1.3 Auditorium Lighting Redesign

1.3.1 Appearance Description

Unlike most of the spaces in Proctor High School, the auditorium is one of the few that did not undergo a previous lighting renovation. Ironically, it is definitely the space in the 440,000 square foot building that needs it the most. The most obvious characteristic of the auditorium is that it relies almost solely and completely on daylighting to illuminate the space. The space has an area of roughly 12,400 square feet and seats approximately 1,500 people and is comprised almost completely of windows. Nine 4'x12' windows and twelve 8'-4"x 18' windows of .75 transmittance run along the length the auditorium. The entire auditorium is made of the existing dark wood that has been in place since 1932. The top area of the walls is a painted white wooden trim that extends around the entire perimeter of the auditorium and the ceiling is white painted gypsum board. The floor is composition tile covered with gray carpet. In front of the stage, which is 4'-8" off the ground, space is available for an orchestra pit. The pit is separated from the audience by an oval 2 1/2' high oval curtain. The red curtains in the auditorium match the red fabric upholstery on the seats.

Reflectance:
Floor surface: (R:122 G:111 B:94) ρ=.33
Ceiling surface: (R:248 G:226 B:189) ρ=.86
Wood Surface: (R:156 G:118 B:89) ρ=.16

1.3.2 Design Focus

The auditorium is the one major space in Proctor High School that still maintains a historical significance after the renovation of the building. Although certain systems in the space have undergone renovation, it still keeps its original architecture and feel. Therefore, it is important to understand that aesthetics play a very important role in the design of the space. A more traditional and classic approach would be a better fit for the large space than a modernistic one. The lighting design should prominently show off the deep wooden architecture to capture the original feel of the room. Full lighting control will also be necessary because the space serves multiple purposes. Overall, the design has to present the occupant with the feeling that the auditorium holds a distinguished quality.

1.3.3 Design Criteria

Perhaps the most important issue that would come to mind in a daylight-friendly space such as the auditorium is glare. Direct glare should not be too much of a concern though, since the auditorium has a northern exposure. Since the bottom half of the walls are wood (low reflectance) as compared to the white tops, reflected glare should also be lessened. The auditorium is used for study halls during the day, so the proper horizontal task illuminance (>30-fc) will be necessary on the workplane during the school day. During evening activities a horizontal illuminance of 10-fc should be maintained. Vertical illuminance should not be an issue since the walls will not have anything on them that needs illumination. The lighting system must be able to adjust for the auditorium's many purposes.

1.3.4 Design Solution

The design for the auditorium was developed from the idea of preserving and enhancing the architecture in the space. The design consists of three types of luminaires:

1. 6" Aperture compact fluorescent downlight
2. 8" Aperture high wattage compact fluorescent downlight
3. 49" Diameter, 53" high decorative chandelier

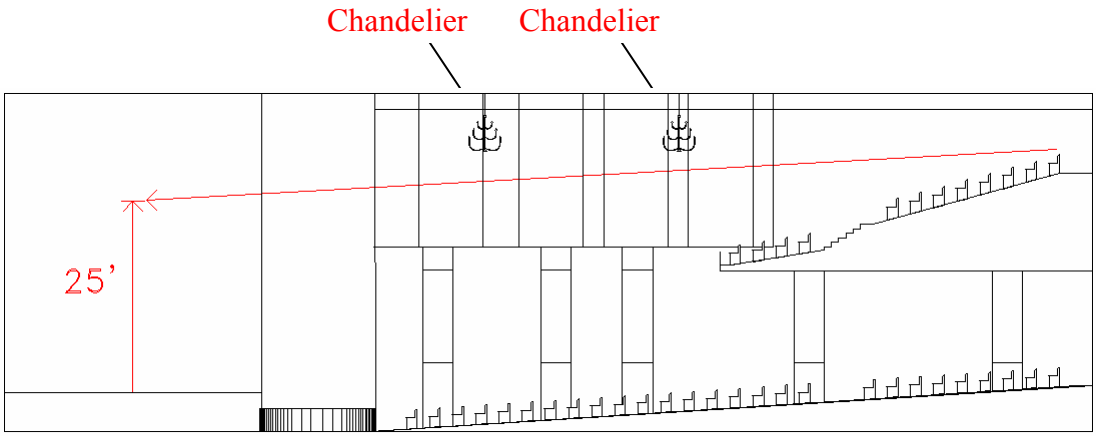
The 6" aperture compact fluorescent downlights have been designed both in the ceiling above the balcony and the ceiling below the balcony. These fixtures are meant to provide general lighting to get the occupant to his/her seat safely while marking the aisles.

Closer to the stage, the (2) 26W CFL fixtures are not enough to contend with the 44 foot span from the auditorium ceiling to the carpeted floor. As a result, a stronger downlight is necessary. Metal halide fixtures would easily be able to adequately illuminate the floor, but high wattage compact fluorescents would achieve the same objective while lending itself to full dimming control. Therefore, 70W compact fluorescent downlights have been designed for the general lighting of the main space.

