Section 7: Analysis #2 – AC Chillers Vs. WC Chiller With Cooling Tower (Mechanical – Breadth Topic #2)

7 – 1 Problem:

During the design phase of construction the owners of the Pearland Recreation Center and Natatorium insisted on using a cooling tower system to cool the water for the building's mechanical system. PBK, the project architect and MEP engineer, convinced them that using a cooling tower system with a water cooled (WC) chiller would be unreasonable since the building was only 105,000 SF. Instead they suggested using an air cooled (AC) chiller system, which would be a more economical choice given the size of the building.

Figure 7-1.1 - Cooling Tower (Courtesy of Zetacorp)

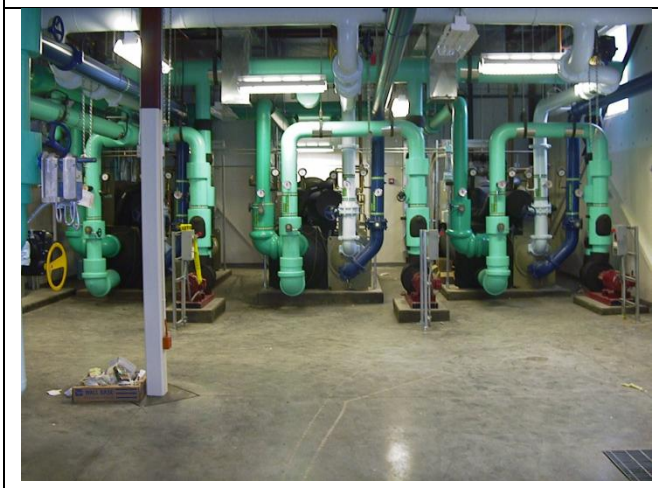

Figure 7-1.2 - Chillers (Courtesy of Tatro Plumbing)

7 – 2 Goal:

The goal of this research topic is to compare the cost of a cooling tower and WC chiller and AC chiller system in order to determine the more economical option. Cost data is already available for the AC chiller system; however it will be necessary to size and develop a construction cost estimate for a WC chiller and cooling tower system.

7 – 3 Analysis Method:

1) Determine the cooling loads on the Pearland Recreation Center and Natatorium
2) Select a cooling tower and WC chiller system that would satisfy the required cooling loads for the building.
3) Obtain construction cost information for the selected WC chiller and cooling tower system.
4) Compare the cost of the WC chiller and cooling tower system to the as designed AC chiller system to determine the more economical option.
5) Consider constructability factors that may make either option more feasible.
6) Consider life-cycle cost and maintenance factors for each option.

7 – 4 Resources:

1) Professor James Freihaut and AE – 310 HVAC Fundamentals course materials
2) Pearland Recreation Center and Natatorium project MEP engineer – PBK MEP
3) Fort Bend Mechanical
4) EMJ Corporation
5) Southland Industries – Nathan Patrick
6) Chesapeake Systems – David Jaworski
7) Boland-Trane – Joe Mulligan

7 – 5 System Selection:

The first step in analyzing the modification of the mechanical system was to design and select a suitable system. As previously mentioned, the current AC chiller would need to be replaced with a WC chiller as well as a Cooling Tower. The 2 as-designed AC chillers each had a capacity of 138 Tons, an entering water temperature of 56d F, a leaving water temperature of 42dF, and a flow rate of 240 GPM. Using these previous design specs and the fact that the project was located in Houston, TX it was determined that the new WC Chiller/Cooling Tower system be designed with a DB temperature of 92dF, a WB temperature of 77dF, a capacity of 276 tons and a 85dF condenser water temperature. Using these parameters it was discovered that the 2 AC chillers could be replaced with only 1 WC chiller. Similarly, the Cooling Tower was sized using an 85dF entering water temperature, a 95dF leaving water temperature and a 828 GPM (3 GPM/ton) flow rate. Product cut sheets for the WC chiller and Cooling Tower supplied by Boland-Trane and Chesapeake Systems are available in **Appendix 7**.

