(2)

308
1/14/81
T.S.

R1156

Analysis of 12 Electric Power System Outages/Disturbances Impacting the Florida Peninsula

MASTER

December 1980

Prepared for:

U.S. Department of Energy

Economic Regulatory Administration

Office of Utility System

DISCLAIMER

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency Thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISCLAIMER

Portions of this document may be illegible in electronic image products. Images are produced from the best available original document.

NOTICE

This report was prepared as an account of work sponsored by the United States Government. Neither the United States nor the United States Department of Energy, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, mark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

Available from:

National Technical Information Service (NTIS)
U.S. Department of Commerce
5285 Port Royal Road
Springfield, Virginia 22161

Price:	Printed Copy:	\$12.50
	Microfiche:	\$4.00

NOTICE

PORTIONS OF THIS REPORT ARE ILLEGIBLE

It has been reproduced from the best available copy to permit the broadest possible availability.

DOE/RG/06359-1

Dist. Category UC-97b

Analysis of 12 Electric Power System Outages/Disturbances Impacting the Florida Peninsula

December 1980

Prepared in Part by:
Systems Control Inc.
Palo Alto Calif. 94304
Under Contract No. AC01-78RG-06359-1

Prepared for:
U.S. Department of Energy
Economic Regulatory Administration
Office of Utility System
Washington D.C. 20585

DISCLAIMER

This book was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

TABLE OF CONTENTS

	<u>Page</u>
FOREWORD	1
1. EXECUTIVE SUMMARY	5
1.1 Introduction	5
1.2 Conclusions	7
1.2.1 Summary of the Characteristics of the Florida Electric Power Supply System	7
1.2.2 Conclusions Regarding the Technical Analysis	8
1.2.3 Conclusions Regarding the Social and Economic Effects of the Jacksonville Disturbances	9
1.3 Recommendations	11
2. CHARACTERISTICS OF THE FLORIDA ELECTRIC POWER SUPPLY SYSTEM	13
2.1 Geographic Features	13
2.2 Electric Power Service Areas	13
2.3 Electric Load Characteristics	13
2.4 Power Supply Equipment	16
2.5 Electric Utility Fuels	19
2.6 The Electric Power Transmission System	22
2.7 The Distribution System	24
2.8 Emergency System Response	26
2.8.1 Inertial Response	26
2.8.2 Load Shedding	27
2.8.3 Spinning Reserve	29
2.9 Planning Criteria.	33
2.9.1 Transmission Planning Criteria	33
2.9.2 System Stability Planning Criteria	37
2.9.3 Operating Reserve Requirements.	37
2.10 Florida Electric Power Coordinating Group	40
2.11 Florida Municipal Power Agency	44
3. EMERGENCY PROCEDURES OF THE FLORIDA UTILITIES	45
3.1 Emergency Guidelines Established by the FCG	45
3.2 Description of the Emergency Procedures Used by the Florida Utilities	50
3.3 Comparison of Florida Utilities Load Shedding Criteria	53
4. DESCRIPTION OF THE TWELVE FLORIDA INCIDENTS ANALYZED	56
4.1 Background.	56
4.2 The Twelve Incidents	56

TABLE OF CONTENTS (Cont'd)

	<u>Page</u>
5. TECHNICAL ANALYSES	61
5.1 Background	61
5.2.1 Multi-Utility Outage/Disturbance	61
5.2.2 Jacksonville Electric Authority Incidents	62
5.2.3 Miscellaneous Incidents	62
5.2.4 Restoration	62
5.3.1 Common Events to Multi-Utility Outages	63
5.4.1 Disturbances on the JEA System	67
5.4.2 JEA's Planned Corrective Actions	68
5.5.1 Investigations/Analysis by Others	69
6. SOCIAL AND ECONOMIC IMPACT ASSESSMENT OF NINE LOAD SHEDDING AND REDUCTION INCIDENTS IN JACKSONVILLE, FLORIDA	73
6.1 Background	73
6.2 The Customer Survey and Supplemental Analysis -- Primary Objectives	76
6.3 Survey Methodology	77
6.3.1 Choosing the Customer Sample for the Survey	77
6.3.2 Implementation of the Questionnaire	84
6.4 Survey Results	84
6.4.1 Processing the Survey Returns	84
6.4.2 Significant Findings	86
LIST OF TABLES	iii
LIST OF FIGURES.	iv
LIST OF REFERENCES	115
LIST OF APPENDICES	116

LIST OF TABLES

2-1	FLORIDA ELECTRIC UTILITY INDUSTRY	14
2-2	SUMMARY OF EXISTING GENERATING CAPACITY IN THE STATE OF FLORIDA, JANUARY 1, 1979	17
2-3	RESERVE ANALYSIS AND LOLP, 1978 - 1987	18
2-4	FCG ECONOMY INTERCHANGE SAVINGS	43
4-1	SUMMARY OF THE TWELVE FLORIDA INCIDENTS	60
5-1	SYSTEM DESCRIPTION DURING PENINSULA-WIDE DISTURBANCES	64
5-2	FCG - OPERATING COMMITTEE PERFORMANCE SUBCOMMITTEE DISTURBANCE ANALYSIS - TOTAL FOR STATE	70
6-1	LIST OF CIRCUITS INTERRUPTED DURING AUTOMATIC AND MANUAL LOAD SHEDDING INCLUDING DATE AND ELAPSED TIME IN MINUTES AND CUMULATIVE TOTALS	78
6-2	LIST OF CHARACTERISTICS FOR EACH FEEDER IN THE SURVEY (FOR THE MONTHS OF JANUARY - AUGUST, 1979)	83
6-3	AVERAGE NUMBER OF POWER FAILURES ATTRIBUTED TO EACH CAUSE -- AND PERCEIVED PERCENTAGE OF POWER FAILURES DUE TO EACH CAUSE.	94
6-4	STATISTICS FOR THE DOLLAR COSTS OF THE REPORTED PROBLEMS	97
6-5	WILLINGNESS TO PAY MORE FOR FEWER OUTAGES -- FREQUENCY TABLE FOR CHI-SQUARE TEST	104
6-6	CHI-SQUARE TABLE FOR HELP-IN-AN-EMERGENCY VERSUS FEAR OF BLACKOUT AS MOTIVATING FORCES	108
6-7	OUTAGE REPORT SUMMARY	112

LIST OF FIGURES

	<u>Page</u>
2-1 STATE OF FLORIDA ELECTRIC SYSTEM MAP	15
2-2 FLORIDA GENERATING CAPACITY OUTAGE PROBABILITIES	20
2-3 1980 - 1989 STATE OF FLORIDA ELECTRIC UTILITY SYSTEMS MAP . .	25
2-4 FLORIDA FREQUENCY RESPONSE WITH LOAD SHEDDING	30
2-5 TYPICAL SPINNING RESERVE RESPONSE	32
2-6 FLORIDA FREQUENCY RESPONSE WITH SPINNING RESERVES	34
2-7 FCG COMMITTEE ORGANIZATIONAL CHART	41
5-1 FLORIDA POWER & LIGHT SYSTEM FREQUENCY FOLLOWING LOSS OF TURKEY POINT UNIT FOUR, MARCH 17, 1979, 2:11 A.M. (t=0 sec) FROM RANCH OSCILLOGRAPH	71
6-1 JACKSONVILLE ELECTRIC AUTHORITY TRANSMISSION SYSTEM MAP - 1978	75
6-2 CENSUS TRACT ZONE MAP SHOWING FEEDER LOCATIONS	82
6-3 DISTRIBUTION OF "WORST OUTAGE" TIMES; "CONTROL GROUP" . . .	88
6-4 DISTRIBUTION OF "WORST OUTAGE" TIMES; "ONE LOAD SHED" GROUP.	89
6-5 DISTRIBUTION OF "WORST OUTAGE" TIMES; "TWO LOAD SHED" GROUP.	90
6-6 DISTRIBUTION OF "WORST OUTAGE" TIMES; "FOUR LOAD SHED" GROUP	91
6-7 DISTRIBUTION OF "WORST OUTAGE" TIMES; BETWEEN HOME AND NOT AT HOME GROUPS	93
6-8 REPORTED PROBLEMS OF CUSTOMERS	95
6-9 REPORTED OCCURRENCES OF CUSTOMER INCONVENIENCES	98
6-10 PERCENT SERIOUS INCONVENIENCES REPORTED	99
6-11 REPORTED OCCURRENCES OF SERIOUS INCONVENIENCES TO CUSTOMERS.	100
6-12 RELATION BETWEEN ALIENATION AND LOAD SHEDDINGS	103
6-13 RESPONSES TO EMERGENCY LOAD-REDUCTION APPEALS	106
6-14 MOTIVATION OF CUSTOMERS TO RESPOND TO PUBLIC APPEALS . . .	107

FOREWORD

This report presents the findings of an analysis of 12 separate incidents involving electric power outages, voltage reductions or public appeals to reduce the consumption of electric power in the State of Florida during 1979.

The Division of Power Supply and Reliability of the Economic Regulatory Administration of the United States Department of Energy (DOE) and the Florida Public Service Commission have cooperated to produce this final report. Systems Control, Inc., was retained by the DOE to conduct the socioeconomic impact assessment portion of the investigation.

Between January 3 and August 3, 1979, there were 10 occasions when electric power incidents or disturbances reportable to the DOE occurred on the Florida peninsula. On two other occasions, the Jacksonville Electric Authority initiated public appeals to their customers to reduce their electric energy consumption so as to have adequate capacity to serve their loads. On October 4, 1979, the intent to conduct this investigation/analysis was announced in the Federal Register.* Prior to this date, representatives from DOE's Division of Power Supply and Reliability and representatives from the Florida Public Service Commission had met with a group of Florida electric utility representatives to communicate to the utilities the overall objectives of the project and to solicit their cooperation. This report covers the following incidents/outages/disturbances.

<u>Date</u>	<u>Event</u>
January 3, 1979	140 MW of customer load lost on the Jacksonville Electric Authority system.
March 17, 1979	Combined total of over 157 MW of firm customer load lost by six utilities.
April 4, 1979	Combined total of over 701 MW of firm customer load lost by five utilities.
May 2, 1979	A total of 69 MW of firm load was interrupted on the Florida Power & Light Company system.

*See Appendix I.

Date	Event
May 4, 1979	Combined total of over 404 MW of firm customer load lost by eight utilities.
June 7, 1979	Jacksonville Electric Authority issued a public appeal to consumers to voluntarily reduce load and the utility reduced its system voltage.
June 21, 1979	Combined total of over 144 MW of firm customer load lost by two utilities.
July 2, 1979	40 MW of customer load lost in the Jacksonville Electric Authority service area.
July 25, 1979	25 MW of customer load lost in the Jacksonville Electric Authority service area.
July 28, 1979	30 MW of customer load lost in the Jacksonville Electric Authority service area.
July 29, 1979	Jacksonville Electric Authority initiated a public appeal to their consumers to voluntarily reduce their load and the utility reduced its system voltage.
August 3, 1979	Combined total of over 278 MW of firm customer load lost by eight utilities.

The primary objectives of this investigation were to:

- (1) Determine the technical causes of the listed power system outages/ interruptions/incidents, and possibly suggest corrective actions to reduce the likelihood of their recurrence;
- (2) Determine the adequacy of the emergency operating procedures developed and implemented by the Florida Electric Utilities during the subject incidents/disturbances/outages.
- (3) Determine the impact of power outages, and public appeals on residential customers in the Jacksonville area.

Technical data collection and analysis was accomplished by Mr. William E. Scott and Mr. Thomas Hitz of the Division of Power Supply and Reliability's Atlanta, Georgia field office. Numerous technical data and completed interruption reports were voluntarily supplied by the Florida utilities. This information served as the primary basis for the technical analysis. During the DOE effort it was noted that the Florida utilities had several continuing efforts to perform transient and dynamic system stability studies to better understand their systems. Many of these results have recently become available.

To accomplish the third goal, the social and economic impacts of the subject power outages and public appeals on residential customers in 1979 were studied. Jacksonville was chosen as the area of focus for this effort, since 10 of the 12 incidents affected the service area of the Jacksonville Electric Authority (JEA). A consumer survey was conducted as a part of the socioeconomic investigation. This portion of the report was prepared by Systems Control, Inc., under U.S. Department of Energy, Contract EB-78-C-01-6359.*

Following the receipt of the contractor material and overall evaluation of all available data, the Division of Power Supply and Reliability independently prepared the conclusions and recommendations contained in this report. The Florida Electric Power Coordinating Group and the Florida Public Service Commission were given the opportunity to review a draft of this report and their written comments are included as Appendix C to this report. The staff of the Division of Power Supply and Reliability is aware of several load reduction incidents that have occurred since August 3, 1979. The actual events were in most cases similar to those listed above. Current reports of these incidents have been utilized to reinforce the analysis done in this report. A committee of the Florida Electric Power Coordinating Group recently completed a series of transient stability studies of the Florida system. These studies were very complete and provide definitive results that the Florida peninsula area will continue to experience separations from the Georgia system when large units suddenly trip and that load shedding will be necessary until the system load and generation balance can be restored.

* A detailed report of this survey was prepared by Systems Control, Inc. and is available for review by interested individuals upon written requests.

The strengthening of connections between Georgia and Florida appears to be the only reasonable means of keeping these systems operating in synchronization especially during disturbances. Some 500kV interconnections are currently planned for 1983 service and these could eliminate the need to separate these two systems during disturbances. If so, the load shedding incidents will be significantly reduced.

1. EXECUTIVE SUMMARY

1.1 Introduction

Between January 3 and August 3, 1979, there were 12 occasions on which electric power was curtailed or public appeals were made to customers to reduce their load in Peninsular Florida due to bulk electric power supply problems. The Economic Regulatory Administration (ERA) of the U.S. Department of Energy (DOE), pursuant to its electric power supply adequacy and reliability responsibilities, initiated a twofold analysis of the bulk power supply situation in Florida.

The first phase of the analysis evaluated the technical and engineering aspects of the overall Florida bulk power supply system with special attention given to the City of Jacksonville's electric system. The second phase evaluated the socioeconomic impacts of the bulk power supply outages on residential customers in Jacksonville.

The technical phase concentrated on the region's spinning reserve and load shedding program and the reliability of the transmission system. Since most of the load shedding incidents were preceded by separation of the transmission system near the Florida-Georgia State line, a particular effort was given to understanding the reasons for these separations. Another point emphasized in the analysis was determining whether the operating reserve policies of the Florida Electric Power Coordinating Group were appropriate for reliable service. The technical evaluation includes a description of the characteristics of the Florida electric supply systems, with special attention given to those aspects which make it unique. A description of the 12 disturbances/incidents/outages and a comparative analysis of the causes is included.

The second phase of the investigation was conducted to evaluate the effect of the electric power interruptions on residential customers in the Jacksonville, Florida area. This area was selected since 10 of the 12 events in the analysis impacted Jacksonville customers. A questionnaire was mailed to 3,000 Jacksonville Electric Authority (JEA) residential customers as a part of this effort.

This survey was designed to ascertain the social and economic consequences of repeated load shedding on residential customers. The customer response to public appeals made by the utility to reduce electric power consumption and primary incentives for compliance was also investigated. Data supplied by the JEA was used to supplement and support the analysis conducted on the survey responses. City newspaper files, distribution outage history, telephone records kept at the utility "trouble" center, and JEA daily load profiles also provided additional information in the following areas:

- o Attitude of population toward their utility;
- o Effectiveness of public appeals in reducing demand;
- o Customer tolerance levels associated with the load sheddings (measured by telephone calls made to the utility trouble center); and
- o Historical outage experience of the customers (measured by the distribution feeder outage history).

This analysis/investigation has provided information on the effects of short but frequently occurring power system outages due to bulk power supply problems. This DOE effort has helped motivate the Florida utilities and Florida Coordinating Group to conduct technical studies that evaluated and improved their operating and emergency response criteria.

The next section presents the principal conclusions of the analysis.

1.2 Conclusions

1.2.1 Summary of the Characteristics of the Florida Electric Power Supply System

Florida is essentially isolated electrically from the rest of the country. There was only one major bulk power system tie between Florida and the Georgia utility system during the period of the subject outages. (A second 230 kV tie line was placed in service in January 1980.) Generation in Florida is located near the load centers in the southern and central parts of the state while generation in Georgia is in the central and northern regions. Florida's electrical generation is derived primarily from oil-fired and nuclear based units.

The electric utilities in Florida are members of a central coordinating council known as the Florida Electric Power Coordinating Group (FCG). The FCG coordinates policies and operating practices among the Florida utilities so that reliable, economical and environmentally acceptable electric service is supplied to the citizens of Florida. Operating and planning guides for the Florida utilities are established through unanimous agreement of committee members and published in the Operating Handbook.

In March 1979 the FCG implemented an energy-broker system to accelerate the exchange of buy-and-sell quotes for economy energy. Consequently, this system has resulted in increased economy energy interchange savings of about \$13.4 million between March and December 1979.

The FCG's Operating Handbook specifies the operating criteria procedures to be followed in an emergency. During the 1979 disturbances the Florida utilities were in compliance with the FCG's operating criteria.

1.2.2 Conclusions Regarding the Technical Analysis

The following conclusions are drawn from the technical evaluation of the events which took place prior to and during each of the 12 outages/disturbances/incidents.

- o There have been more reportable bulk power system disturbances* involving electric utilities on the Florida Peninsula during the January-August 1979 period than in any other area of the United States.
- o Restoration of the interconnected Florida power system following the 1979 disturbances was accomplished very quickly.
- o Most of the automatic load shedding outages resulted from unexpected events during testing of circuits or systems associated with a nuclear unit.
- o Florida's transmission ties to Georgia are opened by "out-of-step" protective relays when there is a loss of a large generator (400 MW and above) on the Florida system. Since Florida usually imports lower-priced power from Georgia, loss of the transmission ties adds to the power deficiency caused by a generator outage.
- o Following a separation from Georgia, load shedding appears to be the most reasonable and effective means of restoring the system load-generation balance.
- o The operating policy of the Florida utilities which requires a large quantity of supplemental reserves to be ready in 30 minutes, allows rapid reintegration of the system and reconnection of load following a disturbance.
- o Jacksonville Electric Authority's generation deficiency problems were primarily caused by a prior deferral of routine generator maintenance. This now results in higher forced outage rates, and in some cases, derating of units. JEA has initiated a program of rehabilitating all generating units. Their low generating reserves are primarily due to this added maintenance. This program is expected to be completed in 1981.

* As defined by the Department of Energy's "Power System Disturbance/Outage/ Incident Reporting Procedures," DOE/ERA-0055, August 1979.

1.2.3 Conclusions Regarding the Social and Economic Effects of the Jacksonville Disturbances

The following conclusions regarding the socioeconomic impacts of the JEA load sheddings are drawn from the survey findings and supplemental data analyses.

