STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

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

BOB MARTINEZ
GOVERNOR

DALE TWACHTMANN
SECRETARY

September 25, 1987

Mr. Wayne Aronson
Chief
Program Support Section
U.S. EPA, Region IV
345 Courtland Street, N.E.
Atlanta, Georgia 30365

Dear Mr. Aronson:

RE: Champion International Corporation
State Construction Permit: AC 17-140962
Federal Permit Number: PSD-FL-126

Enclosed for your review and comment is the permit application for the above referenced company. If you have any comments or questions, please contact Pradeep Raval or Tom Rogers at the above address or at (904)488-1344.

Sincerely,

M. V. Janes

Margaret V. Janes
Planner
Bureau of Air Quality
Management

/mj

cc: Pradeep Raval
Tom Rogers
Ed Middleswart, NW Dist.

AC 17-140962
Receipt # 76187
$1000.00

375 Muscogee Road
P.O. Box 87
Cantonment, Florida 32533-0087
904 968-2121

Champion
Champion International Corporation

DER
OCT 23 1987
BAQM

October 22, 1987

Mr. William Thomas
Department of Environmental Regulation
Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32301

Dear Mr. Thomas:

Champion plans to operate a rental package boiler to supply 125,000 pounds per hour steam. This boiler is needed due to less than design steam production from the existing No. 1 and No. 2 Power Boilers. The package boiler will allow Champion to operate through winter months and during repair down time on existing boilers. Over the next two years, we will be able to eliminate the need for this temporary boiler by repair or replacement of existing boilers.

The attached permit application is for a temporary permit to install and operate this rental package boiler. Champion would like to proceed with installation in mid-November and have the boiler in operation in early December 1987. If there is any additional information required, please contact me at 904/968-2121, ext. 2519.

Sincerely,

David T. Arceneaux
Supervisor
Environmental Control

DTA/ma
Attachments

cc: Thomas Moody, DER
Jack Preece
Tom Rogers/Barry Andrews
Pradeep Raval
} 10/23/87

AC17-140962
Receipt # 76187
$1000.00

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

DER
OCT 23 1987
BAQM

APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

SOURCE TYPE: Gas Fired Boiler [X] New[1] [ ] Existing[1] Temporary Replacement

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

COMPANY NAME: Champion International Corporation **COUNTY:** Escambia

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) Temporary Replacement Gas Fired Package Boiler

SOURCE LOCATION: Street 375 Muscogee Road City Cantonment

UTM: East 469 North 3386

Latitude 30 ° 36 ' 19 "N Longitude 87 ° 19 ' 13 "W

APPLICANT NAME AND TITLE: Ted Crane, V. P. Operations Manager

APPLICANT ADDRESS: P. O. Box 87, Cantonment, Florida 32533

SECTION I: STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

I am the undersigned owner or authorized representative* of Champion

I certify that the statements made in this application for a Construction 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:

T. P. Crane, V.P., Operations Manager
Name and Title (Please Type)

Date: 10/22/87 Telephone No. 904/968-2121

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, that

---

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

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

Daniel B. Smtih
Name (Please Type)

Baskerville Donovan Engineers, Inc.
Company Name (Please Type)

316 S. Baylen, Suite 300, Pensacola FL 32501
Mailing Address (Please Type)

10/22/87

Florida Registration No. 35633 Date: 10/22/87 Telephone No. 904-438-9661

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.

Temporary installation of a leased gas-fired package boiler. Details of the boiler are in Attachment I. This application is for a two-year temporary permit as per DER 17-2.500(3)(C). The project will result in full compliance with all Federal and State regulations.

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

Start of Construction November 15, 1987 Completion of Construction December 1, 1987

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.)

There is no pollution control equipment associated with this source.

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

This is a temporary replacement. Champion does have several permits related to steam generating units (see Attachment II).

E. Requested permitted equipment operating time: hrs/day 24 ; days/wk 7 ; wks/yr 52 ;
if power plant, hrs/yr _____; if seasonal, describe: ____________________

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. No
3. Does the State "Prevention of Significant Deteriorlation" (PSD) requirement apply to this source? If yes, see Sections VI and VII. No
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.

Based on FAC 17-2.500(3)(C), a temporary permit is exempt from most PSD requirements. The permittee must provide "reasonable assurance" that the source emissions will not "cause or contribute to a violation of any ambient air quality standard". See Attachment III.

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

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

N/A

Description	Contaminants		Utilization Rate - lbs/hr	Relate to Flow Diagram
	Type	% Wt		

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

1. Total Process Input Rate (lbs/hr): __________

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]		Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission		Relate to Flow Diagram
	Maximum lbs/hr	Actual T/yr			lbs/yr	T/yr	
NOx	39	147	0.20*	39.0	Same as		Fig. 1
CO	46.8	177	0.24*	46.8	1st column		
SO_2	0.12	0.44	.0006*	0.12			
Particulate	0.89	3.4	.0055*	0.89			
VOC	3.9	14.7	0.02*	3.9			

*Estimates from AP-42, not standards. All values are pounds per MMBTU maximum emissions.

[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).

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

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles Size Collected (in microns) (If applicable)	Basis for Efficiency (Section V Item 5)

E. Fuels

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	avg/hr	max./hr	
Natural Gas	0.153	0.177	195

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

Fuel Analysis:

Percent Sulfur: ______ Percent Ash: ______

Density: N/A lbs/gal Typical Percent Nitrogen: ______

Heat Capacity: 1.1 MMBTU/1000 cubic feet ~~BTU/lb~~ ______ BTU/gal

Other Fuel Contaminants (which may cause air pollution): None

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

Annual Average ______ 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: 36 ft. Stack Diameter: 5 ft.

Gas Flow Rate: 64,947 ACFM 32,900 DSCFM Gas Exit Temperature: 600 °F.

Water Vapor Content: 18.72 % Velocity: 55.13 FPS

SECTION IV: INCINERATOR INFORMATION

N/A

Type of Waste	Type O (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Patholog-ical)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Inciner-ated							
Uncon-trolled (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		Temperature (°F)
			Type	BTU/hr	
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.

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

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 N/A

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

[ ] Yes [ ] No

Contaminant	Rate or Concentration

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

[ ] Yes [ ] No

Contaminant	Rate or Concentration

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

Contaminant	Rate or Concentration

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

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. Stack Parameters

a. Height: ft.

b. Diameter: ft.

c. Flow Rate: ACFM

d. Temperature: ºF.

e. Velocity: FPS

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

1.

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.

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.

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:

F. Describe the control technology selected:

1. Control Device:

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:

a. (1) Company:

(2) Mailing Address:

(3) City:

(4) State:

---

[1] Explain method of determining efficiency.

[2] Energy to be reported in units of electrical power - KWH design rate.

(5) Environmental Manager:

(6) Telephone No.:

(7) Emissions:[1]

Contaminant	Rate or Concentration

(8) Process Rate:[1]

b. (1) Company:

(2) Mailing Address:

(3) City: (4) State:

(5) Environmental Manager:

(6) Telephone No.:

(7) Emissions:[1]

Contaminant	Rate or Concentration

(8) Process Rate:[1]

10. Reason for selection and description of systems:

---

[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 N/A

A. Company Monitored Data

1. ________ no. sites ________ TSP ________ ( ) SO^{2}* ________ Wind spd/dir

Period of Monitoring ____/____/____ to ____/____/____
month day year month day year

Other data recorded ________________________________

Attach all data or statistical summaries to this application.

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

2. Instrumentation, Field and Laboratory

a. Was instrumentation EPA referenced or its equivalent? ☐ Yes ☐ No

b. Was instrumentation calibrated in accordance with Department procedures?

☐ Yes ☐ No ☐ Unknown

B. Meteorological Data Used for Air Quality Modeling

1. _____ Year(s) of data from ____/____/____ to ____/____/____
month day year month day year

2. Surface data obtained from (location)________________________________

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

4. Stability wind rose (STAR) data obtained from (location)________________________________

C. Computer Models Used

1. ________________________________ 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	________________ grams/sec
SO^2	________________ grams/sec

E. Emission Data Used in Modeling

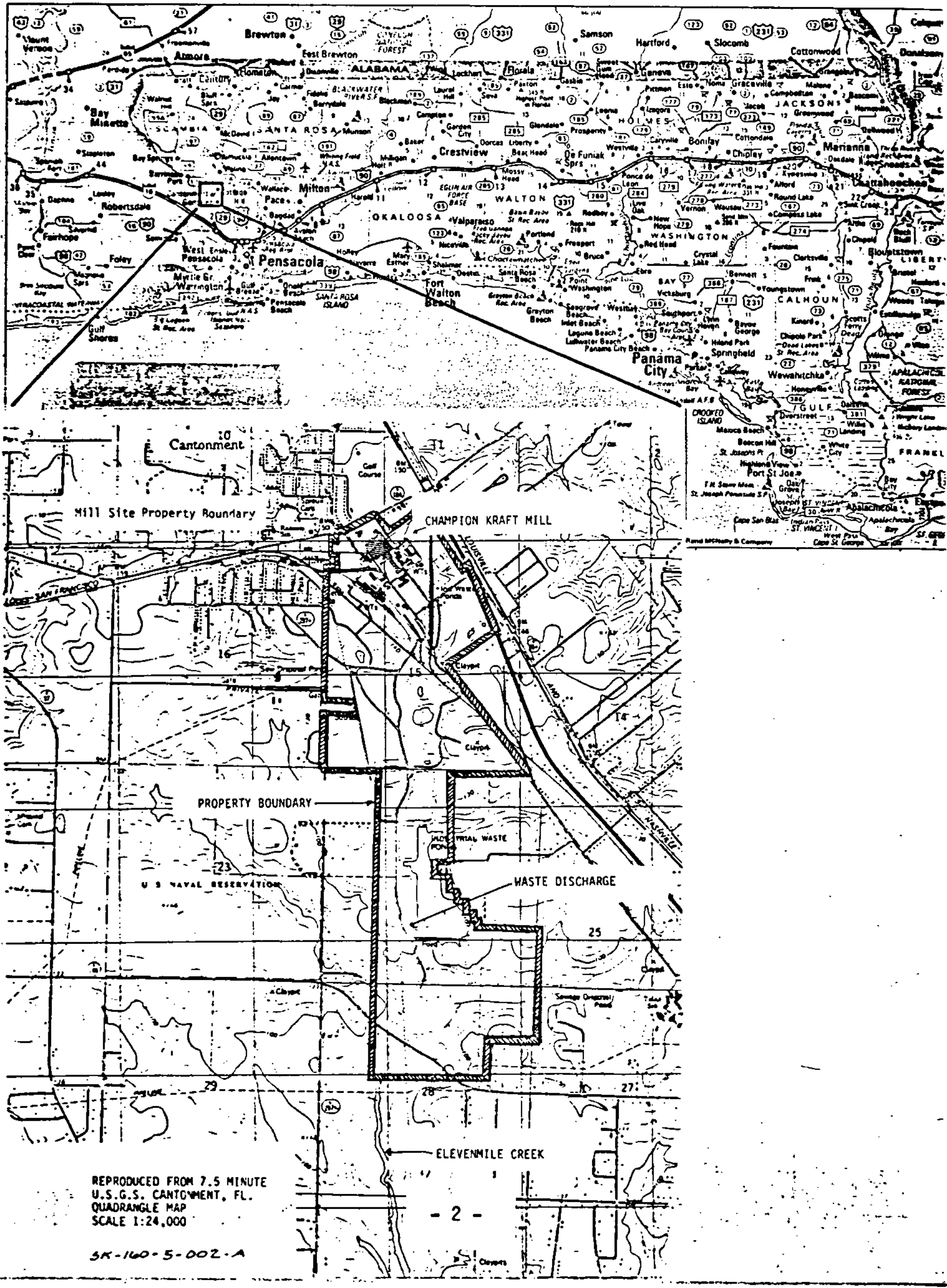
Attach list of emission sources. Emission data required is source name, description of point source (on NEDS point number), UTM coordinates, stack data, allowable emissions, and normal operating time.

F. Attach all other information supportive to the PSD review.

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.

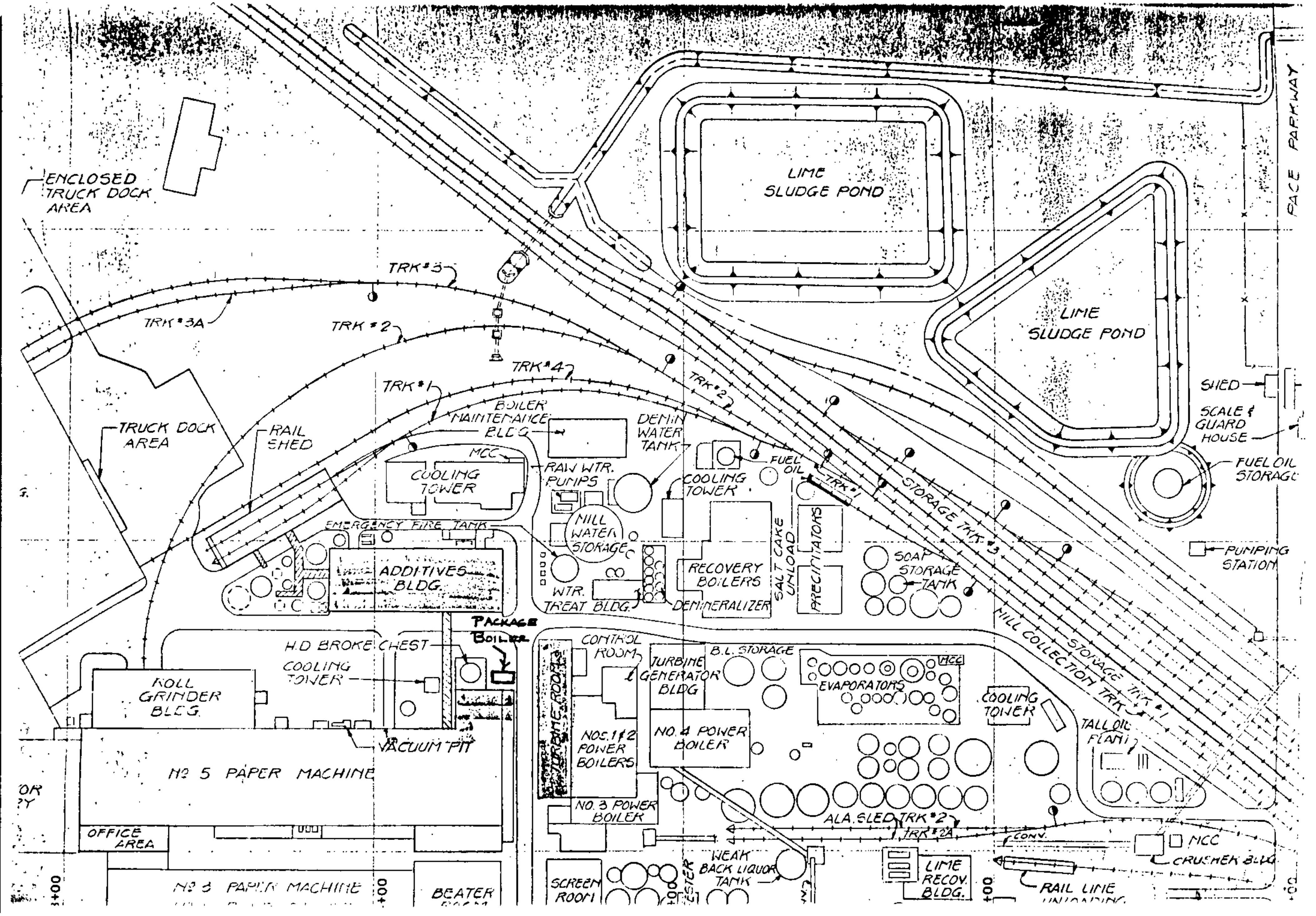
H. Attach scientific, engineering, and technical material, reports, publications, journals, and other competent relevant information describing the theory and application of the requested best available control technology.

