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Lighting/Electrical

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The School of Forest Resources Building
University Park, Pennsylvania

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Technical Assignment 1

Executive Summary

Technical Assignment 1 involved a study of the existing lighting conditions within my thesis building. To begin, I analyzed the existing lighting systems and compiled a list of fixture types and lamps in the building. These typically included recessed fluorescent fixtures as well as several pendant mounted varieties. Compact fluorescent downlights were common in the circulation areas. Additionally, I researched the types of control systems and found dimming panels were used prevalently, along with occupancy sensors.

The next examination was of the important design criteria that would be used to evaluate the performance of the building. Utilizing the IESNA manual as well as the ASHRAE/IESNA 90.1 standard, I developed the list of criteria including providing adequate illumination, avoiding high levels of glare, and providing good lighting for facial rendering.

The final section of the report examines the lighting systems in general and determines that they function adequately to provide the necessary lighting for the spaces. A more detailed examination of the spaces being considered for redesign follows. Minimum average lighting levels were exceeded in the aquaculture lab however the values were quite low in some areas, limiting the uniformity. The video conference room failed to perform as required, with too little illumination being provided in an uneven distribution. Lack of directional lighting would provide poor facial rendering for teleconferences. The atrium in the building met illumination requirements, providing relatively even light levels on each floor. Area lighting outside the building provided insufficient amounts of light. All areas met code requirements for power density as well as minimum control requirements.

Existing Lighting Conditions

The Penn State School of Forest Resources Building is a multi-use facility with a variety of lighting needs. Systems and controls vary on a space-by-space basis and are as follows:

Classrooms- Typically lit with 2x2 fluorescent fixtures. Additional fixtures wash the board, with certain rooms incorporating podium highlights. System controls include manual switches as well as dimming panels.

Labs- Various types of lighting are used, but all involve some type of linear fluorescent fixtures. Control is provided by a combination of occupancy sensors, manual switches, and dimming panels. In special locations, such as the Aquaculture Lab, the controls are set up on a dusk-to-dawn timing system to provide a natural lighting schedule.

Offices- Typically lit with a single linear fluorescent fixture. Control is provided by a manual switch and an occupancy sensor.

Corridors- Lit with a combination of linear fluorescent and compact fluorescent fixtures. Control is provided directly via programmable low voltage (277V) lighting panels in the electrical rooms.

Auditorium- Both linear and compact fluorescent fixtures light the auditorium. Control is provided via a dimming panel in the storage space of the room.

More specific fixture information, including lamp type, number, and ballast type, can be found in the schedules on the following pages.

Fixture Schedule

Designation	Manufacturer	Description	Catalog # And Voltage
FR1	Metalux	2x2 Deep Cell Parabolic with 16 cells, Low Iridescent	2PGX2U6544EB81-277
FR2	Metalux	Recessed 1x4 Parabolic with 12 cells	EP3GX-2325261-EB81-277
FR4	Portfolio	Recessed 6" Compact Fluorescent	C6132-2E-AL6150L1-277
FR5	Portfolio	Recessed Incandescent, 6" Aperture, Low Iridescent	HD6-67000LI-120
FR6	Focal Point	Recessed 2x2 Parabolic, Grid Ceiling	FRP-22-D-3-T831-E-277-G-PL/S-SP-HW
FR6a	Focal Point	Same as FR6 for Dry Wall Ceiling	FRP-22-D-3-T831-E-277-DF-OL/S-SP-HW
FR7	Focal Point	Recessed 2x2 Parabolic, Grid Ceiling	FRP-22-D-3-T831-D-277-G-PL/S-SP-HW
FR8	Focal Point	Recessed 2x2 Parabolic, Grid Ceiling	FRP-22-D-3-T831-4E-277-G-PL/S-SP-HW
FR9	Neoray	Perimeter Fluorescent Cove with Blade Baffles	761-T8-S72-EB81-277
FR10	Metalux	Staggered Fluorescent Strip in Cove	SNL-132-EB81-277
FR11	Metalux	2x4 Acrylic Lensed Fixture	2GC8-332A125-UNV-EB81-277
FR12	Metalux	1x4 Acrylic Lensed Fixture	1X4GC8232125-UNVEB81-277
FR13	Metalux	2x2 Acrylic Lensed Fixture	2GC82U6-125UNVEB81-277
FR15	Portfolio	Surface Mounted Induction Lamp Downlight	QD19-8530-1E-9950LI-277
FR16	Failsafe	Double Gasketed 1x4 Fixture	CFG-232-277V-IK12-EB82-CRP
IR2	Portfolio	Incandescent Wall Washer	HD7-7710-LI-TRM8P-120
S1A	Metalux	Pendant Mounted Strip Light	1C232-P-EB81-277
P1	Corelite	Extruded Aluminum Bidirectional (80% up 20% down)	NB-H2-T81-277-AC-DL4
P2	Corelite	Extruded Aluminum Bidirectional (60% up 40% down)	NB-H2-T81-277-A-DL8
P5	Metalux	Industrial Pendant Mounted Strip Light	8TIA-332-EB81-AYC-277V-WG
W1	Shaper	Architectural Wall Mounted Compact Fluorescent	662-CF2/26-277-ST-277
W4	Failsafe	Wall Pack Style HID	EFS12-100MH-DT-BK-CHR-277
EX	Lithonia	Exit Sign Green LED Lettering	LQNSW36-120/277
EB	Lithonia	Self Contained Battery Unit	62M2NH-277
SL1	Louis Poulsen	Kipp Post Top, Black with Black Shade, 12' Pole	Kipp Post Top
Fixture Cutsheets have been included on the Project CD			
Note: Some consecutive numbers were not used on the schedule by the designer (e.g. FR3)			

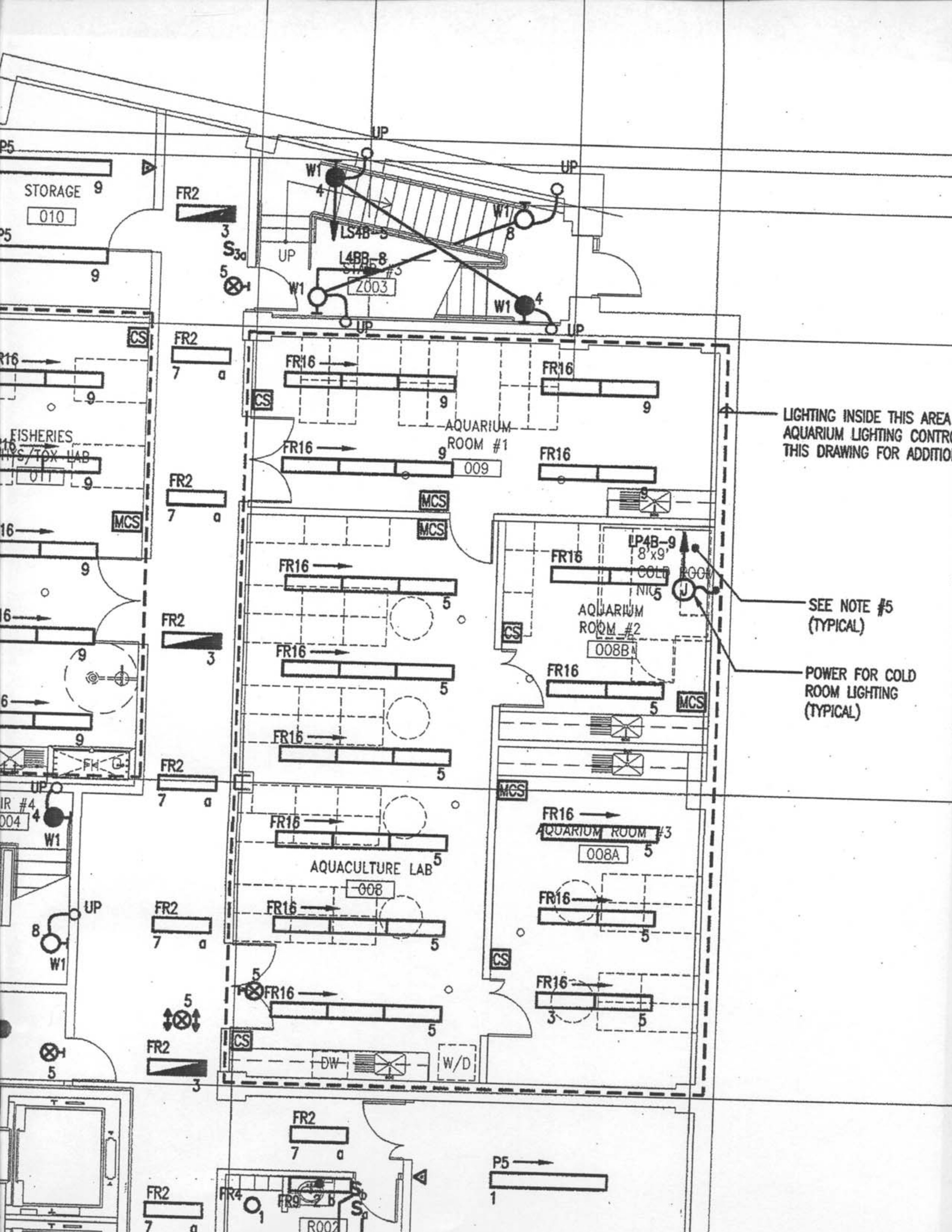
Lamp and Ballast Schedule

Designation	Lamps	#	Ballast
FR1	F31 U/T8	2	VCN-2M32-MC
FR2	F32-SPX35	2	VCN-2M32-MC
FR4	F32TBX-SPX35-A4P	1	ICF-2S26-H1-LD
FR5	100A-19	1	Not Applicable
FR6	F31 U/T8	3	VCN-3P32-SC
FR6a	F31 U/T8	3	VCN-3P32-SC
FR7	F31 U/T8	3	VCN-3P32-SC
FR8	F31 U/T8	3	VCN-3P32-SC
FR9	F32-SPX35	1	VCN-132-MC
FR10	F32-SPX35	1	VCN-132-MC
FR11	F32-SPX35	3	VCN-3P32-SC
FR12	F32-SPX35	2	VCN-2M32-MC
FR13	F32-SPX35	3	VCN-3P32-SC
FR15	85W QL	1	Not Applicable
FR16	F32-SPX35	2	VCN-2M32-MC
IR2	150W/A21	1	Not Applicable
S1A	F32 T8	2	VCN-2M32-MC
P1	F32 T8	2	VCN-2M32-MC
P2	F32 T8	2	VCN-2M32-MC
P5	F32-SPX35	3	VCN-3P32-SC
W1	F26BX-3500L	2	VEZ-2Q26
W4	100W MH	1	71A5337BP
EX	LED	--	Not Applicable
EB	6W Halogena	2	Not Applicable
SL1	150W MH	1	71A5437BP
Lamp and Ballast Cutsheets have been included on the Project CD			

Dimming Panels- For lighting control, Lutron GP Series or equal dimming panels were specified. Four preset lighting scenes are offered on each dimming control station, which connects to a main panel control to change the lighting from a remote location.

Floorplans and Elevations

Floor plans and available elevations for redesign spaces follow. For additional views, see the AGI32 files included on the Project CD. Floorplans are shown at 1’-0” = 1/8” scale, elevations are shown at the scale on the drawing.



