

FLORIDA POWER & LIGHT COMPANY

**ST. LUCIE PLANT
UNIT NO. 2**

ENVIRONMENTAL REPORT

VOLUME NO. 1

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General-1	Complete, see Section 5.1.1, pages 5.1-1 thru 5.1-25, RO	
General-2	Complete, see Section 5.1.1, pages 5.1-1 thru 5.1-25, RO	
General-3	Complete, see Section 5.1.1, pages 5.1-1 thru 5.1-25, RO	
General-4	Complete, see Section 5.1.1, pages 5.1-1 thru 5.1-25, RO	
A-1	Complete, see Section 2.1, page 2.1-1, RO	
A-2	Complete, see Section 2.1, Figure 2.1-6	1
A-3	Complete, see Section 2.2, pages 2.2-1, 2.2-7a	1
A-4	Complete, see Section 2.2.3, pages 2.2-15 & 16, RO	
A-5	Complete, see Section 2.2.3, pages 2.2-15 & 16, RO; and Section 2.5.1, page 2.5-3, RO	
A-6	Complete, see Section 2.5.1, page 2.5-2, RO	
A-7	Complete, see Section 2.2.3, pages 2.2-15 & 16, RO	
A-8	Complete, see Section 2.6.1, page 2.6-1, RO	
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A-12	Complete, see Section 2.6 and 6.2, pages 6.2-8-8e	1
A-13	Complete, see Section 6.1.3.1, pages 6.1-4 and 5, RO	
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A-18	Complete, see Section 2.7.3.5, page 2.7-6, RO	
A-19	Complete, see DNR reports submitted by letter October 1, 1973	1
A-20	Complete, see Section 2.7.5.9, page 2.7-16, RO	
A-21	Complete, see Section 2.7.5.9, page 2.7-14, RO, page 2.7-16, RO	
A-22	Complete, see Section 2.7.3.4, pages 2.7-4 and 5, RO	
A-23	Complete, see DNR reports submitted by letter October 1, 1973	1
A-24	Complete, see Section 2.8, pages 2.8-1 & 2, RO	
B-1	Complete, see Section 3.3, pages 3.3-1, 3.3-2 and Figure 3.3-1	1
B-2	Complete, see Section 3.4, pages 3.4-1, 3.4-2, 3.4-3	1
B-3	Complete, see Section 3.4, pages 3.4-3a, 3.4-4	1
B-4	Complete, see Section 3.4, pages 3.4-1, 3.4-2 3.4-3	1

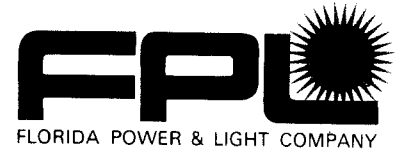
<u>Question</u>	<u>Status</u>	
B-5	Complete, see Section 5.1, pages 5.1-3, 5.1-3a	1
B-6	Complete, see Section 5.3.4	2
B-7	Complete, see Figure 3.5-16, RO	
B-8	Complete, see Section 3.6, pages 3.6-3, 3.6-3a	1
B-9	Complete, see Section 3.6.5, page 3.6.5, RO	
C-1	Complete, see Section 4.1 page 4.1-4 and Section 5.4 page 5.4-2	1
C-2	Complete, see Section 4.1.2, pages 4.1-1 and 2, RO	
D-1	Complete, see Section 5.3 Table 5.3-11	1
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D-2e	Complete, see Section 5.1.2, pages 5.1-26 & 27, RO	
D-2f	Complete, see Section 3.6, page 3.6-5 and Section 5.4 page 5.4-2	1
D-2g	Complete, see Section 3.6, page 3.6-5, Section 5.4, page 5.4-2	1
D-3	Complete, see Section 5.1, pages 5.1-31, 5.1-32	1
D-4	Complete, see Section 6.1.1.1, page 6.1-2, RO	
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D-7b	Complete, see Section 5.3.4	2
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D-8a	Complete, see Table 5.3-2, page 5.3-15, RO	
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D-8c	Complete, see Section 5.3.1.2, pages 5.3-3 & 4	
D-8d	Complete, see Section 2.2, pages 2.2-4 and 2.2-5	1
D-9	Complete, see Section 5.3.1.4, pages 5.3-4 thru 5.3-8, RO	
D-10	Complete, see Section 5.3.4	2
D-11	Complete, see Section 5.4.1, pages 5.4-1 and 2, RO	
D-12	Complete, see Section 5.8, pages 5.8-1 and 2, RO	
E-1	Complete, see Section 6.1.1.1, page 6.1-2, RO	
E-2	Complete, see Section 5.3, page 5.3-9	1
E-3	Complete, see Section 6.3, pages 6.3-2 thru 6.3-7	1
E-4	Complete, see Section 6.2.4, page 6.2-8, RO	
F	Complete, see Section 7.2 pages 7.2-1, 7.2-2	1
G-1	Complete, see Section 9.1.2.1, pages 9.1-2, RO and 9.1-6, RO	
G-2	Complete, see Section 10.1.5.7	2
G-3	Complete, see Section 9.2 pages 9.2-1 thru 9.2-3	1
G-4	Complete, see page 9.2-2a	2
G-5	Complete, see Section 9.3 pages 9.3-1 thru 9.3-2a	1

<u>Question</u>	<u>Status</u>	
H-1	Complete, see Section 10.1, Table 10.1.3 and pages 10.1-5, 10.1-5a.	1
H-2	Complete, see Section 10.1.5.5	
H-3	Complete, see Section 10.1, pages 10.1-5, 10.1-5a	1
H-4	Complete, see Section 10.1, Table 10.1-3	1
I	Complete, see Section 12.0, pages 12.0-3, 12.0-4	1
J	Complete, see Appendix 3A, pages 3A-1-3A-16	1

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<u>Question</u>	<u>Status</u>
1	Complete, see Section 5.7.2
2	Complete, see Section 3.4
3	Complete, see Figure 3.7-2
4	Complete, see Figure 3.7-1
5	Complete, see Section 3.7 and Section 10.6.5
6	Complete, see Section 6.1.3.3 and Table 6.1-6
7	Complete, see Section 4.1.6
8	Complete, see Section 10.1 and Table 10.1-4
9	Complete, see Section 9.2
10.a	Complete, see Section 11.2.2
10.b	Complete, see Section 1.1.2.2
10.c	Complete, see Section 9.2
10.d	Complete, see Section 10.1
10.e	Complete, see Section 10.1
11	Complete, see Section 4.1
12.a	Complete, see Figure 2.1-6 and Section 2.2
12.b	Complete, see Figure 2.2-4 and page 2.2-4
12.c	Complete, see Section 2.2
13	Complete, see Section 12.0
14	Complete, see Section 4.1.4
15	Complete, see Section 4.1.4
16	Complete, see Section 2.6, page 2.6-4
17	Complete, see Section 5.3

**ENVIRONMENTAL
REPORT AMENDMENTS**



October 2, 1973

Mr. Angelo Giambusso, Deputy Director
for Reactor Projects
Directorate of Licensing
Division of Regulation
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Giambusso:

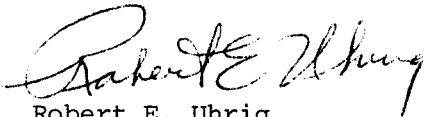
Re: St. Lucie Plant Unit No. 2
Environmental Report - Amendment 1
Docket No. 50-389

Enclosed for your review are two hundred copies of Amendment 1 to the St. Lucie Plant Unit No. 2 Environmental Report. We are holding one hundred additional copies for you that are available upon request.

Amendment 1 provides additional information requested by your letter of May 31, 1973, in the form of change pages to the Environmental Report. An instruction sheet for placement of the change pages is included as well as an update of the status sheet for the May 31, 1973, questions.

Included in the Amendment is the Radioactive Source Term Appendix. If you should have any questions concerning the Appendix, we would be pleased to meet with you at your earliest convenience.

Very truly yours,


Robert E. Uhrig
Director of Nuclear Affairs

REU:nch
Enclosure

cc: Mr. Jack R. Newman, Esq.

Mr. Richard D. Widrig
Battelle Northwest Labs
Richland, Washington 99352

APPROVED:


E. A. Adomat
Executive Vice President

STATE OF FLORIDA)
) SS
COUNTY OF DADE)

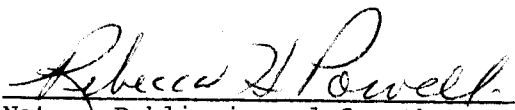
E. A. ADOMAT, being first duly sworn, deposes and says:

That he is an Executive Vice President of Florida Power & Light Company, the Applicant herein;

That he has executed the foregoing Amendment; that the statements made in this said Amendment are true and correct to the best of his knowledge, information and belief, and that he is authorized to execute the Amendment on behalf of said Applicant.


E. A. Adomat

Subscribed and sworn to before me this
2nd day of October, 1973.


Notary Public in and for the County of Dade, State of Florida

My Commission expires NOTARY PUBLIC, STATE OF FLORIDA AT LARGE
MY COMMISSION EXPIRES APRIL 2, 1976
BONDED THRU MAXNARR BONDING AGENCY



November 14, 1973

Mr. Angelo Giambusso, Deputy Director
for Reactor Projects
Directorate of Licensing
Division of Regulation
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Giambusso:

Re: St. Lucie Plant Unit No. 2
Environmental Report - Amendment 2
Docket No. 50-389

Enclosed for your review are two hundred (200) copies of Amendment 2 to the St. Lucie Unit 2 Environmental Report. We are holding one hundred (100) additional copies for you that are available upon request.

Amendment 2 provides additional information which completes all the open items of your letter of May 31, 1973 which remained after the Amendment 1 submittal. Additionally, answers to the questions transmitted via Mr. William H. Regan, Jr., Chief of Environmental Projects Branch # 4 on October 16, 1973 are completed in their entirety. An instruction sheet for placement of the change pages is included as well as an updated status sheet for all questions addressed.

Very truly yours,

Jim F. Pearson
for Robert E. Uhrig
Director of Nuclear Affairs

REU:nch
Enclosure

cc: Mr. Jack R. Newman

Mr. Richard D. Widrig
Battelle Northwest Labs
Richland, Washington 99352

APPROVED

E. A. Adomat
E. A. Adomat
Executive Vice President

STATE OF FLORIDA)
) SS
COUNTY OF DADE)

E. A. ADOMAT, being first duly sworn, deposes and says:

That he is an Executive Vice President of Florida Power & Light Company, the Applicant herein;

That he has executed the foregoing instrument; that the statements made in this said instrument are true and correct to the best of his knowledge, information and belief; and that he is authorized to execute the instrument on behalf of said Applicant.



E. A. Adomat

Subscribed and sworn to before me

this 14th day of November, 1973.



Notary Public in and for the County
of Dade, State of Florida

My Commission expires NOTARY PUBLIC, STATE of FLORIDA at LARGE
MY COMMISSION EXPIRES APRIL 2, 1976
BONDED THRU MAYNARD BONDING AGENCY



January 18, 1974

Mr. Angelo Giambusso, Deputy Director
for Reactor Projects
Directorate of Licensing
Office of Regulation
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Giambusso:

Re: St. Lucie Plant Unit No. 2
Environmental Report - Amendment 3
Docket No. 50-389

Enclosed for your review are two hundred (200) copies of Amendment 3 to the St. Lucie Unit No. 2 Environmental Report. We are holding one hundred (100) copies for you that are available upon request.

Amendment 3 provides additional information and changes which reflects recent revisions to the Unit #2 Preliminary Safety Analysis Report. An instruction sheet for placement of the change pages is included.

Very truly yours,

for A handwritten signature in cursive script, appearing to read "Robert E. Uhrig".

Robert E. Uhrig
Director for Nuclear Affairs

REU:nch
Encl.

APPROVED:

A handwritten signature in cursive script, appearing to read "E. A. Adomat".

E. A. Adomat
Executive Vice President

STATE OF FLORIDA)
) SS
COUNTY OF DADE)

E. A. ADOMAT, being first duly sworn, deposes and says:

That he has executed the foregoing instrument; that the statements made in this said instrument are true and correct to the best of his knowledge, information and belief; and that he is authorized to execute the instrument on behalf of said Applicant.

E. A. Adomat
E. A. Adomat

Subscribed and sworn to before me

this 21st day of January, 1974

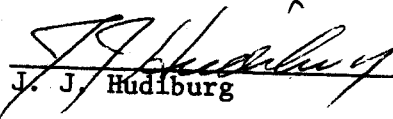
Emelyn D. Kemp
Notary Public in and for the County of Dade,
State of Florida

My Commission expires Notary Public, State of Florida at Large
My Commission Expires July 13, 1977
Bonded by American Fire & Casualty Co.

STATE OF FLORIDA)
) SS
COUNTY OF DADE)

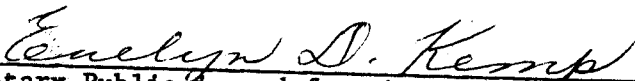
J. J. HUDIBURG, being first duly sworn, deposes and says:

That he has executed the foregoing instrument; that the statements made in this said instrument are true and correct to the best of his knowledge, information and belief; and that he is authorized to execute the instrument on behalf of said Applicant.


J. J. Hudiburg

Subscribed and sworn to before me

this 1st day of April, 1974


Notary Public in and for the County of Dade,
State of Florida

My Commission expires Notary Public, State of Florida at Large
My Commission Expires July 13, 1977
Bonded by American Fire & Casualty Co.

FLORIDA POWER & LIGHT COMPANY

COMMENTS ON THE

DRAFT ENVIRONMENTAL STATEMENT

ST. LUCIE PLANT UNIT NO. 2

APRIL 1, 1974

DOCKET NO. 50-389

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I. Introduction

Florida Power and Light Company ("FPL") hereby submits the following comments on the Draft Environmental Statement prepared by the staff of the Atomic Energy Commission with respect to the proposed St. Lucie Plant Unit No. 2 ("St. Lucie 2").

These comments are submitted by way of amendment to the Applicant's Environmental Report. The data contained herein, to the extent inconsistent with the Environmental Report ("ER"), as amended to date, is to be regarded as superseding earlier data. For ease of review these comments are organized in narrative style; specific page changes to the ER, if and as necessary, will be submitted in a subsequent amendment.

II. Proposed Conditions of the Construction Permit

Applicant has reviewed the conditions on the construction permit proposed by the AEC staff (DES, p. v); the applicant has no objections to conditions a thru h but suggests a minor modification to condition c. Each of the proposed conditions is addressed below.

(1) Measures to control raccoon predation: The DES proposes the following condition:

- "a) During construction and operation the applicant will implement strict procedures to control and dispose of edible refuse, including procedures to prevent deliberate feeding, to limit raccoon population increases with resulting increased turtle predation (Section 4.3.1)."

During plant operation the generating plant will be completely enclosed by a security barrier designed to deny or impede unauthorized access to the generating plant. This barrier, consisting primarily of fencing,

will be illuminated during darkness and will be monitored by electronic devices and patrolled by security personnel. All edible refuse generated by the operating plant will be stored within this barrier prior to sanitary disposal. The presence of the barrier, protective illumination and personnel movement in and around the barrier will substantially discourage entry of raccoons. Raccoons are not known to enter the barrier enclosing FPL's Turkey Point Nuclear Generating Plant even though the natural environment surrounding the Generating Station area included a large raccoon population.

Edible refuse is primarily generated within building areas such as the Service Building. This refuse will be collected and stored in heavy-duty bulk containers prior to sanitary disposal.

During construction, extensive barriers such as those previously mentioned which enclose an operating plant are not present. Some areas of the construction site are fenced. This fence along with the presence of personnel, lighting, and related construction activity will discourage the presence of raccoons. Edible refuse is normally deposited in metal refuse containers which are regularly emptied and the refuse disposed of in a sanitary manner. Regular policing of the construction area for trash results in the collection of any edible refuse not deposited in trash containers. Personnel are instructed to refrain from engaging in acts which would disturb the ecological balance of the area, including feeding of wildlife. Persons familiar with the construction site have been questioned, and the presence of raccoons in the construction area has not been noticed.

It is Florida Power and Light's opinion, therefore, that edible refuse generated during construction and operation will not contribute to substantive raccoon population increases. In any event, however, measures as described above, will be taken to assure the same.

(2) Restoration of Dunes: The DES proposes the following condition:

- "b) In restoring the ocean dune to its original condition after installation of the Unit 2 discharge line, the applicant will replant the dune at the earliest feasible time with dune stabilizing plants indigeneous to the area (Section 4.1). These plantings will be in addition to the applicant's planned replanting of the Australian pine light screen if disturbed."

After installation of the Unit No. 2 discharge line, FPL will restore the dune line to approximately original contours. Further, FPL will replant the restored dune with vegetation native to the area. This rapid replanting of the restored dune will reduce erosion and will speed recovery of the dune area to its undisturbed condition. In addition, FPL will plant Australian pines if the existing light screen is disturbed by Unit 2 discharge construction.

(3) Measures to Monitor Fish Entrapment: The DES proposed the following condition:

- "c) The applicant will monitor fish entrapment in the cooling canals during the time the velocity entering the intake structures is about 0.5 fps. If the entrapment rates are excessive, the applicant will take necessary action to increase the intake velocity to approximately 1 fps (Section 4.3.2)."

The Applicant plans to monitor fish entrapment in the intake canal during the first year of operation to determine the extent of fish entrapment. During this year of operation, both intake lines will be in service with either or both lines passing water at various times depending on the plant cooling water requirements and the extent of barnacle growth in the lines which may require adjusting the water velocity within the lines. Thus, the water velocity thru the intake velocity caps is expected to range between 0.5 and 1.0 fps. It is not now certain whether the lower intake water velocity will cause more or less fish to become entrapped. It should also be noted that even though fish might enter the intake canal via the intake velocity caps, they will not necessarily be impinged on the intake structure traveling screens since velocities in the canal are low, on the order of 0.5 fps.

In view of the fact that there may be more than one acceptable method of reducing fish entrapment, Applicant suggests modifying the second sentence of Condition c, to read as follows:

If entrapment rates are excessive, Applicant would take action as may be necessary to reduce entrapment to acceptable levels such as, but not limited to, increasing the water velocity through the intake caps. (Section 4.3.2)

(4) Flow control out of discharge lines: The DES proposes the following condition:

"d) The applicant will shut off the Unit 1 Y-type discharge to force all flow out the Unit 2 multiport line as soon as it becomes available and when only one unit is operating with total cooling system flow of 1150 cfs (Section 4.3.2)."

A bulkhead is presently installed across the opening to the Unit 2 discharge pipe at the headwall. This bulkhead effectively shuts off flow to the Unit 2 pipe so that construction of the line will be free from disturbances caused by the operation of the discharge canal during that period when Unit 1 is operating alone.

To preclude a condition whereby Unit 1 is operating and the single unit discharge is flowing through both discharge lines, the bulkhead will be left in place until the Unit 2 Circulating Water System is operative.

When both units are operational, the applicant will use a flow control device to divert single unit flow (only one unit operating) through the Unit 2 multiport diffuser.

Applicant does not construe condition d, to prohibit the use of the Unit 1 Y-type discharge if the multiport line is out of service for inspection, maintenance or repair; provided, however, that the discharge in such circumstances must meet applicable water quality requirements. It may be advisable to clarify condition d, in this regard.

(5) Connection to Municipal Sewer Line: The DES proposes the following condition:

- "e) The applicant will discontinue use of the present septic system and connect to a municipal sewer treatment line if and when such a line is extended to the applicant's site (Section 5.2.1)."

The distribution pipes for the leaching fields in the present septic system are at elevation +16(MLW) ocean, which is approximately 16 feet above the ground water table. Since no fresh ground water supplies are available on Hutchinson Island there exists no potential for contamination of any consumable water sources by sanitary sewage. However, participation

in available municipal sewer treatment lines, if extended to the site, is acceptable as an alternate method of disposal and will be employed if and when such a line extends to the site.

(6) Measures to Avoid Unnecessary Impacts of Construction: The DES proposes the following condition:

"f) The applicant shall take the necessary instigating action, including those summarized in Section 4.5 of this Environmental Statement, during construction of the plant to avoid unnecessary adverse environmental impacts from construction activities."

The actions summarized in Section 4.5 of the DES are, in fact, now being implemented in the construction of St. Lucie 1 and will be continued through the construction of St. Lucie 2 including such other action as may be required to avoid unnecessary environmental impacts.

(7) Control Program to Assure Compliance with Construction Permit

Conditions: The DES proposes the following condition:

"g) A control program shall be established by the applicant to provide for a periodic review of all construction activities to assure those activities conform to the environmental conditions set forth in the construction permit."

The activities in question will be conducted by Ebasco Services under the cognizance of the Construction Department of FPL and will be in accordance with the conditions set forth in the construction permit. The Construction Department's activities will be subject to a control program which is part of FPL's Quality Assurance program. The program provides for regular and periodic review of construction permit activities by at least two separate groups to assure compliance with the requirements of the construction permit. The Quality Assurance Department Construction Group is located on site and performs day to day surveillance of construction activities. The Quality Assurance Department Audit Group

performs periodic audits of all aspects of FPL nuclear activities including those of the on-site quality assurance group.

(8) Prior Written Notification to Director of Licensing: The DES proposes the following condition:

"h) Before engaging in a construction activity which may result in a significant adverse environmental impact that was not evaluated or that is significantly greater than that evaluated in this Environmental Statement, the applicant shall provide written notification to the Director of Licensing, U. S. Atomic Energy Commission."

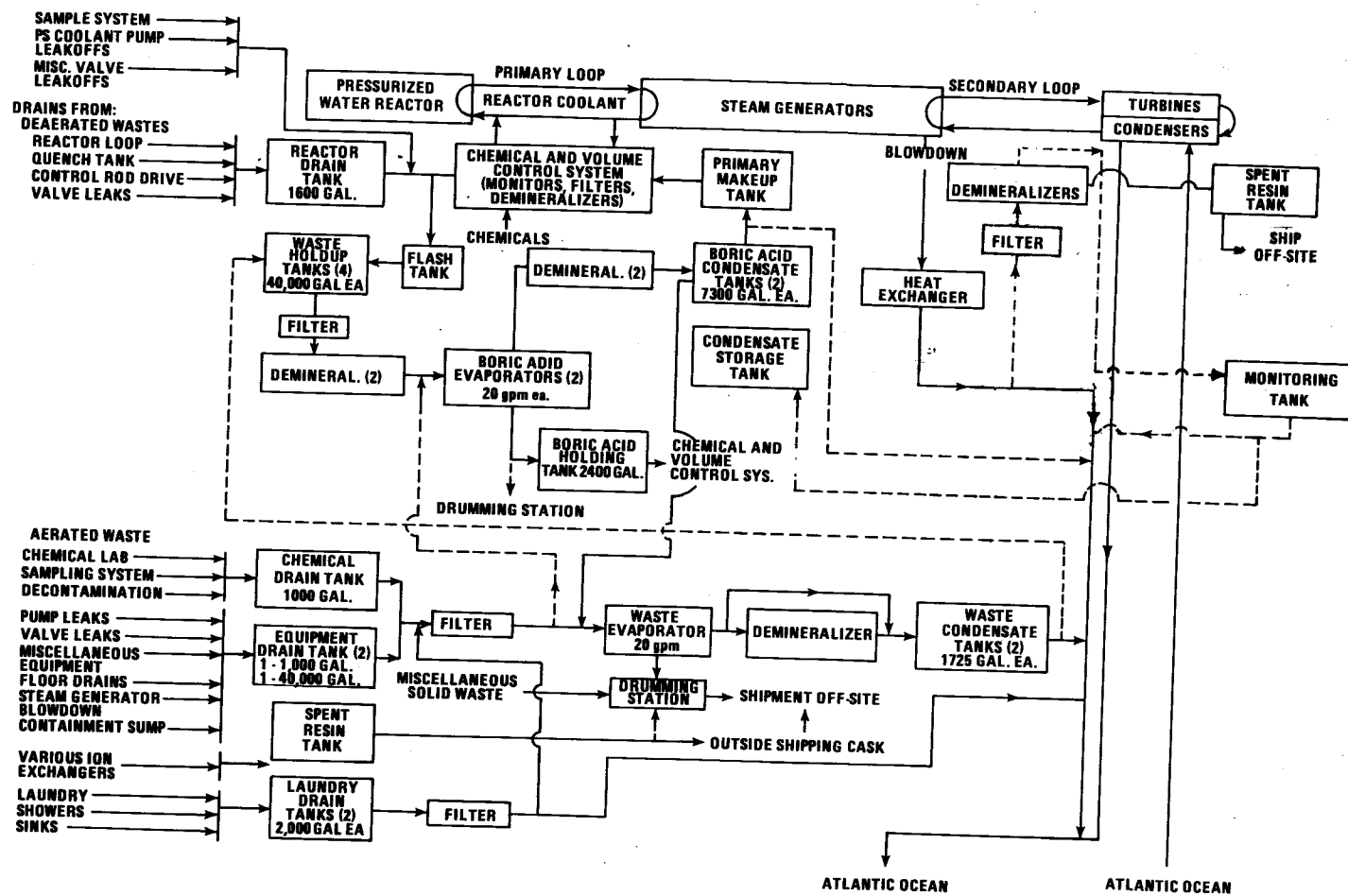
Prior to engaging in a construction activity which may result in a significant adverse environmental impact which was not previously addressed by the Staff and the Applicant in the Environmental Statements, prior written notification will be provided to the Director of Licensing, U. S. Atomic Energy Commission.

As discussed in item (7), above, quality assurance measures will be taken to ensure complete compliance with construction permit conditions.

The Quality Assurance Department's audits of all aspects of FPL nuclear activities will include audits of necessary administrative systems to assure such compliance. Among the systems to be audited will be one which will require that appropriate evaluation be performed with respect to activities that may result in a significant adverse environmental impact that was not previously evaluated or that is significantly greater than that evaluated in the Environmental Statement.

III Steam Generator Blowdown System

On page 3-24 in section 3.5.1.4, the Staff states: "The applicant has verbally committed to a separate treatment system with at least a process capability equivalent to a heat exchanger and a mixed-bed demineralizer,



FLORIDA POWER & LIGHT COMPANY
 ST. LUCIE PLANT UNITS 1 & 2

LIQUID WASTE TREATMENT SYSTEMS
 FIGURE

and will submit the proposed system for our review." The system to which Applicant now has committed formally is the system, the design of which has been submitted in Amendment 6 to the PSAR, described below.

Steam generator blowdown is utilized to maintain the total dissolved solids (TDS) content of steam generator secondary side coolant within normal operating limits. Primary to secondary leakage would result in some activity accumulation within the steam generator secondary. Thus, under these circumstances the blowdown stream would have an activity level associated with it. Should this activity level exceed a specified limit, the blowdown stream would be processed prior to its release via the discharge canal. Three blowdown process streams provide this capability. Each stream can process the total combined blowdown (40 gpm or greater) from both Units 1 and 2.

Radiological evaluations of normal liquid releases performed by the Staff have been based on a blowdown rate of 14 gpm, processing by mixed bed demineralizers, and discharge to the ocean. The process system has a capability in excess of that assumed in the Staff's analysis. Revisions to the liquid waste management system (PSAR Amendments 4 through 6) are reflected by modifications contained in the attached WMS diagram.

IV Fish Monitoring

The staff, after reviewing the FPL Environmental Report for St. Lucie Unit No. 2, commented on page 6-2 of the DES that " an adequate program to identify fish populations in the area of the plant has not been conducted."

An additional program has been initiated since the FPL Environmental Report was written. At present, an otter trawl is being made monthly, both day and night, at each station to collect invertebrates and fishes found near the bottom. All the data are being analyzed by a computer program and the outcome integrated and synthesized to develop, if possible, a predictive model of the overall effect on a particular species of a change in any one parameter.

V Measures To Protect The Environment

During Construction

The applicant has committed to those measures necessary for protection of the environment during the construction of proposed St. Lucie Plant Unit No. 2. These commitments have been outlined in Section 4.5.1 of the DES and are the result of cooperation between the applicant and the Staff in evaluation of construction impact.

VI Use of Big Mud Creek

Section 5.2.2 of the DES describes the environmental impact of the proposed withdrawal of emergency cooling water from Big Mud Creek. Applicant offers the following comment to clarify that paragraph and to explain why it is necessary to use water from Big Mud Creek at all. As described below and in section 5.2.2 of the DES, water use from Big Mud Creek will be minimized consistent with regulatory and testing requirements.

USAEC Regulatory Guide 1.27, entitled, "Ultimate Heat Sink" requires that "suitable redundancy in features be provided for the cooling water system to assure that its safety function can be accomplished." This cooling water system is called the "Ultimate Heat Sink", and is further defined as "that complex of water sources, including necessary retaining structures, and the canals or conduits connecting the sources with, but not including, the cooling water system intake structures for a nuclear power unit." It should be emphasized that this water is not used to provide emergency cooling directly to the reactor core.

For the St. Lucie Units, two water sources and their associated canals and conduits comprise the ultimate heat sink for the plant. The primary source of water is the Atlantic Ocean which together with the ocean intake structure, intake conduits, intake canal, and intake structure bay area constitute the preferred source of emergency cooling water. The secondary source of emergency cooling water is Big Mud Creek which is connected to the Atlantic Ocean through the Indian River and inlets at Ft. Pierce and St. Lucie. The secondary source utilizes an emergency intake canal connecting Big Mud Creek with the intake canal area in front of the intake structures.

As indicated, the primary source of cooling water for dissipating heat during normal or emergency shutdown is the Atlantic Ocean via the circulating water system intake, described above. Two 12.0 ft I.D. reinforced concrete pipes take ocean water from about 1200 ft off-shore. The pipelines are buried their entire length except at the intake velocity cap structure. A 300 ft wide canal carries the water to the intake pump structure.

Because of the redundancy requirement mentioned above in Regulatory Guide 1.27, a second source of cooling water is connected to (but isolated from) the intake canal for use as a backup. This source is Big Mud Creek.

Big Mud Creek is a natural body of water extending easterly from the Indian River just north of the plant site. Big Mud Creek is dredged to a minimum elevation of -40 ft MLW with a minimum 250 ft. bottom width. A barge channel has been dredged from Big Mud Creek across the east side of the Indian River to the channel of the Intracoastal Waterway. The Intracoastal Waterway is a 9 - 12 foot deep channel running north-south in the Indian River. The Indian River is connected via inlets to the ocean at Ft. Pierce to the north and at St. Lucie to the south.

The intake canal in front of the intake structure is separated from Big Mud Creek by a sheet pile and concrete barrier wall which is placed midway in the emergency cooling canal. The barrier maintains separation between the primary and secondary sources of emergency cooling water during normal plant operation. To assure passage of emergency water

through the sheet pile wall, nine stub pipes (normally plugged with pneumatic devices) penetrate the wall.

Before water from Big Mud Creek will be used, the Ocean Intake System will have to become blocked or inoperative to the extent that less than 3% of the flow the system is designed for will pass from the Ocean to the Intake. A schematic diagram showing water supply sources and consumption for both normal operation and emergency shutdown with loss of the Ocean Intake is shown in figure 2.4 of the DES. The likelihood of such an event is considered extremely remote.

Postulating such a condition, however, the plant would begin a shutdown procedure and the pneumatic devices would be deflated, allowing water to flow through the sleeves in the barrier wall. The amount of water drawn from Big Mud Creek for use in the plant would depend upon the number of intake cooling water pumps operating. The design capacity of each pump is 14,5000 gpm and only one pump is required for shutdown of a unit, however, normal shutdown is usually accomplished using two pumps.

Besides the emergency condition noted above, water from Big Mud Creek will be used during normal semi-annual tests of the pneumatic plug operation. Each of the nine pneumatic plugs controlling flow will be tested individually for a period of no more than 10 minutes. The flow passing from Big Mud Creek to the Intake Canal will depend upon the relative elevations of the water on either side of the Barrier and the elevation of the plug (Elev. -6,0.0 or +6 ft). There are three stubs at each elevation (9 total) but only six are at or below the water line. Each stub pipe is capable of passing up to 33 cfs of cooling water, and the total volume of water drawn from Big Mud Creek during each semi-annual test is limited to no more than 2 million gallons by agreement

with the Flood Control District. Additionally, testing will not be conducted during times of high aquatic productivity in the Indian River, such as spawning. In summary, the use of water from Big Mud Creek is limited to a semi-annual removal of up to 2 million gallons and the unlikely use of 29,000 gpm for emergency cooling purposes. Having the capability of using water from Big Mud Creek assures full compliance with AEC Regulatory Guides and gives maximum assurance of the safe operation of the St. Lucie Units.

VII Transmission Facilities

As stated in section 3.8 of the DES, St. Lucie Unit No. 2 will use the transmission facilities which are being constructed for use by St. Lucie Unit No. 1. No additional transmission line circuits will be required for Unit No. 2.

As of March 15, 1974, the construction status was as follow:

CIRCUIT #1

On structures, both steel towers on the river crossing and concrete structures on the land portion have been completed. The conductor on the river crossing has been installed. Wire work began on the land portion during the week of March 18. Completion is scheduled for April 12, 1974.

CIRCUIT #2

71% of the steel towers have been installed. The towers in the Indian River have been erected. Approximately 7 concrete structures have been set in the land portion. Completion is scheduled for August, 1974.

CIRCUIT #3

Approximately 57% of the steel structures have been

installed. The steel towers in the Indian River have been erected. Approximately 7 of the concrete structures have been set on a land section. Completion is scheduled for August, 1974.

VIII Natural Draft Cooling Towers

The discussion of natural draft cooling towers in Section 9.2.4, pages 9-8 and 9-9 of the Draft Environmental Statement may give the impression that natural draft cooling towers are ecologically preferable to the proposed cooling system because they have only an aesthetic disadvantage of visual intrusion of tower and plume. Further perusal of evaluations in Table 10.2, pages 10-3 and 10-4, Table 10-3, page 10-8 and the next to the last paragraph on page 10-9 reveals that a natural draft cooling tower, in addition would offer a potential threat to migratory birds, suppress plant life and reduce number of plant species in downwind areas because of salt drift, have a major visual impact and have a high salinity blowdown with unknown net effects on biota. Thus, it would not result in a significant reduction of environmental cost associated with the ocean outfall discharge system.

The foregoing assumes that a natural draft cooling tower is technologically feasible at this site. However, no existing natural draft cooling towers have been designed to withstand the hurricane winds that may occur at the site. In addition, the prevailing air temperatures and humidities in this area probably would have an adverse effect on the efficiency of natural draft towers. No large natural draft towers have been constructed nearer to this site than the Georgia foothills. Thus, Applicant does not believe that natural draft cooling towers constitute a reasonable alternative to the proposed ocean outfall.

IX Energy Conservation as an Alternative to St. Lucie 2

The St. Lucie 2 unit is planned as base load capacity. Even if customer demand grows at a considerably lower rate than forecasted by FPL, additional base load capacity will be needed in 1980. Moreover, the attractiveness of nuclear power as base load capacity has increased because of uncertainties in the availability and cost of fossil fuels, on which FPL is heavily dependent (See Amendment 4 to ER, dated February 25, 1974, which updates estimated cost and availability of alternative fuels). As demonstrated below, energy conservation measures cannot obviate the need for St. Lucie 2.

However, FPL is extremely interested in the conservation of energy and has consistently informed its customers of available energy conservation measures and discouraged wasteful uses.

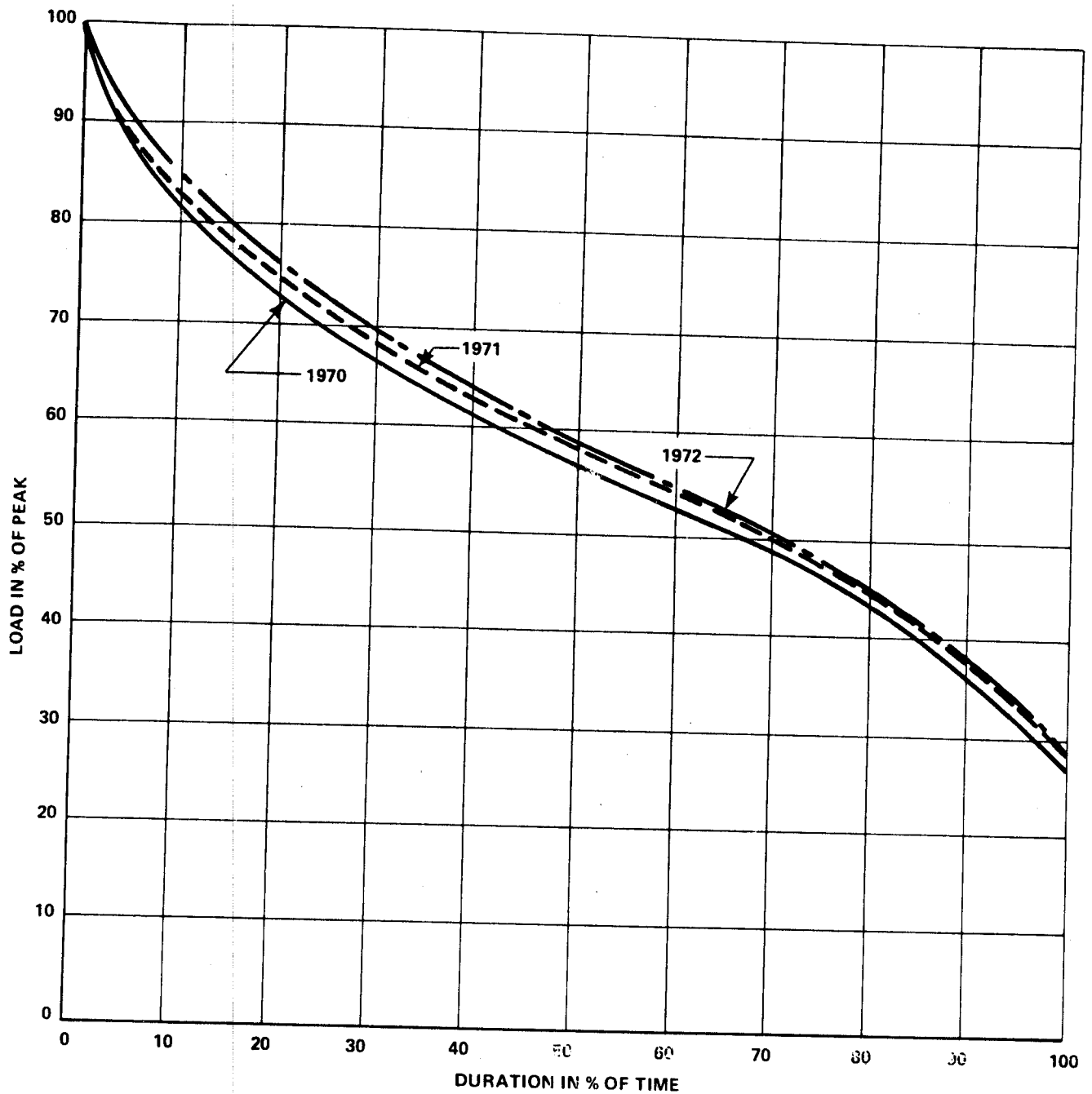
1. The Need for Nuclear Base Load Capacity

a) The Load Duration Curve

The relationship between the demand for electricity vs. time is illustrated by a "load duration curve." ^{1/}The load duration curve is an important tool in planning capacity additions. An actual load duration curve for 1972 (as well as curves for 1970 and 1971) appears as ER Figure 1.1-2, reproduced here as Figure 1, and the estimated load duration curve for 1980 is ER Figure 1.1-3, reproduced here as Figure 2. A load duration curve shows the total time, within a specified time, that the load equalled or exceeded the power value shown. The upper left hand termination point of the curve represents the maximum demand experienced in the peak hour of a year.

^{1/} A load duration curve may be constructed for any period of time. Annual load duration curves are used most often in system planning and are used in this presentation.

FIGURE 1

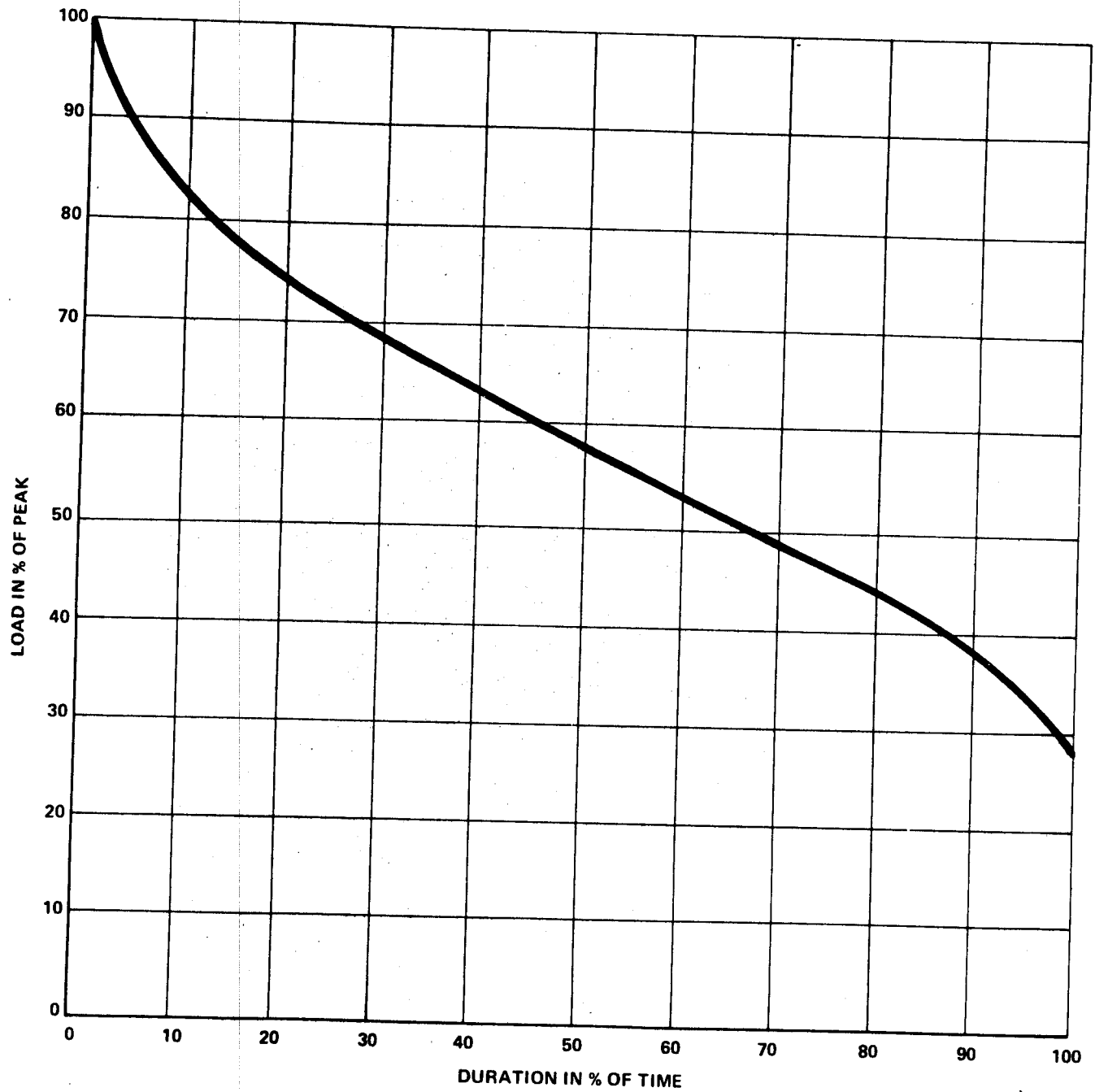


FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ANNUAL LOAD DURATION CURVE
1970, 1971, 1972

FIGURE 1.1-2

FIGURE 2



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PROJECTED ANNUAL LOAD DURATION
CURVE - 1973-1982

FIGURE 1.1-3

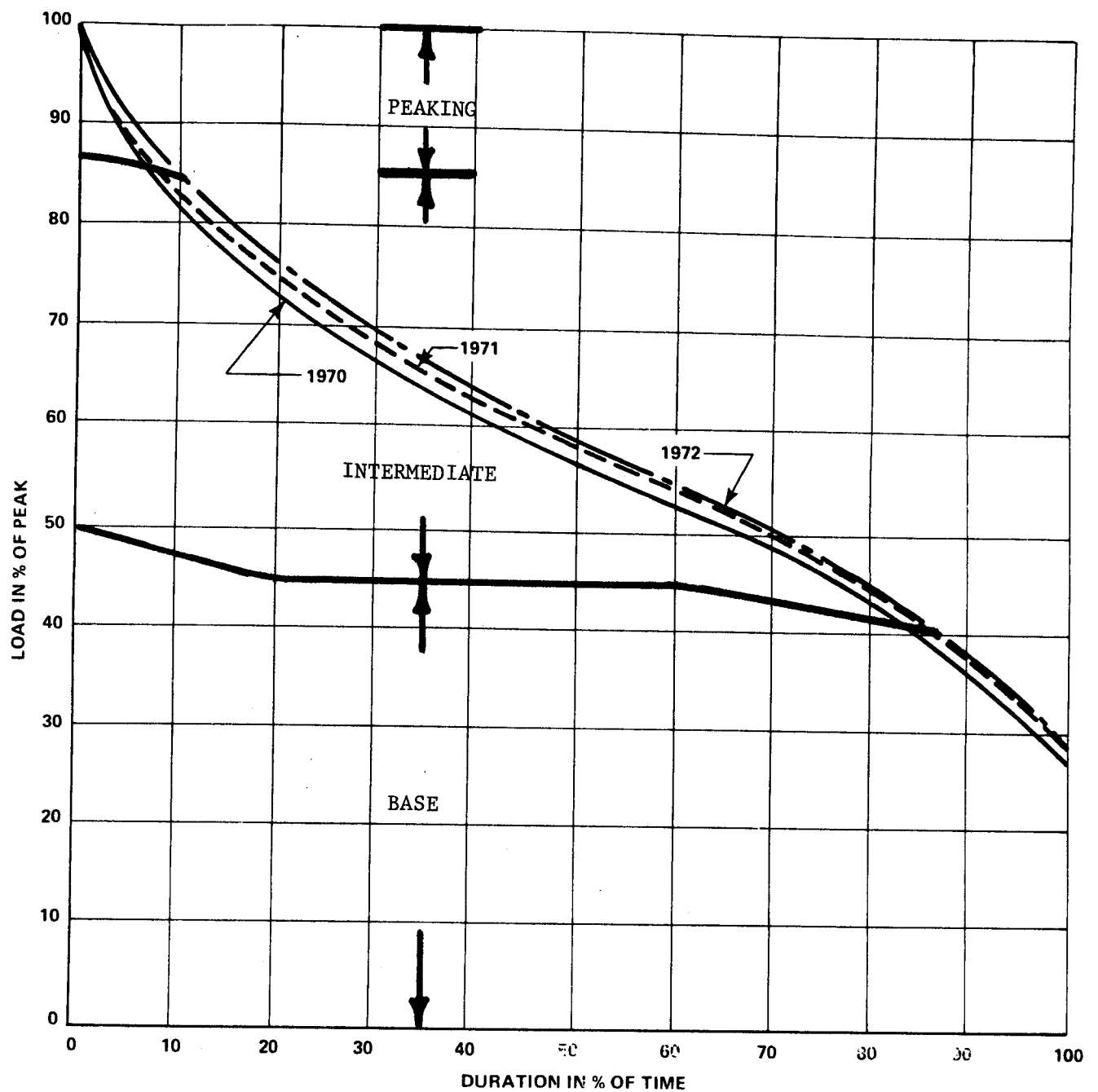
The lower right hand termination point represents the lowest demand experienced in any hour in the year. Intermediate points on the curve indicate the duration of any particular level of demand (load). For example, in 1980 it is estimated that 70% of the time the demand will be greater than or equal to 50% of the peak demand.

b) Base Load, Intermediate and Peaking Capacity

"Base load" capacity consists of generating units that a utility expects to operate at almost all times that the capacity is available. Figure 3 is a 1972 load duration curve with capacity drawn into the graph. Base load units are those that are expected to run at least 70 - 80% of the time. The lines indicating increments of capacity are sloped to account for scheduled and estimated unscheduled unavailability of the generating units, plus the economic dispatch of those units. Planned outages for maintenance (including refueling of nuclear units), will be scheduled to provide the maximum system reliability. The Company makes every effort to assure that all possible capacity is available during peak periods.

A maximum amount of energy, kilowatt hours (Kwh), per kilowatt of capacity (Kw) is produced by the base load type units. Therefore, it is desirable to minimize the fuel cost of generating this energy at the expense of considerable capital expenditure. Of course, nuclear generation, with its high capital cost and low fuel consumption, accomplishes this objective. By comparison, a fossil unit must consume an additional increment of expensive and scarce coal, oil or gas to produce each Kwh. Because of this difference, nuclear generation is always inserted at the bottom of the load duration graph, thereby "pushing up" fossil generation and pushing some of the utility's least efficient fossil generation into peaking unit status.

FIGURE 3



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ANNUAL LOAD DURATION CURVE
1970, 1971, 1972

Peaking capacity is at the opposite end of the scale. It is used sparingly, usually less than 10% of the time, to meet peak demands. Accordingly, such capacity must not have a high fixed (or capital) cost; and the variable cost, made up mostly of fuel, is relatively less important. Peaking capacity is usually comprised of a combination of natural gas turbine units and older, less efficient fossil units. However, FPL's entire peaking capacity in 1972 consisted of gas turbine units. In fact, some gas turbine capacity was used by FPL for intermediate generation.

Intermediate generation consists of those units that are used more often than peaking units, but less than base load units. The lower portion of the "intermediate band" of the load duration curve is usually made up of fossil units that were pushed up from the base load band by nuclear or more efficient fossil capacity. And, as stated above, the upper portion of the intermediate band on Figure 3 is made up of gas turbine units.

c) FPL - 1972

In 1972, FPL generated 31,498,000 Kwh of electricity, almost all with fossil fuels. ^{1/} Much of the fossil fuel consumed was low sulfur oil, which is now in very short supply. Also, a large quantity of natural gas was consumed by FPL's gas turbine units. The Federal Power Commission has adopted a policy of limiting the consumption of natural gas for electric generation to the extent practicable.

Had nuclear generation been available in 1972, each Kwh generated by the nuclear unit(s) would have replaced a Kwh that was produced by natural gas

^{1/} Turkey Point 3, FPL's first nuclear plant, was in operation for a few days in December, 1972. The amount of energy produced commercially was very small and is not shown on Figure 3.

or low sulfur oil. FPL's need for non-fossil fueled, base load capacity, added after 1972, would not have been dependent on any increase in customer usage. As Figure 3 illustrates, 3,427 Megawatts (Mw) served as base load capacity in 1972. Only 1,456 Mw of that fossil fueled capacity would have been pushed up to intermediate status by addition of the Turkey Point nuclear units in 1973 if there had been no growth in customer demand from 1972 to 1973. In fact, peak demand rose 980 Mw from 1972 to 1973.

d) FPL - 1980

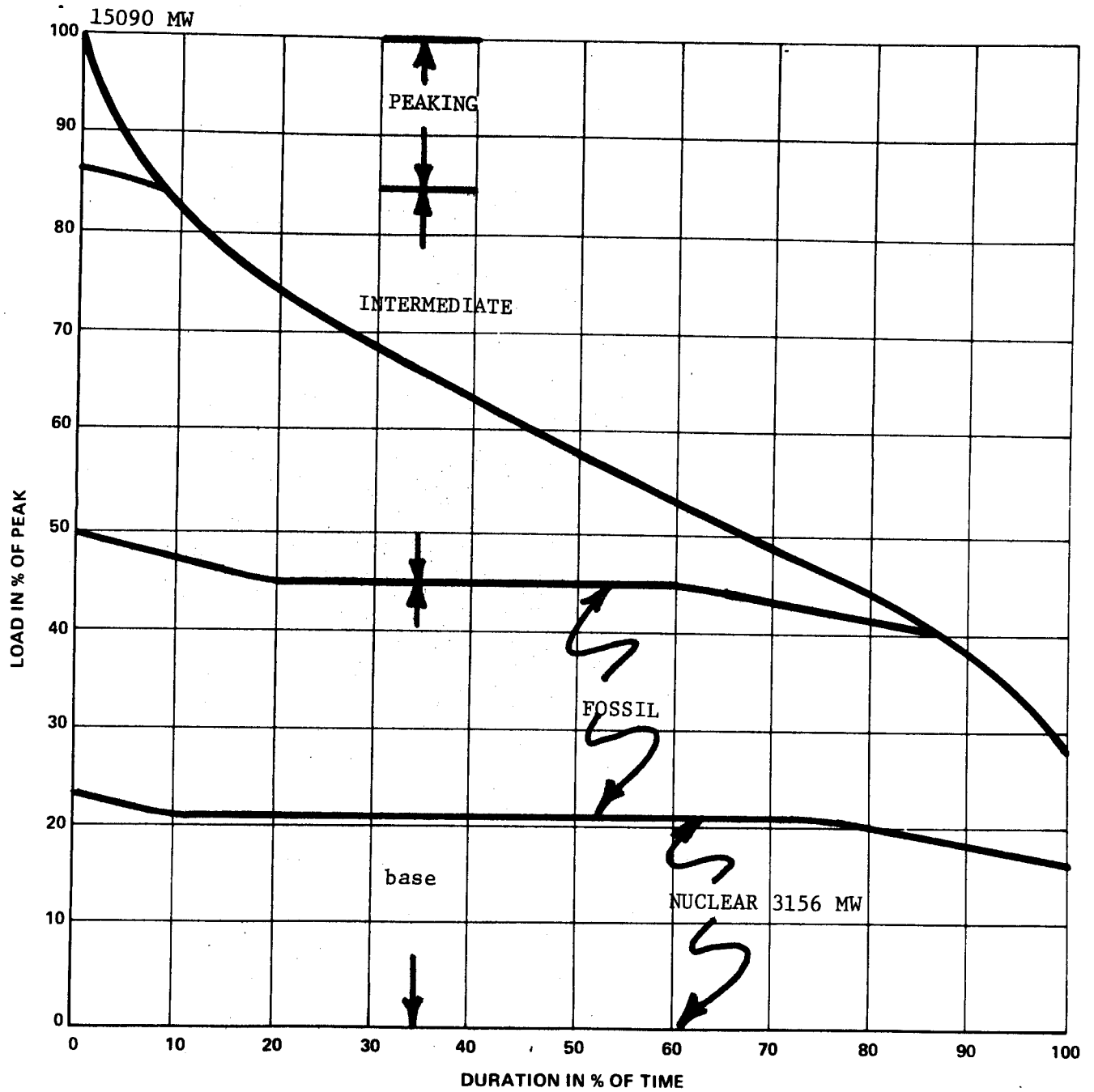
Figure 4 shows an estimated FPL load duration curve for 1980. It projects a peak demand of 15,090 Mw (60 minute gross), and reflects an estimated requirement of 6,790 Mw of base load capacity. The four planned nuclear units--Turkey Point 1 and 2 and St. Lucie 1 and 2--would equal 3,156 Mw, or approximately 46% of FPL's base load capacity. The remainder of FPL's base load capacity would be comprised of large fossil units, probably burning low sulfur oil. Of course, all intermediate and peaking capacity, as well as all reserve capacity--which is above the load duration curve and, therefore, not shown--would be fossil fueled.

It is apparent from comparing Figure 3 with Figure 4 that the nuclear generating units replace fossil units at the bottom of the load duration curve, and the fossil units that are consequently pushed up on the graph serve growth in customer demands.

2. Energy Conservation as an Alternative

Energy conservation measures can be divided generally between those that are intended to result in an overall decline in energy consumption and those that concentrate on reducing the peak demand, without regard for usage off peak.

FIGURE 4



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PROJECTED ANNUAL LOAD DURATION
CURVE - 1973-1982

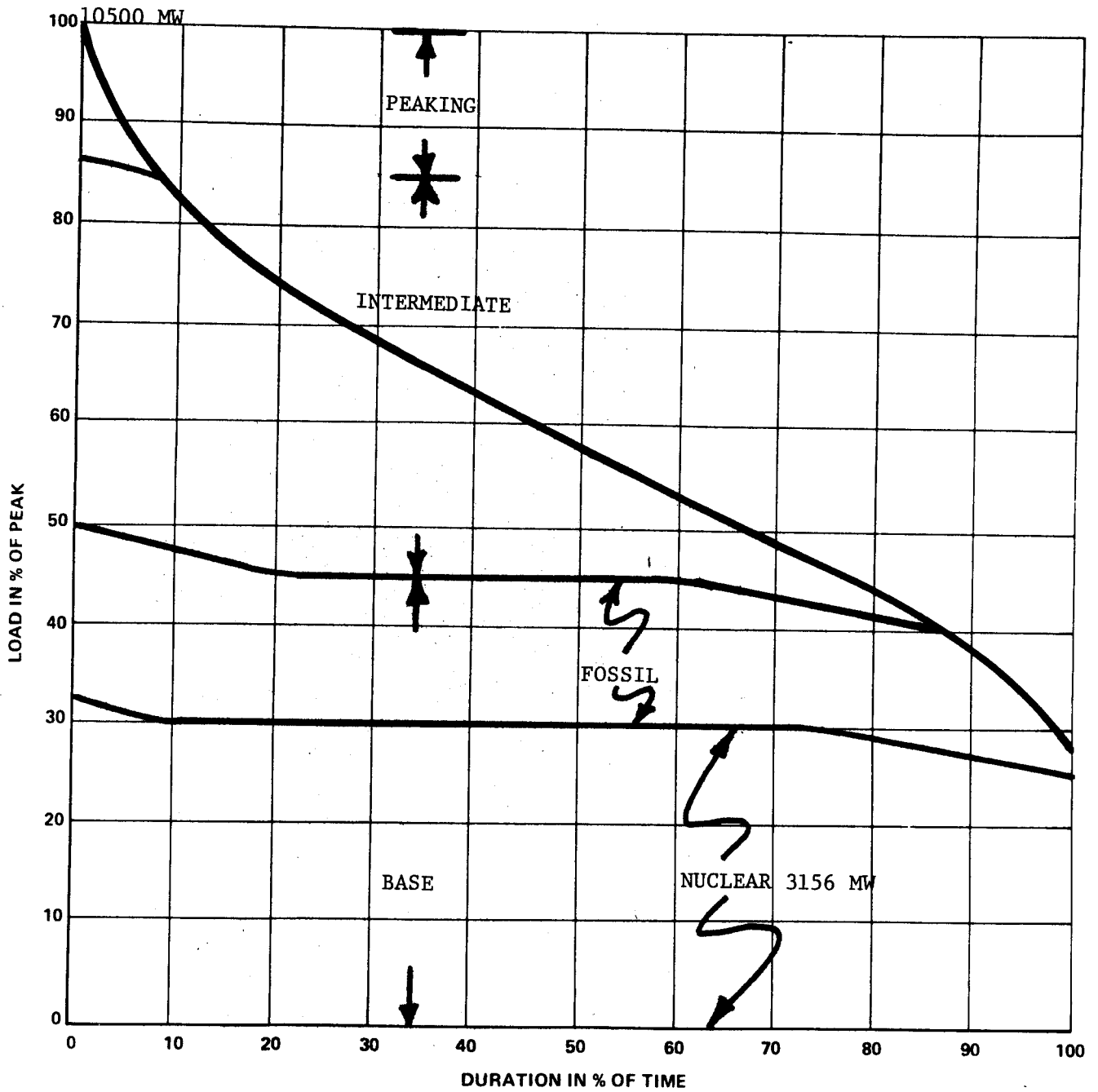
a) Overall Decline

Public consciousness that energy is a depletable resource that should not be wasted can lead to an overall decline in the rate of growth in energy consumption. Better home insulation, lower thermostat settings in winter, higher thermostat settings in summer, elimination of unnecessary lighting and design of new buildings with regard for energy consumption are all measures which should lead to an overall reduction in growth of consumption of electricity. This decline should affect usage in each hour.

Figure 5 shows a hypothetical load duration curve for 1980. Peak demand is assumed to be 10,500 Mw, instead of FPL's forecasted 15,090-- representing 50% less growth of demand from 1972-1980 than forecasted by FPL--6,145 Mw-10,500 Mw vs. 6,145 Mw 15,090 Mw. It is assumed that the shape of the load duration curve will not change, reflecting a balanced (as to time during the year) decline in consumption growth. Comparing Figures 5 and 4, the need for base load capacity has decreased from 6,790 Mw to 4,725 Mw. The Turkey Point and St. Lucie Units, 3,156 Mw, together with several fossil units, are still needed to provide base load capacity. The real difference between the two graphs is that, in Figure 5, very little natural gas and much less low sulfur oil would be utilized by FPL to generate electricity. Of course, the assumption used in Figure 5 is extreme, and, in the Applicants judgement, completely unrealistic.

With regard for the instability in availability and price of oil and the pressing need for low sulfur oil in all parts of the United States, FPL undoubtedly would choose to construct St. Lucie 2 even if energy conservation measures could be expected to reduce forecasted growth in consumption by 50%.

FIGURE 5



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PROJECTED ANNUAL LOAD DURATION
CURVE - 1973-1982

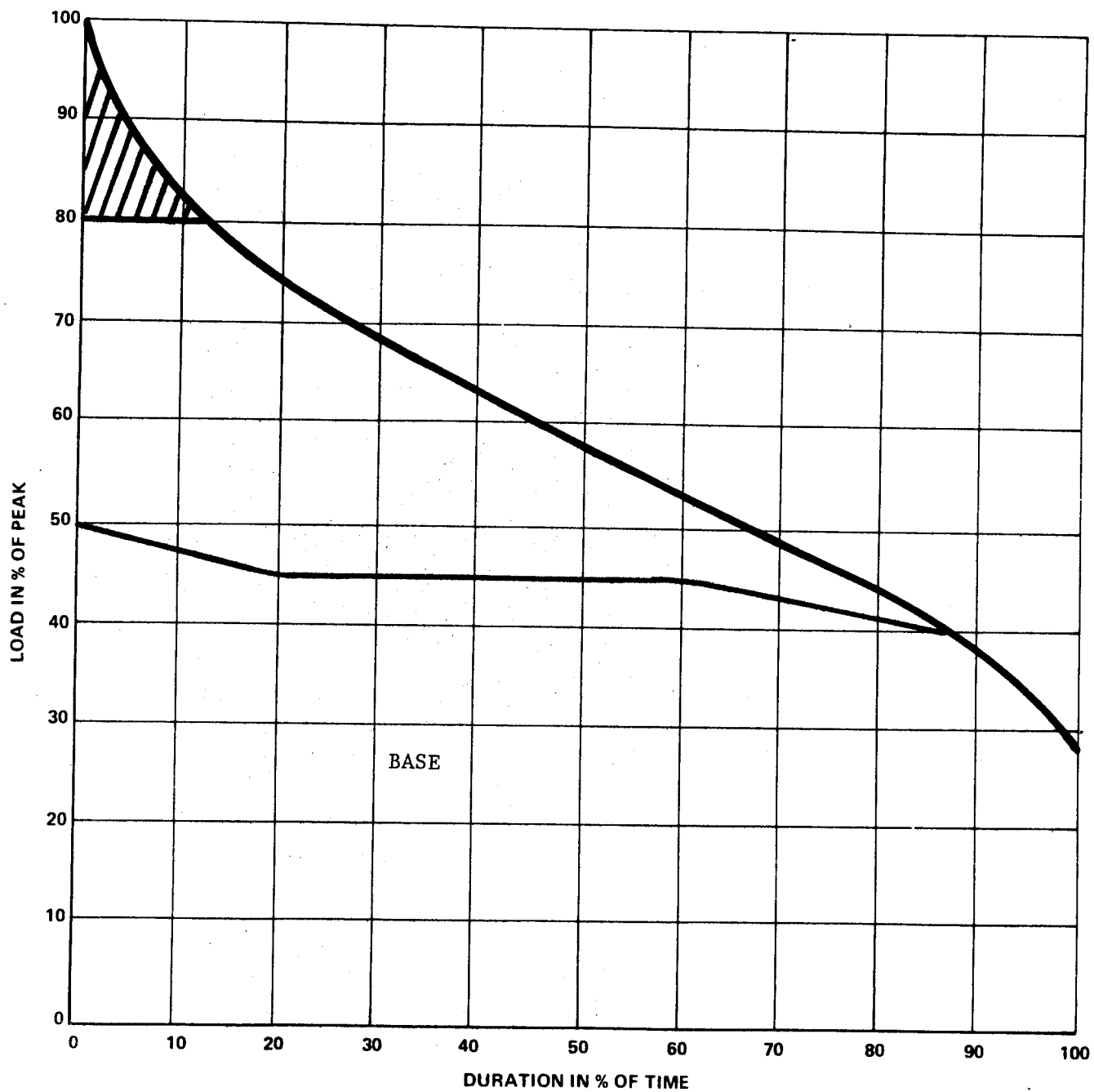
b) Reduction of Peak Demand

The discussion at 8.1 of the DES, based in large part on FPL's ER, is not sufficient basis for consideration of energy conservation alternatives. It emphasizes peak demands and the need to add capacity in order to meet forecasted peak demands. In fact, meeting peak demand is almost an incidental function of base load capacity. Even the most drastic reduction in peak demand would not affect FPL's need for base load nuclear capacity. Instead such a reduction would reduce the need for peaking capacity.

This principle is illustrated by Figure 6, which is a projected load duration curve for 1980 with the peak, above 80% of the forecasted peak, "chopped off." Such a perfect leveling of usage during peak hours could be achieved only by interrupting selected customers and/or by shedding the load imposed by particular communities or geographical regions so as to reduce peak usage. A less graphically perfect leveling out arguably could be achieved by imposition of economic penalties on "on-peak" users.

Nuclear capacity is planned on the basis of the right hand side of the load duration curve and with practically no regard for peak demand. The "energy conservation alternative" most commonly mentioned in AEC proceedings--imposition of a higher price on those who contribute to peak demand--actually contemplates diversion of usage from "on-peak" to "off-peak" times. This would occur because any increase in "on-peak" rates, would probably shift consumption to "off-peak" periods. The result is a leveling of the entire load duration curve, increasing the need for base load capacity.

FIGURE 6



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PROJECTED ANNUAL LOAD DURATION
CURVE - 1973-1982

Accordingly, a reduction in peak demand will not reduce the need for base load nuclear capacity, and would probably increase that need.

3. FPL's Energy Conservation Efforts

Even though energy conservation cannot remove the need for St. Lucie 2, FPL is interested in conserving energy and in reducing peak demand. FPL's efforts in this direction are set forth in response to the Staff's questions, transmitted to FPL on March 8, 1974.

Q.1. (a) Describe the duration and intensity of the advertising programs conducted by the applicant during the last three years.

(b) If promotional advertising has been terminated, when was this type advertising terminated.

A.1. Promotional advertising to encourage the use of electricity was terminated by Florida Power & Light Company in 1971. Since then, Florida Power & Light Company has been conducting communications programs to educate the public in wise energy management and conservation. The rapid population growth occurring in Florida has been emphasized to the public by Florida Power & Light Company to encourage energy conservation. Furthermore, since 1971 Florida Power & Light Company has stressed energy conservation during the peak summer hours when air conditioning loads are highest. These conservation programs have been utilized in addition to an environmental awareness program emphasizing the part played by electricity in meeting the problems of pollution.

The "Watt Watcher" program has been developed extensively to inform the public of methods by which electrical energy can be conserved.

A copy of the "Watt Watcher's Guide to Economy and Efficiency," which has been distributed widely in both English and Spanish languages, is Enclosure 1. In addition to recommendations for optimum use of appliances, Florida Power & Light Company developed suggestions for appliance maintenance to reduce energy requirements. Furthermore, company representatives visit public and private schools within the Florida Power & Light Company service area on a weekly basis to involve teachers and students in the program.

An example of one of the current programs is one which teaches customers how to read their electric bills. By stressing that consumption (kilowatt-hours) is the only item on their bills which the customers can directly control, this program draws together the previous programs on conservation methods, and at the same time emphasizes that it is the consumer who controls consumption.

Present programs are being communicated to the public through the newspaper (30 newspapers) and radio (44 stations) media. Plans also are being formulated to utilize 13 television stations.

- Q.2. Identify the regulatory commissions or bodies that regulate the retail price of electricity in the applicant's service area.
- A.2. The Florida Public Service Commission is the regulatory commission which regulates the price of electricity in the area serviced by Florida Power & Light Company.
- Q.3. (a) Describe the various types of interruptible sale contracts that the applicant has. (b) Provide the size (MWe) of interruptible sale for each type described in 3(a).
- A.3. While Florida Power & Light Company has no contracts which

Provide for total interruption of service to a customer, the Company has developed two rate schedules which are available to customers who contract to curtail their demands upon request by the Company. These two rate schedules are: CG - Curtailable General Service (Enclosure 2), and CI - Curtailable Industrial Service (Enclosure 3). Both provide economic incentives to customers who are willing to accept occasional partial curtailments in service. Moreover, both rates are designed to reward high monthly load factor, and ratchet provisions penalize those whose annual peak demand substantially exceeds normal requirements. Approximately 260 customers are served under schedule CG, and 5 customers are served under schedule CI. These customers constitute a power load of 250 Mw which is curtailable, if necessary, during the peak hours of the year.

- Q.4. Describe the applicant's record of load shedding and load curtailment methods used in the last five years. Information should be supplied as cumulative duration of time by month and by methods. This information should include 3% voltage reduction, 5% voltage reductions, curtailment of electric power usage by the utility, voluntary curtailment by large commercial and industrial customers, and discontinuing service to contractually interruptible loads.
- A.4. FPL's Procedure for Emergency Load Management is set forth in Enclosure 4. Steps 1 and 2 on Enclosure 4 do not involve interruption or curtailment of service to customers other than

FPL itself and those who have contracted to curtail their demands when requested. While these two steps are the first measures taken during an emergency, they are, to some extent, planned curtailments. On the other hand, all of the Steps beyond Step 2 are genuine emergency measures which result in the interruption of service to customers who are under no contractual obligation to curtail their usage.

Step 3 consists of the Phases shown on Enclosure 5. This, from Phase 2 on, is "load shedding"--the automatic disconnection of portions of FPL's service area. The result is a local, and possibly regional, electric blackout. Because FPL operates in parallel with other electric systems in Florida, a decline in system frequency which results in the necessity to shed load affects the entire state. Enclosure 6 lists the occasions that load has been shed in the past 5 years^{1/} Obviously, depriving whole communities of electricity is not an acceptable means of reducing peak demand. Accordingly, FPL resorts to Step 3 only in emergencies, where the loss of one or more generating or major transmission facilities requires action to avoid a cascading power failure.

^{1/} It should be noted that the duration of periods during which load was shed is not included. Since load shedding is used to prevent further degeneration of the mismatch between load demand and generating capacity, relaxation of load shedding depends on the availability of generating capacity to pick up more load. This, in turn, depends on the configuration of the entire Florida Power & Light Company System, which will change as a result of the particular situation. Consequently, it is impractical to identify when the previously shed loads are all regained.

A summary of all curtailments of the loads of individual customers is contained in Enclosure 7. FPL has not experienced voltage reductions during the period 1969-1973. Studies by the Company have indicated that insignificant savings of energy would result from voltage reductions on the FPL system; and such reductions can cause damage to electric motors and equipment.

Q.5. Describe any impact on demand resulting from the recent conservation activities in the applicant's service area.

A.5. As stated above, customers representing 250 Mw of load have converted to the CG and CI rates. It is more difficult to measure the effect of the customer education program. However, energy usage during the winter 1973-1974 was appreciably lower than projected. For at least the past 25 years, FPL's sales have increased at a rate of approximately 12% annually. An 11% increase has been projected for the year 1974. Instead, in November, 1973, an increase in Kwh sales of only 3% over November, 1972 was experienced. December, 1973, showed an increase of 6% over December, 1972; and January, 1974, showed a decrease of .09% as compared with January, 1973. Florida has experienced mild weather during these months; but, unquestionable, cutbacks in use of electricity by FPL customers have also contributed to this reduction in consumption.

X Alternative Sites

Section 9.1.2 of the Draft Environmental Statement compares the impact of the addition of Unit No. 2 at the St. Lucie site with the alternative of installing such a unit on another coastal site. The FPL Environmental Report perhaps discusses in more detail how the environmental impacts caused by construction of a new unit at a new site will be much greater than that caused by further development at the existing site.

Section 9.2 of the FPL Environmental Report points out that:

- (1) At a new site a deep excavation of perhaps 40 feet must be made for the entire plant area in order to prepare the foundation material to support the heavy loads imposed, while the area to be occupied by the proposed facility at St. Lucie has already been excavated to a 60 foot depth and backfilled with suitable compacted material when Unit No. 1 was constructed.
- (2) At a new site, circulating water intake and discharge canals would have to be dug, while at St. Lucie the existing circulating water canals can be utilized.
- (3) At a new site, a new transmission corridor would be required, while at St. Lucie the transmission corridor and construction were virtually completed as part of the initial construction at that site.

It was also pointed out that initial construction at any new site would have to be planned as a multiple unit installation in order to prove economical, thus the additional incremental impact at a new site would, in fact, be even greater than the factors previously mentioned for the addition of just one unit.

The applicant believes that these points must be emphasized in that part

of the FES which discusses site alternatives in order to provide a true perspective on the overwhelming advantages of the St. Lucie site from an environmental standpoint.

XI Hobe Sound

Applicant suggests that at the end of Section 2.2 or at another appropriate place in the DES the Staff may wish to make reference to the Wildlife Sanctuary at Hobe Sound, which is approximately 20 miles southeast of the plant site. At this considerable distance from the site, the environmental effects of the St. Lucie facility are essentially non-existent.

In terms of thermal effluents, it is obvious from the Staff's discussion in Section 5.2.3 that no effects will be detectable at a distance of 20 miles from the planned site. Indeed, the 1° isotherm resulting from the combined operation of Units 1 and 2 is only 3,372 acres. Any variation which might remotely occur in the thermal gradient at Hobe Sound would be well within the magnitude of those variations which normally occur as a result of meteorological conditions.

The Staff's analysis in Section 5.4 of the DES demonstrates that, near the plant, normal operation of the facilities will contribute only a small increment (from both liquid and gaseous effluents) to the total body dose otherwise received from natural background radiation. At a distance of 20 miles, the radiological effects of plant operation on Hobe Sound will be undetectable.

XII MISCELLANEOUS COMMENTS

- A) Pages 1-2 and 1-3: Status of Reviews and Approvals: The list of reviews and approvals should be revised. The Florida Electric Power Plant Siting Act, Chapter 73-33, 403.501, and 403.516, now encompasses the permit requirements under the Florida Department Pollution Control, Chapter 17-17, of the power plant certification statute. This includes the fourth, sixth, seventh, eighth, ninth, and tenth items in the table on pages 1-2 to 1-3. Additionally, the Florida Public Service Commission must review the application from the standpoint of power requirements. The applicant has filed applications for the above approvals. Applications for other permits will be filed in a timely manner.
- B) Page 2-25, Third to last paragraph: Add the following sentence to the end of the paragraph: "While Section 2.73 of the Environmental Report lists several species of 'rare or endangered' animals, which may visit or be resident on Hutchinson Island, the Applicant has found no evidence that they reside on the site."
- C) Page 3-7, Section 3.2, last paragraph: In the first sentence, delete the words "each comprised of 176 fuel rods." and insert the words, "73 of which will contain 236 fuel rods per assembly, 80 of which will contain 220 fuel rods per assembly and 64 of which will contain 230 fuel rods per assembly" (contained in PSAR Amendment 4).

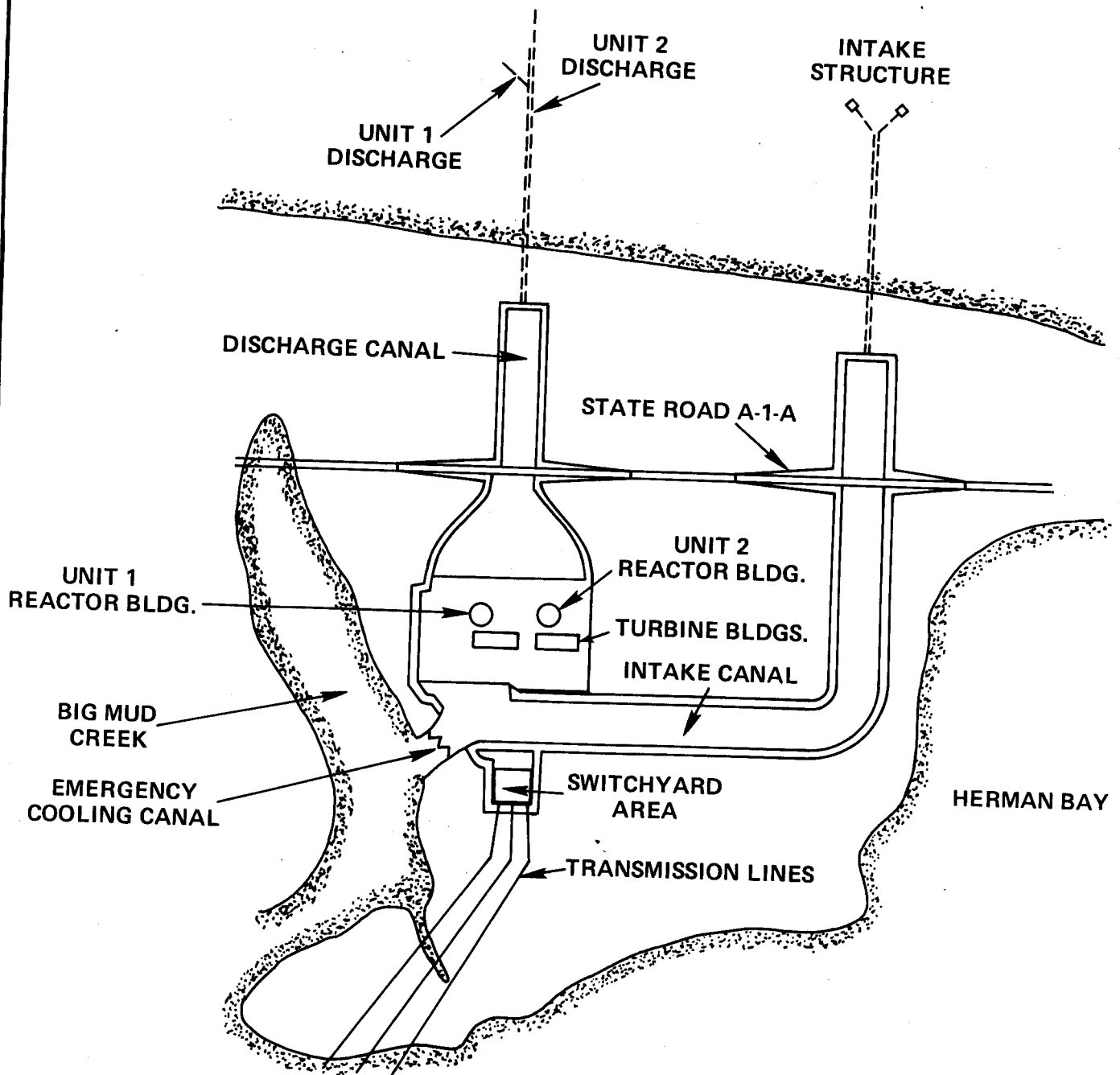
In the second sentence, delete the words "in a 0.44 inch diameter", and insert in lieu thereof "in a 0.382 inch (outer diameter)".

In the last sentence, substitute "81.6" for "85.4".

- D) On page 3-9, Section 3.4.1: In the second paragraph, substitute "400" for "450".

In the last paragraph, revise the second sentence to read as follows:
"a recent agreement with the Flood Control District limits the water drawn from Big Mud Creek to 4 million gallons per year for testing."

- E) Pages 3-14 to 3-16: Substitute the following for Section 3.4.3 "Since a potential for marine growth on the inside of the intake pipe lines exists, present design considerations allow for the installation of oversized intake pipes. This design consideration should mitigate biological fouling as a problem during plant operations. Accordingly, Florida Power & Light Company has no present plans to use thermal defouling or any other defouling measures on the ocean intake lines. As a contingency, studies of alternative systems will be reviewed should marine growth become a problem in later years. Even though thermal defouling may be among alternatives to be considered, no such system for this purpose will be installed until subsequent experience shows it to be necessary and it has been reviewed by the AEC Staff to assure its compliance with applicable water quality and other environmental requirements." Since the applicant's present plans do not provide for thermal defouling, the recirculational canal in the site plot plan should be revised for the FES as depicted in the attached figure.



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PLANT PLOT PLAN
FIGURE

- F) Page 3-34, last paragraph: Change "Chlorine gas will be pumped" to "A chlorine solution will be introduced." With dilution and the chlorine demand of the dilutant water, concentration of free residual chlorine will be 0.1 ppm or less at the terminus of the discharge canal.
- G) Page 3-35, Section 3.7.2: Substitute the following revised section:
"The four coarse screens consist of a fixed rack with 3" spacing to holdup large pieces of trash. The rack is cleaned with a manually operated rake that is lowered over the rack with the aid of a monorail hoist. The four traveling screens consist of a continuous belt of baskets fitted with copper mesh screen with a clear opening of 3/8". The basket speed is variable from 2.5 to 10 fpm. Debris is cleaned from the baskets by fixed spray nozzles that wash the debris into a sluiceway where it is routed to a sheet-pile holding pit or to the settling basin installed at the south end of the plant island. The screen wash water flow rate is approximately 250 gpm for each screen. The traveling screens are normally operated in the automatic mode where in a differential water level across the baskets initiates operation."
- H) Page 3-37, Section 3.7.5: Delete the sentence which reads "Strainers will be installed to reduce the amount of particulates passing through the condensor tubes." and replace with "Water velocity in the tubes will be maintained at less than 7fps to reduce the potential for erosion."
- I) Page 4-1: In order to minimize impact on the natural beach dune during construction of the Unit 2 ocean discharge line, the Staff states that it will be advantageous to install a stub line for Unit 2 through the dune at the same time the dune is breached for the Unit 1 discharge line.

Applicant recognizes that it may be advantageous to install a stub line for Unit 2 through the dune at the same time the dune is breached for the Unit 1 discharge line. However, the process of obtaining the required permits, as well as the design, procurement and construction schedules of Unit No. 1, may preclude this. The Applicant is conducting an investigation to determine the feasibility of installing a stub line for Unit 2 during the construction of the Unit 1 discharge line. If the Unit 2 stub line can be installed simultaneously with the construction of the Unit 1 discharge line, the Applicant will make an effort to do this, subject to Commission approval. If not, the Applicant will insure that adverse effects are minimal by (i) providing a temporary dune line during construction of the Unit 2 line, and (ii) by replanting the dune line with natural plants indigenous to the area.

J) Page 5-7, Section 5.2.3.1: It should be noted that the existing NPDES permit applies only to Unit 1. Timely application will be made for an appropriate NPDES permit for Unit 2.

K) Page 9-4, Section 9.1.3

Geothermal energy is currently being developed as a power source in Europe and to a limited extent in the northern part of this country. However, there are no known sources of geothermal energy in Florida. Solar power and power generated by the wind are also being studied. Neither of these sources are expected to be commercially feasible within the time frame involved here; and, in any event neither could serve as a source of base load generation. None of these can be considered a viable alternative.

Nuclear fusion is being developed as a future source of energy, but an experimental demonstration fusion plant is not expected to be built

before 1990. Therefore, fusion cannot be considered a viable alternative at this time.

L) NUMERICAL CHANGES

Page 2-14: Change the tidal range in the Indian River from "1 ft." to "0.5 ft".

Pages 3-26 to 3-30: In accordance with the assumptions and calculations used in Amendment No. 3 to the Environmental Report, the following changes should be made:

Page 3-26, Section 3.5.2: Change Y 91m 1.1 (3) to Y 91m 1.1 (-3).

Page 3-27, Section 3.5.2.2: Change 450 Ci/yr to 93 Ci/yr; change 0.14 Ci/yr to 0.09 Ci/yr radioiodine; change 50 lb/hr to 10 lb/hr.

Page 3-29, Section 3.5.3.2: Change 210 Ci/yr to 643 Ci/yr; change 0.022 of Iodine-131 to 0.23 Ci/yr of radioiodine; change 10 gpm to 20 gpm; change 0.0073 Ci/yr of Iodine - 131 to 0.039 Ci/yr radioiodine.

Page 3-30, Section 3.5.2.5: Change 1.43 Ci/yr for Iodine - 131 to 0.128 Ci/yr for radioiodine; change 1.6 Ci/yr to 0.18 Ci/yr; change 0.14 gpm to 14 gpm.

Page 5-15, Section 5.43: Change the height of the plant vent from 140 to 184 feet.

CURTAILABLE GENERAL SERVICE -- Rate Schedule CG**AVAILABLE:**

In all territory served.

APPLICATION:

This rate is available to any customer who contracts to curtail his Demand by 200 kw or more upon request of the Company from time to time.

SERVICE:

Single or three phase, 60 cycles and at any available standard voltage.

All service required on premises by Customer shall be furnished through one meter. Stand-by or resale service not permitted hereunder.

MONTHLY RATE:**DEMAND CHARGE**

\$670 for the first 200 kw or less of Demand.

\$2.80 per kw for the next 300 kw of Demand

\$1.62 per kw for each additional kw of Demand.

ENERGY CHARGE

1.21¢ per kwh for the first 280 kwh per kw of Demand.

0.76¢ per kwh for all additional kwh.

OFF-PEAK CREDIT

\$1.00 per each kw that the On-Peak Demand is less than the Demand during the current billing period, but not more than \$1.00 per kw times 80% of the billing Demand.

Minimum: The charge for the currently effective Demand.

Adjustment: The amount computed at the above Monthly Rate shall be adjusted minus or plus by an amount calculated in accordance with the formulae specified in the Company's Fuel and Tax Adjustment Clauses which are incorporated by reference as a part of this Rate Schedule and as filed with the Florida Public Service Commission.

DEMAND:

The Demand is the kw to the nearest whole kw, as determined from the Company's demand meter for the 30-minute period of Customer's greatest use during the month as adjusted for power factor, but never less than any excess above 200 kilowatts of the greatest such adjusted measured demand in the preceding eleven months.

ON-PEAK DEMAND:

On-Peak Demand is the kw to the nearest whole kw as determined from the Company's recording demand meter for any 30-minute interval during a period of curtailment requested by Company.

TERM OF SERVICE:

Not less than one year.

RULES AND REGULATIONS:

Service under this schedule is subject to orders of governmental bodies having jurisdiction and to the currently effective "General Rules and Regulations for Electric Service" on file with the Florida Public Service Commission. In case of conflict between any provision of this schedule and said "General Rules and Regulations for Electric Service" the provision of this schedule shall apply.

CURTAILABLE INDUSTRIAL SERVICE - Rate Schedule CI**AVAILABLE:**

In all territory served.

APPLICATION:

This rate is available to any industrial customer who contracts to curtail his demand at the request of the Company.

SERVICE:

All service required on the premises by the Customer shall be furnished through one meter at an available transmission voltage of 69 kv or higher.

MONTHLY RATE:**CURTAILED SERVICE**

\$34,340 for the first 6,000 kw or less, including 3,000,000 kwh

\$5.05 per kw for demands in excess of 6,000 kw, including
500 kwh per kw.

Kwh used in addition to the above quantities shall be billed at 7.32 mills per kwh.

UNCURTAILED SERVICE

When the Customer fails to comply to the Company's request to curtail load in the amount contracted for, the charge for demands in excess of 6,000 kw becomes \$6.25 per kw applicable to the uncurtailed kw of demand during the current billing period.

Adjustment: The amount computed at the above Monthly Rate shall be adjusted minus or plus by an amount calculated in accordance with the formulae specified in the Company's Fuel and Tax Adjustment Clauses which are incorporated by reference as a part of this Rate Schedule and as filed with the Florida Public Service Commission.

DEMAND:

The kilowatts determined from Company's demand meter for the 30-minute period of Customer's greatest use during the month adjusted for power factor, but not less than 80% of the maximum kw so determined during the 12 months ending with the current month, nor ever less than the kw contracted for.

(Continued on Sheet No. 8.541)

(Continued from Sheet No. 8.540)

Rate Schedule CI - Page 2

TERM OF SERVICE:

Not less than one year.

SPECIAL CONDITIONS:

The Customer will provide and maintain all transformers and related facilities necessary for handling and utilizing the energy delivered hereunder. The Company, at its option, may install metering equipment on the low voltage side of the transformers and, in such case, both the demand indication and the energy registration will be increased to compensate the Company for transformer losses by computing such losses based upon the manufacturer's data pertaining to the specific transformers installed.

RULES AND REGULATIONS:

Service under this schedule is subject to orders of governmental bodies having jurisdiction and to the currently effective "General Rules and Regulations for Electric Service" on file with the Florida Public Service Commission. In case of conflict between any provision of this schedule and said "General Rules and Regulations for Electric Service" the provision of this schedule shall apply.

PROCEDURE FOR EMERGENCY LOAD MANAGEMENTGeneral

Emergency load control is most likely to become necessary during extreme cold or hot weather, and this procedure has been prepared accordingly. It may be necessary, however, to utilize this procedure during normal weather in the event of prolonged loss of major generation or transmission facilities.

Load Control Procedures

When it has been determined that emergency load control measures will necessary, it will be accomplished by one or more of the steps listed below. The order in which these steps are to be taken will depend somewhat on the situation in the various major generation areas of the system.

The general outline of procedure and channels of communication is shown on the accompanying chart (not included). The detailed procedure for each step is given below:

Step 1 - Reduce non-essential utility loads.

General Office - Transfer load to emergency diesel generators.
Other Company Facilities - Turn off all unnecessary lights particularly outside lights consistent with safe operating and security practices. This includes outside lights for substations, power plants and service centers. Turn off or reduce air conditioning load where possible.

Step 2 - Notification of Customers with Curtailment Clauses in Contract

When this step is to be taken, Group Vice President - Divisions, will notify the appropriate division general managers by telephone, of the customers to be requested to drop load. Group Vice President - Divisions, will confirm this request by mailing to the division general managers an Emergency Load Control Notice with copies to interested General Office personnel.

The division general manager will have the necessary contacts made. The next day, or as soon as possible thereafter, he will advise Director of Rate and Research Department by telephone, the load reduction effected and confirm by mail.

Step 3 - Activate Step 0 underfrequency relays to the extent required to maintain FPL's spinning reserve allocation.

Step 4 - Request Large Customers to Voluntarily Reduce Load

Each division general manager is to keep Group Vice President - Divisions, currently advised of customers in his division that will voluntarily reduce load during an extreme emergency.

Upon notification by Group Vice President - Divisions, that Step 4 is to be taken, division general managers are to contact these customers to request their cooperation in load reducing. On the following day a report of customers cooperating in an estimate of load reduction effected is to be telephoned to Director of Rate and Research Department and confirmed by mail.

Step 5 - Reduce System Voltage - Upon the direction of Manager of System Operations, feeder regulators will be blocked in accordance with the Emergency Load Management manual, approximately 15 to 30 minutes prior to reducing system voltage.

Step 6 - Appeal to the Public - In the event that major generation or transmission facilities are lost for a prolonged time and the foregoing load control measures are not sufficient or practicable, appeals are to be made to the public in the form of frequent spot announcements over radio and TV facilities.

Appropriate announcements and plans for getting them on the air are to be prearranged by Director of Corporate Communications. This step is to be taken only upon the authority of Chairman of the Board, President & Chief Executive Officer, Executive Vice President (Corporate Communications, Right of Way, Tax, and Personnel) or Group Vice President - Divisions.

Step 7 - Interrupt Service - Pre-selected distribution feeders which do not serve loads essential to the public welfare will be interrupted on a rotating basis. Manager of System Operations, will keep records of interruptions so as to insure equitable rotation.

Emergency Procedures During Declining System Frequency

Emergency procedures will be implemented as follows:

Phase 1: From 60.0 Hz to 59.2 Hz, all operating reserves and emergency measures should be utilized to the fullest practicable extent. The manner of utilization of these reserves will depend greatly on the behavior of the system during the emergency.

In cases where frequency declines rapidly, only that capacity on line and automatically responsive to frequency (spinning reserve), and such items as interconnection assistance, and load reductions by automatic means are of assistance in arresting the decline in frequency.

If the frequency decline is gradual, the system dispatcher(s) of the system(s) in trouble should invoke non-automatic emergency procedures. This would include the starting of gas turbines, interrupting load, purchasing power, etc. These efforts should continue until the frequency decline is arrested. Generally speaking, it is the responsibility of the system(s) in trouble to take whatever action is necessary to restore the frequency to 60 Hz, and the system dispatcher(s) of such system(s) should take the lead in taking positive action, describing the trouble, asking for assistance, etc. If his actions do not produce results fast enough, the other system dispatchers may have to apply their judgements in assessing a given situation, taking action, and/or rendering assistance without being requested. No hard and fast rules can be made except that all possible cooperation and communications between system dispatchers will be required. If interruptible loads are counted as spinning reserves they should be capable of being disconnected from the system by underfrequency relays to assure their removal prior to Phase 2.

Phase 2: At 59.0 Hz shed with automatic load shedding relays not less than 10 percent of system load. No intentional time delay should be used beyond that absolutely required to avoid improper relay operation.

Phase 3: Between 58.8 and 58.7 Hz inclusive, shed additional load with automatic load shedding relays in an amount not less than 10 percent of system load existing prior to Phase 2. This amount of load should be shed in two nearly equal steps at 58.8 and 58.7 Hz. No intentional time delay should be used beyond that absolutely required to avoid improper relay operation.

Phase 4: Between 58.6 and 58.5 Hz inclusive, shed additional load with automatic load shedding relays in an amount not less than 10 percent of the system load existing prior to Phase 2. This amount of load should be shed in two nearly equal steps at 58.6 and 58.5 Hz. No intentional time delay should be used beyond that absolutely required to avoid improper relay operation.

Phases 5 through 11 not shown.

FLORIDA POWER & LIGHT COMPANY
RECORD OF LOAD SHEDDING
(1969 through 1973)

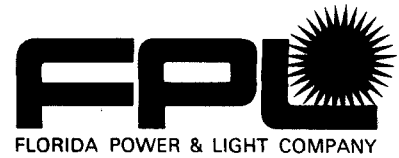
<u>DATE</u>	<u>TIME</u>	<u>CAUSE</u>	<u>LOAD SHED</u>
1/28/69	6:08 P.M.	Loss of Port Everglades Plant	255 MW
8/5/69	6:08 P.M.	Loss of Port Everglades Plant	568 MW
8/18/71	5:48 P.M.	Loss of five Lauderdale gas turbines	131 MW
4/3/73	9:37 A.M.	Loss of Turkey Point 3 and Port Everglades 3 & 4	1230 MW
4/4/73	9:14 A.M.	Loss of Turkey Point 3 and Port Everglades 3 & 4	1330 MW
6/23/73	2:05 P.M.	Dade-Flagami 138 KV circuit faulted	2190 MW

FPL - RESULTS OF LOAD CURTAILMENT

<u>Date</u>	<u>Load Curtailment Period</u>	<u>Number of Customers</u>	<u>Amount of Load Cur- tailed-Kw</u>
12/16/68	5:00 - 7:00 PM	155	115,688
7/7/69	4:00 - 7:00 PM	46	87,240
7/8/69	4:00 - 7:00 PM	58	86,210
7/9/69	4:00 - 7:00 PM	67	77,980
1/8/70	5:00 - 9:00 PM	281	151,680
1/9/70	6:30 - 10:30 AM	204	131,080
1/9/70	5:00 - 9:00 PM	337	161,290
1/10/70	7:00 - 10:30 AM	254	148,910
1/10/70	5:00 - 9:00 PM	215	131,410
2/4/70	5:30 - 9:00 PM	182	122,660
7/15/70	4:45 - 7:00 PM	106	82,699 - Voluntary
7/16/70	4:30 - 7:00 PM	98	72,603 - Voluntary
7/27/70	4:00 - 7:00 PM	119	87,616 - Voluntary
7/28/70	4:30 - 7:00 PM	118	79,665
7/31/70	12:00 N - 10:00 PM	211	173,592
8/3/70	3:00 - 7:00 PM	349	112,237 - Voluntary
8/4/70	4:00 - 7:00 PM	108	80,422 - Voluntary
8/5/70	4:00 - 8:00 PM	317	104,452 - Voluntary
9/2/70	4:00 - 7:00 PM	256	105,570 - Voluntary
9/3/70	4:00 - 7:00 PM	137	90,072 - Voluntary
1/20/71	5:00 - 9:00 PM	467	175,272
4/29/71	4:00 - 8:00 PM	703	202,110
4/30/71	4:00 - 8:00 PM	498	149,372 - Voluntary
6/16/71	4:00 - 7:00 PM	572	162,082 - Voluntary
8/18/71	3:00 - 7:00 PM	684	246,788

FPL - RESULTS OF LOAD CURTAILMENT (CONT.)

<u>Date</u>	<u>Load Curtailement Period</u>	<u>Number of Customers</u>	<u>Amount of Load Curtailed kW</u>
7-3-72	4:00 - 8:00 PM	444	140,002
7-5-72	4:00 - 8:00 PM	577	180,871
7-28-72	4:00 - 8:00 PM	609	228,357
7-29-72	4:00 - 8:00 PM	321	87,728 (Voluntary)
9-7-72	4:00 - 8:00 PM	692	242,079
9-14-72	4:00 - 8:00 PM	671	256,170
9-15-72	4:00 - 8:00 PM	683	263,760
9-18-72	3:30 - 8:00 PM	678	266,142
9-19-72	3:30 - 8:00 PM	692	263,977
9-25-72	4:00 - 8:00 PM	668	241,032
9-26-72	3:00 - 7:00 PM	682	275,734
9-27-72	3:30 - 7:00 PM	704	262,546
5-28-73	4:00 - 8:00 PM	85	57,350 (Holiday)
5-29-73	2:00 - 8:00 PM	267	229,650



April 1, 1974

Mr. Angelo Giambusso, Deputy Director
for Reactor Projects
Directorate of Licensing
Office of Regulation
U. S. Atomic Energy Commission
Washington, D. C. 20545

Dear Mr. Giambusso:

Re: St. Lucie Plant Unit No. 2
Environmental Report - Amendment 5
Docket No. 50-389

Enclosed are two hundred (200) copies of Florida Power & Light Company's comments on the Draft Environmental Statement. These comments are submitted as Amendment 5 to the Applicant's Environmental Report and include the information requested by Mr. William H. Regan, Jr. in a letter of March 8, 1974.

Very truly yours,

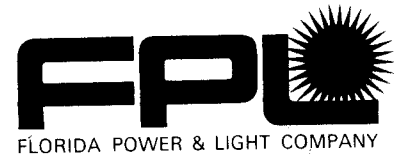
J. A. De Mastry
for

Robert E. Uhrig
Director of Nuclear Affairs

REU:nch
Encl.

APPROVED:

J. J. Hudiburg
J. J. Hudiburg
Executive Vice President



May 9, 1975
L-75-228

Mr. Angelo Giambusso, Director
Division of Reactor Licensing
Office of Nuclear Reactor Regulations
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Giambusso:

Re: St. Lucie Plant Unit No. 2
Environmental Report - Amendment 6
Docket No. 50-389

Enclosed for your review are two hundred copies of Amendment 6 to the St. Lucie Plant Unit No. 2 Environmental Report. We are holding one hundred additional copies for you which are available upon request.

The additional information contained in Amendment 6 serves to update the demographic analyses contained in section 2.2 of the St. Lucie Unit 2 Environmental Report (ER). These data have previously been incorporated in the Preliminary Safety Analysis Report and considered in the ASLB hearings for Unit 2. Therefore its admission to the ER serves to make these documents consistent with regard to content in this area.

Very truly yours,

Robert E. Uhrig
Vice President

REU:tg
Enclosures

cc: Mr. Jack R. Newman, Esquire

Mr. Richard D. Widrig
Battelle Northwest Labs
Richland, Washington 99352

STATE OF FLORIDA)
) SS
COUNTY OF DADE)

ROBERT E. UHRIG, being first duly sworn, deposes and says:

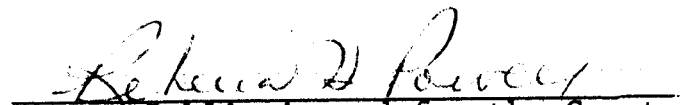
That he is a Vice President of Florida Power & Light Company,
the Applicant herein;

That he has executed the foregoing instrument; that the
statements made in this said instrument are true and correct
to the best of his knowledge, information and belief; and
that he is authorized to execute the instrument on behalf
of said Applicant.


Robert E. Uhrig

Subscribed and sworn to before me

this 9th day of May, 1975


Notary Public in and for the County
of Dade, State of Florida

My Commission expires

MY COMMISSION EXPIRES MAY 1, 1976
BONDED AND SURETY REQUIRED

SL2

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT NO. 2
INSTRUCTION SHEET - AMENDMENT 6

REMOVE

INSERT AMENDMENT 6

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2.2 REGIONAL DEMOGRAPHY, LAND AND WATER USE

2.2.1 POPULATION AND POPULATION DISTRIBUTION

The population and population distribution in the vicinity of the St. Lucie site was studied initially in 1968. The data was subsequently updated in 1971 to reflect the results of the 1970 census. From March to October 1974 a review of the work to date was conducted to i) verify the earlier predictions of permanent residents; ii) to assess more fully the transient population potential of the area; and iii) to assess the potential growth characteristics of the area. The latter study concluded that:

- a) The earlier projections of numbers of permanent residents were substantially correct and no major discrepancies in the earlier studies from recognized and acceptable parameters of demographic projections were noted.
- b) Projections beyond 10 miles, i.e., 10 to 50 miles, were in agreement with the earlier studies.
- c) Projections within 10 miles differed due primarily to the transient population.
- d) Hutchinson Island development is likely to cater to tourist or transient use of the island and luxury condominiums. The latter population group tends to be of a decidedly seasonal nature.

The maximum concentration of persons in the area, which accounts for the winter peak tourist season, is provided in Tables 2.1-1A through 1C. These provide the population distributions by sector and cumulative numbers for the winter peak season for 0 to 5 and 5 to 10 miles respectively.

Figure 2.2-1 shows the population density for 1970, 1980, 1990 and 2000 within a 5-mile radius of the site, sectioned into sixteen directional radii. Figures 2.2-2 and 2.2-3 combined, show similar information for 5, 10, 20, 30, 40 and 50 mile radii.

The cumulative population data for annular radii out to 50 miles is shown in Table 2.2-1D. The 1974 and 1970 figures for distances to 10 miles are provided in this table.

The population estimates have been derived from an analysis of 1970 census tract data and rates of migration and construction in the subject areas. The 1980, 1990 and 2000 projections have been formulated after a careful study of past trends and probable future commercial, residential and industrial development. In all cases, these figures are based on the most reliable information available. The methodology employed was in accordance with generally accepted economic research practices.

2.2.1.1 Population Within 10 Miles

Figure 2.2-1 indicates that the area within a 5-mile radius of the proposed site is sparsely populated at the present time. Hutchinson Island, within a 4-mile radius of the site, does not contain any population at present. The present total population within the 10-mile radius (Figure 2.2-2) is estimated at over 47,000. The largest concentrations of population exist in Sectors WNW, NW and S. Population in the western sectors is not concentrated in any one area, and the population density in these areas is low. However, the area in the 5 to 10 mile arc is good land and, in many cases, has been subdivided. There is a strong indication that this is the area that will experience the bulk of population growth within the next 28 years for the Fort Pierce area.

Fort Pierce, the county seat of St. Lucie County, is located a little north of the center of the county, a distance of 8 miles from the site, and on the Indian River, which is part of the Intracoastal Waterway. Its 29,721 inhabitants account for 60% of the entire county's population.

Other population clusters are located to the Southwest at Port St. Lucie; in the north at Lakewood Park; adjoining Fort Pierce at Sunland Gardens, Harmony Heights and Paradise Park; and in the east-central section is Collins Park Estates.

The future trends of population in the 0 - 5 mile and 5 - 10 mile zones, measured from the plant on Hutchinson Island have been analyzed. Hutchinson Island, having more than a 25-mile stretch of ocean and beach frontage, will have a population made up not only of permanent residents but of a considerable number of transients. The same can be said of the LPZ area where it touches the mainland. In addition, it is noteworthy that among the permanent residents, will be those who own there Florida residences as second homes. These second homes characteristically are utilized only for a month or two during the year. Northern residents owning such second homes in Florida tend to occupy them in the winter time (usually February or March), while southerners who own second homes on beach fronts in Florida tend to occupy them during the summer, in July or August.

In addition to the distinct transient nature of the population, the area tends to be further subdivided by a distinct seasonality. The winter season in Florida by and large extends from December through the end of April, but the accent tends to be in February and March. During this period northerners migrate to Florida staying a month or more in the traditional Florida winter season tourist fashion. Summertime visitors and transients tend to be limited to their summer vacation, i. e. a week, 2 weeks, or 3 weeks, and are usually on the move either in campers or by car or station wagon. Such tourists are oftentimes on a trip throughout the state to see different areas, and therefore are likely not to stay for more than two or three days or possibly a week. The peak months of the winter, February and March, and the peak months of the summer season, July and August, see the highest use of transient and tourist facilities, catering to different types of clientele. Transient and permanent population estimates are provided in Table 2.2-1C.

With regard to permanent residents, summertime travel vacations tend to reduce the number of permanent residents present at any given time. At any given time it is estimated that between 10% and 20% of the year-round population is away during the summer months of July and August. This likely reduction in permanent population is not reflected in Table 2.2-1C, i.e., the figures therein tend to overestimate the permanent population during the summer.

The single-family home has tended to dominate the area along the coast opposite Hutchinson Island in both Martin and St. Lucie Counties. However, in the last several years the rising expense of building and much higher land costs has resulted in the recent trend to the multi-family dwelling and the condominium. On Hutchinson Island, condominium developments over the past two years have been aimed at a retirement market and at a second home market. At the present time and for the foreseeable future they tend to be occupied at a higher rate during the winter months than in the summer months. Many such units are owned by out-of-the-state residents who typically occupy them for a month or two a year with perhaps an occasional rental to friends and leaving them empty for the rest of the year.

There may come a time when condominiums along the beach will be permanently occupied the entire year by residents, but this is not in sight yet. Even those who are retired or live in some of the condominium developments that have been built on Hutchinson Island may be year-round residents but tend to leave for the summer months for either their second original home, or for cooler climates. While it is conceivable that as times goes on the general amenities of the area will improve and make living on the Island year-round more pleasant, it is more likely that the increasing significance of the tourist and recreation industry on the Island and nearby will tend to create a sense of transiency and impermanence. Thus, it is expected that in the summer the area will serve a transient tourist population, and in the peak winter months the area will serve more of the permanent condominium owners.

In any case, these two occupational peaks will see valleys in the months of May and June and in the months of September through December, when the transient population and the tourist industry will be relatively dormant on the island and nearby mainland. This is true throughout Florida and has been so for the last 50 years of tourist economic history in the state.

Finally, the permanent population may further be affected by the lack of permanent employment in the area and the relatively narrow economic base on which the entire area rests. Hutchinson Island is backed by a hinterland in St. Lucie and Martin Counties, where employment, while varied, is not to be found in depth. There are few large employers within the 10-mile and indeed within the 50-mile circle - from the proposed St. Lucie plant, and although the economy is slowly broadening, the small size of the urban areas such as Stuart, Fort Pierce and others do not form an economic foundation on which large, sophisticated or expanded gainful employment may be forthcoming. Under normal circumstances, urban areas foster and develop their own employment and their size to some extent becomes a function of the jobs created within the so-called market area. While employment has been expanding slowly in the Martin County and St. Lucie County area, there are no signs that either the supply of labor sufficient

to support major industrial plants or manufacturing employment is present, nor is there any sign that the area offers economic or locational inducements sufficient to justify a location of any major employer in the area. Thus, the area will likely cater to those who are retired and those who have incomes generated from other sources of capital, from the return on principal or on retirement pools of income originating in other parts of the country.

Building costs and land costs are rising sharply in the area, and present indications are that condominiums in and around Hutchinson Island, now running between \$50,000 and \$110,000 in cost, will be \$75,000 to \$150,000 in the near future. There are few if any new rental apartments in the area to house those on limited incomes or in retirement. Market support for the development of expensive condominium residences is present in the area, but is relatively limited to the affluent, any of whom use these condominiums as second homes, and that the permanent residents of the area will tend to live more inland, in rental houses, smaller multi-family developments or in single-family homes inland, where shelter and land costs are less.

Studies conducted to date indicate that the land available for development on Hutchinson Island will be almost totally utilized by the end of this decade (by 1980) and that the high cost of land and construction will result in the building of expensive condominiums, a limited number of middle-price (\$40,000 - \$60,000) condominiums, luxury motels and the construction of more camper condominium sites for the mobile and travel-conscious clientele. The Island will thus tend to be a haven for the well-to-do, with two seasonal peaks, one in March and one in July. Few if any rental or other apartments available for people actually gainfully employed in the area will be constructed. Most evident will be a number of luxury condominiums in the \$75,000 to \$150,000 price class, with perhaps half or more of the units occupied by people who use them less than two months a year.

Although population growth of the magnitude discussed therein is conceivable, all studies to date indicate such growth is highly unlikely. The bases are:

1. The relatively limited number of ways to reach Hutchinson Island tend to limit residential development there.
2. The addition of an extra causeway or two to the area is likely to expand the area's use, however, as a tourist and recreation area, because of an increasing interest in such natural ecological areas.
3. Lack of additional fresh water on the Island at this time and the difficulties inherent in developing additional water resources for the Island will tend to reduce the attractiveness of the Island for permanent development.
4. The sharply increasing cost of land and of construction on the Island will tend to restrict development to fairly dense use such as condominiums and the like.

5. The lack of depth of the economic base of the St. Lucie/Martin County area and the lack of any significant employers or job opportunities in the area tend to limit Hutchinson Island particularly, and the area along the Indian River either to fairly affluent retirees living in luxury condominiums or transients seeking a view of the ocean and beach.
6. Stringent development laws, tough zoning restrictions, public and official opinions will tend to limit mass development of Hutchinson Island.
7. The Island will see high seasonality of use with peaks in winter and summer.

6

2.2.1.2 Population Between 10 and 50 Miles

The area within the 50-mile radius (Figure 2.2-3) contains an estimated total population of over 310,000. Over 70% of these people reside outside of a 25-mile radius from the site. The major population concentrations are found along the Florida coast line -- principally to the south. During the next 28 years, the area depicted in the figures as Sector H will experience the largest population growth. This sector (H) encompasses the northern portion of what is known as the Florida Gold Coast.

The 1970 census (1) confirms the long range estimates made earlier and gives the 1970 population of major cities within a 50 mile radius: Ft. Pierce, 29,721; Stuart, 4,820; Indiantown, 2,285; Vero Beach, 11,908; Okeechobee, 3,715; West Palm Beach, 57,375.

6

Nearly one-quarter of the population of Martin County live in Stuart, a city of 4,820 inhabitants in 1970. Another population cluster of 2,283 persons is at the small city of Indiantown which is located in the south-central portion of the county, about 26 or 27 miles southwest of the plant site. Small concentrations will be found at Port Sewall, Salerno, Gomez and Hobe Sound. These small communities are along the Waterway south and east of Stuart, ranging from 11 to 22 miles from plant site.

Of the 1970 population, about 68% are concentrated in and around the Indian River county seat of Vero Beach, a city with 11,900 people. Approximately 10,000 people live in the northeastern eighth of the county and 2,000 are spread very sparsely around the western two-thirds to three-fourths of the county.

The Okeechobee county seat, the City of Okeechobee, has the only large concentration of population. Its nearly 4,000 citizens comprise about 38% of the population of the county. The remainder of the inhabitants are scattered over a very wide area.

Of the total estimated 350,000 persons in Palm Beach County, about one-third are living within the study area. Of that portion, 95% live in the coastal region, clustered near the City of West Palm Beach. About 6,000 persons live on the shore of Lake Okeechobee in the Pahokee area, about 45 miles from the plant site.

There are no main concentrations in that portion of Brevard County which is included in this report. There is, however, a small urban development in the Sebastian Inlet area.

The areas under study in Osceola, Highlands and Glades counties are very sparsely populated.

2.2.1.3 Low Population Zone

On the basis of the investigation of population density and land use, the Applicant has determined that the area lying within 5 miles of the plant is presently and likely will remain sufficiently low in population density to be considered a low population zone. The area contained, in 1968, 1,980 persons and is projected to have a maximum of 12,150 persons by the year 2000.

The Regulatory Staff has concluded that in its opinion it is conceivable that during the plant lifetime the population growth on Hutchinson Island could grow to a level such that a future reduction in the low population zone (LPZ) might be required. By copy of its September 3, 1974 letter the Staff required that modifications of engineered safety features be implemented to accommodate an LPZ of as little as one mile, i.e., to a point where essentially all land within the LPZ is owned by the Applicant. The growth potential within 10 miles of the facility is discussed in Section 2.1.3.1. Studies to date indicate that the growth contemplated by the Staff, although conceivable, is most unlikely. Nonetheless, modifications will be incorporated in the design to insure compliance with 10 CFR 100.11 (a) (2) dose requirements at one mile.

2.2.1.4 Transient Population (See also Section 2.2.1.1)

Housing and transient tourist resort developments built, under construction or planned on Hutchinson Island in the 0-to-5 mile zones and the 5-to-10 mile zones north and south of the facility has been evaluated as of July 24, 1974. The study reveals that the Island is somewhat more developed to the south than to the north, largely beyond the LPZ in the 5 to 10 mile zone. There are about 20 completed major buildings, condominium, or resort developments on Hutchinson Island as of July, 1974 and at that time there were 8 building projects under construction, and 9 apartment projects in the planning stage. Several of them have been in the planning stage for several years.

The area south of the plant is predominantly condominium and trailer/camper or transient accommodations. The northern end of the Island beyond the LPZ along AlA and the Causeway is dominated by a number of smaller motels, efficiencies and some sizeable single-family homes which have been there for some time, representing the beach area east of Fort Pierce.

South of the plant, the area includes Outdoor Resorts, a camper development of 1,300 campers about 4.9 miles south of the plant on Nettles Island, plus about 125 motel rooms. The southern edge of the 5-mile LPZ ring therefore is to a large extent transient, the only permanent residents being fewer than 100 families permanently resident year-round on Nettles Island. Beyond the LPZ, the 5-to-10 mile zone to the south, there are some 517 condominium units, and some 801 transient units. Of these, 709 are camper sites in Venture Out and Holiday Out, and 92 in the motel, Holiday Inn. Thus, to the south of the 2,643 existing units, 2,126 units or 80% are transient rather than permanent residents.

The most important center of recreational activities in the vicinity of the plant is the Savannas Recreation Area, located approximately five miles west-northwest of the plant. Operated jointly by the City of Ft. Pierce and St. Lucie County, it features boating, fishing, swimming, camping and picnicking. Overnight campers totaled approximately 9000 during a recent 12-month period, while 160,000 day visitors were reported.

Monthly records of the attendance at the Savannas Recreation Area are maintained by the Fort Pierce-St. Lucie County Playground and Recreation Board. From these records the maximum daily attendance for this area during the period of October, 1972, through September, 1973, is estimated to have been 1,040 visitors. This estimate is based on the tally of the peak attendance in the month of June, 840 visitors per day average, plus the largest single registered group, representative of the maximum expected deviation from the average. Public park areas are located at the north end of Hutchinson Island. The nearest park to the St. Lucie Plant site (and furthest from Ft. Pierce) Douglas Memorial, is more than five miles north of the plant. It is lightly used, averaging 25-50 visitors per day during the summer, with few visitors during the winter. A public beach and park is located approximately seven miles south of the plant. It is estimated that 50-100 persons will wander for no longer than an hour along the ocean beach adjacent to the plant each day. Other recreational activities in the vicinity of the plant include surfing and fishing in the ocean, and fishing and boating in the Indian River. Ducks are hunted on Hutchinson Island in season. Participants in these activities within several miles of the plant are few in number. Shellfishing in Indian River is currently prohibited by order of the State Board of Health.

The city of Stuart is a boating and fishing resort, and boatmen and fishermen increase the transient population on both a year-round and seasonal basis.

A scenic attraction, McKee Jungle Gardens, about three miles south of Vero Beach on U. S. #1 and a horse breeding farm at Fellsmere bring visitors to those areas.

2.2.1.5 Population Center

The nearest "population center" is the city of Fort Pierce at an air-line distance of eight miles in a northwest direction from the containment building, 1.6 times the distance from the plant to the outer boundary of the low population zone.

2.2.1.6 Public Facilities and Institutions

The Fort Pierce Memorial Hospital is located eight miles northwest of containment building (12 miles distant by highway). Douglas Memorial Park is located more than five miles north of the containment building. A public park and beach is located approximately seven miles south of the containment building.

Five small municipal parks are located within the city. Jonathan Dickinson State Park is located in the southeastern corner of the county, south of Jupiter. It covers some 16 or 17 square miles and lies within 29 miles of the plant site. Its facilities include picnic tables, refreshments, boat ramps and camp sites.

2.2.2 REGIONAL LAND USES

The area studied extends fifty miles in all directions from the plant site. Included in the study area were all or parts of nine counties of Florida: St. Lucie, Martin, Indian River, Okeechobee, Palm Beach, Brevard, Osceola, Highlands and Glades.

The gross area studied is 7,854 square miles, more than one-half of which is water -- represented by the Atlantic Ocean, the Indian and St. Lucie Rivers, and Lake Okeechobee. It will be observed from Figure 2.1-7 that a line running southerly from a point $22\frac{1}{2}^{\circ}$ west of north, through the plant site, to a point $22\frac{1}{2}^{\circ}$ east of south very closely parallels the Intracoastal Waterway and the Atlantic Ocean shoreline. This, in effect, cuts the land area to about half of the total 7,854 square miles mentioned earlier. From this can be subtracted about 350 square miles of Lake Okeechobee. Some 125 square miles of water in the Indian and St. Lucie Rivers, forming part of the Intracoastal Waterway can also be deducted. Approximately 75 square miles of the Atlantic Ocean between Jupiter Inlet and Palm Beach should be subtracted. When these total deductions of approximately 550 square miles of water are deducted from one-half of the gross area, there remains about 3,375 square miles of land area, but with no deductions for small lakes. An examination of U. S. Navy Hydrographic Office Chart #1290 and U. S. Coast and Geodetic Survey Chart #1247 reveal no apparently habitable land masses in that portion of the Atlantic Ocean which is included in the gross area of the study.

The overall impressions gained as a result of the study of the subject areas were:

- a) An expanding area of the East Coast of southern Florida, having four principal concentrations of population -- around the cities of Vero Beach, Fort Pierce, Stuart and West Palm Beach -- all located in the coastal region;

- b) An area of low, mostly flat land with elevations running from 50 feet in the western portion to sea level on the east. The central sections are about 20' to 25' above sea level. Swampy areas such as the St. Johns Marsh, Loxahatchee Slough, Allapattah Flats and a portion of Big Cypress occupy large parts of the study area;
- c) Agri-business is the dominant contributor to the commercial economy. Citrus, vegetable and flower culture; cattle raising, including dairying; and related enterprises such as packing houses, processing plants, farm equipment and fertilizer sales are spread throughout the area;
- d) The tourist attractions, and hence heavier seasonal concentrations of population, are found along the Intracoastal Waterway.
- e) The general impression is one of a large area which will expand its activities and population generally in the coastal regions with more gradual expansion of the agricultural economy to the westward.

2.2.2.1 Agricultural Land Use

Tables 2.2-1, 2.2-2 and 2.2-3 show selected statistics on agriculture for six of the subject counties. Data for the counties of Osceola, Highlands and Glades are not presented because of the minimal area of these counties that lies within the 50-mile radius. For all practical purposes, agricultural activities within the six county area portrayed in the following tables can be considered as representative of the study area as a whole.

The statistics shown in Tables 2.2-1 and 2.2-2 pertain to the entire spectrum of agricultural activity in the subject counties and describe these activities by type and by quantitative production measurements. Table 2.2-3 in turn provides specific data for dairy activities. As shown in the table, Okeechobee and Palm Beach Counties exhibit a considerably greater degree of dairy farm activity than the other four counties. In Okeechobee County, the bulk of dairy farm activities can be generally identified as being in those portions of Sectors L and M in the 25 to 50 mile arc. Although only the northern portions of Palm Beach County are included within the 50-mile radius, it appears that it is in these areas that most of the dairy farm activity is found. That portion of Sectors I and J in the 25 and 50 mile radius is the area of Palm Beach County where the bulk of dairy farm activity is concentrated.

The bulk of dairy farm activities in Martin, Indian River and St. Lucie Counties take place in Sector J, 10-25 mile arc; Sector N, 25-50 mile arc; and Sectors N and M, 10-25 mile arc, respectively. Dairy activity in Brevard County is relatively insignificant and that which exists is not within that portion of the county that comes within the 50-mile radius.

SL2

TABLE 2.2-1A
0-5 MILE
REVISED SECTOR PROJECTIONS

Based on Winter
Permanent Peak Population Including Transients

SECTOR	Distance	1970	1980	1990	2000
<u>SSE</u>					
A	4-5	50	2910	3100	3160
B	3-4	0	400	575	630
C	2-3	0	0	0	10
D	1-2	0	0	55	80
E	0-1	0	0	0	0
<u>S</u>					
A	4-5	200	255	350	390
B	3-4	50	80	100	110
C	2-3	0	0	0	0
D	1-2	0	0	0	0
E	0-1	0	0	0	0
<u>SSW</u>					
A	4-5	100	120	150	190
B	3-4	100	180	185	205
C	2-3	100	160	210	270
D	1-2	0	0	0	0
E	0-1	0	0	0	0
<u>SW</u>					
A	4-5	100	1010	1120	1220
B	3-4	0	0	10	30
C	2-3	50	75	125	150
D	1-2	25	45	55	55
E	0-1	0	0	0	0
<u>WSW</u>					
A	4-5	245	750	810	850
B	3-4	10	50	60	100
C	2-3	105	120	130	140
D	1-2	60	100	110	120
E	0-1	0	0	0	0
<u>W</u>					
A	4-5	200	285	320	575
B	3-4	15	80	130	180
C	2-3	85	125	200	220
D	1-2	20	40	40	40
E	0-1	0	0	0	0
<u>WNW</u>					
A	4-5	150	370	400	460
B	3-4	105	130	255	305
C	2-3	55	85	100	100
D	1-2	0	0	0	0
E	0-1	0	0	0	0
<u>NW</u>					
A	4-5	120	135	160	190
B	3-4	35	65	65	65
C	2-3	0	0	0	0
D	1-2	0	0	0	0
E	0-1	0	0	0	0
<u>NNW</u>					
A	4-5	0	675	785	875
B	3-4	0	300	400	480
C	2-3	0	200	300	350
D	1-2	0	0	0	50
E	0-1	0	0	0	0
<u>N</u>					
A	4-5	0	0	0	0
B	3-4	0	0	0	0
C	2-3	0	0	0	0
D	1-2	0	300	500	550
E	0-1	0	0	0	0
TOTALS		1980	9045	10800	12150

SL2

TABLE 2.2-1B

0-10 MILE
REVISED SECTOR PROJECTIONS

Based on Winter
Permanent Peak Population Including Transients

SECTOR	DISTANCE	1970	1980	1990	2000
<u>SSE</u>	0-5	50	3310	3730	3880
	5-10	590	4150	5500	6250
<u>S</u>	0-5	250	335	450	500
	5-10	4000	5200	7300	9250
<u>SSW</u>	0-5	300	460	545	665
	5-10	1325	2160	2950	3800
<u>SW</u>	0-5	175	1130	1310	1455
	5-10	1210	3450	4250	5650
<u>WSW</u>	0-5	420	1020	1110	1210
	5-10	940	2950	4000	4300
<u>W</u>	0-5	320	530	690	1015
	5-10	900	1050	1450	1800
<u>WNW</u>	0-5	310	585	755	865
	5-10	9150	11750	14440	17420
<u>NW</u>	0-5	155	200	225	255
	5-10	26225	31940	41700	51550
<u>NNW</u>	0-5	0	1175	1485	1755
	5-10	2750	4650	5850	6700
<u>N</u>	0-5	0	300	500	550
	5-10	0	0	0	0

TABLE 2.2-1C

ESTIMATED AND PROJECTED NUMBER

OF PERMANENT RESIDENTS AND TRANSIENTS

WITHIN TEN MILES OF THE ST. LUCIE PLANT SITE

WINTER PEAK SEASONS (FEBRUARY - MARCH)

1970 - 2000

Year	Permanent			Transients		
	0 - 5 Miles	5 - 10 Miles	TOTAL	0 - 5 Miles	5 - 10 Miles	TOTAL
1970	1,680	45,340	47,020	300	1,750	2,050
1974	3,350	50,885	54,235	3,130	3,400	6,530
1980	5,145	63,300	68,445	3,900	4,000	7,900
1990	6,300	82,740	89,040	4,500	4,700	9,200
2000	7,250	101,520	108,770	4,900	5,200	10,100

TABLE 2.2-1D
CUMULATIVE POPULATION DATA*
FOR ANNULAR RADII

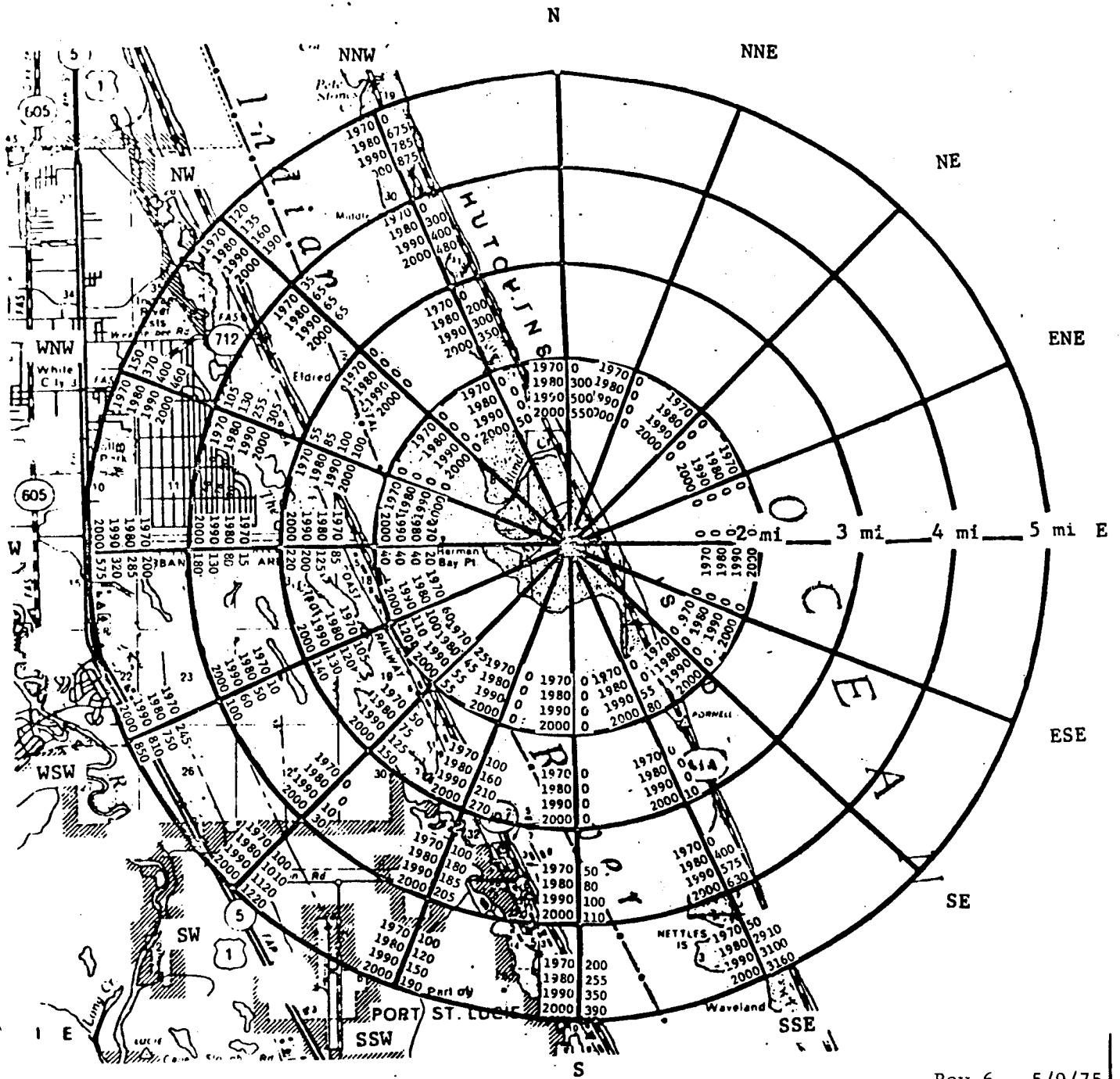
Miles	0-1		1-2		2-3		3-4		4-5		5-10		10-20	20-30	30-40	40-50
Year	1970	1974	1970	1974	1970	1974	1970	1974	1970	1974	1970	1974	_____	_____	_____	_____
1970	0	0	105		175		235		650		45,340		24,450	47,950	55,950	126,300
1980	0	0	140	485	250	765	340	1,285	860	6,510	61,150	67,300	42,284	77,100	82,700	181,800
1990	0	0	180	760	320	1,065	450	1,780	1,150	7,195	82,980	87,440	60,850	108,830	109,600	240,350
2000	0	0	220	895	410	1,240	595	2,105	1,575	7,910	102,800	106,720	76,400	138,900	119,700	300,800

* Estimates based on the 1970 census update and the 1974 study are shown for comparison in the region of interest, 0 to 10 miles.

2.2-17c

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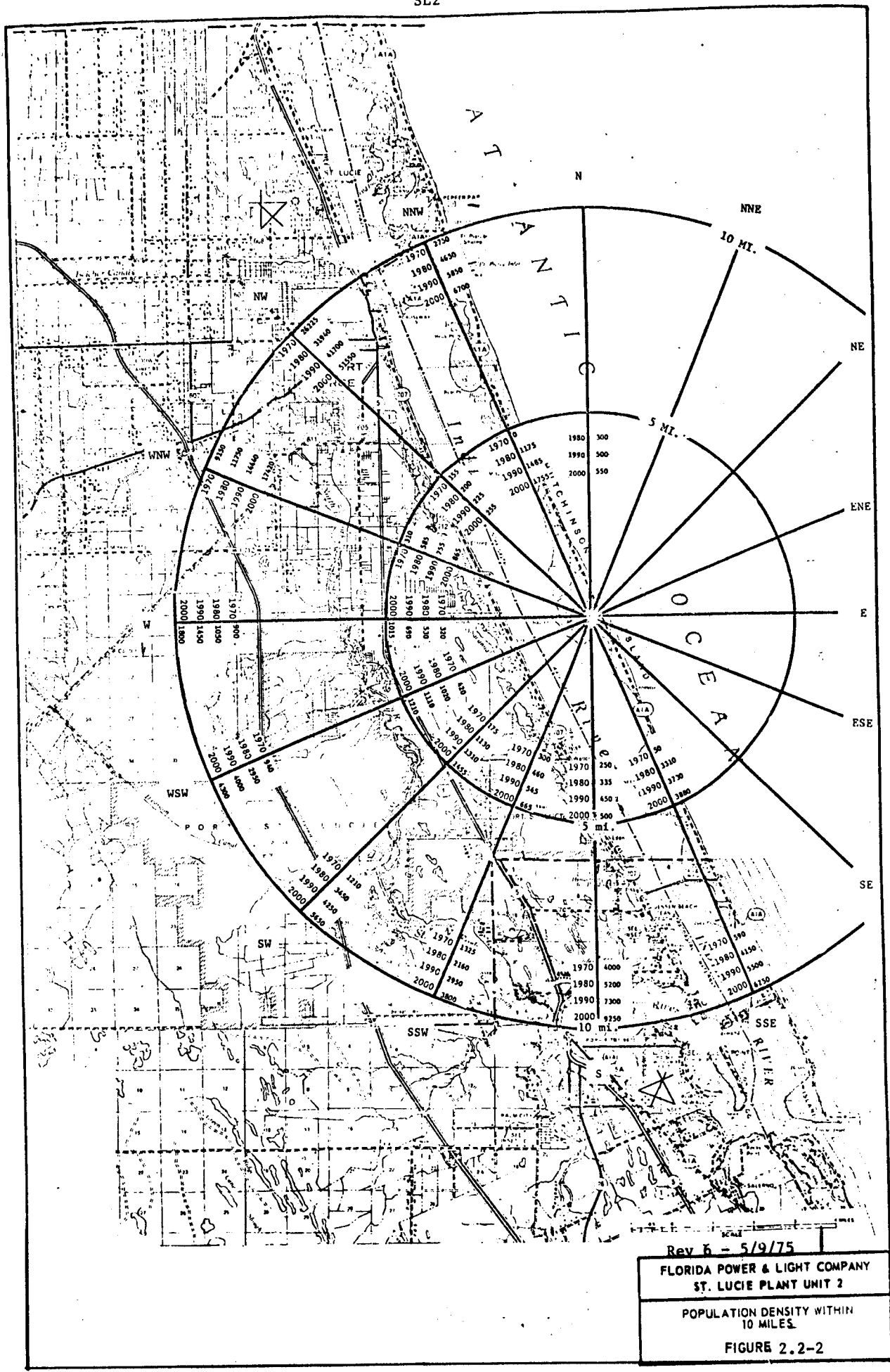


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SCALE 0 1 2 3 4 5 MILES

ST. LUCIE PLANT
POPULATION DENSITY

FIG. 2.2-1





October 10, 1975
L-75-494

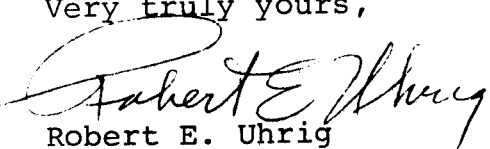
Director of Nuclear Reactor Regulation
ATTN: Roger S. Boyd, Deputy Director
for Reactor Projects
Division of Reactor Licensing
U. S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Boyd:

Re: St. Lucie Plant Unit No. 2
Environmental Report - Amendment No. 7
Docket No. 50-389

Enclosed for your review are two hundred (200) copies of Amendment No. 7 to the St. Lucie Plant Unit No. 2 Environmental Report. This discussion is presented in response to the letter, dated September 12, 1975, from the Nuclear Regulatory Commission concerning the means employed for keeping radioactive materials in plant effluents to unrestricted areas as low as practicable in accordance with Appendix I guidelines. Compliance with the September 4 amendment is chosen and information is provided as set forth in Enclosure 1 of the September 12 letter.

Very truly yours,


Robert E. Uhrig
Vice President

REU:nch
Attachment

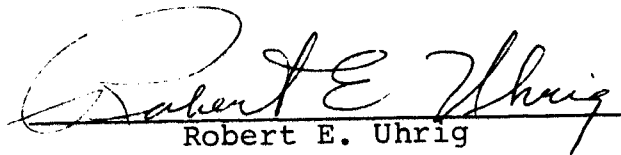
cc: Jack R. Newman, Esq.

STATE OF FLORIDA)
) SS
COUNTY OF DADE)

ROBERT E. UHRIG, being first duly sworn, deposes and says:

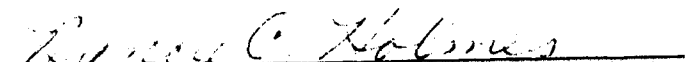
That he is a Vice President of Florida Power & Light Company,
the Applicant herein;

That he has executed the foregoing instrument; and that the
statements made in this said instrument are true and correct
to the best of his knowledge, information and belief; and
that he is authorized to execute the instrument on behalf
of said Applicant.


Robert E. Uhrig

Subscribed and sworn to before me

this 10th day of October, 1975


Notary Public in and for the County
of Dade, State of Florida

My Commission expires _____

NOTARY PUBLIC STATE OF FLORIDA at LARGE
MY COMMISSION EXPIRES AUGUST 27, 1979
BONDED THRU MAYNARD BONDING AGENCY

FLORIDA POWER & LIGHT COMPANY

ST. LUCIE PLANT UNIT 2

ENVIRONMENTAL REPORT

APPENDIX 5A

INFORMATION REQUIRED BY THE NRC TO ASSESS COMPLIANCE WITH THE OPTION PROVIDED
BY THE SEPTEMBER 4, 1975 AMENDMENT TO SECTION II D OF 10CFR50 APPENDIX I

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT NO 2

Revision 7

Instruction Sheet

Insert Appendix 5A directly behind Section 5

INTRODUCTION

Environmental Report Amendment 7 is submitted pursuant to the Nuclear Regulatory Commission's letter of September 12, 1975, which requested that Florida Power & Light supply additional information required to demonstrate compliance of St Lucie Unit 2 with the requirements of Appendix I to 10CFR50. Specifically, in its letter, the NRC has requested that Florida Power & Light (1) define whether it chooses to comply with either the design objectives contained in the September 4 modification of Appendix I or with the design objectives and cost-benefit analysis requirements of Section II of Appendix I and (2) having so selected, submit the answers to the appropriate set of questions contained in either Enclosure 1 (if the September 4 modification was selected) or Enclosure 2 (if the cost-benefit analysis was selected). Based upon the following reasons, Florida Power & Light believes that the St Lucie Unit 2 design is in compliance with the September 4 modification to Appendix I and accordingly will submit only the answers to Enclosure 1 at this time.

The St Lucie Unit 2 docket presently contains three separate analyses of the estimated offsite radiological impacts resulting from normal operation of the St Lucie plant. These three analyses, two performed by the Applicant and one performed by the AEC (NRC) staff, are defined below:

- 1) Applicant's analysis as presented in chapters 3 and 5 of the St Lucie Unit 2 Environmental Report and Chapter 11 of the St Lucie Unit 2 PSAR.
- 2) Applicant's independent analysis as presented at the Environmental and Site Suitability Hearings conducted by the Atomic Safety and Licensing Board in October, 1974 (see hearing transcript pages 2088-2232).
- 3) NRC's staff analysis as reported in the St Lucie Unit 2 Final Environmental Statement issued in May 1974.

The results of each of these analyses, along with a comparison with the guidelines of the September 4 modification to Appendix I, are summarized concisely in Table 5A-1. While a detailed analysis would show differences in some of the assumptions and models employed in making these estimates, it is significant that the results of the three separate analyses are all within the

September 4 guideline values. Accordingly FP&L has elected to submit the answers to Enclosure 1.

Florida Power & Light is however, aware of the NRC's present efforts to revise the models it presently employs to perform radiological assessment. FP&L is equally aware that new guidance when issued may impact previously performed analyses. Accordingly FP&L may reassess its current position based on any new NRC guidance that may become available.

TABLE 5A-1

ST. LUCIE UNITS 1 & 2

PLANT SOURCE TERM AND INDIVIDUAL DOSE ESTIMATES^(a)COMPARISON WITH ALAP CRITERIA^(b)

Source of Analysis	Liquid Releases Dose (mr/yr/site)		Liquid Releases Quantity (Ci/yr/unit) ^(f)		Gaseous Releases Noble Gases Dose (mr/yr/site)		Gaseous Releases Iodine Dose (mr/yr/site)		Gaseous Releases Iodine Quantity (Ci/yr/unit)	
	Calculated	Guideline	Calculated	Guideline	Calculated	Guideline	Calculated	Guideline	Calculated	Guideline
St. Lucie 2 ^(c) Environmental Report	0.0022 (whole body)	5 (whole body)	1.4	5	0.33 (whole body)	5 (whole body) 15 (skin)	1.8	15 (thyroid)	0.180	1
St. Lucie 2 ^(d) Environmental and Site Suit- ability Hearings- Applicants Testi- mony	0.012 (whole body)	5 (whole body)	0.304	5	0.62 (whole body)	5 (whole body) 1.63 (skin) 15 (skin)	3.1	15 (thyroid)	0.357	1
NRC ^(e) Final Environmental Statement on St. Lucie 2 May 1974	0.38 (whole body)	5 (whole body)	4.0	5	0.46 (whole body) 1.4 (skin)	5 (whole body) 15 (skin)	3.5	15 (thyroid)	0.310	1

(a) Source term estimates are on a per unit basis; dose estimates are on a per site basis (i.e., incorporating effects of St. Lucie Units 1 & 2).

(b) As described in Annex to 10CFR50 Appendix I (September 4, 1975).

(c) Applicant's source term (Tables 5.3-8 and 3.5-20 of Environmental Report) and individual dose (Table 5.3-1 of ER) estimates.

(d) Independent source term and individual dose estimates as presented by Applicant's witness W A Rodgers at pages 2089-2232 of St. Lucie Unit 2 hearing transcript. Source term estimates are contained in Tables 2 and 9 of witness Rodger's direct testimony and individual dose estimates in Table 21 of witness Rodger's direct testimony.

(e) NRC staff source term (Tables 3.3 and 3.4 of Final Environmental Statement) and individual dose (Table 5.3 of FES) estimates.

(f) Exclusive of tritium and dissolved noble gases.

Answer to Enclosure 1 Questions

Question 1

For each building housing systems containing radioactive materials:

- a. Provide a description of the provisions incorporated to reduce radioactive releases (iodine and particulates) from ventilation exhaust systems.
- b. Provide the location, height of release, inside dimensions of release point exit, effluent temperature and exit velocity.
- c. For the containment building indicate the expected purge and venting frequencies and duration, and the continuous purge rate (if used).

Answer 1a

Containment Building

The Containment Airborne Radioactivity Removal System is described in PSAR Section 12.2.2.2. HEPA filters and charcoal adsorbers will be utilized in this kidney system.

The Containment Purge System is described in PSAR Section 12.2.2.3. HEPA filters will be provided.

Reactor Auxiliary Building

The Reactor Auxiliary Building Main Ventilation System is described in PSAR Section 12.2.2.4. HEPA filters will be provided.

Fuel Handling Building

The Fuel Handling Building Ventilation System is described in PSAR Section 12.2.2.5. HEPA filters will be provided.

Steam Generator Blowdown Treatment Facility Building

HEPA filters will be provided.

Turbine Generator Structure

No ventilation system. The Steam Jet Air Ejector is the source of release of non condensable gases present in the secondary cycle. There are no filters provided on this discharge.

Answer 1b

Containment Building Purge

Location - Plant Vent (see Figure 5A-1)
Height - Elevation 203 ft⁽¹⁾
Inside Diameter - 70.75 inches
Temperature - 104°F at 93°F ambient ⁽²⁾
Exit Velocity - 4124⁽³⁾ ft/min

Reactor Auxiliary Building

Location - Plant Vent (see Figure 5A-1)
Height - Elevation 203. ft
Inside Diameter - 70.75 inches
Temperature - 104°F at 93°F ambient
Exit Velocity - 2586 ft/min

Fuel Handling Building

Location - Concrete Penthouse above Fuel Handling Building, with louvers facing north (see Figure 5A-1)
Height - Elevation 69 ft
Inside Dimensions - 25.2 sq ft louver free area.
Temperature - 104°F at 93°F ambient
Exit Velocity - (through louver) 817.46 ft/min

Turbine Generator Structure

Location - Steam Jet Air Ejector (see Figure 5A-1)
Height - Elevation 71.5 ft
Inside Diameter - 8 inches
Temperature - 160°F
Exit Velocity - 2253 ft/min

- (1) All elevations are above mean low water. Plant Grade = +18' MLW
- (2) When ambient temperatures are 70°F or above, the effluent temperature is generally 11°F greater than ambient.
- (3) This exit velocity is based on the combined CFM flow of both the Containment Purge and the RAB Ventilation System exhaust.

Steam Generator Blowdown Treatment Facility

Location - Rectangular louver on building's north side (see Figure 5A-1)

Height - Elevation 59.5 ft

Inside Dimensions - 40 sq ft louver free area

Temperature - 104°F at 93°F ambient

Exit Velocity - 1197 ft/min

Answer 1c

The Containment Purge System is operated following the reduction of iodine and particulate activity by the Containment Airborne Radioactivity Removal System. The purge system is used only when prolonged access to the containment is necessary (for example, weekend shutdown or refueling shutdown). The purge frequency is expected to be 4 times per year for a duration of 10 hours each time. See PSAR Section 12.2.2.3.

Question 2

For a pressurized water reactor having recirculating U-tube steam generators and employing all volatile treatment (AVT) to main secondary coolant chemistry, provide the following information:

- a. Expected blowdown rate (lb/hr) and method of processing blowdown.
- b. Number and type of condensate demineralizers (if applicable) and flow rate of condensate through polishing demineralizers (lb/hr).
- c. Expected frequency of resin regeneration or replacement, volumes and radioactivity of regenerant and rinse solutions, sluice water, or backwash water per batch of resin regenerated or replaced.
- d. Method of collection, processing and disposal of liquid wastes, including decontamination factors assumed for process operations.
- e. P&ID's and process flow diagrams for the steam generator blowdown system and condensate polishing system

Answer 2a

The total expected blowdown rate for normal operation is about 50 gpm or 18,900 lb/hr. Upon exiting the steam generator the blowdown stream is reduced in temperature and pressure and then filtered and demineralized if required. There are three separate processing trains in parallel, each consisting of a filter, a mixed bed demineralizer, and a cation demineralizer in series. After processing, the blowdown is sent to a monitoring tank where it is collected, sampled, and either released to the discharge canal or recycled. A detailed description of the method of blowdown processing is found in St Lucie Unit 2 PSAR Section 10.4.7. In the design basis analysis for the Steam Generator Blowdown Treatment System, it has been conservatively assumed that passage through one train (consisting of filter, mixed bed, and cation demineralizers) results in a DF of 100 for all isotopes other than tritium.

Answer 2b

Not applicable to St Lucie Unit 2 design.

Answer 2c

Since there is no resin regeneration, there are no regenerant, rinse or backwash wastes associated with the system operation. Sluice water, however, is used in the resin replacement operation. Both the mixed and cation bed resins are replaced after approximately 3 months of operation and approximately 1100 gallons of sluice water is used in the replacement of each bed. Hence it is expected that a total of 8800 gallons of sluice water will be generated each year. Concentrations of radioactivity on the resin (two beds) and in the sluice water at the end of 3 months operation are given in Table 5A-2. This table conservatively assumes that 10% of the resin activity is transferred to the sluice water.

Answer 2d

The only liquid waste, other than the blowdown stream, associated with the Steam Generator Blowdown Treatment Facility (SGBTF), is the sluice water used in the resin replacement operation. As noted in 2c a total of 2200 gallons of water is needed to replace both the mixed bed and cation bed resins each three months. The resins and sluice water are directed to the Spent Resin Tank (SRT) and thence to the Resin De-watering Tank (RDT). The sluice water drained from the SRT is either recycled or sent to the SGBTF Equipment Drain Tank. From the EDT, the water is pumped to the Liquid Waste System for treatment. PSAR Section 11.2-1 contains a description of the Liquid Waste System.

Answer 2e

Process flow diagrams for the Steam Generator Blowdown Treatment System are given in Figures 5A-2a, b, c

SPENT RESIN AND SLUICE WATER ACTIVITY

Sluice Water Needed For Two Beds	294 cuft (2200 gallons)
----------------------------------	----------------------------

3 months continuous operation
20 g/day Primary to secondary leakage
50 gpm blowdown rate
0.1% failed fuel

5A-9

Question 3

Provide a map showing the detailed topographical features (as modified by the plant) on a large scale within a 10-mile radius of the plant and a plot of the maximum topographic elevation versus distance from the center of the plant in each of the sixteen 22-1/2 degree cardinal compass point sectors (centered on true north), radiating from the center of the plant, to a distance of 10 miles.

Answer 3

Figures 5A-3 and 5A-4a,b,c,d provide the required information. Figure 5A-3 shows the detailed topographical features within a 10-mile radius of the plant while Figures 5A-4a,b,c,d provide plots of maximum elevation versus distance for each of the sixteen directions. Also provided is Table 5A-3 which gives the maximum elevation, and distance to the maximum elevation for each of the sixteen sectors.

TABLE 5A-3
MAXIMUM ELEVATION PER SECTOR WITHIN
10 MILES OF THE PLANT

Direction ⁽¹⁾	Elevation ⁽²⁾ (ft)	Distance from Plant (miles)
N	20	0.1
NNE	21	0.09
NE	20	0.08
ENE	21	0.09
E	21	0.05
ESE	22	0.08
SE	21	0.07
SSE	21	0.05
S	44	4.60
SSW	35	2.75
SW	38	0.40
WSW	26	10.00
W	30	2.22
WNW	25	3.03
NW	37	5.35
NNW	22	0.05

(1) Directions indicate line of sight.

(2) Elevation above mean low water.

Question 4

Provide representative annual and, if available, monthly summaries of wind speed and direction by atmospheric stability class, in joint frequency form from onsite data. If available, describe airflow trajectory regimes of importance in transporting effluents to a distance of 5 miles from the plant, including airflow reversals.

Answer 4

The low latitude of the St Lucie site is the principal influence upon the large scale air trajectories in the site vicinity, the sub-tropical high pressure ridge lies well to the north of the site during the summer and just to the north during winter. This pressure regime causes predominately easterly winds during all seasons. Macro-scale interruptions of the easterly flow consist of usually weak perturbation in the westerlies during the winter which occur rather infrequently; such systems during the summer are rare.

Superimposed upon the macro-scale easterly flow are sea breeze circulations associated with differential heating of land and water surfaces and local convective circulations associated with shower and thunderstorm activity. The sea breeze flow contributes approximately equally to easterly flow during day and to westerly flow at night. Convective circulations, which are primarily confined to the May-October period, are most prevalent during the afternoon and contribute to mean trajectory frequencies in an essentially random manner.

In general, macro-scale easterly trajectories dominate the local influences resulting in a substantial predominance of on shore flow. On site wind data (Table 2.3-6 St Lucie PSAR Unit 2), indicates that winds have an easterly component approximately 60% of the time. Complete trajectory frequencies are given in the on site joint wind speed, wind direction, stability tables (Tables 2.3-20 through 2.3-68, St Lucie PSAR, Unit 2).

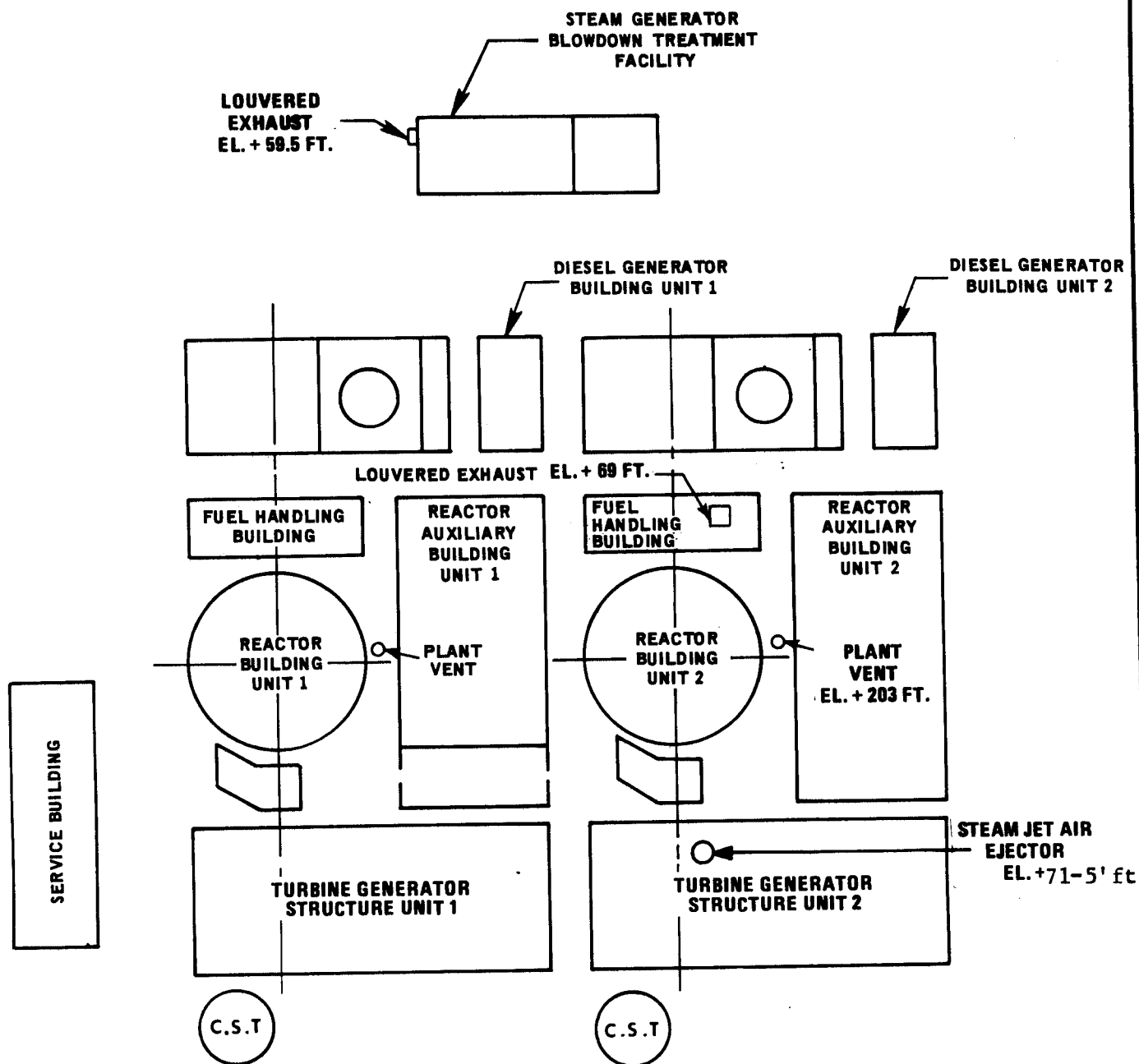
The near flatness of the surrounding topography results in negligible terrain induced alterations of air flow. Thus, the tower wind data at the site is considered meteorologically representative of air flow within a radial distance of five miles of the site.

Question 5

Tabulate, for each compass point sector radiating from the center of the plant, the location of the nearest existing milk producing animals (cows and goats) within 5 miles of the site.

Answer 5

As indicated in the Environmental Report for St Lucie Unit No 2, Section 5.3.1.2 (Rev 3-1/18/74), the nearest privately-owned cow is 7.5 miles SSW of the plant. A confirmatory survey of the area conducted in October, 1974, in support of the Environmental and Site Suitability Hearings, determined that there were no milk-producing animals within 5 miles of the plant. A similar survey was conducted by one of the employees in the FP&L Ft. Pierce office on September 28, 1975. The survey consisted of visual observation along all roads throughout the area within a 5 mile radius of the plant. In addition, the St Lucie County Agricultural Agent was contacted and FP&L meter readers working in the area were surveyed. As a result of the above activity, it was again determined that no milk-producing animals are located within 5 miles of the St Lucie Plant.



NOTE: ALL ELEVATIONS ARE ABOVE MEAN
LOW WATER. PLANT GRADE = 18' MLW

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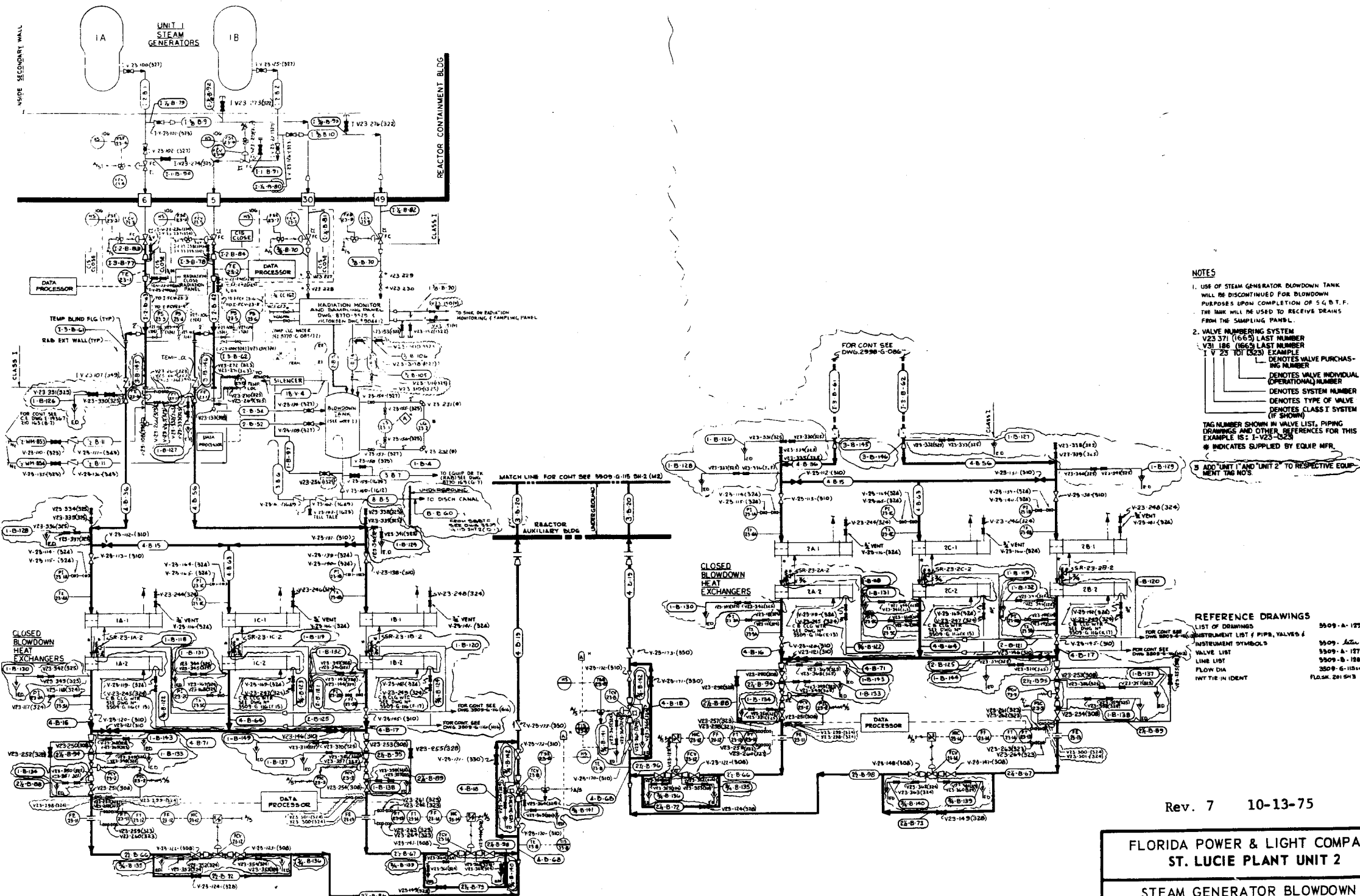
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

VENTILATION RELEASE
POINTS

FIGURE 5A-1

Image Quality

As you review the next group of images, Please note that the original documents were of poor quality.



- NOTES**
- USE OF STEAM GENERATOR BLOWDOWN TANK WILL BE DISCONTINUED FOR BLOWDOWN PURPOSES UPON COMPLETION OF S.G.B.T.F. THE TANK WILL BE USED TO RECEIVE DRAINS FROM THE SAMPLING PANEL.
 - VALVE NUMBERING SYSTEM
V23 371 (1665) LAST NUMBER
V31 186 (1665) LAST NUMBER
V 23 101 (323) EXAMPLE
 - 1 DENOTES VALVE PURCHASING NUMBER
 - 2 DENOTES VALVE INDIVIDUAL (OPERATIONAL) NUMBER
 - 3 DENOTES SYSTEM NUMBER
 - 4 DENOTES TYPE OF VALVE
 - 5 DENOTES CLASS 1 SYSTEM (IF SHOWN)
 - TAG NUMBER SHOWN IN VALVE LIST, PIPING DRAWINGS AND OTHER REFERENCES FOR THIS EXAMPLE IS: V-23-100
 - * INDICATES SUPPLIED BY EQUIP. MFR.
 - 3 ADD "UNIT 1" AND "UNIT 2" TO RESPECTIVE EQUIPMENT TAG NOS.

- REFERENCE DRAWINGS**
- LIST OF DRAWINGS
 - INSTRUMENT LIST / PIPES, VALVES & INSTRUMENT SYMBOLS
 - VALVE LIST
 - LINE LIST
 - FLOW DIA
 - INT TIE IN IDENT

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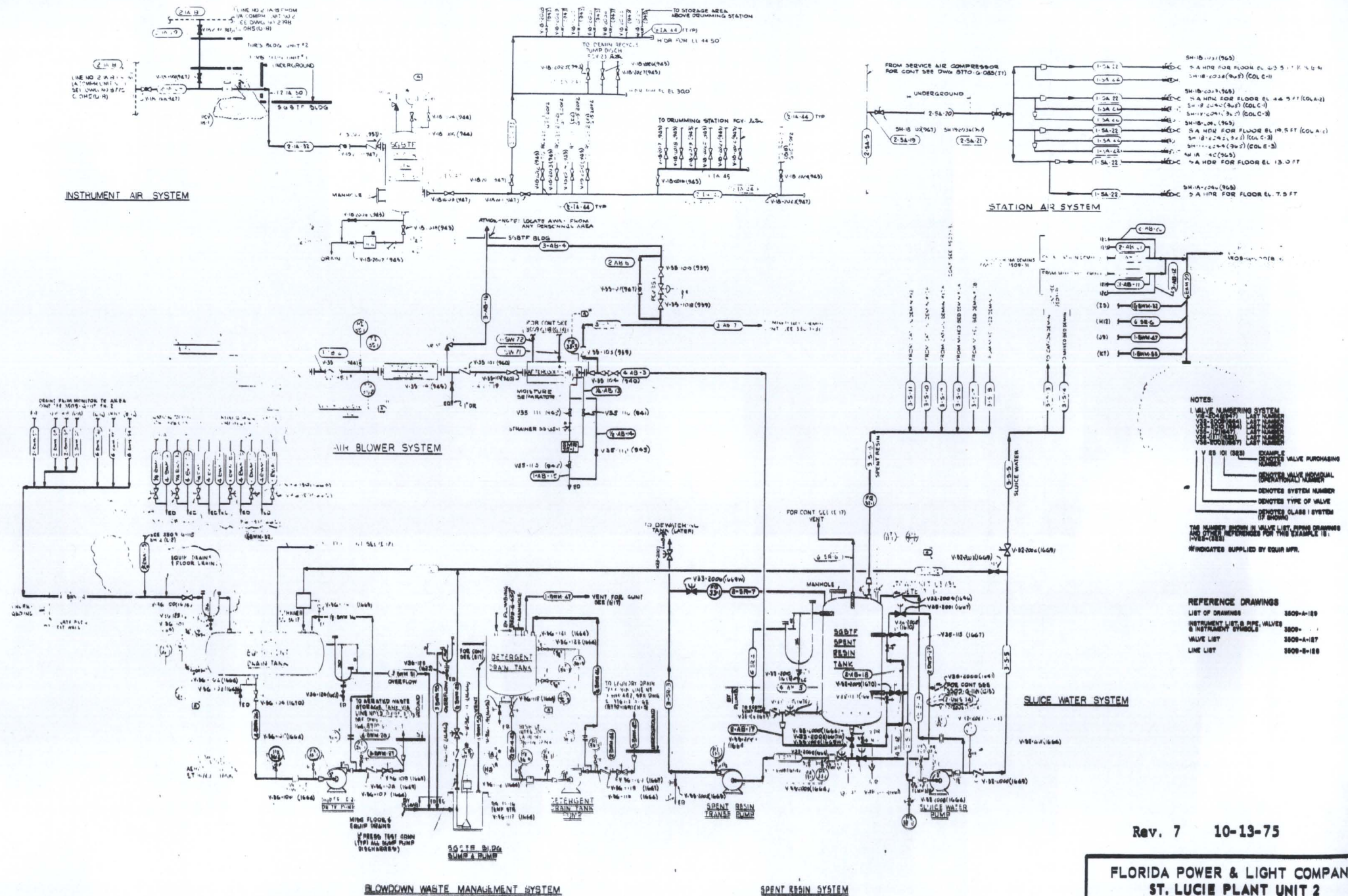
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

STEAM GENERATOR BLOWDOWN
PROCESS FLOW DIAGRAM
SHEET 1
FIGURE 5A-2a



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

STEAM GENERATOR BLOWDOWN
PROCESS FLOW DIAGRAM
SHEET 2
FIGURE 5A-2b

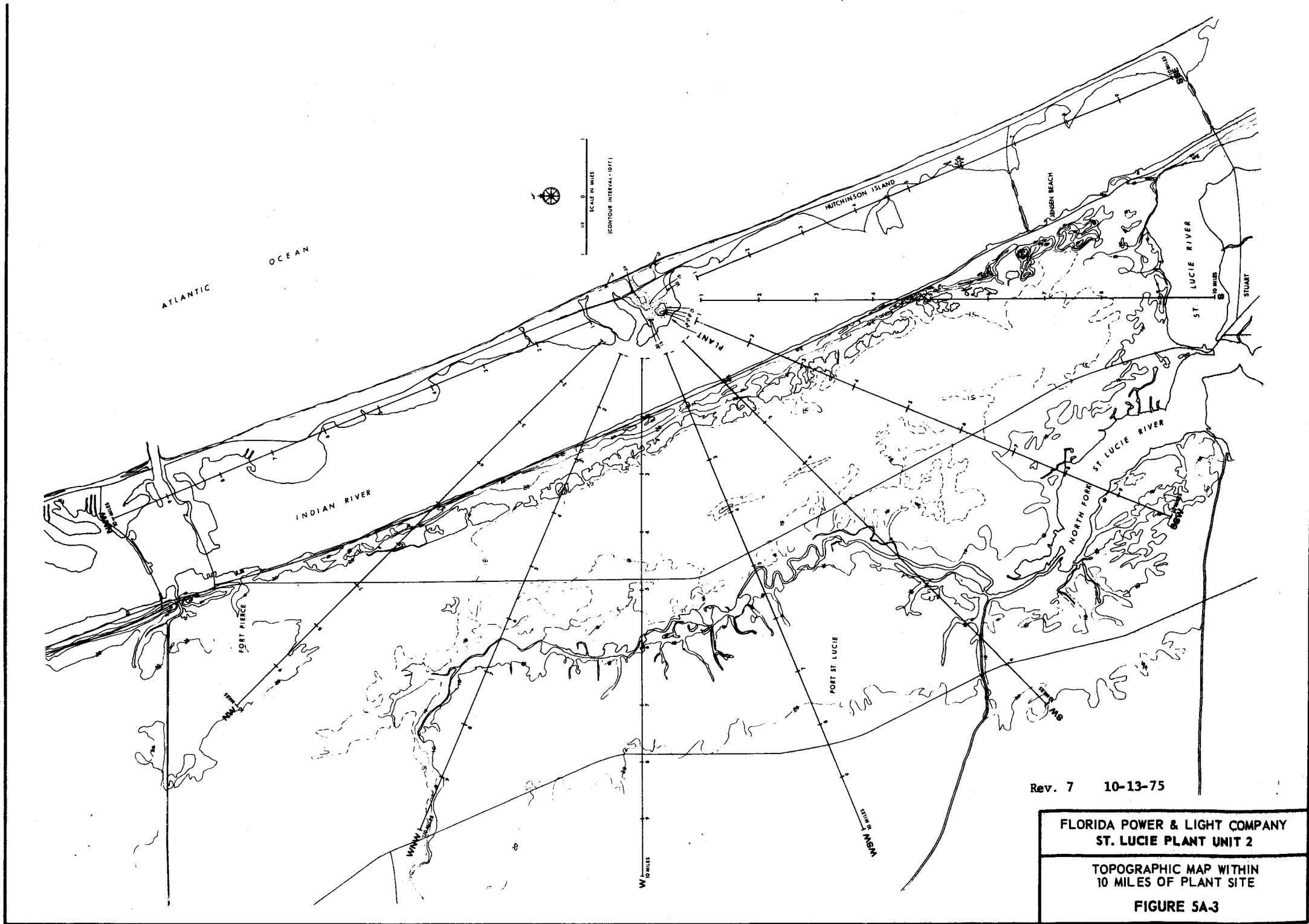


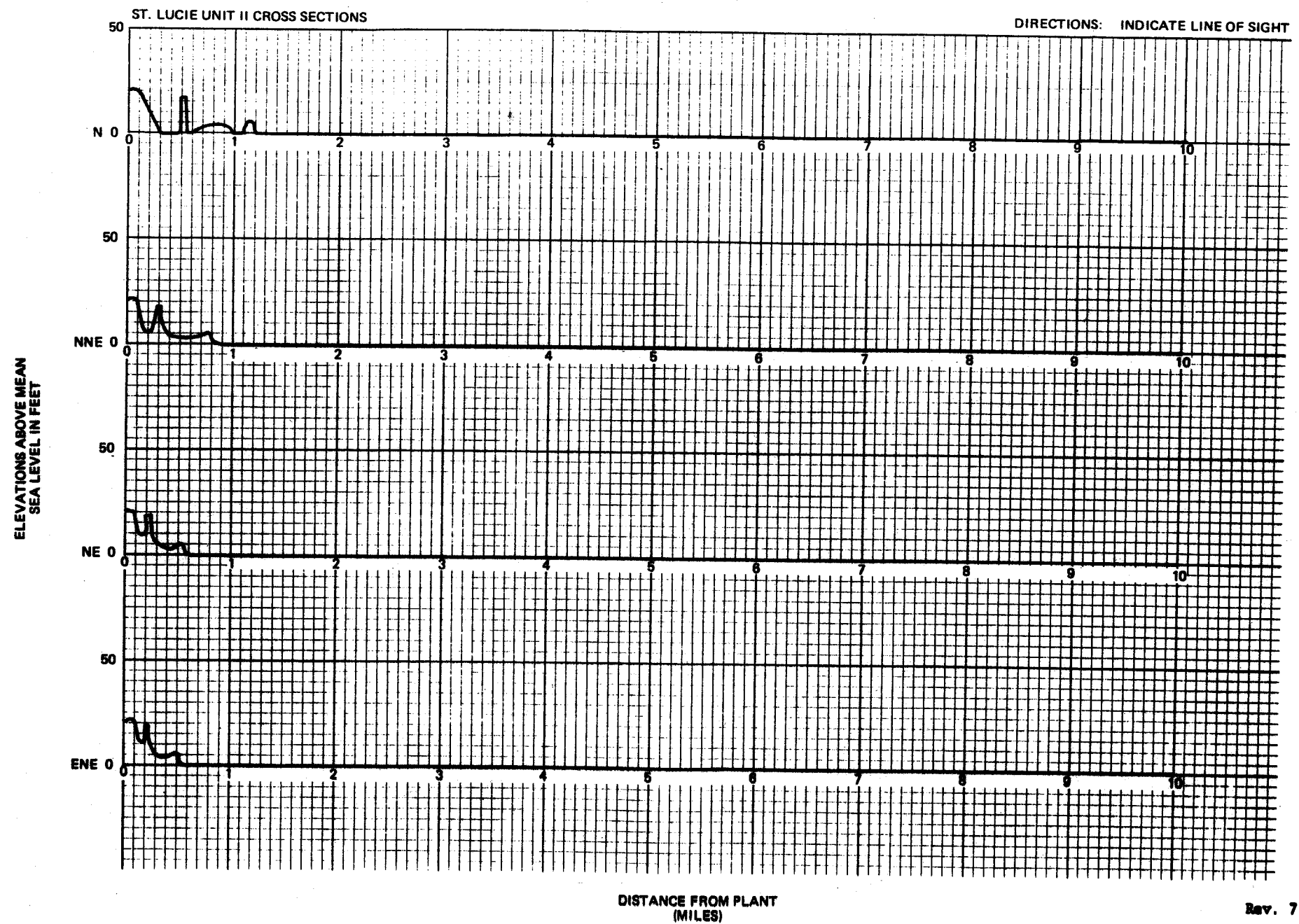
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FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

STEAM GENERATOR BLOWDOWN
PROCESS FLOW DIAGRAM
SHEET 3

FIGURE 5A-2c





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FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ELEVATION VS. DISTANCE
FOR EACH SECTOR WITHIN
10 MILES OF PLANT
FIGURE 5A-4a

ST. LUCIE UNIT II CROSS SECTIONS

DIRECTIONS: INDICATE LINE OF SIGHT

ELEVATIONS ABOVE MEAN
SEA LEVEL IN FEET



DISTANCE FROM PLANT
(MILES)

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FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

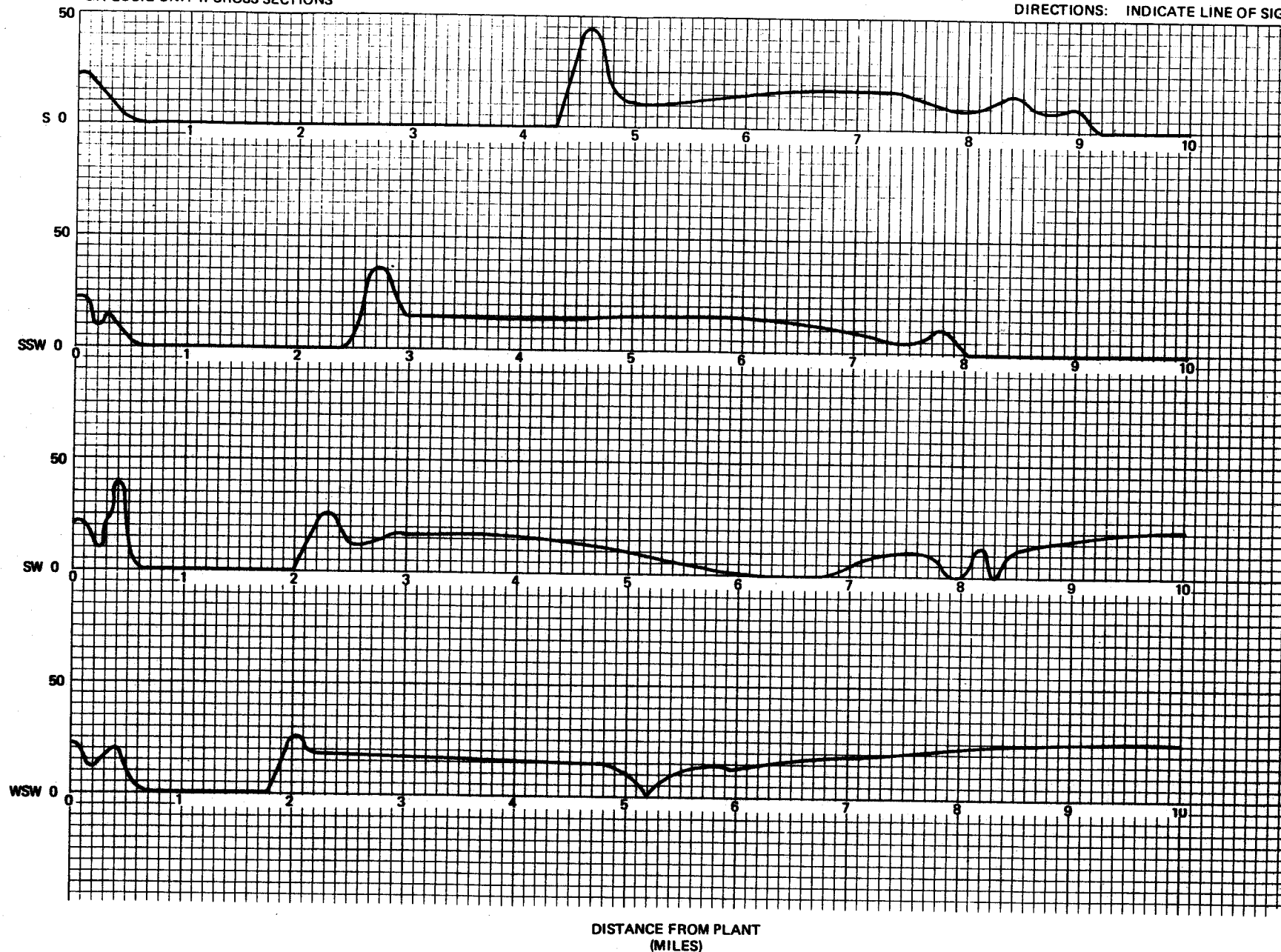
ELEVATION VS. DISTANCE
FOR EACH SECTOR WITHIN
10 MILES OF PLANT

FIGURE 5A-4b

ST. LUCIE UNIT II CROSS SECTIONS

DIRECTIONS: INDICATE LINE OF SIGHT

ELEVATIONS ABOVE MEAN
SEA LEVEL IN FEET



DISTANCE FROM PLANT
(MILES)

Rev. 7 10-13-75

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ELEVATION VS. DISTANCE
FOR EACH SECTOR WITHIN
10 MILES OF PLANT
FIGURE 5A-4c

DIRECTIONS: INDICATE LINE OF SIGHT



Rev. 7 10-13-75

**FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2**

**ELEVATION VS. DISTANCE
FOR EACH SECTOR WITHIN
10 MILES OF PLANT
FIGURE 5A-4d**

**10 OBJECTIVES OF THE
PROPOSED FACILITY**

1.1 REQUIREMENT FOR POWER

The requirement for new generating capacity from St. Lucie Unit No. 2 is best understood in the light of the historical growth of power requirements on Florida Power & Light's system together with projections of this growth into the future.

Florida Power & Light projects an 11.5% average annual growth rate in peak demand for the years 1974 - 1982. The Company's peak demand has been doubling approximately every 5 years for the past 15 years. To meet this projected growth, the current 1972 system capability of 6857 MW must be expanded to 22,081 MW by 1982. This expansion of system capability takes into account the necessity of maintaining an adequate reserve margin to preserve system capability and reliability.

In order to meet the capacity requirements resulting from this high annual growth rate Florida Power & Light will install a nuclear fueled generating unit with an 850 MW gross summer peak capability. This unit is required by 1980 to provide adequate generating capability to serve the projected loads.

1.1.1 DEMAND CHARACTERISTICS

The Florida Power & Light system is one of the most rapidly growing systems in the country. The increase in demand is due to the population growth in the State of Florida and increased per capita use of electricity. The 1970 census figures show that Florida's growth was second only to that of California when the total number of new residents is considered, and second only to that of Nevada on a percentage basis. The influx of people has since the end of World War II resulted in continually increasing demands for power. During 1972 Florida Power & Light experienced the addition of about 120,000 new customers. This rapid rate of load growth is documented further in the Florida Power & Light annual report 1972.(1)

For the 12 months ending in December 1972 the Florida Power & Light energy profile by load types was 50.7% residential, 29% commercial and 8.5% industrial. The remaining kilowatt-hour usages were 7.15% governmental, 3.9% municipal and Co-op systems and 0.75% other including street lighting. The peak hour demand has essentially the same ratio as the kilowatt hour sales. This basis distribution is not expected to change materially during the next 10 to 15 years. Florida Power & Light also has contracted commitments for power supply to certain non-owned distribution systems within the Florida Power & Light service area.

Table 1.1-1 and Figure 1.1-1 show the annual system peak hour demand for the years 1968 - 1972 and the forecast demand for 1973 - 1982. The actual peak loads for 1970, 1971 and 1972 reflect reductions due to load curtailment on peak which, for the most part, were voluntary.

Historically, the peak hour demand for Florida Power & Light system has occurred during the summer months of July, August or September. The subtropical climate together with the high proportion of residential and commercial load, 80% of total demand, and the consequent high saturation of air conditioning make the Florida Power & Light system's peak demand extremely weather sensitive. Figure 1.1-2 shows the annual load duration curves for 1970, 1971 and 1972. The expected load duration curve for the years 1973 - 1982 is shown in Figure 1.1-3.

Florida Power & Light maintains a forecast of peak hour demands and KWH energy sales for the system extending 20 years into the future which is reviewed and updated as deemed necessary, generally on an annual basis. Regression and correlation analysis of historical data are the means for extrapolating load trends into the future. The resulting forecasts are modified by comparison with various independently constructed forecasts for the nation and the Florida Power & Light service territory. The Florida Power & Light system is divided into five load areas. Load projections are made for the system as a whole and for each separate load area. The results of these various projections are then combined and modified to form a single consistent load forecast. Forecasts include all sales of power to municipalities and co-ops not covered by an interchange agreement.

1.1.2 POWER SUPPLY

1.1.2.1 Capacity Resources

Florida Power & Light utilizes economic fuel analysis and probabilistic reliability studies to aid in planning its bulk power supply. Table 1.1-2 shows the actual and planned generating capability by category for the years 1968-1982. The capabilities listed are "gross summer peak" expected at the time of system peak hour demand and reflect unit deratings due to higher ambient temperatures. At present, Florida Power & Light plans no capacity sales or purchases except on an emergency basis. Retirements were considered on the capability figures, however none are planned through 1982. This data is shown graphically on Figure 1.1-4.

1.1.2.2 Reserve Margin

The reserve obligation of FP&L to other Florida operating committee utilities (refer to the antitrust information furnished in the PSAR) consists of two operating requirements: one for spinning reserve and one for supplemental reserve. 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. Supplemental reserve is any generating capability and/or load relief measure which can be made fully applicable within 30 minutes or less. The spinning reserve requirement for each member utility is allocated in proportion to the participant's maximum demand in the preceeding year and the peak capability of its largest unit with the total reserve being equal to or greater than the peak capability rating of the largest generating unit in service. The supplemental reserve requirement is allocated in the same manner and is equal to or greater than the peak capability rating of the second largest generating unit in service.

The system reserve criterion for Florida Power & Light is established primarily on loss-of-load probability (LOLP) calculations based on system 15 minute gross peak demand, weekly load models (based on system history), and forced outage rates based on EEI published data which represent typical outage rates used industry-wide. All maintenance is scheduled to minimize the LOLP. Florida Power & Light attempts to maintain enough reserve margin to produce a LOLP of 0.10 days/yr with the spinning reserve requirement of all other companies in the Florida subregion of Southeast Reliability Council (SERC) available to it at a 0.010 forced outage rate.

The calculational program builds a capacity outage table from size and forced outage rate. After the individual units have been scheduled for maintenance, the program proceeds with the risk calculation.

To the peak load for each day the estimates of effective capability of units on maintenance are added. This quantity is subtracted from the system installed capability to determine the "Critical Outage" for each day. For each critical outage, the program's "Capacity Outage Table" will yield a "Chance" or "Expected Value" of the occurrence of this particular outage. These individual daily chances are totaled for the year, providing a loss of probability expected.

The program assumes that the critical outage for the peak of the day should be used as the design criterion for the passing on the adequacy of system installed reserve. If the system passes the peak hour, it passes the day. Similarly, if it fails the peak hour, a capacity shortage of one day is counted. Present and planned interconnections do not enter into reserve criterion except to insure the available transportation of spinning reserve power.

Figure 1.1-5 depicts the LOLP for Florida Power & Light through 1982. As can be seen a delay in the availability of St. Lucie Unit No. 2 would have a significant adverse effect on the reliability of the Florida Power & Light system. The data shown includes the effect of the 490 MW of spinning reserve available from other Florida subregion companies at the outage rate of 0.01.

1.1.3 SYSTEM DEMAND AND RESOURCE CAPABILITY COMPARISON

Figure 1.1-6 shows actual capability and peak demand data from 1968 through 1972 and forecasted data for 1973 through 1982. The resources capability and generating capability are identical since Florida Power & Light has no commitments for firm sales or purchases.

Figure 1.1-7 depicts the actual and projected reserve margin for the years 1968 through 1972 and 1973 through 1982 respectively. The system reserve is also shown without St. Lucie Unit No. 2 for the years 1980 through 1982.

1.1.4 INPUT AND OUTPUT DIAGRAM

The Florida Power & Light input-output diagram is shown in Figure 1.1-8 and for 1980, the first year of scheduled full power operation for St. Lucie Unit No. 2. The input has been broken down to indicate the 850 MW capability of St. Lucie Unit No. 2, 2306 MW of other nuclear generation, fossil capability of 17,798 MW and 2727 MW of gas turbine capability.

The output diagram is similarly broken down by load category. At the time of system peak hour demand the loads are expected to be composed of 7645 MW residential, 4375 MW governmental and 700 MW for municipalities, Co-ops and others. The peak hour demand of 15,090 MW leaves a reserve of 2591 MW with the 17,681 MW of generating capability.

1.1.5 REPORT FROM THE REGIONAL RELIABILITY COUNCIL

Florida Power & Light is a part of the Florida subregion of the Southeast Reliability Council (SERC). The Florida subregion requires an installed reserve equal to the sum of the two largest operating units in the subregion. The reserve responsibilities are divided among the group according to each member's previous annual peak load and largest generating unit.

The 1973 report of the SERC for the Florida subregion is attached (2) and points up the need for St. Lucie II to maintain adequate capability in the Florida subregion.

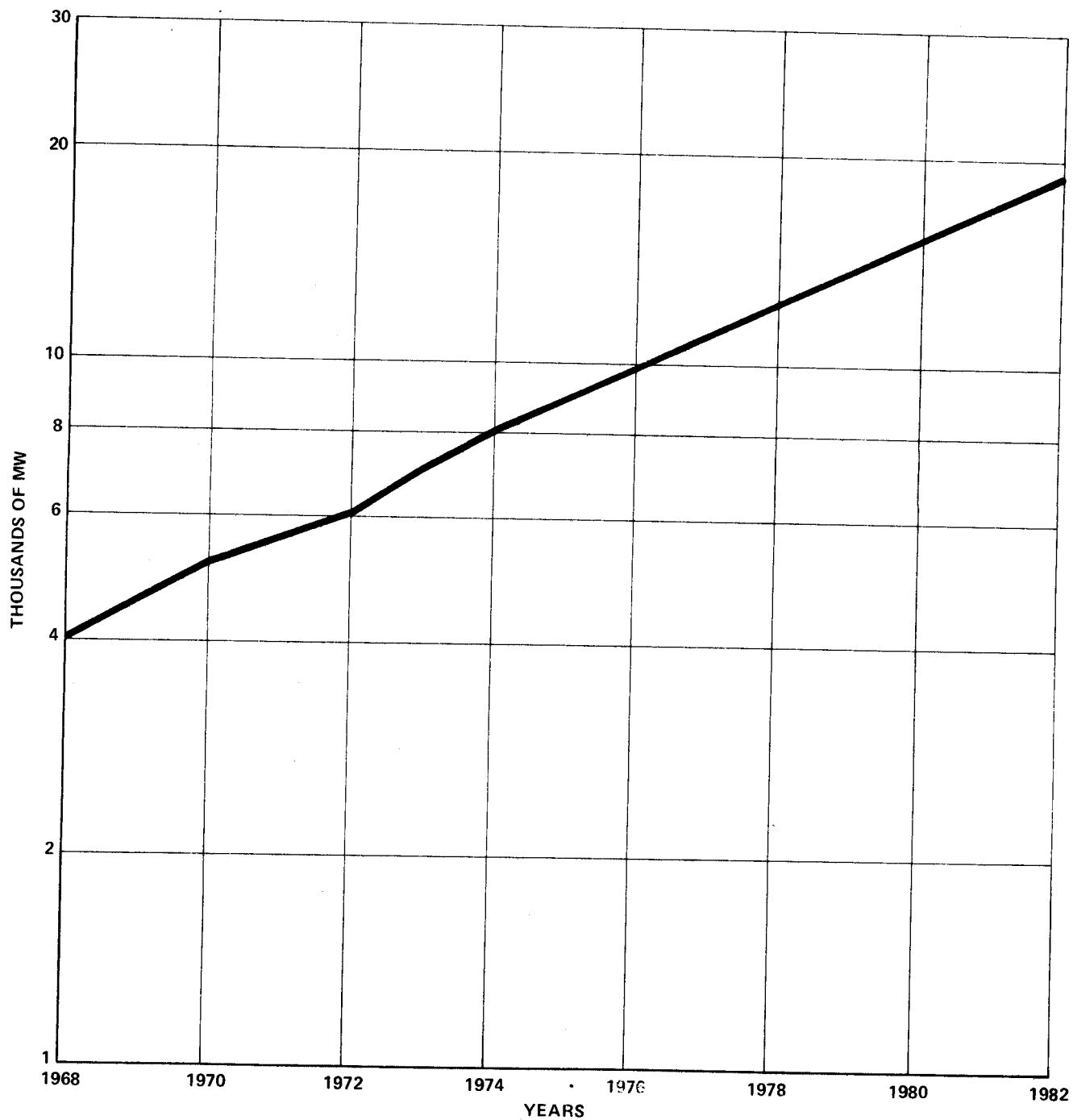
TABLE 1.1-1
SYSTEM LOAD, CAPACITY AND RESERVE

YEAR	GROSS ONE HOUR PEAK DEMAND (MW)	GROSS SUMMER PEAK CAPABILITY (MW)	RESERVE WITH ST. LUCIE UNIT NO. 2 (MW)	(1%)	RESERVE WITHOUT <u>1</u> / ST. LUCIE UNIT NO. 2 (MW)	(1%)
1968	3925	4298	373	9.4		
1969	4470	5125	655	14.7		
1970	5125	5569	444	8.7		
1971	5525	6013	488	8.8		
1972	6145	6857	712	11.6		
1973	7105	8713	1608	22.6		
1974	7940	9397	1457	18.4		
1975	8820	10,081	1261	14.3		
1976	9800	11,731	1931	19.7		
1977	10,925	11,331	2406	22.0		
1978	12,150	14,131	1981	16.3		
1979	13,525	15,731	2206	16.3		
1980	15,090	17,681	2591	17.2	1741	11.5
1981	16,760	19,881	3121	18.6	2271	13.6
1982	18,520	22,081	3561	19.2	2711	14.6

Note: 1/ Same as "with St. Lucie Unit No. 2" except as indicated.

