

# Technical Report 1

Lighting Existing Conditions and Design Criteria  
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Lighting/Electrical Option  
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# Executive Summary

This report summarizes and examines the existing lighting conditions at the Wentz Concert Hall and Fine Arts Center, at North Central College in Naperville, Illinois. Focusing on the concert hall, main lobby, façade, and teaching spaces / practice rooms, it explores both the performance of the existing systems, and criteria for effective lighting design in each space.

With the concert hall being the main feature of the building, many choices are driven by its requirements and then expanded throughout the building. This explains the wide usage of incandescent lighting, as well as the way that lighting is integrated into the architecture throughout the building. Major concerns for the project include illuminance, glare, sound, adaptation while moving between spaces, and power density limitations, which can be particularly challenging with incandescent lighting.

Overall, the Wentz Concert Hall is well designed, differing from my criteria mainly in that it exceeds the 10<sup>th</sup> Edition Handbook's illuminance recommendations. While the solutions developed here are effective, they are by no means the only possibilities, and the spaces I have selected for further study leave room for further lighting exploration.

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# Concert Hall



The Wentz Concert Hall, named after Dr. Myron Wentz, is the focal point of the Wentz Concert Hall and Fine Arts Center, and the space's design plainly shows this. Spanning the first floor and balcony level, warm finishes and upholstery make the space intimate and comfortable, despite its relatively large size.

The balcony level protrudes only slightly over the back of the first floor seating, and the faceted edge of the balcony is mirrored at the perimeter below the ceiling, giving both levels a similar scale despite the wide open spaces. Curtains on the balcony level walls and behind the stage on the first floor add texture to the space, and allow for the concert hall's acoustics to be adjusted.

The walls on the first floor are finished with a textured wood panel, consisting of narrow horizontal strips, in sections that protrude various distances from the wall. The strip element is carried through the rest of the concert hall with an element on the balcony, and another series of them on the upper side walls.

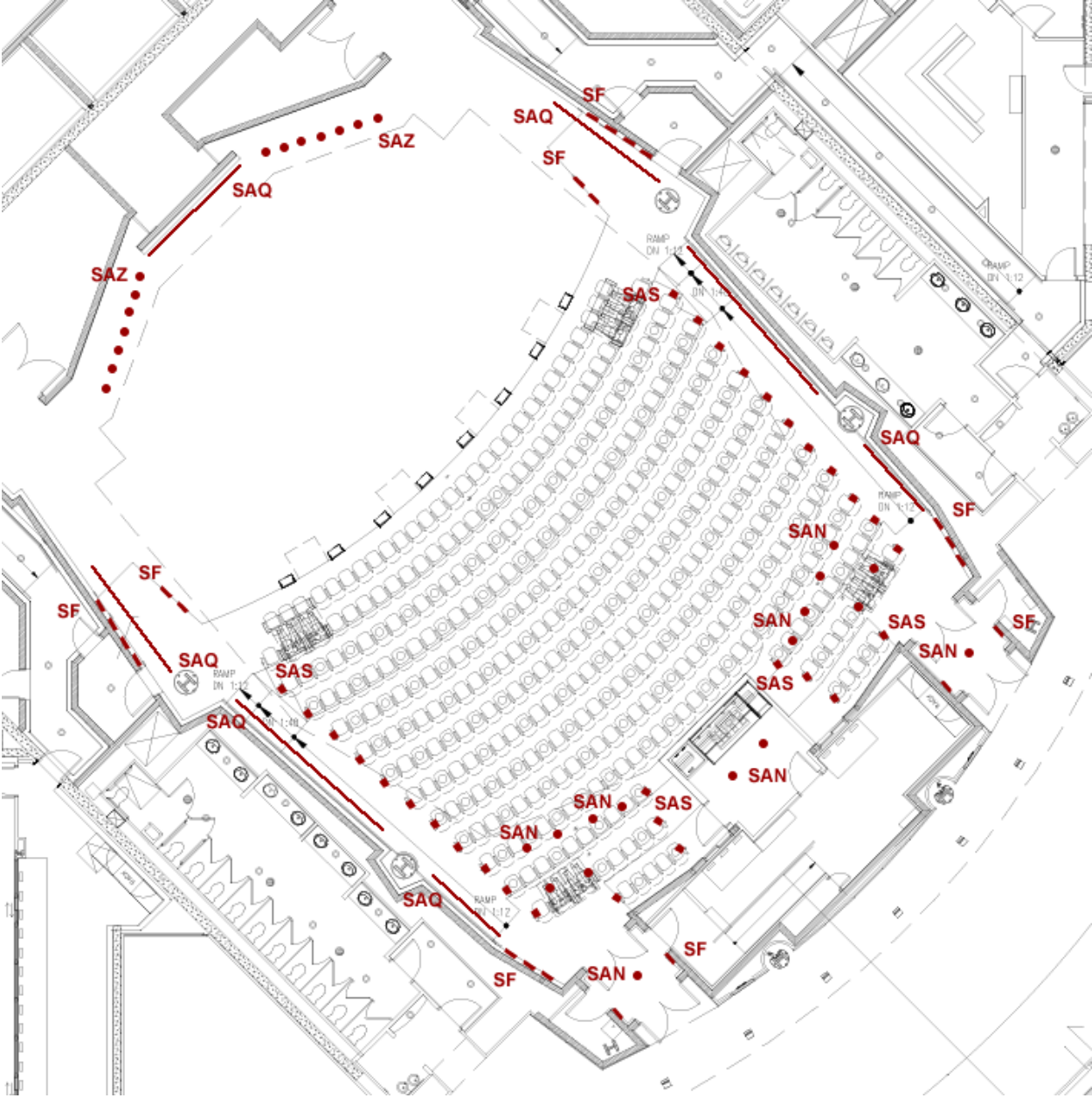
## Materials

Type	Reflectance (estimated)
Carpet	30%
Wood	30%
Curtains	50%
Paint – Walls	70%
Paint – Ceiling	80%
Paint – Balcony	40%

