CONTENTS

INTRODUCTION  v

PART I The Savings Potential in Common Lighting Systems  1

  Commercial Lighting Systems  2
  Emerging Lighting Technology  5

Chapter 1  LINEAR FLUORESCENT SYSTEMS  7
  High Efficiency Fluorescent Lamps and High Performance Ballasts  8
  Linear Fluorescent Lamp/Ballast Retrofit Options Tables  13
  Lighting Controls for Linear Fluorescent Systems  20
  The Impact of Occupancy Sensors on Fluorescent Lamp Performance  26
  Fluorescent Ballasts with Manual Dimming Controls  30
  Dimming Fluorescent Ballasts with Automatic Control Devices  34
  Improving Existing Fluorescent Luminaire Performance  36
  High Performance Replacement Luminaires  51
  Fluorescent Linear Surface-Mounted and Pendant Luminaires  56

Chapter 2  INCANDESCENT, COMPACT FLUORESCENT, AND SOLID STATE SYSTEMS  65
  Lamp Replacement Retrofit Options  68
  Lighting Controls  81
  Luminaire Specific Retrofit Options  85
  Existing Compact Fluorescent Luminaires  105

Chapter 3  HIGH INTENSITY DISCHARGE SYSTEMS  109
  HID Ballast and Lamp Replacement  111
  HID Reflector Retrofit  116
  Lighting Control Considerations  117
  HID Luminaire Retrofit Options  118
  Luminaire Replacement  126

Chapter 4  SPECIAL APPLICATIONS LIGHTING  131
  Industrial Lighting Systems  132
  Outdoor Lighting Systems  143
  Special Commercial Lighting Applications  161
PART II Lighting Retrofit Process 167

Process in Brief 169

Chapter 5 RETROFIT PROJECT QUALIFICATION 171
The Players: Who Are They, What Are Their Objectives, and How Do They Affect the Process? 171
Project Qualification Phase 177

Chapter 6 DATA COLLECTION AND FIELD AUDIT 181
Plan Review 182
Interviews with the Facilities Manager and Building Operators 188

Chapter 7 LIGHTING ENGINEERING AND EVALUATION 205
Assess Lighting Quantity and Quality 205
Retrofit Approaches—Relamping versus Redesign 214
Document and Evaluate Energy Savings 217
Lighting Retrofit Energy Analysis 222
Lighting Retrofit Report 228

Chapter 8 BIDDING, CONSTRUCTION, AND COMMISSIONING 233
Bid Documents 233
Lighting Retrofit Specification and/or Schedule 234
Drawings 236
Project Bidding and/or Negotiation 237
Construction Phase 239
Lamp and Ballast Disposal 240
Fixture Disposal and Recycling 241
Evaluation and Commissioning 242
Energy Savings Verification 245
Ongoing Maintenance 248

Chapter 9 ECONOMIC EVALUATION 251
Components of the Cost of Lighting 252
Maintenance Costs 255
Property Leases and How They Affect Investment Decisions 258
Lighting Retrofit Economic Evaluation Methods 258
Other Economic Evaluation Issues 263

APPENDIX A Glossary 267
APPENDIX B Resources 277
APPENDIX C Calculating Illumination Levels 279
APPENDIX D Measuring Illumination Levels 287
APPENDIX E Power Quality 291
INDEX 295