Florida Power
CORPORATION

March 8, 1989

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DER - BAQM

Mr. Steve Smallwood
Florida Department of Environmental Regulation
Division of Air Resources Management
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

Dear Mr. Smallwood:

Subject: Air Construction Permit Application
Helper Cooling Towers
Crystal River Units 1, 2, & 3

Florida Power Corporation hereby submits four copies of the application to construct Helper Cooling Towers for Crystal River Units 1, 2, & 3. Also enclosed is a check in the amount of $5,000.00 for the filing fee as set forth in FAC 17-4.050(4)(a)1.a.

If you have any questions regarding this application, please contact Mr. Eustice Parnelle at (813)866-4544 or Mr. W. W. (Bud) Vierday at (813)866-4511.

Sincerely,

Patsy Yeater Baynard

Patsy Y. Baynard, Director
Environmental and Licensing Affairs

PYB/REP/bm
Enclosures

cc: W. C. Thomas-DER/Tampa

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[redacted]

Date 03/08/89

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From (Your Name) Please Print: B. Hutchmore, H2G
Your Phone Number (Very Important): ( )
Company: FLORIDA POWER CORP
Department/Floor No
Street Address: 3201 34TH ST SOUTH
City: ST PETERSBURG State: FL ZIP Required: 3 3 7 1 2

To (Recipient's Name) Please Print: Steve Smallwood
Recipient's Phone Number (Very Important): ( )
Company: Florida Dept of Environmental Regulation
Department/Floor No.
Exact Street Address (We Cannot Deliver to P.O. Boxes or P.O. ® Zip Codes.): Div of Air REsources Management 2600 Blair Stone Road.
City: Tallahassee State: FL ZIP Required: 32399-2400

YOUR BILLING REFERENCE INFORMATION (FIRST 24 CHARACTERS WILL APPEAR ON INVOICE.): RA #927 6160.00 FL001

PAYMENT ☐ Bill Sender ☐ Bill Recipient's FedEx Acct No ☐ Bill 3rd Party FedEx Acct No ☐ Bill Credit Card ☐ Cash [redacted]

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City State ZIP Required

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4 ☐ OVERNIGHT TUBE	9 ☐	4 ☐ DANGEROUS GOODS (Extra charge)				
5 ☐ STANDARD AIR Delivery not later than second business day	10 ☐	5 ☐ CONSTANT SURVEILLANCE SERVICE (CSS) (Extra charge) (Release Signature Not Applicable)	Total	Total	Total	
		6 ☐ DRY ICE ____ Lbs				
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		8 ☐				
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Receipt, enter into PATS, hand carry to Revenue Sect – Jewell or Lee for deposit tomorrow

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QUESTIONS? CALL 800-238-5355 TOLL FREE.

PACKAGE TRACKING NUMBER 2459119655

2459119655

[redacted]

Date 3/17/89

RECIPIENT'S COPY

From (Your Name) Please Print: B. Huchmore
Your Phone Number (Very Important): ( )
Company: FLORIDA POWER CORP
Department/Floor No.
Street Address: 3201 34TH ST SOUTH
City: ST PETERSBURG State: FL ZIP Required: 3 3 7 1 2

To (Recipient's Name) Please Print: Mr. Clair Fancy
Recipient's Phone Number (Very Important): ( )
Company: Florida Dept of Environmental Reg.
Department/Floor No.
Exact Street Address (We Cannot Deliver to P.O. Boxes or P.O. ® Zip Codes.): 2600 Blair Stone Road
City: Tallahassee, State: FL ZIP Required: 3 2 3 9 9

YOUR BILLING REFERENCE INFORMATION (FIRST 24 CHARACTERS WILL APPEAR ON INVOICE.): 927 616000 FLACN

PAYMENT ☐ Bill Sender ☐ Bill Recipient's FedEx Acct No ☐ Bill 3rd Party FedEx Acct No ☐ Bill Credit Card ☐ Cash [redacted]

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DEPARTMENT OF ENVIRONMENTAL REGULATION

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Recpt. #117602

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32399-2400

RECEIVED
MAR 9 1989

AC 09-162037
PSD-FL-139

BOB MARTINEZ
GOVERNOR

DALE TWACHTMANN
SECRETARY

APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

SOURCE TYPE: Helper Cooling Tower [X] **New**[1] [ ] **Existing**[1]

APPLICATION TYPE: [X] **Construction** [ ] **Operation** [ ] **Modification**

COMPANY NAME: Florida Power Corporation **COUNTY:** Citrus

Identify the specific emission point source(s) addressed in this application (i.e. Lime Kiln No. 4 with Venturi Scrubber; Peaking Unit No. 2, Gas Fired) Helper Cooling Tower

SOURCE LOCATION: Street N/A City 8 miles NW of Crystal River

UTM: East 333.75 km North 3204.5 km

Latitude 28 ° 57 ' 35 "N Longitude 82 ° 42 ' 30 "W

APPLICANT NAME AND TITLE: John A. Hancock, Vice President, Fossil Operations

APPLICANT ADDRESS: Florida Power Corporation A5A, P. O. Box 14042, St. Petersburg, Florida 33233

SECTION I: STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

I am the undersigned owner or authorized representative* of Florida Power Corporation

I certify that the statements made in this application for a Helper Cooling Tower permit are true, correct and complete to the best of my knowledge and belief. Further I agree to maintain and operate the pollution control source and pollution control facilities in such a manner as to comply with the provision of Chapter 403, Florida Statutes, and all the rules and regulations of the department and revisions thereof. I also understand that a permit, if granted by the department, will be non-transferable and I will promptly notify the department upon sale or legal transfer of the permitted establishment.

*Attach letter of authorization

Signed: Patsy Yates Baynard

Patsy Y. Baynard
Director, Environmental & Licensing Affairs
Name and Title (Please Type)

Date: 3/8/89 Telephone No. 813-866-4491

B. PROFESSIONAL ENGINEER REGISTERED IN FLORIDA (where required by Chapter 471, F.S.)

This is to certify that the engineering features of this pollution control project have been designed/examined by me and found to be in conformity with modern engineering principles applicable to the treatment and disposal of pollutants characterized in the permit application. There is reasonable assurance, in my professional judgment, tha

[1] See Florida Administrative Code Rule 17-2.100(57) and (104)

DER Form 17-1.202(1)
Effective October 31, 1982

the pollution control facilities, when properly maintained and operated, will discharge an effluent that complies with all applicable statutes of the State of Florida and the rules and regulations of the department. It is also agreed that the undersigned will furnish, if authorized by the owner, the applicant a set of instructions for the proper maintenance and operation of the pollution control facilities and, if applicable, pollution sources.

Signed [signature] 2/28/89

Gary L. Christensen
Name (Please Type)

Black & Veatch, Engineers-Architects
Company Name (Please Type)

P. O. Box 8405, Kansas City, Missouri 64114
Mailing Address (Please Type)

Florida Registration No. 40311 Date: 9/21/88 Telephone No. 913-339-2643

SECTION II: GENERAL PROJECT INFORMATION

A. Describe the nature and extent of the project. Refer to pollution control equipment, and expected improvements in source performance as a result of installation. State whether the project will result in full compliance. Attach additional sheet if necessary.

Construct mechanical draft helper cooling tower for Crystal River Units 1, 2, and 3 to attain point of discharge temperature limits specified in the NPDES permit. Cooling tower design includes drift eliminators to minimize particle drift loss.

B. Schedule of project covered in this application (Construction Permit Application Only)

Start of Construction 09/01/89 Completion of Construction 08/31/91

C. Costs of pollution control system(s): (Note: Show breakdown of estimated costs only for individual components/units of the project serving pollution control purposes. Information on actual costs shall be furnished with the application for operation permit.)

The estimated cost for the proposed drift eliminators is approximately $500,000.

D. Indicate any previous DER permits, orders and notices associated with the emission point, including permit issuance and expiration dates.

NPDES permit (FL0036366) issued September 1, 1988, that expires August 31, 1993.

PSD permit PSD-FL-007 issued February 27, 1978, with no expiration date.

E. Requested permitted equipment operating time: hrs/day 24 ; days/wk 7 ; wks/yr 52 ;

if power plant, hrs/yr ____; if seasonal, describe: ____

See Section II-E Attachment

F. If this is a new source or major modification, answer the following questions. (Yes or No)

1. Is this source in a non-attainment area for a particular pollutant? No

   a. If yes, has "offset" been applied? ____

   b. If yes, has "Lowest Achievable Emission Rate" been applied? ____

   c. If yes, list non-attainment pollutants. ____

2. Does best available control technology (BACT) apply to this source? If yes, see Section VI. Yes

3. Does the State "Prevention of Significant Deterioriation" (PSD) requirement apply to this source? If yes, see Sections VI and VII. Yes

4. Do "Standards of Performance for New Stationary Sources" (NSPS) apply to this source? No

5. Do "National Emission Standards for Hazardous Air Pollutants" (NESHAP) apply to this source? No

H. Do "Reasonably Available Control Technology" (RACT) requirements apply to this source? No

   a. If yes, for what pollutants? ____

   b. If yes, in addition to the information required in this form, any information requested in Rule 17-2.650 must be submitted.

Attach all supportive information related to any answer of "Yes". Attach any justification for any answer of "No" that might be considered questionable.

BACT was determined in the NPDES permit process.

PSD requirement applies to particulate drift leaving the cooling tower.

SECTION II-E ATTACHMENT

The helper cooling towers will be operated on an as needed basis to maintain the discharge water temperature at the plant site POD to 96.5 F as a 3-hour average or 97 F maximum. Generally whenever the intake temperature to the three electric generating units exceeds 80 F the cooling tower will be required to support full load operation, i.e., all three generating units at 100 percent electrical output. Historical data suggests that the cooling tower could be used intermittently as early as April or as late as November. The cooling tower will normally operate daily from June through September at either full (36 cells) or partial operation (36 cells or less). The controlling criteria for operation will be compliance with the POD water temperature. Periodic operation during the off season will be required for maintenance and system operating integrity.

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SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES (Other than Incinerators)

A. Raw Materials and Chemicals Used in your Process, if applicable:

Description	Contaminants Type	Contaminants % Wt	Utilization Rate - lbs/hr	Relate to Flow Diagram
Seawater	Salt Particles	2.91	687,000 gpm	See process flow diagram
Biofouling Control	Chlorine		37,000 lb/day Maximum	See process flow diagram
Biofouling Control	Sulfur Dioxide		8,000 lb/day Maximum	See process flow diagram

B. Process Rate, if applicable: (See Section V, Item 1)

1. Total Process Input Rate (lbs/hr): 687,000 gpm of seawater

2. Product Weight (lbs/hr): __________

C. Airborne Contaminants Emitted: (Information in this table must be submitted for each emission point, use additional sheets as necessary)

Name of Contaminant	Emission[1] Maximum lbs/hr	Emission[1] Actual T/yr	Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission lbs/hr	Potential[4] Emission T/yr	Relate to Flow Diagram
(Salt) Particulate	198.4	428	N/A	N/A	198.4	428	See Cooling Tower Diagram
Note: PM_{10} is <5 percent of this total--see attached Section III-C Table also							
Section III-C Attachment							

[1]See Section V, Item 2.

[2]Reference applicable emission standards and units (e.g. Rule 17-2.600(5)(b)2. Table II, E. (1) - 0.1 pounds per million BTU heat input)

[3]Calculated from operating rate and applicable standard.

[4]Emission, if source operated without control (See Section V, Item 3).

SECTION III-C TABLE

AVERAGE DROP-SIZE DISTRIBUTION
EMISSION RATE AT 0.002 PERCENT DRIFT LOSS
(FROM WILBER AND VERCAUTEREN)

Range of Radii um	Mean Radius um	Percent of Total Drive Mass Percent
0 - 20	15	4.8
20 - 30	25	5.4
30 - 50	40	3.6
50 - 100	75	9.2
100 - 150	125	13.0
150 - 200	175	26.0
200 - 250	225	23.5
250 - 350	300	11.5
350 - 500	425	1.9
500 - 800	713	1.1

SECTION III-C ATTACHMENT

The annual emission estimate is based on four cooling towers operating at full continuous operation for six months. The associated drift loss is 0.002 percent of the circulating water. Most of the drift is expected to be deposited on the plant property in the general vicinity of the proposed cooling towers.

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D. Control Devices: (See Section V, Item 4)

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles Size Collected (in microns) (If applicable)	Basis for Efficiency (Section V Item 5)
Drift Eliminators	Salt Particles	(99.8) 0.002% of cooling	Particle size distribution (attached)	Manufacturer's Guarantee
		tower drift	(Section III-C)	

E. Fuels

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	avg/hr	max./hr	

*Units: Natural Gas--MMCF/hr; Fuel Oils--gallons/hr; Coal, wood, refuse, other--lbs/hr.

Fuel Analysis:

Percent Sulfur: ______________________ Percent Ash: ______________________

Density: ______________________ lbs/gal Typical Percent Nitrogen: ______________________

Heat Capacity: ______________________ BTU/lb ______________________ BTU/gal

Other Fuel Contaminants (which may cause air pollution): ______________________

____

F. If applicable, indicate the percent of fuel used for space heating.

Annual Average N/A Maximum ______________________

G. Indicate liquid or solid wastes generated and method of disposal.

N/A

H. Emission Stack Geometry and Flow Characteristics (Provide data for each stack):

Stack Height: Approximately 53 feet per fan ft. Stack Diameter: Fan 34.5 ft./Fan

Gas Flow Rate: 1,140,000 per Fan ACFM ______ DSCFM Gas Exit Temperature: 91 °F.

Water Vapor Content: 100% Saturated % Velocity: 20 FPS

There are four towers with nine cells per tower, for a total of 36 fans.

SECTION IV: INCINERATOR INFORMATION

N/A

Type of Waste	Type O (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Incinerated							
Uncontrolled (lbs/hr)							

Description of Waste ______

Total Weight Incinerated (lbs/hr) ______ Design Capacity (lbs/hr) ______

Approximate Number of Hours of Operation per day ______ day/wk ______ wks/yr. ______

Manufacturer ______

Date Constructed ______ Model No. ______

	Volume (ft)^3	Heat Release (BTU/hr)	Fuel Type	Fuel BTU/hr	Temperature (°F)
Primary Chamber					
Secondary Chamber					

Stack Height: ______ ft. Stack Diamter: ______ Stack Temp. ______

Gas Flow Rate: ______ ACFM ______ DSCFM* Velocity: ______ FPS

*If 50 or more tons per day design capacity, submit the emissions rate in grains per standard cubic foot dry gas corrected to 50% excess air.

Type of pollution control device: [ ] Cyclone [ ] Wet Scrubber [ ] Afterburner

[ ] Other (specify) ______

Brief description of operating characteristics of control devices: ______

______

______

______

______

Ultimate disposal of any effluent other than that emitted from the stack (scrubber water, ash, etc.):

______

______

______

______

NOTE: Items 2, 3, 4, 6, 7, 8, and 10 in Section V must be included where applicable.

SECTION V: SUPPLEMENTAL REQUIREMENTS

Please provide the following supplements where required for this application.

Applicable Supplements provided on following pages.

1. Total process input rate and product weight -- show derivation [Rule 17-2.100(127)]

2. To a construction application, attach basis of emission estimate (e.g., design calculations, design drawings, pertinent manufacturer's test data, etc.) and attach proposed methods (e.g., FR Part 60 Methods 1, 2, 3, 4, 5) to show proof of compliance with applicable standards. To an operation application, attach test results or methods used to show proof of compliance. Information provided when applying for an operation permit from a construction permit shall be indicative of the time at which the test was made.

3. Attach basis of potential discharge (e.g., emission factor, that is, AP42 test).

4. With construction permit application, include design details for all air pollution control systems (e.g., for baghouse include cloth to air ratio; for scrubber include cross-section sketch, design pressure drop, etc.)

5. With construction permit application, attach derivation of control device(s) efficiency. Include test or design data. Items 2, 3 and 5 should be consistent: actual emissions = potential (1-efficiency).

6. An 8 1/2" x 11" flow diagram which will, without revealing trade secrets, identify the individual operations and/or processes. Indicate where raw materials enter, where solid and liquid waste exit, where gaseous emissions and/or airborne particles are evolved and where finished products are obtained.

7. An 8 1/2" x 11" plot plan showing the location of the establishment, and points of airborne emissions, in relation to the surrounding area, residences and other permanent structures and roadways (Example: Copy of relevant portion of USGS topographic map).

8. An 8 1/2" x 11" plot plan of facility showing the location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.

SECTION V: SUPPLEMENTAL REQUIREMENTS

5. With construction permit application, attach derivation of control device(s) efficiency. Include test or design data. Items 2, 3, and 5 should be consistent: actual emissions = potential (1-efficiency).

   The control device efficiency is guaranteed by the manufacturer. Field tested by sensitive paper sampling method after installation for verification.

6. An 8-1/2 inch by 11 inch flow diagram which, without revealing trade secrets, identify the individual operations and/or processes. Indicate where raw materials enter, where solid and liquid waste exit, where gaseous emissions and/or airborne particles are evolved and where finished products are obtained.

   The flow diagram follows this section.

7. An 8-1/2 inch by 11 inch plot plan showing the location of the establishment and points of air borne emissions in relation to the surrounding area, residences and other permanent structures and roadways. (Example: Copy of relevant portion of USGS topographic map.)

   The plot plan and relevant features are shown on the figure following this section.

8. An 8-1/2 inch by 11 inch plot plan of facility showing the location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.

   Figure 3-1 of the supplemental air quality impact analysis locates the modeled fugitive and stationary TSP sources.

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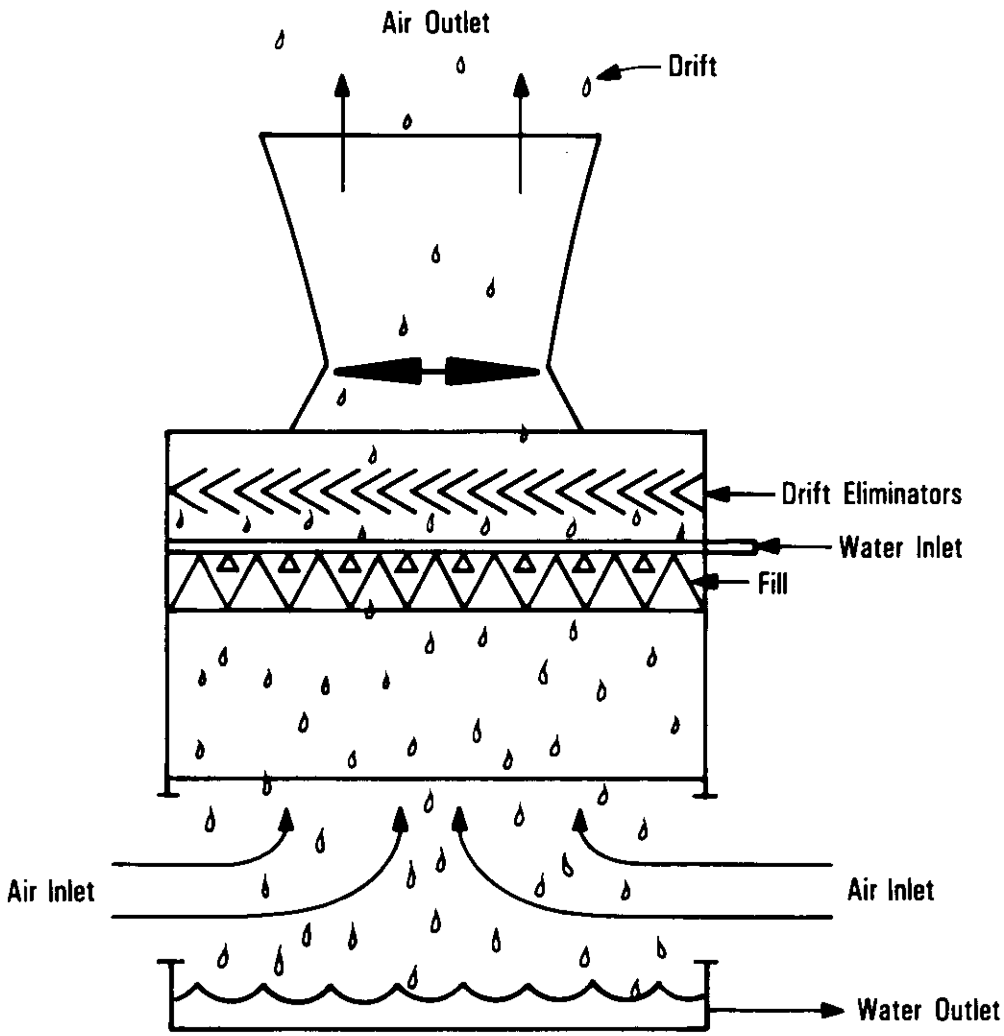
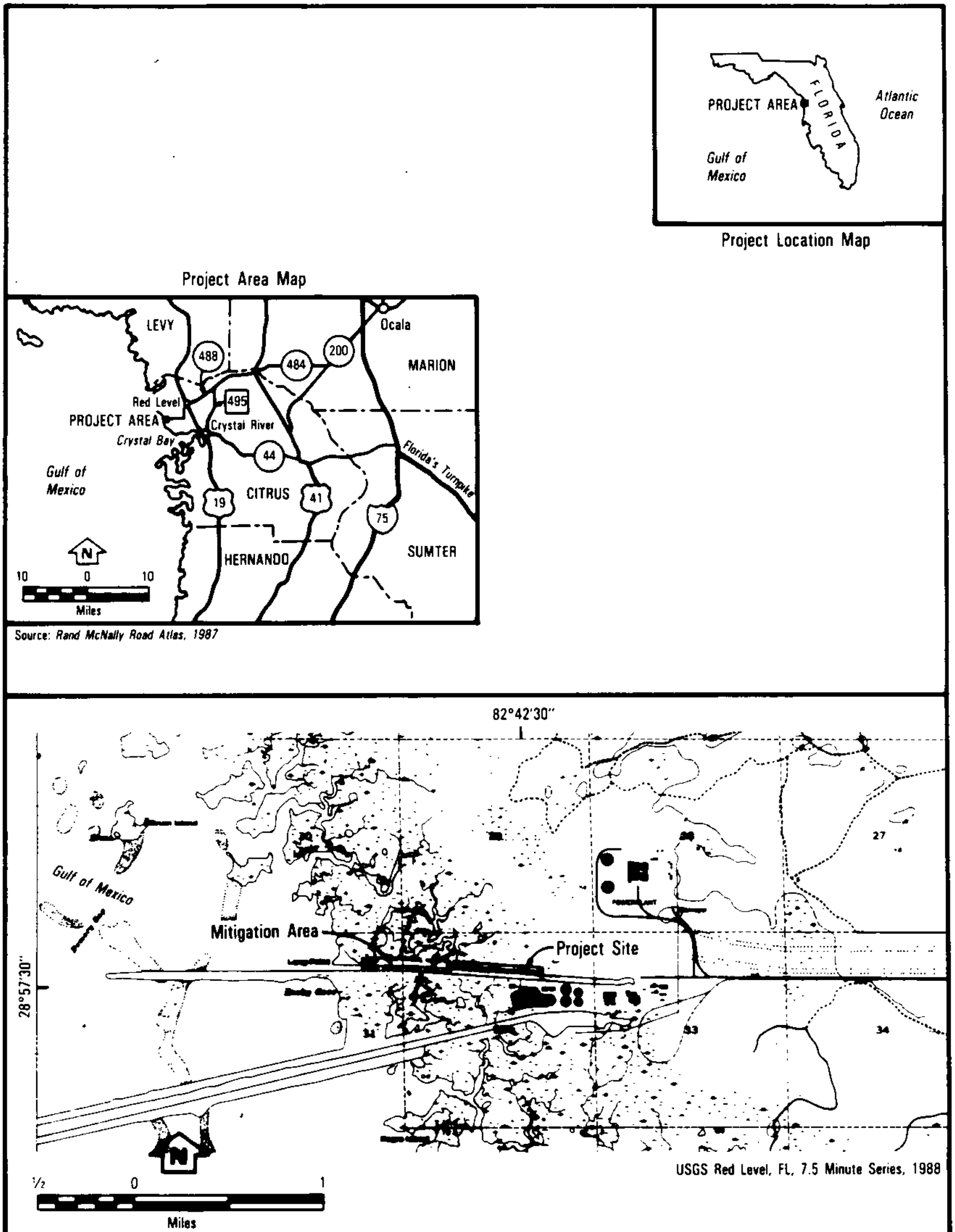
Induced Draft



MECHANICAL DRAFT COUNTERFLOW



PROJECT LOCATION

Figure 1

9. The appropriate application fee in accordance with Rule 17-4.05. The check should be made payable to the Department of Environmental Regulation.

10. With an application for operation permit, attach a Certificate of Completion of Construction indicating that the source was constructed as shown in the construction permit.

SECTION VI: BEST AVAILABLE CONTROL TECHNOLOGY

A. Are standards of performance for new stationary sources pursuant to 40 C.F.R. Part 60 applicable to the source?

[ ] Yes [X] No

Contaminant	Rate or Concentration

B. Has EPA declared the best available control technology for this class of sources (If yes, attach copy)

[ ] Yes [X] No

Contaminant	Rate or Concentration

C. What emission levels do you propose as best available control technology?

Contaminant	Rate or Concentration
Particulate	25 g/s

D. Describe the existing control and treatment technology (if any). N/A

1. Control Device/System:
2. Operating Principles:
3. Efficiency:*
4. Capital Costs:

*Explain method of determining

5. Useful Life:

6. Operating Costs:

7. Energy:

8. Maintenance Cost:

9. Emissions:

Contaminant	Rate or Concentration

10. Fan Stack Parameters (Per Fan)

a. Height: 53 ft.

b. Fan Stack Diameter: 34.5/Fan ft.

c. Flow Rate: 1,140,000 ACFM

d. Temperature: 91 °F.

e. Velocity: 20 FPS

E. Describe the control and treatment technology available (As many types as applicable, use additional pages if necessary).

1. See Following Page

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

2. Same as above

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

[1]Explain method of determining efficiency.
[2]Energy to be reported in units of electrical power - KWH design rate.

a. Control Device: Drift Eliminators

b. Operating Principles: Rapidly changing the direction of tower exit air to separate drift. Momentum of the drift water droplets diverts them from air stream as direction change is encountered.

c. Efficiency: 99.8 Percent (0.002 percent of cooling tower flow) as based on manufacturer's guarantee.

d. Capital Cost: Approximately $500,000.

e. Useful Life: 30 Years--Estimated
5 Years--Guaranteed

f. Operating Cost: None

g. Energy: Cooling tower fan energy cost penalty caused by drift eliminators at $1,800 per fan (36 fans total).

h. Maintenance Cost: Approximately 5 percent of capital cost annually.

i. Availability of construction materials and process chemicals: Readily available.

j. Applicability of manufacturing processes: Proven Process.

k. Ability to construct with control device, install in available space, and operate within proposed levels: Drift eliminators are included in the design of the helper cooling towers.

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

3.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Cost:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels:

4.

a. Control Device:

b. Operating Principles:

c. Efficiency:[1]

d. Capital Costs:

e. Useful Life:

f. Operating Cost:

g. Energy:[2]

h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

j. Applicability to manufacturing processes:

k. Ability to construct with control device, install in available space, and operate within proposed levels: Drift eliminators are included in the design of the helper cooling towers.

F. Describe the control technology selected: Same as previous page.

1. Control Device: Drift Eliminators

2. Efficiency:[1]

3. Capital Cost:

4. Useful Life:

5. Operating Cost:

6. Energy:[2]

7. Maintenance Cost:

8. Manufacturer:

9. Other locations where employed on similar processes: Drift eliminators are an integral part of all cooling towers in the USA.

a. (1) Company:
Florida Power Corporation, Anclote Power Plant Units 1 and 2

(2) Mailing Address:
P. O. Box 938

(3) City: Tarpon Springs

(4) State: Florida 33589

[1]Explain method of determining efficiency.
[2]Energy to be reported in units of electrical power - KWH design rate.

(5) **Environmental Manager:** Patsy Y. Baynard

(6) **Telephone No.:** 813-866-5151

(7) **Emissions:**[1] Not available for cooling tower

Contaminant	Rate or Concentration

(8) **Process Rate:**[1] Not available for cooling tower

b. (1) **Company:** Houston Lighting and Power, P. H. Robinson Station

(2) **Mailing Address:** P. O. Box 1700, Houston, Texas 77001

(3) **City:** Bacliff (4) **State:** Texas

(5) **Environmental Manager:** R. McDonald (General Manager of the P. H. Robinson Station)

(6) **Telephone No.:** 713-228-9211

(7) **Emissions:**[1] Not available for cooling tower

Contaminant	Rate or Concentration

(8) **Process Rate:**[1] Not available for cooling tower

c. See information on following page.

10. **Reason for selection and description of systems:** Drift eliminators are "state of the art" for controlling drift from cooling towers.

[1]Applicant must provide this information when available. Should this information not be available, applicant must state the reason(s) why.

SECTION VII - PREVENTION OF SIGNIFICANT DETERIORATION

A. **Company Monitored Data**

1. ___4___ no. sites ___4___ TSP ______( )___ SO_2* __________ Wind spd/dir

Period of Monitoring ___7___ / ___1___ / ___1985___ to ___6___ / ___30___ / ___1987___
(month / day / year to month / day / year)

Other data recorded ______________________________

Attach all data or statistical summaries to this application.

*Specify bubbler (B) or continuous (C).

c. (Page 11 of 12)

(1) Company: Gulf Power, Crist Steam Plant

(2) Mailing Address: 500 Bayfront Parkway, Box 1151

(3) City: Pensacola (4) State: Florida 32520-1151

(5) Environmental Manager: W. T. Lyford, III (Crist Plant Manager)

(6) Telephone No.: 904-444-6111

(7) Emissions: Not Available for cooling tower

(8) Process Rate: Not available for cooling tower

2. Instrumentation, Field and Laboratory

a. Was instrumentation EPA referenced or its equivalent? [X] Yes [ ] No

b. Was instrumentation calibrated in accordance with Department procedures?

[X] Yes [ ] No [ ] Unknown

B. Meteorological Data Used for Air Quality Modeling

1. 5 Year(s) of data from 1 / 1 / 1982 (month day year) to 12 / 31 / 1986 (month day year)

2. Surface data obtained from (location) Tampa

3. Upper air (mixing height) data obtained from (location) Ruskin

4. Stability wind rose (STAR) data obtained from (location) N/A

C. Computer Models Used

1. ISCST Modified? If yes, attach description.

2. ______ Modified? If yes, attach description.

3. ______ Modified? If yes, attach description.

4. ______ Modified? If yes, attach description.

Attach copies of all final model runs showing input data, receptor locations, and principle output tables.

D. Applicants Maximum Allowable Emission Data

Pollutant	Emission Rate	
TSP	25	grams/sec
SO^2		grams/sec

E. Emission Data Used in Modeling Refer to Modeling Report

Attach list of emission sources. Emission data required is source name, description of point source (on NEDS point number), UTM coordinates, stack data, allowable emissions, and normal operating time.

F. Attach all other information supportive to the PSD review. Refer to Modeling Report

G. Discuss the social and economic impact of the selected technology versus other applicable technologies (i.e., jobs, payroll, production, taxes, energy, etc.). Include assessment of the environmental impact of the sources. N/A

H. Attach scientific, engineering, and technical material, reports, publications, journals, and other competent relevant information describing the theory and application of the requested best available control technology.

Refer to Modeling Report

Summary of 24-hour TSP Ambient Air Quality Data, Florida Power Corporation Crystal River Site, May 1977 through April 1978, and July 1985 through June 1987.

Station Number	Time Period	Number of Samples	Percent Data Capture Percent	Annual Geometric Mean	Observed 24-Hour Maximum	Observed 24-Hour 2nd Maximum
1.	May 1978-April 1978	58	96.7	30	110	69
2	May 1977-April 1978	52	86.7	25	80	67
	July 1985-June 1986	57	96.6	25	46	44
	July 1986-June 1987	58	96.7	26	57	54
3	May 1977-April 1978	58	96.7	46	94	85
4	May 1977-April 1978	50	83.3	30	78	63
	July 1985-June 1986	54	91.5	32	76	61
	July 1986-June 1987	59	98.3	42	95	88

Note: Florida AAQS are 150 ug/m^3, 24-hour average, not to be exceeded more than once per year, and 60 ug/m^3, annual geometric mean.

