

# Thesis Proposal

---

AE 481W  
Final Proposal  
Bucks County Justice Center  
Doylestown, PA

---

Joshua Lange  
Lighting/Electrical

Dr. Richard Mistrick

12/12/2014

## **Executive summary**

The following report is a proposal for the work to be completed as part of the senior thesis in the spring semester of 2015. There are four main parts to the proposal.

The first part of the proposal is the redesign of the lighting of four unique spaces. Criteria were established for each space including illuminance, LPD, and controls. A design will be created and documented that meets these criteria for each of the spaces.

The second part of the proposal outlines the work to be done for the electrical depth. This part has three portions. The first portion is making the required changes to the electrical system in order to accommodate the redesigned lighting systems. This includes wire, conduit, breakers, and panelboards. The second portion is performing a coordination study of the electrical system. The final portion is performing an analysis of using a DC power distribution system. Several devices use DC power and by having a DC distribution system efficiency might be improved.

The third part is an acoustical breadth and MAE depth. This portion analyzes the acoustical aspects of the ceremonial courtroom in regards to speech intelligibility. The breadth portion is to perform a reverberation time (RT) calculation for the space and to recommend any changes that are required to bring it within the criteria. The MAE depth portion will use the skills learned in ACS 597E to perform an analysis of the sound reinforcement system and to see its effect on speech intelligibility. A dB plot will be created as well as auralizations for both when sound reinforcement is used and when it is not.

The fourth and final part of the proposal is to determine if a combined heat and power (CHP) would increase the fossil fuels efficiency of the building while not increasing costs. This analysis will involve performing research on small scale applications of CHP, calculating building loads, and analyzing the effects of a CHP system on initial, maintenance, and operational costs.

## Table of contents

<b>Executive summary.....</b>	<b>1</b>
<b>Table of contents.....</b>	<b>2</b>
<b>1. Building Introduction.....</b>	<b>3</b>
General Information .....	3
Project Team .....	3
<b>2. Lighting Depth.....</b>	<b>4</b>
2.1 Introduction .....	4
2.2 Main Plaza .....	5
2.3 Main Lobby 1000 .....	5
2.4 Open Office 2520 .....	6
2.5 Ceremonial Courtroom 4100.....	6
2.6 Tasks and Software .....	7
2.6.1 Schematic Design.....	7
2.6.2 Calculations and Renders.....	7
2.6.3 Daylighting .....	7
<b>3. Electrical Depth .....</b>	<b>8</b>
3.1 Introduction .....	8
3.2 Branch Circuit Redesign .....	8
3.3 Coordination Study .....	8
3.4 DC Distribution System.....	8
<b>4. Acoustical Breadth/MAE Depth.....</b>	<b>9</b>
4.1 Introduction .....	9
4.2 Breadth: Reverberation Time (RT) Analysis.....	9
4.3 MAE Depth: Sound Reinforcement System Analysis .....	9
<b>5. Mechanical Breadth .....</b>	<b>10</b>
<b>6. Proposed Schedule.....</b>	<b>11</b>

## 1. Building Introduction

The Bucks County Justice Center (BCJC) is the location of various judicial facilities including courtrooms, offices, holding cells, and other supporting spaces. The building is in the shape of a 'V' with the main entrance located at the apex which faces the existing administration building that is located across the street. Two sides of the building border streets with the remaining sides being adjacent to parking. See image below.



### General Information

Project Name: Bucks County Justice Center

Location: Doylestown, PA

Owner: County of Bucks

Occupancy: Assembly, Business, Institutional, Storage

Size: 272,856 SF Gross Square Footage IBC 2006

Levels: 7 stories above grade (including the penthouse) and 2 stories below grade

Construction Schedule: July 2011 - February 2015 (anticipated)

Cost: \$84 million total project cost

Project Delivery: Design-Bid-Build

### Project Team

General Contractor: Ernest Bock & Sons, Inc.

Architect: HOK

MEP: H. F. Lenz

Security and Code Consulting: Brinjac Engineers

Telecommunications, Data, Audio Visual, and Acoustic: Acentech Incorporated

Lighting: Tigue Lighting

## 2. Lighting Depth

### 2.1 Introduction

The lighting of four unique spaces in the BCJC will be redesigned. The designs will adhere to the criteria that were developed in Tech Report 2. These criteria include qualitative functional aspects such as way finding and security and quantitative aspects such as illuminance levels from the IES Handbook and power density requirements from ASHRAE 90.1. The completed designs will be documented with lighting plans, lighting schedules, illuminance calculations, and renders. For each of the spaces changes will be implemented based on the comments from the presentation at Lutron.

