Surge Protection: Measured Lightning Stroke Data

Introduction

Lightning strokes can cause surges that damage electronic devices. The intensity of these strokes can vary greatly and represent the largest energy event a Surge Protective Device (SPD) may experience. For this reason, the maximum surge current of an SPD is often selected based on perceived lightning stroke levels. This Data Bulletin provides objective data about lightning stroke intensity based on a scientific study and can be used as a factor in determining the required maximum surge current of SPDs.

Details

Since 1990, Progress Energy (formerly Florida Power) has used the National Lightning Detection Network to collect data on the total number and magnitude of cloud-to-earth lightning strokes. The Tampa, Florida area has a high frequency of lightning strokes, but in the summer of 2000, a rare event occurred that yielded valuable data on lightning stroke intensity.

On July 15, 2000, between the hours of 0500 and 1900, two different storm fronts passed over the Tampa Bay area from different directions and collided. In a short time, the resultant lightning storms generated an unprecedented 33,863 separate cloud-to-earth lightning strokes.

The data collected by the National Lightning Detection Network measured the time and the current magnitude of each positive and negative stroke. A summary of the data is presented in the table in Appendix A. Table 1 indicates the count of current magnitudes arranged in 5 kA increments and their percentage of the total.

Figure 2 shows the area in Florida covered by the study. Figure 3 shows the distribution of the lightning strokes.

Figure 4 displays the distribution of current magnitudes in 5 kA increments for 2,597 positive lightning strokes. A summary of this data is given below:

- 95% were less than 30 kA
- 98% were less than 60 kA

There were also 31,266 negative stokes during this same time period. Figure 5 shows the measured current values of these strokes. A summary of this data is given below:

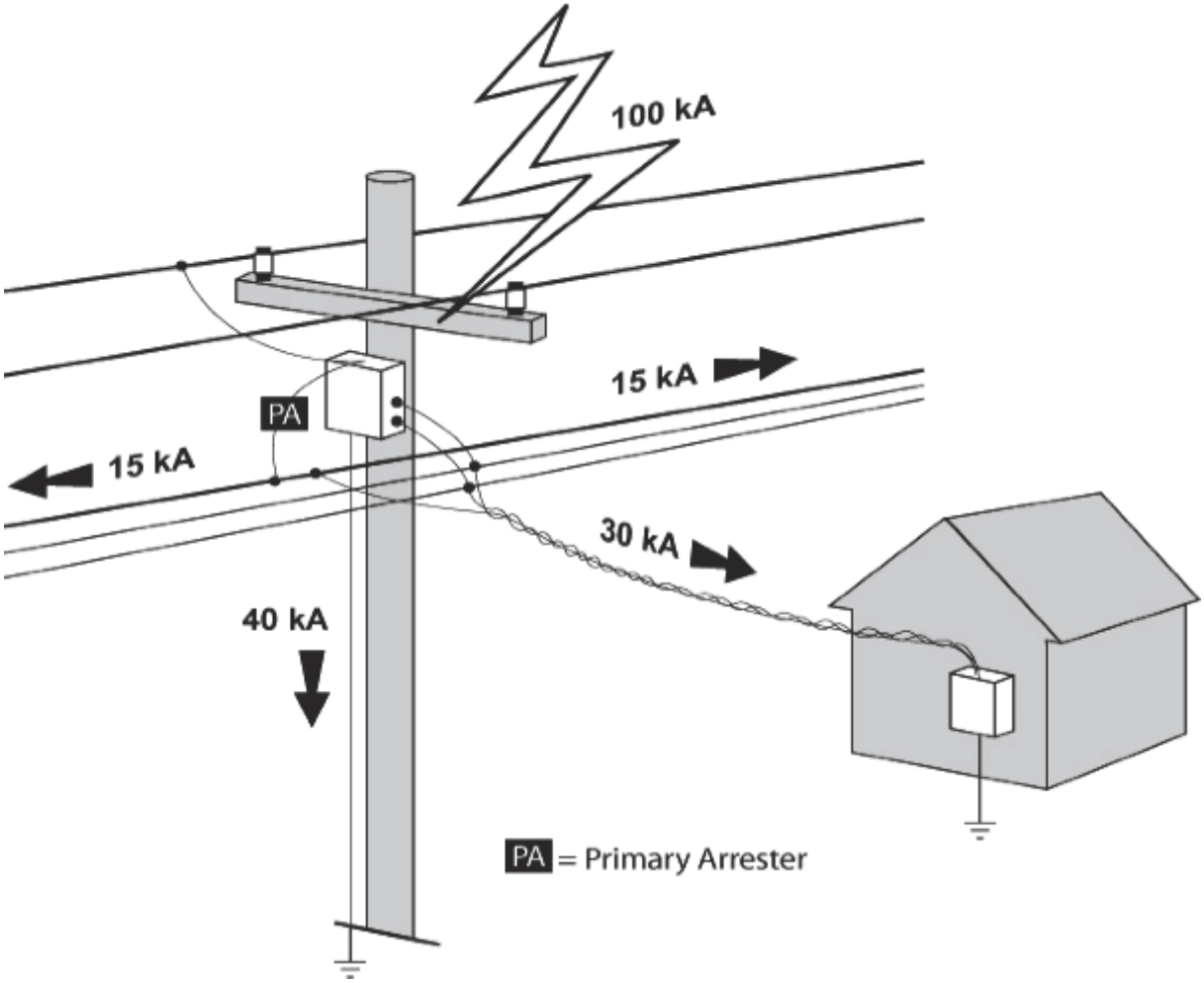
- 82% were less than 30 kA
- 98% were less than 60 kA

