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Incline Village, NV . **location**
10/06/05 . **date**
Technical Report 1 . **title**

This report, along with supplemental information, can be found at “P:\ae 481\tech1”
Full report available for download from the web at “http://www.arche.psu.edu/thesis/eportfolio/current/portfolios/jdm341/”

Executive Summary:

The following is a technical report concerning the current conditions of the lighting system within the Tahoe Center for Environmental Sciences (TCES). Four spaces were analyzed: the lobby/prefunction area, the case study classroom, the chemistry lab, and the exterior facade. AGI 32 v1.8 was used to determine existing illuminance levels and examine rough images of what the space might look like were it built today. Information for materials and their reflectances was obtained from the specification sections and the drawings, and light loss factors for all light fixtures were obtained using standard IES procedures.

The existing conditions were found to be adequate in most cases. ASHRAE 90.1 was only exceeded in the chemistry lab, and the IES recommended illuminance levels were adhered to fairly well. The only exception being the chemistry lab, where it was overlit. Although this overlighting can be attributed to the fine and sometimes dangerous tasks performed in chemistry labs, a similar level of light could possibly be achieved using a different lighting approach that meets ASHRAE 90.1 requirements.

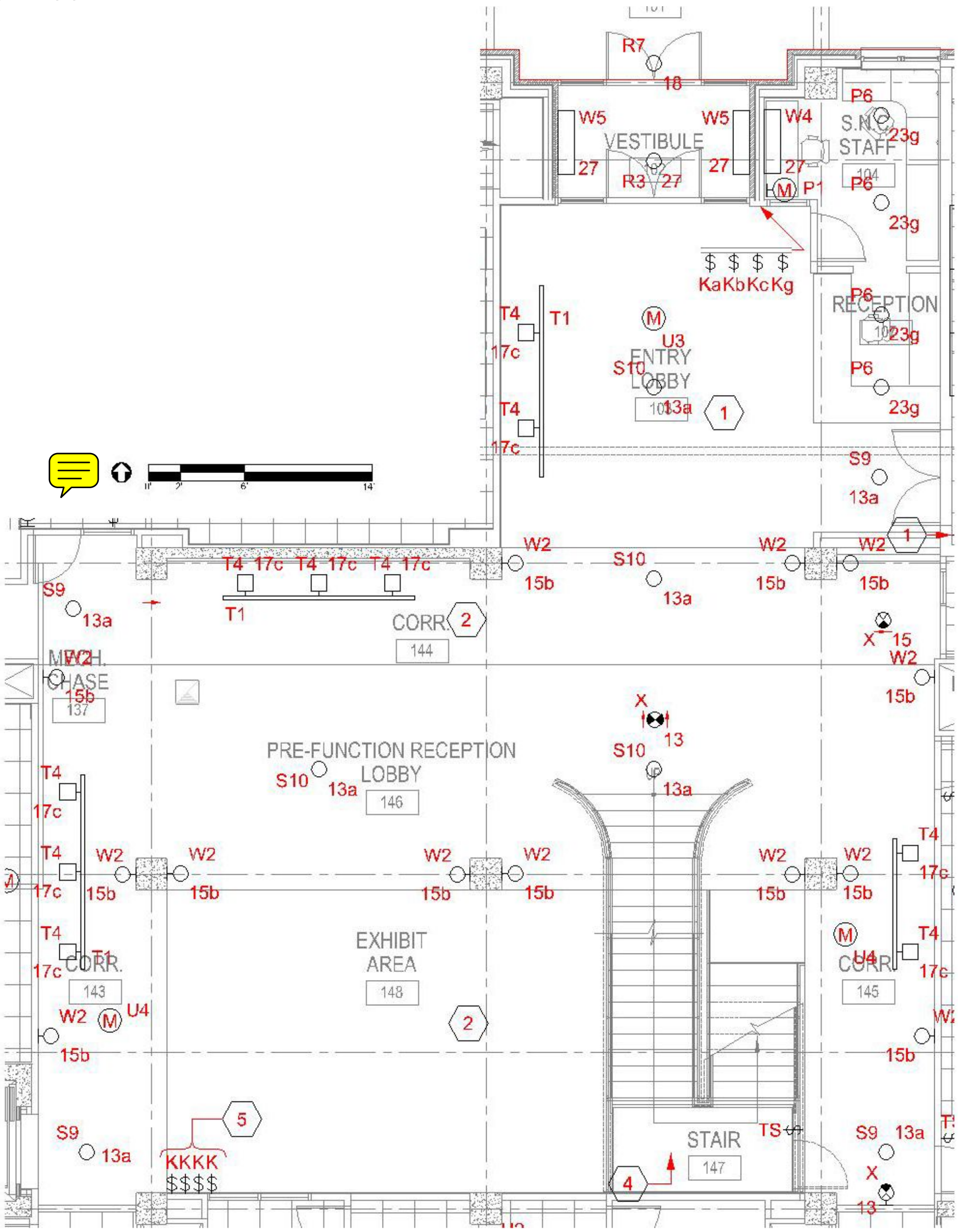
Overall, it was determined that the lighting system in TCES needs to be versatile enough to handle multiple uses. Many of the spaces serve different purposes and as such will need to be lit in such a way that they can be functional in a variety of different situations. This must be done with energy efficient design in mind since TCES is currently slated to be a LEED platinum project. Some methods that were found to possibly reduce energy were switching to more efficient sources (linear fluorescent instead of compact fluorescent) and bringing light directly to where it is needed to avoid over lighting a space (such as task lighting in the case study classroom. Furthermore, it was determined that several of the spaces would benefit from daylight studies to see if a further reduction in energy use can be achieved.

From the analysis, a broader understanding of how the current lighting system within TCES operates, where it has its strengths and where it can use improvement was gained. Using the design criteria generated, along with the analysis of each individual space, a different and hopefully superior lighting system can be designed to meet the tenants needs.

Lobby/Prefunction Area

Floor Plan and Lighting Layout:

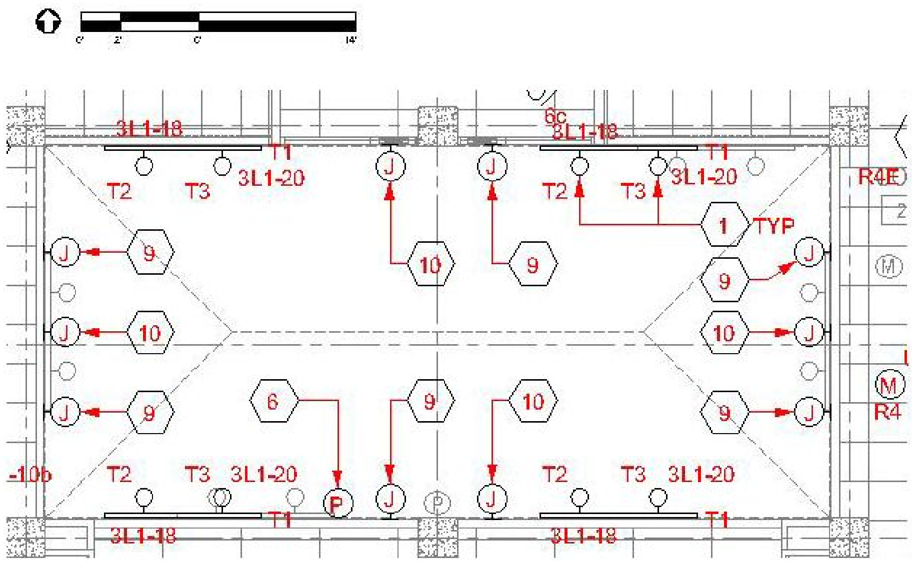
First Floor:



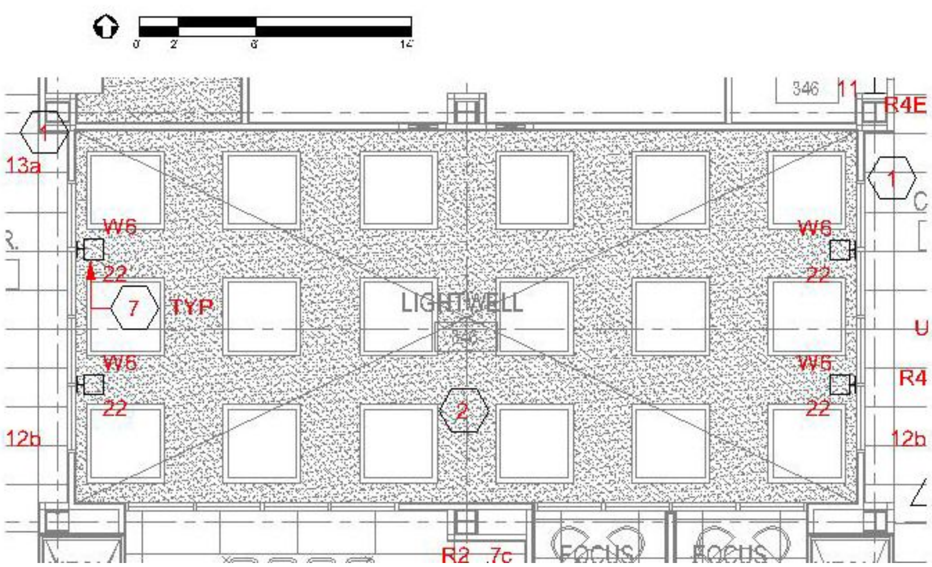
Lobby/Prefunction Area

Floor Plan and Lighting Layout:

Second Floor:



