Joint Testimony

of

MICHEL P. ARMAND, ERNEST L. BIVANS AND WILFRED E. COE

Relating to

Questions A1 and D of ALAB 537

My name is Ernest L. Bivans. I am the Vice President in charge of System Planning for Florida Power & Light Company (FPL). My educational background and professional qualifications appear in the Nuclear Regulatory Commission's record of the St. Lucie 2 proceeding following Tr. 4896 and are incorporated herein by reference.

My name is Michel P. Armand. I am the Supervising Engineer of Reliability and System Security in the System Planning Department of FPL. A resume of my educational and professional qualifications is attached to this testimony and is incorporated herein by reference.

The System Planning Department is responsible for:

(a) Forecasting peak loads and energy requirements;

(b) Planning and recommending to management appropriate expansion for FPL's generation and transmission facilities as needed to meet load and reliability needs; and

(c) Coordinating FPL's generation and transmission planning with other utilities through organizations such as the Florida Electric Power Coordinating Group (FCG) and the Southeastern Electric Reliability Council (SERC).

My name is Wilfred E. Coe. I am Director of Power Supply for FPL. A resume of my educational and professional qualifications is attached to this testimony and is incorporated herein by reference.

The Power Supply Department is responsible for optimizing the quality, reliability and economic supply of electric energy to meet the needs of FPL customers. Power Supply is also responsible for the installation, operation and maintenance of protective relay and power system control equipment associated with generation, transmission and distribution of electric power.

SCOPE OF TESTIMONY

The purpose of this testimony is to respond to Questions A1 and D as stated in the Atomic Safety and Licensing Appeal Board Memorandum and Order of April 5, 1979, which are:

A. General Design Criterion (GDC) 17 21/

1. This criterion, entitled "Electric Power Systems," requires in its third paragraph (emphasis added):

> Electric power from the transmission network to the onsite electric distribution system shall be supplied by two physically independent circuits (not necessarily on separate rights of way) designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions. A switchyard common to both circuits is acceptable. 22/

All three transmission lines connecting the St. Lucie station to the applicant's grid originate at the Midway Substation. The May 14, 1978 incident, in which all power at that substation was lost despite redundant incoming sources, demonstrates that these circuits are indeed susceptible to simultaneous failure. 23/ The testimony should address whether the St. Lucie station nonetheless meets this GDC-17 requirement.

21/ See 10 C.F.R. Part 50, Appendix A ("General Design Criteria for Nuclear Power Plants").

22/ As we now view it, subject to being persuaded otherwise, the "common switchyard" provision refers to the switchyard at the site and not to a distant facility (such as, in this instance, the Midway Substation).

23/ See the applicant's May 25, 1978 "Report on System Disturbance, May 14, 1978."

D. <u>Ongoing Improvement of System Reliability</u>.

> The testimony should provide a concise, up-to-date discussion of existing measures, or those planned for the near future, by which the reliability of the applicant's system may be enhanced. Particular attention should be paid to the seemingly excessive number of personnel errors which appear to have led to the May 14, 1978 outage and to have contributed to the May 16, 1977 disturbance.

Our testimony will first describe how FPL has provided, consistent with the requirements of GDC-17, a strong grid which is constructed and operated so as to minimize to the extent practical, the likelihood of the loss of all sources of offsite power to St. Lucie.[1] We will then detail those measures which have recently been and are being taken to further enhance the reliability of our system.

THE ABILITY OF THE PRESENT FPL GRID TO SUPPLY A RELIABLE SOURCE OF OFFSITE POWER TO ST. LUCIE

No electrical system can be designed, constructed, and operated to completely eliminate all outages.[2]

In order to reduce the probability of occurrence of the loss of all sources of offsite power at St. Lucie, FPL has designed, constructed and operated its system:

1/ A description of the FPL grid is contained in the affidavit of Ernest L. Bivans, dated March 31, 1978. See Attachment #1. (System map omitted.)

2/ See IEEE Standard Definitions in Power Operation Terminology, Standard 346, 1973; OUTAGE-FORCED: An outage that results from emergency conditions directly associated with a component requiring that it be taken out of service immediately, either automatically or as soon as switching operations can be performed, or an outage caused by improper operation of equipment or human error.

A. To reduce the probability of occurrence of an outage of any one component on the system, and

B. To sustain the simultaneous occurrence of multiple events before resulting in a loss of offsite power at St. Lucie.

In recognition of the changing economic and social environment FPL annually updates its long range load forecast. This forecast is then used as the basis for reviewing and modifying long range generation and transmission plans to meet future requirements. One of the objectives of such planning is to prevent outages from occurring from loss of equipment due to overloads or inadequate generating capacity. In addition, FPL selects and tests all major components of the grid to rigid standards to reduce the probability of outages due to equipment malfunctions. This planning and equipment selection process assures that dependability and redundancy is built into the grid, as well as into the relay and telemetering equipment essential to its monitoring and protection. Following installation, a continuous monitoring and testing program, performed by specially trained personnel, maintains the equipment to specifications.

Recognizing that Peninsular Florida has its own unique environment, FPL has designed a system to function reliably within it. Special measures have been taken to prevent outages caused by wind,[3/] lightning,[4/] and various forms of environmental contamination.[5/] In addition to these measures, which

3/ FPL's standards for construction of both substations and transmission lines assure their continued availability even during hurricane force winds.

4/ The use of higher insulation levels, lightning arrestors, and overhead ground wires have significantly reduced the susceptibility of our high voltage transmission grid to lightning--reducing its vulnerability to almost zero at 500 kV.

5/ Critical line sections which may be susceptible to salt contamination have been specially designed to eliminate this cause of outages. Example: portions of the St. Lucie 240 KV line utilize vee-string insulators rated at about 500 kV to prevent outages due to contamination.

have long been a matter of routine practice, efforts have recently been increased to control contamination and a variety of innovative improvements are presently being developed.[6/]

Since November 1965 when the Midway Substation went into service simultaneous events have occurred to interrupt power on only two occasions. The first occasion was May 16, 1977, when the automatic scheme at St. Lucie functioned as designed and twice shifted from offsite to onsite diesel power.[7/]

The only other occasion on which a loss of offsite power to St. Lucie was experienced was on May 14, 1978. At this time, three separate events combined to isolate the Midway substation from the rest of the FPL grid.[8/] During this brief interruption of only eight minutes, the diesel generators responded immediately providing AC power.

6/ Recent experience has shown the need for additional improvements in the area of contamination detection and control. See Attachment #2 discussing a system disturbance in April 1979; the protective systems functioned as designed to contain the outage to the affected area. As a result of this experience new inspection procedures have been initiated giving priority to critical circuits so that contamination can be detected and removed before it can cause an outage. See Attachment #3.

7/ The first changeover to onsite power was the result of a voltage transient lasting only a few cycles; i.e., a fraction of a second. Although it is important to note that none of the three St. Lucie-Midway lines lost power, the instantaneous dip in voltage was enough to actuate the automatic throwover scheme at the plant starting the diesels immediately. The plant operator chose to remain on diesel power for several minutes although offsite power was available. The second shift to onsite power occurred later in the day, when the Andytown Orange River 500 kV line relayed incorrectly at a time when the system had not been fully restored from the earlier disturbance and multiple outages of major equipment still existed. Although this interruption lasted 17 minutes, the diesels started immediately, supplying onsite power.

8/ Attachment #4 (Figures 1-4) illustrate these events. First, the Ranch to Pratt & Whitney 240 kV line was out of service for testing. Second, a

(Footnote continued on next page.)

Consequently, operating history confirms that the FPL grid can sustain the simultaneous occurrence of multiple events, and that at least three separate events had to occur before losing offsite power to St. Lucie.

The Board has raised the question of the reliability of the termination of the St. Lucie lines in a common substation at Midway, and "whether the St. Lucie station nevertheless meets this (independent circuit) GDC-17 requirement."

GDC-17 specifically requires only two independent circuits, while St. Lucie employs three. GDC-17 provides sufficient flexibility to select a practical design which minimizes the probability of a simultaneous failure. This has been done for St. Lucie by tying the plant directly to the grid through the Midway substation by means of three 240 kV lines. This substation has two independent busses and all lines are tied to both busses through a breaker-and-a-half scheme thus maintaining both physical and electrical separation.

The breaker-and-a-half scheme allows isolation of any major component or portion of the substation. This is best illustrated by examining

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8/ (Footnote continued from previous page.)

switching error at Pratt & Whitney substation resulted in the failure of a lightning arrestor, which in turn produced a fault on the Midway-Ranch 240 kV line. Although the Ranch end relayed correctly, the third event, an improperly connected polarizing circuit at Midway, caused the Midway relays looking north to erroneously see the fault and kept the appropriate relay from tripping the Midway to Ranch 240 kV line. The result was to erroneously trip the two Midway-Malabar 240 kV lines, as well as the Midway-Plumosus 138 kV line. The two lines remaining at this time were rated at 69 kV. They then tripped, isolating the Midway substation from all sources of offiste power for eight minutes, sixteen and one-half seconds. Following this outage, the polarizing circuit was corrected and new procedures were established for testing this relay scheme.

the impact of the simultaneous loss of both 240 kV busses at Midway.[9] Power continues to flow into the station on all of the three lines from St. Lucie through the mid-breakers and then out to the Indiantown, Sherman and Malabar substations. With the loss of generation at St. Lucie, the reverse will be true and power will flow into St. Lucie over the three 240 kV lines.

These three 240 kV circuits are so constructed and separated to assure that each cannot physically interfere with the others. Over the Indian River, the towers supporting the separate lines are spaced 200 feet apart and are designed and insulated to resist the effects of environmental contamination and high wind.[10] They rise 173 feet, holding the conductors 153 feet above the river. Tower spacing keeps the conductors at least 90 feet above the Intracoastal Waterway and 61 feet above water elsewhere. Each circuit conductor over water consists of one 3400 kcmil ACSR/AW wire. Over land, the transmission structures for the separate lines are spaced 126 feet apart and rise 60 to 80 feet above grade. Tower structures on each line are spaced at 660 foot intervals, except where road or rail crossings require greater clearance. Right-of-way easements are 1200 feet. Each circuit conductor over land consists of two 1691 kcmil wires. Each circuit is sized for 100 percent of one unit output, or 1000 MVA, which is in excess of 100 times the emergency shutdown load of the unit. Electrostatic shield wires and other lightning protection equipment are provided at each tower as required.

9/ See Attachment #5.

10/ For example, vee-string insulation suitable for 500 kV lines and structures designed for winds in excess of 150 miles per hour are utilized.

The termination of these three circuits into two separate busses at a major strong point in the FPL grid exceeds the requirements of GDC-17. This design configuration is more reliable than a design which only provides for two circuits, each to be terminated at a separate substation. For a two circuit design, the occurrence of only two simultaneous events would result in a loss of all offsite power to St. Lucie. Even if one of the three existing lines were terminated at a second point on the system, no significant increase in reliability can be shown. This can be demonstrated by analysis of the impact of terminating one of the three existing St. Lucie lines at Ranch substation. This could be done by rearranging the Malabar #1 and St. Lucie #1 transmission lines at Midway substation so that the St. Lucie #1 line is in the same bay as the Midway-Ranch line. All three breakers in the bay would then be removed and the two lines connected to result in a St. Lucie to Ranch line which is about 65 miles long. Though this would increase the number of substations tied directly to St. Lucie, it is not electrically different because the present design configuration provides the same electrical ties to the Ranch substation with the breaker-and-half scheme at Midway. Furthermore, removal of the breakers at Midway would result in decreased operating flexibility by eliminating the ability to sectionalize the Ranch-Midway and Midway-St. Lucie lines at Midway. Additionally, the total miles of circuit exposure between St. Lucie and a strong tie into the grid would be increased from 36 miles (three 12-mile lines from St. Lucie to Midway) to 89 miles (one 65-mile and two 12-mile circuits). Finally, such a scheme would reduce the number of lines tied into Midway which would decrease the reliability of Midway with no increase in the reliability of the Ranch substation.

ONGOING IMPROVEMENT OF SYSTEM RELIABILITY

By June 1980 (approximately 3 years before the scheduled operation of St. Lucie 2) several major projects will be completed, which will enhance the reliability of FPL's grid.[11/]

Historically, in the event of a major system disturbance within Florida, interconnections to the north (notably Georgia Power) have been designed so that the two systems immediately separated. Although this has not significantly affected the reliability of FPL's grid, because it is designed to function independently, reliability could be improved if the grids remained interconnected. FPL and Georgia Power Company are now nearing completion of construction of an additional 240 kV tie between the Peninsular Florida grid and Southern Company. This tie directly connects FPL to Georgia Power and will assure that the two systems remain connected even in the event of the loss of the largest unit on the FPL grid.

Another major system improvement, shown on Attachment #6, consists of additions being made to the 500 kV portion of the system. These additions, all of which are to be completed by the summer of 1980, will triple the size of the 500 kV system and establish it as the backbone of the grid. They will consist of a 15.95 mile, 500 kV circuit from the existing 500 kV station at Andytown to a new station in the center of the South Florida load center at Levee; two 83 mile, 500 kV circuits from the new fossil plant site at Martin to Andytown; and a 26 mile, 500 kV cirucit from Martin Plant to Midway substation. The completion of this network will further strengthen Midway substation and its ability to provide offsite power to St. Lucie by electrically shortening its

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11/ See Attachment #6 which illustrates some of these major additons, all of which should be completed by June 1980.

ties via the 500 kV grid to the rest of the system. When Martin Plant Unit #1 becomes operational in the spring of 1980, it will provide a direct source of offsite power to St. Lucie through the Martin-Midway 500 kV line. By 1980, there will be one (1) 500 kV, five (5) 240 kV, and two (2) 138 kV circuits into Midway. As an integral part of the additions mentioned above, the reliability of the relaying scheme at Midway will be improved still further by the installation of additional redundant relays on all existing 240 kV transmission lines.

Particular emphasis has also been placed on reducing personnel errors which could result in system disturbances. Field switching personnel and the system dispatcher/operators who monitor and control both the granting of clearances and the sequence of switching are now better equipped to perform their duties. Before granting a switching request, a steady-state loadflow analysis is run to test the impact of such a clearance under contingency conditions. Next, the resulting loadflows are compared against transfer limits which have been established by a series of transient stability studies to assure that no bounding limits will be exceeded. A written switching order is then drawn up in accordance with specific procedures and guidelines. This order is checked, and if approved, issued to the party in the field. Finally, the party in the field checks it prior to proceeding in accordance with specific switching procedures in which he has been trained. During any switching sequence, the system dispatcher/operator can monitor the progress of the switching from the System Control Center, both on a dynamic board which depicts the whole system as well as a specific dynamic CRT display of the substation where the switching is taking place. He may intervene at various points if conditions change due to the outage of another section of the grid. This improved monitoring and

central control capability is designed to reduce outages which are the result of switching errors.

In addition, the System Control Center, which will be completely inservice by August 1979, will allow dispatcher/operators at a central location to monitor and control the entire grid, including but not limited to breaker status, transformer and line loading, generator output and tie line flows. This system is displayed on a single dynamic map complete with line flow information and equipment status. Additionally, an operator may display any section, subsection, and status information as well. To assist the operator in monitoring the system, various design limits are programmed into the computer such that alarms are automatically generated when limits are approached for items such as line and transformer thermal ratings, equipment status change, and reserve margins (spinning, supplemental, etc.). To assure system reliability, a security constrained dispatch has priority over an optimal power flow. To aid the operator in testing the impact of an anticipated action, he may simulate such action and a Security Analysis Program will quickly alert him to any potential problems that may arise by testing his simulation with up to 500 different contingency conditions.