FIGURE I LOCATION OF CHAMPION FACILITY



REPRODUCED FROM 7.5 MINUTE
U.S.G.S. CANTONMENT, FL.
QUADRANGLE MAP
SCALE 1:24,000

SK-160-5-002-A


ENCLOSED TRUCK DOCK AREA
LIME SLUDGE POND
LIME SLUDGE POND
PACE PARKWAY
TRK #3
TRK #3A
TRK #2
TRK #4
TRK #1
TRK #2
TRUCK DOCK AREA
RAIL SHED
BOILER MAINTENANCE BLDG
MCC
COOLING TOWER
RAW WTR. PUMPS
DEMIN WATER TANK
COOLING TOWER
FUEL OIL
TRK #1
STORAGE TRK #3
SHED
SCALE & GUARD HOUSE
FUEL OIL STORAGE
PUMPING STATION
EMERGENCY FIRE TANK
ADDITIVES BLDG.
MILL WATER STORAGE
WTR. TREAT BLDG.
DEMINERALIZER
RECOVERY BOILERS
SALT CAKE UNLOAD
PRECIPITATORS
SOAP STORAGE TANK
MILL COLLECTION TRK
STORAGE TRK #1
PACKAGE BOILER
H.D BROKE CHEST
COOLING TOWER
ROLL GRINDER BLDG.
VACUUM PIT
TURBINE ROOM
CONTROL ROOM
TURBINE GENERATOR BLDG
B.L. STORAGE
MCC
EVAPORATORS
COOLING TOWER
TALL OIL PLANT
NO. 4 POWER BOILER
NOS. 1 & 2 POWER BOILERS
NO. 3 POWER BOILER
NO 5 PAPER MACHINE
OFFICE AREA
ALA. SLED TRK #2
TRK #2A
CONV.
MCC
CRUSHER BLDG
NO 3 PAPER MACHINE
BEATER ROOM
SCREEN ROOM
WEAK BLACK LIQUOR TANK
LIME RECOV. BLDG.
RAIL LINE UNLOADING

ATTACHMENT I

The source is a rail transported relocatable package boiler supplied by A.F. Holman Boiler Works of Dallas, Texas. The boiler generates 600 psig steam at 125,000 pounds per hour, and is fueled by natural gas. It is skid mounted and requires only gas, water and steam connections.

The boiler will be located on Champion mill property at the site of the package boiler removed in 1985, Permit No. A017-30110 (Issued 8/14/80 - expired 8/1/85). Temporary gas, water and steam lines will be run to the boiler. A rental stack will be installed.

ATTACHMENT II

Steam Generating Sources

Source	Permit No.	I.D. No.	Permit Expiration Date
Power Boiler #1	A017-104901	10/17/0042/24	August 1, 1990
Power Boiler #2	A017-104902	10/17/0042/14	August 1, 1990
Boiler #3	A017-65482	10/17/0042/33	June 1, 1988
Boiler #4	A017-65490	10/17/0042/37	June 1, 1988
Recovery Boiler #1	A017-104903	10/17/0042/30	August 1, 1990
Recovery Boiler #2	A017-104905	10/17/0042/29	August 1, 1990

ATTACHMENT III

The proposed temporary replacement package boiler will generate 125,000 pounds per hour steam. The maximum heat input is 195 MMBtu per hour with average heat input of 168 MMBtu per hour.

Over the last five years, Champion has shut down three power boilers. These boilers were operated under the following permits, all of which expired on August 1, 1985:

Power Boiler No. 1, Mill No. 1	A017-30106
Power Boiler No. 3, Mill No. 1	A017-30107
Power Boiler No. 4, Mill No. 2	A017-30110

The annual emissions of pollutants based on actual operating condition are summarized on the attached Table III-1. Using emission factors listed in Section III-C, and assuming 365 days per year operation, the maximum expected emissions are also shown on Table III-1. The net difference for all pollutants is negative, except for particulate, which is very small.

In 1979, Champion (St. Regis) submitted a PSD permit application for a new 666 MMBtu per hour bark-fired boiler. As part of the permit application, the mill performed a full PSD review including modeling and impact analysis. The Summary and Conclusions (Chapter II), Air Quality Impacts (Chapter VI), Appendices on Dispersion Modeling (Appendix A), and Meteorological (Appendix B) are attached. The three boilers recently shut down were included in the baseline data considered in that application.

For NOx emissions, the air quality model predicted an annual impact of $3 \mu g/m^3$ against a baseline of $32 \mu g/m^3$. Since the annual standard is $100 \mu g/m^3$, the 3510 tons per year of NOx expected from the bark boiler did not significantly impact the NAAQS.

Based on the reduction in NOx emissions through the shutdown of the three power boilers mentioned and the insignificant impact from the new bark boiler, Champion believes that there would be no significant impact of NOx on the NAAQS from their package boiler. A similar discussion can be presented for the other pollutants.

Based on these assessments, Champion believes we have complied with 17-2.500(3)(C)(2), "reasonable assurance that the source emissions will not cause or contribute to a violation of any ambient air quality standard".

TABLE III-1

Emission Inventory
Tons per Year

	SO_2	PM	NOx	VOC	CO
No. 1 Boiler	1.64	0.31	56.3	3.8	45.0
No. 3 Boiler	3.06	1.38	215.0	14.5	172.0
No. 4 Package	0.03	0.14	25.5	1.7	20.4
TOTAL	-4.73	-1.83	-296.8	-20.0	-237.4
Proposed Package Boiler	0.44	3.4	147	14.7	177
Net Difference	-4.29	+1.57	-149.8	-5.3	-60.4

CHAPTER II

SUMMARY AND CONCLUSIONS

1. Approval to construct a major new source (bark-fired boiler) is being requested by St. Regis Paper Company for the Pensacola, Florida mill, which is located near Cantonment. This document contains the engineering analysis associated with obtaining air pollution permits from the Florida DER and the U.S. EPA. The analysis includes an evaluation of control technology used for the new sources, an assessment of whether the ambient air quality standards will be maintained and an analysis as to whether the PSD increments would be consumed for this area.

2. This application is for a 666 MMBtu/hr bark-fired boiler, only. The bark boiler will also be designed to be fired with natural gas and fuel oil as a standby auxiliary fuel. On July 12, 1979, St. Regis submitted an application to construct new sources which were part of the mill expansion, i.e., the fluidized bed calciner, Kamyr® Washer System, and a non-condensable gas system. This expansion will add 750 tons per day of air dried pulp capacity to the existing mill. For the analysis ES assumed that the emissions for the boiler were calculated to reflect the highest emission levels, e.g., for SO_2 the emission rates assumed 100% firing of oil.

3. The bark boiler and other sources related to the mill expansion would make this a major source, according to the EPA definition. The maximum combined emissions after the control devices are given in tons per year. Since the potential emissions are greater than 100 tpy and the actual emissions (shown below) are greater than 50 tpy, a detailed air quality impact analysis was required.

	MILL EXPANSION	BARK BOILER	TOTAL FOR THE SOURCE
TSP	37	292	329
SO_2	0.4	1,867	1,868
NO_x	67	3,443	3,510
HC	22	54	76
CO	1	688	689

Table II-1 summarizes the maximum emission levels which St. Regis is seeking for their air pollution permit for No. 4 Bark Boiler.

TABLE II-1

MAXIMUM EMISSION LEVELS OF NEW BARK BOILER

POLLUTANT	FUEL	EMISSIONS POUNDS PER HOUR	EMISSIONS LB/MMBTU	EMISSIONS TONS PER YEAR
TSP	Bark	67	0.1	292
	Gas	67	0.1	292
	Oil	67	0.1	292
SO_2	Bark	2	.003	5
	Gas	34	.051	148
	Oil	427	.641	1,867
NO_x	Bark	787	1.18 check 0.7 (3 pm)	3,443
	Gas	134	.20	583
	Oil	200	.30	875
HC	Bark	13	.020	54
	Gas	13	.020	54
	Oil	13	.020	54
CO	Bark	158	.237	688
	Gas	158	.237	688
	Oil	158	.237	688

4. Although DER operated several air quality monitoring stations in the area, EPA requested additional monitoring of TSP in the vicinity of the plant for a 4-month period to establish the baseline level for this pollutant. EPA also suggested that SO_2 data being collected by Gulf Power be used to establish baseline SO_2 conditions in this area.

5. All of the air quality data obtained for this area indicate that all ambient air quality standards are being attained. ES computed the available increments of TSP and SO_2 which could be consumed by new sources locating in this area. All of the increments for these pollutants are available for this Class II area. However, the increases in pollution levels for these pollutants must still be within ambient air quality standards.

6. St. Regis proposes the use of a Venturi scrubber with a 9" pressure drop to minimize the emissions of air pollutants from the bark boiler. The exhaust flow rate from this source will be about 265,000 acfm. The scrubber is one of the best systems for removing TSP from this type of source. The NSPS emission limit of 0.10 lb/MMBtu will be achieved. The scrubber will also remove about 20% of the SO_2 when the unit is fired with oil. NO_x and CO emissions will be minimized through the use of burner design and good operating practices. These operating procedures will be established when the boiler is tested at startup and instituted as an operating practice at that time. Hydrocarbons (or volatile organic compounds) will be minimized by designing an efficient combustion chamber for the boiler. This system and operating procedure represent the best available control technology (BACT) for minimizing emissions to the atmosphere.

7. There are no other new major sources of emissions in this area other than the new emissions from the proposed mill expansion, according to EPA and DER officials. Exxon Company, U.S.A. has received a permit for a minor source (gas fired turbine) which has emissions of 12 tpy of SO_2. This source is located 40 km from the St. Regis site and will have less than a 0.1 $\mu g/m^3$ maximum 24-hour impact in Cantonment.

8. There are several Class I PSD areas in Florida and Alabama. Breton National Wildlife Refuge in Louisiana is the closest Class I area, but it is located about 100 miles from the proposed site. EPA considers a new source may have a significant impact if it is within 100 km (62 miles) of a Class I area.

9. The bark boiler and other new sources at the mill expansion have a

minor impact on air quality levels. For TSP the annual impact is less than 1 $\mu g/m^3$, which can be compared to the Class II PSD increment of 19 $\mu g/m^3$. The primary standard for this pollutant is 75 $\mu g/m^3$. For SO_2 the impact is 1.3 $\mu g/m^3$. The Class II PSD increment for SO_2 is 20 $\mu g/m^3$. The SO_2 standard is 80 $\mu g/m^3$, AAM. A minor impact was calculated for the other pollutants. These new sources will consume a small portion of the PSD increment. The air impact for all averaging periods is well within the standards and PSD increments established for this area.

10. In sum, the new bark boiler, as well as the other sources from the mill expansion can be built without significantly impacting air quality near Cantonment, Florida. The best available control technology will be used to minimize emissions to the atmosphere. The NAAQS are not violated in the area and will not be even if the full PSD increments are consumed. The new sources' impact on air quality will be well within the PSD established by EPA. Table II-1 summarizes the maximum emission levels which St. Regis is seeking for their air pollution permit for No. 4 Bark Boiler.

CHAPTER VI

AIR QUALITY IMPACTS

In order to evaluate the possible impact upon ambient air quality from the proposed mill expansion and the bark boiler, mathematical air pollutant dispersion models were used. In addition, a meteorological analysis was performed to determine the impact of the mill expansion and bark boiler upon ozone levels in Mobile, Alabama.

ANALYSIS OBJECTIVES

The modeling and meteorological analyses were designed to accomplish the following objectives:

1. Identify the potential for violating any NAAQS;
2. Quantify the amount of the available particulate and sulfur dioxide increments that would be consumed by the bark boiler and the mill expansion as well as by other new sources in the area; and
3. Determine the potential that volatile organic compounds emitted from the bark boiler would have for exacerbating the ozone nonattainment problem in Mobile.

The statutory and regulatory limits that relate to air quality impacts have been discussed previously in Chapter I.

The general procedures used to accomplish these objectives are described in the next section of this chapter. The central issue is defining control technology requirements, determining whether emissions offsets apply and determining if PSD increments are consumed in the air impact analyses. The emissions from the mill expansion and the bark boiler were evaluated with the use of EPA approved dispersion models. The model results were examined and compared to the criteria outlined above.