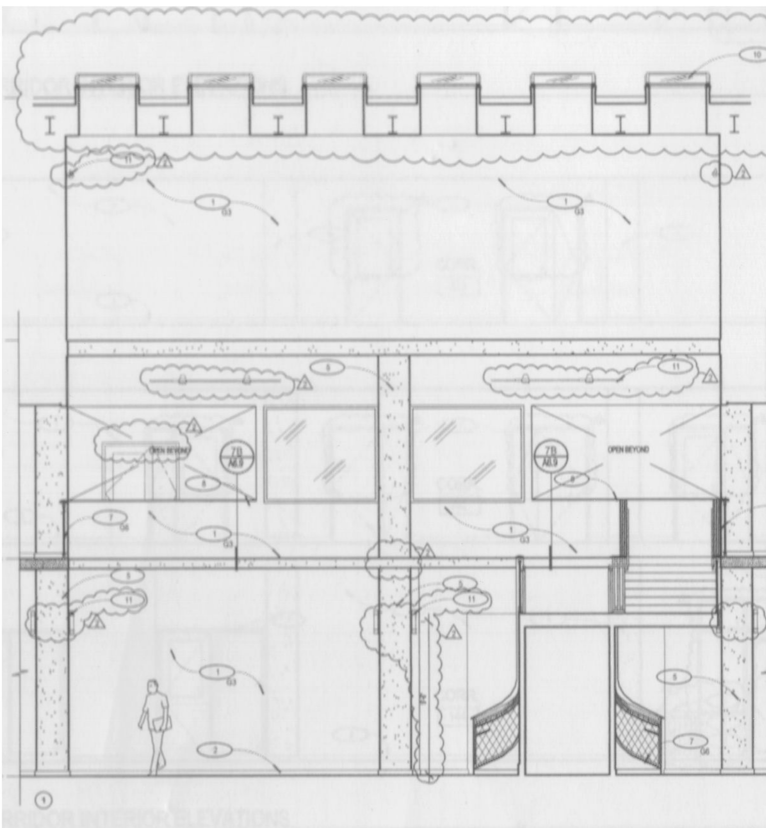
Third Floor:



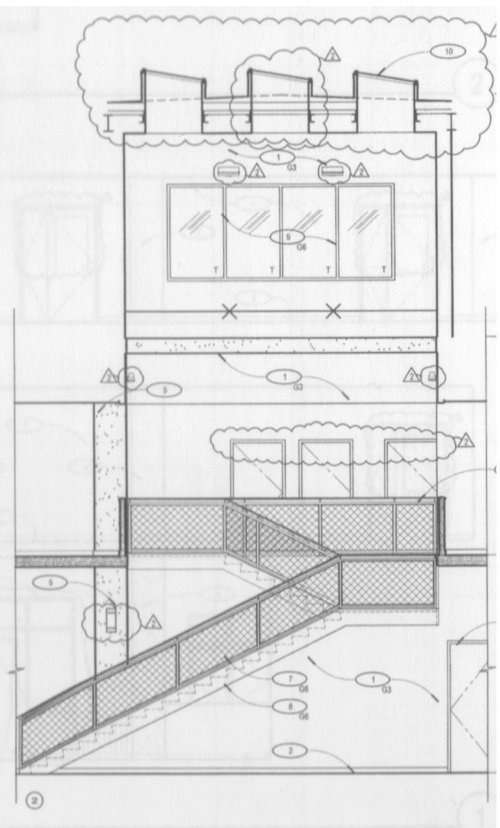
Lobby/Prefunction Area

Floor Plan and Lighting Layout:

Sections:



Looking North



Looking East

Lobby/Prefunction Area

Materials:

Walls: Painted Gyp. Bd. (Eggshell)
Reflectance of 65%

Columns: Exposed Concrete
Reflectance of 40%

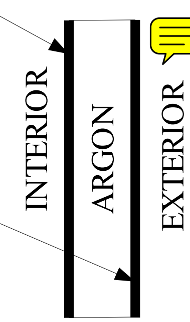
Ceiling: Exposed Concrete
Reflectance of 40%

Wall Base: Molded Wood Base
Reflectance of 30%

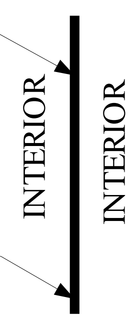
Floor: Colored Concrete with Sealant
Reflectance of 20%

Glazing:

To Exterior: (2) Panes, Argon Filled – construction as follows
Indoor Lite:
Ultra-Clear (Low-Iron) Float Glass
Transmittance of 91%
Reflectance of 8%
Solar Heat Gain Coefficient of .87
Outdoor Lite:
Ultra-Clear (Low-Iron) Float Glass
Transmittance of 91%
Reflectance of 8%
Solar Heat Gain Coefficient of .87



To Interior: 1/4” Monolithic Glass (Safety Glazing)
Amber Tint
Transmittance of 65%
Reflectance of 4%
To Interior: 1/4” Tempered Glass
Transmittance of 91%
Reflectance of 8%



Lobby/Prefunction Area

Controls:

Occupancy Sensors:

U3 = Wattstopper WT-2200
Ceiling mounted ultrasonic motion detector
2200 square feet, 360 degree coverage

U4 = Wattstopper WT-2250
Ceiling mounted ultrasonic motion detector
90 linear feet, 360 degree coverage

Control Systems:

Lutron Grafik Eye GRX-3106A WH and NT GRX-45 wall stations

Operating Conditions:

Fixtures controlled by LCP-1 during normal building hours. After the clock in the control panel times out, the fixtures on circuits 11, 13, 15, 19 and 21 are controlled by occupancy sensors. Lightwell fixtures (2nd and 3rd floor plans, circuit 20) are controlled by LCP-1 and are scheduled to turn off at 12am every day. A manual override for the exhibit space track fixtures (1st floor plan, circuit 17) is provided with a 120 minute time delay. Public corridors on the second on third floor adjacent to the light well follow the normal on/off schedule and do not contain a manual override option.

Normal business hours are here defined as:

Mon-Fri	8am-10pm
Sat-Sun	8am-6pm

Lobby/Prefunction Area

Existing Lighting Conditions:

Fixture Schedule

Label	*Description*	*Lamping*	*Voltage*	*Total Watts*	*Ballast*	*Quantity*
T2	Wall Mounted Spot	(1) M70PAR38/830	120	94	IE	4
T3	Wall Mounted Spot	(1) M35PAR30L/830	120	41	IE	4
T4	Track mounted accent light	(2) CFL24DL/835	120	52	E	10
W2	Rectangular wall sconce	(2) CFL18DD/835	120	38	E	13
W5	Wall Mounted Flood	(1) F32T8/830	120	35	E	4
S9	Surface mounted circular area light	(3) CFL26DT/835	120	87	E	5
S10	Surface mounted circular area light	(4) CFL26DT/835	120	116	E	4
P6	Suspended low-bay lensed pendant	(1) M100/830	120	129	E	2

Ballast Types:
- E: Electronic
- IE: Integral Electronic

Existing Power Density:

$$\frac{[(94W)(4)+(41W)(4)+(52W)(10)+(38W)(13)+(35W)(4)+(87W)(5)+(116W)(4)+(129W)(2)]}{2915sf}$$

= .978 W/sf

Lobby/Prefunction Area

Existing Lighting Conditions:

LLF Schedule

Label	*Cat.*	*Room*	*Clean Interval*	*BF*	*LLD*	*RSDD*	*LDD*	*LLF*
T2	IV	Clean	12 months	1	1*	.95	.89	.85
T3	IV	Clean	12 months	1	1*	.95	.89	.85
T4	IV	Clean	12 months	.95	1*	.95	.89	.81
W2	IV	Clean	12 months	.95	1*	.95	.89	.81
W5	IV	Clean	12 months	.95	1*	.95	.89	.81
S9	V	Clean	12 months	.95	1*	.95	.87	.79
S10	V	Clean	12 months	.95	1*	.95	.87	.79
P6	VI	Clean	12 months	1	1*	.95	.87	.83

* Mean lumens were used in calculations as opposed to initial lumens, so lamp lumen depreciation values are 1

Task Descriptions:

The Lobby area serves multiple purposes. It's main function will be as the primary circulation space for the building. Secondary functions will include being an exhibit area to display research taking place in the building, a prefunction space for people to gather before and after events such as lectures and a greeting and reception area for visitors to the building. Both horizontal and vertical illuminances must be carefully considered since horizontal illuminance is critical to circulation areas and vertical illuminance is critical to facial rendering requirements of a gathering area and display lighting of an exhibit area. Tasks will include walking throughout the space, facial recognition for the receptionist area as well as throughout the space and looking at the various exhibits on display.

Lobby/Prefunction Area

Design Criteria:

Daylight Integration:

Due to the light well present in the center of the lobby, daylight integration must be considered. The well provides an opportunity to bring daylight into the space, but must be approached cautiously so as to avoid bringing direct sunlight inside the building. Dimming or switching are two possibilities to controlling the light levels in order to integrate with the daylight present.

Green Design:

Since TCES is designed to be a LEED platinum project, energy efficient design and general “green design” is of utmost importance. The power density is already low, but could be lower with the successful integration of daylight and the possible use of more efficient light sources such as linear fluorescents instead of compact fluorescents.

Fixture Appearance:

With the exposed concrete slab, there is no possibility of using recessed fixtures, so fixtures must be chosen that will compliment the architecture and will not detract from it. Finding a unifying theme for all fixtures chosen (such as shape or style) may help the fixtures to not detract from the space, and to not distract the users.

Reflected Glare:

The main source of glare in the lobby would be from the light well. Because the skylights are so high up, it may not be a problem as far as direct glare is concerned, but because of the use of glazing in the solarium, some reflected light may become a problem. This reflected light may even pose a safety risk to those using the stairs within the solarium.

Accent Lighting:

As this will be a space to display various research projects, accent lighting is essential. Because the exhibits will be changing fairly frequently, flexibility within the accent lighting system is key. This flexibility may be achieved through a track lighting system, or perhaps through other more innovative means. The lightwell should not interfere too much with accent lighting as the areas to be accented are between 10 and 20 feet away from the lightwell and the ceilings are only about 11 feet high.

(cont'd on next page)

Lobby/Prefunction Area

Design Criteria (cont'd):

Highlighting:

People will need visual cues as to where to go when they enter the building. As such, the receptionist desk will be a highlighted point, as well as the stairwell. Additional layers of light may be used to lead people to various rooms and displays, but the visual hierarchy will first be composed of the receptionist and stairwell.