SOURCE: Florida Power Corporation

021489
SUPPLE

Particulate Matter
Air Quality Impact Assessment
Florida Power Corporation
Crystal River Plant

March 1989

Prepared for:
Florida Power Corporation
St. Petersburg, Florida

Prepared by:
KBN Engineering and Applied Sciences, Inc.
P.O. Box 14288
Gainesville, FL 32604

88047

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1.0 INTRODUCTION

Florida Power Corporation (FPC) is proposing to construct helper cooling towers for Units 1, 2 and 3 located at the Crystal River power plant. These cooling towers will represent new sources of particulate matter (PM) at the Crystal River plant, and will affect the ambient air quality in the vicinity of the plant. As part of the environmental licensing of the helper cooling towers, and to determine the impact of the cooling towers upon ambient PM levels, an air quality impact assessment of all PM emissions from the Crystal River power plant complex was conducted. This assessment considered emissions associated with the following:

* Units 1, 2, 4 and 5 at Crystal River
* Existing cooling towers for Units 4 and 5
* Helper cooling towers for Units 1, 2 and 3
* Coal and ash handling for Units 1, 2, 4, and 5
* Progress Materials Aardelite plant
* Ideal Basic's proposed limestone shipping operations

These represent all of the PM emitting sources identified to exist at the Crystal River power plant complex. PM emission estimates were based upon engineering information and emission factors published by the U.S. Environmental Protection Agency (USEPA).

The air impact analysis was conducted using approved USEPA air dispersion models and modeling methodology. Impacts were addressed in regards to Prevention of Significant Deterioration (PSD) allowable increments for particulate matter [as total suspended particulate matter, i.e., PM(TSP)] and ambient air quality standards (AAQS) for particulate matter (as particulate with aerodynamic diameter less than 10 um, i.e., PM10). The allowable PSD increments and AAQS for PM are presented in Table 1-1.

Presented in Section 2.0 is a description of the PM sources at the Crystal River power plant complex, and their PM(TSP) and PM10 emissions. The air dispersion modeling analysis methodology is described in Section 3.0, and

Table 1-1. Federal and State AAQS and Allowable PSD Increments for Particulate Matter (All values in ug/m^3)

Pollutant	Averaging Time	AAQS National Primary Standard	AAQS National Secondary Standard	AAQS State of Florida	PSD Increments Class I	PSD Increments Class II
Particulate Matter (TSP)	Annual Geometric Mean	NA	NA	NA	5	19
	24-Hour Maximum+	NA	NA	NA	10	37
Particulate Matter (PM10)	Annual Arithmetic Mean	50	50	50	NA	NA
	24-Hour Maximum*	150	150	150	NA	NA

+ Maximum concentration not to be exceeded more than once per year.
* Achieved when the expected number of exceedances per year is less than 1.0.

NA = Not applicable, i.e., no standard exists.

Sources: Federal Register, Vol. 43, No. 118, June 19, 1978.
40 CFR 50
40 CFR 52.21
FAC Chapter 17-2

the results of the impact analysis are presented in Section 4.0. Additional impacts upon soils, vegetation, visibility and growth which may occur due to the addition of the Units 1, 2 and 3 helper cooling towers are discussed in Section 5.0.

2.0 PM EMISSIONS ASSOCIATED WITH CRYSTAL RIVER POWER PLANT

2.1 OVERVIEW

There are a number of PM emitting sources located at the Crystal River power plant. Four coal-fired generating units (1, 2, 4 and 5) emit PM from the boilers, after passing through electrostatic precipitators. These emissions exit the main generating unit stacks. Units 4 and 5 currently have natural draft cooling towers, which use salt water as the cooling water source. PM is emitted from the cooling towers in the form of droplets (commonly referred to as drift). The proposed helper cooling towers for Units 1, 2 and 3 will also utilize salt water for cooling, and will therefore be new sources of PM emissions.

Coal handling facilities for Units 1, 2, 4 and 5 are sources of PM emissions. Coal is brought to the site by barge and by rail, is unloaded, conveyed to storage piles, reclaimed, conveyed to crushers, and then conveyed to the boilers for burning. Ash generated in the boilers must be disposed, and disposal activities generate fugitive dust.

Progress Materials has constructed a facility on the Crystal River site which processes fly ash and limestone into a lightweight aggregate. These activities generate PM emissions.

Ideal Basic Industries has proposed to operate a limestone quarrying operation near to the Crystal River power plant, and to convey the limestone to the power plant, where it will be stored and loaded onto barges for transport offsite. These activities will generate PM emissions.

The sources and activities identified above represent all the PM generating activities known to exist at the Crystal River site. These were identified through a survey of the site and discussions with plant operating personnel. Presented in the following sections are the PM emission factors, PM emission controls and control efficiencies, and PM emissions from the PM emission sources at Crystal River. Sources have been grouped according to type of activity. Estimates have been developed for both PM(TSP) and PM10 emissions.

2.2 POINT SOURCE PM EMISSIONS

Point sources at Crystal River which emit PM consist of the four generating units (1, 2, 4 and 5), the Unit 4 and 5 cooling towers, the proposed Units 1, 2 and 3 helper cooling towers, bagfilters associated with Unit 4 and 5 coal handling within the boiler buildings, and baghouses associated with Progress Materials operations. Pertinent data for the dispersion modeling analysis are presented in Table 2-1 for these point sources. Supportive data for the proposed Units 1, 2 and 3 helper cooling towers are presented in Tables 2-2 and 2-3.

It is noted that although the Units 1, 2 and 3 helper cooling towers will operate a maximum of 180 days/yr (6 months), the towers were assumed to operate year-around for the dispersion modeling analysis.

PM emissions for the four main generating units are based upon the Site Certification conditions for the units. PM emissions and particle size distribution for the existing Units 4 and 5 cooling towers as well as the proposed helper cooling towers are based upon design information. Data for Progress Materials sources are based upon the air permit application and air permit for these sources. Units 4 and 4 coal silo and bunker baghouse emissions are based upon design information for the baghouses.

2.3 FUGITIVE DUST EMISSION SOURCES

2.3.1 Batch/Continuous Drop Operations

A number of batch and continuous drop operations are associated with the coal handling facilities at Crystal River. The coal is brought in by barge or rail, unloaded and conveyed to storage piles, reclaimed from the pile, conveyed to a crusher, and then conveyed to the boiler houses. A schematic of the coal handling system at Crystal River is shown in Figure 2-1. The system was surveyed and reviewed with plant personnel to identify all PM emission sources. Based upon this review, it was determined that the worst

Table 2-1. Summary of Point Sources Used in the ISCST Modeling Analysis

Source Number	Source Description	Location (m) * X	Location (m) * Y	Stack Height (m)	Diameter (m)	Velocity (m/s)	Temperature (K)	Particulate Emissions (lb/hr)	Particulate Emissions (g/s)
100	Units 1-3 Helper Cooling Towers	0	0	16.2	10.52	6.20	306.0	198	25.00
110	Unit 4 Cooling Tower	714	908	135.0	65.20	3.32	311.0	175	22.10
120	Unit 5 Cooling Tower	714	690	135.0	65.20	3.32	311.0	175	22.10
130	Units 4 and 5 Power Generation	1077	786	178.2	7.77	21.03	396.0	1251	157.60
135	Unit 4 and 5 Coal Baghouses	932	786	42.7	0.84	21.20	310.0	7	0.88
140 +	Unit 2 Power Generation	677	-750	153.0	4.88	48.77	422.0	463	58.30
150 +	Unit 1 Power Generation	750	-750	152.0	4.57	40.54	417.0	364	45.90
160	Progress Material Baghouses	517	-113	18.3	0.61	11.40	325.0	2	0.21

* Relative to Units 1-3 Helper Cooling towers

\+ Not a PSD increment consuming source

Table 2-2. Crystal River Units 1, 2 and 3 Tower Specifications and Design Parameters

Parameter	Helper Cooling Towers*
No. Towers/Fans per Tower	4/9
Fan Height	53 ft (16.2 m)
Fan diameter	34.5 ft (10.52 m)
Fan Velocity	20.3 ft/s (6.20 m/s)
Exit Temperature	91°F (306°K)
Tower Flow Rate	687,000 gpm
Drift Rate	0.002%
Total Dissolved Solids	29,100 ppm

<u>Calculation of PM Emissions</u>

PM = 687,000 gpm x 3.75 l/gal x 29,100 mg/l x 0.00002 x g/1000 mg

= 1499.4 g/min

= 25.0 g/s

Operation at 6 months per year**:

PM = 25 g/s x 3600 sec/hr x 24 hr/day x 30 day/mo x 6 mo/yr

x lb/454 g / 2000 lb/ton = 428.2 tons/yr

* Based upon rectangular design cooling towers.

** For modeling analysis emissions are based upon year around operation at 25 g/s, or 868 TPY.

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

Particle Size			Mass
Diameter		Radius	Dist.
Range	Mean	(um)	(%)
0-40	20	15	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

* At 100% capacity and 0.002% drift rate.

Source: Wilber and Vercauteren, Environmental Systems Corp.

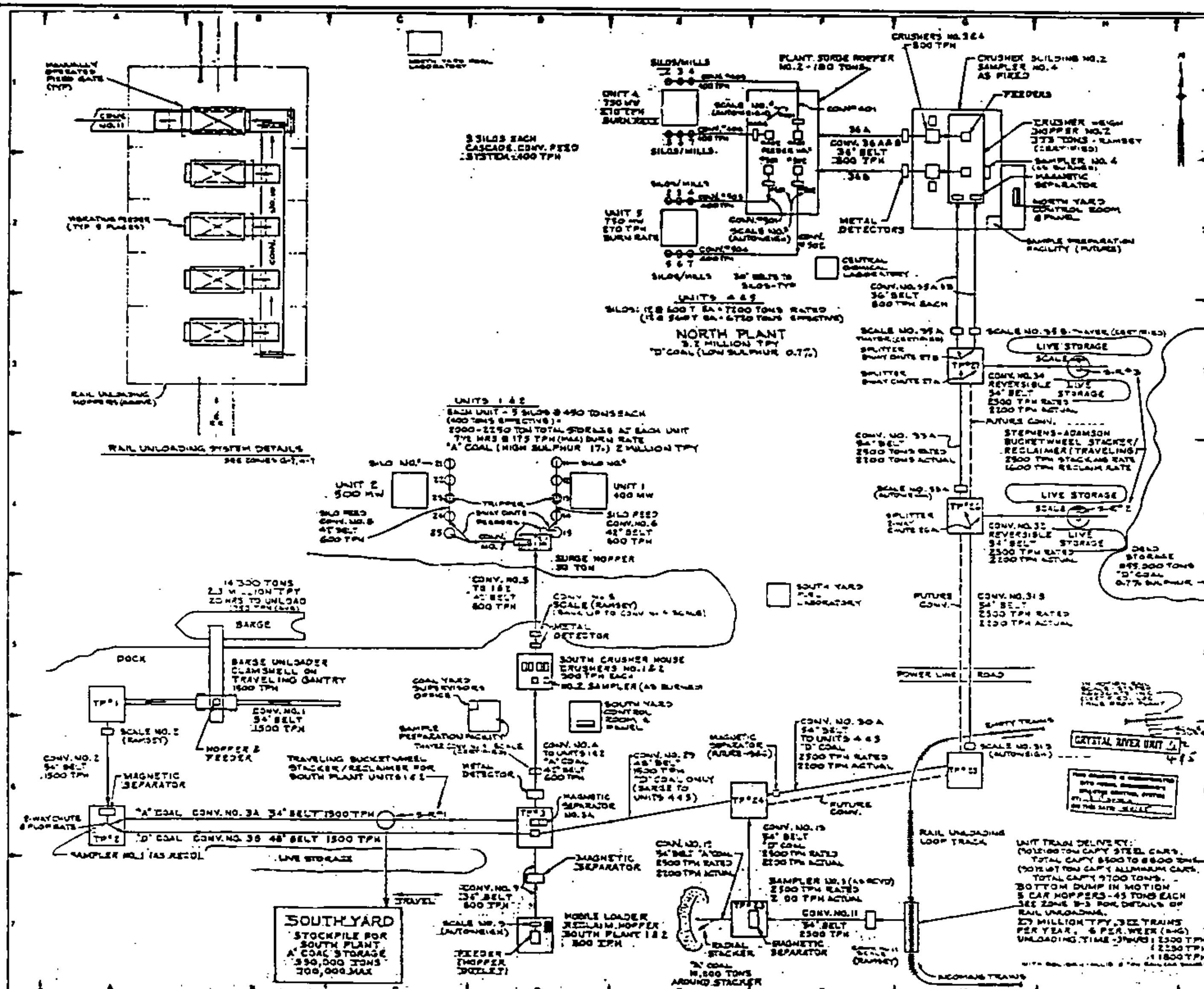

Figure 2-1. Schematic of FPC Crystal River Coal Handling System

case method of coal delivery was by barge for all units, since the coal would have to pass through the greatest number of transfer points. As a result, coal delivery by rail was not considered further.

In addition to coal handling, there are drop operations associated with ash handling activities, Progress Materials operations, and Ideal Basic's operations. These involve truck loading, conveyor transfer point, and truck dumping.

For continuous drop operations, the equation from AP-42, Section 11.2.3 (reference Appendix A) is appropriate for estimating PM emissions:

$$E = k\,(0.0018)\,\frac{(s/5)\,(U/5)\,(H/10)}{(M/2)^2}$$

where: E = emission factor (lb/ton)
k = particle size multiplier
s = material silt content (%)
U = mean wind speed (mph)
H = drop height (ft)
M = material moisture content (%)

For batch drop operations, the equation from AP-42, Section 11.2.3, is appropriate:

$$E = k\,(0.0018)\,\frac{(s/5)\,(U/5)\,(H/5)}{(M/2)^2\,(Y/6)^{0.33}}$$

where: E = emission factor (lb/ton)
k = particle size multiplier
s = material silt content (%)
U = mean wind speed (mph)
H = drop height (ft)
M = material moisture content (%)
Y = dumping device capacity (yd^3)

The batch/continuous drop operations associated with the Crystal River power plant are identified in Tables 1a through 1d and Tables 2a through 2d. Table 1a shows the annual emission factors for each operation associated with the coal handling operations, while the annual emissions are shown in Table 1b. Table 1a also shows the input parameters for each operation. The silt content of the coal was an average value (5%) taken from the literature (ERT, 1982), and the moisture content (7%) was based upon a two year record of data from the Crystal River power plant.

The emission factor for coal crushing was based upon published emission factors for crushing in the metallic mineral industry and crushing in the stone quarrying and processing industry (high moisture ore) (USEPA, 1986). This factor is 0.02 lb/ton of throughput (uncontrolled) for PM(TSP), and 0.01 lb/ton for PM10.

Nearly all transfer points in the coal handling system are enclosed and vented to baghouses for dust control. However, normally the baghouses are not operated. As a result, control efficiencies were based only on enclosures. Enclosures were estimated to result in 90% control efficiency (ERT, 1983; Dames & Moore, 1981) (refer to Appendix B).

Tables 1c and 1d present PM emission factors, control efficiencies and annual PM emissions for other drop operations at Crystal River, i.e., ash handling, Progress Materials and Ideal Basic. Information for Progress Materials was obtained from the permit application submitted for the Aardelite facility (KBN, 1987). Emissions for Ideal Basic operations were obtained from a previous study performed by KBN (refer to Appendix C).

Tables 2a through 2d present maximum 24-hour PM emission factors, control efficiencies and PM emissions for the batch/continuous drop operations at Crystal River. Wind speed for this purpose was 12 mph, which is exceeded approximately 18% of the time (based upon Tampa meteorological data; refer to Appendix D). Coal throughputs represent maximum 24-hour conditions (i.e., barge unloading at maximum rate, units firing at maximum rate).

Thruputs for ash were also based upon the maximum ash disposed in one day for the generating units. Maximum 24-hour emission rates for Progress Materials were obtained from their permit application, and for Ideal Basic, from the previous study performed (see Appendix C).

2.3.2 Wind Erosion

Fugitive dust emissions occur due to wind erosion of open storage piles. At the Crystal River plant, open storage piles consist of Units 1 and 2 coal storage piles, Units 4 and 5 coal storage piles, Units 1 and 2 bottom ash storage piles, and Units 4 and 5 ash storage area. Each of these storage piles consist of active and inactive areas. In addition, Progress Materials operation contains a product storage pile, as does Ideal Basic's limestone shipping operation.

To estimate fugitive particulate emissions due to wind erosion from the storage piles, the equation from AP-42, Section 11.2.3 was used (refer to Appendix A):

$$E = 1.7\ (s/1.5)\ [(365-p)/235)]\ (f/15)$$

where:

E = emission factor (lb/day/acre)
s = material silt content (%)
p = number of days per year on which rainfall exceeds 0.01 inches
f = percentage of time that wind speed exceeds 12 mph

Meteorological data from Tampa was used as the basis for the parameters p and f. Based upon a ten (10) year record, the wind speed in Tampa exceeds 12 mph 18% of the time. Based upon a twenty-nine (29) year of record, rainfall in Tampa exceeds 0.01 inches on 107 days per year (see Appendix D for supportive information).

Silt content of coal (5%) and ash (18%) were based upon values reported in the literature (ERT,1981). Based upon these parameters, uncontrolled PM emission factors for wind erosion were determined for the Crystal River sources. These emission factors are presented in Table 3. To estimate maximum 24-hour emissions, the emission factors were corrected to account for a wind speed of greater than 12 mph occurring 100 percent of the time, and no precipitation. It is noted that emissions due to wind erosion will only occur when the wind speed exceeds 12 mph, as reflected in the emission factor equation.

The control efficiency employed currently at Crystal River consists of watering. However, in the future, if all ash generated at the site is disposed on-site (in the Units 4 and 4 ash disposal area), FPC will utilize a crusting agent on the inactive coal and inactive ash storage piles, and a chemical wetting agent on the active ash storage pile. This will act to control fugitive dust emissions from these activities. Control efficiencies for these control measures were derived from the literature, and are shown in Table 3. Supportive information is contained in Appendix B.

The controlled emission factors for wind erosion are shown in Table 3, for both the annual average and the maximum 24-hour emission case. The size of each storage pile is also shown, along with the resulting PM emission rate. It is again noted that wind erosion emissions only occur when the wind speed exceeds 12 mph.

2.3.3 <u>Vehicular Traffic</u>

Vehicular traffic over unpaved roads and in the storage pile areas is another potential source of PM emissions at Crystal River. In the coal pile areas, frontend loaders, scrapers and bulldozers are used to reclaim coal (Units 1 and 2 only) and maintain the storage piles. Ash produced from the generating units and disposed in the Units 4 and 5 ash disposal area will be transported by truck. A portion of the ash hall road will be unpaved. Progress Materials and Ideal Basic also have vehicular traffic associated with their operations.

For vehicular traffic over unpaved roads and vehicular traffic in storage pile areas, USEPA recommends that the equation for traffic over unpaved roads (AP-42, Section 11.2.1) be used to estimate fugitive dust emissions. This equation is as follows:

$$E = k\ (5.9)\ (s/12)\ (S/30)\ (W/3)^{0.7}\ (w/4)^{0.5}\ [(365-p)/365]$$

where:

E = emission factor (lb/VMT), VMT= vehicle miles traveled
k = particle size multiplier
s = silt content of road surface material (%)
S = mean vehicle speed (mph)
W = mean vehicle weight (tons)
w = mean number of wheels
p = number of days per year on which rainfall exceeds 0.01 inches

Scrapers and bulldozers (tractor type) are unique vehicles, and the generalized vehicular traffic equation may not be representative. As a result, the literature was searched to find a more appropriate factor. AP-42, Section 8.24, Western Surface Coal Mining, contains emission factors developed specifically for these two type of vehicles (refer to Appendix A). As a result, these factors were selected for application to Crystal River. The equation for a scraper, operating in the travel mode, is given as:

$$E = 2.7 \times 10^{-5}\ s^{1.3}\ W^{2.4}$$

where,

s = material silt content (%)
W = mean vehicle weight (tons)
E = emission factor for TSP in lb/VMT

The equation for a bulldozer, bulldozing coal, is given as:

$$E = 78.4\ s^{1.2} / M^{1.3}$$

where,

s = material silt content (%)
M = material moisture content (%)
E = emission factor for TSP in lb/hr

Uncontrolled emission factors for vehicular traffic based upon these equations are shown in Table 4 (annual factors) and Table 5 (maximum 24-hour factors). The input parameters to the equations are also shown. In the coal pile areas, the vehicles will be travelling over coal, thus the material silt content reflects the silt content for coal. In the ash storage areas, the haul trucks will travel over an unpaved road (limestone), and the scrapers and frontend loaders will travel over the ash surface. Silt contents for these materials were obtained from the literature (refer to Appendix A).

Annual fugitive dust emissions due to vehicular traffic at Crystal River are presented in Table 6. Vehicle miles travelled and the basis for such is shown in the table. Vehicle miles for coal and ash transport are based upon the total tonnages moved, the capacity of the vehicle, and the haul distance. For pile maintenance in the coal and ash storage areas, vehicle miles or operating hours were based upon information supplied by FPC. This included total hours of operation for frontend loaders, scrapers and bulldozers. It was assumed that the vehicles were actually in motion 75% of the time during the reported operating hours.

The control method currently employed by FPC at Crystal River is watering. The control efficiency for this technique is estimated at 80%, based upon published literature (see Appendix B). For the Units 4 and 5 ash disposal area, if all ash is disposed on-site in the future, as this analysis assumes, FPC will employ a chemical wetting agent to suppress dust emissions due to vehicular traffic. This control technique is estimated to result in 95% control (see Appendix B). In addition, the ash haul road will be paved, except for the last 0.1 miles in the active ash disposal area. It was assumed that PM emissions from the paved road are negligible in comparison to other fugitive PM sources, and therefore were not considered in this analysis.

Resulting PM emissions due to vehicular traffic are shown in Table 6, for the annual average, and in Table 7 for the maximum 24-hour case.

2.3.4 Summary of Fugitive PM Emissions

A summary of fugitive PM emissions from the Crystal River power plant site is presented in Table 8. This table summarizes the emissions presented in Tables 1 through 7. The emissions are grouped by source activity, and are also identified by source number used in the dispersion modeling analysis. All the fugitive emissions were modeled as area sources (see Section 3.0 for further discussion).

Those fugitive sources which do not consume PSD increments are also identified in Table 8. Non-increment consuming sources consist of sources associated with CR Units 1 and 2, since these units are considered to be coal burning for PSD baseline purposes. All sources associated with CR Units 4 and 5 and with on-site ash disposal from any of the units are increment consuming sources. In addition, PM sources associated with the Progress Materials and Ideal Basic operations are PSD increment consuming sources.

Table 1a. Annual Fugitive Dust Emission Factors, Coal Handling--Batch/Continuous Drop Operations

SOURCE NO.	SOURCE	TYPE	S SILT CONTENT (%)	M MOISTURE CONTENT (%)	U WIND SPEED (MPH)	H DROP HEIGHT (FT)	Y DEVICE CAPACITY (YD**3)	E EMISSION FACTOR (LB/TON)
		ANNUAL EMISSION FACTORS						
CR 1/2 (COAL BY BARGE):								
B-1	Clamshell to hopper	Batch drop	5	7	8.8	10	25	0.00032
B-2	Hopper to belt	Continuous drop	5	7	8.8	3	-	0.00008
B-3	Belt to C1	Continuous drop	5	7	8.8	3	-	0.00008
TP1-1	C1 to C2	Continuous drop	5	7	8.8	15	-	0.00039
TP2-1	C2 to C3A	Continuous drop	5	7	8.8	45	-	0.00116
SR-1	C3A to hopper	Continuous drop	5	7	8.8	5	-	0.00013
SR-2	Hopper to belt	Continuous drop	5	7	8.8	5	-	0.00013
SR-3	Belt to belt	Continuous drop	5	7	8.8	5	-	0.00013
SR-4	Belt to coal pile	Continuous drop	5	7	8.8	10	-	0.00026
MR-1	FEL to reclaim pile	Batch drop	5	7	8.8	8	25	0.00026
MR-2	Pile to hopper	Continuous drop	5	7	8.8	5	-	0.00013
MR-3	Hopper to C9	Continuous drop	5	7	8.8	5	-	0.00013
TP-1	C9 to C4	Continuous drop	5	7	8.8	3	-	0.00008
SC-1	C4 to feeders	Continuous drop	5	7	8.8	15	-	0.00039
SC-2	Feeders to crusher	Continuous drop	5	7	8.8	10	-	0.00026
SC-3	Crusher	Crushing	-	-	-	-	-	0.02000
SC-4	Crusher to C5	Continuous drop	5	7	8.8	5	-	0.00013
CR 4/5 (COAL BY BARGE):								
B-1	Clamshell to hopper	Batch drop	5	7	8.8	10	25	0.00032
B-2	Hopper to belt	Continuous drop	5	7	8.8	3	-	0.00008
B-3	Belt to C1	Continuous drop	5	7	8.8	3	-	0.00008
TP1-1	C1 to C2	Continuous drop	5	7	8.8	15	-	0.00039
TP2-2	C2 to C3B	Continuous drop	5	7	8.8	45	-	0.00116
TP3-2	C3B to C29	Continuous drop	5	7	8.8	20	-	0.00052
TP24-1	C29 to C30A	Continuous drop	5	7	8.8	31	-	0.00080
TP25-1	C30A to C31B	Continuous drop	5	7	8.8	35	-	0.00091
TP26-1	C31B to C33A	Continuous drop	5	7	8.8	60	-	0.00155
TP27-1	C33A to C34	Continuous drop	5	7	8.8	30	-	0.00078
SR-11	C34 to hopper	Continuous drop	5	7	8.8	5	-	0.00013
SR-12	Hopper to belt	Continuous drop	5	7	8.8	5	-	0.00013
SR-13	Belt to Belt	Continuous drop	5	7	8.8	5	-	0.00013
SR-14	Belt to coal pile	Continuous drop	5	7	8.8	10	-	0.00026
SR-15	Bucket wheel to belt	Continuous drop	5	7	8.8	5	-	0.00013
SR-16	Belt to C34	Continuous drop	5	7	8.8	5	-	0.00013
TP27-2	C34 to C35A/B	Continuous drop	5	7	8.8	27	-	0.00070
NC-1	C35A/B to hopper	Continuous drop	5	7	8.8	45	-	0.00116
NC-2	Hopper to feeders	Continuous drop	5	7	8.8	5	-	0.00013
NC-3	Feeder to crusher	Continuous drop	5	7	8.8	5	-	0.00013
NC-4	Crusher	Crushing	-	-	-	-	-	0.02000
NC-5	Crusher to feeder	Continuous drop	5	7	8.8	5	-	0.00013
NC-6	Feeders to C36A/B	Continuous drop	5	7	8.8	5	-	0.00013

Table 1b. Annual Fugitive Dust Emissions, Coal Handling--Batch/Continuous Drop Operations

SOURCE NO.	SOURCE	UNCONTROLLED EMISSION FACTOR (LB/TON)	CONTROL METHOD	CONTROL EFFICIENCY (%)	CONTROLLED EMISSION FACTOR (LB/TON)	ANNUAL THRUPUT (TPY)	PARTICLE SIZE MULTIPLIER (K) TSP	PARTICLE SIZE MULTIPLIER (K) PM10	ANNUAL EMISSIONS (TPY) TSP	ANNUAL EMISSIONS (TPY) PM10
			ANNUAL EMISSION ESTIMATES							
CR 1/2 (COAL BY BARGE):										
B-1	Clamshell to hopper	0.00032	-	0	0.000323	2,000,000	0.73	0.36	0.236	0.116
B-2	Hopper to belt	0.00008	Enclosure	90	0.000008	2,000,000	0.77	0.37	0.006	0.003
B-3	Belt to C1	0.00008	Enclosure	90	0.000008	2,000,000	0.77	0.37	0.006	0.003
TP1-1	C1 to C2	0.00039	Enclosure	90	0.000039	2,000,000	0.77	0.37	0.030	0.014
TP2-1	C2 to C3A	0.00116	Enclosure	90	0.000116	2,000,000	0.77	0.37	0.090	0.043
SR-1	C3A to hopper	0.00013	Enclosure	90	0.000013	2,000,000	0.77	0.37	0.010	0.005
SR-2	Hopper to belt	0.00013	Enclosure	90	0.000013	2,000,000	0.77	0.37	0.010	0.005
SR-3	Belt to belt	0.00013	Enclosure	90	0.000013	2,000,000	0.77	0.37	0.010	0.005
SR-4	Belt to coal pile	0.00026	-	0	0.000259	2,000,000	0.77	0.37	0.199	0.096
MR-1	FEL to reclaim pile	0.00026	-	0	0.000258	2,000,000	0.73	0.36	0.189	0.093
MR-2	Pile to hopper	0.00013	Enclosure	90	0.000013	2,000,000	0.77	0.37	0.010	0.005
MR-3	Hopper to C9	0.00013	Enclosure	90	0.000013	2,000,000	0.77	0.37	0.010	0.005
TP-1	C9 to C4	0.00008	Enclosure	90	0.000008	2,000,000	0.77	0.37	0.006	0.003
SC-1	C4 to feeders	0.00039	Enclosure	90	0.000039	2,000,000	0.77	0.37	0.030	0.014
SC-2	Feeders to crusher	0.00026	Enclosure	90	0.000026	2,000,000	0.77	0.37	0.020	0.010
SC-3	Crusher	0.02000	Enclosures	95	0.001000	2,000,000	1.00	0.50	1.000	0.500
SC-4	Crusher to C5	0.00013	Enclosure	90	0.000013	2,000,000	0.77	0.37	0.010	0.005
								TOTALS =	1.870	0.924
CR 4/5 (COAL BY BARGE):										
B-1	Clamshell to hopper	0.00032	-	0	0.000323	3,200,000	0.73	0.36	0.377	0.186
B-2	Hopper to belt	0.00008	Enclosure	90	0.000008	3,200,000	0.77	0.37	0.010	0.005
B-3	Belt to C1	0.00008	Enclosure	90	0.000008	3,200,000	0.77	0.37	0.010	0.005
TP1-1	C1 to C2	0.00039	Enclosure	90	0.000039	3,200,000	0.77	0.37	0.048	0.023
TP2-2	C2 to C3B	0.00116	Enclosure	90	0.000116	3,200,000	0.77	0.37	0.143	0.069
TP3-2	C3B to C29	0.00052	Enclosure	90	0.000052	3,200,000	0.77	0.37	0.064	0.031
TP24-1	C29 to C30A	0.00080	Enclosure	90	0.000080	3,200,000	0.77	0.37	0.099	0.047
TP25-1	C30A to C31B	0.00091	Enclosure	90	0.000091	3,200,000	0.77	0.37	0.112	0.054
TP26-1	C31B to C33A	0.00155	Enclosure	90	0.000155	3,200,000	0.77	0.37	0.191	0.092
TP27-1	C33A to C34	0.00078	Enclosure	90	0.000078	3,200,000	0.77	0.37	0.096	0.046
SR-11	C34 to hopper	0.00013	Enclosure	90	0.000013	3,200,000	0.77	0.37	0.016	0.008
SR-12	Hopper to belt	0.00013	Enclosure	90	0.000013	3,200,000	0.77	0.37	0.016	0.008
SR-13	Belt to Belt	0.00013	Enclosure	90	0.000013	3,200,000	0.77	0.37	0.016	0.008
SR-14	Belt to coal pile	0.00026	-	0	0.000259	3,200,000	0.77	0.37	0.319	0.153
SR-15	Bucket wheel to belt	0.00013	Enclosure	90	0.000013	3,200,000	0.77	0.37	0.016	0.008
SR-16	Belt to C34	0.00013	Enclosure	90	0.000013	3,200,000	0.77	0.37	0.016	0.008
TP27-2	C34 to C35A/B	0.00070	Enclosure	90	0.000070	3,200,000	0.77	0.37	0.086	0.041
NC-1	C35A/B to hopper	0.00116	Enclosure	90	0.000116	3,200,000	0.77	0.37	0.143	0.069
NC-2	Hopper to feeders	0.00013	Enclosure	90	0.000013	3,200,000	0.77	0.37	0.016	0.008
NC-3	Feeder to crusher	0.00013	Enclosure	90	0.000013	3,200,000	0.77	0.37	0.016	0.008
NC-4	Crusher	0.02000	Enclosures	95	0.001000	3,200,000	1.00	0.50	1.600	0.800
NC-5	Crusher to feeder	0.00013	Enclosure	90	0.000013	3,200,000	0.77	0.37	0.016	0.008
NC-6	Feeders to C36A/B	0.00013	Enclosure	90	0.000013	3,200,000	0.77	0.37	0.016	0.008
								TOTALS =	3.440	1.689