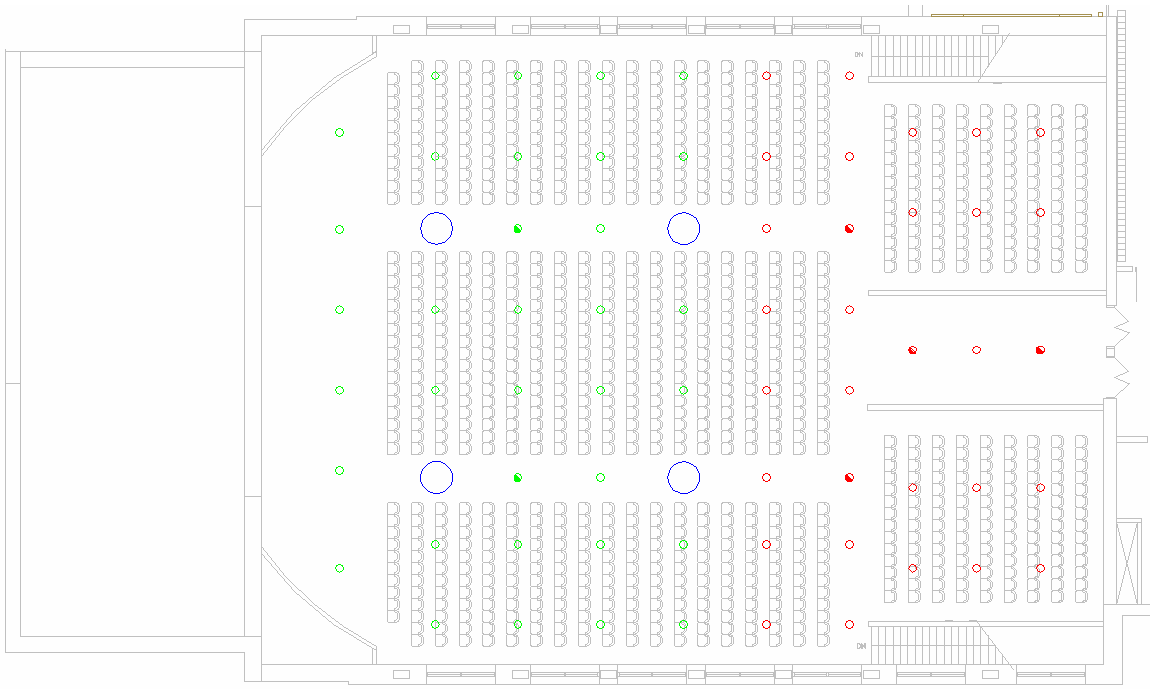
Auditorium Chandelier Fixture

The combination of the two types of downlights specified is a viable option for the auditorium, however, the design focus in the space was to preserve and enhance the architecture. Therefore, four 49" diameter decorative chandelier fixtures have been designed around the central area of the auditorium. These gold and crystal

chandeliers will complement the historic architecture of the auditorium while drawing attention away from the downlights. The fixtures are large enough to deliver a strong message to an entering audience, but are still small enough to allow complete visibility of the stage from the highest point in the balcony.



