State of Florida

Public Service Commission

CAPITAL CIRCLE OFFICE CENTER ● 2540 SHUMARD OAK BOULEVARD
TALLAHASSEE, FLORIDA 32399-0850

-M-E-M-O-R-A-N-D-U-M-

DATE: DECEMBER 4, 2003

TO: DIRECTOR, DIVISION OF THE COMMISSION CLERK & ADMINISTRATIVE SERVICES (BAYÓ)

FROM: DIVISION OF ECONOMIC REGULATION (BREMAN, LEE, MATLOCK, MCNULTY)
OFFICE OF THE GENERAL COUNSEL (C.KEATING)

RE: DOCKET NO. 030834-EI - REQUEST TO EXCLUDE OUTAGE EVENT FROM ANNUAL DISTRIBUTION SERVICE RELIABILITY REPORT FOR CALENDAR YEAR 2003, BY PROGRESS ENERGY FLORIDA, INC.

AGENDA: 12/16/03 - REGULAR AGENDA - PROPOSED AGENCY ACTION - INTERESTED PERSONS MAY PARTICIPATE

CRITICAL DATES: NONE

SPECIAL INSTRUCTIONS: NONE

FILE NAME AND LOCATION: S:\PSC\ECR\WP\030834.RCM
- Attachments 1, 2, 3, and 4 are not electronically submitted.

CASE BACKGROUND

On August 18, 2003, Progress Energy Florida, Inc. ("PEFI" or "Company") filed a petition pursuant to Rule 25-6.0455(3), Florida Administrative Code, seeking to exclude from its 2003 Annual Distribution Service Reliability Report service interruptions due to weather-related events. On October 22, 2003, PEFI filed an amended petition which restated and replaced the original request filed on August 18, 2003. PEFI's amended petition requests an exclusion of 9,220 service interruptions that occurred in PEFI's North Central Region within the midnight-to-midnight, 24-hour period of July 18, 2003.

Rule 25-6.0455, Florida Administrative Code, requires each investor-owned electric utility to file annually a Distribution Service Reliability Report containing data that the Commission uses to assess changes in distribution reliability. Under subsection (2) of the rule, a utility may exclude specified outage events, such as a storm named by the National Hurricane Center, a tornado recorded by the National Weather Service, ice on lines, and an extreme weather event causing activation of the county emergency operation center. In addition, under subsection (3), a utility may petition the Commission to exclude an outage event not specifically enumerated in subsection (2). However, the utility must "demonstrate that the outage was not within the utility's control, and that the utility could not reasonably have prevented the outage." Rule 25-6.0455(3), Florida Administrative Code.

Section 366.05(1), Florida Statutes, gives the Commission the power to prescribe standards of quality and measurements for public utilities. Further, Section 366.041(1), Florida Statutes, provides that the Commission, in setting rates for a public utility, is authorized to consider, among other things, the adequacy of service rendered. By Order No. PSC-02-0655-AS-EI, issued May 14, 2002, in Docket No. 000824-EI, In Re: Review of Florida Power Corporation's earnings, including effects of proposed acquisition of Florida Power Corporation by Carolina Power & Light, p 19, the Commission required PEFI to improve its distribution reliability by 20 percent relative to its year 2000 performance. The reliability index to be used to measure PEFI's distribution reliability improvements is the System Average Interruption Duration Index ("SAIDI"). In the event PEFI does not achieve a 20 percent improvement in SAIDI during 2004 and 2005, the Company must refund $3 million for both years in equal amounts to the ten percent of PEFI customers served by PEFI's worst performing distribution feeder lines. Thus, whether the outage events addressed in PEFI’s amended petition are included or not included in measuring PEFI's electric distribution reliability may have material consequences for the utility and its ratepayers.

The Commission has jurisdiction over this matter pursuant to Chapter 366, Florida Statutes, including Sections 366.04, 366.041, and 366.05, Florida Statutes.

DISCUSSION OF ISSUES

ISSUE 1: Should the Commission approve PEFI's amended petition to exclude from its 2003 Annual Distribution Service Reliability Report 9,220 service interruptions that occurred in PEFI's North Central Region on July 18, 2003?

RECOMMENDATION: No. PEFI has not demonstrated that it took reasonable steps to minimize the number of service interruptions that occurred on July 18, 2003. (BREMAN, LEE, MATLOCK, MCNULTY)

STAFF ANALYSIS: Rule 25-6.0455(3), Florida Administrative Code, provides for an exclusion of outages associated with a severe weather event if the utility is able to demonstrate that it could not reasonably have prevented the outages. Staff's analysis includes a summary of PEFI's petition, an analysis of the severity of the weather event, an analysis of PEFI's use of a statistical methodology, and finally staff's conclusion that PEFI has not demonstrated that it made reasonable efforts to avoid customer outages.

Summary of PEFI's Petition

PEFI seeks an exclusion for 9,220 service interruptions that it alleges were not within its control because it could not reasonably have prevented the outages caused by the level of lightning that occurred on July 18, 2003, in its North Central Service Region. The resulting impact to customers in the region is 3.32 minutes added to PEFI's regional System Average Interruption Duration Index (SAIDI) for the year. A SAIDI value of 100 means that customers experienced on average 100 minutes of service interruption during the year.

In its petition, PEFI states that on July 18, 2003, a storm front developed in the Gulf of Mexico and moved eastward impacting PEFI distribution facilities throughout central Florida before dissipating near midnight. PEFI's restoration efforts addressed a total of 19,167 service interruptions when final restoration activities were completed on July 20, 2003. As indicated in the table below, much of the restoration efforts were in PEFI's North Central Service Region. PEFI only seeks to exclude the outage data for July 18, 2003, that was recorded within its North Central Service Region. PEFI's decision to request exclusions for outages only within its North Central Service Region is based on PEFI's interpretation of a utility-proposed statistical methodology under review by members of the Institute of Electrical and Electronics Engineers ("IEEE"). Excluding the requested data reduces PEFI's system SAIDI by 0.93 minutes.

Summary of July 2003 Storm Impact on PEFI			
	PEFI System	PEFI North Central Region	
	July 18-20	July 18-20	**Petition July 18**
No. of Feeders	248	117	**101**
No. of Outage Events	435	236	**167**
No. of Service Interruptions	19,167	10,012	**9,220**
SAIDI minutes	1.95	4.06	**3.32**
PEFI System SAIDI minutes	1.95		**0.93**

PEFI believes Exhibits A and B to its petition show the unusual nature of the weather event. Exhibit A contains three graphs of cloud-to-ground lightning flash counts which PEFI refers to as Sheets 1, 2, and 3, which are summarized in the table below.

Summary of PEFI Petition Exhibit A - Number of Lightning Flashes			
	Sheet 1	Sheet 2	Sheet 3
	PEFI System Daily Flash Count for July 2003	PEFI System Daily Flash Count for 1997-July 2003	PEFI North Central Region Daily Flash Count 1997-July 2003
Highest Flash Count	7,112 on 7/18/03	7,112 on 7/18/03	3,130 on 7/18/03
Next Highest Flash Count	5,160 on 7/29/03	5,333 on 7/21/02	1,753 on 7/07/00

The first graph, Sheet 1, is the number of daily lightning flashes recorded in PEFI's service area for all of July 2003. The second graph, Sheet 2, is the number of daily lightning flashes recorded by the National Lightning Detection Network in PEFI's service area since January 1, 1997. PEFI notes the 7,112 lightning flash count on July 18, 2003, exceeds the previous maximum count of 5,333 which occurred on July 21, 2002. The third graph, Sheet 3, is the number of daily lightning flashes recorded in PEFI's North Central Region since January 1, 1997. PEFI notes the regional maximum that occurred on July 18, 2003, exceeds the previous maximum for the region set on July 7, 2000. PEFI believes these three graphs indicate that PEFI's service area experienced higher lightning flash counts in July 2003 relative to prior years.

Exhibit B consists of seven Florida maps on which the daily lightning flash density per square kilometer has been plotted for July 15 through July 21, 2003. PEFI believes the seven maps demonstrate where the lightning strikes occurred and provide a measure of the intensity of lightning activity for each of the seven days. The maps show that central Florida experienced many lightning flashes on those days. Staff compared the maps of Exhibit B to PEFI's retail service area boundaries and confirmed that many of the plotted lightning flashes occurred within PEFI's retail service area.

In its petition, PEFI's contends that storms like the July 18 event should be considered beyond the design and operational limits of the company. PEFI's discussion focuses on a statistical methodology under review by members of IEEE. Exhibit C to PEFI's petition is a copy of an IEEE White Paper titled, "Classification of Major Event Days" that describes a newly developed statistical method as a tool for distinguishing abnormal outage events from normal outage events. At this time, different standards and definitions exist nation-wide which tends to frustrate comparison of reliability data from different utilities in different jurisdictions. The intent of the IEEE members is to establish a methodology for compiling and comparing distribution reliability statistics of utilities regardless of any differences that may exist in regulatory definitions or decisions regarding excludable events. The proposed methodology identifies a threshold daily SAIDI value for which, on average, 2.3 days per year are statistical outliers given any five-year data set of daily SAIDI values. The authors of the IEEE White Paper anticipate that a version of the proposed methodology will become an IEEE definition and enrolled into IEEE Publication 1366, *Full-Use Guide on Electric Power Distribution Reliability Indices*.

PEFI applies the proposed statistical methodology to its most recent five-year history of daily SAIDI values on a regional basis and finds that July 18, 2003, is within the threshold of a "major event" day for its North Central Florida Region. Furthermore, PEFI believes the analysis of daily SAIDI values is an objective measure of the severity of the weather event. Thus, PEFI argues, the outages associated with that weather event were beyond its design limits and operational limits.

Furthermore, PEFI states that it has effective lightning protection measures and references a February 2002 staff audit report in support of this statement. The February 2002 staff audit report was a management audit that focused on engineering philosophy and technology related to lightning protection schemes. PEFI footnotes that the audit report showed the Company to be innovative and pace setting in the use of the latest technology and engineering practices for lightning protection. Therefore, PEFI argues, costs associated with designing and operating a system capable of withstanding such an extreme and unusual event as July 18, 2003, would far exceed the infrequent benefit to the Company's general body or customers.

Severity of the Weather Event

In response to Staff data requests, PEFI indicated that the lightning data in Exhibits A and B to its petititon only indicate the level of lightning recorded within the immediate proximity of its facilities. In other words, the footprint of the facilities in its North Florida Central Region experienced, on average 1.22 lightning flashes per square kilometer on July 18, 2003. In contrast, various meteorological publications indicate that central Florida's average annual cloud-to-ground lightning flash rate typically exceeds ranges of 3.3 to 11 lightning flashes per square kilometer[1]. Thus, PEFI's assertion that the level of lightning experienced July 18, 2003, was extraordinary ignores typical levels of lightning that occur within its general service area because PEFI lightning data is based only on the history of events within

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[1]Cloud-to-Ground Lightning in the United States: NLDN Results in the First Decade, 1989-98, Monthly Weather Review, Volume 129, Page 1181, American Meteorological Society

Lightning Ground Flash Density and Thunderstorm Duration in Continental United States: 1989-96, Journal of Applied Meteorology, Volume 38, Page 1014, American Meteorological Society

http://www.srh.noaa.gov/mlb/waf_dos.html.

the footprint of its facilities. The increasing trend in PEFI's lightning data, as shown in Attachment 1 to this recommendation, is not extraordinary or unexpected because central Florida typically has had a higher lightning frequency than PEFI has recorded for its facilities. Therefore, PEFI has not shown that the level of lightning experienced on July 18, 2003, was extraordinary for central Florida or its North Central Florida Region because central Florida typically experiences more than twice the level of lightning PEFI reports for its facilities.

PEFI's Response to Increased Lightning Activity

As previously discussed, the lightning flashes reported in PEFI's data could potentially double because the level of lightning that typically occurs in central Florida is at least twice what PEFI has recorded within the footprint of its facilities. PEFI's graph of system daily lightning flash counts is shown in Attachment 1 to this recommendation. Staff notes that PEFI's chart clearly shows an increasing trend in the number of lightning strikes within its service area for each year since 1999.

On October 31, 2000, PEFI submitted a request to exclude outage events for July 15, 2000, from the outage data for PEFI's Suncoast Region based on a high lightning strike count. PEFI's 2000 exclusion request was made to staff and was not filed with the Commission. Staff informed PEFI and all the investor-owned electric utilities ("IOU") that staff did not have the delegated authority to address the request. PEFI did not petition the Commission regarding an exclusion for the July 15, 2000, lightning event. However, due to PEFI's 2000 request, staff initiated a management audit of each IOU's lightning protection programs. This review resulted in the February 2002 management audit report that PEFI refers to in its amended petition.

Attachment 3 to this recommendation consists of is a copy of the portions of staff's February 2002 management audit report that address PEFI. A summary matrix of each IOU's lightning protection philosophy is also included in Attachment 3. Staff's February 2002 management audit report shows that PEFI had several in-house study results that conclude a doubling of the number of lightning arresters decreases the lightning flash-over rate by a factor of four. The flash-over rate represents the number of times short circuits are caused by lightning arching over fixtures such as insulators and back onto the electrical system. A lightning arrester is a sacrificial device used to protect other distribution equipment from lightning. Lightning arresters are sacrificial devices because, frequently, lightning destroys the arrester due to the extreme energy in lightning. The summary matrix included in Attachment 3 shows that PEFI elected not to implement its internal report findings. In contrast, Attachment 3 shows that Florida Power & Light Company and Gulf Power Company elected to install twice as many arrester stations as PEFI. When recently questioned regarding its choices, PEFI indicated that there was no accepted industry standard regarding the installation of lightning arrester stations. Consequently, staff's February 2002 management audit report demonstrates that PEFI elected to install fewer lightning arrester stations compared to other utilities even though PEFI understood that installing more lightning arresters could reduce customer outages like those on July 18, 2003.