Table 1c. Annual Fugitive Dust Emission Factors, Other Batch/Continuous Drop Operations

SOURCE NO.	SOURCE	TYPE	S SILT CONTENT (%)	M MOISTURE CONTENT (%)	U WIND SPEED (MPH)	H DROP HEIGHT (FT)	Y DEVICE CAPACITY (YD**3)	E EMISSION FACTOR (LB/TON)
			ANNUAL EMISSION FACTORS					
CR 1/2 FLY ASH HANDLING:								
	Fly ash silo to truck	Continuous drop	18	20	8.8	5	-	0.00006
	Truck dump at ash pile	Batch drop	18	20	8.8	8	27	0.00011
CR 1/2 BOTTOM ASH HANDLING:								
	Backhoe to truck	Batch drop	18	20	8.8	5	5	0.00012
	Truck dump at ash pile	Batch drop	18	20	8.8	8	27	0.00011
CR 4/5 FLY ASH HANDLING:								
	Fly ash silo to truck	Continuous drop	18	20	8.8	5	-	0.00006
	Truck dump at ash pile	Batch drop	18	20	8.8	8	27	0.00011
CR 4/5 BOTTOM ASH HANDLING:								
	Fly ash silo to truck	Continuous drop	18	20	8.8	5	-	0.00006
	Truck dump at ash pile	Batch drop	18	20	8.8	8	27	0.00011
PROGRESS MATERIALS:								
	Pile Loading	Continuous drop	Refer to permit application					0.00005
	Loadout Hopper	Batch drop	Refer to permit application					0.00037
	Hopper-to-belt	Continuous drop	Refer to permit application					0.000025
	Truck Loading	Continuous drop	Refer to permit application					0.00005
IDEAL BASIC:								
	Apron feeder	Continuous drop	Refer to separate report					0.000002
	Barge pile loading	Continuous drop	Refer to separate report					0.000029
	Barge loading	Continuous drop	Refer to separate report					0.000057

Table 1d. Annual Fugitive Dust Emissions, Other Batch/Continuous Drop Operations

SOURCE NO.	SOURCE	UNCONTROLLED EMISSION FACTOR (LB/TON)	CONTROL METHOD	CONTROL EFFICIENCY (%)	CONTROLLED EMISSION FACTOR (LB/TON)	ANNUAL THRUPUT (TPY)	PARTICLE SIZE MULTIPLIER (K)		ANNUAL EMISSIONS (TPY)	
							TSP	PM10	TSP	PM10
			ANNUAL EMISSION ESTIMATES							
CR 1/2 ASH HANDLING:										
	Fly ash silo to truck	0.00006	-	0	0.000057	175,000	0.77	0.37	0.0038	0.0018
	Truck dump at ash pile	0.00011	-	0	0.000111	175,000	0.73	0.36	0.0071	0.0035
CR 1/2 BOTTOM ASH HANDLING:										
	Backhoe to truck	0.00012	-	0	0.000121	50,000	0.73	0.36	0.0022	0.0011
	Truck dump at ash pile	0.00011	-	0	0.000111	50,000	0.73	0.36	0.0020	0.0010
CR 4/5 FLY ASH HANDLING:										
	Fly ash silo to truck	0.00006	Enclosure	90	0.000006	262,500	0.77	0.37	0.0006	0.0003
	Truck dump at ash pile	0.00011	-	0	0.000111	262,500	0.73	0.36	0.0106	0.0052
CR 4/5 BOTTOM ASH HANDLING:										
	Fly ash silo to truck	0.00006	Enclosure	90	0.000006	75,000	0.77	0.37	0.0002	0.0001
	Truck dump at ash pile	0.00011	-	0	0.000111	75,000	0.73	0.36	0.0030	0.0015
PROGRESS MATERIALS:										
	Pile Loading	0.00005	-	0	0.000050	350,400	0.77	0.37	0.0067	0.0032
	Loadout Hopper	0.00037	-	0	0.000370	350,400	0.73	0.36	0.0473	0.0233
	Hopper-to-belt	0.00003	-	0	0.000025	350,400	0.77	0.37	0.0034	0.0016
	Truck Loading	0.00005	-	0	0.000050	350,400	0.77	0.37	0.0067	0.0032
								TOTALS =	0.064	0.031
IDEAL BASIC:										
	Apron feeder	0.00000	-	0	0.000002	1,900,000	0.77	0.37	0.0015	0.0007
	Barge pile loading	0.00003	-	0	0.000029	1,900,000	0.77	0.37	0.0212	0.0102
	Barge loading	0.00006	-	0	0.000057	1,900,000	0.77	0.37	0.0417	0.0200
								TOTALS =	0.064	0.031

Table 2a. Maximum 24-Hour Fugitive Dust Emission Factors, Coal Handling--Batch/Continuous Drop Operations

SOURCE NO.	SOURCE	TYPE	S SILT CONTENT (%)	M MOISTURE CONTENT (%)	U WIND SPEED (MPH)	H DROP HEIGHT (FT)	Y DEVICE CAPACITY (YD**3)	E EMISSION FACTOR (LB/TON)
		MAXIMUM 24-HOUR EMISSION FACTORS						
CR 1/2 (COAL BY BARGE):								
B-1	Clamshell to hopper	Batch drop	5	7	12	10	25	0.00044
B-2	Hopper to belt	Continuous drop	5	7	12	3	-	0.00011
B-3	Belt to C1	Continuous drop	5	7	12	3	-	0.00011
TP1-1	C1 to C2	Continuous drop	5	7	12	15	-	0.00053
TP2-1	C2 to C3A	Continuous drop	5	7	12	45	-	0.00159
SR-1	C3A to hopper	Continuous drop	5	7	12	5	-	0.00018
SR-2	Hopper to belt	Continuous drop	5	7	12	5	-	0.00018
SR-3	Belt to belt	Continuous drop	5	7	12	5	-	0.00018
SR-4	Belt to coal pile	Continuous drop	5	7	12	10	-	0.00035
MR-1	FEL to reclaim pile	Batch drop	5	7	12	8	25	0.00035
MR-2	Pile to hopper	Continuous drop	5	7	12	5	-	0.00018
MR-3	Hopper to C9	Continuous drop	5	7	12	5	-	0.00018
TP-1	C9 to C4	Continuous drop	5	7	12	3	-	0.00011
SC-1	C4 to feeders	Continuous drop	5	7	12	15	-	0.00053
SC-2	Feeders to crusher	Continuous drop	5	7	12	10	-	0.00035
SC-3	Crusher	Crushing	-	-	-	-	-	0.02000
SC-4	Crusher to C5	Continuous drop	5	7	12	5	-	0.00018
CR 4/5 (COAL BY BARGE):								
B-1	Clamshell to hopper	Batch drop	5	7	12	10	25	0.00044
B-2	Hopper to belt	Continuous drop	5	7	12	3	-	0.00011
B-3	Belt to C1	Continuous drop	5	7	12	3	-	0.00011
TP1-1	C1 to C2	Continuous drop	5	7	12	15	-	0.00053
TP2-2	C2 to C3B	Continuous drop	5	7	12	45	-	0.00159
TP3-2	C3B to C29	Continuous drop	5	7	12	20	-	0.00071
TP24-1	C29 to C30A	Continuous drop	5	7	12	31	-	0.00109
TP25-1	C30A to C31B	Continuous drop	5	7	12	35	-	0.00123
TP26-1	C31B to C33A	Continuous drop	5	7	12	60	-	0.00212
TP27-1	C33A to C34	Continuous drop	5	7	12	30	-	0.00106
SR-11	C34 to hopper	Continuous drop	5	7	12	5	-	0.00018
SR-12	Hopper to belt	Continuous drop	5	7	12	5	-	0.00018
SR-13	Belt to Belt	Continuous drop	5	7	12	5	-	0.00018
SR-14	Belt to coal pile	Continuous drop	5	7	12	10	-	0.00035
SR-15	Bucket wheel to belt	Continuous drop	5	7	12	5	-	0.00018
SR-16	Belt to C34	Continuous drop	5	7	12	5	-	0.00018
TP27-2	C34 to C35A/B	Continuous drop	5	7	12	27	-	0.00095
NC-1	C35A/B to hopper	Continuous drop	5	7	12	45	-	0.00159
NC-2	Hopper to feeders	Continuous drop	5	7	12	5	-	0.00018
NC-3	Feeder to crusher	Continuous drop	5	7	12	5	-	0.00018
NC-4	Crusher	Crushing	-	-	-	-	-	0.02000
NC-5	Crusher to feeder	Continuous drop	5	7	12	5	-	0.00018
NC-6	Feeders to C36A/B	Continuous drop	5	7	12	5	-	0.00018

Table 2b. Maximum 24-Hour Fugitive Dust Emissions, Coal Handling--Batch/Continuous Drop Operations

SOURCE NO.	SOURCE	UNCONTROLLED EMISSION FACTOR (LB/TON)	CONTROL METHOD	CONTROL EFFICIENCY (%)	CONTROLLED EMISSION FACTOR (LB/TON)	MAXIMUM 24-HOUR THRUPUT (TONS)	PARTICLE SIZE MULTIPLIER (K)		MAXIMUM 24-HR EMISSIONS (LB/DAY	
							TSP	PM10	TSP	PM10
			MAXIMUM 24-HOUR EMISSION ESTIMATES							
CR 1/2 (COAL BY BARGE):										
B-1	Clamshell to hopper	0.00044	-	0	0.000440	15,000	0.73	0.36	4.82	2.38
B-2	Hopper to belt	0.00011	Enclosure	90	0.000011	15,000	0.77	0.37	0.12	0.06
B-3	Belt to C1	0.00011	Enclosure	90	0.000011	15,000	0.77	0.37	0.12	0.06
TP1-1	C1 to C2	0.00053	Enclosure	90	0.000053	15,000	0.77	0.37	0.61	0.29
TP2-1	C2 to C3A	0.00159	Enclosure	90	0.000159	15,000	0.77	0.37	1.83	0.88
SR-1	C3A to hopper	0.00018	Enclosure	90	0.000018	15,000	0.77	0.37	0.20	0.10
SR-2	Hopper to belt	0.00018	Enclosure	90	0.000018	15,000	0.77	0.37	0.20	0.10
SR-3	Belt to belt	0.00018	Enclosure	90	0.000018	15,000	0.77	0.37	0.20	0.10
SR-4	Belt to coal pile	0.00035	-	0	0.000353	15,000	0.77	0.37	4.07	1.96
MR-1	FEL to reclaim pile	0.00035	-	0	0.000352	8,400	0.73	0.36	2.16	1.07
MR-2	Pile to hopper	0.00018	Enclosure	90	0.000018	8,400	0.77	0.37	0.11	0.05
MR-3	Hopper to C9	0.00018	Enclosure	90	0.000018	8,400	0.77	0.37	0.11	0.05
TP-1	C9 to C4	0.00011	Enclosure	90	0.000011	8,400	0.77	0.37	0.07	0.03
SC-1	C4 to feeders	0.00053	Enclosure	90	0.000053	8,400	0.77	0.37	0.34	0.16
SC-2	Feeders to crusher	0.00035	Enclosure	90	0.000035	8,400	0.77	0.37	0.23	0.11
SC-3	Crusher	0.02000	Enclosures	95	0.001000	8,400	1.00	0.50	8.40	4.20
SC-4	Crusher to C5	0.00018	Enclosure	90	0.000018	8,400	0.77	0.37	0.11	0.05
								TOTALS =	24	12
CR 4/5 (COAL BY BARGE):										
B-1	Clamshell to hopper	0.00044	-	0	0.000440	15,000	0.73	0.36	4.82	2.38
B-2	Hopper to belt	0.00011	Enclosure	90	0.000011	15,000	0.77	0.37	0.12	0.06
B-3	Belt to C1	0.00011	Enclosure	90	0.000011	15,000	0.77	0.37	0.12	0.06
TP1-1	C1 to C2	0.00053	Enclosure	90	0.000053	15,000	0.77	0.37	0.61	0.29
TP2-2	C2 to C3B	0.00159	Enclosure	90	0.000159	15,000	0.77	0.37	1.83	0.88
TP3-2	C3B to C29	0.00071	Enclosure	90	0.000071	15,000	0.77	0.37	0.81	0.39
TP24-1	C29 to C30A	0.00109	Enclosure	90	0.000109	15,000	0.77	0.37	1.26	0.61
TP25-1	C30A to C31B	0.00123	Enclosure	90	0.000123	15,000	0.77	0.37	1.43	0.69
TP26-1	C31B to C33A	0.00212	Enclosure	90	0.000212	15,000	0.77	0.37	2.44	1.17
TP27-1	C33A to C34	0.00106	Enclosure	90	0.000106	15,000	0.77	0.37	1.22	0.59
SR-11	C34 to hopper	0.00018	Enclosure	90	0.000018	15,000	0.77	0.37	0.20	0.10
SR-12	Hopper to belt	0.00018	Enclosure	90	0.000018	15,000	0.77	0.37	0.20	0.10
SR-13	Belt to Belt	0.00018	Enclosure	90	0.000018	15,000	0.77	0.37	0.20	0.10
SR-14	Belt to coal pile	0.00035	-	0	0.000353	15,000	0.77	0.37	4.07	1.96
SR-15	Bucket wheel to belt	0.00018	Enclosure	90	0.000018	13,000	0.77	0.37	0.18	0.08
SR-16	Belt to C34	0.00018	Enclosure	90	0.000018	13,000	0.77	0.37	0.18	0.08
TP27-2	C34 to C35A/B	0.00095	Enclosure	90	0.000095	13,000	0.77	0.37	0.95	0.46
NC-1	C35A/B to hopper	0.00159	Enclosure	90	0.000159	13,000	0.77	0.37	1.59	0.76
NC-2	Hopper to feeders	0.00018	Enclosure	90	0.000018	13,000	0.77	0.37	0.18	0.08
NC-3	Feeder to crusher	0.00018	Enclosure	90	0.000018	13,000	0.77	0.37	0.18	0.08
NC-4	Crusher	0.02000	Enclosures	95	0.001000	13,000	1.00	0.50	13.00	6.50
NC-5	Crusher to feeder	0.00018	Enclosure	90	0.000018	13,000	0.77	0.37	0.18	0.08
NC-6	Feeders to C36A/B	0.00018	Enclosure	90	0.000018	13,000	0.77	0.37	0.18	0.08
								TOTALS =	36	18

Table 2c. Maximum 24-Hr Fugitive Dust Emission Factors, Other Batch/Continuous Drop Operations

SOURCE NO.	SOURCE	TYPE	s SILT CONTENT (%)	M MOISTURE CONTENT (%)	U WIND SPEED (MPH)	H DROP HEIGHT (FT)	Y DEVICE CAPACITY (YD**3)	E EMISSION FACTOR (LB/TON)
		MAXIMUM 24-HR EMISSION FACTORS						
CR 1/2 FLY ASH HANDLING:								
	Fly ash silo to truck	Continuous drop	18	20	12	5	-	0.00008
	Truck dump at ash pile	Batch drop	18	20	12	8	27	0.00015
CR 1/2 BOTTOM ASH HANDLING:								
	Backhoe to truck	Batch drop	18	20	12	5	5	0.00017
	Truck dump at ash pile	Batch drop	18	20	12	8	27	0.00015
CR 4/5 FLY ASH HANDLING:								
	Fly ash silo to truck	Continuous drop	18	20	12	5	-	0.00008
	Truck dump at ash pile	Batch drop	18	20	12	8	27	0.00015
CR 4/5 BOTTOM ASH HANDLING:								
	Fly ash silo to truck	Continuous drop	18	20	12	5	-	0.00008
	Truck dump at ash pile	Batch drop	18	20	12	8	27	0.00015
PROGRESS MATERIALS:								
	Pile Loading	Continuous drop	Refer to permit application					0.00005
	Loadout Hopper	Batch drop	Refer to permit application					0.00037
	Hopper-to-belt	Continuous drop	Refer to permit application					0.000025
	Truck Loading	Continuous drop	Refer to permit application					0.00005
IDEAL BASIC:								
	Apron feeder	Continuous drop	Refer to separate report					0.000012
	Barge pile loading	Continuous drop	Refer to separate report					0.000152
	Barge loading	Continuous drop	Refer to separate report					0.000304

Table 2d. Maximum 24-Hr Fugitive Dust Emissions, Other Batch/Continuous Drop Operations

SOURCE NO.	SOURCE	UNCONTROLLED EMISSION FACTOR (LB/TON)	CONTROL METHOD	CONTROL EFFICIENCY (%)	CONTROLLED EMISSION FACTOR (LB/TON)	MAXIMUM 24-HR THRUPUT (TPD)	PARTICLE SIZE MULTIPLIER (K)		MAXIMUM 24-HR EMISS. (LB/DAY)	
							TSP	PM10	TSP	PM10
			MAXIMUM 24-HR EMISSION ESTIMATES							
CR 1/2 ASH HANDLING:										
	Fly ash silo to truck	0.00008	-	0	0.000078	500	0.77	0.37	0.03	0.01
	Truck dump at ash pile	0.00015	-	0	0.000151	500	0.73	0.36	0.06	0.03
CR 1/2 BOTTOM ASH HANDLING:										
	Backhoe to truck	0.00017	-	0	0.000165	140	0.73	0.36	0.02	0.01
	Truck dump at ash pile	0.00015	-	0	0.000151	140	0.73	0.36	0.02	0.01
CR 4/5 FLY ASH HANDLING:										
	Fly ash silo to truck	0.00008	Enclosure	90	0.000008	720	0.77	0.37	0.00	0.00
	Truck dump at ash pile	0.00015	-	0	0.000151	720	0.73	0.36	0.08	0.04
CR 4/5 BOTTOM ASH HANDLING:										
	Fly ash silo to truck	0.00008	Enclosure	90	0.000008	220	0.77	0.37	0.00	0.00
	Truck dump at ash pile	0.00015	-	0	0.000151	220	0.73	0.36	0.02	0.01
PROGRESS MATERIALS:										
	Pile Loading	0.00005	-	0	0.000050	2,100	0.77	0.37	0.08	0.04
	Loadout Hopper	0.00037	-	0	0.000370	2,100	0.73	0.36	0.57	0.28
	Hopper-to-belt	0.00003	-	0	0.000025	2,100	0.77	0.37	0.04	0.02
	Truck Loading	0.00005	-	0	0.000050	2,100	0.77	0.37	0.08	0.04
								TOTALS =	1	0
IDEAL BASIC:										
	Apron feeder	0.00001	-	0	0.000012	7,300	0.77	0.37	0.07	0.03
	Barge pile loading	0.00015	-	0	0.000152	7,300	0.77	0.37	0.85	0.41
	Barge loading	0.00030	-	0	0.000304	15,000	0.77	0.37	3.51	1.69
								TOTALS =	4	2

Table 3. Fugitive Dust Emissions Due To Wind Erosion, Crystal River Power Plant

SOURCE NO.	SOURCE	s SILT CONTENT (%)	p DAYS OF PRECIP. (days/yr)	f FREQ. OF WINDS >12 mph	E EMISSION FACTOR (LB/ACRE-DAY)	CONTROL METHOD	CONTROL EFFICIENCY (%)	CONTROLLED EMISSION FACTOR (LB/ACRE-DAY)	SIZE OF PILE (ACRES)	TSP EMISSIONS
		ANNNUAL EMISSION ESTIMATES								
CR 1/2:										
CP-1	Active coal pile	5	107	18	7.5	Watering	80	1.5	5.1	1.390 TPY
CP-2	Inactive coal pile	5	107	18	7.5	Crusting agent	95	0.4	12.9	0.879 TPY
AP-1	Bottom ash storage									
	-Active	18	107	18	26.9	Watering	80	5.4	1.0	0.981 TPY
	-Inactive	18	107	18	26.9	Crusting agent	95	1.3	30.0	7.357 TPY
CR 4/5:										
CP-3	Active coal pile	5	107	18	7.5	Watering	80	1.5	11.0	2.997 TPY
CP-4	Inactive coal pile	5	107	18	7.5	Crusting agent	95	0.4	11.5	0.783 TPY
AP-2	Ash storage (inactive)	18	107	18	26.9	Crusting agent	95	1.3	7.5	1.839 TPY
AP-3	Ash storage (active)	18	107	18	26.9	Chem. wetting	90	2.7	2.5	1.226 TPY
PROGRESS MATERIALS:										
	Stockpile	Refer to permit application								0.200 TPY
IDEAL BASIC:										
18-11	Limestone storage (Barge)	3	107	18	4.5	-	0	4.5	1.15	0.940 TPY
									TOTALS =	18.593 TPY
		MAXIMUM 24-HOUR EMISSION ESTIMATES								
CR 1/2:										
CP-1	Active coal pile	5	0	100	58.7	Watering	80	11.7	5.1	59.8 lb/day
CP-2	Inactive coal pile	5	0	100	58.7	Crusting agent	95	2.9	12.9	37.8 lb/day
AP-1	Bottom ash storage									
	-Active	18	0	100	211.2	Watering	80	42.2	1	42.2 lb/day
	-Inactive	18	0	100	211.2	Crusting agent	95	10.6	30	316.9 lb/day
CR 4/5:										
CP-3	Active coal pile	5	0	100	58.7	Watering	80	11.7	11	129.1 lb/day
CP-4	Inactive coal pile	5	0	100	58.7	Crusting agent	95	2.9	11.5	33.7 lb/day
AP-2	Ash storage (inactive)	18	0	100	211.2	Crusting agent	95	10.6	7.5	79.2 lb/day
AP-3	Ash storage (active)	18	0	100	211.2	Chem. wetting	90	21.1	2.5	52.8 lb/day
PROGRESS MATERIALS: Stockpile		Refer to permit application								1.1 lb/day
IDEAL BASIC:										
18-11	Limestone storage (Barge)	3	0	100	35.2	-	0	35.2	1.15	40.5 lb/day
									TOTALS =	793 lb/day

Table 4. Annual Fugitive Dust Emission Factors For Vehicular Traffic, Crystal River Power Plant

SOURCE NO.	SOURCE	SURFACE TYPE	s SILT CONTENT (%)	MEAN VEHICLE SPEED (MPH)	VEHICLE WEIGHT (TONS)	NUMBER OF WHEELS	p DAYS OF PRECIP. (days/yr)	E EMISSION FACTOR (LB/VMT)
			ANNUAL EMISSION FACTORS					
CR 1/2 COAL:								
MR-4	FEL Traffic	Coal	5	10	27	4	107	2.7
			5	10	9	4	107	1.2
	Pile Maintenance:							
CP-3	Frontend loader	Coal	5	10	27	4	107	2.7
			5	10	9	4	107	1.2
CP-4	Scraper	Coal	5	10	40	-	107	1.5
CP-5	Bulldozer	Coal	5	-	-	-	-	43.1 lb/hr
CR 4/5 COAL:								
	Pile maintenance:							
CP-13	Frontend loader	Coal	5	10	27	4	107	2.7
			5	10	9	4	107	1.2
CP-14	Scraper	Coal	5	10	40	-	107	1.5
CP-15	Bulldozer	Coal	5	-	-	-	107	43.1 lb/hr
ASH HANDLING:								
AP-	CR 1/2 Bottom ash	Limestone	10	20	33	12	107	21.5
			10	20	13	12	107	11.2
AP-	CR 1/2 Fly ash	Limestone	10	20	33	12	107	21.5
			10	20	13	12	107	11.2
AP-	CR 4/5 Bottom ash	Limestone	10	20	33	12	107	21.5
			10	20	13	12	107	11.2
AP-	CR 4/5 Fly ash	Limestone	10	20	33	12	107	21.5
			10	20	13	12	107	11.2
AP-	Scraper	Fly ash	18	10	40	6	107	15.7
AP-	FEL (maint.)	Fly ash	18	10	27	4	107	9.7
			18	10	9	4	107	4.5
PROGRESS MATERIALS:								
PM-	FEL Traffic	Aardelite	15	5	21.4	4	107	3.4
			15	5	18.6	4	107	3.1
IDEAL BASIC:								
IB-	FEL Traffic (barge)	Limestone	10	5	64.9	4	107	5.0
			10	5	46.5	4	107	3.9

Table 5. Maximum 24-Hour Fugitive Dust Emission Factors For Vehicular Traffic, Crystal River Power Plant

SOURCE NO.	SOURCE	SURFACE TYPE	s SILT CONTENT (%)	MEAN VEHICLE SPEED (MPH)	VEHICLE WEIGHT (TONS)	NUMBER OF WHEELS	p DAYS OF PRECIP. (days/yr)	E EMISSION FACTOR (LB/VMT)
			MAXIMUM 24-HOUR EMISSION FACTORS					
CR 1/2 COAL:								
MR-4	FEL Traffic	Coal	5	10	27	4	0	3.8
			5	10	9	4	0	1.8
	Pile Maintenance:							
CP-3	Frontend loader	Coal	5	10	27	4	0	3.8
			5	10	9	4	0	1.8
CP-4	Scraper	Coal	5	10	40	-	0	1.5
CP-5	Bulldozer	Coal	5	-	-	-	0	43.1 lb/hr
CR 4/5 COAL:								
	Pile maintenance:							
CP-13	Frontend loader	Coal	5	10	27	4	0	3.8
			5	10	9	4	0	1.8
CP-14	Scraper	Coal	5	10	40	-	0	1.5
CP-15	Bulldozer	Coal	5	-	-	-	0	43.1 lb/hr
ASH HANDLING:								
AP-	CR 1/2 Bottom ash	Limestone	10	20	33	12	0	30.4
			10	20	13	12	0	15.8
AP-	CR 1/2 Fly ash	Limestone	10	20	33	12	0	30.4
			10	20	13	12	0	15.8
AP-	CR 4/5 Bottom ash	Limestone	10	20	33	12	0	30.4
			10	20	13	12	0	15.8
AP-	CR 4/5 Fly ash	Limestone	10	20	33	12	0	30.4
			10	20	13	12	0	15.8
AP-	Scraper	Fly ash	18	10	40	6	0	22.1
AP-	FEL (maint.)	Fly ash	18	10	27	4	0	13.7
			18	10	9	4	0	6.4
PROGRESS MATERIALS:								
PM-	FEL Traffic	Aardelite	15	5	21.4	4	0	4.9
			15	5	18.6	4	0	4.4
IDEAL BASIC:								
IB-	FEL Traffic (barge)	Limestone	10	5	64.9	4	0	7.0
			10	5	46.5	4	0	5.6

Table 6. Annual Fugitive Dust Emissions From Vehicular Traffic, Crystal River Power Plant

SOURCE NO.	SOURCE	BASIS FOR VEHICLE MILES TRAVELED	VEHICLE MILES TRAVELED (VMT/YR)	E EMISSION FACTOR (LB/VMT)	CONTROL METHOD	CONTROL EFFICIENCY (%)	CONTROLLED EMISSION FACTOR (LB/VMT)	ANNUAL EMISSIONS (TPY)* TSP	PM10
CR 1/2 COAL:									
MR-4	FEL Traffic- Loaded	2,000,000 TPY; 20 tons; 0.1 mi	10,000	2.7	Watering	80	0.54	2.160	0.972
	- Empty		10,000	1.2	Watering	80	0.24	0.960	0.432
	Pile Maintenance:								
CP-3	Frontend loader	1,185 hr/yr; 10 mph	5,925	2.7	Watering	80	0.54	1.280	0.576
			5,925	1.2	Watering	80	0.24	0.569	0.256
CP-4	Scraper	1,260 hr/yr; 10 mph	12,600	1.5	Watering	80	0.3	1.512	0.680
CP-5	Bulldozer	2,164 hr/yr	-	43.1 +	Watering	80	8.62 +	7.461	3.358
							TOTALS =	13.942	6.274
CR 4/5 COAL:									
	Pile maintenance:								
CP-13	Frontend loader	1,890 hr/yr; 10 mph	9,450	2.7	Watering	80	0.54	2.041	0.919
			9,450	1.2	Watering	80	0.24	0.907	0.408
CP-14	Scraper	2,018 hr/yr; 10 mph	20,180	1.5	Watering	80	0.3	2.422	1.090
CP-15	Bulldozer	3,461 hr/yr	-	43.1 +	Watering	80	8.62 +	11.934	5.370
							TOTALS =	17.304	7.787
ASH HANDLING:									
AP-	CR 1/2 Bottom ash								
	- Loaded	50,000 TPY; 20 tons; 0.1 mi	250	21.5	Chem. stabiliz.	95	1.075	0.108	0.048
	- Empty		250	11.2	Chem. stabiliz.	95	0.56	0.056	0.025
AP-	CR 1/2 Fly ash								
	- Loaded	175,000 TPY; 20 tons; 0.1 mi	875	21.5	Chem. stabiliz.	95	1.075	0.376	0.169
	- Empty		875	11.2	Chem. stabiliz.	95	0.56	0.196	0.088
AP-	CR 4/5 Bottom ash								
	- Loaded	75,000 TPY; 20 tons; 0.1 mi	375	21.5	Chem. stabiliz.	95	1.075	0.161	0.073
	- Empty		375	11.2	Chem. stabiliz.	95	0.56	0.084	0.038
AP-	CR 4/5 Fly ash								
	- Loaded	262,500 TPY; 20 tons; 0.1 mi	1,313	21.5	Chem. stabiliz.	95	1.075	0.565	0.254
	- Empty		1,313	11.2	Chem. stabiliz.	95	0.56	0.294	0.132
AP-	Scraper	430 hr/yr; 10 mph	4,300	9.7	Chem. stabiliz.	95	0.485	0.834	0.375
AP-	FEL (maint.)	400 hr/yr; 10 mph	4,000	4.5	Chem. stabiliz.	95	0.225	0.360	0.162
							TOTALS =	3.034	1.365
PROGRESS MATERIALS:									
PM-	FEL Traffic	Refer to Permit Application						6.256	2.815
IDEAL BASIC:									
IB-	Bulldozer (barge)	Refer to separate report	-	-				0.002	0.001

Table 7. Maximum 24-Hour Fugitive Dust Emissions From Vehicular Traffic, Crystal River Power Plant

SOURCE NO.	SOURCE	BASIS FOR VEHICLE-MILES TRAVELED	VEHICLE MILES TRAVELED (VMT/DAY)	E EMISSION FACTOR (LB/VMT)	CONTROL METHOD	CONTROL EFFICIENCY (%)	CONTROLLED EMISSION FACTOR (LB/VMT)	MAXIMUM 24-HR EMISSIONS (lb/day)* TSP	PM10
		MAXIMUM 24-HOUR EMISSIONS							
CR 1/2 COAL:									
MR-4	FEL Traffic-Loaded	4,200 TPD; 20 tons; 0.1 mi	21	3.8	Watering	80	0.76	13	6
	- Empty		21	1.8	Watering	80	0.36	6	3
	Pile Maintenance:								
CP-3	Frontend loader	3.2 hr/day; 10 mph	16	3.8	Watering	80	0.76	10	4
			16	1.8	Watering	80	0.36	5	2
CP-4	Scraper	3.5 hr/day; 10 mph	35	1.5	Watering	80	0.3	8	4
CP-5	Bulldozer	5.9 hr/day	-	43.1 +	Watering	80	8.62 +	41	18
							TOTALS =	82	37
CR 4/5 COAL:									
	Pile maintenance:								
CP-13	Frontend loader	5.2 hr/day; 10 mph	26	3.8	Watering	80	0.76	16	7
			26	1.8	Watering	80	0.36	7	3
CP-14	Scraper	5.5 hr/day; 10 mph	55	1.5	Watering	80	0.3	13	6
CP-15	Bulldozer	9.5 hr/day	-	43.1 +	Watering	80	8.62 +	66	29
							TOTALS =	102	46
ASH HANDLING:									
AP-1	CR 1/2 Bottom ash								
	- Loaded	140 TPD; 20 tons; 0.1 mi	0.7	30.4	Chem. stabiliz.	95	1.52	0.9	0.4
	- Empty		0.7	15.8	Chem. stabiliz.	95	0.79	0.4	0.2
AP-2	CR 1/2 Fly ash								
	- Loaded	500 TPD; 20 tons; 0.1 mi	2.5	30.4	Chem. stabiliz.	95	1.52	3.0	1.4
	- Empty		2.5	15.8	Chem. stabiliz.	95	0.79	1.6	0.7
AP-3	CR 4/5 Bottom ash								
	- Loaded	220 TPD; 20 tons; 0.1 mi	1.1	30.4	Chem. stabiliz.	95	1.52	1.3	0.6
	- Empty		1.1	15.8	Chem. stabiliz.	95	0.79	0.7	0.3
AP-4	CR 4/5 Fly ash								
	- Loaded	720 TPD; 20 tons; 0.1 mi	3.6	30.4	Chem. stabiliz.	95	1.52	4.4	2.0
	- Empty		3.6	15.8	Chem. stabiliz.	95	0.79	2.3	1.0
AP-5	Scraper	1.2 hr/day; 10 mph	12	22.1	Chem. stabiliz.	95	1.11	10.6	4.8
AP-6	FEL (maint.)	1.1 hr/day; 10 mph	5.5	13.7	Chem. stabiliz.	95	0.69	3.0	1.4
			5.5	6.4	Chem. stabiliz.	95	0.32	1.4	0.6
							TOTALS =	30	13
PROGRESS MATERIALS:									
PM-	FEL Traffic	Refer to permit application	-	-	-	-	-	77	35
IDEAL BASIC:									
IB-	Bulldozer (barge)	-	-	1.38 lb/hr	-	-	-	9	4

Table 8. Summary of Fugitive Dust Emissions, Crystal River Power Plant

Model Source No.	Source	Max. 24-Hr Emissions (lb/day) TSP	PM10	Annual Avg. Emissions (TPY) TSP	PM10
	CR 4/5 Active Ash Storage:				
11	Transfer operations	0	0	0.023	0.011
10	Wind erosion	53	53	1.226	1.226
11	Vehicular traffic	30	13	3.034	1.365
20,21	CR 4/5 Inactive Ash Storage				
	Wind erosion	79	79	1.839	1.839
	CR 4/5 Coal Pile:				
12,31,33	CR 4/5 Transfer operations	36	18	3.440	1.689
30,32,34,35	Wind erosion	163	163	3.780	3.780
31,33	Pile maintenance/traffic	102	46	17.304	7.787
31,33	Ash transfer	0	0	0	0
	CR 1/2 Bottom Ash Storage:				
41 *	Transfer	0	0	0.006	0.003
40 *	Wind erosion	359	359	8.338	8.338
	Progress Materials:				
41	Transfer	1	0	0.064	0.031
41	Vehicular traffic	77	35	6.256	2.815
40	Wind erosion	1	1	0.200	0.200
	Ideal Basic:				
51	Transfer	4	2	0.064	0.031
51	Vehicular traffic	9	4	0.002	0.001
50	Wind Erosion	41	41	0.940	0.940
	CR 1/2 Coal Pile:				
62 *	CR 1/2 Transfer operations	24	12	1.870	0.924
60,61 *	Wind erosion	98	98	2.269	2.269
62 *	Pile maintenance/traffic	82	37	13.942	6.274

* Not a PSD increment consuming source

3.0 SOURCE IMPACT ANALYSIS METHODOLOGY

3.1 GENERAL MODELING APPROACH

The general modeling approach followed USEPA and FDER modeling guidelines for determining compliance with AAQS and PSD increments. In general, when model predictions are used to determine compliance with AAQS and PSD increments, current USEPA and FDER policies stipulate that the highest annual average concentration and highest, second-highest short-term concentration can be compared to the applicable standard.