The unprecedented 33,863 data points provide supportable evidence of representative currents within lightning events. In aggregate, the data reveals that less than 2% of the positive or negative strokes had a current magnitude greater than 60 kA. The vast majority of strokes were less than 30 kA.

Additionally, Figure 1, from ANSI/IEEE C62.41.1-2002, indicates that if a utility power line was hit with a lightning stroke, 30% or less of the stroke current would enter a facility.

NOTE: Example shows a 100 kA stroke for the ease of calculation, but energy from lightning normally will be much less.

Figure 1: Example from ANSI/IEEE C62.41.1-2002



Given the measured lightning stroke data from the study and the ANSI/IEEE C62.41.1-2002 data, a 60 kA stroke hitting a utility power line would dissipate to an energy level of 20 kA that would reach a facility (10 kA for a 30 kA lightning stroke). The increased magnitudes of the remaining 2% of all lightning strokes would also dissipate to 30% of the original energy.

Recommendations

Based on the preceding data, recommended kA rating levels of SPD are:

240 kA rated product at service entrance panels and transfer switches. This rating provides high-energy protection with long-term robustness and reliability.

Divide the kA rating in half for each SPD product in sub-panels.

Appendix A

Figure 2: Area of Study

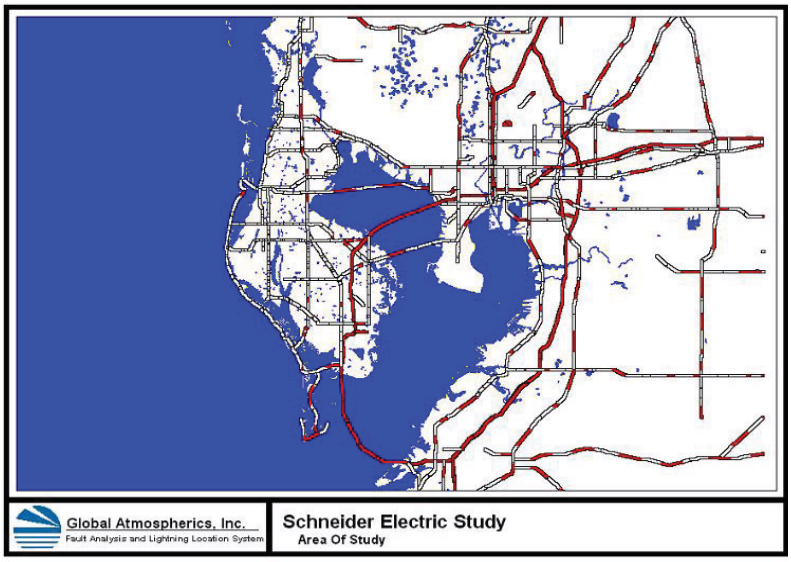


Figure 3: Distribution of Lightning Strokes