TABLE 1.1-2
GROSS SUMMER PEAK CAPABILITY
AND UNIT ADDITIONS

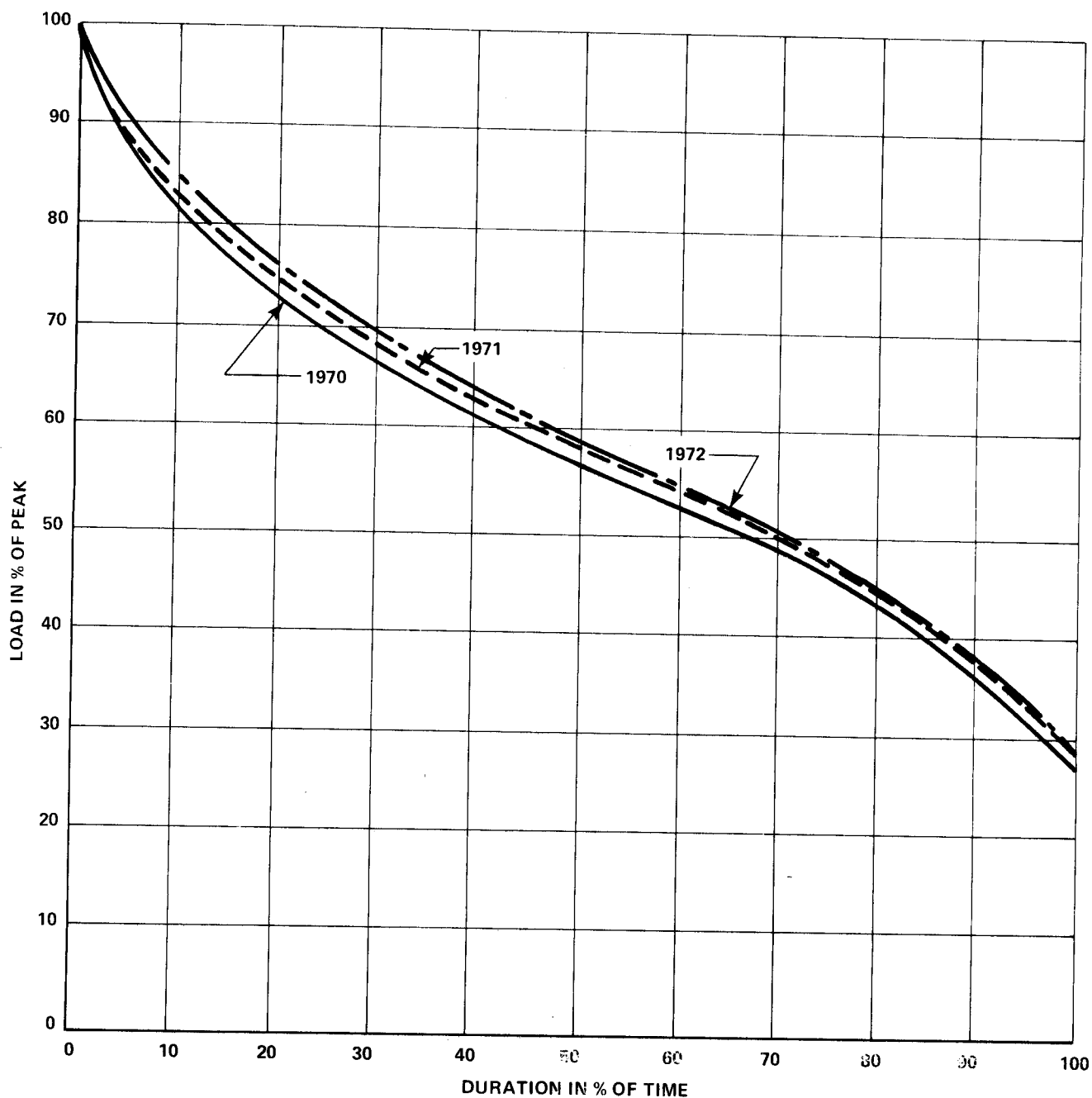
YEAR	UNIT ADDITIONS	CAPABILITY (MW)	FUEL	SYSTEM NUCLEAR STEAM	CAPABILITY FOSSIL STEAM	(MW) FOSSIL GAS TURBINE	TOTAL
1968					4271	27	4298
1969					5098	27	5125
1970					5098	471	5569
1971					5098	915	6013
1972					5498	1356	6857
1973	Turkey Point No 3 Turkey Point No 4 Sanford No 5	728 728 400	Nuclear Nuclear Fossil	1456	5898	1356	8713
1974	Ft. Myers Gas Turbines	684	Fossil	1456	5898	2043	9397
1975	Gas Turbines	684	Fossil	1456	5898	2727	10,081
1976	St. Lucie No 1 Manatee No 1	850 800	Nuclear Fossil	2306	6698	2727	11,731
1977	Manatee No 2 Martin No 1	800 800	Fossil Fossil	2306	8298	2727	13,331
1978	Martin No 2	800	Fossil	2306	9098	2727	14,131
1979	Steam Turbine Steam Turbine	800 800	Fossil Fossil	2306	10,698	2727	15,731
1980	St. Lucie No 2 Steam Turbine	850 1100	Nuclear Fossil	3156	11,798	2727	17,681
1981	Steam Turbine Steam Turbine	1100 1100	Fossil Fossil	3156	13,998	2727	19,881
1982	Steam Turbine Steam Turbine	1100 1100	Fossil Fossil	3156	16,198	2727	22,081



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

SYSTEM 60 MINUTE GROSS
PEAK DEMAND

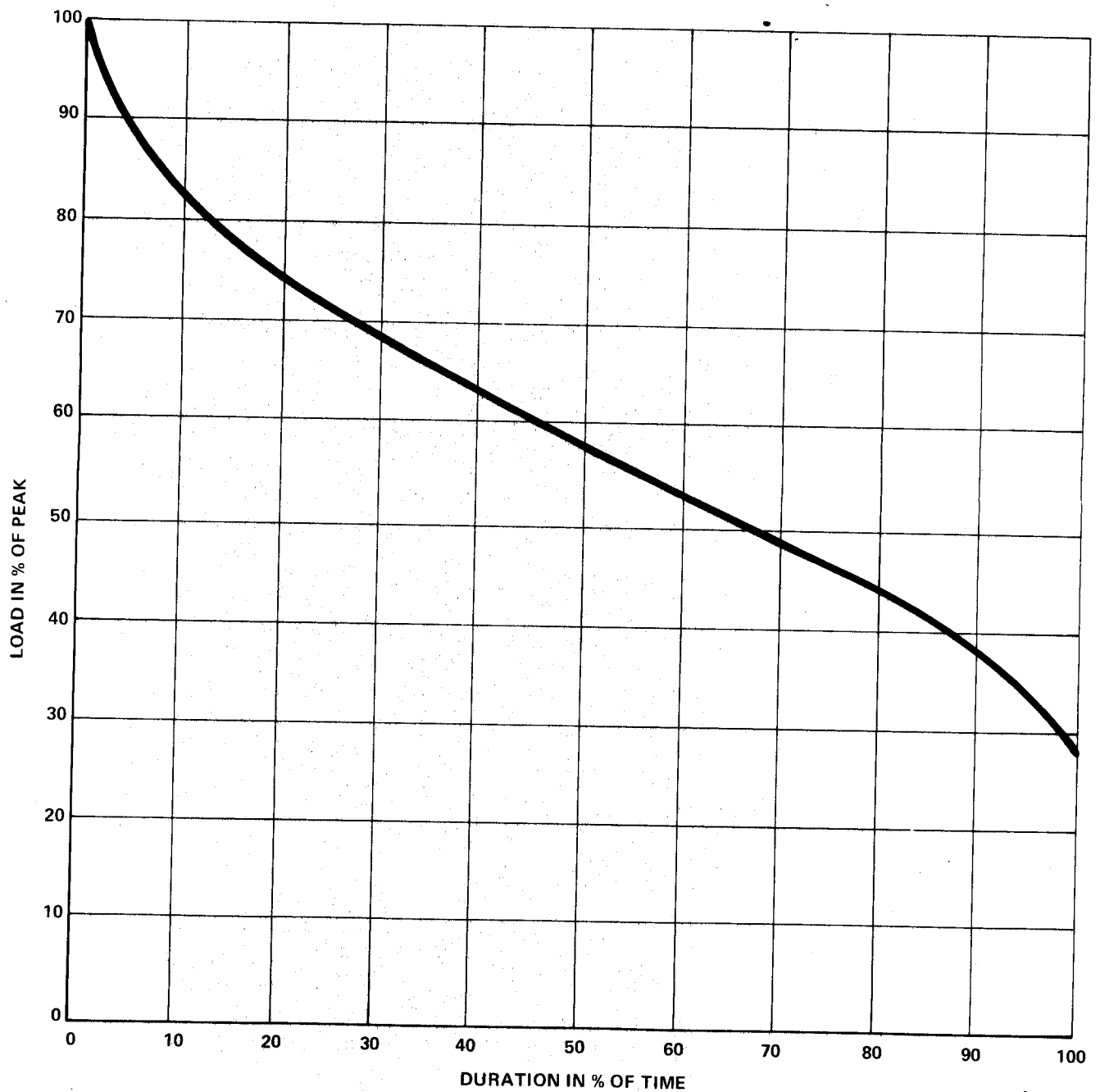
FIGURE 1.1-1



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ANNUAL LOAD DURATION CURVE
1970, 1971, 1972

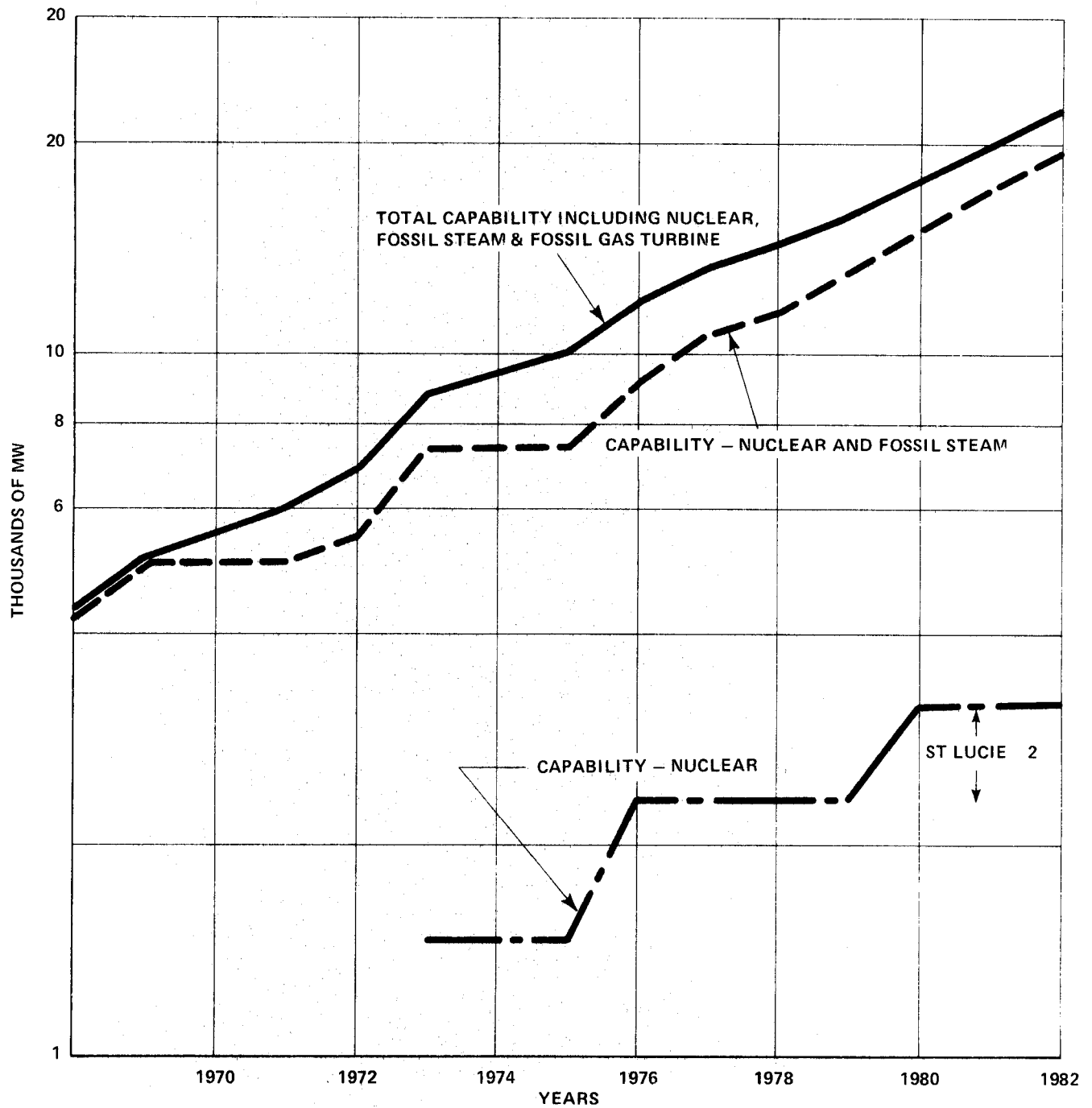
FIGURE 1.1-2



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PROJECTED ANNUAL LOAD DURATION
CURVE - 1973-1982

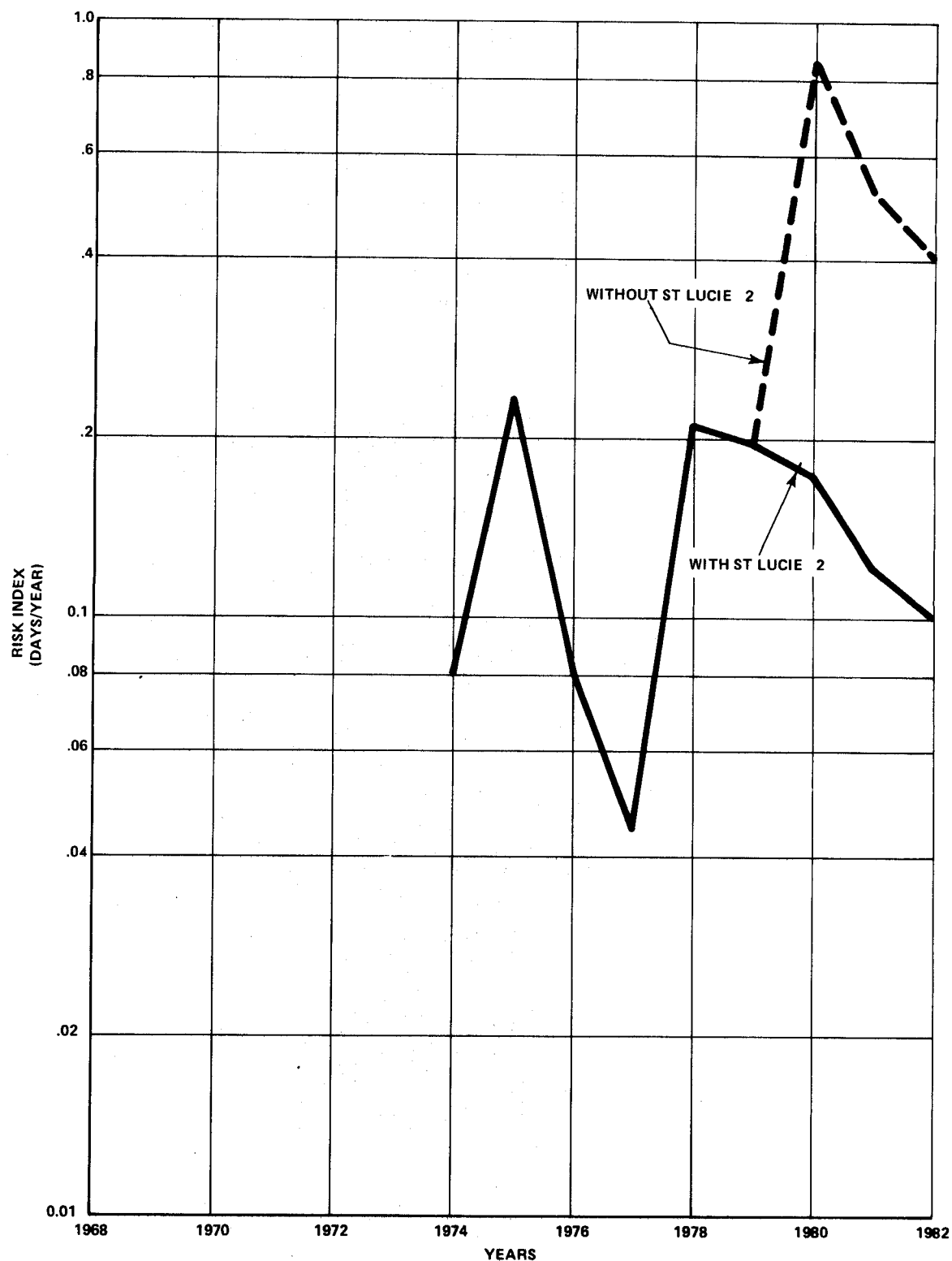
FIGURE 1.1-3



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

SYSTEM PEAK CAPABILITY
SUMMER GROSS

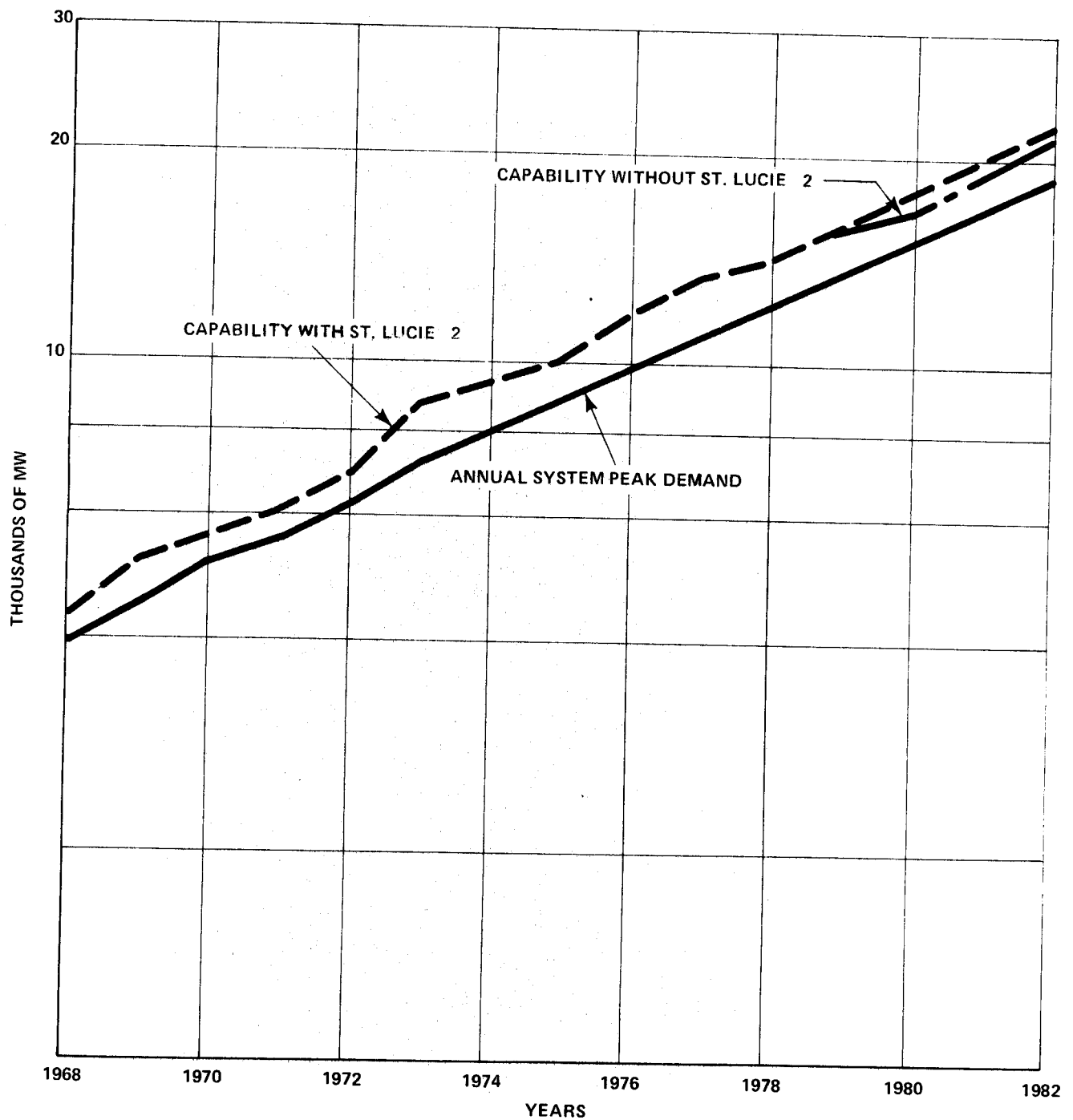
FIGURE 1.1-4



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

LOSS-OF-LOAD PROBABILITY

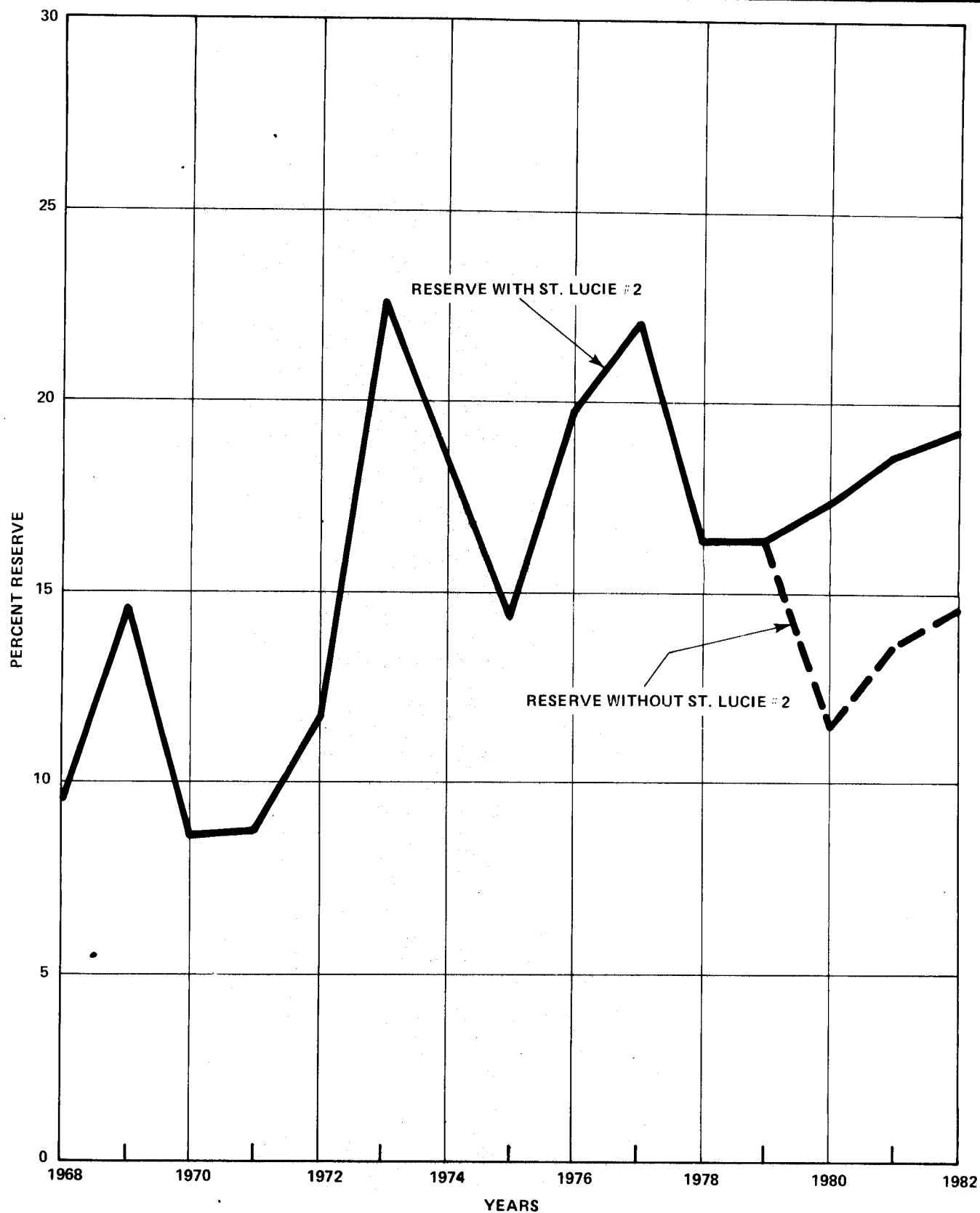
FIGURE 1.1-5



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

SYSTEM LOAD AND CAPABILITY

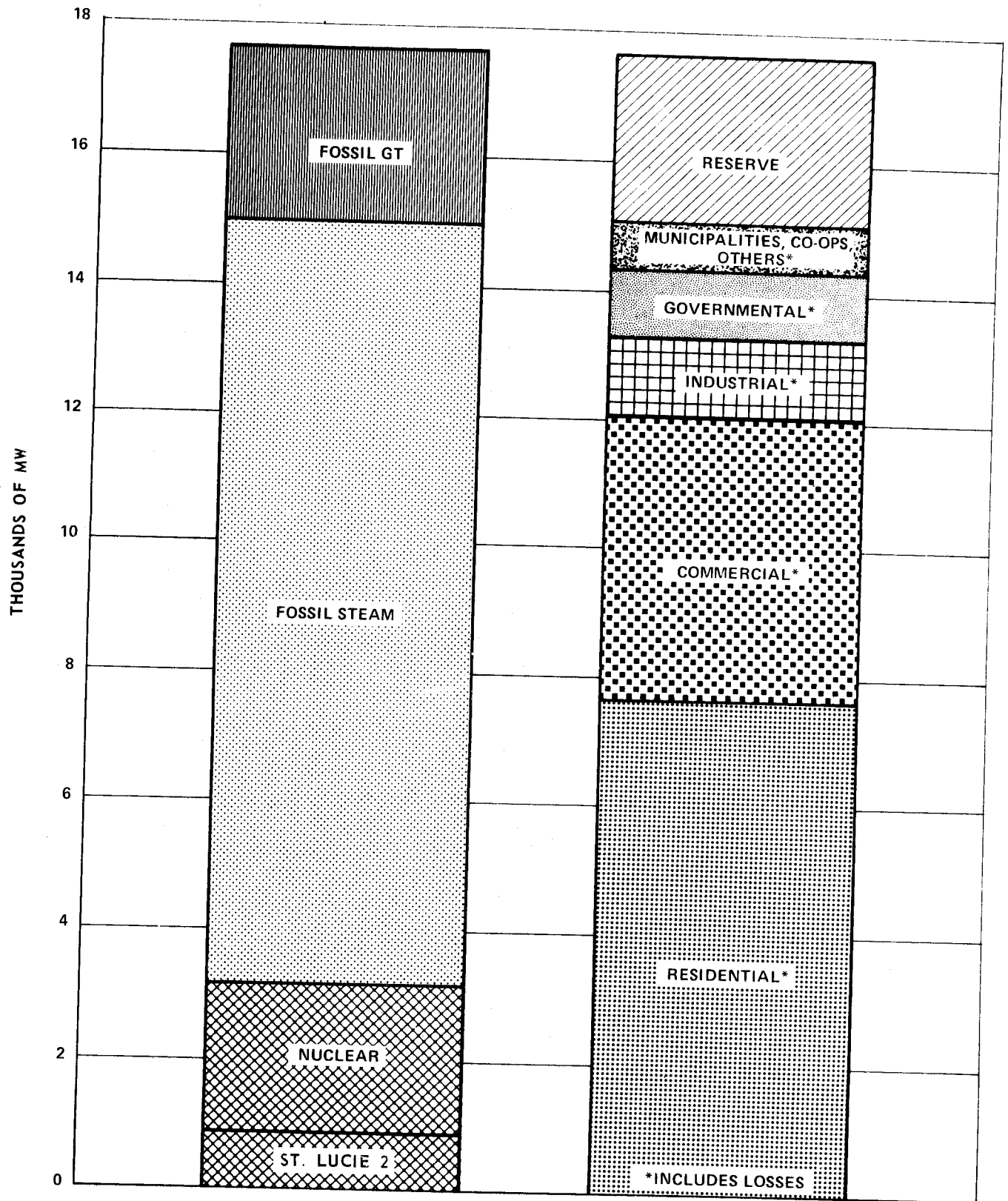
FIGURE 1.1-6



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

SYSTEM RESERVE MARGIN

FIGURE 1.1-7



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

SYSTEM INPUT-OUTPUT

FIGURE 1.1-8

1.2 OTHER PRIMARY OBJECTIVES

There are no primary objectives of the proposed facility other than the supply of adequate and reliable electric energy.

1.3 CONSEQUENCES OF DELAY

The Florida Power & Light Company has an obligation to serve the electric power requirements within its service territory (Chapter 366.03, Florida Statutes). Any delay in the availability of the proposed unit will adversely affect Florida Power & Light's ability to satisfy this obligation. Specifically the loss-of-load probability expressed in days per year, for the year 1980 would increase from 0.172 to 0.855 without the proposed unit. Corresponding figures for 1981 and 1982 are 0.12 and 0.1 with the proposed unit and 0.519 and 0.399 without the proposed unit.

Florida Power & Light has an obligation to maintain reserve, both installed and spinning, as part of the Florida Subregion of SERC. The high values of risk and their attendant low values of reserve (Table 1.1-1) not only would lower Florida Power & Light's ability to meet system load but would also adversely affect the reliability of the Florida Subregion.

2.0
SITE

2.1 SITE LOCATION AND LAYOUT

The property for the St. Lucie Nuclear Power Plant consists of approximately 1132 acres on Hutchinson Island in St. Lucie County about half way between the cities of Fort Pierce and Stuart on the East Coast of Florida. The nearest population center is the city of Fort Pierce which is eight miles from the site across the Indian River. The location of the property is indicated on the map of Florida, Figures 2.1-1, as are the major cities of the State. As an aid in location, the approximate road distances from the site to the principal cities are: Miami - 120 miles, Jacksonville - 225 miles, Tampa - 150 miles, Tallahassee - 360 miles, Atlanta, Georgia - 550 miles. The Georgia state line is some 260 miles away at the closest point.

Figure 2.1-2 provides a map of the east-central portion of the State of Florida that locates the plant property relative to the geography of the State within a 100 mile radius. Figure 2.1-3, on a larger scale, presents an aerial view of the locale out to a 10-mile radius from the plant site, and identifies natural and improved features and reference points. The Company's property lines are shown in Figure 2.1-4 on a plan of a portion of Hutchinson Island. Figure 2.1-5 provides a plan view of the plant, Units 1 & 2, with the finished elevations. Figure 2.1-6 presents an aerial view of the locale out to a 5-mile radius from the plant property as of September 1973.

Of the 1132 acres owned by FP&L, approximately 300 acres will be occupied or modified by the plant (Units 1 & 2) and the plant facilities. There is a visitor's center located on the FPL property. The present plans for the plant fencing include a perimeter security fence west of State Highway A1A that encloses all of the plant building and structures. There are, at present, no plans to fence any of the FPL property east of State Highway A1A, however, this is subject to review by the AEC for purposes of developing the plant security program. Fencing, if required, would be local and would enclose only the canals west of the beach dune.

The property itself is generally flat. Much of it consists of swamp, and, outside the mosquito control areas, the land is covered with a dense vegetation characteristic of Florida costal mangrove swamps. At the ocean shore, the land rises slightly in a dune or ridge to approximately 15 feet above mean low water. The island itself is populated only at the northern and southern ends, the nearest inhabited area being some seven miles north of the reactor site, and the closest inhabited area to the south at a distance of around 4.5 miles.

The St. Lucie plant, then, is sited near the center of a long, narrow, offshore island. To the east is the Atlantic Ocean with the north flowing Gulf Stream currents evident only a few miles offshore. Near shore, a weak counter-current flowing south is usually felt. To the west, the island is separated from the mainland by the Indian River. It should be noted that the Indian

River is not a river in the usually accepted sense, but more a long, thin, tidal lagoon stretching down the southeastern coast of Florida between the mainland and a long series of offshore islands. Passes or inlets between the islands connect the Indian River with the ocean while a very limited number of small streams flow into it. With the exception of Lake Okeechobee some 35 miles to the southwest, there are no major geographic features or important true rivers in the vicinity.

Another fact of importance regarding the property is that there are currently no wells producing fresh water on Hutchinson Island and the many attempts to develop wells, even at considerable depths, have proved unsuccessful. This has limited the development of the island and kept most of the area uninhabited. Development of the northern and southern ends has been possible only because fresh water could be brought from the mainland by pipe lines of limited capacity.

The mainland to the west of the plant site has a low population density. The heavily populated region begins at the West Palm Beach area 45 miles to the south. As will be discussed in detail in the next section, the immediate surrounding area is agricultural in nature with very limited industrial development.

The St. Lucie Unit #2 site is located on FPL's St. Lucie property as depicted in Figure 2.1-7.

2.1 SITE LOCATION AND LAYOUT

The site for the St. Lucie Nuclear Power Plant consists of approximately 1132 acres on Hutchinson Island in St. Lucie County about half way between the cities of Fort Pierce and Stuart on the East Coast of Florida. The nearest population center is the City of Fort Pierce which is eight miles from the site across the Indian River. The location of the site is indicated on the map of Florida, Figure 2.1-1, as are the major cities of the State. As an aid in location, the approximate road distances from the site to the principal cities are: Miami 120 miles, Jacksonville 225 miles, Tampa 150 miles, Tallahassee 360 miles, Atlanta, Georgia 550 miles. The Georgia state line is some 260 miles away at the closest point.

Figure 2.1-2 provides a map of the east-central portion of the State of Florida that locates the plant site relative to the geography of the State within a 100 mile radius. Figure 2.1-3, on a larger scale, presents an aerial view of the locale out to a 10-mile radius from the plant site, and identifies natural and improved features and reference points. The Company's property lines are shown in Figure 2.1-4 on a plan of a portion of Hutchinson Island. Figure 2.1-5 provides a plan view of the plant, Units 1 & 2, with the finished elevations. Figure 2.1-6 presents an aerial view of the locale out to a 5-mile radius from the plant site as of September 1973.

Of the 1132 acres owned by FP&L, approximately 300 acres will be occupied or modified by the plant (Units 1 & 2) and the plant facilities. There are no plans for a visitor's center to be located at the site. The present plans for plant fencing include a perimeter security fence west of State Highway 1A that encloses all of the plant buildings and structures. There are at present, no plans to fence any of the FPL property east of State Highway 1A, however this is subject to review by the AEC for purposes of developing the plant security program. Fencing, if required, would be local and would enclose only the canals west of the beach dune.

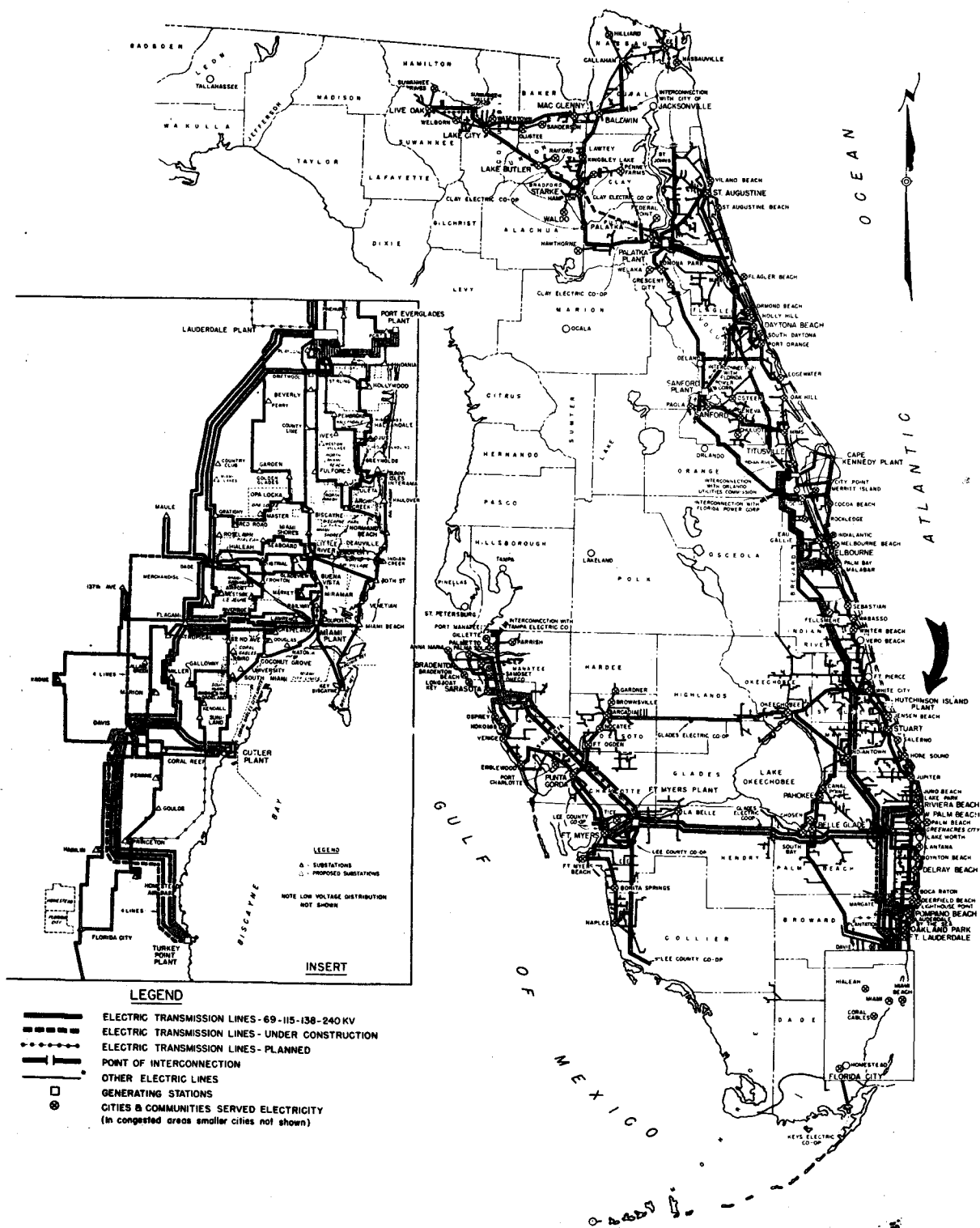
The site itself is generally flat. Much of it consists of swamp and, outside the mosquito control areas, the land is covered with a dense vegetation characteristic of Florida coastal mangrove swamps. At the ocean shore the land rises slightly in a dune or ridge to approximately 15 feet above mean low water. The island itself is populated only at the northern and southern ends, the nearest inhabited area being some seven miles north of the reactor site and the closest inhabited area to the south at a distance of around 4.5 miles.

The St. Lucie plant, then, is sited near the center of a long, narrow, offshore island. To the east is the Atlantic Ocean with the north flowing Gulf Stream currents evident only a few miles offshore. Near shore a weak counter-current flowing south is usually felt. To the west, the island is separated from the mainland by the Indian River. It should be

noted that the Indian River is not a river in the usually accepted sense but more a long, thin, tidal lagoon stretching down the southeastern coast of Florida between the mainland and a long series of offshore islands. Passes or inlets between the islands connect the Indian River with the ocean while a very limited number of small streams flow into it. With the exception of Lake Okeechobee some 35 miles to the southwest, there are no major geographic features or important true rivers in the vicinity.

Another fact of importance regarding the site is that there are currently no wells producing fresh water on Hutchinson Island and the many attempts to develop wells, even at considerable depths, have proved unsuccessful. This has limited the development of the island and kept most of the area uninhabited. Development of the northern and southern ends has been possible only because fresh water could be brought from the mainland by pipe lines of limited capacity.

The mainland to the west of the plant site has a low population density. The heavily populated region begins at the West Palm Beach area 45 miles to the south. As will be discussed in detail in the next section, the immediate surrounding area is agricultural in nature with very limited industrial development.



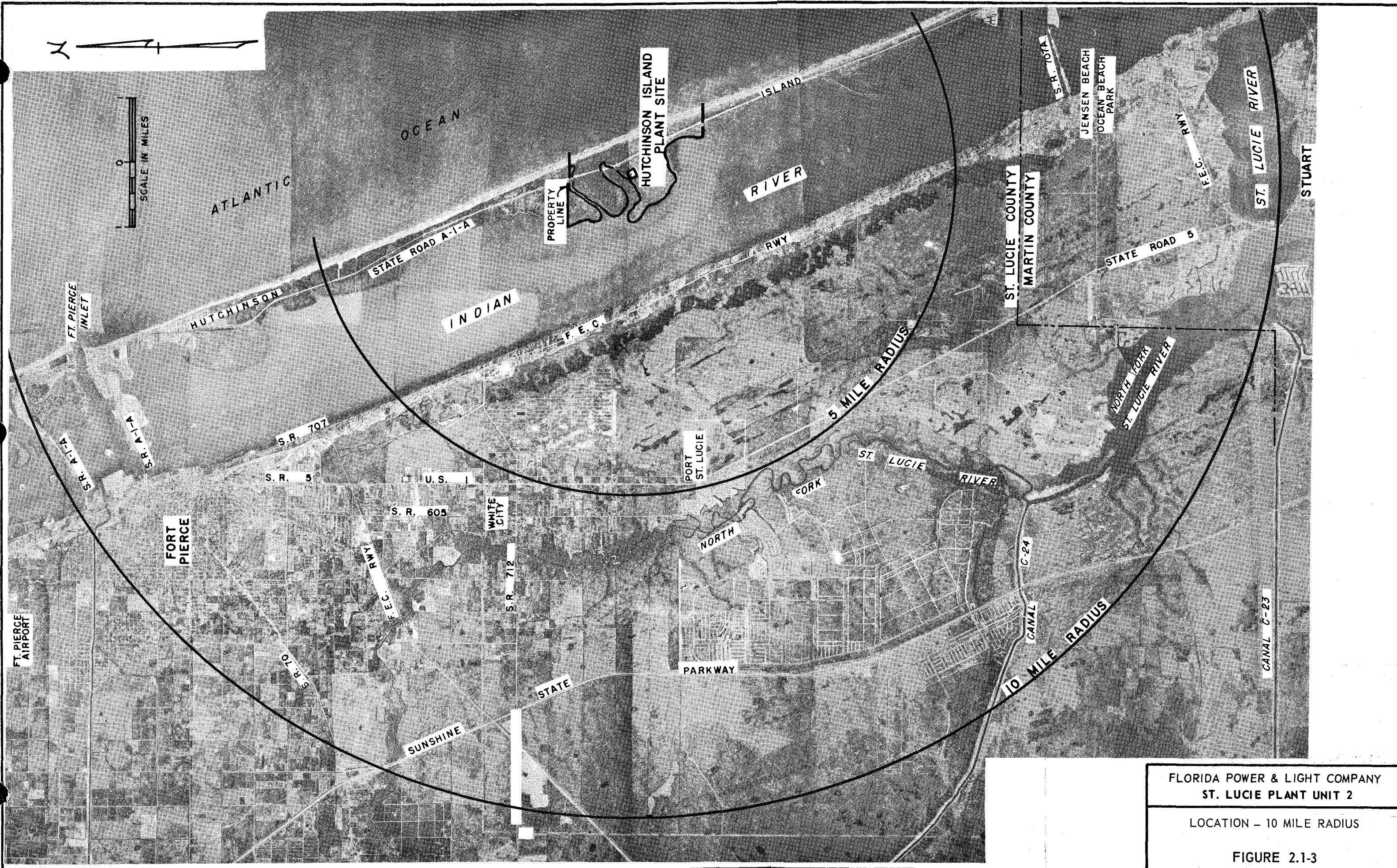
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

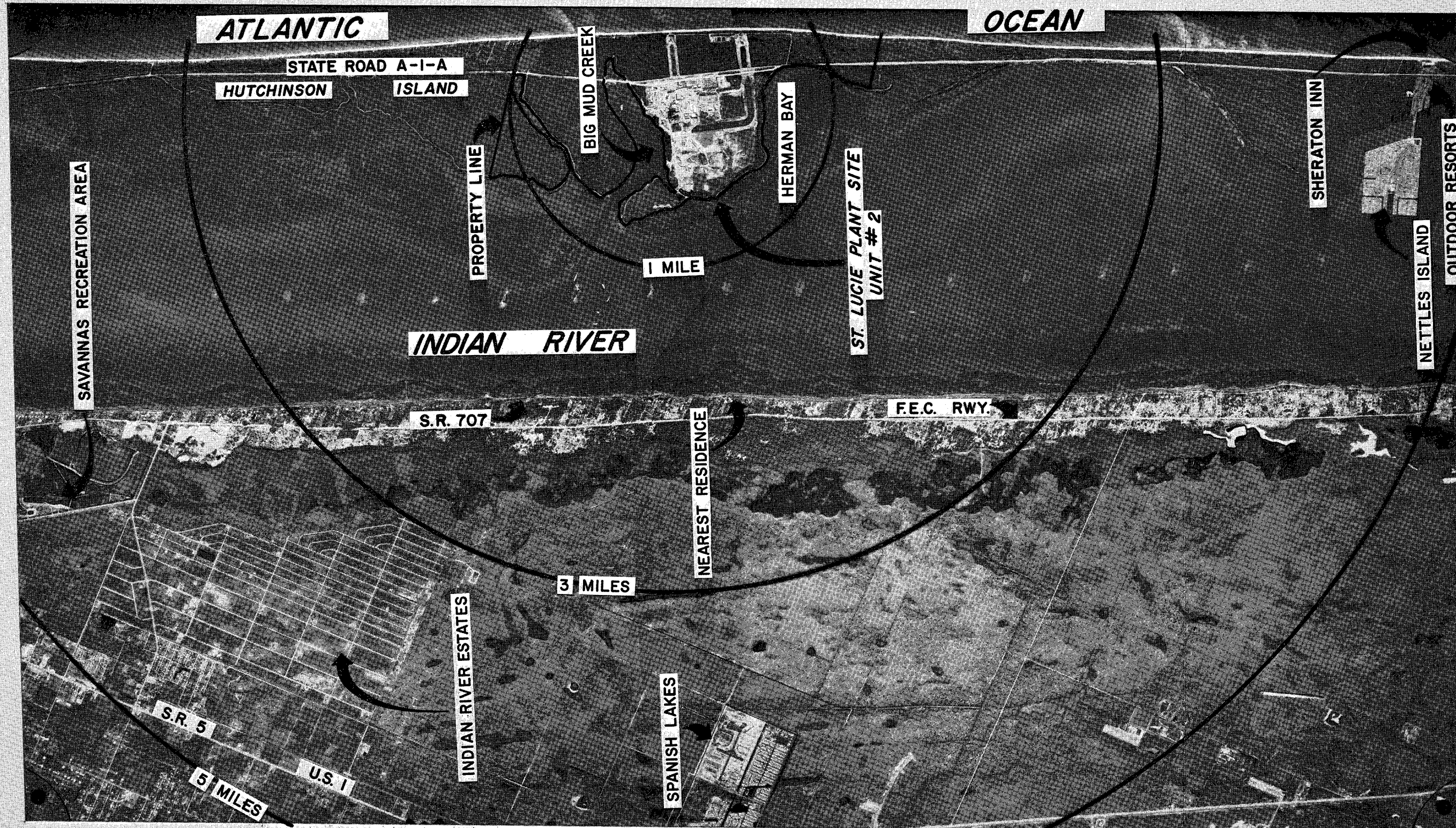
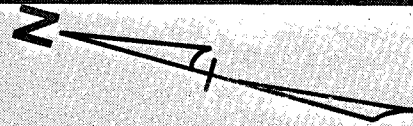
PLANT MAJOR CITIES AND THE FP&L
SERVICE AREA

FIGURE 2.1-1

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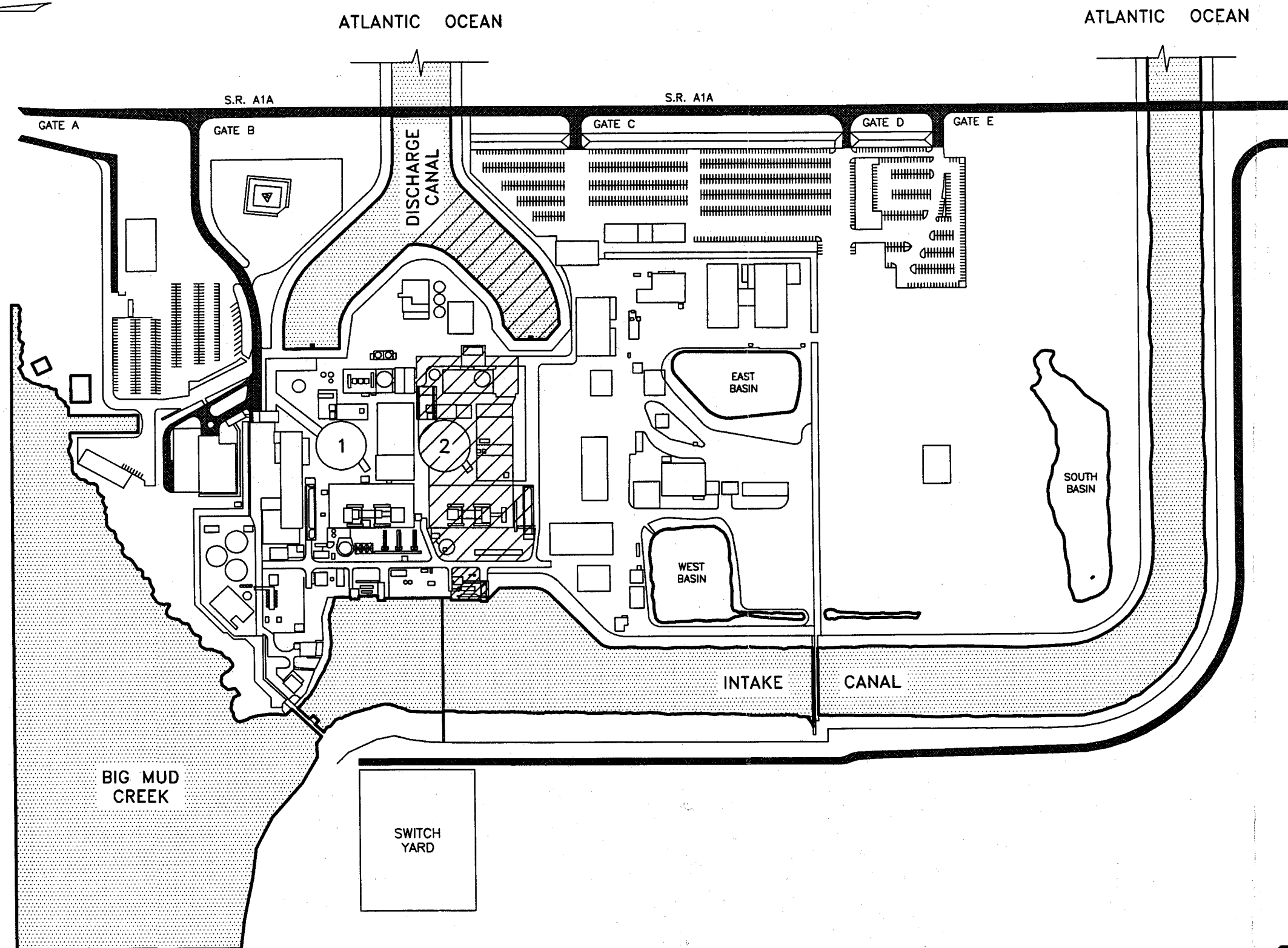
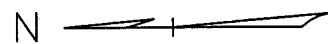
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SCALE IN MILES

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
LOCATION - 5 MILE RADIUS
FIG. 2.1-6 SEPT. 1973



LEGEND:

- EXISTING STRUCTURES
- UNIT 2 SITE
- COOLING WATER

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ST. LUCIE UNIT 2 SITE BOUNDARY

FIGURE 2.1-7

2.2 REGIONAL DEMOGRAPHY, LAND AND WATER USE

2.2.1 POPULATION AND POPULATION DISTRIBUTION

Figure 2.2-1 shows the population density for 1970, 1980, 1990 and 2000 within a 5-mile radius of the site, sectioned into sixteen directional radii. Figures 2.2-2 and 2.2-3 combined, show similar information for 5, 10, 20, 30, 40 and 50 mile radii.

The cumulative population data for the following annular radii are:

Miles:	0-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
1970	0	105	175	235	650	45,340	24,450	47,950	55,950	126,300
1980	0	140	250	340	740	61,000	42,284	77,100	82,700	181,800
1990	0	180	320	450	1,110	82,740	60,850	108,830	109,600	240,350
2000	0	220	410	595	1,415	102,520	76,400	138,900	119,700	300,800

The 1970 estimates have been derived from an analysis of 1970 census tract data and rates of migration and construction in the subject areas. The 1980, 1990 and 2000 projections have been formulated after a careful study of past trends and probable future commercial, residential and industrial development. In all cases, these figures are based on the most reliable information available. The methodology employed was in accordance with generally accepted economic research practices.

2.2.1.1 Population Within 10 Miles

Figure 2.2-1 indicates that the area within a 5-mile radius of the proposed site is sparsely populated at the present time. All of this population is located on the Florida mainland. Hutchinson Island, within a 4-mile radius of the site, does not contain any population at present, and it is projected that this area will support a few permanent residents over the entire 30 year projection period. 3

The total population within the 10-mile radius (Figure 2.2-2) is estimated at over 42,000. The largest concentrations of population exist in Section Sectors WNW, NW and S. Population in the western sectors is not concentrated in any one area, and the population density in these areas is low. However, the area in the 5 to 10 mile arc is good land and, in many cases, has been subdivided. There is a strong indication that this is the area that will experience the bulk of population growth within the next 28 years for the Fort Pierce area.

Fort Pierce, the county seat of St. Lucie County, is located a little north of the center of the county, a distance of 8 miles from the site, and on the Indian River, which is part of the Intracoastal Waterway. Its 29,721 inhabitants account for 60 percent of the entire county's population. 3

Other population clusters are located in the north at Lakewood Park; adjoining Fort Pierce at Sunland Gardens, Harmony Heights and Paradise Park; and in the east-central section is Collins Park Estates.

2.2.1.2 Population Between 10 and 50 Miles

The area within the 50-mile radius (Figure 2.2-3) contains an estimated total population of over 310,000. Over 70 percent of these people reside outside of a 25-mile radius from the site. The major population concentrations are found along the Florida coast line - principally to the south. During the next 28 years, the area depicted in the figures as Sector H will experience the largest population growth. This sector (H) encompasses the northern portion of what is known as the Florida Gold Coast.

The 1970 census (2) confirms the long range estimates made earlier and gives the 1970 population of major cities within a 50 mile radius: Ft. Pierce, 29,721; Stuart, 4,820; Indiantown, 2,285; Vero Beach, 11,908; Okeechobee, 3,715; West Palm Beach, 57,375.

Nearly one-quarter of the population of Martin County live in Stuart, a city of 4,820 inhabitants in 1970. Another population cluster of 2,283 persons is at the small city of Indiantown which is located in the south-central portion of the county, about 26 or 27 miles southwest of the plant site. Small concentrations will be found at Port Sewall, Salerno, Gomez and Hobe Sound. These small communities are along the Waterway south and east of Stuart, ranging from 11 to 22 miles from plant site.

Of the 1970 population, about 68 percent are concentrated in and around the Indian River county seat of Vero Beach, a city with 11,900 people. Approximately 10,000 people live in the northeastern eighth of the county and 2,000 are spread very sparsely around the western two-thirds to three-fourths of the county.

The Okeechobee county seat, the City of Okeechobee, has the only large concentration of population. Its nearly 4,000 citizens comprise about 38 percent of the population of the county. The remainder of the inhabitants are scattered over a very wide area.

Of the total estimated 350,000 persons in Palm Beach County, about one-third are living within the study area. Of that portion, 95 percent live in the coastal region, clustered near the City of West Palm Beach. About 6,000 persons live on the shore of Lake Okeechobee in the Pahokee area, about 45 miles from the plant site.

There are no main concentrations in that portion of Brevard County which is included in this report. There is, however, a small urban development in the Sebastian Inlet area.

The areas under study in Osceola, Highlands and Glades counties are very sparsely populated.

2.2.1.3 Low Population Zone

On the basis of the investigation of population density and land use, the Applicant has determined that the area lying within 5 miles of the plant is presently and likely will remain sufficiently low in population density to be considered a low population zone. The area contained, in 1968,

1,165 persons and is projected to have 2,740 persons by the year 2000.

2.2.1.4 Transient Population

The most important center of recreational activities in the vicinity of the plant is the Savannas Recreation Area, located approximately five miles west-northwest of the plant. Operated jointly by the City of Ft. Pierce and St. Lucie County, it features boating, fishing, swimming, camping, picnicking, etc. Overnight campers totaled approximately 9,000 during a recent 12-month period, while 160,000 day visitors were reported. Public beach and park areas are located at the north end of Hutchinson Island. The nearest park to the Hutchinson Island plant site (and furthest from Ft. Pierce) Douglas Memorial, is more than five miles north of the plant. It is lightly used, averaging 25-50 visitors per day during the summer, with few visitors during the winter.

South of the plant site on Hutchinson Island are commercial campgrounds for travel trailers and similar vehicles. The nearest of these is approximately five miles from the plant. A public beach and park is located approximately seven miles south of the plant.

Other recreational activities in the vicinity of the plant include surfing and fishing in the ocean, and fishing and boating in the Indian River. Ducks are hunted on Hutchinson Island in season. Participants in these activities within several miles of the plant are few in number. Shellfishing in Indian River is currently prohibited by order of the State Board of Health.

The city of Stuart is a boating and fishing resort, and boatmen and fishermen increase the transient population on both a year-round and seasonal basis.

A scenic attraction, McKee Jungle Gardens, about three miles south of Vero Beach, on U. S. Route No. 1 and a horse breeding farm at Fellsmere bring visitors to those areas.

2.2.1.5 Population Center

The nearest "population center" is the city of Fort Pierce at an air-line distance of eight miles in a northwest direction from the containment building, 1.6 times the distance from the plant to the outer boundary of the low population zone.

2.2.1.6 Public Facilities and Institutions

The most important center of recreational activities in the vicinity of the plant is the Savannas Recreation Area, located approximately five miles west-northwest of the plant. Operated jointly by the City of Ft. Pierce and St. Lucie County, it features boating, fishing, swimming, camping, picnicking, etc. Overnight campers totaled approximately 9,000 during a recent 12-month period, while 160,000 day visitors were reported. This averages out to approximately 25 campers per night or 440 visitors per day. Public beach and park areas are located at the north end of Hutchinson Island. The nearest park to the Hutchinson Island plant site

(and furthest from Ft. Pierce), Douglas Memorial, is more than five miles north of the plant. It is lightly used, averaging 25-50 visitors per day during the summer, with few visitors during the winter. Five small municipal parks are located within the city of Ft. Pierce. Jonathan Dickinson State Park is located in the southeastern corner of the county, south of Jupiter. It covers some 16 or 17 square miles and lies within 29 miles of the plant site. Its facilities include picnic tables, refreshments, boat ramps and camp sites.

South of the plant site on Hutchinson Island are commercial campgrounds for travel trailers and similar vehicles. The nearest of these is approximately five miles from the plant. A public beach and park is located approximately seven miles south of the plant.

Other recreational activities in the vicinity of the plant include surfing and fishing in the ocean, and fishing and boating in the Indian River. Ducks are hunted on Hutchinson Island in season. Participants in these activities within several miles of the plant are few in number. There are no schools, plants, or hospitals within five miles of the plant.

Recent investigations regarding the growth of Hutchinson Island have revealed that county zoning will encourage development of hotels and motels east of A-1-A. A review of Figure 2.2-4 indicates a R-4 zoning for most of the island area bordering the Atlantic Ocean. Although apartments and condominiums can also be constructed, the regulations allow hotels and motels twice the density or 36 units per acre. Any projections as to ultimate development are purely speculative at this point. Estimates exceeding 200 (transient population) persons per day within a 5 mile radius by the year 2000 are not unreasonable assuming the present growth rates are sustained or accelerated.

Some of the commercial development on the island can be evidenced by the completed Sheraton Motor Inn, and the Holiday Inn and Ramada Inn planned for the same vicinity. Residential development includes single family homes, duplexes, and condominiums; the latter being far superior in number.

The mainland of St. Lucie County is primarily comprised of residential developments. Figure 2.1-6 depicts most of the developments within five miles of the plant site. Not included are Port St. Lucie, the largest single residential development, and Lakeside Mobile Home Park.

There are no major commercial projects in the area of interest, however, Port St. Lucie has opened an industrial park on the east side of U.S. #1, it is unoccupied at this time. The Port St. Lucie golf and country club and the Savannas recreational area are among the county's activity areas. Development plans are underway for the residential condominium developments of Twin Banyon Plantation and a sizable complex within Port St. Lucie.

2.2.2 REGIONAL LAND USES

The area studied extends fifty miles in all directions from the plant site. Included in the study area were all or parts of nine counties of Florida: St. Lucie, Martin, Indian River, Okeechobee, Palm Beach, Brevard, Osceola, Highlands and Glades.

The gross area studied is 7,854 square miles, more than one-half of which is water - represented by the Atlantic Ocean, the Indian and St. Lucie Rivers, and Lake Okeechobee. It will be observed from Figure 2.1-3 (of the previous section) that a line running southerly from a point $22-1/2^{\circ}$ west of north, through the plant site, to a point $22-1/2^{\circ}$ east of south very closely parallels the Intercoastal Waterway and the Atlantic Ocean shoreline. This, in effect, cuts the land area to about half of the total 7,854 square miles mentioned earlier. From this can be subtracted about 350 square miles of Lake Okeechobee. Some 125 square miles of water in the Indian and St. Lucie Rivers, forming part of the Intra-coastal Waterway can also be deducted. Approximately 75 square miles of the Atlantic Ocean between Jupiter Inlet and Palm Beach should be subtracted. When these total deductions of approximately 550 square miles of water are deducted from one-half of the gross area, there remains about 3,375 square miles of land area, but with no deductions for small lakes. It should also be noted that there are no other nuclear facilities within a 50-mile radius of the site. An examination of U. S. Navy Hydrographic Office Chart No. 1290 and U. S. Coast Guard Geodetic Survey Chart No. 1247 reveals no apparently habitable land masses in that portion of the Atlantic Ocean which is included in the gross area of the study.

The overall impressions gained as a result of the study of the subject areas are:

- a) An expanding area of the East Coast of southern Florida, having four principal concentrations of population - around the cities of Vero Beach, Fort Pierce, Stuart and West Palm Beach - all located in the coastal region;
- b) An area of low, mostly flat land with elevations running from 50 feet in the western portion to sea level on the east. The central sections are about 20' to 25' above sea level. Swampy areas such as the St. Johns Marsh, Loxahatchee Slough, Allapattah Flats and a portion of Big Cypress occupy large parts of the study area;
- c) Agri-business is the dominant contributor to the commercial economy. Citrus, vegetable and flower culture; cattle raising, including dairying; and related enterprises such as packing houses, processing plants, farm equipment and fertilizer sales are spread throughout the area;
- d) The tourist attractions, and hence heavier seasonal concentrations of population, are found along the Intracoastal Waterway.
- e) The general impression is one of a large area which will expand its activities and population generally in the coastal regions with more gradual expansion of the agricultural economy to the westward.

2.2.2.1 Agricultural Land Use

Tables 2.2-1, 2.2-2 and 2.2-3 show selected statistics on agriculture for six of the subject counties. Data for the counties of Osceola, Highlands and Glades are not presented because of the minimal area of these counties that lies within the 50-mile radius. For all practical purposes, agricultural activities within the six county area portrayed in the following tables can be considered as representative of the study area as a whole.

The statistics shown in Tables 2.2-1 and 2.2-2 pertain to the entire spectrum of agricultural activity in the subject counties and describe these activities by type and by quantitative production measurements. Table 2.2-3 in turn provides specific data for dairy activities. As shown in the table, Okeechobee and Palm Beach Counties exhibit a considerably greater degree of dairy farm activity than the other four counties. In Okeechobee County, the bulk of dairy farm activities can be generally identified as being in those portions of Sectors L and M in the 25 to 50 mile arc. Although only the northern portions of Palm Beach County are included within the 50-mile radius, it appears that it is in these areas that most of the dairy farm activity is found. That portion of Sectors I and J in the 25 and 50 mile radius is the area of Palm Beach County where the bulk of dairy farm activity is concentrated.

The bulk of dairy farm activities in Martin, Indian River and St. Lucie Counties take place in Sector J, 10-25 mile arc; Sector N, 25-50 mile arc; and Sectors N and M, 10-25 mile arc, respectively. Dairy activity in Brevard County is relatively insignificant and that which exists is not within that portion of the county that comes within the 50-mile radius.

2.2.2.2 Generalized Land Use by CountySt. Lucie County

a) Location

St. Lucie County, with its 540 square miles of land area, is located on the Atlantic seaboard about 230 miles south of Jacksonville and 120 miles north of Miami. In it is the site for the nuclear power plant on Hutchinson Island. It is bordered on the north by Indian River County, on the west by Okeechobee County and on the south by Martin County. Almost all of its area lies within 25 miles of the plant site and its north-western corner, the most distant point, is about 31 miles distant.

b) General Description

Like its neighbors, St. Lucie County is also flat. The western three-fifths of its area is largely covered by St. Johns Marsh in the northern portion and the Allapattah Flats to the south. The remaining two-fifths paralleling the coast, is flatwoods country but much of the area has been put to productive use for cattle and citrus operations. The swampy area varies in elevation from about 50 feet at the western limits to 25 feet on the east. The flatwoods run east from there to sea level at the Intracoastal Waterway.

Long, narrow, sandy keys known as Hutchinson Island and Sprang Island lie along the entire mainland between the Intracoastal Waterway and the Atlantic Ocean. They are separated from each other by Fort Pierce Inlet, opposite the city of the same name.

The area near the plant site is not settled. This same statement applies to most of Hutchinson Island. The portion near Fort Pierce Inlet, however, does have resort developments on it.

c) Land Uses

The Agribusiness Committee of the Fort Pierce - St. Lucie County Chamber of Commerce reports that two-thirds of the land area of the county is given over to the general agricultural industry; 41 percent pasture land; 23 percent citrus; and one percent vegetables. The citrus figures appear somewhat higher than those given in estimates by the Florida Department of Agriculture but are accurate enough for purposes of this report.

The citrus groves are, in general, located in two major areas in the northern and central sections of the county and generally west of Fort Pierce. The first area is longitudinal in direction and about three or four miles inland from the Indian River, and extends about ten miles south of the Indian River - St. Lucie County line. The second is connected to the first at its southern extremity and turns west of the first area. The nearest of the major grove concentrations are eight or nine miles removed from the site.

The dairy nearest to the St. Lucie plant is located approximately 14 miles west-southwest of the site, and the present size of the dairy herd is approximately 1,000 head.

The cattle raising region is largely in the western half of the county but not limited to that area, with 41 percent of the county's land area given to this use. Small beef and dairy cattle herds can be found between the citrus areas west of Fort Pierce and west of Port St. Lucie.

Florida Power and Light has reviewed the St. Lucie County area for the purpose of locating the hypothetical cow. Upon review of the one mile radius extending from the Unit #2 reactor building all the land encompassed is within the plant site (see Figure 2.1-6). Extending the scope to 1.5 miles, additional land on Hutchinson Island is included outside FP & L property lines. These additional areas, however, are zoned by St. Lucie County as residential R-4 and R-1A (see Figure 2.24). As the radius is again increased to 1.75 miles, mainland areas, east of the R.E.C. Railway are now included. These land parcels are also zoned residential R-1A. Further west, past the railway, 2.1 --- 2.6 miles WSW of Unit #2 are land areas zoned agricultural (A-1). As seen from the 5 mile aerial photograph this section east of the Savannas is covered with dense foliage and is primarily a swamp area. Because of the density of bushes and trees grazing land is very limited. This area, if cleared, could possibly be used to pasture a cow although none are known to be present in this region. Since the grazing areas are almost non-existent, a sizeable portion of the cows feedings would probably have to be supplemented as a result of the above limitations. Estimates for supplemental feedings may exceed 50%. There is no potential for commercial dairying in this area.

Vegetable growing is a much smaller part of the county's agribusiness. Among the crops produced are tomatoes, squash, cabbage and dandelions. Of these, tomatoes represent the major money crop. Tomatoes comprise 99 percent of the entire reported vegetable crop each year.

Although of lesser economic importance, the beekeeper industry produces well over 600,000 pounds of honey a year. Horse breeding, swine production, poultry farms and a number of ornamental nursery farms are also part of the county's agricultural production.

Industrial employers of St. Lucie County are mainly centered around Fort Pierce. Some of these and their employed-force brackets are:

Bell Division of Ward Baking Company	200 +	Employees
Ten packing houses with seasonal employment	101-200	Employees
Six packing houses with seasonal employment	51-100	Employees
Sherold of Florida, Inc. - Quartz Crystals (Electronics)	51-100	Employees
Plastic Specialties - Plastic Pipe Fittings	26-50	Employees
Rinker Materials Corp. - Concrete Products	26-50	Employees
Wilson-Toomer Fertilizer Co. - Fertilizer	26-50	Employees
Twelve miscellaneous employers	11-25	Employees

The vehicular traffic passing the plant site on State Road A-1-A can be characterized as local, private passenger vehicles, typically of the order of 100 cars per day, exclusive of temporary traffic generated by plant construction activity.

d) Probable Future Land Uses

It is probable that some 15,000 additional acres will be added to the citrus production land resources inventory by 1974. Another 30,000 acres are estimated to be added by the year 2000. It is further estimated that 25,000 to 30,000 acres of pasture land will be added during the next 30 years. These changes will come about as the result of the reclamation of swampy lands in the western portion of the county.

An examination of the zoning on Hutchinson Island reveals a pattern common to Florida's "Gold Coast." The land areas bordering on the Atlantic side of the island are zoned R-4 which allows 18 units per acre for apartments and condominiums and 36 units per acre for either hotel or motel usage. It is obvious that this is an enticement for major hotel and motel developments to expand the constantly growing tourist trade in St. Lucie County.

On the west side of A-1-A most of the land, is of a low density residential classification (R-1A) allowing only 3 units per acre.

A majority of this area is now mangroves and will probably not be developed until the availability of the higher density areas diminishes somewhat. It should also be noted, that the costs involved in providing fill for the areas would be an additional deterrent to development.

There has been no official census taken since 1970 in either St. Lucie or Martin County. Future population estimates for 1980 have been researched with the following results: references in the State of Florida Statistical Abstract 1972 as published by the Bureau of Economic and Business Research College of Business Administration, the University of Florida, are contained in the listing below. This study was coordinated with the State of Florida Department of Administration, Bureau of Planning.

	1970 Population (Census)	1980 Projected
St. Lucie County	50,836	61,800
Martin County	28,035	40,700

In relation to recent investigations, the Applicant feels that the St. Lucie County estimate is conservative. Highly geared promotional activities, such as those used by the developers of Port St. Lucie have dramatically accelerated growth in the 5 - 6 mile radius SW of the plant site. As the success of this and similiar developments continue the agriculturally zoned land parcels east of highway US#1 will soon be deminished. These occurrences, however, are not at all unusual for the State of Florida. Development of these and other local land parcels will eventually develop during the construction period of Unit #2.

e) Water Uses in the Plant Vicinity

No successful fresh water wells have been found on Hutchinson Island. Details of local hydrology can be found in Section 2.5 of this report. Details of water recreation activity on Big Mud Creek (an inlet of the Indian River) are presented in Section 2.2.1.6 of this report.

Martin County

a) Location

Martin County is on the East Coast of Florida, with its northern limits near St. Lucie Inlet. Its county seat, Stuart, is located about 35 miles north of the City of West Palm Beach and 18 miles south of Fort Pierce. It is bordered on the north by St. Lucie County; on the west by the Lake and County of Okeechobee; and on the south by Palm Beach County. The land area of the county is entirely within 35 miles of the plant site and its northern border, north of Jensen Beach, is within six miles of the site.

b) General Description

The topography of this county differs somewhat from that of its northerly neighbors. The swampy area of the Allapattah Flats and the Loxahatchee Slough, part of the northern reaches of the Everglades, do not extend fully to the county's western boundaries.

In the western third of the county, the flats are interspersed with large patches of flatwoods. The Flats, Slough and Glades regions have more open water areas observable.

Agricultural activities in Martin County include cut-flower production. The St. Lucie River, with its connections to the Intracoastal Waterway, the St. Lucie Canal and the ocean, provide boating and fishing activity.

c) Land Uses

Agriculture is the primary use of land in this county. The Florida Department of Agriculture reports that over 50,000 acres of Martin County are in developed groves. This is almost 15 percent of its total land area.

The County Agent estimates that:

There are about 500 acres in the ornamental horticultural category planted to supply the cut flower trade in chrysanthemums, roses, Easter lilies, and miscellaneous varieties;

There are about 20,000 head of beef cattle and a minor number of cattle in dairy herds:

The row crops, planted on 2,500 acres, include tomatoes, cucumbers, peppers, and watermelons.

The County Agent states that the agricultural activities are located west of the Sunshines State Parkway, the cut-flower operations are west

of and close to the Stuart area because of the climatic advantages provided by the St. Lucie River. Residential and commercial uses are east of the Parkway and, in general, east of U. S. #1. Industry is in Stuart and also clustered near the airport.

d) Probable Future Uses

Based upon the information supplied by such authorities as the City Manager of Stuart, the County Agricultural Agent and local real estate brokers, it is believed that future expansion of industry will be mainly in the Stuart area and probably near the airport's present industrial cluster.

The residential expansion will be eastward toward the Waterway and southward toward Salerno. Some westward expansion is anticipated between Palm City and Sunshine State Parkway. A very large housing development, which will sit astride the Martin-Palm Beach Counties boundary, is in the "talking" and promotional stage. It is reported to be some 5,400 acres in size and is intended to serve as the development center for a 17,000 acre improvement. Plans are vague at this time.

Commercial development of the Stuart area is now taking place and will be expanded.

Indian River County

a) Location

All but a few square miles in the northwest corner of Indian River County lie within the study area. It occupies most of Sectors N and O from 25 to 50 miles outward. Its most southeasterly point is about 15 miles from the plant site. Its north line, at its junction with the ocean, is 37 miles north-northwest of the plant site. Its eastern boundary is the Atlantic Ocean and on the west is Osceola County. Its two southern neighbors are St. Lucie and Okeechobee Counties.

b) General Description

A generally flat expanse of land, somewhat poorly drained and having the western three-quarters of its area covered by the St. Johns Marsh, this county is one of the major citrus producers of Florida. The general land cover is flatwoods. Major development has been confined to the eastern one-quarter, along the coast. Agriculture is dominant in the central section of the county, with cattle raising spotted in several areas but noticeably in the southwestern corner of the county, some 30 miles northwest of the plant site.

c) Land Uses

Crop use accounts for about 15 percent of the total county land area. Pasture and range lands cover about one-third of the county. The largest concentration of citrus groves is along the coastal region in the southern three-quarters of the county and lying between Interstate #95

and the Intracoastal Waterway. Another large but not so extensive grove area lies along the St. Lucie-Indian River Counties boundary and west of Interstate #95.

The vegetable and other row crop area is mainly concentrated in the northern part of the county, midway between Interstate #95 and the Osceola-Indian River Counties boundary and it covers some 35 to 40 square miles of area.

Cattle raising has previously been commented upon. In this connection, it should be noted the directions of expansion are west and north, and mainly in the western third of the county.

Some 29,000 acres, about nine percent of the county, can be designated as developing urban area and, with the exception of Fellsmere community, about 37 miles northwest of the plant, is along the Waterway and the ocean.

There has been recent and appreciable industrial buildup on the mainland around the City of Vero Beach. Among the important employers are:

Piper Aircraft Company - Airplanes	1,835 Employees
Verogrand Corporation - Machinery	100 Employees
Crosby Builders - Building Supplies	57 Employees
Hobart Brothers - Electrode Coatings	35 Employees
Templin Fabricators - Trusses	30 Employees
Karnish Instruments - Aircraft Parts	30 Employees
Airlite Processing - Permalite	16 Employees
Miscellaneous Service Employers	100 Employees

d) Probable Future Land Uses

There is little to indicate any major changes in the types of land use in the future. The extent of use will increase, especially in the coastal region where further urbanization will take place. It is probable that strip development along the route of Interstate #95 will occur in the next few years and that such change will be related to the agricultural expansion in the middle and western parts of the county.

Okeechobee County

a) Location

This agricultural and cattle county shares its borders with six neighbors - on the north, Osceola and Indian River; on the east, St. Lucie; on the south, Martin and Glades; on the west, Highlands. The greater part of the area under study lies almost due west of the plant site, in the 25 to 50 mile band in a portion of Sector K, all of Sectors L and M and part of Sector N. The most easterly boundary is 27 miles from the plant site.

b) General Description

The country is generally open and flat. Elevations are about 50 feet in much of the county. Flatwoods areas are to be found along Taylor Creek and Cypress Slough and their tributaries and also in many scattered locations.

c) Land Uses

The reports of a 1964 agricultural census show the following:

Less than three percent of the total land area was given over to farming, reported as 499,000 acres, of which 81.8 percent was under cultivation or actual farming use;

The total number of farms was 199; 10 percent engaged in the dairy business and 36 percent were in the beef cattle business;¹

It is noted that 17 of the farms were from 1,000 to 1,999 acres in size, while 39 were larger.*

From a report by the Florida Department of Agriculture, only 3,329 acres in Okeechobee County were listed in the commercial inventory of citrus acreage. Industry is almost totally non-existent in the county. Aside from the residential use in the City of Okeechobee and the small percentage of total land area that is used for farming, citrus and cattle, some 95 percent of the county is undeveloped.

d) Probable Future Land Uses

The probabilities are for substantial increases in agricultural production acreage.

Palm Beach County

a) Location

This lower Florida East Coast county is bounded on the north by Martin; on the south by Broward; and on the west by Hendry. Its eastern limit is the Atlantic Ocean. It has some 40 miles of shoreline on Lake Okeechobee as part of its western land limits. Its principal city and the county seat is West Palm Beach, which is located about 47 miles south-southeast of the site.

That portion of Palm Beach County which is included in the study area is shaped like a partial segment of a parabola. It lies within Sectors H, I, J and a small portion of K, all of the latter and about one-third of the area in Sector J are covered by Lake Okeechobee. The closest part of the Martin-Palm Beach Counties boundary to the plant site is near Jupiter, about 28 miles distant. The area under study lies within the 25 to 50 mile band.

*1. A more recent local release states that in 1968 there are "40 to 45 dairies in the county.

b) General Description

Palm Beach County covers a large area and includes more than 2,000 square miles of land area, about one-quarter of which is in the study area.

The coastal area, for a distance west of about 20 miles, is a flatwoods section. West of this, and in general west of U. S. #441, the land is swampy and constitutes a large portion of the Everglades. Within the county, but not in the study area, is Loxahatchee National Wildlife Refuge. In the northern portion of the county and in the study area is the Loxahatchee Slough, lying west of the Sunshine State Parkway. It contains large areas of open water and is part of the "Glades". Very little flatwoods are found in the western part of the county. Elevations range from about 25 feet to sea level.

c) Land Uses

Industry is in various locations in the study area, the most isolated of these being the Pratt & Whitney Aircraft Development Center located 29 miles south and slightly west of the plant site. Other industries are located at Palm Beach Gardens; west of Riviera Beach; near Mangonia; clustered near Palm Beach International Airport; and near the City of West Palm Beach. All are from 29 to 50 miles removed from the plant site and all generally slightly east of south, in Sector H.

The winter vegetable farms are found mainly in the western part of the county in Sector J. Sugarcane is also produced in this area. Principal row crops are celery, snap beans, radishes, tomatoes, corn, peppers and cabbages.

Citrus groves are to be found in the northeastern part of the county. The Florida Department of Agriculture reports that as of the end of 1967, Palm Beach County had over 17,000 acres of its land planted with citrus trees.

Residential developments are found mainly in the eastern coastal region. Within the study area the major concentrations are in the southern 15 miles - between 35 and 50 miles from the plant site. The population section of this study includes full details. West Palm Beach and its adjoining neighbors are primarily residential in character. Populations along this coastal section fluctuate seasonally, with large increases in the winter.

d) Probable Future Uses

It is reasonable to expect expansion of industry in the vicinity of Palm Beach International Airport; residential increases are reflected in the data supplied in the population study included in this report. Agriculture expansion will be in the western portion of the county, with beef herds and sugarcane production increasing on the land that must be reclaimed for such uses.

Brevard County

a) Location

That portion of Brevard County which is included in this study lies mainly in Sector O, with its coastal area in Sector P. Its most southeasterly point is about 37 miles from the site. Its southwesterly limits in Sector N, are 50 miles from the plant site.

b) General Description

Brevard County is generally flat land running from sea level to elevations of 25 feet to 30 feet, largely covered with flat woods and is very sparsely settled. It is moderately to poorly drained land with some improved pasture and tree crops.

c) Land Uses

In the northern limits of that portion of the county within a 50 mile radius of the plant site, there are extensive citrus groves. The most easterly is astride the proposed Interstate #95. Two larger concentrations are west and somewhat north of the first area. Developed pastures and cattle herds are found along the Brevard-Indian River Counties boundary about 40 miles from the plant site. Some row crops are produced immediately north of the previously mentioned citrus grove area, west of Interstate #95.

d) Probable Future Land Uses

Expansion of the cattle, citrus and row crop operations, especially in the central portion of the sector, is most likely. The Waterway will attract additional tourists and a larger urban development will take place in the southern part of the county in the coastal region.

Osceola County

a) Location

That portion of Osceola County which is included in the study area is confined to the southeastern corner of the county; an area of less than 40 square miles, centered about Yeehaw Junction. It is in Sector N and its nearest point is 44 miles from the site.

b) General Description

The portion of Osceola County under study is moderately drained flatwoods which area is largely undeveloped.

c) Land Uses

There is only a very small area of independent agricultural activity in Osceola County.

d) Probable Future Land Uses

It is generally conceded that the probable future land use in Osceola County will be agricultural in nature.

Highlands County

a) Location

That portion of Highlands County included in the study area is limited to about 15 square miles in the most easterly portion of the county. Its nearest point to the site is 47 miles distant and located in Sector L.

b) General Description

The portion of Highlands County in the study area lies along the Kissimmee River, which is also the boundary between Highlands and Okeechobee Counties. It is at an elevation of 25 feet or slightly lower and is undeveloped.

c) Land Use

The area is presently undeveloped.

Glades County

a) Location

That portion of the county included in the study area is located in portions of Sectors K and L, in the outer limits of the 25 to 50 mile arc. It consists of approximately 100 square miles of the northeastern corner of Glades County and about half of it is covered by Lake Okeechobee. Its closest boundary is 41 miles from the site.

b) General Description

The Glades County area under study is mainly open country with a few small patches of flatwoods. Its altitude varies from a maximum of about 25 feet down to 15 feet at the shores of Lake Okeechobee. The eastern portion is swampy, with brushwoods being toward the west. It is an undeveloped area of the county.

c) Land Uses

This Glades County area is almost totally undeveloped land except as noted under the population section.

2.2.3 REGIONAL WATER USES

Both the cities of Ft. Pierce and Stuart have public water supplies from wells developed in the shallow Anastasia aquifer. The Stuart wells are located 11 miles southwest of the site. Water for plant usage is obtained from the City of Ft. Pierce from a well field located 10 miles northwest of the plant site.

Data on the water supply wells at Stuart and Ft. Pierce are listed below.

<u>City</u>	<u>No. of wells</u>	<u>Average Ground Surface Elevation</u>	<u>Average Depth of Well</u>	<u>Average gal/day per well</u>
Ft. Pierce	17	+20	110 ft	500,000
Stuart	12	+15	105 ft	170,000

No large industrial water usage exists in the area. Irrigation and stock watering account for the largest withdrawals of ground water. Water from the shallow aquifer is used for irrigation by farmers growing vegetables and citrus fruits, by ranchers for pasture lands, stock watering and feed crops. Many of the artesian wells were originally drilled for irrigating vegetable crops.

The total use of artesian water for irrigation may be about 10 million gallons per day during the dry season. During the rainy season most of these wells are not used.

Only two wells were found on Hutchinson Island. Despite the adequate, or more than adequate, supplies of well water on the mainland, no successful freshwater wells have been found on Hutchinson Island.

The approximate number of wells in various communities in the vicinity of the site (within six mile radius) are listed below.

<u>Location</u>	<u>Approximate Number of Wells</u>
Ankona	65
Eldred	53
Eden	70
Indian River Estates	22
Port St. Lucie (West of US #1)	500-600
Walton	75
White City (east of US #1 & South of SR-712)	130
White City (other area within 6 mile radius)	100-150
Between South City limits of Ft. Pierce and and northtown limits of Eldred along SR-707	91
South of White City and north of Jensen Beach Road	50

Field permeability tests at the plant site have indicated a seepage of flow of about 15,000 feet per year in the top 30 feet of the sand deposits. Taking the highest permeability coefficient obtained and a hydraulic gradient of 100 percent any discharge introduced into the ground at the plant site would reach the Indian River in about a day. The discharge would then be greatly diluted. Because of the width of Indian River and presence of a continuous flow of ground water toward the coast line, there is no possibility of subsurface flow from the site to the mainland. This precludes any intrusion of plant releases into the mainland ground water supplies.

The 210 to 550 gpm of water drawn from the Ft. Pierce water supply system has been regarded as totally consumed by the plant. It will be either discharged to the ocean after passing through the radwaste and chemical waste system or to the ground water after passing through the sanitary waste system. Refer to Table 3.3-1 for a description of the distribution of the water drawn by the plant from the Ft. Pierce municipal supply.

An average of 500,000 gal/day of water is obtained from each of the 17 wells of the Ft. Pierce Municipal water supply system. Thus, the system is capable of a supply rate of 8,500,000 gal/day. This quantity is sufficiently large such that the plant withdrawals will create no difficulties. The normal usage of 210 gpm represents 3.6 percent of the available supply.

Both the Indian River and Atlantic Ocean in the vicinity of the plant are used for recreation; such as boating, swimming and sports fishing, and for commercial fishing as described in Section 2.7.5.9.

TABLE 2.2-1

SELECTED AGRICULTURAL DATASELECTED COUNTIES1964

	COUNTY					
	<u>St. Lucie</u>	<u>Martin</u>	<u>Indian River</u>	<u>Okee- chobee</u>	<u>Palm Beach</u>	<u>Brevard</u>
Approximate Total Land in Acres	376,320	357,760	327,040	499,200	1,265,920	660,480
Total Number of Farms	505	134	370	199	529	572
Acres in Farms	338,532	173,041	232,496	408,520	448,276	191,157
Percent Land Area in Farms	90.0%	48.4%	71.1%	81.8%	35.4%	28.9%
Average Size Farm in Acres	670.4	1,291.4	628.4	2,052.9	847.4	334.2
Number of Farms with Cropland	464	115	348	118	467	555
Number of Farms with Pastured Land	84	51	65	172	179	83
Number of Farms with Irrigated Land	293	67	256	24	329	108
Acres of Irrigated Land in Farms	74,894	25,453	58,140	5,974	238,396	3,870
Number of Farms by Type:						
Field Crop Farms Other Than Vegetable & Fruit & Nut	-	-	1	-	89	-
Cash-Grain	-	-	-	-	-	-
Tobacco	-	-	-	-	-	-
Cotton	-	-	-	-	-	-
Other Field Crops	-	-	1	-	89	-
Vegetable Farms	12	3	1	2	141	2
Fruit and Nut Farms	294	12	250	14	21	286
Poultry Farms	7	-	2	1	9	7
Dairy Farms	5	7	4	20	21	2
Livestock Farms Other Than Poultry or Dairy	30	22	15	71	52	22
General Farms	1	2	-	2	3	-
Miscellaneous and Unclassified Farms	156	88	97	89	193	253

Source; U.S. Department of Commerce

TABLE 2.2-2

SELECTED DATA ON AGRICULTURAL PRODUCTION

SELECTED COUNTIES

1964

	C O U N T Y					
	St. Lucie	Martin	Indian River	Okee- chobee	Palm Beach	Brevard
<u>Commercial Farms</u>						
Dollar Value of Products Sold by Source:						
All Farm Products Sold	\$32,676,856	\$11,206,766	\$21,421,540	\$14,379,388	\$96,159,282	\$12,294,444
Average Per Farm	85,542	114,355	73,361	117,864	217,064	33,409
All Crops	30,512,990	8,222,745	19,723,766	499,752	86,213,300	11,671,839
Field Crops, Other Than						
Vegetables & Fruits & Nuts	31,360	12,896	2,593,156	10,551	27,007,431	320
Vegetables	3,492,515	1,030,959	189,989	199,000	48,738,596	18,309
Fruits and Nuts	26,754,853	1,977,531	16,533,130	250,451	4,360,845	11,269,990
Forest Products & Horticultural						
Specialty Products	234,262	5,201,359	407,491	39,750	6,106,428	383,220
All Livestock and Livestock Products	2,148,566	2,984,021	1,694,084	13,860,736	9,943,181	573,184
Poultry and Poultry Products	71,024	9,488	16,235	33,254	420,268	159,473
Dairy Products	1,006,776	2,067,045	768,102	11,205,926	7,215,230	98,394
Livestock and Livestock Products						
Other Than Poultry or Dairy	1,070,766	907,488	909,747	2,621,556	2,307,683	315,317

Note: Major categories (all crops and all livestock and livestock products) will not add to total dollar value of all products sold due to additional miscellaneous farm incomes not included in breakdown.

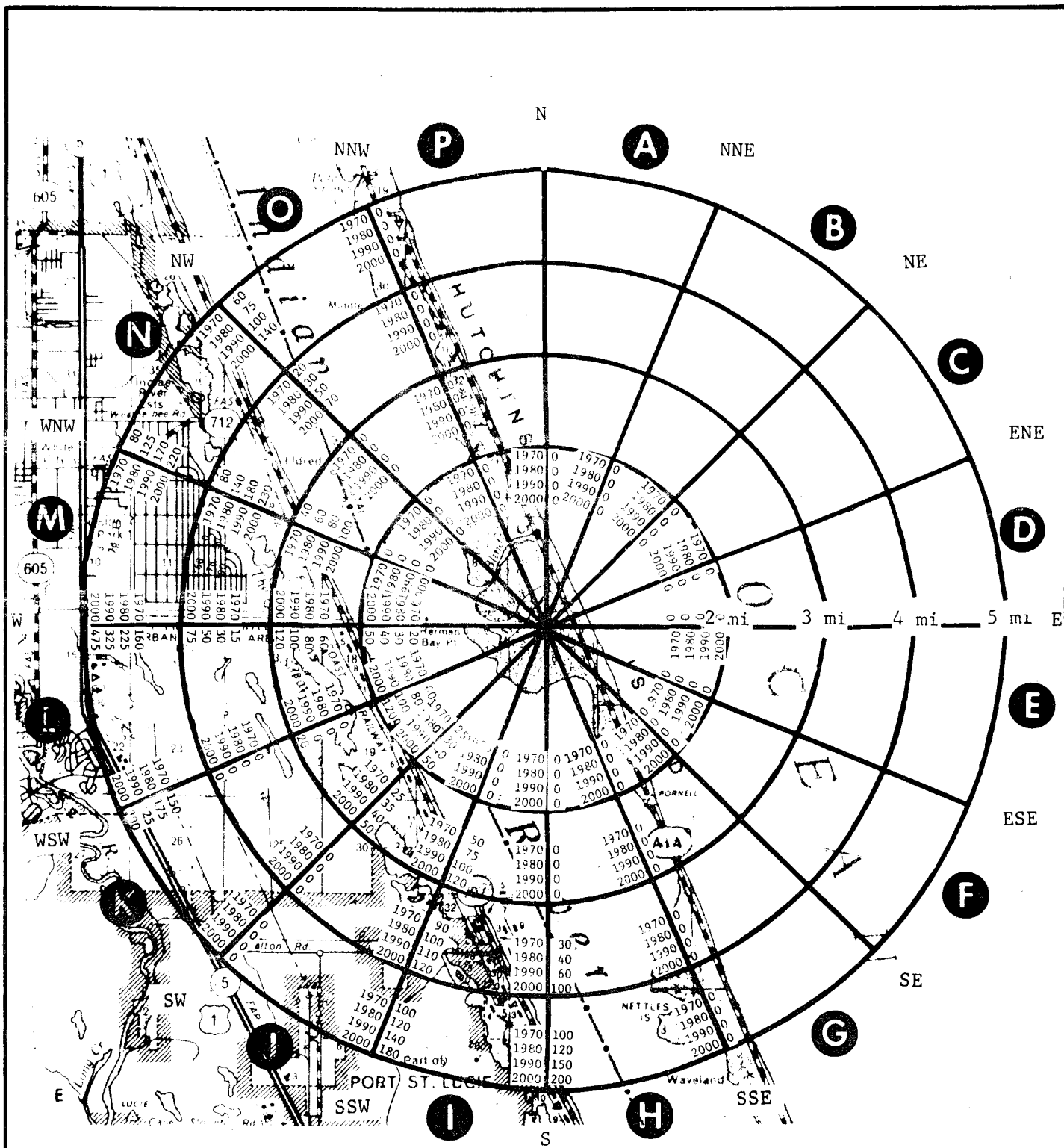
Source: U.S. Department of Commerce

TABLE 2.2-3

SELECTED DATA ON DAIRY FARMSSELECTED COUNTIES1964

	C O U N T Y					
	<u>St. Lucie</u>	<u>Martin</u>	<u>Indian River</u>	<u>Okee- chobee</u>	<u>Palm Beach</u>	<u>Brevard</u>
Total Farms Reporting Milk Cows	8	11	8	42	30	8
Number of Milk Cows	2,040	3,600	2,123	23,148	14,027	175
Breakdown of Farms by Number of Milk Cows at Hand						
1 or 2	3	3	4	17	3	6
3 or 4	-	1	-	3	1	-
5 to 9	-	-	-	1	4	-
10 to 19	-	-	-	1	-	-
20 to 29	-	-	-	-	-	-
30 to 49	-	-	-	1	-	-
50 or more	5	7	4	19	22	2
<u>Commercial Farms Only</u>						
Number of Farms with Milk Cows	7	10	5	30	23	5
Number of Milk Cows	2,039	3,599	2,119	23,123	13,929	171
Number of Farms Selling Milk and Cream	5	7	4	21	21	2
Dollar Value of Milk and Cream	\$1,006,776	\$2,067,045	\$768,102	\$11,205,926	\$7,215,230	\$98,394

Source: U.S. Department of Commerce

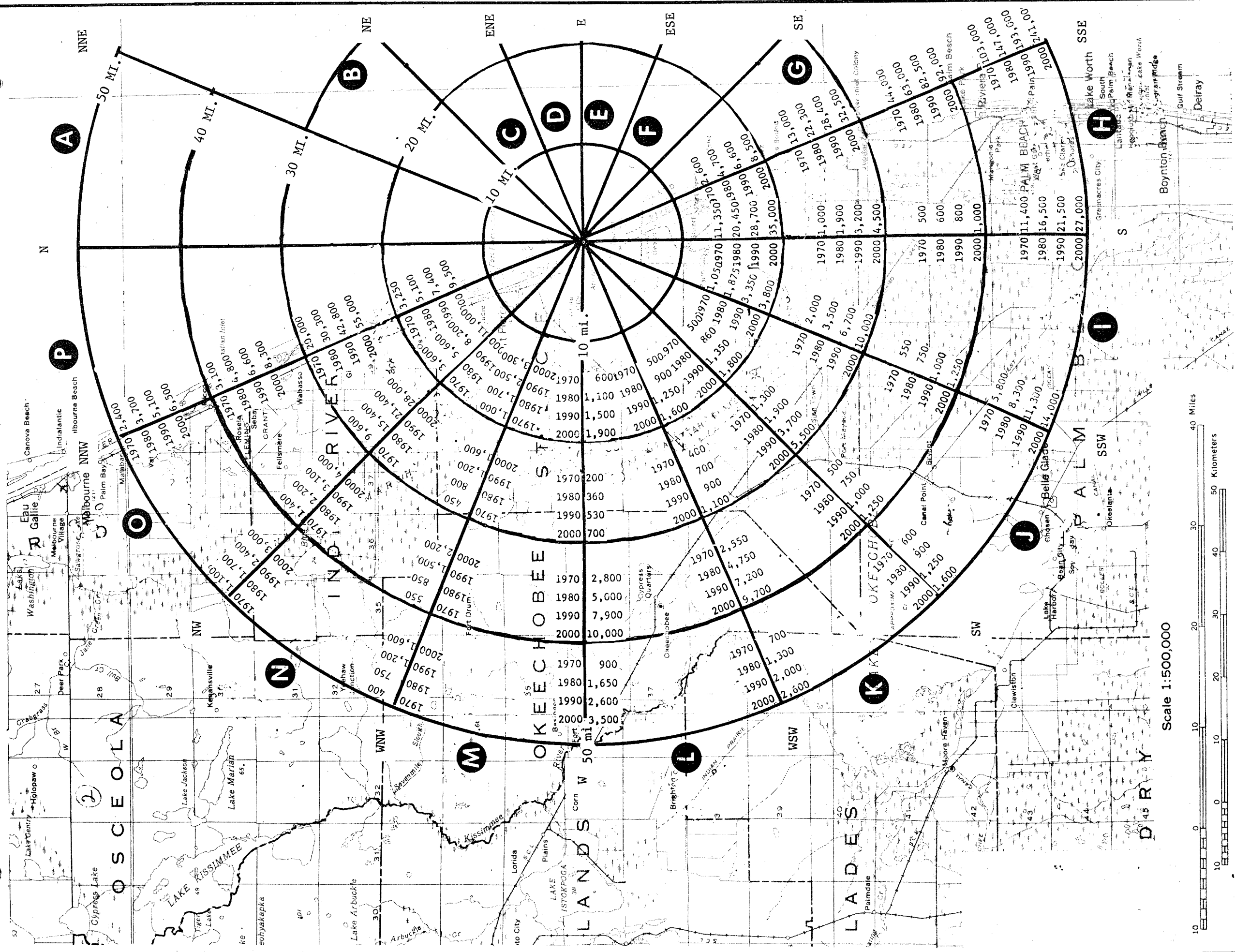


FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

POPULATION DENSITY WITHIN
5 MILES

FIGURE 2.2-1

OVERSIZE
DOCUMENT WAS
REMOVED AND
INSERTED INTO
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SEPARATELY.

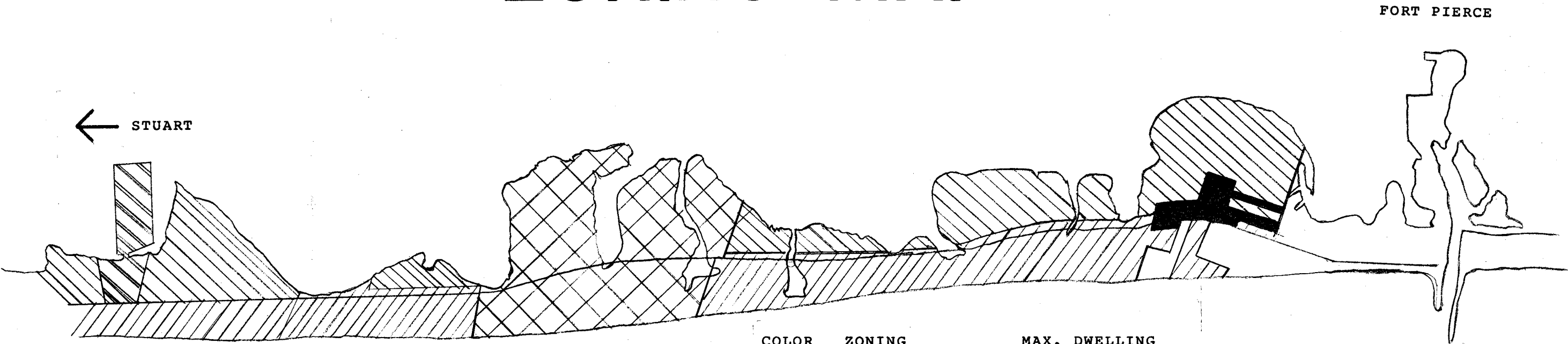


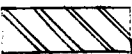
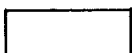
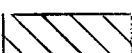
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

POPULATION DENSITY WITHIN
50 MILES

FIGURE 2.2-3

HUTCHINSON. ISLAND ZONING MAP



COLOR CODE	ZONING CLASSIFICATION	MAX. DWELLING UNITS PER ACRE
	FPL SITE	
	B-2	18
	A-1 (campground)	15
	A-1	1
	R-1A	3
	R-4	18*

* 36 for Motels & Hotels

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

HUTCHINSON ISLAND
ZONING MAP
FIGURE 2.2-4

2.3 REGIONAL HISTORIC AND NATURAL LANDMARK SIGNIFICANCE

The National Register of Historic Places⁽¹⁾ lists no historic places on or near the Plant site or Hutchinson Island. The nearest places listed are the Pelican Island National Wildlife Refuge and the site of Salvors Camp for Spanish Wrecks, both near the town of Sebastian approximately 40 miles north of the Plant. The Okeechobee Battlefield is located about the same distance west of the Plant, near the town of Okeechobee.

The State of Florida, Board of Archives and History states "no historical damage will be done by this project."⁽²⁾ They further indicate there are unexplored middens and mounds, but these are mainly located on or near the north end of the site (that part of the site to be left in its natural state).

The transmission line right-of-way is being surveyed for possible historic, natural or archaeological sites of significance.

2.4 GEOLOGY

2.4.1 PHYSIOGRAPHY

The Floridan Plateau is the partially submerged southeastern peninsula of the North American Continental Shelf. The peninsula of the state of Florida is the exposed portion above sea level of the Floridan Plateau. This region is described as part of the Atlantic Coastal Plain physiographic province. The region of study generally includes the Florida Peninsula and the counties of St. Lucie, Martin, Indian River and Okeechobee.

Within this physiographic province is the Atlantic Coastal Ridge, which extends along the Atlantic Ocean shore as an irregularly shaped strip ranging from 5 to 10 miles wide between geomorphic units of the Eastern Sandy Flatlands and the Everglades swampland on the west and the Atlantic Ocean on the east.

2.4.2 GEOMORPHOLOGY

The site is located on the east coast of Florida on an offshore sand bar named Hutchinson Island, part of St. Lucie County.

Hutchinson Island has been developed and has remained exposed above mean sea level since the Pleistocene age, approximately one million years ago. The Pleistocene sediments are slightly thicker at the site than at the mainland due to the depositional processes associated with the island development.

There are about 13,000 feet of sedimentary rock formations overlying the crystalline rock basement in this region (1). Generally speaking, the upper 600 feet of sediments consist of soft rock formations that are partially cemented and indurated sands and clays. Beneath these materials are moderately hard to very hard formations of limestone, dolomite, sandstone, shale and anhydrite. These formations become thicker toward the east coast and gradually taper off near the center of the Florida Peninsula.

The topography of this area is a bar and swale type. There is a low bar near elevation (+) 14 feet on the ocean side of the island. The surface of the island then slopes downward toward the Indian River to about elevation (+) 4 feet, generally forming a swale or marsh. To the north and west of the site, both Big Mud Creek and the Indian River are continuations of the swale and are very shallow, 5 to 10 feet deep. There is a dredged channel in the Indian River as part of the Intracoastal Waterway. To the west, on the mainland, there is another bar with a maximum elevation of about (+) 40 feet parallel to the coast. To the east, the Atlantic Ocean deepens gradually to a depth of 120 feet at a distance of about 15 to 20 miles offshore from Hutchinson Island.

The site was originally covered by a mangrove swamp. A small road-dike, for mosquito control, has been constructed around the portion of the site that is adjacent to Big Mud Creek and the Indian River. The swamp usually has saline water as its surface water in the site area.

There is 4 to 6 feet of peat immediately beneath the surface of the undeveloped portion of the site. This material is a dark brown or black residuum produced by the partial decomposition and disintegration of trees, mangrove roots and other vegetation. This peat was probably formed during the past several thousand years.

2.4.3 STRATIGRAPHY

The Anastasia formation of Pleistocene age underlies the peat (2). No differentiation has been made between the various Pleistocene and possible Pliocene deposits which extend to about elevation (-) 135 to (-) 155 feet below sea level. This material has been termed "Anastasia Contemporaneous". There is an inference from geologic and engineering evidence that the discontinuous cemented pockets are the erosional remnants of the Fort Thompson formation. The Anastasia formation is quite possibly composed of marine, brackish and fresh water deposits. Petrographic studies have shown that at some locations, the well rounded, frosted sand is indicative of a beach or marine depositional environment. At other places within the formation, there is a blackening of shells which may indicate a reducing or brackish depositional environment. Also identified was a fresh water gastropod from one of the partially cemented, discontinuous pockets.

The Anastasia formation consists of gray, slightly clayey and silty fine to medium sand with fragmented shells and, in places, fragmented shell beds with slightly clayey to silty fine sands. There are also discontinuous pockets of cemented sandstone with shells and sandy limestone. Occasional discontinuous thin plastic clay lenses were also found in the upper part of the formation.

The Anastasia aquifer is the main source of water supply for several towns and cities in this coastal area, including the towns of Fort Pierce and Stuart.

The Hawthorne formation of Miocene age unconformably underlies the Anastasia in this region. This formation probably ranges from about 300 to 600 feet thick near the coast and thins toward the northwest. The upper 100 to 150 feet of the Hawthorne formation consists of green, slightly clayey and silty, very fine sand. The lower part becomes generally more clayey. In some areas, there are thin layers of sandy phosphatic limestone and chert in the lower part of the formation. In other areas, the lithology of the lower part of the Hawthorne formation changes slightly to a gray white phosphoritic sandy clay. This formation is generally dense and indurated due to desiccation and cementation.

Below the Hawthorne formation is a continuous horizon of Oligocene limestone called the Suwannee formation. The Suwannee limestone is a cream colored, slightly porous granular mass of limy particles. It contains very few distinguishable fossils. The Suwannee formation is separated from the Hawthorne by an unconformity. The Suwannee formation is probably the only Oligocene age formation in this area. The top of this formation is near elevation (-) 200 feet in Indian River County and thickens eastward to near (-) 700 feet in Martin County.

Below the Suwannee formation are formations of Eocene age. These formations include the Ocala Group limestones and the Avon Park limestone. The thickness of the Eocene age sediments in this area has not been precisely determined but is thought to be at least 1800 feet, or to extend to or below elevation (-) 2500 feet.

The Eocene formations dip and generally thicken to the southeast. The top of the uppermost formation within the Eocene formations, the Ocala limestone, is an irregularly eroded surface and its position is known only approximately.

Below the Eocene formations are the Paleocene formations. These formations are probably limestones and dolomites and extend to about elevation (-) 4200 feet. The Paleocene formations are relatively impermeable and not a part of the principal artesian system of Florida.

Below the generally dense Paleocene formations are the Upper Cretaceous or other Mesozoic rocks. These rocks extend downward to about elevation (-) 13,000 feet in this area. It is postulated that the basement rocks of gneisses and schists underlie the Mesozoic formations. This has not been verified as no well has penetrated that deep in this region.

2.4.4 STRUCTURE

The rocks composing Floridan Plateau range in age from recent deposits, which are still accumulating, to a Precambrian core of metamorphic and igneous rocks similar to those in the Piedmont of the eastern United States. It is believed that the Precambrian core is an arched peninsula with an axis oriented in a north-northwesterly direction (3).

Most of the state is underlain by formations of the Tertiary and Quaternary systems. They have never been subjected to great pressure from overburden or heat and have apparently never suffered from intense tectonic forces. As a result, they have become indurated only by cementation and chemical precipitation.

There is some evidence of faulting along both the east and west coasts (2,4). This is in the vicinity of the edge of the continental shelf in the southernmost portion of Florida. The faulting is essentially minor fracturing that is associated with the flexure of an arch rather than the profound faulting that would result from horst development. There is also a postulated normal fault in the western portion of Indian River County, 15 miles northwest of the site, which is aligned in a north-northwesterly direction (3). This fault has been postulated on a variation in the top of the Suwannee and Ocala Formations from data obtained in deep borings. However, contours can be drawn from the same data that show no faulting.

The St. Lucie River in St. Lucie County parallels the coast at a distance of about 2 miles inland. This is a possible lineation that may tie in with the postulated faults in Martin and Indian River Counties. The closest distance from this possible lineation to the site is about 3 miles. This possible lineation may also be explained by the bar and swale topography present in the area. However, there is no published

geologic literature that indicates that this possible lineation is a fault or is even structurally controlled.

In order to check the possible significance of this lineation, two borings were located on the mainland opposite Hutchinson Island. The general stratigraphy found in these borings is in agreement with conditions found at the site. The borings show a gentle dip of the Miocene sediments toward the ocean, which is typical along the Florida east coast. Therefore, evidence indicates that there is no displacement in the Miocene formations within three miles of the site.

Extensive deep geologic and geophysical studies have been made to the north at Cape Kennedy in conjunction with the launching pads and supporting structures for the NASA space program. These deep borings have found some minor displacements within the Hawthorne formation of Miocene age. There is no suggestion from this work that these displacements extend as deep as the basement or into the overlying sediments. Geophysical studies north of Jacksonville, Florida show no sharp discontinuities in the thicknesses of Tertiary strata near the edge of the shelf that might suggest faulting.

The structure of the geologic formations at the site is uncomplicated. The younger or Pleistocene and Miocene formations are generally flat, dipping very slightly to the southeast at about 15 feet per mile. The older or deeper formations probably dip at a somewhat greater angle. There was no evidence found in the field work and borings to suggest any significant geologic structure within a two mile radius of the site.

2.4.5 SEISMOLOGY

The historical earthquakes observed in Florida have been infrequent, of low to moderate intensity, with epicenters far removed from the site (5,6). The one area of observed earthquake concentration, Green Cove Springs, is more than 180 miles from the site and about 25 miles south of Jacksonville, Florida. The other earthquakes within the state have been scattered. There is no evidence that any are related to known structural features. The strongest earthquake felt in the state was centered far to the north, at Charleston, South Carolina. There is no evidence of any structural features which might project the effects of such an earthquake toward this site at some later time.

There are reasonably well authenticated records of fourteen different earthquakes during the past 241 years whose epicenters were in or near the state of Florida. Two of these had estimated epicentral intensities of VI (Modified Mercalli Scale). Eleven others had epicentral intensities between IV and V. The remaining one had a still lower epicentral intensity.

Several of the postulated Florida epicenters are widely scattered throughout the Plateau. However, it is significant that ten, and possibly eleven, of the estimated epicenters have occurred within about 50 miles of Green Cove Springs. The nearest of these epicenters to the site is approximately 180 miles away.

The origin and the depth of the foci of these earthquakes in the vicinity of Green Cove Springs have not been established. The estimated intensities suggest that these are minor readjustments probably associated with the flexure which accompanied the formation of the Ocala uplift.

2.5 HYDROLOGY

2.5.1 SURFACE-WATER HYDROLOGY

The St. Lucie site is located on the Hutchinson Island in St. Lucie County. The surface hydrologic boundaries of the site are the Atlantic Ocean to the east and Indian River to the west. The average annual temperature is 75 F; the average annual precipitation at Fort Pierce is above 62 inches. The average annual water loss due to evaporation in the area is estimated to be 40 to 45 inches. Rainfall is seasonal, and above 65 percent of the annual amount occurs during the rainy season from June through October. During this period, the rain usually occurs as localized heavy showers. High soil permeability provides significant groundwater recharge from local precipitation, with little runoff.

According to information supplied by the Mosquito Control Commission at Fort Pierce, some areas of Hutchinson Island, including the site, were flooded nine years ago. This was accomplished by the construction of a five foot high road dike penetrated by culverts equipped with flap valves. High tide automatically provides the necessary water cover on the island during the months from September to March. During the remainder of the year water has to be pumped from the Indian River.

The United States Coast and Geodetic Survey Maps indicate the average range of ocean tide in this area to be approximately three feet and that the Indian River tidal range is approximately one foot.

Normal tides in the area are semidiurnal having two highs and lows of approximately equal magnitude every $23\frac{1}{2}$ hours. Information contained in References 2 and 3 gives normal and spring tide ranges at Fort Pierce, St. Lucie Inlets (jetties) and at locations within the Indian River. Those data are given below.

	Mean Range (ft)	Spring Range (ft)	Mean Tide Level (ft)
Fort Pierce Inlet (Breakwater)	2.6	3.0	1.3
Fort Pierce (City Dock)	0.7	0.8	0.3
Jensen Beach	0.5	-	-
Port Sewall	0.5	-	-
St Lucie Inlet (Jetty)	2.6	3.0	1.3

According to data recorded at the Fort Pierce city dock, the average time difference between high water at the jetties and high water in the Indian River is +1 hour and 51 minutes. Between low water occurrences, the time difference is +2 hours and 11 minutes. High and low tides in the plant site vicinity occur 5 to 10 minutes later. Tide relationships between the ocean and St. Lucie Inlets, together with those between the Indian River at Fort Pierce and the site vicinity are graphically presented in Figure 2.5-1.

Limited data are currently available on the near-shore currents at Hutchinson Island. Readings taken by the Florida Department of Natural Resources are given in Table 6.1-2 and indicate that along shore flows vary from 1.6 fps southward to 0.4 fps northward. The Applicant is presently installing two recording current meters which will take readings for a period of one year (see Section 6.1.1.1 for details of the monitoring program).

In the West Palm Beach area, the maximum 24-hour total rainfall was 15.23 inches recorded in April, 1942. Short period rainfall amounts of 6.0 inches in one hour have been recorded west of the West Palm Beach area. The probable maximum precipitation, 32 inches, would occur over a small 10 sq. mile area during the first 24-hour period in a severe hurricane with a probable recurrence period of 75 to 100 years.

Due to the extremely shallow nature of the estuarine river adjacent to the site and to the flat terrain, the hydrological flood flow characteristics are dominated by surge flooding and the associated hurricane winds. In the September 1947 hurricane, 6 to 8 foot tides were noted in Indian River in the vicinity of Fort Pierce. In the August 1949 hurricane, a tide height of 8.5 ft MSL was recorded at Stuart, Florida near St. Lucie Inlet. In the September 1928 hurricane, which also affected Fort Pierce, a tide of 10.1 ft MSL was recorded at Palm Beach, some 50 miles to the south of Fort Pierce. In general, it appears that a tide elevation on the order of 8 plus feet due to a hurricane has been the highest observed in Indian River, both at the inlets and at opposite ends of the reach of river. The peak tide elevation due to the probable maximum hurricane (PMH) is estimated to be 11.8 ft MLW ocean (10.5 ft MSL) along the beach-front of Hutchinson Island, and 8.0 ft MLW river (7.7 ft MSL) in Indian River at the plant site.

In the PMH, a significant wave height of 25 feet with a period of 9.3 seconds could be generated offshore of Hutchinson Island and directed toward shore. The significant wave height occurring in Indian River at or in the vicinity of the plant site during the PMH occurrence would be on the order of 5 feet with a wave period of 5.5 seconds. Wave runup was estimated from the breaking waves on the 1 and 3 side slopes surrounding the plant embankment. During an occurrence of the PMH, wave runup would be 10.12 feet from the oceanside and 5.8 feet from the Indian River above the peak tide elevations.

In consideration of the above results, all features of the plant essential to safety will be flood protected to an elevation +22 ft MLW ocean.

The Indian River is generically a salt water estuary rather than a river, and as such, does not have a sustained flow. It is not normally used as a water source or outlet with respect to the Hutchinson Island plant. Extreme low tides have been observed on numerous occasions in coastal bays and rivers bordering on or emptying into the Atlantic Ocean or the Gulf of Mexico. They are the result of hurricane passage far enough north or south of a coastal area (depending on whether east or west coast of Florida) to have sustained winds oriented either offshore (for bays and open coasts) or along the primary axis of coastal rivers. They may also occur as a result of a storm remaining stationary, or looping just offshore, so that sustained offshore winds of long duration prevail over the

coastal area. For example, at Tampa, Florida tide levels at Seddon Island were lowered to -5.1 ft MSL during passage of the October 1944 hurricane. Similarly tides at Cedar Keys, Florida were lowered to -4.5 ft MSL as a result of the August 1949 hurricane, and to -3.1 ft MSL from the famed "Cedar Key Hurricane", which looped just offshore of the area. For a condition of extreme low tide to occur at the plant site, the PMH must either pass inland some 25-30 miles north of the plant site or remain stationary some 20-30 miles offshore of the site area. For the former condition north winds up to 60 mph would prevail over Indian River prior to storm passage inland; a wind shift to the west would then occur and wind speeds would increase to 100 mph and higher. Water levels in Indian River would be lowered rapidly from Fort Pierce southward to and including the plant site area under the effect of strong north winds. At low tide (see Figure 2.5-1) the average depth in the river is about 4 feet. Under 50-60 mph winds water levels would be lowered about 0.8 foot per mile below Fort Pierce and raised at a comparable rate in the vicinity of Jensen Beach. Some tidal inflow from the ocean at Fort Pierce would prevent water levels in that area from receding much below normal tide; however, near the center of the reach, i.e., the vicinity of the plant site, several feet of lowering can be expected to occur as the removal rate exceeds the inflow rate through Fort Pierce Causeway. It is estimated that an extreme low tide elevation of 3.0 ft MLW river can be expected to occur at the plant site during an occurrence of the above conditions.

St. Lucie Unit No. 2 will utilize 1150 cfs of water from the Atlantic Ocean as condenser cooling water. The Indian River will provide a source of up to a maximum of 30,000 gpm of water for the Emergency Cooling Water System. Further information concerning the plant surface water use is given in Section 3.3.1.

2.5.2 GROUND WATER HYDROLOGY

2.5.2.1 Aquifers

Regional

The region under study is the area of St. Lucie, Martin, Indian River, and Okeechobee Counties. Two main aquifers are found in this region: a shallow non-artesian or locally artesian aquifer, and a deep artesian aquifer.

The shallow aquifer is the principal source of fresh water in the site region. It consists of the Anastasia formation and extends to a depth of about 150 feet below the land surface. It is composed principally of sand that contains thin lenses of shell, limestone, or sandstone which are generally more permeable than the sand (2).

The shallow aquifer receives most of its recharge from rainfall in the immediate surface area. In general, surface water runoff is small. A small amount of recharge to the shallow aquifer also comes from downward seepage of artesian water used for irrigation.

The discharge of the shallow aquifer is by flow into streams, or lakes, by direct flow into the ocean, by evapotranspiration, and by pumping

from wells. Canals and ditches in the area carry some ground water away. The transmissibility of this aquifer in Martin County has been measured to be approximately 20,000 gallons per day per foot (2).

The deep aquifer of the area and principal artesian aquifer of the region is the Floridian aquifer which underlies all of Florida and southern Georgia and consists mainly of permeable limestone beds. The top of the Floridian aquifer in Martin County is usually between 600 and 800 feet below the ground surface and underlies the Hawthorne formation which is an aquiclude. The thickness of the Floridian aquifer in this immediate vicinity is unknown, since no well has completely penetrated it. It is estimated to be approximately 2000 feet thick. The artesian pressure head (piezometric surface) in the area of the site is estimate to average about 45 feet (See Figure 2.5-2) below ground level.

The principal recharge area for the Floridian aquifer in this region is in the area of central Florida around Polk County where the limestone aquifer is overlain by semi-confining beds of the Hawthorne formation which are somewhat permeable for downward leakage or percolation.

The discharge points of the Floridian aquifer are springs and wells and areas where upward leakage occurs through the confining beds. There are no known natural springs in the region, but further discharge may occur in submarine springs approximately 25 miles off shore where the Floridian aquifer is exposed in the ocean floor.

Local

Underlying the 4 to 6 feet of surface peat is the Anastasia formation upper limit which extends to about elevations (-) 135 to (-) 155 feet and consists of grey, slightly silty, fine-to-medium sand with varying amounts of fragmented shells. It also contains discontinuous pockets of cemented sand with shells and sandy limestone. Occasionally, discontinuous thin, plastic clay lenses are found in the upper part of the formation. The Anastasia formation is an unconfined or non-artesian aquifer.

Below the Anastasia formation, the upper 100 feet of the Hawthorne formation at the site consists of a green, slightly clayey to silty, very fine sand. Conditions from about 250 feet and extending to the 400 foot depth of boring termination, are sandy and clayey silts which form the principal aquiclude for the underlying Floridian artesian aquifer.

2.5.2.2 Field Operations

To determine the general ground water environment at the proposed site, piezometers were installed in ten of the borings to measure ground water levels in the Anastasia and the Hawthorne formation (See Figure 2.5-3). Readings of water levels in the piezometers were taken periodically throughout April, 1968. The data are presented in summary form in Figure 2.5-4.

Two additional piezometers were installed in borings B-17 and B-18 on the mainland and monitored for the two month period from the end of June 1968 to the end of August 1968. The locations of these piezometers are

shown on Figure 2.5-5. Rainfall records were kept for the same period. The results are presented in summary form on Figures 2.5-6.

Water samples were obtained from selected piezometers which sampled the Indian River (Big Mud Creek), and the water at the site (swamp water). Chemical tests were conducted on these samples. The test results are shown in Table 2.5-1.

The water temperature measured at various depths of the piezometers indicated an average of 75.8F with negligible variation. Private wells within a radius of 6 miles of the site were surveyed. The data collected are presented in Exhibit 2.5-1.

Constant head field permeability tests were conducted in accordance with the Bureau of Reclamation procedures. Detailed descriptions of the procedures and the results of the field permeability tests are shown in Exhibit 2.5-2.

2.5.2.3 Ground Water Levels

The ground water table occurs very near, or above, the ground surface at the site due to the mosquito control ponds. A continuous body of water was found at the site to the depths investigated. The slight artesian head of 0.5 to 1.0 foot was observed in piezometers P-1 and P-8 installed in the top of the Hawthorne formation (See Figure 2.5-4).

Ground water fluctuations in drill holes in response to tidal changes indicate relatively uniform transmissibilities of the sand desposits. Piezometer P-11 was installed near the Atlantic Ocean shore in the Anastasia formation and directly reflected tidal variations. Piezometers along the Big Mud Creek (P-7, P-9, P-10 installed in the Anastasis formation indicated water levels less than 0.5 foot above the tidal range recorded in the Big Mud Creek. This is probably due to the higher water level on the land side of the dike. Piezometer P-2 was installed partially into the Hawthorne formation, but it generally reflected the Anastasia levels.

On the mainland, piezometer readings varied more than those on Hutchinson Island. The piezometers reflected recent rainfalls within 1 to 5 days after the rainfall. The average water levels were generally decreasing after the large rainfall between July 5 and July 9. During this five day period, 5.82 and 4.91 inches of rain were recorded at Stuart and Fort Pierce, respectively. The effect of the tidal variation was not evaluated.

The average slope of the water levels between the two peizometers was 0.03 percent towards the ocean.

2.5.2.4 Ground Water Development

Water Use

All public, and most domestic, supplies of water in the region are obtained from ground water sources. Ground water is also used extensively for irrigation, stock watering and industry.

The cities of Fort Pierce and Stuart have public water supplies from wells developed in the shallow aquifer (See Table 2.5-2). The city of Fort Pierce water supply wells are 10 miles northwest of the site, and Stuart wells are 11 miles southwest of the site. No large industrial water usage exists in the area. Irrigation and stock watering account for a large percentage of withdrawals of ground water. The total use of artesian water for irrigation may be about 10 million gallons per day during the dry season. During the rainy season, most of these wells are not used.

Water Quality

Chemical analyses of water sample taken from the wells on the mainland indicate that the water from the shallow aquifer has a lower mineral content than the deeper artesian water (2).

The piezometric surface of the Floridian aquifer in Martin County is about 50 feet above mean sea level. This pressure head should be sufficient to insure at least 200 feet of fresh water below sea level. Artesian wells in Martin County down to about 1500 feet have shown high chloride content. It appears that this is due to seawater from the Pleistocene epoch rather than from recent sea water encroachment.

The natural fresh water source on Hutchinson Island is rainfall. Because of the low lying land, the permeable nature of the soils and the short distance to points of discharge, the water table is probably only a few inches above mean sea level. Wells in many places on the island are still in fresh water a foot or so below the water table. However, even moderate pumping allows salty water to enter the wells. At the plant site, pumping Indian River water into the pond has increased the mineral concentration of the ground water. Results of water chemical analyses on seven samples taken at the site are given in Table 2.5-1.

Soil Filtration

Field permeability tests made during this investigation have indicated a seepage rate of about 15,000 feet per year in the top 30 feet of the sand deposits at the site. Taking the highest permeability coefficient obtained and a hydraulic gradient of 100 percent, any discharge introduced into the ground at the reactor site would reach the Indian River in about a day. The discharge would be strongly diluted immediately. Because of the proximity and width of the Indian River and the presence of low flow of ground water toward the coast line, there is no possibility of subsurface flow from the site to the mainland under these conditions.

2.5.2.5 Air Photo Studies

The four county area immediately west of the site was studied using aerial photographs and air reconnaissance to determine if there were any surface indications of geologic structure. The counties involved were Indian River County, St. Lucie County, Martin County, and Okeechobee County. The entire region was examined using the index mosaic sheets. The immediate vicinity of the site (within a radius of about 5 miles)

was studied stereoscopically. The island and the adjacent areas were also covered by direct visual observation from the air.

The land-forms geomorphology of the four county area vary from flat to slightly rolling, typical of an emerging coast (3). The off-shore sand islands extending along the ocean shores of Indian River, St. Lucie, and Martin counties have a flat topography with a maximum elevation of about 15 feet. Across the Indian River on the mainland, a narrow beach ridge extends along the shoreline with a maximum elevation of about 40 feet.

Behind the ridge are found long, shallow, swampy, mucky-bottom swales. These swales are called "the Savannas", and they parallel and lie west of the narrow beach ridge bordering the Indian River. Beyond the Savannas, the land is generally flat with a maximum elevation of about 30 feet extending for approximately 20 miles inland where a gentle slope paralleling the coast line brings the ground elevation to approximately 70 feet within a distance of about 2 miles.

West of the Savannas and the beach ridge, the following general observations can be made about the surface drainage characteristics of the four county area:

- a. Internal (vertical) drainage is the most prominent feature.
- b. The two primary surface drainage ways in the area are the St. Lucie River (North Fork in St. Lucie County, South Fork in Martin County) and the Kissimmee River.
- c. Sandy ridges and bluffs paralleling the coast line are found inland at several locations.
- d. Man-made works such as canals and spoil banks have distorted the natural drainage patterns in some areas.

The primary and secondary drainage paths were located and defined as the first phase of the air photo study. The shapes of subsidence areas were noted to vary from perfectly circular to elongated. In general, the subsidence areas form a drainage pattern which can be described as a combination of collinear or parallel channelless basins and swallow holes reflecting past littoral action and the limestone-solution action of the flat-lying limestone, respectively.

The St. Lucie River North and South Forks, have a braided drainage pattern upstream and a slightly reticular drainage pattern near the mouth. Near the Indian River, areas of elongated bays with inter-related series of channels and oval lakes were observed along with swamps or marshes. The long axes of the ovals were generally found to be parallel to each other and to the coastline. Some ovals were not drained by surface channels. The indications are that the materials on the edges of these bays are unconsolidated, coarse grained, and the materials in the bays are generally soft, unconsolidated silt, peat, or other highly organic matter. These appear to be swales in the original beach deposits.

Several sand ridges were observed inland in the area under study. A well-drained sand slope runs parallel to the coastline along the northeast corner of the Okeechobee County into the western half of Martin County of Lake Okeechobee. This slope represents the limit of the Penholloway Terrace Postulated by Cooke (See Regional Geology Paragraph 2.4-1).

In general, the occurrence of the basins were noted to increase midway between these ridges. Otherwise, the basins were found to be randomly distributed. Even though a general southeasterly drainage direction is indicated for the primary drainage ways, the secondary drainage paths showed a random distribution of drainage directions. The local non-symmetrical tributary distribution of the secondary and primary drainage ways appear to point to the influence of the sand ridges. The secondary drainage paths exhibit a generally dendritic drainage pattern.

Topographic and drainage patterns were found to have strong lineations parallel to the coast line (See Figure 2.5-7). The directions of the elongation of a great number of basins are also an indication of this general lineation. In Indian River County, the vicinity of Blue Cyprus Lake also very strongly shows a topographic as well as drainage lineation supplementing the general observation. This particular lineation appears to approximate an extension of the major sand ridge traversing the area of study. This ridge also forms the drainage divide between the Kissimee River and the St. Lucie River basins. Lineations indicated by the secondary drainageways are considered unreliable since artificial drainage efforts have altered natural drainage patterns extensively at this level of drainage, sometimes re-establishing minor drainage divides.

In conclusion, the air photo studies do not indicate any geologic structures that cannot be related to an emerging coast. The oval shaped swales, topographic and drainage lineations found are typical features of such a coast and the associated past littoral action. The circular subsidence areas (swallow holes) are probably a reflection of the limestone solution activity. None of the features mentioned exist at the site.

2.5.2.6 Conclusions

This investigation of the ground water hydrology of Hutchinson Island permits the conclusion that the possibility of any detrimental effect upon the mainland ground water environment from any accidental release of radioactive materials, gases, or from any other activities at the plant site is extremely remote.

TABLE 2.5-1

WATER QUALITY ANALYSIS
LAW ENGINEERING TESTING COMPANY

Lab. No.....	8231	8232	8240
Sample Location	P-1	P-2	P-11
Date of collection.....	3-30-1968	3-28-1968	3-28-1968
Silica (SiO ₂).....	15.1	10.1	8.4
Iron (Fe).....	1.4	1.2	4.1
Manganese (Mn).....	0.0	0.0	0.0
Calcium (Ca).....	1364	1820	1204
Magnesium (Mg).....	781	190	173
Sodium (Na).....	10000	11400	12700
Potassium (K).....	477	427	406
Bicarbonate (HCO ₃).....	256	659	573
Carbonate (CO ₃).....	0	0	0
Sulfate (SO ₄).....	2515	387	387
Chloride (Cl).....	20800	19200	18600
Fluoride (F).....	21	6	1
Nitrate (NO ₃).....	0.2	0.0	0.0
Dissolved solids			
Calculated.....	36164	33928	33907
Residue on evaporation at 105 C	39840	44580	45760
Residue at 600° C.....	35860	38960	40560
Organic solids.....	3724	4961	4627
Hardness as CaCO ₃	6620	5330	3720
Noncarbonate hardness as CaCO ₃	6410	4790	3250
Alkalinity as CaCO ₃ , Phenolphthalein	0	0	0
Alkalinity as CaCO ₃ , Total.....	210	540	470
Specific conductance			
(micromhos at 25° C).....	40000	38500	40000
pH.....	6.40	6.15	5.5
Color.....			
pH saturation (calculated).....	6.84	6.38	6.60
Langelier Index, I.....	-0.44	-0.23	-1.10
Salinity.....	33630	33780	32680
Specific gravity.....	1.024	1.027	1.028

NOTE: All analytical results are in mg/liter

SL2

TABLE 2-5-1 (Cont'd)

WATER QUALITY ANALYSIS

LAW ENGINEERING TESTING COMPANY

Lab No.	8233	8234	8235	8236
Sample Location	P-3a	Big Mud Creek	Swamp Water	P-9
Date of collection.....	3-31-1968	3-31-1968	3-31-1968	4-6-1968
Silica (SiO ₂).....				
Iron (Fe).....				
Manganese (Ma).....				
Calcium (Ca).....	432	436	440	1800
Magnesium (Mg).....				
Sodium (Na).....				
Potassium (K).....				
Bicarbonate (HCO ₃).....	354	305	232	854
Carbonate (CO ₃).....	0	0	0	0
Sulfate (SO ₄).....	2709	2902	3225	271
Chloride (Cl).....	17600	19400	20800	19200
Fluoride (F).....				
Nitrate (NO ₃).....				
Dissolved solids				
Calculated 105 C.....	45600	40540	44940	44880
Residue on evaporation at 600° C..	30220	31140	34540	38740
Hardness as CaCO ₃				
Noncarbonate hardness as CaCO ₃				
Alkalinity as CaCO ₃ , Phenolphthalein	0	0	0	0
Alkalinity as CaCO ₃ , Total.....	290	250	190	700
Specific conductance (micromhos at 25° C).....				
pH.....	7.10	7.40	7.70	6.30
Color.....				
pH saturation (calculated).....	7.25	7.28	7.42	6.24
Langelier Index, I.....	-0.15	+0.12	+0.28	+0.06
Salinity.....	31230	34330	36630	33630
Specific gravity.....	1.018	1.020	1.024	1.026

NOTE: All analytical results are in mg/liter

TABLE 2.5-2AVERAGE CHARACTERISTICS OF
FORT PIERCE AND STUART
PUBLIC WATER SUPPLY WELLS

CITY	NO. OF WELLS	AVERAGE GROUND SURFACE ELEV.	AVERAGE DEPTH OF WELLS	AVERAGE GAL. PER DAY PER WELL
Ft. Pierce	17	+20	110 Ft.	500,000
Stuart	12	+15	105 Ft.	170,000

EXHIBIT 2.5-1

PRIVATE WELL SURVEY

In May 1968 the existing private wells within a six mile radius of around the site were surveyed by Law Engineering Testing Company.

In addition to Hutchinson Island, where only two wells were found, the area surveyed can be divided into two zones of well concentration:

1. Along State Road 707
2. Along U.S. Highway #1

In these zones there were many private wells. Therefore, no attempt was made to locate and record every well in the area. Approximate number of wells in the various communities are given in Table 2.5-3. Other data are presented below.

In general, every house was found to have one or more wells. Also, almost every well was found to be capped and attached to a pump so that measurements of water levels could not be made at the time of the survey. All shallow wells in the area are drilled and cased full depth with screen on the ends. In the area of Eldred and Eden, shallow wells are 20 to 40 feet deep. Further inland, in White City, 40 to 60 feet deep wells are common.

Only two roads extend west from SR-707 to U. S. #1 within the survey area. These are the Walton Road and the White City Road (SR-712). Along the former, there are no wells. South of SR-712 is a large tract owned by General Development Corporation (Indian River Estates). Presently, this development has 22 homes with expansion planned for the near future.

The cities of Fort Pierce and Stuart have water supply systems on U. S. #1, the Fort Pierce water system extends to the State Farmer's Market. Water from Stuart is piped to Hutchinson Island. This system extends as far north as Holiday Out, a trailer resort located in St. Lucie County approximately 5 miles south of the site. The Port St. Lucie Community, which presently has 500 to 600 homes, also has a private water supply system.

There is no heavy industrial demand for water supply in the area surveyed.

EXHIBIT 2.5-2FIELD PERMEABILITY TESTING

Two types of pump-in, constant head type field permeability tests were conducted at two locations, as shown on Figure 2.5-8. These consisted of open-end pipe and well permeameter methods of testing, as outlined in the Bureau of Reclamation's "Earth Manual". (1) Field permeability tests were also planned at proposed locations of major structures in the swamp area and borings were made for this purpose. However, these holes were found to be clogged with organic fines. In an attempt to remedy this problem, the bore holes were re-drilled and cleaned, using clean swamp water and diluted hydrochloric acid. However, this attempt failed; therefore, tests in the swamp were abandoned.

A total of four test holes were drilled in the vicinity of Boring B-2, two for the open-end pipe (PC-1 and PC-2, fully cased) and two for the well permeameter method (PU-1 and PU-2, partially cased). Dimensions for these holes are shown in Figure 2.5-9. The subsurface conditions as determined by boring B-2 are given in the attached log, Figure 2.5-10.

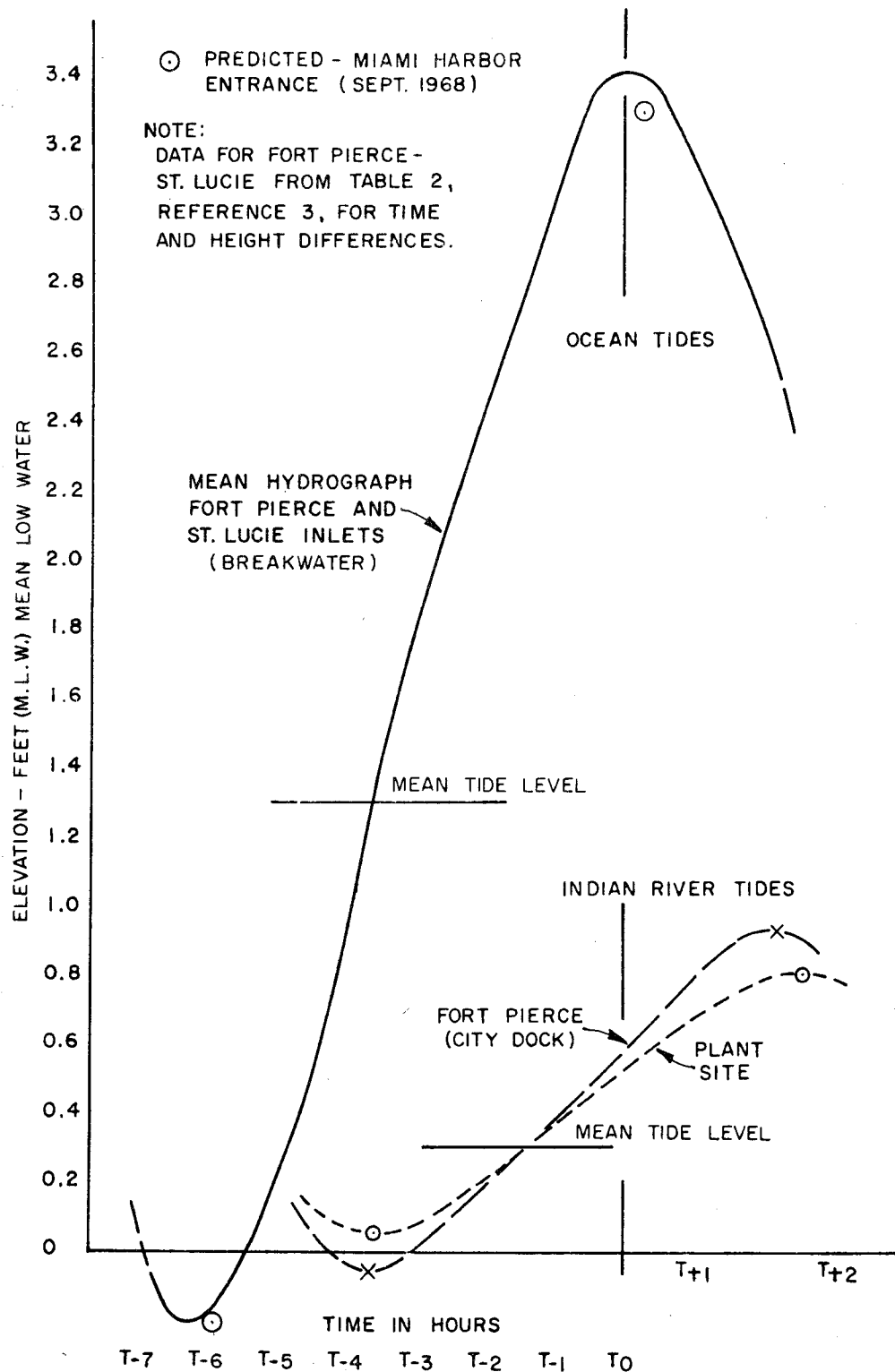
In all test holes, casings were advanced by jetting or by washing and driving. All holes were carefully cleaned before testing was begun. After cleaning, cased holes PC-1 and PC-2, were completely filled with limestone ranging in size from 3/8 to 4 inches. All casings were sealed on the outside using expansive clay pellets.

In conducting all permeability tests clean water was pumped into the casing and a constant gravity head maintained in the casing during the test. The flow was measured with a water meter, the constant head in the casing being maintained by means of regulating valves.

Graphs of cumulative discharge versus cumulative time are shown in Figures 2.5-11 through 2.5-14. The coefficients of permeability were determined using the steady flow part of these curves for the two types of tests.

The field permeability values obtained for all four tests are shown in Figure 2.5-8. Laboratory permeability test results compare favorably with these values.

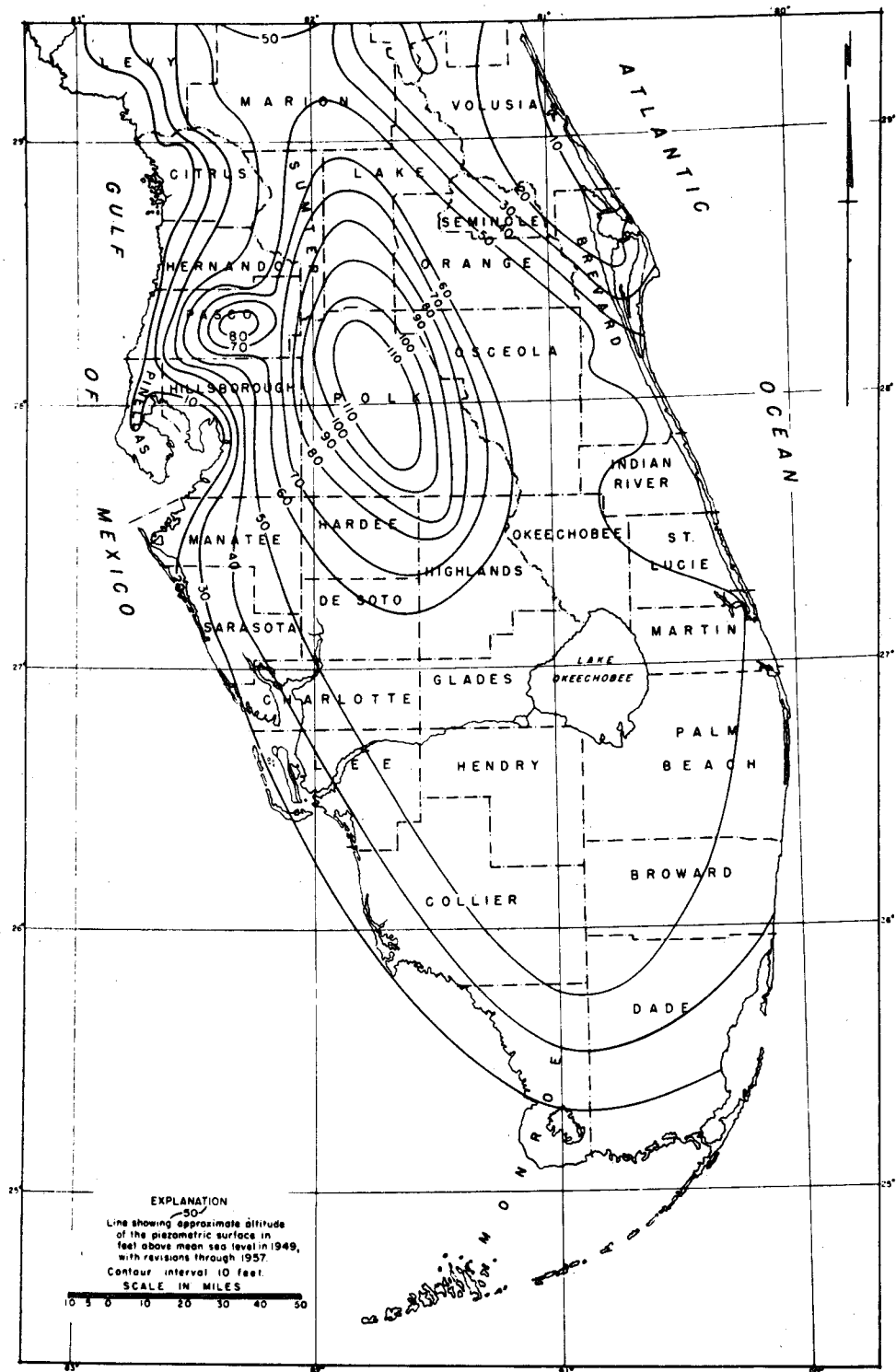
(1) Bureau of Reclamation, Earth Manual, Denver, Colorado, 1963, First Edition, Revised, pp. 541-562.



FLORIDA POWER & LIGHT COMPANY
 ST. LUCIE PLANT UNIT 2

HUTCHINSON ISLAND PLANT NORMAL
 TIDE RELATIONS VICINITY OF
 HUTCHINSON ISLAND

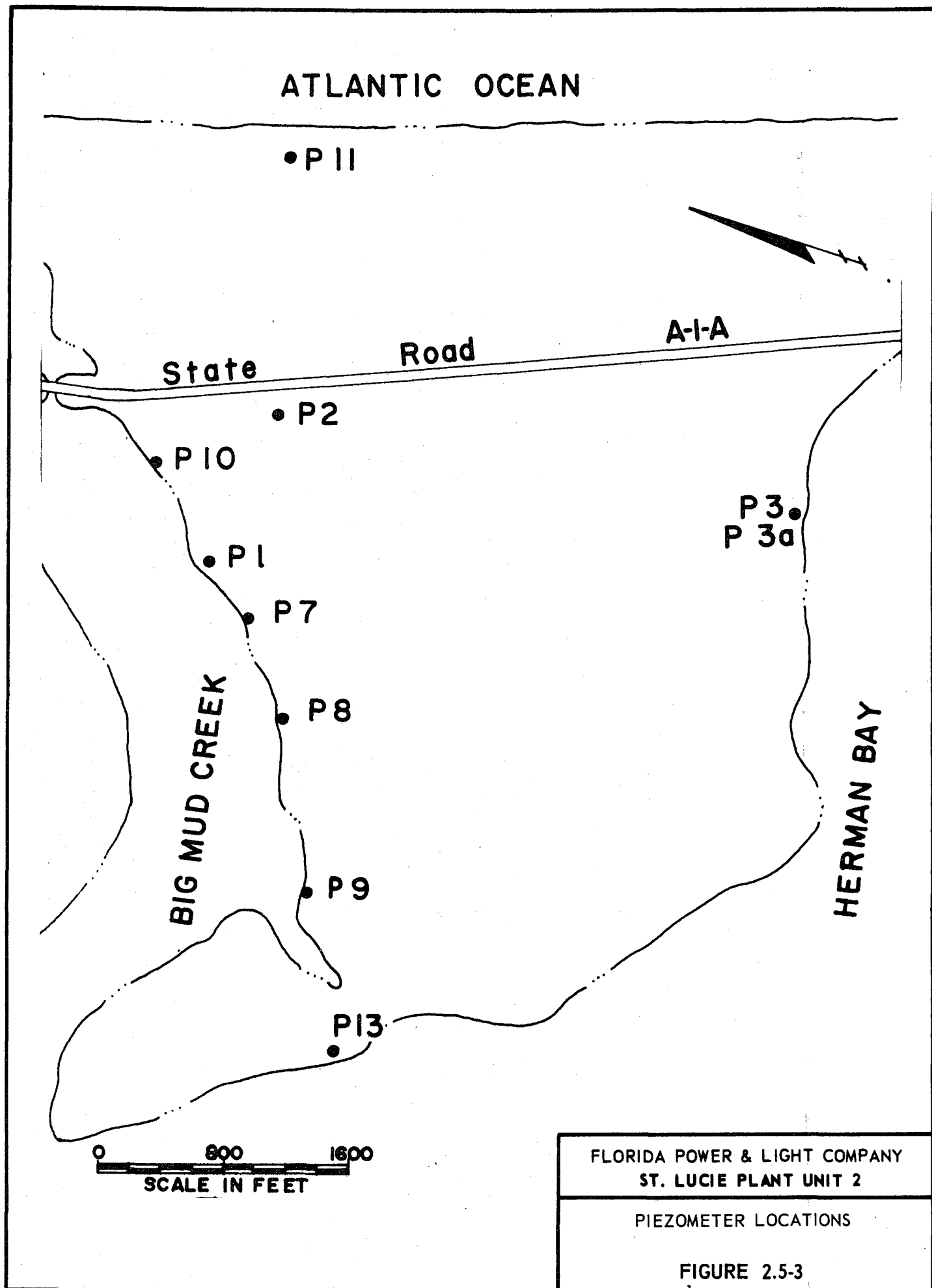
FIGURE 2.5-1

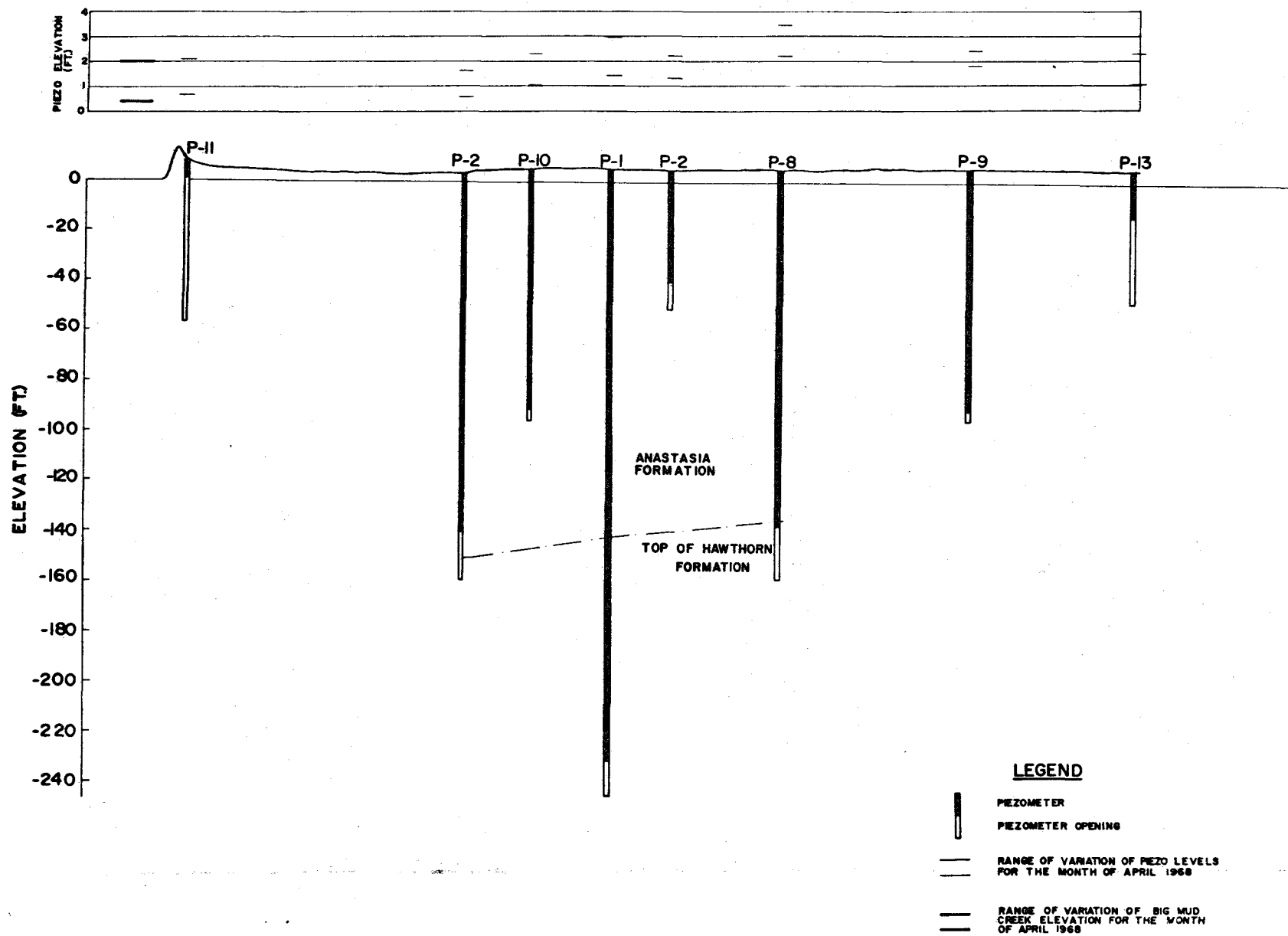


FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PIEZOMETRIC SURFACE OF THE
FLORIDAN AQUIFER

FIGURE 2.5-2





WEST

EAST

B-18

B-17

ELEVATION OF
PIEZOMETRIC
SURFACE

15

10

5

0

MAX.

AVG.

MIN.

MAX.

AVG.

MIN.

50

13

0

-50

-100

50

34

0

-50

-100

SAVANNAHS

18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

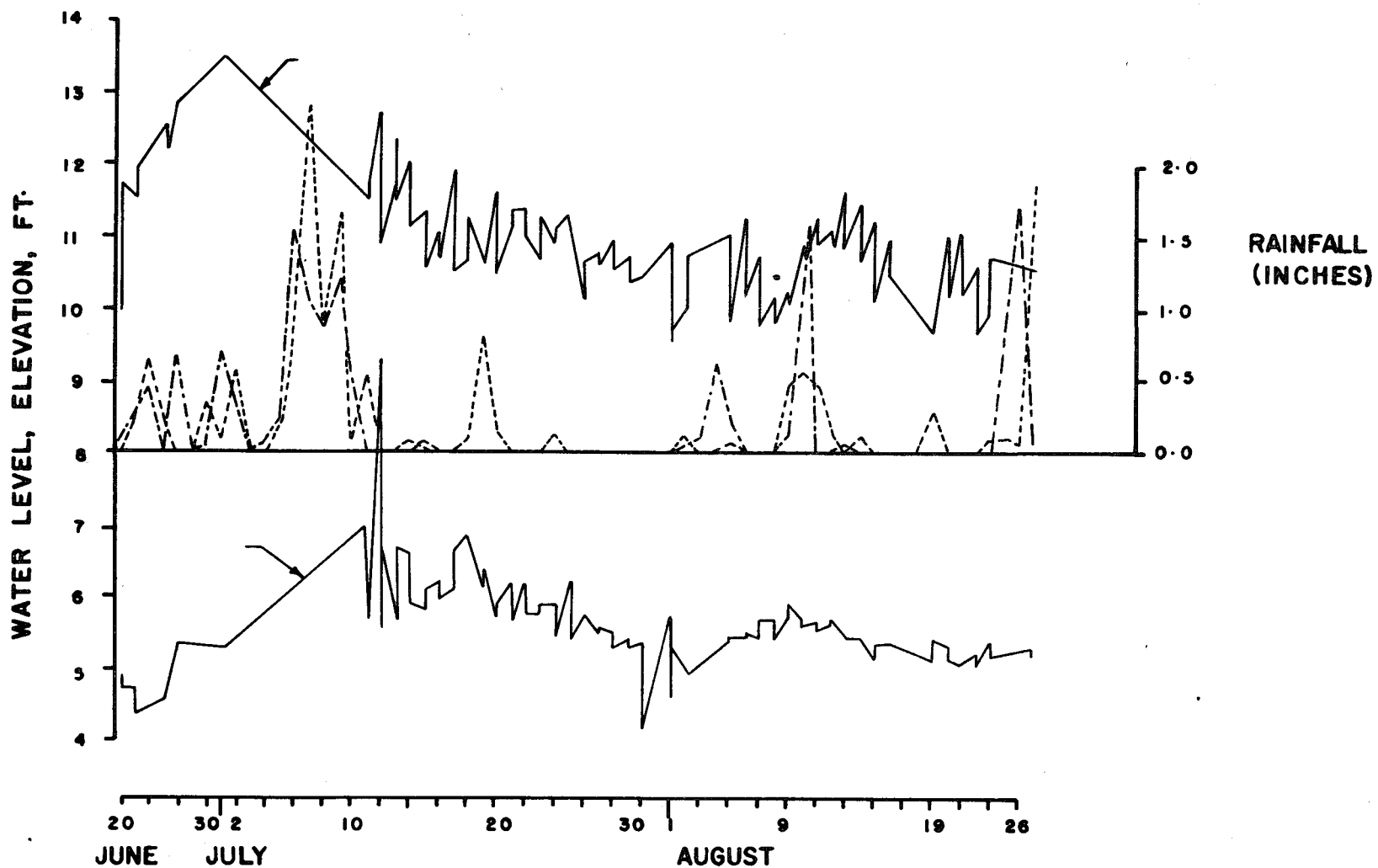
18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

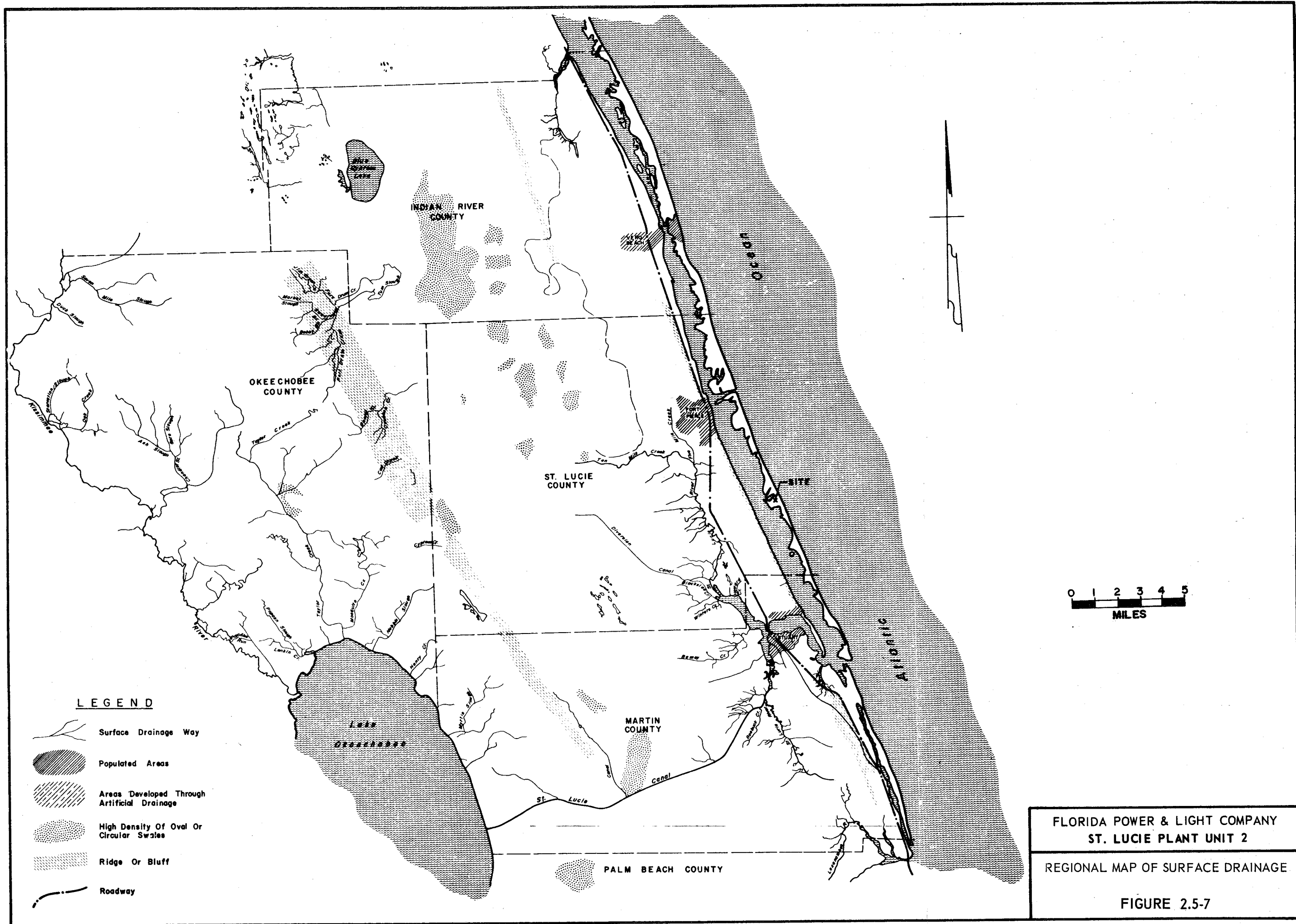
PIEZOMETRIC CROSS SECTION
BORINGS 17 AND 18

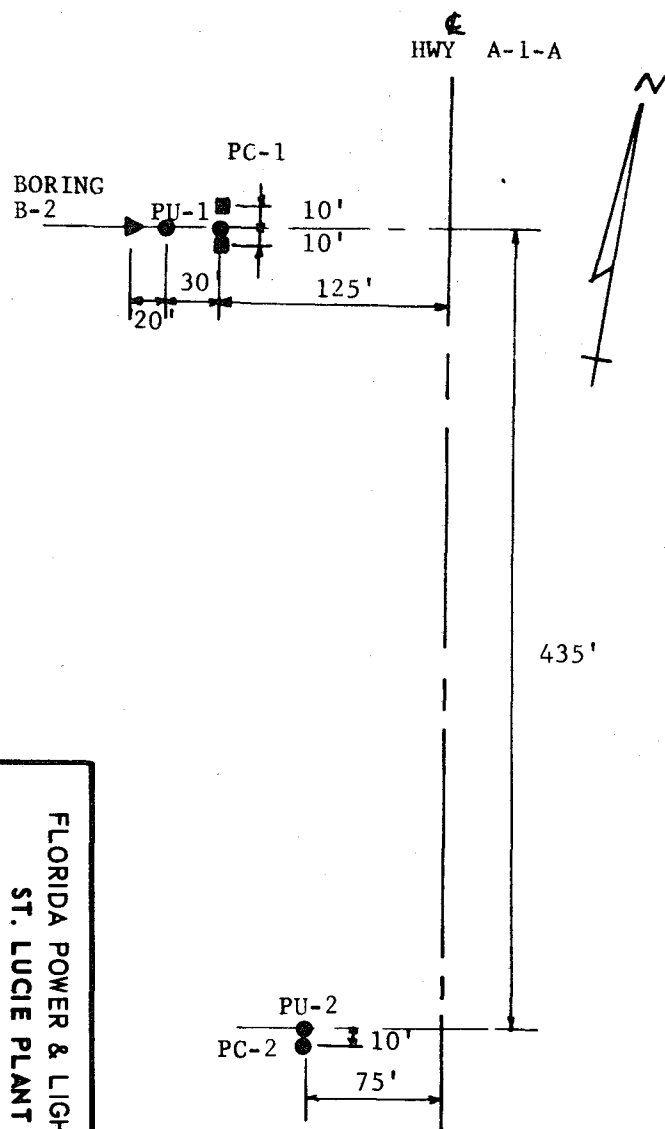
FIGURE 2.5-5



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT 2
PIEZOMETRIC DATA FOR P-17, P-18

FIGURE 2.5-6





TEST RESULTS

HOLE	PERMEABILITY, k (FEET PER SECOND)	
	OPEN PIPE METHOD	WELL PERMEAMETER METHOD
PC - 1	7.5×10^{-3}	
PU - 1		6.7×10^{-4}
PC - 2	3.4×10^{-5}	
PU - 2		4.9×10^{-5}

HUTCHINSON ISLAND - NUCLEAR PLANT
JOB NUMBER EC-163

LABORATORY PERMEABILITY TESTS

Permeability Tests were run on undisturbed samples from two locations. The samples were cut into discs 2.5 inches in diameter and 1 inch thick and sealed in closed chambers. They were then subjected to an unbalanced head of water and the rate of flow through the soil was measured.

RESULTS

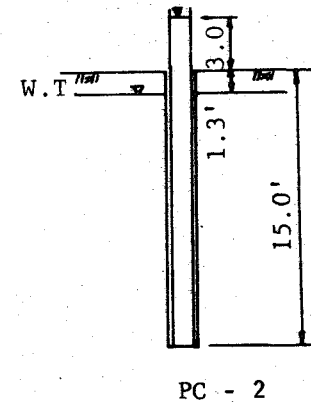
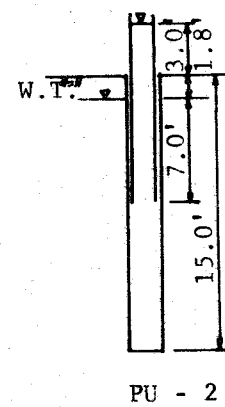
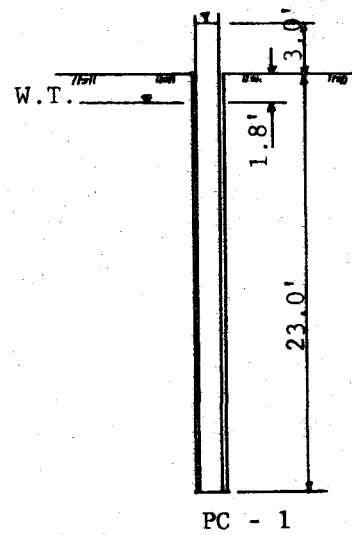
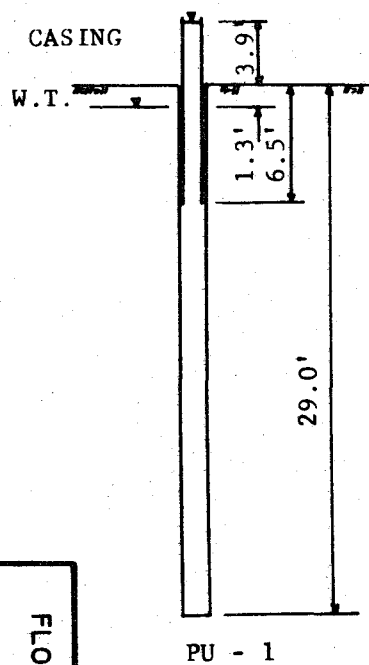
BORING NO.	DEPTH	e	k	SOIL CLASSIFICATION
B-8	15'-16.5'	0.740	9.9×10^{-2} ft./min.	GREY SLIGHTLY SILTY FINE TO COARSE SAND (SHELL FRAGMENTS RETAINED IN SIEVE NO. 40)
B-13	35'-37'	0.915	2.8×10^{-2} ft./min.	GREY SLIGHTLY SILTY VERY FINE SAND WITH TRACE OF SHELLS

FLORIDA POWER & LIGHT COMPANY

ST. LUCIE PLANT UNIT 2

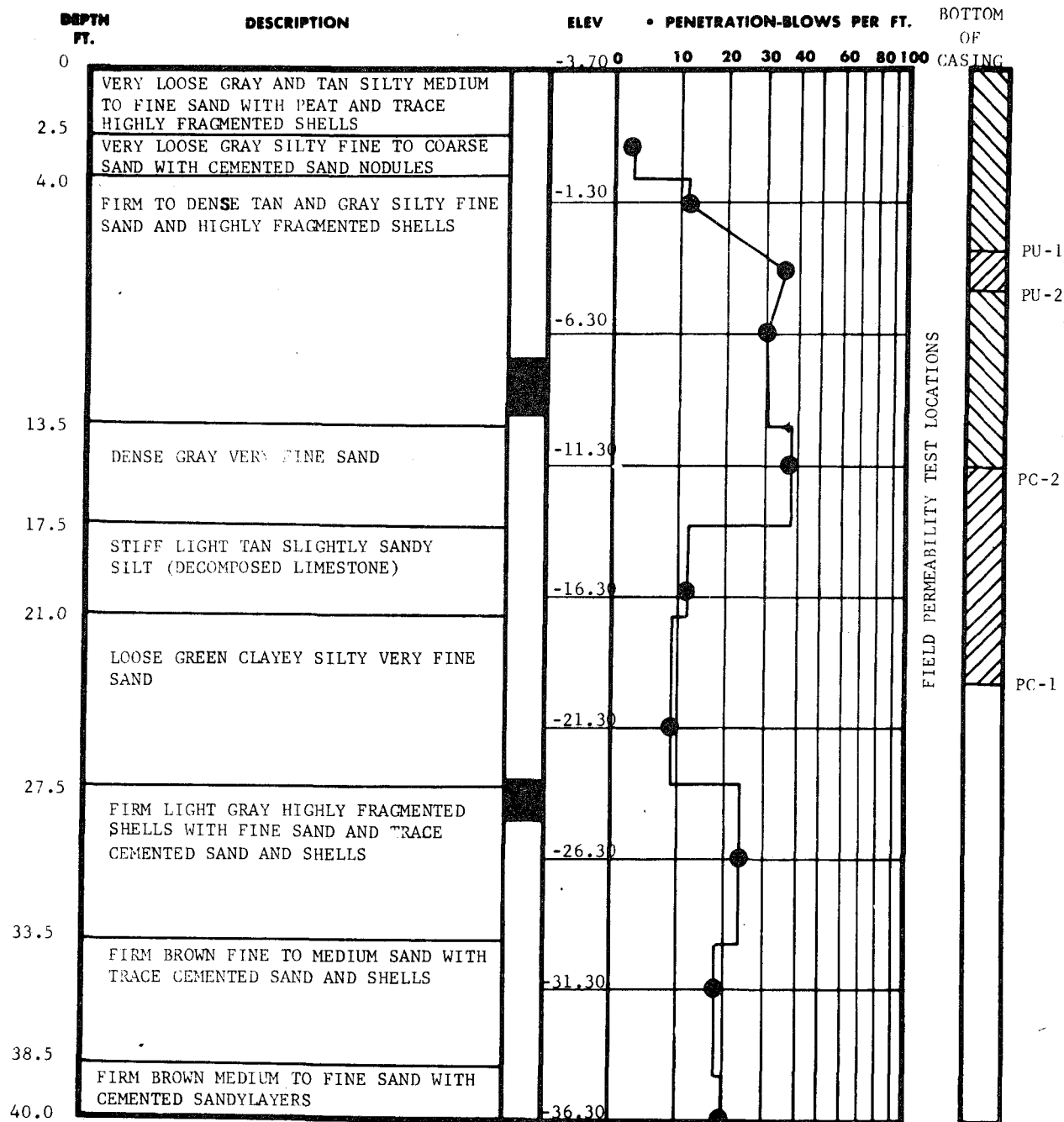
TEST BORING RESULTS

FIGURE 2.5-8



NOTE: 4 inch I.D. casing used throughout.

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
CASING ARRANGEMENT
FIGURE 2.5-9



TEST BORING RECORD

BORING AND SAMPLING MEETS ASTM D-1586
CORE DRILLING MEETS ASTM D-2113

PENETRATION IS THE NUMBER OF BLOWS OF 140 LB. HAMMER
FALLING 30 IN. REQUIRED TO DRIVE 1.4 IN. I.D. SAMPLER 1 FT.

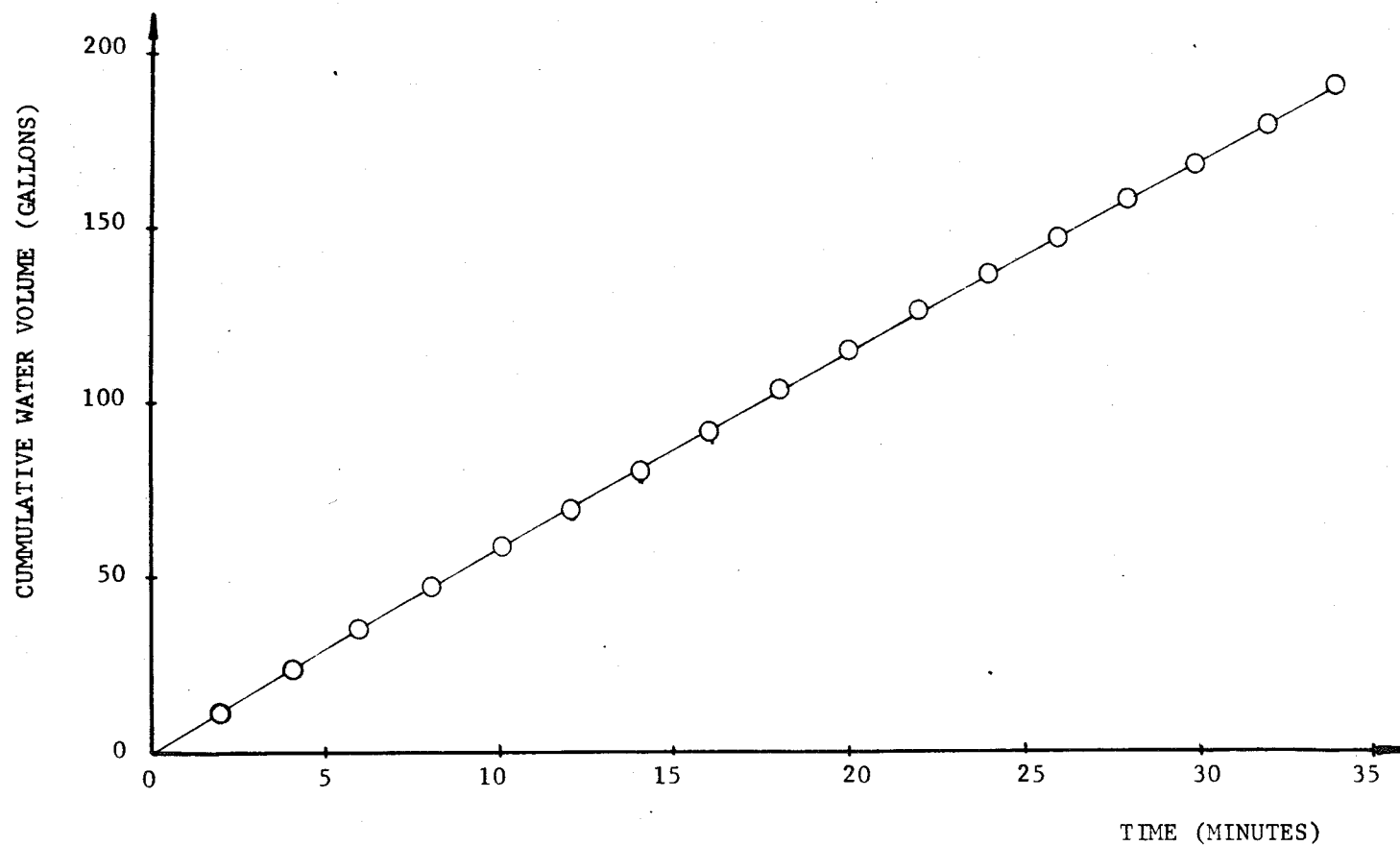
 UNDISTURBED SAMPLE
 WATER TABLE, 24 HR.
 WATER TABLE, 1 HR.
 50% ROCK CORE RECOVERY
 LOSS OF DRILLING WATER

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

TEST BORING RECORD BORING B-2

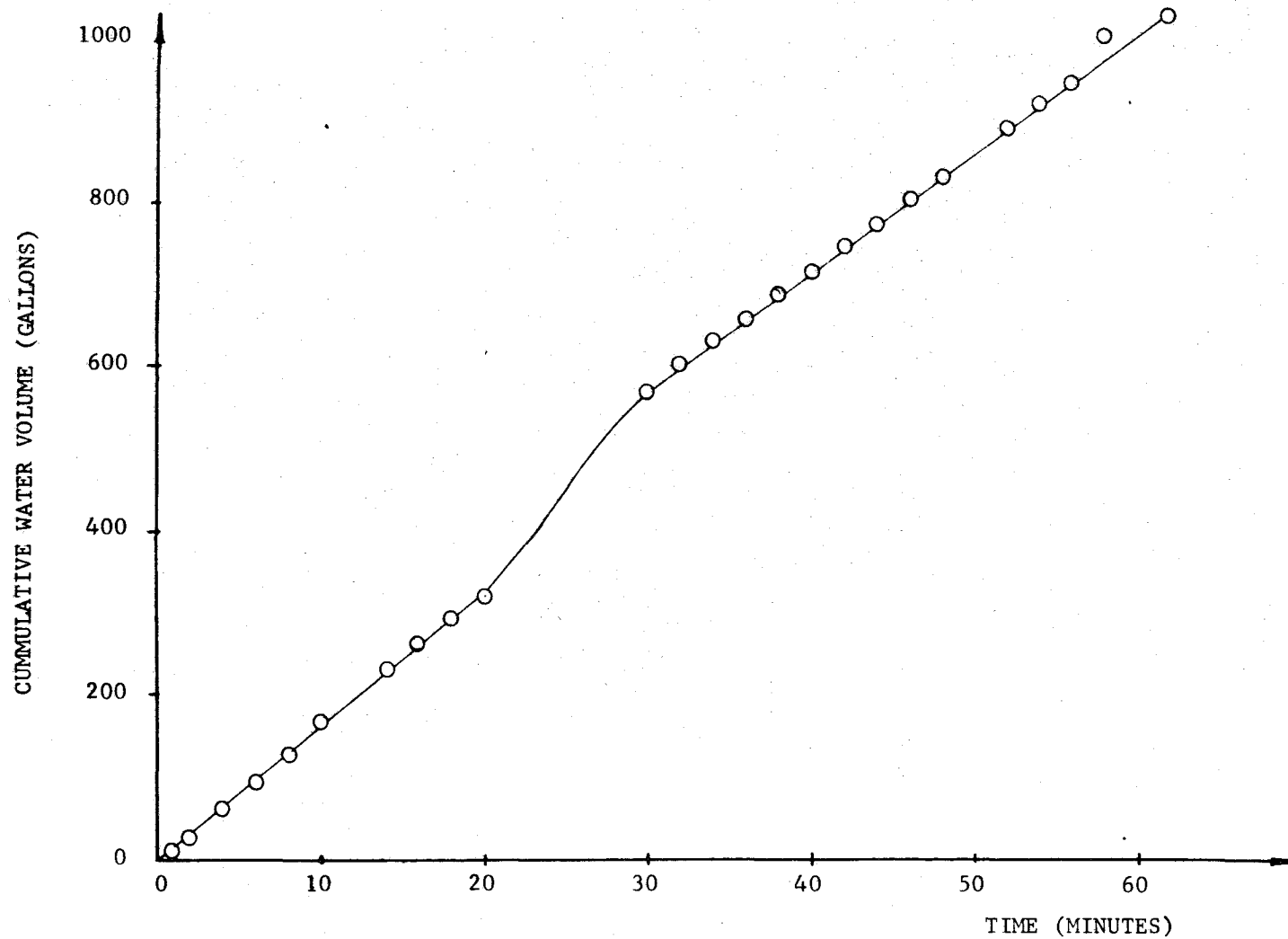
FIGURE 2.5-10

PULI.



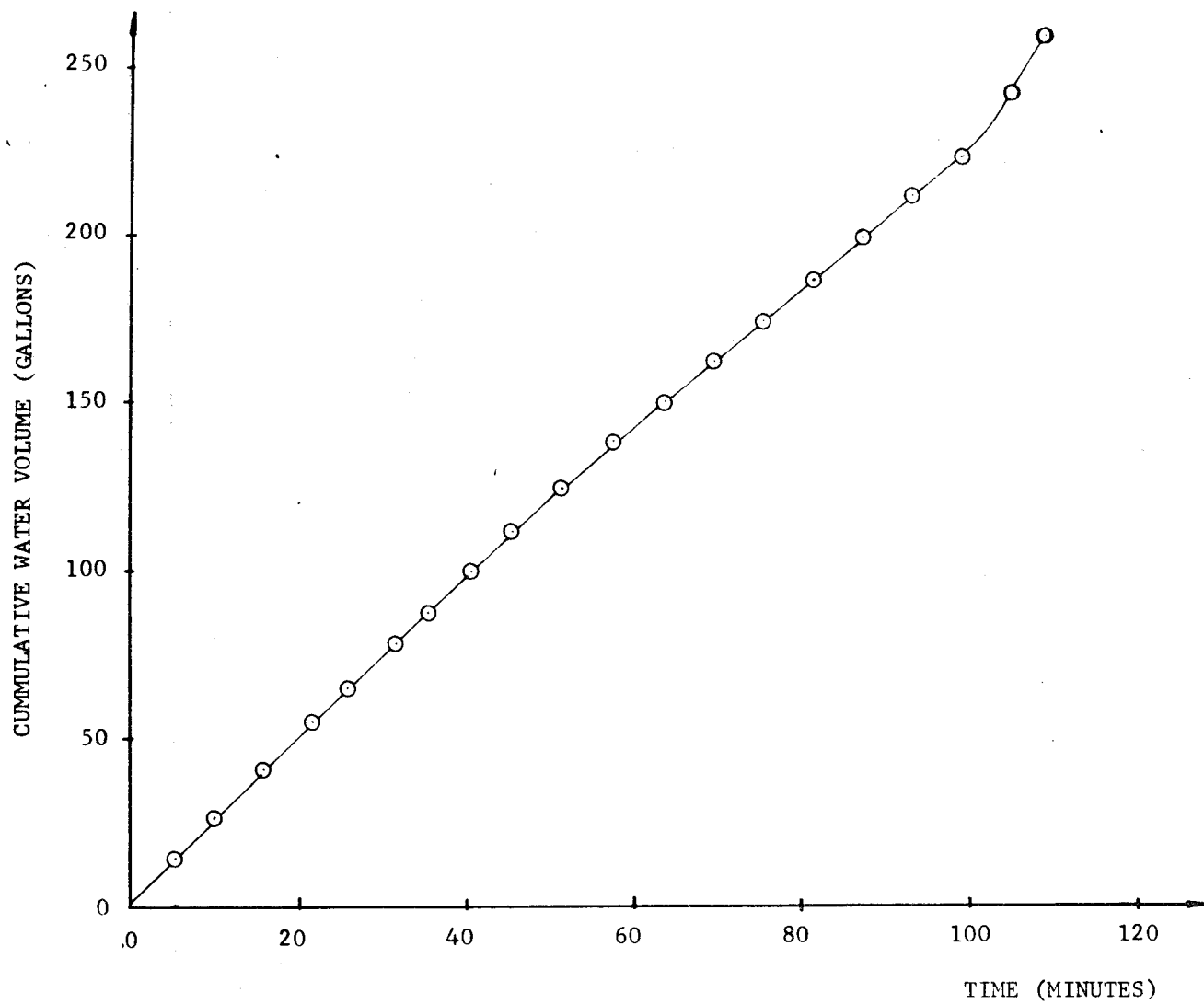
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
FIELD PERMEABILITY TEST OPEN-END
PIPE METHOD
FIGURE 2.5-11

PC-1



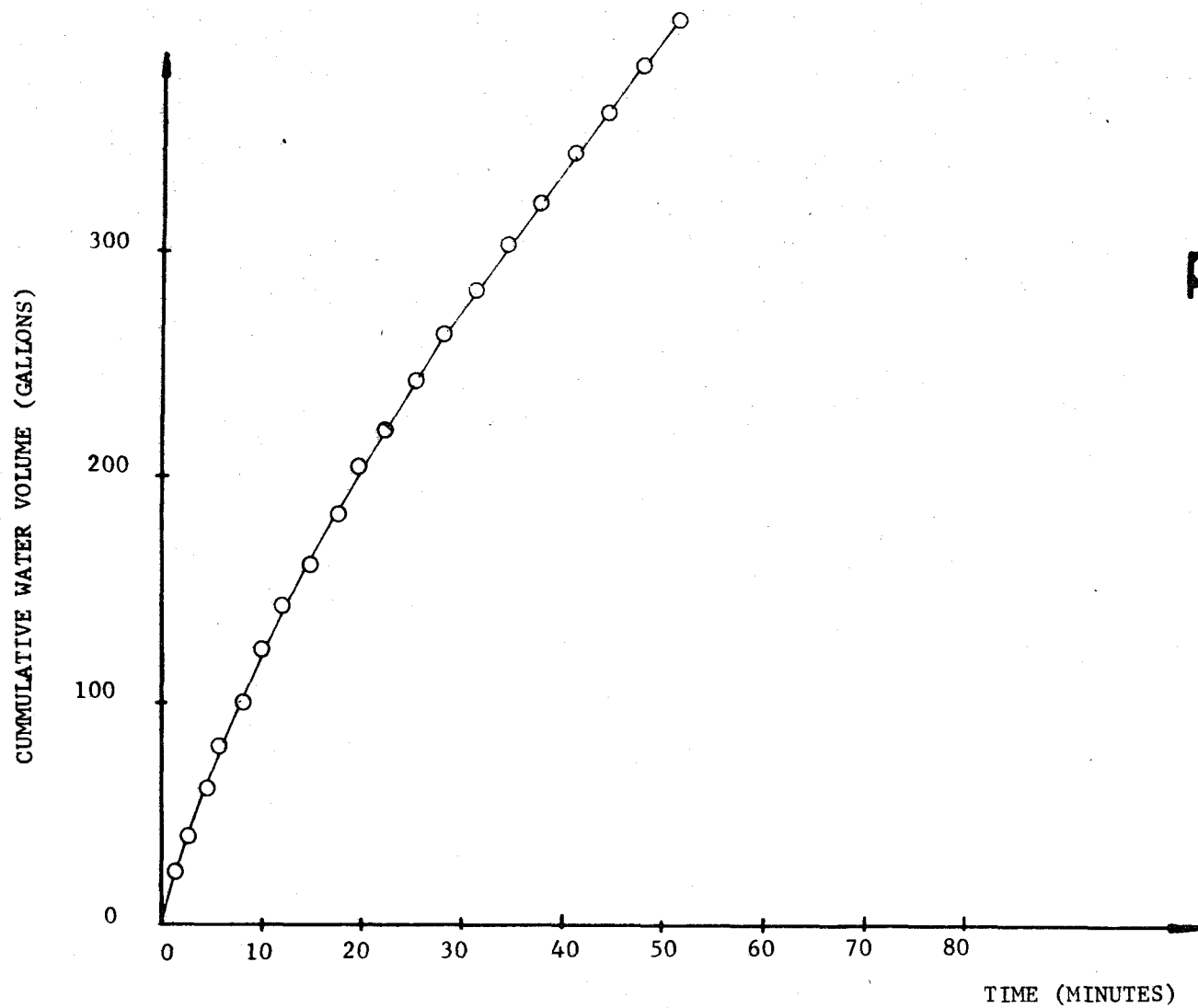
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
FIELD PERMEABILITY TEST OPEN-END
PIPE METHOD
FIGURE 2.5-12

PU_2



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
FIELD PERMEABILITY TEST WELL
PERMEAMETER METHOD
FIGURE 2.5-13

PC-2



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
FIELD PERMEABILITY TEST OPEN-END
PIPE METHOD
FIGURE 2.5-14

2.6 METEOROLOGY

2.6.1 GENERAL CLIMATE

The climate of the St. Lucie site is classified as Tropical Savanna according to the Koeppen-Geiger⁽¹⁾ system of climatic classification. The climate is featured by a long, warm summer with abundant rainfall followed by a mild, dry winter. The high frequency of onshore winds and the proximity of the warm waters of the Gulfstream result in warm, humid conditions during most of the year. During the winter months, the area is occasionally subjected to an outbreak of cold continental air; however, the cold air mass usually moderates rapidly. Consequently, subfreezing temperatures rarely occur in the area.

Rainfall is unevenly distributed during the year. The heaviest rainfall occurs during the period of June through October, followed by a distinct dry period from November through March.

The site is periodically affected by the passage of tropical cyclones of various intensities with the months of September and October having the highest frequency.

The terrain in the site area is essentially flat with elevations in the surrounding area ranging approximately from 20 to 30 feet, MSL. The topography should exert little or no influence on the meteorological characteristics of the site.] 0

2.6.2 TEMPERATURE

Long term temperature data for the site were based on records from the National Weather Service cooperative observing station at Ft. Pierce⁽²⁾ located approximately 9.5 miles northwest of the site. The thermometer at this station is at a height of 5 feet above ground in a standard instrument shelter.] 0

The average daily temperature based on records maintained at Fort Pierce⁽²⁾ ranges from 64.7 F in January to 81.8 F in August with an annual average of 73.7 F. The highest temperature on record is 101 F occurring in June, while the record lowest temperature is 24 F recorded in January. Table 2.6-1 is a presentation of monthly and annual mean and extreme temperatures. Figure 2.6-1 is a graphical presentation of these data. Monthly and annual cumulative frequency distributions of hourly temperatures are shown in Figures 2.6-2 through 2.6-14.

Temperature data collected at the site during the period March 1971 through February 1972 are presented in Table 2.6-2⁽³⁾. During this 12 month period, temperatures ranged from a low of 41 F in February 1972 to a high of 94 F in April 1971.

On the average, there are 39 days each year when the temperature equals or exceeds 90 F, while temperatures of 32 F or lower average one day per year⁽⁴⁾. Table 2.6-1 shows the average number of days per year the temperature is equal to or greater than 90 F and equal to or below 32 F for each month of the year.

2.6.3 ATMOSPHERIC WATER VAPOR AND FOG

The location of the St. Lucie site on a subtropical coast imparts a humid, marine characteristic to the local climate. Hence atmospheric water vapor content is one of the highest in the country. Although there are numerous methods of reporting atmospheric water vapor, the three more common methods, relative humidity, wet-bulb, and dew point temperatures will be utilized in this report.

The most complete, long-term records of atmospheric humidity for the site area are those compiled at the National Weather Service Office in West Palm Beach^(4,5) approximately 47 miles south of the site. The average annual wet-bulb temperature is 69.3 F and ranges from a maximum of 76.5 F in August to a minimum of 60.9 F in January; whereas the dew point temperature averages 66 F for the year and ranges from 74 F in July, August and September to 57 F in December and January. Relative humidity, because of its direct relationship to air temperature, shows considerable diurnal variation. For example, on an average annual basis, the relative humidity ranges from an average maximum of 82 percent at 7 am to an average minimum of 60 percent at 1 pm. Monthly and annual average relative humidity, wet-bulb and dew point temperatures are presented in Table 2.6-3 and Figure 2.6-15. Cumulative frequency distributions of hourly wet-bulb temperatures as recorded at West Palm Beach during the ten-year period 1948-1957 for each month of the year are presented in Figures 2.6-2 through 2.6-13. The annual cumulative frequency distribution is shown in Figure 2.6-14.] 0

Heavy fog which reduces visibility to 1/4 mile or less is an infrequent occurrence in the site area. During the 27-year period 1944-1970, heavy fog occurred on an average of eight days during the year. The most likely month for heavy fog formation is during the month of January when 2 days are recorded on average. July, on the other hand, has had no record of heavy fog during the 27-year period of record.

2.6.4 PRECIPITATION

Rainfall in the area is unevenly distributed during the year. There is a distinct rainy season from June through October followed by a dry season beginning in November and extending through March. The months of April and May can be described as a transitional period between the dry and wet seasons. On the average, September is the wettest month with 9.66 inches and February's 2.35 inches represents the driest month. The annual average rainfall amounts to 61.70 inches.

The maximum monthly rainfall of 24.86 inches was recorded in September 1960. The driest month on record is April 1967 when a sparse 0.04 inches was measured. Table 2.6-4 lists the maximum, minimum, and normal monthly and annual rainfall totals as recorded at West Palm Beach⁽⁴⁾. A graphical representation of these data are shown in Exhibit 2.6-16. The average number of days during the year when precipitation equals or exceeds 0.01 inches is 13.1. September, with 17 days, and February, with 6 days represent the extremes in number of precipitation days. The monthly and annual average number of precipitation days are shown in Table 2.6-4.

The maximum observed rainfall for time periods of 5 minutes through 24 hrs are listed in Table 2.6-5⁽⁶⁾. The storm of April 17, 1942 set maximum rainfall records for all time periods from 1 through 24 hours. The maximum point rainfall records for time periods less than one hour are due to strong convective activity in the form of thunderstorms.

Table 2.6-6 presents estimated average return period in years for maximum rainfall amounts for selected durations for the St. Lucie site. These statistics are based on West Palm Beach precipitation data.⁽⁷⁾ A comparison of Tables 2.6-5 and 2.6-6 shows the 100-year estimated amounts were exceeded for time periods of 1, 2, 3, 6, 12 and 24 hours; whereas the maximum observed one hour rainfall of 4.40 in. has an estimated return period of 80 years.

A theoretical upper limit of precipitation is known as the Probable Maximum Precipitation (PMP) and is an order of magnitude estimate of an extremely rare rainfall⁽⁷⁾.

The PMP is derived using two basic principles - storm transposition and storm maximization. It is assumed that all storms which produced the heaviest rainfall in a meteorologically homogeneous region containing the area under consideration could have passed over the area. The actual conditions during the storms are then increased to the critical meteorological conditions considered probable for the region. The critical meteorological conditions are based on an analysis of air mass properties (effective precipitable water, depth of inflow layer, temperatures, winds, etc.), synoptic situations prevailing during the recorded storms in the region, topographical features, season of occurrence and location of the areas involved (7 a,b).

In the site area, the PMP for a 10 square mile area and a rainfall duration period of 6 hours is 34 inches⁽⁷⁾. This is an average rainfall rate of almost 6 inches per hour. Such a rainfall rate was observed at Hialeah, Florida during the hurricane of 1947⁽⁸⁾.

The maximum point rainfall observed in the United States during a 6 hour period is 32 inches, recorded on July 8, 1942 at Smethport, Pennsylvania⁽⁹⁾.

In central Florida, rainfall of 13.6 and 16.0 inches occurring over a 10 square mile area during a 6 hour period were observed during October 1924 and September 1950, respectively.⁽¹⁰⁾

2.6.5 STORMS

The cycle of storms for the site area takes the form of thunderstorms and tropical storms during summer and early fall months and extropical storms during the winter and early spring.

Thunderstorms have been recorded during each month of the year. However, better than 80 percent occur during the period from May through September. July and August experience the maximum number of thunderstorm days with 16 during an average month. On an annual average basis, there are 78 days during which thunderstorms are observed. Table 2.6-7 lists the

average monthly and annual thunderstorm days as recorded at West Palm Beach during the period 1943-1971.(4)

Some of the thunderstorms are accompanied by hail and locally damaging winds. The one degree, latitude-longitude square in which the site is located has experienced an annual average of 3 hailstorms during the period 1953-67.(11) The occurrence of hail is more likely during the months of March, April and May.

Occasionally, some of the more severe thunderstorm cells will produce a tornado. Although maximum tornadic winds have not been measured, estimates of 300 mph based on structural damage have been made.

In general, Florida tornadoes are less severe than those affecting the midwest United States. Tornado paths in Florida are generally short and extensive damage rarely occurs.(8) The maximum wind speeds associated with Florida tornadoes are estimated between 200 and 300 mph.(12)

Another important characteristic of the tornado is the rapid drop in atmospheric pressure which can amount to an estimated 3 in. of mercury in 3 seconds. Fortunately, tornadoes are rarely more than a few hundred yards wide and in most cases have path lengths less than 5 miles.(13)

The site is located in the St. Lucie county area, where a total of six tornadoes were reported in the last 13 years. Applying Thom's technique for estimating the probability of a tornado striking a point, the probability for the Hutchinson Island area included in a one degree square, was 0.00094 per year. The recurrence interval for the site was 1062 years. This technique is based on the path width of tornadoes in the midwest area. For the Florida region, the tornado paths are narrower and the total frequency for tornadoes in the Hutchinson Island vicinity from Thom's data is fourteen for the period of 1953-1962, with a mean annual frequency of 1.4. ESSA Technical Memorandum WBTM FCST 12, "Severe Local Storm Occurrences", 1955-67 indicates mean annual tornado frequency of 2.5 in the one degree latitude-longitude square containing the plant site. Applying Thom's technique for this data yields a probability of 0.00185 with a recurrence interval of 541 years.

Historically, tornadoes have been observed during all seasons in southeastern Florida; however, the greatest frequency occurs during the spring. Figure 2.6-17 shows the total number of tornadoes which have occurred in one degree squares in southern Florida during the period 1953-1962.

Tropical cyclones are classified according to their stage of development. The hurricane with highest sustained wind speeds of 74 mph or higher, represents the strongest stage of development. Tropical cyclones with sustained winds in the range of 39 to 73 mph are classified as tropical storms and as tropical depressions when wind speeds are less than 30 mph. (15)

During the period 1900-1963, the Florida Peninsula has been affected by 65 tropical cyclones. Of these, 25 were classified as hurricanes, 33 as tropical storms and 7 as tropical depressions. (16) Table 2.6-8 is a presentation of the monthly and annual distribution of tropical cyclones affecting the Florida Peninsula. Roughly half the storms in each category passed close enough to the St. Lucie site to affect it with strong winds and/or heavy rainfall. September and October are the preferred months for hurricanes in the site area.

Hurricane paths affecting the site are generally toward the west-northwest with an average forward speed of about 12 mph. In any given year, the chances of hurricane force winds affecting the site area are 1 in 15. (8)

2.6.6 WINDS

The prevailing wind direction for the area is east-southeast with an annual frequency of 11.5 percent. The dominant wind regime feature of the area is the high frequency of onshore winds and above average wind speed. For the 90° sector east-northeast through southeast, the annual frequency is about 40 percent. Except for the months of December and January, the prevailing wind direction is within this 90° sector. The 10.5 mph average annual wind speed ranks among the highest for the southeastern United States. Calms occur only 7 percent of the total hours. Tables 2.6-9 through 2.6-21 are presentations of monthly and annual wind rose data for West Palm Beach.⁽¹⁷⁾ Seasonal and annual wind rose data as measured at the site during the period March 1, 1971 through February 29, 1972 are shown in Tables 2.6-22 through 2.6-26.⁽³⁾ During the one-year period, calms and variable winds occurred 5.2 percent of the total hours. The prevailing wind direction was east and the annual average wind speed was 8.3 mph.

Based on a 20-year period of record (1950-1969) at West Palm Beach⁽⁴⁾, the maximum observed one minute average wind speed was 86 mph from the east-southeast recorded in August 1964. Maximum observed one minute wind speeds for each month of the year and their associated wind directions are presented in Table 2.6-27. During the hurricane of August 1949, winds at West Palm Beach reached 110 mph with gusts to 125 mph before the anemometer was blown away. The highest one-minute wind speed was estimated at 120 mph with gusts to 130 mph.

Thom⁽¹⁸⁾ has expressed the distribution of extreme wind speeds in terms of a mean recurrence interval based on a Fisher-Tippett Type II extreme value distribution. The mean recurrence intervals for one-minute average wind speeds are shown in Table 2.6-28. These wind speeds are for a one-minute average at a height 30 ft above the ground based on observed data during a 21-year period of record. It can be seen from these data that one-minute average wind speed of 120 mph has a recurrence interval of 100 years.

An upper limit wind speed associated with the Probable Maximum Hurricane⁽¹⁹⁾ occurring at the coast in the site area has been estimated to be 150 mph for a 10-minute average at the 30 ft level. This is the equivalent of a 182 mph one-minute average and about 236 mph for a 1/2 second gust.

2.6.7 CLOUDINESS, SUNSHINE AND SOLAR RADIATION

The average annual sky cover (in tenths of the celestial dome) from sunrise to sunset at West Palm Beach⁽⁴⁾ is 6.1. Maximum cloudiness occurs during the period June through October followed by a decrease in cloudiness from November through May. Percentage of possible sunshine during the year averages 65 percent ranging from a maximum of 73 percent in April to a minimum of 60 percent from September through December.

The average daily solar radiation ranges from 2156 Btu per sq ft in May to 1124 Btu per sq ft in December.⁽⁵⁾

Average monthly cloud cover, sunshine, and solar radiation are listed in Table 2.6-29.

2.6.8 ATMOSPHERIC DIFFUSION

Atmospheric diffusion can be defined as the ability of the atmosphere to dispose of gases and particles emitted into the air. The diffusion is governed primarily by atmospheric motion (wind) and the vertical distribution of temperature (stability).

The onsite meteorological program began in March 1971. Measurements of wind direction, speed and vertical temperature differential are being continuously monitored in order to assess the diffusion potential of the site. Wind direction was classified according to the 16 point compass and wind speed according to the standard wind speed classes (calm 1-3, 4-7, 8-12, 13-18, 19-24, 25-31 and greater than 31 mph).

Atmospheric stability was classified according to the Pasquill classification system as determined by the vertical temperature difference as follows:

<u>Pasquill Class</u>	<u>Description</u>	<u>T(F)/190 ft</u>
A	Extremely unstable	$\leq - 2.0$
B	Unstable	- 1.9 to - 1.8
C	Slightly unstable	- 1.7 to - 1.4
D	Neutral	- 1.3 to - 0.5
E	Slightly stable	- 0.4 to + 1.5
F	Stable	+ 1.6 to + 4.2
G	Extremely stable	>+ 4.2

The first complete year of meteorological data acquisition indicates favorable atmospheric diffusion conditions at the site. This is due to the proximity of the site to the warm waters of the Gulf Stream, the above average wind speed, and the low frequency of calms. Moreover, unfavorable diffusion conditions associated with stagnating high pressure system rarely affects the area.(20)

An analysis of one year of onsite data(3) shows neutral and unstable conditions occurring 56.2 percent of the total hours while inversions (Pasquill classes F and G) prevailed only 10.5 percent of the time. The annual distribution of the seven stability classes at the site is as follows:

<u>Pasquill Class</u>	<u>Frequency (%)*</u>
A	23.1
B	2.9
C	5.9
D	24.3
E	33.4
F	8.4
G	2.1

* All values listed are subject to computer round-off to the second decimal.

The joint relative frequency of stability, wind direction and speed for the period March 1, 1971 through February 29, 1972 are shown in Tables 2.6-30 through 2.6-36.