Auditorium Elevation

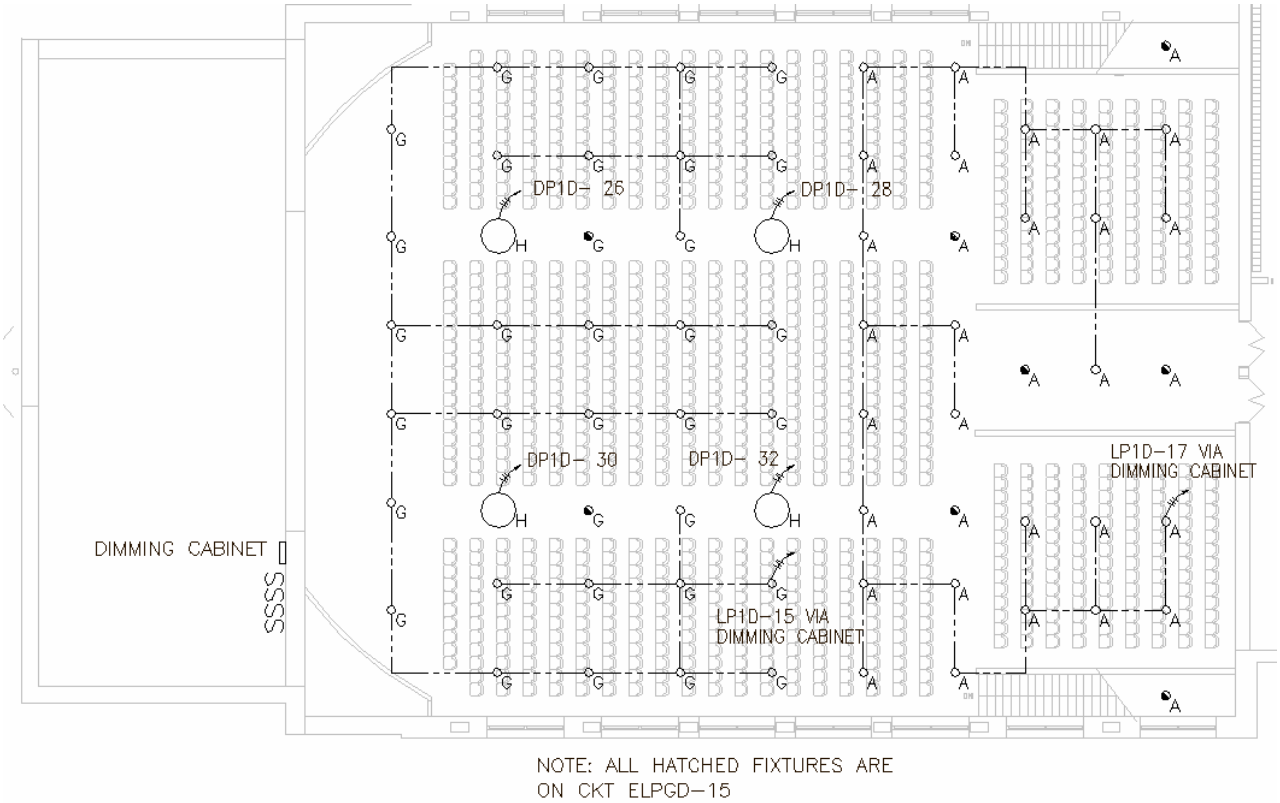


Lighting Layout

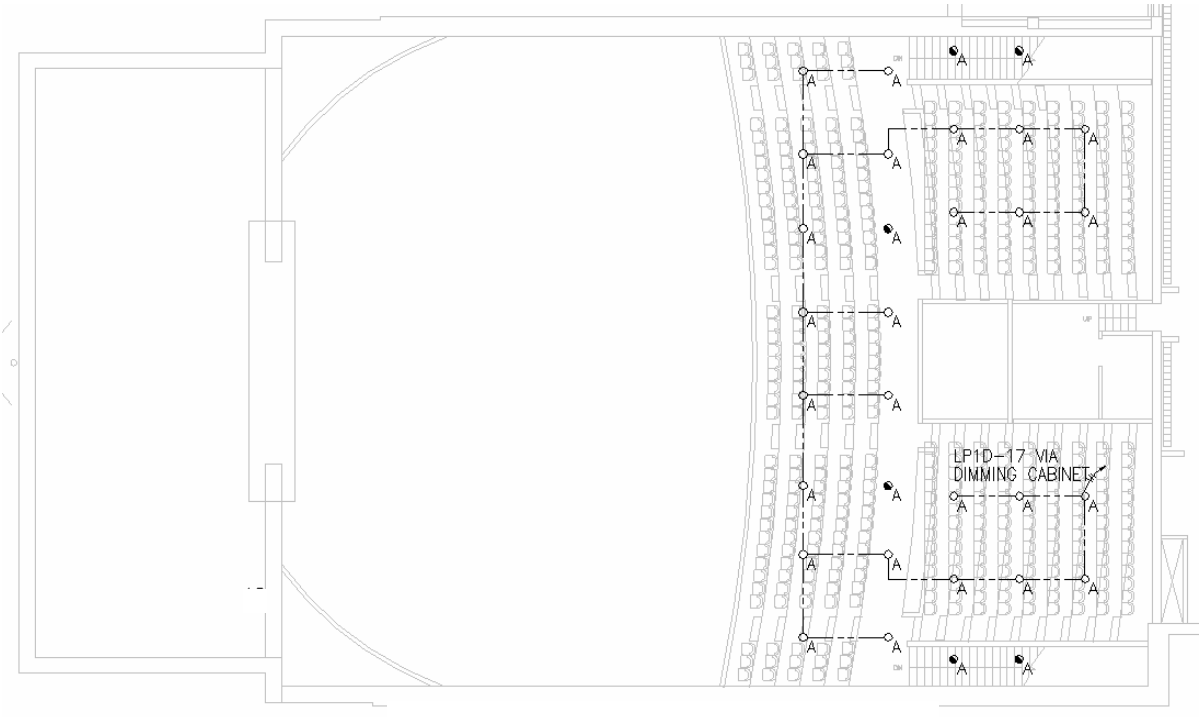
- Downlight
- High Wattage Downlight
- Decorative Chandelier

