Tobin Center
for the
Performing Arts

San Antonio, TX

Technical Report I · Part II
Lighting Existing Conditions & Design Criteria

Laura Ashley A. Alferes
Lighting | Electrical
Faculty Advisor | Dr. Kevin Houser
09.16.2013

Executive Summary

The Tobin Center for the Performing Arts is a 172,970sf venue that will feature major performing arts organizations of San Antonio. The lighting design of the Tobin Center creates a unique and inspiring expression, in which it complements the dynamic movement of interior and exterior architecture.

The following report summarizes and examines the existing lighting conditions of the Center. It focuses on four areas:

- Patron's Lounge [special purpose space]
- Main Auditorium [large work space]
- Main Lobby [circulation space]
- Event Plaza [outdoor space]

Throughout this report, the performance of the existing systems and criteria for an effective lighting design per space will be performed. To study the spatial definition for each space and how light is intended to look and feel for a particular visual experience, several factors were taken into consideration. These include the luminaire types and their control systems and qualitative and quantitative design criteria. A critique and evaluation were then completed based on the existing lighting conditions, design criteria, and calculations.

Overall, although each space does not comply with ASHRAE Standard 90.1 2010, the lighting solution offers flexible and consistent design for the building. The current design provides an adequate solution in most of the spaces. There is, however, opportunity for potential improvements in selecting the quality and efficiency of luminaires.

Table of Contents

I. Building Overview

Location & Site:	100 Auditorium Circle, San Antonio, TX 78205
Building Occupant Name:	Tobin Center for the Performing Arts
Occupancy Type:	Assembly Group A-1 (primary)
Size:	172,970 GSF
Stories:	6 + 1 Basement

II. Project Team

Owner:	Bexar County Performing Arts Center Foundation
Owner's Rep:	The Projects Group Zachry Consturction Corporation Marmon Mok
Construction Manager:	Linbeck Zachry Construction Corporation
Architect of Record/Front of House (Prime):	LMN Architects
CA Lead/Back of House (Assoc./LEED Consulting):	Marmon Mok
Landscape Architect:	Mesa Design Group
Historic Preservation Consultant:	Fisher Heck Architects
Civil Engineer:	Pape-Dawson Engineers, Inc.
Structural Engineer:	Walter P. Moore (Prime/Front of House) Alpha Consulting Engineers (Assoc./Back of House)

III. AGI32 Calculation Files

Files are located in Y:\laa5098\Technical Report 1\AGI Files

1.0 PATRON'S LOUNGE | SPECIAL PURPOSE SPACE

The Patron's Lounge is meant to be a space for socialization, in which patrons and performers can congregate, as well as support donor accommodations and special events.

1.1 EXISTING CONDITIONS

The Patron's Lounge is located on Level 02 within the volume of the existing south entry just above the main entry lobby at the same level as the first balcony box tier. It is connected to the box seating by a separate bridge way leading directly to sound and light locks of the private boxes. The east end includes the men's restroom; whereas the west end includes the women's restroom and a service pantry for patron catering. Moveable bars for drinks and concessions and furniture storages can be located at both east and west ends of the lounge.
Additionally, this space has two ceiling heights. The 16'-6" raised ceiling is located on the south end of the lounge, whereas the 13'-6" ceiling is located on the north end. In Figure 1.1a, the light blue section has windows that look South into the front entry/South plaza. The dark blue area has bead curtains and windows that look north into the main lobby.

Dimensions

Area	1558 SF
Length	64'-2"
Width	24'-3"
Ceiling Height	13'-6" (light blue in Figure 1.1a), 16'-6" (dark blue in Figure 1.1a)

Figures 1.1a-1.1f shows the spatial environment & orientation of the Patron's Lounge through floor plans, sections, elevations, and reflected ceiling plans.

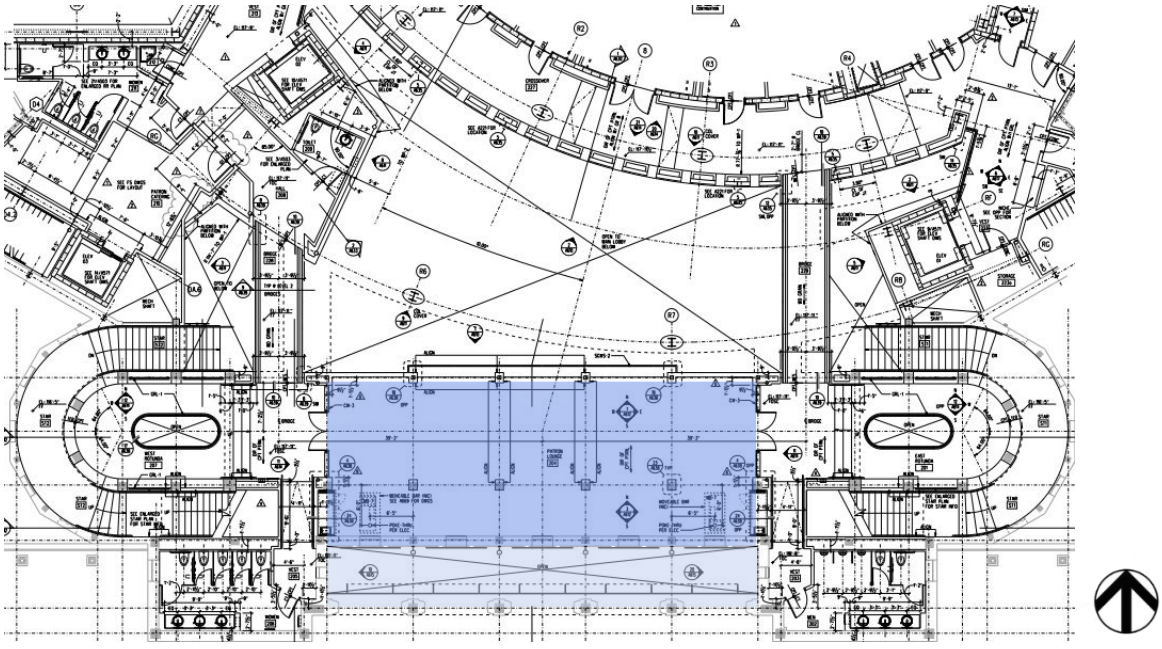


Figure 1.1a: Patron's Lounge Spatial Definition *(Courtesy of LMN Architects)*

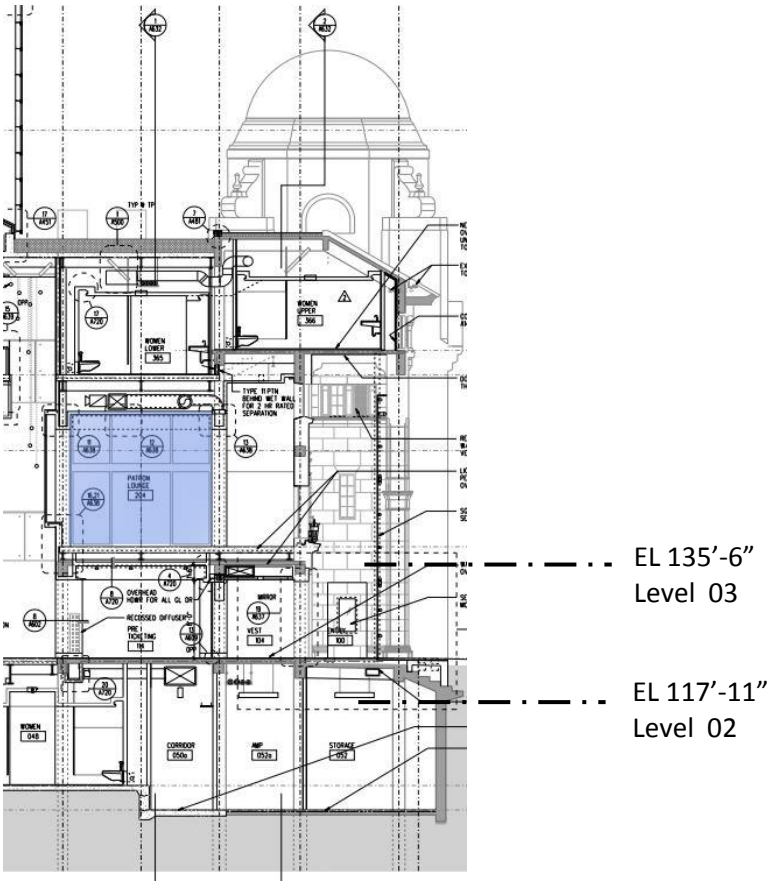


Figure 1.1b: Patron's Lounge Partial Building Section
(Courtesy of LMN Architects)

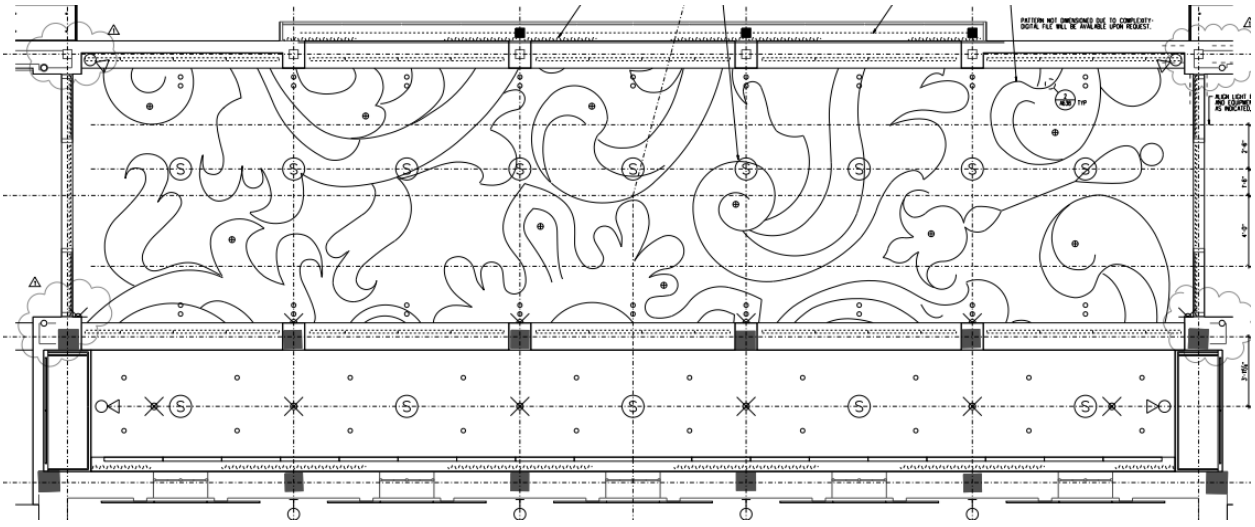


Figure 1.1c: Patron's Lounge Ceiling Pattern *(Courtesy of LMN Architects)*

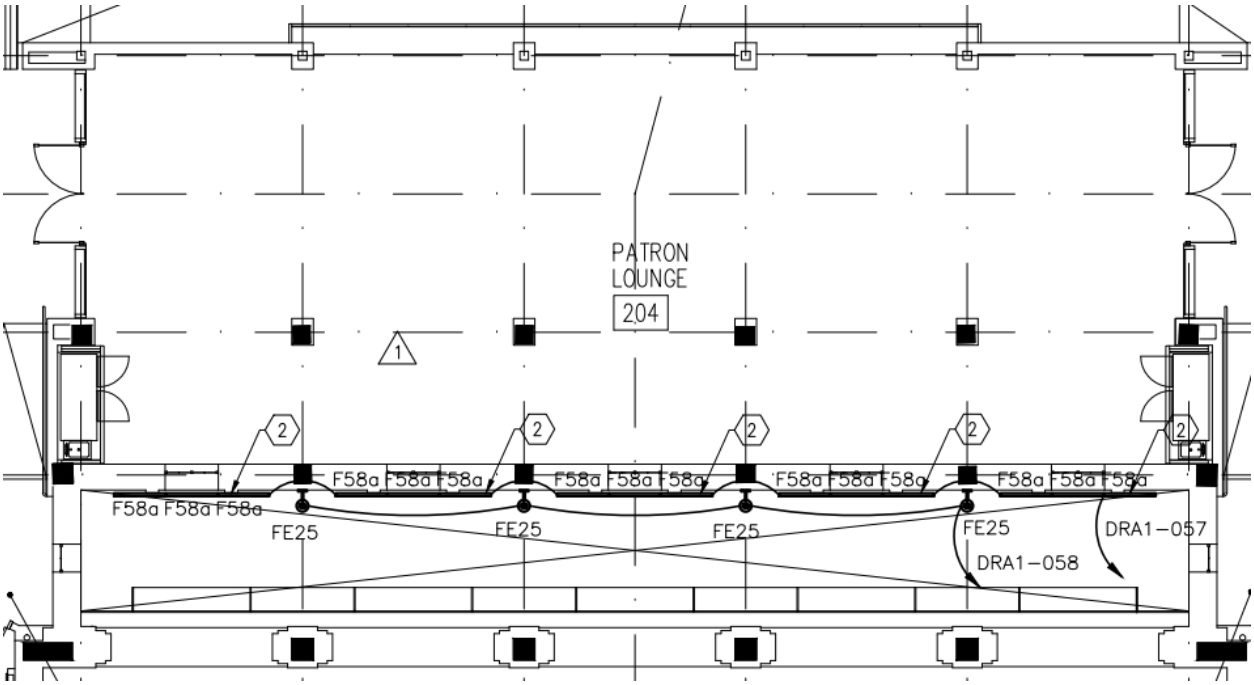


Figure 1.1d: Patron's Lounge Floor Plan *(Courtesy of LMN Architects)*

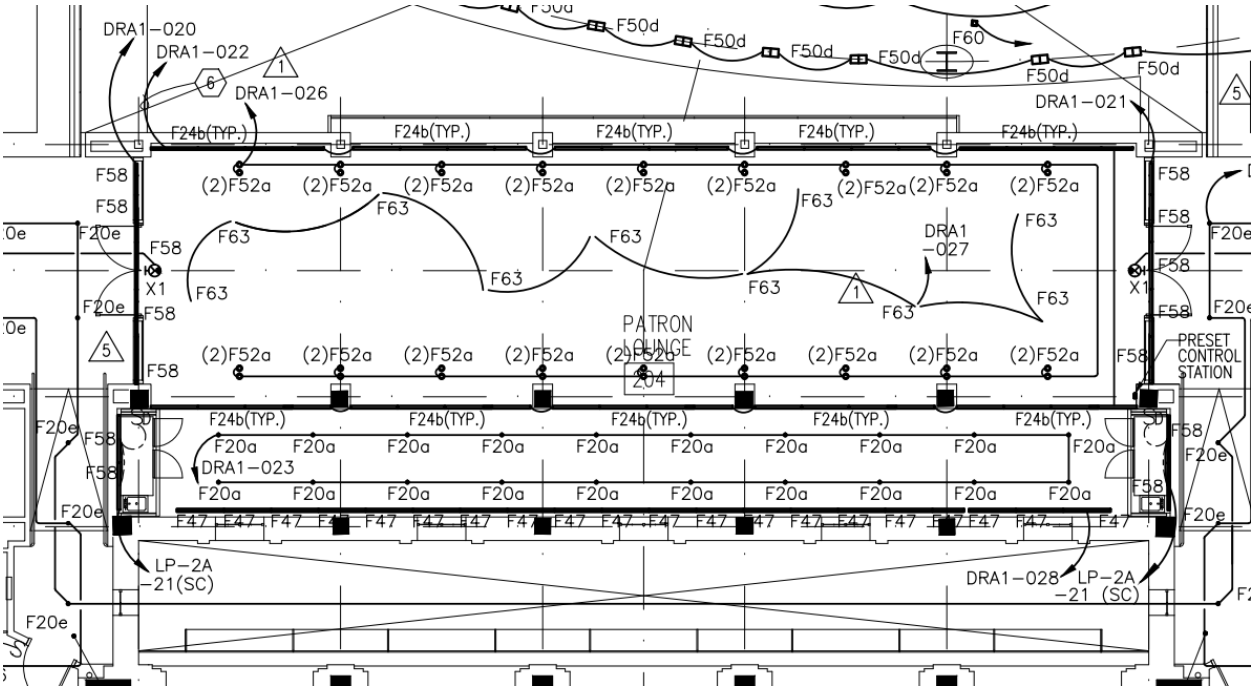


Figure 1.1e: Patron's Lounge Reflected Ceiling Plan *(Courtesy of LMN Architects)*

Finishes

Table 1: Patron's Lounge Finish Schedule

Surface	Type	Description	Reflectance
Floor	CPT-1	Broadloom Carpet	5%
N,S, E,W Walls	PNT-22	Paint Color No. G7634882 (smooth pearl w/ satin clearcoat) Manufacturer: Scuffmaster	50%
Ceiling	SPCLG-1,PNT-24,PNT-25	Paint Color No. DE790 Ice Gray, Paint Color No. G7170210 (smooth pearl w/ satin clearcoat) Manufacturers: Dunn Edwards, Scuffmaster	80%
Cove	PNT-4	Paint Color No. HC-166 Kendall Charcoal Manufacturer: Benjamin Moore	10%
Columns	PNT-22	Paint Color No. G7634882 (smooth pearl w/ satin clearcoat) Manufacturer: Scuffmaster	64%

**Note: reflectances verified by lighting designer*

Glazing

Table 2: Patron's Lounge Structural Glass Wall Finish Schedule

Surface	Type	Description	Transmittance
Structural Glass Wall on North Wall (SGWS-2)	GL-6A	Clear tempered glass, ½ inch	Assume 90%
Glass Door (North Wall) & Window (North & South Walls)	GL-14	Laminated custom graphic image glass, ½ inch nominal, clear tempered low iron laminated glass, consisting of two panes of ¼ inch thick glass bonded with digitally printed image on 0.06 inch polyvinyl butyral interlayer	Assume 89%

**Note: Transmittance values were assumed and referenced from the 2011 AGC Glass Company Notrh America, Inc. glass products. These values were chosen as typical transmittance values, and they are suitable for the type of glass being used in this specific space.* http://www.aisglass.com/pvb_laminated.asp

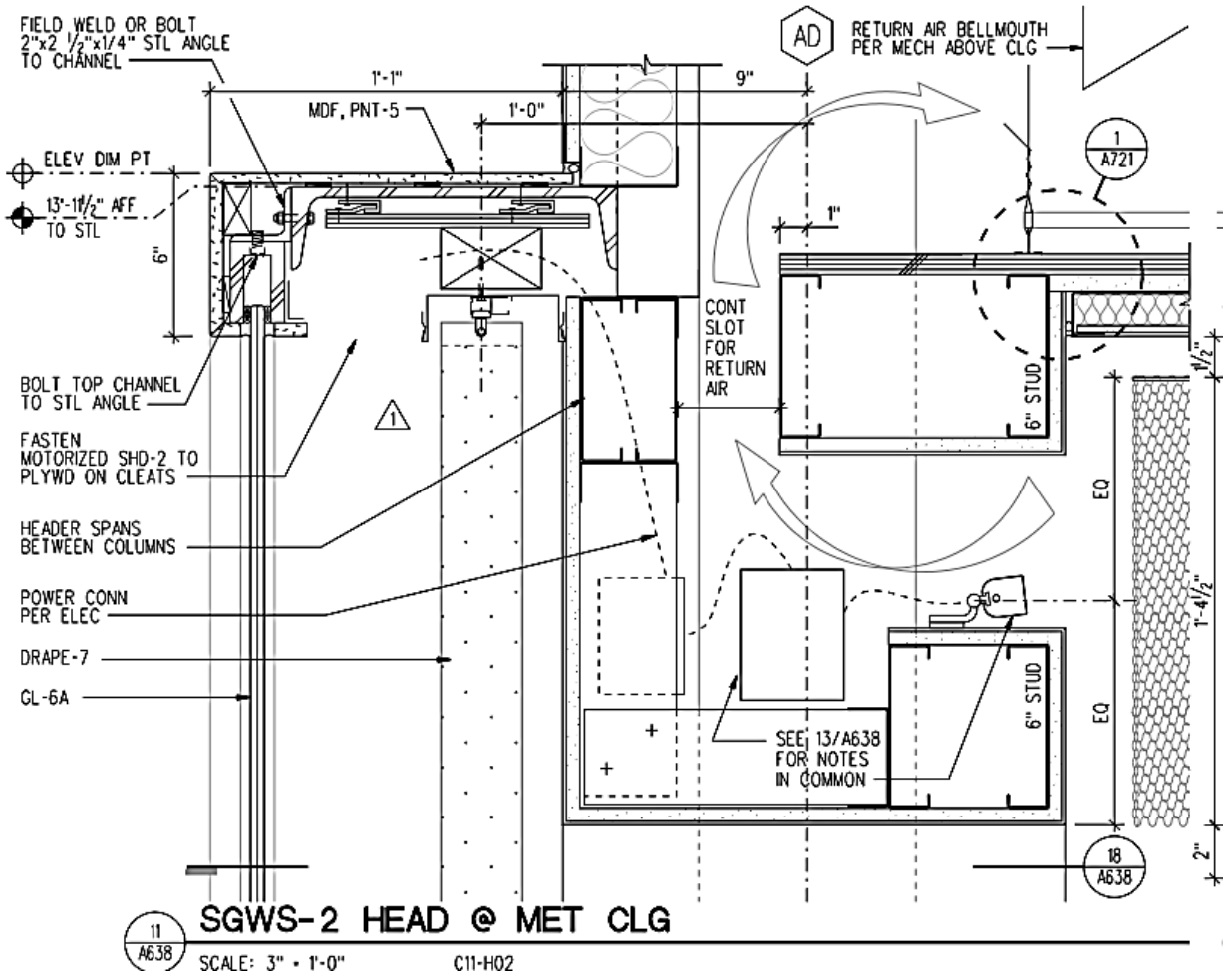


Figure 1.1f: Patron's Lounge Structural Glass Wall Support Framing Detail
(Courtesy of LMN Architects)

1.2 Existing Lighting Conditions

The Patron's Lounge primarily utilizes MR16 downlights for general illumination and LED wall grazing fixtures to accentuate walls within the space. Fixture F24b is to be controlled and dimmed via DMX by Traxon LED engine XB-SD and wall-mounted light-drive RGB or similar next to the preset control station.

Table 3: Patron's Lounge Lighting Fixture Schedule

Type	Description	Finish	Mfr/Catalog No.	Lamping	Electrical Data
F20a	MR16 pinhole downlight with lens	Matte White	Lucifer DL10ZP-W-HAL-SFL2DH-NIC-ZF-HAL-20-VOLT-MOD WRL-20	20W IRMR16 FL Osram Sylvania – 20MR16/IR/FL35/C	Integral Electronic or Magnetic Transformer Input Power: 24W
F24b	Continuous linear color-changing	Concealed in Cove	Traxon XB.NI.1.1.1.4.MOD FROSTED	12.3W/ft LED 82+ CRI, 3000K + 75K,	Remote power supply & driver, 120V only Input Power: 12.3W/ft

	LED grazing light, 25x6-degree graze distribution with frosted lens		XB.AC.0000500 PX.IC.5060200/Scene Controller Traxon SC.CD.5000100 (white) or SC.CD.5000000 (black)	50,000hrs	
F47	Continuous linear white LED wall grazing light in architectural slot, surface-adjustable mounting, 10x60 degree distribution	Aluminum extrusion (concealed fixture)	Ecosense 10LC-LENGTH-30-VOLTAGE-10(10x60) 10-A-MNT-ADJ (adjustable hinged clips)	17.5W/ft LED	Integral dimmable power supply Input Power: 17.5W/ft
F52a	Stem mounted adjustable MR16 cylinder downlight	Satin aluminum powdercoat	B-K SN-0-SAP-12-B-LENGTH-MOD STRAIGHT 360SL KNUCKLE Q-Tran QT-Series Torrodial Transformer with Choke	20W IRMR16 FL Osram Sylvanaia – 20MR16/IR/FL35/C	Remote dimmable transformer – magnetic or electronic Input Power: 23W
F58	Continuous linear white LED wall grazing light surface-adjustable mounted, low output, 10-degree distribution	Black	Boca Flasher HPNFC-HO6-3000K-13x38-VOLTAGE-B-I-S-SI-HL	10W/ft Integral LED 3000K ± 75K CCT 80+ CRI 50,000hr + L70	Integral Electronic Dimmable Power Supply Input Power: 10W/ft
F58a	Same as type F58 but with a custom finish and wet-rated	Custom paint to match architect's sample	Boca Flasher HPNFC-HO6-3000K-13x38-VOLTAGE-CUSTOM-W-S-SI-HL	10W/ft integral LED 3000K ± 75K CCT 80+ CRI 50,000hr + L70	Integral electronic dimmable power supply Input Power: 10W/ft
F63	Halogen decorative pendant	Crystal canopy finish to be selected	Terzani Mizu R01S	10W T3 Halogen Osram Sylvania – 10T3Q/CL/AX	Remote electronic/magnetic transformer Input Power: 10W

Table 4: Patron's Lounge Lighting Control Schedule

Room	Dimmable	Timeclock Control	Daylight Sensor	Occupancy Sensor	Control Engine	Control Type	Preset Control Station
Patron's Lounge	Y	N	N	N	Y	DMX by Traxon LED engine XB-SD & wall-mounted light-drive RGB	Y

Table 5: Light Loss Factors

Type	Luminaire Dirt Depreciation	Ballast Factor	Lamp Lumen Depreciation	Total LLF
F20a	0.94	1.00	0.95	0.89
F24b	0.94	0.80	0.70	0.53
F47	0.94	0.80	0.85	0.64
F52a	0.94	1.00	0.95	0.89
F58	0.94	0.80	0.70	0.53
F58a	0.94	0.80	0.70	0.53
F63	0.94	-	0.95	0.89

**Note: Luminaire Dirt Depreciation is based on a clean environment with an assumed cleaning cycle of 12 months.*

Table 6: Power Density

Type	Quantity	Input Watts	Total Watts	Area (SF)	Power Density (W/SF)	Note (unit or LF)	Compliant (Y/N)
F20a	20	24	480	-	-	Unit	-
F24b	(2) rows of 7.83LF	12.3	192.6	-	-	LF	-
F47	7.41	17.5	129.7	-	-	LF	-
F52a	36	23	828	-	-	Unit	-
F58	(2) rows of 1.75LF & (2) rows of 0.75LF	10	50	-	-	LF	-
F58a	(5) rows of 1.13LF	10	56.5	-	-	LF	-
F63	10	10	100	-	-	Unit	-
			1836.8	1558	1.18	-	N

1.3 Design Considerations & Criteria

Qualitative Criteria:

The appropriate lighting for the Patron's Lounge shall respond to its unique architectural expression, and support the programmatic needs of the space to serve as a special retreat for patrons. A control system is suitable for this space to permit various layers of lighting to be zoned separately, allowing flexibility of the lighting system. Change and control of lighting can add dynamism to this interior space, especially along the walls and custom ceiling. As a form of dramatic lighting, successful dynamic designs use change sparingly, providing contrast with any movement or color change. Additionally, the use of a control system enables the lighting to attract patrons' attention and a level of activity and excitement, when necessary.

To reinforce the psychological impression of relaxation, the room should project a feeling of comfort, conversation, and gathering. [1]In accordance to John Flynn's lighting mode and subjective impression of relaxation, such factors are fitting for this type of space:

- Non-uniform peripheral lighting, especially on walls
- Lower light levels
- Warmer-toned light sources

[1] Light in Architecture and Psychology of Light, RS Lighting Design

For programmatic needs and budget constraints, a combination of halogen, LED and dimmable fluorescent lamp sources should be considered.

Quantitative Criteria:

Illuminance recommendations [IES Lighting Handbook10th Edition (Table 28.2)]

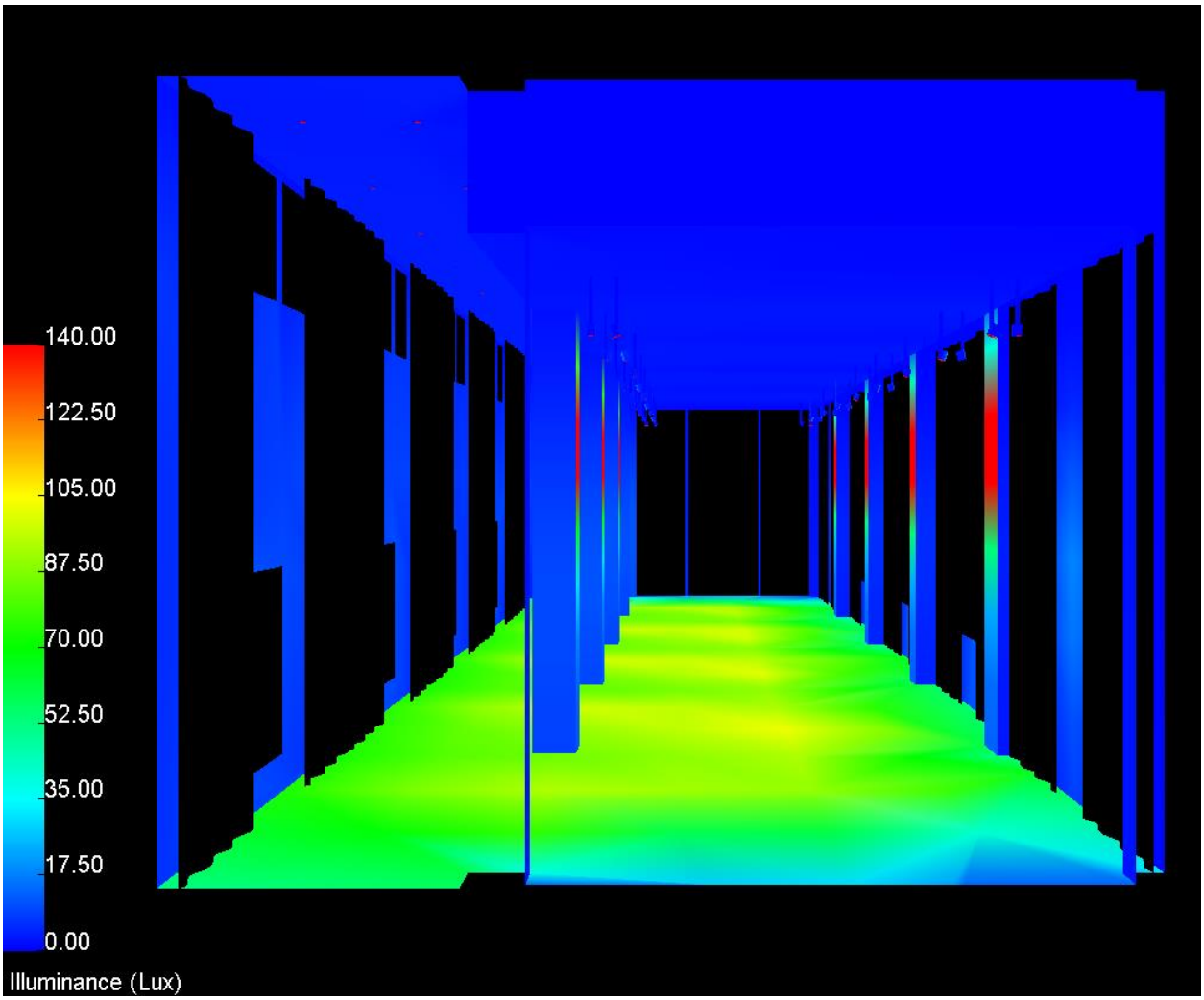
Space	E_h	E_v	Avg:Min
Lounges Social/Waiting Area	40 lux @ floor	15 lux @ 4ft AFF	2:1

Energy Allowance [ASHRAE Standard 90.1]

Space	Power Density (W/sf)
Lounge	0.73 W/ft^2

1.4 Evaluation of Existing Conditions

The AGI model shows the space with the lower and raised ceiling. The horizontal illuminance on the floor, especially on the lower ceiling side, is much greater than what is recommended. This is expected because the custom designed ceiling was not placed into the model. Instead, fins were placed on the ceiling to help portray the intended effect; therefore, giving a misleading illuminance along the floor. If the custom ceiling was designed in AGI, the illuminance would be much less and closer to the recommended value. This also would respond well to the psychological impression of relaxation of lower light levels. The vertical illuminance does meet criteria, accenting the walls between the windows. This helps lead the human eye upwards to the custom ceiling.


140.00
122.50
105.00
87.50
70.00
52.50
35.00
17.50
0.00
Illuminance (Lux)

2.0 MAIN AUDITORIUM | LARGE WORK SPACE

The main auditorium, located in the center of the building program, is a suitable venue space for multiple productions, such as theatrical productions, orchestral concerts, dance performances, films, amplified events, and lectures.

2.1 EXISTING CONDITIONS

The main auditorium can house 1,750 audience members, but is also variable depending on the pit lifts, which are used as stage extensions or for an orchestra. With a focus on the house lighting, this space shall respond to various lighting and rigging requirements for these configurations.

Reflected ceiling plans, floor plans, and an evaluation of design considerations and criteria will be performed specifically on the specialty lighting of the auditorium space only, not the theatrical lighting of the stage. Although stage lighting will not be studied, further investigation can be performed at a later time.

Dimensions

Area	6437.78 SF (Stage), 11,648 SF
Length	176.17’
Width	121.05’ (Stage), 92.01’ (auditorium seating area)
Ceiling Height	88’-0”

Figures 2.1a-2.1t shows the spatial environment & orientation of the Main Auditorium through floor plans, sections, elevations, and reflected ceiling plans.

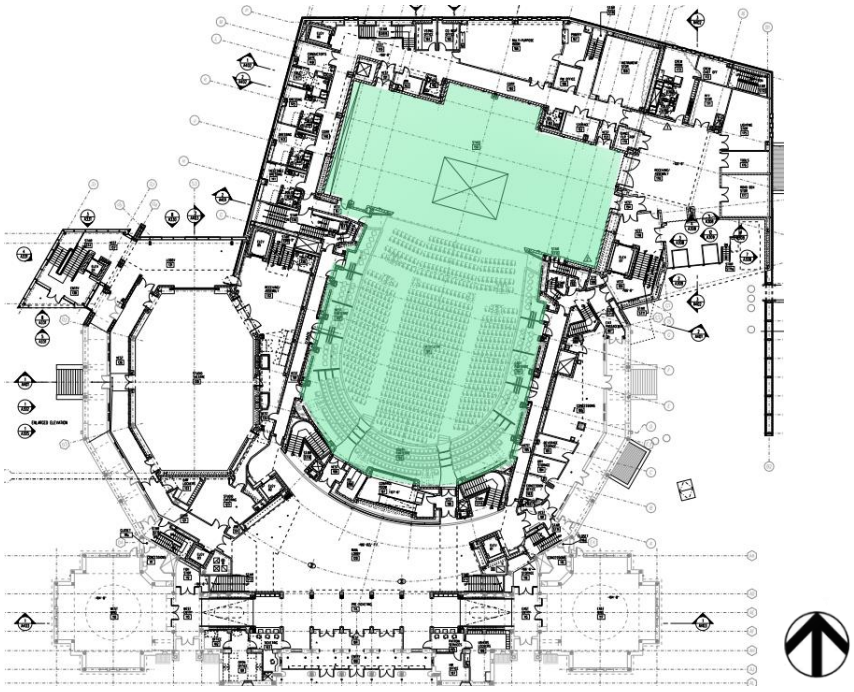


Figure 2.1a: Main Auditorium Spatial Definition
(Courtesy of LMN Architects)

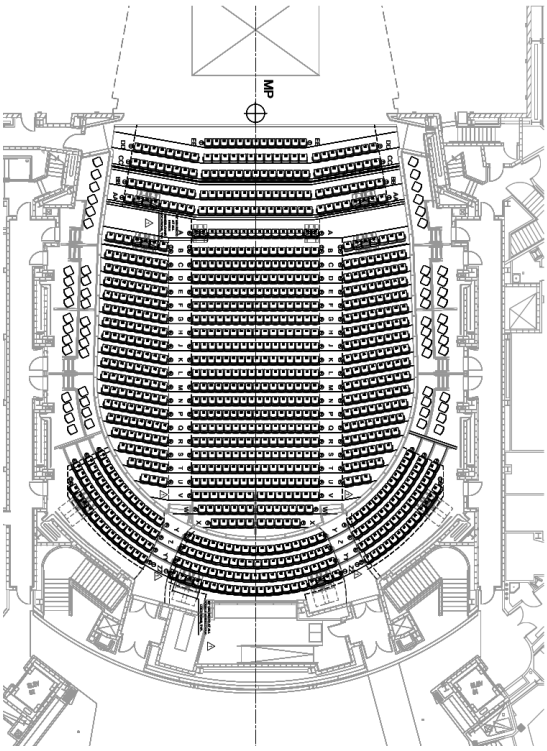


Figure 2.1b: Orchestra Seating Floor Plan
(Courtesy of LMN Architects)

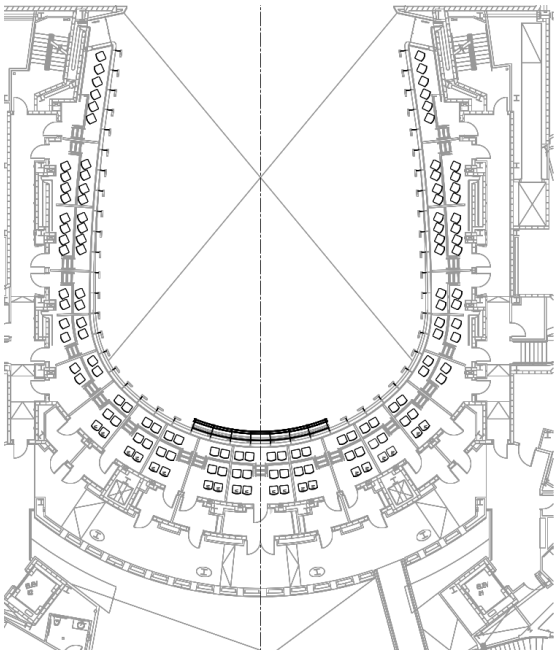


Figure 2.1c: Box Tier Seating Floor Plan
(Courtesy of LMN Architects)

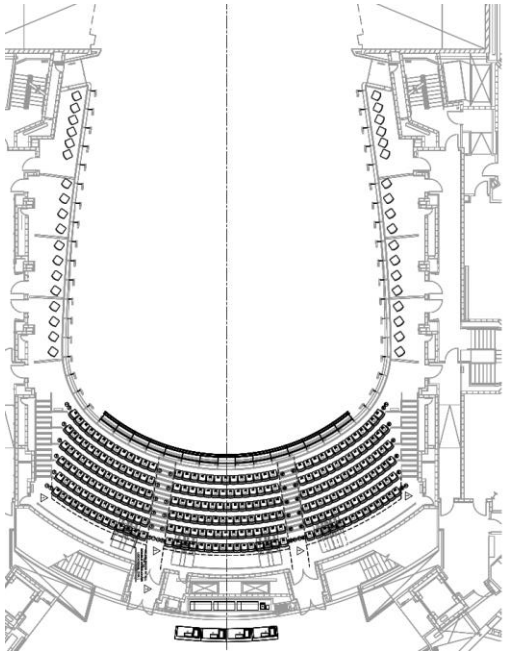


Figure 2.1d: Upper Dress Circle Seating Floor Plan
(Courtesy of LMN Architects)

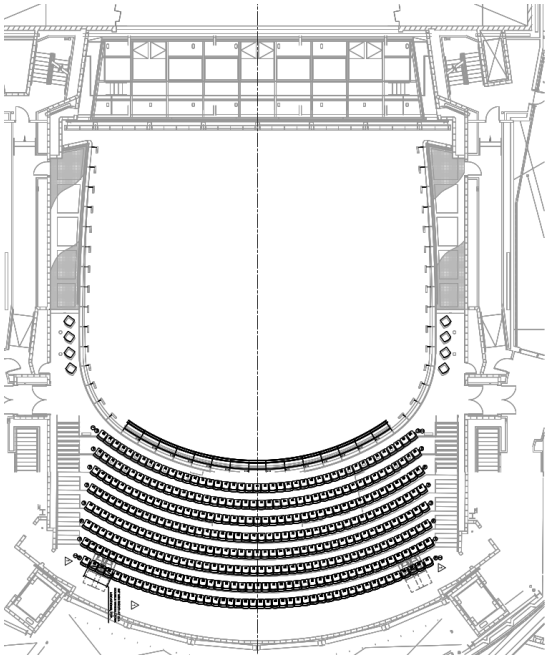


Figure 2.1e: Upper Balcony Seating Floor Plan
(Courtesy of LMN Architects)

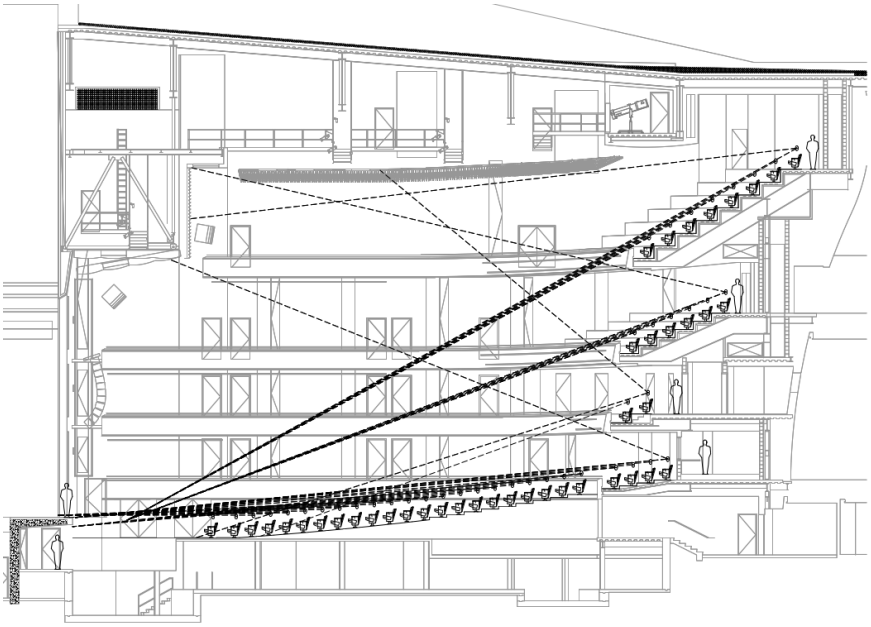


Figure 2.1f: Main Auditorium Long Section
(Courtesy of LMN Architects)

