Improvement and Integration in High Efficiency Equipment to Reduce Energy Cost

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Abstract — *The application of improved models of energy management is vital, because it generates continuous improvement, optimizes energy efficient and strengthens the culture of preservation. Incorporating Energy Efficiency aims to optimize the consumption and use of energy required, and the overall energy performance of the project or process operation stage through implementation and application of best practices and technologies for the efficient use of energy. The article illustrates an example of improving efficiency with the integration of new refrigeration equipment in energy management for Energy Cost Reduction made on EATON facilities at Arecibo, Puerto Rico.*

Key Terms — *Chiller Water Design, Efficiency Energy Use, Energy Cost Reduction, HVAC Efficiency*

INTRODUCTION

This article aims to show the way for optimal energy management in the cooling area on Eaton Facilities at Arecibo PR. The process of improving energy efficiency gravitates on a structured continuous improvement process that is supported by management based on data collected and monitoring consumption. Fortunately, energy flows are measurable, therefore, proper management can only be done through data and analysis tools that transform them into information to make operational decisions and change strategies aimed all of them to reduce consumption and energetic cost.

Statement of Problem

Energy consumption has increased to a level that represents a major area of opportunity for energy savings. Over the past 30 years have been developed cooling systems whose efficiency has increased by almost 50%. The importance acquired energy savings in companies, mainly due to higher energy prices and increased consumption has driven employers to train their technical staff to understand a little more the operation of new air conditioning systems and seek options to increase their efficiency and consequently profitability ways.

Project Description

The focus of this project is to replace damaged and unused air conditioning equipment with new chilled water Air Handling Unit at Eaton Arecibo. The Assembly area is over 52,000 square feet and is currently cooled with air cooled conventional split type air conditioning units. Chilled water can be transferred over long distances more efficiently than Freon. A new water cooled chiller will greatly increase capacity and efficiency and 2 more AHU's will be installed to significantly reduce energy consumption

Objectives

The principal objective of this project is to achieve Energy Costs Reduction by 20% percent compared to last year Consumption.

LITERATURE REVIEW

This project is based on energy savings by improving cooling equipment. It is extremely important to make comparisons of all existing equipment on the market to design efficiently. The current design is based on a design that uses an air-cooled chiller. The implement design for this project is using a water-cooled chiller.

The water-cooled chillers are typically more energy efficient than air-cooled chillers. The condensation temperature in a water-cooled chiller temperature dependent water condenser, which is dependent on temperature and humidity [1]. Water

Cooled Chillers usually last longer than air-cooled chillers. This difference is because the air-cooled chiller is installed outdoors, while the water-cooled chiller is installed inside. Furthermore, the use of water as condensation fluid allows the water-cooled chiller allowed to function lower than the pressure air chiller. In general, air-cooled chillers last 15 to 20 years, while the last water-cooled chillers from 20 to 30 years [2].

Another advantage of the cooled water chillers includes improved energy efficiency and longer equipment life. The efficiency of a chiller is typically defined in terms of its performance coefficient CO, which is simply the ratio BTU output divided by consumption BTU [3]. For example, if the rated power of a Chiller is 1 ton of cooling capacity, equivalent to 12,000 BTU / hr, and the input power it is equivalent to 1 kW, or 3413 Btu / hr, the resulting CP is 12,000 / 3,413 or 3.52. Usually these chillers have a peak load power requirement 0.5-0.7kW / ton, resulting in a COP of 7.0 to 5.0 water chiller. Power consumption in a chiller decreases as the cooling load is reduced tax. These water-cooled chillers operate efficiently between about 30 and 90% loading and more efficiently between 40 and 80% loading manner. In this way, we are designing for our system to work on these parameters [4].

METHODOLOGY

The methodology used for the development of this project is clearly explained in Figure 1. The first phase an analysis of the current system is based to identify areas for improvement. Then the new design based on the expected savings is established and implemented. Finally, start-up the implemented design and results are analyzed.

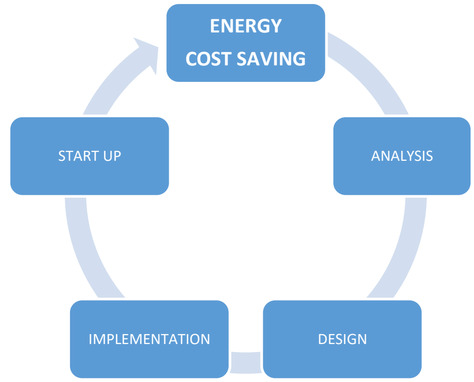

Figure 1
Methodology

Appropriation Request

The purpose of this appropriation is to obtain capital to replace damaged and unused air conditioning equipment with new chilled water Air Handling Units (AHU's).