Illuminance Criteria:

Horizontal:		
Reception:	20fc calculated	(IES 10fc)
Gathering:	21fc calculated	(IES 10fc)
Circulation:	21fc calculated	(IES 5fc)
Vertical:		
Reception:	13fc calculated	(IES 5fc)
Gathering:	8fc calculated	(IES 5fc)
Illuminated Walls:	23fc calculated	(IES 30fc)

Importance and Hierarchy:

Vertical and horizontal illuminances must be maintained in order to accomplish the tasks that the space requires. Horizontal illuminances must also be met to meet local egress code requirements for light levels. Right now, everything is fairly flat, with the walls being the main accent points. The hierarchy of objects in the space will need to be looked at and the illuminances and luminances varied accordingly so that objects will be noticed in order of importance. Since the space will also have various functions, flexibility in terms of the lighting system will be important as well. This flexibility may lead to the ability to dim or separately control certain lights that are not needed for certain functions such as the track lights and the lights near the receptionist desk.

Power Density:

ASHRAE 90.1 allowance (school/university lobby):1.8 W/sf

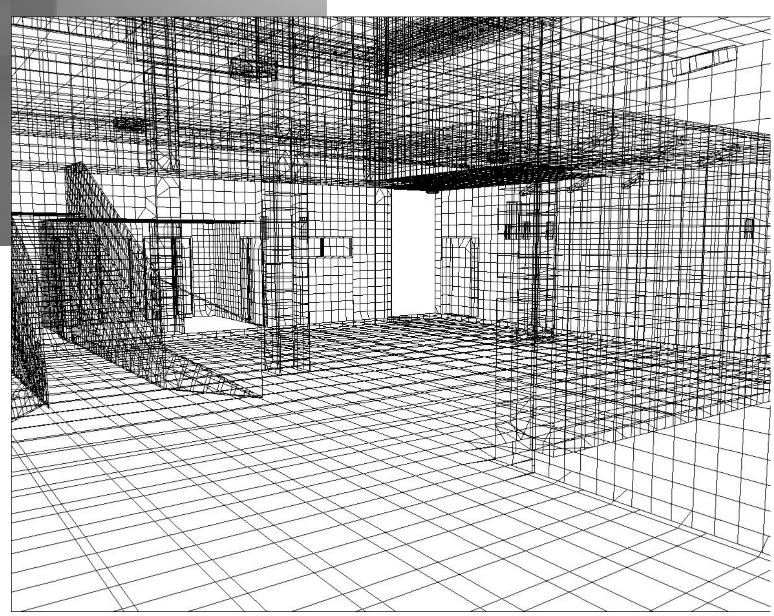
An additional 1W/sf can be added for decorative wall sconces and highlighting exhibits, but will most likely not be used.

Existing: .978 W/sf **OK**

Lobby/Prefunction Area

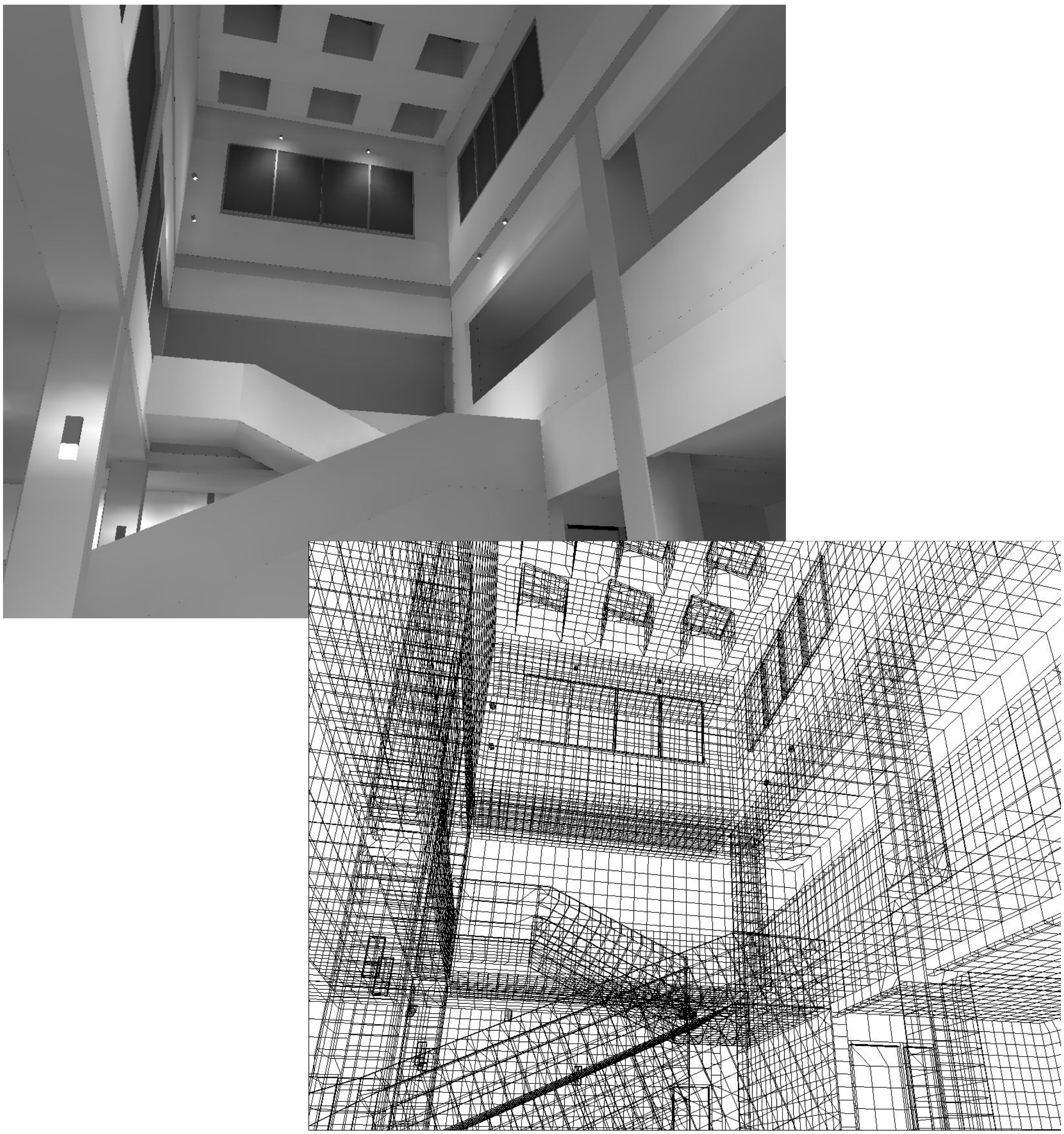
Analysis of Existing System:

AGI 32 was used to calculate the existing lighting conditions for the space. All reflectances and light loss factors cited above were used in the computer model. A fine mesh was used for this space due to the number of obstructions and the possibility for innacurate shadowing effects when using a large patch size. Future calculations will be done using Radiance as an exercise in rendering using alternate software and to aide in the calculation of glare and luminance ratios. Shaded and wireframe views are shown below.



Lobby/Prefunction Area

Analysis of Existing System (cont'd):



Analysis of Existing System (cont'd):

Horizontal calculation grids were placed on the floor workplane, on the receptionist desk and on the stairs. Vertical calculation grids were placed going north-south and east-west within the space and on each of the walls highlighted by track lighting as well. For more information on the locations of grids, see the AGI printouts attached.

Results:

- Horizontal:
  - Floor Avg – 21 fc
  - Receptionist Avg – 20 fc
- Vertical:
  - Wall Avg – 23 fc
  - North-South – 13 fc
  - East-West – 8 fc

All surfaces are satisfactory, or overlit when compared to IES recommendations. As a result, some light levels may be dropped which may improve power density. The walls could possibly be increased to 30 fc to give the exhibits a little more accent. All illuminances will have to be reevaluated once a hierarchy is established.

Dimming and switching systems should be investigated to ascertain the most appropriate control scheme for the space. Also, daylighting scenarios will need to be run to determine the effect of daylight on light levels within the space.

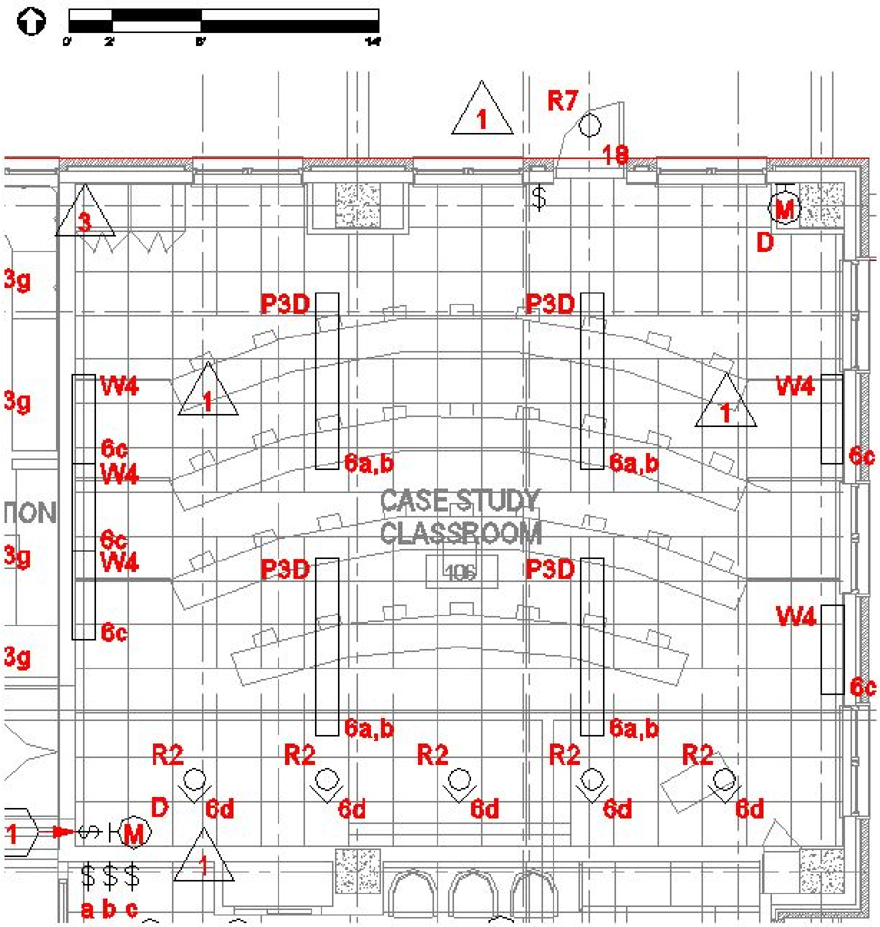
Though the power density is already rather low and the atmosphere is quite nice, the necessity of green design will make any additional power savings a welcome addition to the building. Also, tying in the fixtures with the architecture will give a more unifying theme to the space.