- o Results of this study must be regarded in light of the characteristics of the population surveyed. Jacksonville residential customers are extremely sensitive to the electric rate issue and many regard the utility with criticism and hostility. Therefore, their preoccupation with electricity rates could have overshadowed reliability related problems and biased their responses.
- o Jacksonville residential customers have generally been exposed to numerous power outages (both planned and random); therefore, there may be a built-in "tolerance" for outages. Customers experiencing frequent outages may possess coping mechanisms to mitigate the adverse impacts of outages. (A survey of a population seldom exposed to power failures might result in significantly different findings.)
- o Both test and control groups in the survey identified one of two outages as their "worst outage" of 1979. This implies that there were at least two distribution outages during January-August 1979 that were of greater consequence than any of the load sheddings during this same period.
- o The majority of the customers responding to the survey were unable to recall outages which occurred during the first five or six months of the year. Customers frequently focussed on the past three months. In addition, few customers could estimate the duration of any outages they experienced.
- o There is a slight tendency for those customers experiencing load sheddings to attribute their outages to "equipment failures" rather than load shedding. This could be due to either: (a) publicity about the generator outages (a type of equipment failure); or (b) customers observing that "acts of nature" are not associated with some of their outages (hence the outages are perceived as equipment failures).

- o The most frequent problems customers incurred out-of-pocket expenses for were:
 - Not being able to cook and forced to eat out.
 - Having to purchase supplies (candles, flashlights, batteries, etc.).
- o The less frequent problems, however, led to substantially larger out-of-pocket expenses:
 - Food spoilage.
 - Loss of computer records and computer down-time (important for small commercial customers).
- o Disruption of household activities was the most frequently cited problem.
- o Health, safety and tardiness problems were perceived as the most severe.
- o Customers were unwilling to pay more for improved service reliability, regardless of load shedding experience.
- o Customer alienation toward the utility was not significantly influenced by their load shedding experience.
- o JEA's trouble center received fewer telephone calls during deliberate load shedding than during distribution outages of comparable magnitude. This could mean that rotating blackouts have less effect on the public than "uncontrolled" outages, and/or JEA picked the correct (i.e., non-critical) feeders to interrupt.
- o Over 75 percent of the customers were aware of public appeals.
- o Most of the customers stated that they cut back on either:
 - lighting;
 - appliance usage; or
 - air conditioning.
- o "Fear of a blackout" was the most important motivating factor for reducing electricity usage.

- o JEA load data showed that the amount of load reduction in response to public appeals for conservation was less than the degree of compliance reported by the respondents to the survey. Either the respondents were not representative of the Jacksonville population, or they exaggerated their conservation efforts.
- o A "control" (non load-shed) group was necessary to differentiate the impact of load shedding on customers as opposed to random distribution outages. Some control groups experienced a higher incidence of random outages than the test groups. Future surveys should include groups that experience few or no outages in order to compare them with groups experiencing frequent outages.

1.3 Recommendations

On the basis of the preceding conclusions and the associated analyses, the Department of Energy makes these recommendations for improvement of electric service on the Florida Peninsula to the following organizations:

The Florida Coordinating Group

- o The FCG should continue to strengthen its role in the coordination of planning and operation of electric utilities in Florida. A more effective means of communicating real time system operating data among the electric utilities in Florida is needed. Each utility must be aware of its neighbor's current status.
- o The Florida Peninsula utilities should conduct a coordinated review of the transmission system and if necessary, strengthen it both internally (within Florida) and externally (ties to Georgia).

The Florida Public Service Commission

- o Formal guidelines should be established for shedding firm or interruptible customers. For example, the Jacksonville Electric Authority and Florida Power and Light utilities dropped firm load at the same time that Florida Power Corporation and Tampa Electric Company shed interruptible load.

- o The load shedding schemes utilized by Florida Electric utilities should be examined closely. This examination should address the frequency and duration of the load sheddings which customers experience.

The Florida Electric Power Utilities

- o Individual Florida utilities should coordinate generator testing procedures and schedules so that system security is not jeopardized (e.g., the impact of a unit tripping during a test is minimized).

The United States Department of Energy

- o DOE should continued to investigate the effects of power interruptions and insure that customer as well as utility viewpoints are considered in assessing the costs of outages.
- o Further analysis of socioeconomic effects of repeated load sheddings on customers should be performed.

2. CHARACTERISTICS OF THE FLORIDA ELECTRIC POWER SUPPLY SYSTEM

2.1 Geographic Features

Florida is a peninsula extending over 450 miles from north to south. The overland distance from the northwestern extremity of the "panhandle" to the tip of the Florida Keys is almost 850 miles. Because it is a peninsula, Florida shares common boundaries only with the States of Georgia and Alabama.

2.2 Electric Power Service Areas

Florida's electrical needs are served by utilities ranging from large investor-owned utilities (e.g., Florida Power and Light Company, serving over a million and one-half customers) to small municipally-owned utilities without generating capability, serving only a few thousand customers. Florida utilities include six investor-owned utilities, 35 municipal county departments or public authorities, and 17 rural electric cooperatives, all of which are listed on Table 2-1. Figure 2-1 is a map of the electric generation and transmission system of Florida.

Most of Florida's generating units are in the Central and Southeast parts of the state, near the major load centers. There is little electrical load and few generation and transmission facilities in northern Florida.

2.3 Electric Load Characteristics

On a yearly basis, the utilities within Florida are projecting an increasing seasonal peak demand, in which the winter peak exceeds that of the previous summer, and the summer load exceeds the previous winter's. The winter peak loads have recently increased at a significantly greater rate than the summer loads. Due to the very hot weather and the heavy use of air conditioning in the summer months, the daily load cycle could contain as many as eight hours of peak demand during the afternoon and early evening, while the winter peaks last for about two hours.

TABLE 2-1

FLORIDA ELECTRIC UTILITY INDUSTRY

Investor Owned Systems (All Generate)

1. Florida Power & Light
2. Florida Power Corporation
3. Florida Public Utilities
4. Gulf Power Company
5. Tampa Electric Company
6. Reedy Creek Util. Co., Inc.

Generating Municipal Systems

1. Ft. Pierce
2. Gainesville/Alachua
3. Homestead
4. Jacksonville
5. Key West
6. Kissimmee
7. Lakeland
8. Lake Worth
9. New Smyrna Beach
10. Orlando
11. St. Cloud
12. Sebring
13. Starke
14. Tallahassee
15. Vero Beach
16. Wauchula

Generating Rural Electric Cooperatives

1. Florida Keys

Generating - Other

1. Southeastern Power Administration
(Jim Woodruff Dam)

Nongenerating Municipal Systems

1. Alachua
2. Bartow
3. Blountstown
4. Bushnell
5. Chattahoochee
6. Clewiston
7. Fort Meade
8. Green Cove Springs
9. Havana
10. Jacksonville Beach
11. Lake Helen
12. Leesburg
13. Moore Haven
14. Mount Dora
15. Newberry
16. Ocala
17. Quincy
18. Williston

Nongenerating Rural Electric Cooperatives

1. Central Florida
2. Choctawhatchee
3. Clay
4. Escambia River
5. Glades
6. Gulf Coast
7. Lee County
8. Peace River
9. Sumter
10. Suwannee Valley
11. Talquin
12. Tri-County
13. West Florida
14. Withlacoochee River
15. Okefenokee
16. Alabama

STATE OF FLORIDA
ELECTRIC SYSTEM MAP

SCALE
0 10 20 MILES

2.4 Power Supply Equipment

At the beginning of 1979, 15 utilities in the state of Florida had a combined summer net available capability of 22,804 MW and a winter net capability of 23,896 MW (Table 2-2). Six types of generation are utilized by electric utilities in Florida: fossil and nuclear steam turbines, combustion turbines, combined-cycle units, diesel engines, and hydro. The amount of hydro power is small, only 36 MW of capacity, and is owned by Southeastern Power Administration and the Florida Public Utilities Company. There are six generating units larger than 600 MW; the largest are the Crystal River No. 3 nuclear unit with a net dependable rating of 797 MW and St. Lucie No. 1 nuclear unit with a rating of 795 MW.

About three percent of installed generating capacity in Peninsula Florida is being overhauled during the summer and winter peak load periods. While the winter peak demand now has the potential for being greater than the summer peak in Peninsular Florida, the installed generating capability is increased by about five percent during the winter due to the lower cooling water temperatures. Because the winter peak is of short duration compared to the summer (which is nearly constant from noon until 10:00 p.m. over about a four month period), the summer peak tends to be more critical from a generating capacity standpoint.

The Florida utilities made periodic "loss of load" studies to determine the generating reserves needed to assure adequate power supply. Table 2-3 shows the results from an August 23, 1979, study by the Florida Electric Power Coordinating Group for the 1978 through 1987 period. The study examined the Florida Peninsula as a whole without transmission limitations. These studies indicate that installed generation reserves of about 20 percent of annual peak demand will generally minimize the risk of generating capacity deficiency within the Florida Peninsula.

TABLE 2-2

SUMMARY OF EXISTING GENERATING CAPACITY IN THE STATE OF FLORIDA
JANUARY 1, 1979

<u>Utility</u>	<u>Net Capability - MW</u>	
	<u>Summer</u>	<u>Winter</u>
Florida Power Corporation	3647	4040
Florida Power & Light Company	10957	11516
Fort Pierce Utilities Authority	116	116
Gainesville/Alachua County Regional Utilities Board	257	272
Gulf Power Company	1453	1457
City of Homestead	52	52
Jacksonville Electric Authority	1884	1939
Lake Worth Utilities Authority	141	154
City of Lakeland	372	384
Orlando Utilities Commission	742	760
Seminole Electric Cooperative	14	14
Southeastern Power Administration	36	36
City of Tallahassee	495	518
Tampa Electric Company	2505	2505
Vero Beach Municipal Utilities	<u>133</u>	<u>133</u>
Total	22804	23896
Total Hydro	36	36
Total Nuclear	2876	2968
Total Fossil Steam	15350	15565
Total Diesel	116	117
Total Combustion Turbine	3950	4657
Total Combined-Cycle	<u>476</u>	<u>553</u>
Total	22804	23896

TABLE 2-3
RESERVE ANALYSIS AND LOLP*
1978 - 1987

<u>Year</u>	<u>Capability At Time of Annual Peak (MW)</u>	<u>Projected Annual Peak (MW)</u>	<u>Installed Reserves (%)</u>	<u>LOLP (Days Per Year)</u>
1978	21,578	15,861	36.0	0.02
1979	21,967	16,772	31.0	0.04
1980	22,400	17,801	25.8	0.06
1981	23,546	18,847	24.9	0.08
1982	24,955	19,929	25.2	0.18
1983	25,490	20,991	21.4	0.20
1984	27,028	22,045	22.6	0.25
1985	27,733	23,082	20.1	0.19
1986	30,649	24,172	26.8	0.24
1987	30,559	25,271	20.9	0.56

* Source - Florida Ten Year Plans - 1979

A loss-of-capacity probability analysis was made by the ERA staff to independently determine the magnitude and associated probability of generation forced outages for the Peninsula Florida system for the 1978 generation configuration. The results, in Figure 2-2, show that there will almost certainly be some generating capacity on forced outages at all times. There is about a 50 percent chance of having at least 1,600 MW on forced outage and about a 10 percent chance of having at least 2,800 MW on forced outage. It is typical to plan sufficient generation reserves to cover the maximum amount of capacity on forced outages that would likely occur about one percent of the time. In this particular case the corresponding amount of generation reserves needed to cover forced outages of equipment would be 3,750 MW. This translates to a calculated installed reserve requirement of 22 percent, based on the actual Florida Peninsula 1978 peak load. As shown in Table 2-3, the actual installed reserve was 36 percent in 1978.

2.5 Electric Utility Fuels

Natural gas and oil are the primary fuels for electric generators in Florida. About 90 percent of the natural gas is obtained through three interstate pipelines from sources outside of Florida. Natural gas production in Florida provides only 11 percent of the total consumption in the state.

Residual oil is expected to be the fuel source for 52.7 percent of the electricity in 1980. In 1988 residual oil is projected to be the source of 37.2 percent of the total generation. However, the use of residual oil may increase significantly if delays are experienced in placing planned nuclear and coal burning facilities on line or if the supply of natural gas is curtailed beyond what is anticipated. Residual fuel oil for Florida utilities has normally been obtained from foreign resources, with the Latin American countries being the primary suppliers. Distillate oil has usually been supplied from a United States oil company; however, some of

Florida Generating Capacity Outages Probabilities

Figure 2—2

the oil is refined at facilities in the Carribean Islands. Waterborne transport is the most common method of delivering residual oil to Florida. Seaports located in Tampa and Port Everglades near Ft. Lauderdale and in Jacksonville received almost 80 percent of the State's imports.

Coal has historically been a small source of energy for the State and Tampa Electric Company and Florida Power Corporation have accounted for nearly all of its use. Florida is completely dependent on outside sources for its coal supply and has obtained this fuel from resources in Kentucky, Alabama, Illinois, and has even purchased some coal from South Africa.

Hydroelectricity supplied only about one-tenth of a percent of the total energy used in Florida and is not a potential source for large quantities of energy for the state. Five different hydroelectric facilities are being operated in Florida, the largest being Southeastern Power Administration's 30 MW Jim Woodruff facility.

The first nuclear power plant in Florida was placed in service in 1972 when Florida Power and Light's Turkey Point Unit No. 3 began commercial operation. There are now four nuclear generating units in Florida with operating licenses and collectively are expected to generate approximately 17 percent of the state's electric energy in 1980. Construction work is continuing on a fifth nuclear generating unit.

The state has an onverwhelming dependence on oil. Two natural gas supply contracts, supplying a total of 140 million cubic feet per day, expired in June 1979. Generation from natural gas accounted for about 19 percent of total generation during 1978 and 1979.

Although generation from coal is expected to increase nearly fivefold in the next 10 years, the reduction in natural gas expected to be available will offset this gain. Consequently, oil requirements will actually increase slightly over the 10-year period.

2.6 The Electric Power Transmission System

Presently 230 kV is the basic bulk power system transmission voltage in Florida, although there are segments of 500 kV (230 miles) line in operation. There are over 7,000 miles of high voltage electric transmission lines in service in Peninsula Florida.

The Florida Peninsula utilities have operated with a 115 kV transmission connection to Georgia since 1942. A 230 kV interconnection was established in 1962. The major load areas in Florida are in the central and southeast regions where most of the transmission lines are located. Thus, today there is a minimal number of transmission lines connecting the Georgia and Florida utilities. These lines are all 115 kV or lower except for two 230 kV ties between Suwanee, Florida and Pine Grove, Georgia, and between Yulee, Florida and Kingsland, Georgia. (The second 230 kV interconnection was placed in service in January 1980.) Figure 2-1 is a map of the Florida transmission system and depicts these interconnections between Florida and Georgia.

Increased Florida-Georgia interconnection might result in both reliability and production cost benefits for both systems. In order to interconnect Florida and Georgia strongly, transmission facilities must connect the load centers of the two states. This means that any strong interconnection must go from at least the Orlando area to mid-Georgia. Tying just the northern part of the Florida Peninsula to Georgia will not adequately strengthen the system. The principal impediment to strong interconnection and coordination of the Georgia and Florida electric utilities has been the distance between the electrical centers of each area. The electrical

center of the Southern Company system is in northwest Georgia in the vicinity of Atlanta. The electrical center of the Florida Peninsula is in the vicinity of Crystal River which is on the West Coast of Florida about 60 miles north of Tampa. The distance between these two electrical centers is about 400 miles. In order to substantially increase the level of interconnection and coordination between Southern Company and Florida, the electrical centers must be connected with at least two 500 kV circuits.

While the Florida Peninsula itself is relatively stable electrically, there has been an inherent problem of instability between the Florida and Georgia systems because of their weak interconnections. This is the cause of the electrical separations between these systems when large generation losses occur on the Florida Peninsula system. The second 230 kV interconnection between Georgia and Peninsular Florida was placed in operation in January 1980. Studies made when this facility was authorized indicated significant improvement in the system stability such that separation would not generally occur when the largest unit in the state was lost. This study is conditioned upon not having any power transfers in effect between Georgia and the Florida Peninsula at the time of the disturbance. There is a voltage constrained steady-state loading limit of about 500 MW between Georgia and the Florida Peninsula which limits power transfers that exceed about 15 to 30 minutes to this value.

Northeast Florida is estimated to become tied electrically closer to the electrical center of Peninsula Florida with the planned addition of the Silver Springs-Seminole Plant double circuit 230 kV line in 1982. Georgia Power Company and Florida Power and Light Company

have recently negotiated an agreement for one and possibly two 500 kV interconnections. A similar agreement is being considered by the Florida Power Corporation. If plans proceed on an optimistic basis, there is the possibility of three 500 kV lines connecting Georgia and Florida by 1984. See Figure 2-3 for proposed additional ties between Florida and Georgia.

2.7 The Distribution System

For the most part, the primary distribution circuit voltage used in Florida is 12 kV. The typical distribution feeder circuit is three to four miles long and serves about 1,000 customers and a load of about 4 MW. The feeder circuits generally radiate outward from a stepdown transformer substation. The typical feeder circuit supplies about 350 distribution transformers, which reduce the line voltage to the customer utilization voltage.

The average Florida customer experiences a power outage due to a feeder circuit problem about once every two years, and about once in 25 years due to a distribution transformer problem. The average customer outage time in Florida due to distribution problems is about two hours per year.

Lightning and high winds during storms are the most frequent cause of distribution outages in Peninsular Florida, accounting for about 25 percent of all distribution interruptions. Birds, squirrels and other animals typically account for about 13 percent, while tree contacts account for another 12 percent. Interruptions due to damage to lines

and poles from vehicular accidents account for about 8 percent, while overloaded facilities are involved in about 6 percent of all distribution forced outages. Of these outage causes, possibly the most damaging and affecting the largest number of customers at a single time is an interruption due to a vehicle striking a pole, so that the conductors contact one another.

Repair time is typically four to eight hours, however some customer load can usually be restored to service by line switching to isolate the fault.

2.8 Emergency System Response

There are two remedial methods for arresting power system frequency decline. One is to rapidly increase the amount of system inertia through increased power input to the system generators. The other is to reduce the overload on the connected generators. Inertia may be increased by interconnecting electric systems through high capacity transmission lines which electrically enlarge a power system thereby providing it with more rotating inertia than it would otherwise have. Reduction of the overload on connected generators is usually accomplished by underfrequency load shedding relays which operate when the frequency reaches a preset level. The requirement that corrective action be implemented rapidly following a disturbance which precipitates a declining frequency made it necessary that these schemes be automatic.

2.8.1 Inertial Response

For any sudden generation deficiency in Florida, about 95 percent of the deficiency will instantaneously attempt to flow from the rotating inertia of machines external to Florida on the eastern

interconnected transmission grid into Florida over the Georgia-Florida transmission ties. The Georgia-Florida ties had a 1979 emergency transfer capability of about 400 MW. A second 230 kV tie, established for operation in January 1980, has increased the emergency transfer capability between Georgia and Florida to about 600 MW.