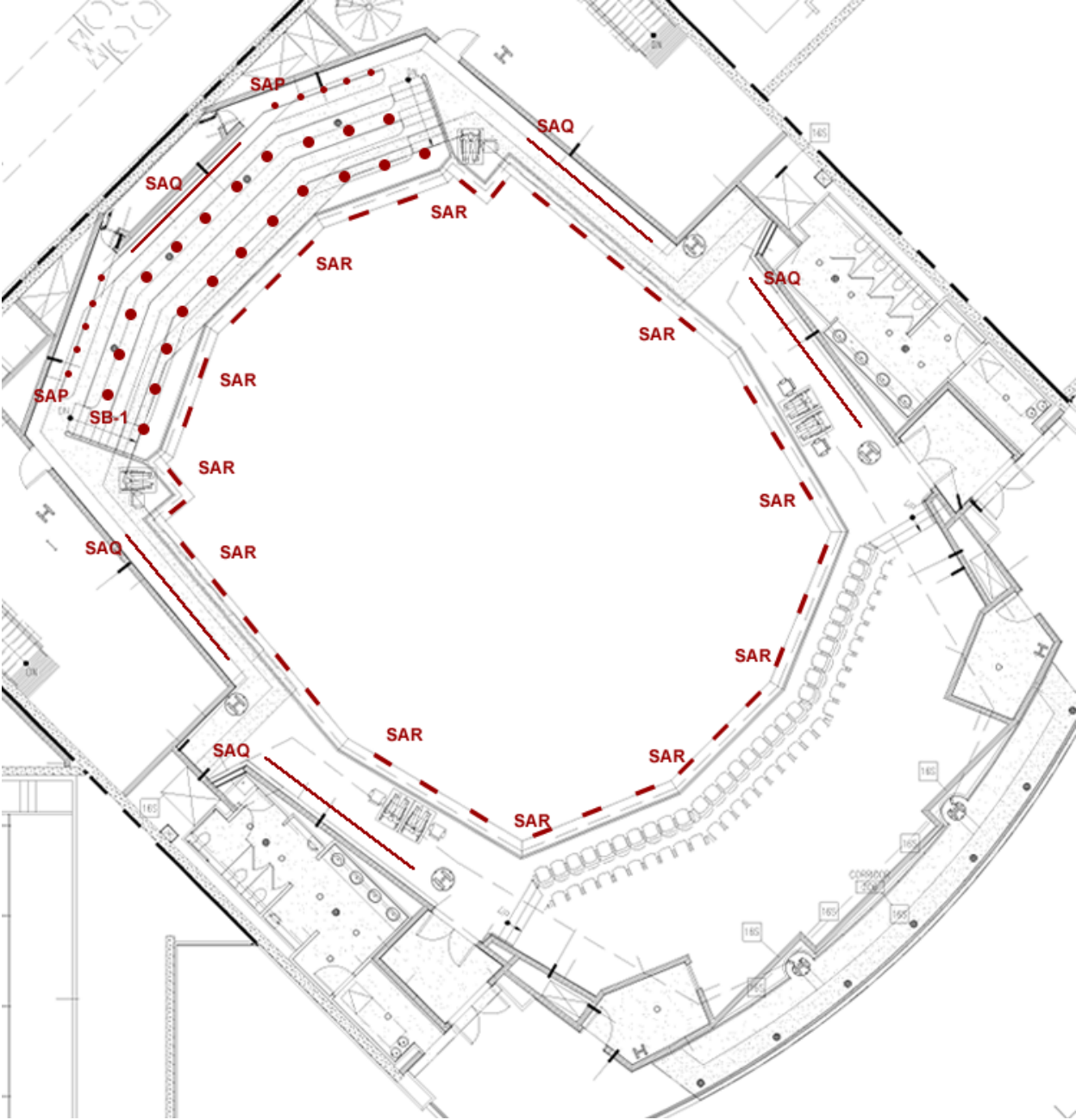
## Existing Lighting

The general lighting in the concert hall is provided by recessed downlights on the main ceiling and under the balcony, with brighter perimeter aisles lit by wall grazers on the first floor and steplights on the balcony level.

