Chilled Water Plant Energy Upgrade

Cristian I. Cabrera Rivera, BSME
Engineering Management Program
Dr. Héctor J. Cruzado
Graduate School
Polytechnic University of Puerto Rico

Abstract *— This project was undertaken to increase the efficiency of the cooling equipment at the Nakamura Courthouse in Seattle, WA which is a building that is managed by the General Services Administration (GSA), the government agency that oversees the administration of several federal buildings in the United States. The building manager and GSA engineers had complaints that their two 200-tons chillers were consuming too much energy and that there should be a way to upgrade these chillers for a more efficient system that saves energy and still satisfy the load of cooling needed in the building. A work plan was developed to remove the old chiller and install a new pony chiller with all its components such as fittings, valves, sensors, and pumps. Also, a new program was developed and implemented in the current server and the controller for the chilled water plant was replaced for the one with the new program which works more efficiently to save energy at low loads. It was proven that the energy efficiency was increased by a 35%*

Key Terms *– Chilled water system, Design, Efficiency, Programming, Project Management*

INTRODUCTION

Multi Air Services Engineers Corp (MASE) is a company with a construction division that covers electrical, mechanical, and building automation system projects in Puerto Rico and United States. MASE was awarded a project by the General Services Administration (GSA), which is the federal agency that oversees Federal buildings in all the states. In this case the project was in a US Federal Courthouse called William Kenzo Nakamura US Courthouse in Seattle, WA. The building manager and GSA engineers had complaints that their two 200-tons chillers were consuming too much energy and that there should be a way to upgrade these chillers for a more efficient system that saves energy and still satisfy the load of cooling needed in the building.

The scope of this project was to upgrade the chilled water plant facilities to reduce the energy costs by replacing one of the chillers and other mechanical components in the plant which is in the basement of the building. This paper summarizes the technical aspects of this project.

POST NOTICE TO PROCEED

The first phase of the project was the planning phase. This phase starts right after getting the award and notice to proceed. Before getting the award, contractor had to prepare a Schedule of Values using MS Excel as the software tool to make a proposal to GSA with the total price and a breakdown of the items required in this project. To be able to provide that Schedule of Values, the project manager had to request quotes to the suppliers for the equipment specified for this project, at least three different suppliers were used to compare prices and the contractor chose the lowest bidder to use its prices in the proposal. In addition to the Schedule of Values, the contractor had to create a Project Schedule using Microsoft Project as the software tool. This Schedule had to comply with the specific time frame given by GSA and the project manager performed an analysis of the man hours needed to get the work done in the time frame requested.

The contractor had the alternative to use its resources to conduct the designing phase of the project and provide the scope of work or subcontract an architecture & engineering firm to do the design of the project following the standards and requirements set by the contractor and the client. In this case the contractor chose to hire a design firm to save time and focus on the

management, organization, and on-site items of the project. The project manager in charge had to use the approved project schedule to comply with the dates established. After having 100% of the design, it was submitted to the client for approval. Once approved, the project manager prepared and sent several submittals for the client's approval prior to placing the orders for the materials and equipment that was going to be used in the project.

At the same time, the Project Manager worked on a Submittal Log that included the following construction documents: Safety Plan, Fire Prevention Plan, Execution Plan, Lift Plan, Testing Adjusting and Balancing Plan, etc.

The Project Manager took some time to hire the necessary personnel and requested quotes from subcontractors to perform the labor.

After completing the planning process, the client gave the notice to proceed with the on-site work. That's when the Pre-Testing, Adjusting and Balancing phase started, this had to be done to have a record and evidence on how the current system is operating. Tested every mechanical component of the chilled water plant and prepared reports with the obtained data. After that, as shown in Figure 1, the contractor went to the chilled water plant to properly recover the refrigerant from the chiller that was going to be removed.

Figure 1
Refrigerant Recovery

On the second day of onsite work, the laborers went to the facility to work on the existing chiller to be removed; drained, disconnected from the chilled and condensed water pipes, removed from the concrete pad, and positioned the Chiller 2 (CH-2) that is going to be replaced for the new pony chiller. Figure 2 shows when the old chiller was removed from the concrete pad and the pipes and fittings were disassembled from the chiller that was going to be removed.

Figure 2
Second day onsite work

The old chiller was too big to remove from the basement using the existing double door, therefore, the contractor had to hire a local subcontractor to remove the doorframe and demolish part of the wall to be able to fit the old chiller through that door and remove it with a crane and insert the new chiller after that. The contractor managed to remove the double door and demolish the frame. MASE personnel removed Chiller 2 (CH-2) from the building with the help of Western Crane and brought the new 135ton Pony Chiller to start with the mechanical installation. P&L Contractors then proceeded to reinstall the double door and frame and made sure that the building was secured. This had to be coordinated to make it happen in a single workday, since the courthouse is a federal building, and it was not an option to leave it exposed to the

public. Everything went through as planned. The Figure 3 below shows how the old chiller was being removed from the basement using the crane and the laborers helping by pushing the chiller through the double door. The crane operator is constantly communicating with the personnel that is in the basement giving direction to help remove the old chiller. Figure 4 shows how the old chiller is finally removed from the basement to the street where there's a crane waiting to receive the old chiller to properly dispose it.

