Andrew Rhodes

The Pennsylvania State University
Architectural Engineering – Mechanical

The Hilton Baltimore Convention Center Hotel

8.0 Conclusions and Final Recommendation

Conclusions

In the conclusion portion of Section 5.0 of this report, it was mentioned that the results of the chiller plant optimization study did not turn out as expected. Originally, absorption cooling with a backpressure steam turbine was assumed to be the best design alternative. Since it did not turn out as the best, time was taken to analyze why this was the case. The required Trigen district steam price that would make this design alternative optimal was calculated, and this rate was then compared to current 2007 fuel prices.

First, the cost of Trigen district steam per therm used was calculated. This value was found using the following equation:

Trigen Price = Usage Rate + (Set Rate / # Therms)

Where…
Usage Rate = $0.43
Set Rate = $180,000
Therms = 688,200

Figure-18 below shows how this calculation was carried out in an Excel spreadsheet, and it shows that a district steam cost of $0.69 per therm is currently being paid. In order to calculate the required price of steam that would make combined heat and power worthwhile, a difference in yearly steam utility costs was found which made the overall life-cycle cost equal to the on site centrifugal cooling design alternative. This difference was $55,926 per year. This value was subtracted from the current steam cost and then divided by the total number of therms used. The resulting steam cost, seen in Figure-18, is $0.61 per them, or $0.08 per therm less than the current rate.

Figure-18: Making CHP Worthwhile

What Steam Rate Would Be Needed to Make CHP Worthwhile?						
Usage Rate ($/Therm)	# Therms	Set Rate ($)	**Current Price ($/Therm)**	Current Steam Cost	Reduction in Steam Cost to make CHP Worthwhile	**Steam Price Required to make CHP Worthwhile**
$0.43	688,200	$180,000.00	**$0.69**	$475,926.00	$55,926.00	**$0.61**

Now that the actual and required steam costs are known, they will be compared to the cost of generating steam using various fuels. Data used in Figure-19 below was taken from www.eia.doe.gov. It is interesting that the rates for steam generation are higher than the rate being paid by the HBCCH for both natural gas and oil generation. Only producing steam using coal appears to be a viable option for Trigen.

Figure-19: Current Fuel Prices

Current Fuel Prices ($/Therm)			
Fuel	Unit Price ($/ft^3)	Heating Value (Btu/ft^3)	**Price ($/Therm)**
Natural Gas	$0.0121	0.001078749	**$1.31**
Fuel	Unit Price ($/lb)	Heating Value (Btu/lb)	**Price ($/Therm)**
Coal	$0.03	12500	**$0.22**
Fuel	Unit Price ($/gallon)	Heating Value (Btu/gallon)	**Price ($/Therm)**
Oil	$2.00	140000	**$1.43**

Once the values in Figure-19 were known, a phone call was made and numerous emails were sent to the manager of Trigen's Baltimore plant in order to find out how they generate their steam. The manager refused to give specific information as to how steam is produced, but he did definitively say that coal is not a means of generation. If coal isn't used, then how does Trigen make money? Obviously Trigen produces so much steam that they were able to strike a deal in order to create it at a cost that is lower than expected. This allows them to sell their steam to customers like the HBCCH at a perceived "low rate" while still making a profit. Unfortunately, this perceived low rate is not low enough to justify installing a backpressure steam turbine with absorption cooling at the HBCCH. The manager at Trigen also refused to disclose how long their contract with Hilton Hotels lasts, so it is impossible to know how soon steam rates could be changed, regardless of whether or not the change if for better or for worse.

Final Recommendation

Hilton Hotels chose the base case scenario, district chilled water and district steam, for two main reasons. First, they utilize district systems at other hotels and are happy with their performance. Little maintenance is needed, and system operation is guaranteed. Second, original conceptual designs for the HBCCH placed cooling towers on the roof of the west podium. With baseball fans at Oriole Park at Camden Yards having a clear view of the hotel, Hilton Hotels felt the on site equipment would detract from the aesthetic beauty of their building. The immediately looked for district systems to be used instead of on site cooling and heating.

Neither of these considerations is within the scope of this report. The main purpose of this report was to improve economics by lowering the life-cycle cost of the mechanical system of the HBCCH. This means that the system with the lowest life-cycle cost is considered the best. After completing the chiller plant optimization study, it is the final recommendation of this report that on site centrifugal cooling, along with associated cooling towers and pumps, be installed at the HBCCH. With an overall life-cycle cost of $13,291,220, this design alternative saves $3,094,057 compared to the base case scenario.