1.3.5 Controls

A principal criterion for the auditorium is the ability to have dimmable control. This is important mainly for evening activities, when house lights may need to be dimmed up and down for a performance. As a result, most of the luminaires in the design are on dimmable control. Specifically, a 277V dimming cabinet is designed to be installed in the stage area. This dimming cabinet will control all of the type A and G fixtures and allow room for additional lighting. A likely scenario for dimming control would be to dim the type A fixtures independently from the type G fixtures. Each type H chandelier fixture will have its own switch located next to the dimming cabinet. Since these luminaires are for decorative appearance more than light level requirements, keeping them off of the dimming system should not be of concern. The dimming zones can actually benefit daytime activities as well. For example, during a daytime assembly in which the occupants underneath the balcony are not receiving enough light, the type G fixtures can remain off while the type A fixtures are turned on and dimmed to an appropriate level.



Lighting Circuiting Plan – Ground Floor



Lighting Circuiting Plan - Balcony

1.3.6 Circuit and Panelboard Data

Each of the three types of three types of luminaires in the space will be circuited independently. A fourth circuit is dedicated to emergency fixtures. One individual circuit, from panel LP1D in sector D, is dedicated to type A fixtures and another is dedicated to type G fixtures. Since the type H fixtures operate at 120V, each of the four fixtures will have a dedicated circuit on panel DP1D. The hatched fixtures on the circuit layout refer to luminaires that are backed by the emergency generator and are circuited together from panel ELPGD (refer to the lighting circuiting plan). The calculations for each lighting circuit in the library are listed below:

CKT LPD1D-15: 32 x 50W = 2.24 kVA, 8.08A
CKT LPD1D-17: 44 x 32W = 2.9 kVA, 10.47A
CKT DP1D-26: 1 x 1260W = 1.26 kVA, 10.50A
CKT DP1D-28: 1 x 1260W = 1.26 kVA, 10.50A
CKT DP1D-30: 1 x 1260W = 1.26 kVA, 10.50A
CKT DP1D-32: 1 x 1260W = 1.26 kVA, 10.50A
CKT ELPGD-15: (4 x 50W) + (2 x 70W) = .34 kVA, 1.23A

None of the branch circuits were near exceeding the designed current limit of 16 amps, even with a 1.25 continuous load factor.

Panelboards

The impact of the lighting circuits to the overall panelboard load is given below (Note: The wire size for each of the new lighting circuits is #10 AWG since none of the circuits exceed 16 amps and there are no voltage drop issues):

DESIGNATION:	VOLTAGE: 480/277V–3ø–4W	LOCATION: ELECTRIC ROOM D109
LP1D	MAINS: 100A MLO	FED BY: LPGD
	TYPE: LIGHTING	
	O.C. DEVICE: CIRCUIT BREAKER	MINIMUM O.C. DEVICE INTERRUPTING RATING: 14,000 AIC
	MOUNTING: SURFACE	

Description	CKT.	O.C. AMP	P	KVA Ø A		KVA Ø B		KVA Ø C		P	O.C. AMP	CKT.	Description
AUXILIARY GYM LIGHTING	1	20	1	3.5	3.0					1	20	2	AUXILIARY GYM LIGHTING
LIGHTING CONTROL AUX. GYM LTG	3	20	1			0.1	1.0			1	20	4	LOBBY LIGHTING
LOBBY LIGHTING	5	20	1					1.22	1.3	1	20	6	CORR C109, D131
ROOMS D120 THRU D125	7	20	1	1.3	1.6					1	20	8	ROOMS D113 THRU D118
LIBRARY LIGHTING	9	20	1			1.66	1.4			1	20	10	LIBRARY LIGHTING
LIBRARY LIGHTING	11	20	1					1.06	1.12	1	20	12	LIBRARY LIGHTING
LIBRARY LIGHTING	13	20	1	1.06	.328					1	20	14	LOBBY LIGHTING
AUDITORIUM LIGHTING	15	20	1			2.24						16	
AUDITORIUM LIGHTING	17	20	1					2.9				18	
	19											20	
	21											22	
	23											24	
SPARE BREAKER	25	20	1							1	20	26	SPARE BREAKER
SPARE BREAKER	27	20	1							1	20	28	SPARE BREAKER
SPARE BREAKER	29	20	1							1	20	30	SPARE BREAKER
	TOTAL KVA/ø			10.8		6.4		7.6				TOTAL KVA	24.8

DESIGNATION:	VOLTAGE: 208/120V–3ø–4W	LOCATION: ELECTRIC ROOM D109 – SECTOR D – 1ST FLR
DP1D	MAINS: 225 AMP MAIN BREAKER	FED BY: XXX
	TYPE: POWER	
	O.C. DEVICE: CIRCUIT BREAKER	MINIMUM O.C. DEVICE INTERRUPTING RATING: 10,000 AIC
	MOUNTING: SURFACE	