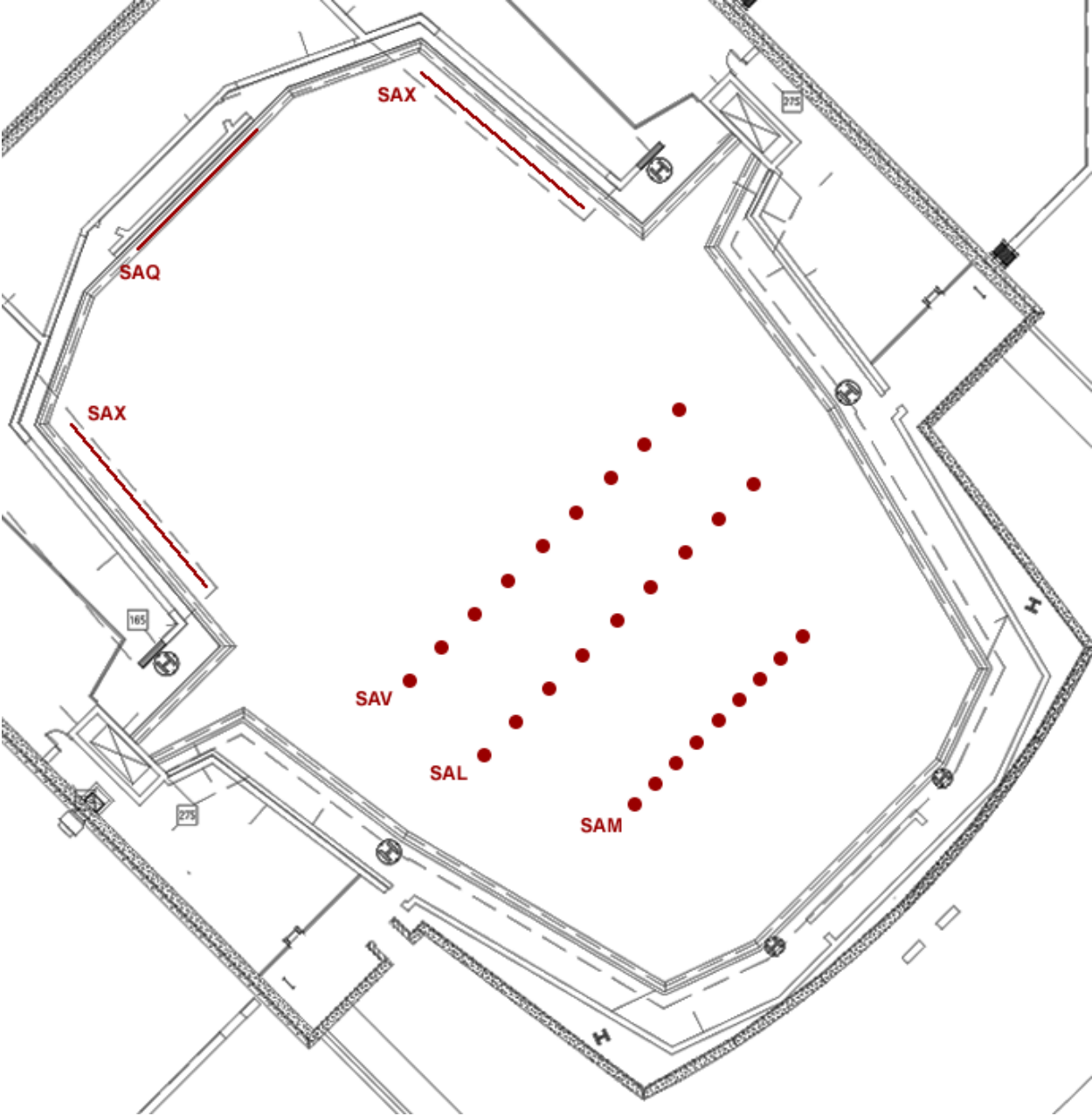
# Concert Hall, First Floor Lighting



# Concert Hall – Balcony Level Lighting



# Concert Hall – Upper Ceiling Lighting





## Lighting Equipment

Type	Description	Manufacturer / Catalog Number	Lamp(s)	Location
SF	Shielded CFL steplight	Bega 2288P	9W CFT	Aisle walls
SAS	Seat mounted shielded LED steplight	Permlight 500-W-MOD (2800k, custom finish)	1W LED	Aisle seats
SAQ	Halogen PAR16 borderstrip with 4 lamps, 11" O.C., linear spread lens, and trunnion mount with locking tilt	Times Square Lighting 701-MOD-x (custom spacing and length)	(4) 60W PAR16	Wood walls
SAQ1	Halogen PAR16 borderstrip with 6 lamps, 11" O.C., linear spread lens, and trunnion mount with locking tilt	Times Square Lighting 701-MOD-x (custom spacing and length)	(6) 60W PAR16	Wood walls
SAN	Incandescent A lamp downlight with nominal 6" aperture	Iris PN5-E5A19-H	100W A19	1st floor rear
SAB	Incandescent A lamp downlight/wallwasher with nominal 6" aperture	Iris PN5-E5A19-WW-H	100W A19	1st floor rear
SAZ	Incandescent A lamp downlight with nominal 6" aperture and shallow housing	Portfolio H760T-1641-H-WF	100W A19	1st floor front
SAR	Halogen wall sconce with 8" square flush aperture, scoop upright reflector, and flangeless trim	Engineered Lighting Products140HAL-HITW-8x8- ML-TGLF	40W T4	Balcony edge
SAP	Halogen PAR38 adjustable accent with spread lens, tilt/rotation locking, and top relamping capability	Kurt Versen C7311-SC-WT-FF38-1-LP	100W PAR38	Balcony level front
SAX1	Incandescent 4-lamp socket strip with lamps spaced 12" O.C. and overall length of 42"	Belfer 2520-12-S-F (42 in.)	(4) 100W A19	Upper wood grille
SAX2	Incandescent 6-lamp socket strip with lamps spaced 12" O.C. and overall length of 66"	Belfer 2520-12-S-F (66 in.)	(6) 100W A19	Upper wood grille
SAV	Halogen PAR38 cylinder downlight with nominal 5" aperture, 8" diameter, and 13" height	Rambusch PD-PAR-250-PAR38-MOD (custom finish, cable suspension)	250W PAR38	Upper ceiling
SAM	Halogen PAR38 adjustable accent with nominal 7" aperture, tilt/rotation locking, and top relamping capability	Rambusch RA-30-PAR-250-PAR38-LC	250W PAR38	Upper ceiling
SAL	Halogen PAR38 adjustable accent with nominal 7" aperture, tilt/rotation locking, and top relamping capability	Rambusch RA-30-PAR-100-PAR38-LC	100W PAR38	Upper ceiling

# Lighting Design Criteria

## IES Lighting Handbook 10<sup>th</sup> edition

### Illuminance

#### *Audience seating*

The main tasks performed in the audience area are wayfinding, facial recognition, and reading programs. Lighting must be sufficient for patrons to easily and safely find their seats, and must smoothly dim to the low levels required during a performance.

- Horizontal (average at floor)
  - 0.2 fc during production
  - 10 fc pre/post production and during intermissions
  - Avg:Min = 2:1
- Vertical (average at 5 ft. AFF)
  - 0.1 fc during production
  - 3 fc pre/post production and during intermissions
  - Avg:Min = 2:1

#### *Aisles*

Used for circulation by large crowds, the aisle lighting is critical for ensuring that patrons can quickly and safely navigate the concert hall. As with other lighting in the concert hall, it must also be smoothly dimmable to very low levels.

- Horizontal (average at floor)
  - 0.2 fc during production
  - 10 fc pre/post show and during intermissions
  - Avg:Min = 5:1
- Vertical (average at 5 ft. AFF)
  - 0.1 fc during production
  - 3 fc pre/post production and during intermissions
  - Avg:Min = 2:1

### *Control Booths*

Control of light and sound is crucial to the success of an event, but it must be done without lighting that would be distracting to the audience. To this end, control panels are frequently backlit to alleviate the need for supplemental lighting.

- Horizontal (average at floor)
  - 0.2 fc during production
  - 20 fc pre/post production and during intermissions
  - Avg:Min = 2:1

### **Isolation (*High priority*)**

Given the importance of a dark environment in the concert hall during productions, care must be taken to prevent light from external sources into the space.

