



AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
MECHANICAL POWER ENGINEERING DEPARTMENT

**THE ANALYSIS OF THE NON-RESIDENTIAL
INSTANTANEOUS COOLING LOAD COMPONENTS AND
ITS PARAMETERS FOR CONTINUOUS SUMMER AIR-
CONDITIONING ON A HEAT BALANCE BASIS USING
FINITE-DIFFERENCES**

A Thesis Submitted in Partial Fulfillment of the Requirements for the
Degree of Master of Science in Mechanical Engineering

by

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STATEMENT

This thesis is submitted to the Faculty of Engineering, Ain Shams University, in partial fulfillment of the requirements for the degree of Master of Science in Mechanical Engineering, Power Section.

The work included in this thesis was carried out by the author in the Mechanical Power Engineering Department, Faculty of Engineering, Ain Shams University.

The author carried out the work included in this thesis, and no part of this thesis has been submitted for a degree or a qualification at any other university or institution.

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ABSTRACT

Prediction of building cooling loads is one of the key factors in building design where the selection of an appropriate air-conditioning system necessitates accurate information associated with the cooling load. Cooling load calculations can significantly affect the first cost of building construction, and the comfort and productivity of building occupants, as well as the building operating cost and energy consumption.

Actually, accurate estimation of building cooling loads requires the application of the heat balance method (HDM). This method is the most scientifically rigorous method that comprises the implementation of a full heat balance, i.e. the application of the first law of thermodynamics, to the external and the internal fabrics of the conditioned zone, together with its outside and inside boundary conditions, and solving the transient heat conduction equations for all of the structural components enveloping the zone.

This thesis utilizes a one-dimensional transient heat conduction numerical model to calculate zone cooling loads on a heat-balance basis. The Barakat and Clark alternating direction explicit (ADE) unconditionally-stable finite difference scheme is applied to solve the fundamental transient heat conduction equations for all of the structural components enveloping the zone with suitable initial and steady-periodic boundary conditions. The ASHRAE Clear-Sky Solar Model is used with its revised solar data in 2005 to calculate the total incident solar radiation. The differences between the revised and the old solar data of this solar model and their effects on the cooling load results are explained.

Cooling loads for different zone classes are calculated and the contributions of different heat gain components to the cooling loads are investigated. Some of the cooling load results are compared with the ASHRAE cooling load data and pronounced differences have been obtained from this comparison.

The effects of corners, as well as the effects of the external and the internal thermal conditions, on the cooling loads are also investigated. Moreover, the current model is also used to generate updated and revised cooling load tables to serve as a single-step cooling load calculation method on a heat balance basis .

The validation process of the applied numerical model is incorporated in this thesis with the choice of the suitable spatial and time increments that give results with acceptable degree of accuracy. The verification of the constructed computer code is also included.

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TABLE OF CONTENTS

Abstract	v
Acknowledgements	vii
Table of Contents	ix
List of Figures	xiii
List of Tables	xxvii
Nomenclature	xxxiii
Chapter 1: Introduction	1
1.1 General Background	1
1.1.1 Classification of Heat Gains	2
1.1.2 Classification of Cooling Loads	2
1.1.3 Thermal Storage Effect	3
1.2 Motivation	4
1.3 Objectives of the Present Work	6
1.4 Thesis Outline	7
Chapter 2: Brief Review of the Common Cooling Load Calculation	
Methods for Non-Residential Buildings	9
2.1 North American (ASHRAE) Methods	10
2.1.1 TETD/TA Method	11
2.1.2 TFM Method	12
2.1.3 CLTD/SCL/CLF Method	13
2.1.4 ASHRAE HBM Method	15
2.1.5 RTS Method	17
2.2 U.K.'s Admittance Method	19
Chapter 3: Heat Analysis for the Opaque Fabrics Enveloping	
the Zone	21

3.1	Modeling the Transient Heat Conduction Process within the Zone Fabrics	22
3.1.1	The Barakat and Clark Finite Difference Scheme	24
3.2	Modeling the Internal Longwave Radiation Exchange	26
3.3	Distribution of the Transmitted Solar Radiation	28
3.4	Distribution of the Internal Heat Gains	30
3.5	Furniture Representation Model	30
3.6	Surface Heat Balance for Sunlit Walls and Roofs	32
3.6.1	External-Surface Heat Balance for a Sunlit Exterior Wall or Roof	33
3.6.1.1	Outdoor-Air Temperature Model	37
3.6.1.2	Solar Radiation Model	37
3.6.2	Internal-Surface Heat Balance for a Sunlit Exterior Wall or Roof	43
3.7	Heat Balance for the Other Interior Surfaces	46
Chapter 4:	Heat Analysis for Glazed Windows	51
4.1	Determination of the Solar-Optical Properties of a Window System	52
4.1.1	Determination of the Solar-Optical Properties of a Window System without Shading Devices	52
4.1.2	Determination of the Solar-Optical Properties of a Window System with Shading Devices	54
4.1.2.1	Determination of the Solar-Optical Properties of Horizontal Slat-Type Shading Devices	57
4.2	Heat Analysis Models for Multi-Layer Window Systems	58
4.2.1	Heat Analysis between Two Adjacent Glazing Layers in a Window System	60
4.2.2	Heat Analysis at the Outdoor-Side Glazing Surface of a Window System	61
4.2.2.1	Heat Analysis at the Outdoor-Side Glazing Surface of a Window System with an Exterior Shading Device	63
4.2.3	Heat Analysis at the Indoor-Side Glazing Surface of a Window System	66
Chapter 5:	Case Studies & the Corresponding Results and Discussions	69
5.1	Validating the Model Accuracy and Choosing the Spatial and Time Increments	70

5.2	General Assumptions and Zone Characteristics	78
5.3	Cooling Load Calculation Procedure	82
5.4	Code Verification	85
5.5	Comparison with ASHRAE Results	87
5.5.1	Comparing Cooling Loads from Sunlit Walls and Roofs	88
5.5.2	Comparing Cooling Loads from Internal Heat Sources	95
5.5.3	Comparing Cooling Loads from Windows	98
5.6	Further Investigations Included in the Current Work	106
5.6.1	Investigating the Influence of the Furniture Model on Cooling Loads	106
5.6.2	Investigating the Internal Thermal Conditions in the Surrounding Zones	111
5.6.3	Investigating the External Thermal Conditions Under Variable Wind Velocity	120
5.6.4	Investigating the Influence of the Color of the External Sunlit Surfaces on Cooling Loads	143
5.6.4.1	Application of the Superposition Principle to Determine the Color Effect	148
5.6.5	Investigating the Influence of Corners on Cooling Loads	150
5.6.6	Investigating the Influence of the Window Surface Area on Its Cooling Load Components	158
5.7	Revised CLTD Tables for Walls and Roofs	164
5.7.1	CLTD Corrections for Outdoor- and Indoor-Air Temperatures	166
5.7.2	CLTD Corrections for Light-Colored External Sunlit Surfaces	169
5.7.3	CLTD Corrections for Months and Latitudes	172
5.7.4	New CLTD Tables for Corner Walls and Roofs	177
5.8	Revised CLF Tables for Internal Loads	178
5.8.1	Applying the Superposition Principle with the CLF Values of the Internal Loads	189
5.9	Revised Conduction and Solar Cooling Load Tables for Windows	191

Chapter 6: Conclusions	199
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References	201
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