TABLE 2.6-1

MONTHLY AND ANNUAL
MEAN AND EXTREME TEMPERATURES
FORT PIERCE FLORIDA
(1904-1960)

<u>Month</u>	Mean Temperatures(F)			Extreme Temperatures(F)		Mean Number Days with Temperature*	
	<u>Daily Max</u>	<u>Daily Min</u>	<u>Daily Mean</u>	<u>Record Max</u>	<u>Record Min</u>	<u>≥90F</u>	<u>≤32F</u>
January	73.1	56.3	64.7	88	24	0	1
Feb	74.5	56.7	65.5	90	26	0	+
March	77.5	59.6	68.6	93	35	+	0
April	80.8	64.0	72.5	96	40	+	0
May	84.8	68.5	76.5	98	50	1	0
June	87.7	72.1	79.9	101	60	6	0
July	89.4	73.4	81.4	100	61	10	0
August	89.6	74.0	81.8	99	62	15	0
Sept	87.5	73.9	80.7	99	60	6	0
Oct	83.4	69.9	76.6	96	48	1	0
Nov	77.8	62.4	70.2	90	32	+	0
Dec	74.2	57.2	65.8	91	27	0	+
Annual	81.7	65.7	73.7	101	24	39	1

* Period of Record 1951-1960

+ Less than $\frac{1}{2}$

TABLE 2.6-2

MONTHLY AND ANNUAL TEMPERATURE DATA(F)
 HUTCHISON ISLAND ON-SITE METEOROLOGICAL MONITORING PROGRAM
 MARCH 1971 - FEBRUARY 1972

<u>Month</u>	<u>Average Daily Maximum</u>	<u>Average Daily Minimum</u>	<u>Monthly</u>
January	77	66	71
February	72	58	65
March	73	58	66
April	78	65	71
May	81	70	75
June	85	73	79
July	86	75	80
August	87	75	81
September	84	75	80
October	82	72	77
November	76	67	72
December	76	69	73
Annual	80	69	74

Extremes:

Maximum 94 April 1971

Minimum 41 February 1972

TABLE 2.6-3

MONTHLY AND ANNUAL MEAN RELATIVE HUMIDITY
WET BULB AND DEWPOINT TEMPERATURES (F)
WEST PALM BEACH, FLORIDA

<u>Month</u>	Relative Humidity(%) (1965 - 1969)				Wet Bulb(F) (1949 - 1965)	Dewpoint(F) (1949 - 1965)
	<u>1AM</u>	<u>7AM</u>	<u>1PM</u>	<u>7PM</u>		
January	79	81	59	73	60.9	57
February	81	83	56	70	61.8	58
March	76	79	54	66	64.2	61
April	75	78	53	65	66.9	63
May	77	78	59	70	71.1	68
June	84	83	69	77	74.5	72
July	85	85	65	76	76.3	74
August	82	84	63	73	76.5	74
September	84	86	66	78	76.1	74
October	82	84	65	75	71.2	68
November	77	80	56	71	65.7	62
December	76	78	56	70	61.4	57
Annual	80	82	60	72	69.3	66

TABLE 2.6-4

MONTHLY AND ANNUAL AVERAGE AND EXTREME
PRECIPITATION (INCHES) AND NUMBER OF DAYS
PRECIPITATION ≥ 0.01 INCHES
WEST PALM BEACH, FLORIDA
(1931-1960)

<u>Month</u>	<u>Maximum¹ Monthly</u>	<u>Year</u>	<u>Minimum¹ Monthly</u>	<u>Year</u>	<u>Normal</u>	<u>Average Number² of Days Precipitation ≥ 0.01</u>
January	7.92	1958	0.22	1960	2.48	7
February	6.88	1966	0.29	1948	2.35	6
March	9.11	1947	0.33	1956	3.44	8
April	18.26	1942	0.04	1967	4.34	7
May	14.10	1946	0.39	1967	5.11	11
June	17.91	1966	1.07	1952	7.53	14
July	17.74	1941	1.22	1961	6.66	15
August	13.52	1950	2.16	1955	6.74	16
September	24.86	1960	2.73	1939	9.66	17
October	18.74	1965	2.16	1962	7.96	14
November	7.16	1947	0.33	1944	2.86	8
December	8.73	1949	0.06	1968	2.57	7
Annual	24.86	Sept 1960	0.04	April 1967	61.70	131

1 Period of Record 1939-1969

2 Period of Record 1943-1969

TABLE 2.6-5

MAXIMUM RECORDED POINT RAINFALL
WEST PALM BEACH, FLORIDA

	<u>M I N U T E S</u>				<u>H O U R S</u>				
Time Period	5	10	15	60	2	3	6	12	24
Amount (inches)	0.74	0.90	1.17	4.40	8.35	8.77	9.90	15.16	15.23
Date	7/19/58	9/16/59	5/11/58	4/17/42	4/17/42	4/17/42	4/17/42	4/17/42	4/17/42
Period of Record	1953-1961				1941-1961				

SL2

TABLE 2.6-6

ESTIMATED RAINFALL FREQUENCY FOR THE ST. LUCIE SITE
(inches)

<u>Time Interval</u>	<u>Return Period (Years)</u>						
	1	2	5	10	25	50	100
30 minutes	1.6	1.9	2.3	2.6	3.0	3.3	3.5
1 hour	2.1	2.4	3.0	3.3	3.7	4.1	4.6
2 hours	2.4	2.9	3.6	4.3	4.7	5.4	6.0
3 hours	2.7	3.3	4.1	4.8	5.5	6.1	6.8
6 hours	3.2	3.8	5.0	6.0	6.8	7.6	8.5
12 hours	3.7	4.5	6.0	7.1	8.1	9.4	10.5
24 hours	4.3	5.4	7.1	8.5	9.9	11.1	12.5

TABLE 2.6-7

AVERAGE MONTHLY AND ANNUAL THUNDERSTORM ACTIVITY
WEST PALM BEACH, FLORIDA
(1943-1971)

<u>Month</u>	<u>Average Number of Thunderstorm Days</u>
January	1
February	1
March	2
April	4
May	7
June	13
July	16
August	16
September	11
October	5
November	1
December	1
Annual	78

TABLE 2.6-8

MONTHLY DISTRIBUTION OF TROPICAL CYCLONES
AFFECTING THE FLORIDA PENINSULA
(1900-1963)

<u>Month</u>	<u>Hurricanes</u>	<u>Tropical Storms</u>	<u>Tropical Depressions</u>	<u>Total</u>
January	0	0	0	0
February	0	1	0	1
March	0	0	0	0
April	0	0	0	0
May	0	1	0	1
June	2	2	2	6
July	2	3	1	6
August	3	9	2	14
September	10	5	1	16
October	7	9	1	17
November	1	2	0	3
December	0	1	0	1
Annual	25	33	7	65

TABLE 2.6-9

DIRECTIONAL - SPEED - TIME INTERVAL
JANUARY WIND SUMMARY (PERCENT OF TOTAL HOURS)
WEST PALM BEACH, FLORIDA
(1956-1960)

	<u>Windspeed (mph)</u>						<u>Total</u>	<u>Average speed</u>
	0-3	4-7	8-12	13-18	19-24	≥25		
N	0.1	1.0	2.0	1.0	0.5	0.1	4.7	11.7
NNE	0.1	0.4	0.5	0.6	0.5	0.5	2.6	16.7
NE	+	0.2	0.7	0.7	1.0	0.2	2.8	16.8
ENE	+	0.3	1.3	1.3	1.2	0.3	4.5	15.8
E	+	0.7	2.4	3.0	0.9	0.1	7.1	13.4
ESE		0.8	2.0	1.9	0.3		5.0	11.9
SE	0.1	1.4	2.7	2.7	0.5	0.1	7.4	11.8
SSE	+	0.5	1.4	1.6	0.3	0.1	3.9	12.8
S	+	1.3	2.2	1.1	0.3	0.1	4.9	10.8
SSW	0.1	0.9	1.5	0.7	0.3	0 +	3.4	10.8
SW	0.1	1.4	1.5	0.6	0.1		3.5	9.1
WSW	0.1	1.1	2.3	1.1	0.2	+	4.8	10.7
W	0.1	1.2	3.3	1.4	0.3	0.2	6.5	11.1
WNW	0.3	1.6	3.3	2.6	1.0	0.4	9.2	12.5
NW	0.1	2.4	6.0	4.6	1.4	0.1	14.7	12.0
NNW	0.1	2.3	3.8	2.0	0.8	0.1	9.1	11.2
CALM	5.9						5.9	
TOTAL	7.0	17.4	36.7	26.9	9.6	2.5	100	11.5

+ indicates more than 0, but less than 0.05

TABLE 2.6-10

DIRECTIONAL - SPEED - TIME INTERVAL
FEBRUARY WIND SUMMARY (PERCENT OF TOTAL HOURS)
WEST PALM BEACH, FLORIDA

	<u>Windspeed (mph)</u>						<u>Total</u>	<u>Average speed</u>
	0-3	4-7	8-12	13-18	19-24	≥25		
N	0.1	1.0	1.8	1.1	0.6	+	4.7	12.1
NNE	+	0.2	0.9	0.8	0.2		2.1	12.4
NE	+	0.2	0.7	1.5	0.3		2.7	13.9
ENE		0.2	1.8	2.3	1.0	0.1	5.4	14.5
E	+	0.5	2.9	2.9	1.2	0.1	7.6	13.6
ESE	+	1.0	3.0	2.4	0.4	+	6.9	12.1
SE	+	1.3	4.7	3.4	0.6	0.1	10.1	12.4
SSE		1.5	3.2	3.5	0.8		9.0	12.4
S	0.1	2.1	3.6	1.3	0.4		7.5	9.9
SSW	+	1.7	2.0	1.1	0.2	+	5.1	10.1
SW	0.1	1.7	2.1	0.8	0.3		5.0	9.7
WSW	+	1.2	1.3	0.8	0.3	0.1	3.7	10.8
W	0.1	1.1	1.8	0.8	0.6	0.3	4.6	12.4
WNW	+	1.2	2.2	2.1	1.2	0.3	7.0	13.6
NW	0.1	1.6	3.7	2.5	0.6	0.2	8.7	11.8
NNW	+	1.6	3.1	1.8	0.3	0.1	7.0	10.8
CALM	2.7						2.7	
TOTAL	3.5	18.1	38.7	29.3	9.1	1.3	100	11.7

+ indicates more than 0, but less than 0.05

TABLE 2.6-11

DIRECTIONAL - SPEED - TIME INTERVAL
MARCH WIND SUMMARY (PERCENT OF TOTAL HOURS)
WEST PALM BEACH, FLORIDA

	<u>Windspeed (mph)</u>						<u>Total</u>	<u>Average speed</u>
	0-3	4-7	8-12	13-18	19-24	≥ 25		
N	0.1	1.2	1.7	0.8	0.2	0.1	4.2	10.5
NNE	+	0.5	1.2	1.4	0.5	+	3.7	13.1
NE	+	0.3	1.2	1.6	0.1		3.3	12.6
ENE	+	0.3	2.2	1.4	0.3	+	4.3	12.5
E	0.1	0.5	2.0	2.4	0.6	0.4	6.0	14.0
ESE	0.1	0.9	3.0	2.9	0.3	+	7.2	12.0
SE	0.1	2.0	3.6	3.4	0.9	0.1	10.1	11.8
SSE	0.1	1.5	2.6	3.5	1.0	0.1	8.7	12.9
S	+	1.7	2.3	1.5	0.3	+	5.8	10.6
SSW	0.2	1.8	1.9	1.0	0.3	+	5.3	9.9
SW	0.2	1.9	1.2	0.8	0.3		4.5	9.5
WSW	0.2	1.8	1.2	1.2	0.3	0.1	4.7	10.4
W	0.2	1.8	2.2	1.0	0.3	0.2	5.6	10.4
WNW	+	1.9	2.3	1.9	0.7	0.2	6.9	11.7
NW	0.2	1.6	3.7	2.1	0.4	0.1	8.2	10.9
NNW	0.1	1.8	3.8	2.0	0.3		8.1	10.4
CALM	3.4						3.4	
TOTAL	5.1	21.6	36.1	28.9	7.0	1.3	100	11.1

+ indicates more than 0, but less than 0.05

TABLE 2.6-12

DIRECTIONAL - SPEED - TIME INTERVAL
APRIL WIND SUMMARY (PERCENT OF TOTAL HOURS)
WEST PALM BEACH, FLORIDA

	<u>Windspeed (mph)</u>						<u>Total</u>	<u>Average speed</u>
	0-3	4-7	8-12	13-18	19-24	≥25		
N	0.1	0.8	1.1	1.3	0.4	+	3.7	12.1
NNE	+	0.3	0.6	1.3	0.3		2.5	13.5
NE	+	0.2	0.9	1.9	0.5	0.1	3.6	14.1
ENE	0.1	0.5	2.3	3.7	0.9	0.1	7.6	14.1
E	0.1	0.8	5.1	9.1	2.4	0.1	17.7	14.3
ESE	+	1.7	7.3	7.9	1.1	0.1	18.1	12.6
SE	0.1	1.3	3.8	4.3	1.2	0.1	10.8	12.7
SSE	0.1	0.8	1.7	2.3	0.9	0.4	6.2	14.2
S	0.1	1.2	1.5	0.8	0.3	0.1	3.9	10.4
SSW	0.2	0.8	0.9	0.4	0.2	0.1	2.5	9.9
SW	+	0.9	1.2	0.4	0.2	0.1	2.8	10.7
WSW	+	0.6	1.0	0.7	0.1	0.1	2.5	11.1
W	0.1	1.1	0.8	0.7	0.1	0.3	3.2	11.9
WNW	0.3	0.9	1.7	0.6	0.3	0.1	3.8	10.5
NW	0.3	1.1	1.8	1.3	0.4	0.1	4.9	10.9
NNW	0.1	0.7	1.4	0.9	0.3	0.2	3.6	11.8
CALM	2.7						2.7	
TOTAL	4.3	13.6	33.1	37.6	9.5	1.9	100	12.4

+ indicates more than 0, but less than 0.05

TABLE 2.6-13

DIRECTIONAL - SPEED - TIME INTERVAL
MAY WIND SUMMARY (PERCENT OF TOTAL HOURS)
WEST PALM BEACH, FLORIDA

	<u>Windspeed (mph)</u>						<u>Total</u>	<u>Average speed</u>
	0-3	4-7	8-12	13-18	19-24	≥25		
N	0.2	0.8	0.8	0.2			1.9	7.7
NNE	+	0.3	0.6	0.4	0.2		1.6	11.7
NE	+	0.4	1.6	2.3	0.6	+	4.9	13.5
ENE	+	0.6	5.5	5.6	1.4	0.1	13.2	13.4
E	0.1	1.3	6.2	6.3	0.6	0.1	14.5	12.4
ESE	+	2.3	8.9	8.6	0.8	+	20.7	12.0
SE	0.1	2.1	4.7	3.7	0.5		11.2	11.3
SSE	0.2	1.0	1.7	1.0	0.1		4.1	10.2
S	0.1	1.4	0.8	0.2	+		2.6	7.7
SSW	0.1	1.4	0.8	0.1			2.4	7.4
SW	0.1	1.5	1.5	0.4	+		3.4	8.4
WSW	0.1	1.3	1.0	0.2	+		2.7	7.7
W	0.2	0.7	1.3	0.3	0.1		2.6	8.7
WNW	0.2	1.3	0.9	0.5	0.3		3.2	9.3
NW	0.1	1.0	0.8	0.1			2.0	7.5
NNW	0.1	1.0	0.6	0.1			1.7	7.6
CALM	7.2						7.2	
TOTAL	8.9	18.5	37.6	29.9	4.8	0.3	100	10.4

+ indicates more than 0, but less than 0.05

TABLE 2.6-14

DIRECTIONAL - SPEED - TIME INTERVAL
JUNE WIND SUMMARY (PERCENT OF TOTAL HOURS)
WEST PALM BEACH, FLORIDA

	<u>Windspeed (mph)</u>						<u>Total</u>	<u>Average speed</u>
	0-3	4-7	8-12	13-18	19-24	≥25		
N	0.1	1.1	0.4	0.1			1.7	7.3
NNE	0.1	0.3	0.4	0.4	0.1		1.3	10.9
NE	+	0.4	0.8	1.0	0.1		2.3	12.0
ENE	0.1	0.8	2.6	3.4	0.6	+	7.5	12.8
E	0.1	1.2	6.1	4.4	+		11.9	11.2
ESE	0.1	2.5	8.3	4.5	0.1		15.6	10.7
SE	0.2	3.1	5.2	2.8	+		11.4	9.8
SSE	0.1	2.3	2.4	1.8	+	0.1	6.8	9.9
S	0.3	3.5	2.0	0.6	0.2	+	6.7	8.2
SSW	0.1	2.9	1.8	0.4	0.2	+	5.4	8.2
SW	0.1	2.6	1.8	0.7	0.1		5.3	8.6
WSW	0.2	1.8	1.9	0.6	+		4.4	8.6
W	0.2	1.7	1.1	0.3	0.1		3.3	7.7
WNW	0.3	1.5	0.8	0.3		0.1	2.9	7.7
NW	0.2	1.0	0.6	0.1			1.9	7.0
NNW	0.1	0.9	0.6	0.2			1.8	7.6
CALM	10.1						10.0	
TOTAL	12.3	27.4	36.8	21.6	1.7	0.2	100	8.9

+ indicates more than 0, but less than 0.05

TABLE 2.6-15

DIRECTIONAL - SPEED - TIME INTERVAL
JULY WIND SUMMARY (PERCENT OF TOTAL HOURS)
WEST PALM BEACH, FLORIDA

	<u>Windspeed (mph)</u>						<u>Total</u>	<u>Average speed</u>
	0-3	4-7	8-12	13-18	19-24	≥25		
N	0.1	0.7	0.1	0.1			1.0	6.0
NNE	+	0.4	0.2	+			0.6	6.9
NE	0.1	0.5	0.1	0.1			0.7	7.2
ENE	+	0.7	1.0	0.8	+		2.5	10.1
E	0.2	1.1	3.8	4.1	0.3		9.5	11.8
ESE	0.2	3.3	8.7	5.2	0.1		17.4	10.4
SE	0.3	3.0	6.4	4.2	0.3		14.1	10.5
SSE	0.2	2.0	3.2	2.0	+		7.4	9.8
S	0.3	4.6	2.7	0.5			8.0	7.3
SSW	0.2	3.7	2.2	0.3			6.4	7.4
SW	0.2	3.9	2.2	0.5	0.1		6.8	7.6
WSW	0.2	2.2	1.0	0.3	+		3.9	7.7
W	0.2	1.6	1.2	0.3	0.1	+	3.4	8.2
WNW	0.2	1.6	0.6	0.4	0.1		2.9	7.8
NW	0.3	1.2	0.3	0.1	+	+	2.0	6.9
NNW	0.2	0.9	0.2	+			1.3	6.0
CALM	12.0						12.0	
TOTAL	14.8	31.3	33.7	19.1	1.0	0.1	100	8.2

+ indicates more than 0, but less than 0.05

TABLE 2.6-16

DIRECTIONAL - SPEED - TIME INTERVAL
AUGUST WIND SUMMARY (PERCENT OF TOTAL HOURS)
WEST PALM BEACH, FLORIDA

	<u>Windspeed (mph)</u>						<u>Total</u>	<u>Average speed</u>
	0-3	4-7	8-12	13-18	19-24	≥25		
N	0.1	1.0	0.6	0.1	0.1		1.9	8.1
NNE	0.1	0.7	0.5	0.4	0.1		1.6	9.6
NE	0.1	0.8	1.0	1.5	0.1		3.5	11.6
ENE	+	0.8	2.8	2.3	0.2		6.1	11.5
E	0.1	1.4	5.6	3.9	0.1		11.1	11.2
ESE	0.1	2.6	7.7	3.8	0.2		14.3	10.4
SE	0.1	3.0	3.8	2.0	0.1		9.1	9.5
SSE	0.1	2.0	1.5	0.8	+		4.5	8.6
S	0.2	3.3	1.8	0.4	+		5.8	7.5
SSW	0.1	2.6	2.0	0.4	+		5.1	7.9
SW	0.2	3.3	2.2	0.3		+	6.0	7.5
WSW	0.1	2.3	1.6	0.4	0.1		4.4	8.2
W	0.2	2.6	1.5	0.4	0.1	0.1	4.8	8.2
WNW	0.1	2.2	0.8	0.5	0.1		3.6	7.8
NW	0.2	1.8	0.6	0.2	0.1	+	2.8	7.4
NNW	0.2	1.6	0.4	0.1	+	+	2.3	6.9
CALM	13.0						13.0	
TOTAL	14.7	31.9	34.5	17.6	1.1	0.2	100	8.1

+ indicates more than 0, but less than 0.05

TABLE 2.6-17

DIRECTIONAL - SPEED - TIME INTERVAL
 SEPTEMBER WIND SUMMARY (PERCENT OF TOTAL HOURS)
 WEST PALM BEACH, FLORIDA

	<u>Windspeed (mph)</u>						<u>Total</u>	<u>Average speed</u>
	0-3	4-7	8-12	13-18	19-24	≥25		
N	0.3	1.7	1.4	0.3	+		3.7	8.1
NNE	0.2	0.8	1.0	1.2	0.4	0.1	3.7	12.3
NE	0.1	1.1	2.1	3.3	1.0	0.1	7.6	13.2
ENE	+	1.2	5.8	6.5	1.4	0.2	15.1	13.1
E	0.1	2.1	5.6	5.1	0.6	0.2	13.8	11.9
ESE	0.1	2.9	4.9	2.8	0.1	0.4	11.2	10.9
SE	0.1	2.3	2.9	1.8	0.1	0.1	7.3	10.2
SSE	0.1	1.3	1.8	1.3	0.3	0.2	5.0	11.3
S	0.1	1.8	1.2	0.4	0.2	+	3.7	8.6
SSW	0.1	1.5	1.3	0.4	0.2	+	3.4	8.9
SW	0.1	1.4	0.6	0.3	+		2.5	7.9
WSW	0.2	1.4	0.9	0.5	+		3.0	8.4
W	0.2	1.0	0.8	0.3	+		2.3	8.0
WNW	0.2	1.7	0.6	0.3			2.8	7.2
NW	0.1	1.4	1.1	0.3			2.9	7.7
NNW	0.3	1.6	0.9	0.2	+		2.9	7.6
CALM	9.1						9.1	
TOTAL	11.3	25.2	33.0	24.8	4.4	1.3	100	9.8

+ indicates more than 0, but less than 0.05

TABLE 2.6-18

DIRECTIONAL - SPEED - TIME INTERVAL
OCTOBER WIND SUMMARY (PERCENT OF TOTAL HOURS)
WEST PALM BEACH, FLORIDA

	<u>Windspeed (mph)</u>						<u>Total</u>	<u>Average speed</u>
	0-3	4-7	8-12	13-18	19-24	≥25		
N	+	2.1	2.4	0.7	0.2		5.4	9.0
NNE		0.8	1.4	1.9	0.6	0.2	4.9	13.6
NE	0.1	0.9	2.3	2.4	1.8	1.1	8.5	15.5
ENE	0.1	0.8	3.9	4.0	2.4	0.9	12.0	15.3
E	+	1.0	3.3	2.9	0.9	0.1	8.2	12.6
ESE	+	1.9	3.5	2.0	+		7.5	10.2
SE		1.6	2.7	1.4	0.2		6.0	10.2
SSE	0.2	1.0	1.3	1.3	+		3.9	10.4
S	0.2	1.3	1.3	0.6	0.1	+	3.5	8.8
SSW	0.1	1.0	0.6	0.2	0.1		1.9	8.2
SW	0.1	1.3	0.9	0.4	+		2.7	8.4
WSW	0.1	0.6	0.8	0.5	0.2	+	2.3	10.5
W	0.1	1.0	1.0	0.2	0.1	+	2.5	8.8
WNW	+	1.9	2.0	0.7	0.1		4.7	8.8
NW	0.3	2.5	3.2	2.3	0.3		8.6	10.0
NNW	0.2	2.0	3.0	1.1	0.2	+	6.5	9.5
CALM	10.7						10.7	
TOTAL	12.3	21.8	33.8	22.5	7.2	2.5	100	10.2

+ indicates more than 0, but less than 0.05

TABLE 2.6-19

DIRECTIONAL - SPEED - TIME INTERVAL
 NOVEMBER WIND SUMMARY (PERCENT OF TOTAL HOURS)
 WEST PALM BEACH, FLORIDA

	<u>WINDSPEED (mph)</u>						<u>Total</u>	<u>Average speed</u>
	0.3	4-7	8-12	13-18	19-24	≥25		
N	0.1	1.1	2.6	2.2	0.6	0.1	6.7	12.1
NNE	+	0.4	1.2	1.7	0.8	0.4	4.4	15.2
NE	+	0.6	2.0	2.4	1.5	0.8	7.4	15.9
ENE	0.1	0.7	3.3	5.8	2.6	0.4	12.8	15.0
E	+	0.6	4.0	6.7	1.9	+	13.2	14.2
ESE		0.9	4.0	2.6	0.4	+	7.9	11.8
SE	0.1	0.9	2.2	1.5	0.1		4.8	10.9
SSE		0.5	1.3	0.7			2.5	10.8
S	+	0.8	2.0	0.4	+		3.2	9.2
SSW	0.1	1.0	1.4	0.5	0.1		3.0	9.0
SW	0.1	0.9	1.1	0.3	0.1		2.6	9.1
WSW	0.1	0.4	0.5	0.2	0.1		1.3	8.9
W	+	1.1	1.2	0.3	0.1	+	2.7	8.8
WNW	0.1	1.7	1.3	0.4	0.2		3.6	8.8
NW	0.2	2.7	3.7	2.3	0.8	0.1	9.7	10.9
NNW	0.1	1.8	5.2	3.1	0.6	0.1	11.0	11.2
CALM	3.2						3.2	
TOTAL	4.2	16.0	37.1	31.0	9.9	1.9	100	11.9

+ indicates more than 0, but less than 0.05

TABLE 2.6-20

DIRECTIONAL - SPEED - TIME INTERVAL
 DECEMBER WIND SUMMARY (PERCENT OF TOTAL HOURS)
 WEST PALM BEACH, FLORIDA

	<u>WINDSPEED (mph)</u>						<u>Total</u>	<u>Average speed</u>
	0-3	4-7	8-12	13-18	19-24	≥25		
N	+	1.5	1.8	1.2	0.5	+	5.0	11.0
NNE	0.1	0.3	1.0	0.9	0.6	0.2	3.0	14.1
NE	0.2	0.6	2.1	2.0	0.7	+	5.6	12.6
ENE	0.1	0.6	4.4	5.6	2.4	0.7	13.7	14.8
E	0.1	0.9	4.6	5.5	0.8	0.1	12.0	12.9
ESE	+	0.8	2.6	2.8	0.1		6.4	11.8
SE	+	1.0	2.4	1.3	0.1		4.8	10.4
SSE	+	0.6	1.0	1.4	0.2		3.3	12.1
S	0.1	1.1	0.9	0.5	0.1		2.7	9.3
SSW		0.8	0.9	0.3	0.1		2.3	9.5
SW	+	1.1	1.2	0.5	0.1		2.9	9.2
WSW		1.0	0.9	0.4	0.1	+	2.3	9.3
W	0.1	0.9	0.8	0.3	0.1	+	2.1	9.1
WNW	0.2	1.7	2.0	1.8	0.5	0.1	6.2	11.2
NW	0.2	2.9	5.6	3.8	0.7	0.2	13.4	11.3
NNW	0.1	1.9	4.5	3.8	0.8	+	11.2	11.8
CALM	3.2						3.2	
TOTAL	4.3	17.7	36.7	32.2	7.8	1.3	100	11.6

+ indicates more than 0, but less than 0.05

TABLE 2.6-21

DIRECTIONAL - SPEED - TIME INTERVAL
ANNUAL WIND SUMMARY (PERCENT OF TOTAL HOURS)
WEST PALM BEACH, FLORIDA

	<u>WINDSPEED (mph)</u>						<u>Total</u>	<u>Average speed</u>
	0-3	4-7	8-12	13-18	19-24	≥25		
N	0.1	1.2	1.4	0.7	0.3	+	3.7	10.4
NNE	0.1	0.5	0.8	0.9	0.4	0.1	2.7	13.3
NE	0.1	0.5	1.3	1.7	0.6	0.2	4.4	13.9
ENE	+	0.6	3.1	3.5	1.2	0.2	8.7	13.9
E	0.1	1.0	4.3	4.7	0.9	0.1	11.0	12.8
ESE	0.1	1.8	5.3	4.0	0.3	+	11.5	11.3
SE	0.1	1.9	3.8	2.7	0.4	+	8.9	11.0
SSE	0.1	1.2	1.9	1.8	0.3	0.1	5.4	11.4
S	0.1	2.0	1.8	0.7	0.2	+	4.8	9.0
SSW	0.1	1.7	1.4	0.5	0.1	+	3.8	8.9
SW	0.1	1.8	1.5	0.5	0.1	+	4.0	8.7
WSW	0.1	1.3	1.2	0.6	0.1	+	3.3	9.4
W	0.1	1.3	1.4	0.5	0.2	0.1	3.6	9.7
WNW	0.2	1.6	1.6	1.0	0.4	0.1	4.8	10.5
NW	0.2	1.8	2.6	1.6	0.4	0.1	6.7	10.7
NNW	0.1	1.5	2.3	1.3	0.3	+	5.5	10.4
CALM	7.0						7.0	
TOTAL	8.6	21.8	35.6	26.7	6.1	1.2	100	10.5

+ indicates more than 0, but less than 0.05

TABLE 2.6-22

HUTCHINSON ISLAND METEOROLOGICAL TOWER 50 FOOT HEIGHT
WIND FREQUENCY DISTRIBUTION IN PERCENT

SEASON: WINTER
DEC. 1, 1971 TO FEB. 29, 1972

WIND SPEED CLASSES IN M.P.H.

WIND SECTOR	1-3	4-7	8-12	13-18	19-24	25-31	31+	TOTAL PERCENT	AVERAGE SPEED M.P.H
NNE	0.14	1.19	1.24	0.37	0.46	0.00	0.00	3.39	10.19
NE	0.05	1.10	1.97	1.51	0.73	0.14	0.00	5.50	12.43
ENE	0.05	1.51	2.38	1.37	0.78	0.14	0.00	6.23	11.60
E	0.05	1.92	2.79	1.37	0.55	0.00	0.00	6.69	10.68
ESE	0.05	5.18	5.41	1.37	0.09	0.00	0.00	12.09	8.56
SE	0.05	2.47	5.36	1.47	0.09	0.00	0.00	9.44	9.67
SSE	0.18	2.02	3.85	1.15	0.05	0.00	0.00	7.24	9.31
S	0.37	5.22	4.81	0.60	0.00	0.00	0.00	10.99	7.86
SSW	0.32	2.06	1.74	0.60	0.18	0.00	0.00	4.90	8.42
SW	0.55	2.43	1.69	0.60	0.18	0.00	0.00	5.45	8.07
WSW	0.46	1.28	0.78	0.05	0.00	0.00	0.00	2.57	6.14
W	0.41	0.55	0.41	0.18	0.14	0.00	0.00	1.69	8.16
WNW	0.41	0.96	0.96	0.50	0.18	0.00	0.00	3.02	8.74
NW	0.18	2.66	2.02	0.60	0.00	0.00	0.00	5.45	7.68
NNW	0.18	1.83	2.34	0.82	0.00	0.00	0.00	5.18	8.81
N	0.05	1.37	2.52	1.47	0.09	0.00	0.00	6.09	11.47
CALM AND VARIABLE		0.00	0.00	0.00	0.00	0.00	0.00	4.08	1.66
TOTALS	3.52%	33.76%	40.27%	14.02%	4.12%	0.27%	0.00%	100.00%	9.00

NUMBER OF VALID SEASONAL OBSERVATIONS = 2183

NUMBER OF INVALID SEASONAL OBSERVATIONS = 1

NOTE: ALL PERCENTS ARE BASED ON VALID SEASONAL OBSERVATIONS FOR WIND SPEEDS AT THE
50 FT ELEVATION

TABLE 2.6-23

HUTCHINSON ISLAND METEOROLOGICAL TOWER 50 FOOT HEIGHT
WIND FREQUENCY DISTRIBUTION IN PERCENT

SEASON: SPRING
MAR. 1, 1971 TO MAY 31, 1971

WIND SECTOR	WIND SPEED CLASSES IN M.P.H.							TOTAL PERCENT	AVERAGE SPEED M.P.H.
	1-3	4-7	8-12	13-18	19-24	25-31	31+		
NNE	0.16	0.84	3.42	0.95	0.00	0.00	0.00	5.37	9.65
NE	0.21	2.74	2.95	0.21	0.00	0.00	0.00	6.11	7.93
ENE	0.05	2.42	2.37	0.00	0.00	0.00	0.00	4.85	7.27
E	0.37	3.27	4.21	0.05	0.00	0.00	0.00	7.90	7.59
ESE	0.26	2.58	3.37	0.11	0.00	0.00	0.00	6.32	7.47
SE	0.42	1.53	4.32	1.32	0.00	0.00	0.00	7.59	9.61
SSE	0.32	1.58	2.74	1.58	0.00	0.00	0.00	6.22	9.60
S	0.11	1.21	2.85	0.79	0.11	0.00	0.00	5.06	9.53
SSW	0.47	1.37	2.11	1.48	0.47	0.00	0.00	5.90	10.30
SW	0.47	3.32	2.85	1.69	0.90	0.11	0.00	9.33	10.01
WSW	0.58	2.32	2.69	0.37	0.42	0.00	0.00	6.38	8.84
W	0.42	2.48	1.26	0.26	0.00	0.00	0.00	4.43	7.10
WNW	0.58	2.00	2.90	1.00	0.00	0.00	0.00	6.48	8.41
NW	0.47	1.74	4.58	1.63	0.00	0.00	0.00	8.43	9.46
NNW	0.11	1.05	1.05	0.68	0.00	0.00	0.00	2.90	9.27
N	0.05	0.79	2.11	2.21	0.00	0.00	0.00	5.16	11.52
CALM		0.00	0.00	0.00	0.00	0.00	0.00	1.58	1.37
AND VARIABLE									
TOTALS	5.05%	31.24%	45.79%	14.33%	1.90%	0.11%	0.00%	100.00%	8.88

NUMBER OF VALID SEASONAL OBSERVATIONS = 1898

NUMBER OF INVALID SEASONAL OBSERVATIONS = 310

NOTE: ALL PERCENTS ARE BASED ON VALID SEASONAL OBSERVATIONS FOR WIND SPEEDS AT THE
50 FT ELEVATION

TABLE 2.6-24

HUTCHINSON ISLAND METEOROLOGICAL TOWER 50 FOOT HEIGHT
WIND FREQUENCY DISTRIBUTION IN PERCENT

SEASON: SUMMER
JUNE 1, 1971 TO AUG. 31, 1971

WIND SECTOR	WIND SPEED CLASSES IN M.P.H.							TOTAL PERCENT	AVERAGE SPEED M.P.H.
	1-3	4-7	8-12	13-18	19-24	25-31	31+		
NNE	0.11	1.03	0.65	0.11	0.00	0.00	0.00	1.89	7.23
NE	0.70	2.06	0.76	0.11	0.00	0.00	0.00	3.63	6.01
ENE	0.70	3.47	2.27	0.05	0.00	0.00	0.00	6.50	6.70
S	0.65	5.85	5.31	0.22	0.00	0.00	0.00	12.02	7.26
ESE	0.54	4.87	4.44	0.11	0.00	0.00	0.00	9.96	7.06
SE	0.70	6.17	7.47	0.32	0.00	0.00	0.00	14.67	7.64
SSE	0.43	3.63	3.47	0.60	0.00	0.00	0.00	8.12	7.61
S	0.54	2.44	3.74	1.08	0.00	0.00	0.00	7.80	8.78
SSW	0.22	2.76	2.17	0.43	0.05	0.00	0.00	5.63	7.64
SW	0.60	4.93	2.00	0.11	0.00	0.00	0.00	7.63	6.20
WSW	0.43	1.89	0.32	0.38	0.05	0.00	0.00	3.09	6.56
W	0.81	1.84	0.81	0.05	0.00	0.00	0.00	3.52	5.74
WNW	0.32	1.68	0.16	0.05	0.00	0.00	0.00	2.22	5.39
NW	0.05	0.87	0.60	0.00	0.00	0.00	0.00	1.52	6.82
NNW	0.11	0.22	0.11	0.05	0.00	0.00	0.00	0.49	6.89
N	0.27	1.03	0.60	0.05	0.00	0.00	0.00	1.95	6.36
CALM		0.00	0.00	0.00	0.00	0.00	0.00	9.37	1.18
AND VARIABLE									
TOTALS	7.19%	44.72%	34.87%	3.74%	0.11%	0.00%	0.00%	100.00%	6.59

NUMBER OF VALID SEASONAL OBSERVATIONS = 1847

NUMBER OF INVALID SEASONAL OBSERVATIONS = 361

NOTE: ALL PERCENTS ARE BASED ON VALID SEASONAL OBSERVATIONS FOR WIND SPEED AT
THE 50 FT ELEVATION

TABLE 2.6-25

HUTCHINSON ISLAND METEOROLOGICAL TOWER 50 FOOT HEIGHT
WIND FREQUENCY DISTRIBUTION IN PERCENT

SEASON: FALL
SEP. 1, 1971 TO NOV. 30, 1971

WIND SECTOR	WIND SPEED CLASSES IN M.P.H.							TOTAL PERCENT	AVERAGE SPEED M.P.H.
	1-3	4-7	8-12	13-18	19-24	25-31	31+		
NNE	0.05	0.69	2.43	1.47	0.23	0.00	0.00	4.85	11.34
NE	0.14	1.88	2.61	0.92	0.73	0.00	0.00	6.27	10.67
ENE	0.78	2.75	5.27	2.61	0.50	0.00	0.00	11.90	9.97
E	0.18	3.89	6.00	2.98	0.23	0.00	0.00	13.28	9.89
ESE	0.37	2.88	3.43	1.28	0.05	0.00	0.00	8.01	8.90
SE	0.37	3.11	3.02	0.55	0.00	0.00	0.00	7.05	7.74
SSE	0.27	2.70	1.05	0.16	0.00	0.00	0.00	4.21	6.82
S	0.23	1.51	1.28	0.14	0.00	0.00	0.00	3.16	7.36
SSW	0.23	2.01	0.96	0.41	0.14	0.00	0.00	3.75	8.11
SW	0.96	3.48	2.20	0.46	0.00	0.00	0.00	7.10	6.97
WSW	0.46	2.15	1.28	0.23	0.00	0.00	0.00	4.12	6.99
W	0.27	1.01	0.27	0.00	0.00	0.00	0.00	1.56	5.47
WNW	0.41	1.60	0.46	0.05	0.00	0.00	0.00	2.52	5.73
NW	0.87	3.89	1.28	0.27	0.00	0.00	0.00	6.32	6.45
NNW	0.23	1.51	1.65	0.78	0.00	0.00	0.00	4.17	8.58
N	0.09	0.73	2.43	2.66	0.00	0.00	0.00	5.91	11.70
CALM		0.00	0.00	0.00	0.00	0.00	0.00	5.82	1.57
AND VARIABLE									
TOTALS	5.91%	35.81%	35.62%	14.97%	1.88%	0.00%	0.00%	100.00%	8.36

NUMBER OF VALID SEASONAL OBSERVATIONS = 2184

NUMBER OF INVALID SEASONAL OBSERVATIONS = 0

NOTE: ALL PERCENTS ARE BASED ON VALID SEASONAL OBSERVATIONS FOR WIND SPEEDS AT
THE 50 FT ELEVATION

TABLE 2.6-26

HUTCHINSON ISLAND METEOROLOGICAL TOWER 50 FOOT HEIGHT
WIND FREQUENCY DISTRIBUTION IN PERCENT

ANNUAL WIND REPORT
MAR. 1, 1971 TO FEB. 29, 1972

WIND SECTOR	WIND SPEED CLASSES IN M.P.H.							TOTAL PERCENT	AVERAGE SPEED M.P.H.
	1-3	4-7	8-12	13-18	19-24	25-31	31+		
NNE	0.11	0.94	1.94	0.74	0.18	0.00	0.00	3.91	10.07
NE	0.26	1.91	2.10	0.73	0.39	0.04	0.00	5.42	9.72
ENE	0.39	2.50	3.13	1.08	0.35	0.04	0.00	7.50	9.28
E	0.30	3.66	4.56	1.23	0.21	0.00	0.00	9.96	8.88
ESE	0.30	3.88	4.18	0.76	0.04	0.00	0.00	9.16	8.09
SE	0.37	3.27	4.97	0.92	0.02	0.00	0.00	9.55	8.57
SSE	0.30	2.47	2.75	0.86	0.01	0.00	0.00	6.39	8.44
S	0.31	2.65	3.16	0.63	0.02	0.00	0.00	6.77	8.33
SSW	0.31	2.05	1.71	0.71	0.21	0.00	0.00	4.99	8.68
SW	0.65	3.49	2.17	0.70	0.26	0.02	0.00	7.30	7.92
WSW	0.48	1.90	1.26	0.25	0.11	0.00	0.00	3.99	7.46
W	0.47	1.42	0.67	0.12	0.04	0.00	0.00	2.71	6.62
WNW	0.43	1.54	1.10	0.39	0.05	0.00	0.00	3.51	7.53
NW	0.41	2.37	2.10	0.62	0.00	0.00	0.00	5.49	7.88
NNW	0.16	1.20	1.34	0.60	0.00	0.00	0.00	3.30	8.76
N	0.11	0.99	1.96	1.64	0.18	0.00	0.00	4.88	11.09
CALM AND VARIABLE		0.00	0.00	0.00	0.00	0.00	0.00	5.15	1.42
TOTALS	5.36%	36.22%	39.08%	12.01%	2.08%	0.10%	0.00%	100.00%	8.25

NUMBER OF VALID ANNUAL OBSERVATIONS = 8112

NUMBER OF INVALID ANNUAL OBSERVATIONS = 672

NOTE: ALL PERCENTS ARE BASED ON VALID ANNUAL OBSERVATIONS FOR WIND SPEEDS AT THE
50 FT ELEVATION

TABLE 2.6-27MONTHLY MAXIMUM OBSERVED ONE MINUTE WINDSPEED
WEST PALM BEACH, FLORIDA
(1950-1969)

<u>Month</u>	<u>Fastest Mile (mph)</u>	<u>Direction Degrees</u>
Jan	48	290
Feb	46	290
March	51	270
April	55	320
May	45	270
June	71	090
July	45	200
Aug	86	130
Sept	55	030
Oct	74	160
Nov	35	340
Dec	36	070
Annual	86	130

TABLE 2.6-28ONE MINUTE WIND SPEED RECURRENCE INTERVALS
WEST PALM BEACH, FLORIDA

<u>Recurrence Interval</u> <u>(Years)</u>	<u>Wind Speed</u> <u>(mph)</u>
2	50
10	80
25	100
50	110
100	120

TABLE 2.6-29

MONTHLY AND ANNUAL AVERAGE SKY COVER AND INSULATION DATA
WEST PALM BEACH, FLORIDA

Month	Average Sky Cover ^(a) (Tenths) Sunrise to Sunset	Average Number of Days ^(b)			Percent ^(c) of Possible Sunshine	Solar ^(d) Radiation (BTU/ft ² -day)
		Clear	Partly Cloudy	Cloudy		
Jan	5.8	7	12	12	64	1235
Feb	5.6	8	11	9	68	1474
March	5.6	8	13	10	70	1769
April	5.6	8	13	9	73	1986
May	5.8	8	12	11	70	2156
June	6.8	9	12	14	70	2009
July	6.6	3	14	14	64	1964
Aug	6.5	3	16	12	68	1843
Sept	7.1	2	13	15	60	1622
Oct	6.4	6	13	12	60	1437
Nov	5.6	7	14	9	60	1308
Dec	5.6	9	11	11	60	1124
Annual	6.1	73	154	138	65	1666

Periods of Record

a) 1949-1969 c) 1916-1960

b) 1946-1969 d) 1951-1960

TABLE 2.6-30

ST. LUCIE SITE
WIND DISTRIBUTION BY PASQUILL STABILITY CLASS A
PERCENTAGE FREQUENCY DISTRIBUTION
(NUMBER OF OBSERVATIONS = 8764)

SPEED (MPH)	WIND DIRECTION																	TOTAL
	CALM	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
CALM	0.07																	0.07
1-3				0.02	0.07	0.04	0.02	0.01	0.01	0.02	0.02	0.03			0.04	0.01	0.01	0.33
4-7		0.16	0.33	1.03	1.45	2.60	1.69	1.28	0.20	0.13	0.21	0.26	0.19	0.20	0.18	0.27	0.12	10.26
8-12		0.74	0.74	0.45	0.65	1.10	1.10	2.72	0.50	0.25	0.21	0.42	0.28	0.14	0.22	0.31	0.23	10.06
13-18		0.54	0.09	0.01	0.12	0.17	0.06	0.29	0.31	0.13	0.05	0.16	0.08	0.05	0.05	0.14	0.07	2.17
19-24						0.01						0.04	0.02	0.02	0.03			0.13
25-31																		
>31																		
TOTAL	0.07	1.43	1.15	1.51	2.23	3.91	2.87	4.29	1.02	0.51	0.51	0.94	0.58	0.42	0.53	0.64	0.44	23.11

Note: All values are subject to computer round-off
 Period of Record - March 1, 1971 to February 29, 1972
 Height of wind sensor, 50 feet above grade

SL2

TABLE 2.6-31

ST. LUCIE SITE
WIND DISTRIBUTION BY PASQUILL STABILITY CLASS B
PERCENTAGE FREQUENCY DISTRIBUTION
(NUMBER OF OBSERVATIONS = 8764)

SPEED (MPH)	WIND DIRECTION																	TOTAL
	CALM	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
CALM	0.05																	0.05
1-3					0.03	0.01	0.01	0.01		0.01	0.03		0.01	0.01				0.13
4-7		0.02	0.10	0.14	0.16	0.21	0.12	0.11	0.04	0.08	0.04	0.09	0.08	0.03	0.02	0.06	0.02	1.38
8-12		0.10	0.05	0.07	0.04	0.05	0.03	0.06	0.09	0.03	0.04	0.08	0.03	0.04		0.02	0.04	0.82
13-18		0.10	0.03		0.03	0.02	0.01	0.03	0.05		0.01	0.04	0.02		0.01	0.1	0.05	0.43
19-24		0.03										0.03	0.01					0.08
25-31																		
>31																		
TOTAL	0.05	0.26	0.19	0.21	0.28	0.30	0.17	0.22	0.18	0.13	0.14	0.25	0.15	0.08	0.03	0.10	0.11	2.89

Note: All values are subject to computer round-off
 Period of Record - March 1, 1971 to February 29, 1972
 Height of wind sensor, 50 feet above grade

SL2

TABLE 2.6-32

ST. LUCIE SITE
WIND DISTRIBUTION BY PASQUILL STABILITY CLASS C
PERCENTAGE FREQUENCY DISTRIBUTION
(NUMBER OF OBSERVATIONS = 8764)

SPEED (MPH)	WIND DIRECTION																	
	CALM	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM	0.21																	0.21
1-3			0.01	0.01	0.09	0.01			0.01	0.03	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.31
4-7		0.09	0.12	0.21	0.12	0.25	0.29	0.24	0.16	0.05	0.17	0.32	0.12	0.13	0.15	0.12	0.06	2.60
8-12		0.14	0.12	0.13	0.10	0.09	0.16	0.12	0.18	0.27	0.15	0.27	0.05	0.02	0.04	0.04	0.11	2.02
13-18		0.08	0.14	0.03	0.01	0.08		0.03	0.11	0.02	0.13	0.05	0.01	0.01	0.01	0.01		0.66
19-24		0.02	0.02		0.01						0.01	0.01	0.01					0.08
25-31																		
>31																		
TOTAL	0.21	0.34	0.30	0.38	0.35	0.44	0.45	0.38	0.46	0.39	0.47	0.67	0.21	0.18	0.23	0.19	0.20	5.89

Note: All values are subject to computer round-off
 Period of Record - March 1, 1971 to February 29, 1972
 Height of wind sensors, 50 feet above grade

SL2

TABLE 2.6-33

ST. LUCIE SITE
WIND DISTRIBUTION BY PASQUILL STABILITY CLASS D
PERCENTAGE FREQUENCY DISTRIBUTION
(NUMBER OF OBSERVATIONS = 8764)

SPEED (MPH)	WIND DIRECTION																	TOTAL
	CALM	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
CALM	0.41																	0.41
1-3		0.02	0.03	0.02	0.07	0.06	0.04	0.07	0.01	0.01	0.04	0.09	0.03	0.09	0.07	0.08	0.06	0.82
4-7		0.28	0.22	0.46	0.46	0.89	0.77	0.59	0.55	1.06	1.17	1.10	0.47	0.25	0.40	0.56	0.27	9.42
8-12		0.55	0.45	0.49	0.77	1.01	0.53	0.39	0.81	1.38	0.84	0.55	0.34	0.14	0.12	0.34	0.26	8.68
13-18		0.44	0.25	0.48	0.51	0.46	0.13	0.12	0.24	0.25	0.37	0.17	0.03	0.02	0.18	0.13	0.22	4.04
19-24		0.03	0.07	0.12	0.06	0.03	0.01				0.01	0.05						0.61
25-31				0.01														0.01
>31																		
TOTAL	0.41	1.36	1.04	1.43	1.91	2.50	1.53	1.19	1.60	2.70	2.42	1.96	0.87	0.58	0.80	1.13	0.80	24.31

Note: All values are subject to computer round-off
 Period of Record - March 1, 1971 to February 29, 1972
 Height of wind sensor, 50 feet above grade

TABLE 2.6-34

ST. LUCIE SITE
WIND DISTRIBUTION BY PASQUILL STABILITY CLASS E
PERCENTAGE FREQUENCY DISTRIBUTION
(NUMBER OF OBSERVATIONS = 8764)

SPEED (MPH)	WIND DIRECTION																	TOTAL
	CALM	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
CALM	1.40																	1.40
1-3		0.09	0.09	0.18	0.23	0.26	0.44	0.57	0.42	0.35	0.35	0.74	0.53	0.41	0.36	0.28	0.13	5.53
4-7		0.31	0.33	0.62	1.12	1.18	2.04	2.18	1.92	1.66	0.80	1.81	0.97	0.63	0.70	1.17	0.51	17.40
8-12		0.32	0.38	0.50	0.72	0.72	0.90	0.57	0.47	0.47	0.36	0.30	0.24	0.14	0.30	0.67	0.41	7.48
13-18		0.06	0.02	0.03	0.14	0.19	0.11	0.14	0.03	0.03	0.04	0.08	0.02					0.93
19-24				0.06														0.06
25-31																		
>31																		
TOTAL	1.40	0.79	0.84	1.38	2.20	2.36	3.51	3.46	2.85	2.52	1.57	2.94	1.77	1.18	2.51	2.13	1.08	33.36

Note: All values are subject to computer round-off

Period of Record - March 1, 1971 to February 29, 1972

Height of wind sensor, 50 feet above grade

TABLE 2.6-35

ST. LUCIE SITE
WIND DISTRIBUTION BY PASQUILL STABILITY CLASS F
PERCENTAGE FREQUENCY DISTRIBUTION
(NUMBER OF OBSERVATIONS = 8764)

SPEED (MPH)	WIND DIRECTION																	TOTAL
	Calm	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	
Calm	2.24																	2.24
1-3		0.20	0.06	0.15	0.14	0.09	0.22	0.30	0.34	0.28	0.20	0.31	0.30	0.21	0.24	0.24	0.07	3.40
4-7		0.10	0.06	0.06	0.04	0.03	0.05	0.13	0.27	0.26	0.11	0.35	0.14	0.11	0.09	0.38	0.34	2.58
8-12						0.01	0.02	0.03	0.01	0.01		0.01						0.09
13-18		0.01																0.01
19-24																		
25-31																		
>31																		
TOTAL	2.24	0.31	0.14	0.20	0.18	0.13	0.32	0.46	0.62	0.57	0.30	0.69	0.44	0.32	0.34	0.61	0.42	8.35

Note: All values are subject to computer round-off.
Period of Record - March 1, 1971 to February 29, 1972.
Height of wind sensors, 50 feet above grade

SL2

TABLE 2.6-36

ST. LUCIE SITE
WIND DISTRIBUTION BY PASQUILL STABILITY CLASS G
PERCENTAGE FREQUENCY DISTRIBUTION
(NUMBER OF OBSERVATIONS = 8764)

WIND DIRECTION

SPEED (MPH)	CALM	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	TOTAL
CALM	0.70																0.70	
1-3		0.05	0.01	0.03	0.03	0.02	0.06	0.01	0.03	0.05	0.05	0.14	0.09	0.09	0.14	0.13	0.04	1.06
4-7								0.01		0.01	0.01	0.03	0.01	0.01		0.19	0.04	0.32
8-12					0.01												0.01	
13-18																		
19-24																		
25-31																		
>31																		
TOTAL	0.70	0.05	0.01	0.03	0.03	0.03	0.06	0.02	0.03	0.06	0.07	0.17	0.10	0.10	0.14	0.32	0.09	2.10

Note: All values are subject to computer round-off
Period of Record - March 1, 1971 to February 29, 1972
Height of wind sensors, 50 feet above grade

TABLE 2.6-37

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE METEOROLOGICAL DATA

PERIOD OF RECORD: MARCH 1, 1971, to DEC. 31, 1972
ANNUAL HOURLY PERCENT FREQUENCY OF VERTICAL
TEMPERATURE STABILITY CATEGORIES BY WIND DIRECTION AND
WIND SPEED (MPH)
PASQUILL STABILITY CATEGORY A

WIND DIR	WIND SPEED (MPH) ADJUSTED TO 10 METER ELEVATION							Total%
	1<4	4<8	8<13	13<19	19<25	25-31	>31	
NNE	0.012	0.447	0.702	0.050	0.000	0.000	0.000	1.211
NE	0.137	1.341	0.546	0.087	0.000	0.000	0.000	2.111
ENE	0.230	1.646	0.720	0.098	0.000	0.000	0.000	2.683
E	0.242	2.658	1.329	0.137	0.006	0.000	0.000	4.372
ESE	0.093	1.670	1.006	0.050	0.000	0.000	0.000	2.819
SE	0.043	1.155	2.726	0.075	0.000	0.000	0.000	3.999
SSE	0.012	0.192	0.602	0.205	0.000	0.000	0.000	1.012
S	0.056	0.081	0.155	0.043	0.000	0.000	0.000	0.335
SSW	0.050	0.155	0.174	0.025	0.000	0.000	0.000	0.404
SW	0.081	0.279	0.466	0.106	0.006	0.000	0.000	0.938
WSW	0.019	0.230	0.447	0.050	0.012	0.000	0.000	0.758
W	0.025	0.192	0.180	0.019	0.006	0.000	0.000	0.422
WNW	0.043	0.230	0.224	0.050	0.012	0.000	0.000	0.522
NW	0.050	0.329	0.286	0.019	0.000	0.000	0.000	0.683
NNW	0.037	0.149	0.242	0.000	0.000	0.000	0.000	0.428
N	0.019	0.130	0.832	0.224	0.006	0.000	0.000	1.211
Variable and Calm								0.049
Total								23.957

1

TABLE 2.6-38

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE METEOROLOGICAL DATA

PERIOD OF RECORD: MARCH 1, 1971, to DEC. 31, 1972
ANNUAL HOURLY PERCENT FREQUENCY OF VERTICAL
TEMPERATURE STABILITY CATEGORIES BY WIND DIRECTION AND
WIND SPEED (MPH)
PASQUILL STABILITY CATEGORY B

WIND DIR	WIND SPEED (MPH) ADJUSTED TO 10 METER ELEVATION							Total%
	1<4	4<8	8<13	13<19	19<25	25-31	>31	
NNE	0.006	0.087	0.050	0.006	0.000	0.000	0.000	0.149
NE	0.037	0.093	0.062	0.012	0.000	0.000	0.000	0.205
ENE	0.093	0.062	0.056	0.012	0.000	0.000	0.000	0.224
E	0.043	0.143	0.099	0.019	0.000	0.000	0.000	0.304
ESE	0.031	0.106	0.043	0.000	0.000	0.000	0.000	0.180
SE	0.031	0.106	0.068	0.012	0.000	0.000	0.000	0.217
SSE	0.006	0.031	0.087	0.019	0.000	0.000	0.000	0.143
S	0.025	0.043	0.025	0.006	0.000	0.000	0.000	0.099
SSW	0.019	0.043	0.050	0.012	0.000	0.000	0.000	0.124
SW	0.012	0.068	0.093	0.025	0.019	0.000	0.000	0.217
WSW	0.012	0.075	0.043	0.012	0.006	0.000	0.000	0.149
W	0.019	0.019	0.031	0.000	0.000	0.000	0.000	0.068
WNW	0.006	0.031	0.012	0.000	0.000	0.000	0.000	0.050
NW	0.012	0.056	0.031	0.006	0.000	0.000	0.000	0.106
NNW	0.012	0.012	0.056	0.006	0.000	0.000	0.000	0.087
N	0.012	0.012	0.099	0.037	0.012	0.000	0.000	0.174
Variable and Calm								0.031
Total								2.527

1

TABLE 2.6-39

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE METEOROLOGICAL DATA

PERIOD OF RECORD: MARCH 1, 1971, TO DEC. 31, 1972
ANNUAL HOURLY PERCENT FREQUENCY OF VERTICAL
TEMPERATURE STABILITY CATEGORIES BY WIND DIRECTION AND
WIND SPEED (MPH)
PASQUILL STABILITY CATEGORY C

WIND DIR	WIND SPEED (MPH) ADJUSTED TO 10 METER ELEVATION							Total%
	1<4	4<8	8<13	13<19	19<25	25-31	>31	
NNE	0.006	0.075	0.062	0.012	0.000	0.000	0.000	0.155
NE	0.043	0.093	0.068	0.006	0.000	0.000	0.000	0.211
ENE	0.043	0.081	0.062	0.012	0.006	0.000	0.000	0.205
E	0.043	0.143	0.093	0.012	0.000	0.000	0.000	0.292
ESE	0.037	0.118	0.068	0.000	0.000	0.000	0.000	0.224
SE	0.006	0.099	0.068	0.006	0.000	0.000	0.000	0.180
SSE	0.006	0.050	0.075	0.025	0.000	0.000	0.000	0.155
S	0.025	0.012	0.099	0.006	0.000	0.000	0.000	0.143
SSW	0.050	0.062	0.062	0.025	0.000	0.000	0.000	0.199
SW	0.037	0.149	0.118	0.025	0.000	0.000	0.000	0.329
WSW	0.037	0.031	0.031	0.012	0.000	0.000	0.000	0.112
W	0.037	0.037	0.006	0.000	0.000	0.000	0.000	0.081
WNW	0.031	0.043	0.000	0.000	0.000	0.000	0.000	0.075
NW	0.037	0.025	0.019	0.000	0.000	0.000	0.000	0.081
NNW	0.031	0.043	0.019	0.000	0.000	0.000	0.000	0.093
N	0.019	0.056	0.081	0.019	0.019	0.000	0.000	0.192
Variable and Calm								0.049
Total								2.776

TABLE 2.6-40

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE METEOROLOGICAL DATA

PERIOD OF RECORD: MARCH 1, 1971, TO DEC. 31, 1972
ANNUAL HOURLY PERCENT FREQUENCY OF VERTICAL
TEMPERATURE STABILITY CATEGORIES BY WIND DIRECTION AND
WIND SPEED (MPH)
PASQUILL STABILITY CATEGORY D

WIND DIR	WIND SPEED (MPH) ADJUSTED TO 10 METER ELEVATION							Total%
	1<4	4<8	8<13	13<19	19<25	25-31	>31	
NNE	0.112	0.317	0.466	0.137	0.043	0.000	0.000	1.075
NE	0.174	0.323	0.832	0.397	0.075	0.006	0.000	1.807
ENE	0.261	0.497	1.099	0.317	0.081	0.000	0.000	2.254
E	0.236	1.087	1.540	0.379	0.037	0.000	0.000	3.279
ESE	0.199	0.851	0.727	0.130	0.012	0.000	0.000	1.919
SE	0.174	0.683	0.460	0.081	0.012	0.000	0.000	1.410
SSE	0.112	0.689	0.913	0.168	0.006	0.000	0.000	1.888
S	0.124	1.025	1.422	0.118	0.000	0.000	0.000	2.689
SSW	0.224	1.207	1.012	0.310	0.000	0.000	0.000	2.763
SW	0.255	1.018	0.640	0.130	0.019	0.000	0.000	2.062
WSW	0.118	0.404	0.385	0.031	0.006	0.000	0.000	0.944
W	0.199	0.255	0.149	0.006	0.000	0.000	0.000	0.609
WNW	0.224	0.422	0.161	0.093	0.000	0.000	0.000	0.900
NW	0.186	0.602	0.385	0.050	0.000	0.000	0.000	1.223
NNW	0.099	0.217	0.323	0.081	0.000	0.000	0.000	0.720
N	0.081	0.348	0.584	0.354	0.025	0.000	0.000	1.391
Variable and Calm								0.416
Total								27.349

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TABLE 2.6-41

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE METEOROLOGICAL DATA

PERIOD OF RECORD: MARCH 1, 1971, TO DEC. 31, 1972
ANNUAL HOURLY PERCENT FREQUENCY OF VERTICAL
TEMPERATURE STABILITY CATEGORIES BY WIND DIRECTION AND
WIND SPEED (MPH)
PASQUILL STABILITY CATEGORY E

WIND DIR	WIND SPEED (MPH) ADJUSTED TO 10 METER ELEVATION							Total%
	1<4	4<8	8<13	13<19	19<25	25 31	>31	
NNE	0.174	0.416	0.242	0.012	0.000	0.000	0.000	0.844
NE	0.248	0.708	0.546	0.081	0.031	0.000	0.000	1.615
ENE	0.329	1.366	0.702	0.149	0.000	0.000	0.000	2.546
E	0.292	1.447	1.006	0.124	0.000	0.000	0.000	2.869
ESE	0.596	2.223	0.832	0.062	0.000	0.000	0.000	3.713
SE	0.714	2.391	0.627	0.087	0.000	0.000	0.000	3.819
SSE	0.627	1.882	0.484	0.019	0.000	0.000	0.000	3.012
S	0.335	1.273	0.404	0.075	0.012	0.000	0.000	2.099
SSN	0.422	0.751	0.267	0.056	0.000	0.000	0.000	1.497
SW	0.770	1.577	0.186	0.050	0.000	0.000	0.000	2.583
WSW	0.776	0.969	0.174	0.012	0.000	0.000	0.000	1.931
W	0.633	0.615	0.093	0.000	0.000	0.000	0.000	1.341
WNW	0.453	0.807	0.180	0.000	0.000	0.000	0.000	1.441
NW	0.366	1.223	0.428	0.006	0.000	0.000	0.000	2.024
NNW	0.192	0.416	0.267	0.000	0.000	0.000	0.000	0.876
N	0.130	0.329	0.292	0.037	0.000	0.000	0.000	0.789
Variable and Calm								1.124
Total								34.123

1

TABLE 2.6-42

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE METEOROLOGICAL DATA

PERIOD OF RECORD: MARCH 1, 1971, TO DEC. 31, 1972
ANNUAL HOURLY PERCENT FREQUENCY OF VERTICAL
TEMPERATURE STABILITY CATEGORIES BY WIND DIRECTION AND
WIND SPEED (MPH)
PASQUILL STABILITY CATEGORY F

WIND DIR	WIND SPEED (MPH) ADJUSTED TO 10 METER ELEVATION							Total%
	1<4	4<8	8<13	13<19	19<25	25-31	>31	
NNE	0.087	0.068	0.000	0.000	0.000	0.000	0.000	0.155
NE	0.118	0.050	0.000	0.000	0.000	0.000	0.000	0.168
ENE	0.130	0.050	0.000	0.006	0.000	0.000	0.000	0.186
E	0.093	0.056	0.006	0.000	0.000	0.000	0.000	0.155
ESE	0.180	0.062	0.019	0.000	0.000	0.000	0.000	0.261
SE	0.255	0.124	0.025	0.000	0.000	0.000	0.000	0.404
SSE	0.279	0.192	0.006	0.000	0.000	0.000	0.000	0.478
S	0.248	0.199	0.012	0.000	0.000	0.000	0.000	0.460
SSN	0.248	0.062	0.000	0.000	0.000	0.000	0.000	0.310
SW	0.273	0.267	0.006	0.000	0.000	0.000	0.000	0.546
WSW	0.317	0.106	0.006	0.000	0.000	0.000	0.000	0.428
W	0.230	0.106	0.000	0.000	0.000	0.000	0.000	0.335
WNW	0.298	0.186	0.000	0.000	0.000	0.000	0.000	0.484
NW	0.286	0.329	0.000	0.000	0.000	0.000	0.000	0.615
NNW	0.118	0.261	0.000	0.000	0.000	0.000	0.000	0.379
N	0.199	0.099	0.000	0.006	0.000	0.000	0.000	0.304
Variable and Calm								1.794
Total								7.462

1

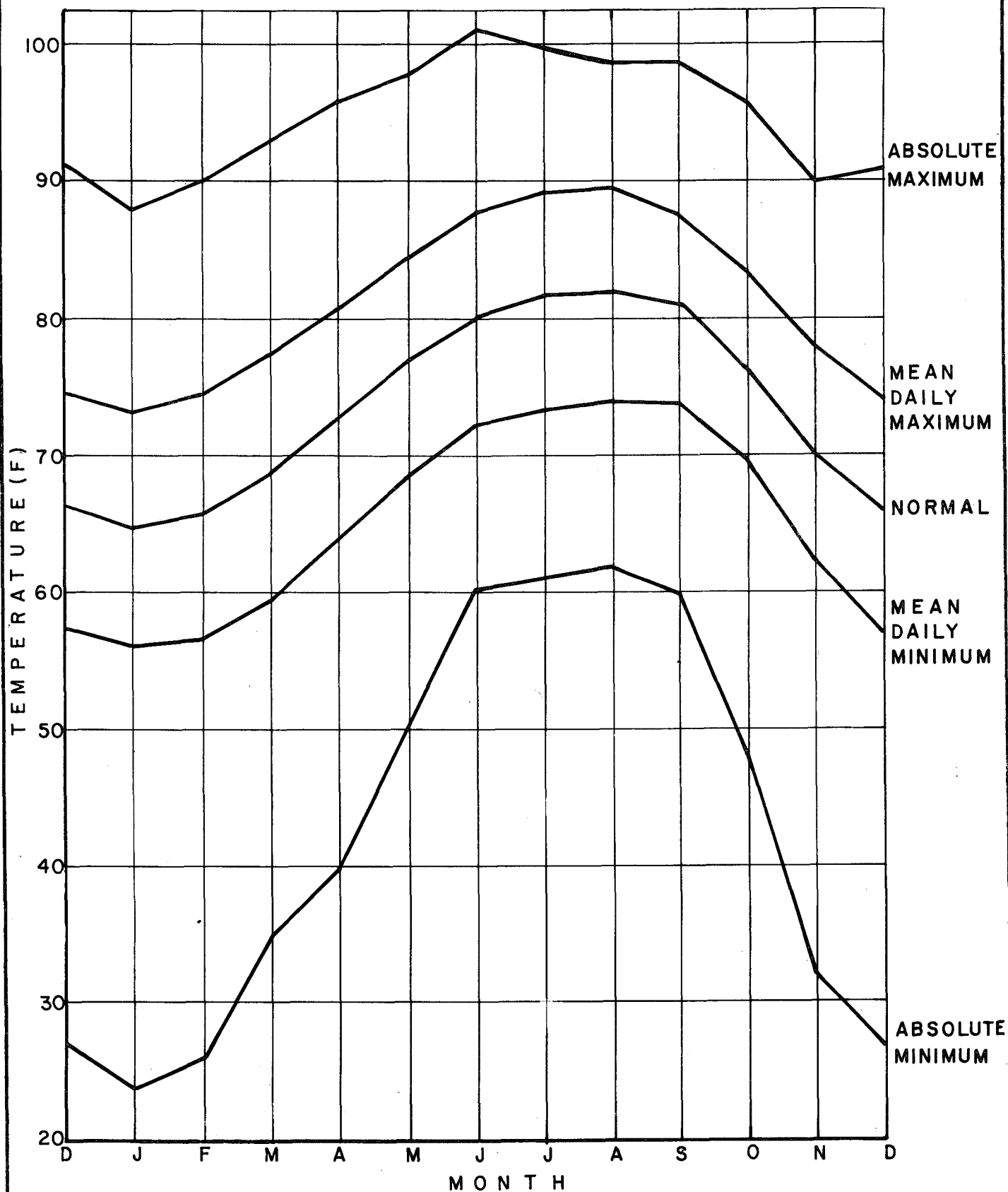
TABLE 2.6-43

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE METEOROLOGICAL DATA

PERIOD OF RECORD: MARCH 1, 1971, TO DEC. 31, 1972
ANNUAL HOURLY PERCENT FREQUENCY OF VERTICAL
TEMPERATURE STABILITY CATEGORIES BY WIND DIRECTION AND
WIND SPEED (MPH)
PASQUILL STABILITY CATEGORY G

WIND DIR	WIND SPEED (MPH) ADJUSTED TO 10 METER ELEVATION							Total%
	1<4	4<8	8<13	13<19	19<25	25-31	>31	
NNE	0.012	0.006	0.000	0.000	0.000	0.000	0.000	0.019
NE	0.019	0.000	0.000	0.000	0.000	0.000	0.000	0.019
ENE	0.019	0.006	0.000	0.000	0.000	0.000	0.000	0.025
E	0.012	0.000	0.012	0.000	0.000	0.000	0.000	0.125
ESE	0.037	0.000	0.000	0.000	0.000	0.000	0.000	0.037
SE	0.006	0.006	0.000	0.000	0.000	0.000	0.000	0.012
SSE	0.025	0.006	0.000	0.000	0.000	0.000	0.000	0.031
S	0.043	0.025	0.000	0.000	0.000	0.000	0.000	0.068
SSN	0.081	0.012	0.000	0.000	0.000	0.000	0.000	0.093
SW	0.118	0.037	0.000	0.000	0.000	0.000	0.000	0.155
WSW	0.062	0.006	0.000	0.000	0.000	0.000	0.000	0.068
W	0.081	0.012	0.000	0.000	0.000	0.000	0.000	0.093
WNW	0.186	0.043	0.000	0.000	0.000	0.000	0.000	0.230
NW	0.130	0.161	0.000	0.000	0.000	0.000	0.000	0.292
NNW	0.037	0.050	0.000	0.000	0.000	0.000	0.000	0.087
N	0.043	0.012	0.000	0.000	0.000	0.000	0.000	0.056
Variable and Calm								0.497
Total								1.807

1



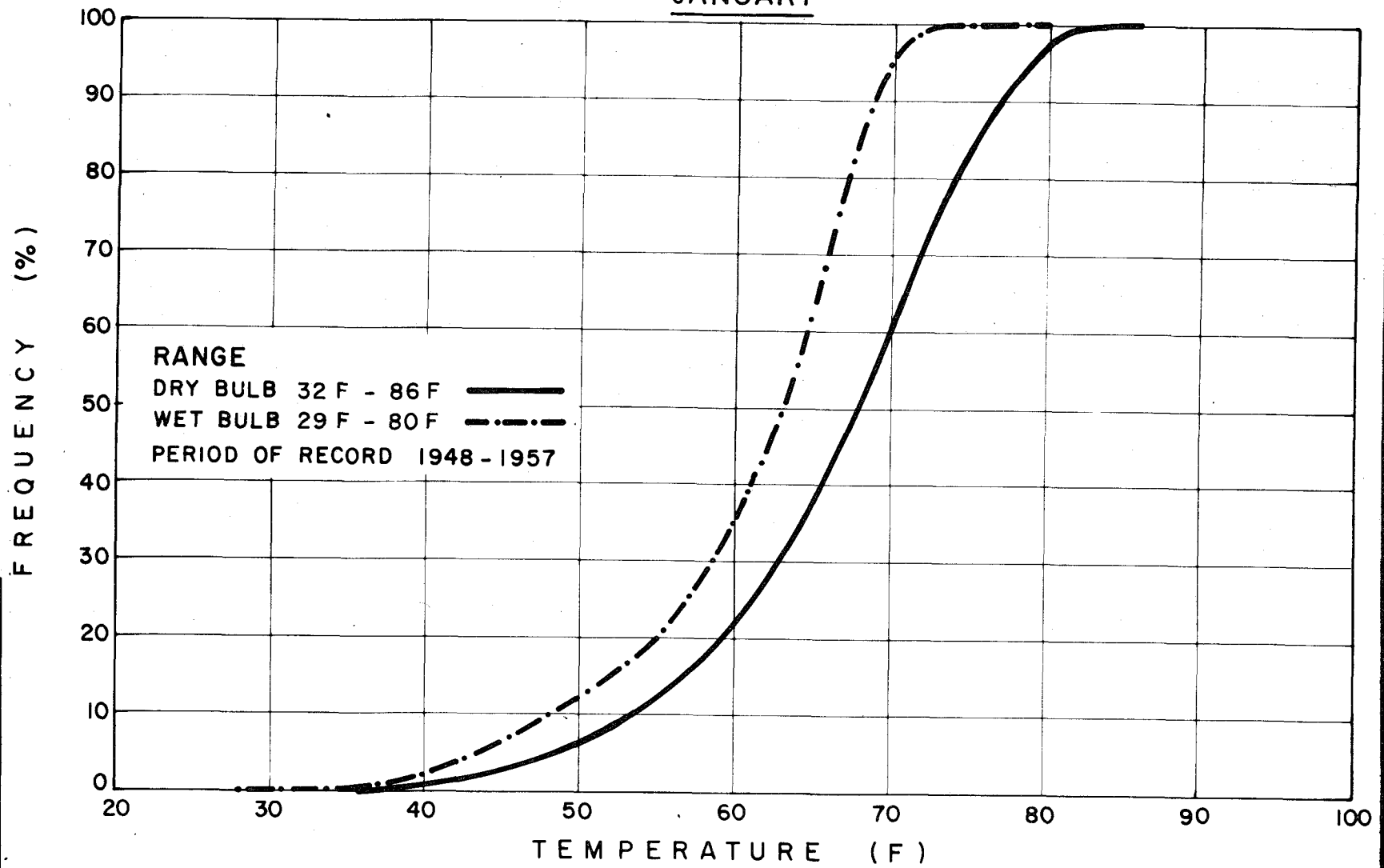
PERIOD OF RECORD 1904-1960

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

MEAN DAILY AND EXTREME
TEMPERATURE (F)
FT. PIERCE, FLORIDA

FIGURE 2.6-1

JANUARY



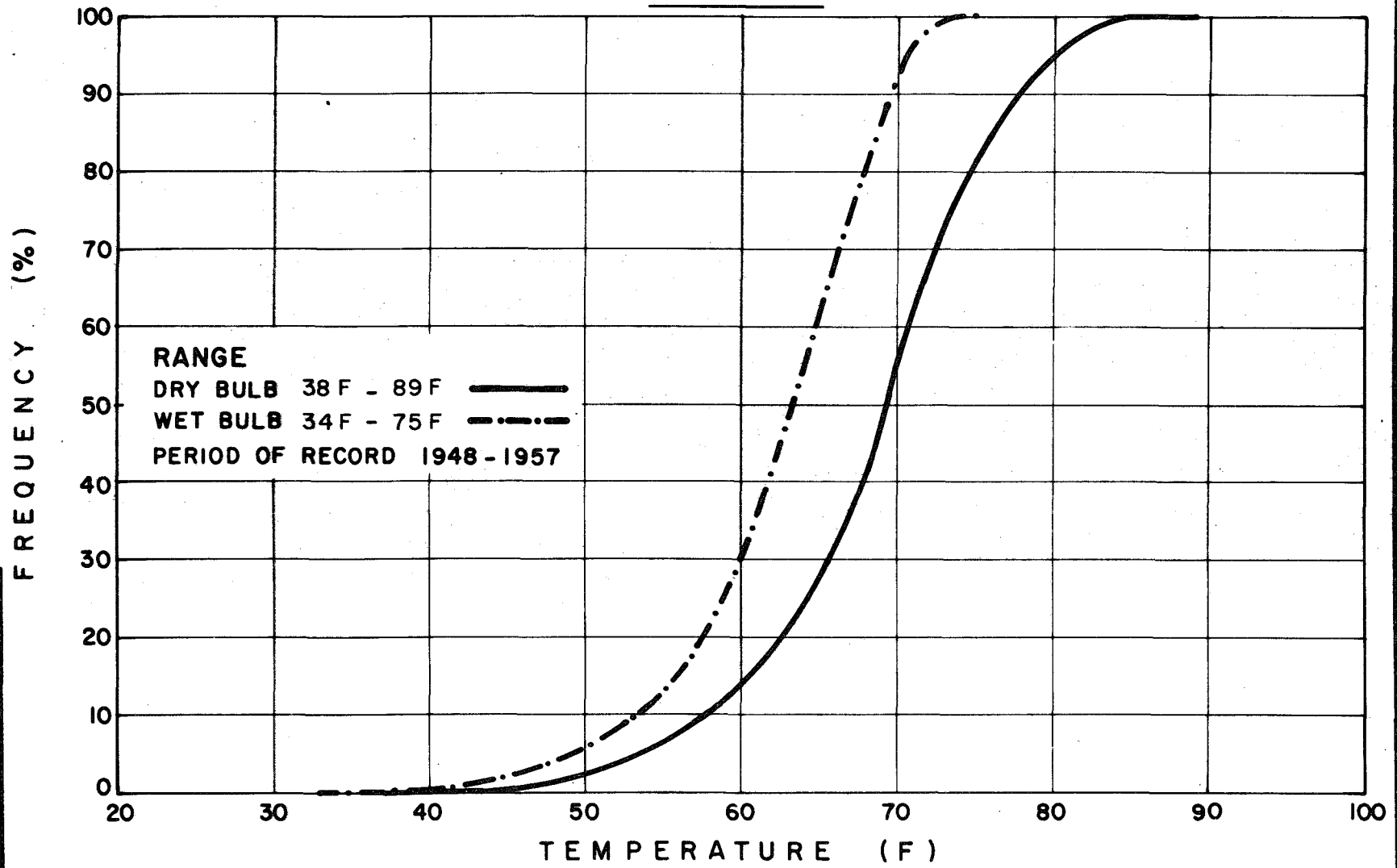
FLORIDA POWER & LIGHT COMPANY

ST. LUCIE PLANT UNIT 2

PERCENT OF HOURS DRY & WET BULB
 TEMPERATURES ARE LESS THAN OR
 EQUAL TO STATED VALUES
 WEST PALM BEACH FLORIDA

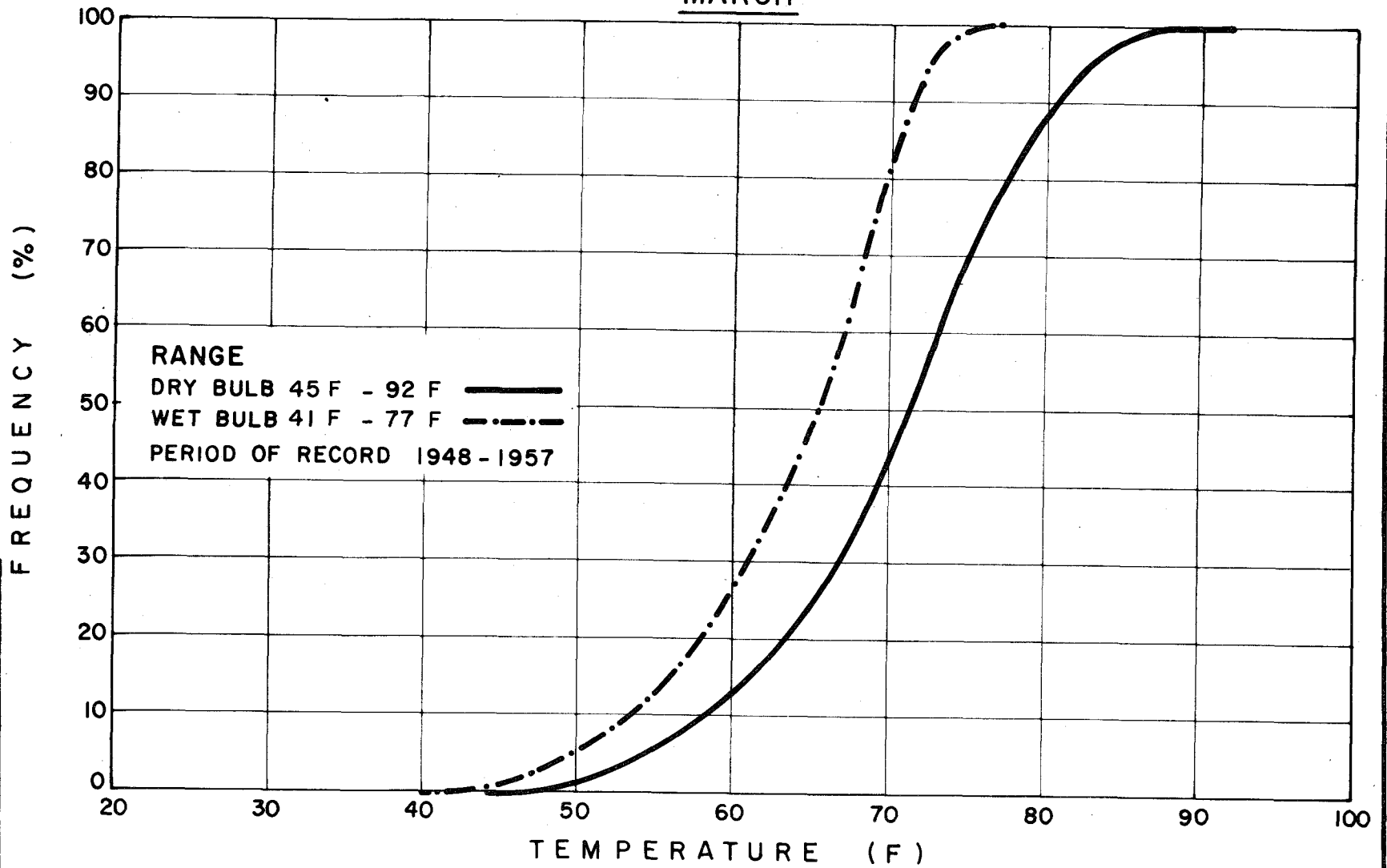
FIGURE 2.6-2

FEBRUARY



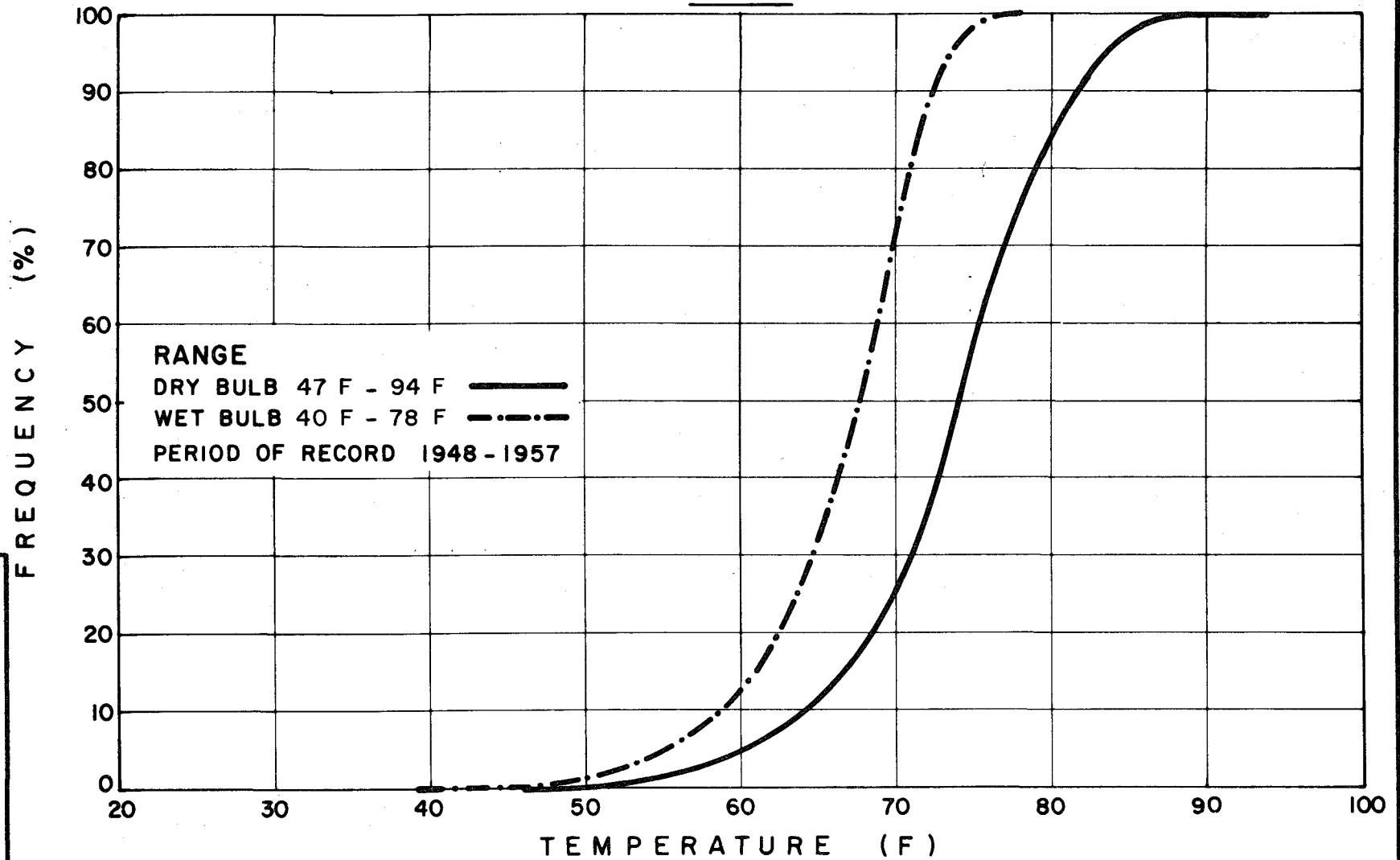
FLORIDA POWER & LIGHT COMPANY
 ST. LUCIE PLANT UNIT 2
 PERCENT OF HOURS DRY & WET BULB
 TEMPERATURES ARE LESS THAN OR
 EQUAL TO STATED VALUES
 WEST PALM BEACH FLORIDA
 FIGURE 2.6-3

MARCH



FLORIDA POWER & LIGHT COMPANY
 ST. LUCIE PLANT UNIT 2
 PERCENT OF HOURS DRY & WET BULB
 TEMPERATURES ARE LESS THAN OR
 EQUAL TO STATED VALUES
 WEST PALM BEACH FLORIDA
 FIGURE 2.6-4

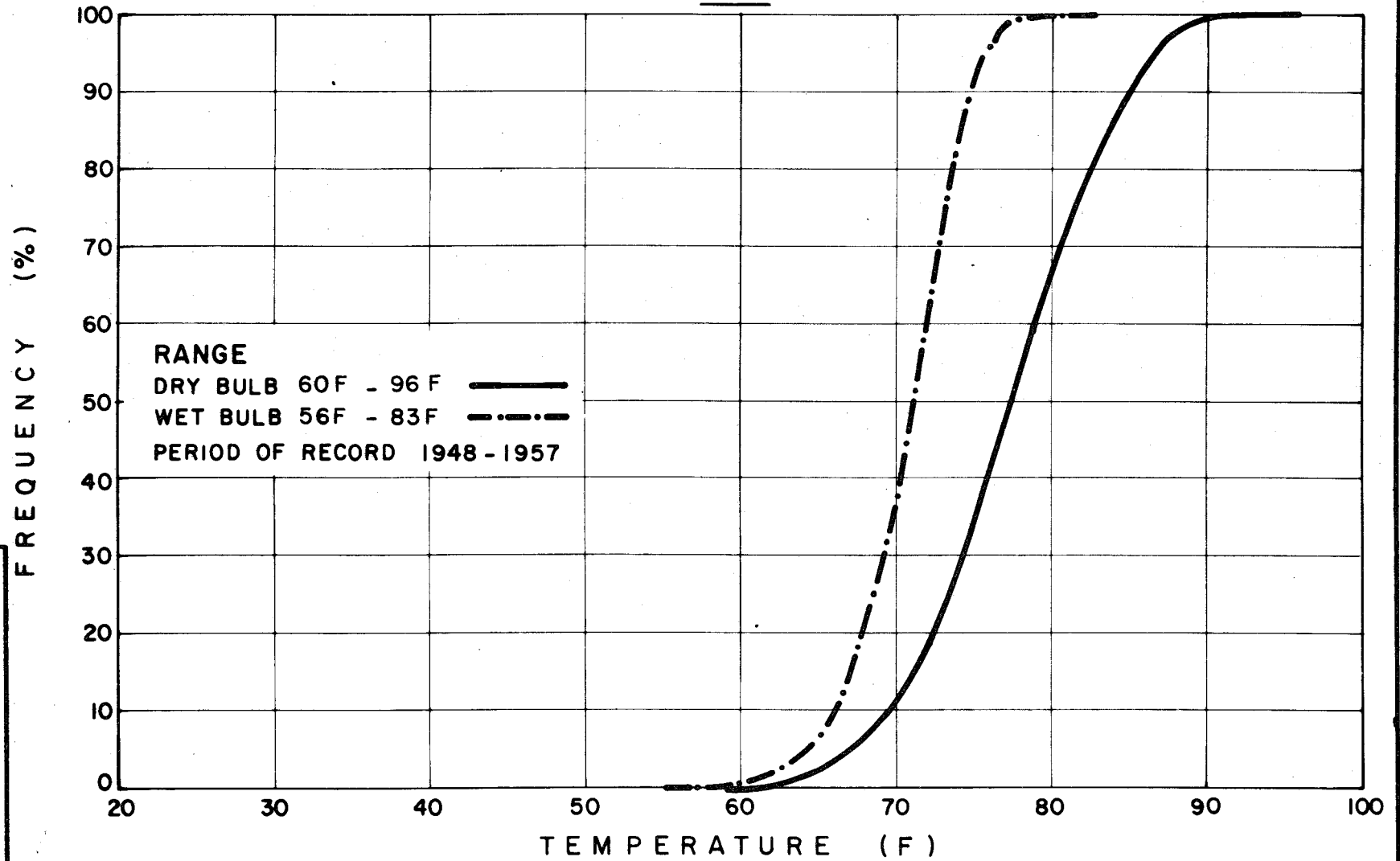
APRIL



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
PERCENT OF HOURS DRY & WET BULB
TEMPERATURES ARE LESS THAN OR
EQUAL TO STATED VALUES
WEST PALM BEACH FLORIDA

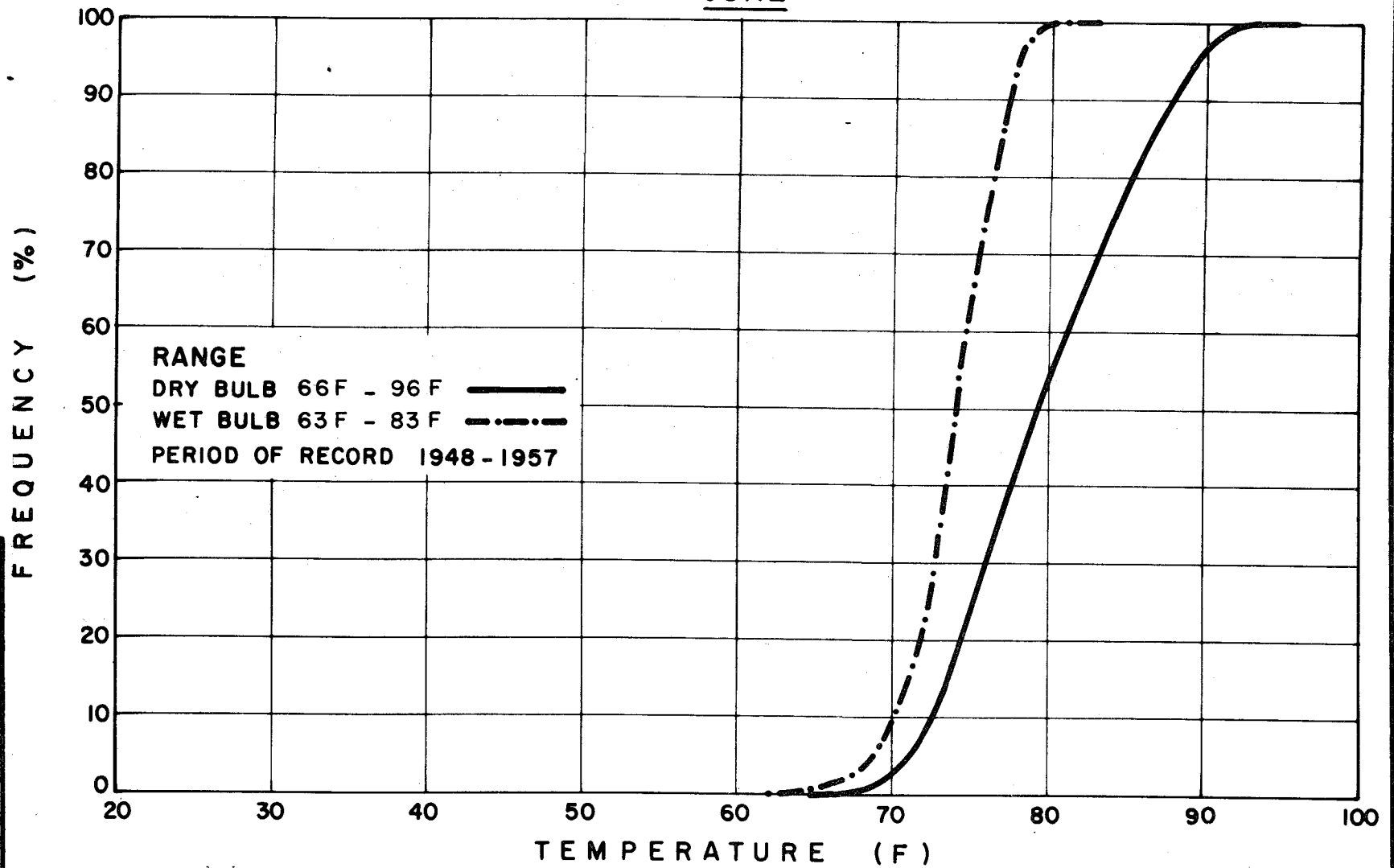
FIGURE 2.6-5

MAY



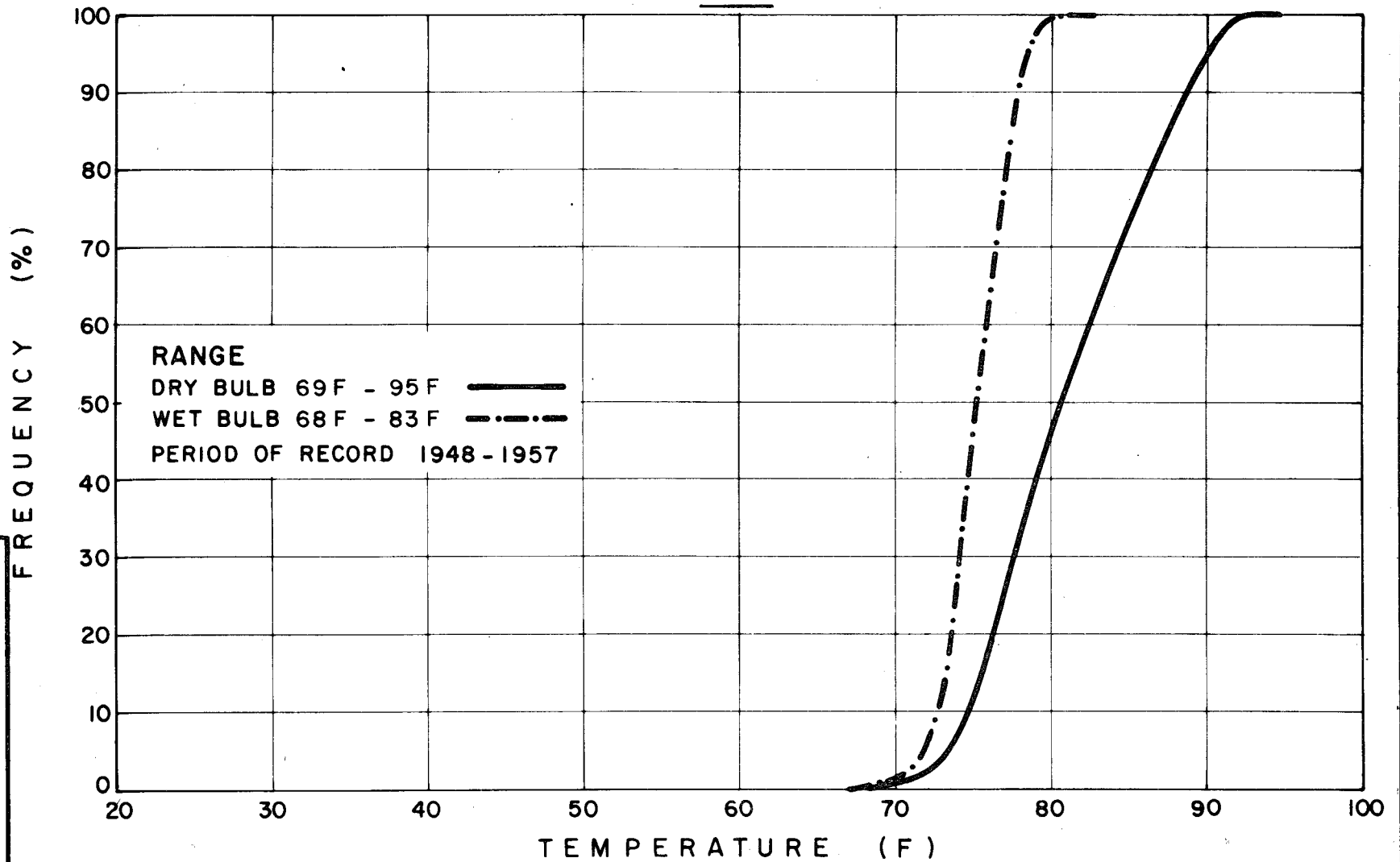
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
PERCENT OF HOURS DRY & WET BULB
TEMPERATURES ARE LESS THAN OR
EQUAL TO STATED VALUES
WEST PALM BEACH FLORIDA
FIGURE 2.6-6

JUNE



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
PERCENT OF HOURS DRY & WET BULB
TEMPERATURES ARE LESS THAN OR
EQUALS TO STATED VALUES
WEST PALM BEACH FLORIDA
FIGURE 2-6-7

JULY



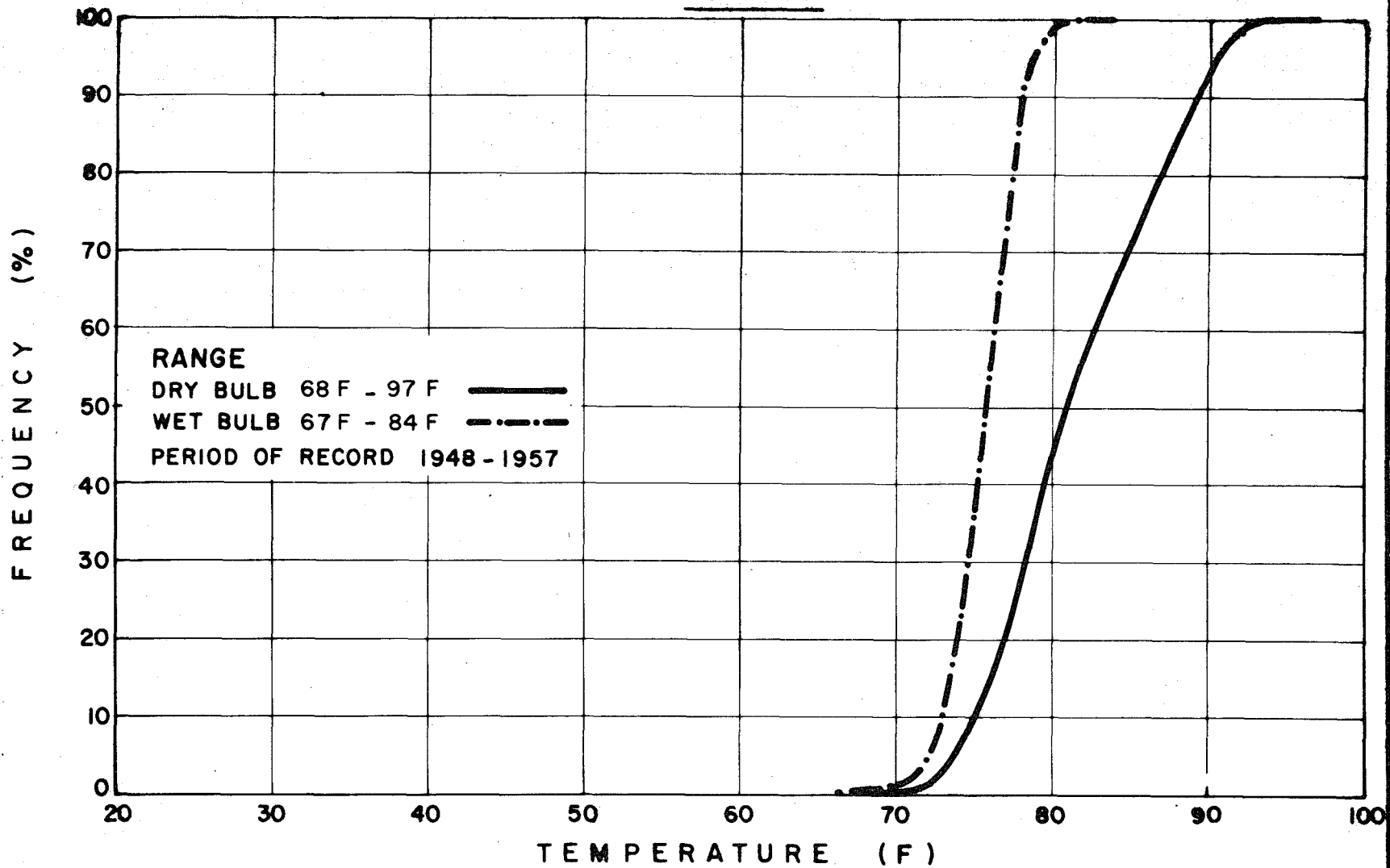
FLORIDA POWER & LIGHT COMPANY

ST. LUCIE PLANT UNIT 2

PERCENT OF HOURS DRY & WET BULB
TEMPERATURES ARE LESS THAN OR
EQUAL TO STATED VALUES
WEST PALM BEACH FLORIDA

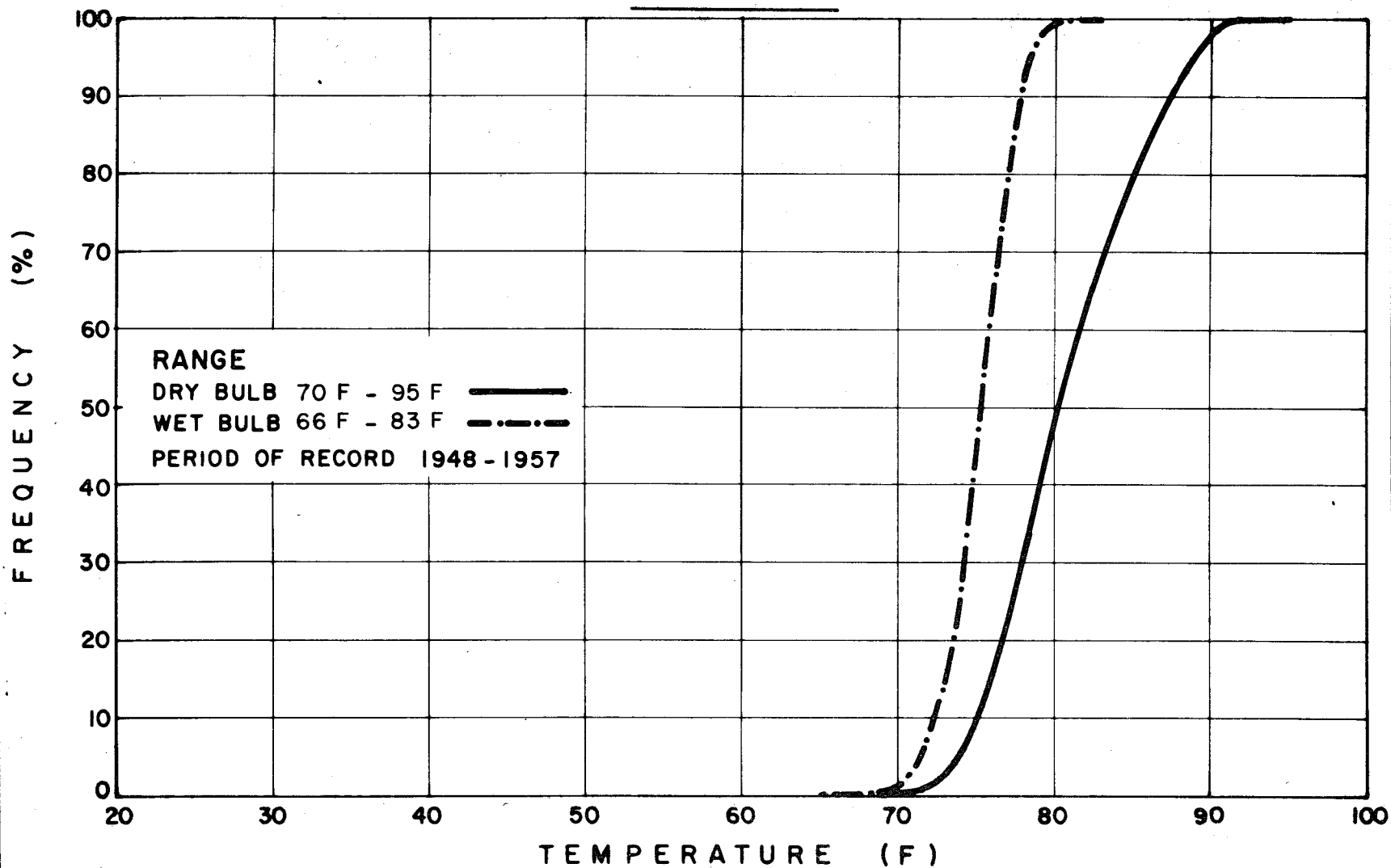
FIGURE 2-6-8

AUGUST



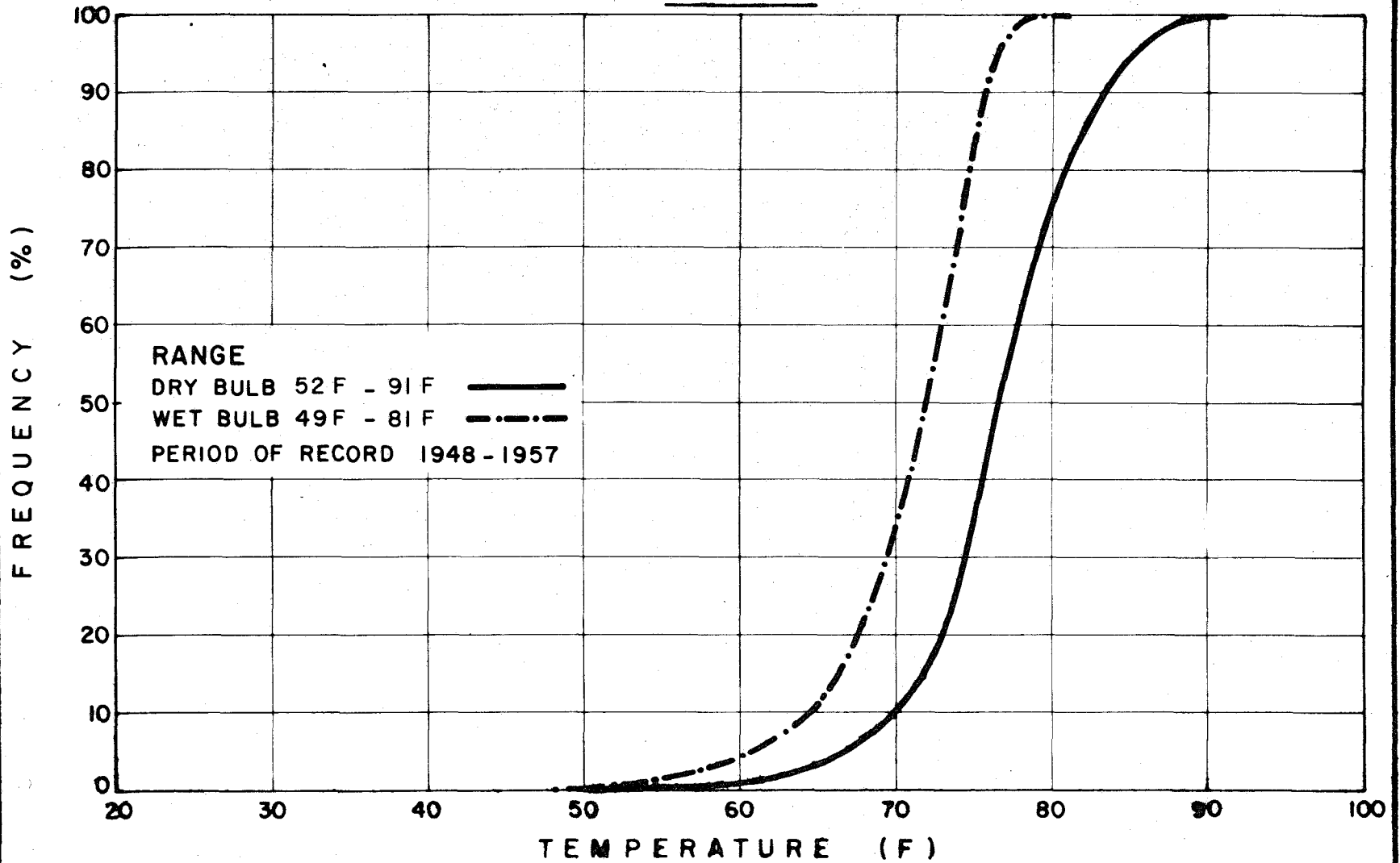
FLORIDA POWER & LIGHT COMPANY
 ST. LUCIE PLANT UNIT 2
 PERCENT OF HOURS DRY & WET BULB
 TEMPERATURES ARE LESS THAN OR
 EQUAL TO STATED VALUES
 WEST PALM BEACH FLORIDA
 FIGURE 2-6-9.

SEPTEMBER



FLORIDA POWER & LIGHT COMPANY
 ST. LUCIE PLANT UNIT 2
 PERCENT OF HOURS DRY & WET BULB
 TEMPERATURES ARE LESS THAN OR
 EQUAL TO STATED VALUES
 WEST PALM BEACH FLORIDA
 FIGURE 2.6-10

OCTOBER



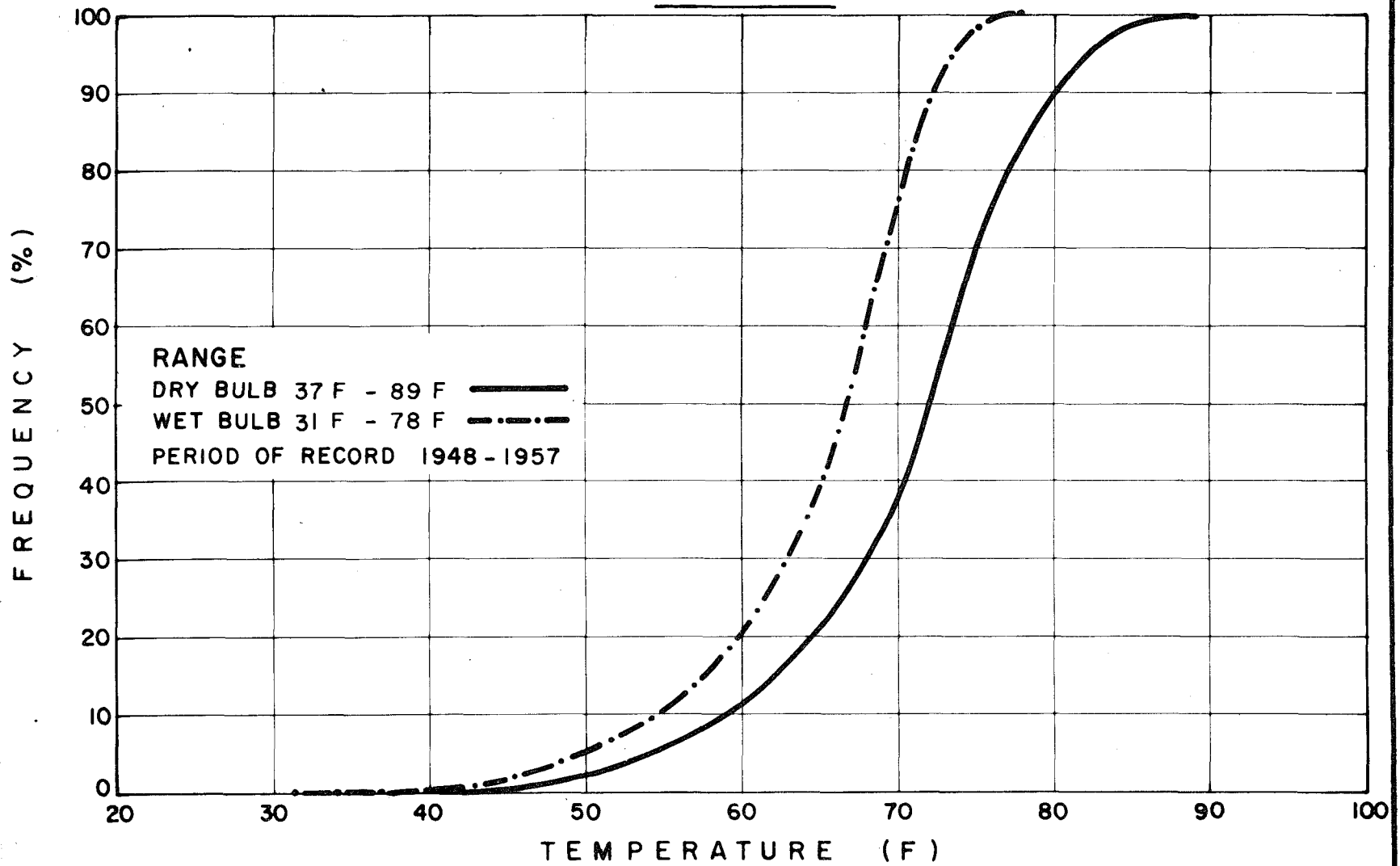
FLORIDA POWER & LIGHT COMPANY

ST. LUCIE PLANT UNIT 2

PERCENT OF HOURS DRY BULB
 TEMPERATURES ARE LESS THAN OR
 EQUAL TO STATED VALUES
 WEST PALM BEACH FLORIDA

FIGURE 2.6-11

NOVEMBER



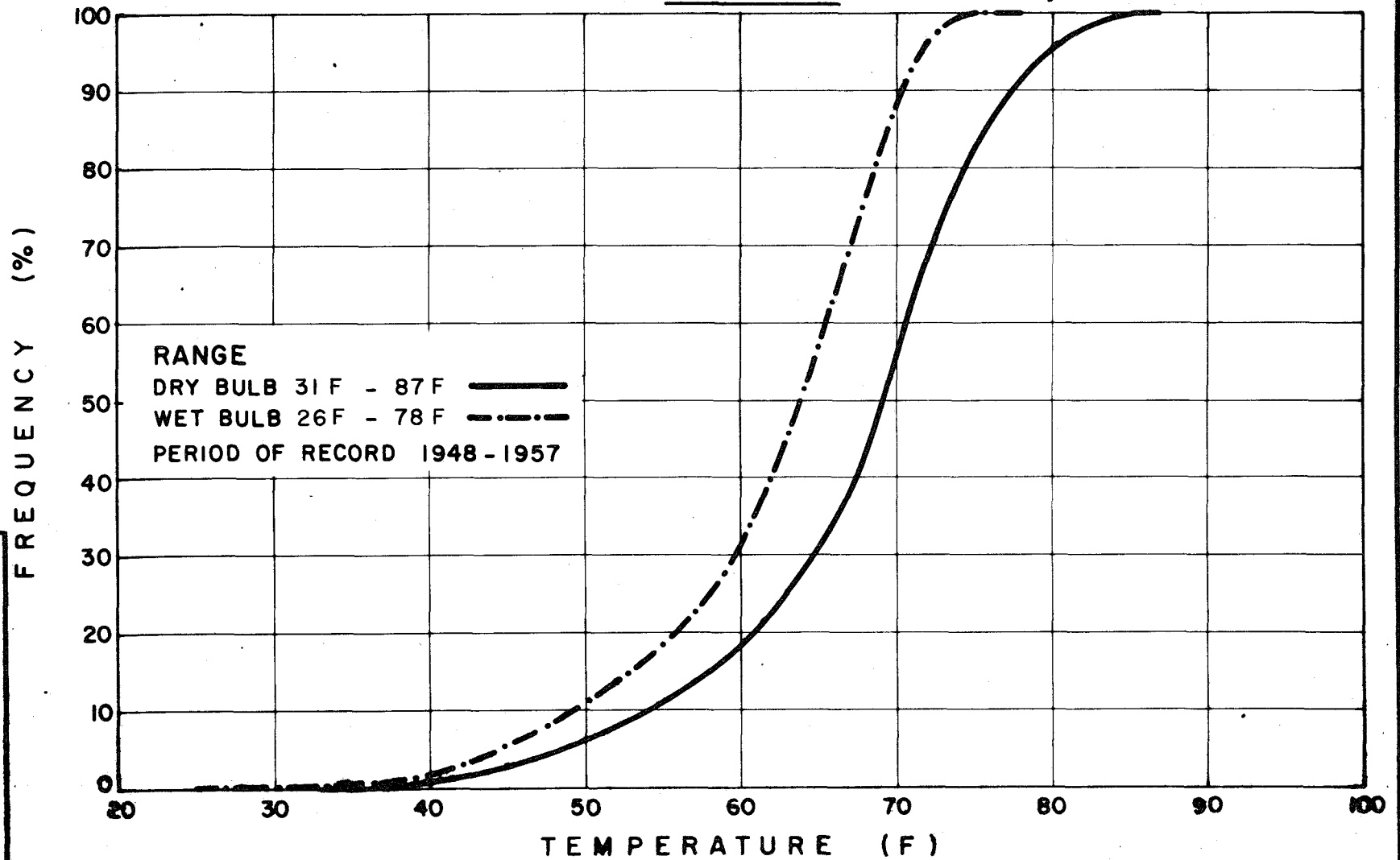
FLORIDA POWER & LIGHT COMPANY

ST. LUCIE PLANT UNIT 2

PERCENT OF HOURS DRY & WET BULB
 TEMPERATURES ARE LESS THAN OR
 EQUAL TO STATED VALUES
 WEST PALM BEACH, FLORIDA

FIGURE 2.6-12

DECEMBER



FREQUENCY (%)

RANGE

DRY BULB 31 F - 87 F

WET BULB 26 F - 78 F

PERIOD OF RECORD 1948 - 1957

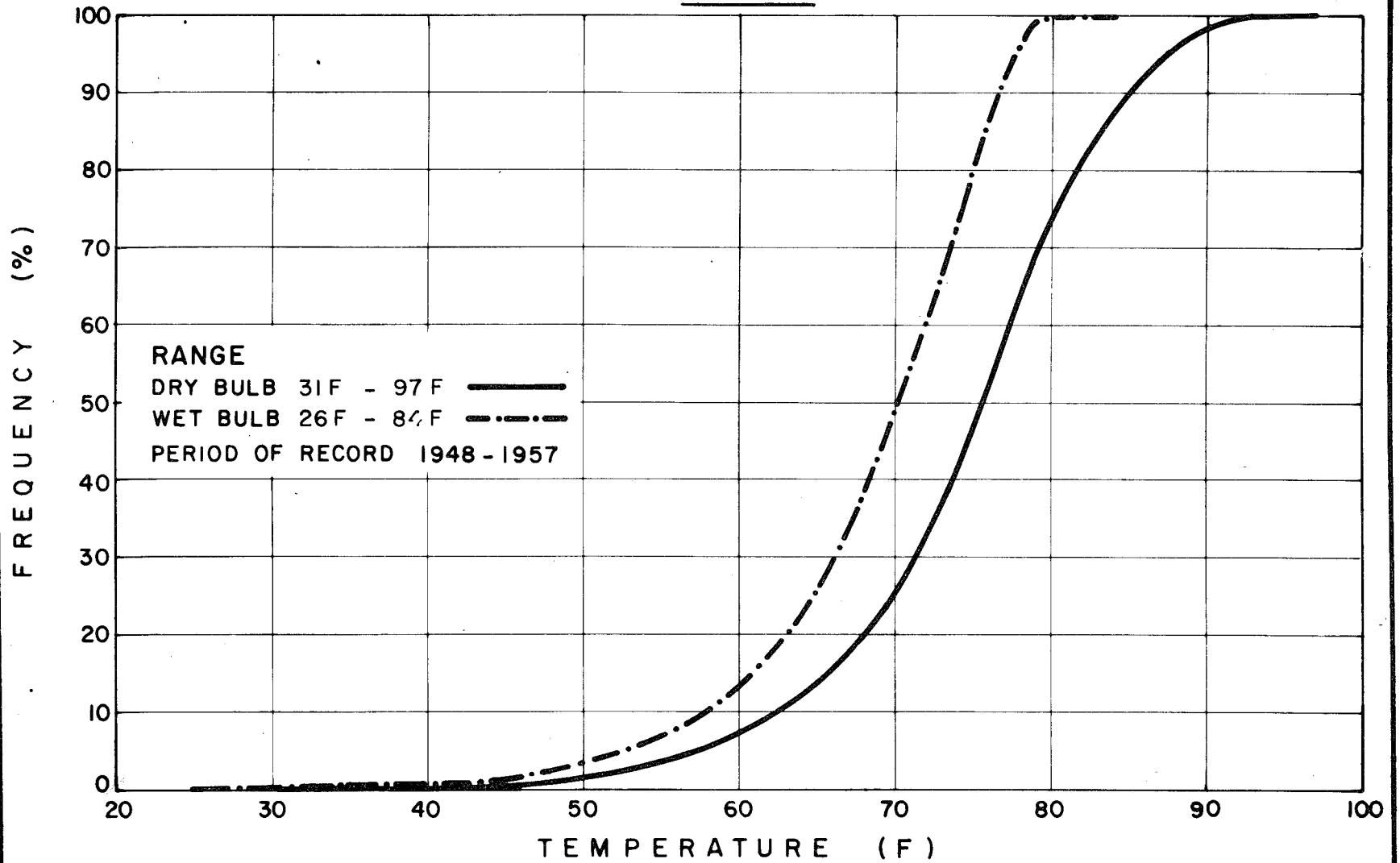
FLORIDA POWER & LIGHT COMPANY

ST. LUCIE PLANT UNIT 2

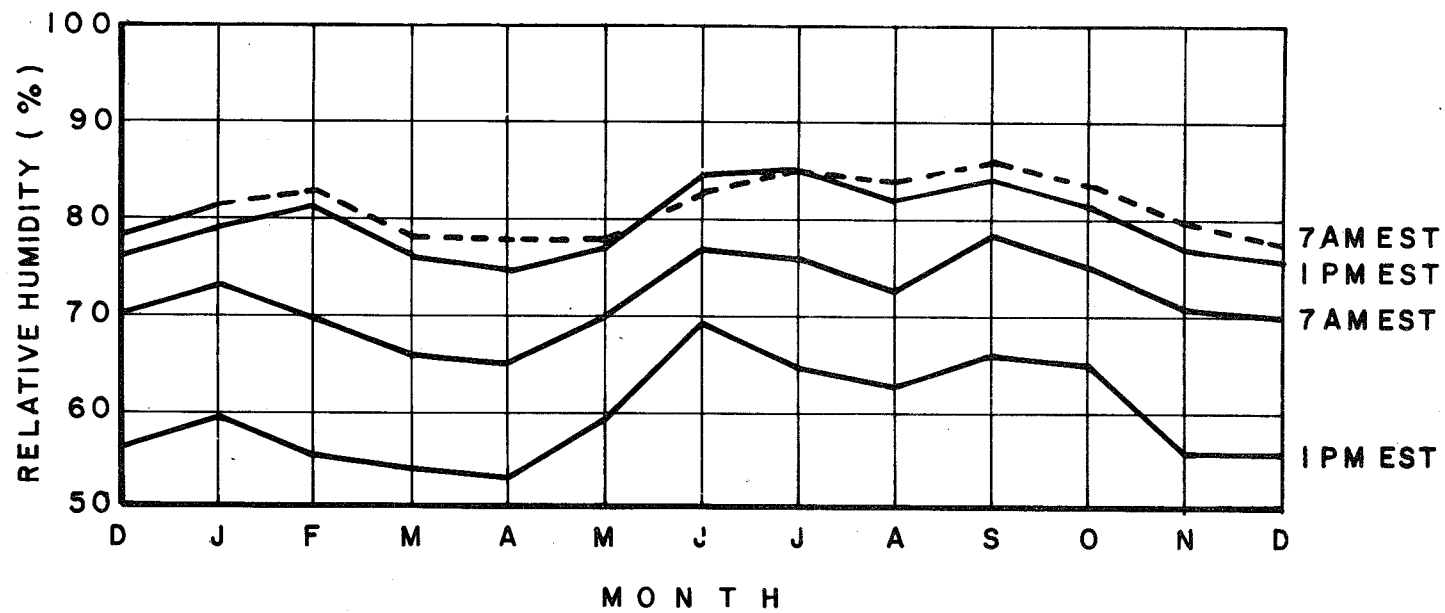
PERCENT OF HOURS DRY & WET BULB
TEMPERATURES ARE LESS THAN OR
EQUAL TO STATED VALUES
WEST PALM BEACH, FLORIDA

FIGURE 26-13

ANNUAL



FLORIDA POWER & LIGHT COMPANY
 ST. LUCIE PLANT UNIT 2
 PERCENT OF HOURS DRY & WET BULB
 TEMPERATURES ARE LESS THAN OR
 EQUAL TO STATED VALUES
 WEST PALM BEACH, FLORIDA
 FIGURE 2.6-14



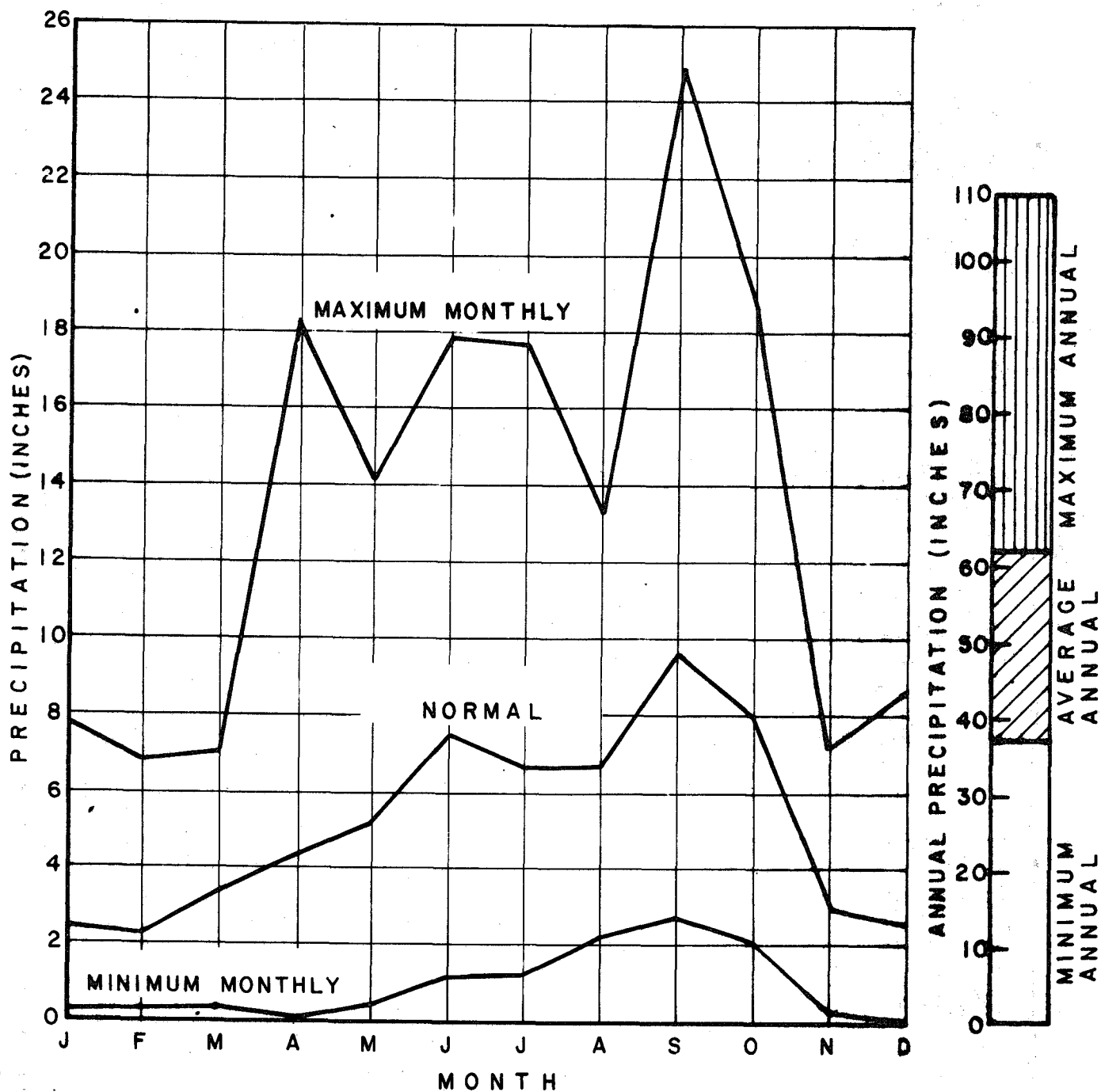
PERIOD OF RECORD 1965-1969

FLORIDA POWER & LIGHT COMPANY

ST. LUCIE PLANT UNIT 2

MEAN 1AM, 7AM, 1PM & 7PM EST
RELATIVE HUMIDITY (PERCENT)
WEST PALM BEACH, FLORIDA

FIGURE 2.6-15

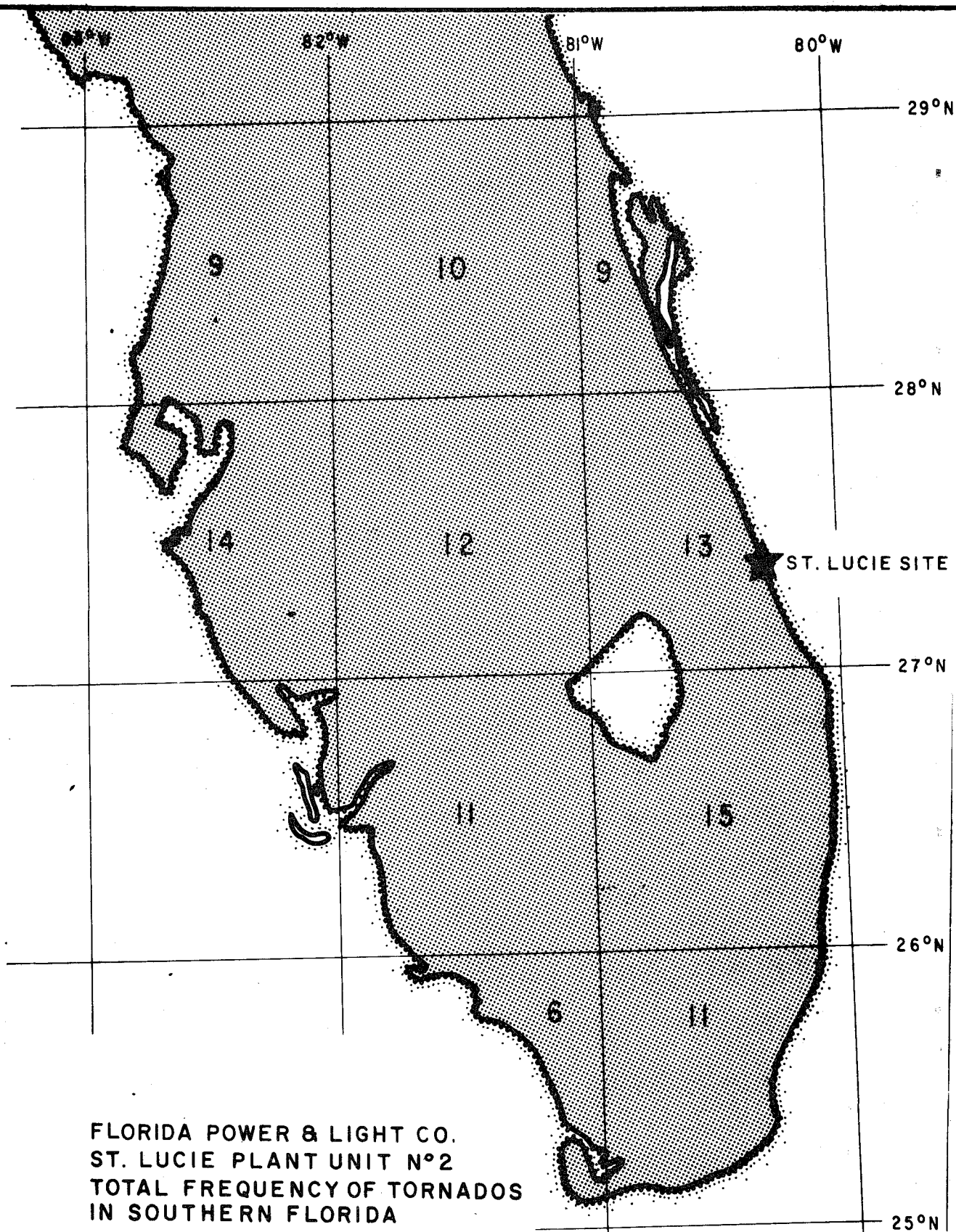


PERIOD OF RECORD :
 NORMAL 1931 - 1960
 EXTREMES 1939 - 1969

FLORIDA POWER & LIGHT COMPANY
 ST. LUCIE PLANT UNIT 2

MONTHLY AND ANNUAL MEAN AND
 EXTREME PRECIPITATION (INCHES)
 WEST PALM BEACH, FLORIDA

FIGURE 2.6-16



FLORIDA POWER & LIGHT CO.
ST. LUCIE PLANT UNIT N°2
TOTAL FREQUENCY OF TORNADOS
IN SOUTHERN FLORIDA
1953 - 1962

10 0 10 20 30
SCALE IN MILES

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

TOTAL FREQUENCY OF TORNADOS
IN SOUTHERN FLORIDA

FIGURE 2.6-17

2.7 ECOLOGY

2.7.1 GENERAL

Hutchinson Island is a bar and swale barrier island located on the east coast of Florida between the cities of Fort Pierce and Stuart. The island, oriented north-south, is approximately 22 miles long with a maximum width of about one mile. The eastern (Atlantic Ocean) side of Hutchinson Island consists of a dune line with approximate elevation of +15 feet MSL. This low bar slopes toward the west to about elevation + 4 feet MSL, generally forming a swale. The island is separated from the Florida mainland by the Indian River, a shallow tidal lagoon.

More detailed information on the geology and topography of Hutchinson Island is presented in Section 2.4 of this report.

2.7.2 TERRESTRIAL VEGETATION

Hutchinson Island is typical of the offshore sandbar islands which line the southern U S Atlantic coastline. It consists of an eastern sandbar which rises to approximately +15 feet MSL. This dune line divides the island into two habitats, a beach-dune eastern zone and a western swale primarily occupied by mangroves.

2.7.2.1 Coastal Strand Beaches and Dunes

The coastal beach and dune habitat extends from the high tide mark to the dune line. The Australian pine (Casuarina spp.) has established heavy growth on the dunes. These trees have such a compact and extensive root system and their foliage provides such dense shade that virtually no plants can grow under them. The most abundant plant seen on the fore-shore slope of the dune ridge is sea oats (Uniola paniculata), and many shrubs, herbs, and grasses are found on the upper slopes, top and face of the dune ridge. The normal vegetation of the dune line is listed in Table 2.7-1.

2.7.2.2 Mangrove Swamps

Mangrove swamps are principally maintained by tidal and occasional storm-driven incursions of sea water as well as by rain. In the lower zones along Indian River and Big Mud and Blind Creeks, the red mangrove (Rhizophora mangle) predominated while the larger black mangrove (Avicennia nitida) and the smaller white mangrove (Laguncularia racemosa) were established on higher ground which was less frequently and less deeply flooded. In an undisturbed environment, mangrove swamps are noteworthy for their high productivity with leaf fall leading to a basal mangrove peat which provides the energy source to support a rich population of zooplankton, insects, snails, fiddler crabs, and minnows, which in turn support large populations of fish, reptiles, birds and mammals.

Much of the mangrove forest was destroyed in the 1930's and 1940's when a mosquito control program was initiated under the WPA. The mangrove swamps were trenched, diked, and flooded with seawater which remained stagnant at a relatively fixed level. Since mangrove roots obtain their

oxygen supply through specialized breathing pores which are normally only slightly above mean high water level, such flooding caused the death of large numbers of trees, primarily the black mangroves, and drastically reduced the productivity of the area.

In these stagnant, high water areas there has been little or no recovery of the original black mangrove. Red mangrove growth has developed over the past 25 to 40 years in some parts of the swamp areas. This is not a restoration of the original black mangrove swamp but it is a partial restoration of a major species. The best regrowth of mangroves, mostly red mangroves, has occurred in the area across Highway A-1-A from the plant site. The area of least regrowth is northwest of Blind Creek and on the finger northwest of the construction area.

With these large areas of mangroves destroyed, it is unlikely that any part of Hutchinson Island near the plant site is capable of supporting a normal complement of animals, especially mammals, birds, and reptiles. Presently, animal life in the water-impounded areas is very sparse. There are now virtually no fiddler crabs, ladder spiders, and snails. Fish minnows (e.g., species of Fundulus) are few and the abundance of water birds is below normal.

Those parts of the Island which have been altered for mosquito control are relative biological deserts where the normal ecosystem of mangrove swamps no longer exists. If some restoration of the former mangrove swamp life is desired, a program of reestablishing tidal exchanges into these areas could, in time, restore some of their productivity.

Table 2.7-1 lists almost all of the plants present in the area when ecologically undisturbed.

2.7.2.3 Upland Areas

The few upland areas of loamy and shell soils are usually located well above normal tides. On these mounds are found the coastal hardwoods and cabbage palm scrub type forests. The cabbage palm (Sabal palmetto) is usually the tallest and most abundant tree. A few live oaks and the red bay are common, and the Australian pine is increasing and may predominate in some areas. These and other shrub and tree-size plants are listed in Table 2.7-1.

With the exception of mangroves bordering the outside of a perimeter road, the area immediately surrounding the plant and bordered by the road is now almost completely changed by settling ponds, spoil bank, and fill from pumping of the dredges. The topography is uneven and the spoil and fill material are of many different qualities, ranging from sand to silt to rock and shells. The old black mangroves remain in some ponded areas and there is some growth of red mangroves between the outer perimeter road and an inner canal.

The spoil and silt materials are piled up to +25 feet MSL, and some of the sides and slopes of these piles have a few grasses, bushes and weeds growing on them. The most common grass is a dropseed or smut grass, Sporobolus floridanus, a bunch grass not useful as a pasture grass or

for sodded lawns. This grass is not salt-tolerant and it grows on high spoil because the soils have been leached of salt by rains.

2.7.2.4 Agriculture Near the Plant Site

Citrus groves comprise the major agricultural resource of the area. The nearest groves are located near U S Route 1 five miles west of the plant site. The nearest truck farm is in Martin County, approximately ten miles south of the site.

2.7.3 TERRESTRIAL ANIMALS

2.7.3.1 Mammals

Of the nearly forty species of mammals reported for Hutchinson Island, the racoon, opossum, and beach mouse appear to be the most abundant. The "rare or endangered" Florida manatee and Florida panther may also occasionally visit the vicinity of the island.

There is no evidence that hunting is a significant activity on the island, although some duck hunting along Indian River is reported and hunting for small mammals may be assumed.

Table 2.7-2 lists the mammals which inhabit Hutchinson Island and the surrounding areas.

The dairy nearest to the St. Lucie Plant is located 14 miles west-southwest of the plant site. Domesticated livestock were not observed nearer than seven miles from the plant. Single grazing animals may exist at closer distances, but on the mainland west of the Savannas, and not closer than five miles from the plant site. The nearest beef producer is near Port St. Lucie, approximately five miles southwest of the plant.

2.7.3.2 Birds

Nearly 160 species of birds are either resident or visitors to the island. Water birds are the most common. Table 2.7-3 lists the species which inhabit Hutchinson Island, and Table 2.7-4 specifies which of the species are classified as "rare or endangered."

The major impact on terrestrial life from plant operation will probably result from lighting the buildings and perimeter fence. Some migrating bird species, when caught in a storm front, become disoriented, are attracted by lights, and may be killed in large numbers by dashing themselves against the lights or supporting structures (1, 2).

2.7.3.3 Insect Infestation in the Area

The only mosquito species indigenous to Hutchinson Island is the salt marsh mosquito (Aedes taeniorhynchus). The common varieties of domestic mosquitos (Culex spp.) are not capable of breeding in salt water marshes and, therefore, are not to be found on Hutchinson Island. The salt marsh mosquito is not a carrier of encephalitis and, correspondingly, there have been no reports of disease vectors made to the St. Lucie County

Health Department for the Hutchinson Island area. Florida Power and Light gives full support to the St. Lucie County Mosquito Control District and allows its personnel to flood the low-lying land on the site in order to control mosquito populations.

2.7.3.4 Sea Turtle Nests on Hutchinson Island

The beach along Hutchinson Island is an important nesting area for Atlantic loggerhead turtles, (*Caretta caretta caretta*). Data collected in July 1972 by the Florida Department of Natural Resources (3) from nine segments of beach, each 0.75 miles long, indicated the existence of 1420 nests. Nesting density was found to increase from north to south. The total number of loggerhead turtle nests was estimated by plotting nesting density (number of nests per 0.75 miles of beach) of the various survey areas against distance along the beach, and geometrically calculating the area under the curve.

The number of loggerhead turtle nests on Hutchinson Island beaches during 1971 was estimated earlier as 3550. Routa's 1968 estimate (4) of total nesting on Hutchinson Island was 5265 nests, but his method assumed no north-south nesting density gradient, so his calculations incorporated unweighted ratios, and included at least one green turtle nest and several unidentified nests. All of these factors are error sources for the final estimate, and partly explain the discrepancy in the three different numbers.

The 1971 estimates of clutch size for loggerhead turtles range between 120 and 130 eggs per nest. Assuming an average of 120 eggs per nest, total estimated egg production for loggerhead turtles nesting on Hutchinson Island was 426,000 in 1971. Nest predation by racoons reached a total of 395 nests or 28 percent of nests surveyed. Thirty-four percent (111 nests) were plundered within 48 hours of nesting. Figure 2.7-1 indicates the locations of the study segments and the data findings.

The loggerhead has the most northerly and extensive breeding territory of any of the Atlantic sea turtles. It has been so consistently persecuted at the nesting ground, however, that the original patterns of the nesting can no longer be discerned. In America the Atlantic loggerheads still nest as far north as the coast of North Carolina.

Until recently the Atlantic loggerhead appeared to be in no serious immediate danger. When the nesting takes place on beaches and coastal islands of the United States, the turtles are protected by law, and varyingly effective patrols control poaching. Lately, however, their future is threatened by a marked expansion of the racoon population, and by the rapid development of the coastlines as real estate and recreational areas. Even where the beach is not disturbed, when the turtles come ashore to nest they are confused by lights along coastal highways. The emerging hatchlings may be disoriented enough to be veered away from their usually direct path to the sea and be killed by the thousands on the highways.

An extensive search of the entire Atlantic Coast of Hutchinson Island revealed 22 nests of the Atlantic green turtle (*Chelonia mydas mydas*),

which displayed a high degree of nest selectivity. With one exception, nest sites were far above mean high water, either at the base or on top of the dune face, and were never located on beaches where erosion (northern areas) or accretion (southernmost study segment) was substantial.

Green turtles produce about 100 eggs per nest and each mature female nests about 4 times each season. After nesting, dogs, lizzards, and racoons attack and destroy many of the nests. The eggs in undisturbed nests hatch after 60 days, and the hatchling turtles are subjected to new dangers, including birds, and fish, once they get to the ocean.

At the present time, the green sea-turtle is included in the list of threatened wildlife of the U.S. (compiled by the U.S. Department of the Interior, Fish and Wildlife Service) primarily due to the overexploitation by man for food. During their nesting season the turtles are now protected by Florida game laws. Nesting of the green turtle is already sufficiently limited on Hutchinson Island so that neither it nor any part of the U.S. is considered to be a principal nesting ground of the species (5).

There is a regular seasonal arrival of a colony of young green turtles off the west coast of peninsular Florida near Cedar Key. None is ever less than several months old, suggesting that their hatching place is a long distance away. Some green turtles still come ashore singly to nest along the lower east coast of Florida, but this happens so infrequently that the nests there cannot be considered the source of any green turtle population.

The main controlling influence in the survival of the green turtle is either protection of the nesting habitat or, when that is not feasible, retrieval and artificial hatching of the eggs.

Since 1956, the House of Refuge Museum located on Hutchinson Island has been transplanting, hatching, rearing, and releasing turtles from eggs laid in nests on the beach (6). This organization, with Dr. A. Carr of the University of Florida, has been instrumental in preserving the green turtle as a native Florida animal.

Six nests of the Atlantic leatherback turtle (Dermochelys coriacea coriacea) were encountered during the 1971 survey. The nests were widely dispersed throughout the island but all were located well above mean high water at the base of the dune face.

No data are available which provide a reliable estimate of the world population of sea turtles to better than a factor of three or four. No data exist on the current population ratios among the loggerhead, green and leatherback varieties, but of the three, the leatherback is the least commonly seen on Hutchinson Island. These sea turtles are found throughout the world, principally between the latitudes of 35'N and 35'S. The Hutchinson Island shoreline is estimated to contain approximately 0.1 percent of the world shoreline suitable for turtle nesting. On the basis of nesting data, the world population of sea turtles is about 10,000,000. The percentage that nested on Hutchinson Island in 1972 is, therefore, approximately 0.014 percent (3).

The St. Lucie Plant site nesting shoreline is slightly less than 0.1 of the entire ocean side shoreline length of the island. Therefore, the approximate fraction of the population of sea turtles nesting on the site is 0.001 percent.

2.7.3.5 Intertidal Fauna

The open sandy beach of Hutchinson Island is subject to the force of ocean waves which produce a physically unstable environment. No macroscopic plants can survive on the beach, so the sand beach is essentially an environment occupied by animals and some microscopic plants.

The intertidal community of Hutchinson Island has not been studied but some unpublished data on the beach fauna of Jupiter beach, an area similar to Hutchinson Island, is available ⁽²⁵⁾. Intertidal organisms were collected 1.25 miles south of Jupiter Inlet, approximately 30 miles south of the St. Lucie site. Both mega and meiofauna were collected. Three species of megafaunal organisms were found on Jupiter beach; the most common was the anomura crab Emerita talpoida, followed by the polychaete Nerine agilis. In addition, one specimen of the intertidal pelecypod, Donax variabilis, was found.

The meiofauna (organisms less than 1 mm in size) was sampled quantitatively. The most abundant organisms were foraminifera, gastropods and harpacticoid copepods, in that order. In addition a few nematodes, ostracods and calanoid copepods were collected. The density of the Jupiter beach meiofauna was calculated, and ranged from 650 to 1770 organisms per m².

Another megafaunal organism, not collected at Jupiter, is known to occur on Hutchinson Island. The ghost crab, Ocypode albicans, is a common inhabitant of sandy beaches and spends most of its life above the high tide line, and is therefore, not strictly intertidal.

2.7.4 INDIAN RIVER ECOLOGY

Ecological surveys of the Indian River adjacent to and including Big Mud Creek were made during 1968, 1969 and 1970 by Dr. James B. Lackey for the Florida Power and Light Company ⁽⁹⁾. The findings show that Indian River supports an enormous biomass of manatee grass (Syringodium filiforme) and several species of macroscopic algae. Turtle grass (Thalassia) was not found. The dominant alga was Gracilaria, but several others are also common, most of which are red algae, although patches of Sphacelaria, a brown alga, were found. This "forest", often up to 10 inches high, contains large numbers of gammarids, shrimp, isopods, small crabs, and juvenile fish. Eggs of various invertebrates are found here, and the branches and leaves of the plants support large numbers of caprellids, bryozoans, very small worms, and very small attached algae. The leaves of manatee grass are a substrate for the attachment of vast quantities of organisms, mostly diatoms (e.g. Licmophora), and also various protozoa (including the colonial ciliate Zoothamnium).

The Indian River affords protection to a great variety of and number of animals, and provides them with an abundance of food, especially the smaller forms which feed on attached diatoms and other plants.

The characteristics of the water, especially salinity and turbidity, vary considerably with time. There is an increase in biomass from the eastern shore to the western shore, and the growth is so thick as to trap and hold free-floating material (e.g. eggs, copepods, protozoa, and invertebrates).

The Indian River supports abundant and diverse plankton which thrive due to a constant raindown of organic matter in the overgrown areas. This organic matter undergoes bacterial decomposition on the bottom and liberates mineral salts which are utilized by the algae. The protozoa, rotifers and copepods, among other organisms, maintain their high population by utilizing the bacteria. All of the plankton algal groups are present in the river except the Coccolithophora and Silicoflagellata. The diversity of species (more than 90) indicates water of no extreme condition, and the large numbers of organisms per unit volume suggest a high nutrient concentration. Gross inspection of the bottom growths in the Indian River indicate that it is a highly productive and balanced biological environment.

The sediment-water interface is also densely populated and hence it is assumed to be an area of intense biochemical activity, although this inference may not be valid for large areas, since only four cores were examined during the surveys. But these contained a large number of organisms of great diversity, and are comparable to cores from other estuaries such as Great South Bay, New York. The same groups were found in the sediment as in the water, and in addition, four species of sulfur bacteria were present. Diatoms and dinoflagellates were less abundant, but colorless euglenids and ciliates were more abundant both in species and in biomass. The interface bacteria appear to decompose much organic matter, which is utilized by the colorless euglenids, and the ciliates in turn eat the bacteria.

The benthic population is large, as shown by Dr. A. Carr in a May 1969 report to the Florida Power and Light Company (9), and contains shellfish, tube dwelling worms, and crustaceans. They either dwell in the mud or in tubes or crawl about in the macroscopic growths or on the bottom. Accordingly, they are hardly susceptible to being displaced and swept along by a moderate current.

Tows in Big Mud Creek and in the channel of the Intracoastal Waterway revealed adult calanoid copepods but very few eggs or larval forms. There appear to be no great numbers of suspended invertebrates, eggs, or juvenile forms of the copepods present in the sections of the river examined.

The only organisms of direct economic importance found thus far in the river in significant numbers have been shrimp and young blue crabs (an occasional fish and a very few conchs are also present). Normally, speckled trout are available for sport fishing, but in May and June of 1970 fishermen were far more abundant in both inlets. Channel bass, speckled trout, and snook are the fish most taken, but drum, sheepshead and mangrove snappers have also been caught. However, none of these were collected during the survey.

2.7.5 ATLANTIC OCEAN

The Atlantic Ocean bounds Hutchinson Island to the east. The sea floor slopes gently to a depth of about 40 feet, a little more than one nautical mile (nmi) offshore, then rises to form Pierce Shoal which is nearly two nmi offshore. Here, minimum water depth is 21 feet (U S Coast and Geodetic Chart 1247). Five nmi east of the plant site is the St. Lucie Shoal, with a minimum depth of 20 feet. Beyond the St. Lucie Shoal, water depths gradually increase with distance offshore and the 120 feet contour occurs approximately 11 nmi offshore of the St. Lucie Plant site.

Most of the environmental and ecological data presented below have been provided by the Florida Department of Natural Resources (FDNR) Marine Research Laboratory. This information has been abstracted from three reports which contain results of the preliminary environmental studies of coastal waters near Hutchinson Island (10, 11, 12). These studies are discussed in detail in Section 6.1 of this report.

1

2.7.5.1 Salinity

Surface and bottom salinities have been measured at five stations offshore of Hutchinson Island (Figure 2.7-2). From September 1971 to November 1972, salinity varied from 33.0 to 38.0 parts per thousand (0/00), with 75 percent of the values between 34.0 and 36.0 0/00. The maximum variation between surface and bottom salinity at any station was 3.0 0/00, as was the maximum difference in salinity between stations in any given sampling period.

In general, salinity was lowest during the fall and winter, increasing to a seasonal maximum during the summer. Table 2.7-5 and Figures 2.7-3 through 2.7-7 show the salinity of Atlantic Ocean water offshore of Hutchinson Island.

These data, in general, agree with those obtained by the U S Coast and Geodetic Survey (13) at Canova Beach, Florida, which is located approximately 50 miles north of Hutchinson Island. There, mean salinity of the Atlantic Ocean peaks in May at 36.6 0/00 and reaches a low of 35.4 0/00 in November. The greater variability in salinity at Hutchinson Island may reflect the proximity of St. Lucie and Fort Pierce Inlets as well as countercurrents and eddies induced by the Gulf Stream.

2.7.5.2 Temperature

Florida Power and Light Company (FP&L) maintains a temperature monitoring station located approximately 2,000 feet offshore of the St. Lucie Plant site. Two thermographs installed at the station monitor surface and bottom (30 ft depth) water temperature.

Two years of water temperature data (December 1970 to November 1972) have been tabulated as five-day average temperatures and are shown in Table 2.7-6. Water temperatures (five-day means) offshore of Hutchinson Island ranged from 66 F to 83 F for the two year period of record. Lowest

temperatures occurred in January, February and March, while highest temperatures were recorded in September and October. Figures 2.7-3 to 2.7-7 show monthly water temperatures recorded at the five stations off-shore of Hutchinson Island.

Anomalous decreases in water temperature occurred both in July and August of 1971 and June, July and August of 1972. Long-term water temperature records from Canova Beach and Daytona Beach, both located north of Hutchinson Island, show similar depressions of summer temperatures. This phenomenon has been explained by the U S Coast and Geodetic Survey as the result of summer upwelling which occurs along this section of Florida's East coast (13). If the upwelling theory is valid, it may explain the high phosphate concentrations measured at all five Hutchinson Island stations in July, 1972, since upwelling normally brings deep, nutrient rich water to the surface.

2.7.5.3 Dissolved Oxygen

Dissolved oxygen (DO) concentrations were measured at the five stations established offshore of Hutchinson Island. Surface and bottom levels of DO were measured monthly from December 1971 to November 1972. These data have been tabulated and are shown in Table 2.7-7 and Figures 2.7-8 to 2.7-12.

In general, DO levels ranged from 5.0 to 7.0 mg/l for the period November 1971 to June 1972. In July, August and September 1972, DO concentrations dropped markedly, and values as low as 3.2 mg/l were recorded. These low DO levels coincide with decreased water temperatures, increased phosphate concentrations and very low phytoplankton density. These phenomena indicate that upwelling occurred during this period of time. During upwelling, the surface waters are displaced by deeper waters, characterized by lower temperature, high nutrient concentrations and often, low levels of dissolved oxygen.

2.7.5.4 Nutrients

From February 1972 to November, monthly surface and bottom water samples taken at five stations offshore of Hutchinson Island were analyzed for the following nutrients: phosphate (PO_4), nitrate (NO_3), nitrite (NO_2), ammonia (NH_3) and silicate (SiO_4).

Phosphate values were quite similar from station to station during any single sampling period, but varied markedly from month to month. Phosphate concentrations ranged from 0.017 to 0.420 mg/l (0.179 to 4.42 mg at $\text{PO}_4\text{-P/m}^3$). Peak phosphate levels occurred during July 1972, when very few phytoplankton were observed. A second peak was recorded in October 1972 and coincided with a fall bloom of phytoplankton.

Concentrations of nitrate ranged from 0.0022 to 0.0748 mg/l (0.036 to 1.206 mg at $\text{NO}_3\text{-N/m}^3$). Nitrate levels between surface and bottom samples taken at the same station were quite variable, and there appears to be no obvious correlation between nitrate levels and phytoplankton numbers.

In general, nitrate levels were low, ranging from zero to 0.0188 mg/l

(zero to 0.408 mg at $\text{NO}_2\text{-N/m}^3$). Lowest values occurred during July 1972 when very few phytoplankton were present. The rather high levels observed in November 1972 (0.0014 to 0.0106 mg/l) may have represented degradation products from the previous month's phytoplankton bloom.

Ammonia concentrations varied by three orders of magnitude, with values of 0.001 to 1.000 mg/l (0.005 to 0.911 mg/l or 0.294 to 53.588 mg at $\text{NH}_3\text{-N/m}^3$). As with the phosphate concentrations, ammonia values were reasonably similar between stations during any sampling period, but fluctuated from month to month. Highest concentrations occurred in February 1972, with much lower levels prevailing thereafter. Lowest values were recorded during July 1972, when phosphate levels peaked and phytoplankton numbers were very low.

The levels of silicate measured offshore of Hutchinson Island varied from 0.072 to 0.900 mg/l (0.78 to 9.88 mg at $\text{SiO}_4\text{-Si/m}^3$). The concentration of silicate was highest in July 1972, when phytoplankton were scarce. The low levels of silicate observed in October 1972 may have reflected the phytoplankton bloom which occurred at that time, as diatoms require silicate for the production of frustules. However, silicate concentrations were quite variable, and correlations between silicate levels, phytoplankton numbers and concentrations of the other nutrients are not apparent.

Tables 2.7-8 to 2.7-12 show levels of the nutrients mentioned above as recorded at Hutchinson Island.

2.7.5.5 Chlorophyll a

Monthly surface and bottom water samples from all stations were analyzed for chlorophyll a from November 1971 to November 1972. Concentrations of this pigment ranged from 0.08 to 7.70 mg/m³. Highest values occurred at Station I (nearest shore) and may reflect an input of terrestrial vegetation to the nearshore waters. Chlorophyll a levels correlated well with the autumn 1972 phytoplankton bloom. It is difficult to interpret the February and May 1972 chlorophyll a peaks as phytoplankton samples were not taken during those months.

Chlorophyll a concentrations measured at the five Hutchinson Island stations are given in Table 2.7-13.

2.7.5.6 Phytoplankton

Phytoplankton collected at five stations offshore of Hutchinson Island were enumerated and identified. Phytoplankton densities ranged from 1.0 to 30,532.9 cells/l for the 45 samples taken from September 1971 to November 1972. In general, phytoplankton densities were relatively similar from station to station during any given sampling period. The greatest variation in cell density occurred in September 1971, when a difference of 10^3 cells/l was recorded between Station I and Station V. (See Table 2.7-14 and Figures 2.7-13 to 2.7-17.)

From the available data, it appears that two blooms occur yearly. The autumn bloom peaks in September-October, and a winter bloom occurred in January 1972.

Very few phytoplankton were collected in November 1971 and during March-September 1972. Lowest cell densities occurred in July 1972, when fewer than 20 cells/l were obtained.

Phytoplankton cell density correlates very poorly with nutrient levels. Highest phosphate values occurred in July when cell counts were lowest, but the October 1972 bloom coincided with high phosphate concentrations. Similarly, comparison of phytoplankton densities with levels of nitrate, nitrite, ammonia and silicate showed no apparent correlations, positive or negative.

Chlorophyll a concentrations in surface water samples showed a reasonable, positive correlation with phytoplankton cell counts, as would be expected.

In general, the phytoplankton collected at Hutchinson Island were numerically dominated by diatoms, although five samples contained more than 50 percent dinoflagellates and/or blue green algae (Oscillatoriaceae).

Although many species of diatoms and dinoflagellates, as well as a few blue-green algae, were identified, the most important members of the planktonic flora, in terms of number and frequency of appearance, were the following diatoms:

Nitzschia spp.
Bellerochea sp. "A"
Chaetoceros spp.
Thalassionema nitzschioides
Skeletonema costatum

Various species of Nitzschia were present in large numbers during all nine sampling periods, while Chaetoceros spp. and Bellerochea sp. "A" were numerous during seven sampling periods. Bellerochea sp. "A" was not plentiful in the January and March 1972 collections, and may be inhibited by low temperatures. Thalassionema nitzschioides was very abundant during six of the sampling periods, and Skeletonema costatum was present in large numbers on five of the collection days.

In November 1971, Station III was dominated by blue-green algae, as was Station I of the following November. During July 1972, a period of very low phytoplankton density, dinoflagellates (primarily Ceratium spp.) formed more than 50 percent of the flora at Stations III, IV and V and more than 10 percent of the phytoplankton collected at Stations I and II.

2.7.5.7 Zooplankton

Zooplankton were collected every other month at the five stations offshore of Hutchinson Island. Data are available from September 1971 to July 1972. Total zooplankton ranged from 244 to 12,023 organisms/m³ and copepods varied in number from 82 to 10,930 per m³ (see Table 12.7-15). Copepod numbers and total zooplankton counts correlate well, and zooplankton density appears broadly correlated with phytoplankton cell counts.

Station I yielded fewest zooplankton, while the greatest numbers were found at Station III. Zooplankton were least abundant in November 1971, peaked in January 1972, and remained relatively constant until July of the same year, when their numbers declined. These data are shown graphically in Figures 2.7-18 through 2.7-22.

Copepods of the genera Acartia, Paracalamis, Oithona, Temora, Undinula, Corycaeus, Euterpina and Labidocera were frequently collected in large numbers, as were the larvacean Oikopleura and various larval forms of both invertebrates and vertebrates.

2.7.5.8 Benthic Fauna

An analysis of the benthic fauna data indicates that the diversity of taxa found at Stations II, IV and V were similar throughout the sampling period, while Station III had a somewhat less diverse fauna. Data from Station I seems to indicate a paucity of fauna both qualitatively and quantitatively.

In terms of numbers of organisms per square meter, Station IV appears to be the most productive followed by Station V and II, respectively. Station III appears comparable to II, IV and V quantitatively although the diversity is lower. Station I again rates considerably lower than the others. These data are shown graphically in Figure 2.7-23.

The most obvious factor which might be responsible for this distribution is sediment size. It has been suggested by many investigators that benthic organisms show a marked preference for different substrates. From the data provided, it is evident that Stations II, IV and V are quite similar in substrate, having a mixed sand-shell fragment composition. The size range is fairly coarse. Station III has a more intermediate sized sediment while the particular sizes at Station I are quite fine.

In the analysis of data it was observed that polychaetes and echinoderms were not counted after January 1972. Gastropods were only counted in September 1971. For this reason data were compared both with and without consideration of these groups. Generally the observed trends were not greatly affected.

It should be noted that polychaetes were quite numerous at Stations II, IV and V but were found in comparatively low numbers at III and I. Station III is comparable in population density to II, IV and V if polychaetes are not included. Initially, (Sept. 71- Jan. 72) Station III had considerably fewer bivalves than Stations II, IV and V; however, in March through July their densities were very comparable, reaching a peak in March 1972.

Echinoderms and decapods were found in highest numbers at Station I (Nov. 71 and May 72 respectively). In contrast, lancelets were never found at Station I. Amphipods reached their highest numbers at Station IV in Jan. 1972.

Peak density of benthic invertebrates was noted in January 1972 for Stations IV and V, November 1971 for Station II and March 1972 for Station III. Station I had a peak density in May due to an unusually high number

of bivalves in the samples. This was also reflected in the number of species obtained.

The total number of species found at the stations are shown below by group.

	I	II	III	IV	V
Annelids	14	32	15	33	32
Molluscs	7	46	15	51	29
Amphipods	3	10	4	9	8
Isopods		2	2		1
Decapods	5	7	3	10	15
Stomatopods				1	
Echinoderms	2	2	1	6	5
Lancelets		1	1	1	1
Total	31	100	41	111	91

The greatest diversity occurred at Stations IV, II and V respectively while the diversity at Stations I and III was significantly lower.

Comparison of the data for temperature, salinity and nutrients with that for benthic abundance and species variation show no relationship.

As mentioned previously, substrate type would appear to be the principal factor involved. Seasonal variations at each station in the numbers of organisms present may well be due to life habits of individuals.

2.7.5.9 Fishes

Fish populations in the area offshore of Hutchinson Island have not been rigorously examined from either a qualitative or quantitative standpoint. The available data are sparse and most records deal with species of economic importance. Springer (14) investigated the fish of the lower St. Lucie and Indian Rivers, but confined his sampling to waters west of Hutchinson Island. Gunter and Hall (15) also sampled the ichthyofauna of the St. Lucie River, but confined their studies to the area inland of Sewall Point.

Few fish have been collected at the five Hutchinson Island offshore stations. A single 15 minute tow with a 12 ft balloon trawl was made at each station every other month from September 1971 to March 1972. A total of 39 fish were collected using this technique. Table 2.7-16 shows the numbers and species of fish caught, by station.

Seines 50 feet in length were used to collect fishes at the three beach stations established on Hutchinson Island. A total of 11,598 fish were captured from October 1971 to March 1972, 11,407 of them in November 1971 collection. The great majority of these (11,241 of 11,407) consisted of various species of anchovy (Engraulidae). The numbers and species of fish collected by seining are given in Table 2.7-17.

Fish, such as ladyfish (Elops saurus, (16), snook (Centropomus undecimalis (17) and the various species of billfish, are taken primarily by sport fishermen. As stated in Ref 18, St. Lucie County is the northernmost county on Florida's east coast with an extensive winter sports fishery. While the value of this fishery has not been determined, it presumably forms a significant portion of the income St. Lucie County derives from its tidal waters.

Three species of fish, king mackerel, Spanish mackerel, and bluefish, are discussed below. These fish were chosen for detailed discussion because they are found in the ocean offshore of Hutchinson Island and because they form an important constituent of the St. Lucie County fin fishery.

The Spanish mackerels (genus Scomberomorus) form the nucleus of the St. Lucie County fin fishery. A number of scientists have studied this group of fish and as a result, it is reasonably well-known. Klima (19) investigated both the biology and fishery for Spanish mackerel (Scomberomorus maculatus) in southern Florida. Generally, this fish is abundant in Florida waters from October through February or March. In southeastern Florida, the Spanish mackerel spawns in coastal waters from August to December. This fish moves north in the spring, and is found as far north as the Gulf of Maine (where it is sparse and rare). Spanish mackerel remain in the north until September, when they move south. Klima gives the distribution of the genus Scomberomorus throughout the world as encompassed by the 68 F isotherm. Information from local fisherman in St. Lucie County indicates that Spanish mackerel migrate close to shore, as most of the commercial catch is netted within a mile or so of the shoreline. In southeastern Florida, the Spanish mackerel spawns in coastal waters from August to December, but eggs and larvae of this species have not been reported offshore of Hutchinson Island.

Beaumariage (20) has synopsized much of the literature dealing with the Spanish and king mackerels. His data show that Spanish mackerel from the east coast of Florida are essentially spawned out by the end of September. King mackerel (Scomberomorus cavalla) which occur in the same area spawn later in the year, beginning in September and ending in October. Larvae (3-7 mm total length) of both Spanish and king mackerel were captured in plankton tows made off Cape Kennedy during September. The small size of the larvae indicates that the eggs from which they were hatched were spawned near the point where the collection was made, offshore of Cape Kennedy.

Wollam (21) has investigated the distribution of larval and juvenile forms of king and Spanish mackerel in the western north Atlantic. Although most of the specimens he examined were captured in the Gulf of Mexico (including all the Spanish mackerel), 22 king mackerel were obtained during September from stations located about 70 miles east-northeast of Cape Kennedy. Wollam believes that the southern portion of the range of the king mackerel is not an important spawning area, due to the paucity of larvae and juveniles which have been collected there. He also states that the larvae which have been observed are the result of spawning of resident (non-migratory) fish.

In an effort to determine the migratory patterns of king mackerel, Moe (22) tagged 128 king mackerel offshore of Jupiter Inlet in 25-30 fathoms of water (26° 56' N, 79° 58' W). No tags were returned. King mackerel apparently migrate north farther offshore than do Spanish mackerel. In St. Lucie County, most king mackerel are caught eight to ten miles from shore.

The bluefish, Pomatomus saltatrix, is found on the east coast of North America from Cape Florida to Nova Scotia. It is a pelagic fish, and migrates to the north as the water temperature increases in the spring and early summer. Data obtained from a tagging program (23) show that bluefish on the east coast of Florida migrate to the north during the months of February through April. During this period of northward travel, bluefish remain near the coast of southern Florida. Commercial fishermen from St. Lucie County net much of the commercial catch within one mile of shore.

Bluefish spawn off the east coast of Florida in depths of 60 to 300 feet. Mr. D. Deul of the National Marine Fisheries Service Narragansett Laboratory has collected ripe bluefish off south Florida in the spring, but doubts that this fish spawns south of Cape Kennedy (personal communication).

Landings of commercial fishes in St. Lucie County are dominated by migratory pelagic fish, such as the bluefish (Pomatomus saltatrix) Spanish mackerel (Scomberomorus maculatus) and king mackerel (Scomberomorus cavalla). In 1971, (24) landings in St. Lucie County yielded 3,072,838 lb of finfish worth \$682,997. Bluefish, Spanish mackerel and king mackerel formed 69.1 percent of the total St. Lucie landings, with a \$493,310 value at dockside (72.2 percent of total value of St. Lucie finfish landings). The 1971 St. Lucie finfish landings formed 4.9 percent of total Florida finfish landings. Table 2.7-18 shows St. Lucie County landings (1971) for bluefish, Spanish mackerel and king mackerel as a percentage of total Florida landings for these fish.

St. Lucie County commercial fishery landing data for the seven most important species (bluefish, groupers, king mackerel, black mullet, spotted sea trout, Spanish mackerel and spot) are given for the period 1970 to 1972 in Table 2.7-19. This information, tabulated as pounds per month for each of the above species, is shown in the attached tables. The seven species enumerated form approximately 90 percent of the annual St. Lucie County landings, by weight.

According to local sources, approximately 60 to 65 commercial fishing boats are based in Fort Pierce. Most of the boats are small, 24 to 26 feet long, and usually have a crew of two or three men.

At the present time, three charter boats and one party boat sail from Fort Pierce. The charter boats carry six fishermen and the party boat about 50. One or two more charter boats work out of Fort Pierce during the winter, as does one additional party boat. As of 1972 approximately 1800 pleasure craft were registered in St. Lucie County, according to the office of St. Lucie tax collector.

The precise location of the fishing grounds is not available. However, net fishermen usually work within one mile of shore when fishing for bluefish and Spanish mackerel. King mackerel groupers and snapper are caught with hook and line, usually eight to ten miles offshore. Mr. D. Deuel, of the Narragansett Laboratory of the National Marine Fisheries Service, has stated that most of the winter king mackerel are caught near the 90 foot contour, in the vicinity of Jupiter Inlet and Hobe Sound, south of Hutchinson Island.

None of the fishes collected from the Indian River or offshore of Hutchinson Island are included in the 1973 edition of "Threatened Wildlife of the United States," compiled by the Bureau of Sports Fisheries and Wildlife, Department of the Interior (Resource Publication 114, March 1973).

TABLE 2.7-1

LOCAL PLANTS

I. Dune Ridge Plants:

1. Situated on the foreshore slope of the dune

Uniola paniculata -- sea oats

Ipomoea pes-caprae -- beach morning-glory

Iva imbricata -- marsh elder

Spartina patens -- cordgrass

2. Situated on the upper slopes, top and back

Suriana maritima -- bay cedar

Yucca spp -- Spanish bayonet

Coccoloba uvifera -- sea grape

Opuntia spp -- prickly pear cactus

Sesuvium portulacastrum -- sea purslane

Helianthus debilis -- sand sunflower

Canavalia obtusifolia -- dune pea vine

Casuarina spp -- Australian pine

II. Mangroves and Mangrove Border Plants:

Avicennia nitida - black mangrove

Laguncularia racemosa - white mangrove

Rhizophora mangle - red mangrove

Batis maritima - saltwort

Baccharis halimifolia - sand myrtle

Schinus terebinthifolius - Brazilian pepper tree

Casuarina spp - Australian pine

Ficus aurea - native fig

Distichlis spicata - salt grass

Notable is the ABSENCE of buttonwood trees (Conocarpus) and many sedges and rushes, such as Juncus and Spartina

TABLE 2.7-1 - continued

III. Upland, Coastal Hammock Forest (partial list):

Sabal palmetto - cabbage palm
Quercus virginiana - live oak
Persea spp - red bay
Casuarina - Australian pine
Morus rubra - red mulberry
Baccharis spp - sand myrtle
Serenoa repens - saw palmetto
Rapanea guyanensis - Rapanea
Icacorca paniculata - marl berry
Zanthoxylon clava-hercules - Hercules club
Rhus copallina - sumach
Rhus toxicodendron - poison ivy
Eugenia spp - stopperwoods

TABLE 2.7-2

NATIVE MAMMALS OF HUTCHINSON ISLAND AND SURROUNDING AREAS
(Abundance proportional to number of "X's")

<u>Species</u>	<u>Abundance & Location</u>		
	<u>Hutch.</u> <u>Island</u>	<u>Indian</u> <u>River</u>	<u>Main-</u> <u>land</u>
Virginia opossum (<u>Didelphis virginiana</u>)	XXX		XXX
Short-tailed shrew (<u>Blarina brevicauda</u>)	X		X
Least shrew (<u>Cryptotis parva</u>)	X		X
Eastern mole (<u>Scalopus aquaticus</u>)	XX		XX
Mississippi myotis (<u>Myotis austroriparius</u>)	XX	XX	XX
Big brown bat (<u>Eptesicus fuscus</u>)	XX	XX	XX
Yellow bat (<u>Dasypus floridanus</u>)	X	X	X
Evening bat (<u>Nycticeus humeralis</u>)	X	X	X
Florida freetail bat (<u>Tadarida cynocephala</u>)	X	X	X
Armadillo (<u>Dasypus novemcinctus</u>)			XX
Cottontail rabbit (<u>Sylvilagus floridanus</u>)			XX
Marsh rabbit (<u>Sylvilagus palustris</u>)	XX		X
Gray squirrel (<u>Sciurus carolinensis</u>)	X		X
Fox squirrel (<u>Sciurus niger</u>)			X
Flying squirrel (<u>Glaucomys volans</u>)			X
Pocket gopher (<u>Geomys pinetus</u>)			X
Rice rat (<u>Oryzomys palustris</u>)	X		X
Beach mouse (<u>Peromyscus polionotus</u>)	XXX		XX
Pine mouse (<u>Peromyscus gossypinus</u>)	XX		XXX
Cotton rat (<u>Sigmodon hispidus</u>)	XX		XX
Wood rat (<u>Neotoma floridana</u>)	X		X
Roof rat (<u>Rattus norvegicus</u>)			X
Brown rat (<u>Rattus rattus</u>)	X		X
Porpoise (<u>Stenella frontalis</u>)		X	
Gray fox (<u>Urocyon cinereoargenteus</u>)	X		X
Black bear (<u>Ursus americanus</u>)			X
Raccoon (<u>Procyon lotor</u>)	XXX		XXX
Mink (<u>Mustela frenata</u>)	X		X
Spotted skunk (<u>Spilogale ambarvalis</u>)	X		X
Striped skunk (<u>Mephitis mephitis</u>)			X
River otter (<u>Lutra canadensis</u>)	X	X	X
Panther (<u>Felis concolor</u>)			X
Bobcat (<u>Lynx rufus</u>)	X		X
Manatee (<u>Trichechus manatus</u>)		X	
White-tailed deer (<u>Odocoileus virginianus</u>)	X		XX

The following mammals are classed as "rare or endangered":

Florida manatee, Trichechus manatus latirostris (Harlan)
Florida panther, Felis concolor coryi (Bangs)

One mammal is listed with status (undetermined):

Florida water rat, Neofiber alleni (probably nigrescens A. H. Howell)

TABLE 2.7-3

LOCAL BIRD SPECIES

Below is a list of bird species that inhabit Hutchinson Island and adjacent land areas, with abundance proportional to the number of "X" marks given. Seasonal use of the area is indicated as follows:

W = Winter
 Sp = Spring
 Su = Summer
 F = Fall

Status is given by:

M = Migrant
 P = Permanent

<u>Species</u>	<u>Abundance</u>	<u>Seasonal Occurrence</u>	<u>Status</u>
Common loon (<u>Gavia immer</u>)	X	W	
Horned grebe (<u>Podiceps auritus</u>)	X	W	
Pied-billed grebe (<u>Podilymbus podiceps</u>)	X	W, Sp	
White pelican (<u>Pelecanus erythrorhynchos</u>)	XX	W	
Brown pelican (<u>Pelecanus occidentalis</u>)	XXX		P
Gannet (<u>Morus bassanus</u>)	X	W	
Double-crested cormorant (<u>Phalacrocorax auritus</u>)	XXX		P
Anhinga (<u>Anhinga anhinga</u>)	XX		P
Magnificent frigatebird (<u>Fregata magnificens</u>)	X		P
Great white heron (<u>Ardea occidentalis</u>)	X	Sp, Su	
Great blue heron (<u>Ardea herodias</u>)	XXX		P
Green heron (<u>Butorides virescens</u>)	X		P
Little blue heron (<u>Florida caerulea</u>)	XX		P
Cattle egret (<u>Bubulcus ibis</u>)	XXXX		P
Common egret (<u>Casmerodius albus</u>)	XXXX		P
Snowy egret (<u>Leucophoyx thula</u>)	XXX		P
Louisiana heron (<u>Hydranassa tricolor</u>)	XX		P
Black-crowned night heron (<u>Nycticorax nycticorax</u>)	X		P
Yellow-crowned night heron (<u>Nyctanassa violacea</u>)	X		P
Least bittern (<u>Ixobrychus exilis</u>)	X		P
Wood ibis (<u>Mycteria americana</u>)	XX		P
Glossy ibis (<u>Plegadis falcinellus</u>)	X		P
White ibis (<u>Eudocimus albus</u>)	XX		P
Pintail (<u>Anas acuta</u>)	X	W	
Mottled duck (<u>Anas fulvigula</u>)	X		P
Green-winged teal (<u>Anas carolinensis</u>)	X	W	
Blue-winged teal (<u>Anas discors</u>)	XXX	W	

TABLE 2.7-3 (Cont'd)

Species	Abundance	Seasonal Occurrence	Status
American widgeon (<u>Mareca americana</u>)	X	W	
Shoveller (<u>Spatula clypeata</u>)	X	W	
Wood duck (<u>Aix sponsa</u>)	X		P
Ringed-necked duck (<u>Aythya collaris</u>)	X	W	
Lesser scaup (<u>Aythya affinis</u>)	XX	W	
Hooded merganser (<u>Lophodytes cucullatus</u>)	X	W	
Red-breasted merganser (<u>Mergus serrator</u>)	XXX	W	
Turkey vulture (<u>Cathartes aura</u>)	XXX		P
Black vulture (<u>Coragyps atratus</u>)	XX		P
Swallow-tailed kite (<u>Elanoides forficatus</u>)	X		P
Cooper's hawk (<u>Accipiter cooperii</u>)	X		P
Red-tailed hawk (<u>Buteo jamaicensis</u>)	X		P
Red-shouldered hawk (<u>Buteo lineatus</u>)	X		P
Bald eagle (<u>Haliaeetus leucocephalus</u>)	X	W, Sp, F	
Marsh hawk (<u>Circus cyaneus</u>)	X		P
Osprey (<u>Pandion haliaetus</u>)	XXX		P
Peregrine falcon (<u>Falco peregrinus</u>)	X	W	
Pigeon hawk (<u>Falco columbarius</u>)	X	W	
Sparrow hawk (<u>Falco sparverius</u>)	XXX		P
Bobwhite (<u>Colinus virginianus</u>)	XXX		P
Clapper rail (<u>Rallus longirostris</u>)	X		P
Purple gallinule (<u>Porphyryula martinica</u>)	X		P
Common gallinule (<u>Gallinula chloropus</u>)	XX		P
American coot (<u>Fulica americana</u>)	XXXX	W	
Semipalmated plover (<u>Charadrius semipalmatus</u>)	X	W	
Piping plover (<u>Charadrius melodus</u>)	X	W	
Killdeer (<u>Charadrius vociferus</u>)	XX		P
Black-bellied plover (<u>Squatarola squatarola</u>)	XXX	W	
Ruddy turnstone (<u>Arenaria interpres</u>)	XX	W	
American woodcock (<u>Philohela minor</u>)	X	W	
Common snipe (<u>Capella gallinago</u>)	X	W	
Spotted sandpiper (<u>Actitis macularia</u>)	X		M
Willet (<u>Catoptrophorus semipalmatus</u>)	XX	Sp, Su, F	
Greater yellowlegs (<u>Totanus melanoleucus</u>)	X	W	
Lesser yellowlegs (<u>Totanus flavipes</u>)	X	W	
Least sandpiper (<u>Erolia minutilla</u>)	X	F, W, Sp	
Dunlin (<u>Erolia alpina</u>)	XX	W	
Short-billed dowitcher (<u>Limnodronus griseus</u>)	XXX	W	
Semipalmated sandpiper (<u>Ereunetes pusilus</u>)	X	W, Sp	
Western sandpiper (<u>Ereunetes mauri</u>)	X	W	
Sanderling (<u>Crocethia alba</u>)	XXX	W	
Avocet (<u>Recurvirostra americana</u>)	X		M
Great black-backed gull (<u>Larus marinus</u>)	X	W	
Herring gull (<u>Larus argentatus</u>)	XX	W, Sp, F	
Ring-billed gull (<u>Larus delawarensis</u>)	XXXX	W	
Laughing gull (<u>Larus atricilla</u>)	XXX		P
Bonaparte's gull (<u>Larus philadelphia</u>)	XX	W	

TABLE 2.7-3 (Cont'd)

Species	Abundance	Seasonal Occurrence	Status
Forster's tern (<u>Sterna forsteri</u>)	X		M
Common tern (<u>Sterna hirundo</u>)	X		M
Royal tern (<u>Thalasseus maximus</u>)	XXX		P
Sandwich tern (<u>Thalasseus sandvicensis</u>)	XX		P
Caspian tern (<u>Hydroprogne caspia</u>)	XX	W	
Black skimmer (<u>Rynchops nigra</u>)	XXX		P
Mourning dove (<u>Zenaidura macroura</u>)	XXX		P
Ground dove (<u>Columbigallina passerina</u>)	XX		P
Yellow-billed cuckoo (<u>Coccyzus americanus</u>)	XX	Su	
Smooth-billed ani (<u>Crotophaga ani</u>)	XX		P
Barn owl (<u>Tyto alba</u>)	X		P
Screech owl (<u>Otus asio</u>)	X		P
Great-horned owl (<u>Bubo virginianus</u>)	X		P
Barred owl (<u>Strix varia</u>)	X		P
Chuck-wills widow (<u>Caprimulgus carolinensis</u>)	X	Su	
Common nighthawk (<u>Chordeiles minor</u>)	XX	Su	
Ruby-throated hummingbird (<u>Archilochus colubris</u>)	X	Su	
Belted kingfisher (<u>Megaceryle alcyon</u>)	XXX		P
Yellow-shafted flicker (<u>Colaptes auratus</u>)	XX		P
Pileated woodpecker (<u>Dryocopus pileatus</u>)	X		P
Red-bellied woodpecker (<u>Centurus carolinus</u>)	XX		P
Red-headed woodpecker (<u>Melanerpes erythrocephalus</u>)	X		P
Yellow-bellied sapsucker (<u>Sphyrapicus varius</u>)	X	W	M
Downy woodpecker (<u>Dendrocopos pubescens</u>)	X		P
Eastern kingbird (<u>Tyrannus tyrannus</u>)	XX	Su	
Great crested flycatcher (<u>Myriarchus crinitus</u>)	XX	Su	
Eastern phoebe (<u>Sayornis phoebe</u>)	X	W	
Tree swallow (<u>Iridoprocne bicolor</u>)	XXXXX	W	M
Purple martin (<u>Progne subis</u>)	XX	Su	
Blue jay (<u>Cyanocitta cristata</u>)	XX		P
Scrub jay (<u>Aphelocoma coerulescens</u>)	X		P
Common crow (<u>Corvus brachyrhynchos</u>)	X		P
Fish crow (<u>Corvus ossifragus</u>)	XXXXX		P
House wren (<u>Troglodytes aedon</u>)	X	W	
Carolina wren (<u>Thryothorus ludovicianus</u>)	X		P
Long-billed marsh wren (<u>Telmatodytes palustris</u>)	X	W	
Mockingbird (<u>Mimus polyglottos</u>)	XXX		P
Catbird (<u>Dumetella carolinensis</u>)	XX	W	M
Brown thrasher (<u>Toxostoma rufum</u>)	X		P
Robin (<u>Turdus migratorius</u>)	XXXXX	W	
Hermit trush (<u>Hylocichla guttata</u>)	X	W	
Eastern bluebird (<u>Sialia sialis</u>)	X		P
Blue-gray gnatcatcher (<u>Polioptila caerulea</u>)	XX	Su	
Ruby-crowned kinglet (<u>Regulus calendula</u>)	X	W	

TABLE 2.7-3 (Cont'd)

Species	Abundance	Seasonal Occurrence	Status
Cedar waxwing (<u>Bombycilla cedrorum</u>)	XXX	W	M
Loggerhead shrike (<u>Lanius ludovicianus</u>)	XX		P
Starling (<u>Sturnus vulgaris</u>)	XX		P
White-eyed vireo (<u>Vireo griseus</u>)	X	Su	
Solitary vireo (<u>Vireo solitarius</u>)	X	W	
Black and white warbler (<u>Mniotilta varia</u>)	X		M
Worm-eating warbler (<u>Helminthos vermivorus</u>)	X		M
Orange-crowned warbler (<u>Vermivora celata</u>)	X	W	
Myrtle warbler (<u>Dendroica coronata</u>)	XXX	W	M
Parula warbler (<u>Parula americana</u>)	X		M
Yellow warbler (<u>Dendroica petechia</u>)	X		M
Yellow-throated warbler (<u>Dendroica dominica</u>)	X	Su	
Pine warbler (<u>Dendroica pinus</u>)	X		P
Prairie warbler (<u>Dendroica discolor</u>)	XXX	W	M
Ovenbird (<u>Seiurus aurocapillus</u>)	X	W	M
Northern waterthrush (<u>Seiurus noveboracensis</u>)	X		M
Yellowthroat (<u>Geothlypis trichas</u>)	XX		P
American redstart (<u>Setophaga ruticilla</u>)	XX		M
House sparrow (<u>Passer domesticus</u>)	XXX		P
Eastern meadowlark (<u>Sturnella magna</u>)	XX		P
Red-winged blackbird (<u>Agelaius phoeniceus</u>)	XXXX		P
Baltimore oriole (<u>Icterus galbula</u>)	X		M
Rusty blackbird (<u>Euphagus carolinus</u>)	XX	W	
Boat-tailed grackle (<u>Cassidix mexicanus</u>)	XXXX		P
Common grackle (<u>Quiscalus quisculas</u>)	XXX		P
Brown-headed cowbird (<u>Molothrus ater</u>)	XX		M
Summer tanager (<u>Piranga rubra</u>)	XX	Su	
Cardinal (<u>Richmondia cardinalis</u>)	XXX		P
Indigo bunting (<u>Passerina cyanea</u>)	X		M
Painted bunting (<u>Passerina ciris</u>)	XX		M
American goldfinch (<u>Spinus tristis</u>)	XXX	W	
Rufous-sided towhee (<u>Pipilo erythrophthalmus</u>)	XX		P
Savannah sparrow (<u>Passerculus sandwichensis</u>)	XX	W	
Sharp-tailed sparrow (<u>Ammospiza caudacuta</u>)	X	W	
Seaside sparrow (<u>Ammospiza maritima</u>)	X		P
Chipping sparrow (<u>Spizella passerina</u>)	X	W	
Field sparrow (<u>Spizella pusilla</u>)	X	W	
White-throated sparrow (<u>Zonotrichia albicollis</u>)	X	W	
Swamp sparrow (<u>Melospiza georgiana</u>)	X	W	M
Song sparrow (<u>Melospiza melodia</u>)	X	W	

TABLE 2.7-4

RARE OR ENDANGERED SPECIES OF BIRDS

Several species of birds classified as "Rare or Endangered" by the U S Bureau of Sport Fisheries and Wildlife (1968) may occasionally occur in the region of Hutchinson Island. These include the following:

Florida great white heron, Ardea o. occidentalis (Audubon)

This bird breeds primarily in southern Florida but may occasionally wander northward through the Hutchinson Island area.

Short-tailed hawk, Buteo brachyurus (Viellot)

This species is more likely to occur inland but it could also occur in the Hutchinson Island area. It breeds throughout peninsular Florida, being more common in deep cypress swamps.

Southern bald eagle, Haliaeetus leucocephalus (Linnaeus)

Eagles doubtless occur everywhere along the Indian River, never with any great abundance; they all migrate northward out of the state during the summer months.

American peregrine falcon, Falco peregrinus anatum (Bonaparte)

Peregrine falcons (also known as duck hawks) are classified as rare migrants along the Atlantic Coastal islands bordering the eastern coast of Florida; some writers list this species as a regular winter resident; this species is likely to occur on Hutchinson Island itself.

TABLE 2.7-5

OCEAN WATER SALINITY OFFSHORE
OF HUTCHINSON ISLAND, parts per thousand

<u>DATE</u>		<u>STATION</u>				
		I	II	III	IV	V
Sept 1971	S*	34.0	36.0	36.0	36.0	35.5
	B**	34.0	36.5	36.0	36.0	35.0
Nov 1971	S	33.0	34.0	35.0	36.0	36.2
	B	34.0	34.5	35.0	35.8	36.0
Dec 1971	S	35.0	34.0	34.0	33.9	35.0
	B	35.0	34.5	34.0	34.0	35.0
Jan 1972	S	35.0	35.0	34.5	34.0	34.5
	B	35.0	34.0	34.0	33.0	34.0
Feb 1972	S	34.0	34.0	34.0	34.0	34.0
	B	34.0	34.0	34.0	35.0	36.0
Mar 1972	S	35.0	35.0	35.5	36.0	34.0
	B	36.0	38.0	37.0	36.0	35.0
Apr 1972	S	36.0	35.5	36.0	36.0	36.0
	B	36.0	36.0	35.5	36.0	36.0
May 1972	S	37.0	38.0	35.0	35.0	36.0
	B	37.0	38.0	35.0	35.0	36.0
Jun 1972	S	36.0	36.0	36.0	36.0	36.0
	B	37.0	37.0	37.0	37.0	37.0
5 Jul 1972	S	35.0	36.0	37.0	38.0	38.0
	B	38.0	37.0	37.0	38.0	37.0
18 Jul 1972	S	36.0	36.0	37.0	38.0	36.0
	B	35.0	38.0	38.0	38.0	36.0
Aug 1972	S	35.0	35.0	35.5	35.5	36.0
	B	36.0	36.0	36.5	36.5	36.0
Sept 1972	S	36.0	33.0	35.0	35.0	35.0
	B	37.0	36.0	36.0	35.0	36.0
Oct 1972	S	35.5	35.5	36.0	35.5	35.5
	B	36.5	36.5	36.5	36.5	36.5
Nov 1972	S	35.0	34.0	34.0	34.0	35.0
	B	35.0	34.0	34.0	34.0	35.0

* S= Surface Sample

** B= Bottom Sample

TABLE 2.7-6

OCEAN WATER TEMPERATURES OFFSHORE OF HUTCHINSON ISLAND
FIVE-DAY MEANS F

<u>Month</u>	<u>Day</u>	<u>Mean Temperature</u>	
		<u>Surface</u>	<u>Bottom</u>
Dec 1970	1-5	76	75
	6-10	74	73
	11-15	74	74
	16-20	73	74
	21-25	73	74
	26-31	69	70
Jan 1971	1-5	69	69
	6-10	72	72
	11-15	73	73
	16-20	68	71
	21-25	66	64
	26-31	68	68
Feb 1971	1-5	71	69
	6-10	67	69
	11-15	69	66
	16-20	72	71
	21-25	74	73
	26-28	74	73
Mar 1971	1-5	66	66
	6-10	68	67
	11-15	73	71
	16-20	-	70
	21-25	-	70
	26-31	-	70
Apr 1971	1-5	-	69
	6-10	69	69
	11-15	71	70
	16-20	73	73
	21-25	73	73
	26-30	73	73
May 1971	1-5	74	74
	6-10	75	75
	11-15	73	73
	16-20	74	71
	21-25	76	74
	26-31	76	75

TABLE 2.7-6 (cont'd)

<u>Month</u>	<u>Day</u>	<u>Mean Temperature</u>	
		<u>Surface</u>	<u>Bottom</u>
June 1971	1-5	78	77
	6-10	80	79
	11-15	80	79
	16-20	80	79
	21-25	80	79
	26-30	78	75
Jul 1971	1-5	78	77
	6-10	83	81
	11-15	81	77
	16-20	78	76
	21-25	80	78
	26-31	79	77
Aug 1971	1-5	78	75
	6-10	78	75
	11-15	79	78
	16-20	75	73
	21-25	77	74
	26-31	81	81
Sept 1971	1-5	83	82
	6-10	82	82
	11-15	81	82
	16-20	82	82
	21-25	83	83
	26-30	82	82
Oct 1971	1-5	83	82
	6-10	82	83
	11-15	81	82
	16-20	81	81
	21-25	81	80
	26-31	80	80
Nov 1971	1-5	79	-
	6-10	78	-
	11-15	74	-
	16-20	76	-
	21-25	74	-
	26-30	74	-
Dec 1971	1-5	74	73
	6-10	73	74
	11-15	75	76
	16-20	73	75
	21-25	72	73
	26-31	74	75

TABLE 2.7-6 (cont'd)

<u>Month</u>	<u>Day</u>	<u>Mean Temperature</u>	
		<u>Surface</u>	<u>Bottom</u>
Jan 1972	1-5	75	76
	6-10	74	75
	11-15	74	76
	16-20	71	71
	21-25	74	73
	26-31	76	75
Feb 1972	1-5	74	74
	6-10	69	70
	11-15	71	69
	16-20	72	-
	21-25	65	-
	26-29	72	-
Mar 1972	1-5	70	-
	6-10	71	-
	11-15	69	-
	16-20	75	76
	21-25	75	75
	26-31	75	74
Apr 1972	1-5	74	73
	6-10	74	73
	11-15	73	74
	16-20	70	67
	21-25	74	73
	26-30	73	73
May 1972	1-5	74	74
	6-10	77	77
	11-15	77	76
	16-20	78	78
	21-25	78	78
	26-31	80	80
June 1972	1-5	80	80
	6-10	81	80
	11-15	80	80
	16-20	80	80
	21-25	73	70
	26-30	76	74

TABLE 2.7-6 (cont'd)

<u>Month</u>	<u>Day</u>	<u>Mean Temperature</u>	
		<u>Surface</u>	<u>Bottom</u>
Jul 1972	1-5	78	75
	6-10	79	76
	11-15	81	79
	16-20	82	81
	21-25	83	81
	26-31	78	73
Aug 1972	1-5	82	82
	6-10	78	77
	11-15	77	78
	16-20	82	82
	21-25	82	81
	26-31	83	82
Sep 1972	1-5	82	82
	6-10	83	84
	11-15	83	83
	16-20	84	83
	21-25	83	84
	26-30	83	83
Oct 1972	1-5	83	83
	6-10	81	80
	11-15	80	79
	16-20	80	80
	21-25	78	77
	26-31	80	79
Nov 1972	1-5	80	80
	6-10	80	80
	11-15	79	79
	16-20	76	77
	21-25	74	74
	26-30	72	73

TABLE 2.7-7

DISSOLVED OXYGEN CONCENTRATIONS OFFSHORE OF
HUTCHINSON ISLAND, mg/l

DATE		STATION NUMBERS				
		I	II	III	IV	V
Sept 1971	S*	5.9	5.3	6.6	7.3	5.7
	B**	5.7	5.9	5.8	6.8	6.4
Dec 1971	S	6.9	6.9	6.5	6.8	6.9
	B	6.9	6.7	6.7	6.7	6.3
Jan 1972	S	6.5	7.2	6.2	6.2	6.2
	B	6.5	6.9	6.3	6.5	-
Feb 1972	S	5.4	5.9	5.3	4.1	5.7
	B	6.6	5.9	6.8	6.7	6.6
Mar 1972	S	6.8	6.2	6.5	8.0	7.2
	B	6.7	6.2	6.0	6.0	7.0
Apr 1972	S	7.1	-	6.1	-	-
	B	6.5	-	6.0	-	-
May 1972	S	6.0	5.8	6.4	6.5	6.5
	B	6.7	5.8	6.0	6.0	5.8
June 1972	S	5.8	6.3	6.2	6.2	6.1
	B	5.4	6.1	6.3	6.0	6.0
5 July 1972	S	4.6	6.4	6.6	6.3	8.6
	B	5.9	6.6	7.0	6.8	6.8
18 July 1972	S	4.8	4.3	5.6	3.9	4.3
	B	5.1	4.9	6.1	4.9	4.9
Aug 1972	S	4.5	4.3	3.9	3.2	3.3
	B	4.8	5.0	5.1	4.3	3.9
Sept 1972	S	6.3	6.1	4.0	-	-
	B	6.0	4.1	4.4	-	-
Oct 1972	S	7.8	6.8	6.1	6.5	6.1
	B	5.7	6.6	6.4	6.3	6.3
Nov 1972	S	6.5	6.2	9.1	8.4	7.0
	B	5.9	5.9	5.5	5.4	6.4

* Surface

** Bottom

TABLE 2.7-8

PHOSPHATE CONCENTRATIONS OFFSHORE OF
HUTCHINSON ISLAND, mg/l

<u>DATE</u>		<u>STATION NUMBERS</u>				
		I	II	III	IV	V
Feb 1972	S*	-	0.039	0.032	0.034	0.056
	B**	0.044	0.032	0.034	0.033	0.047
Mar 1972	S	0.065	0.055	0.055	0.052	0.066
	B	0.054	0.052	0.052	0.065	0.070
Apr 1972	S	0.150	0.136	0.168	0.138	0.161
	B	0.141	0.168	>1.000	0.134	0.129
May 1972	S	0.043	0.020	0.019	0.071	0.021
	B	0.017	0.027	0.040	0.037	0.032
Jun 1972	S	0.038	0.032	0.030	0.034	0.039
	B	0.043	0.032	0.030	0.032	0.038
Jul 1972	S	0.345	0.365	0.359	0.386	0.404
	B	0.420	0.346	0.408	0.323	0.386
Aug 1972	S	0.069	0.056	0.076	0.100	0.059
	B	0.095	0.059	0.119	0.068	0.126
Sep 1972	S	0.084	0.058	0.059	0.060	0.055
	B	0.102	0.070	0.061	0.063	0.060
Oct 1972	S	0.205	0.342	0.212	0.185	0.236
	B	0.197	0.249	0.189	0.192	0.225
Nov 1972	S	0.038	0.316	0.027	0.036	0.308
	B	0.047	0.035	0.038	0.027	0.030

* Surface

** Bottom

range, in mg/l: 0.017 to 0.420, plus one reading of >1.000
0.179 to 4.42 mg at $\text{PO}_4\text{-P/m}^3$

TABLE 2.7-9

NITRATE CONCENTRATIONS OFFSHORE OF
HUTCHINSON ISLAND, mg/l

DATE		STATION NUMBERS				
		I	II	III	IV	V
Feb 1972	S*	-	0.0244	0.0134	0.0274	0.0748
	B**	0.0133	0.0247	0.0280	0.0279	0.0139
Mar 1972	S	0.0096	0.0058	0.0076	0.0100	0.0189
	B	0.0025	0.0024	0.0149	0.0062	0.0171
Apr 1972	S	0.0341	0.0118	0.0138	0.0128	0.0158
	B	0.0230	0.0180	0.0183	0.0172	0.0145
May 1972	S	0.0272	0.0200	0.0116	0.0227	0.0030
	B	0.0161	0.0308	0.0218	0.0304	0.0025
Jun 1972	S	0.0103	0.0090	0.0040	0.0081	0.0098
	B	0.0112	0.0090	0.0022	0.0028	0.0084
Jul 1972	S	0.0177	0.0120	0.0131	0.0130	0.0084
	B	0.0043	0.0141	0.0054	0.0064	0.0087
Aug 1972	S	0.0077	0.0093	0.0034	0.0111	0.0055
	B	0.0048	0.0071	0.0067	0.0051	0.0194
Sep 1972	S	0.0073	0.0113	0.0197	0.0186	0.0040
	B	0.0138	0.0064	0.0036	0.0064	0.0026
Oct 1972	S	0.0058	0.0118	0.0177	0.0112	0.0105
	B	0.0104	0.0107	0.0084	0.0071	0.0264
Nov 1972	S	0.0083	0.0061	0.0105	0.0216	0.0734
	B	0.0082	0.0090	0.0121	0.0070	0.0065

*Surface

**Bottom

range, in mg/l: 0.0022 to 0.0748
 0.036 to 1.206 mg at $\text{NO}_3\text{-N/m}^3$

TABLE 2.7-10

NITRITE CONCENTRATIONS OFFSHORE OF
HUTCHINSON ISLAND, mg/l

		<u>Station Numbers</u>				
		<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>	<u>V</u>
Feb 1972	S*	-	0.0029	0.0027	0.0016	0.0086
	B**	0.0039	0.0027	0.0030	0.0016	0.0066
Mar 1972	S	0.0017	0.0004	0.0003	0.0009	0.0019
	B	0.0004	0.0006	0.0013	0.0007	0.0188
Apr 1972	S	0.0048	0.0018	0.0025	0.0022	0.0042
	B	0.0038	0.0020	0.0037	0.0023	0.0028
May 1972	S	0.0004	0.0006	0.0027	0.0041	0.0013
	B	0.0001	0.0022	0.0113	0.0181	0.0032
Jun 1972	S	0.0014	0.0003	0.0004	0.0006	0.0008
	B	0.0008	0.0003	0.0017	0.0007	0.0009
Jul 1972	S	0.0000	0.0005	0.0002	0.0000	0.0000
	B	0.0000	0.0002	0.0000	0.0000	0.0013
Aug 1972	S	0.0016	0.0021	0.0009	0.0041	0.0013
	B	0.0016	0.0006	0.0066	0.0009	0.0045
Sep 1972	S	0.0051	0.0046	0.0051	0.0046	0.0034
	B	0.0084	0.0043	0.0038	0.0036	0.0052
Oct 1972	S	0.0019	0.0025	0.0023	0.0020	0.0020
	B	0.0024	0.0025	0.0021	0.0015	0.0030
Nov 1972	S	0.0082	0.0079	0.0015	0.0033	0.0106
	B	0.0067	0.0036	0.0014	0.0020	0.0015

Range in mg/l: 0.0000 to 0.0188
 0.0000 to 0.480 mg at $\text{NO}_2\text{-N/m}^3$

* Surface

** Bottom

TABLE 2.7-11

AMMONIA CONCENTRATIONS OFFSHORE OF
HUTCHINSON ISLAND, mg/l

DATE		STATION NUMBERS				
		I	II	III	IV	V
Feb 1972	S*	-	0.846	0.885	0.911	> 1.000
	B**	0.800	> 1.000	0.865	0.682	0.880
Mar 1972	S	0.004	0.004	0.006	< 0.005	0.035
	B	0.005	0.008	0.015	0.010	0.038
Apr 1972	S	< 0.005	< 0.005	0.006	< 0.005	< 0.005
	B	0.008	< 0.005	0.089	0.006	0.003
May 1972	S	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
	B	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Jun 1972	S	0.0045	< 0.0010	< 0.0010	0.0055	0.0120
	B	< 0.0010	0.0030	< 0.0010	< 0.0010	< 0.0050
Jul 1972	S	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
	B	< 0.005	0.012	< 0.005	< 0.005	< 0.005
Aug 1972	S	0.011	< 0.005	< 0.005	0.030	< 0.005
	B	0.028	< 0.005	0.023	< 0.005	0.044
Sep 1972	S	0.013	0.013	0.010	0.010	0.010
	B	0.041	0.011	0.045	0.017	< 0.005
Oct 1972	S	0.024	< 0.005	< 0.005	< 0.005	< 0.005
	B	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Nov 1972	S	0.017	0.010	0.010	-	0.274
	B	0.029	0.010	0.010	0.010	0.005

*Surface

**Bottom

range, in mg/l: < 0.001 to > 1.000 (0.005 to 0.911)
or 0.294 to 53.5 mg at $\text{NH}_3\text{-N/m}^3$

TABLE 2.7-12

SILICATE CONCENTRATIONS OFFSHORE OF
HUTCHINSON ISLAND, mg/l

<u>DATE</u>		<u>STATION NUMBERS</u>				
		<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>	<u>V</u>
Feb. 1972	S*	-	0.225	0.164	0.211	0.266
	B**	0.265	0.199	0.294	0.200	0.268
Mar. 1972	S	0.147	0.072	0.105	0.111	0.111
	B	0.098	0.139	0.162	0.071	0.117
Apr. 1972	S	0.193	0.131	0.118	0.133	0.145
	B	0.177	0.153	0.153	0.137	0.153
May 1972	S	0.187	0.152	0.239	0.232	0.515
	B	0.245	0.410	0.227	0.226	0.326
June 1972	S	0.289	0.166	0.099	0.150	0.171
	B	0.155	0.097	0.094	0.090	0.121
July 1972	S	0.383	0.725	0.376	0.487	0.506
	B	0.344	0.409	0.364	0.430	0.374
Aug. 1972	S	0.348	0.400	0.120	0.342	0.231
	B	0.166	0.125	0.230	0.148	0.303
Sept. 1972	S	0.616	0.476	0.426	0.474	0.694
	B	0.427	0.516	0.434	0.524	0.546
Oct. 1972	S	0.400	0.275	0.420	0.325	0.355
	B	0.900	0.245	0.520	0.380	0.360
Nov. 1972	S	0.311	0.260	0.187	0.257	0.357
	B	0.266	0.249	0.179	0.209	0.279

* Surface

** Bottom

range, in mg/l: 0.072 to 0.900
 0.78 to 9.88 mg at SiO_4 - Si/m^3

TABLE 2.7-13

CHLOROPHYLL "A" CONCENTRATIONS MEASURED OFFSHORE
OF HUTCHINSON ISLAND, mg/m³

<u>DATE</u>		<u>STATION NUMBERS</u>				
		I	II	III	IV	V
Nov 1971	S*	2.55	2.26	0.76	2.14	3.14
	B**	7.70	1.92	0.94	1.85	2.18
Dec 1971	S	1.09	0.88	0.87	0.66	0.51
	B	2.14	1.21	1.71	2.28	2.42
Jan 1972	S	1.46	0.98	1.57	0.75	0.90
	B	2.05	2.78	1.18	1.11	2.07
Feb 1972	S	3.99	2.40	2.55	1.68	2.89
	B	5.87	2.89	2.41	1.79	2.75
Mar 1972	S	2.13	0.97	0.08	0.99	0.92
	B	1.51	1.15	0.08	1.50	1.85
Apr 1972	S	2.76	1.01	0.78	1.48	1.77
	B	4.99	2.04	1.62	3.79	3.67
May 1972	S	1.62	1.07	2.03	3.92	2.40
	B	1.21	2.49	4.39	2.57	3.56
Jun 1972	S	0.86	0.77	0.60	0.61	0.47
	B	5.86	0.31	0.26	0.55	1.42
Jul 1972	S	0.82	0.31	0.60	0.82	1.02
	B	0.43	0.33	0.24	0.38	0.65
Aug 1972	S	2.25	0.64	0.81	0.75	0.98
	B	1.47	0.51	0.63	0.68	1.31
Sep 1972	S	2.89	1.65	2.45	2.11	2.27
	B	4.85	2.06	2.75	1.47	2.06
Oct 1972	S	6.50	3.50	2.14	2.30	4.54
	B	5.20	3.18	1.52	3.41	5.29
Nov 1972	S	1.09	1.48	0.87	0.95	0.56
	B	1.60	1.60	0.90	1.15	0.74

*Surface

**Bottom

SL2

TABLE 2.7-14PHYTOPLANKTON CONCENTRATIONS OFFSHORE OF
HUTCHINSON ISLAND, CELLS/l

<u>DATE</u>	<u>STATION NUMBERS</u>				
	<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>	<u>V</u>
Sept., 1971	92.8	4655.1	1357.9	449.9	30,532.9
Nov. 1971	9.6	4.3	19.3	3.6	3.2
Jan. 1972	1088.1	248.1	763.9	919.3	123.7
Mar. 1972	165.5	83.8	53.2	243.8	12.3
May 1972	122.3	47.3	42.7	90.3	286.1
July 1972	1.0	14.4	3.1	4.3	7.2
Sep. 1972	201.3	414.7	166.0	238.1	179.7
Oct. 1972	845.9	2,111.6	664.3	3,233.5	5,612.8
Nov. 1972	7.9	15.7	15.2	11.8	24.9

TABLE 2.7-15

ZOOPLANKTON CONCENTRATIONS OFFSHORE OF HUTCHINSON ISLAND,
ORGANISMS/M³

<u>DATE</u>		<u>STATION NUMBERS</u>				
		<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>	<u>V</u>
Sept. 1971	Copepods	178	1128	1206	820	458
	Total	299	1416	2638	1211	958
Nov. 1971	C	206	159	82	198	215
	T	244	478	249	550	307
Jan. 1972	C	2292	3232	3948	2872	4570
	T	3005	4868	5462	4971	7432
Mar. 1972	C	1613	1111	2207	1895	1082
	T	1965	1441	2399	2847	1291
May 1972	C	2576	1085	10930	4958	3041
	T	3943	1525	12023	5775	3769
July 1972	C	194	958	2303	758	492
	T	379	1758	3843	2135	1272

TABLE 2.7-16

FISH COLLECTED BY TRAWL
OFFSHORE OF HUTCHINSON ISLAND

<u>SPECIES</u>	<u>STATION NUMBERS</u>				
	<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>	<u>V</u>
Synodontidae					
<u>Synodus foetens</u> inshore lizardfish		1		2	
Serranidae					
<u>Centropristis philadelphica</u> rock sea bass					2
Gerreidae					
<u>Eucinostomus gula</u> silver jenny				2	
Sparidae					
<u>Archosargus probatocephalus</u> 11 sheepshead					
Gobiidae					1
taken by bottom grab					
Scorpaenidae					
<u>Scorpaena brasiliensis</u> barbfish					2
Triglidae					
<u>Prionotus scitulus</u> leopard searobin	3	1			1
<u>Prionotus martis</u> barred searobin		1			1
Bothidae					
<u>Bothus ocellatus</u> eyed flounder				2	
<u>Citharichthys Macrops</u> spotted whiff	1				3

SL2

TABLE 2.7-16 (cont'd)

<u>SPECIES</u>	<u>STATION NUMBERS</u>				
	<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>	<u>V</u>
<u>Etropus crossotus</u> fringed flounder	1				
<u>Paralichthys abligutta</u> gulf flounder	2				
<u>Synacium papillosum</u> dusky flounder				1	1

TABLE 2.7-17

FISH COLLECTED BY BEACH SEINE AT THREE
HUTCHINSON ISLAND SHORE STATIONS

<u>SPECIES</u>	<u>STATION NUMBERS</u>		
	<u>VI</u>	<u>VII</u>	<u>VIII</u>
Clupeidae			
<u>Harengula pensacolae</u> Scaled sardine	19	10	
<u>Opisthonema oglinum</u> Atlantic threadfin herring	3	3	
<u>Sardinella anchovia</u> Spanish sardine	22	1	
<u>Brevoortia</u> sp. Menhaden			1
Engraulidae			
<u>Anchoa cubana</u> Cuban anchovy	3240	1970	8
<u>Anchoa mitchelli</u> Bay anchovy	5	1	
<u>Anchoa nausta</u> Longnose anchovy	3758	2234	18
<u>Engraulis eurystole</u> Silver anchovy	5	2	
Pomatomidae			
<u>Pomatomus saltatrix</u> Bluefish	2	2	
Carangidae			
<u>Caranx chrysos</u> Blue runner	1		
<u>Caranx hippos</u> Crevalle jack	1		
<u>Chloroscombrus chrysurus</u> Atlantic bumper	31	12	

TABLE 2.7-17 (cont'd)

<u>SPECIES</u>	<u>STATION NUMBERS</u>		
	<u>VI</u>	<u>VII</u>	<u>VIII</u>
<u>Selene vomer</u> Lookdown	7		
<u>Trachinotus carolinus</u> Pompano	3	18	1
<u>Trachinotus falcatus</u> Permit	5	2	6
Gerreidae			
<u>Eucinostomus gula</u> Silver jenny		1	
Sparidae			
<u>Lagodon rhomboides</u> Pinfish	1		
Sciaenidae			
<u>Menticirrhus littoralis</u> Gulf kingfish	11	26	22
<u>Umbrina coroides</u> Sand drum	7	62	12
<u>Leiostomus xanthurus</u> Spot	59		
<u>Pogonias chromis</u> Black drum	1		
Mugilidae			
<u>Mugil cephalus</u> Striped mullet		5	

SL2

TABLE 2.7-18

1971 FINFISH LANDINGS, FLORIDA AND ST. LUCIE COUNTY

<u>Species</u>	<u>Florida Landings, lb</u>	<u>St. Lucie Landings, lb</u>	<u>St. Lucie Landings as % Fla. Landings</u>
Bluefish	2,134,989	228,663	10.7
Spanish Mackerel	9,964,946	679,110	6.8
King Mackerel	5,644,148	1,217,356	21.6
Total Finfish Landings	63,203,944	3,072,838	4.9

Data obtained from Florida Landings, Annual Summary 1971, Current Fisheries Statistics No. 5919. Data in Table 2.7-19 is taken from Preliminary Florida Landings, 1970 to 1972. Numerical discrepancies between Tables 2.7-18 and 2.7-19 reflect the difference between preliminary and final data as compiled in the Current Fisheries Statistics Bulletins.

