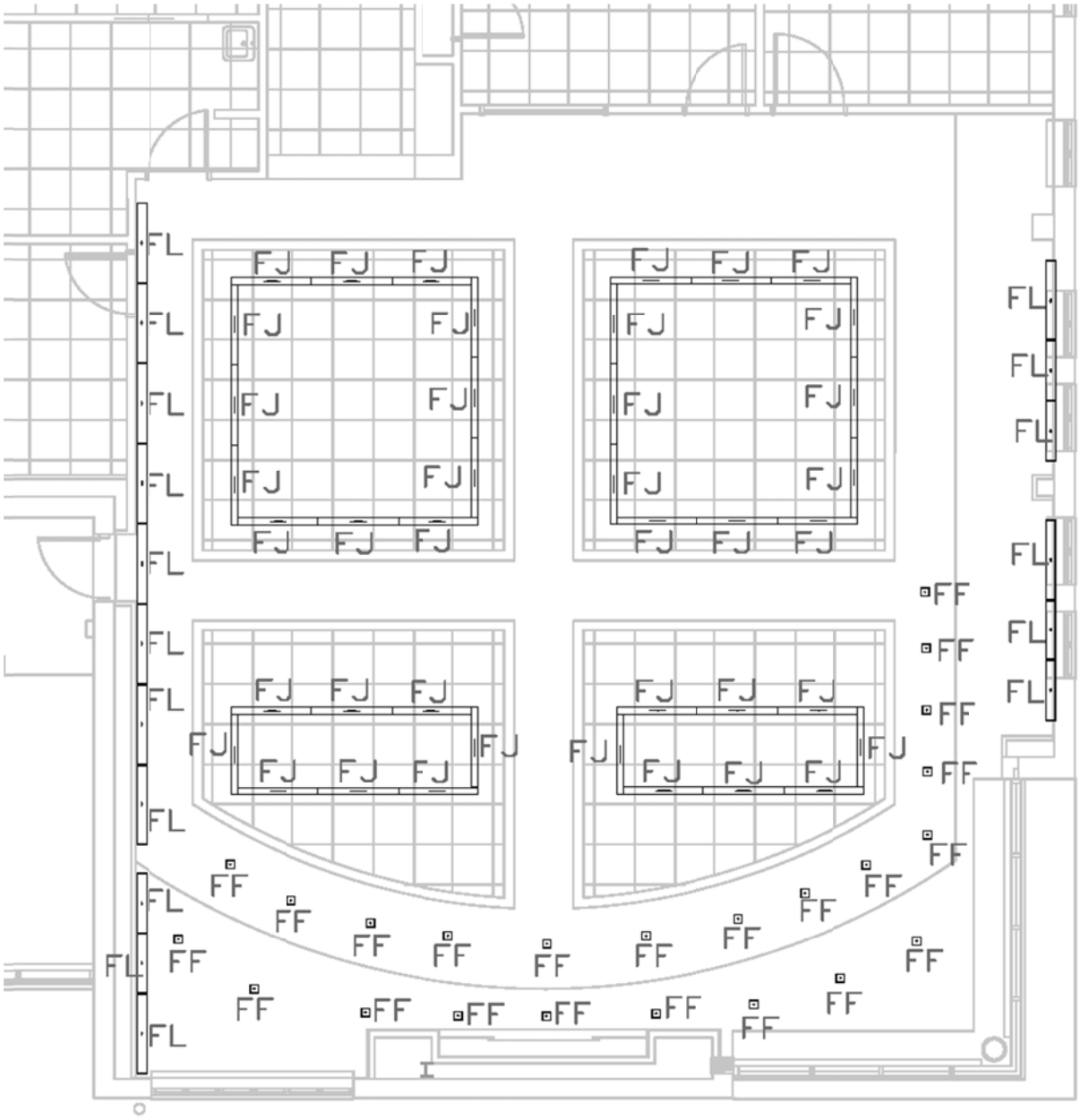
The council chambers lighting design builds off concepts introduced in earlier spaces, most notably the Main Lobby. Like the lobby, the side walls of the chambers are washed. The only difference is the type of fixture used grazes the wall at a steeper angle, creating a dramatic lighting effect from a hidden source.

Luminaire and Ballast Schedule

Type		Mfr	Catalog #	Description	Lamp	Fixture Watts	Volts	Quantity
FL		Focal Point	FMG-NS-1T5-1C-277-D-3' / 4'	Perimeter hidden fluorescent source	F28W/T5/835/ECO	36 W	277	

Ballast: Electronic Dimming Ballast, BF = 1.10

Lighting Plan



Control System

Requirements: ASHRAE Standard 90.1

Standard 90.1 requires automatic lighting shutoff for interior lighting in buildings larger than 5000 SF

Space Control Scheme

Other than the luminaires being placed on a timer to ensure they turn off when the building is unoccupied, the Council Chambers requires multiple scenes for different uses of the space. For televised meetings, the rear cove lights will be dimmed or switched off. The system will also dim the luminaires in the cove near the council to reduce glare on the ceiling mounted monitors.

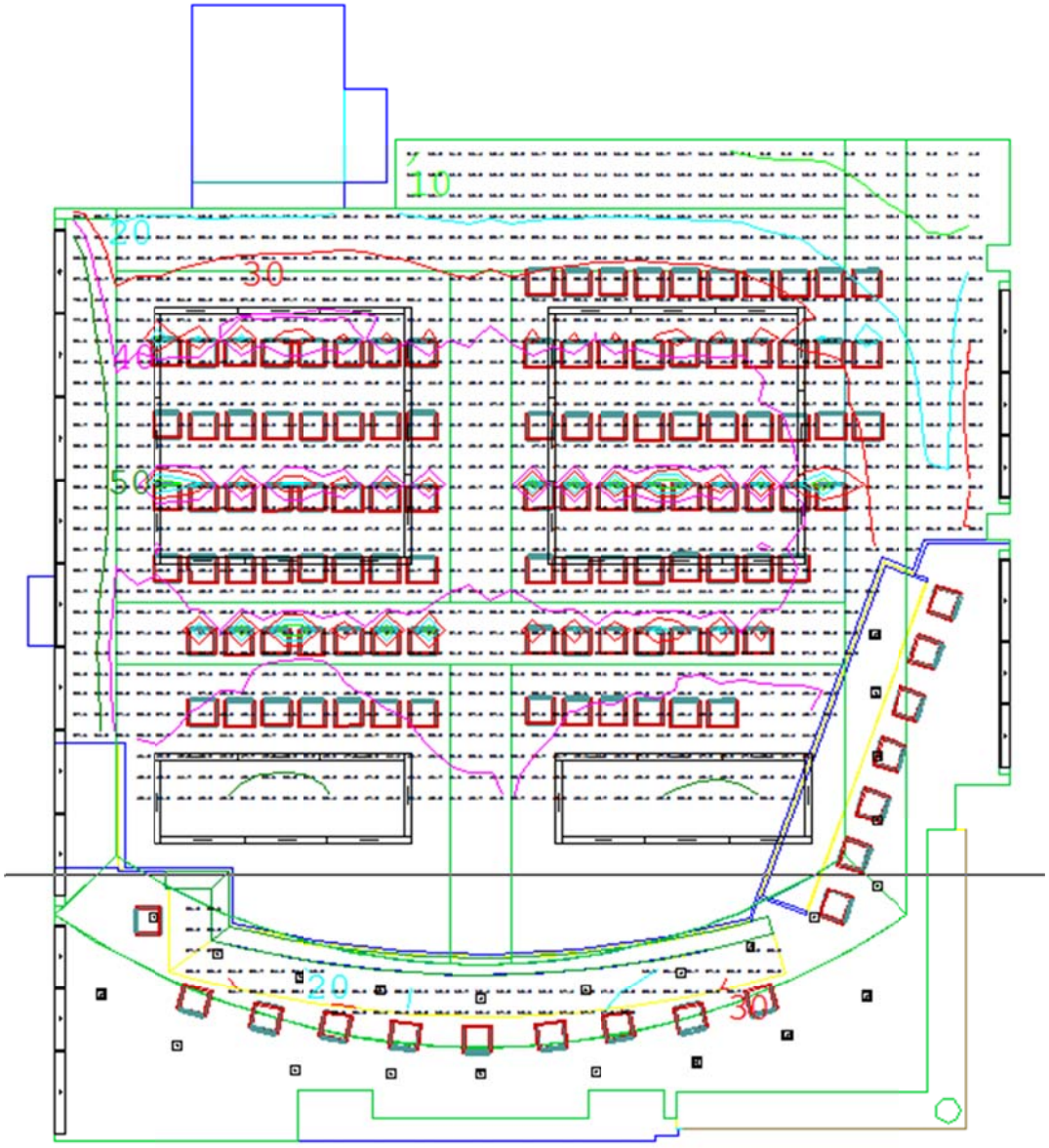
Performance Summary

Energy Calculations

Luminaire Type	Input Watts	Quantity	Total Watts
FF	24 W	23	552 W
FJ	32 W	40	1280 W
FL	34 W	11	374 W
FL2	24 W	6	144 W
Lighting Power Allowance = 2062 SF			**2350 W**

The design does not meet the required lighting power allowance.

AGI Calculations



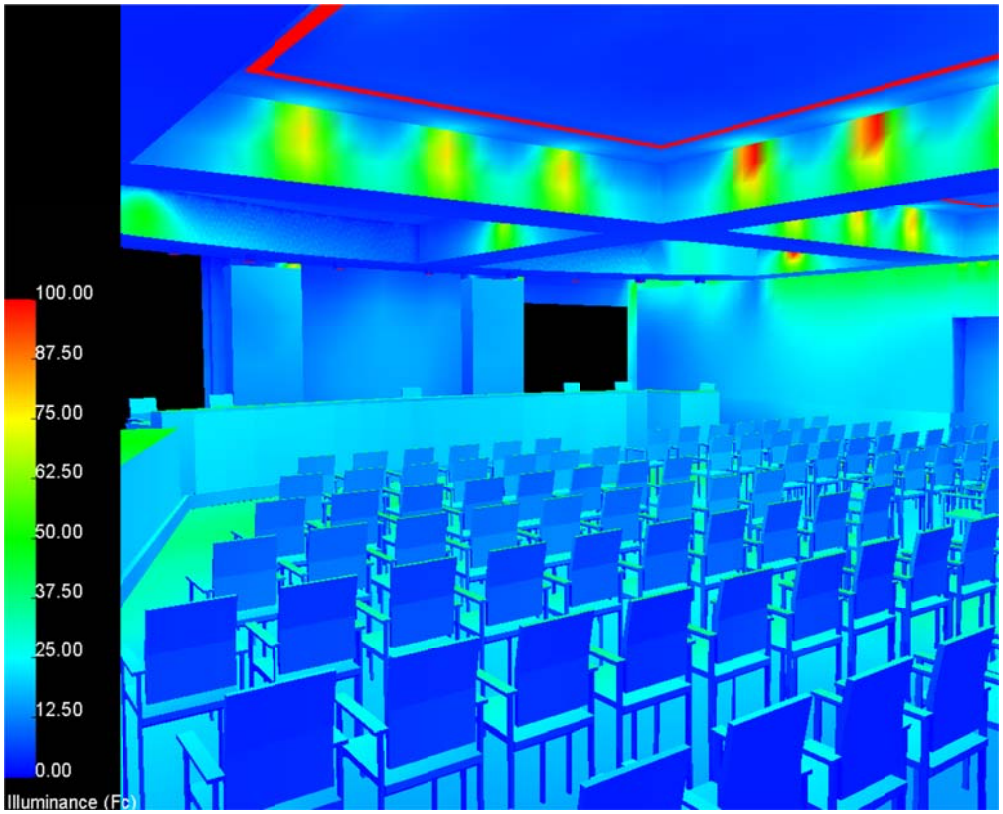
Audience Area

Average = 36.31 fc	Maximum = 92.9 fc	Minimum = 0.0 fc

Council Desk

Average = 22.71 fc	Maximum = 34.7 fc	Minimum = 15.8 fc

Renderings

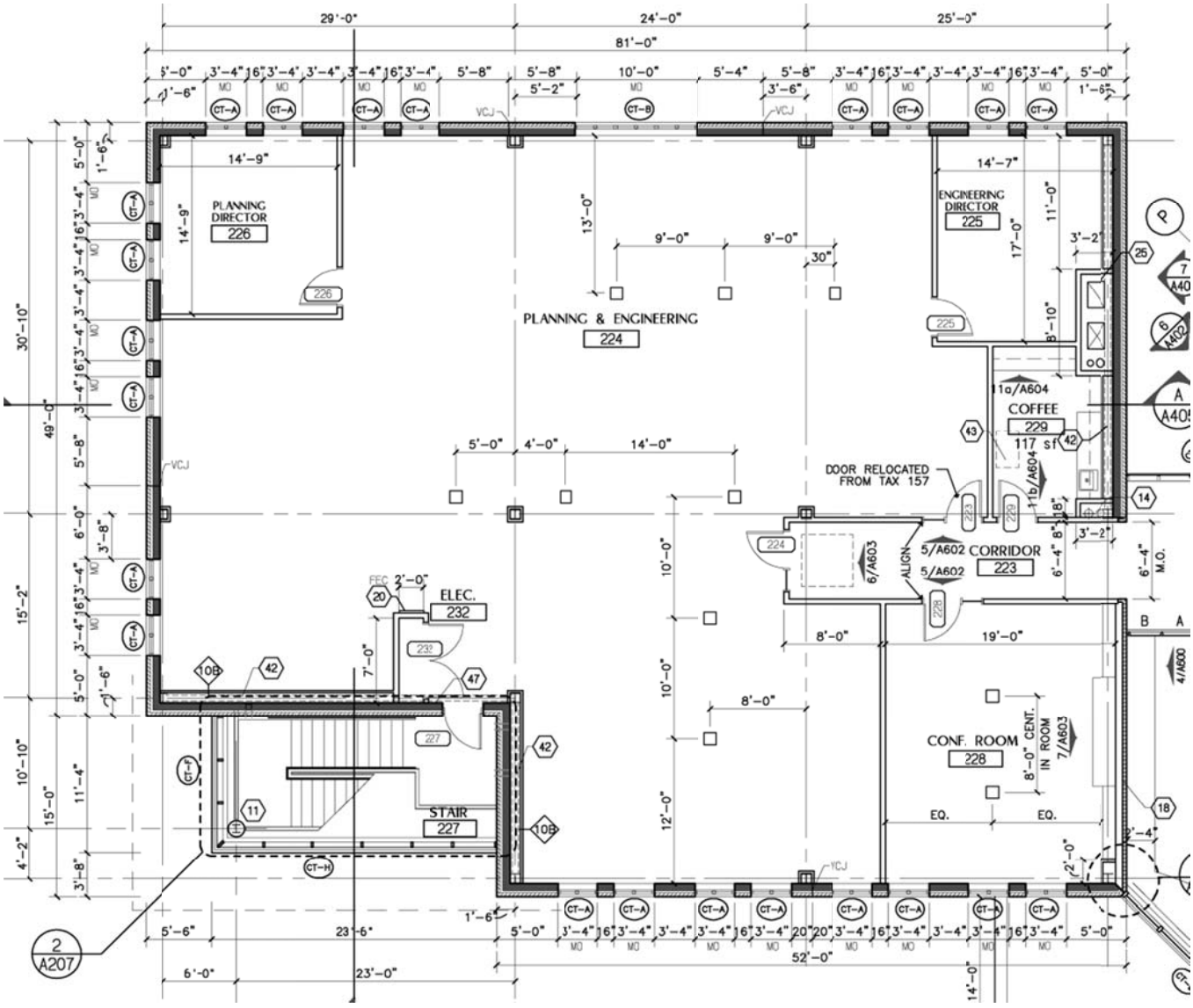


Lighting Design: Planning & Engineering (Work Space)

Spatial Description

The City of Green Planning and Engineering department workspace is a relatively simple space with few distinguishing features. The space is an open office located on the second floor of the West. It contains cubicle style work stations, drafting tables, and filing cabinets. These elements are spread out with a lot of space in between them in an inconsistent pattern because of the varying size of individual areas, as shown in the floor plan below.

Area: 3120 SF Ceiling Height = 12 ft.



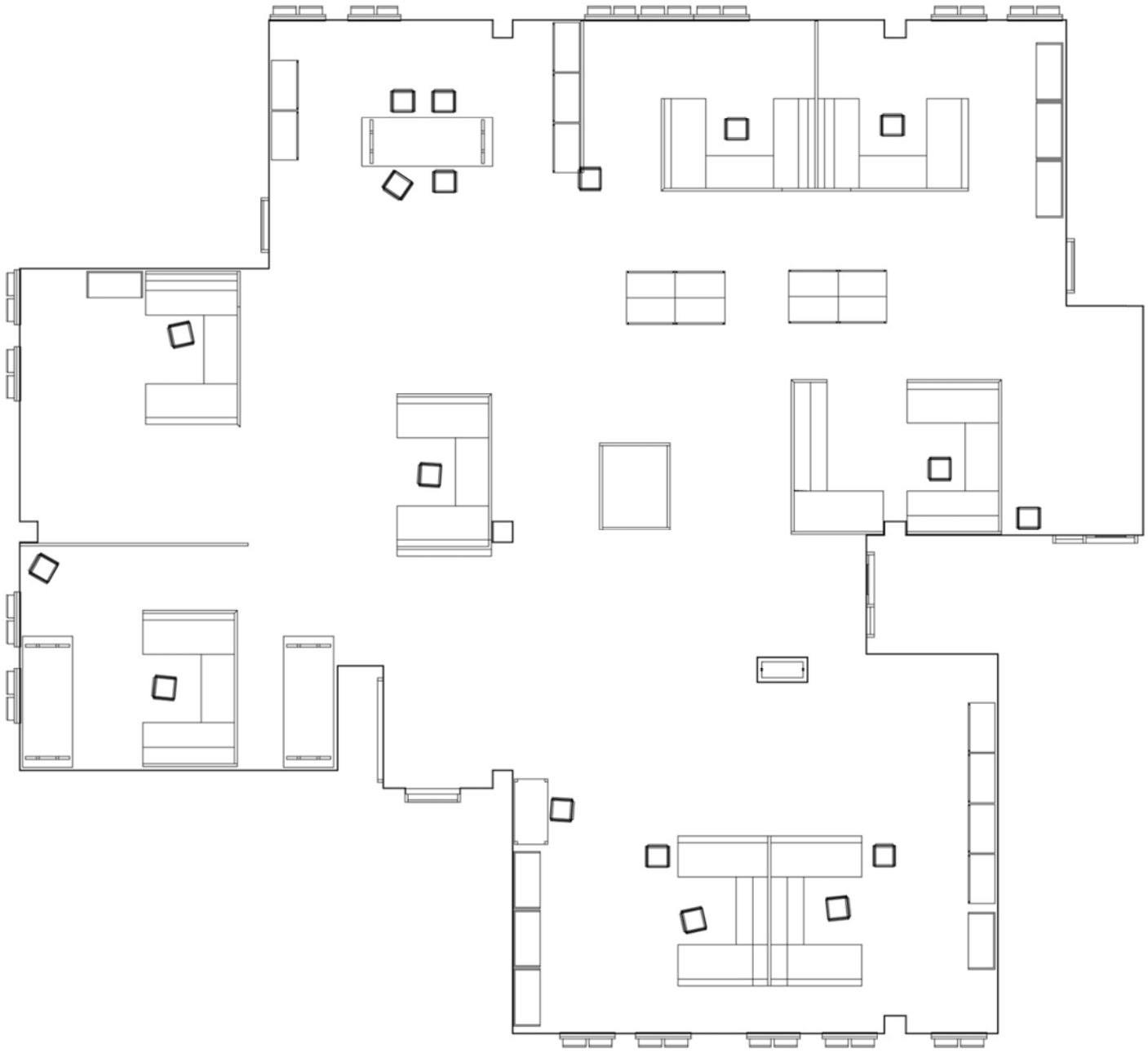
Planning & Engineering Workspace: Floor Plan

Finishes (Materials)

Material	Location	Reflectance
Armstrong acoustical ceiling tile "Dune Second Look II." Appears as a 24" by 24" tile because of additional scoring. Is actually 48" by 24." Fine texture.	Ceiling	0.84
Carpet, Bolyu / On the Edge Color	Floor	0.2
Painted GWB, "waterbury cream" color	Walls	0.79
Painted GWB, "barrington green" color	Walls	0.49
Painted Door and Window Frames	Frames	0.79
Wood Doors	Doors	0.3
Painted wood baseboard	Bottom 4" of Walls	0.14
Desk, Chair, and Table Metal	Desks, Chairs, Tables	.5
Desk Wood	Wooden Work Desks	.44
Chair Fabric	Chairs	.06
Partition Fabric	Partitions	.31
Glazing	Windows	.44 Transmittance

Furnishings

The space contains cubical style workstations, drafting tables, shelving units, chairs, and partitions. The layout was estimated from photographs of the space taken during a visit to the site. All of this furniture is easily moved or reconfigured as needed by the department; therefore the lighting design must match the flexibility of the space. The metal drawers located in the middle of the walkway near the side entrance are not used as a workspace; however the wood topped tables are sometimes used to view full sized architectural or site drawings. Specifically, the large wooden table located in the center is used for group viewing of project drawings and must be well illuminated.



Planning & Engineering Workspace: Furniture Plan

Visual Tasks

The visual tasks for the space are consistent with a typical engineering workplace. This means heavy VDT use when using modeling software as well as the viewing of printed out drawings and plans. Every cubicle style workspace has a computer station and a lot of table space for laying out full sized drawings. Typical reading, writing, and filing tasks are also commonplace. Not all areas will require the same amount of light because of the abundance of open space between individual workstations. These open spaces, which are highlighted on the following Visual Task Plan, are only used for circulation in the current configuration of the room. Maintaining a balance between the overall flexibility of the space and reduction of power consumption by lowering illumination values for the open spaces is a primary concern for the Planning and Engineering Department.

Planning & Engineering Department: Visual Task Plan

Design Criteria

Space Type in IESNA Lighting Guide

Open plan office with intensive / intermittent VDT use, depending on the task

Luminance of Room Surfaces

Reducing luminance contrast between surfaces while still maintaining a slightly higher luminance on the work plane or task will help with dark and light adaption and disability glare. The following luminance ratios should not be exceeded:

Between paper task and adjacent VDT screen: 3:1 or 1:3

Between task and adjacent dark surroundings: 3:1 or 1:3

Between task and remote surfaces: 10:1 or 1:10

[IESNA 11-3]

Overall, the ceiling luminance should not exceed 850 cd/m^2 as well as the 10:1 ratio.

Direct / Reflected Glare and Source-Task-Eye Geometry

Direct glare from the luminaires needs to be avoided by choosing proper fixtures for the application. This type of glare would be very distracting for the employees. Surface reflectance's and furniture layout need to be considered when laying out luminaires to ensure there is no possibility for reflected glare.

Uniformity of Light Distribution on Task Plane

The light on work surfaces such as desks and drafting tables must be very uniform to allow the occupants to perform the visual tasks of reading and writing without difficulty.

Appearance of Space and Luminaires

The overall appearance of the office should be uniform, but contain elements that make the space an enjoyable place to work by adding visual interest.

Daylight Control

All windows in the space are equipped with MechoShade "Mecho 5" chain driven roller shades. The one larger window has the same type of roller shade, but is motor controlled via a switch.

Illuminance Values Based on IESNA Lighting Guide

Horizontal Illuminance: 40 fc on task plane, 35 fc average across space with no furniture

Vertical Illuminance: 5 fc

Because of the possibility of heavy VDT use in the space, the Illuminance should not pass 50 fc on the work plane at any point. My design should also keep potential usage of the space flexible by meeting the 35 fc average with no furniture. This will ensure that if future occupants would like to re-arrange the workspaces, there will still be adequate illumination.

Power Allowances: ASHRAE Standard 90.1

Using the Space-by-Space method for an open office plan and Table 9.6.1, the power allowance is equal to 1.1 W/SF.

Area = 3102 SF

(3120 SF)*(1.1 W/SF) = 3432 W Lighting Power Allowance

Summary of Numerical Design Criteria

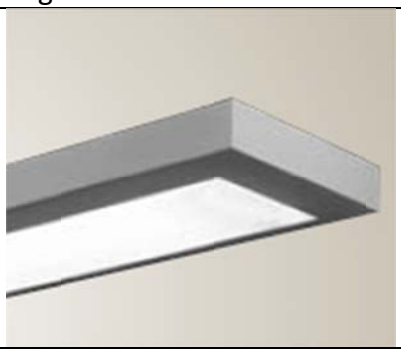
Horizontal Illuminance	40 fc	(Task Plane)
Horizontal Average Illuminance	35 fc	(Without Furniture)
Vertical Illuminance	5 fc	
Max Work plane Illuminance	50 fc	
Power Allowance	3432 W	
Luminance Ratios	3:1 or 1:3	(Paper task and adjacent VDT screen)
	3:1 or 1:3	(Task and adjacent dark surroundings)
	10:1 or 1:10	(Task and remote surfaces)
Max Ceiling Luminance	850 cd/m^2	
Lamp CRI	<70	

Lighting Solution Overview

The lighting solution for the Planning & Engineering workspace incorporates rows of direct – indirect suspended luminaires mounted at 8 ft. and arranged in rectangular patterns to not only light, but define, the major areas within the space. These fixtures provide diffuse ambient illumination to the work plane, and are supplemented by under cabinet task lighting when shadows caused by the furniture location do not allow enough light to reach the work area. The combination of these two fixtures provides the required 40 fc of illumination on all major work surfaces while rarely going over the maximum of 50 fc. Because the majority of light from the suspended fixtures is indirect, ceiling and wall luminance stays within the required ratios. The locations and size of the rectangles formed by the suspended luminaires provides a balance between illuminating work areas more than circulation areas and keeping the flexibility of the space for any possible changes to furniture layout.