For sudden generation deficiencies in Florida in amounts greater than the Georgia-Florida interconnection transfer capability, the interconnections open by relay action and Florida isolates from the rest of the eastern interconnected transmission grid system. The frequency in Florida then declines in proportion to the magnitude of the connected inertia in Florida and magnitude of the generation loss or deficiency. Frequency decline in Florida is likely to be more rapid during off-peak periods when there is less generating capacity operating and when economy coal-by-wire transfers from Georgia to Florida are greatest.

2.8.2 Load Shedding

Florida's coordinated automatic underfrequency load shedding program is used to:

- a. Restore the balance between load and generation in the affected area in the shortest possible time and permit the subsequent return to 60 Hz operation, so as to minimize adverse affects on customer service; and

- b. Minimize the risk of damage to company and customer facilities and equipment.

The program is designed to disconnect not less than 30 percent of the load on each system and to spread the load reduction uniformly over three steps and sub-steps. Assignment of load to underfrequency relay control is reviewed and updated in April of each year. The amount of assigned load is based on the peak load forecast for that year. The following table shows the 1979 load shedding schedule for the Florida coordinated system.

<u>Step Number</u>	<u>Relay Setting in Hz</u>	<u>1979 Amount in MW</u>	<u>Percent of 1979 Peak</u>
*	59.7	501	2.9
1	59.2, 59.1, 59.0	2,859	16.6
2	58.8, 58.7	2,829	16.4
3	58.6, 58.5	4,438	25.7
TOTAL		10,627	61.6

* Step zero applies to contractual interruptible load and can be utilized as part of the spinning reserve requirement.

Should the load shedding program fail to arrest frequency decline and return the frequency to 59 Hz or above, plant operators have the authority to disconnect their plants from the system in order to prevent damage after the following time limits have been exceeded:

Below 59.0 Hz - 30.0 minutes maximum time before unit isolation.

Below 58.5 Hz - 7.0 minutes maximum time before unit isolation.*

Below 58.0 Hz - Automatic isolation by underfrequency relay with 12 seconds time delay.** (One system has chosen to separate at 57.0 Hz due to area problems.)

Computer simulations were made to evaluate the effect of the 1979 load shedding schedule on frequency for various generation deficiencies without spinning reserve. The purpose of this was to isolate the effects of load shedding on frequency for Florida. The results are shown on Figure 2-4. In every case examined, up to and including a 60 percent loss of generation, the Florida 1979 load shedding program returns the frequency to above 59.0 Hz in less than 12 seconds after separation from Georgia. However, for generation losses between about 20 and 40 percent, the frequency return is so fast that frequency overshoot could cause turbine intercept valves to operate and shut down the generator.

2.8.3 Spinning Reserve

Spinning reserve is generating capacity operated at less than full capability so as to be immediately available to support additional

* This seven minutes is part of the total time of 30 minutes allowed below 59.0 Hz.

** Some smaller systems have elected to separate from the subregion grid under these frequency departure conditions.

Florida Frequency Response with Load Shedding

Figure 2-4

load. It is typically available at a rate of one percent per second over the first five seconds for modest departures from design frequency. Saturation typically occurs at about 10 seconds due to boiler and turbine dynamics, and gradual load pickup begins again at about 60 seconds. A typical response curve is shown in Figure 2-5.

In Florida, spinning reserve is typically activated in one of two ways in response to a disturbance. It is activated by governor action in response to unit speed departure, or by load-frequency control or automatic generation control equipment in response to either a generation-load imbalance or a frequency departure, or both. Both control systems operate the throttle valves, in the case of steam-electric units, to control steam flow to the turbine and hence power output. Governor response typically begins in about 0.5 seconds following a frequency departure greater than about 0.05 Hz.

Distribution of spinning reserve among generating units is at least as important as maintaining a proper amount, as only about five percent of a unit's spinning reserve is available within the time frame associated with dynamic control (2 to 20 seconds).

The Florida Coordinating Group operating procedures require that member utilities maintain an amount of spinning reserve equal to the largest generating unit in service in Peninsular Florida and a distribution of spinning reserve such that no more than $16 \frac{2}{3}$ percent of the total requirement is concentrated in any one generating unit. An

Typical Spinning Reserve Response

Figure 2-5

allocation formula used to distribute the spinning reserve requirement among member systems is weighted 50 percent toward relative system peak demand and 50 percent toward relative unit size. The Florida spinning reserve requirement is equivalent to about four percent of connected generating capacity on peak and about eight percent off-peak.

Figure 2-6 shows the Florida frequency response with an average six percent spinning reserve for various generation deficiencies. No underfrequency load shedding was represented in the computer simulation in order to isolate the effect of spinning reserve. For generation losses greater than about five percent, spinning reserve appears not to be effective in arresting frequency decline, and load shedding is necessary.

The Florida utilities estimate that the cost of maintaining the present amount of spinning reserve is about \$13 million annually.

Because of this cost, the Florida utilities are examining the use of a smaller spinning reserve requirement.

2.9 Planning Criteria

2.9.1 Transmission Planning Criteria

While the Florida Coordinating Group has no formal agreements to ensure that members use uniform criteria for transmission planning, they have developed transmission planning criteria for the purpose of setting priorities. These are as follows:

- A. More Probable Contingencies - To be sustained without loss of load (other than the load connected to the line

Florida Frequency Response with Spinning Reserves

Figure 2-6

or transformer which is lost):

1. Loss of Generation

- a. Sudden loss of any one generating unit.

2. Loss of Transmission

- a. Loss of any one transmission line.
- b. Loss of any one transformer bank at any one generating plant or bulk transmission substation.

Following any single element outage, all equipment shall be loaded within its long time rating and voltages shall be reasonably normal.

B. Less Probable Contingencies - To be sustained with the possibility of loss of some load:*

1. Loss of Generation

- a. Sudden loss of any one generating unit while any one generating unit is out of service.

2. Loss of Transmission

- a. Loss of any two transmission lines which are on the same double-circuit tower.

3. Loss of Generation and Transmission

- a. Loss of any one transmission line while any one generating unit is out of service for scheduled routine maintenance.

* "Load Relief" measures in all load areas and transmission relaying are acceptable means for maintaining stability and avoiding cascading.

The above less probable contingencies, may cause loss of some load and/or instability of some localized generation, but the State bulk power system shall stay capable of readjustment after the occurrence of the disturbance so it can be operated within its emergency ratings, and at voltages that can be accepted for their duration time interval.

C. Possible But Improbable Disturbances - To be sustained without occurrence of cascading:

1. Loss of Generation

- a. Sudden loss of entire generating capability in any one plant.

2. Loss of Transmission

- a. The outage of the most critical transmission line caused by a three-phase fault during the outage of any other critical transmission line.
- b. Sudden loss of all lines on a common right-of-way.
- c. Sudden loss of a substation (limited to a single voltage level within the substation, plus transmission from that voltage level within the substation), including any generating capacity connected thereto.
- d. Delayed clearing of a three-phase fault at any point on the system due to failure of a breaker to open.

3. Loss of Load

- a. Sudden loss of a large load or major load center.

These contingencies may cause disruption of a portion of the system resulting in loss of some load, instability of some generating units, and some islanding, but should not result in cascading.

2.9.2 System Stability Planning Criteria

1. All load areas shall remain stable during and following a normally cleared three-phase fault at any location of the transmission system.
2. Stability shall be maintained in all load areas, exclusive of the load area the disturbance occurred in, during and following the contingencies in paragraphs B.1, B.2, and B.3, assuming that transmission element loss contingencies are associated with the above fault conditions of paragraph D.1.

2.9.3 Operating Reserve Requirements

The FCG sets criteria for minimum operating reserves which member systems must maintain. This consists of both "spinning" and "supplemental" reserve. FCG uses the following definitions:

- o Operating Reserve is that amount of generating capability and/or equivalent load relief in excess of the load which is available to provide for load variations and forecast error, frequency regulation, area protection and contingencies such as loss of generating capability. It consists of Spinning Reserve and Supplemental Reserve.

- o Daily Operating Reserve is that amount of generating capability and/or equivalent load relief in excess of forecasted daily peak load which is available to provide for load variation and forecast error, frequency regulation, area protection and contingencies such as loss of generating capability. It consists of Spinning Reserve and Supplemental Reserve.
- o Spinning Reserve is the reserve generating capability connected to the bus, ready to pick up load immediately, and capable of becoming fully applicable with a frequency decline to 59.5 Hz.
 - a) Steam Unit

Due to special operating conditions in Peninsular Florida, no more than 16 2/3 percent of the continuous capability of a steam unit may be counted in computing the system spinning reserve.
 - b) Combustion Turbine Unit
 - 1) A portion, generally 30 percent, of the base rating of combustion turbine generating units may be counted as Spinning Reserve, provided: i) the units are operating in their automatic control mode; ii) the units are equipped with solid-state underfrequency relays in their ramp rate control circuits to change their response rate emergency; iii) tests have been made to demonstrate that such amount counted will respond and become fully applicable with a frequency decline

to 59.5 Hz; and iv) unit response is equal to or faster than the same amount of steam unit capacity as defined above.

- 2) The capacity between base and peak load of combustion turbine units may be counted as spinning reserve provided: i) the units are equipped with solid-state underfrequency relays which will automatically change the operating mode from "base" to "peak" when the frequency declines to 59.9 Hz; and ii) unit response is equal to or faster than the same amount of steam capacity as defined above.

- o Supplemental Reserve is any generating capability and/or load relief measure which can be made fully applicable within 30 minutes or less. It includes, but is not limited to diesel units, combustion turbines, interruptible loads, load relief measures, and any increase in generation that may be obtained from a generating unit.
- o Step Zero (Step 0) is load set to disconnect at 59.7 Hz. This is usually applied to contractually interruptible customers, but may be applied to other customers under emergency conditions.

The Florida Operating Committee of the FCG requires that all spinning reserve be applicable with a frequency decline to 59.5 Hz. Some spinning reserve can be met using Step 0 load shedding.

2.10 Florida Electric Power Coordinating Group

The Florida Electric Power Coordinating Group (FCG) was established in 1972, to coordinate the planning, construction and operation of the bulk electric power generation and transmission facilities in the State of Florida. Today FCG is a statewide group of electric utilities working together to address many electric utility industry problems. This group assists its member utilities to meet their basic responsibility of providing reliable, economical and environmentally acceptable electric service to the citizens of Florida. This organization is voluntary and its member systems include cooperative, municipal, and investor-owned utilities. The FCG is supported by the Florida utilities as a common resource for the coordination of operating practices and record keeping. FCG provides an Operating Handbook to its supporting utilities that cover practices in relation to:

- o Operation of bulk power systems;
- o Equipment spare parts;
- o Maintenance coordination;
- o Under-frequency relays; and
- o Reports and record-keeping.

The organizational structure of the FCG consists of several committees which address technical, environmental, economic, political and occasionally, social issues (see Figure 2-7).

Although the FCG and its immediate predecessor, the Florida Operating Committee, have been established for two decades, the organization has remained in a continual state of transition. As needs and priorities have shifted, the organization has updated its programs to meet those needs and priorities.

Figure 2-7 FCG COMMITTEE ORGANIZATIONAL CHART

As a result, committee structure of the FCG has been under constant revision since the group was founded in 1972.

This flexible committee makeup has been identified as a major strength of the FCG. Regularly scheduled meetings are held at one- or two-month intervals so as to aid in the timely resolution of pertinent proposals brought before the committees.

Operating guidelines and procedures are established by FCG committees which are appointed by the member utilities. To be adopted, a procedure must be approved unanimously by the committee members. Changes to existing procedures and policies must also be approved unanimously before they are adopted.

All of the committees work under the direction of the Executive Committee.

The Technical Advisory Group works to develop long-range objectives to meet the overall goal of providing member systems with added reliability.

Overseeing the activities of both the Operating Committee and the System Planning Committee, this group serves to coordinate the planning of generation and transmission expansion programs of the Florida utilities.

The FCG Operating Committee establishes policies for operating and spinning reserve, for scheduled and inadvertent power interchange, for load shedding procedures, and for time error correction. Generator unit maintenance schedules, protective relay coordination, and emergency procedures are coordinated through the FCG forum. In addition, this group establishes special task forces to investigate disturbances and seek ways of preventing future occurrences. This committee is the sponsoring group for the Florida

economy energy broker system which has made possible significant savings to Florida consumers (see Table 2-4). It has the continuing function of increased system integration and may eventually result in a central dispatch scheme for the Florida peninsula.

TABLE 2-4
FCG ECONOMY INTERCHANGE SAVINGS

	1977	1978	1979
January	\$ 380,232	\$ 878,200	\$1,457,400
February	224,685	1,632,500*	1,577,200**
March	117,045	1,236,700†	1,387,000
April	166,496	1,585,700	1,571,000
May	314,618	1,064,200	2,678,566
June	330,048	1,644,800	
July	603,526‡	2,071,800	
August	758,211	1,751,000	
September	742,868	1,769,400	
October	621,965	739,800	
November	582,359	784,600	
December	653,100	1,343,600	
Total	\$5,495,153	\$16,502,300	

SOURCE: Department of Energy

*First month after FPSC demonstrated the potential benefit of economy interchange.

**First month in which the automated energy broker was implemented.

†First month in which the manual energy broker system was implemented.

‡First month after FPSC revised fuel adjustment clause to allow recovery of total costs of purchased economy energy.

The FCG System Planning Committee is charged with the responsibility of coordinating the plans for the expansion of electric bulk power supply facilities in Florida. While there are no formal agreements among the Florida utilities to provide a standard amount of installed reserves,

the FCG member utilities have adopted operating criteria that require each generating utility to install enough generating capacity to meet its own load requirements and its share of the region's coordinated operating reserves.

At the present time, to gain access to neighboring generating capacity, each FCG member must execute a bilateral interconnection agreement with any other member with which it might engage in short- or long-term power exchange transactions. Economy energy interchange is governed by bilateral surplus energy agreements between participating members. Individual utilities must negotiate transmission service agreements such that any power entitlements in joint generating units can be delivered. Only the Florida Power Corporation has established a uniform transmission service rate for wheeling firm power; however, it can refuse to wheel firm power if such service requires it to build additional transmission facilities.

2.11 Florida Municipal Power Agency

The Florida Municipal Power Agency (FMPPA) is an alliance of 26 municipal electrical utilities, both generating and wholesale purchasing systems. FMPPA was created February 24, 1978, by the signing of an interlocal agreement among the member cities. The alliance was motivated by the desire of the participating entities to provide the most economical and reliable electric power to their consumer-owners through joint cooperation with all the electric utilities in Florida: rural electric cooperatives, investor-owned electric utilities, and municipal utilities.

The following objectives were enumerated:

- (1) Plan, finance, construct and maintain joint electric generation and transmission facilities with member systems, investor-owned utilities, rural electric cooperatives and other municipal systems;
- (2) Purchase and acquire electricity from member systems;
- (3) Purchase, exchange and interchange electricity for member systems; and
- (4) Purchase equipment, supplies and materials in bulk.

3. EMERGENCY PROCEDURES OF THE FLORIDA UTILITIES

In this section the following topics will be discussed:

- (1) The emergency guidelines established by the Florida Coordinating Group under which all member utilities plan and operate;
- (2) The generic emergency procedures which are implemented by utility systems during periods of generation or bulk power transmission deficiency; and
- (3) Similarities and differences between the Florida utilities' emergency response procedures and policies with respect to load shedding criteria.

To fulfill the third objective defined above, a comparative analysis of the Florida utilities' emergency response procedures and policies regarding load shedding criteria was conducted based on information submitted by several of the utilities. The Florida utilities comply with the general emergency guidelines established by the FCG, but there are significant differences in each utility's load shedding program.

3.1 Emergency Guidelines Established by the FCG

In order to better understand the load shedding criteria used by Florida utilities, a description of the emergency guidelines established by the Florida Coordinating Group (FCG) will be given. These guidelines are part of an overall emergency response program which is followed by the utilities operating on the Florida peninsula.

These emergency procedures cover the following situations:

- o Operation during declining system frequency;
- o Isolation of power plants from the system;
- o Recovery after a system disturbance; and
- o Procedures for underfrequency relays.

a) Operation During Declining System Frequency

In the event of a sudden serious emergency, load shedding is used to restore the balance between load and generation in the affected area in the shortest possible time and to permit the return to 60 Hz operation. This minimizes the adverse effects on customer service. In addition, load shedding is used to minimize the risk of damage to company and customer facilities and equipment. Load shedding is a measure that is to be taken only after the system has suffered an incident which could lead to widespread system outages.

According to the FCG Emergency Operating Handbook, declining system frequency procedures are implemented sequentially.

A brief summary of these steps follows:

- Phase 1: From 60.0 Hz to 59.2 Hz, all operating reserves and emergency measures should be utilized to the fullest extent. If the decline is gradual the system dispatchers should invoke non-automatic emergency procedures. These include: startup of gas turbines, disconnecting interruptible loads and purchasing power from neighboring systems.
- Phase 2: Between 59.2 and 59.0 Hz inclusive, load shedding should be accomplished via automatic load shedding relays (not less than 10 percent of system load).
- Phase 3: Between 58.8 and 58.7 Hz inclusive, additional load should be shed via automatic load shedding relays in an amount not less than 10 percent of system load existing prior to Phase 2.
- Phase 4: Between 58.6 and 58.5 Hz inclusive, additional load should be shed via automatic load shedding relays in an amount not less than 10 percent of the system load existing prior to Phase 2.
- Phase 5: If frequency is declining at 58.5 Hz, any action should be taken to arrest it. This may include additional load shedding, manual or automatic, and coordinated network separation. This action shall be completed before frequency declines to 58.0 Hz.

Phase 6: At 58.0 Hz, generating units should be isolated in accordance with the FCG program described in the next section. If it becomes necessary for a system to isolate a generating unit at either a frequency higher than 58.0 Hz or in a time period shorter than stipulated, such system shall also simultaneously disconnect an amount of load equal to that particular generating unit's output. This amount shall be an additional amount over any load previously shed. Automatic isolation of generating units is preferred over manual isolation.

Phase 7: If the decline in area frequency is arrested and it levels out between 58.0 Hz and 59.0 Hz, the systems in the low-frequency area should shed an additional 10 percent of their remaining load. They shall maintain or increase, if possible, their generating output to a value corresponding to the fully opened control valve position until frequency is restored to the synchronizing range of the main network.

Phase 8: If after three minutes the action taken in Phase 7 has not returned area frequency to 59.0 Hz or above the systems in the low-frequency area should shed an additional 10 percent of their remaining load, repeating this at two-minute intervals until 59.0 Hz is reached.

Phase 9: When area frequency has been established at 59.0 Hz or above, the systems in the low-frequency area should take any action necessary to permit resynchronization of the isolated area to the main network.

Phase 10: After frequency has returned to synchronizing range, the isolated area should be synchronized with the interconnected system.