LIGHTING INSIDE THIS AREA
AQUARIUM LIGHTING CONTR
THIS DRAWING FOR ADDITIO
SEE NOTE #5
(TYPICAL)
POWER FOR COLD
ROOM LIGHTING
(TYPICAL)
STORAGE
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FISHERIES
011
AQUARIUM
ROOM #1
009
8'x9'
COLD ROOM
NIC
AQUARIUM
ROOM #2
008B
AQUARIUM ROOM #3
008A
AQUACULTURE LAB
008
Z003
LS4B-5
L4BB-8
LP4B-9
UP
W1
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FR9
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CS
MCS
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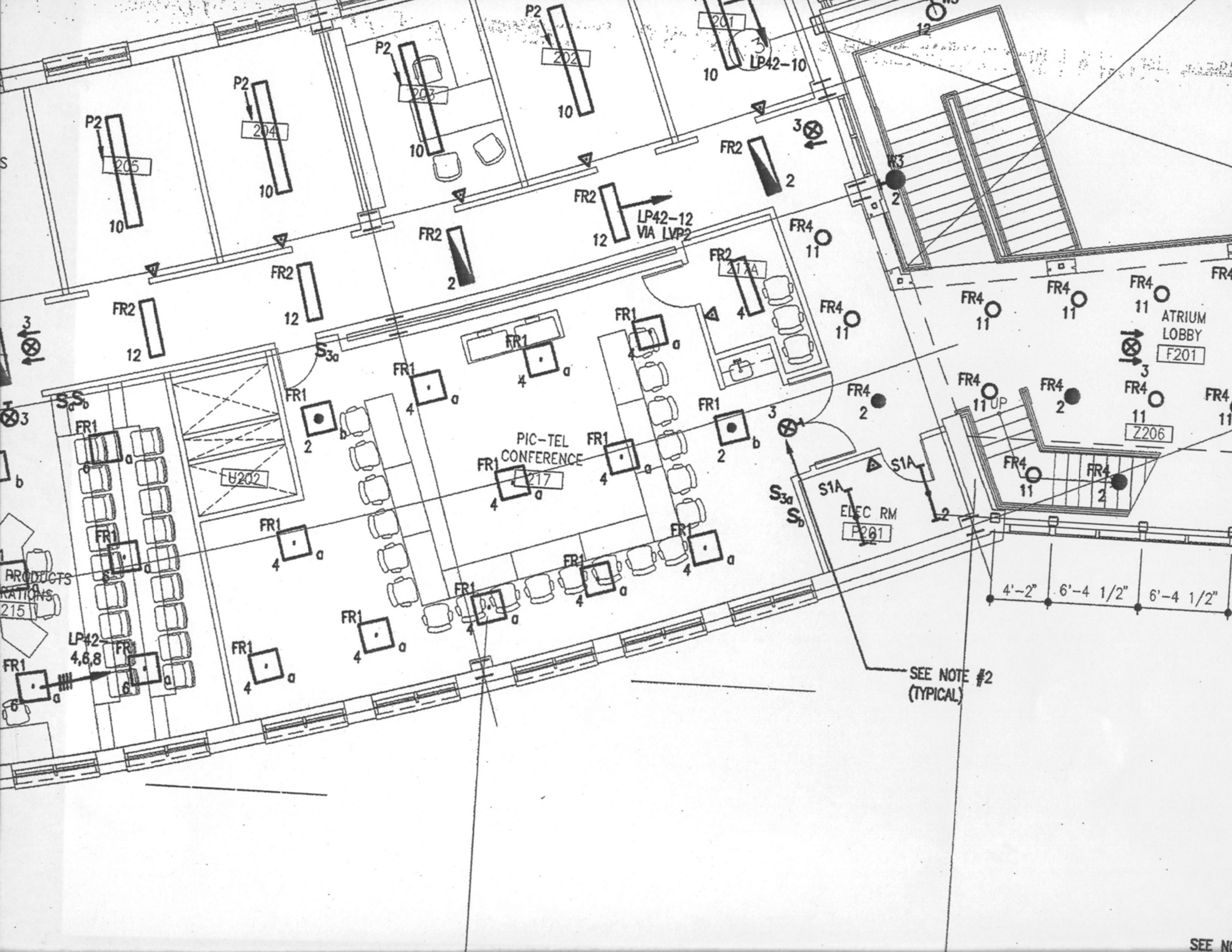
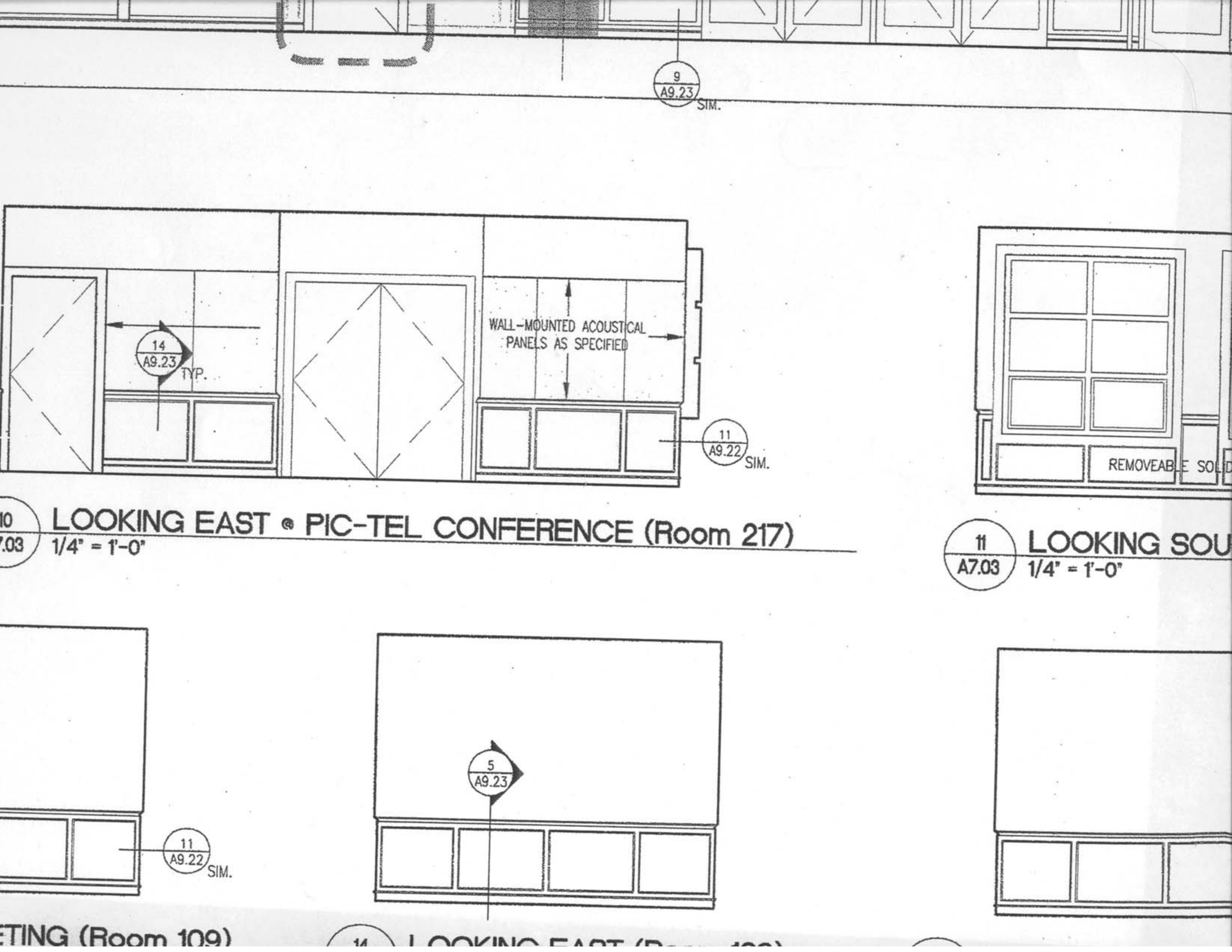
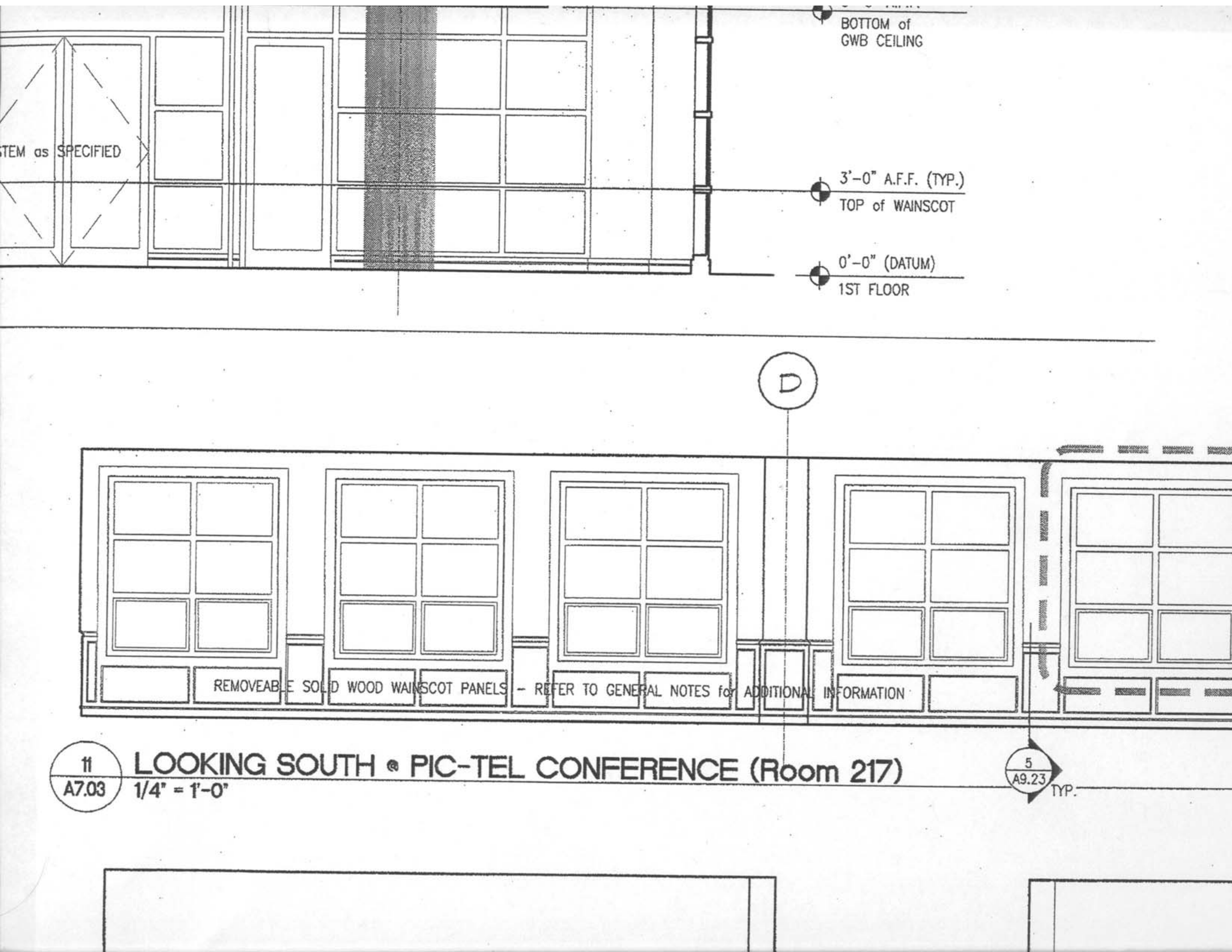
W/D
R002
004