1

Table 2.7-19

ST LUCIE COUNTY FINFISH LANDINGS, LB - 1970

	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Total</u>
Bluefish	150,178	87,733	199,470	75,869	49,762	17,343	4,264	14,344	11,720	15,722	35,057	63,682	725,144
Groupers	6,822	1,957	1,363	7,259	5,273	15,029	7,732	1,613	9,701	15,431	14,774	9,788	96,742
King Mackerel	1,633	7,213	73,284	126,557	54,220	21,722	44,325	117,493	73,975	15,737	53,390	405,352	994,901
Mullet, Black	4,927	672	2,073	1,067	824	4,566	16,915	27,959	4,867	12,383	12,962	21,793	111,008
Sea Trout, Spotted	10,361	5,277	6,153	10,460	2,940	9,068	10,843	13,731	2,746	1,210	3,466	4,533	80,788
Spanish Mackerel	22	338	154,645	70,617	13,770	6,534	2,925	4,991	4,734	2,241	880,871	100,401	1,242,089
Spot	1,126	2,121	2,287	44,671	21,462	43,502	29,073	29,433	10,928	20,229	49,746	21,834	276,412
Total	175,069	105,311	439,275	336,500	148,251	117,764	116,077	209,564	118,671	82,953	1,050,266	627,383	3,527,084

1970 Total Finfish Landing in St Lucie County Equalled 3,948,940 lb (preliminary data); The Species Noted Above Formed 89.3 percent of the Total.

Table 2.7-19 (Cont'd.)

ST LUCIE COUNTY FINFISH LANDINGS, LB - 1971

	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Total</u>
Bluefish	72,823	24,293	28,515	47,219	9,046	656	498	4,785	12,536	9,750	8,286	7,881	226,288
Groupers	3,945	3,445	37,058	266	720	8,195	7,033	8,012	35,694	2,299	264	3,994	110,925
King Mackerel	255,260	72,273	84,555	22,772	117,926	93,367	62,903	99,671	82,607	41,539	4,730	222,123	1,159,726
Mullet, Black	601	134	1,550	1,617	3,672	9,854	23,188	14,814	14,232	10,368	16,950	19,116	116,096
Sea Trout, Spotted	1,959	3,127	2,345	2,230	3,530	3,003	7,284	7,022	5,654	4,925	3,281	3,129	47,489
Spanish Mackerel	167,816	17,687	149,166	210,416	3,878	5,148	6,783	15,117	10,729	15,585	14,436	43,157	659,918
Spot	41,523	12,134	5,193	1,709	18,136	28,346	27,753	50,531	49,891	46,641	23,470	3,931	309,258
Total	543,927	133,093	308,382	286,229	156,908	148,569	135,422	199,952	211,343	131,107	71,417	303,331	2,629,700

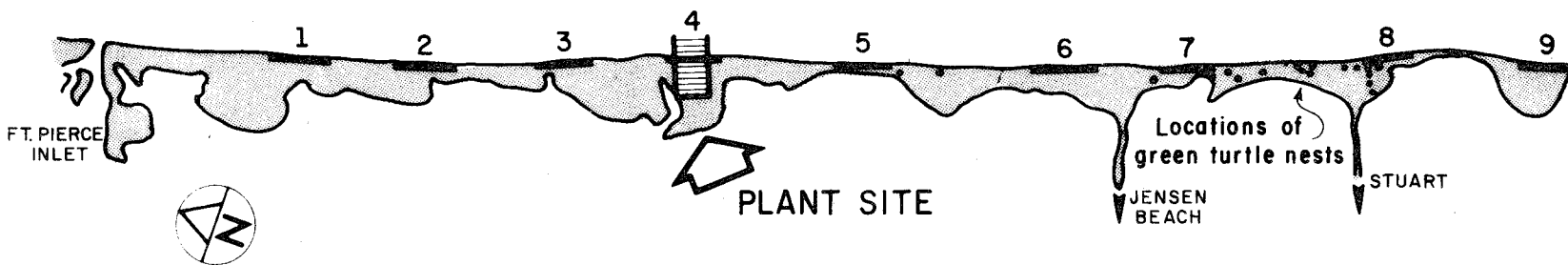
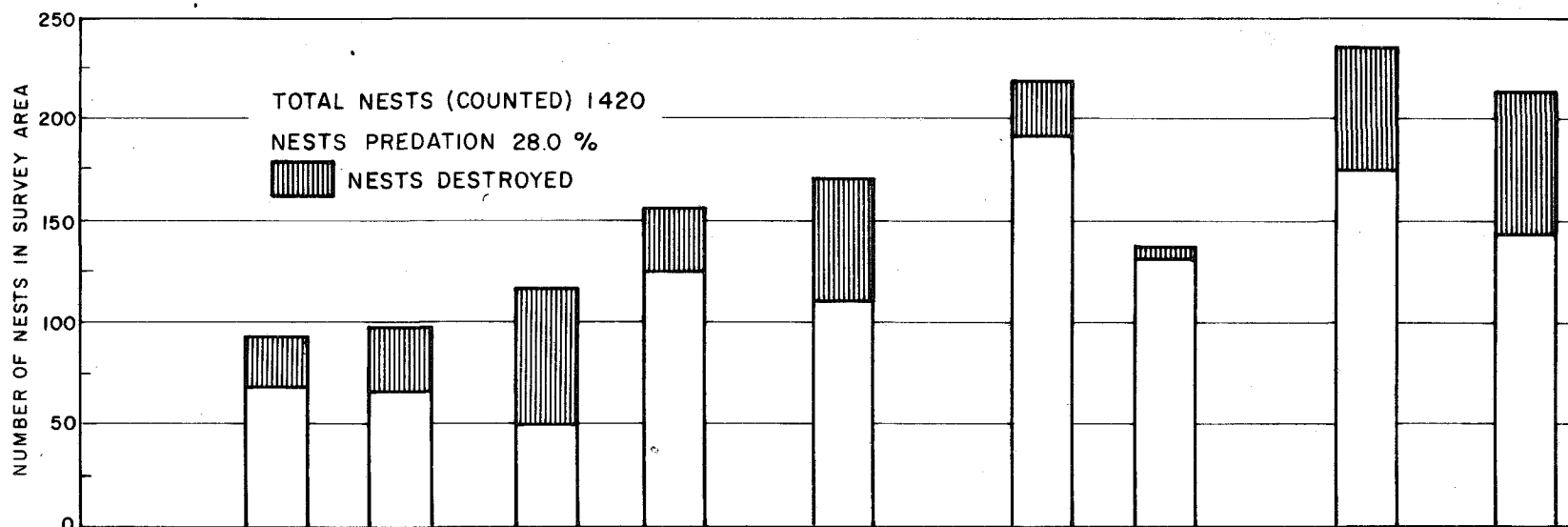
1971 Total Finfish Landings in St Lucie County Equaled 2,883,303 lb (preliminary data); the Species Noted Above Formed 91.2 Percent of the Total.

Table 2.7-19 (Cont'd.)

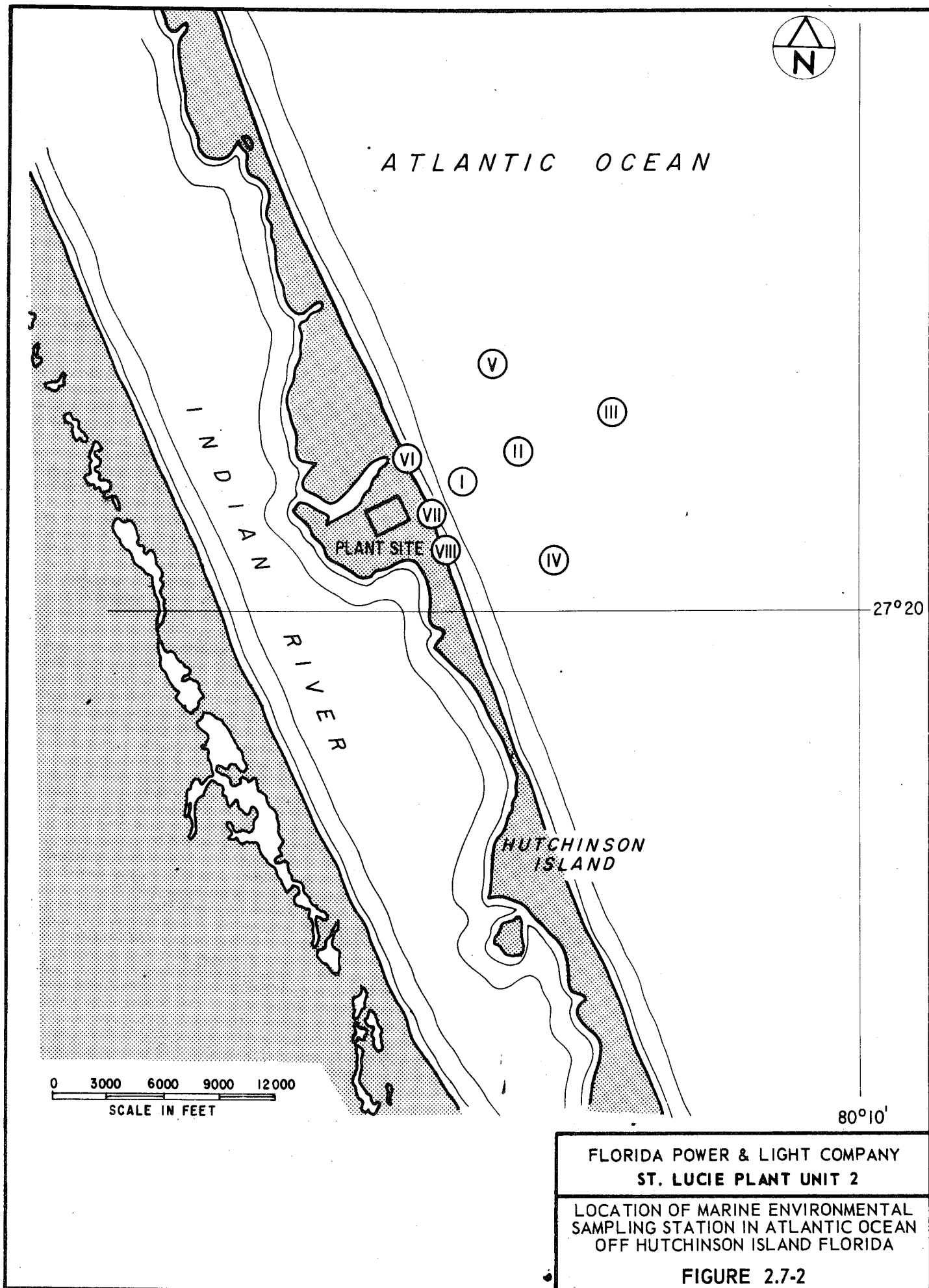
ST LUCIE COUNTY FINFISH LANDINGS, LB - 1972

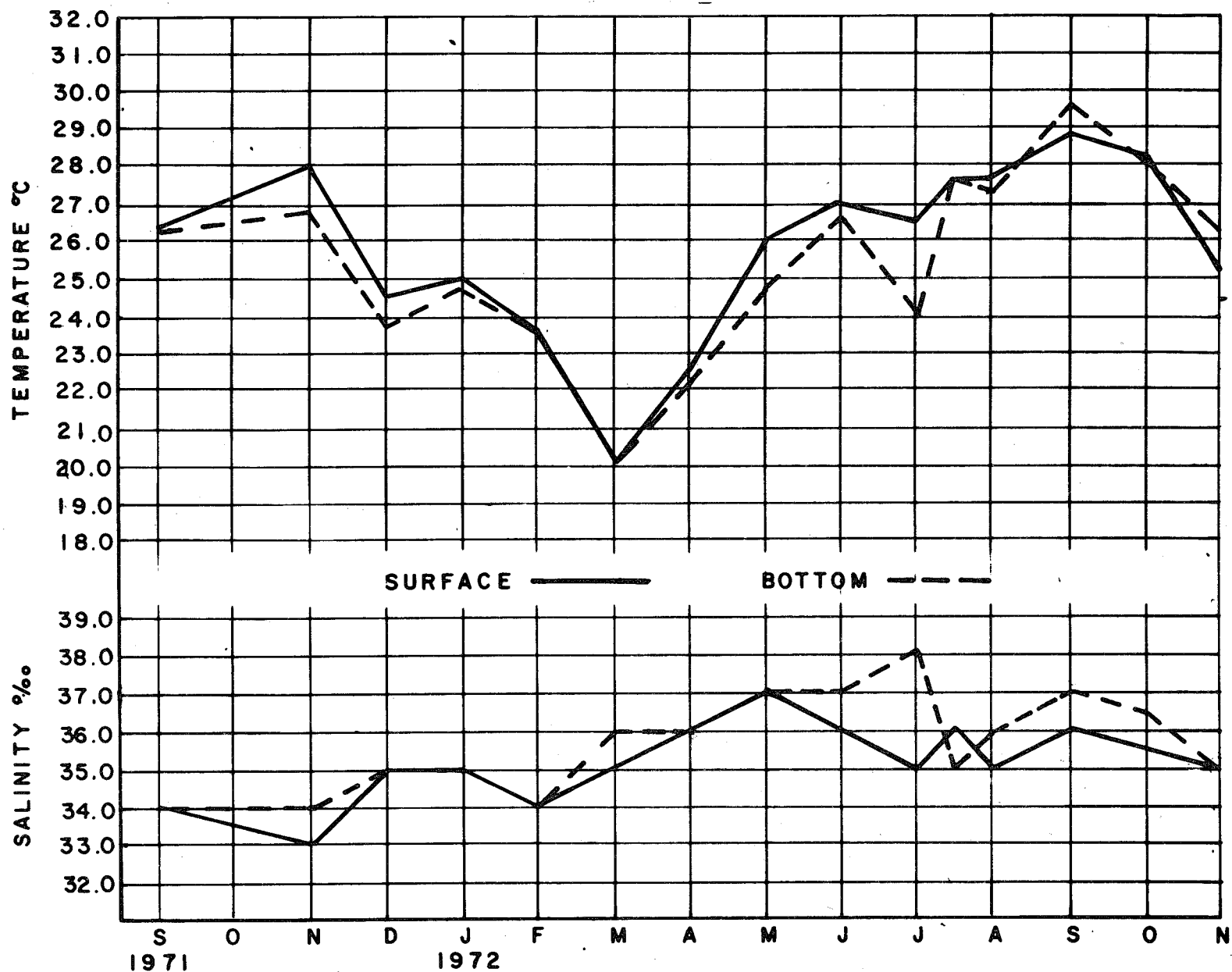
	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sep</u>	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Total</u>
Bluefish	14,995	46,176	139,049	102,806	12,729	5,912	2,048	3,213	10,741	23,384	15,548	32,042	408,643
Groupers	1,650	3,484	21,547	655	10,826	12,690	18,319	9,051	1,573	3,418	5,507	1,132	89,852
King Mackerel	428,172	105,334	159,190	41,899	33,461	52,693	18,870	79,614	102,781	28,921	8,281	237,813	1,297,029
Mullet, Black	1,750	5,700	385	-	1,280	2,774	15,660	14,221	18,062	12,426	9,040	13,372	94,670
Sea Trout, Spotted	2,601	6,813	2,478	1,481	4,101	6,033	5,943	4,700	3,749	5,188	4,578	3,806	51,471
Spanish Mackerel	30,619	4,597	144,507	79,891	18,053	11,317	8,083	7,258	55,838	91,957	286,936	252,206	991,262
Spot	8,672	6,297	6,632	1,818	29,985	43,473	38,699	61,371	14,628	28,534	55,402	3,760	304,271
Total	488,459	178,401	473,788	228,550	110,435	139,892	107,622	179,428	207,372	193,828	385,292	544,131	3,237,198

1972 Total Finfish Landings in St Lucie County Equalled 3,564,267 lb (preliminary data); the Species Noted Above formed 90.8 Percent of the Total.

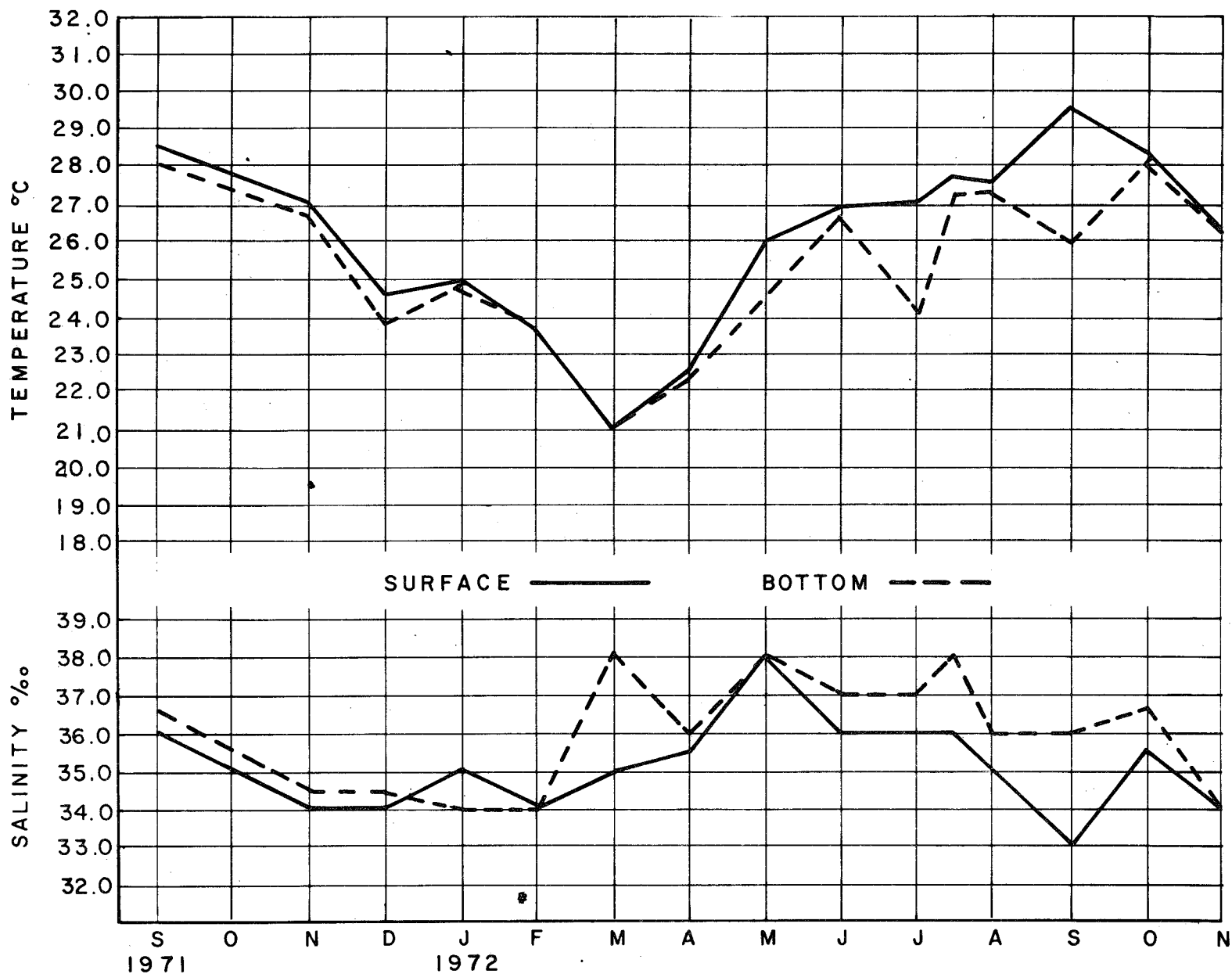


FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
TURTLE NEST SURVEY AREAS
DENSITY OF NESTING AND PREDATION
FIGURE 2.7-1

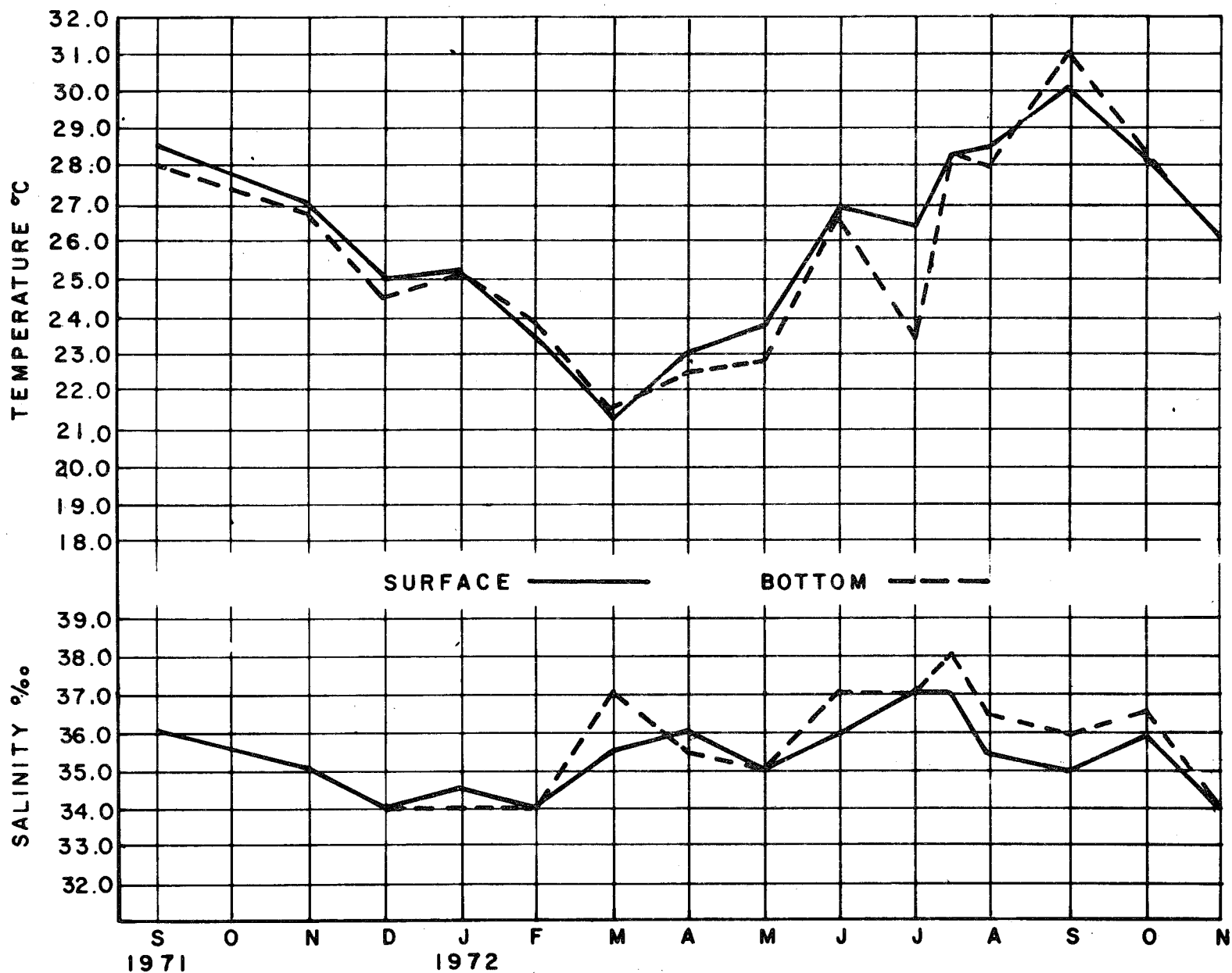




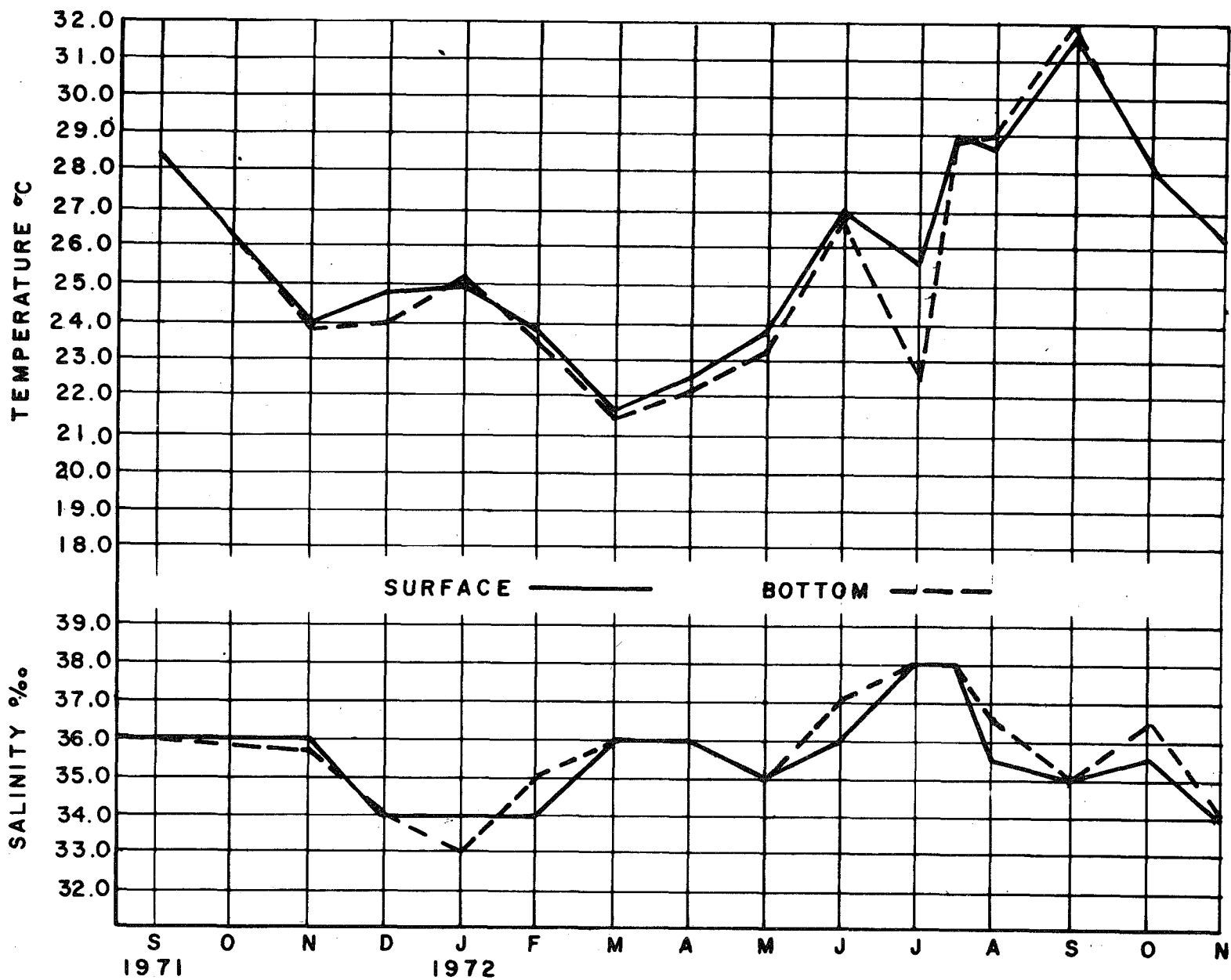
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
MONTHLY TEMPERATURE AND SALINITY
STATION 1
FIGURE 2.7.3



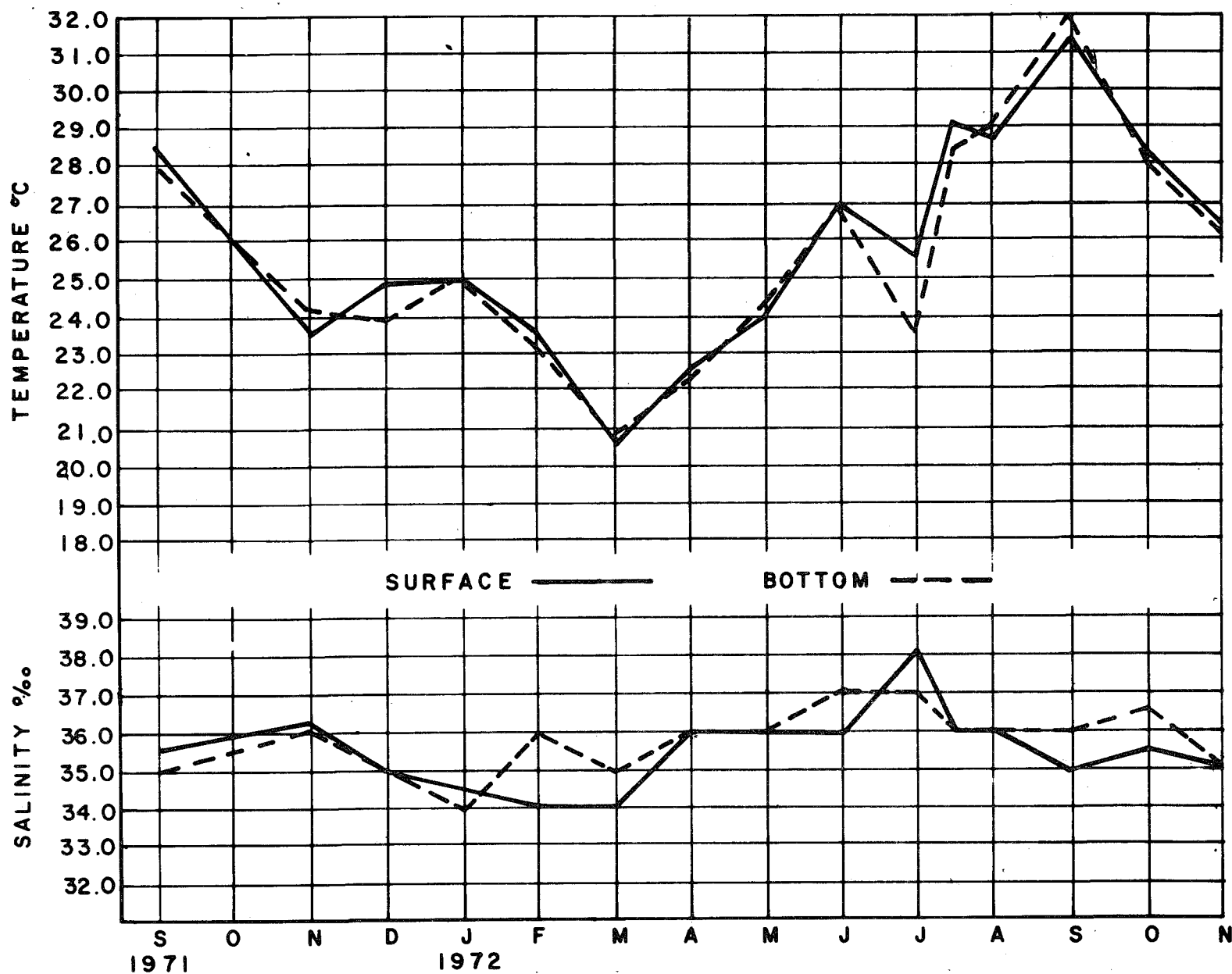
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
MONTHLY TEMPERATURE AND SALINITY
STATION 11
FIGURE 2.7-4



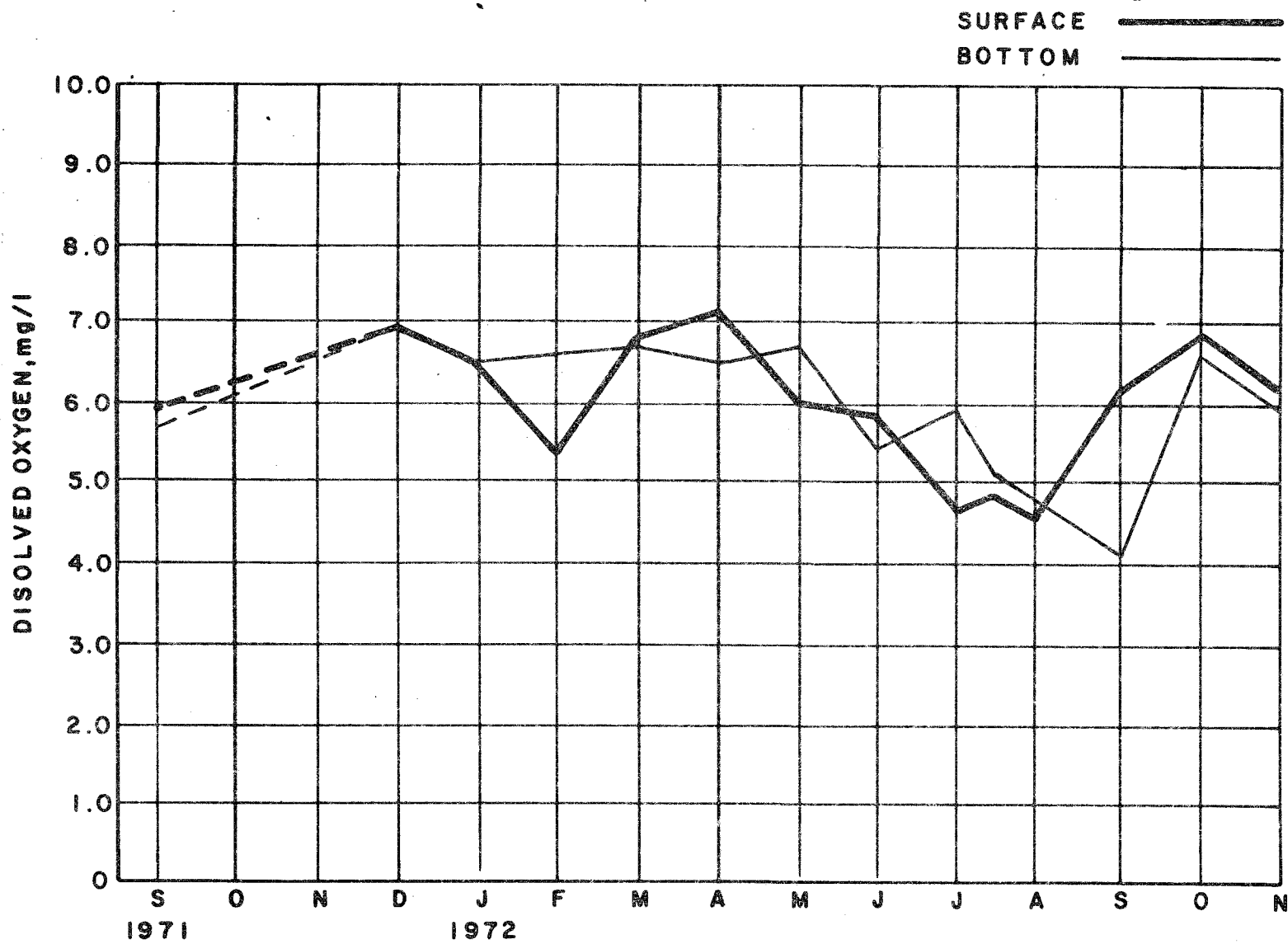
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
MONTHLY TEMPERATURE AND SALINITY
STATION III
FIGURE 2.7-5



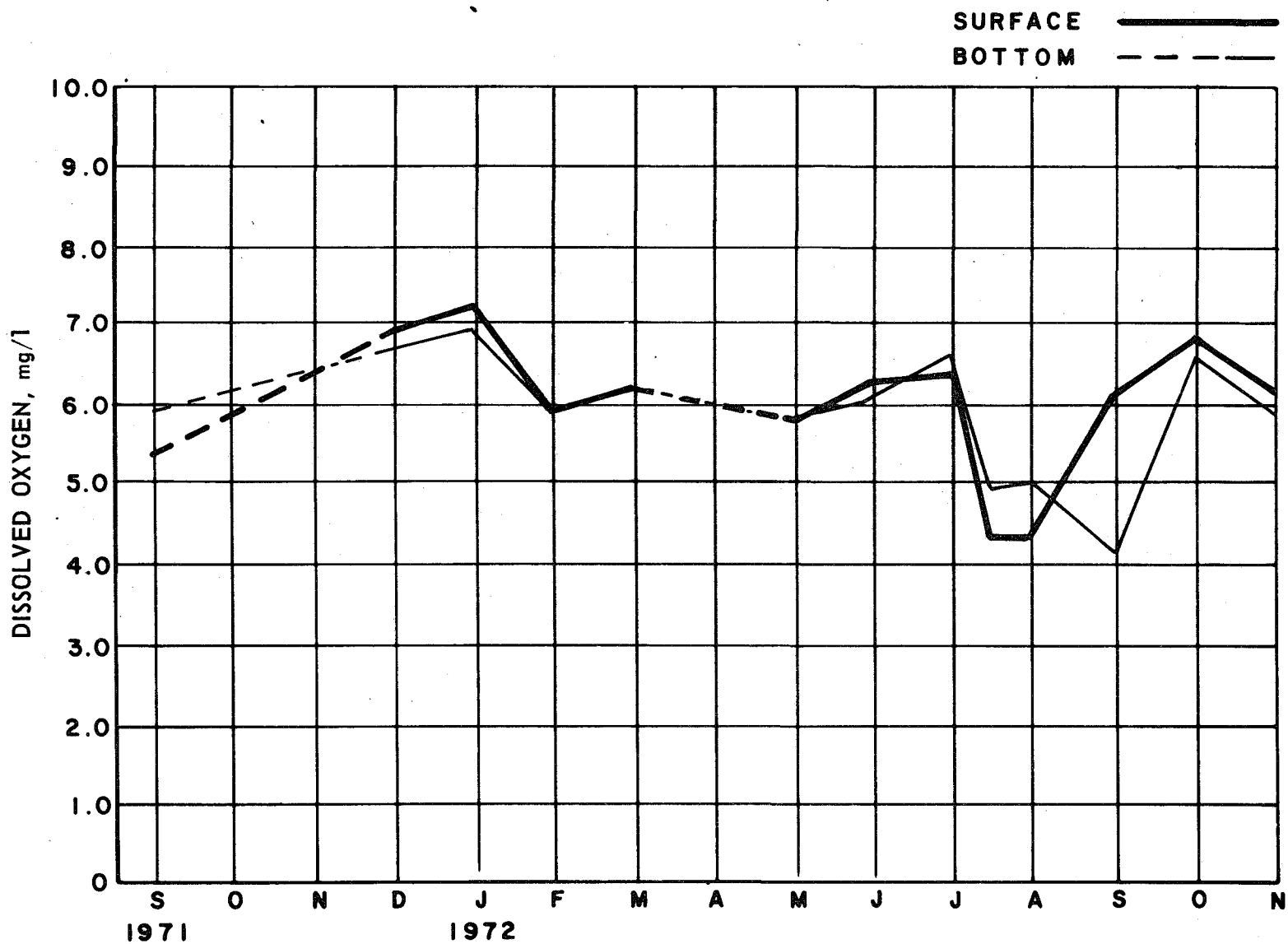
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
MONTHLY TEMPERATURE AND SALINITY
STATION IV
FIGURE 2.7-6



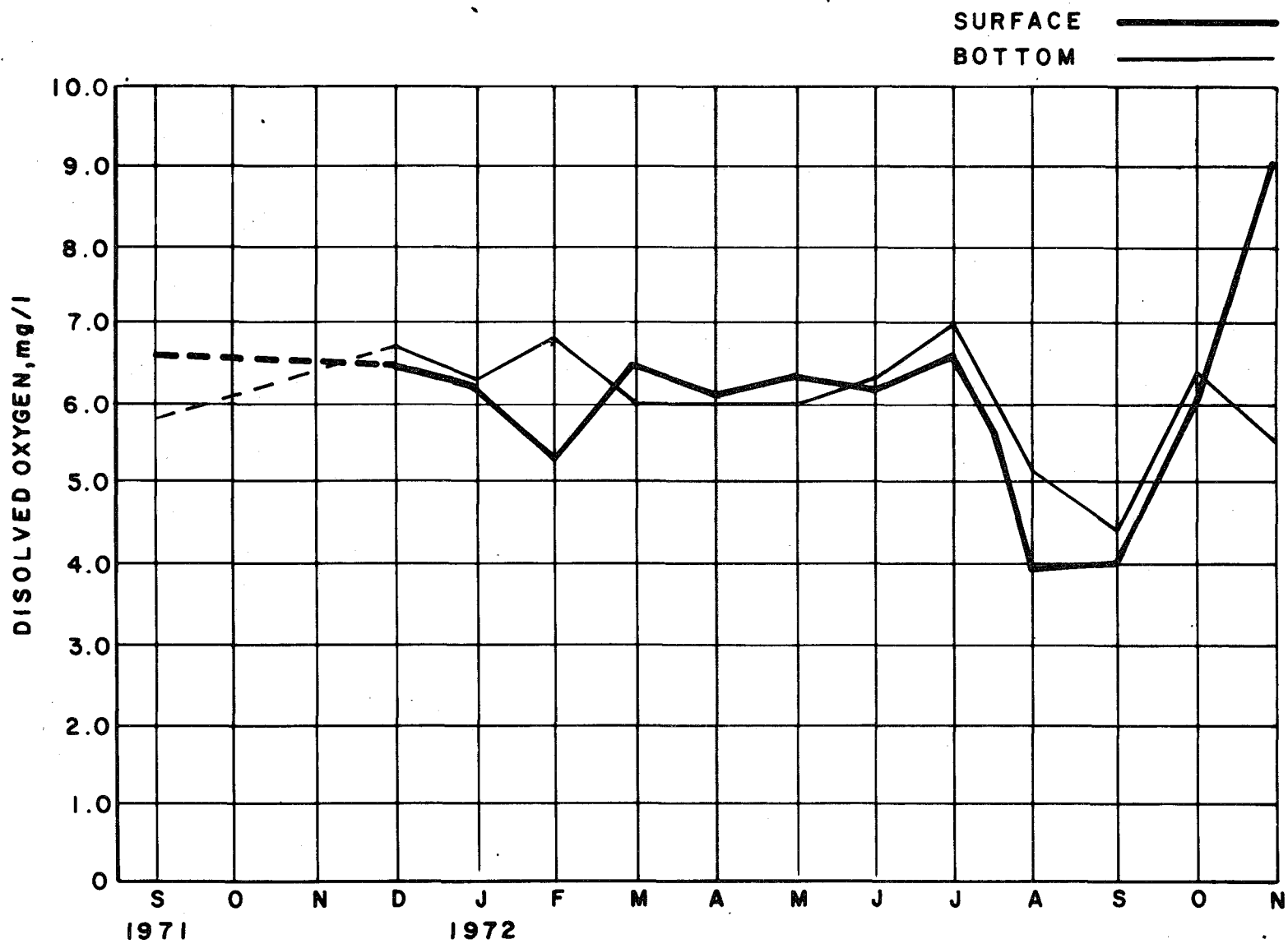
FLORIDA POWER & LIGHT COMPANY
 ST. LUCIE PLANT UNIT 2
 MONTHLY TEMPERATURE AND SALINITY
 STATION V
 FIGURE 2.7-7



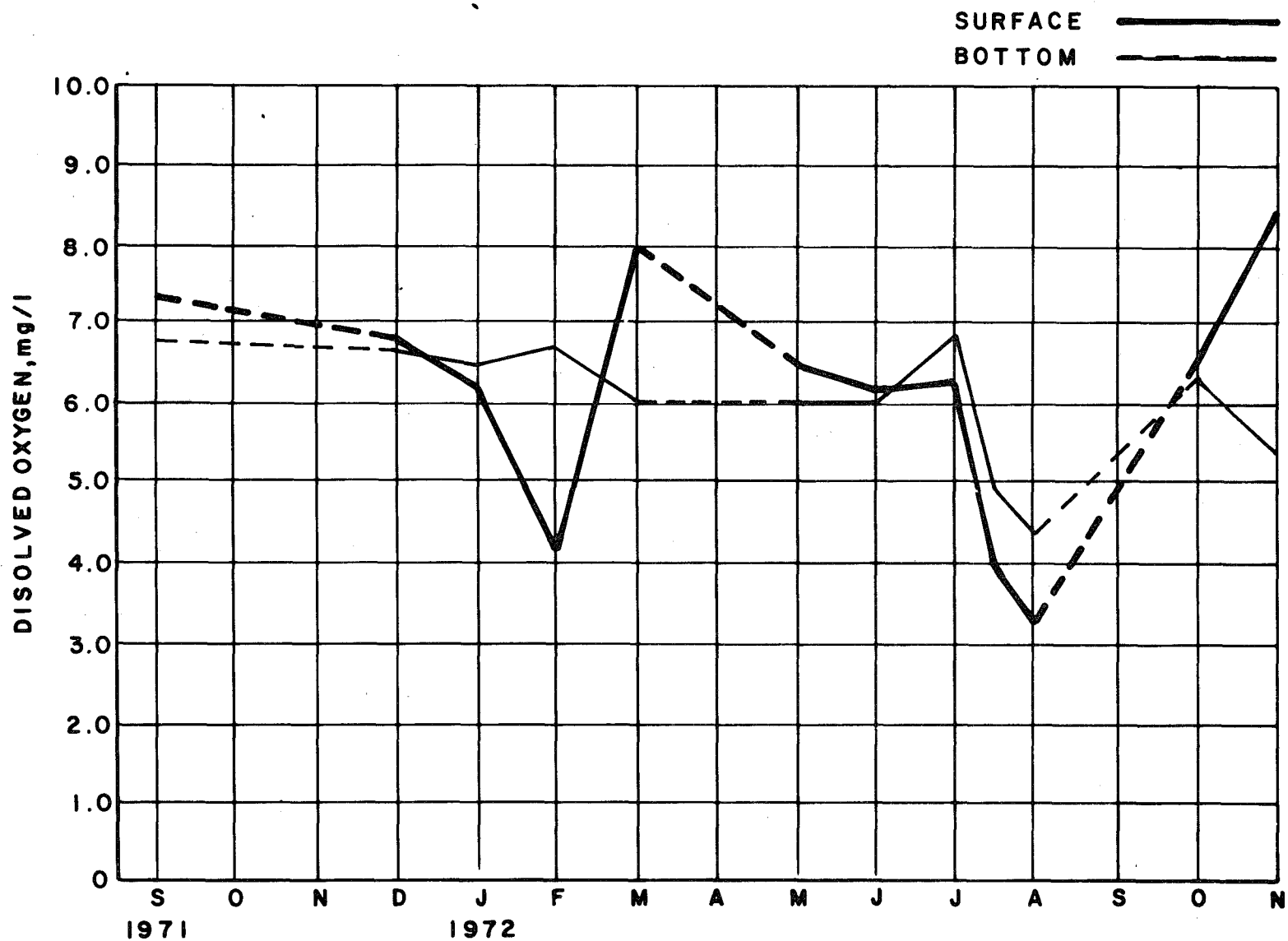
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
MONTHLY DISSOLVED OXYGEN
STATION 1
FIGURE 2.7-8



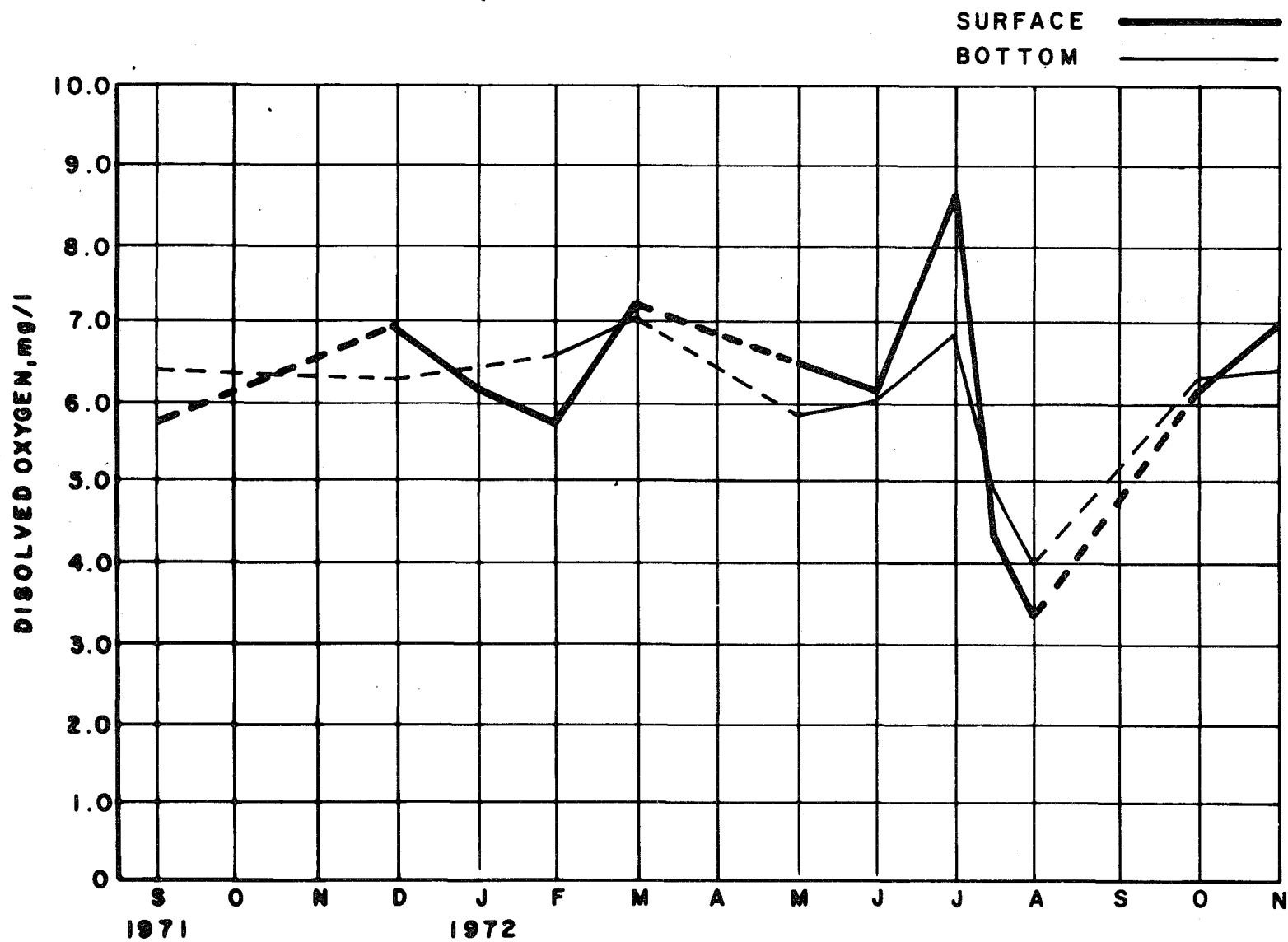
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
MONTHLY DISSOLVED OXYGEN
STATION II
FIGURE 2.7-9



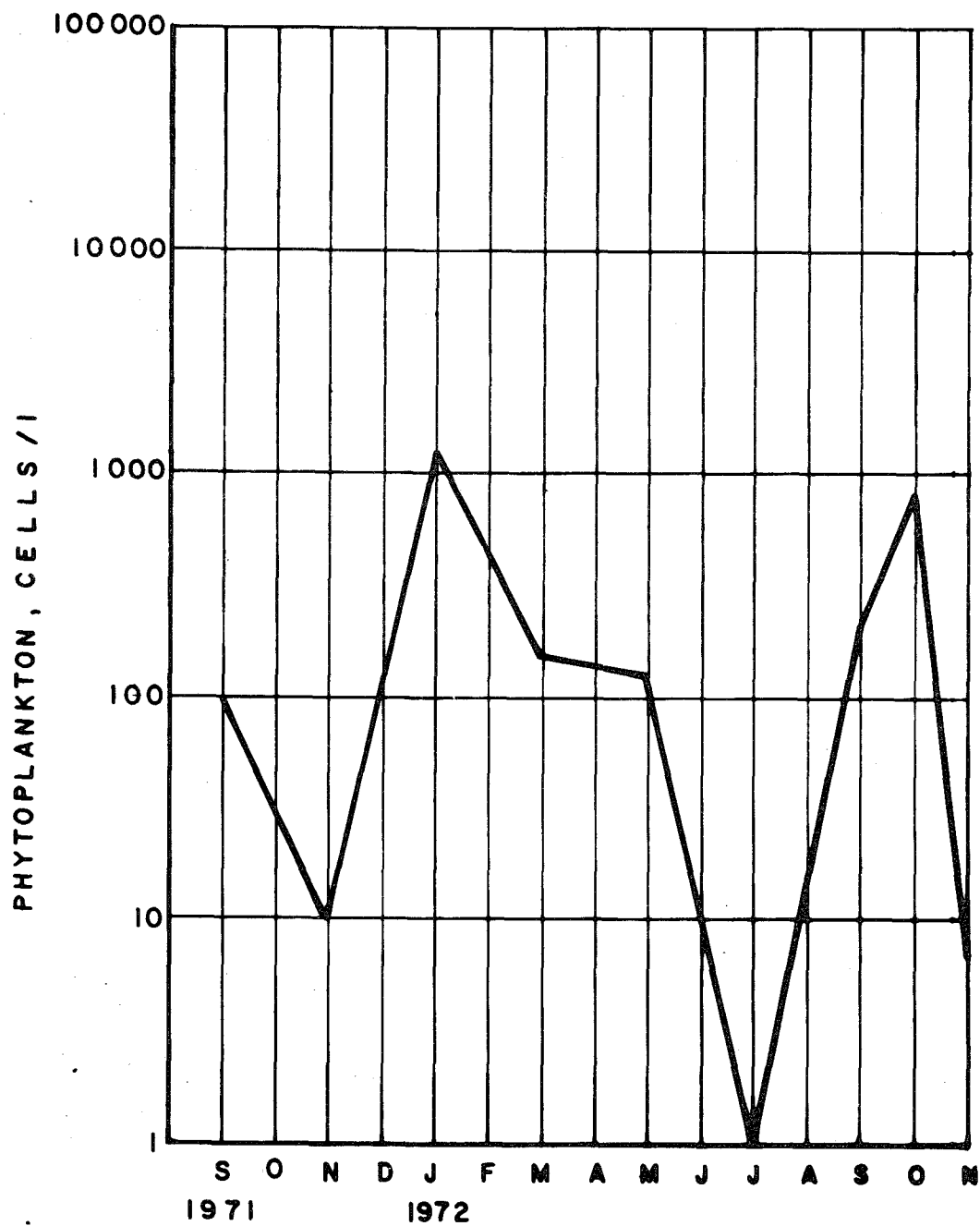
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
MONTHLY DISSOLVED OXYGEN
STATION III
FIGURE 2.7-10



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
MONTHLY DISSOLVED OXYGEN
STATION IV
FIGURE 2.7-11



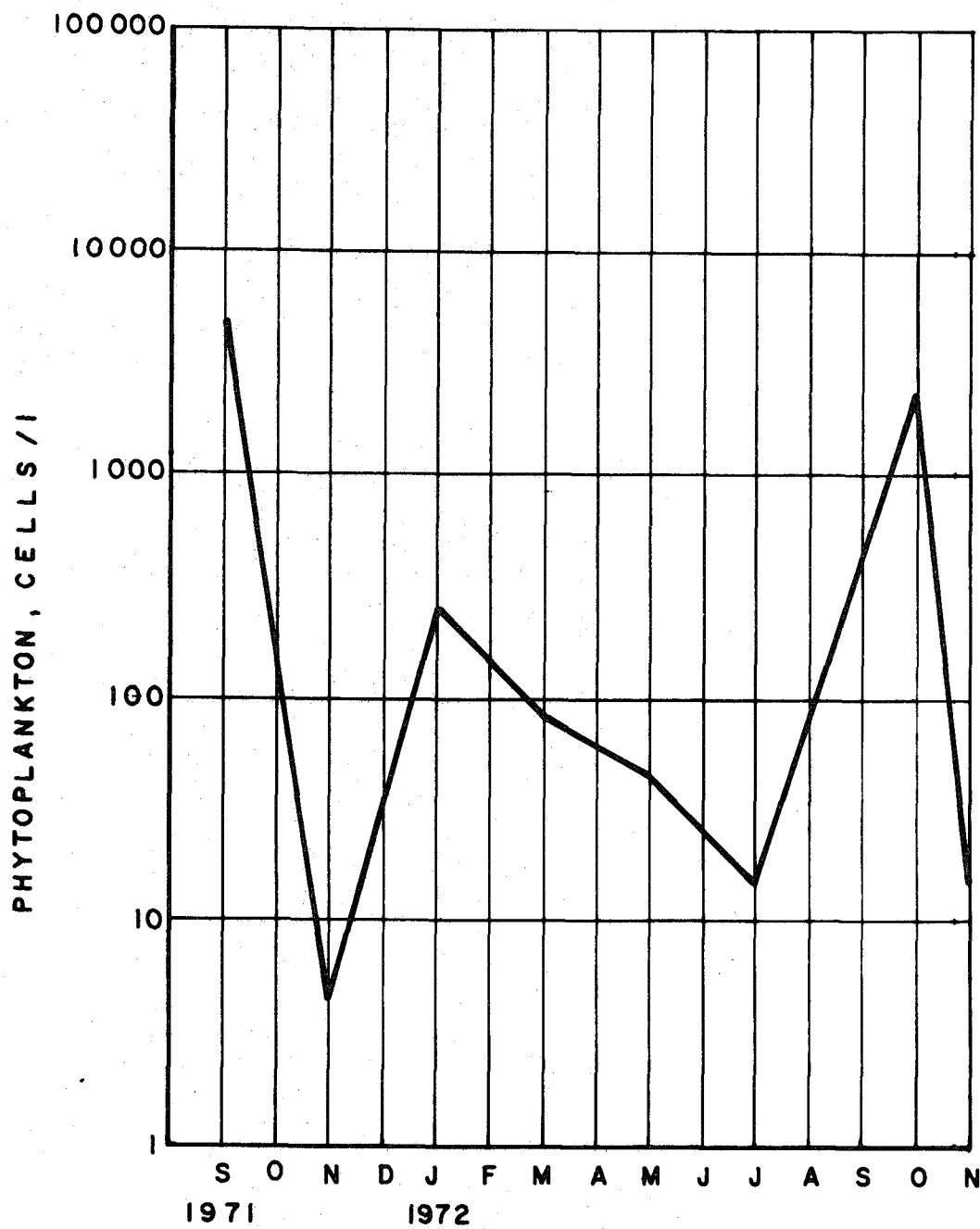
FLORIDA POWER & LIGHT COMPANY
 ST. LUCIE PLANT UNIT 2
 MONTHLY DISSOLVED OXYGEN
 STATION V
 FIGURE 2.7-12



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PHYTOPLANKTON CELL COUNTS
STATION 1

FIGURE 2.7-13



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PHYTOPLANKTON CELL COUNTS
STATION II

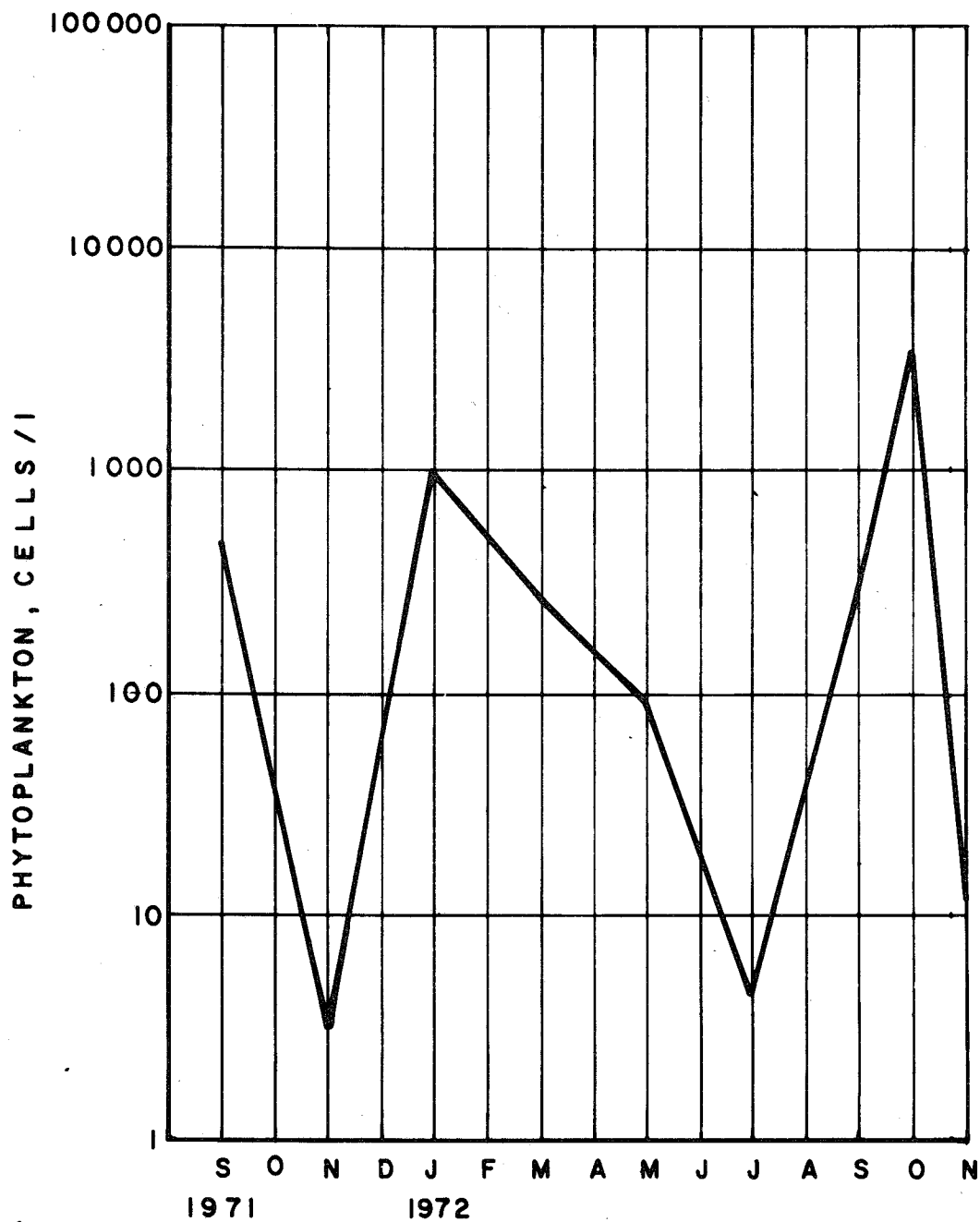
FIGURE 2.7-14



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PHYTOPLANKTON CELL COUNTS
STATION III

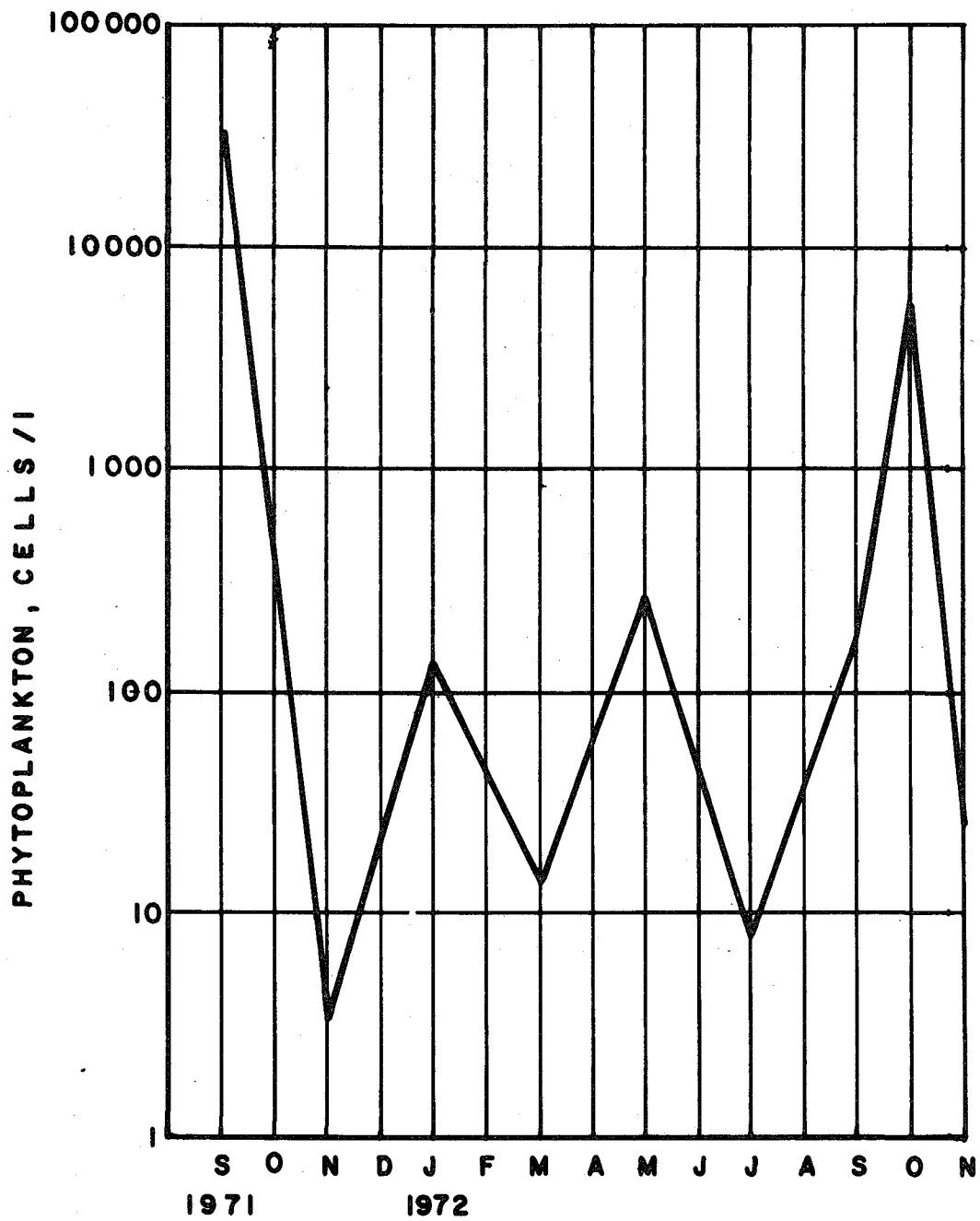
FIGURE 2.7-15



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PHYTOPLANKTON CELL COUNTS
STATION IV

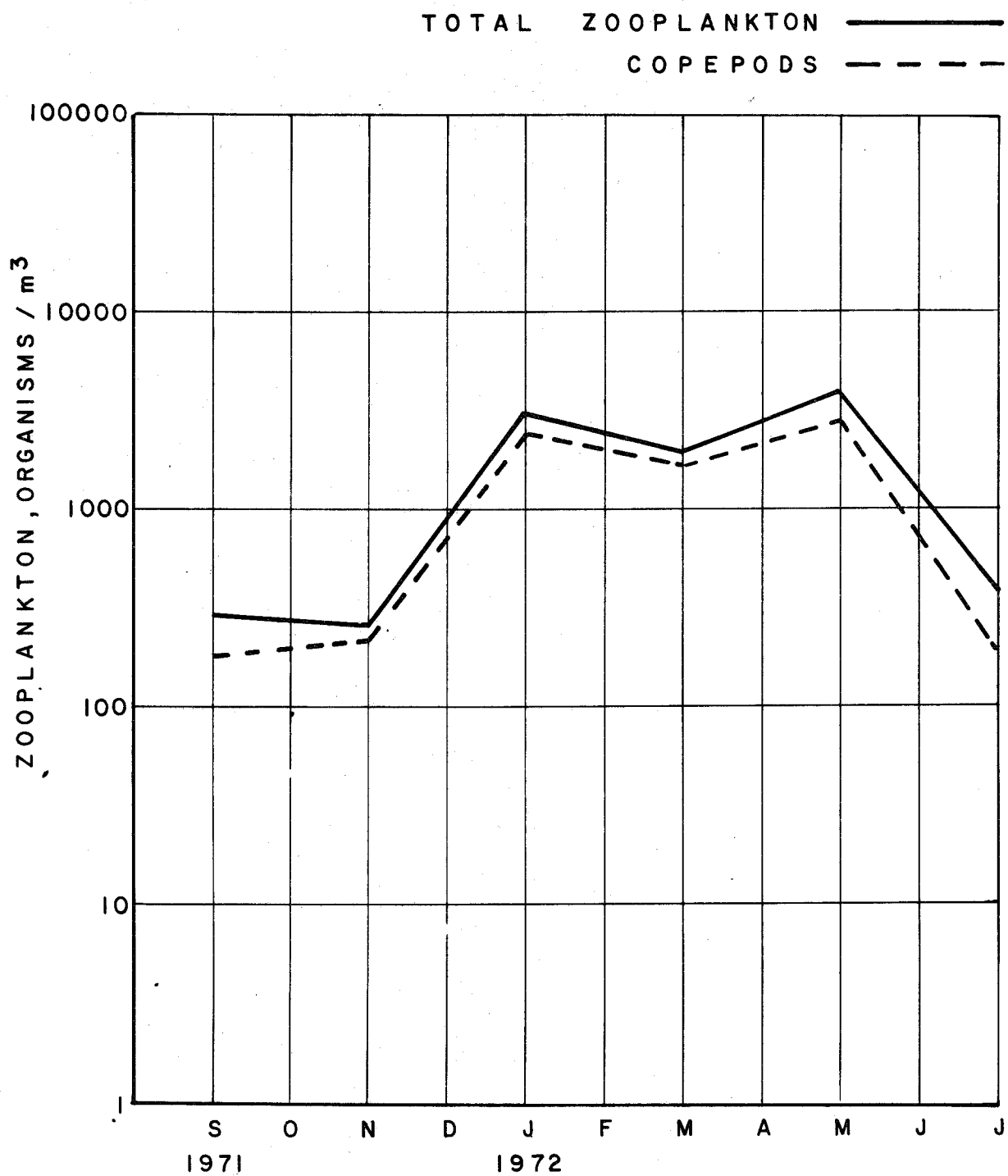
FIGURE 2.7-16



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PHYTOPLANKTON CELL COUNTS
STATION V

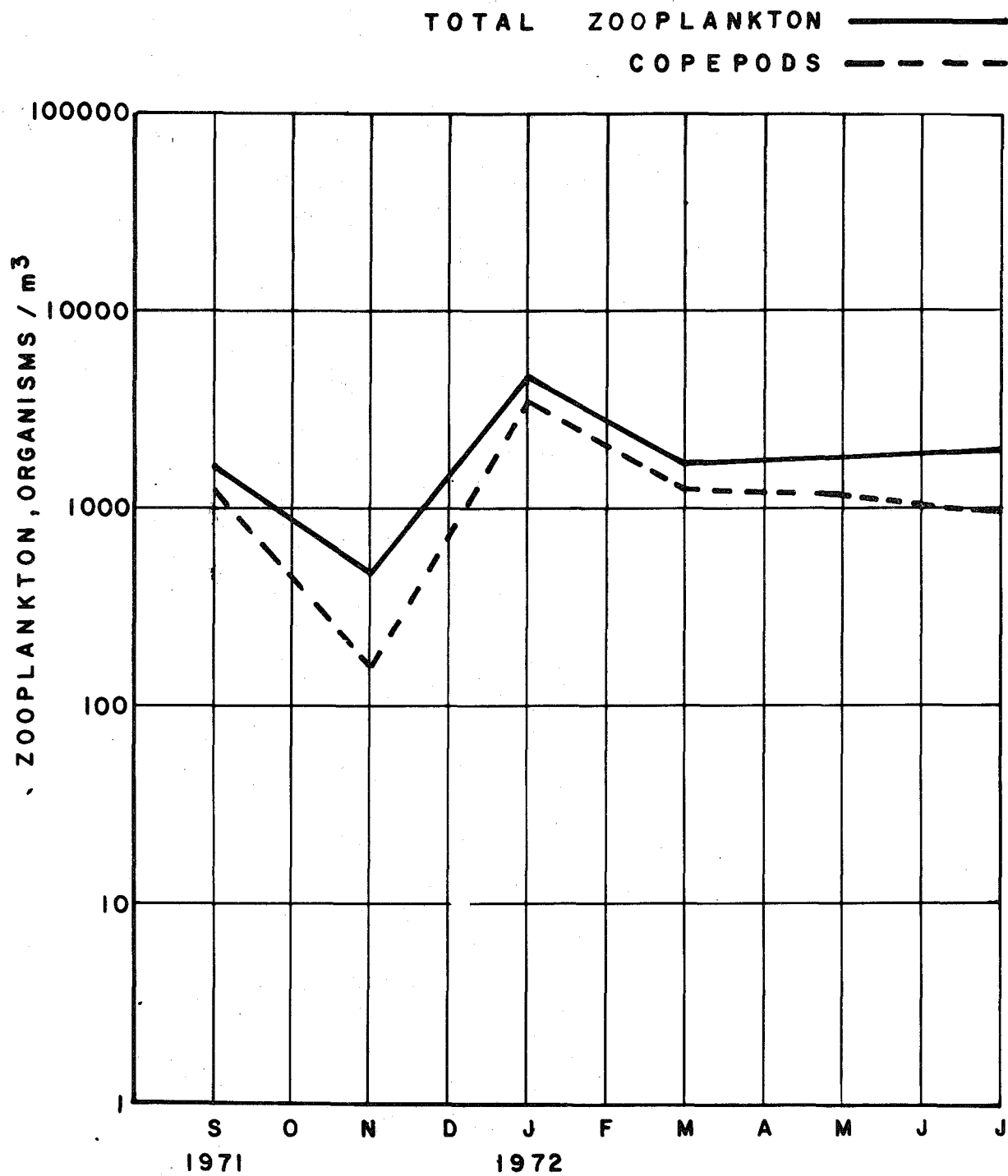
FIGURE 2.7-17



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ZOOPLANKTON COUNTS
STATION 1

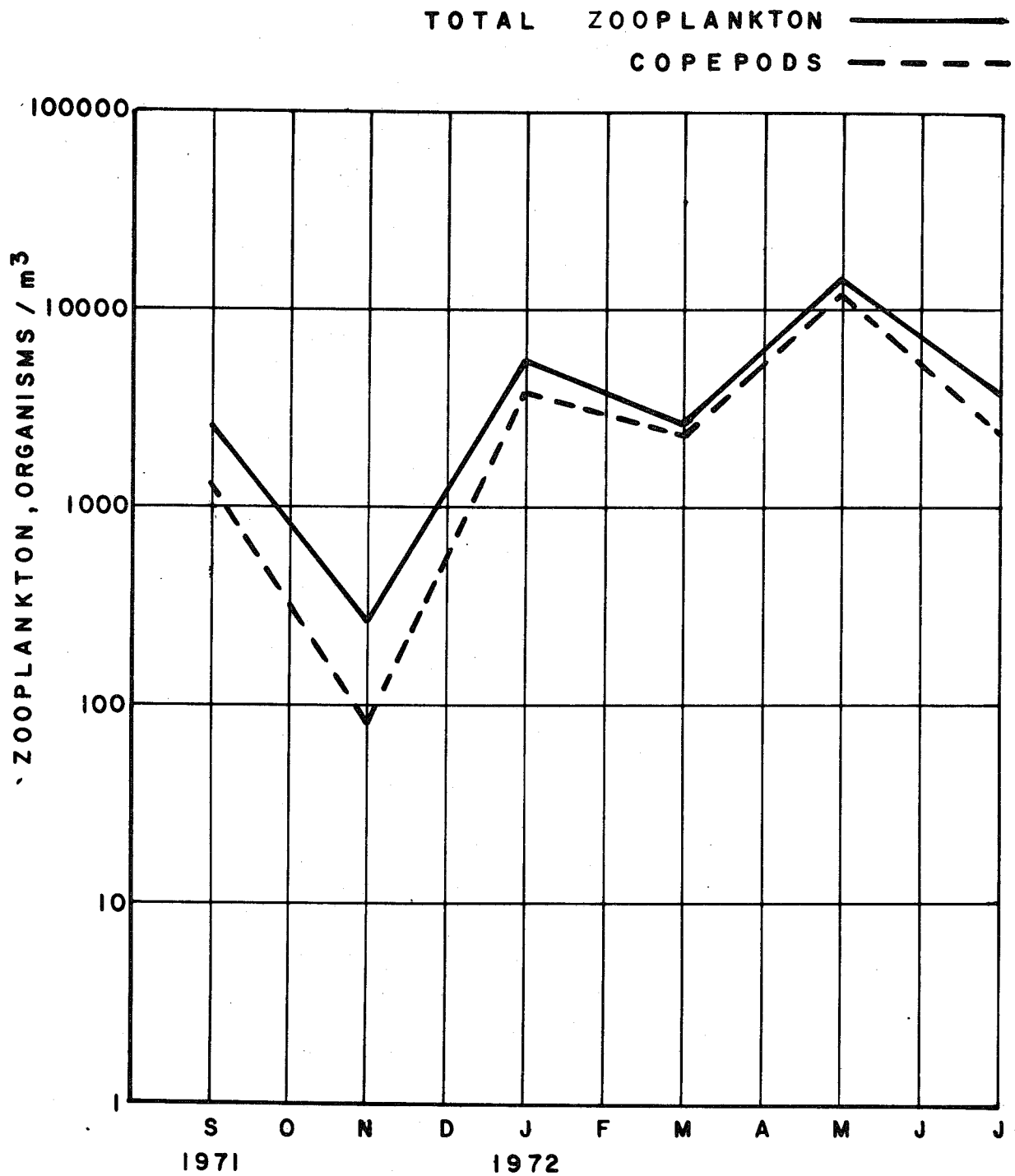
FIGURE 2.7-18



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ZOOPLANKTON COUNTS
STATION II

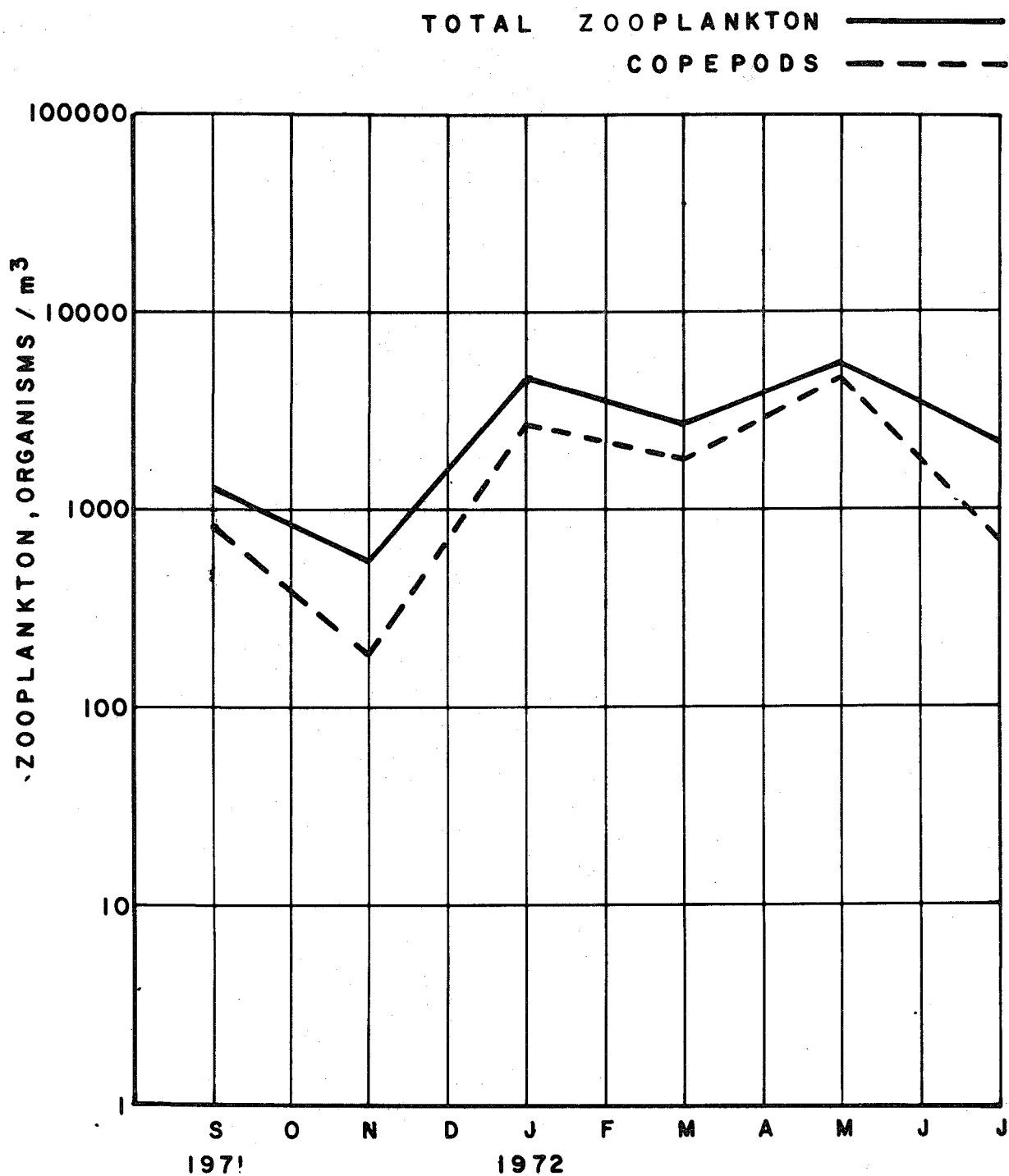
FIGURE 2.7-19



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ZOOPLANKTON COUNTS
STATION III

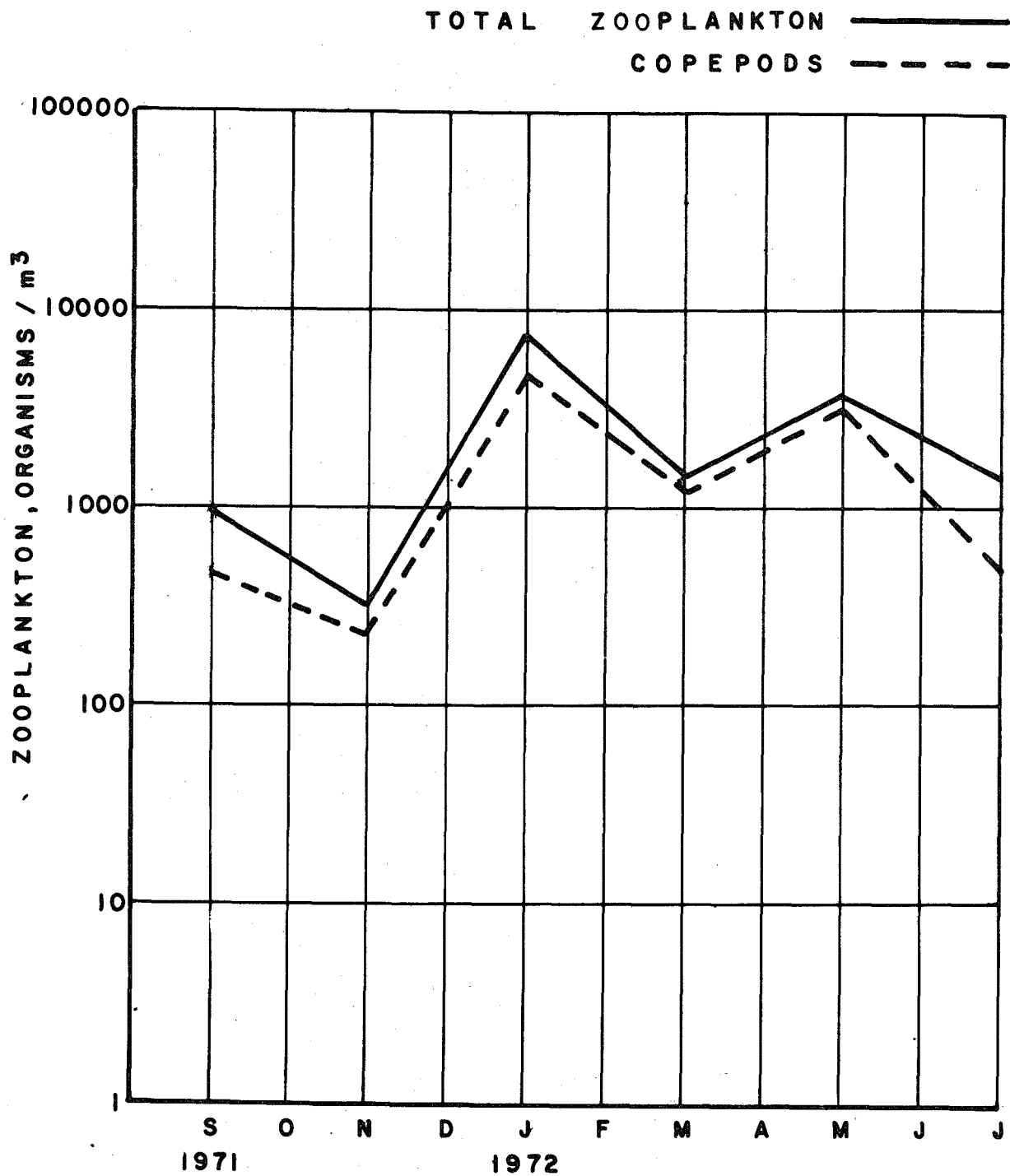
FIGURE 2.7-20



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ZOOPLANKTON COUNTS
STATION IV

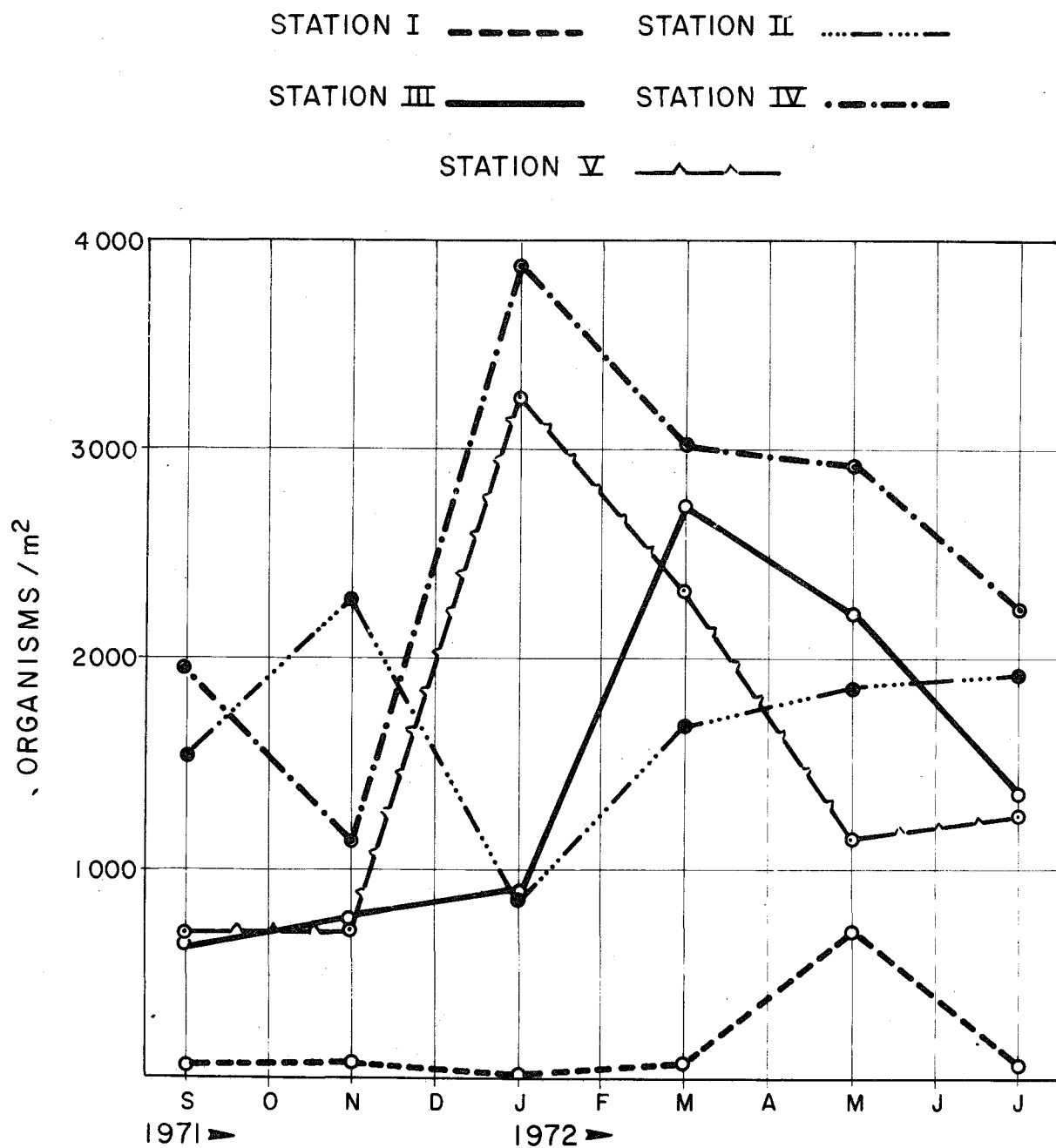
FIGURE 2.7-21



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ZOOPLANKTON COUNTS
STATION V

FIGURE 2.7-22



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

BENTHIC ORGANISMS COLLECTED AT
HUTCHINSON ISLAND
(EXCLUDING ANNELIDS, ECHINODERMS
AND GASTROPODS)
FIGURE 2.7-23

2.8 BACKGROUND RADIOLOGICAL CHARACTERISTICS

The Florida State Division of Health, in cooperation with FP&L, has been conducting a preoperation radiation monitoring program for Unit No. 1 and sequentially for Unit No. 2 since January 1971. When Unit No. 1 begins commercial operation (1975) the program will evolve into an operational monitoring program for Unit No. 1 and a continuing preoperational radiation monitoring program for Unit No. 2. This will provide approximately nine years of preoperational data for Unit No. 2, which is expected to begin commercial operation in 1979.

The program includes sampling of air, precipitation, surface water, bottom sediment, beach sand, various aquatic biota, mulk, terrestrial biota and soil. Appendix I, of this report, contains the background radiation monitoring data reported from January 1, 1971 to December 30, 1972.

Table 2.8-1 summarizes the radiation background levels reported during 1971 and 1972. Figures 2.8-1 and 2.8-2 show the radiological surveillance sampling stations and marine biota sampling stations, respectively. The annual whole body background gamma exposure at the St. Lucie Site is expected to be 120 mrem.

0

TABLE 2.8-1

TYPICAL BACKGROUND CONCENTRATIONS - 1971

Well Water (pCi/l)	- 20
Sea Water (pCi/l)	- 490; K 40-320
Biota (Fish) (pCi/kg)	-3000; K 40-2000; Fe 55-30; Sr 90-18
Citrus (pCi/kg)	-1800; K 40-1700; Sr 90-40; Cs 137-70
Milk (pCi/l)	K 40-150; Sr 90-6; I 131--; Cs 137-90
Soil (pCi/kg)	K 40-400; Zr 95-100; Cs 137-200
Beach Sand (pCi/kg)	Zr 95-70; Cs 137-200; Ce 144-400

TYPICAL BACKGROUND CONCENTRATIONS - 1972

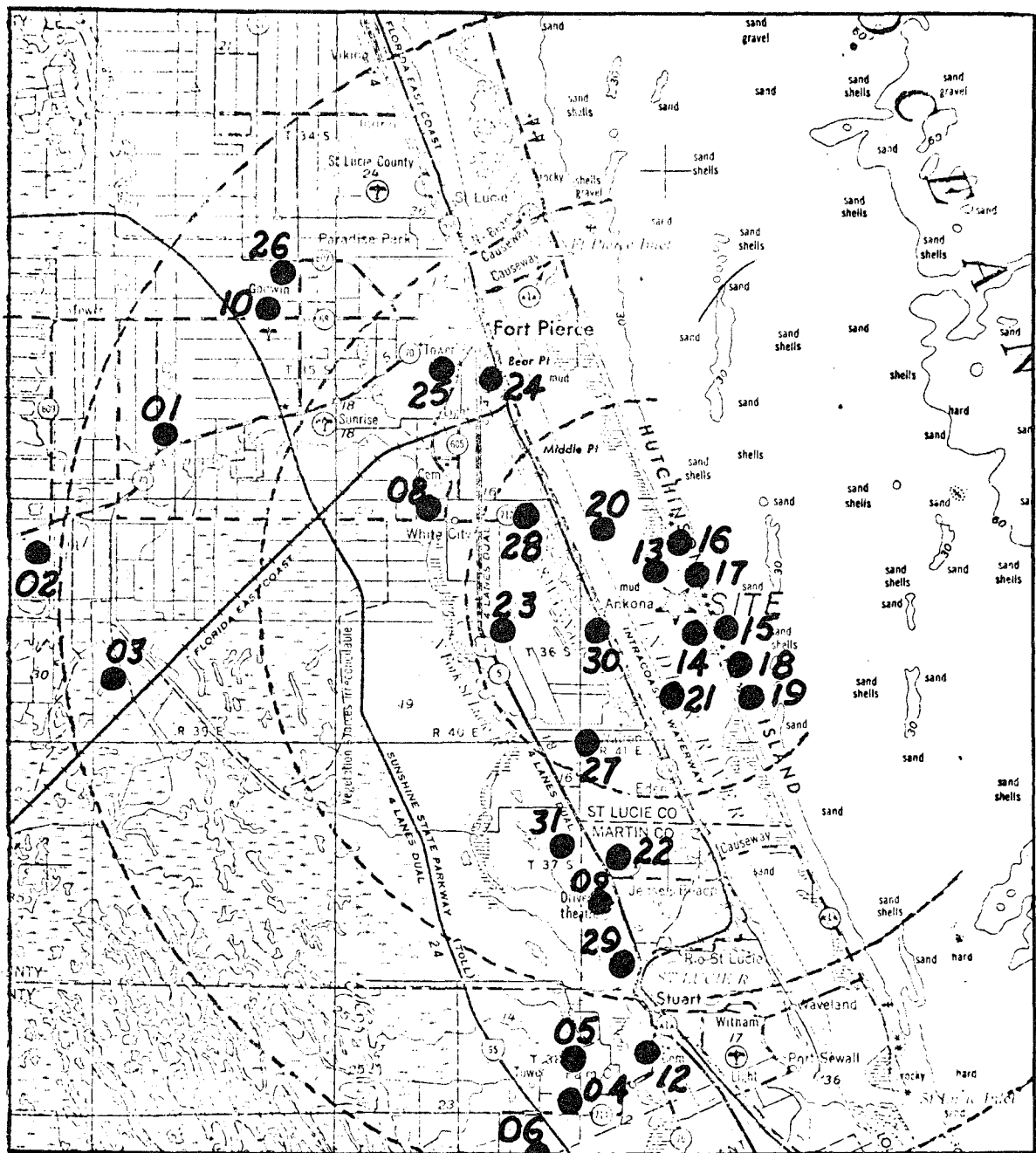
Well Water (pCi/l)	-less than MDA*
Sea Water (pCi/l)	-496; K 40-464
Biota (Fish) (pCi/kg)	-2800; K 40-2230; Sr 90-7
Citrus (pCi/kg)	-1950; K 40-2160; Sr 90-50; Cs 137-85
Milk (pCi/l)	K 40-1500; Sr 90-less than MDA; I 131- less than MDA; Cs 137-88
Soil (pCi/kg)	K 40-900; Zr 95-130; Cs 137-210
Beach Sand (pCi/kg)	Cs 137-less than MDA; Zr 95-84; Ce 144- less than MDA

* MDA's are reported in Table 6.1-4, Section 6.1.5.

0

Image Quality

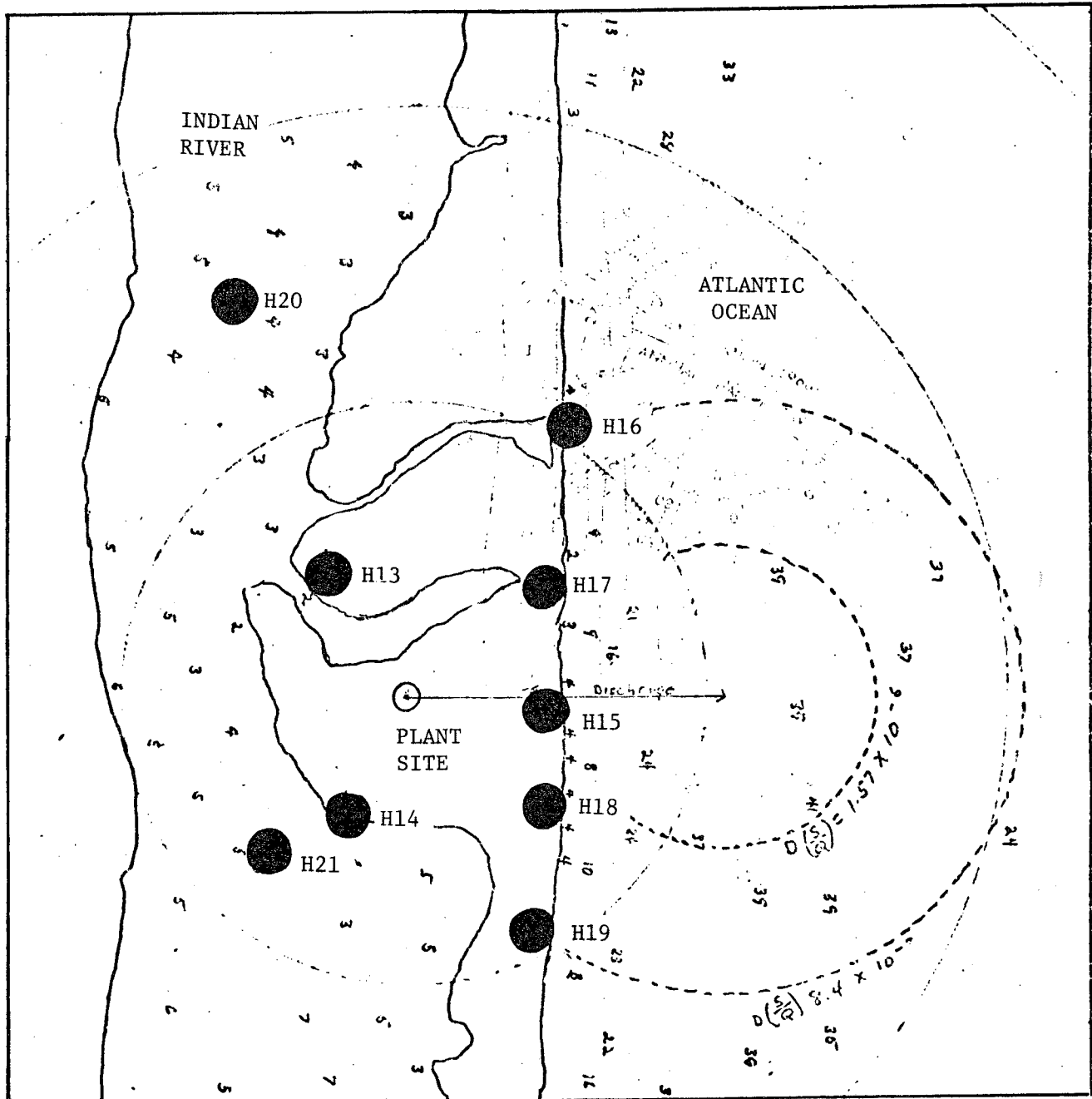
As you review the next group of images, Please note that the original documents were of poor quality.



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

RADIOLOGICAL SURVEILLANCE
SAMPLING STATIONS

FIGURE 2.8-1



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

MARINE BIOTA SAMPLING LOCATIONS

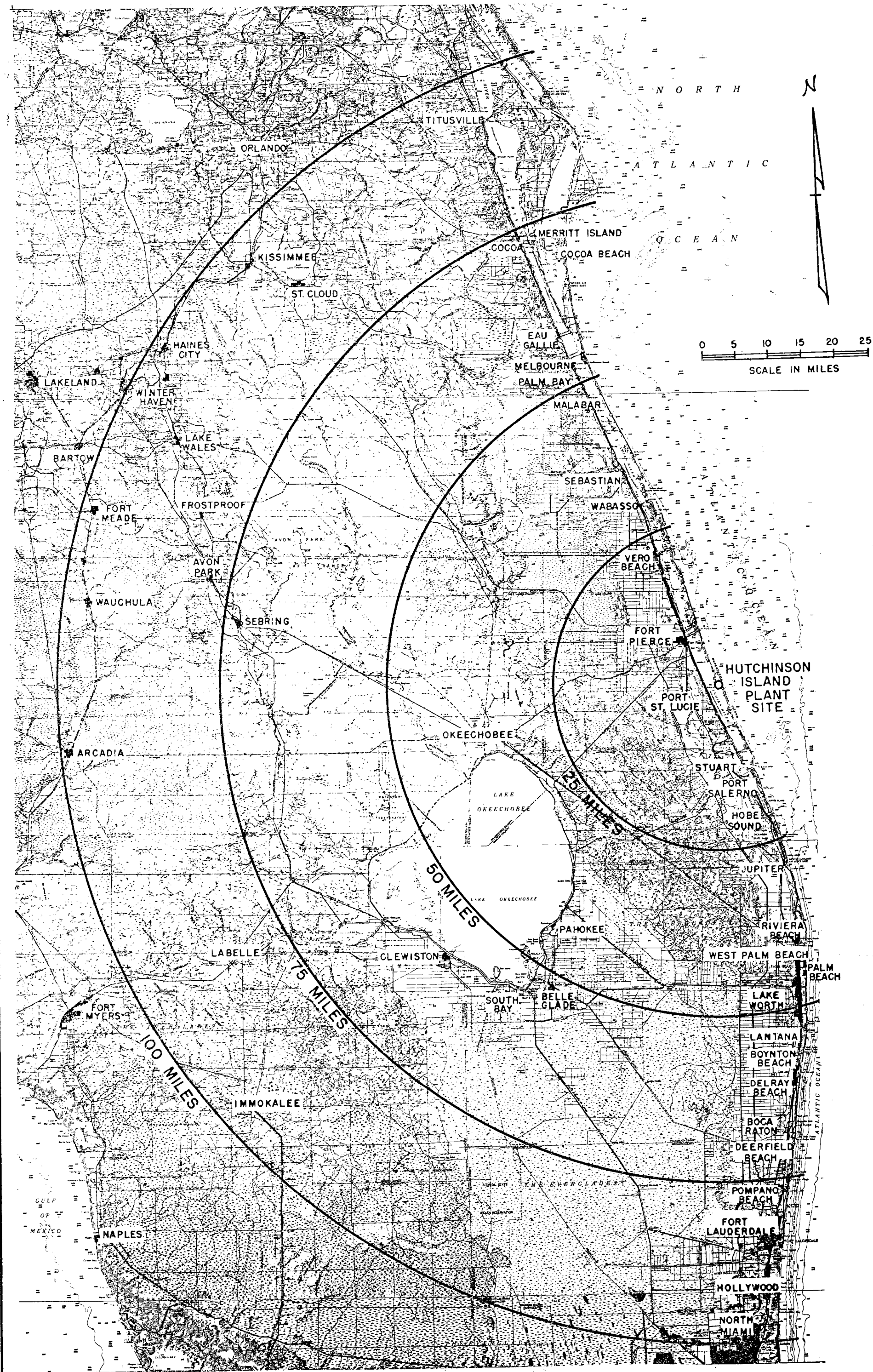
FIGURE 2.8-2

2.9 OTHER ENVIRONMENTAL FEATURES

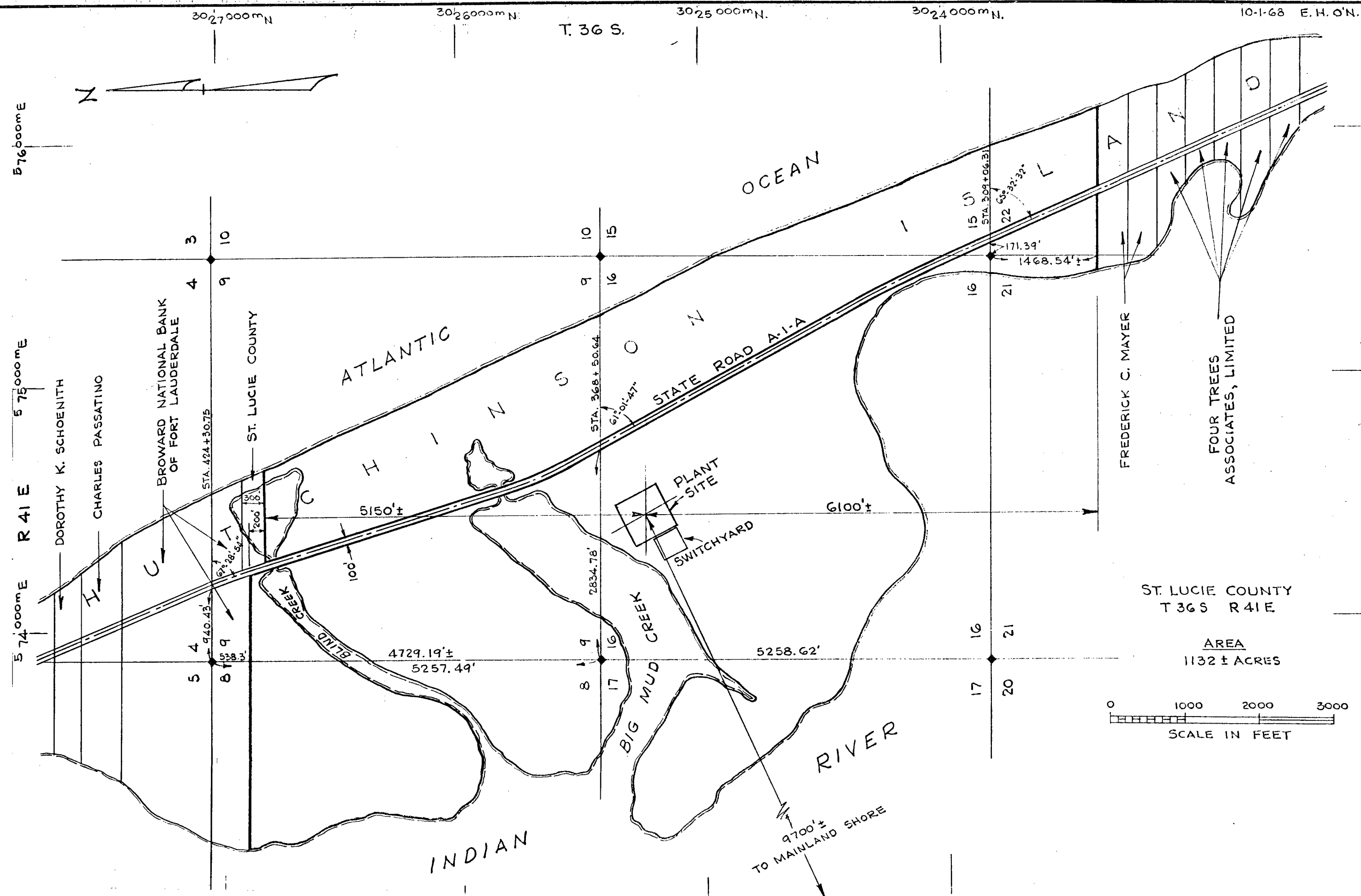
Other than those discussed in the eight preceeding sections, there are no additional environmental features pertinent to a description of the physical and ecological characteristics of the Saint Lucie site.

Image Quality

As you review the next group of images, Please note that the original documents were of poor quality.



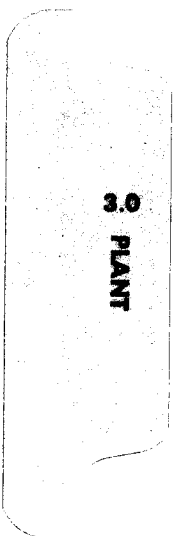
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
GENERAL LOCATION MAP
FIGURE 2.1-2



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PROPERTY PLAN

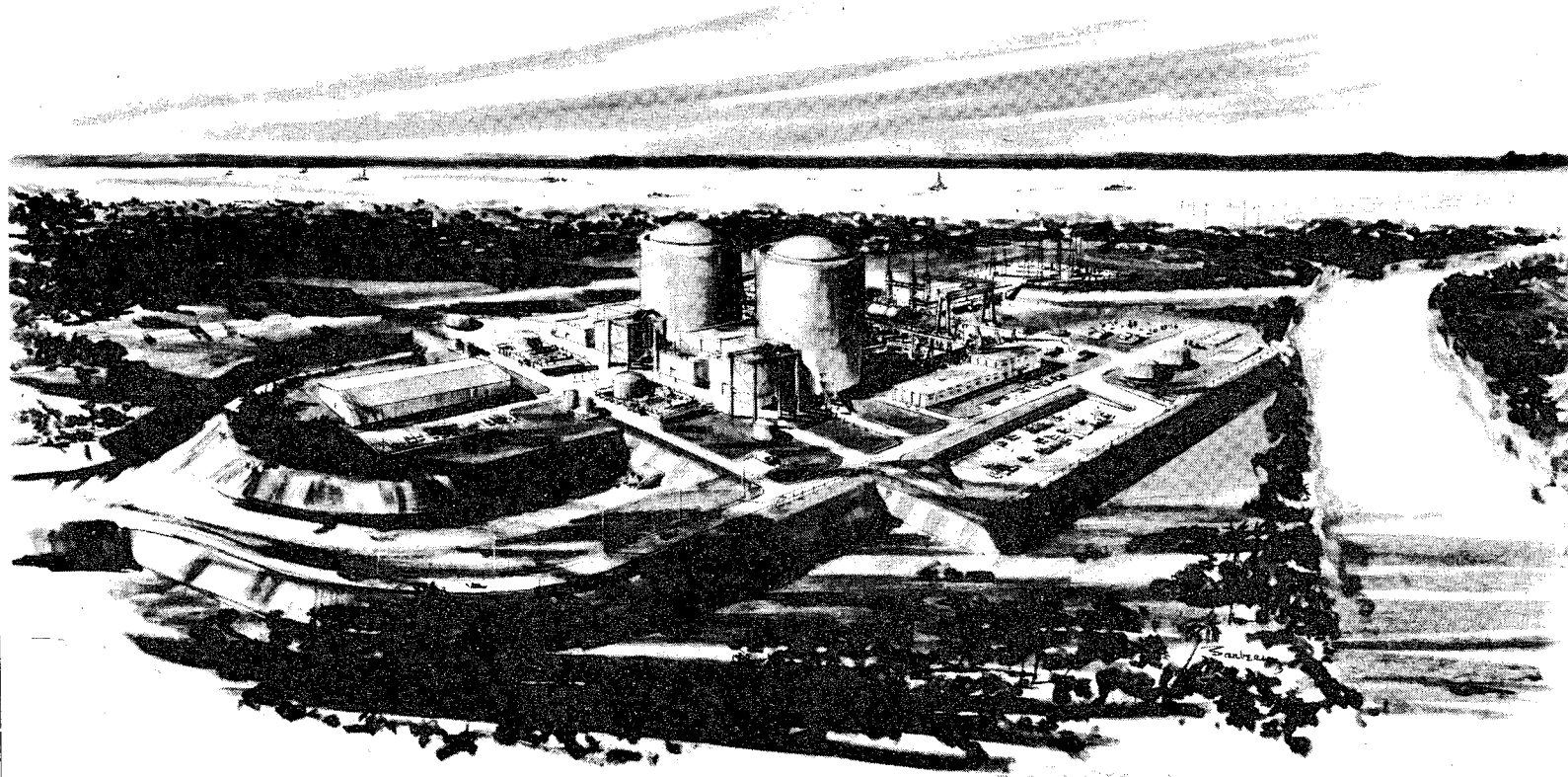
FIGURE 2.1-4



3.1 EXTERNAL APPEARANCE

Figure 3.1-1 depicts the St. Lucie Plant and its immediate surroundings after the completion of Unit No. 2. Plans for landscaping the site are not yet complete, however, the post construction landscape will be made environmentally compatible with the surrounding area. Section 2.1 of this report provides a detailed description of the St. Lucie Site as well as figures showing the plant perimeter and exclusion boundary. Figures 10.1-3 and 10.1-4 are aerial photographs of the site taken during the construction of Unit No. 1 on November 17, 1972.

The radioactive liquid and gaseous release points are shown on Figure 3.5-6.



FLORIDA POWER & LIGHT COMPANY, ST. LUCIE PLANT, UNITS 1 & 2

ERASCO SERVICES INCORPORATED, NEW YORK, N.Y. 3-1-73 REV 3-15-73

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ARTIST'S RENDITION OF COMPLETED
FACILITY - UNIT NO. 2 ON LEFT

FIGURE 3.1-1

3.2 REACTOR AND STEAM ELECTRIC SYSTEM

a) Reactor

The reactor core is fueled with uranium dioxide pellets enclosed in zircaloy tubes with welded end plugs. The tubes are fabricated into assemblies in which end fittings prevent axial motion and grids prevent lateral motion of the tubes. The core consists of 217 fuel assemblies loaded with three different U-235 enrichments. The control element assemblies (CEA's) consist of NiCrFe alloy clad boron carbide absorber rods which are guided by tubes located within the fuel assembly.

The reactor vessel and its closure head are fabricated from manganese-moly steel internally clad with stainless steel. The vessel and its internals are designed so that the integrated neutron flux (greater than 1.0 Mev) at the vessel wall will be less than 2.14×10^{19} nvt over a 40-year period.

The internal structures include the core support barrel, the core support plate, the core shroud, the thermal shield, and the upper guide structure assembly. The core support barrel is a right circular cylinder supported from a ring flange from a ledge on the reactor vessel. It carries the entire weight of the core. The core support plate transmits the weight of the core to the core support barrel by means of vertical columns and a beam structure. The core shroud surrounds the core and minimizes the amount of bypass flow. The upper guide structure provides a flow shroud for the CEA's and prevents upward motion of the fuel assemblies during pressure transients. Lateral motion limiters are provided at the lower end of the core support barrel assembly.

b) Reactor Coolant System

The reactor coolant system is arranged as two closed loops connected in parallel to the reactor vessel. Each loop consists of one 42-in.-ID outlet (hot) pipe, one steam generator, two 30-in.-ID inlet (cold) pipes and two pumps. An electrically heated pressurizer is connected to one of the loops and a safety injection line is connected to each of the four inlet legs.

The reactor coolant system operates at a nominal pressure of 2,250 psi absolute. The reactor coolant enters near the top of the reactor vessel, then flows downward between the reactor vessel shell and the core support barrel into the lower plenum. It then flows upward through the core, leaves the reactor vessel, and flows through the tube side of the two vertical U-tube steam generators where heat is transferred to the secondary system. Reactor coolant pumps return the reactor coolant to the reactor vessel.

The two steam generators are vertical shell and U-tube units. The steam generated in the shell side of the steam generator flows upward through moisture separators which are designed to reduce its moisture content to less than 0.2 percent. All surfaces in contact with the reactor coolant are either stainless steel or NiCrFe alloy in order to maintain reactor coolant purity.

The reactor coolant is circulated by four electric motor driven single-suction centrifugal pumps. The pump shafts are sealed by mechanical seals. The seal performance is monitored by pressure and temperature sensing devices in the seal system.

c) Containment

The containment is comprised of a steel containment vessel surrounded by a reinforced concrete shield building. The containment vessel is a low leakage steel shell which is designed to confine the radioactive material that could be released from a postulated loss of integrity of the reactor coolant system boundary coupled with gross failure of fuel elements in the core. It is a cylindrical vessel with hemispherical dome and ellipsoidal bottom. The shield building is a medium leakage concrete structure which surrounds the steel containment vessel. It protects the containment vessel from external missiles, and provides biological shielding and a means of collecting radioactive fission products that may leak from the containment following a major hypothetical accident.

The containment in conjunction with the engineered safety features is designed to withstand the internal pressure and coincident temperature resulting from the energy release associated with the worst postulated loss-of-coolant accident at a power level of 2,700 Mwt.

d) Engineered Safety Features

Engineered safety features comprise several systems provided to protect the public and plant personnel in the highly unlikely event of an accidental release of radioactive fission products from the reactor system, particularly as the result of loss-of-coolant accidents. These safeguards function to localize, control, mitigate, and terminate such accidents to hold exposure levels below applicable limits.

The engineered safety features are:

- 1) Safety injection system (including high pressure and low pressure safety injection pumps and the safety injection tanks)
- 2) Containment spray system
- 3) Containment cooling system
- 4) Shield building ventilation
- 5) Hydrogen recombiner and purge
- 6) Containment isolation

In the highly unlikely event of a loss-of-coolant accident, the safety injection system injects borated water into the reactor coolant system. This provides cooling to limit core damage and fission product release, and assures adequate shutdown margin regardless of temperature. The

injection systems also provide continuous long-term post-accident cooling of the core by recirculation of borated water from the containment sump.

The containment is equipped with two 100 percent capacity spray systems and an independent full capacity containment cooling system for cooling the containment atmosphere following the postulated loss-of-coolant accident.

The containment sprays supply borated water to cool and reduce pressure in the containment atmosphere. The system is designed so that with one pump, one set of spray nozzles, and one shutdown cooling heat exchanger in operation, adequate cooling is provided to cool the containment atmosphere. The pumps take suction initially from the refueling water tank. Long term cooling is based on suction from the containment sump through the recirculation lines.

The containment cooling system is designed to provide containment atmosphere mixing by recirculation. The cooling coils and fans of the containment cooling system are sized to provide adequate containment cooling at post-accident conditions of temperature and humidity.

A shield building ventilation system is provided to maintain a negative pressure in the annulus between the steel containment and the concrete shield building following a loss-of-coolant accident. Two independent 100 percent capacity systems are provided. This system reduces the escape of radioactivity to the environment. The out-leakage from the containment is consolidated with the in-leakage from the outside into the annulus, because of the negative pressure. It is processed before being released into the atmosphere.

e) Plant Instrumentation and Control

The reactor control system provides for startup and shutdown of the reactor and for adjustment of the reactor power in response to turbine load demand. The Nuclear Steam Supply System is capable of following a ramp change from 15 percent to 100 percent power at a rate of ± 5 percent per minute and at greater rates over smaller load change increments up to a step change of 10 percent. This control is normally accomplished by automatic movement of one or more preselected groups of CEA's in response to a change in reactor coolant temperature, with manual control capable of overriding the automatic signal at any time. A temperature controller compares the existing average reactor coolant temperature with the value corresponding to the power called for by the temperature control program. If the temperature is different, the CEA's are adjusted until the difference is zero. Regulation of the reactor coolant temperature in accordance with this program maintains the secondary steam pressure within operating limits and matches reactor power to load demand.

The reactor is controlled by a combination of control element assemblies and dissolved boric acid in the reactor coolant. Boric acid is used for reactivity changes associated with large but gradual changes in water temperature and fuel burnup. Additions of boric acid also provide an increased shutdown margin during the initial loading and subsequent refuelings.

CEA movement provides changes in reactivity for shutdown or power changes. The CEA's are actuated by control drive mechanisms mounted on the reactor vessel head. The control drive mechanisms are designed to permit rapid insertion of the CEA's into the reactor core by gravity. CEA motion can be initiated manually or automatically.

The pressure in the reactor coolant system is controlled by regulating the temperature of the coolant in the pressurizer, where steam and water are held in thermal equilibrium. Steam is formed by the pressurizer heaters or condensed by the pressurizer spray to reduce variations caused by expansion and contraction of the reactor coolant due to reactor system temperature changes.

Over-pressure protection is provided by power-operated relief valves and spring-loaded safety valves connected to the pressurizer and designed in accordance with Section III of the ASME code. The discharge from the pressurizer safety and relief valves is released under water in the pressurizer quench tank, where it is condensed and cooled. In the event the discharged steam exceeds the capacity of the tank, the tank relieves to the containment atmosphere.

f) Instrumentation

The nuclear instrumentation includes out-of-core and in-core flux detectors. Ten channels of out-of-core instrumentation monitor the neutron flux and provide reactor protection and control signals during startup and power operation. Four of the channels follow the neutron flux through the startup range, and six channels follow the neutron flux from within the startup range through the full power range. Of the latter, four are used for reactor protection and two for reactor control. The neutron flux detectors are located in instrument thimbles in the biological shield around the reactor vessel.

The in-core monitors provide information on neutron flux distribution.

The reactor parameters are maintained within the acceptable limits by the inherent characteristics of the reactor, by the CEA system, by boron in the moderator and by the operating procedures. In addition, in order to preclude unsafe conditions for plant equipment or personnel, the reactor protective system initiates reactor shutdown if selected parameters reach their preset limits. Four independent channels normally monitor each of the selected plant parameters. The reactor protective system logic is designed to initiate protective action whenever the signal of any two of four channels reaches the preset limit. Redundancy is provided in all parts of the reactor protective system to assure that no single failure will prevent protective action when it is required.

The process instrumentation monitoring includes those critical channels which are used for protective action. Additional temperature, pressure, flow and liquid level monitoring is provided, as required, to keep the operating personnel informed of plant conditions, and to provide information from which plant processes can be evaluated and/or regulated. The boron concentration in the reactor coolant water is also monitored and the information is presented in the control room.

Instrument signals penetrating the containment are electric. Instrument signal transmission for the remaining plant instruments is either electric or pneumatic depending on the function to be served. The wiring and cabling between sensor locations and control room or control panel are physically separated and mechanically protected.

The plant gaseous and liquid effluents are monitored for radioactivity. Activity levels are displayed and off-normal values are annunciated. Area monitoring stations are provided to measure radioactivity at selected locations in the plant.

g) Electrical Systems

The St. Lucie plant includes a 1,000 Mva, 0.85 power-factor generator delivering power to a 240 kv switchyard through a step-up power transformer. Auxiliary power is utilized at 6.9 kv, 4.16 kv, 480 v, and 120 v ac. 125 v dc systems are also provided for emergency power, engineered safety features control, and essential nuclear instrumentation.

The auxiliary load is normally supplied from two auxiliary transformers connected to the main generator bus. Startup power is supplied from two startup transformers connected to the 240 kv switchyard. Emergency power for the engineered safety features is supplied by redundant diesel generators.

h) Auxiliary Systems

1) Chemical and Volume Control System

The activity level in the reactor coolant system is controlled by continuous purification of a bypass stream of reactor coolant. Water removed from the reactor coolant system is cooled in the regenerative heat exchanger. From there, the coolant flows to the letdown heat exchanger and then through a filter and a demineralizer where corrosion and fission products are removed. It is then sprayed into the volume control tank, and returned to the reactor coolant system by the charging pumps.

The chemical and volume control system automatically adjusts the amount of reactor coolant to compensate for changes in specific volume due to coolant temperature changes and reactor coolant pump shaft controlled seal leakage in order to maintain a constant level in the pressurizer.

The CVCS system injects chemicals into the reactor coolant system to control coolant chemistry and minimize corrosion.

2) Shutdown Cooling System

The shutdown cooling system is used to reduce the temperature of the reactor coolant at a controlled rate from 300 F approximately to a refueling temperature of approximately 130 F and to maintain the proper reactor coolant temperatures during refueling.

The shutdown cooling system utilizes the low-pressure safety injection pumps to recirculate the reactor coolant through two shutdown heat exchangers, returning it to the reactor coolant system through the low-pressure injection header. Use of one shutdown heat exchanger will provide cooldown capability at a reduced rate.

The component cooling system supplies cooling water for the shutdown heat exchangers.

3) Component Cooling Water System

The component cooling water system, consisting of three pumps and two heat exchangers, removes heat from the various auxiliary systems associated with the reactor coolant system. Corrosion inhibited, demineralized water is circulated by the system through all components of the nuclear steam supply system that require cooling water. During reactor shutdown, component cooling water is also circulated through the shutdown heat exchangers. The component cooling system provides an intermediate barrier between the reactor coolant system and the intake cooling water system and thus helps prevent release of activity directly into the environment in the event of a leak from the primary to the secondary side.

4) Fuel Handling and Storage

New fuel is stored dry in vertical racks within a storage vault in the fuel handling building. Room is provided for storing approximately one-third of a core. The vault construction and fuel assembly spacing preclude accidental criticality.

The fuel pool is a reinforced concrete stainless steel lined structure which provides storage capacity for approximately one and one-third cores. Spent fuel assemblies are stored in vertical racks so spaced as to preclude criticality with no credit taken for the borated pool water.

Cooling and purification equipment is provided for the fuel pool water. This equipment may also be used for cleanup of refueling water after each fuel change in the reactor.

The fuel handling systems provide for the safe handling of fuel assemblies and control element assemblies under all foreseeable conditions and for the required assembly, disassembly, and storage of reactor internals. These systems include a refueling machine located inside containment above the refueling pool, the fuel transfer carriage, the tilting machines, the fuel transfer tube, a fuel handling machine in the spent fuel storage room, and various devices used for handling the reactor vessel head and internals.

5) Sampling Systems

Two sampling systems are provided; one for the reactor coolant and its auxiliary systems, and one for the turbine steam and feedwater system.

These systems are used for determining both chemical and radiochemical conditions of the various process fluids used in the plant.

6) Cooling Water Systems

The surface condenser is cooled by the circulating water system which takes suction from, and discharges into, the Atlantic Ocean, by a combination of pipes and canals.

An intake cooling water system provides seawater from the circulating water system intake structure to the component cooling water heat exchangers and the turbine cooling water heat exchangers.

The turbine cooling water system removes heat from the turbine generator oil cooler, hydrogen coolers, feed pump oil coolers, sample coolers, and other components by circulating demineralized water buffered with potassium dichromate through the system.

7) Plant Ventilation Systems

Separate ventilation systems are provided for the containment vessel, the control room, the auxiliary building, and the turbine building. A purge system is also provided for the containment vessel atmosphere.

The annular space between the steel containment vessel and the concrete shield building has a separate ventilation system with charcoal filters. This system is automatically put into operation following a loss-of-coolant accident.

8) Plant Fire Protection System

The fire protection system provides water to fire hydrants, spray systems and hose racks in the various areas of the plant.

Where possible, noncombustible and fire resistant materials are used throughout the facility, particularly in areas containing critical portions of the plant such as the containment structure, control room, cable spreading room, and rooms containing components of the engineered safety features systems.

A number of portable fire extinguishers are placed at key locations for use in extinguishing limited fires.

Fire detectors with alarms have also been provided at a number of locations where there is heavy concentration of electrical cables and in the diesel generator rooms to get an early warning on potential fire hazards.

TABLE 3.2-1

REACTOR AND STEAM ELECTRIC SYSTEM COMPONENTS

Reactor type	Pressurized water
Full power thermal rating	2560 MWt.
Reactor manufacturer	Combustion Engineering Inc.
Architect-engineer	Ebasco Services Inc.
Number of units	Two
	Unit No. 1 Startup February 1975
	Unit No. 2 Startup September 1979
Turbine generator type	Tandem compound, four flow
	Impulse reaction type
Turbine manufacturer	Westinghouse
Turbine rated output	841 MWe. Gross
Turbine maximum output (not guaranteed)	874 MWe. Gross
Inplant electric power consumption (at full load)	40 MWe.

3.3 PLANT WATER USE

This section describes the water use pattern for the St. Lucie Unit No. 2 in terms of flows and the relative condition of water in each input and output from the various plant water systems. A flow diagram showing overall plant water use is shown in Figure 3.3-1. Table 3.3-1 lists the estimated flow rates.

3.3.1 WATER SOURCES AND CONDITIONS

All water required for normal plant operation will be drawn from either the Atlantic Ocean or the Fort Pierce Municipal Water Supply System. Provisions have been made for emergency cooling water to be drawn from Big Mud Creek in the event that the normal cooling water supply is interrupted. There is no use of ground water on the plant site for plant operation other than what percolates to the ground water from the sanitary waste treatment system and the settling basin located south of the plant. Surface water will be used to maintain the mosquito control program in the undeveloped areas of the plant site.

The plant heat dissipation systems, including condenser cooling water and miscellaneous closed cooling systems will utilize ocean water on a once through basis. The water required for potable, sanitary, and other general uses will be supplied by the Fort Pierce water system, without further treatment. The makeup water supply to the nuclear steam system will also be drawn from the Fort Pierce water system, but will be demineralized in the water treatment system described in Section 10.4.3 prior to use. This is necessary because of the requirement of mineral free water for steam generation. The quality of the Fort Pierce water is shown in Table 3.6-1.

The discharge of various waters from the heat dissipation system, radwaste management system, chemical and biocide system and sanitary waste system are schematically shown in the flow diagram, Figure 3.3-1. The quality of the discharge water from the heat dissipation system will generally be the same as that of ocean water, but will differ from the input condition by increased temperature. As noted in Section 3.4, the temperature rise is estimated at 24 F maximum, 21 F normal full load and an average one day rise is less than 21 F.

Chlorine gas will be added intermittently to the condenser cooling water in order to control the growth of microorganisms in the cooling system. Only one of the eight sections of the condenser will be chlorinated at a time. This addition of chlorine will result in a free residual chlorine concentration of approximately 1.5 mg/l in the condenser cooling water before it enters the discharge canal. This residual chlorine concentration will occur only during the chlorination periods. After entering the discharge canal, the free residual chlorine will be immediately reacted with the chlorine demand from the cooling water flow coming from the other seven untreated water boxes. Thus, any available free chlorine is expected to be consumed prior to discharge to the Atlantic Ocean.

SL2

The radwaste management system discharge will be through 3 in. pipe to the discharge canal. Refer to Section 3.5 for further information on flow variations and quality description.

Release of waste water from the chemical system will be to the circulating water discharge. In this facility, the regenerant waste water from the demineralizer treatment system is estimated normally at 150,000 gallons per day. It is alkaline in character and will be released to the discharge canal after neutralization. Further detailed description on flow variations and quality changes are given in Section 10.4.5 and Figure 3.3-1.

1

Sanitary waste water generated at the plant will be collected and treated in a sewage treatment facility described in Section 3.7. After the treatment, the normal flow will be allowed to percolate through a leaching field to the ground water thereby eliminating any discharge to surface waters from the sanitary waste system.

TABLE 3.3-1

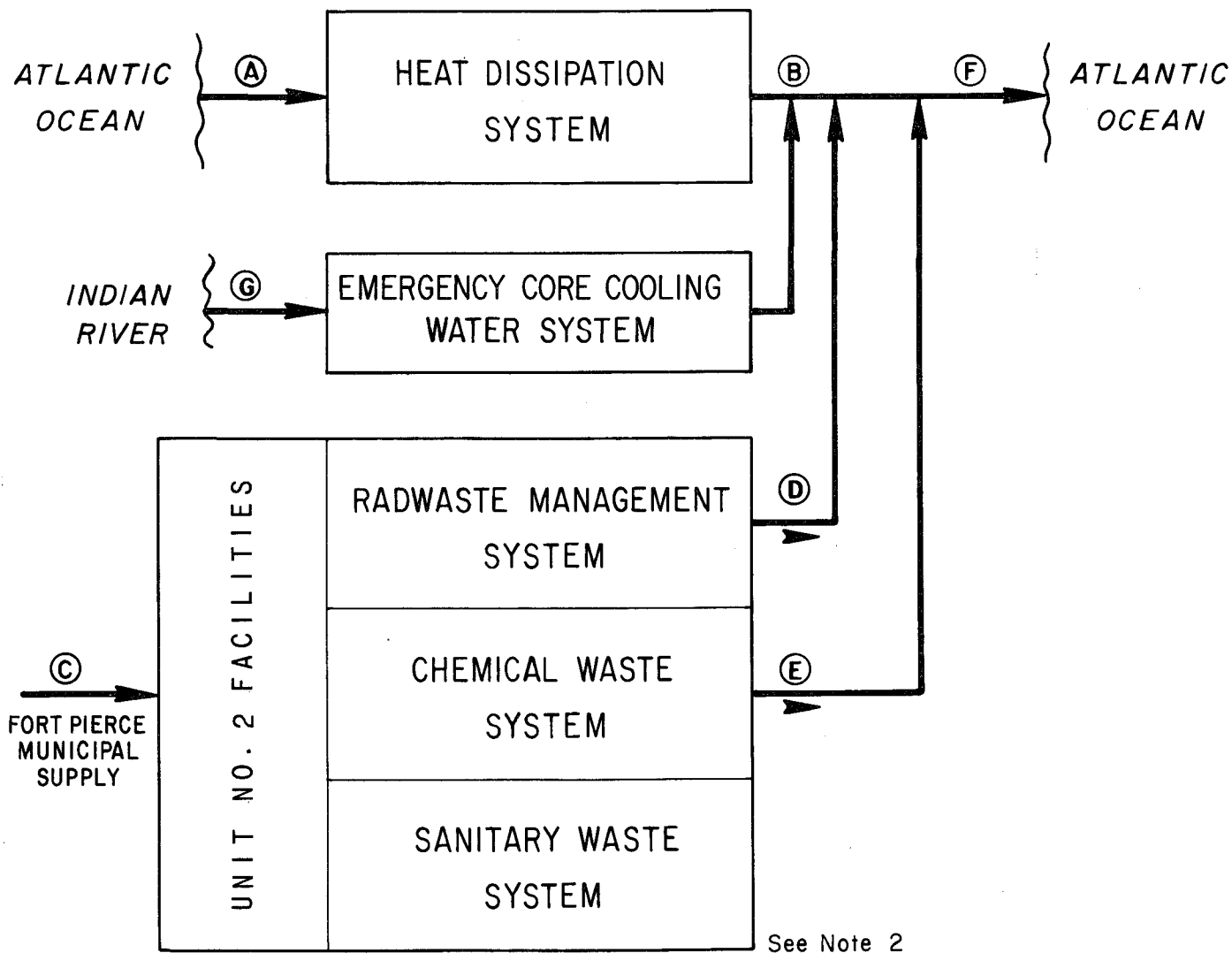
ESTIMATED SYSTEM FLOW RATES FOR UNIT NO. 2
 FLOWS (gpm)

<u>Location</u>	<u>Normal Operation</u>	<u>Maximum Condition</u>	<u>Minimum Condition (Shutdown)</u>
A	530,000	530,000	14,500
B	530,000	530,000	14,500
C	210	550	0
D	3.5	200	0
E	200	500	0
F	530,203.5	530,700	0
G	0	29,000	0

0

Total consumptive use = 210 gpm average

550 gpm maximum



See Note 2

NOTES:

- 1- Refer to Table 3.3-1 for each Stream Flow Rates thus marked (A) etc.
- 2- No Discharge Due to Ground Percolation of Treated Effluent.

AUGUST 1973

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PLANT WATER USE SYSTEM

FIGURE 3.3-1

3.5 RADWASTE SYSTEMS

The waste management system, located in the auxiliary building, is composed of tanks, process equipment and piping necessary for handling radioactive wastes within the confines of the plant and for preparing these wastes for reuse or for offsite disposal. The waste management system includes two subsystems; (1) the boric acid recovery system for normally recoverable liquids, and (2) the waste treatment system for nonrecoverable liquid, gaseous and solid wastes.

The waste treatment system treats all nonrecoverable radioactive liquid wastes, solid wastes and gaseous waste mixtures. The system is also designed to process effluent with an activity level based on plant operation with 1 percent failed fuel although, the anticipated percent of failed fuel is expected to be well below this value. The basic processing methods used are storage, filtration, concentration, and ion exchange. Radioactive solid wastes are compacted in drums for offsite disposal. Any releases of gaseous and liquid effluent from the waste treatment processes shall be in accordance with the provisions of Part 20 of Title 10 of the Code of Federal Regulations. Means are provided to sample potentially radioactive liquid and gaseous wastes in storage tanks prior to their release.

The waste management system is designed to provide controlled treatment and disposal of gaseous and solid wastes and either disposal or reuse of liquid wastes. The principal design criterion concerning disposal is to ensure that the general public is protected by maintaining releases of radioactive materials well within the limits of 10CFR20. Releases of radioactivity will be via the batch process after the stored liquid or gas to be released has been sampled. Liquid will be released to its circulating water discharge canal, which has an 2300 cfs (530,000 gpm) design flow. Gases will be discharged to the plant vent which is located on the side of the shield building and is released to the atmosphere at an elevation of 202 ft.

3.5.1 SOURCE TERMS

Appendix 1 to Regulatory Guide 4.2 "Preparation of Environmental Reports for Nuclear Power Plants" is a questionnaire containing 36 questions concerning basic data utilized in source term calculations. Responses to these questions are provided as Appendix 3A to this document. This Appendix supplements the source term discussions that follow.

3.5.1.1 Fission Products

The mathematic model used for determining the specific concentration of nuclides in the reactor coolant involves a group of time dependent simultaneous equations. The fuel pellet region and reactor coolant region are analyzed by applying a mass balance of production and removal for each nuclide thereby establishing a set of first order, differential equations. In the fuel pellet region the mass balance includes the fission product production by direct fission yield, by parent fission product decay, and by neutron activation, and removal by decay, by neutron activation, and by escape to the reactor coolant. In the coolant region the analysis includes the fission product production by escape from the fuel through defective fuel rod cladding, by parent decay in the coolant, and by neutron activation of coolant fission products. Removal is by decay, by coolant purification, by feed (makeup) and bleed (letdown to waste management system) for fuel burnup, and by

leakage or other feed and bleed due to such operations as cold or hot startups and shutdowns or load follow operations.

The expression derived to determine the fission product inventory in the fuel pellet region is:

$$\frac{dN_{p,i}}{dt} = FY_i P + (f_{i-1} \lambda_{i-1} + \sigma_{i-1} \phi) N_{p,i-1} - (\lambda_{i-1} + \nu_i + \sigma_i \phi) N_{p,i}$$

and in the reactor coolant region is:

$$\begin{aligned} \frac{dN_{c,i}}{dt} = & D \nu_i N_{p,i} + (f_{i-1} \lambda_{i-1} + \sigma_{i-1} \phi_{FCS}) N_{c,i-1} \\ & - \left(\lambda_i + \frac{R}{W} \eta_i + \frac{(1-\eta_i)C}{C_o} \frac{1}{Ct} + \frac{Q}{W} \right) N_{c,i} \end{aligned}$$

where: N = population, atoms

F = average fission rate, fissions/MWt-sec

Y = U-235 fission yield of nuclide fraction

P = core power, MWt

λ = decay constant, sec^{-1}

σ = microscopic cross section, cm^2

ϕ = thermal neutron flux, $\text{neutrons}/\text{cm}^2\text{-sec}$

ν = escape rate coefficient, sec^{-1}

f = branching fraction

t = time, sec.

D = defective fuel rod cladding, fraction

FCS = core coolant volume to reactor coolant volume ratio

R = purification flow rate during power cycle, lbs/sec

W = reactor coolant mass during power cycle, lbs

η = resin efficiency of chemical and volume control system ion exchanger for a given nuclide, fraction

C_o = initial boron concentration, ppm

C = boron reduction rate by feed and bleed, ppm/sec compensating for fuel burnup

Q = leakage or other feed and bleed from reactor coolant
lbs/sec

Subscripts

p, pellet region

c, core region

i, designates the nuclide parameters (i.e., $^{133}\text{Xe}_{54}$)

i-1 designates the parent nuclide parameters (i.e., $^{133}\text{I}_{53}$)

The model does not involve the fuel plenum and gap region of the core because the escape rate coefficients represent the overall release from the fuel pellets to the reactor coolant.

The production terms involving the microscopic cross section are used only to produce Cs^{134} from Cs^{133} , the stable end product of the 133 chain. The removal term involving the microscopic cross section is used only with Xe^{135} and only in the pellet region because of insignificant effects on other nuclides and in the coolant region.

The fission product activity concentrations used as basic source terms are given in Table 3.5-1. The data used for these calculations are given in Table 3.5-2. The effects of expected plant operation as a result of start-ups and shutdowns are simulated by using a constant liquid waste rate of 1.2 gpm or 617,000 gallons per year. The tritium concentration is based on no recycle of concentrator distillate.

The primary factor in determining the fission product inventories is the escape rate coefficient. This is an empirical coefficient which was derived from experiments initiated by Bettis and performed in the NRX and MTR reactors.⁽¹⁾ The escape rate coefficients derived from these data are given in Table 3.5-2. The escape rate coefficients were obtained from test rods which were operated at high linear heat rates. The linear heat rates were uniform over the test sections which were 10.25 inches in length. The exact linear heat rates were not precisely known but post-irradiation showed that some tests rods had experienced centerline melting. Later tests were conducted in the NRX reactor to determine the effect of rod length on the release of fission gases and iodines from defective fuel.⁽²⁾ A by-product of these experiments was the effect of linear heat rate on the escape rate coefficient. The escape rate coefficient for several nuclides as a function of the linear heat rate is shown in Figure 3.5-1. Also shown in Figure 3.5-1 are the escape rate coefficients used for noble gases and halogens. Since the average heat rate for a fuel rod will be well below the crossover points in Figure 3.5-1 which is above 17 kilowatts per foot in each case, the presently used escape rate coefficients are conservative.

3.5.1.2 Fuel Experience

Current operation of stainless steel clad fuel rods in the Connecticut Yankee reactor shows fuel failure rates on the order of 0.01 percent.

Zircaloy-clad UO_2 fuel in the Obrigheim reactor in Germany sustained a fuel failure rate just over 0.1 percent in its first cycle; this has fallen in the second cycle to essentially zero (0.001 percent). The fuel failure rate in the Dresden 1 reactor over a nine-year period has averaged 0.1 percent with the rate more recently being even lower. Fuel in the Mihama reactor in Japan and the Point Beach reactor has exceeded the burnup at which failures in fuel of similar design were observed in Ginna, without exhibiting increases in coolant activity (indicative of fuel defects).

The fact that widespread defects in some reactors, associated with fuel clad contamination have now been recognized and corrective measures taken, provides further assurance that failures at this frequency from this cause will not occur in the future. Existing licensing regulations limit coolant activity to that associated with 1 percent failed fuel. Over the lifetime of an operating reactor, it is expected that coolant activity levels corresponding to 0.1 percent failed fuel will predominate.

3.5.1.3 Leakage Sources

There are several potential sources of leakage from the plant systems that can contribute to the total release to the environs. If leakage occurs from systems containing reactor coolant, gaseous radioactivity could be released via several pathways.

Normal leakage from the reactor coolant system exposed to the containment atmosphere is expected to be 40 gallons per day or less. Reactor coolant nuclide activities given in Table 3.5-1 are used as source terms for all leakage calculations. Under equilibrium conditions, 10 percent or less of the iodine and particulates leaking into the containment remains in the atmosphere and is available for release. The other 90 percent of the iodine and particulates is either plated out in the containment or remains in the liquids and is collected in the containment sump. The annual average exposed leakage into the reactor auxiliary building (of unprocessed reactor coolant at 120 F) is expected to be 10 gallons per day or less. 3

Regulatory Guide 1.42 (RG 1.42) recommends leakage values to be used in gaseous release pathway estimates. These suggested leakage values have been used in the gaseous release analysis.

Estimated liquid and gaseous releases due to leakage from various systems containing radioactivity are discussed later in this section.

3.5.2 LIQUID WASTE SYSTEMS

3.5.2.1 Design Bases

The boron recovery system and the liquid waste system (integral parts of the waste management system) are designed to:

- a) Process the various potentially radioactive liquid wastes such that the radioactivity release to the environs during normal operation

will be as low as practicable. The numerical design objectives for releases during normal operation are to limit average annual liquid activity release quantity to 5 Ci and average annual activity release concentration to 2×10^{-8} Ci/cc excluding tritium and dissolved fission product gases.

- b) Limit the annual average tritium discharge concentration to 5×10^{-6} Ci/cc in accordance with the proposed Appendix I to 10 CFR 50.
- c) Limit releases due to anticipated operational occurrences within 10 CFR 20.

3.5.2.2 System Description

Liquid waste influent to the waste management system, shown in Table 3.5-3 is segregated by chemistry and/or probable source activity for more efficient processing. Tritiated, hydrogenated, borated reactor coolant quality wastes of potentially high activity are mainly processed in the boron recovery system. Aerated, chemically contaminated, and low activity liquid wastes are received and processed separately in the liquid waste system.

a) Boron Recovery System

The major influent to the boron recovery system is reactor coolant from the chemical and volume control system letdown due to feed and bleed operations for shutdown, startups, and boron dilution over core life. Reactor coolant quality water from valve and equipment leakoffs, drains and relief valve within the containment are collected in the reactor drain tank and subsequently processed by this system. Reactor coolant from leakoffs and drains in the reactor auxiliary building are collected in the equipment drain tank of the liquid waste system.

The boron recovery diagrams are shown on Figures 3.5-2, 3.5-3 and 3.5-4. The borated and hydrogenated water discharged by the reactor drain pumps or diverted by the chemical and volume control system volume control tank diversion valve (V-2500) is sent to the flash tank where dissolved hydrogen and fission gases are stripped by a counter current flow of nitrogen gas from the liquid and discharged to the gas decay tanks. Hydrogen is stripped from the water so that an explosive gas mixture does not occur in subsequent process equipment. Use of nitrogen cover gas in the holdup tanks provides additional protection. The nitrogen stripping medium maintains a slight overpressure in the flash tank to prevent air in-leakage, thus precluding potential formation of an explosive gas mixture in the flash tank. In the event of a high liquid level in the flash tank, the influent is automatically diverted to the holdup tanks. A low level in the flash tank stops the flash tank pumps automatically. The flash tank high and low pressure and level alarms are annunciated in the control room. A flow switch in the inlet line to the flash tank automatically opens the nitrogen supply valve and starts the flash tank pumps when water enters the tank. The degassed liquid is automatically pumped from the flash tank to the holdup tanks. The holdup tanks provide sufficient storage capacity to

accumulate discharges until a sufficient volume is available for further processing on a batch basis. The radioactivity of the liquid is significantly reduced during storage by natural decay of the short lived radionuclides. During this period any degasification and radioactive decay can be monitored by liquid sample analysis or periodic sampling of the tank gas space with the gas analyzer. Air in-leakage to the holdup tanks is precluded by a nitrogen overpressure maintained in the tanks. As the holdup tanks fill, nitrogen is displaced to other interconnected holdup tanks or to the gas collection header. The holdup tanks have high and low water level and pressure alarms which are annunciated in the control room. In the event process fluid has to bypass the flash tank due to malfunction of the flash tank controls or pumps, the stored liquid can be recirculated by the holdup drain or recirculation pumps to the flash tank to remove any hydrogen once the flash tank returns to service. The holdup recirculation pump supplies flushing water to the preconcentrator ion exchangers and spent resin tank during resin sluice operations.

Normally, the contents of the holdup tanks are transferred to the boric acid concentrator through the preconcentrator filter and preconcentrator ion exchanger. If necessary, the contents of one holdup tank may be recirculated through a preconcentrator filter and ion exchanger while a second holdup tank's contents are processed through the other preconcentrator filter and ion exchanger prior to discharge to the boric acid concentrators. The holdup pumps and holdup recirculation pump are stopped on low holdup tank level. The boric acid concentrators have both automatic sampling and local grab sample provisions to ensure control of the effluent chemistry. The boric acid concentrators provide a level signal that, after the initial manual pump start, automatically starts and stops the holdup or holdup recirculation pump aligned to either boric acid concentrator. The two boric acid concentrators have a very low usage factor (approximately 4 percent) and thus provide a high system reliability and availability.

The bottoms from each boric acid concentrator are pumped via the boric acid discharge strainer to the boric acid holding tank for temporary storage and sampling. The recovered boric acid may then be returned to the makeup tanks for recycle or discharged to the drumming station for ultimate offsite disposal.

The concentrator distillate passes through one of the two boric acid condensate ion exchangers to remove boron carryover and into one of the two boric acid condensate tanks. While one boric acid condensate tank is filling, the other is sampled and discharged. In the event that the contents of the tank do not meet the chemical or radioactivity limitations, the contents can be recycled to the holdup tanks for further processing or recycled through the boric acid condensate ion exchangers.

A local high and low level alarm is provided on the boric acid condensate tanks. The boric acid condensate pumps automatically stop on low water level in the tanks.

Prior to controlled discharge of the treated liquid waste, the fluid must be analyzed and its activity verified as acceptably low. Discharge is accomplished through an effluent radiation monitor which records the release activity level and automatically terminates discharge on high radiation. If reuse in the plant is desired, the fluid is analyzed for acceptability of both chemistry and activity.

Design data for the major components are listed in Table 3.5-4. Flow, temperature, and pressure data are given in Table 3.5-5 with the locations corresponding to process points on Figures 3.5-2, 3.5-3, and 3.5-4.

The nuclide concentrations for normal operation and for anticipated operational occurrences adjusted to 70 F are indicated for selected locations in the chemical and volume control system in Tables 3.5-8 and 3.5-9 respectively. The selected locations are indicated by the process points on Figures 3.5-2, 3.5-3, and 3.5-4. Normal operation is defined as operating with 0.1 percent failed fuel, and anticipated operational occurrences is defined as operation with 1 percent failed fuel.

Analysis is made assuming that the activities in Table 3.5-3 exist in the coolant upstream of the purification equipment in conjunction with the expected equipment performance given in Table 3.5-6 and in Table 3.5-7.

Systems similar in function and design to the boron recovery system described herein have been used successfully at plants such as Connecticut Yankee and Ginna. Even with significant coolant radioactivity at Ginna, releases have been controlled well within the 10CFR20 limits.

All process components have been used extensively in the nuclear industry to remove radioactive contaminants from liquids. The performance of process units used in the analysis is in agreement with general industry experience.

b) Liquid Waste System

The liquid waste system is shown on Figure 3.5-5. Liquid wastes include those from the laboratory sink drains, decontamination area drains, floor drains, building sumps, laundry effluent, and contaminated showers. The wastes are segregated for batch processing by collection in the equipment drain tank, chemical drain tank, and laundry drain tanks. 3

Low activity, aerated, and potentially dirty liquid drains and building sumps discharge to the equipment drain tank. Low activity chemical drains from the sampling system, decontamination drains, and chemical laboratory drains flow to the chemical drain tank. When a sufficient volume is collected in the drain tanks, the contents are sampled and neutralized, if required, and then pumped through a filter to the waste concentrator. The boric acid concentrators are available for processing liquid wastes if the waste concentrator is not available for service.

Concentrator bottoms are pumped to the drumming station which is described in Section 3.8. The condensate (distillate) passes through the waste ion exchanger and is collected in the waste condensate tanks and monitored for radioactivity. In the event that discharge limitations can not be met, the condensate can be recirculated through the waste ion exchanger, returned to the waste concentrator, or the holdup tanks in the boron recovery system for further treatment. Normally at least one holdup tank will be available for storage of waste condensate for reprocessing through a boric acid concentrator if necessary.

After the condensate activity has been determined to be sufficiently low by sample analysis, the tanks are pumped out at a controlled rate to the circulating water discharge. The activity of the discharge line effluent is monitored and recorded. Should the activity exceed the high set point value, the discharge is automatically terminated.

The laundry wastes are collected in the laundry drain tanks and analyzed for activity. Because of negligible activity levels, the laundry waste is normally pumped from the tanks through a filter to the circulating water discharge via the radiation monitor mentioned above. The tank contents can be processed in the waste concentrator prior to discharge if significant activity is detected.

All tanks are equipped with water level instrumentation alarms and their respective pumps are tripped on low level signals.

Design data for the major components is given in Table 3.5-10. Flow, temperature, and pressure are given in Table 3.5-10 with the locations corresponding to data points on Figure 3.5-5. Expected performance of components is given in Table 3.5-12.

The nuclide concentrations adjusted to 70 F for normal operation and anticipated operational occurrences are given in Tables 3.5-13 and 3.5-14, respectively. The selected locations are indicated by the process data points on Figure 3.5-5.

As indicated in Table 3.5-3, an estimated 156,000 gallons per year of liquid wastes, exclusive of laundry wastes are processed in the liquid waste system. The activity of the aerated liquid wastes collected in the equipment drain tank and chemical drain tank is approximately 1 percent of the reactor coolant activity, owing to dilution from washdown and decontamination procedures.

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Major radioactivity removal is accomplished by the concentrators. Experience indicates that a concentrator DF (bottoms to distillate) of 10^4 can be obtained. The concentrators are specified at this rating and testing by the vendor has confirmed the performance.

Table 3.5-15 lists the leakage sources and the assumptions used in calculating estimated normal and anticipated operational occurrence releases due to leakage sources. Additional plant liquid releases can result from turbine system leakage.

c) System Design

The Liquid Waste System is designed for batch type operation. These batching operations proceed intermittently at faster flow rates than the annual average process rates and therefore the system components are sized accordingly. Tables 3.5-4 and 3.5-10 list the design parameters for the major components of the liquid waste system.

d) Estimated Releases

The expected liquid releases from the plant are summarized by nuclide in Table 3.5-16. The reactor coolant concentrations utilized from this evaluation are indicated in Table 3.5-1. The curies released from the boron recovery and liquid waste systems are determined by multiplying the nuclide concentrations in the boric acid and waste condensate tanks as shown in Tables 3.5-8, 3.5-9, 3.5-13, and 3.5-14 by the waste processed through each system. The waste schedule is shown in Table 3.5-3.

e) Release Points

The only liquid release point from the waste management system to the environs is via the boric acid condensate or the waste condensate pumps discharge to the circulating water discharge. Prior to discharge the contents of the tank to be discharged are sampled for chemical and radioactivity concentrations. If the contents of the tank are found acceptable in terms of environmental discharge limits, the tank contents are discharged. A radiation monitor is provided in the discharge line to verify that the fluid discharge is below the applicable radioactivity limits. In the event that the discharged activity is unacceptable, the discharge monitor automatically terminates discharge operations. The discharge is located on Figures 3.5-4 and 3.5-5. Release points from the plant are shown on Figure 3.5-6.

f) Dilution Factors

An average annual dilution factor of 1.73×10^5 is obtained in the circulating water discharge based on 513,000 gpm flow in the discharge canal and an average annual liquid effluent flow rate of 2.95 gpm from the boron recovery system and the liquid waste system. The discharge and intake pipes are separated by 2400 feet of ocean shoreline which results in a negligible recirculation of discharged water.

3.5.3 GASEOUS WASTE SYSTEM

3.5.3.1 Design Bases

The gaseous waste system processes the vent gases from equipment located in the chemical and volume control system, waste management system and fuel pool system, such that the radioactive gaseous release to the environs will be as low as practicable. The numerical design objective for releases during normal operation is to limit the site boundary noble gas dose to less than 10 mrem/year and iodine-131 and particulate site boundary concentrations to 10^{-5} times 10 CFR 20 limits. Releases due to anticipated operational occurrences will be within 10 CFR 20 limits.

3.5.3.2 System Description

a) Waste Gas Systems

The principal flow paths of the waste gas system are shown on Figure 3.5-7. Process flow and activity data are given in Table 3.5-17, component data in Table 3.5-18.

Plant gaseous releases come from the steam generator blowdown, reactor auxiliary building ventilation, turbine system leakage, steam jet air ejector operation, and containment purging, gas collection header and gas surge header.

Releases from the reactor auxiliary building ventilation system are based on leakage of unprocessed reactor coolant at 120 F. Containment purging results in a constant release regardless of percent failed fuel since the airborne radioactivity removal system is operated for as long as required to achieve the required activity level.

Waste gas is collected from the various source components by three headers; containment vent header, gas surge header, and gas collection header. The containment vent header receives hydrogenated potentially radioactive gas mixtures vented from the reactor drain tank, quench tank, refueling failed fuel detector vent, and reactor vessel head vent within the containment and directs the gases to the gas surge header. Hydrogenated and potentially radioactive gases vented from the volume control tank, flash tank, and boric acid concentrators in the reactor auxiliary building are also directed to the gas surge header along with the discharge gas from the gas analyzer. The vented gases flow to the surge tank where they are collected prior to being compressed. The gases remain in the surge tank until removed by the waste gas compressors which are automatically controlled by pressure instrumentation located on the surge tank. The surge tank is equipped with a drain line to remove any water that accumulates in the tank due to condensation. A water level switch with a local alarm on the surge tank indicates to the operator when the tank should be emptied.

Since the contents of the surge tank are expected to contain significant amounts of hydrogen, the gas is sampled frequently by the gas analyzer to determine the oxygen-hydrogen composition. If oxygen should increase

above 2 percent by volume (2 percent by volume below allowable limit) an alarm is annunciated, and provisions are made to purge with nitrogen. A nitrogen line connected to the surge tank, and a pressure regulating valve in the line opens when pressure in the tank falls below 1.5 psig thereby maintaining a positive pressure above atmospheric and preventing air ingress.

The gases flow from the gas surge tank to a compressor where they are compressed to 165 psig and cooled by an aftercooler prior to entering the gas decay tanks where the gases are held up for radioactive decay. Two compressors are available for transferring the gas to the gas decay tanks controlled by pressure instrumentation on the surge tank. One compressor starts when pressure in the surge tank increases to 3 psig and stops when pressure falls to 1.5 psig. The second compressor starts at 7 psig and stops at 5 psig.

Aftercoolers supplied with each gas compressor cool the compressed gas prior to entering the gas decay tanks. There are three gas decay tanks (each provided with a pressure indicator including local alarm and temperature indicator) which receive the compressed gas from the waste gas compressors. The decay tanks have sufficient storage capacity for an average 30 day holdup, and after radioactivity has decayed to an acceptable level which is consistent with the design objective and has been verified by laboratory sample analysis, the gas is released to the environment via the vent pipe at a controlled rate.

The fill procedure for the decay tanks is to have only one tank lined up to the compressor discharge. When the pressure in the tank increases to 165 psig the tank is isolated and manually switched over to an empty tank. The gaseous radioactivity in the filled isolated tank is allowed to decay for an average decay time of approximately 30 days. During this decay period the gas is periodically sampled and activity level determined.

The following components are located in the discharge line from the gas decay tanks to the plant vent; a pressure reducing valve, pressure indicator, needle valve, pneumatic operated fail closed on-off valve, an in-line radiation monitor, and a gas flow meter.

Prior to release, the required flow rate is determined, and the set point on the radiation monitor is established. Initially the discharge valve from the gas decay tank, needle valve and pneumatic operated valve are closed. The on-off pneumatic operated valve is opened and placed in automatic, and the discharge valve on the desired gas decay tanks is opened. The pressure reducing valve will automatically close when pressure from the decay tank in excess of 10 psig is sensed at the pressure reducing valve outlet. The needle valve is then opened as required to establish the desired flow rate to the vent pipe, and the pressure reducing valve will open to maintain constant downstream pressure of 10 psig. The on-off pneumatic operated valve automatically closes on high radioactivity level thus terminating discharge flow. An alarm will annunciate this event in the control room. When discharge flow decreases and the decay tank pressure decreases to approximately 10 psig, as noted by observing the gas flow meter and pressure indicator on the gas decay

tank, the pressure reducing valve set point must be reduced to vent the tank down to atmospheric pressure.

The system flow paths and release points of the gases from the gas decay tanks and gas collection header are indicated on Figure 3.5-7. The diagram also shows the only flow bypass line in the waste gas system. This line from the gas surge tank to the vent pipe bypasses the waste gas compressor and gas decay tanks. This path is used to bypass compressors and gas decay tanks when the air or nitrogen is purged from process equipment after initial plant startup or maintenance operations. During these periods essentially no activity will be present in the gas streams and it is unnecessary to route these gases to the gas decay tanks. A locked closed valve facilitates administrative control of this bypass line.

The waste gas system has connections for sampling the gas in the containment vent header gas surge tank, and each gas decay tank. The gas to the gas surge header is primarily hydrogen, and a gas analyzer located in the sampling system is used to monitor hydrogen and oxygen concentration. Connections are available in the sampling system for taking a grab sample via gas analyzer to determine activity level prior to release.

The gas collection header collects the gases from primarily aerated vents of process equipment in the waste management system, chemical and volume control system, and fuel pool system. A listing of sources is given in Table 3.5-19. Because of the large volume of gas and the low activity level from the sources, the gases are routed directly to the vent pipe. The gases and expected activities to the vent pipe from the gas collection header are given in Table 3.5-17 at process data point No. 12. As a further check on activity from this source, the plant vent contains radioactivity monitors with alarms to indicate unexpected activity release.

The hydrogen and nitrogen required for plant operations are also a part of this system and redundant supply headers for each gas are provided. Hydrogen gas is supplied to the volume control tank gas space to maintain the desired concentration of reactor coolant dissolved hydrogen to suppress the net decomposition of water in the reactor flux. Nitrogen cover and/or purge gas is provided to the holdup tanks, quench tank, reactor drain tank, safety injection tanks, spent resin tank, and gas surge tank. A nitrogen stream is supplied to the flash tank for degassing liquid waste, and periodic purges with nitrogen are provided as required for various waste management system and chemical and volume control system components. The two gas supply systems include relief valves, regulators, and instrumentation with alarms and valving to allow flexible operation. A low pressure alarm indicates when the backup source should be placed in service.

3.5.3.3 Estimated Releases

The estimated releases from the waste gas system in curies per year are listed in Table 3.5-20. The source terms and assumptions used to determine these releases are given in Section 3.5.1.2. These release estimates are based on the guidance provided by Regulatory Guide 1.42 except that a 0.1% failed fuel rate was assumed. All the non-

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condensable gases in the condenser are released to the environment. The releases from the reactor auxiliary building are calculated by multiplying the leak rate for reactor auxiliary building equipment by the appropriate partition factors and ventilation system filter efficiencies. The assumed leak rates, partition factors, and filter efficiencies are given in Table 3.5-15.

During normal operation the expected activity releases from the plant is based on a 0.1 percent failed fuel, while the anticipated operational occurrences are assumed at 1.0 percent failed fuel. The radioactivity that is released from the failed fuel is reduced in concentration by the process equipment in the chemical and volume control system and waste management system. For iodine, the purification and preconcentrator ion exchanger decontamination factor (DF) is 10^3 , and a liquid to gas partition factor of 10^4 is used for the reactor drain tank, flash tank, holdup tank, equipment drain tank, and boric acid concentrator. Noble gases are stripped by a factor of approximately 2 in the flash tank and 5 in the boric acid concentrator. Activity will also be reduced by natural decay due to residence time in the reactor drain tank, holdup tank, and gas decay tanks.

3.5.3.4 Release Points

Release points to the vent pipe from the gas decay tanks are indicated on Figure 3.5-7 and Table 3.5-17. The gaseous effluents from the reactor auxiliary building ventilation system and containment purge system are also released from the vent pipe. The vent pipe is shown on reactor auxiliary building general arrangement Figure 3.5-8. The air ejector releases are from the turbine area. The air ejectors are shown on Figure 3.5-10. All the release points are shown on the plant liquid and gaseous release points diagram Figure 3.5-6.

3.5.4 Steam Generator Blowdown Process System

Steam generator blowdown is utilized to maintain the total dissolved solid (TDS) content of steam generator secondary side coolant at or below the normal operating limit. Normally the blowdown stream's temperature is reduced during passage through the blowdown heat exchanger prior to its release to the discharge canal. In the event that activity in the blowdown stream resulting from primary to secondary leakage exceeds a specified value an alarm will be annunciated in the control room, and flow will be diverted to the blowdown process system. A schematic of this system is provided as Figure 3.5-11.

Blowdown diverted to one of the three process streams passes through filters and demineralizers prior to entering one of the three monitor tanks. Processed blowdown pumped from the monitor tanks to the discharge canal is continuously monitored for activity level. Automatic release termination capability on high activity level is provided.

condensable gases in the condenser are released to the environment. The releases from the reactor auxiliary building are calculated by multiplying the leak rate for reactor auxiliary building equipment by the appropriate partition factors and ventilation system filter efficiencies. The assumed leak rates, partition factors, and filter efficiencies are given in Table 3.5-15.

During normal operation the expected activity releases from the plant is based on a 0.1 percent failed fuel, while the anticipated operational occurrences are assumed at 1.0 percent failed fuel. The radioactivity that is released from the failed fuel is reduced in concentration by the process equipment in the chemical and volume control system and waste management system. For iodine, the purification and preconcentrator ion exchanger decontamination factor (DF) is 10^3 , and a liquid to gas partition factor of 10^4 is used for the reactor drain tank, flash tank, holdup tank, equipment drain tank, and boric acid concentrator. Noble gases are stripped by a factor of approximately 2 in the flash tank and 5 in the boric acid concentrator. Activity will also be reduced by natural decay due to residence time in the reactor drain tank, holdup tank, and gas decay tanks.

3.5.3.4 Release Points

Release points to the vent pipe from the gas decay tanks are indicated on Figure 3.5-7 and Table 3.5-17. The gaseous effluents from the reactor auxiliary building ventilation system and containment purge system are also released from the vent pipe. The vent pipe is shown on reactor auxiliary building general arrangement Figure 3.5-8. Steam generator blowdown is released to the blowdown tank in the reactor auxiliary building. The blowdown tank is shown on general arrangement, Figure 3.5-9. The air ejector releases are from the turbine area. The air ejectors are shown on Figure 3.5-10. All the release points are shown on the plant liquid and gaseous release points diagram Figure 3.5-6.

TABLE 3.5-1

REACTOR COOLANT SPECIFIC ACTIVITY ($\mu\text{Ci/cc}$), 577 F

Nuclide	Half Life	Anticipated Operational Occurrences (1.0% Failed Fuel)	Normal Operations (0.1% Failed Fuel)	Nuclide	Half Life	Anticipated Operational Occurrences (1.0% Failed Fuel)	Normal Operations (0.1% Failed Fuel)
H-3	12.3y	0.132	0.107	I-133	21h	5.66	0.566
Br-84	32m	4.66(-2)*	4.66(-3)	Xe-133	5.3d	181.0	18.1
Kr-85m	4.4h	1.49	0.149	Te-134	42m	2.62(-2)	2.62(-3)
Kr-85	10.8y	0.885	8.85(-2)	I-134	52m	0.62	6.2(-2)
Kr-87	76m	0.81	8.1(-2)	Cs-134	2.1y	0.10	1.0(-2)
Kr-88	2.8h	2.6	0.26	I-135	6.7h	2.7	0.27
Rb-88	18m	2.55	0.255	Xe-135	9.2h	7.53	0.753
Rb-89	15m	6.4(-2)	6.4(-3)	Cs-136	13d	2.55(-2)	2.55(-3)
Sr-89	51d	5.07(-3)	5.07(-4)	Cs-137	30y	0.32	3.2(-2)
Sr-90	28.8y	2.61(-4)	2.61(-5)	Xe-138	17m	0.36	3.6(-2)
Y-90	64h	1.02(-3)	1.02(-4)	Cs-138	32m	0.69	6.9(-2)
Sr-91	9.7h	3.56(-3)	3.56(-4)	Ba-140	12.8d	6.11(-3)	6.11(-4)
Y-91	59d	0.111	1.11(-2)	La-140	40.2h	5.85(-3)	5.85(-4)
Mo-99	67h	2.03	0.203	Pr-143	13.6d	5.84(-3)	5.84(-4)
Ru-103	39.6d	4.13(-3)	4.13(-4)	Ce-144	285d	4.13(-3)	4.13(-4)
Ru-106	367d	2.48(-4)	2.48(-5)	(Corrosion Products)			
Te-129	67m	2.51(-2)	2.51(-3)	Co-60	5.2y	5.19(-4)	5.19(-4)
I-129	1.7(7)y	7.21(-8)	7.21(-9)	Fe-59	45d	2.13(-5)	2.13(-5)
I-131	8.0d	3.97	0.397	Co-58	71d	4.66(-3)	4.66(-3)
Xe-131m	12d	1.48	0.148	Mn-54	312d	2.75(-5)	2.75(-5)
Te-132	78h	0.33	3.3(-2)	Cr-51	27d	3.8(-3)	3.8(-3)
I-132	2.3h	1.09	0.109	Zr-95	65d	9.35(-7)	9.35(-7)

*() denotes power of ten.

TABLE 3.5-2

BASES FOR REACTOR COOLANT RADIOACTIVITY

Core power level, Mwt	2700
Fuel cycle full power days	357
Percent failed fuel	1.0
CVCS purification ion exchanger decontamination factor	10
Purification flow rate (CVCS purification ion exchanger), gpm	40
Effective purification flow rate for lithium and cesium removal, gpm	8
Fission product escape rate coefficients, sec^{-1} (Based on centerline melting of fuel)	
Noble gases (Xenon, Krypton)	6.5×10^{-8}
Iodines, Cs	2.3×10^{-8}
Te, Mo.	1.4×10^{-9}
All others	1.4×10^{-11}
Feed and bleed liquid waste for fuel burnup, gal/yr	216,000
Other feed and bleed liquid waste, gal/yr	617,000
Thermal neutron flux, $\text{n/cm}^2 \text{sec}$	4.3×10^{13}
Reactor coolant volume, ft^3	9662

TABLE 3.5-3

SOURCES AND VOLUMES OF LIQUID WASTE

1. Boron Recovery System

<u>Source</u>	<u>Waste Generating Operation</u>	<u>Volume (gal/yr)</u>
Chemical and volume control system	Boron reduction for fuel burnup	216,000
	Cold shutdown and startups	332,000
	Hot shutdowns and startups	161,000
	Refueling shutdown and startup	68,000
Resin dewatering	Sluice and dewater 256 ft ³ resin per year at 2 ft ³ water/ft ³ resin	3,800
Reactor coolant leakage	200 gpd for four reactor coolant pumps	<u>62,600</u>
		843,400

2. Liquid Waste System

Equipment drains and leakage	75 gal/day	28,000
Sample and laboratory sink drains	20 gal/day	7,000
Equipment decontamination	10 gpm for 20 minutes per day	73,000
Floor drains	5 gpm for 10 minutes per day	18,000
Fuel cask washdown	400 gal/cask per refueling	<u>30,000</u>
Sub-total		156,000
Laundry	200 gal/day	73,000
Showers	4 showers per day at 30 gal per shower	<u>44,000</u>
Total	Estimated Normal Operation	273,000

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TABLE 3.5-4

DESIGN DATA FOR BORON RECOVERY SYSTEM COMPONENTS

<u>Ion Exchangers</u>	<u>Preconcentrator</u>	<u>Boric Acid Condensate</u>			
Quantity	2	2			
Type resin	Mixed Bed	Hydroxil Anion			
Design pressure, psig	150	150			
Design temperature, F	200	200			
Normal operating pressure, psig	40	25			
Normal operating temperature, F	100	120			
Resin volume, ft ³	32	32			
Materials	SS	SS			
ASME Code, Section	III, Class 2	III, Class 2			

<u>Tanks</u>	<u>Reactor Drain</u>	<u>Flash</u>	<u>Holdup</u>	<u>Boric Acid Condensate</u>	<u>Boric Acid Holding</u>
Quantity	1	1	4	2	1
Internal Volume, gal	1600	400	40,000	7,300	2,400
Design pressure, psig	25	15	10	Atmos.	Atmos.
Design temperature, F	250	250	240	250	200
Normal operating pressure, psig	0.5	0.5	0.5(psia)	Atmos.	Atmos.
Normal operating temperature, F	120	120	120	120	150
Blanket gas	Nitrogen	Nitrogen	Nitrogen		
Material	SS	SS	SS	SS	SS
ASME Code, Section	III,3	III,3	VIII,1		

<u>Pumps</u>	<u>Flash Tank</u>	<u>Reactor Drain</u>	<u>Holdup Drain, Holdup Recir. Boric Acid Cond.</u>	<u>Boric Acid Holding</u>
Quantity-full capacity	2	2	5	2
Type	Centrifugal	Centrifugal	Centrifugal	Centrifugal
Design pressure, psig	150	150	150	150
Design temperature, F	200	200	200	200

TABLE 3.5-4 (Cont'd)

<u>Pumps</u>	<u>Flash Tank</u>	<u>Reactor Drain</u>	<u>Holdup Drain, Holdup Recir. Boric Acid Cond.</u>	<u>Boric Acid Holding</u>
Design conditions				
Flow, gpm	150	50	50	50
Head, ft	51	140	140	96
Wetted materials	SS	SS	SS	SS
Seal type	Mechanical	Mechanical	Mechanical	Mechanical
Motor horsepower	7.5	5	5	5
Motor voltage, volt	460	460	460	460
ASME Code, Section	III, 3	III, 3	None	None

Filters

Preconcentrator

Quantity	2
Type of Elements	Replaceable Cartridge
Retention of 2 micron particles, %	98
Design pressure, psig	150
Design temperature, F	200
Design flow, gpm	100
Material	Stainless Steel
ASME Code, Section	VIII

Boric Acid Concentrator

Quantity	2
Design pressure, psig	80
Design temperature, F	250
Design flow, gpm	20
Cooling water flow rate, gpm	650
Steam required at 15 psig, lb/hr	13,000
ASME Code, Section	VIII

TABLE 3.5-5

BORON RECOVERY SYSTEM PROCESS FLOW DATA

Mode #1⁽¹⁾

Location:	1	2	3	4	5	6	7	8
Flow, gpm	200 gpd	50	50	50	50	60	50	50
Pressure, psig	1	4	12	7.5	6.5	4	45	2
Temperature, F	120	120	120	120	120	120	120	120

Mode #2⁽¹⁾

Location:	1	2	3	4	5	6	7	8
Flow, gpm	200 gpd	-	-	40	40	50	40	40
Pressure, psig	1	-	-	5	4.5	4	44	2
Temperature, F	120	-	-	120	120	120	120	120

Mode #3⁽¹⁾

Location:	1	2	3	4	5	6	7	8
Flow, gpm	200 gpd	-	-	84	84	94	84	84
Pressure, psig	1	-	-	21	18.5	4	34	2
Temperature, F	120	-	-	120	120	120	120	120

Mode #4⁽¹⁾

Location:	1	2	3	4	5	6	7	8
Flow, gpm	200 gpd	-	-	128	128	138	128	128
Pressure, psig	1	-	-	51	45.5	4	18	2
Temperature, F	120	-	-	120	120	120	120	120

TABLE 3.5-5 (Cont'd)

Mode #5⁽¹⁾

Location:	12	13	14	15	16	17	18	19	20	21
Flow, gpm	20	20	20	20	0-10	16-19	16-19	50	50	50
Pressure, psig	3	65	62	60	5	5	2	4	60	10
Temperature, F	120	120	120	120	120	120	120	120	120	120

Mode #6⁽¹⁾

Location:	9	10	11	15a	16a
Flow, gpm	50	50	50	50	50
Pressure, psig	4	32	27	24	20
Temperature, F	120	120	120	120	120

Mode #7

Location:	22	23
Flow, gpm	50	50
Pressure, psig	4	40
Temperature, F	150	150

NOTES:

(1) The modes of operation are defined as follows:

<u>Mode No.</u>	<u>Description</u>
1	Processing RDT Contents
2	CVCS normal purification VCT diversion processing
3	CVCS intermediate purification VCT diversion processing
4	CVCS maximum purification VCT diversion processing
5	Processing holdup tank contents via the boric acid concentrator
6	Holdup tank contents recirculation
7	Pumping BAHT contents to the BMT in the CVCS.

(2) The pressure drop across the filters and ion exchangers will vary with loading.

TABLE 3.5-6

EXPECTED FILTER AND ION EXCHANGER PERFORMANCE

Nuclide	Chemical and Volume Control System		Boron Recovery Waste Processing System	
	Filter DF	Ion Exchanger DF	Filter DF	Ion Exchanger DF
Br-84	1	10^3	1	10^2
Rb-88	1	1	1	10^2
Rb-89	1	1	1	10^2
Sr-89	1	10^2	1	10
Sr-90	1	10^2	1	10
Y-90	1	1	1	10
Sr-91	1	10^2	1	10
Y-91	1	1	1	10
Mo-99	1	1	1	10
Ru-103	1	10	1	10
Ru-106	1	10	1	10
Te-129	1	10^3	1	10^3
I-129	1	10^3	1	10^3
I-131	1	10^3	1	10^3
Te-132	1	10^3	1	10^3
I-132	1	10^3	1	10^3
I-133	1	10^3	1	10^3
Te-134	1	10^3	1	10^3
I-134	1	10^3	1	10^2
Cs-134	1	1	1	10^2
I-135	1	10^3	1	10^2
Cs-136	1	1	1	10^2
Cs-137	1	1	1	10^2
Cs-138	1	1	1	10^2
Ba-140	1	10^2	1	10
La-140	1	10	1	10
Pr-140	1	10	1	10
Ce-144	1	10	1	10
Co-60	10	1	1	1
Fe-59	10	1	1	1
Co-58	10	1	1	1
Mn-54	10	1	1	1
Cr-51	10	1	1	1
Zr-95	10	1	1	1

TABLE 3.5-7

BORON RECOVERY SYSTEM PERFORMANCE DATA

Flash tank DF for fission gases	2
Boric acid concentrator	
DF for liquid (influent to distillate)	200
DF for fission gases	5
Holdup tank delay factor, days	9
Annual system condensate released to circulating water discharge ⁽¹⁾	
Volume, gal.	843,000
Activity, curies	
H-3	339
Dissolved Fission Product Gases	24,500
All Others	0.89

Note: (1) The volume and activity values obtained are based on 843,000 gals of waste to BMS with 1% failed fuel.

TABLE 3.5-8

BORON RECOVERY SYSTEM (BRS) MAXIMUM NUCLIDE CONCENTRATIONS (70F) DURING NORMAL OPERATIONS ($\mu\text{Ci/cc}$)

Nuclide	CVCS 6 BRS 1	CVCS 7	CVCS 10 BRS 2,3,4,5	BRS 6,7,8	BRS 12,13,14	BRS 15	BRS 16	BRS 18,19,20,21
H-3	1.47(-1)*	1.47(-1)	1.47(-1)	1.47(-1)	1.47(-1)	1.47(-1)	1.47(-1)	1.47(-1)
Br-84	6.40(-3)	6.40(-2)	6.43(-6)	6.43(-6)	0.0	0.0	0.0	0.0
Kr-85m	2.05(-1)	2.05(-1)	2.05(-1)	1.03(-1)	1.71(-16)	1.71(-16)	0.0	3.43(-17)
Kr-85	1.22(-1)	1.22(-1)	1.22(-1)	6.11(-2)	6.10(-2)	6.10(-2)	0.0	1.22(-2)
Kr-87	1.12(-1)	1.12(-1)	1.12(-1)	5.59(-2)	0.0	0.0	0.0	0.0
Kr-88	3.59(-1)	3.59(-1)	3.59(-1)	1.79(-2)	0.0	0.0	0.0	0.0
Rb-88	3.52(-1)	3.52(-1)	3.52(-1)	3.52(-1)	0.0	0.0	0.0	0.0
Rb-89	8.80(-3)	8.80(-3)	8.80(-3)	8.80(-3)	0.0	0.0	0.0	0.0
Sr-89	6.99(-4)	6.99(-4)	6.99(-6)	6.99(-6)	6.18(-6)	6.18(-7)	3.09(-5)	3.09(-9)
Sr-90	3.60(-5)	3.60(-5)	3.60(-7)	3.60(-7)	3.60(-7)	3.60(-8)	1.80(-6)	1.80(-10)
Y-90	1.41(-4)	1.41(-4)	1.41(-4)	1.41(-4)	1.36(-5)	1.36(-6)	6.83(-5)	6.83(-9)
Sr-91	4.91(-4)	4.91(-4)	4.91(-6)	4.91(-6)	9.72(-13)	9.72(-14)	4.86(-12)	4.86(-16)
Y-91	1.53(-2)	1.53(-2)	1.53(-2)	1.53(-2)	1.38(-2)	1.40(-3)	6.89(-2)	6.89(-6)
Mo-99	2.80(-1)	2.80(-1)	2.80(-1)	2.80(-1)	3.00(-2)	3.00(-3)	1.50(-1)	1.50(-5)
Ru-103	5.70(-4)	5.70(-4)	5.70(-5)	5.70(-5)	4.87(-5)	4.87(-6)	2.43(-4)	2.43(-8)
Ru-106	3.42(-5)	3.42(-5)	3.42(-6)	3.42(-6)	3.36(-6)	3.36(-7)	1.68(-1)	1.68(-9)
Te-129	3.50(-3)	3.50(-3)	3.46(-4)	3.46(-4)	0.0	0.0	0.0	0.0

*Numbers in () are powers of ten

TABLE 3.5-8 (Cont'd)

Nuclide	CVCS 6	CVCS 7	CVCS 10	BRS 6,7,8	BRS 12,13,14	BRS 15	BRS 16	BRS 18,19,20,21
	BRS 1		BRS 2,3,4,5					
I-129	9.95(-9)	9.95(-9)	9.95(-12)	9.95(-12)	9.95(-12)	9.95(-15)	4.97(-13)	4.97(-17)
I-131	5.48(-1)	5.48(-1)	5.48(-4)	5.48(-4)	2.52(-4)	2.52(-7)	1.26(-5)	1.26(-9)
Xe-131m	2.04(-1)	2.04(-1)	2.04(-1)	1.02(-1)	6.07(-2)	6.07(-2)	0.0	1.21(-2)
Te-132	4.55(-2)	4.55(-2)	4.60(-3)	4.60(-3)	6.92(-4)	6.92(-5)	3.5(-3)	3.46(-7)
I-132	1.50(-1)	1.50(-1)	1.50(-4)	1.50(-4)	0.0	0.0	0.0	0.0
I-133	7.81(-1)*	7.81(-1)	7.81(-4)	7.81(-4)	6.25(-7)	6.26(-10)	3.13(-8)	3.13(-12)
Xe-133	2.49(+1)	2.49(+1)	2.49(+1)	1.25(+1)	3.82	3.82	0.0	7.64(-1)
Te-134	3.60(-3)	3.60(-3)	3.61(-4)	3.61(-4)	0.0	0.0	0.0	0.0
I-134	8.56(-2)	8.56(-2)	8.55(-5)	8.55(-5)	0.0	0.0	0.0	0.0
Cs-134	1.38(-2)	1.38(-2)	1.38(-2)	1.38(-2)	1.37(-2)	1.37(-4)	6.80(-3)	6.84(-7)
I-135	3.72(-1)	3.72(-1)	3.72(-4)	3.72(-4)	7.35(-14)	7.35(-17)	3.68(-15)	3.68(-19)
Xe-135	1.04	1.04	1.04	5.19(-1)	8.18(-11)	8.18(-11)	0.0	1.63(-11)
Cs-136	3.50(-3)	3.50(-3)	3.50(-3)	3.50(-3)	2.20(-3)	2.18(-5)	1.10(-3)	1.09(-7)
Cs-137	4.42(-2)	4.42(-2)	4.42(-2)	4.42(-2)	4.41(-2)	4.41(-4)	2.21(-2)	2.21(-6)
Xe-138	4.97(-2)	4.97(-2)	4.97(-2)	2.48(-2)	0.0	0.0	0.0	0.0
Cs-138	9.52(-2)	9.52(-2)	9.52(-2)	9.52(-2)	0.0	0.0	0.0	0.0
Ba-140	8.43(-4)	8.43(-4)	8.43(-6)	8.43(-6)	5.18(-6)	5.18(-7)	2.59(-5)	2.59(-9)
La-140	8.07(-4)	8.07(-4)	8.07(-5)	8.07(-5)	1.95(-6)	1.95(-7)	9.74(-6)	9.74(-10)
Pr-143	8.06(-4)	8.06(-4)	8.06(-5)	8.06(-5)	5.11(-5)	5.11(-6)	2.55(-4)	2.55(-8)

*Numbers in () are powers of ten.

TABLE 3.5-8 Cont'd)

<u>Nuclide</u>	<u>CVCS 6</u> <u>BRS 1</u>	<u>CVCS 7</u>	<u>CVCS 10</u> <u>BRS 2,3,4,5</u>	<u>BRS 6,7,8</u>	<u>BRS 12,13,14</u>	<u>BRS 15</u>	<u>BRS 16</u>	<u>BRS 18,19,20,21</u>
Ce-144	5.70(-4)	5.70(-4)	5.70(-5)	5.70(-5)	5.57(-5)	5.57(-6)	2.79(-4)	2.79(-8)
Co-60	7.16(-4)	7.16(-5)	7.16(-5)	7.16(-5)	7.14(-5)	7.14(-5)	3.60(-3)	3.57(-7)
Fe-59	2.94(-5)	2.94(-6)	2.94(-6)	2.94(-6)	2.56(-6)	2.56(-6)	1.28(-4)	1.28(-8)
Co-58	6.40(-3)	6.43(-4)	6.43(-4)	6.43(-4)	5.89(-4)	5.89(-4)	2.94(-2)	2.94(-6)
Mn-54	3.79(-5)	3.79(-6)	3.79(-6)	3.79(-6)	3.72(-6)	3.72(-6)	1.86(-4)	1.86(-8)
Cr-51	5.20(-3)	5.24(-4)	5.24(-4)	5.24(-4)	4.19(-4)	4.19(-4)	2.10(-2)	2.09(-6)
Zr-95	1.29(-6)	1.29(-7)	1.29(-7)	1.29(-7)	1.17(-7)	1.17(-7)	5.86(-6)	5.86(-10)

*Numbers in () are powers of ten

TABLE 3.5-3

BORON RECOVERY SYSTEM (BRS) MAXIMUM NUCLIDE CONCENTRATIONS (70F) DURING ANTICIPATED OPERATIONS (uCi/cc)

Nuclide	CVCS 6	CVCS 7	CVCS 10	6, 7, 8	12, 13, 14	15	16	18, 19, 20, 21
	1		2, 3, 4, 5					
H-3	1.82(-1)*	1.82(-1)	1.82(-1)	1.82(-1)	1.82(-1)	1.82(-1)	1.82(-1)	1.82(-1)
Br-84	6.43(-1)	6.43(-1)	6.43(-5)	6.43(-5)	0.0	0.0	0.0	0.0
Kr-85m	2.06	2.06	2.06	1.03	1.72(-15)	1.72(-15)	0.0	3.43(-16)
Kr-85	1.22	1.22	1.22	6.10(-1)	6.09(-1)	6.09(-1)	0.0	1.22(-1)
Kr-87	1.12	1.12	1.12	5.59(-1)	0.0	0.0	0.0	0.0
Kr-88	3.59	3.59	3.59	1.79	0.0	0.0	0.0	0.0
Rb-88	3.52	3.52	3.52	3.52	0.0	0.0	0.0	0.0
Rb-89	8.83(-2)	8.83(-2)	8.83(-2)	8.83(-2)	0.0	0.0	0.0	0.0
Sr-89	7.00(-3)	7.00(-3)	6.99(-5)	6.99(-5)	6.18(-5)	6.18(-6)	3.09(-4)	3.09(-8)
Sr-90	3.60(-4)	3.60(-4)	3.60(-6)	3.60(-6)	3.60(-6)	3.60(-7)	1.80(-5)	1.80(-9)
Y-90	1.40(-3)	1.40(-3)	1.40(-3)	1.40(-3)	1.36(-4)	1.36(-5)	6.83(-4)	6.83(-8)
Sr-91	4.90(-3)	4.90(-3)	4.91(-5)	4.91(-5)	9.72(-12)	9.72(-13)	4.86(-11)	4.86(-15)
Y-91	1.53(-1)	1.53(-1)	1.53(-1)	1.53(-1)	1.38(-1)	1.38(-1)	6.89(-1)	6.89(-5)
Mo-99	2.80	2.80	2.80	2.80	2.99(-1)	3.00(-2)	1.50	1.50(-4)
Ru-103	5.70(-3)	5.70(-3)	5.69(-4)	5.69(-4)	4.87(-4)	4.87(-5)	2.40(-3)	2.44(-7)
Ru-106	3.42(-4)	3.42(-4)	3.42(-5)	3.42(-5)	3.36(-5)	3.36(-6)	1.68(-4)	1.68(-8)
Te-129	3.46(-2)	3.46(-2)	3.50(-3)	3.50(-3)	0.0	0.0	0.0	0.0
I-129	9.95(-8)	9.95(-8)	9.95(-11)	9.95(-11)	9.95(-11)	9.95(-14)	4.97(-12)	4.97(-16)
I-131	5.48	5.48	5.50(-3)	5.50(-3)	2.50(-3)	2.52(-6)	1.26(-4)	1.26(-8)
Xe-131m	2.04	2.04	2.04	1.02	6.07(-1)	6.07(-1)	0.0	1.21(-1)
Te-132	4.55(-1)	4.55(-1)	4.55(-2)	4.55(-2)	6.90(-3)	6.92(-4)	3.46(-2)	3.46(-6)
I-132	1.50	1.50	1.50(-3)	1.50(-2)	0.0	0.0	0.0	0.0
I-133	7.81	7.81	7.80(-3)	7.80(-3)	6.26(-6)	6.26(-9)	3.13(-7)	3.13(-11)
Xe-133	2.49(+2)	2.49(+2)	2.49(+2)	1.25(+2)	3.82(+1)	3.82(-1)	0.0	7.64

* Numbers in () are powers of ten.

TABLE 3.5-9 (Cont'd)

Nuclide	CVCS 6 1	CVCS 7	CVCS 10 2, 3, 4, 5	6, 7, 8	12, 13, 14	15	16	18, 19, 20, 21
Te-134	3.62(-2)*	3.62(-2)	3.60(-3)	3.60(-3)	0.0	0.0	0.0	0.0
I-134	8.55(-1)	8.55(-1)	8.55(-4)	8.55(-4)	0.0	0.0	0.0	0.0
Cs-134	1.38(-1)	1.38(-1)	1.38(-1)	1.38(-1)	1.37(-1)	1.40(-3)	6.84(-2)	6.84(-6)
I-135	3.73	3.73	3.70(-3)	3.70(-3)	7.35(-13)	7.35(-16)	3.68(-14)	3.68(-18)
Xe-135	10.39	10.39	10.39	5.19	8.18(-10)	8.18(-10)	0.0	1.64(-10)
Cs-136	3.52(-2)	3.52(-2)	3.52(-2)	3.52(-2)	2.18(-2)	2.18(-4)	1.09(-2)	1.09(-6)
Cs-137	4.42(-1)	4.42(-1)	4.42(-1)	4.42(-1)	4.41(-1)	4.40(-3)	2.20(-1)	2.21(-5)
Xe-138	4.97(-1)	4.97(-1)	4.97(-1)	2.48(-1)	0.0	0.0	0.0	0.0
Cs-138	9.52(-1)	9.52(-1)	9.52(-1)	9.52(-1)	0.0	0.0	0.0	0.0
Ba-140	8.40(-3)	8.40(-3)	8.43(-5)	8.43(-5)	5.18(-5)	5.18(-6)	2.59(-4)	2.59(-8)
La-140	8.10(-3)	8.10(-3)	8.07(-4)	8.07(-4)	1.95(-5)	1.95(-6)	9.74(-5)	9.74(-9)
Pr-143	8.10(-3)	8.10(-3)	8.06(-4)	8.06(-4)	5.11(-4)	5.11(-5)	2.60(-3)	2.55(-7)
Ce-144	5.70(-3)	5.70(-3)	5.70(-4)	5.70(-4)	5.70(-4)	5.57(-5)	2.80(-3)	2.79(-7)
Co-60	7.16(-4)	7.16(-5)	7.16(-5)	7.16(-5)	7.14(-5)	7.14(-5)	3.60(-3)	3.57(-7)
Fe-59	2.94(-5)	2.94(-6)	2.94(-6)	2.94(-6)	2.56(-6)	2.56(-6)	1.28(-4)	1.28(-8)
Co-58	6.40(-3)	6.34(-4)	6.43(-4)	6.43(-4)	5.89(-4)	5.89(-4)	2.94(-2)	2.94(-6)
Mn-54	3.79(-5)	3.79(-5)	3.79(-6)	3.79(-6)	3.72(-6)	3.72(-6)	1.86(-4)	1.86(-8)
Cr-51	5.20(-3)	5.24(-4)	5.24(-4)	5.24(-4)	4.19(-4)	4.19(-4)	2.10(-2)	2.09(-6)
Zr-95	1.29(-6)	1.29(-7)	1.29(-7)	1.29(-7)	1.17(-7)	1.17(-7)	5.86(-6)	5.86(-10)

*Numbers in () are powers of ten.

TABLE 3.5-10

DESIGN DATA FOR LIQUID WASTE SYSTEM COMPONENTS

1.	<u>Ion Exchanger</u>	<u>Waste</u>			
	Quantity	1			
	Type resin	Mixed bed			
	Design pressure, psig	150			
	Design temperature, F	200			
	Normal operating pressure, psig	40			
	Normal operating temperature, F	120			
	Resin volume, ft ³	32			
	Materials	SS			
	ASME code, division	VIII			
2.	<u>Tanks</u>	<u>Equipment Drain</u>	<u>Chemical Drain</u>	<u>Laundry Drain</u>	<u>Waste Condensate</u>
	Quantity	2	1	2	2
	Internal volume, gal.	25,000	1000	2000	1725
	Design pressure, psig	Atmos.	Atmos.	Atmos.	Atmos.
	Design temperature, F	200	200	200	250
	Normal Operating pressure, psig	Atmos.	Atmos.	Atmos.	Atmos.
	Normal operating temperature, F	120	120	120	120
	Material	SS	SS	SS	SS
	ASME code, division	VIII, I(1)	VIII, I(1)	VIII, I(1)	N.A.
3.	<u>Pumps</u>	<u>Equipment Drain, Chemical Drain Laundry Drain, Waste Condensate</u>			
	Quantity	6			
	Type	Centrifugal			
	Design pressure, psig	150			
	Design temperature, F	200			

TABLE 3.5-10 (Cont'd)

3. Pumps (cont'd)Equipment Drain, Chemical Drain
Laundry Drain, Waste Condensate

Design conditions

Flow, gpm
Head, ft
Wetted materials
Seal type
Motor horsepower
Motor voltage/phase/hz
ASME code50
140
SS
Mechanical
7.5
460/3/60
N.A.4. FiltersWasteLaundryQuantity
Type of elements
Particle retention
Design pressure, psig
Design temperature, F
Design flow, gpm
Material
ASME code, division1
Replaceable Cartridge
25 micron, absolute
150
200
50
Stainless Steel
VIII1
Replaceable Cartridge
150 micron, nominal
150
200
50
Stainless Steel
VIII

SL2

5. Waste ConcentratorQuantity
Design pressure, psig
Design temperature, F
Design flow, gpm
Cooling water flow rate, gpm
Steam required at 15 psig, lb/hr
ASME code, division1
80
250
2
130
1300
VIII

TABLE 3.5-11

LIQUID WASTE SYSTEM
PRESSURE, TEMPERATURE AND FLOW DATA

Mode 1⁽¹⁾

Location	1	2	3	4	5	6	7	8	9
Pressure, psig	0.5	0.5	2.0	67	0.5	2.0	2.0	0.5	2.0
Temperature, F	120	120	120	120	120	120	120	120	120
Flow, gpm	0.825	.912	7	2	.209	0	0	0.223	0

Location	10	11	12	13	14	15	16
Pressure, psig	2.0	2.0	67	5	4	4	62
Temperature, F	120	120	120	120	120	120	120
Flow, gpm	0	0	2	2	2	55	50

Mode 2⁽²⁾

Location	1	2	3	4	5	6	7	8	9
Pressure, psig	0.5	0.5	2.0	2.0	0.5	2.0	67	0.5	2.0
Temperature, F	120	120	120	120	120	120	120	120	120
Flow, gpm	0.825	0.912	0	0	0.209	7	2	.223	0

Location	10	11	12	13	14	15	16
Pressure, psig	2.0	2.0	67	5	4	62	62
Temperature, F	120	120	120	120	120	120	120
Flow, gpm	0	0	2	2	2	55	50

TABLE 3.5-11 (Cont'd)Mode 3⁽³⁾

Location	1	2	3	4	5	6	7	8	9
Pressure, psig	0.5	0.5	2.0	2.0	0.5	2.0	2.0	0.5	2.0
Temperature, F	120	120	120	120	120	120	120	120	120
Flow, gpm	0.825	0.912	0	0	0.209	0	0	0.223	55

Location	10	11	12	13	14	15	16
Pressure, psig	62	47	2.0	0	0	0	0
Temperature, F	120	120	120	120	120	120	120
Flow, gpm	50	50	0	0	0	0	0

- (1) Mode 1 Processing equipment drain tank contents via the waste concentrator; discharging a waste condensate tank.
- (2) Mode 2 Processing chemical drain tank contents via the waste concentrator; discharging a waste condensate tank.
- (3) Mode 3 Discharging a laundry drain tank.