Phase 11: System dispatchers should direct load restoration and the resumption of normal interconnected operation.

b) Isolation of Power Plants From the System

The FCG has developed a program for utilities to facilitate the isolation of generating units during low system frequency. If system dispatchers have been unsuccessful in returning system frequency to 59.0 Hz according to the 11 phases described above, the FCG mandates the isolation of generating units from the system. Isolation must be accomplished within certain established time limits. These specified time periods for certain frequencies are designed to assure expedited recovery of the system and protection of generating units.

c) Recovery After a System Disturbance

Procedures for orderly recovery after a system disturbance are given for several conditions:

- o In the event of a loss of unit or plant without separation from the interconnected systems, the system in trouble should request necessary power deliveries from other systems. Frequent checks should be made to assure that requests equal net power on all ties with other systems.
- o If the loss of a unit results in separation from the interconnected systems, and if there is insufficient generation to restore frequency, the system in trouble is responsible for taking whatever action is required to restore frequency to 60 Hz. Load restoration should not be attempted until frequency has returned to normal.
- o If the loss of a unit results in separation from the interconnected systems and loss of load by underfrequency relay action, load restoration should not be attempted until frequency has returned to normal and ties to the interconnected systems are reestablished. All load pickup should be coordinated with the Florida Power Corporation System Dispatcher.
- o Following a statewide total loss of generation, recovery of individual systems is to be facilitated by opening ties at prearranged switching points.

d) Procedures for Underfrequency Relays

This next section describes emergency procedures via underfrequency relays for the following situations:

- o Load shedding;
- o Startup of gas turbines and diesels;
- o Isolation of generating units from system; and
- o Step Zero (0).

To prevent a frequency decline below tolerable limits if a loss of generation should exceed the amount of spinning reserve available, underfrequency relays are set to disconnect not less than 30 percent of the load on each system. The relay scheme is designed to spread load reduction uniformly over three steps as follows:

Underfrequency Relay Settings (in Hz)

59.2	
59.1	10%
59.0	
58.8	
58.7	10%
58.6	
58.5	10%

Assignment of load to underfrequency relay control is based on annual peak load forecasts. Interruptible loads which are utilized as part of the operating reserve are not counted as part of the load shedding obligation.

Gas turbines and diesel units are started by underfrequency relays set at 59.4 Hz (or other appropriate setting.)

Generating units are isolated from the system by underfrequency relay action with appropriate auxiliary relays and guard circuits set for 58.0 Hz and 12 seconds time delay. An additional underfrequency relay may be installed to separate the units with their auxiliaries after seven minutes of operation below 58.5 Hz.

A utility may place interruptible loads on underfrequency relay control and consider that load to be part of the spinning reserve requirement (up to 75 percent of the reserve allocation). These relays are set to disconnect load at 59.7 Hz and are considered to be on Step 0. (A more detailed description of these emergency procedures is contained in the FCG Operating Handbook.)

3.2 Description of the Emergency Procedures Used by the Florida Utilities

There are a number of emergency procedures that can be implemented during periods of generation/transmission deficiency. Some of the procedures do not involve load reduction measures and so are not emphasized in this report. These are:

- o Procedures for full utilization of generating reserves;
- o Procedures for reestablishing ties or transmission lines; and
- o Tripping of generator units in severe underfrequency conditions.

This report focusses on load reduction measures.

These include:

- o Industrial/Commercial Appeals;
- o Public Appeals;
- o Disconnection of interruptible load;
- o Voltage reduction;
- o Underfrequency (automatic) load shedding; and
- o Non-automatic load shedding.

These load reduction measures the Florida utilities take when they experience a generation deficit are defined below.

Industrial/Commercial Appeals. When a utility forecasts a potential generation deficit, it can telephone preselected large customers and ask them to reduce their electrical consumption as much as possible. Contacting individual customers is time consuming, but only large consumers are involved and the utility can expect to achieve significant load reduction with each telephone call. This action can be initiated quickly (i.e., customers can be contacted starting within 15 minutes of the utility's decision to make the appeal) and the load reduction achieved is expected to have only a minimum impact on the customers contacted.

Public Appeals. It is not practical to contact a utility's many residential customers individually, so a news media message is used to request the general public to reduce electricity consumption. Newspapers, radio and/or television announcements may be used.

Because of the nature of the communication, more lead time is needed for a public appeal than for a commercial/industrial appeal (e.g., the message must be recorded or written and air time requested, or must be typeset for a newspaper). It has been the experience of some utilities that if too many public appeals are issued, the public ceases to heed them. Consequently, public appeals have been used with discretion and prudence.

Disconnection of Interruptible Load. Some large industrial electricity consumers purchase part of their electricity requirements through interruptible contracts. They allow the utility to interrupt their service during a system capacity emergency in return for a lower rate. The utility may accomplish this through remote controlled breaker operation, or by sending a crew to manually disconnect service. The utility usually does not have to open a switch to interrupt the customer's load, but simply contacts the customer and requests that consumption be reduced by a certain amount. By voluntarily reducing his load, the customer can cease equipment operation in an orderly manner and avoid possible production losses (e.g., spoilage of work in progress) that could result from a sudden unexpected power interruption. In choosing this type of rate, the customer has decided that the possible losses (e.g., product spoilage, load production) due to power interruptions are outweighed by the lower electric rate.

Voltage Reduction. By reducing voltage throughout its system, a utility can continue to serve its load at reduced power consumption levels. The amount of load reduction achieved by reducing voltage depends on the type of load. Straight resistance loads (e.g., lighting and electric heat) are most responsive. Certain other loads are not responsive. For example, a voltage reduction will cause the compressor of an air conditioner to operate less efficiently, resulting in the air conditioner running for longer periods than normal in order to do the same amount of cooling. (For example, an air conditioner that runs 7-1/2 minutes out of every 15 may run nine minutes out of 15 during a voltage reduction.) Voltage reduction may be accomplished through remote or manual control of substation transformer tap settings or voltage regulators.

Underfrequency (Automatic) Load Shedding. Underfrequency relays throughout the power system are set to open circuit breakers and disconnect load at various frequencies below 60 Hz. Their response to a generation deficiency is the quickest of the actions described here. During a generation deficiency the system frequency drops, and could damage utility and customer equipment. In order to retain a generation-load balance, the underfrequency relays are set to drop specified blocks of load to prevent the entire system from experiencing a cascading outage. The relays must be set in advance to drop that given amount of load at a specified frequency. A priority list is maintained to determine the order in which circuits should be interrupted.

Non-Automatic Load Shedding. A conscious decision to reduce load can be implemented through non-automatic load shedding. This procedure, often referred to as a "rotating blackout," consists of interrupting

service to selected non-critical feeders or substations for short periods of time (typically 10-20 minutes). The blackouts are termed "rotating" because after a time service will be restored to an interrupted feeder and another one interrupted in its stead. A utility may implement this manually (i.e., individually interrupting or restoring service to each feeder), or it may have a load shedding program which automatically interrupts and restores service according to a predetermined schedule. A utility must decide what load it is willing to interrupt under this load shedding option. Often, priorities or categories of "criticality" are used to classify each distribution feeder or substation.

3.3 Comparision of Florida Utilities Load Shedding Criteria

In this section similarities and differences between the criteria adhered to by the Florida utilities* are presented in a summary format. The criteria is based on information submitted to the study from each utility. Some utilities submitted their entire emergency procedures plan and others focussed specifically on their load shedding criteria. Despite the variance in reporting technique, some interesting comparisons can be made.

a) Similarities

- o All the Florida utilities adhere to the guidelines established by the Florida Coordinating Group regarding automatic underfrequency relaying.

* Florida Power Corporation (FPC); Florida Power & Light Company (FPL); Gainesville-Aluchua County Regional Electric Water & Sewer Utilities Board (Gainesville); Jacksonville Electric Authority (JEA); Orlando Utilities Commission (Orlando); Tampa Electric Company TECO); and Vero Beach Municipal Power Plant (Vero Beach).

- o Selection and order of circuits to be shed are determined by individual utilities.
- o All circuits in a utility's service area are assigned priorities based on the nature of the load (primarily residential, commercial or industrial) and established feeder priority lists.
- o Circuits serving hospitals, defense facilities and airports are assigned top priority
- o Circuits which are primarily residential in character are considered the first choice for load shedding because these loads are deemed to be the "least" critical in nature and because large blocks of load, immediately shed, are most helpful in restoring system conditions to normal.
- o Circuits on automatic and non-automatic load shedding are reviewed periodically and updated or revised as appropriate
- o Load shedding is regarded by all the utilities as the final step in a series of actions taken during a generation deficit or emergency situation. Generally speaking, the actions taken by a utility are prioritized according to the magnitude, severity and cause of the problem.
- o For all the utilities, 30 percent of the total system load is interruptible by underfrequency relaying in three frequency ranges.
- o Responsibility for classifying customers as "critical" is placed on local area managers.
- o Critical customers are generally defined as those who affect public health and safety, have life-support equipment, or would suffer extensive damage because of an outage.
- o Feeders on Step 0 underfrequency load shed are generally excluded from non-automatic load shedding schedules. This is because it may be necessary for the system dispatcher to drop the former without notice after scheduled rotation has begun.

b) Major Differences

- o In some cases, utilities rotate the list of circuits to be shed and place circuits already shed at the bottom of the list. Over a period of time, all equal priority circuits will be equally exposed to the chance of selection. In other cases load shedding follows a standard pattern. For example, load shedding of circuits begins at the north end of the service area for each emergency. This means that some equal priority feeders are exposed to load sheddings more than others.
- o For some utilities non-automatic load shedding is accomplished via a formal computerized program. In other utilities underfrequency scheduling is the guide for non-automatic (manual) load shedding. The list of feeders to be shed is often hand-typed and passed out to system dispatchers.
- o Vero Beach has no customers on 59.7 Hz load shed or Step 0 underfrequency.
- o Some utilities omit top priority circuits (airports, hospitals and defense utilities with critical loads) from load shedding schemes while others place them at the bottom of the load shedding list.
- o A standard list of reasons for excluding a feeder from load shedding is provided by some utilities, but is more informal or not documented at all by others.
- o The average duration of a circuit interruption via load shedding varies with the utility. In some systems the outage time per feeder may be 15-20 minutes, while in other systems may be 45 minutes.

4. DESCRIPTION OF THE TWELVE FLORIDA INCIDENTS INCLUDED IN THIS INVESTIGATION

4.1 Background

Between January 1 and August 31, 1979, there were 12 occasions in which electric power was curtailed or electric voltage reduced for major portions of the Florida peninsula due to bulk power supply problems. Five of these incidents involved systemwide load shedding to preserve the integrity of the bulk power supply system. These incidents were due to generation or transmission failures at various locations in Florida. Six incidents involved only the Jacksonville Electric Authority System and were either manual load sheddings, voltage reductions to reduce load, or public appeals to reduce load voluntarily. One incident involved only the Florida Power and Light System. The loads interrupted ranged from 25 to 921 megawatts, and the total customers affected ranged from approximately 5,000 to over 335,000.

4.2 The Twelve Incidents

A summary of each incident which occurred is presented in this section.

Detailed technical analysis and evaluation will follow in section 5.

Table 4-1 presents the following descriptive analysis in tabular form.

<u>Date/Time</u>	<u>Incident</u>
7:34 a.m., Wednesday January 3, 1979	Extremely cold weather caused the peak demand in Florida to approach the amount of operating generating capacity. A 100 MW delivery to Jacksonville (JEA) from Florida Power and Light (FPL) was withdrawn on short notice. Due to a "garbled" conversation between JEA and FPL operators, emergency load shedding was initiated by JEA. A total of 34-25kV distribution circuits were interrupted for approximately 14 minutes each during the next 40 minutes.
2:11 a.m., Saturday March 17, 1979	Florida Power and Light Company's Turkey Point No. 4 nuclear unit tripped as a result of a low flow signal which was inadvertently originated during periodic testing by FPL's plant personnel. The unit was carrying 615 MW at the time. System instability following the unit trip caused the 230kV intertie to Georgia

Date/Time

Incident

11:51 p.m., Wednesday
April 4, 1979

to open. The Florida systems were then an island and the system frequency declined to 59.14 Hz, causing the operation of some automatic underfrequency load shedding relays. A total of 157 MW of firm load was shed on six electric utility systems in peninsular Florida. Service was restored to most customers within 20 minutes. At the time of the incident, Florida utilities were importing 150 MW of power from Georgia in order to displace oil use in Florida.

Florida Power and Light Company (FPL) was experiencing transmission line trippouts in the region south of Miami due to a salt contamination build up on insulators and a heavy evening dew. Transmission lines from the Turkey Point nuclear plant had been tripping throughout the day and early evening. Maximum possible generation from the three operable Turkey Point Units was continued for economic reasons. Late in the evening the remaining three transmission lines from Turkey Point tripped within four minutes, isolating these generators from the Florida grid. The resulting system instability caused the ties with Georgia to open and the system frequency on the islanded Florida systems declined to 59.01 Hz. Load shedding relays operated to drop 921 MW of distribution load on five systems. Service was restored to most customers within 13 minutes. Peninsula Florida utilities were importing 200 MW of power from Georgia at the time of the incident.

11:22 a.m., Wednesday
May 2, 1979

An energized 138 kV transmission conductor in Southeast Florida was accidentally contacted by equipment during reconductoring. This caused the line to open and interrupt service to Lee County Electric Cooperative. A total load of 69 MW involving 30,000 customers was interrupted for four hours and eight minutes.

8:16 a.m., Friday
May 4, 1979

A gasket failed on the Florida Power and Light Company's Turkey Point No. 3 nuclear unit condensate water pump causing the generator to trip. The unit was carrying 665 MW at the time. Peninsular Florida was islanded when the transmission ties opened and the system frequency declined to 59.14 Hz, resulting in operation of underfrequency load shedding relays. A total of 404 MW of firm

Date/TimeIncident

2:30 p.m., Thursday
June 7, 1979

load was shed on eight different systems. Service was restored to most customers within 43 minutes. Peninsula Florida utilities were importing 150 MW of power from Georgia at the time of the disturbance. The net generation loss was 935 MW.

Very hot weather resulting in very high loads caused Jacksonville's system load to equal 99% of the available generating capacity. The JEA operators made a public media appeal to reduce usage at 2:30 p.m. A voltage reduction to reduce load was instituted at 3:10 p.m. No load was dropped and voltage was returned to normal levels at 6:55 p.m. JEA was purchasing 200 MW from Florida Power and Light Company during the incident.

9:30 a.m., Thursday
June 21, 1979

An incorrect sequence of operator actions during a routine surveillance test on the reactor protection system tripped FPL's St. Lucie No. 1 nuclear unit while it was carrying 775 MW. The tie to Georgia was tripped by out-of-step relays, isolating the Florida peninsula. The system frequency on the Florida peninsula declined to 59.175 Hz, resulting in some automatic load shedding. A total of 144 MW of firm load was shed on two systems. Service was restored in about 19 minutes. Florida utilities were importing 140 MW of power from Georgia at the time.

5:03 p.m., Monday
July 2, 1979

The Jacksonville Electric system was operating with high loads and insufficient reserves when mechanical problems at the Northside Generating Station forced them to reduce the generating output. To preserve the load and supply balance, 40 MW of customer load was shed. Shortly thereafter additional power was purchased from other Florida utilities and full service was restored within 11 minutes.

1:49 p.m., Wednesday
July 25, 1979

The Jacksonville Electric system was experiencing high loads due to very hot weather. As the loads continued to increase transmission system voltage levels declined to a point where operating procedures called for corrective action by the system operator. None of the combustion turbine units in the area would start immediately. Approximately 25 MW of load was manually shed by the Jacksonville system operator to alleviate this problem. The problem was corrected when a combustion turbine unit was started. The load interruption lasted for 15 minutes.

Date/Time	Incident
2:00 p.m., Saturday July 28, 1979	Extremely hot weather on this date caused system load to exceed available generation and available purchased power on the Jacksonville electric system. The Northside No. 3 unit (480 MW) had experienced a forced outage due to a boiler tube leak during the morning. The outage created a capacity shortage in the JEA system. All available purchases of power were arranged. System voltage continued to deteriorate and a public media appeal and system voltage level reduction were implemented at 2:00 p.m. Loads continued to increase and load dropping through rotating feeder disconnection was initiated at 2:30 p.m. A total of 30 MW of load was dropped on a rotating basis about every 18 minutes. Normal operation was resumed at 6:03 p.m.
2:20 p.m., Sunday July 29, 1979	A public appeal for load reduction was issued at 2:20 p.m. and system voltage reduction was initiated at 5:25 p.m. on the JEA system. This was due to the continuing forced outage of Northside Units 1 and 3 to repair boiler tube leaks, transmission limits on purchased power and extremely hot weather. This resulted in a generation capacity deficiency. A delay occurred in implementation of the voltage reduction measure due to failure of a microwave supervisory channel. No load was dropped.
7:07 a.m., Friday August 3, 1979	Florida Power and Light Company had initiated periodic testing of some of the systems at its Turkey Point Nuclear Power Plant. Due to a procedural error, two systems were being tested simultaneously and a failure in one cascaded to the other, causing Turkey Point Units 3 and 4 to trip within three minutes of each other. The Peninsular Florida separated from Georgia due to system instability. System frequency on the islanded system declined to 59.14 Hz, and some automatic load shedding operated. A total of 277.5 MW of firm load was shed on eight systems in Florida. Service was restored in about 18 minutes. Florida utilities were importing 300 MW of power from Georgia at the time of the incident. The net generation loss in Florida was about 1,560 MW.

The individual Florida electric utilities, as well as the Performance Subcommittee of the Florida Electric Power Coordinating Group (FCG), investigated several of these power supply interruptions in Peninsular Florida. These analyses are very thorough and self-critical and have been used as a technical basis for this report.*

* Those reports utilized in this report are available from the ERA, Office of Public Information, 2000 M Street, N. W. Washington, D. C. 20461.

TABLE 4-1

SUMMARY OF THE TWELVE FLORIDA INCIDENTS

	<u>DATE</u>	<u>DESCRIPTION OF INCIDENT</u>	<u>TOTAL FIRM LOAD DROPPED</u>	<u>DURATION</u>	<u>ESTIMATED TOTAL # OF CUSTOMERS</u>	<u>INVOLVED UTILITY(S)</u>
1.	January 3, 1979	Manual Load Shedding	140 MW	30 Minutes	70,000	JEA
2.	March 17, 1979	Automatic Load Shedding (Underfrequency 59.14 Hz)	157 MW	5-20 Minutes	150,000	JEA, TAMPA, FP&L FPC, ORLANDO, Ft. PIERCE
3.	April 4, 1979	Automatic Load Shedding (Underfrequency 59.01 Hz)	701 MW	2-20 Minutes	335,800	JEA, TAMPA, FP&L ORLANDO, FPC
4.	May 2, 1979	Load Dropped Due to Error During Line Rebuild	69 MW	4 Hours	30,000	FP&L
5.	May 4, 1979	Automatic Load Shedding (Underfrequency-59.14 Hz)	404 MW	8-43 Minutes	200,000	FP&L, TAMPA, FPC JEA, ORLANDO, FT. PIERCE, HOMESTEAD,
6.	June 7, 1979	System Voltage Reduction and Public Appeals	50 MW	4 Hours	210,000	LAKELAND JEA
7.	June 21, 1979	Automatic Load Shedding (Underfrequency 59.175 Hz)	144 MW	4-17 Minutes	200,000	FP&L & FPC
8.	July 2, 1979	Manual Load Shedding Voltage Reduction	40 MW	11 Minutes	5,000	JEA
9.	July 25, 1979	Manual Load Shedding	25 MW	15 Minutes	35,000	JEA
10.	July 28, 1979	Manual Load Shedding Voltage Reduction Public Appeal	30 MW	15 Minutes	35,000	JEA
11.	July 29, 1979	Voltage Reduction (5%) Public Appeal	N/A	1 HR 25 Min. 4 HR 55 Min.	NA	JEA
12.	August 3, 1979	Automatic Load Shedding (Underfrequency-59.29 Hz)	278 MW	8-18 Minutes	NA	FP&L, FPC, JEA, TAMPA, ORLANDO Ft. PIERCE, HOMESTEAD, LAKELAND

5. TECHNICAL ANALYSES

5.1 BACKGROUND

The 12 electric power system disturbances in Florida as described in this report had several common operating and engineering characteristics. In most cases the initiating event was followed by the operation of some manual or automatic load shedding on the involved utility system(s). The involved utilities in Florida have, in all appropriate cases, conducted a thorough and detailed investigation of each disturbance. These reports were made available to the DOE staff in preparing this report. As a result of these self-investigations, the Florida utilities and/or the Florida Electric Power Coordinating Group have taken several actions to minimize the possibility of recurrence of a similar event.