Model predictions for annual and 24-hour average concentrations were performed using the Industrial Source Complex Short-Term (ISCST) model (Version 88167). A brief description of the ISC model is given in Section 3.2.

3.2 MODEL SELECTION

The ISC dispersion model (USEPA, 1988a) was used to evaluate the TSP emissions from FPC's Crystal River facility and associated sources (Ideal Basic and Progress Materials). This model is contained in USEPA's User's Network for Applied Modeling of Air Pollution (UNAMAP), Version 6 (USEPA, 1988b). The ISC model was selected primarily for the following reasons:

1. USEPA and FDER have approved the general use of the model for air quality dispersion analysis because the model assumptions and methods are consistent with those in the Guideline on Air Quality Models (USEPA, 1987b);
2. The ISC model is capable of predicting the impacts from stack, area, and volume sources that are spatially distributed over large areas and located in flat or gently rolling terrain; and
3. The results from the ISC model are appropriate for addressing compliance with AAQS and PSD increments.

The ISC model consists of two sets of computer codes which are used to calculate short- and long-term ground level concentrations. The main differences between the two codes are the input format of the meteorological data and the method of estimating the plume's horizontal dispersion. The first model code, the ISCST model, is an extended version of the single-source (CRSTER) model (USEPA, 1977). The ISCST model is designed to calculate hourly concentrations based on hourly meteorological parameters (i.e., wind direction, wind speed, atmospheric stability, ambient temperature, and mixing height). The hourly concentrations are processed into non-overlapping short-term averaging periods and annual averaging periods. For example, a 24-hour average concentration is based on twenty-four 1-hour averages determined from midnight to midnight of each day. For each short-term averaging period selected, the highest and second-highest average concentrations are determined for each receptor. As an option, a table of the 50 highest concentrations over the entire field of receptors can be produced.

The second model code of the ISC model is the ISC long-term (ISCLT) model, which is an extension of the Air Quality Display Model (AQDM) and the Climatological Dispersion Model (CDM). The ISCLT model uses joint frequencies of wind direction, wind speed, and atmospheric stability to calculate seasonal and/or annual average ground-level concentrations. Because the input wind directions are for 16 sectors, with each sector defined as 22.5 degrees, the model calculates concentrations by assuming that the pollutant is uniformly distributed in the horizontal plane within a 22.5-degree sector.

In this analysis, the ISCST model was used to calculate both short-term and annual average concentrations, since these concentrations are readily obtainable from the model output.

Major features of the ISCLT and ISCST model are presented in Table 3-1. Concentrations due to stack and volume sources are calculated by the models using the steady-state Gaussian plume equation for a continuous source. The area source equation in the ISC model is based on the equation for a continuous and finite crosswind line source.

Table 3-1. Major Features of the ISC Model

ISC Model Features
o Polar or Cartesian coordinate systems for receptor locations
o Rural or one of three urban options which affect wind speed profile exponent, dispersion rates, and mixing height calculations
o Plume rise due to momentum and buoyancy as a function of downwind distance for stack emissions (Briggs, 1969, 1971, 1972, and 1975)
o Procedures suggested by Huber and Snyder (1976) and Huber (1977), and Scire-Schulman (1980) and Schulman and Hanna (1986) for evaluating building wake effects
o Procedures suggested by Briggs (1974) for evaluating stack-tip downwash
o Separation of multiple point sources
o Consideration of the effects of gravitational settling and dry deposition on ambient particulate concentrations
o Capability of simulating point, line, volume and area sources
o Capability to calculate dry deposition
o Variation with height of wind speed (wind speed-profile exponent law)
o Concentration estimates for annual average
o Terrain-adjustment procedures for elevated terrain including a terrain truncation algorithm
o Consideration of time-dependent exponential decay of pollutants
o The method of Pasquill (1976) to account for buoyancy-induced dispersion
o A regulatory default option to set various model options and parameters to EPA recommended values (see text for regulatory options used)

The ISC model has rural and urban options which affect the wind speed profile exponent algorithm, dispersion rates, and mixing-height formulations used in calculating ground level concentrations. The criteria used to determine when the rural or urban mode is appropriate are based on land use near the proposed plant's surroundings (Auer, 1978). If the land use is classified as heavy industrial, light-moderate industrial, commercial, or compact residential for more than 50 percent of the area within a 3 km radius circle centered on the proposed source, the urban option should be selected. Otherwise, the rural option is more appropriate.

For modeling analyses that will undergo regulatory review, such as PSD permit applications, the following model features are recommended by USEPA (1987b) and are referred to as the regulatory options in the ISC model:

1. Final plume rise at all receptor locations,
2. Stack-tip downwash,
3. Buoyancy-induced dispersion,
4. Default wind speed profile coefficients for rural or urban option,
5. Default vertical potential temperature gradients, and
6. Reducing calculated concentrations in urban areas by using a decay half-life.
7. Consideration of calm winds in calculating concentrations for averaging periods of 24-hours or more.

Some of the above model features have been recommended for use by USEPA over the last 5 years. These assumptions include the use of final plume rise, default wind speed profile coefficients, default vertical potential temperature gradients, and calm wind processing. The recently revised USEPA modeling guidelines recommend use of the remaining features, including the use of calm wind processing regardless if impacts are expected to occur under such meteorological conditions. The effect of using these options to predict maximum ground level concentrations from elevated point sources is to produce higher concentrations than if these options were not used by:

- o Lowering the effective plume height (stack-tip downwash),
- o Increasing the plume width such that the plume may have an impact over areas where it previously would not (buoyancy-induced dispersion), and
- o Mathematically adjusting the longer term averaging concentration (i.e., 24 hours or more) by the number of non-calm hours (calm wind processing).

In this analysis, the USEPA regulatory options were used to address maximum TSP emissions at FPC Crystal River and associated facilities. Based on a review of the land use around the facility, the rural mode was selected because of the general lack of, or minimal, residential, industrial and commercial development.

3.3 METEOROLOGICAL DATA

USEPA (1987b) recommends the use of five (5) years of representative meteorological data for use in air quality modeling. The most recent, readily available 5-year period is preferred. The meteorological data may be collected either onsite or at the nearest National Weather Service (NWS) station.

Meteorological data used in the analysis consisted of a 5-year record of surface weather observations (1982-1986) from the NWS office located at Tampa International Airport. The database consists of hourly surface data (i.e., wind speed, wind direction, etc.) which are recorded and then sent to the National Climatic Center (NCC) in Asheville, North Carolina. The NCC digitizes the recorded data onto magnetic tape for sale to the public.

The NWS in Tampa is the nearest weather station which routinely records the hourly surface data required by the air dispersion models. Due to the proximity of the Tampa NWS office to the plant site, its similar location relative to the Florida west coast, and the use of five years of hourly data, the Tampa meteorological data are considered to be representative of weather conditions occurring at the plant site.

3.4 EMISSION INVENTORY

The TSP emission inventory used in the modeling analyses was presented in Section 2.0. The source parameters used as input to the dispersion model are presented in Tables 3-2 and 3-3. The locations of point and area sources relative to the Units 1, 2 and 3 Helper Cooling Towers are shown in Figure 3-1.

As indicated in Table 3-2, the fugitive sources were modeled as area sources, which were defined by the spatial extent of the activities associated with each operation. In the case of wind erosion sources, the emission source was considered to be the entire extent of the storage pile. Because the ISCST model only allows for representation of area sources as squares, large sources (i.e., Units 1 and 2 inactive coal pile) were divided into several area sources located where TSP emissions will occur. For this analysis, sources for which emissions were based on time of operation (i.e., 12 hr/day) were assumed to have emissions only during normal hours of operation (i.e., 7 a.m. to 7 p.m.). For sources representing wind erosion emissions from storage piles, the emissions were assumed to occur when the wind speed was greater than 12 mph, which is the basis of the emission factors presented in Section 2.0.

Source emission height was based upon actual average release height of each specific source. For storage piles, the average pile height was used.

The nonfugitive TSP sources presented in Table 3-3 were simulated as point sources. The parameters for these sources were provided by FPC, or in the case of sources associated with Ideal Basic and Progress Materials, from recent air permit applications and air modeling studies (see Appendix C).

To account for the effects of particle deposition due to emissions from the existing units Nos. 4 and 5 cooling towers and the proposed helper cooling towers, particle size distributions were input into the model for these sources. The particle size distribution, settling velocities and reflection coefficient for TSP emissions from Units Nos. 4 and 5 cooling tower is as

Table 3-2. Summary of Area Source Parameters Used in the ISCST Modeling Analysis

Source Number	Source Description	Location (m) * X	Location (m) * Y	Height (m)	Area (m2)	Actual Width (m)	Modeled Width (m)	Basis of Emission Rate Scalars	Particulate Emissions (lb/day)	Particulate Emissions (g/s)	Particulate Emissions (g/s/m2)
10	Unit 4/5 Active Ash Pile (wind erosion)	1948	460	12.0	10,118	100.6	100.0	Wind > 12 mph	53	0.28	0.0000277
11	Haul Road to Unit 4/5 Active Ash Pile	1948	460	12.0	10,118	100.6	100.0	12 hr/day	30	0.32	0.0000315
12	Unit 4/5 Coal Transfer	690	-753	3.0	145,352	381.3	380.0	24 hr/day	11	0.06	0.0000004
20	Unit 4/5 Inactive Ash Pile (wind erosion)	1876	393	24.4	15,177	123.2	125.0	Wind > 12 mph	40	0.21	0.0000133
21	Unit 4/5 Inactive Ash Pile (wind erosion)	2000	393	24.4	15,177	123.2	125.0	Wind > 12 mph	40	0.21	0.0000133
30	Unit 4/5 Inactive Coal Pile (wind erosion)	1380	563	3.0	22,764	150.9	150.0	Wind > 12 mph	41	0.22	0.0000096
32	Unit 4/5 Inactive Coal Pile (wind erosion)	1380	381	3.0	22,764	150.9	150.0	Wind > 12 mph	41	0.22	0.0000096
34	Unit 4/5 Inactive Coal Pile (wind erosion)	1561	563	3.0	22,764	150.9	150.0	Wind > 12 mph	41	0.22	0.0000096
35	Unit 4/5 Inactive Coal Pile (wind erosion)	1561	381	3.0	22,764	150.9	150.0	Wind > 12 mph	41	0.22	0.0000096
31	Unit 4/5 Active Coal Pile (maintenance)	1380	563	3.0	22,764	150.9	150.0	24 hr/day	64	0.33	0.0000148
33	Unit 4/5 Active Coal Pile (maintenance)	1380	381	3.0	22,764	150.9	150.0	24 hr/day	64	0.33	0.0000148
40 +	Unit 1/2 Bottom Ash (wind erosion)	145	12	5.0	125,457	354.2	350.0	Wind > 12 mph	360	1.89	0.0000154
41 +	Unit 1/2 Bottom Ash Pile (Progress Materials)	145	12	5.0	125,457	354.2	350.0	12 hr/day	78	0.82	0.0000067
50	Ideal Basic (wind erosion)	-97	-363	5.0	91,058	301.8	300.0	Wind > 12 mph	41	0.22	0.0000024
51	Ideal Basic (general operation)	-97	-363	5.0	91,058	301.8	300.0	24 hr/day	13	0.07	0.0000008
52	Ideal Basic Quarry (wind erosion)	600	3000	3.8	3,147	56.1	56.1	Wind > 12 mph	28	0.14	0.0000459
53	Ideal Basic Quarry (general operation)	600	3000	3.8	3,147	56.1	56.1	12 hr/day	117	1.84	0.0005858
60 +	Unit 1/2 Inactive Coal Pile (wind erosion)	460	-753	5.0	36,423	190.8	190.0	Wind > 12 mph	49	0.26	0.0000071
61 +	Unit 1/2 Inactive Coal Pile (wind erosion)	460	-753	5.0	36,423	190.8	190.0	Wind > 12 mph	49	0.26	0.0000071
62 +	Unit 1/2 Active Coal Pile (maintenance)	460	-753	5.0	36,423	190.8	190.0	24 hr/day	106	0.56	0.0000154

* Relative to helper cooling towers

+ Not a PSD increment consuming source

Table 3-3. Summary of Point Sources Used in the ISCST Modeling Analysis

Source Number	Source Description	Location (m) * X	Location (m) * Y	Stack Height (m)	Diameter (m)	Velocity (m/s)	Temper-ature (K)	Particulate Emissions (lb/hr)	Particulate Emissions (g/s)
100	Units 1-3 Helper Cooling Towers	0	0	16.2	10.52	6.20	306.0	198	25.00
110	Unit 4 Cooling Tower	714	908	135.0	65.20	3.32	311.0	175	22.10
120	Unit 5 Cooling Tower	714	690	135.0	65.20	3.32	311.0	175	22.10
130	Units 4 and 5 Power Generation	1077	786	178.2	7.77	21.03	396.0	1251	157.60
135	Unit 4 and 5 Coal Baghouses	932	786	42.7	0.84	21.20	310.0	7	0.88
140 +	Unit 2 Power Generation	677	-750	153.0	4.88	48.77	422.0	463	58.30
150 +	Unit 1 Power Generation	750	-750	152.0	4.57	40.54	417.0	364	45.90
160	Progress Material Baghouses	517	-113	18.3	0.61	11.40	325.0	2	0.21

* Relative to Units 1-3 Helper Cooling towers

\+ Not a PSD increment consuming source

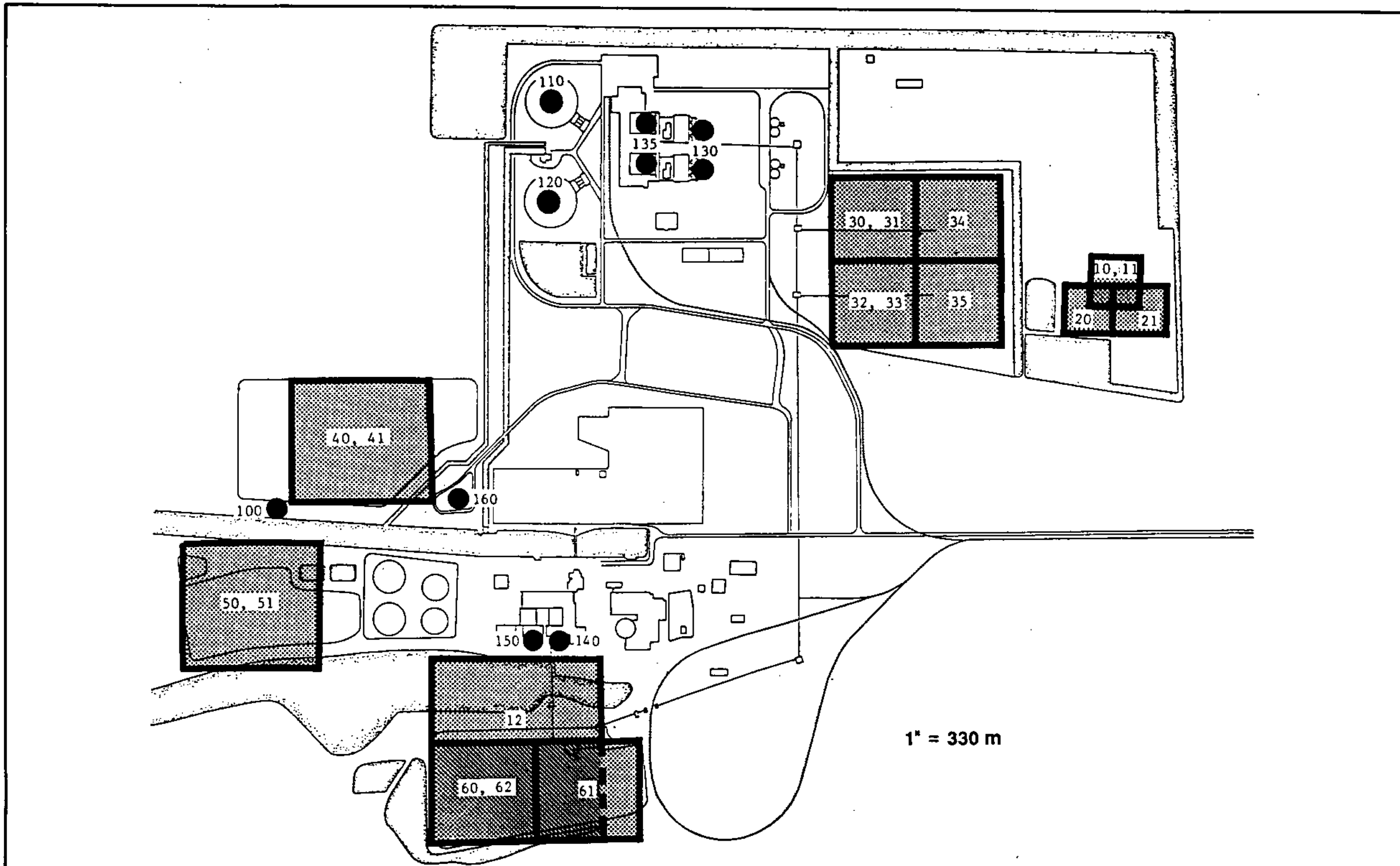

Figure 3-1. Locations of Fugitive and Stationary TSP Sources, FPC Crystal River Site

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described in the Site Certification Application for Units 4 and 5 (ESE, 1977). The particle size distributions for the proposed Units 1, 2 and 3 helper cooling towers are based on design information, as presented in Table 2-3. Corresponding settling velocities and reflection coefficients for the helper cooling towers are presented in Table 3-4.

The proposed helper cooling towers were modeled for every hour of the year, even though they will operate a maximum of 180 days per year. The cooling towers were modeled as a single, colocated point source with stack parameters equivalent to a single fan within the towers. In reality, there will be a total of 36 fans located over a 2,000 ft length spanning the four helper towers. Therefore, resulting impacts from the proposed cooling towers are conservative and would be lower if these sources were separated. Furthermore, the reflection coefficients used in the modeling are designed to account for effects of dry deposition and reentrainment of particles into the atmosphere. However, emissions from the towers will be wet (i.e., water droplets), and therefore the particles should not reflect or become reentrained. However, the impacts predicted in this analysis considered reflection of particles, as described in the ISCST Users Guide, Volume I, and are therefore conservative.

As described in Section 1.0, the AAQS for PM is in terms of PM10, while the PSD increments are in terms of TSP. For this analysis, TSP emissions only were modeled. **For PM10, it was assumed that PM10 emissions were equal to TSP emissions.** This assumption will result in overpredictions of actual PM10 air quality levels, and therefore is a conservative assumption.

3.5 RECEPTOR LOCATIONS

As discussed in Section 3.1, the general modeling approach addressed compliance with maximum allowable PSD Class II and PSD Class I increments and AAQS. The locations of receptors used in the analysis were based on identifying the areas in which maximum concentrations would be expected due to fugitive and nonfugitive PM sources at the Crystal River facility.

Table 3-4. Summary of Source Particulate Data for the Proposed Helper Cooling Towers to Simulate the Effects of Deposition

Particle Diameter (um)	Mean Diameter (um)	Mass Fraction	Settling Velocity (m/s)	Reflection Coefficient
0-40	20	0.048	0.027	0.680
40-60	50	0.054	0.074	0.560
60-100	80	0.036	0.190	0.270
100-200	150	0.092	0.669	0.00
200-300	250	0.130	1.860	0.00
300-400	350	0.260	3.640	0.00
400-500	450	0.235	6.020	0.00
500-700	600	0.115	10.700	0.00
700-1000	850	0.019	21.500	0.00
1000-1750	1,425	0.011	60.500	0.00

A listing of the receptor locations used in the screening analysis for determining compliance with PSD Class II increments and AAQS is presented in Table 3-5. A radial grid was used in the analysis, centered on the location of the Units 1, 2 and 3 Helper Cooling Towers.

The first receptor distance given for each direction in Table 3-5 is based on the location of the facility property boundaries relative to the location of the Helper Cooling Towers. A visual representation of the limit of public access onto FPC's property is shown in Figure 3-2.

The boundary of the FPC Crystal River Power Plant, outside of which determines "ambient air" as defined by 40 CFR Part 50.1(e), is based on the accessibility of the general public to the site. The boundaries to the east, north and south are fenced. Guard positions are located on the access road to the plant. The western boundary designates the landward extent of the salt marsh (mean high water level) beyond which public access is not possible. The plant proper, roads and boundaries are patrolled by FPC security.

The receptors used to demonstrate compliance with PSD Class I increments for TSP are presented in Table 3-6. The receptors are located along the northern border of Chassahowitzka National Wildlife Refuge (closest border to FPC Crystal River).

3.6 BACKGROUND AIR QUALITY

Background PM air quality concentrations are necessary in order to predict total PM air quality for comparison to AAQS. The AAQS are in terms of PM10.

Presented in Table 3-7 is a summary of 24-hour TSP samples taken at two (2) locations in the vicinity of the Crystal River power plant during 1985, 1986 and 1987. Locations of the sites are shown in Figure 3-3. PM10 levels were not measured at the sites, but will be less than the reported TSP levels. Station No. 2 is located closest to the Crystal River site, and therefore was selected to determine background levels. As a conservative estimate of

Table 1. Stack Parameters Used for Crystal River 4 and 5 PSD Analysis

Unit(s)/Fuel	Stack Height (M)	Stack Diameter (M)	Stack Gas Velocity (M/S)	Stack Temperature (°K)	Heat Input (10^6 Btu/hr)
CR 4 & 5 (each)	182.9	6.86	27.4	400	6672
CR 2 (Coal)	153.0	4.88	44.8	422	4715
CR 1 (Coal)	152.0	4.57	42.1	422	3890
CR 1 (Oil)	152.0	4.57	35.7	416	3890

Table 2. Summary of Maximum Sulfur Dioxide Impacts With Unit 2 on Coal in the Baseline

Scenario	Maximum Concentration (ug/m^3) Annual	24-Hour	3-Hour
Unit 4 @ 1.2* and Units 1 and 2 @ 4.0			
Class I Increment Consumption	0.2	4.0	25.0
Allowable Class I Increments**	2	5	25
Class II Increment Consumption	1.2	22	123
Allowable Class II Increments**	20	91	512
Maxium Air Quality Impact	11.5	112	653
Florida Air Quality Standards**	60	260	1300
Unit 4 and 5 @ 1.2 and Units 1 and 2 @ 3.11			
Class I Increment Consumption	0.1	3.1	24.9+
Allowable Class I Increments**	2	5	25
Class II Increment Consumption	1.3	25	197
Allowable Class II Increment**	20	91	512
Maximum Air Quality Impact	10.2	97	533
Florida Air Quality Standards**	60	260	1300

* Numbers represent SO2 emission in $lb/10^6$Btu.
** 24-Hour and 3-Hour increments and standards can be exceeded once per year.
\+ Resulting increment consumption with Units 1 and 2 emitting at 3.10 $lb/10^6$ Btu.

Table 3-5. Receptors Used in the ISCST Screening Analysis

Direction (deg.)	Distances (m)	Direction (m)	Distances (m)
10	1100, 1300, 1600	170	1500, 1600, 1900
20	1150, 1300, 1600	180	1500, 1600, 1900
30	1250, 1300, 1600	190	1200, 1300, 1600
40	1450, 1600, 1900	200	1100, 1300, 1600
45	1550	210	1000, 1300, 1600
50	1700, 1900, 2300	220	950, 1000, 1300
55	1900	230	950, 1000, 1300
60	2150, 2300, 2700	240	1500, 1600, 1900
65	2300	250	1600, 1900, 2300
70	2250, 2300, 2700	260	1550, 1600, 1900
75	2200	270	1550, 1600, 1900
80	2200, 2300, 2700	280	1600, 1900, 2300
90	7200, 8000, 9000	290	1600, 1900, 2300
100	3750, 4000, 4500	300	1750, 1900, 2300
110	3900, 4000, 4500	310	1750, 1900, 2300
120	4300, 4500, 5000	320	1450, 1600, 1900
130	4800, 5000, 5500	330	1250, 1300, 1600
140	4200, 4500, 5000	340	1200, 1300, 1600
150	3750, 4000, 4500	350	1100, 1300, 1600
160	1600, 1900, 2300	360	1100, 1300, 1600

Note: Distance and Direction Relative to the Location of Proposed Units 1, 2 and 3 Helper Cooling Towers

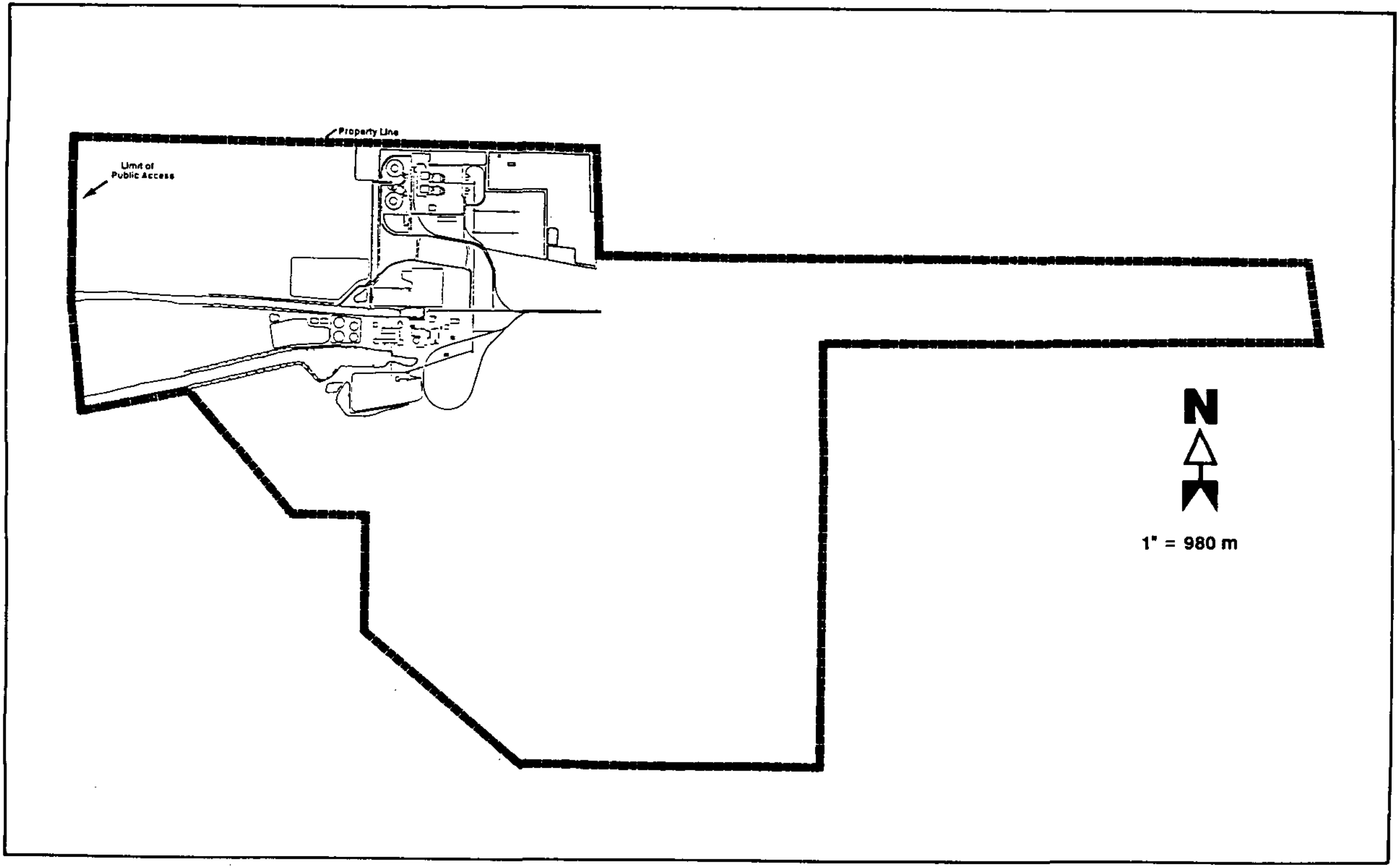

Figure 3-2. Limit of Public Access at the FPC Crystal River Site

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Table 3-6. Summary of PSD Class I Receptors Used in the ISCST Modeling Analysis*

UTM Coordinates (km) Zone 17		Location Relative to Helper Cooling Towers	
East	North	Direction (degrees)	Distance (km)
334	3184	180	21.1
335	3184	177	21.1
336	3184	175	21.2
337	3184	172	21.3
338	3184	169	21.5
339	3184	167	21.7
340	3184	164	21.9
341	3184	161	22.2
342	3184	159	22.6
343	3184	157	22.9
344	3184	155	23.3
345	3184	152	23.8

* Located along northern border of the Chassahowitzka National Wildlife Refuge.