Staff's 2002 management audit report does not address the extent to which PEFI seeks and replaces failed lightning arresters. Further, the 2002 management audit report does not address the extent to which PEFI responds to observed changes in weather patterns. Actions by PEFI in either of these areas would be an indicator that PEFI was actively trying to avoid lightning-caused outages.

Staff performed several field observations, beginning in late August, to assess PEFI's response to the level of lightning that had occurred. The timing of staff's field observations allowed PEFI at least four weeks to initiate remediation actions after the July 18 weather event. Staff's field observations included approximately 400 pole miles of PEFI's facilities throughout central Florida. Attachment 4 to this recommendation is a photographic catalog of staff's findings. Staff observed fifty locations that needed repairs to the lightning protection equipment. In many cases, only pieces of the lightning arresters are visible because of the destructive force of direct lightning strikes. Staff also found various instances of vegetation encroachment. Staff re-visited the same locations approximately four to eight weeks later to observe the effectiveness of PEFI's program to maintain its lightning protection equipment in good working order. No repairs had occurred. On October 20, 2003, PEFI was informed of staff's field observations and results. PEFI states it completed all repairs, including vegetation clearing, within two weeks from the time the field offices received the information.

Staff believes the results of its field observations tend to indicate that PEFI allows defective lightning arresters to remain unrepaired for long periods of time and that PEFI did not survey its lightning arresters after the July 18 weather event. This is a concern because the next lightning event may cause even more outages due to fewer and fewer lightning arresters remaining functional with each passing storm.

Staff's field observations were confirmed by PEFI's management. During an October 8, 2003, presentation to staff, Mr. Sipes, Vice President of Distribution Operations and Support, indicated that it would not surprise him if a failed lightning arrester would go undiscovered for months. As stated in response to Staff data requests, PEFI inspects all of its distribution facilities on a ten-year cycle. PEFI does not have a program that specifically targets lightning arresters. PEFI does not know the number of lightning arresters replaced due to the July 18 weather event because PEFI does not track the number of replaced lightning arresters. Consequently, PEFI's assertion that the weather event was beyond its design and operation limits is not correct.

Based on this analysis, staff believes PEFI does not know and cannot demonstrate the extent to which its lightning protection scheme contributed to or avoided the July 18, 2003, service interruptions. Further, based on staff's field observations of unrepaired lightning protection equipment and the increased use of lightning arresters by other IOUs, Staff finds fault with PEFI's claim that the costs associated with designing and operating a system capable of withstanding weather events of the type experienced July 18, 2003, would be prohibitive.

PEFI's Proposed Use of a Statistical Methodology

PEFI asserts that the outage events of July 18, 2003, should be excluded because the SAIDI value for that day is a statistical outlier compared to the daily SAIDI values for years 1997 through 2002 for its North Central Florida Region. Furthermore, PEFI believes the analysis is an objective indicator of the severity of the weather event. Staff believes that PEFI's assertions are not correct because PEFI's SAIDI data is affected by company policies and practices. The Commission has already determined PEFI's SAIDI values need improvement. For example, the SAIDI value for year 2000 is the base to measure PEFI's distribution reliability improvement, pursuant to Order No. PSC-02-0655-AS-EI. Thus, SAIDI can not be considered an objective measure of the severity of weather events because SAIDI is an indicator of the effectiveness of company policies. Similarly, PEFI's statistical analysis alone is not a demonstration that PEFI took any specific measures to avoid customer outages or that PEFI was responsive to weather patterns. Even the IEEE members, by way of their White Paper, recommend regulatory review of utility actions. The members of the IEEE state the following in the White Paper.

> The fact that major event contributions vary from year-to-year is to be expected, and may be directly correlated to weather variations. <u>If the major event variation is due to conditions within the utility's control, then executives and regulators should take appropriate action.</u> Furthermore, if over time there is indeed a true and sustained change in the weather patterns affecting a utility's service territory, this "normalization" process will reflect (and include) that change. <u>If that occurs, then there are strong and supported reasons for the utility to change its operating practices.</u> (PEFI Petition Exhibit C, page 3 emphasis added.)

Pursuant to the IEEE White Paper, PEFI should have implemented changes in its operating practices when PEFI began to notice an increasing trend in the intensity of weather patterns as seen in Attachment 1. Instead, as previously discussed, PEFI makes no specific effort to find and replace failed lightning arresters. PEFI elects to have fewer lightning arrester stations in lightning prone areas compared to other utilities. Furthermore, PEFI's 10-year inspection cycle may not be sufficient to address changes in weather patterns. In this instance, PEFI's proposed use of statistics to achieve an exclusion conflicts with the IEEE White Paper because PEFI has not demonstrated its actions have been the appropriate response to the observed weather patterns.

<u>Conclusion</u>

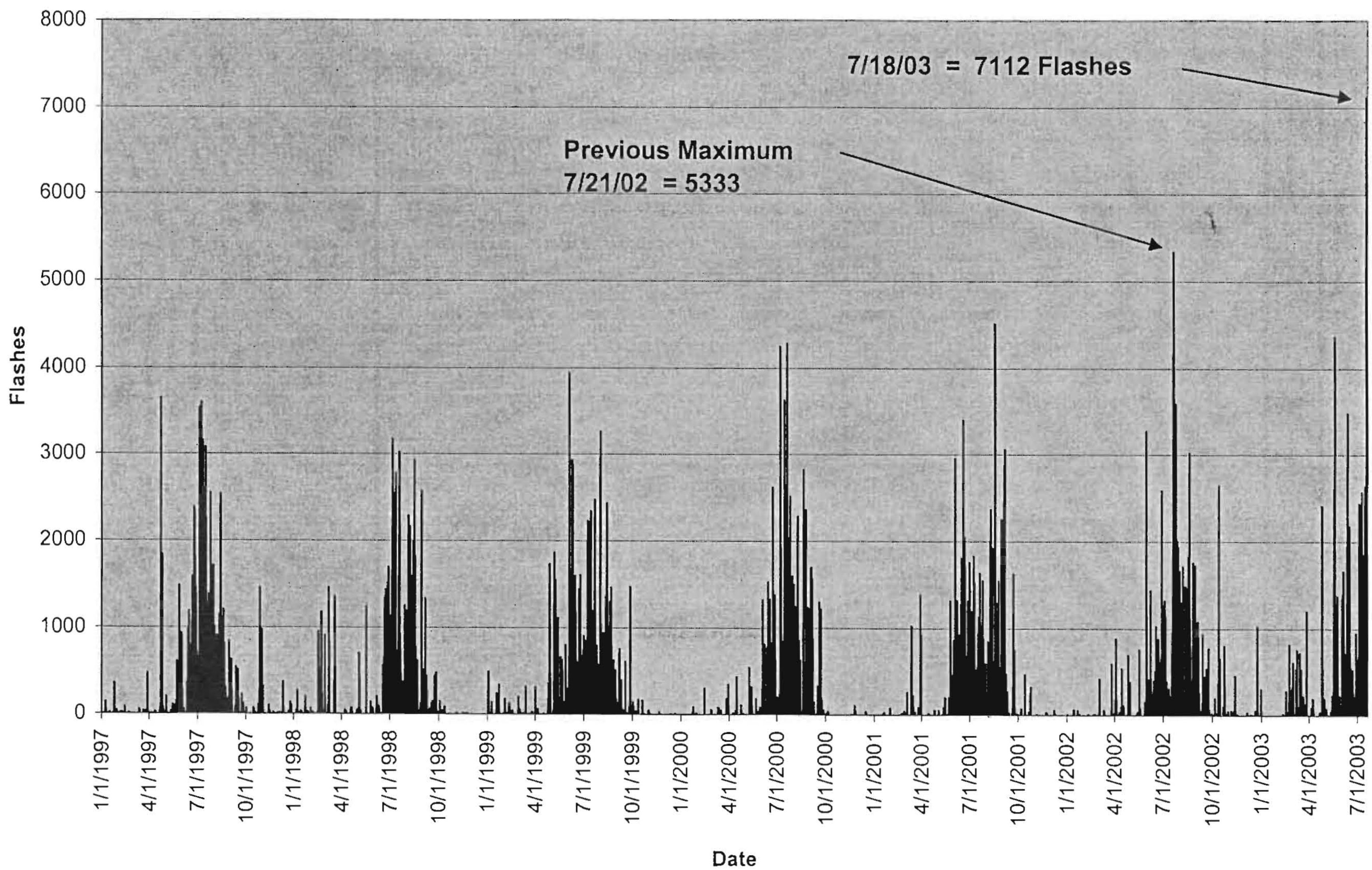
PEFI has not shown that extraordinary lightning occurred on July 18, 2003, within its North Central Florida Region. Staff's 2002 management audit report clearly shows that PEFI was aware of possible lightning protection options and that other utilities elect to install more lightning arrester stations in lightning prone areas than PEFI. The IEEE White Paper addresses the need to take appropriate action when weather patterns change. Staff has not seen any evidence that PEFI is changing its operating practices in response to PEFI's observed increases in lightning events. PEFI's statistical analysis alone is not a demonstration that PEFI took any specific measures to avoid customer outages. In this instance, PEFI's proposed use of statistics to achieve an exclusion conflicts with the IEEE White Paper because PEFI has not demonstrated its actions have been the appropriate response to the observed weather patterns. Therefore, PEFI has not demonstrated that it took reasonable steps to prevent the outage event of July 18, 2003, consistent with the requirements of Rule 25-6.0455(3). Therefore, Staff recommends that PEFI's petition for an exclusion related to the July 18, 2003, weather event be denied.

ISSUE 2: Should this docket be closed?

RECOMMENDATION: Yes, this docket should be closed upon issuance of a Consummating Order unless a person whose substantial interests are affected by the Commission's decision files a protest within 21 days of the issuance of the proposed agency action. (C. KEATING)

STAFF ANALYSIS: If no timely protest to the proposed agency action is filed within 21 days, this docket should be closed upon the issuance of the Consummating Order.

System Daily Flash Count



Florida Power
CORPORATION

October 31, 2000

Subject: Florida Power Corporation Request for Exclusion
7/15/00 Suncoast Region Storm

Summary Of Events:

- The Suncoast Region was impacted with a lightning storm of magnitude not experienced in the past ten years.
- National Weather Service reported very heavy rainfall of 7 to 9 inches in less than six hours caused flooding of homes, businesses and roadways in Pinellas County.
- Lightning flashes for the region (5813) were 22 times greater than an average July day and more than 2.7 times greater than the average worst day experienced over the past 10 years (see appendix A, B).
- Outages for the region (422) were 7.7 times greater than an average July day and more than 2.2 times greater than the average worst day for the past 10 years (see appendix C,D).
- Line resources from all regions of Florida Power Corporation were brought in to restore service.
- Outside contractors were brought in to restore service.

Impact:

- System = 3.7 minutes
- Suncoast region = 7.9 minutes

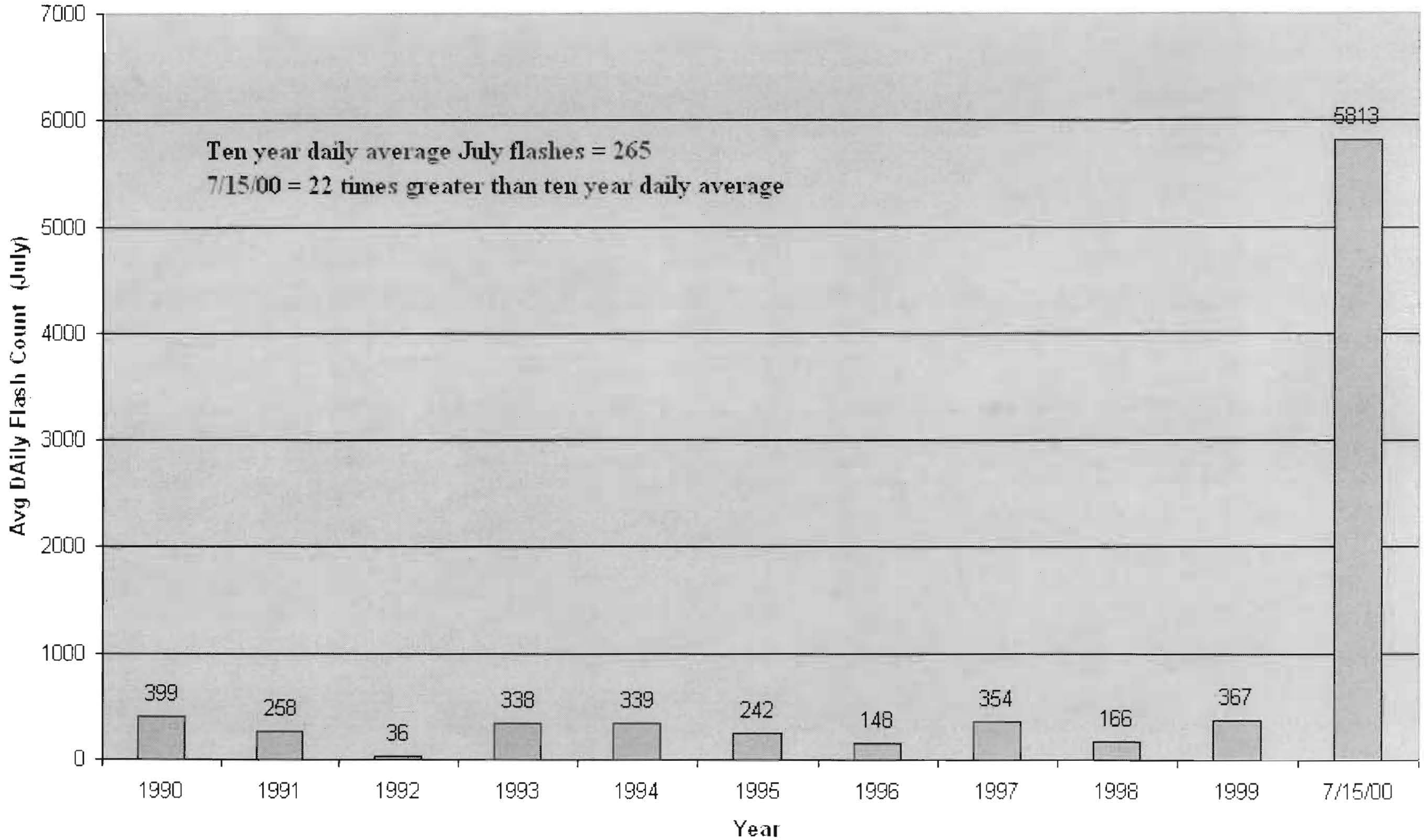
- 5 year average SAIDI for 7/15
  - System = .7
  - Suncoast Region = .7

Reasons For Exclusions:

- Independent studies conducted by FPL and FPC have concluded that lightning is a predominant component of weather initiated outages.
- Reasonable and prudent engineering would not have prevented outages from occurring.
- Lightning data provided and verified by an independent third party.