5.2.1 MULTI-UTILITY OUTAGE/DISTURBANCE

Five of the 12 events involved more than one utility and all were initiated by the unexpected loss of a generator unit supplying 600 megawatts or more. The loads lost were through the actions of automatic underfrequency relays that were set to open a circuit breaker(s) should the system frequency drop to that level or lower. Electric utilities in Florida have installed underfrequency relays that will shed controlled amounts of load at three different frequency levels known as Step 1, Step 2, and Step 3. In addition, customer load supplied under interruptible contract is set to be automatically interrupted by a decline in frequency. This setting is known as Step 0 and is triggered at 59.7 hertz.

In the five statewide outages most of the load lost was accomplished by the activation of the Step 0 load dropping scheme. Step 1 actions at 59.2 hertz occurred only in the April 4, and August 3 disturbances. The loads lost by the Florida Power Corporation and the Tampa Electric Company were contract

interruptible loads while the loads shed by the Florida Power and Light Company, the Jacksonville Electric Authority and others was firm customer load that had been specially armed to be dropped at the 59.7 hertz level. The amount of loads connected to this scheme varied in proportion to the electric power being imported into the Florida Peninsula.

5.2.2 JACKSONVILLE ELECTRIC AUTHORITY INCIDENTS

Six of the 12 Florida incidents involved actions by the Jacksonville Electric Authority (JEA) to constrain load levels to below available generation. The June 7 and July 29 incidents involved public appeals and a lowering of the system voltage by 5 percent. These activities are a "brownout", however, there was no direct customer impact. The January 3, July 2, July 25 and July 28 incidents involved manual load shedding of certain predetermined circuits by the JEA system operator. Some of these circuits were outaged for only short periods and then returned to service while others were interrupted.

5.2.3 MISCELLANEOUS INCIDENTS

The May 2 incident involved a human error that unfortunately caused the lost of 69 MW of load. This situation was an accident and was thoroughly investigated by the Florida Power and Light Company. No further analysis will be included in this report.

5.2.4 RESTORATION

One common positive aspect of the Florida systems' responses to these disturbances was the fast restoration time. Typically, all loads were restored and interties reestablished within 20 to 30 minutes of the initiating event. This is reflective of the thorough and complete procedures developed and implemented by the Florida utilities. Also, the presence of a very sophisticated supervisory control system has significant impact on this rapid restoration time.

5.3.1 COMMON EVENTS TO MULTI-UTILITY OUTAGES

All of the multi-utility outages (Table 5.1) were initiated by the trip of a generator supplying over 600 MW. The March 17, June 1 and August 3 generator outages all occurred when a required test of a control system on a nuclear generating unit was being conducted. This common event raises concern as to the time scheduling of the required tests. Do they have to be done when imports of power from Georgia require that some load be set for "zero" step shed? NRC requirements are for routine testing within certain time periods, and the actual schedule is established by the operating utility. Thus, Florida Power and Light has the flexibility to conduct these required tests at times when a unit trip should have a minimum impact.

In all of the multi-utility outages, power was being imported from the Georgia Power Company over the then existing single 230kV transmission line between the two regions. Loss of the generation on the Florida Peninsula caused system oscillations and the protective relay scheme caused the Florida Peninsula and Georgia systems to separate at the Ft. White substation. At this time, the Florida Peninsula became an electrical island and frequency began to decay because there was an imbalance between load and generation. The automatic frequency load shedding relays were activated causing the customer outages, however, the net result was the restoring of a balance between the available generation and load. If this balance had not been quickly reestablished, frequency decline would have continued, additional generator units would have tripped, and a major blackout could have occurred.

TABLE 5-1

SYSTEM DESCRIPTION DURING PENINSULA-WIDE DISTURBANCES

Date (1979)	Initiating Event	Pre-Disturbance						Disturbance Initiation		Post Initiation			
		FP&L Spin. Reserves		FP&L Supplemental Reserves		Interruptible Load (Step 0)		Generation Deficiency of Florida Peninsula (MW)	Frequency Decline (Hz)	FP&L Governor Responses (MW)	Increased FP&L Imports (MW)	Load Shed*	
		Actual (MW)	FCG Criteria (MW)	On-Line Steam (MW)	Gas Turbine (MW)	FPC (MW)	TECO (MW)					FP&L (MW)	Total Florida Peninsula (MW)
3/17	Loss of Turkey Point #4	359	313	590	1,774	120	0	855	59.14	181	329	105	277
4/04	Loss of Transmis- sion of Turkey Point	492	331	491	1,778	150	70	1,313	59.01	173	491	470	921
5/04	Loss of Turkey Point #3	353	304	832	1,598	125	40	935	59.14	41	374	250	571
6/21	Loss of St. Lucie	580	306	-	1,777	70	-	990	59.175	215	432	128	214
8/3	Loss of Turkey Point #4 Loss of Turkey Point #3	623	306	-	1,777	150	0	920	59.29	356	274	0	0
								640	59.14	130	270	240	427.5

* Includes interruptible Load.

Source: Florida Power & Light

The fact that each of the multi-utility disturbances resulted in the dropping of firm customer load, might suggest that the FCG spinning reserve requirements are inadequate. An in-depth review of this matter has been conducted by the Operating Committee of the FCG. This review primarily involved inertial and transient stability studies of the Florida Peninsula systems with various levels of power imports from Georgia. While these technical studies were being accomplished, the FCG adopted a temporary operating policy requiring that an amount of load equal to the power being imported be armed for dropping at "Step Zero" (59.7 Hz). Dropping these small amounts of load was viewed as an arresting measure to allow a system load-generation balance to be re-established. The results of these studies have now indicated that, currently, the Florida systems can withstand the loss of a generating unit supplying 400 megawatts or less and shed no load. Loss of a unit supplying more than 400 megawatts will likely result in dropping an amount of firm load equal to the power being imported. This situation will continue until additional transmission lines are constructed between Florida and Georgia such that the interconnecting facilities can remain intact during the loss of a large generator unit in Florida.

During the outages subject to this investigation, and continuing to the present, the interconnections between Georgia and the Florida Peninsula are set to open by relay action during major disturbances in Florida. These disturbances cause flows which overload lines and cause rapid declines in system voltages in South Georgia. Such voltages are unsatisfactory from a customer service viewpoint. These high flows tend to cause an increased electrical angle and the protective relays

separate the systems to prevent equipment damage and to minimize the load interrupted. All of these actions must occur in fractions of seconds, if a more extensive outage or equipment damage is to be prevented. Since load shedding is a relay action, it can be accomplished very rapidly. In contrast, the spinning reserve available from operating generators requires response time in seconds because valves must open wider, boilers must produce more steam, etc. Therefore, spinning reserve, while required for the longer-term system equalization, is not a very effective instantaneous solution when a large unit trips on the Florida Peninsula.

Actual studies have indicated that load shedding has a 2-to-1 advantage in response effectiveness. In other words, twice the amount of spinning reserve is required to have the same effect as load shedding. While such an operating requirement could be established, it would significantly increase oil use and, thus, consumer cost would increase.

In conclusion, it appears that the operating criteria developed by the Florida Electric Power Coordinating Group is an appropriate technical solution when the economics of alternatives are considered. If the customer costs incurred in these extremely short outages are determined to be greater than is apparent now, a further review of the alternatives may be proper. As stronger interconnections between Florida and Georgia are established, the need to shed load during the trip of a single generator will disappear.

5.4.1 DISTURBANCES ON THE JEA SYSTEM

The Jacksonville Electric Authority reported that its electrical difficulties during the first nine months of 1979 were due to transmission system and generating capacity limitations resulting from the following combination of circumstances:

- (1) Due to financial problems, preventive maintenance of generating units on the JEA system has been limited for about a seven-year period. This lack of preventive maintenance essentially caught up with JEA during 1979 when generating equipment failed in-service or was scheduled out for prolonged overhaul in order to return the equipment to satisfactory condition. In some instances, units were out of service for five to 18 months to correct problems that likely would not have occurred had there been regular maintenance.
- (2) Northside Unit No. 3 is the largest generating unit (518 MW) on the JEA system and represents about 40% of the 1979 peak demand. This unit is the most fuel efficient on the JEA system, and there is economic incentive to load this unit as fully as possible. Loss of the unit has a significant impact on the performance of the JEA system. Failure of this unit to perform reliably during peak load periods often caused the city to depend on large amounts of purchased power to meet its load.
- (3) The Jacksonville electrical system is radially interconnected with only one other system in peninsular Florida (Florida Power and Light Company) and is essentially an appendate to the rest of the Florida Peninsula's bulk power supply network.

Voltage support in the Jacksonville area is critical and the lack of dependable generation often caused low voltage on the JEA system. FP&L and JEA have a coordination agreement regarding this voltage matter, however, power imports cannot be a substitute for local area voltage support.

5.4.2 JEA's PLANNED CORRECTIVE ACTIONS

In FY 77, JEA initiated two new programs to insure that the operating and maintenance requirements of the JEA system were met. First, an intensive review of operating procedures has produced more economical work methods in many cases. Second, the JEA has approved rate increases designed to meet the utility's revenue requirements. With this new program, the JEA embarked on an aggressive maintenance program to rectify accumulated maintenance problems. The JEA is now entering into its fourth year of a five-year maintenance program to restore all of the units to rated capacity with an 85% availability factor. At present, 59.8% of the total generating capacity has undergone overhaul. During FY 80, 21.5% will undergo extensive maintenance. The remaining 18.7% is expected to be completed in the next two years.

As part of the five-year program, the JEA is embarking on a maintenance improvement program to review and revise operating and maintenance practices, including a system-wide review of the operating, maintenance, inventory, warehouse, and training practices. In addition, JEA will determine the necessary budget support to conduct these programs. Simultaneously, the JEA will be studying each unit in the system to determine if additional generating capacity can be obtained through modifications of either equipment or operating practices. The goal of this program is to obtain additional

system capacity at the lowest possible cost. Together, these programs will greatly improve system reliability. This aggressive maintenance program has significantly contributed to the current reduced reliability experienced during this "catch-up" period. It is believed that with the present programs underway and other future programs being planned, the systems will be back to an acceptable level of reliability by the early 1980s.

5.5.1 INVESTIGATIONS/ANALYSIS BY OTHERS

In 1978, the FCG Operating Committee established procedures for conducting official reviews of disturbances and evaluating the performance of Peninsular Florida's interconnected electric system. In accordance with these procedures. The FCG Performance Subcommittee immediately began an intensive study of all the multi-utility incidents cited in this report.

This activity is in addition to any analysis or investigative report accomplished by an individual utility. In order to analyze each disturbance thoroughly, data is requested from 13 utilities throughout the state. The collection of this data results in some additional benefits by identifying calibration and metering errors.

Data was collected for 17 incidents from March through October 1979 as listed in Table 5-2. Ten of these were thoroughly analyzed. Any changes in transmission line configuration or relaying during this period were also noted. Particular emphasis was placed on frequency excursion, generation lost, power import lost, and total generation. Figure 5-1 shows a chart of the frequency excursion of one incident.

Table 5-2

FCG - OPERATING COMMITTEE
 PERFORMANCE SUBCOMMITTEE
 DISTURBANCE ANALYSIS - TOTAL FOR STATE

DISTURBANCE DATE	1	2	3	4	5	6	7	8	9	10
DATA	3/17/79 0211 Hrs.	4/4/79 2357 Hrs.	5/4/79 0816 Hrs.	6/21/79 0039 Hrs.	6/24/79 1127 Hrs.	6/24/79 1440 Hrs.	6/28/79 1825 Hrs.	7/11/79 1300 Hrs.	7/14/79 2050 Hrs.	8/3/79 0707 Hrs.
1. Initiating Event	TP4	TP1,2&4	TPU3	St. Lucie I	TP4	CR1	Acclsta	CR1	Manatee	TP3&TP4 DELAYED**
2. Generation Loss	615	1133	565	775	560	380	500	365	705	1270
3. Loss From Ties Separating	240	180	270	220	240	220	150	300	220	240
4. Gross Source Loss (L2+L3)	855	1313	935	995	800	600	650	665	925	1510
5. Spinning Reserve Assigned	740	740	740	740	740	740	740	740	740	740
6. Step Zero Shed	120	220	167	70	80	148	175	103	112	120
7. Step 1, Shed	189	723	604	132	0	0	0	0	40*	271
8. Net Deficiency	546	370	571	793	720	452	475	562	773	1119
9. Net Generation Response	549	620*	332	697	829	311	534	585	789	1332
10. Response - Loss Imbalance (L9-L8)	+ 3	+250		- 96	109	-141	+ 29	+ 23	+ 16	+213
11. Average low Frequency	59.19	59.04	59.18	59.22	59.44	59.61	59.62	59.57	59.45	59.23
12. State Load Before Disturbance	6161	7694*		9708	11710	13232	14025	14818	14146	9661
13. State Load After Disturbance	---*	---*		9483	11546	12968	13823	14628	13954	9273
14. Total Generation Before Disturbance	5921	7514	9189	9500	11406	13096	13649	14369	13661	9313
15. Total Generation After Disturbance	---*	7011*		9314	11654	11837	13629	14484	13728	9134
16. %Total Source Loss/ Total Generation (L4+L14x100)	14%	17.5%	7%	10%	7%	4.5%	4.5%	4.5%	6.5%	16.2%
17. %Total Source Loss/ Spinning Reserve MW (L4+L5x100)	115%	177%	126%	134%	108%	81%	88%	90%	125%	204%

NOTES:

4/28/79, Fort White-Newberry-Crystal River 230KV Line In Service.

7/5/79, Relaying at Fort White changed from out-of-step blocking to out-of-step tripping breakers 5063, 5065, and 350.

*Data unavailable or questionable

**TP3 trip 2 minutes after TP4

Figure 5—1

The FCG analysis shows a direct relationship between total power imports and average low frequency. Further indications are that a frequency decline initiating load shedding results when the loss of generation plus import exceeds 7% of total generation. Either decreasing total source loss or increasing on-line generation resulted in smaller frequency excursion and a decreased possibility of underfrequency load shedding.

The analyses of these incidents indicated that the performance of the state's interconnected utilities is predictable and there is no reason to expect catastrophic widespread cascading power outages. The primary reason for the frequency decline was the loss of generation at a time when Peninsular Florida was importing electricity from the Southern Company.

The FCG has concluded that:

- (1) The Peninsula Florida systems performed as expected during all the incidents as determined by previous transient stability studies;
- (2) Spinning reserve was being carried by all utilities essentially in conformance with Operating Committee guidelines;
- (3) There is no indication of instability which might lead to cascading outages;
- (4) The simultaneous loss of Turkey Point Units 1, 2, and 4 while Florida was importing 180 MW on April 4, 1979, still resulted in a predictable frequency excursion with a controlled rapid recovery to normal operation;
- (5) Step 1 underfrequency load shedding would probably not have occurred in most instances if power had not been imported at the time of the outage; and
- (6) Present reserve policy does not consider transfers of power into Peninsular Florida.

6. SOCIAL AND ECONOMIC IMPACT ASSESSMENT OF NINE LOAD SHEDDING AND REDUCTION INCIDENTS IN JACKSONVILLE, FLORIDA

6.1 Background

A technical description and analysis of the 12 load shedding and reduction incidents which occurred in Florida between January and August 1979 is contained in the first four sections of this report. In conjunction with this technical investigation, another area of research was undertaken. This has to do with the social and economic problems which frequently result from the interruption of electric power in urban centers. Studying the effects of power outages on customers is a relatively recent endeavor which has been undertaken in the research community. The first such effort to "quantify" and define the type of impacts which can result from power outages was undertaken by the Department of Energy in 1977 following the massive 25 hour New York City blackout.* Other studies have also been conducted since that time to assess the impact of outages on customers.** These studies have in varying degrees revealed new facts regarding the consequences of power outages for customers who live in densely populated regions. For example, during the 1977 New York City blackout, severe looting and rioting took place which resulted in substantial financial and economic losses. Such "indirect"*** impacts in fact resulted in far greater economic losses than the obvious "direct" impacts (e.g., food spoilage, loss of wages and productivity) which accompany prolonged power failures. The identification, classification and quantification of these types of impacts have served as useful inputs to the overall consideration

* Reference No. 1.

** References Nos. 2-4.

*** Indirect impacts are those impacts which result from one or more direct impacts and reflect social responses made to blackout conditions (i.e., looting, vandalism, etc.). Direct impacts relate to the interruption of an activity or service which requires direct input of electrical energy *i.e., loss of refrigeration, elevator shutdowns, loss of traffic control devices, etc.).

and evaluation of the worth or value of reliable electric service. Therefore, it was thought that the repeated load shedding incidents which took place in Florida provided a unique opportunity to gather extensive and valuable data directly relevant to this question of the worth of service continuity.

This study differs from impact assessments conducted previously because it attempts to distinguish between outages which are "deliberate" and those which are "random". In addition, this is the first survey to focus on the actual impacts or effects on residential customer as opposed to the "perceived" effects.

In order to better understand the impacts of repeated load shedding incidents, voltage reductions, and public appeals on customers, a survey of residential consumers in the Jacksonville area was conducted.

The primary reason for selecting Jacksonville for study was simply because this city was affected by more incidents (10) than any other area in Florida. In addition, JEA was the only utility to initiate media appeals to ask the public to reduce consumption of electric power. Jacksonville was also selected because it is a city of "manageable" size (in terms of survey implementation), large enough to achieve a reasonable cross-section of various demographic groups of residential customers but small enough to be able to gather sufficient data from all relevant agencies needed to characterize the entire area in terms of customers types, consumption patterns and primary socioeconomic activities (e.g., growth trends, population, housing, and business patterns).* (See Figure 6-1 for a map of the JEA service territory and electric power supply system.)