METHODOLOGY USED FOR THE ANALYSIS

Several discussions were held with EPA Region IV and Florida DER personnel as to the methodology to be used to conduct such an analysis. EPA Region IV provided a kit and established certain modeling procedures[1] which provided

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[1] Letter dated December 21, 1978 from W. Ray Cunningham, Chief, Air Strategy Development Section.

a stepwise technique for obtaining the PSD permits. As best possible, these instructions were followed in conducting this analysis.

Recently, EPA has published guidelines on air quality dispersion modeling[1]. Two of the models recommended in the guidelines are the AQDM and the CRSTER dispersion models. These models were selected for use in the Pensacola Mill area to predict the annual average concentrations and the short term concentrations. The models were used to estimate air quality impacts from particulates, sulfur dioxide, nitrogen oxides, carbon monoxide, and hydrocarbons.

A complete description of the AQDM and CRSTER models is included in Appendix A. The CRSTER model used was a version which had been modified, under contract to EPA Region IV, to handle spatially distributed point sources and to allow greater flexibility in output format. This version has been used by EPA Region IV to estimate short-term impacts from PSD sources. The modifications are briefly described in Appendix A.

Model Inputs

Model inputs required by both AQDM and CRSTER are emissions data and meteorological data. The emissions data used in this analysis have been discussed previously in Chapter IV. These emissions were calculated at maximum design heat input. Thus, during much of the time, actual emissions could be quite lower. Stack parameters given in Chapter IV were used for both models.

Meteorological data for input to the dispersion models were obtained from the National Climatic Center (NCC) in Asheville, North Carolina. For the AQDM, a ten-year (1962-1971) STAR summary of three-hour observations taken at the Whiting Naval Air Station in Milton, Florida was used. These summaries are used in AQDM to estimate the frequency of occurence for various dispersion conditions. Thus, realistic estimates can be made of the annual average concentrations based on the ten years' worth of data. For the CRSTER model, hourly surface and upper air measurements are required. The necessary upper air data were collected only during a five year period from 1960 to 1965 at selected meteorological stations in the U.S. Similarly,

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[1] Guidelines on Air Quality Models, EPA-450/2-78-027, OAQPS No. 1.2-080, U.S. EPA, Research Triangle Park, North Carolina, April 1978.

hourly surface data have not been collected since approximately the same time. Therefore, 1964 surface data from Pensacola and upper air data from Mobile were used in the CRSTER modeling. This choice of meteorological data was approved by EPA Region IV[1]. EPA had conducted modeling with CRSTER before and had determined that 1964 was the critical year. Summaries of the meteorological data are included in Appendix B.

Receptor Grids

For each model, a receptor grid system was selected which would provide sufficient confidence in the maximum value determined by modeling. For the AQDM, a 1.0 km spacing between receptors was used. A stepwise screening procedure was used with CRSTER. Based upon an initial analysis using techniques in the Workbook of Atmospheric Dispersion Estimates (Publication No. AP-26), it was estimated that the short-term maximum would lie within 2-4 km of the bark boiler. A square grid system with a receptor spacing of 1.0 km extending 4-5 km from the source was used. Outside of this inner grid, a grid with a spacing of 2.0 km was extended to a distance of 8-9 km from the boiler. A full year of meteorological data was used to estimate the maximum at each receptor in these grids. Based upon these results, the days of the year on which a maximum could be expected and the areas where a maximum might occur were identified. Then, receptor grids with a spacing of 0.1 km were placed around the areas of a possible maximum and modeled for the days identified. The same procedure was used for the calciner. Separate runs were made to determine the combined impact of the boiler, calciner, and new sources other than St. Regis.

DISCUSSION OF THE RESULTS

The results of the air pollutant dispersion modeling were reviewed with regard to the objectives outlined previously. Particulate emissions only were modeled. The impacts from other pollutants were determined based upon the results for particulate. The results for the bark boiler and the calciner, which were the only emission sources considered, are given in Table VI-1.

Attainment of the NAAQS

The impact of the bark boiler and calciner upon attainment of the NAAQS

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[1] Letter dated December 21, 1978 from W. Ray Cunningham, Chief, Air Strategy Development Section.

TABLE VI-1

SUMMARY OF AIR QUALITY IMPACTS

($\mu g/m^3$)

POLLUTANT[b]	AVERAGING TIME[a]	MAXIMUM CONCENTRATIONS PREDICTED		
		BARK BOILER	CALCINER	BOTH SOURCES[d] COMBINED
Particulate	Annual	0.2	0.4	0.5
	24-Hour	5.6	4.4	6.6
Sulfur Dioxide	Annual	1.3	<0.1	1.3
	24-Hour	35.8	0.1	35.8
	3-Hour	95.3	0.2	95.3
Carbon Monoxide	8-Hour	c	-	c
	1-Hour	67.5	-	67.5
Hydrocarbons	3-Hour	2.8	7.6	7.6
Nitrogen Dioxide	Annual	2.5	0.6	2.9

[a] The values reported are estimates of the annual arithmetic mean and the maximum concentration for other averaging times.

[b] Particulate was modeled and the values for other pollutants were scaled from the TSP results.

[c] No estimate of the 8-hour maximum concentration was made.

[d] The maximum concentration from both sources is not necessarily the sum of the individual maximum from the boiler and the calciner. This is because the maximum occurs at different locations, and, for 24-hour and 3-hour averaging times, during different time intervals.

for each of the criteria pollutants was determined. In this analysis it was asssumed that hydrocarbons are nonreactive in order to estimate the impact of the proposed new sources at the mill upon the NAAQS.

Total Suspended Particulates

The bark boiler and calciner will have little impact upon particulate air quality on an annual basis or on a 24-hour averaging period basis. The maximum predicted concentration on an annual basis was 0.5 $\mu g/m^3$. The maximum predicted 24-hour TSP concentration was 6.6 $\mu g/m^3$. The estimated baseline annual average TSP concentration was 40 $\mu g/m^3$ and the second highest 24-hour concentration was 58 $\mu g/m^3$. Thus, if the maximum impacts from the mill expansion were added to these baseline concentrations, the results would still be substantially below the NAAQS of 75 $\mu g/m^3$, annual primary standard, and 150 $\mu g/m^3$ maximum 24-hour secondary standard.

Sulfur Dioxide

Based upon the modeling results, the mill expansion will have an insignificant impact upon sulfur dioxide concentrations if the boiler is operated on bark and natural gas. The maximum annual arithmetic mean concentration predicted using AQDM was 1.3 $\mu g/m^3$. The maximum 24-hour concentration resulting from the boiler and calciner was predicted to be 35.8 $\mu g/m^3$. The estimate of the maximum 3-hour concentration was 95.3 $\mu g/m^3$. None of these impacts should significantly endanger attainment of the NAAQS in the area.

Carbon Monoxide

The potential threat to the carbon monoxide NAAQS from the bark boiler would be infinitesimal. By proportioning CO emissions to particulate emissions, an estimate was made of the CO impact based upon particulate modeling results. This estimated impact was 67.5 $\mu g/m^3$ on a 1-hour basis compared to the NAAQS of 40,000 $\mu g/m^3$.

Ozone

Because no viable and readily usable photochemical oxidant model is available for analyzing the impact of sources such as the mill expansion and bark boiler, no modeling for ozone was performed. However, an estimate of the impact of these sources upon ozone ambient air quality in Escambia County can be made by comparing the VOC emissions from the calciner and bark boiler to those from all other sources in Escambia County. The estimated VOC emissions in Escambia County are as follows in tons per year:

YEAR	STATIONARY SOURCES	MOBILE SOURCES	TOTAL
1977	6813	16,583	23,396
1982	6402	13,507	19,909
1987	6414	10,579	16,993

These emissions estimates were developed by DER for their recent SIP revision. Of the total 1977 VOC emissions from stationary sources, only 419 tpy result from fuel combustion, solid waste disposal or open burning. VOC emissions from petroleum storage, transportation, and marketing were 2822 tpy in 1977. Industrial processes emitted 1904 tpy, and surface coating and solvent usage was responsible for 1668 tpy. The VOC emissions from the mill expansion and bark boiler will increase the total VOC emissions in Escambia County by 0.4% in 1982. VOC emissions from stationary sources will be increased by 1.2% in 1982. Thus, VOC emissions from the bark boiler and calciner should have a negligible impact on total VOC emissions in Escambia County and, consequently, upon ozone ambient air quality in the county.

Hydrocarbons

Assuming that hydrocarbons are nonreactive and scaling the estimated concentration from the results for TSP based upon the ratio of emissions, the maximum 3-hour concentration resulting from the mill expansion sources would be 7.6 $\mu g/m^3$. This impact should not represent a substantial threat to attainment of the hydrocarbon NAAQS. However, this NAAQS is designated as only a guide for developing an SIP for ozone.

Nitrogen Dioxide

Using the model results for TSP and proportioning the impact based upon the ratio of emissions, the impact from the mill expansion sources would be about 2.9 $\mu g/m^3$. On an annual basis, this predicted impact should not endanger the NAAQS for NO_2.

PSD Increment Consumption

The PSD increment available and consumed by the proposed new sources at St. Regis is discussed below for total suspended particulate and sulfur dioxide. Increments have not been established for other pollutants.

Total Suspended Particulate

The area around Cantonment, Florida is a Class II PSD area with maximum allowable increase in TSP concentration of 19 $\mu g/m^3$ AGM and 37 $\mu g/m^3$ 24-hour maximum as discussed in Chapter V. The increments are evaluated based on four months of baseline data collected by St. Regis. No new major sources have been constructed which would consume these increments. Consumption of PSD increment by minor and area sources would be negligible. No new major sources have been proposed that would consume increment. Thus, the full PSD increments are available.

The maximum annual arithmetic mean concentration isopleths for both the bark boiler and calciner combined are shown in Figure VI-1. The total impact has a maximum of 0.5 $\mu g/m^3$ near St. Regis. (The predicted value would be somewhat less if AGM is calculated rather than the AAM.) Clearly, the consumption of annual TSP increment is minimal.

The maximum 24-hour concentrations for the bark boiler alone, the calciner alone, and both sources combined are shown in Figures VI-2 through VI-4. These values were predicted without regard to day of the year. The maximum 24-hour concentration predicted to result from both sources combined was 6.6 $\mu g/m^3$, about one-fifth of the available increment.

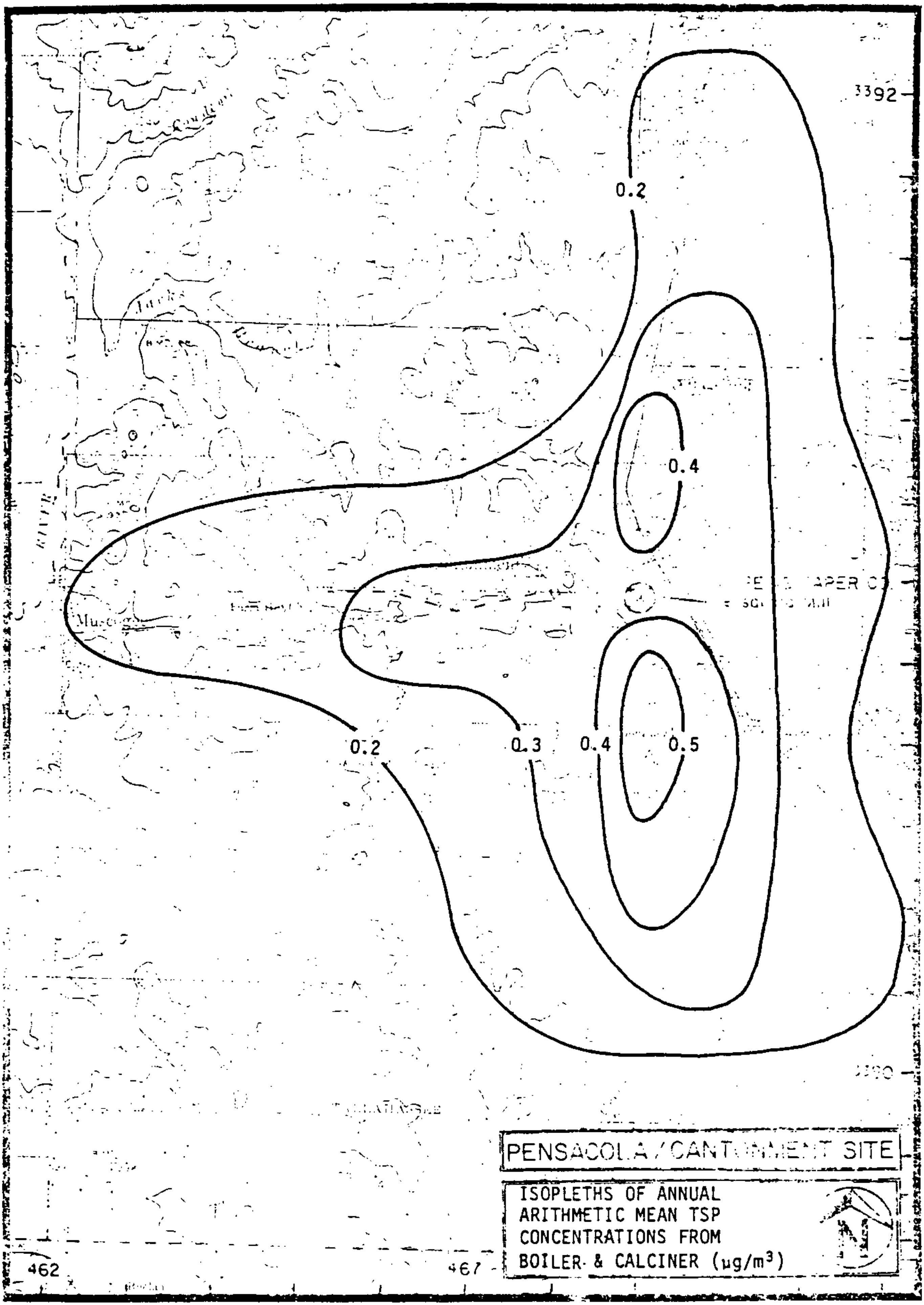
Sulfur Dioxide

Class II increments apply at all points impacted by the proposed new sources at St. Regis. These increments apply to three averaging periods: 20 $\mu g/m^3$ annual arithmetic mean; 91 $\mu g/m^3$ maximum 24-hour mean; and 512 $\mu g/m^3$ maximum 3-hour mean. No major construction since the baseline has consumed increment. Area and minor sources have not substantially consumed increment. No known PSD applications other than that filed previously by St. Regis have consumed SO_2 increment.