PIC-TEL CONFERENCE
217
217A
U202
205
204
203
202
201
LP42-10
LP42-12 VIA LVP2
LP42 4,6,8
PRODUCTS
RATIONS
215
ELEC RM
P201
ATRIUM LOBBY
F201
Z206
UP
4'-2"
6'-4 1/2"
6'-4 1/2"
SEE NOTE #2 (TYPICAL)
SEE N

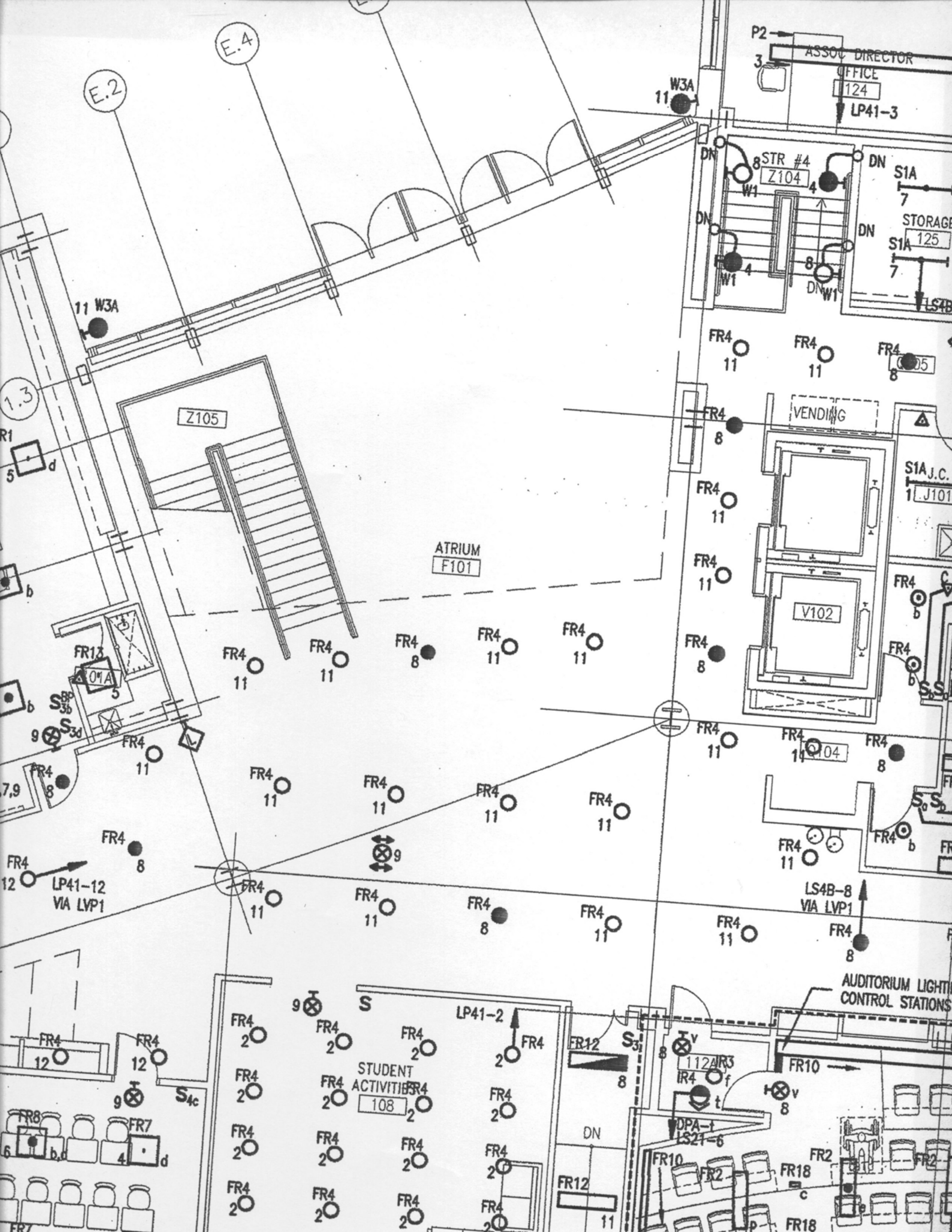

9
A9.23
SIM.
14
A9.23
TYP.
WALL-MOUNTED ACOUSTICAL
PANELS AS SPECIFIED
11
A9.22
SIM.
LOOKING EAST @ PIC-TEL CONFERENCE (Room 217)
1/4" = 1'-0"
11
A7.03
1/4" = 1'-0"
5
A9.23
11
A9.22
SIM.

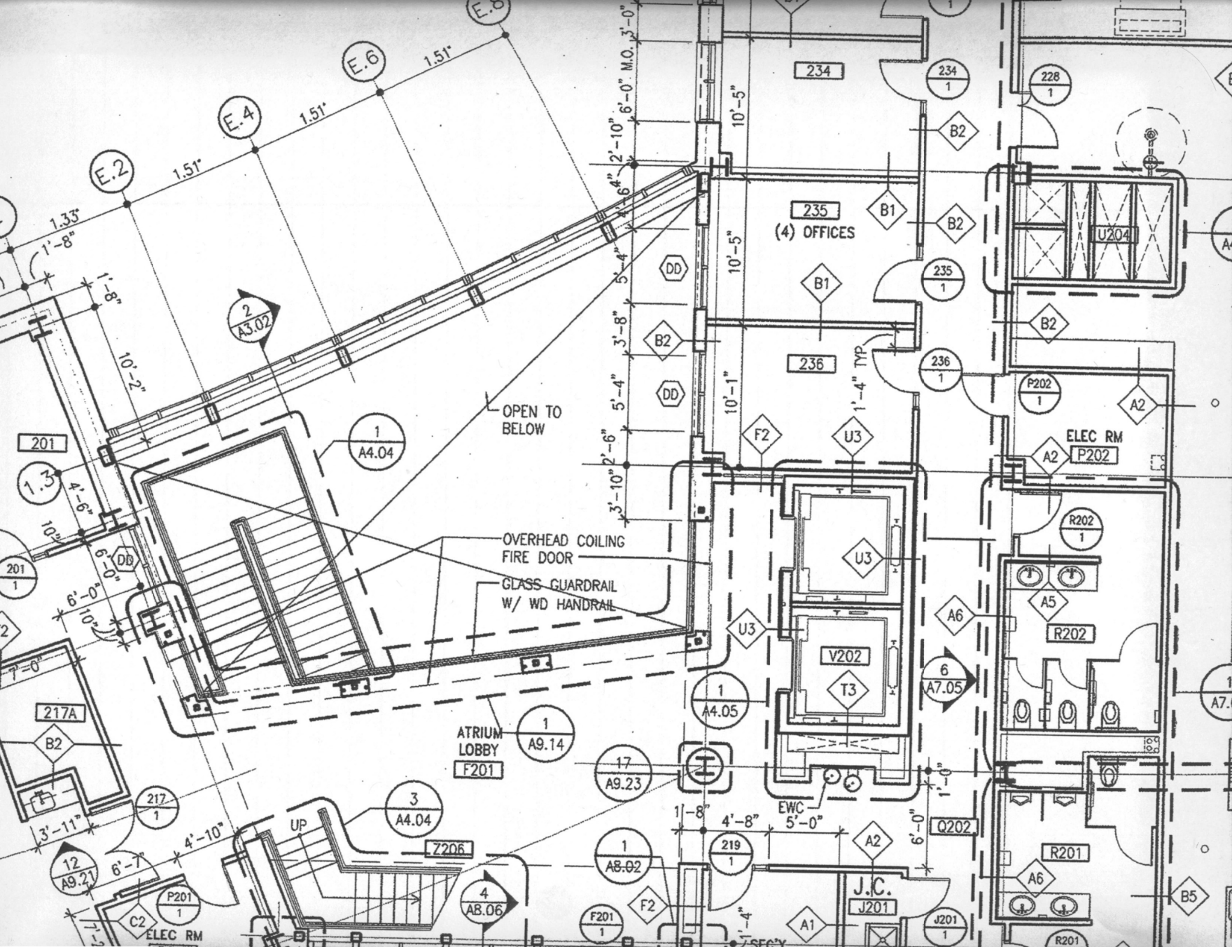


11
A7.03

LOOKING SOUTH @ PIC-TEL CONFERENCE (Room 217)

1/4" = 1'-0"


E.2
E.4
1.3
ASSOC DIRECTOR OFFICE
124
LP41-3
P2
W3A
STR #4
Z104
DN
W1
S1A
STORAGE
125
LS4B
Z105
VENDING
J.C.
J101
ATRIUM
F101
V102
FR4
FR13
FR1
LP41-12 VIA LVP1
LS4B-8 VIA LVP1
AUDITORIUM LIGHTING CONTROL STATIONS
LP41-2
STUDENT ACTIVITIES
108
FR12
FR10
FR8
FR7
FR2
FR18
IR3
IR4
112A
DPA-t
LS21-6



