

**Numerical Simulation Of Atrium Fire Using Two
CFD Tools**

by

Choi Hong Fei

Master of Science in Electromechanical Engineering

2007



**Faculty of Science and Technology
University of Macau**

TABLE OF CONTENTS

LIST OF FIGURES.....	v
LIST OF TABLES	vii
LIST OF ABBREVIATIONS.....	viii
ACKNOWLEDGMENTS	ix
CHAPTER 1: Introduction	1
1.1 Background	1
1.2 Fire Modeling	3
1.2.1 Probailistic Models	3
1.2.2 Deterministic Models.....	3
1.3 Research Objectives.....	7
1.4 Thesis Outline.....	8
CHAPTER 2: Literature Review	9
2.1 Field Modeling History.....	9
2.2 Description of STAR-CD and FDS	10
2.3 Model Validation.....	12
2.4 Existing Calculation Methods for Fire Plume in Atrium.....	15
2.4.1 Axisymmetric Plume.....	15
2.4.2 Wall Plume	20
2.4.3 Corner Plume	20
2.4.4 Spill Plume	21
2.4.5 Window Plume	21
2.5 Atrium Somke Control.....	22
2.5.1 Smoke Filling	22
2.5.2 Natural Venting.....	22
2.5.3 Smoke Exhaust	23
CHAPTER 3: Mathematical Model Used in FDS and STAR-CD	24
3.1 Physical Mechanism of Fire.....	24

3.2 Theoretical Basis of FDS	25
3.2.1 Hydrodynamic Model	25
3.2.2 Combustion Model.....	29
3.2.3 Thermal Radiation Model	32
3.2.4 Visibility.....	34
3.3 Theoretical Basis of STAR-CD.....	34
3.3.1 The Fundamental Conservation Equations.....	34
3.3.2 Combustion Model.....	39
3.3.3 Thermal Radiation Model	40
CHAPTER 4: CFD Modeling.....	42
4.1 Scenario.....	42
4.2 Computational Domain and Grid	43
4.3 Fire Source	45
4.4 Boundary Condition.....	48
4.5 Initial Condition.....	48
4.6 Numerical Method	48
CHAPTER 5: Result and discussion.....	52
5.1 Simulation - Case 1	53
5.2 Simulation - Case 2.....	61
5.3 Sensitivity of Turbulence Model.....	68
5.4 Model Run Time.....	70
5.5 Performance Based Design Results	71
CHAPTER 6: Conclusion and Recommendations for Future Work	74
BIBLIOGRAPHY	78