The maximum predicted impact from the proposed new sources at St. Regis was predicted to be 1.3 $\mu g/m^3$ on an annual basis. The maximum predicted 24-hour concentration was 35.8 $\mu g/m^3$. The maximum 3-hour concentration was predicted to be 95.3 $\mu g/m^3$. Thus, no major part of the available SO_2 increments would be consumed by these two new sources.

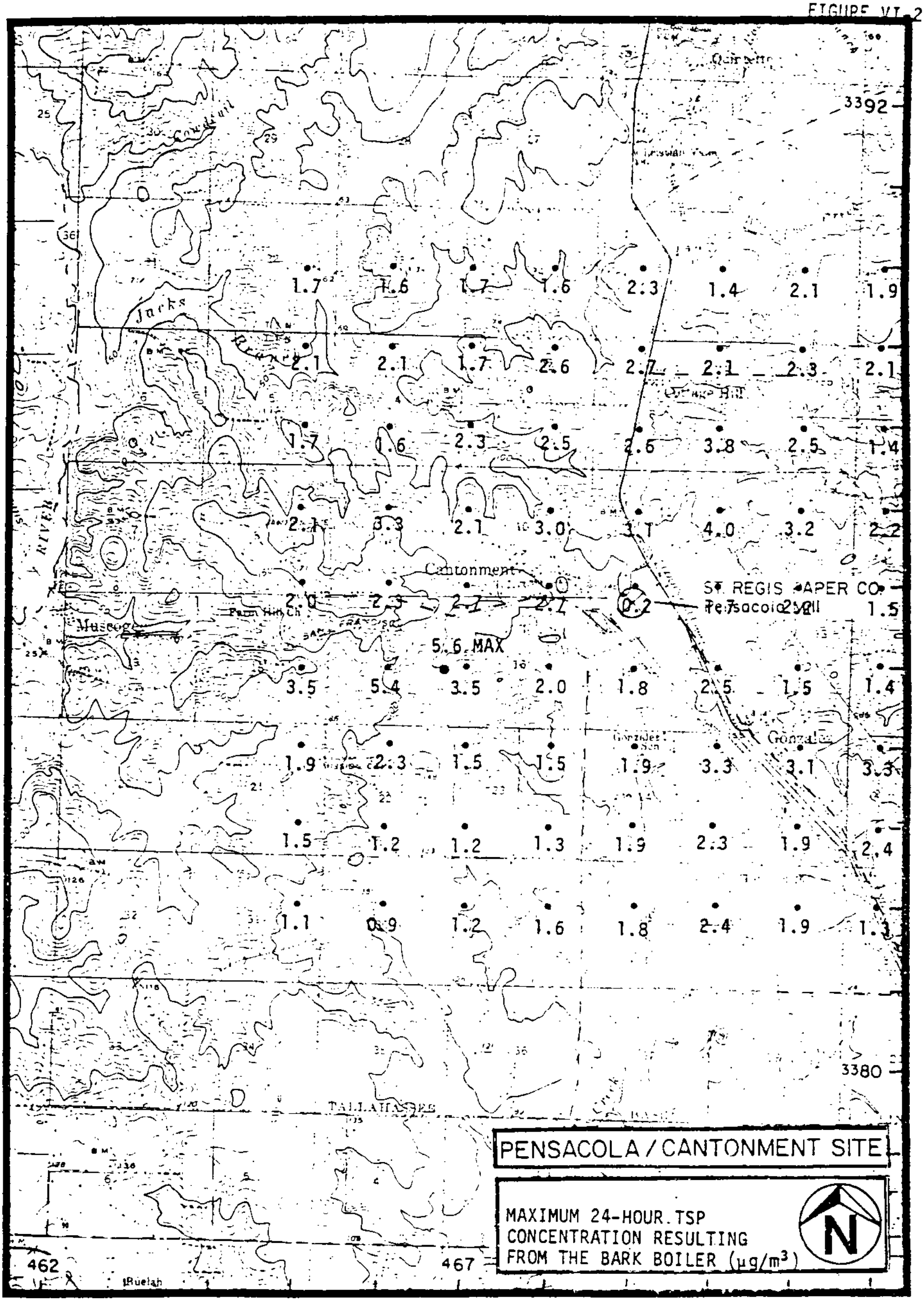
POTENTIAL IMPACT OF ST. REGIS VOC SOURCES UPON OZONE ATTAINMENT

Because a large amount of the ozone measured in the ambient atmosphere results from complex photochemical reactions between VOCs and oxides of nitrogen, the basic philosophy for attaining the ozone standard has been to limit



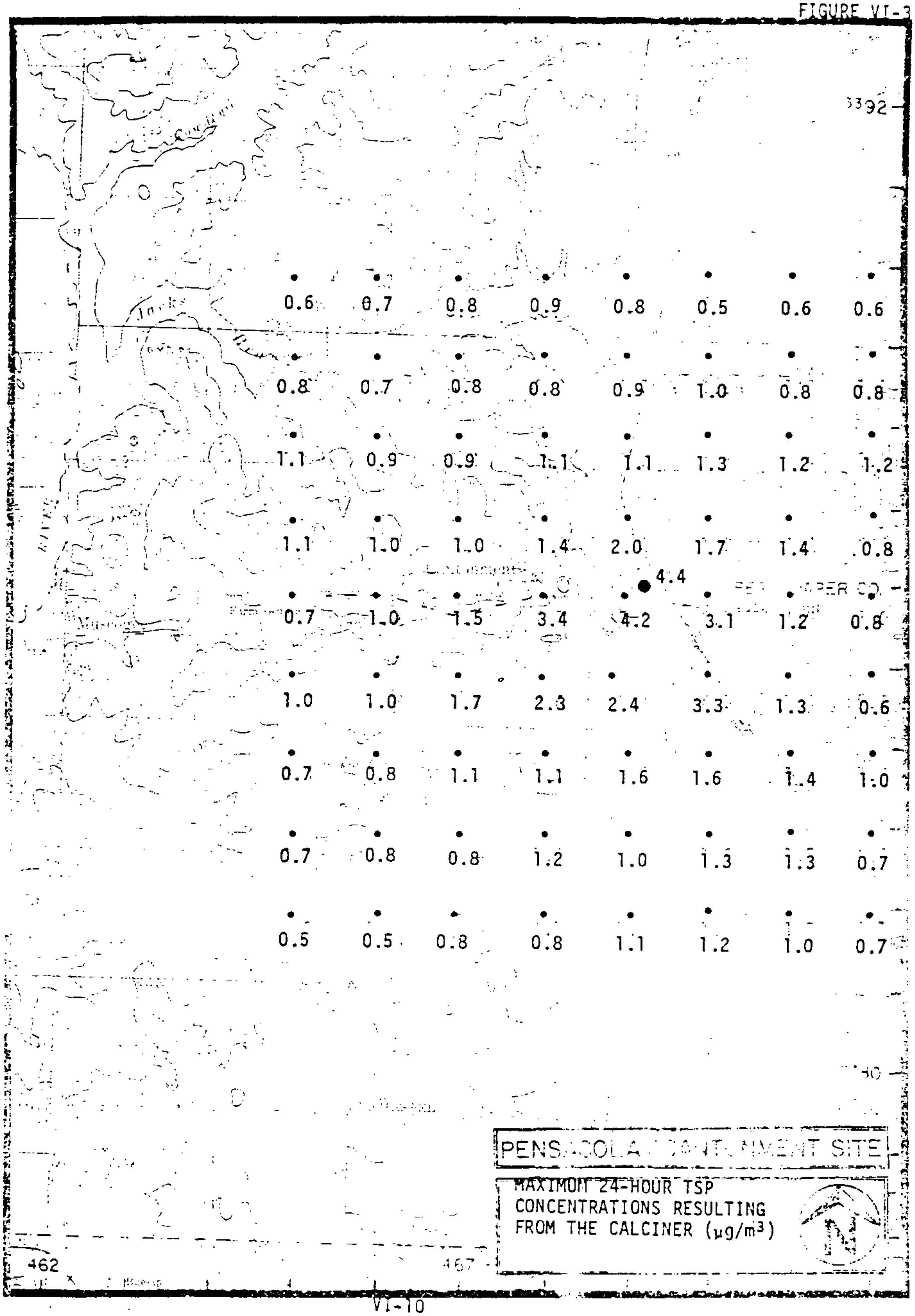
PENSACOLA / CANTONMENT SITE

ISOPLETHS OF ANNUAL ARITHMETIC MEAN TSP CONCENTRATIONS FROM BOILER & CALCINER (μg/m³)



PENSACOLA / CANTONMENT SITE

MAXIMUM 24-HOUR TSP CONCENTRATION RESULTING FROM THE BARK BOILER (μg/m³)

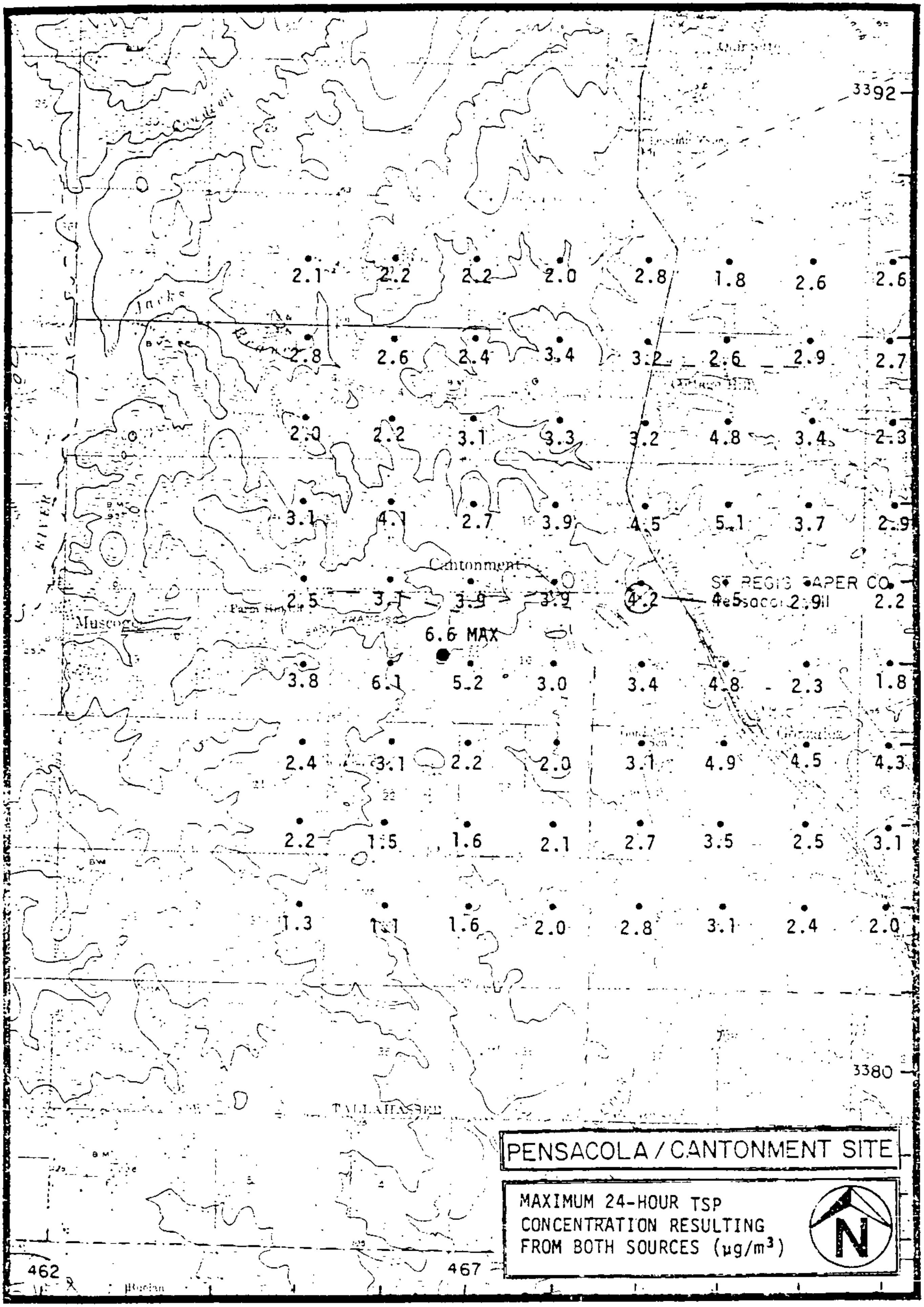


0.6	0.7	0.8	0.9	0.8	0.5	0.6	0.6
0.8	0.7	0.8	0.8	0.9	1.0	0.8	0.8
1.1	0.9	0.9	1.1	1.1	1.3	1.2	1.2
1.1	1.0	1.0	1.4	2.0	1.7	1.4	0.8
0.7	1.0	1.5	3.4	4.2	3.1	1.2	0.8
1.0	1.0	1.7	2.3	2.4	3.3	1.3	0.6
0.7	0.8	1.1	1.1	1.6	1.6	1.4	1.0
0.7	0.8	0.8	1.2	1.0	1.3	1.3	0.7
0.5	0.5	0.8	0.8	1.1	1.2	1.0	0.7

PENSACOLA CONTAINMENT SITE

MAXIMUM 24-HOUR TSP
CONCENTRATIONS RESULTING
FROM THE CALCINER (μg/m³)

FIGURE VI-4



PENSACOLA / CANTONMENT SITE

MAXIMUM 24-HOUR TSP CONCENTRATION RESULTING FROM BOTH SOURCES ($\mu g/m^3$)

VOC emissions. No PSD increments have been established for VOC emissions. For a nonattainment area, however, there are specific offset requirements. Although Escambia County, Florida is designated as unclassifiable, Mobile County, Alabama is a nonattainment area, and the potential impact of the St. Regis VOC sources upon Mobile must be considered.