Description	CKT.	O.C. AMP	P	KVA Ø A		KVA Ø B		KVA Ø C		P	O.C. AMP	CKT.	Description
RECEP – SECTOR D	1	20	1	1.20	1.20					1	20	2	RECEP – SECTOR D
RECEP – SECTOR D	3	20	1			1.20	1.20			1	20	4	RECEP – SECTOR D
RECEP – SECTOR D	5	20	1					1.20	1.20	1	20	6	RECEP – SECTOR D
RECEP – SECTOR D	7	20	1	1.20	1.20					1	20	8	RECEP – SECTOR D
RECEP – SECTOR D	9	20	1			1.20	1.20			1	20	10	RECEP – SECTOR D
RECEP – SECTOR D	11	20	1					1.20	1.20	1	20	12	RECEP – SECTOR D
RECEP – SECTOR D	13	20	1	1.20	1.20					1	20	14	RECEP – SECTOR D
RECEP – SECTOR D	15	20	1			1.20	1.20			1	20	16	RECEP – SECTOR D
RECEP – SECTOR D	17	20	1					1.20	1.20	1	20	18	RECEP – SECTOR D
RECEP – SECTOR D	19	20	1	1.20	1.20					1	20	20	RECEP – SECTOR D
RECEP – SECTOR D	21	20	1			1.20	1.20			1	20	22	RECEP – SECTOR D
RECEP – SECTOR D	23	20	1					1.20	1.0	1	20	24	CAB HTR.
CAB HTR	25	20	1	1.00	1.26					1	20	26	AUDITORIUM CHANDELIER
CAB HTR	27	20	1			0.7	1.26			1	20	28	AUDITORIUM CHANDELIER
SPARE	29	20	1						1.26	1	20	30	AUDITORIUM CHANDELIER
	31			15.0	1.26					1	20	32	AUDITORIUM CHANDELIER
PANEL DPGD	33	100	3			15.0						34	SPACE
	35							15.0				36	
SPARE BREAKER	37	20	1									38	
	39											40	
	41											42	
	TOTAL KVA/ø			27.12		26.56		25.66				TOTAL KVA	79.34

DESIGNATION:	VOLTAGE: 480/277V-3ø-4W	LOCATION: ELECTRIC ROOM DG22
	MAINS: 100 AMPS – MLO	FED BY: EDP
	TYPE: EMEGENCY LIGHTING	
ELPGD	O.C. DEVICE: CIRCUIT BREAKER	MINIMUM O.C. DEVICE INTERRUPTING RATING: 14,000 AIC
	MOUNTING: SURFACE	

Description	CKT.	O.C. AMP	P	KVA Ø A	KVA Ø B	KVA Ø C	P	O.C. AMP	CKT.	Description
BASEMENT LTG	1	20	1	0.8			1	20	2	AUXILIARY GYM
AUXILIARY GYM LTG CONTROL	3	20	1		0.1		1	20	4	CORRIDOR B202/B319
TOILETS D329/334	5	20	1			1.8	1	20	6	TOILETS D310/D312
GALLERY C201	7	20	1	0.8			1	20	8	CORRIDOR DG15
TEACHERS DINING	9	20	1		1.0		1	20	10	LOBBY D112
CORRIDOR D119	11	20	1			1.6	1	20	12	CORRIDOR C109, D131
LIBRARY LIGHTING	13	20	1	0.81			1	20	14	LOBBY LIGHTING
AUDITORIUM LIGHTING	15	20	1		.34				16	
	17								18	
	19								20	
	21								22	
	23								24	
SPARE	25	20	1				1	20	26	SPARE
SPARE	27	20	1				1	20	28	SPARE
SPARE	29	20	1				1	20	30	SPARE
	TOTAL KVA/ø			6.6	3.9	6.3			TOTAL KVA	16.8

None of the lighting circuits had a significant impact on the overall capacity of the existing panelboards. The total load on panel LP1D is 29.83A, the load on DP1D is 95.43A and the total load on panel ELPGD is 20.20A.

1.3.7 Calculation Parameters

Light Loss Factors:

Type A:

LLD: 1530/1800= **.85**

LDD: Type IV, cleaned annually = **.89**

RCR: (2.5)(cavity height)(cavity perimeter)/(area of cavity)

= (2.5)(42.5')(336')/(12400 ft^2) = 2.88

RSDD: **.98**

BF: **1.1**

LLF = (.85)(.89)(.967)(1.1) = .82

Type G:

LLD: 4470/5200 = **.86**

LDD: Type IV, cleaned annually = **.89**

RCR: (2.5)(cavity height)(cavity perimeter)/(area of cavity)

= (2.5)(42.5')(336')/(12400 ft^2) = 2.88
RSDD: **.967**
BF: **.95**
LLF: .71

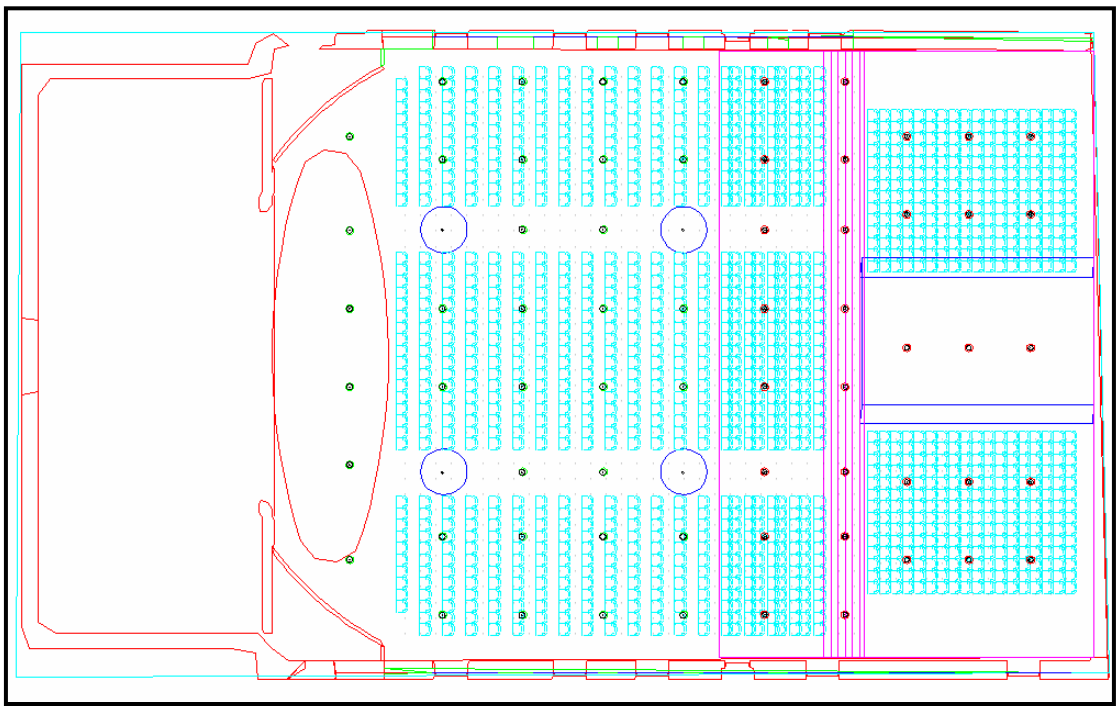
Type H:
LLD: 495/550 = **.9**
LDD: Type IV, cleaned annually = **.89**
RCR: (2.5)(cavity height)(cavity perimeter)/(area of cavity)
= (2.5)(42.5')(336')/(12400 ft^2) = 2.88
RSDD: **.967**
BF: **----**
LLF: **.78**

Power Density:
Type A: 44 x 50W = 2200W
Type G: 34 x 70W = 2380W
Type H: 4 x 1260W = 5040W
9620W
Total Power Density = 9620W/12400 ft^2 = **.78W/ft^2 < .9W/ft^2**