SYSTEM RELIABILITY: 2600 Lake Lucien Dr • Suite 400 MT3B • Maitland • Florida 32751 • (407) 475-2480
A Florida Progress Company

Appendix A
Suncoast Average Daily Flash Count - July



Attachment 2
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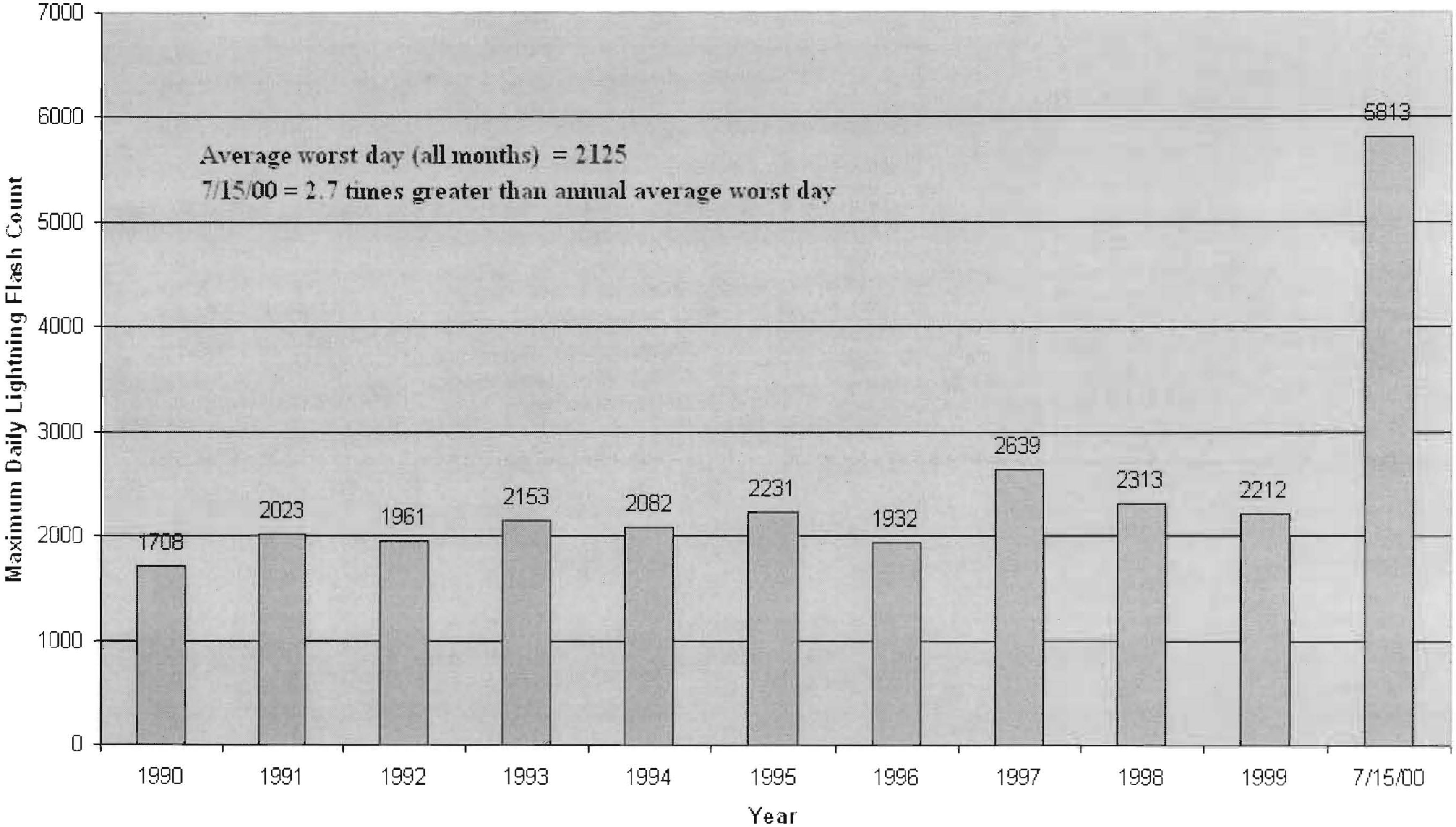
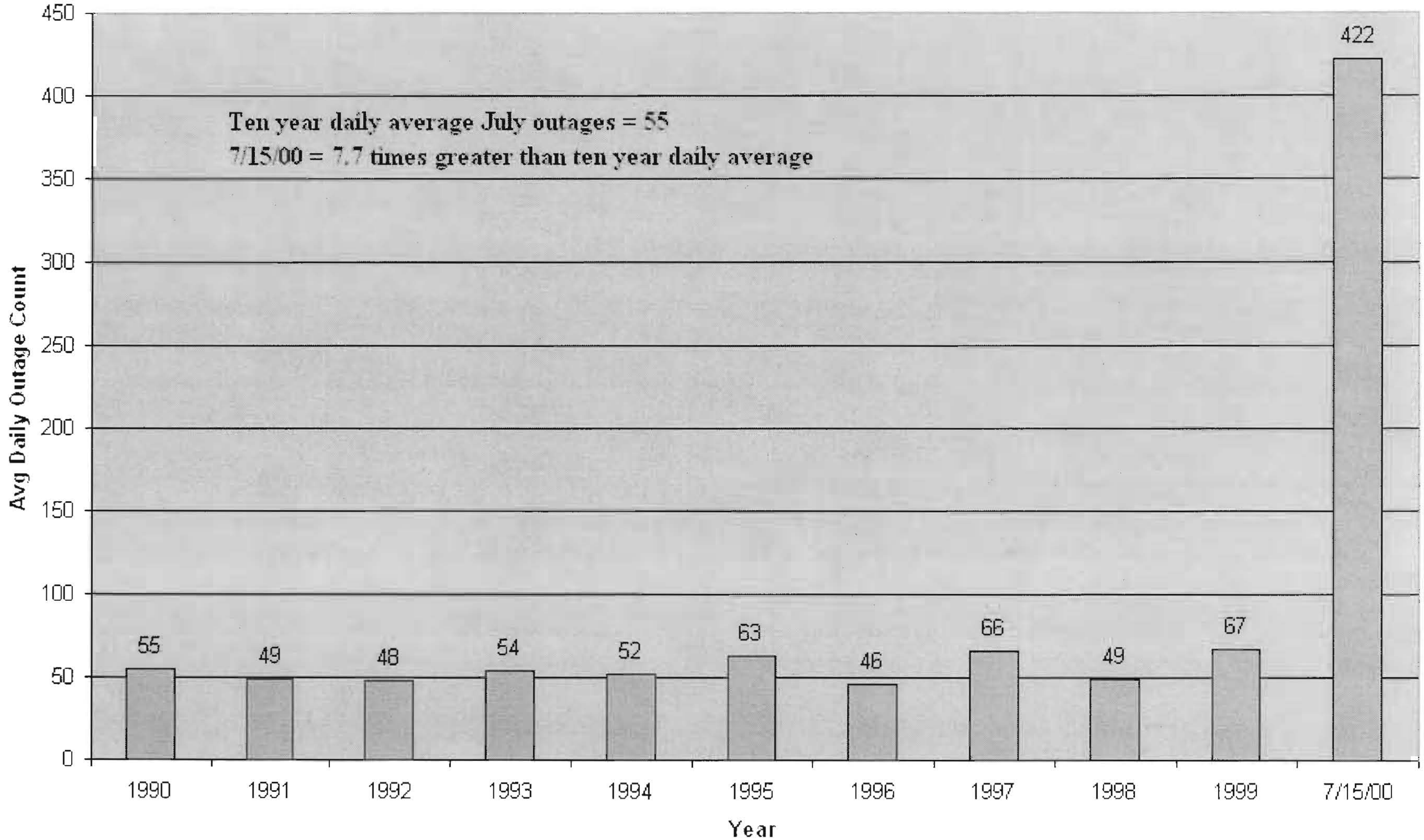
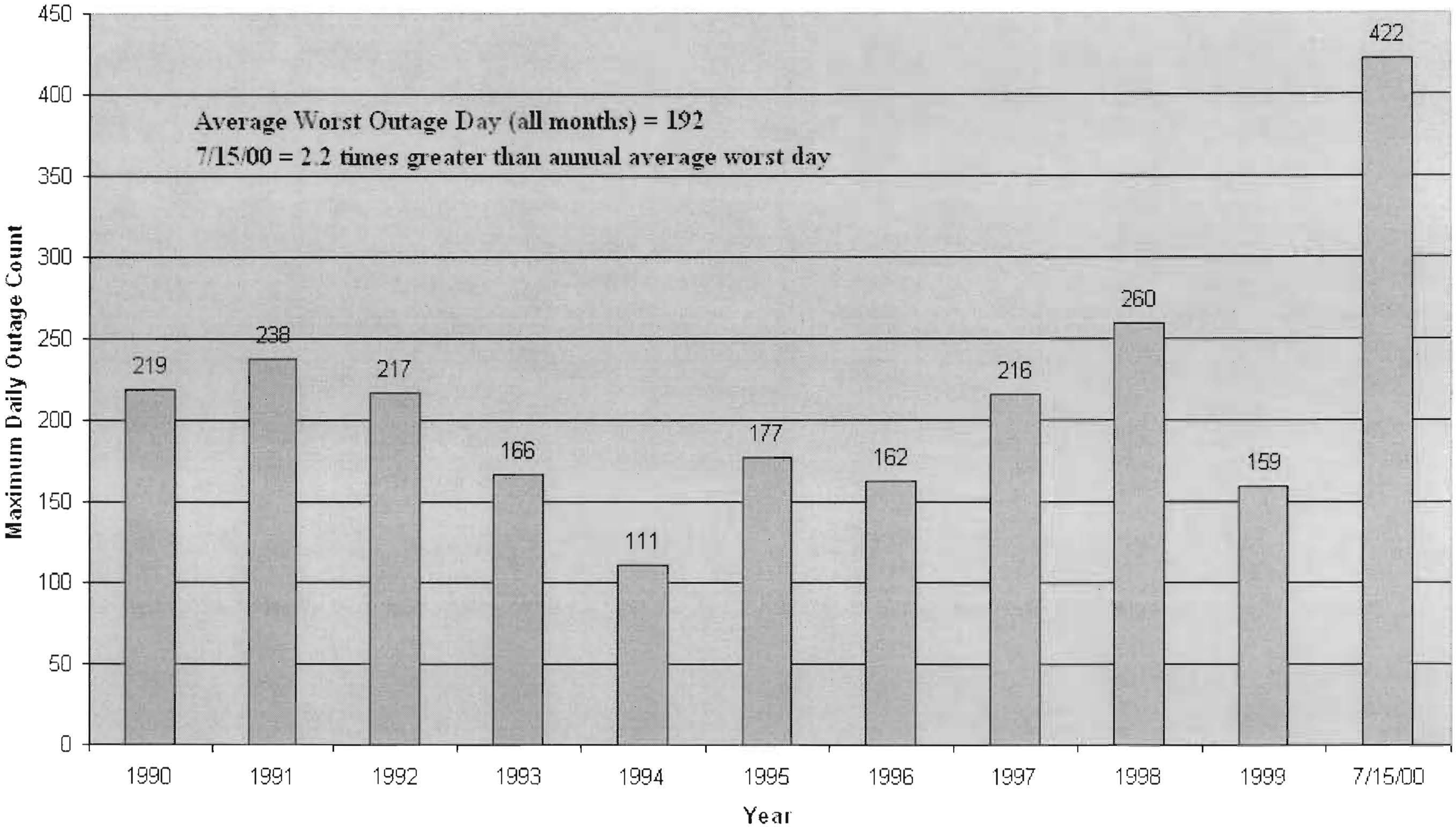
Appendix B
Suncoast Region
Maximum Daily Lightning Flash Count



