

## SIMULATION-BASED AUTOMATED COMMISSIONING METHOD FOR AIR-CONDITIONING SYSTEMS AND ITS APPLICATION CASE STUDY

Fulin Wang<sup>1\*</sup>, Harunori Yoishida<sup>1</sup>, Satoshi Masuhara<sup>1</sup>, Hiroaki Kitagawa<sup>1</sup>, and Kyoko Goto<sup>2</sup>

<sup>1</sup>Department of Urban and Environmental Engineering, Kyoto University, Kyoto, Japan

\*fuwang@archi.kyoto-u.ac.jp, +81-75-753-5732

<sup>2</sup>YANMAR CO., LTD., Shiga-ken, Japan

### ABSTRACT

This paper proposes an automated commissioning method for air-conditioning systems through comparing the measured energy consumption with the simulated energy consumption, which is simulated using a model newly developed through fitting manufacturer's specification data. This commissioning method is verified using a Gas-engine Heat Pump (GHP) air-conditioning system. The results show that this method can verify whether a real air-conditioning system is performing in conformity with the design intent or not. Finally a commissioning case is studied using the commissioning method proposed here.

### INTRODUCTION

Since the Energy Crisis caused by the Middle East War in 1973 to 1974, the urgent need for oil security management and energy policy co-operation led to the establishment of International Energy Agency (IEA) and comprehensive study on energy efficiency (Scott, 1994). In the field of building energy conservation, many Energy Conservation Measures (ECM) were developed and used in the buildings participating in the energy conservation program. However some analyses on the data from these buildings revealed that many of the installed energy efficiency measures were not performing as expected (Bonneville Power Administration, 1992). Therefore the idea that commissioning is a viable method to help ensure good performance of buildings and their ECMs was gradually conceived since 1989.

Building commissioning is the process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained to perform in conformity with the design intent (ASHRAE, 1996).

However building commissioning is a time and cost-consuming work because there are too many types of equipment and component in an air-conditioning system should be verified. Furthermore, the verification check and functional performance test should be conducted under a wide range of load conditions. Therefore to reduce commissioning cost and time is an urgent problem to solve. Automating

commissioning progress is a viable way to reduce commissioning cost and time. Simulation is considered to be a powerful tool to automate commissioning progress because it can give the performance of a building and its systems matching the design intent (Wang and Yoshida, 2003). The simulation-based commissioning for many types of components or subsystems in a Heating, Ventilation and Air-conditioning (HVAC) system has been studied. For example, Wang et al. (2003) proposed a model-based commissioning method for fan subsystems. Miyata et al. (2004) studied how to commission Variable Air Volume (VAV) unit using statistical method and dynamic system analysis. The research of using simulation in commissioning process can also be found about Air Handling Units (Erikson, 2003), chilling plant (Georges and Lebrun, 2004), coil energy recovery Loop systems (Erikson, 2004), duct system (Odajima et al., 2004), and filter in room air-conditioners (Wang et al., 2004). However the simulation-based commissioning for multi-condenser/evaporator air-conditioning system has not yet been studied. This paper focuses on developing an automated commissioning method for multi-condenser/evaporator air-conditioning systems through comparing the measured energy consumption with the simulated energy consumption.

The key components of an automated commissioning tool should include a set of models suitable for commissioning, a set of test sequences, and software to implement the test sequences and to analyze data to give commissioning recommendation (Annex 40, 2004). This paper firstly describes the energy consumption estimation model newly developed through fitting manufacturer's specification data. Based on this model, the performance in conformity with design intent can be simulated and used to check whether the real performance matches design intent or not. Finally using this simulation-based commissioning method, a case study is introduced, which is the commissioning for a multi- evaporator/condenser Gas-engine Heat Pump (GHP) air-conditioning system.