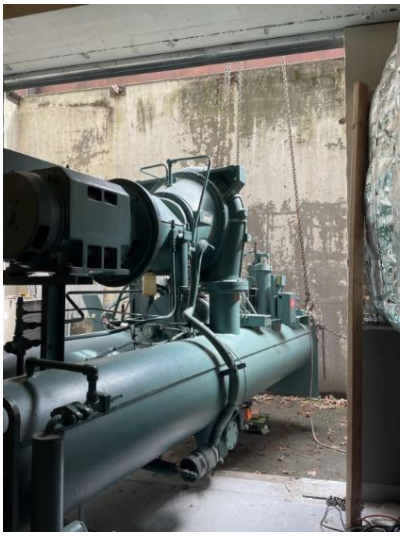

Figure 3
Removal of the old chiller from the basement

Figure 4
Removal of the old chiller from the basement II

Figure 5 shows how the new chiller is lowered by the crane operator to the basement where the mechanical contractor laborer received the new chiller to install it in the concrete pad where the old chiller was previously installed.

Figure 5
Getting the new chiller into the basement

As shown in Figure 6, P & L Contractors finished the reconstruction of the door frame area and painted matching the existing conditions and MASE resumed their mechanical work, the installation of the new Pony Chiller CH-2.

Figure 6
Reconstruction of the demolished frame and wall

From that point on, the following workdays were all about the mechanical installation of the components related to the new chiller. After the new chiller was completely installed, the electrician came in to place to set up the electrical components needed to start up the new chiller, including the new Variable Frequency Drive for the Primary Chilled Water Pump number two which was going to serve the new chiller. Also, the electrician was in charge of installing the new communication cable for the new Chilled Water Plant controller. Figure 7 shows the electrician installing the new communication cable from the panel where the controllers are installed through the electrical conduits to the new variable frequency drive that operates the new primary chilled water pump and new Chiller-2.

Figure 7
New Communication Cable Installation

After finishing all the electrical and mechanical installation the contractor sent its insulator to give the specified finishes to the new pipes and fittings. Figure 8 shows how the new chiller looks installed with its new pipes, fittings, and insulation.

After completing the mechanical and electrical installation and miscellaneous such as insulation, MASE worked on the integration of the new sequence of operations program that would save energy. There were modifications to the building automation system such as new expansion board for existing field controller, installation of three BACnet MSTP Danfoss VFDs (Two for condenser pumps One for new PCHWP), installation of four new valves actuators and the installation of three new flow meters monitoring.

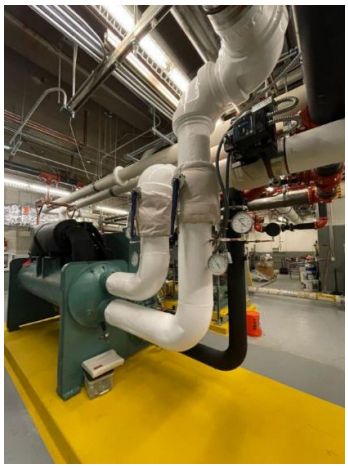

Figure 8
New Chiller installed and insulated

As shown in Figure 9, new graphics were provided as well as part of the programming design phase. And a training was given to the building operations and maintenance engineers to help them familiarize with the new sequence and commands shown in these new graphics.

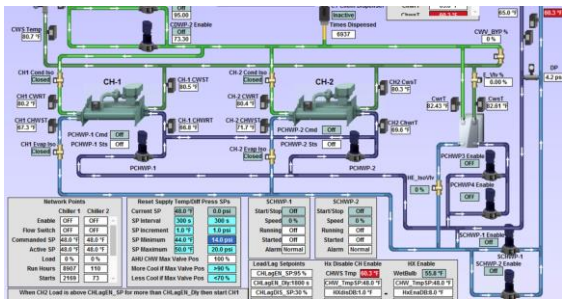

Figure 9
New Graphics

With this work it was achieved the mechanical design integration of existing heat exchanger as a parallel equipment to be the first stage of cooling when outside air conditions allow it. It was also achieved to set the new pony chiller of 130 Tons to be the second stage of cooling when building requires cooling and Heat Exchanger operation is not possible. And having the existing 200 Tons

chiller (CH-1) to be the third stage of cooling when pony chiller cannot satisfy the load.

CONCLUSION

After finishing the mechanical installation and integrating the new program and sequence of operations, the contractor asked the client for the next months energy bills to compare to the energy bill from the months prior the beginning of the project and see how the new chiller and implementations in the chilled water plants such as new sequence of operations help save energy. After comparing them, it was proven that the upgraded chilled water system reduced the costs of energy at low loads down to 35%.