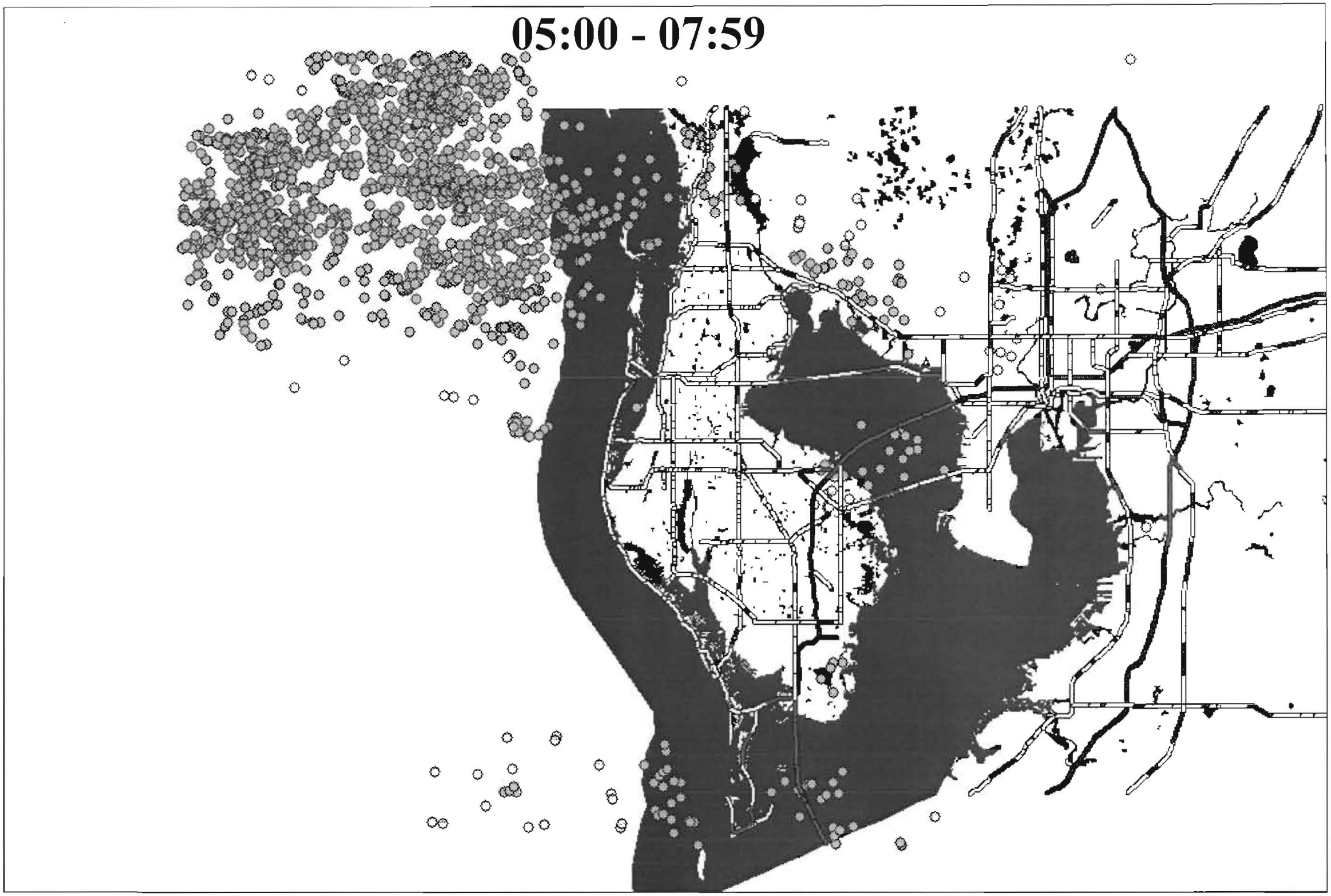
Appendix C
Suncoast Average Daily Outages - July



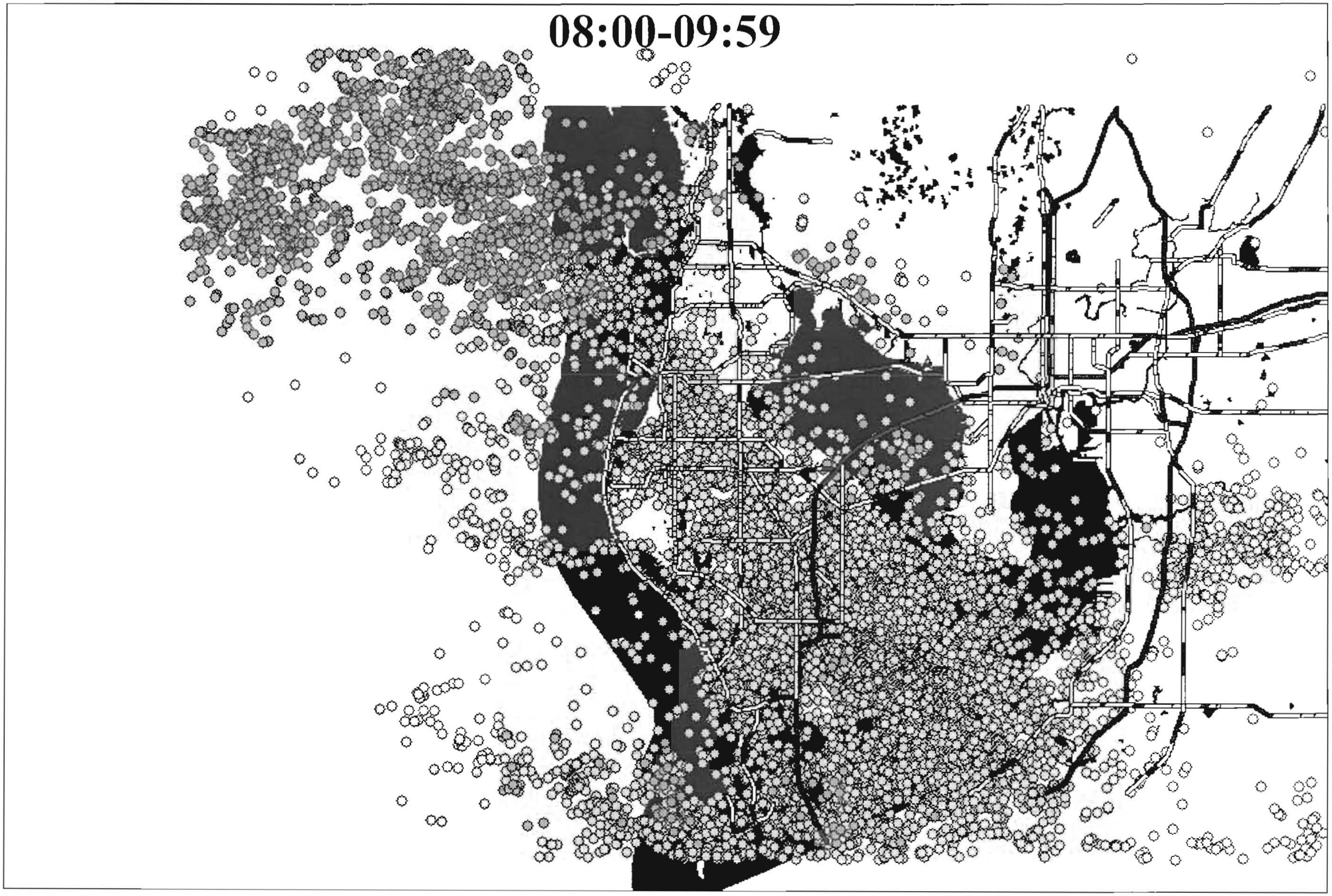
Appendix D
Suncoast Region
Worst Outage Days