Since the building is designed to have as little impact on the environment and to mesh as well with nature as possible, a possible theme might be nature. Nature tends to keep things as simple as possible and yet at the same time make them beautiful. The bare concrete on the ceiling and on the columns seems to lend itself to expressing the true nature of materials. I will attempt to present the concrete as concrete. Any fixtures selected will be chosen to have as little impact on the space as possible so it can be presented simply and so they will not be a distraction.

Case Study Classroom

Floor Plan and Lighting Layout:

Floor Plan:

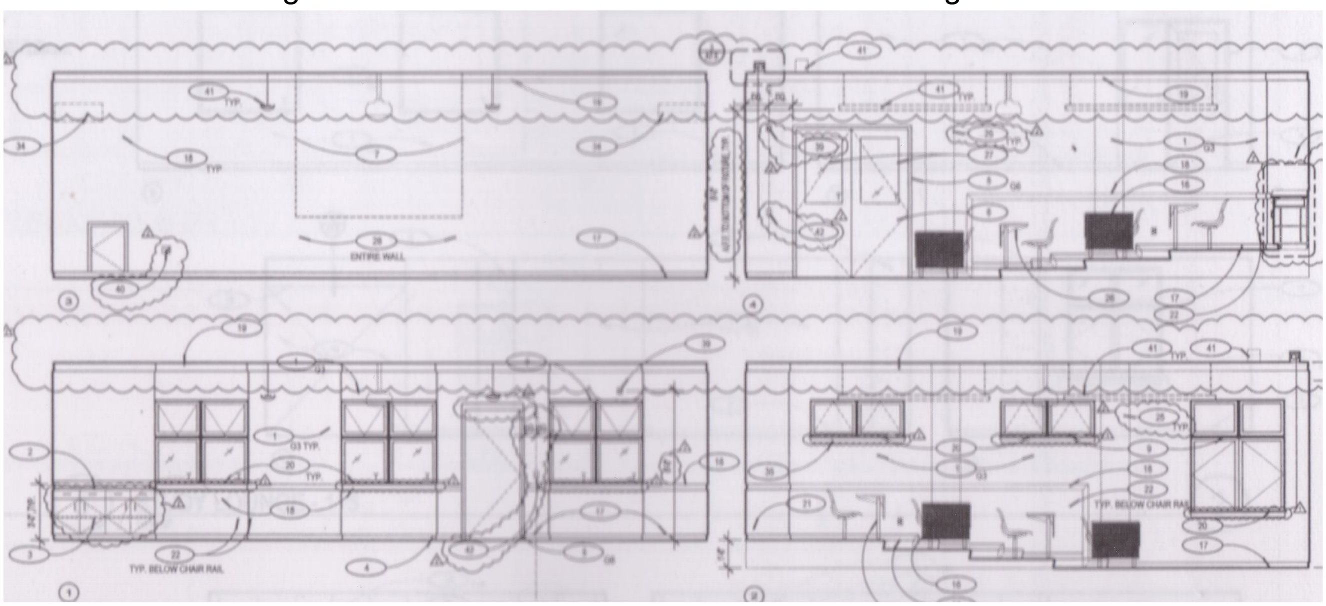


Case Study Classroom

Floor Plan and Lighting Layout:

Sections:

Looking South Looking West



Looking North Looking East

Case Study Classroom

Materials:

Walls: Painted Gyp. Bd. (Eggshell)
Reflectance of 65%

Vinyl Wallcovering (Eggshell)
Reflectance of 50%

Ceiling: White Acoustical Tile (AC-2: 1.5" thick)
Reflectance of 90%

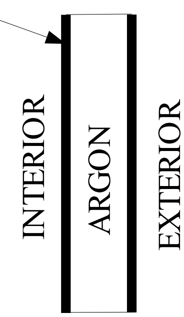
Painted Gyp. Bd. (Eggshell)
Reflectance of 65%

Wall Base: Vinyl Base
Reflectance of 15%

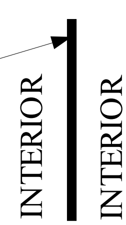
Floor: Carpet Tile
Reflectance of 20%

Glazing:

To Exterior: (2) Panes, Argon Filled – construction as follows
Indoor Lite:
Ultra-Clear (Low-Iron) Float Glass
Transmittance of 91%
Reflectance of 8%
Solar Heat Gain Coefficient of .87
Outdoor Lite:
Ultra-Clear (Low-Iron) Float Glass
Transmittance of 91%
Reflectance of 8%
Solar Heat Gain Coefficient of .87



To Interior: 1/4" Tempered Glass
Transmittance of 91%
Reflectance of 8%



Controls:

Occupancy Sensors:

D = Wattstopper DT-200
Wall mounted dual-tech (ultrasonic and passive infrared) motion detector
2000 square feet walking motion @ 10'-0” A.F.F.
1000 square feet desktop motion @ 10'-0” A.F.F.

Control Systems:

Lutron Grafik Eye NT GRX-45 wall station
Lutron Grafik Eye GRX-FDBI interface for P3D fixtures

Operating Conditions:

Fixtures are controlled by LCP-1 during normal building hours. After the clock in the control panel times out, the fixtures are controlled by occupancy sensors. Dimming Ballasts within the pendant fixtures allow for different scenes to be set depending on what the room is currently being used for.

Normal business hours are here defined as:

Mon-Fri	8am-10pm
Sat-Sun	8am-6pm

Case Study Classroom

Existing Lighting Conditions:

Fixture Schedule

Label	*Description*	*Lamping*	*Voltage*	*Total Watts*	*Ballast*	*Quantity*
P3D	Linear Fluorescent Indirect Pendant	(3) F32T8/835	120	102	E	8
W4	Wall Mounted Linear Fluorescent Indirect	(2) F32T8/830	120	68	E	5
R2	Recessed Compact Fluorescent Wallwasher	(1) CFL32DT/835	120	35	E	5

Ballast Types:
E: Electronic

Existing Power Density:

$$\frac{[(102W)(8)+(68W)(5)+(35W)(5)]}{1021sf}$$

= 1.3 W/sf

Case Study Classroom

Existing Lighting Conditions:

LLF Schedule

Label	*Cat.*	*Room*	*Clean Interval*	*BF*	*LLD*	*RSDD*	*LDD*	*LLF*
P3D	VI	Clean	12 months	.95	1*	.97	.89	.82
W4	VI	Clean	12 months	.95	1*	.97	.89	.82
R2	IV	Clean	12 months	.95	1*	.97	.89	.82

* Mean lumens were used in calculations as opposed to initial lumens, so lamp lumen depreciation values are 1

Task Descriptions:

The Case Study Classroom has varied uses and occupants. Day to day lectures will be attended by Sierra Nevada College students, but the room will also be used by industry professionals and professors to attend lectures on various topics. As such, the most important visual tasks will be reading papers and pamphlets in front of the user, reading slides or posters at the front of the room that are used during these lectures and facial recognition and modeling for the speaker at the front of the room. As with the lobby, both horizontal and vertical illuminances must be carefully considered since horizontal illuminance is critical to reading tasks in front of the user and vertical illuminance is critical to facial rendering requirements for the speaker as well as reading materials placed vertically on the south wall.

Design Criteria:

Daylight Integration:

North facing windows may provide some measure of daylight into the space, which may allow for an alternative dimming/switching system than what is currently designed. Currently, there is no zoning within the room, and with some zoning consideration it may be possible to utilize the daylight that is brought into the space. One factor that may be prohibitive is the overhang of the arcade just outside the window, which may block much of the light into the space. Since the lights will also be out for presentations, however, means of controlling and blocking daylight are also needed.

Reading Tasks:

Since a majority of the time in this room will be devoted to reading one form of material or another, priority should be placed on vertical and horizontal light levels that are appropriate for reading various types of media. Since the types of media can vary between pamphlets, papers, slides (PowerPoint and the like) and posters, the lighting system must be flexible enough to allow for all these types of materials to be easily read.

Fixture Appearance:

Since the main use of the room is to teach people and to help the flow of information from speaker to listener, the fixtures must not be distracting to the occupants. Both the speaker and the listeners must not be distracted by obnoxious looking fixtures or fixtures that may interfere with a listeners line of sight.

Accent Lighting:

Some forms of media such as posters may need to be accented, while other forms such as computerized slides, will not benefit from being accented. As such, a versatile and controllable accenting system should be implemented that allows the speaker to easily highlight whatever the wish while at the same time not washing out slides they may be using. The controls should be simple enough for visiting presenters to understand.

(cont'd on next page)

Case Study Classroom

Design Criteria (cont'd):

Illuminance Criteria:

Horizontal:

Reading - Desk:	60fc calculated	(IES 30fc)
Demonstration:	64fc calculated	(IES 100fc)

Vertical:

Front Wall:	41fc calculated	(IES 30fc)

Importance:

Vertical and horizontal illuminances must be maintained in order to accomplish the tasks that the space requires. While this space may be used for demonstrations that require very fine work, that will not be it's primary use, so the 100fc that the IES recommends may be a bit high for something that isn't required very often. 50 to 60 footcandles should be sufficient for ambient lighting for most tasks. Additional power savings may be observed by bringing the light directly down to the user in the form of task lights at each desk, plus the 100 footcandles that the IES recommends can be achieved by the use of these task lights.

