Contents

Acknowledgments . . . . . **xi**
Abbreviations and Acronyms . . . . . **xiii**
Forward: A Message for Building Owners and Developers . . . . . **xv**
Enhanced Shopping Environments and Humidity Control xvi
Lower Life-Cycle Costs xvii
Reduced Operating Costs xvii
Partners in the Community xvii
Closing xviii
References and Resources xviii
Chapter 1 **Introduction** **1**
Goal of this Guide 2
Scope 2
Water as a Resource 3
Reduced Greenhouse Gas Emissions 3
Energy Modeling Analysis 3
Achieving 50% Energy Savings 5
Conditions to Promote the Grocery Store Function 7
Sales Environment 7
Indoor Air Quality (IAQ) 7
Thermal Comfort 8
Visual Comfort 8
Acoustic Comfort 8
How to Use this Guide 8
References 10

© 2015 ASHRAE (www.ashrae.org).
For personal use only. Additional reproduction, distribution, or transmission in either print or digital form is not permitted without ASHRAE's prior written permission.

Chapter 2 **Integrated Design Process** **15**
Principles of Integrated Design 15
Using Integrated Design to Maximize Energy Efficiency 17
Project Kick-Off 17
Programming and Concept Design 18
Schematic Design 19
Design Development 20
Construction Documents 21
Bid Phase 21
Construction Administration 21
Commissioning 22
Start-Up and Operation 22
Prototype Development—Continuous Improvement 23
Integrated Design Process Strategies 24
Charettes and Design Reviews 24
Use of Energy Modeling as Design Guidance 24
Multidisciplinary Coordination for Energy Efficiency 25
References and Resources 31

Chapter 3 **Design Concepts and Practices** **35**
Introduction 35
Building Site and Design Influences 36
Climate Characterizations 36
Climate Dependence 40
Building Orientation 41
Refrigeration and Design Philosophies 43
Impacts of Refrigerant Selection 43
Sizing Concepts 46
Air versus Evaporative Condensing 50
Direct versus Indirect System Design and Efficiency 54
Distributed versus Centralized Rack Designs 57
Electric versus Hot-Gas Defrost 58
Specific Design Philosophies 58
Mass-Flow-Based Design 58
Use of Data from New and Existing Stores 60
Determining Design Evaporator and discharge Air Temperature 60
Control Systems 60
Changing Technologies and Paradigm Shifts 61
Implications for Future Improvements 61
Electronic Expansion Valves and Superheat Optimization 61
Refrigerant Heat Recovery 62

© 2015 ASHRAE (www.ashrae.org).
For personal use only. Additional reproduction, distribution, or transmission in either print or digital form is not permitted without ASHRAE's prior written permission.

Interaction Between Systems 63
Kitchen Equipment and HVAC 63
Refrigeration and HVAC 64
Impact of Doors on Refrigerated Cases 64
References and Resources 66

Chapter 4 **Design Strategies and Recommendations by Climate Zone 67**
Introduction 67
Climate Zone Recommendations 68
Zone 1 70
Zone 2 74
Zone 3 78
Zone 4 82
Zone 5 86
Zone 6 90
Zone 7 94
Zone 8 98
References 102

Chapter 5 **How to Implement Recommendations 103**
Envelope 103
Opaque Envelope Components 103
Vertical Fenestration 114
Window Design Guidelines for Thermal Conditions 117
Window Design Guidelines for Daylighting 119
References 120
Daylighting 121
General Recommendations 121
References and Resources 128
Electric Lighting 129
Goals for Grocery Lighting 129
Interior Lighting 129
Sample Design Layouts for Grocery Stores 138
Exterior Lighting 148
References and Resources 150
Plug Loads 151
Equipment and Control Guidelines 151
References and Resources 156
Kitchen Equipment 158
Equipment and Design Guidelines 158
References 163

© 2015 ASHRAE (www.ashrae.org).
For personal use only. Additional reproduction, distribution, or transmission in either print or digital form is not permitted without ASHRAE's prior written permission.

Refrigeration Equipment . . . 165
Condenser Selection and Condenser Control . . . 165
Compressors . . . 172
Display Cases and Walk-In Boxes . . . 175
Heat Recovery . . . 182
References . . . 185
Service Water Heating . . . 186
Service Water Heating System Types . . . 186
General Recommendations . . . 186
References and Resources . . . 190
HVAC Systems and Equipment . . . 191
General Information . . . 191
HVAC System Types . . . 194
HVAC Equipment Considerations . . . 198
References and Resources . . . 216
Quality Assurance . . . 218
Commissioning . . . 218
Measurement and Verification . . . 221
References and Resources . . . 222
Additional Bonus Savings . . . 223
Envelope Options . . . 223
Refrigeration Options . . . 223
Other HVAC System Types . . . 224
Renewable Energy . . . 225
References . . . 229
Appendix A **Envelope Thermal Performance Factors . . . 231**
Appendix B **International Climatic Zone Definitions . . . 233**

© 2015 ASHRAE (www.ashrae.org).
For personal use only. Additional reproduction, distribution, or transmission in either print or digital form is not permitted without ASHRAE's prior written permission.

Sidebars—Case Studies and Technical Examples

Chapter 1	Refrigeration Baseline Assumptions	4
	Whole Foods Market—A Case Study	11
Chapter 2	Refrigeration Commissioning Guide	22
	Walmart—A Case Study	32
Chapter 3	Daylighting in Grocery Stores	41
	Compressor Systems with Ammonia Refrigerant	45
	Condenser Derating Example	49
	Hybrid Condensers and Precooling	53
	CO_2 Indirect System versus Standard Direct System	55
	Annual Energy Usage Comparison of Cooling System Designs	57
	California Title 24 Heat Recovery Requirements	62
	Display Cases with Glass Doors	65
Chapter 4	Bonus Savings	68
Chapter 5	Tubular Daylighting Devices	122
	ASHRAE/IES Standard 90.1-2013 Sidelighting (Vertical Fenestration) Prescriptive Requirements	127
	Display and Accent Lighting Strategies	132
	LED Lighting Color, Optics, and Characteristics	141
	Grocery Store Plug Load Strategies	154
	Demand-Controlled Kitchen Ventilation System	160
	Condensing Temperature	169
	Airflow versus Fan Power	170
	Display Case and Walk-In Standards	176
	Examples of Walk-In Freezer and Cooler Doors, Hinges, Closers, and Alarms	178

© 2015 ASHRAE (www.ashrae.org).
For personal use only. Additional reproduction, distribution, or transmission in either print or digital form is not permitted without ASHRAE's prior written permission.