234
235
(4) OFFICES
236
201
217A
ELEC RM
P202
R202
R201
U204
V202
J.C.
J201
Q202
Z206
F201
ATRIUM
LOBBY
OPEN TO
BELOW
OVERHEAD COILING
FIRE DOOR
GLASS GUARDRAIL
W/ WD HANDRAIL
EWC
UP
TYP
E.2
E.4
E.6
1.3
1.51'
1.33'
10'-5"
10'-1"
10'-2"
6'-0" M.O.
3'-0"
2'-10"
4'-6"
5'-4"
3'-8"
2'-6"
3'-10"
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6'-0"
4'-10"
6'-7"
3'-11"
1 A4.04
3 A4.04
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6 A7.05
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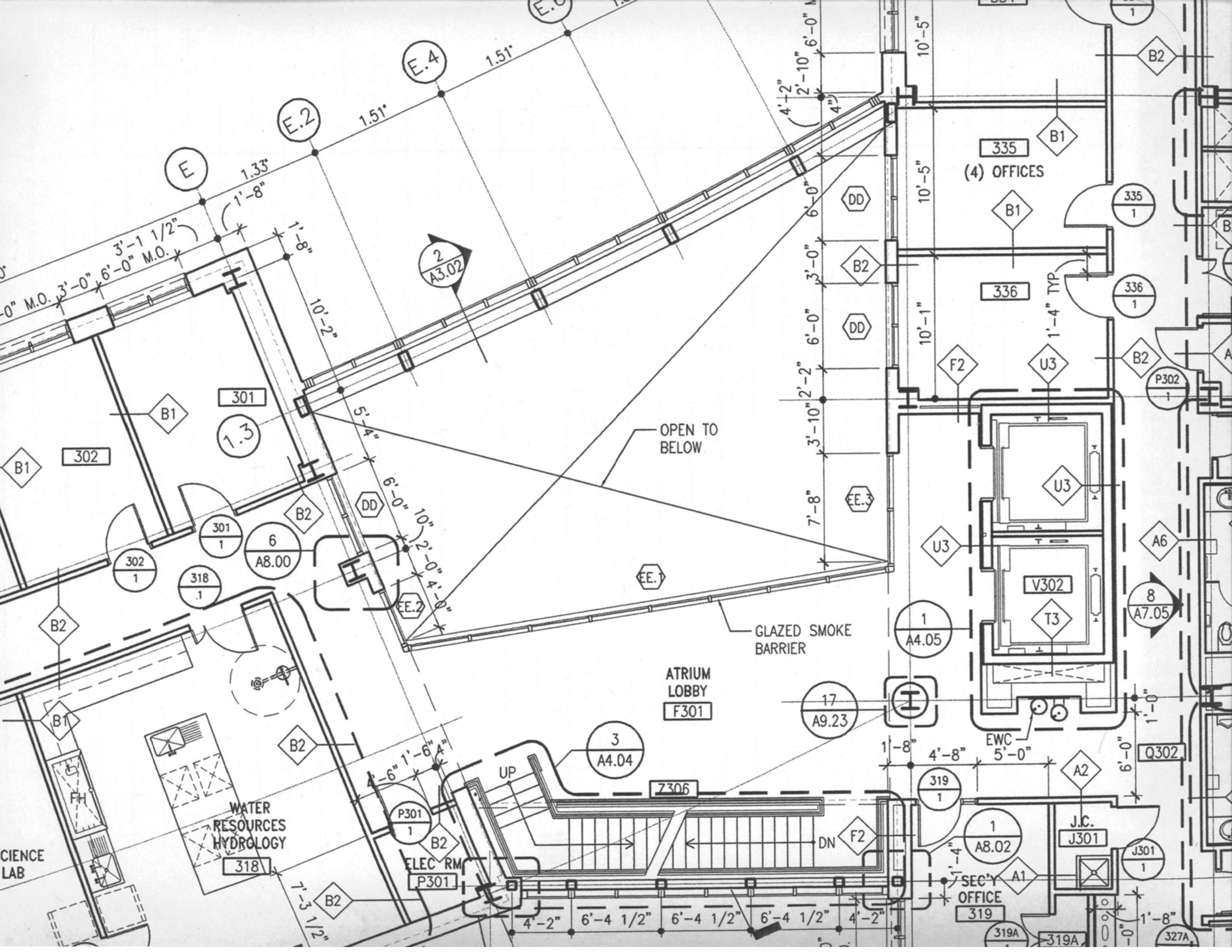
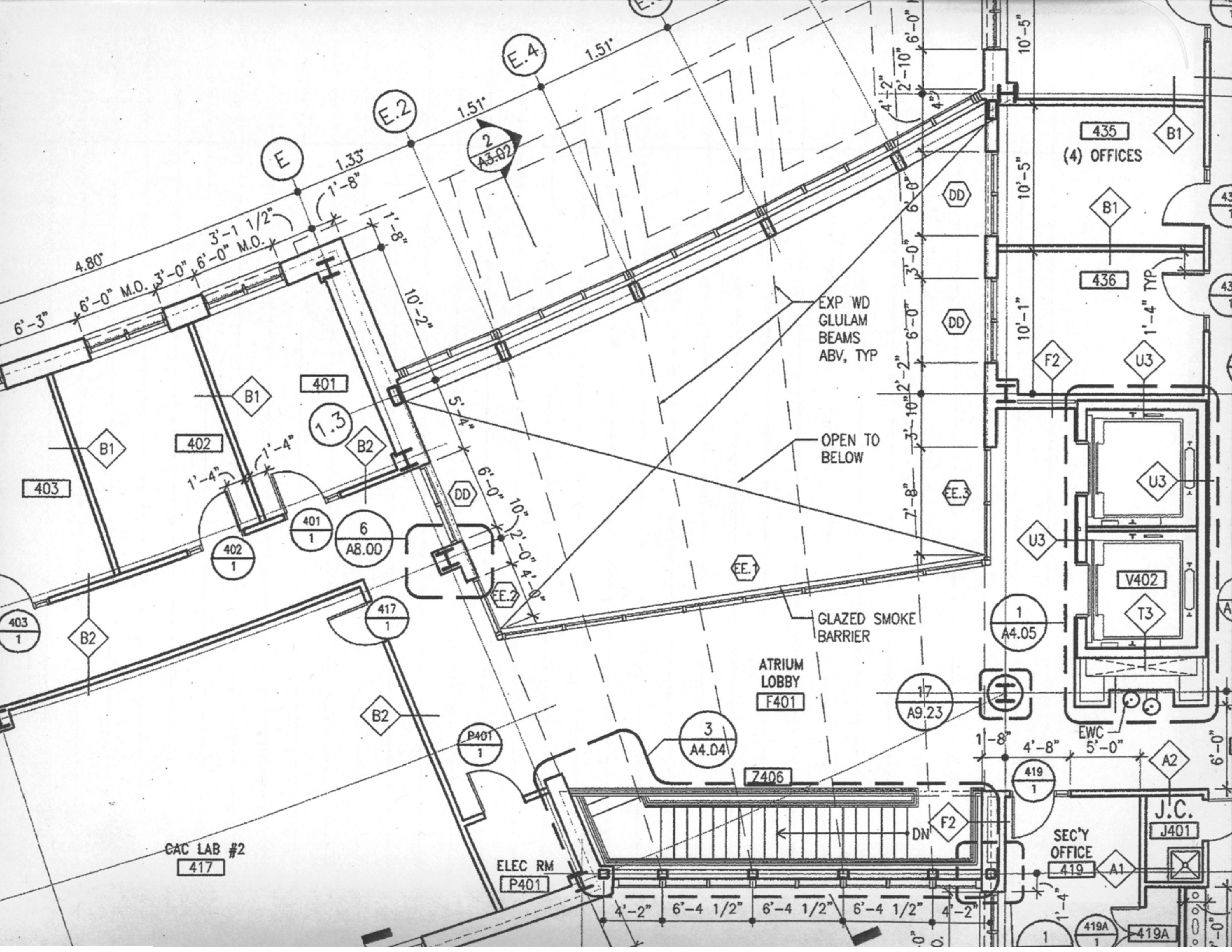
17 A9.23
1 A8.02
2 A3.02
4 A8.06
12 A9.21


(4) OFFICES
335
336
301
302
OPEN TO BELOW
GLAZED SMOKE BARRIER
ATRIUM LOBBY
F301
V302
Z306
WATER RESOURCES HYDROLOGY
318
ELEC RM
P301
SEC'Y OFFICE
319
J.C.
J301
Q302
EWC
UP
DN
CIENCE LAB


(4) OFFICES
435
436
1'-4" TYP
EXP WD GLULAM BEAMS ABV, TYP
OPEN TO BELOW
GLAZED SMOKE BARRIER
ATRIUM LOBBY
F401
Z406
DN
EWC
J.C.
J401
SEC'Y OFFICE
419
419A
ELEC RM
P401
CAC LAB #2
417
401
402
403
E
E.2
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10'-5"
10'-1"
10'-2"
6'-0"
3'-0"
2'-2"
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7'-8"
5'-4"
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6'-4 1/2"
4'-8"
5'-0"
1'-8"
3'-1 1/2"
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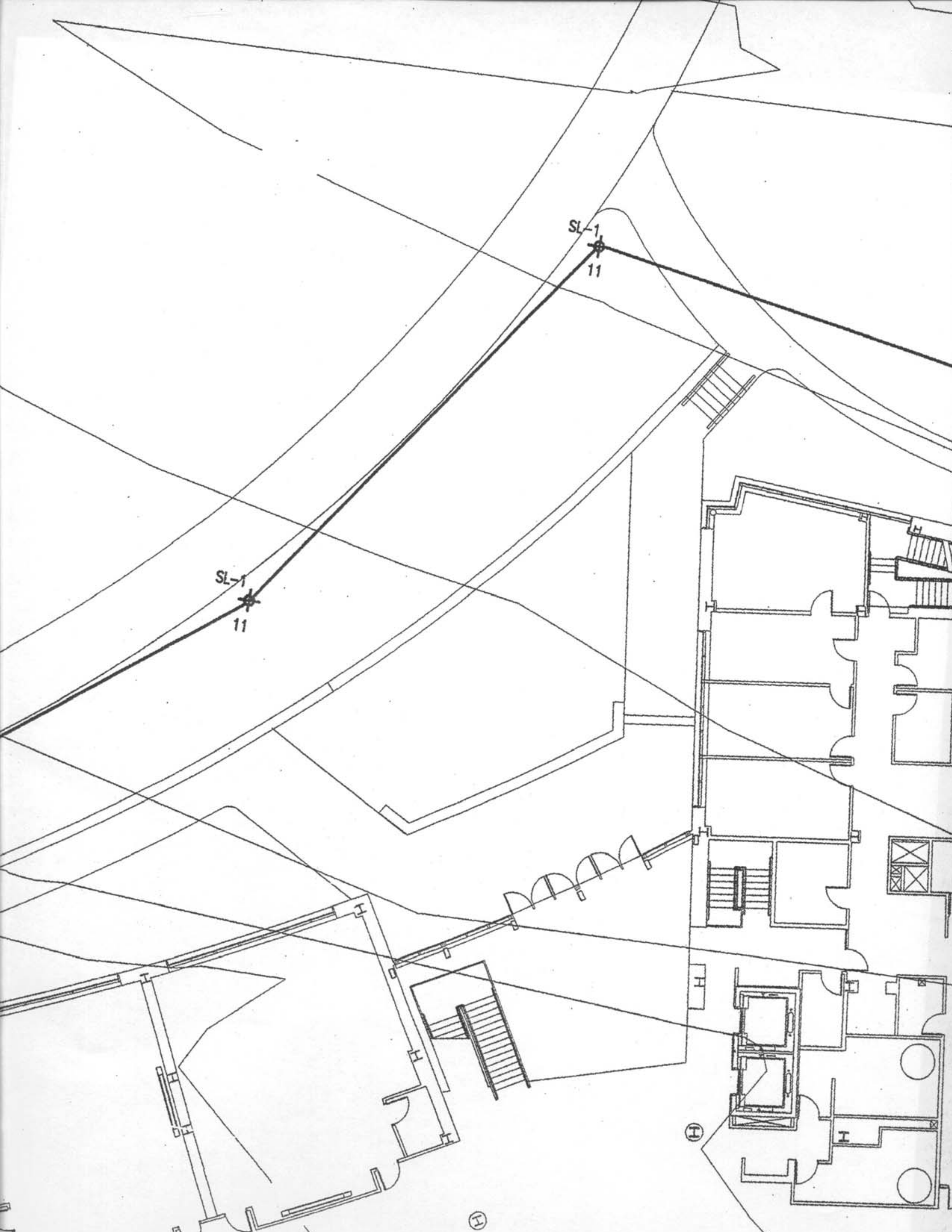
6'-3"
A3.02
A4.05
A9.23
A4.04
A8.00
V402


SL-1
11
SL-1
11

Design Criteria

The following Design Criteria are taken from the IESNA Lighting Handbook as well as from ASHRAE/IESNA Standard 90.1.

IESNA Lighting Design Guide Criteria for Illuminance

Science Labs: 50 fc horizontal, 30 fc vertical
Video Conference Rooms: 50 fc horizontal, 30 fc vertical
Lobby: 10 fc horizontal, 3 fc vertical
Building Exterior Active Entrance: 5 fc horizontal, 3 fc vertical

Quality and System Performance Criteria

Aquaculture lab-

Color Appearance- Color appearance is an integral part of the scientific work in the aquaculture lab. The ability to perceive accurate color is necessary for observations in the tanks. Fish and plant health are sometimes indicated by coloration and thus appearance must be accurate. Experiments can also rely heavily on the perception of color. For example, even a simple litmus test of the water's pH relies on the ability to distinguish colors. After dipping litmus paper in a water sample, the paper shifts colors to indicate the level of acids or bases in the water. Use of lamps with high CRI values should provide the accurate color rendering required in this lab space.

Daylighting Integration and Control- This space is in the basement and does not utilize natural light.

Direct Glare- Direct glare from luminaires is critical in the lab. Glare from luminaires can interfere with observations by making it difficult to see clearly. Long amounts of time spent in spaces with direct glare can lead to physical discomfort and the inability to perform tasks well. Direct glare can be avoided by keeping within proper luminance ratios: 1 to 3 for tasks, 1 to 10 for backgrounds, and 1 to 100 for the luminaire.