The System Control Center will also provide the capability to analyze near term (present through up to seven days) network conditions, allowing dispatcher/operators to improve their operating strategy.

In addition to these measures, specific procedures have been adopted which guide the system operator's decisions under potential emergency conditions.[12/]

12/ See Attachment #7, Emergency Manual, Section 16521, "Transfer Limits" (describes transfer limits to be followed to assure a reliable power system); Section 16527, "Emergency Codes" (identifies emergency codes to be established under various power supply conditions and assigns certain personnel action to be followed).

Included among the actions to be taken are the reduction of non-essential loads, notification of customers with curtailable load contracts, and other measures designed to reduce load if deemed necessary to protect the integrity of the transmission grid.

In addition to minimizing the number of outages, it is also important to contain the impact of a fault or malfunction of equipment to that component of the grid. The System Control Center will further augment existing containment efforts such as primary, redundant, and backup relays,[13] underfrequency load shedding schemes,[14] and spinning reserve requirements.[15] As described above, this center, which represents the state-of-the-art, contains a variety of systems that alert the operator to any deteriorating conditions and allow him to immediately assess the situation and take corrective action.

To fully utilize this capability, FPL operators are being trained, on a newly installed Dispatcher Training Simulator, to respond to crisis situations. With this trainer, the instructor can simulate any major outage on a training console identical to the one at which the operator will normally work. As a result of this training, operators will be able to respond to crisis situations more rapidly, isolating the outage and restoring the critical components of the grid.

13/ These relaying schemes are designed to detect and trip appropriate breakers to isolate a fault in a fraction of a second. Additional redundancy here is currently being installed at substations such as Midway to assure prompt and correct action.

14/ Underfrequency load shedding schemes are designed to drop large blocks of load prior to the system becoming unstable due to the loss of generation. This is done in recognition of the need to protect the grid from an outage.

15/ Spinning reserve enables us to offset the loss of the largest generator on our system by picking up load at various other plants which have maintained a reserve of generation for this purpose.

MICHEL P. ARMAND

Resume of Educational
and
Professional Qualifications

My name is Michel P. Armand. My business address is P.O. Box 529100, Miami, Florida. I am Supervising Engineer of the Reliability and System Security Section of the System Planning Department of Florida Power & Light Company and I have served in that capacity since July 1, 1977.

I graduated from the City College of The City University of New York in June 1968, with the degree of Bachelor of Electrical Engineering. In June 1971, I graduated from the Bernard M. Baruch College of The City University of New York with a degree of Master of Business Administration.

In 1971, I attended in Schenectady, New York, the General Electric Company's one-year course in "Advanced Power System Engineering." In 1978, I attended the one-month "Public Utility Executive Program" of the Graduate School of Business Administration of the University of Michigan.

I am a registered Professional Engineer in the State of Florida. I am a senior member of the Florida Engineering Society and of the National Society of Professional Engineers. I am a member of the Institute of Electrical and Electronic Engineers.

In June 1968, I joined the cadet training program of the Consolidated Edison Company of New York, where for two years I was assigned to various departments. In June 1970, I was permanently assigned to the System Planning Department in the Transmission Planning Section. I progressed to Assistant Engineer, then Engineer.

In April 1974, I was employed by Florida Power & Light Company in the System Planning Department. In April 1976, I became a Senior Engineer in charge of the Reliability and System Security Section and I was promoted to Supervising Engineer of the section in July 1977. I am responsible for testing and assessing the dynamic performance of the planned generation and transmission system and making recommendations.

WILFRED E. COE

Resume of Educational
and
Professional Qualifications

My name is Wilfred E. Coe. My business address is P. O. Box 529100, Miami, Florida. I am the Director of the Power Supply Department of Florida Power & Light Company and I have served in that capacity since October 1, 1973.

I graduated from the Georgia Institute of Technology in 1950 with a degree of Bachelor of Electrical Engineering and in 1951 with a Master of Science in Electrical Engineering Degree. I attended Stanford University Graduate School.

I am a registered Professional Engineer in the State of Florida, a member of the Institute of Electrical and Electronics Engineers, and on the Interconnection Arrangement Committee of the Edison Electric Institute.

I was employed in June 1951 as a Student Engineer. Thereafter, I worked in the Commercial Department and Engineering Department as various engineer classifications. In 1963 I became Regional Manager of System Protection Department and in 1968 was made Manager of System Protection Department. In 1973, I became Director of Power Supply Department.

As the Director of Power Supply I am responsible for directing the System Protection, System Operations and Power Supply Technical Services Groups. These groups are operating and associated technical support personnel who dispatch the delivery of power to the distribution substations as well as provide for the protection and control of the electrical equipment throughout the system.

ATTACHMENT #1

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING APPEAL BOARD

In the Matter of:	)	
	)	
FLORIDA POWER AND LIGHT COMPANY	)	DOCKET NO. 50-389
	)	
(St. Lucie Nuclear Power Plant, Unit No. 2)	)	

AFFIDAVIT OF ERNEST L. BIVANS

I am Ernest L. Bivans, Vice President in charge of System Planning for Florida Power & Light Company. My education and professional qualifications appear in the Nuclear Regulatory Commission's record of the St. Lucie 2 proceeding following Tr. 4896.

The purpose of this affidavit is to address questions B.1(a) and B.2 in the Appeal Board's Order of March 10, 1978 together within their common context.

Grid

FPL serves approximately 200 municipalities and over 30 counties in the State of Florida. The Company's existing generation facilities consist of eleven generating plants distributed geographically around its service territory. These plants are tied into a system-wide transmission network, sometimes referred to as a grid, the purpose of which is to

transport energy from the generating plants to the load areas and to assure system reliability. Florida Power & Light Company operates approximately 4,165 circuit miles of transmission lines. A map showing the FPL system and interconnections is attached to this affidavit.

Florida Power & Light Company is directly interconnected with nine other Florida utilities, both public and private, which have significant generating capacity. FPL maintains fourteen normally closed and two normally open interconnections. Included in the normally closed interconnections are one 115 kV and two 240 kV interconnections with Florida Power Corporation, which in turn has interconnections outside of Florida: one 230 kV and four 115 kV ties to Georgia Power Company, and one 230 kV tie to Gulf Power Company.

Peninsular Florida possesses special geographic and electrical features. Surrounded by water on three sides, opportunities for interconnections with major utilities outside of Florida are restricted to the north. In addition, Florida has been subject to hurricanes and is one of the most severe lightning storm areas in the United States.

Consequently, Florida Power & Light Company, and the other utilities in Florida, have had to take

these factors into consideration in designing and building a reliable statewide system and thereby lessening the need for strong interconnections outside of Florida.

The St. Lucie Plant

The Florida Power & Light Company grid and connections to nuclear power plants on it are designed and operated so as to comply with applicable NRC requirements. In particular, GDC-17 requires a system of sufficient capacity and capability "to assure that (1) specified acceptable fuel design limits and design conditions of the reactor coolant pressure boundary are not exceeded as a result of anticipated operational occurrences and (2) the core is cooled and containment integrity and other vital functions are maintained in the event of postulated accidents". With respect to offsite power, GDC-17 also requires that there must be "two physically independent circuits . . . designed and located so as to minimize to the extent practical the likelihood of their simultaneous failure under operating and postulated accident and environmental conditions". In addition, there must be provisions "to minimize the probability of losing electric power from

any of the remaining supplies as a result of, or coincident with, the loss of power generated by the nuclear power unit, the loss of power from the transmission network, or the loss of power from the onsite electric power supplies".

At this time, offsite power is available to St. Lucie Plant from not two but three separate 240 kV transmission circuits from Florida Power & Light's Midway substation ten miles to the west. The transmission system consists of three separate circuits, placed parallel to each other, which are designed and constructed to assure that each cannot physically interfere with the other. Over the Indian River, the towers supporting the separate lines are spaced 200 feet apart. They rise 173 feet, holding the conductors 153 feet above the river. Tower spacing keeps the conductors at least 90 feet above the Intracoastal Waterway and 61 feet above water elsewhere. Each circuit conductor over water consists of one 3400 kcmil ACSR/AW wire. Over land, the transmission structures for the separate lines are spaced 126 feet apart and rise 60 to 80 feet above grade. Tower structures on each line are spaced at 660 foot intervals, except where road or rail crossings require greater clearance. Right-of-way easements are 1200 feet.

Each circuit conductor over land consists of two 1691 kcmil wires. Each circuit is sized for 100 percent of one unit output, or 1000 MVA, which is in excess of 100 times the emergency shutdown load of the unit. Electrostatic shield wires and other lightning protection equipment are provided at each tower as required.

The design of St. Lucie Plant also provides for the independence of power supplies so as "to minimize the probability of losing electric power from any of the remaining supplies as a result of, or coincident with, the loss of" one. Each unit is provided with two start-up transformers. During normal plant operation, AC power is provided from the main generator through the unit's two auxiliary transformers. Normal transfer of power between the auxiliary and start-up transformers would be initiated by the operator from the control room. If a main generator should trip unexpectedly, the auxiliary AC load transfer from the auxiliary transformers to the start-up transformers would be initiated automatically by protective relay action, thereby providing sufficient offsite power to safely shutdown or mitigate the consequences of a design basis accident. Offsite power, in such case, would be supplied from the transmission system or the other operating St. Lucie unit. Should offsite power

not be available from either of these sources, sufficient power to accomplish a shutdown would automatically be provided by the onsite diesel generators.

Physical separation of transformers and transmission lines and flexible, automatic switching arrangements are utilized to protect against the simultaneous loss of any two sources of power (unit main generator, offsite, and onsite) to safety related loads. In addition, the onsite safety related electric power system for each unit is separated into two redundant and independent trains, each with a diesel generator. Either train is capable of assuring a safe unit shutdown.

<u>The Midway Substation</u>

The Midway 240 kV substation is presently connected to the north by two 240 kV circuits to Malabar Substation and from there by two 240 kV circuits to Brevard Substation which provides access to generation at Cape Canaveral Plant, Sanford Plant, and also interconnections with Florida Power Corporation, Orlando Utilities Commission, and Jacksonville Electric Authority.

Two 240 kV circuits connect Midway Substation to the south with one circuit going directly to Ranch Substation and the other going to Ranch Substation via Indiantown and Pratt & Whitney Substations. Ranch

Substation provides access to generation at Riviera Plant, Lauderdale Plant, Port Everglades Plant, Turkey Point Plant, all of which are on the east coast, and Fort Myers and Manatee Plants on the west coast. Also included are interconnections to the Lake Worth municipal system and Tampa Electric Company (which is also interconnected with Florida Power Corporation).

In addition, the 240 kV Midway Substation is connected by two 112 MVA autotransformers to a 138 kV substation, also at Midway, which is in turn supplied by one 138 kV line to Plumosus Substation to the south and from there to the Riviera Plant; another 138 kV line, temporarily operated at 69 kV, ties the Midway 138 kV substation to the Malabar 138 kV substation to the north. This last line serves as an interconnection with the municipal generating systems of the Cities of Fort Pierce and Vero Beach. In the unlikely event of separation of all the four 240 kV and the two 138 kV lines feeding into Midway Substation at present, the restoration of any one of these lines would allow energization of the Midway bus and restoration of offsite power to the St. Lucie Switchyard.

System Improvements and Modifications

The growth of any dynamic system requires additions and changes. These changes involve transmission construction, relaying practices and operating procedures and are designed to minimize the likelihood of an outage.

As a result of outages which occurred on April 3 and 4, 1973, FPL contracted with Stone & Webster Engineering Corporation to review the Florida Power & Light Company bulk power system reliability and to provide recommendations designed to improve it. Out of such recommendations and other internal studies, Florida Power & Light Company has implemented numerous changes to its system since 1973, including transmission additions which have strengthened the ties between the southern area (south of Ranch Substation) and the rest of Florida; a second tie to Tampa Electric Company; new transmission lines down the west coast to Ft. Myers; and the new 500 kV circuit across the Everglades from Ft. Myers to Lauderdale. In addition, the east coast transmission was strengthened by reinforcing old lines, adding new lines, and rearranging circuits from the Midway Substation southerly through Lauderdale and into the Miami area. Two major additional interconnections with adjoining utilities were also established at Sanford (Florida Power Corporation) and at

Bradford (Jacksonville Electric Authority). During this same time frame, additional generation was added at Manatee, Ft. Myers, Putnam, and St. Lucie Plants.

Scheduled Improvements - 1978 to 1981

During the period from 1978 to 1981, new lines are scheduled to be installed which will increase reliability and therefore benefit the St. Lucie units.

In 1978, a new 240 kV circuit from Midway Substation to Martin Plant, which is under construction, will be energized. In 1980, a 500 kV circuit from Midway Substation to Martin Plant will be energized and two 500 kV circuits from Martin Plant to Andytown Substation will be built and energized to coincide with the operation of the first unit at Martin (775 MW). By 1980, there will be one 500 kV, five 240 kV, and two 138 kV feeds into Midway Substation. In addition, at Martin Plant, a second unit (775 MW) is scheduled to go into service in 1981.

In 1980, a 240 kV tie between Georgia Power Company (Kingsland) and Florida Power & Light Company (Yulee) is scheduled for completion. A new System Control Center is scheduled to become operational by December 1978.

Operating History

The Midway Substation, originally named St. Lucie Substation, went into service in November 1965.

The Florida Power & Light Company operating record reflects that until the events of May 16, 1977, no outage or any system disturbance had ever caused a loss of power at the Midway Substation.

Two days prior to the events of May 16, 1977, the Florida Power & Light Company Andytown - Orange River transmission line had been converted from 240 kV to 500 kV operation, as part of the continuing program to strengthen the system. This line was out of service on May 16, 1977, in order to complete the final tests of its protective relays. Had this 500 kV line been in service, the loss of the Turkey Point Unit No. 3 at 10:08 a.m. and the outage of the Ft. Myers - Ranch 240 kV line at 10:24 a.m. would not have resulted in the loss of any system load.

A number of independent contingencies caused part of the system to come down. The principal reasons for the outage were the loss of Turkey Point Unit No. 3 due to a defective auxiliary relay and 16 minutes later, the Ft. Myers - Ranch 240 kV line from an unrelated phase-to-ground fault. The loss of the Ft. Myers - Ranch 240 kV line caused the system to split south of Midway, leaving Midway Substation and St. Lucie Plant switchyard energized from the system to the north of Midway. The split of the system caused the St. Lucie

Unit No. 1 to reject load and it was tripped manually at 10:24 a.m. The Plant continued to receive offsite power from Midway until 10:38am, when the system voltage decayed to a level which caused the diesels to start automatically. The Plant continued on onsite power for a period of time after the grid stabilized, and at 11:00am, offsite power was reconnected, and the use of diesels was terminated.

Immediately following the system outage south of Midway, the Orange River - Andytown 500 kV line was put back into service to facilitate the restoration of service. At 12:03pm, an incorrect relay operation at Andytown caused the 500 kV line to trip. The resulting power surges resulted in the interruption of service from Midway south, this time inclusive of Midway Substation, causing a loss of offsite power to St. Lucie. Emergency diesels were again started automatically. However, 17 minutes later, Midway was re-energized from the northern part of the system, offsite power was restored to the St. Lucie switchyard and the use of diesels was terminated. The unit was returned to service in a normal manner, and synchronized to the system at 9:58pm, without incident.

Following the May 16 events, the grid status was reexamined, previous studies reviewed, new studies

initiated, and a number of actions taken to further improve reliability. Gas turbine controls were modified to permit automatic synchronizing at lower bus voltages; restoration plans were reviewed and updated; maintenance priorities were set and inspection increased for transmission lines; a "dispatcher training simulator", has been purchased and is being used to improve dispatcher or power coordinator training; a new type of fault locating equipment was purchased for installation on key transmission lines; the Martin - Midway 500 kV circuit was also rescheduled for completion in 1980 instead of 1983 as originally planned.