Table 3-7. Summary of 24-Hour TSP Ambient Air Quality Data, Florida Power Corporation Crystal River Site, July 1985 through June 1987

Station Number	Time Period	Number of Samples	Percent Data Capture	Annual Geometric Mean	Observed 24-Hour Maximum	Observed 24-Hour 2nd Maximum
2	July 1985-June 1986	57	96.6%	24	46	44
	July 1986-June 1987	58	96.7%	26	57	54
4	July 1985-June 1986	54	91.5%	32	76	61
	July 1986-June 1987	59	98.3%	42	95	88

Source: Florida Power Corporation

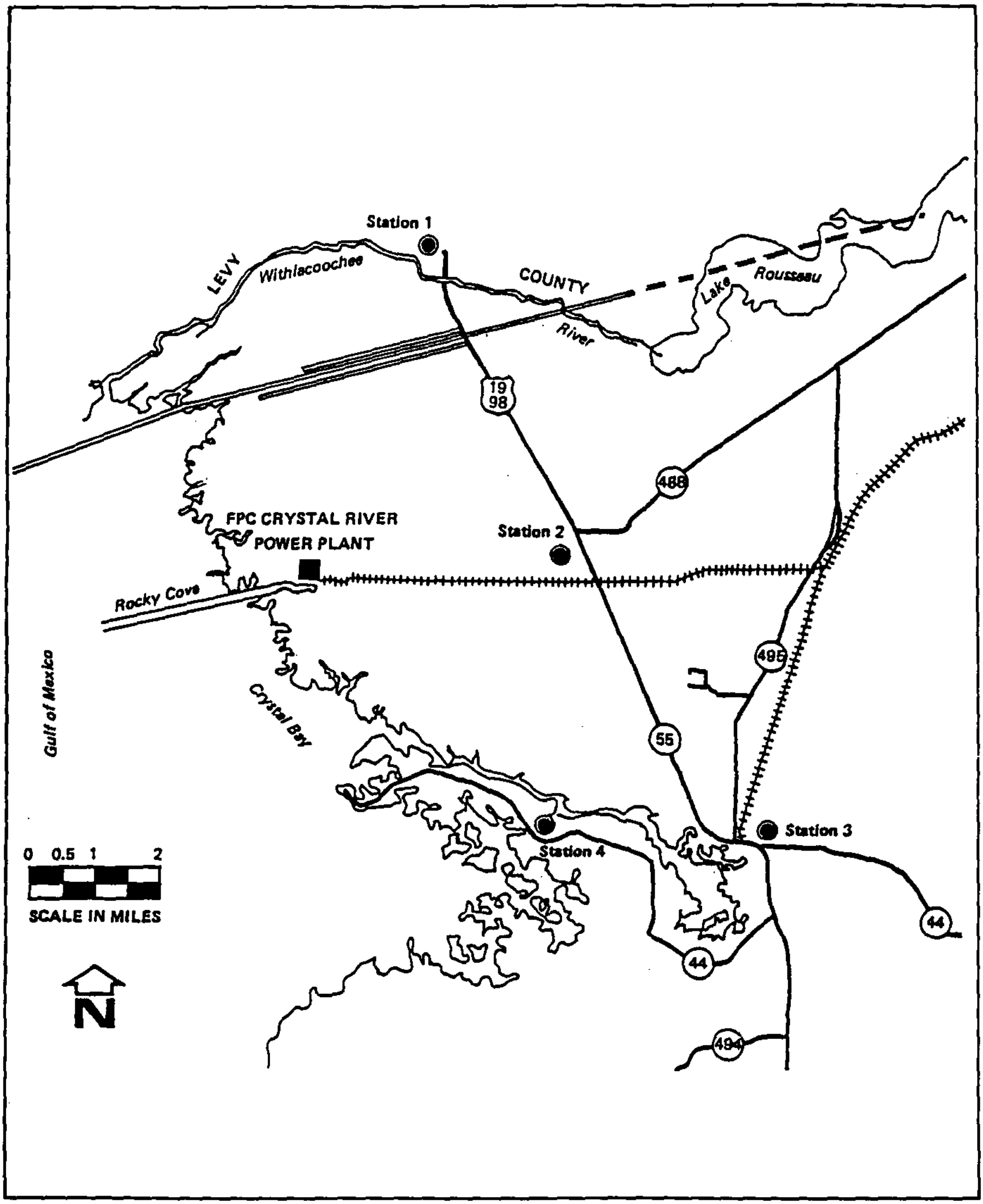

Figure 3-3. Locations of Ambient Air Monitoring Stations at Crystal River Power Plant

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background PM10 concentrations, the highest annual average and second highest 24-hour average TSP concentration reported for any period at the site was chosen. Based on this methodology, the annual average PM10 background concentration is 26 ug/m^3, and the 24-hour PM10 background concentration is 54 ug/m^3.

4.0 <u>AIR QUALITY ASSESSMENT RESULTS</u>

4.1 AAQS ANALYSIS

The results of the screening analysis for AAQS are presented in Table 4-1. The maximum annual and highest, second-highest 24-hour average predicted PM10 concentrations due to modeled sources only are 6.5 and 37.0 ug/m^3, respectively. When added to the background PM10 concentrations, total predicted PM10 concentrations are 33 ug/m^3, annual average and 91 ug/m^3, 24-hour average. Each of these predicted concentrations is well below the annual and 24-hour average PM10 AAQS of ~~60~~ 50 and 150 ug/m^3, respectively. Predicted impacts are much less than applicable PM10 AAQS, and therefore no refined modeling analysis was performed.

The modeling results presented herein are conservative because TSP emissions were modeled, and the resulting impacts are being compared to PM10 standards. Emissions from the proposed helper cooling towers were modeled for every hour of the year, even though they will operate no more than 180 days per year. In addition, the simulation of the helper cooling towers as a single point use, and the assumption of particle reflection at the ground surface, will cause over predictions of actual PM impacts.

4.2 PSD CLASS I ANALYSIS

The results of the PSD Class I modeling analysis are presented in Table 4-2. In this table predicted TSP impacts due to sources consuming PSD increment are compared to PSD Class I increments. The maximum annual and highest, second-highest 24-hour average predicted TSP concentrations are 0.12 ug/m^3 and 2.1 ug/m^3, respectively. Each of these predicted impacts are much less than the annual and 24-hour average PSD Class I increments of 5 ug/m^3 and 10 ug/m^3, respectively, for TSP. As a result of these low impacts, a refined modeling analysis was not necessary.

4.3 PSD CLASS II ANALYSIS

The results of the PSD Class II screening analysis are presented in Table 4-3. The maximum predicted annual and highest, second-highest

Table 4-1. Results of ISCST AAQS Screening Analysis

Year	PM10 Concentration Due to Modeled Sources (ug/m^3)	Receptor Location* Direction (degrees)	Receptor Location* Distance (km)	Julian Day	Background PM10 Concentration+ (ug/m^3)	Total PM10 Concentration (ug/m^3)	PM10 AAQS (ug/m^3)
Annual							
1982	6.4	230	0.950	--	26	32	50
1983	5.8	230	0.950	--	26	32	
1984	6.4	230	0.950	--	26	32	
1985	6.3	75	2.200	--	26	32	
1986	6.5	75	2.200	--	26	33	
24-Hour**							
1982	35.6	75	2.200	185	54	90	150
1983	33.9	60	1.700	257	54	88	
1984	36.7	80	2.200	224	54	91	
1985	37.0	75	2.200	152	54	91	
1986	35.7	75	2.200	213	54	90	

* Relative to location of Helper Cooling Towers.

** Highest, second-highest concentration reported for comparison to AAQS.

\+ Based upon measured TSP concentrations (refer to Section 3.5).

Table 4-2. Summary of PSD Class I Modeling Analysis Results

Year	TSP Concentration (ug/m^3)	Receptor Location* Direction (degrees)	Receptor Location* Distance (km)	Julian Day	PSD Class I Increment (ug/m^3)
Annual					
1982	0.08	175	21.2	--	5
1983	0.10	177	21.1	--	
1984	0.12	180	21.1	--	
1985	0.10	177	21.1	--	
1986	0.08	177	21.1	--	
24-Hour**					
1982	1.38	177	21.1	67	10
1983	1.30	172	21.3	167	
1984	1.53	180	21.1	342	
1985	1.15	180	21.1	279	
1986	2.08	155	23.3	56	

* Relative to location of Helper Cooling Towers.

** Highest, second-highest concentration reported for comparison to PSD Class I increment.

Table 4-3. Results of PSD Class II Screening Analysis

Year	TSP Concentration (ug/m^3)	Receptor Location* Direction (degrees)	Receptor Location* Distance (km)	Julian Day	PSD Class II Increment (ug/m^3)
Annual					
1982	4.6	230	0.950	--	19
1983	5.0	75	2.200	--	
1984	5.3	75	2.200	--	
1985	6.0	75	2.200	--	
1986	6.1	75	2.200	--	
24-Hour**					
1982	32.6	75	2.200	185	37
1983	32.6	50	1.700	220	
1984	35.8	80	2.200	224	
1985	34.5	75	2.200	152	
1986	32.6	45	1.550	205	

* Relative to location of Helper Cooling Towers.
** Highest, second-highest concentration reported for comparison to PSD Class II increments.

24-hour concentrations are 6.1 ug/$m^3$and 35.8 ug/m^3, respectively. The maximum annual impact is much less than the applicable PSD Class II increment of 19 ug/m^3 and, therefore, no refinements were performed. However, predicted 24-hour impacts for all modeled years are approaching the 24-hour PSD Class II increment of 37 ug/m^3. Therefore, a refined modeling analysis was performed to determine if predicted 24-hour concentrations could exceed PSD Class II increments if a finer receptor grid was used.

The results of the PSD Class II refined analysis are presented in Table 4-4. Although 100 m and 2-degree receptor spacing was used in the analysis, maximum concentrations or their locations did not change and predicted 24-hour concentrations remained in compliance with PSD Class II increments.

Table 4-4. Results of PSD Class II Refined Analysis

Year	24-Hour* Concentration (ug/m^3)	Receptor Location** Direction (degrees)	Receptor Location** Distance (km)	Julian Day	PSD Class II Increment (ug/m^3)
1982	32.6	75	2.200	185	37
1983	32.6	50	1.700	220	
1984	35.8	80	2.200	224	
1985	34.5	75	2.200	152	
1986	32.6	45	1.550	205	

* Highest, second-highest concentration reported for comparison to PSD Class II increments.
** Location relative to Helper Cooling Towers.

5.0 ADDITIONAL IMPACT ANALYSIS

5.1 IMPACTS UPON SOILS AND VEGETATION

The predicted ambient PM levels due to all PM sources operating at the Crystal River site, including the proposed Units 1, 2 and 3 helper cooling towers, are well below the AAQS for PM 10. These results are based upon all PM sources emitting PM at maximum rates. In addition, predicted ambient PM10 levels decrease considerably with distance beyond the FPC plant property boundaries. As a result, no significant impact upon vegetation and soils near to the site is expected to occur due to ambient PM levels.

Effects of deposition of salt particulate upon vegetation and soils in the vicinity of the site due to cooling tower emissions were addressed in a previous report (KBN, 1988). This study considered soil deposition due to Units 4 and 5 cooling towers as well as the Units 1, 2 and 3 helper cooling towers. The study concluded that there would result maximum deposition rates of 10 $g/m^2/yr$ or less offsite, and that no significant offsite effects on soils or vegetation would occur.

Maximum predicted PM impacts upon the Class I area (Chassahowitzka NWR) due to all increment consuming sources at Crystal River are predicted to be very low - less than 0.15 ug/m^3, annual average concentration, and less than 2.1 ug/m^3, maximum 24-hour average concentration. These levels are well below the AAQS and the Class I PSD increments, and well below levels which would cause impacts to vegetation or soils. Indeed, the natural background particulate concentration in the Class I area is expected to average 25 ug/m^3 or higher. This natural background level is more than 100 times greater than the average impacts due solely to the increment consuming sources of the FPC Crystal River facility.

5.2 IMPACTS UPON VISIBILITY

To evaluate the potential for visibility impairment in the Chassahowitzka Class I area due to the Units 1, 2 and 3 helper cooling towers, a Level-1 visibility screening analysis was performed. The recommended USEPA methodology for conducting a Level-1 analysis was followed (USEPA, 1980).

The total particulate emissions from the helper cooling towers (428.2 TPY or 2.38 tons/day at 180 day/yr operation) were considered in the screening model, even though most of these particles have large diameters and would fall out and not contribute to visibility impairment.

The results of the Level-1 visibility screening analysis are presented in Figure 5-1. As indicated, the three visibility parameters, C1, C2 and C3, are all well below the screening criteria of 0.1. As a result, no visibility impairment is predicted in the Class I area due to operation of the helper cooling towers.

5.3 Impacts Upon Growth

No significant impacts to growth in the area will occur as a result of construction and operation of the helper cooling towers. Construction workers and personnel will have a relatively small impact upon traffic in the area, but only during the construction period. During the operational period, only a few additional plant personnel will be required to support operation and maintenance of the cooling towers. This additional growth will be insignificant in terms of the total work force now at the Crystal River site.

VISIBILITY LEVEL-1 SCREENING MODEL

DEVELOPED BY:
KBN ENGINEERING AND APPLIED SCIENCES, INC.
JANUARY 1986

BASED UPON "WORKBOOK FOR ESTIMATING VISIBILITY IMPAIRMENT" (NOV. 1980)

FPC UNITS 1-3 HELPER COOLING TOWERS

UNITS 1-3 HELPE

INPUT PARAMETERS:

PARTICULATE MATTER EMISSION RATE	=	2.38	TONS/DAY
SULFUR DIOXIDE EMISSION RATE	=	0.00	TONS/DAY
NITROGEN OXIDES EMISSION RATE	=	0.00	TONS/DAY
BACKGROUND VISUAL RANGE	=	25.00	KM
DISTANCE TO CLASS I AREA	=	21.10	KM

CALCULATED PARAMETERS:

DISPERSION PARAMETER SIGMA Z	=	61.36	METERS
PLUME DISPERSION PARAMETER	=	154479.7	
OPTICAL THICKNESS (PARTICULATES)	=	0.33347	
OPTICAL THICKNESS (NOX)	=	0.00000	
OPTICAL THICKNESS (AEROSOL)	=	0.000572	

PLUME CONTRAST AGAINST THE SKY, C1	=	0.0000
PLUME CONTRAST AGAINST TERRAIN, C2	=	0.0760
CHANGE IN SKY/TERRAIN CONTRAST, C3	=	0.000210

THE ABSOLUTE VALUE OF C1,C2,AND C3 ARE ALL BELOW 0 .1

THE SOURCE HAS PASSED THE LEVEL-1 SCREENING ANALYSIS

Figure 5-1. Level - 1 Visibility Screening Analysis for Units 1, 2 and 3 Helper Cooling Towers

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APPENDIX A

AP-42 EMISSION FACTORS

11.2.3 AGGREGATE HANDLING AND STORAGE PILES

11.2.3.1 General

Inherent in operations that use minerals in aggregate form is the maintenance of outdoor storage piles. Storage piles are usually left uncovered, partially because of the need for frequent material transfer into or out of storage.

Dust emissions occur at several points in the storage cycle, during material loading onto the pile, during disturbances by strong wind currents, and during loadout from the pile. The movement of trucks and loading equipment in the storage pile area is also a substantial source of dust.

11.2.3.2 Emissions and Correction Parameters

The quantity of dust emissions from aggregate storage operations varies with the volume of aggregate passing through the storage cycle. Also, emissions depend on three correction parameters that characterize the condition of a particular storage pile: age of the pile, moisture content and proportion of aggregate fines.

When freshly processed aggregate is loaded onto a storage pile, its potential for dust emissions is at a maximum. Fines are easily disaggregated and released to the atmosphere upon exposure to air currents from aggregate transfer itself or high winds. As the aggregate weathers, however, potential for dust emissions is greatly reduced. Moisture causes aggregation and cementation of fines to the surfaces of larger particles. Any significant rainfall soaks the interior of the pile, and the drying process is very slow.

Field investigations have shown that emissions from aggregate storage operations vary in direct proportion to the percentage of silt (particles $< 75\ \mu m$ in diameter) in the aggregate material.[1 3] The silt content is determined by measuring the proportion of dry aggregate material that passes through a 200 mesh screen, using ASTM-C-136 method. Table 11.2.3-1 summarizes measured silt and moisture values for industrial aggregate materials.

11.2.3.3 Predictive Emission Factor Equations

Total dust emissions from aggregate storage piles are contributions of several distinct source activities within the storage cycle:

1. Loading of aggregate onto storage piles (batch or continuous drop operations).
2. Equipment traffic in storage area.
3. Wind erosion of pile surfaces and ground areas around piles.
4. Loadout of aggregate for shipment or for return to the process stream (batch or continuous drop operations).

TABLE 11.2.3-1. TYPICAL SILT AND MOISTURE CONTENT VALUES OF MATERIALS AT VARIOUS INDUSTRIES

Industry	Material	Silt (%)			Moisture (%)		
		No. of test samples	Range	Mean	No. of test samples	Range	Mean
Iron and steel production[a]	Pellet ore	10	1.4 - 13	4.9	8	0.64 - 3.5	2.1
	Lump ore	9	2.8 - 19	9.5	6	1.6 - 8.1	5.4
	Coal	7	2 - 7.7	5	6	2.8 - 11	4.8
	Slag	3	3 - 7.3	5.3	3	0.25 - 2.2	0.92
	Flue dust	2	14 - 23	18.0	0	NA	NA
	Coke breeze	1		5.4	1		6.4
	Blended ore	1		15.0	1		6.6
	Sinter	1		0.7	0	NA	NA
	Limestone	1		0.4	0	NA	NA
Stone quarrying and processing[b]	Crushed limestone	2	1.3 - 1.9	1.6	2	0.3 - 1.1	0.7
Taconite mining and processing[c]	Pellets	9	2.2 - 5.4	3.4	7	0.05 - 2.3	0.96
	Tailings	2	NA	11.0	1		0.35
Western surface coal mining[d]	Coal	15	3.4 - 16	6.2	7	2.8 - 20	6.9
	Overburden	15	3.8 - 15	7.5	0	NA	NA
	Exposed ground	3	5.1 - 21	15.0	3	0.8 - 6.4	3.4

[a] References 2-5. NA = not applicable.
[b] Reference 1.
[c] Reference 6.
[d] Reference 7.

Adding aggregate material to a storage pile or removing it usually involves dropping the material onto a receiving surface. Truck dumping on the pile or loading out from the pile to a truck with a front end loader are examples of batch drop operations. Adding material to the pile by a conveyor stacker is an example of a continuous drop operation.

The quantity of particulate emissions generated by a batch drop operation, per ton of material transferred, may be estimated, with a rating of C, using the following empirical expression[2]:

$$E = k(0.00090)\ \frac{\left(\frac{s}{5}\right)\left(\frac{U}{2.2}\right)\left(\frac{H}{1.5}\right)}{\left(\frac{M}{2}\right)^{2}\left(\frac{Y}{4.6}\right)^{0.33}} \quad (\text{kg/Mg}) \qquad (1)$$

$$E = k(0.0018)\ \frac{\left(\frac{s}{5}\right)\left(\frac{U}{5}\right)\left(\frac{H}{5}\right)}{\left(\frac{M}{2}\right)^{2}\left(\frac{Y}{6}\right)^{0.33}} \quad (\text{lb/ton})$$

where: E = emission factor
k = particle size multipler (dimensionless)
s = material silt content (%)
U = mean wind speed, m/s (mph)
H = drop height, m (ft)
M = material moisture content (%)
Y = dumping device capacity, m^3 (yd^3)

The particle size multipler (k) for Equation 1 varies with aerodynamic particle size, shown in Table 11.2.3-2.

TABLE 11.2.3-2. AERODYNAMIC PARTICLE SIZE MULTIPLIER (k) FOR EQUATIONS 1 AND 2

Equation	< 30 µm	< 15 µm	< 10 µm	< 5 µm	< 2.5 µm
Batch drop	0.73	0.48	0.36	0.23	0.13
Continuous drop	0.77	0.49	0.37	0.21	0.11

The quantity of particulate emissions generated by a continuous drop operation, per ton of material transferred, may be estimated, with a rating of C, using the following empirical expression[3]:

$$E = k(0.00090) \frac{\left(\frac{s}{5}\right)\left(\frac{U}{2.2}\right)\left(\frac{H}{3.0}\right)}{\left(\frac{M}{2}\right)^2} \quad (kg/Mg) \qquad (2)$$

$$E = k(0.0018) \frac{\left(\frac{s}{5}\right)\left(\frac{U}{5}\right)\left(\frac{H}{10}\right)}{\left(\frac{M}{2}\right)^2} \quad (lb/ton)$$

where: E = emission factor
k = particle size multiplier (dimensionless)
s = material silt content (%)
U = mean wind speed, m/s (mph)
H = drop height, m (ft)
M = material moisture content (%)

The particle size multiplier (k) for Equation 2 varies with aerodynamic particle size, as shown in Table 11.2.3-2.

Equations 1 and 2 retain the assigned quality rating if applied within the ranges of source conditions that were tested in developing the equations, as given in Table 11.2.3-3. Also, to retain the quality ratings of Equations 1 or 2 applied to a specific facility, it is necessary that reliable correction parameters be determined for the specific sources of interest. The field and laboratory procedures for aggregate sampling are given in Reference 3. In the event that site specific values for correction parameters cannot be obtained, the appropriate mean values from Table 11.2.3-1 may be used, but in that case, the quality ratings of the equations are reduced by one level.

TABLE 11.2.3-3. RANGES OF SOURCE CONDITIONS FOR EQUATIONS 1 AND 2[a]

Equation	Silt content (%)	Moisture content (%)	Dumping capacity m^3	Dumping capacity yd^3	Drop height m	Drop height ft
Batch drop	1.3 - 7.3	0.25 - 0.70	2.10 - 7.6	2.75 - 10	NA	NA
Continuous drop	1.4 - 19	0.64 - 4.8	NA	NA	1.5 - 12	4.8 - 39

[a] NA = not applicable.

For emissions from equipment traffic (trucks, front end loaders, dozers, etc.) traveling between or on piles, it is recommended that the equations for vehicle traffic on unpaved surfaces be used (see Section 11.2.1). For vehicle travel between storage piles, the silt value(s) for the areas among the piles (which may differ from the silt values for the stored materials) should be used.

For emissions from wind erosion of active storage piles, the following total suspended particulate (TSP) emission factor equation is recommended:

$$E = 1.9 \left(\frac{s}{1.5}\right) \left(\frac{365-p}{235}\right) \left(\frac{f}{15}\right) \text{ (kg/day/hectare)} \qquad (3)$$

$$E = 1.7 \left(\frac{s}{1.5}\right) \left(\frac{365-p}{235}\right) \left(\frac{f}{15}\right) \text{ (lb/day/acre)}$$

where: E = total suspended particulate emission factor
s = silt content of aggregate (%)
p = number of days with ≧ 0.25 mm (0.01 in.) of precipitation per year
f = percentage of time that the unobstructed wind speed exceeds 5.4 m/s (12 mph) at the mean pile height

The coefficient in Equation 3 is taken from Reference 1, based on sampling of emissions from a sand and gravel storage pile area during periods when transfer and maintenance equipment was not operating. The factor from Test Report 1, expressed in mass per unit area per day, is more reliable than the factor expressed in mass per unit mass of material placed in storage, for reasons stated in that report. Note that the coefficient has been halved to adjust for the estimate that the wind speed through the emission layer at the test site was one half of the value measured above the top of the piles. The other terms in this equation were added to correct for silt, precipitation and frequency of high winds, as discussed in Reference 2. Equation 3 is rated C for application in the sand and gravel industry and D for other industries.

Worst case emissions from storage pile areas occur under dry windy conditions. Worst case emissions from materials handling (batch and continuous drop) operations may be calculated by substituting into Equations 1 and 2 appropriate values for aggregate material moisture content and for anticipated wind speeds during the worst case averaging period, usually 24 hours. The treatment of dry conditions for vehicle traffic (Section 11.2.1) and for wind erosion (Equation 3), centering around parameter p, follows the methodology described in Section 11.2.1. Also, a separate set of nonclimatic correction parameters and source extent values corresponding to higher than normal storage pile activity may be justified for the worst case averaging period.

11.2.3.4 Control Methods

Watering and chemical wetting agents are the principal means for control of aggregate storage pile emissions. Enclosure or covering of inactive piles to reduce wind erosion can also reduce emissions. Watering is useful mainly to reduce emissions from vehicle traffic in the storage pile area. Watering of the storage piles themselves typically has only a very temporary slight effect on total emissions. A much more effective technique is to apply chemical wetting agents for better wetting of fines and longer retention of the moisture film. Continuous chemical treatment of material loaded onto piles, coupled with watering or treatment of roadways, can reduce total particulate emissions from aggregate storage operations by up to 90 percent.[8]

References for Section 11.2.3

1. C. Cowherd, Jr., et al., Development of Emission Factors for Fugitive Dust Sources, EPA-450/3-74-037, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1974.

2. R. Bohn, et al., Fugitive Emissions from Integrated Iron and Steel Plants, EPA-600/2-78-050, U. S. Environmental Protection Agency, Research Triangle Park, NC, March 1978.

3. C. Cowherd, Jr., et al., Iron and Steel Plant Open Dust Source Fugitive Emission Evaluation, EPA-600/2-79-103, U. S. Environmental Protection Agency, Research Triangle Park, NC, May 1979.

4. R. Bohn, Evaluation of Open Dust Sources in the Vicinity of Buffalo, New York, U. S. Environmental Protection Agency, New York, NY, March 1979.

5. C. Cowherd, Jr., and T. Cuscino, Jr., Fugitive Emissions Evaluation, Equitable Environmental Health, Inc., Elmhurst, IL, February 1977.

6. T. Cuscino, et al., Taconite Mining Fugitive Emissions Study, Minnesota Pollution Control Agency, Roseville, MN, June 1979.

7. K. Axetell and C. Cowherd, Jr., Improved Emission Factors for Fugitive Dust from Western Surface Coal Mining Sources, 2 Volumes, EPA Contract No. 68-03-2924, PEDCo Environmental, Inc., Kansas City, MO, July 1981.

8. G. A. Jutze, et al., Investigation of Fugitive Dust Sources Emissions and Control, EPA-450/3-74-036a, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1974.

11.2.1 UNPAVED ROADS

11.2.1.1 General

Dust plumes trailing behind vehicles traveling on unpaved roads are a familiar sight in rural areas of the United States. When a vehicle travels an unpaved road, the force of the wheels on the road surface causes pulverization of surface material. Particles are lifted and dropped from the rolling wheels, and the road surface is exposed to strong air currents in turbulent shear with the surface. The turbulent wake behind the vehicle continues to act on the road surface after the vehicle has passed.

11.2.1.2 Emissions And Correction Parameters

The quantity of dust emissions from a given segment of unpaved road varies linearly with the volume of traffic. Also, field investigations have shown that emissions depend on correction parameters (average vehicle speed, average vehicle weight, average number of wheels per vehicle, road surface texture and road surface moisture) that characterize the condition of a particular road and the associated vehicle traffic.[1-4]

Dust emissions from unpaved roads have been found to vary in direct proportion to the fraction of silt (particles smaller than 75 micrometers in diameter) in the road surface materials.[1] The silt fraction is determined by measuring the proportion of loose dry surface dust that passes a 200 mesh screen, using the ASTM-C-136 method. Table 11.2.1-1 summarizes measured silt values for industrial and rural unpaved roads.

The silt content of a rural dirt road will vary with location, and it should be measured. As a conservative approximation, the silt content of the parent soil in the area can be used. However, tests show that road silt content is normally lower than in the surrounding parent soil, because the fines are continually removed by the vehicle traffic, leaving a higher percentage of coarse particles.

Unpaved roads have a hard nonporous surface that usually dries quickly after a rainfall. The temporary reduction in emissions because of precipitation may be accounted for by not considering emissions on "wet" days (more than 0.254 millimeters [0.01 inches] of precipitation).

The following empirical expression may be used to estimate the quantity of size specific particulate emissions from an unpaved road, per vehicle kilometer traveled (VKT) or vehicle mile traveled (VMT), with a rating of A:

$$E = k(1.7)\left(\frac{s}{12}\right)\left(\frac{S}{48}\right)\left(\frac{W}{2.7}\right)^{0.7}\left(\frac{w}{4}\right)^{0.5}\left(\frac{365-p}{365}\right) \quad (\text{kg/VKT}) \qquad (1)$$

$$E = k(5.9)\left(\frac{s}{12}\right)\left(\frac{S}{30}\right)\left(\frac{W}{3}\right)^{0.7}\left(\frac{w}{4}\right)^{0.5}\left(\frac{365-p}{365}\right) \quad (\text{lb/VMT})$$

TABLE 11.2.1-1. TYPICAL SILT CONTENT VALUES OF SURFACE MATERIALS ON INDUSTRIAL AND RURAL UNPAVED ROADS[a]

Industry	Road Use Or Surface Material	Plant Sites	Test Samples	Silt (%, w/w)	
				Range	Mean
Copper smelting	Plant road	1	3	[15.9 - 19.1]	[17.0]
Iron and steel production	Plant road	9	20	4.0 - 16.0	8.0
Sand and gravel processing	Plant road	1	3	[4.1 - 6.0]	[4.8]
Stone quarrying and processing	Plant road	1	5	[10.5 - 15.6]	[14.1]
Taconite mining and processing	Haul road	1	12	[3.7 - 9.7]	[5.8]
	Service road	1	8	[2.4 - 7.1]	[4.3]
Western surface coal mining	Access road	2	2	4.9 - 5.3	5.1
	Haul road	3	21	2.8 - 18	8.4
	Scraper road	3	10	7.2 - 25	17
	Haul road (freshly graded)	2	5	18 - 29	24
Rural roads	Gravel	1	1	NA	[5.0]
	Dirt	2	5	5.8 - 68	28.5
	Crushed limestone	2	8	7.7 - 13	9.6

[a]References 4 - 11. Brackets indicate silt values based on samples from only one plant site.
NA = Not available.

where: E = emission factor
k = particle size multiplier (dimensionless)
s = silt content of road surface material (%)
S = mean vehicle speed, km/hr (mph)
W = mean vehicle weight, Mg (ton)
w = mean number of wheels
p = number of days with at least 0.254 mm (0.01 in.) of precipitation per year

The particle size multiplier, k, in Equation 1 varies with aerodynamic particle size range as follows:

Aerodynamic Particle Size Multiplier For Equation 1

$\leq 30\ \mu m$	$\leq 15\ \mu m$	$\leq 10\ \mu m$	$\leq 5\ \mu m$	$\leq 2.5\ \mu m$
0.80	0.50	0.36	0.20	0.095

The number of wet days per year, p, for the geographical area of interest should be determined from local climatic data. Figure 11.2.1-1 gives the geographical distribution of the mean annual number of wet days per year in the United States.

Equation 1 retains the assigned quality rating if applied within the ranges of source conditions that were tested in developing the equation, as follows:

RANGES OF SOURCE CONDITIONS FOR EQUATION 1

Equation	Road silt content (%, w/w)	Mean vehicle weight		Mean vehicle speed		Mean no. of wheels
		Mg	ton	km/hr	mph	
1	4.3 - 20	2.7 - 142	3 - 157	21 - 64	13 - 40	4 - 13

Also, to retain the quality rating of the equation applied to a specific unpaved road, it is necessary that reliable correction parameter values for the specific road in question be determined. The field and laboratory procedures for determining road surface silt content are given in Reference 4. In the event that site specific values for correction parameters cannot be obtained, the appropriate mean values from Table 11.2.1-1 may be used, but the quality rating of the equation is reduced to B.

