

## CONTENTS

			Page
<b>Unit</b>	<b>1</b>	<b>GENERAL INFORMATION FOR ELECTRICAL INSTALLATIONS</b>	<b>1</b>
		The working drawings	1
		Specifications	2
		Symbols and notations	2
		National Electrical Code (NEC)®	3
		Code use of metric (SI) measurements	4
		Underwriters Laboratory, Inc. (UL)	5
<b>Unit</b>	<b>2</b>	<b>ELECTRICAL SYMBOLS AND OUTLETS</b>	<b>8</b>
		Electrical symbols	8
		Fixtures and outlets	10
		Flush switches	10
		Junction boxes and switch (device) boxes (Article 370)	10
		Special-purpose outlets	15
		Number of conductors	16
		Height of receptacle outlets	18
<b>Unit</b>	<b>3</b>	<b>DETERMINING THE NUMBER OF CIRCUITS REQUIRED</b>	<b>25</b>
		Branch circuit	25
		Branch-circuit computations	25
		Voltage	26
		Calculating floor area	26
		Determining the minimum number of lighting circuits	27
		Determining the number of small appliance branch circuits	27
		Receptacle outlet circuit ratings	28
		Replacing existing receptacles	28
		General requirements for receptacle outlets	30
		General requirements for lighting outlets	31
<b>Unit</b>	<b>4</b>	<b>CONDUCTOR SIZES AND TYPES</b>	<b>37</b>
		Conductors	37
		Aluminum conductors	38
		Proper installation procedures	39
		Voltage drop	41
		Nonmetallic-sheathed cable (Article 336)	44
		Use of nonmetallic-sheathed cable (Article 336)	45
		Armored cable (Article 333)	47
		Installing cables through wood and metal framing members (Section 300-4)	49
		Installation of cables through ducts	50
		Connectors for installing nonmetallic-sheathed and armored cable	51
		Electrical metallic tubing (Article 348), intermediate metal conduit (Article 345), and rigid metal conduit (Article 346)	51
		Flexible connections (Articles 350 and 351)	52
		Service grounding conductor	53
<b>Unit</b>	<b>5</b>	<b>SWITCH CONTROL OF LIGHTING CIRCUITS</b>	<b>59</b>
		Conductor identification (Articles 200 and 210)	59
		Toggle switch (Article 380)	60
		Toggle switch types	61

<b>Unit</b>	<b>6</b>	<b>LIGHTING BRANCH CIRCUIT FOR BEDROOM NO.2</b>	<b>68</b>
		Grouping outlets	68
		Estimating loads for outlets	69
		Symbols	70
		Drawing the wiring diagram of a lighting circuit	70
		Branch lighting circuit for bedroom No.2	72
		Determining the wall box size	72
		Ground-fault circuit interrupters (Section 210-8)	75
		Ground-fault circuit interrupter in residence circuits	76
		Fixtures in clothes closets	80
<b>Unit</b>	<b>7</b>	<b>LIGHTING BRANCH CIRCUIT FOR BEDROOM NO.1</b>	<b>86</b>
		Circuit design	86
		Baseboard electric heaters and receptacle outlets	87
		Outlets and wattage for bedroom circuit	87
		Selection of boxes	87
		Estimating cable lengths	88
		Paddle fans	88
<b>Unit</b>	<b>8</b>	<b>LIGHTING BRANCH CIRCUIT FOR BATHROOM AND PASSAGE</b>	<b>93</b>
		Types of lighting fixtures	93
		Bathroom fixtures and outlets	95
		Passage closet fixtures	100
		Lighting branch circuit for bathroom and passage	101
		Equipment grounding requirements for a bathroom circuit	102
<b>Unit</b>	<b>9</b>	<b>LIGHTING BRANCE CIRCUIT FOR THE HALL AND FRONT ENTRANCE</b>	<b>106</b>
		Wiring considerations for the circuit	106
		Outdoor lighting	109
		Pilot light switches in circuit	110
		Wiring with type UF cable (Article 339)	110
		Installation of conduit	
		Switch locations and arrangements for hall, front entrance, and outdoor lighting	
		Determining the circuit load	
<b>Unit</b>	<b>10</b>	<b>LIGHTING BRANCH CIRCUITS FOR KITCHEN AND REAR ENTRY AND SMALL APPLIANCE CIRCUITS FOR KITCHEN</b>	<b>120</b>
		Light circuit A31	121
		Rear entry lighting	121
		Kitchen lighting fixtures	121
		Fan outlet	122
		Small appliance branch circuits for convenience receptacles in kitchen	124
		Circuit arrangement possibilities	126
		Split-circuit receptacles and multiwire circuits	126
		Receptacles and outlets	128
		Load estimate for the lighting branch circuit	128
		Small appliance branch circuit load calculations	129
		General grounding considerations	129
<b>Unit</b>	<b>11</b>	<b>LIGHTING BRANCH CIRCUIT FOR THE LIVING ROOM</b>	<b>134</b>
		Living room convenience receptacles	134
		Multioutlet assemble (Article 353)	136
		Valance lighting	137
		Dimmer controls	138
		Use of dimmer controls with fluorescent fixtures	140
		Current ratings for fluorescent fixture ballasts	141
		Ballast protection	141