Flicker and Strobe- Flicker and strobe are an important issue from a visual comfort perspective. Utilizing fluorescent lamps with appropriate electronic ballasts should eliminate any concerns.

Lighting Distribution on Surfaces and Uniformity- Light should be uniformly spread over vertical and horizontal elements in the spaces to allow for uniform observation conditions around the lab area. For example, some of the tanks are located against the walls of the room. It would not be acceptable to have a high fall off of illuminance near the room edges as this would constitute different living conditions for the plants and fish.

Luminances of Surfaces- Surface luminance is a major concern in the aquaculture lab as it can lead to glare. Luminances should be kept within the proper ratios (1 to 3 for tasks, 1 to 10 for backgrounds, and 1 to 100 for the luminaire) to avoid glare.

Modeling of Faces- This is not a critical aspect of the aquaculture lab. Providing adequate lighting for plant and fish growth as well as the tasks in the room should give the necessary levels for facial recognition.

Points of Interest- The points of interest in the lab are obviously the aquariums. Unlike a display area or directory sign however, these are not to be lit with spotlights or other highlighting fixtures for the purpose of maintaining proper conditions in the tank. The aquarium lights as well as the general space lighting are all that is needed.

Reflected Glare- Reflected glare should be a careful consideration in this space due to the glass aquarium tanks being used. Improper positioning of luminaires can result in glare off the tanks, which would make observations inside difficult and inaccurate at best.

Shadows- Shadows should be avoided in the room to maintain a uniform lighting level on all tanks for proper living conditions.

Source/task/eye geometry- As mentioned in the reflected glare section, the positioning of luminaires relative to the tanks and the observer is critical to the ability to properly see in the space.

Sparkle- Sparkle is not a major consideration in this lab.

System Control and Flexibility- System control flexibility is essential in this lab. As it is used for growing and maintaining aquarium life, the system needs to provide a proper amount of light for a specified time interval. The system should be able to provide a set illuminance level per time period on an aquarium by aquarium basis for maximum flexibility.

Video Conference-

Color Appearance- Color appearance in the video conference room is critical for having a successful meeting. Proper illuminance with good color rendering lamps is necessary to provide a quality appearance. This is especially important given the changes in appearance that can occur when meeting via camera. Having a cool background can make people look warm through a camera and vice versa. The most important concern with color appearance is making people look real.

Daylighting Integration and Control- Windows line the south-facing wall of the teleconference room. Controlling the penetration of sunlight is critical, especially when being used for a video conference. Overwhelming background luminance can drown out the people sitting in the room.

Direct Glare- High amounts of direct glare should be avoided. While it is important to provide a light source that supplies natural looking facial illumination, the source should not be at a location or of an intensity that causes the subject to experience discomfort.

Flicker and Strobe- Flicker and strobe are an important issue from a visual comfort perspective. Utilizing fluorescent lamps with appropriate electronic ballasts should eliminate any concerns.

Lighting Distribution on Surfaces and Uniformity- Lighting should be distributed evenly on the task plane (the desk) to provide good working conditions. Additionally, surrounding surfaces such as the walls should be illuminated so the background is not overly dark. The most important surfaces in the room are the faces of the occupants. Overly uniform lighting can make the face look washed out, while creating harsh shadows is also undesirable.

Luminances of Surfaces- Surface luminance is important in the video conference room as it can lead to glare, for both the occupants and the camera. Glare in the camera can wash out the view of the people. Luminances should be kept within the proper ratios (1 to 3 for tasks, 1 to 10 for backgrounds, and 1 to 100 for the luminaire) to avoid glare.

Modeling of Faces- Facial modeling is perhaps the most critical concern in the video conference room. As stated previously, the primary goal is to make a person look natural. Washing the face with diffuse light fails to accentuate the features of the occupants, while having too much direct light can create harsh shadows. Grazing light that shows facial flaws should be avoided. The lighting system should strike a balance by having direct light from a single angle with diffuse light illuminating the other side of the face.

Points of Interest- Aside from highlighting faces, accentuating additional points of interest is not a major concern.

Reflected Glare- Reflected glare from surfaces in the room should be avoided. Glare picked up by the camera can wash out the rest of the scene in the room and create a poor visual environment. Additionally, reflected glare off of the table should be avoided for reading purposes. Proper luminance ratios and good source/task/eye geometry should help to eliminate this problem.

Shadows- Once again, having shadows for facial modeling is critical. Too many shadows create an unnatural appearance and should be avoided.

Source/task/eye geometry- Proper source/task/eye geometry is important to avoid reflected glare, especially off of papers, books, etc. that are located on the desk.

Sparkle- Sparkle is not a major consideration in the video conference room.

System Control and Flexibility- To accommodate various scenes and various natural lighting scenarios, the lighting system in the video conference room should be flexible. Additionally, if there are visual problems on the display end of the video feed, have flexible controls would potentially allow the user to correct the problem on the sending end.

Lobby-

Color Appearance- Color appearance is important in the atrium area of the building. This is the main entrance and one of the main architectural features of the building. Good rendering is significant to accentuating architectural features as well as the people within the space.

Daylighting Integration and Control- The north and south walls of the atrium consist almost entirely of glazing, so daylight integration is key. Additionally, skylights are used in the back area of the atrium on the meadow (west) side of the building. Utilizing this light well can save energy and provide a very comfortable, natural lighting design.

Direct Glare- Controlling direct glare is a main task in the atrium. Possible sun light penetration from the south side could cause discomfort for anyone passing through or meeting in the area. Additionally, the lights could be a source of glare during a night time reception or other function that could be located in the atrium. Once again, luminances should be within the proper ratios.

Flicker and Strobe- Flicker and strobe are an important issue from a visual comfort perspective. Utilizing fluorescent lamps with appropriate electronic ballasts should eliminate any concerns.

Lighting Distribution on Surfaces and Uniformity- Having uniformly lit surfaces is primarily an aesthetic concern in the atrium area. Since the area is rather large, a sizable area of floor, ceiling, and wall space will be visible from a single location. As such, the atrium would look better if the lighting levels within it were consistent on a given surface.

Luminances of Surfaces- Surface luminance is important in the atrium to avoid reflected glare. Luminances should be kept within the proper ratios (1 to 3 for tasks, 1 to 10 for backgrounds, and 1 to 100 for the luminaire) to avoid glare.

Modeling of Faces- Facial modeling via the artificial lighting system is primarily a night time concern due to the large amount of natural light flooding the space during the day. At night, facial modeling becomes a key issue, especially during social functions. Adequate lighting levels (both directional and diffuse) should be provide to display a proper shadow level on the face.

Points of Interest- The atrium itself is a point of interest in the building as a main architectural feature. Within the atrium, some of the key elements include the large amount of wood paneling used on the walls. Highlighting the walls via a wall washer could help accentuate this natural feature. Directories should be highlighted by task lighting within the case.

Reflected Glare- A high amount of reflected glare, for example off the floor, could pose a source of discomfort.

Shadows- Shadows are linked once again to facial modeling and also to the areas of the atrium that are underneath the overhanging landings for each floor.

Source/task/eye geometry- This is primarily a transit and meeting space, so geometry will not be as critical as when the tasks were more demanding (reading f or example). Care should be taken to not put extremely bright sources where occupants are forced to look however as this may cause glare and discomfort.

Sparkle- Sparkle is not an issue in this space.

System Control and Flexibility- Due to the large amount of natural light in the space and the degree to which it changes given time of day and season, the artificial lighting system must be very flexible. Having adequate control capability to adapt to changes conditions is imperative.

Main Entrance-

Appearance- The main entrance is the primary exterior architectural feature of the building. It is critical that the lighting system performs well to accentuate the atrium space inside as well as address the surrounding trees.

Color Appearance- For safety issues, lamps should be chosen to provide good color rendering to better address any potential danger.

Direct Glare- Direct glare can cause visual discomfort as well as the inability to see well. This inability occurs both while in view of the light and shortly after leaving view until vision adapts. This is a major safety concern.

Lighting Distribution on Surfaces- Distribution should be even to avoid dark areas on path ways and also to provide good aesthetics in the front area of the building.

Light Pollution/Trespass- Cutoff luminaires will help avoid light pollution. Light trespass is not a major concern as the University owns all the property surrounding the building.

Modeling of Faces- Facial modeling is critical for the exterior of the building for recognition and perception of threats.

Points of Interest- The building entrance itself is a point of interest and should be highlighted. Additionally, large numbers of trees have been planted outside of the building which could be addressed to provide a good architectural feature, seeing as the building is for forest resources.

Reflected Glare- Similarly to direct glare, reflected glare impedes vision as well as threat identification and should be avoided.

Shadows- Shadows along pathways should be avoided for safety issues.

Source/task/eye geometry- Geometry should be addressed to avoid potential issues with direct and reflected glare along pathways.

System control and Flexibility- Control of the system should be a main concern to account for time of day and season. Flexibility is required to avoid wasting energy or having inadequate lighting levels when required.

ASHRAE/IESNA Standard 90.1 Power Allowance and Controls

Allowable Watts/ Square Foot (Based on table 9.3.1.2)

School/University:	Laboratory-	1.6 W/sq ft
	Conference Room-	1.5 W/sq ft
	Atrium (first three floors) -	1.3 W/sq ft
	Atrium (remaining floors) -	0.2 W/sq ft
	Exterior (under canopy) -	3.0 W/sq ft

Control Requirements

From 9.2.1.2: Space Control

Each space enclosed by ceiling-height partitions shall have at least one *control device* to independently *control* the *general lighting* within the space independently from the rest of the building. The control device can be an occupant sensor, a manual switch, or another type of lighting control. Each control device shall control a maximum of 2500 sq ft area for a space 10,000 sq ft or less.

From 9.2.1.3: Exterior Lighting Control

Lighting for all exterior applications not exempted in 9.1 and 9.3.2 (this building is not exempt) shall be controlled by a photosensor or astronomical time switch that is capable of automatically turning off the exterior lighting when sufficient daylight is available or the lighting is not required.

Design Evaluation

General-

The lighting systems in the School of Forest Resources Building perform well for providing adequate lighting levels at an acceptable power density. Typical 2x2 and linear fluorescent fixtures are used commonly and successfully. The result is not overly extravagant, but the systems serve their purpose well. One of the best features for the lighting system is the control capabilities. Using dimming panel control stations in classroom and conference areas allows for great flexibility in lighting levels, as well as energy savings. Many of the rooms are located along exterior walls, and can receive natural lighting through the large areas of glazing. This makes a dimming system a natural choice and an easy way to save energy.

Redesign Spaces-

The following is a basic analysis of the spaces being examined for redesign. AGI 32 computing software was used to examine illuminance levels and luminance ratios. Calculations and screenshots are shown. The computer files are included on the course CD if additional information is required.