Equation 1 was developed for calculation of annual average emissions, and thus, is to be multiplied by annual vehicle distance traveled (VDT). Annual average values for each of the correction parameters are to be substituted into

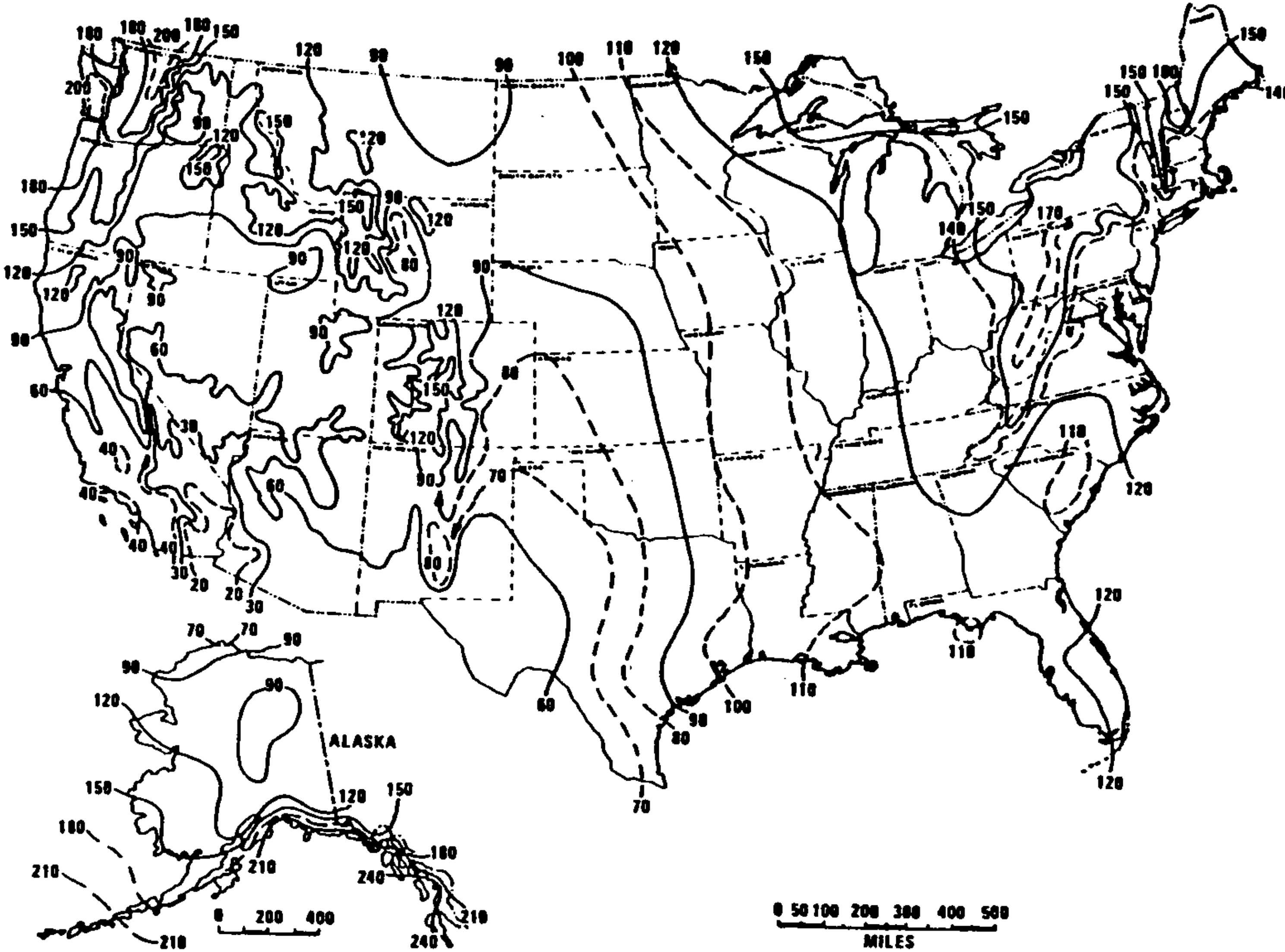

Figure 11.2.1-1. Mean number of days with 0.01 inch or more of precipitation in United States.[10]

the equation. Worst case emissions, corresponding to dry road conditions, may be calculated by setting p = 0 in the equation (which is equivalent to dropping the last term from the equation). A separate set of nonclimatic correction parameters and a higher than normal VDT value may also be justified for the worst case averaging period (usually 24 hours). Similarly, to calculate emissions for a 91 day season of the year using Equation 1, replace the term (365-p)/365 with the term (91-p)/91, and set p equal to the number of wet days in the 91 day period. Also, use appropriate seasonal values for the nonclimatic correction parameters and for VDT.

11.2.1.3 Control Methods

Common control techniques for unpaved roads are paving, surface treating with penetration chemicals, working into the roadbed of chemical stabilization chemicals, watering, and traffic control regulations. Chemical stabilizers work either by binding the surface material or by enhancing moisture retention. Paving, as a control technique, is often not economically practical. Surface chemical treatment and watering can be accomplished with moderate to low costs, but frequent retreatments are required. Traffic controls, such as speed limits and traffic volume restrictions, provide moderate emission reductions but may be difficult to enforce. The control efficiency obtained by speed reduction can be calculated using the predictive emission factor equation given above.

The control efficiencies achievable by paving can be estimated by comparing emission factors for unpaved and paved road conditions, relative to airborne particle size range of interest. The predictive emission factor equation for paved roads, given in Section 11.2.6, requires estimation of the silt loading on the traveled portion of the paved surface, which in turn depends on whether the pavement is periodically cleaned. Unless curbing is to be installed, the effects of vehicle excursion onto shoulders (berms) also must be taken into account in estimating control efficiency.

The control efficiencies afforded by the periodic use of road stabilization chemicals are much more difficult to estimate. The application parameters which determine control efficiency include dilution ratio, application intensity (mass of diluted chemical per road area) and application frequency. Between applications, the control efficiency is usually found to decay at a rate which is proportional to the traffic count. Therefore, for a specific chemical application program, the average efficiency is inversely proportional to the average daily traffic count. Other factors that affect the performance of chemical stabilizers include vehicle characteristics (e. g., average weight) and road characteristics (e. g., bearing strength).

Water acts as a road dust suppressant by forming cohesive moisture films among the discrete grains of road surface material. The average moisture level in the road surface material depends on the moisture added by watering and natural precipitation and on the moisture removed by evaporation. The natural evaporative forces, which vary with geographic location, are enhanced by the movement of traffic over the road surface. Watering, because of the frequency of treatments required, is generally not feasible for public roads and is used effectively only where water and watering equipment are available and where roads are confined to a single site, such as a construction location.

References for Section 11.2.1

1. C. Cowherd, Jr., et al., Development of Emission Factors for Fugitive Dust Sources, EPA-450/3-74-037, U. S. Environmental Protection Agency, Research Triangle Park, NC, June 1974.

2. R. J. Dyck and J. J. Stukel, "Fugitive Dust Emissions from Trucks on Unpaved Roads", Environmental Science and Technology, 10(10):1046-1048, October 1976.

3. R. O. McCaldin and K. J. Heidel, "Particulate Emissions from Vehicle Travel over Unpaved Roads", Presented at the 71st Annual Meeting of the Air Pollution Control Association, Houston, TX, June 1978.

4. C. Cowherd, Jr., et al., Iron and Steel Plant Open Dust Source Fugitive Emission Evaluation, EPA-600/2-79-103, U. S. Environmental Protection Agency, Research Triangle Park, NC, May 1979.

5. R. Bohn, et al., Fugitive Emissions from Integrated Iron and Steel Plants, EPA-600/2-78-050, U. S. Environmental Protection Agency, Research Triangle Park, NC, March 1978.

6. R. Bohn, Evaluation of Open Dust Sources in the Vicinity of Buffalo, New York, U. S. Environmental Protection Agency, New York, NY, March 1979.

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8. T. Cuscino, Jr., et al., Taconite Mining Fugitive Emissions Study, Minnesota Pollution Control Agency, Roseville, MN, June 1979.

9. K. Axetell and C. Cowherd, Jr., Improved Emission Factors for Fugitive Dust from Western Surface Coal Mining Sources, 2 Volumes, EPA Contract No. 68-03-2924, PEDCo Environmental, Inc., Kansas City, MO, July 1981.

10. T. Cuscino, Jr., et al., Iron and Steel Plant Open Source Fugitive Emission Control Evaluation, EPA-600/2-83-110, U. S. Environmental Protection Agency, Research Triangle Park, NC, October 1983.

11. J. Patrick Reider, Size Specific Emission Factors for Uncontrolled Industrial and Rural Roads, EPA Contract No. 68-02-3158, Midwest Research Institute, Kansas City, MO, September 1983.

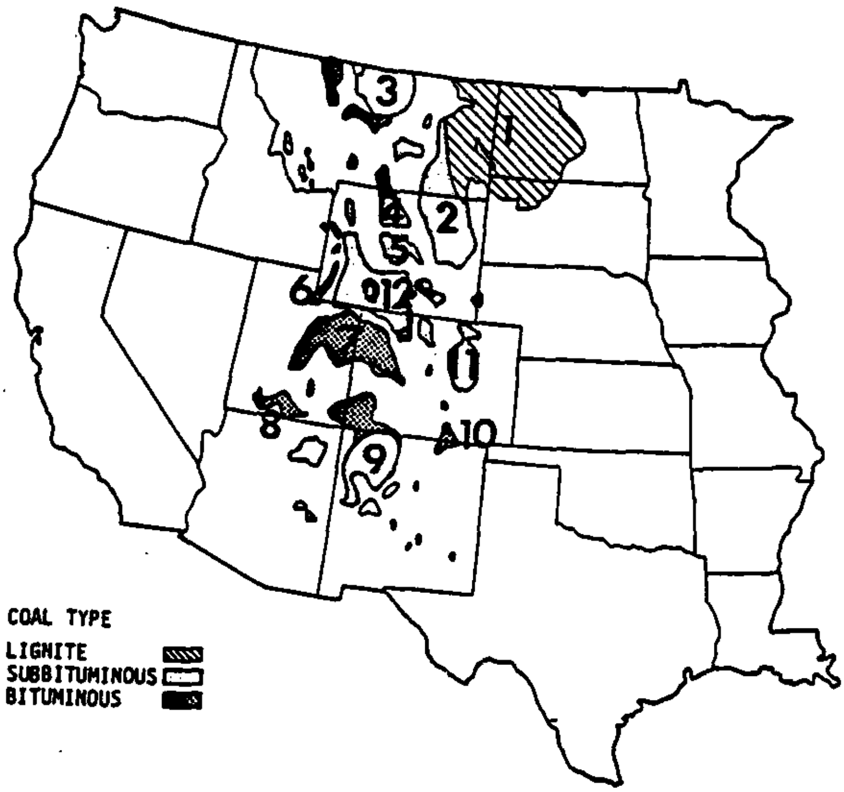
12. C. Cowherd, Jr., and P. Englehart, Size Specific Particulate Emission Factors for Industrial and Rural Roads, EPA-600/7-85-038, U. S. Environmental Protection Agency, Research Triangle Park, NC, September 1985.

13. Climatic Atlas of the United States, U. S. Department of Commerce, Washington, DC, June 1968.

8.24 WESTERN SURFACE COAL MINING

8.24.1 General[1]

There are 12 major coal fields in the western states (excluding the Pacific Coast and Alaskan fields), as shown in Figure 8.24-1. Together, they account for more than 64 percent of the surface minable coal reserves



	Coal field	Strippable reserves (10^6 tons)
1	Fort Union	23,529
2	Powder River	56,727
3	North Central	All underground
4	Bighorn Basin	All underground
5	Wind River	3
6	Hams Fork	1,000
7	Uinta	308
8	Southwestern Utah	224
9	San Juan River	2,318
10	Raton Mesa	All underground
11	Denver	All underground
12	Green River	2,120

Figure 8.24-1. Coal fields of the western U.S.[3]

in the United States.[2] The 12 coal fields have varying characteristics which may influence fugitive dust emission rates from mining operations, including overburden and coal seam thicknesses and structure, mining equipment, operating procedures, terrain, vegetation, precipitation and surface moisture, wind speeds and temperatures. The operations at a typical western surface mine are shown in Figure 8.24-2. All operations that involve movement of soil, coal, or equipment, or exposure of erodible surfaces, generate some amount of fugitive dust.

The initial operation is removal of topsoil and subsoil with large scrapers. The topsoil is carried by the scrapers to cover a previously mined and regraded area as part of the reclamation process or is placed in temporary stockpiles. The exposed overburden, the earth which is between the topsoil and the coal seam, is leveled, drilled and blasted. Then the overburden material is removed down to the coal seam, usually by a dragline or a shovel and truck operation. It is placed in the adjacent mined cut, forming a spoils pile. The uncovered coal seam is then drilled and blasted. A shovel or front end loader loads the broken coal into haul trucks, and it is taken out of the pit along graded haul roads to the tipple, or truck dump. Raw coal sometimes may be dumped onto a temporary storage pile and later rehandled by a front end loader or bulldozer.

At the tipple, the coal is dumped into a hopper that feeds the primary crusher, then is conveyed through additional coal preparation equipment such as secondary crushers and screens to the storage area. If the mine has open storage piles, the crushed coal passes through a coal stacker onto the pile. The piles, usually worked by bulldozers, are subject to wind erosion. From the storage area, the coal is conveyed to a train loading facility and is put into rail cars. At a captive mine, coal will go from the storage pile to the power plant.

During mine reclamation, which proceeds continuously throughout the life of the mine, overburden spoils piles are smoothed and contoured by bulldozers. Topsoil is placed on the graded spoils, and the land is prepared for revegetation by furrowing, mulching, etc. From the time an area is disturbed until the new vegetation emerges, all disturbed areas are subject to wind erosion.

8.24.2 Emissions

Predictive emission factor equations for open dust sources at western surface coal mines are presented in Tables 8.24-1 and 8.24-2. Each equation is for a single dust generating activity, such as vehicle traffic on unpaved roads. The predictive equation explains much of the observed variance in emission factors by relating emissions to three sets of source parameters: 1) measures of source activity or energy expended (e.g., speed and weight of a vehicle traveling on an unpaved road); 2) properties of the material being disturbed (e.g., suspendable fines in the surface material of an unpaved road); and 3) climate (in this case, mean wind speed).

The equations may be used to estimate particulate emissions generated per unit of source extent (e.g., vehicle distance traveled or mass of material transferred).

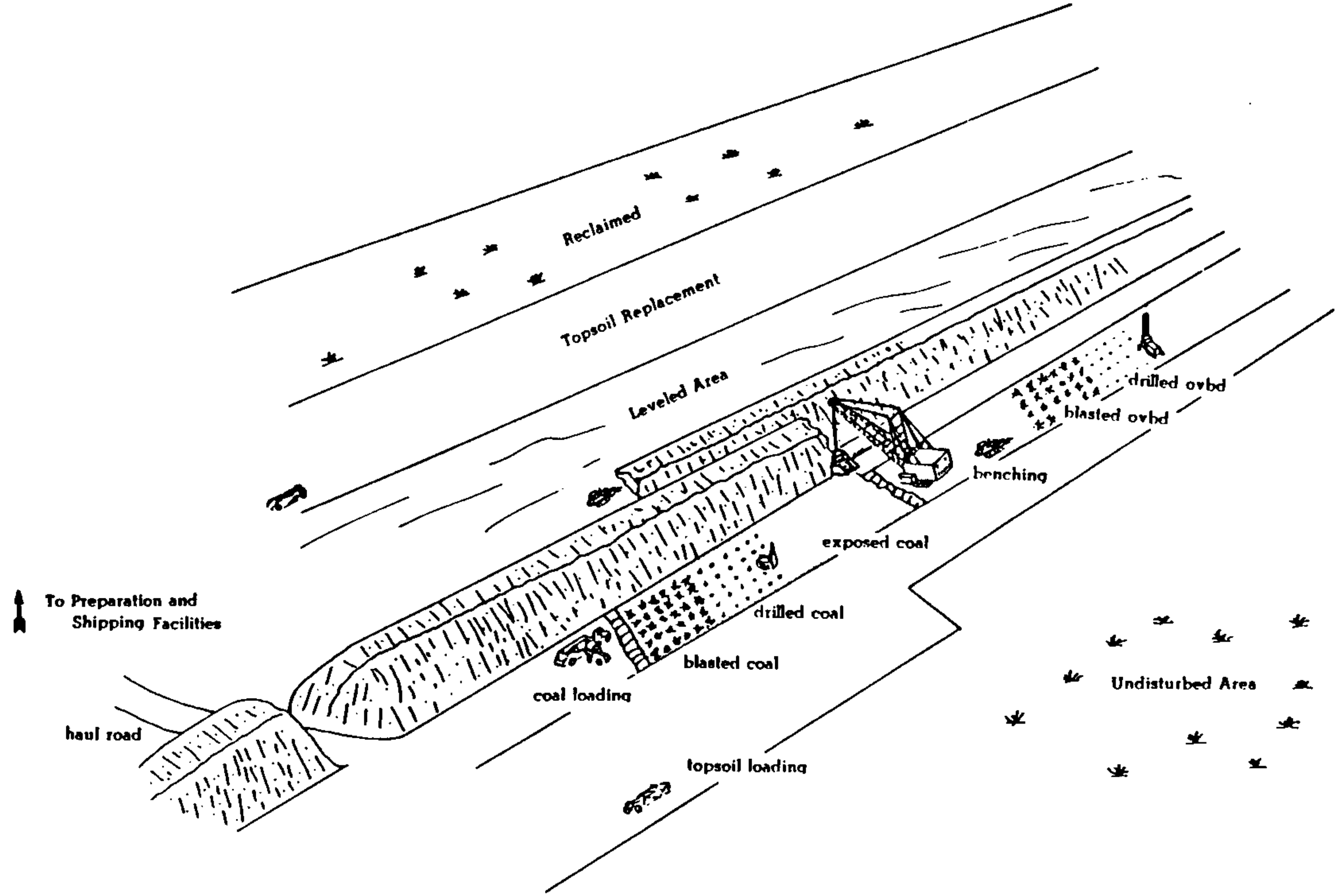


Figure 8.24-2. Operations at typical western surface coal mines.

TABLE 8.24-1. EMISSION FACTOR EQUATIONS FOR UNCONTROLLED OPEN DUST SOURCES AT WESTERN SURFACE COAL MINES (METRIC UNITS)[a]

Operation	Material	Emissions by particle size range (aerodynamic diameter)[b,c]			Units	Emission Factor Rating
		TSP < 30um	< 15um	< 2.5 um/TSP[d]		
Truck loading	Coal	$\frac{0.580}{(M)^{1.2}}$	$\frac{0.0596}{(M)^{0.9}}$	0.019	kg/Mg	B
Bulldozing	Coal	$\frac{35.6\ (s)^{1.2}}{(M)^{1.3}}$	$\frac{8.44\ (s)^{1.5}}{(M)^{1.4}}$	0.022	kg/hr	B
	Overburden	$\frac{2.6\ (s)^{1.2}}{(M)^{1.3}}$	$\frac{0.45\ (s)^{1.5}}{(M)^{1.4}}$	0.105	kg/hr	B
Dragline	Overburden	$\frac{0.0046\ (d)^{1.1}}{(M)^{0.3}}$	$\frac{0.0029\ (d)^{0.7}}{(M)^{0.3}}$	0.017	kg/m^3	B
Scraper (travel mode)		$9.6 \times 10^{-6}\ (s)^{1.3}\ (W)^{2.4}$	$2.2 \times 10^{-6}\ (s)^{1.4}\ (W)^{2.5}$	0.026	kg/VKT	A
Grading		$0.0034\ (S)^{2.5}$	$0.0056\ (S)^{2.0}$	0.031	kg/VKT	B
Vehicle traffic (light/medium duty)		$\frac{1.63}{(M)^{4.0}}$	$\frac{1.05}{(M)^{4.3}}$	0.040	kg/VKT	B
Haul truck		$0.0019\ (w)^{3.4}\ (L)^{0.2}$	$0.0014\ (w)^{3.5}$	0.017	kg/VKT	A
Active storage pile (wind erosion and maintenance)	Coal	1.8 u	NA	NA	$\frac{kg}{(hectare)(hr)}$	C[e]

[a]All equations are from Reference 1, except for coal storage pile equation from Reference 4. TSP = total suspended particulate. VKT = vehicle kilometers traveled. NA = not available.
[b]TSP denotes what is measured by a standard high volume sampler (see Section 11.2).
[c]Symbols for equations:

M = material moisture content (%)	W = mean vehicle weight (Mg)
s = material silt content (%)	S = mean vehicle speed (kph)
u = wind speed (m/sec)	w = mean number of wheels
d = drop height (m)	L = road surface silt loading (g/m^2)

[d]Multiply the TSP predictive equation by this fraction to determine emissions in the <2.5 m size range.
[e]Rating applicable to Mine Types I, II and IV (see Tables 8.24-5 and 8.24-6).

TABLE 8.24-2. EMISSION FACTOR EQUATIONS FOR UNCONTROLLED OPEN DUST SOURCES AT WESTERN SURFACE COAL MINES (ENGLISH UNITS)[a]

Operation	Material	Emissions by particle size range (aerodynamic diameter)[b,c]			Units	Emission Factor Rating
		TSP < 30um	< 15um	< 2.5um/TSP[d]		
Truck loading	Coal	$\frac{1.16}{(M)^{1.2}}$	$\frac{0.119}{(M)^{0.9}}$	0.019	lb/ton	B
Bulldozing	Coal	$\frac{78.4\ (s)^{1.2}}{(M)^{1.3}}$	$\frac{18.6\ (s)^{1.5}}{(M)^{1.4}}$	0.022	lb/hr	B
	Overburden	$\frac{5.7\ (s)^{1.2}}{(M)^{1.3}}$	$\frac{1.0\ (s)^{1.5}}{(M)^{1.4}}$	0.105	lb/hr	B
Dragline	Overburden	$\frac{0.0021\ (d)^{1.1}}{(M)^{0.3}}$	$\frac{0.0021\ (d)^{0.7}}{(M)^{0.3}}$	0.017	lb/yd^3	B
Scraper (travel model)		$2.7 \times 10^{-5}\ (s)^{1.3}\ (W)^{2.4}$	$6.2 \times 10^{-6}\ (s)^{1.4}\ (W)^{2.5}$	0.026	lb/VMT	A
Grading		$0.040\ (S)^{2.5}$	$0.051\ (S)^{2.0}$	0.031	lb/VMT	B
Vehicle traffic (light/medium duty)		$\frac{5.79}{(M)^{4.0}}$	$\frac{3.72}{(M)^{4.3}}$	0.040	lb/VMT	B
Haul truck		$0.0067\ (w)^{3.4}\ (L)^{0.2}$	$0.0051\ (w)^{3.5}$	0.017	lb/VMT	A
Active storage pile (wind erosion and maintenance)	Coal	1.6 u	NA	NA	$\frac{lb}{(acre)(hr)}$	C[e]

[a] All equations are from Reference 1, except for coal storage pile equation from Reference 4. TSP = total suspended particulate. VMT = vehicle miles traveled. NA = not available.

[b] TSP denotes what is measured by a standard high volume sampler (see Section 11.2).

[c] Symbols for equations:

- M = material moisture content (%)
- s = material silt content (%)
- u = wind speed (m/sec)
- d = drop height (ft)
- W = mean vehicle weight (tons)
- S = mean vehicle speed (mph)
- w = mean number of wheels
- L = road surface silt loading (g/m^2)

[d] Multiply the TSP predictive equation by this fraction to determine emissions in the < 2.5um size range.

[e] Rating applicable to Mine Types I, II and IV (see Tables 8.24-5 and 8.24-6).

The equations were developed through field sampling of various western surface mine types and are thus applicable to any of the surface coal mines located in the western United States.

In Tables 8.24-1 and 8.24-2, the assigned quality ratings apply within the ranges of source conditions that were tested in developing the equations, given in Table 8.24-3. However, the equations are derated one letter value (e. g., A to B) if applied to eastern surface coal mines.

TABLE 8.24-3. TYPICAL VALUES FOR CORRECTION FACTORS APPLICABLE TO THE PREDICTIVE EMISSION FACTOR EQUATIONS[a]

Source	Correction factor	Number of test samples	Range	Geometric mean	Units
Coal loading	Moisture	7	6.6 - 38	17.8	%
Bulldozers					
Coal	Moisture	3	4.0 - 22.0	10.4	%
	Silt	3	6.0 - 11.3	8.6	%
Overburden	Moisture	8	2.2 - 16.8	7.9	%
	Silt	8	3.8 - 15.1	6.9	%
Dragline	Drop distance	19	1.5 - 30	8.6	m
	" "		5 - 100	28.1	ft
	Moisture	7	0.2 - 16.3	3.2	%
Scraper	Silt	10	7.2 - 25.2	16.4	%
	Weight	15	33 - 64	48.8	Mg
	"		36 - 70	53.8	ton
Grader	Speed	7	8.0 - 19.0	11.4	kph
	"		5.0 - 11.8	7.1	mph
Light/medium duty vehicle	Moisture	7	0.9 - 1.7	1.2	%
Haul truck	Wheels	29	6.1 - 10.0	8.1	number
	Silt loading	26	3.8 - 254	40.8	g/m^2
	" "		34 - 2270	364	lb/ac

[a]Reference 1.

In using the equations to estimate emissions from sources found in a specific western surface mine, it is necessary that reliable values for correction parameters be determined for the specific sources of interest, if the assigned quality ranges of the equations are to be applicable. For example, actual silt content of coal or overburden measured at a facility should be used instead of estimated values. In the event that site specific values for correction parameters cannot be obtained, the appropriate geometric mean values from Table 8.24-3 may be used, but the assigned quality rating of each emission factor equation is reduced by one level (e.g., A to B).

Emission factors for open dust sources not covered in Table 8.24-3 are in Table 8.24-4. These factors were determined through source testing at various western coal mines.

The factors in Table 8.24-4 for mine locations I through V were developed for specific geographical areas. Tables 8.24-5 and 8.24-6 present characteristics of each of these mines (areas). A "mine specific" emission factor should be used only if the characteristics of the mine for which an emissions estimate is needed are very similar to those of the mine for which the emission factor was developed. The other (nonspecific) emission factors were developed at a variety of mine types and thus are applicable to any western surface coal mine.

As an alternative to the single valued emission factors given in Table 8.24-4 for train or truck loading and for truck or scraper unloading, two empirically derived emission factor equations are presented in Section 11.2.3 of this document. Each equation was developed for a source operation (i.e., batch drop and continuous drop, respectively), comprising a single dust generating mechanism which crosses industry lines.

Because the predictive equations allow emission factor adjustment to specific source conditions, the equations should be used in place of the factors in Table 8.24-4 for the sources identified above, if emission estimates for a specific western surface coal mine are needed. However, the generally higher quality ratings assigned to the equations are applicable only if 1) reliable values of correction parameters have been determined for the specific sources of interest and 2) the correction parameter values lie within the ranges tested in developing the equations. Table 8.24-3 lists measured properties of aggregate materials which can be used to estimate correction parameter values for the predictive emission factor equations in Chapter 11, in the event that site specific values are not available. Use of mean correction parameter values from Table 8.24-3 reduces the quality ratings of the emission factor equations in Chapter 11 by one level.

TABLE 8.24-4. UNCONTROLLED PARTICULATE EMISSION FACTORS FOR OPEN DUST SOURCES AT WESTERN SURFACE COAL MINES

Source	Material	Mine location[a]	TSP emission factor[b]	Units	Emission Factor Rating
Drilling	Overburden	Any	1.3	lb/hole	B
			0.59	kg/hole	B
	Coal	V	0.22	lb/hole	E
			0.10	kg/hole	E
Topsoil removal by scraper	Topsoil	Any	0.058	lb/T	E
			0.029	kg/Mg	E
		IV	0.44	lb/T	D
			0.22	kg/Mg	D
Overburden replacement	Overburden	Any	0.012	lb/T	C
			0.0060	kg/Mg	C
Truck loading by power shovel (batch drop)[c]	Overburden	V	0.037	lb/T	C
			0.018	kg/Mg	C
Train loading (batch or continuous drop)[c]	Coal	Any	0.028	lb/T	D
			0.014	kg/Mg	D
		III	0.0002	lb/T	D
			0.0001	kg/Mg	D
Bottom dump truck unloading (batch drop)[c]	Overburden	V	0.002	lb/T	E
			0.001	kg/T	E
	Coal	IV	0.027	lb/T	E
			0.014	kg/Mg	E
		III	0.005	lb/T	E
			0.002	kg/Mg	E
		II	0.020	lb/T	E
			0.010	kg/Mg	E
		I	0.014	lb/T	D
			0.0070	kg/Mg	D
		Any	0.066	lb/T	D
			0.033	kg/Mg	D
End dump truck unloading (batch drop)[c]	Coal	V	0.007	lb/T	E
			0.004	kg/Mg	E
Scraper unloading (batch drop)[c]	Topsoil	IV	0.04	lb/T	C
			0.02	kg/Mg	C
Wind erosion of exposed areas	Seeded land, stripped overburden, graded overburden	Any	0.38	$\frac{T}{(acre)(yr)}$	C
			0.85	$\frac{Mg}{(hectare)(yr)}$	C

[a] Roman numerals I through V refer to specific mine locations for which the corresponding emission factors were developed (Reference 4). Tables 8.24-4 and 8.24-5 present characteristics of each of these mines. See text for correct use of these "mine specific" emission factors. The other factors (from Reference 5 except for overburden drilling from Reference 1) can be applied to any western surface coal mine.

[b] Total suspended particulate (TSP) denotes what is measured by a standard high volume sampler (see Section 11.2).

[c] Predictive emission factor equations, which generally provide more accurate estimates of emissions, are presented in Chapter 11.

TABLE 8.24-5. GENERAL CHARACTERISTICS OF SURFACE COAL MINES REFERRED TO IN TABLE 8.24-4[a]

Mine	Location	Type of coal mined	Terrain	Vegetative cover	Surface soil type and erodibility index	Mean wind speed		Mean annual precipitation	
						m/s	mph	cm	in.
I	N.W. Colorado	Subbitum.	Moderately steep	Moderate, sagebrush	Clayey, loamy (71)	2.3	5.1	38	15
II	S.W. Wyoming	Subbitum.	Semirugged	Sparse, sagebrush	Arid soil with clay and alkali or carbonate accumulation (86)	6.0	13.4	36	14
III	S.E. Montana	Subbitum.	Gently rolling to semirugged	Sparse, moderate, prairie grassland	Shallow clay loamy deposits on bedrock (47)	4.8	10.7	28 - 41	11 - 16
IV	Central North Dakota	Lignite	Gently rolling	Moderate, prairie grassland	Loamy, loamy to sandy (71)	5.0	11.2	43	17
V	N.E. Wyoming	Subbitum.	Flat to gently rolling	Sparse, sagebrush	Loamy, sandy, clayey, and clay loamy (102)	6.0	13.4	36	14

[a] Reference 4.

TABLE 8.24-6. OPERATING CHARACTERISTICS OF THE COAL MINES REFERRED TO IN TABLE 8.24-4[a]

Parameter	Required information	Units	Mine I	Mine II	Mine III	Mine IV	Mine V
Production rate	Coal mined	10^6 T/yr	1.13	5.0	9.5	3.8	12.0[b]
Coal transport	Avg. unit train frequency	per day	NA	NA	2	NA	2
Stratigraphic data	Overburden thickness	ft	21	80	90	65	35
	Overburden density	lb/yd^3	4000	3705	3000	-	-
	Coal seam thicknesses	ft	9,35	15,9	27	2,4,8	70
	Parting thicknesses	ft	50	15	NA	32,16	NA
	Spoils bulking factor	%	22	24	25	20	-
	Active pit depth	ft	52	100	114	80	105
Coal analysis data	Moisture	%	10	18	24	38	30
	Ash	%, wet	8	10	8	7	6
	Sulfur	%, wet	0.46	0.59	0.75	0.65	0.48
	Heat content	Btu/lb	11000	9632	8628	8500	8020
Surface disposition	Total disturbed land	acre	168	1030	2112	1975	217
	Active pit	acre	34	202	87	-	71
	Spoils	acre	57	326	144	-	100
	Reclaimed	acre	100	221	950	-	100
	Barren land	acre	-	30	455	-	-
	Associated disturbances	acre	12	186	476	-	46
Storage	Capacity	ton	NA	NA	-	NA	48000
Blasting	Frequency, coal	per week	4	4	3	7	7[b]
	Frequency, overburden	per week	3	0.5	3	NA	7[b]
	Area blasted, coal	ft^2	16000	40000	-	30000	-
	Area blasted, overburden	ft^2	20000	-	-	NA	-

[a] Reference 4. NA = not applicable. Dash = not available.
[b] Estimate.