Power Density:

ASHRAE 90.1 allowance (school/university lecture hall):1.6 W/sf

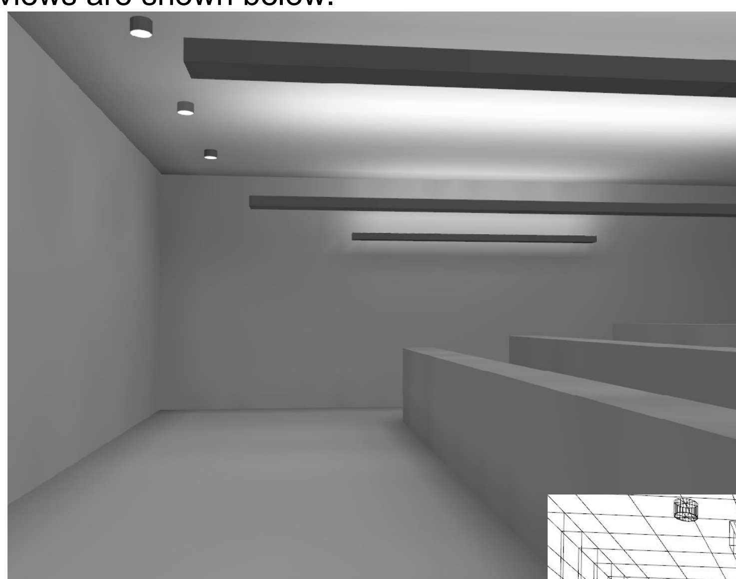
An additional 1W/sf can be added for decorative wall sconces and highlighting artwork, but will not be used.

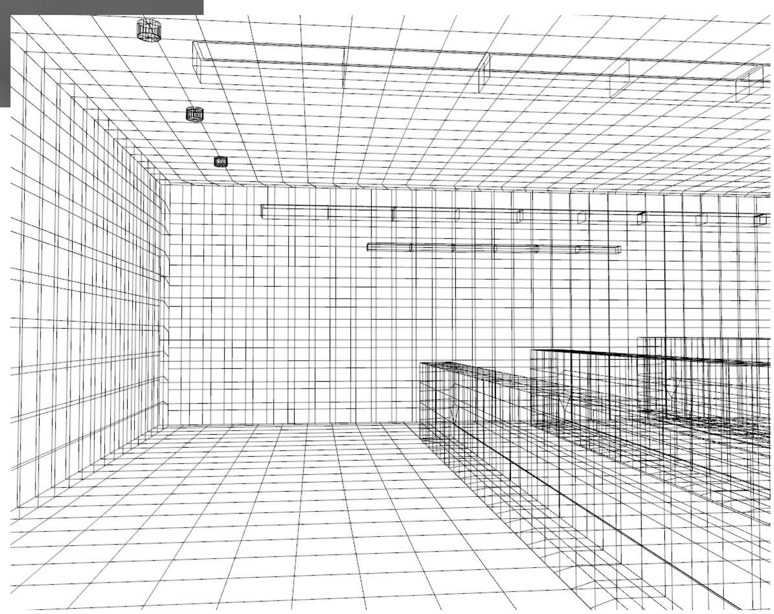
Existing: 1.3 W/sf **OK**

Dave Maino
Tahoe Center for Environmental Sciences
Incline Village, NV

Analysis of Existing System:

AGI 32 was used to calculate the existing lighting conditions for the space. All reflectances and light loss factors cited above were used in the computer model. A larger mesh than what was used in the lobby was used for this space to speed up calculation time. Future calculations will be done using Radiance as an exercise in rendering using alternate software and to aide in the calculation of glare and luminance ratios. Shaded and wireframe views are shown below.





Analysis of Existing System (cont'd):

Horizontal calculation grids were placed on the desk workplane. Vertical calculation grids were placed on the southern wall. For more information on the locations of grids, see the AGI printouts attached.

Results:
- Horizontal:
  - Desk Avg – 60 fc
  - Demonstration Avg – 64 fc
- Vertical:
  - South Wall Avg – 41 fc

All surfaces are satisfactory, or overlit when compared to IES recommendations. As a result, some light levels may be dropped which may improve power density. As it is currently designed, the room is well designed for the reading tasks that may take place in the space, with the possible flaw being the inability to fully control accent lighting.

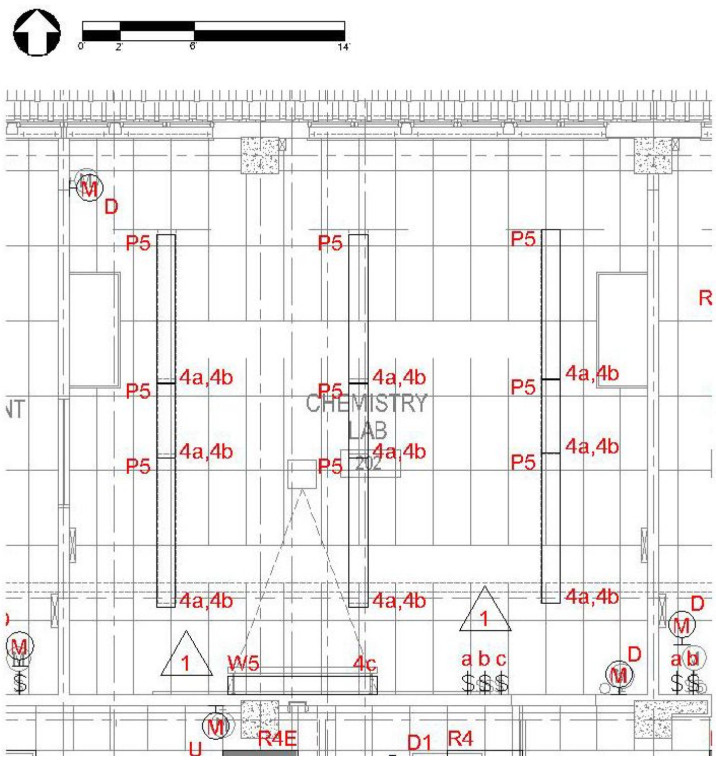
Dimming and switching systems should be investigated to ascertain the most appropriate control scheme for the space. Also, daylighting scenarios will need to be run to determine the effect of daylight on light levels within the space as mentioned previously. Some daylight may be available from the northern windows, and the eastern windows may provide some useful daylight, although care will have to be taken to examine conditions when the room will receive direct daylight.

Again, the necessity of green building design may drive the need for an even lower power density in this space. If the power density can drop even another 5-10% this may aide in the collection of additional LEED credits for Energy and Atmosphere by being significantly under ASHRAE 90.1.

Chemistry Lab

Floor Plan and Lighting Layout:

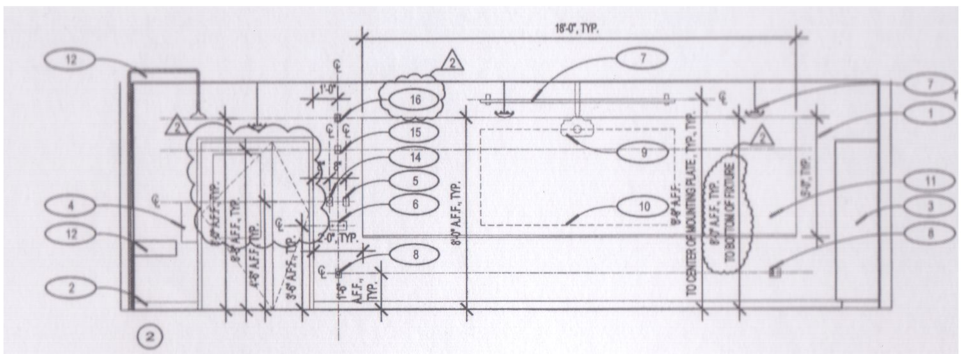
Floor Plan:



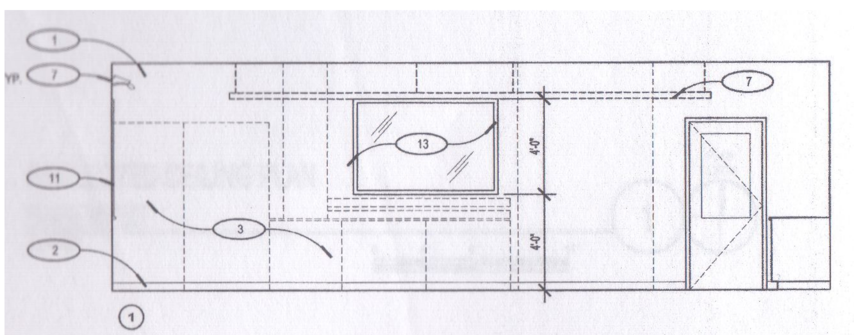
Chemistry Lab

Floor Plan and Lighting Layout:

Sections:



Looking South



Looking West

Chemistry Lab

Materials:

Walls: Painted Gyp. Bd. (Epoxy)
Reflectance of 60%

Columns: Exposed Concrete
Reflectance of 40%

Ceiling: White Acoustical Tile (AC-1: 1" thick)
Reflectance of 90%

Wall Base: Vinyl Base
Reflectance of 15%

Floor: Linoleum Tile (Armstrong "Marmorette")
Reflectance of 30%

Glazing:

To Exterior: (2) Panes, Argon Filled – construction as follows
- Indoor Lite:
  - Ultra-Clear (Low-Iron) Float Glass
  - Transmittance of 91%
  - Reflectance of 8%
  - Solar Heat Gain Coefficient of .87
- Outdoor Lite:
  - Ultra-Clear (Low-Iron) Float Glass
  - Transmittance of 91%
  - Reflectance of 8%
  - Solar Heat Gain Coefficient of .87

To Interior: 1/4" Monolithic Glass (Safety Glazing)
Amber Tint
Transmittance of 65%
Reflectance of 4%

To Interior: 1/4" Tempered Glass
Transmittance of 91%
Reflectance of 8%

Chemistry Lab

Controls:

Occupancy Sensors:

D = Wattstopper DT-200
Wall mounted dual-tech (ultrasonic and passive infrared) motion detector
2000 square feet walking motion @ 10'-0” A.F.F.
1000 square feet desktop motion @ 10'-0” A.F.F.

