



bcc: David Voigts  
Mike Kennedy

File: Crystal River Salt Drift Study

May 24, 1995

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Mr. Hamilton S. Oven, Jr.  
Florida Department of Environmental Protection  
Douglas Building, Room 953AA  
2900 Commonwealth Blvd., MS 48  
Tallahassee, FL 32399-3000

Dear Mr. Oven:

Re: Crystal River Salt Drift Study  
Permit Number PSD-FL-007

Enclosed is the Annual Report of the Crystal River Salt Drift Study 1993-1994 study year, the 13th year of the study. As noted in the conclusions, the vegetation generally continued to be in good condition. Accordingly, Florida Power again formally requests that DEP approve the discontinuation of the Crystal River salt drift study.

Florida Power Corporation (FPC) has been conducting this salt drift deposition study since 1981 to assess the effects of the two natural draft cooling towers which serve Units 4 and 5 at FPC's Crystal River plant. In addition, the study has, for the past two years, been used to determine whether any vegetation damage is occurring due to salt deposition from the new mechanical helper cooling towers for Units 1, 2, and 3.

The study, originally a part of the NPDES permit and the Site Certification for Units 4 and 5, was incorporated into the PSD permit referenced above on November 30, 1988. Condition 5.c. contains language regarding changes to the monitoring program, which includes the following:

*Should the data indicate that no significant impacts are occurring to the surrounding area, the permittee, after consultation with and approval by the Director of the EPA Region IV Air, Pesticides, and Toxics Management Division and FDER, may reduce or eliminate the monitoring program.*

In past correspondence and at a November 2, 1994, meeting in Crystal River, FPC has presented its rationale for stopping the study. However, since FPC has not been allowed to end the study, and in response to questions that have been asked, FPC offers the following information that gives additional reasons and documentation to support the request to end the salt drift study. Discussed are a June 1988 deposition modeling study for the Crystal River cooling towers by KBN Engineering, the results and subsequent ending of a three-year salt drift study for the St. Johns River Power Park, and the questionable scientific validity of such studies.

### KBN Study

In 1988, as part of the permitting effort for the helper cooling towers, KBN Engineering performed a detailed deposition modeling analysis to assess the total effects of the two natural draft cooling towers for Units 4 and 5 and the four mechanical draft helper cooling towers for Units 1, 2, and 3. The enclosed Figure 3-2, which is from that KBN report, shows the total predicted salt deposition during the summer months resulting from permitted levels of salt drift from the natural draft and helper cooling towers. The summer season was modeled because the helper cooling towers do not operate from November through April.

The maximum total combined deposition over a naturally vegetated area was predicted to occur near the helper cooling towers, and was approximately  $400 \text{ g/m}^2$ . The vegetation in this area is mainly comprised of salt marsh, which is very tolerant of atmospheric salt deposition. The predicted deposition levels fall rapidly with distance from the helper cooling towers to a level of approximately  $10 \text{ g/m}^2$  at the north property line. Sections 3 and 4 from the KBN report, which discuss the modeling analysis, are also enclosed.

Actual deposition levels are likely much lower than those predicted by the conservative modeling analysis. The drift rate measured from the helper cooling towers was at 8% of the permitted level during the most recent stack test. Indeed the salt deposition at the Open Hammock site, the closest monitoring site to the helper cooling towers, was measured during the 1993-1994 study year to be about  $146 \text{ kg/ha}$  ( $14.6 \text{ g/m}^2$ , Figure 4-1). In addition, the amount of salt collected at this site during the months that the helper towers were operating was not significantly different than the amount collected during the months when the towers were not operating.

### St. Johns River Power Park Study

A salt deposition study was conducted by the Jacksonville Electric Authority and Florida Power and Light to assess the effects of the salt drift from the cooling towers for two 600 MW coal-fired steam electric units at the St. Johns River Power Park (SJRPP). The study period was from February 1986 through September 1989. The study began prior to the operation of the first cooling tower and continued for 18 months after the second tower began operation. As with the Crystal River study, the SJRPP study involved the collection of deposition samples at multiple sites combined with a photographic record of the vegetative effects in the surrounding area.

The SJRPP study found no salt-related injury to the vegetation on or surrounding the plant site. The study was concluded after only 18 months of data were obtained while both cooling towers were in operation.

### Scientific Validity

The scientific value of salt deposition studies in coastal areas is questionable. The salt drift from power plant cooling towers is only one variable in a complex system. At the Crystal River plant, natural deposition of salt from the Gulf of Mexico, coastal vegetative dieback from sea level rise, and damage due to disease confound the study results and subsequent data interpretation.

Natural deposition may be quite large from coastal storms. For example, the March 1993 storm deposited such a massive amount of salt on the coastal vegetation that it dwarfs the amount of salt deposited by the operation of the cooling towers. Also, some damage and dieback are occurring along the immediate coastline from the slow sea level rise that is taking place along the west coast of Florida. This coastal dieback is not confined to the Crystal River area, but is occurring along a large portion of the coastline.

#### Conclusion

FPC, for the following reasons, which have been discussed above, requests that the Crystal River salt drift study be terminated:

- No significant impacts are occurring to the area surrounding the Crystal River plant from the operation of the cooling towers. The study has recorded the effects of the Units 4 and 5 natural draft cooling towers since its inception in 1981. In addition, two full operating seasons of the helper cooling towers have been added to the study results.
- A KBN modeling study showed minimal deposition off FPC plant property from the permitted levels of salt drift. Actual drift is a fraction of the permitted amount.
- The SJRPP study yielded results similar to the Crystal River study, and it was terminated after 18 months of data from both cooling towers.
- The scientific value of the study is limited, and given the 13 year length of the Crystal River study, it has reached its limit in terms of providing additional meaningful data.

Termination of the study would be effective immediately upon approval.

Thank you for your consideration of this request. Please contact David Voigts at (813) 866-5166 or Mike Kennedy at (813) 866-4344 if you have any questions or if you need additional information.