References for Section 8.24

1. K. Axetell and C. Cowherd, Improved Emission Factors for Fugitive Dust from Western Surface Coal Mining Sources, 2 Volumes, EPA Contract No. 68-03-2924, U. S. Environmental Protection Agency, Cincinnati, OH, July 1981.

2. Reserve Base of U. S. Coals by Sulfur Content: Part 2, The Western States, IC8693, Bureau of Mines, U. S. Department of the Interior, Washington, DC, 1975.

3. Bituminous Coal and Lignite Production and Mine Operations - 1978, DOE/EIA-0118(78), U. S. Department of Energy, Washington, DC, June 1980.

4. K. Axetell, Survey of Fugitive Dust from Coal Mines, EPA-908/1-78-003, U. S. Environmental Protection Agency, Denver, CO, February 1978.

5. D. L. Shearer, et al., Coal Mining Emission Factor Development and Modeling Study, Amax Coal Company, Carter Mining Company, Sunoco Energy Development Company, Mobil Oil Corporation, and Atlantic Richfield Company, Denver, CO, July 1981.

TABLE 8.23-1. UNCONTROLLED PARTICULATE EMISSION FACTORS FOR METALLIC MINERAL PROCESSES[a]

Process	Low moisture ore[b]		High moisture ore[b]		Emission Factor Rating
	Emissions kg/Mg (lb/ton)	Particulate emissions < 10 μm kg/Mg (lb/ton)	Emissions kg/Mg (lb/ton)	Particulate emissions < 10 μm kg/Mg (lb/ton)	
Crushing[c]					
Primary	0.2 (0.5)	0.02 (0.05)	0.01 (0.02)	0.004 (0.009)	C
Secondary	0.6 (1.2)	NA	0.03 (0.05)	0.012 (0.02)	D
Tertiary	1.4 (2.7)	0.08 (0.16)	0.03 (0.06)	0.001 (0.02)	E
Wet grinding	Negligible	-	Negligible	-	
Dry grinding[d]					
With air conveying and/or air classification	14.4 (28.8)	13.0 (26.0)	d	d	C
Without air conveying or air classification	1.2 (2.4)	0.16 (0.31)	d	d	D
Drying[e]					
All minerals but titanium/zirconium sands	9.8 (19.7)	5.9 (12.0)	e	e	C
Titanium/zirconium with cyclones	0.3 (0.5)	NA	e	e	C
Material handling and transfer[f]					
All minerals but bauxite	0.06 (0.12)	0.03 (0.06)	0.005 (0.01)	0.002 (0.006)	C
Bauxite/alumina	0.6 (1.1)	NA	NA	NA	C

[a]References 9-12. Controlled particulate emission factors are discussed in Section 8.23.3. NA = not available.
[b]Defined in Section 8.23.2.
[c]Based on weight of material entering primary crusher.
[d]Based on weight of material entering grinder. Factors are the same for both high moisture and low moisture ores, because material is usually dried before entering grinder.
[e]Based on weight of material exiting dryer. Factors are the same for both high moisture and low moisture ores. SO_x emissions are fuel dependent (see Chapter 1). NO_x emissions depend on burner design, combustion temperature, etc. (see Chapter 1).
[f]Based on weight of material transferred. Applies to each loading or unloading operation and to each conveyor belt transfer point.
[g]Bauxite with moisture content as high as 15 - 18% can exhibit the emission characteristics of low moisture ore. Use low moisture factor for bauxite unless material exhibits obvious sticky, nondusting characteristics.

higher than those based upon plume profiling tests, but they have a greater degree of reliability. Some test data for primary crushing indicate higher emissions than from secondary crushing, although factors affecting emission rates and visual observations suggest that the secondary crushing emission factor, on a throughput basis, should be higher. Table 8.19.2-1 shows single factors for either primary or secondary crushing reflecting a combined data base. An emission factor for tertiary crushing is given, but it is based on extremely limited data. All factors are rated low because of the limited and highly variable data base.

TABLE 8.19.2-1. UNCONTROLLED PARTICULATE EMISSION FACTORS FOR CRUSHING OPERATIONS[a]

Type of Crushing[b]	Particulate Matter		Emission Factor Rating
	$\leq$ 30 μm kg/Mg (lb/ton)	$\leq$ 10 μm kg/Mg (lb/ton)	
Primary or secondary			
Dry material	0.14 (0.28)	0.0085 (0.017)	D
Wet material[c]	0.009 (0.018)	-	D
Tertiary, dry material[d]	0.93 (1.85)	-	E

[a]Based on actual feed rate of raw material entering the particular operation. Emissions will vary by rock type, but data available are insufficient to characterize these phenomena. Dash = no data.
[b]References 4-5. Factors are uncontrolled. Typical control efficiencies: cyclone, 70 - 80%; fabric filter, 99%; wet spray systems, 70 - 90%.
[c]References 5-6. Refers to crushing of rock either naturally wet or after moistened to 1.5 to 4 weight % by use of wet suppression techniques.
[d]Range of values used to calculate emission factor was 0.0008 - 1.38 kg/Mg.

There are no screening emission factors presented in this Section. However, the screening emission factors given in Section 8.19.1, Sand and Gravel Processing, should be similar to those expected from screening crushed rock. Milling of fines is also not included in this Section as this operation is normally associated with non construction aggregate end uses and will be covered elsewhere in the future when information is adequate.

Open dust source (fugitive dust) emission factors for stone quarrying and processing are presented in Table 8.19.2-2. These factors have been determined through tests at various quarries and processing plants.[6-7] The single valued open dust emission factors given in Table 8.19.2-2 may be used when no other information exists. Empirically derived emission factor equations presented in Section 11.2 of this document are preferred and should be used when possible. Because these predictive equations allow the adjustment of emission factors for

APPENDIX B

BASIS FOR CONTROL EFFICIENCIES

WORKBOOK ON ESTIMATION OF EMISSIONS AND DISPERSION MODELING FOR FUGITIVE PARTICULATE SOURCES

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TABLE 3.2.9-3

UNPAVED ROADS: EFFICIENCIES OF CONTROL TECHNIQUES AND METHODS

Technique	Control Efficiency	Comments	Reference
Watering	50% ± 25%	Should be watered regularly.	EPA 1978a EPA (VIII) 1978 EPA 1979a EPA 1977a
Oiling	75%	Surface runoff problems as well as VOC evaporation could inhibit acceptance by environmental agencies	EPA 1978a
Chemical stabilization	90-95%	Based on "Coherex" and "Lignin" and regular application.	EPA 1978a EPA 1979a
Use of low silt aggregate	30%	Increased maintenance to reduce accumulation of fractured aggregate is needed.	EPA 1978a
Oil and double chip surface	80-85%	Increased maintenance is needed	EPA 1978a EPA 1977
Paving	See Table 3.2.10-1		
Speed Control	See equations on Table 3.2.9-1		
Road carpet	Up to 90% for PM < 1μ.	Needs to be demonstrated in practice.	Blackwood 1979

TABLE 3.2.17-2

TRANSFER POINTS:

EFFICIENCIES OF CONTROL TECHNIQUES AND METHODS

Technique	Control Efficiency	Comments	Reference
Enclosure	90% 70-99%*		Szabo 1978 EPA 1978a
Enclosure with control device	99(+)%	See Appendix A for calculating controlled emissions.	EPA 1978a
Spraying	70-95%		EPA 1978a
Telescopic chutes	75%		EPA 1978a

*Lower value uses "weathertight" system; higher value utilizes dust collection system.

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TECHNICAL GUIDE FOR ESTIMATING FUGITIVE DUST IMPACTS FROM COAL HANDING OPERATIONS

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TABLE 4-2

ESTIMATED DUST CONTROL EFFICIENCIES FOR CONVEYING AND TRANSFER OPERATIONS

Activity	Control Method	Estimated Control Efficiencies (%)	References
A. Conveyor Systems	- partial enclosure	70	Bohn, et al. (1978), Currier & Neal (1979)
		90	EPA (1979a)
	- full enclosure	99	Bohn, et al. (1978), TRW (1982)
		100	EPA (1979a)
	- wet conveyor belt	15	Jutze, et al. (1977)
B. Conveyor Transfer Stations	- full enclosure	70	Bohn, et al. (1978)
		90	Currier & Neal (1979), Szabo (1978)
	- enclosure with baghouse	99	Bohn, et al. (1978), EPA (1979a), TRW (1982)
		99.5	Davis, et al. (1981)
	- water spray	35	Jutze, et al. (1977)
		50	Currier & Neal (1979)
		70-95	Bohn, et al. (1978)
	- micron droplet spray	90	Kretch (1983)
	- chemical spray	85	Currier & Neal (1979)
	- foam	75	Jutze, et al. (1977)
	- micron-sized foam spray	99	Cole & Ayers (1983)

TABLE 4-4

ESTIMATED DUST CONTROL EFFICIENCIES FOR STORAGE PILE WIND EROSION

Activity	Control Method	Estimated Control Efficiencies (%)	References
Storage Pile Wind Erosion			
	A. Surface Stabilization		
	- water sprays	50	Jutze, et al. (1977), TRW (1982)
		80	Bohn, et al. (1978)
	- chemical wetting agents	80-99	Ohio EPA (1980)
		85	Currier & Neal (1979)
		90	Jutze, et al. (1977)
	- surface crusting agent	95	Davis, et al. (1981)
		<99	Bohn, et al. (1978)
	- carry over wetting from load-in	80	Davis, et al. (1981)
	B. Enclosures		
	- silo with baghouse	100	Bohn, et al. (1978)
		95-99	Jutze, et al. (1977)
		99	Collins (1979), EPA (1979a), TRW (1982)
	C. Wind Speed Reduction		
	- vegetative wind breaks	30	Bohn, et al. (1978)
	- reduced pile height	30	Bohn, et al. (1978)
	- wind screens/wind fences	<80	Carnes & Drehmel (1981)
		<75	Larson (no date)
		<60 (IP* only)	Larson (no date)
	- pile shaping/orientation	<60	Martin & Drehmel (1981)

* Inhalable particulate matter

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User's Guide

Emission Control Technologies and Emission Factors for Unpaved Road Fugitive Emissions

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Chapter 5
Estimation Of Control System Performance

The principal control measures for unpaved roads are wet suppression, chemical stabilization, and paving. This chapter will discuss available performance data and design considerations for each of these control measures. Other control approaches, such as physical stabilization, will be discussed briefly. Work practices, such as speed control on unpaved travel surfaces, will not be discussed.

Performance capabilities of unpaved road dust controls can be affected by four categories of variables: a) control application parameters; b) vehicle characteristics; c) properties of the surface to be treated; and d) climatic factors. Furthermore, because of site–to–site differences in most of these parameters, the performance of a given control system can be expected to vary significantly from one application to another. Therefore, in using the control efficiency data presented in this section, care must be taken to document the source and control parameters tied to each control efficiency data set. The selection of a control technique involves the evaluation of both performance characteristics and cost considerations. No individual table or figure can provide all the required information.

Most of the control techniques involve periodic rather than continuous control application, for example, watering unpaved travel surfaces. The control efficiency is cyclic, peaking immediately after application, then eroding with time. Because of the finite durability of these control techniques, ranging from hours to months, it is essential to relate an average efficiency value to a frequency of application. For measures of extended durability such as paving, the application program required to sustain control effectiveness should be indicated. One common pitfall to be avoided is using field data collected soon after control measure application to represent the average control efficiency over the lifetime of the measure.

For a periodically applied control measure, the most representative value of control efficiency is the time average, given by:

$$C(T) = \frac{1}{T} \int_0^T c(t)\, dt \qquad (5\text{-}1)$$

where:

C(T) = average control efficiency during period of T days between application (%)

c(t) = instantaneous control efficiency at t days after application (%), where $t \leq T$

It must be emphasized that the rate of control efficiency decay is heavily dependent upon the source and control variables discussed in the following sections.

5.1 Wet Suppression

This section will discuss the use of water as a road dust suppressant. The addition of surfactants or other chemical agents to the water to improve control efficiencies will be discussed in the chemical stabilization section of this chapter.

An empirical model for the performance of watering as a control technique has been developed.[1] The supporting data base consists of 14 tests performed in four states during five different summer and fall months.[2–4] The model is:

$$c = 100 - \frac{0.8\, pdt}{i} \qquad (5\text{-}2)$$

where:

c = average control efficiency, %

p = potential average hourly daytime evaporation rate mm/hr (Reference 5 has this information on an annual basis. The National Climatic Data Center in Asheville, NC maintains computer files of this information on a daily basis.)

d = average hourly daytime traffic rate, hr^{-1}

i = application intensity, l/m^2

t = time between applications, hr

The data to support this empirically based mathematical model are shown in Table 5–1 along with additional results from testing of unpaved haul roads with water control. No significant difference in the average control efficiency of watering as a function of particle size has been established to date. As with all empirical models, equation 5–2 should not be applied beyond the ranges of independent variable values tested.

5.2 Chemical Stabilization

5.2.1 Design Considerations

The control application parameters affecting control performance of chemical dust suppressants are: a) application intensity; b) application frequency; c) dilution ratio; and d) application procedure. Application intensity is the volume of diluted solution applied per unit area of surface (for example, l/m^2 or gal/yd^2). The higher the intensity, the higher the anticipated control efficiency. However, this relationship applies only to a point, because too intense an application will begin to run off the surface.

Application frequency is the number of applications per unit of time. The dilution ratio is the volume of chemical concentrate to the volume of water (for example, a 1:7 dilution ratio = 1 part chemical to 7 parts water).

The decay in control efficiency of a chemical dust suppressant occurs largely because vehicles traveling over the road surface impart energy to the treated surface which breaks the adhesive bonds that keep fine particles on the surface from becoming airborne. An increase in vehicle weight and speed accelerates the decay in efficiency for chemical treatment of unpaved roads.

Any action which contributes to the breaking of a surface crust will adversely affect the control efficiency. For example, the structural characteristics of an unpaved road affect the performance of chemical controls. These characteristics are: a) combined subgrade and base bearing strength, as measured by the California Bearing Ratio (CBR); b) amount of fine material (silt and clay) on the surface of the road; and c) the friability of the road surface material. Low bearing strength causes the road to flex and rut in spots with the passage of heavy trucks; this destroys the compacted surface enhanced by the chemical treatment. A minimum amount of fine material in the wearing surface is needed to provide the chemical binder with the particle surface area necessary for effective interparticle bonding. Finally, the larger particles of a friable wearing surface material simply break up under the weight of the vehicles and cover the treated road with layer of untreated dust.

Adverse weather usually accelerates the decay of control performance. For example, freeze–thaw cycles break up the crust formed by chemical binding agents; heavy precipitation washes away water–soluble chemical treatments like lignin sulfonates; and intense solar radiation dries out watered surfaces. On the other hand, light precipitation might improve the efficiency of water extenders and hygroscopic chemicals like calcium chloride.

Table 5-1. Field Data on Watering Control Efficiency

Location	Reference(s)	No. of Tests	Month	Application Intensity (L/m²)	Average Time Between Applications (hr)	Average Traffic Rate (hr⁻¹)	Average Potential Evaporation (mm/hr)	Average Control Efficiency (%)[a]
N. Dakota	2-4	4	October	0.2	1.8	40	0.084	59[b]
New Mexico	2-4	5	July/Aug.	0.2	2.0	23	0.23	69[b]
Ohio	2-4	3	November	0.6	4.5	98	0.042	77[b]
Missouri	2-4	2	September	1.9	2.8	72	0.26	88[b]
Mine 1	7	–	–	–	2.0	32	–	TSP: 16 FP: 29
Mine 1	7	–	–	–	1.0	24	–	TSP: 37 FP: 40
Mine 1	7	–	–	–	0.5	28	–	TSP: 51 FP: 43
Mine 2	7	–	–	–	1.0	65	–	TSP: 41 FP: 26
Mine 2	7	–	–	–	0.5	78	–	TSP: 59 FP: 47

[a]TSP = total suspended particulate; FP = fine particulate.

[b]No significant difference in control efficiency as a function of particle size was observed.

5.2.2 Performance Data

The control of dust emissions from unpaved roads has received the widest attention in the literature (see Table 5-2). Exposure profiling and upwind/downwind sampling have been used to measure control efficiencies for watering and for a range of chemicals which bind the surface material or increase its capacity for moisture retention. Tables 5-3 and 5-4 summarize the measured performance data for chemical dust suppressants.

The observed control efficiency decay functions for several dust suppressants are shown in a series of nine figures contained in Appendix D (Figures D-1 through D-9). Most of the data on the figures are expressed in terms of vehicle passes rather than time because vehicle traffic is the primary cause of the loss of control effectiveness. The control efficiency decay functions can be used to derive the critical relationships between average control efficiency and application frequency. Assuming, as a first approximation, that control efficiency decays linearly from an initial value of 100%, the average control efficiency for a given frequency of application is twice the value at the end of the decay cycle.

The quality rating of control performance data for a periodically applied control measure must address the reliability of the average control efficiency for the particular application frequency tested. Obviously, a spread in the measured values of instantaneous control efficiency is expected as the efficiency decays. The quality rating must be based on how well the instantaneous values fit a decay function. At the time of this writing, mathematically derived decay functions were available for only a few of the control measures. Therefore, no quality ratings were assigned to the control efficiency data presented.

In most of the extended tests of control performance, efficiency values were found to decay with vehicle passes (and time) after application. In Figures D-1 through D-3 and D-9, the best-fit linear decay functions determined by least-squares analysis are shown. In Figures D-4 through D-8, the data points are connected by line segments.

Apparent increases in control efficiency with vehicle passes were observed in several test series from Reference 7. This behavior is thought to be the result of moisture effects on the uncontrolled emission rate, which was measured simultaneously with each controlled emission rate. In other words the efficiency values were not always referenced to a dry uncontrolled emission rate.

Table 5-2. Classification of Tested Chemical Road Dust Suppressants

Dust Suppressant Category	Trade Name	Number of Valid Controlled Tests[a]	Reference Numbers
Petroleum-based	Petro Tac®	13	2-4,6
	Coherex®	130	2-4,6,8-10
	Arco 2200®	20	7
	Arco 2400®	91	11
	Generic 2 (QS)[b]	8	6
Lignosulfonates	Lignosite	73	11
	Trex®	3	12
Salts	Peladow®	1	13
	LiquiDow®	34	7
	Dustgard®	11 (17)	11
	Oil Well Brine	4	8
Polymers	Soil Sement®	32	6,7
Surfactants	Biocat®	3	7
Mixtures	Arcote 220® / Flambinder®	4	8

[a]Numbers without parentheses represent total suspended particulate (TSP) and numbers in parentheses represent respirable particulate (RP).

[b]This is a petroleum resin product developed at the Mellon Institute for the American Iron and Steel Institute.

5.3 Paving

The control efficiencies afforded by paving unpaved road segments can be estimated by comparing the AP-42 emission factors for the unpaved and paved road conditions. The emission factor for the paved road condition requires an estimated silt loading on the paved surface. An urban street dust loading model[14] can be used to estimate silt loadings as a function of traffic volume. The model is expressed as follows:

$$sL = 21.3\ (ADT)^{-0.41} \tag{5-3}$$

where:

sL = silt loading, oz/yd² (g/m²)

ADT = average daily traffic, vehicles/day

This urban model was developed from silt loading measurements in five urban areas (Baltimore; Buffalo; Granite City, IL; Kansas City; and St. Louis). All of the streets were paved edge to edge and had curbs and gutters. The calculated control efficiencies for paving are usually on the order of 90%.

5.4 Other Control Alternatives

A number of open source control techniques have not yet been quantitatively evaluated for control effi-

Table 5-3. Summary of Major Unpaved Road Dust Suppressant Control Efficiency Tests

Ref. No.	Dust Suppressant Tested	No. of Valid Controlled Tests	Test Site	Measurement Method[a]	Days After Application	Application Intensity (gal sol/ yd^2)	Dilution Ratio (gal chem: gal H_2O)	Average Vehicle Weight (ST)	Control Efficiency[b] (%)
2-4	Coherex®	2	Steel plant	P	< 7	Unknown	1:9	3	91[c]
	Coherex®	4	Steel plant	P	1-2	0.19	1:6	50	TP: 92-98 TSP: 91-96 FP: 90-97
	Coherex®	5	Steel plant	P	1-2	0.19	1:6	3	TP: 94-100 TSP: 91-99 FP: 92-97
9-10	Coherex®	4	Steel plant	P	Unknown	Unknown	Unknown	4-19	TP: 81
	Coherex®	2	Steel plant	P	14-15	Unknown[d]	1:4-1:7	26	TP: 99
11	Coherex®	91	Public road	U/D	30-270	1.5[e]/0.33[f]	1:5[e]/1:9[f]	4	TSP: 53 RP: 64
	Arco 2400®	91	Public road	U/D	30-270	3.5	1:0	4	TSP: 96 RP: 57
	Lignosite (50% solids)	73	Public road	U/D	30-270	0.125[e]/0.25[f]	1:1[e]/1:1[f]	4	TSP: 46 RP: 42
	Dustgard®	11 (17)[g]	Public road	U/D	3-60	0.5	1:0[h]	4	TSP: 48 RP: 24
	Peladow®	1	Surface coal mine	P	90	0.6	1:2	3	TSP: 95 RP: 95 FP: 88
12	Trex® (ammonium lignin sulfonate)	3	Taconite mine	P	< 7	0.08	1:4	110-127	TSP: 88

[a]P = profiling; U/D = upwind/downwind.
[b]TP = total particulate; TSP = total suspended particulate; RP = respirable particulate; FP = fine particulate.
[c]Particles of less than 30μm stokes diameter (47μm aerodynamic diameter).
[d]Four applications; testing began 2 weeks after fourth application.
[e]Initial application.
[f]Repeat application.
[g]Eleven TSP tests and 17 RP tests conducted.
[h]Dilution as shipped unknown; no further dilution.

ciency. These methods include physical stabilization of unpaved surfaces, mud/dirt carryout control, and vegetative stabilization. Vegetative stabilization can be used only when the material to be stabilized is inactive and will remain so for an extended time period; therefore, the technique has limited, if any, application to controlling unpaved road emissions. References which describe these control alternative methods in further detail are available in the literature. [15–20]

5.5 Calculation of Controlled Emission Rate

Calculation of the estimated emission rate for a given source requires data on source extent, uncontrolled emission factor, and control efficiency. The mathematical expression for this calculation is as follows:

$$R = M E (1 - c) \quad (5\text{–}4)$$

where:

R = estimated controlled mass emission rate

M = source extent

E = uncontrolled emission factor, i.e., mass of uncontrolled emissions per unit of source extent

c = fractional efficiency of control

The source extent is the appropriate measure of source size or level of activity which is used to scale the uncontrolled emission factor to the particular source in question. For unpaved roads, the source extent is reported in vehicle miles traveled per year (VMT/yr) or vehicle kilometers traveled per year (VKT/yr). Source extent is calculated by multiplying the average daily traffic count (ADT) by the length of

APPENDIX C

EMISSION ESTIMATES FOR IDEAL BASIC'S PROPOSED OPERATIONS

(EXCERPTS FROM PREVIOUS REPORT PREPARED FOR FPC)

Table 1. Summary of Parameters Used to Calculate Annual and 24-Hour Average Emission Rates

Parameter	Annual Average Value	Annual Average Units	24-Hour Average Value	24-Hour Average Units	Source
Lime Rock					
Moisture Content	20	percent	14	percent	IDEAL
Silt Content	3	percent	3	percent	IDEAL
Density	105	lb/cubic ft.	105	lb/cubic ft.	IDEAL
Weather					
Precipitation *	107	days	0	hours	NOAA
Average Wind Speed	8.8	mph	23	mph	NOAA +
Frequency of Winds Greater Than 12 mph	18	percent	100	percent	NOAA **
Process Rates					
Production	1,900,000	tons limestone	7,300	tons limestone	IDEAL
Barge Loading	1,900,000	tons limestone	15,000	tons limestone	IDEAL
Equipment Specifications					
Dragline					
Dragline Capacity	8	yds	8	yds	IDEAL
Dragline Drop Height	15	ft.	15	ft.	KBN ++
Front End Loader					
Front End Loader Capacity	13	yds	13	yds	IDEAL
Front End Loader Drop Ht.	12	ft.	12	ft.	IDEAL
Avg. Front End Loader Speed	5	mph	5	mph	IDEAL
FEL WT. (loaded)	64.93	tons	64.93	tons	IDEAL
FEL WT. (empty)	46.5	tons	46.5	tons	IDEAL
Wheels	4	wheels	4	wheels	IDEAL
Miscellaneous					
Crusher drop Height	3	ft.	3	ft.	IDEAL
Barge Loading Drop Height	30	ft.	30	ft.	KBN ++
Conveyor Drop Height	15	ft.	15	ft.	KBN ++
Apron Feeder Drop Height	6	ft.	6	ft.	IDEAL

* Number of days in which more than 0.1 inch of rain occurred.

\+ Annual average wind speed was obtained from "Climates of the States" (NOAA, 1984). The maximum 24-hour average wind speed was derived from a 5 Year (1981-1985) database from the National Weather Station in Tampa, Florida.

** The annual average frequency of winds greater than 12 mph was obtained from "Climates of the States" (NOAA, 1984). The 24-hour average frequency of winds greater than 12 mph was determined from the 5-year (1981-1985) database mentioned above.

++ Half of the pile height

Note: NOAA = National Oceanic and Atmospheric Administration
IDEAL = Ideal Basic Industries
FEL = Front End Loader

Table 2. Summary of Particulate Matter Emission Factors and Rates

Source	Model Area * Source No.	Source Type	24-hour Emission Factor	24-hour Emission Rate (lb/day)	Annual Emission Factor	Annual Emission Rate (Tons/year)
Quarry Storage Pile	100	Wind Erosion	35.21 lb/day/acre	27.460	4.48 lb/day/acre	0.638
Crusher	110	Crusher (wet)	0.0180 lb/ton	131.40	0.0180 lb/ton	17.10
Frontend Loader (loaded)	110	Vehicular -Unpaved Road	6.35 lb/VMT	44.998	4.49 lb/VMT	4.135
Frontend Loader (empty)	110	Vehicular -Unpaved Road	5.02 lb/VMT	35.620	3.55 lb/VMT	3.273
Dragline	110	Batch Drop	0.000277 lb/ton	2.02	0.000052 lb/ton	0.05
Crusher Loading	110	Batch Drop	0.000189 lb/ton	1.38	0.000035 lb/ton	0.03
Transfer to Conveyor	110	Continuous Drop	0.000030 lb/ton	0.22	0.000006 lb/ton	0.01
Barge Storage Pile	200-220	Wind Erosion	35.21 lb/day/acre	40.487	4.48 lb/day/acre	0.940
Bulldozer	230-250	Bulldozer -Overburden	1.38 lb/hr	11.030	0.87 lb/hr	0.003
Apron Feeder	230-250	Continuous Drop	0.000012 lb/ton	0.089	0.000002 lb/ton	0.002
Barge Pile Loading	230-250	Continuous Drop	0.000152 lb/ton	1.110	0.000029 lb/ton	0.027
Barge Loading	300	Continuous Drop	0.000304 lb/ton	4.560	0.000057 lb/ton	0.054

Table 3. Source Input Data Used in the ISCST Model

Source Description		Location (m)*		Height (m)		Area Source Size		Emissions+			
Model Number	Activity	X	Y	Physical	Emission	Side (m)	Area (m^2)	lb/day	lb/hr	g/s	g/s-m^2
	Quarry Area										
100	Wind erosion	-3	2545	7.62	3.81	56.1	3147	27.5	1.15	0.144	0.000046
110	Crusher, Front-end loader, transf	-3	2545	**	3.81	56.1	3147	215.6	26.95	3.400	0.0011
	Barge Storage Pile										
200	Wind erosion	7	109	9.14	4.57	39.4	1552	13.5	0.56	0.071	0.000046
210	Wind erosion	7	148	9.14	4.57	39.4	1552	13.5	0.56	0.071	0.000046
220	Wind erosion	7	187	9.14	4.57	39.4	1552	13.5	0.56	0.071	0.000046
230	Bulldozer, apron feeder, pile loading	7	109	**	4.57	39.4	1552	4.1	0.51	0.064	0.000041
240	Bulldozer, apron feeder, pile loading	7	148	**	4.57	39.4	1552	4.1	0.51	0.064	0.000041
250	Bulldozer, apron feeder, pile loading	7	187	**	4.57	39.4	1552	4.1	0.51	0.064	0.000041
	Barge										
300	Loading	-9	-9	++	6.1	18.3	335	4.6	0.57	0.072	0.000214

* Southwest corner of area source used to represent location of emission releases.

\+ For wind erosion sources, emissions are assumed to occur when wind speeds are greater than 12 mph. For other sources, emissions occur over 8 hours: 8 am to 12 pm, 1 pm to 5 pm.

** Varies, but assumed to be characteristic of physical pile height.

++ Assumed to be characteristic of approximate mid-point between top of conveyor belt height and barge deck height.

APPENDIX A

FUGITIVE DUST EMISSIONS

A. Basis

Fugitive dust emissions may occur from the product storage pile, the crusher, the pile loading operation, the pile maintenance operations and the barge loading operation. To estimate fugitive dust emissions from these sources, AP-42 emission factors (USEPA, 1986) were used. The product data necessary for these factors for the proposed facility are as follows:

Maximum hourly product throughput = 1,000 tons/hr
Maximum 24-hour product throughput = 7,300 tons/day
Annual product throughput = 1.9×10^6 tons/year
Product moisture = 14% (minimum)
Product moisture = 25% (maximum)
Product silt content = 3% (maximum)

Other data specific for each operation is presented below.

B. Pile Loading

There are two limerock storage areas. The first storage area stockpiles raw limerock brought in by the dragline from the quarry. The capacity of the dragline bucket is 8 yd^3. The pile loading operation is a batch process and the batch drop equation from AP-42, Section 11.2.3, is appropriate:

$$E = k\ (0.0018)\ \frac{(s/5)\ (U/5)\ (H/5)}{(M/2)^2\ \ (Y/4.6)^{0.33}}$$

where: E = emission factor (lb/ton)
k = particle size multiplier
s = material silt content (%)
U = mean wind speed (mph)
H = drop height (ft)
M = material moisture content (%)
Y = dumping device capacity (yd^3)

The particle size multiplier, k, was taken to be 1.0, which reflects total particulate matter emissions.