Because no photochemical dispersion model currently exists which can adequately assess the air quality impact of a single VOC source, EPA has established a general approximation of the area around a nonattainment area in which a source would reasonably have an impact upon a nonattainment area. This area is defined as 36 hours travel time under wind conditions associated with oxidant concentrations exceeding the NAAQS. This distance is based upon evidence which suggests that precursor emissions which occur within 36 hours travel time of each other interact to form oxidant. In addition, EPA allows an applicant to demonstrate that its VOC and NO_x would have a minimal impact on an area exceeding the standards. Such considerations are appropriate only for remote rural sources whose emissions would be very unlikely to interact with other significant sources of VOC or NO_x to form additional oxidant.

In order to analyze the impact of VOC and NO_x emissions from the bark boiler and calciner, the following three-step procedure was used:

1. The nature of the VOC and NO_x emissions from the bark boiler and calciner were defined in order to characterize the plumes.
2. The impact of the plumes upon air quality near the plant was assessed.
3. The potential of the plumes for impacting air quality in Mobile was assessed by considering the meteorological aspects of exceedances in Mobile, the 10-year average wind frequency, and the dispersion of VOC and NO_x by the time that the plumes might reach Mobile.

The results of these three analyses are presented below along with the conclusions resulting from them.

VOC Emissions and Interactions

Volatile Organic Compounds (VOC) include all forms of hydrocarbon compounds which are generally in the vapor phase at ordinary temperatures. Generally this restricts consideration to those with carbon number equal to 10 or less. The most common compound in this group is methane which is relatively inert photochemically and measurements typically try to separate out the methane from the photochemically active non-methane volatile organic compounds. EPA has listed other compounds for which there need not be control strategies in Table 1 of their "Recommended Policy on Control of Volatile Organic Compounds" (42FR35314, July 8, 1977). In the following, reactive VOC should be construed to exclude methane and the Table 1 compounds listed by EPA.

ES has determined the VOC emissions from the new bark boiler to be principally ethylene. The total VOC emissions will be 54 tons/year (refer to Table IV-1). In the laboratory combustion of pine slash samples, in addition to methane and ethylene, small amounts of ethane, acetylene, and propylene and traces of C_4 and C_5 olefins are produced[1]. The VOC emissions from the calciner total 22 tons/year, which is also mostly ethylene. The NRC[1] reports that α-pinene, methyl alcohol, and, to a lesser extent, acetone are the major organic compounds emitted from kraft paper mills (sulfur compounds excluded).

In addition to the VOC emissions, 875 tons/year of oxides of nitrogen will be emitted from the bark boiler and 67 tons per year from the calciner. Thus, in the two effluent streams, the reactive VOC/NO_x ratio will be 0.062 for the bark boiler and 0.33 for the calciner. Finally, the bark boiler will emit 706 tons/year of sulfur dioxide and the calciner, 22 tons/year.

The principal interactions of concern among these gases begin with the oxidation of the hydrocarbons by solar radiation, free-radical chain processes, and many complex and as yet not fully explored reactions. End products such as aerosols, aldehydes, ozone, and peroxyacetylnitrate (PAN) are typically associated with urban smog. Initially nitrogen dioxide and aldehydes are produced as the nitric oxide and hydrocarbons are consumed. As the nitric oxide is exhausted, the nitrogen dioxide passes through a maximum, for its photodissociation leads to the formation of ozone, PAN and other oxidants. In the presence of sulfur dioxide other complexities enter which have not been fully studied. One result, however, is the increased production of aerosol, in particular sulfuric acid aerosol, as a result of the oxidation of sulfur dioxide.

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[1] Vapor-Phase Organic Pollutants, National Research Council Committee on Medical and Biological Affects of Environmental Pollutants, National Academy of Sciences, Washington, D.C., 1976.

There is a fundamental difference, however, between automobile exhaust and the effluent from either the St. Regis bark boiler or the calciner, and that is the reactive VOC/NO_x ratio. In urban atmospheres where the dominant hydrocarbon source is clearly the automobile, reactive VOC/NO_x ratios vary from 1.5 to 24 to 1[1]. In smog chamber studies covering this range of VOC/NO_x ratio the same source reported that the lower the ratio the lower the production of aldehydes, the lower the rate of oxidant formation, and the lower the percent NO_x reacted. In both the St. Regis plumes the oxides of nitrogen dominate the hydrocarbons which should make these plumes nearly nonreactive[2]. In fact, rather than producing ozone these plumes may well be ozone scavenging plumes, reducing the natural background rather than adding to it.

Near-Site Impact

The modeling results for TSP can be scaled using the ratio of TSP to VOC emissions. This will give fairly good estimates of the hydrocarbon concentrations which can be expected near the St. Regis plant if the hydrocarbon were inert. We find 3-hour concentrations of about 8 $\mu g/m^3$ as the maximum to be expected from the calciner; about 3 $\mu g/m^3$ from the bark boiler. Since they have different stack parameters, the two maxima do not occur at the same point. However, a 3-hour maximum of about 8 $\mu g/m^3$ (0.0120 ppm) should be the maximum VOC concentration and this will occur within 1 km of the St. Regis emission points.

Twenty-four hour maximum concentrations would be rather smaller and annual contributions almost negligible. The combined 24-hour maximum was estimated at 5 $\mu g/m^3$ (0.0075 ppm) and the annual maximum should be less than 0.5 $\mu g/m^3$ (0.750 ppm). Again, these maxima will fall within 1 km, perhaps within the St. Regis property line. At a distance of 5 km from the sources, maxima for all averaging periods will be 20% of these close-in values, or less.

Adverse effects on man and vegetation are commonly associated with the

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[1] Effects of the Ratio of Hydrocarbon to Oxides of Nitrogen in Irradiated Auto Exhaust be Merill W. Korth, U.S. Dept. of Health, Education, and Welfare, Public Health Service, Cincinatti, Ohio, 1966.

[2] Procedures for Quantifying Relationships Between Photochemical Oxidants and Precursors: Supporting Documentation, U.S. EPA, EPA-450/2-77-0216, MDAD, OAQPS, Research Triangle Park, North Carolina, February 1978.

oxygenated, irradiated reactive VOC products: aldehydes, peroxyacetylnitrate, ozone, and others. However, as mentioned above, because of the NO_x excess over hydrocarbons in both effluent streams reactions to produce these harmful byproducts will be minimal. This is expecially likely to be the case close in where concentrations reach their maximum values. Here the plumes may well be ozone scavenging and deplete the ambient supply of ozone. Farther out the plume may well become reactive and produce the harmful species. However, by the time 5 km is reached, concentrations will be 20% of the close-in values or less and no significant impact will be possible.

Impact on Mobile

The provisions of 40 CFR 51.18, Appendix S, Emission Offset Interpretive Ruling (Section II C, Review of specified sources for air quality impact) include the possibility of exemption of a VOC source from emission offset requirements if the source owner can demonstrate that the emissions from the proposed source will have virtually no effect upon an area that exceeds the NAAQS for photochemical oxidant (ozone). The nearest nonattainment area is Mobile County. The monitors at which the violations occurred in 1976, 77 and 78 are in the immediate vicinity of the city of Mobile. They lie about 70 km from St. Regis on an approximate heading of 280°. The argument is made in this section that at this distance from the source the impact is entirely negligible. The basis for this statement is threefold: 1) the great majority of the exceedances in the past three years have occurred without any possible contribution from the St. Regis area, suggesting that the significant factors lie elsewhere; (2) it would be a fairly rare event to have the plume pass over the city of Mobile for a long enough period during the time of ozone formation; (3) the plume under worst meteorological conditions would be very dilute and a minimal impact would be expected.

Engineering-Science considered an elaborate mesoscale analysis for each ozone standard exceedance. There are seven surface observing stations which could be used for making hourly streamline analyses: Pascagoula, Mobile, Mobile Point, Pensacola, Milton, Crestview and Eglin Air Force Base. From these streamline maps an hourly transport vector could have been obtained for each of the 36 hours prior to the exceedance at Mobile in such a way that each vector represented the distance the plume moved in each hour. When superimposed on a common base map, the end points of the most recently added vector would trace out the envelope of the St. Regis plume. However, this elaborate procedure has only the appearance of great precision and has actually the same technical and logical problems of the method selected.

The problems with any plume tracking based on surface wind observations are that the surface wind does not represent very well the wind at the effective plume height which actually determines the transport vector; the station density is not really adequate for detailed streamline analysis because errors due to microscale circulation features, such as urban heat island and land-sea breeze effects, cannot be adequately assessed; and the exceedances generally occur when the winds are weak and variable and most prone to errors of measurement. Furthermore, without a detailed emission inventory along each trajectory there is no sure way of countering the implicit but perhaps false argument that if the St. Regis plume tracks ultimately into Mobile County prior to an exceedance it has contributed to it. Finally, sampling variability makes it difficult to generalize. In view of these difficulties, Engineering-Science decided on a simpler analysis which should be of comparable accuracy.

Analysis of Ozone Exceedance at Mobile

The ozone level has exceeded the 0.12 ppm standard at Mobile ten times in the last three years. An analysis of the meteorological conditions leading to these exceedances was made to determine whether a plume from St. Regis could possibly be a contributor. NOAA's Daily Weather Map was the basic source of weather data. Geostrophic winds were determined from the pressure gradient which should provide a better estimate of the transport wind than the surface wind observations. These transport winds were computed for the day of the exceedance. It was assumed that the plume travelled with the geostrophic wind. A conclusion was drawn in each case as to the possibility of a St. Regis contribution. These analyses are presented in Appendix C.

In 7 of the 10 cases, there could clearly have been no contribution from St. Regis. In 2 of the 10 cases, there might have been a contribution, but it is more likely that the plume passed 25 miles north and east of Mobile. In 1 case of 10, it was possible, even likely, that there was a St. Regis contribution. Even in this case, however, there were westerly surface winds at Mobile which were opposite to the geostrophic flow. A microscale analysis might reveal local circulations that kept the St. Regis plume from contributing.

The result of this analysis is that the exceedances observed at Mobile have been associated mainly with wind fields that would blow the St. Regis plume away from Mobile. Thus, the significant factors leading to the Mobile exceedances lie elsewhere.

Analysis of Wind Frequency Data

The above analysis indicates that ozone exceedances at Mobile are very rarely associated with meteorological conditions which would cause St. Regis sources to impact Mobile. A further analysis was conducted to determine the frequency of wind in a 22.5° sector which would result in the St. Regis plume reaching the Mobile area.

A STAR summary of ten years of meteorological data collected at Milton, Florida which is just east of Cantonment is included in Appendix B. The probability of a wind within a 22.5° sector centered on 100° is 6.62%, i.e., during these ten years of record winds from this direction were observed 6.62% of the time. However, only the portion of the time during which stable conditions prevail should be considered because it is only under stable conditions that the plumes will remain intact. Thus, during the ten years of record, the wind blew from a direction and under stable conditions which could carry a St. Regis plume to Mobile only 2.64% of the time.

The probability of an impact by St. Regis upon Mobile can be calculated if the following assumptions are made:

1. The hourly observations are serially correlated such that only every third hourly observation can be considered independent.
2. Stable conditions occur only once a day during early morning.
3. Stable conditions persist for the entire six hour period of ozone formation which is unlikely.

Based upon these assumptions, the probability of two successive 3-hourly observations being from 100° is 0.0007 which is 0.0264^2. Thus, the plume from St. Regis could be expected to impact Mobile on one day every four years (365 x 0.0007 = 0.25).

Dispersion Analysis

Using Turner's Workbook of Atmospheric Dispersion Estimates, we can assess the probable ground-level concentration of a plume after travelling 70 km. A stack height of 50 m, zero plume rise, a mixing height of 625 m and a mean transport wind of 5.5 m $\sec^{-1}$ (from Holzworth's Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous

United States), and stability F were assumed. At a distance of 70 km, with a source intensity of 2.88 g/sec (100 tons/year), the ground-level concentration of VOC would be about 1.3 $\mu g/m^3$ or 2 ppb. This is a short-term concentration and is generally multiplied by a meteorological persistence factor of about 0.7 to give a long-term, say 6 to 8 hour, value. Thus, the concentration is more likely to be 1.4 ppb.

The above estimate rests upon the further assumption that the VOC will be inert. In fact, the major constituent of the plumes, ethylene, is quite reactive. It would be expected that the amount of unreacted VOC still in the plume when it reaches Mobile would be minimal, i.e., much less than 1.4 ppb.

Finally, the VOC concentration in the St. Regis plume as it reaches Mobile can be compared to the concentration that might result from leaf litter. Leaf litter in the Florida area emits reactive hydrocarbons at a rate of 162 $\mu g/m^2$ hr.[1] If complete mixing within a 625 m layer and a transport wind of 5.5 m/sec are assumed, the VOC concentration at Mobile resulting from hydrocarbon exudation by leaf litter over the 70 km distance from St. Regis would be 1.4 ppb. Thus, the VOC emissions at St. Regis could be reasonably expected to have an impact on ozone exceedances at Mobile comparable to that resulting from leaf litter.

Conclusions

Based upon the analyses above, the following conclusions concerning the potential impact of the VOC emissions from the bark boiler and calciner upon ozone attainment can be drawn:

1. The VOC/NO_x ratio in the St. Regis plumes is such that ozone formation could be expected to be retarded. The plumes might even scavenge ozone.
2. The impact of the plumes near the St. Regis plant, where ambient non-methane hydrocarbon concentrations resulting from the plumes would be a maximum, should be minimal.
3. During only one of ten ozone exceedances in Mobile which were investigated, were meteorological conditions such that St. Regis

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[1] Testing of Hydrocarbon Emissions From Vegetation Leaf Litter, and Aquatic Surfaces and Development of a Methodology for Compiling Biogenic Emission Inventories, by Partick R. Zimmerman. Prepared for U. S. EPA, OAQPS, Research Triangle Park, North Carolina 27711, February 1979.

sources would be likely to have had any impact. Even during this one exceedance, local meteorological conditions at Mobile might have precluded any impact from St. Regis.