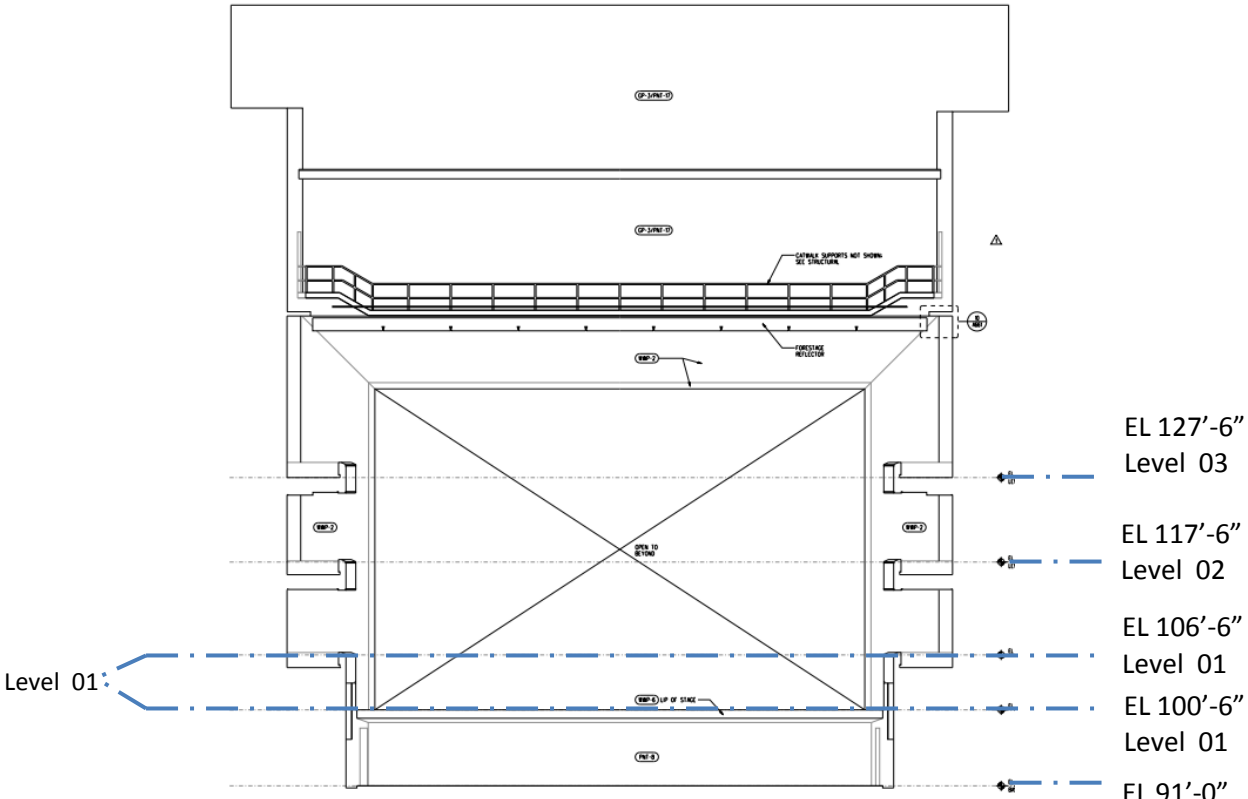


Figure 2.1g: North Elevation
(Courtesy of LMN Architects)

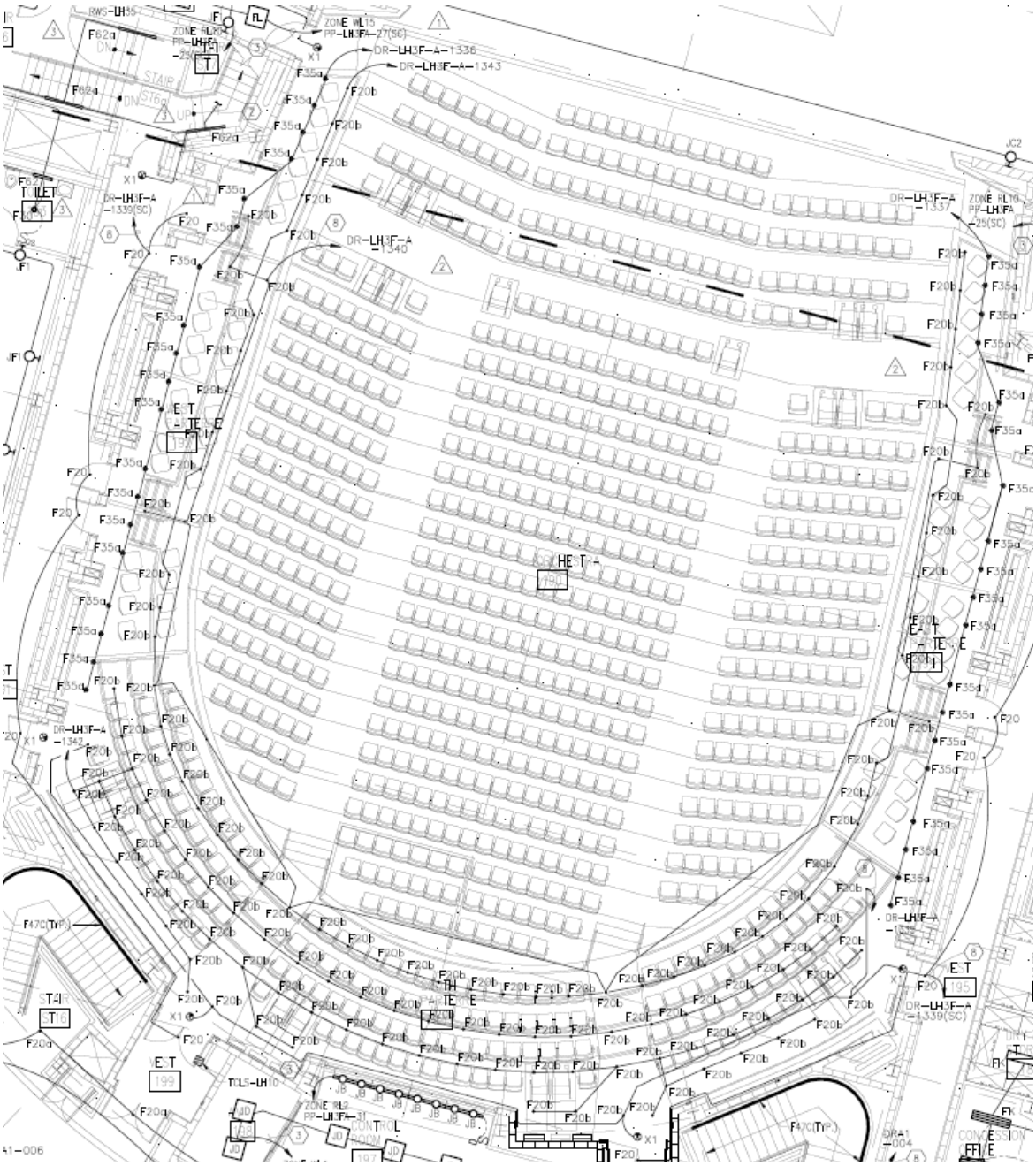


Figure 2.1h: Level 01 South Lighting RCP
(Courtesy of LMN Architects)

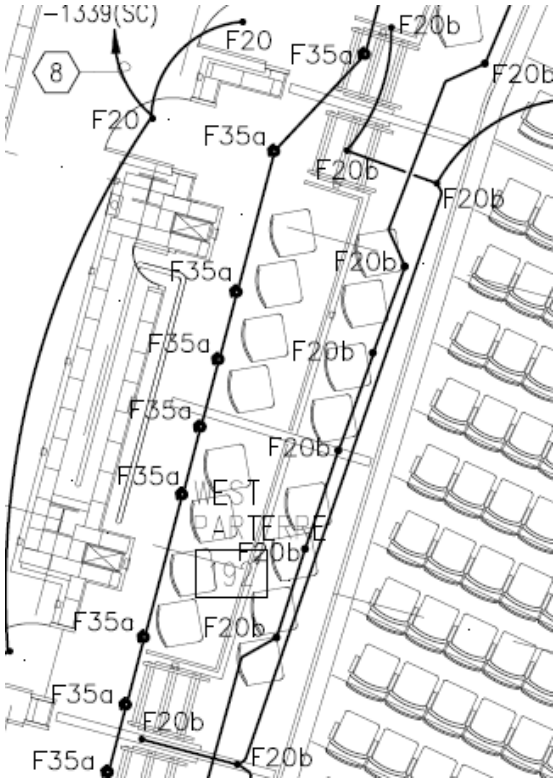


Figure 2.1i: Enlarged Level 01 South RCP
(Courtesy of LMN Architects)

**Note: typical for east and west sides of auditorium*

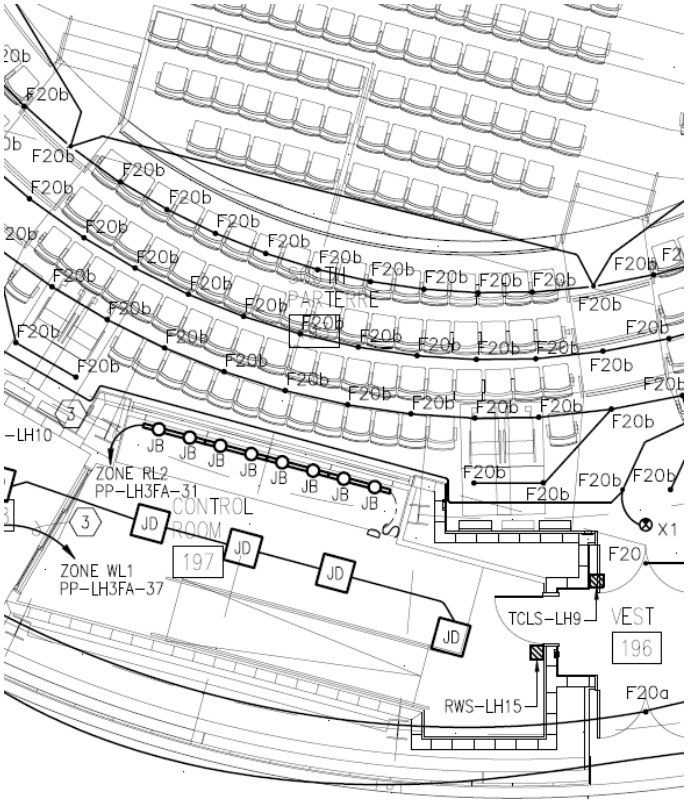


Figure 2.1j: Enlarged Level 01 South RCP
(Courtesy of LMN Architects)

**Note: typical for south side of auditorium*

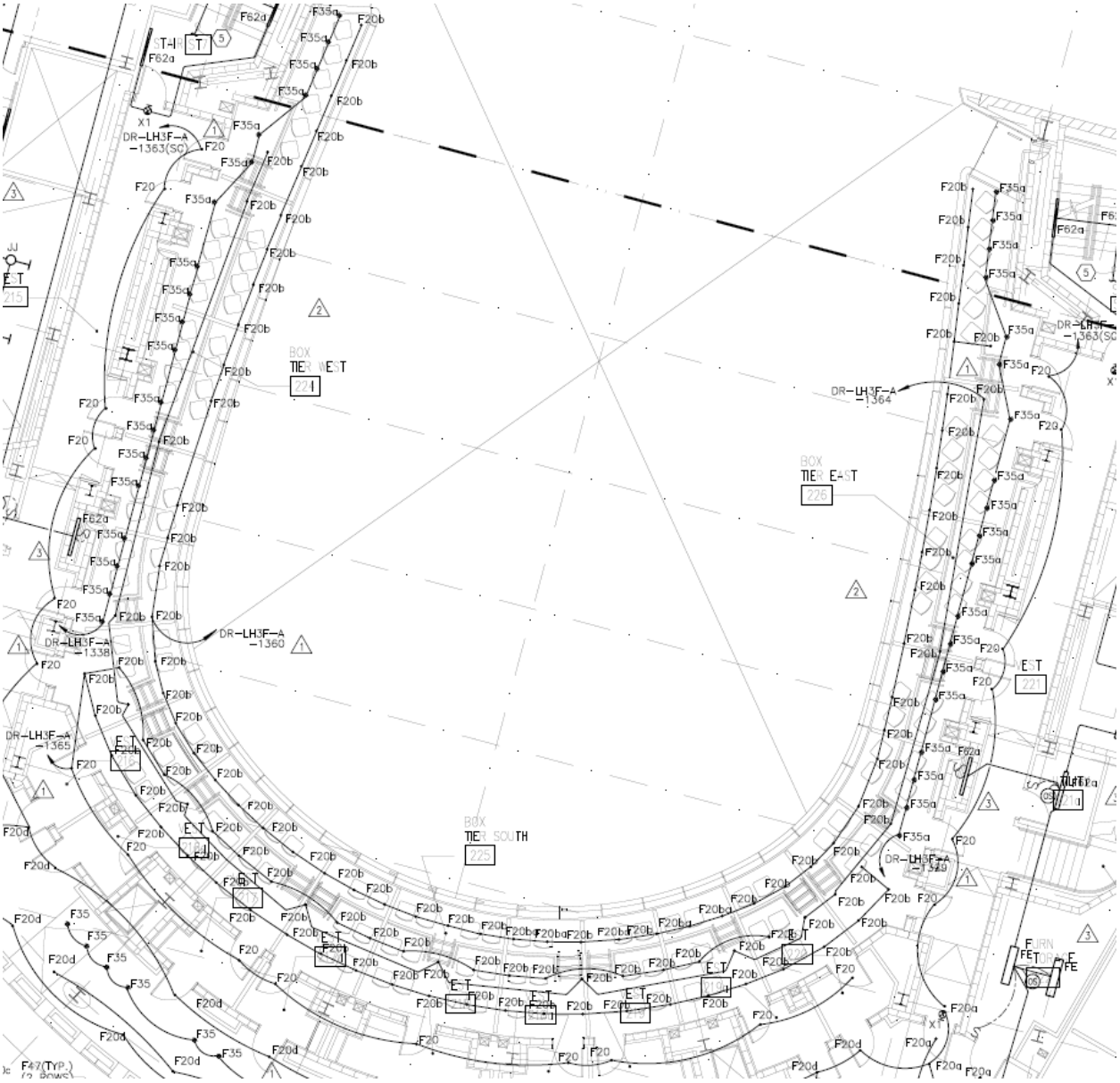


Figure 2.1k: Level 02 South Lighting RCP
(Courtesy of LMN Architects)

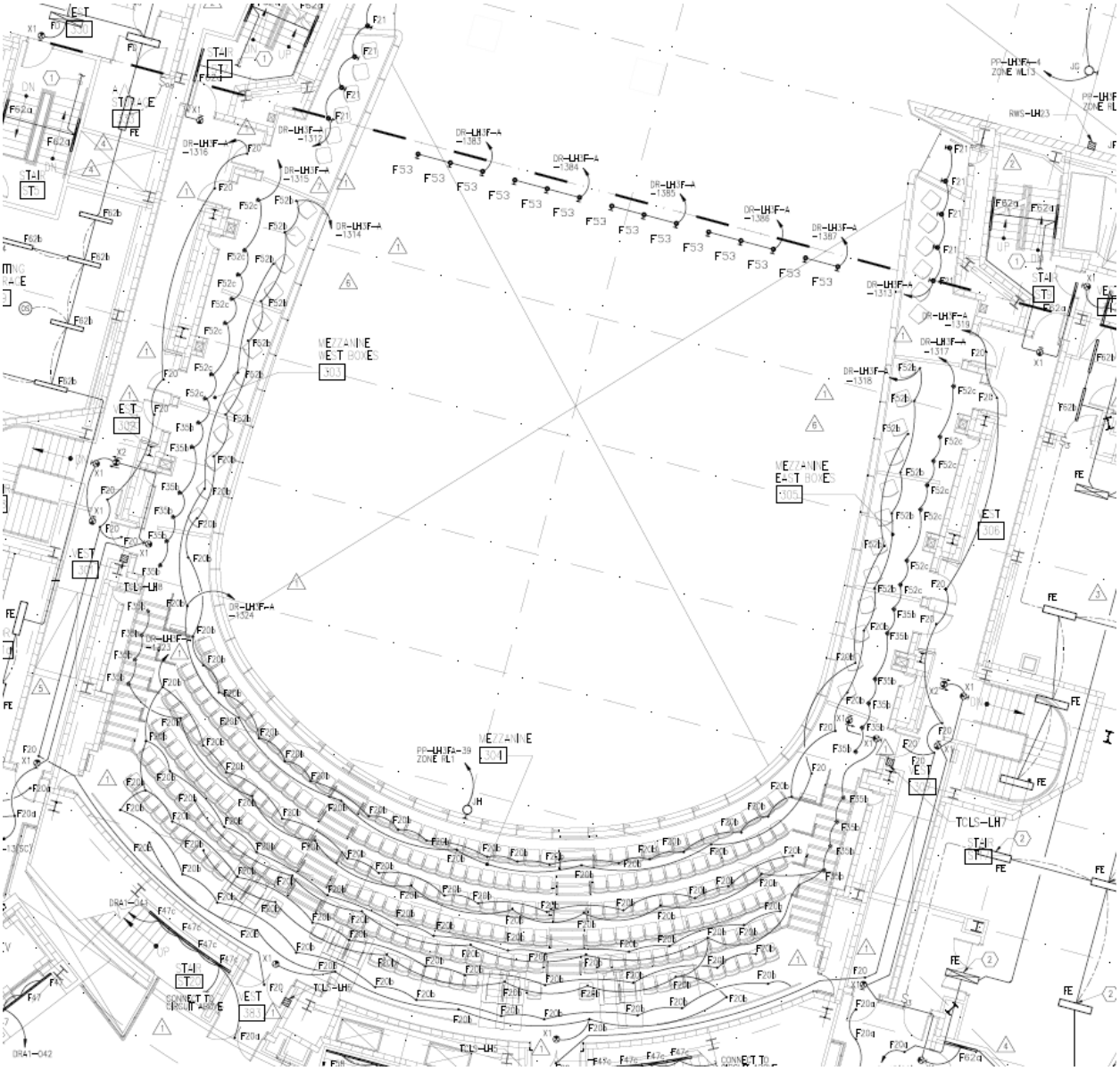
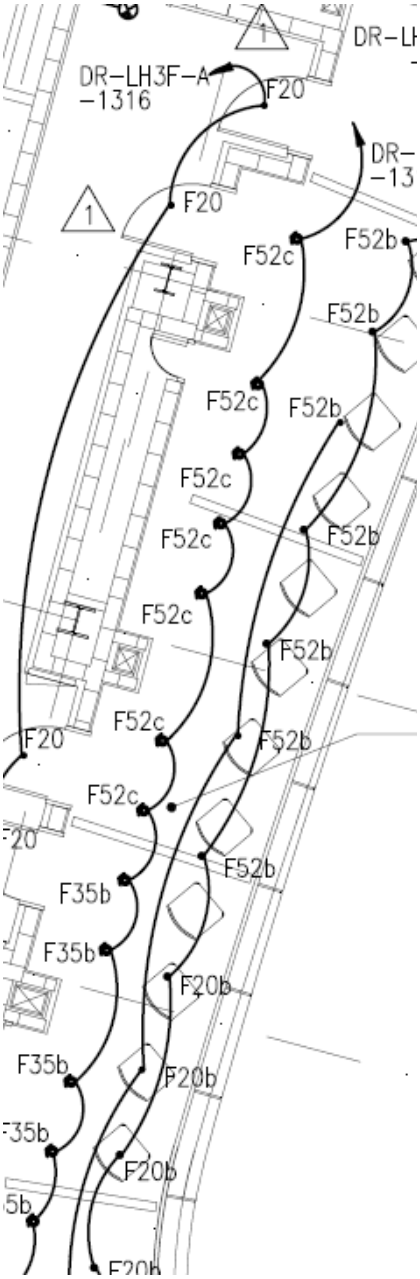


Figure 2.1l: Level 03 South Lighting RCP
(Courtesy of LMN Architects)



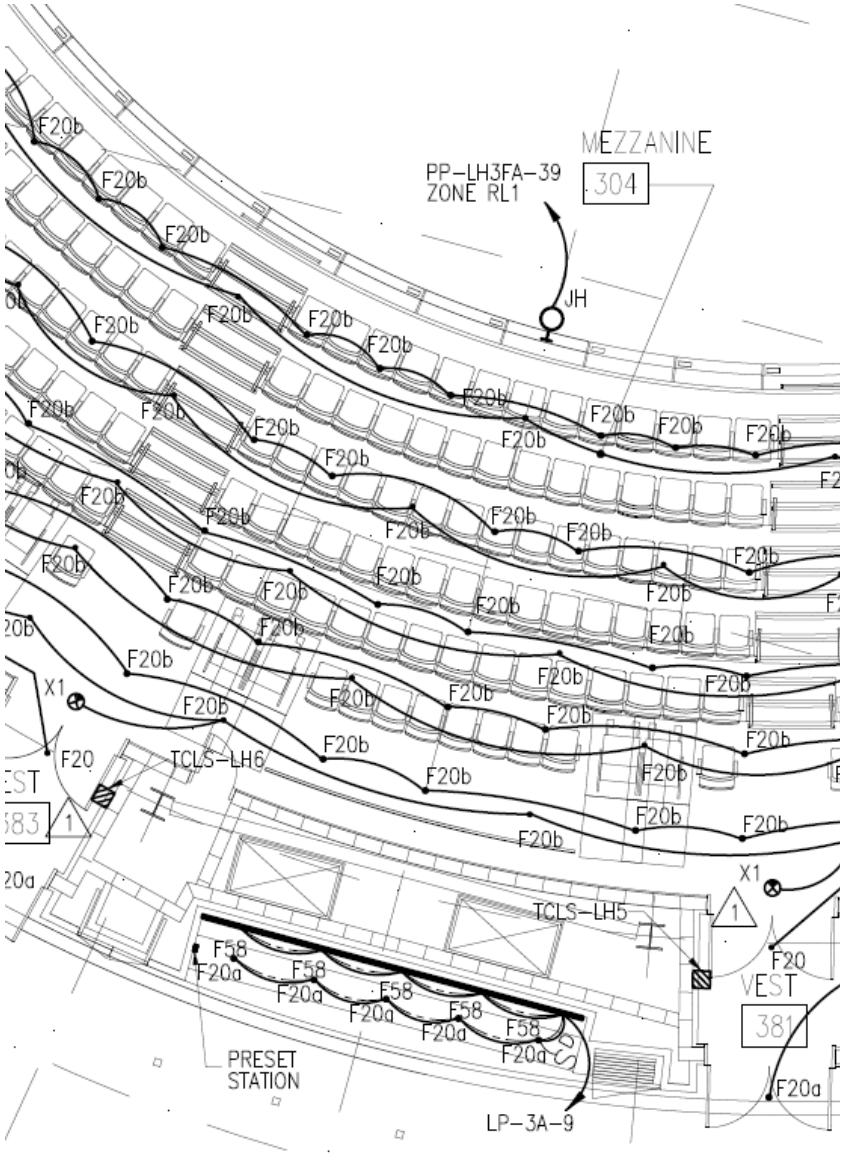


Figure 2.1m: Enlarged Level 03 South RCP
(Courtesy of LMN Architects)