Luminaire & Ballast Schedules

Luminaire Images

Type	Image	Type	Image
FA		FB	

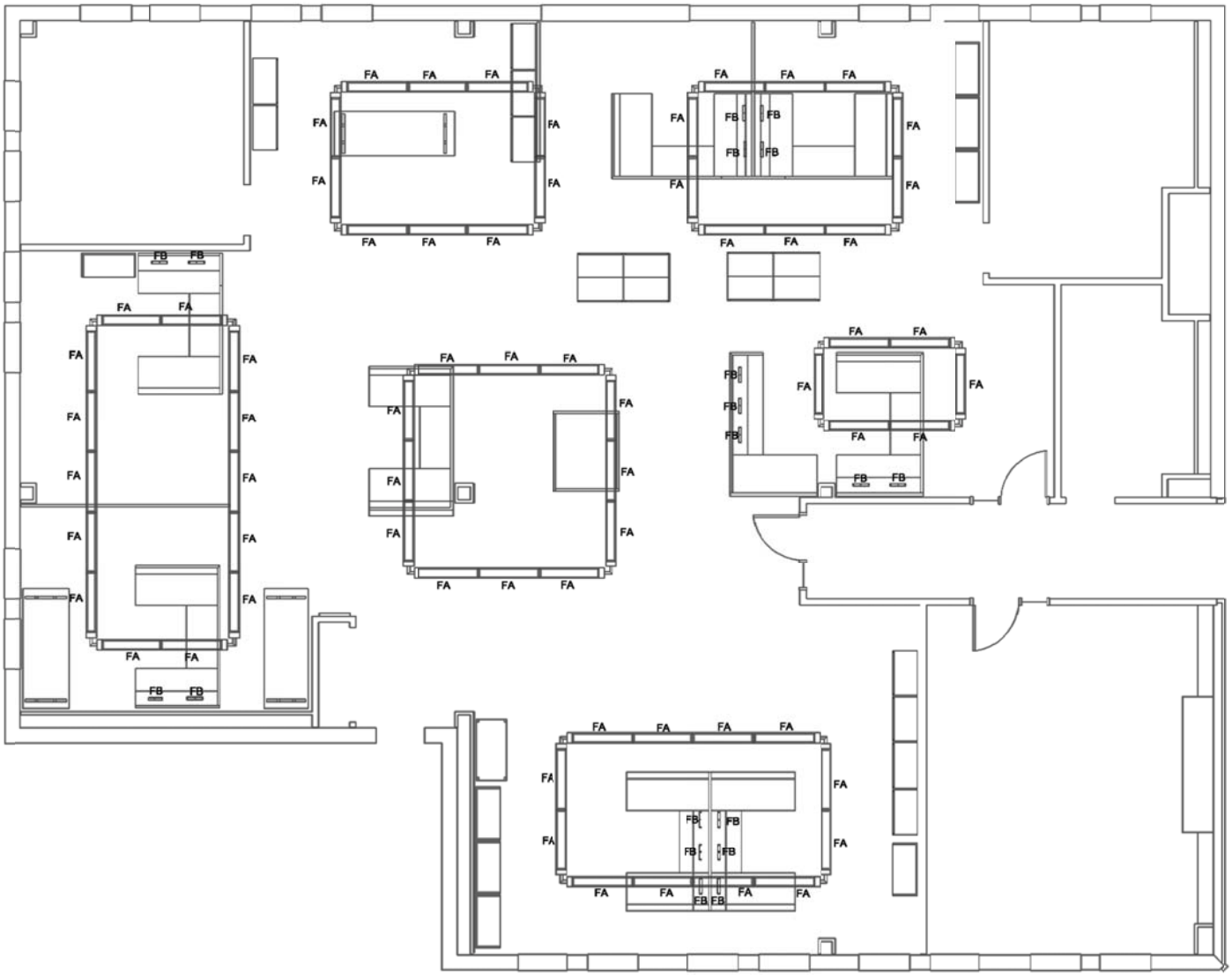
Luminaire Schedule

Type	Mfr	Catalog #	Description	Lamp	Fixture Watts	Volts	Quantity
FA	Peerless	BRM9-1-32T8-SSH	8-1/4" by 1-11/16" , direct-indirect, diffuse lens, pendant mount	GE F28T8/XL/SPX30/ECO	30 W	277	64
FB	Philips Alkco	SFHP-108	8" BY 1-1/8", under cabinet task, prismatic lay-in diffuser	1/T5 8W	9.4 W	120	19

Ballast Schedule

Type	Description	Input Watts	BF	Other
FA	QTP-1X32T8/UNV-ISN-SC	30 W	.88	
FB	Fully Electronic Integral Ballast	9.4 W	1	

Lighting Plan



Planning & Engineering Lighting Plan: See Appendix X for Full Size Drawing and Scale

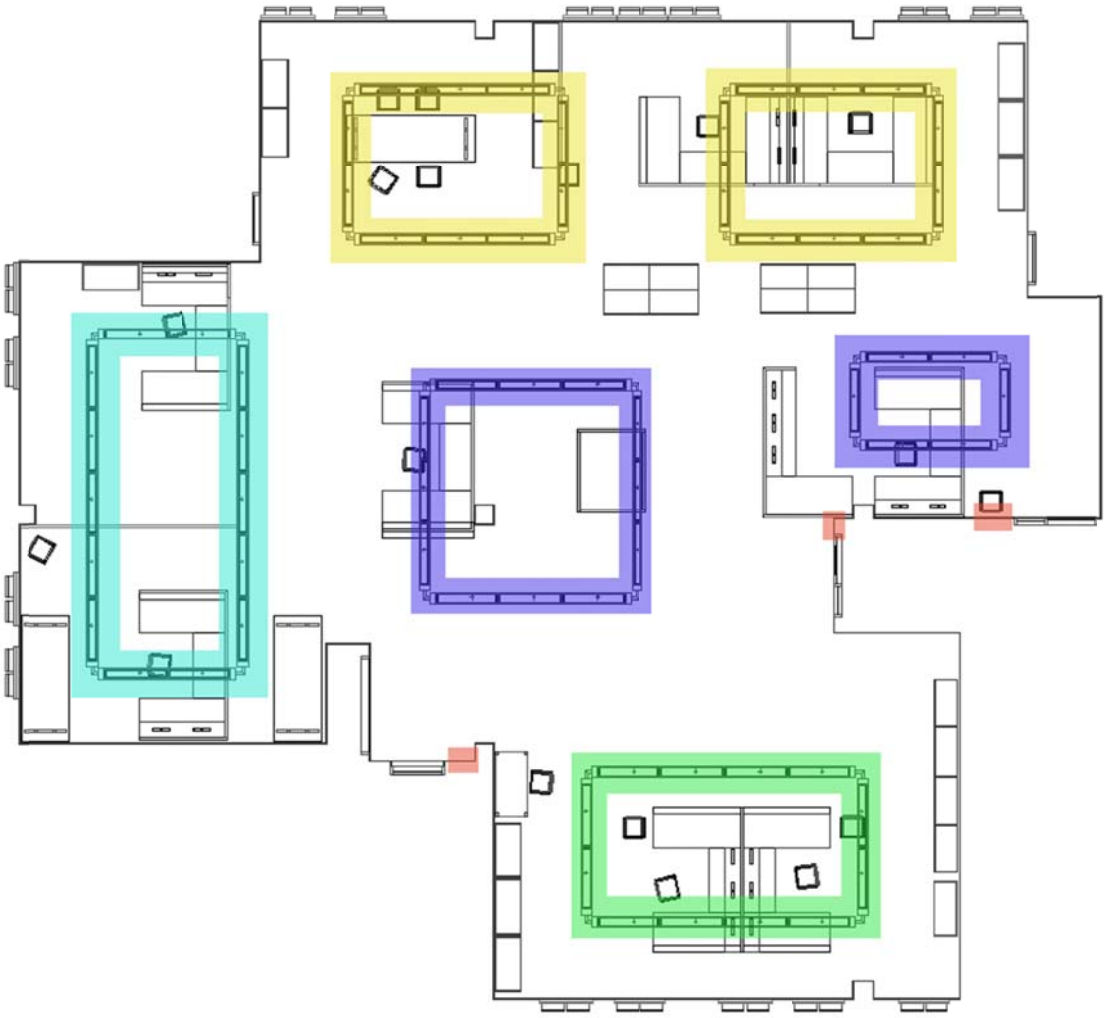
Control System

Requirements: ASHRAE Standard 90.1

Standard 90.1 requires automatic lighting shutoff for interior lighting in buildings larger than 5000 SF. The requirement will me met with a timed automatic shutoff device which will turn off all non-emergency lighting while the building is closed.

Operating Hours

Occupant controlled on/off switching will be located at each entrance to the space, and will allow the main areas to be controlled individually as they are in use, or not being used. The lighting control plan below shows the location of switching, as well as controlled zones. Red indicated switch locations, blue is zone 1, yellow is zone 2, green is zone 3 and teal is zone 4.



Planning & Engineering: Lighting Control Plan

Performance Summary

Light Loss Factors

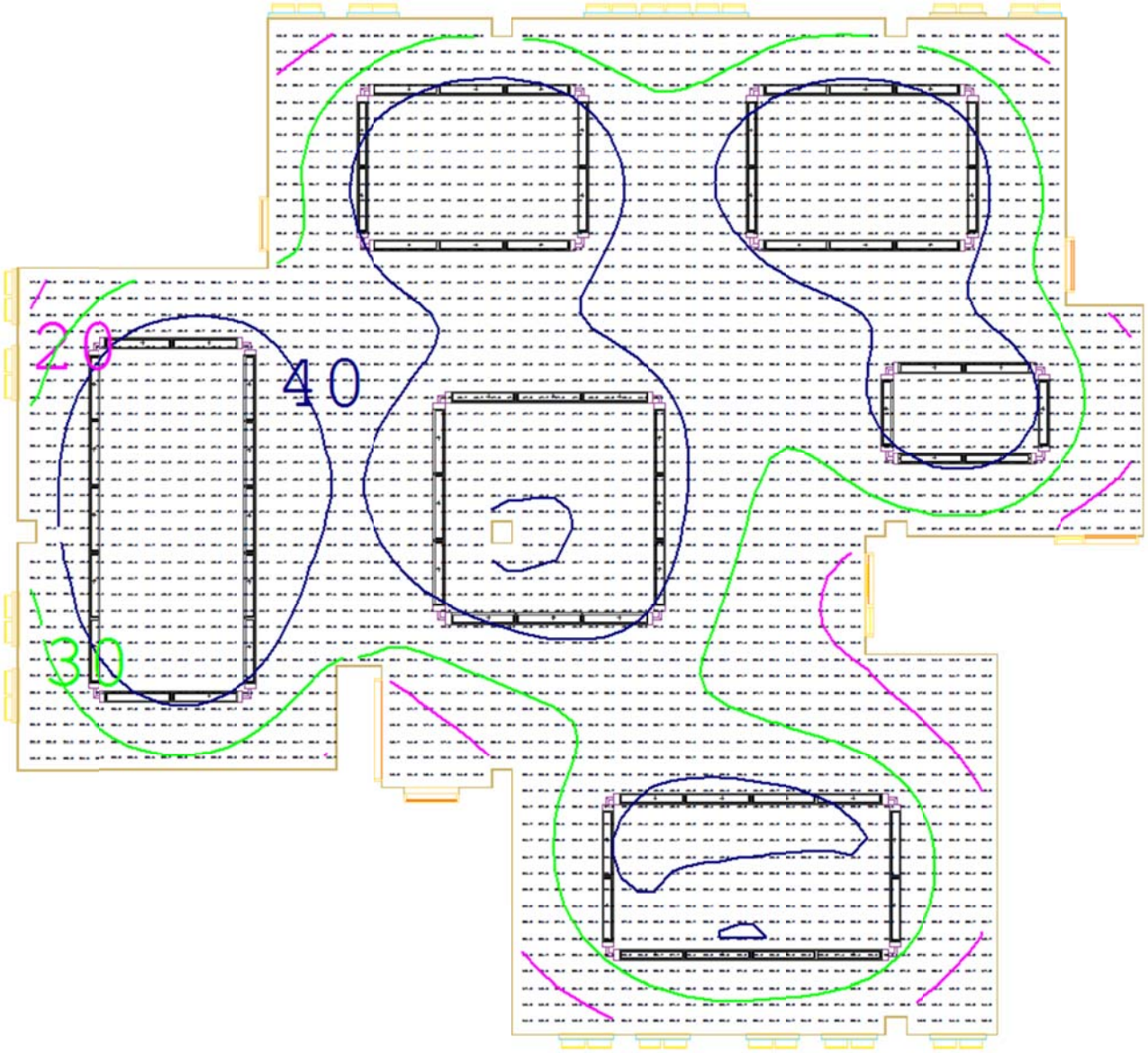
Luminaire Type	LDD	LLD	BF	Total LLF
FA	.94	.94	.88	.78
FB	.94	.87	1	.82

Energy Calculations

Luminaire Type	Input Watts	Quantity	Total Watts
FA	30 W	46	1380 W
FB	9.4 W	19	178.6 W
Lighting Power Allowance = 3432 W			**2098.6 W**

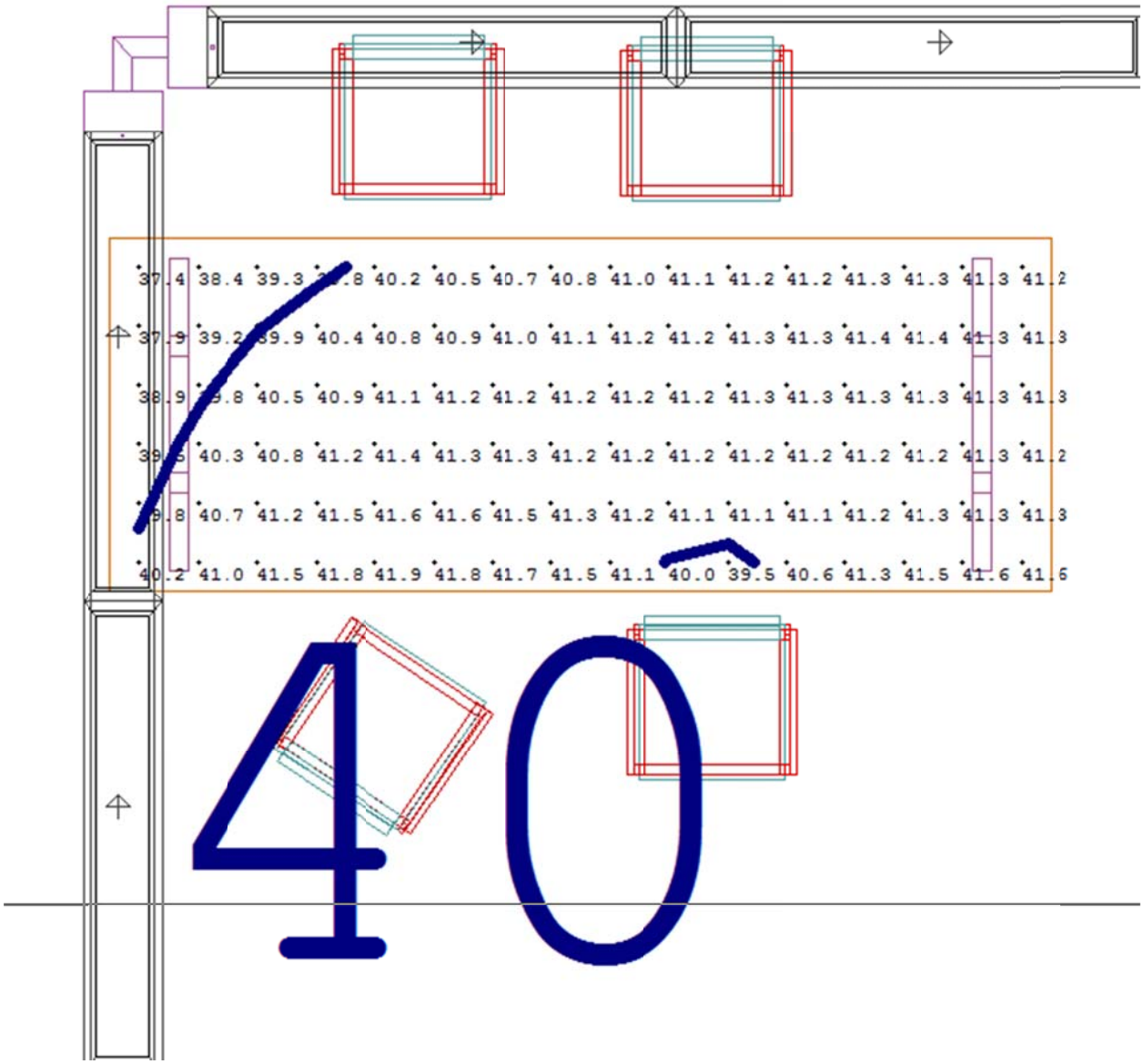
AGI Calculations

(Calc. 1) Planning & Engineering: Work Plane Illuminance at 2’-6” with no Furniture



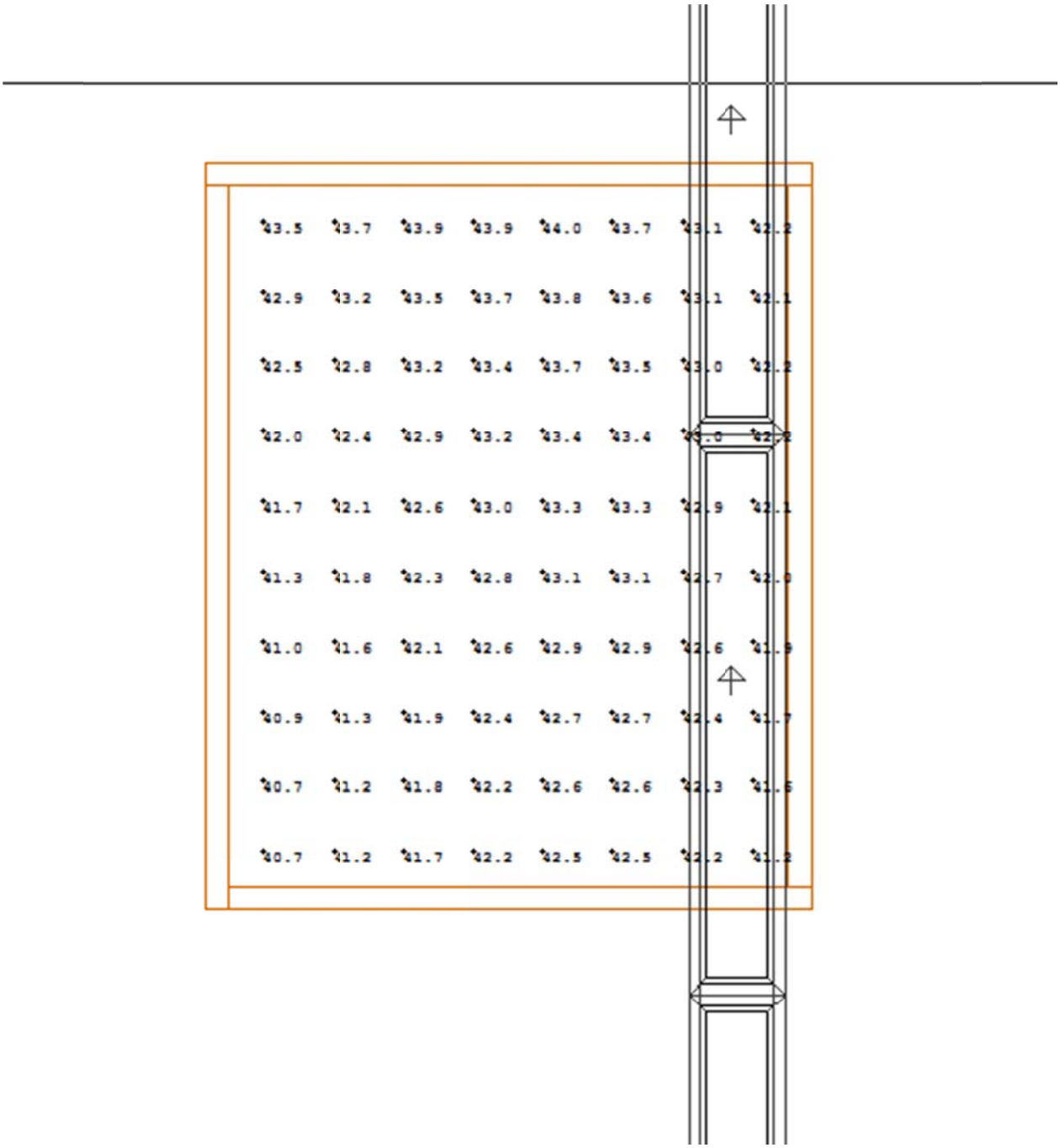
Average = 35.80 fc	Maximum = 48.2 fc	Minimum = 10.9 fc
Ave / Min = 3.28	Max / Min = 4.42	Max / Ave = 1.35
Coeff. Variation = 0.23	Uniform. Grad. = 1.28	% Points (25 fc – 45 fc) = 76.51

(Calc. 2) Planning & Engineering: Work Plane Illuminance on Meeting Table



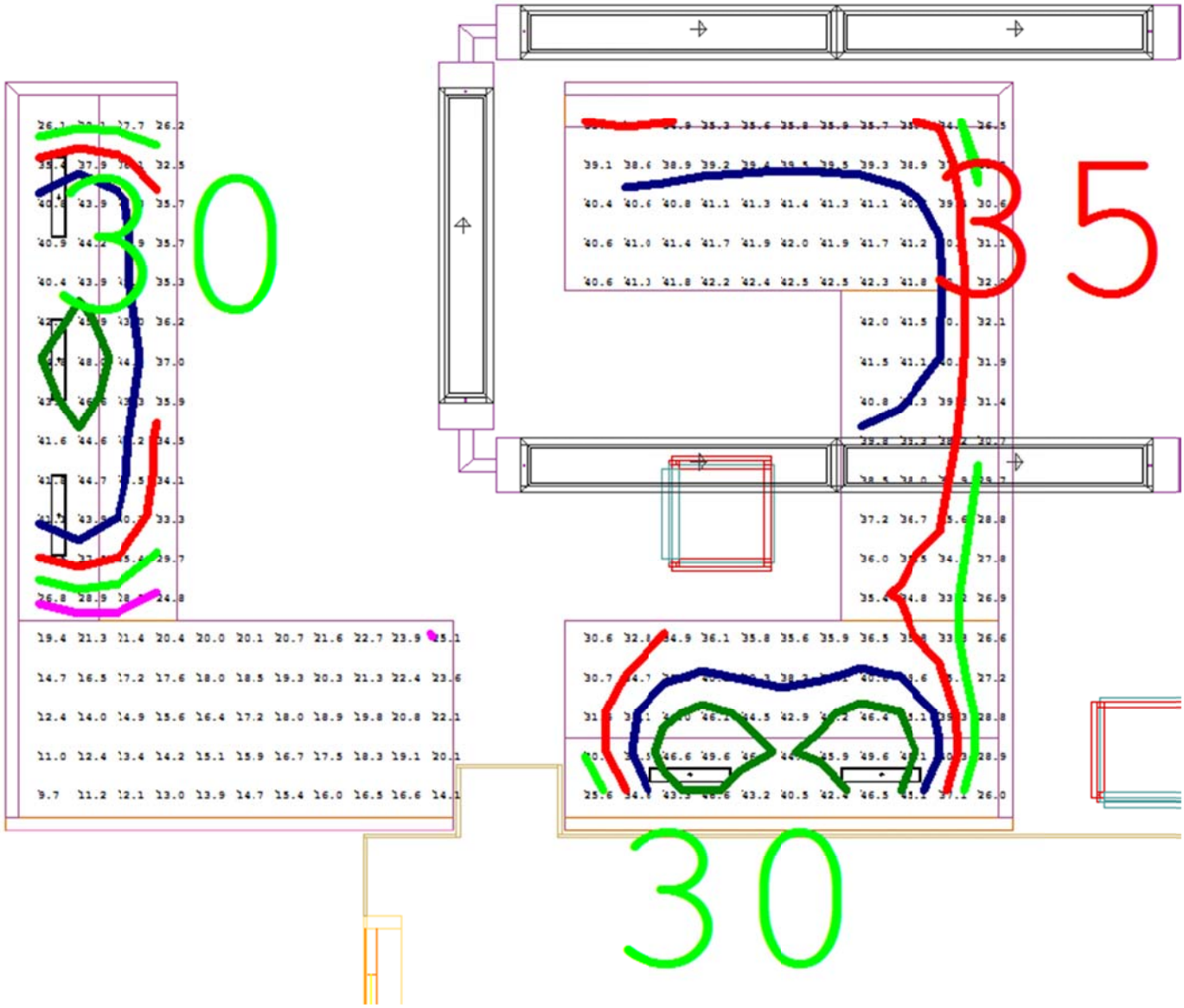
Average = 40.91 fc	Maximum = 41.9 fc	Minimum = 37.4 fc
Ave / Min = 1.09	Max / Min = 1.12	Max / Ave = 1.02
Coeff. Variation = 0.02	Uniform. Grad. = 1.04	

(Calc. 3) Planning & Engineering: Work Plane Illuminance on Center Table



Average = 42.55 fc	Maximum = 44.0 fc	Minimum = 40.7 fc
Ave / Min = 1.05	Max / Min = 1.08	Max / Ave = 1.03
Coeff. Variation = 0.02	Uniform. Grad. = 1.02	

(Calc. 4) Planning & Engineering: Work Plane Illuminance on Secretaries Desk



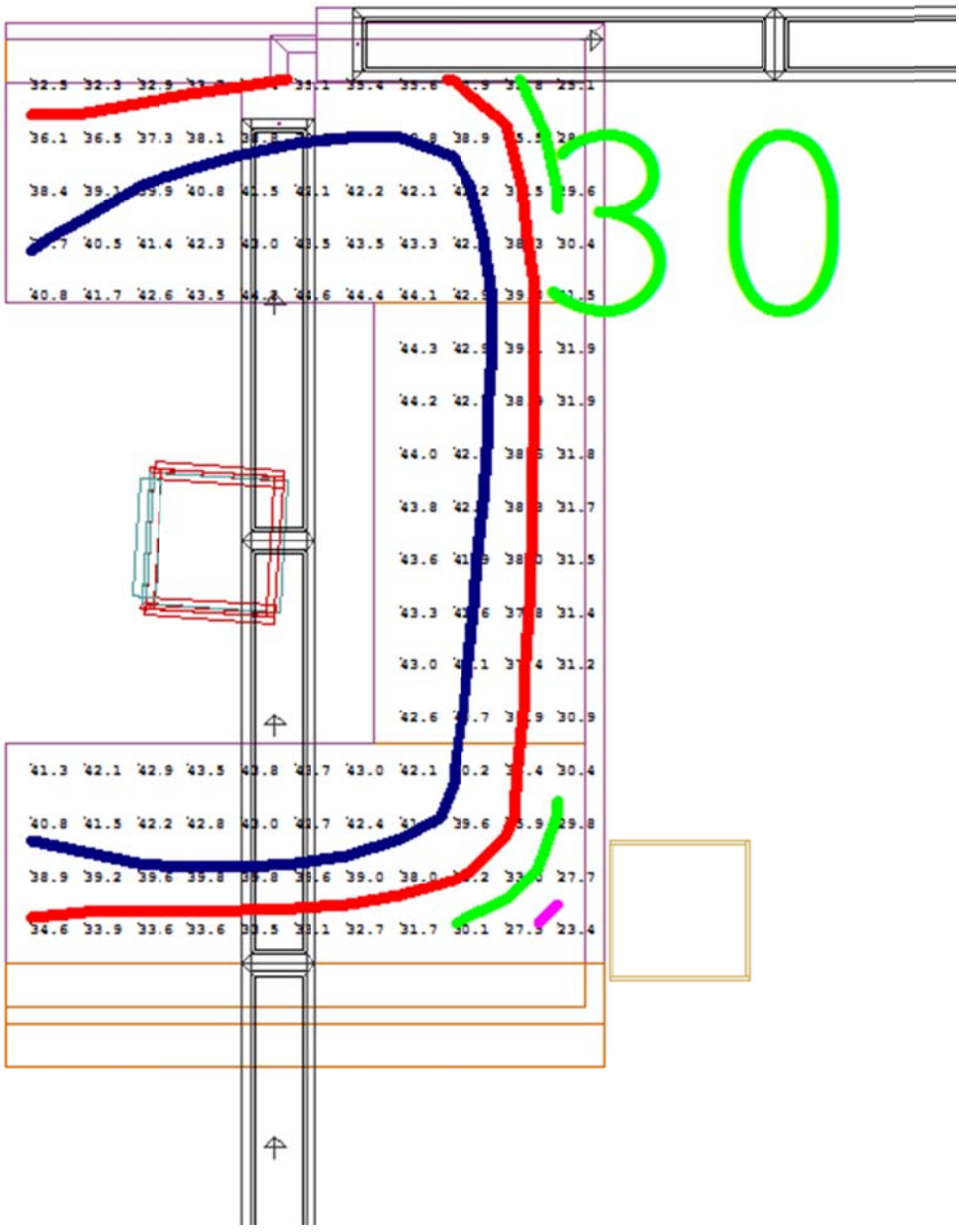
Front Desk

Average = 38.14 fc	Maximum = 49.6 fc	Minimum = 25.6 fc
Ave / Min = 1.49	Max / Min = 1.94	Max / Ave = 1.30
Coeff. Variation = 0.14	Uniform. Grad. = 1.43	