4. Only once every four years would the St. Regis plumes have any probability of reaching Mobile based upon an analysis of ten years of wind frequency data.
5. If the plumes were to reach Mobile, the resulting VOC concentration would be so low as to be indistinguishable from that which might result from leaf litter.

Thus, St. Regis should not be required to offset its VOC emissions because there is little likelihood that the impact of these emissions upon ozone air quality in Mobile would be other than minimal.

IMPACT ON SOILS, VEGETATION, AND VISIBILITY

The secondary NAAQS are primarily designed to protect the welfare of the public. Dangers to the public welfare against which the secondary standards are designed to protect, include vegetation damage, harmful effects to the soil, and impairments to visibility. The secondary NAAQS will not be violated because of any of the emissions from these proposed sources.

The pollutant with the greatest potential for causing vegetation damage is sulfur dioxide. The maximum 3-hour sulfur dioxide concentration resulting from these proposed sources is 95.3 $\mu g/m^3$, which is about one-fifth of the Class II PSD increment. With such a low consumption of the increment, and the low 3-hour concentrations observed in the Cantonment area, there is no danger that the secondary NAAQS will be violated. At these concentrations, vegetation should not be damaged.

The particulate emissions from the boiler and calciner will be similar to fly ash. Since most of the particulate will be very small because of the control devices employed to remove larger particles, little should be deposited from the plume. Although minute quantities of trace metals may be present, any effect of these emissions upon the soil should be negligible. The maximum impact from the plant should occur within 2-5 km.

Because of the water vapor content of the plumes from these two new sources, the plumes should be visibile for a few hundred meters beyond the stacks. Although the particle size in the plumes will be quite small, the plumes should not be visible beyond the dissipation of the steam because of the dilution. However, since the nearest Class I PSD area is about 100 miles away, no effect should be noticeable in any Class I area. The particles should not serve as condensation nuclei because of their size.

APPENDIX A

DISPERSION MODELING

To determine the impact of the bark boiler and mill expansion particulate and SO_2 emissions on ambient air quality in the vicinity of the plant, dispersion analyses have been conducted. Two basic dispersion models have been used in this evaluation, the Air Quality Display Model (AQDM) for predicting annual average impact and a modified version of the Single Source (CRSTER) Model for predicting 24-hour concentrations of TSP and SO_2 and 3-hour SO_2 concentrations.

DESCRIPTION OF MODELS

Present day air quality analyses are conducted using mathematical dispersion models that date back to the 1930's. The models are generally Gaussian (cone) shaped and require inputs which include stack characteristics, mass emission rates, and meteorological data. The two basic dispersion models used in this analysis were the AQDM and CRSTER Model. Both models represent the state-of-the-art in dispersion modeling and are consistent with the recommended analytical techniques of the U.S. EPA. The models do not provide infallible predictions; however with accurate input data, the models have been used for many different geographic areas.

Air Quality Display Model (AQDM)

The model which was used to predict the annual average impact of the mill facility on ambient TSP and SO_2 levels is the AQDM. This model was developed for the U.S. Department of Health, Education and Welfare, National Air Pollution Control Administration which is the predecessor organization of the U.S. EPA. The model was completed in 1969 and was intended to help state and local air pollution control agencies evaluate the effect of emission regulations on ambient air quality. The AQDM was originally developed by Martin-Tikvart in 1968 and they have made several simplifying assumptions that differ from the work completed by Turner, Pasquill-Gifford, and others. These modifications will be discussed later.

The specific computer program was obtained from the U.S. EPA in North Carolina in the fall of 1973 with program changes supplied by EPA for incorporating the Briggs plume rise equation. The 1969 version of AQDM utilized the Holland equation when calculating plume height. All AQDM runs were made on an IBM 3033 computer.

The model inputs included meteorological and point source emission data. The emission stack configuration parameters were also required to estimate annual average ground level concentrations of TSP. Other inputs regarding study area location and grid spacing were also included.

Assumptions of the Air Quality Display Model

There is very little difference in any of the presently published air quality dispersion models. All of the models assume some form of conical dispersion pattern and make assumptions about the terrain and secondary atmospheric reactions which help reduce the number of input parameters. Frequently, investigators tailor a model to their local conditions by measuring air quality and then apply correction factors to different portions of the dispersion equation.

It is important to point out key assumptions that have been made in simplifying the basic equations for use in this dispersion model. The assumptions incorporated in the Gaussian plume equation and the AQDM can be summarized as follows:

1. The plume description represents conditions averaged over a time period of several minutes. At any given time, the behavior of the plume is more complex, particularly during unstable conditions.
2. The pollutant has neutral buoyancy in the atmosphere; that is, no fall-out is modeled by the equation. Most particulates with equivalent diameters less than 20 microns satisfy this assumption.
3. The time-averaged plume exhibits a Gaussian distribution of concentrations in the cross-plume and vertical dimensions. The measures of the spread in both directions (the standard deviations) are considered to be a function of downwind distance and atmospheric stability only.
4. The plume is assumed to be steady state, resulting from a continuous and constant source.

Plume Behavior

The AQDM was developed to estimate ambient air concentrations over a very large built up metropolitan area. The developers of the AQDM used Chicago as their test city and obvious inputs to the model included a number of area, point, and transportation sources. For calibration of the model, the developers had available an abundance of air quality data representing various averaging times collected over several years.

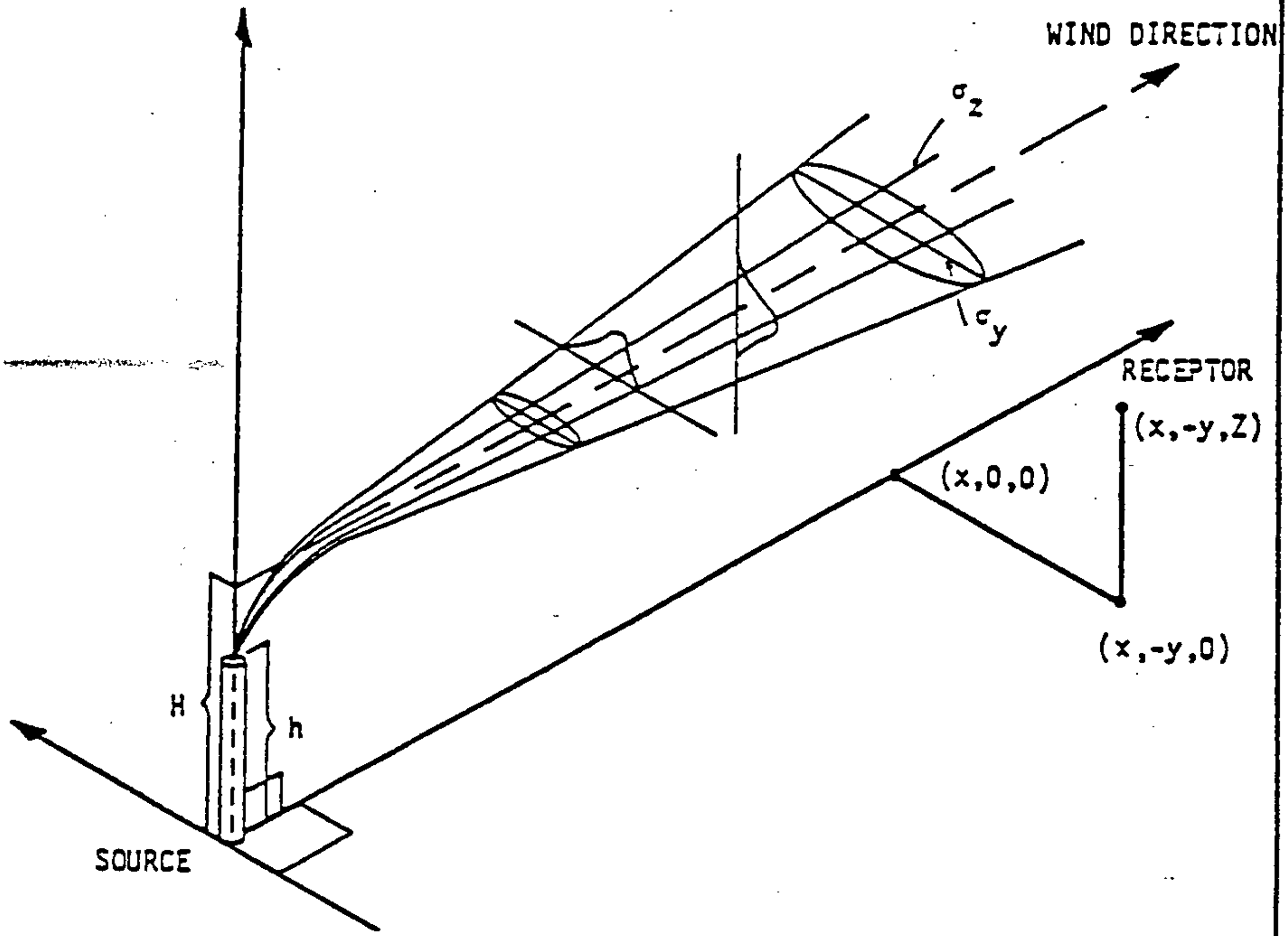
One of the key differences that has been made in the current AQDM from that of the earlier investigators is the treatment of the crosswind deviations (σ_y). Most investigators assume the Gaussian distribution. The AQDM, on the other hand, uses a linear distribution. In general, the linear distribution in the AQDM is more applicable to large built up metropolitan areas where channeling, turbulence, and multiple sources create a more uniform distribution of the ground level concentrations. In rural situations involving several point sources, other investigators have used the Gaussian distribution for the σ_y's and σ_z's.[†] The effect on ground level concentrations of using a linear distribution would probably be to estimate lower maximum ground level values. Furthermore, the expected location of the maximum may differ from those formulae assuming a Gaussian distribution for σ_y. Figure A-1 is the classical form of the Gaussian Distribution.

The concentration (x) at a position (x, y, z) for substances emitted at (0, 0, h) is given in the figure. An estimate of the concentration for a specific source-receptor relationship is obtained by choosing a representative speed for each wind class and solving the equation for all wind speed and stability classes. The average concentration is obtained by summing all concentrations and weighting each one according to its frequency for the particular wind speed, wind direction, and stability class. To obtain the total concentration at a specific receptor, the results of the equation are summed over all sources.

[†] Jepsen, A.F. and Weil, J.C., Maryland Power Plant Air Monitoring Program Preliminary Results, presented at APCA Meeting in Chicago, June 1973, (Paper No. 73-147).

FIGURE A-1

DISPERSION PATTERN AND EQUATION



$$X_{x,y,z,H} = \frac{Q_m}{2\pi\ U\ \sigma_y \sigma_z}\left[\exp\ -\ \frac{1}{2}\left(\frac{y}{\sigma_y}\right)^2\right]\left\{\exp\left[-\frac{1}{2}\left(\frac{z-H}{\sigma_z}\right)^2\right] + r\ \exp\left[-\frac{1}{2}\left(\frac{z+H}{\sigma_z}\right)^2\right]\right\}$$

where $X_{x,y,z}$ = concentration, gms/m^3 and commonly converted to µg/m^3

Q_m = emission rate, gms/sec

x,y,z = downwind locations, meters

U = wind speed, meters/second

H = effective stack height = f (h + bouyancy)

h = stack height

σ_y, σ_z = std, horizontal and vertical deviation, meters (depends on atmospheric stability classification A, B,.....F wind speed and distance downwind)

r = reflectivity of surface

The stack in Figure A-1 represents a typical elevated point source. The "effective stack height" (or effective height of emission release) is the height at which the plume center line becomes horizontal. The effective stack height is the sum of the physical stack height and an incremental factor related to the buoyancy and vertical momentum of the effluent.

Plume Rise

All plume rise formulae consider the rise due to two effects: momentum and buoyancy. The momentum term depends upon physical stack parameters, exit velocity and diameter; the buoyancy term depends upon heat parameters, heat emission rate or the difference between effluent and ambient air temperature. This immediately leads to a model of the form:

$$\Delta h = C_1 \frac{V_s d}{U} + C_2 \frac{Q_h^{\,C_3}}{u^{C_4}}$$

where Δh = plume rise

V_s = effluent exit velocity

d = stack diameter

Q_h = heat emission rate

u = wind speed

C = fitted constants

There are over 100 such formulae and probably 50 papers published reviewing and analyzing their accuracy and applicability. Without exception, the investigators have concluded that none predicts plume rise accurately under all meteorological conditions.

The AQDM originally utilized the Holland plume rise equation. In 1969, the Holland equation was in fact the preferred equation of the meteorological fraternity. Since then, however, Briggs published his (latest) equation in 1971 and provided supporting data to establish the validity of the estimates provided by his equation. The Holland formula is now known to greatly underpredict plume rise while the Briggs formula is believed to be more accurate under most conditions. At the present time, EPA meteorologists are advising use of the Briggs equation.

Briggs concluded from dimensional analysis that:

$$\Delta h = \left[\frac{12.17 F_m x}{u^2} + \frac{12.17 F x^2}{2u^3}\right]^{1/3}$$

F_m is the momentum term and F is the buoyant term. x is downwind distance and because its value is squared in the buoyancy term, this effect will dominate beyond $x > 3\ h_s$, the actual stack height. Briggs concluded that momentum rise could be ignored, a conservative assumption, and found a best fit constant.

$$\Delta h = \frac{1.6 F^{1/3} x^{2/3}}{u}$$

F is the flux of bouyant force/$\pi\rho_a$. ρ_a is the density of the ambient air. Force flux is equal to mass flux times the acceleration.