The new System Control Center will allow power coordinators to monitor relevant parameters such as megawatts, megavars, volts, amperes, and hertz for transmission lines, generators and substations. The status of all positional devices such as circuit breakers and switches in the transmission system will also be monitored. All information received from the field will be checked against limits and alarms produced if these limits are exceeded. The power coordinator will be capable of assessing system security under

both single and double contingency conditions by use of a computer program which is capable of simulating automatically up to 500 contingency conditions every 30 minutes.

The System Control Center will also provide the capability to analyze near term (present through up to seven days) network conditions, allowing the power coordinators to improve their operating strategy.

All these actions, taken since May 16, 1977, will make major improvements to the reliability of the system.

<u>Assurance of Electric Power at St. Lucie</u>

With specific reference to Appeal Board Question B.1(a), Florida Power & Light Company does not possess the data to compare the assurance of power at St. Lucie with other plants. Nevertheless, based upon the foregoing, there is overall assurance that there will be electric power at St. Lucie under both accident and normal conditions:

A. The Florida Power & Light Company system is designed and operated to take into account the unique nature of Peninsular Florida and its electric grid and to conform to all

applicable NRC requirements.

B. Offsite power to St. Lucie is available from three separate 240 kV transmission circuits. Each circuit has conductors which are sized to carry the entire output of one unit.

C. There are at present six sources of power to the Midway Substation 240 kV bus connecting the three circuits to St. Lucie Plant. By 1983, there will be eight sources of power to the Midway Substation. This assures that Florida Power & Light Company's ability to supply offsite power to St. Lucie Plant will not be impaired.

D. There are no critically shared systems between the two St. Lucie units.

E. Finally, a variety of significant measures have been and continue to be taken to improve the reliability of the transmission system.

With reference to Appeal Board Question B.2,

and the need to minimize the probability of the co-incident loss of power sources, as demonstrated above, (1) GDC-17 will be met, (2) the likelihood of the trip of one of the St. Lucie units causing the other to trip is minimal, and (3) the possibility of a reoccurrence of an outage similar to that on May 16, 1977 has been substantially reduced.

Further, FPL's evaluation of the system as projected for 1983 and thereafter indicates that in the event the two St. Lucie units were to trip simultaneously, offsite power will not become un-available due to system stability.

ERNEST L. BIVANS
Vice President

STATE OF FLORIDA)
) ss.
COUNTY OF DADE)

Subscribed and sworn to before me this 31st day of March, 1978.

My commission expires: NOTARY PUBLIC STATE OF FLORIDA at LARGE MY COMMISSION EXPIRES AUGUST 24, 1981 BONDED THRU MAYNARD BONDING AGENCY

NOTARY PUBLIC

ATTACHMENT #2

FLORIDA POWER & LIGHT COMPANY

May 22, 1979

United States Department of Energy
Division of Power Supply & Reliability
Office of Utility Systems
Economic Regulatory Administration
Washington, D.C. 20461

Gentlemen:

Attached is a copy of the disturbance analysis report for the power interruption which occurred on the Florida Power & Light system at 11:57 p.m. on April 4, 1979.

Further analyses of this disturbance are being done by the Florida Electric Coordinating Group - Operating Committee. The findings of their study will be furnished when completed.

Sincerely,

W. E. Coe

W. E. Coe
Director - Power Supply

WEC/ayg

Attachment

cc: Florida Public Service Commission - J. D. Jenkins
SERC - Grady L. Smith
Florida Electric Coordinating Group - W. D. Lang

bcc: E. A. Adomat
E. L. Bivans
G. E. Liebler
H. N. Paduano
A. D. Schmidt
R. E. Uhrig
G. D. Whittier
C. O. Woody

4/25/79
Rev. 5/8/79

FLORIDA POWER & LIGHT COMPANY

SYSTEM DISTURBANCE

LOSS OF GENERATION AT TURKEY POINT

WEDNESDAY, APRIL 4, 1979

11:57 PM

TABLE OF CONTENTS

HTG/DAM:dep
4/21/79
Rev. 5/8/79

PRE-DISTURBANCE CONDITIONS

During the afternoon and evening of Wednesday, April 4, 1979, the Florida Power & Light transmission system was experiencing widespread incidents of flashovers resulting in the tripping of major 230 kV transmission lines in its Southern service area. The flashovers were caused by the combination of an accumulation of salt and dust on insulators caused by a period of extremely dry weather and strong winds, followed by an increase in the humidity level. By 11:53 P.M. four of seven transmission lines leaving Florida Power and Light's Turkey Point plant were out of service as shown by the system configuration diagram and sequence of events chart on page 8. These were the Turkey Point-Davis #1 230 kV line, the Turkey Point-Davis #3 230 kV line, the Turkey Point-Flagami #1 230 kV line, and the Turkey Point-Dade #1 230 kV line. The three remaining transmission circuits out of Turkey Point Plant had a combined thermal capacity of 1621 MVA.

Prior to the disturbance Florida Power & Light's load was 3870 Mw and the net interchange was 150 Mw, out of FP&L. The system frequency was 60.03 Hertz. FPL was carrying approximately 492 Mw of spinning reserve*, while its requirement was 331 Mw. Furthermore, there were an additional 491 Mw of on-line steam available and 1778 Mw of quick start gas turbines which could be made available within 30 minutes. At the time of the disturbance Florida Power Corporation was importing 200 Mw of power from Southern Company.

* Spinning Reserve as defined by the Florida Coordinating Group.

DISTURBANCE

Between 11:53 and 11:57 P.M. the remaining three transmission lines out of Turkey Point plant tripped, and isolated Turkey Point from the rest of the system. At the time the lines tripped, three Turkey Point units were on: Turkey Point Unit 1 was carrying 352 Mw net, Turkey Point Unit 2 was carrying 181 Mw net, and Turkey Point Unit 4 was carrying 600 Mw net. With the loss of the transmission lines, Turkey Point Unit 4's instruments detected the loss of connected load, and ran the unit back. Immediately after, the unit tripped on a low steam generator level trip signal. Simultaneously, Turkey Point Unit 2 was tripped by its anti-motoring protection, and Turkey Point Unit 1 reduced its generation but remained on-line carrying the plant auxiliary uses. The resultant combined generation loss within FPL was 1133 Mw.

When the Turkey Point generation was lost, the power flow into Peninsular Florida increased. This power surge caused Florida Power Corporation's Archer-Ft. White 230 kV line and Ft. White-High Springs 69 kV line to trip, isolating Peninsular Florida from the external systems. At the time of separation FPC's interchange with Southern Company changed from 200 Mw (IN) to 20 Mw into Florida indicating the creation of an additional loss of 180 Mw within the isolated region. Thus, the loss of this import from Southern Company, coupled with the loss of Turkey Point generation resulted in a total deficiency of 1313 Mw within Peninsular Florida.

The resulting mismatch of load and generation caused the frequency to decline. Within FPL the system frequency declined to a low of 59.01 Hz, and initiated underfrequency relays which shed approximately 470 Mw of load in the areas shown below. Governor response and load shedding within Peninsular Florida stabilized the frequency at 59.85 Hertz within 10 seconds.

FPL LOAD SHED BY UNDERFREQUENCY RELAYS

Division		Load
Southern		240
Northern		95
Eastern		66
Western		69
	TOTAL	470

In addition, other utilities within Peninsular Florida shed the following amounts of load:

Utility	Step '0' (59.7 Hz)	Step '1' (59.2-59.0 Hz)	Total
FPC	150	76	226
TECO	70	60	130
OUC	0	5	5
JEA	0	90	90
TOTAL	220 Mw	231 Mw	451 Mw

FPL generating units responded by providing 173 Mw (see Governor Response Table, page 6), while the FPL tie lines with other utilities provided an additional 491 Mw (see Tie Line Response, page 7). The generating unit and tie line response, coupled with the reduction in load, made up the entire loss of Turkey Point generation. A summary of the response of the FPL system is shown on page 5 .

Prior to the reestablishment of the ties with the external systems, FPL's net interchange was 310 Mw (IN) and the frequency had recovered to 59.92 Hertz as a result of an increase in generator output.

Florida Power Corporation's transmission ties with the external system were reestablished approximately two minutes after the start of the disturbance, at which time load restoration was initiated by other affected systems. Once this was completed, FP&L proceeded to restore its own load. Most of the FPL load was picked up within 20 minutes after the disturbance originated.

The FPL net interchange returned to its predisturbance level 11 minutes after the origination of the disturbance.

At 1:02 AM a transmission line was closed in to tie the Turkey Point 230 kV buss to the network, but it separated at 1:05 AM. At 1:27 AM the buss was once again synchronized to the network, but the line tripped at 2:12 AM. Finally, at 6:11 AM a third and successful attempt was made to tie Turkey Point to the network permanently. A second transmission line was successfully closed in at 7:23 AM. Turkey Point Unit 2 was brought back on-line at 7:43 AM on April 5th after these two transmission circuits had been restored. The remaining transmission circuits were subsequently restored. Turkey Point Unit 4 was intentionally left off-line, as it was scheduled to come off for refueling after the system peak of April 5th.

FLORIDA POWER AND LIGHT
DISTURBANCE RESPONSE SUMMARY

FPL SYSTEM DISTURBANCE RESPONSE DATA SHEET — Prepared By D. A. McInnis — Date 4/16/79

Disturbance: LOSS OF TURKEY POINT UNITS — Date 4/4/79 — Time 11:57

Cause: TRANSMISSION LINE OUTAGES

F_1 60.03 Hz, F_2 59.85 Hz, ΔF .15 Hz, F_1+ 59.01 Hz

G_1 4020 Mw, G_2 3060 Mw, Δ Gen -960 Mw

N_1 150 OUT Mw, NI_2 341 IN Mw, Δ NI 491 IN Mw

L_1 3870 Mw, L_2 3400 Mw, ΔL 470 Mw

Loss* (Load +, Generation -) 663 Mw, Scheduled NI_1 179

Response(ΔNI - Loss) 173 Mw

* Generation Loss 1133 MW; Load Loss 470 MW

F_1 = FREQUENCY JUST BEFORE DISTURBANCE

F_1+ = MAXIMUM FREQUENCY EXCURSION

F_2 = FREQUENCY AFTER STABILIZATION BUT BEFORE CORRECTIVE CONTROL ACTION TAKES PLACE

G_1 = GENERATION JUST BEFORE DISTURBANCE

G_2 = GENERATION IMMEDIATELY AFTER FREQUENCY STABILIZES

NI_1 = NET INTERCHANGE JUST BEFORE DISTURBANCE

NI_2 = NET INTERCHANGE IMMEDIATELY AFTER FREQUENCY STABILIZES

L_1 = LOAD JUST BEFORE DISTURBANCE

L_2 = LOAD IMMEDIATELY AFTER FREQUENCY STABILIZES

FPL GENERATING UNIT GOVERNOR RESPONSE

Date 4/16/79
Prepared By D.A. McInnis

UNIT	CONTINUOUS CAPACITY (MW)[5]	ACTUAL GEN BEFORE DISTURBANCE (MW)	ESTIMATED % VALVE OPENING[1]	.15 Hz EXPECTED RESPONSE (MW)[2]	ACTUAL PLANT RESPONSE (MW)
TURKEY POINT 1	369	352	95	0	0
TURKEY POINT 2	185	181	98	TRIPPED	TRIPPED
TURKEY POINT 3	OFF	OFF	--	OFF	OFF
TURKEY POINT 4	610	600	--	TRIPPED	TRIPPED
PORT EVERGLADES 1	190				
PORT EVERGLADES 2	205	391*	99	4	0
PORT EVERGLADES 3	369				
PORT EVERGLADES 4	150	457**	89	26	40
PORT EVERGLADES GT	OFF	OFF	--	OFF [3]	OFF
LAUDERDALE 4	138				
LAUDERDALE 5	138	180	65	14	16
LAUDERDALE GT	OFF	OFF	--	OFF[3]	OFF
RIVIERA 1	OFF	OFF	--	OFF	OFF
RIVIERA 2	OFF	OFF	--	OFF	OFF
RIVIERA 3	273	207	77	14	5
RIVIERA 4	OFF	OFF	--	OFF	OFF
ST. LUCIE 1	OFF	OFF	--	OFF	OFF
FT. MYERS 1	138	112	81	7	10
FT. MYERS 2	369	345	93	18 [4]	22
FT. MYERS GT	OFF	OFF	--	OFF	OFF
MANATEE 1	OFF	OFF	--	OFF	OFF
MANATEE 2	772	370	48	38	30
CAPE CANAVERAL 1	369	345	93	18	25
CAPE CANAVERAL 2	OFF	OFF	--	OFF	OFF
SANFORD 3	OFF	OFF	--	OFF	OFF
SANFORD 4	364	230	63	18	15
SANFORD 5	364	250	69	18	10
PUTNAM 1	OFF	OFF	--	OFF	OFF
PUTNAM 2	OFF	OFF	--	OFF	OFF
TOTALS	5003	4020	--	175	173

Notes: [1]Actual Gen/Continuous Capacity (Before Disturbance)
[2]The smaller of:
a) Continuous capacity X .167 X HZ/.5 (Max Hz to be used = .5 or
b) Continuous capacity - actual gen.

[3]No. of units on line X (37-28) if (F_1 +) ≤59.9 Hz.
[4]No. of units on line X (57-40) if (F_1 +) ≤59.9 Hz.
No. of units on line X (23.5 X Hz) if (F_1 +)>59.7 Hz.
[5]Actual Continuous Capacity

* Generation for Pt. Everglades Unit 1 and 2 are combined into a single value.