Rear Desk

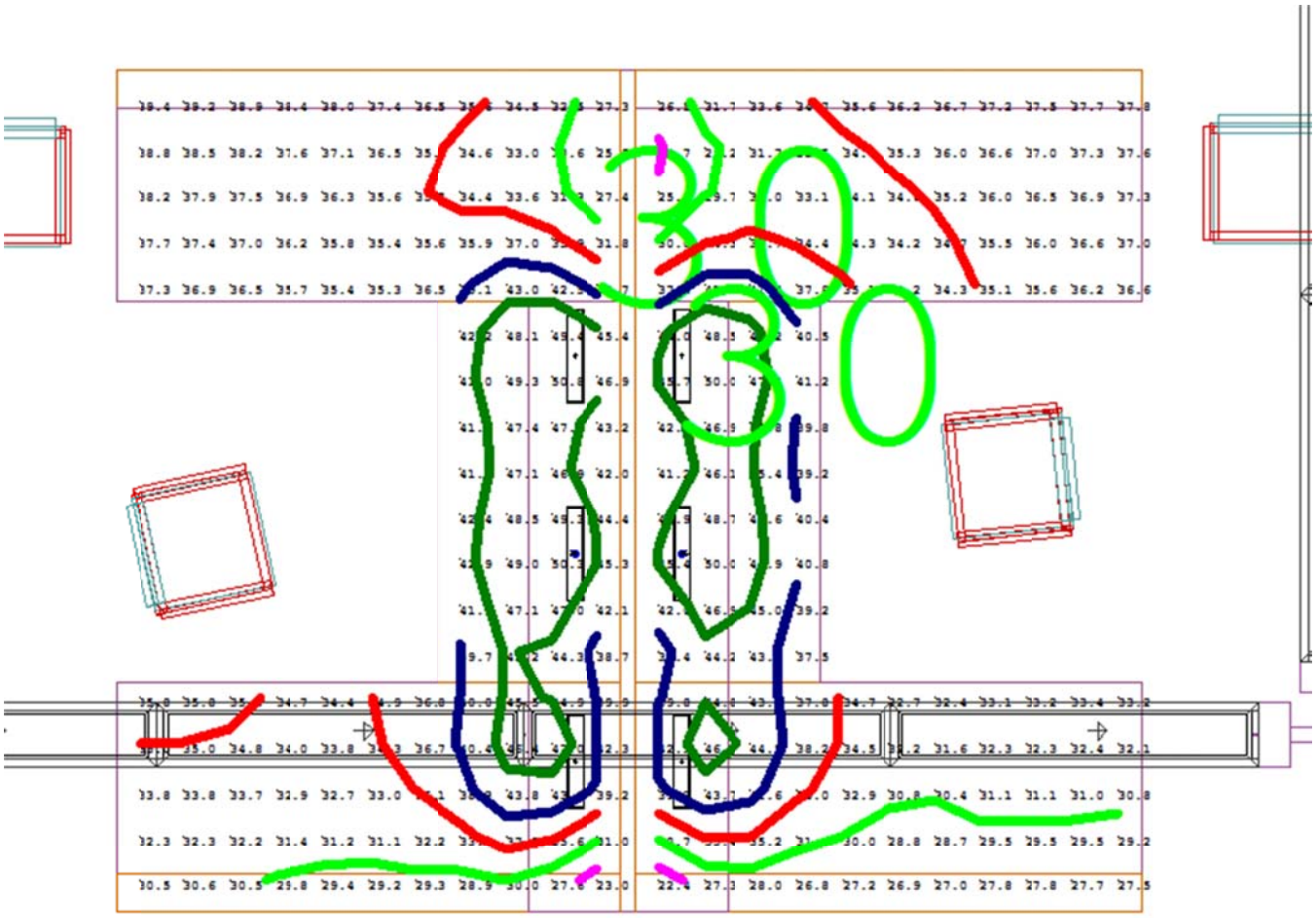
Average = 27.48 fc	Maximum = 48.0 fc	Minimum = 9.7 fc
Ave / Min = 2.83	Max / Min = 4.95	Max / Ave = 1.75
Coeff. Variation = 0.41	Uniform. Grad. = 1.43	

(Calc. 5) Planning & Engineering: Work Plane Illuminance on Center Workspace



Average = 38.21 fc	Maximum = 44.6 fc	Minimum = 23.4 fc
Ave / Min = 1.63	Max / Min = 1.91	Max / Ave = 1.17
Coeff. Variation = 0.13	Uniform. Grad. = 1.27	

(Calc. 6) Planning & Engineering: Work Plane Illuminance on Lower Workspaces



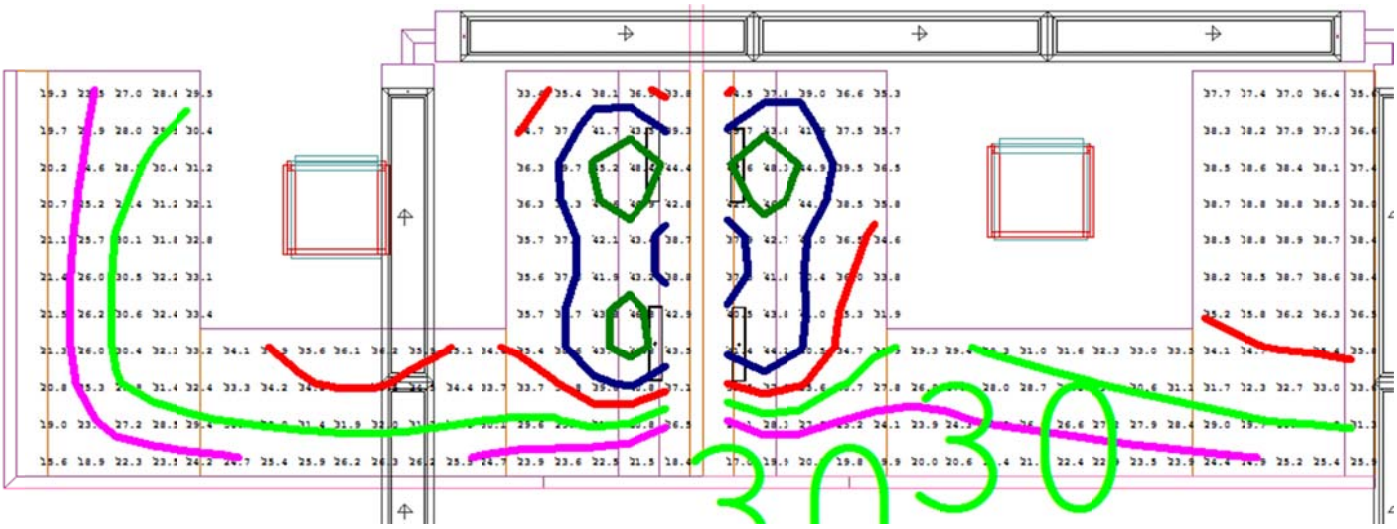
Left Workspace

Average = 37.66 fc	Maximum = 50.8 fc	Minimum = 23.0 fc
Ave / Min = 1.64	Max / Min = 2.21	Max / Ave = 1.35
Coeff. Variation = 0.15	Uniform. Grad. = 1.35	

Right Workspace

Average = 36.18 fc	Maximum = 50 fc	Minimum = 22.4 fc
Ave / Min = 1.62	Max / Min = 2.23	Max / Ave = 1.38
Coeff. Variation = 0.17	Uniform. Grad. = 1.37	

(Calc. 7) Planning & Engineering: Work Plane Illuminance on Upper Workspaces



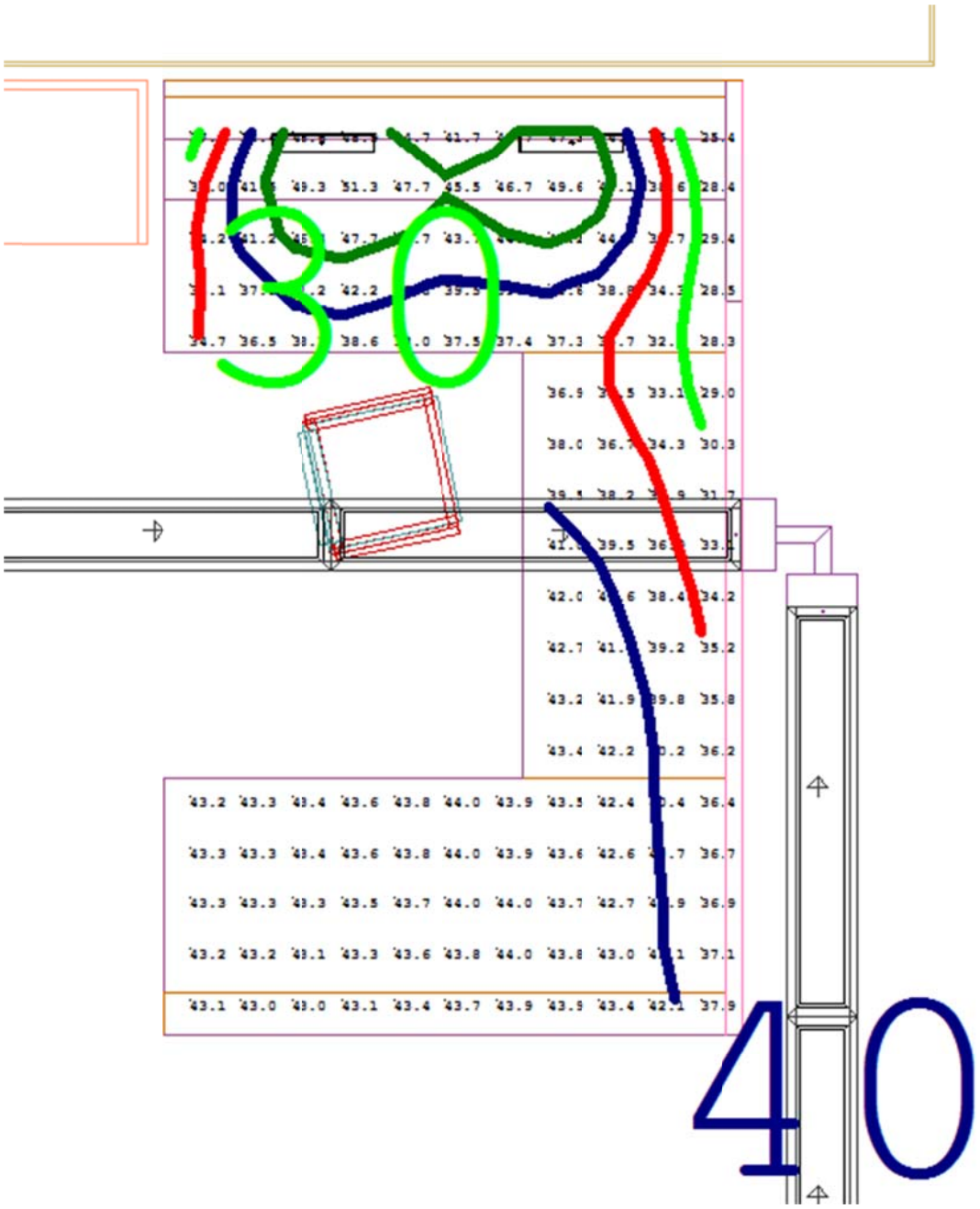
Left Workspace

Average = 31.97 fc	Maximum = 48.4 fc	Minimum = 15.6 fc
Ave / Min = 2.05	Max / Min = 3.10	Max / Ave = 1.51
Coeff. Variation = 0.22	Uniform. Grad. = 1.44	

Right Workspace

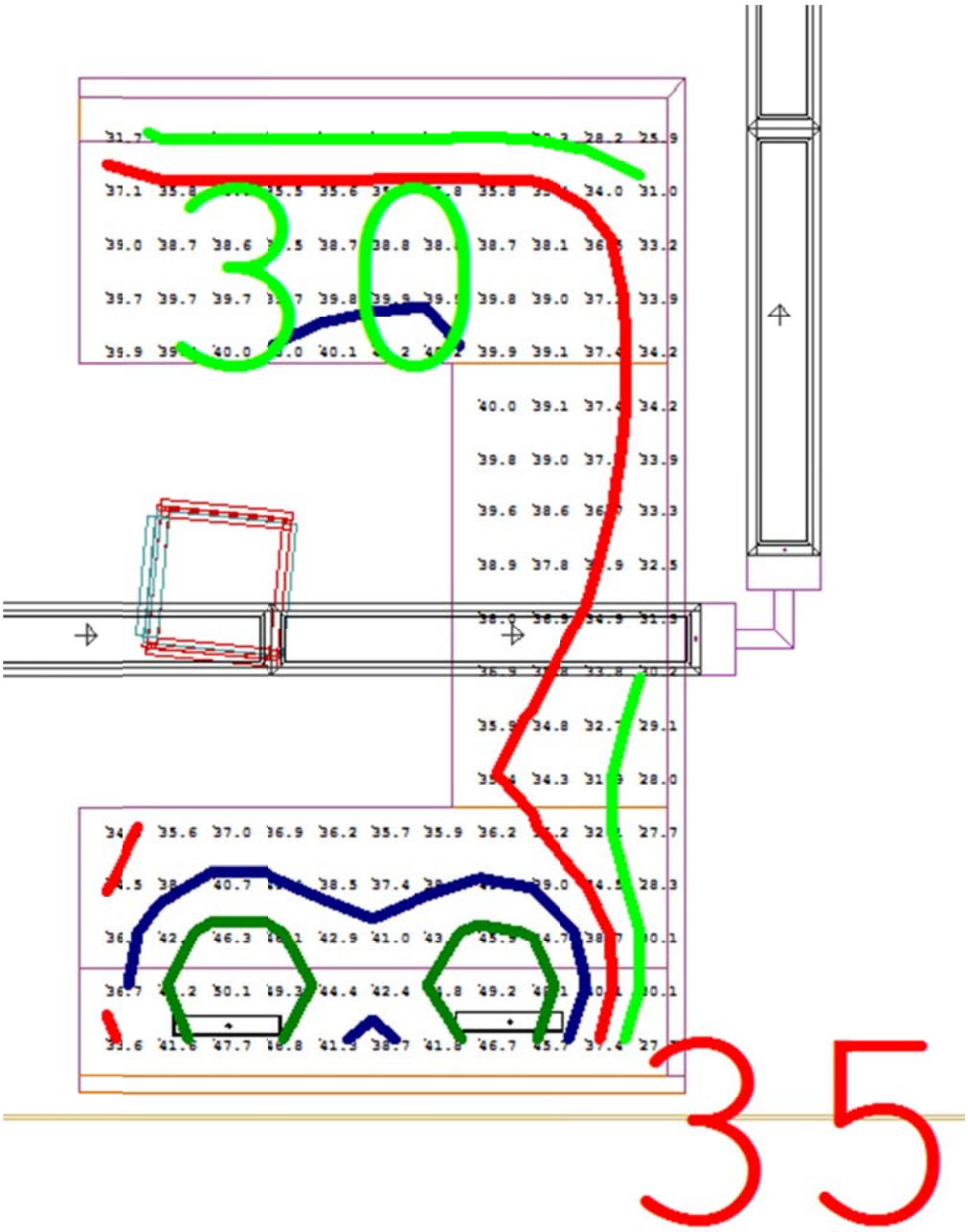
Average = 33.58 fc	Maximum = 48.3 fc	Minimum = 17 fc
Ave / Min = 1.98	Max / Min = 2.84	Max / Ave = 1.44
Coeff. Variation = 0.2	Uniform. Grad. = 1.48	

(Calc. 8) Planning & Engineering: Work Plane Illuminance on Left Workspace (1)



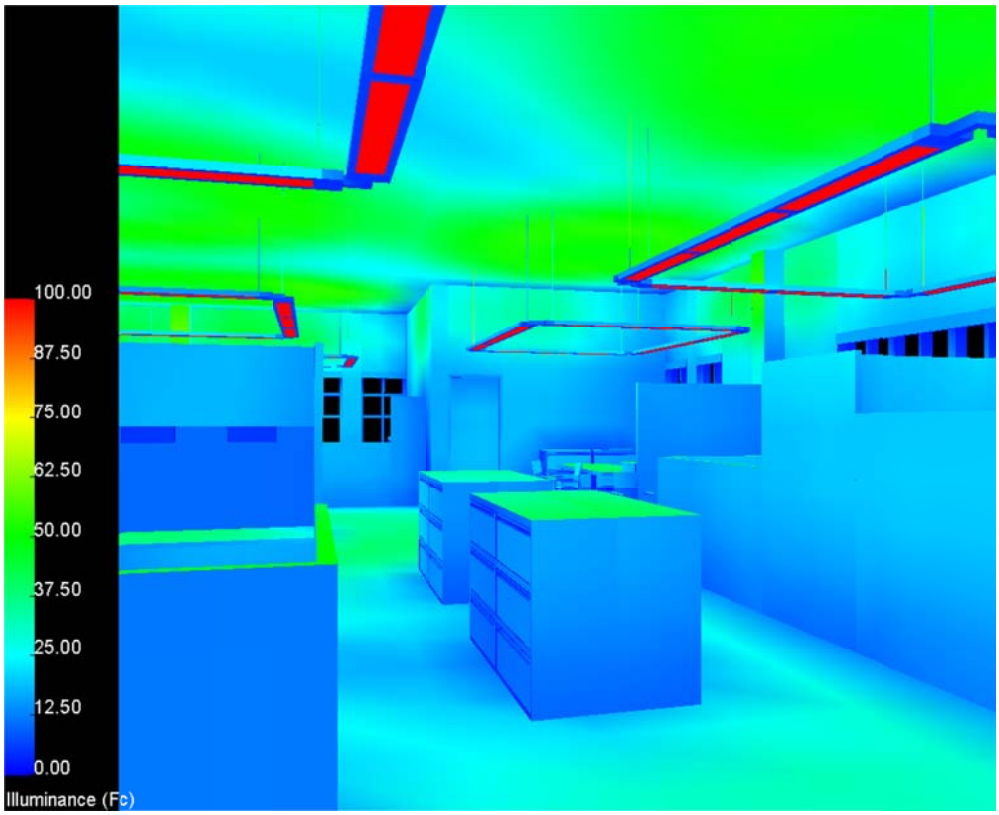
Average = 40.48 fc	Maximum = 51.3 fc	Minimum = 25.4 fc
Ave / Min = 1.59	Max / Min = 2.02	Max / Ave = 1.27
Coeff. Variation = 0.12	Uniform. Grad. = 1.41	

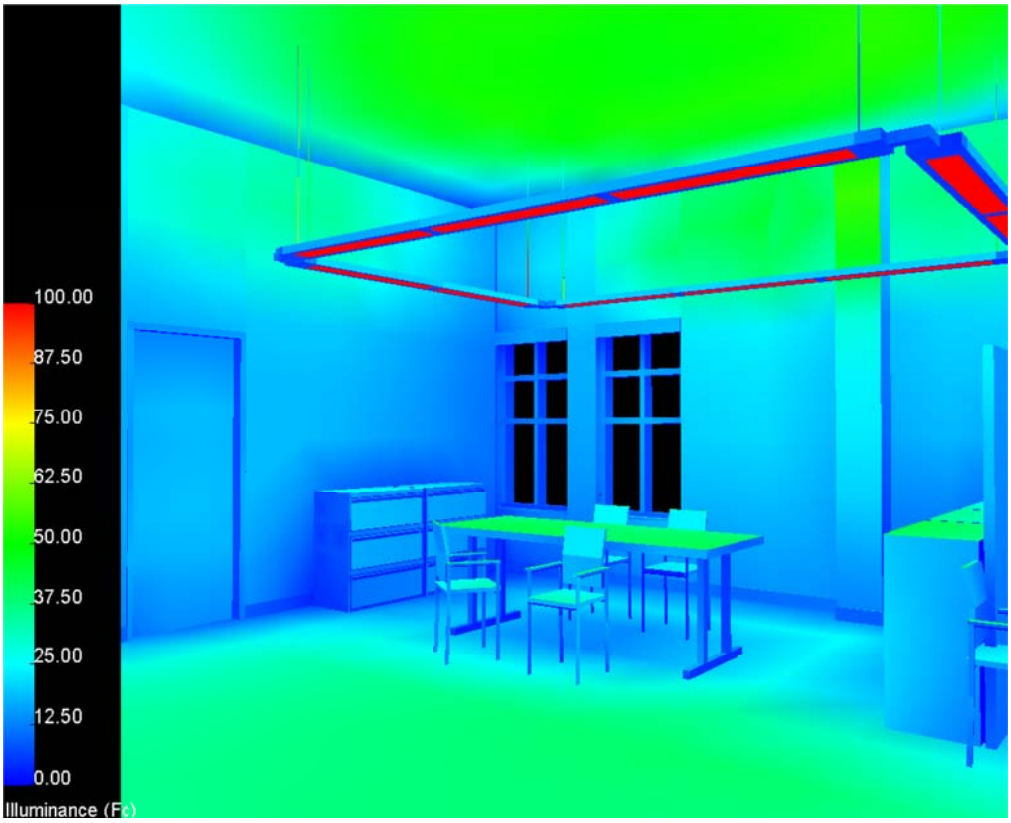
(Calc. 9) Planning & Engineering: Work Plane Illuminance on Left Workspace (2)

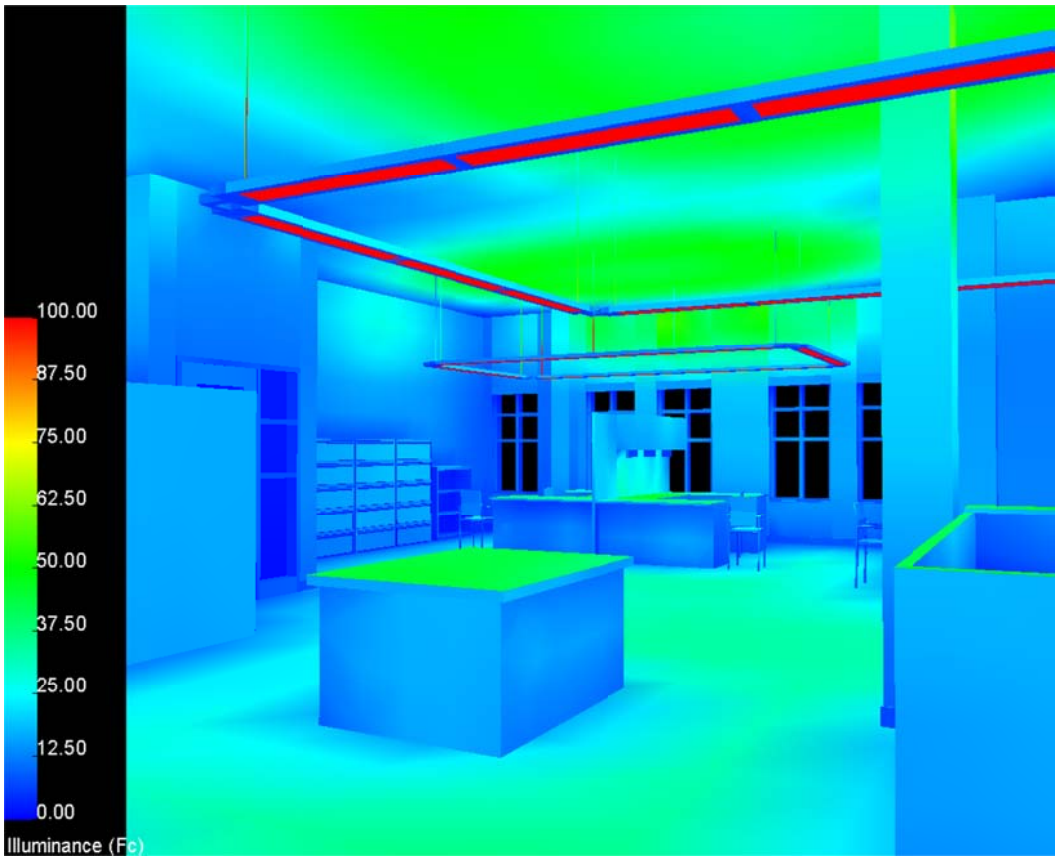


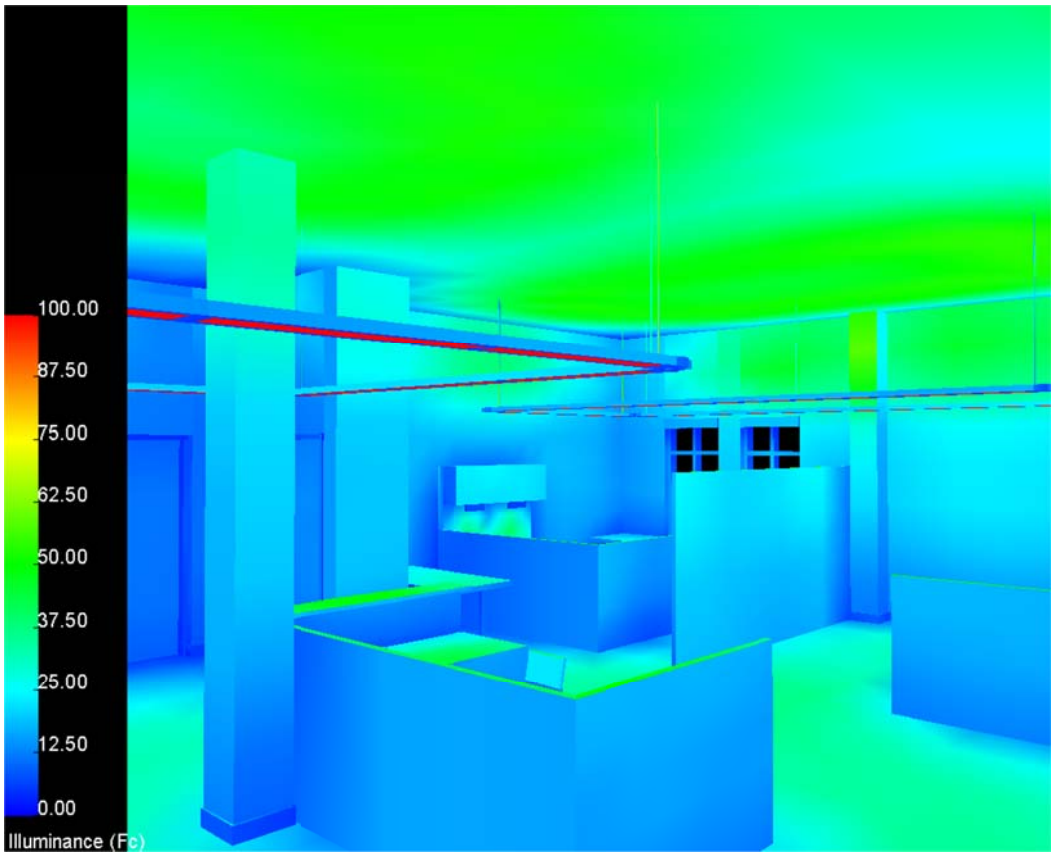
Average = 37.30 fc	Maximum = 49.9 fc	Minimum = 25.9 fc
Ave / Min = 1.44	Max / Min = 1.93	Max / Ave = 1.34
Coeff. Variation = 0.13	Uniform. Grad. = 1.37	

AGI Renderings


100.00
87.50
75.00
62.50
50.00
37.50
25.00
12.50
0.00
Illuminance (Fc)


100.00
87.50
75.00
62.50
50.00
37.50
25.00
12.50
0.00
Illuminance (Fc)


100.00
87.50
75.00
62.50
50.00
37.50
25.00
12.50
0.00
Illuminance (Fc)


100.00
87.50
75.00
62.50
50.00
37.50
25.00
12.50
0.00
Illuminance (Fc)

Electrical Design: Four Lighting Spaces

The four spaces in the City of Green Administration building that were chosen for the lighting design portion of this report are the Entrance Structure, Main Lobby, Council Chambers, and Planning & Engineering Department. Each one coincides to a specific type of space, as per project requirements. The Entrance Structure is the outdoor space, the Main Lobby is the circulation space, the Council Chambers is the special purpose space, and the Planning & Engineering Department is the workspace.

The Entrance Structure consists of a covered walkway leading to a canopy over the building entrance. This entrance is characterized by a large clock tower that stands at about the same height of the main building. In the redesign of the lighting system, several fixtures that are not directly associated with the entrance structure have been removed and replaced by low profile bollards to eliminate visual interference. The covered walkway is illuminated with linear fluorescents mounted to the covering, and the clock tower is highlighted with compact fluorescent wall washers and down lights. All but one of the fixtures chosen for the new design operate at 220-240V, which differs from the existing panelboards.

Immediately inside the entrance under the clock tower is the Main Lobby of the building. This two story space has a mezzanine overlooking the first story entrance, and provides circulation between the three wings of the building. My redesign incorporates continuous recessed rows of linear fluorescents combined with recessed compact fluorescent down lights to illuminate the space. All fixtures operate at 277 V.

Directly accessible through the first floor of the Main Lobby, the Council Chambers is the premier space in the building. This is where the city's administrative personal hold meetings which are sometimes televised. All luminaires are linear or compact fluorescents operating at 277 V.