Control Systems:

Multi-level switching

Operating Conditions:

Fixtures are controlled via three levels of switching, with the occupancy sensor present to turn off the lights as is appropriate when no one is there. The fixtures are not wired back to a lighting control panel, but instead rely solely on the occupancy sensor to turn off the lights when the space is unoccupied.

Chemistry Lab

Existing Lighting Conditions:

Fixture Schedule

Label	*Description*	*Lamping*	*Voltage*	*Total Watts*	*Ballast*	*Quantity*
P5	Linear Fluorescent Direct/Indirect Pendant	(3) F32T8/835	120	102	E	15
W5	Wall Mounted Linear Fluorescent Direct/Indirect	(1) F32T8/830	120	34	E	1

Ballast Types:
E: Electronic

Existing Power Density:

$$\frac{[(102W)(15)+(34W)(1)]}{915sf}$$

= 1.7 W/sf

Existing Lighting Conditions:

LLF Schedule

Label	*Cat.*	*Room*	*Clean Interval*	*BF*	*LLD*	*RSDD*	*LDD*	*LLF*
P5	VI	Clean	12 months	.95	1*	.97	.89	.82
W5	IV	Clean	12 months	.95	1*	.97	.89	.82

* Mean lumens were used in calculations as opposed to initial lumens, so lamp lumen depreciation values are 1

Chemistry Lab

Task Descriptions:

The Chemistry Lab is used primarily by students and faculty for classes and for research. Day to day lectures and classes will be attended by Sierra Nevada College students. Most of the important tasks will be done at the workstations and will require good horizontal and vertical illuminances due to dangerous nature of some chemistry experiments. Also required will be good levels of illuminance on the southern wall, where the professor will likely be lecturing. Reading will be a high priority on both the front wall and at the workstations.

Design Criteria:

Reflected Glare:

The high level of risk involved in some chemistry experiments necessitates restricting the amount of glare and the number of glare sources in the space. Since there will be large amounts of glass in the space in the form of windows, beakers and jars elimination of glare sources is essential.

Direct Glare:

As with reflected glare, direct glare from the fixtures cannot be tolerated as it may pose a safety hazard to those in the lab as they work on experiments.

Daylight Integration:

The Chemistry Lab sits on the north face of the building, lending itself to daylighting well. Unlike the Case Study Classroom which has the arcade blocking the sunlight, the Chemistry Lab has few obstructions to the northern sky. This, combined with the fact that the lights will also not need to be out for presentations like the Case Study Classroom, makes the Chemistry Lab the perfect candidate for switching or dimming based on the amount of light a photocell receives.

(cont'd on next page)

Design Criteria (cont'd):

Illuminance Criteria:

Horizontal:

Workstation: 102fc (IES 50fc)

Vertical:

Workstation: 47fc (IES 30c)

South Wall: 46fc (IES 30fc)

Importance:

Vertical and horizontal illuminances must be maintained in order to accomplish the tasks that the space requires. Right now, the space is overlit per IES recommendations, and perhaps some overlighting is called for, but in order to bring the power density down the lighting levels may need to be dropped. The importance of the tasks, however may dictate that the power allowance not drop much below that of ASHRAE 90.1. By reducing the horizontal illuminance for ambient lighting the power densities may be reduced, and by adding task lighting for fine tasks, the 100 footcandles currently designed may be reached without greatly increasing the power density.

Power Density:

ASHRAE 90.1 allowance (school/university classroom):1.6 W/sf

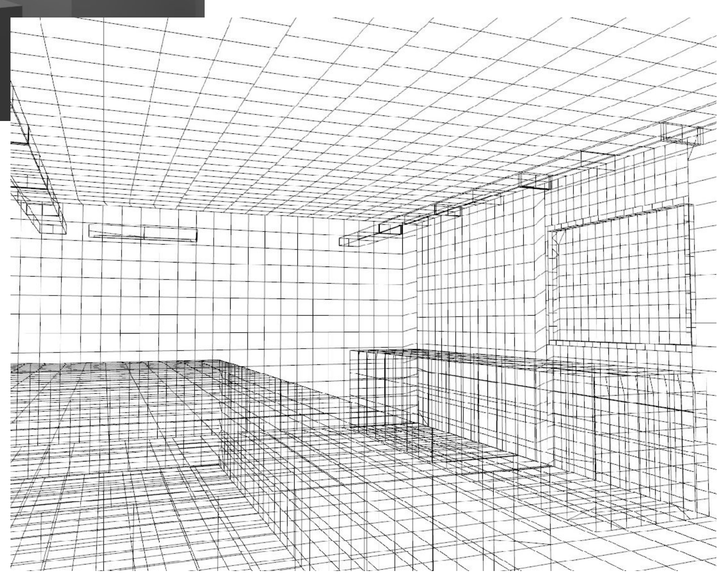
An additional 1W/sf can be added for decorative wall sconces and highlighting artwork, but will not be used.

Existing: 1.7 W/sf **OVER**

Chemistry Lab

Analysis of Existing System:

AGI 32 was used to calculate the existing lighting conditions for the space. All reflectances and light loss factors cited above were used in the computer model. A larger mesh than what was used in the lobby was used for this space to speed up calculation time. Future calculations will be done using Radiance as an exercise in rendering using alternate software and to aide in the calculation of glare and luminance ratios. Shaded and wireframe views are shown below.



Analysis of Existing System (cont'd):

Horizontal calculation grids were placed on the desk workplane. Vertical calculation grids were placed on the southern wall. For more information on the locations of grids, see the AGI printouts attached.

Results:
- Horizontal:
  - Desk Avg – 102 fc
- Vertical:
  - Desk Vert Avg – 47fc
  - South Wall Avg – 46 fc

All surfaces are overlit when compared to IES recommendations. As a result, some light levels may be dropped which may improve power density. Currently, the light levels in the space make it easy to perform the nontrivial tasks required in a laboratory environment. Unfortunately, this light level comes at the price of exceeding ASHRAE 90.1.

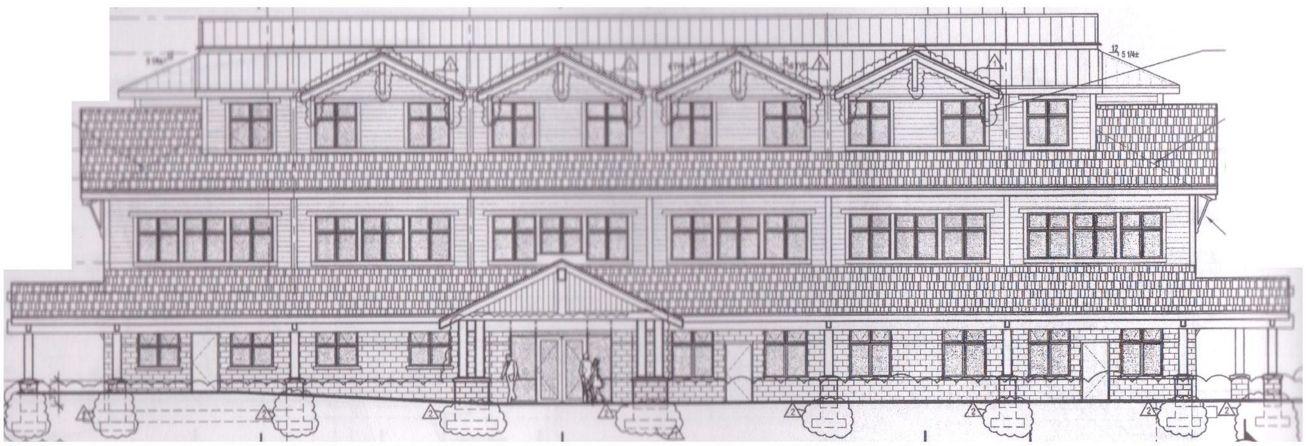
Because the existing power density does exceed the allowable power density, different alternatives to the current lighting setup will need to be explored. If at all possible, retaining the original lighting levels while lowering the current power density to acceptable levels.

Daylighting scenarios will need to be run to determine the effect of daylight on light levels within the space as mentioned previously. Daylight, combined with switching or dimming may end up being a feasible solution for the space. Since the room has only north facing windows, direct light will not be a problem. This will aid in the elimination of glare sources as well as provide a nice source of light for the room. The addition of a photocell in the room may aide in determining appropriate electric lighting levels.

Exterior

Elevation and Lighting Layout:

North Elevation:



Materials:

Walls: Split Face Concrete Masonry (Med. Brown)
Reflectance of 15%

Fiber Cement Siding (Med. Brown)
Reflectance of 15%

Columns: Split Face Concrete Masonry (Med. Brown)
Reflectance of 15%

Roof: Shakes and Seam Metal (Dark Green)
Reflectance of 25%

Glazing: (2) Panes, Argon Filled – construction as follows
Indoor and Outdoor Lite:
- Ultra-Clear (Low-Iron) Float Glass
- Transmittance of 91%
- Reflectance of 8%
- Solar Heat Gain Coefficient of .87

Exterior

Controls:

Control Systems:

Simple switching

Operating Conditions:

Fixtures are off during daylight hours then turned on at night by the staff.

Existing Lighting Conditions:

Fixture Schedule

Label	*Description*	*Lamping*	*Voltage*	*Total Watts*	*Ballast*	*Quantity*
W1	Wall mounted wet location sconce	(2) CFL18DD/835	120	42	E	22
W3	Wall mounted full cutoff wet location area light	(1) M50/830	120	69	E	2
R7	Recessed wet location downlight	(2) CFL32DT/835	120	70	E	7

Ballast Types:

E: Electronic

Existing Power Density:

Main Door:

$$\frac{[(70W)(1)]}{6lf} = 11.6\ W/lf$$

Other Doors:

$$\frac{[(70W)(6)+(50W)(2)]}{30lf} = 17.3\ W/lf$$

Canopy:

$$\frac{[(42W)(22)]}{2394sf} = .39\ W/sf$$

Exterior

Existing Lighting Conditions:

LLF Schedule

Label	*Cat.*	*Room*	*Clean Interval*	*BF*	*LLD*	*RSDD*	*LDD*	*LLF*
W1	VI	Dirty	12 months	.95	1*	.78	.75	.56
W3	IV	Dirty	12 months	1	1*	.78	.75	.59
R7	IV	Dirty	12 months	.95	1*	.78	.72	.53

* Mean lumens were used in calculations as opposed to initial lumens, so lamp lumen depreciation values are 1

Task Descriptions:

The facade of the serves as the point of engress and egress for TCES. As such, the main tasks are walking and, for safety reasons, facial recognition. Glare from fixtures and reflected glare from windows could potentially interfere with these tasks.