** Generation for Pt. Everglades units 3 and 4 are combined into a single value.

FPL
TIE LINE RESPONSE

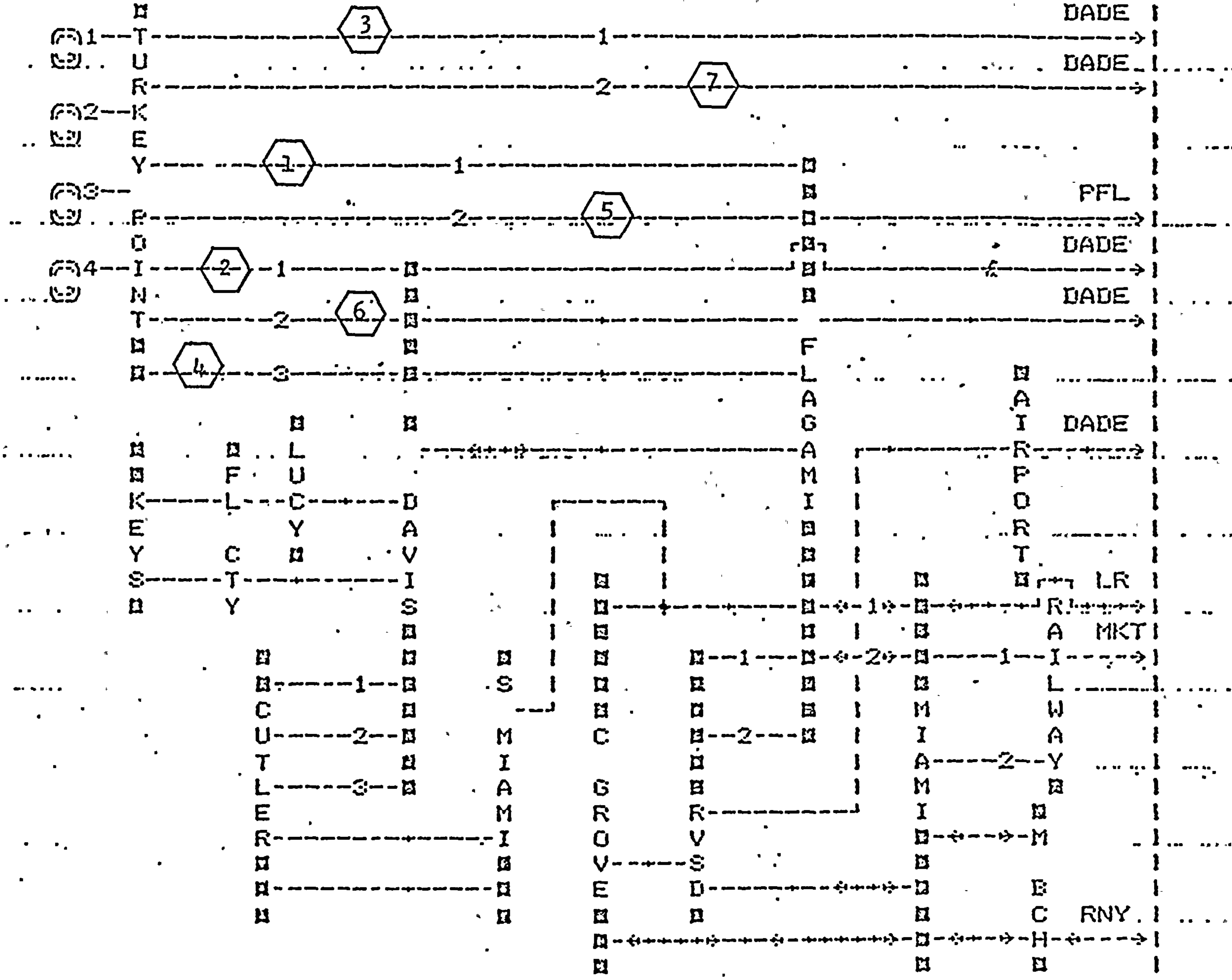
Prepared By D.A. McInnis Date 4/16/79

Disturbance LOSS OF TURKEY POINT UNITS Date 4/4/79 Time 11:57

TIE	FLOW BEFORE DISTURBANCE	SUBTOTAL	CHANGE	SUBTOTAL	FLOW AFTER DISTURBANCE
Big Bend-Ringling 230kV	70 IN				190 IN
Big Bend-Manatee 230kV	38 OUT	32 IN	258 IN 53%	290 IN	100 IN
Sanford-Turner 115kV	12 IN				8 IN
North Longwood-Sanford 230kV	80 OUT				115 OUT
Brevard-West Lake Wales 230kV	10 OUT	12 IN	93 IN 19%	105 IN	50 IN
Indian River-Cape Canaveral 230kV	90 IN				162 IN
Greenland-Putnam 230kV	125 OUT				50 OUT
Baldwin-Normandy 115kV	5 OUT	170 OUT	133 IN 27%	37 OUT	8 IN
Duval-Normandy 230kV	40 OUT				5 IN
* New Smyrna Beach 115kV	13 OUT				13 OUT
Vero Beach 138kV	18 OUT				14 OUT
Ft. Pierce 138kV		37 OUT	7 IN 1%	30 OUT	
Lake Worth 138kV	6 OUT				3 OUT
Homestead 138kV	0				0
TOTAL	163 OUT		491 100%		328 IN

*Discrepancy between net interchange total and sum of individual ties due to New Smyrna Beach not included in total.

TURKEY POINT TRANSMISSION LINE
TRIPPING SEQUENCE



1) FLAGAMI-TP #1 Tripped 10:35 PM - Shattered Insulator String

2) DAVIS-TP #1 Tripped 10:41 PM - Contamination Left Out of Service for Washing

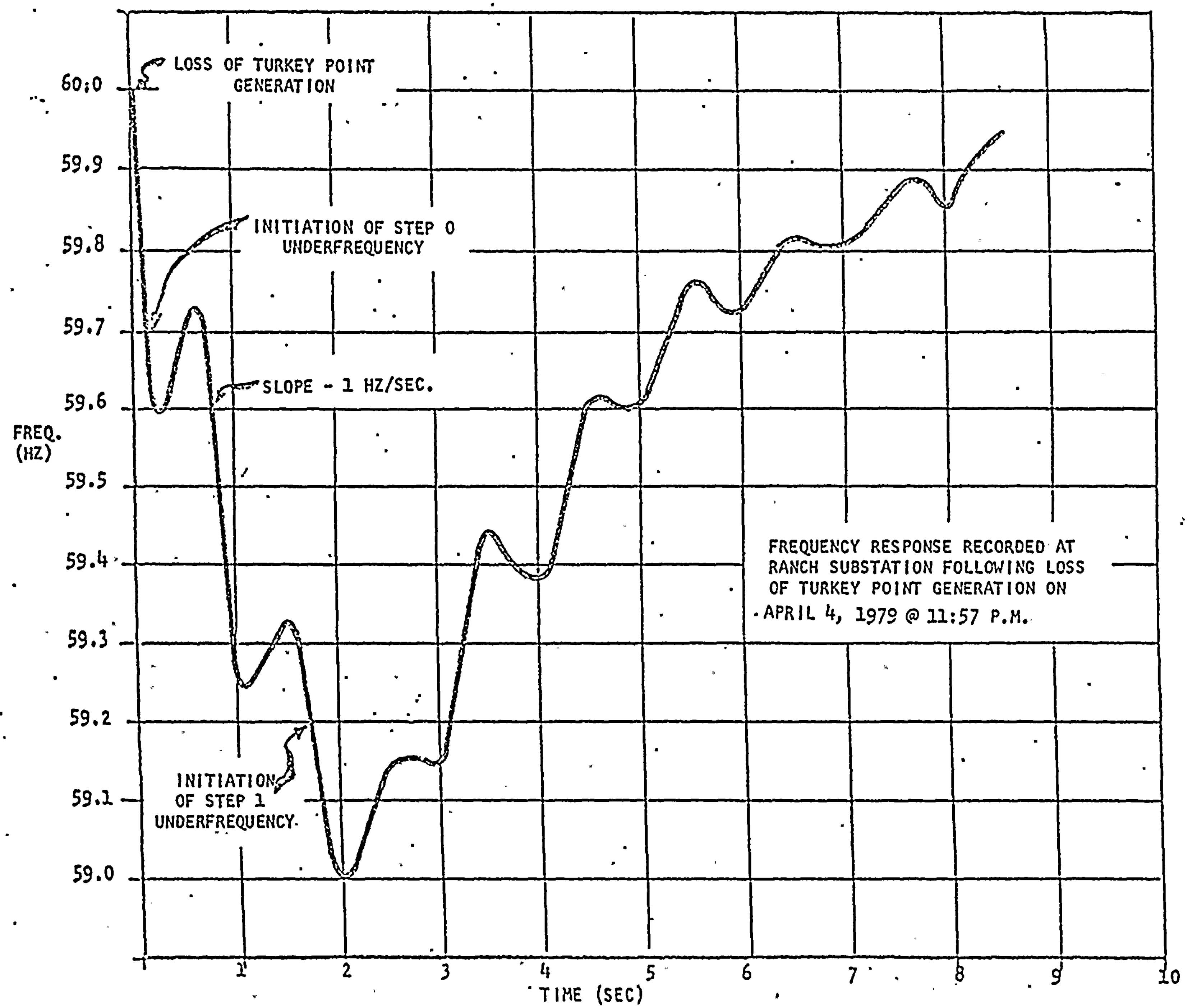
3) DADE-TP #1 Tripped 11:50 - Contamination

4) DAVIS-TP #3 Tripped 11:53 - Shattered Insulator String

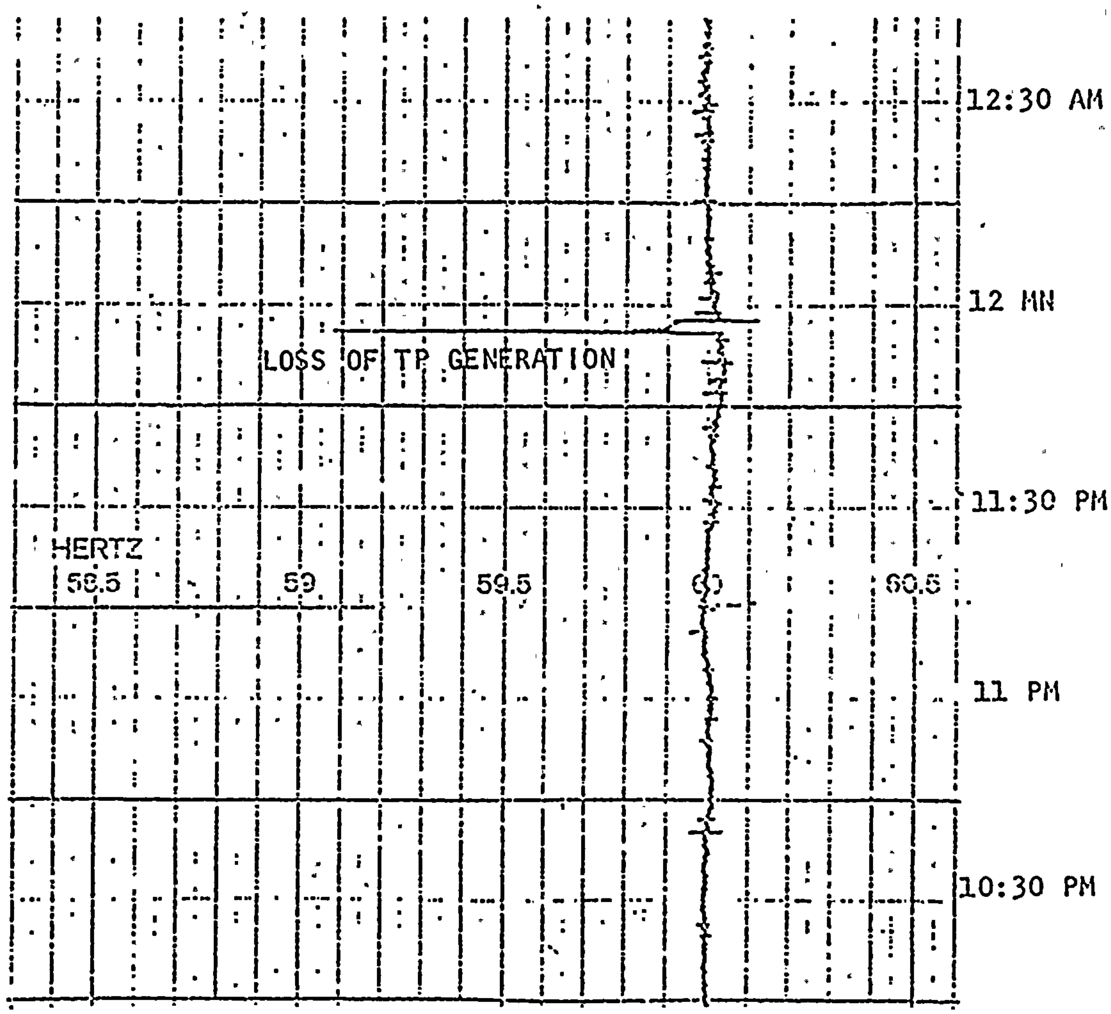
5) FLAGAMI-TP #2 Exact Trip Time Unknown 11:53 - 11:57 Shattered Insulator String Found

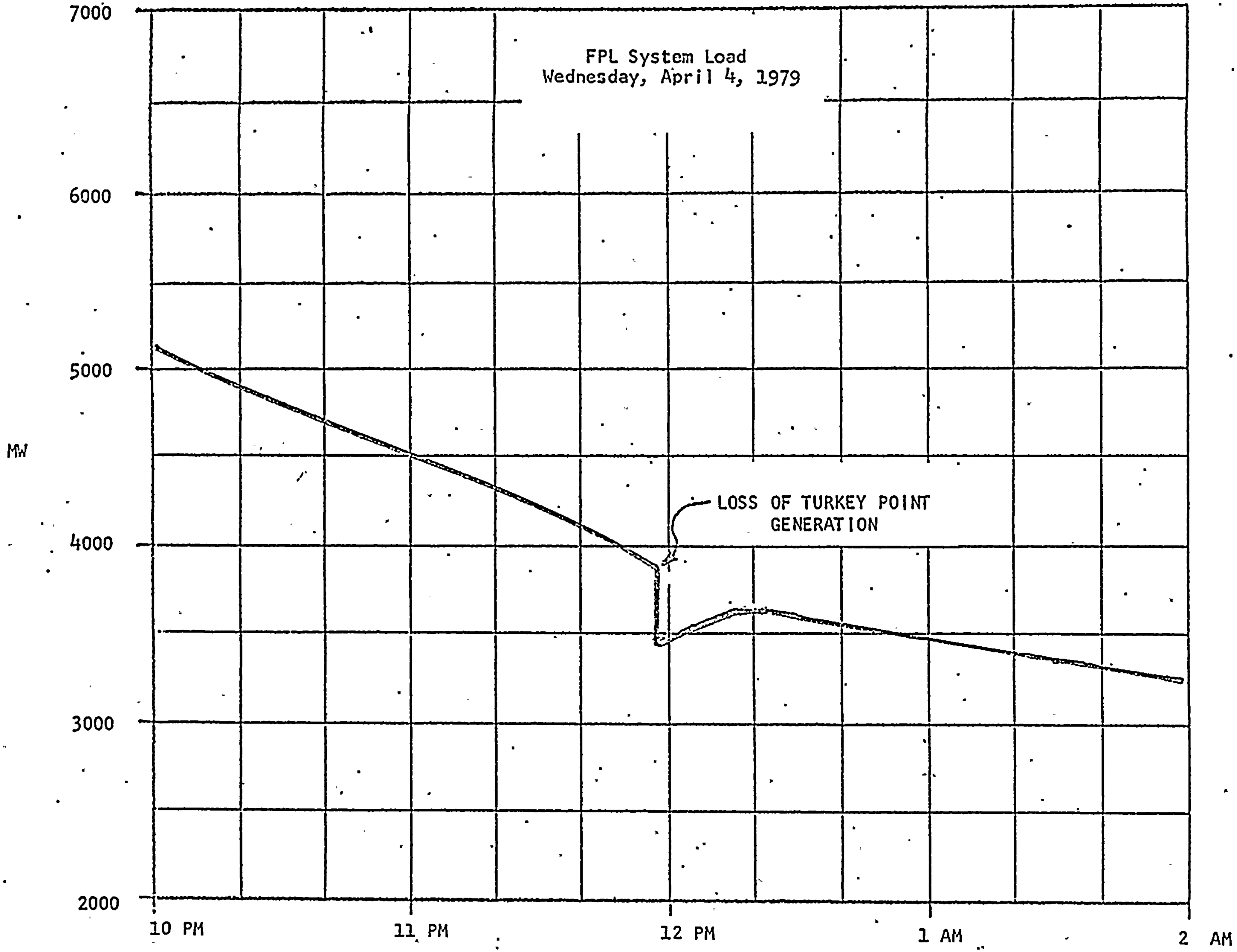
6) DAVIS-TP #2 Exact Trip Time Unknown 11:53 - 11:57 Shattered Insulator String Found