The last space is a large office workspace inhabited by the city's planning and engineering department. The office is completely open with no permanent furniture; however the lighting was designed considering the current workstation layout. Two types of fixtures were used in the redesign: Direct/indirect suspended luminaires for general ambient illumination, and an under cabinet task fixture. The direct/indirect fixture can operate at 120V or 277V, and the task fixtures only operate at 120V. The branch circuit redesign will have to involve panelboards of multiple voltages because existing lighting equipment is 480/277V in all spaces being redesigned. It is possible to use spare circuits on receptacle panelboards.

PANELBOARDS						
Panel Tag	Voltage	System	Entrance	Lobby	Chambers	P&E
BHA	480/277V, 3P, 4W	N	X			
GHA	480/277V, 3P, 4W	N	X	X	X	
2HA	480/277V, 3P, 4W	N		X		X
LS-1H	480/277V, 3P, 4W	E		X		X

General Luminaire Control Description

All spaces in the building, including the latter four, utilize a communications based lighting control system which allows real time two way communication with each system component from a computer control station. Occupant controlled digital switches communicate with individual relays within lighting control panels (master / slave). The location of these digital switches varies by space. Also, the digital switches can be configured to control the luminaires on specific lighting control panel relays for zone control, and dimming if the lighting control panel supports it.

Luminaire and Control Layout

Entrance Structure

Refer To Appendix A for Luminaire and Control Layout

Main Lobby

Refer To Appendix A for Luminaire and Control Layout

Council Chambers

Refer To Appendix A for Luminaire and Control Layout

Planning & Engineering

Refer To Appendix A for Luminaire and Control Layout

Existing Panelboard Schedules

PANELBOARD SCHEDULE

PANEL: BHA LOCATION: 008 MOUNTING: SURFACE

SERVICE 480/277VOLTS, 3 PHASE, 4 WIRE, 60 HZ

MAINS 100 AMPS, ____ LUGS, ____ CCT. BKR.

FED FROM DP-2 FULL CAPACITY, NEUTRAL, SEPARATE GROUNDING BUS

LOAD	DESCRIPTION	CCT. BKR.	CCT. NO.		CCT. NO.	CCT. BKR.	DESCRIPTION	LOAD
L-722	RM 1	20/1	1		2	20/1	RM 12	L-100
L-484	RM 14,3,4,5	20/1	3		4	20/1	RM 10	L-1152
L-1292	RM 30,20,21	20/1	5		6	20/1	RM 7,8,9	L-960
L-1142	RM 29,27,26,25	20/1	7		8	20/1	RM 23,24	L-2484
L-448	RM 22	20/1	9		10	20/1	RM 15,3, RM 28	L-1356
F-1000	SPARE	20/1	11		12	20/1	SPARE	F-1000
F-1000	SPARE	20/1	13		14	20/1	SPARE	F-1000
F-1000	SPARE	20/1	15		16	20/1	CANOPY LIGHTING	L-600
L-2700	WEST PARKING	20/1	17		18	20/1	SPARE	F-1000
L-2450	SOUTH PARKING	20/1	19		20	20/1	SPARE	F-1000
L-1800	NORTH PARKING LOT	20/1	21		22	20/1	SPARE	F-1000
L-1200	ENTRY CANOPY	20/1	23		24	20/1	SPARE	F-1000
L-400	ENTRY BOLLARDS	20/1	25		26	20/1	SPARE	F-1000
L-990	GROUND LIGHTING	20/1	27		28	20/1	SPARE	F-1000
L-1080	ENTRY POLES	20/1	29		30	20/1	SPARE	F-1000
L-900	FLAG POLE LIGHTING	20/1	31		32	20/1	SPARE	F-1000
L-750	PATIO BOLLARDS	20/1	33		34	20/1	SPARE	F-1000
F-1000	SPARE	20/1	35		36	20/1	SPARE	F-1000
F-1000	SPARE	20/1	37		38	20/1	SPARE	F-1000
F-1000	SPARE	20/1	39		40	20/1	SPARE	F-1000
F-1000	SPARE	20/1	41		42	20/1	SPARE	F-1000

REMARKS:

1. ALL NEW CIRCUIT BREAKERS TO BE 25,000 AIC FOR 480V SYSTEMS UNLESS OTHERWISE NOTED.

LOAD LEGEND:

R – RECEPTACLES
L – LIGHTING
P – PLUMBING
H – HVAC
K – KITCHEN
M – MISCELLANEOUS
F – FUTURE
PREFIX "x" INDICATES EXISTING LOAD

PANELBOARD SCHEDULE

PANEL: GHA LOCATION: 114A MOUNTING: SURFACE

SERVICE 480/277 VOLTS, 3 PHASE, 4 WIRE, 60 HZ

MAINS 100 AMPS, X LUGS, ---- CCT. BKR.

FED FROM DP-2 FULL CAPACITY, NEUTRAL, SEPARATE GROUNDING BUS

LOAD	DESCRIPTION	CCT. BKR.	CCT. NO.		CCT. NO.	CCT. BKR.	DESCRIPTION	LOAD
L-1944	RM 104,105,108,109	20/1	1		2	20/1	RM 157,158	L-1944
L-492	RM 106	20/1	3		4	20/1	RM 151,152,153,154	L-3132
L-1204	RM 114,115,116,114A,120,119	20/1	5		6	20/1	RM 155,156	L-1728
L-2592	RM 139,138,137,136, 133,132,131,134,135	20/1	7		8	20/1	CORR. 150	L-432
L-2564	RM 122,124,125,126,127,129,130	20/1	9		10	20/1	RM 111,112,142,110	L-2380
L-1728	CORR. 113,143,147,144	20/1	11		12	20/1	RESTROOMS 117,118	L-648
L-500	ENTRY EXT. DOWNLIGHT	20/1	13		14	20/1	LOBBY PERIMETER	L-975
F-1000	SPARE	20/1	15		16	20/1	ENTRY VESTIBULE	L-128
F-1000	SPARE	20/1	17		18	20/1	RM 102 PEND/SCONCES	L-700
F-1000	SPARE	20/1	19		20	20/1	RM 102 PERIMETER	L-2368
F-1000	SPARE	20/1	21		22	20/1	RM 102 CENTER DOWNLGHTS	L-1920
L-640	LOBBY DOWNLIGHTS	20/1	23		24	20/1	LCP-G2	M-200
F-1000	SPARE	20/1	25		26	20/1	RM 123	L-364
F-1000	SPARE	20/1	27		28	20/1	SPARE	F-1000
F-1000	SPARE	20/1	29		30	20/1	ATTIC	L-800
F-1000	SPARE	20/1	31		32	20/1	LCP-G3,G3D	M-200
F-1000	SPARE	20/1	33		34	20/1	LCP-G1, G1A	M-200
F-1000	SPARE	20/1	35		36	20/1	SPARE	F-1000
F-1000	SPARE	20/1	37		38	20/1	SPARE	F-1000
F-1000	SPARE	20/1	39		40	20/1	SPARE	F-1000
F-1000	SPARE	20/1	41		42	20/1	SPARE	F-1000

REMARKS:

1. ALL NEW CIRCUIT BREAKERS TO BE 25,000 AIC FOR 480V SYSTEMS UNLESS OTHERWISE NOTED.

LOAD LEGEND:

R - RECEPTACLES
L - LIGHTING
P - PLUMBING
H - HVAC
K - KITCHEN
M - MISCELLANEOUS
F - FUTURE
PREFIX "x" INDICATES EXISTING LOAD

PANELBOARD SCHEDULE

PANEL: 2HA LOCATION: 215 MOUNTING: SURFACE

SERVICE 480/277VOLTS, 3 PHASE, 4 WIRE, 60 HZ

MAINS 100 AMPS, X LUGS, ---- CCT. BKR.

FED FROM DP-2 FULL CAPACITY, NEUTRAL, SEPARATE GROUNDING BUS

LOAD	DESCRIPTION	CCT. BKR.	CCT. NO.		CCT. NO.	CCT. BKR.	DESCRIPTION	LOAD
L-1664	RM 218,215,212,216	20/1	1		2	20/1	RM 206,207	L-1944
L-1296	RESTROOMS 221,222	20/1	3		4	20/1	RM 208,209	L-1728
L-2700	RM 224,225,229	20/1	5		6	20/1	RM 202,203,CORR 201	L-1620
L-2800	RM 224	20/1	7		8	20/1	RM 213,214	L-2102
L-320	ENTRY COVE	20/1	9		10	20/1	SPARE	F-1000
L-1216	LOBBY DOWNLIGHTS	20/1	11		12	20/1	SPARE	F-1000
L-256	LOBBY SCONCES	20/1	13		14	20/1	SPARE	F-1000
L-512	LOBBY CENTER	20/1	15		16	20/1	RM 228/CORR 223	L-944
M-200	RM 215 LCP-2 & LCP-2D	20/1	17		18	20/1	SPARE	F-1000
L-800	ATTIC LIGHTING	20/1	19		20	20/1	SPARE	F-1000
L-500	ATTIC LIGHTING	20/1	21		22	20/1	SPARE	F-1000
L-800	ATTIC LIGHTING	20/1	23		24	20/1	SPARE	F-1000
F-1000	SPARE	20/1	25		26	20/1	SPARE	F-1000
F-1000	SPARE	20/1	27		28	20/1	SPARE	F-1000
F-1000	SPARE	20/1	29		30	20/1	SPARE	F-1000
F-1000	SPARE	20/1	31		32	20/1	SPARE	F-1000
F-1000	SPARE	20/1	33		34	20/1	SPARE	F-1000
F-1000	SPARE	20/1	35		36	20/1	SPARE	F-1000
F-1000	SPARE	20/1	37		38	20/1	SPARE	F-1000
F-1000	SPARE	20/1	39		40	20/1	SPARE	F-1000
F-1000	SPARE	20/1	41		42	20/1	SPARE	F-1000

REMARKS:

1. ALL NEW CIRCUIT BREAKERS TO BE 25,000 AIC FOR 480V SYSTEMS UNLESS OTHERWISE NOTED.

LOAD LEGEND:

R – RECEPTACLES
L – LIGHTING
P – PLUMBING
H – HVAC
K – KITCHEN
M – MISCELLANEOUS
F – FUTURE
PREFIX "x" INDICATES EXISTING LOAD

PANELBOARD SCHEDULE

PANEL: LS–1H LOCATION: 008 MOUNTING: SURFACE

SERVICE: 480/277 VOLTS, 3 PHASE, 4 WIRE, 60 HZ

MAINS 100 AMPS, X LUGS, ---- CCT. BKR.

FED FROM ATS–3 FULL CAPACITY, NEUTRAL, SEPARATE GROUNDING BUS

LOAD	DESCRIPTION	CCT. BKR.	CCT. NO.		CCT. NO.	CCT. BKR.	DESCRIPTION	LOAD
L–400	STAIR 002	20/1	1		2	20/1	SPARE	F–1000
L–542	RM. 010 LTG/STAIR	20/1	3		4	20/1	NL LIGHTS	L–400
M–100	LCP–B1	20/1	5		6	20/1	EXT. DOOR FIXTURES	L–320
L–1520	NL LTG	20/1	7		8	20/1	EXT. DOOR FIXTURES	L–320
L–400	RM. 117, 118 NL	20/1	9		10	20/1	NL LIGHTS	L–1350
L–387	NL (EAST WING)	20/1	11		12	20/1	NL FIXTURES (SOUTH)	L–516
L–1666	NL (LOBBY)	20/1	13		14	20/1	NL FIXTURES (NORTH)	L–1248
L–1312	NL (WEST WING)	20/1	15		16	20/1	SPARE	F–1000
M–30000	T–3 RM. 008	50/3	17		18	20/1	SPARE	F–1000
			19		20	20/1	SPARE	F–1000
			21		22	20/1	SPARE	F–1000
F–1000	SPARE	20/1	23		24	20/1	SPARE	F–1000
F–1000	SPARE	20/1	25		26	20/1	SPARE	F–1000
F–1000	SPARE	20/1	27		28	20/1	SPARE	F–1000
F–1000	SPARE	20/1	29		30	20/1	SPARE	F–1000

REMARKS:

1. ALL NEW CIRCUIT BREAKERS TO BE 25,000 AIC FOR 480V SYSTEMS UNLESS OTHERWISE NOTED.

LOAD LEGEND:

R – RECEPTACLES
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PREFIX "x" INDICATES EXISTING LOAD

Allowed Load on 20 amp Circuit

(20 amps)(80%, NEC) = 16 amps (80%, engineering practice) = 12.8 maximum allowed amps per circuit

VA = (12.8 amps) (277V) (3) = 10,637 VA = 10.6 kVA load on each circuit

Loads (Lighting for each space, VA = W/PF)	
Entrance Structure	2752.22
Main Lobby	2963.33
Council Chambers	2611.11
Planning & Engineering	2331.77

Each space lighting load requires less than a single 20 amp circuit because none are above 10.6 kVA

Revised Panelboard Worksheets

PANELBOARD SIZING WORKSHEET

Panel Tag---------->				BHA	Panel Location:			8			
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	Lighting		RM 1	722	w		722	903		
2	A	Lighting		RM 12	100	w		100	125		
3	B	Lighting		RM 14,3,4,5	484	w		484	605		
4	B	Lighting		RM 10	1152	w		1152	1440		
5	C	Lighting		RM 30,20,21	1292	w		1292	1615		
6	C	Lighting		RM 7,8,9	960	w		960	1200		
7	A	Lighting		M 29,27,26,2	1142	w		1142	1428		
8	A	Lighting		RM 23,24	2484	w		2484	3105		
9	B	Lighting		RM 22	448	w		448	560		
10	B	Lighting		RM 15,3,28	1356	w		1356	1695		
11	C	Future		Spare	1000	w		1000	1250		
12	C	Future		Spare	1000	w		1000	1250		
13	A	Future		Spare	1000	w		1000	1250		
14	A	Future		Spare	1000	w		1000	1250		
15	B	Future		Spare	1000	w		1000	1250		
16	B	Lighting		lkway Bolla	1586	w		1586	1983		
17	C	Lighting		West Parkin	2700	w		2700	3375		
18	C	Future		Spare	1000	w		1000	1250		
19	A	Lighting		South Parkin	2450	w		2450	3063		
20	A	Future		Spare	1000	w		1000	1250		
21	B	Lighting		North Parkin	1800	w		1800	2250		
22	B	Future		Spare	1000	w		1000	1250		
23	C	Lighting		Walkway, c	849	w		849	1061		
24	C	Future		Spare	1000	w		1000	1250		
25	A	Future		Spare	1000	w		1000	1250		
26	A	Future		Spare	1000	w		1000	1250		
27	B	Future		Spare	1000	w		1000	1250		
28	B	Future		Spare	1000	w		1000	1250		
29	C	Future		Spare	1000	w		1000	1250		
30	C	Future		Spare	1000	w		1000	1250		
31	A	Lighting		Flag Pole	900	w		900	1125		
32	A	Future		Spare	1000	w		1000	1250		
33	B	Lighting		Patio Bollard	750	w		750	938		
34	B	Future		Spare	1000	w		1000	1250		
35	C	Future		Spare	1000	w		1000	1250		
36	C	Future		Spare	1000	w		1000	1250		
37	A	Future		Spare	1000	w		1000	1250		
38	A	Future		Spare	1000	w		1000	1250		
39	B	Future		Spare	1000	w		1000	1250		
40	B	Future		Spare	1000	w		1000	1250		
41	C	Future		Spare	1000	w		1000	1250		
42	C	Future		Spare	1000	w		1000	1250		
PANEL TOTAL								46.2	57.7	Amps=	69.5

PHASE LOADING								
		kW	kVA	%	Amps			
PHASE TOTAL	A	15.8	19.7	35%	71.3			
PHASE TOTAL	B	14.6	18.2	32%	65.8			
PHASE TOTAL	C	15.8	19.3	34%	69.5			

LOAD CATAGORIES		Connected			Demand				Ver. 1.04
		kW	kVA	DF	kW	kVA	PF		
1	receptacles	0.0	0.0		0.0	0.0			
2	computers	0.0	0.0		0.0	0.0			
3	fluorescent lighting	0.0	0.0		0.0	0.0			
4	HID lighting	0.0	0.0		0.0	0.0			
5	incandescent lighting	0.0	0.0		0.0	0.0			
6	HVAC fans	0.0	0.0		0.0	0.0			
7	heating	0.0	0.0		0.0	0.0			
8	kitchen equipment	0.0	0.0		0.0	0.0			
9	unassigned	46.2	57.7		46.2	57.7	0.80		
Total Demand Loads					46.2	57.7			
Spare Capacity		20%			9.2	11.5			
Total Design Loads					55.4	69.3	0.80	Amps=	83.3

Default Power Factor =	0.80
Default Demand Factor =	100 %

PANELBOARD SIZING WORKSHEET

Panel Tag---------->					2HA	Panel Location:			215		
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	Lighting		RM	1664	w		1664	2080		
2	A	Lighting		RM	1944	w		1944	2430		
3	B	Lighting		RM	1296	w		1296	1620		
4	B	Lighting		RM	1728	w		1728	2160		
5	C	Lighting		P&E	1830	w		1830	2288		
6	C	Lighting		RM	1620	w		1620	2025		
7	A	Lighting		Lobby	720	w		720	900		
8	A	Lighting		RM	2102	w		2102	2628		
9	B	Lighting		Lobby	620	w		620	775		
10	B	Future		Spare	1000	w		1000	1250		
11	C	Lighting		Lobby	528	w		528	660		
12	C	Future		Spare	1000	w		1000	1250		
13	A	Future		Spare	1000	w		1000	1250		
14	A	Future		Spare	1000	w		1000	1250		
15	B	Future		Spare	1000	w		1000	1250		
16	B	Lighting		rm	944	w		944	1180		
17	C	Mechanical			200	w		200	250		
18	C	Future		Spare	1000	w		1000	1250		
19	A	Lighting		attic	800	w		800	1000		
20	A	Future		Spare	1000	w		1000	1250		
21	B	Lighting		attic	500	w		500	625		
22	B	Future		Spare	1000	w		1000	1250		
23	C	Lighting		attic	800	w		800	1000		
24	C	Future		Spare	1000	w		1000	1250		
25	A	Future		Spare	1000	w		1000	1250		
26	A	Future		Spare	1000	w		1000	1250		
27	B	Future		Spare	1000	w		1000	1250		
28	B	Future		Spare	1000	w		1000	1250		
29	C	Future		Spare	1000	w		1000	1250		
30	C	Future		Spare	1000	w		1000	1250		
31	A	Future		Spare	1000	w		1000	1250		
32	A	Future		Spare	1000	w		1000	1250		
33	B	Future		Spare	1000	w		1000	1250		
34	B	Future		Spare	1000	w		1000	1250		
35	C	Future		Spare	1000	w		1000	1250		
36	C	Future		Spare	1000	w		1000	1250		
37	A	Future		Spare	1000	w		1000	1250		
38	A	Future		Spare	1000	w		1000	1250		
39	B	Future		Spare	1000	w		1000	1250		
40	B	Future		Spare	1000	w		1000	1250		
41	C	Future		Spare	1000	w		1000	1250		
42	C	Future		Spare	1000	w		1000	1250		
PANEL TOTAL								44.3	55.4	Amps=	66.6

PHASE LOADING		kW	kVA	%	Amps
PHASE TOTAL	A	16.2	20.3	37%	73.2
PHASE TOTAL	B	14.1	17.6	32%	63.6
PHASE TOTAL	C	14.0	17.0	31%	61.3

LOAD CATAGORIES			Connected			Demand				Ver. 1.04
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0		0.0	0.0			
2	computers		0.0	0.0		0.0	0.0			
3	fluorescent lighting		0.0	0.0		0.0	0.0			
4	HID lighting		0.0	0.0		0.0	0.0			
5	incandescent lighting		0.0	0.0		0.0	0.0			
6	HVAC fans		0.0	0.0		0.0	0.0			
7	heating		0.0	0.0		0.0	0.0			
8	kitchen equipment		0.0	0.0		0.0	0.0			
9	unassigned		44.3	55.4		44.3	55.4	0.80		
Total Demand Loads						44.3	55.4			
Spare Capacity			20%			8.9	11.1			
Total Design Loads						53.2	66.4	0.80	Amps=	80.0

Default Power Factor =	0.80
Default Demand Factor =	100 %

PANELBOARD SIZING WORKSHEET

Panel Tag---------->					GHA	Panel Location:			114A		
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	Lighting		RM	1944	w		1944	2430		
2	A	Lighting		RM	1944	w		1944	2430		
3	B	Lighting		RM	492	w		492	615		
4	B	Lighting		RM	3132	w		3132	3915		
5	C	Lighting		RM	1204	w		1204	1505		
6	C	Lighting		RM	1728	w		1728	2160		
7	A	Lighting		RM	2592	w		2592	3240		
8	A	Lighting		RM	432	w		432	540		
9	B	Lighting		RM	2564	w		2564	3205		
10	B	Lighting		RM	2380	w		2380	2975		
11	C	Lighting		Corr	1728	w		1728	2160		
12	C	Lighting		Restroom	648	w		648	810		
13	A	Lighting		Lobby	594	w		594	743		
14	A	Lighting		Lobby Stairs	468	w		468	585		
15	B	Future		Spare	1000	w		1000	1250		
16	B	Lighting		Vestibule	128	w		128	160		
17	C	Future		Spare	1000	w		1000	1250		
18	C	Lighting		CC Side	544	w		544	680		
19	A	Future		Spare	1000	w		1000	1250		
20	A	Lighting		CC Rear	552	w		552	690		
21	B	Future		Spare	1000	w		1000	1250		
22	B	Lighting		CC Rear Cov	512	w		512	640		
23	C	Lighting		CC Front Cov	768	w		768	960		
24	C	Mechanical		LCP-G2	200	w		200	250		
25	A	Future		Spare	1000	w		1000	1250		
26	A	Lighting		Rm	364	w		364	455		
27	B	Future		Spare	1000	w		1000	1250		
28	B	Future		Spare	1000	w		1000	1250		
29	C	Future		Spare	1000	w		1000	1250		
30	C	Lighting		Attic	800	w		800	1000		
31	A	Future		Spare	1000	w		1000	1250		
32	A	Mechanical		LCP-G3	1000	w		1000	1250		
33	B	Future		Spare	1000	w		1000	1250		
34	B	Mechanical		CP-G1, G1A	200	w		200	250		
35	C	Future		Spare	1000	w		1000	1250		
36	C	Future		Spare	1000	w		1000	1250		
37	A	Future		Spare	1000	w		1000	1250		
38	A	Future		Spare	1000	w		1000	1250		
39	B	Future		Spare	1000	w		1000	1250		
40	B	Future		Spare	1000	w		1000	1250		
41	C	Future		Spare	1000	w		1000	1250		
42	C	Future		Spare	1000	w		1000	1250		
PANEL TOTAL								44.9	56.1	Amps=	67.6

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					14.9	18.6	33%	67.2
PHASE TOTAL	B					16.4	20.5	37%	74.0
PHASE TOTAL	C					13.6	16.5	30%	59.7

LOAD CATAGORIES			Connected			Demand				Ver. 1.04
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0		0.0	0.0			
2	computers		0.0	0.0		0.0	0.0			
3	fluorescent lighting		0.0	0.0		0.0	0.0			
4	HID lighting		0.0	0.0		0.0	0.0			
5	incandescent lighting		0.0	0.0		0.0	0.0			
6	HVAC fans		0.0	0.0		0.0	0.0			
7	heating		0.0	0.0		0.0	0.0			
8	kitchen equipment		0.0	0.0		0.0	0.0			
9	unassigned		44.9	56.1		44.9	56.1	0.80		
Total Demand Loads						44.9	56.1			
Spare Capacity			20%			9.0	11.2			
Total Design Loads						53.9	67.4	0.80	Amps=	81.1

Default Power Factor =	0.80	
Default Demand Factor =	100	%

PANELBOARD SIZING WORKSHEET

Panel Tag---------->					LS-1H	Panel Location:			8		
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	Lighting		RM	400	w		400	500		
2	A	Future		Spare	1000	w		1000	1250		
3	B	Lighting		RM	542	w		542	678		
4	B	Lighting		RM	400	w		400	500		
5	C	Mechanical			100	w		100	125		
6	C	Lighting		RM	320	w		320	400		
7	A	Lighting			1520	w		1520	1900		
8	A	Lighting		RM	320	w		320	400		
9	B	Lighting			400	w		400	500		
10	B	Lighting		Lobby Emer	208	w		208	260		
11	C	Lighting			877	w		877	1096		
12	C	Lighting			516	w		516	645		
13	A	Future		Spare	1000	w		1000	1250		
14	A	Lighting			1248	w		1248	1560		
15	B	Lighting		P&E Emer	90	w		90	113		
16	B	Lighting		rm	944	w		944	1180		
17	C	Future		Spare	1000	w		1000	1250		
18	C	Future		Spare	1000	w		1000	1250		
19	A	Future		Spare	1000	w		1000	1250		
20	A	Future		Spare	1000	w		1000	1250		
21	B	Future		Spare	1000	w		1000	1250		
22	B	Future		Spare	1000	w		1000	1250		
23	C	Future		Spare	1000	w		1000	1250		
24	C	Future		Spare	1000	w		1000	1250		
25	A	Future		Spare	1000	w		1000	1250		
26	A	Future		Spare	1000	w		1000	1250		
27	B	Future		Spare	1000	w		1000	1250		
28	B	Future		Spare	1000	w		1000	1250		
29	C	Future		Spare	1000	w		1000	1250		
30	C	Future		Spare	1000	w		1000	1250		
31	A					w		0	0		
32	A					w		0	0		
33	B					w		0	0		
34	B					w		0	0		
35	C					w		0	0		
36	C					w		0	0		
37	A					w		0	0		
38	A					w		0	0		
39	B					w		0	0		
40	B					w		0	0		
41	C					w		0	0		
42	C					w		0	0		
PANEL TOTAL								23.9	29.9	Amps=	35.9

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					9.5	11.9	40%	42.8
PHASE TOTAL	B					6.6	8.2	28%	29.7
PHASE TOTAL	C					7.8	9.8	33%	35.3

LOAD CATAGORIES			Connected			Demand				Ver. 1.04
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0		0.0	0.0			
2	computers		0.0	0.0		0.0	0.0			
3	fluorescent lighting		0.0	0.0		0.0	0.0			
4	HID lighting		0.0	0.0		0.0	0.0			
5	incandescent lighting		0.0	0.0		0.0	0.0			
6	HVAC fans		0.0	0.0		0.0	0.0			
7	heating		0.0	0.0		0.0	0.0			
8	kitchen equipment		0.0	0.0		0.0	0.0			
9	unassigned		23.9	29.9		23.9	29.9	0.80		
Total Demand Loads						23.9	29.9			
Spare Capacity			20%			4.8	6.0			
Total Design Loads						28.7	35.8	0.80	Amps=	43.1

Default Power Factor =	0.80
Default Demand Factor =	100 %

Revised Panelboard Schedules

PANELBOARD SCHEDULE

VOLTAGE:	408Y/277V,3PH,4W	PANEL TAG:	BHA	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	8	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	RM 1	722	20A/1P	1	*			2	20A/1P	100	RM 12	Lighting
Lighting	RM 14,3,4,5	484	20A/1P	3		*		4	20A/1P	1152	RM 10	Lighting
Lighting	RM 30,20,21	1292	20A/1P	5			*	6	20A/1P	960	RM 7,8,9	Lighting
Lighting	RM 29,27,26,25	1142	20A/1P	7	*			8	20A/1P	2484	RM 23,24	Lighting
Lighting	RM 22	448	20A/1P	9		*		10	20A/1P	1356	RM 15,3,28	Lighting
Future	Spare	1000	20A/1P	11			*	12	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	13	*			14	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	15		*		16	20A/1P	1586	Walkway Bollards	Lighting
Lighting	West Parking	2700	20A/1P	17			*	18	20A/1P	1000	Spare	Future
Lighting	South Parking	2450	20A/1P	19	*			20	20A/1P	1000	Spare	Future
Lighting	North Parking	1800	20A/1P	21		*		22	20A/1P	1000	Spare	Future
Lighting	d Walkway, clo	849	20A/1P	23			*	24	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	25	*			26	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	27		*		28	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	29			*	30	20A/1P	1000	Spare	Future
Lighting	Flag Pole	900	20A/1P	31	*			32	20A/1P	1000	Spare	Future
Lighting	Patio Bollards	750	20A/1P	33		*		34	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	35			*	36	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	37	*			38	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	39		*		40	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	41			*	42	20A/1P	1000	Spare	Future