**Note: typical for east and west sides of auditorium*

Figure 2.1n: Enlarged Level 03 South RCP
(Courtesy of LMN Architects)

**Note: typical for south side of auditorium*

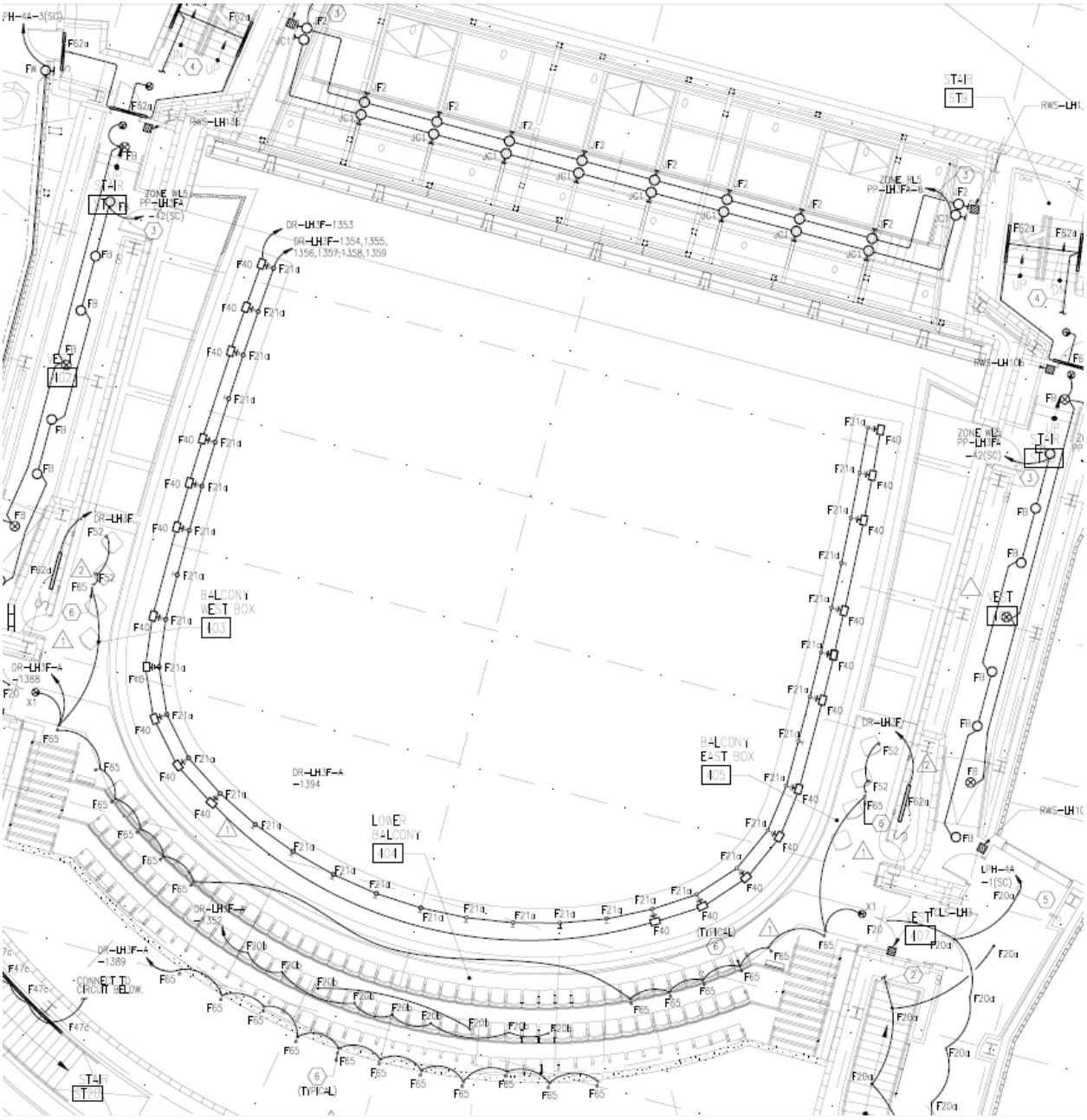


Figure 2.1o: Level 04 Lighting RCP
(Courtesy of LMN Architects)

Figure 2.1p: Enlarged Level 04 RCP
(Courtesy of LMN Architects)

**Note: typical for east and west sides of auditorium*

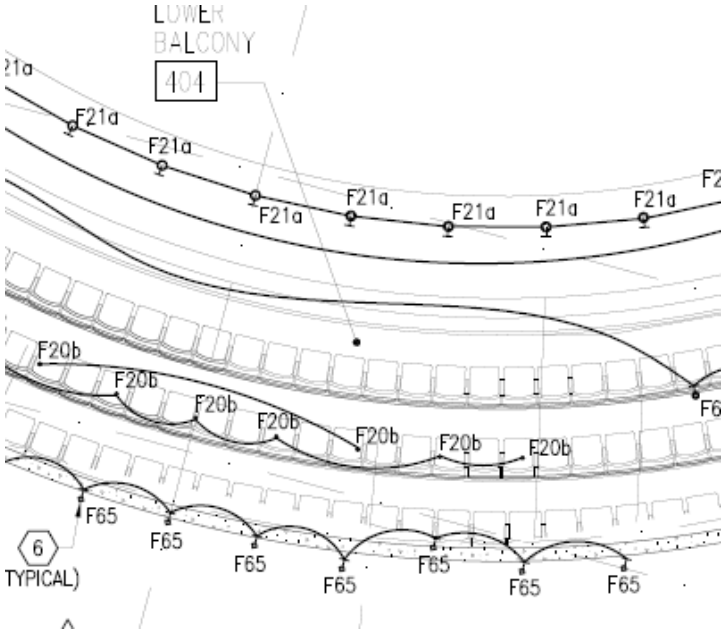


Figure 2.1q: Enlarged Level 04 RCP
(Courtesy of LMN Architects)

**Note: typical for south side of auditorium*

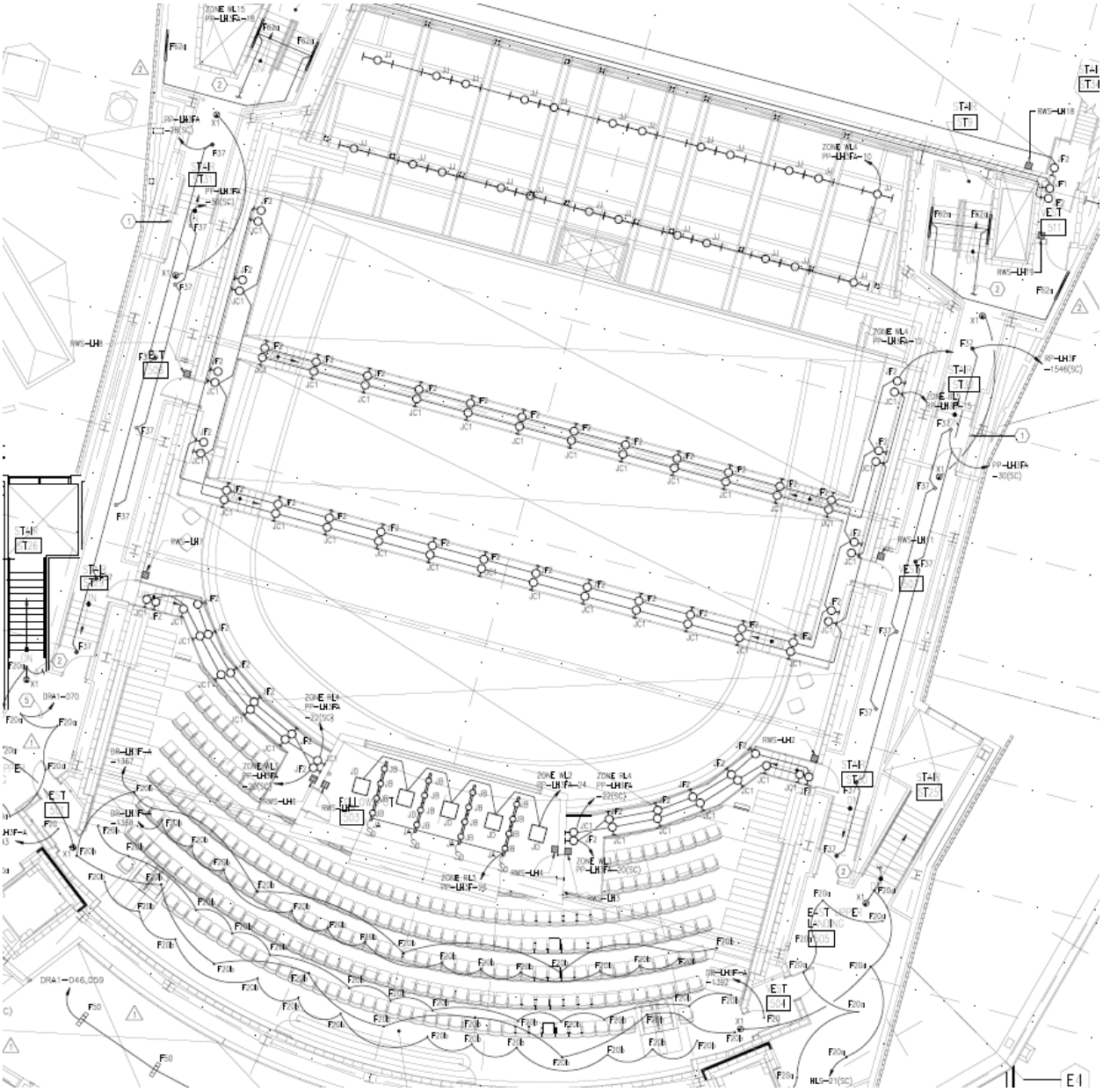


Figure 2.1r: Level 05 South Lighting RCP
(Courtesy of LMN Architects)

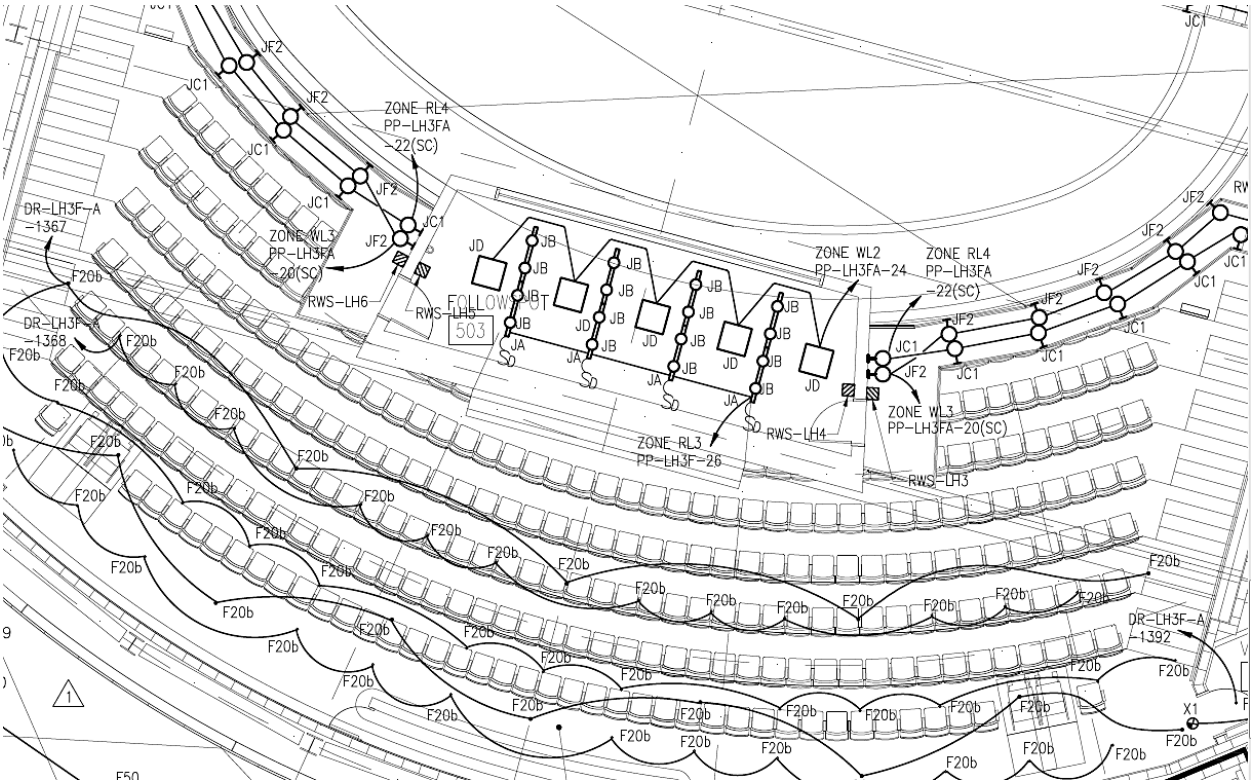


Figure 2.1s: Enlarged Level 05 Lighting RCP ***(Courtesy of LMN Architects)***

**Note: south side of auditorium*

Below shows a typical light plot for theatrical lighting.

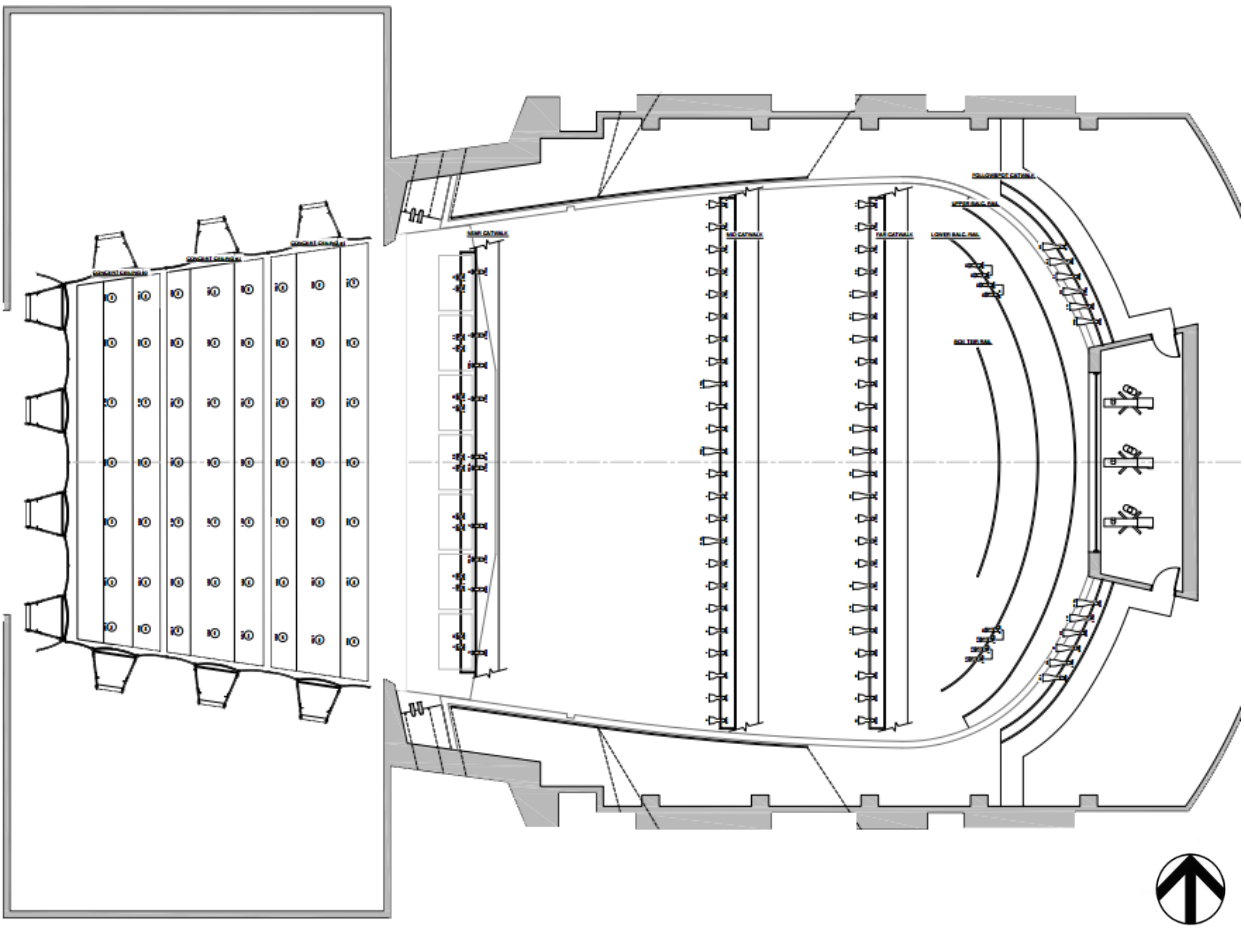


Figure 2.1t: Theater Lighting Large Hall Concert Light Plot *(Courtesy of LMN Architects)*

5° ellipsoidal spotlight

10° ellipsoidal spotlight

19° ellipsoidal spotlight

26° ellipsoidal spotlight

36° ellipsoidal spotlight

50° ellipsoidal spotlight

7.5°-19° ellipsoidal spotlight

Source Four PAR MCM – Lens as Noted

Source Four PAR MCM – MFL Lens (integral to concert ceiling)

Finishes

Table 7: Main Auditorium Finish Schedule

Surface	Type	Description	Reflectance
Floor	CPT-2	Modular Tile Carpet	20%
N, S, E, W Walls	PNT-17	Paint Color No. DEA 146 Scarlet Apple Manufacturer: Dunn Edwards	20%
Ceiling	PNT-21	Paint Color No. DEA 195 Primitive Plum Manufacturer: Dunn Edwards	20%

**Note: reflectances verified by lighting designer*

(Courtesy of LMN Architects)

2.2 Existing Lighting Conditions

The Main Auditorium uses several LEDs, fluorescents, and incandescents for house lighting. They provide general illumination, when necessary. Several fixtures have dimmable capability, allowing the lighting to be adjusted depending on the function or performance in the space. Additionally, theatrical lighting is incorporated into the space, mostly to focus on the stage lighting.

Table 8: Main Auditorium Lighting Fixture Schedule

Type	Description	Finish	Mfr/Catalog No.	Lamping	Electrical Data
F20	MR16 pinhole recessed downlight with torroidal transformer to reduce noise Location: Sound and Light Locks	Gray primer to be field painted	Lucifer DL1ZP-CUSTOM GRAY PRIMER-HAL-FGL-2 DH-NIC-ZF-HAL-20-12OT-MOD WRL 20	20W IRMR16 FL Osram Sylvania – 20MR16/IR/FL35/C	Integral torroidal transformer, 120V only Input Power: 24 W Dimmable
F20b	MR16 pinhole recessed downlight with torroidal transformer to reduce noise, modified for 2" thick ceilings with an airtight housing as required Location: Auditorium, sound and light locks	Gray primer to be field painted	Lucifer DL1XM-CUSTOM GRAY PRIMER-HAL-FGL-2DH-IC/NIC-XF-HAL-20-120T-MOD WRL 2O-CFPX-2.5 CUSTOM COLLAR	20W IRMR16 FL Osram Sylvania – 20MR16/IR/FL35/C	Integral torroidal transformer, 120V only Input Pwer: 24W
F21	Incandescent surface canopy mounted cylinder downlight Location: Auditorium	Black	Lighting Services Inc. CX38-5A-B-C998-MOD 100WRL	100W IR PAR38 Osram Sylvania – 100PAR38/CAPIR/FL40	Input Power: 100W
F21a	Incandescent surface canopy mounted cylinder downlight Location: Auditorium	Black	Lighting Services Inc. CX38-5A-B-C998	250W PAR38 GE - Q250PAR/FL30	Input Power: 250W
F22	Seat-mounted shielded LED steplight Location: Auditorium	Refer to theatrical drawings	Supplied as part of auditorium seats by manufacturer in theatrical light specifications	2700K, 82 CRI 1.5W LED recommended by Theatrical Consultant	Remote power supply Input Power: allow 2W
F24	Linear color-changing LED backlighting curved balcony front panels with constant current power supplies Location: Auditorium	Concealed in cove	Traxon XB.NI.111-4-1 XB.AC.0000500 PX.IC.5060200	12.2W/ft RGB LED	Remote power supply & driver, 120V only Input Power: 12.2W/ft

Table 8: Main Auditorium Lighting Fixture Schedule Cont.