Sincerely,



W. Jeffrey Pardue, C.E.P.  
Director

Enclosures

cc: EPA Region IV  
Ms. Marilyn Polson, Esq  
Mr. Clair Fancy, DEP - Tallahassee

## **Attachment 1**

## **Attachment 1**

### **KBN Modeling Study Results**

### 3.0 EXISTING AND PREDICTED DEPOSITION LEVELS AT THE CRYSTAL RIVER POWER PLANT

#### 3.1 MONITORING RESULTS

As part of the environmental permits, FPC was required to perform pre- and post- operational monitoring of salt deposition and its effects to nearby vegetation (NPDES Permit No. FL0036366 Part III M, and Florida Conditions of Certification, Case No. PA77-09, I.B.7. Special Conditions). The pre- and post- operational monitoring studies were initiated in 1981 and consisted of a series of activities to assess the condition of local plant communities, and to monitor deposition levels prior to and after cooling tower operation. Currently, six years of deposition and vegetation monitoring has been performed for a series of sites previously predicted to receive maximum salt deposition impact, as well as natural background salt deposition from the Gulf of Mexico.

Deposition monitoring for sodium, chloride and total particulates has been performed on an annual cycle with each study period, starting in September and continuing through the following August. During the first year of monitoring, 1981-1982, Crystal River Units 4 and 5 cooling towers were under construction; data collected during this period serve as the pre-operational or baseline data from which future deposition levels can be compared. Deposition data for this phase of the project were collected from four stations using a bulk collector design (ABI, 1984). For the second and third years of sampling, 1982-1984, only the cooling tower for Unit 4 was operating (ABI, 1985 and ABI, 1986). During the fourth year of monitoring, data were obtained while both the Unit 4 and Unit 5 cooling towers were in operation (FPC, 1986). For the second, third, and fourth years, deposition was collected from six sites. During the first 5 years of the study, the location of sampling stations were in areas of maximum predicted deposition.

Beginning with the fifth year study, the site location design was modified to facilitate complete sample coverage and minimize the potential for missing significant deposition events by establishing a broader, more encompassing directional grid around the towers. The pine, hardwood and control sites were abandoned as salt deposition monitoring sites in favor of

establishing the Southwest, Northwest, and Northeast Open Test sites (see Section 2.1.1) in order to sample a broader spectrum of wind vectors.

These six monitoring sites were also kept during the start of the sixth year of study. However, the monitoring network was reevaluated and several changes made. The primary changes included the elimination of the Switchyard site due to contamination by fugitive dust and the elimination of total settleable particulates (TSP) due to lack of correlation with sodium and chloride concentrations. TSP analysis was eliminated in January 1987 and the Switchyard site was eliminated in June 1987.

In addition to the deposition monitoring, vegetation in the vicinity of the cooling towers was monitored during the same periods. This part of the study consisted of monthly inspections of approximately 50 specifically tagged plants within specified plots in the area of predicted maximum deposition, and 15 specifically tagged plants within a control area plot. These inspections were performed monthly. In addition, quarterly surveys were made by biologists experienced in salt-induced stress. In both surveys, photographs were taken of all plants inspected and a detailed log was made. Periodically, low altitude color infrared aerial photographs were used to assess the general condition of vegetation within a one-mile radius of the plant.

Results of the six years of monitoring have been summarized in previous reports (ABI, 1984; ABI, 1985; ABI, 1986; FPC, 1986 KBN, 1987 and KBN, 1988).

The results of the available deposition monitoring data for the latest two monitoring years are presented in Table 3-1. The results of the vegetation monitoring program indicated the following conclusions:

1. No vegetation damage attributable to, or typical of, airborne salt deposition was evident from the monthly on-site vegetation inspections and photographs;

Table 3-1. Total Sodium and Chloride Deposition ( $\text{g}/\text{m}^2/\text{yr}$ ) in the Vicinity of Crystal River Units 4 and 5 (1985/86 and 1986/87 Study Years)

| Site         | Total Salt Deposition<br>( $\text{g}/\text{m}^2/\text{yr}$ ) |         | Distance*<br>(km) | Direction+<br>(°) |
|--------------|--|---------|-------------------|-------------------|
|              | 1985/86  | 1986/87 |                   |                   |
| Open Control | 7.9  | 4.1     | 1.40              | 150               |
| Opent Test   | 11.1   | 7.5     | 0.24              | 230               |
| NE Open Test | 13.4   | 6.7     | 0.37              | 35                |
| NW Open Test | 10.3   | 6.0     | 0.42              | 315               |
| SW Open Test | 9.7  | 7.6     | 0.44              | 210               |

\* From geographic center between cooling towers.

+ From North.



2. The lack of visible damage signs at the monitoring stations is consistent with the observed deposition levels and expected impacts calculated from vegetation models; and
3. No consistent evidence of salt drift damage to vegetation was observed during its quarterly surveys.

### 3.2 MODELING ANALYSIS

Estimates of salt deposition from Crystal River Units 4 and 5 cooling towers and from the proposed cooling tower configuration for Units 1, 2 and 3 were made by McVehil-Monnett Associates of Denver, Colorado (1987). A computerized mathematical model was used to simulate the expected transport, dispersion and deposition of drift aerosols emitted by the cooling towers. The bases for these estimates were the cooling tower design parameters and the average particle size distribution of aerosols presented in Tables 3-2 through 3-5. The meteorological data used for the modeling analysis consisted of joint frequency distribution of wind speed, wind direction and stability for the period 1965-1969 from Tampa, Florida. This data was obtained from the National Climatic Center in STAR format. Meteorological data from Tampa was considered representative of the Crystal River area because of the proximity and similar physiography. In addition, the previous deposition model estimates for Units 4 and 5, as well as the federal Prevention of Significant Deterioration analysis, used surface data obtained for Tampa.

The helper cooling towers for Crystal River Units 1, 2 and 3 were only modeled for the months of June, July, August and September, while the cooling towers for Units 4 and 5 were modeled on an annual basis. The annual deposition was determined by superimposing the individual modeling results for each tower configuration and drift rate over the receptor grid and summing calculated depositions. The results of the modeling analysis are shown in Figures 3-1 through 3-3.