Aquaculture Lab-

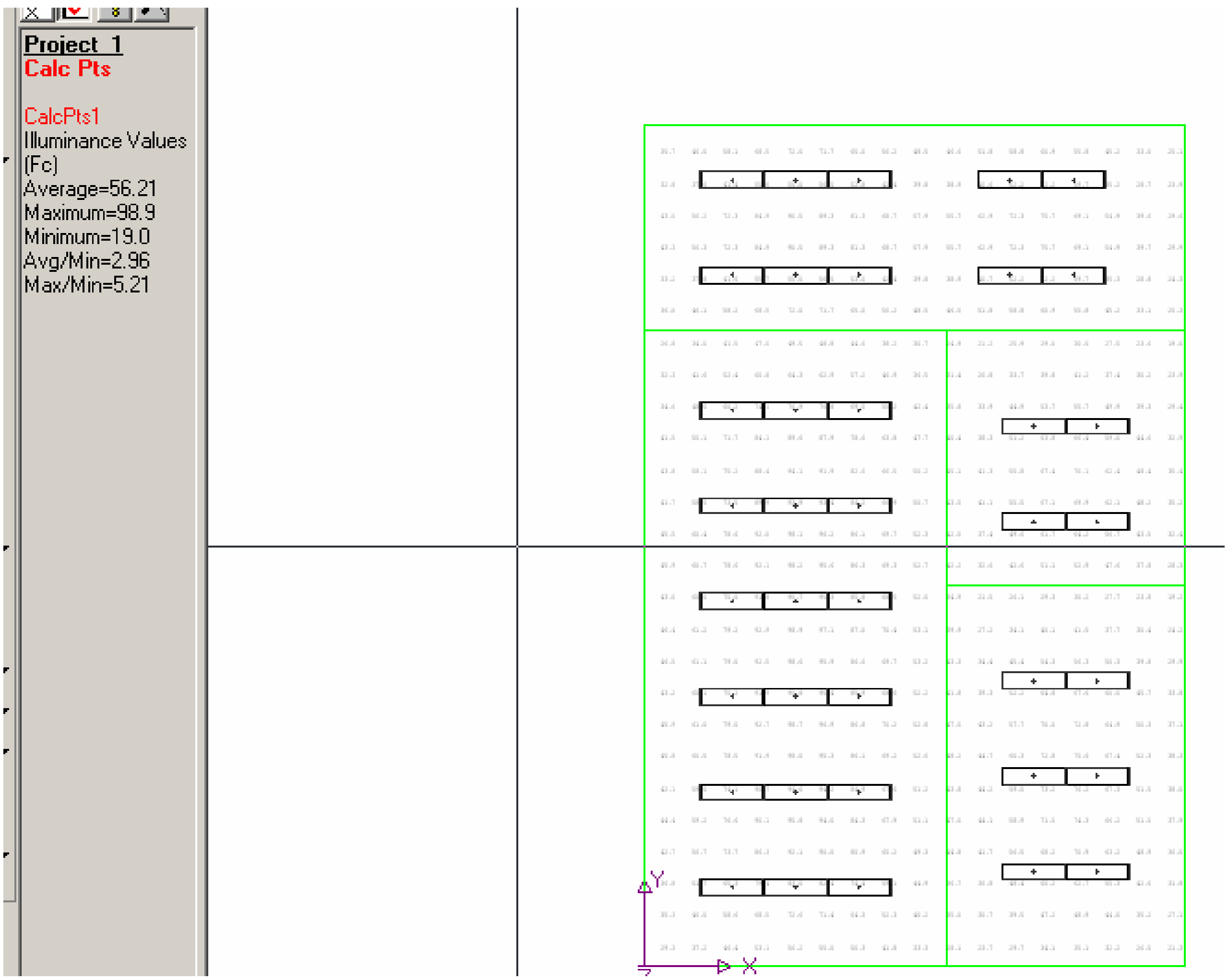
Surface Materials and Assumed Reflectances

Surface	Material	Reflectance
Floor	Finished Concrete	0.3
Walls	White Paint	0.7
Ceiling	Exposed Structural	0.25

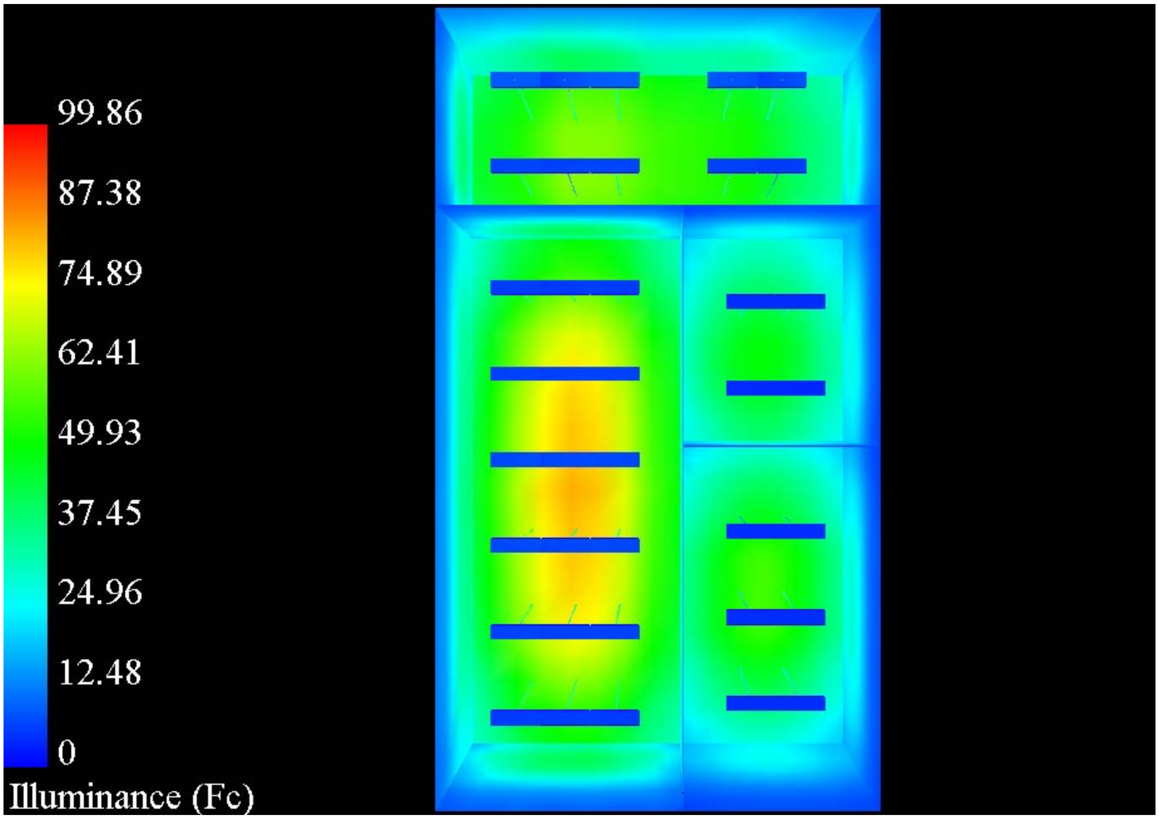
Light Loss Factors

Luminaire	Ballast Factor	Maintenance Category	Cleaning Interval	RSDD	LDD	LLD	Total LLF
FR16	0.88	V	Very Clean, 24 Months	0.98	0.9	0.95	0.737

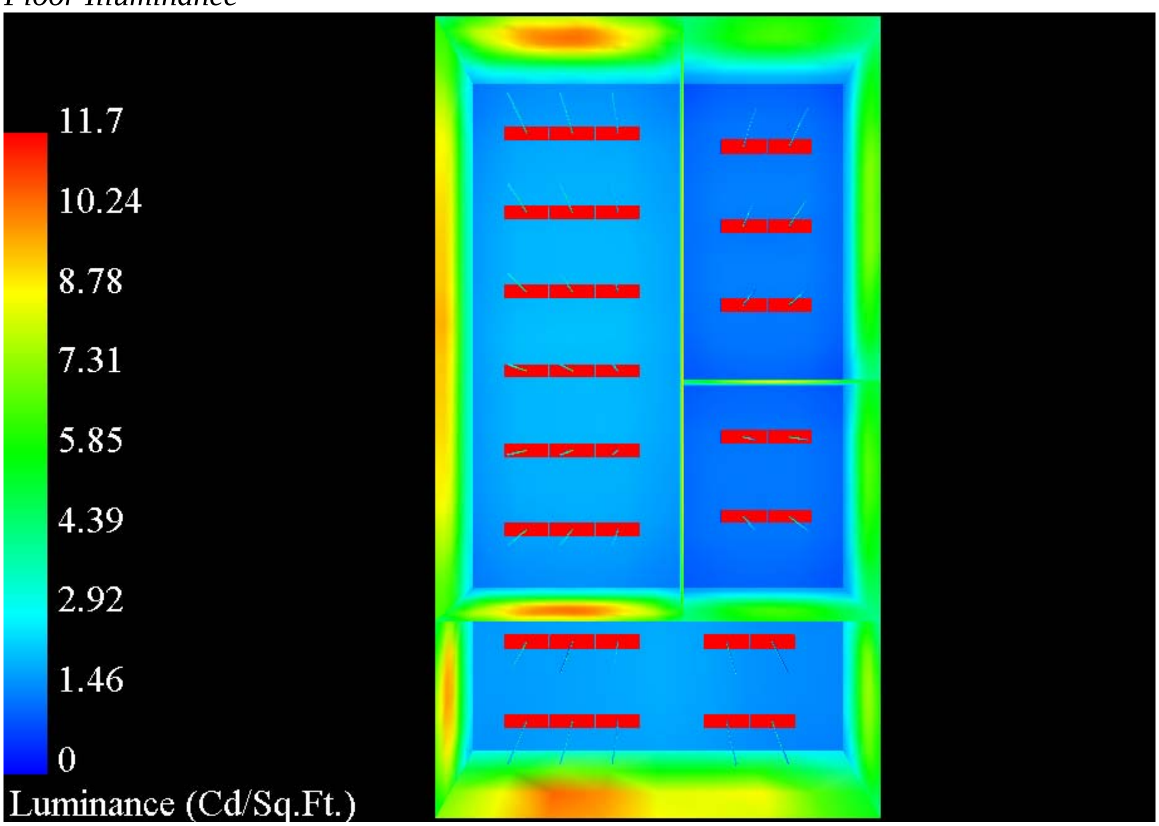
AGI 32



Calculation Grid Values



Floor Illuminance



Ceiling Luminance

Discussion- The system performs relatively well, providing an average of 56 fc, which is above the required 50fc set forth by the IESNA. Luminance ratios between the luminaires and the ceiling are within acceptable limits, so glare should not be a major concern. The system consumes a total of 2242W over an area of 1802 sq ft, bringing the power density to 1.24 W, well under the 1.6 prescribed by ASHRAE 90.1. Lighting is relatively uniform but falls off around the edges, which could cause some problems with uniform growth in the tanks. System control is via dimming panels in the space as well as dusk to dawn timers for the tanks and will meet ASHRAE 90.1 code requirements.

