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VALIDATION AND REFINEMENT OF A DYNAMIC DIGITAL
MODEL OF A FAN COIL HEATING SYSTEM

by

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A THESIS

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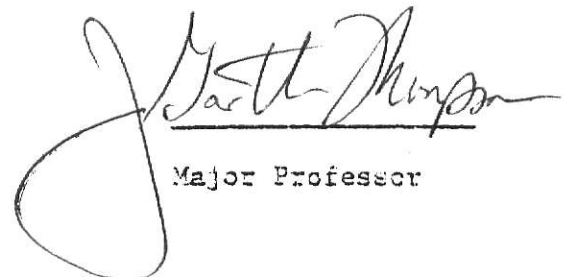
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NOMENCLATURE

A2, B2, C2	Weighting factors to compute return air temperature
A7, B7	Weighting factors to compute effective thermostat temperature
A9, B9	Characteristic parameters of valve
CA	Specific heat of air (Btu/lbm °F)
CW	Specific heat of water (BTU/lbm °F)
CF	Specific heat of furniture (Btu/lbm °F)
D	Transit delay of room (hr)
E	Effectiveness of heat exchanger
FLO	Water flow rate (GPM)
HYS	Valve travel correction due to hysteresis
K7	Thermostat gain
K, c	Parameters to relate T _{EFF} and P7
\dot{M}_w	Mass flow rate of water through the coil (lbm/hr)
\dot{M}_{max}	Maximum mass flow rate of water through the coil (lbm/hr)
P_a	Air density (lbm/ft ³)
P7	Output pressure of thermostat (psi)
P8	Input pressure to valve actuator (psi)
T1, TS	Supply air temperature (°F)
T2, TRM	Average room air temperature (°F)
T3, TR, TRET	Return air temperature (°F)
T4	Temperature of the air entering the fan (°F)
T5	Temperature of the air entering the coil (°F)
T6	Temperature of the air leaving the coil (°F)

TO, TOUT	Annular space temperatures ($^{\circ}\text{F}$)
TW, TWAL	Wall temperatures ($^{\circ}\text{F}$)
TEFF	Temperature sensed by the thermostat ($^{\circ}\text{F}$)
T71	Thermostat time constant (effected by room air) (hr)
T72	Thermostat time constant (effected by wall) (hr)
THWTR	Hot water temperature ($^{\circ}\text{F}$)
Tai	Temperature of the air entering the duct ($^{\circ}\text{F}$)
Tao	Temperature of the air leaving the duct ($^{\circ}\text{F}$)
T_{iw}	Temperature of the water entering the coil ($^{\circ}\text{F}$)
T_{ow}	Temperature of the water leaving the coil ($^{\circ}\text{F}$)
U	Slope of the Valve actuator characteristic
UAD	Overall heat transfer coefficient of supply duct ($\text{Btu}/^{\circ}\text{F}\cdot\text{hr}$)
V_a	Volume of room (ft^3)
wm	Energy input to the motor (BTU/hr)
X, Y, Z	Weighting factors
a	'y'-intercept of valve actuator characteristic
b, c, d, e	Parameters of valve characteristics
C_o, C_l	Coefficients of coil
h_m	Mechanical efficiency of fan
h_s	Static efficiency of fan
h_t	Overall efficiency of fan
s	Laplace variable
t, T	Time (hr)
δ	Ratio of mass flow rate of return air to ventilation air
ϕ	Ratio of pressure drop in return air duct to pressure drop in the system

DEDICATED TO MY PARENTS

CHAPTER 1INTRODUCTION

This thesis presents results of a part of the project to determine the influence of room equipment and control system dynamics on energy consumption in HVAC systems. This study will help to implement optimal control strategies to save energy. To conduct such a study, it is required to have validated dynamic simulation of room, equipment and control system. Model formulation, digital simulation and experimental validation of the transient thermal response of the room with fan coil heating system has been reported in this thesis.