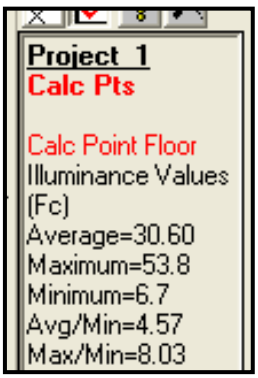
1.3.8 Calculation Results

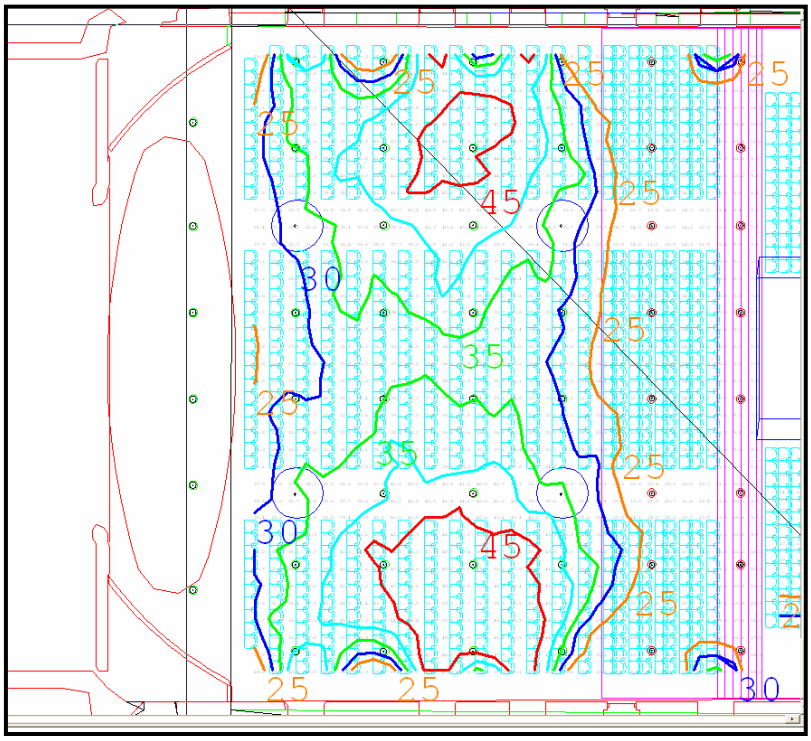
Since a main concern for the lighting design in the auditorium is whether the space will receive adequate light for reading intensive activities (such as study halls) during the day, the model space in AGI-32 was calculated using only daylight (an overcast day at 3:00 pm on December 21, 2005, was used as the daylight parameter) in order to get a "poor-case scenario" of how much daylight can enter the space. Even in such a scenario, the auditorium received an average illuminance of more than 30-fc. Therefore, the space can operate throughout the school day without needing any lights. To verify that the necessary 10-fc horizontal illuminance in the audience was maintained during evening performances, the model space was also calculated using only electric light. The ground floor and balcony both received more than the 10-fc of horizontal illuminance necessary in an auditorium seating space.

Auditorium AGI-32 Model



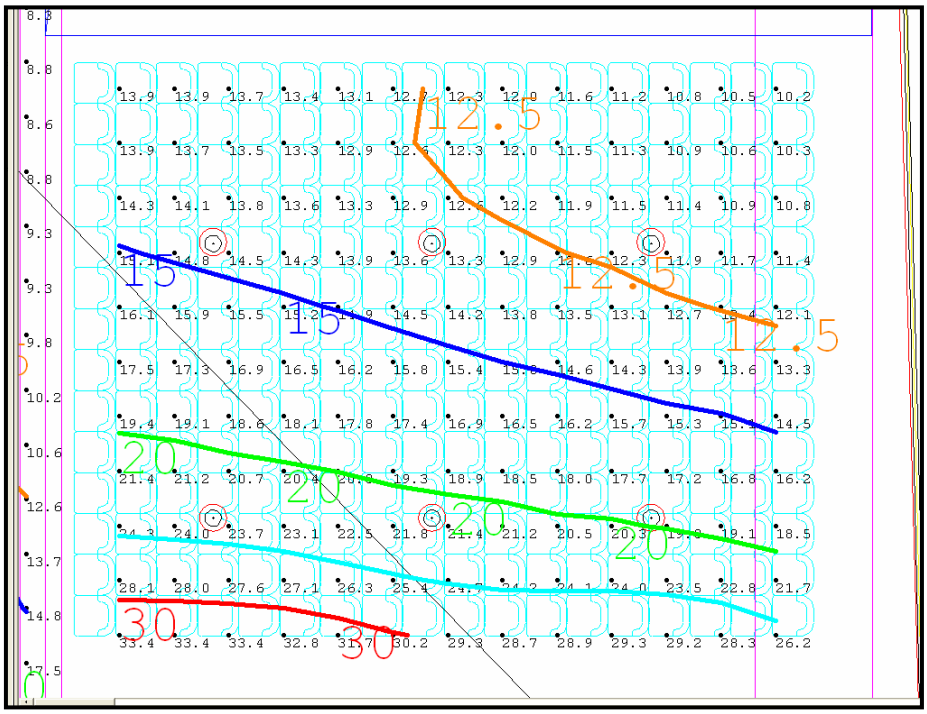
Daylight Only - Illuminance Values – Ground Floor





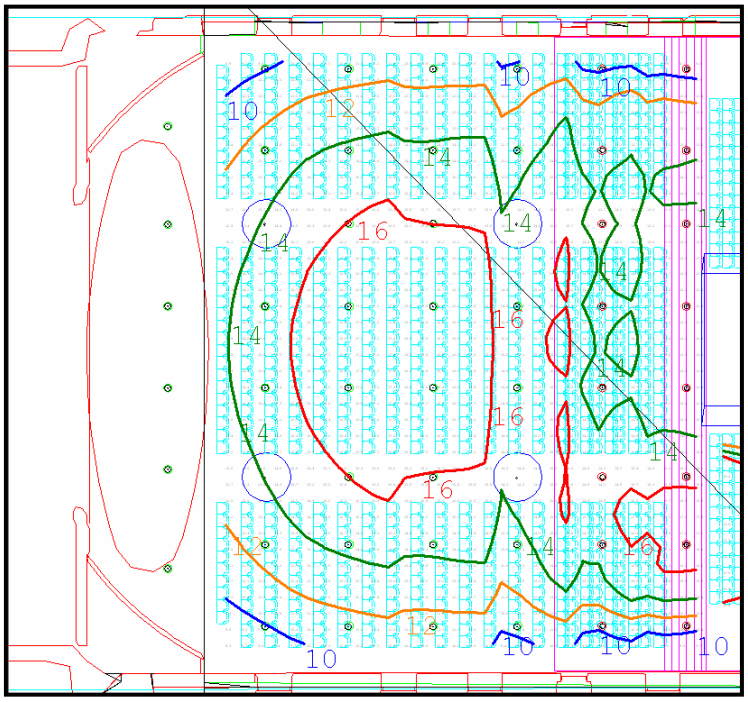
Daylight Only - Illuminance Values - Balcony

