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7.0 Lighting Breadth

PENNSTATE

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MCCCH's Current Use of Incandescent Fixtures:

As mentioned earlier, a large majority of the existing interior lighting system for the Montgomery County Conference Center and Hotel incorporates the use of decorative custom, incandescent fixtures. Areas where these fixtures are most prominent include the conference center main areas like the lobby, pre-function, ballroom, conference rooms, classrooms, and main corridors. The hotel lobby, restaurant, lounge, and guestroom corridors are also lit by these custom fixtures. The fixtures themselves are designed in a variety of forms like ceiling mounted, pendant, wall sconce, and chandelier. Below is a picture of one type of ceiling mounted custom fixture found in the building's ballroom area.

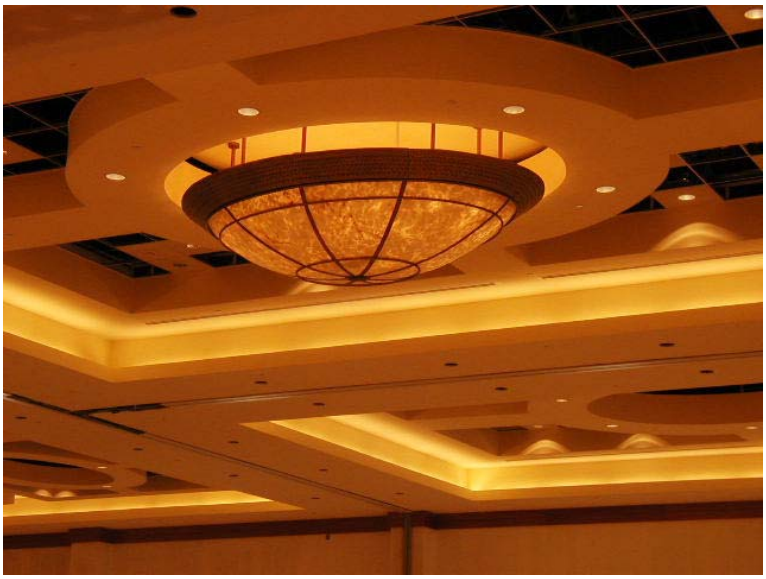

Figure 10: One Type of Existing Incandescent Ballroom Fixtures

Although these fixtures provide wonderful aesthetics, their incandescent lamps give off a tremendous amount of heat, which in turn creates a very high mechanical cooling load on individual building spaces. Other types of lighting lamps, like fluorescents, for example, do not give off nearly as much heat as

incandescent lamps. This is due to the fact that most fluorescent lamps operate at lower wattages than incandescent lamps.

Therefore, for this part of my project, I chose to investigate the possibility of replacing the incandescent lamps within the custom lighting fixtures with compact fluorescent lamps. The goal was to decrease the building's mechanical cooling load while not losing any of the lighting quality. Lower electrical loads would also result from the change.

For simplicity, only the custom fixtures and the mechanical cooling loads on the conference center's ballroom were studied. That room was large enough (approximately 25,000 sq. ft.) and contained an adequate amount of the custom fixtures that there would be a definite indication of whether or not a lamp replacement throughout the building could be effective at significantly reducing the mechanical cooling load.

Lighting Calculations:

The following table shows the original custom incandescent fixture schedule for MCCCH's grand ballroom.

Ballroom Incandescent Fixtures:

Fixture # from Schedule	Description	Location	Level/Floor	Size (Dia. X Ht.)	Qty.	Weight	Wattage (each)	Source
LD-12	Chandelier	Ballroom (CC)	Ballroom	14' x 24'	2	2000	124 x 60W	La Spec
LD-13	Chandelier	Ballroom (CC)	Ballroom	9' x 12'	6	550	40 x 60W	La Spec
LD-14	Chandelier	Ballroom (CC)	Ballroom	6 x 10'	8	300	24 x 60W	La Spec
LD-15	Wallsconce	Ballroom (CC)	Ballroom	12" x 36"	40	30	4 x 60W	La Spec

Table 14: Ballroom Custom Incandescent Fixture Schedule

The lamps that were housed inside these fixtures were standard incandescent (General Electric 60A/W) lamps. Some of the lamps' characteristics included:

- Volts: 120V
- Watts: 60W
- Average Life in Hours: 1000
- Lumens (Initial): 850
- Color Rendering Index (CRI): 100

- Bulb Type: A19
- Base Type: Med.
- Max Overall Length: 4.43”
- Temperature: 2700 K

In order to effectively replace these incandescent lamps with compact fluorescents while not losing any lighting quality, equal lighting color (determined by lamp temperature) and equal lumens/illuminance levels had to be established on the ballroom’s work plane. Therefore, a compact fluorescent lamp with a temperature of 2700 K and a mean lumen value of 850 or more had to be selected.