### **Glare (*High priority*)**

Direct glare from light sources should be avoided, since it could interfere with adaptation to the low light levels. Bright light sources detract attention from the intended focus on the stage.

### **Color Rendition**

Good color rendering is important for stage lighting, and using sources with similar color rendering throughout the space will maintain uniform appearance of room finishes.

### **Color Temperature**

Warm materials are used throughout the space, and a similarly warm color temperature should be selected for light sources.

### **Sound**

As the concert hall is an acoustically sensitive environment, sources should be selected to avoid background noise generation.

## **ASHRAE 90.1 2010**

### **Power Allowance (*Mandatory*)**

Permanent audience / seating area for performing arts theatre

- Lighting Power Density: 2.43 W/ft<sup>2</sup>
- Theatrical lighting equipment is exempt from this allowance, the full amount is available for architectural lighting purposes
- An additional allowance of up to 1.0 W/ft<sup>2</sup> is available for decorative lighting

### **Automatic Shutoff (*Mandatory*)**

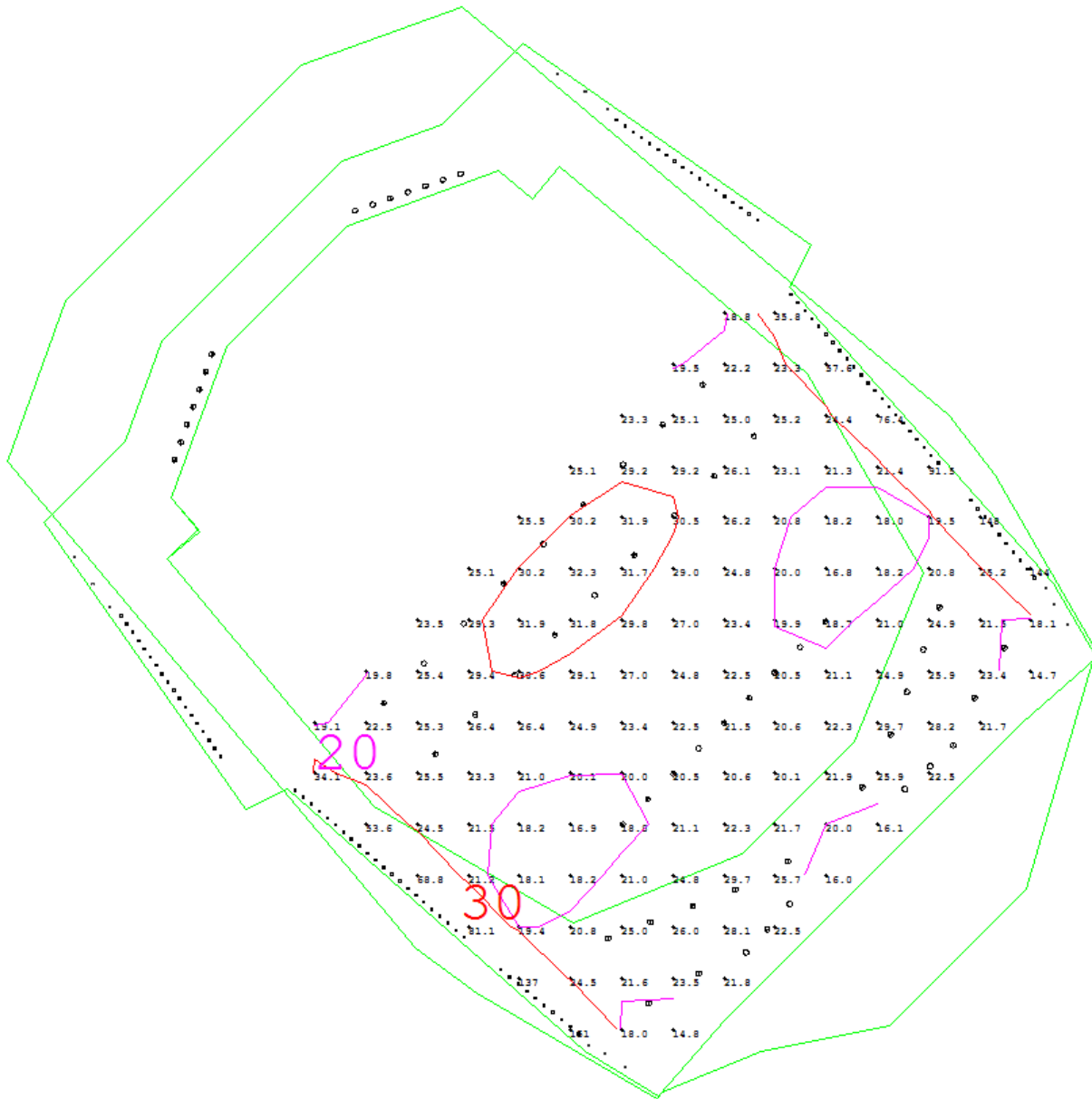
An automatic control device is required to control lighting in all spaces. It must be based on either a preset schedule, occupancy sensors, or information from another control system that indicates a space is not occupied.

### **Display/Accent Lighting (*Mandatory*)**

Display or accent lighting must be controlled separately from general lighting.

# Evaluation and Critique

## Concert Hall AGI Calculation



The existing lighting systems for the concert hall appear to be well thought out. Compared to most lighting designs it seems energy inefficient, but the need for accurate dimming, low noise, good color rendering, and warm color temperature may have forced the decision to light it entirely using halogen and incandescent sources. Examination of the seating area with a simplified AGI model suggests that light levels exceed the current IES handbook's recommendations, but it may have been designed to different criteria.

Lighting is used to good effect for the emphasis of architectural features, including the texture of the wood panels, the faceted balcony overhang, and even the rows of maroon upholstered seats. It creates a welcoming environment, but even with the house lighting on it puts a clear focus on the stage.

The peripheral emphasis on the first floor reflects the fact that a large crowd of people must pass in and out through the aisles in a relatively short amount of time, but it does so in a way that also enhances architectural features.

# Main Lobby



Important both as a gathering space and for providing access to the concert hall, the main lobby is long and relatively narrow. On one side, it has a high curtain wall, and on the other a wood paneled wall and balcony level corridor.