Implementation

The most important part of this project will be the development and management of design as this depends on the expected savings is reached. To achieve this expert engineers were hired from company Carrier of Puerto Rico. The design integrates a new 300 Ton Chiller, 275 Ton Cooling Tower, 4 X 30 Tons Chilled Water AHU.

Project Timing

The Schedule for this project is defined by Table 1. The management period for this project extends from August to October 2016.

Table 1
Project Timing

Schedule		
Appropriation Approval	August	2016
Proposed Design	September	2016
Project Implementation	September	2016
Project Completion	October	2016

Analysis Approach

Current Design

The current design is based on a system using air cooled chiller. There are two 100 Ton manufactured by TRANE. Figure 2 shows the actual chillers existing at Eaton Arecibo, PR. The current design also included eight 30 Ton Air Handle Units manufactured by York. Figure 3 shows the actual air handle units existing at Eaton Arecibo, PR.

Figure 2
Actual Chillers

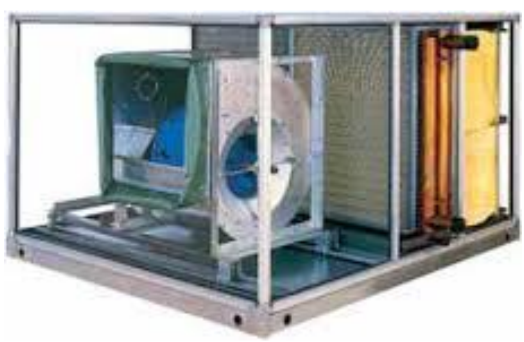

Figure 3
Actual Air Handles Units

Figure 4 presents Air Temperatures Supply over a period of 5 days of normal operation. Figure 5 shows the Return Air temperatures over a period of 5 days of normal operation. Figure 6 shows the Zone Temperatures recorded over a period of 5 days. Figure 7 shows the Operating Status (on/off) monitored for a period of 5 days. For this chart were considered the days 12,13,14,15 and 16 of September in one of the actual air-handling units as part of data collection. This is one of the air-cooled AHU that will be replace by water-cooled. It is very important to know this information because it can be clearly seen as it is difficult for this actual system to maintain the desired temperature of 74 degrees during the periods from 11:00 am to 6:00 pm.

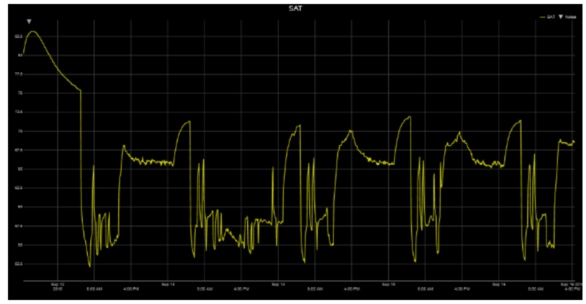

Figure 4
Air Temperatures Supply

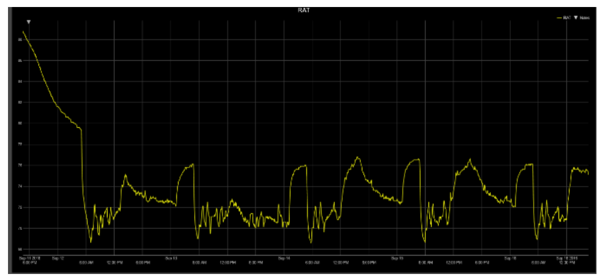

Figure 5
Return Air Temperatures

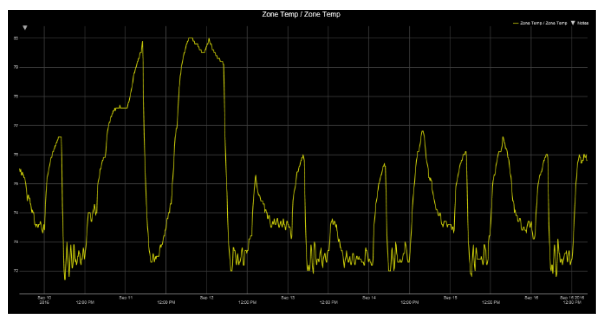

Figure 6
Zone Temperatures

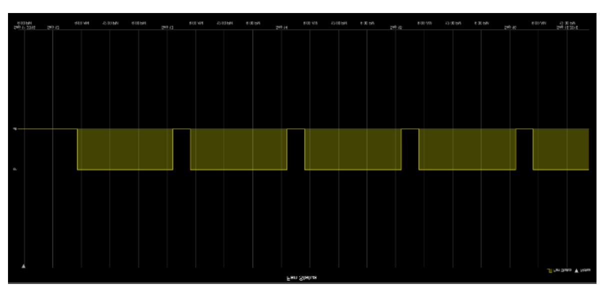

Figure 7
Operating Status (on/off)

New Design

A new water cooled chiller will greatly increase capacity and efficiency and 4 more AHU's will be installed to significantly reduce energy consumption. Figure 8 shows the specifications of this new water-cooled chiller. Figure 9 shows the New Carrier Water-Chiller already installed.