		Load estimate for living room circuit	142
<b>Unit</b>	<b>12</b>	<b>LIGHTING BRANCH CIRCUIT FOR THE DINING AREA, PORCH AND CORNICE, GARAGE STORAGE AREA, AND ATTIC</b>	<b>146</b>
		Dining area	146
		Porch area	148
		Rear yard	149
		Garage storage area and attic	149
		Installation of cable in attic area	149
		Wattage estimate for lighting branch circuit A32	151
<b>Unit</b>	<b>13</b>	<b>LIGHTING BRANCH CIRCUIT FOR THE GARAGE</b>	<b>154</b>
		Fixtures	154
		Receptacle outlets	154
		Wiring of circuit	155
		Wattage estimate for lighting branch circuit A30	156
<b>Unit</b>	<b>14</b>	<b>LIGHTING AND RECEPTACLE BRANCH CIRCUITS FOR THE TERRACE, RECREATION ROOM, AND UTILITY ROOM</b>	<b>159</b>
		Terrace and recreation room	159
		Utility room (Laundry room)	161
		What is a basement?	163
		Summary of circuits	164
<b>Unit</b>	<b>15</b>	<b>LIGHTING AND CONVENIENCE RECEPTACLE BRANCH CIRCUITS FOR THE LAVATORY, WORKSHOP, AND STORAGE ROOM</b>	<b>169</b>
		Code requirements for the installation of cable and conduit	169
		Lavatory	170
		Workshop and storage room	170
		Conduit fill calculations	172
		Conduit bodies (Section 370-6 (c))	173
		Derating factors (For more than three wires in conduit or cable)	176
		Correction factors (Due to high temperatures)	176
		Maximum size overcurrent protection	176
		Other code limitations	177
		Examples of derating	177
		Wattage estimate	178
<b>Unit</b>	<b>16</b>	<b>SPECIAL-PURPOSE OUTLETS FOR PORTABLE HEATING UNITS</b>	<b>182</b>
		Grounding-type receptacle for heaters	182
		Wiring circuits for grounding-type receptacles	183
		Bonding at grounding-type receptacles	183
		Grounding provisions on heater units	185
<b>Unit</b>	<b>17</b>	<b>SPECIAL-PURPOSE OUTLETS FOR A WATER PUMP AND A WATER HEATER FOR RESIDENTIAL USE</b>	<b>187</b>
		Water pump circuit	187
		Jet pump operation	187
		Submersible pump	189
		Water heater circuit	190
		Water heater metering	191
		Heating element ratings	192
		Water heater load demand	194
<b>Unit</b>	<b>18</b>	<b>SPECIAL-PURPOSE OUTLETS FOR THE DRYER AND THE OVERHEAD GARAGE DOOR OPENERS</b>	<b>199</b>
		Dryer circuit	199

		Code requirements for connecting a dryer (Article 422)	201
		Grounding frames of ranges and dryers	202
		Alternate method of connecting dryers and ranges: service-entrance cable	202
		Overhead garage door opener circuit	203
<b>Unit</b>	<b>19</b>	<b>SPECIAL-PURPOSE OUTLETS FOR THE REFRIGERATION-FREEZER, COUNTER-MOUNTED COOKING UNIT, AND WALL-MOUNTED OVEN CIRCUITS</b>	<b>208</b>
		Refrigerator-freezer circuit	208
		Counter-mounted cooking unit circuit	209
		Wall-mounted oven circuit	211
		Circuit requirements for group installations	212
		Free-standing range	215
<b>Unit</b>	<b>20</b>	<b>SPECIAL-PURPOSE OUTLETS FOR A FOOD WASTE DISPOSER AND A DISHWASHER</b>	<b>220</b>
		Food waste disposer	220
		Disconnecting means	221
		Dishwasher	222
		Common feed for dishwasher and food waste disposer	223
		Portable dishwashers	223
		Dishwasher ratings	224
		Cord connection of fixed appliances	224
<b>Unit</b>	<b>21</b>	<b>SPECIAL-PURPOSE OUTLETS FOR THE BATHROOM CEILING HEATER AND ATTIC EXHAUST FAN</b>	
		Bathroom ceiling heater circuit	
		Attic exhaust fan circuit	
		Humidity control	
		Appliance disconnecting means	
<b>Unit</b>	<b>22</b>	<b>TELEVISION, TELEPHONE, AND SIGNAL SYSTEMS</b>	<b>232</b>
		Television	232
		Code rules for cable television (CATV) (Article 820)	234
		Satellite antennas	235
		Code rules for the installation of antennas and lead-in wires (Section 810)	236
		Telephone wiring	239
		Telephone conductors	240
		Conduit	242
		Grounding	242
		Safety	243
		Signal system (chimes)	243
<b>Unit</b>	<b>23</b>	<b>ELECTRIC HEATING AND AIR CONDITIONING</b>	<b>250</b>
		Types of electric heating systems	251
		Control of electric heating systems	251
		Circuit requirements for baseboard units	251
		Location of electric baseboard heaters	254
		Wiring for heater circuits	254
		Air-conditioner circuits (wall and window type)	255
		Central heating and air conditioning	257
		Special terminology	258
		Disconnect to be within sight and readily accessible	258
		Noncoincident loads	260
<b>Unit</b>	<b>24</b>	<b>OIL AND GAS HEATING SYSTEMS</b>	<b>265</b>
		Principles of operation	265
		Major components	265
		Self-generating system	270

		Supply-circuit wiring	271
		Control-circuit wiring	271
<b>Unit</b>	<b>25</b>	<b>HEAT AND SMOKE DETECTORS AND SECURITY SYSTEMS</b>	<b>276</b>
		The importance of heat and smoke detectors	276
		National Fire Protection Association (NFPA) Standard No. 74	276
		Types of smoke detectors	277
		Installation requirements	277
		Installation restrictions	278
		Features of smoke and heat detectors	278
		Wiring requirements	279
		Security systems	279
<b>Unit</b>	<b>26</b>	<b>SERVICE ENTRANCES AND EQUIPMENT</b>	<b>283</b>
		Overhead service	283
		Service mast as support	284
		Main service disconnect location	285
		Underground service	286
		Disconnect means (Panel A)	288
		Load center (Panel B)	288
		Meter	289
		Cost of using electrical energy	290
		Grounding — Why ground?	293
		Grounding electrode systems (Article 250, Part H)	296
		Summary — Service-entrance equipment grounding	297
		Bonding	298
		Branch-circuit overcurrent protection	301
		Interrupting ratings for fuses and circuit breakers	310
<b>Unit</b>	<b>27</b>	<b>SERVICE-ENTRANCE CALCULATIONS</b>	<b>310</b>
		Size of service-entrance conductors and service disconnecting means	310
		Method No.1 — Article 220, Parts A and B	310
		Method No. 2 — Article 220, Part C	312
		Reading the meter	313
<b>Unit</b>	<b>28</b>	<b>REMOTE-CONTROL SYSTEMS FOR LIGHTING CIRCUITS</b>	<b>316</b>
		Remote-control switches	316
		Low-voltage relay	317
		Transformers	319
		Conductors	319
		Installation Procedure	320
		Typical wiring installation	320
		National Electrical Code	321
<b>Unit</b>	<b>29</b>	<b>SWIMMING POOLS, SPAS, AND HOT TUBS</b>	<b>326</b>
		Pool wiring (Article 680)	326
		Electrical hazards	326
		Code-defined pools	327
		Grounding and bonding of swimming pools	327
		Grounding (Section 680-24)	328
		Bonding (Section 680-22)	329
		Electric heating of swimming pools (Sections 680-9 and 680-27)	330
		Spas and hot tubs (Article 680, Par D)	331
		Grounding	331
		Bonding	331
		Hydromassage bathtubs	331
		Summary (figure 29-6)	331

<b>SPECIFICATIONS FOR ELECTRICAL WORK—SINGLE-FAMILY DWELLING</b>	<b>335</b>
<b>Appendix</b>	<b>339</b>
<b>Index</b>	<b>341</b>