CONNECTED LOAD (KW) - A Ph.	15.80	TOTAL DESIGN LOAD (KW)	55.41
CONNECTED LOAD (KW) - B Ph.	14.58	POWER FACTOR	0.80
CONNECTED LOAD (KW) - C Ph.	15.80	TOTAL DESIGN LOAD (AMPS)	83

PANELBOARD SCHEDULE

VOLTAGE:	408Y/277V,3PH,4W	PANEL TAG:	2HA	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	215	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	RM	1664	20A/1P	1	*			2	20A/1P	1944	RM	Lighting
Lighting	RM	1296	20A/1P	3		*		4	20A/1P	1728	RM	Lighting
Lighting	P&E	1830	20A/1P	5			*	6	20A/1P	1620	RM	Lighting
Lighting	Lobby	720	20A/1P	7	*			8	20A/1P	2102	RM	Lighting
Lighting	Lobby	620	20A/1P	9		*		10	20A/1P	1000	Spare	Future
Lighting	Lobby	528	20A/1P	11			*	12	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	13	*			14	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	15		*		16	20A/1P	944	rm	Lighting
Mechanical	0	200	20A/1P	17			*	18	20A/1P	1000	Spare	Future
Lighting	attic	800	20A/1P	19	*			20	20A/1P	1000	Spare	Future
Lighting	attic	500	20A/1P	21		*		22	20A/1P	1000	Spare	Future
Lighting	attic	800	20A/1P	23			*	24	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	25	*			26	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	27		*		28	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	29			*	30	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	31	*			32	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	33		*		34	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	35			*	36	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	37	*			38	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	39		*		40	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	41			*	42	20A/1P	1000	Spare	Future

CONNECTED LOAD (KW) - A Ph.	16.23	TOTAL DESIGN LOAD (KW)	53.16
CONNECTED LOAD (KW) - B Ph.	14.09	POWER FACTOR	0.80
CONNECTED LOAD (KW) - C Ph.	13.98	TOTAL DESIGN LOAD (AMPS)	80

PANELBOARD SCHEDULE

VOLTAGE:	408Y/277V,3PH,4W	PANEL TAG:	GHA	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	114A	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	RM	1944	20A/1P	1	*			2	20A/1P	1944	RM	Lighting
Lighting	RM	492	20A/1P	3		*		4	20A/1P	3132	RM	Lighting
Lighting	RM	1204	20A/1P	5			*	6	20A/1P	1728	RM	Lighting
Lighting	RM	2592	20A/1P	7	*			8	20A/1P	432	RM	Lighting
Lighting	RM	2564	20A/1P	9		*		10	20A/1P	2380	RM	Lighting
Lighting	Corr	1728	20A/1P	11			*	12	20A/1P	648	Restroom	Lighting
Lighting	Lobby	594	20A/1P	13	*			14	20A/1P	468	Lobby Stairs	Lighting
Future	Spare	1000	20A/1P	15		*		16	20A/1P	128	Vestibule	Lighting
Future	Spare	1000	20A/1P	17			*	18	20A/1P	544	CC Side	Lighting
Future	Spare	1000	20A/1P	19	*			20	20A/1P	552	CC Rear	Lighting
Future	Spare	1000	20A/1P	21		*		22	20A/1P	512	CC Rear Cove	Lighting
Lighting	CC Front Cove	768	20A/1P	23			*	24	20A/1P	200	LCP-G2	Mechanical
Future	Spare	1000	20A/1P	25	*			26	20A/1P	364	Rm	Lighting
Future	Spare	1000	20A/1P	27		*		28	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	29			*	30	20A/1P	800	Attic	Lighting
Future	Spare	1000	20A/1P	31	*			32	20A/1P	1000	LCP-G3	Mechanical
Future	Spare	1000	20A/1P	33		*		34	20A/1P	200	LCP-G1, G1A	Mechanical
Future	Spare	1000	20A/1P	35			*	36	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	37	*			38	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	39		*		40	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	41			*	42	20A/1P	1000	Spare	Future

CONNECTED LOAD (KW) - A Ph.	14.89	TOTAL DESIGN LOAD (KW)	53.90
CONNECTED LOAD (KW) - B Ph.	16.41	POWER FACTOR	0.80
CONNECTED LOAD (KW) - C Ph.	13.62	TOTAL DESIGN LOAD (AMPS)	81

PANELBOARD SCHEDULE

VOLTAGE:	408Y/277V,3PH,4W	PANEL TAG:	LS-1H	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	225A	PANEL LOCATION:	8	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	225A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Lighting	RM	400	20A/1P	1	*			2	20A/1P	1000	Spare	Future
Lighting	RM	542	20A/1P	3		*		4	20A/1P	400	RM	Lighting
Mechanical	0	100	20A/1P	5			*	6	20A/1P	320	RM	Lighting
Lighting	0	1520	20A/1P	7	*			8	20A/1P	320	RM	Lighting
Lighting	0	400	20A/1P	9		*		10	20A/1P	208	Lobby Emer	Lighting
Lighting	0	877	20A/1P	11			*	12	20A/1P	516	0	Lighting
Future	Spare	1000	20A/1P	13	*			14	20A/1P	1248	0	Lighting
Lighting	P&E Emer	90	20A/1P	15		*		16	20A/1P	944	rm	Lighting
Future	Spare	1000	20A/1P	17			*	18	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	19	*			20	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	21		*		22	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	23			*	24	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	25	*			26	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	27		*		28	20A/1P	1000	Spare	Future
Future	Spare	1000	20A/1P	29			*	30	20A/1P	1000	Spare	Future
0	0	0	20A/1P	31	*			32	20A/1P	0	0	0
0	0	0	20A/1P	33		*		34	20A/1P	0	0	0
0	0	0	20A/1P	35			*	36	20A/1P	0	0	0
0	0	0	20A/1P	37	*			38	20A/1P	0	0	0
0	0	0	20A/1P	39		*		40	20A/1P	0	0	0
0	0	0	20A/1P	41			*	42	20A/1P	0	0	0

CONNECTED LOAD (KW) - A Ph.	9.49	TOTAL DESIGN LOAD (KW)	28.66
CONNECTED LOAD (KW) - B Ph.	6.58	POWER FACTOR	0.80
CONNECTED LOAD (KW) - C Ph.	7.81	TOTAL DESIGN LOAD (AMPS)	43

Panelboard Sizing

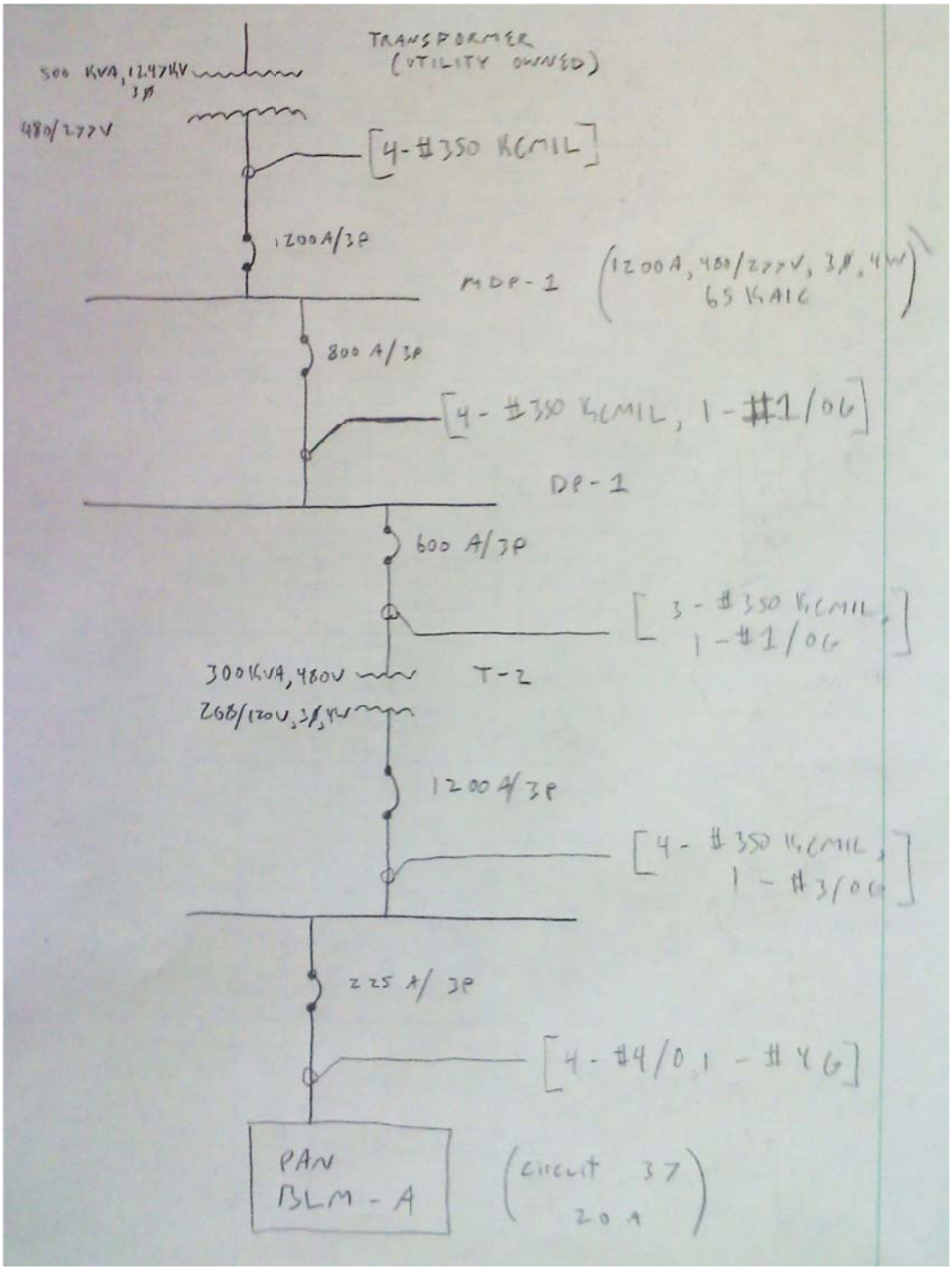
Panelboard	Total Design Load (Amps)	Panelboard Size
BHA	83	125 A
2HA	80	125 A
GHA	81	125 A
LS-1H	43	80 A

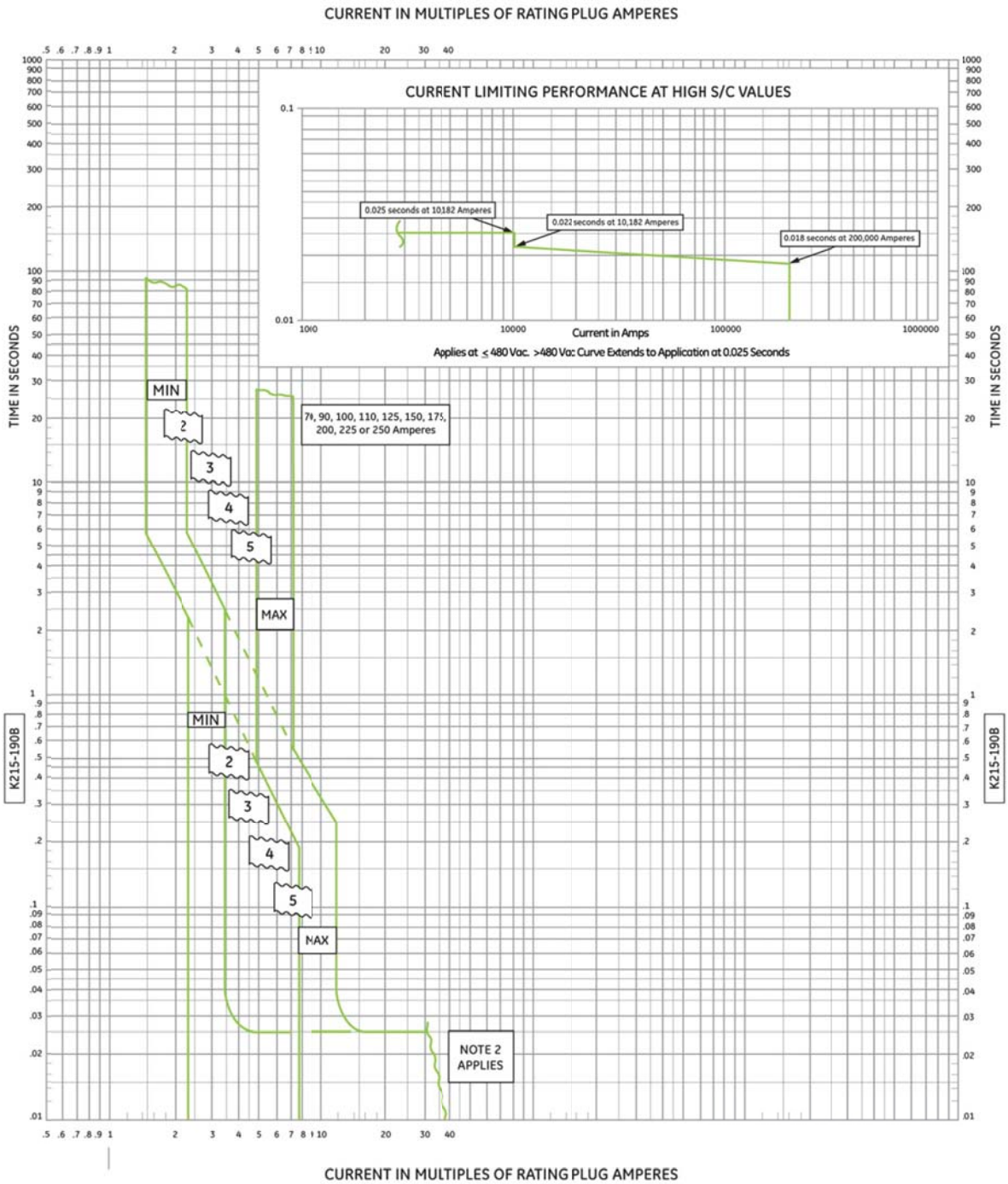
Resize Feeders for Revised Panelboards

Panelboard	Total Design Load (Amps)	Raceway Size	Conductor Size
BHA	83	2”	#2 P/N, #4 G
2HA	80	2”	#2 P/N, #4 G
GHA	81	2”	#2 P/N, #4 G
LS-1H	43	1.25”	#3 P/N, #10 G

Short Circuit Analysis

The single path chosen for the short circuit analysis is to a branch on mechanical panelboard BLM-A, which is a 150 Amp panelboard fed by Distribution Panel 4 (DP-4) via DP-1. The DP-4 protection device is a 225A circuit breaker; DP-1 protection device is 1200 A circuit breaker. Coordination studies assure that the circuit breakers will operate properly. The path is shown in the sketch below.





GE Consumer & Industrial - Electrical Distribution

MAG-BREAK® Motor Circuit Protector Type SF with Spectra RMS® Solid-state Trip

Instantaneous with Tracking Short-time Delay Time-current Curves

Curves apply at 50 to 400 Hertz and from -20°C to 70°C breaker ambient

K215-190B

Current Ratings

Frame Amperes	Rating Plug Amperes
250	70, 90, 100, 110, 125, 150, 175, 200, 225, 250

Voltage Ratings

2 Pole — 480 Vac max.
3 Pole — 600 Vac max.

Adjustments

Instantaneous pick-up settings in multiples of rating plug rating: MIN, 2, 3, 4, 5, MAX

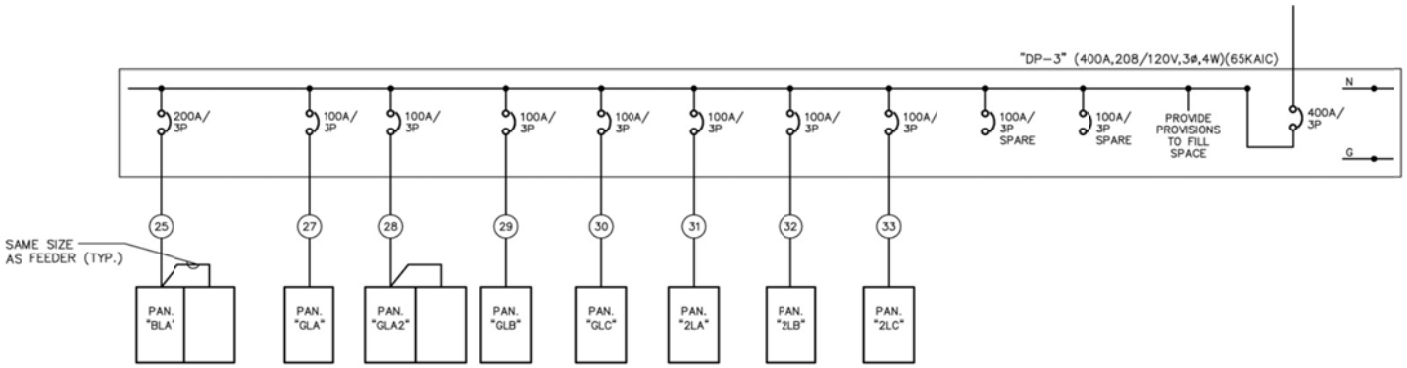
Note 1: Operation above 60 Hertz and 50°C play require thermal and interrupting derating of the circuit breaker. Refer to Selection and Application manual.

Note 2: Current limiting range, please refer to inset curve.

05.10

Electrical Depth: Panel Consolidation

This electrical depth will consider the existing electrical distribution system, and attempt to consolidate existing panelboards to decrease the cost of the electrical system. This will be done by reducing spare slots and combining panelboards when possible. Only the panelboards fed from DP-3 will be considered for the panel consolidation, which includes panelboards BLA, GLA, GLB, GLC, 2LA, 2LB, and 2LC. These components are shown in the following portion of the existing single line diagram:



Existing Panelboard Summary Chart

Panelboard	Voltage	# Circuits	# Spare Circ.	Size	Location
BLA	**208/120V**	**84**	**29**	**200 A, 3P, 4W**	**008**
GLA	208/120V	42	2	100 A, 3P, 4W	147B
GLB	208/120V	42	3	100 A, 3P, 4W	103
GLC	208/120V	42	8	100 A, 3P, 4W	159
2LA	**208/120V**	**42**	**13**	**100 A, 3P, 4W**	**215**
2LB	**208/120V**	**42**	**20**	**100 A, 3P, 4W**	**211**
2LC	**208/120V**	**42**	**10**	**100 A, 3P, 4W**	**232**

Consolidation attempts will be focused on panelboards with the largest number of spares, and will consider building location to minimize the length of conductor that must be run to the panelboards. DP-3 is mainly used to distribute electrical power to Lower, Ground, and Upper floor receptacles but also serve some mechanical equipment. The basement panelboard is located in the middle of the building. This differs from the ground and upper floor panelboards because they are located in the three wings surrounding the center of the building. The new panelboard design will keep the existing ground floor panelboards (GLA, GLB, and GLC) unchanged because of the low number of spare circuits and larger distance between the three panelboards and the distribution panel. The second floor will be the focus on the ground floor panelboard, and the three upper floor panelboards. The upper floor only contains two wings, so distance between the panelboards and loads are shorter.

Existing Panelboard Schedules

BLA

PANELBOARD SCHEDULE

PANEL: BLA LOCATION: 008 MOUNTING: SURFACE

SERVICE 208/120 VOLTS, 3 PHASE, 4 WIRE, 60 HZ

MAINS 200 AMPS, X LUGS, ---- CCT. BKR.

FED FROM DP-3 FULL CAPACITY, NEUTRAL, SEPARATE GROUNDING BUS

LOAD	DESCRIPTION	CCT. BKR.	CCT. NO.	CCT. NO.	CCT. BKR.	DESCRIPTION	LOAD
R-600	RM 30	20/1	1	2	20/1	RM 28	R-400
R-600	RM 30	20/1	3	4	20/1	RM 28	R-400
R-1400	CORR. 13,31	20/1	5	6	20/1	RM 28	R-400
R-800	RM 23	20/1	7	8	20/1	RM 28	R-400
R-400	RM 23	20/1	9	10	20/1	RM 7,8	R-600
R-400	RM 24	20/1	11	12	20/1	RM 9	R-600
R-400	RM 24 WM.	20/1	13	14	20/1	RM 10	R-800
R-400	RM 24 WM.	20/1	15	16	20/1	COOR. 13	R-400
R-400	RM 24 WM.	20/1	17	18	20/1	RM 3,4,5	R-800
R-400	RM 24 WM.	20/1	19	20	20/1	RM 1	R-1000
R-400	RM 24 WM.	20/1	21	22	20/1	RM 1, STAIR 2	R-600
R-400	RM 24 WM.	20/1	23	24	20/1	RM 1	R-800
R-400	RM 24 WM.	20/1	25	26	20/1	RM 12	R-200
R-1000	RM 014 VENDING	20/1	27	28	20/1	ELEV. PIT	R-400
R-1000	RM 014 VENDING	20/1	29	30	20/1	ELEV. PIT SUMP	R-600
R-1000	RM 014 VENDING	20/1	31	32	20/1	ROOM 14 TV	R-200
R-1000	RM 014 VENDING	20/1	33	34	20/1	RM 20	R-800
R-1000	RM 014 VENDING	20/1	35	36	20/1	RM 21	R-800
R-1000	RM 014 REF.	20/1	37	38	20/1	RM 14	R-200
R-1000	RM 014 REF.	20/1	39	40	20/1	RM 14	R-800
R-200	RM 014	20/1	41	42	20/1	SPARE	F-1000
M-400	POLE SEC. CAMERA	20/1	43	44	20/1	RM 24	R-400
M-400	POLE SEC. CAMERA	20/1	45	46	20/1	RM 24	R-400
M-400	POLE SEC. CAMERA	20/1	47	48	20/1	ROOM 23 TV	R-200
F-1000	SPARE	20/1	49	50	20/1	ROOM 24 TV	R-200
M-600	LAVATORY CONNECTIONS	20/1	51	52	20/1	RM 14 DISHWASHER	R-1000
M-200	LAVATORY CONNECTIONS	20/1	53	54	20/1	SPARE	F-1000
M-1656	GARBAGE DISPOSAL	20/1	55	56	20/1	SPARE	F-1000
M-1656	GARBAGE DISPOSAL	20/1	57	58	20/1	SPARE	F-1000
F-1000	SPARE	20/1	59	60	20/1	SPARE	F-1000
F-1000	SPARE	20/1	61	62	20/1	SPARE	F-1000
F-1000	SPARE	20/1	63	64	20/1	SPARE	F-1000
F-1000	SPARE	20/1	65	66	20/1	SPARE	F-1000
F-1000	SPARE	20/1	67	68	20/1	SPARE	F-1000
F-1000	SPARE	20/1	69	70	20/1	SPARE	F-1000
F-1000	SPARE	20/1	71	72	20/1	SPARE	F-1000
F-1000	SPARE	20/1	73	74	20/1	SPARE	F-1000
F-1000	SPARE	20/1	75	76	20/1	SPARE	F-1000
F-1000	SPARE	20/1	77	78	20/1	SPARE	F-1000
F-1000	SPARE	20/1	79	80	20/1	SPARE	F-1000
F-1000	SPARE	20/1	81	82	20/1	SPARE	F-1000
F-1000	SPARE	20/1	83	84	20/1	SPARE	F-1000

REMARKS:

1. ALL NEW CIRCUIT BREAKERS TO BE 22,000 AIC FOR 208V SYSTEMS UNLESS OTHERWISE NOTED.

LOAD LEGEND

R - RECEPTACLES
L - LIGHTING
P - PLUMBING
H - HVAC
K - KITCHEN
M - MISCELLANEOUS
F - FUTURE
PREFIX "x" INDICATES EXISTING LOAD

GLA

PANELBOARD SCHEDULE

PANEL: GLA LOCATION: 147B MOUNTING: SURFACE

SERVICE 208/120 VOLTS, 3 PHASE, 4 WIRE, 60 HZ

MAINS 100 AMPS, X LUGS, ---- CCT. BKR.

FED FROM DP-3 FULL CAPACITY, NEUTRAL, SEPARATE GROUNDING BUS

LOAD	DESCRIPTION	CCT. BKR.	CCT. NO.		CCT. NO.	CCT. BKR.	DESCRIPTION	LOAD
R-400	RM 130	20/1	1		2	20/1	RM 129	R-800
R-600	RM 130	20/1	3		4	20/1	RM 125	R-600
R-400	RM 131	20/1	5		6	20/1	RM 125	R-800
R-600	RM 131	20/1	7		8	20/1	CORR. 143	R-600
R-600	RM 144	20/1	9		10	20/1	RM 132	R-400
R-600	RM 128	20/1	11		12	20/1	RM 132	R-600
R-600	RM 126	20/1	13		14	20/1	RM 138	R-800
R-400	RM 126	20/1	15		16	20/1	RM 136	R-400
R-1200	RM 133	20/1	17		18	20/1	RM 139	R-800
R-1200	RM 133	20/1	19		20	20/1	RM 136	R-600
R-600	CORR. 145, RM 135, 134	20/1	21		22	20/1	RM 136	R-600
R-600	RM 123	20/1	23		24	20/1	RM 133	R-600
R-400	RM 123	20/1	25		26	20/1	RM 133	R-200
R-600	RM 124	20/1	27		28	20/1	CORR. 147	R-800
R-600	RM 124	20/1	29		30	20/1	RM 134 LAV. CONN.	M-200
R-200	ROOM 104 TV	20/1	31		32	20/1	ATTIC	R-600
M-200	EXTERIOR CAMERA	20/1	33		34	20/1	CORR 146, 147 CAMERAS	M-200
R-400	RM 122	20/1	35		36	20/1	RM 137	R-600
R-800	RM 122	20/1	37		38	20/1	WP/GFI EXT.	R-600
M-200	RM. 122A LAV. CONN.	20/1	39		40	20/1	SPARE	F-1000
R-200	RM 123 TV	20/1	41		42	20/1	SPARE	F-1000

REMARKS:

1. ALL NEW CIRCUIT BREAKERS TO BE 22,000 AIC FOR 208V SYSTEMS UNLESS OTHERWISE NOTED.

LOAD LEGEND:

R - RECEPTACLES
L - LIGHTING
P - PLUMBING
H - HVAC
K - KITCHEN
M - MISCELLANEOUS
F - FUTURE
PREFIX "x" INDICATES EXISTING LOAD

GLB

PANELBOARD SCHEDULE

PANEL: GLB LOCATION: 103 MOUNTING: SURFACE

SERVICE 208/120 VOLTS, 3 PHASE, 4 WIRE, 60 HZ

MAINS 100 AMPS, X LUGS, ---- CCT. BKR.

FED FROM DP-3 FULL CAPACITY, NEUTRAL, SEPARATE GROUNDING BUS

LOAD	DESCRIPTION	CCT. BKR.	CCT. NO.		CCT. NO.	CCT. BKR.	DESCRIPTION	LOAD
R-1000	LOBBY 101	20/1	1		2	20/1	RM 106	R-800
R-600	RM 104	20/1	3		4	20/1	RM 102	R-1000
R-600	RM 104	20/1	5		6	20/1	RM 102	R-1000
R-800	RM 105	20/1	7		8	20/1	RM 102	R-800
R-800	RM 105	20/1	9		10	20/1	RM 102	R-600
R-200	RM 105	20/1	11		12	20/1	RM 102	R-800
R-1000	RM 105	20/1	13		14	20/1	CAM/TV RM 102	R-400
R-400	RM 102	20/1	15		16	20/1	MICROPHONE POWER	M-200
R-400	RM 102 FODIUM	20/1	17		18	20/1	ROOM 108	R-400
R-1000	WP/GFI EXT.	20/1	19		20	20/1	RM 102 BULKHEAD RPC	R-400
R-1000	RM 108	20/1	21		22	20/1	SPARE	F-1000
R-400	RM 108/109	20/1	23		24	20/1	LOBBY CAM	R-200
R-600	MOTORIZED SHADE	20/1	25		26	20/1	LOBBY TV	R-200
R-300	MOTORIZED SHADE	20/1	27		28	20/1	LOBBY DESK	R-800
R-400	ROOM 108	20/1	29		30	20/1	ROOM 108	R-400
R-400	CLG CAM RM 102	20/1	31		32	20/1	CAM/TV RM 102	R-400
R-1200	RM 104 COPY	20/1	33		34	20/1	STAIRWELL 107 CAMERA	M-200
R-400	ROOM 108	20/1	35		36	20/1	SPARE	F-1000
F-1000	SPARE	20/1	37		38	20/1	RM 102 TV/CAM	R-400
R-200	RM 104	20/1	39		40	20/1	RM 104	R-200
R-200	RM 106	20/1	41		42	20/1	SPARE	F-1000

REMARKS:

1. ALL NEW CIRCUIT BREAKERS TO BE 22,000 AIC FOR 208V SYSTEMS UNLESS OTHERWISE NOTED.

LOAD LEGEND:

R - RECEPTACLES
L - LIGHTING
P - PLUMBING
H - HVAC
K - KITCHEN
M - MISCELLANEOUS
F - FUTURE
PREFIX "x" INDICATES EXISTING LOAD

GLC

PANELBOARD SCHEDULE

PANEL: GLC LOCATION: 159 MOUNTING: SURFACE

SERVICE 208/120 VOLTS, 3 PHASE, 4 WIRE, 60 HZ

MAINS 100 AMPS, X LUGS, ---- CCT. BKR.