TABLE 3.5-12

LIQUID WASTE SYSTEM EXPECTED PERFORMANCE

Ion exchanger decontamination factor	
Tritium, corrosion products	1
All others	10
Filter decontamination factor	
All nuclides	1
Waste concentrator decontamination factor	500
Holdup time for liquid waste system, days	
Anticipated	1
Normal	4.5

TABLE 3.5-13

LIQUID WASTE SYSTEM NORMAL ACTIVITY DISTRIBUTION ($\mu\text{Ci/cc}$ at 70F)

Location	1	2	3 & 12	13	14	15	21
H-3	6.65(-3)*	1.48(-3)	5.29(-3)	5.29(-3)	5.29(-3)	5.29(-3)	5.29(-3)
Br-84	1.31(-7)	6.43(-5)	0.0	0.0	0.0	0.0	0.0
Kr-85m	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kr-85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kr-87	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kr-88	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rb-88	4.05(-6)	3.50(-3)	0.0	0.0	0.0	0.0	0.0
Rb-89	9.22(-8)	8.83(-5)	0.0	0.0	0.0	0.0	0.0
Sr-89	2.22(-5)	6.99(-6)	1.71(-5)	3.42(-8)	3.42(-9)	3.22(-9)	3.42(-4)
Sr-90	3.56(-6)	3.60(-7)	2.72(-6)	5.44(-9)	5.44(-10)	5.43(-10)	5.44(-5)
Y-90	3.38(-7)	1.41(-6)	1.93(-7)	3.87(-10)	3.86(-11)	1.21(-11)	3.89(-6)
Sr-91	1.82(-7)	4.91(-6)	6.37(-10)	1.27(-12)	1.27(-13)	5.66(-17)	1.27(-8)
Y-91	5.39(-4)	1.53(-4)	4.15(-4)	8.29(-7)	8.29(-8)	7.87(-8)	8.30(-3)
Mo-99	7.02(-4)	2.80(-3)	4.11(-4)	8.22(-7)	8.22(-8)	2.69(-8)	8.20(-3)
Ru-103	1.53(-5)	5.70(-6)	1.18(-5)	2.37(-8)	2.37(-9)	2.19(-9)	2.37(-4)
Ru-106	2.64(-6)	3.42(-7)	2.01(-6)	4.03(-9)	4.03(-10)	3.99(-10)	4.03(-5)
Te-129	1.48(-7)	3.46(-5)	0.0	0.0	0.0	0.0	0.0
I-129	9.95(-10)	9.95(-11)	7.58(-10)	1.52(-12)	1.52(-13)	1.52(-13)	1.52(-8)
I-131	3.80(-3)	5.50(-3)	2.90(-3)	5.74(-6)	5.74(-7)	3.89(-7)	5.74(-2)
Xe-131m	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Te-132	1.35(-4)	4.55(-4)	8.55(-5)	1.71(-7)	1.71(-8)	6.67(-9)	1.70(-3)
I-132	1.32(-5)	1.50(-3)	2.97(-18)	5.95(-21)	5.95(-22)	4.35(-36)	5.95(-17)
I-133	6.24(-4)	7.80(-3)	7.13(-5)	1.43(-7)	1.43(-8)	4.04(-10)	1.40(-3)
Xe-133	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Te-134	9.71(-8)	3.62(-5)	0.0	0.0	0.0	0.0	0.0

* Numbers in () are powers of ten.

TABLE 3.5-13 (Cont'd)

Location	1	2	3 & 12	13	14	15	21
I-134	2.90(-6)*	8.55(-4)	0.0	0.0	0.0	0.0	0.0
Cs-134	1.20(-3)	1.38(-4)	9.20(-4)	1.84(-6)	1.84(-7)	1.83(-7)	1.84(-2)
I-135	9.55(-5)	3.70(-3)	1.48(-8)	2.96(-11)	2.96(-12)	4.16(-17)	2.96(-7)
Xe-135	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cs-136	3.76(-5)	3.52(-5)	2.90(-5)	5.82(-8)	5.82(-9)	4.58(-9)	5.82(-4)
Cs-137	4.40(-3)	4.42(-4)	3.30(-3)	6.67(-6)	6.67(-7)	6.66(-7)	6.67(-2)
Xe-138	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cs-138	1.96(-6)	9.52(-4)	0.0	0.0	0.0	0.0	0.0
Ba-140	8.89(-6)	8.43(-6)	6.87(-6)	1.37(-8)	1.37(-9)	1.08(-9)	1.37(-4)
La-140	1.22(-6)	8.07(-6)	4.71(-7)	9.42(-10)	9.42(-11)	1.46(-11)	9.42(-6)
Pr-143	9.03(-6)	8.06(-6)	6.98(-6)	1.39(-8)	1.39(-9)	1.11(-9)	1.40(-4)
Ce-144	4.13(-5)	5.70(-6)	3.15(-5)	6.31(-8)	6.31(-9)	6.24(-9)	6.31(-4)
Co-60	6.78(-5)	7.16(-6)	5.17(-5)	1.03(-7)	1.03(-7)	1.03(-7)	1.00(-3)
Fe-59	8.61(-7)	2.94(-7)	6.64(-7)	1.33(-9)	1.33(-9)	1.24(-9)	1.33(-5)
Co-58	2.54(-4)	6.43(-5)	1.95(-4)	3.91(-7)	3.91(-7)	3.74(-7)	3.90(-3)
Mn-54	2.81(-6)	3.79(-7)	2.15(-6)	4.30(-9)	4.30(-9)	4.26(-9)	4.30(-5)
Cr-51	1.07(-4)	5.24(-5)	8.27(-5)	1.65(-7)	1.65(-7)	1.48(-7)	1.70(-3)
Zr-95	4.83(-8)	1.29(-8)	3.71(-8)	7.43(-11)	7.43(-11)	7.08(-11)	7.23(-7)

* Numbers in () are powers of ten.

TABLE 3.5-14

LIQUID WASTE SYSTEM ANTICIPATED OPERATIONAL OCCURRENCE ACTIVITY DISTRIBUTION ($\mu\text{Ci/cc}$ at 70F)
(Reference Figure 11.2-4)

WMS Location	1	2	3 & 12	13	14	15	21
H-3	1.60(-2)*	1.82(-3)	1.13(2)	1.13(-2)	1.13(-2)	1.13(-2)	1.13(-2)
Br 84	7.88(-6)	6.43(-4)	4.99(-18)	0.0	0.0	0.0	9.98(-17)
Kr 85m	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kr 85	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kr 87	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Kr 88	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Rb 88	2.43(-4)	3.52(-2)	0.0	0.0	0.0	0.0	0.0
Rb 89	5.53(-6)	8.83(-4)	0.0	0.0	0.0	0.0	0.0
Sr 89	5.15(04)	6.99(-5)	3.92(-4)	7.85(-7)	7.85(-8)	7.74(-8)	7.80(-3)
Sr 90	3.59(-5)	3.60(-6)	2.74(-5)	5.48(-8)	5.48(-9)	5.48(-9)	5.48(-4)
Y 90	1.81(-5)	1.41(-5)	1.32(-5)	2.63(-8)	2.63(-9)	2.03(-9)	2.63(-4)
Sr 91	1.07(-5)	4.91(-5)	3.75(-6)	7.51(-9)	7.51(-10)	1.35(-10)	7.51(-5)
Y 91	1.17(-2)	1.50(-3)	8.90(-3)	1.78(-5)	1.78(-6)	1.76(-6)	1.78(-1)
Mo 99	3.74(-2)	2.80(-2)	2.73(-2)	5.45(-5)	5.45(-6)	4.25(-6)	5.45(-1)
Ru 103	3.92(-4)	5.70(-5)	2.98(-4)	5.97(-7)	5.97(-8)	5.87(-8)	6.00(-3)
Ru 106	3.26(-5)	3.42(-6)	2.48(-5)	4.97(-8)	4.97(-9)	4.96(-9)	4.97(-4)
Te 129	8.88(-6)	3.46(-4)	3.32(-11)	6.64(-14)	6.64(-15)	2.25(-21)	6.64(-10)
I 129	9.95(-9)	9.95(-10)	7.58(-9)	1.52(-11)	1.52(-12)	1.52(-12)	1.52(-7)
I 131	1.69(-1)	5.48(-2)	1.27(-1)	2.54(-4)	2.54(-5)	2.33(-5)	2.54
Xe 131m	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Te 132	7.00(-3)	4.60(-3)	5.20(-3)	1.04(-5)	1.04(-6)	8.40(-7)	1.04(-1)
I 132	7.92(-4)	1.50(-2)	3.29(-6)	6.58(-9)	6.58(-10)	4.75(-13)	6.58(-5)
I 133	3.60(-2)	7.81(-2)	2.13(-2)	4.27(-5)	4.27(-6)	1.93(-6)	4.27(-1)
Xe 133	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Te 134	5.82(-6)	3.62(-4)	4.76(-15)	9.52(-18)	9.52(-19)	0.0	9.52(-14)

*Numbers in () are powers of ten.

TABLE 3.5-14 (Cont'd)

WMS Location	1	2	3 & 12	13	14	15	21
I 134	1.73(-4)	8.60(-3)	1.58(-11)	3.16(-14)	3.16(-15)	2.09(-23)	3.16(-10)
Cs 134	1.35(-2)	1.40(-3)	1.03(-2)	2.05(-5)	2.05(-6)	2.05(-6)	2.05(-1)
I 135	5.70(-3)	3.73(-2)	1.20(-3)	2.34(-6)	2.34(-7)	1.95(-8)	2.34(-2)
Xe 135	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cs 136	1.50(-3)	3.52(-4)	1.10(-3)	2.23(-6)	2.23(-7)	2.11(-7)	2.23(-7)
Cs 137	4.41(-2)	4.40(-3)	3.36(-2)	6.72(-5)	6.72(-6)	6.72(-6)	6.72(-1)
Xe 138	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cs 138	1.17(-4)	9.50(-3)	8.97(-17)	1.79(-19)	1.79(-20)	0.0	1.79(-15)
Ba 140	3.49(-4)	8.43(-5)	2.64(-4)	5.29(-7)	5.29(-8)	5.01(-8)	5.30(-3)
La 140	6.83(-5)	8.07(-5)	4.73(-5)	9.47(-8)	9.47(-9)	6.26(-9)	9.47(-4)
Pr 143	3.47(-4)	8.06(-5)	2.63(-4)	5.26(-7)	5.26(-8)	5.00(-8)	5.30(-3)
Ce 144	5.36(-4)*	5.70(-5)	4.08(-4)	8.17(-7)	8.17(-8)	8.15(-8)	8.20(-3)
Co 60	7.09(-5)	7.16(-6)	5.41(-5)	1.08(-7)	1.08(-7)	1.08(-7)	1.10(-3)
Fe 59	2.09(-5)	2.94(-7)	1.59(-6)	3.19(-9)	3.19(-9)	3.14(-9)	3.19(-5)
Co 58	5.12(-4)	6.43(-5)	3.90(-4)	7.81(-7)	7.81(-7)	7.73(-7)	7.80(-3)
Mn 54	3.58(-6)	3.79(-7)	3.73(-6)	5.47(-9)	5.47(-9)	5.45(-9)	5.46(-5)
Cr 51	3.17(-4)	5.24(-5)	2.41(-4)	4.83(-7)	4.83(-7)	4.71(-7)	4.80(-3)
Zr 95	1.01(-7)	1.29(-8)	7.68(-8)	1.54(-10)	1.52(-10)	1.52(-10)	1.54(-6)

*Numbers in () are powers of ten.

TABLE 3.5-15

ASSUMPTIONS USED IN CALCULATING ESTIMATED NORMAL AND
ANTICIPATED OPERATIONAL OCCURRENCE RELEASES ⁽¹⁾

	Estimated Normal Releases	Anticipated ⁽²⁾ Operational Occurrence
1. <u>Steam Generator Blowdown</u>		
Main steam flow rate, lb/hr	11,206,000	11,206,000
Liquid inventory per steam generator, lb	130,500	130,500
Blowdown rate, gal/day	200 (26,567)	1,200
Fuel failure, %	0.1	1.0
Iodine partition coefficient	5×10^{-2} (10^{-2})	5×10^{-2}
2. <u>Releases to Reactor Auxiliary Building</u> ⁽³⁾		
Fuel failure, %	0.1	1.0
Leakage to reactor auxiliary building, gal/day	10 (19.2)	10
Iodine partition coefficient	5×10^{-3}	5×10^{-3}
3. <u>Secondary System Releases</u>		
Steam generator tube leakage rate, gal/day	20 (18.1)	120
Failed fuel, %	0.1	1.0
Condenser iodine partition coefficient	5×10^{-4} (10^{-4})	5×10^{-4}
Flow rate into condenser, lb/hr	7,840,000	7,840,000
Steam weight in main steam piping from steam generator to turbine stop valves (both loops), lb	7940	7940
Condenser steam space ⁽⁴⁾ , lb	327	327
Turbine steam ⁽⁴⁾ , lb	87,000	87,000

- (1) Regulatory Guide 1.42 assumptions utilized in the gaseous release analysis that differ from normally applied values are shown in parenthesis.
- (2) Releases for anticipated operational occurrences are assumed processed through the waste management system.
- (3) Assumed reactor coolant activities to 120 F.
- (4) Including hotwell

TABLE 3.5-15 (Cont'd)

Steam generator steam space, ⁽³⁾ lb	<u>9,500</u>	<u>9,500</u>	
Total steam space, lb	104,767	104,767	
Condenser hotwell water weight, lb	680,000	680,000	
Liquid inventory between hotwell and steam generator, lb	480,000	480,000	
Steam leakage to turbine building, lb/hr	20 (1700)	20	3
4. <u>Containment Purge System</u>			
Releases independent of % failed fuel			
Reactor coolant system leak rate, lb/hr	50 (10)		3
Airborne activity cleanup flow rate	20,000 cfm = .48 volume/hr.		
HEPA filter efficiency, %	99.9		
Charcoal filter efficiency, %			
Organic iodine	70		
Inorganic iodine	90		
Operating time of removal system after shutdown, hr	10		
Purge initiation after shutdown, hr	10		
Purge flow rate	20,000 cfm = .48 volume/hr.		
Purge frequency, times/yr.	4		
Purge filter efficiencies, %	0		
Iodine partition coefficient	0.1		
5. <u>Liquid Waste System Releases</u> ⁽⁴⁾			
Miscellaneous waste, gal	156,000		
Laundry and showers	117,000		

(3) Including piping

(4) See item 1 for assumptions about blowdown releases from steam generator.

TABLE 3.5-15 (Cont'd)6) Decay Tanks

	<u>Holdup Time</u> days	<u>Tank Inventory</u> per cent
Reactor Drain Tank	3	50
Holdup Tank	9	50
Boric Acid Condensate Tank	3	50

7) Calculation Assumptions for Seafood Ingestion Dose

A. Individual Dose

1) Consumption

a) fish, kg/yr	18
b) crustacea, kg/yr	9
c) mollusk, kg/yr	9

2) Discharge canal flow, gpm 513,000

3) Reconciliation Factors

<u>Radionuclide</u>	<u>Fish</u>	<u>Crustacea</u>	<u>Mollusks</u>
Cr-51	100	1,000	1,000
Mn-54	3,000	10,000	50,000
Fe-55	1,000	4,000	20,000
Fe-59	1,000	4,000	20,000
Co-58	100	10,000	300
Co-60	100	10,000	300
Rb-86	30	50	10
Sr-89	1	1	1
Sr-90	1	1	1
Y-90	30	100	100
Y-91	30	100	100
Zr-95	30	100	100
Zr-97	30	100	100
Nb-95	100	200	200
Mo-99	10	100	100
Ru-103	3	100	100
Ru-106	3	100	100
Rh-105	10	100	100
Sb-127	1,000	1,000	1,000
Te-127m	10	10	100
Te-129m	10	10	100
Te-131m	10	10	100
Te-132	10	10	100
I-131	20	100	100

TABLE 3.5-15 (Cont'd)

<u>Radionuclide</u>	<u>Fish</u>	<u>Crustacea</u>	<u>Mollusks</u>
I-132	20	100	100
I-133	20	100	100
I-135	20	100	100
Cs-136	30	50	10
Cs-137	30	50	10
Ba-140	3	3	3
Ce-141	30	100	100
Ce-143	30	100	100
Ce-144	30	100	100
Pr-143	100	1,000	1,000
Nd-147	100	1,000	1,000
Pm-147	100	1,000	1,000
Pm-149	100	1,000	1,000
Sm-153	100	1,000	1,000
H-3	1	1	1

B. Population Dose

1) Consumption of seafood harvest in St. Lucie County

	<u>Total</u>	<u>Contaminated Fish Consumed</u>
a) fin fish, kg/yr	1.2×10^6	1.2×10^5
b) mollusk, kg/yr	1.0×10^5	1.0×10^4
c) crustacea, kg/yr	4.7×10^3	4.7×10^2

2) Seafood harvested from contaminated waters, % 10

3) Ocean dilution factor 20

8) Population Density DataPopulation within 5.0 mil. (1970) 1.165×10^3

Annular population,

5 - 10 mi.	4.53×10^4
10 - 20 mi.	2.45×10^4
20 - 30 mi. -	4.79×10^4
30 - 40 mi.	5.59×10^4
40 - 50 mi.	1.26×10^5
0 - 50 mi.	3.01×10^5

TABLE 3.5-16

EXPECTED LIQUID RELEASES FROM THE LIQUID WASTE SYSTEM

Nuclide	Curies Released per Year		Activity in Circulating Water Discharge (μ Ci/cc)	
	Normal Operation (0.1% Failed Fuel)	Anticipated Operation (1.0% Failed Fuel)	Normal Operation (0.1% Failed Fuel)	Anticipated Operation (1.0% Failed Fuel)
H-3	2.26 (2)*	3.39 (2)	2.21 (-7)	3.32 (-7)
Br-84	0.0	0.0	0.0	0.0
Kr-85m	1.09 (-13)	1.09 (-12)	0.0	1.07 (-21)
Kr-85	3.89 (+1)	3.89 (+2)	3.81 (-8)	3.81 (-7)
Kr-87	0.0	0.0	0.0	0.0
Kr-88	0.0	0.0	0.0	0.0
Rb-88	0.0	0.0	0.0	0.0
Rb-89	0.0	0.0	0.0	0.0
Sr-89	1.41 (-5)	2.71 (-4)	1.38 (-14)	2.66 (-13)
Sr-90	1.29 (-6)	1.80 (-5)	1.26 (-15)	1.76 (-14)
Y-90	2.18 (-5)	2.22 (-4)	2.13 (-14)	2.18 (-13)
Sr-91	1.62 (-12)	3.02 (-7)	1.59 (-21)	2.96 (-16)
Y-91	2.21 (-2)	2.24 (-1)	2.16 (-11)	2.19 (-10)
Mo-99	4.79 (-2)	4.88 (-1)	4.69 (-11)	4.78 (-10)
Ru-103	8.06 (-5)	9.09 (-4)	7.90 (-14)	8.90 (-13)
Ru-106	5.89 (-6)	6.47 (-5)	5.77 (-15)	6.34 (-14)
Te-129	0.0	5.04 (-18)	0.0	0.0
I-129	1.99 (-10)	3.39 (-9)	1.95 (-19)	3.32 (-18)
I-131	5.14 (-4)	5.22 (-2)	5.04 (-13)	5.11 (-11)
Xe-131m	3.87 (+1)	3.87 (+2)	3.79 (-8)	3.79 (-7)
Te-132	1.10 (-3)	1.29 (-2)	1.09 (-12)	1.26 (-11)
I-132	0.0	1.06 (-9)	5.58 (-42)	1.04 (-18)
I-133	5.39 (-7)	4.30 (-3)	5.28 (-16)	4.23 (-12)
Xe-133	2.44 (+3)	2.44 (+4)	2.39 (-6)	2.39 (-5)
Te-134	0.0	0.0	0.0	9.95 (-35)
I-134	0.0	0.0	0.0	0.0
Cs-134	2.40 (-3)	2.64 (-2)	2.37 (-12)	2.59 (-11)

*Numbers in () are powers of ten

TABLE 3.5-16 (Cont'd)

Nuclide	Curies Released per Year		Activity in Circulating Water Discharge (μ Ci/cc)	
	Normal Operation (0.1% Failed Fuel)	Anticipated Operation (1.0% Failed Fuel)	Normal Operation (0.1% Failed Fuel)	Anticipated Operation (1.0% Failed Fuel)
I-135	5.57 (-14)	4.36 (-5)	0.0	4.27 (-14)
Xe-135	5.22 (-8)	5.22 (-7)	5.11 (-17)	5.11 (-16)
Cs-136	3.53 (-4)	3.90 (-3)	3.46 (-13)	3.86 (-12)
Cs-137	7.90 (-3)	8.54 (-2)	7.75 (-12)	8.37 (-11)
Xe-138	0.0	0.0	0.0	0.0
Cs-138	0.0	0.0	0.0	0.0
Ba-140	9.67 (-6)*	1.95 (-4)	9.47 (-15)	1.91 (-13)
La-140	3.12 (-6)	4.51 (-5)	3.06 (-15)	4.41 (-14)
Pr-143	8.30 (-5)	9.27 (-4)	8.13 (-14)	9.08 (-13)
Ce-144	9.71 (-5)	1.10 (-3)	9.51 (-14)	1.05 (-12)
Co-60	1.30 (-3)	1.40 (-3)	1.25 (-12)	1.35 (-12)
Fe-59	4.24 (-5)	4.78 (-5)	4.15 (-14)	4.68 (-14)
Co-58	9.90 (-3)	1.11 (-2)	9.68 (-12)	1.09 (-11)
Mn-54	6.49 (-5)	7.15 (-5)	6.36 (-14)	7.01 (-14)
Cr-51	6.90 (-3)	7.70 (-3)	6.73 (-12)	7.58 (-12)
Zr-95	1.96 (-6)	2.21 (-6)	1.92 (-15)	2.16 (-15)
Total: H-3	2.26 (+2)	3.39 (+2)	2.21 (-7)	3.32 (-7)
Total: Noble Gas	2.51 (+3)	2.51 (+4)	2.47 (-6)	2.46 (-5)
Total: All Others	1.01 (-1)	9.22 (-1)	9.87 (-11)	9.02 (-10)

*Numbers in () are powers of ten.

TABLE 3.5-16 (Cont'd)

TURBINE BUILDING FLOOR DRAINAGE

<u>Nuclide</u>	Curies Released Per Year	
	<u>Normal Operating (0.1% Failed Fuel)</u>	<u>Anticipated Operation (1.0% Failed Fuel)</u>
H-3	1.29 (-1)	5.47 (-1)
Br-84	3.18 (-7)	2.01 (-5)
Rb-88	9.93 (-6)	5.97 (-4)
Rb-89	2.18 (-7)	1.31 (-5)
Sr-89	4.32 (-5)	1.32 (-3)
Sr-90	1.84 (-6)	6.08 (-5)
Y-90	1.99 (-11)	1.20 (-9)
Sr-91	2.51 (-6)	1.40 (-4)
Y-91	6.50 (-4)	2.38 (-2)
Mo-99	1.49 (-3)	8.30 (-2)
Ru-103	2.03 (-5)	7.93 (-4)
Ru-106	2.07 (-6)	6.36 (-5)
Te-129	1.17 (-4)	4.60 (-3)
I-129	6.49 (-10)	1.93 (-8)
I-131	7.27 (-3)	3.62 (-1)
Te-132	2.80 (-4)	1.52 (-2)
I-132	8.60 (-4)	4.72 (-2)
I-133	1.37 (-3)	8.04 (-2)
Te-134	2.51 (-7)	1.51 (-5)
I-134	6.67 (-6)	4.03 (-4)
Cs-134	8.65 (-4)	2.62 (-2)
I-135	2.15 (-4)	1.28 (-2)
Cs-136	6.81 (-5)	3.43 (-3)
Cs-137	2.87 (-3)	8.55 (-2)
Cs-138	4.76 (-6)	2.86 (-4)
Ba-140	1.64 (-5)	7.53 (-4)
La-140	2.67 (-6)	1.52 (-4)
Pr-143	1.58 (-5)	7.28 (-4)

TABLE 3.5-16 (Cont'd)

<u>Nuclide</u>	Curies Released Per Year	
	<u>Normal Operating (0.1% Failed Fuel)</u>	<u>Anticipated Operation (1.0% Failed Fuel)</u>
Ce-144	3.38 (-5)	1.05 (-3)
Co-60	4.59 (-5)	1.38 (-4)
Fe-59	1.15 (-6)	4.29 (-6)
Co-58	2.95 (-4)	1.04 (-3)
Mn-54	2.24 (-6)	7.02 (-6)
Cr-51	1.60 (-4)	6.51 (-4)
Zr-95	2.02 (-11)	1.22 (-10)

TABLE 3.5-17

WASTE GAS SYSTEM FLOW DATA POINTS

ANTICIPATED OPERATIONAL OCCURRENCE FOR 1% FAILED FUEL*

Position No.	1	2	3	4	5	6
Flow, scfm	2.46(-2)	(1.90-9.5)x10 ⁻⁴	3.46(-3)	1.96(-2)	4.82(-2)	9.65(-2)
Pressure, psig	0.5-7	0.5-7	0.5-7	0.5-7	0.5-7	0.5-7
Temperature/F	70-120	70-120	70-120	70-120	70-120	70-120
Kr-85m μ Ci/cc	0.12	2.19	0	0-22	4.16	2.19
Kr-85 "	0.464	2.24	21.8	0.16	2.56	2.24
Kr-87 "	0.206	1.24	0	8.29(-2)	2.30	1.24
Kr-88 "	0.140	3.81	0	0.35	7.24	3.81
Xe-131m "	0.728	3.18	21.5	0.26	4.26	3.18
Xe-133 "	81.80	257.0	996.	32.14	381.0	257.0
Xe-135 "	1.12	11.21	0	1.18	21.1	11.21
Xe-138 "	2.12(-3)***	0.51	0	3.98(-3)	1.01	0.51
I-129 "	4.80(-14)	2.70(-14)	3.98(-16)	1.29(-15)	2.84(-14)	2.70(-14)
I-131 "	2.31(-4)	1.20(-4)	7.76(-7)	7.06(-8)	1.19(-4)	1.20(-4)
I-132 "	4.50(-6)	2.63(-6)	0	1.38(-8)	2.89(-6)	2.63(-6)
I-133 "	1.57(-4)	8.26(-5)	9.53(-10)	9.72(-8)	8.25(-5)	8.26(-5)
I-134 "	1.00(-6)	7.21(-7)	0	5.37(-9)	9.07(-7)	7.21(-7)
I-135 "	3.03(-5)	3.16(-5)	0	4.24(-8)	1.68(-5)	3.16(-5)

* Concentrations of nuclides are reduced by a factor of 10 for the expected operation of 0.1% failed fuel.

** Activity values calculated at standard temperature and pressure.

*** Numbers in () are powers of ten.

TABLE 3.5-17

WASTE GAS SYSTEM FLOW DATA POINTS (Cont'd.)

ANTICIPATED OPERATIONAL OCCURRENCE FOR 1% FAILED FUEL*						
Position No.	7	8	9	10	11	12
Flow, scfm	0.097	0.097	0.097	0.097	0.097	0.75
Pressure, psig	0.5-7	10-165	10-165	10	< 0.1	< 0.1
Temperature/F	70-120	70-110	80	80	80	70-120
Kr-85m $\mu\text{Ci/cc}^{**}$	2.19	2.19	0	0	0	1.33(-3)
Kr-85 "	2.24	2.24	2.22	2.22	2.22	4.31(-2)
Kr-87 "	1.24	1.24	0	0	0	2.80(-4)
Kr-88 "	3.81	3.81	0	0	0	1.70(-3)
Xe-131m "	3.18	3.18	0.56	0.56	0.56	4.41(-2)
Xe-133 "	257.0	257.0	4.98	4.98	4.98	2.29
Xe-135 "	11.21	11.21	0	0	0	9.92(-3)
Xe-138 "	0.51	0.51	0	0	0	3.52(-10)
I-129 "	2.70(-14)***	2.70(-14)	2.30(-13)	2.30(-13)	2.30(-13)	1.84(-15)
I-131 "	1.20(-4)	1.20(-4)	9.10(-6)	9.10(-6)	9.10(-6)	3.54(-6)
I-132 "	2.63(-6)	2.63(-6)	0	0	0	2.82(-10)
I-133 "	8.26(-5)	8.26(-5)	0	0	0	4.97(-9)
I-134 "	7.21(-7)	7.21(-7)	0	0	0	6.60(-12)
I-135 "	3.16(-5)	3.16(-5)	0	0	0	1.63(-10)

* Concentrations of nuclides are reduced by a factor of 10 for the expected operation of 0.1% failed fuel.

** Activity values calculated at standard temperature and pressure.

*** Numbers in () are powers of 10.

TABLE 3.5-18

COMPONENT DATA

1. Waste Gas Compressor

Type	Diaphragm Positive Displacement
Quantity	2
Capacity, scfm	2
Discharge pressure, psig	0-165
Codes	ASME Boiler and Pressure Vessel Code, Section III, Class 3; ASME Power Test Code PTC-9, Displacements Compressors, Vacuum Pumps and Blowers
Materials	Carbon Steel
Design temperature, F	150 - Inlet; 350 - Outlet
Design pressure, psig	200

2. Compressor Aftercooler

Type	Shell and Tube
Quantity	2
Codes: gas side	ASME Boiler and Pressure Vessel Code, Section III, Class 3
shell side	ASME Boiler and Pressure Vessel Code, Section III, Class 3
Materials	Carbon Steel
Discharge temperature, F	110

3. Compressor Inlet Filter

Type	Stainless Steel Screen
Quantity	2
Rating	5 micron
Clean pressure drop, psi @ 2 Cfm	0.3
Code	ASME Boiler and Pressure Vessel Code, Section III, Class 3

TABLE 3.5-18 (Cont'd)4. Gas Surge Tank

Type	Vertical
Quantity	1
Volume, ft ³	10
Design pressure, psig	40
Design temperature, F	200
Codes	ASME Boiler and Pressure Vessel Code, Section III, Class 3
Material	Carbon steel

5. Gas Decay Tank

Type	Vertical
Quantity	3
Volume, each, ft ³	144
Design pressure, psig	190
Design temperature, F	250
Codes	ASME Boiler and Pressure Vessel Code, Section III, Class 3
Material	Carbon steel

TABLE 3.5-19

GAS COLLECTION HEADER SOURCE POINTS

1. Preconcentrator ion exchanger vent
2. Holdup tank vent
3. Boric acid condensate ion exchanger vent
4. Boric acid holding tank vent
5. Boric acid condensate tank vents
6. Waste ion exchanger
7. Equipment drain tank vent
8. Chemical drain tank vent
9. Laundry drain tank vents
10. Waste condensate tank vents
11. Spent resin tank vent
12. Waste concentrator vent
13. CVCS ion exchanger vents
14. Fuel pool system ion exchanger vent
15. Boric acid makeup tank vents
16. Charging pump vents
17. Charging pump seal lubrication tank vents
18. Boric acid makeup pump vents

TABLE 3.5-20

ESTIMATED GASEOUS RELEASES BASED ON REGULATORY GUIDE 1.42 (Ci/sec)* AND 0.1% FAILED FUEL

Isotope	Gas Surge Header	Gas Collection Header	Steam Generator Blowdown	Reactor Auxiliary Building Vent	Turbine Building Leakage From Secondary System	Steam Jet Air Ejector	Containment Purge	Turbine Steam Heating	Total Ci/sec.	Total Ci/yr.
Kr-85m	0	4.72(-8)	6.16(-11)	1.54(-7)	1.54(-11)	1.01(-7)	4.72(-9)	5.44(-13)	3.08(-7)	9.68(0)
Kr-85	1.01(-5)**	1.54(-6)	3.65(-11)	9.16(-8)	9.16(-12)	6.04(-8)	1.29(-7)	3.24(-13)	1.19(-5)	3.74(+2)
Kr-87	0	9.84(-9)	3.30(-11)	8.40(-8)	8.28(-12)	5.44(-8)	1.69(-9)	2.85(-13)	1.50(-7)	4.72(0)
Kr-88	0	6.08(-8)	1.06(-10)	2.70(-7)	2.68(-11)	1.76(-7)	1.09(-8)	9.48(-13)	5.20(-7)	1.64(+1)
Xe-131m	2.46(-6)	1.58(-6)	6.08(-11)	1.53(-7)	1.53(-11)	1.01(-7)	4.44(-8)	5.40(-13)	4.32(-6)	1.36(+2)
Xe-133	2.55(-6)	8.12(-5)	7.48(-9)	1.88(-5)	1.88(-9)	1.24(-5)	2.70(-6)	6.64(-11)	1.18(-4)	3.70(+3)
Xe-135	0	3.52(-7)	3.03(-10)	7.64(-7)	7.64(-11)	4.80(-7)	2.76(-8)	2.69(-12)	1.62(-6)	5.12(+1)
Xe-138	0	1.27(-9)	1.39(-11)	3.74(-8)	3.41(-12)	2.25(-8)	2.86(-10)	1.20(-13)	6.18(-8)	1.94(0)
I-129	1.04(-18)	6.56(-20)	4.88(-19)	3.74(-17)	1.22(-17)	4.04(-17)	1.64(-17)	4.32(-19)	1.08(-16)	3.42(-9)
I-131	4.12(-11)	1.26(-10)	2.35(-11)	2.06(-9)	5.92(-10)	1.95(-9)	9.04(-10)	2.09(-11)	5.72(-9)	1.80(-1)
I-132	0	1.00(-14)	5.44(-12)	5.64(-10)	1.37(-10)	4.52(-10)	1.89(-10)	4.84(-12)	1.35(-9)	4.24(-2)
I-133	0	1.76(-13)	1.65(-11)	2.94(-9)	4.16(-10)	1.36(-9)	1.26(-9)	1.46(-11)	6.00(-9)	1.89(-1)
I-134	0	2.34(-16)	1.28(-13)	3.22(-10)	3.21(-12)	1.06(-11)	8.80(-11)	1.13(-13)	4.24(-10)	1.33(-2)
I-135	0	5.80(-15)	3.57(-12)	1.40(-9)	8.96(-11)	2.96(-10)	5.68(-10)	3.16(-12)	2.36(-9)	7.48(-2)

* Activity values calculated at standard temperature and pressure.

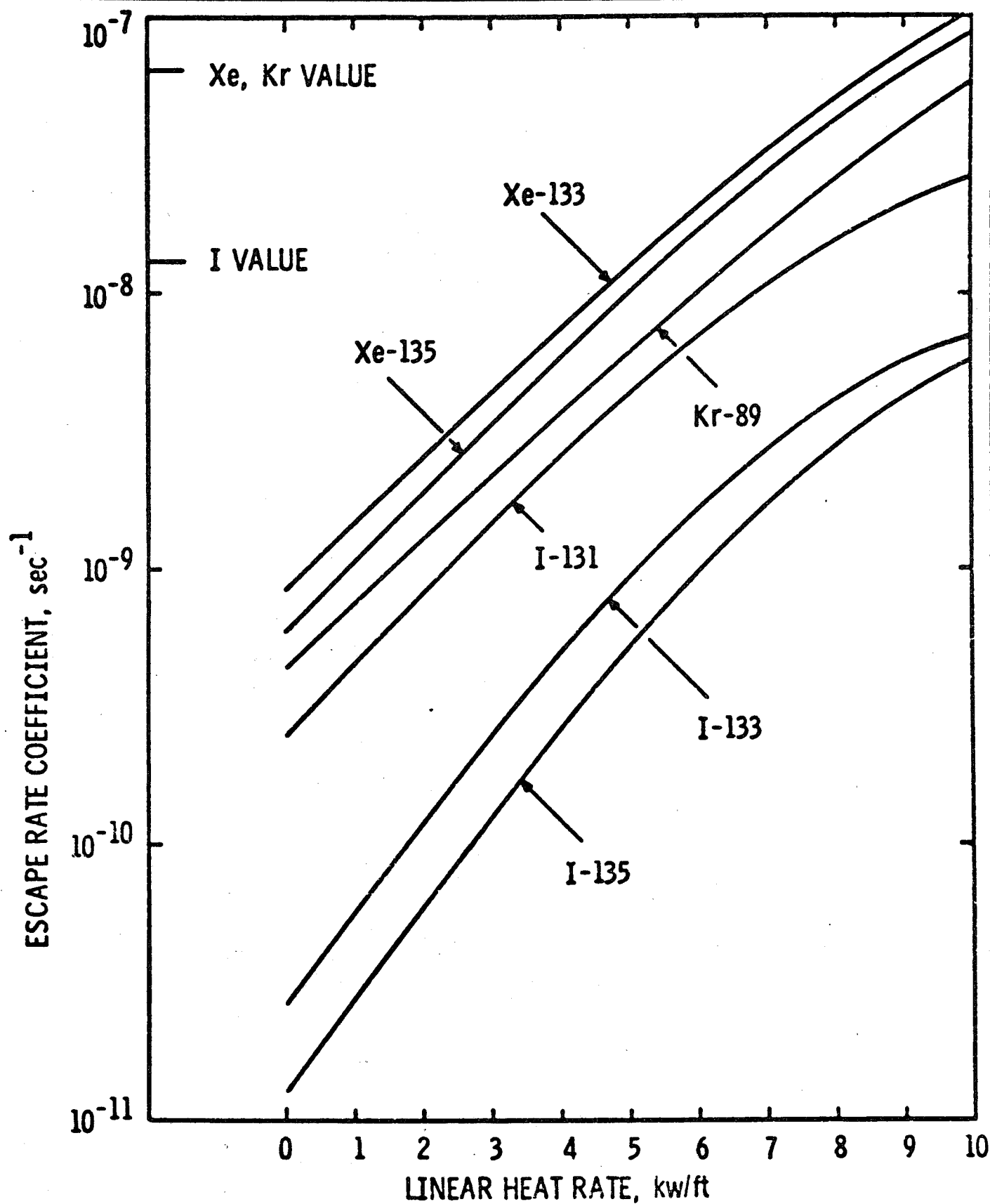
** Numbers in () are powers of ten

TABLE 3.5-20 (Cont'd)

Isotope	Turbine Building Leakage from Secondary System		Steam Jet Air Ejector		Containment Purge	
	Estimated Normal Releases	Anticipated Operational Occurrence Releases	Estimated Normal Releases	Anticipated Operational Occurrence Releases	Estimated Normal Releases	Anticipated Operational Occurrence Releases
Kr-85m	8.36(-6)**	5.01(-4)	3.28(0)	1.97(+2)	7.42(-1)	7.42(-1)
Kr-85	2.17(-6)	1.30(-4)	8.52(-1)	5.11(+1)	2.03(+1)	2.03(+1)
Kr-87	4.51(-6)	2.70(-4)	1.77(0)	1.06(+2)	2.66(-1)	2.66(-1)
Kr-88	1.46(-5)	8.74(-4)	5.71(0)	3.43(+2)	1.71(0)	1.71(0)
I-129	6.49(-10)	1.93(-8)	1.27(-7)	3.78(-6)	2.58(-9)	2.58(9)
I-131	7.27(-3)	3.62(-1)	1.43(0)	7.10(+1)	1.42(-1)	1.42(-1)
Xe-131m	8.35(-6)	5.01(-4)	3.27(0)	1.96(+2)	6.98(-0)	6.98(-0)
I-132	8.88(-4)	4.72(-2)	1.69(-1)	9.26(0)	2.97(-2)	2.97(-2)
I-133	1.42(-3)	8.04(-2)	2.69(-1)	1.58(+1)	1.98(-1)	1.98(-1)
Xe-133	1.02(-3)	6.13(-2)	4.00(+2)	2.40(+4)	4.26(+2)	4.26(+2)
I-134	6.63(-6)	4.01(-4)	1.31(-3)	7.87(-2)	1.39(-2)	1.39(-2)
I-135	2.15(-4)	1.37(-2)	4.20(-2)	2.52(0)	8.93(-2)	8.93(-2)
Xe-135	4.24(-5)	2.54(-3)	1.66(+1)	9.97(+2)	4.35(0)	4.35(0)
Xe-138	1.80(-6)	1.10(-4)	7.14(-1)	4.31(+1)	4.51(-2)	4.51(-2)

* Activity values calculated at standard temperature and pressure.

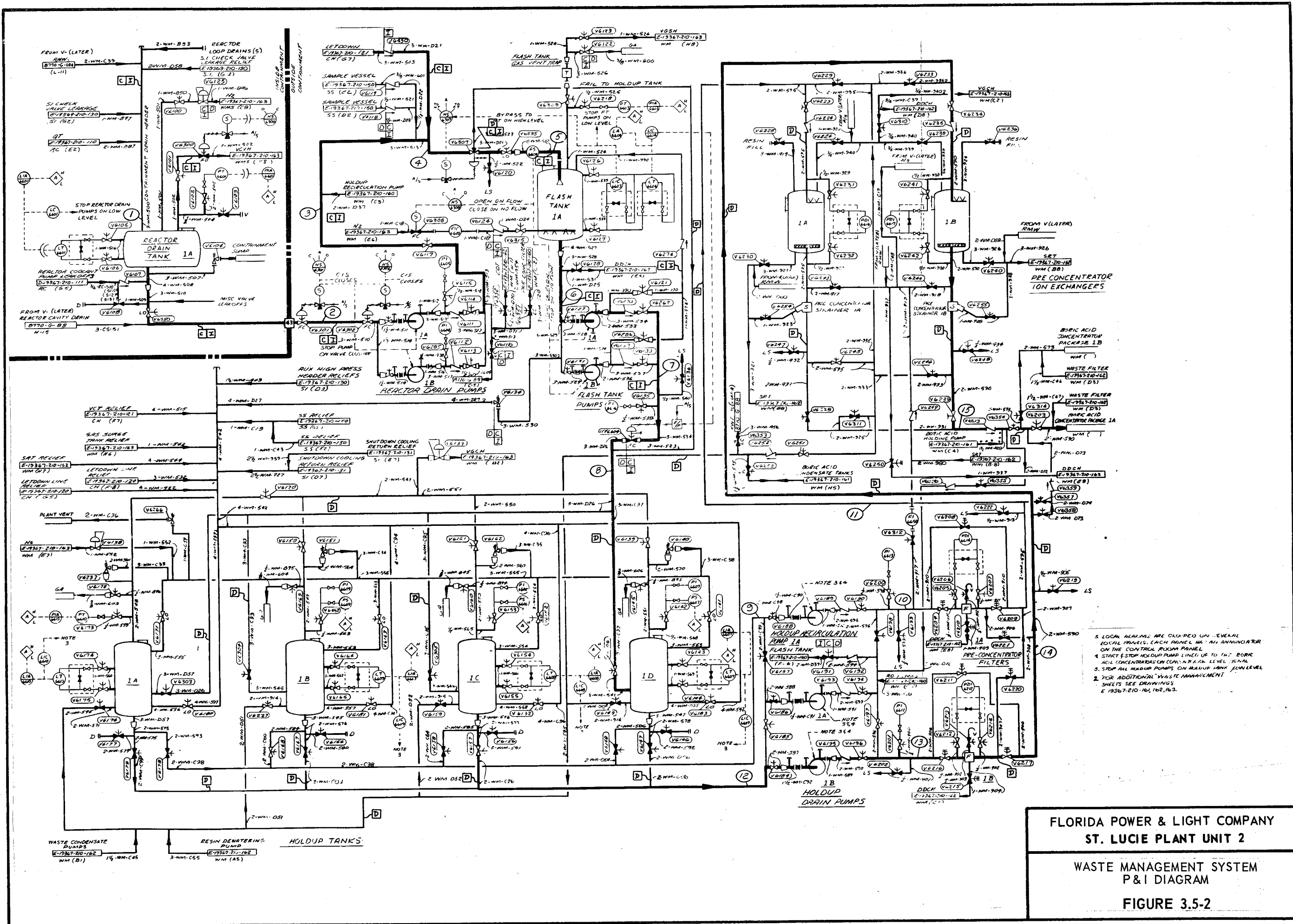
** Numbers in () are powers of ten.



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ESCAPE RATE COEFFICIENTS

FIGURE 3.5-1



PRE-CONCENTRATOR
ION-EXCHANGER

(15)

STEAM

CONDENSATE

RMW

N₂

DDCH

BORIC ACID
CONCENTRATOR
PACKAGE 1A

GSN

(17)

BORIC ACID CONDENSATE
ION EXCHANGER

HOLDUP PUMPS

CCS

CCS

BORIC ACID DISCHARGE
STRAINER

(16)

PRE-CONCENTRATOR
ION-EXCHANGER

STEAM

CONDENSATE

RMW

N₂

DDCH

BORIC ACID
CONCENTRATOR
PACKAGE 1B

GSN

BORIC ACID CONDENSATE
ION EXCHANGER

HOLDUP PUMPS

CCS

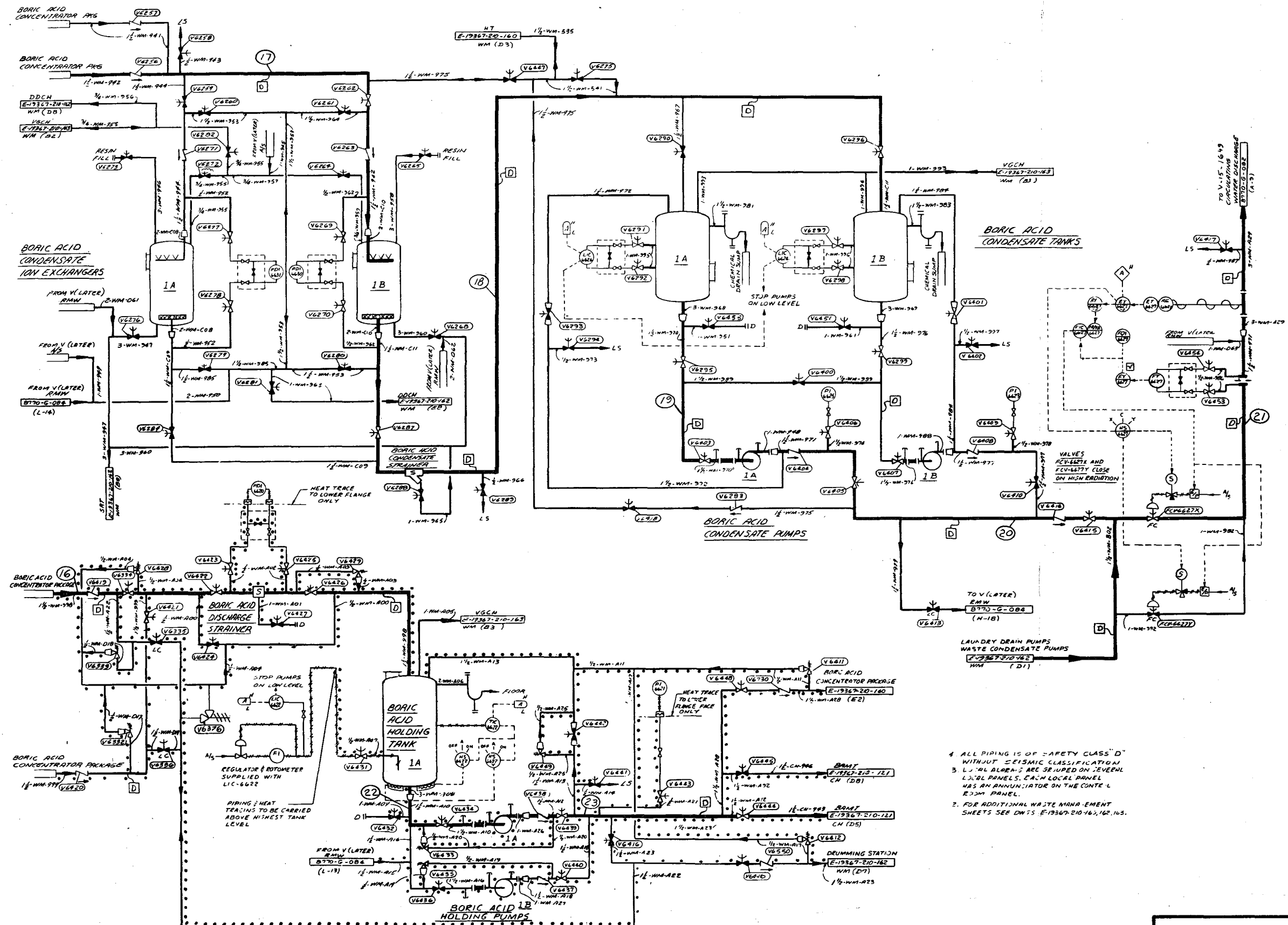
CCS

BORIC ACID DISCHARGE
STRAINER

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

BORIC ACID CONCENTRATOR PACKAGE

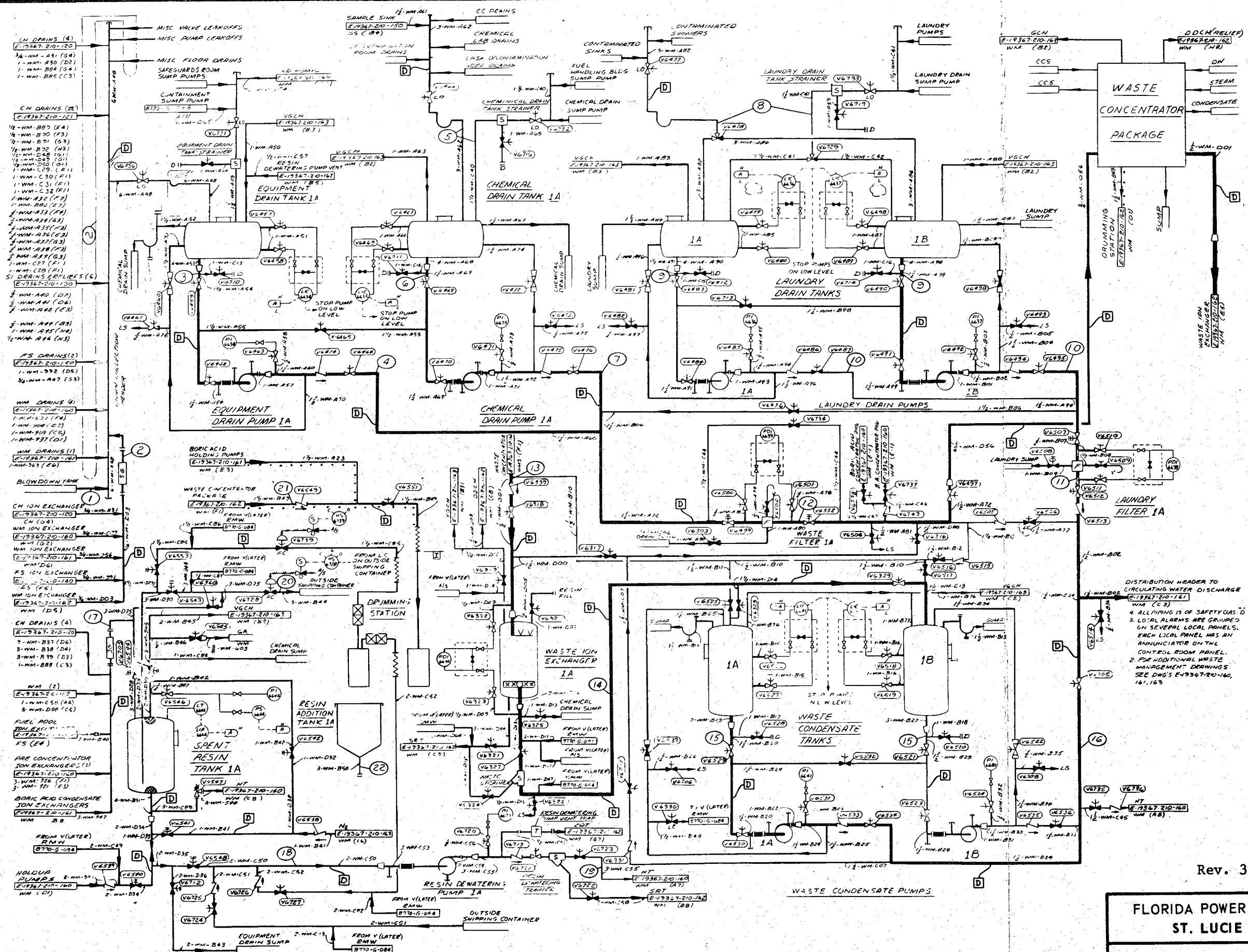
FIGURE 3.5-3



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

WASTE MANAGEMENT SYSTEM
P&I DIAGRAM

FIGURE 3.5-4

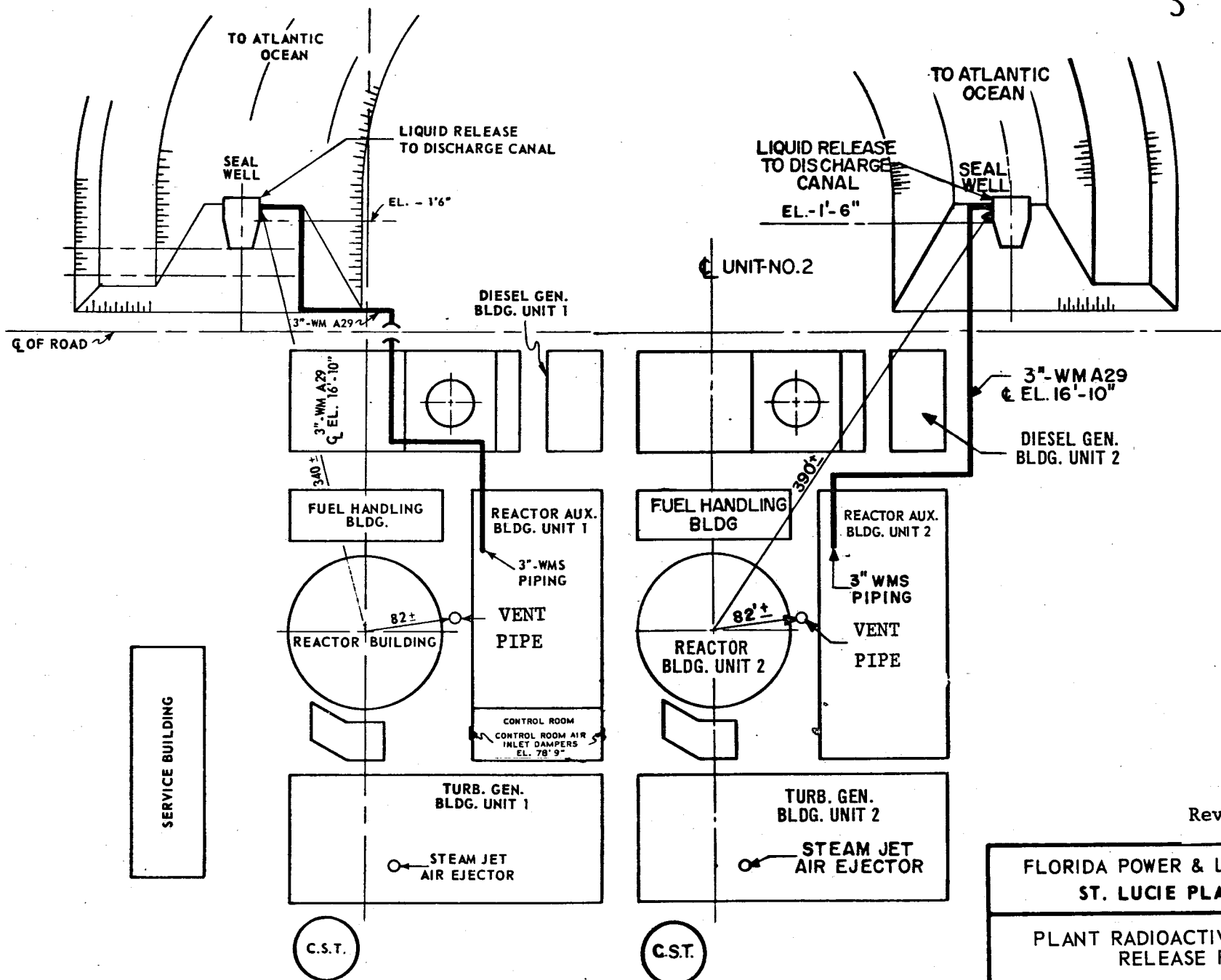


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FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

WASTE MANAGEMENT SYSTEM P&I DIAGRAM

FIGURE 3.5-5



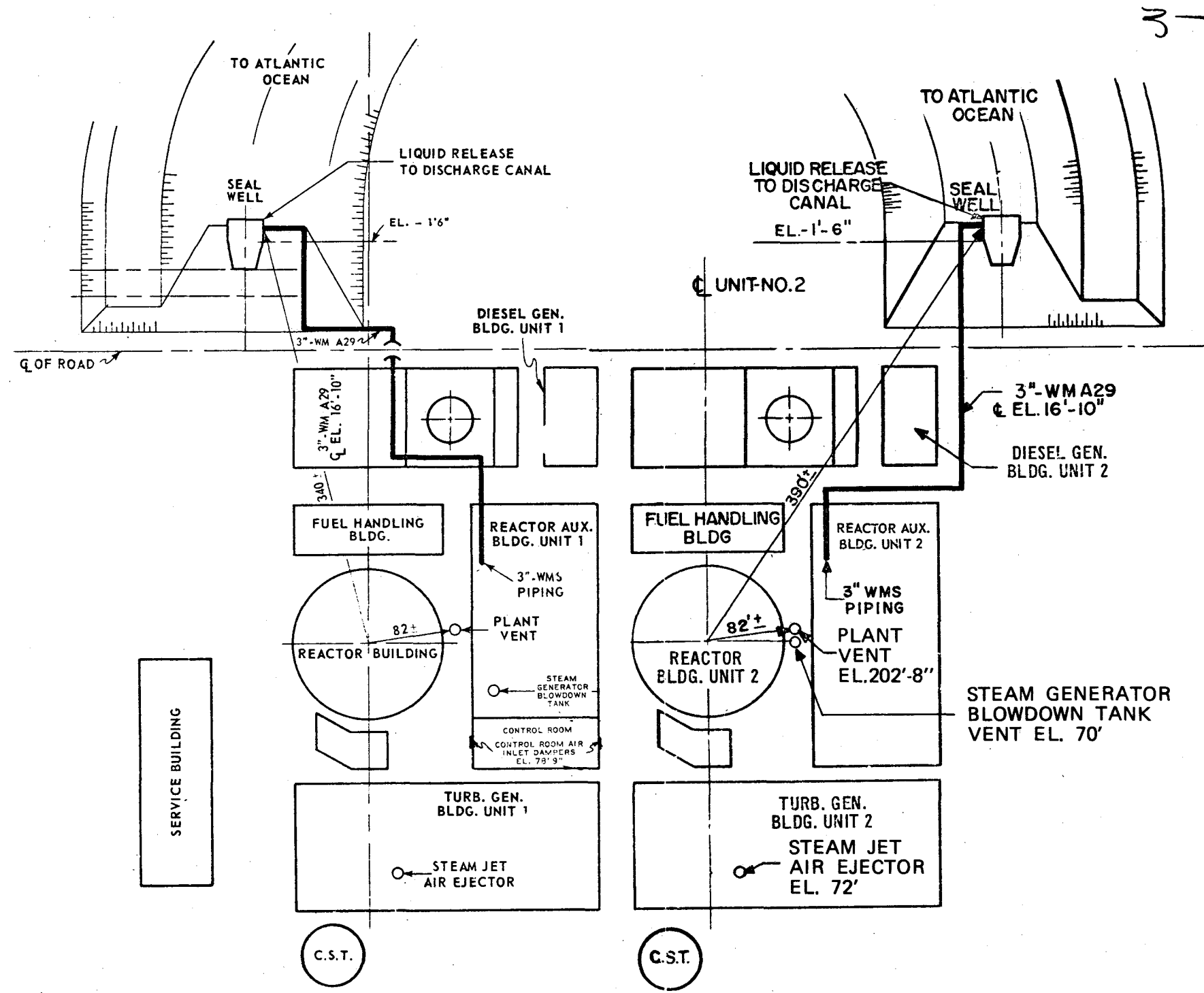
NOTE: NOT TO SCALE

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FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PLANT RADIOACTIVE LIQUID AND
RELEASE POINTS

FIGURE 3.5-6



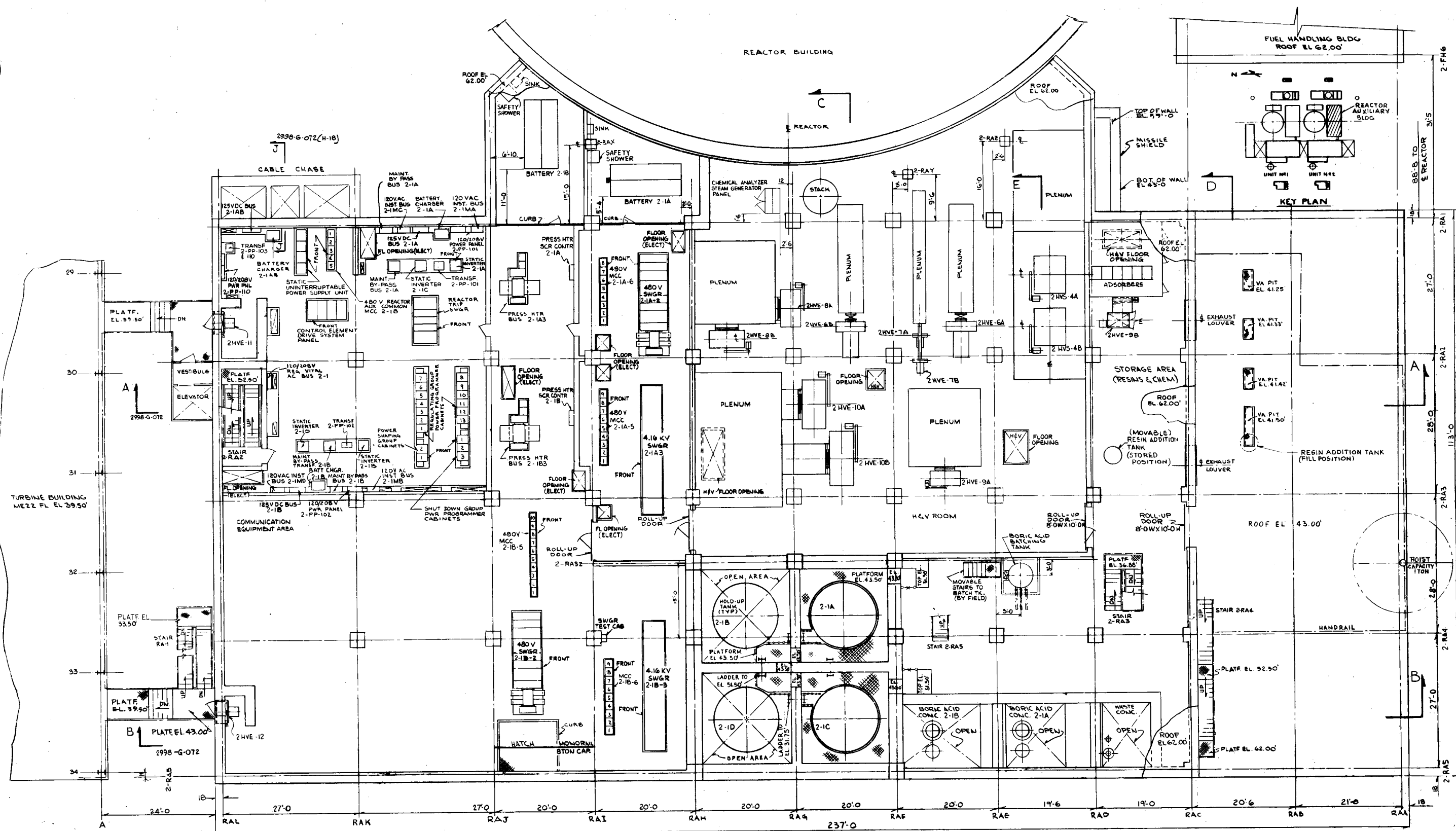
NOTE: NOT TO SCALE

AUGUST, 1973

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PLANT RADIOACTIVE LIQUID AND
RELEASE POINTS

FIGURE 3.5-6



PLAN AT EL.43.00'

NOTE:
FOR NOTES & REFERENCE DWGS SEE DWG.
NR 2998-G-069

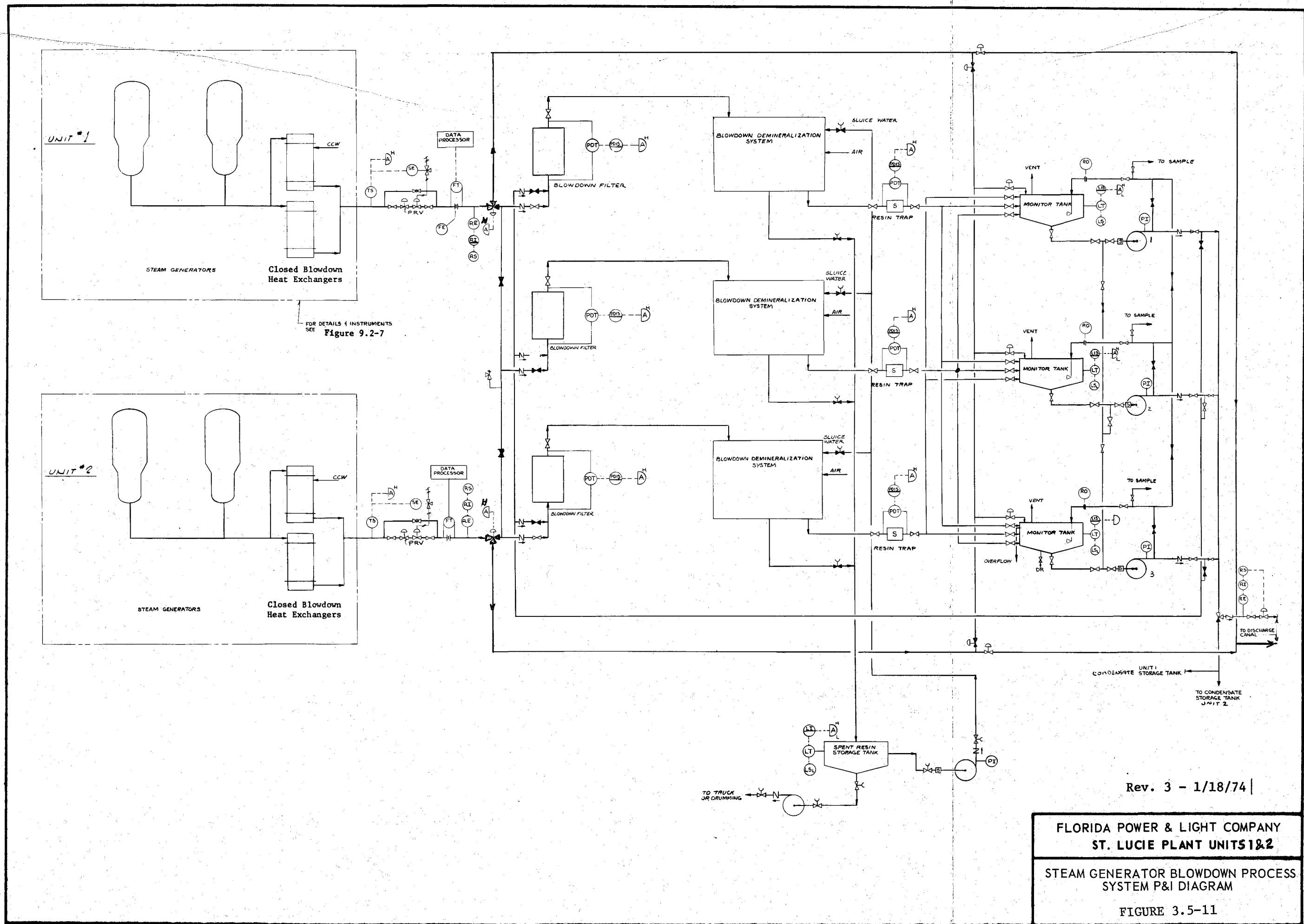
2 0 5 10 15 20 25 30 FT.
1/8"=1'-0"

DWG NO. 2998-G-071

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

GENERAL ARRANGEMENT
REACTOR AUXILIARY BUILDING
PLAN SHEET 3

FIGURE 3.5-8



3.6 CHEMICAL AND BIOCIDES SYSTEMS

The purpose of this section is to describe the chemical additives such as corrosion inhibitors, and the waste streams from water treatment and other operations that may enter the environment as the result of operating St. Lucie Units Nos. 1 & 2.

This discussion outlines the methods by which liquid and gaseous effluents will be treated, controlled and discharged and includes the expected nominal quantities that will be discharged.

The order of presentation is:

- a) Release of chemicals in waste water from the plant water treatment facility
- b) Chemicals released from plant corrosion control systems
- c) Chemicals released from plant control laboratories
- d) Chemicals released from biocide control
- e) Miscellaneous chemicals released.

3.6.1 CHEMICALS RELEASED FROM PLANT WATER TREATMENT FACILITY

Water from Fort Pierce municipal system is used for steam system makeup water during plant operation. This water is purified in an on-site water treatment facility comprising two demineralizer trains, each with a 600 gpm net capacity.

The mineral constituents in the water which are removed by the ion exchange resins are in turn released from the resins by washing with sulfuric acid and sodium hydroxide during regeneration. These regenerant streams are then discharged to a holding basin where they are neutralized by the addition of acid or caustic as required.

The neutralized basin contents will be discharged to the circulating water system. Table 3.6-1 presents the average and maximum expected levels of the constituents in the Fort Pierce water. From these data, estimates have been made of the average and maximum releases in pounds expected on a continuous basis from the water treatment facility. The results are summarized in Table 3.6-2 which also indicates the small incremental increases in mg/l over the background concentrations for each of the listed constituents in the Fort Pierce water.

3.6.2 CHEMICALS RELEASED FROM PLANT CORROSION CONTROL SYSTEMS

A number of chemicals are used in corrosion control of various plant systems. These chemicals are used in small amounts under highly controlled conditions. The various plant systems where these chemicals are utilized, along with their functions and principles of corrosion control, are given in the following table.

Chemicals Released From Plant Corrosion Control Systems

For control of corrosion in susceptible plant water systems, the various chemical additives and their service functions are indicated in this table:

<u>Chemical Additive</u>	<u>System Served</u>	<u>Purpose</u>
Hydrazine	Boiler Feed Water and Reactor Coolant System	Oxygen Scavenging
Mono-, Di-, & Trisodium Phosphate	Steam Generator Feed water System	pH Control of Water
Cyclohexylamine	Condensate Feed water	pH Control
Potassium Dichromate	Closed System of Cooling Water for Turbine Cooling and Component Cooling	Inhibition of Corrosion of Iron and Steel
Nitrogen and Hydrogen	Various Nuclear Steam Supply Systems	Cover Gas exclusion of Air and Oxygen

For each of the above additives, the quantities used, their mode of application, and rates of consumption and release are given below.

Hydrazine

Hydrazine is added to the steam generator make-up water to remove residual oxygen which, if not removed, would be detrimental to the turbine operation. The end products of the reaction between oxygen and hydrazine are water and free nitrogen gas which does not affect turbine operation. The free nitrogen will be removed in the condenser de-aerator and released to the atmosphere.

Only trace quantities of nitrogen and any residual hydrazine are released since the steam generator make-up water will have been vacuum de-aerated prior to treatment with hydrazine. Approximately 0.65 lb/hr of free nitrogen will be released at the maximum rate of hydrazine injection into the feedwater system.

Phosphates

The coordinated control and addition of phosphates in the steam generator water will result in phosphate concentrations ranging from 8 to 80 mg/l. In normal operation, these are released from the steam generator in the blowdown stream. This release is intermittent and depends on the concentration of silica in the water, condenser tube leakage and steam generator tube leakage. The blowdown may be treated in the radwaste management system, or it may be released, if low in activity, to the circulating water system.

The design blowdown rate of steam generator cycle water is 1.5 percent of the full power steam flow. The release for St. Lucie Unit No. 2 will be approximately 14 lb/hr of phosphate (PO_4) to the circulating water system, or for both units, 28 lb/hr of phosphate. This would cause a concentration increase of 0.05 ppm at the point of discharge to the ocean. During normal operation, however, the release will be less than 10 percent of this design value. Draining a steam generator for maintenance is a rare occurrence. However, during draining, the release of phosphate will be less than the rate of discharge during blowdown.

Cyclohexylamine

In the condensate feedwater system, a concentration of about 2 mg/l of cyclohexylamine is maintained. It is released to the environment in the blowdown of the steam generator flowing into the circulating water system. At the maximum blowdown rate of 1.5 percent, the concentration of cyclohexylamine would be one part per billion at the point of discharge to the ocean.

At normal plant operating rates the discharge rate will be less than 10 percent of this maximum still exists.

Potassium Dichromate

In the closed cooling systems for turbine cooling water and for component cooling, a 200 to 300 mg/l concentration of dichromate (CrO_4) is maintained in order to inhibit corrosion. Since these are closed systems, there will be no chromate releases during normal plant operation. During periods of equipment malfunction or maintenance, the potential for release of chromates does exist. Maintenance practices are to collect and recycle the chromated water as much as is practicable, however it is recognized that the potential for chromate release does exist.

Since the component cooling water is potentially radioactive, drains serving the areas housing equipment and piping of the component cooling system are routed to the radioactive waste management system. The turbine cooling water is not potentially radioactive and the equipment is installed outdoors in the turbine building. Drains serving this area are tied to the plant storm drains which flow to a settling basin located south of the plant island. This settling basin also collects wash water from the intake structure travelling screens when the wash water is not routed to the trashpit located in front of the intake structure.

Approximately 30,000 gallons of chromated water are contained in the turbine cooling water system. If the highly unlikely events of a complete release of the turbine cooling water to the settling basin, no dilution with any other waters in the storm drains or settling basin, and complete percolation to the intake canal over a period of just a few days are postulated, the result is only a part per billion

increase in the background chromate concentration in the intake canal. This is significantly less than the limits prescribed by the State of Florida for release of chromium to the environment. If a more probable sequence of events is considered the chromate releases are many orders-of-magnitude less. Providing a lined holding basin (many acres in size) for hold up and evaporation of these waters, in lieu of a earthen diked settling basin would further reduce the chromate releases. However the costs are judged to be high in relation to the added benefit.

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3.6.3 RELEASE OF CHEMICALS FROM THE LABORATORY

R. The plant chemical laboratories are organized to perform radiochemical, wet, dry and photometric analyses. Some typical determinations are: alkalinity, ammonia, boron, calcium, conductance, crud separation, fluoride, hardness, hydrazine, hydrogen, iodine, iron, lithium, oxygen, pH, phosphate, silica, strontium, sulfate and turbidity. The estimated annual use of laboratory chemicals is presented in Table 3.6-3. (One unit would consume about one half this usage).

Table 3.6-3 indicates the expected maximum annual weight and volume usage of laboratory chemicals. The average use will be approximately 50 to 80 percent of the values listed. The liquid and solid wastes from the control laboratory are collected and batch processed by the radwaste management system where they are concentrated for packing as solids, and whenever practical, they are neutralized, filtered, diluted, and discharged to the circulating water system.

3.6.4 CHEMICALS RELEASED FROM BIOCIDAL CONTROL

The system for biocide control, as described in Section 10.5, comprises adding gaseous chlorine at the pump intake to the circulating cooling water at a rate sufficient to provide a concentration of up to 5 ppm of chlorine for fifteen minutes each day. Therefore, chlorine requirement for St. Lucie Units 1 and 2 will be about 700 lbs/day.

A portion of the chlorine will combine with organic materials and nitrogenous and carbonaceous materials in the seawater. The chlorine combining with amino compounds will form mono-, di-, and triamino chloramine compounds. The balance will be available to combat the growth of microorganisms and the incipient organic slime materials. This biocidal action will retard the fouling of condenser tubing.

During the fifteen minute period of treatment the chlorine content of the cooling water leaving the condensers will be controlled to contain a maximum free chlorine residual content of 1.5 mg/l. The total cooling water flow of 530,000 gpm in one unit will be divided between the two condensers (with 2 water boxes per condenser) in parallel flow. The flow in each water box will be successively chlorinated, therefore any free residual chlorine discharged will be diluted by a 3:1 ratio of unchlorinated cooling water discharged by the three other water boxes. If Unit No. 1 is also operating, the dilution ratio will be 7:1 in the discharge canal. A portion of all of the residual chlorine will be reduced to chlorides and chloramines by the oxidation of compounds contained in the diluting seawater. For the purposes of evaluating environmental effects, it was assumed that the reduction of free residual chlorine will not occur.

3.6.5 MISCELLANEOUS CHEMICALS RELEASED

This section covers such releases as hydrogen, carbon dioxide, nitrogen, boric acid and various drains.

The hydrogen leakage from the main generators will be 400 scf per day, continuous, for each of the two 850 MW units.

Similarly, for each of the two units, the carbon dioxide used for purging the main generator is estimated as 64,000 scf per year.

For the various nuclear steam supply systems of each unit, the release of nitrogen cover gas is 260,000 scf per year.

Boric acid is used for reactor reactivity control. A small amount of the boric acid is discharged to the circulating water system, since it is carried over from the boric acid concentrators on a continuous basis. The annual release of boric acid by this mechanism is approximately 170 pounds for two units. Boric acid may also be released on a contingency basis from the various storage tanks in the plant. Once during the life of the plant, the release of the contents of the refueling water storage tank is postulated. For two units done at two intervals, the release

from each would be approximately 8,3000 pounds of boric acid into the circulating water system over a period of eight hours. With a recirculating water flow rate of 530,000 gpm per unit, this results in an addition of approximately 2 ppm boric acid to the area of discharge into the Atlantic Ocean.

Also, on a similar basis, the release of the contents of the boric acid hold-up tanks once during each fuel cycle would result in addition 2,400 pounds of boric acid to the circulating water system over a period of four hours. With a recirculating water flow rate of 530,000 gpm per unit, this results in an addition of approximately 1 ppm of boric acid to the area of discharge to the Atlantic Ocean.

The floor drains and equipment drains that are potentially radioactive are routed to the radwaste management system for processing by concentration to a solid prior to the release of residual water.

Storm drains, floor and equipment drains that are not potentially radioactive are routed to a settling basin located at the south end of the plant island.

It has been suggested that heavy metals could be released to the circulating water system from plant equipment in contact with the sea water. By several orders of magnitude, the condenser tubes constitute the largest metal surface in contact with sea water. Corrosion or erosion of the condenser tubes would release copper and zinc to the circulating water. Assuming a corrosion rate of 0.0008 inches per year and 6.2×10^7 in² of tube surface in contact with sea water, the calculated release is approximately 7 ppb of which approximately 80 percent is copper. Erosion is also a possible tube wastage mechanism, but is considered to be a lesser contributor. Water velocity in the tubes is maintained less than 7 fps to reduce the potential for erosion. Strainers are installed in the system to reduce the amount of particulates passing through the tubes. The condenser is chlorinated periodically to minimize the growth of shells and barnacles. All of the above reduce the potential for tube erosion.

TABLE 3.6-1

ANALYSES OF CITY WATER - FORT PIERCE, FLORIDA

<u>CONSTITUENT</u>	<u>AVERAGE WATER ANALYSIS mg/l</u>	<u>MAXIMUM WATER ANALYSIS mg/l</u>
Ca, Calcium	24.0	32.0
Mg, Magnesium	3.4	6.6
Na, Sodium	13.2	16.3
Fe, Iron	0.006	-
HCO ₃ , Bicarbonate	12.8	20.7
CO ₃ , Carbonate	-	-
SO ₄ , Sulfate	47.0	53.0
Cl, Chloride	22.0	25.0
CO ₂ , (as CO ₂)	4.0	6.5
SiO ₂ (as SiO ₂)	5.0	10.0
Turbidity, APHA	3.0	-
Conductivity, (Micromhos/cm)	200.	312.0
TDS (Total Dissolved Solids)	131.4	176.1
pH	8.2	9.2

TABLE 3.6-2

ESTIMATED RELEASE OF CHEMICAL ELEMENTS IN WASTEWATER
FROM THE PLANT WATER TREATMENT FACILITY
FOR UNITS NOS. 1 & 2

<u>Chemical Released</u>	<u>Continuous Release lb/hr *</u>		<u>Incremental Increase in Concentration mg/l</u>	
	<u>Ave</u>	<u>Max</u>	<u>Ave</u>	<u>Max</u>
Calcium	7.7	10	0.03	0.10
Magnesium	1.1	2.8	0.005	0.004
Sodium	170	212	0.66	2.3
Iron	0.011	0.013	0.44×10^{-4}	1.5×10^{-4}
Silicon	1.6	3.2	6×10^{-3}	0.2
Bicarbonate	8.2	13.3	0.028	0.11
Sulfate	183	207	0.71	2.5
Chloride	14.2	16.3	0.06	0.21
pH	7.0	7.5	-	-
Total Dissolved Solids	386	465	1.5	5.8

*The above values are based upon a treated water flow rate of 500 gpm average and 1000 gpm maximum.

TABLE 3.6-3

ESTIMATED ANNUAL USE OF LABORATORY CHEMICAL FOR UNITS NOS. 1 & 2

<u>Chemical</u>	<u>Amount</u>	
	<u>Solid</u>	<u>Liquid</u>
Acetic Acid, glacial		20 l
Alkaline Iodide Solution		15 l
Ammonia-Free Water		24 l
Ammonia Nitrogen Standard		8 l
Ammonium Acetate	6 lb	
Ammonium Chloride	2 lb	
Alizarol Cyanine	200 g	
Ammonium Hydroxide	48 lb	
Ammonium Molybdate	20 lb	
Ammonium Molybdate Solution		20 l
Ammonium Oxalate	5 lb	
Ammonium Nitrate	2 lb	
Ammonium Phosphate Monobasic	6 lb	
Ammonium Vanadate (meta)	1.5 lb	
Ammonium Persulfate	2 lb	
Ascarite	6 lb	
Barium Acetate	2 lb	
Barium Chloride	6 lb	
Barium Chloride N/40		6 l
Barium Sulfate	5 lb	
Boric Acid Standard		20 l
Borax Sulfide Buffer		8 l
Boric Acid	50 lb	
Brom Cresol Green		1 l
Brom Phenol Blue	10 g	
Buffer Reference Solution, ph 5.00		10 l
Buffer Reference Solution, ph 7.00		30 pt
Buffer Reference Solution, ph 9.18		40 pt
Carbon Tetrachloride		2 gal
Calcium Carbonate Standard		2 l
Calcium Chloride		2 l
Carminic Acid	40 g	
Cobalt Chloride	2 lb	
Chloroform		8 gal
Cupric Sulfate	8 lb	
Dextrose	8 lb	
Dimethylglyoxime	4 oz	
p-Dimethylaminobenzaldehyde	1 kg	
p-Diphenylamine Sulfonic Acid		32 oz
Diphenylcarbazone	200 g	
Di-sodium phosphate	2 lb	
E.D.T.A. Solution		24 l
Eriochrome Black T		2 l
Ferric Nitrate	2 kg	
Ferric Chloride	4 lb	

TABLE 3.6-3 (cont'd)

<u>Chemical</u>	<u>Amount</u>	
	<u>Solid</u>	<u>Liquid</u>
Ferrous Ammonium Sulfate	10 lb	
Glycerin		20 qt
Hydrazine Dihydrochloride	200 g	
Hydrochloric Acid	50 lb	
Hydrogen		6 A-size cyl (gas)
Hydrogen Peroxide	4 lb	
Hydroquinone	4 lb	
Hydroxylamine Hydrochloride	2 lb	
Hydroxy Quinoline	$\frac{1}{2}$ lb	
Iodine	1 lb	
Indigo Carmine	200 g	
Isopropyl Alcohol		12 gal
Lithium Flame Standard		6 l
Mannitol	40 lb	
Manganese Chloride	4 lb	
Manganous Sulfate		6 qt
Mercuric Nitrate, 0.0141 N		16 l
Mercuric Thiocyanate	2 g	
Methyl Alcohol		10 gal
Methyl Orange		6 pints
Murexide-Sodium Chloride	400 g	
Nessler's Reagent		6 pints
Nickel Chloride	1 lb	
Nitric Acid	200 lb	
Oxalic Acid	20 lb	
Phenolphthalein		6 qt
Phosphate Standard		6 l
Platinizing Solution		400 ml
Potassium Acid Phthalate	4 lb	
Potassium Bi-iodate		2 qt
Potassium Chromate Indicator		10 l
Potassium Chloride	6 lb	
Potassium Chromate	4 lb	
Potassium Hydroxide	90 lb	
Potassium Iodate-Iodide		4 l
Potassium Iodide	2 lb	
Potassium Nitrate	2 lb	
Potassium Pyrosulfate	4 lb	
Reagent Alcohol (95%)		8 gal
Silica Standard		4 l
Silver Nitrate	2 lb	
Sodium Bisulfite	4 lb	
Sodium Carbonate		4 l
Sodium Chlorate	4 lb	
Sodium Chloride Standard	6 lb	
Sodium Chromate	4 lb	
Sodium Fluoride Standard		12 l
Sodium Hydroxide	8 lb	

TABLE 3.6-3 (cont'd)

<u>Chemical</u>	<u>Amount</u>	
	<u>Solid</u>	<u>Liquid</u>
Sodium Hypochlorite		4 gal
Sodium Nitrate	2 lb	
Sodium Thiocyanate	4 lb	
Sodium Thiosulfate Solution, N/100		12 gal
Starch Indicator		6 l
Strontium Nitrate	1 lb	
Sulfuric Acid	200 lb	
Thiosemicarbazide	400 g	
THO Indicator	400 g	
Tolidin Solution		6 l
Toluene		8 l
Zinc Sulfate	4 lb	
Zirconium Oxynitrate	2 lb	
Molybdate Reagent		30 l
Phosphoric Acid, 85%, Orthos	20 lb	
Potassium Dichromate Indicator		30 qt
Acetone		16 gal
Barium Nitrate	16 lb	
TISAB Solution		30 gal

3.7 SANITARY WASTE TREATMENT AND DISPOSAL SYSTEM

3.7.1 DESCRIPTION OF SANITARY WASTES

As a basis for design of the sanitary waste facilities for the St. Lucie Plant, it is estimated that a maximum population of 100 will be engaged at the site in administrative, operational and maintenance functions. Of this total, it is estimated that 90 persons will comprise the permanent staff that will be distributed equally over the 24 hour day, seven days per week. The remaining 10 persons are considered temporary staff that would be engaged at the plant site only during major maintenance periods. Assuming normal use of toilet and kitchen facilities, a unit wastewater flow of 20 gallons per capita per day has been conservatively used to predict the sanitary waste flow. Based upon the foregoing, a design sanitary waste flow of 2000 gallons per day has been defined. The raw wastewater will contain little or no dissolved oxygen and will contain settleable, suspended and dissolved organic and inorganic solids. A portion of these solids will require removal prior to disposal of the wastewater to the ground.

3.7.2 DESCRIPTION OF THE TREATMENT SYSTEM

Raw sanitary wastewater is conveyed by gravity to a pneumatic ejector station which is located ahead of the septic tank and which serves to pump the wastewater into the septic tank. The ejector station is a compressed-air, vacuum type with automatic operation controlled by high and low water level probes located in the wet wells.

Ejector station discharge will be conveyed to the septic tank which is reinforced concrete. Based upon the design flow and governing standards, a 2300 gallon capacity tank is provided to allow for 24 hours retention of the daily flow and for storage of approximately 300 gallons of sludge. The tank incorporates a baffle wall that divides the tank volume into 2/3 and 1/3 parts and which acts to minimize the potential for short-circuiting. Tank effluent is then discharged by gravity into a siphon box for transport to a leaching field flow-splitting box.

A vertical crossection of the septic tank leach field is presented in figure 3.7-1 which shows that there is a minimum of 14½ feet of sand between the bottom of the gravel fill of the leach field and the local ground water table. Figure 3.7-2, a plot plan of the site, locates the sanitary waste treatment facility for the plant.

3.7.3 DESCRIPTION OF WASTE DISPOSAL SYSTEM

Septic tank effluent is disposed of via a regulatory agency approved leaching field system composed of six leaching lines, each 100 feet long and of four inch perforated vitreous clay pipe. Each pipe is sloped at 1/4 to 1/2 inch per 10 feet of length and is surrounded by approximately 1'-9" of one inch crushed stone and screened gravel. The effective leaching area is 900 feet².

The proposed sanitary tile field should be effective under the most adverse conditions considering the quantity of flow and its elevation above the ground water table and the fine sand existing below the tile field.

3.7.4 DIESEL GENERATOR-GASEOUS WASTE

Two 3500 Kw (approx) diesel generator sets for St. Lucie Unit No. 2 will be used to supply power to those electrical loads which are needed to achieve a safe shutdown of the plant or to mitigate the consequences of a loss of coolant accident. Each 3500 Kw diesel generator set operating at full capacity, will require a maximum of 240 gallons per hour of No. 2 diesel fuel oil.

The diesel generator sets are used only in the event of a loss of normal AC power. Consequently, their frequency of service will be limited to periodic testing of about one hour duration on a semi-monthly basis to ascertain operational readiness. Due to the infrequent operation of the diesel generators, the combustion products released will be insignificant.

The following table indicates the combustion products released per pound of fuel consumed for each 3500 Kw diesel generator set based on manufacturers data and the U S Environmental Protection Agency's publication No. AP-42, February 1972, entitled "Compliance of Air Pollutant Emission Factors".

<u>Combustion Product</u>	<u>Emission Factor lb/10³ gal</u>	<u>Emissions Per D-G Set lb/hr</u>
Particulate	25	6.0
Oxides of sulfur* (SO _x as SO ₂)	58	15.6
Carbon monoxide	68	16.3
Hydrocarbons	27	6.4
Oxides of nitrogen (NO _x as NO ₂)	348	145.
Aldehydes (as HCHO)	4	.94
Organic acids	7	1.68

*These figures are based on No. 2 diesel fuel oil with a sulfur content of 0.5 percent taken from Table 3.2 of EPA's Publication No. AP-42.

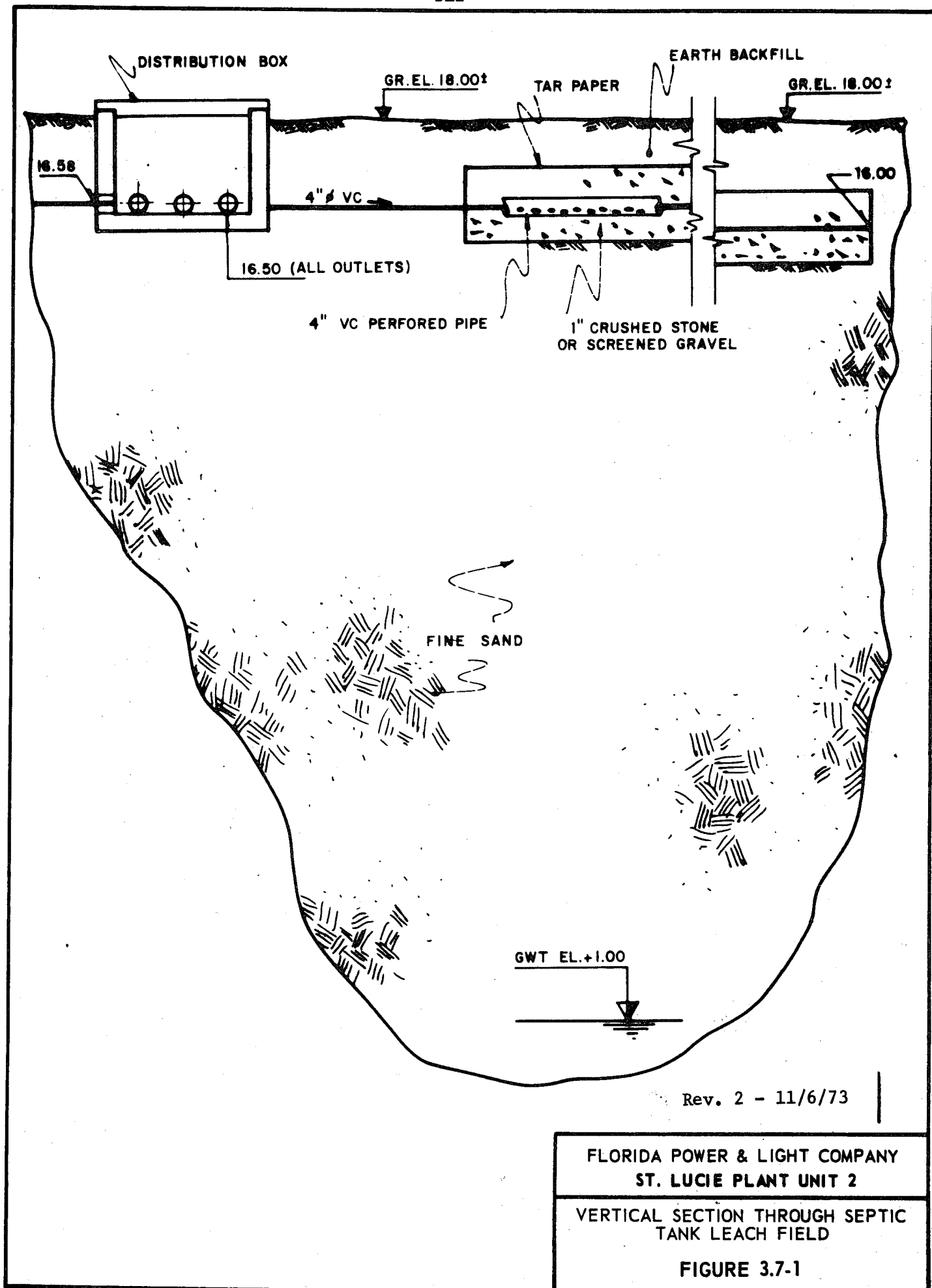
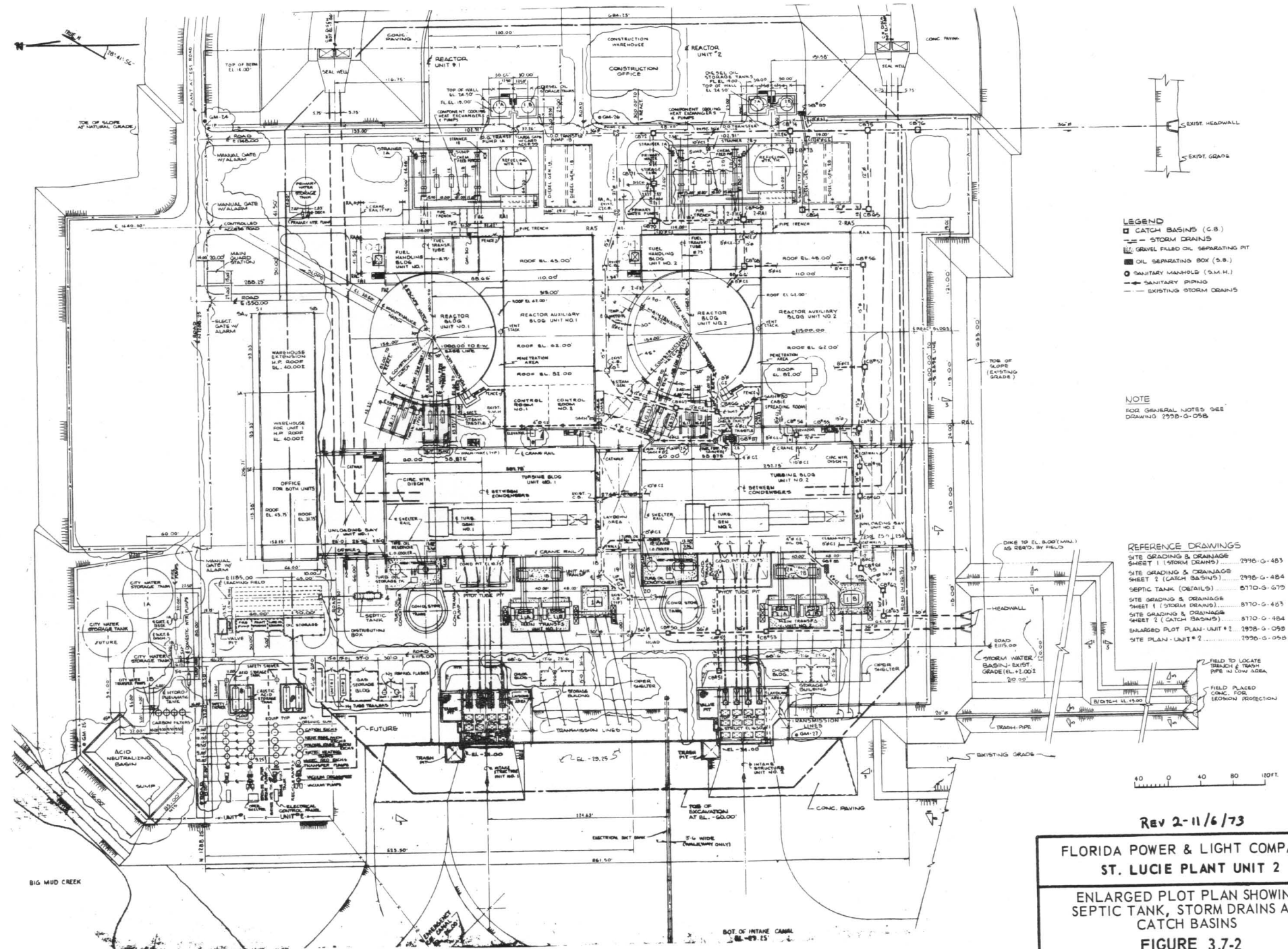


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3.8 RADIOACTIVE MATERIALS INVENTORY

a) Fresh Fuel

Nuclear fuel for the reactor is slightly enriched uranium in the form of 0.44 inch diameter, 137 inch long rods of sintered uranium oxide pellets encapsulated in zircaloy. Each fuel assembly contains 176 fuel rods, and there are 217 fuel assemblies in the reactor. Each year during normal operation about 72 fuel assemblies will be replaced. This requires five truckloads of about 8 containers each, 2 assemblies per container. The total weight of the uranium in the 72 fuel assemblies is approximately 28 metric tons. The nuclear fuel will be transported by truck from the supplier, Combustion Engineering, located in Windsor, Connecticut, to the plant site, a shipping distance of about 1400 miles.

Combustion Engineering's containers for transferring unirradiated zircaloy clad fuel assemblies containing special nuclear material are identified as Models 927A, 927B and 927C. The Atomic Energy Commission has authorized the use of these shipping containers for the delivery of special nuclear material to a carrier (Amendment 71-3 to Special Nuclear Material License SNM-1067) and the United States Department of Transportation (USDOT) has issued Special Permit No. 6078, including First Revision, authorizing the shipment of special nuclear material in these containers. Details of shipping are discussed in Section 5.3.4.2.

The above mentioned shipping container(s) consist of a lower and upper shell. These steel shells have a positive closure which prevents inadvertent opening. The outer diameter of the assembled container is 43 inches. Each container houses two unirradiated zircaloy clad fuel bundles that are individually protected by a polyethylene covering. Internal structures and a clamping assembly secure the fuel bundles within the individual containers. The gross weights of model 927A, 927B and 927C containers are 6200 lbs., 6200 lbs. and 7200 lbs. respectively.

Fuel must be transported to the recovery facility where valuable uranium and plutonium are recovered and residual radioactive wastes are packaged for safe disposal.

The St. Lucie Unit No. 2 will discharge approximately 72 spent fuel assemblies containing approximately 28 metric tons of uranium and 240 Kg of plutonium about once a year after the first 20 months of operation. The spent fuel will be cooled in the spent fuel pool for a minimum of 4 months prior to shipment to reduce the radioactivity and heat generation in the spent fuel. During this period, the fuel assemblies will be monitored to determine whether there are any "leakers" which will require canning prior to insertion in shipping casks to further ensure against activity leakage.

After the cooling period, the spent fuel will be loaded into shipping casks designed and constructed to meet the rigorous requirements of the AEC and USDOT. These requirements provide for cooling, radiation shielding and containment of radioactivity for protection of the public in the event of abnormal and accident conditions as well as for normal conditions of transport. Prior to use, each cask design and its transport system will be reviewed and approved by AEC and USDOT, and transportation

will be authorized by license issued by the AEC. License provisions will include adequate quality assurance, testing program and operating procedures to assure equipment is constructed and used in accordance with approved designs and procedures. When loaded, the casks will be carefully surveyed for leak tightness and surface radioactivity contamination and inspected to assure that they have been properly prepared for shipment and fully comply with license provisions governing transportation. Shipment will also be placarded in accordance with federal regulations.

Detailed shipping and packaging safety requirements are contained in Section 5.3.4.2 B.

It is planned that spent fuel will be transported by barge and/or exclusive use truck. Based on this plan, approximately three barge shipments or 36 truck shipments will be made per year with two fuel elements per cask and one cask per truck. It is anticipated that the destination will be Allied-Gulf Nuclear Services in Barnwell, South Carolina. The total yearly spent fuel shipping program will be carried out in approximately one month by barge or two to three months by truck.

b) Solid Radwaste

Spent resins, waste evaporator bottoms, and some process liquids will be dewatered and concentrated and, with other solid wastes, loaded into containers for shipment and disposal. It is estimated that there will be about 15 to 20 truckloads of wastes each year. Final arrangements have not been completed, but if shipped to the nearest disposal site, Morehead, Kentucky, the distance will be about 800 miles. The carriers will be licensed contractors operating in accordance with Department of Transportation and other applicable regulations.

Shipping containers or vehicles will not normally be stored on site. If short term storage does occur on site, the allowed locations will be selected such that the security and radiological surveillance procedures for plant operation are met with respect to the activity involved.

1) Expected Quantities of Radwaste (See Table 3.8-1)

The concentrator bottoms input is estimated at approximately 11,700 gallons per year. This results from two sources. The first source is from the processing of 156,000 gallons of liquid waste from primarily decontamination operations and floor washdowns. This waste is concentrated to approximately 8000 gallons or 940 cubic feet of concentrate per year to be solidified for shipment.

The second source, steam generator blowdown due to primary to secondary leakage, is processed similarly to liquid waste. Approximately 3,700 gallons or 440 cubic feet per year are generated as a result of a continuous 20 gpd steam generator leakage for normal operation.

To solidify the 11,700 gallons of liquid requires approximately two pounds of cement per pound of liquid. Using a liquid density of 10 pounds per gallon, 117,000 pounds of liquid requires 235,000 pounds of

cement powder for a total weight of 352,000 pounds. The density of the cured mixture is approximately 100 pounds per cubic foot resulting in a solidified waste volume of 3520 cubic feet. Approximately 490 55-gallon drums will be required per year to dispose of this waste. The principal radionuclides in the waste are Cs-137 or Co-60 depending on the extent of failed fuel.

The anticipated operational occurrence with a steam generator leak of 120 gpd results in approximately 22,000 gallons per year of bottoms and 4,360 cubic feet of solidified waste. The estimated activity of the concentrator bottoms solid radwaste is included in Table 3.8-2.

The ion exchange resins will be shipped dewatered containing a volume of approximately 256 cubic feet per year. Activities on the various ion exchange resin beds after six months and one year decay are shown on Table 3.8-3. Cesium-137 dominates the activity that must be shipped, but without significant failed fuel, Co-60 would dominate. Assuming eight beds are disposed of per year (one purification, one deborating, two preconcentrator, two boric acid condensate, one waste condensate, and one fuel pool purification) the mixed activity would be about 23,000 Ci or 90 Ci/ft³.

Approximately 14 filter elements per year will be shipped. Packaging requirements for filter cartridges will be based on the activities contained in Table 3.8-4.

Miscellaneous compressible solid waste such as contaminated clothing, plastic sheeting, and tape, accumulates as a result of health physics and maintenance activities. Volumes before compression typically range from 1000 to 2500 cubic feet per year at operating plants. The baler compacts the compressible solid waste with a volume reduction ranging from 5 to 10, thus producing 100 to 500 cubic feet per year as shipped. The activity is expected to range from 0.5 to 1 curie per year.

Noncompressible solid waste such as tools and contaminated equipment, is estimated to range from 500 to 1000 cubic feet per year as packaged. The estimated activity ranges from 5 to 15 curies.

2) Packaging and Shipping

As discussed in Section 3.8 C.1, liquid wastes are solidified by mixing with cement in standard, 55-gallon steel drums. The drums are preloaded with dry cement, transported via a monorail chain hoist system to the fill station, and filled with a predetermined volume of concentrator bottoms. Activity levels in the drums will be controlled such that shipments will not exceed the limits specified in Title 49 of Code of Federal Regulations.

Spent resins are sluiced to a shipping container or 55 gallon drums from the spent resin tank and dewatered via the resin dewatering pump. Activity levels will be controlled such that shipments will not exceed the limits specified in Title 49 of Code of Federal Regulations.

TABLE 3.8-1

INPUTS TO SOLID WASTE SYSTEM PER CORE CYCLE
BASED ON CONTINUOUS OPERATION WITH 1 PERCENT FAILED FUEL

<u>Liquids</u>	<u>Quantity</u>	<u>Operation</u>	<u>Approximate Shipped Volume/Yr. (cu ft)</u>	<u>Approximate No. of Drums (55 gal)</u>
Concentrator Bottoms, gal/yr	8,000	miscellaneous waste processing	2405*	330
Concentrator Bottoms, gal/yr	3,700	steam generator blow-down processing estimated normal operation	1115*	160
Concentrator Bottoms, gal/yr	22,000	steam generator blow-down processing anticipated operational occurrence	4360*	640
<u>Solids</u>				
IX Resins, dewatered, ft ³	256	sluice ion exchangers once per year	256	40
Filter Elements	14 per year	change each filter cartridge twice per year	196**	28**
Miscellaneous Compressible Solid Waste, ft ³	1,000 to 2,500	compact	100-500	14-70
Miscellaneous Noncompressible Waste, ft ³	500 to 1,000	place in suitable containers	500-1000	

* Mixed with cement, absorbents, and solidified for shipment.

** Approximate values.

TABLE 3.8-2

WASTE CONCENTRATOR BOTTOMS INPUT ACTIVITY TO SOLID RADWASTE SYSTEM

<u>Nuclide</u>	<u>Normal Operation (1% failed fuel)</u>		<u>Anticipated Operational Occurrence (0.1% failed fuel)</u>	
	<u>Waste Concentration</u> (μ Ci/cc at 70 F)	<u>Total Curies/year</u>	<u>Waste Concentration</u> (μ Ci/cc at 70F)	<u>Total Curies/year</u>
H-3	2.21(-3)	9.86(-2)	1.39(-2)	1.60
Sr-89	1.67(-4)	7.45(-3)	8.68(-3)	.998
Sr-90	1.07(-5)	4.77(-4)	5.5 (-4)	6.33(-2)
Y-90	4.34(-6)	1.94(-4)	3.6 (-4)	4.14(-2)
Sr-91	1.35(-8)	6.02(-7)	9.12(-5)	1.05(-2)
Y-91	3.78(-3)	1.69	1.97(-1)	22.66
Mo-99	9.3 (-3)	.415	7.44(-1)	85.56
Ru-103	1.28(-4)	5.71(-3)	6.70(-2)	7.71
Ru-106	1.02(-5)	4.55(-4)	5.24(-3)	.603
I-129	2.981(-9)	1.33(-7)	1.52(-7)	1.75(-5)
I-131	5.72(-2)	2.55	3.32	382.80
Te-132	1.87(-3)	8.34(-2)	1.38(-1)	15.87
I-133	1.56(-3)	6.96(-2)	5.54(-1)	63.71
Cs-134	4.1 (-3)	.183	2.1 (-1)	24.15
I-135	3.08(-7)	1.37(-5)	2.74(-3)	.315
Cs-136	5.08(-4)	2.27(-2)	2.8 (-2)	3.22
Cs-137	1.12(-2)	.500	6.54(-1)	75.21
Ba-140	1.2 (-4)	5.35(-3)	6.6 (-3)	.759
La-140	1.06(-5)	4.73(-4)	1.29(-3)	.148
Pr-143	1.19(-4)	5.31(-3)	6.52(-3)	.750
Ce-144	1.69(-4)	7.54(-3)	8.72(-3)	1.003
Co-60	2.14(-4)	9.54(-3)	1.1 (-3)	.127
Fe-59	3.36(-6)	1.50(-4)	1.35(-5)	1.55(-3)
Co-58	1.63(-3)	7.27(-2)	8.42(-3)	.968
Mn-54	1.21(-5)	4.50(-4)	5.8 (-5)	6.67(-3)
Cr-51	1.05(-3)	4.68(-2)	5.56(-3)	.639
Zr-95	3.22(-7)	1.44(-5)	1.67(-6)	1.23(-4)
Total		5.78		689

TABLE 3.8-3

ACTIVITY ON ION EXCHANGER RESINS AFTER DECAY (CURIES)

Nuclide	CVCS Purification		CVCS Deborating		WMS Pre Conc.(each)		FPS Purification	
	6 mo	1 yr	6 mo	1 yr	6 mo	1 yr	6 mo	1 yr
Br-84	0	0	0	0	0	0	0	0
Rb-88	0	0	0	0	0	0	0	0
Rb-89	0	0	0	0	0	0	0	0
Sr-89	9.0	0.736	0	0	1.81(-2)*	1.47(-3)	3.88(-2)	3.17(-3)
Sr-90	24.2	24.0	0	0	4.84(-2)	4.78(-2)	3.05(-2)	3.01(-2)
Y-90	0	0	0	0	0	0	0	0
Sr-90	0	0	0	0	0	0	0	0
Y-91	58.5	6.85	0	0	2.93	0.343	4.96(-3)	5.81(-4)
Mo-99	0	0	0	0	0	0	0	0
Ru-103	2.74	1.16(-2)	0	0	5.50(-3)	2.32(-4)	1.57(-2)	6.65(-4)
Ru-106	11.7	8.25	0	0	2.33(-2)	1.65(-2)	1.79(-2)	1.27(-2)
Te-129	0	0	0	0	0	0	0	0
I-129	1.10(-2)	1.10(-2)	5.24(-6)	5.24(-6)	2.27(-7)	2.2(-7)	7.92(-6)	7.92(-6)
I-131	2.08(-3)	0	2.38(-5)	0	0	0	4.41(-5)	0
Te-132	0	0	0	0	0	0	0	0
I-132	0	0	0	0	0	0	0	0
I-133	0	0	0	0	0	0	0	0
Te-134	0	0	0	0	0	0	0	0
I-134	0	0	0	0	0	0	0	0
Cs-134	3380	2850	0	0	169	142.5	188	159
I-135	0	0	0	0	0	0	0	0
Cs-136	2.18(-3)	0	0	0	1.51(-4)	0	1.16(-4)	0
Cs-137	18,280	18,040	0	0	914	904	89.4	88.4
Cs-138	0	0	0	0	0	0	0	0
Ba-140	1.72(-3)	0	0	0	0	0	2.52(-5)	0
La-140	0	0	0	0	0	0	0	0
Pr-143	3.10(-3)	0	0	0	0	0	3.11(-5)	0
Ce-144	170	109	0	0	0.338	0.216	0.245	0.157
Fission Product Total	21,900	21,000	2.91(-5)	5.24(-6)	1065	1050	280	250
Cr-51	6.3(-2)	0	1.52(-3)	0	0	0	0	0
Mn-54	0.20	0.133	0	0	0	0	0	0
Co-58	3.18	0.534	7.65(-3)	1.28(-2)	0	0	1.8(-2)	3.05(-3)
Fe-59	0	0	0	0	0	0	0	0
Co-60	7.77	7.28	0.186	0.174	1.22(-2)	1.14(-2)	1.22(-2)	1.14(-2)
Zr-95	0	0	0	0	0	0	0	0
Corrosion Product Total	11.21	7.95	0.264	0.187	1.22(-2)	1.14(-2)	3.02(-2)	1.45(-2)

Note: * denotes power of 10

TABLE 3.8-4

ACTIVITY ON FILTER CARTRIDGES AFTER DECAY (CURIES)

Nuclide	1A		1B		WMS-Pre- Concentrator (Each)		WMS Waste		FPS Purification	
	6 mo	1 yr	6 mo	1 yr	6 mo	1 yr	6 mo	1 yr	6 mo	1 yr
Co-60	37.4	35.0	3.74	3.5	6.92(-2)*	6.48(-2)	**	**	6.86(-2)	6.42(-2)
Fe-59	1.90(-2)	**	**	**	**	**	**	**	**	**
Co-58	17.9	3.00	1.79	0.330	3.32(-2)	**	**	**	1.02(-1)	1.71(-2)
Mn-54	0.98	0.655	9.8(-2)	6.55(-2)	**	**	**	**	**	**
Cr-51	0.364	**	3.64(-2)	**	**	**	**	**	**	**
Zr-95	2.82(-2)	**	**	**	**	**	**	**	**	**
Total	56.6	38.7	5.66	3.87	1.024(-1)	6.48(-2)	**	**	1.706(-1)	8.13(-2)

** less than 10^{-2}

* () power of 10

3.9 TRANSMISSION FACILITIES

The construction and operation of St. Lucie Unit No. 2 will not require any additions to the power transmission system external to the plant site. As part of the development of St. Lucie Unit No. 1, three 240 kv circuits are being installed along a single right of way and will be operational in 1973-74(1). Each of these three circuits is capable of carrying the total power load from either Unit No. 1 or Unit No. 2. Therefore, no additional transmission lines will be required resulting from the construction of St. Lucie Unit No. 2.

The Unit No. 1 circuits are carried on separate structures in a single corridor. For the Indian River crossing, a long span design using single 3400 Kc mil ACSR/AW conductors was chosen. The land portions of the transmission link are carried on concrete H-frame structures with an average span length of about 660 ft. Conductors are 2-1691 Kc mil. Right-of-way width is 1200 ft. immediately adjacent to the Indian River shore to minimize effects on adjacent properties, and 660 ft. elsewhere. Half the right-of-way is required for the three transmission circuits, the remainder being held for future expansion.

Line routing was chosen to avoid residential or other developed areas. Of the approximately 760 acres of right-of-way, 43 acres of ridge land on the west side of the Indian River are divided into tracts. The two houses located within this 43 acres have been purchased by FP&L. Approximately 712 acres of right-of-way are considered undeveloped and have been used for natural pasture lands. Of these 712 acres, approximately 80 acres are cultivated in orange trees, 40 acres are a water storage savanna and 30 acres are included in river swamp. The transmission line facilities will have very little effect on the orange groves within the right-of way and have no significant effect on the water storage in the savannas or the river swamp. Approximately 630 acres of right-of-way are suitable for residential and commercial development, of which 4800 acres were held by a single land development company. The right-of-way has created a potential green belt through this future development.

The switching station within the plant boundaries will have four input bays which will be constructed for Unit No. 1. These four bays will suffice for both Units No. 1 and No. 2. However, the eastern end of the third circuit for Unit No. 1 will be moved about 200 feet south and then used as the backup circuit for Unit No. 2.

Approximately 1000 sq ft of additional land will be required to locate the main transformers for Unit No. 2. The new connecting lines from the Unit No. 2 main transformers to the switchyard will be a single span and will not require any intervening tower structures.

Therefore, there will be virtually no environmental impact resulting from the construction of the additional transmission facilities associated with the St. Lucie Unit No. 2.

APPENDIX 3A

PRESSURIZED WATER REACTORS
BASIC DATA FOR SOURCE TERM CALCULATION

- 1) Operation power (mwt) at which impact is to be analyzed.

The rated power of the nuclear steam supply system is 2570 mwt, of which 2560 mwt is generated by the reactor and 10 mwt by the reactor coolant pumps. Accident analyses and calculations of radioactivity discharges were performed assuming operation at 2700 mwt (105 percent of rated power) for conservatism.

- 2) Weight of the uranium loaded (first loading and equilibrium cycle).

The first loading weight of uranium will be 82.85 metric tons and the equilibrium loadings will be 85.4 metric tons.

- 3) Isotopic ratio in the fresh fuel (first loading and equilibrium cycle).

The fuel enrichments for St. Lucie Unit No. 2 are as follows:

	<u>Batch</u>	<u>Enrichment (w/o U²³⁵)</u>
Initial Loading	A	1.93
	B	2.33
	C	2.82

The equilibrium cycle fuel enrichments for reload batches have not been firmed up at this time since the physics evaluation studies have not been completed.

The best estimate of the fuel enrichments for the equilibrium core is:

	<u>Batch</u>	<u>Enrichment (w/o U²³⁵)</u>
	D	(48 assemblies) 3.40
		(25 assemblies) 2.85
Equilibrium Core	E	(48 assemblies) 3.40
		(25 assemblies) 2.85
	F	(48 assemblies) 3.07
		(25 assemblies) 2.66

- 4) Expected percent of leaking fuel.

1.0 percent leaking fuel is the basis for maximum design and maximum anticipated releases. 0.1 percent leaking fuel is the basis for expected releases.

5) Escape rate coefficients used (or reference).

The escape rate coefficients for fission product releases are as follows:

<u>Elements</u>	<u>Escape Rate Coefficients, sec⁻¹</u>
Noble Gases	6.5×10^{-8}
Halogens, Cesium	2.3×10^{-8}
Tellurium, Molybdenum	1.4×10^{-9}
All Others	1.4×10^{-11}

6) Plant capacity factor, percent.

It is estimated that St. Lucie Unit No. 2 will operate with a plant capacity factor of 72 percent for the first cycle. An 80 percent factor is expected for subsequent cycles.

7) Number of steam generators.

St. Lucie Unit No. 2 has two steam generators.

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8) Type of steam generator (recirculating, straight through).

Each steam generator is a vertical U-tube recirculating heat exchanger with the reactor coolant on the tube side and the secondary fluid on the shell side.

9) Mass of primary coolant in system total (lbs) and mass of primary coolant in reactor (lbs).

When operating at 100 percent power, the reactor contains 201,700 lbs of primary coolant. The Reactor Coolant System including the pressurizer and Chemical and Volume Control System (CVCS) contains 464,317 lbs of coolant when operating at 100 percent power. Excluding the CVCS, the Reactor Coolant System contains 434,796 lbs of coolant when operating at 100 percent power.

Under the same operating conditions, the reactor contains 44,719 lbs of coolant in the active core region.

When operating at 105 percent power, the reactor contains 200,000 lbs of primary coolant. The Reactor Coolant System including the pressurizer and Chemical Volume Control System contains 460,300 lbs of coolant when operating at 105 percent power. Excluding the CVCS, the Reactor Coolant System contains 430,800 lbs of coolant when operating at 105 percent power.

10) Primary coolant flow rate (lbs/hr).

Reactor coolant flow rate (4 pumps) is 122×10^6 lbs/hr.

- 11) Mass of steam and mass of liquid in each steam generator (lbs).

Each steam generator contains 9,500 lbs of steam and 130,500 lbs of water under operating conditions of 105 percent power.

- 12) Total mass of secondary coolant (lbs).

Total mass of secondary coolant is expected to be approximately 1.3×10^6 lbs.

- 13) Steam generator operating conditions at 100 percent power are as follows:

Outlet Steam Pressure	800 psig
Flow Rate	11,206,000 lb/hr (2 Units)
	5,603,000 lb/hr (1 Unit)
Steam Temperature	520.3°F
Steam Quality	99.8%

Steam generator operating conditions at 105 percent power are as follows:

Outlet Steam Pressure	815 psia
Flow Rate	11,760,000 lb/hr (2Units)
	5,880,000 lb/hr (1 Unit)
Steam Temperature	520.3°F
Steam Quality	99.8%

- 14) Total flow rate in the condensate demineralizer (lb/hr)..

St. Lucie Unit No. 2 does not have a condensate demineralizer. The total flow rate in the condenser is 7,820,000 lb/hr at 100 percent power. The total flow rate in the condenser is 8,225,000 lb/hr at 105 percent power.

- 15) What is the containment free volume (ft³)?

The net free containment is 2.5×10^6 ft³.

- 16) What is the expected leak rate of primary coolant (lb/hr) to the containment atmosphere?

Leakage of the reactor coolant to the containment atmosphere is expected to be 240 lb/day or 10 lb/hr.

- 17) How often is the containment purged? Is it filtered prior to release? Are iodine absorbers provided? What decontamination factor is expected?

For the purposes of evaluating environmental impact, it is assumed that the containment will be purged 4 times per year for long term access with the reactor shut down. It is expected that short term access with the reactor at power can be achieved without reliance

on purging. The containment iodine cleanup system (see question 18) will be operated prior to purging operations. The purge flow rate is 42,000 cfm. The purge stream is processed through a pre-filter and then a HEPA filter prior to release to atmosphere. The expected HEPA filter efficiency is 99.9 percent for particles 0.3 microns and larger in diameter. No iodine absorbers are provided.

- 18) Is there a continuous air cleanup for iodine in the containment? If so, what volume per unit time is circulated through it? What decontamination factor is expected? At what concentration will purging be initiated?

There is an airborne radioactivity removal system which will be operated intermittently. There are two fans, each of which is capable of processing 10,000 cfm (0.24 vol/hr). A decontamination factor of 100 is expected based on a charcoal absorber efficiency of 99.9 percent. It is expected that purging operations will be initiated after the cleanup system has been operated for a period of 10 hours after reactor shutdown.

- 19) Give the total expected annual average letdown rate (lb/hr) during power operation.

a) What fraction of the letdown is returned to the primary system? How is it treated? What are the expected decontamination factors for removal of principal isotopes?

b) How is Li and Cs normally controlled?

c) What fraction of this goes to boron control system? How is this treated, demineralization, evaporation, filtration?

d) Is plant design for load follow or base load? What fraction of the letdown stream is diverted to the radwaste system for boron control? How is this treated (demineralization, evaporation, filtration, etc.) and what fraction will be discharged from the plant.

a) The total expected continuous letdown rate is 40 gpm or 19,800 lbs/hr which flows through a prefilter, demineralizer and afterfilter in the Chemical and Volume Control System to remove soluble and particulate activity from the reactor coolant. The expected demineralizer and filter decontamination factors are listed below. During steady state power operation all of this letdown flow is returned to the reactor coolant system after purification.

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<u>Element</u>	<u>Ion Exchanger* Decontamination Factor</u>	<u>Filter Decontamination Factor</u>
H-3, Kr, Y, Mo, Xe, Cs	1	1
Ru, Te, La, Pr, Ce	10	1
Sr, Ba	100	1
Br, Rb, I	1,000	1
Corrosion Products	1	10

- b) Provisions have been incorporated in the CVCS for intermittent removal of cesium and lithium during normal purification of the letdown flow. A separate mixed bed ion exchanger with a 3:1 cation to anion volume ratio is employed approximately 20 percent of the time for this purpose, with a decontamination factor of 10 for these isotopes. For system analysis assume that the continuous purification ion exchanger (in a, above) is not in service during periods when the Li removal ion exchanger is being used.
- c) During periods of reactor coolant fluid expansion or feed and bleed operation for boron concentration changes, all of the letdown flow is diverted, after purification, to the Waste Management System for additional treatment prior to discharge. It is estimated that approximately 780,000 gallons of liquid wastes per year will be discharged from the Waste Management System as a result of these operations. Operations of the Waste Management System are discussed in Section 3.5 of the Environmental Report and Section 11.2 of the PSAR.
- d) St. Lucie Unit No. 2 is designed for load following.

3.8 percent of the 40 gpm letdown stream is diverted to the Boron Management System for boron recovery.

The Boron Management System processes 780,000 gallons of diverted letdown per year. This diverted stream passes through a flash tank, enters a hold-up tank, passes through a pre-concentration filter, and then into the boric acid concentrator. The concentrator is assumed to release all its effluents (concentrate and distillate) to the Waste Management System for processing.

The entire 780,000 gallons of diverted letdown is processed through the Boron Management System & Waste Management System and then discharged from the plant.

- 20) What fraction of the letdown stream is stripped of noble gases and iodines? How are these gases collected? What decay do they receive prior to release? Indicate stripping fraction.

Letdown returned to the Reactor Coolant System is not stripped of noble gases. Iodine is removed in the CVCS ion exchangers with an expected decontamination factor of 1,000.

- 21) What fraction of the noble gases and iodines are stripped from that portion of the letdown stream which is sent to the boron control system? How are these gases collected? What decay do they receive before release?

Approximately 90 percent of the noble gases are stripped from fluids routed through the Waste Management System. The flash tank is used for stripping inert gases from the letdown flow prior to processing in the Waste Management System demineralizers, filters and concentrators. Stripped gases are collected in the gas decay tanks. As indicated in Section 3.5 of the Environmental Report the gases are held in the gas decay tanks for an average time of 30 days.

Three 144 cu ft gas decay tanks are provided to hold up the waste gas at 165 psig. Approximately 50,000 scf per year (140 scf per day) of nitrogen and hydrogen gas are generated due to all degassifying operations. An overall partition factor 10^{-3} (including plate-out effect) is assumed for iodine in the gas decay tanks.

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* Ion exchange performance is based on data in WAPD-TM-215.

- 22) Are releases from the decay tanks passed through a charcoal absorber? What decontamination factor is expected?

No.

- 23) How frequently is the system shutdown and degassed? How many volumes of the primary coolant system are degassed in this way each year? What fraction of the gases present are removed? What fraction of other principle nuclides are removed and by what means? What decay time is provided?

The Reactor Coolant System will be degassed through the volume control tank prior to each of the assumed five cold shutdowns during the operating cycle. Approximately five reactor coolant system volumes will be degassed in this way each year. Conservatively, it is assumed that all gases are removed during each degasification and are routed to the gas decay tank for an average decay time of 30 days discussed in the response to Item 21. Approximately 7,500 scf of nitrogen and hydrogen gas are generated for the five shutdown degassing operations.

Other soluble nuclides are removed by the dilution of reactor coolant due to feed and bleed operations. It is anticipated that an average value of 56 percent of such nuclides will be removed during each shutdown. The maximum reactor coolant system concentrations at 0.1 percent failed fuel were used for evaluation of normal release.

- 24) Are there any other methods of degassing (i.e., through pressurizer, etc.)? If so, describe. How is it treated?

Degassing of the Reactor Coolant System is accomplished primarily through the volume control tank in the Chemical and Volume Control System. Chemistry control may dictate venting of the pressurizer through the steam space sample gas line. The cooled sample will be routed to the flash tank and thence to the Gaseous Radwaste System.

Gas removed from the pressurizer through the Sampling System is routed through the flash tank to the Gaseous Radwaste System terminating in the gas decay tanks. There they are held up as described in the response to Item 21.

- 25) What is the expected leak rate of primary coolant to the secondary system?

The total average annual primary to secondary leak rate is assumed to be approximately 20 gallons per day with 0.1 failed fuel. The estimated Technical Specification limit on secondary iodine concentration is 1.6 ci/cc.

- 26) What is the normal rate of system generator blowdown? Where are the gases from the blowdown vent discharged? Are there charcoal absorbers on the blowdown tank vent? If so, what decontamination factor is expected?

The normal blowdown required is determined by the amount of steam generator leakage and the time that the leakage occurs. A condenser leak will require immediate attention to maintain secondary chemistry. For a continuous 20 gallon per day primary to secondary leak an average annual blowdown of approximately 200 gallons per day is required to maintain the steam generator total dissolved solids below a normal limit of 500 ppm (400 ppm boric acid plus 100 ppm of normal boiler water additives or impurities). Blowdown may be routed to the blowdown process system. The blowdown heat exchanger eliminates the need for a blowdown tank and vent.

- 27) What is the expected leak rate of steam to the turbine building? What is the ventilation air flow through the turbine building (cfm)? Where is it discharged? Is the air filtered or treated before discharge? If so, provide expected performance.

The turbine building is an open structure with no ventilation system for the equipment areas. It is estimated that the leakage

in the turbine area is in the order of 20 lb/hr, of which about 10 percent would be in vapor form.

- 28) What is the flow rate of gaseous effluent from the main condenser ejector? What treatment is provided? Where is it released?

The main condenser air ejector discharge rate is 25 scfm air. It is released to the atmosphere. The activity concentration at which the air ejector flow will be transferred to the plant vent is approximately 1×10^{-8} μ ci/cc.

- 29) What is the origin of the steam used in the gland seals (i.e., is it primary steam, condensate, or demineralized water from a separate source, etc.) How is the effluent steam from the gland seals treated and disposed of?

The gland sealing steam is taken from the main steam line header. The leak-off from the gland seals is condensed in the gland steam condenser and returned to the main condenser. The gland steam condenser is vented by an exhaust fan to the off gas header which combines with the main condenser air ejector discharge. The gland steam exhauster flow rate is 740 cfm of air.

- 30) What is the expected leak rate of primary coolant to the auxiliary building? What is the ventilation air flow through the auxiliary building (cfm)? Where is it discharged? Is the air filtered or otherwise treated before discharge. If so, provide expected performance.

The expected leak rate of primary coolant to the auxiliary building is 10 gallons per day.

The ventilation flow rate through the various reactor auxiliary building areas is as follows:

- a) Control room: 2000 cfm
- b) Laboratory and personnel areas: 10,000 cfm
- c) Switchgear and electrical equipment areas: 50,000 cfm
- d) Waste management system and chemical and volume control system areas: 70,600 cfm
- e) Engineered safety features area: 60,000 cfm

The exhaust from potentially contaminated areas (d) of the building is discharged to the plant vent. Other areas are exhausted directly outside the building. Air exhaust from the engineered safety features area will be exhausted through charcoal filters under accident conditions.

- 31) Provide the average gallons/day and Ci/cc for the following categories of liquid effluent. Use currently observed data in

the industry where different from the PSAR or the Environmental Report (indicate which is used):

- a) High-level wastes (for example, primary coolant letdown, "clean" or low conductivity waste, equipment drains and deacrated wastes);
- b) "Dirty" wastes (for example, floor drain wastes, high-conductivity wastes, aerated wastes and laboratory wastes);
- c) Laundry, decontamination and wash-down wastes;
- d) Steam generator blowdown - give average flow rate and maximum short-term flows and their duration;
- e) Drains from turbine building.

For these wastes (a-e) provide:

- 1) Number of capacity of collector tanks.
- 2) Fraction of water to be recycled or factors controlling decision.
- 3) Treatment steps-include number, capacity and process decontamination factor for each principal nuclide for each step. If step is optional state factors controlling decision.
- 4) Decay time from primary loop to discharge.

- (a) High Level Wastes: High activity "clean" wastes consist of reactor coolant letdown diverted to the boron recovery system (portion of the Waste Management System) as the result of coolant expansion or feed and bleed operations for boron concentration adjustment, sample system drains, valve leakoffs and various reactor coolant auxiliary stem relief valves. It is estimated that approximately 780,000 gallons per year of "clean" waste will be generated at an average rate of 2200 gallons per day with an expected activity of approximately 30 Ci/cc prior to any processing. More than 99 percent of the "clean" waste will be discharged to the boron recovery system after processing in the CVCS ion exchangers. Table 2.3.7-1 yields a more conservative estimate.
- (b) Dirty waste consist of floor drains from possible contaminated areas, decontamination drains, chemical laboratory drains, and reactor coolant auxiliary systems equipment drains. It is estimated that approximately 155,000 gallons of these wastes could be generated during the annual operating

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cycle at an average rate of 425 gal/day with an expected activity of approximately 0.1 Ci/cc prior to processing.

The dirty wastes are normally directed to the equipment drain (EDT) or chemical drain (CDT) tanks. An approximate breakdown of waste to these two tanks is as follows:

<u>Waste Source</u>	<u>Gallons/Day</u>	Influent Activity (Fraction of RCS Activity)	<u>EDT</u>	<u>CDT</u>
Equipment Drains and Leakage	75	0.01	X	
Sample and Lab Drains	20	0.1		X
Decontamination Drains	180	0.001		X
Floor Drains	150	0.1	X	

3

- (c) Laundry Waste: Laundry waste consists of drains from the laundry and contaminated showers. Approximately 117,000 gal/year of these wastes are assumed to be generated with an expected influent activity level of approximately 10^{-5} μ Ci/cc prior to dilution.

- (d) Turbine Building Drains: The drains from the turbine building are estimated to be 1 GPM or 1440 gallons per day. The activity concentration has not been calculated, but other plant experience indicates an order of 1×10^{-5} μ Ci/cc can be expected.

3

- (1) Number and Capacity of Collector Tanks
(Refer to Section 3.5 of this report for location of tanks in processing scheme.)

<u>Tank</u>	<u>Quantity</u>	<u>Capacity (gal)</u>
Reactor Drain Tank	1	1,560
Flash Tank	1	400
Holdup Tank	4	40,000 (ea)
Boric Acid Condensate Tank	2	7,300 (ea)
Boric Acid Holding Tank	1	2,400
Equipment Drain Tank	2	25,000 (ea)
Laundry Drain Tank	2	2,000 (ea)
Chemical Drain Tank	1	1,000
Spent Resin Tank	1	3,200
Waste Condensate Tank	2	1,370 (ea)

- (2) Fraction of Water Recycled: It is expected that most of the water processed by the boron recovery system will be recycled. However, the effluent from the concentrators enables discharge to the environment at concentrations well below current proposed discharge guidelines when diluted in the circulating water flow, and thus represent a negligible effect on the environment. For environmental impact it is assumed that all of the concentrator condensate wastes are discharged.

- (3) Treatment Steps: A discussion of processing "clean" and "dirty" wastes is given in Section 3.5 of this report. The expected equipment performance is given in Tables 1 and 2.

Ion exchanger performance is based on data in WAPD-TM-215. Normally it is expected that the pH of the miscellaneous dirty wastes will be adjusted to obtain the optimum waste concentrator performance for the retention of iodine.

- (4) Cooling Time Prior to Discharge: There is no direct discharge of wastes from the primary loop to the environment. Because of the very small discharge flow rates of liquid wastes compared to the circulating water flow rate and the minimum processing times required for all wastes, it is expected that the heating effect of liquid waste discharge on the environment is negligible and insignificant. A nine day holdup time is assumed for liquid radwaste processing as shown in Table 1.

- 32) Dilution flow rate for liquid effluents, minimum and normal gpm and total gallons per year.

The normal dilution flow rate for Unit 2 is 530,000 gpm. For short periods of time this may be reduced to 265,000 gpm. The annual dilution flow rate is estimated to be $2.5-2.7 \times 10^{11}$ gallons allowing for equipment maintenance.

- 33) How is waste concentrate (filter cake, demineralizer resin, evaporator bottoms) handled? Give total volume, weight and curies per day or year.

Treatment of Bottoms and Resins: Concentration bottoms will either be reused or stabilized in 55 gallon drums for offsite disposal. Spent resins will be collected in the spent resin tank, prior to being sluiced to 55 gallon drums or a shielded shipping container for offsite disposal.

<u>Source</u>	<u>Unsolidified Volume per Year</u>	<u>Curies per Year (Maximum Expected)</u>
Concentrator Bottoms (with reuse of boric acid concentrator bottoms)	8,000 gal	80
Spent Resins	256 ft ³	2,000

It is expected that boric acid concentrator bottoms will be reused.

- 34) Include the expected annual volume of dry waste and curie content of each drum.

The expected annual volume of solidified liquids is 2400 ft³ with an activity of 0.25 Ci/drum.

The expected activity for shipping containers containing spent resins is 57.4 Ci/drum.

- 35) For demineralizer regenerants, provide (a) time between regeneration; (b) treatment of regenerants; (c) regenerant volumes; and (d) fraction discharged.

The 2 Boron Recovery Processing System Pre-Concentrator ion exchangers the 2 Chemical Volume Control System ion exchangers, and the Liquid Waste System ion exchanger are not regenerated. Spent resins are collected and shipped in shielded containers for offsite disposal.

- 36) Provide a process and instrumentation flow diagram for the gaseous and liquid radwaste systems.

Figure 3.5-5 of the Environmental Report is a process and instrumentation diagram for the Liquid Waste System. Figure 3.5-7 of the Environmental Report is a process and instrumentation diagram for the Gaseous Waste System.

TABLE 3.A-1

EXPECTED OPERATING CONDITIONSI. Boron Recovery Process System

1. 780,000 gal/yr water due to the cold and hot shutdown and fuel burnup for a base loaded plant.
2. Average 9 day holdup based on average fill and process time of one holdup tank.
3. Equipment Performance
 - a) Ion exchanger and filter DF (See Table 2)
 - b) Boric acid concentrator overall DF=200 (inlet/distillate) and DF=10⁴ (bottoms to distillate)
 - c) Gas stripping overall DF=10 for flash tank and concentrator (i.e., dissolved fission gases in liquid effluent)
4. Influent activity = average RCS activity

II. Waste Treatment Process System

A. Liquid, exclusive of steam generator blowdown

1. Influent activity = 0.01 RCS activity, due to dilution from decontamination, washdown, etc. No fission gases in aerated influent.
2. 156,000 gal/yr miscellaneous waste
3. Nominal 9 day process time
4. Equipment performance
 - a) Waste concentrator overall DF=500 (inlet/distillate) DF=10⁴ (bottom to distillate)
 - b) Waste condensate ion exchanger DF=10

B. Liquid, steam generator blowdown only

1. Average RCS activity (no fission gas in blowdown)
2. 5 gph SG tube leak, 50 gph blowdown to waste treatment process system
3. Nominal 20,000 gal steam generator water volume
4. Process time and equipment performance same as IIA

TABLE 3.A-1 (Cont'd)

C. Gaseous release from gas decay tank

1. Gas stripping $DF=10$
2. Average 30 day holdup for decay

III. Basis for Gas Collection Header Releases

A. Noble Gas Release

1. Release due to diffusion from holdup tank
2. Average 20 ft depth @ 100 F

B. Iodine Releases (I-131 only)

1. Boron recovery processing system
 - a) Iodine partition factor in holdup tank = 10^{-2}
(ratio of weight of iodine in air to water)
 - b) CVCS ion exchanger $DF=10^3$
2. Waste treatment process system
 - a) Iodine partition factor = 10^{-3}

TABLE 3.A-2

TABULATION OF EXPECTED DECONTAMINATION FACTORS

<u>Nuclide</u>	<u>CVCS Purification Ion Exchanger</u>	<u>Boron Recovery Processing System Pre-Concentrator Ion Exchanger</u>	<u>Filter</u>	<u>Nuclide</u>	<u>CVCS Purification Ion Exchanger</u>	<u>Boron Recovery Processing System Pre-Concentrator Ion Exchanger</u>	<u>Filter</u>
H-8	1	1	1	I-133	1000	1000	1
Br-84	1000	1000	1	Xe-133	1	1	1
Kr-85m	1	1	1	Te-134	10	10	1
Kr-85	1	1	1	I-134	1000	1000	1
Kr-87	1	1	1	Cs-134	1	100	1
Kr-88	1	1	1	I-135	1000	1000	1
Rb-88	1000	10	1	Xe-135	1	1	1
Rb-89	1000	10	1	Cs-136	1	100	1
Sr-89	100	10	1	Cs-137	1	100	1
Sr-90	100	10	1	Xe-138	1	1	1
Y-90	1	10	1	Cs-138	1	100	1
Sr-91	100	10	1	Ba-140	100	10	1

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TABLE 3-A-2 (Cont'd)

Nuclide	CVCS	Boron Recovery	Filter	Nuclide	CVCS	Boron Recovery	Filter
	Purification Ion Exchanger	Processing System Pre-Concentrator Ion Exchanger			Purification Ion Exchanger	Processing System Pre-Concentrator Ion Exchanger	
Y-91	1	10	1	La-140	10	10	1
Mo-99	1	10	1	Pr-143	10	10	1
Ru-103	10	10	1	Ce-144	10	10	1
Ru-106	10	10	1	Co-60	1	1	10
Te-129	10	10	1	Fe-59	1	1	10
I-129	1000	1000	1	Co-58	1	1	10
I-131	1000	1000	1	Mn-54	1	1	10
Xe-131m	1	1	1	Cr-51	1	1	10
Te-132	10	10	1	Zr-95	1	1	10
I-132	• 1000	1000	1				

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9. EFFECTS OF CONSTRUCTION

4.1 SITE PREPARATION AND PLANT CONSTRUCTION

4.1.1 SUMMARY OF PLANS AND SCHEDULES

Since St. Lucie Unit No. 2 is to be an exact duplicate of Unit No. 1, the design, manpower and equipment are readily available to initiate construction almost immediately. To meet a 1979 fuel loading date, the site preparation for the reactor and auxiliary buildings must commence February 15, 1975. Any improvement in this date will result in a significant potential for an earlier completion date. Site preparation for the intake and discharge canals, switchyard, transmission lines, highway bridges and plant roads for Unit No. 2 are in various stages of construction as part of the Unit No. 1 construction program.

It is expected that an average of 750 workers will be employed in the construction force. The force is expected to peak at 1400 between December 1977 and December 1978, decline to 900 in January 1979, 500 by the end of May 1979, and to zero by the end of March 1980.

Initial loading of fuel is scheduled for September 1979, and initial commercial operation is scheduled for December 1979.

4.1.2 CUT AND FILL AREAS

Cutting the beach and dune line for installation of the intake and discharge pipelines increases the possibility of wave damage during major storms. The sand dune is the highest point on the Island and is therefore its defense against wave overrun. To maintain the dunes during construction, the installation of the discharge pipeline will be accomplished in two phases. A trench will be opened either east or west of the dune, but not breaching the dune, the pipe will be installed and the trench filled in before proceeding with the second phase. A second temporary "dune" will then be established using previously excavated sands and sheet piling. The temporary "dune" will be located over the previously installed pipe and blend well into the existing dune to afford a continuous dune line. The existing dune will then be excavated, the pipe installed, and the dune restored.

Installation of the discharge pipeline through the dune and beach is estimated to require two months. Since the beach and dune will be restored to the original conditions after installation of the pipeline, the sand excavated from the trenches into which the lines are to be installed will be stockpiled in the immediate vicinity and will be readily available for filling in the trenches.

The site area for Unit No. 2 is located on a portion of an approximate 300 acre tract of previously filled and dewatered mangrove swamp. The terrestrial habitat of this area has already been markedly changed by the filling and dredging of canals and spoil banks required for the construction of Unit No. 1. No additional land beyond this 300 acre site will be disturbed for the construction of Unit No. 2.

After construction, the crest of the restored dune will be planted with Australian Pine to match existing vegetation at the site of the intake and discharge excavations. The east side of the dune will remain in its natural unplanted state in order to react to natural wave action cycles.

Prior to exavation for the foundations of the turbine building reactor building, intake structure and seal well, local dewatering will be implimented. Water extracted during this process will be directed to either the intake or discharge canals or the settling basin south of the plant island. To assure protection of the ocean biota, any discharges to coastal waters will meet all applicable State of Florida regulations for turbidity.

The nuclear reactor building and its auxiliary buildings will occupy approximately 5 acres of this 300 acre site. The service building, parking and lay down as well as other temporary use area for Unit No. 1 will be utilized for Unit No. 2. It is anticipated that no additional mangrove swamp acreage will be cleared for Unit No. 2. 3

During construction, all solid wastes are transported to a fill area southwest of the switchyard. Periodically, combustibles are burned. All material is covered with clean fill somewhat in the manner of a sanitary landfill. Operational disposal will be carried out in a manner consistent with local sanitary regulations and practices.

Combined construction effects of Units 1 and 2 will be minimal as Unit No. 1 is scheduled for initiation of commercial operations mid 1975 while construction for Unit No. 2 is not scheduled to begin until early 1975.

Approximately 830 acres of the Applicant's land area will continue in its preconstruction form to the extent that is possible within the dictates of the mosquito control district and the AEC. It is not anticipated that recreational and other uses of the surrounding area will be impaired. However, security requirements may necessitate restricted access even in peripheral areas of the Applicant's property, thereby limiting access to the beach or other recreational sites within the Applicant's jurisdiction. Indian River, including Big Mud Creek, and the ocean beach below the dune line (mean high water) will remain available to the public. Existing small dirt roads, if not closed for security reasons, could be used for general access. The canals could become desirable fishing areas, unless security restrictions prohibit their use.

4.1.3 CONSTRUCTION FORCE

No special burden on schools, public facilities and services by the work force is anticipated as there was no evidence of strain on the local communities during the peak employment of over 1200 construction workers for Unit No. 1. It is expected that many of the present workers will remain employed at the site for Unit No. 2 construction and thereby reduce fluctuations in the economies of the nearby communities. 3

Minor traffic congestion can be expected along Highway A1A and the causeways leading to the mainland during rush hour periods. Only a small amount of inconvenience is anticipated from construction noise, dust and smoke as the island project is well isolated from populated areas. As of May 1972, the nearest inhabited areas on Hutchinson Island were 7 miles to the north and 4.5 miles south of the plant site.

4.1.4 LANDSCAPE RESTORATION

Plans for landscaping the site are not complete, however, the post construction to landscape will be made environmentally compatible with the surrounding area. The ground area sloping from the road up to the plant will probably be grassed with plantings of trees and shrubs to blend in naturally with the surroundings. The borders of the intake and discharge canals passing under the road will be grassed for erosion control. The services of a landscape architect will be employed for direction of the landscaping effort.

A 100 to 200 ft wide border of naturally occurring vegetation (mainly mangroves) will be left between the plant site and the Indian River. The only exception is the barge facility on Big Mud Cr  ek which is not visible from the mainland and only visible from one location on State Road A-1-A.

The exterior of the main structures including the reactor building, auxiliary building, fuel handling and turbine building are not coated. Structural steel and tanks (other than stainless steel or aluminum) are either galvanized or coated in beige, soft blue or green.

4.1.5 MISCELLANEOUS

The National Register of Historic Places lists no historic places on or near the plant site of Hutchinson Island. The State of Florida, Board of Archives and History has indicated that no historical damage will be done by the construction of power facilities on this site. Due to the porous nature of subsurface conditions at the site, the use of explosives is not anticipated.

Approximately ten acres of land will be permanently utilized by the plant and its adjacent intake and discharge structures. Building material supply areas and service lines for Unit No. 2 are completed or have been approved for the construction of Unit No. 1. Disposition of construction and operational trash will be completed through the filling of borrow pits, adding clean fill and compaction.

4.1.6 CONSTRUCTION EFFECTS ON WILDLIFE HABITATS

The construction of Unit No. 1 has affected the wildlife only in the relatively small area where construction has been in progress. Construction noise may have caused some disturbance also in the immediately surrounding area. Overall effects on wildlife, as a result of the construction of Unit No. 2, are expected to be minimal because the site was disturbed during Unit No. 1 construction.

During construction, elevated outside lighting will be extinguished as much as possible when a storm front moves through, in order to protect migrating birds which otherwise might become confused and fly into the lights and supporting structures.

Construction of the discharge system may affect loggerhead turtle nesting during at least one nesting season. Loggerhead turtles average 200 nests per mile on the portion of the beach owned by FP&L, but no leatherback or green turtles nests were observed further north than one mile south of the area of the proposed intake pipeline.

If construction is active in the beach area during the turtle breeding season, a nest surveillance and relocation program will be instituted on those areas of the beach affected by construction activity. Nests found will be immediately transferred to some suitable safe location for hatching and release. This program will minimize short-term effects of construction, and no long-term effects are expected to result.

Turtle hatchlings emerge from the nest and immediately head for the ocean, leaving their nesting and breeding ground for distant feeding areas. Light is known to disorient turtles during all stages of their life cycle, and hatchlings could become confused by plant lighting and perhaps be prevented from reaching the ocean safely. In order to minimize possible hatchling disorientation, a screen of Australian pines will be maintained along the beach dune line bordering the plant property. This may help the hatchlings to orient toward the ocean by both screening out any light from the plant and by increasing the contrast between ocean and shore.

Studies of green turtles indicate that they avoid lights and activity on the beach when selecting a nesting site. Loggerhead nests are common along even developed areas of the Florida coast, so that while female loggerheads may be displaced from the immediate vicinity, they may well nest on other portions of the island.

The area between the intake and discharge canals east of U.S. A-1-A will be flooded and drained for mosquito control. Flooding will be accomplished by pumping water from the intake canal into the area, or, in the case where the intake canal water level is high enough, opening the control gate and allowing the water to flow by gravity through the pipeline buried under the canal dike. Buildup of radionuclides in the water and soil of this area due to the mosquito control efforts will be less than the practical limits of measurement.

Draining will be accomplished by opening the control gate and allowing the water to drain by gravity into the intake canal. No water will be taken from the discharge canal.

4.1.7 EFFECTS OF DREDGING FOR DISCHARGE PIPES ON THE OFFSHORE BENTHIC FAUNA

The effects of construction of the discharge line for Unit No. 2 will have a minimal effect on the benthic production of the area. The discharge line will involve dredging a channel approximately 3,500 feet out into the ocean to a depth of about 20 feet. The channel will be protected by sheet piling for the first 1,250 feet and will be about 40 feet wide. An unprotected channel 80 feet wide will continue for 250 feet to the terminus of the Unit 1 discharge pipe. The additional 2,000 feet of unprotected channel will be about 60 feet wide and include the remaining pipe and diffuser sections for Unit No. 2 discharge. Approximately 17,600 square meters of area or a sediment volume of 82,000 cubic meters will be disturbed. The dredge spoils will not be deposited on the ocean floor. All material not utilized as backfill will be transported to an approved onshore disposal area.

The ocean intake structures for Unit No. 1 which will also serve Unit No. 2 are under construction. The environmental effects of the intakes have been discussed in the Unit No. 1 Environmental Report and will not be considered here.

The total surface disturbed by dredging will be approximately 17,600 square meters. This represents less than 0.06 percent of the 34,900,000 square meters of ocean bottom within the 30 foot depth contour between Fort Pierce Inlet and St. Lucie Inlet.

To obtain an approximation of the benthic faunal density in that area, data obtained from Station I by Ingle and Joyce were used^(1,2,3). Average values for polychaetes and amphipods were determined. However, since the high and low values for other faunal groups were extremely variable, the highest values were used to develop a conservative approximation of the standing crop of bivalves, echinoderms and decapods.

The estimated density of benthic organisms for Station I is given in Table 4.1-1. In addition, estimates of the maximum number of organisms eliminated by dredging operations are also tabulated. It must be emphasized that a relatively small area will be disturbed and that the assumption of 100 percent mortality is high. It would appear on the basis of these estimates that the effects on the benthic ecology of the area will not be significant.

Of additional importance is the amount of time required for the benthic fauna to become reestablished in the disturbed area. According to Godcharles⁽⁴⁾, benthic fauna became reestablished in the Tampa Bay area in less than 240 days. In areas where sea grasses occurred, revegetation was slow but appeared to have little effect on benthic faunal abundance. It was felt that the exposure of shell particles by dredging might create favorable conditions. Luntz⁽⁵⁾ concluded that sediment drift in the area during dredging had little effect on oysters. Shellfish mortality was low unless the organisms were actually buried by spoils. He observed little difference in spawning and setting in dredged and undredged areas. Ingle⁽⁶⁾ also reported the limited effects of turbidity and sediment drift on fish and shellfish.

Pfitzenmeyer and Drobeck⁽⁷⁾ noted that the major factors affecting re-burrowing activities in the clam, Mya arenaria, were temperatures, sediment size and size of the organism. Rapid reburrowing (1-4 hrs) occurred between 8.8 C and 21 C in fine (0.5mm) sediments. In addition, small clams (60 mm) were more successful than larger size classes. Hanks⁽⁸⁾ noted that in "new" experimental saltwater ponds, a benthic community was established quite rapidly. Polychaetes were well established within nine months. Clams of the genus Macoma became well established after the first six months. Amphipods and certain decapods became established within the first year.

It is concluded that the effects of dredging on the offshore benthic community will be minimal. The use of sheet piling and the on-shore disposal of spoil material will further limit any adverse effects. The disturbed area will be relatively small and it would appear that re-establishment of benthic communities in the affected area should be complete within one year.

4.1.8 CHEMICAL RELEASES DURING CONSTRUCTION

Chemicals are used during plant construction and startup primarily for cleaning system piping and equipment. Volatiles, such as acetone, are used for cleaning stainless steel components. Alkaline solutions such as 1200 ppm tri-sodium phosphate, 1200 ppm sodium bicarbonate and 160 ppm DOW chemical DIS-FO-57 detergent or alternately 2000 ppm tri-sodium phosphate, 1000 ppm disodium phosphate and a wetting agent are used for cleaning carbon steel components. Components may require cleaning to remove chemical preservatives, but on a lesser scope than the systems cleaning requirements. Spent chemicals are routed to the settling basin south of the plant island or to the neutralization basin located in the water treatment plant if neutralization is required prior to discharge.

TABLE 4.1-1ESTIMATED ELIMINATION OF BENTHIC FAUNA DUE TO
DREDGING CHANNELS FOR DISCHARGE PIPE*

<u>Benthic Organisms</u>	<u>Estimated Density per Meter² at Station I</u>	<u>Number Eliminated By Dredging Discharge Channel</u>
Polychaetes [†]	100	1.76×10^6
Bivalves**	550	9.68×10^6
Echinoderms**	150	2.64×10^6
Amphipods [†]	15	0.26×10^6
Decapods**	80	1.41×10^6
Totals	930	16.39×10^6

* Assume 100 percent mortality of disturbed organisms.

** Represents highest population.

[†] Represents average population.

4.2 TRANSMISSION FACILITIES CONSTRUCTION

Power transmission from Unit No. 2 will utilize existing switchyard and transmission lines designed and erected for Unit No. 1 and, therefore, will produce virtually no additional environmental impact.

4.3 RESOURCES COMMITTED (CONSTRUCTION)

The resources such as iron, steel and concrete in the construction of St. Lucie Unit No. 2 are those common to any large industrial facility. Most other resources are either left undisturbed or committed only temporarily as during construction or during the life of the plant and are not irreversibly or irretrievably lost.

Restrictions on use of the plant during construction should be similar to those associated with other heavy industrial facilities. Public access to the site may have to be controlled due to AEC security requirements, but recreational and other uses of the surrounding area should not be impaired. The Indian River, including Big Mud Creek and the ocean beach, will remain public property.

It would appear that only a small portion of the land used for plant buildings, such as the reactor, control room, radwaste and the turbine-generator buildings, would be irreversibly committed. Also, some facility components, such as large underground concrete foundations and certain equipment, are essentially irretrievable due to practical aspects of reclamation and/or radioactive decontamination. The degree of dismantlement of the plant, as previously noted, will be determined by the intended future use of the site. This will involve a balance of health and safety considerations, salvage values and environmental effects.

2 EFFECTS OF
3 PLANT OPERATION

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5.1 EFFECTS OF HEAT DISSIPATION SYSTEM

5.1.1 EFFECT OF THERMAL DISCHARGE ON OCEAN TEMPERATURES

The condenser cooling water discharged from the subaqueous discharge structures into the ocean results in an efficient turbulent mixing which will dilute the original discharge so that the resulting surface temperature is greatly reduced. The mixing and dilution are due to turbulent shear caused by the high velocity and buoyancy of the discharge relative to the ambient ocean. The multiport diffuser for St. Lucie Unit No. 2 has been designed to achieve a high degree of mixing and resulting dilution by the time the discharge reaches the ocean surface. In the present case, assuming that the ambient waters are not stratified (this being a conservative assumption), the positively buoyant jet will rise to the surface and spread laterally. Even though jet buoyant forces decrease as the length of travel of the jet and entrainment increase, the jet will continue to rise to the surface and spread as it is buoyant when compared with the ambient waters.

The jet flow is usually divided into near field and far field regions. Near field is normally understood as the region where the dynamics of the jet and the resulting temperature and dilution are determined largely by the behavior of the buoyant jet. The temperature reduction in the near field is governed by geometric, dynamic and buoyant characteristics of the jet and the ocean. In this region significant dilution takes place.

An estimate of the surface spreading and surface temperature distribution is made by the far field predictive techniques. The far field region is characterized by the heated water being convected at the velocity of the ocean current and being mixed by the turbulence of the ocean. The temperature reduction in the far field is accomplished by ambient currents, turbulent diffusion processes, surface heat losses and other heat losses associated with ambient hydrodynamic conditions.

In general, even though overall performance characteristics of the multiport diffuser involve near field and far field processes, the efficiency of the near field processes in reducing the initial temperature is far superior to that of the far field processes. Furthermore, there is greater reliability in the analysis of near field processes because of uncertainties involved in the analysis of several far field characteristics. These characteristics include the effects of free surface, stability of the surface layer, cross flow and turbulence, bottom interaction and the dynamics of the flowaway from the surface. Consequently, since the efficiencies of the near field processes outweigh those of the far field, maximum use of near field characteristics should be made in reducing the temperature and in increasing the dilution. These factors have been taken into consideration in designing the multiport diffuser system for Unit No. 2. Based on near field temperature predictive techniques, the multiport diffuser has been designed so that the resulting near field surface temperature is below the allowable limits. Consequently, the temperature in the far field region will be well below allowable limits.

5.1.1.1 Effect of Unit No. 2 Discharge-Near Field Analysis

The heat dissipation system to be used for St. Lucie Unit No. 2 is described in detail in Section 3.4. The method used for the discharge of heated water will result in dilution and decreased temperature at the water surface. This will be accomplished by discharging the heated water at a depth of approximately 30 to 40 feet through multiple ports. Discharging the water as sub-surface high velocity jets produces a reduction in temperature of the heater water as it travels to the surface.

The heated water discharged near the ocean bottom from the manifold is subject to a buoyant force which is proportional to the density difference between the heated water that is ejected and the ambient water. Thus, the jet has not only a kinetic energy due to the efflux velocity, but also a potential energy due to its submergence. The kinetic energy is dissipated in the turbulent mixing of the jet, while the buoyant force drives the jet plume towards the surface, thus achieving increased dilution and a more effective use of the available receiving water (1,2). The dilution results in a significant reduction of the initial temperature. As the water reaches the surface, it will spread out and be carried away from the discharge. There will be further reduction in temperature due to heat loss to the atmosphere, diffusion and entrainment of adjacent water.

The methodology for the preliminary analysis of the diffuser system is based on the works of Brooks⁽³⁾, Rawn et al^(4,5), Fan and Brooks^(6,7), Cedarwall⁽⁸⁾, and others (9,10,11). Initial selection of the diameter of the jets and spacing is based on a recent publication of the National Environmental Research Center⁽¹²⁾. The analysis and the calculation of temperature is based on the report "Mathematical Models for the Prediction of Temperature Distributions Resulting from the Discharge of Heated Water into Large Bodies of Water" by Koh and Fan⁽¹³⁾. The results of these studies provided the basis for the present selection of port spacing, port size, angle of discharge and depth of submergence.

The 1150 cfs condenser cooling water is discharged through 48 ports one and one half feet in diameter. The method used to determine the port diameter follows the guidelines prescribed by Rawn et al⁽⁴⁾ and Brooks⁽¹⁴⁾. This method for port size selection makes it possible to make the diffuser flow full and to make the jet velocity greater than the velocity in the manifold. Such a multiport system like the one described above has been examined recently by the AEC⁽¹⁵⁾.

The jet angle in the present system is zero with respect to the ocean floor i.e., it discharges horizontally into the open waters of the Atlantic Ocean. It is well known from field tests, laboratory experiments and theoretical calculations that a zero discharge angle gives the highest surface dilution^(5,7,12,13) and hence, the smallest surface temperature rise.

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Jets are spaced at 45 ft center to center on both sides of the manifold and they are located at alternate positions as shown in the Figure 3.4-4. This makes the shortest distance between the consecutive jets about 25 ft. It is known from the fluid dynamics of jets that large distances between the jets would not induce any static pressure drop in the water column contained between the jets(2). The spacing of 45 ft between jets on each side of the manifold provides the advantages of hydraulic isolation from the neighboring jet.

The discharge that is ejected horizontally into the ocean undergoes rapid initial mixing. Bottom scouring will be minimized as the heated water will be discharged in many small jets rather than one large jet and because the jet is elevated several feet above the ocean floor. A schematic drawing of the jet is shown in Figure 3.4-4.

The analytical model used for the discharge analysis is based on a computer program following the work of Koh and Fan(13). The results were counterchecked from the curves prepared by Shirazi and Davis(12) for their general validity. Koh and Fan's model treats the discharge as separate round forced jets. If the spacing between the jets is small, or if the distance above the jets is large, the jets coalesce with each other and at this point, the model treats the combined jets as a slot source at the intersections of the round jet plumes. At this intersection, the simulated slot characteristics are evaluated and then used in a slot jet discharge model. In those cases where there is any interference with the adjacent jet plume a conservative estimate of the resultant flow field could be made by utilizing a linear superposition technique(16). However, as shown in Figure 5.1-1, in the present system, the spacing of 45 feet reduces interference to such a low degree that there would not be any significant increase in individual jet temperature.

Values of the input parameters to the mathematical model (Koh-Fan's) are as follows:

Spacing of jet on each side	= 45 ft
diameter of the jet	= 1.5 ft
discharge angle	= 0° (horizontal)
discharge velocity	= 12 fps - 14 fps
discharge temperature	= 111°F
discharge density	= 1.0179 gm/cc
discharge depth	= 30 ft - -0 ft
ambient temperature	= 87°F
ambient density density	= 1.0235 gm/cc
(no stratification assumed)	

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Some of the typical results obtained with the aid of the computer model for different conditions are shown in Table 5.1-1. Figure 5.1-2 shows the results obtained for non-stratified stagnant ocean conditions and for the month of September as a maximum case. Under natural ocean conditions, stratification, turbulence, eddies, and wave action are present. However, in calculating thermal dilutions from the multiport jet diffuser system, ocean stratification and wave action, turbulence and eddies, and excess free turbulence, eddies and vortices produced

by jet action have not been considered. This adds conservatism to the values obtained.

These analytical results, based on slack tide (stagnant ocean), nonstratified ocean, no induced jet turbulence as a maximum case and conservative heat discharge assumptions into the ocean at its mean low water depth, showed an absolute maximum ocean surface temperature rise (at the plume centerline) of about 1.5°F with the plant operating at full capacity during September weather conditions. The resulting temperature rise in the ocean would even be less during other months since the lower ocean ambient temperatures cause increased dilution. This effect can be observed by reviewing Table 5.1-1. In other words the maximum temperature of the water surface would never exceed 89°F . Away from the plume centerline, there is a rapid decay of the excess temperature, becoming almost the ambient temperature at its ends. The results show that the plume centerline when it reaches the surface is about 80 to 90 feet away from the manifold and has a jet width of about 30 to 32 feet. Thus, with a jet spacing of 45 feet on one side of the manifold, chances of interference are small. With a known plume centerline temperature and its width, it is possible to estimate the temperatures at other points and hence it is possible to estimate isotherms and the areas enveloped by them. Figure 5.1-3 shows the isotherms 24 feet above the discharge ports for 1.5°F , 1°F and 0.5°F for a jet plume during the month of September. The horizontal areas affected by the 1.5°F , 1°F and 0.5°F isotherms of temperature rise are, respectively, 0.0018 acres, 0.0046 acres and 0.0078 acres. Actual ocean depth will vary from 35 feet to 40 feet at the multiport diffuser system and therefore the maximum surface temperature will be less than the temperature calculated at 24 feet above the ports. These areas are quite insignificant compared to the surface isotherms in a surface discharge or discharge from a single jet port. Further, the isotherm areas created by the jets located further downstream along the manifold would even be less considering the increased depth of submergence.

An independent evaluation of the St. Lucie Unit No. 2 thermal plume is made by estimating the values of surface-to-river temperature differentials. For these calculations, use has been made of the results of Brooks⁽³⁾, Rawn et al^(4,5), and others^(6,7,10,12). The results obtained are shown in Table 5.1-2.

The surface temperature obtained by different methods gives values in the same range as obtained by Koh and Fan's⁽¹³⁾ mathematical model. Since the present state of the art does not lead to the expectation of exact checks between different thermal plume models and since the differences observed between different approaches are relatively insignificant, the estimates that are presented here are considered reasonable.

5.1.1.2 Effect of Unit No. 2 Discharge - Far Field Analysis

a) Near Source Boundary Condition for Far Field Analysis

The predicted maximum surface temperature rise above the diffuser system is about 1.5 F. This maximum surface temperature rise is below that permitted by the water quality standards of the State of Florida which limits surface temperature rise to 2 F in coastal waters. The surface temperature rise of 1.5 F is the plume centerline temperature and affects a very small area. The average temperature across the plume will be much lower. Baumgartner and others⁽¹⁷⁾ have observed that the average concentration across each plume is about 22 percent of the maximum, thereby making the average surface temperature rise along the length of the diffuser about 0.35 F. In other words, a realistic near source temperature condition for the far field analysis would be to assume an initial temperature rise of 0.35 F rather than 1.5 F. However, as seen later, far field analysis is carried out here assuming an initial temperature rise of 1.5 F to add a degree of conservatism to the results obtained.

1

In addition to the work of Baumgartner and others⁽¹⁷⁾, the work of several other investigators, namely, Adams⁽¹⁸⁾, Harleman⁽¹⁹⁾, and Jirka and Harleman⁽²⁰⁾, have been reviewed to further confirm the conservatism of using 1.5 F as the near source temperature for far field temperature predictions.

Adams⁽¹⁸⁾ and Harleman⁽¹⁹⁾, observing the inability to apply detailed analytical models with confidence to the multiport diffusers (as in the present case), resorted to one dimensional average models which would provide a more gross view of the mixing processes.

Harleman's analysis deals with the estimation of energy and losses in a two dimensional channel system. Predicted dilution in the fully mixed flowaway zone is simply given by the volume flux ratio,

$$S = \frac{U_m H L}{\frac{U_o D^2 \Pi}{4}}$$

which could be expressed as

$$S = \frac{1}{(1 + \Sigma k)^{1/2}} 2 \left(\frac{H}{B} \right)^{1/2}$$

Where:

S = dilution

U_m = Velocity of the current set up by the jet discharge and the ambient ocean current

U_o = jet discharge velocity

H = water depth

L = nozzle spacing

D = nozzle diameter

B = equivalent slot width = $\frac{D^2 \Pi}{4L}$

Σk = total frictional head loss coefficient

Harleman found satisfactory agreement between the dilution predicted by the above equation and his experimental results. For the present case, the application of Harlemen's analysis results in a full depth average temperature rise on the order of 0.7 F with the surface temperature rise still being less.

On the other hand, Adams(18) presents a three dimensional analysis of such a diffuser system by considering the pressure forces and momentum fluxes. Dilution is expressed as

$$S = \frac{1}{2} \frac{U_a}{U_o} \frac{H}{B} + \frac{1}{2} \left[\left(\frac{U_a}{U_o} \frac{H}{B} \right)^2 + 2 \frac{H}{B} \right]^{1/2}$$

where:

U_a = ambient cross flow velocity

(Other symbols as previously defined)

The application of Adams' analysis results in a full depth average temperature rise of about 0.5 F when the ambient current flow is in the same direction as the jet and about 0.8 F when the ambient current flows against the diffuser. The resulting temperature for the well mixed case with jets issuing on either side of the manifold is estimated to be about 0.6 F. As the ocean current approaches zero velocity, the resulting dilution is due only to mixing between the jets and the ambient induced flow, in which case, this results in a full depth average temperature of about 1 F. Adams compared predictions based on his method of analysis to his experimental results and found satisfactory agreement.

Quite recently, Jirka and Harleman(20) considered the jet structure as comprised of four flow regions namely:

- | | |
|---|--------------------------------|
| (i) Buoyant jet region | } Designated as
near field. |
| (ii) Surface impingement region | |
| (iii) Hydraulic jump region | |
| (iv) Stratified counterflow region
and the ambient ocean | } Designated as
far field |

The buoyant jet region refers to the initial flow region where the jet, forced by its initial momentum and buoyancy, rises entraining the ambient water. Next, the presence of the free surface and its density discontinuity directs the impinging jet in the horizontal direction; this is called the surface impingement region. Transition between the surface impingement region and the stratified counterflow region is provided by an internal hydraulic jump. Finally, the flowaway zone is called the stratified counterflow region.

For the range of densimetric Froude numbers and relative depths that are applicable for the multiport diffuser at St. Lucie, the surface temperature rise near the diffuser as predicted by this study and those predicted by earlier analytical models (Section 5.1.1.1) are nearly the same. Predicted maximum surface temperature rises are 1.5 F for slack conditions, about 0.5 F when there is an ambient current of 1.3 fps (southerly current) and about 1 F when the ambient current reduces to 0.7 fps (northerly current).

The analysis of Jirka and Harleman, even though it is an improvement over the earlier methods, has several shortcomings. Principally: (i) the synthesis or the matching of solutions for each flow region to provide an overall prediction of dilution (near field and far field) is not provided (ii) there is insufficient evidence to assume that a multiport diffuser with jets on both sides of the manifold would behave the same way as its equivalent slot diffuser and (iii) far field temperature prediction cannot be obtained using the techniques of Jirka and Harleman.

Thus, a detailed analysis using several available techniques (Section 5.1.1.1) shows that the maximum near field surface temperature rise will be about 1.5 F above ambient; consequently, temperature rises in the far field region will be less. Again, as mentioned before, this 1.5 F temperature rise occurs at the center of the plume and covers a very small area. A realistic estimate of the average temperature rise across the plume would be less than 1 F. Present far field predictions based on an average temperature rise across the length of diffuser of 1.5 F makes the far field analysis quite conservative.

b) Far Field Temperature Predictions

1) Method of Analysis

The surface temperature distribution discussed above provides the "near-source" boundary condition for the far field surface temperature distribution. The far field region will be assumed to have been reached when the mixing processes possess no dependence on the initial mode of discharge and are associated with only ambient hydrodynamic conditions. In general, the amount of mixing and the decrease of excess temperature in the far field are due to ambient currents, turbulence and density induced currents.

For discharge of heated water at St. Lucie in which the major portion of the reduction of temperature has been as a result of near field mixing, the excess variance⁽²¹⁾ due to density differences in the far field is not significant. This is because small excess temperature in the far field gives rise to rather small density differences. On the other hand the mixing and the resulting temperature reduction due to ambient turbulence is predominant.

In a strict sense the equation for excess temperature in the far field and the appropriate boundary conditions are:

$$\frac{\partial T}{\partial t} + u \frac{\partial T}{\partial x} + v \frac{\partial T}{\partial y} + w \frac{\partial T}{\partial z} = \frac{\partial}{\partial x} \left(K_x \frac{\partial T}{\partial x} \right) + \frac{\partial}{\partial y} \left(K_y \frac{\partial T}{\partial y} \right) + \frac{\partial}{\partial z} \left(K_z \frac{\partial T}{\partial z} \right) \quad | \quad 1$$

$$-K_y \frac{\partial T}{\partial y} \bigg|_{y=0} = \frac{K_E T}{\rho C_p} \bigg|_{y=0} = kT \bigg|_{y=0}$$

$$K_y \frac{\partial T}{\partial y} \bigg|_{y=h} = 0$$

Where:

- t = time coordinate
 u, v, w = velocity in x, y, z directions
 K_x, K_y, K_z = eddy diffusion coefficients in x, y, z directions
 T = temperature above ambient
 h = depth of diffusion slab
 k = kinematic surface heat exchange coefficient
 K_E = surface heat exchange coefficient
 ρ = density
 C_p = specific heat capacity at constant pressure

Numerical or exact solution to this full governing equation, as applicable to the conditions at St. Lucie, with time and space variables is extremely difficult and is not presently available. Hence the problem is simplified and a more realistic analysis of the far field constituent concentration as discussed by Ditmars⁽²²⁾ is given here. Recently Ditmars analyzed the temperature distribution in large flow environments for heated sources of finite extent of width b and depth h .

The governing equation in this case is:

$$V \frac{\partial T}{\partial x} = \frac{\partial}{\partial z} \left(K_z \frac{\partial T}{\partial z} \right) - \frac{kT}{h}$$

The rate of spreading and the consequent temperature decay is dependent on K_z , the lateral eddy diffusion coefficient among other factors. Yudelso⁽²³⁾ has shown that, for oceans and other large bodies of water, K_z follows "Richardson's four-thirds law"^(24,25,26) and is given by

$$K_z = A L^{4/3}$$

Where A = a dissipation parameter

where σ_z = standard deviation of the lateral temperature profile.

$$L = 2\sqrt{3} \sigma_z$$

(This definition of L is chosen instead of the usual value of $L = 4\sigma_z$ so that $L = b$ at $x = 0$)

In the above equation,

x = longitudinal distance from the source

z = lateral distance from the plume centerline

v = ambient velocity

k = kinematic surface heat exchange coefficient

T = temperature rise at any point (x, z)

K_{z_o} = lateral eddy diffusion coefficient based on the initial plume width b , at $x = 0$

Brooks⁽²⁷⁾ has found a solution for the above equation to describe the temperature distribution

$$\frac{T}{T_0} = \frac{e}{2} \frac{-kx}{hv} \left[\operatorname{erf} \left(\frac{z+(b/2)}{2b} \sqrt{\frac{24}{\left[1 + 8K_{z_o} x^3 - 1\right] - \frac{z_o^2}{vb^2}}} \right) - \operatorname{erf} \left(\frac{z-(b/2)}{2b} \sqrt{\frac{24}{\left[1 + 8K_{z_o} x^3 - 1\right] - \frac{z_o^2}{vb^2}}} \right) \right]$$

where the function erf is the standard error function defined as

$$\operatorname{erf} \psi = \frac{2}{\sqrt{\pi}} \int_0^\psi e^{-w^2} dw$$

and T_0 is the surface temperature rise in the near field region. If T_m is the temperature rise along the axis $z = 0$ the above equation reduces to

$$\frac{T_m}{T_0} = e^{-kx/hv} \operatorname{erf} \left[\sqrt{\frac{3/2}{\left(1 + 8K_{z_o} x^3 - 1\right) - \frac{z_o^2}{vb^2}}} \right]$$

This method of analysis given here for the determination of far field dilutions and temperature prediction has been used in several instances. Recently Tsai⁽²⁸⁾ used this method for predicting far field temperatures, resulting from heated water discharges from a submerged multiport diffuser for James Fitzpatrick Nuclear Power Plant. In this case the submerged multiport diffuser discharged into Lake Ontario. For far field thermal analysis, during slack water conditions, Tsai considered the heated water flow as a surface jet following the analyses of Tamai et al⁽²⁹⁾ and Jen et al⁽³⁰⁾. Baumgartner and others⁽¹⁷⁾ used this method to analyze the subaqueous multiport ocean outfalls at Newport and Gardiner in the State of Oregon.

ii) Temperature Predictions

In Section 5.1.1.1, an estimate of the near field surface temperature rise as a result of condenser cooling water discharge through the multiport diffuser is made. These details form the input parameters for the far field analysis. As shown previously, a realistic estimate of the initial excess surface temperature would be on the order of 1 F or less. However, for the present far field analysis, to add conservatism, the near source initial condition has been assumed to be 1.5 F, which is the plume centerline temperature rise. The initial width of the temperature field is about 1200 feet and the thickness of the diffusion slab is about 5 - 6 feet. The lateral eddy diffusion coefficient is assumed to be about $10^4 \text{ cm}^2/\text{sec}$ (23,24,25). This essentially means that the eddy size is about 1000 - 1200 to start with. Because these eddies are a sufficient distance away from the shore (about 1500 feet) no interference with the shore is expected. For the temperature analysis during slack water conditions, the method suggested by Tsai has been followed.

With these known values an estimate of the temperature in the far field region and temperature reduction is made and the isotherms are prepared. These are shown on Figure 5.1-4 for a southerly current of 1.3 fps, in Figure 5.1-5 for a northerly current of 0.7 fps and in Figure 5.1-6 for slack water conditions. The surface areas covered by these isotherms are shown in Table 5.1-3.

The analysis presented here shows that a high degree of dilution can be obtained with the present multiport diffuser. The surface isotherm areas and surface temperature rises are very modest and far below the acceptable surface temperature limits suggested in the water quality standards and are confined to a very small area with minimal environmental impact.

5.1.1.3 Combined Effects of Units 1 and 2

a) Unit No. 1 Thermal Effects

i) Introduction

The cooling water discharge system for St. Lucie Unit No. 1 consists of a 12 ft diameter pipe about 1500 ft long running easterly from the discharge canal outfall structure to the transition section of a two port Y nozzle. The pipe will be buried under the sand dunes and beach and beneath the ocean bottom. Each port of the Y discharge nozzle will be 7-1/2 ft in diameter and is designed for an average flow of 575 cfs and a discharge velocity of about 13 fps. Ocean depth at the discharge point is -18 ft (MLW). A short sloping trench will be excavated to -36 ft with plans to line it with tremie concrete, sheet pilings and riprap to prevent scour from the jet discharge. The centerline of the discharge ports will be 30 ft below the water surface. The design is a high momentum type jet which produces a relatively high degree of entrainment of ambient water, thus enhancing the diluting characteristics of the outfall.

Thermal analysis of the heated water discharge from this Y discharge nozzle is presented by Florida Power and Light Company in several reports(31,32,33). A review of this analysis is presented in the Final Environmental Statement for St. Lucie Unit No. 1 by the Atomic Energy Commission(34).

The discharge plume from the Y discharge nozzle will extend in an easterly direction generally perpendicular to the shoreline due to its high outlet velocity which imparts a large inertial force on the water mass. Models of the plume indicate that it will result in a maximum surface temperature rise of about 5 to 5.5 F.

A very conservative estimate based on Pritchard's technique(35) shows that the 3 F isotherm should cover about 35 acres, the 1.5 F isotherm about 565 acres and the 1 F isotherm about 2860 acres. In the Final Environmental Statement for St. Lucie Unit No. 1, it is concluded that these temperatures are expected to have only minimal effect on marine life and will result in minimum environmental impact. This Y discharge nozzle does not lend itself to a very exacting hydrothermal analysis with available state of the art plume models. Surface and bottom effects complicate the hydrothermal patterns, circulation and entrainment. As a result, computation of the isotherms and their respective areas must be made on a "best estimate" and/or "maximum case" basis(34).

The surface isotherms for Unit No. 1 discussed so far are based on Pritchard's technique which produces highly conservative estimates of the areas. This is due to the fact that vertical and lateral mixing and subsequent dilution are not treated in Pritchard's model.

ii) Thermal-Hydraulic Model Studies for Unit No. 1

As an outcome of these considerations, Florida Power and Light Company sponsored a detailed physical undistorted hydrothermal model analysis of the outfall structure at the Coastal and Oceanographic Engineering Department of the University of Florida. A detailed two year analysis(33) showed that the maximum surface temperature rise is about 5.5 F and the isotherm areas are much smaller than those predicted by Pritchard's techniques. Normally the results of any undistorted model study (such as the present model) indicate that they simulate correctly the areal extent of the temperature field and interaction with currents, but are always somewhat conservative in dilution prediction(20).

In the final environmental impact statements for Nine Mile Point(36) and James Fitzpatrick Nuclear Power Plant(37), it is stated that thermal hydraulic modeling is particularly suitable for studying jet behavior and for thermal prediction in the region close to the diffuser. The Applicant also believes that it is the best state of the art tool available to simulate mixing and entrainment as a function of the complicated diffuser structure, local topography and ocean currents. In some cases(36,37), certain correction

factors (due to turbulence, shear produced by the velocity distribution, ambient current, etc.) are applied to make the model results more consistent or compatible with expected prototype behavior. At St. Lucie these correction factors and the actual depth of jet discharge would bring down the predicted surface rise from 5.5 F to about 5 F or even less. In other words, maximum predicted surface temperature rise from the Y nozzle would never exceed 5.5 F. However, in the present case, a surface temperature rise of 5.5 F is used for all the calculations because of the conservatism provided by such an assumption.

Model studies for St. Lucie Unit No. 1 have shown that the interference between the two jets of the Y nozzle is minimal and that the flow could be treated as two separate jets. Assuming that the jets are issuing from two separate sources, a near field jet analysis was carried out using Koh and Fan's mathematical model(13). The temperature plume predicted for one of the jets is given in Figure 5.1-7. In this figure, the vertical scale has been exaggerated for clarity. This mathematical model also predicts the surface temperature rise of 5.5 F just as the physical model did. After the plume reaches the surface it spreads out and the predicted surface temperature rise and the isotherms are primarily dependent on the ocean currents near the outfall. The physical model predicts that the jet centerline when it surfaces is at a distance of about 175 ft from the jet mouth, as predicted by the mathematical models, and has a width of about 75 ft. The depth of influence of the thermal plume is not expected to be more than 6 ft except in the immediate vicinity of the discharge. Model studies show that within a distance of about 175 ft of the discharge, the thermal plume will extend to near the ocean bottom. Isotherms as predicted by Pritchard's technique(35) have been compared in Table 5.1-4 with those predicted by the physical model analysis. This demonstrates that Pritchard's technique will produce highly conservative estimates for isotherm areas. Figures 5.1-8 through 5.1-10 show the isotherm patterns as predicted by Pritchard's technique.

Because of excessive conservatism in Pritchard's technique another hydrothermal analysis using Brooks(27), Ditmars'(22) and Tsai's(28) method was carried out. This method of analysis has been previously explained in Section 5.1.1.2. It is realized that the above methods which are designed for a heated line source in an ambient current are applicable here only under judicious assumptions concerning plume geometry between the submerged jet and the established surface plume. A thermal analysis was carried out assuming conservatively a line source of 500 ft at 5.5 F above ambient temperature. The predicted isotherm areas are shown on Table 5.1-4 along with similar areas predicted by Pritchard's technique and the physical model analysis. These hydrothermal analyses demonstrate that Pritchard's technique does produce conservative estimates for both higher and lower temperature isotherm areas. However, for the present two unit interaction analysis, it was decided to use Pritchard's technique for the thermal analysis of Unit No. 1 in order to establish the results on a "maximum case" basis.

b) Unit No. 2 Thermal Effects

The Unit No. 2 discharge system consists of a multiport diffuser 12 ft in diameter about 3110 ft long. The last 1060 feet of this discharge pipe is fitted with 48 ports, each 1-1/2 feet in diameter discharging alternately in the north and south directions. The average flow through all the ports will be 1150 cfs at an average discharge velocity of about 13 fps. The ocean depth in this case varies from about 35 ft (MLW) at the first port to about 40 ft (MLW) at the last port.

The near field temperature analysis of the multiport diffuser is based on the mathematical model of Koh and Fan⁽¹³⁾ as explained in Section 5.1.1.1. The predicted plume for one representative jet is shown in Figure 5.1-2. The predicted maximum surface temperature rise will be about 1.5 F, and the average temperature rise will be even less. Each plume when it reaches the surface will be at a distance of about 80 ft from the manifold and will have a width of about 30-35 ft. The thickness of the flowaway zone will be about 5 ft. After the jet reaches the surface it starts spreading. The surface spreading and the far field surface isotherms for three ocean current conditions are given here. The areas of the isotherms of 1 F and 0.5 F are shown in Table 5.1-3.

For the evaluation of the isotherms and the areas, results of Brooks⁽²⁷⁾ and Ditmars⁽²²⁾ have been adopted. Tsai⁽²⁸⁾ has used the same method to evaluate the far field effect from the submerged multiport diffuser of James Fitzpatrick Nuclear Power Plant discharging into Lake Ontario. Baumgartner and others⁽¹⁷⁾ have also used Brooks' method to analyze the two submerged multiport ocean outfalls in the State of Oregon.

The predicted isotherms for St. Lucie Unit No. 2 are shown in Figure 5.1-4 for southerly current, in Figure 5.1-5 for northerly current and in Figure 5.1-6 for slack water conditions.

c) Interference of Thermal Discharges from Units 1 and 2 - Near Field Effects

i - Introduction

The separation distance between the two discharge systems (Y discharge nozzle of Unit No. 1 and the first jet of the multiport diffuser of Unit No. 2) is about 500 ft and the analysis shows that this distance is sufficiently large not to have any adverse interference or interaction effects between the effluents of Units 1 and 2.

An examination of the isotherms from Unit No. 1 and the location of the multiport diffuser of Unit No. 2 indicates that under slack water conditions the Unit No. 2 diffuser is in an area of approximately 2 to 3 F (surface temperature rise) generated by Unit No. 1 discharge. Thermal-hydraulic (physical) Model studies⁽³³⁾ of Unit No. 1 indicate that the surface flowaway velocity in these regions where the Unit No. 2 diffuser is located is on the order of 0.2 fps or less.

The diffusion slab thickness created by the Unit No. 1 Y discharge nozzle is about 6 feet or less. Figure 5.1-11 shows the condition schematically in an ideal case.

The Unit No. 2 discharge, by the time it reaches the diffusion slab of Unit No. 1, will have enough kinetic energy left for it to enter or "break through" the diffusion slab generated by Unit No. 1. A discussion of the energy dissipation characteristics of the jets and a method to estimate the energy is presented in the following section.

ii) Energy Dissipation Characteristics and Its Relation to Near Field Interference

The flow of all real fluids involves an energy loss due to viscous resistance of the fluid. The term "energy decay" adopted in this discussion is used to describe the eventual changing to heat of the energy producing flow of the jet. The rate at which the energy is dissipated in viscous flows can be predicted from a knowledge of the flow pattern and the characteristics of the fluid. However, this is not the case in turbulent flows where the characteristics depend on the flow rather than the fluid.

Specifically in the case of jets, the difference in the velocity between the jet and the region into which it is delivered creates a high degree of instability. The kinetic energy of the oncoming jet flow is steadily being converted into the kinetic energy of turbulence which is dissipated through shear. This energy conversion takes place throughout the jet region. The approximate method which indicates the rate at which the energy of the jet is transferred from the mean flow to the turbulence is shown below.

The appropriate Reynolds equation in a jet with zero pressure gradient is:

$$\bar{U} \frac{\partial \bar{U}}{\partial X'} + \bar{V} \frac{\partial \bar{U}}{\partial Y'} = \frac{1}{\rho_T} \frac{\partial \tau}{\partial Y'}$$

where:

$$\tau = -\rho_T \overline{u'v'} = \eta \frac{d\bar{U}}{dY'}$$

(Here the laminar, molecular shear is neglected since it is much smaller in magnitude.)

Where $\bar{U}$ is the mean velocity in the direction of the jet (i.e. X'). For the present discussion, direction of the jet is X' and the normal direction is Y' .

Where:

$\bar{U}, \bar{V}$ = mean velocities along and across the axis X' and Y' , respectively

ρ_T = density of the jet at that temperature

τ = turbulence shear stress

u', v' = turbulence components

η = eddy viscosity

It is interesting to see the independent integral relation which is obtained by multiplying the above equation by $\bar{U}$ and then integrating it. Then the equation becomes:

$$\rho_T \int_0^\infty \left[\bar{U}^2 \frac{\partial \bar{U}}{\partial X'} - \bar{U} \frac{\partial \bar{U}}{\partial Y'} \int_0^{Y'} \frac{\partial \bar{U}}{\partial X'} dY' \right] dY' = \int_0^\infty \bar{U} \frac{\partial^2 \bar{U}}{\partial Y'^2} dY' \quad | \quad 1$$

This can be written as:

$$\rho_T \int_0^\infty \left[\bar{U}^2 \frac{\partial \bar{U}}{\partial X'} - \bar{U} \frac{\partial \bar{U}}{\partial Y'} \left(\int_0^{Y'} \frac{\partial \bar{U}}{\partial X'} dY' \right) - \bar{\bar{U}} \frac{\partial \bar{U}}{\partial X'} \right] dY' = \eta \int_0^\infty \bar{U} \frac{\partial^2 \bar{U}}{\partial Y'^2} dY' \quad | \quad 1$$

Where $\bar{\bar{U}}$ is some characteristic velocity. It may be observed that this is the same as Wieghardt's⁽³⁸⁾ energy-integral equation for laminar boundary layers. The final solution can be put in the form:

$$- \frac{d}{dX'} \int_0^\infty \left[\frac{1}{2} \rho_T (\bar{U})^3 Y' \right] dY' = \int_0^\infty \tau \frac{d\bar{U}}{dY'} Y' dY' \quad | \quad 1$$

In a jet, the left hand side of this equation represents the X' rate of increase in the rate of flow of mean kinetic energy. The right hand side is the total rate at which the turbulent shear stress does work on the mean motion over a transverse section. Thus, it is the rate at which the mean flow kinetic energy is transformed to turbulent kinetic energy which is a "dissipated" form of energy. The above equation is valid for both laminar and turbulent flows. For laminar flows, this equation equates the rate of decrease of mean flow kinetic energy per unit volume to the rate of production of heat. For turbulent flows, it equates the rate of decrease of mean flow kinetic energy per unit volume to the rate of production of turbulent kinetic energy. This shows that as the jet

flow travels to increasing distances, the mean velocities generate the time mean values of the shear stresses; these time mean shear stresses generate the turbulent motion which has a decaying character owing to viscous dissipation. In short, the above equation shows the rate at which the energy is transferred from the mean flow to the turbulence and this energy can be computed as follows:

Consider a particle in the jet stream. If its average velocity is $\bar{U}$, then the elemental energy, ΔE_s at any Section S is

$$\Delta E_s = \frac{1}{2} \rho_T \bar{U} dA \left[\bar{U}^2 + \bar{u}'^2 + \bar{v}'^2 + \bar{w}'^2 \right]$$

where dA = Volume of any elemental area.

Total energy across that Section, E_s , is given by

$$E_s = \int_0^A \frac{1}{2} \rho_T \bar{U} dA \left[\bar{U}^2 + \bar{u}'^2 + \bar{v}'^2 + \bar{w}'^2 \right] \text{ ft-lbs/sec}$$

At any Section the total energy can be computed using the above idealized equation⁽³⁹⁾. The energy decreases monotonically with increasing distance (because of turbulent shear and dilution) from the jet mouth and this can be approximately expressed as shown on Figure 5.1-12.

The net effect of a jet of higher energy (and lower temperature) forcing its way into the diffusion slab of Unit No. 1 (of higher temperature) is to mechanically mix and bring down the original temperature rise of the surface. However, as a conservative estimate, it could be assumed that the original temperature of the diffusion slab generated by Unit No. 1 would still prevail.

An evaluation of Unit No. 2 plume surface water temperature when it breaks through the Unit No. 1 diffusion slab is made as follows:

Figure 5.1-13 shows a schematic diagram applicable for the mathematical model employed here.

The following nomenclature is used for this analysis:

Q_o = Volume discharge rate from one jet of Unit No. 2 diffuser

ΔT_o = Excess temperature of Unit No. 2 discharge

Q_A = Volumetric entrainment rate of subsurface water

ΔT_A = Excess temperature of subsurface water

Q_N = Volumetric entrainment rate of Unit No. 1 diffusion slab

ΔT_N = Excess temperature of Unit No. 1 diffusion slab (2 F, 3 F)

Q_s = Volumetric flow rate of Unit No. 2 effluent at ocean surface

ΔT_s = Computed excess temperature of Unit No. 2 effluent at ocean surface

S_A = Dilution factor up to bottom of diffusion slab of Unit No. 1

S_s = Dilution factor up to ocean surface

Then the following four equations of thermal energy balance are written in terms of dilutions and flows.

$$Q_o(\Delta T_o) + Q_A(\Delta T_A) + Q_N(\Delta T_N) = Q_s(\Delta T_s)$$

$$Q_A = Q_o (S_A - 1)$$

$$Q_N = Q_o (S_s - S_A)$$

$$Q_s = Q_o S_s$$

Upon simplifying and solving the above equations, the excess temperature of St. Lucie Unit No. 2 effluent at the ocean surface is computed as

$$\Delta T_s = \frac{T_o}{S_s} + \frac{(S_A - 1)}{S_s} \Delta T_A + \frac{(S_s - S_A)}{S_s} \Delta T_N$$

In the present case, knowing the thermal plume characteristics of Unit No. 1 above the diffuser of Unit No. 2 and other quantities, ΔT_s , the excess temperature at the ocean surface resulting from the Unit No. 2 diffuser is computed.

As an example, the above equation is solved here for slack water conditions as it is the conservative case. Furthermore, previously known information about the Unit No. 1 plume is used. This analysis shows the resulting ΔT_s would be 2 F which is lower than the surface water temperature of Unit No. 1 operating alone. This shows that the effect of "break through phenomenon" is to bring down the original temperature to a lower value. In addition, in the above formulation

variation in current direction, shear produced by velocity distribution, wind and wave effects, etc., have not been considered. With these factors, the surface temperature after interference would still be lower.

In case of a southerly or a northerly current the diffuser from Unit No. 2 still continues to discharge in an isotherm area from Unit No. 1 of approximately 2 F. Thus, the two discharges will have a definite interference. However, by a discussion similar to the one presented above for slack water conditions, the effect of interference would be to reduce the effective near field surface temperature rises of Unit No. 1 operating alone.

The analysis presented above shows that the effects of interference would tend to reduce the near field surface temperature rises resulting from the discharges of Unit No. 1. More specifically, interference would result in a reduction in the surface areas affected by the 5F, 4F, 3F and 2F isotherms of temperature rise. Correspondingly, interference would increase the surface areas affected by the 1.5 F and 1.0 F isotherms of temperature use. The far field analysis, which is presented in the following section, shows the extents to which the 1.5 F and 1.0 F isotherms of temperature rise are increased as a result of interference. For purposes of far field analysis of the combined effects of Units 1 and 2, the isotherms of temperature rise of 2 F, 3 F, 4 F and 5 F, as produced by Unit 1 alone, are presented. This is felt to represent a conservative presentation with respect to these temperature rises because interference would act to reduce the Unit No. 1 effect.

d) Far Field Effects of Interference

It has been shown above that the tendency of interference would be to bring down the surface temperature rise near the diffuser. The effect of this reduction in temperature would be to bring down the surface area of the isotherms of 5 F, 4 F, 3 F and possibly 2 F. At the same time, at far field distances, the condition might be reversed. That is, because of the increase in the thickness of the diffusion slab, the rate of heat dissipated to the atmosphere might be decreased. This has a tendency to increase the isotherm areas of lower temperatures such as 1.5 F and 1 F. But, an exact analysis to determine the extent of these isotherms of lower temperatures presents insurmountable difficulties, and presently there are no available methods to determine such areas. This difficulty is overcome by a "linear superposition" technique; even though

this technique is a violation of strict physical and mathematical principles as they are non-linear systems. The linear superposition technique is inherently conservative and was, therefore, adopted for this analysis. The basic assumption made in this linear superposition technique is that when Unit No. 1 is operating alone, area A_1 is covered by a particular isotherm of temperature rise T_1 , and when Unit No. 2 is operating alone, area A_2 is covered by the same particular isotherm of temperature T_1 , then when both discharges interfere the area covered by the isotherm T_1 would be $A_1 + A_2$. But the conservatism inherent in this technique has to be recognized.

In order to calculate the effective isotherm areas after interference, methods suggested by Brooks(27), Ditmars(22) and Tsai(28) (as explained in Section 5.1.1.2) were applied to Unit No. 2, and Pritchard's technique(35) was applied to Unit No. 1. These two areas were then superimposed. The areas obtained for different isotherms are shown in Table 5.1.5. Figures 5.1-14 through 5.1-16 show the predicted superimposed isotherm patterns. Table 5.1-5 also shows the total superimposed area based on Brooks' method applied to both Unit No. 1 and Unit No. 2.

5.1.1.4 Estimation of Recirculation

a) Introduction

The intake for both units at St. Lucie will be located 1200 feet offshore and about 2400 feet south of the discharge structures. As shown in Figure 5.1-17, the top of the intake will be situated approximately 8 feet below the water surface at mean low water. A vertical section to prevent sanding and a velocity cap to minimize fish entrapment will be constructed for each pipe. Horizontal intake velocities will approach 1 fps.

The discharge systems are explained in Section 3.4 and in the Environmental Report for St. Lucie Unit No. 1(31). The Y discharge nozzle of Unit No. 1 is located at a distance of 1250 feet from the shore line. The first jet of the multiport diffuser serving Unit No. 2 is at a distance of 1750 feet and the last jet is at a distance of 2810 feet both measured from the shore line.

Recirculation between discharge and intake at St. Lucie is mainly a function of the currents and the effective surface dilution at the ocean intake structure. With northerly currents and during slack current conditions no recirculation is expected. Some recirculation might occur under a southerly current and the degree of expected recirculation is evaluated here with both units in operation and with only Unit No. 2 operating.

b) Estimated Recirculation Under Unit No. 2 Operation

Section 5.1.1.2 explains the surfacing of the thermal effluent and the far field temperature distribution for the multiport diffuser. It is seen from that analysis that the surface temperature rise that could be expected near the intake point would be on the order of 0.5 F or less.

The reasons for such low temperatures are (i) employment of a multiport diffuser for rapid dilution with bottom waters (ii) north-south separation distance of 2400 feet and (iii) east-west separation of 500 feet between the intake and the first jet and 1610 feet between intake and the last jet of the multiport diffuser.

In addition to low surface water temperature rise in the vicinity of the intake, the design of the intake itself contributes to the low temperature of the water drawn into the plant. Figure 5.1-17 shows the details of the ocean intake structure. Water is drawn radially into the two intake pipes. Each pipe is provided with a velocity cap having a minimum water cover of 8 feet. Since the surface temperature rise predicted in this region is about 0.5 F or less and assuming conservatively that the diffusion slab thickness is about 6 feet, the water withdrawn at the intake as a result of mixing with bottom colder waters would be less than 0.5 F. Assuming no selective withdrawal of bottom waters, average temperature rise of water withdrawn at the intake as a result of recirculation would be about 0.2 to 0.3 F. Selective withdrawal of bottom waters would act to further reduce this temperature rise.

c) Estimated Recirculation Under Unit No. 1 Operation

Far field dilution estimation and the resulting temperatures when Unit No. 1 alone is in operation have been mentioned in Section 5.1.1.3. It is seen from that analysis, that a surface temperature rise of about 1 F could be expected above the intake point and that the diffusion slab thickness would be on the order of 6 feet.

Detailed field dye studies⁽⁴⁰⁾ conducted at the site in 1970 by the Coastal and Oceanographic Engineering Department of the University of Florida showed that for the Unit No. 1 heat load and under a southerly current, the surface temperature rise in the vicinity of the intake would be less than 1.0 F. Dye was released 1000 feet seaward, near the surface, at a location where the depth is approximately 20 feet. That is, the dye release point had approximately the same characteristics as those of the 'Y' discharge nozzle.

These two analyses show that a conservative estimate would be to assume a surface temperature rise of about 1 F at the intake point. Assuming no selective withdrawal of bottom waters, the average temperature rise of water drawn into the intake pipe, as a result of recirculation, would be less than 0.5 F.

d) Estimated Recirculation With Both Units in Operation

Exact estimation of the surface temperature rise and diffusion slab thickness at the intake point under two unit operation is extremely complicated, since the systems that are being dealt with do not lend themselves to exact physical or mathematical analysis. Consequently, a conservative estimate based on the "Principle of Superposition" is presented here.

It is mentioned above that surface temperature rises of 1 F or less from Unit No. 1 and about 0.5 F or less from Unit No. 2 could be expected at the intake point. Since waters with higher temperature differences are more buoyant compared to waters with lower temperature differences, the discharge from Unit No. 1, when there is interference, lies over the discharge from Unit No. 2. The net effect of this interference would be to initiate some more mixing and to bring down the net effective temperature rise from 1 F. As regards the diffusion slab, its thickness would increase because of interference. The total thickness is estimated to be on the order of 10 feet.

The intake draws water radially from about -8 feet to -16 feet with respect to mean low water. This means in effect, about half of the total amount of water that is being drawn would be from the diffusion slab and the rest of the water would be from the lower cooler layers.

An approximate analysis of the withdrawal of the waters from these two layers can be made as follows:

Craya⁽⁴¹⁾ investigated the case of selective withdrawal from a two-layered (stratified) system. The result of the analysis is that the critical Froude number, above which both layers flow and below which only one layer flows, is equal to 2.55 for a small circular opening. The equation for the critical Froude number reads as follows:

$$F_c = \frac{Q_c}{\sqrt{\frac{g \Delta \rho h^5}{\rho}}} = 2.55$$

Where:

F_c = critical Froude number

Q_c = critical intake flow through the orifice

h = half-width of the withdrawal layer

ρ = density

g = gravitational constant

Gariel⁽⁴²⁾ performed experiments and substantiated the analytical findings of Craya.