Type	Description	Finish	Mfr/Catalog No.	Lamping	Electrical Data
F24a	10" long dynamic white LED with frosted front lens and adjustable aiming mounted within architectural bracket on 11" arm front-lighting curved balcony front panels Location: Auditorium	Concealed in 8" architectural bracket arm	Traxon Custom XB.MOD N(6)-1-1-8-CUSTOM WHITE-6-MOD FROSTED XB.AC.00005600 PX.IC.5060200	12.2 W White LED, (2) Amber, (4) 3,000K + 75K, 82+ CRI, 50,000hrs	Remote power supply & driver, 120V only Input Power: 8.2W
F33	Recessed LED steplight Location: Auditorium	Black	Lucifer SSL-ALED-3K-B-L/SSL-BB and PSA-60-12H	3W LED Module 3000K, 82+CRI	Remote power supply Input Power: 3.3W
F33a	Same as type F33 but stainless steel finish in quardrail posts Location: Auditorium	Brushed stainless steel	Lucifer SSL-ALED-3K-SS-L/SSL-BB and PSA-60-12H	3W LED Module 3000K, 82+CRI	Remote power supply Input Power: 3.3W
F35a	Same as type F35b	-	-	-	-
F35b	Recessed MR16 adjustable downlight for 2" thick ceilings supplied with integral linear spread and frosted glass lenses aimed for consistent wallwash distribution, airtight housing as required. With various dichroic glasas color filters. Location: Auditorium Balcony and Mezzanine	Gray primer to be field painted	Lucifer DL2RXM-CUSTOM GRAY PRIMER-CR-HAL-LSL-2-FGL-2DH-IC/NIC-XF-HAL-20-120T-20WRL CFPX-2.5 CUSTOM COLLAR	20W IRMR16 FL Osram Sylvania – 20MR16/IR/FL35/C	Integral 120V torroidal transformer Input Power: 24W
F40	Color-changing LED surface-mounted floodlight Location: Auditorium	Aluminum extrusion	Traxon XB.WE.2.1.1.6.1 PX.IC.5060200	54W RGB LED	Remote power supply, 120V Input Power: 54W

Table 8: Main Auditorium Lighting Fixture Schedule Cont.

Type	Description	Finish	Mfr/Catalog No.	Lamping	Electrical Data
F52	Stem mounted MR16 cylinder downlight mounted in fixed position with stem Location: Auditorium and Light Lock Open Ceilings	Aluminum, black satin powder coat	B-K RM-MR-0-BLP-12 Canopy: BC6-BLP pendant ring mount delta star-length Q-Tran QT-Series Torroidal Transformer with Choke	20W IRMR16 FL Osram Sylvania – 20RM16/IR/FL35/C	Remote Q-Tran QT Seriies torroidal transformer with choke Input Power: 24W
F52b	Same as type F52 but with a custom finish to match auditorium slat ceiling Location: Auditorium Level 03	Custom powdercoat to match slat ceiling (PNT-21)	B-K RM-MR-0-CUSTOM-9 Canopy: BC6-BLP PENDANT RING MOUNT DELTA STAR-LENGTH Q-Tran QT-Series torroidal transformer with choke	20W IRMR16 FL Osram Sylvania – 20RM16/IR/FL35/C	Remote Q-Tran QT Seriies torroidal transformer with choke Input Power: 23W
F52c	Stem mounted adjustable MR16 cylinder downlight with a custom finish to match auditorium slat ceiling and linear spread lens for wallwashing, glass dichroic color filter to match type F35b Location: Auditorium Level 03	Custom powdercoat to match slat ceiling (PNT-21)	B-K SN-0-CUSTOM-10/13-B-LENGTH-MOD STRAIGHT 360SL KNUCKLE Q-Tran QT-Series torroidal transformer with choke	20W IRMR16 FL Osram Sylvania – 20MR16/IR/FL35/C	Remote dimmable transformer – magnetic or electronic Input Power: 23W
F53	Surface mounted spotlight Location: Auditorium Proscenium	Black	Lighting Services Inc. CX38-5A-B-C998	250W PAR38 GE-Q25OPAR/FL30	Input Power: 250W
F65	MR16 surface-mounted adjustable downlight Location: Auditorium	Aluminum, satin black	B-K DS-MR-0-BLP-9-E-360SL Canopy: BC12-BLP Q-Tran QT-Series Torroidal transformer with choke	20W IRMR16 FL Osram Sylvania – 20MR16/IR/FL35/C	Remote Q-Tran QT Series torroidal transformer with choke Input Power: 24W

Table 9: Main Auditorium Lighting Control Schedule

Room	Dimmable	Timeclock Control	Daylight Sensor	Occupancy Sensor	Control Engine	Control Type	Preset Control Station
Main Auditorium	Y	N	N	N	N/A	N/A	Y

Table 10: Light Loss Factors (does not apply to theatrical and concert lighting)

Type	Luminaire Dirt Depreciation	Ballast Factor	Lamp Lumen Depreciation	Total LLF
F20	0.94	1.00	0.85	0.80
F20b	0.94	1.00	0.85	0.80
F21	0.94	-	0.85	0.80
F21a	0.94	-	0.85	0.80
F22	0.94	0.80	0.70	0.53
F24	0.94	0.80	0.70	0.53
F24a	0.94	0.80	0.70	0.53
F33	0.94	0.80	0.70	0.53
F33a	0.94	0.80	0.70	0.53
F35a	0.94	1.00	0.85	0.80
F35b	0.94	1.00	0.85	0.80
F40	0.94	0.80	0.85	0.64
F52	0.94	1.00	0.85	0.80
F52b	0.94	1.00	0.85	0.80
F52c	0.94	1.00	0.85	0.80
F53	0.94	1.00	0.85	0.80
F65	0.94	1.00	0.85	0.80

**Note: Luminaire Dirt Depreciation is based on a clean environment with an assumed cleaning cycle of 12 months.*

Table 11: Power Density

Type	Quantity	Input Watts	Total Watts	Area (SF)	Power Density (W/SF)	Note (unit or LF)	Compliant (Y/N)
F20	52	24	1248	-	-	Unit	-
F20b	345	24	8280	-	-	Unit	-
F21	10	100	1000	-	-	Unit	-
F21a	35	250	8750	-	-	Unit	-
F22	179	2	358	-	-	Unit	-
F24	752	12.2	9174.4	-	-	LF	-
F24a	560	8.2	4592	-	-	Unit	-
F33	147	3.3	574.2	-	-	Unit	-
F33a	52	3.3	171.6	-	-	Unit	-
F35a	76	24	1824	-	-	Unit	-
F35b	20	24	480	-	-	Unit	-
F40	22	52	1144	-	-	Unit	-
F52	4	24	96	-	-	Unit	-
F52b	14	23	322	-	-	Unit	-
F52c	14	23	322	-	-	Unit	-
F53	14	250	3500	-	-	Unit	-
F65	25	24	600	-	-	Unit	
			41896.2	11648	3.59	-	N

2.3 Design Considerations & Criteria

Qualitative Criteria:

It is necessary for the architectural and theatrical lighting design to be flexible, in order to respond to various lighting and rigging requirements.

To enhance the audience's entertainment experience, theatrical lighting should properly illuminate performers and scenery depending on the type of production. It is appropriate for both the theatrical and architectural lighting to have performance-quality dimming. This allows for smooth and continuous dimming from full output to extreme low output and vice versa. Without quality dimming ability, abrupt lighting changes and unsettling color shifts will occur.

Other criteria that are important include a very high color rendering index (CRI≥85), and aisle lighting requirements should allow safe and convenient access into and out of the auditorium at all times. It is undesirable for distracting shadows or reflections from people to occur as they move in and out of the seating areas.

Quantitative Criteria:

Illuminance recommendations [IES Lighting Handbook10th Edition (Table 28.2)]

Space	E_h	E_v	Avg:Min
Audience – during production	2 lux @ floor	1 lux @ 5ft AFF	2:1
Audience – pre/post show, intermission	100 lux @ floor	30 lux @ 5ft AFF	2:1
Circulation – during production	2 lux @ floor	4 lux @ 5ft AFF	5:1
Circulation – pre/post show, intermission	100 lux @ floor	30 lux @ 5ft AFF	2:1

Energy Allowance [ASHRAE Standard 90.1]

Space	Power Density (W/sf)
Auditorium/Seating Area – Permanent (for Performing Arts Theater)	2.43 W/ft^2

2.4 Evaluation of Existing Conditions

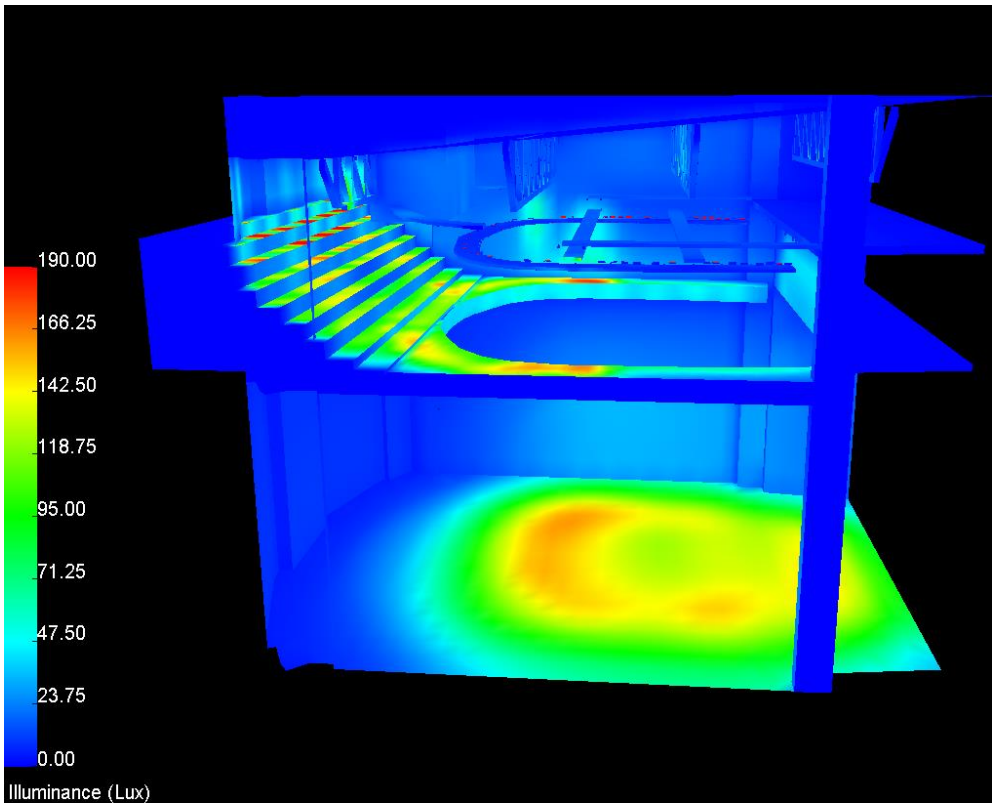
The main auditorium is a complex space, in which it incorporates theatrical and architectural lighting. Further investigation on theatrical lighting can be performed; however, for this exercise, the focus is on the architectural specialty or "house" lighting.

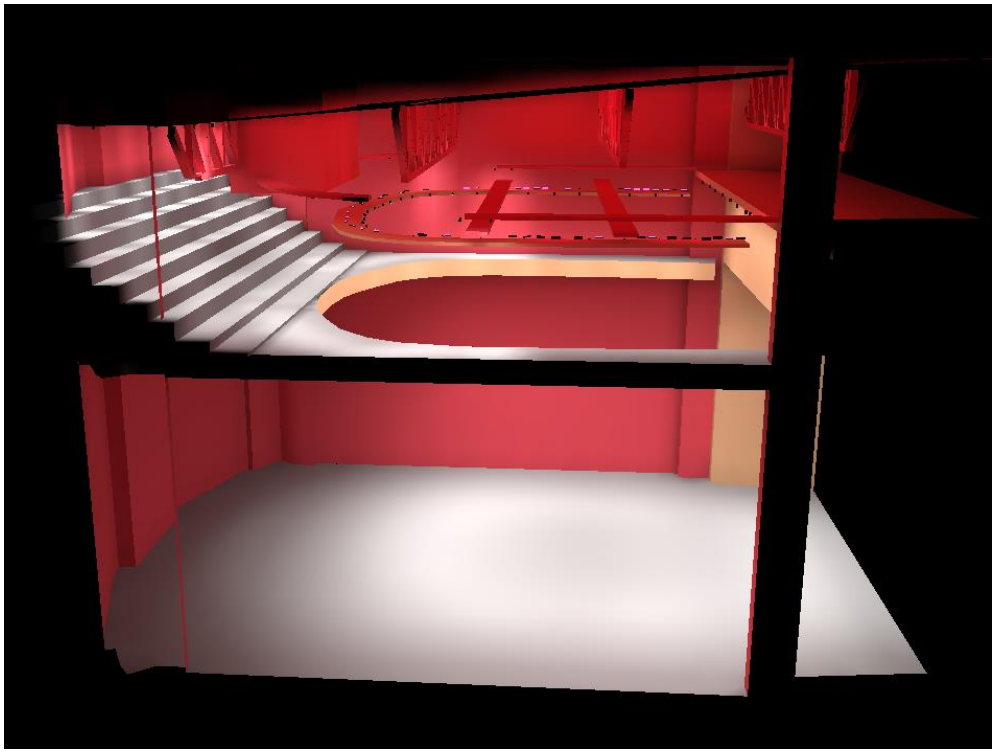
Due to the complexity of the space, AGI calculations were performed as a ceiling study. Fixture placement is primarily on the level 04 seating area, serving as a typical lighting design for the below levels. It also includes back and front ceiling and orchestra level calculations.

The values calculated from AGI exceed the recommended illuminances. Perhaps, this could be due to the luminaires being at full output, in which case could be a scenario of when fixtures are completely on before and after a performance. Based on the power density calculated, in surpasses the ASHRAE Standard 90.1 2010 requirement of 2.43 W/ft^2, indicating an overall inefficient system. This seems unavoidable, though, due to the need for performance-quality dimming, low noise, and high color rendering. If this was based on the initial code requirement from 2007, the power density would comply.

Overall, the lighting design for the auditorium was well sought out, especially for what this space demands in terms of lighting and controls. It is used to good effect, in which it addresses several factors such as:

- Architectural features, including the balcony overhang,
- Rows of upholstered seating,
- Warm colors of the walls and ceilings, and
- It complies with safety reasons as audience members move in and out of the rows and aisles.


190.00
166.25
142.50
118.75
95.00
71.25
47.50
23.75
0.00
Illuminance (Lux)



3.0 MAIN LOBBY | CIRCULATION SPACE

The main lobby is a large circulation space, in which attendees can congregate and socialize.

3.1 EXISTING CONDITIONS

The main lobby, located on two levels includes an upper and lower lobby. It provides a strong visual and experiential connection between the historic entry & pre-ticketing foyer, known as the Municipal Auditorium, and the new auditorium. To promote a sense of welcome and express the culture of performing arts, the architecture and lighting is both dynamic and unique, giving the main lobby character.

Dimensions

Area	3,626 SF
Ceiling Height	67'-5"

Figures 3.1a-3.1o shows the spatial environment & orientation of the Main Auditorium through floor plans, sections, elevations, and reflected ceiling plans.

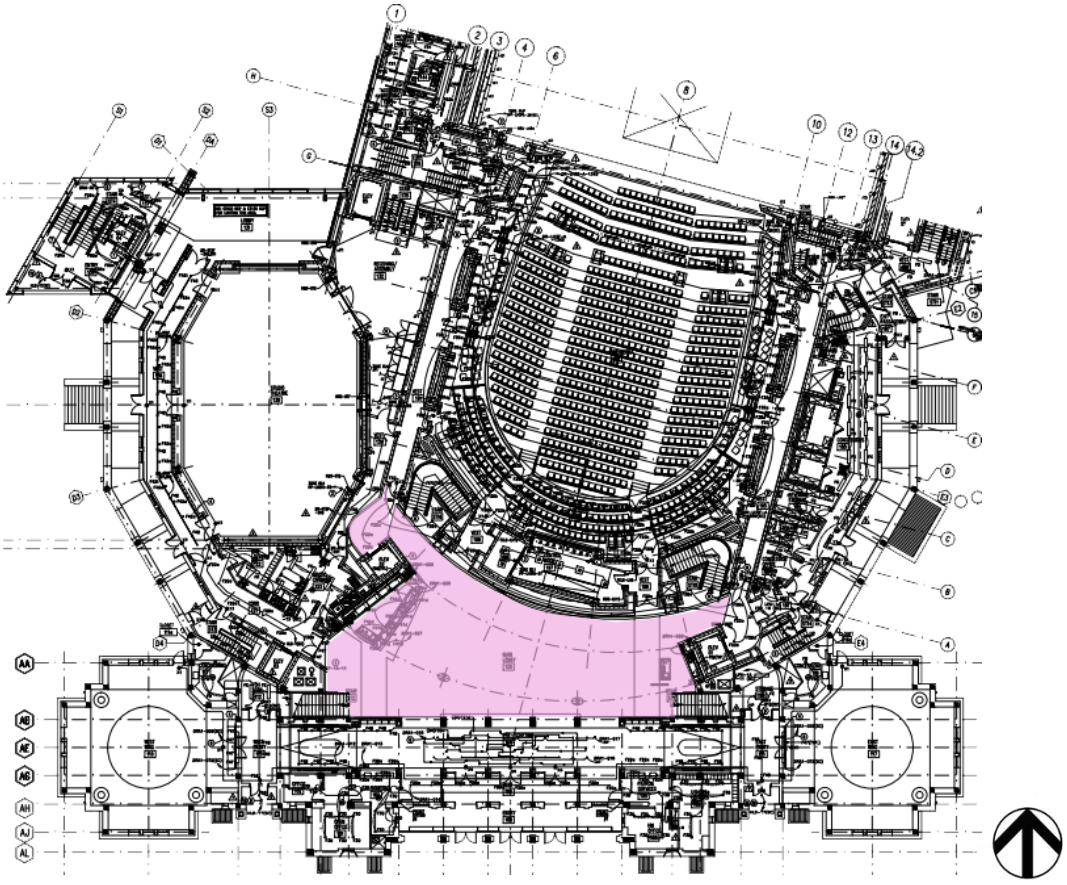


Figure 3.1a: Main Lobby Spatial Definition
(Courtesy of LMN Architects)

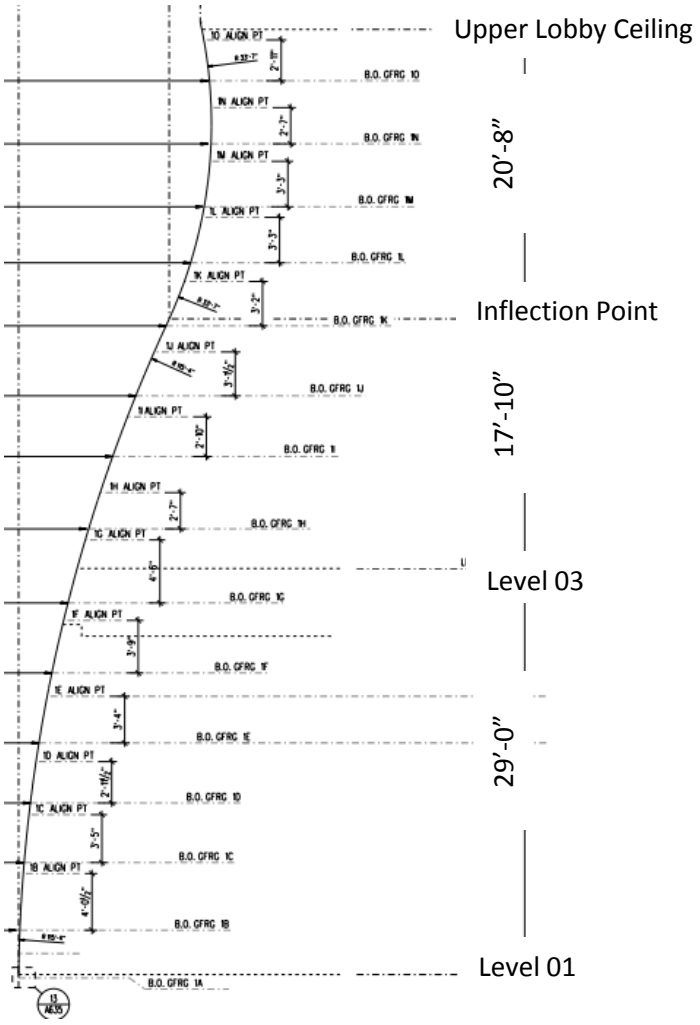


Figure 3.1b: Main Lobby Glass Fiber Reinforced Gypsum Wall Curve *(Courtesy of LMN Architects)*