FED FROM DP-3 FULL CAPACITY, NEUTRAL, SEPARATE GROUNDING BUS

LOAD	DESCRIPTION	CCT. BKR.	CCT. NO.		CCT. NO.	CCT. BKR.	DESCRIPTION	LOAD
R-600	RM 157	20/1	1		2	20/1	RM 152	R-1000
R-800	RM 157	20/1	3		4	20/1	RM 151	R-600
R-600	RM 157	20/1	5		6	20/1	RM 151	R-800
R-400	RM 157	20/1	7		8	20/1	RM 151	R-800
R-800	RM 158	20/1	9		10	20/1	RM 156	R-1000
R-600	RM 157	20/1	11		12	20/1	RM 155	R-800
R-600	RM 157	20/1	13		14	20/1	RM 155	R-600
R-800	RM 153	20/1	15		16	20/1	RM 155	R-600
R-600	RM 153	20/1	17		18	20/1	RM 155	R-600
R-600	RM 153	20/1	19		20	20/1	RM 155	R-600
R-800	RM 154	20/1	21		22	20/1	RM 150/LOBBY	R-1000
R-200	LOBBY CAMERA	20/1	23		24	20/1	RM 155	R-400
R-400	RM 157	20/1	25		26	20/1	RM 151	R-400
R-800	NW EXTERIOR	20/1	27		28	20/1	SPARE	M-1000
R-200	RM 155	20/1	29		30	20/1	STAIRWELL 160 CAMERA	M-200
R-200	RM 155	20/1	31		32	20/1	SPARE	F-1000
R-200	RM 153	20/1	33		34	20/1	SPARE	F-1000
R-200	RM 153	20/1	35		36	20/1	SPARE	F-1000
R-200	RM 157	20/1	37		38	20/1	SPARE	F-1000
R-200	RM 157	20/1	39		40	20/1	SPARE	F-1000
F-1000	SPARE	20/1	41		42	20/1	SPARE	F-1000

REMARKS:

1. ALL NEW CIRCUIT BREAKERS TO BE 22,000 AIC FOR 208V SYSTEMS UNLESS OTHERWISE NOTED.

LOAD LEGEND:

R - RECEPTACLES
L - LIGHTING
P - PLUMBING
H - HVAC
K - KITCHEN
M - MISCELLANEOUS
F - FUTURE
PREFIX "x" INDICATES EXISTING LOAD

2LA

PANELBOARD SCHEDULE

PANEL: 2LA LOCATION: 215 MOUNTING: SURFACE

SERVICE 208/120 VOLTS, 3 PHASE, 4 WIRE, 60 HZ

MAINS 100 AMPS, X LUGS, ---- CCT. BKR.

FED FROM DP-3 FULL CAPACITY, NEUTRAL, SEPARATE GROUNDING BUS

LOAD	DESCRIPTION	CCT. BKR.	CCT. NO.		CCT. NO.	CCT. BKR.	DESCRIPTION	LOAD
R-800	RM 221,222,LOBBY 200	20/1	1		2	20/1	RM 213/214	R-600
R-1000	RM 218 COPY	20/1	3		4	20/1	RM 213 COPY	R-1000
R-200	RM 218	20/1	5		6	20/1	RM 213	R-200
R-200	RM 218	20/1	7		8	20/1	RM 212	R-800
R-200	RM 218 COPIER	20/1	9		10	20/1	RM 213	R-800
R-200	RM 218	20/1	11		12	20/1	RM 213	R-600
M-800	RESTROOM 222 LAV. CONN.	20/1	13		14	20/1	RM 213	R-400
M-800	RESTROOM 221 LAV. CONN.	20/1	15		16	20/1	RM 213	R-400
R-1000	EWC	20/1	17		18	20/1	RM 213, ATTIC	R-400
R-1000	EWC	20/1	19		20	20/1	RESTROOM 214 LAV. CONN.	M-200
M-2400	RR 222 HD	30/1	21		22	20/1	RM 215	R-400
M-2400	RR 221 HD	30/1	23		24	20/1	RM 215	R-400
F-1000	SPARE	20/1	25		26	20/1	RM 215	R-400
F-1000	SPARE	20/1	27		28	20/1	RM 215	R-400
F-1000	SPARE	20/1	29		30	20/1	-	R-600
F-1000	SPARE	20/1	31		32	20/1	RM 216 REF, ATTIC	R-1000
F-1000	SPARE	20/1	33		34	20/1	RM 213	R-200
F-1000	SPARE	20/1	35		36	20/1	SPARE	F-1000
F-1000	SPARE	20/1	37		38	20/1	SPARE	F-1000
F-1000	SPARE	20/1	39		40	20/1	SPARE	F-1000
F-1000	SPARE	20/1	41		42	20/1	SPARE	F-1000

REMARKS:

1. ALL NEW CIRCUIT BREAKERS TO BE 22,000 AIC FOR 208V SYSTEMS UNLESS OTHERWISE NOTED.

LOAD LEGEND:

R - RECEPTACLES
L - LIGHTING
P - PLUMBING
H - HVAC
K - KITCHEN
M - MISCELLANEOUS
F - FUTURE
PREFIX "x" INDICATES EXISTING LOAD

2LB

PANELBOARD SCHEDULE

PANEL: 2LB LOCATION: 211 MOUNTING: SURFACE

SERVICE 208/120 VOLTS, 3 PHASE, 4 WIRE, 60 HZ

MAINS 100 AMPS, X LUGS, ---- CCT. BKR.

FED FROM DP-3 FULL CAPACITY, NEUTRAL, SEPARATE GROUNDING BUS

LOAD	DESCRIPTION	CCT. BKR.	CCT. NO.		CCT. NO.	CCT. BKR.	DESCRIPTION	LOAD
R-600	RM 208	20/1	1		2	20/1	RM 206	R-600
R-600	RM 208	20/1	3		4	20/1	RM 206	R-600
R-600	RM 209	20/1	5		6	20/1	RM 206	R-600
R-600	RM 209	20/1	7		8	20/1	RM 206	R-200
R-600	RM 203	20/1	9		10	20/1	RM 206/207	R-600
R-400	RM 203	20/1	11		12	20/1	RM 207	R-600
R-200	LOBBY CAMERA	20/1	13		14	20/1	CORR. 201	R-1000
R-800	RM 203	20/1	15		16	20/1	RM 206	R-800
R-800	RM 203	20/1	17		18	20/1	-	R-400
F-1000	SPARE	20/1	19		20	20/1	SPARE	F-1000
F-1000	SPARE	20/1	21		22	20/1	RM 209	R-200
F-1000	SPARE	20/1	23		24	20/1	RM 209	R-200
F-1000	ATTIC	20/1	25		26	20/1	SPARE	F-1000
F-1000	SPARE	20/1	27		28	20/1	SPARE	F-1000
F-1000	SPARE	20/1	29		30	20/1	SPARE	F-1000
F-1000	SPARE	20/1	31		32	20/1	SPARE	F-1000
F-1000	SPARE	20/1	33		34	20/1	SPARE	F-1000
F-1000	SPARE	20/1	35		36	20/1	SPARE	F-1000
F-1000	SPARE	20/1	37		38	20/1	SPARE	F-1000
F-1000	SPARE	20/1	39		40	20/1	SPARE	F-1000
F-1000	SPARE	20/1	41		42	20/1	SPARE	F-1000

REMARKS:

1. ALL NEW CIRCUIT BREAKERS TO BE 22,000 AIC FOR 208V SYSTEMS UNLESS OTHERWISE NOTED.

LOAD LEGEND:

R - RECEPTACLES
L - LIGHTING
P - PLUMBING
H - HVAC
K - KITCHEN
M - MISCELLANEOUS
F - FUTURE
PREFIX "x" INDICATES EXISTING LOAD

2LC

PANELBOARD SCHEDULE

PANEL: 2LC LOCATION: 232 MOUNTING: SURFACE

SERVICE 208/120 VOLTS, 3 PHASE, 4 WIRE, 60 HZ

MAINS 100 AMPS, X LUGS, ---- CCT. BKR.

FED FROM DP-3 FULL CAPACITY, NEUTRAL, SEPARATE GROUNDING BUS

LOAD	DESCRIPTION	CCT. BKR.	CCT. NO.		CCT. NO.	CCT. BKR.	DESCRIPTION	LOAD
R-800	RM 228	20/1	1		2	20/1	RM 229	R-200
R-400	RM 228	20/1	3		4	20/1	RM 229	R-200
R-800	RM 224	20/1	5		6	20/1	RM 229	R-200
R-800	RM 224	20/1	7		8	20/1	RM 229	R-200
R-1000	RM 224	20/1	9		10	20/1	RM 225	R-800
R-800	RM 224	20/1	11		12	20/1	RM 224	R-400
R-600	RM 224	20/1	13		14	20/1	RM 224	R-800
R-600	RM 224	20/1	15		16	20/1	RM 224	R-800
R-400	RM 224	20/1	17		18	20/1	RM 224	R-800
R-800	RM 229,224,227	20/1	19		20	20/1	RM 224	R-600
R-400	RM 226	20/1	21		22	20/1	RM 224	R-400
R-600	RM 226	20/1	23		24	20/1	RM 229 MW.	R-1000
R-400	-	20/1	25		26	20/1	GARBAGE DISPOSAL	M-1656
F-1000	SPARE	20/1	27		28	20/1	RM 229 DISHWASHER	R-1000
F-1000	SPARE	20/1	29		30	20/1	LOBBY CAMERA, ATTIC	M-200
F-1000	SPARE	20/1	31		32	20/1	SPARE	F-1000
F-1000	SPARE	20/1	33		34	20/1	RM 228	R-200
F-1000	SPARE	20/1	35		36	20/1	RM 224	R-400
F-1000	SPARE	20/1	37		38	20/1	ROOM 224	R-400
F-1000	SPARE	20/1	39		40	20/1	SPARE	F-1000
F-1000	SPARE	20/1	41		42	20/1	SPARE	F-1000

REMARKS:

1. ALL NEW CIRCUIT BREAKERS TO BE 22,000 AIC FOR 208V SYSTEMS UNLESS OTHERWISE NOTED.

LOAD LEGEND:

R - RECEPTACLES
L - LIGHTING
P - PLUMBING
H - HVAC
K - KITCHEN
M - MISCELLANEOUS
F - FUTURE
PREFIX "x" INDICATES EXISTING LOAD

New Panelboard Layout and Design

An attempt was made to reduce panelboard BLA to a smaller size, with 42 circuits; however the loads on the panelboard are too high to provide extra space for future expansion. The location of this PB will remain the same due to the existing central location on the ground floor. The new design will lower the amount of panelboards serving upper floor receptacles to 2 by eliminating panelboard 2LB and dispersing the loads it served to the remaining two panelboards, 2LA and 2LC. The location of panelboards 2LA and 2LC will be changed to decrease distance from the panelboards to the loads.

Panelboard	Voltage	# Circuits	# Spare Circ.	Size	Location
BLA	208/120V	84	29	200 A, 3P, 4W	008
GLA	208/120V	42	2	100 A, 3P, 4W	147B
GLB	208/120V	42	3	100 A, 3P, 4W	103
GLC	208/120V	42	8	100 A, 3P, 4W	159
2LA	208/120V	42	**6**	**125 A, 3P, 4W**	**208**
2LC	208/120V	42	**4**	**125 A, 3P, 4W**	**228**

2LA: Worksheet and Schedule

PANELBOARD SIZING WORKSHEET

Panel Tag---------->				2LA	Panel Location:			208			
Nominal Phase to Neutral Voltage-------->				120	Phase:			3			
Nominal Phase to Phase Voltage--------->				208	Wires:			4			
Pos	Ph.	Load Type	Cat.	Location	Load	Units	l. PF	Watts	VA	Remarks	
1	A	Rec.		221 222 200	800	w		800	1000		
2	A	Rec.		213, 214	600	w		600	750		
3	B	Rec.		218	1000	w		1000	1250		
4	B	Rec.		213	1000	w		1000	1250		
5	C	Rec.		218	200	w		200	250		
6	C	Rec.		213	200	w		200	250		
7	A	Rec.		218	200	w		200	250		
8	A	Rec.		212	800	w		800	1000		
9	B	Rec.		218	200	w		200	250		
10	B	Rec.		213	800	w		800	1000		
11	C	Rec.		218	200	w		200	250		
12	C	Rec.		213	600	w		600	750		
13	A	Mech.		222	800	w		800	1000		
14	A	Rec.		213	400	w		400	500		
15	B	Mech.		221	800	w		800	1000		
16	B	Rec.		213	400	w		400	500		
17	C	Rec.		ewc	1000	w		1000	1250		
18	C	Rec.		213, attic	400	w		400	500		
19	A	Rec.		ewc	1000	w		1000	1250		
20	A	Mech.		214	200	w		200	250		
21	B	Mech.		222	2400	w		2400	3000		
22	B	Rec.		215	400	w		400	500		
23	C	Mech.		221	2400	w		2400	3000		
24	C	Rec.		215	400	w		400	500		
25	A	Future		Spare	1000	w		1000	1250		
26	A	Rec.		215	400	w		400	500		
27	B	Future		Spare	1000	w		1000	1250		
28	B	Rec.		215	400	w		400	500		
29	C	2LB - Rec.		208	1200	w		1200	1500		
30	C	Rec.		n/a	600	w		600	750		
31	A	2LB - Rec.		206	1200	w		1200	1500		
32	A	Rec.		216, attic	1000	w		1000	1250		
33	B	2LB - Rec.		209	1200	w		1200	1500		
34	B	Rec.		213	200	w		200	250		
35	C	2LB - Rec.		N/a	400	w		400	500		
36	C	2LB - Rec.		209		w		0	0		
37	A					w		0	0		
38	A					w		0	0		
39	B					w		0	0		
40	B					w		0	0		
41	C					w		0	0		
42	C					w		0	0		
PANEL TOTAL								25.8	32.3	Amps=	89.6

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					8.4	10.5	33%	87.5
PHASE TOTAL	B					9.8	12.3	38%	102.1
PHASE TOTAL	C					7.6	9.5	29%	79.2

LOAD CATAGORIES			Connected			Demand				Ver. 1.04
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0		0.0	0.0			
2	computers		0.0	0.0		0.0	0.0			
3	fluorescent lighting		0.0	0.0		0.0	0.0			
4	HID lighting		0.0	0.0		0.0	0.0			
5	incandescent lighting		0.0	0.0		0.0	0.0			
6	HVAC fans		0.0	0.0		0.0	0.0			
7	heating		0.0	0.0		0.0	0.0			
8	kitchen equipment		0.0	0.0		0.0	0.0			
9	unassigned		25.8	32.3		25.8	32.3	0.80		
Total Demand Loads						25.8	32.3			
Spare Capacity			20%			5.2	6.5			
Total Design Loads						31.0	38.7	0.80	Amps=	107.5

Default Power Factor =	0.80
Default Demand Factor =	100 %

PANELBOARD SCHEDULE

VOLTAGE:	408Y/277V,3PH,4W	PANEL TAG:	2LA	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	125A	PANEL LOCATION:	208	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	125A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Rec.	221 222 200	800	20A/1P	1	*			2	20A/1P	600	213, 214	Rec.
Rec.	218	1000	20A/1P	3		*		4	20A/1P	1000	213	Rec.
Rec.	218	200	20A/1P	5			*	6	20A/1P	200	213	Rec.
Rec.	218	200	20A/1P	7	*			8	20A/1P	800	212	Rec.
Rec.	218	200	20A/1P	9		*		10	20A/1P	800	213	Rec.
Rec.	218	200	20A/1P	11			*	12	20A/1P	600	213	Rec.
Mech.	222	800	20A/1P	13	*			14	20A/1P	400	213	Rec.
Mech.	221	800	20A/1P	15		*		16	20A/1P	400	213	Rec.
Rec.	ewc	1000	20A/1P	17			*	18	20A/1P	400	213, attic	Rec.
Rec.	ewc	1000	20A/1P	19	*			20	20A/1P	200	214	Mech.
Mech.	222	2400	20A/1P	21		*		22	20A/1P	400	215	Rec.
Mech.	221	2400	20A/1P	23			*	24	20A/1P	400	215	Rec.
Future	Spare	1000	20A/1P	25	*			26	20A/1P	400	215	Rec.
Future	Spare	1000	20A/1P	27		*		28	20A/1P	400	215	Rec.
2LB - Rec.	208	1200	20A/1P	29			*	30	20A/1P	600	n/a	Rec.
2LB - Rec.	206	1200	20A/1P	31	*			32	20A/1P	1000	216, attic	Rec.
2LB - Rec.	209	1200	20A/1P	33		*		34	20A/1P	200	213	Rec.
2LB - Rec.	N/a	400	20A/1P	35			*	36	20A/1P	0	209	2LB - Rec.
0	0	0	20A/1P	37	*			38	20A/1P	0	0	0
0	0	0	20A/1P	39		*		40	20A/1P	0	0	0
0	0	0	20A/1P	41			*	42	20A/1P	0	0	0

CONNECTED LOAD (KW) - A Ph.	8.40	TOTAL DESIGN LOAD (KW)	30.96
CONNECTED LOAD (KW) - B Ph.	9.80	POWER FACTOR	0.80
CONNECTED LOAD (KW) - C Ph.	7.60	TOTAL DESIGN LOAD (AMPS)	108

2LC: Worksheet and Schedule

PANELBOARD SIZING WORKSHEET

Panel Tag---------->				2LC	Panel Location:			228			
Nominal Phase to Neutral Voltage-------->				120	Phase:			3			
Nominal Phase to Phase Voltage-------->				208	Wires:			4			
Pos	Ph.	Load Type	Cat.	Location	Load	Units	L PF	Watts	VA	Remarks	
1	A	Rec.		228	800	w		800	1000		
2	A	Rec.		229	200	w		200	250		
3	B	Rec.		228	400	w		400	500		
4	B	Rec.		229	200	w		200	250		
5	C	Rec.		224	800	w		800	1000		
6	C	Rec.		229	200	w		200	250		
7	A	Rec.		224	800	w		800	1000		
8	A	Rec.		229	200	w		200	250		
9	B	Rec.		224	1000	w		1000	1250		
10	B	Rec.		225	800	w		800	1000		
11	C	Rec.		224	800	w		800	1000		
12	C	Rec.		224	400	w		400	500		
13	A	Rec.		224	600	w		600	750		
14	A	Rec.		224	800	w		800	1000		
15	B	Rec.		224	600	w		600	750		
16	B	Rec.		224	800	w		800	1000		
17	C	Rec.		224	400	w		400	500		
18	C	Rec.		224	800	w		800	1000		
19	A	Rec.		229, 224, 22	800	w		800	1000		
20	A	Rec.		224	600	w		600	750		
21	B	Rec.		226	400	w		400	500		
22	B	Rec.		224	400	w		400	500		
23	C	Rec.		226	600	w		600	750		
24	C	Rec.		229	1000	w		1000	1250		
25	A	Rec.		n/a	400	w		400	500		
26	A	Mech.		arbage disp	1658	w		1658	2073		
27	B	2LB - Rec.		203	1000	w		1000	1250		
28	B	Rec.		229	1000	w		1000	1250		
29	C	2LB - Rec.		203	1600	w		1600	2000		
30	C	Mech.		lobby, attic	200	w		200	250		
31	A	2LB - Rec.		Lobby camer	200	w		200	250		
32	A	2LB - Rec.		201	1000	w		1000	1250		
33	B	2LB - Rec.		206/207	1200	w		1200	1500		
34	B	Rec.		228	200	w		200	250		
35	C	2LB - Rec.		206	1200	w		1200	1500		
36	C	Rec.		224	400	w		400	500		
37	A	2LB - Rec.		206	800	w		800	1000		
38	A	Rec.		224	400	w		400	500		
39	B					w		0	0		
40	B					w		0	0		
41	C					w		0	0		
42	C					w		0	0		
PANEL TOTAL								25.7	32.1	Amps=	89.1

PHASE LOADING						kW	kVA	%	Amps
PHASE TOTAL	A					9.3	11.6	36%	96.4
PHASE TOTAL	B					8.0	10.0	31%	83.3
PHASE TOTAL	C					8.4	10.5	33%	87.5

LOAD CATAGORIES			Connected			Demand				Ver. 1.04
			kW	kVA	DF	kW	kVA	PF		
1	receptacles		0.0	0.0		0.0	0.0			
2	computers		0.0	0.0		0.0	0.0			
3	fluorescent lighting		0.0	0.0		0.0	0.0			
4	HID lighting		0.0	0.0		0.0	0.0			
5	incandescent lighting		0.0	0.0		0.0	0.0			
6	HVAC fans		0.0	0.0		0.0	0.0			
7	heating		0.0	0.0		0.0	0.0			
8	kitchen equipment		0.0	0.0		0.0	0.0			
9	unassigned		25.7	32.1		25.7	32.1	0.80		
Total Demand Loads						25.7	32.1			
Spare Capacity			20%			5.1	6.4			
Total Design Loads						30.8	38.5	0.80	Amps=	106.9

Default Power Factor =	0.80
Default Demand Factor =	100 %

PANELBOARD SCHEDULE

VOLTAGE:	208Y/277V,3PH,4W	PANEL TAG:	2LC	MIN. C/B AIC:	10K
SIZE/TYPE BUS:	125A	PANEL LOCATION:	228	OPTIONS:	PROVIDE FEED THROUGH LUGS
SIZE/TYPE MAIN:	125A/3P C/B	PANEL MOUNTING:	SURFACE		FOR PANELBOARD 1L1B

DESCRIPTION	LOCATION	LOAD (WATTS)	C/B SIZE	POS. NO.	A	B	C	POS. NO.	C/B SIZE	LOAD (WATTS)	LOCATION	DESCRIPTION
Rec.	228	800	20A/1P	1	*			2	20A/1P	200	229	Rec.
Rec.	228	400	20A/1P	3		*		4	20A/1P	200	229	Rec.
Rec.	224	800	20A/1P	5			*	6	20A/1P	200	229	Rec.
Rec.	224	800	20A/1P	7	*			8	20A/1P	200	229	Rec.
Rec.	224	1000	20A/1P	9		*		10	20A/1P	800	225	Rec.
Rec.	224	800	20A/1P	11			*	12	20A/1P	400	224	Rec.
Rec.	224	600	20A/1P	13	*			14	20A/1P	800	224	Rec.
Rec.	224	600	20A/1P	15		*		16	20A/1P	800	224	Rec.
Rec.	224	400	20A/1P	17			*	18	20A/1P	800	224	Rec.
Rec.	229, 224, 227	800	20A/1P	19	*			20	20A/1P	600	224	Rec.
Rec.	226	400	20A/1P	21		*		22	20A/1P	400	224	Rec.
Rec.	226	600	20A/1P	23			*	24	20A/1P	1000	229	Rec.
Rec.	n/a	400	20A/1P	25	*			26	20A/1P	1658	garbage disp.	Mech.
2LB - Rec.	203	1000	20A/1P	27		*		28	20A/1P	1000	229	Rec.
2LB - Rec.	203	1600	20A/1P	29			*	30	20A/1P	200	lobby, attic	Mech.
2LB - Rec.	Lobby camera	200	20A/1P	31	*			32	20A/1P	1000	201	2LB - Rec.
2LB - Rec.	206/207	1200	20A/1P	33		*		34	20A/1P	200	228	Rec.
2LB - Rec.	206	1200	20A/1P	35			*	36	20A/1P	400	224	Rec.
2LB - Rec.	206	800	20A/1P	37	*			38	20A/1P	400	224	Rec.
0	0	0	20A/1P	39		*		40	20A/1P	0	0	0
0	0	0	20A/1P	41			*	42	20A/1P	0	0	0

CONNECTED LOAD (KW) - A Ph.	9.26	TOTAL DESIGN LOAD (KW)	30.79
CONNECTED LOAD (KW) - B Ph.	8.00	POWER FACTOR	0.80
CONNECTED LOAD (KW) - C Ph.	8.40	TOTAL DESIGN LOAD (AMPS)	107

In conclusion, after consolidating the three upper floor panelboards into two panelboards, the size of the two remaining would need to be increased to 125 Amps to handle the existing loads with room for future expansion. The increase in size of the panelboards will result in an increased price of the equipment. When you consider this increased panelboard cost in addition to a slight increase in conductor length caused by relocation of the consolidated panelboards, the consolidation does not improve over the existing design. If the loads were slightly reduced on the consolidated panelboards, which is possible given further research into existing loads, the existing 100 A equipment could be kept which would result in savings.

This consolidation process can be performed for every distribution panel in the electrical system, and would surely result in decreased cost with less room for future expansion.

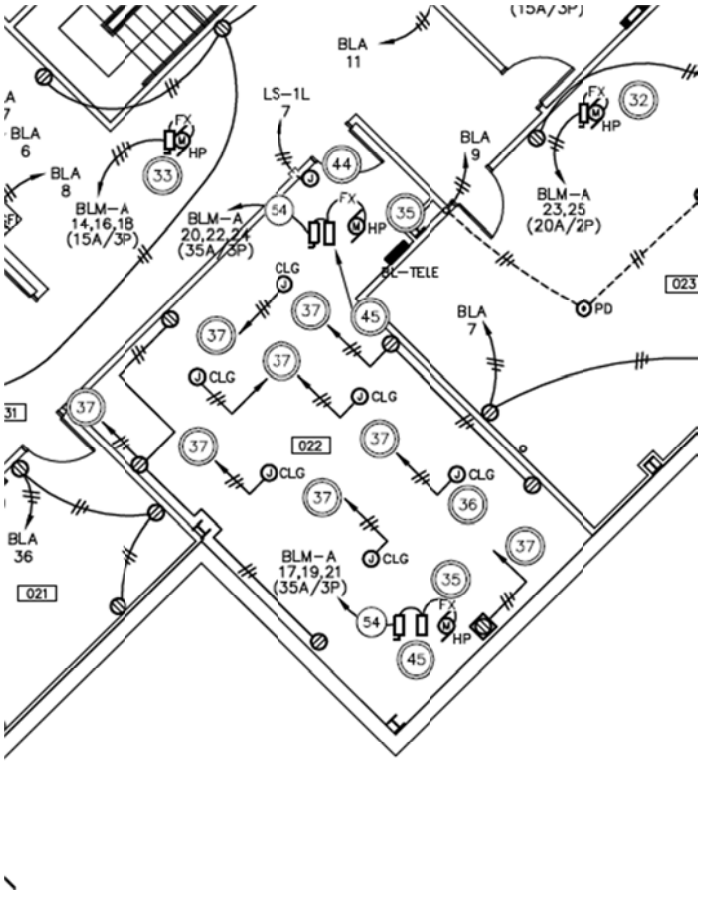
Electrical Depth: Addition of UPS System

Currently, the City of Green Administration Building does not employ an uninterruptible power supply system (UPS) to protect important computer systems and servers. Even though the entire building is supplied with emergency power via an on-site diesel generator, these computer systems would still be without electricity during the 30 second approximate startup time for the generator. This portion of the report will detail the addition of a UPS system to the electrical design, and include a wiring diagram, floor plan, and cost information.