Exterior

Design Criteria:

Reflected Glare:

Glare reflected in the windows can be distracting and due to low ambient light levels at night, can have a blinding effect since the eye is not accommodated to higher light levels at night. For safety reasons, glare in glazing should be avoided whenever possible.

Direct Glare:

Glare coming directly from fixtures is also a problem for the same reason that reflected glare is problematic.

Light Trespass:

In order to meet LEED standards, no direct light may leave the property. This means that fixtures must be chosen carefully so as not to create light tresspass onto neighboring properties.

Dark Sky:

Again, to satisfy LEED criteria full cutoff fixtures must be used to avoid light pollution into the sky. Full cutoff fixtures do not put out light above the horizontal plane, so no light can escape into the sky where it would be useless.

Illuminance Criteria:

Horizontal:

Walkways:	1.71fc	(IES .5fc)

Vertical:

Facial Recognition:	1.59fc	(IES 3fc)

Importance:

Vertical and horizontal illuminances must be increase in order to accomplish the tasks that the space requires. Right now, the space is underlit per IES recommendations and should probably be increased both for ease of accomplishing tasks and for safety reasons.

(cont'd on next page)

Exterior

Design Criteria (cont'd):

Power Density:

- ASHRAE 90.1 allowance:
  - 30 w/lf main entrance
  - 20 w/lf other doors
  - 1.25 w/sf canopies

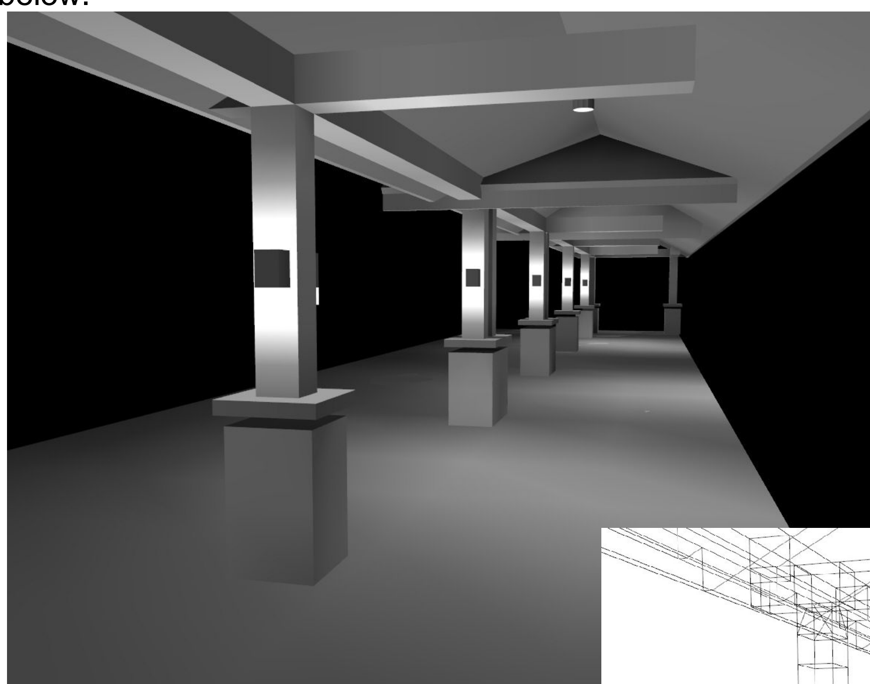
- Existing:

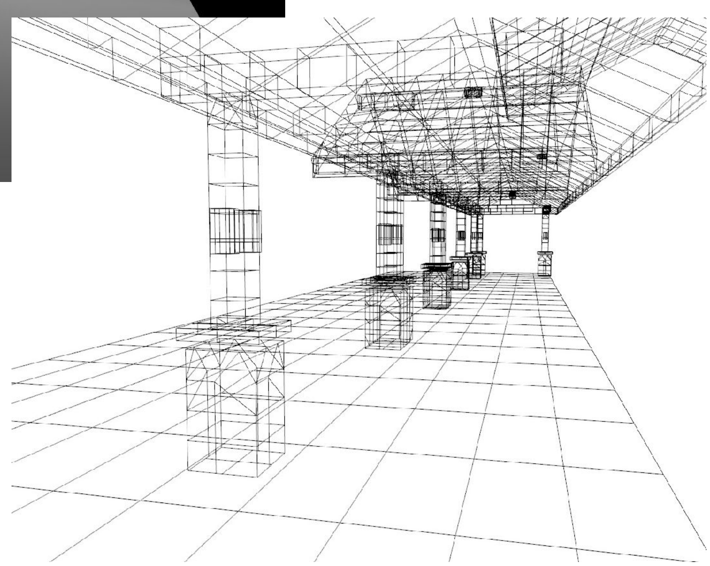
Main Door:	11.6 W/lf	OK
Other Doors:	17.3 W/lf	OK
Canopy:	.39 W/sf	OK

Exterior

Analysis of Existing System:

AGI 32 was used to calculate the existing lighting conditions for the space. All reflectances and light loss factors cited above were used in the computer model. A larger mesh than what was used in the lobby was used for this space to speed up calculation time. Future calculations will be done using Radiance as an exercise in rendering using alternate software and to aide in the calculation of glare ratios. Shaded and wireframe views are shown below.





Analysis of Existing System (cont'd):

Horizontal calculation grids were placed on the ground workplane. Vertical calculation grids were placed along the axis of the arcade. For more information on the locations of grids, see the AGI printouts attached.

Results:
- Horizontal:
  - Ground Avg – 1.71 fc
- Vertical:
  - Arcade Avg – 1.59fc

All surfaces are underlit when compared to IES recommendations. As a result, light levels will need to be increased. Fortunately, the power densities are already below those prescribed in ASHRAE 90.1 so increasing the light levels won't be too much of a challenge. In order to maintain a "green" building, however, every attempt should be made to stay significantly below ASHRAE 90.1.

Alternate fixtures which offer more favorable distributions should be examined, and wall mounted fixtures with a full cutoff distribution to replace the current sconces should be explored as well.

Supplemental Information

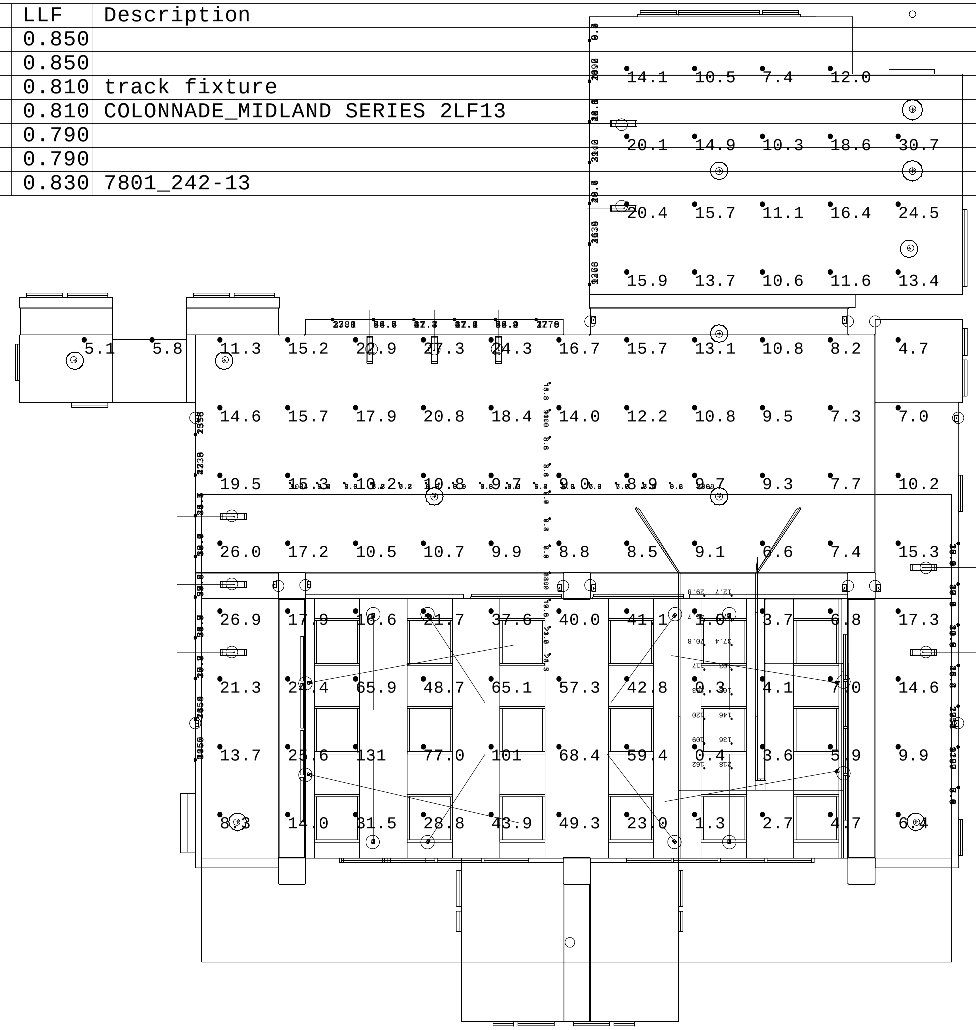
AGI Calculations
(4 pages - attached)

AGI Models
(4 files – P:\ae 481\tech1)