The four spaces are as follows:

Outdoor Space: Main Plaza

Circulation Space: Main Lobby 1000

Large Workspace: Open Office 2520

Special Purpose Space: Ceremonial Courtroom 4100

In addition to the individual criteria that are outline for each space the following are criteria for all of the spaces.

CCT of 3500K: Because of the significant amount of daylight that will penetrate many of the spaces a high CCT was chosen to help with daylight mixing. This CCT will also be used in all of the spaces to help bring uniformity to the building.

20% reduction from ASHRAE LPD requirements: In order to help the lighting design to be as efficient as possible a target reduction was set.

General comments from the presentation at Lutron:

- Good job for including ASHRAE 2013, state that it is the version being used early on
- Use more color in the presentation
- Include overarching concept
- Put fixtures/equipment on 'layers of light' slides
- Make sure to say why you are using the criteria you are using (CCT, CRI, etc.)
- State who the lighting designer and architect are at the beginning.

## **2.2 Main Plaza**

The main plaza located outside of Main Lobby 1000 connects the main entrance of the BCJC with the administration building that is located across the street. The majority of this space is hardscape. The main criteria for this space are summarized below.

Way finding: This space leads up to the main entrance of the building and therefore providing a clear path to the entrance is important.

Safety: Ample light must be provided to discourage criminal activity as well as to allow cameras to capture any illegal activity.

Both the illuminance level and ratios are based on the recommendations in the IES Handbook.

Control and LPD requirements are based on ASHRAE 90.1 2013

In order to limit light trespass and sky glow the Model Lighting Ordinance will be followed.

Comments from the presentation at Lutron:

- MLO probably does not have an exception for flag lighting

## **2.3 Main Lobby 1000**

Main Lobby 1000 is approximately 3000 SF and is located on the east side of the building at the intersection of the two wings. It is double height with a second floor balcony overlooking it. The east façade is primarily glass which provides extensive daylight exposure. The main criteria for this space are summarized below.

Spaciousness: This space is the main entrance of the building and should be designed in such a way as to instill a sense of awe and grandeur

Safety: This space houses the main security screening for the building and therefore the lighting must be designed to not hinder the screening process

Both the illuminance level and ratios are based on the recommendations in the IES Handbook.

Control and LPD requirements are based on ASHRAE 90.1 2013

Comments from the presentation at Lutron:

- Do not light the etched glass county emblem (it doesn't work)
- Every surface is lit so nothing is the focal point
- Hard to light the security from the double height ceiling
- Check the ceiling plan to make sure the balcony does not block light for the security area

#### **2.4 Open Office 2520**

Open Office 2520 is a 1600 SF "L" shaped open office located in the southwest corner of the building. This office is typical of the open offices located throughout the building, but has significant exterior exposure on the northwest side.

Views/Daylight: in order to create as friendly of a working environment as possible views and daylighting should be utilized as much as possible while keeping glare to a minimum

Community: the lighting design of this space should promote community and encourage the occupants to work in collaboration

Both the illuminance level and ratios are based on the recommendations in the IES Handbook.

A daylight analysis will be performed in this space including automatic shade optimization and light fixture dimming.

Control and LPD requirements are based on ASHRAE 90.1 2013

Comments from the presentation at Lutron:

- The pendant does not look it is hanging
- Since calculations have not been performed space the fixtures evenly (it is more visually appealing)

#### **2.5 Ceremonial Courtroom 4100**

Ceremonial Courtroom 4100 is located in the southeast end of the building and is the largest of the courtrooms. This courtroom has an area of 2900 SF, 222 public seats, and a large area of proceedings that includes the typical items (attorney's tables, evidence table, jury seating, etc.) and seating for a panel of judges. There are various activities that take place in the courtroom that require very different illuminance levels.

Flexibility: in order to accommodate the various activities that will take place in the courtroom the lighting solution must have various scenes

Respect: the lighting design of this space should convey a sense of honor and respect

Both the illuminance level and ratios are based on the recommendations in the IES Handbook.