UPS Design

The systems which will be connected to the UPS are a server room on the basement level and a server room on the first level. There are several computer labs, however these systems are not a priority and will not be connected to the UPS. The larger basement server room services the City of Green School District. This room is already circuited via its own Panelboard located in the room, making it a suitable location for the UPS system. The other server room will be serviced through this existing Panelboard and a new 8 circuit panel located in the other server room on the ground floor.

Basement Server Room Existing Floor Plan



Basement Server Room Existing Panelboard

PANELBOARD SCHEDULE

PANEL: BL–TEL LOCATION: 22 MOUNTING: SURFACE

SERVICE 208/120 VOLTS, 3 PHASE, 4 WIRE, 60 HZ

MAINS 200 AMPS, X LUGS, ---- CCT. BKR.

FED FROM DP–3 FULL CAPACITY, NEUTRAL, SEPARATE GROUNDING BUS

LOAD	DESCRIPTION	CCT. BKR.	CCT. NO.		CCT. NO.	CCT. BKR.	DESCRIPTION	LOAD
M–1000	TELECOM	20/1	1		2	20/1	TELECOM	M–1000
M–1000	TELECOM	20/1	3		4	20/1	TELECOM	M–1000
M–1000	TELECOM	20/1	5		6	20/1	TELECOM	M–1000
M–1000	TELECOM	20/1	7		8	20/1	TELECOM	M–1000
F–1000	SPARE	20/1	9		10	20/1	SPARE	F–1000
F–1000	SPARE	20/1	11		12	20/1	SPARE	F–1000
F–1000	SPARE	20/1	13		14	20/1	SPARE	F–1000
F–1000	SPARE	20/1	15		16	20/1	SPARE	F–1000
F–1000	SPARE	20/1	17		18	20/1	SPARE	F–1000
F–1000	SPARE	20/1	19		20	20/1	SPARE	F–1000
F–1000	SPARE	30/1	21		22	20/1	SPARE	F–1000
F–1000	SPARE	30/1	23		24	20/1	SPARE	F–1000
F–1000	SPARE	20/1	25		26	20/1	SPARE	F–1000
F–1000	SPARE	20/1	27		28	20/1	SPARE	F–1000
F–1000	SPARE	20/1	29		30	20/1	SPARE	F–1000
F–1000	SPARE	20/1	31		32	20/1	SPARE	F–1000
F–1000	SPARE	20/1	33		34	20/1	SPARE	F–1000
F–1000	SPARE	20/1	35		36	20/1	SPARE	F–1000
F–1000	SPARE	20/1	37		38	20/1	SPARE	F–1000
F–1000	SPARE	20/1	39		40	20/1	SPARE	F–1000
F–1000	SPARE	20/1	41		42	20/1	SPARE	F–1000

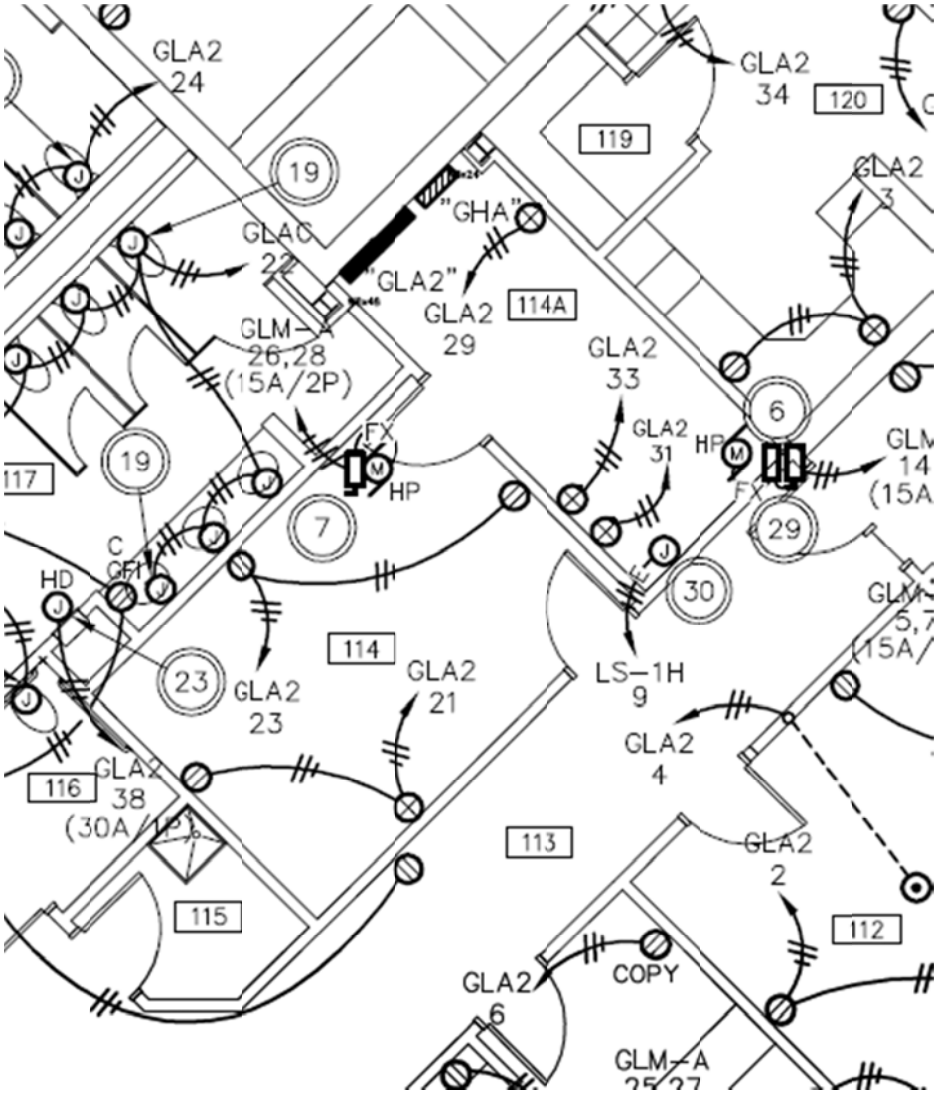
REMARKS:

1. ALL NEW CIRCUIT BREAKERS TO BE 22,000 AIC FOR 208V SYSTEMS UNLESS OTHERWISE NOTED.

LOAD LEGEND:

R – RECEPTACLES
L – LIGHTING
P – PLUMBING
H – HVAC
K – KITCHEN
M – MISCELLANEOUS
F – FUTURE
PREFIX "x" INDICATES EXISTING LOAD

Ground Floor Server Room Existing Floor Plan



Sizing the UPS System

The UPS system will be sized based on the estimated server load of 200 W/SF, as per the following calculation:

Area, Basement Server Room = 306.5 SF

Area, Ground Floor Server Room = 68.2 SF

Total Area = 374.7 SF

Estimated Total Electrical Load = (347.7 SF) * (200 W/SF) = 74,940 W = **74.94 kW**

Basement = 61.3 kW Ground Floor = 13.64 kW

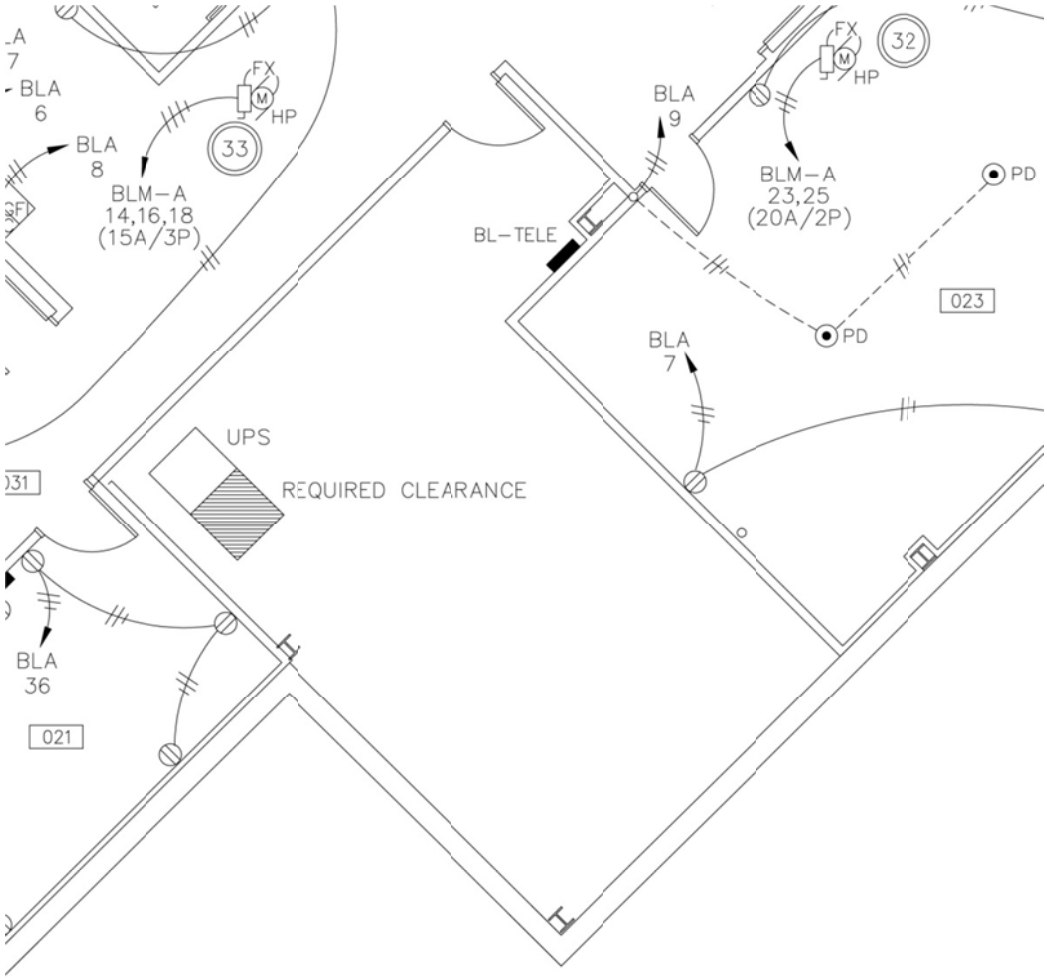
UPS Equipment Selection

The UPS system selected is the Eaton 9390, and is rated for 20 - 160 kVA. The specific model is rated for 120 kVA / 108 kW. The technical specifications for this model can be located in the appendix of this report. The physical dimensions of the system are 73.7" x 35.6" x 31.6" (H x W x D).

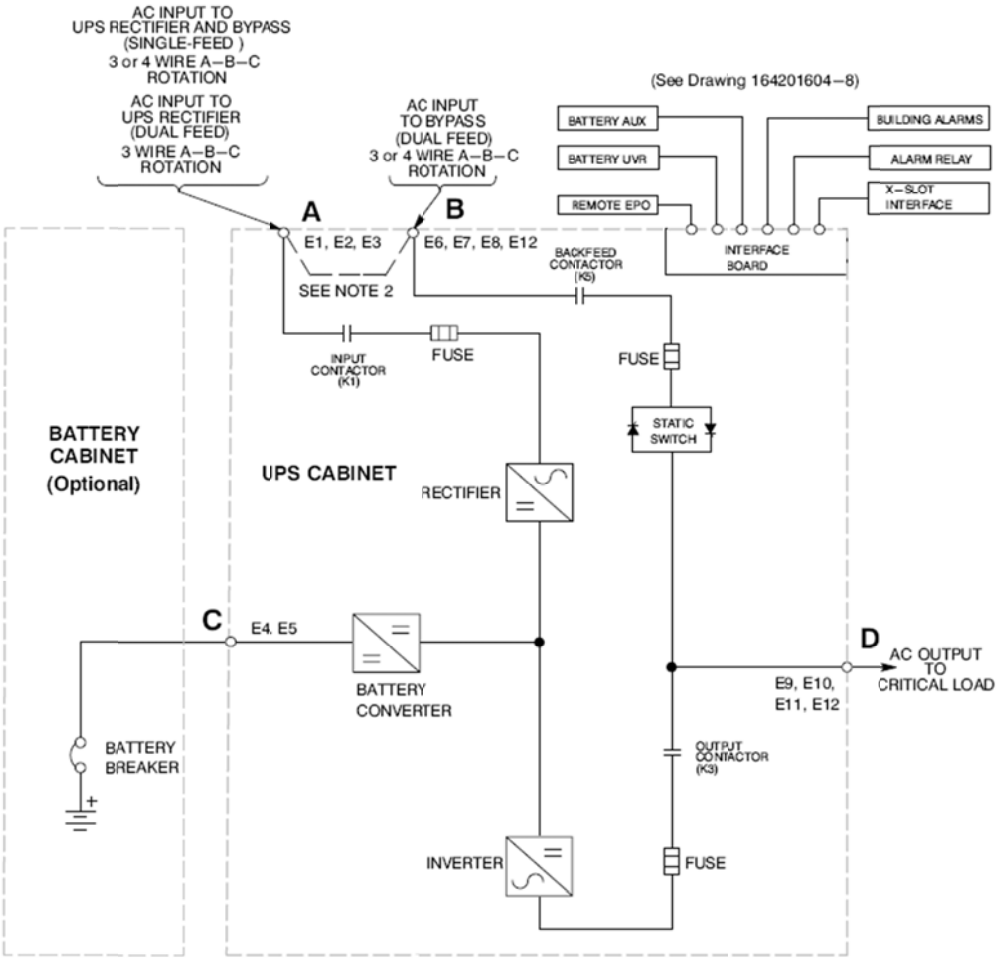
Location of UPS System

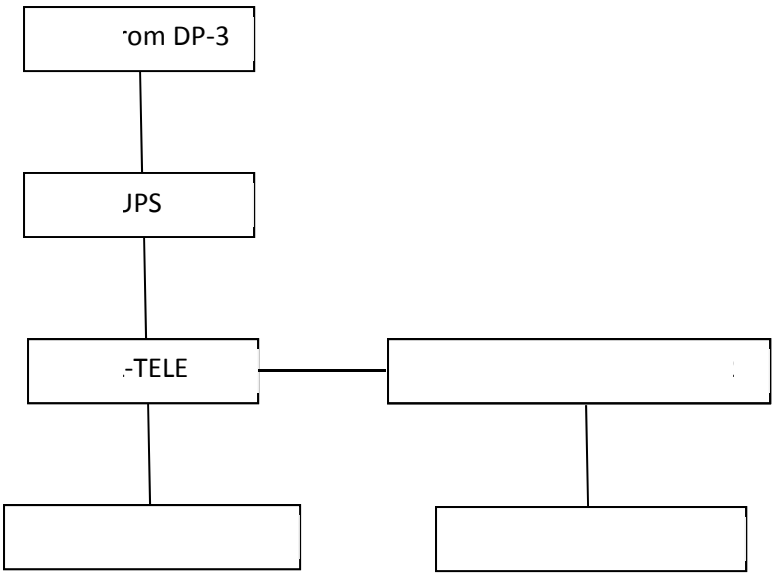
The location of the cabinet must meet the following clearance requirements:

Table B. UPS Cabinet Clearances	
From Top of Cabinet	Minimum clearance over the UPS cabinet is 457.2 mm (18 in.) for ventilation
From Front of Cabinet	914.4 mm (36 inches) working space
From Back of Cabinet	None required
From Right Side of Cabinet	None required
From Left Side of Cabinet	None required

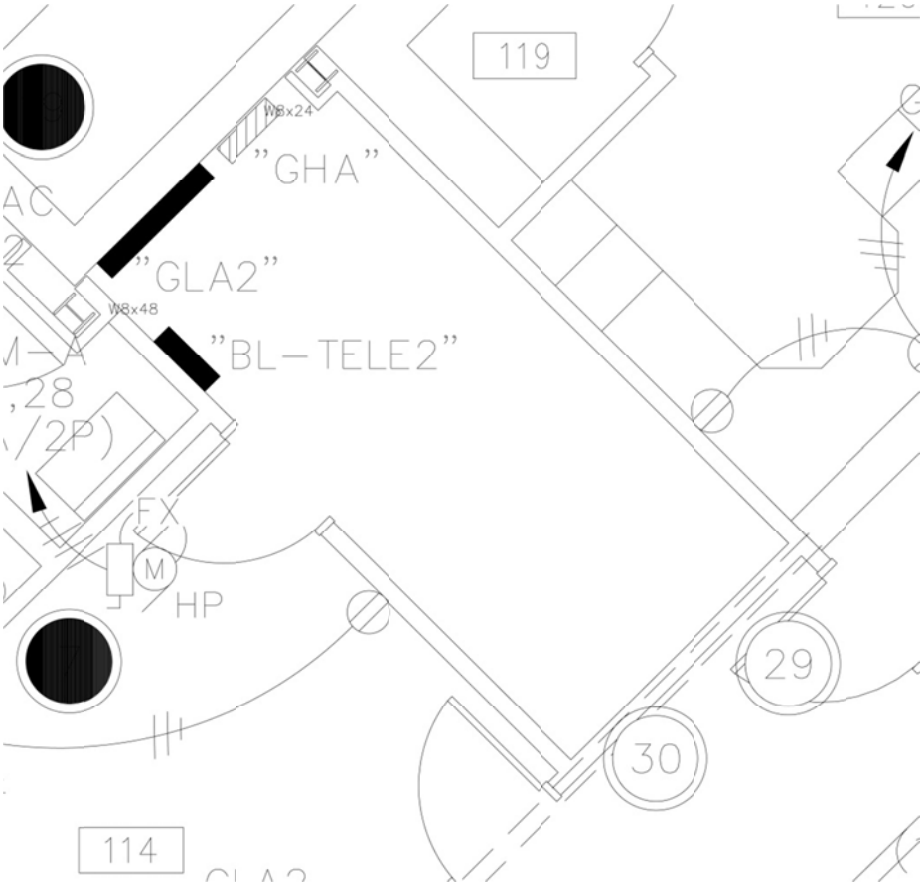


Wiring Diagram





Location of New Panelboard "BL-TELE2"



Distributed Rack Mounted Distributed vs. Central UPS Systems

The centralized UPS solution used in this application was chosen for a variety of reasons. The location of the two server rooms relative to each other is a short distance, meaning the power does not need to be distributed long distances or to many systems. This type of system is also cheaper than a distributed rack mounted system with multiple locations when you consider future expansion and efficiency. Space considerations also drove the decision. The server room on the ground floor is far smaller, and fitting a UPS system in this room would have been difficult. Also, the life expectancy of the batteries in a centralized system is greater than a rack mounted distributed system resulting is reduced maintenance costs.

Mechanical Breadth: Heat Pump to Variable Refrigerant Flow

Summary

For the mechanical breadth of my thesis project, I will be investigating a change from the existing Water Loop Heat Pump System to a Variable Refrigerant Flow System made by Daiken. This new system will reduce energy use in the building due to increased heat-moving efficiency. This investigation will also calculate an approximate financial savings each year due to this increased efficiency and the estimated payback period. The estimate will use design information provided by the mechanical designer who originally designed the system, and is familiar with typical operating hours of the building and climatic conditions of the surrounding area.

Assumptions

1. I am assuming the load calculations were performed correctly by the designers of the original system because there were no complaints about the thermal conditions in the building
2. The new system can be designed based on the listed cooling and heating capacity of existing equipment.

Examine Existing Heat Pumps

Because I am assuming the original load calculations are accurate, the capacity of the existing heat pumps in a specific space represents the required capacity (Btu / hr) needed in that space for the new system.

Number	Make	Model	CFM	Volts / Phase	GPM	**Cooling Capacity (BTU / hr)**
HP-1	Trane	GEH006	190	208/1	1.5	**6,800**
HP-2	Trane	GEH009	285	208/1	2.1	**8,400**
HP-3	Trane	GEH012	380	208/1	2.8	**11,800**
HP-4	Trane	GEH015	460	208/1	3.5	**13,400**
HP-5	Trane	GEH018	570	208/1	4.2	**19,300**
HP-6	Trane	GEH024	760	208/1	5.5	**24,500**
HP-7	Trane	GEH030	900	208/1	6.9	**27,400**
HP-8	Trane	GEH036	1140	208/1	8.3	**34,000**
HP-9	Trane	GEH042	1330	208/1	9.7	**38,500**
HP-10	Trane	GEH048	1520	208/1	11.0	**46,000**
HP-11	Trane	GEH060	1900	208/1	14.5	**55,500**

Existing Water Loop Heat Pump Schedule

Basement

Heat Pump #	Location (Room #)	**Cooling Capacity (BTU / hr)**
HP-11	010	**55,500**
HP-7	014	**27,400**
HP-3	009	**11,800**
HP-4	015	**13,400**
HP-11	006	**55,500**
HP-6	015	**24,500**
HP-6	029	**24,500**
HP-6	028	**24,500**
HP-3	025	**11,800**
HP-6	024	**24,500**
HP-10	022	**46,000**
HP-10	022	**46,000**
HP-5	023	**19,300**
HP-6	024	**24,500**
Total Cooling Capacity		**409,200**

Existing Basement Heat Pumps

Ground Floor

Heat Pump #	Location (Room #)	**Cooling Capacity (BTU / hr)**
HP-9	155	**38,500**
HP-1	156	**6,800**
HP-1	154	**6,800**
HP-6	153	**24,500**
HP-1	158	**6,800**
HP-8	157	**34,000**
HP-5	151	**19,300**
HP-2	152	**8,400**
HP-9	113	**38,500**
HP-1	114	**6,800**
HP-3	114A	**11,800**
HP-5	143	**19,300**
HP-1	142	**6,800**
HP-4	143	**13,400**
HP-3	111	**11,800**
HP-9	110	**38,500**
HP-5	110	**19,300**
HP-4	104	**13,400**
HP-11	105	**55,500**

HP-3	106	**11,800**
HP-11	109	**55,500**
HP-6	108	**24,500**
HP-5	147	**19,300**
HP-3	126	**11,800**
HP-4	145	**13,400**
HP-4	145	**13,400**
HP-3	133	**11,800**
HP-3	144	**11,800**
HP-3	131	**11,800**
HP-5	144	**19,300**
Total Cooling Capacity		**584,600**

Existing Ground Floor Heat Pumps

<u>Second Floor</u>

Heat Pump #	Location (Room #)	**Cooling Capacity (BTU / hr)**
HP-3	224	**11,800**
HP-9	224	**38,500**
HP-11	227	**55,500**
HP-9	229	**38,500**
HP-2	224	**8,400**
HP-2	223	**8,400**
HP-4	223	**13,400**
HP-11	204	**55,500**
HP-7	206	**27,400**
HP-8	206	**34,000**
HP-2	209	**8,400**
HP-7	202	**27,400**
HP-5	208	**19,300**
HP-2	202A	**8,400**
HP-1	208	**6,800**
HP-5	212	**19,300**
HP-10	218	**46,000**
HP-10	221	**46,000**
HP-2	218	**8,400**
HP-1	215	**6,800**
HP-5	216	**19,300**
Total Cooling Capacity		**507,500**

Existing Second Floor Heat Pumps

Total Cooling Capacity for Entire Building = Basement + Ground + Second

= 409,200 + 584,600 + 507,500

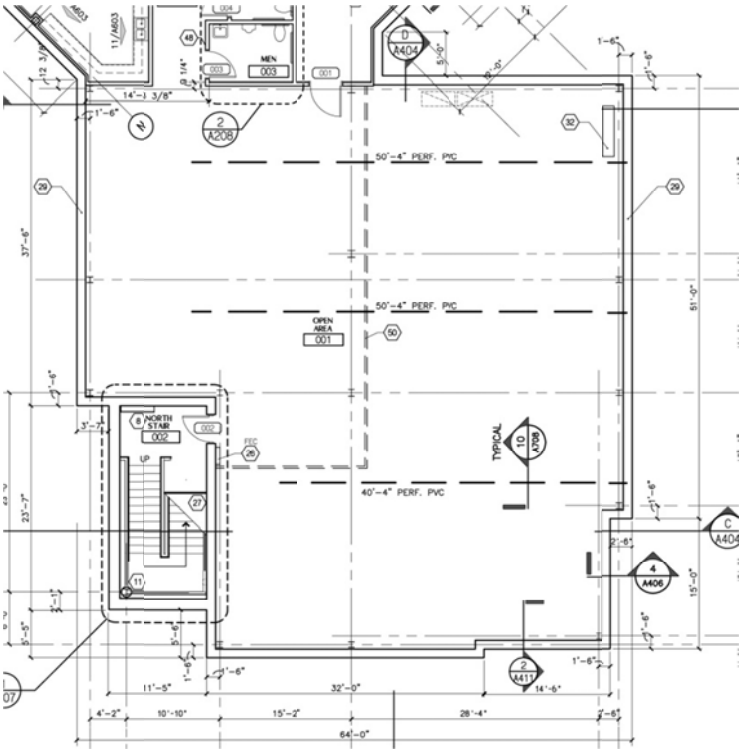
= **1,501,300 BTU / hr Total Cooling Capacity (125 tons)**

New System Design

The new system will differ from the existing system because the numerous unitary heat pump systems located throughout the building are substituted for a localized area heat pump / heat recovery system that uses centrally located compressors. The boilers will remain located in the basement. Currently, the basement AHU blows to heat pumps above the ceiling. Because I am removing these heat pumps, the air will need to go to a diffuser and then into the space.

A variable refrigerant flow system will still require refrigerant to be transported throughout the building. The existing water loop supply and return pipes will be replaced by the necessary piping for the new system. This includes a refrigerant suction cold pipe, refrigerant liquid room temperature pip, and a refrigerant hot gas pipe. These replacement pipes can utilize the same path as the existing water loop supply and return pipes.

The addition of centralized compressors requires a space to place them where the noise will not be an issue to surrounding spaces. Maintenance clearance must also be considered while placing the centralized compressors. The best location for the compressors is the large open room in the basement of the East wing, as shown in the plan below.E



Energy Use Comparison of Old and New System

This comparison of the energy used between the systems was performed using the Energy Efficiency Ratio (EER) (watts of power required per BTU that it moves in heating or cooling) of each to estimate the total energy consumed per year, and cost of that energy at 9 cents per kilowatt hour. The same values were used for both systems. The cost savings should occur due to the improved EER of the new system.

Old and New System: Occupied Hours, Heating and Cooling Capacity

1. There is a total of 8,760 hours in a year.
2. The City of Green Administration Building is only occupied half of the time, or 4,380 hours per year
3. The building must be conditioned to normal temperatures For these 4,380 hours per year
    a. 70 Degrees (F) in the Winter
    b. 72 Degrees (F) in the Summer
4. Of the 4,380 occupied hours per year, about half is heating and half is cooling
    a. 2,190 hours heating
        i. (100%) heating capacity for about 15% of the 2,190 hours per year
            1. (100%) heating capacity for 328.5 hours
        ii. (75%) heating capacity for about 20% of the 2,190 hours per year
            1. (75%) heating capacity for 438 hours
        iii. (50%) heating capacity for about 30% of the 2,190 hours per year
            1. (50%) heating capacity for 657 hours
        iv. (25%) heating capacity for about 35% of the 2,190 hours per year
            1. (25%) heating capacity for 766.5 hours
    b. 2,190 hours cooling
        i. (100%) cooling capacity for about 15% of the 2,190 hours per year
            1. (100%) cooling capacity for 328.5 hours
        ii. (75%) cooling capacity for about 20% of the 2,190 hours per year
            1. (75%) cooling capacity for 438 hours
        iii. (50%) cooling capacity for about 30% of the 2,190 hours per year
            1. (50%) cooling capacity for 657 hours
        iv. (25%) cooling capacity for about 35% of the 2,190 hours per year
            1. (25%) cooling capacity for 766.5 hours
5. For the 4,380 hours per year of unoccupied time, most equipment is off
    a. This results in heating capacity percentages being about 2/3 of when the building is occupied for the 2,190 hours of unoccupied heating.
        i. (66.67%) heating capacity for about 15% of the 2,190 hours per year
            1. (66.67%) heating capacity for 328.5 hours
        ii. (50%) heating capacity for about 20% of the 2,190 hours per year
            1. (50%) heating capacity for 438 hours

iii. (33.3%) heating capacity for about 30% of the 2,190 hours per year
    1. (33.3%) heating capacity for 657 hours
iv. (16.6%) heating capacity for about 35% of the 2,190 hours per year
    1. (16.6%) heating capacity for 766.5 hours

b. This results in cooling capacity percentages being about 1/3 of when the building is occupied for the 2,190 hours of unoccupied cooling.
    i. (33.33%) cooling capacity for about 15% of the 2,190 hours per year
        1. (33.33%) cooling capacity for 328.5 hours
    ii. (25%) cooling capacity for about 20% of the 2,190 hours per year
        1. (25%) cooling capacity for 438 hours
    iii. (16.6%) cooling capacity for about 30% of the 2,190 hours per year
        1. (16.6%) cooling capacity for 657 hours
    iv. (8.3%) cooling capacity for about 35% of the 2,190 hours per year
        1. (8.3%) cooling capacity for 766.5 hours

6. Because the method used for system design will only result in a total cooling capacity used, it is important to note that the heating capacity will be between 40 and 55 percent of the cooling capacity. This analysis will use a value of 50 %.