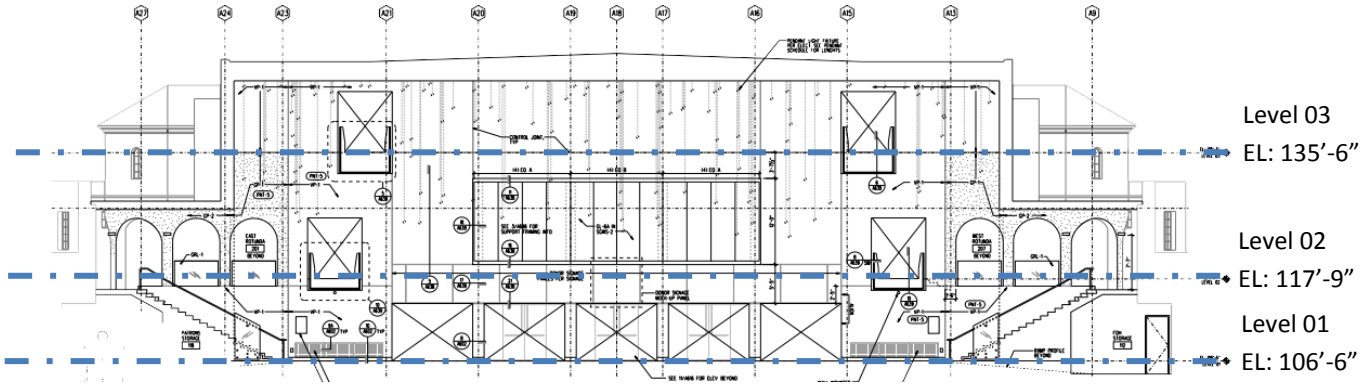


Figure 3.1c: Main Lobby South Interior Elevation *(Courtesy of LMN Architects)*

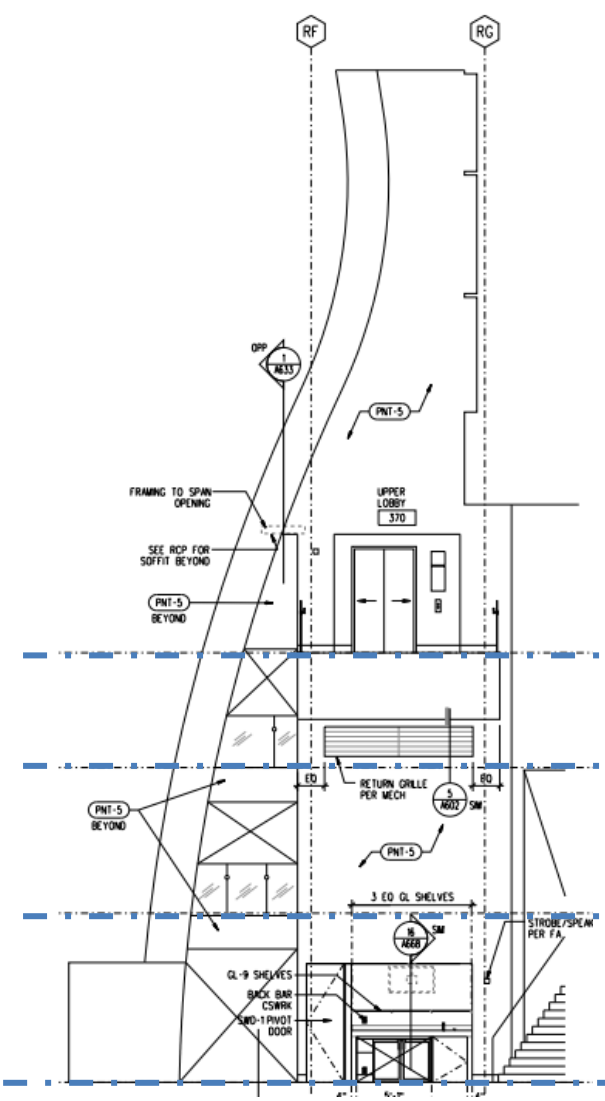


Figure 3.1d: Main Lobby East Elevation
(Courtesy of LMN Architects)

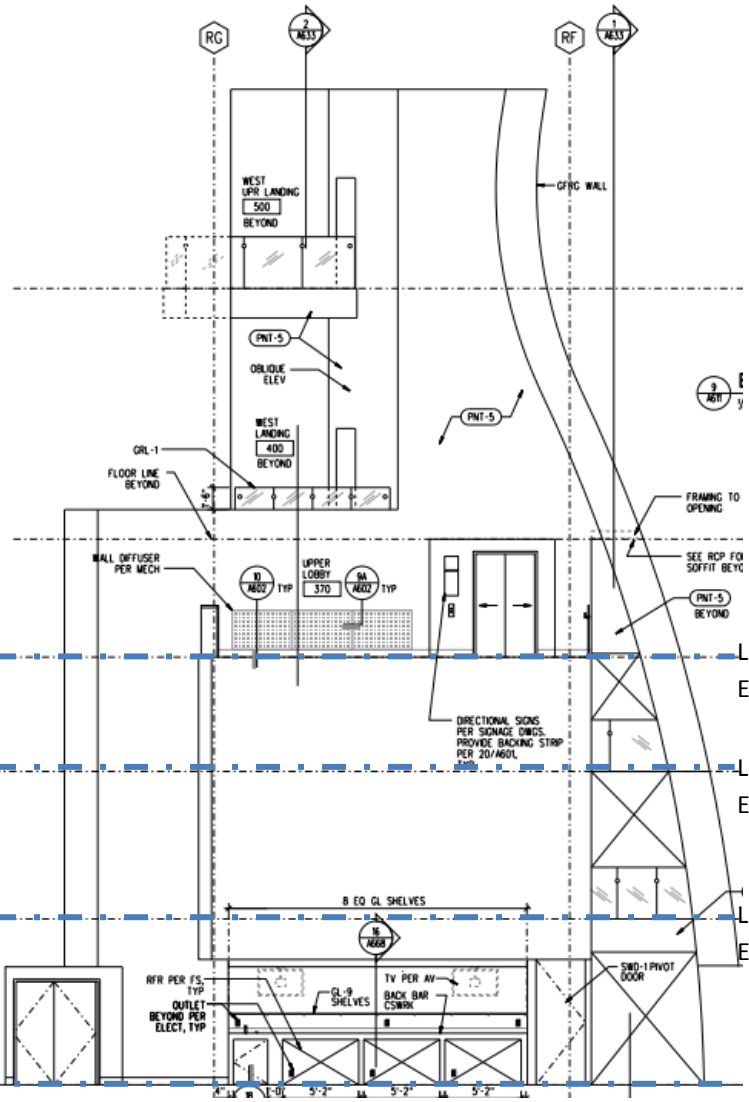


Figure 3.1e: Main Lobby West Elevation
(Courtesy of LMN Architects)

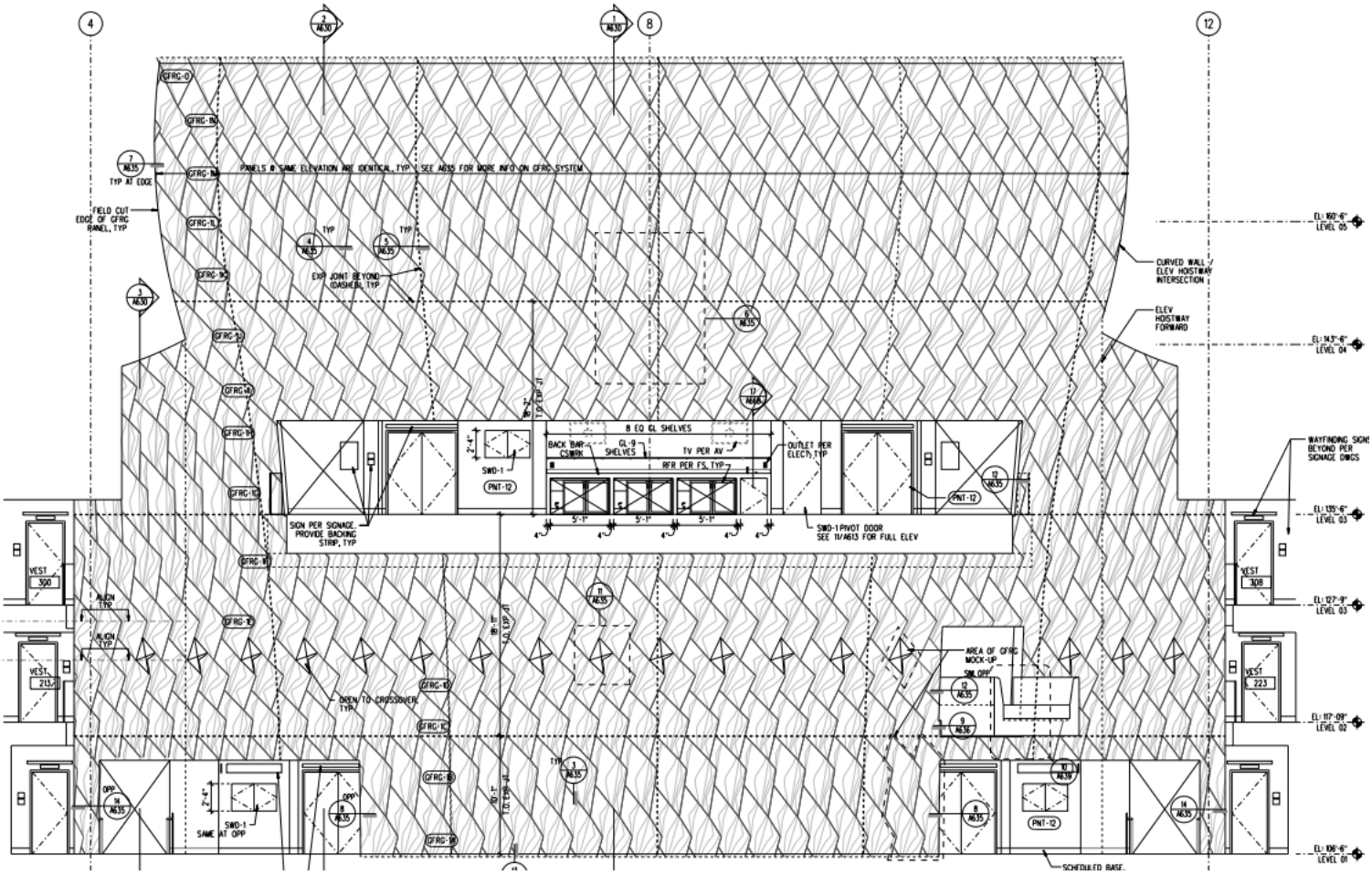


Figure 3.1f: Main Lobby & Upper Lobby North Interior Elevation *(Courtesy of LMN Architects)*