Control and LPD requirements are based on ASHRAE 90.1 2013

Comments from the presentation at Lutron:

- Good three designs
- Get out of the box, use color renderings
- Use concept imagery to relay the desired information
- Judge wants controls at his desk
- There will need to be different scenes

## **2.6 Tasks and Software**

### **2.6.1 Schematic Design**

The schematic design will be based on the criteria derived primarily from ASHRAE 90.1, the IES Handbook, and the Model Lighting Ordinance. The designs will be updated based on the feedback that was received and will be represented through Photoshop images.

### **2.6.2 Calculations and Renders**

The illuminance calculations will be performed in AGI32. Final renders will be created in AGI32 and possibly Radiance.

### **2.6.3 Daylighting**

AGI32 will be used to create the solar study and Daysim will be used to perform daylight analysis.

### **3. Electrical Depth**

#### **3.1 Introduction**

The BCJC's electrical system utilizes a 3200 A unit substation that is fed by a 2000 KVA building transformer with a 34.5 KV primary and a 277/480 secondary. The building utilizes a dual voltage AC distribution system of 277/480 V and 120/208 V. A 1000 KW generator and a 100 KW UPS serve the emergency power distribution system. There are various low voltage systems throughout the building including audio visual, telecommunications, fire alarm, and an expansive security system.

#### **3.2 Branch Circuit Redesign**

The first part of the electrical depth is to update all of the circuits to reflect the changes in the lighting fixture quantity and layout for the four spaces that were redesigned. The conductors, conduit, circuit breakers, and panelboards will be resized as required.

#### **3.3 Coordination Study**

The next portion is to perform a coordination study of the electrical system. This study will be performed in SKM or a similar program.

#### **3.4 DC Distribution System**

The final portion is to perform an analysis of the affects of using a DC distribution system. The first part of this analysis will be to conduct research into studies that have already been performed and what steps can be taken to optimize a dual distribution system. Research will also be performed to see what devices are currently available that can utilize DC power. The most likely devices to utilize DC power are motors, servers, telecommunications equipment, and LED lighting fixtures. After research is performed a study will be conducted to investigate the changes in operational, maintenance, and first cost as well as changes in equipment space requirements that will occur for a DC distribution system to be utilized in the BCJC.

## **4. Acoustical Breadth/MAE Depth**

### **4.1 Introduction**

Speech intelligibility is an important part of court proceedings and Ceremonial Courtroom 4100 is of a size such that conditions that are unfavorable for speech intelligibility could easily exist. The large size of the space also makes the application of a sound reinforcement system potentially very beneficial to speech intelligibility. The design for Ceremonial Courtroom 4100 includes acoustical treatment and a sound reinforcement system. The influence of these systems on speech intelligibility will be evaluated through a reverberation time analysis and a sound distribution analysis.

### **4.2 Breadth: Reverberation Time (RT) Analysis**

For the acoustical breadth an analysis will be performed of the RT of the space. This analysis will involve deciding what range of RT is acceptable for a courtroom, modeling the space as currently designed (including geometry and materials), calculating the RT of the space, and making recommendations to improve it as required.

### **4.3 MAE Depth: Sound Reinforcement System Analysis**

For the MAE depth skills that were learned in ACS 597E will be utilized to investigate the effectiveness of the sound reinforcement system. The geometric model will be imported into Odeon and an acoustical analysis will be performed. The analysis will determine the audio level and distribution that will occur when sound reinforcement is and is not utilized. A dB plot of the room will be created for both cases. Auralizations will be created to simulate what a person seated in the public seating area would hear if a person (attorney, judge, witness, etc.) were speaking without reinforcement and what they would hear with reinforcement. Based on the results of the analysis recommendations to improve the performance of the system will be made.

## **5. Mechanical Breadth**

Combined Heat and power (CHP), when applied correctly, is a means of using fossil fuels much more efficiently than the typical method of using grid supplied power and a separate heat source. An analysis will be performed to determine the practicality of applying a CHP system to the BCJC. This analysis will include performing research into studies that have already been conducted, calculating the loads that are on the building, performing a cost/benefit analysis of applying a CHP system, and determining how to integrate a CHP system electrically.

## 6. Proposed Schedule