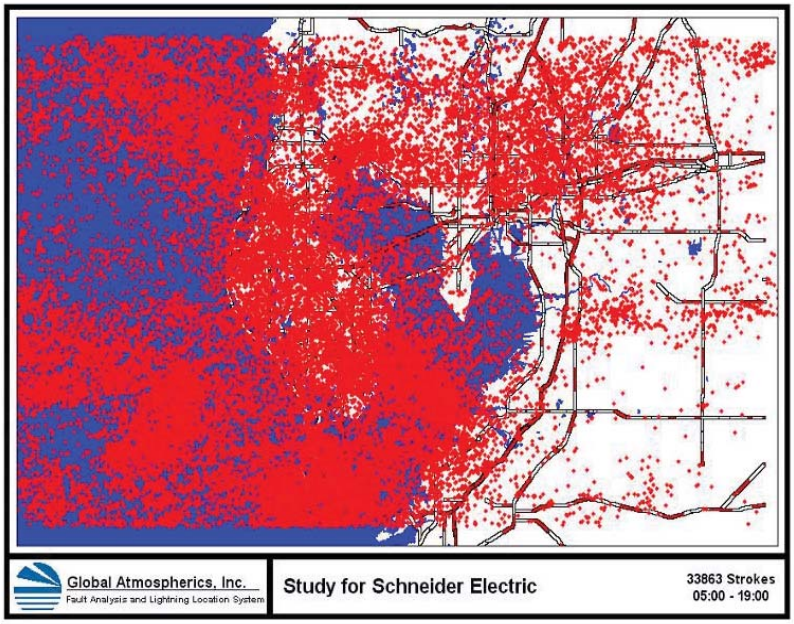


Figure 4: Positive Lightning Strokes

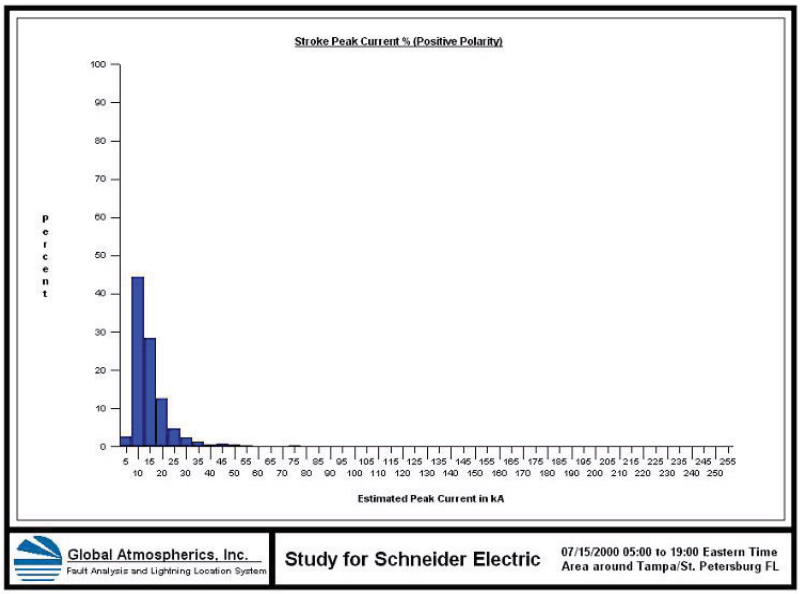


Figure 5: Negative Lightning Strokes

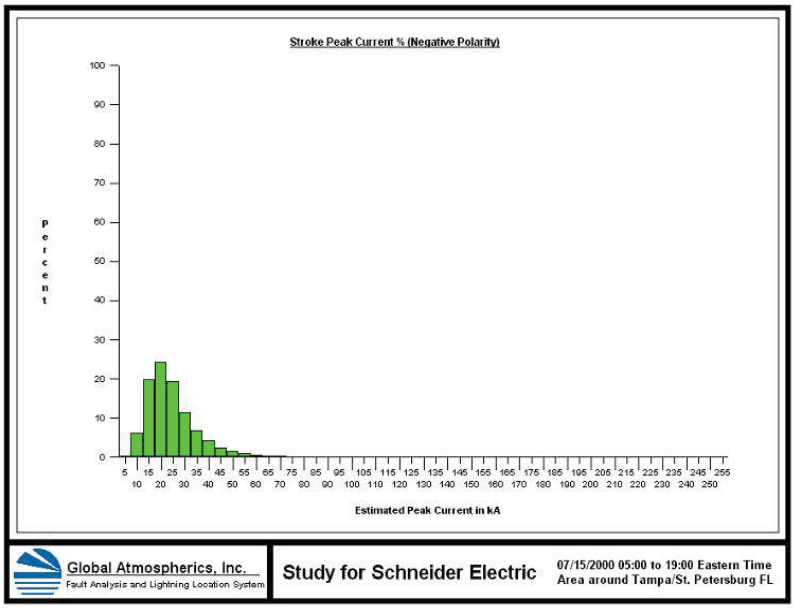


Table 1: Lightning Stroke Data

Positive Lightning						Negative Lightning					
Lo KA	Hi KA	Count	% of Pos	Cumm %	% of Total	Lo KA	Hi KA	Count	% of Pos	Cumm %	% of Total
0	5	70	2.70%	2.70%	0.21%	0	-5	115	0.37%	0.37%	0.34%
5	10	1,152	44.36%	47.05%	3.40%	-5	-10	1,919	6.14%	6.51%	5.67%
10	15	737	28.38%	75.43%	2.18%	-10	-15	6,201	19.83%	26.34%	18.31%
15	20	327	12.59%	88.02%	0.97%	-15	-20	7,601	24.31%	50.65%	22.45%
20	25	123	4.74%	92.76%	0.36%	-20	-25	6,067	19.40%	70.05%	17.92%
25	30	60	2.31%	95.07%	0.18%	-25	-30	3,617	11.57%	81.62%	10.68%
30	35	31	1.19%	96.26%	0.09%	-30	-35	2,142	6.85%	88.47%	6.33%
35	40	16	0.62%	96.88%	0.05%	-35	-40	1,310	4.19%	92.66%	3.87%
40	45	18	0.69%	97.57%	0.05%	-40	-45	766	2.45%	95.11%	2.26%
45	50	14	0.54%	98.11%	0.04%	-45	-50	497	1.59%	96.70%	1.47%
50	55	9	0.35%	98.46%	0.03%	-50	-55	307	0.98%	97.68%	0.91%
55	60	5	0.19%	98.65%	0.01%	-55	-60	194	0.62%	98.30%	0.57%
60	65	5	0.19%	98.84%	0.01%	-60	-65	121	0.39%	98.69%	0.36%
65	70	2	0.08%	98.92%	0.01%	-65	-70	99	0.32%	99.01%	0.29%
70	75	6	0.23%	99.15%	0.02%	-70	-75	46	0.15%	99.16%	0.14%
75	80	3	0.12%	99.27%	0.01%	-75	-80	53	0.17%	99.33%	0.16%
80	85	5	0.19%	99.46%	0.01%	-80	-85	47	0.15%	99.48%	0.14%
85	90	2	0.08%	99.54%	0.01%	-85	-90	27	0.09%	99.56%	0.08%
90	95	3	0.12%	99.65%	0.01%	-90	-95	23	0.07%	99.64%	0.07%
95	100	1	0.04%	99.69%	0.00%	-95	-100	22	0.07%	99.71%	0.06%
100	105	1	0.04%	99.73%	0.00%	-100	-105	20	0.06%	99.77%	0.06%
105	110	1	0.04%	99.77%	0.00%	-105	-110	17	0.06%	99.82%	0.05%
110	115	1	0.04%	99.81%	0.00%	-110	-115	15	0.05%	99.87%	0.04%
115	120	1	0.04%	99.85%	0.00%	-115	-120	10	0.03%	99.90%	0.03%
120	125	1	0.04%	99.88%	0.00%	-120	-125	11	0.04%	99.94%	0.03%
125	130	1	0.04%	99.92%	0.00%	-125	-130	6	0.02%	99.96%	0.02%
130	135	—	0.00%	99.92%	0.00%	-130	-135	4	0.01%	99.97%	0.01%
135	140	—	0.00%	99.92%	0.00%	-135	-140	2	0.01%	99.98%	0.01%
140	145	—	0.00%	99.92%	0.00%	-140	-145	2	0.01%	99.98%	0.01%
145	150	—	0.00%	99.92%	0.00%	-145	-150	3	0.01%	99.99%	0.01%
150	155	—	0.00%	99.92%	0.00%	-150	-155	2	0.01%	100.00%	0.01%
155	160	—	0.00%	99.92%	0.00%	-155	-160	—	0.00%	100.00%	0.00%
160	165	—	0.00%	99.92%	0.00%	-160	-165	—	0.00%	100.00%	0.00%
165	170	—	0.00%	99.92%	0.00%	-165	-170	—	0.00%	100.00%	0.00%
170	175	1	0.04%	99.96%	0.00%	-170	-175	—	0.00%	100.00%	0.00%
175	180	—	0.00%	99.96%	0.00%	-175	-180	—	0.00%	100.00%	0.00%
180	185	1	0.04%	100.00%	0.00%	-180	-185	—	0.00%	100.00%	0.00%
185	190	—	0.00%	100.00%	0.00%	-185	-190	—	0.00%	100.00%	0.00%
190	195	—	0.00%	100.00%	0.00%	-190	-195	—	0.00%	100.00%	0.00%
195	200	—	0.00%	100.00%	0.00%	-195	-200	—	0.00%	100.00%	0.00%
200	205	—	0.00%	100.00%	0.00%	-200	-205	—	0.00%	100.00%	0.00%
Total Positive: 2,597						Total Negative: 31,266					
Total Strikes: 33,863											

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