## Materials

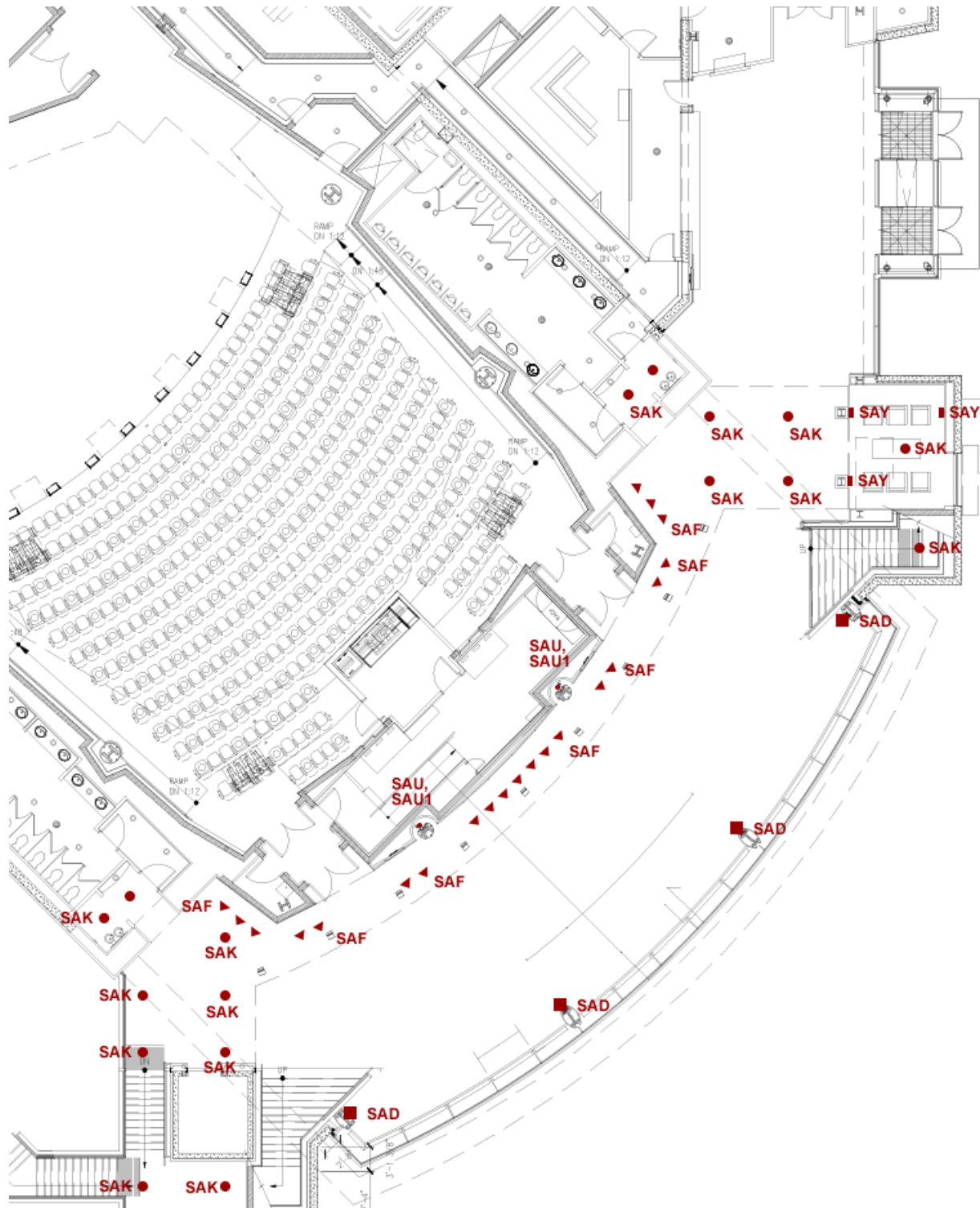
Type	Reflectance (estimated)	Transmittance
Carpet	20%	n/a
Wood	15%	n/a
Paint – Columns	80%	n/a
Paint – Ceiling	60%	n/a
Paint – Upper Wall	40%	n/a
Glazing	—	—

## Existing Lighting

General illumination is provided by track lighting from the ceiling, which also produces scallops along the upper interior wall. Suspended spotlights along the curtain wall also