### 3.3 EFFECTIVE DEPOSITION

The annual average deposition levels predicted in the previous section are based upon the annual frequency of wind speed and direction, atmospheric

Table 3-2. Crystal River Units 1, 2 and 3 Tower Specifications and Design Parameters Used in Modeling Analysis of Helper Cooling Towers.

| Parameter                 | Helper Cooling Towers |                      |
|---------------------------|-----------------------|----------------------|
|                           | Rectangular           | Round                |
| No. Towers/Fans per Tower | 4/10                  | 3/12                 |
| Fan Height                | 60 ft. (18.3m)        | 82 ft.(25.0m)        |
| Fan diameter              | 28 ft. (8.54m)        | 28 ft.(8.54m)        |
| Fan Velocity              | 26.24 ft./s (8.0 m/s) | 29.4 ft./s (8.96 ms) |
| Exit Temperature          | 91°F (306K)           | 91°F (306 K)         |
| Tower Plow Rate           | 687,000 gpm           | 687,000 gpm          |
| Draft Rate                | 0.002%                | 0.002%               |
| Total Dissolved Solids    | 29,100 ppm            | 29,100 ppm           |

Source: McVehil-Monnett Associates, Inc., 1987

Table 3-3. Particle Distribution Used in Deposition Modeling from Helper Cooling Towers for Units 1, 2 and 3.

| Particle Size |                     |                             | Mass<br>Dist.<br>(%) |
|---------------|---------------------|-----------------------------|----------------------|
| Range         | Diameter<br>Average | Radius<br>( $\mu\text{m}$ ) |                      |
| 0-40          | 20                  | 10                          | 4.8                  |
| 40-60         | 50                  | 25                          | 5.4                  |
| 60-100        | 80                  | 40                          | 3.6                  |
| 100-200       | 150                 | 75                          | 9.2                  |
| 200-300       | 250                 | 125                         | 13.0                 |
| 300-400       | 350                 | 175                         | 26.0                 |
| 400-500       | 450                 | 225                         | 23.5                 |
| 500-700       | 600                 | 300                         | 11.5                 |
| 700-1000      | 850                 | 425                         | 1.9                  |
| 1000-1750     | 1425                | 713                         | 1.1                  |

Source: McVehil-Monnett Associates, Inc., 1987

Table 3-4. Crystal River Units 4 and 5 Cooling Tower Design  
Parameters Used in Deposition Modeling Analysis

| Parameter  | Units 4, 5 |
|--|------------|
| Number per Unit  | 1          |
| Height (ft)  | 443        |
| Base Diameter (ft)   | 380        |
| Exit Diameter (ft)   | 214        |
| Range (deg F)  | 22.5       |
| Approach (deg F)   | 17.7       |
| Flow Rate, each (gpm)                                      | 331,000    |
| Annual Capacity Factor (%)                                 | 81         |
| Circulating Water Total Dissolved<br>Solids Content (mg/l) | 32,000     |

Source: McVehil-Monnett Associates (1988)

Table 3-5. Particle Distribution Used in Deposition Modeling of  
Crystal River Units 4 and 5 Cooling Towers

| Range of<br>Droplet Radii<br>( $\mu\text{m}$ ) | Mean<br>Radius<br>( $\mu\text{m}$ ) | Percent of<br>Total Drift Mass<br>(%) | Cumulative<br>Percent<br>(%) |
|--|-------------------------------------|---------------------------------------|------------------------------|
| 5-10   | 7.5                                 | 0.0                                   | 0.0                          |
| 10-15  | 12.5                                | 0.0                                   | 0.0                          |
| 15-20  | 17.5                                | 0.08                                  | 0.08                         |
| 20-25  | 22.5                                | 4.23                                  | 4.31                         |
| 25-30  | 27.5                                | 7.02                                  | 11.33                        |
| 30-35  | 32.5                                | 8.86                                  | 20.19                        |
| 35-45  | 40.0                                | 15.95                                 | 36.14                        |
| 45-55  | 50.0                                | 14.59                                 | 50.73                        |
| 55-65  | 60.0                                | 10.44                                 | 61.17                        |
| 65-75  | 70.0                                | 7.48                                  | 68.65                        |
| 75-90  | 82.5                                | 7.41                                  | 76.06                        |
| 90-105   | 97.5                                | 5.12                                  | 81.18                        |
| 105-120  | 12.5                                | 4.19                                  | 85.37                        |
| 120-135  | 127.5                               | 3.16                                  | 88.53                        |
| 135-150  | 142.5                               | 2.61                                  | 91.14                        |
| 150-175  | 162.5                               | 3.45                                  | 94.59                        |
| 175-200  | 187.5                               | 2.13                                  | 96.72                        |
| 200-225  | 212.5                               | 1.42                                  | 98.14                        |
| 225-250  | 237.5                               | 0.80                                  | 98.94                        |
| 250-300  | 275.0                               | 0.70                                  | 99.64                        |
| 300-350  | 325.0                               | 0.11                                  | 99.75                        |
| 350-400  | 375.0                               | 0.25                                  | 100.00                       |

Source: McVehil-Monnett Associates, 1986

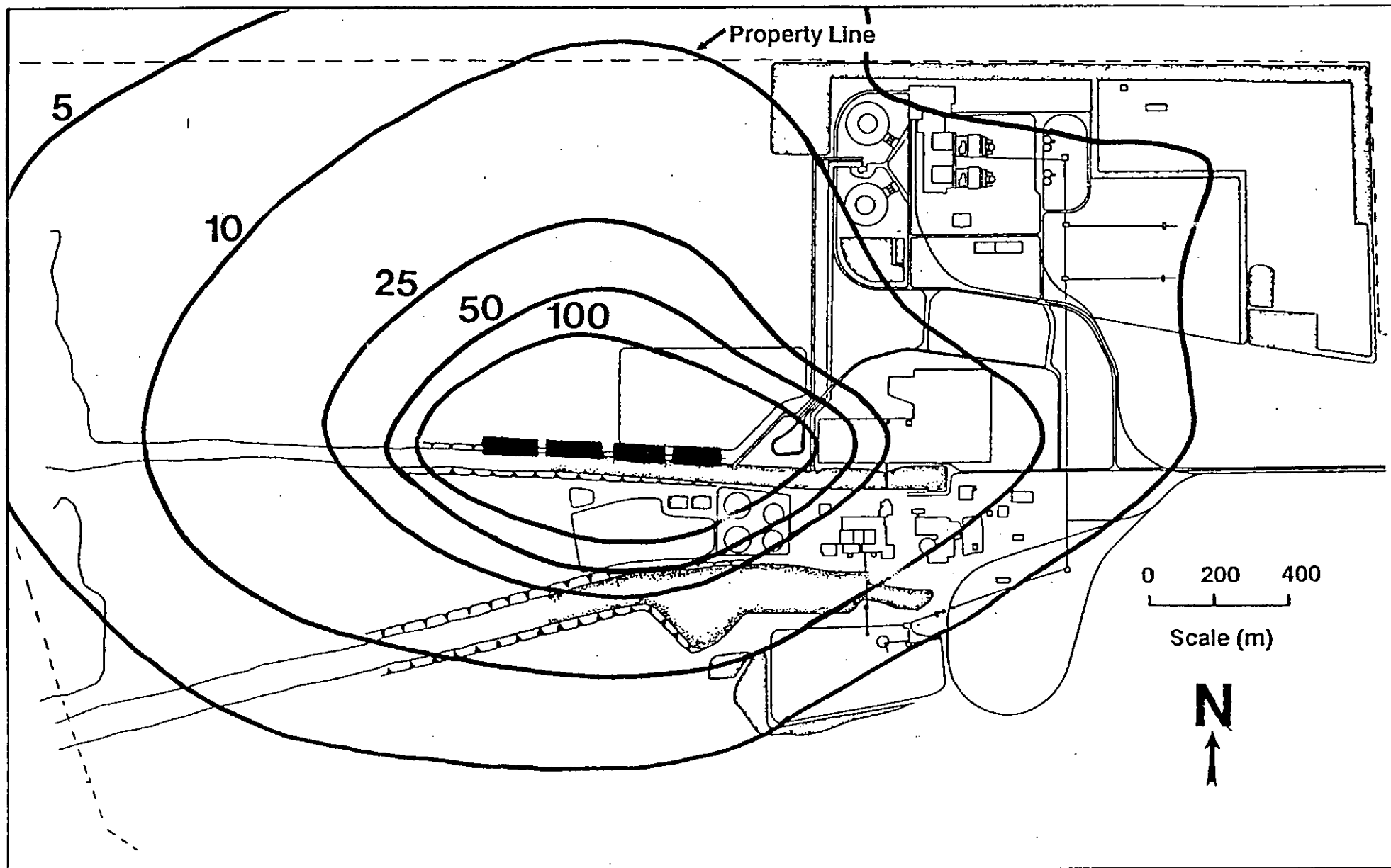


Figure 3-2. Total Summer Deposition of Cooling Tower Drift ( $\text{g/m}^2$ ) - Four Rectangular Draft Towers (Case 1)



stability and temperature. The effect of rainfall is, however, extremely important because rainfall can cleanse the leaves and mitigate salt accumulation. Thus, by taking into account rainfall frequency, the actual or effective deposition that impacts vegetation can be evaluated.

To determine the significance of rainfall frequency or accumulated deposition, five years (1974, 1975, 1978, 1979 and 1981) of Tampa surface observations were processed to determine the number of days between rainfall events greater than 0.11 inch/hour (2.5 mm/hour). Five years of meteorological data were used to develop a range of rainfall frequency distributions. In addition, the five years selected (1974, 1975, 1978, 1979 and 1981) for analysis are representative of current meteorological conditions as well as a random sampling of a larger database (i.e., 10 years). A rainfall amount of greater than 0.11 inch/hour (2.5 mm/hour) was selected since this rainfall rate would be sufficient to physically wash accumulated deposition from leaves and is considered by the National Weather Service to be a moderate rainfall event (in contrast to a light rain or drizzle).

The results of this analysis are presented in Tables 3-6 and 3-7. As seen from these data, for the number of days between rainfall events of greater than 0.11 inch/hour (2.5 mm/hour) appears to be generally similar from year to year. As would be expected, the number of days between rainfall events decreases as a function of increasing number of days between those events. For example, in 1974 rain events occurred 38 times during the next day while only 7 times did the number of days between events exceed 10 days. Over the course of a year, about 16 percent of the time a rainfall event of greater than 0.11 inch/hour could be expected to occur at least every other day. About 40 percent of the time over a year a rainfall event of greater than 0.11 inch/hour would be expected at least every 5 days. Ten days or more between rainfall events greater than 0.11 inch/hour is expected only about 9 times in any year. Rarely do the number of days between rainfall events exceed 14 days or more (Table 3-6). Indeed, only about 3 times in any year does the days between rainfall events equal or exceed 14 days. The longest period between rainfall events of greater than 0.11 inch/hour occurred in

Table 3-6. Number of Days (24-hour periods) Between Rainfall Events Greater than 0.11 inch/hour for 1974, 1975, 1978, 1979 and 1981 (Tampa Surface Observations)

| Days Between<br>Rain Events<br>Greater Than<br>0.11 inches/hour | Number of Occurrences in the Year |      |      |      |      |
|---|-----------------------------------|------|------|------|------|
|   | 1974                              | 1975 | 1978 | 1979 | 1981 |
| 0   | 38                                | 14   | 37   | 51   | 39   |
| 1   | 12                                | 4    | 18   | 10   | 10   |
| 2   | 8                                 | 4    | 11   | 7    | 10   |
| 3   | 7                                 | 5    | 8    | 3    | 2    |
| 4   | 2                                 | 4    | 5    | 4    | 3    |
| 5   | 5                                 | 5    | 5    | 5    | 3    |
| 6   | 3                                 | 1    | 3    | 1    | 6    |
| 7   | 2                                 | 5    | 4    | 2    | 1    |
| 8   | 0                                 | 1    | 1    | 2    | 3    |
| 9   | 1                                 | 0    | 1    | 2    | 2    |
| 10  | 2                                 | 2    | 1    | 1    | 1    |
| 11  | 2                                 | 1    | 0    | 0    | 2    |
| 12  | 1                                 | 1    | 1    | 1    | 3    |
| 13  | 1                                 | 1    | 1    | 3    | 0    |
| 14  | 0                                 | 0    | 1    | 1    | 1    |
| 15  | 0                                 | 0    | 1    | 3    | 0    |
| 16  | 0                                 | 2    | 0    | 0    | 0    |
| 17  | 0                                 | 0    | 0    | 0    | 0    |
| 18  | 0                                 | 0    | 0    | 0    | 1    |
| 19  | 0                                 | 1    | 0    | 1    | 0    |
| 20  | 0                                 | 0    | 0    | 0    | 0    |
| 21  | 0                                 | 0    | 0    | 0    | 0    |
| 22  | 0                                 | 0    | 0    | 0    | 0    |
| 23  | 0                                 | 0    | 0    | 0    | 0    |
| 24  | 0                                 | 1    | 0    | 0    | 0    |
| 25  | 0                                 | 0    | 0    | 0    | 1    |
| 26  | 0                                 | 1    | 0    | 0    | 0    |
| 27  | 0                                 | 0    | 1    | 0    | 0    |
| 28  | 0                                 | 0    | 0    | 0    | 0    |
| 29  | 0                                 | 0    | 0    | 0    | 0    |
| 30  | 0                                 | 0    | 0    | 0    | 0    |
| 31  | 0                                 | 0    | 0    | 0    | 0    |
| 32  | 0                                 | 1    | 0    | 0    | 0    |
| 33  | 0                                 | 0    | 0    | 0    | 0    |
| 34  | 0                                 | 0    | 0    | 0    | 0    |
| 35  | 0                                 | 0    | 0    | 0    | 0    |
| 36  | 0                                 | 0    | 0    | 0    | 0    |
| 37  | 0                                 | 0    | 0    | 0    | 0    |
| 38  | 0                                 | 0    | 0    | 0    | 0    |
| 39  | 0                                 | 0    | 0    | 0    | 0    |
| 40  | 0                                 | 0    | 0    | 0    | 0    |
| 41  | 0                                 | 0    | 0    | 0    | 0    |
| 42  | 0                                 | 0    | 0    | 0    | 0    |
| 43  | 0                                 | 0    | 0    | 0    | 0    |
| 44  | 0                                 | 0    | 0    | 0    | 0    |
| 45  | 1                                 | 0    | 0    | 0    | 0    |