Therefore:

$$F = \frac{1}{\pi\rho_a} \left(\pi r^2 V_s \rho_e\right) \left(g \frac{T_s - T_a}{T_s}\right) ,$$

where ρ_e is the density of the effluent, g is gravity force, and T_s and T_a are stack and ambient temperature. If $\rho_e = \rho_a$, another conservation assumption, then

$$F = g r^2 V_s \left(\frac{T_s - T_a}{T_s}\right)$$

The Briggs formula above predicts plume rise within a short distance downwind from the stack. As the distance increases, ambient air is entrained into the plume and under stable conditions a deceleration of the plume is exerted. This force is defined by the equation,

$$S = \frac{g}{T_a} \frac{\partial\theta}{\partial z} ,$$

where $\frac{\partial\theta}{\partial z}$ is the lapse rate of the potential temperature

$g = 9.8\ \text{msec}^{-1}$

$T_a = 293°K$, the mean annual temperature for most of the U.S.

$$\frac{\partial\theta}{\partial z} = 1.75°K\ (100\ m)^{-1}$$, a moderately stable lapse rate

$$S = \frac{9.8}{293} \times \frac{1.75}{100} = 5.85 \times 10^{-4}\ sec^{-2}$$

Briggs estimated the maximum rise under stable conditions as

$$\Delta h = 2.9 \left(\frac{F}{uS}\right)^{1/3}$$

Using the value of S calculated above, and the formula for F, we arrive at the plume rise equation for stable conditions (classes E and F):

$$h = 74.2 \left[\left(\frac{V_s r^2}{u}\right)\left(\frac{T_s - T_a}{T_s}\right)\right]^{1/3}$$

For very low winds, an even greater plume rise would be expected:

$$\Delta h = 5.0 \frac{F^{1/4}}{S^{3/8}}$$

Under the above conditions, this would result in a plume rise of 178 m. We have elected not to use this low wind speed estimate of plume rise because of our desire to be conservative. Higher values for the effective stack height will result in lower ground line concentrations when using the dispersion equations.

In neutral and unstable conditions, ambient air is again entrained into the plume but does not exert a retarding force. The plume continues to rise until it is dominated by atmospheric turbulence. Briggs estimated a conservative approximation:

$$\Delta h = 1.6 \frac{F^{1/3}}{u} \left(3x^*\right)^{2/3}$$

where $x^* = 2.16\ F^{2/5} h_s^{3/5}$. Empirical modifications to this formula recommended by EPA[†] have been used in this study to yield:

$$\Delta h = 1.6 \frac{F^{1/3}}{u} \left(3.5\right)^{2/3}$$

[†] Personal correspondence with Joseph Tikvart, EPA, North Carolina, November 28, 1973.

where $x^* = 14\ F^{5/8},\ F < 55$

$$x^* = 34\ F^{2/5},\ F \geq 55$$

The EPA modifications follow:

If the momentum term F is simplified to

$$F = 9.8\ r^2 V_s \left(\frac{T_s - T_a}{T_s}\right)$$

$$= 2.45\ d^2\ V_s\ \left(\frac{T_s - T_a}{T_s}\right) \quad r = \frac{d}{2}$$

and, if $ABRG = d^2 V_s \left(\frac{T_s - T_a}{T_s}\right)$

$$F = 2.45\ ABRG$$

then

$$\Delta hu = 1.6(2.45\ ABRG)^{1/3}\ \ 3.5\ (14)\ (2.45\ ABRG)^{5/8}\ \ ^{2/3}$$

which reduces to:

$$\Delta hu = 42\ ABRG^{0.75}$$

Similarly, for the case of $F > 55$,

$$\Delta hu = 66.3\ ABRG^{0.6}$$

These equations are used in the AQDM.

One simplifying assumption has been made in incorporating the Briggs plume rise equation into the model by the EPA. The stable conditions (E and F) are calculated with this latter equation instead of having two routines for plume rise (one for stable and one for all other conditions). As a result of this assumption, a conservative estimate of ground concentrations (from a lower plume height) will be calculated.[†]

[†] This is strictly true only if the wind speed is greater than 3.5 meters per second. However, under lower wind speeds, the plume rise is ordinarily high and will not show that much of a difference.

Moses[†], et. al., made a comprehensive survey of the accuracy and suitability of some 16 plume rise formulae for power plant flue gases. The results of this survey indicate that the Concave #2 formula gave the best results. However, where the source stacks were of small diameter, the Briggs was the best formula. The underprediction of the Holland formula was evident. In view of the known preference for the Briggs formula by AEC,[††] the approval of this formula by EPA, the results of the Moses survey, and a growing acceptance of the Briggs formula as the most accurate, it is believed that its use in this study is warranted.

Modified CRSTER Model

The model which was used to predict the maximum 24-hour impact of the power plant on ambient total suspended particulate (TSP) levels is a modified version of the CRSTER Model. The original single source model was developed by the Meteorology Laboratory of the U.S. EPA in 1972. Since that time, numerous modifications and revisions have been added to the computer program to increase its utility. Recently, ES expanded the capabilities of CRSTER. These modifications will be discussed later.

The types of application for which the model was designed include:

- stack design studies;
- combustion source permit applications;
- regulatory variance evaluation;
- monitoring network design;
- control strategy evaluation for SIP's;
- fuel conversion studies;
- control technology evaluation;
- design of supplementary control systems;
- new source review; and
- prevention of significant deterioration.

[†] Harry Moses and Martin R. Kraimer, Paper No. 71-61, APCA Annual Meeting Atlantic City, 1971.

[††] "Meteorology and Atomic Energy", U.S. Atomic Energy Commission, Washington. D.C., July 1968.

The model has been successfully applied previously to these types of problems.

Modified CRSTER is a steady state Gaussian plume technique applicable to both rural and urban areas in uneven terrain. The purpose of the technique is to: determine the maximum 24-hour concentration over a one year period due to point source emissions, determine the meteorological conditions which cause the maximum concentrations, and store concentration information useful in calculating frequency distributions for various averaging times. The concentration for each hour of the year is calculated and midnight-to-midnight averages are determined for each 24-hour period.

The model inputs included meteorological data, point source emission data, and receptor elevations. The emission stack configuration parameters were also required to estimate 24-hour ground level concentrations of TSP. Other inputs regarding study area location and grid spacing were also included. Initially, a grid spacing of 1.0 kilometer was employed. A second run of the dispersion model was made using a refined grid spacing of 0.1 kilometer around the initially predicted maximum receptor site.

Assumptions of the Modified CRSTER Model

The modified CRSTER is based on a recent version of the Gaussian plume equation. The model assumes a continuous emission source, steady-state downwind plume, and a Gaussian distribution for concentrations of pollutants within the plume in both the crosswind and vertical directions. Plume rise is estimated using equations proposed by Briggs for hot, buoyant plumes. As the plume expands due to eddy diffusion, it is diluted and transported downwind by the mean wind. The rate of expansion is characterized by a series of empirical dispersion coefficients which are dependent on the stability of the atmosphere, as determined in studies made by Pasquill and Gifford, and reported by Turner.

The assumptions incorporated in the Gaussian plume equation and the modified CRSTER model can be summarized as follows:

1. The pollutant emitted is a stable gas or aerosol which remains suspended in the air and participates in the turbulent movement of the atmosphere; none of the material is removed as the plume advects and diffuses downwind and there is complete reflection at the ground.

2. The pollutant material within the plume takes on a Gaussian distribution in both the horizontal crosswind and vertical directions, described by empirical dispersion parameters σ_y and σ_z.

3. The plume is assumed to be steady-state, resulting from a continuous and constant source.

Plume Behavior

As previously mentioned, the modified CRSTER model assumes a continuous emissions source, steady-state downwind plume, and a Gaussian distribution for concentrations of particulates within the plume in both the crosswind and vertical directions. The general Gaussian plume equation used in the modified CRSTER model for a continuous emission source gives the local concentration χ of a gas or aerosol at a ground-level location (x,y) by the following expression:

$$\chi(x,y) = \frac{Q}{\pi \sigma_y \sigma_z u} \exp -\left[\frac{1}{2}\left(\frac{y}{\sigma_y}\right)\right]^2 \exp \left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)\right]^2$$

where the wind is advecting the plume at a speed u along the x-axis and dispersing it along the crosswind and vertical direction with diffusion coefficients σ_y, and σ_z, respectively. The pollutant emission from the source is at a uniform rate Q and is assumed to be released at an "effective stack height" H. It is assumed that complete reflection of the plume takes place at the earth's surface, i.e., there is no atmospheric transformation or deposition at the surface. The concentration χ is an average over the time interval represented by σ_y and σ_z. The modified CRSTER Model calculates short-term concentrations and uses these directly as 1-hour average concentrations without consideration of plume history, i.e., each 1-hour period is completely independent.

The empirical dispersion coefficients, σ_y and σ_z, used in the modified CRSTER model are those suggested by Pasquill and Gifford and reported by Turner. Values for σ_y and σ_z are represented as a function of downwind distance from the emissions source and the stability of the atmosphere. These values are representative for a sampling time of up to about 1-hour and were developed based on aerometric measurements taken in open, level to gently rolling country.

Atmospheric stability is determined indirectly from the amount of incoming solar radiation at the surface (insolation), and the wind speed. Pasquill suggested a six category classification scheme from A for extremely unstable to F for moderately stable, based on the range of these two parameters. Because solar radiation is not a widely measured parameter, Turner developed an objective classification method based on cloud cover, ceiling height, and solar elevation. The modified CRSTER model calculates the stability classification by this method for each hour from the recorded meteorological observations.

The wind speed required for input to the modified CRSTER model is considered to be representative of the conditions throughout the vertical height interval in which the plume is dispersing. The wind at the stack elevation is commonly used as an approximation to this condition. Because the wind is generally measured near 7 meters by the National Weather Service (NWS), an adjustment is made in the model by the following power law relationship:

$$u = u_o \ (h/7)^p$$

where

u = hourly wind speed at stack height ($m \ s^{-1}$)

u_o = hourly wind speed near 7m above the ground ($m \ s^{-1}$)

h = stack height (m)

p = wind profile exponent

The profile exponent p is a function of stability and has the values given in Table A-1. The adjusted wind speed is used by the model to calculate plume rise and dilution.

Turbulent mixing and vertical diffusion of a plume is often limited by the existence of a stable layer of air aloft, i.e., an inversion layer. The effects of limited mixing (or plume "trapping") on plume dispersion are incorporated into the modified CRSTER model by the assumption that the plume is completely reflected at the mixing height, as well as the ground. Since multiple reflections are possible, trapping is simulated using the method of

TABLE A-1

WIND SPEED PROFILE EXPONENT

PASQUILL STABILITY CLASS	WIND SPEED PROFILE EXPONENT, P
A = extremely unstable	0.10
B = moderately unstable	0.15
C = slightly unstable	0.20
D = neutral	0.25
E = slightly stable	0.30
F = moderately stable	0.30

multiple images proposed by Bierly and Hewson.[†] In this procedure, each reflection is represented by an "image plume" from an imaginary source with a "stack height" equal to the vertical distance travelled by the plume "edge" to the point of ground reflection. The reflections between the mixing height (L) and the ground are represented by the convergent infinite series of Gaussian plume terms given in Table A-2. Another assumption is that whenever the plume centerline is above the mixing height at a given receptor location, there is no contribution from the plume at that receptor.

Plume Rise

The effective height of emission used in the Gaussian plume equation is defined as the sum of the physical stack height and the plume rise. Estimates of plume rise are required to predict the dispersion of continuous gaseous emissions possessing buoyancy. The rise of emission plumes above their source release height often accounts for a significant reduction in related ground-level concentrations.

Plume rise in the modified CRSTER model is estimated using equations proposed and later modified by Briggs. These equations are based on the assumption that plume rise depends on the inverse of the mean wind speed and is directly proportional to the 2/3 power of the downwind distance from the source, with different equations specified for the neutral-unstable conditions and the stable conditions. Only the final plume rise as predicted by Briggs is used in the modified CRSTER model. Briggs' plume rise equations are detailed below, where all symbols are defined in Table A-3.

- For unstable or neutral atmospheric conditions, the downwind distance of final plume rise is $x_f = 3.5\, x^*$, where

  $$x^* = 14\, F^{5/8}, \text{ when } F < 55 \text{ m}^4 \text{ s}^{-3}$$

  $$x^* = 34\, F^{2/5}, \text{ when } F \geq 55 \text{ m}^4 \text{ s}^{-3}.$$

  The final plume rise under these conditions is

  $$\Delta h = 1.6\, F^{1/3} (3.5\, x^*)^{2/3}\, u^{-1}.$$

[†] Bierly, E.W. and Hewson, E.W., "Some Restrictive Meteorological Conditions to be Considered in the Design of Stacks", Journal of Applied Meteorology, 1:383-390, March 1962.

TABLE A-2

MODIFIED GAUSSIAN PLUME EQUATIONS USED IN THE MODIFIED CRSTER MODEL

If $H \leq L$ and $\sigma_z \leq 1.6L$	$\chi = \frac{Q}{\pi \sigma_y \sigma_z u} \exp \left[- \frac{1}{2} \left(\frac{y}{\sigma_y} \right)^2 \right] \sum_{\substack{N=-\infty \\ (-k)}}^{\substack{(+k) \\ +\infty}} \exp \left[- \frac{1}{2} \left(\frac{H+2NL}{\sigma_z} \right)^2 \right]$
If $H \leq L$ and $\sigma_z > 1.6L$	$\chi = \frac{Q}{\sqrt{2\pi}\sigma_z Lu} \exp \left[- \frac{1}{2} \left(\frac{y}{\sigma_y} \right)^2 \right]$
If $H > L$	$\chi = 0$

TABLE A-3

DEFINITION OF SYMBOLS USED IN BRIGGS' PLUME RISE EQUATIONS

SYMBOL	DEFINITION	UNITS
g	gravitational acceleration	$9.8\ m\ s^{-2}$
d	stack inside diameter at top	m
F	buoyancy flux parameter $[g\ v_s\ (d/2)^2\ (T_s - T/T_s)]$	$m^4\ s^{-3}$
x^*	distance at which atmospheric turbulence begins to dominate entrainment	m
Δh	plume rise above stack top	m
x	downwind distance from the source	m
T	ambient air temperature	°K
T_s	stack gas temperature	°K
u	mean wind speed from stack top to plume top	$m\ s^{-1}$
v_s	stack gas exit velocity	$m\ s^{-1}$
$\partial\theta/\partial z$	vertical potential temperature gradient from stack top to plume top	$°K\ m^{-1}$
s	restoring acceleration per unit vertical displacement for adiabatic motion in the atmosphere, a stability parameter	s^{-2}

- For stable atmospheric conditions, the downwind distance of final plume rise is $x_f = \pi u\ s^{-1/2}$, where

$$s = g\ \partial\theta/\partial z\ T^{-1}.$$

The plume rise is

$$\Delta h = \begin{cases} 2.4\ [F/(u\ s)]^{1/3}, & \text{for windy conditions} \\ 5\ F^{1/4}\ s^{-3/8}, & \text{for near calm conditions} \end{cases}$$

The final plume rise given by these formulae does not take cognizance of "negative" buoyancy due to cold plumes, or aerodynamic effects from flow fields around the stack or nearby tall buildings and prominent terrain. The final plume height used by the modified CRSTER model does not follow changes in terrain height, as described later in this appendix in the discussion of terrain considerations.