The scope of this study was precisely defined to facilitate the short time frame of the overall DOE investigation, and was set as follows:

- o The emergency actions studies were limited to those of January - August 1979;

* Characterizing the city in terms of social and economic descriptors is important because it enables extrapolations to other areas with similar characteristics to be made. The question of how "unique" Jacksonville is as a city can be answered.

Jacksonville Electric Authority Transmission System Map 1978

Figure 6—1

- o A survey of a sample of 3,000 JEA residential customers was used to assess the socioeconomic impacts of a utility's emergency actions to reduce electric load. The emergency actions included rotating blackouts, appeals to the public to reduce consumption, and voltage reductions;
- o The survey was supplemented with an analysis of some of JEA operations data in order to corroborate the survey results and to answer questions not suitable for a customer survey; and
- o The survey was limited to residential customers because the majority of customers interrupted during the identified manual and automatic load shedding incidents were, by design, residential users.

6.2 The Customer Survey and Supplemental Analysis--Primary Objectives

A JEA residential customer survey was designed and conducted by Systems Control, Inc., to attempt to provide relevant data in the following areas:

- a) Do customers recall brief load-shedding incidents or distribution power outages? How is their memory of such incidents affected by:
 - o the number of load shedding incidents the customer remembered?
 - o the number of random, uncontrolled incidents they've also remembered in the same period (e.g., storm outages, etc.)?
- b) If the customer recalls a load-shedding incident:
 - o what inconveniences occurred?
 - o what out-of-pocket costs were incurred?
 - o was there any damage or spoilage?
- c) Did the disturbances have any effect on the welfare (e.g., health, safety, etc.) of the general public?
- d) Do customers recall utility appeals to reduce their demand for electricity and how seriously do the consumers take the appeals?
- e) If the customer complied with the appeal:
 - o what types of electricity uses were curtailed?
 - o what were the motivations for complying?
- f) Do customers distinguish between load shedding outages and "normal" distribution outages?

A supplemental data analysis was conducted by Systems Control, Inc., to provide information on the following:

- a) The effect of the emergency actions upon the daily JEA load profile;
- b) To ascertain whether the survey respondents were representative of the JEA service area;
- c) To provide information as to whether responses to the questionnaire depended on the number, type, and duration of power outages experienced by the customers;
- d) To provide information that would aid in interpreting the results of the survey and to insure some data was available if the responses to the questionnaire were lower than expected.

Data sources used to conduct this analysis included JEA records of distribution outages, records of telephone calls made to JEA's trouble center by customers to report outage incidents, JEA's daily capability reports and city newspaper files.

6.3 Survey Methodology

6.3.1 Choosing the Customer Sample for the Survey

Table 6-1 provides a summary of the manual and automatic load shedding under investigation, including the feeder interrupted, the date of the interruption and duration of each outage. Cumulative totals for each circuit are also included in the far right column. This table shows that no one feeder was interrupted for more than 20 minutes for any one load shedding incident and only a few feeders have been involved more than two or three times in the load shedding incidents. This raised several questions about the potential value of a customer survey. First, could the impact of different numbers of load sheddings on customers be assessed when there was a limited range to the number experienced by the customer? Secondly, since relatively few load sheddings were experienced over a period of eight months, would a customer recall a particular outage which may have occurred months ago and/or only for a short period of time?

TABLE 6-1

LIST OF CIRCUITS INTERRUPTED DURING AUTOMATIC AND MANUAL LOAD SHEDDING

INCLUDING DATE AND ELAPSED TIME IN MINUTES AND CUMULATIVE TOTALS

District	Substation	Circuit	Duration in		Duration in		Duration in		Duration in		Duration in		Total Outage Time in Minutes
			Date	Minutes	Date	Minutes	Date	Minutes	Date	Minutes	Date	Minutes	
N	Ritter	426			4/5	13 A							13
N	Ritter	428	3/17	7 A	4/5	8 A	5/4	2 A	8/3	6 A			23
N	Ritter	429	3/17	8 A	4/5	9 A	5/4	3 A	8/3	8 A			28
N	Ritter	430			4/5	10 A							10
S	Merrill	431	3/17	7 A	4/5	22 A	5/4	3 A					32
S	Merrill	432	3/17	8 A	4/5	10 A	5/4	2 A					20
S	Merrill	433	1/3	9 M	7/28	16 M							25
S	Merrill	434	1/3	4 M									4
8 W	Naval Air Station	349	3/17	7 M	4/5	8 A	5/1	1 A	8/3	1 A	7/28	12 M	29
W	Naval Air Station	352	3/17	7 A	4/5	8 A	5/4	2 A	8/3	6 A			23
S	Phillips Hwy.	523			4/5	11 A			7/23	14 M	7/28	31 M	56
S	Phillips Hwy.	527			4/5	8 A							8
W	Randall	411			4/5	11 A							11
W	Randall	446			4/5	6 A							6
W	Randall	447			4/5	12 A							12
W	Randall	448			4/5	12 A					7/28	14 M	26
W	Lane Avenue	435			4/5	7 A							7
W	Lane Avenue	436			4/5	7 A							7
W	Lane Avenue	437			4/5	11 A							11
W	Lane Avenue	438			4/5	8 A							8
W	Randall	413			4/5	9 A							9

A = Automatic Load Shedding via Underfrequency Relays.
M = Manual Load Shedding.

TABLE 6-1 (cont'd)
LIST OF CIRCUITS INTERRUPTED DURING AUTOMATIC AND MANUAL LOAD SHEDDING
INCLUDING DATE AND ELAPSED TIME IN MINUTES AND CUMULATIVE TOTALS

District	Substation	Circuit	Duration in		Duration in		Duration in		Duration in		Total Outage Time in Minutes
			Date/Minutes		Date/Minutes		Date/Minutes		Date/Minutes		
W	Hamilton	307			4/5	6 A					6
W	Hamilton	308			4/5	6 A					6
W	Hamilton	309			4/5	7 A					7
S	San Souci	504			4/5	13 A			7/28	16 M	29
N	Garden City	496	1/3	16 M							16
N	Imenson	494			4/5	9 A					9
	Imenson	495	1/3	17 M	4/5	12 A	7/2	9 M			38
N	Kennedy	463					7/2	9 M			9
N	Brooklyn	471	1/3	15 M							15
N	Brooklyn	472	1/3	16 M			7/2	9 M			25
N	Brooklyn	473	1/3	17 M			7/2	9 M			26
N	North Shore	405	1/3	14 M			7/2	9 M			23
N	North Shore	406	1/3	4 M			7/2	9 M			13
N	North Shore	407					7/2	9 M			9
S	Mandarin	509	1/3	4 M							4
S	Mandarin	510	1/3	15 M							15
S	Mandarin	511							7/28	16 M	16
S	Fort Caroline	470							7/28	17 M	17
S	May Port	593	1/3	9 M							9
S	May Port	594	1/3	4 M							4
S	Robin Wood	441					7/25	8 M	7/28	15 M	23
S	Robin Wood	554			4/5	8 A	7/25	11 M	7/28	17 M	36
S	Arlington	479	1/3	15 M							15
S	Arlington	480	1/3	16 M							16

TABLE 6-1 (cont'd)

LIST OF CIRCUITS INTERRUPTED DURING AUTOMATIC AND MANUAL LOAD SHEDDING
INCLUDING DATE AND ELAPSED TIME IN MINUTES AND CUMULATIVE TOTALS

<u>District</u>	<u>Substation</u>	<u>Circuit</u>	<u>Duration on</u>		<u>Duration on</u>		<u>Duration on</u>		<u>Duration on</u>		<u>Duration on</u>		<u>Total Outage Time in Minutes</u>
			<u>Date/Minutes</u>		<u>Date/Minutes</u>		<u>Date/Minutes</u>		<u>Date/Minutes</u>		<u>Date/Minutes</u>		
S	Arlington	577	1/3	6 M					7/28	18 M			24
S	Powers	512	1/3	16 M									16
S	Powers	513	1/3	4 M					7/28	15 M			19
W	Herlong	328							7/28	15 M			15
W	Orange Park	303					7/25	8 M	7/28	14 M			22
W	Firestone	422	1/3	16 M									16
N	Northwest	455	1/3	12 M			7/2	12 M					24
S	University	535	1/3	26 M									26

With the aid of JEA and available customer outage data, customers who experienced the load shedding and curtailment incidents under investigation were identified in terms of circuit location. Because it was not practical to survey customers on all the circuits which were interrupted, five "test circuits" were selected from those listed in Table 6-1. These circuits selected were intended to be representative of high, medium and low-income classes of customers, different geographic locations in the city and a range of the number of load shedding incidents experienced. Figure 6-2 shows the geographic location of each of these test circuits in census tract zones.* It is important to remember that each of these test circuits has been subjected to a certain number of load sheddings in addition to typical distribution outages.

In addition to these test circuit customers, a group of "control circuit" customers was selected for the survey. Control circuits, located in the same census tract zones as the test circuits, represent socioeconomic characteristics similar to the test population. However, these control circuits were not interrupted on a load shedding basis because they supply essential customers such as large industries, hospitals or defense facilities in addition to residential customers. The control circuits were compared to the test circuits. Customers on control circuits were responding to typical distribution outages while those on the test circuits were responding to both load sheddings and typical distribution outages. Table 6-2 is a listing of each circuit number, test or control designation, average income level of the customers, total number of outages for that feeder and other miscellaneous descriptions. Figure 6-1 and Table 6-2 are intended to show that the circuits selected for this survey represent a diverse cross section of the city in terms of both topography and demographics.

* Census tract data was used to determine the demographic and socioeconomic characteristics of the customer supplied by the distribution feeder.

Figure 6—2 Census Tract Zone Map Showing Feeder Locations

TABLE 6-2
LIST OF CHARACTERISTICS FOR EACH FEEDER IN THE SURVEY
(FOR THE MONTHS OF JANUARY - AUGUST, 1979)

Customer Groups (I-IX) and pairings of "test" and "control" feeders	JEA Feeder Number	Test or Control	Income Level	Total Number of Distribution Outages	Other Information (including No. of load sheddings).
I	501	Control	Mid-High	23	Substation: San Souci Test feeder is #504 Not on load shedding cycle, essential customer circuit.
II	401	Control	Low	22	Substation: Grand park Test feeder is #472 Not on load shedding cycle, essential customer circuit.
III	407	Test	Low-middle	33	Substation: Northshore Control feeder is #408 On manual load shedding Total load sheddings: 1 time for 9 minutes.
IV	408	Control	Low-middle	9	Substation: Northshore Test feeder is #407 Not on load shedding cycle, essential customer circuit.
V	428	Test	Middle	schedule B Step 1. 34	Substation: Ritter No control group for this feeder. On underfrequency load shed., Total 4 times for 23 minutes.
VI	472	Test	Low	22	Substation: San Souci Control feeder is #401 On manual load shed, Total 2 times for 25 minutes.
VII	504	Test	Mid-High	32	Substation: San Souci Control feeder is #501 On manual load shedding Total: 2 times for 29 min.
VIII	511	Test	High	114	Substation: Mandarin Control is #525. On manual load shedding Total 1 time for 16 minutes.
IX	525	Control	High	32	Substation: Phillips Hw. Test is #511. Not on manual shed.

6.3.2 Implementation of the Questionnaire

The questionnaire was developed, pretested by System Control in cooperation with JEA volunteer customer groups (to ensure clarity and eliminate ambiguity), and mailed to approximately 3,000 JEA customers on October 31, 1970.* These customers were located on the nine feeders identified in Table 6-2. Responses received were analyzed to determine what the people of Jacksonville perceived as the incidence and impacts of power interruptions. Hypotheses could be tested on how those perceptions differed by customer characteristics, area of the city, and number and type of interruptions experienced by each customer.**

6.4 Survey Results

6.4.1 Processing the Survey Returns

Of the 3,000 questionnaires mailed to residential customers, approximately 400 useful responses were received. The SPSS*** software system was used to process and analyze the questionnaire returns. Most of the analysis tested for differences between the "test" and "control" groups. Prior to testing statistically significant differences between groups, descriptive statistics were calculated for each variable. (Each question's answers were defined as one variable.) This was done for the entire population and each separate group.

The descriptive statistics included:

- o mean;
- o median;
- o mode;
- o variance;
- o range; and
- o frequency distribution.

* Appendix III contains a copy of the questionnaire sent to customers.

** JEA data provided the number of distribution interruptions experienced on each feeder for 1979 and previous years.

*** Statistical Package for Social Sciences (SPSS).

For tests of statistically significant differences between groups, the chi-squared test was used.

The lower-than expected response rate* limited the amount of statistical analysis which could be done on the survey returns. Therefore, it was difficult to make generalizations or extrapolations to the large population regarding impacts associated with the power failures and correlations between customer demographic profile, number of load sheddings experienced and circuit characteristics (test vs control).

The respondents were placed into the following categories:

"Control Group"

Each of these groups represented a cluster of customers on a distribution circuit which was not exposed to a load-shedding incident in 1979. It includes customers on feeders 401, 408, 501 and 525; or

"Test Group"

Each of these groups represent a cluster of customers on a distribution circuit which was exposed to load-shedding incidents.

The groups were:

"One Load-Shed" Group:

This group experienced a single load shedding. It includes customers on feeders 407 and 511.

"Two Load-Sheds" Group:

This group experienced two load sheddings and includes customers on feeders 472 and 504.

"Four Load-Sheds" Group:

This group experienced four load sheddings and includes customers on feeder 428.

* The JEA had received a very good response (40-50% return) to its load survey questionnaires in the past, so a fairly high response was expected for this survey.

6.4.2 Significant Findings

The survey results are summarized in the following section. The following subjects are addressed:

- o Customer's Recall of "Worst" Outage Experience;
- o Perceived Outage Causes;
- o Customer outage costs;
- o Disruption in daily activities and inconveniences;
- o Customer attitudes of load sheddings experienced;
- o Effect of public appeals on customers;
- o Newspaper coverage of JEA; and
- o Customer call-in to JEA.

"Worst" Outage

The customers' recall of their "worst" outage was tested. To do this, a variable, Z, was defined that assumed numerical values in correspondence to the following items:

<u>Z</u>	<u>Month</u>	<u>Day</u>	<u>Time of Day</u>
0	(Before the month of June)		
1	June	Weekday	Morning
2	"	"	Noon
3	"	"	Afternoon
4	"	"	Evening
5	"	"	Night
6	July	Weekend	Morning
7	"	"	Noon
8	"	"	Afternoon
9	"	"	Evening
10	"	"	Night
11	July	Weekday	Morning
12	"	"	Noon
13	"	"	Afternoon
14	"	"	Evening

<u>Z</u>	<u>Month</u>	<u>Day</u>	<u>Time of Day</u>
15	July	Weekday	Night
16	"	Weekend	Morning
17	"	"	Noon
18	"	"	Afternoon
19	"	"	Evening
20	"	"	Night
21	August	Weekday	Morning
22	"	"	Noon
23	"	"	Afternoon
24	"	"	Evening
25	"	"	Night
26	August	Weekend	Morning
27	"	"	Noon
28	"	"	Afternoon
29	"	"	Evening
30	"	"	Night

Figures 6-3 through 6-6 illustrate the choice of worst outage by the control group and by each of the test groups (1 to 4 load sheddings). The times picked as those of the worst outage were approximately the same for each group:

- o There are two times that were frequently chosen by each group. These correspond to:
 - a) a weekday afternoon in July (Z = 13);* and
 - b) a weekday evening in August (Z = 24).**
- o Since the test groups pick the same times as the control group, the test groups must not consider any of the load shedding incidents as its "worst" outage.

* The following large storms took place in July: 4th - 7:00 p.m.; 5th - 3:45 p.m.; 11th - 4:00 p.m.; 17th - 4:30 p.m.; 19th - 2:50 p.m.; 24th - 3:30 p.m.

** The following large storms took place in August: 4th - 1:00 a.m.; 8th - 3:00 p.m.; 18th - 11:00 a.m.; 23rd - 6:00 p.m.

FIGURE 6-3 DISTRIBUTION OF "WORST OUTAGE" TIMES;
"CONTROL GROUP"

* See pages 86 and 87 of text for explanation of variable z .

FIGURE 6-4 DISTRIBUTION OF "WORST OUTAGE" TIMES;
"ONE LOAD SHED" GROUP

* See pages 86 and 87 of text for explanation of variable Z.

FIGURE 6-5 DISTRIBUTION OF "WORST OUTAGE" TIMES;
"TWO LOAD SHED" GROUP

* See pages 86 and 87 of text for explanation of variable Z.

FIGURE 6-6 DISTRIBUTION OF "WORST OUTAGE" TIMES;
"FOUR LOAD SHED" GROUP

* See pages 86 and 87 of text for explanation of variable Z.

It can be observed that the media coverage of major storm related outages may have caused customers to perceive those as their "worst" outage regardless of actual experience.

The time of "worst" outage was also the same for respondents who were usually at home during the day (when most load sheddings occurred) and those who were usually not at home. Figure 6-7 illustrates this.

Perceived Outage Causes

The survey questionnaire asked the consumer if he knew whether power failures he had experienced were caused by:

- o equipment failures;
- o storms;
- o not enough power plants;
- o people wasting electricity; or
- o don't know.

Table 6-3 illustrates the average response for the test and control groups.

It also lists the perceived percentage of power failures caused by each of the above. Though the percentages are remarkably similar, there is a slight tendency for those experiencing load sheddings to attribute more of their outages to equipment failures.

Outage Costs to Customers

Two types of impacts were sought from the survey data: (1) out-of-pocket costs associated with the worst outage experienced; and (2) disruptions in daily activities. Figure 6-8 shows the frequency with which each type of problem was reported by customers. The percentages appearing to the right of each portion of this bar graph are the percentages from the entire survey population who reported the various problems. The most common problems that can lead to out-of-pocket costs are:

- o Not being able to cook therefore necessitating eating "out"; and
- o Having to purchase emergency supplies (batteries, candles, kerosene, dry ice, etc.).

FIGURE 6-7 DISTRIBUTION OF "WORST OUTAGE" TIMES;
BETWEEN HOME AND NOT AT HOME GROUPS

* See pages 86 and 87 of text for explanation of variable Z.