Table 3-7. Number of Rainfall Events Greater Than 0.11 inch/hour by Month  
for 1974, 1975, 1978, 1979, and 1981 (Tampa Surface Observations)

| MONTH     | <u>Number of Occurrences in the Year</u> |      |      |      |      |
|-----------|--|------|------|------|------|
|           | 1974                                     | 1975 | 1978 | 1979 | 1981 |
| JANUARY   | 4  | 1    | 8    | 8    | 2    |
| FEBRUARY  | 2  | 3    | 6    | 5    | 7    |
| MARCH     | 3  | 4    | 6    | 6    | 4    |
| APRIL     | 3  | 1    | 2    | 5    | 2    |
| MAY       | 6  | 4    | 7    | 7    | 2    |
| JUNE      | 18                                       | 10   | 14   | 6    | 13   |
| JULY      | 10                                       | 8    | 15   | 11   | 14   |
| AUGUST    | 18                                       | 8    | 17   | 23   | 17   |
| SEPTEMBER | 13                                       | 6    | 6    | 16   | 11   |
| OCTOBER   | 1  | 6    | 8    | 3    | 5    |
| NOVEMBER  | 1  | 1    | 2    | 4    | 5    |
| DECEMBER  | 6  | 2    | 8    | 3    | 6    |
| TOTAL     | 85                                       | 54   | 99   | 97   | 88   |

1974 with a duration of 45 days. For all other years the longest period between rainfall events was 32 days or less.

The months with the greatest number of rainfall events (greater than 0.11 inches/hour) are June, July and August while the months with the least number of rainfall events are November and April (Table 3-7). The implications of this result and the coincident operation of the Units 1, 2 and 3 cooling towers to vegetation impacts are discussed in Section 4.4.

#### 4.0 ANALYSIS OF IMPACTS

##### 4.1 BACKGROUND DEPOSITION

Pre-operational or ambient baseline values ranged from 3.49 to 6.67 g/m<sup>2</sup>-yr. These ambient deposition levels include inputs from both rainfall and non-rainfall (i.e., dry) periods. Since rainfall concentrations of sea salt are extremely dilute (volume weighted mean concentration of less than 5 mg/l even in coastal sites in Florida) and rainfall effectively washes leaves of accumulated deposition, dry salt deposition is more important in determining total salt accumulation. Subtracting the estimates by 2.5 g/m<sup>2</sup>-yr inputted through rainfall (developed from Florida Acid Deposition Study, FCG, 1986), this implies an ambient dry deposition load in the pine flatwoods and coastal hydric hammock of 1.0 to 4.2 g/m<sup>2</sup>-yr due to natural wind driven salts from the coastal zone.

##### 4.2 MAXIMUM POTENTIAL EFFECTS

The natural deposition level supports the premise that salt deposition up to ambient levels is not a limiting factor in this ecosystem naturally, and also supports the fact that the Crystal River area of the Gulf coast is a lower energy system than that of the east coast with less wind, wave, and storm action, and less resultant salt spray. This fact is also evidenced by the physiognomic profile of the coastal forest, in which a shear effect is not seen in the canopy. A survey of salt content in soil and leaves in the area also showed no correlation to distance from the Gulf (Dames and Moore, 1974).

The coastal hammock and coastal hydric hammocks of Crystal River are dominated by many of the same species that dominate in the high salt environment of these maritime forests, including live oak, cabbage palm (Sabal palmetto), yaupon, American holly, wax myrtle, winged sumac, saltbush, and southern red cedar (Juniperus silicicola). Therefore, salt spray or deposition would not appear to be a natural limiting factor in the areas most impacted by the cooling towers. Many of the dominant species determining the nature of the community have shown adaptations in other regions to salt deposition levels up to ten times higher than the naturally occurring levels at Crystal River, and should be capable of withstanding

substantial additional deposition rates from the cooling towers. The same is true of the salt marsh community.

However, assuming the model prediction of a maximum cooling tower deposition from three round mechanical draft towers of  $45.0 \text{ g/m}^2\text{-yr}$  on natural forest vegetation (see Section 3.2), a maximum deposition of  $51.7 \text{ g/m}^2\text{-yr}$  ( $461 \text{ lbs/ac-yr}$ ) ( $45 + 6.7 \text{ g/m}^2$  from natural background or about  $461 \text{ lbs/ac-yr}$ ) for all sources, including wet deposition from rainfall, might occur at Crystal River during operation of the cooling towers. This level is close to ten times the background level at Crystal River and the upper limit in which maritime forests and coastal hammocks normally occur. Many of the same species are dominant in the Crystal River area. Therefore, this level of deposition may be close to the upper limit to which the dominant species of the region are capable of acclimating (refer to Section 2.0) without showing some degree of damage and long-term effects on growth. Consequently, the vegetative growth and composition of a portion of the natural coastal forest communities could be altered under some alternatives.