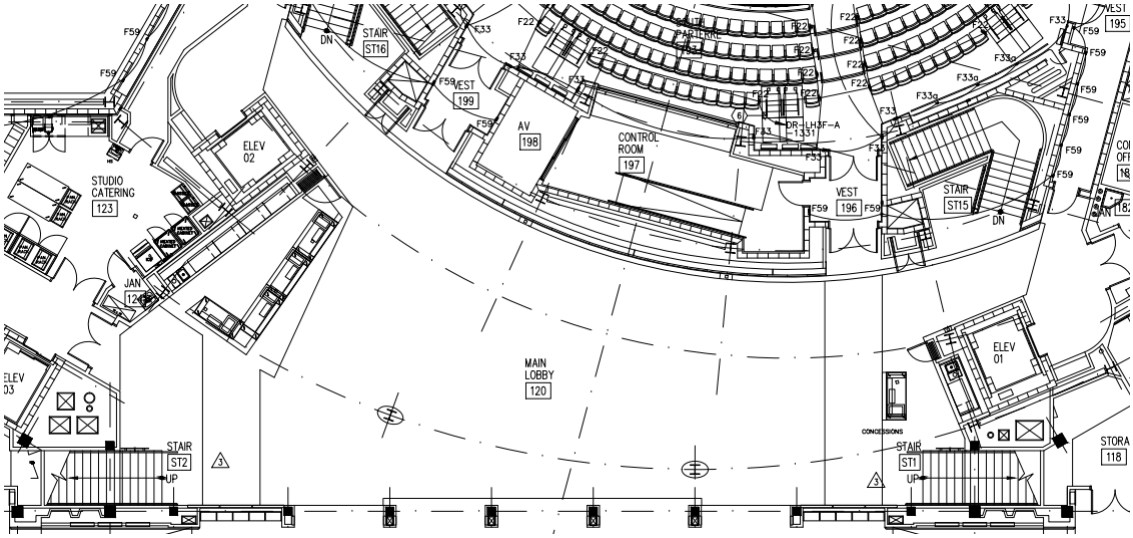


Figure 3.1g: Main Lobby Level 01 Floor Plan *(Courtesy of LMN Architects)*

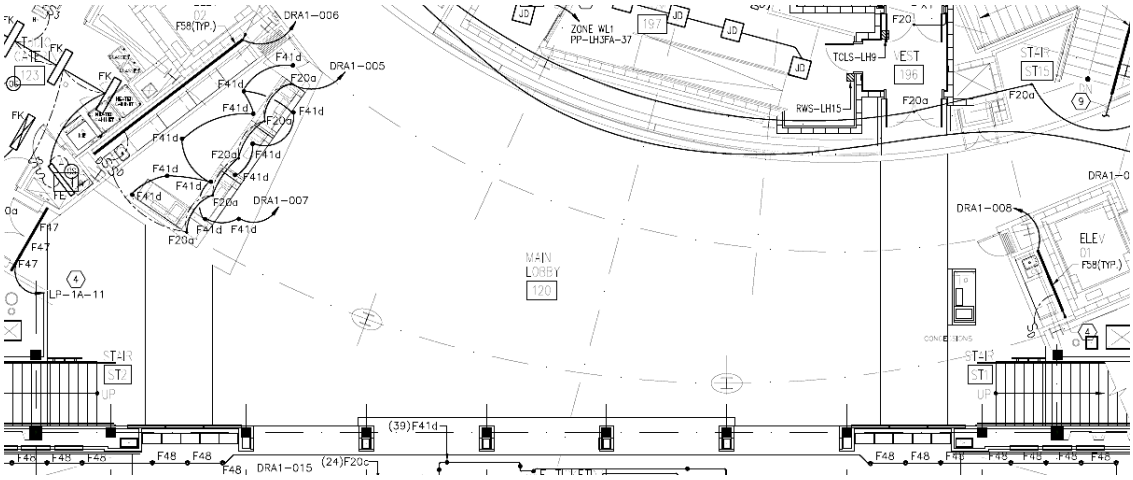


Figure 3.1h: Main Lobby Level 01 RCP *(Courtesy of LMN Architects)*

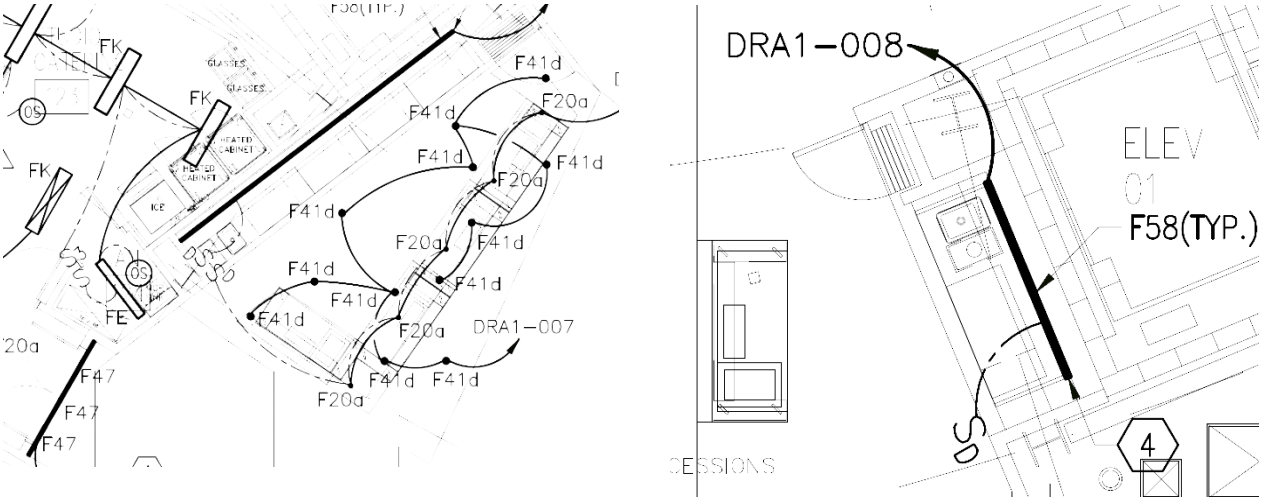


Figure 3.1i: Enlarged Main Lobby Level 01 RCP *(Courtesy of LMN Architects)*

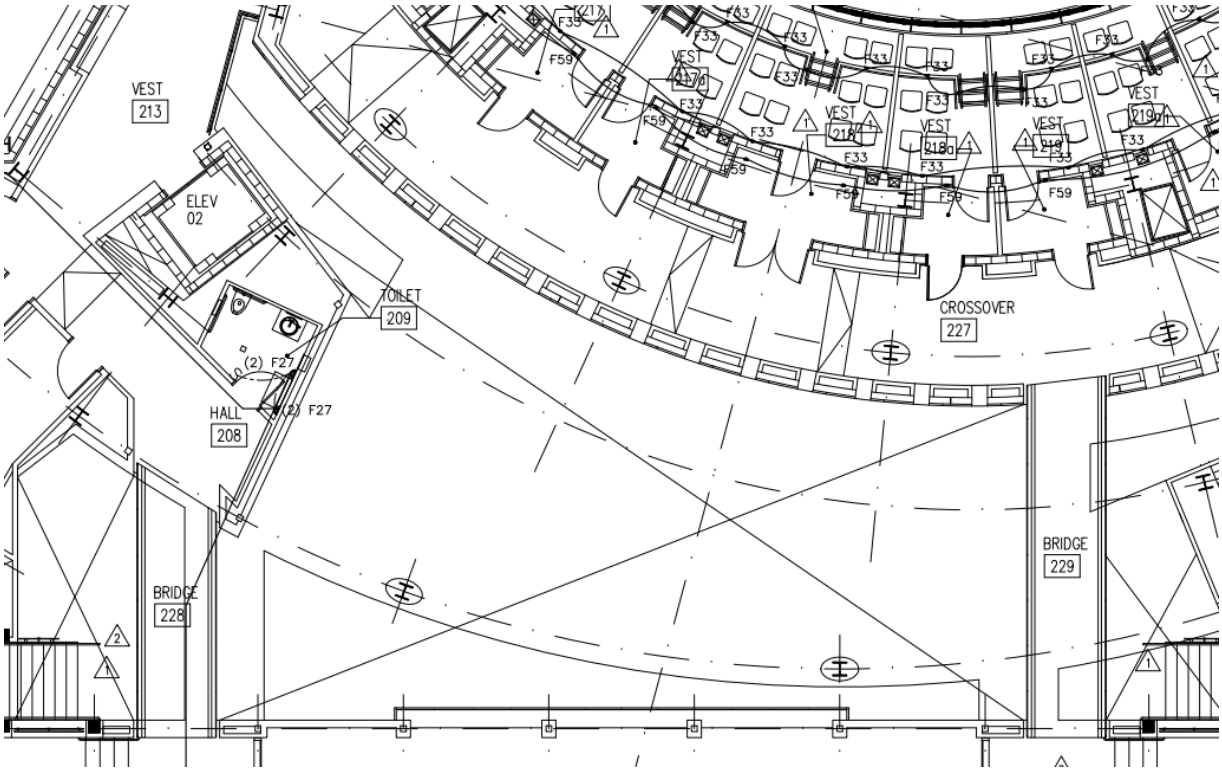


Figure 3.1j: Main Lobby Level 02 Floor Plan *(Courtesy of LMN Architects)*

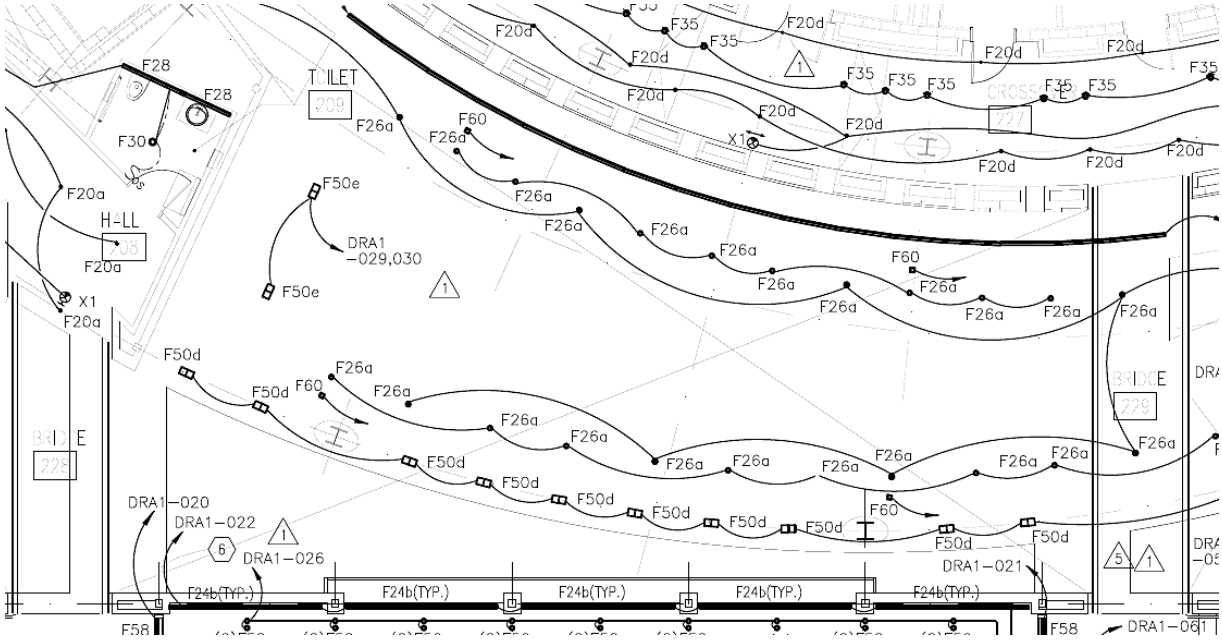


Figure 3.1k: Main Lobby Level 02 Floor Plan *(Courtesy of LMN Architects)*

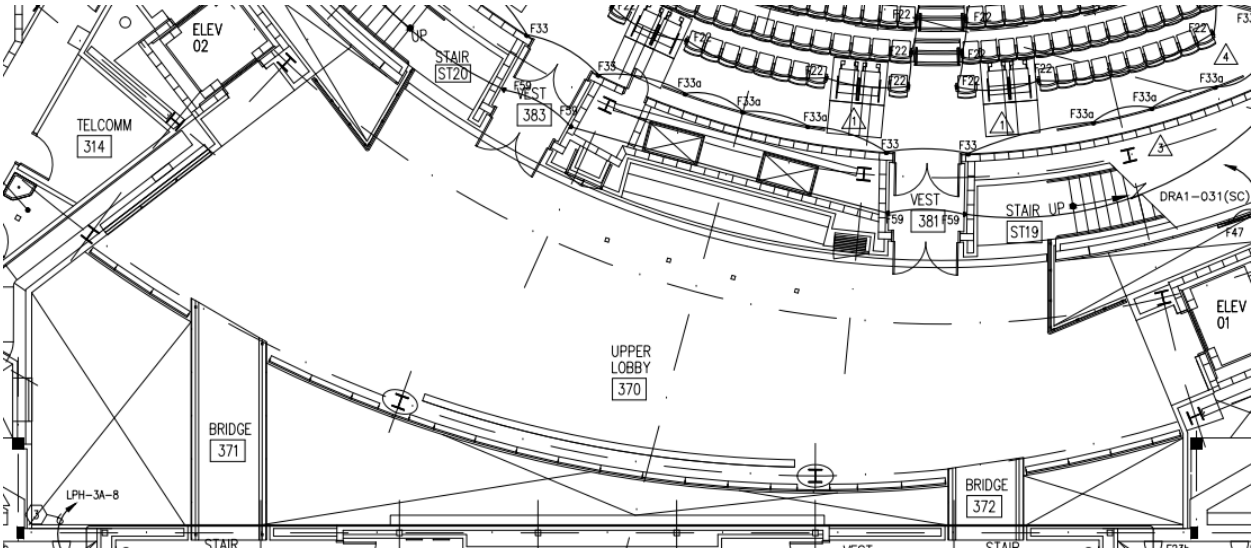


Figure 3.1l: Upper Lobby Level 03 Floor Plan *(Courtesy of LMN Architects)*

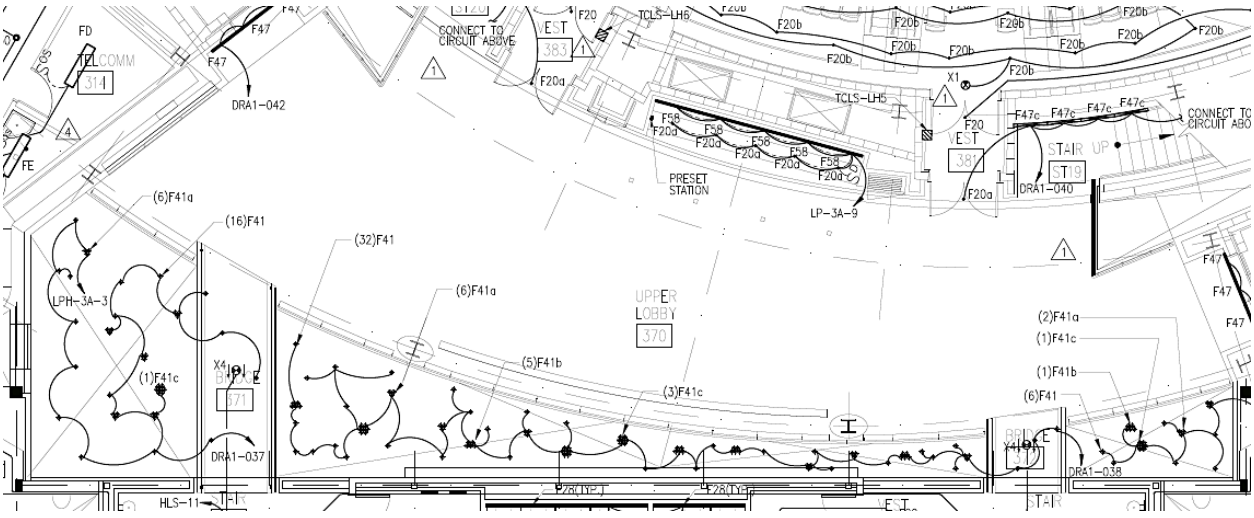


Figure 3.1m: Upper Lobby Level 03 Floor Plan *(Courtesy of LMN Architects)*

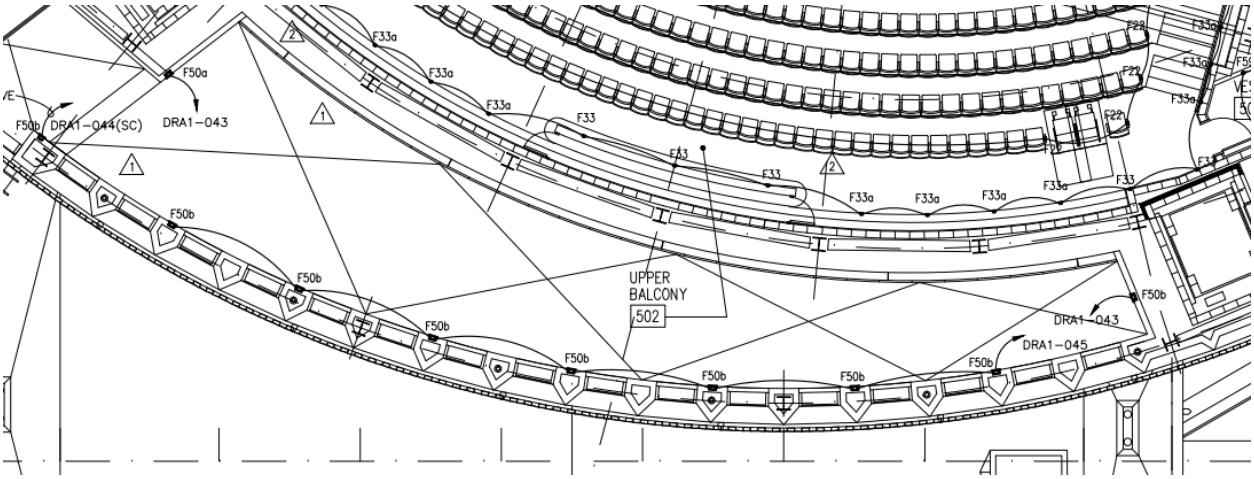


Figure 3.1n: Upper Lobby Level 05 Floor Plan *(Courtesy of LMN Architects)*

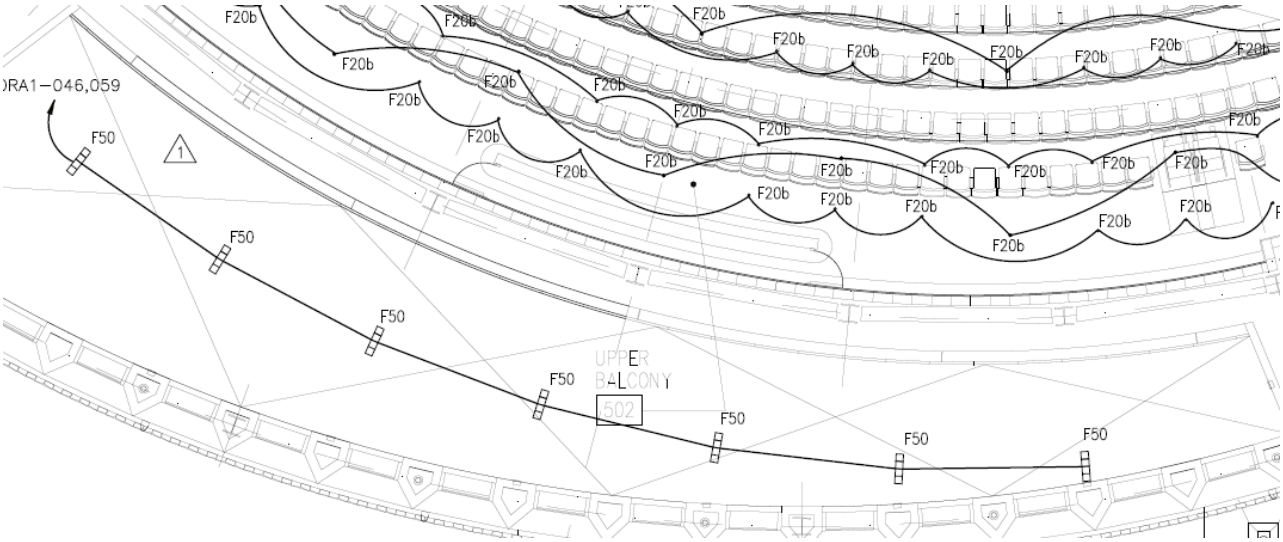


Figure 3.1o: Upper Lobby Level 05 Floor Plan *(Courtesy of LMN Architects)*

Finishes

Table 12: Main Lobby Finish Schedule

Surface	Type	Description	Reflectance (Upper Lobby/Lower Lobby)
Floor	TER-1/2/3	Thinset Epoxy Terrazzo	50%/20%
North Wall	GFRG-1	Glass Fiber Reinforced Gypsum Panels, paint with ArmourColor, Perlata sprayed textured, with clearseal gloss Color: PLS	80%/50%
	PNT-12	Paint Color No. DEA109 Bonfire Flame Manufacturer: Dunn Edwards	80%/50%
E & W Wall	PNT-5	Paint Color. No. OC-138 White Drifts Manufacturer: Benjamin Moore	80%/50%
	PNT-12	Paint Color No. DEA109 Bonfire Flame Manufacturer: Dunn Edwards	80%/50%
South West	PNT-5	Paint Color. No. OC-138 White Drifts Manufacturer: Benjamin Moore	80%/50%
Ceiling	PNT-6	Paint Color No. OC-64 Pure White Manufacturer: Benjamin Moore	80%/80%
	SPCLG-1	Support Ceiling	80%/80%

3.2 Existing Lighting Conditions

The Main Lobby utilizes several LEDs and halogens to provide general illumination throughout the space. Several areas of interest, such as the Donor Wall, concessions and bar area, and curved wall, are emphasized by specific fixtures. Not only does this provide visual interest and add character to the architecture, but also provide subtle signals about what is visually important in the public's visual environment.

Table 13: Main Lobby Lighting Fixture Schedule

Type	Description	Finish	Mfr/Catalog No.	Lamping	Electrical Data
F20a	MR16 pinhole downlight with lens Location: above bar area	Matte White	Lucifer DL10ZP-W-HAL-SFL2 DH-NIC-ZF-HAL-20-VOLT-MOD WRL 20	20W IRMR16 FL Osram Sylvania – 20MR16/IR/FL35/C	Integral Electronic or Magnetic Transformer Input Power: 24W
F26a	LED 4.5" aperture high output LED downlight with beam softening lens with narrow distribution Location: lobby low ceilings	White	Lucifer DL1YP-HOUSING-W-CEILING-8030-30-2 DH-HOUSING-YF-CEILING-8021-DIMMING	Replaceable LED Module Xicato-XSM 3000lm, 3000K	Integral electronic dimmable driver, 1050mA for 3000lm Input Power: 53W
F41	Halogen decorative sphere pendant Location: Level 3	Cast glass, white canopy	Bocci 14.1m-HAL-LENGTH-MOD WHITE CANOPY WH-601E6A-3C	10W T3 Halogen OSram Sylvania – 10T3Q/CL/AX	Remote magnetic transformer Input Power: 10W

Table 13: Main Lobby Lighting Fixture Schedule Cont.

Type	Description	Finish	Mfr/Catalog No.	Lamping	Electrical Data
F41a	Halogen decorative sphere pendant (3) per canopy Location: Level 3	Same as F41	Bocci 14.3m-HAL-LENGTH-MOD WHITE CANOPY WH-601E6A-3C	(3) 10W T3 Halogen Osram Sylvania – 10T3Q/CL/AX	Remote magnetic transformer Input Power: 30W
F41b	Halogen decorative sphere pendant (5) per canopy Location: Level 3	Same as F41	Bocci 14.5m-HAL-LENGTH-MOD WHITE CANOPY WH-601E6A-3C	(5) 10W T3 Halogen Osram Sylvania – 10T3Q/CL/AX	Remote magnetic transformer Input Power: 50W
F41c	Halogen decorative sphere pendant (7) per canopy Location: Level 3	Same as F41	Bocci 14.7m-HAL-LENGTH-MOD WHITE CANOPY WH-601E6A-3C	(7) 10W T3 Halogen Osram Sylvania – 10T3Q/CL/AX	Remote magnetic transformer Input Power: 70W
F41d	Halogen decorative glass sconce Location: Level 1	Same as F41	Bocci 14.s-HAL wh-601e6a-3c	(1) 10W T3 Halogen Osram Sylvania – 10T3Q/CL/AX	Remote magnetic transformer Input Power: 10W
F47	Continuous linear white LED wall grazing light in architectural slot, surface-adjustable mounting, 10x60-degree distribution Location: Lobby Wallwash, Ceiling Cove	Aluminum extrusion (concealed fixture)	Ecosense 10LC-LENGTH-30-VOLTAGE-10(10x60) 10-A-MNT-ADJ (adjustable hinged clips)	17.5W/ft LED	Integral dimmable power supply Input Power: 17.5W/ft
F50	Ceiling recessed LED multiple adjustable and lockable, (4) heads with (2)SP and (2) NFL distribution types with two circuits of control, dimmable Location: Upper Lobby	White interior and gimbal rings	ALW RCST-MOD4-XC8030-2000-INT-(2)NF(2)SP-HEX (hexcell louver)-LSS (linear spread lens)-VOLT-WH-/WH-MOD 2CIRCUIT-MOD 2” CEILING	(4) Replaceable LED module Xicato – XSM 2000lm, 3000K	Integral electronic dimmable driver, 1000mA for 2000lm Lutron Hi-Lume A-Series driver Input Power: 144W
F50a	Wall recessed LED multiple adjustable, (4) heads with NFL distribution types, dimmable Location: Upper Lobby	Same as F50	ALW RCST-MOD4-XC8030-2000-INT-(4)NF-HEX -LSS -VOLT-WH-/WH-MOD WALL-MOD 2” WALL	(4) Replaceable LED module Xicato – XSM 2000lm, 3000K	Integral electronic dimmable driver, 1000ma for 2000lm Lutron Hi-Lume A-Series Driver Input Power: 144W
F50d	Ceiling recessed trimmed LED multiple adjustable, (2) heads with SP distribution types and linear spread lenses, dimmable Location: Level 2	Same as F50	ALW RCST-2-XC8030-2000-INT-(2)SP-LS-VOLT-WH/WH-MOD 2” CEILING	(2) Replacement LED module Xicato – XSM 2000lm, 3000K	Integral electronic dimmable driver, 1000ma for 2000lm Lutron Hi-Lume A-Series Driver Input Power: 72W
F50e	Same as type F50d but with FL distribution types and soft focus lenses Location: Main Lobby	Same as F50	ALW RCST-2-XC8030-2000-INT-(2)FL-SBF-VOLT-WH/WH-MOD 2” CEILING	(2) Replaceable LED module Xicato – XSM 2000lm, 3000K	Integral electronic dimmable driver, 1000mA for 2000lm Lutron Hi-Lume A-Series Driver Input Power: 72W

Table 13: Main Lobby Lighting Fixture Schedule Cont.

Type	Description	Finish	Mfr/Catalog No.	Lamping	Electrical Data
F58	Continuous linear white LED wall grazing light surface-adjustable mounted, low output, 10-degree distribution Location: Lobbies Small Wallwash	Black	Boca Flasher HPNFC-HO6-3000K-13x38-VOLTAGE-B-I-S-SI-HL	10W/ft Integral LED 3000K ± 75K CCT 80+CRI 50,000hr + L70	Integral electronic dimmable power supply Input Power: 10W/ft
F60	Ceiling recessed retractable theatrical power, control and mounting pipe Location: lower lobby	Black, white faceplate	Leviton SHD-CONNECTION	-	-

Table 14: Main Lobby Lighting Control Schedule

Room	Dimmable	Timeclock Control	Daylight Sensor	Occupancy Sensor	Control Engine	Control Type	Preset Control Station
Main Lobby	Y	N	N	N	N/A	N/A	Y

Table 15: Light Loss Factors

Type	Luminaire Dirt Depreciation	Ballast Factor	Lamp Lumen Depreciation	Total LLF
F20a	0.94	1.00	0.85	0.80
F26a	0.94	0.80	0.70	0.53
F41	0.94	-	0.95	0.89
F41a	0.94	-	0.95	0.89
F41b	0.94	-	0.95	0.89
F41c	0.94	-	0.95	0.89
F41d	0.94	-	0.95	0.89
F47	0.94	0.80	0.70	0.53
F50	0.94	0.80	0.70	0.53
F50a	0.94	0.80	0.70	0.53
F50d	0.94	0.80	0.70	0.53
F50e	0.94	0.80	0.70	0.53
F58	0.94	0.80	0.70	0.53
F60	-	-	-	-

Table 16: Power Density

Type	Quantity	Input Watts	Total Watts	Area (SF)	Power Density (W/SF)	Note (unit or LF)	Compliant (Y/N)
F20a	19	24	456	-	-	Unit	-
F26a	16	53	848	-	-	Unit	-
F41	54	10	540	-	-	Unit	-
F41a	14	30	420	-	-	Unit	-
F41b	6	50	300	-	-	Unit	-
F41c	4	70	280	-	-	Unit	-
F41d	12	10	120	-	-	Unit	-
F47	(2) rows of 64LF	17.5	2240	-	-	LF	-
F50	7	144	1008	-	-	Unit	-
F50a	1	144	144	-	-	Unit	-
F50d	11	72	792	-	-	Unit	-
F50e	2	72	144	-	-	Unit	-
F58	45	10	450	-	-	LF	-
F60	4	-		-	-	Unit	-
			7742	3626	2.13	-	N

3.3 Design Considerations & Criteria

Qualitative Criteria:

The main lobby serves as a transition space between the historic entry/pre-ticketing foyer and the new main auditorium. The lighting in this space should be engaging and inviting, allowing patrons to gain a strong sense of layers of architecture. Therefore, various layers of lighting shall be zoned separately, allowing for a flexible lighting system to respond to the various uses in the main lobby.

Other criteria to consider include: (1) general lighting to meet illuminance recommendations for safety regulations, (2) having a dramatic difference in lighting approach from the pre-ticketing foyer, which has a lower ceiling, into the main lobby, and (3) special lighting treatment should be incorporated to distinguish destination points, especially the main auditorium's entry.

Quantitative Criteria:

Illuminance recommendations [IES Lighting Handbook10th Edition (Table 28.2)]

Space	E_h	E_v	Avg:min
Lobbies – distant from entries	100 lux @ floor	30 lux @ 5ft AFF	4:1

Energy Allowance [ASHRAE Standard 90.1]

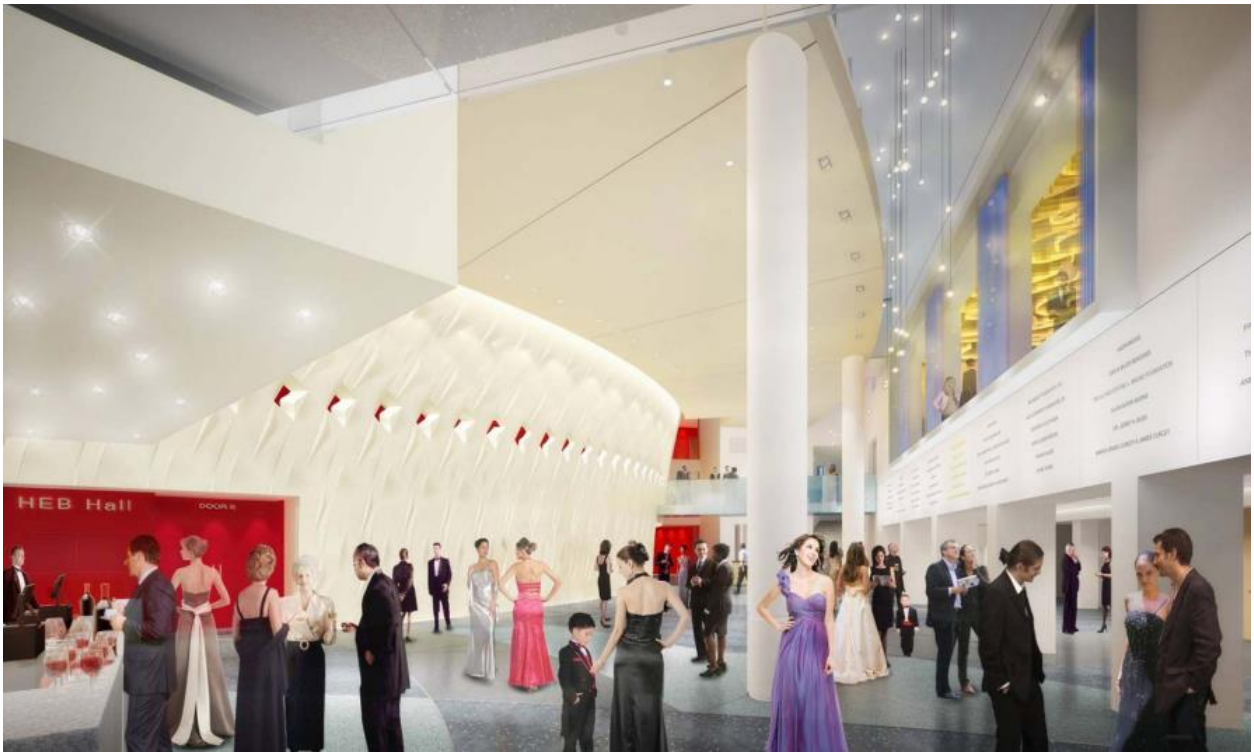
Space	Power Density (W/sf)
Lobby for Performing Arts Theater	2.00 W/ft^2

3.4 Evaluation of Existing Conditions

The existing lighting design for the main lobby is complex, yet flexible. Several fixtures highlight points of interest, such as the bar and concessions, Donor Wall, and entrances into the main auditorium. It is especially unique that the halogen decorative pendants are placed in a random fashion and are of varying heights. This design responds well to the height of the ceiling and gives it a dynamic character.