7) DADE-TP #2 Exact Trip Time Unknown 11:53 - 11:57 Contamination

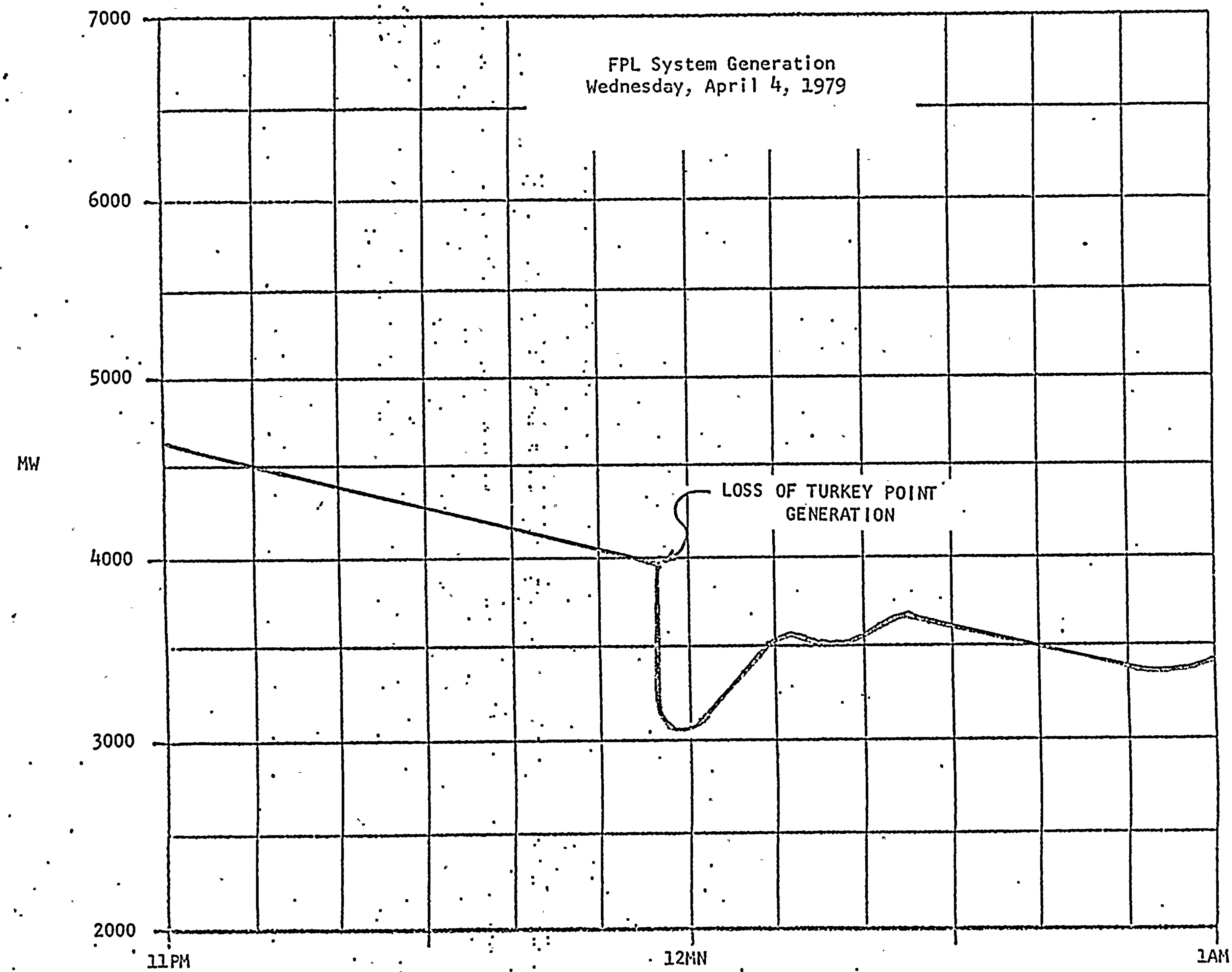

LOSS OF TURKEY POINT GENERATION
INITIATION OF STEP 0 UNDERFREQUENCY
SLOPE - 1 HZ/SEC.
INITIATION OF STEP 1 UNDERFREQUENCY
FREQ. (HZ)
60.0
59.9
59.8
59.7
59.6
59.5
59.4
59.3
59.2
59.1
59.0
1
2
3
4
5
6
7
8
9
10
TIME (SEC)
FREQUENCY RESPONSE RECORDED AT RANCH SUBSTATION FOLLOWING LOSS OF TURKEY POINT GENERATION ON APRIL 4, 1979 @ 11:57 P.M.

SYSTEM FREQUENCY
AT PORT EVERGLADES 138kV BUSS
APRIL 4, 1979



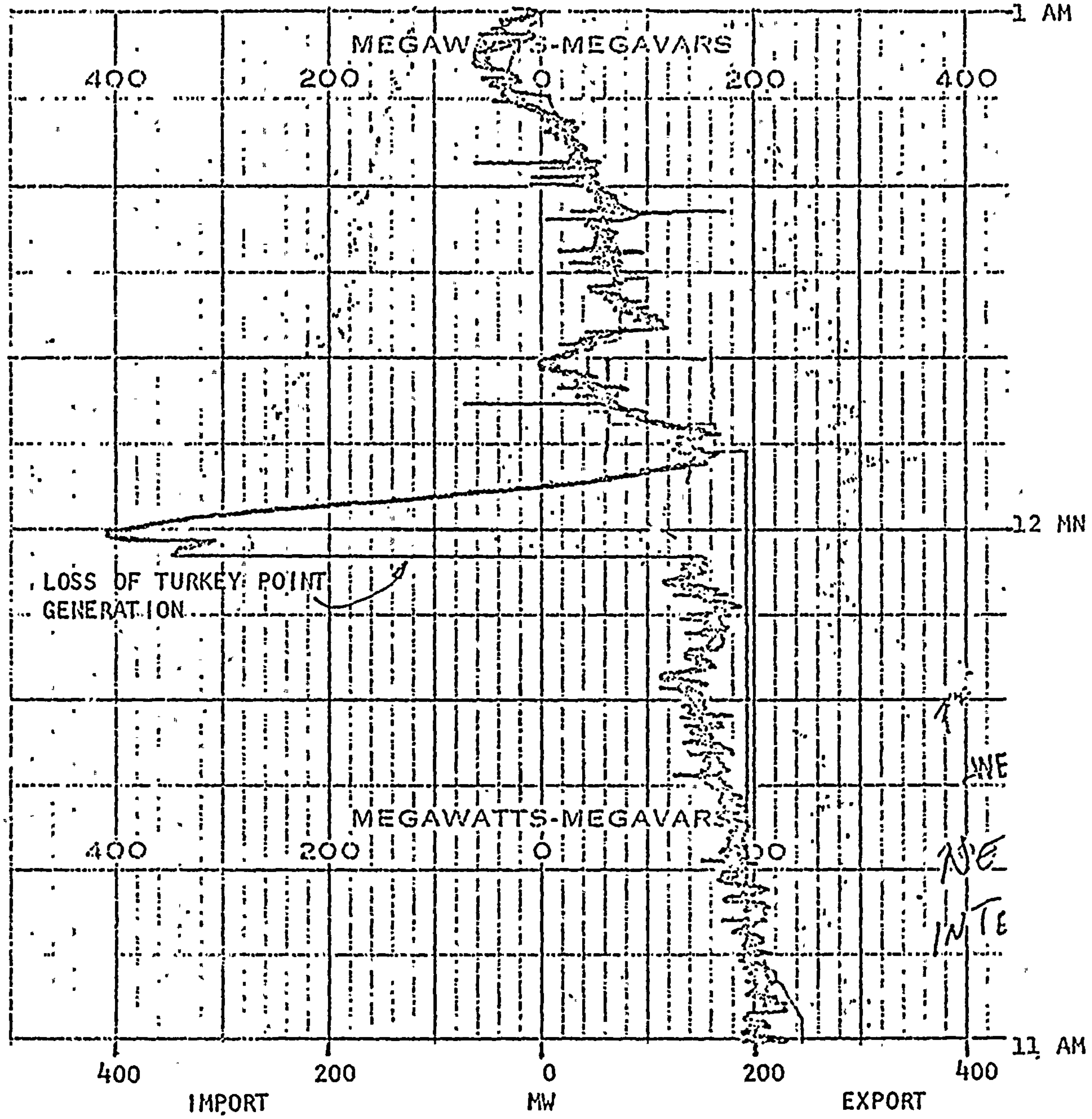


FPL System Load
Wednesday, April 4, 1979
LOSS OF TURKEY POINT GENERATION
7000
6000
5000
4000
3000
2000
MW
10 PM
11 PM
12 PM
1 AM
2 AM

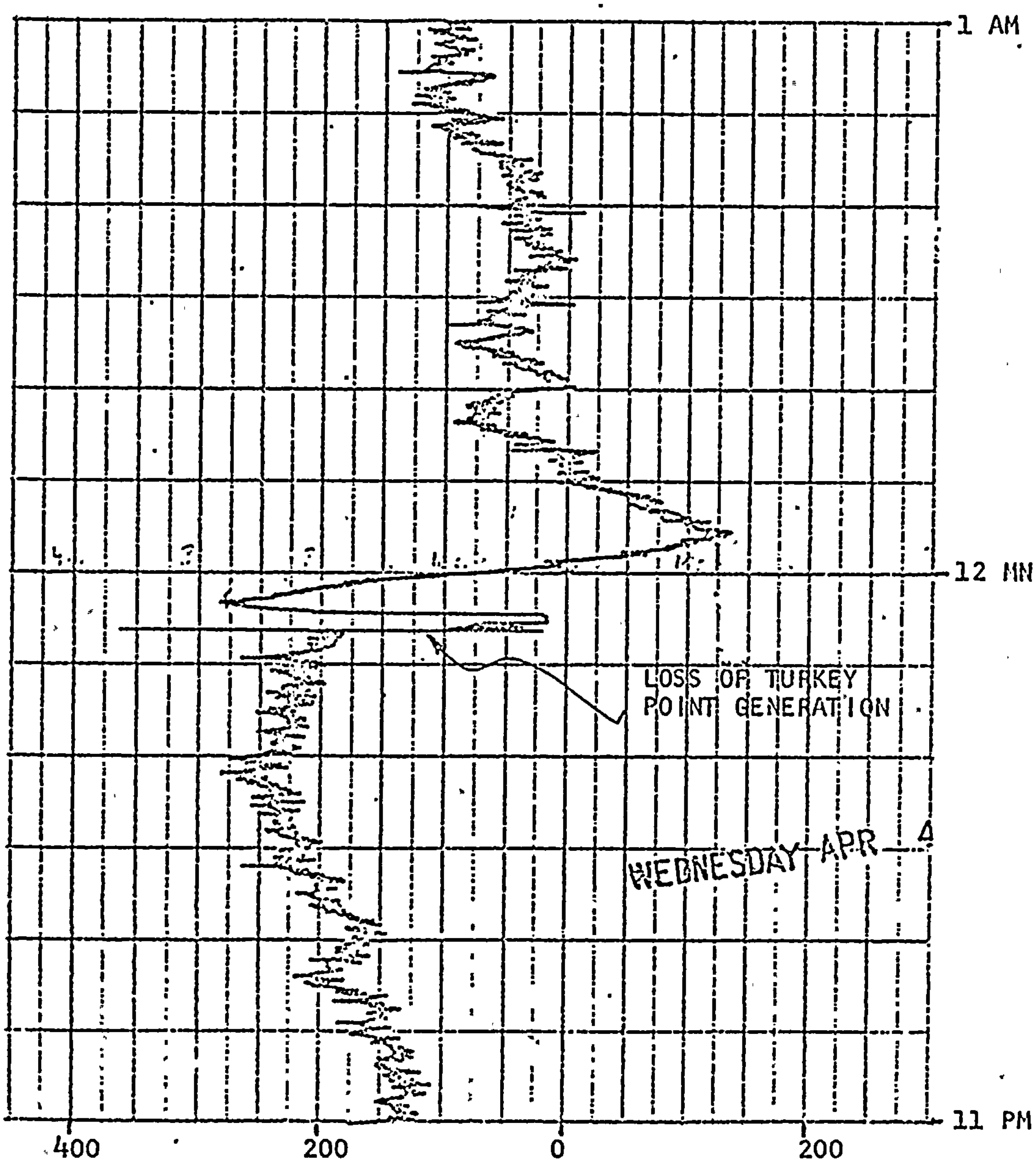


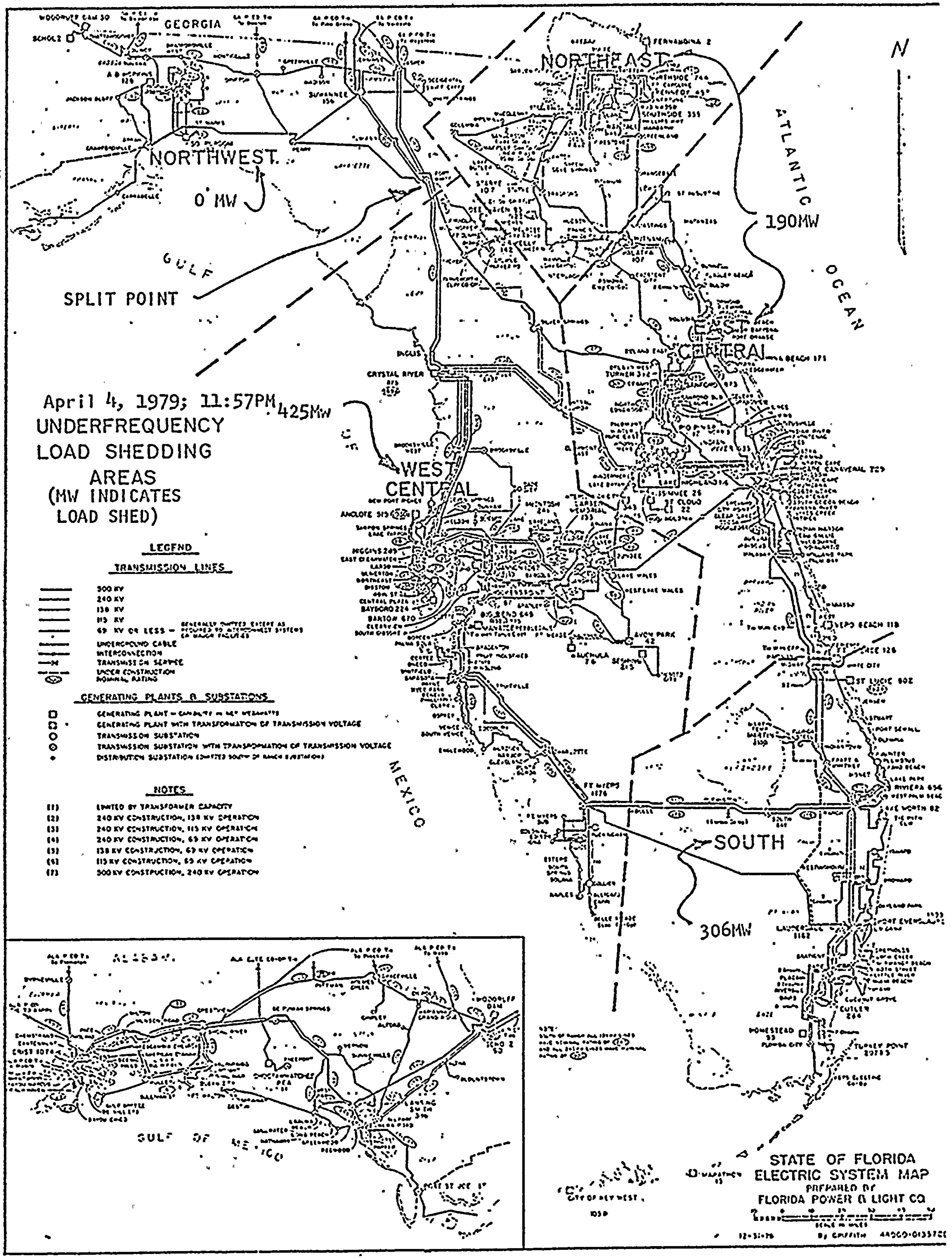
FPL System Generation
Wednesday, April 4, 1979
7000
6000
5000
4000
3000
2000
MW
LOSS OF TURKEY POINT GENERATION
11PM
12MN
1AM

FLORIDA POWER & LIGHT
NET INTERCHANGE
APRIL 4/5, 1979



SOUTHERN COMPANY
NET INTERCHANGE
APRIL 4/5, 1979




April 4, 1979; 11:57PM
UNDERFREQUENCY
LOAD SHEDDING
AREAS
(MW INDICATES
LOAD SHED)
NORTHWEST
0 MW
NORTHEAST
190MW
EAST
CENTRAL
WEST
CENTRAL
425Mw
SOUTH
306MW
SPLIT POINT
GEORGIA
GULF
MEXICO
ATLANTIC
OCEAN
N
LEGEND
TRANSMISSION LINES
GENERATING PLANTS & SUBSTATIONS
NOTES
CRYSTAL RIVER
FERNANDINA
ST AUGUSTINE
PALATKA
AVON PARK
FT MYERS
CUTLER
HOMESTEAD
TURKEY POINT
SULF OF MEXICO
STATE OF FLORIDA
ELECTRIC SYSTEM MAP
PREPARED BY
FLORIDA POWER & LIGHT CO

FLORIDA POWER & LIGHT COMPANY

SYSTEM OPERATIONS | ISSUE DATE 4-25-79 | 16651

SUBJECT	SECTION
TRANSMISSION LINES - ENVIRONMENTAL EFFECTS	EMERGENCY MANUAL

SCOPE

To provide guidelines for action by System Operations in the event of abnormal environmental effects that may affect critical transmission lines, substations, and/or plant switchyards.