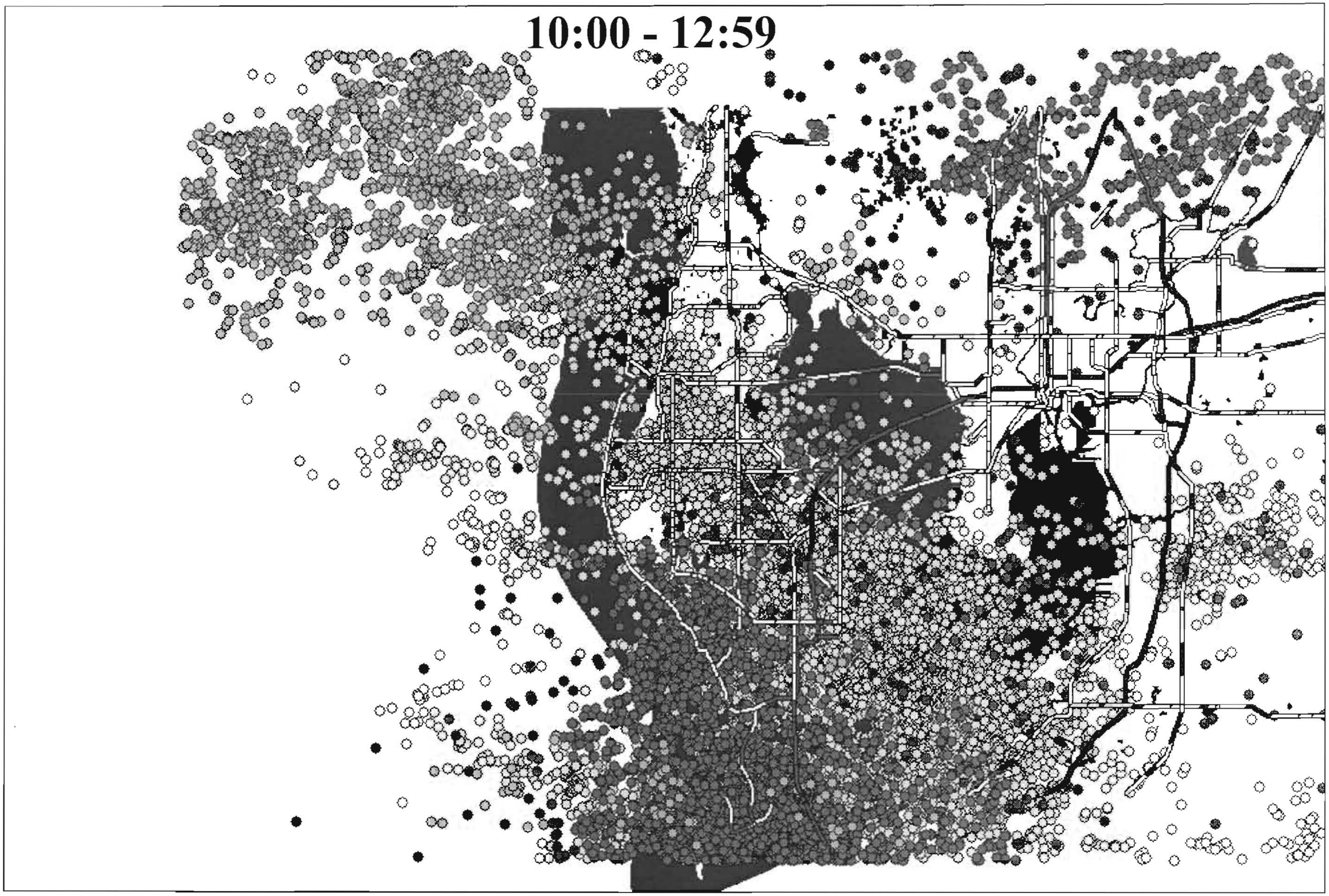
Suncoast Lightning Flashes - 7/15/00



Suncoast Lightning Flashes - 7/15/00



Suncoast Lightning Flashes - 7/15/00



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Attachment 2
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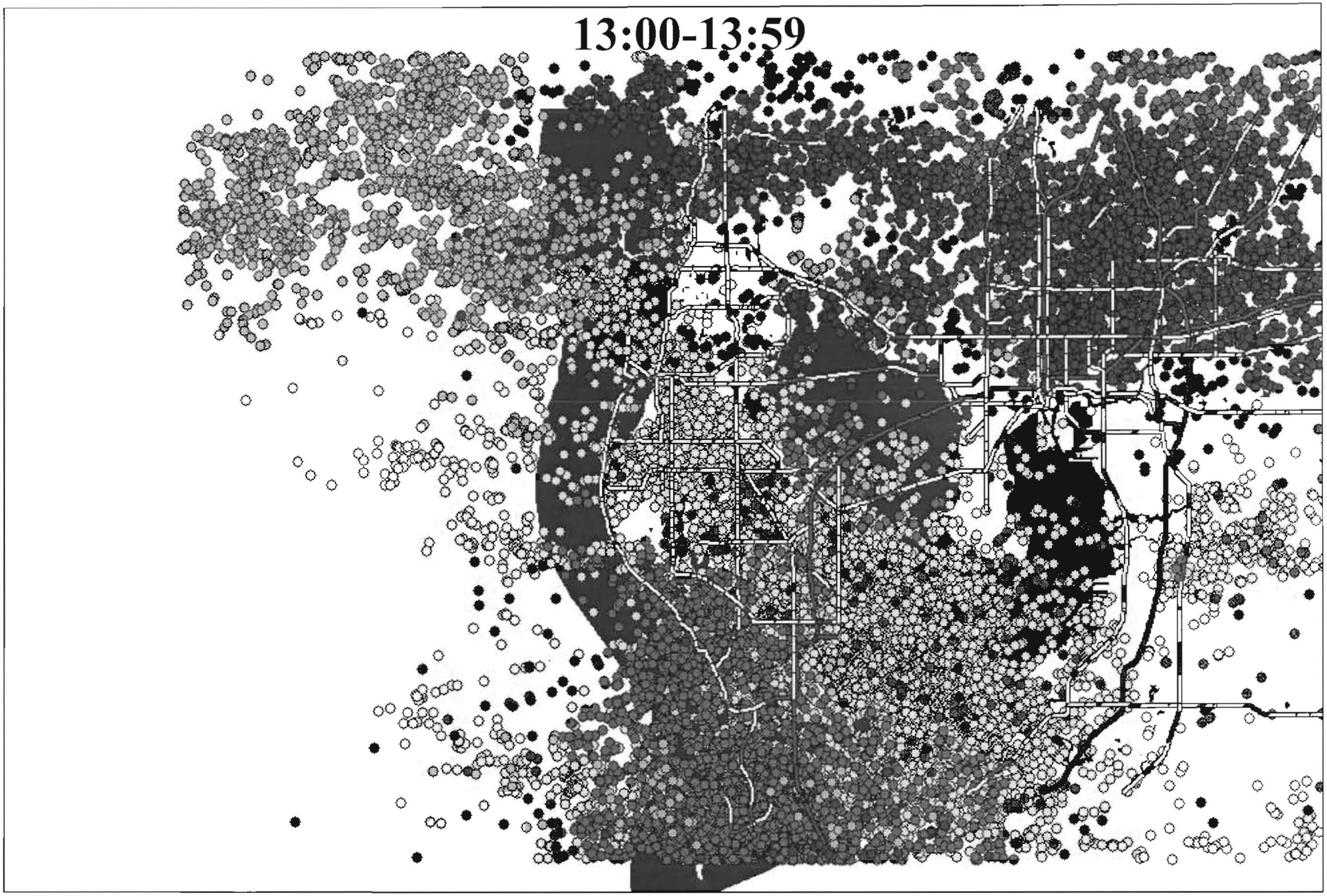
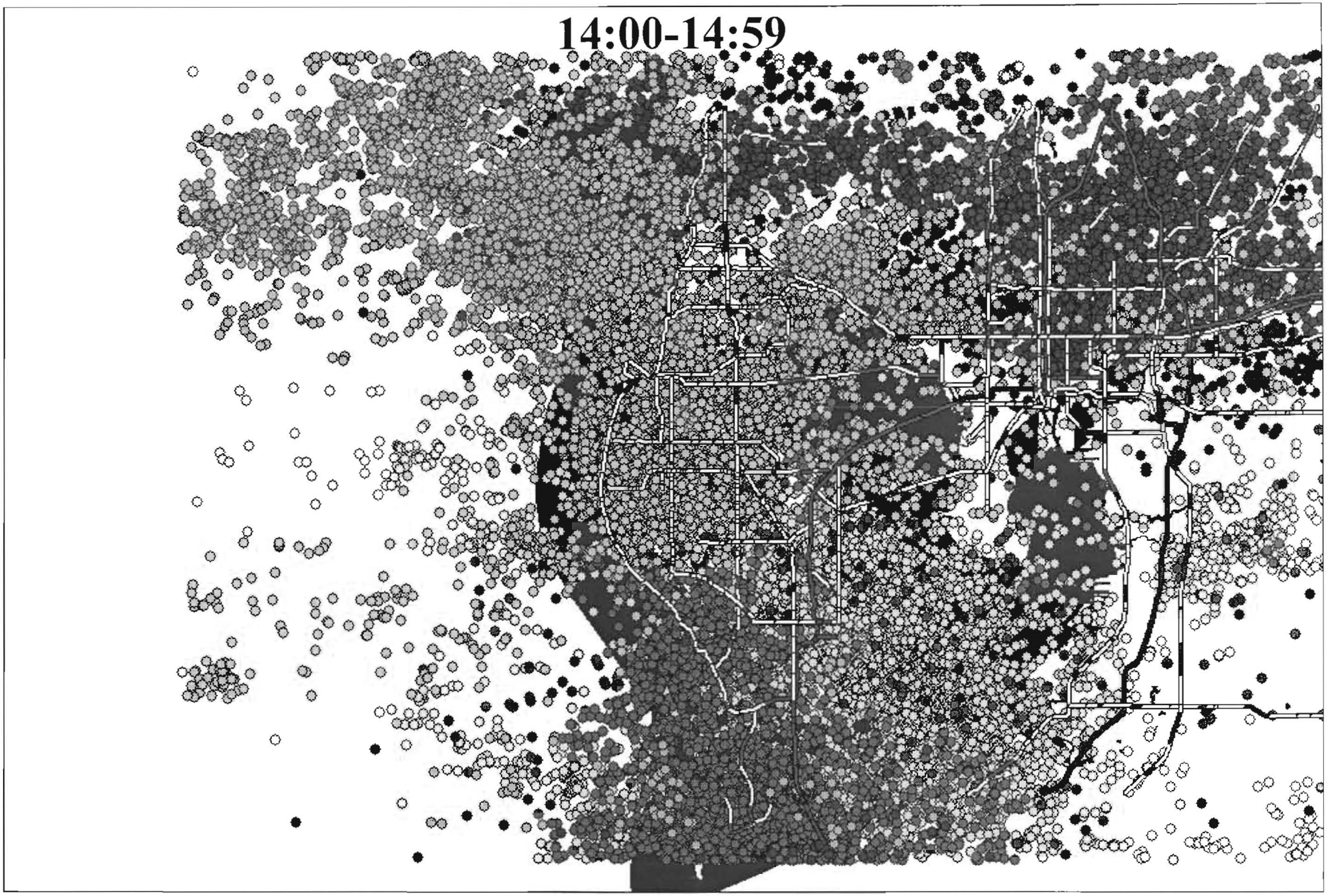
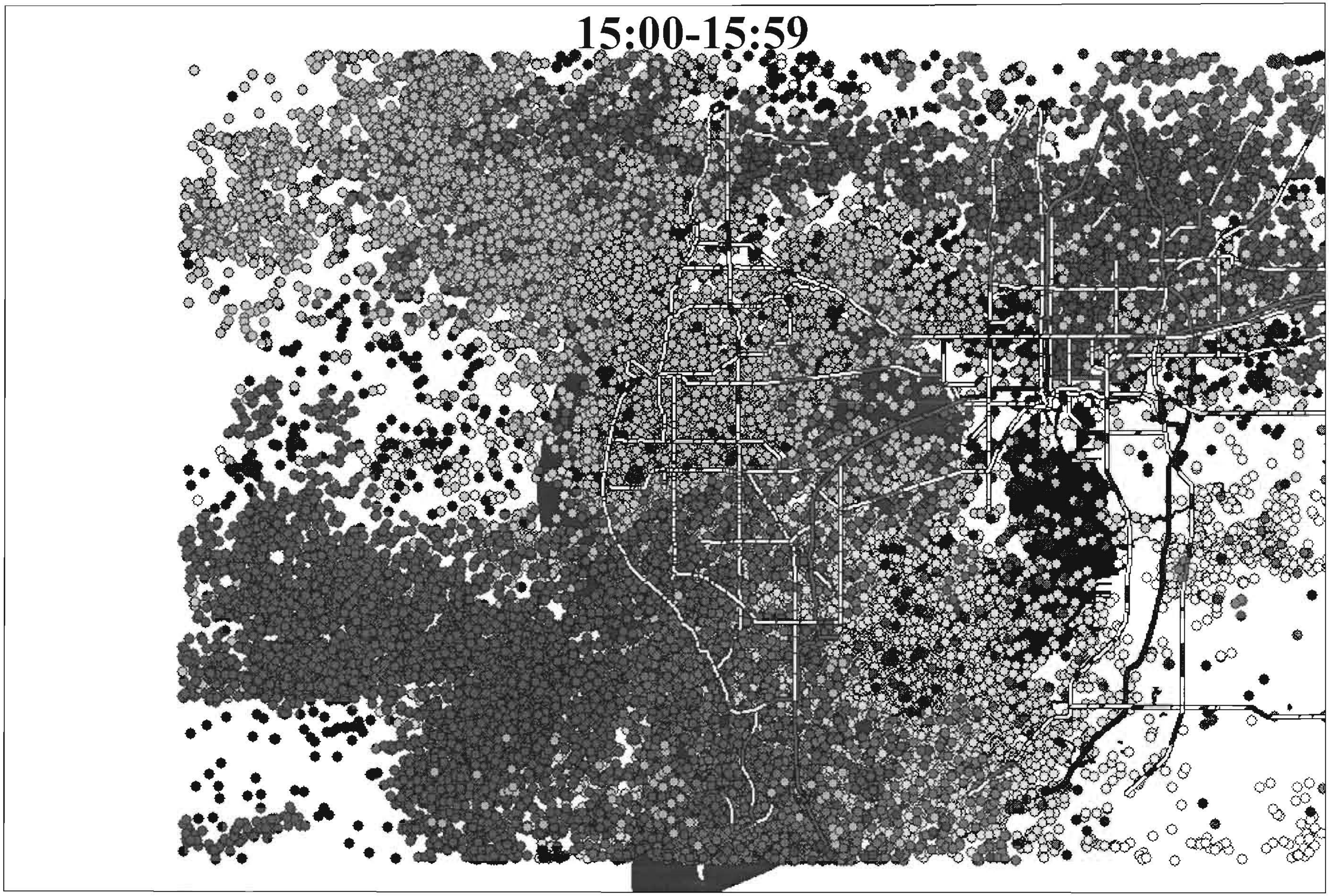
Suncoast Lightning Flashes - 7/15/00



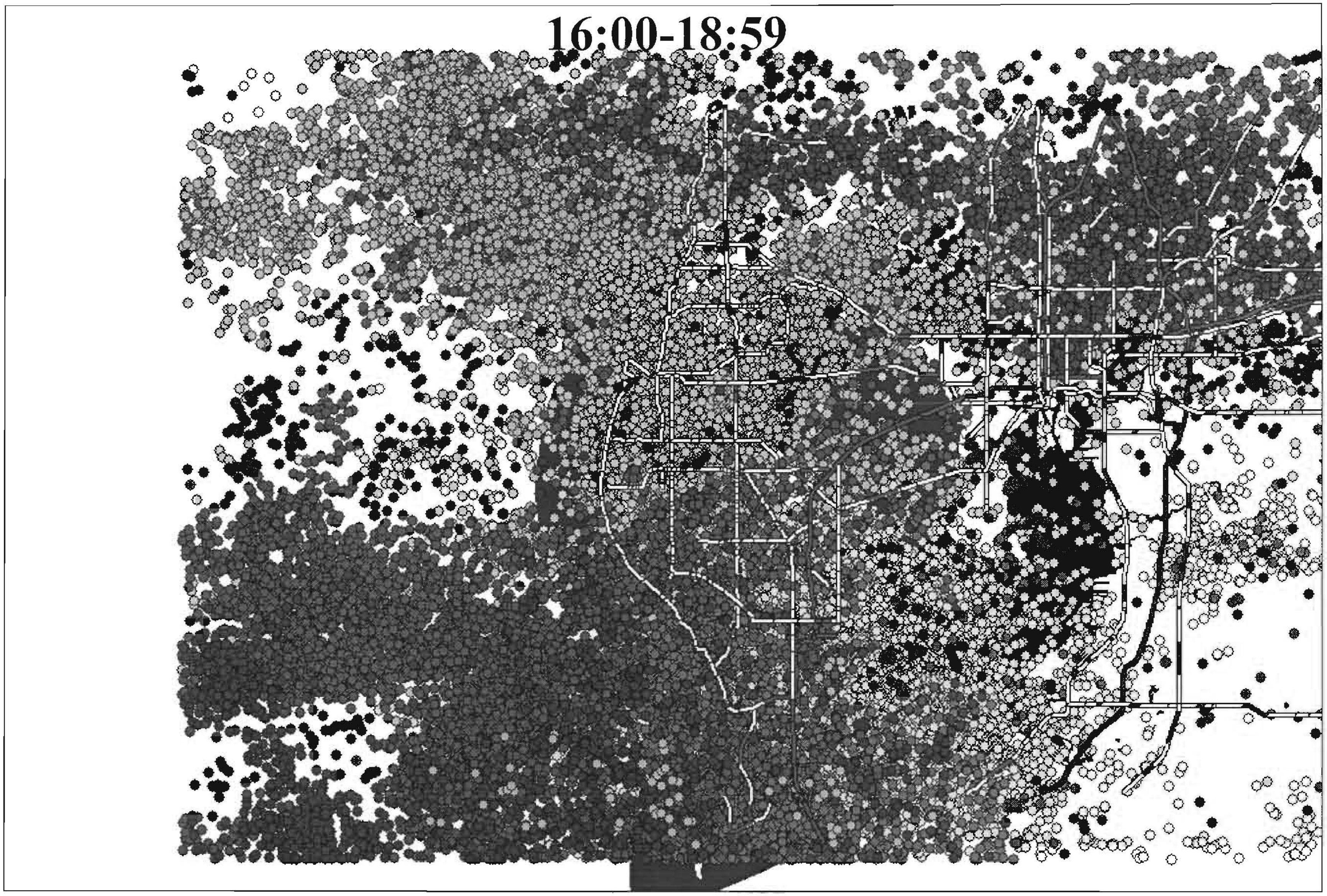
Suncoast Lightning Flashes - 7/15/00



Suncoast Lightning Flashes - 7/15/00



Suncoast Lightning Flashes - 7/15/00



3.0 Company Engineering Policy and Practices in Florida

Each IOU has its own engineering staff that develops each system's engineering and equipment. Each decision should be based on good electrical engineering practices including compliance to the safety code and research noted by organizations such as the Institute of Electrical and the Electronic Engineers and Electric Power Research Institute. The Institute of Electrical and Electronic Engineers governs itself and issue guides, recommendations, and standards. Most utilities consider the Institute of Electrical and Electronic Engineers standards adoptable policy. Company policy is mandated through a corporate engineering manual, construction manual, engineering bulletin, or other means of written documentation.

It should be noted that the Institute of Electrical and Electronic Engineers, which is the primary source of information for electrical engineers, has a national standard for lightning protection and grounding. For example, standard's C62.11 and C62.22 relate to the design and application of MOV arresters.

When examining individual companies, it is important to consider the amount of total line exposure miles and square miles of territory each Florida IOU covers. Including transmission, FPL covers 27,650 square miles of territory and 45,000 miles of lines. FPC covers 20,000 square miles and 27,000 miles of line. TEC covers 2,000 square miles and 11,000 miles of line. Finally, Gulf spans 7,400 square miles and 7,700 miles of line. Chapter 4 further defines exposure on transmission and substations.

There are many ways to protect a system. The best utility engineering practices are constantly debated between professionals, and differences of opinion on best practices are common. However, systems, weather, and equipment performance can vary greatly among companies. Absolute conclusions appear elusive. Each company uses the standard protection devices, as noted in Section 2.1, but they all have distinct variances in the application. Each company's application will be discussed and compared in more detail in the following sections.