The intake flows at St. Lucie of 1150 cfs per unit result in a densimetric Froude number higher (about 4.8) than the criterion stipulated in the above equation and, hence, it can be predicted that water will be withdrawn from both layers. After this water is withdrawn, water from the diffusion slab with about 0.5 F to 1 F above the ambient temperature, and the water from the lower cooler layer would thoroughly mix before entering the plant. This mixing in effect would bring down the water temperature and a simple mass balance would indicate that the resulting temperature rise after mixing would be lower than 1 F and would be on the order of 0.5 F.

An evaluation of the degree of expected recirculation shows that the quantity of condenser cooling water recirculated to the subaqueous intake would be very small considering: (i) the depth at which the water is being withdrawn, (ii) the separation distance between the discharge ports and the intake and (iii) effective surface temperature rises from Units 1 and 2 above the intake point. A conservative estimate shows that when Unit No. 2 alone is in operation, the recirculation would be on the order of 0.2 F to 0.3 F and when both are in operation the recirculation would be on the order of 0.5 F. Therefore, recirculation should not pose significant problems.

5.1.1.5 Effect of Unit No. 1 Shutdown

a) Introduction

When Unit No. 1 is shut down, the discharge from Unit No. 2 will be split between Units 1 and 2 discharge structures. Under normal operating conditions (i.e., when four pumps of Unit No. 2 are in operation), the hydraulics of the plant system indicate that the total discharge will be about 1226 cfs and about half of this would flow through the 'Y' discharge nozzle at a velocity of about 6.9 fps and the remainder would flow through the multiport diffuser at an average velocity of about 7.3 fps. An analysis conducted, shows that the maximum resulting surface temperature rise would be about 7.4 F in the vicinity of the 'Y' discharge nozzle and about 2 F in the neighborhood of the multiport diffuser. These temperatures have been predicted using Koh and Fan's mathematical model and have been counterchecked by other approaches mentioned in Section 5.1.1.1. The thermal-hydraulic model study performed at the University of Florida predicts hydraulic isolation of the two jets of the 'Y' discharge nozzle and this permits the application of the mathematical model. In addition, the parametric study conducted at the University of Florida also predicts the surface temperature rise of about 7.4 F for the 'Y' discharge nozzle.

b) Alternative Schemes to Reduce Surface Temperature Rise

Florida Power and Light Company is considering several alternative schemes to reduce the resulting surface temperature rise thereby minimizing the heating of the ocean waters and thus, eliminating possible detrimental environmental effects. Alternative schemes such as:

- (i) flow dilution scheme
- (ii) flow diversion scheme

are given here in detail.

The flow dilution scheme refers to the arrangement when Unit No. 2 is operating with a 24 F temperature rise across the condenser and the Unit No. 1 heat load has been reduced to zero. The flow diversion scheme refers to the arrangement when the complete discharge from Unit No. 2 will be diverted through the multiport diffuser system.

c) Thermal Predictions - Flow Dilution Scheme

The St. Lucie Nuclear Power Plant has a total of eight circulating water pumps, four pumps for each unit. The quantity of cooling water discharged into the ocean depends upon the number of pumps in operation. In the flow dilution scheme the Unit No. 1 circulating water flow with no heat load will be used to dilute the Unit No. 2 circulating water flow with a 24 F condenser rise. The discharge plume surface temperature will vary depending on the distribution of flow between Units 1 and 2 discharge lines, the total discharge flow and the resulting temperature at the jet mouth after flow dilution. The flow for various combinations and numbers of operating circulating water pumps is shown in Table 5.1-6.

In all the calculations maximum summer ambient temperature conditions were used because the temperature rises would result in higher density changes and correspondingly minimum dilution resulting in higher surface temperatures. This provides a degree of conservatism in the final temperature predictions. Additional conservatism was obtained by assuming a slack water condition so that there will be no ambient turbulence to increase mixing.

Test cases 1 and 2 refer to the plant operating mode explained in the introduction above. In these cases, of the total of eight pumps, only four pumps of Unit No. 2 are in operation. The incoming circulating water flow is divided between the 'Y' discharge nozzle and the multiport diffuser. The predicted plume behavior is shown in Figure 5.1-18 and 5.1-19. In all the figures, vertical scale has been exaggerated to clarify the presentation. The corresponding maximum surface temperature rises are 7.4 F and 2 F.

Test cases 3 through 8 refer to the condition when only Unit No. 2 is operating but two or four of Unit No. 1 pumps are operating. This results in a discharge temperature of less than 24 F (18 F for cases 3 and 4 and 12 F for cases 5 through 8). For these cases, the cooling water flow from the non-operating unit (Unit No. 1) will dilute the heated discharge from Unit No. 2 resulting in temperature rises at the ocean discharge of from 12 F to 18 F. The resulting surface temperature rises for these cases vary from 2.1 F to 4.2 F for the flow exiting from the 'Y' discharge nozzle and from about 0.5 F to 1.1 F for the flow exiting from the multiport diffuser. However, it is worthwhile to note that the surface temperature rises of 2.1 F to 4.2 F in the vicinity of the 'Y' discharge nozzle are significantly below 5.5 F when no dilution is available. Similarly, the surface temperature rise of 0.5 F to 1 F that has been predicted for the multiport diffuser is considerably less than the resulting surface temperature rise without the availability of dilution water from Unit No. 1. Predicted plume behavior for 'Y' discharge nozzle for test cases 3, 5 and 7 is shown in Figures 5.1-20, 22 and 24. Figures 21, 23 and 25 show the predicted plume behavior for the multiport diffuser for test cases 4, 6 and 8.

d) Normal Mode of Operation

Test cases 9 and 10 refer to the condition when all eight pumps of Units 1 and 2 are in operation with a 24 F temperature rise across the condenser. This refers to the normal mode of operation. The thermal plume prediction for Unit No. 1 and the related environmental impact has been discussed in several reports and will not be duplicated here. (31,32,33) In the Final Environmental Statement for St. Lucie Unit No. 1⁽³⁴⁾, it is concluded that these temperatures are expected to have only minimal effect on marine life and will result in minimum environmental impact. The environmental impact of thermal discharges from Unit No. 2 is discussed in subsequent sections of this report. Surfacing of the jets and far field distribution of the diluted discharge is given in Section 5.1.1.2. Interaction between the effluents of Units 1 and 2 is given in Section 5.1.1.3. The degree of expected recirculation between discharge and intake has been evaluated and is included in Section 5.1.1.4.

e) Thermal Predictions - Flow Diversion Scheme

The 12 ft. diameter discharge line serving Unit No. 1 has a provision to install a sluice gate. When Unit No. 1 is shut down, the sluice gate could be used to divert the incoming condenser cooling water flow from Unit No. 2 into the multiport diffuser system. The details of the flow, velocity and predicted maximum surface temperature rise are shown in Table 5.1-6 as case 11. The maximum surface temperature rise of the jet when it surfaces will be about 1.5 F and the average temperature rise across the length of diffuser would be much less. The eventual surfacing of the thermal effluent from the multiport diffuser and the far field distribution of the diluted discharge, under a range of ocean current conditions are presented in Section 5.1.1.2. The degree of expected recirculation when Unit No. 2 alone is operating has been found to be negligible (see Section 5.1.1.4).

f) Flow Dilution Scheme and Florida Water Quality Standards

A close look at test cases 3 through 8 shows that when Unit No. 2 is operating with a condenser rise of 24 F, mixed with Unit No. 1 circulating water with zero condenser rise, the resulting maximum predicted surface temperature rise in the vicinity of the 'Y' nozzle is about 2.1 F to 4.2 F and in the vicinity of the multiport diffuser would be about 0.5 F to 1.1 F. It is clearly seen that these temperatures are considerably lower than the resulting temperature under a mode of operation without the availability of dilution water (7.4 F for 'Y' nozzle discharge and 2 F for multiport diffuser discharge) or the normal mode of operation (5.5 F for 'Y' nozzle discharge and 1.5 F for the multiport diffuser). In the Final Environmental Statement for St. Lucie Unit No. 1, the Atomic Energy Commission has evaluated the environmental impact resulting from the surface temperature rise of 5.5 F in the vicinity of 'Y' nozzle and it is concluded that the impact would be minimal and that applicable water quality standards are met.

Subsequent sections of this report discuss the environmental impact resulting from a surface temperature rise of about 1.5 F in the vicinity of the multiport diffuser. It is concluded that the resulting impact on ecological balance would again be minimal. Thus, it is concluded that the thermal impact resulting from Unit No. 2 operating along using the flow dilution scheme would be smaller than the normal two unit operational impact and also would be considerably smaller than the thermal impact resulting from operating without the availability of dilution water. In this case, the surface water quality standards applicable to St. Lucie Unit No. 2 will be met.

g) Flow Diversion Scheme and Florida Water Quality Standards

Test case 11 shows that when Unit No. 2 is operating alone and if all the incoming condenser cooling water discharge flow is diverted through the multiport diffuser the resulting maximum surface water temperature rise would be on the order of 1.5 F. Subsequent sections of this report discuss the environmental impact resulting from these thermal discharges and it is concluded that the impact is minimal. The far field effects and recirculation are discussed in Sections 5.1.1.2 and 5.1.1.4. In this case also, all the surface water quality standards applicable to St. Lucie Unit No. 2 will be met.

5.1.2 EFFECTS OF THERMAL DISCHARGE ON AQUATIC LIFE

Phytoplankton form the base of the food chain and their condition is therefore fundamentally important to the development of the community in any marine ecosystem. Because of the rapid dilution of condenser cooling water, planktonic organisms in the Atlantic Ocean are not likely to be adversely affected by the discharge of cooling water from St. Lucie Unit No. 2.

Comparison of the data for temperature, salinity, and nutrients with the abundance of benthic organisms show no relationship. Substrate type, rather than other factors, appears to be the significant factor affecting the benthic environment. Because the diffuser ports are located several feet above the ocean floor (refer to Section 5.1.1.1), the heated discharge will affect very little of the ocean floor and the benthic community will not be adversely affected by the operation of St. Lucie Unit No. 2.

Very few fish have been collected at the five offshore Hutchinson Island sampling stations. From September 1971 to March 1972, a total of 39 fish were obtained (see Table 2.7-16). During the same period, nearly 12,000 small forage fish (see Section 2.7.5.9) were captured by seining in the surf zone. However, these small fish which occur near shore are not expected to experience any increase in water temperature from the operation of St. Lucie Unit No. 2 (see Section 5.1.1). In the immediate area of the diffuser section, the heated areas are so small that a fish which has moved into one of the zones can easily escape it by swimming less than two feet into cooler water. The velocity of the water in the heated zones will exceed 10 fps, and this current is strong enough to carry most fish away from the warmer portion of the discharge plume into much cooler areas.

The water column above the diffuser section will show small temperature increases in the surface layer. From the ocean surface, to a depth of about 12 feet, water temperatures will be less than 2 F over ambient and will not exceed 89 F. Beneath this 12 foot depth, the discharge from the diffuser section will form small separate cones of warm water. Each discharge port has a diameter of 1.5 feet. At 20 feet above the diffuser section, the diameter of the cone of heated water at 1 F or greater above ambient will be less than 20 feet (See Figure 3.4-5). (See Section 3.4 for a complete description of the heat dissipation system). Because the ports are located on alternate sides of the diffuser section, 22.5 feet apart on centerline, the discharge from each port will be separated by volumes of water at ambient temperature. It is therefore possible for fish to swim 20 feet or less above the diffuser section without encountering elevated water temperatures.

Bluefish and Spanish mackerel appear to migrate near the shore and thus may enter the discharge plume during their migration. Since the maximum temperature increase in the upper 12 feet of water will be less than 2 F, and daily 2 F changes in the Atlantic Ocean temperatures have been measured at Hutchinson Island, the thermal plume is believed to pose no

barrier to migrating fish. While the stimuli which induce migration in bluefish and Spanish mackerel are not known, but may include temperature, it is possible that fish inhabiting the area of the discharge might begin their northward migration earlier than bluefish and Spanish mackerel resident in water unaffected by the St. Lucie plume. Conversely, the same fishes might, upon entering the plume during their southern migration, remain in the area for longer than usual periods of time. Since the responses of bluefish and Spanish mackerel to small temperature changes are poorly known, and because factors such as light intensity may also influence migration behavior, the hypothesis suggested above is, at best, conjectural.

Thermal stress is a time-temperature function with greater stress produced the longer an organism is exposed to elevated temperatures. The expected time of exposure in these zones will not exceed a few seconds, so the possibility of aquatic life experiencing thermal stress is virtually nonexistent. The warmer zones of the discharge plume are so small that if an emergency shut-down were to occur, the ecology of the receiving water body would not be affected because little or no aquatic life would be present within those areas.

Plant operation is expected to produce no significant effects on fish migration or spawning. In general, fish are able to detect small thermal gradients in both the horizontal and the vertical direction, and will select the most favorable thermal situation. Thermal effects on fish survival are expected to be inconsequential.

Few data are available on the thermal tolerances of the sea turtle with respect to changes in behavioral responses during mating, nest site selection, and hatchling migration. Green turtles mate within one mile of shore, which potentially places them in a thermal plume zone during their mating period.

Turtle hatchlings are known to respond to increased temperatures by slowing their activity, which prevents them from digging out of their sandnests during the hot daylight hours when they would be vulnerable to dessication and predation by birds. It is possible that this response continues for a time after the young turtles emerge from their nests and travel to the water, where the temperature could affect the extent of their swimming activity. If encountering the thermal plume causes them to cease swimming, they would perhaps be more susceptible predation. However, this postulated response to changes in water temperatures has not been observed. The maximum surface temperature increases resulting from the operation of Unit No. 2 will be less than 2 F. It is expected that the behavior of young sea turtles will be unaffected.

5.1.3 ENTRAINMENT OF AQUATIC ORGANISMS

Planktonic organisms of various types will be entrained in the circulating water and passed through the condensers. From information presented in Section 2.7 of this report, estimates have been made of the numbers of organisms entrained in the cooling water required by St. Lucie Unit No. 2.

The maximum circulating water flow required by St. Lucie Unit No. 2 will be 1150 cfs or $2.81 \times 10^6 \text{ m}^3/\text{day}$. The average number of phytoplankton collected at Station I (the sampling area nearest the intake) has been calculated as $2.82 \times 10^5 \text{ cells/m}^3$. Thus the number of phytoplankton passed through St. Lucie Unit No. 2 condensers is approximately $7.92 \times 10^{11} \text{ cells/day}$. If the highest number of phytoplankton organisms collected at Station I ($1.09 \times 10^6 \text{ cells/m}^3$) is substituted in the above formula, the number of phytoplankton entrained in the circulating water flow is found to be $3.06 \times 10^{12} \text{ cells/day}$.

The weight of entrained phytoplankton may be approximated with the following assumptions and equation.

- a. The carbon content of phytoplankton is taken as $2 \times 10^{-10} \text{ gC/dry cell}^{(43)}$,
- b. cellular dry weight = $2.2 \times \text{particulate organic carbon}^{(43)}$,
- c. cellular wet weight = $10 \times \text{cellular dry weight}^{(44)}$.

If the values given above are substituted in the following equation,

$$W = P \times C \times D \times R$$

where,

W is phytoplankton wet weight in g/day,

P is number of phytoplankton cells entrained/day,

C is the carbon content of phytoplankton in g/dry cell,

D is the conversion factor for carbon content to cellular dry weight,

R is the conversion factor for cellular dry weight to cellular wet weight, then the wet weight of phytoplankton can be estimated.

Using the calculated average number of phytoplankters entrained daily ($7.92 \times 10^{11} \text{ cells/day}$),

$$W = (7.92 \times 10^{11} \text{ phytoplankters/day}) (2 \times 10^{-10} \text{ gC/cell}) (2.2 \text{ g dry wt cell/gC}) (10 \text{ g wet wt cell/g dry wt cell})$$

$$W = 3.5 \times 10^3 \text{ g phytoplankton/day.}$$

If the highest number of phytoplankton calculated to be passed through the condenser is used (3.06×10^{12} phytoplankters/day), then

$$W = 13.5 \times 10^3 \text{ g phytoplankton/day.}$$

Zooplankton collected at Station I has been enumerated in Table 2.7-15. The average number of zooplankters obtained from Station I was 1.47×10^3 organisms/ m^3 , with a peak value of $3.94 \times 10^3/m^3$ in May 1972. In all collections, copepods formed from 51.2 to 84.4 percent of the zooplankton, and averaged almost 70 percent of the total zooplankton collected at Station I. Numerically, copepods averaged 1176.5 organisms/ m^3 , with a high value of 2576 organisms/ m^3 recorded in May 1972.

The weight of copepods entrained in the condenser cooling water used by St. Lucie Unit No. 2 has been calculated below. Since copepods formed the major portions of zooplankton at Station I, and because reasonable data were available for the following computations, copepod mass rather than total zooplankton mass was calculated.

Calculated values for total zooplankton, copepods, and fish eggs and larvae passed through St. Lucie Unit No. 2 given in Table 5.1.

The following assumptions have been used to estimate the quantity of copepods passed through the St. Lucie Unit No. 2 condensers in the course of a day.

- a. the average N content of a dry copepod is taken as $18 \times 10^{-6} \text{ g}^{(45)}$,
- b. 1 g N equals 10 g dry copepod⁽⁴⁶⁾,
- c. 1 g dry copepod equals 7 g wet copepod⁽⁴⁶⁾.

From these assumptions, the following expression was developed:

$$W_c = C \times N \times K_1 \times K_2$$

where:

W_c = wet weight of copepods entrained, g/day,

C = number of copepods entrained/day,

$N = 18 \times 10^{-6} \text{ g N/dry copepod,}$

$K_1 = 10 \text{ g dry copepod/g N,}$

$K_2 = 7 \text{ g wet copepod/g dry copepod.}$

If the average number of copepods calculated to be entrained per day (see Table 5.1) is substituted into the above equation,

$$W_e = (3.31 \times 10^9 \text{ copepods/day}) (18 \times 10^{-6} \text{ g N/dry copepod}) \\ (10 \text{ g dry copepod/g N}) (7 \text{ wet copepod/g dry copepod})$$

it then follows that 4.17×10^6 g of copepods will be passed through the Plant in a 24 hour period. Using the highest number of copepods collected at Station I ($2.576 \times 10^3/\text{m}^3$) the mass of copepods entrained by St. Lucie Unit No. 2 can be approximated at 9.14×10^6 g per day.

Both phytoplankton and zooplankton entrained in the condenser cooling water will experience an increase in temperature (maximum 24 F) for a period of approximately 40 minutes. Since definitive studies of the effects of entrainment on plankton have not yet been reported, 100 percent mortality of entrained organisms has been assumed when ambient water temperature exceed 75 F. This condition exists at Hutchinson Island from May to October, or half the year. Plankton mortality at ambient water temperatures has not been estimated, but is believed to be proportional to condenser ΔT and the duration of exposure.

The St. Lucie Unit 2 intake structure has been designed to minimize the entrapment of fish and other mobile marine organisms. Experience at several West coast power plants, (El Segundo, Huntington Beach, Redondo, Ormond Beach and San Onofre), all of which are equipped with velocity caps, indicate that velocity caps markedly reduce the number of fish trapped at the intake screens.

Studies to date have shown very few fish in the vicinity of the proposed intake structure. While pelagic fish such as bluefish and Spanish mackerel may occur near the St. Lucie Unit 2 intake, it seems unlikely that such powerful swimmers would be engulfed by the low velocity field which surrounds the intake. Should fish be trapped at the intake, they will be carried into the intake canal.

At the present time, no fish removal system, other than the travelling screens at the plant intake structure, is planned for St. Lucie Unit 2. Because of the low water velocities in the canal (less than 1 fps), it seems unlikely that healthy fish would become impinged on the screens. Those fish which are removed from the screens will be sluiced to a trash retention pond. Should fish entrapment at St. Lucie prove to be a significant problem, Florida Power and Light Company will investigate the installation of a fish removal system.

5.1.4 OTHER ENVIRONMENTAL EFFECTS OF THERMAL DISCHARGE SYSTEM

Because of the low temperatures (less than 2°F above ambient) expected at the ocean surface, fogging is not anticipated to occur due to heat added by the operation of St. Lucie Unit No. 2. State road A-1-A will cross the St. Lucie discharge canal at a location due east of the Unit #2 Reactor Building at a distance of approximately 1000 feet. Water temperatures in this area will range from ≈90 to ≈110 during operation because of the naturally occurring high humidity no additional effects are seen for fogging as described in section 2.6.3 (page 2.6-2). Additionally because of the high ambient temperatures indigenous to the area and the additional winter influence of the Gulf Stream no problems of icing are foreseen.

Scour of the ocean bottom is not possible because the discharge ports for the multiport diffuser are 1-1/2 ft. in diameter and located about 7 ft. above the ocean bottom. Because of the height above the bottom, no scour is possible. Refer to Figures 9.2-1B and 9.2-1C in PSAR.

Because of the potential for marine growth in the two intake pipelines, provisions for the future addition of a recirculation canal were included in the design of the Unit 1 cooling system. The recirculation canal functions to route heated to approximately 122-125°F into the intake pipelines for a soak period of approximately four (4) hours. The principle constraints considered in developing the defouling program include:

- a) limiting the maximum release temperature from the line being defouled to 120°F
- b) limiting the maximum surface temperature rise from the line being defouled to 2°F
- c) limiting the velocity of the water drawn into the line not being defouled to 1 fps
- d) limiting the temperature rise in the intake canal as much as practicable
- e) assuring that the normal plant discharge limits are not exceeded
- f) minimization of frequency of defouling consistent with required defouling results

With the addition of Unit 2, the same defouling program is contemplated. The preliminary operating procedure for defouling the intake pipelines with two units in operation follows; however, if necessary, the defouling operation can still be conducted with only one unit in operation.

1. Reduce unit load for 30 minutes to effect a condenser discharge temperature rise of 18°F and accumulate a buffer of cooler water in the discharge canal.

2. Adjust circulating water flow and load of each unit to effect a condenser discharge temperature of 125°F and generate 1.5 million cubic feet of the 125°F water.
3. Adjust circulating water flow and unit load to effect a flow of no more than 600 cfs for each unit with a maximum condenser temperature rise of 21 F.
4. Ten minutes prior to time the 125 F water reaches the recirculation canal, open both of the recirculation canal sluice gates and close No. 1 intake line sluice gate located at the gate control structure.
5. When the 125°F water reaches the recirculation canal close both of the discharge pipe sluice gates.
6. When the 125°F water reaches the No. 1 intake line all of the 125°F water will be contained in the recirculation canal. The following operations are then initiated:
 - a. Increase circulating water flow to a maximum of 650 cfs for each unit.
 - b. Open discharge pipe sluice gates.
 - c. Throttle the recirculation canal sluice gate to reduce the intake line recirculation flow to 50 cfs. Continue 50 cfs flow for four hours to defoul the No. 1 intake line.

Note that actual circulating water flow will be dependent upon:

- a. Maintaining the discharge canal water level above that in the recirculation canal to prevent backflow of the 125°F water in the recirculation canal to the discharge pipe when discharge pipe sluice gates are opened.
 - b. Maximum flow which can be carried through the intake line not being defouled without exceeding 1 fps intake velocity. For the condition of ocean at elevation 0.0 MLW, and pump submergence elevation -9.0 MLW, the maximum one pipe (114"Ø) flow is 1300 cfs.
 - c. c. Maximum allowable condenser cooling water temperature rise for discharge to the ocean.
7. After maintaining a 50 cfs flow for four hours through the No. 1 intake pipe, close the recirculation canal sluice gate, re-open the No. 1 intake pipe sluice gate to one-quarter open for twenty minutes. Then open No. 1 intake pipe sluice gate fully and close No. 2 intake sluice gate in sequence. Re-open the recirculation canal sluice gate to maintain a 50 cfs recirculation flow for four and one half hours through the No. 2 intake line.
 8. After defouling of the No. 2 line is complete, close recirculation canal sluice gate and re-open No. 2 intake canal sluice gate one-quarter open for twenty minutes, then open No. 2 intake pipe sluice gate fully and return to normal plant operation.

TABLE 5.1-2

EVALUATION OF MAXIMUM SURFACE TEMPERATURE BY DIFFERENT METHODS

Jet Efflux = 1150 cfs

Ambient Temperature For September = 87 F

Jet Efflux Temperature = 111 F

Method	Dilution Factors	Absolute Maximum Temp at the Surface F	Remarks
Brooks ³ Rawn et al ^{4,5}	20	88.2	Semi-empirical analysis supported by the data from field studies
Fan and Brooks ⁶ Ibid. ⁷	15 14	88.6 88.7	Numerical solution for a system of equations which is obtained by introducing suitable dimensionless parameters describing velocity and temperature
Cedarwall ⁸	14	88.7	Rate of entrainment is defined as in Ref. 10. Final equations have been solved by assuming Guassian distribution for velocity and concentration.
Abraham ^{10,11} (after Liseth ¹ , Frankel and Cumming ⁹)	16	88.5	Equations were formed similar to those in Ref. 8. Solutions were achieved numerically by assuming end of the zone of flow establishment as a boundary.
Shirazi and Davis ¹²		88.5	Nomograms have been prepared for Ref. 13,10 etc.

SL2

TABLE 5.1-3

0

PREDICTED SURFACE WATER TEMPERATURE AT
THE OCEAN DISCHARGE DURING UNIT NO. 2 OPERATION

Temperature Rise (F)	Length of Isotherm (ft)	Area of Isotherm	
		(ft ²) x 10 ⁷	Acres
1	14,500 ft	2.25	512
0.5	36,500	7.56	1728

TABLE 5.1-4

PREDICTED ISOTHERM AREA FOR UNIT NO. 1

<u>Areas of Isotherms (Acres)</u>			
<u>Temperature Rise (F)</u>	<u>Pritchard's Formula (35)</u>	Brooks (27) Ditmars (22) Tsai's (28) <u>Approach</u>	<u>Thermal-Hydraulic Model Studies (33)</u>
5	4.6	4	0.002
4	11.2	9	0.4
3	35.3	24	1/25*
2	180.0	120	
1-5	565.0	220	
1	2860.0	580	

* Approximate

TABLE 5.1-5

0

PREDICTED ISOTHERM AREAS AFTER INTERFERENCE

<u>Temperature Rise (F)</u>	<u>Areas of the Isotherms (Acres)</u>			<u>Superposed Area Based on Brook's Method for Both Units 1 and 2</u>
	<u>Unit No.1</u>	<u>Unit No. 2</u>	<u>Units 1 and 2</u>	
5	4.6	Zero	≤ 4.6	4
4	11.2	Zero	≤ 11.2	9
3	35	Zero	≤ 35	24
2	180	Zero	≤ 180	120
1	2860	512	3372	1092

TABLE 5.1-6
TEST CASE RESULTS

Test Case No.	Units in Operation	Number of Pumps in Operation	Total Discharge $Q_1 + Q_2$ (cfs) ²	Discharge from Unit No. 1 Q_1 (cfs)	Jet Velocity for Unit No. 1 V_1 (fps)	Discharge from Unit No. 2 Q_2 (cfs)	Jet Velocity for Unit No. 2 V_2 (fps)	Maximum Temperature Rise (°F)	Maximum Predicted Surface Temperature (°F)		Exhibit No.	Remarks
									Unit No. 1	Unit No. 2		
1 and 2	2	4	1,226	613	6.9	613	7.3	24	7.4	2	1 and 2	Mode of operation without flow dilution or diversion
3 and 4	1 and 2 (Unit No. 1 with $\Delta T = 0$)	6 (4 in Unit No. 2; 2 in Unit No. 1)	1,822	911	10.31	911	10.74	18	4.2	1.1	3 and 4	With flow dilution
5 and 6	1 and 2 (Unit No. 1 with $\Delta T = 0$)	8	2,290	1,145	13	1,145	13.5	12	2.1	0.5	5 and 6	With flow dilution
7 and 8	1 and 2 (Unit No. 1 with $\Delta T = 0$)	4	1,354	677	7.66	677	7.86	12	2.6	0.8	7 and 8	With flow dilution
9 and 10	1 and 2	8	2,290	1,145	13	1,145	13.5	24	5.5	1.5		Normal mode of operation
11	2	4	1,150	0	0	1150	13.5	24	0	1.5		With flow diversion

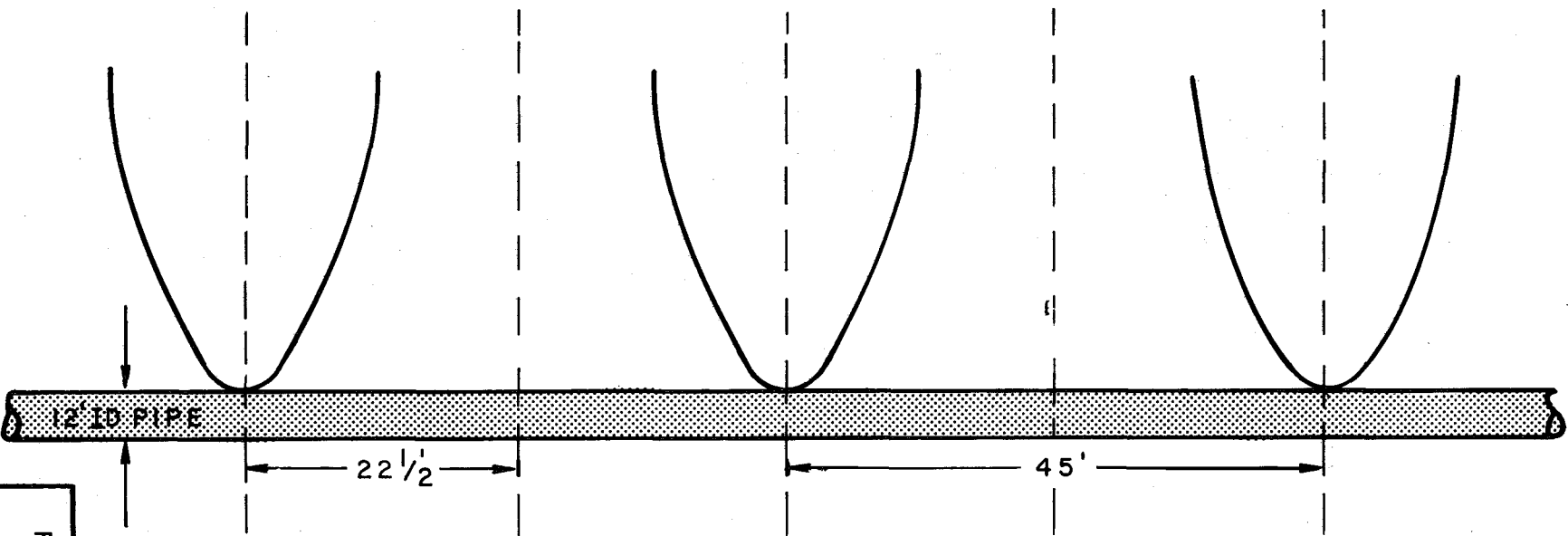
SL2

TABLE 5.1-7

CALCULATED NUMBERS OF VARIOUS ZOOPLANKTON
ENTRAINED AT ST LUCIE UNIT NO. 2

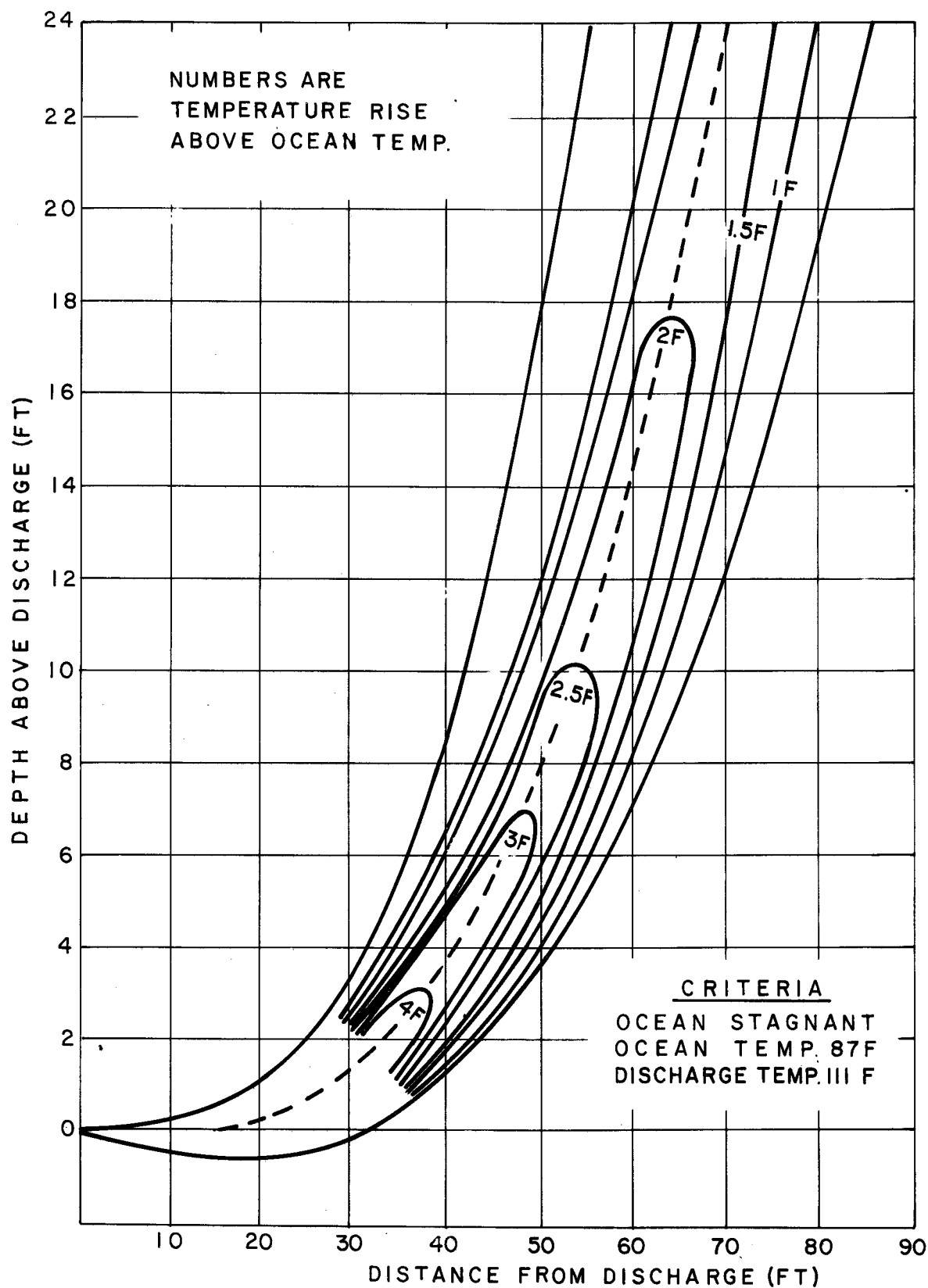
		Number Entrained/Day*
Total Zooplankton/m ³		
average	1.47×10^3	$4.15 \times 10^9/\text{day}$
high (May 1972)	3.94×10^3	$1.11 \times 10^{10}/\text{day}$
Copepods/m ³		
average	1.18×10^3	$3.31 \times 10^9/\text{day}$
high (May 1972)	2.58×10^3	$7.25 \times 10^9/\text{day}$
Fish Eggs and Larvae/m ³		
average	7	$1.97 \times 10^7/\text{day}$
high (Jan 1972)	24	$6.75 \times 10^7/\text{day}$

* number of organisms/m³ multiplied by condenser cooling water flow
of $2.81 \times 10^6 \text{ m}^3/\text{day}$



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
NONINTERACTING JETS FROM ONE SIDE
OF THE MANIFOLD

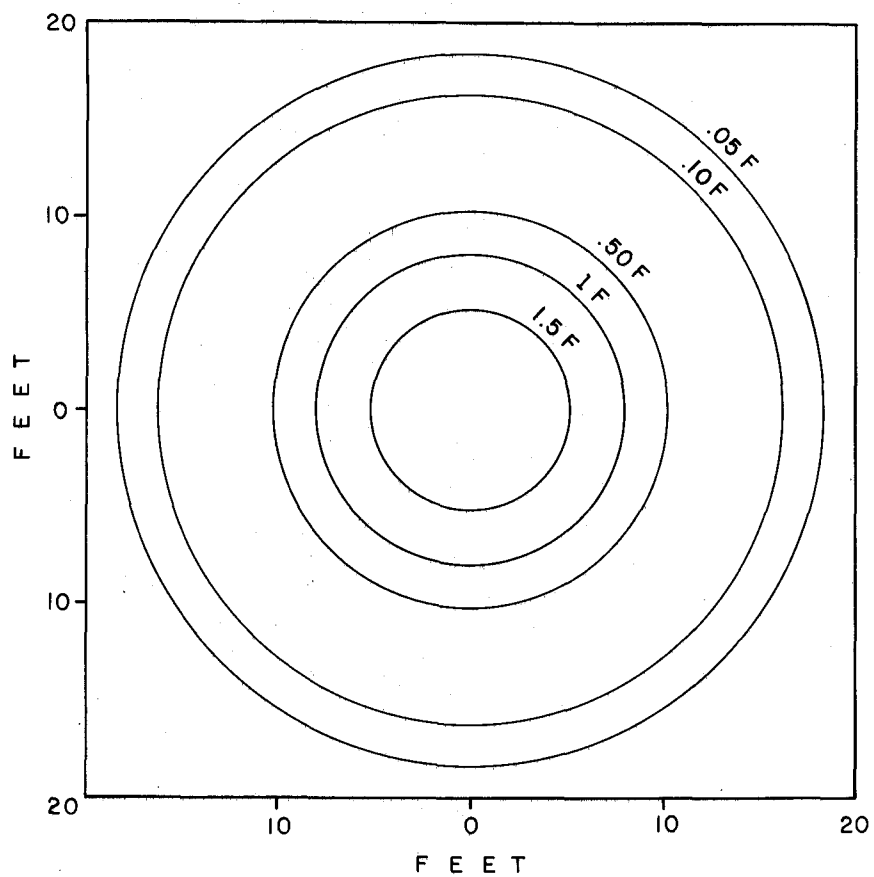
FIGURE 5.1-1



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PLUME TEMPERATURE DISTRIBUTION
INITIAL 24 FEET ABOVE PORT

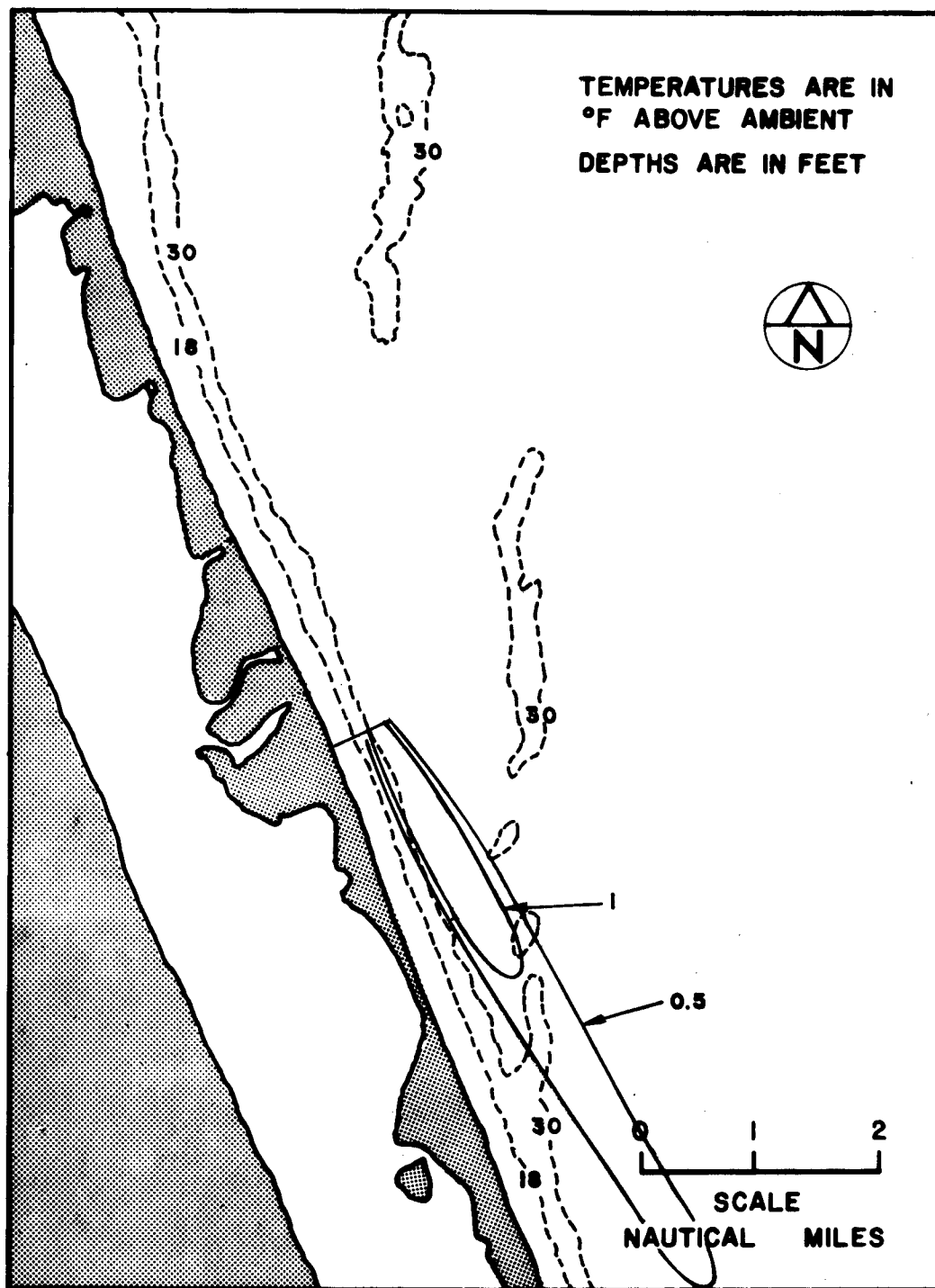
FIGURE 5.1-2



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PREDICTED ISOTHERMS OF TEMPERATURE
RISE (°F) 24 FEET ABOVE PORT

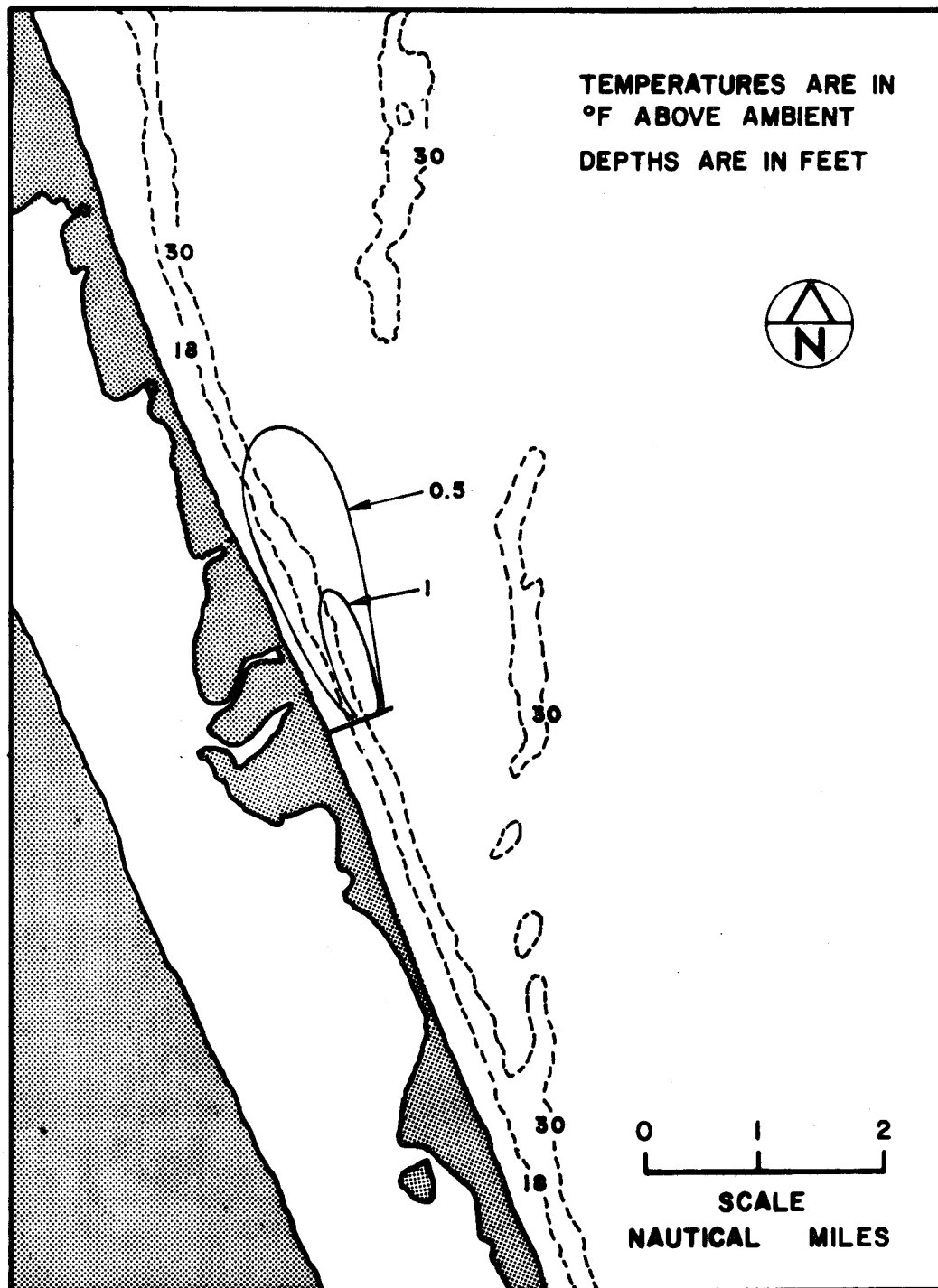
FIGURE 5.1-3



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PREDICTED SURFACE WATER TEMPERATURE
RISES DURING MAXIMUM OBSERVED
SOUTHERLY CURRENTS OF 1.3 fps

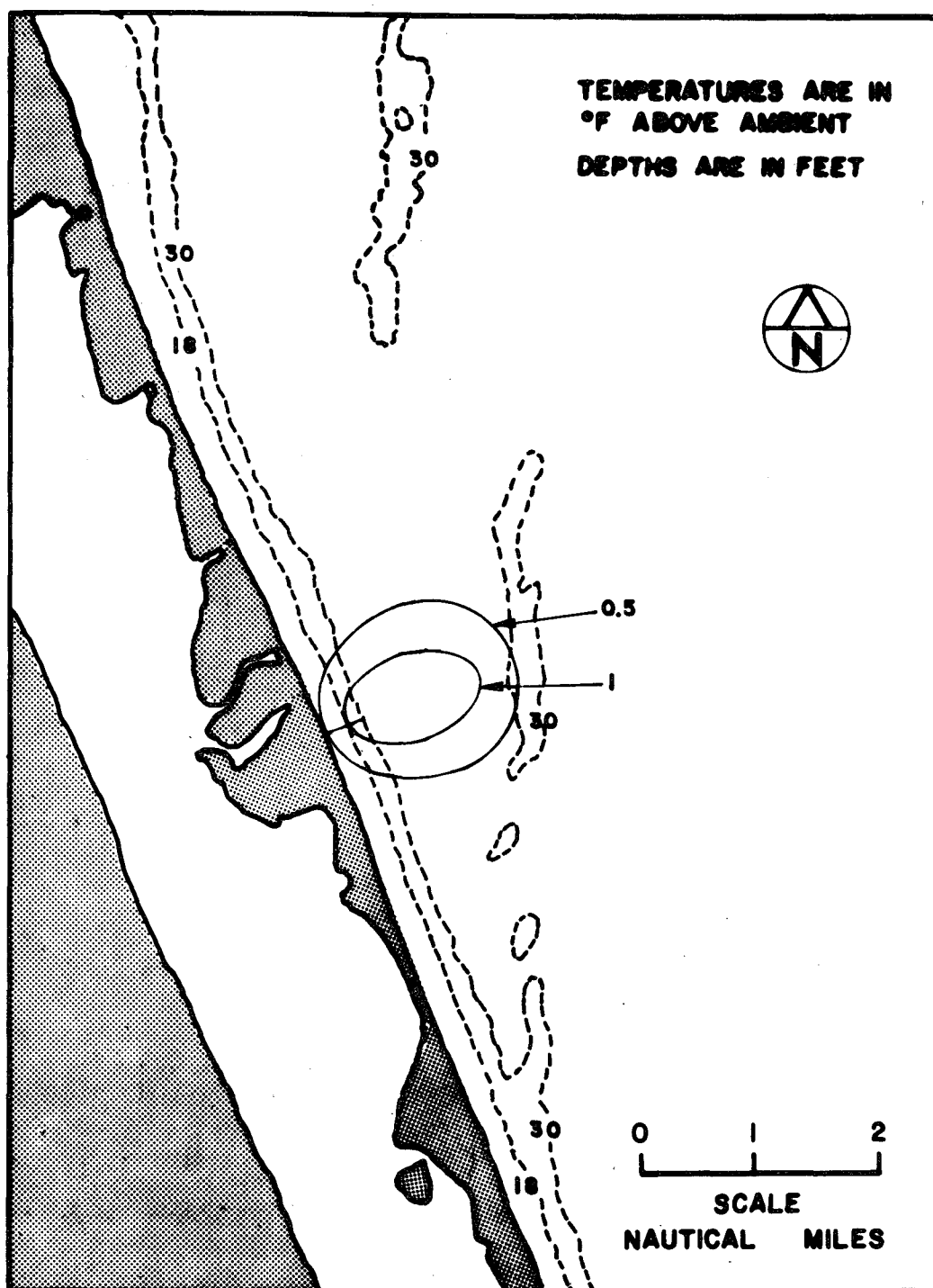
FIGURE 5.1-4



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PREDICTED SURFACE WATER TEMPERATURE
RISES DURING MAXIMUM OBSERVED
NORTHERLY CURRENTS OF 0.7 fps

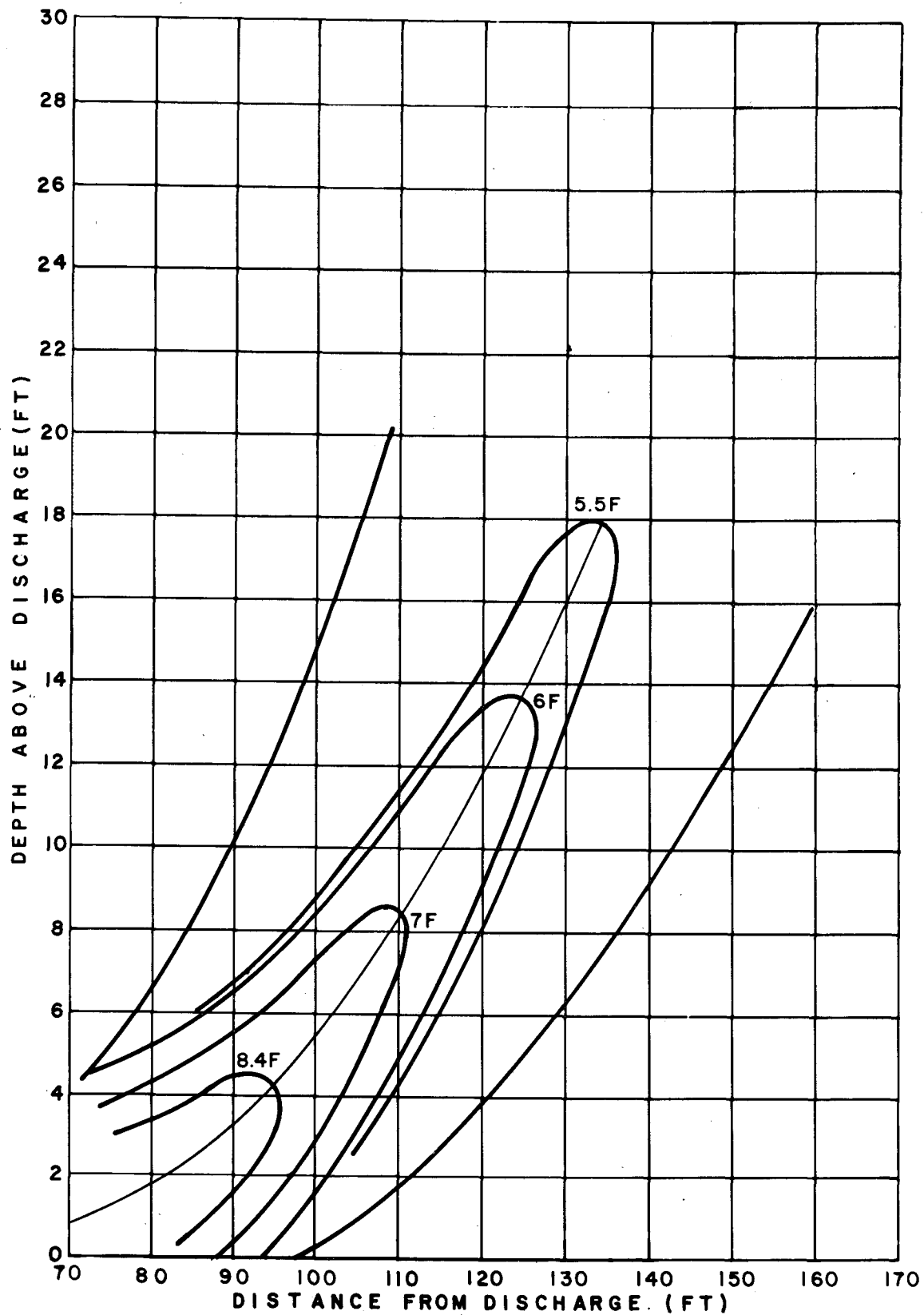
FIGURE 5.1-5



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PREDICTED SURFACE WATER
TEMPERATURE RISES DURING
SLACK WATER CONDITIONS

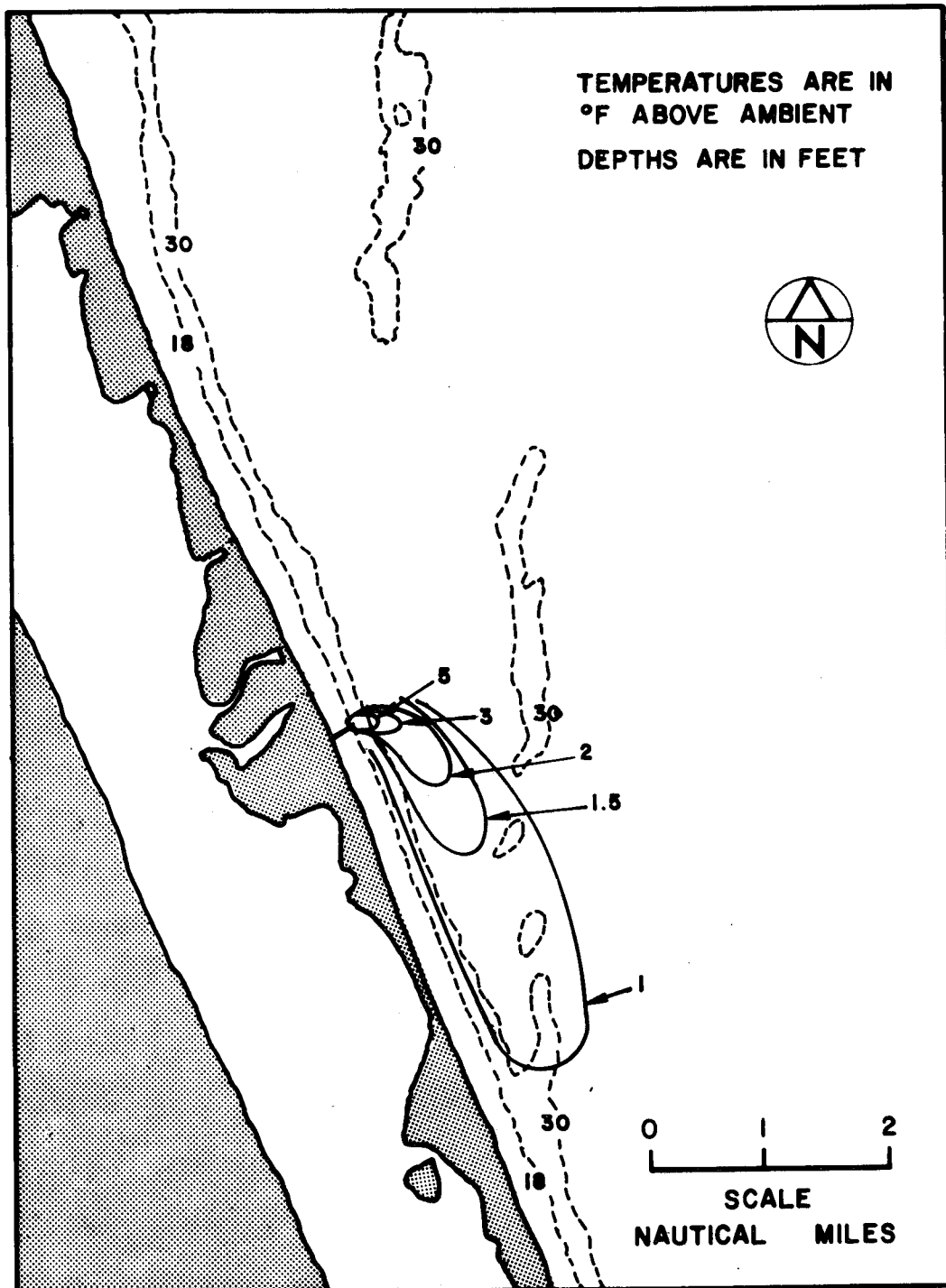
FIGURE 5.1-6



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PLUME TEMPERATURE DISTRIBUTION
FOR UNIT 1 TOTAL DISCHARGE (IN cfs)
THROUGH DIFFUSERS = 1145

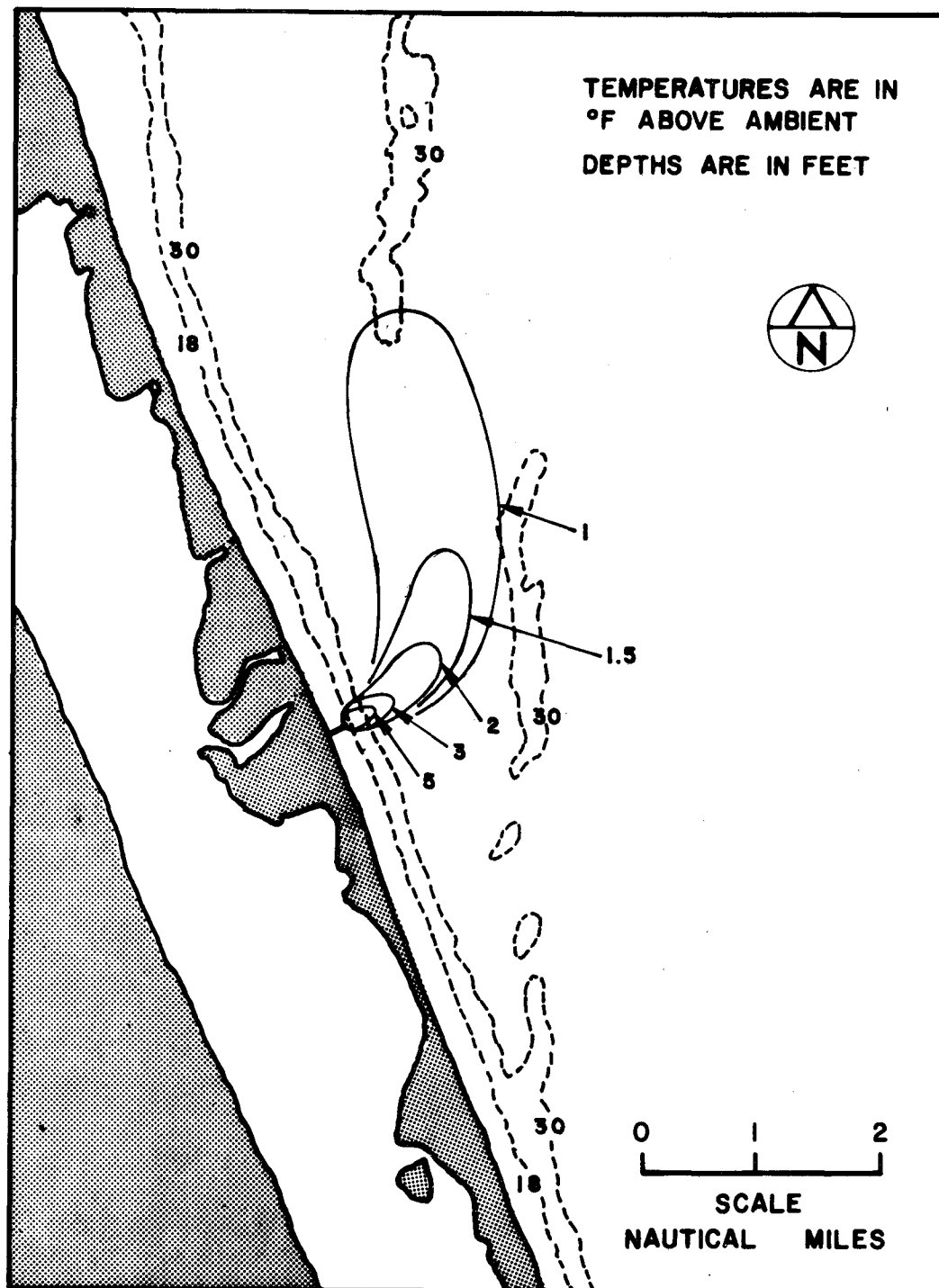
FIGURE 5.1-7



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PREDICTED SURFACE WATER TEMPERATURE
RISES FOR UNIT 1 DURING MAXIMUM
OBSERVED SOUTHERLY CURRENTS OF 1.3 fps

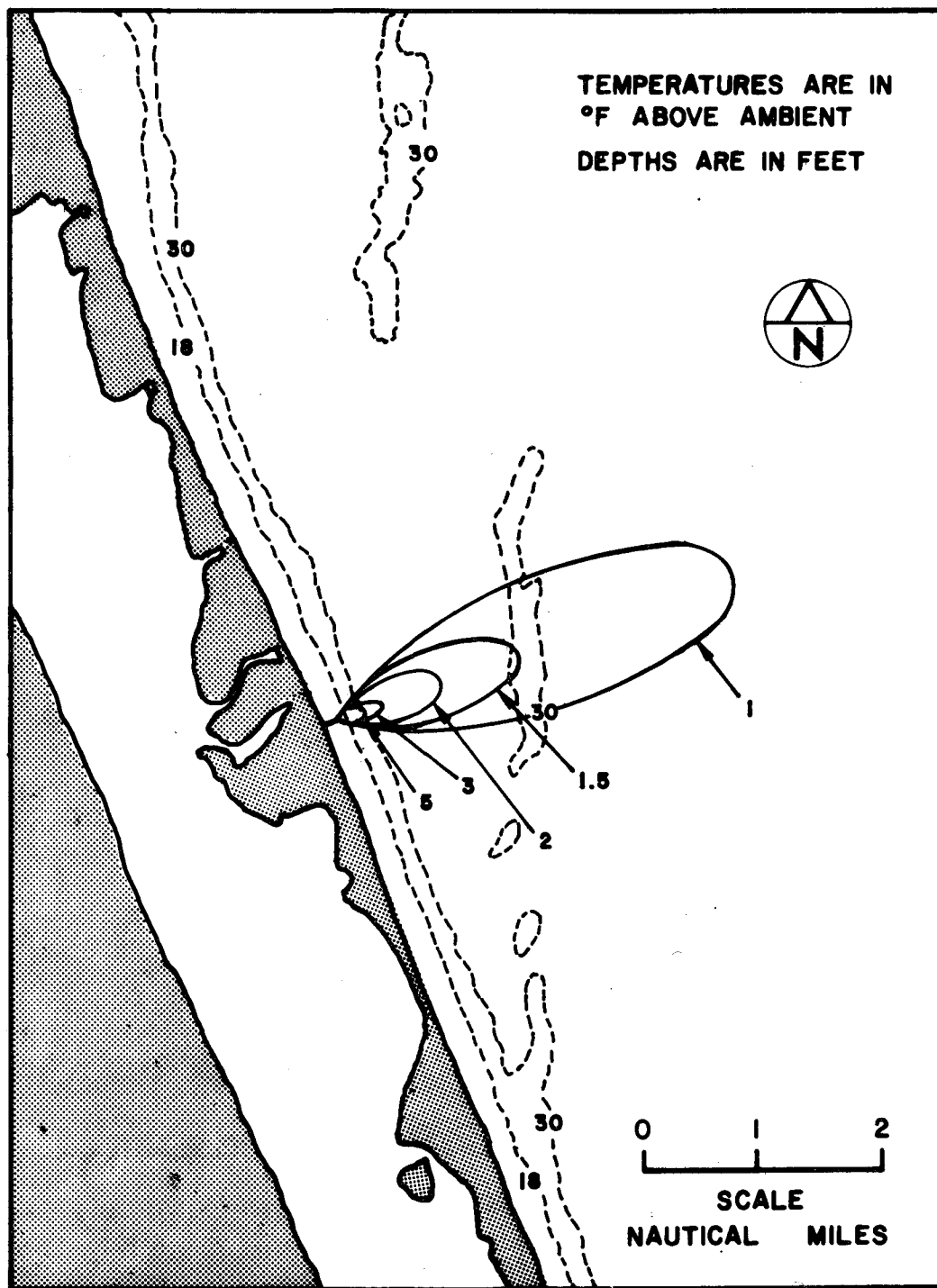
FIGURE 5.1-8



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PREDICTED SURFACE WATER TEMPERATURE
RISES FOR UNIT 1 DURING MAXIMUM
OBSERVED NORTHERLY CURRENTS OF 0.7 fps

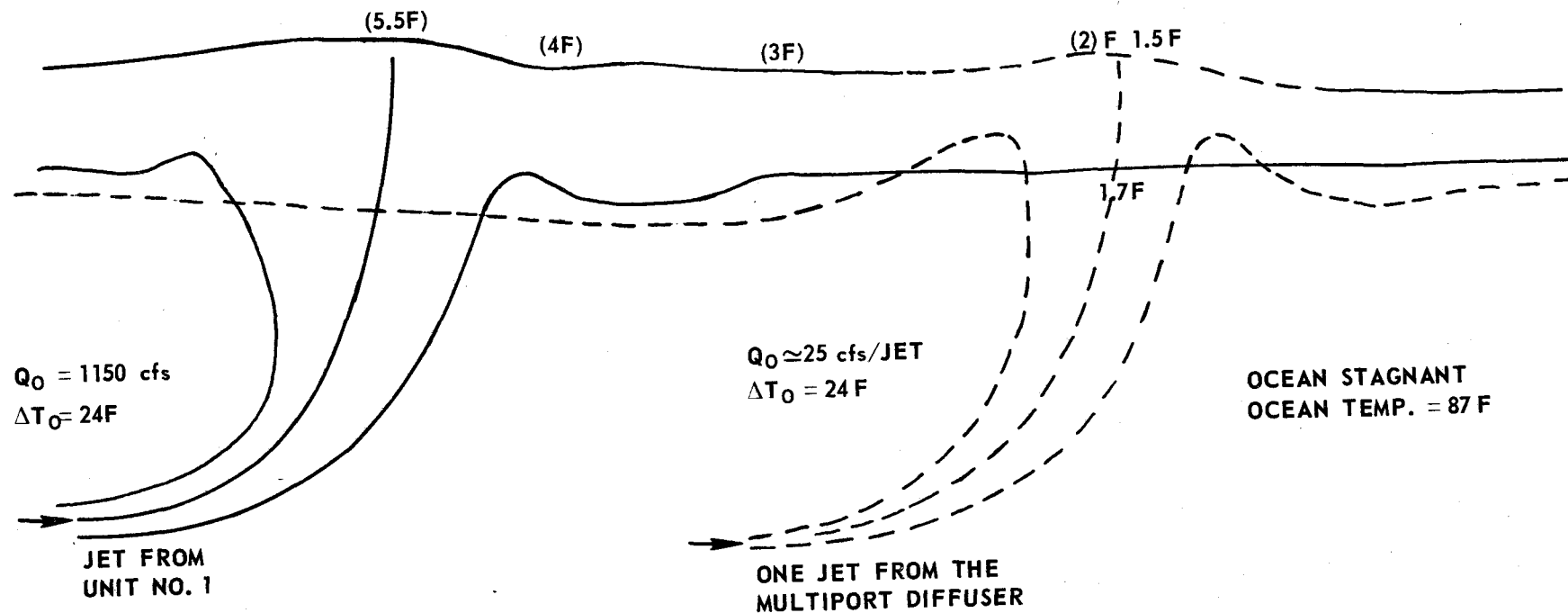
FIGURE 5.1-9



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

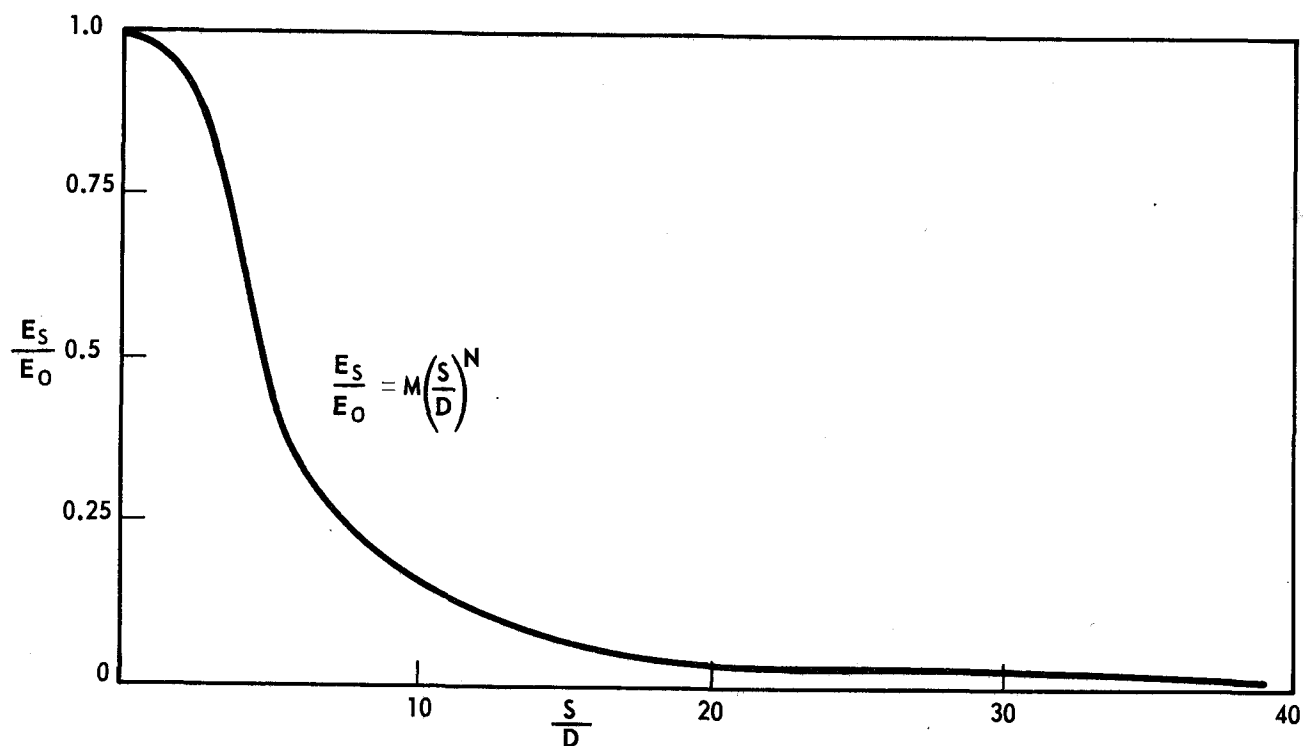
PREDICTED SURFACE WATER
TEMPERATURE RISES DURING
SLACK WATER FOR UNIT 1

FIGURE 5.1-10



*NOTE: NUMBERS SHOWN IN THE PARANTHESIS REFER TO UNIT NO. 1 TEMPERATURES AT THE SURFACE.

FLORIDA POWER & LIGHT COMPANY
 ST. LUCIE PLANT UNIT 2
 SCHEMATIC DIAGRAM SHOWING THE
 INTERFERENCE BETWEEN TWO JETS
 FIGURE 5.1-11



E_0, E_s = ENERGY AT THE JET MOUTH AND AT ANY OTHER SECTION 'S' RESPECTIVELY.

M, N = CONSTANTS.

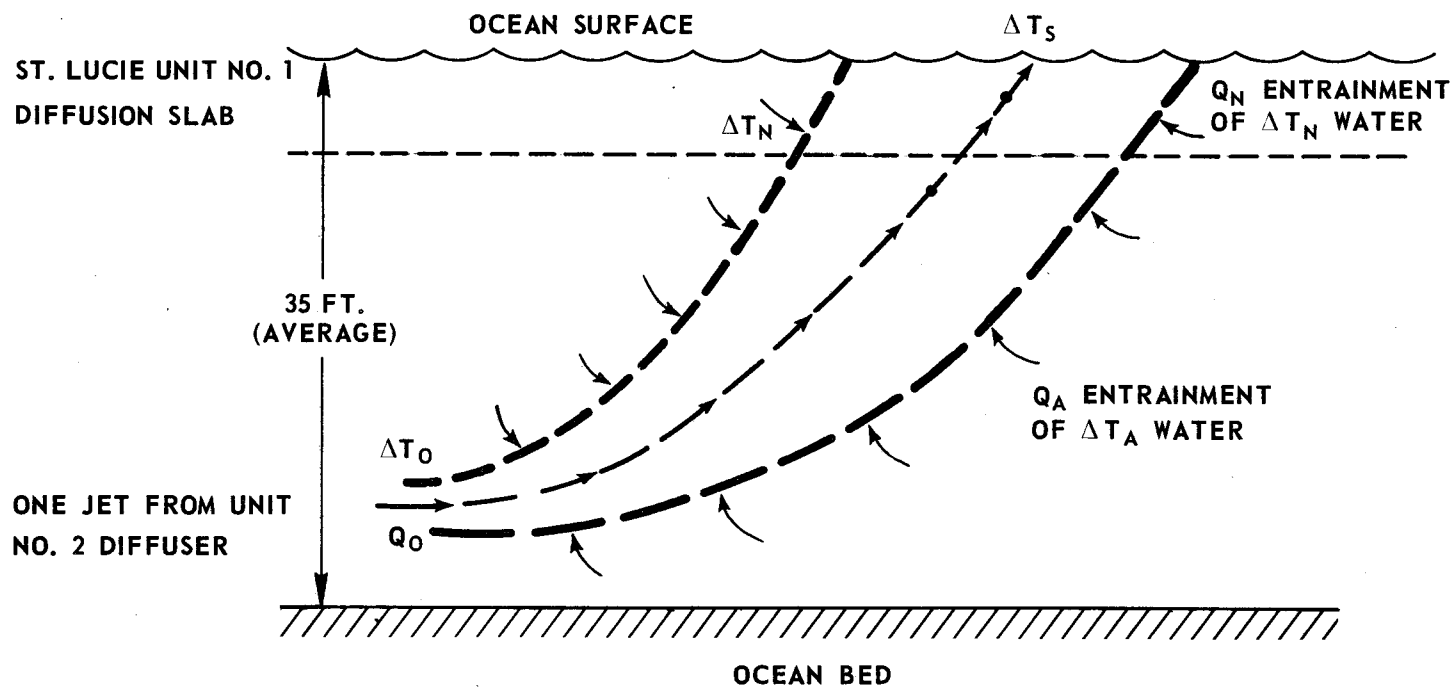
S = DISTANCE ALONG THE AXIS.

D = DIAMETER OF THE JETS.

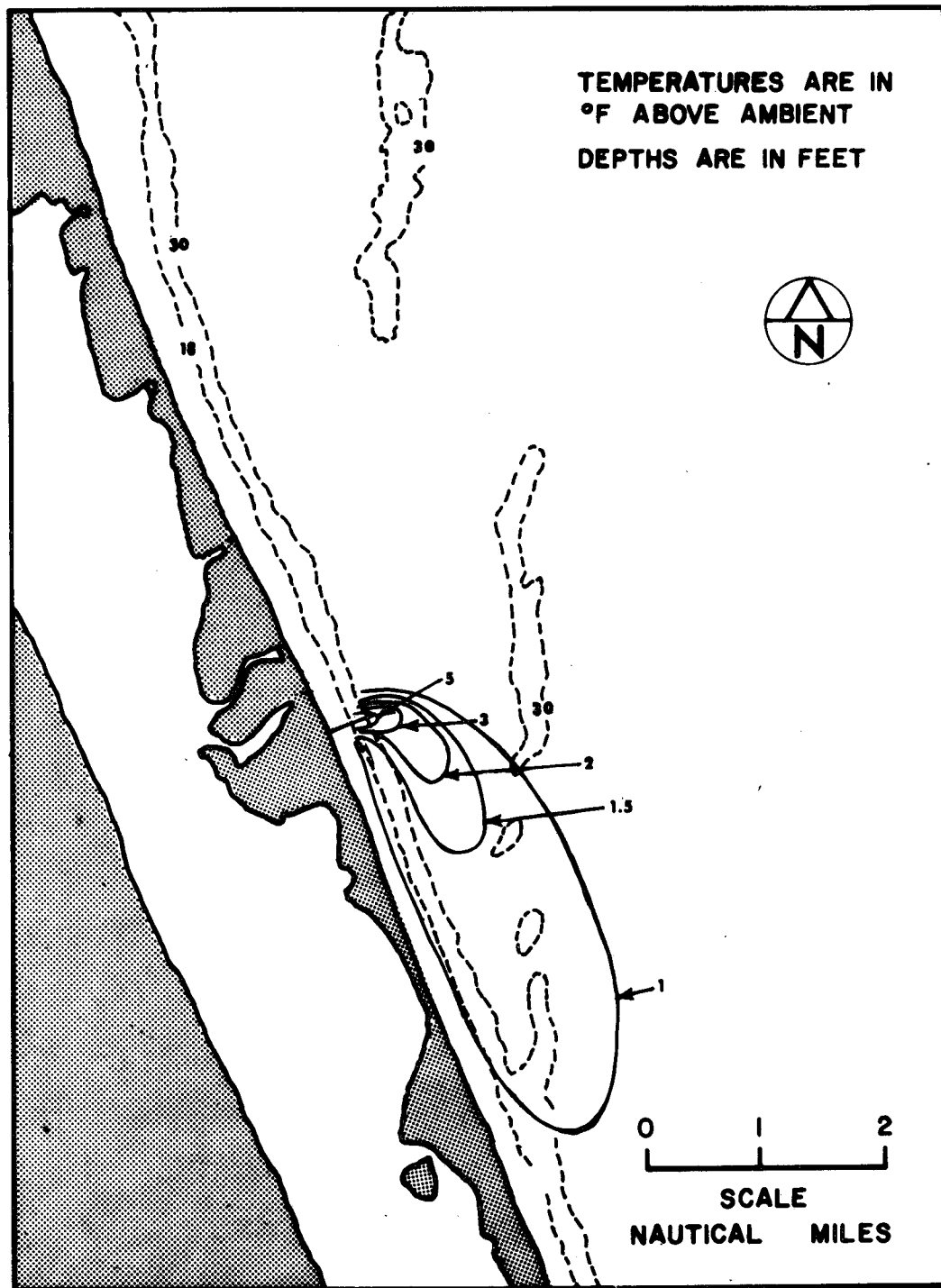
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

SCHEMATIC REPRESENTATION OF
ENERGY DISSIPATION CHARACTERISTICS
OF A JET

FIGURE 5.1-12



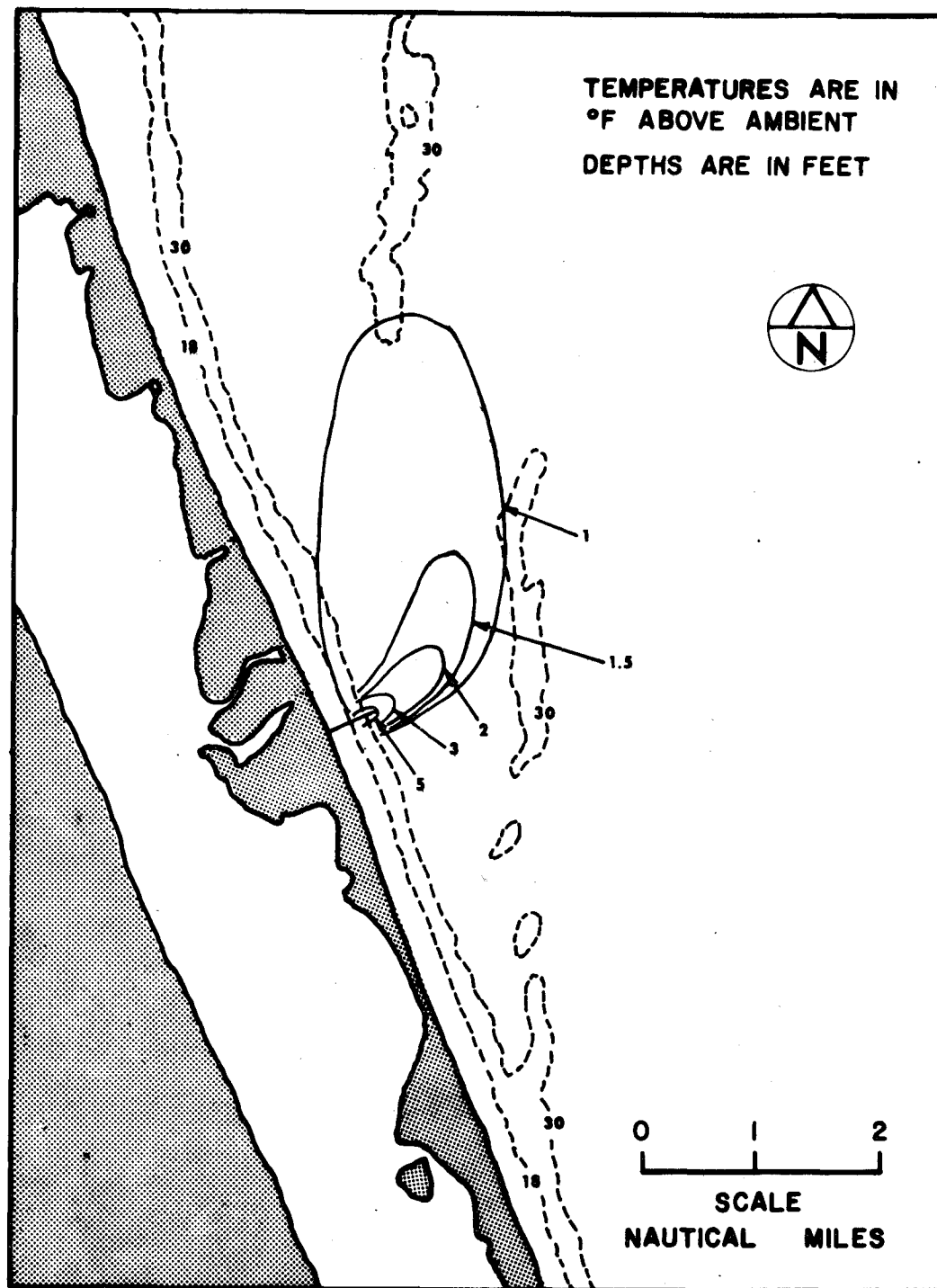
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
ESTIMATED PLUME SURFACE TEMPERATURES AFTER INTERFERENCE
FIGURE 5.1-13



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PREDICTED SURFACE WATER TEMPERATURE
RISES FOR UNITS 1 AND 2 DURING MAXIMUM
OBSERVED SOUTHERLY CURRENTS OF 1.3 fps

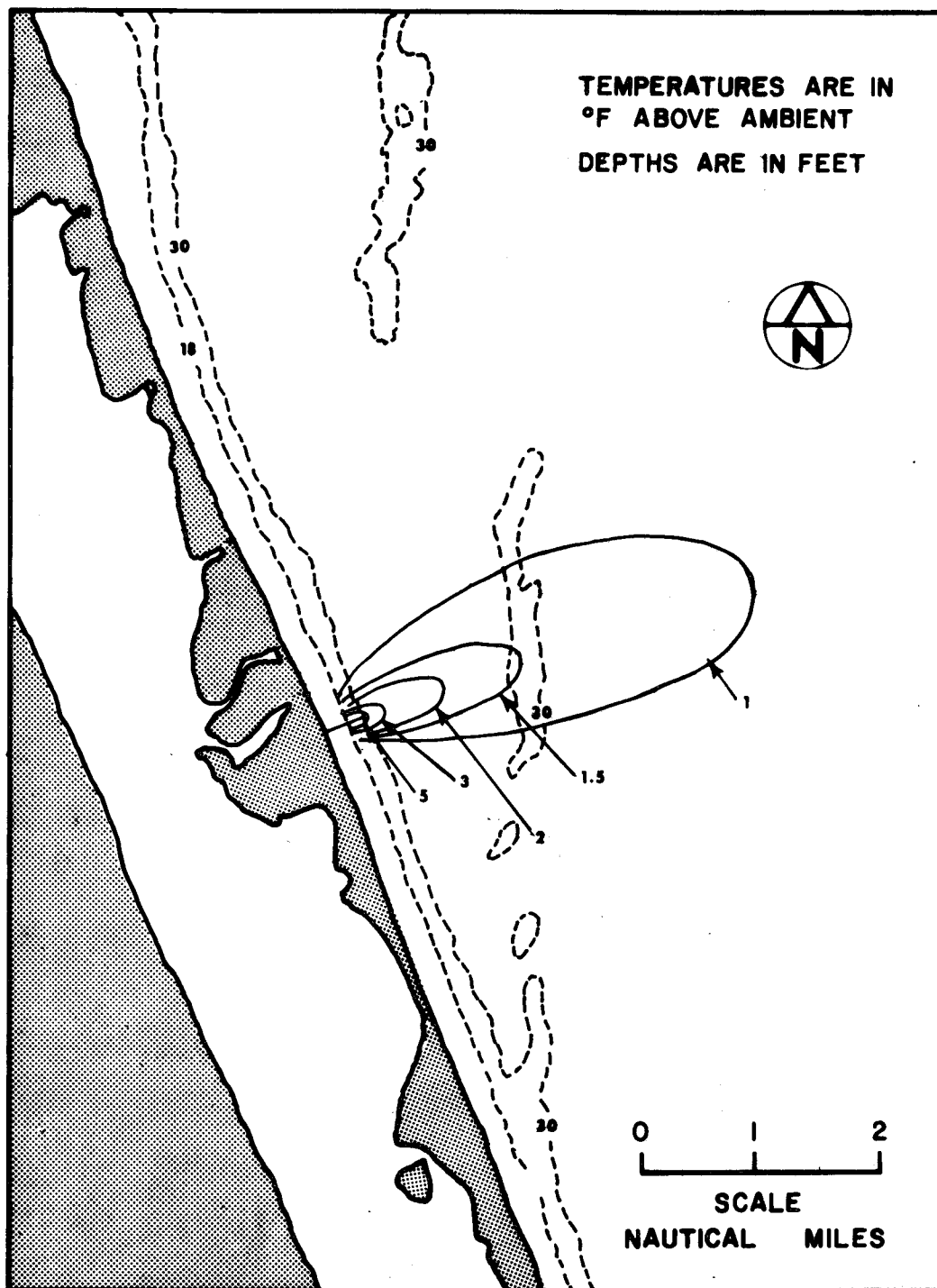
FIGURE 5.1-14



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PREDICTED SURFACE WATER TEMPERATURE
RISES FOR UNITS 1 AND 2 DURING MAXIMUM
OBSERVED NORTHERLY CURRENTS OF 0.7 f_{ps}

FIGURE 5.1-15



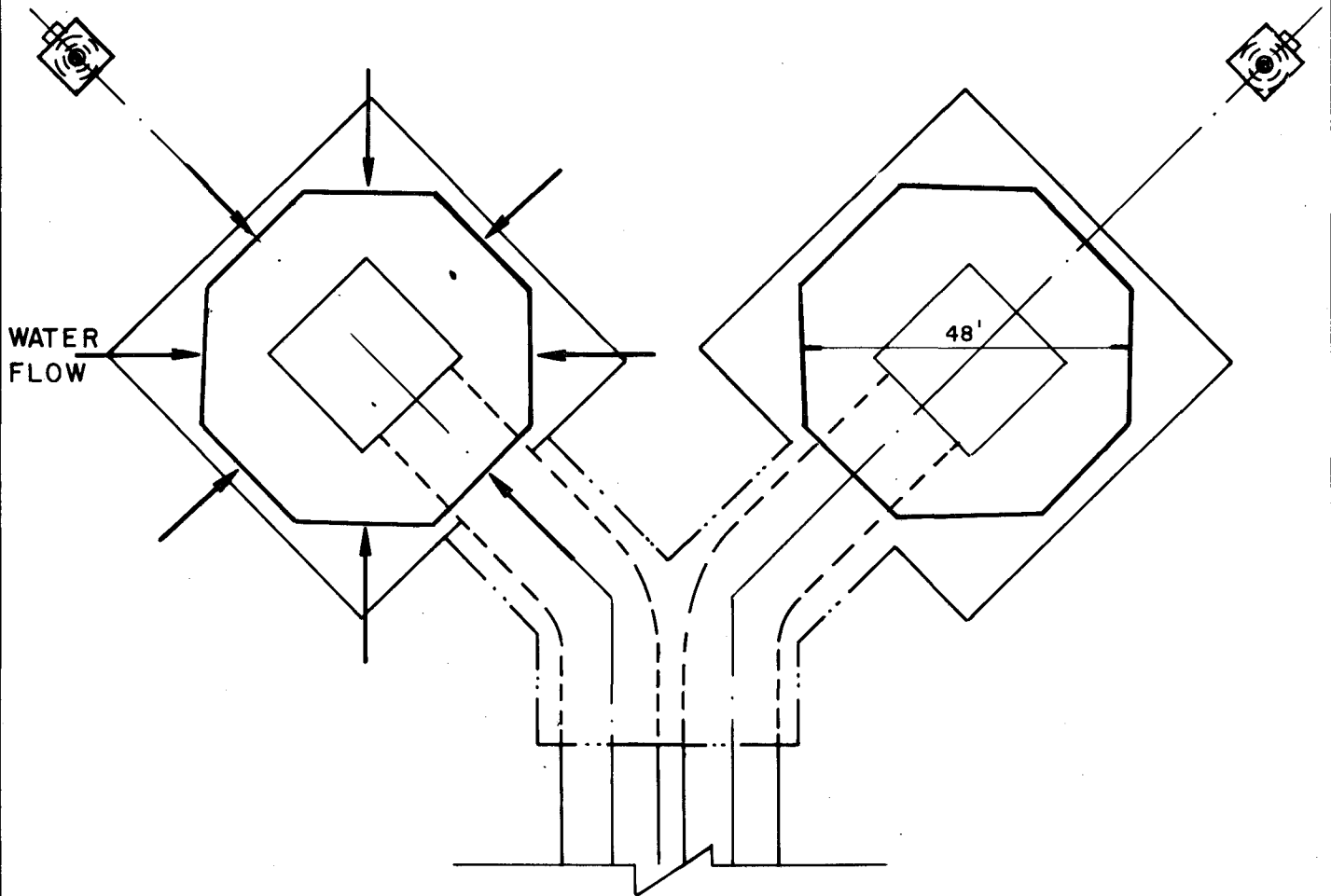
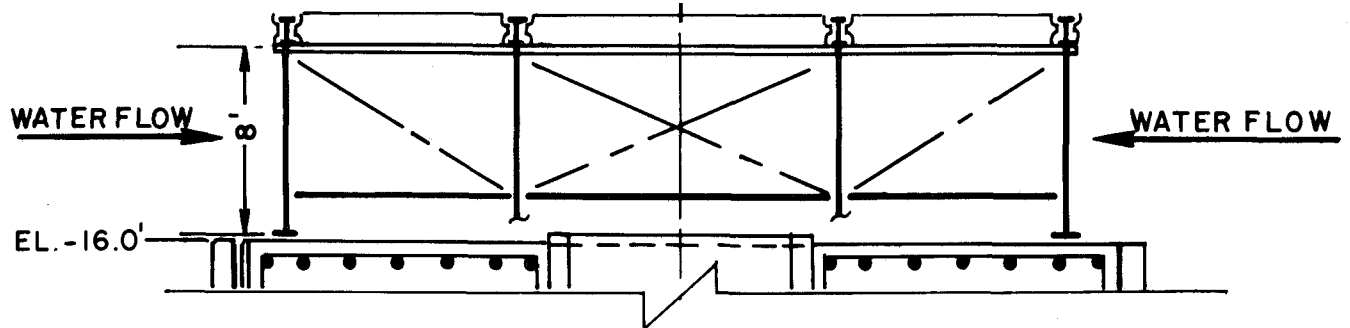
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PREDICTED SURFACE WATER
TEMPERATURE RISES DURING
SLACK WATER FOR UNITS 1 AND 2

FIGURE 5.1-16

MEAN LOW WATER EL. ± 0.00

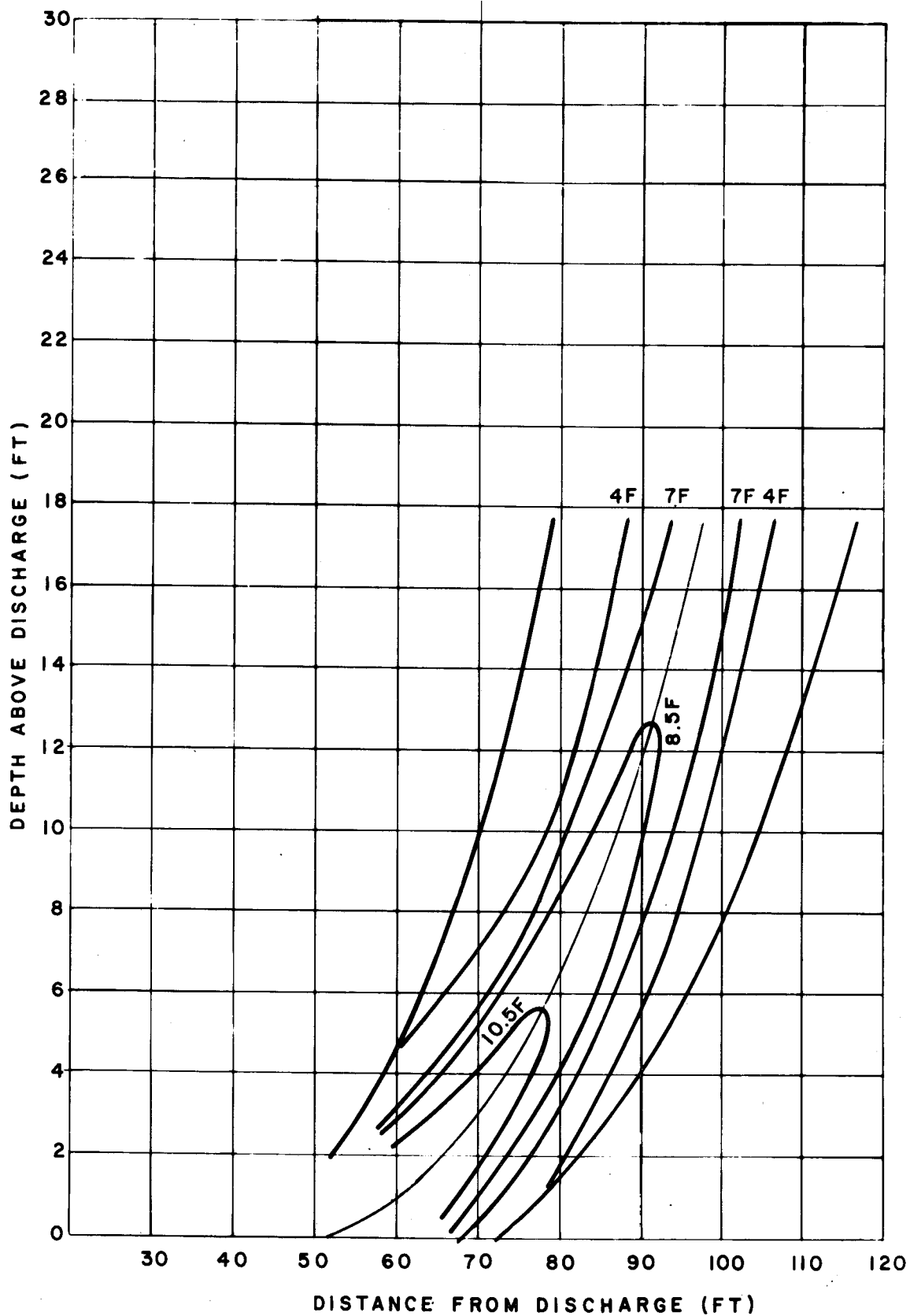
82



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

DETAILED VELOCITY CAP FOR
COOLING WATER INTAKE

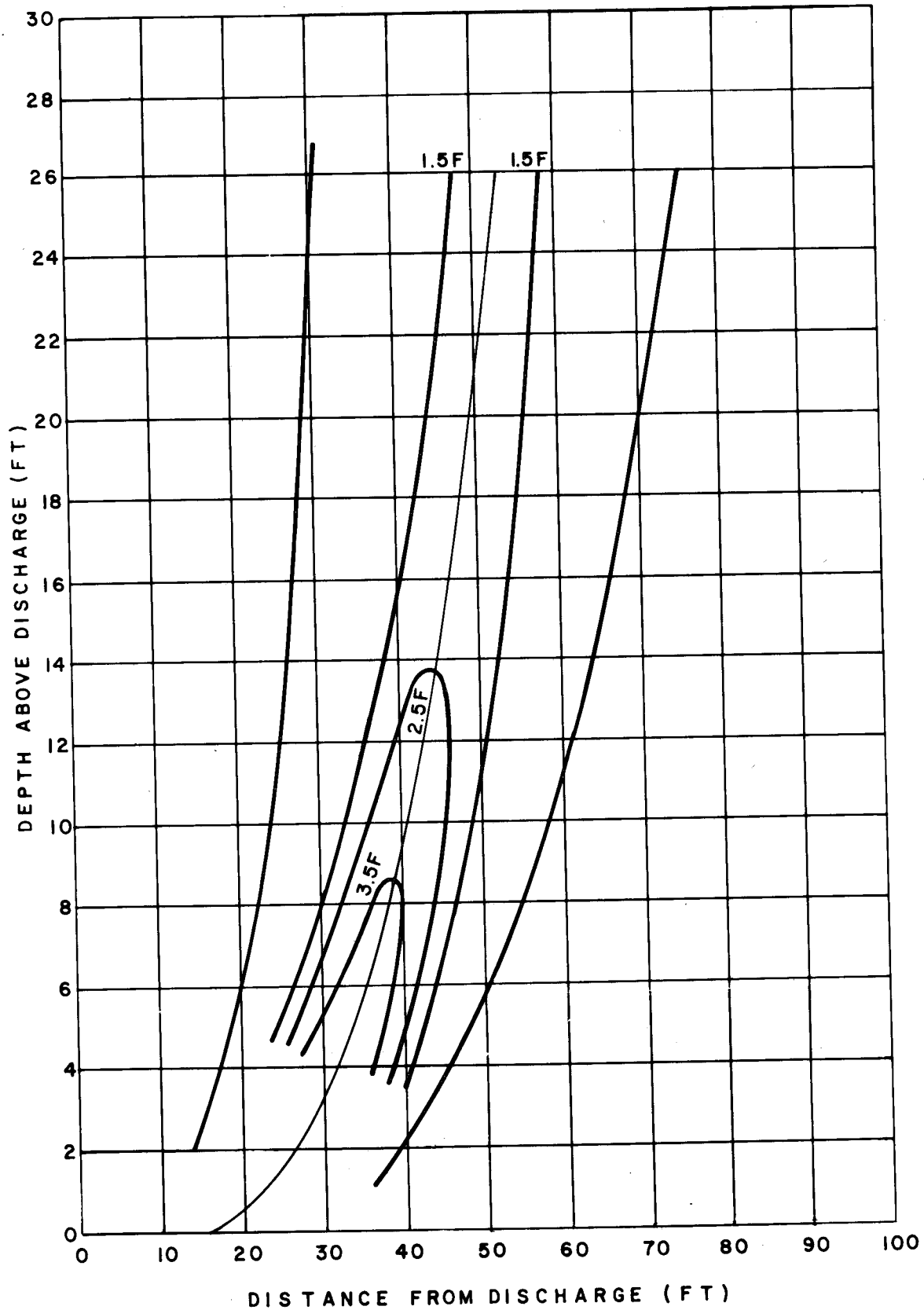
FIGURE 5.1-17



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PLUME TEMPERATURE DISTRIBUTION
TOTAL DISCHARGE (IN cfs)
THROUGH DIFFUSERS = 613

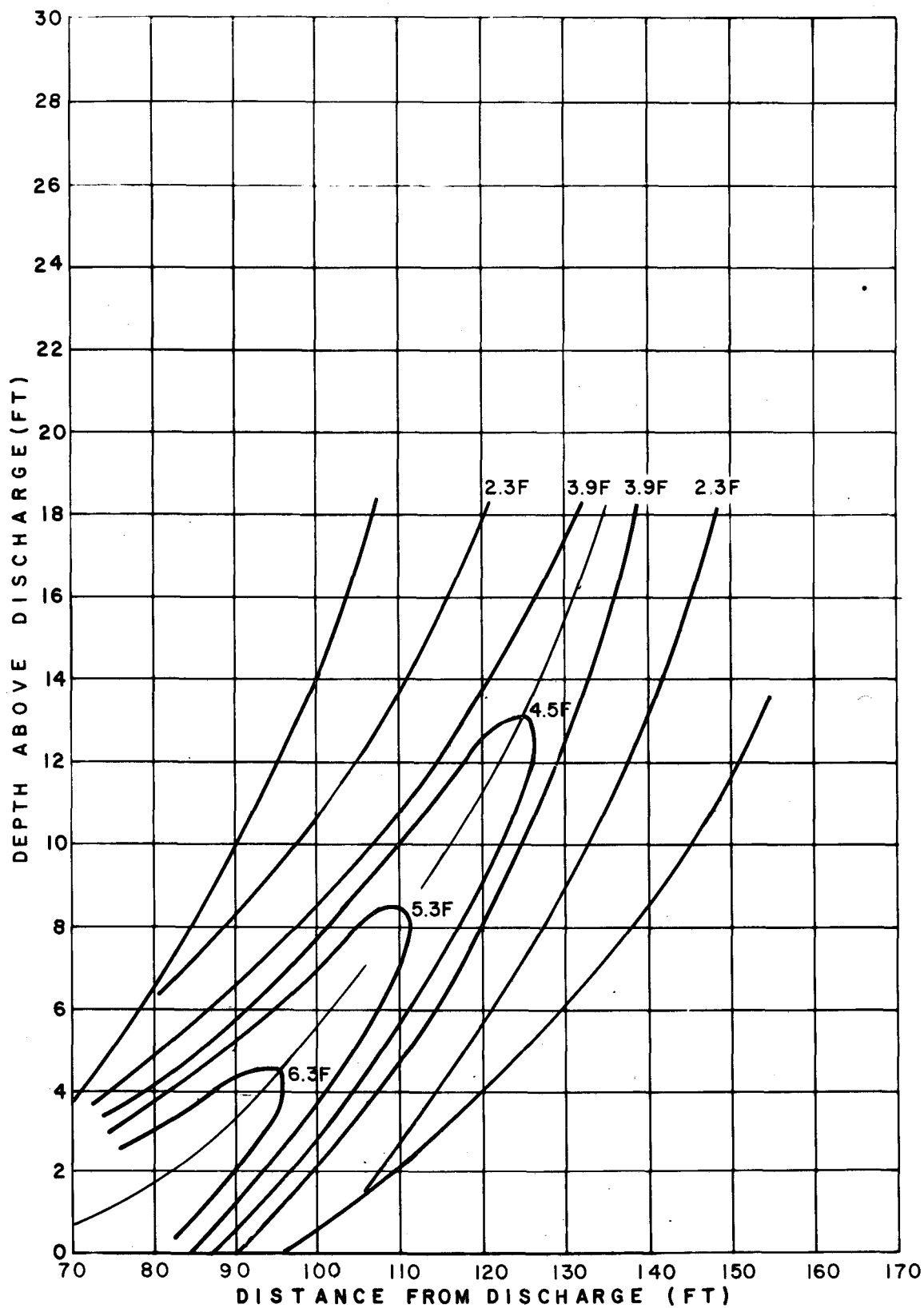
FIGURE 5.1-18



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PLUME TEMPERATURE DISTRIBUTION
TOTAL DISCHARGE (IN cfs)
THROUGH DIFFUSERS = 613

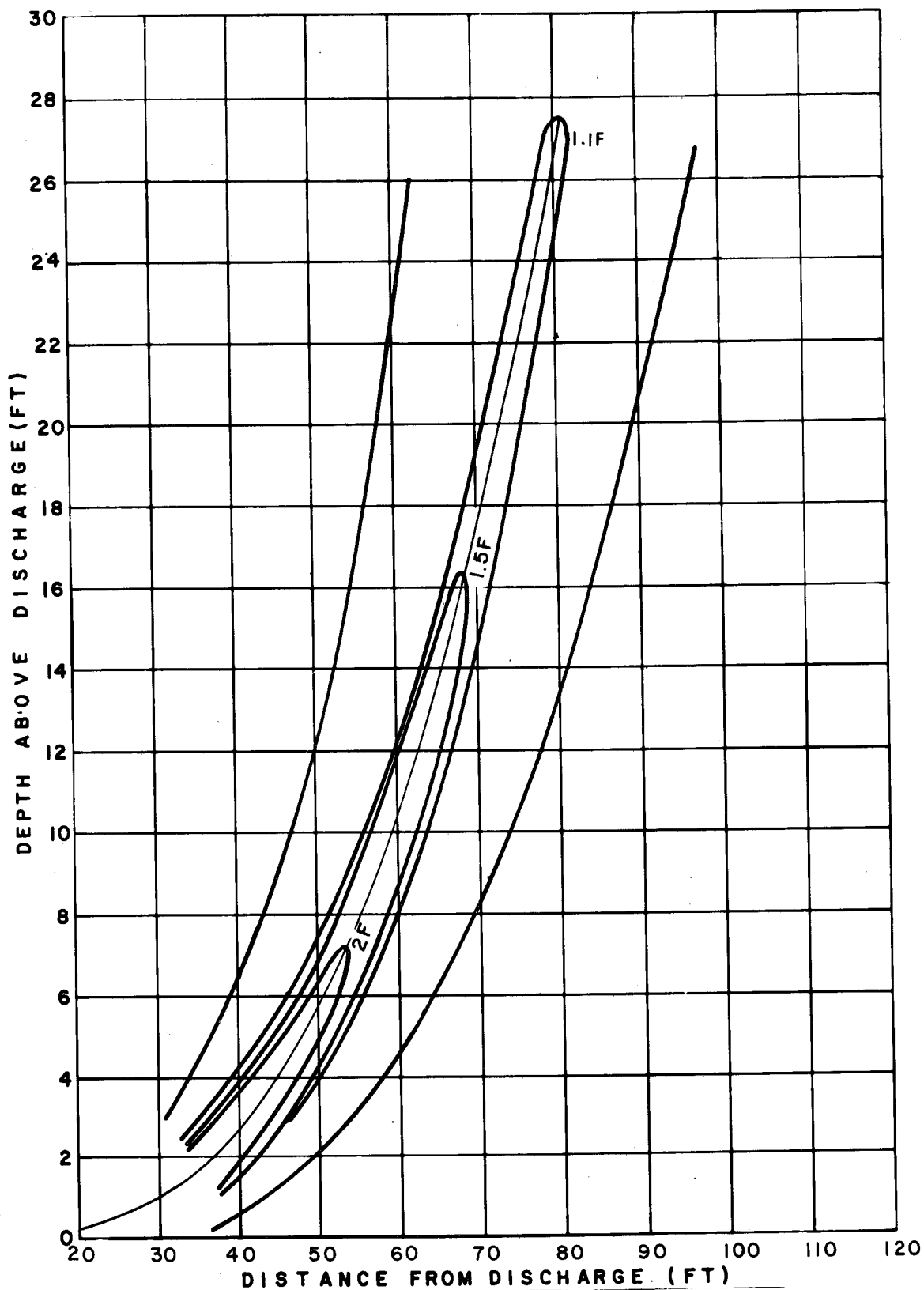
FIGURE 5.1-19



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PLUME TEMPERATURE DISTRIBUTION
TOTAL DISCHARGE (IN cfs)
THROUGH DIFFUSERS = 911

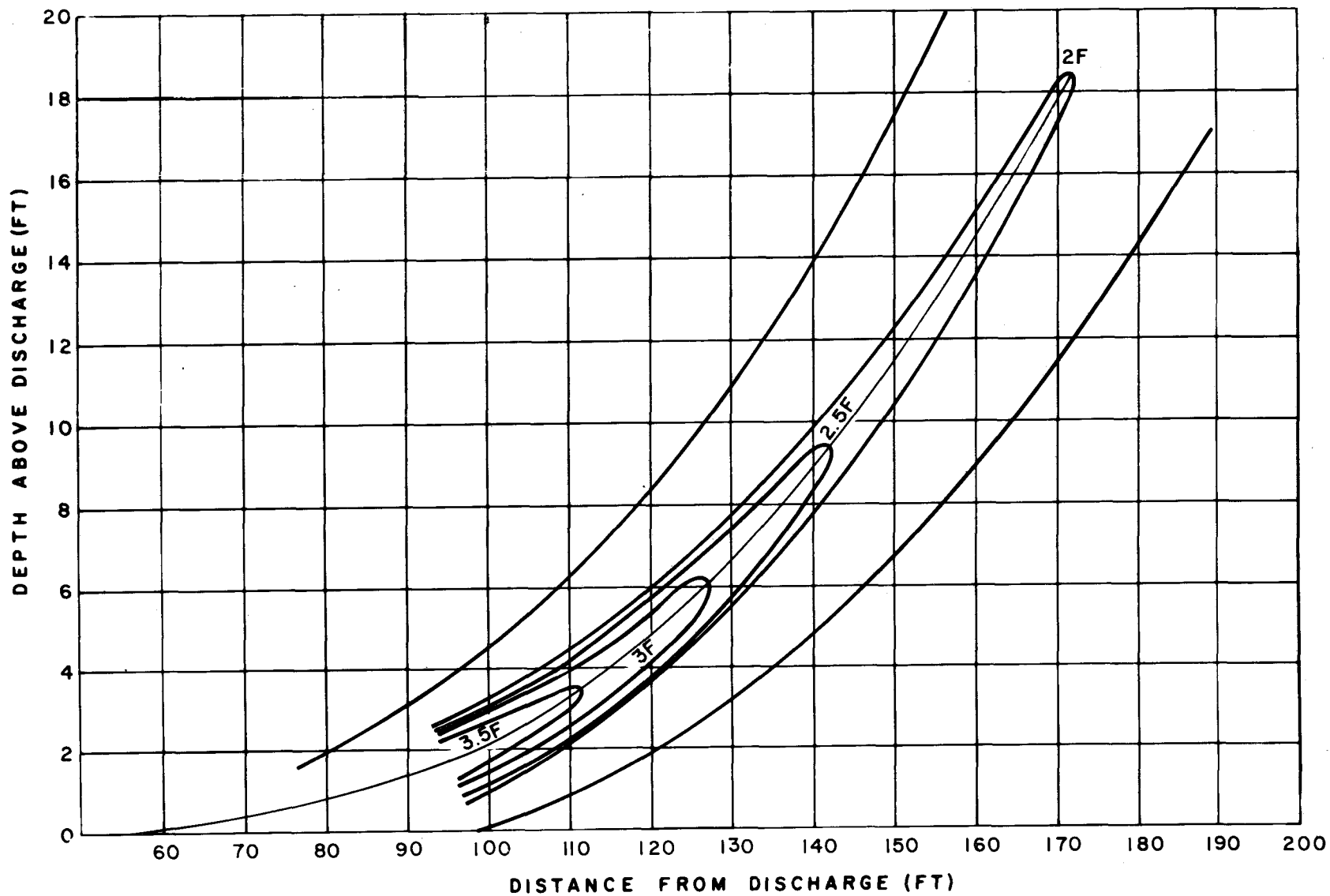
FIGURE 5.1-20



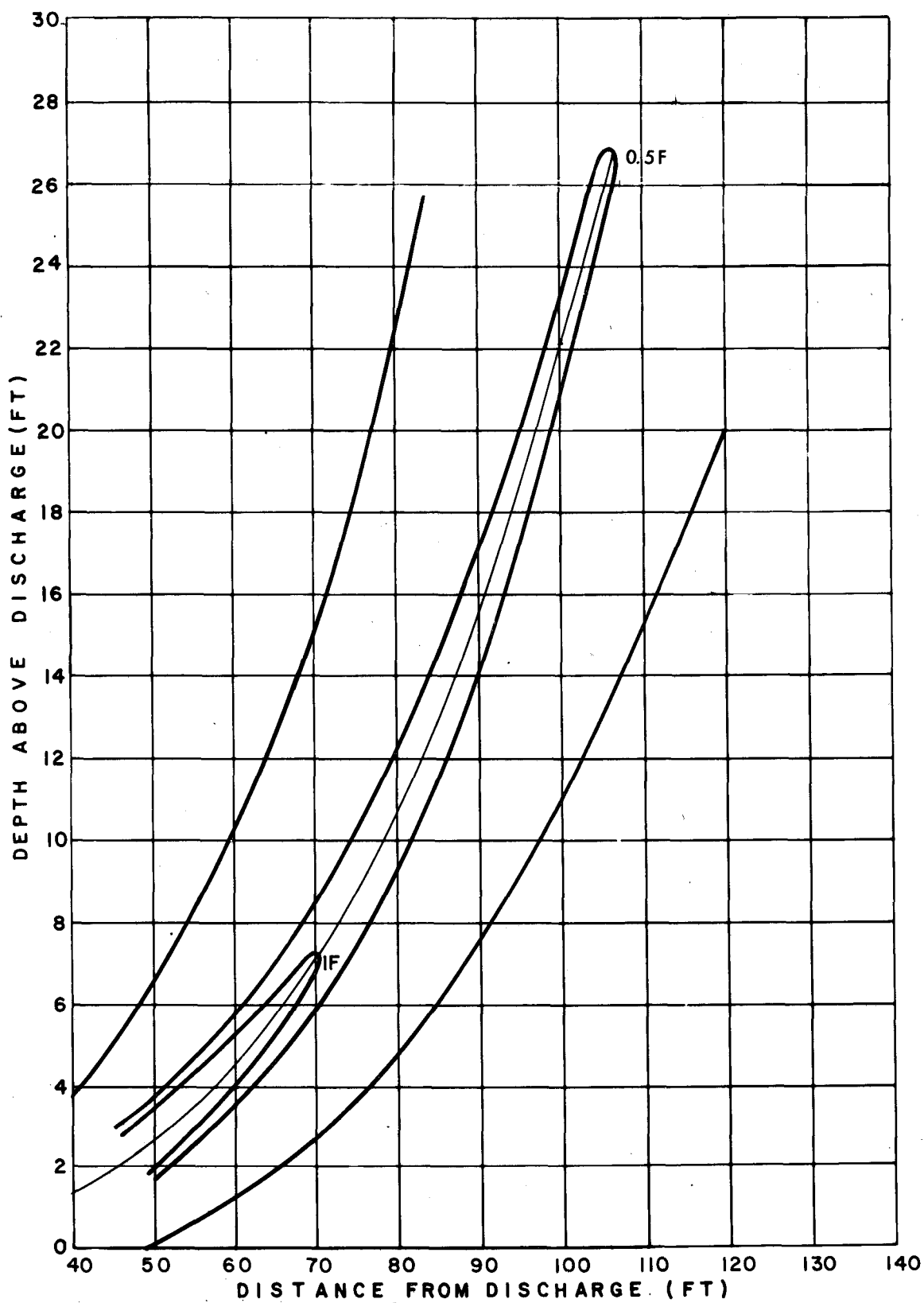
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PLUME TEMPERATURE DISTRIBUTION
TOTAL DISCHARGE (IN cfs)
THROUGH DIFFUSERS = 911

FIGURE 5.1-21



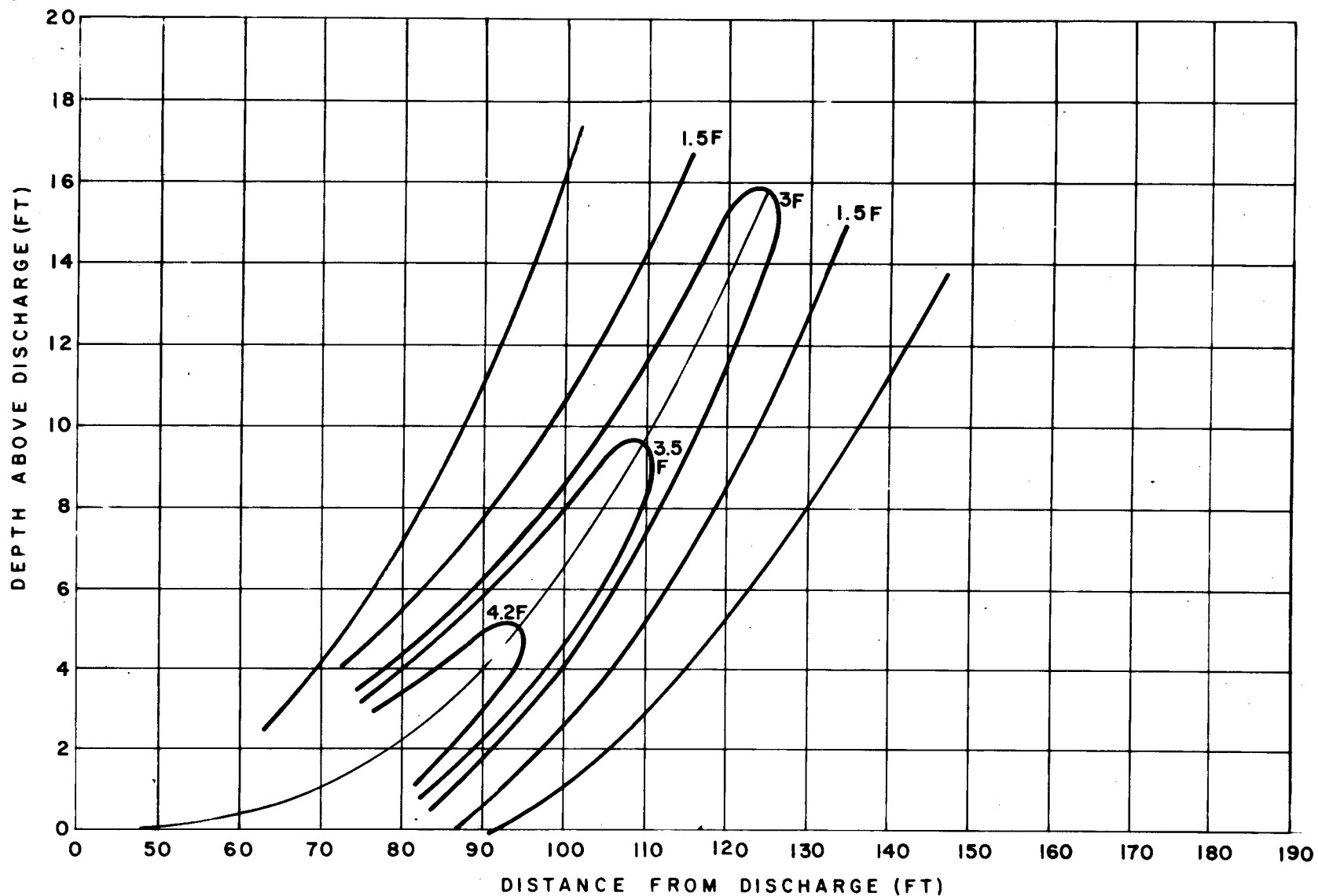
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
PLUME TEMPERATURE DISTRIBUTION
TOTAL DISCHARGE (IN cfs)
THROUGH DIFFUSERS = 1145
FIGURE 5.1-22



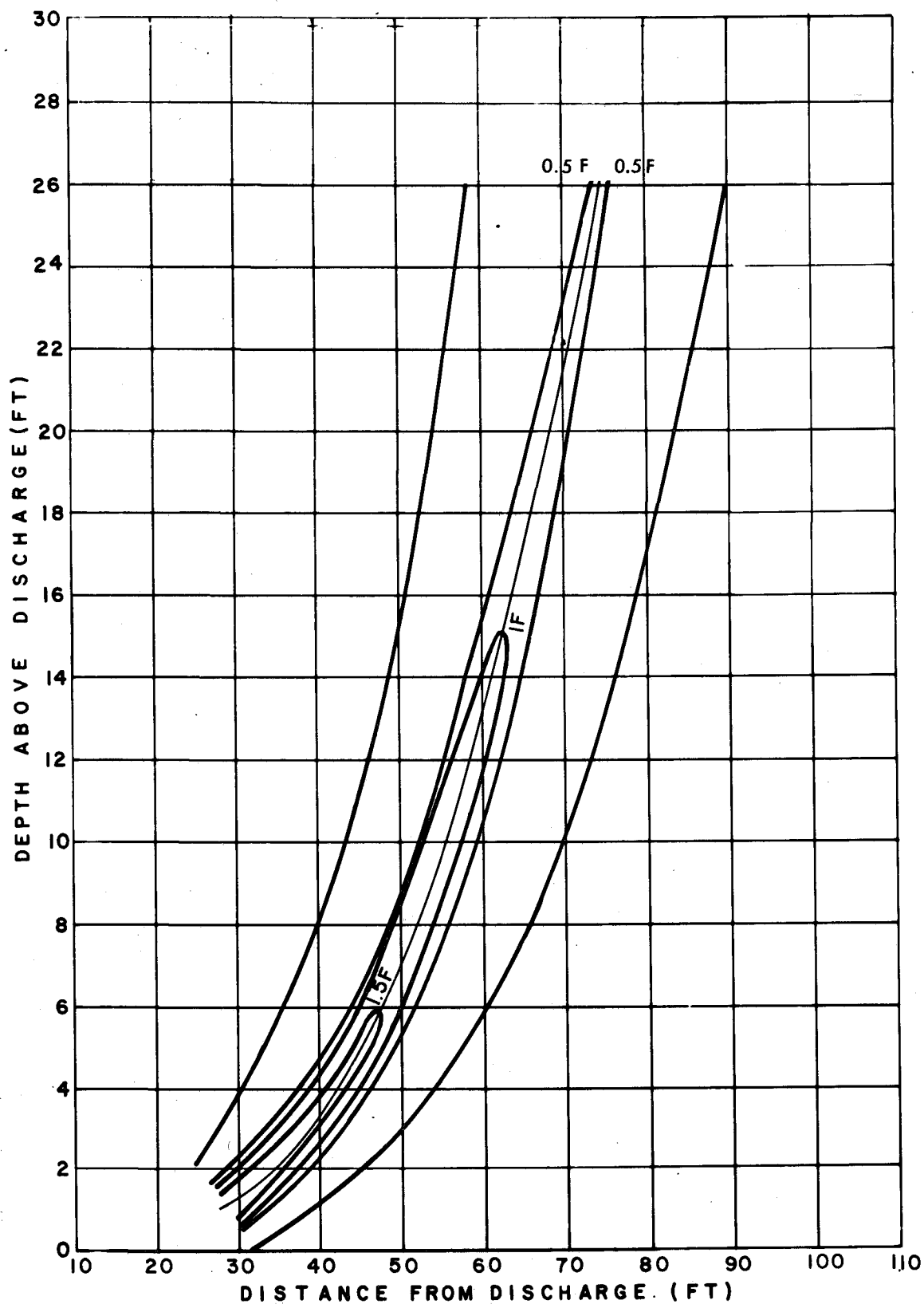
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PLUME TEMPERATURE DISTRIBUTION
TOTAL DISCHARGE (IN cfs)
THROUGH DIFFUSERS = 1145

FIGURE 5.1-23



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
PLUME TEMPERATURE DISTRIBUTION
TOTAL DISCHARGE (IN cfs)
THROUGH DIFFUSERS = 667
FIGURE 5.1-24



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PLUME TEMPERATURE DISTRIBUTION
TOTAL DISCHARGE (IN cfs)
THROUGH DIFFUSERS = 667

FIGURE 5.1-25

5.2 RADIOLOGICAL IMPACT ON BIOTA OTHER THAN MAN

Terrestrial and aquatic biota in the vicinity of Hutchinson Island will be exposed to radioactive materials released in the liquid and gaseous effluent from the facility. In this section an estimate is made of the maximum realistic dose to terrestrial and aquatic organisms, and the critical radionuclides and exposure pathways responsible for this dose are identified.

5.2.1 EXPOSURE PATHWAYS

Section 2.7 presents a list of the local flora and local and migratory fauna in the terrestrial and aquatic environment in the vicinity of Hutchinson Island. Aquatic biota will be exposed to external radiation from the water and sediment and internal radiation from the uptake of radionuclides through their food chain and direct sorption from water. Terrestrial biota will be exposed to external radiation from the air and soil and internal radiation from the assimilation of radioactive materials.

In the aquatic environment the first trophic level consists predominantly of diatoms, dinoflagellates and bluegreen algae. The second trophic level is predominantly zooplankton of the order copepoda. These organisms feed on phytoplankton and serve as the link in the food chain between the first and higher trophic levels. A sparse benthic population (listed in Section 2.7) exists which feed on phytoplankton, zooplankton and organic detritus.

Section 2.7 presents a list of the local and migratory fish observed offshore of Hutchinson Island. The fish of greatest importance to the St. Lucie county fin fishery are the migratory fish king mackerel (Scomberomous cavalla), Spanish mackerel (Scomberomous maculatus) and bluefish (Pomatomus saltatrix). These fish feed upon smaller fish, which in turn feed upon the benthic organisms.

Figure 5.2-1 is a flowchart of the transfer of radionuclides through the food web described above. In addition to uptake via the ingestion of food organisms, fish and invertebrates acquire radionuclides through direct sorption from water. It is also possible that radioactivity on ingested sediment can be at least partially assimilated by fish and invertebrates.

A group of organisms of unique concern on Hutchinson Island are the sea turtles Caretta caretta and Chalonia mydas mydas. The latter are considered marginal to being included on most lists of endangered species. These turtles nest in the sand along the shore of Hutchinson Island and feed in the sea offshore. Caretta is generally carnivorous while Chalonia is generally herbivorous.

Figure 5.2-2 presents the pathways by which terrestrial biota in the vicinity of Hutchinson Island are exposed to radionuclides released in the gaseous effluent of the St. Lucie Unit No. 2 facility. The specific wildlife involved in this food web are numerous and are listed in Section 2.7. The racoon and opossum are the most numerous omnivores on the island.

5.2.2 RADIOACTIVITY IN THE ENVIRONMENT

The liquid effluent of the plant is discharged into the Atlantic Ocean off Hutchinson Island at a rate of approximately 530,000 gallons per minute. The expected average concentration of the radionuclides present in the effluent canal, based on releases listed in Table 5.3-8 is presented in Column 1 of Table 5.2-1. The releases have been calculated assuming the contribution of steam generator blowdown rates of 0.14 and 10 gpm. Column 2 presents the expected concentration of radionuclides in sea water in the vicinity of Hutchinson Island after the effluent canal water mixes with the surrounding sea water. A dilution factor of 20 was used in this calculation. Based on near field diffusion models for St. Lucie, this appears to be a conservative assumption.

A conservative estimate of the concentration of radionuclides in the ocean sediment was made using the distribution coefficients** presented by Duursma and Gross.¹ Column 3 of Table 5.2-1 presents the expected activity in the sediment using the most conservative of Duursma and Gross's distribution coefficients.

The ground level airborne activity (Ci/m^3) in the vicinity of the plant is the product of the values of X/Q (sec/m^3), presented in Table 5.2-2, with the release rates (Ci/sec), presented in Table 5.2-3. The highest offsite airborne ground level concentration is expected to occur at the site boundary in the SW direction where $X/Q = 1.73 \times 10^{-6} \text{ sec/m}^3$.

The gaseous release rates were calculated utilizing the guidance provided as specified in Regulatory Guide 1.42 except that a 0.1% failed fuel rate was assumed. This failed fuel rate or less corresponds to the average fuel performance anticipated over the life of the facility. Regulatory Guide 1.42 assumptions result in a blowdown rate of about 18 gpm.

Table 5.2-3 presents the expected ground concentration of radionuclides at the area of maximum ground level air concentration. These values were determined by using a deposition velocity of .01 m/sec and a removal process which only considers radiological decay.

Table 5.2-3 also lists the expected radioiodine activity on vegetation at the site of predicted maximum airborne ground level radionuclide concentration. This was determined by using a deposition rate which assumes that $\frac{1}{4}$ of the deposited activity lands on edible portions of the vegetation and a removal rate which considers both radioactive decay and physical removal processes. The physical removal processes include fall-off and wash-off and have a half life of 14 days.

5.2.3 DOSE RATE ESTIMATES

The radiation dose rates to aquatic biota presented in Table 5.2-4 are based on radionuclide concentrations presented in Table 5.2-1 and the bioaccumulation factors in Table 5.2-5. The greatest dose rate is to organisms living in the ocean sediment (1.2 mrem/year), and the radio-cesium and radiocobalt isotopes are predominantly responsible for this dose.

** Distribution coefficient = activity per gram sediment $\div$ activity per ml water

This exposure rate is considered negligible because it has been generally assumed that if the dose to biota other than man is within the guidelines for man, there will be no detrimental effects to the biota from this exposure. Templeton et al (1971)⁶ and also the 1972 UNSCEAR Report⁵ indicate that at the above doses no adverse effects to aquatic biota are expected.

The green turtle, Chalonia mydas mydas, is an organism of unique concern at Hutchinson Island because it is considered marginal to being included on most lists of endangered species. Chalonia nest in the sand along the ocean shore above the mean high water level and feed on marine plants in the ocean offshore. Accordingly, they are exposed externally to radioactivity in the air, water, and on the ground, and internally, from radioactivity associated with ingested marine plants. The dose to Chalonia mydas mydas from its various exposure pathways are presented in Table 5.2-6.

The total dose to Chalonia from all pathways is 25 mrem/year. The doses from submersion in water, submersion in air, contaminated ground and ingestion of marine plants were analyzed. The ingestion of marine plants living in the effluent canal is almost totally responsible for this dose and tritium is the critical radionuclide.

The exposure rate to Chalonia mydas mydas of 25 mrem/year reflects the most conservative dose estimate for terrestrial biota. The dose to terrestrial biota from the ingestion of food will be no greater, and usually appreciably lower, than that calculated from Chalonia mydas mydas because Chalonia feeds on marine algae which are expected to have a relatively high radionuclide concentration as compared to terrestrial organisms.

5.2.4 MATHEMATICAL PROCEDURES

The external gamma dose to biota from continuous immersion in water, (¹D), is given by the following equation:

$${}^1D_i = \frac{A_i \mu\text{Ci}}{\text{cc water}} \cdot \frac{3.7 \times 10^4 \text{ dis}}{\text{sec} - \mu\text{Ci}} \cdot \frac{E_{\gamma i} \text{ MeV}}{\text{dis}} \cdot \frac{1.6 \times 10^{-6} \text{ ergs}}{\text{MeV}} \cdot \frac{3.5 \times 10^7 \text{ sec}}{\text{yr}} \cdot \frac{10^{-2} \text{ rem-g}}{\text{erg}} \cdot \frac{1 \text{ cc}}{\text{g}} = 18.65 \times 10^3 E_{\gamma i} A_i$$

where:

1D_i = dose from the i^{th} radionuclide to an organism in an effectively infinite plume of radioactivity (rems/yr)

$E_{\gamma i}$ = average gamma energy per disintegration (MeV) of the i^{th} radionuclide

A_i = activity of the i^{th} radionuclide in water ($\mu\text{Ci/ml}$)

The external gamma dose from the sediment to organisms living in the sediment, (2D), is given by the following equation:

$$^2D_1 = (18.65 \times 10^3) (S_i) (E_{\gamma i})$$

where:

$$S_i = \text{activity in the sediment of the } i^{\text{th}} \text{ radionuclide} \\ (\mu\text{Ci/g})$$

The external gamma dose from the sediment to organisms living at the sediment surface (3D) is given by the following:

$$^3D_1 = \frac{1}{2} ^2D_1$$

The external beta dose from water to algae and small invertebrates is given by the following equation:

$$(<1 \text{ cm}) (^4D), \\ ^4D_1 = (18.65 \times 10^3) (A_i) E_{\beta i}$$

where:

$$E_{\beta i} = \text{average beta energy per disintegration (MeV)} \\ \text{of the } i^{\text{th}} \text{ radionuclide.}$$

The external beta dose from water to fish and large invertebrates (5D), is given by the following equation:

$$^5D_1 = \frac{1}{2} ^4D_i$$

The internal gamma exposure (6D) is given by:

$$^6D_{ij} = (18.65 \times 10^3) (\text{c.f.}_{ij}) (E_{\gamma i}) (A_i) (\Delta t_{ij})$$

where:

$c.f._{ij}$ = concentration factor of the i^{th} radionuclide by the j^{th} organism. (The j organisms being fish, crustacea, algae and molluscs.)

Δ_{ij} = fraction of the emitted energy of the i^{th} radionuclide which is absorbed by the j^{th} organism.

The internal beta exposure (7D) is given by:

$${}^7D_i = (18.65 \times 10^3) (c.f._{ij}) (A_i) (1 - e^{-\mu_i l_j}) (E_{\beta i})$$

where:

μ_i = linear attenuation coefficient of the i^{th} radionuclide (microns⁻¹)

l_j = effective radius of the j^{th} organism (microns)

The internal alpha dose, (8D), is given by:

$${}^8D_i = (18.65 \times 10^{-3}) (A_i) (E_{\alpha i}) (c.f._{ij})$$

where:

E_i = average alpha energy per disintegration of the i^{th} radionuclide (MeV)

The dose to the Chalonia mydas mydas from the ingestion of algae can be estimated using the following equation:

$${}^9D_i = \frac{(1.87 \times 10^7) (C_i) (E_i)}{m}$$

where:

9D_i = the dose rate in mrem/year from the i^{th} radionuclide

C_i = the equilibrium concentration of the i^{th} radionuclide in the organism ($\mu C_i/g$)

E_i = the effective energy per disintegration in the organism (MeV)

m = mass of the organism (g)

The equilibrium body burden of the organism (C_i) can be obtained using the following equation:

$$C_i = 1.4 T_i A_i (c.f._{ij}) F_i I_i$$

where:

T_i = effective half life of the i^{th} radionuclide in the organism (days)

A_i = concentration of the i^{th} radionuclide in the effluent canal ($\mu\text{Ci/ml}$)

c.f._i = the concentration factor for the i^{th} radionuclide in aquatic plants

F_i = the fraction of the ingested activity which is assimilated

I_i = ingestion rate (g/day)

a) Major Assumptions

For the external gamma dose, assume that the plume of radioactive water is effectively infinite. This means that the diameter of the plume is much greater than the range of the gamma rays within it. Under these conditions it can be assumed that the energy absorbed per unit of volume equals the energy released per unit of volume.

Further, if the range of the emissions is large in comparison to the diameter of an organism inside the plume, one can assume that the dose to that organism is the same as the dose to an adjacent volume of water.

For the external gamma dose to organisms living in the sediment, it is conservatively assumed that the activity in the sediment is uniformly distributed with depth.

For calculation of the internal beta dose, the factor $1 - e^{-\mu_1 l_j}$ is used in the above equation as the fraction of the emitted beta energy which is absorbed within the organism. In reality it expresses the fraction of the total beta flux which is attenuated. Since the lower energy beta particles (of a flux of beta particles with a continuous spectrum of energies) are the first to deposit their energy, the attenuation of a given fraction of the beta flux does not mean that fraction of the total energy of the beta emissions has been deposited. Therefore, the above is a conservative estimate of the dose.

For calculation of the internal alpha dose, it is assumed that all of the energy emitted within an organism (plankton included) is deposited within the organism.

For the dose to Chalonia mydas mydas it was assumed that the organism is 10^3 grams and its feeding rate 100 grams/days. The effective energy per disintegration was assumed to be the same as that for lung given in ICRP-2. The fractional assimilation (F_i) by Chalonia for the i^{th} radionuclide was assumed to

be the same as that for man presented in ICRP-2. The effective half life (T_i) for the i^{th} radionuclide in Chalonia was assumed to be the radiological half life of the individual isotopes or 50 years, whichever was less.

The dose to Chalonia and terrestrial biota from contaminated ground and submersion in the air are assumed to be the same as that for man. The procedures used to calculate these doses are presented in Section 5.3.

b) Special Data

In the above series of equation, the values of E_i , E_j , d.f. $_{ij}$, $_{ij}$, i and j are required.

The values of E_i and E_j were calculated from Lederer, C.M., J.M. Hollander and I. Perlman, "Table of Isotopes", 6th Edition, John Wiley and Son, Inc. 1967.

The values of c.f. $_{ij}$ were taken from Chapman, W.H., H.L. Fisher and M.W. Pratt, "Concentration Factors of Chemical Elements in Edible Aquatic Organisms", UCRL-50564, 1968.

Freke, A.M., "A Model for the Approximate Calculation of Safe Rates and Discharge of Radioactive Wastes into Marine Environments", Health Physics, 13:743, 1967.

Soldat, J. K., "Modeling of Environmental Pathways and Radiation Doses from Nuclear Facilities", USAEC Report, BNWL-SA-3939, Pacific Northwest Laboratory, Richland, Va., 1971.

The values of $_{ij}$ were taken from Brownell, G. L., W. H. Ellett and A. R. Reddy, "Absorbed Fraction for Photon Dosimetry", Journal of Nuclear Medicine, Supplement No. 1, February 1968.

The values of i were taken from Radiological Health Handbook, compiled and edited by Division of Radiological Health, U. S. Department of Health, Education and Welfare, 1960.

The values of 1_j will vary with the specific organisms of concerns at each reactor site and therefore must be supplied at the time the calculations are to be done.

TABLE 5.2-1

RADIOACTIVITY IN THE MARINE ENVIRONMENT IN THE VICINITY OF HUTCHINSON ISLAND

<u>Isotope</u>	1 Effluent Canal (Ci/ml)		2 Ocean (Ci/ml)		3 Ocean Sediment (Ci/ml)	
	<u>10gpm</u>	<u>.14gpm</u>	<u>10gpm</u>	<u>.14gpm</u>	<u>10gpm</u>	<u>.14gpm</u>
H-3	0.21(-6)	0.21(-6)	0.11(-7)	0.11(-7)		
Kr-85m	0.10(-21)	0.97(-22)	0.51(-23)	0.49(-23)		
Kr-85	0.37(-7)	0.36(-7)	0.18(-8)	0.18(-8)		
Kr-87	0	0	0	0		
Kr-88	0	0	0	0		
Rb-88	0.33(-11)	0	0.17(-12)	0		
Rb-89	0.74(-13)	0	0.37(-14)	0		
Sr-89	0.10(-11)	0.13(-13)	0.50(-13)	0.65(-15)	0.13(-9)	0.17(-11)
Sr-90	0.51(-13)	0.12(-14)	0.25(-14)	0.60(-16)	0.66(-11)	0.16(-12)
Y-90	0.21(-13)	0.21(-13)	0.11(-14)	0.11(-14)		
Sr-91	0.40(-12)	0.15(-20)	0.20(-13)	0.75(-22)	0.52(-10)	0.20(-18)
Y-91	0.41(-10)	0.21(-10)	0.21(-11)	0.11(-11)		
Mo-99	0.27(-9)	0.46(-10)	0.14(-10)	0.23(-11)		

TABLE 5.2-1 (Cont'd)

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<u>Isotope</u>	1 Effluent Canal (Ci/ml)		2 Ocean (Ci/ml)		3 Ocean Sediment (Ci/ml)	
	<u>10gpm</u>	<u>.14gpm</u>	<u>10gpm</u>	<u>.14gpm</u>	<u>10gpm</u>	<u>.14gpm</u>
Ru-103	0.85(-12)	0.77(-13)	0.23(-13)	0.39(-14)	0.17(-9)	0.16(-10)
Ru-106	0.54(-13)	0.56(-14)	0.27(-14)	0.28(-15)	0.11(-10)	0.11(-11)
Te-129	0.47(-11)	0	0.23(-12)	0		
I-129	0.14(-16)	0.19(-18)	0.71(-18)	0.10(-19)		
I-131	0.62(-7)	0.49(-12)	0.31(-8)	0.25(-13)		
Xe-131m	0.35(-7)	0.35(-7)	0.17(-8)	0.18(-8)		
Te-132	0.41(-10)	0.10(-11)	0.22(-11)	0.50(-13)		
I-132	0.12(-9)	0	0.61(-11)	0		
I-133	0.11(-9)	0.51(-15)	0.53(-11)	0.26(-16)		
Xe-133	0.23(-5)	0.23(-5)	0.12(-6)	0.12(-6)		
Te-134	0.82(-13)	0	0.41(-14)	0		
I-134	0.69(-12)	0	0.35(-13)	0		
Cs-134	0.21(-11)	0.21(-11)	0.11(-12)	0.11(-12)	0.17(-9)	0.17(-9)
I-135	0.32(-10)	0.53(-23)	0.32(-11)	0.27(-23)		

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TABLE 5.2-1 (Cont'd)

<u>Isotope</u>	1 Effluent Canal (Ci/ml)		2 Ocean (Ci/ml)		3 Ocean Sediment (Ci/ml)	
	<u>10gpm</u>	<u>.14gpm</u>	<u>10gpm</u>	<u>.14gpm</u>	<u>10gpm</u>	<u>.14gpm</u>
Xe-135	0.49(-16)	0.49(-16)	0.25(-17)	0.25(-17)		
Cs-136	0.34(-12)	0.34(-12)	0.17(-13)	0.17(-13)	0.27(-10)	0.27(-10)
Cs-137	0.26(-10)	0.75(-11)	0.13(-11)	0.38(-12)		
Xe-138	0	0	0	0		
Cs-138	0.43(-11)	0	0.22(-12)	0	0.35(-9)	0
Ba-140	0.63(-10)	0.95(-14)	0.31(-11)	0.48(-15)		
La-140	0.10(-11)	0.31(-14)	0.52(-13)	0.16(-15)		
Pr-143	0.17(-11)	0.81(-13)	0.83(-13)	0.41(-14)		
Ce-144	0.60(-12)	0.95(-13)	0.30(-13)	0.48(-14)	0.29(-8)	0.46(-9)
Co-60	0.21(-11)	0.13(-11)	0.11(-12)	0.70(-13)	0.86(-8)	0.57(-8)
Fe-59	0.14(-12)	0.42(-13)	0.71(-14)	0.12(-14)	0.38(-9)	0.65(-10)
Co-58	0.98(-11)	0.97(-11)	0.49(-12)	0.49(-12)	0.40(-7)	0.40(-7)
Mn-54	0.95(-12)	0.64(-13)	0.48(-12)	0.32(-14)	0.23(-8)	0.15(-9)
Cr-51	0.71(-11)	0.67(-11)	0.36(-12)	0.34(-12)		
Zr-95	0.18(-14)	0.18(-14)	0.90(-16)	0.90(-16)	0.11(-10)	0.11(-10)

TABLE 5.2-2

HUTCHINSON ISLAND SITE
AVERAGE ANNUAL RELATIVE CONCENTRATIONS
AS A FUNCTION OF WIND DIRECTION AND DISTANCE

PERIOD OF RECORD: 03/01/71 TO 02/29/72

SECTOR	DISTANCE IN METERS AND MILES						
	201.13 0.125	402.25 0.25	604.50 0.5	1554.29 0.97*	2413.50 1.5	4022.50 2.5	5631.50 3.5
NNE	2.52(-05)	6.69(-06)	1.96(-06)	6.35(-07)	3.16(-07)	1.49(-07)	8.89(-08)
NE	3.40(-05)	9.29(-06)	2.64(-06)	8.53(-07)	4.24(-07)	2.00(-07)	1.10(-07)
ENE	4.25(-05)	1.16(-05)	3.28(-06)	1.06(-06)	5.24(-07)	2.47(-07)	1.47(-07)
E	4.59(-05)	1.24(-05)	3.49(-06)	1.22(-06)	5.56(-07)	2.61(-07)	1.55(-07)
ESE	5.61(-05)	1.58(-05)	4.50(-06)	1.46(-06)	7.26(-07)	3.41(-07)	2.03(-07)
SE	5.74(-05)	1.56(-05)	4.42(-06)	1.43(-06)	7.11(-07)	3.34(-07)	1.99(-07)
SSE	5.53(-05)	1.52(-05)	4.37(-06)	1.42(-06)	7.08(-07)	3.34(-07)	1.98(-07)
S	5.47(-05)	1.51(-05)	4.33(-06)	1.42(-06)	7.04(-07)	3.31(-07)	1.96(-07)
SSW	4.53(-05)	1.25(-05)	3.60(-06)	1.17(-06)	5.81(-07)	2.73(-07)	1.62(-07)
SW	6.71(-05)	1.84(-05)	5.32(-06)	1.73(-06)	8.60(-07)	4.04(-07)	2.40(-07)
WSW	4.66(-05)	1.29(-05)	3.71(-06)	1.21(-06)	6.02(-07)	2.65(-07)	1.70(-07)
W	3.79(-05)	1.04(-05)	3.01(-06)	9.81(-07)	4.89(-07)	2.31(-07)	1.36(-07)
WNW	4.21(-05)	1.16(-05)	3.33(-06)	1.09(-06)	5.42(-07)	2.57(-07)	1.53(-07)
NW	5.28(-05)	1.45(-05)	4.20(-06)	1.37(-06)	6.84(-07)	3.35(-07)	1.94(-07)
NNW	3.29(-05)	9.07(-06)	3.61(-06)	8.32(-07)	4.25(-07)	2.02(-07)	1.20(-07)
N	3.10(-05)	3.50(-06)	2.43(-06)	7.88(-07)	3.93(-07)	1.86(-07)	1.11(-07)

* Restricted Distance

TABLE 5.2-2 (Cont'd)

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SECTOR	DISTANCE IN METERS AND MILES						
	7240.5 4.5	8046.50 5.0**	12067.5 7.5	24135.0 15.0	40225.0 25.0	56315.0 35.0	72405.0 45.0
NNE	5.93(-06)	4.96(-08)	2.83(-08)	1.10(-08)	5.53(-09)	3.56(-09)	2.56(-09)
NE	7.95(-08)	6.69(-08)	3.79(-08)	1.40(-08)	7.45(-09)	4.31(-09)	3.50(-09)
ENE	9.77(-08)	8.16(-08)	4.66(-08)	1.81(-08)	9.12(-09)	5.36(-09)	4.25(-09)
E	1.03(-07)	8.61(-08)	4.92(-08)	1.91(-08)	9.64(-09)	6.22(-09)	4.53(-09)
ESE	1.35(-07)	1.13(-07)	6.43(-08)	2.31(-08)	1.27(-08)	2.19(-09)	5.96(-09)
SE	1.32(-07)	1.11(-07)	6.31(-08)	2.47(-08)	1.25(-08)	8.10(-09)	5.91(-09)
SSE	1.32(-07)	1.10(-07)	6.27(-08)	2.44(-08)	1.23(-08)	7.91(-09)	5.75(-09)
S	1.30(-07)	1.09(-07)	6.18(-08)	2.39(-08)	1.19(-08)	7.65(-09)	5.54(-09)
SSW	1.07(-07)	8.96(-08)	5.09(-08)	1.96(-08)	9.76(-09)	6.24(-09)	4.52(-09)
SW	1.59(-07)	1.33(-07)	7.57(-08)	2.94(-08)	1.47(-08)	9.47(-09)	6.87(-09)
WSW	1.13(-07)	9.46(-08)	5.39(-08)	2.11(-08)	1.06(-08)	6.82(-09)	4.95(-09)
W	9.16(-08)	7.69(-08)	4.37(-08)	1.71(-08)	8.60(-09)	5.54(-09)	4.02(-09)
WNW	1.02(-07)	8.56(-08)	4.67(-08)	1.91(-08)	9.59(-09)	6.17(-09)	4.48(-09)
NW	1.29(-07)	1.06(-07)	6.15(-08)	2.41(-08)	1.22(-08)	7.79(-09)	5.65(-09)
NNW	8.03(-08)	6.73(-08)	3.63(-08)	1.50(-08)	7.51(-09)	4.80(-09)	3.50(-09)
N	7.42(-08)	6.26(-08)	3.54(-08)	1.38(-08)	6.93(-09)	9.40(-09)	3.23(-09)

** Low Population Zone Distance

5.2-12

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TABLE 5.2-3

HIGHEST OFF-SITE CONCENTRATION OF RADIONUCLIDES
IN THE TERRESTRIAL ENVIRONMENT

	Gaseous			
	Release Rate (1)	Ground Level (2)	Ground (3)	Vegetation (4)
	(Ci/sec per unit)	Air (Ci/m ³)	(Ci/m ²)	(Ci/m ²)
Kr-85m	0.31(-6)	0.53(-12)	0	0
Kr-85	0.12(-4)	0.21(-10)	0	0
Kr-87	0.15(-6)	0.27 (-12)	0	0
Kr-88	0.52(-6)	0.89 (-12)	0	0
Xe-131m	0.43(-5)	0.75(-11)	0	0
Xe-133	0.12(-3)	0.20(-9)	0	0
Xe-135	0.16(-5)	0.27(-11)	0	0
Xe-138	0.62(-7)	0.11(-12)	0	0
I-129	0.11(-15)	0.20(-21)	0	0
I-131	0.57(-8)	0.98(-14)	0.98 (-11)	0.16(-10)
I-132	0.14(-8)	0.24(-14)	0.98(-11)	0.20(-11)
I-133	0.60(-8)	0.95(-15)	0.10(-9)	0.27(-11)
I-134	0.42(-9)	0.73 (-15)	0.33(-13)	0.82(-14)
I-135	0.24(-8)	0.42(-14)	0.15(-11)	0.36(-12)

(1) Based on Regulatory Guide 1.42 assumption and 0.1% failed fuel.

(2) $X/Q = 1.73 \times 10^{-6} \text{ sec/m}^3$

(3) 1 cm/sec deposition velocity and loss via decay.

(4) 1 cm/sec deposition velocity x 0.25. Loss via decay plus removal processes with a $T_{1/2} = 14 \text{ days}$

TABLE 5.2-4

DOSE TO AQUATIC BIOTA

A. Exposure to aquatic biota in ocean - 10 gpm blowdown

<u>Source of Exposure</u>	<u>Algae (mrem/yr)</u>	<u>Crustacea (mrem/yr)</u>	<u>Molluscs (mrem/yr)</u>	<u>Fish (mrem/yr)</u>
External γ from water	0.86(-3)*	0.86(-3)	0.86(-3)	0.86(-3)
External β from water	0.16(-2)	0.80(-3)	0.80(-3)	0.80(-3)
Internal γ from assim- ilated and sorped activity	negligible	0.31(-1)	0.17(-1)	0.37(-2)
Internal β from assim- ilated and sorped activity	0.32(-1)	0.62(-1)	0.44(-1)	0.89(-2)
External γ from sub- mersion in sediment	1.2	1.2	1.2	1.2

B. Exposure to aquatic biota in ocean - .14 gpm blowdown

External γ from water	0.35(-4)	0.35(-4)	0.35(-4)	0.35(-4)
External β from water	0.13(-2)	0.7(-3)	0.7(-3)	0.7(-3)
Internal γ from assim- ilated and sorped activity	negligible	0.16(-1)	0.12(-2)	0.26(-3)
Internal β from assim- ilated and sorped activity	0.1(-2)	0.2(-1)	0.45(-2)	0.15(-2)
External γ from sub- mersion in sediment	0.8	0.8	0.8	0.8

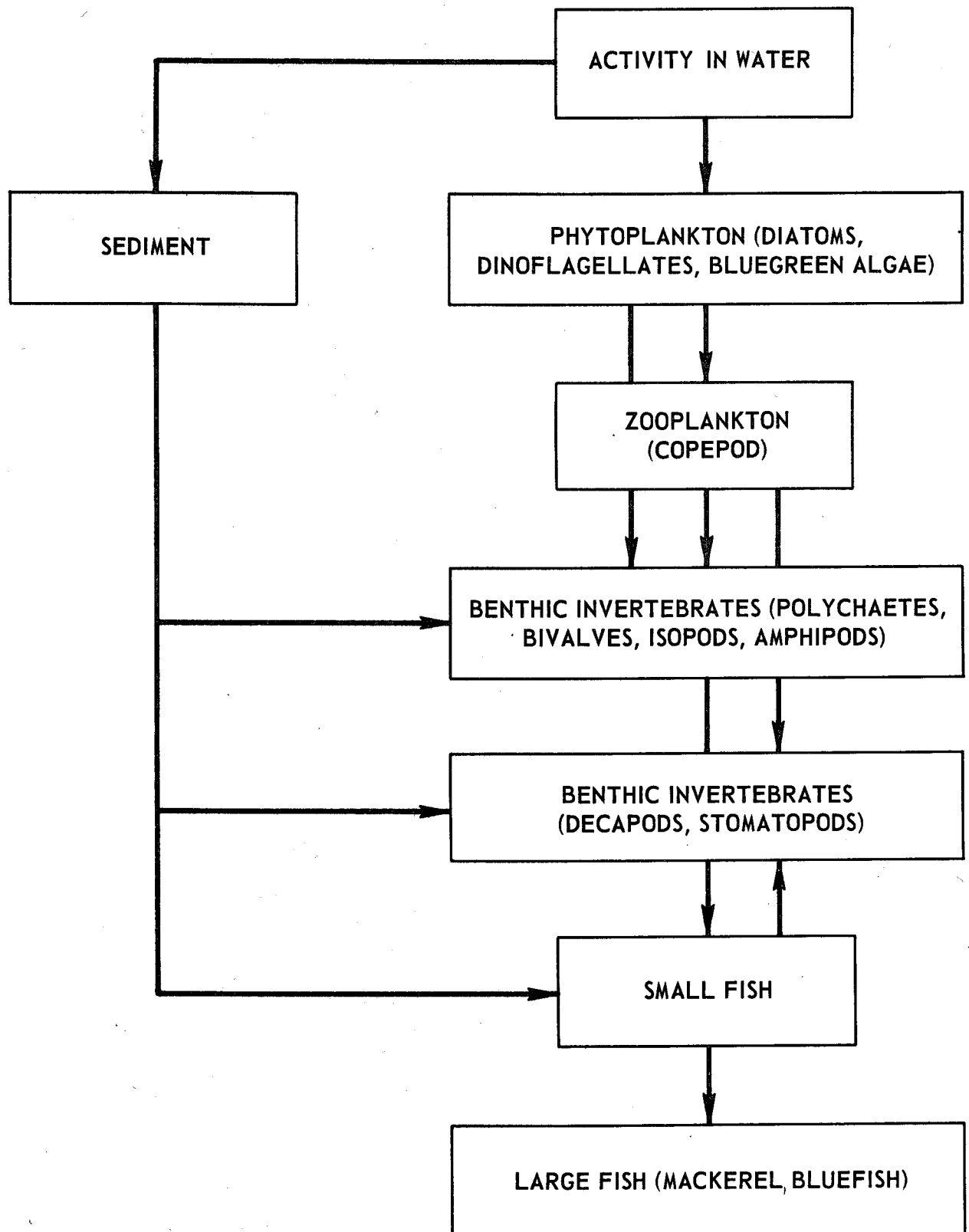
* Numbers within () denote powers of ten.

TABLE 5.2-5
BIOLOGICAL CONCENTRATION FACTORS
(pCi/kg per pCi/liter)

Nuclide	Fresh Water (2,3)				Salt Water (4)			
	Fish	Crustacea	Molluscs	Algae	Fish	Crustacea	Molluscs	Algae
H-3	1	1	1	1	1	1	1	1
C-14	5,000	4,000	4,000	5,000	1	1	1	1
F-18	3	3	3	2	4	4	4	1
NA-22	100	100	100	150	1	1	1	1
NA-24	100	100	100	150	1	1	1	1
P-32	100,000	100,000	100,000	100,000	10,000	10,000	10,000	100,000
AR-39	0	0	0	0	0	0	0	0
AR-41	0	0	0	0	0	0	0	0
SC-46	100	1,000	1,000	10,000	100	300	300	1,000
CR-51	1	10	10	20	100	1,000	1,000	1,000
MN-54	1,000	40,000	40,000	10,000	3,000	10,000	50,000	10,000
MN-56	1,000	40,000	40,000	10,000	3,000	10,000	50,000	10,000
FE-55	5,000	10,000	10,000	5,000	1,000	4,000	20,000	6,000
FE-59	5,000	10,000	10,000	5,000	1,000	4,000	20,000	6,000
CO-57	50	200	200	1,000	100	10,000	300	100
CO-58	50	200	200	1,000	100	10,000	300	100
CO-60	50	200	200	1,000	100	10,000	300	100
NI-63	40	100	100	100	500	100	100	100
NI-65	40	100	100	100	500	100	100	100
CU-64	50	200	200	1,000	1,000	5,000	5,000	1,000
ZN-65	150	5,000	5,000	4,000	5,000	5,000	50,000	1,000
ZN-69M	150	5,000	5,000	4,000	5,000	5,000	50,000	1,000
ZN-69	150	5,000	5,000	4,000	5,000	5,000	50,000	1,000
BR-82	130	100	100	750	3	10	10	100
BR-83	130	100	100	750	3	10	10	100
BR-84	130	100	100	750	3	10	10	100
BR-85	130	100	100	750	3	10	10	100
KR-83M	0	0	0	0	0	0	0	0
KR-85M	0	0	0	0	0	0	0	0
KR-85	0	0	0	0	0	0	0	0
KR-87	0	0	0	0	0	0	0	0
KR-88	0	0	0	0	0	0	0	0
RB-86	2,000	2,000	2,000	1,000	30	50	10	10
RB-88	2,000	2,000	2,000	1,000	30	50	10	10
RB-89	2,000	2,000	2,000	1,000	30	50	10	10
SR-89	1	20	20	500	1	1	1	20
SR-90	1	20	20	500	1	1	1	20
SR-91	1	20	20	500	1	1	1	20
SR-92	1	20	20	500	1	1	1	20
Y-90	100	1,000	1,000	10,000	30	100	100	300
Y-91M	100	1,000	1,000	10,000	30	100	100	300
Y-91	100	1,000	1,000	10,000	30	100	100	300
Y-92	100	1,000	1,000	10,000	30	100	100	300
Y-93	100	1,000	1,000	10,000	30	100	100	300
ZR-95	10	100	100	1,000	30	100	100	1,000
ZR-97	10	100	100	1,000	30	100	100	1,000
NB-95	30,000	100	100	1,000	100	200	200	100
NB-97	30,000	100	100	1,000	100	200	200	100
MO-99	100	100	100	100	10	100	100	100
TC-99M	1	25	25	100	10	100	100	1,000
TC-101	1	25	25	100	10	100	100	1,000
RU-103+D	5	100	100	2,000	3	100	100	1,000
RU-105+D	5	100	100	2,000	3	100	100	1,000
RU-106+D	5	100	100	2,000	3	100	100	1,000
RH-105	100	100	100	2,000	10	100	100	100
RH-106	100	100	100	2,000	10	100	100	100
PD-109+D	100	2,000	2,000	2,000	10	100	100	100
AG-110M+D	3,000	3,100	3,100	200	1,000	5,000	5,000	1,000
AG-111	3,000	3,100	3,100	200	1,000	5,000	5,000	1,000

TABLE 5.2-5 (cont'd)

Nuclide	(2,3) Fresh Water				(4) Salt Water			
	Fish	Crustacea	Molluscs	Algae	Fish	Crustacea	Molluscs	Algae
SN-125	1,000	670	670	33	3	3	3	10
SB-124	40	16,000	16,000	10,000	1,000	1,000	1,000	10,000
SB-125	40	16,000	16,000	10,000	1,000	1,000	1,000	10,000
SB-127	40	16,000	16,000	10,000	1,000	1,000	1,000	10,000
TE-125M	400	75	75	100	10	10	100	1,000
TE-127M	400	75	75	100	10	10	100	1,000
TE-127	400	75	75	100	10	10	100	1,000
TE-129M	400	75	75	100	10	10	100	1,000
TE-129	400	75	75	100	10	10	100	1,000
TE-131M	400	75	75	100	10	10	100	1,000
TE-131	400	75	75	100	10	10	100	1,000
TE-132	400	75	75	100	10	10	100	1,000
TE-133M+D	400	75	75	100	10	10	100	1,000
TE-134	400	75	75	100	10	10	100	1,000
I-129	1	25	25	100	20	100	100	10,000
I-130	1	25	25	100	20	100	100	10,000
I-131	1	25	25	100	20	100	100	10,000
I-132	1	25	25	100	20	100	100	10,000
I-133	1	25	25	100	20	100	100	10,000
I-134	1	25	25	100	20	100	100	10,000
I-135	1	25	25	100	20	100	100	10,000
XE-131M	0	0	0	0	0	0	0	0
XE-133M	0	0	0	0	0	0	0	0
XE-133	0	0	0	0	0	0	0	0
XE-135M	0	0	0	0	0	0	0	0
XE-135	0	0	0	0	0	0	0	0
XE-137	0	0	0	0	0	0	0	0
XE-138	0	0	0	0	0	0	0	0
CS-134M	1,000	1,000	1,000	200	30	50	10	10
CS-134	1,000	1,000	1,000	200	30	50	10	10
CS-135	1,000	1,000	1,000	200	30	50	10	10
CS-136	1,000	1,000	1,000	200	30	50	10	10
CS-137	1,000	1,000	1,000	200	30	50	10	10
CS-138	1,000	1,000	1,000	200	30	50	10	10
CS-139	1,000	1,000	1,000	200	30	50	10	10
BA-139	10	200	200	500	3	3	3	100
BA-140	10	200	200	500	3	3	3	100
BA-141	10	200	200	500	3	3	3	100
BA-142	10	200	200	500	3	3	3	100
LA-140	50	500	500	10,000	30	100	100	300
LA-141	50	500	500	10,000	30	100	100	300
LA-142	50	500	500	10,000	30	100	100	300
CE-141	50	500	500	10,000	30	100	100	300
CE-143	50	500	500	10,000	30	100	100	300
CE-144+D	50	500	500	10,000	30	100	100	300
PR-143	50	500	500	10,000	100	1,000	1,000	1,000
PR-144	50	500	500	10,000	100	1,000	1,000	1,000
ND-147	100	1,000	1,000	10,000	100	1,000	1,000	1,000
PM-147	100	1,000	1,000	10,000	100	1,000	1,000	1,000
PM-148	100	1,000	1,000	10,000	100	1,000	1,000	1,000
PM-149	100	1,000	1,000	10,000	100	1,000	1,000	1,000
PM-151	100	1,000	1,000	10,000	100	1,000	1,000	1,000
SM-153	100	1,000	1,000	10,000	100	1,000	1,000	1,000
EU-156	100	1,000	1,000	10,000	100	1,000	1,000	1,000
W-181	1	30	30	30	10	10	100	100
W-185	1	30	30	30	10	10	100	100
W-187	1	30	30	30	10	10	100	100
U-237	10	300	300	1,000	10	300	300	1,000
NP-238	10	300	300	1,000	10	300	300	1,000
NP-239	10	300	300	1,000	10	300	300	1,000
PU-241	10	300	300	1,000	10	300	300	1,000

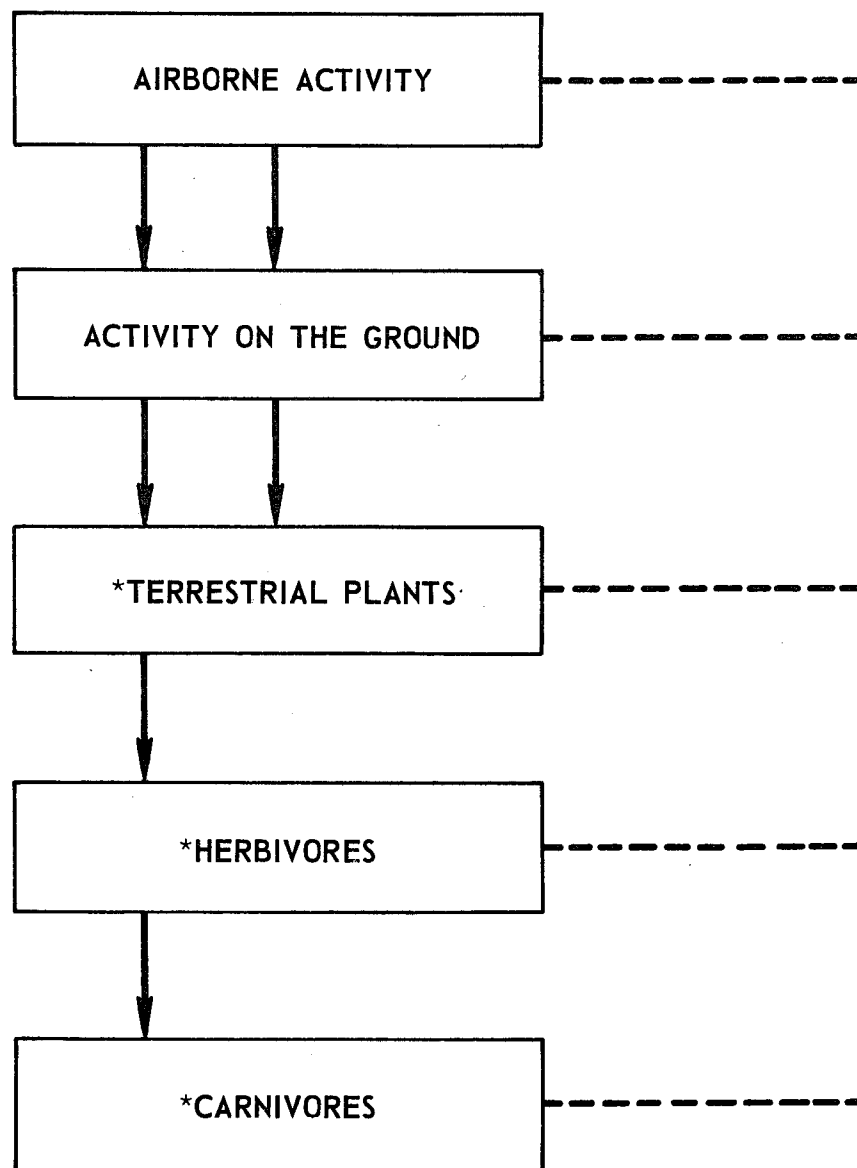


AUGUST, 1973

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

TRANSFER OF RADIONUCLIDES
THROUGH THE MARINE FOOD WEB

FIGURE 5.2-1



————— TRANSFER THROUGH FOOD CHAIN

- - - - - EXTERNAL EXPOSURE

*THE SPECIFIC ORGANISMS ARE LISTED IN
SECTION 2.7.

AUGUST, 1973

FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ROUTES OF EXPOSURE OF
TERRESTRIAL BIOTA

FIGURE 5.2-2

5.3 RADIOLOGICAL IMPACT ON MAN

St. Lucie Unit Nos. 1 and 2 are designed to keep radioactive releases as low as practicable. Dose calculations based upon the liquid and gaseous release source terms of Sections 5.3.2 and 5.3.3 show that the normal operation of St. Lucie Unit Nos. 1 and 2 will result in additional whole body doses of less than 0.33 mrem/year to the most exposed individual in the vicinity of the plant, 0.0045 mrem/year to the average individual within 50 miles of the site, and less than 1.4 man-rem/year to the population within a 50 mile radius of the site. On the other hand, natural background radiation and medical radiation exposures are likely to result in doses in excess of 60,200 man-rem to the population during the same period. The predicted dose to the most exposed individual is 28 percent of the limits defined in the AEC's proposed regulation 10CFR50 Appendix I (5.0 mrem/year). The dose calculation results are summarized in Table 5.3-1 and the assumptions used in these calculations are summarized in Table 5.3-2. The meteorological data base for annual average "chi over Q" values presented in Table 5.3-2 is presented and referenced as Table 5.2-2. These values were based on the 50 foot data level of the on-site meteorological tower and the vertical temperature stability between 200 and 10 feet, for the period March 1, 1971 through February 29, 1972.

Individuals are constantly being exposed to radiation from such usual sources as the sun and even from their own bodies and their homes. The source of this exposure is referred to as "background radiation." Additional exposure comes from such sources as medical X-rays. The limits established on such additional exposures are based on radiation protection guides developed by the International Commission on Radiological Protection, the National Commission on Radiological Protection, and the Federal Radiation Council.

Table 5.3-3 shows comparative radiation exposure to the general public. From this table it is evident that the radiation exposures to an individual living as close as possible to the St. Lucie plants are insignificant even when compared to naturally occurring variations in background radiation. Variations in natural background radiation, as indicated in this table, have not produced any observable harmful effects.

The formal procedures and scientific bases in setting radiation protection standards are among the most comprehensive and conservative of any applied to environmental stresses. The information required was developed through investigations and analyses by the medical and scientific communities throughout the world. The standard setting body of longest standing is the International Commission on Radiological Protection (ICRP), founded in 1928. The 40 members of the ICRP and its committees come from some 14 countries. In the U.S. the National Council on Radiation Protection and Measurements (NCRP) was formed in 1929 under the sponsorship of the U. S. National Bureau of Standards. This group recommends radiation protection standards for activities involving broad use of radiation in the U. S. From its inception, the AEC has depended on the recommendations of NCRP and ICRP in setting AEC radiation standards. In 1959 the Federal Radiation Council (FRC) was formed to advise the President with respect to radiation matters in all Federal agencies formulating radiation standards. The members of these standards groups are some of the world's leading authorities on radiation and its biological effects. They are independent in judgment, highly specialized in each of their fields, and have devoted years to their standard setting work. There are few environmental factors that have been as extensively studied

and about which we know as much as the effects of radiation on life processes.

More than 500 reactors of various kinds, including many power reactors have been constructed and operated throughout the world. More than 29 civilian power reactors have been operated in the United States and another 33 are currently undergoing design and construction. No nuclear accidents releasing significant amounts of fission products have occurred in the operation of these 29 reactors. The safety record of the nuclear industry is the best of any heavy industry in the world. There have been no cases in this country where physical injury or illness to any member of the general public has been shown to result from operation of any reactors. The St. Lucie units will be designed to meet current AEC radiation standards. The ability of the St. Lucie units to withstand all postulated incidents including the AEC maximum hypothetical accident is fully discussed in Chapter 15 of the Preliminary Safety Analysis Report for St. Lucie Unit No. 2 filed with the AEC.

The releases of radioactive gases and liquids from the currently operating, earlier designed PWRs (some of which do not have the long holdup capacity of newer PWRs) are quite low. Releases from 1967 through 1969 for these older PWRs, given in Table 5.3-4 and Table 5.3-5, were less than 1 percent of AEC's 10CFR20 limits. The operating experience of some 13 nuclear power plants in 1969 shows that the average exposures to the population living within a 50-mile radius of these plants was less than 0.0001 millirem for the year, or less than 10^{-6} of the AEC's 1969 limit of 170 millirems to the general public.

Current PWRs can be expected to release comparatively less tritium than earlier PWRs. Earlier PWRs listed in the Table 5.3-5 used stainless steel clad fuel. Up to 30 percent of the fission product source of tritium produced in the fuel can diffuse through stainless steel cladding into the reactor coolant system. Current PWRs employment of zircaloy-clad fuel has been of prime importance in accomplishing this reduction.

Although the quantities of tritium discharged into the aquatic environment are greater than other nuclides, it has low radiotoxicity (it is a very low-energy beta emitter) and there is no environmental or metabolic mechanism by which tritium can be concentrated. The tritium concentration in the waters of the U. S approximate 1,000 picocuries (10^{-9} Ci) per liter of water. The tritium released from power reactors contributes only a very small fraction (less than 1 percent) of this activity.

5.3.1 EXPOSURE PATHWAYS

5.3.1.1 Introduction

As a result of the operation of the two St. Lucie nuclear power plants, there are several potential radiation exposure pathways to man. These potential pathways may be divided into two categories: those pathways resulting in a radiation dose via internal exposure, and those pathways resulting in a dose via external exposure. External exposure occurs if an individual is immersed in a cloud containing radioactive gaseous effluents, or if while swimming or engaged in some similar activity

comes in direct contact with water containing radioactive liquid effluents. Internal exposures result from the contamination of various food chains, or by the ingestion of contaminated drinking water.

The anticipated doses to man resulting from internal or external exposure through the relevant pathways may be estimated, but detailed information will have to come from the environmental surveillance program (see Section 6.1.5 and 6.2.1). The pre-operational phase of the environmental surveillance program will establish the base-line radiological characteristics of the area so that it will be possible to differentiate operational trends from background characteristics.

5.3.1.2 Internal Exposure

Since liquid effluents from St. Lucie Unit Nos. 1 and 2 will be discharged directly into the Atlantic Ocean, there are several potential pathways of internal exposure which are of interest to those assessing the radiological impact of the two units on man. The marine food chains will be monitored during pre-operational and operational stages in order to accurately assess the radiological impact of the liquid effluents and to verify the accuracy of pre-operational estimates.

The general public receives some small internal dose as a result of the ingestion of locally harvested seafood. The critical radionuclides for fin fish are Cs-134 and Cs-137 which are reconcentrated in the edible flesh of the fish. Co-58 and Co-60, tend to reconcentrate in the nonedible portions of the fish (in the liver and kidney) and are consequently not as important from a population dose viewpoint as radio-cesium (2). The following radionuclides are reconcentrated in the edible tissues of shellfish; Cr-51, Mn-54, Co-58, Fe-59, Co-60, Zr-95, Ru-103, Ru-106, I-131, I-133 and Ce-144.

The existence of commercial dairy and crop farms in St. Lucie and surrounding counties suggests two more possible routes of internal exposure. These routes result from the discharge of radioactive gaseous wastes into the atmosphere. The first is the air-grass-milk-child route, and the second is the air-soil-foodcrop-man route. I-131, is the critical radionuclide for the milk pathway, but Cs-134 and Cs-137 may also contribute. The nearest dairy herd, supplying milk to the St. Lucie area is located about 14 miles from the site. The nearest privately owned cow is 7.5 miles SSW of the plant where the atmospheric dilution factor is about 7.57×10^{-8} sec/m³. Cs-134 and Cs-137, which concentrate in the green leafy portions of plants, are the critical radionuclides for the food crop pathway. They enter the chain by direct contamination. Tomato production accounts for more than 99 percent of the county's produce other than citrus. Since the leafy portions of the tomato plant are not usually consumed, it is not considered a significant route of exposure to man. However, the dose to individuals from the ingestion of garden vegetables grown near the plant is considered a potential route of exposure. For this calculation, it is assumed that

vegetables are raised about 2.5 miles west southwest of the site. The area is zoned for but generally unsuited for agricultural development. There is some beef production west of the plant in an area principally outside of the 10 mile radius where the atmospheric dilution factor is of the order of 10^{-8} sec/m³. It is therefore readily apparent that this does not constitute a significant internal exposure pathway.

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The drinking water pathway of exposure is not relevant to St. Lucie Units 1 and 2 because the salt content of the Atlantic Ocean precludes its use as a drinking water supply. The wells on the mainland will not be affected by the discharge of plant liquid effluents into the Atlantic Ocean. The surveillance program will assure that this will remain true.

Estimated doses for the pathways of internal exposure discussed in this section are presented in Sections 5.3.2 and 5.3.3.

5.3.1.3 External Exposure Pathways

People living in the vicinity of or frequenting the plant site will be subject to low level external exposures due to plant liquid and gaseous effluent releases. The principle external exposure from plant liquid effluents would be a result of direct contact with ocean or discharge water while swimming, boating or fishing. The principle external exposure from plant gaseous releases will be the result of immersion in a cloud containing radioactive gaseous effluents.

There are no individuals who derive a major part of their income from the water immediately adjacent to the St. Lucie site, and there are no recreational areas close to the plant site boundary. The closest recreational areas are located at least five miles from the plant. The largest is the Savannas Recreational Area which is located 5 miles WNW of the plant. This facility attracts approximately 9,000 overnight campers and 160,000 day visitors annually and features boating, picnicking, swimming, fishing, etc. Other recreational areas include Douglas Memorial Park which is more than 5 miles north of the plant; a public beach 7 miles south of the plant; and camp grounds 5 miles north of the plant.

External doses resulting from the various activities mentioned above are presented in Sections 5.3.2 and 5.3.3, and 5.3.4.

5.3.1.4 Dose Calculation Methodology

a) Dose due to Submersion in Airborne Releases

The annual off-site whole body dose to an individual as a result of plant gaseous releases was calculated using the following model:

$$\text{Whole body dose (rems)} = \sum_{i=1}^m \frac{X}{Q} W_1 Q'_1$$

where:

W_1 = whole body dose conversion factor for the i^{th} isotope.
This factor is based on immersion in a semi-infinite cloud of gamma emitters.

Q'_i = amount of activity of the i^{th} isotope released annually in Ci

$\frac{X}{Q}$ = the annual average dispersion factor for the critical sector and distance of interest in sec/m^3 .

The annual average population doses due to plant gaseous releases are obtained by summing the product of the average annual individual dose computed for each sector and the sector population over each of the sectors centered on the sixteen compass directions for various radii out to a distance of 50 miles from the centerline of the reactor buildings.

The average annual inhalation thyroid dose to an individual off-site was calculated using the following model:

The off-site concentration of each relevant iodine isotope, i , is calculated:

$$\frac{Q'_i \frac{\text{Ci}}{\text{year}}}{3.15 \times 10^7 \frac{\text{sec}}{\text{year}}} \times \frac{X}{Q} \frac{\text{sec}}{\text{m}^3} \times 10^{12} \frac{\text{pCi}}{\text{Ci}} = \frac{Q'_i}{3.15} \frac{X}{Q} \times 10^5 \frac{\text{pCi}}{\text{M}^3}$$

This off-site concentration is then multiplied by the appropriate factor (see Tables 5.3-6 or 5.3-7) in order to determine the dose in mrem/year that an individual receives from inhaling air contaminated with the above concentration of isotope i . The dose contributions for the individual isotopes are added in order to get the total annual dose in mrem/year.

The factors for converting air concentrations of radioiodine to thyroid dose via inhalation are given in Table 5.3-6. These factors are based upon the assumptions given at the end of the table.

The annual average thyroid doses to an individual as a result of the milk and vegetable pathways are calculated by multiplying the off-site concentration by the appropriate factors from Tables 5.3-7 and 5.3-7A, respectively.

b) Dose due to Exposure from Radioactivity in the Liquid Effluent

The submersion (swimming) dose to an individual is calculated using the following model:

$$D_i = (1.865 \times 10^7) (A_i) (\bar{E}_{\gamma i}) (\text{o.f.})$$

where:

D_i = γ dose to a person submerged in water due to the i^{th} radionuclide (mrem/year).

A_i = the activity of the i^{th} radionuclide in water ($\mu\text{Ci}/\text{ml}$).

$\bar{E}_{\gamma i}$ = the average energy per γ disintegration of the i^{th} radionuclide (MeV).

o.f. = the fraction of a year that the person is submerged in water containing radionuclide i .

$$D_i^2 = \frac{1}{2} D_i'$$

where:

D_i^2 = the β^- dose to a person submerged in water due to the i^{th} radionuclide (mrem/year).

c) External γ Exposure from Standing on Contaminated Soil (or Sediment)*

The external γ exposure to a person standing on contaminated soil or sediment is calculated using the following model:

$$D_i^3 = (8.0 \times 10^9) W_i E_{\gamma i} U_{ai} \left[E_i(\mu_i b) + \frac{K \exp(-\mu_i b)}{2} \right]$$

Where:

D_i^3 = the dose rate b meters above a contaminated plane from the i^{th} radionuclide (mrem/year).

W_i = the activity of the i^{th} radionuclide on the ground (Ci/m^2).

U_{ai} = the energy absorption coefficient for gamma rays (m^{-1}).

$E_i(\mu b)$ = the exponential integral $\left[\int_{\mu}^{\infty} \exp(-\mu b) / b \, db \right]$

$$K = \frac{\mu - \mu_{ai}}{\mu_a}$$

μ_i = total γ ray absorption coefficient (m^{-1}) for the i^{th} radionuclide.

For marine environments, the value of W is related to the activity in the water by the following:

$$W_i = 10^{-1} (A_i) T_{1/2i}$$

where:

$T_{1/2}$ = radiological half-life of the i^{th} radionuclide (days)

*Taken from Healy, J. W., and Baker, R. E., 1968, "Radioactive Dose Cloud Calculations; Meteorology and Atomic Energy", Edited by D. H. Slade.

The activity on the soil due to airborne deposition is obtained in the following manner:

$$W_i = \frac{(Q_i) (X_i/Q_i) (d.v.)}{\lambda_i}$$

where:

W_i = the activity of the i^{th} radionuclide on the ground (Ci/m²).

Q_i = the release rate of the i^{th} radionuclide (Ci/sec).

X_i = the concentration of the i^{th} radionuclide in ground level air at the area of interest.

d.v. = the deposition velocity (m/sec). A value of 0.01 m/sec is used.

λ_i = the radiological decay constant of the i^{th} radionuclide (sec⁻¹).

d) Internal Exposure due to Radioactivity in the Liquid Effluent

The concentration of the radionuclide in an internal organ of interest is calculated by the following:

$$C_{ij} = I f_{ij} T_{ij}$$

where:

C_{ij} = the concentration of the i^{th} radionuclide in the j^{th} organ at equilibrium (μ Ci).

I = the intake rate of the i^{th} radionuclide (ρ Ci/day).

f_{ij} = the fraction of the ingested i^{th} radionuclide which enters the j^{th} organ.

T_{ij} = the mean life of the i^{th} radionuclide in the j^{th} organ (days).

$$D_{ij}^4 = (1.865 \times 10^7) (I_i) (A_i) (c.f._{jL}) (E_{ij}) (T_{ij}) f_{ij} / m_j$$

where:

D_{ij} = the dose to the j^{th} organ due to the i^{th} radionuclide (mrem/year).

E_{ij} = the effective energy per disintegration of the i^{th} radionuclide in the j^{th} organ (MeV).

m_j = the mass of the j^{th} organ (g).

c.f._{iL} = the concentration factor for the i^{th} radionuclide by the L^{th} aquatic organism.

The dose to the G.I. tract:

$$D_{iK}^5 = (9.33 \times 10^6) (I_j) (A_i) (c.f._{ij}) T_{iK} f'_{iK} E_{iK} \left(\exp - \frac{.693 t_K}{T_{1/2 i}} \right) / M_K$$

where:

D_{iK} = the dose to the k^{th} section of the G.I. tract by the i^{th} radionuclide (mrem/year).

t_K = time during which the i^{th} ingested radionuclide exposes the K^{th} section of the G.I. tract.

f'_{iK} = the fraction of the ingested activity of the i^{th} radionuclide which reaches the k^{th} section of the G.I. tract.

t_K = the time required for the ingested activity to pass from the mouth to the K^{th} section of the G.I. tract (days).

$T_{1/2i}$ = radiological half-life of the i^{th} radionuclide (days).

M_K = mass of the K^{th} section of the G.I. tract (g).

5.3.2 LIQUID EFFLUENTS

Estimated annual plant liquid releases for the two St. Lucie units, as discussed in Section 3.5 of this report, are summarized in Table 3.5-8. These releases are added to the Circulating Water System and exit into the Atlantic Ocean via the plant discharge canal. The total circulating water flow rate and the discharge canal flow rate are 1,060,000 gpm. A diagram of the plant liquid and gaseous release points for the two units is shown in Figure 5.3-1. The estimated annual doses to the general public due to the ingestion of contaminated fish, crustacea and shellfish have been calculated and are presented in Table 5.3-1. A description of the model used in the calculations is given in Section 5.3.1.4. The individual and population doses are based upon the assumptions given in Table 5.3-2. The demographic information used in the calculation of population doses is presented in Figures 2.2-1 through 2.2-3 of this report.

5.3.3 GASEOUS EFFLUENTS

Estimated annual plant gaseous releases are given in Table 5.3-9. These effluents exit to the atmosphere via the plant vent, and steam jet air ejector. A diagram of the plant liquid and gaseous release points is presented in Figure 5.3-1.

The anticipated annual doses to the general public as a result of submersion, inhalation, and the ingestion of locally produced milk and vegetables have been calculated and are presented in Table 5.3-1. A description of the model used in the dose calculations is given in Section 5.3.1.4. The individual and population doses are based upon the assumptions given in Table 5.3-2. The demographic information used in the calculating of the population doses due to gaseous releases is presented in Section 2.1.3. Section 6.1.3.2 presents the meteorological model.

3

5.3.4 DIRECT RADIATION

5.3.4.1 Radiation from Facility

There are two pathways of exposure to a man and terrestrial biota from direct radiation resulting from plant operations. The first pathway would be exposure to direct radiation from the plant turbines (turbine shine). The second pathway would be exposure to direct radiation emanating from outside storage tanks containing radioactive materials.

During normal operations, the exposure rate due to turbine shine at the site boundary is expected to be 4.6×10^{-9} mrem/hr. This would yield an annual whole body dose of 4.0×10^{-5} mrem to an individual standing continuously at the site boundary. Since the closest continually occupied dwelling is located two miles SW of the plant, turbine shine is not a significant exposure pathway.

The outside storage tanks which may contain some radioactivity during normal operations are the primary water storage tank, the refueling water tank and the condensate storage tank. These tanks are unshielded and their locations are shown on Figure 2.1-5. Maximum expected radionuclide inventories for the three tanks are presented in Table 5.3-12 and were calculated using the assumptions presented in Appendix 3A.

The refueling water tank inventories were calculated at the end of refueling assuming clean-up by the fuel pool system filter and ion exchanger, but no decay in the tank. The assumptions are quite conservative and the actual radionuclide inventories should be much smaller.

The resultant dose rates at the surfaces of the three tanks and at the site boundary are given in Table 5.3-13. These dose rates are highly conservative because the maximum activity level was assumed throughout the year. Of the three tanks, the refueling water tank would be the largest exposure source. This tank, however, is only operated intermittently and the actual radionuclide inventory and resultant dose rate should be considerably smaller.

The maximum expected dose rate at the site boundary due to the above sources is less than 0.79 mrem/year. This is well within the proposed Appendix I of 10 CFR 50 guideline of 5 mrem/year. Accordingly, any effects to man or biota due to this exposure are considered negligible.

The highest surface dose rate for an outside storage tank was calculated to be 4.6 mrem/hr for the refueling water tank. The dose to a terrestrial mammal continuously residing in a burrow or nest immediately adjacent to the tank would be approximately 20 rem/year. Such an exposure would be genetically insignificant since it is unlikely that more than a few animals, if any, would choose to reside in the tank vicinity. It is unlikely that a whole body dose of 20 rem/year will cause any acute radiation effects. The most sensitive indicator of an acute radiation effect is the circulating lymphocyte blood count. An acute exposure of at least 5 rems is required before one could detect a decrease in the lymphocyte count.* Since the postulated 20 rem exposure is fractioned over one year, it is unlikely that there will be any observable acute radiation effects.

2

5.3.4.2 Transportation of Radioactive Materials

Under the terms of the agreement with the fuel supplier, Combustion Engineering, FP&L will take title to the fuel after its receipt at the plant. Title to the spent fuel, via a buy-back agreement, will return to C-E when the irradiated fuel has been transferred to the transporting conveyances after storage in the spent fuel pool. Fuel transportation both to and from the reactor will be the responsibility of C-E.

a) Transportation of Fuel Assemblies from the Fabrication Facility to the Plant Site

The environmental effects of the transportation of fuel assemblies from the fuel fabrication facility in Windsor, Connecticut to the plant site will be no greater than the environmental effects of any normal material shipment. The fuel will be transported by truck a distance of approximately 1400 miles, in AEC-DOT approved containers.

* Casarett, A. P. "Radiation Biology", Prentice-Hall, Inc. 1968.

The above mentioned new fuel shipping containers will be transported in motor vehicles for the sole use of Combustion Engineering, Inc. These containers are authorized for shipment up to a total of 16 fuel assemblies per vehicle load. The containers are secured by chains in protective covering and shored by wooden blocks.

Maximum radiation dose rates and removable radioactive contamination levels for shipments are specified in 49 CFR 173.393 (j), 173.389 (f), and 173.397 (a) as follows:

- 1) 1,000 millirem per hour at 3 feet from the external surface of the package when transportation is by closed vehicle;
- 2) 200 millirem per hour at any point on the external surface of the car or vehicle when transportation is by closed vehicle;
- 3) 10 millirem per hour at 6 feet from the external surface of the car or vehicle;
- 4) 2 millirem per hour in any normally occupied position in the car or vehicle; and
- 5) 10^{-11} curies of beta-gamma per square centimeter and 10^{-10} curies of alpha per square centimeter as measured on the wiping material used to wipe the external surface of packaged radioactivity.

Experience on past new fuel shipments demonstrates that radiation dose rates for shipments of fuel elements from the fuel fabrication plant to St. Lucie Unit No. 2 will easily meet all of the above limits with normal radiation levels seldom exceeding 5 mrem/hr on contact with the external surface of the shipping container and dose rates in the vehicle not measurable.

It is planned that the initial core fuel bundles will be transported from the fabrication facility to the plant site in approximately fifteen (15) shipments over a period of about one (1) month. Thereafter, a fraction of the reactor core will be renewed approximately annually which should result in approximately five (5) shipments over a period of about one (1) month.

Nuclear radiations and heat emitted by new fuel are small, hence there will be essentially no effect on the environment during transport under normal conditions. It is estimated that exposure of individual transport workers will be less than 1 millirem (mrem) per shipment. For the 5 shipments, with 2 drivers for each vehicle, the total dose would be about 0.01 man-rem/yr. The radiation level associated with each truckload of new fuel will be less than 0.1 mrem/hr at 6 ft from the truck. A member of the general public who spends three minutes at an average distance of 3 ft from the truck might receive a dose of about 0.005 mrem/shipment. The dose to other persons along the shipping route would be extremely small. It is concluded that the environmental impact of the transportation of new fuel from the fuel fabrication facility to the plant site will be negligible.

b) Transportation of Spent Fuel Assemblies from the Plant Site to the Fuel Reprocessing Plant

St. Lucie Unit No. 2 will discharge approximately 72 spent fuel assemblies about once a year after the first 20 months of operation.

After the cooling period, the spent fuel will be loaded into shipping casks designed and constructed to meet the rigorous requirements of the AEC and USDOT. These requirements provide for cooling, radiation shielding and containment of radioactivity for protection of the public in the event of abnormal and accident conditions as well as for normal conditions of transport. Prior to use, each cask design and its transport system will be reviewed and approved by AEC and USDOT, and transportation will be authorized by license issued by the AEC. License provisions will include adequate quality assurance, testing programs and operating procedures to assure equipment is constructed and used in accordance with approved designs and procedures. When loaded, the casks will be carefully surveyed for leak tightness and surface radioactivity contamination and inspected to assure that they have been properly prepared for shipment and fully comply with license provisions governing transportation. Shipments will also be placarded in accordance with federal regulations.

The cask used for the shipment of irradiated fuel is constructed and its contents limited by design such that, under hypothetical conditions (10 CFR 71):

- 1) The reduction of shielding would not be sufficient to increase the external radiation dose rate to more than 1,000 millirems per hour at 3 feet from the external surface of the package.
- 2) No radioactive material would be released from the cask except for gases and contaminated coolant containing total radioactivity of exceeding neither 0.1 percent of the total radioactivity of the cask contents nor 0.01 curie of Group I radionuclides, 0.5 curie of Group II radionuclides, 10 curies of Group III radionuclides, 10 curies of Group IV radionuclides and not more than 1,000 curies of inert gases irrespective of transport group.

In addition to the above the cask is designed such that its contents will remain subcritical under hypothetical accident conditions which result in the fissile material occupying its most reactive credible configuration with complete water moderation and reflection on all sides.

The cask is also designed to meet structural standards for load resistance and external pressure which will assure that the containment vessel will suffer no loss of contents if subjected to static loads equal to five times its fully loaded weight or external pressure of 25 psig.

During normal conditions of transport, there will be no release of radioactive material from the shipping cask and radiation emitted from the containers will be within established limits. Furthermore, in the

- 1) The volume of barge and truck traffic added in the region of interest is an insignificant part of existing traffic.
- 2) Both the packaging and the vehicle will be designed to withstand normal and accident conditions without harmful radiation exposure of the public or release of the radioactive spent fuel.
- 3) The hazards associated with accidents are largely those associated with conventional heavy object shipments, not radiological hazards.
- 4) The probability of such accidents is lower than comparably heavy object shipments because of the additional equipment design and operational safety requirements as well as personnel screening and training.

c) Transportation of Packaged Waste Radioactive Materials

Spent resins, waste evaporator bottoms, and some process liquids will be dewatered and concentrated and, with other solid wastes, loaded into containers for shipment and disposal. This will result in approximately 15 to 20 truckloads per year for St. Lucie Unit No. 2. Under normal conditions, an individual truck driver might receive as much as 15 mrem per shipment. If the same driver were to drive 20 truckloads in a year, he could receive an estimated dose of about 300 mrem during that year. The cumulative dose to all drivers for the year, assuming two drivers per vehicle and 20 truckloads per year, might be about 0.6 man-rem.

A member of the general public who spends 3 minutes at an average distance of 3 ft from the truck might receive a dose of as much as 1.3 mrem. If 10 persons were so exposed per shipment, the cumulative annual dose would be about 0.3 man-rem.

Detailed plans for the shipment of solid and liquid radioactive waste have not as yet been developed as such shipments will not be necessary until 1979 for St. Lucie Unit No. 2. Possible contractors for radwaste transportation and burial are being investigated. When plans are finalized, all pertinent laws and regulations will be determined and rigorously complied with.

5.3.5 OTHER EXPOSURE PATHWAYS

No other relevant exposure pathways as a result of the operation of St. Lucie Units Nos. 1 and 2 have been identified at this time. It is believed that the pathways analyzed in this chapter account for all the significant exposure routes to species in the local ecology and to man.

5.3.6 SUMMARY OF ANNUAL RADIATION DOSES

Dose calculations based upon the liquid and gaseous release terms of Sections 5.3.2 and 5.3.3 are summarized in Table 5.3-1. These calculations show that the normal operation of St. Lucie Unit Nos. 1 and 2 will result in additional whole body doses of less than 0.33 mrem/year 3

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to the exposed individual in the vicinity of the plant, 0.0045 mrem/year average individual living within a 50 mile radius of the plant, and less than 1.4 man-rem/year to the entire population within a 50 mile radius of the plant. On the other hand, natural background radiation and medical radiation exposures are likely to result in doses in excess of 60,200 man-rems/year to the same population group. The predicted dose to the most exposed individual is 28 percent of the limits defined in the AEC's regulations 10CFR50 Appendix I.

3

TABLE 5.3-1

CALCULATED ANNUAL RADIATION DOSES TO
INDIVIDUALS FROM LIQUID AND GASEOUS EFFLUENTS RELEASED
FROM ST. LUCIE UNITS NOS. 1 & 2

	RG 1.42	Whole Body (mrem/year)		Child Thyroid (mrem/year) RG 1.42	Adult Thyroid (mrem/year)		G-I Tract (mrem/year)	
		10 gpm Blowdown	0.14 gpm Blowdown		RG 1.42	10 gpm Blowdown	10 gpm Blowdown	0.14 gpm Blowdown
Maximum dose to individual from ingestion of aquatic foods	--	0.54(-3)*	0.19(-3)	--	--	0.18	0.32(-2)	1.2(-3)
Population dose from ingestion of aquatic foods	--	0.39(-5)**	0.56(-6)**	--	--	---	--	1.2(-6)**
Dose to individual from plume submer-sion at site boundary	0.17	---	---	0.17	0.14	---	--	--
Population dose from plume submer-sion	0.7**	---	---	--	--	---	--	--
Individual dose from cow-milk pathway from nearest actual cow	--	---	---	1.61	0.18	---	--	--
Maximum dose to an individual from plume submer-sion (Big Mud Creek)	0.33	---	---	0.33	0.27	---	--	--
Maximum dose to an individual from ingestion of garden vegetables	--	---	---	0.584	0.36	---	--	--
Dose to individual from swimming	--	0.49(-4)γ	---	--	--	---	--	--
	--	0.46(-4)β	---	--	--	---	--	--
Dose to individual from boating		0.25(-4)	---	--	--	---	--	--
Dose to individual from fishing	--	0.16(-2)γ	---	--	--	---	--	--
	--		---	--	--	---	--	--

* Numbers in () are powers of 10

** mrem/year

TABLE 5.3-2ASSUMPTIONS USED IN ST. LUCIE UNIT NOS. 1 AND 2 DOSE CALCULATIONS

1. Drinking water - Pathway not applicable.
2. Aquatic Foods - individual doses
 - a. Aquatic life grown in ocean concentrations (i.e., 5% of the concentration in the discharge canal)
 - b. Consumption rate is 18 kg/year fin fish, 9 kg/year crustacea, 9 kg/year mollusc. These values are somewhat conservative since the U.S. Department of Agriculture (1965) reports that the average amount of seafood ingested in the South during 1965-1966 was 13.2 kg fish and 0.50 kg shellfish. The maximum amount of seafood ingested by any one income group occurred among rural farmers where the seafood ingestion rate was 15.5 kg fish and 0.79 kg shellfish.
 - c. Marine bioaccumulation factors (See Table 5.3-7)
 - d. No credit taken for nuclear decay during interval between harvest and consumption
3. Aquatic Foods - population doses
 - a. Aquatic life grown in ocean concentrations
 - b. Entire annual catch in St. Lucie County locally consumed, (i.e., 1.2×10^6 kg fish, 1.04×10^5 kg mollusc, and 4.7×10^3 kg crustacea)
 - c. 10% of St. Lucie County Catch grown in waters contaminated by St. Lucie Unit Nos. 1 and 2.
 - d. Marine bioaccumulation factors
 - e. No credit taken for nuclear decay during interval between harvest and consumption
 - f. Population distribution around site as per Figures 2.2-1,2,3
4. Plume Submersion - Maximum individual doses
 - a. Points of maximum potential exposure are at Big Mud Creek 0.15 miles NNW of the plant where the atmosphere dilution factor (X/Q) is 5.8×10^{-5} sec/m³ and an individual spends 500 hours/year fishing at this point, and at the site boundary where the X/Q is 1.73×10^{-6} sec/m³.
 - b. Whole body dose due to submersion in semi-infinite cloud

TABLE 5.3-2 (cont'd)

- | | |
|--|---|
| c. Thyroid dose is internal due to inhalation of gaseous iodine. | |
| d. Dose conversion factors specified in Table 5.3-6. | 3 |
| 5. Plume Submersion - population dose | |
| a. Whole body dose due to submersion in semi-infinite cloud. | |
| b. Population distribution around site as per Figures 2.2-1, 2, 3. | |
| c. Annual average dispersion factors as per Table 5.2-2 (based on on-site meteorological data). | |
| 6. Cow-Milk-Pathway - Maximum potential individual doses | |
| a. Location of nearest existing cow at 7.5 miles where the X/Q is 7.57×10^{-8} sec/m ³ . | |
| b. Dose conversion factors specified in Table 5.3-6. | 3 |
| 7. Leafy Vegetable-Pathway | |
| a. Location of garden at 2.5 miles where the X/Q is 4.04×10^{-7} sec/m ³ . | |
| b. Dose conversion factors specified in Table 5.3-6. | |

TABLE 5.3-3

RADIATION EXPOSURES
(COMPARATIVE INFORMATION)

REM - Radiation Dose Unit
MILLIREM - 1/1000 of a Rem

ANNUAL WHOLE BODY EXPOSURES FROM NATURAL BACKGROUND RADIATION (Cosmic Radiation; Radioactivity in Rocks, Soil, Building Materials, Radioactivity in Body)

United States	70-200 Millirem (.07-.2 rem)	
<u>Special Areas</u>	<u>Average</u>	<u>Population</u>
Brazil - Monazite Sand Areas	500 Millirem (.5 rem)	30,000
India - Monazite Sand Areas	1300 Millirem (1.3 rem)	100,000
France - Granitic, Schistous Sandstone Areas	180-350 Millirem (.18-.35 rem)	7,000,000 (one-sixth of French popu- lation)

FEDERAL RADIATION COUNCIL (FRC) GUIDES - ANNUAL WHOLE BODY EXPOSURE

Occupational Exposure	5000 Millirem (5 rem)
Individual in Population	500 Millirem (.5 rem)
Suitable Sample Population Group	170 Millirem (.17 rem)

FIRST DETECTABLE CLINICAL EFFECTS - ACUTE WHOLE BODY EXPOSURES

25,000 - 100,000 Millirem
(25-100 rem)

COSMIC RADIATION EXPOSURE TO WHOLE BODY DURING ROUND-TRIP FLIGHT FROM
WASHINGTON, D.C. to WEST COAST AT 35,000 FEET

3-5 Millirem (.003-.005 rem)

ADDITIONAL EXPOSURE FROM LIVING IN A STONE OR BRICK HOUSE AS COMPARED
TO A WOODEN HOUSE

Generally higher by values that range up to more than 50 millirem per year.

