



*Technology Training that Works*

---

# Practical Electrical Safety Techniques for Industry

---

## Contents

<b>1</b>	<b>Principles of Safety Rules</b>	<b>1</b>
1.1	Overview	2
1.2	Industrial Hazards	3
1.3	Electrical Hazards	6
1.4	Electrical Accidents and Safety Measures	8
1.5	Summary	10
<b>2</b>	<b>Earthing and Bonding</b>	<b>11</b>
2.1	Basics of Earthing	11
2.2	Bonding	14
2.3	Earthing from Protection from Lightning and Flashes	14
2.4	Static Charges and Need for Bonding	15
2.5	System Earthing	17
2.6	Supply Classifications	29
2.7	More on TN-C-S system	33
2.8	Installations where use of TN-C-S system is Prohibited	34
2.9	Summary	36
<b>3</b>	<b>Basic Theory of Electrical Safety</b>	<b>37</b>
3.1	Introduction	37
3.2	Shock Hazard	38
3.3	Role of Protective Earthing	44
3.4	Metal Enclosures for Earthing Conductors	48
3.5	Indirect Contact Hazards-Equipment Classes	50
3.6	Sensing of Earth Faults	52
3.7	Equipotential Bonding for Safety against Indirect Contact	53
3.8	Use of Protective Equipment	56
3.9	Electrical Shock Hazard Due to Lightning	57
3.10	Arc Flash Danger in Electrical Equipment	58
3.11	Summary	58



*Technology Training that Works*

<b>4</b>	<b>Static Electricity and Protection</b>	<b>61</b>
4.1	Introduction	61
4.2	What is static electricity	61
4.3	Generation of charge	62
4.4	Some Common examples of static build up	63
4.5	Energy of spark and its ignition capability	64
4.6	Danger of Static electricity buildup	64
4.7	Control of Static build up	65
4.8	Assessment of Static Risk and Planning Prevention	68
4.10	Summary	68
<b>5</b>	<b>Hazards Due to Electrical Arcing and Heating</b>	<b>69</b>
5.1	Introduction	69
5.2	Electrical Hazard: Arc Flash	69
5.3	Important Definitions Related to Arc Flash	71
5.4	How electric Arcs are developed	72
5.5	Effect and consequences of arc flash	73
5.6	Arc Blast	74
5.7	Incident Energy	74
5.8	Hazards of Arcing Fault	74
5.9	Arc Flash Protection Program	77
5.10	Summary	78
<b>6</b>	<b>Hazards Due to Electrical Arcing and Heating (part 2)</b>	<b>79</b>
6.1	Introduction	79
6.2	Limiting Arc Exposure	79
6.3	Avoiding Arc Flash Accidents	80
6.4	Reducing Level of Fault	81
6.5	Reducing Arcing Time	84
6.6	Arc Flash Protection Program	91
6.7	Electrical Equipment in Explosive environment	92
6.8	Hazards due to high temperature	94
6.9	Summary	97
<b>7</b>	<b>Safety Aspect in Electrical Design and Selection</b>	<b>99</b>
7.1	Objectives of Safe Design	99
7.2	Preventing Electrical Shock	100



*Technology Training that Works*

7.3	Importance of Insulation in Electrical Safety	101
7.4	Importance of Enclosure in Electrical Safety	104
7.5	Prevention of Adverse Thermal Effect	108
7.6	Isolation Arrangements	115
7.7	Earthing and Interlock	116
7.8	Equipment Selection	118
7.9	Restrictive Conductive Locations	119
7.10	Role of Codes and Standards in Equipment Installations	120
7.11	Summary	120

---

<b>8</b>	<b>Safe Operation and Maintenance of Electrical Equipment</b>	<b>123</b>
----------	---	------------

---

8.1	Introduction	123
8.2	Key safety factors in Operations and Maintenance of Electrical Installations	125
8.3	Isolation During Maintenance of Electrical Installations	128
8.4	Visual Checks for Safety	130
8.5	Earthing for Safety During Maintenance	131
8.6	Policies of Operational and Safety Locking	132
8.7	Safety aspect for repair work on Cable Installations	133
8.8	Monitoring Hot Spot to Improve Safety	134
8.9	Safety Appliances	139
8.10	Role of Caution Boards/Warning signs	145
8.11	Need for Periodic Testing	148
8.12	Need for Periodic Inspection and Maintenance	149
8.13	Emergency First Aid Training	151
8.14	Summary	151

---

<b>9</b>	<b>Substation Safety</b>	<b>153</b>
----------	--------------------------	------------

---

9.1	Introduction	153
9.2	Safety Operations and Maintenance of outdoor Substations and Switch yards	154
9.3	Outdoor Safety for Overhead Lines	155
9.4	Substation Checklist	155
9.5	Gas Safety and Ventilation in Substations	158
9.6	Working with Compressed Fluids	159
9.7	Fire Protection in Substations	159
9.8	Summary	160



*Technology Training that Works*

<b>10</b>	<b>Safety in Battery Installations</b>	<b>161</b>
10.1	Introduction	161
10.2	Applicable Codes and Regulations	162
10.3	Hazards in Battery Installations	162
10.4	General Safety Precautions	163
10.5	Safety Aspects of Battery Premises	165
10.6	Ventilations	166
10.7	Transportation, handling and Storage	168
10.8	Upkeep of Batteries	169
10.9	Installation Accessories: Salient Points	169
10.10	Precautions During Inspection of Batteries	170
10.11	First Aid	170
10.12	Hygiene and Housekeeping	171
10.13	Safety During Operation and Use of Personnel Protective Equipment	171
10.14	Safety Aspect During Dismantling and Disposal	172
10.15	Summary	173
<b>11</b>	<b>Organizational Aspects Of Safety</b>	<b>175</b>
11.1	Introduction	175
11.2	Organizational Responsibility for Safety	178
11.3	Employees and Safety	178
11.4	Safety Functions and Coordination	179
11.5	Accident Reporting and Records	180
11.6	Accident Investigation, Analysis and Preventive Measures	182
11.7	Safety Awareness	184
11.8	Summary	185
<b>12</b>	<b>UK Regulations on Safety</b>	<b>187</b>
12.1	Introduction	187
12.2	Factory Act	188
12.3	Health and Safety at Work Act	188
12.4	Electricity at Work Regulation	190
12.5	Electricity Supply Regulations	193
12.6	BS7671 Wiring Regulations	195
12.7	AETX directive for installations in Hazardous Location	197
12.8	Summary	199



*Technology Training that Works*

<b>13</b>	<b>Inspection of Electrical Systems for Safety</b>	<b>201</b>
13.1	Objectives of Inspection	201
13.2	BS 7671 Wiring Regulations	202
13.3	Initial Verification	203
13.4	Testing	204
13.5	Alteration and Additions	205
13.6	Periodic Inspections and Testing	205
13.7	Follow up Measures	206
13.8	Summary	206
	<b>Appendix A</b>	<b>207</b>
	Australian Regulations on Safety	
	<b>Appendix B</b>	<b>225</b>
	Australian Safety Regulations in Detail	
	<b>Exercises</b>	<b>247</b>