Cost of Electric for Old and New System and Payback Period

Existing System

1,501,300 BTU / hr Total Cooling Capacity

(1,501,300 BTU / hr Total Cooling Capacity) * (.50) = 750,000 BTU / hr Total Heating Capacity

Description	% Total Capacity	Capacity (BTU / hr)	# Hours	BTU
Occupied Cooling	100	1,501,300	328.5	493,177,050
Occupied Cooling	75	1,125,975	438	493,177,050
Occupied Cooling	50	750,650	657	493,177,050
Occupied Cooling	25	375,325	766.5	287,686,612.5
Unoccupied Cooling	33.33	500,383	328.5	164,375,815.5
Unoccupied Cooling	25	375,325	438	164,392,350
Unoccupied Cooling	16.6	249,216	657	163,734,912
Unoccupied Cooling	8.3	124,608	766.5	95,512,032
Occupied Heating	100	750,000	328.5	246,375,000
Occupied Heating	75	562,500	438	246,375,000
Occupied Heating	50	375,000	657	246,375,000
Occupied Heating	25	187,500	766.5	143,718,750
Unoccupied Heating	66.67	500,025	328.5	500,353.5
Unoccupied Heating	50	375,000	438	164,250,000
Unoccupied Heating	33.3	249,750	657	164,085,750
Unoccupied Heating	16.6	124,500	766.5	95,429,250
Totals			1 Year	3,662,341,975

Cost of Electricity = 9 Cents / KWh

Total Cooling BTU = 2,355,232,872 BTU

Average EER of Heat Pumps (Cooling) = 12

[9 (Cents / KWh)] / [12 ((BTU / hr) / W)] = .00075 Cents / BTU

[.00075 Cents / BTU] * [2,355,232,872 BTU] * [1 Dollar / Cent] = **$ 17,664.24**

Total Heating BTU = 1,307,109,103 BTU

Average COP of Heat Pumps (Heating) = 4.6(3.412) = 15.7 EER

[9 (Cents / KWh)] / [15.7 ((BTU / hr) / W)] = .000573 Cents / BTU

[.000573 Cents / BTU] * [1,307,109,103 BTU] * [1 Dollar / Cent] = **$ 7,489.74**

New System

Cost of Electricity = 9 Cents / KWh

Total Cooling BTU = 2,355,232,872 BTU

Average EER of new system (Cooling) = 18

[9 (Cents / KWh)] / [18 ((BTU / hr) / W)] = .0005 Cents / BTU

[.0005 Cents / BTU] * [2,355,232,872 BTU] * [1 Dollar / Cent] = **$ 11,776.2**

Total Heating BTU = 1,307,109,103 BTU

Average COP of new system (Heating) = 4.5(3.412) = 15.35 EER

[9 (Cents / KWh)] / [15.35 ((BTU / hr) / W)] = .000586 Cents / BTU

[.000586 Cents / BTU] * [1,307,109,103 BTU] * [1 Dollar / Cent] = **$ 7,659.66**

Total Electricity Cost per Year New System = $ 19,435.86

Total Electricity Cost per Year Old system = $25,153.98

Total Savings per Year = $ 5718.12

Tried to get payback period by calling, but could not get help from manufacturers

Breadth 2: Architectural Redesign of Entrance Structure

Summary

Several aspects of the existing entrance structure do not coincide well with architectural elements throughout the exterior and interior of the building. This breadth will start by identifying problem areas, and continue to present potential solutions which will improve upon the aesthetic appeal of the exterior as a whole.

Existing Design

The City of Green Administration Building is characterized by clean horizontal lines of similar materials along the length of the façade. These are formed by alternating horizontal layers of red and tan brick, as shown in below.

Lines of Horizontal Tan Brick on Building Façade

Unfortunately, the entrance structure disrupts these horizontal lines in several locations. The four columns supporting the clock tower are constructed of tan brick under the canopy instead of alternating with the red brick. Also, white fiberglass circular columns were chosen for the walkway cover support. These columns are used in the lobby as well, and seem to be chosen for the walkway in an attempt to connect the two spaces architecturally. The problem with this is the lack of a similar material on the façade, so while they succeed in relating the entrance to the lobby, there is no such relation from the walkway to the façade or from the main lobby to the rest of the interior. Furthermore, the white material is better suited for interior spaces because white gypsum wall board is used as a ceiling material. One final material related issue is the roofing chosen for the clock tower. This appears to be an additional attempt to differentiate the clock tower from the façade, and attract attention to the entranceway. Realistically, the size of the clock tower combined with its position away from the building already attracts attention to it, rendering the material change unnecessary.

One final observation regarding the walkway design is the orientation of the glass covering. All glass other than the walkway covering that is visible to an outside observer is vertically oriented. The only other examples of sloped glass are the two skylights. One is located within the clock tower, and the other in the main lobby. Neither of these two examples matches the walkway covering because they both cover square openings, meaning the glass meets at one point and creates a pyramid form similar to the roof of the clock tower. All problem areas of the entrance structure that will be redesigned are highlighted below.

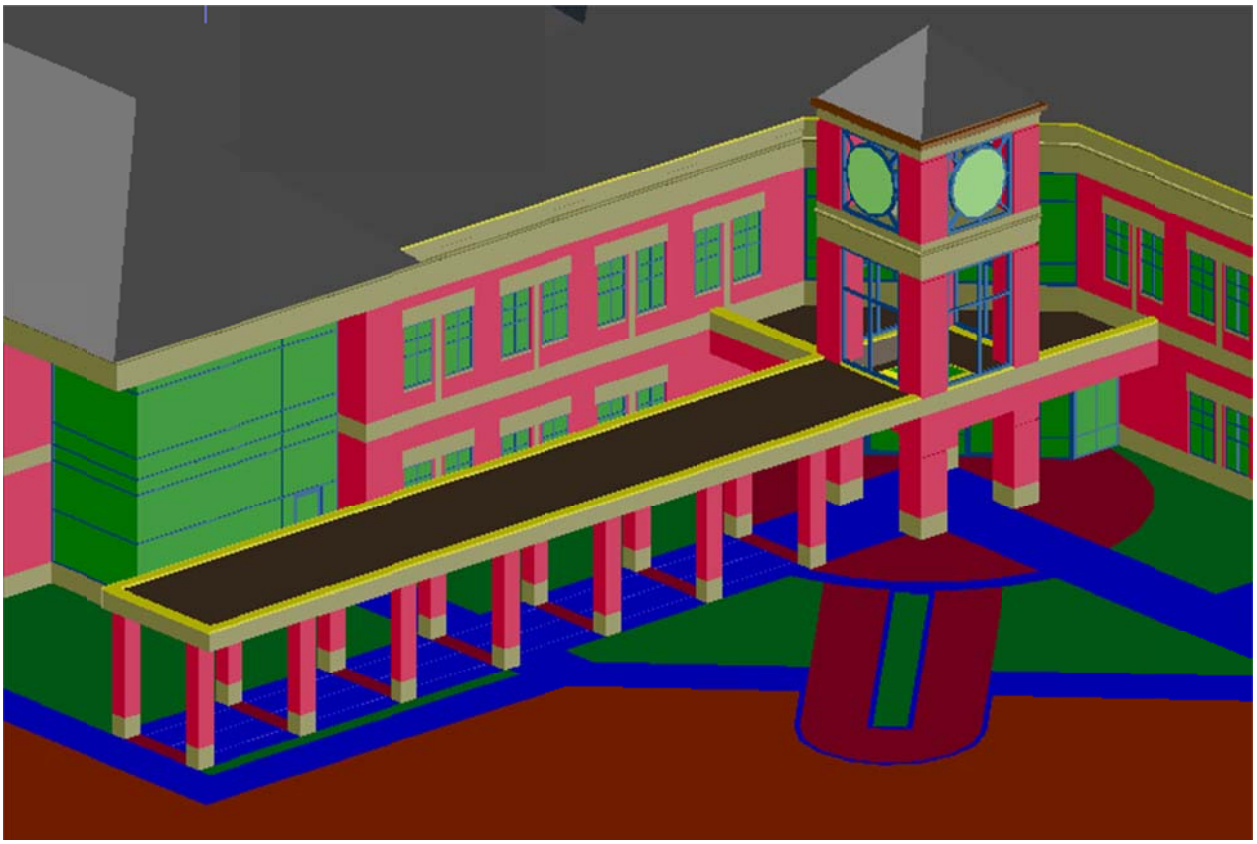
Entrance Structure Architectural Problem Areas

Summary of Design Issues

- Roof material on clock tower does not match building.
- Brick pattern on columns below clock tower disjoints horizontal material lines.
- White, circular columns do not relate to façade.
- Sloped glass does not connect architecturally to façade.

Proposed Redesign

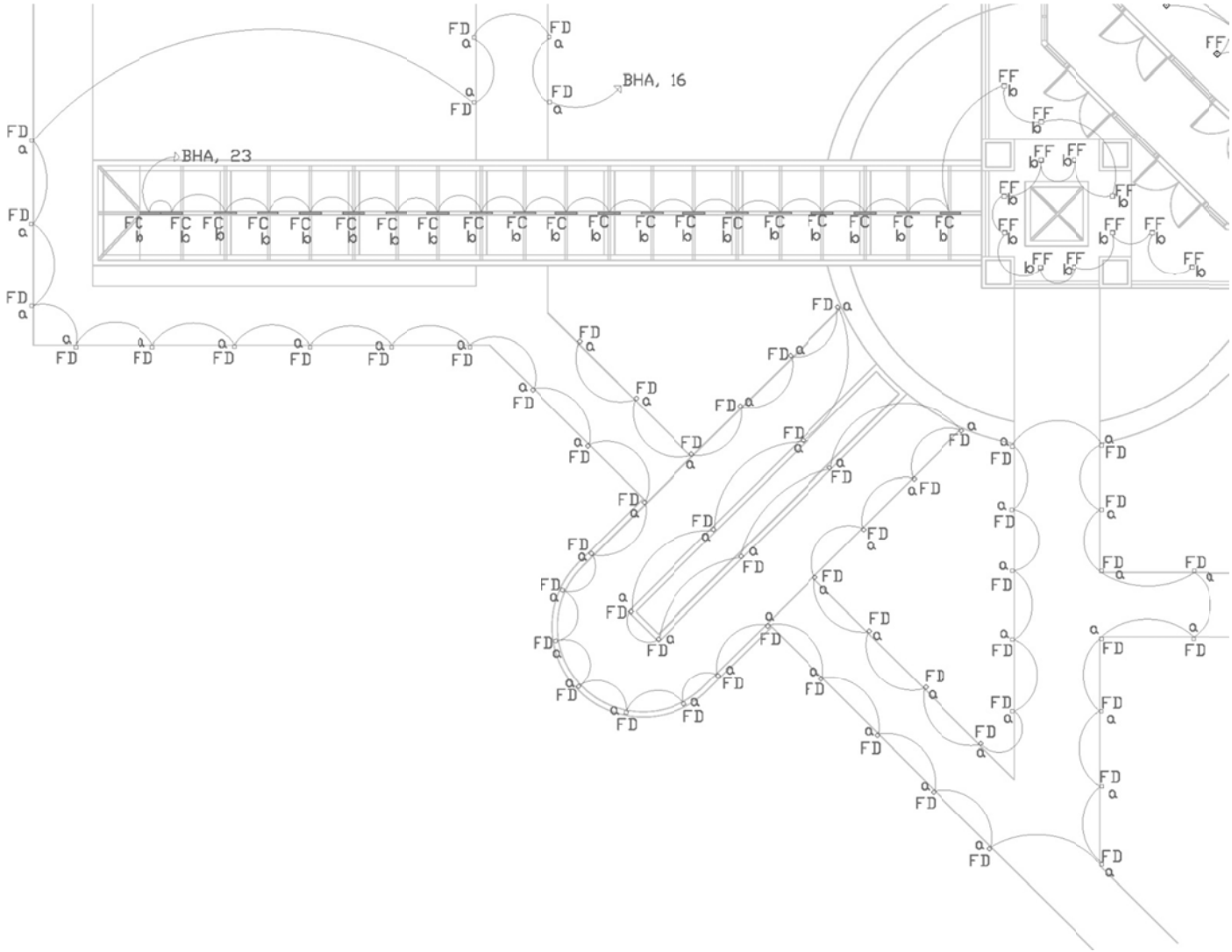
The proposed changes to the entrance structure address the design issues summarized above. The roofing material has been changed to match the main building's roof. Also, the brick on the four main columns supporting the clock tower now aligns horizontally with the rest of the façade. The most pronounced change in architectural design involves the walkway which was previously covered by a skylight glazing system. To eliminate the sloped glass, a flat solid roof has been used. In addition to this the white circular columns have been removed and replaced with a slimmer version of the columns supporting the clock tower. The materials on the slimmer columns follow the horizontal lines on the building façade.



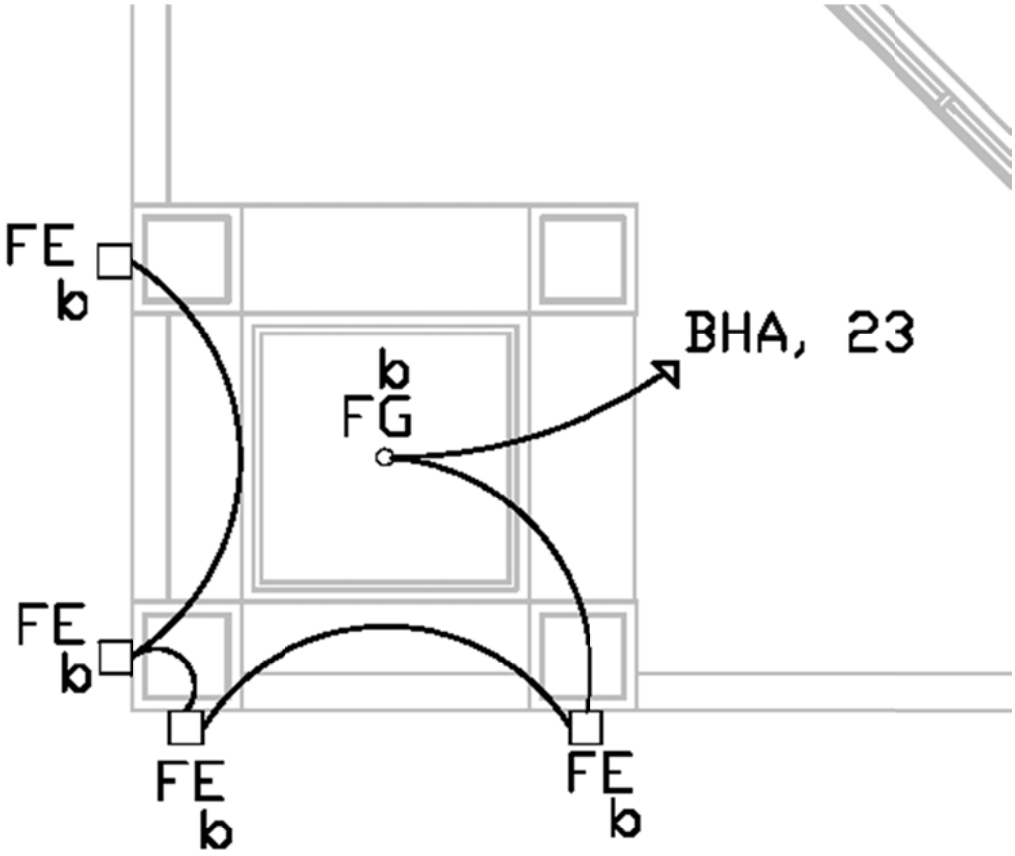
Proposed Redesign: AutoCAD Model

Appendix A: Luminaire and Control Layout

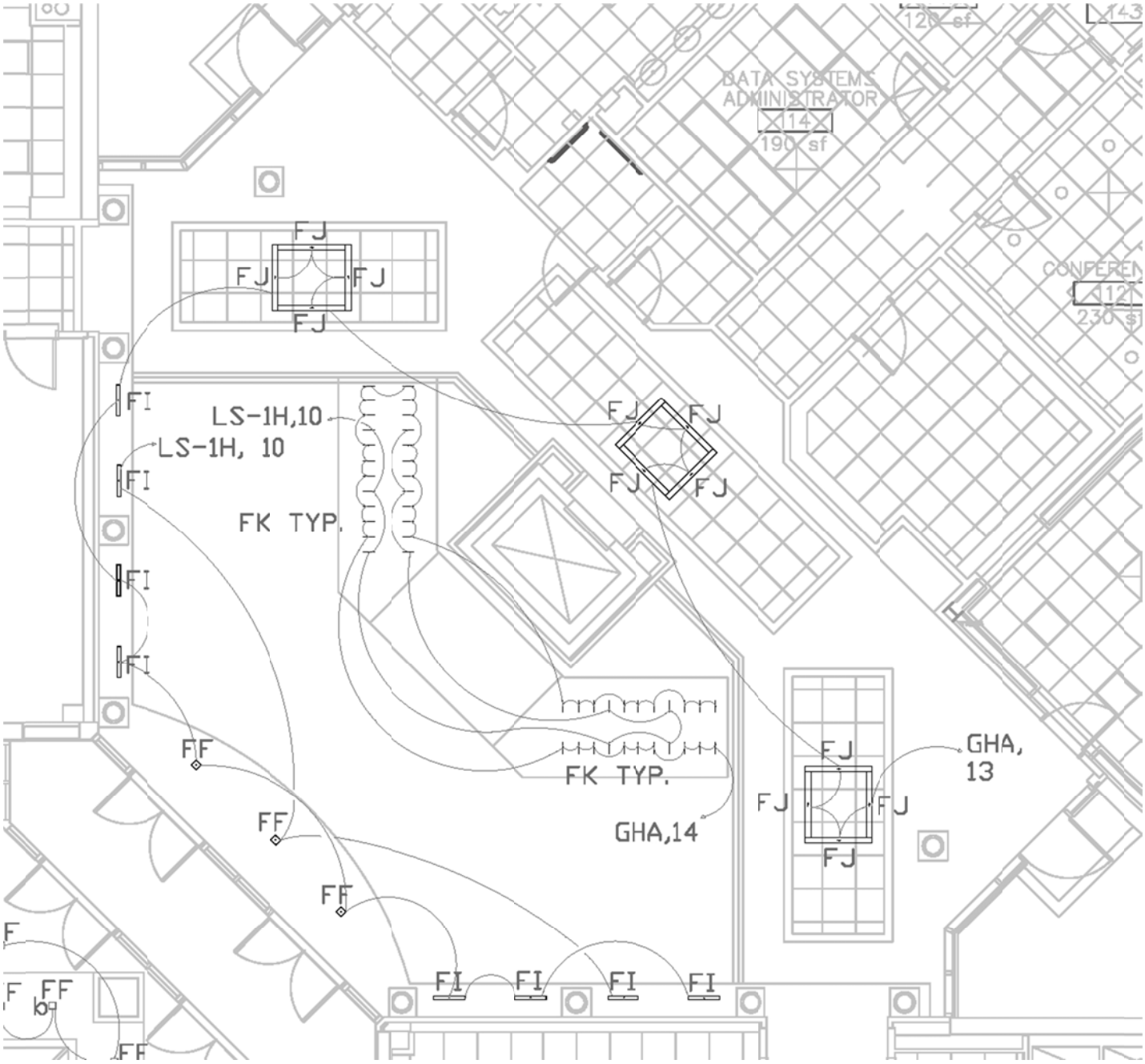
Entrance Structure Ground Level



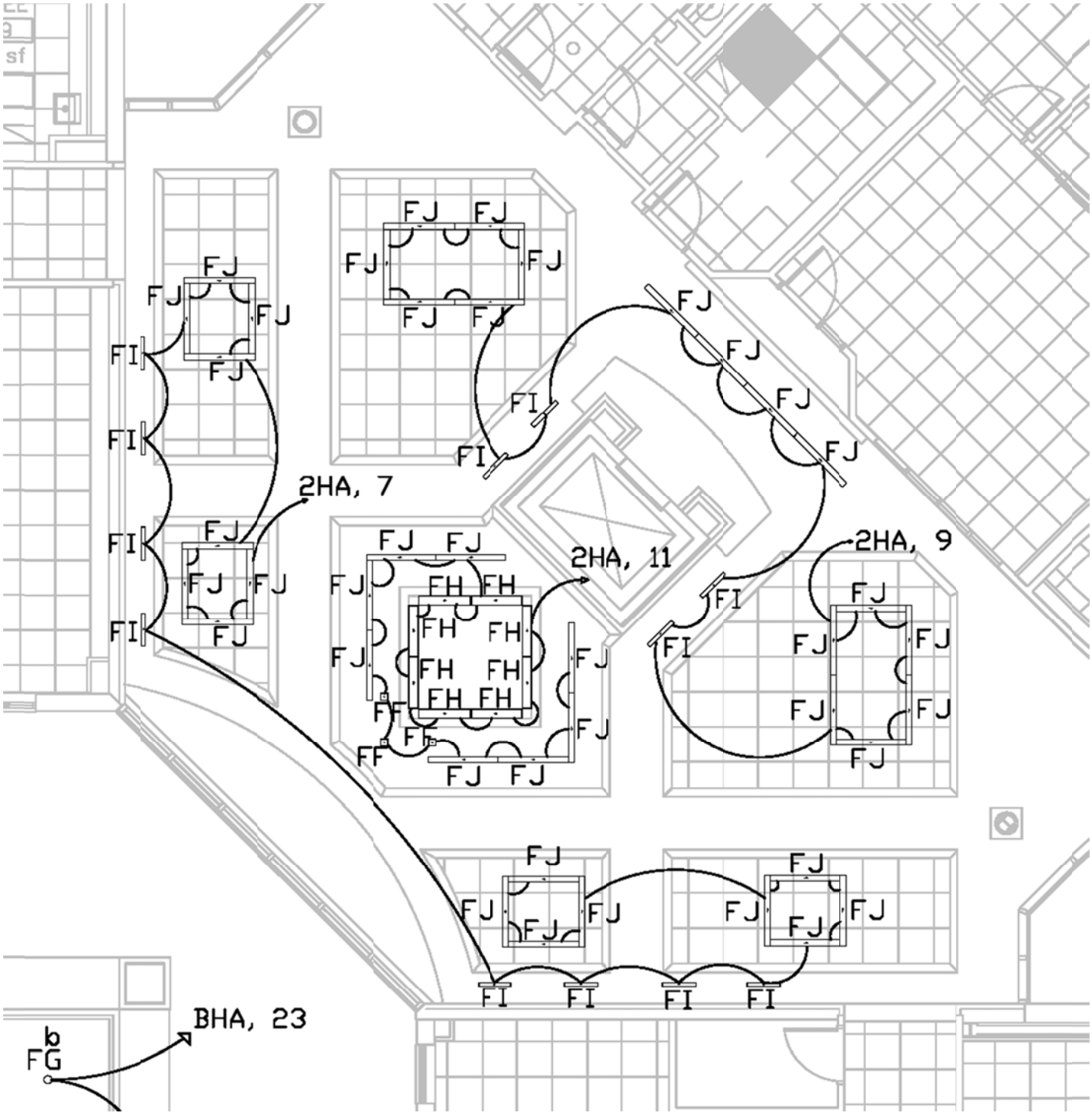
Entrance Structure Clock Tower



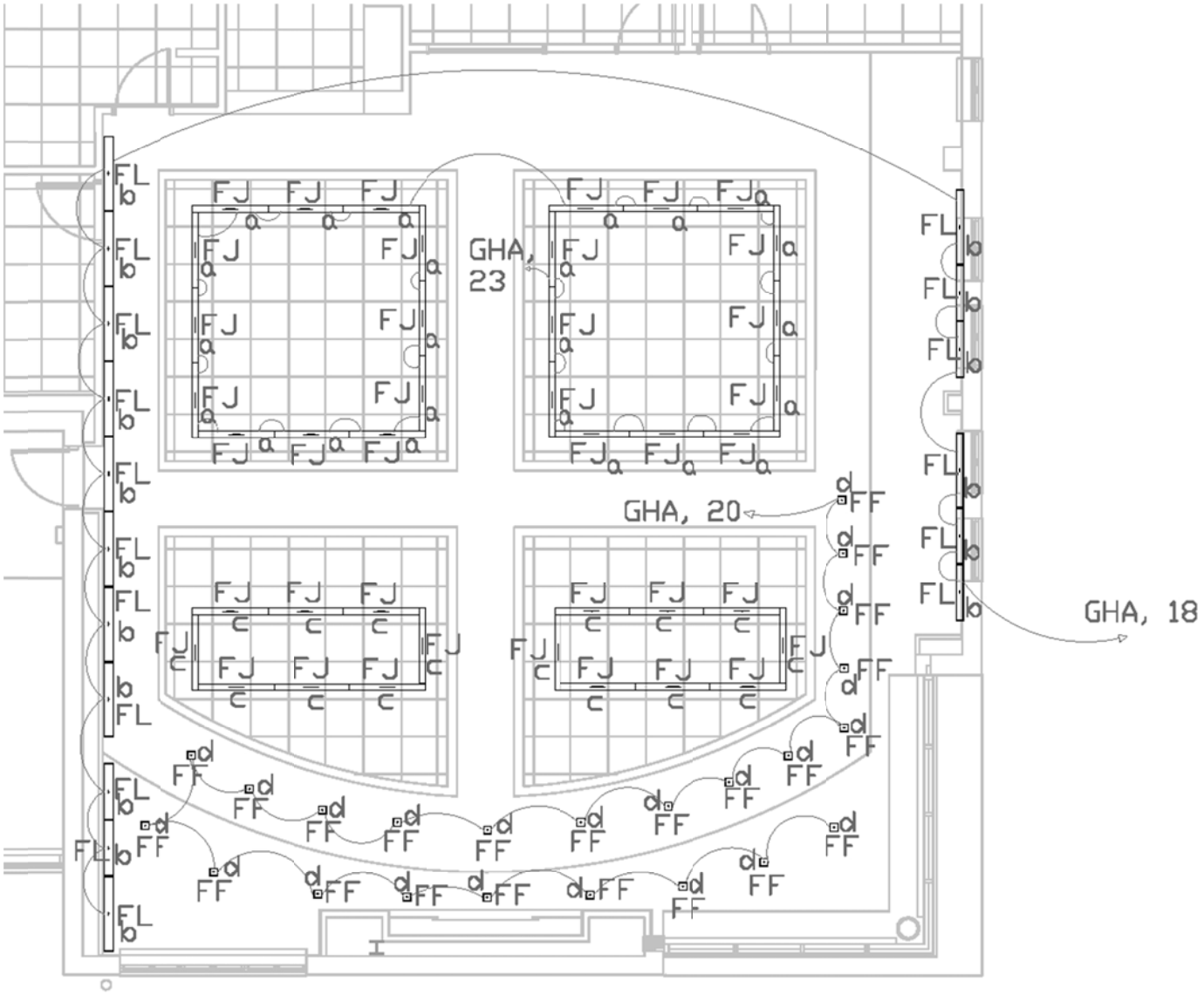
Main Lobby 1st Floor



Main Lobby 2nd Floor



Council Chambers



Planning & Engineering Workspace