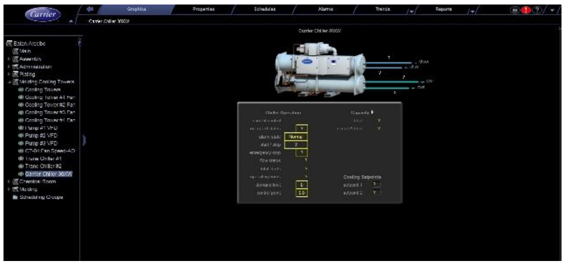

Figure 8
Water-Cooled Chiller Integration

Figure 9
Water-Cooled Chiller Installed

For this new design, Cooling Towers were integrated as part of the necessary cycle for a chilled Water, (see Figure 10). Four Air Handles Units were installed to complete the improvement of equipment integration, (see Figure 11).

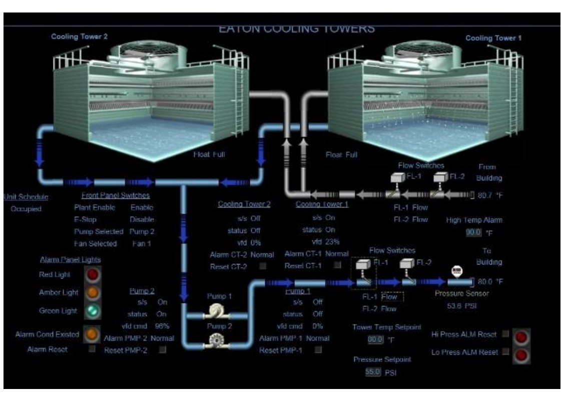

Figure 10
Cooling Tower Integration

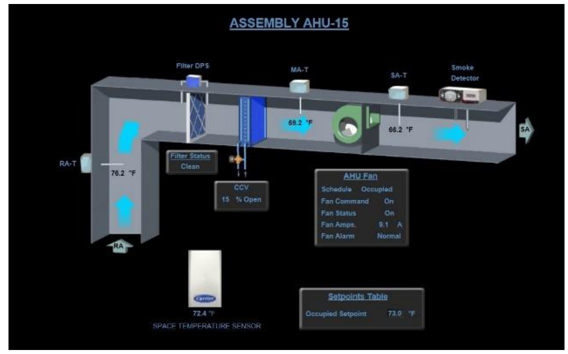

Figure 11
Air Handle Unit Integration

Project Cost

The investment for this project includes the purchase of a water-cooled chiller 300 Ton, a cooling tower 275 Ton capacity and four air handlers cooled water for a total of $ 200,000 as stipulated in Table 2.

Table 2
Project Investment

Assets to be acquired	Cost ($K)
300 Ton Chiller – Water Cooled	80
275 ton CT	35
(4) x 30 Ton Chilled Water AHU	30
Installation	55
Total	200

RESULTS

The efficiency of the chillers verses the older HVAC units is > 25% more efficient and will reduce energy consumption at least 765,818 kWh each year. These are very conservative calculations and are based on industry standards for comparison of Energy Efficiency Ratings (EER). 765,818.18kWh x $0.24 (AEE charge/kWh) = $183,796 per year in energy savings. Also, the results as to the temperatures obtained with this new design were as expected. See Figure 12. Now with the integration of these new air handlers are meeting the set point temperatures. That mean not only saved energy also obtaining a more stable temperature zone.

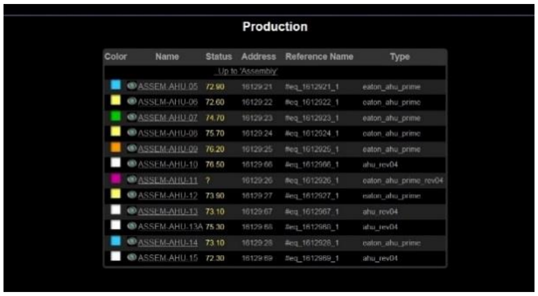

Figure 12
Zones Temperatures

CONCLUSION

No negative marketing effects are expected of this project. The volumes of the operation are forecasted to increase for the future. One way to achieve this is to increase the Overall Equipment Effectiveness and increase the productivity of each operation using better equipment and method. A centralized chilled water system is the preferred method of cooling large industrial spaces and continues to be revered as a best practice and highest industry standard. The application of continuous improvement tools allowed an optimization of the electrical energy consumption per ton and achieving energy savings proposed.

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