TCES - Lobby

Numeric Summary							
Project: All Projects							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
face-ns	Illuminance	Fc	13.07	24.7	7.7	1.70	3.21
face-ew	Illuminance	Fc	7.78	10.9	5.8	1.34	1.88
floor_Planar_60	Illuminance	Fc	19.86	131	0.3	66.20	437.67
wall-gyp_Planar_16	Illuminance	Fc	19.79	47.1	1.9	10.42	24.79
wall-gyp_Planar_21	Illuminance	Fc	24.80	73.4	2.5	9.92	29.36
wall-gyp_Planar_33	Illuminance	Fc	31.59	62.4	3.7	8.54	16.86
wall-gyp_Planar_34	Illuminance	Fc	18.27	46.6	0.9	20.30	51.78
stair_Planar_36	Illuminance	Fc	103.14	218	12.7	8.12	17.17
wall-gyp_TotalTop	Illuminance	Fc	23.42	73.4	0.9	26.02	81.56

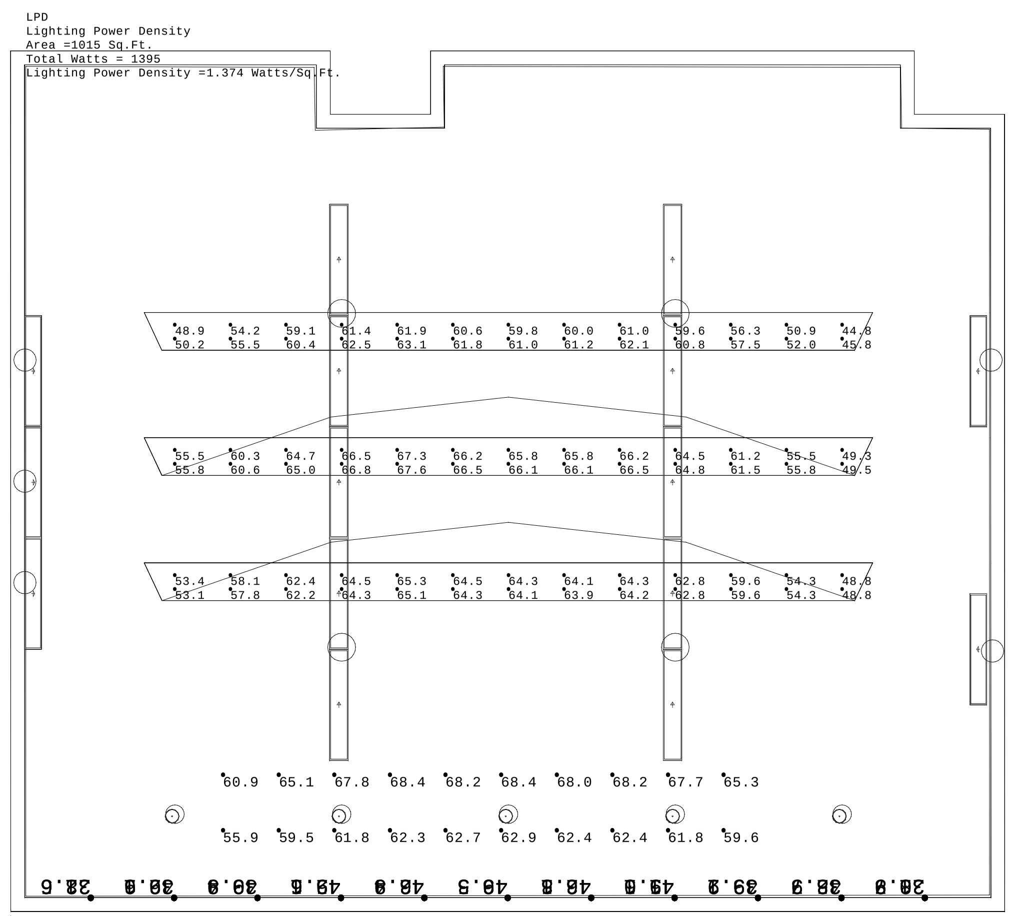
Luminaire Schedule						
Project: All Projects						
Symbol	Qty	Label	Arrangement	Lumens	LLF	Description
	8	t2-10038S3K	SINGLE	6800	0.850	
	4	t3-CDM35PAR30_M_SP	SINGLE	-1	0.850	
	10	t4-DF227	SINGLE	1548	0.810	track fixture
	12	w2-2_13w_changeto18w-080	SINGLE	1075	0.810	COLONNADE_MIDLAND SERIES 2LF13
	5	s9-3_26w-01249	SINGLE	1161	0.790	
	4	s10-4_26w-01249	SINGLE	1548	0.790	
	2	p6-7801_242-13	SINGLE	2400	0.830	7801_242-13



TCES - Case Study Classroom

Numeric Summary							
Project: All Projects							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
walls_Planar_19	Illuminance	Fc	40.71	49.5	28.6	1.42	1.73
desk_Planar_4	Illuminance	Fc	57.40	63.1	44.8	1.28	1.41
desk_Planar_10	Illuminance	Fc	62.36	67.6	49.3	1.26	1.37
desk_Planar_16	Illuminance	Fc	60.42	65.3	48.8	1.24	1.34
demo	Illuminance	Fc	63.97	68.4	55.9	1.14	1.22
desk_TotalTop	Illuminance	Fc	60.06	67.6	44.8	1.34	1.51

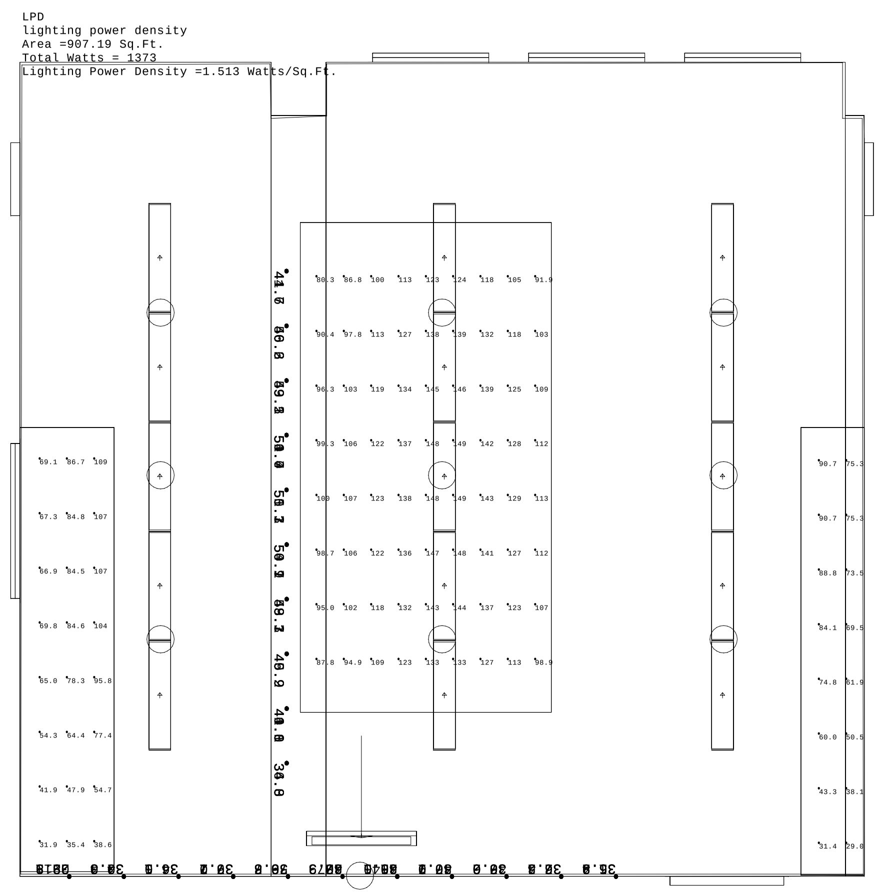
Luminaire Schedule						
Project: All Projects						
Symbol	Qty	Label	Arrangement	Lumens	LLF	Description
	10	p3,p3d - Peerless_PRIMA_	SINGLE	2850	0.820	PRM3-3-32
	5	w4-changeto32w-crw228w	SINGLE	2850	0.820	CRW2-2-32-WHR
	5	r2-Lithonia_Lighting_Dow	SINGLE	2400	0.820	6W7A (32TRT)



TCES - Chemistry Lab

Numeric Summary							
Project: All Projects							
Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
vertical	Illuminance	Fc	47.20	55.1	34.0	1.39	1.62
workplane_Planar_4	Illuminance	Fc	64.81	90.7	29.0	2.23	3.13
workplane_Planar_10	Illuminance	Fc	120.75	149	80.3	1.50	1.87
workplane_Planar_16	Illuminance	Fc	71.99	109	31.9	2.26	3.42
blackboard_Planar_4	Illuminance	Fc	46.75	227	0.1	467.50	2278
floor_TotalTop	Illuminance	Fc	0.00	0.0	0.0	N.A.	N.A.
workplane_TotalTop	Illuminance	Fc	102.31	149	29.0	3.53	5.17

Luminaire Schedule						
Project: All Projects						
Symbol	Qty	Label	Arrangement	Lumens	LLF	Description
	15	p5 - Peerless_PRIMA_prm4	SINGLE	2850	0.808	PRM4-3-32
	1	w5-V_F28_W	SINGLE	2850	0.850	VIA-28T5-B-1-W



TCES - Exterior

Numeric Summary

Project: All Projects

Label	CalcType	Units	Avg	Max	Min	Avg/Min	Max/Min
walkway	Illuminance	Fc	1.71	5.6	0.0	0.00	0.00
Vertical	Illuminance	Fc	1.59	9.6	0.0	0.00	0.00

Luminaire Schedule

Project: All Projects

Symbol	Qty	Label	Arrangement	Lumens	LLF	Description
⊡	16	w1-2_26w_changeto18w-080	SINGLE	1075	0.560	CB4064-2QF26
⊙	4	r7-Downlighting_8_Ltl976	SINGLE	2400	0.530	8O2AZ (32TRT)