GENERAL RESPONSIBILITY

It is the responsibility of System Operations to advise the responsible Division Transmission and Distribution management of the need for specific maintenance action and to confirm that the actions are timely and adequate. Actions within the authority of System Operations, such as de-energizing lines and substations are to be carried out as expeditiously as practical should such environmental conditions arise.

ACTION REQUIRED

Transmission lines, substations, and plant switchyards located in high contamination areas require special attention at times due to environmental conditions and require specific actions such as:

1. Washing while energized.
2. De-energizing until washed.
3. De-energizing until environmental conditions change.
4. De-energizing and repair as required.

ENVIRONMENTAL CONDITIONS

Conditions that may require specific action are:

1. Salt spray as a result of wind speed and direction.
2. Dust or other contaminants, such as bird droppings.
3. Fire or smoke.
4. Heavy lightning activity.
5. Other conditions which cause unexplained relay actions.

SPECIFIC RESPONSIBILITY

Division Load Dispatcher:

- Notify the System Operator when any condition described above may affect system reliability.

System Operator:

- Notify the Assistant Manager - Power Coordination or the Manager. If immediate action is required, direct appropriate switching to alleviate equipment damage and/or system jeopardy.

  Direct the Division Load Dispatcher to notify the appropriate T&D personnel of problem.

  Log appropriate comments on the System Log (recording tape).

SUBJECT	SECTION
TRANSMISSION LINES - ENVIRONMENTAL EFFECTS	EMERGENCY MANUAL

CRITICAL CIRCUITS

The following list of circuits is considered critical and requires special consideration:

Andytown - Orange River 500kV circuit

Andytown - Broward 240kV circuit

Andytown - Lauderdale #1 - 240kV circuit

Andytown - Lauderdale #2 - 240kV circuit

Broward - Lauderdale #1 - 240kV circuit

Dade - Davis 240kV circuit

Dade - Lauderdale #1 - 240kV circuit

Dade - Port Everglades 240kV circuit

Dade - Turkey Point #1 - 240kV circuit

Dade - Turkey Point #2 - 240kV circuit

Davis - Flagami 240kV circuit

Davis - Turkey Point #1 - 240kV circuit

Davis - Turkey Point #2 - 240kV circuit

Davis - Turkey Point #3 - 240kV circuit

Flagami - Lauderdale 240kV circuit

Flagami - Turkey Point #1 - 240kV circuit

Flagami - Turkey Point #2 - 240kV circuit

Ft. Myers - Orange River #1 - 240kV circuit

Ft. Myers - Orange River #2 - 240kV circuit

Indiantown - Midway 240kV circuit

Indiantown - Pratt & Whitney 240kV circuit

Laudania - Lauderdale 240kV circuit

Laudania - Port Everglades 240kV circuit

Lauderdale - Port Everglades #1 - 240kV circuit

Lauderdale - Port Everglades #3 - 240kV circuit

Malabar - Midway #1 - 240kV circuit

Malabar - Midway #2 - 240kV circuit

Midway - Ranch 240kV circuit

Midway - St. Lucie #1 - 240kV circuit

Midway - St. Lucie #2 - 240kV circuit

Midway - St. Lucie #3 - 240kV circuit

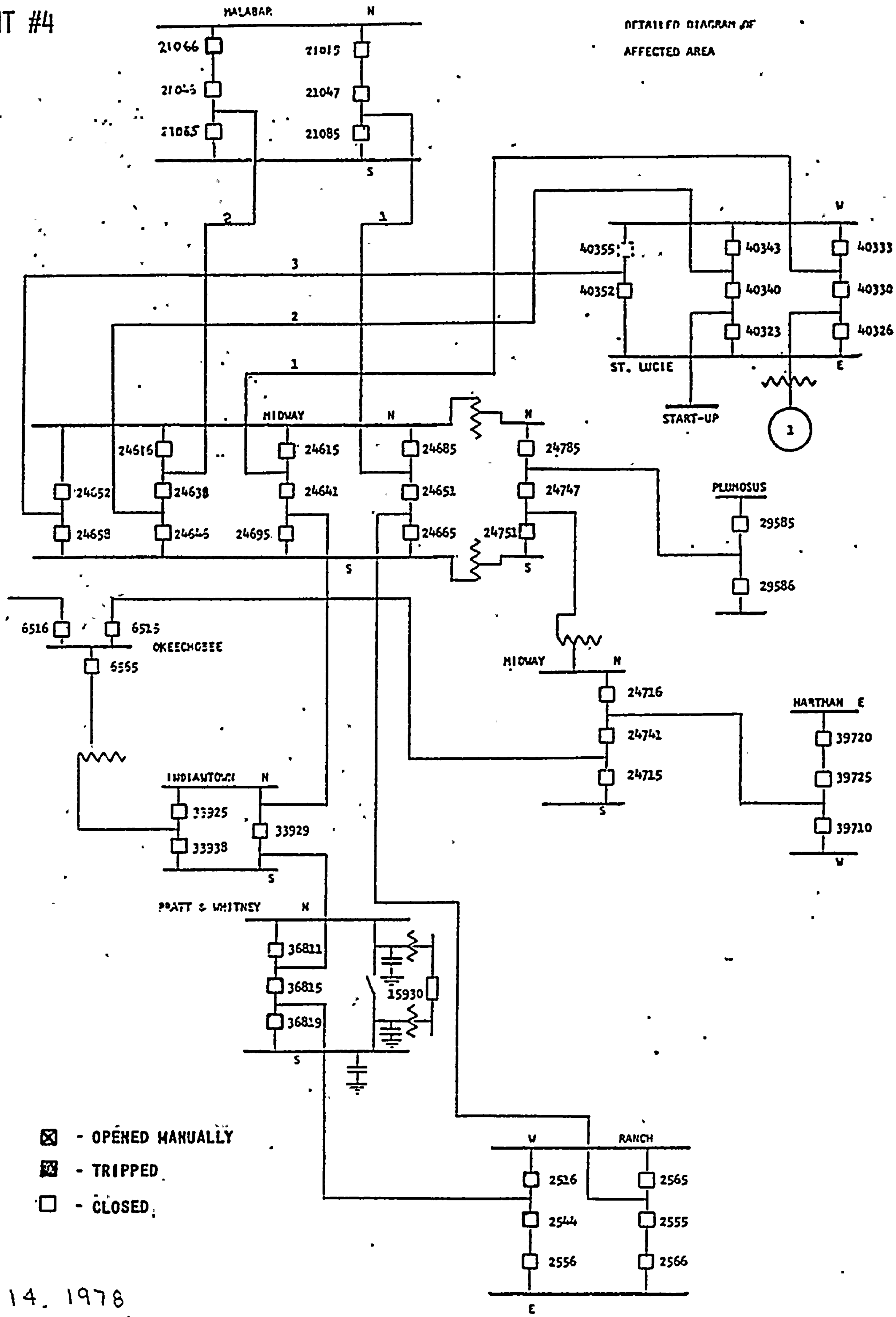
CRITICAL CIRCUITS (CONT)

Orange River - Ranch 240kV circuit
Pratt & Whitney - Ranch #2 - 240kV circuit

APPROVAL: R L Taylor DATE: 5-4-79
Manager - System Operations

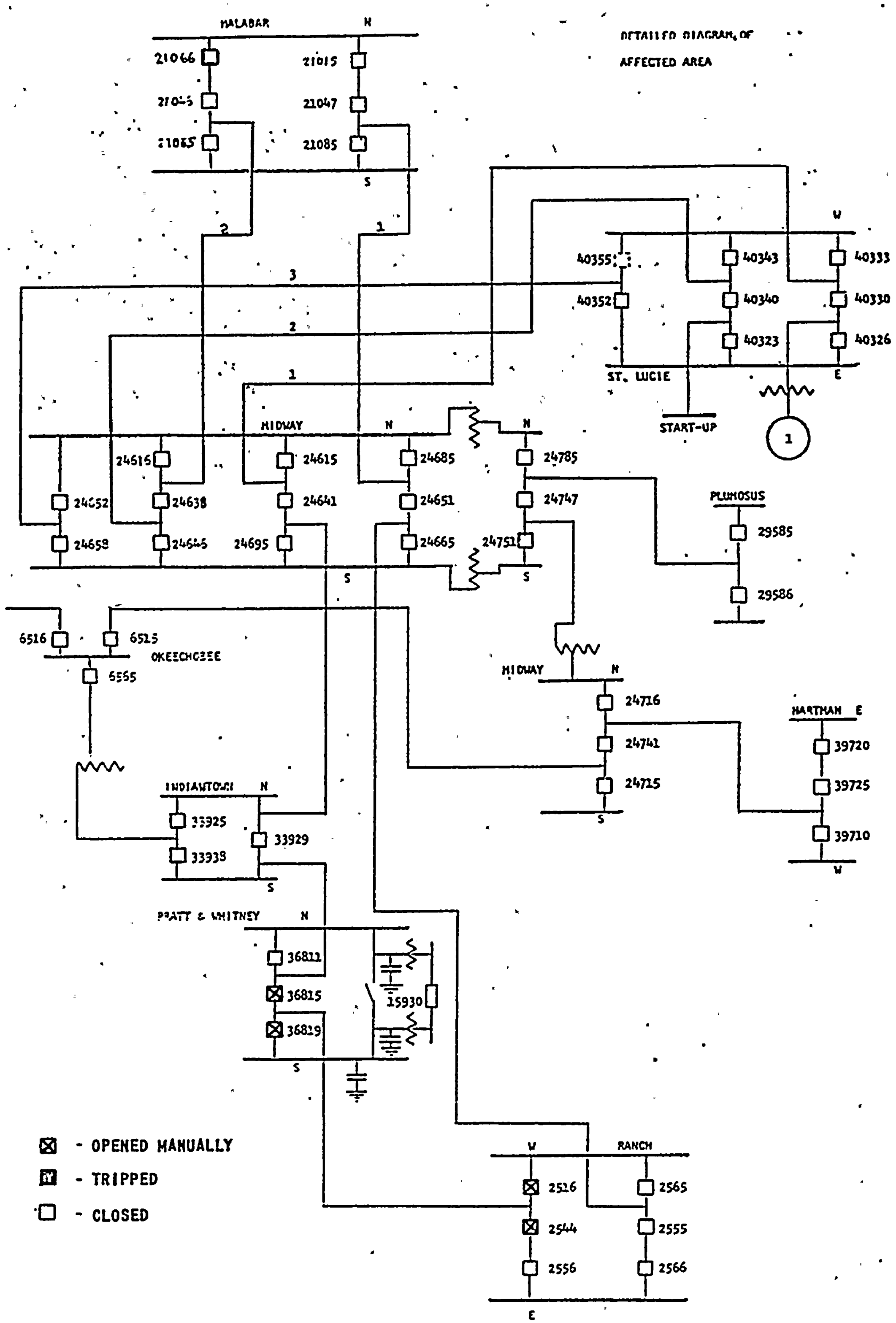
APPROVAL: [signature] DATE: 5-11-79
Director - Power Supply