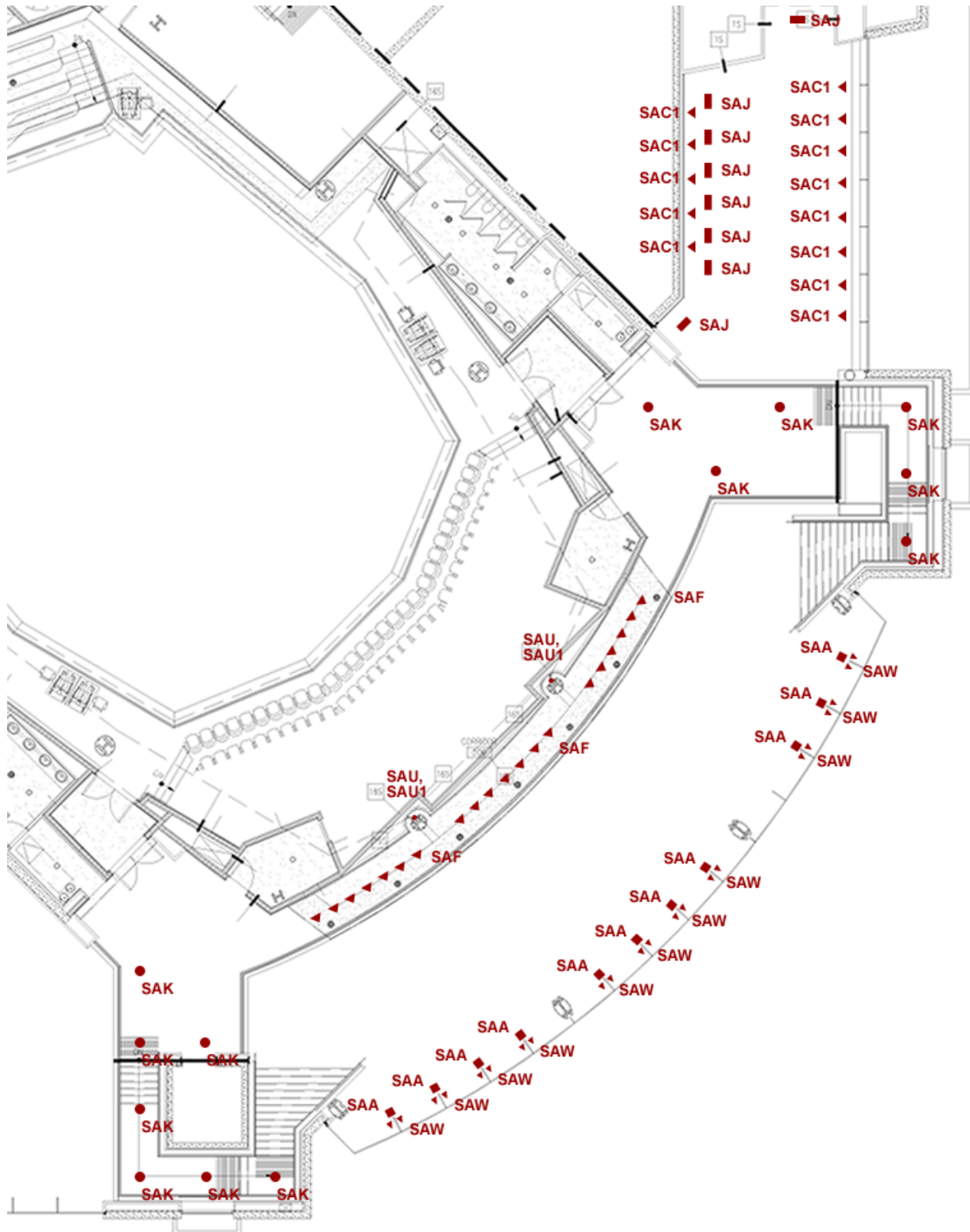
light the upper wall, highlighting the metal Wentz Concert Hall lettering. Near the top of the curtain wall, asymmetric uplights are mounted to a beam light the ceiling. The first floor and balcony's wood finished walls are lit by halogen track lights, with linear striplights concealed behind the columns.