#### 4.3 AREAS OF IMPACT

##### 4.3.1 Alternative 1 - Three Round Towers

The estimated point of maximum deposition falls over a developed area devoid of natural vegetation. The point of maximum deposition over a naturally vegetated area [about  $90 \text{ g/m}^2\text{-yr}$  ( $802 \text{ lbs/ac-yr}$ )] lies approximately 0.6 km (1,800 ft) northwest of the Units 1-3 cooling tower site. This point is within the salt marsh north of the discharge canal. Approximately 8 acres of this salt marsh will receive a calculated deposition loading above  $45.0 \text{ g/m}^2\text{-yr}$  ( $401 \text{ lbs/ac-yr}$ ); 150 acres will be exposed to rates from  $10.0 \text{ g/m}^2\text{-yr}$  ( $89 \text{ lbs/ac-yr}$ ) to  $45.0 \text{ g/m}^2\text{-yr}$ .

A portion (40 acres) of coastal hydric hammock will be exposed to annual deposition levels of  $20.0 \text{ g/m}^2\text{-yr}$  ( $178 \text{ lbs/ac-yr}$ ) to  $45.0 \text{ g/m}^2\text{-yr}$  ( $401 \text{ lbs/ac-yr}$ ). An additional 70 acres will be exposed to deposition levels of  $6.0 \text{ g/m}^2\text{-yr}$  ( $53 \text{ lbs/ac-yr}$ ) to  $20 \text{ g/m}^2\text{-yr}$ . The point of maximum deposition within the coastal hydric hammock community is about 0.6 km

(1,800 ft) north-northwest of the Units 1-3 cooling tower site. This location is on the north side of the fly ash pond for Units 1 and 2. Deposition levels decrease rapidly to the north and northwest.

A secondary zone of impact may occur in natural vegetation south of Units 1-3. Vegetation in this area consists of salt marsh on the west grading into a mix of salt marsh/fresh marsh/coastal hammock to the south of Unit 3. A coastal hydric hammock community occurs along the east side of the railroad loop and within the loop. Deposition in the this salt marsh complex will rapidly decrease from about  $60 \text{ g/m}^2\text{-yr}$  near the south side of the intake canal to about  $5 \text{ g/m}^2$  (44 lbs/ac-yr) at the transition to brackish marsh at the southeast end of the rail loop. Maximum deposition in the coastal hydric hammock east of the rail loop will range from  $5 \text{ g/m}^2\text{-yr}$  to  $10 \text{ g/m}^2\text{-yr}$  (88 lbs/ac-yr). Within the rail loop, levels may range up to  $15 \text{ g/m}^2\text{-yr}$  (132 lbs/ac-yr).

Deposition levels in pine flatwoods and fresh marsh communities will be less than  $15 \text{ g/m}^2\text{-yr}$ , with an off-site maximum of about  $7 \text{ g/m}^2\text{-yr}$  (62 lbs/ac-yr) at the north property boundary. The mechanical draft cooling towers will account for only about 2 g of the total at this point. This alternative has the highest deposition to power plant areas. FPC (1988) has indicated that this alternative is the least desirable from an engineering perspective due to increased corrosion from drift.

*bnilt* → 4.3.2 Alternative 2 - Four Rectangular Towers on North Side of Discharge Canal

The estimated point of maximum deposition falls over the discharge canal. The point of maximum deposition over a naturally vegetated area [over  $400 \text{ g/m}^2\text{-yr}$  (3,564 lbs/ac-yr)] lies immediately north of the Units 1-3 cooling tower site. This point is within the salt marsh on the north edge of the discharge canal. Approximately 9 acres of this salt marsh will receive a calculated deposition loading above  $400 \text{ g/m}^2\text{-yr}$  (3,560 lbs/ac-yr); 6 acres will be exposed to rates from  $200 \text{ g/m}^2\text{-yr}$  (1,780 lbs/ac-yr) to  $400 \text{ g/m}^2\text{-yr}$ . A total of approximately 75 acres of salt marsh will receive salt deposition loads greater than  $60 \text{ g/m}^2\text{-yr}$  (538 lbs/ac-yr).

A small amount (15 acres) of coastal hydric hammock will be exposed to annual deposition levels of over 50 g/m<sup>2</sup>-yr. An additional 55 acres will be exposed to deposition levels of 20 g/m<sup>2</sup>-yr to 50 g/m<sup>2</sup>-yr. The point of maximum deposition within the coastal hydric hammock community is about 0.4 km (1,300 ft) north of the Units 1-3 cooling tower site. This location is on the north side of the fly ash pond for Units 1 and 2. Deposition levels decrease rapidly to the north and northeast.

A secondary zone of impact may occur in natural vegetation southwest of Units 1 and 2. Vegetation in this area consists of salt marsh on the west grading into a mix of salt marsh/fresh marsh/coastal hammock to the south of Unit 3. Deposition in the this salt marsh complex will rapidly decrease from about 15 g/m<sup>2</sup>-yr (132 lbs/ac-yr) near the south side of the intake canal to about 5 g/m<sup>2</sup> (44 lbs/ac-yr) at the south side of the coal pile. Maximum deposition in the coastal hydric hammock within and east of the rail loop will be less than 5 g/m<sup>2</sup>-yr.

Deposition levels in pine flatwoods and fresh marsh communities will be less than 12 g/m<sup>2</sup>-yr (106 lbs/ac-yr), with an off-site maximum of about 7 g/m<sup>2</sup>-yr (62 lbs/ac-yr) at the north property boundary. The mechanical draft cooling towers will account for only about 2 g of the total at this point.

#### 4.3.3 Alternative 3 - Four Rectangular Towers on Both Sides of Discharge Canal

Impacts from this alternative are very similar to those for alternative 2. The main difference lies in a slight reduction of the extent of coastal hydric hammock subjected to severe depositional loads.