Table 6-3

Average Number of Power Failures Attributed to Each Cause -- and
Perceived Percentage of Power Failures Due to Each Cause

<u>Causes</u>	<u>Control Group</u>	<u>Test Group</u>
Equipment Failures	2.1 (22%)	3.95 (29%)
Storms	2.1 (22%)	2.60 (19%)
Not Enough Power Plants	1.7 (18%)	2.13 (16%)
People Wasting Electricity	1.4 (15%)	1.91 (14%)
Dont ' Know	2.1 (22%)	2.81 (21%)
Total:	9.4	13.4

HAD TO GO OUT TO EAT

(34%)

FOOD SPOILED

(11%)

PURCHASED SUPPLIES

(37%)

DAMAGE TO HOME

(NONE)

OTHER

(7%)

NUMBER OF RESPONDENTS CITING THESE PROBLEMS

FIGURE 6-8 REPORTED PROBLEMS OF CUSTOMERS

Seven percent of all respondents cited "other" problems. The most frequently cited other problems were:

- o Water was unavailable because electric pumps would not function. (Four respondents cited this; none gave a dollar cost estimate);
- o Computers did not function and computer data records were lost. Three commercial firms in the sample cited this. Estimated costs were \$1,000, \$500, and "many in-hours lost." (Note: There were only 19 commercial respondents, so these three reports are quite significant.);
- o Damage to compressor motors due to low voltage (which might have occurred during voltage reductions). This was noted three times with replacement costs cited as: \$1,000, \$900, and \$620;
- o Three commercial clients reported that their business could not operate primarily due to lack of lighting; no costs were cited. Two residential customers also expressed the problem lack of lighting;
- o Three residential customers said they were late for work because electric clocks didn't function; no costs were cited. Another residential customer purchased a non-electric alarm clock at a cost of \$25;
- o Two residential customers cited a loss of leisure time (T.V. watching). No costs were cited; and
- o Two residential customers required air-conditioning for medical reasons--no costs were cited for the added expense.

Other problems cited (once each) were:

- o Power surges associated with the restoration of power after outages were said to have damaged a T.V. set;
- o Special equipment (not specified) had to be purchased for an elderly person who was ill;

- o A doctor was conducting minor surgery; he said that if complications had occurred, the costs would have been significant;
- o A sewage pump did not operate--the probable cost, \$60;
- o Safety was impaired by lack of street lighting;
- o No heat during freezing weather; and
- o Additional chemicals were purchased to fix a pool failure; cost was \$20.

The mode, mean, standard deviation, and range of the dollar costs for the reported problems are given below in Table 6-4.

TABLE 6-4
STATISTICS FOR THE DOLLAR COSTS OF THE REPORTED PROBLEMS

<u>Problem</u>	<u>Modal Cost (\$)</u>	<u>Mean Cost (\$)</u>	<u>Standard Deviation (\$)</u>	<u>Cost Range</u>
Had to go out to eat	\$10	\$13.28	\$5.68	\$0-80
Food spoilage	\$10	\$61.12	\$71.12	\$0-\$300
Purchased supplies	\$5	\$13.79	\$22.74	\$0-\$200
Damage to home	0	0	0	0
Other*	0	\$201.39	\$327.45	\$0-\$1,000

* See previous discussion of the various "other" problems reported.

The survey also elicited data on inconveniences created by the worst outages experienced and estimation of severity. Figure 6-9 depicts the frequency with which each type of inconvenience was reported. Figure 6-10 shows, for the inconveniences reported, the percentage of respondents who thought each type of inconvenience was "serious." By combining these two sets of results, Figure 6-11 is obtained which shows the number of "serious" inconveniences reported in each category.

FIGURE 6-9 REPORTED OCCURRENCES OF INCONVENIENCES TO CUSTOMERS

FIGURE 6-10 PERCENT SERIOUS INCONVENIENCES REPORTED

FIGURE 6-11 REPORTED OCCURRENCES OF SERIOUS INCONVENIENCES TO CUSTOMERS

From the three graphs, the following observations can be made:

- o Inconveniences associated with household activities or the environment (T.V.-watching, washing, cleaning, air conditioning) were cited most frequently by at least a 2:1 margin.
- o If they occur, health and safety problems are four to five times more frequently cited as "serious" than are T.V.-watching or washing/cleaning inconveniences. They are about two times more frequently cited as "serious" than cooking inconveniences or heating or cooling discomforts. Being late to work is cited as "serious" almost as frequently as are health/safety problems.
- o "Serious" inconveniences related to home temperature and inability to prepare meals were cited twice as frequently as any other inconvenience.

Customer Attitudes and Load Sheddings

The survey data permitted the exploration of customer attitudes toward the utility. In particular, an analysis was conducted to determine if there was any relationship between the number of load sheddings experienced by a customer and:

- o The "degree of alienation" the customer felt toward the utility; and
- o The willingness of the customer to pay more if fewer outages occurred.

The first relationship was examined by comparing the distributions of "degree of alienation" scores for each of the customer groups. The degree of alienation or y , was given a numerical value in the following way:

$$Y = X1 + X2$$

where:

X1 Assumes one of three values, depending on how responsive the customer thought the electric utility was to the demands of its customers--either:

- o almost never responsive ($X1 = 1$),

- o sometimes responsive ($X_1 = 2$), or
 - o almost always responsive ($X_1 = 3$)
- X2 assumes one of two values, based on how dependable the customer felt his electric service was--either:
- o not dependable ($X_2 = 1$), or
 - o dependable ($X_2 = 2$)

thus the "degree of alienation" was measured on a scale from 2 to 5--with 5 representing the least degree of alienation.

The frequency distribution of alienation scores is plotted in Figure 6-12 for all of the customer groups:

- o the "Control" Group
- o the "One Load-Shed" Group
- o the "Two Load-Shed" Group
- o the "Four Load-Shed" Group

Figure 6-12 reveals that the degree of alienation of a customer was not much affected by the number of load sheddings experienced. The distribution of alienation scores are nearly alike for both the control and test groups. The data actually show a tendency for the "many" group to be less alienated, but not much credence can be placed in this because the "many" group had only 34 respondents. This sampling is regarded as too small to draw firm conclusions.

A Chi-Square test was used to assess whether there were differences among the four groups in willingness to pay more for electricity to prevent the type of power outages experienced during the year. The answer was a definite "no" among all groups.

There were no significant differences among the responses of the groups on this question. Table 6-5 gives the frequency table used for a Chi-Square test of the group differences. The differences were insignificant at the 0.96 level (i.e., there is a .96 probability that the differences were due to chance).

Relation Between Alienation and Load Sheddings

Figure 6—12

TABLE 6-5

Willingness To Pay More For Fewer Outages --
Frequency Table For Chi-Square Test

	Yes	No	TOTAL
			<u>Raw Total</u>
"Control"	9 (8.3%)	100 (91.7%)	109 (33.7%)
"One" Load-Shed Group	8 (7.9%)	93 (92.1%)	101 (31.3%)
"Four" Load-Sheds Group	3 (11.1%)	24 (88.9%)	27 (8.4%)
"Two" Load-Sheds Group	7 (8.1%)	79 (71.9%)	86 (26.6%)
Column Total:	27 (8.4%)	296 (91.6%)	

Public Appeals

The survey results showed that:

- o 77% of the customers surveyed recalled the utility's radio and television appeals for customers to reduce their loads due to an impending system emergency.
- o Of those who indicated the number of times appeals were made in the year:
 - a) 6% said there had been only one appeal;
 - b) 54% said there had been between one and five appeals; and
 - c) 40% said there had been more than five appeals.*
- o 73% of the customers surveyed said they cut back their electricity use in response to at least one of the appeals. (See Figure 6-13 for an analysis of the number of times customers cited cutbacks of electricity).

Of the 337 customers who gave their opinions of the expected results of a public appeal, the following breakdown of expectations was observed:

- o 28% definitely expect a power failure to occur after an emergency appeal is made;
- o 50% expect that a power failure might occur after an emergency appeal is made; and
- o 22% don't expect any power failure after an emergency appeal is made.

Customers cited various factors which motivate them to cutback on electricity use in response to public appeals. Figure 6-14 shows the frequency with which various motivating factors were cited.

Table 6-6 illustrates the results of a Chi-Square test comparing "help in emergency" and "fear of blackout" as motivating forces to comply

* According to utility records, public appeals were made on three occasions between January and August (June 7, July 28, and July 29). A sizable portion of the respondents have probably confused the JEA emergency appeals with general appeals made for energy conservation.

FIGURE 6-13 RESPONSES TO EMERGENCY LOAD-REDUCTION APPEALS

FIGURE 6-14 MOTIVATION OF CUSTOMERS TO RESPOND TO
PUBLIC APPEALS

with public appeals.* The percentage of customers motivated by the fear of a blackout was significantly higher than those motivated by a desire to aid the utility during a crisis. Fear of blackouts was the most frequently cited motivating force.

TABLE 6-6
CHI-SQUARE TABLE FOR HELP-IN-AN-EMERGENCY VERSUS FEAR OF
BLACKOUT AS MOTIVATING FORCES

	YES	NO
Help Out in An Emergency	217 (.76)	70 (.24)
Fear of a Blackout	245 (.86)	40 (.14)
	X2 = 10.1	.01 significance

JEA data does not support the survey response that 73% of the respondents said they cut back their electricity use in response to JEA's public media appeals. In the first eight months of 1979, JEA made three emergency public appeals for load reduction (on June 7, July 20, and July 28). Load curves of those days, together with JEA's estimates, show an estimated 20 to 30 MW load reduction due to the public appeals.

In the survey, 60 percent of those responding said they changed their air-conditioning settings in response to JEA's appeals. Approximately 85.5 percent of the residences in Jacksonville have air-conditioning. Typically, the air-conditioning is about 60 percent of the diversified residential peak load and about 60 percent of the JEA system peak is residential load. If it is assumed that the average customer changed his air-conditioning

from a 72o to a 78o setting and a 3% change in cooling energy occurs for each degree change*, the survey results imply a 3.3% load reduction:

- 3.3% = 18% reduction in cooling energy,
- .60 fraction of residential load which is air conditioning,
- .60 fraction of JEA peak which is residential load,
- .855 saturation of residential air conditioning in Jacksonville, and
- .60 fraction of respondents who reduced their air conditioning.

JEA's peak loads on these days were about 1,200 MW. 3.3 percent of this is about 40 MW predicted load reduction due only to reduction in residential air conditioning. Since this is considerably higher than the 20-30 MW actually observed, it appears that:

- o the survey respondents stated a higher compliance to load reduction appeals than actually occurred; or
- o the survey respondents were not representative of JEA's customers.

Newspaper Coverage of JEA

This section gives a synopsis of newspaper articles in Jacksonville in 1978 and 1979 dealing with the loss of electrical service through load shedding, distribution outages, non-payment of bills, or JEA's lack of fuel. Knowledge of the political climate in which JEA operates aids the interpretation of responses to the questionnaire. Six underlying themes about the Jacksonville public's and press's attitude toward JEA emerge from the articles. They are:

* "Technical options for Energy Conservation in Building," National Bureau of Standards, Technical Note No. 789, July 1973.

- o The majority of power outages in Jacksonville are storm-related (wind or lightning). These are often reported by the newspapers as part of overall storm dangers. Typically, "JEA crews are working (or have worked) all-out to restore service to all customers." The reaction of the public and the press is generally favorable to JEA's attempts to rectify these "acts of nature."
- o JEA has made a number of predictions of rolling blackouts. The predictions and blackouts that occurred have been extensively reported, analyzed, and editorialized in the Jacksonville newspapers. JEA has blamed the blackouts on power plant maintenance problems which cause a lack of capacity. The general focus of JEA's complaints have been environmental regulations. The newspapers given detailed descriptions of the reasons for both blackouts and JEA's public appeals for conservation.
- o The editorial position of the Jacksonville newspapers is to warn of power shortages and to urge regulatory agencies to expedite generation construction. The Jacksonville Times Union has warned against relying too much on purchased (i.e., interchange) power, because it is unreliable and high-priced. The paper suggests that occasional blackouts might not be too bad if the price of electricity could be held down.
- o Many articles on energy conservation are published. JEA sponsors advertisements which ask customers to conserve as part of its overall plan to demonstrate that they are doing everything possible to meet demand. The conservation efforts of various city departments, businesses, and electric customers, in general, are widely reported. The newspapers and JEA are providing positive reinforcement that the requested voluntary curtailments have been necessary.
- o The newspapers advocate construction of coal-fired generation to reduce JEA's dependence on high cost oil or expensive interchange power. That would reduce electric rates and improve the reliability of electric power service in the Jacksonville area.
- o JEA's rates, which are the highest in the country, attract the most attention in the media's coverage. Almost all aspects of JEA are analyzed in terms of their effect on consumer rates.

Customer Call-In to JEA

Within five minutes of the beginning of a power outage, customers begin to telephone the JEA trouble center using a special telephone number for reporting loss of power. The number and timing of customer calls to the trouble center seem to be indicative of the number of people affected and the degree of inconvenience of the outage (e.g., time of day, unusual weather conditions, etc.). Comparison of the number of calls received by the JEA trouble center during a rotating blackout with the number received after a more typical distribution outage was utilized as an indication of the impact of manual load shedding on the customer.

JEA keeps a record of the number and types of telephone calls received by the trouble center. Records classifying each call are not maintained. Telephone records were obtained from JEA for the following types of days:

- o Days on which load shedding had occurred;
- o Days on which major distribution outages occurred; and
- o Days on which no major outages occurred.

To ascertain the number of calls received by the center for routine business (administrative, minor distribution outages, etc.), an average number of calls per day for an uneventful day (i.e., a "base" number of calls) was determined. The total number of calls to the trouble center during the five week period from September 17 to October 19, 1979 during the working week was 5,221, and average of 1,044 per five day week, or about 210 per day. The JEA provided information regarding the events of these days such that impact of a major outage could be determined.

Table 6-7 (pages 106 and 107) summarizes the outage reports and telephone records maintained by JEA's trouble center. Calls per customer interrupted

TABLE 6-7

OUTAGE REPORT SUMMARY

Date	Time	# Cust.	Duration (Min.)	Customer Outage Hours	Total Calls That Day	Event	Calls /Cust. ^a	Calls /Cust. ^a Hour
12/29/78	12:00 am	6,467	45	9,737	2,830	Distribution Outages	.19	.27
	7:00 pm	6,830	36			Distribution Outages		
	10:00 pm	860	55			Distribution Outages		
12/30/78	9:00 pm	550	124	1,401	1,283	Distribution Outages	.92	.77
	10:00 pm	611	26			Distribution Outages		
12/31/78	10:00 pm	795	1	13	281	Distribution Outages	=0	=0
1/1/79	1:00 am	2,251	20	750	787	Distribution Outages	.26	.77
1/3/79	7:30 am	40,000	31 (12 avg.)	8,000	1,830	Manual load shedding-140 MW	.04	.20
3/17/79	2:10 am	NA ^{aa}	7	--	182	Underfrequency load shed-40 MW	=0	=0
4/4/79	11:57 pm	49,000	10 avg.	8,167	472 4/4 794 4/5	Underfrequency load shed-90 MW	.02	.10
5/4/79	8:20 am	NA ^{aa}	3	--	251	Underfrequency load shed-40 MW	=0	=0
5/25/79	1:30 pm	3,021	39	2,057	928	Distribution Outages	.23	.35
	11:50 pm	561	10			Distribution Outages		
6/3/79	7:15 pm	200	45	4,036	1,138	Distribution Outages-Storm #19	.22	.23
	8:05 pm	240	85			Distribution Outages-Storm #19		
	7:45 pm	400	45			Distribution Outages-Storm #19		
	7:50 pm	350	50			Distribution Outages-Storm #19		
	8:12 pm	3,021	13			Distribution Outages-Storm #19		
	"	1,200	90			Distribution Outages-Storm #19		
	"	500	60			Distribution Outages-Storm #19		
7/2/79	5:03 pm	5,000	11	917	681	Manual load shedding & voltage reduc.-40 MW	.07	.51
7/24/79	4:18 pm	850	39	8,920	2,622	Distribution Outages-Storm #31	.21	.27
	3:46 pm	650	35			Distribution Outages-Storm #31		
	3:49 pm	NA ^{aa}	64			Distribution Outages-Storm #31		
	4:01 pm	1,259	36			Distribution Outages-Storm #31		
	4:18 pm	2,576	26			Distribution Outages-Storm #31		
	3:46 pm	500	41			Distribution Outages-Storm #31		
	3:46 pm	400	47			Distribution Outages-Storm #31		
	3:42 pm	350	78			Distribution Outages-Storm #31		
	3:44 pm	400	109			Distribution Outages-Storm #31		
	4:36 pm	374	39			Distribution Outages-Storm #31		
	3:31 pm	634	70			Distribution Outages-Storm #31		

TABLE 6-7 (Cont'd)

<u>Date</u>	<u>Time</u>	<u># Cust.</u>	<u>Duration (Min.)</u>	<u>Customer Outage Hours</u>	<u>Total Calls That Day</u>	<u>Event</u>	<u>Calls /Cust.*</u>	<u>Calls /Cust.* Hour</u>
7/24/79	3:38 pm	3,297	60			Distribution Outages-Storm #31		
7/25/79	1:49 pm	35,000	14	8,167	2,799	Manual load shedding	.07	.32
7/28/79	4:30 pm	35,000	93 (15 avg.)	8,750	1,773	Manual load shedding, public appeal, voltage reduction	.04	.18
7/31/79	4:45 pm	2,704	30	7,279	1,593	Distribution Outages-Storm #35	.14	.19
	5:53 pm	325	47			Distribution Outages-Storm #35		
	4:38 pm	2,400	52			Distribution Outages-Storm #35		
	4:38 pm	2,199	83			Distribution Outages-Storm #35		
	4:15 pm	2,202	15			Distribution Outages-Storm #35		
8/3/79	7:07 am	5,300	2	177	439	Automatic load shedding	.04	1.29

* 210 calls (base number of calls) are first subtracted from the total number of calls to obtain these figures.

** Not Available

and calls per customer outage hours are given (to obtain these figures, the "base load" number of calls, 210 per day, was subtracted from the "total calls to center" column being divided by number of customers or number of outage hours). After an outage has lasted about 10 minutes, duration does not seem to markedly effect the number of telephone calls received by the trouble center. It was observed that the number of calls seems to have little correlation with total customer outage hours. For major distribution outages in the waking hours, due to storms and other causes, it seems that the utility receives one trouble call for every five people interrupted. For underfrequency load shedding the number was much less, with one call being received for about every 30 customers interrupted. This may be due to the short time of the incident, ranging from 2 to 7 minutes, or the time of day the interruption occurs. When manual load shedding occurred, JEA received about one call for every 15 customers interrupted, about one-third the number for a major distribution outage. It is apparent that the JEA customers react less to the rotating blackouts than to the typical distribution outage. This finding may be directly related to the fact that load shedding interruptions were of relatively short duration.

LIST OF REFERENCES

1. "Impact Assessment of the 1977 NYC Blackout," Systems Control, Inc., for Department of Energy, Division of Electric Energy Systems, July, 1978.
2. "Power Shortage Costs and Efforts to Minimize: An Example," Jack Faucett Associates, July, 1979.
3. "The Economic Cost of Power Outages: Methodology and Application to Jamaica," August 18, 1976, Prepared by The World Bank.
4. "A Survey of Disruption and Consumer Costs Resulting from a Major Residential Power Outage," June 1978, Gregory C. Krohm, Argonne National Laboratory.