Video Conference

Surface Materials and Assumed Reflectances

Surface	Material	Reflectance
Floor	Carpet	0.35
Walls		
East and West	Acoustic panel	0.5
South	White Paint	0.7
North	Glazing	0.15
Ceiling	Acoustic Tile	0.7

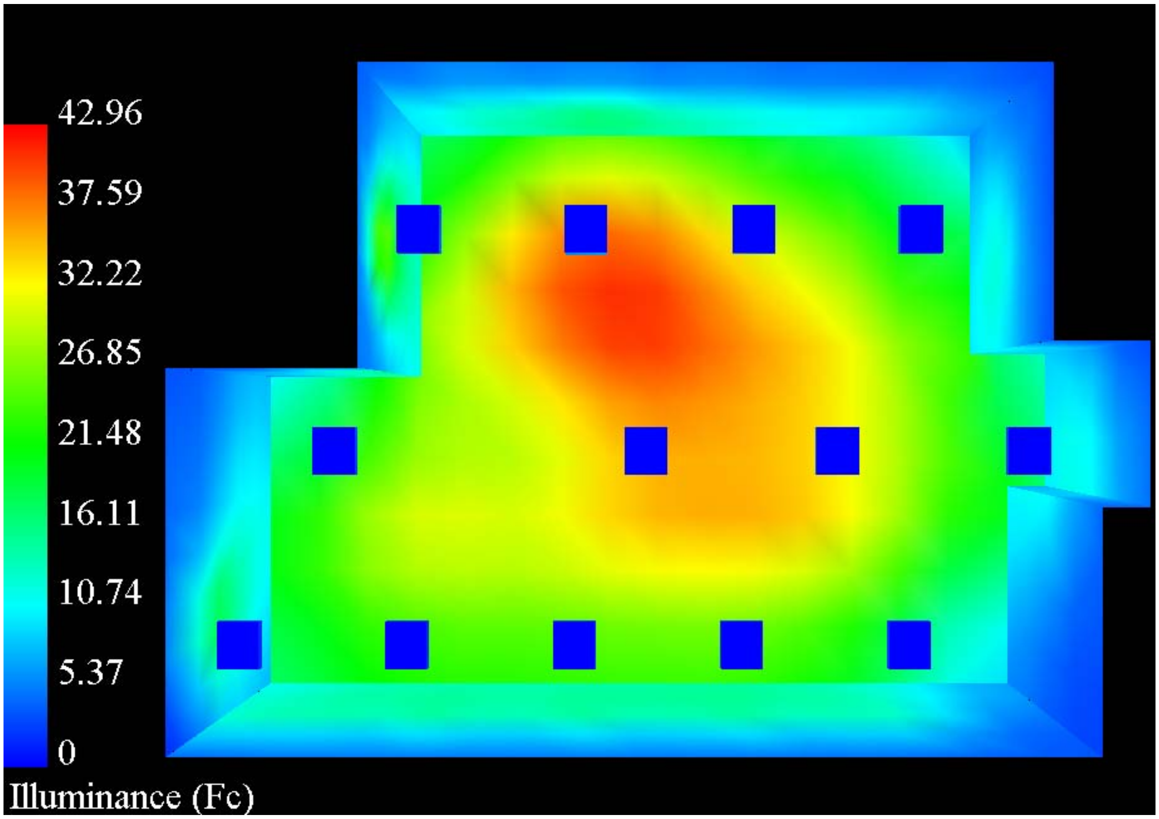
Light Loss Factors

Luminaire	Ballast Factor	Maintenance Category	Cleaning Interval	RSDD	LDD	LLD	Total LLF
FR1	0.88	IV	Clean, 24 Months	0.97	0.8	0.92	0.628

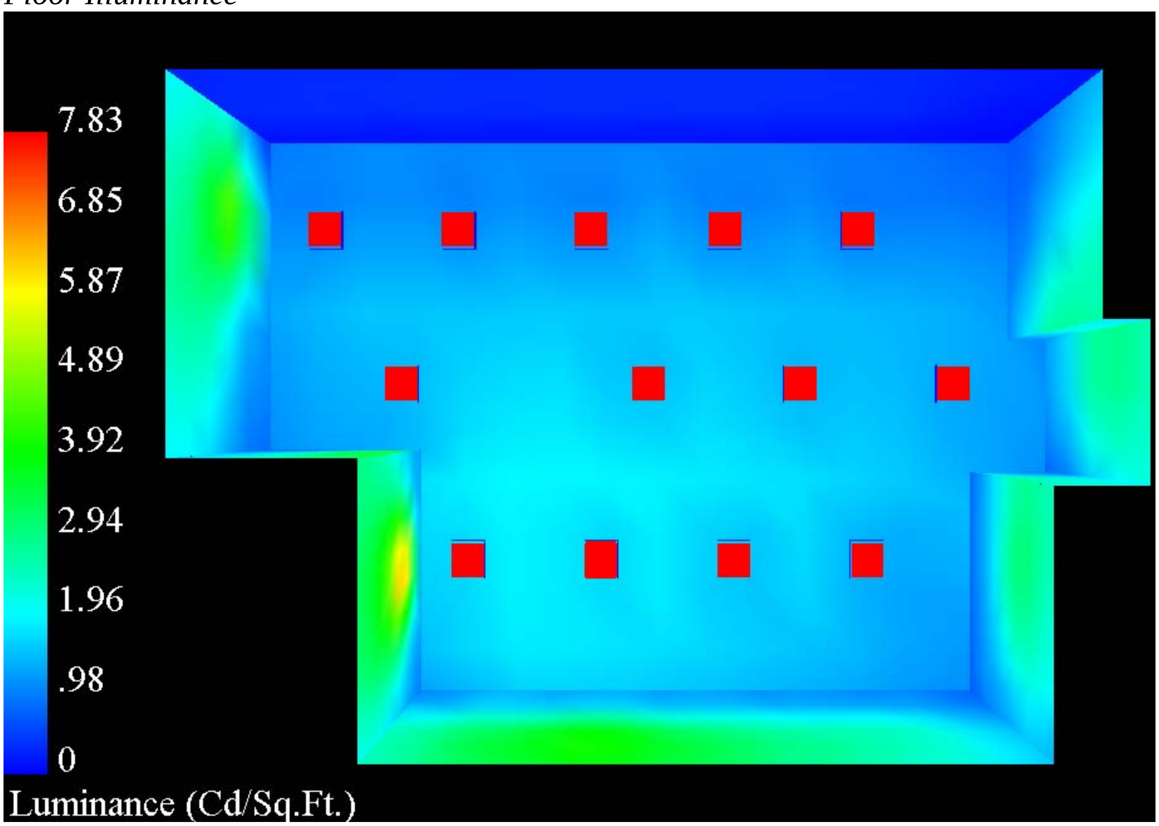
AGI 32

Calculation Grid Values

Rendering



Floor Illuminance



Ceiling Luminance

Discussion- This system showed mediocre performance. The floor illuminance is irregular and varies greatly. The required 50fc on horizontal surfaces was not achieved. Luminance ratios on the ceiling were acceptable. No source of directional light was provided to give good facial shadows. The system uses 767W over 879 square feet, which is under the power density requirement of 1.5 W/sq ft. This means additional luminaires could be added to improve performance. System control is via 3 manual switches located in the space and meets ASHRAE 90.1 requirements.

Atrium

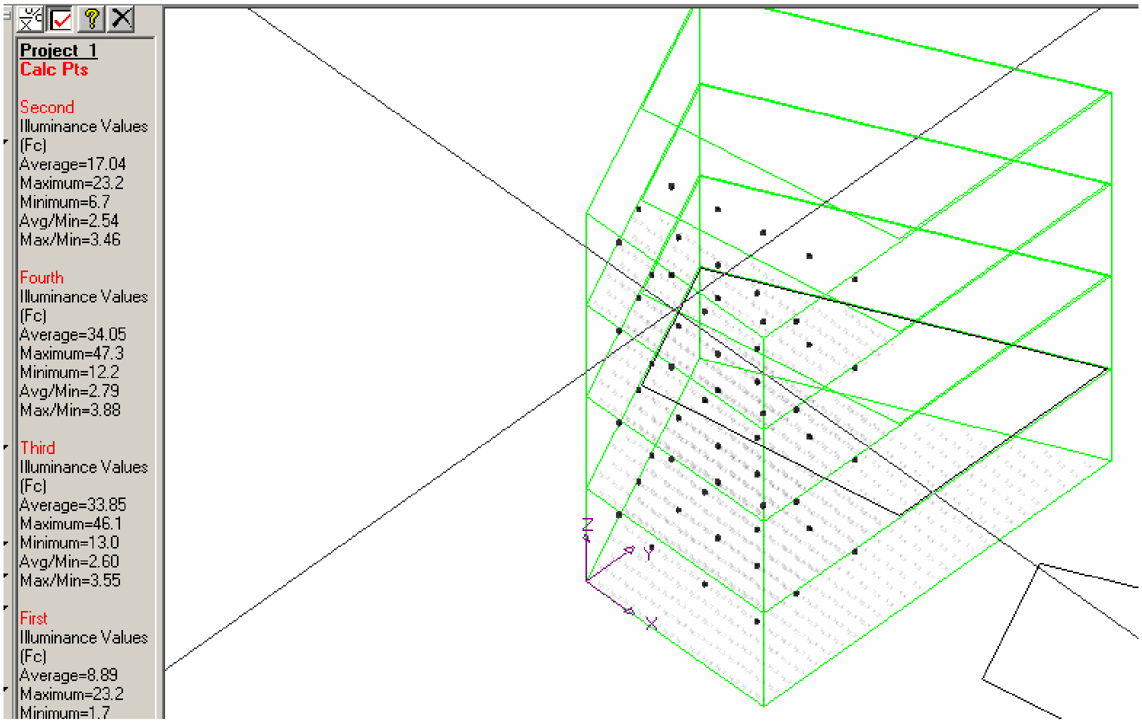
Surface Materials and Assumed Reflectances

Surface	Material	Reflectance
Floor	Terrazzo	0.3
Walls		
East and West	White Paint	0.7
North and South	Glazing	0.15
Ceiling	White Paint	0.7