The estimated point of maximum deposition falls over the discharge canal. The point of maximum deposition over a naturally vegetated area [over 400 g/m<sup>2</sup>-yr (3,564 lbs/ac-yr)] lies immediately north of the Units 1-3 cooling tower site. This point is within the salt marsh on the north edge of the discharge canal. Approximately 9 acres of this salt marsh will receive a calculated deposition loading above 400 g/m<sup>2</sup>-yr (3,560 lbs/ac-yr); 6 acres

Using the period of ten days between rainfall events, as developed in Section 3.3, as a "worst case" summer condition assumption, an accumulation of  $33.67 \text{ g/m}^2$  (300 lbs/ac) would result at the point of maximum deposition in the salt marsh, and an accumulation of  $7.42 \text{ g/m}^2$  (66 lbs/ac) would occur at the point of maximum deposition in the coastal hydric hammock. Calculations by Davis (1979) based on the data of Francis (1977) and Lauver, et al. (1978) indicate that such a level of deposition could result in leaf chloride concentrations of 6,000 to 8,000 ppm and visible damage on 50-100% of the leaves of the sensitive species, such as dogwood.

Such levels probably would not significantly affect the salt marsh vegetation, but they would be expected to result in 80-100% leaf damage to sensitive hammock species and significant damage to moderately resistant species. For this ten-day impact event, about 25-40% of the leaf material along the southern edge of the coastal hydric hammock west of Units 4 and 5 has the potential to be impacted. Potential effects would also be possible for a small amount of the pine flatwoods and freshwater marsh areas both onsite and offsite. Such impacts would comprise a long-term injury event that would persist throughout the year and could destroy the integrity of the southern part of the coastal hydric hammock, leading to a progressive retreat of the community to the north and northeast. An opening of this canopy potentially could expose understory plants to additional natural salt spray.

As Table 3-5 indicates, an average of 12 rainfall events occurred during each of the summer months during a five-year period, indicating that the number of days between rainfall events is commonly less than 10 days, with an average period of less than three days between events.

Salt accumulation on leaves during the period of operation is likely to be substantially below the values predicted above for 10 day intervals. Such reduced levels of accumulation would result in proportionally less effect on vegetation. Based upon an average of 3 days between rainfall events, salt accumulation would be  $2.25 \text{ g/m}^2$  in the southern end of the hammock. This level is still sufficient to induce significant effects (potentially

affecting up to 10% of total leaf area) in an area of less than 15 acres in the coastal hydric hammock adjacent to the north side of the fly ash pond for Units 1 and 2. Potential damage should be confined to the less resistant species in all other areas of the FPC property, and no effects are expected outside of the FPC property.

#### 4.4.3 Alternative 3 - Four Rectangular Towers on Two Sides of Discharge Canal

The effects and conditions for Alternative 3 are almost exactly like those for Alternative 2. The maximum monthly depositions in the salt marsh and coastal hydric hammock are about the same as for Alternative 2. The treatment and analysis are also identical.

The only difference is that the area of coastal hydric hammock which may experience significant effects (potentially affecting up to 10% of total leaf area) is reduced from about 15 acres to 5 acres in this alternative. The maximum accumulation would still be  $2.25 \text{ g/m}^2$  in the southern end of the hammock, but the area of influence would be restricted to the west end of the ash pond. Potential damage should be confined to the less resistant species in all other areas of the FPC property, and no effects are expected outside of the FPC property.

Based on this evaluation of the maximum "effective deposition rate" due to washout by rainfall, significant injury is expected for low and moderate resistance and intolerant native species in the southern portion of the on-site coastal hydric hammock community during the summer months. Some minor effects could possibly be experienced by resistant species in this portion of the coastal hydric hammock next to the ash pond, depending on the alternative selected.

#### 4.5 POTENTIAL INJURY MODEL

Freudenthal and Beals' (1978) method (refer to Section 2.0) for modeling botanical injury from saline drift was also used to analyze potential impacts. Their scale for injury evaluation was adjusted from a four level range to a five level range to allow for better evaluation of effects on



## **Attachment 2**

## **Attachment 3**

PERMIT NO. FL0036366  
Major non-POTW

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION IV

AUTHORIZATION TO DISCHARGE UNDER THE  
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Clean Water Act, as amended (33 U.S.C. 1251 et seq.; the "Act"),

Florida Power Corporation  
P.O. Box 14042  
St. Petersburg, Florida 33733

is authorized to discharge from a facility located at

Crystal River Units 4 and 5  
Power Line Road  
Citrus County  
Crystal River, Florida 32629

to receiving waters named

Gulf of Mexico

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein. The permit consists of this cover sheet, Part I 10 pages, Part II 16 pages, Part III 6 pages, and Part IV 2 pages.

This permit became effective on January 1, 1993, and was then modified with an effective date of January 1, 1994.

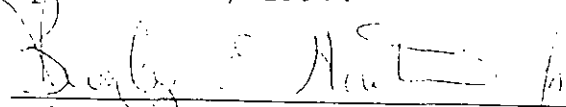
This modification adds monitoring requirements and effluent limitations for Calgon PCL-361, a chemical added to the cooling water for Units 4 and 5. Only the modified pages (Pages I-1 and I-2) are included.

The modification shall become effective on November 1, 1994.

This permit and the authorization to discharge shall expire at midnight, September 30, 1997.

September 11, 1992

Date Issued

  
Robert F. McGhee, Acting Director  
Water Management Division

September 27, 1994

Date Modified

## A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS - FINAL

1. During the period beginning on the effective date of this permit and lasting through expiration, the permittee is authorized to discharge from Outfalls 009 and 010 - Cooling Tower Blowdown from Units 4 and 5, respectively, to the Site Discharge Canal thence the Gulf of Mexico.

Such discharges shall be limited and monitored by the permittee as specified below:

| <u>PARAMETER</u>                                  | <u>DISCHARGE LIMITATIONS</u>     |  | <u>MONITORING REQUIREMENTS</u>   |                           |
|---|----------------------------------|--|----------------------------------|---------------------------|
|   | <u>Instantaneous<br/>Maximum</u> | <u>Two-hour<br/>Average<sup>3/</sup></u> | <u>Measurement<br/>Frequency</u> | <u>Sample<br/>Type</u>    |
| Flow, MGD   | Report                           | ---                                      | Continuous                       | Recorder                  |
| Temperature, °F                                   | Report                           | 96.0                                     | Continuous                       | Recorder                  |
| Total Residual Oxidants,<br>(TRO), mg/l           | See Item 2, below                |  | Continuous <sup>1/</sup>         | Recorder                  |
| Conductivity (as Total Dissolved<br>Solids), mg/l | Report                           | ---                                      | Continuous                       | Recorder                  |
| Total Phosphorus as P, mg/l                       | Report                           | 10.0                                     | 1/Week <sup>2/</sup>             | Grab                      |
| Cycles of Concentration,<br>number                | Report                           | ---                                      | 1/Week                           | Calculation               |
| Free Available Oxidants, mg/l                     | See Item 7, Page I-2             |  | Each Application                 | Grab <sup>4/</sup>        |
| pH, Standard Units                                | See Item 3, below                |  | 1/Day                            | Grab                      |
| Time of Chlorine Discharge,<br>minutes/day/unit   | 120                              | ---                                      | Daily                            | Logs                      |
| Calgon PCL-361, ppm                               | 10.0                             | ---                                      | 1/Month <sup>5/</sup>            | Calculation <sup>5/</sup> |