3.1 Florida Power Corporation

Much of FPC's territory is located in Central Florida and part of it lies in a densely populated portion that starts in Pinellas county and goes west to east following the I-4 corridor. According to the National Lightning Detection Network, it is a zone that receives more lightning strikes than any other area in North America. FPC's distribution system exceeds 27,000 miles of lines. When compounded with 500,000 strokes of lightning per year, this represents a volatile situation. FPC needs to have the best lightning protection policy because it is in the highest strike zone.

FPC's distribution engineering program for lightning includes the basic elements of MOV arresters at every 1300 feet, submersed arresters in transformers, and a standard BIL of 300KV. FPC states that overhead ground wire is good for direct strikes only and, therefore, has just two feeders using this construction. FPC's standard for distribution ground rod application is 25 Ohms or less.

The utility has a specific written policy guide on lightning protection. However, staff noted during the review that the policy needs to be updated. FPC has committed to rewrite it. Additionally, FPC's transmission, substation, and distribution overhead construction specifications lightning philosophy needs updating to reflect changes made in the last five years. These two items are addressed in Chapter 5.

FPC has found that using internally mounted overhead or underground primary and secondary transformer arresters utilizes the dielectric (nonconductive) strength of the oil. This configuration stops water intrusion and contamination the externally mounted arrester is constantly exposed to. Thus, it mitigates problems caused by constant exposure. The company started using this type of transformer in 1997.

FPC provided data that the use of submersed arresters has lowered its failed transformer rate. Prior to 1996, the overhead failure rate was .486 percent with 31,834 units in service. Subsequently, in 2000, the rate was .375 percent on 32,317 units. The end result is a 30 percent reduction in the failure rate. At an average transformer cost of $1000 each, excluding labor and material, this could equate to savings of millions of dollars. This would also decrease outages and benefit reliability results.

In 1997 and 1998, FPC commissioned several in-house reliability studies on lightning and line design performance, as well as overall weather trends. In the detailed conclusions regarding line design, FPC engineering states:

- The only method that will significantly improve lightning protection is to build the distribution with an overhead static wire construction in open unshielded areas, with high insulation and low Ohm ground rod resistance
- Increase basic insulation levels above 300 KV
- Performance of Delta and Vertical line construction is very similar, crossarm is poor (metal braces and greater exposure)
- Lightning arresters are not that ground sensitive
- Changing arrester spacing from 1300 feet down to 600 feet decreases the flashover rate by a factor of four

These conclusions provide useful data for consideration by all electric utilities. First, in optimum circumstances, shielding should be considered as the best protection against lightning. Second, if that is not feasible, construction should be vertical stand-off or delta since both types have high BIL because each uses fiberglass. Vertical construction consists of installing "stacked" conductors one under each other thus limiting exposure to lightning. In the same context, delta is a triangular configuration and crossarm construction is horizontal. Crossarm configuration exposes all three conductors to a strike. Third, if options one and two are not feasible, arresters should be installed every 600 feet.

FPC has also considered the effect weather has on its transmission and substation facilities. In its substations on the 69 KV line, the company has started to install surge arresters together with the SF6 (gas insulated) circuit breakers. It also employs a program to change all aged silicon carbide station arresters to the newer MOVs. FPC builds its substations to comply with the American National Standards Institute and the Institute of Electrical and Electronic Engineers Standard 80-1986.

In a joint effort by FPC and the insulator manufacturer, the company has built one 69 KV transmission line with MOV arresters in lieu of the overhead static wire. Results have not been totally evaluated, but preliminary observations are positive. Additionally, the insulator standard was changed to a polymer instead of the older porcelain types, which increased basic insulation.

Additionally, FPC took its reliability program one step further. As part of the program implementation, training was given to field inspectors so they could identify system weaknesses. Line crews were given hands-on training to give them familiarity with basic insulation levels, how to take corrective action, and specific instructions on their part in reliability. Additionally, engineering personnel were given training on basic lightning protection. Lastly, the utility participates in the lightning study conducted by the University of Florida in Camp Blanding, Florida. Referred to as the Camp Blanding Project, this joint endeavor is discussed further in the following section.

3.2 Florida Power & Light Company

FPL is Florida's largest utility and, therefore, has the greatest total lightning exposure. According to FPL, 25 percent of its outages are related to lightning. Since lightning is a major problem, FPL's engineers have taken a proactive approach to mitigate interruptions. In its Distribution Engineering Reference Manual, the company found that poor grounding, inadequate pole bonding, and poor workmanship render arresters and overhead ground wires useless in any distribution system.

FPL's reference manual has extensive information and policies on lightning defense. Staff believes that FPL's engineering manuals are well written and expansive and present a model for all IOUs. In past studies, FPL concluded that several improvements in the overall surge protection

3.5 Comparison and Staff Analysis

Exhibit 4 summarizes each company's lightning protection engineering philosophy for distribution facilities. The four companies reviewed are quite similar in the most basic areas of lightning defense. A distinct difference is transformer protection. For instance, in the matter of the primary arrester, FPL was most adamant that the arrester was a sacrificial part of the system and that it should not be hidden away inside a transformer. In contrast, FPC endorses the submersed technique and has had apparent success with it. Gulf adopted internal arresters for all its underground transformers for the past ten years. TEC asserts that both the submersed and mounting the arrester on the tank methods are unproven concepts.

IOU Lightning Protection Comparison for Distribution

Engineering Method	FPC	FPL	TEC	GULF
Types of arresters used	heavy duty MOV	heavy duty MOV	heavy duty MOV	heavy duty MOV
Arrester stations-feeder line footage, wood poles, rural and open areas- at every	1300 ft	600 ft (on triangular construction)	1300 ft	1200 ft; 600ft in high lightning areas
Use of OHGW	yes-limited to two 25 KV feeders only; not a preferred std.	yes-limited to 12 feeders only; not a preferred std.	no	yes-limited to 2 feeders only; not a preferred std.
Mounting of Transformer (TX) primary arrester	on and inside TX	on TX	on pole	on pole-OH inside TX on UG
Transformer service side low voltage arrester used	yes	no	no	no
Computer software for lightning stroke correlation	yes	yes	no	no
BIL KV (tangent wood poles)	300	350	350-400	350-500
Ground rod application-Ohms	25	25 but 10 is desired	25 or less	25 or less
UG Elbow, parking, bushing arresters used	yes	13 KV- no 23 KV-yes	no	yes, but may discontinue because of internal arrester in URD TX

EXHIBIT 4 *Source: Document Requests 1-1 through 1-16.*

Velazquez No. 1: Pole 133647-039450 on Frontage Rd between Towerview Dr and 7th St. Vines have engulfed a transformer.

(Lake Wales area)

Velazquez No. 2: Adjacent to pole 133647-039450 on Frontage Rd between Towerview Dr and 7th St. Tree limbs at several locations in this general vicinity are contacting the power line.

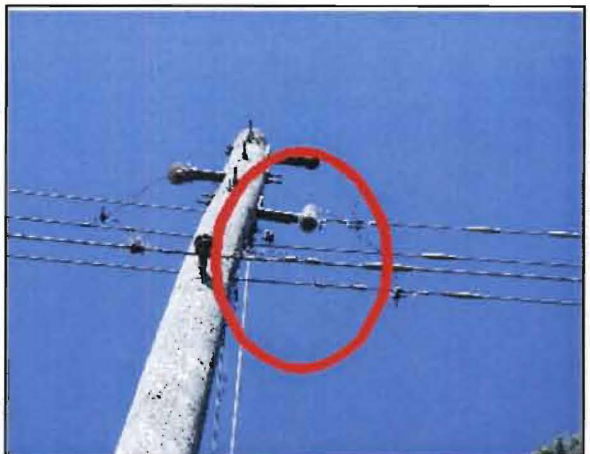
(Lake Wales area)

Velazquez No. 3: Across from pole 6357034 on Scenic Hwy (Alt 27) between Egg Farm Rd and Mountain Lake Cutoff Rd. Vines are encroaching on primary lines here and at various locations along this stretch of highway.

(Lake Wales area)

Velazquez No. 4: Approximately 1/10 of a mile south of pole 6357034 on Scenic Hwy (Alt 27). Vines have engulfed a capacitor bank.

(Lake Wales area)

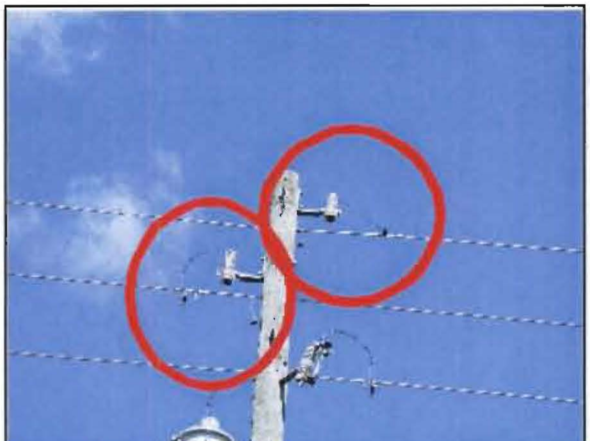


Velazquez No. 5: Pole 6-61554 on Poinciana Pkwy approximately ½ mile south of Lake Marion Creek Drive. Bottom of lightning arrester on lowest phase failed.

(Poinciana area)

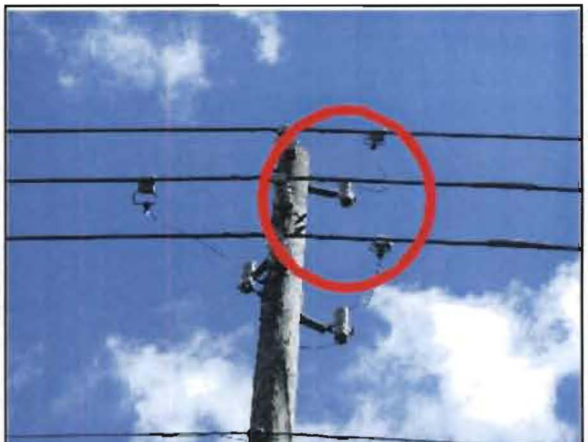
Velazquez No. 6: Next to pole 136062-045422 on Poinciana Pkwy approximately 2/10 of mile south of Lake Marion Creek Dr. Bottom of lightning arrester on top phase has failed. Note: The grounding conductor wraps around the highest insulator on the front side of the pole with the lightning arrester connection resting on top of the insulator. The grounding conductor-arrester connection can fall from its perch on the insulator and come in contact with the stinger wire of the top phase and cause a phase to ground fault on that phase.

(Poinciana area)



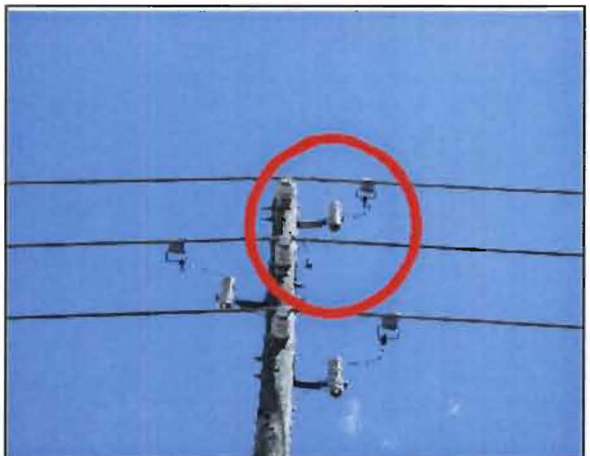
Velazquez No. 7: Pole 135140-045580 on Poinciana Pkwy, 2 poles north of Lake Marion Creek Dr. Lightning arresters on the top two phases failed.

(Poinciana area)



Velazquez No. 8: Pole 6-65409 on Hemlock Ave approximately 3/10 of a mile northwest of Poinciana Pkwy. Bottom of top phase lightning arrester failed.

(Poinciana area)

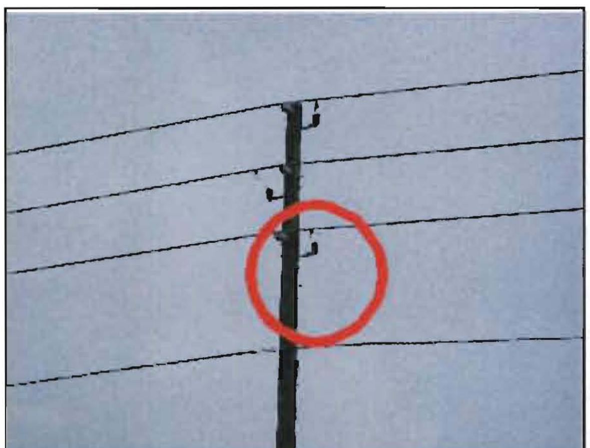


Velazquez No. 9: Pole 6-65413 on Hemlock Ave just southeast of Flounder Rd. Bottom of top phase lightning arrester failed.

(Poinciana area)

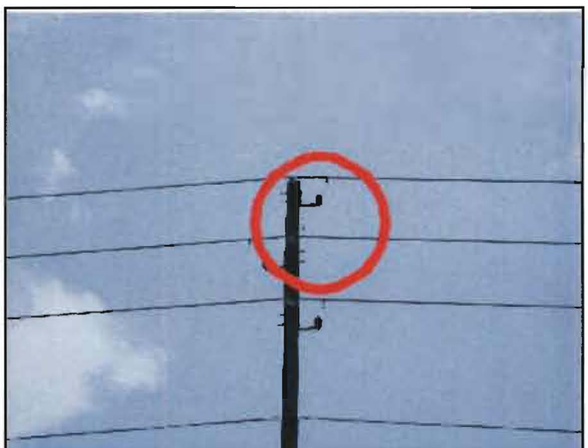
Velazquez No. 10: Pole at corner of Laurel Ave and Halibut Rd. Connection of failed lightning arrester can be seen between the arrester and the fuse holder on the right-hand side of the pole.

