ENERGY CONSERVATION ON A CENTRAL CHILLER PLANT

Master of Science Thesis

SANJAYA RAMANAYAKE

Department Of Electrical Engineering
University of Moratuwa, Sri Lanka

December 2007

ENERGY CONSERVATION ON A CENTRAL CHILLER PLANT

This thesis was submitted to the
Department of Electrical Engineering of the University of Moratuwa
in partial fulfillment of the requirement for the Degree of
Master of Science in Industrial Automation.

by

VIRAJ SANJAYA RAMANAYAKE

Supervised by:

Dr. Lanka Udawatta

&

Mr. Sanjeewa Witharana

Department Of Electrical Engineering
University of Moratuwa, Sri Lanka

December 2007

DECLARATION

The work submitted in this thesis is the result of my own investigations, except where it is otherwise stated.

It has not already been accepted for any degree, and also is not being concurrently submitted for any other degree.

UOM Verified Signature

Sanjaya Ramanayake Date: 19,
(Candidate)

We endorse the declaration by the candidate

.....

Dr. Lanka Udawatta Date:
(Supervisor)

.....

Mr. Sanjeewa Witharana Date:
(Co-Supervisor)

Dedicated to my loving kids

Sahasya, Aindi & Virane

CONTENTS

ABSTRACT

Air-conditioning is no more treated as a luxury but a day to day requirement essential for the human comfort and productivity. When compared among different sub systems of a building, air-conditioning subsystem is responsible for the largest proportion of the energy consumption especially in a tropical climate like Sri Lanka. Central air-conditioning that comprise of a chiller plant is the most common means of air-conditioning in large commercial buildings. Hence successful energy optimizations that are implemented on a central chiller plant will definitely result with large financial savings.

Even though it is a known fact that all individual components that comprise a central chiller plant are now optimized in terms of energy efficiency, the overall behavior of the entire system once these pieces are put together is something that has to be separately worked out. This research proposes and implements energy optimizations on top of a central chiller plant. It evaluates the amount of saving from each optimization and presents a practical model to follow in a similar plant.

Energy optimizations proposed in this research were implemented in conjunction with the capabilities of the central chiller plant control system that is already available at the site for the purpose of real time monitoring and controlling of the central chiller plant. Results of energy saved was quantified using the run hour reading gathered prior and after the implementation of the optimizations. A saving of 15.8% from COW pumps, 23.8% from CHW pumps and 32.8% from CTs were achieved as a result of those optimizations.

Outcomes of this research can be made use by different parties including investors and decision makers of buildings to promote similar energy saving projects in their organizations.

ACKNOWLEDGEMENT

My sincere gratitude goes to Dr. Lanka Udawatte the internal supervisor of this research, for his guidance and support despite his busy schedules, which helped me carry out research activities effectively. It must be noted with thanks that he was always available for me to guide when ever it was necessary.

My thanks also go to the co-supervisor Mr. Sanjeeva Vitharana of Mechanical Engineering Department of University of Moratuwa for his kind assistance in various aspects to locate required resources and information.

Special thanks to the management and the engineering staff of Cinnamon Grand Hotel, especially to Mr. Panduka Wijewardena the chief engineer of the hotel for providing me the opportunity to implement and test various energy optimizing options on their live site, and bearing with me the unexpected outcomes that were experienced during early R&D stage of the research.

My heartiest thank goes to my wife Ruvini for her genuine encouragement and loving care and my three little kids for their sacrifices by allowing me find time to involve in my research work.

Last but not least, I sincerely thank my loving parents for bringing me up in a culture that helped me appreciate higher education.

Sanjaya Ramanayake

TERMS AND ABBREVIATIONS

AHU	– Air Handling Unit
AI	- Analog Input
AO	- Analog Output
ARI	- Air-conditioning and Refrigeration Institute
ASHRAE	- American Society of Heating Refrigeration & Air-conditioning Engineers
CHW	- Chilled Water
CMS	- Chiller Management System
COW	- Condenser Water
CT	- Cooling Tower
CTI	- Cooling Tower Institute
DI	- Digital Input
DO	- Digital Output
ELF	- Electrical Load Factor
FCU	- Fan Coil Unit
HVAC	- Heating Ventilation and Air-conditioning
M&V	- Monitor and Verification
NPLV	- Non Standard Part Load Value
PLR	- Part Load Ratio
RH	- Relative Humidity
SCADA	- Supervisory Control and Data Acquisition
VFD	- Variable Frequency Drive
VSD	- Variable Speed Drive

LIST OF FIGURES AND TABLES

LIST OF FIGURES:

LIST OF TABLES: