

# TABLE OF CONTENTS

---

<b>Introduction</b> .....	<b>i</b>		
<b>Section One History and Nature of Fuel Gases</b> .....	<b>1</b>	<b>Section Three Fundamental Control Devices</b> .....	<b>51</b>
<b>Chapter 1 Understanding Natural Gas</b> .....	<b>3</b>	<b>Chapter 7 Manual Gas Valves</b> .....	<b>53</b>
1. Composition.....	<b>3</b>	1. Manual Gas Shutoff Valves .....	<b>53</b>
2. Characteristics of Natural Gas .....	<b>4</b>	2. Manual Gas Control Valve Systems .....	<b>54</b>
3. Recovery and Distribution .....	<b>7</b>	<b>Chapter 8 Millivolt Automatic Gas Control Valves</b> .....	<b>61</b>
<b>Chapter 2 Understanding Propane</b> .....	<b>9</b>	1. Automatic Millivolt Gas Control Valve Components .....	<b>62</b>
1. Composition.....	<b>9</b>	2. Operational Sequence: Millivolt Automatic .....	<b>68</b>
2. Characteristics.....	<b>9</b>	Gas Control Valve	
3. Recovery, Storage, and Distribution .....	<b>11</b>	<b>Chapter 9 Electronic Gas Control Valves</b> .....	<b>73</b>
<b>Chapter 3 Comparing Natural Gas</b> .....	<b>15</b>	1. Electronic Gas Control Valve System Components .....	<b>73</b>
<b>and Propane Gas</b>		2. Electronic Gas Control Valve Operational Sequence .....	<b>80</b>
1. Composition .....	<b>15</b>	3. Summary: Gas Valves .....	<b>84</b>
2. Characteristics .....	<b>15</b>	<b>Chapter 10 Standing Pilot Ignition Systems</b> .....	<b>85</b>
3. Operational Cost .....	<b>17</b>	1. Millivolt Standing Pilot Systems .....	<b>85</b>
<b>Chapter 4 Combustion Principles</b> .....	<b>21</b>	2. Oxygen Depletion Sensor (ODS) Pilot Systems .....	<b>91</b>
<b>of Natural Gas and LP Gases</b>		<b>Chapter 11 Electronic Ignition Systems</b> .....	<b>93</b>
1. Principles of Combustion .....	<b>21</b>	1. Electronic Ignition Systems .....	<b>93</b>
2. Heating Value .....	<b>26</b>	2. Flame Sensing System (Safety Shutoff) .....	<b>97</b>
3. Gas Combustion Hazards.....	<b>27</b>	3. Flame Rectification Problems.....	<b>98</b>
<b>Section Two Gas Hearth Appliances</b> .....	<b>29</b>	<b>Chapter 12 Orifices</b> .....	<b>101</b>
<b>Chapter 5 Gas Hearth Appliance Categories</b> .....	<b>31</b>	1. Gas Flow Rate .....	<b>101</b>
1. Vented Gas Hearth Appliances .....	<b>33</b>	2. Appliance Input Rating.....	<b>101</b>
2. Unvented Gas Hearth Appliances .....	<b>37</b>	3. Orifice Size .....	<b>102</b>
3. Summary.....	<b>40</b>	4. Orifice Spud Categories .....	<b>102</b>
<b>Chapter 6 Gas Hearth Appliance Standards</b> .....	<b>41</b>	5. Orifice Problems .....	<b>104</b>
1. Standards .....	<b>41</b>	6. Servicing Orifices.....	<b>104</b>
2. Vented Gas Hearth Appliance Standards .....	<b>44</b>	7. Fuel Conversion.....	<b>105</b>
3. Process and Scope of Standards .....	<b>48</b>		

<b>Chapter 13 Main Gas Burners</b> .....	<b>107</b>	4. Roof Safety.....	<b>156</b>
1. Combustion Air .....	<b>107</b>	5. Electrical Safety .....	<b>156</b>
2. Air Control and Mixing .....	<b>108</b>	6. Gas Safety.....	<b>156</b>
3. Main Burner Configurations .....	<b>111</b>	<b>Chapter 19 Venting Installation Guidelines</b> .....	<b>157</b>
4. Burner Operation .....	<b>112</b>	1. Preliminary and General Venting Installation Concerns .....	<b>157</b>
<b>Chapter 14 Thermostats, Wall Switches,</b> .....	<b>115</b>	2. Installation Guidelines by Venting Type .....	<b>158</b>
<b>Remote Controls</b>		<b>Chapter 20 Appliance Installation Guidelines</b> .....	<b>173</b>
1. Thermostats .....	<b>115</b>	1. Installation Safety Guidelines .....	<b>173</b>
2. Wall Switches .....	<b>118</b>	2. Gas Piping Installation Guidelines .....	<b>174</b>
3. Remote Controls.....	<b>118</b>	3. Appliance Installation Guidelines .....	<b>180</b>
<b>Chapter 15 Operational Safety Lockout</b> .....	<b>119</b>	<b>Chapter 21 Putting Appliances into Operation</b> .....	<b>185</b>
<b>and Limit Switches</b>		1. Purging Air from Supply Lines .....	<b>185</b>
1. Safety Lockout Switch .....	<b>119</b>	2. Leak Detection.....	<b>186</b>
2. Limit Switch.....	<b>119</b>	3. Set Logs and Embers .....	<b>187</b>
<b>Section Four Venting</b> .....	<b>123</b>	4. Cycle Appliance.....	<b>187</b>
<b>Chapter 16 Principles of Gas Appliance Venting</b> .....	<b>125</b>	5. Perform Spillage Test (Draft Hood Appliances).....	<b>188</b>
1. Combustion Fundamentals Review.....	<b>125</b>	6. Verify Appliance Btu Input.....	<b>189</b>
2. Purposes of Venting Systems .....	<b>126</b>	7. Communicating with the Customer .....	<b>190</b>
3. Principles of Draft and Flow.....	<b>128</b>	<b>Section Six Troubleshooting Installation</b> .....	<b>191</b>
<b>Chapter 17 Venting Classifications</b> .....	<b>133</b>	<b>and Operation Problems</b>	
1. Types of Gas Appliance Venting Systems.....	<b>133</b>	<b>Chapter 22 Principles of Systematic Troubleshooting</b> .....	<b>193</b>
2. Venting System Considerations .....	<b>139</b>	1. Systematic Troubleshooting .....	<b>193</b>
3. Summary .....	<b>147</b>	2. Troubleshooting Guidelines .....	<b>195</b>
<b>Section Five Installation</b> .....	<b>149</b>	<b>Chapter 23 Troubleshooting Millivolt System</b> .....	<b>197</b>
<b>Chapter 18 Installation and Service</b> .....	<b>153</b>	1. Ignition Side: Pilot Problems .....	<b>197</b>
<b>Safety Guidelines</b>		2. Main Burner Side .....	<b>201</b>
1. Personal Safety .....	<b>153</b>	<b>Chapter 24 Troubleshooting Direct Spark Ignition</b> .....	<b>209</b>
2. Power Tool Equipment .....	<b>154</b>	<b>(DSI) Systems</b>	
3. Ladder Safety .....	<b>154</b>	1. Direct Spark Ignition Troubleshooting .....	<b>209</b>
		2. Direct Spark Ignition: Main Burner Problems .....	<b>211</b>

<b>Chapter 25 Troubleshooting Hot Surface Ignition (HSI) Systems</b> .....	<b>215</b>	<b>Section Eight Appendices</b> .....	<b>249</b>
1. Hot Surface Ignition Troubleshooting.....	215	<b>A. Combustibles</b> .....	<b>251</b>
2. Hot Surface Ignition: Main Burner Problems.....	217	1. Framing, Walls, and Ceilings .....	251
<b>Chapter 26 Troubleshooting Intermittent Pilot Ignition (IPI) Systems</b> .....	<b>221</b>	2. Floors.....	251
1. Intermittent Pilot Ignition Troubleshooting.....	221	3. Heat Transfer .....	251
2. Intermittent Pilot Ignition: Main Burner Problems .....	223	4. Clearances .....	252
<b>Chapter 27 Troubleshooting Main Burner Performance Problems</b> .....	<b>227</b>	5. Protection .....	253
1. Sooting .....	227	<b>B. Basic Electricity</b> .....	<b>255</b>
2. Flame Appearance Problems.....	230	1. Background and Theory .....	255
3. Burner Noise Problems.....	232	2. Electrical Circuits.....	256
<b>Chapter 28 Venting and Ventilation Problems</b> .....	<b>233</b>	3. Characteristics of Electrical Current.....	257
1. Troubleshooting Venting Problems.....	233	4. Practical Applications: Measuring and Testing .....	259
<b>Section Seven Service After The Installation</b> .....	<b>239</b>	<b>C. House Pressure Test</b> .....	<b>263</b>
<b>Chapter 29 Annual Service</b> .....	<b>241</b>	1. Simplified House Pressure Test.....	263
1. Service Safety Considerations .....	241	2. Sizing Make-up Air Systems.....	267
2. Annual Service Procedures .....	242	2. Adjusting a Make-up Air System.....	270
<b>Chapter 30 Repair and Fuel Conversion Service:</b> .....	<b>245</b>	<b>D. Tools and Instruments</b> .....	<b>271</b>
<b>General Recommendations</b>		1. Suggested Tools .....	271
1. Repair .....	245	2. Suggested Testing Equipment.....	272
2. Fuel Conversion.....	245	3. Miscellaneous.....	273
		<b>E. Glossary</b> .....	<b>275</b>