(Poinciana area)



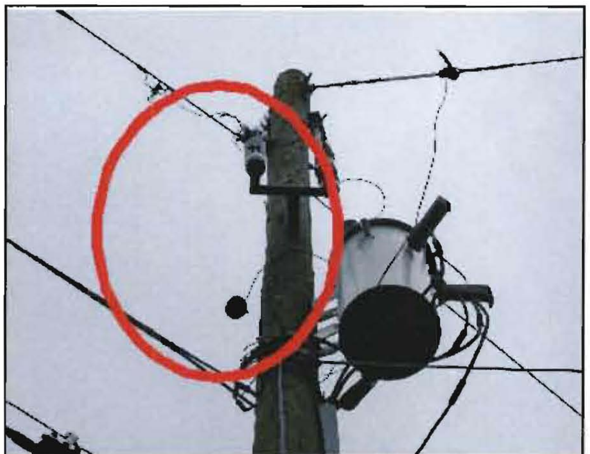
Velazquez No. 11: Pole on KOA St approximately 1/10 of a mile east of Monterey Rd. Lowest phase lightning arrester failed. Connection dangling beside pole.

(Poinciana area)



Velazquez No. 12: Pole on KOA St approximately 1/10 of a mile west of Monterey Rd. Highest phase lightning arrester failed.

(Poinciana area)



Velazquez No. 13: Pole 136852-049312 on San Lorenzo Rd just north of Taranto Wy. Bottom of failed lightning arrester dangling on left side of pole beside transformer.

(Poinciana area)

Velazquez No. 14: Pole on Laurel Ave. approximately 2/10 of a mile north of Monterey Rd. Highest phase lightning arrester failed. Bottom of arrester cab be seen on left of pole between the top two phases.

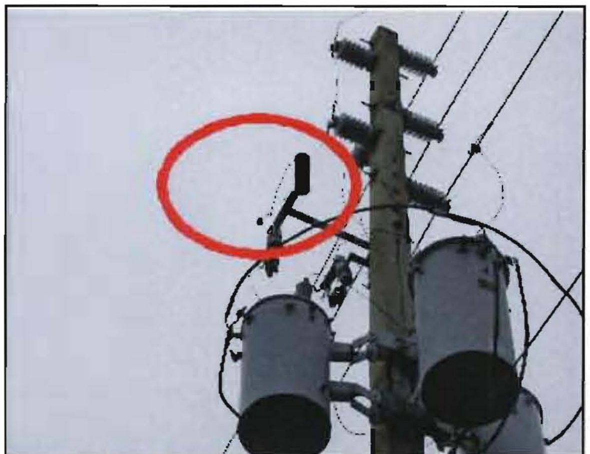
(Poinciana area)

Velazquez No. 15: Pole next to 1915 10th St. Lightning arrester failed. The connector is dangling on left of pole beneath fuse holder.

(Haines City area)

Velazquez No. 16: Pole 6-75351 in front of 2604 4th St South. Top phase lightning arrester failed. Connector dangling on right side of pole beneath arrester.

(Haines City area)



Velazquez No. 17 Pole 132108-047324 at Lily Ave East and 9th St North. Lightning arrester of leftmost transformer failed. Connector is dangling to left of fuse holder.

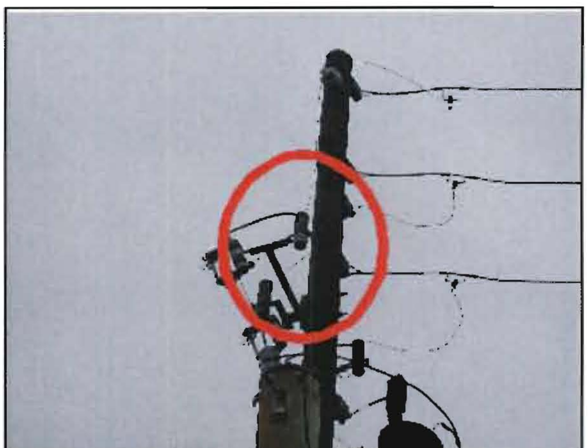
(Haines City area)

Velazquez No. 18: Pole 132110-047260 at Ingraham Ave and 9th St North. Lightning arrester of leftmost transformer failed. Connector cannot be seen in photo, it is hidden behind fuse holder.

(Haines City area)

Velazquez No. 19: Pole 132477-044360 on Ridgewood Ave, first pole east of 6th St. Lightning arrester failed. Connector can be seen directly below arrester.

(Dundee area)

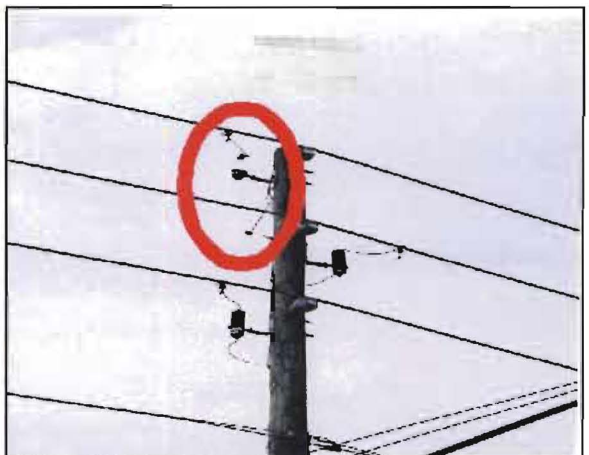


Velazquez No. 20: Pole 6-77498 on Lake Mabel Loop Rd just east of Lake Trask Rd. Lightning arrester failed. Connector can be seen next to fuse holder.

(Dundee area)

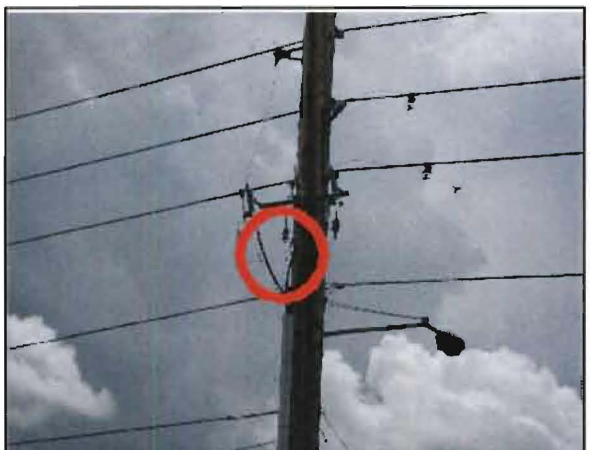
Sobrino No. 1: South side of US 192 just east of US 441 at Holopaw. Broken ground line on lightning arrester.

(Holopaw area)



Sobrino No. 2: Pole #972990 on Sand Hill Rd., ½ mile west of Old Lake Wilson Rd. Failed lightning arrester.

(West Kissimmee area)



Sobrino No. 3: Pole #136404/056017, on SR 535, ½ mile north of US 192 on parking lot of Lake Buena Vista Factory Outlet. Failed lightning arrester.

(Kissimmee area)

Sobrino No. 4: Pole #136344, ½ mile north of previous location on SR 535. Failed lightning arrester.

(Kissimmee area)

Sobrino No. 5: Pole is located by the Bay Meadows Elementary School on CR 435. Failed lightning arrester.

(Kissimmee area)

Sobrino No. 6: Pole is located at the intersection of Magnolia St. and 6th Ave., north on CR 435 and west on CR 439 towards Windermere. Failed lightning arrester.

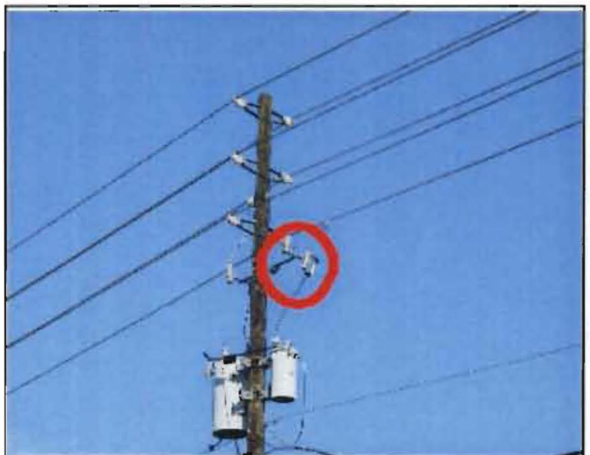
(Windermere area)

Sobrino No. 7: Pole is located across the street from 19 Main St., Windermere. Failed lightning arrester.

(Windermere area)

Sobrino No. 8: Vegetation problem at the intersection of Lake Butler Blvd. and Park Avenue, Windermere.

(Windermere area)

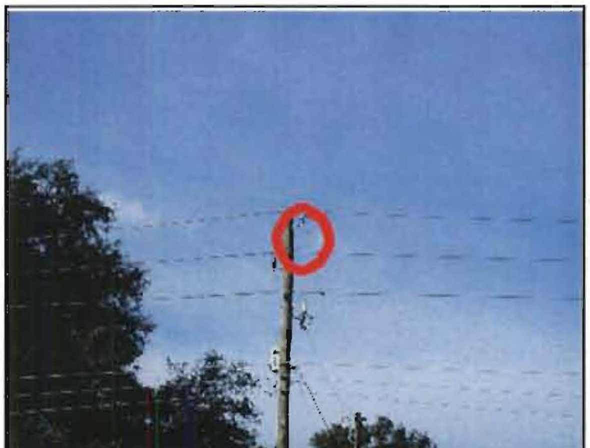


Sobrino No. 9: The pole is located just east of Lexington Avenue on US 92. Failed lightning arrester.

(De Land area)

Sobrino No. 10: The pole at the intersection of CR 15A and Trail-in-the-Pines Ave. Failed lightning arrester.

(De Land area)



Sobrino No. 11: The pole is on US 17 south of De Leon Springs. Failed lightning arrester.

(De Land area)

Sobrino No. 12: The pole is located at the northeast corner of Amelia Ave. and New York Ave., De Land. Failed lightning arrester.

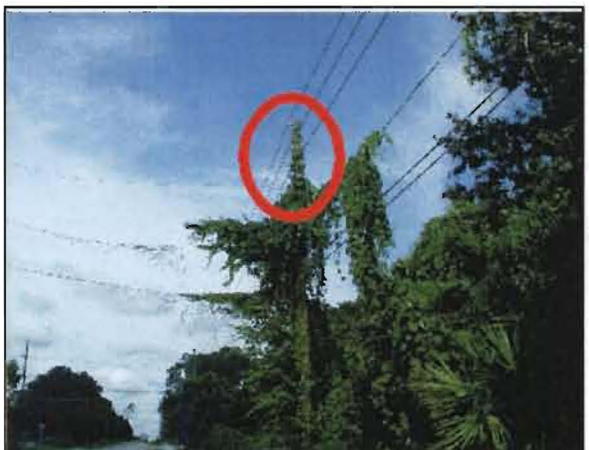
(De Land area.)

Sobrino No. 13: Pole #142597 located on Enterprise Road, 5 poles north of Saxon Road. Failed lightning arrester.

(Deltona area)

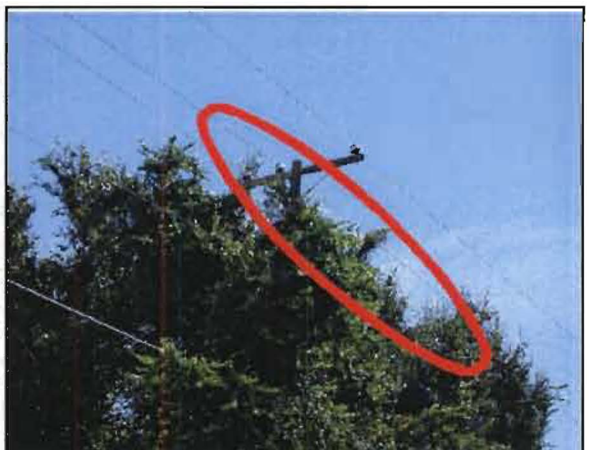
Sobrino No. 14: Failed lightning arrestor on pole serving 1440 Normandy Blvd., Deltona.

(Deltona area)



Sobrino No. 15: Vegetation variance at Highbanks Road and Gracie Road.

(DeBary area)



Sobrino No. 16: Vegetation variance on Dirksen Dr. and Aqua Vista St.

(DeBary area)

Sobrino No. 17: Failed lightning arrester on Dirksen Dr. and Fredricka Road.

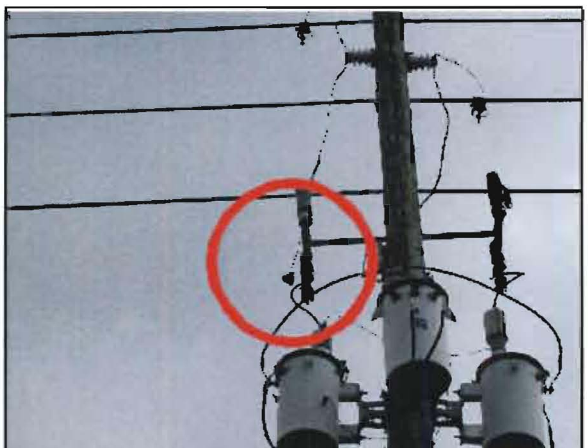
(DeBary area)

Sobrino No. 18: Failed lightning arrester at Semoran and Wilshire Blvd.

(Casselberry area)

Sobrino No. 20: Three failed lightning arresters on the same pole at SR 426 and Eastbrook Ave. Photograph No. 19 is of the same pole and not included.

(Goldenrod area)



Sobrino No. 21: Two blocks east of previous pole in photograph No. 20. Failed lightning arrester.

(Goldenrod area)

Sobrino No. 22: Pole # 131190, serving 18515 US 441, north of Mount Dora. Failed lightning arrester.

(Mount Dora area)

Sobrino No. 23: Failed lightning arrester in front of Eustis Square, on US 19, in Eustis, Florida.

(Eustis area)

Sobrino No. 24: Failed lightning arrester just north of previous photographed pole along US 19 in Eustis.

(Eustis area)

Sobrino No. 25: Pole #130168, located on Key Ave. and a half block east of S. Grove St. (US 19). Failed lightning arrester.

(Eustis area)

Sobrino No. 26: Failed lightning arrester one block north of the previous photograph (See No. 25). The pole is located on the corner of Ward Ave. and S. Grove St.

(Eustis area)

Sobrino No. 27: Failed lightning arrester at 38851 US 19, Umatilla, Florida.

(Approximately 5 miles north of Eustis area)

Sobrino No. 28: Failed lightning arrester on pole #723187.

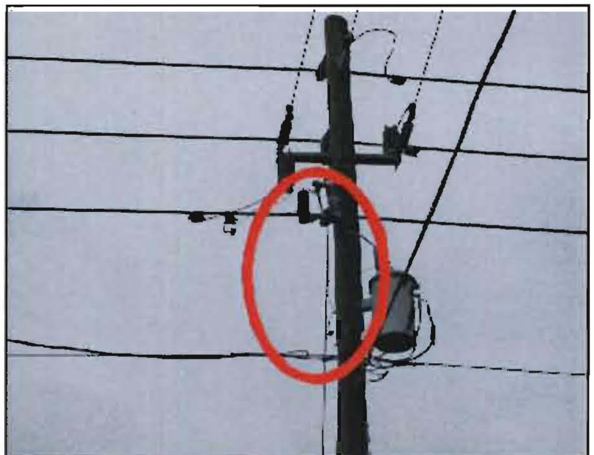
(Eustis area)

Sobrino No. 29: Failed lightning arrester on pole #129215 at the entrance to Lake Yale Landing.

(Eustis area)

Sobrino No. 30: Failed lightning arrester at the pole on CR 561 near Leatrice Drive and at the entrance to Sugar Ridge Estates.

(Clermont area)



Sobrino No. 31: Failed lightning arrester at the corner of US 27 and Lake Minneola Shores Blvd.

(Clermont area)

Sobrino No. 32: Failed lightning arrester along SR 50 between Clermont and Groveland at the entrance to Green Valley Country Club.

(Clermont area)

Sobrino No. 33: Failed lightning arrester along Hartwood Marsh Road approximately 1/4 mile south of the entrance to the Tarmac quarry.

(Clermont area)

	
Sobrino No. 32: Failed lightning arrester approximately three miles from the entrance to Tarmac quarry on Hartwood Marsh Road. (Clermont area)	Sobrino No. 33: Failed lightning arrester on E. Bay Street one pole west of Ninth Street. (Winter Garden area)

Transmission & Distribution World

Northern Utilities Optimize Lightning Arrester Placement

By Jennifer Johnson, Minnkota Power Cooperative Inc., and David Van House, Minnesota Power

Transmission & Distribution World, Dec 1, 2002

In 1994, Minnkota Power (Grand Forks, North Dakota, U.S.) embarked on a program to improve power quality within its system. The scope of the project was to provide a method of increasing system reliability by reducing lightning-caused outages. The initial plan was to add lightning arresters to the existing 69-kV transmission lines, add fault-locating distance relays and use a real-time lightning-detection system.

Arrester and relay installation began in 1995, and by 1999, Minnkota Power had installed 30 fault-locating distance relays and more than 360 miles (579 km) of arresters to its transmission lines. The utility used the real-time lightning-detection system for one year before it was discontinued because of limited application.

When Minnkota Power implemented the initial plan, it decided it would review the program after a couple of years to determine its effectiveness and to make any necessary modifications or changes. The utility conducted preliminary studies in 1996 and 1999, and more complete analysis in 2001. This current study contains five years of lightning and operations data from 1996 to 2000.

Study Process

Minnkota Power contracted with Minnesota Power (MP; Duluth, Minnesota, U.S.) to use the Fault Analysis and Lightning Location System (FALLS) to correlate which faults on its 69-kV lines were attributed to lightning. The FALLS software uses line location, fault time and lighting data from the National Lightning Detection Network (NLDN) as inputs. Outputs include information on lightning strokes that correlate both spatially and temporally to a fault event including the stroke location, arrival time and stroke current. The software will also provide information on line stroke density, flash density and peak current histograms of area lightning activity.

For study purposes, Minnkota Power provided MP with fault times and geographic information system (GIS) data files for the 69-kV transmission lines. This study included line sections from seven separate breakers across the Minnkota system. Line sections ranged from 20 to 83 miles (32 to 134 km) in length and covered areas in North Dakota and Minnesota. Minnkota's system control center provided fault times listing the dates, times and probable causes of breaker operations.

MP loaded the fault times into the FALLS fault database, converted the GIS files from

AutoCAD to MapInfo format and imported them into the FALLS GIS. MP then ran a fault-correlation analysis for each fault. The correlated faults were plotted and characteristics such as peak current and stroke time were exported to an Excel spreadsheet for further analysis.

In addition to the fault analysis, MP completed an annual exposure analysis for each line. This provides information on the number of cloud-to-ground lightning events that occurred in the line proximity. Both stroke data and flash data were used in this analysis, and again, lightning characteristics such as peak current and stroke time were exported to an Excel spreadsheet. In this format, the data can be sorted and categorized to show possible lightning trends or patterns. Lastly, stroke and flash density area maps were plotted on each line. This allowed Minnkota the ability to readily see if some lines, or portions of a line, were more exposed to lightning than other areas.

Fault Analysis

The fault-time data Minnkota provided was accurate only to plus-or-minus one minute. Timing such as this is generally adequate if the only goal is to determine whether lightning caused the fault. However, if the goal is to determine if line performance is improving, it has several shortcomings. One of these shortcomings, for example, is that faults often correlate temporally to more than one stroke. In this example, stroke currents range from -8 kA, which should be below the fault threshold of an arrester protected line, to -33 kA, which is at or above the fault threshold for footing resistances greater than approximately 50 ohms. Since the NLDN typical location accuracy is ±500 m (±1640 ft), it is not always possible to determine which stroke actually terminated on the line and caused the fault.

Over a short period of time, it may be difficult to say for certain that performance has improved without better fault timing. This is because lightning activity can be highly variable, and it will not always be possible to determine which stroke actually caused a fault. However, over a long period of time, a utility can collect enough data so that any improvement in performance will become discernible. Since FALLS provides more than just fault-correlation information, it will reduce the time period required to obtain meaningful results, even without accurate fault timing.

Another shortcoming was the inability to determine exactly where on the line the fault occurred. This is important because portions of some lines did not have arresters. For example, in the figure on the left, the strokes were correlated spatially over three different areas of the line separated by distances greater than 10 miles (16 km). From this, it is not possible to tell if the fault occurred on the portion of the line with arresters, or the unprotected areas.

One method to resolve this issue would be to use relay-fault location data to determine more precisely where the fault occurred. This approximate location will then help to determine which stroke most likely caused the fault and also allow for line inspection following any operations. Minnkota's experience with fault-locating relays demonstrates its accuracy in determining fault locations. Recently, a blown post top insulator was located using the distance indicated on the fault-locating relay. This type of relaying data is instrumental for determining the location of a problem and allowing for quick repairs. Since half of all operations are non-lightning related, it is a good practice to have in place another means of assessing the situation.

Lightning Exposure Analysis

MP provided tables of correlated lightning stroke current to Minnkota to determine if any pattern occurred that would indicate improved performance. For example, the utility can use the table of all correlated fault currents to determine if the typical fault-inducing stroke current increased after the arresters were added.

In addition to the fault correlations, MP also provided Minnkota Power with information on each line's annual lightning exposure, a multi-year exposure summary and a table of stroke currents of all lightning strokes located within 1 km of each line. This information allowed Minnkota to determine if it could attribute any increase or decrease in fault numbers to changes in lightning exposure, which had substantial yearly variations.

Evaluation of FALLS Study Results

The first step in the evaluation process was to categorize the lightning data above or below 50 kA. MP conducted an EMTP study to determine this demarcation line. If the expected stroke current withstand is calculated as modeled in EMTP, then the line-exposure data combined with the peak current information can be used to estimate expected performance. These estimates can then be compared to see if performance has improved based on the transmission line's actual exposure.

Any known line-performance improvement takes into account only those lightning strikes that are deemed preventable because arresters are unable to protect against some of the stronger lightning strikes. The EMTP analysis of Minnkota's structures revealed that 50 kA is the maximum level of arrester protection.

For example, EMPT studies indicated that without arresters, virtually any direct strike to the line would result in a fault. It also indicated that with arresters and a 50 ohm footing resistance, the line could withstand a 30 kA stroke. With a footing resistance of 25 ohms or less — the resistance Minnkota attempted to achieve when installing arresters — the line should be able to withstand a stroke to the line of approximately 40 to 50 kA.

The next step in the analysis process involved conducting a line-by-line assessment of operations. Each year operations were categorized and charted as lightning induced above and below 50 kA, and those that were non-lightning related. The overall results indicated that about 45% of all operations were lightning induced. Of these lightning strikes, 23% were in excess of 50 kA. Taking this 50 kA limitation into account, arresters are capable of preventing about 77% of the total lightning challenges assessed in this study. Therefore, the utility can reduce 77% of the 45% of lightning outages that register less than 50 kA — an overall line-performance improvement of just about 35%.

The magnitude (amperage) of a strike is important to understanding that more lightning does not necessarily mean more operations. The graph above shows that in 1996, 10% of the challenges were in excess of 50 kA, and in 1997, 23% were over 50 kA. This resulted in nearly twice the number of potential operations with nearly the same amount of lightning action. In 1999, there were 60% more challenges than in 2000, yet the increase in challenges over 50 kA was only

30%.

After analyzing several years of lightning data a picture of what is happening within the system each year comes into focus. Taking into consideration whether or not the lightning strike is positive or negative and may also have an impact on system performance. In 2000, there were more storms with higher percentages of positively charged lightning strokes, which indicate possible higher storm winds than in any other year. Extreme wind can cause debris or trees to blow into the line resulting in a fault. But when looking at the data initially, it showed (at least ratio-wise) that there were as many lightning challenges to breaker operations in 2000 as there were in 1999. However, further study showed there were fewer actual lightning-induced operations — the direct correlation between lightning and operations — than the previous year. There was the same ratio of operations/challenges, but in 2000, 10% less were the direct result of lightning. The analysis shows that despite the arrester installations other influences still impact line performance.

Another consideration that Minnkota is still in the process of assessing is to note any specific patterns or clusters in the location of the lightning on each line over the five years. Are there concentrations where lightning seems to strike over and over again? If so, is this a reality or just a trend during this specific five-year period? Nonetheless, it does pose an important question: Can lightning arresters effectively be installed only in a specified area instead of across the whole line?

Looking at any one line segment during any one year gives a glimpse of any possible patterns, but it is the overall compilation of five years worth of data that gives the best view of whether or not adding arresters improves line performance. From reviewing five years worth of lightning data, it is safe to say that, yes, arresters have helped reduce the number of lightning induced operations.

To quantify this improvement, Minnkota developed a ratio of the number of operations to the number of challenges for each year. In 1996, the lines in this study were basically unprotected. In 2000, all but a small portion of the lines had arresters installed. Using this information, the number of challenges per operation (less than a 50 kA) should increase. About 20% of the lightning strikes are going to cause an operation even with arresters.

The graph on the left shows that with each year and the addition of more arresters, the number of lightning challenges that it took to cause an operation increased. In 1996, for every 41 lightning challenges, there was an operation. By 2000, there were 129 challenges before an operation occurred. This data provides a snapshot of how arrester-treated lines performed.

Other Areas of Consideration

For a lightning-mitigation program to be effective, the utility must take additional measures beyond installing lightning arresters. Minnkota identified the following guidelines to make its program more valuable and consistent.

- **Maintenance**

Replace failed arresters in a timely manner. At times, failed arresters have gone unnoticed or replacements have been delayed. The integrity of the line is compromised for each arrester not in service. While one failed arrester might not significantly affect a line's performance, if several arresters are not replaced, it could lead to a serious problem.

- **Grounding**

  The goal is a desired ground resistance of less than 25 ohms. Check and install ground rods as needed when the arresters are installed. If this step is overlooked or not considered, arrester performance will likely be much less than expected.

- **Fault-Locating Distance Relays**

  Install fault-locating relays with a good means to download and archive the data to correlate the lightning events. Use the relay distances to assist in timely storm inspections and other alternate problems like trees, wind or birds.

Minnkota's lightning-mitigation program has proven that arresters reduce outages on lightning strikes less than 40 to 50 kA, which account for 77% of the area's lightning challenges and 35% of the total line outages. While the arrester program is effective, studies of lightning data and overall line performance need to continue to further improve power quality. Better fault timing is needed to confidently correlate faults with single lightning strokes. Based on MP's experience with global positioning system (GPS) fault timing, the technology is available to increase the accuracy and reduce the time of the analysis. Using GPS technology to improve the program is the next logical step.

David Van House received a BSEE degree from the University of Minnesota. Since 1989, he has worked at Minnesota Power as a transmission-planning engineer in the substation and telecommunications department.

Jennifer Johnson earned a BS degree in industrial technology with an energy/power emphasis from the University of North Dakota. In 1981, she started work at Minnkota Power Cooperative Inc. in substation engineering, and in 1996, she transferred into the transmission engineering department.