It is also reasonable for fixtures to have dimming capability. Typically, lights are dimmed to indicate the start of a performance. Other controls, such as occupancy sensors and timeclocks, are unnecessary. This space will typically be occupied before, during, and after a performance. After hours, however, the lights can be dimmed to its lowest output or be completely shut-off.

The lighting system is originally designed to meet ASHRAE/IESNA 90.1 2007 energy code requirements. However, to compare with a more updated version, ASHRAE Standard 90.1 2010 was used. 2007 requires an LPD of 1.2 W/ft^2, whereas Standard 90.1 2010 requires 0.73 W/ft^2. The calculated power density of 1.18 W/ft^2 exceeds the 2010 requirement; therefore, indicating that the energy code has become more stringent.



4.0 EVENT PLAZA | OUTDOOR SPACE

The Event Plaza is a unique transition to the outdoors, in which the public is exposed to a strong sense of exterior happenings. They get a view of the San Antonio River, as well as enjoy outdoor performances that enhance the experience of events being held inside the Tobin Center.

4.1 EXISTING CONDITIONS

The Event Plaza is located primarily on the northwest side of the site. Served as an outdoor space, it will include the following:

- To accommodate audience control for entrance and egress regulations.
- To be made available for renting and have the ability to tent the area with tie offs.
- The west side of the Center will have a surface for movie projections.
- To engage activity and promote performing arts, music and speakers will be provided as background music in the plaza area.
- Performers will have access to electrical outlets to plug in equipment when necessary.

The upper section of the plaza, near the building, is at an elevation of 646.50'. Seats can be set up in this area for performances and other events. Ramps and steps bring the public to the San Antonio River Walk, which features monuments dedicated to Metal of Honor recipients of San Antonio. Additionally, the San Antonio River Walk has a river connection, which can be made either by pedestrian or as river barge access. It is intended for those within this space to experience a wow factor as they travel along the river and see a momentous view of the Tobin Center.

Dimensions	
Area	1558 SF

Figures 4.1a-4.1i shows the spatial environment of the Event Plaza through plans, event layouts, and renderings.

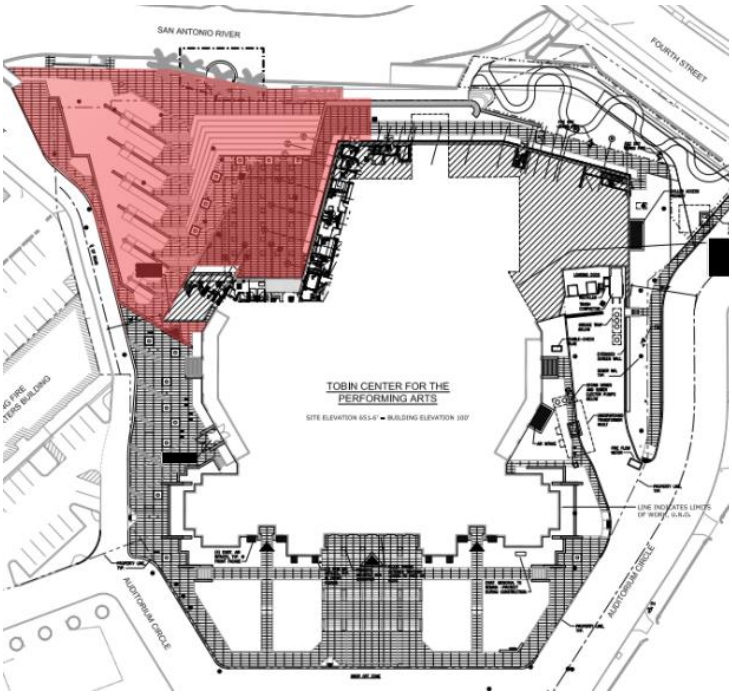


Figure 4.1a: Event Plaza Spatial Definition
(Courtesy of LMN Architects)

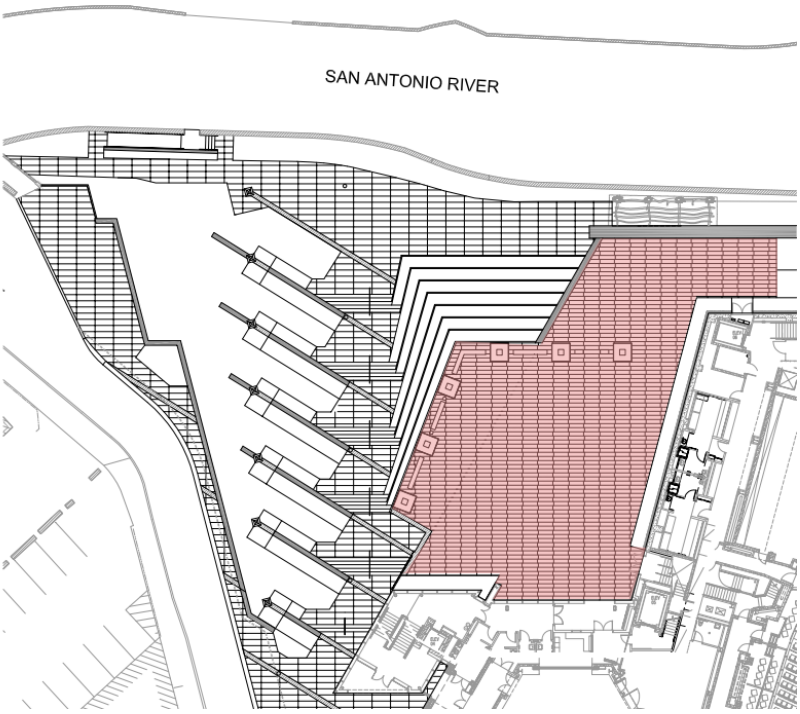


Figure 4.1b: Enlarged Event Plaza Plan
(Courtesy of LMN Architects)
**Note: red area indicates event layout, which are shown below*

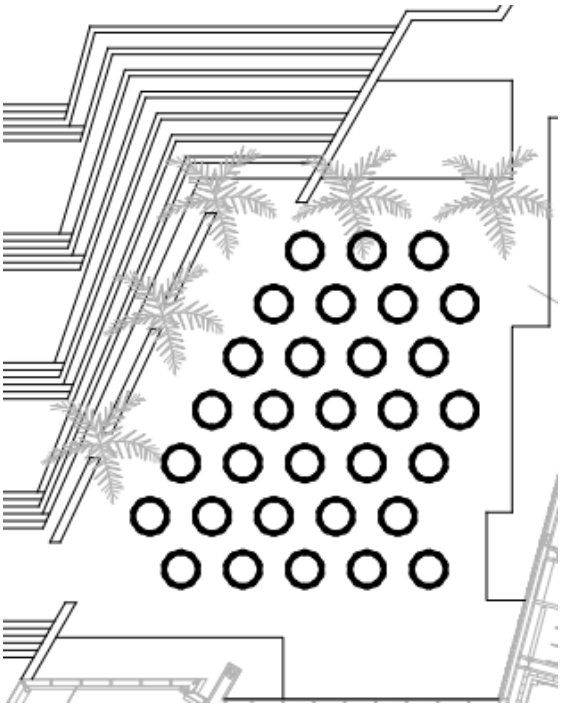


Figure 4.1c: Dinner Set Up
(31-Ten Top Tables)

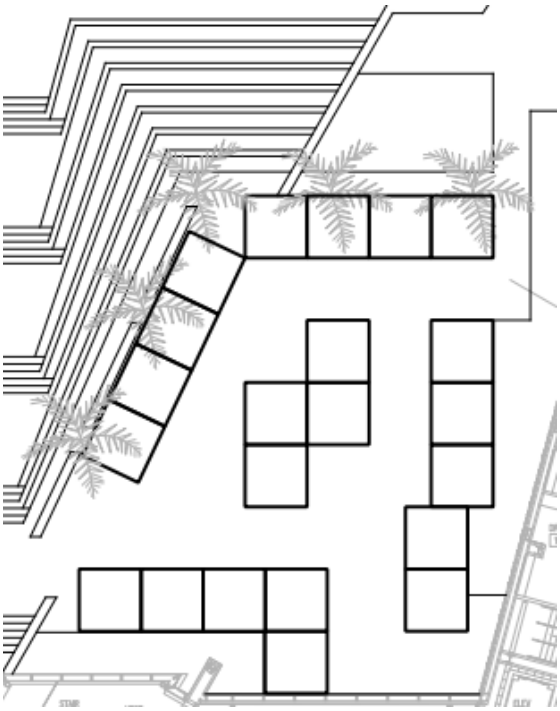


Figure 4.1d: Festival Set Up
(22- 10'x10' Booths)

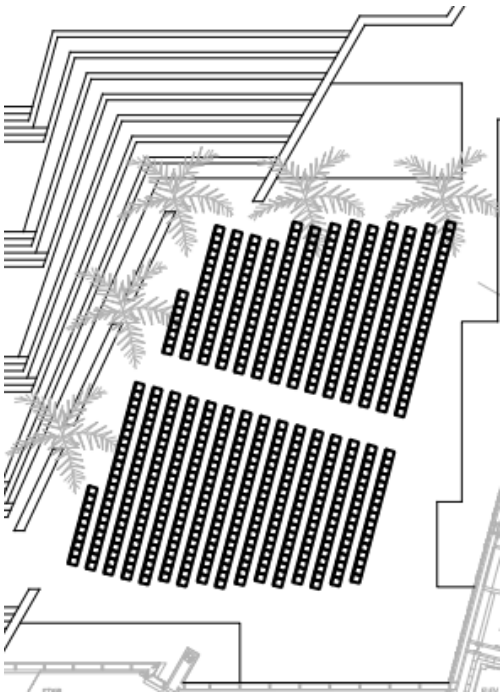


Figure 4.1e: Concert Set Up 1
(606 Chairs)

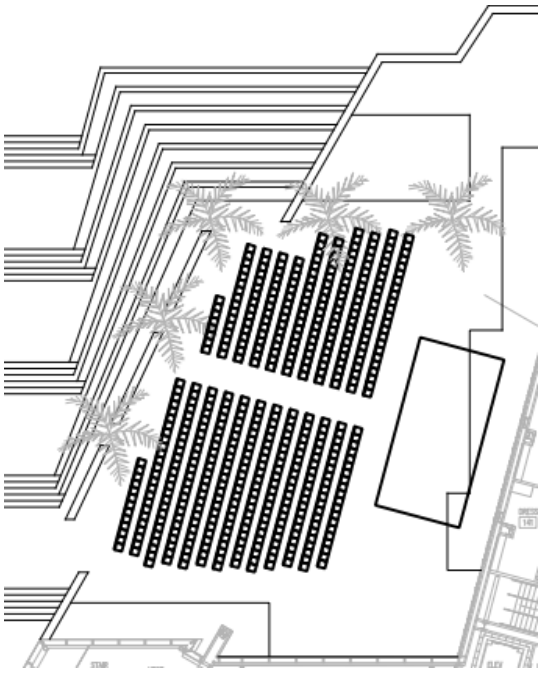


Figure 4.1f: Concert Set Up 2
(16'x32' Stage, 501 Chairs)

Figure 4.1g: Event Plaza Rendering *(Courtesy of LMN Architects)*

Figure 4.1h: Event Plaza Rendering *(Courtesy of LMN Architects)*

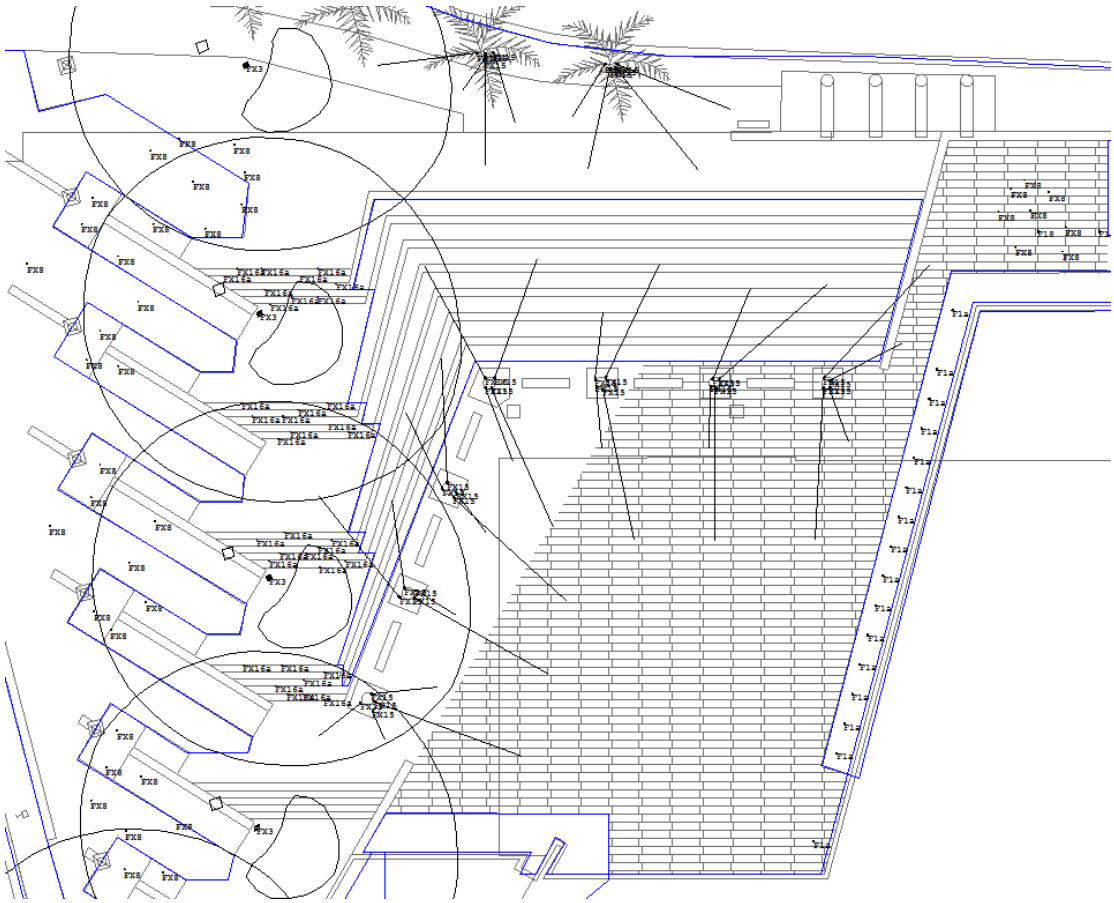


Figure 4.1i: Event Plaza Lighting Plan *(Courtesy of LMN Architects)*

4.2 Existing Lighting Conditions

Table 17: Event Plaza Lighting Fixture Schedule

Type	Description	Finish	Mfr/Catalog No.	Lamping	Electrical Data
FX3	Ceramic metal halide, 13' column pole, external flange with base cover and anchor bolts	Graphite Grey	Hess Lighting SE40000-70-M-7-13RB-13' COLUMN-GG-EFBC	G12 ceramic metal halide 70W T6MH	277V Input Power: 70W
FX8	20W MR11	-	Lumascape	Osram Sylvania – 37MR11/IR/WFL60/C	Input Power: 20W
FX15	40 degree, 70 mm metal spun aluminum reflector	-	Xicato XSM80XX-10000	Xicato XSA-14 80CRI module	Input Power:25W
FX16a	LED, Frosted lens, 30 degree angle bracket	Matte clear anodized	MP Lighting L01-1W30S12F30-0MA	LED 3000K, Std. CRI, 85lm	Input Watt:1W

Table 18: Event Plaza Lighting Control Schedule

Room	Dimmable	Timeclock Control	Photocell	Occupancy Sensor	Control Engine	Control Type	Preset Control Station
Event Plaza	Y	Y	Y	N	N/A	N/A	Y

Table 19: Light Loss Factors

Type	Luminaire Dirt Depreciation	Ballast Factor	Lamp Lumen Depreciation	Total LLF
FX3	0.80	1.00	0.83	0.66
FX8	0.80	0.90	0.75	0.54
FX15	0.80	0.80	0.70	0.45
FX16a	0.80	0.80	0.70	0.45

Table 20: Power Density

Type	Quantity	Input Watts	Total Watts	Area (SF)	Power Density (W/SF)	Note (unit or LF)	Compliant (Y/N)
FX3	4	70	280	-	-	Unit	
FX8	45	20	900	-	-	Unit	
FX15	37	25	925	-	-	Unit	
FX16a	36	1	36	-	-	Unit	
			2141	1558	1.37	-	N

4.2 Design Considerations & Criteria

Qualitative Criteria:

The appropriate lighting for the Event Plaza should address illuminance recommendations for the following: (1) pedestrian pathways, (2) performance space, (3) accent lighting and (4) tree lighting.

Lighting for pedestrian pathways and performance space depends on nighttime outdoor lighting zone and activity level. Zone LZ3 (moderately high ambient lighting outdoor lighting situation) would be ideal for this situation. According to the IES Handbook 10th edition, LZ3 addresses areas of human activity where vision is adapted to moderately high light levels. It is desired for lighting to accommodate safety, security, and convenience needs, but also be uniform and/or continuous. As activity level declines, lighting may be extinguished or reduced.

Accent lighting can highlight monuments throughout the plaza. Tree lighting could be considered moderate focal points. They establish a visual outdoor perimeter and avoid a black hole effect.

Quantitative Criteria:

Illuminance recommendations [IES Lighting Handbook 10th Edition (Table 15.2)]

Space	Attraction	Role	Focal-Point Reflectance	Illuminance Ratio	E_h	E_v
Accenting - Important Focal Point	Moderate	Feature	≥50%	5:1 focal-point-to-task	typically vertical	5 lux on focal point plane
Accenting - Performance Area	Moderate	Feature	<50%	10:1 focal-point-to-task	10:1 average illuminance of horizontal orientation	-
Accenting - Performance Area	Strong	Dominant	<50%	40:1 focal-point-to-task	-	40:1 avgerage illuminance of vertical

						orientation
Accenting - Perimeter (trees)	Soft	Visual Edge	<50%	5:1 focal-point-to-task	-	5:1 average illuminance of vertical orientation

Illuminance recommendations [IES Lighting Handbook10th Edition (Table 34.2)]

Space	E_h	E_v	Max:Avg	Avg:Min
Plazas - Medium Activity LZ3	4 lux @ pavement	2 lux @5ft AFG in at least the two primary directions of circulation	4:1	5:1
Plazas - Ramps, Stairs, and Steps - Medium Activity LZ3	6 lux @ treads/landings	2 lux @ 5ft AFG in at least the two primary directions of circulation	4:1	5:1

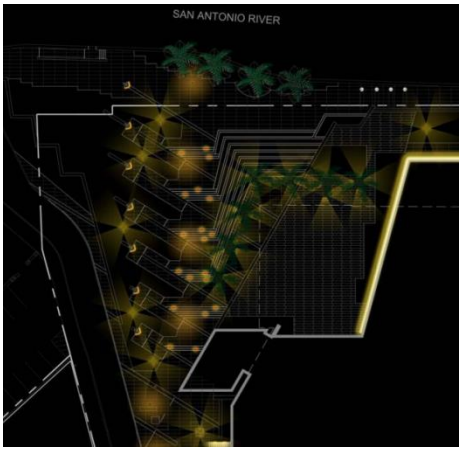
Medium Activity – IES Lighting Handbook 10th Edition (Table 22.4)
Lighting Zone LZ3 – IES Lighting Handbook 10th (Table 26.4)

Energy Allowance [ASHRAE Standard 90.1]

Space	Power Density (W/sf)
Plaza Areas - Walkways 10ft wide or greater	0.16 W/ft^2

4.4 Evaluation of Existing Conditions

The lighting corresponds well to the spatial definition and overall topography of the Event Plaza. Having trees with tree-mounted fixtures as a perimeter to the far edge of the Plaza where the steps begin is ideal. The tree-mounted fixtures not only provide ambient lighting, but also highlights and indicates hierarchy of space and level of activity on the performance area. The step-lights are randomly placed, giving the site a playful visual effect to pedestrians. Most importantly, they provide a generous amount of light to comply with safety reasons. For this exercise, design criteria were based on a medium nighttime outdoor activity level. This addresses the relatively moderate volumes of pedestrians and outdoor audience members during dark hours. Further investigation will be conducted to address BUG ratings, if necessary, and light trespass.



5.0 REFERENCES

DiLaura, David L., Kevin W. Houser, Richard G. Mistrick, and Gary R. Steffy, eds. *Illumination Engineering Society Lighting Handbook 10th Edition Reference and Application*.

"Light in Architecture and Psychology of Light, RS Lighting Design." Lecture. *Http://www.rsltg.com/images/ArchID_-_Light_in_Architecture_and_Psychology_of_Light.pdf*. Web.

Product, #. 86269. *Ashrae 90.1-2010 Energy Standard for Buildings except Low-rise Residential Buildings*. [S.l.]: Ashrae, n.d. Print.

"PVB Laminated Glass - AIS Glass Solutions." *PVB Laminated Glass - AIS Glass Solutions*. N.p., n.d. Web. 16 Sept. 2013.