



*Technology Training that Works*

---

# Emergency Power Supplies: Electrical Distribution Design, Installation and Commissioning

---

## Contents

<b>1</b>	<b>Emergency Power Needs</b>	<b>1</b>
1.1	Problems of power failure in industries	1
1.2	Tolerance for interruptions and Voltage/ frequency excursions	5
1.3	Uninterrupted power, emergency power and standby power	8
<b>2</b>	<b>Emergency Power - Options</b>	<b>11</b>
2.1	Different solutions for different needs	11
2.2	UPS for critical loads and various available options	23
2.3	Battery as source: types and their pros and cons	45
<b>3</b>	<b>Configuring Power Distribution Systems for Emergency Loads</b>	<b>57</b>
3.1	Integrating emergency and critical power needs in distribution networks	57
3.2	Multiple units nearer consumer vs larger centralized units	62
3.3	Typical distribution scenarios in large industrial systems for integration of emergency power	64
3.4	Capacity and voltage planning for emergency power in large industries	65
<b>4</b>	<b>Special Requirements for Emergency Systems</b>	<b>69</b>
4.1	Control room power and escape route lighting	69
4.2	Automation of starting, load changeover and shutdown	69
4.3	UPS and other power conditioning requirements	71
4.4	Paying attention to motor starting requirements and accompanying voltage sag	72
4.5	Safe shutdown requirements	75



*Technology Training that Works*

<b>5</b>	<b>Harmonics in Emergency Supply Systems</b>	<b>77</b>
5.1	Harmonic producing load and their best effect on generator capacity	77
5.2	Tackling harmonics produced by static UPS	79
<b>6</b>	<b>Parallel Operation of Emergency Generators</b>	<b>83</b>
6.1	Parallel operation between emergency sources	83
6.2	Load sharing between sources	86
6.3	Parallel operation of emergency sources with utility (normal) source	88
6.4	Pros and cons of operation	89
6.5	Automation for paralleling - available equipment	89
6.6	Utility stipulations and local codes	90
<b>7</b>	<b>Tie Protection Systems</b>	<b>93</b>
7.1	Avoiding emergency generator collapse on external events	93
7.2	Appropriate protection: reverse power, frequency rate and vector surge relays	94
7.3	Islanding of systems and generator behavior	96
7.4	Load management in islanded systems	96
<b>8</b>	<b>Emergency power equipment installation</b>	<b>99</b>
8.1	Ensuring availability of critical power supplies through proper installation	99
8.2	Equipment cooling, premises ventilation and noise control measures	101
8.3	Fuel storage requirements	104
8.4	Special requirements in extreme climates	111
8.5	Regular routine start up for checking	112
8.6	Diesel Generator Troubleshooting	113
<b>9</b>	<b>Emergency power equipment - Cabling and Earthing</b>	<b>117</b>
9.1	Earthing of emergency power sources	117
9.2	Special requirements for multiple generator earthing	120
9.3	Grounding of UPS derived supplies	121
9.4	Cable sizing issues	127
9.5	Routing of cables: precautions to avoid simultaneous failures by physical separation	133
9.6	Emergency power for hazardous installations	133



*Technology Training that Works*

<b>10</b>	<b>Safety in Emergency Power Supplies</b>	<b>135</b>
10.1	Fire safety	135
10.2	Battery safety	138
<b>A</b>	<b>Appendix A</b>	<b>139</b>
	Practical Exercises	