### Lobby – First Floor Lighting

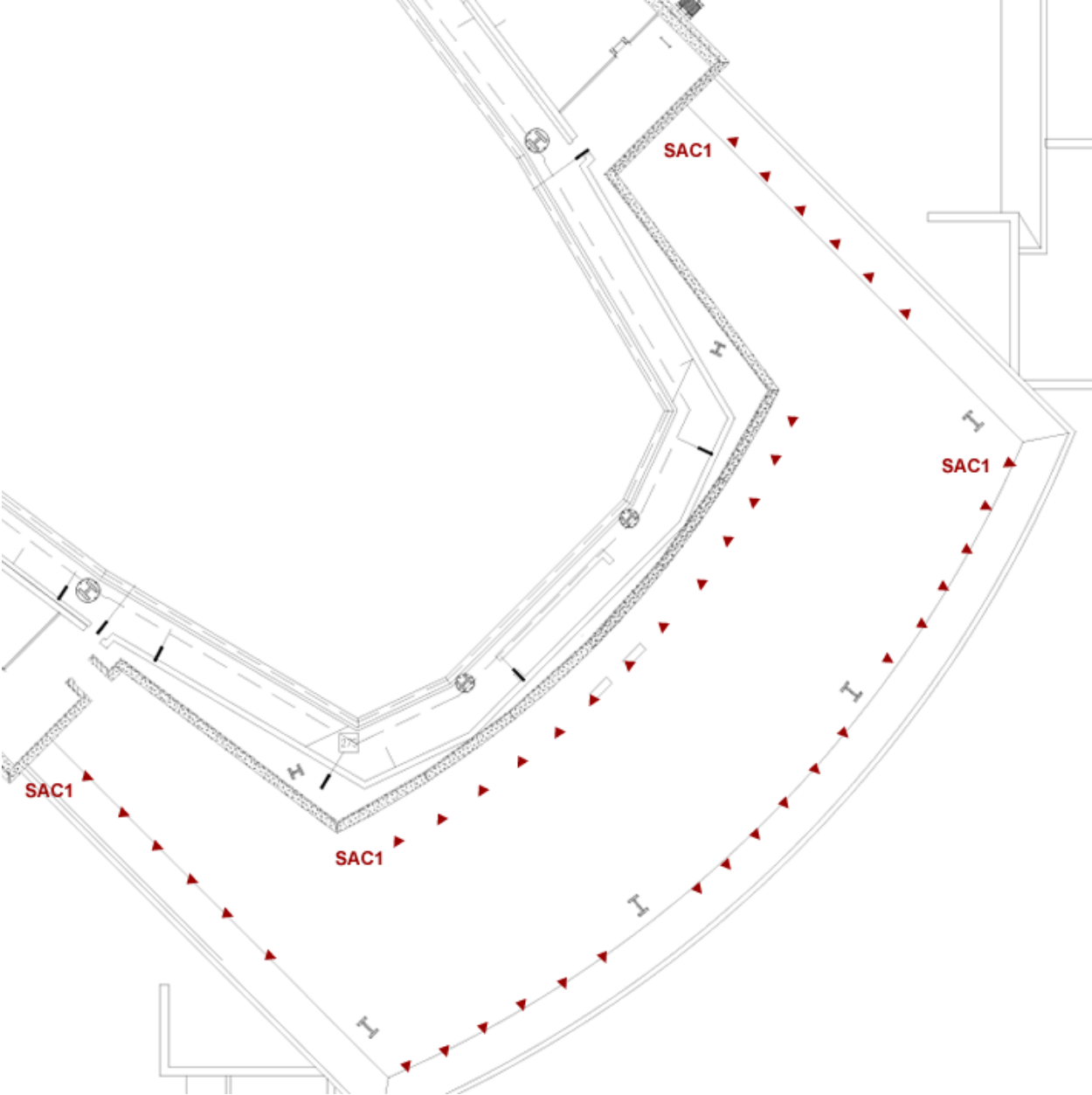




# Lobby – Second Floor Lighting



Lobby – Upper Ceiling Lighting



## Lighting Equipment

Type	Description	Manufacturer / Catalog number	Lamp(s)	Location
SAD	Halogen ellipsoidal projector with 50° lens barrel and faceted borosilicate reflector	ETC 450-MOD (custom finish)	150W T6	Lower exterior wall
SAU	Linear fluorescent T5 staggered strip with 4' length and 3" lamp overlap	H.E. Williams 73SS-4-128T5-EB1-xxx	F28T5	Interior column backlight
SAU1	Linear fluorescent T5 staggered strip with 3' length and 3" lamp overlap	H.E. Williams 73SS-4-121T5-EB1-xxx	F21T5	Interior column backlight
SAY	Linear fluorescent decorative sconce with extruded aluminum housing and etched glass diffuser. Nominal 24" height, 6.5" width, and 3.5" depth.	Lightolier 48021alu-40874-MOD (electronic dimming ballast)	F14T5	Sitting area
SAK	Incandescent A lamp downlight with nominal 6" aperture	Iris PN5-E5A19-H	100W A19	Stairwells
SAF	Halogen PAR30 trackhead	Lighting Services Inc 230-5A-x-WL	75W PAR30	Wood walls
SAA	Halogen asymmetric wedge uplight with extruded aluminum housing	SPI EIW5002-1T250-FT-120V-PTxx	250W T4	Upper exterior wall
SAW	Halogen PAR38 accent light with two (2) heads and tilt/rotation locking	Lighting Services Inc (2) 238-00-x-WL-MOD (custom finish, 4' stem)	(2) 100W PAR38	Upper exterior wall
SAC1	Halogen PAR38 trackhead with 5°x30° linear spread lens	Lighting Services Inc 238-00-3G-x-WL-CCx	100W PAR38	Ceiling perimeter

## Lighting Design Criteria

### IES Lighting Handbook 10<sup>th</sup> edition

The lobby serves two main purposes: it is a main circulation path between the main entry, black box theater lobby, and concert hall, as well as a gathering area before performances and during intermissions. Lighting levels must be designed to suit both of these uses.

#### **Illuminance** (*High priority*)

A prefunction area outside a concert hall may adjust its lighting levels during events to allow easier transitions between spaces. Since the lobby here is also used as a central circulation space, lighting levels during events may need to be maintained at higher than the IES recommendation.

- Horizontal (average at floor)
  - 5 fc during production
  - 15 fc pre/post production and during intermissions
  - Avg:Min = 3:1
- Vertical (average at 5 ft. AFF)
  - 3 fc during production
  - 7.5 fc pre/post production and during intermissions
  - Avg:Min = 3:1

### **Glare (*High priority*)**

Since the lobby is used as a transition area from the concert hall, direct glare from light sources should be avoided. Exiting the concert hall during a performance into the brighter lobby will require some adaptation, and additional glare could be blinding.

### **Color Rendition**

Because of the rich materials used in the lobby, color rendering will be particularly important for lights illuminating the wooden walls.

### **Color Temperature**

As discussed above, warmer color temperatures are preferred in the concert hall. As this space is directly adjacent, it will be desirable to use the same color temperature here.

### **Sound**

While the vestibule between the lobby and concert hall helps to block light and sound, source sound emission should still be considered. In this case, quiet noises will not be problematic, but the buzz emitted by many magnetic ballasts would be undesirable.

## **ASHRAE 90.1 2010**

### **Power Allowance (*Mandatory*)**

Lobby for performing arts theatre

- Lighting Power Density: 2.00 W/ft<sup>2</sup>
- An additional allowance of up to 1.0 W/ft<sup>2</sup> is available for decorative lighting

### **Automatic Shutoff (*Mandatory*)**

An automatic control device is required to control lighting in all spaces. It must be based on either a preset schedule, occupancy sensors, or information from another control system that indicates a space is not occupied.

### **Display/Accent Lighting (*Mandatory*)**

Display or accent lighting must be controlled separately from general lighting.

### **Automatic Daylighting Controls for Primary Sidelighted Areas (*Mandatory*)**

In sidelighted spaces over 250 ft<sup>2</sup>, lamps for general lighting must be separately controlled by a multilevel photocontrol dimming system.

## **Flynn Psychological Impressions**

### **Relaxation**

Flynn's research suggests two methods of promoting the impression of relaxation:

- Non-uniform lighting mode
- Peripheral (wall) emphasis, with reduced overhead lighting

## **Evaluation and Critique**

The existing lighting in the main lobby is very well done. The equipment integrates into the space without drawing attention to itself, but the lighting effects are dramatic. Track lighting overhead not only provides general illumination, but also creates a series of scallops along the upper wall. This serves to draw attention to the large lettering, which is visible from the street. Shadowing below the letters is avoided using spotlights suspended by the curtain wall, which uplight it slightly.

On the first floor and balcony levels, which patrons pass through on the way to the concert hall, care is taken to not allow the overhead lighting to overpower the lower portion of the room. Warm halogen lights illuminate the wooden walls, and the columns are backlit by concealed fluorescent strips. During the day, the space can be brightly lit using only daylight through the large curtain wall.

# Teaching Spaces / Practice Rooms

The teaching spaces and practice rooms are on the first floor's main corridor. Teaching spaces are furnished as one would expect an office to be, with the addition of a piano. They have wood floors, with painted drywall walls and ceilings.

## Materials

Type	Reflectance (estimated)
Wood floor	40%
Painted walls	60%
Acoustical ceiling	80%

## Existing Lighting

The existing lighting is by 2x2 fluorescent troffers. Each room has between two and four, depending on size.

## Teaching Space / Practice Room Lighting



### Lighting Equipment

Type	Description	Manufacturer / Catalog Number	Lamp(s)	Location
F-2	2'x2 parabolic louvered troffer	H.E. Williams U3G-D22-231UN-33S-EB2	(2) 32W T8 U-shape	Teaching spaces, Practice rooms

# Lighting Design Criteria

## IES Lighting Handbook 10<sup>th</sup> edition

### Illuminance (*High Priority*)

The teaching spaces serve a dual function: they are offices as well as musical instructional spaces, and should meet the needs of both.