7 – 6 Cost Analysis:

Once the new mechanical system was designed it was then necessary to estimate the cost of the new system and compare it to the previous system. To do this, quotes were obtained from Chesapeake Systems and Trane-Boland for the cooling tower and WC chiller respectively. Labor costs for the installation of this equipment and additional pumps and piping required for the cooling tower were obtained from RS Means 2008 Cost Data. Cost information for the as-designed system was obtained from Fort Bend Mechanical, the mechanical contractor on the project. The new mechanical system offered a $48,523 savings over the previous system. **Table 7-1.3 – Mechanical System Cost Estimate** contains a summary of this comparison and the complete cost estimate calculations are contained in **Appendix 7**.

Table 7-1.3 – Mechanical System Cost Estimate

Item	Cost	Source
Cooling Tower		
Material	$30,171	Chesapeake Systems
Labor	$2,650	RS Means 2008 Cost Data, Pg. 374
Additional Pumps & Piping		
Labor & Material	$26,082	RS Means 2008 Cost Data, Pg. 374
Water Cooled Chiller		
Material	$93,840	Boland-Trane
Labor	$11,700	RS Means 2008 Cost Data, Pg. 373
Additional Structural Support for Cooling Towers		
Labor & Material	$15,557	Fort Bend Mechanical
Total Cost for New System	$180,000	
Total Cost for Old System	$228,523	
Initial Cost Savings with New System	$48,523	

7 – 7 Schedule/Constructability Analysis:

There are three potential constructability issues that would need to be considered with the new WC Chiller/Cooling Tower system that were not present with the old system:

1) The Cooling Tower would require additional structural support in the concrete slab that it would be placed on. This issue should not pose a problem, given the concrete slab is properly reinforced when it is constructed.

2) The Cooling Tower would require a crane for placement. It would be important to properly plan for this and ensure that adequate access is left to the mechanical courtyard on the north side of the building where it would be placed.

3) Previously, the AC chiller had been placed outside in the mechanical courtyard. With the new system, the cooling tower would be placed here and the water cooled chiller would need to be placed inside. There would be room for this equipment in the mechanical room on the northwest corner of the building. However it is important to consider access to this room for chiller installation.

While none of these issues should be a problem, it would be important to give them careful consideration while planning construction to ensure that adequate measures would be taken to account for them. This system modification should have no effect on the schedule since the only additional activities will be cooling tower placement and some extra pumps and piping which could be included in the current mechanical system construction duration.

7 – 8 Energy Cost Analysis:

An energy cost comparison between the two systems was also performed. The old air-cooled chiller system consumed 1.3 KW/Ton for each chiller, or a total of 718 KW. Using a water-cooled chiller and cooling tower the total energy usage would be only 427 KW. Energy information for the water-cooled chiller came from Boland-Trane and for the cooling tower a COP of 4 was assumed and the KW/ton value was calculated from that. Assuming energy costs of 10 cents per KWh in Houston, TX the total energy cost savings using the new system are shown in **Table 7-1.4 - Energy Cost Savings**. All the calculations for this cost comparison can be found in **Appendix 7**.

Table 7-1.4 - Energy Cost Savings

Time Period	Cost Savings
Daily	$698
Monthly	$20,707
Yearly	$248,488

7 – 9 Conclusions and Remarks:

Modification of the mechanical system from an air cooled chiller system to a water cooled chiller with a cooling tower system presents a savings of almost $50,000 in construction costs, almost $250,000 a year in energy costs, and no change in construction schedule duration.

While the new system is preferred economically, there are some additional factors that would need to be taken into consideration during construction such as additional structural reinforcing and construction logistics in mechanical equipment placement. Similarly, a cooling tower will require additional consideration throughout its life-time to ensure that the water in the cooling tower is controlled. Considering the building contains two swimming pools, this water maintenance should not be an issue for the owner as they should already have water control systems in place for the swimming pools and the monitoring of the cooling tower water could just be folded into these duties. In conclusion, a water cooled chiller and cooling tower system could be beneficial for the Pearland Recreation Center and Natatorium project.