ATTACHMENT #4



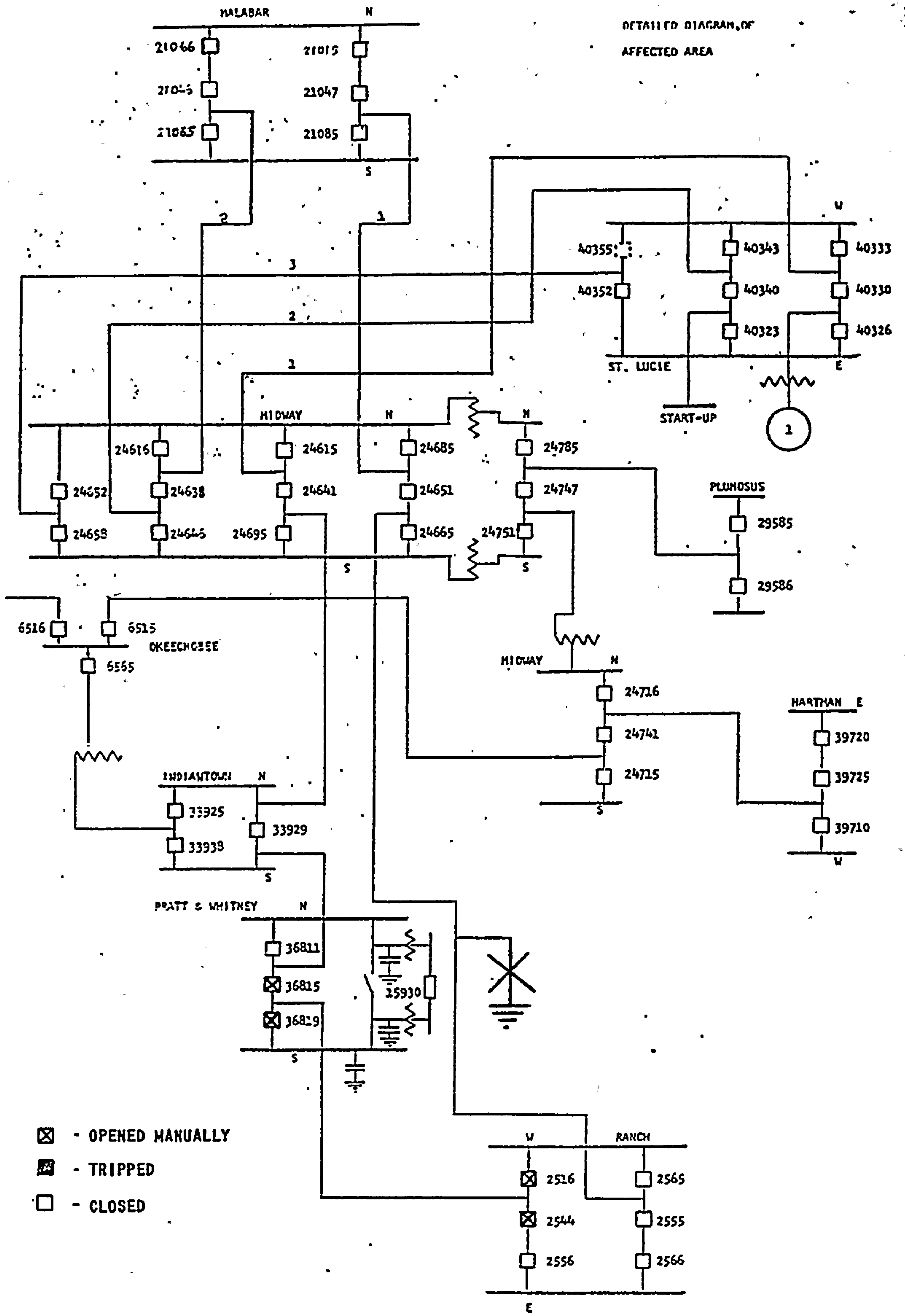
MAY 14, 1978
EXISTING CONDITIONS
PRIOR TO SYSTEM DISTURBANCE

FIGURE I



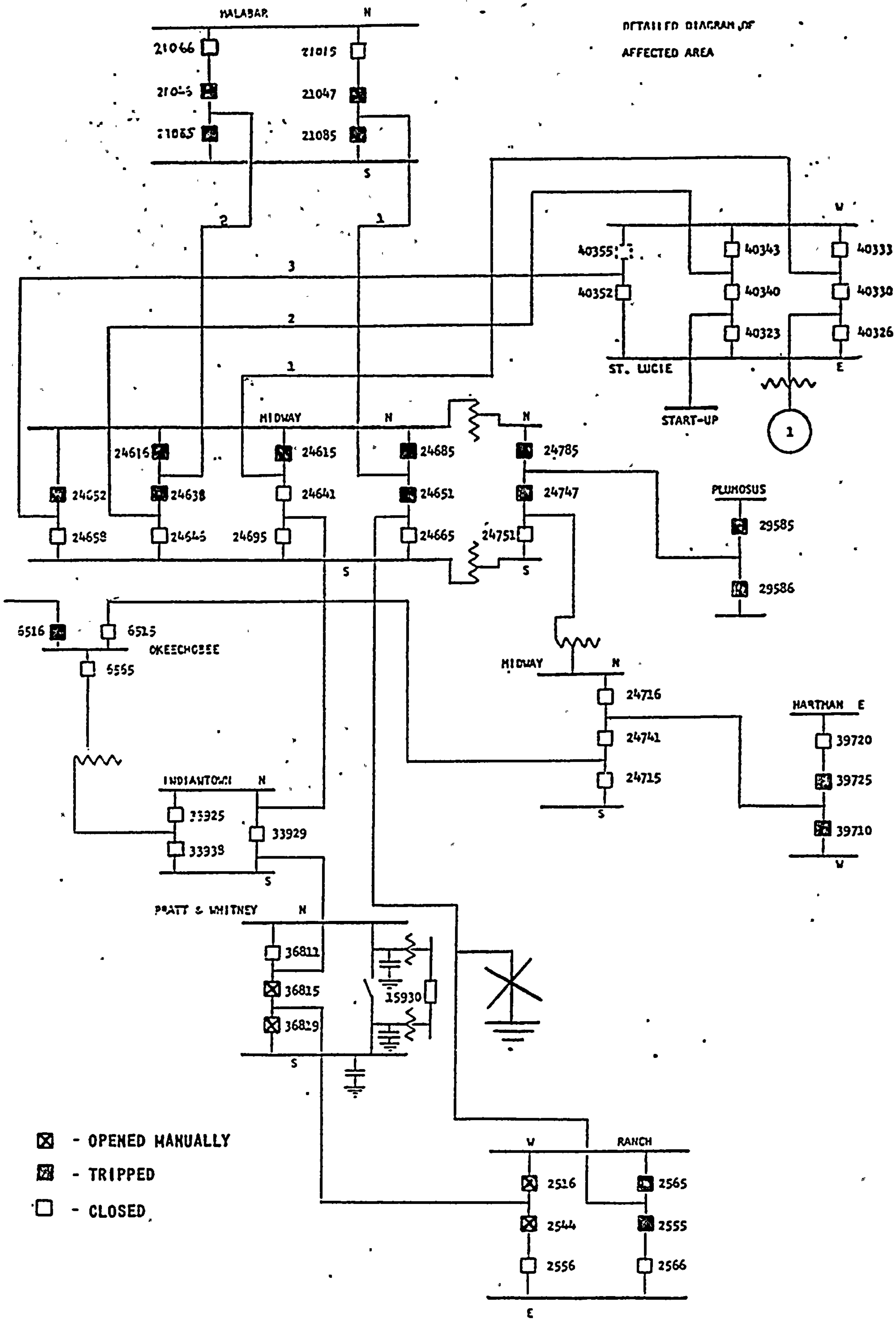
EVENT I

FIGURE 2



EVENT II

FIGURE 3



EVENT III

FIGURE 4

ATTACHMENT #5

An analysis was performed on the contingency of the loss of both Midway 240 kV busses. The end result of the loss of both busses with a breaker and a half scheme is that the breakers connected to the busses are open and the lines coming into the substation only connect to the mid-breaker and continue on out again. Specifically at Midway, after the loss, there would be four lines that would pass through the Midway mid breakers:

1. St. Lucie-Midway-Sherman 230 kV
2. Malabar-Midway-St. Lucie 230 kV
3. St. Lucie-Midway-Indiantown 230 kV
4. Malabar-Midway-Ranch 230 kV

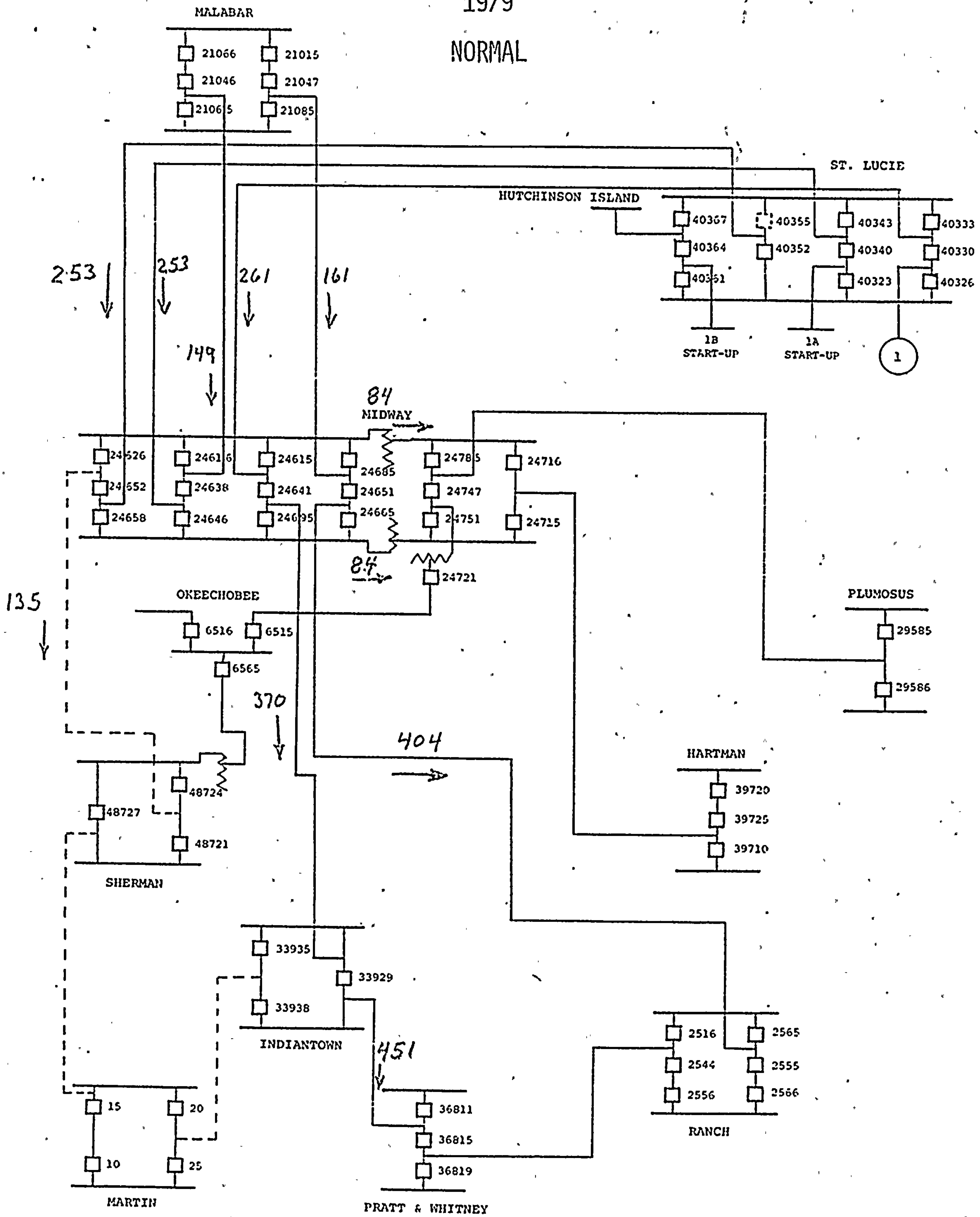
Of these four lines, one connects St. Lucie to the north, two connect St. Lucie to the south, and a fourth passes by with no connection to St. Lucie.

A loadflow study was performed to test what distribution of power flow would result if the loss of both busses occurred at the time of peak summer 1979 load with the St. Lucie #1 unit in service.

Two loadflows were run, (normal and with the loss of both busses) and the pertinent flows were plotted on the attached maps. These plots show that no line overloads would be expected and the St. Lucie 240 kV bus is still connected to both the north and south.