#### *Music Classroom*

- Horizontal (average at 4 ft. AFF)
  - 30 fc
  - Avg:Min = 2:1
- Vertical (average at 4 ft. AFF)
  - 20 fc
  - Avg:Min = 2:1

#### *Office (with black on white VDT use)*

- Horizontal (average at 2 ft. 6 in. AFF)
  - 30 fc
  - Avg:Min = 2:1
- Vertical (average at 4 ft. AFF)
  - 15 fc
  - Avg:Min = 2:1

### Uniformity

Since desk tasks are often spread over multiple sheets of paper, providing uniform illumination on the workplane allows for working over a wide area without requiring constant adaptation.

### Glare (*High Priority*)

In spaces where VDTs are used, glare is always a concern. The design should minimize reflections of light sources or brightly illuminated surfaces on the computer screen. Glare is less of an issue for reading sheet music, but should still be minimized.



## **Color Temperature**

Color temperature should generally be selected to match other sources in an architectural project, avoiding transitions between areas of different CCT. While there are fewer direct reasons to select a warm color temperature here, they would be consistent with the other spaces. On the other hand, some research suggests that higher color temperatures can increase focus and productivity, which could be desired in an office space.

## **Color Rendition**

The tasks performed in these spaces do not require highly accurate color rendition, but consistency with other spaces may be a consideration.

## **ASHRAE 90.1 2010**

### **Power Allowance (*Mandatory*)**

Office, Enclosed

- Lighting Power Density: 1.11 W/ft<sup>2</sup>
- An additional allowance of up to 1.0 W/ft<sup>2</sup> is available for decorative lighting

### **Automatic Shutoff (*Mandatory*)**

An automatic control device is required to control lighting in all spaces. It must be based on either a preset schedule, occupancy sensors, or information from another control system that indicates a space is not occupied.

### **Display/Accent Lighting (*Mandatory*)**

Display or accent lighting must be controlled separately from general lighting.

# Evaluation and Critique

## Teaching Space / Practice Room AGI Calculation



While not the most interesting design, the teaching spaces are a “back of house” area, not seen by patrons of the concert hall. The design here utilitarian and economical, eschewing more elaborate style of the lobby and concert hall. It is an effective system, but according to an AGI approximation, the light levels are significantly higher than my 30 fc criteria, and it easily has room for energy savings. Effectively lighting the multiple sizes of rooms would require more than one fixture type, and a non-troffer approach might fit better with the other parts of the building.

# Facade

The exterior of the Wentz Concert Hall building is finished with off-white precast concrete panels. On the southeast side, the main lobby's curtain wall dominates the view from the street. The cornice and top level are finished with architectural aluminum panels, giving it a distinctly modern aesthetic.

## Materials

Type	Reflectance (estimated)
Precast concrete	60%
Aluminum panels	75%

## Existing Lighting

The building as designed does not have any exterior lighting, except for downlights in the entrance canopies and sconces at the loading dock. Instead, it relies on the view into the lobby and the bright lighting inside the main entrance to draw visitors in.

## Lighting Equipment

Type	Description	Manufacturer / Catalog Number	Lamp(s)	Location
SAT	Wet listed 4" downlight with semi-specular Alzak reflector and tempered glass lens	Designplan SP2-9-4M-x-SS-1-C-T-0	39W CMH PAR20	Entry canopies

## Lighting Design Criteria

### IES Lighting Handbook 10<sup>th</sup> edition

#### Illuminance (*High Priority*)

Façade illuminance criteria are as recommended for an area of medium night activity and LZ3 lighting zone.

#### *Facade*

- Vertical
  - 7.5 fc maximum, to highlight façade details or features
    - Apply to <20% of façade
  - 3 fc average for large illuminated areas

## Entry

- Horizontal (average at grade)
  - 1.5 fc
  - Avg:Min = 2:1
- Vertical (average at 5 ft. above grade)
  - 0.8 fc
  - Avg:Min = 4:1

## Wayfinding

The main entry is the primary destination for most people entering the building, though some will also be entering at the black box theater lobby. Since many visitors may not be familiar with the building, lighting can be used as a wayfinding aid.

## Landmark Appearance (*High Priority*)

The bright lobby with its Wentz Concert Hall lettering makes a powerful landmark, which will help patrons recognize the building even if they have never seen it before. Exterior lighting should avoid overpowering this effect.

## Light Pollution/Trespass

Exterior lighting should minimize light trespass to adjacent properties and light emitted upward.

## ASHRAE 90.1 2010

### Power Allowance (*Mandatory*)

Lighting Zone 3:

- 30 W/ft of main entrance width
- 20 W/ft of other door width
- 0.4 W/ft<sup>2</sup> of entry canopies
- All given allowances are tradable

## Evaluation and Critique

Thanks to the glass enclosed main lobby, the Wentz Concert Hall and Fine Arts Center has stunning nighttime appearance, despite the decision to not light the facade. The Technical Report 1: Lighting Existing Conditions and Design Criteria

current design works well, and any revisions would need to be careful not to overly distract from the lobby as a focal point. Entrances are identifiable by their bright lighting inside and in the canopies, but do not grab as much attention as they could.

# Conclusion

Overall, the lighting in the Wentz Concert Hall and Fine Arts Center is very well done. The most obvious potential for change is in the illuminance values, which are designed to be higher than those recommended by the 10<sup>th</sup> Edition IES Handbook.

Wide use of incandescent and halogen sources means that the building isn't as energy efficient as it could be, but they have numerous advantages that make them a sensible choice here. Warm finishes benefit from the color temperature and uniform rendering, the acoustic environment isn't polluted by noise from ballasts and drivers, and they dim uniformly and smoothly.

The back of house spaces aren't designed with the same sort of theatrical flair that the concert hall and lobby possess. Without budget constraints, the rear corridor could be better tied in to the more public facing areas.

As designed, the exterior is almost entirely unlit. This works well, with the lobby space gaining strong emphasis through its curtain wall. The entries are marked with recessed downlights, but the walls are lit only by ambient light.