Balcony Floor
Illuminance Values
(Fc)
Average=17.53
Maximum=33.4
Minimum=10.2
Avg/Min=1.72
Max/Min=3.27

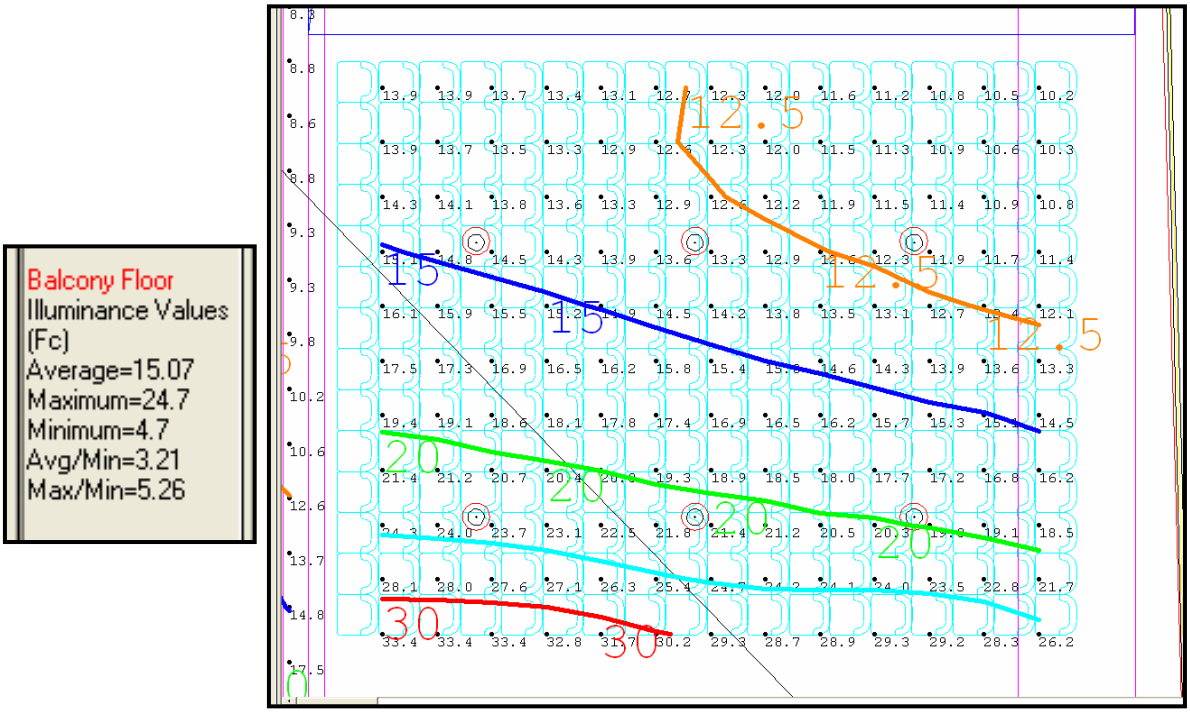


Daylight Only - Illuminance Values – Ground Floor

Calc Point Floor
Illuminance Values
(Fc)
Average=14.09
Maximum=17.6
Minimum=8.3
Avg/Min=1.70
Max/Min=2.12



No Daylight - Illuminance Values – Balcony



1.3.9 Luminaire Schedule

Luminaire Schedule							
Type	**Description**	**Manufacturer-Model #**	**Voltage**	**Mounting**	**No. and Type of Lamp**	**Lamp Manufacturer-Designation**	**Ballast**
A	Compact Fluorescent 6" Aperture Downlight	Portfolio – C6-226-2D-6251-LI	277	Recessed	2-26-CF	Philips - CFQ26W/G24q/830	Advance - ICF-2S26-M1-LS@277
G	Compact Fluorescent 8" Aperture High Wattage Downlight	Prescolite - CFT870EB-DM-STF87/70HZ	277	Recessed	1-70W Double Quad Tube CFL	General Electric - F70QBX835A4P/EOL	Advance – REZ-2T42-M3-BS
H	Decorative Pendant Chandelier	ELK Lighting – 6858/12+6+3	120	Suspended	21-60W B10	Philips – 60B10-1/2/CL 130V	---