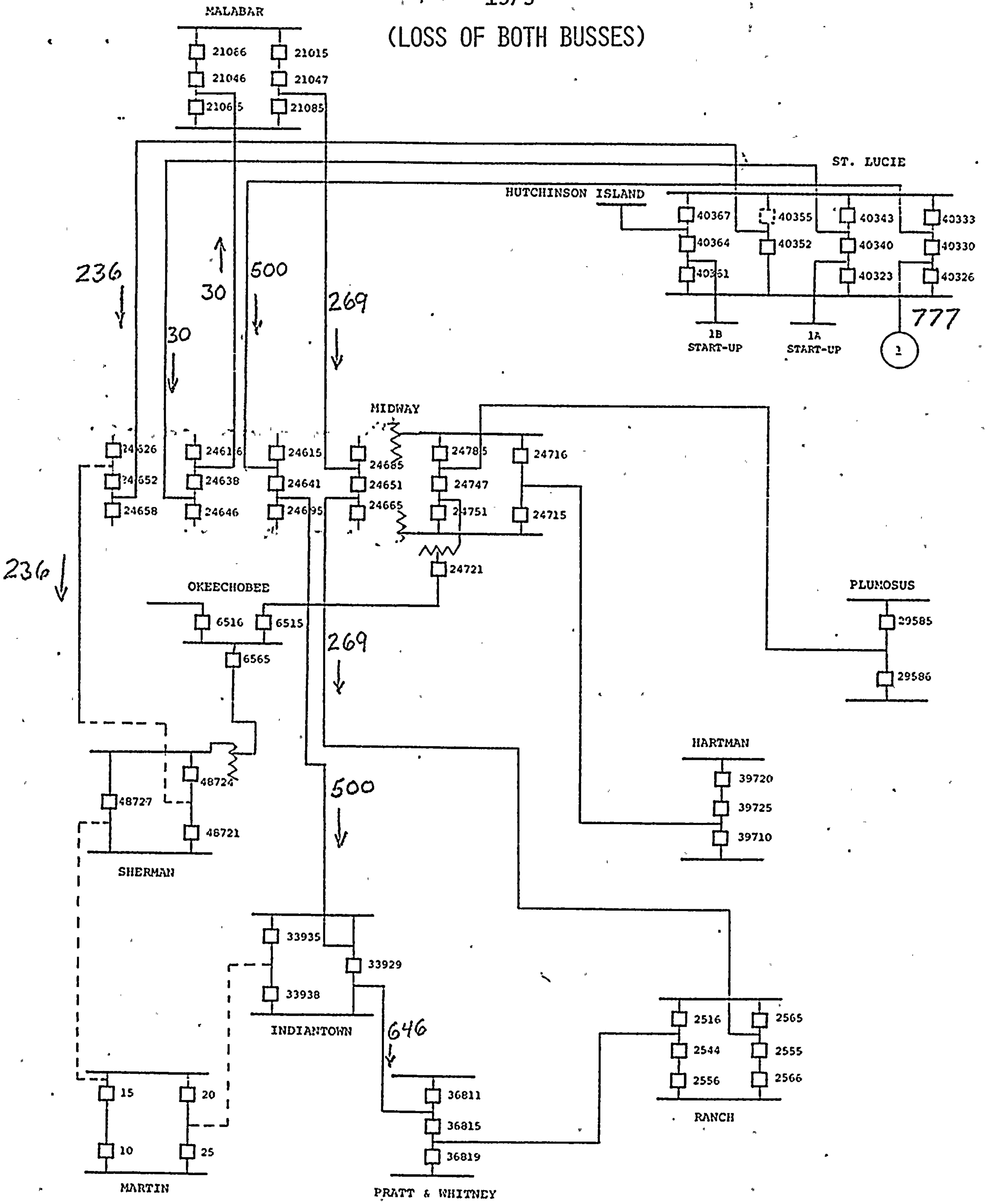
1979

NORMAL

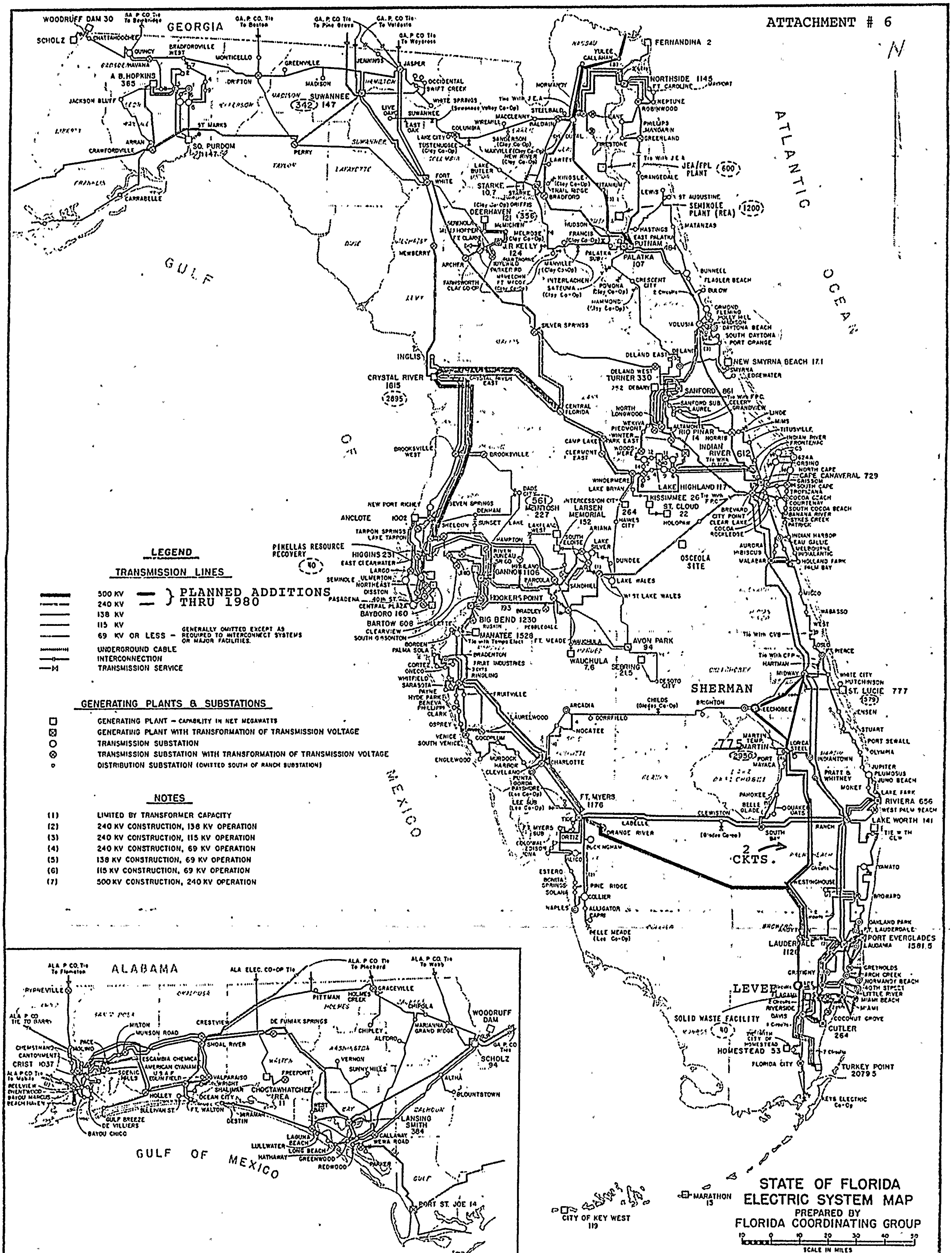


MALABAR
21066
21015
21046
21047
21065
21085
ST. LUCIE
HUTCHINSON ISLAND
40367
40355
40343
40333
40364
40352
40340
40330
40351
40323
40326
1B
START-UP
1A
START-UP
1
2.53
253
261
161
149
84
MIDWAY
24626
24616
24615
24685
24785
24716
24652
24638
24641
24651
24747
24658
24646
24695
24665
24751
24715
84
24721
135
OKEECHOBEE
6516
6515
6565
370
404
PLUMOSUS
29585
29586
HARTMAN
39720
39725
39710
48724
48727
48721
SHERMAN
33935
33929
33938
INDIANTOWN
451
36811
36815
36819
PRATT & WHITNEY
RANCH
2516
2565
2544
2555
2556
2566
15
20
10
25
MARTIN

1979
(LOSS OF BOTH BUSSES)



ATTACHMENT # 6



SUBJECT	SECTION
Area Protection	EMERGENCY MANUAL

SCOPE

There are modifications to dispatching steps required in order to maintain a reliable power system. This procedure outlines these steps.

SOUTH FLORIDA AREA BOUNDARY

The boundary for protecting the South Florida load area is:

1- Malabar-Midway 240kV lines.
2- Malabar-West 138kV line.
3- Ft. Myers-S. Bay 138kV line.
4- Ft. Myers-Ranch 240kV line.
5- Andytown-Orange River 500kV line.

TRANSFER LIMITS

Add

The transfer limits are to provide for protection in the South Florida area for the reasons listed below. Area spinning reserve will allow an additional import on a megawatt for megawatt basis.

1) Loss of largest unit in south and east load areas, immediately followed by,

2) Loss of largest east-west line due to a fault (500kV line if in service).

<u>Andytown-Orange River 500kV line in service:</u>

For loss of the largest generating unit in the south and east areas:

Rev

Largest unit on line + present import - Spinning reserve = 1500 MW

<u>Andytown-Orange River 500kV line out of service:</u>

For loss of the largest generating unit in the south and east areas:

Rev

Largest unit on line + present import - Spinning reserve = 1200 MW

SUBJECT	SECTION
Area Protection	EMERGENCY MANUAL

DISPATCH STEPS

CONDITION GREEN *exists for normal operation.*

1. Follow the normal dispatching steps until the transfer limit is reached. Area spinning reserve will allow an additional import on a megawatt for megawatt basis.

2. Maintain area limit with GT operation. Provide system regulation with generating units north of boundary.

CONDITION BLUE *exists when the area reserve capacity and import cannot cover the loss of the largest unit on line.*

3. Purchase schedule "A" or "B" power as appropriate. Run Port Everglades and Turkey Point Diesels.

4. Exceed limit by adding spinning reserve on a megawatt for megawatt basis. Limit to 200 MW step zero.

CONDITION YELLOW *exists when not able to maintain spinning reserve within the area or import spinning without exceeding dispatch limits.*

Additional import should be on the west-east lines rather than the Malabar-Midway lines as long as the 500kV is in service.

5. Peak GT's in area with additional spinning on step zero.

6. Peak steam units in area.

CONDITION RED *exists when load reduction measures are in effect. (Voltage reduction, curtailing load, or feeder dropping.)*

7. Voltage reduction.

8. Reduce load.

APPROVAL: R L Taylor DATE: 6-1-78
Manager - System Operations

APPROVAL: W. E. Poe DATE: 6-1-78
Director - Power Supply

SUBJECT: Emergency Codes

SECTION: EMERGENCY MANUAL

SCOPE

Power Supply conditions are identified by color codes to assist in a general understanding of system conditions.

CODES

Green	Normal condition. Reserve generation capacity available to back up loss of largest unit. No transmission limitations.
Blue	Alarm condition. Reserve generation capacity not available to back up loss of largest, or transmission limitation may limit use of reserve, or imminent extreme loads expected due to weather change.
Yellow	Critical condition. Operating reserve nearly exhausted. Not able to maintain spinning reserve. Imminent possibility of load curtailment or voltage reduction.
Red	Interruption condition. Customer interruption in effect. Emergency load control procedures in progress. Blackout restoration in progress.

OPERATION ACTION

The following actions are to be taken by System Operation personnel.

Condition Green - Normal, no action required.

Condition Blue - Notify Assistant Manager and Manager. Normal - full staffing in divisions and System Control Center. Teletype messages are sent to Division/Plants affected stating concern. Notify Director - Power Supply by Assistant Manager or Manager. Plant and/or transmission maintenance work curtailed as necessary.

Condition Yellow - Emergency manning of Divisions and System Control Center. Notification of Assistant Manager, Manager, and Director - Power Supply of condition. Teletype messages are sent to Division/ Plants affected stating concern. Some substation manning may be required (Non-supervisory controlle[illegible] Extra crews called as required. Communications Center manned (minimum).

Condition Red - Interruption of service in effect. Emergency manning required in Divisions and System Control Center. Communications Center manned fu[illegible] Restoration procedures in effect. Emergency communications in effect, updated as required.

APPROVAL: R L Taylor DATE: 5-16-78
Manager - System Operations

APPROVAL: W. E. [illegible] DATE: 5-15-78
Director - Power Supply

ATTACHMENT 8

Restoration Time of Offsite Power

Since FPL's first nuclear plant became operational in 1972 until the present, there have been four major system disturbances which resulted in the loss of offsite power to power plants. Table 1 tabulates the restoration times encountered in each instance.

TABLE 1

Restoration Times Minutes

Power Plant	April 3, 1973 Disturbance	April 4, 1973 Disturbance	May 16, 1977 Disturbance	May 14, 1978 Disturbance
Cutler	30	40	--	--
Ft. Lauderdale	17	13	31 & 9 & 20	--
Port Everglades	22	43	15 & 17	--
Riviera	--	30	32 & 17	--
St. Lucie	--	--	1* & 17	8
Turkey Point	20*	23 & 43	53 & 77 Min	--

*Restored offsite power to station buss though Plant Operator elected to remain on diesel power.

A statistical analysis of these restoration times determined that FPL has had a mean restoration time of 26.27 minutes with a standard error of 3.65 minutes. Using the student t distribution for 21 degrees of freedom (sample 22-1), there is only a .005 probability that the restoration time will exceed 36.6 minutes. Conservatively, we have therefore chosen a mean restoration time of 37 minutes as being representative of our grid.

SUBJECT	SECTION
System Restoration - Area	EMERGENCY MANUAL

SCOPE

To provide guidelines for system restoration where a portion of the power system is still connected to the interconnected system.

GENERAL

1. Inform the Division Load Dispatchers of blackout and instruct them not to close any lines until the boundaries of the blackout area have been determined.

2. Maintain off-site power to the nuclear plants if at all possible.

3. In reenergizing system, protect FPL and customer equipment from damage.

4. Maintain control of system conditions during restoration.

5. If possible, restore system from the interconnected system.

6. In reenergizing portions of the blacked out system, try to limit the frequency dip to a maximum of 0.1 Hz on each step of load pick up.

7. Avoid energizing high voltage cables at the end of a long, lightly loaded system.

RESTORATION PROCEDURE

Energize in a step by step "ladder" sequence from the energized system to each bulk station load center.

1. At the bulk station that is to be energized:

    a. Open all high voltage line terminals that feed "beyond" the bulk station.

    b. Open all subtransmission line terminals.

2. Close the breaker at the station in the "energized" system to energize the high voltage line and the "bulk" station.

3. Close the necessary subtransmission terminals to pick up "radial" load to load the high voltage transmission line to more than "surge impedance loading".

    a. An example of a "radial" load could be a 138kV line serving several substations with the far terminal opened.

RESTORATION PROCEDURE (cont)

b. "Surge impedance loading" is the load which prevents a rise in voltage on a lightly loaded transmission line. The MW values for various line voltages are:

LINE VOLTAGE KV	SURGE IMPEDANCE LOADING MW
500	625
240	144
138	48
115	33
69	12

4. Close a second high voltage tie from the original energized system to the "bulk" station.

5. Pick up additional "radial" load to load both high voltage lines to "surge impedance loading", if possible.

This "bulk" station is now part of the energized system. Now proceed to energize the next "bulk" station in a similar manner.

This could result in the high voltage transmission being tied together serving the "bulk" stations and "radial" subtransmission lines out of the "bulk" stations. Once most of the load has been picked up, the subtransmission can be restored to a normal arrangement.

APPROVAL: R L Taylor DATE: 4-21-78
Manager - System Operations

APPROVAL: W. E. Roe DATE: 4-21-78
Director - Power Supply

SUBJECT: SYSTEM RESTORATION - TURKEY POINT

SECTION: EMERGENCY MANUAL

SCOPE

To provide a specific switching guide for a statewide blackout in order to restore off site power to Turkey Point Plant from the Lauderdale Plant and Port Everglades Gas Turbines.

GENERAL

Refer to Procedure 16601 for general guidelines.

RESTORATION OF GAS TURBINES

For a statewide blackout the Port Everglades and Lauderdale Gas Turbines are to be restored by using the Independent Start Procedure #16612.

EMERGENCY AUXILIARY POWER TO LAUDERDALE STEAM PLANT

The next step would be to provide emergency auxiliary power to Lauderdale Steam Plant following Procedure #16611.

RESTORATION OF 240KV LINES TO TURKEY POINT

The restoration of 240kV to Turkey Point is to be done carefully not to exceed the capability of the generation available. Surge impedance loading is to be followed in order to maintain a proper voltage profile on the restored part of the system.

PROCEDURE

1. Open all 240kV and 138kV breakers at Lauderdale Plant, Port Everglades Plant, and Laudania.
2. At Lauderdale, close 240W1146 - energized E. 240kV bus and auto.
3. Close 240W1076 - energizes Laudania 240kV line.
4. At Laudania, close 240W43414 - energizes Port Everglades line.
5. At Port Everglades, close 240W19058 - energizes South 240kV bus and auto.
6. Synchronize Port Everglades GT's and close 240W35140, tieing Port Everglades GT's to Lauderdale Site 2 GT's together.
7. At Flagami, open all 240kV and 138kV breakers.
8. At Lauderdale, close 240W1092 - energizes Flagami 240kV line.
9. At Flagami, prepare the 138kV system to pick up approximately 144 MW of load in stages to coordinate with the available GT generation.

PROCEDURE (CONT.)

10. Close 240W28565 - energizes North 240kV bus, auto and 138kV bus.

11. Pick up approximately 144 MW of radial load at Flagami. The Riverside 138kV lines energized up thru Airport and into Miami thru the Lawrence cable is the preferred restoration path.

12. At Turkey Point, open all 240kV breakers.

13. At Flagami, proceed by closing 240W28545 - energizes the Turkey Point #2 line.

14. At Turkey Point, close 240W26534 - energizes the Unit #3 startup, NE bus and Unit #1 and #2 startup.

15. Close 240W26522 - energizes Unit #4 startup and SE bus.

APPROVAL: [signature] DATE: 4-24-79
Manager - System Operations

APPROVAL: [signature] DATE: 4-25-79
Director - Power Supply

SUBJECT	SECTION
SYSTEM RESTORATION - ST. LUCIE	EMERGENCY MANUAL

SCOPE

To provide a specific switching guide for a statewide blackout in order to restore off site power to St. Lucie Plant from the Lauderdale Plant and Port Everglades Gas Turbines.

GENERAL

Refer to Procedure #16601 for general guidelines.

This is a continuation of the restoration of off-site power to the nuclear units. See Procedure #16602.

PROCEDURE

1. Open, if not already open, all 240kV and 138kV breakers at Ranch, Midway, Pratt & Whitney, Indiantown, and St. Lucie.
2. Close 240W1080 - energizes the Ranch 240kV line.
3. At Ranch, close 240W2556 - energizes E 240kV bus.
4. Close 240W2544 - energizes the Pratt & Whitney 240kV line.
5. At Pratt & Whitney, close 240W36815 - energizes the Indiantown line.
6. Close 240W36819 - picking up the Pratt & Whitney load.
7. At Indiantown, close 240W33929 - energizes the Midway 240kV line.
8. At Midway, close 240W24641 - energizes the St. Lucie #1 240kV line.
9. At St. Lucie, close 240W40333 - energizes the West 240kV bus.
10. Close 240W40367 - energizes Hutchison Island Substation.
11. Close 240W40364 - energizes the startup transformer 1B.
12. Close 240W40361 - energizes the East 240kV bus.
13. Close 240W40323 - energizes the startup transformer 1A.

APPROVAL: [signature] DATE: 4-24-79
Manager - System Operations

APPROVAL: [signature] DATE: 4-24-79
Director - Power Supply

SUBJECT	SECTION
Plant Protection - Blackout	EMERGENCY MANUAL

SCOPE

To provide a basic understanding as to procedures to be followed at power plants following a major system disturbance.

PROTECTION

After a system disturbance that isolates individual plants from the energized transmission system, it is essential that first, the generating units be protected, and second, that they be ready to come back on the line as soon as possible.

RELIABLE AUXILIARY POWER

Those units that were tripped by low frequency relays and are supplying their own auxiliary power should be kept in that condition, if possible. Care must be taken, however, to insure that 60 Hz power is being supplied to the auxiliary equipment. In a system disturbance of this magnitude the unit auxiliary power is the most stable source of power to the unit and should be kept until such time as a reliable source of start-up power is assured.

DIESELS

Those units that tripped and were not able to supply their auxiliary power should be secured in such a way as to protect them until a source of start-up power can be supplied. The diesel unit at Port Everglades is required for any units at these locations. Start-up of these units should be based on the availability of start-up power and the re-establishment of the transmission system.

INDEPENDENT START

Protecting the gas turbine units at Port Everglades and Lauderdale can be accomplished by initiating "Independent Start". "Independent Start" will be performed by plant personnel without instructions from System Operations in the event of a total power failure at the location. See procedure #16612.

APPROVAL: R L Taylor DATE: 4-21-78
Manager - System Operations

APPROVAL: W. E. [illegible] DATE: 4-24-78
Director - Power Supply