TABLE 5.3-3 (Cont'd)

ANNUAL WHOLE BODY EXPOSURE FROM TYPICAL OPERATING POWER REACTOR TO
PERSONS LIVING NEAR SITE BOUNDARY

Persons living near site boundary	5 Millirem (.005 rem)
Average to persons living within 4 miles	Less than 1 Millirem (.001 rem)
<u>Millirem</u>	<u>Circumstances</u>
1,000,000	Instantaneous exposure at 400,000 mr (death for 50 percent of persons ex- posed)
100,000	Fluoroscopic exam - local dose range of 5000 to 22,000 mr
10,000	Background radiation for coastal area of India - 1300 mr/yr
1,000	Chest X-rays - local dose of 50 to 200 mr
170 (CFR Limit)	Natural background in Denver - 180 mr/yr
100	Normal background radiation - 90 mr/yr Living in brick houses - 50 mr/yr additional
10	One coast-to-coast airplane trip - 3-5 mr
.1	Living at St. Lucie Unit Nos. 1 and 2 site boundary - .249 mr/yr

TABLE 5.3-4

RADIOACTIVITY IN GASEOUS EFFLUENTS FROM PRESSURIZED
WATER REACTORS 1967-1969

Noble & Activation Gases

<u>Reactor</u>	<u>Curies Released</u>			<u>% of 10CFR20 Limit *</u>		
	<u>1967</u>	<u>1968</u>	<u>1969</u>	<u>1967</u>	<u>1968</u>	<u>1969</u>
Yankee	2.3	6.6×10^{-1}	4.0	< 1.0	< 1	0.06
Indian Point 1	2.3×10^1	5.5×10^1	6.0×10^2	< 1.0	< 1	0.01
San Onofre	4.0	4.7	2.6×10^2	< 1.0	< 1	0.04
Conn. Yankee	2.0×10^{-2}	3.7	1.9×10^2	< 1.0	< 1	< 1
Saxton	2.2×10^1	1.8×10^1	< 1.0	< 1.0	< 1	0.03
Shippingport	2×10^{-2}	1×10^{-2}	1×10^{-2}	< 1.0	< 1	< 1

*Percent of 10CFR20 limit is based on the concentration of curies released in the discharged effluent.

TABLE 5.3-5

RADIOACTIVITY IN LIQUID EFFLUENTS FROM PRESSURIZED
WATER REACTORS IN U.S. 1967-1969

Reactor	Mixed Fission & Corrosion Products						Tritium					
	Curies Released			Percent of 10CFR20 Limit			Curies Released			Percent of 10CFR20 Limit		
	1967	1968	1969	1967	1968	1969	1967	1968	1969	1967	1968	1969
Yankee	0.06	0.01	0.02	1.0	1.0	0.07	1600	1170	1200	<1	<1	0.14
Indian Pt. 1	28.0	35.0	28.0	1.3	2.0	1.5	297	787.0	1100	<1	<1	
San Onofre	0.32	1.5	8.0	1.0	2.5	14.0		2300	3500		<1	0.2
Conn. Yankee	0.39	3.8	12.0	1.0	7.3	1.4	123	1700	5200	<1	<1	0.24
Saxton	0.02	0.01	0.01	1.0	2.3	2.5	6	7.5	1	<1	<1	0.008

*Percent of 10CFR20 limits is based on the concentration of curies released in the discharged effluent.

TABLE 5.3-6

FACTORS FOR CONVERTING AIR CONCENTRATIONS OF RADIOIODINE
TO THYROID DOSE *
VIA INHALATION

(mrem/yr per pCi/m³)

<u>Age</u>	<u>I-129</u>	<u>I-130</u>	<u>I-131</u>	<u>I-132</u>	<u>I-133</u>	<u>I-134</u>	<u>I-135</u>
1 yr.	44.6	1.62	12.7	0.452	3.31	0.227	1.09
Adult	34.3	1.57	10.9	0.414	2.70	0.209	0.985

VIA CONSUMPTION OF GREEN LEAFY VEGETABLES

(mrem/yr per pCi/m³)

<u>Age</u>	<u>I-129</u>	<u>I-130</u>	<u>I-131</u>	<u>I-132</u>	<u>I-133</u>	<u>I-134</u>	<u>I-135</u>
4 yr.	2280	3.25	244	0.168	10.1	0.033	1.16
Adult	1300	2.13	150	0.106	5.99	0.021	0.731

VIA THE MILK PATHWAY

(mrem/yr per pCi/m³)

<u>Age</u>	<u>I-129</u>	<u>I-130</u>	<u>I-131</u>	<u>I-132</u>	<u>I-133</u>	<u>I-134</u>	<u>I-135</u>
1 yr.	26,700	70.2	3560	2.35	151	0.468	16.7
Adult	2680	5.67	396	0.280	16.0	0.0561	1.96

WHOLE BODY DOSE CONVERSION FACTORS FOR PLUME IMMERSION

(rem/sec per C/m³)

<u>Kr-85m</u>	<u>Kr-85</u>	<u>Kr-87</u>	<u>Kr-88</u>	<u>Xe-131m</u>	<u>Xe-133</u>	<u>Xe-135</u>	<u>Xe-138</u>
4.63(-2)	5.28(-4)	3.44(-1)	5.18(-1)	4.10(-2)	2.05(-2)	6.52(-2)	1.05(-1)
<u>I-131</u>	<u>I-132</u>	<u>I-133</u>	<u>I-134</u>	<u>I-135</u>			
9.56(-2)	5.19(-1)	1.62(-1)	5.86(-1)	5.34(-1)			

*Factors taken from "Final Environmental Statement Concerning Proposed Rule Making Action: Numerical Guides for Design Objectives and Limiting Conditions to Meet the Criterion "As Low As Practicable" for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents; Directorate of Regulatory Standards, U.S. Atomic Energy Commission."

TABLE 5.3-8

ANNUAL AVERAGE LIQUID EFFLUENT
RELEASE FOR BOTH UNIT NOS. 1 AND 2
BASED ON 0.1% FAILED FUEL

<u>ISOTOPE</u>	<u>AVERAGE ANNUAL LIQUID RELEASE AT .1% FF (Ci/YR)</u>	
	.14 gpm blowdown	10 gpm blowdown
H-3	4.52(2)	4.52(3)
Br-84	6.36(-7)	6.36(-7)
Rb-88	19.86(-6)	.710(-2)
Sr-89	10.90(-5)	.214(-2)
Sr-90	5.06(-6)	1.08(-4)
Y-90	4.18(-5)	.438(-4)
Sr-91	5.02(-6)	.838(-3)
Y-91	4.36(-3)	.888(-1)
Mo-99	9.50(-2)	.582(0)
Ru-103	15.16(-5)	1.80(-3)
Ru-106	15.34(-6)	1.14(-4)
Te-129	2.34(-4)	.99(-2)
I-129	12.98(-10)	.302(-7)
I-131	15.74(-3)	1.32(0)
Te-132	2.58(-3)	.868(-1)
I-132	17.20(-4)	.260(0)
I-133	2.74(-3)	.222(0)
Te-134	5.02(-7)	1.75(-4)
I-134	13.34(-6)	1.47(-3)
Cs-134	5.24(-3)	.444(-2)
I-135	4.30(-4)	1.36(-1)
Cs-136	8.20(-4)	.720(-3)
Cs-137	16.3(-3)	.562(-1)
Cs-138	9.52(-6)	.920(-2)
Ba-140	5.16(-5)	1.34(-1)
La-140	11.32(-6)	.220(-2)
Pr-143	18.94(-5)	.35(-2)
Ce-144	2.42(-4)	1.27(-3)
Co-60	2.30(-3)	.444(-2)
Fe-59	2.50(-5)	.300(-3)
Co-58	18.76(-3)	.208(-1)
Mn-54	11.86(-5)	.202(-2)
Cr-51	12.14(-3)	.121(-2)
Zr-95	3.58(-6)	.380(-5)
Rb-89	4.36(-7)	4.36(-7)

Numbers in () are powers of ten

TABLE 5.3-9

FOOD CHAIN CONCENTRATION FACTORS

<u>Nuclide</u>	<u>Fish</u>	<u>Crustacea</u>	<u>Mollusks</u>
H ³	1	1	1
Mn ⁵⁴	3000	10000	50000
Co ⁵⁸	100	10000	300
Co ⁶⁰	100	10000	300
Sr ⁸⁹	1	1	1
Sr ⁹⁰	1	1	1
Y ⁹⁰	30	100	100
Y ⁹¹	30	100	100
Mo ⁹⁹	10	100	100
I ¹³¹	20	100	100
Te ¹³²	10	10	100
I ¹³³	20	100	100
Cs ¹³⁶	30	50	10
Cs ¹³⁷	30	50	10
Ba ¹⁴⁰	3	3	3
La ¹⁴⁰	30	100	100
Ce ¹⁴⁴	30	100	100

Reference: A. M. Freke, "A Model for the Approximate Calculation of Safe Rates of Discharge of Radioactive Wastes into Marine Environment," Health Physics, Vol. 13, No. 7, 7/1967.

TABLE 5.3-10

ANTICIPATED ANNUAL AVERAGE
GASEOUS RELEASES AT 0.1% FF*

Isotope	Yearly Release from 2 Units (Ci)**
Kr-85m	1.94 (+1)
Kr-85	7.49 (+2)
Kr-87	9.44 (0)
Kr-88	3.28 (+1)
I-129	6.85 (-9)
I-131	3.61 (-1)
I-132	8.48 (-2)
I-133	3.78 (-2)
I-134	2.66 (-2)
I-135	1.50 (-1)
Xe-131m	2.72 (+2)
Xe-133	7.41 (+3)
Xe-135	1.02 (+2)
Xe-138	3.88 (0)

* Regulatory Guide 1.42 assumptions

** numbers in () are powers of 10

TABLE 5.3-11

COMPARISON BETWEEN FLORIDA WATER QUALITY STANDARDS
AND ENVIRONMENTAL REPORT QUANTITIES AT ST. LUCIE UNIT NO. 2

<u>Constituent</u>	<u>St. Lucie Plant Max. Incremental Increase in Conc. (ER Table 3.6-2)</u>	<u>State of Florida Class III Waters (PSL)</u>	<u>General</u>
Calcium	0.10	---	
Magnesium	0.004	---	
Sodium	2.3	---	
Iron	0.00015	---	<0.30
Silicon	0.2	---	
Bicarbonate	0.11	---	
Sulfate	2.5	---	
Chloride	0.21	Not increased more than 10% above background	
pH	7.0-7.5*	6.0-8.5	6.0-8.5
Total Dissolved Solids	5.8		
Dissolved Oxygen	---	>4.0	>4.0
Coliform	---	<1000	---
Turbidity	---	<50J.T.U.	<50J.T.U.
Fluorides	---	---	<10.0
Gross Beta Activity	---	---	<1000pCi/L
Cyanide or Cyanates	---	---	0
Copper	5 ppb (est.)	---	<0.5
Zinc	2 ppb (est.)	---	<1.0
Chromium - total	---	---	<1.0
Chromium - hexavalent	trace (intermittent)	---	<0.5
Phenols	trace (intermittent)	---	<0.001
Lead	---	---	<0.05
Arsenic	---	---	<0.05
Oils	---	---	<15
Detergents	---	---	<0.5
Mercury	---	---	none

Above values in ppm except where noted

1. Ref. Chapter 17-3, Supplement 25

*Actual pH range of discharged waters

TABLE 5.3-11 (con't.)

COMPARISON BETWEEN FLORIDA WATER QUALITY STANDARDS
AND ENVIRONMENTAL REPORT QUANTITIES AT ST. LUCIE UNIT NO.2

	<u>St. Lucie Plant</u> <u>Temperature Rises *</u>		<u>State of Florida</u>	
	June-Sept.	Oct. - May	June-Sept.	Oct. - May
Ambient Temperature:	86°F	61°F	92°F	90°F
Maximum Temperature: Rise	1.5 to 1.7° F		Ambient +2°F Ambient +2°F	

*Ref: ER Table 5.1-1

TABLE 5.3-12

ACTIVITY IN OUTSIDE STORAGE TANKS

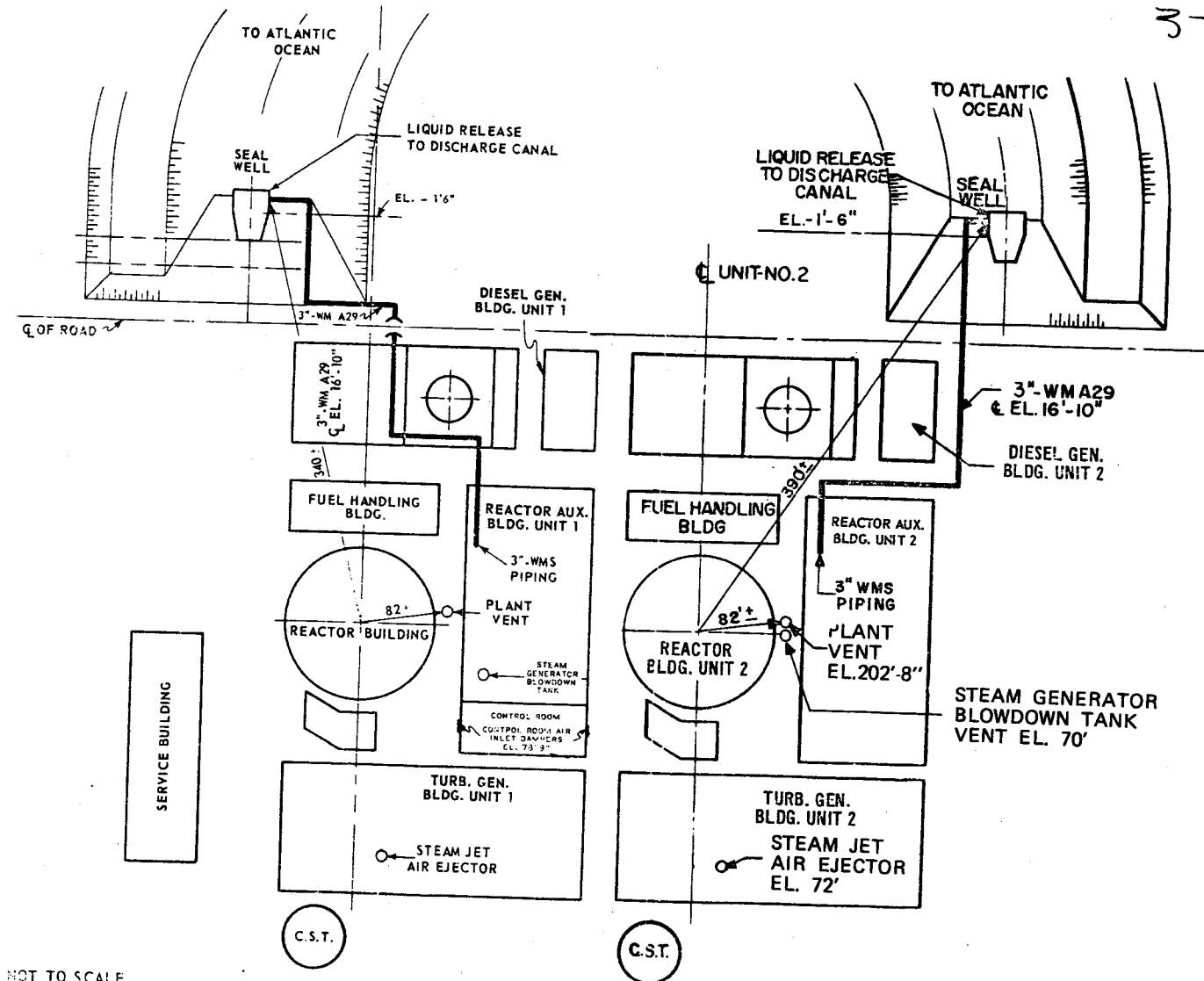
Isotope	Refueling Water Tank Activity Ci	Primary Water Storage Tank Activity Ci	Condensate Storage Tank Activity Ci
Kr-85	1.55(-8)*	6.86	-
Sr-89	9.42(-4)	9.97(-7)	5.21(-5)
Sr-90	7.65(-5)	1.02(-7)	2.26(-6)
Sr-91	2.72(-12)	-	3.32(-6)
Y-90	9.65(-3)	2.50(-7)	1.13(-12)
Y-91	2.13	3.55(-6)	8.10(-4)
Mo-99	1.00	5.71(-4)	1.97(-3)
Ru-103	7.97(-3)	7.03(-6)	2.61(-5)
Ru-106	5.59(-4)	8.63(-7)	2.49(-6)
Te-129	3.36(-2)	-	1.48(-4)
I-129	1.68(-9)	-	7.80(-10)
I-131	2.29(-2)	1.24(-7)	9.48(-3)
Xe-131m	1.84	1.68	-
Te-132	2.77(-2)	1.52(-5)	3.69(-4)
I-132	2.95(-4)	-	1.13(-3)
I-133	3.07(-6)	3.90(-11)	1.82(-3)
Xe-133	7.18	5.22(1)	-
Cs-134	2.30	3.69(-4)	1.44(-6)
I-135	5.52(-12)	-	2.82(-4)
Xe-135	3.60(-7)	9.12(-11)	-
Cs-136	2.46(-1)	1.56(-5)	2.73(-6)
Cs-137	7.44	1.25(-5)	1.05(-3)
Xe-138	-	-	-
Cs-138	-	-	8.79(-5)
Ba-140	5.88(-4)	3.66(-7)	3.47(-3)
La-140	6.72(-3)	8.30(-8)	2.11(-5)
Pr-143	1.21(-2)	3.77(-6)	5.24(-6)
Ce-144	9.23(-3)	1.39(-5)	3.53(-6)
Co-60	1.58(-2)	1.99(-4)	2.04(-5)
Fe-59	6.49(-4)	3.91(-6)	5.55(-5)
Co-58	1.42(-1)	1.08(-3)	4.07(-5)
Mn-154	8.37(-4)	9.40(-6)	3.65(-4)
Cr-51	1.16(-1)	4.96(-4)	2.03(-4)
Zr-95	2.85(-5)	2.10(-7)	1.55(-11)

*Numbers in () denote power of 10

TABLE 5.3-13

DOSE RATES RESULTING FROM
OUTSIDE STORAGE OF RADIOACTIVE
LIQUIDS

	<u>Primary Water</u> <u>Storage Tank</u>	<u>Refueling Water</u> <u>Tank</u>	<u>Condensate</u> <u>Storage Tank</u>	
			10 gpm <u>blowdown</u>	0.14 gpm <u>blowdown</u>
Tank Surface (mrem/hr.)	0.11	4.6	0.025	0.071
Site Boundary (mrem/yr.)	3.4×10^{-2}	0.79	8×10^{-4}	2.5×10^{-3}



NOTE: NOT TO SCALE

5.4 EFFECTS OF CHEMICAL AND BIOCIDES DISCHARGES

5.4.1 CHLORINE

Chemical and biocide discharges have been described in Section 3.6 of this report.

St. Lucie Unit Nos. 1 and 2 will have identical cooling water requirements and condenser systems. Two condensers containing two parallel water boxes each will be installed in both St. Lucie Unit Nos. 1 and 2. Five parts per million (ppm) of chlorine will be added to one bay of the intake structure for approximately 15 minutes each day to control fouling of the circulating water pumps, lines and condenser. The individual water boxes will not be chlorinated simultaneously, and the maximum concentration of residual chlorine expected at the discharge of a water box is 1.5 ppm. Therefore, the maximum concentration of free chlorine in the discharge canal will not normally exceed 0.19 ppm due to dilution with the water flowing through the other seven water boxes. If one assumes that this 0.19 ppm of residual chlorine passes down the discharge canal and through the discharge pipeline to the diffuser section without further reduction by organic material, an unlikely event, the maximum concentration of free residual chlorine at the ocean surface at the point of the plume rise, using the calculated thermal dilution factor is, less than 0.02 ppm.

Chloride is present in Hutchinson Island sea water at concentrations of 18,000 to 21,000 ppm, but chlorine (Cl_2) is not a normal constituent of such waters. At concentrations of total chlorine less than 1,000 mg/l, all the chlorine is present as HOCl or its dissociated ions (H^+ and OCl^-). The undissociated form appears to be the effective biocide, and the percentage of chlorine present in this form is a function of sea water pH (96 percent HOCl at pH 6, 75 percent at pH 7, 22 percent at pH 8, and 3 percent at pH 9). Normal sea water has a pH of 7.5 to 8.4, with higher values at the surface.

Low concentrations of free available chlorine (HOCl and OCl^-) in water may be toxic to fish and to other aquatic life. Hiatt and his colleagues⁽¹⁾ have shown that the marine fish Kuhlia sandvicensis exhibited slight irritant activity when exposed to 1.0 ppm chlorine for two minutes. Other fish of the same species, when exposed to 10 ppm chlorine showed violent irritant activity. Most investigators of the effects of chlorine on fish have used fresh water fish as test animals. Lethal concentrations of chlorine for various species of fresh water fishes have ranged from 0.03 to 3.0 mg/l⁽²⁾.

In sea water conduits, exposure for eight hours per day to sea water containing 10 mg/l chlorine did not kill all adult mussels and anemones, but most barnacles were killed by exposure for one hour. With continuous chlorination to a residual of 2.5 mg/l, all organisms were killed in five to eight days, but at 1.0 mg/l a few barnacles and all the anemones were alive after fifteen days⁽³⁾.

5.4.2 MISCELLANEOUS CHEMICALS RELEASED

During the course of demineralizer regeneration, various ions will be released to the St. Lucie Plant circulating water system after holdup and neutralization. These ions, and the amounts released are shown in Table 3.6-2. Assuming a constant release of 465 lb per hour of total dissolved solids (TDS) into a circulating water flow of 1150 cfs, the resultant increase in TDS of the circulating water will be less than 2 ppm. The seawater into which these ions will be discharged contains 33,000 to 38,000 ppm of dissolved solids. Because the ions discharged from the St. Lucie Plant naturally occur in seawater, no measurable effect of this discharge is expected.

Routine releases of boric acid to the ocean are minute (reference Section 3.6.5) and should cause no perceptible impact. Larger discharges of boric acid are postulated on a contingency basis. Such releases amount to 1 or 2 ppm over a period of several hours. Normal seawater levels of boric acid are approximately 4.6 ppm at normal salinity. Thus concentrations at the point of discharge may reach 6 or 7 ppm, but will be diluted within a short distance of the discharge point. No measurable impact is expected to result from boric acid discharge.

Calculated releases of copper (reference Section 3.6.5) resulting from corrosion of condenser tubes indicate that the discharge to the ocean will be approximately 5.6 ppb.

5.5 EFFECTS OF SANITARY WASTE DISCHARGE

5.5.1 SPECIFIC CONCENTRATIONS OF SANITARY WASTES

A description of the treatment and disposal system for the St. Lucie Unit Nos. 1 and 2 is given in Section 3.7. It is expected that the system effluent would have approximately the following constituents:

Biochemical Oxygen Demand	-	50 ppm
Suspended Solids	-	45 ppm
Settleable Solids	-	none
Total Nitrogen	-	50 ppm as N
PO ₄	-	20 ppm as P
Toxics, Heavy Metals	-	none
Greases and Oils	-	none

5.5.2 PROJECTED EFFECTS OF SANITARY WASTES

No discernible adverse environmental effects are expected as a result of the discharge of the treated sanitary wastes. There is no off-site discharge to surrounding land or natural waters. It should be noted that the sanitary disposal system meets all applicable regulations and has received approval from the State of Florida, Department of Health and Rehabilitative Services. Further, it should be noted that because the leaching field is to be located approximately 22 feet above the groundwater table, the natural water purification capabilities of the soil will be taken advantage of and further enhancement of the discharged water quality will be effected.

5.6 EFFECTS OF OPERATION AND MAINTENANCE OF THE TRANSMISSION SYSTEM

Power from St. Lucie Unit No. 2 will be delivered to the FP&L system at the St. Lucie substation via one of the three 240 circuits constructed for St. Lucie Unit No. 1. Therefore, no additional transmission lines will be required for the operation of Unit 2.

Maintenance of the transmission right-of-way does not include the use of herbicides or pesticides. Control of excess plant growth on the land portion of the right-of-way will be by mowing.

3

5.7 OTHER EFFECTS

5.7.1 EMERGENCY DIESEL GENERATORS

Sections 5.1 through 5.6 of this report discuss in detail the major environmental effects of the St. Lucie Unit No. 2 plant operations. Possible adverse environmental effects would occur as a result of the gaseous wastes emitted by the emergency diesel generating system. This system is utilized only in the event of an emergency plant shutdown and its operation will be limited to periodic testing on a semi-monthly basis. These tests will require running the diesel generators for about one hour. Section 3.7.2 describes the diesel-generators and their combustion products.

In view of the quality of emissions and the infrequent use of the diesel generators, this system is not source of significant adverse environmental impact.

5.7.2 RACCOON POPULATION

It has been stated that raccoons are a major predator of turtle nests and postulated that the presence of the St. Lucie Plant may cause the numbers of raccoons to increase (1). FP&L's Turkey Point Plant is quite similar to the St. Lucie Plant in that it is also bordered by mangrove swamp. It is also known that a raccoon population exists in the area of the Turkey Point Plant, however there has been no known raccoon foraging within the plant. It is believed that the Plant perimeter fencing is an effective barrier and/or the Plant lighting and personnel activity within the Plant deters the raccoons. Thus it is concluded that St. Lucie Plant will be equally effective in precluding entry of raccoons since the fencing, lighting and personnel staffing is quite similar to that of the Turkey Point Plant. Should raccoons gain entry to the Plant, the accessibility of food to the raccoons is minimal due to normal house-keeping practices. Food wastes are disposed of by temporary storage in commercial containers with secure lids. These containers are periodically emptied by a commercial carrier for ultimate disposal of the food wastes.

5.8 RESOURCES COMMITTED

The resources committed in the operation of St. Lucie Unit No. 2 are those common to any large industrial facility with the exception of the nuclear fuel. Only that portion of the nuclear fuel which is burned up or not recovered in reprocessing is irretrievably lost to other uses. This will amount to approximately 25 metric-tons of Uranium 235 assuming a 30-year lifetime for the Plant. Plutonium generated during the course of reactor operation will be recovered, and this plutonium could be either recycled in the Plant thus reducing the U-235 consumed or could be used elsewhere as nuclear fuel.

Long-lived radioactive materials will be produced by fission of nuclear fuel in the reactor core and by neutron activation of reactor parts near the core. A certain amount of space, probably remote from the Plant site, will be needed for the eventual disposal and storage of radioactive materials for a very long period of time. This space, in a sense, could be considered an irretrievable commitment of resources but is not peculiar to this plant-site.

Due to AEC security requirements, public access to the Site will have to be controlled. However, recreational and other uses of the surrounding area should not be altered significantly. The Indian River, including Big Mud Creek will remain public property. The ocean beach below the dune line (mean high water) will remain available to the public.

Estimates of the numbers of planktonic organisms passed through the condenser of St. Lucie Unit 2 have been made and are presented in Section 5.1.3 of this report. While large numbers of plankters will be subjected to increased temperatures and turbulence because of entrainment in the cooling water; the effects of these stresses on entrained organisms cannot be precisely predicted at this time.

If 100 percent of the planktonic organisms passed through the plant are killed, their remains will be discharged into the Atlantic Ocean. The constituent elements of which these organisms consist will not be lost (i.e. removed from the ecosystem), but will be added to the nutrient pool offshore of Hutchinson Island. If the "pool" of ocean water from Fort Pierce Inlet to St. Lucie Inlet, and from the low tide mark to the 30 ft. contour is assumed to have an average depth of 5 m, then the volume of this "pool" may be estimated at $173 \times 10^6 \text{ m}^3$. During the course of one day, St. Lucie Unit 2 will pass approximately $2.8 \times 10^6 \text{ m}^3$, or 1.6 percent of the "pool's" volume through its condensers. Because the water in this "pool" is not stagnant, but is replenished due to long-shore currents, (which carry planktonic organisms) long-term effects on plankton densities are not expected to occur. The flow-through rate for this hypothetical "pool" of water will vary with the velocity of long-shore currents. From September 1971 to April 1973, surface current velocities at station I (located near the 30 ft. contour) ranged from 0 to 39.0 cm/sec, with a mean value of 22.1 cm/sec (see section 6.1.1.1). Assuming an average and constant long-shore current velocity of 10 cm/sec, and knowing the length of Hutchinson Island (36,000 m), the flow-through rate may be approximated at 24 percent of the "pool's" volume per day. How-

0

ever, until additional data on the velocity and duration of the long-shore currents offshore of Hutchinson Island have been collected, precise computations of flow-through rates are not possible.] 0

Detailed analysis of the data collected during the pre-operational surveillance program should provide additional insight into the dynamics of the plankton communities of Hutchinson Island. When these data are available, more refined predictions may be possible.

Prior to the construction of St. Lucie Unit No. 1, the site was actually a dead mangrove swamp, which has now been converted into filled land. The area in question was never farmed or at any time had any economic importance. From the amount of effort expended to control mosquitos in this swamp area, some negative view of its value is evident. Beyond the plant area itself, the present plans for the remaining other property on the island owned by the applicant are to preserve in its natural state as much as practical. Since this will protect it from the future encroachment by the usual Florida beach type of development, it should be of considerable value in preserving the amenities. Should it be desired to decommission the facility at the end of its expected life, the land itself could be returned to a natural state as a filled area rather than a swamp, or employed for other purposes. The land used for the site is not considered to be an irreversible or irretrievable commitment of resources.

6. MONITORING
PROGRAMS

6.0 EFFLUENT AND ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

Effluent and environmental measurements and monitoring programs for the St. Lucie Nuclear Plant are described in this section. The methods by which FPL is determining existing conditions and will determine effects of the nuclear units on the surrounding environment during construction and operation are discussed as well.

6.1 PREOPERATIONAL ENVIRONMENTAL PROGRAMS

Preoperational environmental monitoring programs establish reference base line conditions for assessing the environmental effects of site preparation, plant construction and operation. Such programs consist of radiological, ecological and meteorological monitoring of the on-site and near off-site environment that is potentially affected by the plant. Following is a technical description of the instrumentation, technique and procedures employed to implement these programs.

All other programs for radiological monitoring, ecological monitoring, soil analysis, etc. will be described as well.

6.1.1 SURFACE WATERS

The condenser cooling water will be drawn from and discharged to the Atlantic Ocean offshore of the St. Lucie plant site. Therefore, a program was established for monitoring the physical, chemical and ecological parameters necessary to establish the base line characteristics of the ocean at the plant site.

6.1.1.1 Physical and Chemical Parameters

A long-term preoperational study of Atlantic Ocean waters near Florida Power & Light Company's St. Lucie Plant site began in April 1971. (1,2,3) (Prior to this long term study a preliminary study was conducted and is described in Appendix 3 of the Unit 1 Environmental Report.) This study, which includes investigations of temperature, salinity, dissolved oxygen concentrations, and nutrient levels, is being continued under the supervision of the Florida Department of Natural Resources (FDNR). The five offshore sampling stations are shown in Figure 6.1-1, and they are located as follows in Table 6.1-1.

Surface and bottom seawater samples are collected monthly at each of the five stations with an 8 - liter Niskin bottle. Temperature and dissolved oxygen are measured with a YSI Oxygen Meter (Model 54), while salinity is determined by refractometry. The direction and velocity of surface currents are measured at each station. The concentration of inorganic particulate material suspended in seawater is also determined on a monthly basis at each of the five stations.

Since February 1972, monthly surface and bottom water samples taken at each station have been analyzed for orthophosphate, nitrate, nitrite, ammonia and silicate. These analyses are made with a Technicon Auto-analyzer. Bottom sediments are sampled semiannually for grain size. An aliquot of sediment is dried and divided into 7 fractions with a

Ro-Tap sieve shaker. Sieve mesh sizes are 2.000, 1.000, 0.500, 0.250, 0.125 and 0.062 mm. The distribution of sediment particle size is determined for 5 replicates from each station. The results of these investigations are detailed in Section 2.7 of this report.

The current velocity and direction data presented in Table 6.1-2 have been extracted from the progress reports issued to Florida Power and Light by the Florida Department of Natural Resources. These data points are the result of instantaneous current direction and velocity measurements taken normally once per month at each of the five stations.

Florida Power and Light Company is installing two film recording current direction and velocity meters (General Oceanics Model 2010) at the Hutchinson Island thermograph station. Current direction and velocity will be measured near the surface above the bottom and data recorded every 15 minutes for a period of one year. Data from recorders will be translated each month and presented as supplements to the St. Lucie Unit 2 Environmental Report on a quarterly basis.

6.1.1.2 Ecological Parameters

Regular biological sampling at Hutchinson Island began in September 1971. Ecological data have been collected at five offshore stations and three beach stations as shown in Figure 6.1-1 and Table 6.1-1.

Monthly samples of surface and bottom seawater collected at the five offshore stations are analyzed for chlorophyll a, phaeopigments and suspended organic particulate matter.

Phytoplankton samples were taken every other month from September 1971 to September 1972, and at monthly intervals from that time to November 1972. At this time, zooplankton data are available for the first year of sampling (six samples collected every other month from September 1971 to July 1972). Plankton samples are collected with a 0.5 m plankton net of 202 micron mesh. Bottom to surface step-oblique 10-minute tows were made at each station. The net is equipped with a flowmeter which records the volume of water passed through the net. Planktonic organisms are then identified and enumerated.

Benthic invertebrates are sampled every other month (September 1971 to July 1972) with a Shipek Sediment Sampler (Model 860). This device collects 0.04 m² of bottom sediment, to a depth of 0.10 m. Five replicates are collected at each station. Benthic organisms are removed from the sediment, enumerated and identified. In addition, benthic invertebrates and fishes are collected with a 12 ft balloon trawl. A single 15 minute trawl is made at each station every other month.

Three beach stations were selected for sampling the ichthyofauna of Hutchinson Island and near St. Lucie site. A 50 ft beach seine (1/2 in. stretched mesh) is used to obtain three replicate samples at each of the beach stations.

The results of the biological investigations may be found in Section 2.7 of this document.

SIEVE
SIZE?

Σ 0.2 m²

6.1.1.3 Continuing Environmental and Ecological Investigations

In order to assess accurately the environmental and biotic changes which occur naturally at Hutchinson Island, a continuing program of environmental and ecological monitoring has been established to monitor water quality parameters, numbers and types of benthic, planktonic and nektonic fauna and flora. How?

6.1.2 GROUNDWATER

As discussed in Section 2.5 the nature and hydrology of the aquifers under Hutchinson Island are such that groundwater flows slowly toward the coastline. This flow precludes the possibility that accidental subsurface releases will be transported toward the mainland. (1,2,4)

6.1.2.1 Physical and Chemical Parameters

A series of subsurface investigations (2) have been performed to determine the general groundwater environment at the site.

Through the month of April, 1968 piezometric investigations were conducted in 10 borings located as shown in Figure No. 6.1-2. Groundwater levels were recorded periodically in that month. In addition, in late March and early April 1968 complete chemical analyses were performed on samples extracted from borings numbers P-1, P-2, P-3a, P-9 and P-11. These analyses were evaluated comparative to analyses of the Big Mud Creek and local swamp water.

Two piezometers were also installed in mainland boring holes, B-17 and 18, the locations of which are defined on Figure 6.1-3. Groundwater head was recorded periodically at these points from June through August 1968.

In May of 1968 a survey was conducted by the Law Engineering Testing Company to identify all existing private wells within a 5 mile radius of the St. Lucie site. (2)

Complete chemical analyses were performed on the two mainland wells serving public water supplies for the cities of Stuart and Fort Pierce.

Laboratory permeability tests were performed on undisturbed samples from boring holes B-8 and B-13. Two types of pump-in, constant head field permeability tests were conducted at locations 50 ft east of B-2 and approximately 435 ft south of B-2 and 75 ft west of highway A-1-A. Open end pipe and well permeater type tests were performed at each site in accordance with US Bureau of Reclamation Methods.

6.1.2.2 Models

The possibility of intrusion of plant releases into mainland groundwater is remote based on review of physical and chemical investigation of subsurface conditions. As a result, dispersive modeling was not employed.

6.1.3 LOCAL AIR QUALITY AND METEOROLOGY

FPL has conducted extensive atmospheric monitoring at the St. Lucie site to accurately define existing meteorological characteristics and atmospheric quality. This background data has been input to a mathematical model to evaluate dispersion and impact of possible releases.

6.1.3.1 On Site Meteorological Monitoring Program

Since March 1971 on-site meteorological data have been continuously collected at the St. Lucie site.

The on-site meteorological monitoring program is designed to provide a diffusion climatology for use in safety planning of radioactive effluent releases and as a means of determining the appropriately conservative meteorological parameters to be used in estimating the potential consequences of hypothetical accidents.^(1,2)

The instrumentation and system design is consistent with the criteria presented in AEC Regulatory Guide 1.23 with one exception, the starting speed of the aerovane is 1 mps rather than 1 mph as recommended in Safety Guide 23. The system is equipped to monitor the following meteorological parameters on a continuous basis; wind speed and direction, temperature and delta temperature, precipitation, barometric pressure and dew point temperature.

The on-site monitoring system consists of the following equipment:

- a) Meteorological Tower - A guyed 200 ft steel frame tower is located approximately 2400 ft northeast of the Unit 1 structures. It is situated in a relatively flat area densely covered by mangrove trees from 6 to 8 ft high.
- b) Wind Sensors - Bendix (Model 120) six-bladed aerovanes are located at the 50 and 190 ft levels of the tower. The threshold speed for tracking of the wind direction sensor is 3 mph while the anemometer starting speed is 1 mps.
- c) Temperature Sensors - Climet (Model 104-MB) platinum resistance thermometers are installed in Climet (Model 181) aspirated radiation shields at the 33, 110, and 200 ft levels. The overall accuracy of the shield sensor combination is 0.2 F with a calibration accuracy of ± 0.25 percent. A continuous record of ambient temperature at each level and temperature differential between the 33 ft, 110 ft and 200 ft levels is provided.
- d) Rain gauge - A standard ESSA type (USWB No. 595 tipping bucket) weighing rain gauge is installed at ground level at the site near the tower.
- e) Barometric Pressure - A Belfort microbarograph (USWB No. 355-31SW) is employed to provide a continuous strip chart record of atmospheric pressure.

- f) Dew Point Temperature - A Climet (Model M2711AAG) lithium chloride dew cell with an accuracy of ± 0.5 F between 10 and 90 percent RH is installed at the 10 meter level in a Climet (Model 180) motor aspirated temperature and dew cell shield. 1
- g) Data Acquisition System - The meteorological data is continuously recorded on two Bendix (Model 141) wind speed and direction recorders, two Bristol (Model 261(1)-4) temperature and dew point recorders, and one USWB (No. 592) rainfall recorder which are housed in a small building at the base of the tower.
- h) Data Reduction - The strip chart data are manually reduced to mean hourly data and placed on computer punch cards. The hourly data is then analyzed to provide summaries which include: wind direction and speed, and joint frequency distribution of wind direction, wind speed and atmospheric stability. 0

The inspection and calibration program for the meteorological instrumentation provides for weekly checks of the instrumentation to note the general condition and function of all the equipment. At this time the recorders are checked for proper timing and serviced with paper, lubricants and ink as required. The aerovanes are visually correlated to the recorder trace. The temperature sensor motor aspirators are checked for current flow. The rain gauge recorder and counter is serviced and checked against the measuring cylinder, however the objective is to service the rain gauge as soon after a rain as practical, i.e. during daylight working hours. On a bi-monthly basis the temperature sensor installed at the 10 meter elevation is checked against a laboratory thermometer, the dewpoint recorder against a laboratory sling psychrometer and the microbarograph against a laboratory mercury barometer. The aerovane sensors are removed once each year for major inspection, maintenance and calibration. Calibration records are maintained and are available at the site for audit.

6.1.3.2 Models

Estimates of relative ground level concentration of releases from the St. Lucie plant for the area surrounding the site were estimated using the on-site meteorological data collected during the period March 1971 - February 1972. (2) The Pasquill stability categories were determined from the on-site data by a split sigmas technique. For wind speeds less than 3 mph both the vertical and horizontal stability classes were determined from measurements of vertical temperature gradient as discussed in the previous section. At wind speeds greater than 3 mph the horizontal stability was determined by the sigma-theta technique. Sigma-theta was calculated by dividing the range of wind direction by 6. The Sigma-theta criteria used to determine Pasquill stability classes are as follows:

<u>Pasquill Class</u>	<u>Description</u>	<u>Range of σ_θ (degrees)</u>
A	Extremely unstable	$\sigma_\theta \geq 22.5$
B	Unstable	22.4 to 17.5
C	Slightly unstable	17.4 to 12.5
D	Neutral	12.4 to 7.5
E	Slightly stable	7.4 to 3.8
F	Stable	3.7 to 1.3
G	Extremely stable	$\sigma_\theta < 1.3$

The wind data from the 15 m (50 ft) level, supplemented by data from the 58 m (190 ft) level during periods of missing 50 ft data, was used in the calculations. However, all wind data was reduced to the 10 m (33 ft) level by the following power law equation:

$$\mu_{10} = \mu_h \left(\frac{h}{10} \right)^{-n}$$

where μ_{10} = wind speed (mph) at the 10 meter level

μ_h = wind speed (mph) at height h

h = height in meters

$n = 0.25$ for Pasquill A, B, C, D or 0.50 Pasquill E, F and G

This on-site data was used to compute hourly relative concentrations. Total sample moving average relative concentrations were calculated for various time periods and the resulting values ranked according to severity.

The following equation was used to estimate the 0-2 hour relative concentration at the nearest site boundary:

$$\frac{X}{Q} = \frac{1}{\mu_{10} (\pi \sigma_y \sigma_z + CA)}$$

where X/Q = relative concentrations (seconds per cubic meter)

μ_{10} = average hourly wind speed adjusted to 10-meter elevation (m/sec)

σ_y = horizontal dispersion as determined by the standard deviation of the hourly horizontal wind variability (m)

σ_z = vertical dispersion as determined by the vertical temperature lapse rate (m).

CA = one-half the minimum cross-sectional area of the containment structure (1363 m^2)

For the longer time periods of 0-8 hours, 8-24 hours, 1-4 days, and 4-30 days the plant release plume was assumed to be uniformly spread over a $22\frac{1}{2}$ degree sector. The following equation was used to calculate the relative concentrations at the low populations zone distance of 5 miles (8,047 meters) for these time periods:

$$\frac{X}{Q} = \frac{1}{n} \sum_{i=1}^n \frac{2.032}{\mu_{10} \sigma_{zi} D}$$

where $\frac{X}{Q}$ = average relative concentration in seconds per cubic meter for time period of interest for each sector.

μ_{10} = average hourly wind speed in meters per second with a minimum assignment of 0.447 mps (110 mph).

σ_z = vertical dispersion as determined by the vertical temperature lapse rate (m).

D = the distance in meters to the low population zone distance of 8047 meters

n, i = the average time periods of 8 hours, 16 hours, 3 days, and 26 days

2.032 = constant that incorporates a sector spread of $22\frac{1}{2}$ degrees or $\pi/8$ radians.

The average annual relative concentration was computed for each of the 16 sectors out to a distance of 50 miles using the following equation:

$$\frac{\bar{X}}{Q_{(s,x)}} = \frac{1}{n} \sum_{i=1}^{n \text{ hrs}} \frac{2.032}{\sigma_z(x,p) \mu_s x}$$

where $\frac{\bar{X}}{Q_{(s,x)}}$ = average annual relative dilution for each sector s and distance x (meters).

$\sigma_z(x,p)$ = vertical dispersion coefficient at distance x as defined by the vertical temperature gradient Pasquill category p (m)

μ_s = average hourly wind speed in the specific sector, s (mps) with a minimum assignment of 0.447 mps (1.0 mph)

n,i = the valid hourly data sample for the year

6.1.3.3 Air Particulate Sampling

The organization that monitors suspended particulate concentration levels near the St. Lucie Site is the Florida State Department of Pollution Control, Southeast Region, Fort Lauderdale, Florida. The concentration values are for a 24 hour period, in micrograms per cubic meter, measured with a high volume sampler. Table 6.1-6 summarizes all the available data. Readings are taken about twice each month, varying from month to month in one of four locations. These locations are:

1. Roof of 806 South Sixth Street,
Fort Pierce, Florida (9 miles NNW of plant site)
2. Okeechobee City - on top of old jail
(35 miles WSW of plant site)
3. Martin County - on top of Dixie Park
water plant south and west of Stuart
(20 miles SSW of plant site)
4. Vero Beach - Division of Forestry Ranger Station
43rd Avenue and 5th Street
(25 miles NNW of plant site)

2

The instrumentation to measure chemical pollutants is semi-permanently mounted on the roof of 806 South Sixth Street, Fort Pierce, Florida. Readings are taken once every three months.

6.1.4 LAND

Extensive investigations have been performed on the existing terrestrial environment in order to identify all relevant surface and subsurface conditions.

6.1.4.1 Geology and Soils (Preexisting and present conditions of site)

Initial subsurface conditions prior to site preparation were investigated⁽²⁾ with 20 soil test borings located as shown on Figure 6.1-3.

Seven of these borings were in the plant area and the remaining thirteen were for the purpose of defining foundation and geologic conditions in the vicinity.

A second set of borings was conducted as shown in Figures 6.1-5 and 6.1-6. Standard penetration tests were performed and samples were taken from all borings at five foot intervals and at all changes in soil formation using a standard 2 in. split spoon sampler. A Shelby tube sampler was used to obtain undisturbed soil samples. A third set of borings was performed for verification at locations shown by suffix "A" on Figure 6.1-6.

A refraction seismic survey was undertaken at St. Lucie site to determine the compression wave velocities under dynamic conditions and to determine if there were any significant changes in the rigidity of the formations (which could be detected by seismic velocity) below the deepest borings made at the site. An additional use of the data from the geophysical exploration was to determine if there were any significant differences in elevation between the lithologic boundaries that might suggest structural displacements, in an area more extensive than that covered by the on-site borings.

Twenty-eight seismic lines were investigated running essentially parallel to and at right angles to the grid established in the boring and sampling work. The length of these lines varied from 450 to 3200 ft. They crisscrossed the island and extended along the highway well beyond the limits of the boring work.

The instrument used was a Dresser Model RS-4, 12 channel, recording seismograph with surface geophones capable of recording compression waves.

The charges of explosive detonated ranged from 2 to 15 pounds of gelatin dynamite placed both at the ground surface and in bore holes as deep as 70 ft.

Details of soil test program covered in FSAR for Unit No. 1.⁽²⁾

A comprehensive foundation investigation was conducted at the site to supplement the data obtained from the initial site boring program. The purposes of the supplementary foundation investigation were as follows:

- a) To verify in further detail the subsurface conditions at the location of the structures.
- b) To establish the liquefaction resistance of the soils in greater detail.

- c) To develop additional foundation data to verify bearing capacity and estimated settlements
- d) To determine the physical properties of compacted soils for use in the dynamic evaluation of the soil foundation structural system
- e) To locate suitable fill material
- f) To determine the degree of compaction that can be obtained from the available soil to be used in the controlled fill.

Samples extracted from the second set of borings were subjected to laboratory tests to determine the physical properties of the soils.

The complete laboratory program included the following tests:

- a) Grain size analysis
- b) Specific gravity
- c) Moisture content and density
- d) Maximum-minimum density
- e) Proctor compaction test
- f) Consolidation

Additional laboratory tests were performed to determine the static and dynamic shear properties of the soils. These tests include the following:

- a) Direct shear
- b) Triaxial compression
- c) Cyclic triaxial shear
- d) Compression wave velocity

Direct Shear and Triaxial Compression tests were performed on representative samples of the compacted material that was used for the plant backfill. These tests further established the soil parameters, such as the angle of internal friction and the effect of pore water pressure, which are utilized in bearing capacity evaluations.

A settlement analysis was performed for the critical plant structures of Unit 1 to determine the anticipated relative vertical displacements for static conditions. The excavation and backfill plan yielded surcharge pressures in the underlying deep strata which were comparable to the final loading conditions. The construction sequence of maintaining the ground water table at EL 60 ft. during the backfilling operations and construction of the Unit 1 containment structure reduced the "seat of settlement" to within the dense sand strata above EL 150 ft.

Cyclic triaxial shear tests were also conducted on representative samples of the backfill material compacted to 85 percent relative density. These tests verified the stability potential of the compacted backfill materials with respect to earthquake motions.

An analysis of the post earthquake settlements made on the granular materials of the intermediate zone from 50 ft to 150 ft deep was accomplished by performing special cyclic triaxial tests and utilizing the results and strain parameters to predict the settlements.

6.1.4.2 Land Use and Demographic Survey

Population figures have been estimated for 1980, 1990 and 2000 based on 1970 census data⁽⁵⁾ and projected based on generally accepted economic research methods. Projections have included rates of migration and growth based on best available conventional sources of such information.

Land use investigations have encompassed state and local sources of information typically including the Florida Department of Agriculture, the St. Lucie County Chamber of Commerce⁽²⁾, the City Manager of Stuart and local real estate brokers.

6.1.4.3 Ecological Parameters

No formal sampling has been conducted in terrestrial life or ecological characteristics in the area of St. Lucie Unit 2. A survey of the area⁽¹⁾ of the plant prior to the installation of Unit 1 concluded that the terrestrial biology in the vicinity had been severely altered during the 1940's by mosquito control efforts which killed mangrove shrubs and trees which were critical for support of the salt water marsh habitat.

6.1.5 RADIOLOGICAL SURVEYS

a) Expected Background

A preoperational radiological monitoring program is being conducted to determine the magnitude and nature of the radioactivity in the environment surrounding the site prior to the startup of the plant. The preoperational program for Unit No. 1 and sequentially for Unit No. 2 began in January 1971. When Unit No. 1 begins commercial operation in 1975 the program will evolve into an operational radiation monitoring program for Unit No. 1 and a continuing preoperational radiation monitoring program for Unit No. 1.

The preoperational program is being closely coordinated with the State program for monitoring radioactivity levels. Discussions held with State agencies assist in formulating an acceptable preoperational environmental radioactivity monitoring program. The resulting program will be reviewed to assure maximum effectiveness.

The expected annual whole body exposure from natural sources is 120 mrem.

b) Sampling Media, Locations and Frequency

Sampling stations and sites are established on the basis of population density and distribution, meteorological, hydrological and topography conditions.

The sampling program was initiated in January 1971 and includes samples of air, precipitation, surface water, bottom sediments, beach sand, various marine organisms, milk, terrestrial biota and soil.

Marine organisms are collected where available near the site, with emphasis on obtaining samples near the plant discharge. (See Figure 2.8-2, Section 2.8.) Bottom sediment samples are collected at the plant outfall. Surface water samples from the outfall are collected and composited for analysis. Groundwater samples are collected from an appropriate nearby well. Soil samples are collected from the immediate plant environment. Air radiation dosimeters of air particulate samplers are located at various onsite or offsite positions. The preoperational and operational environmental radiological surveillance program sampling locations, sampling media, collection frequency and analysis type is contained in Table 6.1-2. Figure 2.8-1 is a map showing the location of the sampling stations. A brief description of the analysis methods and equipment used is contained in Appendix 1, Radiological Surveillance Data, First Quarter 1972.

Minimum levels of detectable activity in gaseous and liquid media for selected radionuclides is contained in Table 6.1-3. Table 6.3-4 contains the analysis method used for the specific radionuclide.

Environmental radiological monitoring data is evaluated in terms of potential human radiation exposure. Whole body exposure to individuals living in the vicinity of the plant will comply with the limits contained in 10CFR50, Appendix I.

TABLE 6.1-1

LOCATION AND DEPTH OF SAMPLING STATIONS
OFFSHORE OF HUTCHINSON ISLAND

<u>Station</u>	<u>Coordinates*</u>	<u>Mean Depth (m)</u>	<u>Nautical Miles Offshore</u>
I	27°21'06" N, 80°13'58" W	8.4	0.34
II	27°21'23" N, 80°13'24" W	11.2	0.93
III	27°21'42" N, 80°12'28" W	7.1	1.81
IV	27°20'24" N, 80°13'04" W	10.9	0.87
V	27°22'08" N, 80°13'44" W	10.8	0.95
VI	27°21'18" N, 80°14'30" W	--	surf zone
VII	27°20'51" N, 80°14'14" W	--	surf zone
VIII	27°20'32" N, 80°14'06" W	--	surf zone

*USC&GS Chart No. 1247

TABLE 6.1-2

ATLANTIC OCEAN SURFACE CURRENTS OFFSHORE
OF HUTCHINSON ISLAND

SURFACE CURRENTS Velocity (cm/sec) and Direction	STATION				
	I	II	III	IV	V
September, 1971	17.5 NE	17.4 NE	23.0 N	23.0 N	12.0 NE
November, 1971	26.7 SSE	25.0 SSE	18.5 E	35.0 NW	32.5 NW
December, 1971	17.0 NW	18.5 N	19.0 NW	17.0 NW	17.0 NW
January, 1972	32.5 NW	36.5 N	29.0 N	27.9 N	30.0 N
February, 1972	31.5 NW	38.0 NNW	36.5 NNW	35.5 NNW	37.5 N
March, 1972	17.0 N	26.0 N	35.0 N	37.5 N	33.5 NNW
April, 1972	26.5 S	26.2 S	29.0 variable	25.5 variable	25.0 variable
May, 1972	19.6 N	25.5 NNE	18.0 E	<15.0 S	22.5 S
June, 1972	0 -	21.5 SE	19.5 SE	19.4 SE	18.0 SE
5 July 1972	32.5 N	36.0 N	26.0 N	32.5 N	15.8 N
18 July 1972	18.0 W	19.0 W	18.5 W	19.0 W	20.0 W
August, 1972	24.8 NNW	27.5 NNW	33.6 NNW	28.5 NNW	29.3 NNW
September, 1972	21.5 S	44.0 S	38.6 S	47.0 S	34.5 S
October, 1972	19.6 S	25.4 S	19.7 S	21.8 S	18.2 S
November, 1972	32.4 N	17.0 N	21.0 N	26.0 N	27.5 N

0

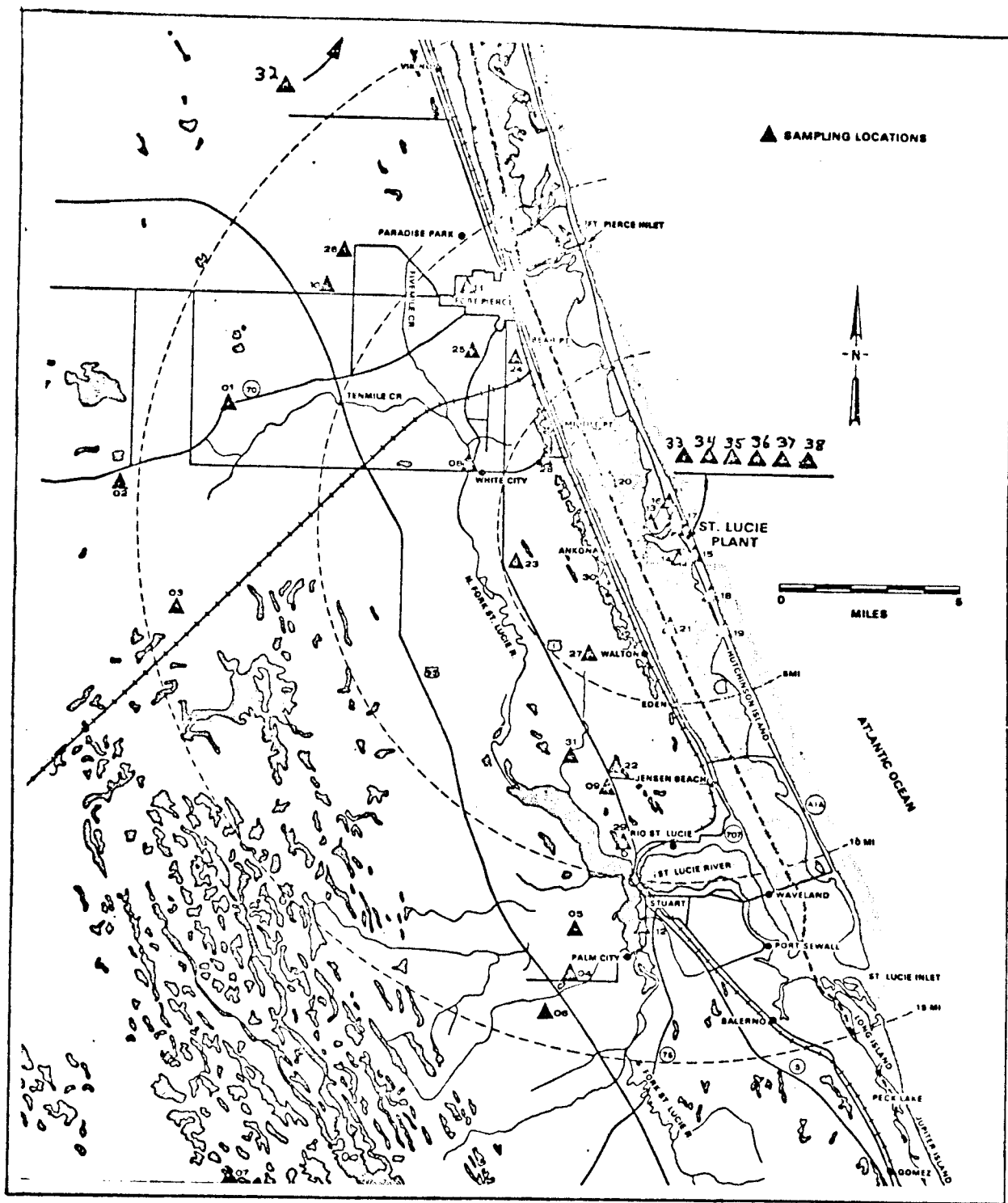
TABLE 6.1-2 (Cont'd)

<u>SURFACE CURRENTS</u> <u>Velocity (cm/sec)</u> <u>and Direction</u>	<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>	<u>V</u>
December, 1972	X*	26.0	48.6	X	29.6
	X	S	S	X	S
January, 1973	0	0	0	21.4	30.0
	-	-	-	N	N
February, 1973	18.0	18.0	0	0	0
	NW	NW	-	-	-
March, 1973	26.5	32.5	30.0	28.5	27.5
	NNW	NNW	N	N	N
April, 1973	39.0	26.5	24.8	22.5	20.7
	N	N	N	N	N

* no data
collected

General Oceanics
Digital Flowmeter
Model 2030 used to
measure current
velocity

Velocities ranged
from 12 to 48.6
cm/sec, or 0.39
to 1.63 ft/sec.



**FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2**

**RADIOLOGICAL SURVEILLANCE
SITES**

FIGURE 6.1-4

TABLE 6.1-3 SHEET 1

OPERATIONAL ENVIRONMENTAL RADIOLOGICAL SURVEILLANCE PROGRAM

	<u>Criteria and Sampling Locations (1)</u>	<u>Collection Frequency(2)</u>	<u>Analysis/Counting</u>
1. <u>AIR</u>			
1.1 Particulate and Iodine	Comparison on-site versus off-site & reference locations 3 locations on-site, north, east, & southeast of the plant H 34, H 14, H 33 (6) 6 locations off-site within a radius of 10 miles of plant H 08, H 09, H 10, H 12, H 30, H 32	Weekly	Gross Beta Gamma spectral analysis of monthly composite if indicated by high beta activity (5) Radioactive Iodine
1.2 Direct Radiation	Comparison of on-site versus off-site & reference locations 3 locations on-site, north, east, & southeast of the plant H 34, H 14, H 33 (6) 6 locations off-site within a radius of 10 miles of plant H 08, H 09, H 10, H 12, H 30, H 32	Monthly	Determine direct radiation exposure by TLD readout (mean of 2 TLDs)
1.3 Precipitation (3)	Comparison of on-site versus off-site reference locations 1 location on-site, site meteorological tower, H 34 3 locations off-site H 08, H 10, H 32	Monthly	Gross Beta Gamma spectral analysis(4) Tritium (4)
2. <u>WATER</u>			
2.1 Surface Water			
2.1.1 Discharge Canal	1 location, east of A1A, H 35 1 location, west of A1A, H 36	Monthly	Gamma spectral analysis Tritium Sr-89 & 90
2.1.2 Ocean	5 locations, H 15, H 16, H 17, H 18, H 19	Quarterly	Gamma spectral analysis Tritium Sr-89 & 90 (if detected in discharge canal)
2.1.3 Intake Canal	1 location, H 37, east of A1A at beginning of open canal	Quarterly	Gamma spectral analysis Tritium Sr-89 & 90 (if detected in discharge canal)
2.1.4 Estuarine	1 location, Big Mud Creek, H 13	Quarterly	Gamma spectral analysis Tritium Sr-89 & 90 (if detected in discharge canal)
2.1.5 River (fresh water)	1 location, St. Lucie River at US 1, H 29	Quarterly	Gross Beta Tritium
2.1.6 Inland (fresh water)	1 location, Walton Road & Marsh, H 27 1 location, Weatherbee Road & Marsh, H 28	Semi-annually	Gross Beta Tritium

TABLE 6.1-3 SHEET 2

OPERATIONAL ENVIRONMENTAL RADIOLOGICAL SURVEILLANCE PROGRAM

	<u>Criteria and Sampling Locations (1)</u>	<u>Collection Frequency(2)</u>	<u>Analysis/Counting</u>
2. WATER (cont'd)			
2.2 Ground Water (wells)	1 location, Residence, 7609 Indian River Drive, H 30	Semi-annually	Gross Beta Tritium
2.3 Potable Water (wells)	1 location, City of Ft. Pierce, drinking water supply, H 11 1 location, City of Stuart, drinking water supply, H 12 1 location, Port St. Lucie, drinking water supply, H 31	Quarterly	Gamma spectral analysis Gross Beta Tritium
3. BOTTOM SEDIMENT			
3.1 Discharge Canal	1 location, east of A1A, H 35 1 location, west of A1A, H 36	Quarterly	Gamma spectral analysis Sr-89 & 90
3.2 Ocean	1 location, mouth of discharge structure, H 15 1 location, offshore, 1 mile north of discharge, H 16 1 location, offshore, 1 mile south of discharge, H 19	Semi-annually	Gamma spectral analysis Sr-89 & 90 (if detected in discharge canal sediment)
3.3 Beach (sand)	1 location, Plantom Beach, opposite discharge, H 38 1 location, east of Blind Creek, 1 mile north of discharge, H 16 1 location, near intake, 1 mile south of discharge, H 19	Quarterly	Gamma spectral analysis Sr-89 & 90 (if detected in discharge canal sediment)
3.4 Estuarine	1 location, Big Mud Creek, H 13	Semi-annually	Gamma spectral analysis Sr-89 & 90 (if detected in discharge canal sediment)
4. AQUATIC BIOTA			
4.1 Crustacea			
Lobster or crab or shrimp	4 locations, H 17, H 18, H 20, H 21 1 location, discharge canal, west of A1A, H 36	Semi-annually Quarterly	Gamma spectral analysis Sr-89 & 90 Gamma spectral analysis Sr-89 & 90
4.2 Fish			
4.2.1 Carnivores (Mangrove Snapper)	4 locations, H 17, H 18, H 20, H 21	Semi-annually	Gamma spectral analysis Sr-89 & 90
4.2.2 Herbivores (Mullett)	4 locations, H 17, H 18, H 20, H 21 1 location, discharge canal, west of A1A, H 36	Semi-annually Quarterly	Gamma spectral analysis Sr-89 & 90 Gamma spectral analysis Sr-89 & 90

TABLE 6.1-3 SHEET 3

OPERATIONAL ENVIRONMENTAL RADIOLOGICAL SURVEILLANCE PROGRAM

	<u>Criteria and Sampling Locations (1)</u>	<u>Collection Frequency(2)</u>	<u>Analysis/Counting</u>
5. <u>TERRESTRIAL</u>			
5.1 Milk	1 location within 15 mile radius of plant and in the prevailing wind direction from the plant, H 03 1 location, Florida (state) Milk Shed	Monthly	Gamma spectral analysis Sr-89 & 90 I-131
5.2 Biota			
5.2.1 Food Crop (Citrus)	6 locations, H 10, H 22, H 23, H 24, H 25, H 26	Harvest time	Gamma spectral analysis Sr-89 & 90
5.2.2 Other Vegetation	5 locations within a 10 mile radius of plant, H 08, H 09, H 10, H 27, H 28	Semi-annually	Gamma spectral analysis Sr-89 & 90
5.3 Soil	5 locations within a 10 mile radius of plant, H 08, H 09, H 10, H 27, H 28	Semi-annually	Gamma spectral analysis Sr-89 & 90

(1) Samples will be taken whenever biologically available.

(2) Frequency definitions follow:

Weekly - Not less than 48 times per annum - interval may vary by 3 days.
 Monthly - Not less than 10 times per annum - interval may vary by 15 days.
 Quarterly - Not less than 4 times per annum - interval may vary by 30 days.
 Semi-annually - Not less than 2 times per annum - interval may vary by 60 days.

(3) Analysis will be performed provided sufficient wet deposition occurs.

(4) Gamma spectral and tritium analysis will be performed provided sufficient size liquid sample is collected.

(5) If mean of gross beta activity of the 9 air samples exceeds 10^{-12} $\mu\text{Ci/cc}$ (1pCi/m^3)

(6) East of AIA & plant structures--to be installed when construction activity permits.

TABLE 6.1-4

MINIMUM LEVELS OF DETECTABILITY

Nuclide	Minimum Concentration in Gas, Ci/ml	Minimum Concentration in Liquid, Ci/ml
H-3	5×10^{-6}	-
Co-58	2×10^{-11}	9×10^{-7}
Kr-85	3×10^{-7}	8×10^{-5}
Sr-90	4×10^{-12}	-
I-131	4×10^{-12}	3×10^{-7}
Xe-133	5×10^{-7}	6×10^{-6}
Cs-137	5×10^{-12}	4×10^{-7}

(Proposed ANSI standard, Subcommittee N/13/43, submitted 1/12/72)

TABLE 6.1-5

PRE-OPERATIONAL ENVIRONMENTAL RADIOLOGICAL SURVEILLANCE PROGRAM
RADIONUCLIDE ANALYSIS METHOD

1. Gamma Spectroscopy

Ce-144	Ba-140
I-131	K-40
Ru-106	Ra-226
Cs-134	Th-232
CS-137	Co-58
Zr-95	Co-60
Mn-54	Cr-51
Zn-65	

2. Beta Liquid Scintillation Spectroscopy

H-3
C-14
P-32

3. Chemical Separation and Analysis

Sr-89
Sr-90

SUSPENDED PARTICULATE CONCENTRATION LEVELS
NEAR ST. LUCIE

<u>Location</u>	<u>Type of Reading</u>	<u>Date and Time Reading Began</u>	<u>24 Hour Reading $\mu\text{g}/\text{m}^3$</u>
421 N. 4th St. Ft. Pierce, Fla.	Complaint investigation	June 8, 1973 1700 EDT	.0592
" "	" "	June 13, 1973 1700 EDT	.0611
Residence adjacent to Rinker Cement Company, Rt. 1A 8 mi. S. of Ft. Pierce	Complaint investigation	December 11, 1972 1000 EST	.0957
" "	" "	December 12, 1972 1000 EST	.1125
Monterey Rd. and U.S. 1, Stuart, Fla.	Complaint investigation	August 7, 1973 0900 EDT	.0425
" "	" "	August 8, 1973 0900 EDT	.0339
" "	" "	August 9, 1973 0900 EDT	.0330
806 S. 6th St. Ft. Pierce, Fla.	Background surveillance	August 3, 1973 1000 EDT	.0570
" "	" "	July 26, 1973 0000 EDT	.0573
" "	" "	September 18, 1973 0900 EDT	.0471
" "	" "	September 20, 1973 1000 EDT	.0371
" "	" "	September 24, 1973 1000 EDT	.0375
Ranger Tower, 34th Ave. and 4th St., Vero Beach, Fla.	Background surveillance	September 25, 1973 0900 EDT	.0228
" "	" "	September 26, 1973 0900 EDT	.0207
" "	" "	September 27, 1973 0900 EDT	.0249

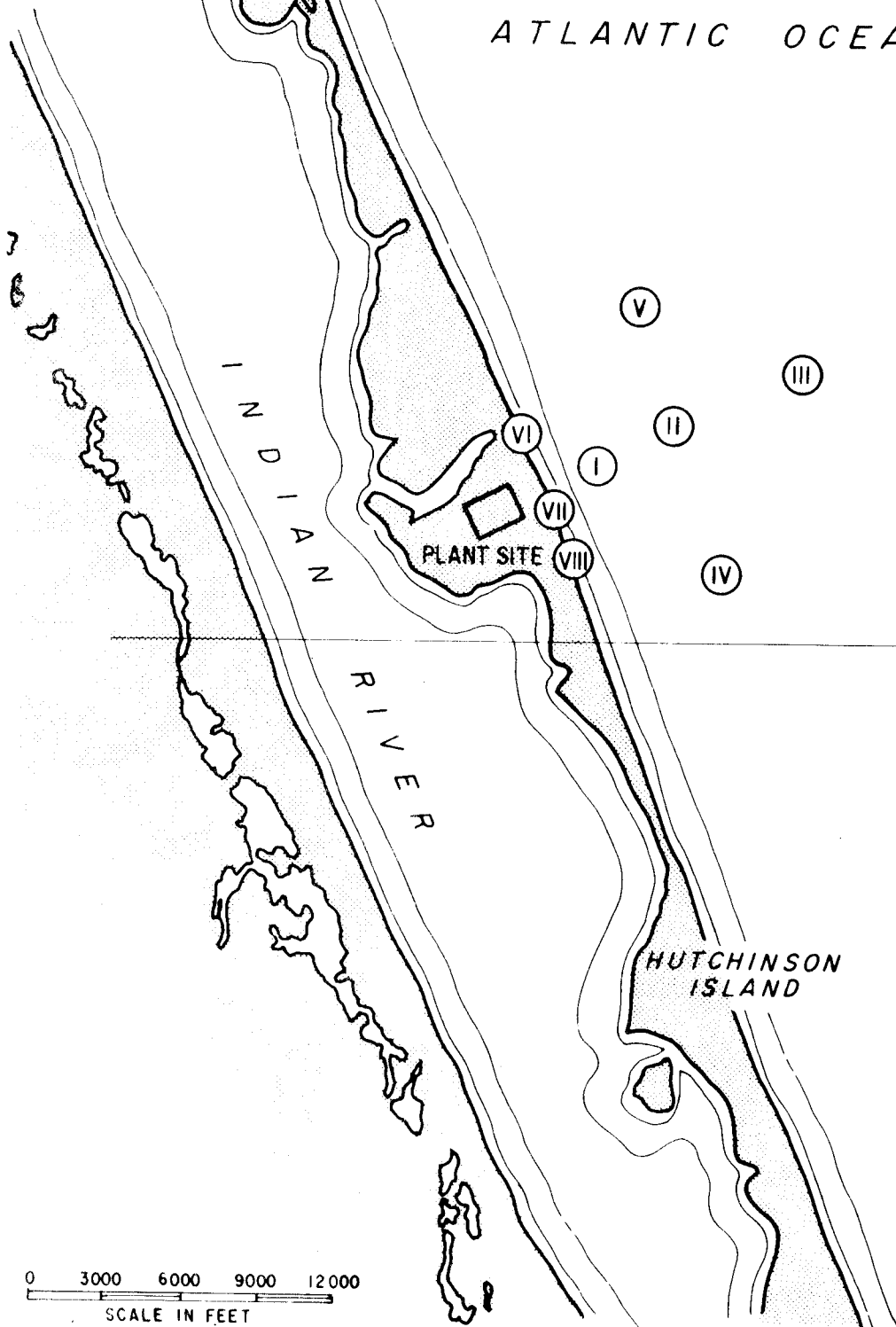
TABLE
6.1-6(cont'd)

SUSPENDED PARTICULATE CONCENTRATION LEVELS

<u>Location</u>	<u>Type of Reading</u>	<u>Date and Time Reading Began</u>	<u>24 Hour Reading $\mu\text{g}/\text{m}^3$</u>
Indiantown, Fla. on State Rd. 710 near Florida Steel Company	Complaint investigation	March 27, 1973 1000 EST	.3377
" "	" "	April 4, 1973 1000 EDT	1.990
Roof of Dixie Park Sewer Treatment plant, Port Salerno, Martin County, Florida	Background surveillance	September 13, 1973 0900 EST	.0290
" "	" "	September 19, 1973 0900 EST	.0220
" "	" "	September 20, 1973 0900 EST	.0264



ATLANTIC OCEAN

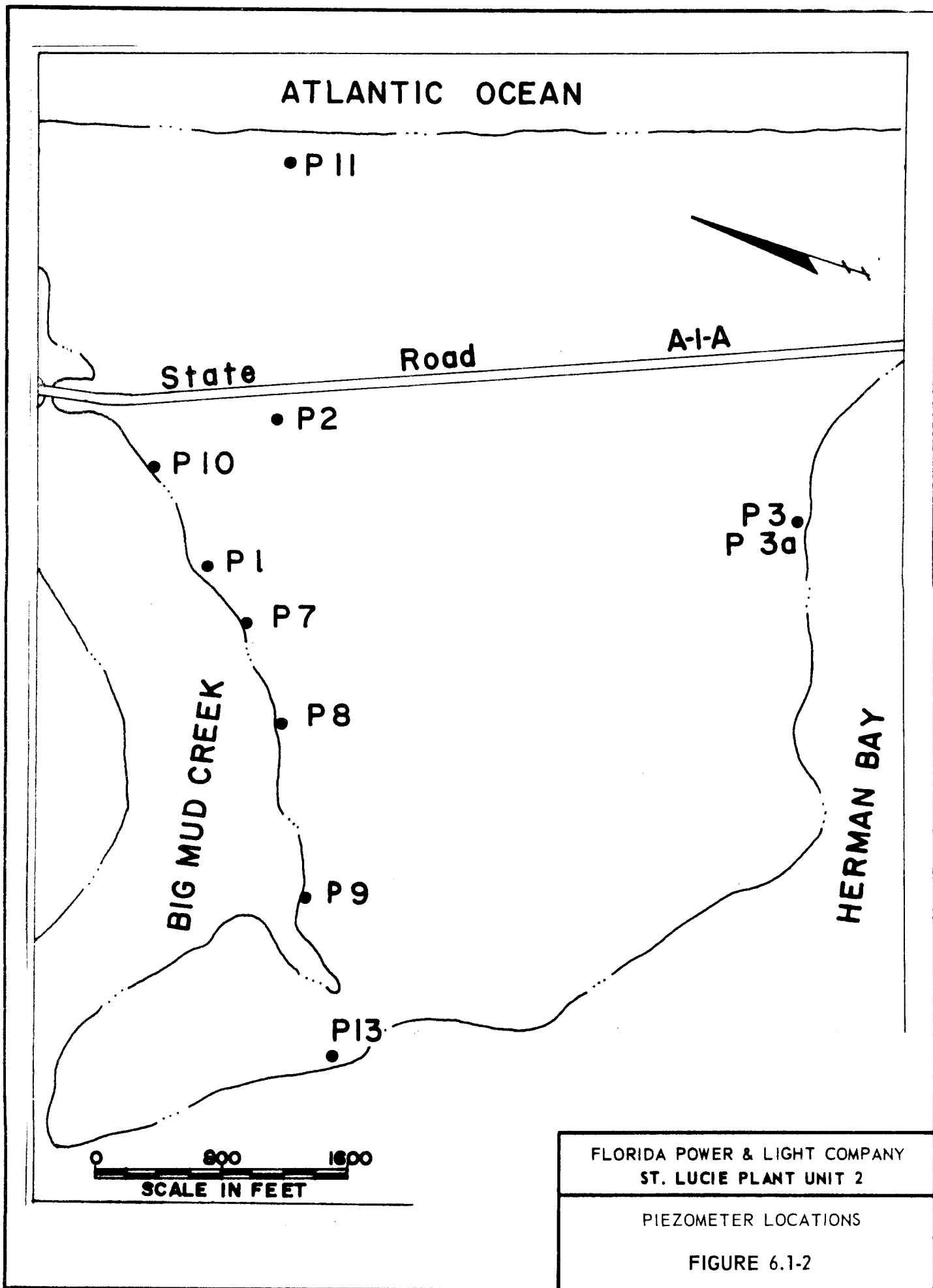


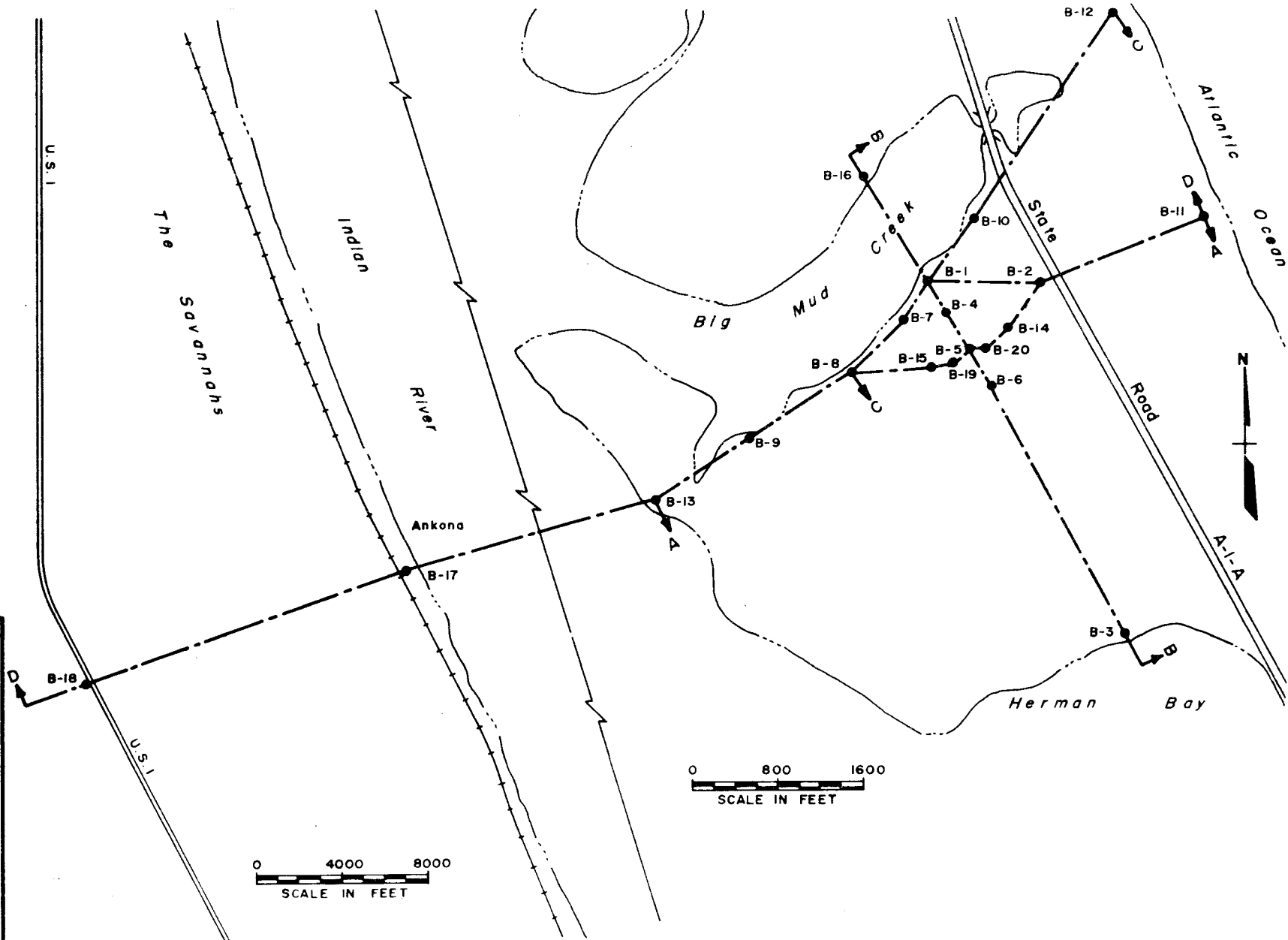
0 3000 6000 9000 12000
SCALE IN FEET

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THERMAL CRITERIA ZONES

FIGURE 6.1-1

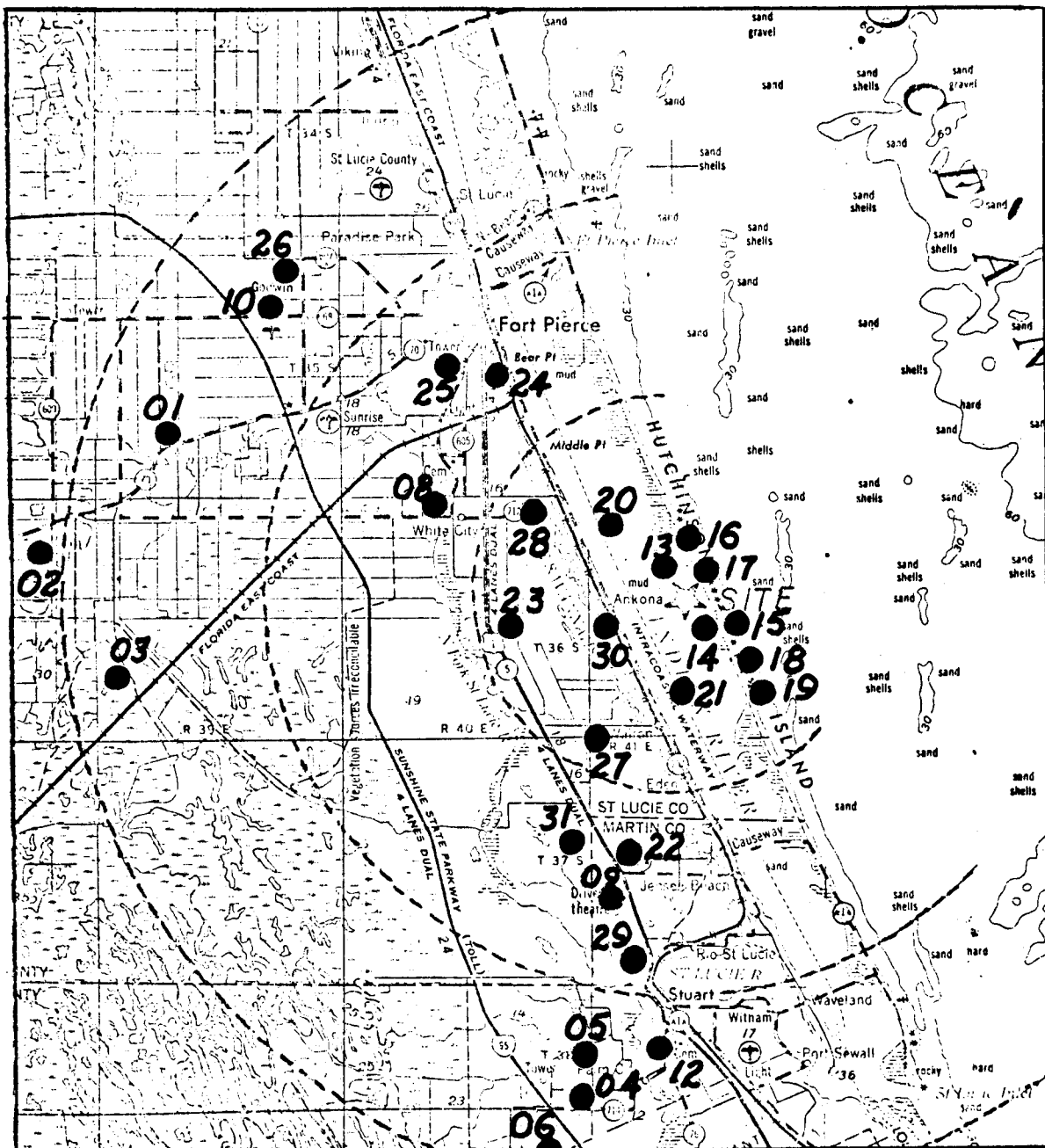




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BORING PLAN

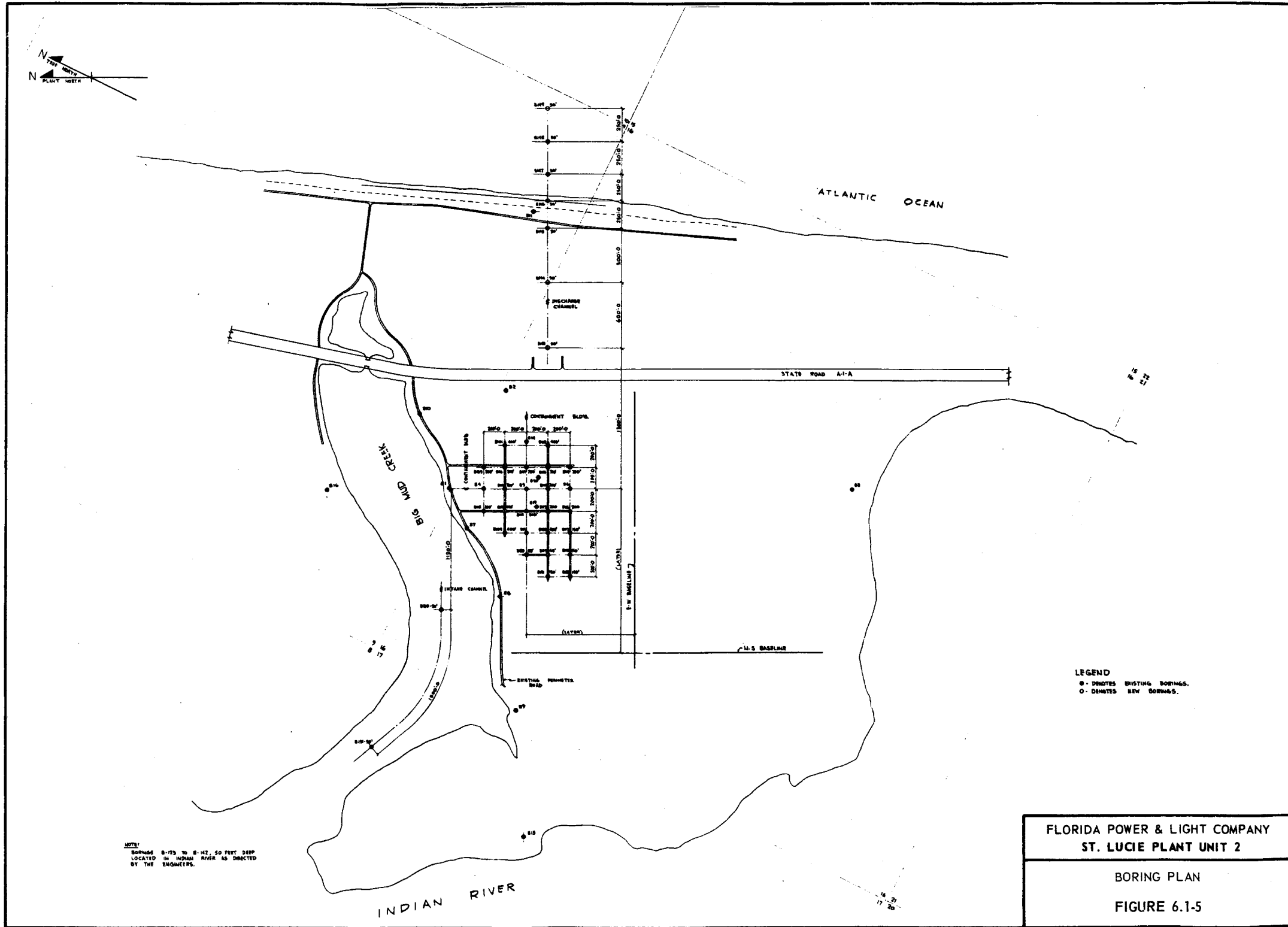
FIGURE 6.1-3



**FLORIDA POWER & LIGHT COMPANY
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**ATMOSPHERIC SUSPENDED PARTICULATE
SAMPLING STATIONS**

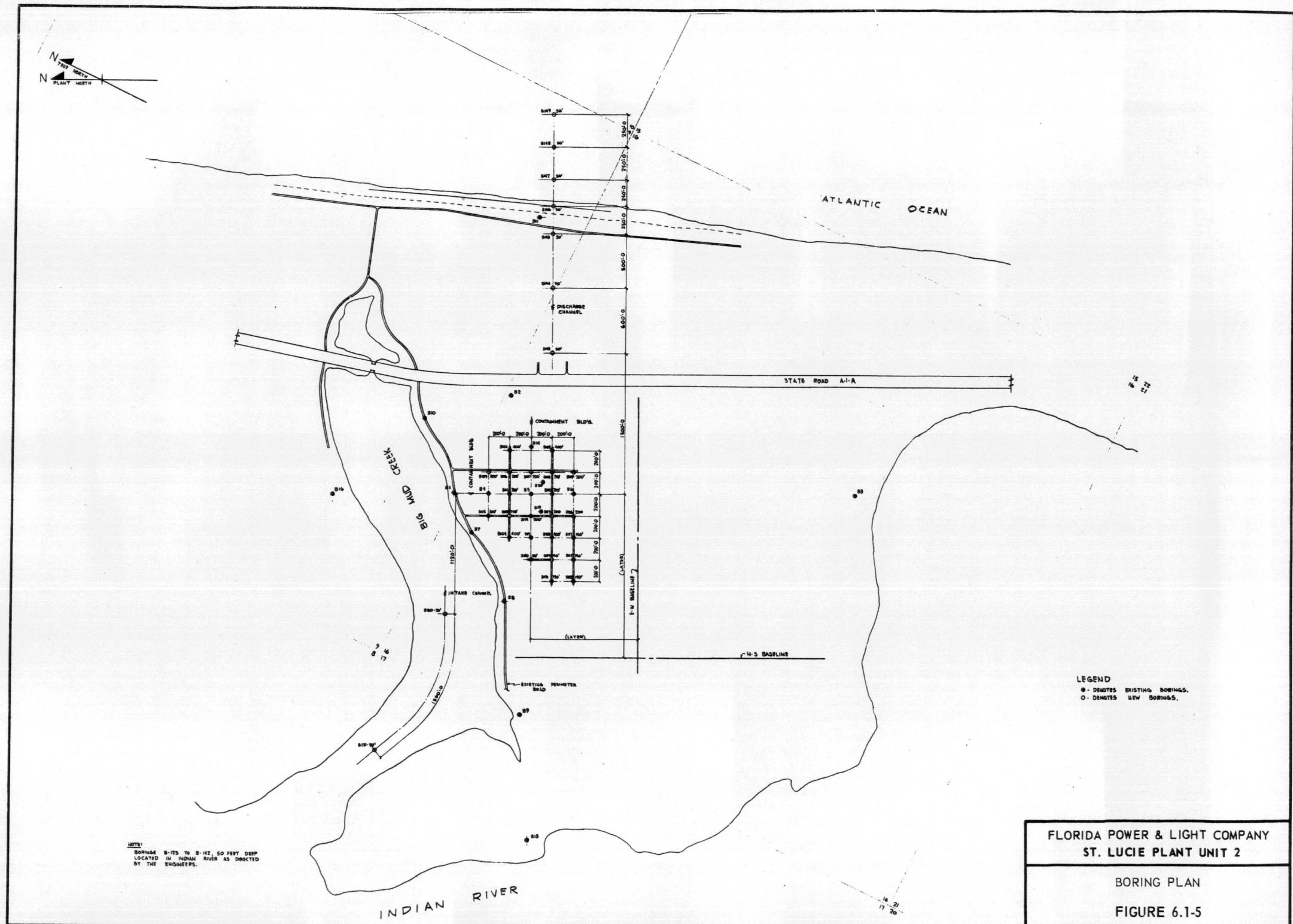
FIGURE 6.1-4



LEGEND
 ● - DENOTES EXISTING BORINGS.
 ○ - DENOTES NEW BORINGS.

NOTE:
 BORINGS 8-13 TO 8-15, 50 FEET DEEP
 LOCATED IN INDIAN RIVER AS DIRECTED
 BY THE ENGINEERS.

FLORIDA POWER & LIGHT COMPANY
 ST. LUCIE PLANT UNIT 2
 BORING PLAN
 FIGURE 6.1-5



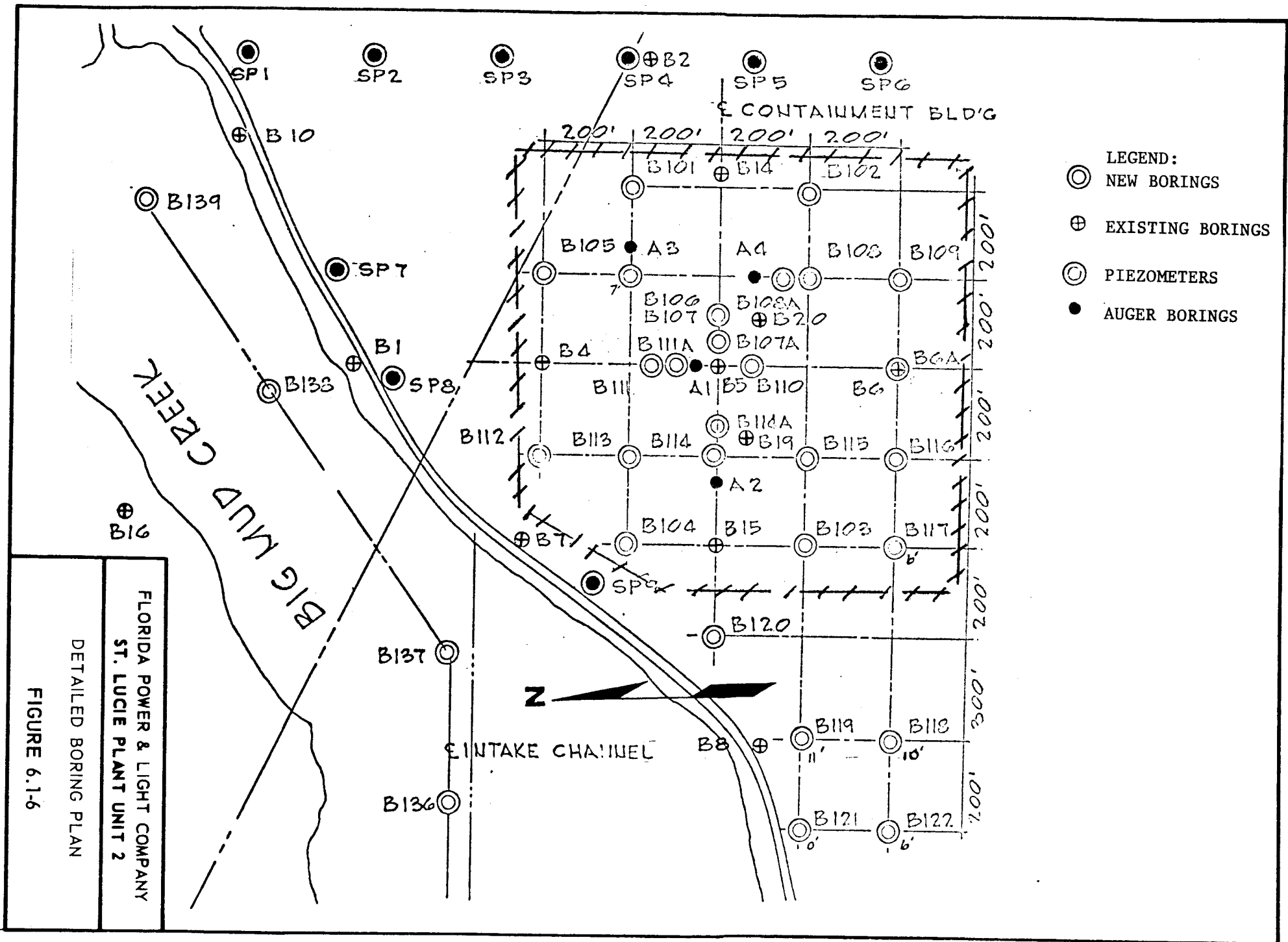


FIGURE 6.1-6

6.2 FP&L PROPOSED OPERATIONAL MONITORING PROGRAMS

Comprehensive monitoring will be conducted by FP&L after commencement of operation of Unit 2 to evaluate the quantitative environmental impact of all discharges, emissions, releases and environmental alterations attributable to Unit 2, and to provide surveillance for the prevention and control of critical impact due to operational irregularities. Monitoring will encompass radiological effects, chemical effluents, thermal effluent, meteorological phenomena and ecological effects.

6.2.1 RADIOLOGICAL MONITORING

6.2.1.1 Plant Monitoring System

a) Gaseous Discharge Monitor

The primary purpose of the gaseous waste discharge monitor is to continuously monitor and record all gaseous radioactivity released from the gas decay tanks and to prevent radioactivity in excess of the limits in 10CFR20 and 10CFR50, Appendix I, being released to the environment.

This monitor is located in the waste management system in the gaseous discharge line downstream of the gas decay tanks but upstream of the plant stack. Therefore monitoring is accomplished before the gases are diluted in the plant stack.

The monitor measures gross gamma radioactivity. Even though some of the partially volatile fission products (iodines) will adhere to the walls of the piping and tanks this will not cause false low readings since the activity actually being released is the primary concern. Shielding is provided with this monitor to minimize the effects of background radiation.

The monitor consists of an in-line sample detector assembly, shielding, check source, and logarithmic rate meter and recorder. Flow through sampler is 1 to 10 scfm and all parts in contact with the process gas are stainless steel.

The detector is a thin-wall Geiger-Muller tube which is shielded against background gamma radiation for a minimum sensitivity of 2×10^{-5} Ci/cc of Xe^{133} . The total detector range is 10^{-5} to 10^3 Ci/cc based on discharged activity of unknown identity. A collimating plug is used in conjunction with the detector and is used for range of 10^{-1} to 10^3 Ci/cc. Without the collimating plug detector range is 10^{-5} to 1.0 Ci/cc. The logarithmic rate meter receives the output signal from the detector. The range of rate meter is 10 to 10^6 counts per minute.

There are two separate calibration check sources for the monitor. A remotely operated radiation check source can be exposed to the detector to calibrate the activity range of the detector. An internally generated count rate signal is used to calibrate the logarithmic rate meter.

The two pen horizontal strip chart recorder receives an electrical signal from the logarithmic rate meter and continuously records the gaseous

radioactivity that is released from the plant. The gas discharge flow rate is measured by a recorder in the control room.

The monitor has an alarm and trip system that is operated by the logarithmic rate meter. The set point of the alarm and trip is adjustable over the full range of the rate meter. Prior to the release of gaseous activity, a sample is taken for radioactive analysis as described in Section 6.2.1.1 F. Both gross and isotopic radioactivity analyses are performed to verify that the activity in the tank can be released to the environment without exceeding the limits in 10CFR20 and 10CFR50, Appendix I. The alarm set point of the monitor is set slightly greater than the level determined by the gross gamma radioactivity analysis but below the applicable release limits.

If the activity should increase above the set point, an alarm is activated in the control room and a valve is tripped closed stopping discharge flow. The operator must then determine the cause of the alarm and trip. Another sample would be taken for radioactivity analysis to determine if the alarm and trip were due to high activity or instrument mis-calibration or malfunction. If high activity is the source of alarm, discharging from that particular gas decay tank must either be justified at a higher activity level or the contents must be allowed to decay for an additional time period. However, if radioactivity analysis is identical or slightly less than that found prior to initiating the gaseous discharge, the operator must recalibrate the detector and logarithmic rate-meter. The logarithmic rate-meter is calibrated by activating the internal count rate signal which is an internal component of the rate-meter. If necessary, adjustments are made to the rate meter to coincide with the count rate signal. The rate-meter is then turned to the detector reading and the standard check source is positioned in front of the detector by activating the pushbutton on the rate-meter control panel. Adjustments are made as required. If it has been established that the alarm was caused by instrument malfunction, discharging can continue only after the malfunction has been rectified.

b) Liquid Waste Discharge Monitor

The primary purpose of the liquid waste discharge monitor is to continuously monitor and record the radioactivity (gross gamma) that is being discharged in the liquid waste being released to the circulating water canal. The monitor will also terminate the liquid discharge from the plant if the radioactivity being released exceeds the monitor set point which is set below the applicable activity release limits.

The monitor is located in the waste management system in the discharge line to the circulating water canal. Monitoring before dilution with circulating water allows greater accuracy of measurement.

Since all the liquid discharge flow passes through the monitor, representative sampling is assured. If excessive radioactivity should be deposited in the sampler, the sampler may be removed for decontamination. Shielding is provided to reduce the effect of background radiation.

The monitor consists of an in-line sampler, detector assembly, shielding, check source, logarithmic rate-meter and recorder. Flow through the sampler is 10 to 50 gpm and all wetted parts are stainless steel. The monitor detector is a gamma scintillation crystal with photo-multiplier tube and integral preamplifier shielded against background gamma radiation for a minimum detector sensitivity of 5×10^{-6} Ci/cc of Cs-137. The operating range is 10^{-6} to 10^{-1} Ci/cc based on discharged activity of unknown identity.

The logarithmic rate-meter receives the output signal from the detector and has a range of 10 to 10^6 cpm. Rate-meter sensitivity is adjustable over the range of preamplifier output. Gammas with energies in the range of 100 Kev to 3 Mev can be detected.

The monitor contains two separate calibration check sources, remotely operated radiation check source for calibrating the detector and an internally generated count rate signal for calibrating the logarithmic rate-meter. A two pen strip chart recorder receives an electrical signal from the logarithmic rate-meter and records the liquid radioactivity that is released from the plant. The liquid discharge flow rate is measured and is recorded in the control room.

If the activity reaches the set point, an alarm is activated in the control rooms and valves are tripped closed stopping discharge flow. The operator must then determine the cause of the alarm and trip. Operator actions would be the same as those described for the gaseous discharge monitor.

c) Steam Generator Blowdown Monitor

The primary purpose of the steam generator blowdown radioactivity monitors is to continuously monitor and record the gross gamma activity discharged during blowdown of the steam generators.

One monitor is located in each blowdown sample line upstream of the blowdown line isolation valve.

One blowdown monitoring system is provided for each steam generator. Each consists of a sampler, gamma scintillation detector assembly with an integral photomultiplier tube and preamplifier, shielding, check source, logarithmic rate-meter. One recorder serves both monitors.

The detector is a gamma scintillation crystal with photomultiplier tube and integral preamplifier shielded against background radiation for a minimum detector sensitivity of 1.0×10^{-6} Ci/cc of Cs-137. The operating range is 10^{-6} to 10^{-1} Ci/cc based on discharged activity of unknown identity.

The monitor contains two separate calibration check sources, a remotely operated radiation check source for calibrating the detector, and an internally generated count rate signal for calibrating the logarithmic rate-meter.

A two pen strip chart recorder in the control room receives electrical signals from the two logarithmic rate-meters and records the radioactivity in the blowdown from each steam generator.

Each rate-meter activates a high radiation alarm in the control room and provides a signal to trip closed the blowdown valves on high radiation. The high radioactivity alarm set point is adjustable over the full range of the rate-meter.

Since blowdown water normally contains no radioactivity and very low chemical concentration, it is normally discharged directly to the circulating water canal. The blowdown radioactivity monitor alarm/trip set point is selected to assure that the discharge limits required by 10CFR20 and 10CFR50, Appendix I, are not exceeded.

The monitor has an alarm and trip system controlled by the logarithmic rate-meter. The high radioactivity set point is adjustable over the full range of the rate-meter. The set point is determined as a result of sample analysis prior to the discharge of any fluid from the blowdown tank. The analysis must verify that the concentration of radioactivity to be discharged is less than applicable release limits. The alarm and trip set point of the logarithmic rate-meter is set slightly above the activity determined from the gross radioactivity analysis but below the applicable release limits.

d) Condenser Air Ejector Monitor

The condenser air ejector gas monitor measures noncondensable fission product gases in the condenser air ejector discharge to detect any primary to secondary leakage. Activity levels are recorded in the control room and alarms annunciated when the activity level exceeds predetermined limits. The channel consists of an off-line effluent sampler, a beta scintillation detector, a Cs-137 check source, a logarithmic rate-meter and power supply.

The dynamic range of the monitor allows resolution of pulses from 80 Kev to 2 Mev. The sampler is shielded with 3" of lead. The detector has a plastic scintillator, 2" diameter and approximately 10 mil thick, with a 10 stage photomultiplier. The operation limit for pressure is 50 psig and temperature limit 125 F. The rate-meter covers a range of 10 to 10^6 cpm with a meter accuracy of ± 2 percent full scale. The channel activity level is recorded in the control room.

The rate-meter has lights to indicate the local indicator failure, to indicate a high radiation level warning and to indicate a high-high radiation alarm.

e) Component Cooling Water Monitor

The component cooling water monitors are designed to provide an indication to operation personnel whenever the activity in the component cooling system reaches or exceeds a pre-established level above the normal radiation level.

Each monitor consists of a shielded sampler, detector holder, gamma scintillation detector, a Cs-137 check source, preamplifier and logarithmic rate-meter. The gamma scintillation detector utilizes a 1-1/2" diameter, 1" thick sodium iodide crystal with a 10 stage photomultiplier tube and integral preamplifier. The preamplifier has a dynamic range which allows resolution of pulses from ranges of 80 Kev to 2 Mev. The minimum and maximum detectable coolant activities of Cs-137 in 2 mR/hr background of 1.25 Mev gamma radiation incident on the detector shield is 2.8×10^{-6} Ci/cc to 1.6×10^{-2} Ci/cc. The sampler is of the off-line type with a sampler volume of 191 in³. The sampler is provided with 3" of lead shielding.

The detectors are located downstream of each of the component cooling system heat exchangers so that any possible release of radioactivity via a tube leak is monitored. The rate-meter associated with this channel is similar to the one described in Section D. This channel is annunciated both locally and in the control room whenever an abnormal level of activity is detected. The effected heat exchanger may then be isolated and removed from service by closing isolation valves.

f) Sampling

Periodic sampling is required for a performance check on some of the process equipment, and to alert the operator to any abnormal condition that may be developing. The gaseous samples are taken directly by the gas analyzer. Local liquid samples are taken from various points in the system piping such as: equipment drain tank recirculation, chemical drain tank recirculation, laundry drain tank recirculation, waste condensate tank recirculation, waste concentration distillate and bottoms, liquid effluent discharge to the circulating water canal, containment vent header and the gas decay tank. Additional samples are also taken at various strategic locations in the plant.

The basis for selecting their locations for sampling stations is to check the performance of process equipment, thus maintaining the required chemistry throughout the operating plant.

For all the liquid samples the analysis performed will determine isotopic concentrations. The sample can also be used for a gross elemental analysis. The gaseous samples, however, are analyzed for gross concentration, as well as isotopic concentrations. Gas samples to the gas analyzer are analyzed for gross oxygen and hydrogen concentrations and alarms warn the operator if a potential explosive mixture exists at the sample point. A connection of the discharge side of the gas analyzer is available for taking a grab sample for isotopic analysis.

The frequency of taking samples from the various locations (not listed above or in Table 6.2-1 along with the analysis to be performed is listed in Table 6.2-2. The frequency of sampling for the gaseous content is used as a preliminary guide and may be increased or decreased as operating personnel become more familiar with the plant.

6.2.1.2 Environmental Radiological Monitoring

The St. Lucie Unit No. 2 is presently in the preconstruction stage. A preoperational radiological monitoring program was initiated in January 1971 and will continue until transition to the operational radiological monitoring program, scheduled for plant start-up. The operational radiological monitoring program will be an extension of the program for Unit No. 1. A sampling and analysis schedule will be established based on the level of activity and information gained in the pre-operational program. Results of the sample analyses will be evaluated to insure the effectiveness of plant radiation control and compliance with the requirements of all regulatory agencies, both Federal and State. This program will be reviewed and revised as required.

The standard operational environmental monitoring program will be reflective of the approach used in the sample collection frequency and analysis summarized in the pre-operational program. This schedule is designed to ensure that changes in the environmental radioactivity can be detected. A continuing review and evaluation of the program will verify the suitability and adequacy of the environmental program.

All potential paths for release of radioactive material during normal reactor operation, including anticipated operational occurrences will be monitored. The sensitivity and calibration of each monitor will be determined periodically. In the event that an unexpected increase in radioactivity or radiation levels is measured, a more comprehensive program will be carried out. (AEC Regulatory Guide 4.1, "Measuring and Reporting of Radioactivity in the Environs of Nuclear Power Plants," February 1973.)

6.2.2 CHEMICAL EFFLUENT MONITORING

As previously discussed in Sections 3.5 and 3.6 chemical effluents will be released from the water supply treatment system, the boric acid concentration system and the condenser cooling water desliming system.

An acid and base chemical mechanism will be used to regenerate resin in the ion exchange water treatment system. The effluent will be neutralized and will not create either a low pH or high solids discharge. Continuous monitoring instruments for pH and dissolved solids will be installed in the discharge system.

Continuous releases of boric acid from the cooling system boric acid concentrators will be negligible relative to ambient concentration of boron in the ocean. Shutdown and start-up of the Unit will cause infrequent releases of boric acid as will emptying of the refueling water tank in the event of major breakdown. Neither continuous or nonroutine releases of boron are expected to create discharge concentrations in excess of existing ambient levels of boron in the ocean. In no case are levels of boron in the vicinity of the discharge expected to reach toxic levels. Monitoring for boron will not be necessary.

Periodically a solution of chlorine will be introduced into the condenser cooling system to reduce the formation of slime on heat exchanging surfaces. Residual chlorine will be monitored at the condenser outlet and correlated with chlorine feed rates so as to maintain discharge concentration below 1.5 ppm.

A Hydrolab multiparameter monitor or proven equivalent unit will be installed at a location on the discharge system permitting representative surveillance of pH and conductivity which will be related to dissolved solids.

The proposed electropotential system will have the capacity to monitor pH in a range from 2 to 12 with accuracy of ± 0.2 pH under exposed conditions sampling seawater. The unit will have automatic calibration and temperature correction features. Acceptable reliability will be proven acceptable service in a similar application for one year or greater.

The proposed multiparameter unit will have an over all conductivity accuracy of ± 5.0 percent of operating salinities in temperatures from 0° C to 45° C. The range capacity will extend up to 100,000 micromho/cm with high range probe. Acceptable reliability will be proven acceptable service in a similar application for one year or greater.

A Wallace and Tieran residual chlorine analyzer or proven equivalent will be installed at the cooling system condenser outlet. The proposed electropotential unit will measure residual chlorine to the nearest tenth ppm, and will not lose accuracy due to interference by turbidity, manganese, iron or nitrites. The unit sensitivity will be 0.01 ppm. Acceptable reliability will be proven service in a similar application for one year or greater. Periodic wet chemical laboratory analysis will be made to calibrate the accuracy of the chlorine analyzer.

Monitoring data will be related by FP&L to applicable state and federal discharge and ocean standards. If noncompliance is detected attributable to FP&L operation, corrective action will be taken and responsible enforcement agencies will be notified.

6.2.3 THERMAL EFFLUENT MONITORING

A self-contained recording thermograph has been operated offshore by FP&L with cooperation from the Florida State Department of Health since August 24, 1970. (1) The unit monitors surface and bottom temperatures at an approximate depth of 30 ft of water near the anticipated discharge for Unit No. 1. This monitoring station will remain active after the unit begins operation.

Because applicable Florida State Thermal Standards limit temperature increases over existing ambient background, it will be necessary to define more accurately operational background temperatures outside of the thermal plume.

In addition to the monitor presently in operation over the discharge of Unit No. 1, three additional monitors are stationed to monitor critical temperatures from the addition of Unit No. 2 and to provide background ambient temperatures. A second thermograph will be located over the first part of the proposed Unit No. 2 multiport diffuser, a third will be located midway between the discharge monitors and approximately 300 ft north and the fourth will be midway and approximately 600 ft south. Northerly and southerly currents moving along the coastline will alternately expose the third and fourth temperature sensors at ambient background temperature.

The proposed thermographs will be of a type similar to the present unit. They will be capable of sensitivity less than 0.5 F in a range from 32 F to 100 F.

6.2.4 POSTOPERATIONAL ECOLOGICAL MONITORING

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At this time, the details of the postoperational ecological monitoring program have not been finalized. However, many of the sampling methods and analytical techniques discussed in Section 6.1.1 will be used to determine what effects the cooling water discharge produces on the marine environment and associated biota.

By the time St. Lucie Unit No. 2 is operational, the preoperational environmental investigations will have provided a detailed account of the various environments and ecosystems which exist offshore at St. Lucie

This information will include variations in number of organisms; planktonic, nektonic and benthic, seasonal changes in water chemistry, and productivity data. With this information, a postoperational monitoring program similar to the program now underway would easily and rapidly detect any major changes in ecosystem structure and function due to power plant operation.

Subtle alterations in segments of the marine ecosystem will be less easily observed. However, the acquisition of long-term postoperational data should provide adequate resolution of any significant environmental or ecological changes should they occur as the result of St. Lucie Unit No. 2 operation.

6.2.5 METEOROLOGICAL MONITORING

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The onsite meteorological program will continue at the present level until Unit No. 1 is operational. At that time the program will be re-evaluated to develop a program to be implemented for plant operation.

The operational phase of the onsite meteorological monitoring program will be basically a continuation of the onsite program which has been in operation since March 1971 and is described in Section 6.1.3.1 except that during the operational phase of the onsite monitoring program a data acquisition system will be installed in the Unit No. 1/2 control room.

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The St. Lucie nuclear power plant preoperational meteorological program is divided into five major procedures plus a continuing interrelated quality assurance program. The five phases are:

- I Meteorological Data Acquisition at St. Lucie
- II Meteorological Data Reduction
- III Computer Services and Programming
- IV Data Interpretation and Report Preparation
- V Review Process

The individual procedural steps for each phase are discussed below in greater detail.

I Meteorological Data Acquisition at St. Lucie

The meteorological station, located 2400 feet north of the St. Lucie nuclear facility, consists of a 200 foot instrumented tower, and an instrument shed. The meteorological instruments are checked at least once each week, calibrated on a predetermined schedule, and the strip chart data is mailed to the data reduction center on a monthly basis. The following summarizes the meteorological instrument maintenance schedule and the data collection procedure.

A. Meteorological Instrument Maintenance Schedule

Microbarograph Recorder

Chart time: Checked once each week

The recorder is checked each month against the mercury barometer.
Wind Direction and Velocity Recorder 50' and 190' elevations

Chart time: Checked once each week

Velocity: The aerovane sensor is serviced and calibrated once each year, and checked against a hand anemometer.

Direction: The aerovane sensor is checked for direction against the recorder when it is replaced after each yearly calibration.

Temperature and Dewpoint Recorder

Time: Checked once each week

The recorded temperature is checked once each month at the 32.8 feet

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(10 meter) elevation against a laboratory thermometer and a sling psychrometer at the 32.8 feet elevation.

Temperature Difference Recorder

Chart time: Checked once each week.

The recorder is continuously checked against a test resistor which operates on a spare point of the recorder.

Rain Gauge

Chart time: checked once each week

B. Chart Paper Changes

The chart paper is labeled at the beginning and end of each sheet. Also maintenance checks are identified and comments are labeled on the data charts. The following information is provided:

- 1) Time on or off (Eastern Standard Time)
- 2) Day, month, year
- 3) Specific location of instrument
- 4) Initials of the servicing instrument engineer
- 5) Descriptive comments

II Meteorological Data Reduction

The meteorological data reduction phase consists of data inspection, data reduction and a review process. The following steps are taken.

A. Inspection

Shortly after the strip charts are received by the data reduction center, the charts are inspected for time continuity, missing data, and a cursory appraisal of data validity.

B. Data Reduction

The strip chart data is reduced on an hourly basis and logged on a climatological data sheet. The following rules are followed for the specific method of reducing meteorological data parameters.

- 1) The 190-foot wind direction and speed are only reduced if the 50 foot winds are missing or invalid.

- 2) The 50-foot wind direction is averaged over the hour to the nearest cardinal 22 1/2 degree sector (i.e., N sector = 1, NNE sector = 2 etc.). If the wind speed is two miles per hour or less and the wind directional trace is in a step-like pattern, a value of 0 is logged which indicates a calm or variable wind direction.
- 3) The 50-foot wind speed is averaged over the hour to the nearest 1.0 mph. If the wind speed is less than 1.0 mph, a zero value is logged.
- 4) The wind range is averaged hourly to the nearest five degrees. If the wind speed is 2.0 mph or less and the wind directional trace is in a step-like pattern, a value of zero is logged.
- 5) The 10 meter (32.8 foot) temperature and dew point temperature is read to the nearest degree F.
- 6) The 200 minus 32.8 foot temperature difference is read directly to the nearest 0.1 F. If the temperature difference is missing, the remaining temperature values are read to the nearest 0.1 F (i.e. 110 and 32.8 foot or 200 and 110 foot temperature values).
- 7) Rain is recorded hourly to the nearest 0.01 inch.
- 8) Barometric pressure is read at 0600, 1200, 1800 and 2400 EST.
- 9) The remarks section is available for pertinent comments.
- 10) Missing, invalid or unread data is left blank.

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C. Review Process

The climatological data log forms are then reviewed by the project meteorologist. The hourly values are reviewed for the following items:

- 1) Amount of missing data
- 2) Realistic values of meteorological parameters
- 3) Apparent malfunctions of instruments
- 4) Transposition errors of data reading and logging.

III Computer Services and Programming

The climatological data log forms are delivered to the keypunching department and the hourly meteorological punch cards provide the input for the meteorological computer program entitled LSD 1 through LSD 7. A description of each computer program output follows.

- A. LSD-1. Lists of the hourly meteorological parameters. Several computational techniques are included with the hourly data listings.

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- 1) The 50-foot wind speed (or 190-foot wind speed) is adjusted to the 32.8-foot height (10 meters) through the Standard Wind Power Law.
 - 2) The wind range is divided by six to convert to Sigma Theta.
 - 3) The vertical and horizontal stability categories are defined per Regulatory Guide 1.23.
 - 4) Computer program LSD-1 has numerous tests for the acceptable range of meteorological parameters. A series of error codes will identify potential problems, e.g. wind sector greater than 16, wind speed greater than 50 mph, dew point higher than temperature, etc.
 - 5) Monthly listings of the LSD-1 output are reviewed by the project meteorologist.
- B. The output of LSD-2 consists of 49 tables of the joint percent occurrence of wind direction, adjusted 10 meter wind speed, vertical and horizontal Pasquill stability.
- C. LSD-3. This output presents the distribution of hourly X/Q values by class intervals, observations, percent of occurrence at the minimum exclusion zone of 1,555 meters. Eighteen tables are generated; one table for each of the 16 sectors, a table for calm wind conditions, and a table of the total of all on-shore sectors.
- D. LSD-4. This output provides the highest calculated average relative concentration X/Q by wind direction and date at a distance of 5 miles for 8 hours, 16 hours, 72 hours, and 624 hours. A total of 68 tables are generated; 16 tables for each time period, one table for each time period is a summary table; the remaining tables provide the distribution of hourly X/Q values by intervals, hourly observations, percent and cumulative percent by wind sector.
- E. LSD-5. The computer output provides average annual relative concentration as a function of wind direction and distance. The wind direction is tabulated by 16 sectors and the distance is indicated both in meters and miles.
- F. LSD-6. This output summarizes one year of climatological non-diffusion data for permanent record. This data provides a comparison of one year of on-site data with data collected at U.S. Weather Bureau stations.
- G. LSD-7. This output tabulates the number of occurrences of the consecutive hours of joint persistence of wind direction and vertical Pasquill stability.

IV Data Interpretation and Report Preparation

The data interpretation and report preparation phase of the Florida

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Power & Light meteorological program is based on monthly progress reports, annual climatological summaries and special reports. The monthly progress report has several objectives; document progress, identify problems, and direct future activities. The annual climatological summary has two objectives, the library documentation of one chronological year of meteorological data input/output, and the execution of all meteorological computer analysis associated with the Safety Analysis Report.

Monthly progress letters, annual and special reports are submitted to Florida Power & Light where the reports are reviewed.

At the present time, the St. Lucie meteorological data is summarized on a monthly and annual basis. The purpose of the monthly data summaries is for internal review and quality control. The annual summaries provide a composite of meteorological computer output listings. During the on-line operation of the St. Lucie nuclear facility the meteorological data will be summarized in a format and time period that is compatible with existing governmental regulations.

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TABLE 6.2-1

AERATED WASTES SAMPLING

<u>Sample Location</u>	<u>Sample Analysis</u>	<u>Frequency</u>
Laundry Drain Tank	Gross beta-gamma	Each time contents of tank are discharged to circulating water canal
Discharge Line to the Circulating Water Discharge	Gross beta-gamma activity	During each boric acid tank discharge operation
Equipment Drain Tank	Gross beta-gamma and boron content	Each time contents of tank are processed or discharged to circulating water canal
Chemical Drain Tank	Gross beta-gamma	Each time contents of tank are processed or discharged to circulating water canal
Waste Condensate Tank	Gross beta-gamma	Each time contents of tank are discharged to circulating water canal
Waste Concentrator Distillate and Bottoms	Boron content and gross beta-gamma	5/batch*
Gas Decay Tank	Hydrogen, oxygen, and isotopic analysis	1/week
Containment Vent Header	Isotopic analysis	5/year

* Frequency subject to change based on operating experience and Technical Specifications requirement.

TABLE 6.2-2

SAMPLE LOCATIONS AND ANALYSIS

<u>Sample Location</u>	<u>Sample Analysis</u>	<u>Frequency</u>
Flash tank		
Influent and effluent	Dissolved hydrogen and gaseous activity	2/year
Pre-concentrator filter		
Influent and effluent	Suspended solids and suspended solids activity	1/week
Pre-concentrator ion exchanger		
Influent and effluent	Gross beta-gamma and lithium content	1/week
Boric acid concentrator bottoms and distillate	Boron content and gross beta-gamma activity	2/batch*
Boric acid condensate ion exchanger		
Influent and effluent	Boron content and gross beta-gamma activity	3/year
Boric acid condensate recirculation	Isotopic	Prior to discharge content of tank
Boric acid holding tank	Boron content and gross beta-gamma activity	Each time tank is emptied
Waste filter influent and effluent	Suspended solids and suspended solids activity	1/week
Waste ion exchanger	Boron content and gross beta-gamma activity	3/year
Gas surge tank	Hydrogen, oxygen and isotopic analysis	1/day
Volume control tank	Hydrogen, oxygen and isotopic analysis	1/week
Flash tank	Hydrogen, oxygen and isotopic analysis	2/year
Holdup tank	Hydrogen and oxygen	2/year
Spend resin tank	Isotopic analysis	1/year

6.3 RELATED ENVIRONMENTAL MEASUREMENT AND MONITORING PROGRAMS

The Florida State Division of Health has been conducting an environmental monitoring program in cooperation with FP&L. The program which began in January 1971 includes samples of air, precipitation, surface water, ground water, bottom sediments, beach sand, various aquatic biota, milk, terrestrial biota and soil. (2) It is expected that the program will continue through 1975 to provide extended background on radiological and environmental parameters. When Unit No. 1 begins commercial operation (1975) the program will evolve into an operational monitoring program for Unit No. 1 and a continuing preoperational monitoring program for Unit No. 2. This will provide approximately nine years of preoperational data for Unit No. 2, which is expected to begin commercial operation in 1979.

A long-term study was initiated in April of 1971 by the Florida Department of Natural Resources, Bureau of Marine Science and Technology. The purpose of the investigations is to monitor and evaluate marine life and seawater conditions in the Atlantic Ocean near the St. Lucie site. (3)

Both the state programs will provide invaluable background information which is presently being reported to FP&L for use in predicted operational environmental impact. Operational phase monitoring data will be reported by FP&L to the state for their use and record.

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6.3.1 SAMPLE COLLECTION PROCEDURES

SOIL

A cup, 2 1/2 inches in diameter and 1 inch deep is used to take soil samples. At each site to be sampled, 20 cups are taken. Hence the area sampled is 98.175 in². The volume approximates a one liter sample, depending on soil density and particle size.

SILT

One liter samples are taken by scraping the sediment from the benthic area in question.

VEGETATION

Vegetation samples, excluding food crops, are comprised of the leaves of plants. No stems are collected. Three and one-half liters are collected.

FOOD CROPS

These samples are collected during the harvest season, and include only the edible portion of the plant with the exception of the peel on fruit, and hush on corn, etc. Three and one-half liters are collected.

BIOTA

Fish are collected by rod and reel and cast net. Mobile crustacea are trapped, while sessile crustacea are taken by hand. Sponges are also collected by hand. Small animal collection is accomplished by traps.

ALGAE

All algae are collected by hand, since specimens taken are entirely macroscopic.

WATER

All water samples are taken in 4 liter containers. Precipitation samplers consist of 55 gallon drums with 7000 cm² funnels. The volume in each sampler is measured before collecting the specimen.

AIR

Air samples are collected by vacuum pumps on either 47 mm² or 50 mm² metrical vinyl filters. Low pressure gas meters are used to measure the air volume. Sampling period is one week.

GAMMA BACKGROUND

Thermoluminescent dosimeters are used exclusively. These dosimeters are CaF:Mn glass encapsulated. The dosimeters are exposed for one-month periods and dose is normalized to hours for reporting.

6.3.2 PROCEDURE FOR GROSS ALPHA AND GROSS BETA ANALYSIS

EQUIPMENT

- 1) Stainless steel planchets, 2 inch diameter
- 2) 1 1/2 quart, Corning Ware dishes
- 3) 6 ounce, Pyrex custard cups
- 4) Hotplates and drying lamps
- 5) Small muffle furnace
- 6) Lucifer Muffle Furnace, 15 x 21 x 21 inch inside dimensions - two
- 7) Large desiccators
- 8) Nuclear-Chicago low background proportional counter, Model 4334
- 9) Sartorius analytical balance, Series 2600
- 10) Olivetti Programa 101 calculator

SAMPLE PREPARATION

A) Water Samples

One liter of the water sample is filtered through Whatman No. 541 paper in a 9 cm. Buchner funnel. The filter paper and residue are ashed at 600°C., and the ash is transferred to a planchet and weighed. The filtrate is poured into a one liter beaker and evaporated to near dryness on a hotplate; a few milliliters of 6 N HCl is added to samples which have high carbonate content. The residue is scraped and washed into a planchet and evaporated under an infra-red lamp to dryness. The samples are further dried in a small drying oven, weighed, and placed in a desiccator. For seawater samples which have a large amount of dissolved solids, the final evaporation is done in an evaporating dish and after complete drying a one gram aliquot is transferred to a planchet.

B) Vegetation and Fauna Samples

After chopping and gamma analysis the sample is put in a 1 1/2 quart Corning Ware dish, weighed, and ashed at 600°C. for 36 hours. The ashed samples are transferred to a small, sealed, plastic bag and weighed. One gram of the ash is distributed uniformly on the bottom of a planchet for counting and stored in a desiccator.

C) Soil Samples

100 grams of the material is ashed in a small Pyrex dish at 600°C. for 24 hours, and the ash is transferred to a small, sealed, plastic bag and weighed. One gram of the ash is distributed uniformly on the bottom

of a planchet for counting, and placed in a desiccator.

D) Air Samples, Particulates

A Millipore Filter (2" 5 micron) is placed in a planchet and counted.

E) Air Samples, Radioiodines

Samples are collected on a 2" Cesco Chemical Cartridge (50 cc) - organic vapor. These cartridges are counted on the gamma spectroscopy system described in the following section.

CALIBRATION

Self-absorption curves and counter efficiency for gross beta radioactivity in vegetation and fauna are based on standards of KCl on 200 mesh silica gel and on standards of Sr-90-Y-90 on 200 mesh silica gel for soil and water. Gross beta activity in air samples is based on a standard of Sr-90-Y-90 dried on a blank air filter. Self-absorption curves and counter efficiency for gross alpha are based on Pu-239 on 200 mesh silica gel for all sample types. A daily check is performed using Sr-90-Y-90 and P0-210 standards to confirm instrument efficiency, plateau position, and separation between alpha and beta channels.

COUNTING

Air samples are counted for 5 minutes for gross beta activity; all other samples are counted for 60 minutes for both gross alpha and gross beta activity. Generally, a background standard is counted for 60 minutes every fifth sample. Backgrounds average 0.85 CPM for beta and 0.05 CPM for alpha.

CALCULATION

Gross alpha-gross beta results are calculated in pCi/liter (or kilogram) using the Olivetti calculator to subtract background, correct for self-absorption losses and instrument efficiency. The finished results are combined with the gamma data and specific nuclide analysis data and sent to the State Data Center, Jacksonville, Florida for computer listing.

6.3.3 PROCEDURE FOR GAMMA ANALYSIS

EQUIPMENT

- 1) Hewlett-Packard 5406B Gamma Analysis System with 2100A 16K Computer. Complete with visual displays and triple deck magnetic tape cassette unit.
- 2) Two Gamma Products 4 inch steel shields with 20 x 20 x 24 inch inside dimensions, each with 4 x 4 inch, Na(Tl)I Harshaw crystal and photomultiplier tube.
- 3) 3 1/2 and 1 liter Marinelli beakers and one pint cottage cheese type containers.

- 4) Hobart commercial size food chopper.
- 5) Single beam balance, 4 kilogram capacity.

SAMPLE PREPARATION

A) Water and Milk Samples

Three and one-half liters of the sample are measured in a four-liter graduated cylinder and poured into a Marinelli beaker.

B) Vegetation Samples

Samples are chopped fine enough to fit into a 3 1/2 liter Marinelli beaker and weighed.

C) Soil and Fauna Samples

The sample is placed in a one-liter Marinelli beaker and weighed. Only large rocks and roots are removed, and the samples are not dried prior to counting. Fauna samples usually require chopping to fit into the beaker.

D) Algae Samples

250 ml. of the sample is measured into a cottage cheese container and weighed.

CALIBRATION

The system is calibrated for 3 1/2 liter Marinelli beaker, 1.0 liter Marinelli beaker, and 250 ml. cottage container geometries using the following standards; Ce-144, I-131, Ru-106, Cs-134, Cs-137, Zr-Nb-95, Mn-54, Zn-65, Ba-140, K-40, Co-58, Co-60, Ra-226 and Th-232. The standard solutions are obtained either from the Environmental Protection Agency, Office of Quality Assurance - Radiation, Los Vegas, Nevada, or the Amersham/Searle Corporation, and are made up in aqueous solution with appropriate carriers and acid concentration. Daily alignment and calibration of the system is done using a set of Co-60 and Cs-137 sealed sources, and a weekly check is performed using an aqueous Cs-137 standard in a one-liter Marinelli beaker to verify stability of resolution and efficiency.

COUNTING

A background is run each morning in the geometry appropriate for the samples to be counted that day. The background standards are deionized, aged water. All samples are counted for 60 minutes over 256 channels at 10 KeV per channel. The data is printed out on the teletype and magnetic tape cassettes.

CALCULATIONS

Quantitative results are calculated by the 16K computer using a linear least squares program. Results are computed in pCi/liter or pCi/kilogram on all samples for the nuclides mentioned above, and are reviewed for accuracy, number of significant figures, and limits of detectability, and then combined with the gross alpha-beta data and specific nuclide analysis data and sent to the Data Center for card punching and computer listing.

6.3.4 PROCEDURE FOR TRITIUM ANALYSIS OF WATER SAMPLES

EQUIPMENT AND REAGENTS

- 1) Instrumentation: Packard Tri-Carb Liquid Scintillation Spectrometer, Model 3375
- 2) 7 ml. pipet
- 3) 25 ml. plastic vials with screw-type caps supplied by Packard Instrument Company.
- 4) Distillation apparatus: All-glass distillation apparatus with ground glass joints and 100 ml. pot and receiving flasks. 100 ml. capacity heating mantle and transformer. After distillation of a sample which contains levels of tritium higher than background levels, the glass distillation apparatus should be thoroughly cleaned, soaked in 2 N HCl, rinsed in distilled water, and dried in an oven.
- 5) Scintillation reagent: Dissolve 1.50 grams bis-MSB and 7.00 grams PPO in about 500 ml. of toluene using gentle heat. Cool, add 350 ml. of triton X-100 are scintillation grade reagents supplied by the Packard Instrument Company and the toluene is ACS Reagent Grade. The counting instrument should be recalibrated whenever a new batch of scintillation reagent is prepared; also the optimum amounts of bis-MSB and PPO should be determined for each instrument or after major repair to an instrument.

CALIBRATION

The standards for calibrating the instrument are prepared exactly like a background standard except that 10 to 50 microliters of a tritiated water standard are added to and mixed with the 7 ml. of distillate before adding the scintillation reagent. The standards should be prepared in triplicate, and the instrument should be calibrated frequently. A standard prepared in a glass instead of a plastic vial can be used as a daily check on instrument calibration. The standards should be counted long enough to provide statistically reliable readings. Calculate the efficiency as follows:

$$\begin{aligned}\text{Efficiency} &= (\text{DPM})/(\text{CPM})(2.22\text{DPM/pCi})(.007 \text{ liter}/7\text{ml.}) \\ &= (\text{pCi})(7\text{ml.})/(\text{CPM})(2.22)(.007 \text{ liter})\end{aligned}$$

TABLE NO. 6.3-1

PRACTICAL REPORTING LIMITS

Gamma Spectroscopy

<u>Nuclide</u>	<u>Vegetation and Water</u>	<u>Soil and Biota</u>
	3.5 l Geometry	1.0 l Geometry
Cerium 144	9.7×10^{-8} $\mu\text{Ci/ml}$	2.0×10^{-7} $\mu\text{Ci/ml}$
Iodine 131	1.7×10^{-8} $\mu\text{Ci/ml}$	4.0×10^{-8} $\mu\text{Ci/ml}$
Ruthenium 106	8.3×10^{-8} $\mu\text{Ci/ml}$	1.8×10^{-7} $\mu\text{Ci/ml}$
Cesium 137	1.7×10^{-8} $\mu\text{Ci/ml}$	4.0×10^{-8} $\mu\text{Ci/ml}$
Cesium 134	1.7×10^{-8} $\mu\text{Ci/ml}$	6.0×10^{-8} $\mu\text{Ci/ml}$
Cobalt 58	1.7×10^{-8} $\mu\text{Ci/ml}$	6.0×10^{-8} $\mu\text{Ci/ml}$
Cobalt 60	1.7×10^{-8} $\mu\text{Ci/ml}$	6.0×10^{-8} $\mu\text{Ci/ml}$
Zirconium 95	1.4×10^{-8} $\mu\text{Ci/ml}$	3.0×10^{-8} $\mu\text{Ci/ml}$
Manganese 54	1.4×10^{-8} $\mu\text{Ci/ml}$	3.0×10^{-8} $\mu\text{Ci/ml}$
Zinc 65	3.1×10^{-8} $\mu\text{Ci/ml}$	7.0×10^{-8} $\mu\text{Ci/ml}$
Potassium 40	1.8×10^{-7} $\mu\text{Ci/ml}$	3.9×10^{-7} $\mu\text{Ci/ml}$
Barium 140	1.7×10^{-8} $\mu\text{Ci/ml}$	4.0×10^{-8} $\mu\text{Ci/ml}$
Radium 226	5.7×10^{-8} $\mu\text{Ci/ml}$	2.0×10^{-7} $\mu\text{Ci/ml}$
Thorium 232	2.8×10^{-8} $\mu\text{Ci/ml}$	1.0×10^{-7} $\mu\text{Ci/ml}$

Other Analyses

Strontium 90	8.0×10^{-7} $\mu\text{Ci/gm ash}$
Tritium	2.0×10^{-7} $\mu\text{Ci/ml (1 liter sample)}$
Gross Alpha (water)	7×10^{-9} $\mu\text{Ci/ml (1 liter sample)}$
Gross Alpha (ash)	7×10^{-6} $\mu\text{Ci/gm ash}$
Gross Beta (water)	3×10^{-9} $\mu\text{Ci/ml (1 liter sample)}$
Gross Beta (ash)	1×10^{-5} $\mu\text{Ci/gm ash}$
Gross Beta - air particulate filters	7.7×10^{-12} $\mu\text{Ci/ml}$ (Based on a total flow of 2200 m^3)
Air Iodine Cartridges	7.7×10^{-12} $\mu\text{Ci/cm}^3$

PROCEDURE

Measure 50 ml. of the water sample in a graduate cylinder and pour into the distillation apparatus. Distill the sample to complete dryness but avoid baking the residue. Pipet 7 ml. of the distillate into a plastic vial and add 15 ml. of the scintillation reagent (use of an automatic dispenser is convenient for this operation). Mark the sample identification number on the cap of the vial (any mark on the vial proper interferes with the transmission of light to the photomultiplier tubes) and cap the vial securely. Immerse the vial in a hot water bath (45-50°C.) for a couple of minutes and then shake the vial until a clear, transparent solution is obtained (use of an automatic shaker is convenient for multiple samples.) Place the vial inside the counter and leave it overnight before counting the sample (this allows the sample to come to thermal equilibrium and for any spurious fluorescence to decay.) Count the sample for 100 minutes and calculate the results in picocuries per liter according to the following equation:

$$\text{pCi/l} = A \times B$$

where A = Net CPM for the sample in (CPM)/(7 ml.)

B = Instrument counting efficiency in (pCi)(7 ml.)/(CPM)(2.22)(.007 liter) Backgrounds should be prepared in the same manner as the samples using 50 ml. of previous distilled or deionized water in place of the water sample. A background standard should be prepared and counted for every six samples analyzed.

6.3.5 PROCEDURE FOR Sr-89-90 ANALYSIS OF MILK SAMPLES

SPECIAL EQUIPMENT

Ion Exchange Column, Kontes Glass Company #001193-43

PROCEDURE

The procedure is identical to that referenced below except that only the cation exchange column mentioned above is used, instead of the plastic anion and cation exchange columns in the original procedure, and the cation exchange column is used only for strontium analysis and not for gamma and strontium analyses. Also, all of the procedure for strontium analysis is done in the laboratory and no part is done in the field.

**7.0 EFFECTS OF
ACCIDENTS**

7.1 PLANT ACCIDENTS

The accidents which are of concern from the environmental protection standpoint are those which might result in an uncontrolled release of radioactive materials to the environment. Viewed in this context, the design and construction of the facility are basic to safety. Numerous barriers and features are provided which guard against accidental or uncontrolled releases of radioactive materials from the plant. These barriers are (1) the uranium oxide fuel pellets, (2) the sealed metal tubes which contain the pellets, (3) the reactor coolant system which encloses the reactor, (4) the containment which houses the reactor coolant system, and (5) the shield building which encloses the containment. Additional protection of the public is provided by the engineered safety features which control the release of radioactivity in the event of an accident, and the remote site location, which was chosen to further reduce the effects to the general public of an accidental release of radioactivity.

Various postulated incidents and accidents have been analyzed as reported in the Preliminary Safety Analysis Report (PSAR). These analyses were made for the purpose of demonstrating that the plant can be operated safely and that maximum radiation exposures from credible accidents would be within the guidelines of 10CFR100. To provide a high degree of assurance that the radiation doses will be within these guidelines under any credible circumstances, the analyses have been performed in a highly conservative way. Because of the degree of conservatism built into the analyses reported in the PSAR, the resulting doses are far in excess of what would be realistically expected.

To facilitate the assessment of the impact of possible incidents and accidents in a realistic and timely manner, and therefore to allow a judgement as to the environmental risk inherent to operation of the facility, further analyses have been made. As compared to the PSAR analyses, the environmental risk analyses are more realistic and less conservative due to the use of experimental data not previously available, consistent assessments of the events resulting from an incident or accident, and a diminution of the degree of conservatism applied to the analyses. Realistic values have been assigned to such parameters as filter efficiencies, shield building mixing efficiency, and atmospheric diffusion.

7.1.1 ANALYSIS OF ENVIRONMENTAL IMPACT OF ACCIDENTS

A variety of accidents and incidents have been analyzed covering a wide range of severity, in order to facilitate a realistic assessment of risk. Table 7.1-1 summarizes the events which were considered. These events were chosen to represent a spectrum of events from relatively minor to the most severe which could credibly be postulated. Calculated results of these events are shown in Table 7.1-2 in terms of site boundary whole body dose, site boundary thyroid dose, and average integrated population dose (man-rem). The site boundary doses should be regarded as typical doses that would be expected from a particular event. The man-rem exposures were calculated in a similar fashion, the results being "average expected" exposures. Engineered safeguards operation of 100 percent design value was assumed as appropriate. Details of the parameters used for each accident are included in the discussion of that event.

7.1.2 DOSE CALCULATION METHODOLOGY

The radiological impacts of the postulated events are evaluated in terms of the radiation doses delivered to individuals and to the population as a whole. Whole body doses due to external exposure and thyroid doses due to inhalation are calculated for: 1) an individual at the site boundary and 2) the population within 50 miles of the site.

The individual doses have been calculated using the following dose models:

$$\text{Thyroid Dose (rems)} = \sum_{i=1}^B \frac{X}{Q} T_i Q'_i$$

$$\text{Whole body dose (rems)} = \sum_{i=1}^B \frac{X}{Q} W_i Q'_i$$

B = individual breathing rate for adult; taken as $3.47 \times 10^{-4} \text{ m}^3/\text{sec}$.

T_i = thyroid dose conversion factor for the i^{th} iodine isotope.

W_i = whole body dose conversion factor for the i^{th} noble gas isotope; this factor is based on immersion in a semi-infinite cloud of gamma emitters.

Q'_i = amount of activity of the i^{th} isotope released; for cases where the release takes place outside containment, Q'_i is equal to the total release for the incident; for releases inside the containment Q'_i is calculated for a time period of 31 days.

$\frac{X}{Q}$ = the atmospheric dispersion factor (sec/m^3) at the site boundary not exceeded during more than 50 percent of the time.

The population doses due to airborne radiation are obtained by combining the individual doses as computed above with the population distribution around the St. Lucie Site (Table 7.1-10). The combination used gives a conservative result since it assumes that the annual average dispersion in all directions is equal to that in the critical sector. Table 7.1-3 lists the atmospheric dispersion factors used in this analysis.

7.1.3 DISCUSSION AND ANALYSIS OF EVENTS

7.1.3.1 Class 2 Events - Small Releases Outside the Containment

a) CVCS Pipe Break

Spills, leaks and pipe breaks can be postulated to occur in a variety of components outside the containment over the lifetime of the plant. The components of greatest concern are those containing fluids with potentially significant radioactive concentrations. The Chemical and Volume Control System components contain reactor coolant and are representative of such potentially significant sources. Small continuous leaks have been analyzed in the routine release analysis of this report (5.2 and 5.3), where the annual average radioactive effluents were based

upon the various reactor coolant system leakage terms expected during plant operations as a result of small leaks in such system components as CVCS piping. Larger cracks are less likely in systems containing reactor coolant, but would be accompanied by larger leakage rates. Such a crack would be detected by area radiation monitoring systems and the operator would isolate the leaking line. For the purpose of this section a crack in the CVCS piping is postulated. Such an incident is unlikely to release more than 1000 gal. of reactor coolant prior to isolation, even if the maximum charging flow of 132 gpm were initially in progress. A release of 1000 gal. of reactor coolant to the auxiliary building is used for this evaluation. The reactor coolant system activity associated with this release is based upon 0.1 percent failed fuel.

Activity Release

Although these events result in the release of liquid activity to the auxiliary building, the environmental impact is due to the release of gases which evolve from the released liquid. The liquid itself drains to equipment and building sumps, and is pumped to the waste management system for treatment. In calculating the release of gaseous activity it is assumed that all of the noble gases dissolved in the leaking liquid are released, while 0.1 percent of the contained iodine becomes airborne. These assumptions lead to the activity releases listed in Table 7.1-4.

Off-Site Exposure

The calculated exposures resulting from the accident are given in Table 7.1-2. The exposures due to the pipe break are given in rems/-event.

Remoteness

Primary consideration is given to minimizing leakage in the design of systems and components. Pipes, valves and flanges of the CVCS are designed, fabricated, and erected to strict quality standards that insure the remoteness of a leak to the environment.

CVCS components are designed for pressures and temperatures substantially greater than their normal operating conditions to provide an adequate margin for normal load changes and operating transients. It is therefore apparent that a break in the CVCS piping as postulated for this analysis is a remote incident.

7.1.3.2 Class 3 Events - Radwaste System Failures

a) Equipment Leakage or Malfunction

A release of the stored radioactive gases in the waste gas decay tanks as a result of component failure or inadvertent venting is considered improbable. The waste gas decay tanks are not subjected to high pressures or unusual stresses. Inadvertent release of the contents of the waste gas decay tanks would be detected by the radiation detectors in the line leading to the plant vent. In the event of a high radiation level of the effluent gases to the vent that would result in exceeding

the limits of 10CFR20, an alarm will sound in the control room and the flow of gas to the vent will be automatically interrupted.

The radioactive gases stored in the decay tanks consist of fission gases and the hydrogen and nitrogen cover gases. The nitrogen is added in the various collection and holdup tanks to preclude the possibility of obtaining a flammable mixture of hydrogen gas. Hence, tank rupture as a result of ignition of hydrogen in the decay tank is remote.

For the purpose of this analysis it is assumed that an inadvertent venting occurs in which 25 percent of the activity contained in the waste gas decay tank is released to the atmosphere before automatic termination of the gas flow.

Activity Release

Based upon 0.1 percent failed fuel, the waste gas decay tank will contain the following dose equivalent curies:

Xe-133 7,300

I-131 .002

A release of 25 percent of the tank contents would release 1,825 dose equivalent curies of Xe-133 and .0005 dose equivalent curies of I-131.

Off-Site Exposure

The calculated exposures for this accident are given in Table 7.1-2.

b) Waste Gas Decay Tank Failure

A release of the stored radioactive gases in the waste gas decay tanks as a result of component failure or inadvertent venting is considered improbable. The waste gas decay tanks are not subjected to high pressures or unusual stresses. Inadvertent release of the contents of the waste gas decay tanks would be detected by the radiation detectors in the line leading to the plant vent. In the event of a high radiation level of the effluent gases to the vent that would result in exceeding the limits of 10CFR20, an alarm will sound in the control room and the flow of gas to the vent will be automatically interrupted.

The radioactive gases stored in the decay tanks consist of fission gases and the hydrogen and nitrogen cover gases. The nitrogen is added in the various collection and holdup tanks to preclude the possibility of obtaining a flammable mixture of hydrogen gas. Hence, tank rupture as a result of ignition of hydrogen in the decay tank is remote.

To determine an upper limit to the environmental consequences resulting from a failure of a waste gas decay tank it is assumed that 100 percent of the contents of the tank are released instantaneously at ground level. The tank is assumed to contain fission gases stripped from one complete system volume of reactor coolant. Radioiodine content is based on a partition coefficient of 1×10^{-4} and a chemical and volume control sys-

tem purification ion exchanger decontamination factor of 10. It is also assumed that the reactor coolant contains fission products resulting from long term operation at 2700 Mw with 0.1 percent defective fuel rods in the core. No credit is taken for decay of the contents of the gas decay tank prior to release.

Activity Released

For the assumed concentrations the waste gas decay tank will contain the following dose equivalent curies:

Xe-133	7,300
I-131	.002

Off-Site Exposure

The calculated exposures resulting from this accident are given in Table 7.1-2.

c) Failure of Liquid Waste Holdup Tank

A release of stored radioactive liquid wastes from a liquid waste holdup tank as the result of component failure is considered improbable. The liquid waste holdup tanks are not subject to high pressures or unusual stresses. Any release of liquid from the tank to the auxiliary building would be drained to equipment and building sumps and pumped to the waste management system for treatment. The environmental impact of any release from a liquid waste holdup tank to the auxiliary building would be due to the release of gases evolving from the spilled liquid.

The liquid waste holdup tank inventory is based upon 0.1 percent failed fuel.

For the purpose of this analysis it is assumed that the entire contents of the liquid waste holdup tank is spilled on the auxiliary building floor.

Activity Released

A complete rupture of the liquid waste holdup tank would result in the release of the activities shown in Table 7.1-5 to the environment.

Off-Site Exposures

The resultant off-site doses are listed in Table 7.1-2.

7.1.3.3 Class 5 Events

a) Fuel Cladding Defects and Steam Generator Leakage

Environmental consequences of plant operations with 0.1 percent failed fuel and a primary to secondary system leakage of 20 gallons per day have been evaluated in Sections 5.2 and 5.3 of this report.

b) Steam Generator Tube Rupture

The steam generator tube rupture accident is a penetration of the barrier between the reactor coolant system and the main steam system. Integrity of this barrier is significant from the radiological safety standpoint, since a leaking steam generator tube would allow transport of reactor coolant into the main steam system. Radioactivity contained in the reactor coolant would mix with shell-side water in the affected steam generator. This radioactivity would pass to the turbine and condenser, or directly to the condenser via dump and condenser bypass valves. Noncondensable radioactive materials would be discharged through the condenser air ejectors to the atmosphere.

The probability of complete severance of a steam generator tube is considered remote. The vertical U-tubes are Ni-CR-Fe alloy. A double-ended rupture has never occurred in a Combustion Engineering steam generator of this design. The more probable modes of failure are those involving the occurrence of pinholes or small cracks in the tubes or cracks in the seal welds between the tubes and the tube sheet.

The system response varies depending on the size of the leak. For leak rates not exceeding the capacity of the charging pumps (132 gpm total), the reactor coolant inventory can be maintained and an automatic reactor trip would not occur.

For leaks exceeding the capacity of the charging pumps, pressurizer water level and pressure decrease, initiating reactor trip (thermal margin/low pressure trip) and turbine trip. The steam dump and bypass valves open, discharging steam to the condenser. The steam dump valves close when reactor coolant average temperature drops below 535 F. Once the dump valves close, operation of the bypass valves allows steam to pass to the condenser for cooldown and decay heat removal. The steam bypass controller functions to maintain pressure between 895 psia and 905 psia; for cooldown of the reactor coolant system, the steam bypass valves must be manually controlled for pressure below 895 psia. When the reactor coolant temperature is about 300 F, the operator can place the shutdown heat removal system into operation and isolate both steam generators to terminate the accident.

Steam generator water level indication aids in detecting these larger leaks, since the water inventory in the leaking steam generator will increase more rapidly than that of the intact steam generator following reactor trip. (Following trip, feedwater flow is ramped down to 5 percent of full-power flow, and manual control action is required for variation from this setting.)

The amount of radioactivity released increases with the size of the tube rupture. For this analysis, a double-ended break of one steam generator tube is assumed. At normal operating conditions, the leak rate would equal 54 lb/sec, which exceeds the maximum flow available from the charging pumps. Reactor coolant system pressure decreases and a low pressurizer pressure trip occurs. Following reactor trip, reactor coolant average temperature is normally reduced by dumping steam through the steam dump and bypass system. The radioactivity passed

through this system flows to the condenser, where the noncondensable gaseous products are discharged to the atmosphere via the condenser air ejector, which exhausts to the plant vent.

Activity Released

After 30 minutes, it is assumed that the operator has diagnosed the problem and has closed the main steam and feedwater isolation valves and the atmospheric dump valve for the leaking steam generator. Radio-activity levels at the plant vent and steam generator blowdown lines and increasing water level in the damaged steam generator are the main indicators. Plant cooldown is then initiated by dumping steam from the intact steam generator to the condenser by manual actuation of the bypass valves. At about 300 F, the operator initiates shutdown cooling and isolates both steam generators. During plant cooldown, the operator manually regulates safety injection and charging flow rates in order to maintain a measurable pressurizer water level. During the first 30 minutes following the tube rupture, 59,300 pounds of reactor coolant is transported to the main steam system. The resulting quantities of activity released via the air ejectors to the atmosphere over this period are 0.00224 dose equivalent curies of I-131 and 1,890 dose equivalent curies of Xe-133. These releases include contributions from residual secondary activity, the equilibrium level of which is assumed to have been established by a long term primary-to-secondary leak of 1.0 gpm and a primary activity level corresponding to 0.1 percent fuel cladding defects. During the cooldown period, 3.5 hours, an additional 0.0 dose equivalent curie of I-131 is released via the air ejectors.

Off-Site Exposure

The doses resulting from the above activity release through the steam jet air ejectors are listed in Table 7.1-2.

7.1.3.4 Class 6 Events - Refueling Accidents

The likelihood of a fuel handling accident is minimized by administrative controls and physical limitations imposed on fuel handling operations. All refueling operations are conducted in accordance with prescribed procedures under direct surveillance of a qualified supervisor. Before any refueling operations begin, verification of complete CEA insertion is obtained by tripping each CEA individually to obtain indication of assembly drop and disengagement from the drive shaft. Boron concentration in the coolant is raised to the refueling concentration and is verified by chemical analysis. At the refueling boron concentration, the core would be subcritical even with all CEA's withdrawn.

After the vessel head is removed, the CEA drive shafts are removed from their respective assemblies. A load cell is used to indicate that the drive shaft is free of the CEA as the lifting force is applied.

The maximum elevation to which the fuel assemblies can be raised is limited by the design of the fuel handling hoists and manipulators to assure that the minimum depth of water above the top of a fuel

assembly required for shielding is always present. This constraint is present in the fuel handling areas both inside containment and in the fuel handling building. Supplementing the physical limits on fuel withdrawal, radiation monitors located at the fuel handling areas provide both audible and visual warning of high radiation levels in the event of a low water level in the refueling cavity and fuel pool. Fuel pool structural integrity is assured by designing the pool and the spent fuel storage racks as Class I structures.

The design of the spent fuel storage racks and handling facilities in both the containment and fuel handling building is such that sub-criticality would be maintained if the pool were flooded with unborated water. Natural convection of the surrounding water provides adequate cooling of fuel during handling and storage. Adequate cooling of the water is provided by forced circulation in the spent fuel pool cooling system. At no time during the transfer from the reactor core to the spent fuel storage rack is there less than 112 inches of water above a fuel assembly.

Fuel failure during refueling as a result of inadvertent criticality or overheating is not possible. The possibility of damage to a fuel assembly as a consequence of mishandling is minimized by thorough training, detailed procedures and equipment design. The design precludes the handling of heavy objects such as shipping casks over the spent fuel storage racks. Inadvertent disengagement of a fuel assembly from the fuel handling machine is prevented by mechanical interlocks, consequently, the possibility of dropping and damaging of a fuel assembly is remote.

Should a spent fuel assembly be damaged during handling, radioactive release could occur in either the containment or the fuel handling building. The ventilation exhaust air from both of these areas is monitored before release to the atmosphere. Area radiation monitors provide alarm and indication of increased activity level. The affected area would then be evacuated.

Release of activity through the containment purge system is prevented by automatic closure of the containment isolation valves upon containment isolation signal. The containment personnel hatches and equipment hatches are closed during fuel handling operations.

Since the fuel handling building is not a sealed structure, fuel damage in the spent fuel pool would result in a greater activity release than a release in the containment. The ventilation system draws air across the spent fuel pool area and this air is discharged to the atmosphere.

Since all exterior doors are closed during fuel handling operations, this is the only pathway for the release of activity.

a) Fuel Bundle Drop Inside Containment

Although, as stated above, the dropping of a ten bundle is an unlikely event, it is assumed for the purpose of this analysis that a fuel bundle is dropped inside the containment during refueling operations. It is

assumed that 14 rods (one row) in the hottest fuel assembly are broken three days after reactor shutdown, releasing their entire gap inventory of fission products. All noble gas activity was assumed to reach the water surface and mix with the containment air, while the iodine activity was assumed to be reduced by a factor of 1000. Containment purge was assumed to continue for two minutes following the accident, being terminated by the automatic shutoff on high purge activity. Half the iodine reaching the containment atmosphere was assumed to plate out inside the containment.

Activity Release

The above event would result in the activities listed in Table 7.1-6 being released to the environment.

Off-Site Doses

The calculated off-site doses for this accident are presented in Table 7.1-2.

b) Fuel Bundle Drop Outside Containment

It is assumed for the purpose of this analysis that a fuel bundle is dropped in the spent fuel storage pool three days after reactor shutdown. Fourteen rods (one row) of the hottest fuel assembly are broken releasing their entire gap inventory of fission products. All noble gas activity was assumed to reach the water surface and mix with the fuel handling building air, while the iodine activity was assumed to be reduced by a factor of 1000. Of the iodine leaving the spent fuel pool, one-half was assumed to plate out on the surface and ductwork of the fuel handling building.

Activity Release

The above event would result in the activities listed in Table 7.1-7 being released through the fuel handling building ventilation system to the environment.

Off-Site Doses

The calculated off-site doses for this accident are presented in Table 7.1-2.

7.1.3.5 Class 7 Accidents

a) Spent Fuel Transportation Accident On Site

For the purpose of this analysis it is assumed that a loaded spent fuel cask is dropped in the fuel handling building 120 days after reactor shutdown. The entire gap inventory of the noble gases from two fuel assemblies is released to the building atmosphere. One-half of the iodine activity in the gas gap of two assemblies leaves the fuel cask. One-half of the iodine activity released from the fuel cask is assumed to plate out on the fuel handling building surfaces and ductwork.

Activity Released

The activity escaping from the fuel handling building to the environment is given in Table 7.1-8.

Off-Site Doses

The off-site doses for the spent fuel transportation accident on site are listed in Table 7.1-2.

7.1.3.6 Class 8 Events

a) Loss of Coolant Accident

Description of Incident

A loss of coolant accident represents a breach of the reactor coolant system boundary which interrupts the normal mechanism for removing heat from the reactor core and results in the release of reactor coolant to the containment building.

Analysis

A Loss of Coolant Accident represents the design basis accident for the engineered safety features and containment building. To demonstrate the effectiveness of these protective features, it is conservatively assumed that all fuel rod cladding is perforated during the accident and that the fission product gas in the gas gap is released. The accident is analyzed for environmental risk using realistic assumptions as to containment leak rate, iodine removal in the Shield Building Ventilation System (SBVS) filters, and atmospheric dispersion.

Activity Release

The gas gap activities for the total core are based upon azimuthal and axial distributions considered typical for the core power distributions. The total core gas gap activity is listed in Table 7.1-9. The gas gap activity is large compared with that contained in the primary coolant, thus the latter is not considered in the analysis.

Off-Site Exposure

The low leakage containment vessel, the Containment Spray and Containment Cooling Systems, and the Shield Building Ventilation System act to mitigate the off-site effects resulting from a fission product release within the primary containment. The results of the individual and population dose calculations are given in Table 7.1-2.

Remoteness

The Loss of Coolant Accident is the design basis accident for the plant. Therefore, consideration of factors relating to the prevention and mitigation of this accident is contained throughout the entire Preliminary

Safety Analysis Report. Only a few of the more significant considerations are summarized in this review.

The plant has been designed, fabricated and constructed under a comprehensive Quality Assurance Program to assure compliance with all applicable specifications and codes.

All reactor coolant system components are designed and fabricated in accordance with the ASME Boiler and Pressure Vessel Code, Section III, and piping is to ANSI Code for Pressure Piping. The Reactor Coolant System is designed to withstand the loads imposed by the design basis Loss of Coolant Accident and the Design Basis Earthquake without loss of function required for emergency reactor shutdown and emergency core cooling.

The major Reactor Coolant System components are designed for a 40-year design lifetime. Components are austenitic stainless steels or are internally clad to assure material compatibility with coolant chemistry. Fatigue analyses based upon conservative design cyclic transients and primary stress combinations have been evaluated in accordance with the applicable codes. Overpressure protection is assured by ASME Code safety valves. Special attention is given to prevention of brittle fracture in the selection of materials, fabrication procedures, operating procedures and programs to determine the effect of irradiation upon the material properties.

Engineered Safety Features act to control and mitigate the consequences of a Loss of Coolant Accident for the entire spectrum of break sizes, up to and including the double-ended rupture of the hot leg reactor coolant pipe.

After installation, the reactor coolant system is hydrostatic tested and leak tested. A series of tests are conducted prior to reactor fueling, during fueling and following initial criticality.

Technical Specifications, operating procedures and other administrative controls assure plant operating conditions within limits previously determined to be acceptable. An extensive in-service inspection program requires periodic surveillance and inspection of safety related equipment and components during plant operation.

Safety analyses are conducted for the Loss of Coolant Accident in the PSAR based upon very conservative assumptions to evaluate the capability of the installed safety equipment to mitigate the potential consequences of the accident. The results are within the guidelines established by the AEC for the accident.

One of the safety analyses reviewed in the PSAR is based upon a maximum hypothetical accident (MHA). The safety evaluation of reactor plants has historically been based on a "hypothetical accident" defined in TID 14844 and involving the gross release of fission products from the fuel to the containment. The MHA involves a much greater fission product release than that which results from any series of events which is considered credible. The analyses in the PSAR conclude that the exclusion

boundary and low population zone guideline dose values of 10CFR100 would not be exceeded even for the hypothetical accident. More realistic fission products releases are used for the case considered here. While all the fuel rods are assumed to perforate, the activity release is much less than that associated with the maximum hypothetical accident. Thus, even though a loss of coolant is highly unlikely to occur during the lifetime of the plant, there is considerable margin between the activity contained in the core fuel rods and that hypothetical activity which would result in a 10CFR100 off-site dose.

b) Control Element Assembly Ejection Accident

Rapid ejection of a control element assembly (CEA) from the core would require a complete circumferential rupture of the control element drive mechanism (CEDM) housing or of the CEDM nozzle on the reactor vessel head. The CEDM housing and CEDM nozzle are an extension of the reactor coolant system boundary and designed and manufactured to Section III of the ASME Boiler and Pressure Vessel Code. Hence, the occurrence of such a failure is considered highly unlikely.

A typical CEA ejection transient behaves in the following manner: After ejection of a CEA from the full power or zero power (critical) initial conditions, the core power rises rapidly for a brief period. The rise is terminated by the Doppler effect. Reactor shutdown is initiated by the high power level trip, and the power transient is then completed. The core is protected against severe fuel damage by the allowable CEA patterns and by the high power trip; the maximum enthalpy in the fuel during the transient is limited to an acceptable value.

The consequences of the loss of coolant resulting from the reactor coolant system rupture are similar to those for small reactor coolant system breaks.

Full power and zero power CEA ejection accidents are shown in Chapter 15 of the PSAR to be acceptable both at beginning and end of cycle. No clad damage or fully molten centerline condition is reached for any CEA ejection accident. Incipient centerline melting occurs in only a small portion of the fuel in both full power cases. Since there is no clad damage, the activity released following a CEA ejection accident is limited to that existing in the reactor coolant system prior to the accident.

Activity Released

When operating with failed fuel in the core, there is some activity present in the reactor coolant system prior to ejection. As an upper limit, the dose equivalent I-131 inventory in the coolant with 0.1 percent failed fuel is approximately 100 curies, while the corresponding dose equivalent Xe-133 inventory is 10,837.5 curies.

Off-Site Exposure

The off-site doses resulting from a CEA ejection accident are given in Table 7.1-2.

c) Major Secondary System Pipe Breaks (Steam Line Rupture Accident)

A rupture in the main steam system increases the rate of heat extraction by the steam generators and causes cooldown of the reactor coolant. With a negative moderator coefficient of reactivity, the cooldown will produce a positive reactivity addition.

The decrease in main steam pressure will initiate reactor trip (low steam generator pressure) and close the main steam isolation valves. If the break occurs between the steam generator and the isolation valve, blowdown of the affected steam generator continues. Flow from the intact steam generator stops with closure of both isolation valves, either of which is capable of stopping flow.

Since the steam generators are designed to withstand reactor coolant system operating pressure on the tube side with atmospheric pressure on the shell side, the continued integrity of the reactor coolant system barrier is assured.

For the purpose of this analysis it is assumed that a circumferential rupture of a 34-inch (inside diameter) steam line occurs upstream of the main steam isolation valve outside the containment. All of the mass leaving the break is assumed to be in the steam phase.

Activity Released

The initial radioactivity in the steam generators is assumed to be the equilibrium concentration reached with a 1 gpm leak and 5 gpm continuous blowdown assuming 0.1 percent failed fuel. In addition, it is conservatively assumed that the leak rate increases to 5 gpm at the start of blowdown and remains at that level until the plant is cooled down and depressurized.

The radiological releases for this accident are 10.4 dose equivalent curies of I-131 and 30.0 dose equivalent curies of Xe-133.

Off-Site Exposure

The off-site doses resulting from this accident are listed in Table 7.1-2.

TABLE 7.1-1

PLANT ACCIDENTS ANALYZED

Class	Accident
2	Chemical Volume Control System pipe break
3	Leakage or malfunction of waste gas decay tank
3	Failure of waste gas decay tank
3	Failure of liquid waste holdup tank
5	Steam generator tube rupture
6	Fuel bundle drop inside containment
6	Fuel bundle drop outside containment
7	Fuel Cask Drop
8	Loss of coolant accident
8	Control element assembly ejection accident
8	Steam line break outside containment

TABLE 7.1-2

SUMMARY OF CALCULATED PLANT ACCIDENT DOSES

Accident	Individual Whole Body Dose at Site Boundary mrem	Individual Thyroid Dose at Site Boundary mrem	Cumulative Pop- ulation Dose (Whole Body) man-rem
Minor Release CVCS Pipe Break	0.0313	0.144	0.159
Release of 25% Waste Gas Decay Tank Inventory	0.320	0.0220	1.63
Release of 100% Waste Gas Decay Tank Inventory	1.28	0.0878	6.51
Release of Liquid Waste Holdup Tank	0.0698	0.0000751	.355
Steam Generator Tube Rupture	331	.00984	0.142
Refueling Accident Inside Containment	0.094	0.0098	0.478
Refueling Accident Outside Containment	1.38	0.146	4.32
Steam Line Break	0.0053	45.7	26.7
Loss of Coolant Accident	34	1.44	106
Control Element Assembly Ejection	0.0177	0.00002	0.0554
Spent Fuel Transportation On Site	0.0270	5.66	0.0845

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TABLE 7.1-3

ATMOSPHERIC DISPERSION FACTORS USED IN ACCIDENT ANALYSES

<u>Distance</u> <u>meters</u>	<u>Distance</u> <u>miles</u>	$\frac{X/Q}{\text{sec/m}}^3$
1,555	.976	8.55 (-6)
8,045	5	8.55 (-7)
16,090	10	3.33 (-7)
32,180	20	1.32 (-7)
48,270	30	7.43 (-8)
64,360	40	5.0 (-8)
80,450	50	3.84 (-8)

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TABLE 7.1-4

ACTIVITIES RELEASED TO AUXILIARY BUILDING AS A RESULT
OF CVCS PIPE BREAK

<u>Isotope</u>	<u>Curies Released</u>
Kr-85m	0.564
Kr-85	0.336
Kr-87	0.307
Kr-88	0.986
I-131	1.505
Xe-131m	0.56
I-132	0.413
I-133	2.14
Xe-133	68.7
I-134	0.235
I-135	1.03
Xe-135	2.86
Xe-138	.136

TABLE 7.1-5

ACTIVITIES RELEASED TO THE ENVIRONMENT AS A
RESULT OF COMPLETE FAILURE OF LIQUID WASTE HOLDUP TANK

<u>Isotope</u>	<u>Curies Released</u>
Kr-85m	7.43
Kr-85	1.505(+1)*
Kr-87	1.21
Kr-88	8.49
I-129	2.45(-11)
I-131	1.30(-3)
I-132	5.90(-5)
I-133	1.39(-3)
I-134	1.27(-5)
I-135	3.77(-4)
Xe-131m	2.46(+1)
Xe-133	2.91(+3)
Xe-135	6.44(+1)
Xe-138	1.00(-1)

*Numbers in () are powers of 10

TABLE 7.1-6

ACTIVITIES RELEASED TO ENVIRONMENT AS A
RESULT OF A FUEL HANDLING ACCIDENT INSIDE THE CONTAINMENT

<u>Isotope</u>	<u>Curies Released</u>
Kr-85	1.84(1)
Xe-131m	2.25
Xe-133	5.30(2)
I-131	2.24(-3)

*Numbers in () are powers of 10

TABLE 7.1-7

ACTIVITIES RELEASED TO THE ENVIRONMENT AS A
RESULT OF A FUEL BUNDLE DROP IN THE
SPENT FUEL STORAGE POOL

<u>Isotope</u>	<u>Curies Released</u>
Kr-85	2.73 (2)
Xe-131m	3.37 (1)
Xe-133	7.89 (3)
I-131	3.33 (-2)

TABLE 7.1-8

ACTIVITIES RELEASED TO THE ENVIRONMENT
AS A RESULT OF FUEL CASK DROP
INSIDE THE FUEL HANDLING
BUILDING

<u>Isotope</u>	<u>Activity (Curies)</u>
Kr-85	5.7×10^3
Xe-131m	4.01×10^{-1}
Xe-133	1.66×10^{-2}
I-131	1.29

TABLE 7.1-9

EQUILIBRIUM TOTAL CORE GAS GAP ACTIVITY

<u>Isotope</u>	<u>Gas Gap Activity (Curies)</u>
Kr-85	2.25(+5)
Kr-85m	3.75(+5)
Kr-87	4.14(+5)
Kr-88	8.59(+5)
Xe-131m	3.43(+4)
Xe-133	9.35(+6)
Xe-133m	1.53(+6)
Xe-135	2.69(+6)
Xe-135m	1.39(+5)
Xe-138	4.29(+5)
I-131	8.86(+6)
I-132	1.82(+6)
I-133	7.83(+6)
I-134	2.10(+6)
I-135	4.34(+6)

7.2 OTHER ACCIDENTS

7.2.1 INTRODUCTION

St. Lucie Unit No. 2, like any other large industrial plant, could experience industrial accidents during its lifetime. Typical accidents that might occur are small electrical fires, chemical spills, etc. The procedures and safety equipment at St. Lucie Unit No. 2 will limit accidents of this type, so that their environmental consequences will be trivial. An analysis of the plant operations has shown that there is only one postulated accident that might have any environmental significance; that being the leakage or rupture of a chlorine storage tank.

7.2.2 CHEMICALS STORED ON SITE

The types, quantities, and storage location of the major chemicals that will be stored on site are given in Table 7.2-1.

7.2.3 CHLORINE GAS RELEASE

7.2.3.1 INTRODUCTION

There are two ways in which chlorine gas can be released to the environment. The first is a continuous emission from a small orifice leak. The second would be the complete rupture of a chlorine cylinder and the subsequent, almost instantaneous release of a large fraction of the cylinder contents. The probability of a complete rupture is so small it is considered to be of little significance in terms of a realistic environmental risk analysis. An accident analysis has been performed for a continuous one hour release from a small orifice leak. A one hour time frame was chosen because the contents of the tank have been effectively discharged within one hour.

7.2.3.2 CALCULATION ASSUMPTIONS

The effects from a chlorine gas release from a full one ton cylinder (expected form of storage) have been calculated using the following assumptions:

- a) Distance to exclusion radius: 5000 ft.
- b) Vapor discharge through a .34" orifice (at an initial temperature of 130°F).
- c) Mass flow rate vs time data from Howenton(1).
- d) A continuous release for one hour.
- e) It is assumed that there is no chemical interaction of the chlorine with the environment before 5000 ft.

7.2.3.3 Consequences

The consequences of a chlorine gas release, from a leakage one ton tank, will depend greatly upon the meteorological condition of the time of the accident. An analysis has been performed under various weather conditions and the concentrations at the exclusion distance of 5000 ft. are given in Table 7.2-2.

The physiological effects experienced by a person standing at the exclusion distance for one hour during the course of the release, will vary from severe coughing under the most unfavorable weather conditions, to only mild throat irritation under more favorable weather conditions. It is very unlikely that anyone would remain for one hour at the exclusion distance during a chlorine release accident. A more probable event would be that a person would detect the chlorine gas and remove himself (herself) from the area being affected. The consequences of a chlorine release would then be less significant and would probably consist of only mild coughing and throat irritation even under the most unfavorable weather conditions.

Considering the low occurrence probability of this accident and the small number of people that might be exposed to the release of chlorine gas, the consequences of this accident are therefore considered to be small.

TABLE 7.2-1

MAJOR CHEMICALS STORED ON SITE

<u>TYPE</u>	<u>QUANTITY</u>	<u>STORAGE LOCATION</u>
Chlorine	1-3 one ton cylinders	Chlorine Storage Building
Diesel Oil	2-20,000 gallon tanks 2-400 gallon tanks	Diesel Generator Building
Phosphate	3-12, 100 lb sacks	Turbine Building
Hydrazine	1-2, 55 gallon drums	Turbine Building
Cyclohexylamine	1-2, 55 gallon drums	Turbine Building
Hydrogen	2-tube trailers - 40-50,000 scf 18-190 scf gas bottles	Gas storage area
Liquid nitrogen	1-2, 40-50,000 scf tank	Gas storage building
Sodium Hydroxide	2-10,000 gal tanks 50% by wt sodium hydroxide	
Sulfuric Acid	1-10,000 gal tank (66° Be H ₂ SO ₄)	
Boric Acid	2-11,200 gallon tanks 8.25% by wt boric acid-maximum	Reactor Auxiliary Building

TABLE 7.2-2Calculations ResultsConcentration of Chlorine Gas at 5000 ft from the Site

<u>Weather Conditions</u>	<u>Exposure Time (min)</u>	<u>Concentration (ppm)</u>
<u>Stable</u>		
<u>Wind Speed</u>		
1m/sec	0-5	75
	5-10	50
	10-20	30
	20-30	20
	30-60	15
2m/sec	0-5	40
	5-10	30
	10-20	17
	20-30	10
	30-60	6
<u>Unstable</u>		
<u>Wind Speed</u>		
1m/sec	0-5	6
	5-10	4
	10-20	2.5
	20-30	1.8
	30-60	.8
2m/sec	0-5	2.1
	5-10	1.8
	10-20	1.2
	20-30	.8
	30-60	.2

TABLE 7.2-3

PHYSIOLOGICAL EFFECTS OF EXPOSURE TO CHLORINE IN AIR (2)

<u>EFFECT</u>	<u>CHLORINE (ppm)</u>	
	Reference: (3)	(4)
Detectable		
Throat irritation	3.5	3.0 to 3.5
Coughing	15.1	10 to 15
Dangerous $\frac{1}{2}$ hours	40 to 60	40 to 69
Fatal		
30 minutes	-	1000
10 minutes	-	1800
few deep breath	1000	-

**o ECONOMIC AND
o SOCIAL EFFECTS**

8.1 VALUE OF DELIVERED PRODUCTS

The primary product to be derived from the operation of FP&L's St. Lucie Plant is electric energy available as a service to its customers.

Due to the high investment cost per kilowatt of capacity versus a relatively low fuel cost per kilowatt hour of energy produced, these two units will be used for base loading rather than for peaking purposes. The kilowatt hours available for sales to customers for each unit are estimated by assuming a plant capacity factor of 80 percent and average system electric loss of 8.0 percent (based upon the year 1972 operations).

An estimate of kilowatt hour sales was conducted and the determination was proportioned among six standard sales classifications based on the year 1972 experience. They include: Residential, Commercial, Industrial, Public Street Lighting, Sales to Public Authorities and Sales for Resale (see Section 1.1).

The first 850 megawatt unit is scheduled for commercial operation in 1975 and the second unit of the same size in 1979.

A thirty-year plant life is assumed in accordance with Section 10d of "Guide to the Preparation of Environmental Reports for Nuclear Power Plants" dated August 1972.

The value of delivered benefits is defined as the present value of the total operating revenue resulting from the operation of the nuclear unit over a thirty year life.

The revenues which would be derived from the output of a generating plant could be estimated, within reasonable limits of accuracy, for a current twelve month period. However, it is not practical to make such an estimate for a thirty year period. Therefore, another means of estimating revenues must be used. The electric utility industry ratio of plant cost per dollar of revenue shows a historically stable relationship as shown in Table 10 of "Statistics of Privately Owned Electric Utilities in the United States". Such stability also exists in the FP&L system as shown on Table 8.1-1. The unweighted average plant cost per dollar of revenue for a 15 year period including 1972 is \$3.39, with a high of \$3.66 and a low of \$3.15. Economic inflation tends to influence this ratio by increasing plant investment, but it has not created a significant rise in this trend because of increased sales volume (see Section 1.1). Further, in most cases there is an upward adjustment in the rates of charge, which also tends to modify the effects of inflation.

Estimated operating revenues from the operation of St. Lucie Unit No. 2 is the best monetized measure of value of product. This product is the benefit which would be obtained when water and land resources are diverted from one use to another. These measures are shown on Table 8.1-2.

8.1.1 RESIDENTIAL USAGE

The availability of dependable electric service for household use in the

areas of labor saving, personal comfort and entertainment has been one of the primary contributions to the increased standard of living for the United States.

The annual kilowatt hour usage per residential FP&L customer for 1972 was 11,367, one of the highest in the continental United States. This is expected to rise to 12,600 and 13,500 in 1976 and 1980, respectively.

The estimated annual generation by St. Lucie Unit No. 2 is about 550 million kwh. On the basis of 1972 operations, 50.7 percent of the output will be delivered to residential customers.

In the service area of FP&L, which covers a sizable portion of Southern Florida, residential air conditioning is probably the highest contributing factor to this large usage. The air conditioning load is expected to increase in the future. Additional high kwh frost free refrigerators and electric water heating will contribute to this increase. Because domestic air cooling is almost a year round load on the FP&L system, it does not contribute to a large variation in summer and winter peaks (as is the case of many other electric utilities). The use of electric service for residential air conditioning, space heating, water heating and cooking minimize the contribution to the pollution of the environment.

8.1.2 COMMERCIAL AND INDUSTRIAL USAGE

On the basis of 1972 operations, 37.5 percent of the annual output of St. Lucie Unit No. 2 will be used by commercial and industrial customers. Commercial sales, designated by FPC Revenue Acct. 442.1 (Table 8.1-3) are comprised of department stores, hotels, motels, theaters, retail shops, automobile service stations and similar retail service enterprises. Due to the large number of customers in this classification, 139,743 in 1972, the ultimate use of electric service by any useful classification or category is not available. The growth in commercial customers is dependant upon the population growth and tourist business. Sales to the industrial class of customers, designated by Revenue Account 442.2 (Table 8.1-4), can be identified by ultimate use within the broad categories of agriculture, mining manufacturing and other (unclassified) with appropriate subclassifications in accordance with the Standard Industrial Classifications (Table 8.1-4). The percent contribution of each classification to the total kwh sales within Revenue Account 442.2 is applied to the industrial portion of the estimated kwh output of St. Lucie Unit No. 2 as shown on Table 8.1-2.

The largest division, manufacturing, comprises about 77 percent of the total industrial kwh sales. Within the manufacturing category the three largest industries, from the standpoint of kwh usage, are electric machinery equipment, chemical stone, clay and glass products. These three industries make up about 41 percent of kwh usage by the manufacturing group. This is extremely important to the economy of the company's service area, since these products are sold both within and outside the State of Florida.

8.1.3 STREET LIGHTING SERVICE

Adequate lighting of streets and highways of the central cities and surrounding suburban areas is considered to be a major deterrent to crime as well as providing additional safety and security to all citizens. For several years, FP&L has been actively campaigning to persuade the cities and local communities to replace low output incandescent units with modern high intensity mercury vapor or sodium vapor lamps. The company has petitioned the Florida Public Service Commission for authority to discontinue service for the incandescent type of street lighting. Commercial operation of Unit No. 2 will provide about 30 million kwh annually for street lighting purposes.

The major share of this will be used for street lighting in many developed residential areas. The smaller portion will probably be devoted to illumination of thoroughfares and the business districts.

8.1.4 ASSOCIATED DIS-BENEFITS

The St. Lucie nuclear generating plant will be located on Hutchinson Island, south of Fort Pierce. This island has never been developed to any extent for residential or recreational purposes due to the lack of fresh water. Drilled wells would not produce enough fresh water to support any real estate development at the present time.

The one area on the island which is presently used for fishing and bathing is located about seven miles from the generating station. Therefore, there appears to be no actual dis-benefits which stem from the construction and operation of the generating plant. There will be no displacement of residents of the island or any loss of productive agricultural labor. The existing areas now used for recreational purposes will remain unchanged so there will be no depletion of land values. In fact, the presence of the generating station, which will require fresh water piped in from the mainland, may serve to enhance land values of the island with possible residential and recreational development.

8.1.5 SUMMARY OF NET VALUE OF DELIVERED PRODUCTS

There are no measurable dis-benefits stemming from the construction and operation of the St. Lucie Nuclear generating station. The benefits are the 30 year operating revenues discounted at 10 percent to start-up date present values. These values for Unit No. 2 are shown on Table 8.1-5.

The total direct and indirect benefits from the facility are shown on Table 11.1-1, Section 11.

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TABLE 8.1-1

PLANT COST PER DOLLAR OF OPERATING REVENUES

<u>YEAR</u>	<u>TOTAL PLANT ACCT (\$000)</u>	<u>TOTAL OPERATING REVENUES (\$000)</u>	<u>PLANT ACCT PER DOLLAR OF OPERATING REVENUES (\$000)</u>
1958	449,397	142,745	3.15
1959	503,080	154,350	3.26
1960	546,966	172,177	3.28
1961	617,313	180,723	3.42
1962	670,592	199,690	3.36
1963	721,269	219,750	3.28
1964	770,133	234,761	3.28
1965	860,206	247,973	3.47
1966	938,031	267,577	3.51
1967	1,040,429	284,044	3.66
1968	1,143,489	323,159	3.54
1969	1,268,966	367,794	3.45
1970	1,402,214	414,295	3.38
1971	1,574,260	482,752	3.26
1972	1,896,925	567,334	3.34
TOTAL	14,421,270	4,259,124	3.39

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TABLE 8.1-2

ESTIMATED ANNUAL GENERATION AND SALES DERIVED FROM ST. LUCIE UNIT NO. 2

	<u>ONE UNIT</u>
Capacity in Megawatts	853
Annual Hours	8,760
Estimated Capacity Factor	80%
Mwh Generation	5,977,824
System Energy Loss Factor	8.0%
Mwh System Losses	478,226
Mwh Available for Sale	5,499,598

Proportional Distribution of Mwh

Residential (FPC-Acct. No. 440)	50.7%
Commercial (FPC-Acct. No. 442.1)	29.0%
Industrial (FPC-Acct. No. 442.2)	8.5%
Street Lighting (FPC-Acct. No. 444.)	0.7%
Public Authorities (FPC-Acct. No. 445.)	7.2%
Resale (FPC-Acct. No. 447.)	3.9%

TABLE 8.1-3

ELECTRIC OPERATING REVENUE (ACCOUNT 400)*

<u>ACCOUNT</u>	<u>Million Kwh Sold (one year)</u>	<u>Average Number of Customer per Month</u>
SALES OF ELECTRICITY		
440 Residential sales	14,652,751	1,289,027
442 Commercial and industrial sales		
0.1 Small (or commercial)	8,389,495	139,743
0.2 Large (or industrial)	2,468,342	5,208
444 Public street and highway lighting	216,229	1,069
445 Other sales to public authorities	2,078,903	11,030
446 Sales to railroads and railways		
448 Interdepartmental sales		
Total sales to ultimate consumers	27,805,720	1,446,077
447 Sales for resale	1,122,088	37
Total sales of electricity	28,927,808	1,446,114

* From the FP&L Annual Report, FPC Form 1 - Electric Operating Revenue Acct. 400

TABLE 8.1-4

INDUSTRIAL Mwh SALES REPORTED BY
STANDARD INDUSTRIAL CLASSIFICATIONS
YEAR 1972

<u>DIVISION</u>	<u>Mwh SALES</u>	<u>PERCENT OF INDUSTRIAL GROUP</u>
Agriculture, forestry and fisheries	69,823	2.8
<u>MINING</u>		
Metal Mining	75,583	3.1
Mining & Quarrying of Nonmetallic Minerals (except fuel)	44,464	1.8
Total Mining	120,047	4.9
<u>MANUFACTURING</u>		
Ordnance and Accessories (arms)	390	
Food and Kindred Products	307,707	12.5
Tobacco Manufacturers	146	
Textile Mill Products	35,281	1.4
Apparel & Other Finished Products made from fabrics & similar materials	53,370	2.2
Lumber & Wood Products (except furniture)	19,730	0.8
Furniture and Fixtures	22,699	0.9
Paper & Allied Products	31,691	1.3
Printing, Publishing & Allied Industries	117,777	4.8
Chemicals & Allied Products	261,465	10.6
Petroleum Refining and Related Industries	21,640	0.8

TABLE 8.1-4 (Cont'd)

<u>DIVISION</u>	<u>Mwh SALES</u>	<u>PERCENT OF INDUSTRIAL GROUP</u>
<u>MANUFACTURING (Cont'd)</u>		
Rubber and Miscellaneous Plastic Products	90,578	3.7
Leather & Leather Products	19,850	0.9
Stone, Clay & Glass Products	204,072	8.3
Primary Metal Industries (incl. production of coke)	79,739	3.2
Fabricated Metal Products (except ordnance, machinery & transportation equipment)	94,566	3.8
Machinery (except electrical)	20,824	0.8
Electric Machinery Equipment & Supplies	300,301	12.5
Transportation Equipment	160,409	6.5
Professional, Scientific & Controlling Instruments		
(includes photographic and optical goods: watches & clocks)	30,110	1.2
Miscellaneous Manufacturing Industries	10,444	0.4
Total Manufacturing	1,391,739	76.6
Total Mining & Manufacturing	2,011,836	81.5
Other "Industrial Customers" not classified	107,623	4.4
Non-manufacturing "Industrial Customers"	279,060	11.3
Total Industrial	2,473,342	100

TABLE 8.1-5

ESTIMATED 1980 PRESENT VALUE OF DELIVERED PRODUCT
(OPERATING REVENUES) FROM ST. LUCIE UNIT NO. 2

	<u>PLANT INVESTMENT PER \$1.00 OF OPERATING REVENUE</u>		
	<u>AVERAGE</u>	<u>LOW</u>	<u>HIGH</u>
	<u>\$3.39</u>	<u>3.15</u>	<u>3.66</u>
Total Investment in Plant 1980 Dollars	\$360,000,000	\$360,000,000	\$360,000,000
Plant Investment Per Dollar of Operating Revenue	\$3.39	\$3.15	\$3.66
Estimated Annual Operating Revenues in 1980 Dollars	\$106,195,000	\$114,285,000	\$ 98,361,000
Annual Series Present Worth Factor (For 10% Annual Discount @ 30 year life)	9.4269145	9.4269145	9.4269145
Thirty Years of Operating Revenues Discounted to 1980 Dollars	\$1,001,091,000	\$1,077,355,000	\$927,241,000

8.2 INCOME

8.2.1 EXPENDITURES

Expenditures for the construction of St. Lucie Unit No. 2 have been separated into monies spent in the local or regional area and monies spent in the national or inter-regional area. This separation of local expenditures and national expenditures is done to arrive at that portion of the plant investment that is spent regionally and therefore, subject to the multiplier effect.

Local expenditures consist primarily of land costs, sales and use taxes, FP&L engineering and wages to operate and maintain the plant. National expenditures consist primarily of costs for large components such as the turbine generators, nuclear steam supply system, component alternates and electrical equipment. The secondary major costs included in the national and local expenditures are for material, labor and architect-engineer services.

Table 8.2-1 shows the total cost (less interest) for building Unit No. 2. The table is separated into local expenditures, national expenditures and both.

8.2.2 INCOME MULTIPLIER

The multiplier shows that a change in investment spending has an effect on income which is greater than the original change in investment on income. For example, if the wage earner spends, 70 percent of his income on goods and services this is added to the income of other individuals in the economy. If they, too, spend 70 percent of their income, another multiple is added and the process is repeated. Each group receives new income and spends, in turn, a fraction of it. Carried to its conclusion the multiplier would be 3.33. Therefore, the multiplier is the numerical relationship between the initial new investment and the total increase in income.

The size of the multiplier is determined by the marginal propensity to consume, which is another way of saying the portion that is spent out of each dollar of new income. The larger the portion of new income consumed, the larger the multiplier. This is the same as saying the smaller the portion of income saved, the larger the multiplier. Therefore, the multiplier is the reciprocal of the fraction of income saved or one over the marginal propensity to save ($1/mps$). If 30 percent of new income is saved, the multiplier is $1/0.3$ or 3.3333. If 50 percent is saved, or diverted from consumption, the multiplier is $1/0.5$ or 2.

There are, however, other factors besides saving which influence the size of the multiplier. In the United States, personal savings as a percent of personal income ususally runs from five to seven percent. The marginal propensity to save, which is the ratio of additional savings to increases in income has remained fairly stable at about six percent.⁽¹⁾ At this level of savings, the multiplier should be $1/0.06 = 16.67$. A change in investment should change income 16.67 times as much. However, such is not the case because there are other withdrawals from the respending cycle, called leakage.

The combined effects of leakage reduce the actual multiplier in the United States economy in the 1970's down to a figure of two for a one-year period.⁽¹⁾ In other words, about 50 cents of each dollar of new income leaks before that income moves into the respending cycle. ($1.00/0.50 = 2$.) All of these leakages can come back into the income stream but the timing and dependability of such re-entry is largely unknown.

The foregoing has been a discussion of the operation of the multiplier in a closed economy. In the case of the national economy, the leakage outside the system has been fairly well measured through national income accounting. Meticulous care is taken in determining the net effect of trade balances on the internal economy. Aggregation allows a good picture of the other leakages. Therefore, the estimate of the multiplier is a credible procedure.

In the case of a regional economy, no such methods exist which allow for the accounting of goods and services which are imported and exported into and out of the region. Perhaps 70 percent of the first round construction wages will be spent within the region, but those who receive it as income may elect to respend only 40 percent within the local region. The rest may be spent for goods outside the region. Very sophisticated models of input-output analysis are required to even begin to make an estimate of the respending patterns in a regional economy.⁽²⁾ Such being the case, it is assumed that the national multiplier of 2 for a one-year period can be used.

TABLE 8.2-1

St. Lucie Unit No. 2
Capital Costs *

<u>Item</u>	<u>Income Spent Locally (\$000)</u>	<u>Income Spent Nationally (\$000)</u>	<u>Total \$000)</u>
Land Expenditures (1132 acres)	2600		2600
Annual Expenditures for Wages to Operate and Maintain the Plant (25 employees)	450		450
Sales and Use Tax	6300		6300
F.P. & L. Engineering	3000		3000
Turbine Generators		28810	28810
NSSS		45400	45400
Electrical Equipment		1500	1500
Duplicate Equipment		1000	1000
Material	22400	52900	75300
Labor	48900	33600	82500
Subcontractors Costs (other than overhead)	1200	10500	11700
Architect-Engineer			
Office Services	6200	20000	26200
Design Modifications	4700	6600	11300
Totals	92700	201300	294000

* Less Interest During Construction (estimated at \$66,000,000)

8.3 EMPLOYMENT

8.3.1 ESTIMATED CONSTRUCTION EMPLOYMENT AND STAFFING REQUIREMENTS

Table 8.3-1 shows the estimated average and peak construction employment related to the St. Lucie Unit No. 2 project.

The average employment during the construction period will range from approximately 450 to 1300 construction workers. It is anticipated that there will be 25 employees for the operation and maintenance of Unit No. 2.

8.3.2 EFFECT ON EMPLOYMENT

An employment multiplier of 0.65 is used to estimate the effect of the St. Lucie Unit No. 2 project on the employment of the region. This means that for every 100 new jobs, an additional 65 new jobs will be created. This additional 65 new jobs could result in direct support of the project that stimulated this new employment or could spring from the increase in incomes spent in the region.

The effect on new jobs created is not necessarily immediate. Each year's employment of construction workers creates a chain of subsequent effects on new employment. The 0.65 multiplier shows this the long run effect. For instance, the first 100 new construction jobs could result in the creation of 40 new jobs the first year. In turn, the 40 new jobs resulting from the original 100 construction workers could generate 16 new jobs in related or unrelated fields. The 16 new jobs continue to have a multiplier effect. This goes on until approximately 65 new jobs can be attributed to the initial 100 new construction jobs.

Assuming a uniform pattern of growth in the multiplier effect, a growth factor of $0.394 \left(1 - \frac{1}{1.65}\right)$ can be applied to the new employment connected

with St. Lucie Unit No. 2. Table 8.3-2 shows that a total of 7258 man-years of new employment in the region arising from the construction of St. Lucie Unit No. 2. Of this, 4400 man years are directly related to the construction project, and 2858 new jobs created as a result of the construction project. Additionally, the 25 new employees required by the second unit would have a multiplier effect on the regional economy that would continue for the life of the project. Assuming a constant employment of 25, and an operating life of 30 years, each year's employment would generate a chain of benefits resulting in the eventual employment of 16 additional persons. Over the life of the investment, this would amount to 1230 man years of employment, 750 of which will be directly employed at the site.

In summary, the St. Lucie Unit No. 2 project can be estimated to create roughly 8,500 man-years of new employment. The project would directly employ 5150 man-years. This new employment would in turn create 3,350 new jobs in related or unrelated fields within the economic region.

SL2

TABLE 8.3-1

SCHEDULE OF AVERAGE AND PEAK CONSTRUCTION EMPLOYMENT

<u>YEAR</u>	<u>AVERAGE</u>	<u>PEAK</u>
1975	450	760
1976	750	1000
1977	1250	1400
1978	1300	1400
1979	650	1150

TABLE 8.3-2

EMPLOYMENT MULTIPLIER EFFECT

<u>Construction Employment</u>												<u>Total Employment Effect</u>	
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	
1975	450	177	70	28	11	4	2						742
1976		750	296	116	46	18	7	3	1				1,237
1977			1,250	493	194	76	30	12	5	2			2,062
1978				1,300	512	202	80	31	12	5	2	1	2,145
1979					650	256	101	40	16	6	2	1	1,072
Total	450	927	1,616	1,937	1,413	556	220	86	34	13	4	2	7,258
<u>Operations Staff</u>													
					1980	25	10	4	2				41
					1981		25	10	4	2			41
					1982			25	10	4	2		41
					1983				25	10	4	2	41
					1984					25	10	4 . . .	41
					1985						25	10 . . .	41
					1986							25 . . .	41
						25	35	39	41	41	41	41 . . .	Continuing Effect Through Life of Product

8.4 TAXES

The addition to the tax base has not yet been determined, therefore, the amount of taxes to be paid to the County cannot yet be ascertained. The taxes to be paid, however, are sure to be of such amount as to be of considerable assistance to County finances and to make possible improvements in County services.

8.5 EXTERNALITIES

8.5.1 EFFECT ON INDUSTRY

The output of St. Lucie Unit No. 2 will be incorporated into the system's power supply. Assuming 100 percent of capacity operation, the plant could add 7.5 billion kWh to the system generating capacity. At a load factor of 80 percent, and a system loss factor of 8 percent, this would be reduced to 5.5 billion kWh.

Distribution of kWh sales in 1972 has been:

Residential	-	50.7%
Commercial	-	29.0%
Industrial	-	8.5%
Other	-	<u>11.8%</u>
Total		100.0%

Only 37.5 percent of kWh sales went to the commercial and industrial classes.

The effect of St. Lucie Unit No. 2 on local industry would very likely fall in the commercial-industrial rate classifications. Industries that will be affected by the availability of electricity include: wholesale and retail trade; manufacturing; service industry; transportation; communications; utilities; construction, etc. Electricity is not a significant factor in the cost structure of any of these industries. In manufacturing, for instance, The Edison Electric Institute has determined that electricity represents only 0.9 percent of the value of the product. There are no studies of the significance of electricity in the cost considerations of the other industries, but there is reason to suppose that it is much more significant in retail sales or the service industry. It is highly unlikely that the availability of more electricity, even lower cost electricity, would induce any industry to produce more goods or services. The unavailability of electricity would have a serious effect in the increase in production because it is a necessary element in the factors of production, but the availability of more electricity is not apt to stimulate greater production.

If the entire output of St. Lucie Unit No. 2 were channeled to manufacturing, there would be enough electricity to produce an additional \$9 billion of value added to manufactures. This is based on the availability of 5.5 billion kWh and a constant relationship between kWh sold (at the industrial rate) and value added by manufactures in 1967. This would be ample to support the probable growth in value added by manufactures to 1980, considering that the value added by manufactures was only \$1.56 billion in 1967 for the counties in the FP&L's service area. Applying the growth rate experienced in the Miami area between 1965 and 1970 (the highest in the nation, at 7.2 percent per year) value added by manufacture could total \$3.8 billion by 1980. A more probable growth rate of 4% annually would produce \$2.5 billion by 1980.

8.5.2 ENVIRONMENTAL EFFECTS

It is rather difficult to relate the available energy to be supplied by St. Lucie Unit No. 2 to the economic cost of the environment. In the previous section, 8.5.1, it has been argued that the availability of power is not likely to spur industry to greater production of goods or services. Industry will probably continue to grow, but for reasons other than the additional electric energy available from St. Lucie Unit No. 2.

Florida's growth in the past decade has been spectacular. However, it is expected to decline in the next decade. The Bureau of Economic and Business Research of the University of Florida projects a decline in the population growth rate from 1970-1980. The average annual growth rate (for 21 counties in the service area) is forecasted to be 2.85 percent between 1970-1980, and was 4.25 percent between 1960-1970. With a decline in the growth rate of the population, other industries, such as construction, wholesale trade, retail trade, and services are likely to slow down in its rate of growth.

The environmental effects of new industries will be closely reviewed by local and state governments in order to comply with the standards set forth by the Environmental Protection Agency. Compliance could involve additional use of antipollution equipment. The cost of removing pollutants for industry, as a whole, has not been quantified due to an insufficient basis. Therefore, an arbitrary figure of from 5 - 10 percent of value added has been used. The Air Pollution Handbook suggests that 75 percent of the pollution cost could be substituted by a dollar for dollar addition of capital and operating cost. Intuitively, each industry would spend close to the minimum amount that would result in compliance with government standards.

The projected addition of approximately \$1 billion in value added by manufacture in 1980 would apply to the entire service area and for the entire system. It would not be created by the addition of St. Lucie Unit No. 2. In fact, most of this additional growth in manufacture would be realized before the plant contributes any generation to the power supply.

The unrefined parameters for estimating the economic cost of pollution by manufactures, mentioned above, results in the following costs:

Additional value added, 1967-1980	-	\$ 1,000,000,000
Cost to remove pollutants	-	\$ 50. - 100,000,000
Portion of pollution cost that could be substituted		\$ 37.5 - 75,000,000
Remaining pollution cost	-	\$ 12.5 - 25,000,000

8.6 OTHER EFFECTS

NATURAL ECOLOGY PROTECTION

Better than 90 percent of the water-front beach and mangrove tideland will be retained and maintained in its original natural condition along both the Atlantic Ocean and the Indian River. Recreation activities which do not disturb the ecology of the perimeter, such as beach front swimming and river front fishing can continue indefinitely.