For annual emission estimates, a mean wind speed, U, of 8.8 mph, measured in Tampa, Florida, was used in the emission calculation based upon a twenty-nine (29) year record. The drop height, H, from the radial stacker to the storage pile was assumed to average 15 feet. An average moisture content of 20 percent was also used. The resulting annual emission factor and emissions are as follows:

$$E = 1.0\ (0.0018)\ \frac{(3/5)\ (8.8/5)\ (15/5)}{(20/2)^2\ \ (8/6)^{0.33}}$$

$$= 0.000052 \text{ lb/ton}$$

Annual emissions = 1.9 x 10^6 ton/year x 0.000052 lb/ton

/ 2000 lb/ton = 0.05 ton/year

Daily emissions are based on the minimum moisture content of 14 percent, and a maximum daily average wind speed of 23 mph, Determined from a 5 year (1981-1985) Tampa database. The 24-hour emission factor and rate are calculated as follows:

$$E = 1.0\ (0.0018)\ \frac{(3/5)\ (23/5)\ (15/5)}{(14/2)^2\ \ (8/6)^{0.33}}$$

$$= 0.000277 \text{ lb/ton}$$

Maximum 24-hour emissions = 7,300 ton/day x 0.000277 lb/ton

= 2.02 lb/day

In the second storage area, crushed limerock is brought in from the quarry stockpile using a conveyor. The pile loading operation is a continuous drop operation and the continuous drop operation equation from AP-42, Section 11.2.3 is appropriate:

$$E = 1.0\ (0.0018)\ \frac{(s/5)\ (U/5)\ (H/10)}{(M/2)^2}$$

Using annual average values for appropriate variables, the resulting annual emission factor and emission rate is as follows:

$$E = 1.0\ (0.0018)\ \frac{(3/5)\ (8.8/5)\ (15/10)}{(20/2)^2}$$

$$= 0.000029 \text{ lb/ton}$$

Annual emissions = 1.9×10^6 tons/yr x 0.0000285 lb/ton / 2000 lb/ton = 0.027 tons/yr

The 24-hour emission factor, which again is based on a maximum daily average wind speed of 23 mph and a limerock moisture content of 14 percent, and rate are as follows:

$$E = 1.0\ (0.0018)\ \frac{(3/5)\ (23/5)\ (15/10)}{(14/2)^2}$$

$$= 0.000152 \text{ lb/ton}$$

Maximum 24-hour emissions = 7,300 ton/day x 0.000152 lb/ton = 1.110 lb/day

C. Crusher

The operation of the crusher involves three limerock handling processes: limerock loading, crushing, and limerock transfer to the conveyor. All of these processes have fugitive particulate emissions associated with them.

During the limerock loading process, the crusher is loaded with a frontend loader. To estimate fugitive particulate emissions from this process, the batch drop equation is appropriate. The capacity of the frontend loader is 13 yards. All other assumptions for the calculation of annual and 24-hour average emissions factors are the same as previously stated. The annual and 24-hour emissions factors are 0.000035 lb/ton and 0.000189 lb/ton, respectively. The corresponding annual and 24-hour emission rates are 0.03 ton/year and 1.38 lb/day.

For the crushing of wet material, an emission factor of 0.0180 pounds of fugitive particulate emissions per ton of material process was used to calculate both annual and 24-hour emission rates:

Annual emissions rate = 0.018 lb/ton x 1.9 x 10^6 ton/year
= 17.1 ton/year

Maximum 24-hour emission rate = 0.018 lb/ton x 7,300 ton/day
= 131.4 lb/day

Because the transfer of limerock from the crusher to the conveyer is a continuous drop process, the continuous drop equation was used. The drop height from the crusher to the conveyer is 3 ft. Using the previous assumptions for annual and 24-hour averaging periods, the annual and 24-hour emission rates are 0.01 ton/year and 0.22 lb/day, based on annual and 24-hour emission factors of 0.000006 and 0.00003 lb/ton, respectively.

D. Storage Pile Wind Erosion

To estimate the fugitive particulate emissions from the storage piles due to wind erosion, the equation from AP-42, Section 11.2.3 was used:

$$E = 1.7\ (s/1.5)\ [(365-p)/235)]\ (f/15)$$

where:

E = emission factor (lb/day/acre)
s = material silt content (%)
p = number of days per year on which rainfall exceeds 0.01 inches
f = percentage of time that wind speed exceeds 12 mph

Meteorological data from Tampa was used as the basis for the parameters, p and f. Based upon a ten (10) year record, the wind speed in Tampa exceeds 12 mph 18% of the time. Based upon a twenty-nine (29) year of record, rainfall in Tampa exceeds 0.01 inches on 107 days per year. Based upon these values, the annual emission factor is calculated as follows:

$$E = 1.7\ (3/1.5)\ [(365-107)/235]\ (18/15)$$
$$= 4.48 \text{ lb/day/acre}$$

The total area of the two quarry storage piles will be approximately 0.78 acres. The resulting emissions due to wind erosion of the quarry storage piles are calculated as follows:

Annual emissions = 4.48 lb/day/acre x 0.78 acres
x 365 days/yr / 2000 lb/ton
= 0.64 tons/year

Daily wind erosion emissions are calculated with the wind erosion equation by assuming that precipitation did not occur in a 24-hour period (i.e., p = 0) and that the frequency of wind speeds over 12 mph occurred for the entire day. The 24-hour emission factor and rate are calculated as follows:

$$E = 1.7\ (3/1.5)\ [(365-0)/235]\ (100/15)$$
$$= 35.21 \text{ lb/day/acre}$$

Maximum 24-hour emissions = 35.21 lb/day/acre
x 0.78 acres
= 27.46 lb/day

Because the annual and 24-hour emission factors are the same for the quarry and barge loading storage piles, emission rates for the barge storage pile can be calculated by accounting for the difference in areas of the two piles. The total area of the barge loading storage pile is approximately 1.15 acres. The resulting emissions due to wind erosion of the barge loading storage pile are calculated as follows:

Annual emissions = 4.48 lb/day/acre x 1.15 x 365 days/year
= 1880 lb/year
= 0.94 tons/year

Maximum 24-hour emissions = 35.21 lb/day/acre x 1.15 acres
= 40.49 lb/day

E. Vehicular Traffic in Storage Pile Area

A frontend loader will be used to move the limerock from the storage pile to the crusher. The equation in AP-42 for traffic over unpaved roads (Section 11.2.1) was used to estimate emissions from vehicular traffic.

$E = k\ (5.9)\ (s/12)\ (S/30)\ (W/3)^{0.7}\ (w/4)^{0.5} \times [(365-p)/365]$

where:

- E = emission factor (lb/VMT), VMT= vehicle miles traveled
- k = particle size multiplier
- s = silt content of road surface material (%)
- S = mean vehicle speed (mph)
- W = mean vehicle weight (tons)
- w = mean number of wheels
- p = number of days per year on which rainfall exceeds 0.01 inches

To be conservative, the particle size multiplier (k) was taken to be 1.0. The silt content of the storage pile traffic area was estimated to be 9%, or three times that of the material in the storage pile. The higher value was used to account for the movement of the frontend loader in the pile area and the breakdown of the product present on the traffic area into smaller particles. The mean vehicle speed of the frontend loader is calculated from the following information supplied by IDEAL for the operation of the frontend loader:

Average distance from Pile to Crusher and Back = 300 ft

Number of cycles per hour = 31.2

Time of operation per hour = 50 minutes/(85% efficiency).

The mean speed = 300 ft/cycle x 31.2 cycles/hour / 50 minutes/hour

= 180 ft/minute

= 2 mph

Because the speed represents an average speed, a speed of 5 mph was used in the emission factor calculations to produce maximum emissions. The frontend loader will have four rubber-tired wheels and will weigh approximately 46.5 tons empty and 64.9 tons fully loaded. The value of p is the same value used in the storage pile wind erosion equation. Using these values, the annual emission factor and emissions are as follows:

$$E\ (\text{empty}) = 1.0\ (5.9)\ (9/12)\ (5/30)\ (46.5/3)^{0.7}\ (4/4)^{0.5} \times [(365-107)/365] = 3.55\ \text{lb/VMT}$$

$$E\ (\text{loaded}) = 1.0\ (5.9)\ (9/12)\ (5/30)\ (64.9/3)^{0.7}\ (4/4)^{0.5} \times [(365-107)/365] = 4.49\ \text{lb/VMT}$$

Vehicle miles (loaded) = 150 ft/trip x 31.2 trip/hour x 8 hour/day x 5 day/week x 52 week/year / 5280 ft/mile = 1,843.6 mile/year

Vehicle miles (unloaded) = 1,843.6 mile/year

Annual Emissions = (1,843.6 mile/year x 4.49 lb/VMT + 1,843.6 mile/year x 3.55 lb/VMT) / 2000 lb/ton = 7.41 ton/year

To calculate maximum 24-hour emissions, precipitation was assumed not to occur during the 24-hour period. Therefore, the loaded and unloaded emission factors are 6.35 and 5.02 lb/VMT, respectively. The number of miles traveled per day was computed and emissions calculated:

1,843.6 mile/year / 5 day/week /52 week/year = 7.1 mile/day

Maximum 24-hour emissions (loaded) = 6.35 lb/VMT x 7.1 mile/day = 45.0 lb/day

Maximum 24-hour emissions (empty) = 5.02 lb/VMT x 7.1 mile/day = 35.6 lb/day

F. Apron Feeders

The apron feeders are located in underground tunnels beneath the barge area storage piles. The tops of the tunnels are open under the storage pile to allow limerock to fall by gravity (i.e., gravity fed) to the apron feeders. Two bulldozers are used to push limerock that does not fall into the tunnels.

The emission factor equation from AP-42 for the operation of a bulldozer is as follows:

$$E = \frac{5.7\ (s)^{1.2}}{(M)^{1.3}}$$

where, the variables are previously defined

Annual emissions are calculated using a moisture content of 20% and a silt content of 3%. The annual emission factor and rate are calculated below:

$$E = \frac{5.7\ (3)^{1.2}}{(20)^{1.3}}$$

$$= 0.43 \text{ lb/hour}$$

To calculate maximum 24-hour emissions, the moisture content was reduced to 14%. The resulting 24-hour emission factor was 0.69 lb/hour.

Each bulldozer is operated for 2,080 hours per year, for a total of 4,160 hour/year for the 2 bulldozers (8 hour/day per dozer). Fugitive particulate emissions are calculated as follows:

Annual emissions = 0.43 lb/hour x 4,160 hour/year
= 0.89 ton/year

Maximum 24-hour emissions = 0.69 lb/hour x 16 hour/day
= 11.0 lb/day

Fugitive emissions for the two apron feeders were calculated using the continuous drop equation. The drop height from the apron feeders to the conveyor is 6 ft. Because the apron feeders are underground, a 90% control efficiency was assumed. The annual and maximum 24-hour emission factors are 0.0000023 lb/ton and 0.000012 lb/ton, respectively, which results in annual and 24-hour emission rates of 0.002 ton/year and 0.089 lb/day, respectively.

G. Barge Loading

The barge will be loaded by conveyor belt at a rate of 15000 tons/day. The barge loading is a continuous process, therefore the continuous drop equation previously used is appropriate.

$$E = k\ (0.0018)\ \frac{(U/5)\ (H/10)\ (s/5)}{(M/2)^2}$$

The annual emission factor and rates are calculated as follows:

$$E = 1.0\ (0.0018)\ \frac{(8.8/5)\ (30/10)\ (3/5)}{(20/2)^2}$$

$$= 0.0000570 \text{ lb/ton}$$

Annual emissions = 0.0000570 lb/ton x 1.9 x 10^6 ton/year
= 0.054 ton/year

To calculate the maximum 24-hour emission factor and rate, the moisture content was reduced to 14% and the wind speed was increased to 23 mph.

$$E = 1.0\ (0.0018)\ \frac{(23/5)\ (30/10)\ (3/5)}{(14/2)^2}$$

$$= 0.000304 \text{ lb/ton}$$

Maximum 24-hour emissions = 0.000304 lb/ton
x 15,000 ton/day
= 4.56 lb/day

APPENDIX D

METEOROLOGICAL DATA FOR TAMPA, FL

CLIMATES OF THE STATES

National Oceanic and Atmospheric Administration
Narrative Summaries, Tables, and Maps
for Each State

with

Overview of State Climatologist Programs

Second Edition

New Material by
James A. Ruffner

Volume 1

Alabama — North Dakota

GALE RESEARCH COMPANY • BOOK TOWER • DETROIT, MICHIGAN 48226

NORMALS, MEANS, AND EXTREMES

TAMPA, FL — INTERNATIONAL AIRPORT — EASTERN — 27° 58′ N — 82° 32′ W — 19 FT — 1975

Month	Temp °F Normal: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Normal Degree days Base 65 °F: Heating	Cooling	Precipitation in inches, Water equivalent: Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, Ice pellets: Maximum monthly	Year	Maximum in 24 hrs.	Year
(a)				12		12					29		29		29		29		29	
J	70.6	50.1	60.4	86	1975	23	1971	203	60	2.33	8.02	1948	T	1950	3.29	1953	T	1965	T	1965
F	71.9	51.7	61.8	88	1971	27	1967	176	90	2.86	7.93	1963	0.21	1950	3.25	1963	T	1951	T	1951
M	76.1	55.9	66.0	88	1974	33	1971	90	118	3.89	12.64	1959	0.06	1956	5.20	1960	0.0		0.0	
A	82.4	61.6	72.0	93	1975	40	1971	9	219	2.10	8.39	1957	T	1967	3.70	1951	0.0		0.0	
M	87.5	66.9	77.2	98	1975	49	1971	0	378	2.41	7.33	1959	0.17	1972	3.97	1971	0.0		0.0	
J	89.9	72.0	81.0	97	1964	61	1972	0	480	6.49	13.75	1974	1.86	1951	3.53	1974	0.0		0.0	
J	90.3	73.7	81.9	97	1964	63	1970	0	524	8.43	20.59	1960	2.31	1962	12.11	1960	0.0		0.0	
A	90.4	74.0	82.2	98	1973	67	1973	0	533	8.00	18.59	1949	2.33	1952	5.37	1949	0.0		0.0	
S	89.0	72.6	80.8	96	1972	64	1972	0	474	6.23	13.04	1947	1.28	1972	4.67	1950	0.0		0.0	
O	83.9	65.5	74.7	93	1971	40	1966	0	301	2.54	7.36	1952	0.23	1974	2.54	1968	0.0		0.0	
N	77.1	56.4	66.8	90	1971	23	1970	71	155	1.79	6.12	1963	T	1960	4.22	1963	0.0		0.0	
D	72.0	51.2	61.6	86	1972	27	1968	169	64	2.19	8.06	1950	0.21	1956	3.28	1969	0.0		0.0	
YR	81.7	62.6	72.2	98	AUG 1973	23	JAN 1971	718	3366	49.38	20.59	JUL 1960	T	APR 1967	12.11	JUL 1960	T	JAN 1965	T	JAN 1965

Month	Relative humidity pct. Hour 01	Hour 07	Hour 13	Hour 19 (Local time)	Wind: Mean speed m.p.h.	Prevailing direction	Fastest mile: Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset	Mean number of days, Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility ½ mile or less	Temperatures °F Max.: (b) 90° and above	32° and below	Min.: 32° and below	0° and below	Average station pressure mb. Elev. 11 feet m.s.l.
(a)	12	12	12	12	29	14	23	23		29	29	29	29	29	29	15	29	29	12	12	12	12	3
J	85	87	60	74	8.9	N	38	29	1959	65	5.3	10	10	11	6	0	1	6	0	0	2	0	1020.0
F	81	86	55	69	9.4	E	50	32	1956	67	5.4	9	9	10	7	0	1	3	0	0	1	0	1019.3
M	81	85	54	66	9.9	S	43	29	1956	71	5.5	10	10	11	7	0	2	3	0	0	0	0	1017.4
A	81	86	49	61	9.7	ENE	37	29	1961	74	5.0	11	11	8	5	0	5	3	1	0	0	0	1018.3
M	80	84	50	60	9.2	E	46	36	1938	73	5.2	10	12	9	6	0	6	1	10	0	0	0	1015.4
J	82	85	59	67	8.6	E	67	31	1964	66	6.3	5	14	11	12	0	14	*	16	0	0	0	1015.8
J	84	87	62	73	7.6	E	38	32	1963	61	6.8	2	16	13	16	0	22	*	20	0	0	0	1017.0
A	86	90	64	73	7.4	ENE	38	11	1961	59	6.7	3	16	12	17	0	21	*	20	0	0	0	1017.4
S	85	89	60	74	8.4	ENE	56	34	1960	60	6.5	4	14	12	13	0	12	*	16	0	0	0	1015.1
O	84	86	56	71	9.1	NNE	38	02	1953	64	5.2	11	11	9	7	0	3	1	2	0	0	0	1017.4
N	84	87	56	73	8.8	NNE	40	29	1963	66	4.8	12	10	8	5	0	1	3	*	0	*	0	1019.5
D	83	86	56	73	8.9	N	43	36	1951	63	5.1	11	9	11	6	0	1	3	0	0	1	0	1020.2
YR	83	86	57	69	8.8	E	67	31	JUN 1964	66	5.7	98	142	125	107	0	88	24	85	0	4	0	1017.8

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 98 in June 1952+; lowest temperature 18 in December 1962; maximum monthly snowfall 0.1 in February 1899; fastest mile wind 84 in September 1935.

WEST PALM BEACH, FL — PALM BEACH INTL AP — EASTERN — 26° 41′ N — 80° 06′ W — 15 FT — 1975

Month	Temp °F Normal: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Normal Degree days Base 65 °F: Heating	Cooling	Precipitation in inches, Water equivalent: Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, Ice pellets: Maximum monthly	Year	Maximum in 24 hrs.	Year
(a)				11		11					37		37		37		30		30	
J	75.0	55.9	65.5	87	1971	29	1970	83	98	2.60	8.30	1974	0.22	1960	6.36	1957	0.0		0.0	
F	76.0	56.2	66.1	89	1974	35	1967	91	127	2.60	6.08	1966	0.29	1968	4.70	1966	0.0		0.0	
M	79.3	60.2	69.8	92	1969	31	1968	21	149	3.32	11.75	1970	0.33	1956	4.88	1970	0.0		0.0	
A	82.9	64.9	73.9	99	1971	45	1971	0	270	3.51	18.26	1942	0.04	1967	15.23	1942	0.0		0.0	
M	86.1	68.9	77.5	96	1971	56	1971	0	388	5.17	14.10	1946	0.39	1967	7.04	1958	0.0		0.0	
J	88.3	72.7	80.5	96	1972	62	1963	0	465	8.14	17.71	1966	1.07	1952	9.21	1945	0.0		0.0	
J	89.6	74.1	81.9	96	1969	68	1975	0	524	6.52	17.74	1941	1.22	1961	5.93	1972	0.0		0.0	
A	90.2	74.6	82.3	97	1970	66	1969	0	536	6.91	13.52	1950	2.16	1955	5.09	1949	0.0		0.0	
S	88.3	74.7	81.5	93	1972	68	1973	0	495	9.83	24.86	1960	2.73	1939	8.71	1960	0.0		0.0	
O	84.3	70.1	77.2	93	1971	46	1968	0	378	8.75	18.76	1965	1.20	1972	9.56	1965	0.0		0.0	
N	79.5	62.5	71.0	89	1973	37	1970	22	202	2.48	10.77	1973	0.23	1973	5.52	1972	0.0		0.0	
D	76.1	57.4	66.8	87	1972	33	1968	78	134	2.21	8.73	1949	0.06	1968	5.26	1953	0.0		0.0	
YR	83.0	66.0	74.5	99	APR 1971	29	JAN 1970	299	3786	62.06	24.86	SEP 1960	0.04	APR 1967	15.23	APR 1942	0.0		0.0	

Month	Relative humidity pct. Hour 01	Hour 07	Hour 13	Hour 19 (Local time)	Wind: Mean speed m.p.h.	Prevailing direction	Fastest mile: Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset	Mean number of days, Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, Ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility ½ mile or less	Temperatures °F Max.: (b) 90° and above	32° and below	Min.: 32° and below	0° and below	Average station pressure mb. Elev. 21 feet m.s.l.
(a)	11	11	11	11	33	14	26	26			27	30	30	30	33	33	33	33	11	11	11	11	3
J	80	82	59	73	9.8	NW	48	29	1955		5.8	7	12	12	7	0	1	2	0	0	*	0	1019.6
F	79	81	56	69	10.3	SE	46	29	1956		5.7	8	10	10	7	0	1	1	0	0	0	0	1018.0
M	76	80	53	66	10.7	SE	51	27	1957		5.6	8	13	10	7	0	2	1	1	0	*	0	1016.9
A	74	77	52	64	10.9	E	55	12	1958		5.4	8	14	8	7	0	3	1	2	0	0	0	1017.5
M	77	77	57	68	9.6	ESE	45	27	1956		5.9	7	13	11	11	0	8	*	6	0	0	0	1015.0
J	83	82	66	76	8.0	ESE	71	09	1957		6.9	4	12	14	14	0	13	*	6	0	0	0	1015.3
J	84	84	66	73	7.5	ESE	46	34	1974		6.7	3	14	14	15	0	16	*	14	0	0	0	1016.7
A	83	84	63	73	7.4	ESE	86	13	1964		6.6	3	16	12	16	0	14	*	16	0	0	0	1017.1
S	84	85	66	78	8.7	ENE	55	03	1963		7.0	2	14	14	17	0	11	*	8	0	0	0	1014.7
O	80	83	63	74	10.8	ENE	74	16	1964		6.3	6	13	12	14	0	5	*	2	0	0	0	1015.8
N	78	81	58	71	9.9	ENE	35	34	1959		5.6	7	14	9	8	0	5	1	0	0	0	0	1018.3
D	77	79	57	71	9.9	NNW	38	07	1958		5.5	9	12	10	7	0	1	1	0	0	0	0	1019.3
YR	80	81	59	72	9.4	ESE	86	13	AUG 1964		6.1	72	157	136	131	0	79	8	54	0	*	0	1017.0

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: Highest temperature 101° in July 1942.

(a) Length of record, years, through the current year unless otherwise noted, based on January data.
(b) 70° and above at Alaskan stations.
* Less than one half.
T Trace.

NORMALS - Based on record for the 1941-1970 period.
DATE OF AN EXTREME - The most recent in cases of multiple occurrence.
PREVAILING WIND DIRECTION - Record through 1963.
WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.
FASTEST MILE WIND - Speed is fastest observed 1-minute value when the direction is in tens of degrees.

TABLE 2.2-1

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ANNUAL PERCENTAGE FREQUENCY OF WIND BY SPEED GROUPS AND THE MEAN SPEED

STATE AND STATION	0 - 3 m.p.h.	4 - 7 m.p.h.	8 - 12 m.p.h.	13 - 18 m.p.h.	19 - 24 m.p.h.	25 - 31 m.p.h.	32 - 38 m.p.h.	39 - 46 m.p.h.	47 m.p.h. and over	Mean speed m.p.h.
ALA. Birmingham	27	22	30	17	3	1	•	•	•	7.9
Mobile	7	28	38	20	6	1	•	•	•	10.0
Montgomery	31	29	27	12	2	•	•			6.9
ALASKA, Anchorage	28	35	25	11	2	•	•	•		6.8
Cold Bay	4	9	18	27	21	14	5	2	•	17.4
Fairbanks	40	35	19	5	1	•	•	•		5.2
King Salmon	11	20	30	24	10	4	1	•	•	11.4
ARIZ. Phoenix	38	36	20	5	1	•	•	•		5.4
Tucson	18	35	30	14	3	1	•	•		8.1
ARK. Little Rock	12	30	39	16	2	•	•	•		8.7
CALIF. Bakersfield	35	30	24	10	1	•	•			5.8
Burbank	52	26	18	4	1	•	•	•		4.5
Fresno	30	41	22	7	1	•	•			6.1
Los Angeles	28	33	27	11	1	•	•			6.8
Oakland	26	28	28	16	2	1	•	•	•	7.5
Sacramento	15	28	31	18	5	1	•	•	•	9.3
San Diego	28	38	28	6	•	•	•			6.3
San Francisco	16	21	26	22	11	3	•	•	•	10.6
COLO. Colorado Springs	9	27	38	19	6	2	•	•	•	10.0
Denver	11	27	34	22	5	2	•	•	•	10.0
CONN. Hartford	13	28	32	24	6	1	•	•	•	9.8
D.C. Washington	11	24	35	22	5	1	•	•	•	9.7
DEL. Wilmington	15	31	30	19	4	1	•	•	•	8.8
FLA. Jacksonville	10	33	35	18	3	•	•	•		8.9
Miami	14	30	34	20	2	•	•	•	•	8.8
Orlando	18	28	32	17	4	•	•	•		8.6
Tallahassee	33	36	23	7	•	•				6.1
Tampa	9	31	40	18	2	•	•	•	•	8.8
West Palm Beach	9	22	36	27	6	1	•	•		10.5
GA. Atlanta	13	24	36	21	6	1	•	•		9.7
Augusta	36	29	25	9	1	•	•			6.3
Macon	10	28	46	18	2	•	•	•	•	8.9
Savannah	12	34	37	14	3	•	•	•	•	8.4
HAWAII, Hilo	7	34	43	15	2	•	•			8.7
Honolulu	9	17	27	32	12	2	•	•	•	12.1
IDAHO, Boise	15	30	32	18	4	1	•	•		8.9
ILL. Chicago (O'Hare)	8	22	33	27	8	2	•	•	•	11.2
Chicago (Midway)	7	26	36	25	5	1	•	•	•	10.2
Moline	14	23	32	24	7	2	•	•	•	10.0
Springfield	7	22	28	27	12	3	1	•	•	12.0
IND. Evansville	19	23	32	21	5	1	•	•		9.1
Fort Wayne	9	23	33	25	8	2	•	•	•	10.9
Indianapolis	9	22	34	26	7	2	•	•	•	10.8
South Bend	7	21	35	30	7	1	•	•		10.9
IOWA, Des Moines	3	17	38	29	10	3	1	•	•	12.1
Sioux City	10	20	31	25	10	4	1	•	•	11.7
KANS. Topeka	11	19	30	27	10	2	•	•	•	11.2
Wichita	4	12	30	31	16	5	1	•	•	13.7
KY. Lexington	8	25	39	22	6	1	•	•		10.1
Louisville	17	28	31	20	3	1	•	•		8.8
LA. Baton Rouge	17	29	34	17	3	•	•	•		8.3
Lake Charles	19	31	29	17	4	1	•	•	•	8.5
New Orleans	16	27	32	19	5	1	•	•	•	9.0
Shreveport	12	26	37	21	4	1	•	•	•	9.5
MAINE, Portland	10	30	33	22	4	1	•	•	•	9.6
MD. Baltimore	7	24	39	22	6	2	•	•	•	10.4
MASS. Boston	3	12	33	35	12	4	1	•	•	13.3
MICH. Detroit (City AP)	8	23	37	26	5	1	•	•	•	10.3
Flint	16	26	32	22	3	1	•	•	•	9.0
Grand Rapids	14	23	32	25	5	1	•	•	•	9.8
MINN. Duluth	6	15	33	31	11	4	1	•	•	12.6
Minneapolis	8	21	34	28	9	2	•	•	•	11.2
MISS. Jackson	33	25	26	14	2	•	•	•		7.1
MO. Kansas City	9	29	35	23	5	1	•			9.8
St. Louis	10	29	36	21	3	1	•	•	•	9.3
Springfield	4	13	34	32	13	3	1	•	•	12.9
MONT. Great Falls	7	19	24	24	15	9	3	1	•	13.9
NEBR. Omaha	12	17	29	28	11	3	•	•		11.6
NEV. Las Vegas	18	26	25	20	8	3	1	•	•	9.7
Reno	52	20	13	10	4	1	•	•	•	5.9
N. J. Newark	11	25	34	24	5	1	•	•	•	9.8
N. MEX. Albuquerque	17	36	26	13	5	2	•	•	•	8.6
N. Y. Albany	23	24	27	21	4	1	•	•		8.6
Binghamton	11	23	35	25	5	1	•	•	•	10.0
Buffalo	5	17	34	27	13	3	1	•	•	12.4
New York (Kennedy)	6	17	35	28	10	3	•	•	•	12.0
New York (La Guardia)	6	15	30	31	12	4	1	•	•	12.9
Rochester	8	22	34	25	9	2	1	•	•	11.2
Syracuse	14	27	30	23	5	1	•	•	•	9.7
N. C. Charlotte	20	32	31	14	2	•	•	•		7.9
Greensboro	20	32	31	14	2	•	•	•	•	8.0
Raleigh	18	33	34	14	2	•	•	•	•	7.7
Winston-Salem	19	22	33	21	4	1	•	•		9.0
N. DAK. Bismarck	14	20	27	24	12	3	1	•	•	11.2
Fargo	4	13	28	31	15	7	2	•	•	14.4
OHIO, Akron-Canton	7	25	35	26	5	1	•	•	•	10.4
Cincinnati	11	27	36	22	4	1	•	•	•	9.6
Cleveland	7	18	35	29	9	2	•	•	•	11.6
Columbus	26	23	29	18	4	1	•	•	•	8.2
Dayton	8	25	36	23	6	2	•	•	•	10.3
Youngstown	7	26	36	24	6	1	•	•	•	10.3
OKLA. Oklahoma City	2	11	34	34	13	6	1	•	•	14.0
OKLA. (Cont.) Tulsa	9	24	34	26	7	1	•	•	•	10.6
OREG. Medford	47	31	14	6	2	•	•	•		4.6
Portland	28	27	25	16	4	1	•	•	•	7.7
Salem	25	32	28	13	2	•	•			7.1
PA. Harrisburg	28	31	25	13	3	1	•	•		7.3
Philadelphia	11	27	35	21	5	1	•	•	•	9.6
Pittsburgh	12	26	34	22	4	1	•	•		9.4
Scranton	11	33	35	18	2	•	•	•		8.8
R. I. Providence	11	20	32	28	7	2	•	•	•	10.7
S. C. Charleston	12	28	35	19	4	1	•	•		9.2
Columbia	25	35	26	12	2	•	•			7.0
S. DAK. Huron	10	18	29	29	10	3	1	•	•	11.9
Rapid City	15	22	28	21	10	4	1	•	•	11.0
TENN. Chattanooga	39	25	24	11	1	•	•			6.1
Knoxville	29	29	25	12	4	1	•	•	•	7.5
Memphis	14	26	34	20	5	1	•	•		9.4
Nashville	27	31	25	14	2	•	•	•		7.2
TEX. Amarillo	5	15	32	32	12	4	1	•	•	12.9
Austin	13	25	34	23	5	1	•	•		9.7
Brownsville	10	17	25	30	14	3	•	•	•	12.3
Corpus Christi	11	16	28	33	12	2	•	•		11.9
Dallas	9	21	32	28	9	1	•	•		11.0
El Paso	10	22	32	22	9	4	1	•	•	11.3
Ft. Worth	4	14	34	34	10	3	•	•	•	12.5
Galveston	4	13	39	33	10	2	1	•	•	12.5
Houston	6	18	36	28	10	2	•	•	•	11.8
Laredo	6	15	32	34	12	1	•	•		12.3
Lubbock	4	11	33	34	13	5	1	•	•	13.6
Midland	9	22	36	26	4	1	•	•		10.1
San Antonio	16	23	32	22	4	1	•	•		9.3
Waco	3	14	36	35	10	2	•	•		12.5
Wichita Falls	5	22	41	27	5	1	•	•	•	10.5
UTAH, Salt Lake City	12	33	36	14	4	1	•	•	•	8.7
VT. Burlington	24	24	28	22	2	•	•			8.3
VA. Norfolk	14	23	30	25	6	1	•	•	•	10.2
Richmond	14	37	36	11	1	•	•	•		7.8
Roanoke	31	22	23	17	5	2	•	•		8.3
WASH. Seattle-Tacoma AP	13	16	35	26	8	2	•	•	•	10.7
Spokane	17	38	27	14	3	1	•	•		8.1
W. VA. Charleston	29	37	25	8	1	•	•			6.2
WIS. Green Bay	8	22	32	26	10	2	•	•	•	11.2
Madison	15	22	30	23	7	2	•	•	•	10.1
Milwaukee	8	17	31	30	11	3	1	•	•	12.1
WYO. Casper	8	16	27	27	13	7	2	•	•	13.3
PACIFIC, Wake Island	1	6	27	48	17	2	•	•		14.6
P. R. San Juan	13	28	27	25	4	•	•	•	•	9.1

Source: Climatography of the United States Series 82; Decennial Census of the United States Climate -- Summary of Hourly Observations, 1951-60 (Table B)

In the folder labeled as follows there are documents, listed below, which were not reproduced in this electronic file. That folder can be found in the supplementary documents file drawer. Folders in that drawer are arranged alphabetically, then by permit number.

Folder Name: Florida Power Corporation

Permit(s) Numbered:

AC	09	-6528
AC	09	-21352
AC	09	-21353
AC	09	-14168

Documents:

Period during which document was received	Detailed Description
Application	1. Book: PSD Analysis for the Proposed Fly Ash Handling Facilities for Crystal River Units 1&2