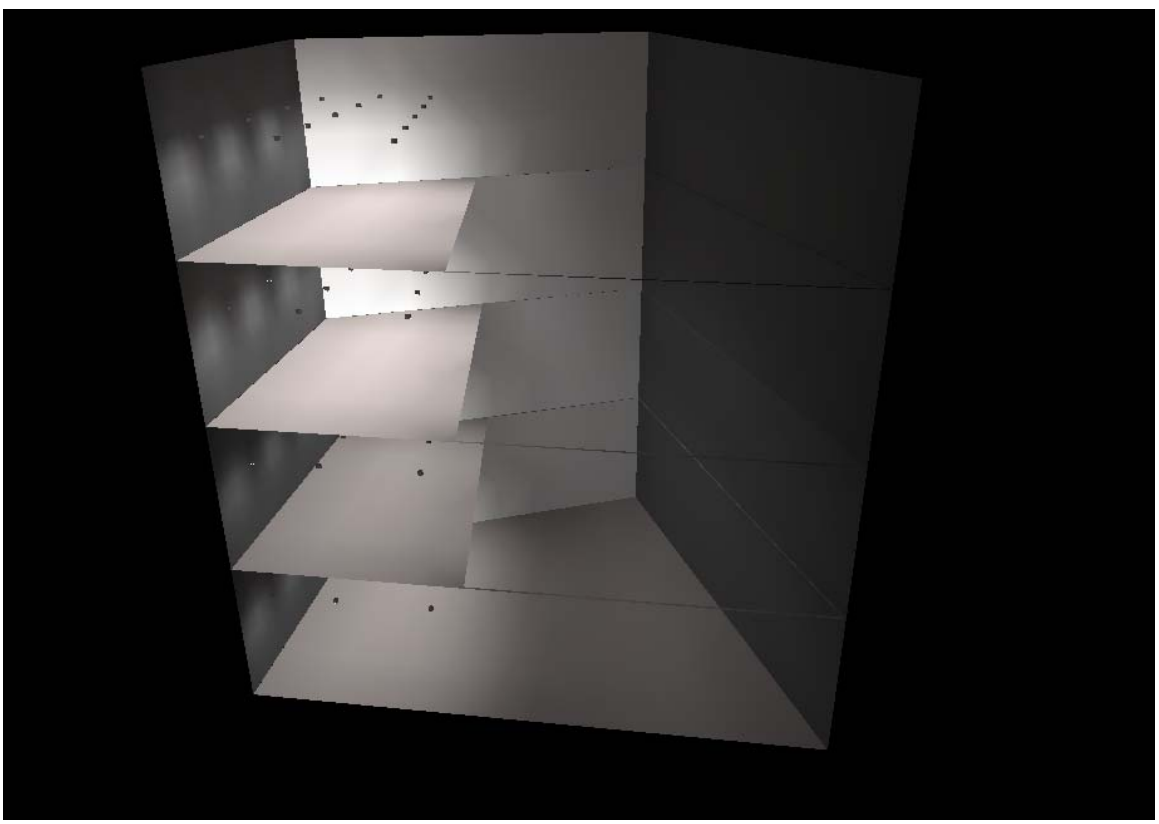
Light Loss Factors

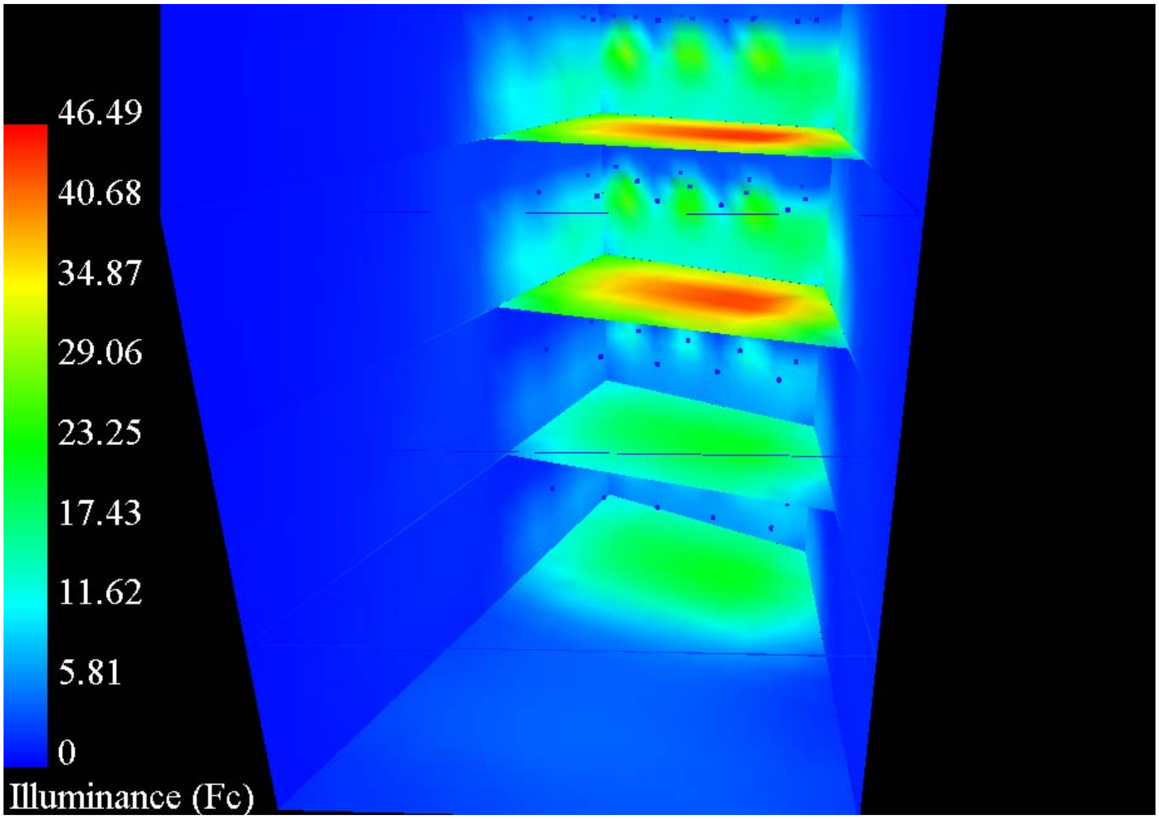
Luminaire	Ballast Factor	Maintenance Category	Cleaning Interval	RSDD	LDD	LLD	Total LLF
FR4	0.98	IV	Clean, 24 Months	0.94	0.8	0.91	0.67

AGI 32



Calculation Grid Values


Rendering



Floor Illuminance

Discussion- This system performed reasonably well. Illuminance was fairly consistent on each floor. The minimum 10 fc level was exceeded, so lighting requirements for illumination were met. Luminance ratios were within acceptable limits. The system consumes 2016 W spread over all floor areas totaling 3319 sq ft. This is well below the power allowance for only three floors, despite have four. System control in this space is divided up among several dimming panels and will meet ASHRAE control requirements.

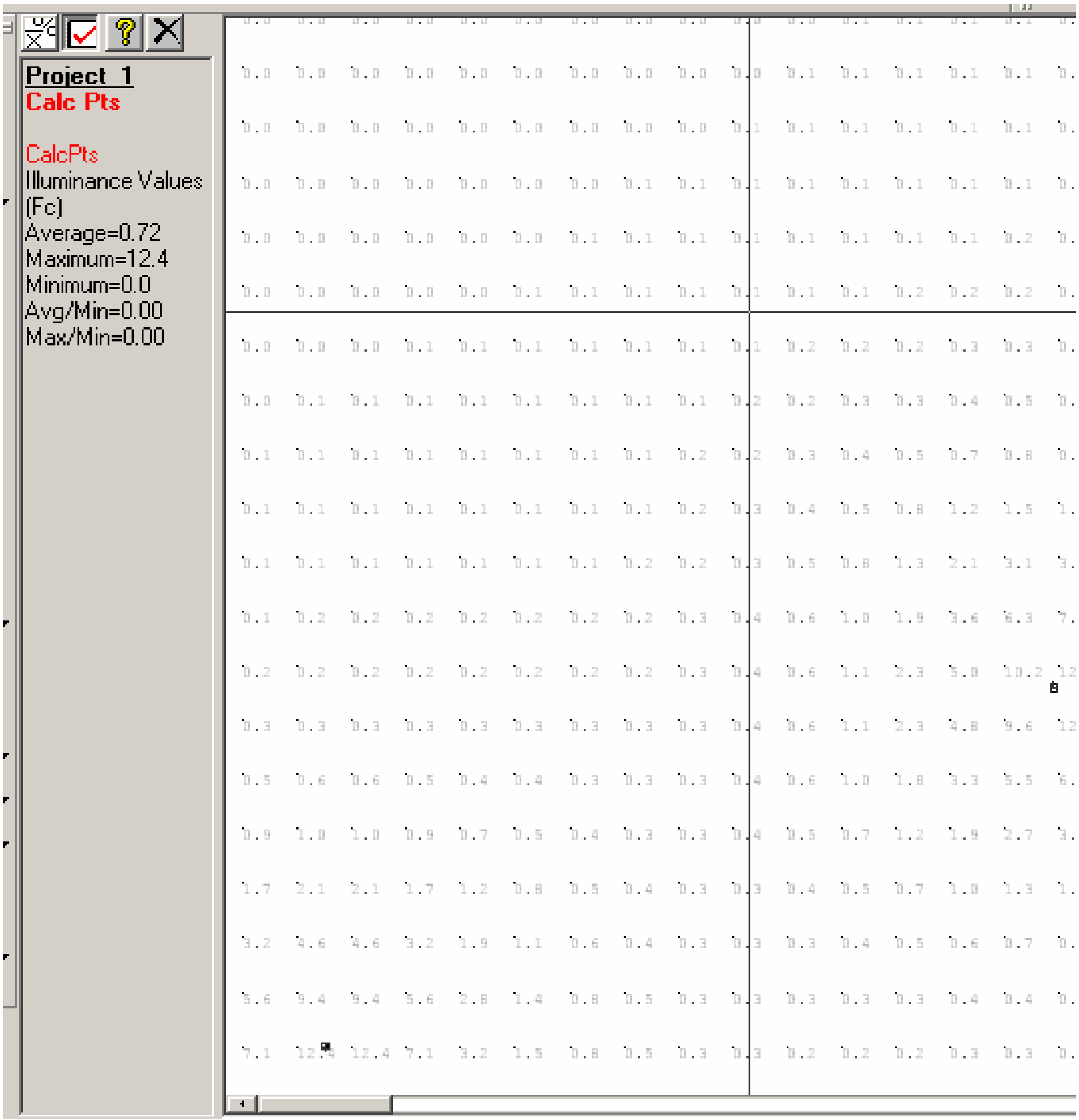
Note: Additional luminaires of currently unknown type are being specified by the architect for addition to the front glass wall section of the atrium. This will provide additional illumination to the areas below (mainly the darkest areas of the first floor). This will be updated as soon as possible.

Main Entrance

Note: Two additional luminaires are being added to the main entry space of the building and are being provided by the architect. Luminaires are currently of unknown type. Examination of front façade of building will be inaccurate without them. Examination of the exterior site lighting near the main entrance has been conducted.

Light Loss Factors

Luminaire	Ballast Factor	Maintenance Category	Cleaning Interval	RSDD	LDD	LLD	Total LLF
Sl1	0.9	V	Clean, 24 Months		0.85	0.87	0.665



Left Portion of Screen

.1	0.1	0.1	0.1	0.1	0.2	0.2	0.4	0.6	1.1	2.3	4.6	[illegible]	12.0	8.3	4.0
.1	0.1	0.1	0.1	0.1	0.2	0.2	0.4	0.6	1.1	2.4	5.1	10.4	12.3	9.0	4.2
.1	0.1	0.1	0.1	0.1	0.2	0.2	0.4	0.6	1.0	1.9	3.7	6.5	7.9	5.8	3.2
.1	0.1	0.1	0.1	0.2	0.2	0.2	0.3	0.5	0.8	1.3	2.2	3.2	3.6	2.9	1.9
.1	0.1	0.2	0.2	0.2	0.2	0.2	0.3	0.4	0.6	0.8	1.2	1.6	1.7	1.5	1.1
.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.4	0.5	0.7	0.8	0.9	0.8	0.6
.2	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.4
.3	0.4	0.5	0.5	0.5	0.4	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
.5	0.7	0.8	0.8	0.8	0.7	0.5	0.4	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2
.8	1.2	1.5	1.6	1.5	1.1	0.8	0.5	0.4	0.3	0.2	0.2	0.2	0.2	0.1	0.1
.3	2.1	3.1	3.5	2.9	1.9	1.1	0.7	0.4	0.3	0.2	0.2	0.2	0.1	0.1	0.1
.9	3.6	6.3	7.7	5.7	3.2	1.6	0.9	0.5	0.3	0.2	0.2	0.1	0.1	0.1	0.1
.3	5.0	10.2	12.4	9.1	4.3	2.0	1.0	0.6	0.3	0.2	0.2	0.1	0.1	0.1	0.1
.3	4.8	9.6	12.2	8.6	4.1	2.0	1.0	0.5	0.3	0.2	0.2	0.1	0.1	0.1	0.1
.8	3.3	5.5	6.6	5.0	2.9	1.5	0.8	0.5	0.3	0.2	0.1	0.1	0.1	0.1	0.1
.2	1.9	2.7	3.0	2.5	1.7	1.0	0.6	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1
.7	1.0	1.3	1.4	1.3	1.0	0.7	0.4	0.3	0.2	0.1	0.1	0.1	0.1	0.1	0.0
.5	0.6	0.7	0.7	0.7	0.6	0.4	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.0	0.0
.3	0.4	0.4	0.4	0.4	0.3	0.3	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0
.2	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0

Right Portion of Screen

Discussion: An inadequate amount of light is provided by the three fixtures, resulting in large dark areas between them. This should be improved however by the addition of the façade lights nearby. The system power density relative to the canopy allowance will be computed when the new fixtures are available. Exterior lighting is controlled by a panel equipped with a time clock for function during specified times. This will meet the control standards set forth in ASHRAE 90.1. Light pollution should be minimized as the fixture has a solid cap on the top minimizing any light shooting upwards. Additionally, shields within the housing prevent direct glare from impeding vision at night.