By searching around on GE’s website, a self-ballasted, compact fluorescent lamp with all of the above qualities was found. Its characteristics were the following:

- Volts: 120V
- Watts: 20W
- Average Life in Hours: 8000
- Lumens (Initial): 1200
- Lumens (Mean): 965
- Color Rendering Index (CRI): 82
- Bulb Type: HLX (T3)
- Base Type: Med.
- Max Overall Length: 4.7”
- Temperature: 2700 K

From here, the original amount of lumens on the ballroom work plane was calculated by multiplying the # of incandescent lamps in each ballroom fixture by the lamp’s amount of initial lumen output. These values for lumens given off by each fixture type were then multiplied by their respective # of fixtures in the ballroom and the total # of lumens required was summed.

The individual fixture lumen output requirements were then taken and divided by the *mean* lumen output of the compact fluorescent lamps to get a required # of lamps per fixture. When that # was determined, the amount of lumen output per fixture was again calculated for the new C.F. lamps by multiplying the C.F.’s

mean lumen output by the # of C.F. lamps per fixture. The total # of lumens on the ballroom work plane were then calculated for the new C.F. lamps.

Finally, the total wattages and power densities for each lamp type were calculated and compared. The total cooling loads produced by each of the lamp types were also configured. All results were compared and can be viewed in the 'results' table below. For full lighting calculations and lamp selection information, please see Appendix I.

Results:

Total Original Lumens:	714000	lumens
New Total Wattage:	744980	lumens
Difference:	30980	lumens (more)
Total Original Wattage:	50400	W
New Total Wattage:	15440	W
Difference:	34960	W (less)
Ballroom Sq. Ft.:	23296	sq. ft.
Original Power Density:	2.16	W/sq. ft.
New Power Density:	0.66	W/sq. ft.
Difference:	1.50	W/sq. ft. (less)
Original Btu/h given off by lamps:	171955	Btu/h
New Btu/h given off by lamps:	52679	Btu/h
Difference:	119276	Btu/h (less)
Difference (tons):	9.94	Tons (less)
Original Ballroom Cooling Load:	**39.2**	**Tons**
New Ballroom Cooling Load with C.F.'s:	**29.26**	**Tons**

Table 15: Lighting Calculation Results

From the results, it was very clear that changing the lamps in the ballroom's custom fixtures would save on both energy and mechanical cooling loads all while providing more lumens but, how would this effect system first costs as well as system maintenance?

First Cost Economic Analysis and Maintenance Considerations:

The following table shows both lighting and mechanical system first cost calculations for the replacement of the ballroom's incandescent lamps with compact fluorescents.

Costs:

Incandescent Lamp First Cost:	3.38 / lamp	
# Incandescent Lamps:	840	
Total First Cost for Incandescent Lamps:	**$2,839.20**	
Compact Fluorescent Lamp First Cost:	8.70 / lamp	
# Compact Fluorescent Lamps:	772	
Total First Cost for Compact Fluorescent Lamps:	**$6,716.40**	
Difference:	**$3,877.20**	**(more)**
However, Cooling Saved:	10 tons	
Original Ballroom Cooling Sized at:	40 tons	
New Ballroom Cooling Sized at:	30 tons	
Initial Cost of Cooling (First Cost - $ / Ton):	$1,000.00	**(Estimate, Mumma, Doas-Radiant (see references))**
Cost of Original Ballroom Cooling:	$40,000.00	
Cost of New Ballroom Cooling:	$30,000.00	
Difference:	**$10,000.00**	**(less)**
Total F.C. Savings (Cooling Savings - Extra Lamp Expense):	**$6,122.80**	

Table 16: Lighting First Cost Economic Analysis

Replacing the ballroom's incandescent lamps with C.F.'s did result in a higher lamp first cost but, the mechanical system first cost savings caused by this change far outweighed the added lighting system first cost. (Decreased operating costs would have also resulted but were not considered for this project.)

In the end, it was determined that changing the custom lighting system from incandescent lamps to compact fluorescent lamps was a good idea. As long as all the new aesthetics were found acceptable by the building owner and architect, lower first costs and lower operating costs could be realized. Additionally, there was a possibility for lower amounts of lighting system maintenance with a

fluorescent lighting. Table 17 below conveys this possibility of lower maintenance occurrences.

If Lamps Replaced at Average Life Hours:		
Incandescent Average Life Hours:	1000	
C.F.'s Average Life Hours:	8000	
Incandescent Maintenance/Replacement Efforts per Year (Approximately):	4.24	~4 times a year
C.F. Maintenance/Replacement Efforts per Year (Approximately):	0.53	~1 in two years

Table 17: Possible Incandescent vs. Fluorescent Lighting System Maintenance