2. The daily maximum concentration for Total Residual Oxidants shall be limited to 0.01 mg/l at the point of discharge from the discharge canal to the Gulf of Mexico and monitoring shall be done 1/year by grab sample. Also, TRO shall be limited to 0.05 mg/l at the point of discharge to the discharge canal; monitoring shall be performed continuously by recorder.
3. The pH shall not be less than 6.5 nor greater than 8.5 standard units at the combined discharge to the Site Discharge Canal.
4. The dechlorination system shall be maintained to assure that excessive quantities of sulfur dioxide are not discharged.
5. There shall be no discharge of floating solids or visible foam in other than trace amounts, nor shall the discharge cause a visible sheen on the receiving waters.
6. Discharge of debris filter backwash is permitted without limitations or monitoring requirements.

## **Attachment 4**

ATTACHMENT  
UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
REGION IV

AUTHORIZATION TO DISCHARGE UNDER THE  
NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM

In compliance with the provisions of the Clean Water Act, as amended (33 U.S.C. 1251 et seq.; the "Act"),

Florida Power Corporation  
P.O. Box 14042  
St. Petersburg, Florida 33733

is authorized to discharge from a facility located at

Crystal River Power Plant  
Units 1, 2, and 3  
US Highway 19 & Powerline Road  
Crystal River, Citrus County, Florida 32629

to receiving waters named

Gulf of Mexico

in accordance with effluent limitations, monitoring requirements and other conditions set forth herein. The permit consists of this cover sheet, Part I 19 pages, Part II 16 pages, Part III 6 pages, Part IV 5 pages, Part V 2 pages, and Table I.

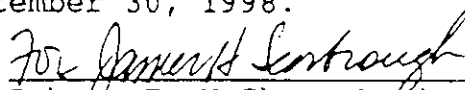
The revised permit shall become effective May 1, 1995.

Part IV of the current permit is being withdrawn, revised and reissued to resolve an Evidentiary Hearing Request. Part IV has been revised to address only stormwater runoff. Only the revised pages are attached.

This permit and the authorization to discharge shall expire at midnight, September 30, 1998.

September 30, 1993

Date Issued

  
Robert F. McGhee, Acting Director  
Water Management Division

APR 18 1995

Date Modified

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS - Final

1. During the period beginning on the effective date of the permit and lasting through expiration, the permittee is authorized to discharge from Outfalls 001, 002, 005 (Once through cooling water from Units 1, 2, and 3, respectively) and Outfalls 010A, 010B, and 011 (intake screen backwash to the plant intake or discharge canals) to the site discharge canal thence the Gulf of Mexico.

Such discharges shall be limited and monitored by the permittee as specified below:

| <u>EFFLUENT PARAMETERS</u>                        | <u>DISCHARGE LIMITATIONS</u> |                          | <u>MONITORING REQUIREMENTS</u>   |                        |
|---|------------------------------|--------------------------|----------------------------------|------------------------|
|   | <u>Daily<br/>Maximum</u>     | <u>Daily<br/>Average</u> | <u>Measurement<br/>Frequency</u> | <u>Sample<br/>Type</u> |
| Flow, MGD   | See item 2.                  | Report                   | Continuous                       | Pump Log <sup>2/</sup> |
| Discharge Temp., °F<br>(Point of Discharge (POD)) | See item 3.                  | Report                   | Continuous                       | Recorders              |
| POD Temp. Rise, °F                                | Report                       | Report                   | Continuous                       | Recorders              |
| Total Residual Oxidants<br>(POD), mg/l            | 0.01 <sup>1/</sup>           | Report                   | 2/ week                          | Multiple<br>Grabs      |
| Time of TRO Discharge,<br>min/day/unit            | See item 7, page I-2.        |                          | 2/ week                          | Logs                   |
| Copper-trol CU-1, mg/l                            | 6.8                          | ---                      | See item 8, pg I-3.              | Grab                   |
| Acute Whole Effluent<br>Toxicity                  | See item 8, page I-3.        |                          | See Part V.                      | Grab                   |

Continued

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS - Final (continued)

2. Combined condenser flow from Units 1, 2, and 3 shall not exceed 1897.9 MGD during the period May 1st through October 31st of each year, nor 1613.2 MGD during the remainder of the year.
3. The discharge temperature at the bulkhead line shall not exceed 96.5°F for a period of more than three consecutive hours, or a daily maximum value of 97.0°F.
4. Intake screen backwash may be discharged from Outfalls 010A, 010B, and 011 without limitation or monitoring requirements after passage through debris baskets, except that there shall be no discharge of floating oil. Debris removed by the intake bar racks, intake flumes and debris baskets shall be disposed in a landfill.
5. Samples taken in compliance with the monitoring requirements specified in item 1 shall be taken at the following locations: TRO and Copper-trol CU-1 at the outlet corresponding to an individual condenser (4 condensers per unit); flow from the combined circulating water pumps; intake temperature at the water boxes of each individual unit; and discharge temperature at the intersection of the site discharge canal and the original bulkhead line.
6. There shall be no discharge of floating solids or visible foam in other than trace amounts, nor shall the effluent cause a visible sheen on the receiving waterbody (i.e., discharge canal).
7. Discharge of TRO from the condenser(s) of each unit shall not exceed a maximum of 60 minutes each in any calendar day. This requirement shall be waived in the event that TRO is monitored continuously by recorder(s). During the period(s) when TRO may be discharged from Outfalls 001, 002, 005, 012, and 013, TRO may be discharged from one or more individual condensers and/or TRO may be discharged from either or both cooling tower outfalls, individually, or in any combination; however, each individual point of discharge shall not exceed a maximum instantaneous TRO concentration of 0.01 mg/l.

continued



## Figure 1