LIST OF APPENDICES

- A FEDERAL REGISTER NOTICE
- B DRAFT QUESTIONNAIRE AND COVER LETTER
- C RESPONSES FROM THE FLORIDA ELECTRIC POWER COORDINATING GROUP AND
FLORIDA PUBLIC SERVICE COMMISSION

DEPARTMENT OF ENERGY
ECONOMIC REGULATORY ADMINISTRATION

NOTICE OF INVESTIGATION INTO
SEVERAL ELECTRIC POWER OUTAGES INVOLVING
ELECTRIC UTILITIES OPERATING ON THE FLORIDA PENINSULA

AGENCY: Department of Energy
Economic Regulatory Administration

ACTION: Notice of initiation of investigation into nine recent incidents of either automatic or manual load shedding involving certain electric utilities operating on the Florida peninsula

Summary: The Division of Power Supply and Reliability of the Economic Regulatory Administration working with the Florida Public Service Commission is investigating nine 1979 incidents of manual or automatic load shedding by Electric Utilities located on Peninsula Florida. This investigation will consist of a technical review of the facts associated with the specific events and an evaluation of the associated consumer costs.

FOR FURTHER INFORMATION CONTACT:

Mr. James M. Brown, Jr.
Chief, System Reliability and Emergency
Response Branch
Department of Energy
Room 4110E
2000 M Street, N.W.
Washington, D.C. 20461
(202) 254-8247

Ms. Lise Courtney M. Howe
Office of General Counsel
Department of Energy
Room 5116, Federal Building
12th and Pennsylvania Avenue, N.W.
Washington, D.C. 20461
(202) 633-9380

SUPPLEMENTARY INFORMATION: Certain electric Utilities located in Florida have experienced nine incidents of either manual or automatic load shedding in the last eight months. In addition there were two other occasions when the Jacksonville

PUBLISHED IN FEDERAL REGISTER - OCTOBER 4, 1979

Electric Authority made appeals to their customers to voluntarily reduce their loads until additional generating capacity could be made operable or additional capacity purchased. Specific dates of the subject events are as follows:

<u>Date</u>	<u>Load Shed</u>
January 3, 1979	140 MW by Jacksonville
March 17, 1979	200+ MW Total by several utilities
April 4, 1979	770+ MW Total by several utilities
May 4, 1979	450+ MW Total by several utilities
June 21, 1979	300+ MW Total by several utilities
July 2, 1979	40 MW by Jacksonville
July 25, 1979	25 MW by Jacksonville
July 28, 1979	30 MW by Jacksonville
August 3, 1979	600+ MW Total by several utilities

On June 7 and July 29, the Jacksonville Electric Authority asked their customers to reduce their loads to avoid outages.

These load shedding incidents have occurred too frequently to consider them a rare event resulting from an accident or other sudden unexpected critical conditions. It is likely that there has been substantial public discomfort and inconvenience. The number of load shedding incidents and the amounts of load lost are of concern to the Division staff.

In order to better understand the causes of these load reduction incidents and to ascertain the impacts on the involved consumers, the Division of Power Supply and Reliability staff pursuant to Section 311 of the Federal Power Act and Section 209 of the Public Utilities Regulatory Policy Act is investigating these events jointly with the Florida Public Service Commission. The investigation will center on the precise events in Florida that lead to the initiation of each load reduction measure and the sequence of events associated with restoring the interrupted load. In addition the effect on consumers of the Jacksonville outages will be evaluated and quantified. Actions to minimize the need to reduce consumer loads as well as actions to mitigate the consumer impacts will be recommended.

Representatives of the Division met with representatives of the Florida Public Service Commission and the Florida Utilities on September 5, 1979, to initiate this investigation. A final report will be published by ERA by January 31, 1980.

Any person desiring to submit information or to obtain additional information concerning this investigation should contact the Chief, System Reliability and Emergency Response Branch, Economic Regulatory Administration, Room 4110, 2000 M Street, N.W., Washington, D.C. 20461.

Dated: September 28, 1979.

Jerry L. Pfeffer
Assistant Administrator
for Utility Systems
Economic Regulatory Administration

SYSTEMS CONTROL, INC.

1901 NORTH FORT MYER DRIVE
SUITE 200
ARLINGTON, VIRGINIA 22209

TELEPHONE (703)
522-5770

October 31, 1979

Dear Electricity User:

We are asking you to participate in a study of electric service. YOUR ANSWERS ARE IMPORTANT! The United States Congress has asked the Department of Energy to recommend standards for the quality of electric service. The Department of Energy has chosen Jacksonville as one of the areas for study, and they have asked our firm, Systems Control, Inc., to evaluate the effect on consumers of power outages and voluntary appeals to reduce electricity use. This survey is going to be used to aid in this evaluation.

With the cooperation of the Jacksonville Electric Authority, we have sampled about 3,000 JEA customers to participate in this survey. Your pre-addressed return envelope requires no postage and will be treated confidentially. For this reason, we ask that you do not sign the enclosed survey. It is very important for you to fill out the enclosed questionnaire to the best of your ability and return it to us by November 20, 1979.

Information about your experiences with power failures will help the Department of Energy assess the electrical supply situation here in Jacksonville and will help in planning for tomorrow's electrical needs.

Thank you for your cooperation.

Sincerely,

William T. Miles
William T. Miles
Vice President
Systems Control, Inc.
Washington, D. C.

P.S. COMMERCIAL CUSTOMERS PLEASE NOTE: This survey was designed principally for residential customers however, if you are a commercial customer please mark the top of the questionnaire with a letter "C" and do not answer Questions 3 and 19.

Questionnaire

This questionnaire can be filled out by any adult. Please try to be sure that the person who fills it out is able to speak for the household as a group.

1. Do you think the electric authority is responsive to the demands of its customers?

Almost Never

☐

Sometimes

☐

Almost Always

☐

2. Is your electric service dependable?

Yes

☐

No

☐

3. How long have you lived in this house/apartment/mobile home?

Less than
6 months

☐

6 months -
1 year

☐

More than
1 year

☐

4. Please tell us about any power failures you can remember at your present address only during the following months of 1979 (fill in the blanks):

<u>Month</u>	<u>Number of Times Power Failed</u>	<u>Average Time Power Was Out (Hours)</u>	<u>Number of Times You Called Electric Authority When Power Went Out</u>
January	_____	_____	_____
February	_____	_____	_____
March	_____	_____	_____
April	_____	_____	_____
May	_____	_____	_____
June	_____	_____	_____
July	_____	_____	_____
August	_____	_____	_____

5. What do you think caused these power failures?

- Possible Causes
- a) Equipment failures
 - b) Storms
 - c) Not enough power plants
 - d) People are wasting electricity
 - e) Don't know

How many of your power failures were caused by this problem?

6. Please tell us about the worst power failure you've had this year.

a) It happened in the month of (check one):

Jan. Feb. Mar. Apr. May June July Aug.
☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐

b) It happened on a:

Weekday Weekend
☐ ☐

c) It happened at approximately the following time of day:

Morning Noon Afternoon Evening Night
☐ ☐ ☐ ☐ ☐

d) It lasted:

Less than 10 min. 10 to 30 min. 30 to 60 min. 1 to 3 hours over 3 hours
☐ ☐ ☐ ☐ ☐

7. For the worst power failure you remember, did the following problems happen, and did they cost you anything?

	Happened?		If yes, give
	Yes	No	Approximate cost
a) Couldn't cook; had to go out to eat.	☐	☐	\$ _____
b) Food spoiled; had to throw it away.	☐	☐	\$ _____
c) Purchased batteries, lights, kerosene, dry ice, or other supplies.	☐	☐	\$ _____
d) Damage to my home (such as flooding because sump pump didn't work).	☐	☐	\$ _____
e) Other _____	☐	☐	\$ _____

8. Again, for the worst power failure, tell us whether the following things happened and how serious they were:

	<u>Happened?</u>		<u>If yes, how serious?</u>	
	<u>Yes</u>	<u>No</u>	<u>Not Serious</u>	<u>Serious</u>
a) Late for work or appointment.	☐	☐	☐	☐
b) Couldn't cook.	☐	☐	☐	☐
c) Heating or cooling didn't work.	☐	☐	☐	☐
d) Couldn't watch television.	☐	☐	☐	☐
e) Washing/cleaning couldn't be done.	☐	☐	☐	☐
f) There was a health hazard.	☐	☐	☐	☐
g) There was a safety or security problem.	☐	☐	☐	☐

	<u>Yes</u>	<u>No</u>
9. Do you feel you are prepared to deal with future power failures?	☐	☐
10. As a result of power failures you have experienced, do you plan to buy fewer electric appliances in the future (such as electric clocks, stoves, heaters)?	☐	☐
11. Do you pay your own electricity bill? If no, go to Question 14.	☐	☐
12. Are you willing to accept more power outages in the future? If no, would you be willing to accept more power outages in exchange for lower electric bills?	☐
☐	☐
☐
13. Would you be willing to pay more for electricity to prevent the type of power outages you have experienced this year?	☐	☐
14. What would be the worst time of day for an outage to occur for you?		

<u>Morning</u>	<u>Noon</u>	<u>Afternoon</u>	<u>Evening</u>	<u>Night</u>
☐	☐	☐	☐	☐

Generally speaking, when does this outage become a real problem for you?
When it lasts:

Less than 15 minutes	20 - 40 minutes	1 hour or more
☐	☐	☐

	<u>Yes</u>	<u>No</u>										
15. Do you recall any time the electric authority made an appeal on television to ask you to reduce electricity use this past year?	☐	☐										
If yes, how many times? 1 1 - 5 More than 5												
☐ ☐ ☐												
16. a) Did you cut back on your electricity use in response to any of these TV appeals?	☐	☐										
b) If so, did you do the following things?												
1. Changed air conditioning setting.	☐	☐										
2. Turned off more lights.	☐	☐										
3. Cooked energy-saving meals (such as one-pot meals).	☐	☐										
4. Used fewer electric appliances.	☐	☐										
17. Would you say that most people who respond to these TV appeals reduce their electricity use:												
<table border="0" style="display: inline-table; vertical-align: top;"> <thead> <tr> <th style="text-align: center;"><u>Yes</u></th> <th style="text-align: center;"><u>No</u></th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> </tr> <tr> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> </tr> <tr> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> </tr> <tr> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> </tr> </tbody> </table>	<u>Yes</u>	<u>No</u>	☐	☐	☐	☐	☐	☐	☐	☐		
<u>Yes</u>	<u>No</u>											
☐	☐											
☐	☐											
☐	☐											
☐	☐											
Because they feel they have to help out in an emergency?												
Because they fear that otherwise there will be more blackouts?												
Only if what they are doing can be done again at another time (such as washing)?												
To slow down the rising costs of electricity?												
18. When you see a TV appeal to reduce your use of electricity, do you expect a power failure to occur?												
<table border="0" style="display: inline-table; vertical-align: top;"> <thead> <tr> <th style="text-align: center;">Yes</th> <th style="text-align: center;">Sometimes</th> <th style="text-align: center;">No</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> <td style="text-align: center;">☐</td> </tr> </tbody> </table>	Yes	Sometimes	No	☐	☐	☐						
Yes	Sometimes	No										
☐	☐	☐										
19. Does at least one adult stay at home for most of the day?	☐	☐										

Department of Energy
Washington, D.C. 20461

Mr. J. Kenneth Wiley
General Manager
Florida Electric Power
Coordination Group
402 Reo Street, Suite 214
Tampa, Florida 33609

JUL 30 1980

Mr. Joseph D. Jenkins, P.E.
Electrical Engineering Supervisor
Florida Public Service Commission
700 South Adam Street
Tallahassee, Florida 32304

Gentlemen:

Enclosed for your review is a draft copy of the DOE report on the investigation into several electric power system outages that occurred in Florida in the January thru August 1979 period. This report is preliminary and subject to further changes by the DOE staff, however, these changes are expected to be minimal.

I would appreciate your review and comments on this report. If the comments received indicate factual errors, the report will be changed appropriately. Differences in opinions will be considered, however no commitments to make any changes to resolve the differences are being made. We do, however, intend to include any comments received by August 17, 1980, in Appendix 2 to the final report.

It would be most helpful if the comments by the individual utilities were consolidated by the FCG, however, this is not required. In particular, the JEA may want to provide a specific series of comments on Chapter 6.

Your assistance during the preparation of this report has been appreciated. It has been our intent to present a report that is technically accurate, and that is fair to the views of all concerned parties. We believe this goal has been accomplished. Your efforts in providing comments will surely improve the quality of the final report.

Sincerely,

James M. Brown, Chief
System Reliability and Emergency
Response Branch, ERA

FLORIDA ELECTRIC POWER COORDINATING GROUP (FCG)
402 REO STREET, SUITE 214 • TAMPA, FLORIDA 33609 • (813) 877-5301

August 15, 1980

Mr. James M. Brown, Chief
System Reliability and Emergency
Response Branch, ERA
Department of Energy
Washington, D. C. 20461

Dear Jim:

Thank you for the opportunity for the FCG to review and comment on the draft copy of the DOE report on the investigation into power outages from July through August, 1979. Our comments cover factual errors and/or omissions in the report, as well as content or wording differences.

Jacksonville Electric Authority has indicated to me that they have communicated their responses to you personally.

Please feel free to call and discuss any of the items we have commented on.

Sincerely,

J. KEN WILEY
General Manager

JKW/tmb

cc: Technical Advisory Group

FCG COMMENTS

"DOE INVESTIGATION OF TWELVE BULK POWER INCIDENTS INVOLVING ELECTRIC UTILITIES OPERATING ON THE FLORIDA PENINSULA DURING 1979"

- Page 1 Second paragraph: We feel that 25 MW of load out of a total of approximately 17,000 MW is not a major portion of load.
- Page 5 23 lines from the top: A "proper" level of reliability has not been determined. Section 209 of PURPA is to address that very important definition.
- Page 6 Third paragraph, first sentence: "March 1979" should be changed to "March 1978."
- Page 7 Third paragraph: Loss of a major generating unit in Peninsular Florida while importing economy power from the Southern Companies will most likely result in some loss of load. However, the Florida utilities have taken steps to minimize the occurrences, control them and restore the load in a quick and efficient manner.
- Page 11 Recommendations to FCG: These recommendations are being implemented by the member utilities of FCG.
- Page 12 We feel it is the utilities responsibility and does not require formal guidelines from the PSC.
- Florida utilities have coordinated planned unit tripping for test purposes for many years, in order to maximize system security.
- Page 16 Second paragraph: The statement that 140 MW is the average size of the generators in Florida, while probably mathematically correct, is grossly misleading as far as the average size unit on line. Moreover, the amount of generation lost in the disturbance analysis ranges from 365 MW to 1270 MW.
- Page 21 Last paragraph: Florida utilities have operated with 115 kV interconnection with Georgia since 1942. The first 230 kV interconnection was energized in 1962.
- Page 22 First line: Change "138 kV" to "115 kV."
- Last paragraph: Studies made at the time the line was authorized indicated that the ties could withstand the loss of the largest unit in the state (800 MW) without separation due to instability. Also the steady loading limit is 500 MW due to voltage constraints.
- Page 23 First paragraph: The new Duval-Hatch 500 kV line should be included in the list of additions. Also, the Fort White-Columbia 230 kV circuit is not in the current plans.

- Page 25 Second paragraph, line 9: Change "present level" to "Preset level."
- Page 27 Second and third paragraphs: The supporting studies and the source of the statements should be referenced. Under 2.8.3, second line, the word "ready" should be changed to "immediately available."
- Page 30 Second, third and fourth paragraphs: Again, we would like to have the supporting studies and the source of the statements referenced.
- Page 52 "Section 2:30 p.m., Thursday June 7, 1979": "Florida Power Corporation" should be changed to "Florida Power & Light Company."
- Page 58 Second paragraph, last sentence: This has been a Florida policy for almost two decades.
- Third paragraph, line 9: The Operating Committee did not "revise" the Spinning Reserve Policy.
- Third paragraph: There has to be frequency decline before any governor action can take place. Since the loss of generation in Florida is made up by increasing tie line flows from Georgia, it is not until these ties relay out, about 1 to 2 seconds after initiation of the disturbance, that the frequency will decline and thereby cause the governors to respond. Also, in Florida, spinning reserve has always been defined as being "connected to the bus, ready to pick up load immediately, and capable of becoming fully applicable with a frequency decline to 59.5 Hz."
- Page 59 First paragraph, line 4: Outage No. 12 was not a loss of all Turkey Point generation. Unit No. 1 was on line carrying 360 MW of load and remained on line.

State of Florida

Robert T. Mann
Chairman

FLETCHER BUILDING
101 EAST GAINES STREET
TALLAHASSEE 32301
(904) 488-7001

Public Service Commission

August 11, 1980

Mr. James M. Brown, Chief
System Reliability and Emergency
Response Branch, ERA
Department of Energy
Washington, D.C. 20461

Dear Mr. Brown:

This is in response to your Investigation of Twelve Bulk Power Incidents Involving Electric Utilities Operating on the Florida Peninsula During 1979. In this report, the ERA suggests the following actions be taken by the Florida Public Service Commission:

The Florida Public Service Commission (PSC) should establish formal guidelines as to when firm or interruptible customers are interrupted. For example, the JEA and FPL utilities are dropping firm load at the same time that FPC and TECO are shedding interruptible load.

The Florida PSC should examine more closely the different load shedding schemes utilized by Florida electric power utilities. The various factors which should be examined include the frequency and duration with which customers are exposed to load shedding.

In response to these concerns, the Commission has adopted rules for monitoring and reporting major service interruptions parallel to those required by the ERA pursuant to Federal Power Commission (now FERC) Order No. 331-1 (see attached copy). Also, the Commission staff works closely with the individual utilities in the State as well as with the Operating Committee of the Florida Electric Power Coordinating Group, made up of representatives from the major peninsula generating utilities, to ensure that appropriate measures are taken to minimize the occurrence and length of service interruptions in the State.

MR. JAMES N. BROWN
August 11, 1980
Page 2

Pursuant to the Commission's reporting requirements, peninsular Florida utilities have reported a total of nine (9) occurrences of major service interruptions as of year to date June, 1980. The duration of these service interruptions ranged from 5 to 45 minutes per occurrence. Almost without exception, these interruptions were caused by the loss of a major peninsular generating unit while importing energy from the Southern Pool. It is believed that the frequency of these interruptions may have been reduced during this period by limiting Peninsula purchases of energy from Southern. Such action, however, would result in a significant cost penalty to Florida ratepayers. As of year to date 1980, Florida ratepayers have saved in excess of \$7 million due to energy purchases from Southern. Obviously, such savings must be given considerable attention in evaluating the impact of load shedding by Florida utilities.

In closing, we appreciate the opportunity for comment on this report prior to publication. Let me assure you that the Florida Public Service Commission is as concerned as you over the availability of economical, reliable electrical energy supply in Florida. We look forward to working with you in the future and would welcome any suggestions or comments you may wish to offer.

Very truly yours,

ROBERT T. MANN
Chairman

RTM/RLT/cd

**United States
Department of Energy
Washington, D.C. 20585**

THIRD-CLASS MAIL
POSTAGE & FEES PAID
U.S. DEPT. OF ENERGY
PERMIT NO. G 20

THIRD CLASS MA

Official Business
Penalty for Private Use, \$300

DO NOT MICROFILM
COVER