• **ALTERNATIVE**
• **SOURCES AND SITES**

9.0 ALTERNATIVE ENERGY SOURCES & SITES

9.1 ALTERNATIVES NOT REQUIRING THE CREATION OF NEW GENERATING CAPACITY

9.1.1 THE NEED FOR POWER

Section 1.1 of the Environmental Report describes the extremely rapid growth -- one of the largest in the country -- of the power demand in the FP&L system. Practically the entire southern portion of the Florida Peninsula is critically short of the electrical power necessary to adequately and reliably meet projected future power demands and to remedy currently inadequate reserve margins. The present situation with regard to the demand for electrical power was accurately summarized in an article appearing in the August 27, 1971 edition of The Miami Herald which concluded that, "If the demand for power continues to outstrip available supplies at the present rate, the inevitable result will be a succession of forced power cutbacks, brownouts and occasional blackouts."

Table 9.1-1 lists the peak load and generating capability for the Applicant's system for the period 1968 through 1972 and the projected peak load and generating capability for the period 1973-1982.

The excess of generating capability over peak load is called "reserve". Adequate reserve capability is necessary to cover a variety of contingencies such as actual load being greater than forecast, and equipment, plant and transmission outages for maintenance. A reserve adequate to meet such contingencies is generally considered to be 15 percent to 25 percent of the peak load.

Examination of Table 9.1-1 will show that for the year 1971 the maximum peak load experienced was 5525 MW while the actual generating capability of the Applicant's system was 6013 MW. This resulted in an actual reserve of 488 MW for a margin of 8.8% in excess of peak load. In 1979 it is anticipated that the maximum peak load will be 13,525 MW while generating capability will increase to only 15,731 MW. This will provide a reserve of 2206 and a margin of only 16.3 percent.

In the past, the peak loads of the calendar year for Applicant's system occurred in the summer. However, experience indicates that peaks reached the following January or February are even higher than the previous year's peak. An indication of the critical nature of the available power supply is demonstrated by the necessity to curtail loads in recent years. Table 9.1-4 provides a listing of load reductions from 7/72 through 9/73. The Applicant already relies heavily on automatic load shedding to restrict the disruption of electric service during system disturbances.

9.1.2 ALTERNATIVE METHODS OF PROCURING POWER

St. Lucie Unit No. 2 is needed to furnish power in 1980. The projected peak load for 1980 is 15,090 MW while the expected generating capacity is 17,681 MW. This means that with St. Lucie Unit No. 2 on line, the reserve would be 2591 MW or 17.2 percent. Without St. Lucie Unit No. 2 on line, the reserve would be only 1741 MW or 11.5 percent. Since Unit

No. 2 is needed in 1980 it is necessary to consider whether any alternatives would be available in 1980 in the event Unit No. 2 were delayed.

9.1.2.1 Transmission From Other Florida Power Systems

The alternative of purchasing power from outside sources is not available to the Applicant, because of the low reserves of all neighboring systems. The Applicant cannot depend on securing its power from other companies in Florida as is evident from the following table¹ taken from The Miami Herald.

<u>Company</u>	1971 Capacity (Megawatts)	1971 Reserves (Percent)
Florida Power & Light Company	6,013	1.7
Florida Power Corporation	2,634	11.1
Tampa Electric Company	1,825	41.9
Jacksonville Electric	966	-1.1
Orlando Utilities	361	12.5
Lakeland Municipal	260	78.1
Tallahassee Municipal	240	43.7
	<u>12,299</u>	<u>10.0</u>

All evidence indicates that the situation may become slightly less critical but will not greatly improve for 5 to 10 years as can be seen by Table 9.1-2, a summary of the 1972 Southeastern Electric Reliability Council report for the Florida Subregion. A recently completed statistical study of available daily generation versus daily installed generation revealed that on an average day only 93.6 percent of installed capacity was available (three years of daily data). The last three columns of Table 9.1-2 show this adjustment.

At present, of the investor utilities only Tampa Electric has adequate reserves, and its entire capacity is relatively low. Problems also exist with maintaining any interconnection in the Florida group of utilities. The report reviewing the Florida power supply situation prepared by the Bureau of Power of the Federal Power Commission in 1970 made the following comment with regard to weakness existing in transmission ties, "Past performances have demonstrated the likelihood that connections in the northern part of the Florida Peninsula, in the general vicinity of Suwanee, Fort White, and Silver Springs in the Florida Power Corporation's system, will open under power swings which accompany most network disturbances."

9.1.2.2 Transmission From Areas Outside Florida

To go beyond Florida to Georgia or Alabama would not provide a satisfactory solution because reserve capabilities are not high in either of these states. It is unlikely that either Georgia or Alabama utilities will have a reserve in the early 1980's large enough to insure the sale of large blocks of power to FP&L since, like states all over the U.S., both Georgia and Alabama are facing rapidly increasing energy demands within their own states. Since dependable future power supplies are not available from others, the Applicant must generate its own.

9.1.2.3 Other Methods of Generation

As shown in Table 9.1-3, FP&L is planning to install approximately 5200 MW in fossil fueled generating capacity during the time interval from January 1973 to January 1980. These units are necessary in order to partially meet the projected 1980 peak load of 15,090 MW. Another 1368 MW of gas turbine capability is also planned. Without St. Lucie Unit No. 2 on the line, FP&L will barely be able to meet its 1980 projected peak load.

Gas turbine peaking units which could be installed by 1980 are not acceptable alternatives for a base load plant such as St. Lucie Unit No. 2. The Applicant has installed 1332 Mwe and will have installed by 1980 a total of 2700 Mwe of these units. Experience has shown that gas turbines are not suited for carrying base loads. Gas turbine capacity beyond that already planned for the system would be required to operate for more hours than would normally be the case for gas turbines intended solely for peaking capacity. Especially when base loaded, maintenance is much more often required than for other types of generating units. Since service maintenance time keeps the turbine off-line to some extent, a system cannot rely heavily on peaking load units to carry its base load. In addition, fuel costs are high, and this increased cost, along with maintenance costs is passed on to the consumer. Gas turbines would have a lower capital cost (estimated to be \$156 per kw excluding transmission) than St. Lucie Unit No. 2 (estimated to be \$405 per kw when completed excluding transmission). However, gas turbines would have a much higher production cost (about 11 mills per kwh based on use of liquid fuel at \$1.05/MBtu, a fixed charge rate of 20 percent, and 1300 hours per year operation as compared to approximately 2 mills per kwh for St. Lucie Unit No. 2). As a result of the significantly higher operating costs, total system costs will be greater if a gas turbine alternative were installed.

9.1.2.4 Updating Existing Units or Delaying Scheduled Retirements

Florida Power & Light does not plan to retire any of its presently existing units through 1982. St. Lucie Unit No. 2 is to be a baseline generating facility. It is not reasonable to anticipate creating an equivalent reliable capacity (850 MW) by updating the boilers or turbines on older, existing units.

TABLE 9.1-1

SYSTEM LOAD, CAPACITY AND RESERVE

YEAR	GROSS ONE HOUR PEAK DEMAND (MW)	GROSS SUMMER PEAK CAPABILITY (MW)	RESERVE WITH ST. LUCIE UNIT NO. 2		RESERVE WITHOUT <u>1</u> / ST. LUCIE UNIT NO. 2	
			(MW)	(1%)	(MW)	(1%)
1968	3925	4298	373	9.4		
1969	4470	5125	655	14.7		
1970	5125	5569	444	8.7		
1971	5525	6013	488	8.8		
1972	6145	6857	712	11.6		
1973	7105	8713	1608	22.6		
1974	7940	9397	1457	18.4		
1975	8820	10,081	1261	14.3		
1976	9800	11,731	1931	19.7		
1977	10,925	11,331	2406	22.0		
1978	12,150	14,131	1981	16.3		
1979	13,525	15,731	2206	16.3		
1980	15,090	17,681	2591	17.2	1741	11.5
1981	16,760	19,881	3121	18.6	2271	13.6
1982	18,520	22,081	3561	19.2	2711	14.6

Note: 1/ Same as "with St. Lucie Unit No. 2" except as indicated.

TABLE 9.1-2

STATE OF FLORIDA
 EXPECTED AND PLANNED GENERATION AS REPORTED
 BY SOUTHEASTERN ELECTRIC RELIABILITY
 COUNCIL TAC REPORT OF MARCH 1, 1973

<u>Year</u>	<u>Summer Peak Load</u>	<u>Installed Capability</u>	<u>Reserve</u>		<u>Capability X .936</u>	<u>Reserve</u>	
			<u>MW</u>	<u>% Load</u>		<u>MW</u>	<u>% Load</u>
1973	12747	15557	2810	22.0	14561	1814	14.2
1974	14190	17155	2965	20.9	16057	1867	13.2
1975	15713	19870	4157	26.5	18598	2885	18.4
1976	17408	22218	4810	27.6	20796	3388	19.5
1977	19291	24403	5112	26.5	22841	3550	18.4
1978	21316	25816	4500	21.1	24164	2848	13.4
1979	23533	28826	5293	22.5	26981	3448	14.7
1980	26001	31268	5267	20.3	29267	3266	12.6
1981	28651	34841	6190	21.6	32611	3960	13.8
1982	31504	39335	7831	24.9	36836	5332	16.9

0

TABLE 9.1-3

GROSS SUMMER PEAK CAPABILITY
AND UNIT ADDITIONS

Year	Unit Additions	Capability (MW)	Fuel	System Capability (MW)			Total
				Nuclear Steam	Fossil Steam	Fossil Gas Turbine	
1968					4,271	27	4,298
1969					5,098	27	5,125
1970					5,098	471	5,569
1971					5,098	915	6,013
1972					5,498	1,356	6,857
1973	Turkey Point No. 3	728	Nuclear				
	Turkey Point No. 4	728	Nuclear				
	Sanford No. 5	400	Fossil	1,456	5,898	1,356	8,713
1974	Ft. Myers Gas Turbines	684	Fossil	1,456	5,898	2,043	9,397
1975	Gas Turbines	684	Fossil	1,456	5,898	2,727	10,081
1976	St. Lucie No. 1	850	Nuclear				
	Manatee No. 1	800	Fossil	2,306	6,698	2,727	11,731
1977	Manatee No. 2	800	Fossil				
	Martin No. 1	800	Fossil	2,306	8,298	2,727	13,331
1978	Martin No. 2	800	Fossil	2,306	9,098	2,727	14,131
1979	Steam Turbine	800	Fossil				
	Steam Turbine	800	Fossil	2,306	10,698	2,727	15,731
1980	St. Lucie No. 2	850	Nuclear				
	Steam Turbine	1,100	Fossil	3,156	11,798	2,727	17,681
1981	Steam Turbine	1,100	Fossil				
	Steam Turbine	1,100	Fossil	3,156	13,998	2,727	19,881
1982	Steam Turbine	1,100	Fossil				
	Steam Turbine	1,100	Fossil	3,156	16,198	2,727	22,081

TABLE 9.1-4

FLORIDA POWER & LIGHT COMPANY
LOAD REDUCTION - 1972

<u>Date</u>	<u>Load Curtailement Period</u>	<u>Number of Customers</u>	<u>Amount of Load Curtailed kW</u>
7-3-72	4:00 - 8:00 PM	444	140,002
7-5-72	4:00 - 8:00 PM	577	180,871
7-28-72	4:00 - 8:00 PM	609	228,357
7-29-72	4:00 - 8:00 PM	321	87,728 (Voluntary)
9-7-72	4:00 - 8:00 PM	692	242,079
9-14-72	4:00 - 8:00 PM	671	256,170
9-15-72	4:00 - 8:00 PM	683	263,760
9-18-72	3:30 - 8:00 PM	678	266,142
9-19-72	3:30 - 8:00 PM	692	263,977
9-25-72	4:00 - 8:00 PM	668	241,032
9-26-72	3:00 - 7:00 PM	682	275,734
9-27-72	3:30 - 7:00 PM	704	262,546
5-28-73	4:00 - 8:00 PM	85	57,350 (Holiday)
5-29-73	2:00 - 8:00 PM	267	229,650
* 9-1-73			

* There have been no load reductions since 5-29-73.

9.2 ALTERNATIVES REQUIRING THE CREATION OF NEW GENERATING CAPACITY
POWER NETWORK CONSIDERATIONS

The proposed facility, St. Lucie No. 2, will be located within 12 miles of the existing high voltage lines connecting load centers on the east coast. The new generating capacity will be installed to serve these load centers. No alternative new plant site is more conveniently located to the transmission grid and load centers. Development of a new site would entail acquiring a new transmission right-of-way to connect with the high voltage lines. This would not be necessary for the proposed installation because the transmission lines constructed for Unit No. 1 are to be used.

Energy Type and Source Consideration

The four sources of energy, often considered in seeking new sites for electric power generation, are nuclear, fossil-fuel, hydroelectric, and geothermal. Two can be immediately eliminated as unavailable in the State of Florida. There is no source of geothermal energy in the State, and the flat terrain and limited streamflow make the economical development of hydroelectric energy impossible.

The fossil fuels are coal, natural gas and oil. Presently Florida utilities burn approximately 5,000,000 tons of coal annually. This represents 17 percent of the BTU consumption of fuel for electric power production. Because the use of coal in the FP&L system involves complex logistics requirements to assure a reliable source of fuel and coal fired plants are substantially more costly to build, operate and maintain as compared to either a gas or oil-fired plant, there are no coal-fired plants presently operating in the FP&L system. The capital cost of a coal-fired plant installed in the FP&L system is presently estimated to be approximately 50 \$/KW more than a comparable oil-fired plant. Operating costs are estimated to be 25-30% higher than for an oil-fired plant. Recent inquiries into the delivered cost of low sulfur fuel indicate a 1973 cost of approximately \$1.10 per million Btu which includes \$0.89 per million Btu for delivery.

Natural gas is now being used extensively in FP&L plants for electric power generation. However, due to the present scarcity of this fuel, it is not expected that natural gas will be available in the future for use in large new generating plants in Florida.

FP&L has operating and is presently building many oil-fired plants for electric power generation (refer to Table 9.1-3). These power plants require medium capital outlay and are economical in the medium range of operation (1,500 to 6,000 hours per year). The supplies of fuel oil are much greater than the supplies of gas, although the supply of low sulfur fuel oil is limited. This limitation is mitigated by oil desulfurization which is a commercial reality, and which is able to supply oil that contains less than 1.0% sulfur. While short to intermediate supplies of oil are relatively favorable, intermediate to long term supplies present problems because of the high domestic consumption rates and relatively low oil reserves. While large reserves do exist

in the Mid-East, transporting them to the United States involves long distance shipping costs, the risks associated with Mid-East politics, and the United States' balance of payments and national defense policies. FP&L is presently paying approximately 70 cents per million Btu for low sulfur oil, and it is estimated that the price may be as high as \$1.10 per million Btu by 1980.

The logistics of oil transport to the power plant is also a major consideration. Pipeline delivery is considered to be the only practical way to transport the large quantities of oil required by a large modern power station. Approximately 100 miles of 12-inch pipeline would be required to connect the St. Lucie Plant to the nearest oil import terminal.

Nuclear power offers the opportunity to eliminate combustion product effluents and the daily problem of transporting a large fuel supply to the plant. Nuclear power is also economically attractive for large bulk supply of electricity. The relative economics of generating electricity with an oil-fired unit located at the St. Lucie site instead of the proposed nuclear unit are shown in Table 9.2-1. The costs shown for the fossil unit are based on the current generation of 800-850 Mwe units being built for the FP&L system.

Alternative Plant Site Considerations

In selecting a plant site, a major consideration is one of proximity to the load center(s). The location of a generating facility near the point of consumption of its output serves the following power supply objectives. First an area generation policy in accordance with reliability objectives since the reliance on long distance transmission lines, which may be vulnerable to both man-made and natural accidents, is diminished. Second, the diffusion of generating facilities permits each area to be able to rely on its own power supply. If a natural disaster should strike one area, the remaining areas can be provided with power. Due to the growing demand for power in the South Florida area, the generation expansion program for the years 1977 through 1980 are focused on serving this area.

Due to the requirements for a cooling water supply, the characteristics of potential sites in South Florida fall into a number of categories having different sources of water, greatly different plant land, access, fuel supply, and environmental requirements.

Coastal sites are those located on, or close to, the shoreline taking their supply of cooling water directly from the ocean or salt water estuary and discharging the heated effluent directly back to the ocean or estuary. The St. Lucie site, proposed for this facility, is typical of such sites. Coastal sites are further characterized by the fact that they are generally smaller in area than inland sites, are scarcer due to the

competing commercial interests for development, and are generally more accessible for transportation of fuel and heavy materials.

Inland sites are those that utilize cooling ponds or cooling towers. Suitable on-stream sites do not exist in the South Florida area. Florida Power & Light Company does have one on-stream plant operating in the South Florida area, the Miami Plant, located on the Miami River. The Miami Plant is approximately 50 Mwe. The small amount of cooling water available from streams in South Florida cannot supply adequate cooling capacity for a unit of the 800-850 Mwe size. Florida Power & Light Company is presently developing two inland sites in South Florida that are suitable for either fossil or nuclear generation. These include the Martin site located in Martin County approximately 50 miles west of West Palm Beach and the South Dade site located in Dade County south of the Turkey Point Plant. The Martin site is a cooling pond site and the South Dade site may be either a cooling pond or cooling tower site. Two 800-850 Mwe oil-fired fossil units are scheduled to be installed in the period between 1977 and 1980 at each of these sites.

Although the proposed St. Lucie Unit 2 could possibly be located at either of the two aforementioned inland sites or located at some undeveloped coastal or inland site, the present schedule for commercial operation in late 1979 could not be met and the design concept, that of duplicating the St. Lucie Unit 1 design, would be seriously jeopardized. The St. Lucie Plant site characteristics uniquely influence the design due to the considerations for the effects of natural phenomena. Thus to duplicate the design of St. Lucie Unit 1 to the largest extent possible an alternative site must match the St. Lucie site characteristics. Inland sites in the South Florida area differ markedly in soil characteristics, hydrology and meteorology.

TABLE 9.2-1

MONETIZED BASES FOR GENERATING
COST FOR ST. LUCIE UNIT 2

<u>Item</u>	<u>St. Lucie Unit 2 850 Mwe Nuclear</u>	<u>St. Lucie Unit 2 850 Mwe Fossil</u>
1) Total outlay required to bring facility to operation	$365 \times 10^6 \$$	$175 \times 10^6 \$$
2) Annual operating cost, where "t" varies from 0 to 29 for each year of plant life	$(4.5 \times 10^6) (1.06)^t \$/\text{yr.}$	$(2.5 \times 10^6) (1.06)^t \$/\text{yr.}$
3) Annual insurance and licensing cost	$1.2 \times 10^6 \$/\text{yr}$	$1 \times 10^5 \$/\text{yr}$
4) Annual fuel cost, where "t" varies from 0 to 29 for each year of nuclear plant life, "i" varies from 0 to 10 for first eleven years then "j" varies from 1 to 19 for last nineteen years of fossil plant life	$(15 \times 10^6) (1.03)^t$	$(59 \times 10^6) (1.06)^i \text{ then } (107 \times 10^6) (1.03)^j \$/\text{yr}$
5) Total generating cost present value	$730 \times 10^6 \$$	$1430 \times 10^6 \$$
6) Total generating cost, present value annualized	$83 \times 10^6 \$/\text{yr}$	$127 \times 10^6 \$/\text{yr}$

Notes:

- 1) Reference Table 2, page 4.2-4.7 of AEC Regulatory Guide 4.2, Rev 3/73
- 2) Costs figures adjusted to 1979.
- 3) Discount factor assumed as $(1.08)^{-1}$
- 4) Both nuclear and fossil units assumed to be base loaded with a capacity factor of 0.8. Heat rates assumed as 10,500 Btu/Kwh and 9,000 Btu/Kwh for nuclear and fossil units respectively.
- 5) Annual insurance and licensing costs are also subject to escalation; but 1979 cost figures are used since the effect on the overall economics is small.

9.3 COMPARISON OF PRACTICAL ALTERNATIVES AND THE PROPOSED FACILITY GENERAL

The environmental impact caused by the construction of power generating facilities at the St. Lucie power plant site has already been made by installing Unit No. 1. The environmental impact resulting from opening up a new power plant site will be much greater than that caused by further development at an existing site. In addition, initial construction at any new site must be planned as a multiple unit installation in order to prove economical.

The St. Lucie site has been compared with another coastal site located within a 40 mile radius near West Palm Beach. The alternative site is also an off-shore island which is typical of coastal sites along the east coast of Florida.

1

Access

Both the St. Lucie site and the alternative site have good road access. Florida State Highway A-1-A passes through both sites. At St. Lucie, an access road into the plant area has been constructed from this highway. At the alternative site, access would probably be from US 1 which forms the western boundary of the property. The Florida East Coast Railroad passes within 2 miles of both sites, but a spur to either site would require a crossing over the Intracoastal Waterway. Both sites front on the Atlantic Ocean.

Geology - Seismology

The geology-seismology of the St. Lucie site is discussed in Section 2.4 of this report. Conditions at the alternative site would be similar.

Foundation

The area to be occupied by the proposed facility at St. Lucie was excavated to a 60-foot depth when Unit No. 1 was constructed. After removal of unsuitable foundation material, the remaining material was returned as compacted backfill. Some sand was borrowed to replace the rejected material. A new excavation will be required only to the plant foundation depth. It is probable that it will be necessary to remove and replace unsuitable foundation material to depths in the order of 50 feet at any new location for either a coastal or inland site. This is to overcome the danger of soil liquefaction under earthquake conditions. Based on the logs of borings made along the highway rights-of-way in the vicinity of the alternative site, it is estimated that foundation excavation would be required to a 40-foot depth at this location. The environmental impact of this deep excavating and backfilling has been already made at the St. Lucie site.

Land Use

Land use in the vicinity of the St. Lucie site is discussed in Section 2.2 of this report.

The alternative site is a large coastal beach and inland area undeveloped except for one restaurant motel on the property. There are residential areas 1 to 2 miles north and south of the site.

Population Distribution

Regional demography for the St. Lucie site is discussed in Section 2.2 of this report.

There are population centers within 2 miles north and south of the alternative site; the nearest major population center is Riviera Beach, approximately 10 miles to the south. Population estimates for this area are provided on Figure 2.2-3. However, a 2000 foot exclusion distance can be provided.

1

Hydrology

Both sites are located adjacent to the Atlantic Ocean, and the plant grade must be high enough to avoid flooding under hurricane conditions. Plant grade at St. Lucie has been established at El 18 and would have to be raised to this same elevation at the alternative site. Present grade in the area of St. Lucie No. 2 is about El 12. At the alternative site, the natural grade is about El 5.

Economic Considerations

Most of the differential cost between constructing the proposed facility at St. Lucie and constructing the alternative site results from the fact that foundation preparation, intake and discharge canal excavation, and transmission line construction were virtually completed for St. Lucie No. 2 as part of the initial construction at that site. The differential cost of these items at an alternative site over the cost for St. Lucie No. 2 is estimated to be \$70,000,000 which includes escalation and interest during construction. The breakdown of costs for the alternative site are as follows:

a) Site improvement	0.6 x 10 ⁶ \$
b) Earthwork	10.1
c) Circulating Water System	18.4
d) Service Building	0.7
e) Transmission Lines	3.2
f) Indirect costs	9.2
g) Escalation	10.9
h) Engineering	3.2
i) Interest During Construction	<u>13.3</u>
TOTAL	69.6 x 10 ⁶ \$

1

The cost of land at the alternative site must be added to obtain the total incremental investment at a new site. In estimating costs for opening up a new site, circulating water intake and discharge canals were sized for two units, and foundation preparation for power plant structures was assumed to be made for two units. Transmission line cost to connect the new plant to the 230 kV grid is based upon a three circuit line to an existing substation 18 miles west of the site. It is recognized that a power flow study might show that an additional line would be required from the new site to the St. Lucie substation, 55 miles away.

1

Summary

The factors considered in comparing the two sites can be summarized as follows:

- a) There is little difference in ease of access at the two locations, but the access road into the St. Lucie site has already been constructed.
- b) Geology-seismology conditions at the two sites are about equal.
- c) Necessary excavation of foundation material is expected to be to a shallower depth (40 ft) at the alternative site compared to that (60 ft) at St. Lucie. However, foundation preparation for St. Lucie No. 2 has already been completed.
- d) There is little difference in compatibility of land use. The alternative site is largely an undeveloped area, and the St. Lucie site has already been designated for power production.
- e) Population distribution is somewhat more favorable at the St. Lucie site.
- f) Ecological aspects of the two sites are similar.
- g) Meteorological conditions at the two sites are similar.
- h) Hydrological conditions at the two sites are considered equal.
- i) Site development and transmission costs would be \$70,000,00 less at St. Lucie than at the alternative site.
- j) Development of a new site would entail approximately one additional year of construction time. This would add an additional cost of \$24,000,000 for the purchased power required to meet system demand during this period.

It can be seen readily that the cost of opening up a new site for the installation of the proposed generating capacity will be much more than the cost of installing the second unit at St. Lucie. Also, as previously pointed out, the environmental impact caused by construction at a new site will be much greater than that caused at the existing site. At a new site, an access road must be provided; a deep excavation must be made to prepare the foundation material to support the heavy loads to be imposed; circulating water canals must be dug, and a new transmission corridor cleared. The impact on the environment caused by construction of these components has already been made at the St. Lucie site. In view of these economic and environmental factors, the applicant has concluded that installation of a second unit at St. Lucie site is the proper way to provide for serving increased system loads in 1979.

0 PLANT DESIGN
01 ALTERNATIVES

Chapter 10 - Plant Design Alternatives

10.1 COOLING SYSTEMS, EXCLUDING INTAKE SYSTEMS AND DISCHARGE SYSTEMS

10.1.1 GENERAL

This section of the report, along with Sections 10.2 and 10.3, concerns itself with alternative cooling water systems for St. Lucie Unit No. 2.

Because Unit No. 2 will be located alongside Unit No. 1, and because Unit No. 1 is already well along in construction it is recognized that a valid comparison of alternative cooling systems for Unit No. 2 should include the simultaneous effects of Unit No. 1.

The Florida Power and Light Company has previously submitted the Environmental Report, the Preliminary Safety Analysis Report and the Final Safety Analysis Report for St. Lucie Unit No. 1. Construction and other required permits to date have been obtained and construction on Unit No. 1 is currently about 50 percent complete. The present scheduled fuel loading is September, 1975.

10.1.2 ST. LUCIE UNIT NO. 1

Since the installation and operation of St. Lucie Unit No. 1 is a factor in this evaluation, a brief account of the pertinent information on Unit No. 1 is presented here. The property involved and the general location of the unit on that property is shown on Figure 10.1-1. Figure 10.1-2 shows the Unit No. 1 location and the circulating water system. Figures 10.1-3 and 10.1-4 are aerial photographs of the plant construction as of November 17, 1972.

The basic design criteria for the cooling water system for St. Lucie Unit No. 1 are listed below. St. Lucie Unit No. 2 is proposed as a duplicate of Unit No. 1.

Plant Capacity 850 MW

Condenser Rise = 24 F

Heat Rejection Rate = 6.2×10^9 BTU/Hr

10.1.3 ST. LUCIE UNIT NO. 1 - COOLING WATER SYSTEM (REFER TO FIGURE 10.1-2)

The cooling water system for St. Lucie Unit No. 1 is a direct or once through system. Water is taken from the Atlantic Ocean, adjacent to the plant site and is pumped through the condensers at a rate of 1150 cfs where the temperature of the water is raised by a maximum of 24 F. The water is then conveyed back past the shoreline and discharged into the ocean approximately 2300 feet north of the intake area.

The intake lines originate in the ocean in water that is about 18 feet deep, located approximately 1200 feet offshore. These lines consist

of two - 12 foot diameter concrete pipes, buried beneath the ocean floor such that a minimum of five feet of cover is provided. This is done in order that the pipe be free of the effects of currents and wave action as well as to ensure that the presence of the lines will not cause the ocean floor in the area to be altered. The intake end of the lines is equipped with a velocity cap, the details of which are shown in Figure 10.1-5. The purpose of the velocity cap is to provide an area, around the intake pipe, where the velocity of water is kept to 1 FPS so that any fish swimming in the area are somehow alerted and can swim out of the current before being swept into the intake lines.

The buried intake lines cross the shoreline and travel about 400 feet across land where they are cast integrally in a concrete headwall which also forms the seaward end of the intake canal. The intake canal is routed in a westerly direction for about 2600 feet and then north for about 2600 feet, where it feeds water to the circulating water pumps located on a concrete intake structure on the western side of the unit. The flow of water to this point is by gravity and the hydraulics of the intake lines and intake canal have been designed to accommodate the flows involved.

The water is then pumped through the tube side of the condenser where it picks up the waste heat load and is consequently heated by 24 F. The condenser effluent is then discharged into an open canal and flows eastward for approximately 2000 feet to the concrete headwall of the subaqueous 12 foot diameter concrete discharge pipe. This pipe is buried and is routed about 1550 feet eastward (300 feet to the shoreline and 1250 feet underwater) and ends in a two port diffuser which is shown in detail on Figure 10.1-6. The discharge line, except for the diffuser, is buried beneath the ocean floor such that a minimum of five feet of cover is maintained.

10.1.4 ST. LUCIE UNIT NO. 1 - ENVIRONMENTAL REPORT

As has been indicated, a formal Environmental Report has previously been issued by Florida Power and Light Company. In addition, the AEC has published its "Draft Environmental Statement" dated September 15, 1972. These documents are a matter of public record and are available for reference.

10.1.5 ALTERNATIVE COOLING WATER SYSTEMS

10.1.5.1 General

The following systems are evaluated here:

a) Alternative A - (Design Case)

This system is the same system as used for St. Lucie Unit No. 1. It is a direct cooling system using water from the Atlantic Ocean (Figure 10.1-7).

b) Alternative B

A closed cycle system using mechanical draft conventional cooling towers to reject waste heat to the atmosphere.

c) Alternative C

A closed cycle system using a natural draft hyperbolic cooling tower to reject waste heat to the atmosphere.

d) Alternative D

A closed cycle system using a cooling pond for heat rejection.

e) Alternative E

A closed cycle system using power spray modules in an open canal for heat rejection.

10.1.5.2 Plant Efficiency With Alternative Cooling Water Systems

A study was performed to evaluate the effects on the plant efficiency when using a direct cooling water system versus a closed cycle system with evaporative type cooling towers. It was found that the electrical output of the plant was reduced by 2.6 percent when using the closed cycle systems.

This reduction is due ultimately to higher turbine back pressures which result in lower turbine efficiencies. The temperature of the cooling water is directly related to the turbine back pressure. For this study, the temperature of the cold water side of the cooling tower flows was established using average monthly values of the meteorological parameters involved namely: wet bulb temperature and relative humidity. In addition, average monthly values of ocean water temperatures were obtained for the direct cooling case. The back pressures were obtained for each case and the attendant turbine efficiencies were obtained from a Unit No. 1 turbine rating curve.

The results indicated that when using the closed cycle system with either mechanical or natural draft towers the electrical output (on an average monthly basis) was reduced. The reduction ranged from 2.35 percent in December to 3.05 percent in July with a yearly average of 2.6 percent. These calculations were based on the plant running at full capacity. This reduction in plant efficiency is factored into the economic evaluation.

10.1.5.3 Economic Evaluation of Alternates

Each of the viable alternatives have been evaluated economically in accordance with the principals established in the AEC Guidelines. A capital cost estimate was executed for each alternative cooling system. The costs related to the generating plant itself were not included since these costs are assumed to be the same regardless of the cooling water system being used. The costs submitted therefore are only the costs

associated with the cooling water systems and in addition only those costs over the above the costs associated with St. Lucie Unit No. 1.

The plant electrical output is assumed constant for all the alternatives. The connected power of all the equipment related to the cooling water system is handled as a power deficit. The reduction in plant efficiency for the closed cycle systems using evaporative type towers has also been handled as a deficit. These deficits are factored into the economic evaluation thusly:

a) Capital Cost Penalty

\$156/KW (1978 cost): This is added to the capital cost estimate.

b) Energy Penalty

\$1990/10⁶ KWHr: This is based on a heat rate of 10,450 BTU/KW and a fuel cost of \$.19 per 10⁶ BTU.

The operating and maintenance costs are only those costs related to the cooling water systems. The costs related to the plant are the same for each alternative and are therefore not included in this evaluation.

Since each of the alternatives evaluated here can be installed so as to meet the scheduled start up date, a makeup power penalty is not required for any alternative. The makeup power penalty is an adjustment that operates only when a particular alternative requires a longer construction schedule.

The average cost of capital over the lifetime of the unit is taken as 15.1 percent per annum.

10.1.5.4 Design Cooling Water System - Alternative A

a) Description

The design cooling water system, carried here for comparison as Alternative A is described in detail in other sections of this report. In general, the system is the same as for St. Lucie Unit No. 1. It is a direct cooling system using seawater and which shares common facilities with Unit No. 1. The layout of the system is shown on Figure 10.1-7.

Each of the two - 12 foot diameter concrete subaqueous intake lines installed with St. Lucie Unit No. 1 is capable of carrying a full flow of water for operating one unit at 100 percent capacity. The reason for the redundancy is so that one line can be taken out of service for marine growth defouling or major maintenance while the other still provides the entire cooling water flow. Since this defouling operation is estimated to take a relatively short time (approximately six hours per month), these two lines installed for Unit No. 1 are capable of carrying flows for both units, and no additional intake lines are required.

The earthen diked intake and discharge canals supplied with St. Lucie Unit No. 1 are also sufficient to carry the two unit flows of cooling water. The only modification required is to add a short S-shaped canal section from Unit No. 2 to join the discharge canal. In addition the St. Lucie Unit No. 1 intake pump structure with its pumps are duplicated for Unit No. 2.

A second 12 foot diameter subaqueous discharge line is to be provided to handle the Unit No. 2 flows. This line runs parallel and adjacent to the Unit No. 1 line and is buried beneath the ocean floor in a similar manner. It is a longer pipe however, extending approximately 500 additional feet beyond the first pipe where it is then equipped with a 1060 foot length section containing discharge ports for thermal diffusion purposes. The thermal aspects and operation of this line are discussed in detail in Section 3.4.

b) Economic Considerations

The cooling water pumps for this alternative consist of four - 25 percent capacity pumps. Each pump has a connected power requirement of 1500 hp and the total connected power is therefore 4460 KW. As previously noted, this power requirement is applied as a deficit in the economic analysis.

c) Environmental Effects

The direct once-through cooling water system alternative for St. Lucie Unit No. 2 will have the least environmental effect. The system, at large, will utilize existing facilities shared with Unit No. 1 thus minimizing environmental effects from construction. The system will double the usage of cooling water and the amount of heat rejected to the ocean to that of Unit No. 1 and as such the effect on marine life is expected to be minimal. Since the alternative does not employ evaporative type coolers (cooling towers), the potential for fogging is absent as is salt deposition on surrounding areas. While evaluation of aesthetic appearances is to an extent a subjective judgment, a lesser visual impact results from this alternative than from a closed cooling system using evaporative type cooling.

d) Alternative Open Cooling Water Systems

Several variations to the base case open cooling water system described in (a) were also evaluated in the process of selecting the cooling water system. The alternatives evaluated were: (1) duplication of the Unit 1 "Y" port discharge; (2) dilution with ocean water; (3) combination of spray canals and ocean discharge; (4) combination of cooling towers with ocean discharge. The principle environmental design considerations influencing the evaluation were the latest State of Florida water quality standards.

Exact duplication of the Unit 1 "Y" port discharge was considered first. This alternative was dismissed on the basis that it would not satisfy the State of Florida requirements for discharge of heated water

into coastal waters of the State which are defined as waters landward of -18MLW. Discharge of heated water into coastal waters is presently restricted to a 2 F rise during the months of June, July and August. Extension of the "Y" port further off shore was then considered and subsequently rejected in favor of the base case multiport diffuser since multiport diffuser could be designed to ensure sufficient dilution so that at no point would the surface temperature rise exceed 2 F and still satisfy the system hydraulic requirements which the "Y" port discharge could not.

Next the four hybrid cooling water system alternatives were evaluated against the base case multiport diffuser. Combinations of dilution; spray ponds, cooling towers, or cooling pond, coupled to a duplicate "Y" port discharge require the intermediate cooling device to lower the temperature to a 2 F rise above ambient in order to satisfy the requirements for discharge into coastal waters. Detailed cost estimates were not prepared for these schemes since it was concluded that the ponding alternative would not meet the criteria and although the other three alternatives could be designed to meet the criteria, the design would not be as economically attractive as designs with the discharge located further off-shore. By this process of elimination it was then concluded that hybrid cooling water systems utilizing a multiport diffuser offered the only potentially viable alternatives to the base case multiport diffuser systems. These alternatives are evaluated in Sections 10.1.5.9 through 10.1.5.13.

Investigation of systems utilizing a multiport diffuser coupled to each of the four alternatives indicated that the diffuser would not be shortened significantly over the base case diffuser. Thus it was concluded that there would be no economic advantage associated with any of the alternative systems. Assessment of the environmental impact of the four alternatives indicated that there is little, if any, benefit. The dilution scheme increases water usage, and depending on the dilution flow selected, requires larger or additional intake lines, and requires additional on-site canals. The environmental effects of the mechanical draft cooling towers and spray ponds are discussed in Sections 10.1.5.5 and 10.1.5.8. Ponding of Big Mud Creek would provide approximately 100 acres of cooling surface which would effect approximately a 2°F drop in water temperature prior to entering the ocean discharge. The design would also require the Unit 2 discharge to be routed under the existing Unit 1 discharge lines or canal and that the discharge line be relocated north of the Unit 1 "Y" - port with a new discharge headwall structure. The ponding scheme then creates significant environmental impact by utilizing land and water areas which would not otherwise be affected by the base case design.

Thus it was concluded that the base case diffuser system is the most promising in terms of environmental protection and is also the most economical system.

10.1.5.5 Mechanical Draft Cooling Towers - Alternative B

a) Description

This system is a closed cycle system using mechanical draft cooling towers to dissipate the waste heat to the atmosphere. A plan of the system is shown on Figure 10.1-8.

The cooling towers used for this study were designed to cool the water flow from the condensers by 24 F. What this does in effect is to take the entire waste heat load rejected by the condenser and release it to the atmosphere through the mechanics of the cooling tower operation. The design parameters for the towers are the wet bulb temperature and the concurrent relative humidity. The combination used for towers in this service is that combination which produces a worse situation (relative to cooling efficiency) for only 1 percent of the yearly operating time, which for this location is 80 F wet bulb temperature with a 70 percent relative humidity.

Based on those parameters and the circulating water flow (530,000 gpm), 24 cooling cells are required, each cell being approximately 70 feet wide by 40 feet long in plan dimension and each equipped with a fan requiring a power input of 188 HP. As shown on the plan, the cells are arranged in 2 groups of 12 and orientated parallel to the direction of the prevailing wind for efficient operation.

In the operation of an evaporative type cooling tower used on a closed cycle system, the concentration of dissolved minerals in the water tends to increase. On this type application, using saline water, the increase must be controlled for two reasons, namely: to prevent deposition of minerals in the condenser tubes and to prevent deposition in the component parts of the cooling towers. The way the concentration is controlled is to discharge (blowdown) from the system a certain amount of the water containing the higher mineral content and replace this deficit with water of a lower mineral content.

For this operation, using ocean water, the cooling tower vendors recommend 3 as a maximum concentration factor. This means that the system will operate efficiently with water up to 3 times the mineral concentration of the seawater. On this basis, the system must operate with a continuous blowdown of 5000 gpm and a continuous makeup, to compensate for blowdown, evaporation and drift losses, of 19,000 gpm.

The makeup for the cooling towers for Unit No. 2 is drawn from the Unit No. 1 intake canal. A concrete intake structure is located on the canal which supports the pumps and is equipped with revolving screens. Two 50 percent capacity pumps are used, each with a capacity of 10,000 gpm and each requiring a power input of 130 HP (260 HP total).

The blowdown is discharged to the Unit No. 1 discharge canal through a concrete box. The purpose of the box is to dissipate the energy of the blowdown stream and assure a smooth transition of the water from the closed conduit to the open canal. The blowdown (5000 gpm) is immediately mixed with the canal flow (530,000 gpm).

The pumping structure for the closed cycle circulating water system feeding the condensers is located at the cooling tower basin. This structure supports four - 25 percent pumps, each having a capacity of 132,000 gpm and each requiring a power input of 3300 HP (13,200 HP total).

b) Economic Considerations

The power required to operate this alternative cooling water system is as follows:

4-Circulating Water Pumps	13,200 HP
2-Makeup Water Pumps	260 HP

Cooling Tower Fans

4,512 HP

Total

17,972 HP 13,400 KW

In addition, the plant electrical output is reduced by 2.6 percent because of the use of the closed cycle evaporative type cooling rather than the direct cooling system. This represents approximately 22,100 KW. The total power deficit applied against this alternative is therefore 35,500 KW.

c) Environmental Effects

With this alternative all of the environmental effects of St. Lucie Unit No. 1 are present and, in addition, those new effects introduced for Unit No. 2, which are related mainly to the evaporative type cooling towers. Environmental effects of cooling tower operation, including effects of salt drift, are discussed below.] 0

1) Construction Effects

A large additional part of the plot area must be cleared, excavated and backfilled to accommodate the cooling towers and the buried circulating water piping. The area involved would be about 20 acres of what is now a mangrove swamp located between the beach dunes and Florida Highway A1A. While the mangrove swamp itself is judged to be non-productive in an ecological sense, construction activities in the area, so close to the beach, would probably have a temporary effect on the turtle hatching areas.

The cooling towers would have to be supported at about elevation 22' (relative to MSL) in order to provide flood protection. This would require large amounts of structural fill material which would have to be obtained from other parts of the site or else dredged from the surrounding waterways.

2) Cooling Tower Operation

The use of cooling towers for St. Lucie Unit No. 2 introduces additional environmental effects, effects which would not be present with alternative "A". This is because the waste heat is now rejected directly to the atmosphere rather than to the Atlantic Ocean.

The operating of a cooling tower such as the one considered for this alternative involves taking the hot water discharge from the condenser and conveying it to the top of the tower. The water is then cascaded down into the tower internals (packing) while simultaneously a counter flow current of air is caused to flow upward by a draft produced by fans located on the top of the tower. The intimate mixing of the hot water and the colder air cause a small portion of the water to evaporate thereby producing refrigeration to cool the remaining water.

The evaporated water flows upward and out of the tower where it mixes with the colder air. This mixing causes the vapor to recondense, forming a vapor plume or if the relative humidity of the ambient air is low, to mix with the air without condensing.

While the vaporized water which leaves the tower is distilled water (no mineral content), the stream carries with it droplets of water which do contain mineral impurities. These droplets ride on the air current and are eventually dropped to the ground. While this does not normally produce any significant impact, it is important here because the water is seawater with a high salt content to start with and the operation of the cooling tower concentrates the strength of the solution by a factor of three. This water carried out of the system is referred to as "drift loss" or "drift".

The fogging potential of the cooling towers was studied using a Gaussian diffusion model ⁽¹⁾ and five years of historical meteorological data. On the average there are 22 hours per year of relatively dense natural fog in the vicinity of the site. This average value would be increased by the tower induced fog as shown in Figure 10.1-9.

Cooling tower induced ground fog is predicted to occur predominantly to the northeast and southeast of the plant. The major impacts would be experienced in nearby coastal waters and along Route A1A, which crosses the site. Due to the small separation distance between the towers and Route A1A, any wind-induced downwash on the tower plume could intensify the fogging problems on the highway. The following table presents the frequency of cooling tower induced fog that may be expected at specific locations in the vicinity of the site.

<u>Location</u>	<u>Annual Frequency of Induced Fog (Hrs)</u>
Fort Pierce	9
Port St. Lucie	20
Port Sewall	20
Route A1A	60 *
Sunshine State Parkway	10
Coastal Waters	70
Intercoastal Waterway	25

The drift from a cooling tower using seawater causes a mineral fallout on the surrounding area under the plume. While the drift rates on cooling towers are generally low (about 0.005

percent of the circulating water flow for mechanical draft towers), the fallout for this installation is significant. The drift mass can be broken down into several size populations and this is shown on Table 10.1-1. Preliminary calculations indicate that the salt release rate would be about 1460 lb/hr. The average annual areal salt deposition for this alternative is illustrated on Figure 10.1-10. As can be seen, the peak salt depositions occur in the immediate vicinity of the plant. It should be pointed out here that these depositions are in addition to the natural deposition for this coastal area.

The environmental impact of the salt fallout on terrestrial ecology is very difficult to assess and no attempt has been made here to quantify the impact. There has been very little definitive experimental work done on the effects of salt drift from a cooling tower installation. Some work has been done to obtain a "baseline" of normal chloride ion and sodium ion concentrations in the leaves of several species and to determine the toxic level of each ion. The results of this work seem to indicate that for most plants studied, the toxic level for the sodium ion is about 2000 ppm or 5000 ppm chloride ion (the concentrations being based on dry weights). But according to Eaton (4), some species of plant manifest chloride ion toxicity symptoms at concentrations below 5000 ppm. He found that leaves of avocado and grapefruit plants showed toxicity symptoms with concentrations as low as 2200 and 2600 ppm respectively, and that new growth of some fruit trees was retarded up to 60 percent leaf concentrations of 2000 ppm.

Since approximately two-thirds of the land area in St. Lucie County is given over to the general agriculture industry, with much of that in citrus crops, it is judged that at least a moderate impact would be expected.

3) Marine Impact

Since the makeup to the closed cycle cooling system with evaporative towers is drawn from the Unit No. 1 intake canal and since the blowdown from the system is discharged to the Unit No. 1 discharge canal and since the flow ratios (Unit No. 2/Unit No. 1) are 1 percent and 4 percent respectively, it is judged that any additional marine impact will be negligible.

4) Visual Impact

The attendant vapor plumes from these cooling towers will be highly visible and as such constitute an undesirable visual impact.

10.1.5.6 Natural Draft Cooling Tower - Alternative C

a) Description

*Subject to Aerodynamic Downwash Effects

This system is a closed cycle system using a single natural draft cooling tower to dissipate the waste heat to the atmosphere. A plan of the system is shown on Figure 10.1-11.

This system is much the same as described for Alternative B. The design parameters of the tower are the same, namely: wet bulb temperature 80 F and relative humidity 70 percent. The flow of 530,000 gpm is cooled by 24 F. For this application, a natural draft tower of approximately 480 feet in diameter and 400 feet high is required.

The operation of this type tower is much the same as with the mechanical draft towers except that the large hyperbolic chimney (veil) creates a natural draft by setting up convection currents.

The recommended cooling water concentration factor for this type of tower is three, requiring approximately the same makeup and blowdown as with the mechanical draft towers.

The makeup is drawn from the Unit No. 1 intake canal by the use of two - 50 percent pumps, each designed for a flow of 10,000 gpm and requiring a power input of 130 HP (260 HP total). The discharge from the tower is approximately 5000 gpm, which is directed into the Unit No. 1 discharge canal.

The pumping structure for the closed cycle cooling water system feeding the condensers is located at the tower. A pump suction structure is required supporting four - 25 percent pumps, each having a capacity of 132,000 gpm and requiring a power input of 4200 HP (16,800 HP total).

b) Economic Considerations

The power input required to operate this alternative cooling water system is as follows:

4-Circulating Water Pumps	16,800 HP	
2-Makeup Water Pumps	260 HP	
Total	17,060 HP	12,700 KW

In addition, the electrical output of the plant is reduced by 2.6 percent. This represents approximately 22,100 KW. The total power deficit applied against this alternative is therefore 34,800 KW.

c) Environmental Effects

As with Alternative B, the environmental effects of St. Lucie Unit No. 1 are present and in addition, those new effects introduced for Unit No. 2, which are related mainly to the construction and operation of the evaporative type cooling tower.

1) Construction Effects

Approximately 20 additional acres of the plant area must be cleared, excavated and backfilled to accommodate the cooling tower and underground circulating water lines.

The ecological effects would be approximately the same as discussed for Alternative B.

2) Cooling Tower Operation

The operation of a natural draft cooling tower such as considered in this alternative is similar to that discussed for a mechanical draft tower (Alternative B). The release of water vapor to the atmosphere will result in formation of a visible water vapor plume downwind of the tower. The plume length and trajectory depends upon local meteorology and the cooling system operating characteristics. Baker (1) derived an empirical relationship between visible plume length, ambient meteorological conditions, and the vapor release characteristics. Using this approach, an analysis was performed to determine the plume length frequency. Five years of meteorological data for West Palm Beach, Florida were used for this study. The vapor release rate and the resulting plume lengths were calculated for each hour of this five year period (1948-1952). Based on this data, the annual average frequency of plume lengths was calculated and is presented here on Figure 10.1-12.

Nearly 73 percent of the plumes are expected to be less than 1500 feet long. Plume lengths less than 3000 feet will occur 90 percent of the time. Visible plumes longer than two miles should occur an average of eight hours per year. These long plumes will be associated largely with winds from the northwest. The longest plume calculated during the five year period of study extended approximately 2.8 miles downwind.

Although the cooling tower plume will be visible, no ground fogging problems are anticipated due to the great height of the hyperbolic shell and the sustained buoyancy of large vapor plumes. With wind speeds greater than about 20 mph, it is possible for the plume to become trapped in the aerodynamic wake of the tower. However, even in these situations, the plume is not expected to reach the ground and should be rapidly dispersed by the wind. Furthermore, the possibility of plume impingement upon elevated areas is obviated due to the flat topography of the surrounding area.

Figure 10.1-13 presents the annual hourly frequency that an elevated plume will exist over the plant site region. The spatial distribution of the cooling tower plumes can also be seen. Approximately 40 percent of all plumes longer than 1500 feet are carried to the southeast while 33 percent of these plumes will extend to the northeast. The cooling tower plumes are not expected to interfere with local air traffic since the St. Lucie County Airport, the nearest public air field, is located approximately 12 miles to the northwest of the plant site.

The drift rate of a cooling tower of this type operating at a concentration factor of 3 is about 0.003 percent of the circulating water flow. With the concentrations involved, this

represents about 875 lbs./hr of salt released to the atmosphere. The salt deposition on the surrounding area depends on the wind, atmospheric stability and humidity conditions, as well as the droplet size distribution of the tower drift.

The drift droplet size determines both the height to which the drift is carried by the vapor plume and the speed at which the droplets fall to ground level. Relative humidity, in turn, affects the droplet size by determining the rate of droplet evaporation during the settling process. Finally wind and atmospheric stability control the spacial and temporal distribution of the drift.

In order to assess the salt deposition characteristics of the natural draft cooling system, five years of meteorological data from West Palm Beach were analyzed in terms of joint frequencies of wind speed and relative humidity for each of sixteen wind directions. These meteorological data were used to determine the deposition rate ⁽²⁾ of a typical natural draft drift size distribution derived from field tests conducted at the Homer City Station ⁽³⁾.

The droplet size distribution is as follows:

<u>Droplet Diameter (μ)</u>	<u>Percent of Total Mass</u>
0-60	20
60-120	46
120-180	24
180	10

Comparatively speaking, natural draft towers exhaust smaller droplets at greater heights than mechanical draft towers. This results in a relatively low ground level concentration of salt deposited over a larger area. Figure 10.1-14 shows the annual salt deposition expected. A peak salt deposition of 92 lbs/acre-year is experienced about 3 miles west of the plant site.

As discussed with the preceding alternative, the ecological effects of this salt deposition is very difficult to assess and no attempt has been made here to quantify that effect. It is judged that at least a moderate impact on surrounding terrestrial ecology would be experienced.

3) Marine Impact

This system is a closed cycle system with evaporative type cooling towers similar to Alternative B, having approximately the same makeup and blowdown requirements. The makeup is drawn from the Unit No. 1 intake canal and the blowdown is released to the Unit No. 1 discharge canal. Since these flows are small relative to the Unit No. 1 flows, the additional impact on marine ecology is negligible.

4) Visual Impact

Natural draft cooling towers are very large structures. The one used in this application is approximately 480 feet in diameter at the base and 400 feet high. This is about 200 feet higher than any other major structures in the plant and would probably be the highest structure for many miles around. The visual impact of the tower and its plume would be substantially out of harmony with the surrounding scenic vistas.

5) Other Impacts

A tower of this size would present a hazard to low flying planes in the area and the operation of the tower would probably produce thermal air currents and attendant turbulent air, which would very well be an additional hazard to low flying planes.

10.1.5.7 Closed Cycle System With Cooling Pond - Alternative Da) Description of System

This system is a closed cycle system using a large open pond to dissipate waste heat to the atmosphere. The mechanism of heat dissipation is the evaporation and attendant refrigeration which occurs at the surface of the pond. For this location and the meteorological conditions which prevail, it is estimated that a pond in excess of 1000 acres would be required for efficient cooling duty.

b) Conclusion

This system is rejected as a viable alternate mainly because the land is not available, but even if it were, there are no apparent environmental advantages. A large additional area of land would be altered causing what is judged to be a substantial ecological impact.

10.1.5.8 Closed Cycle System With Spray Canals - Alternative E

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a) Description

This system is a closed cycle system using canals equipped with power sprays to effect the cooling required. The power sprays considered here are of the floating type. The module contains 4 spray heads and a pump arranged on a buoyant frame. The pump takes suction on the canal (on which it floats) and feeds water to the spray heads where it is sprayed into the air. Each head sprays water over an area 40 feet in diameter. The pump on each module is rated at 75 HP.

While spray systems on fresh water ponds have been in use for many years, there is very little experience with salt water ponds. A mathematical predictive model was employed to determine approximately the number of modules and the length of canal required. Using 3 modules abreast in a 200 foot wide canal, the total number of units required would be 165

and the length of the canal would be approximately 8000 feet. Using a U shaped canal and providing proper separation distance between the canal legs, an area in excess of 700 acres would be required.

b) Conclusion

This system is rejected as a viable alternative for the following reasons:

- * A large additional area of the natural landscape must be altered to construct the canals. It is judged that this would cause a substantial ecological impact (terrestrial ecology).
- * Spray systems have not been proven for salt water applications such as those prevalent at this site.
- * The amount of drift with a system such as this is estimated to be in the order of magnitude of 1 percent of the circulating water flow. This means that a large amount of salt will be sprayed over the surrounding countryside with attendant environmental effects. It is noted that this drift rate is 200 times higher than the rate associated with mechanical draft cooling towers.

10.1.5.9 One Through Partial Cooling With Spray Modules - Alternative F

a) Description of System

This alternative is a once through system where about one-third of the waste heat is dissipated directly to the atmosphere by using 60 spray modules floating in an extended discharge canal. The discharge canal extension will be 200 feet wide and approximately 2800 feet long located in the area west of the ocean sand dune, east of route A1A and between the intake and discharge canals. The intake and discharge structures, pipes and canals will be the same as for the base design multiport diffuser (Alternative A).

b) Conclusion

This system was rejected as a viable alternative for the same reasons that alternative E was rejected. Though the additional land required is only one third that of alternative E and the salt water spray drift is also only one third of alternative E it is still nearly 70 times as great as for a mechanical draft cooling tower, and the spray system has not been proven for a salt water application such as the conditions existing at the St. Lucie site.

10.1.5.10 Once Through - Partial Cooling by Cooling Pond Or Canal - Alternative Ga) Description of System

This alternative is a once through system where one third of waste heat will be rejected directly to the atmosphere from the surface of an additional 350 acres of cooling pond. To obtain this additional area most of the natural mangrove swamp and a large part of Big Mud Creek would have to be diked and the water level raised to form a pond.

The discharge from the cooling pond will be by subaqueous multiport diffuser as required in the base (alternative A) system. The intake and discharge structures, pipes and canals will be the same as for the base design multiport diffuser (alternative A).

b) Conclusion

This system has been eliminated as a viable alternative for the following reason:

A large additional land and estuarine area will have to be removed from all productive life and thus incur a significant ecological impact. Perhaps the more significant being the inpounding of Big Mud Creek. It is doubtful that the necessary permits could be obtained to close off Big Mud Creek and raise its temperature 24 F.

10.1.5.11 Once Through System With Partial Cooling By Mechanical Draft Cooling Towers - Alternative Ha) Description of System

This alternative is a once-through system where about one third of the waste heat will be dissipated to the atmosphere by use of a single mechanical draft cooling tower. In this arrangement about 40 to 45 percent of the cooling water discharge will be drawn from the discharge canal and passed through a mechanical draft cooling tower. The cooling tower effluent will be mixed with the remainder of circulating water discharge resulting in a final temperature no higher than 17 F above ambient.

The discharge line will still terminate in a subaqueous multiport diffuser system to insure compliance with the 2 F maximum ΔT in coastal waters. The intake and discharge structures, pipes and canals will be the same as for the base design multiport diffuser - (alternative A).

b) Conclusion

This system has been rejected as a viable alternative for the following reason:

This alternative will have the same adverse problems as alternative B but to a somewhat lesser extent (one tower instead of two). The salt deposition due to drift will still be significant (100th acre/year) for some areas on the Florida mainland.

The vapor plumes from the cooling tower will be highly visible and as such will constitute an undesirable visual impact. However, only a slight increase in ground fogging is expected to occur (somewhat less than those predicted for alternative B - page 10.1-8).

10.1.5.12 Once Through System With Partial Cooling By Natural Draft Cooling Tower - Alternative I

a) Description of System

This alternative is a once-through system where about one third of the waste heat will be dissipated to the atmosphere by use of a natural draft cooling tower. In this arrangement from 40 to 45 percent of the cooling water discharge will be passed through a natural draft cooling tower (similar to the tower described in alternative C but of about one half the capacity and somewhat smaller in size). The cooling tower effluent will be mixed with the remainder of the cooling water discharge resulting in a final temperature no higher than 17 F above ambient. The discharge line from the head wall to the subaqueous multiport diffuser and the intake lines and structures will be the same as for the base system (alternative A).

b) Conclusion

This system has been rejected for the following reasons:

The plume visibility as discussed in alternative C presents a strong visual impact.

The physical size of the cooling tower presents both a visual impact as well as some hazard to low flying aircraft.

The tower lights being both higher and closer to the ocean, may have an adverse effect on the turtles during the mating season and especially for the hatchlings which can be disoriented by light and not travel directly to the relative safety of the sea.

10.1.5.13 Once-Through Cooling With Dilution to 17 F - Alternative J

a) Description of System

This alternative is a once-through system where an increased diameter intake line will permit an additional 50 percent more water to enter the intake canal. This additional amount is taken via a bypass canal directly to the area of the discharge canal head wall. At this point the extra intake water is pumped into the discharge canal where it mixes with the circulating water reducing its temperature to less than 17 F above ambient. The discharge pipe and multiport diffuser will have its diameter increased to account for the increased flow.

b) Conclusion

The dilution system was not selected for the St. Lucie Unit 2 because of the following reasons:

Both the intake and discharge pipes will have to be significantly enlarged or a third line added to accommodate the increased flow. This will cause greater environmental impact due to the wider trench required by these pipes.

The increased flow will proportionally increase the recirculation of the warm discharge (assuming the same separations between intake and discharge).

There will be a 50 percent increase in the suspended organisms that will be drawn into the plant and all are presumed to be eliminated by the thermal shock (ΔT 17 F).

A 50 percent increase in the number of fish drawn into the inlet will have to be assumed even if the intake velocity at the velocity caps is maintained at the present maximum one foot per second.

10.1.5.14 Cost Description - Alternative Cooling Systems

The cost description for the alternative cooling systems are given in Table 10.1-2. The economic summary for alternatives A, B and C is given in Table 10.1-3.

All of the viable alternative cooling systems will incur a cost penalty over the basic once-through multiport diffuser alternative A. Table 10.1-4 gives an order of magnitude estimate of the increased cost associated with each alternative cooling system. The basic once through system also requires the least land area. Table 10.1-4 also gives the increased amount of land required for each alternative system.

TABLE 10.1-1

TYPICAL MECHANICAL DRAFT TOWER DRIFT⁽²⁾

<u>Droplet Size Diameter (μ)</u>	<u>Salt Deposition Percent of Total Drift Mass (%)</u>
0-100	5
100-200	30
200-300	39
300	26

TABLE 10.1-2

COST DESCRIPTION-ALTERNATIVE COOLING SYSTEMS
(INCLUDING INTAKE AND DISCHARGE STRUCTURE)

		"A"	"B"	"C"	
	ALTERNATIVES	DESIGN CASE	MECH. DR. TWRS	NAT. DR. TWRS	
INCREMENTAL GENERATING COST	Present Worth	0	13,795,000	23,845,000	
	Annualized	0	1,434,000	2,479,000	REMARKS
CAPACITY FACTOR		80%	80%	80%	
ENVIRONMENTAL COSTS	UNITS	Magnitude	Magnitude	Magnitude	
1. Natural Surface Water Body					
1.1 Impingement or entrapment by cooling water intake structure					
1.1.1 Fish	#/YR	UNKNOWN	4% OF ALT A	4% OF ALT A	SEE NOTE 1
1.2 Passage through or retention in cooling systems		3.4×10^6 TO	12×10^4 TO	12×10^4 TO	
1.2.1 Phytoplankton and zooplankton	NET #/YR	7.3×10^6	27×10^4	27×10^4	SEE NOTE 2
1.2.2 Fish	NET #/YR	2.2×10^9 TO 24.6×10^9	2.6×10^8 TO 9.1×10^8	2.6×10^8 TO 9.1×10^8	SEE NOTE 3
1.3 Discharge area and thermal plume					
1.3.1 Water quality, excess heat	BTU/HR	6.2×10^9	NEGLIGIBLE	NEGLIGIBLE	SEE NOTE 4
1.3.2 Water quality, oxygen availability	ACRE-FEET	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	SEE NOTE 5
1.3.3 Aquatic organisms		NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	SEE NOTE 6
1.3.4 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)		NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	" " "
1.3.5 Fish, migratory		0	0	0	SEE NOTE 7
1.4 Chemical effluents					
1.4.1 Water quality, chemical		NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	SEE NOTE 8
1.4.2 Aquatic organisms		NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	" " "

TABLE 10.1-2 (Continued)

ENVIRONMENTAL COSTS	ALTERNATIVES		"A"	"B"	"C"	REMARKS
	UNITS		Magnitude	Magnitude	Magnitude	
1.4.3 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)			NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	SEE NOTE 8
1.4.4 People			NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	" " "
1.5 Radionuclides discharged to water body						
1.5.1 Aquatic organisms	ACRE-FEET					THESE EFFECTS INCLUDED WITH LIQUID RAD-WASTE SYSTEMS
1.5.2 People, external	" "					
1.5.3 People, ingestion	" "					
1.6 Consumptive use (evaporative losses)						
1.6.1 People	G/YR	0	0	0	0	SEE NOTE 9
1.6.2 Property	AFT/YR	0	0	0	0	" " "
1.7 Plant Construction (including site preparation)						
1.7.1 Water quality, physical	ACRES & AFT	MODERATE	MINIMAL	MINIMAL	MINIMAL	SEE NOTE 10
1.7.2 Water quality, chemical	ACRES FTZ	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	
1.8 Other Impacts						NONE APPARENT
1.9 Combined or interactive effects						
1.10 Net effects						
2. Groundwater						
2.1 Raising/lowering of ground water levels						
2.1.1 People	G/YR	0	0	0	0	SEE NOTE 11
2.1.2 Plants	ACRES	0	0	0	0	" " "

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TABLE 10.1-2 (Continued)

ALTERNATIVES		"A"	"B"	"C"	REMARKS
ENVIRONMENTAL COSTS	UNITS	Magnitude	Magnitude	Magnitude	
2.2 Chemical contamination of ground water (excluding salt)					THIS EFFECT COVERED WITH CHEMICAL & BIOCIDES SYSTEMS
2.2.1 People	NOT APPLICABLE				
2.2.2 Plants	NOT APPLICABLE				
2.3 Radionuclide contamination of ground water					THIS EFFECT COVERED UNDER LIQUID RAD-WASTE SYSTEMS
2.3.1 People	NOT APPLICABLE				
2.3.2 Plants and animals	NOT APPLICABLE				
2.4 Other Impacts on ground water					NONE APPARENT
3. Air					
3.1 Fogging and icing caused by evaporation and drift)					
3.1.1 Ground transportation	HRS/YR	MINOR	70	0	" " "
3.1.2 Air transportation	HRS/YR	0	0	0	" " "
3.1.3 Water transportation	HRS/YR	0	0	0	" " "
3.1.4 Plants					
3.2 Chemical discharge to ambient air					
3.2.1 Air quality, chemical		0	0	0	NO EFFECT ON CHEMICAL QUALITY OF AIR
3.2.2 Air quality, odor		0	0	0	
3.3 Radionuclides discharged to ambient air and direct radiation from radioactive materials (in plant or being transported)					COVERED UNDER OTHER SECTIONS OF THIS REPORT
3.3.1 People, external	NOT APPLICABLE				
3.3.2 People, ingestion	NOT APPLICABLE				
3.3.3 Plants and animals	NOT APPLICABLE				

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TABLE 10.1-2 (Continued)

ENVIRONMENTAL COSTS	ALTERNATIVES		"A"	"B"	"C"	REMARKS
	UNITS		Magnitude	Magnitude	Magnitude	
3.4 Other impacts on air						NONE APPARENT
4. Land						
4.1 Site selection						
4.1.1 Land, amount	ACRES		0	0	0	SEE NOTE 12
4.2 Construction activities (including site pre- paration)						
4.2.1 People (amenities)			MINIMAL	MINIMAL	MINIMAL	SEE NOTE 13
4.2.2 People (accessi- bility of histor- ical sites)			MINIMAL	MINIMAL	MINIMAL	SEE NOTE 14
4.2.3 People (accessi- bility or arche- ological sites)			MINIMAL	MINIMAL	MINIMAL	" " "
4.2.5 Land (erosion)	CY & ACRES		MINIMAL	MODERATE	MODERATE	SEE NOTE 15
4.3 Plant operation						
4.3.1 People (amenities)			NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	SEE NOTE 16
4.3.2 People (aesthetics)			NEGLIGIBLE	SUBSTANTIAL	SUBSTANTIAL	SEE NOTE 17
4.3.3 Wildlife			NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	SEE NOTE 18
4.3.4 Land, flood control						
4.4 Salts discharged from cooling towers						
4.4.1 People	#/SF/YR		NEGLIGIBLE	5000	90	SEE NOTE 19
4.4.2 Plants and animals			NONE	NOT KNOWN	NOT KNOWN	" " "
4.4.3 Property resources	#/YR		0	NOT KNOWN	NOT KNOWN	SEE NOTE 20
4.5 Not applicable						

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TABLE 10.1-2 (Continued)

ALTERNATIVES		"A"	"B"	"C"	REMARKS
ENVIRONMENTAL COSTS	UNITS	Magnitude	Magnitude	Magnitude	
4.6	Not applicable				
4.7	Not applicable				
4.8	Other land impacts				NONE APPARENT
4.9	Combined or interactive effects				
4.10	Net effects	MINIMAL	SUBSTANTIAL ADVERSE EFFECT	SUBSTANTIAL ADVERSE EFFECT	SEE NOTE 21

NOTES TO TABLE 10.1-2

NOTE 1

At this time, the rate of fish entrapment to be expected at St. Lucie Unit No. 2 intake is unknown. However, trawls made by the Florida Department of Natural Resources (FDNR) offshore of Hutchinson Island have produced very few fish. Beach seine hauls made by FDNR on the shoreline have produced occasional large catches of forage fishes (family Engraulidae) and commercial fishermen harvest large quantities of such pelagic fish as bluefish, Spanish mackerel and king mackerel from the waters offshore of St. Lucie County.

Offshore intake structures of the type planned for St. Lucie Unit No. 2 have not been used on the East Coast of the United States, but fish entrapment by similar intake structures located in California has been low.

While the magnitude of fish entrapment at St. Lucie Unit No. 2 cannot be estimated at this time, it is expected to be low due to low intake velocities (1 fps at the edge of the velocity cap) and because fish populations in the vicinity of intake are low.

NOTE 2

Based on data obtained by FDNR, estimates of combined phytoplankton and copepods entrained per year at St. Lucie Unit No. 2 have been made. The assumptions made to derive the equations used to develop mass numbers for plankton entrained through St. Lucie Unit No. 2 are given in Section 5.1.3 of the Environmental Report.

NOTE 3

Fish eggs and larvae collected offshore of Hutchinson Island have not been identified nor have separate counts of eggs and larvae been made. Because of this lack of data, the effects of entrainment on fish populations in the area of St. Lucie Unit No. 2 have not been estimated. The number of fish eggs and larvae (combined) calculated to be passed through the St. Lucie Unit No. 2 cooling water system is given in Section 5.1.3 of this report.

NOTE 4

For Alternative A, which is a once thru case rejecting the heat to the Atlantic Ocean, the heat rejection rate is 6.2×10^9 Btu/Hr. Effects are described in detail in Chapter 5.

For Alternatives B & C using evaporative towers, the only water discharged from the cooling water system is the blowdown from the cooling tower. This stream is discharged to the Unit No. 1 discharge canal and is a very small portion of the Unit No. 1 discharge. The thermal discharge to the ocean for Unit No. 2 is therefore judged to be negligible.

NOTE 5

Dissolved oxygen (DO) concentrations in the waters offshore of Hutchinson Island have been measured by FDNR and are discussed in Section 2.7.5.3 of the Environmental Report. In late summer 1972, low DO levels occurred offshore of the St. Lucie plant site.

Concentrations of DO in the condenser cooling water discharged from St. Lucie Unit No. 2 are not expected to be significantly different from ambient levels. The following data from the Turkey Point Plant for 10 randomly selected but representative days may be of interest.

Date	Dissolved Oxygen Content, ppm	
<u>1971</u>	<u>Intake</u>	<u>Discharge</u>
Feb 4	5.7	5.5
May 20	3.4	3.4
July 22	2.8	2.7
Sept 30	5.2	4.9
<u>1972</u>		
Jan 20	6.3	6.2
Feb 3	4.9	4.9
Feb 17	5.5	5.4
March 16	5.9	6.0
May 4	5.6	5.8

NOTE 6

Aquatic organisms are not expected to be adversely affected by the discharge plume because of the rapid temperature reduction produced by the diffuser discharge system.

NOTE 7

Bluefish, Spanish mackerel and king mackerel are migratory fishes which pass by Hutchinson Island in the course of their travels. None of these fishes are known to spawn near Hutchinson Island. Because of the low temperature rise produced by the diffuser discharge at St. Lucie Unit No. 2, no perceptible effects on the migration patterns of these fishes is expected to occur.

NOTE 8

Chemical discharges have been discussed in Section 3.6 of this report. As stated in Section 5.4.1, chlorine used to defoul condenser tubes is expected to produce no effects on organisms in the Atlantic Ocean offshore of Hutchinson Island.

Approximately 150,000 gallons per day of wastewater containing about 25,000 parts per million (ppm) of dissolved solids will be discharged into the condenser cooling water each day. The condenser cooling water

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contains from 33,000 to 38,000 ppm dissolved solids and will be passed through St. Lucie Unit No. 2 condensers at a rate of approximately 500,000 gallons per minute or 720×10^6 gallons per day. The addition of 150,000 gallons of water which contains a lower concentration of dissolved solids than seawater to the circulating water system will have no adverse effects on wildlife, aquatic organisms or water chemistry when discharged to the Atlantic Ocean.

NOTE 9

The water used in the circulating water system is ocean water and the consumptive use of this water has no direct effect on people or property.

NOTE 10

The natural surface water bodies considered here are the Atlantic Ocean, Indian River and Big Mud Creek. The construction of Unit No. 1 caused an impact to Mud Creek (which was dredged for fill material) and the ocean (which was dredged in connection with installing the subaqueous intake and discharge lines). The additional impact for the Unit No. 2 installation is considered to be minor. For Alternative A (the once-thru system) an additional subaqueous line would have to be installed which would disturb the ocean bed. For Alternatives B & C this line would not be required and the only aspect of the construction which would possibly affect the surrounding waterways would be silt carried by runoff and this is judged to be minimal.

NOTE 11

Potable groundwater level at the site is located in deep aquifers. Construction or operation of the plant will have no effect on this groundwater.

NOTE 12

No additional acreage required for the installation of Unit No. 2 over what is required for Unit No. 1.

NOTE 13

St. Lucie is located on a barrier island off the east coast of Florida. The island itself and the surrounding mainland is sparsely populated. The closest population center is Fort Pierce which is 8 miles north of the site. The minimum exclusion radius is one mile. The effects of construction activities on people is therefore judged to be minimal.

NOTE 14

St. Lucie Unit No. 1 has been under construction for several years. There is no knowledge of any problems concerned with the restriction of public access. The construction activities associated with Unit No. 2 will be approximately the same as for Unit No. 1., i.e., no additional effects are anticipated. The St. Lucie Unit No. 2 construction would, of course, extend the total construction time and therefore the inconvenience period.

NOTE 15

For Alternative A there is very little additional cut and fill and the effect is judged to be minimal.

However, for Alternatives B & C, additional land would have to be stripped of its natural vegetative cover and filled to support the cooling towers. The land involved is a mangrove swamp located behind the dune line and which is probably the reason this dune line developed. The dune line presents a natural protection against wave action and the swamp vegetation against erosion. There would undoubtedly be some adverse erosive effects; however, it would be impossible to quantify without considerable additional study. It is therefore judged that for Alternatives B & C a moderate amount of erosion would occur.

NOTE 16

Based on experience with nuclear units of this type, the overall noise level would be expected to be in the order of 65 db(A) at a distance 100 feet from the plant and that level would be reduced to approximately 45 db (A) at 8000 feet from the plant. Under HUD guidelines 45 db(A) is termed "Clearly Acceptable". This effect is therefore considered negligible.

NOTE 17

The operation of the Alternative A cooling water system is not visible from areas outside the plant area and would therefore have a negligible adverse effect on the scenic values of the general area. The cooling towers considered in Alternatives B & C, however, would be highly visible for many miles around. This is particularly so since most of the time a vapor plume will be generated. The aesthetic impact is therefore judged to be substantial.

NOTE 18

The effects on wildlife for the entire plant are discussed in Chapter 5 of this report. The additional effects due to alternate cooling water systems is deemed to be negligible.

NOTE 19

The area salt disposition has been illustrated on exhibits presented with this chapter. With Alternative B (mech draft towers) the salt deposition is heaviest in the plant vicinity and amounts to 5000 pounds per acre per year at the site. This reduces to 10 pounds per acre per year at a distance of about 12 miles from the site.

With the Alternative C natural draft towers, the deposition varies from 90 pounds per acre per year in the plant vicinity to 10 pounds per acre per year at a distance of 20 miles from the site.

The effects on plants and animals is difficult to assess. The area involved is a coastal area and is subjected to salt depositions from the dynamics of the ocean.

NOTE 20

With Alternative A, the once thru system, there is no additional salt deposition to the surrounding areas. With Alternatives B & C, however, there is an additional salt deposition over the natural deposition from the ocean. The additional corrosive effect is not evaluated here; however, it is judged that these effects would not be major mainly because the areas in the immediate vicinity of the plant, where depositions are heaviest, are sparsely settled.

NOTE 21

Of the three viable alternatives studied here, Alternative A, the once-thru system similar to the Unit No. 1 operation, is judged to have the least adverse environmental effect as well as being considerably less costly than the other alternates.

Alternatives B & C exhibit substantial environmental impacts in the following areas:

- a) Construction - additional land must be altered to construct the cooling tower and associated piping.
- b) Plant capability is reduced by approximately 2.6 percent.
- c) The visual impact of the towers and associated plumes is substantial and completely out of harmony with the scenic values of the area.
- d) Additional salt is deposited over a relatively large area. While it is difficult to quantify the effect, it is obvious that there will be an adverse effect. A large percentage of the surrounding area is given over to raising citrus crops and there is evidence that salt deposition could damage at least some of the crops.
- e) Additional fogging produced in the area as a result of the cooling tower operation.

The only environmental advantage is that the Alternative A thermal effects on the Atlantic Ocean are reduced because the waste heat is dissipated directly to the atmosphere. Since this impact for Alternative A is not judged to be a major impact in the first place, reducing that impact at the expense of added new, substantial impacts is not considered desirable.

TABLE 10.1-3

Alternative Cooling Water Systems
Economic Summary

	<u>Alternative A</u> <u>in \$1000s</u>	<u>Alternative B</u> <u>in \$1000s</u>	<u>Alternative C</u> <u>in \$1000s</u>
Total Capital Cost (1978)	20,500	23,400	31,000
Capital Cost	(4,460 kw)	(35,500 kw)	(34,800 kw)
Differential Capacity	695	5,450	5,450
Total Capital Cost (C _i)	21,195	28,850	36,450
Differential Annual Operating and Maintenance Cost (O _t)	-	180	450
Differential Annual Fuel Costs	(4,460 kw) 63	(35,500 kw) 495	(34,800 kw) 485
Total Generating Cost Present Value GC _p Average Cost of Capital = 9.75% Discount Factor = 0.912	21,815	35,610	45,660
Total Generating Cost-Present Value Annualized (GC _a)	2,280	3,714	4,760

Note: Total capital cost of each of the alternatives is estimated on the basis of a complete system. For Alternative A the estimate includes costing for plant intake structure, plant piping, seal well and ocean piping.

TABLE 10.1-4
COST DIFFERENTIAL FOR ALTERNATIVE COOLING SYSTEMS

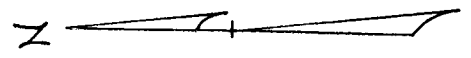
	<u>ALTERNATIVE</u> (x \$1,000)									
	A	B	C	D	E	F	G	H	I	J
Capital Cost	---	28,850	36,450	Not Estimated	11,800	3,500	Not Estimated	4,900	6,200	4,700
Annual Operating Cost (Fuel)	---	495	485	Not Estimated	129	47	Not Estimated	59	37	21
Additional Land in Acres	---	20	20	1,000	70	25	350	10	15	0-15

576,000mE

575,000mE

R 41 E

574,000mE



3027000mN

3026000mN

T. 36 S.

3025000mN

3024000mN

10-1-68 E. H. O'N.

DOROTHY K. SCHOENITH
CHARLES PASSATINO

BROWARD NATIONAL BANK
OF FORT LAUDERDALE

ST. LUCIE COUNTY

ATLANTIC

H I N S O N

OCEAN

STATE ROAD A-1-A

BLIND CREEK

BIG MUD CREEK

RIVER

INDIAN

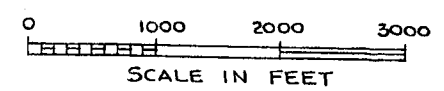
PLANT SITE
SWITCHYARD

FREDERICK C. MAYER

FOUR TREES
ASSOCIATES, LIMITED

ST. LUCIE COUNTY
T 36 S R 41 E

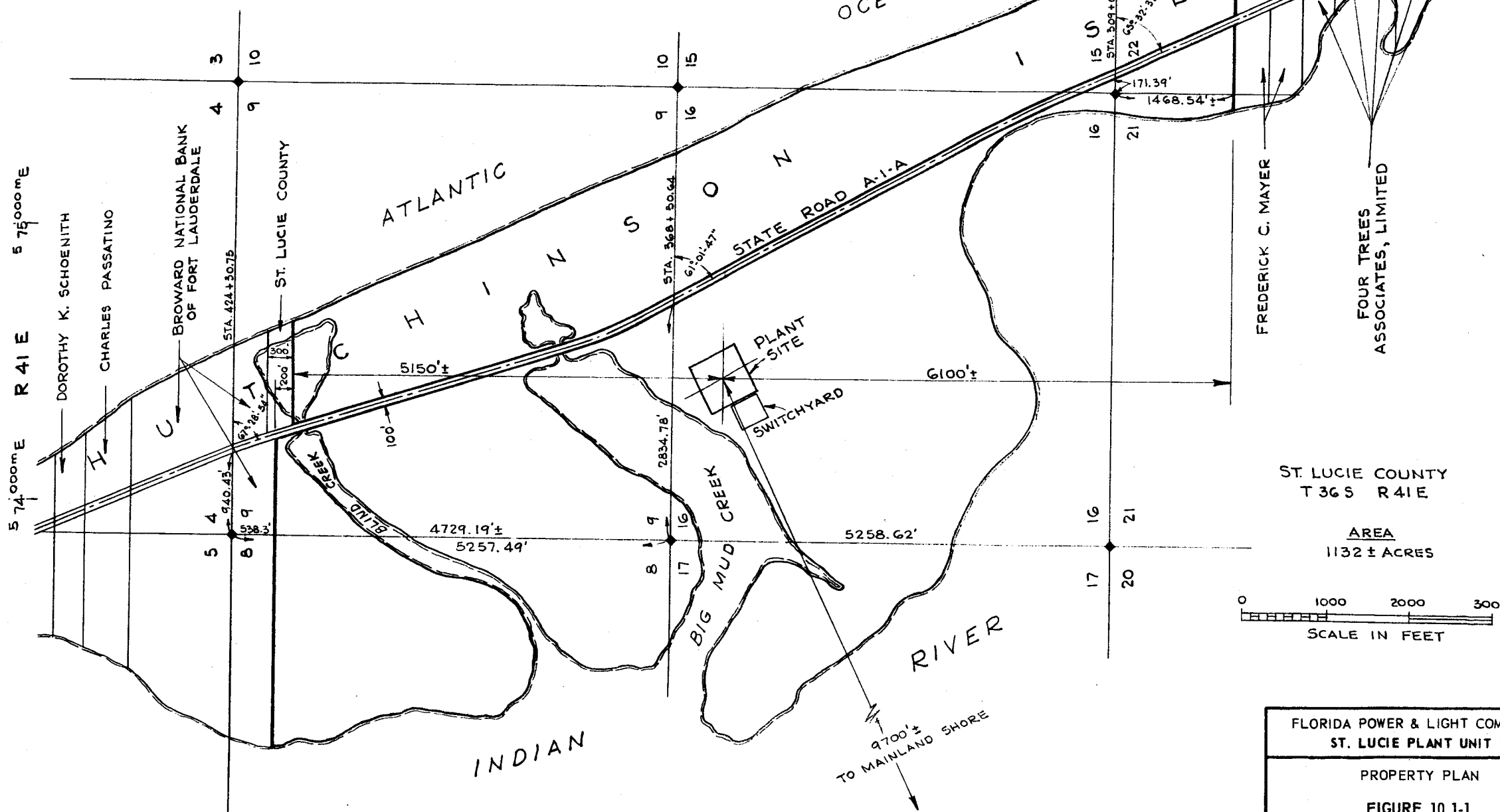
AREA
1132 ± ACRES

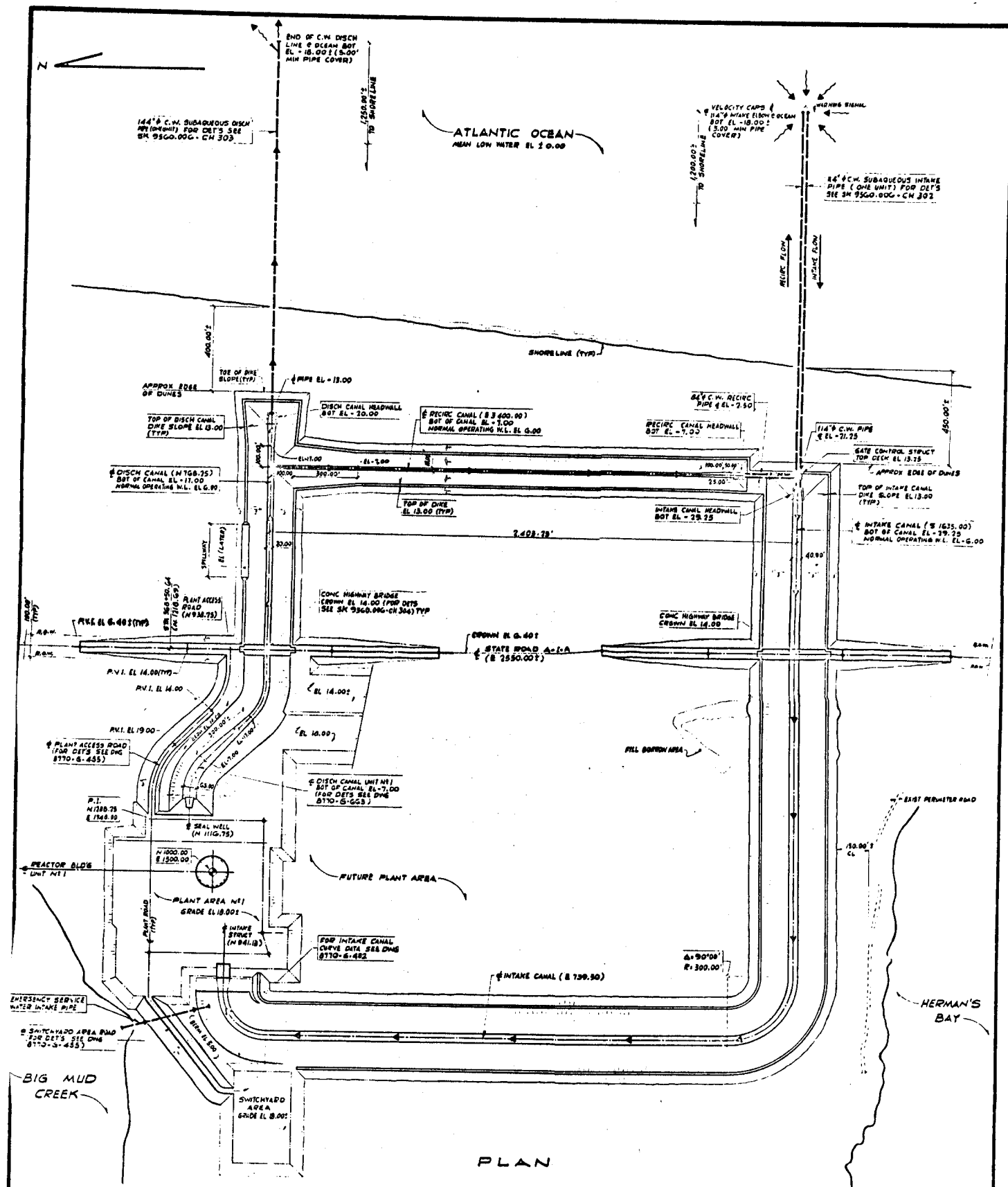


FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

PROPERTY PLAN

FIGURE 10.1-1

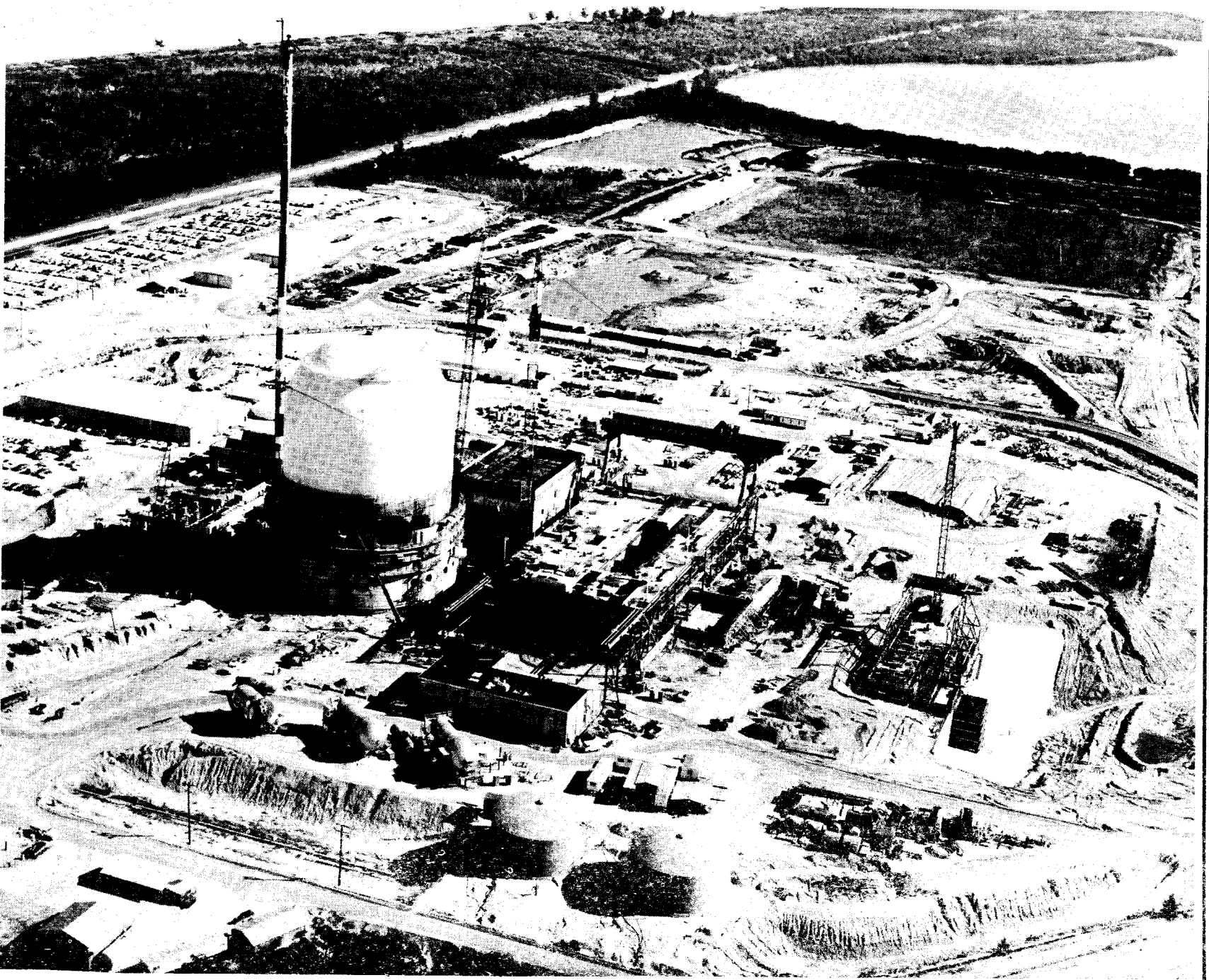




FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

CIRCULATING WATER SYSTEM

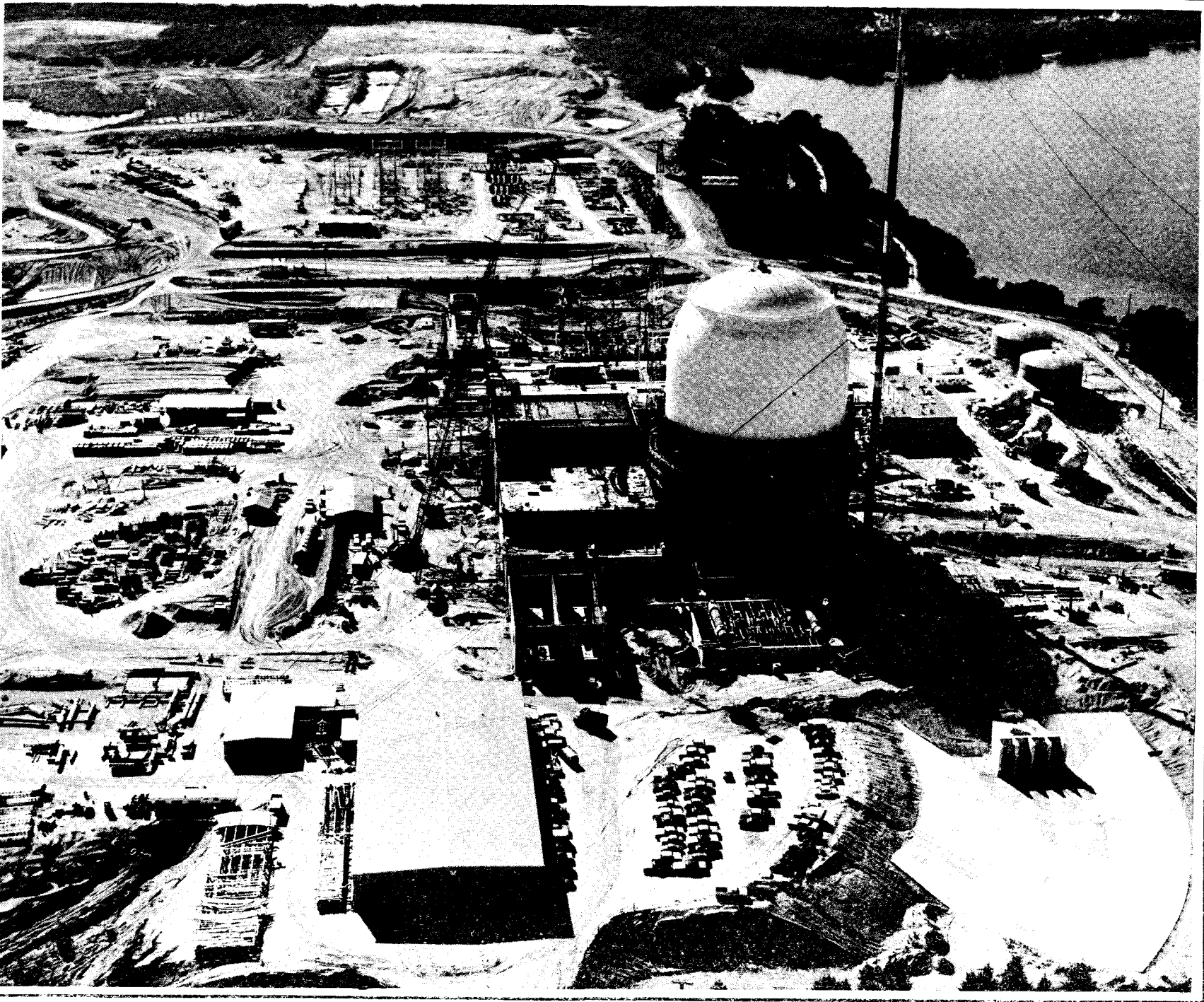
FIGURE 10.1-2



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

AERIAL PHOTOGRAPH OF UNIT NO. 1
CONSTRUCTION AS OF NOVEMBER 17, 1972

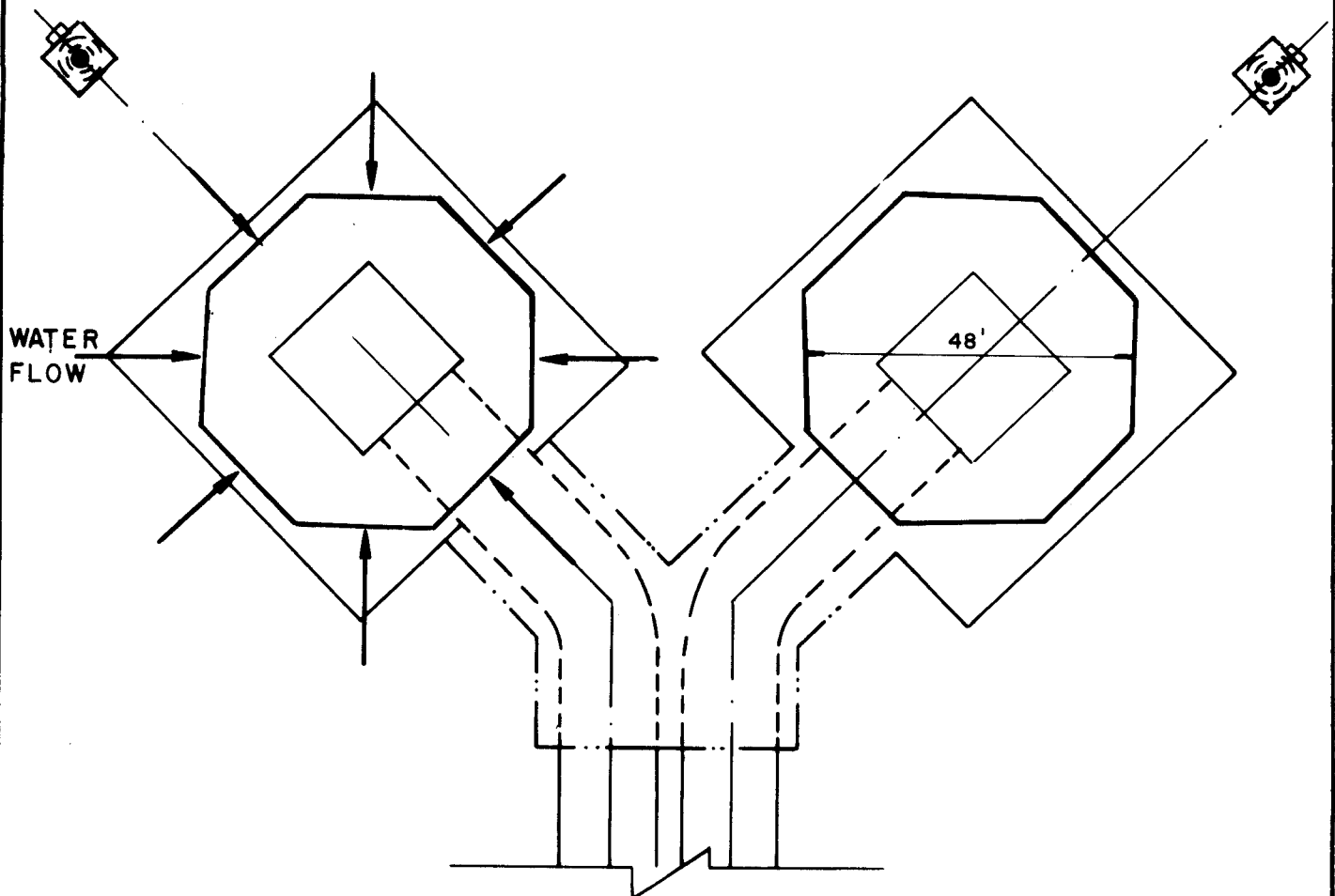
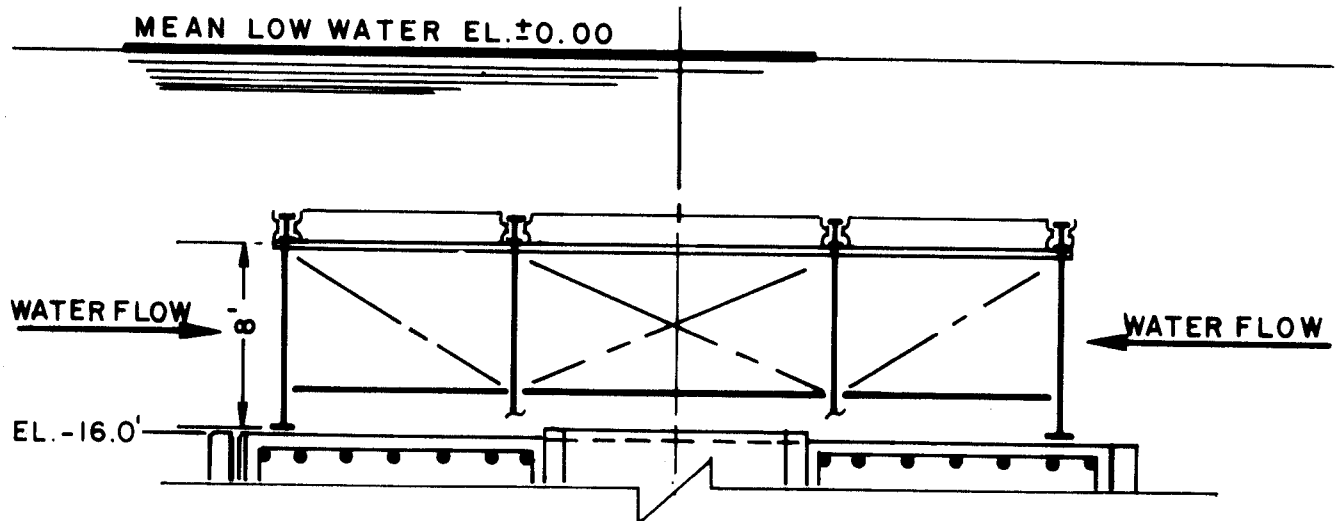
FIGURE 10.1-3



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

AERIAL PHOTOGRAPH OF UNIT NO. 1
CONSTRUCTION AS OF NOVEMBER 17, 1972

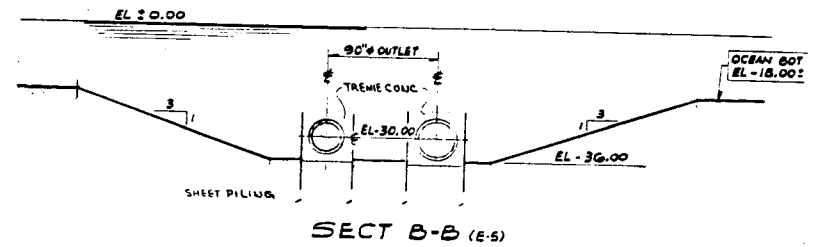
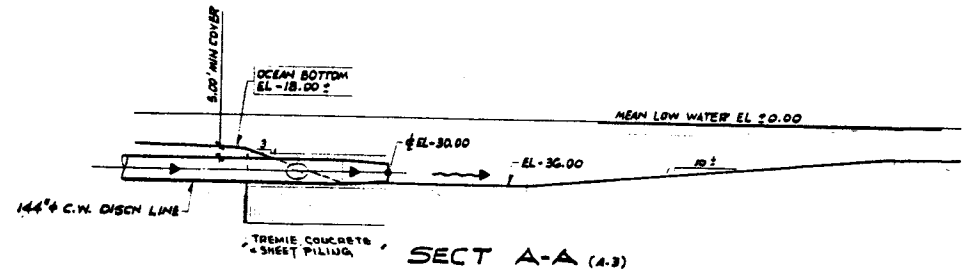
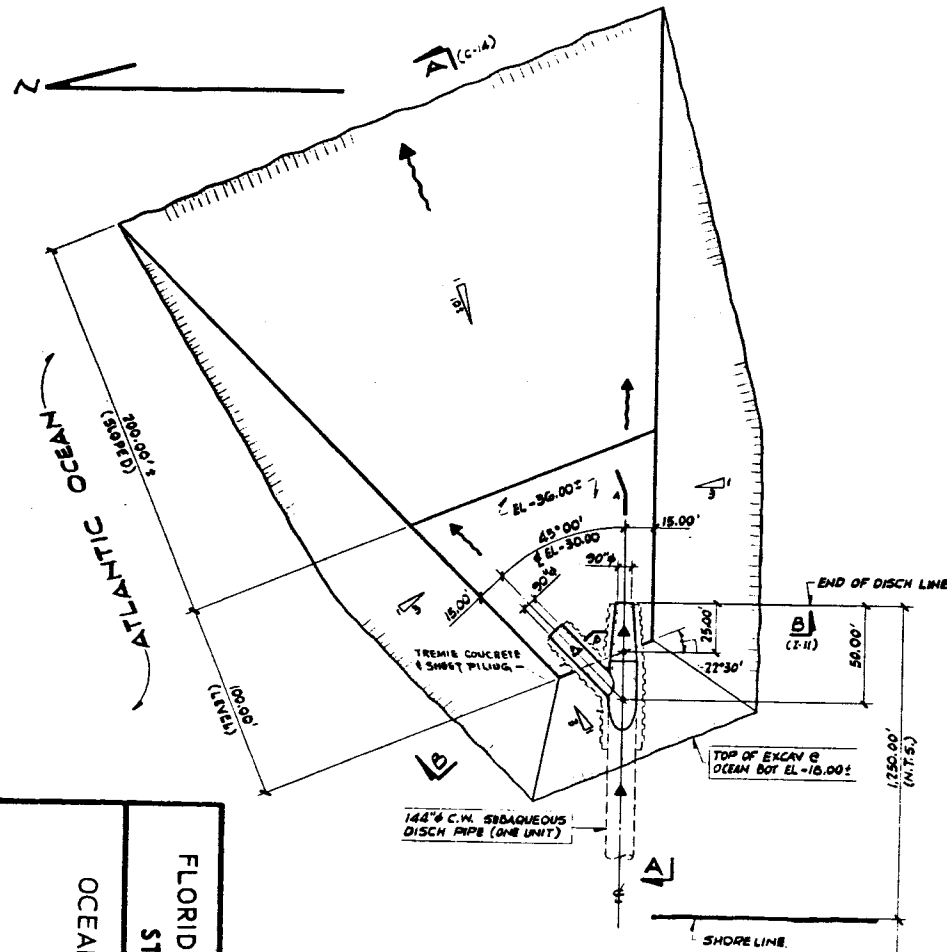
FIGURE 10.1-4



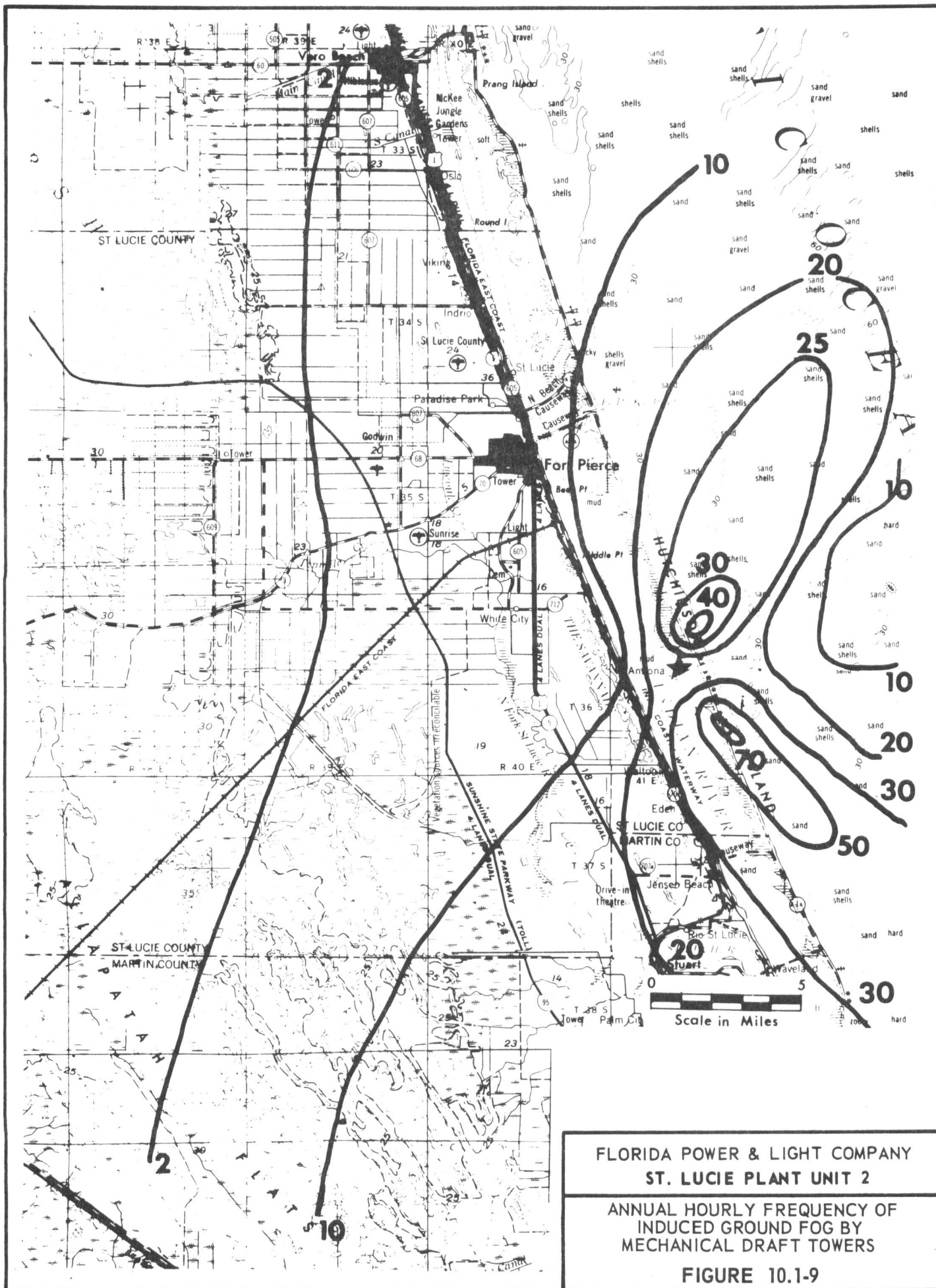
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

DETAILED VELOCITY CAP FOR
COOLING WATER INTAKE

FIGURE 10.1-5



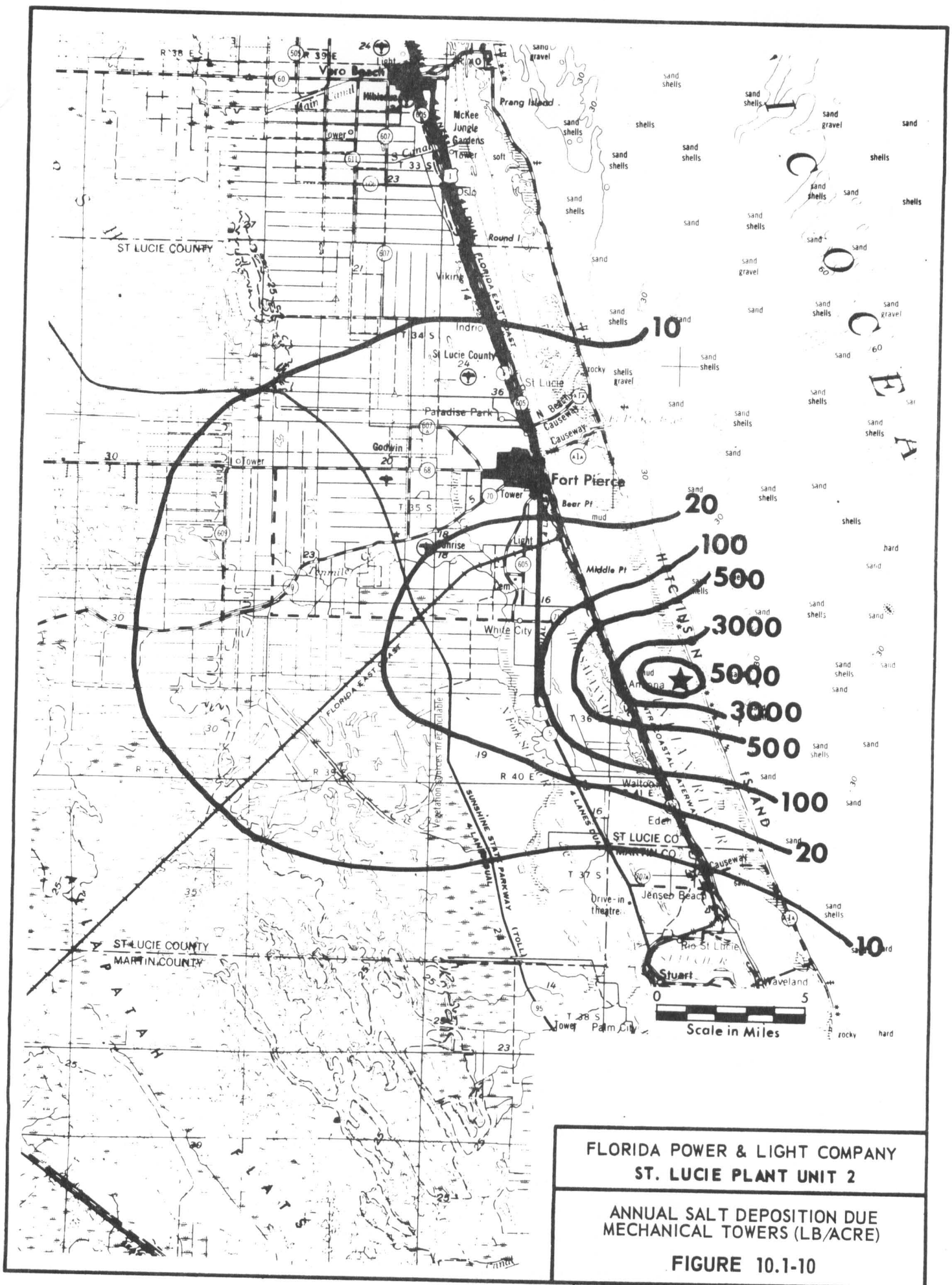
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
OCEAN DISCHARGE STRUCTURES
FIGURE 10.1-6



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

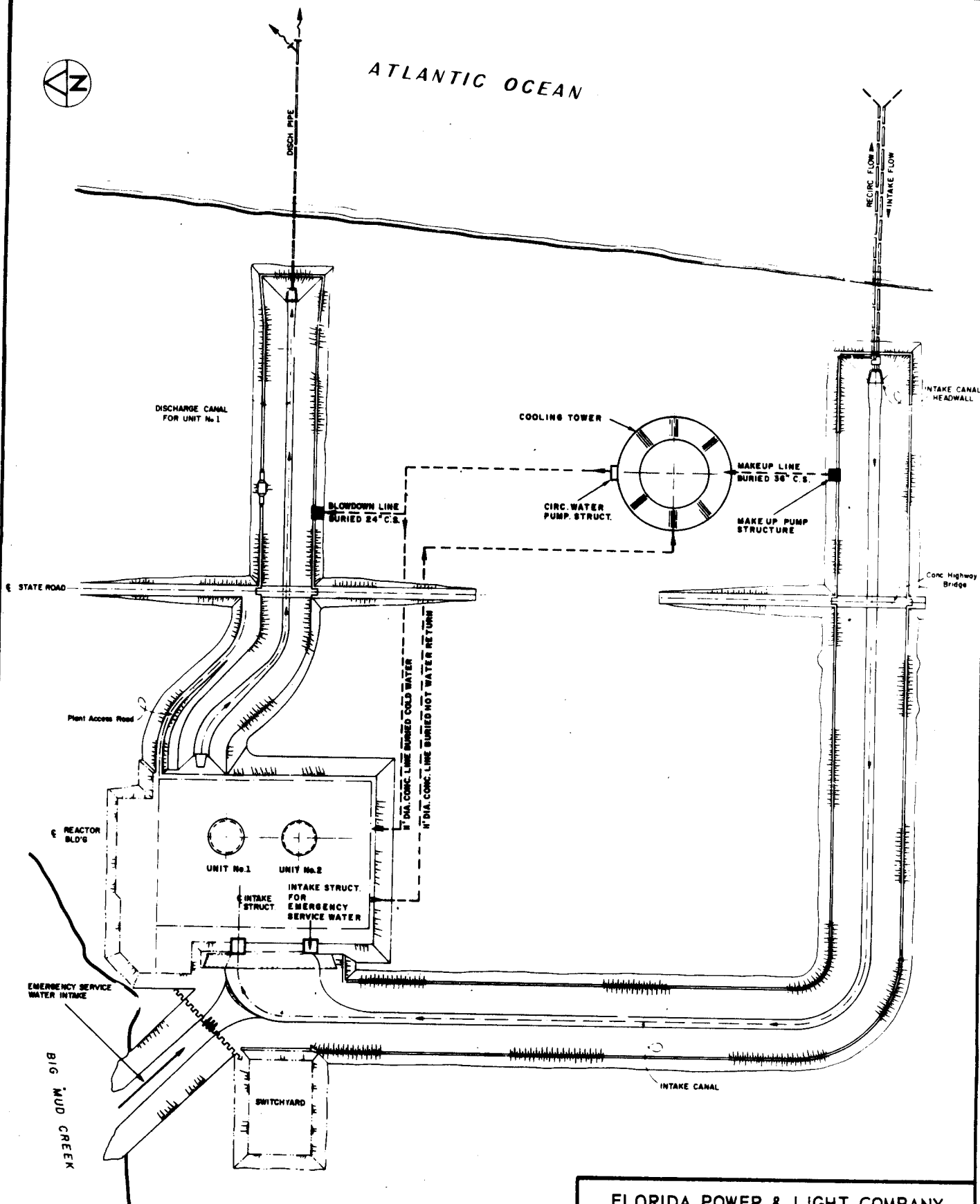
ANNUAL HOURLY FREQUENCY OF
INDUCED GROUND FOG BY
MECHANICAL DRAFT TOWERS

FIGURE 10.1-9





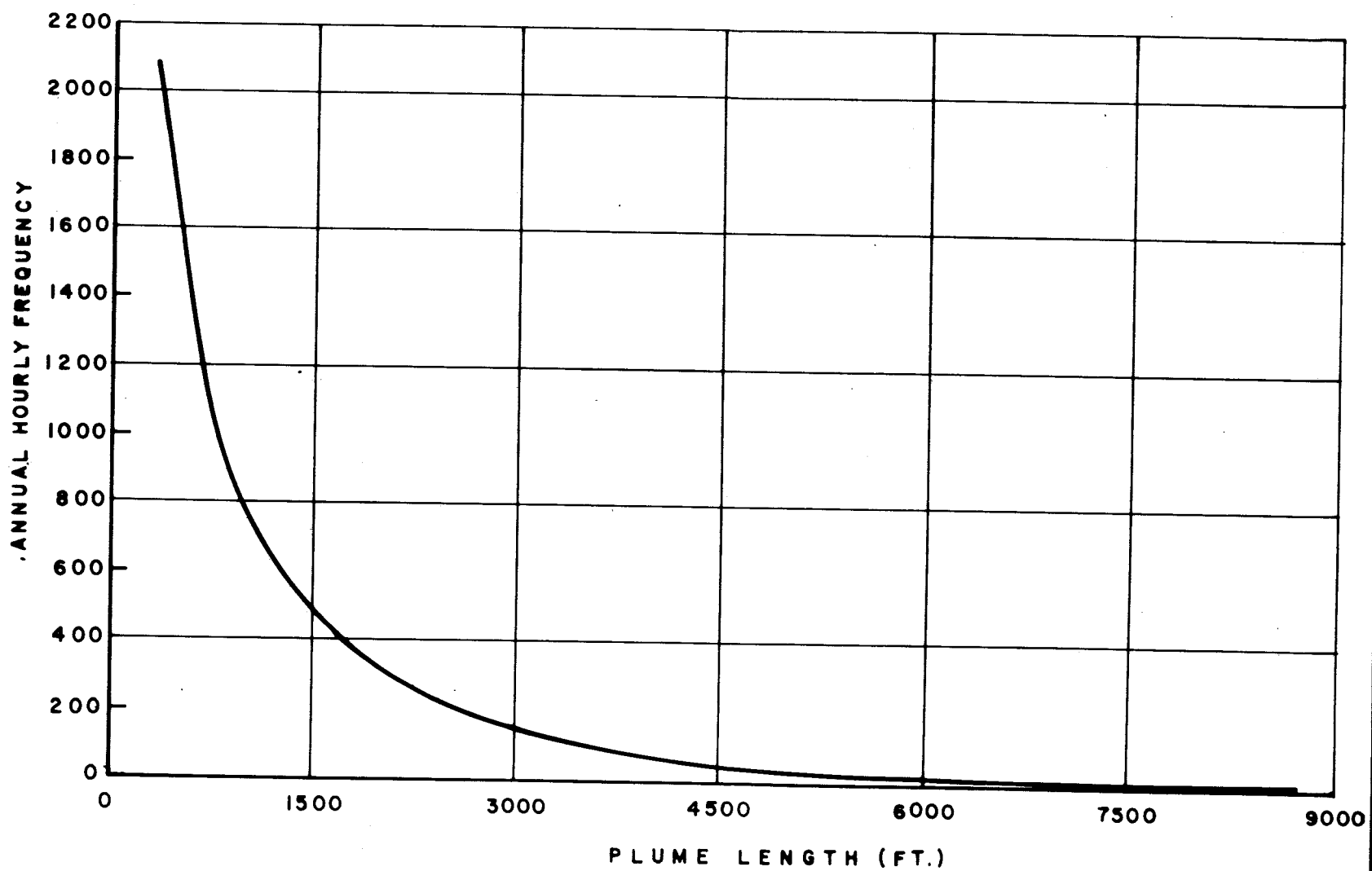
ATLANTIC OCEAN



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

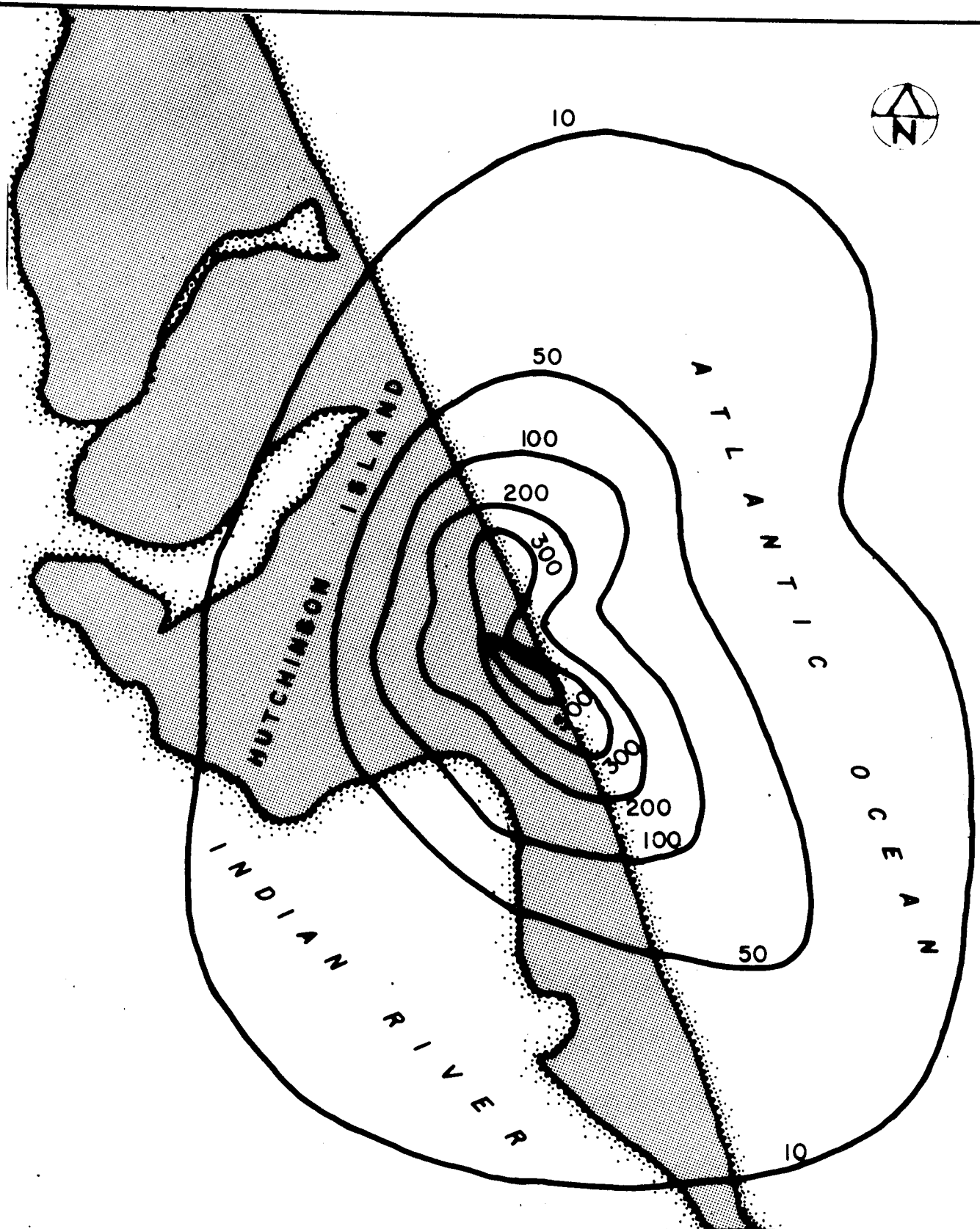
ENVIRONMENTAL REPORT ALTERNATE
COOLING WATER SYSTEMS PLAN -
ALTERNATE C

FIGURE 10.1-11



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
ANNUAL HOURLY FREQUENCY OF
NATURAL DRAFT COOLING TOWER
PLUME LENGTHS

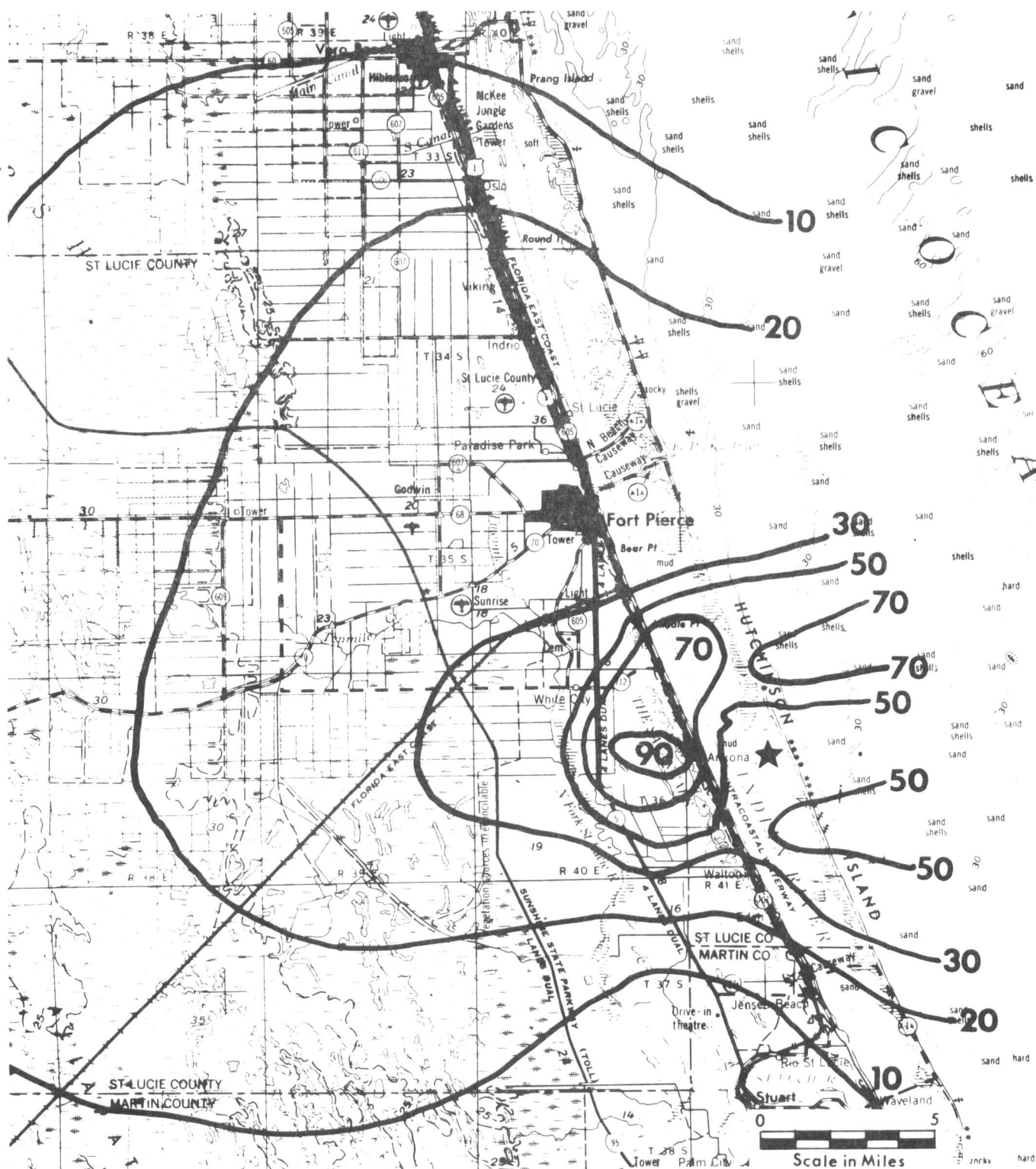
FIGURE 10.1-12



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ANNUAL HOURLY FREQUENCY OF
OVERHEAD PLUMES DUE TO
NATURAL DRAFT TOWER

FIGURE 10.1-13



**FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2**

**ANNUAL SALT DEPOSITION DUE TO
NATURAL DRAFT COOLING TOWER
(LB/ACRE)**

FIGURE 10.1-14

10.2 INTAKE SYSTEM

Since the presently installed Intake System provided for Unit No. 1 is adequate for the additional cooling water requirement for Unit No. 2, no alternatives were considered. The present design carrying the combined flow for Units Nos. 1 and 2 will maintain an entrance velocity of 1 ft/sec maximum. Therefore, it is not anticipated that there will be any environmental impact due to the operation of the additional Unit No. 2.

10.3 DISCHARGE SYSTEM

Since a once through cooling system was selected for Unit No. 2 on the basis presented in Section 10.1, a discharge system as described in Section 3.4, a multiport sub-aqueous discharge, was the only viable and practical alternative that would meet current state thermal discharge limits.

10.4 CHEMICAL SYSTEMS

10.4.1 GENERAL

The plant water use is described in Section 3.3 of this report. There it is noted that chemical systems for the two 850 MW units are associated with cooling water treatment, treatment of steam generator water, and the potentially radioactive liquid wastes. This section will describe the chemical systems associated with cooling water and steam generator makeup water treatment. The discussion and data for the potentially radioactive wastes are presented in Section 10.7.

For the proper treatment of cooling water, the fouling and scale forming tendencies of the various constituents must be evaluated. Where treatment is indicated, the objective of such treatment is to maintain the cooling efficiency of the condensers while minimizing environmental effects and controlling the overall cost of plant operation.

Similarly, steam generator feedwater treatment is required to provide high quality water to the nuclear steam system for the required efficiency of steam generator, minimal maintenance and long plant life. Natural waters almost never meet these standards for low mineral content. The system to be used for St. Lucie Unit No. 2 is a duplicate of the system provided for Unit No. 1 and is a viable alternative for providing the required large volume of high purity water.

10.4.2 EVALUATION OF COOLING WATER PROPERTIES

At St. Lucie Unit No. 1 and Unit No. 2, the plan is to use sea water for cooling on a once-through basis. Because there is no evaporation, no scaling due to thermal action on bicarbonates, or scaling due to silica or sulfate can occur. Accordingly it is concluded that the only treatment required for sea water is thermal treatment of the intake, and chlorination for maintenance of the piping and steam condenser tubes.

10.4.3 EVALUATION OF STEAM GENERATOR MAKEUP WATER

As outlined in Section 3.3, the city water supply of Fort Pierce, Florida is used for the steam generator water makeup. Section 2.5 provides average and maximum analyses of the city water quality. An evaluation of these data indicates the requirement for demineralization prior to use as makeup water for the high pressure nuclear steam generating system.

The demineralization system to be used comprises the following sequential unit processes:

- Carbon Filters
- Organic Scavenger
- Strong Acid Cation Exchanger
- Weak Base Anion Exchanger
- Mixed Bed Polishing Exchanger

Some design features of the proposed system follow:

- A - For the first 850 MW unit two trains of demineralization have been provided. Each train was designed based on an average flow of 375 gpm. If additional demineralizer capacity is found necessary for Unit No. 2, it will be added at a later date.
- B - The carbon filters will consist of four pressure filter units 8 ft in diameter each containing 100 cubic ft of carbon granules with a gravel support.
- C - The organic scavenger will consist of two units 6½ ft in diameter each containing 131 cubic ft of ion exchange resin to absorb calcium and other metallic ions. The regeneration of the resin occurs by using the partially spent caustic from the regeneration cycle of the strong and weak base anion exchangers.
- D - The strongly acidic cation consists of 2 units 8½ ft in diameter each of which contains about 316 cubic feet of resin. The regenerants are 1 and 5 percent sulfuric acid.
- E - The weak base cation exchanger will consist of 2 units 8½ ft in diameter holding about 109 cubic feet of resin. The regeneration will be with the partially spent caustic effluent of the strong base regenerant cycles.
- F - The strong base anion exchanger will consist of 3 units, 7½ feet in diameter each holding about 297 cubic feet of resin. The regeneration will be with 7 percent caustic.
- G - The mixed bed polisher will be 2 feet in diameter and contain anionic and cationic resins. Regeneration is with 8 percent sulfuric acid and 4 percent caustic soda.

10.4.4 OPERATIONAL MODE AND REGENERATION REQUIREMENTS

For the ion exchange system, one regeneration per 30 hrs per train is planned for the anionic and cationic exchanger resin beds. But the mixed bed demineralizer will be regenerated approximately once per week. Approximately 4300 pounds of 98 percent sulfuric acid will be used per cycle per train in the regeneration of the strongly acidic cation exchangers. The anion exchangers and organic scavenger will use approximately 2600 pounds per regeneration per train of 50 percent sodium hydroxide. The mixed bed demineralizer will use approximately 700 pounds each of 98 percent sulfuric acid and 50 percent caustic soda.

10.4.5 REGENERANT WASTE CHARACTERISTICS

The city water analysis determines the quality and quantity of the regenerant waste stream.

The daily volume of regenerant waste produced is approximately 150,000 gallons, maximum, based on regenerating 2 trains in one day.

Based on the foregoing and the city water analysis presented in Section 2.5, it is estimated that the total mix of regenerant wastes will have the following characteristics:

Volume - 150,000 gallons per day maximum

pH - acid until neutralized by base. The water waste before treatment will contain approximately 1.7×10^6 lbs of excess acid per year which will require about 1×10^6 lbs of 100 percent NaOH for neutralization to pH = 7.0, approx.

Total Dissolved Solids - Approximately 613 ppm based on raw water flow of 750 gpm. Based on 1-850 MW unit, this is equivalent to about 3.67 tons per day of total dissolved solids. A total of 7.35 tons per day of dissolved solids will be added to the condenser cooling water, discharged to the ocean, as a result of the operation of both 850 MW units. This will increase the concentration of dissolved solids in the 1,300,000 gpm condenser cooling water flow by less than 1.0 ppm.

10.5 BIOCIDE SYSTEMS

All cooling water systems are subject to growth of fungi and bacteria which, with inorganic and other organic materials, usually adhere to metal surfaces. Such slime deposits can reduce the heat transfer of surface condensers and may promote corrosive attack of the metal tubes and tube sheets. Bacteria and other organisms grow as slime masses in zones not subject to sunlight or ultraviolet rays. Aerobic bacteria can produce an environment favorable for anerobic bacteria which can reduce sulfates to sulfides. These compounds are corrosive to certain metals.

Fungi comprise simple plants, molds and yeasts, and may be associated with bacterial slimes. All generally require water and oxygen for growth. Biostats and biocides are used to control these growths. The biocides kill the organisms; whereas biostats, which often are dilute solutions of biocides, inhibit their growth. Proper selection of a treatment program starts with a full definition of the anticipated problems. The rate of their formation, their nature, and the importance of eliminating the biological deposits must be determined. Factors in the selection of toxicant or toxicants depend on effectiveness, cost, safety in handling, possible side effects on the cooling system, plus environmental effects. The dosage schedule of frequency, time and required concentration of the biocide is important. Occasionally alternation or a mixture of agents proves more effective and less expensive than using a single agent. The need for alternation must also be determined. The alternative biocide systems considered for this project include oxidizing and non-oxidizing systems as listed:

- a) Chlorination
- b) Ozonation
- c) Mechanical Devices
- d) Copper Sulfate Addition and Other Alternatives

10.5.1 CHLORINATION

Chlorine is the biocide generally used to control biological fouling of condenser cooling systems. Used as a gas, it is available in liquid form, in steel cylinders (1 ton) and tank cars; and as sodium hypochlorite in solution (see Figure 10.5-1 Chlorination System schematic flow diagram). In water both chlorine and hypochlorite hydrolyze to hypochlorous acid and hydrochloric acid. The effective biocide is hypochlorous acid which ionizes to hydrogen, H^+ , and hypochlorite, OCl^- ions. In practice, these two prevailing active species, $HOCl$ and OCl^- , are referred to as "free available chlorine".

The usual mode of application for the treatment of a once-through seawater in Florida is described for control of slime in the cooling water system. For the control of slime in the cooling water system, a solution of chlorine in water at about 3 to 5 ppm is introduced into the suction of the circulating water pumps so that the chlorine residual

measured in the cooling water leaving the plant condensers is less than 1.5 ppm as free available chlorine. The chlorination treatment is repeated daily for a duration of approximately 15 minutes. Plant operating experience and time of year will dictate the final selected cleaning schedule.

The above system of chlorination treatment can also be accomplished by site generated hypochlorite. The operation would use the same chlorine dosage already described. The generation of sodium hypochlorite from seawater is feasible, and is more economical in use of salt and electrical power than generation of sodium hypochlorite from rock salt brine.

10.5.2 OZONATION

An alternate method to chlorination now gaining more prominence is ozonation. Ozone can be prepared from pure oxygen or from air. The air to be processed is cleaned, dried to -30 F dewpoint and passed through charged plate zones of high voltage, usually up to 20,000 volts. Under these conditions a small fraction of the oxygen, O_2 , in the air is converted to ozone, O_3 .

Ozone is a highly reactive form of oxygen having high biocidal powers.

Large cities such as Philadelphia and Paris have long used ozonation to deliver purified water into their distribution mains. In the past, using ozonation was more expensive than chlorination but newer, more reliable and more efficient ozone plants have placed the ozone process in a competitive position.

Another factor is that many usual chlorine sources have shorter supplies due to government restrictions on mercury cells; some sources of chlorine lack facilities to fulfill future contracts. The increasing cost plus governmental recommendations to limit chlorine use or storage at certain nuclear plants favors more serious consideration of ozone for biocidal use.

Dosage levels of up to 2 ppm ozone in the makeup water are contemplated. A preliminary flow diagram for ozonation appears in Figure 10.5-2. The ozonation system appears to be environmentally acceptable to the aquatic ecosystem. Because of the short half-life of the gas (approximately 20 minutes) it will not persist of any length of time in the discharge. At the present time very little information exists on the toxic effects of ozone on aquatic organisms.

10.5.3 MECHANICAL DEVICES

The problem of reducing slime and scale build-up on the inside of condenser tubes has also been successfully attacked directly. The mechanical approaches described here can reduce the usage of biocides to treat the cooling water. Two of the proprietary systems being used in large USA installations originated in Europe: Amertap and M.A.N.

The Amertap condenser tube cleaning system uses sponge rubber balls whose diameter is slightly larger than the inside diameter of the condenser tubes. These balls are continually recirculated through the condenser tubes. Their rubbing action scours the tube walls to maintain the condensing rate of heat transfer. The attached Figure 10.5-3 shows a general outline of the overall cleaning system. It includes ball recirculating pump (s), balls collector (s) and an arrangement for ball re-injection.

A variation called M.A.N. uses plastic brushes instead of the sponge rubber balls. This system requires cages which fit on the inlet and outlet end of each condenser tube. To cause these brushes to travel over the tubes, an external arrangement of piping and water reversing flow valves is used. By periodically changing the direction of the water flow, each plastic scrubbing brush is moved through each tube.

A major advantage of this system is the ability to use better wearing brushing materials. Thus maintenance costs can be less than for the relatively fragile sponge rubber balls. Initial costs may also be less.

These systems are gaining wider acceptance in certain areas for problem cooling waters. A Figure 10.5-4 attached illustrates some of the features of use and operation.

The use of mechanical devices to minimize fouling in the cooling water have little impact on the aquatic biota. However, these systems are limited to condenser and heat exchanger defouling only and are not effective for cleaning valves, pumps and auxiliary piping. Thus, a supplementary chemical biocide system would be required to work in conjunction with either mechanical system.

10.5.4 COPPER SULFATE ADDITION AND OTHER ALTERNATIVES

In addition to the more usual biocides already described, there are several alternate materials. Prominent among them are copper sulfate, iodine and bromine.

Copper sulfate in cooling water systems has long been used to control the growth of algae. But at St. Lucie, the use of seawater for cooling on a once-through basis would result in conditions not conducive to the growth of algae (lack of light within the system). Since copper sulfate is not an effective slimicide, its use therefore is not recommended.

Considerations of effectiveness and cost rule out iodination, a process related to chlorination. Iodine crystals cost over \$1.00 per lb FOB, N.Y. in 150-lb containers. This compares with chlorine at a cost of about \$0.08 per lb in steel cylinders. As to effectiveness, free chlorine as HOCl is five times more viricidal and four times more cysticidal than HIO. Comparing the two, chlorination dominates on both counts, and is the method of choice over iodination for water treatment.

Regarding bromination, the germicidal efficiency of bromine, iodine, and chlorine has been compared by at least 10 investigators in the past three decades. In the pH range of 8 to 9 (Seawater: 8.3 pH) molecular bromine is converted to hypobromous acid. Generally the killing rates of bacterial spores decrease in this order: chlorine, bromine, and iodine. Liquid bromine at 1 to 2 ppm is as effective as 0.6 ppm of available chlorine in water. Again it is concluded that chlorine is superior because bromine is hazardous to handle, is less biocidal, and in small quantities costs over \$9.00 per lb. Bromine is the least efficient of the halogens, and because of cost, its use in stick form (as bromo-chloro-dimethyl hydantoin) is limited to small swimming pools where pH is controlled between 7.1 and 7.5.

10.5.5 CONCLUSION

The chlorination has been chosen since it is environmentally acceptable, there is positive control of the concentration of the free chlorine and there is maximum operating experience with this system.

The Cost Description - Alternative Biocide Systems data is presented in Table 10.5-1.

TABLE 10.5-1

COST DESCRIPTION - ALTERNATIVE BIOCIDES SYSTEMS

ALTERNATIVES		"A" Cl ₂	"B" Ozone	"C" M.A.N.	"D" Amertap
INCREMENTAL GENERATING COST					
Present Worth		\$2,536,000.	\$3,300,000.	\$4,624,000.	\$4,296,000.
Annualized		\$264,000.	\$343,000.	\$478,000.	\$510,000.
CAPACITY FACTOR		0.8	0.8	0.8	0.8
ENVIRONMENTAL COSTS					
UNITS		Magnitude	Magnitude	Magnitude	Magnitude
CHEMICAL SPECIES DISCHARGED (LIST BELOW)					
(indicate concentrations at point of discharge)					
ppm		max. 1.5 free Cl ₂ residual	max. 1.5 O ₃ residual	max. 1.5 Cl ₂ residual	max. 1.5 Cl ₂ re- sidual
1. Natural Surface Water Body					
1.1 Impingement or entrapment by cooling water intake structure					
1.1.1 Fish	-	Nil	Nil	Nil	Nil
1.2 Passage through or retention in cooling systems					
1.2.1 Phytoplankton and zooplankton					
1.2.2 Fish					
1.3 Discharge area and thermal plume					
1.3.1 Water quality, excess heat	-	none	Nil	none	Nil
1.3.2 Water quality, oxygen availability	ppm	no effect	.5 ppm O ₂ added	none	none
1.3.3 Aquatic organisms				none	none
1.3.4 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)	-	Nil	Nil	none	none
1.3.5 Fish, migratory	-	Nil	Nil	none	none
1.4 Chemical effluents					
1.4.1 Water quality, chemical	ppm	0.12 to 1.5 ppm free Cl ₂ residual	max. 1.5 O ₃ residual	max. 1.5 Cl ₂ residual	max. 1.5 Cl ₂ re- sidual
1.4.2 Aquatic organisms			Nil	none	none

SL2

TABLE 10.5-1 (Cont'd)

COST DESCRIPTION - ALTERNATIVE BIOCIDES SYSTEMS

ENVIRONMENTAL COSTS	ALTERNATIVES	"A" Cl ₂	"B" Ozone	"C" M.A.N.	"D" Amertap
	UNITS	Magnitude	Magnitude	Magnitude	Magnitude
1.4.3 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)				Nil	Nil
1.4.4 People	-	Nil	Nil	Nil	Nil
1.6 Consumptive use (evaporative losses)					
1.6.1 People	-	Nil	Nil	Nil	Nil
1.6.2 Property	-	Nil	Nil	Nil	Nil
1.7 Plant construction (including site preparation)					
1.7.1 Water quality, physical	-	Nil	Nil	Nil	Nil
1.7.2 Water quality, chemical					
1.8 Other impacts	-	Nil	Nil	Nil	Nil
1.9 Combined or interactive effects					
1.10 Net effects	-	Nil	Nil	Nil	Nil
2. Ground Water	-	Nil	Nil	None	None
2.1 Raising/lowering of ground water levels					
2.1.1 People					
2.1.2 Plants	-	Nil	Nil	None	None
2.2 Chemical contamination of ground water (excluding salt)					
2.2.1 People					
2.2.2 Plants					
2.3 Not applicable					
2.4 Other impacts on ground water	-	None	None	None	None

10.5-6

SL2

TABLE 10.5-1 (Cont'd)

COST DESCRIPTION - ALTERNATIVE BIOCIDES SYSTEMS

ENVIRONMENTAL COSTS		ALTERNATIVES	"A" Cl ₂	"B" Ozone	"C" M.A.N.	"D" Amertap
		UNITS	Magnitude	Magnitude	Magnitude	Magnitude
3.	Air					
3.1	Fogging and icing (caused by evaporation and drift)	-	None	None	None	None
3.1.1	Ground transportation					
3.1.2	Air transportation					
3.1.3	Water transportation		Nil	Nil	Nil	Nil
3.1.4	Plants		Nil	Nil	Nil	Nil
3.2	Chemical discharge to ambient air					
3.2.1	Air quality, chemical	-	Nil	Nil	None	None
3.2.2	Air quality, odor	-	Nil	Nil	None	None
3.3	Not applicable					
3.4	Other impacts on air	-	None	None	None	None
4.	Land					
4.1	Site selection					
4.1.1	Land, amount	S.F	1,801 S.F.	3,000 S.F.	Nil	Nil
4.2	Construction activities (including site preparation)					
4.2.1	People (amenities)	-	Nil	Nil	Nil	Nil
4.2.2	People (accessibility of historical sites)	-	Nil	Nil	Nil	Nil
4.2.3	People (accessibility of archeological sites)					
4.2.4	Wildlife	-	Nil	Nil	None	None
4.2.5	Land (erosion)	-	None	None	None	None
4.3	Plant operation (including site preparation)					

TABLE 10.5-1 (Cont'd)

COST DESCRIPTION - ALTERNATIVE BIOCIDES SYSTEMS

ENVIRONMENTAL COSTS	ALTERNATIVES	"A" Cl ₂	"B" Ozone	"C" M.A.N.	"D" Amertap
	UNITS	Magnitude	Magnitude	Magnitude	Magnitude
4.3.1 People (amenities)					
4.3.2 People (aesthetics)	-	Nil	Nil	None	None
4.3.3 Wildlife	-	Nil	Nil	None	None
4.3.4 Land, flood control	-	None	None	None	None
4.4 Salts discharged from cooling towers					
4.4.1 People	N.A.	-	-	-	-
4.4.2 Plants and animals	N.A.	-	-	-	-
4.4.3 Property resources	N.A.	-	-	-	-
4.8 Other land impacts	-	None	None	None	None
4.9 Combined or interactive effects	-	None	None	None	None
4.10 Net effects	-	Nil	Nil	Nil	Nil

TABLE 10.5-2

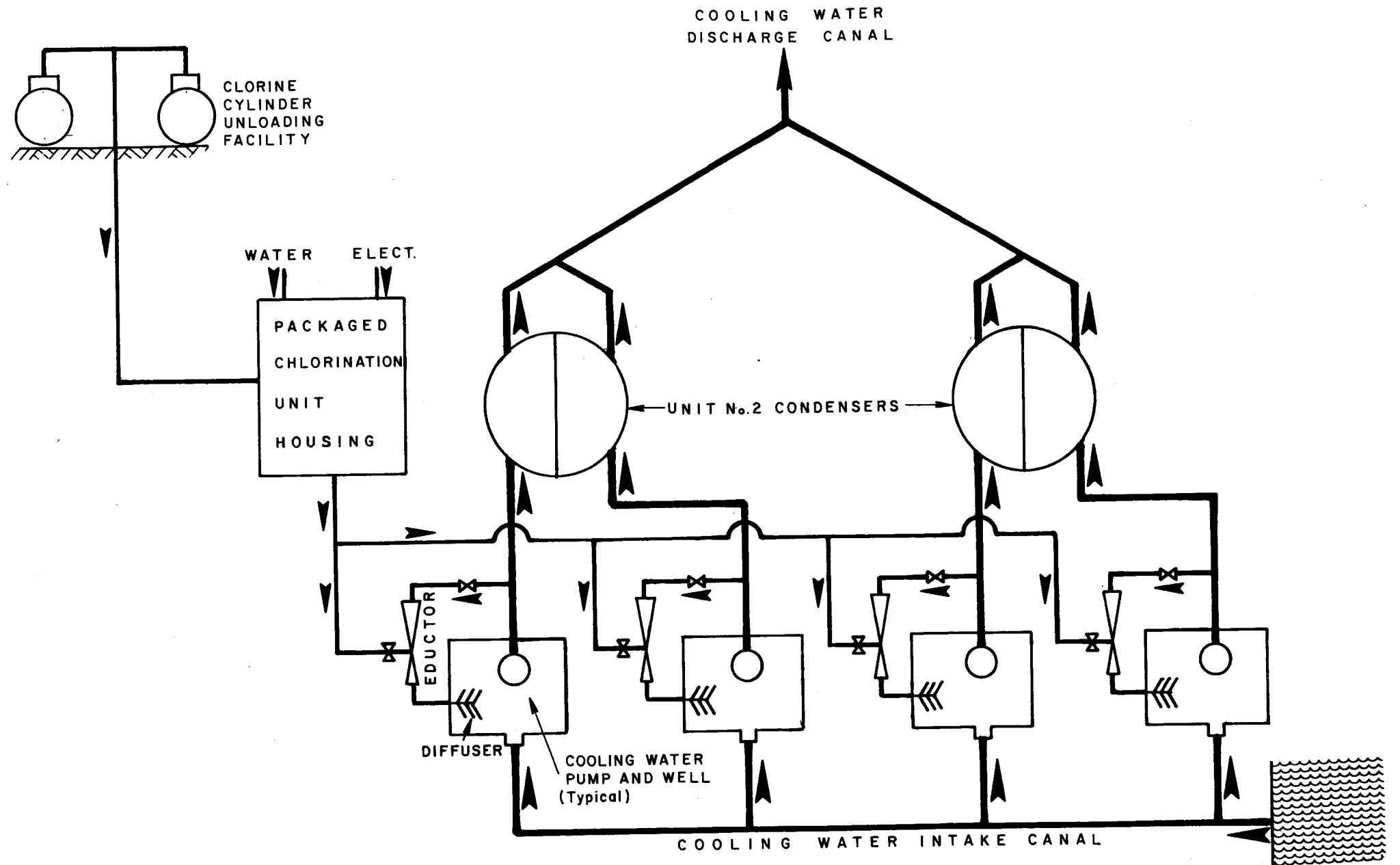
COST SUMMARY FOR ALTERNATIVE BIOCIDES SYSTEMS

Biocide Alternate	(Order of Magnitude) Capital Cost	To Mid- 1979 Interest ^{a)}	Est. Eng'g Cost*	Total Est. Capital C _I	Est. Annual Oper. Cost ^{b)}
	Est.	Est.		C _I	O _t
Chlorination	\$ 700,000	\$144,000	\$42,000	\$ 886,000	\$168,000
Ozonation	\$ 900,000	\$186,000	\$54,000	\$1,140,000	\$220,000
Mech. Clean Amertap - Sponge Balls	\$1,600,000	\$310,000	\$96,000	\$2,006,000	\$233,000
Mech. Clean M.A.N. Plastic brushes	\$1,400,000	\$270,000	\$84,000.	\$1,754,000	\$292,000

a) Interest at 9.75% assumes purchase in mid-1977.

* Based on Eng'g Planning at 6%.

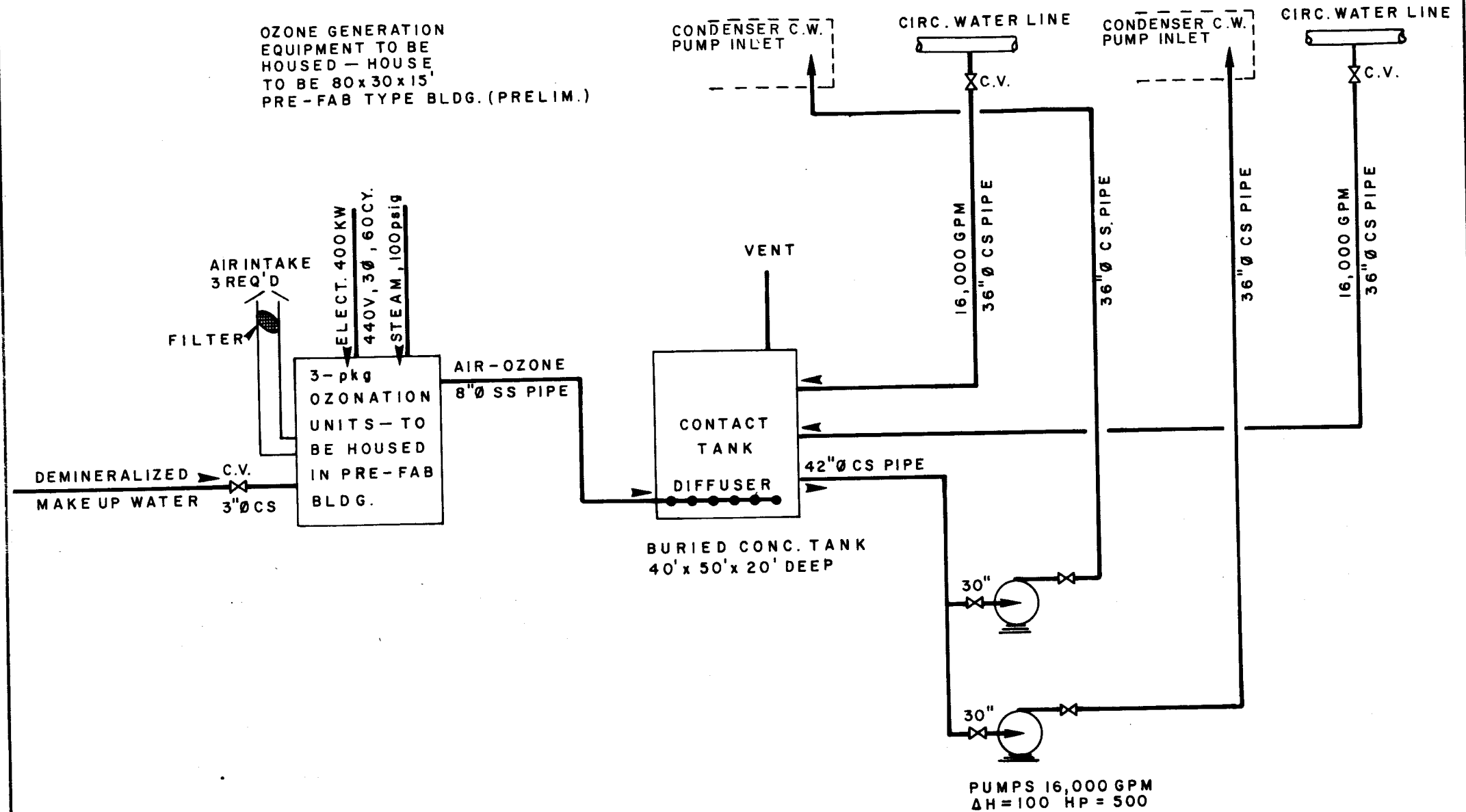
b) INCLUDES FIXED OPER. COSTS AT 15.1%.



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ALTERNATIVE "A" BIOCIDES SYSTEM
CHLORINATION SYSTEM SCHEMATIC
FLOW DIAGRAM

FIGURE 10.5-1

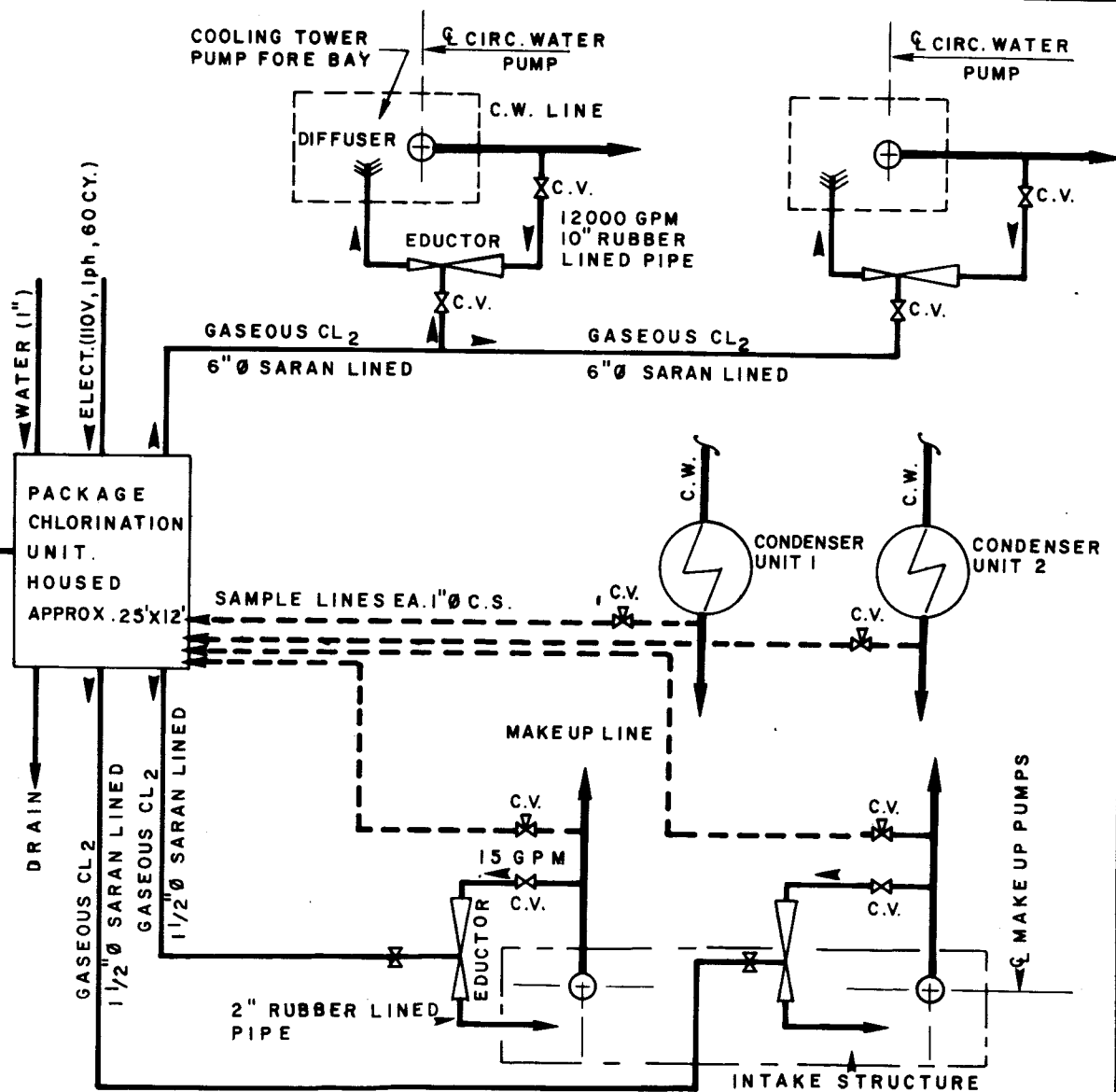
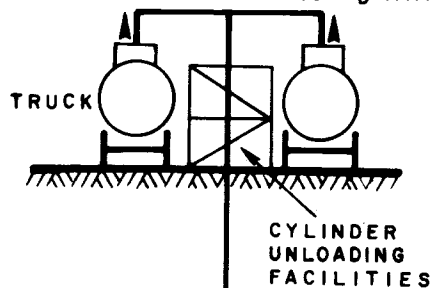


FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ALTERNATIVE "B" BIOCIDES SYSTEM
OZONATION SYSTEM SCHEMATIC
FLOW DIAGRAM

FIGURE 10.5-2

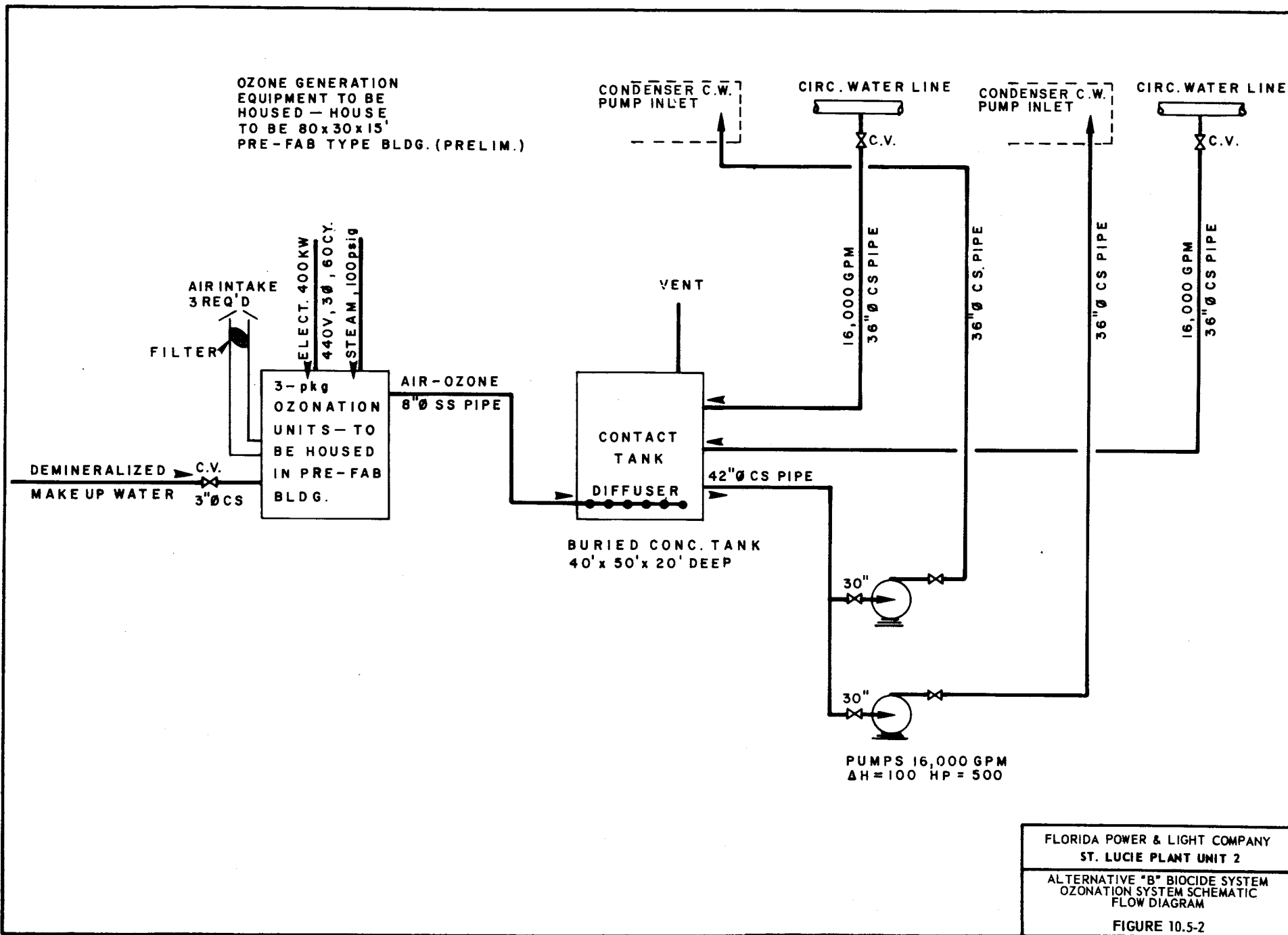
TRUCK CYLINDER UNLOADING
FACILITIES
(DESIGN USE RATE = 2.0 T/D MAX.)



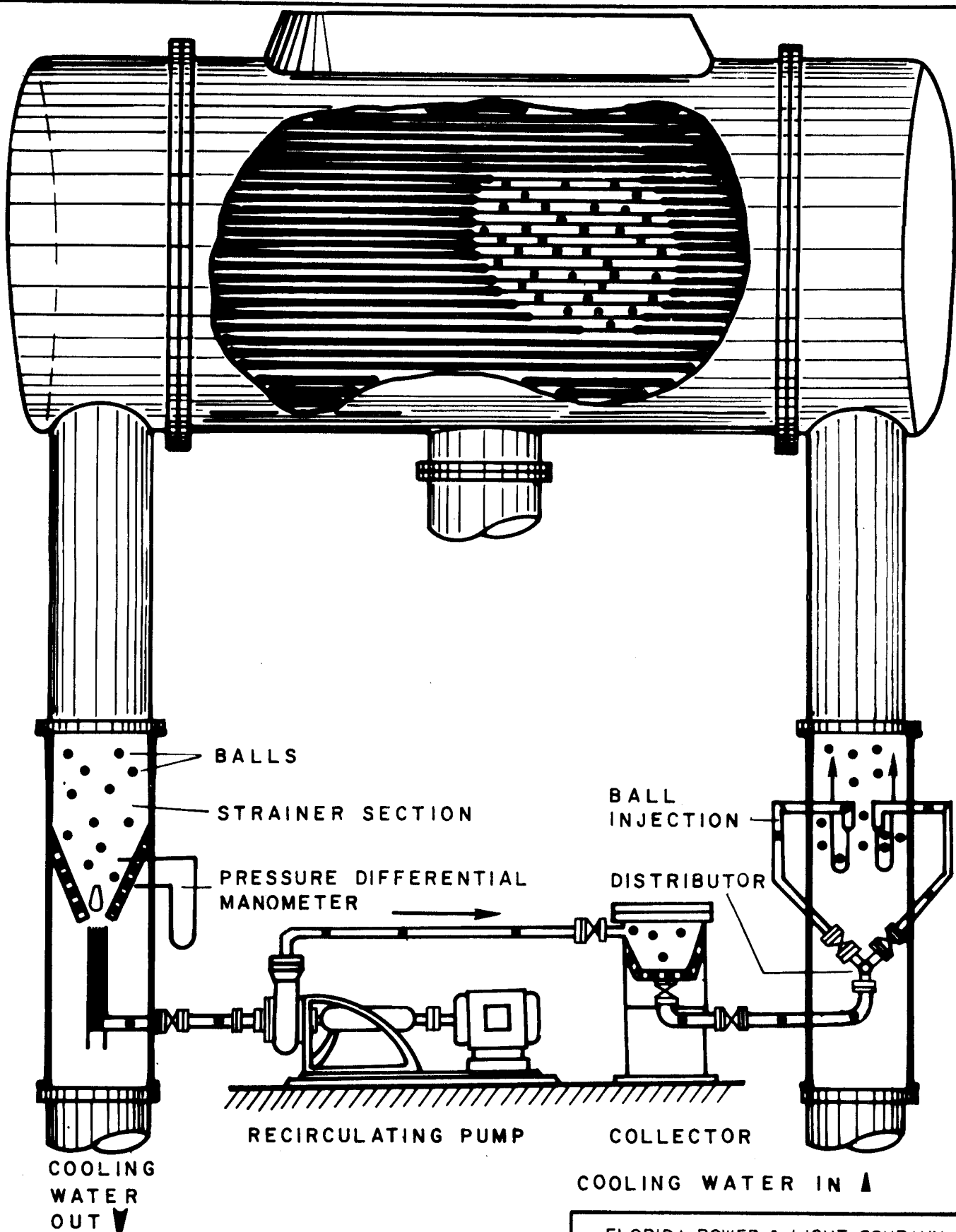
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

ALTERNATIVE "A" BIOCIDES SYSTEM
CHLORINATION SYSTEM SCHEMATIC
FLOW DIAGRAM

FIGURE 10.5-1



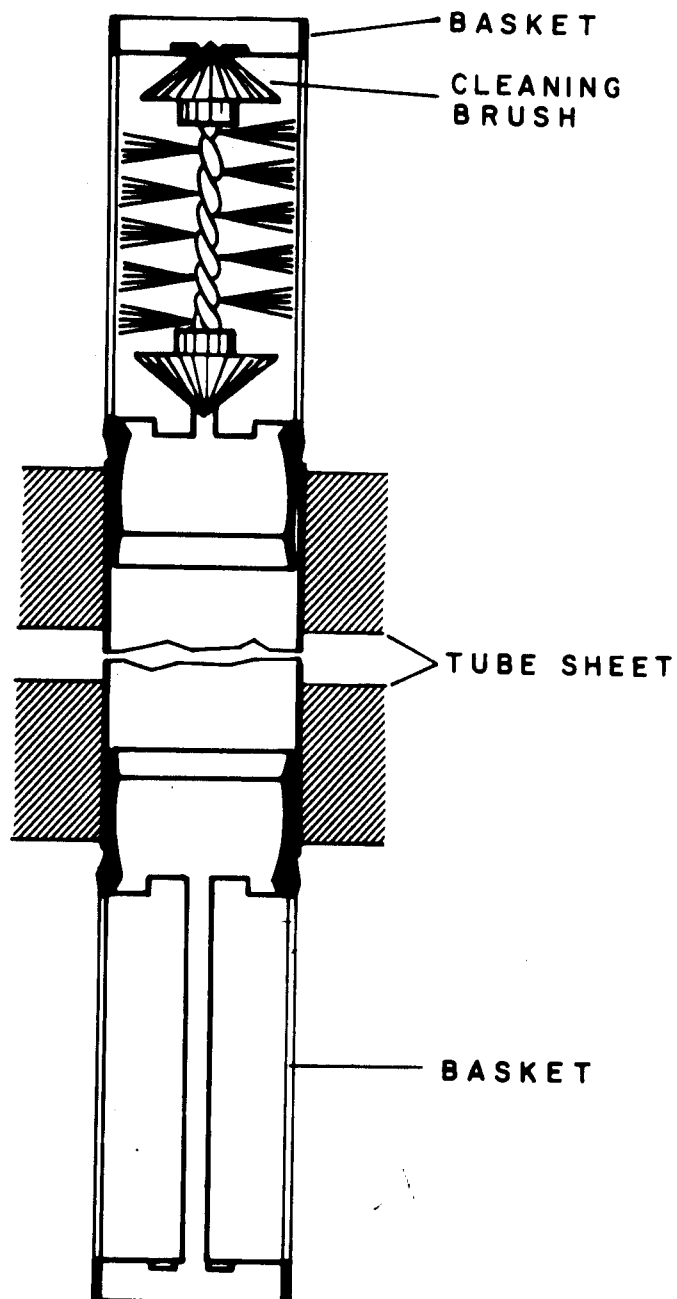
FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2
ALTERNATIVE "B" BIOCIDES SYSTEM
OZONATION SYSTEM SCHEMATIC
FLOW DIAGRAM
FIGURE 10.5-2



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

THE AMERTAP TUBE CLEANING SYSTEM

FIGURE 10.5-3



FLORIDA POWER & LIGHT COMPANY
ST. LUCIE PLANT UNIT 2

THE M.A.N. ON-LOAD TUBE
CLEANING SYSTEM

FIGURE 10.5-4

10.6 SANITARY WASTE TREATMENT AND DISPOSAL SYSTEM

10.6.1 GENERAL

For a permanent or semi-permanent population where sanitary facilities are provided, the sanitary wastes which are produced must be disposed of in an environmentally acceptable manner. Depending on site location, site conditions and regulatory constraints, a number of alternative sanitary waste disposal techniques may be feasible. Each of these alternative disposal techniques may, however, require different degrees of waste treatment depending on the explicit or implicit regulatory requirements governing a given disposal technique.

The purpose of this section is to identify and discuss alternative sanitary wastes disposal systems that are technically feasible and available for use in handling the additional sanitary wastes produced under operating conditions of St. Lucie Unit No. 2. Construction sanitary wastes are discussed in Section 4.3. For each disposal alternative, a description of effluent and/or treatment requirements associated with that alternative will be given. Finally, an evaluation of the alternatives will be made, and a recommended system will be selected.

In the following discussions and analyses, cognizance will be taken of the fact that a regulatory agency approved sanitary waste system is presently in service for St. Lucie Unit No. 1. This sanitary waste system has the capacity to handle the additional loads imposed by the operation of St. Lucie Unit No. 2.

10.6.2 SOURCES AND QUANTITIES OF SANITARY WASTES

Sanitary wastes produced at the plant site will be from normal sanitary uses that include showers and minor food preparation operations. Laundering wastes that are potentially radioactive will be handled via the radwaste system whereas clothes that are not potentially radioactive will be laundered by an off-site commercial establishment.

At operational levels, St. Lucie Unit No. 1 will normally be staffed by approximately 75 persons for maintenance, operation and administration over a 24 hour day, seven days per week. Upon initiating operation of St. Lucie Unit No. 2, the site staff will be increased by 25 persons to a total operational and administrative staff of approximately 100 persons for both plants. These totals include an approximate 10 percent excess to account for temporary personnel that may be required, on occasion, at the site under conditions of emergency maintenance or repair.

Based upon a flow of 20 gallons per capita per day, anticipated sanitary wastewater flows are 1500 and 2000 gallons per day, respectively, for the operation of St. Lucie Unit No. 1 and the combined St. Lucie Unit Nos. 1 and 2.

10.6.3 ALTERNATIVE SANITARY WASTE DISPOSAL TECHNIQUES

Three basic conceptual alternatives exist at the St. Lucie site concerning sanitary waste disposal. These are:

- a) Disposal to Surface Waters,
- b) Disposal to the Groundwater, and
- c) Zero Discharge.

The following describes the constraints and implementation needs associated with each of these disposal alternatives.

10.6.3.1 Disposal To Surface Waters

The quality of effluent discharges to the surface and coastal waters of the State of Florida is governed by Chapter 28-5 of the "Rules of the Florida Air and Water Pollution Control Commission." In general, the Rules require that an equivalent of secondary treatment be provided all waste discharges and that all discharges be free from settleable solids, floating, deleterious and toxic substances. Further, the Rules specifically state that "... when ... nitrates, phosphates, sulfates, sulfides ... occur in any amounts in any individual body of water, they shall be suspected of degrading the quality (of the receiving water)."

Based on the foregoing regulatory constraints, a minimum of tertiary treatment is required for sanitary wastes prior to discharging to surface or coastal waters.

10.6.3.2 Disposal To The Groundwater

Effluent discharges to the groundwater are regulated under the "Rules of the State of Florida, Department of Health and Rehabilitative Services, Standards for Individual Sewage Disposal Facilities, Chapter 10D-6". A major requirement is that discharge to the groundwater via a septic tank and leaching field system is allowable if soil conditions permit and if there are no water supply wells existing or planned within 100 feet of the system.

Implementing such a system is governed by the requirement for 24-hour retention of the daily wastewater flow plus adequate excess volume for sludge storage. Further, the required leaching area must be determined from on-site percolation tests.

10.6.3.3 Zero Discharge

Zero discharge at the site can be reached using evaporation ponds. However, the putrescible nature of the solids retained in such ponds must be seriously evaluated when such a system is considered for use.

10.6.4 EVALUATION OF ALTERNATIVE SANITARY WASTE DISPOSAL SYSTEMS

An analysis of the foregoing alternatives was made during the preparation of the Environmental Report for the St. Lucie Unit No. 1 facility. The conclusions resulting from that evaluation were:

- a) From an environmental and technical viewpoint, discharge to either surface or groundwater is acceptable. Alternatively, zero discharge is not considered to be viable because of the vector and odor problem that would result during periods of complete evaporation of wastewater and the subsequent exposure of the putrescible solids.
- b) From a regulatory viewpoint, both surface and groundwater disposal are feasible provided that the specific elements of the governing rules are adhered to.
- c) From an economic viewpoint, disposal to the groundwater is significantly more desirable than surface water disposal. This results because of the higher capital and operating cost of a tertiary plant for disposal to surface water for disposal to the groundwater.

These conclusions are also valid with respect to the disposition of the added sanitary wastes contributed by the St. Lucie Unit No. 2 plant.

10.6.5 RECOMMENDED SANITARY WASTE DISPOSAL SYSTEM

Based upon the foregoing conclusions, discharge to the groundwater has been selected as the optimum disposal system. A septic tank and leaching field system can be used at the St. Lucie site to meet groundwater disposal requirements. Plans for such a system to handle the sanitary flow from the combined St. Lucie Unit Nos. 1 and 2 plants were prepared as Ebasco Drawing No. G679, Revision 3A, dated 7 December 1972. These plans were submitted to the State of Florida Department of Health for review. Approval for construction was received under Permit No. SL492 dated December 12, 1972, and issued by the "Florida Department of Pollution Control". The system is now in service with the approval of the Department of Health.

In the event that ground water interaction with the sanitary leaching field obviates the effective use of the sanitary system, alternative treatment facilities will be further evaluated and installed. At such time, if a sewage line has been installed on the island that is accessible to the Plant, hookup to the line would be the favored course of action.

10.7 LIQUID RADWASTE SYSTEMS

The liquid radwaste system is designed to limit radioactive effluents to levels that are within the numerical guides for design objectives and limiting conditions of operation set forth in the AEC's proposed amendments to 10CFR50 and embodied in the new Appendix I. Therefore, according to Section 10.7 of the AEC's Guide to the Preparation of Environmental Reports for Nuclear Power Plants (August 1972), no further consideration need be given to a discussion of alternative liquid radwaste systems.

The description of the liquid radwaste system is contained in Section 3.5.2. Discussion of the radiological impact on biota and man are contained in Sections 5.2 and 5.3, respectively.

10.8 GASEOUS RADWASTE SYSTEMS

The gaseous radwaste system is designed to limit radioactive effluents to levels that are within the numerical guides for design objectives and limiting conditions of operation set forth in the AEC's proposed amendments to 10CRF50 and embodied in the new Appendix I. Therefore, according to Section 10.7 of the AEC's Guide to the Preparation of Environmental Report for Nuclear Plants (August 1972), no further consideration need be given to a discussion of alternative gaseous radwaste systems.

The description of the gaseous radwaste system is contained in Section 3.5.3. Discussions of the radiological impact on biota and man are contained in Sections 5.2 and 5.3, respectively.

10.9 TRANSMISSION FACILITIES

The transmission facilities required to connect the generating unit to the system will comprise minor additions to the substation at the plant as shown in the plant description. No additional transmission lines will be required since the 3 - 240 kv lines being constructed for Unit No. 1 will have sufficient capacity to transmit the output of Unit No. 2 to the system.

10.10 OTHER SYSTEMSEmergency Generating System

The standby power supplies are designed in accordance with criteria set up in AEC's Safety Guides 6 and 9, and General Design Criteria 17. Diesel generating sets are being used as the onsite (standby) power supply for this nuclear power station. At this time, there are no known feasible alternatives with the capability or reliability of starting in time to mitigate the consequences of loss of coolant accidents for this plant. The diesel generating sets are described in detail in Subsection 3.7.2 of this report.

10.11 THE PROPOSED PLANT

The generating and transmission cost of the plant as described herein are presented in a tabular form Table 10.11-1.

TABLE 10.11-1

COST DESCRIPTION OF PROPOSED FACILITY AND TRANSMISSION HOOK-UP

(All monetized costs expressed in terms of their present and annualized values)

Generating Cost	Present Worth		
	Annualized		
Transmission and Hook-up Cost	Present Worth		
	Annualized		
Environmental Costs	UNITS	MAGNITUDE	PAGE
1. Natural surface water body			
1.1 Impingement or entrapment by cooling water intake structure			
1.1.1 Fish	lb/year	9,125*	
1.2 Passage through or retention in cooling systems			
1.2.1 Phytoplankton and zooplankton	lb/year	$3.4 \text{ to } 7.3 \times 10^6$	
1.2.2 Fish eggs and larvae	Number/year	$7.2 \text{ to } 24.6 \times 10^9$	
1.3 Discharge area thermal plume			
1.3.1 Water quality, excess heat	F	No area will exceed 2F.	
1.3.2 Water quality, oxygen availability	ppm	No Change	
1.3.3 Aquatic biota		No Effect	
1.3.4 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)		No Effect	
1.3.5 Fish, migration		No Effect	

TABLE 10.11-1 (Cont'd)

Environmental Costs	UNITS	MAGNITUDE	PAGE
1.4 Chemical effluents			
1.4.1 Water quality, chemical	ppm	Max 1.5 ppm free chlorine release to discharge canal during chlorination of condenser. None at ocean discharge	
1.4.2 Aquatic organisms		No Effect	
1.4.3 Wildlife (including birds, aquatic and amphibious mammals, and reptiles)		None	
1.4.4 People		None	
1.5 Radionuclides discharged to water body			
1.5.1 Aquatic organisms			
1.5.2 People, external			
1.5.3 People, ingestion			
1.6 Consumptive use (evaporative losses)			
1.6.1 People	gal/year	54×10^6 from Ft. Pierce Municipal water supply to Atlantic Ocean	
1.6.2 Property		None	

TABLE 10.11-1 (Cont'd)

Environmental Costs	UNITS	MAGNITUDE	PAGE
1.7 Plant construction (including site preparation)			
1.7.1 Water quality, physical		Negligible	
1.7.2 Water quality, chemical		No Effect	
1.8 Other impacts		None	
1.9 Combined or interactive effects		None	
1.10 Net effect		Acceptable - Minor loss of Aquatic Biota	
2. Ground water			
2.1 Raising/lowering of ground water levels	gal/year	13×10^7 from Ft. Pierce Municipal Supply - No effect expected	
2.1.1 People			
2.1.2 Plants			
2.2 Chemical contamination of ground water (excluding salt)			
2.2.1 People		None	
2.2.2 Plants		None	
2.3 Radionuclide contamination of ground water			
2.3.1 People		None	
2.3.2 Plants and animals			

TABLE 10.11-1 (Cont'd)

Environmental Costs	UNITS	MAGNITUDE	PAGE
2.4 Other impacts on ground water		None	
3. Air			
3.1 Fogging and icing (caused by evaporation and drift)		No Effect	
3.1.1 Ground transportation		No Effect	
3.1.2 Air transportation		No Effect	
3.1.3 Water transportation		No Effect	
3.1.4 Plants		No Effect	
3.2 Chemical discharge to ambient air		None	
3.2.1 Air quality, chemical		None	
3.2.2 Air quality, odor		None	
3.3 Radionuclides discharged to ambient air and direct radiation from radioactive materials			
3.3.1 People, external			
3.3.2 People, ingestion			
3.3.3 Plants and animals			
4. Land			
4.1 Site selection			
4.1.1 Land, amount		No additional land required	
4.2 Construction activities (including Site preparation)			
4.2.1 People (amenities)		Negligible	
4.2.2 People (accessibility of historical sites)		None on site	

TABLE 10.11-1 (Cont'd)

Environmental Costs	UNITS	MAGNITUDE	PAGE
4.2.3 People (accessibility of archeological sites)		None on site	
4.2.4 Wildlife		Temporary displacement during construction	
4.2.5 Land		Negligible permanent	
4.3 Plant operation			
4.3.1 People (amenities)		No Effect	
4.3.2 People (aesthetics)		Negligible	
4.3.3 Wildlife		Negligible	
4.3.4 Land, flood control		None	
4.4 Salts discharged from cooling towers		Not applicable	
4.4.1 People		Not applicable	
4.4.2 Plants and animals		Not applicable	
4.4.3 Property resources		Not applicable	
4.5 Transmission route selection			
4.5.1 Land, amount		No additional beyond Unit 1	
4.5.2 Land use and land value		No additional beyond Unit 1	
4.5.3 People (aesthetics)		No additional beyond Unit 1	
4.6 Transmission facilities construction			
4.6.1 Land adjacent to right-of-way		No additional beyond Unit 1	
4.6.2 Land, erosion		Negligible	
4.6.3 Wildlife			
4.7 Transmission line operation			
4.7.1 Land use		Negligible	
4.7.2 Wildlife		Negligible	
4.8 Other land impacts		None	
4.9 Combined or interactive effects		None	
4.10 Net effects		Negligible	

Note: * This is the same value estimated for the Unit No. 1 Environment Report

11.0 SUMMARY BENEFIT-COST ANALYSIS

11.1 INTRODUCTION

A benefit-cost analysis essentially consists of evaluating the relative values of the net benefits of several alternatives. In this report, benefit-cost analysis of all reasonable alternatives for construction and operation of St. Lucie Unit No. 2 have been presented in Section 9. A definite need for power was established. Analyses of alternatives were made, in Section 10, to establish the type of energy source (nuclear), the site location (Hutchinson Island), plant design, cooling water intake and discharge design, chemical and sanitary waste systems, biocide system, radioactive waste systems, and transmission facilities. The results of the analysis of each of these alternatives are summarized below in Section 11.2. In Section 11.3, the benefits and costs associated with the construction and operation of St. Lucie Unit No. 2 are summarized, and it is shown that the net benefits of this facility decisively favor its construction.

TABLE 11.1-1

BENEFITS FROM THE PROPOSED FACILITY

Direct Benefits		Note
Expected Average Annual Generation in Kilowatt Hours 853x0.8x8760x1000	5,978,000,000	F
Capacity in Kilowatts	853,000	
Proportional Distribution of Electrical Energy-Expected Annual Delivery in Kilowatt Hours:		
Industrial 8.5% of 5,978,000,000 kwh x 0.92	467,500,000	A, F
Commercial 29.7% of 5,978,000,000 kwh x 0.92	1,595,000,000	F
Residential 50.7% of 5,978,000,000 kwh x 0.92	2,788,000,000	F
Other 11.8% of 5,978,000,000 kwh x 0.92	648,900,000	F
Total Delivered Electrical Energy	5,500,000,000	F
Expected Average Annual Btu (in millions) of Steam Sold from the Facility	none	
Expected Average Annual Delivery of Other Beneficial Products (appropriate physical units)	none	
Revenues from Delivered Benefits (Annual) 5,500,000,000 x \$.0187	\$103,000,000	
Electrical Energy Generated		A
Steam Sold	none	
Other Products	none	
Employment (Direct salaries and benefits)*	\$132,300,000	
Indirect Benefits (as appropriate)		
Taxes (Local, State, Federal)	see note	B
Research	400,000	C
Regional Product	see note	D
Environmental Enhancement		
Recreation		
Navigation		
Air Quality:		

11.1-3

SL.2

Benefits (continued)		Note
SO ₂	(lbs produced by equivalent oil fired plant)	(35,000,000)
NO _x	(lbs produced by equivalent oil fired plant)	(41,200,000)
Particulates	(lbs produced by equivalent oil fired plant)	(3,960,000)
Others	(Hydrocarbons lbs produced by equivalent oil fired plant)	(1,380,000)
Employment	(Indirect employment effect)	
	new jobs created as a result of construction activities	2858 man years
	new jobs created as a result of plant operation	480 man years
Education		none
Others		none

* CONSTRUCTION:	4400 man years @ \$27,000/man year	=	\$118,800,000
OPERATION:	750 man years @ \$18,000/man year	=	\$ 13,500,000
	(1979)		<u>\$132,300,000</u>

Notes to Accompany Table 11.1-1 - Benefits from Proposed Facility

- A. Percentages given for electrical energy distribution are those experienced for Kwh sales by the Company in 1971 as reported in the FPL Annual Report for 1971, Facts and Figures Supplement. The average revenue per Kwh for 1971 was 1.87¢ as reported in the above source.
- B. Taxes to be paid by the St. Lucie plant have not as yet been determined. However, the plant will provide an important source of tax revenue to St. Lucie County and other taxing authorities.
- C. A four year operational monitoring program will be conducted on St. Lucie Unit No. 1 as the preoperational study for St. Lucie Unit No. 2. This program has been estimated to cost \$100,000/year.
- D. The Regional Product does not consist of the readily quantifiable products of a few large industrial plants as it does in some areas. In the area served by FPL a large part of what might be considered the Regional Product are facilities and services provided to tourists, vacationers, and the retired. Motels, hotels, retirement homes and related facilities, in the aggregate are large users of electrical power and the area must have this power in order to grow. Quantifying this product in terms of the electrical power required, however, is not amenable to simple analysis.
- E. The quantities of emissions listed are those which would be released by an average steam plant burning low sulfur (0.5%S) oil and producing the same amount of power as the Hutchinson Island nuclear unit. Figures for pounds of emission per 1,000 gallons of oil burned were taken from Appendix D of the report, Considerations Affecting Steam Power Plant Site Selection, a Report sponsored by the Energy Policy Staff, Office of Science and Technology.
- F. Assume 80 per cent capacity factor and 8 per cent system loss.

11.2 ALTERNATIVES SUMMARY ANALYSIS

Section 1.1 presents the data to establish that by 1982 it will be necessary to expand FP&L's system capability from the current 8700 MW to 22,000 MW in order to satisfy the power demand and meet the obligations to its customers in the service area. The data includes the present and future total resources, taking into account the addition of new units, retirements, demand requirements and reserve margin. Without the proposed unit on line in 1979 the loss-of-load probability, expressed in days per year, for the year 1980 would increase from 0.172 to 0.855. Corresponding figures for 1981 and 1982 are 0.12 and 0.1 with the proposed unit and 0.519 and 0.399 without the proposed unit. The projected gross peak load for 1980 is 15,090 MW while the expected generating capacity is 17,681 MW. This means that with St. Lucie Unit No. 2 on line, the reserve would be 2591 MW or 17.2%. Without Unit No. 2 on line, the reserve would be only 1741 MW or 11.5%.

Section 9.1 presents the alternative means of satisfying the power requirements established in Section 1.1. The alternative of purchasing power, which requires no new construction was eliminated due to the inadequate reserve margin in neighboring utilities. The average reserve margin of other Florida power systems was 10% in 1971. This reserve is not expected to improve during the next 5 to 10 years. Procuring power from areas outside of Florida was also considered, and was eliminated due to the low reserve capabilities. Therefore, dependable future power supplies are not available from outside the FP&L system and must be generated by the Applicant.

Other energy sources are discussed in Section 9.2. They include fossil-fuel, hydroelectric, geothermal and nuclear. All but nuclear and fossil fuel units were eliminated due to flat terrain and limited stream flow - (hydroelectric); no known geothermal source. As noted in Table 1.1-2, the addition of generating capability through the year 1982 is a blend of both nuclear and fossil fueled units. The choice of a nuclear over a fossil fueled unit at the St. Lucie site is based on lesser environmental impact and economic considerations. The economics strongly favor a nuclear unit because of significantly lower fuel cost and capital cost savings that result from duplicating Unit No. 1. Duplication results in reduced equipment, engineering and construction cost; shorter schedule and utilization of facilities provided for Unit No. 1.

Section 9.3 describes the elimination process that led to the final selection of the St. Lucie site. On-stream inland sites were eliminated due to the undependable stream flow and temperature restrictions imposed. An alternate coastal site was considered, but eliminated on the basis of environmental impact and cost considerations. Foundation preparation, intake and discharge canal excavation, and transmission line construction are virtually completed for St. Lucie Unit No. 2 as part of the initial construction for Unit No. 1 at that site. The differential cost of these items at an alternative site over the cost for St. Lucie Unit No. 2 is estimated to be \$70,000,000. The cost of land at the alternative site must be added to obtain the total incremental investment at a new site. The environmental impact caused by the construction at a new site will be much greater than that caused at the existing site, therefore, in

view of the above considerations the St. Lucie site is concluded to be the most desirable of the available sites.

The next step in the analysis of alternatives, as presented in Section 10, was to examine and select alternative plant systems which will impose the least adverse effects to the environment during construction and operation. The system which has the potential of greatest environmental impact, the cooling water system, was considered first. Spray canals and cooling ponds were eliminated because of the systems inherent need for large areas of unavailable land area, and construction and operation of the systems would render permanent damage to an ecologically rich aquatic-terrestrial ecosystem. Mechanical and natural draft hyperbolic cooling towers were eliminated because they present negligible environmental advantages over the current design (once through cooling). They have substantial environmental effect caused by salt drift and visual impact, and they reduce plant electrical output. The once through direct cooling water system is a duplicate of the system under construction for Unit No. 1. It will present minimal environmental impact and lowest cost.

The remaining parts of Section 10 analyzed alternatives of the other plant systems: intake and discharge systems; chemical and biocide systems; sanitary waste system; radioactive waste systems; and transmission facilities. These plant alternatives were selected to result in the least environmental impact.

11.3 BENEFITS AND COSTS ASSOCIATED WITH CONSTRUCTION AND OPERATION
OF ST. LUCIE UNIT NO. 2

11.3.1 COSTS

Monetized Costs - Capital costs for the completed station will total an estimated \$360,000,000.

Environmental Cost - Land and Terrestrial Wild Life

An 1132 acre site will be committed to the development of the station. Only 100 acres will be required for Unit No. 2. All remaining land area was developed in connection with Unit No. 1. Further, off-site right-of-way for the transmission lines have been developed as part of Unit No. 1 construction.

Environmental Cost - Water and Aquatic Life

Operation of the plant will require a very small amount of Atlantic Ocean water; about 530,000 gpm to be used primarily as cooling water. Virtually all of this cooling water will be returned to the ocean (Section 3.3).

The activities associated with the construction of the intake and discharge lines will alter some of the aquatic life on the beach and adjacent sea bed. After construction, the aquatic life is expected to return to a natural state (Section 4.1).

The operation of the plant through the release of small volumes of heated water discharge, will have some, but small, effect on the aquatic organisms. The maximum surface water temperature increase will be less than 2 F (Section 5.1).

A small percent of the area planktonic organisms will be entrained in the circulating water system. It is expected that there will not be any measurable environmental effect. There will be some fish entrapment at the intake of the circulating and cooling water system (Section 5.1).

The very small amounts of chemicals that will be released into the water during operation will be rapidly mixed and diluted, and are not expected to have an effect on the biota (Sections 5.4 and 5.5). The amount of radioactive waste that will be discharged is insignificant and no adverse effect to the biota or man is expected (Sections 5.2 and 5.3).

11.3.2 BENEFITS (See Table 11.1-1; Benefits From The Proposed Facility)

Electric Power - The station will provide an increase of 850 MW in base-load generating capacity (which is equivalent to approximately 6 million kwh of electrical energy annually, assuming a capacity factor of 80 percent). This power will be of direct benefit to all present users and will help to meet the rising power requirements in the Applicant's service area (Section 1, 8.1 and 8.5).

Socio-Economic Benefits - During the five year construction period, a total of some \$119,000,000 will be disbursed as payroll to a work force

numbering up to 1400 men. This is expected to induce an indirect effect of creating 2858 new jobs in the region and a total of 7258 man years of new employment. During the operating phase, some 25 permanent employees will receive about \$13,500,000 over the life of the plant, in direct income. Induced regional employment effects are expected to create a total of 1230 man years of employment.

Even the comparatively small permanent operating staff and payroll are large enough to place the station among the more important employers in the area. Tax revenues will be substantial and will help to improve the revenues for county, state and federal governments, (Section 8.2, 8.3, 8.4, 8.5).

Other Benefits - Other benefits include unquantifiable indirect social and cultural benefits through the development of additional recreational opportunities (Section 8.6).

**120 APPROVALS AND
CONSULTATIONS**

12.0 ENVIRONMENTAL APPROVALS AND CONSULTATIONS

Under Florida Water Resources Act, FS 373, the Department of Natural Resources is responsible for establishing a consumptive use permitting program which will effect the water use for cooling St. Lucie I condensers and for any use of water from Big Mud Creek associated with the ECCS.

The Trustees of the Internal Improvement Trust Fund regulate the sovereign waters of the state. Any facility touching these waters (ECCS and intake and discharge pipes) must be permitted.

DNR Ch. 70-231, FS 161.052-2(c). A variance must be obtained--"For the construction of pipe lines or pipes extending outward from the shoreline unless it is determined by the department that the construction of such projects would not cause erosion of the beach in the area of such structures."

Table 12.0-1 Summarizes the licenses, permits, and other approvals required by Federal, State, local and regional authorities for the construction and operation of St. Lucie Unit No. 2 and for the protection of the environment.

TABLE 12.0-1

LISTING AND STATUS OF
THE REQUIRED PERMITS
AND LICENCES FOR
ST. LUCIE UNIT NO. 2

<u>Category</u>	<u>Permit or License</u>	<u>Statutory Authority or Issuing Agency</u>	<u>Status</u>
Construction	Plant Construction Permit	AEC-Title 10 CFR Parts 20, 50, 100	Application filed April 1973
	General Plant Construction Permit	Board of County Commissioners Building and Zoning Dept. St. Lucie County, Florida	Issued October 6, 1971
	Building Permit for Reactor Building Base Mat	St. Lucie County Building & Zoning Dept.	Issued June 5, 1970
	Building Permit for Reactor Auxiliary Building Base Mat	St. Lucie County Building & Zoning Dept.	Issued June 26, 1970
	Permit to Erect Personnel Hoist	State of Florida Dept. of Commerce	Issued January 3, 1970
	Tower Crane Erection Permit	Department of Transportation Federal Aviation Administration	
	Building Permit for Security Fence	St. Lucie County Building & Zoning Dept.	Issued December 22, 1970
	Building Permits for Iron Workers, Carpenters, Guard and Time Keepers Buildings	St. Lucie County Building & Zoning Dept.	Issued June 16, 1970

TABLE 12.0-1

LISTING AND STATUS OF
THE REQUIRED PERMITS
AND LICENSES FOR
ST. LUCIE UNIT NO. 2

<u>Category</u>	<u>Permit or License</u>	<u>Statutory Authority or Issuing Agency</u>	<u>Status</u>
Construction	Construction of Atlantic Ocean discharge line	U. S. Army Corps of Engineers; Section 10 Act of Congress March 3, 1899 (33USC403)	SL2
		State of Florida Trustees of the Internal Improvement Fund; Chapter 253 Florida Statutes	
	Construction of Atlantic Ocean discharge line	St. Lucie County Board of Commissioners	
	Certification to Construct & Operate Pollution Source	Florida Dept. of Pollution Control; Power Plant Siting Act 1972 Sec. 403.505	
	Certification of site suit- ability	Dept. of Administration Fla. State Planning Board; Power Plant Siting Act 1972 Sec. 403.505	
Water	Water quality certification	State of Fla. Dept. of Air & Water Pollution Control; Fla. Quality regulations Chapter 17-3 F.S.	

TABLE 12.0-1 (Cont'd.)

<u>Category</u>	<u>Permit or License</u>	<u>Statutory Authority or Issuing Agency</u>	<u>Status</u>
Water (cont'd.)	Beaches & shores	Department of Natural Resources; Chapter 161 F. S.	
	Biological Survey	Department of Natural Resources; Chapter 253	
	Discharge Permit	Environmental Protection Agency; Federal Water Quality Act as amended	
	Certification	Fla. Dept. of Pollution Control; Section 401 EPA Water Quality Amendment of 1972 to 1970 Water Quality Act	
Air	Reactor Building Lighting	Federal Aviation Agency	
Other	Plant Operating License	AEC-Title 10 CFR Parts 20, 50, 100	
	Contractor's Certificate of Competency	St. Lucie County Board of Contractors Examiners	Issued June 1, 1971
	Ambulance Permit	Florida Dept. of Health and Rehabilitative Services	Issued June 20, 1972
	Possession and Use of Special Nuclear Materials	U. S. AEC Title 10 CFR Parts 30, 40	
	Possession and Use of Nuclear Fuel	U. S. AEC Title 10 CFR Parts 70	

TABLE 12.0-1 (Cont'd.)

<u>Category</u>	<u>Permit or License</u>	<u>Statutory Authority or Issuing Agency</u>	<u>Status</u>
Water (cont'd.)	Beaches & shores	Department of Natural Resources; Chapter 161 F. S.	
	Biological Survey	Department of Natural Resources; Chapter 253	
	Discharge Permit	Environmental Protection Agency; Federal Water Quality Act as amended	
	Certification	Fla. Dept. of Pollution Control; Section 401 EPA Water Quality Amendment of 1972 to 1970 Water Quality Act	
Air	Reactor Building Lighting	Federal Aviation Agency	
Radioactive Materials	Radioactive Materials License	Florida State Board of Health	Issued July 31, 1969
Other	Plant Operating License	AEC-Title 10 CFR Parts 20, 50, 100	
	Contractor's Certificate of Competency	St. Lucie County Board of Contractors Examiners	Issued June 1, 1971
	Ambulance Permit	Florida Dept. of Health and Rehabilitative Services	Issued June 20, 1972
	Possession and Use of Special Nuclear Materials	U. S. AEC Title 10 CFR Parts 30, 40	
	Possession and Use of Nuclear Fuel	U. S. AEC Title 10 CFR Parts 70	

12.0-4

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