Urban-Rural Considerations

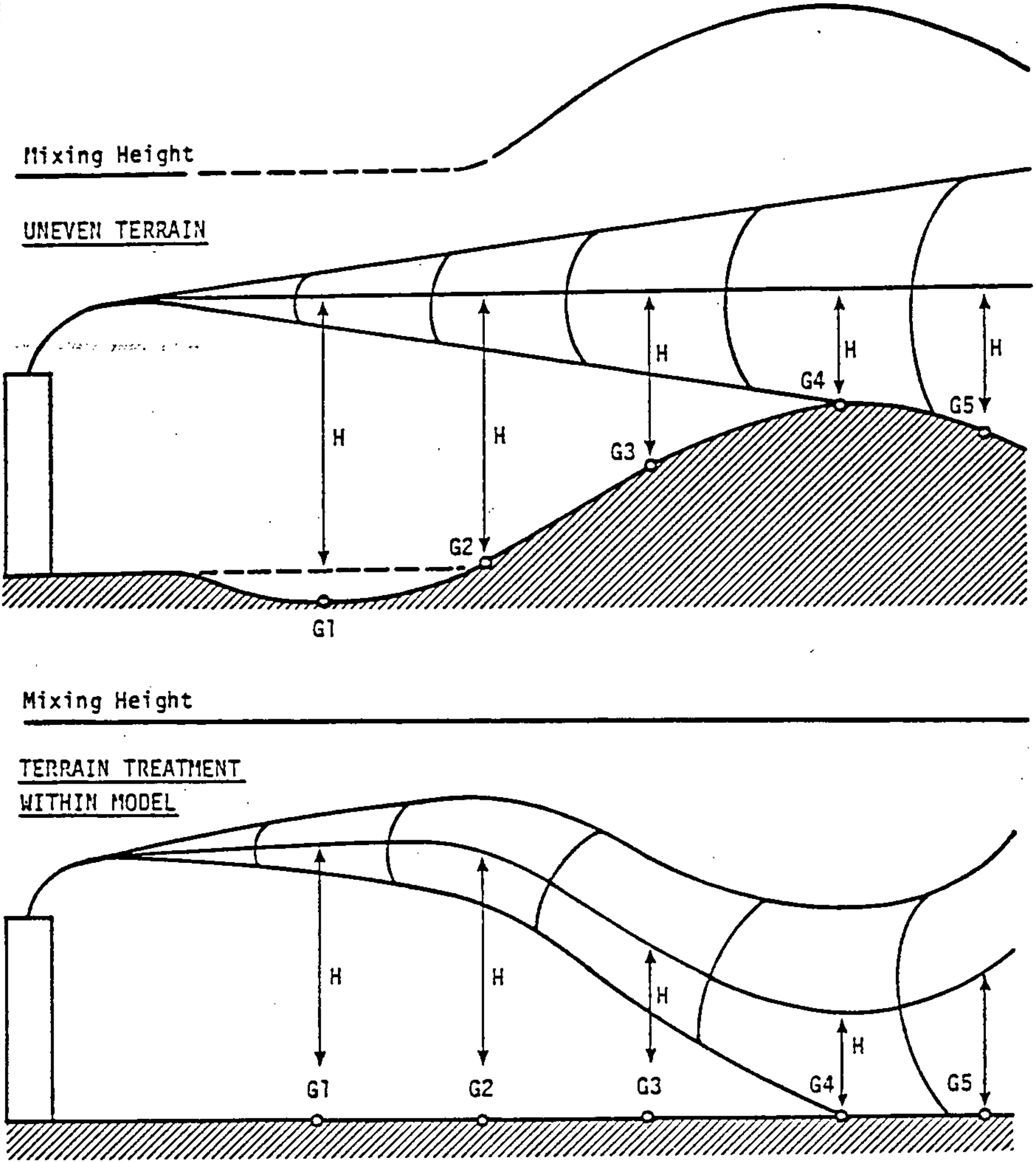
The principal difference between dispersion coefficients in rural and urban environments is associated with the occurrence of the nocturnal, ground-based temperature inversion. On calm, clear nights, radiational cooling can produce such an inversion, and hence stable atmospheric conditions, in a rural environment. Such inversions do not occur, though, in urban areas, due primarily to the influence of a city's larger surface roughness and the release of stored heat from structural surfaces, i.e., the urban heat island effect. Thus, stable atmospheric conditions do not occur near the ground in urban areas on calm, clear nights.

The modified CRSTER model accounts for these effects in both the choice of dispersion coefficients and mixing heights. If an urban application is indicated, stability categories E and F default to category D for the purpose of determining σ_y and σ_z. Separate sets of hourly mixing height data, for urban and rural environments, are input to the model and it chooses between these, depending on the conditions indicated. For the proposed bark boiler, a rural environment was selected for the purpose of short-term disperion modeling.

Terrain Considerations

The modified CRSTER is an uneven terrain model that takes into account certain changes in ground elevation between the point of source emissions (the plant) and the surrounding grid receptor points. The basic method used in the model for making terrain adjustments is illustrated in Figure A-2. For receptors with elevations greater than the stack elevation but less than the top of the lowest stack, the difference in elevation is subtracted from the effective plume height. The terrain adjustment made for any one receptor point does not affect concentrations at any other receptor point. When the height of a receptor is above the shortest stack height, plume impaction on surrounding terrain is possible and the model terminates. The model considers receptors below the ground elevation of the plant to be at plant elevation.

Figure A-2 also illustrates the mixing height assumption. This permits calculations to be made using the modified Gaussian equations without adding a vertical displacement term. This method of treating terrain adjustments assumes ground based receptors and is not equivalent to simply including a vertical coordinate term z in the Gaussian plume equation. The method would not imply any changes in terrain elevation at all. Rather, the value of z would specify the height at which the receptor point would be "floating" in the air, and reflections of the plume at the ground close to the stack, caused by elevated terrain, would not be simulated.



Note: G1-G5 are receptor points at 5 grid distances.

BASIC ILLUSTRATION OF THE METHOD FOR TERRAIN ADJUSTMENT IN THE MODIFIED CRSTER MODEL

APPENDIX B

METEOROLOGICAL CONSIDERATIONS

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METEOROLOGICAL CONSIDERATIONS

All air pollutants emitted by point sources are transported and dispersed by meteorological and topographical conditions. The airborne cycle is initiated with the emission of the pollutants followed by their transport and diffusion through the atmosphere. The cycle is completed when the pollutants are deposited on vegetation, soil, and other surfaces, when they are washed out of the atmosphere by rain, or when they escape into space. In some cases, the pollutants may be reinserted into the atmosphere by the action of the wind.

PARAMETERS OF INTEREST

Three important parameters for the determination of the transport and dispersion of airborne material are wind speed, wind direction, and atmospheric stability. Wind direction and speed determine where the pollutants will go and the degree of downwind dilution. The stability of the atmosphere determines the extent of the vertical and horizontal mixing of the pollutants. Topographic features, including wake effects of the buildings around the stack, require special investigation.

The influence of the wind and stability is evident whenever the effluent forms a visible plume. Terms like fanning, fumigation, coning, looping and lofting have been empirically associated with stability and used to describe plume behavior. The non-visible effluent plume behaves in a similar manner. We know from watching plume behavior that stability must change from day to day and within the day. Actually because the atmosphere is both heated and cooled at the earth's surface everyday, the stability goes through a typical cycle on an average day.

When the temperature of ambient air decreases with altitude at a superadiabatic rate (>0.01°C/m), typically during midday due to heating of the ground surface, unstable conditions prevail, vertical currents are induced, and good vertical mixing of the pollutants occurs. The more normal situation is characterized by a decrease in temperature with height at a rate between neutral conditions (0.01°C/m) and isothermal conditions, temperature being constant with height. Under these conditions, less pronounced but still significant vertical mixing occurs. Under inversion conditions, i.e., an increase of temperature with height which occurs typically near dawn when the ground surface has been cooled by radiation, vertical mixing is inhibited. Such a surface inversion is accompanied by lighter winds and thus concentration levels are raised further. After sunrise, as the sun begins to heat the surface, the lower part of the inversion may be removed, leaving an inversion aloft. Figure B-1 shows possible changes in the vertical temperature gradient during the course of the day. In each case, the dashed line is the neutral or dry adiabatic rate of temperature change. At 3 p.m., an unstable condition is evident. By midnight, a surface inversion begins to form, becoming fully formed by 6 a.m. and extending to some unknown level. By 9 a.m., the surface has warmed up, leaving an inversion aloft, and by noon the sounding is nearly neutral.

Pollutants released below an inversion will be trapped and inhibited from mixing to greater depths than the bottom of the stable layer. Pollutants released into or above an inversion will be prevented from mixing downward. Thus, ground-level concentrations from a surface or low level source are increased by low-level stability, and ground-level concentrations from a plume released sufficiently high are reduced by low-level stability. In the latter case, short-term concentrations are highest in unstable conditions where the plume is brought rapidly down with little dilution or dispersion.

An inversion or a stable layer aloft may also exist resulting from the dynamic effects of the earth's large scale circulation. These, too, effectively limit the vertical extent to which a pollutant may be mixed. Holzworth has calculated the average height of this mixed layer for the morning and afternoon (minimum and maximum depths, respectively) for the four seasons. The Holzworth data were used to calculate daily variations of mixing depths for the site of the emissions being modeled.

SPECIFIC METEOROLOGICAL DATA

For a dispersion model to provide useful and valid results, the meteorological data used must be representative of the transport and dispersion conditions in the vicinity of the plant that the model is attempting to simulate. The representativeness of the data is dependent on: the proximity of the meteorological monitoring site to the power plant, the complexity of the terrain in the area, the exposure of the meteorological monitoring site, and

CHANGES IN VERTICAL TEMPERATURE GRADIENT DURING THE COURSE OF THE DAY

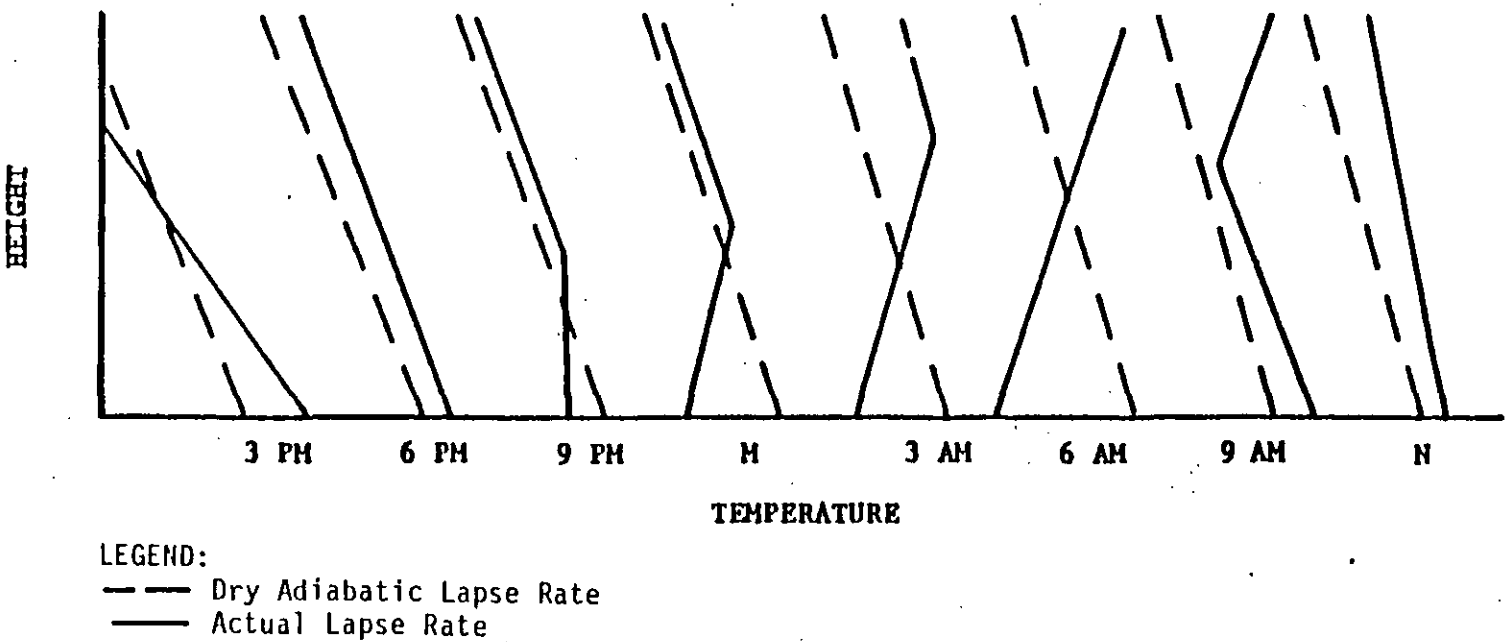

FIGURE B-1

the period of time during which the data were collected. The representativeness of the data can be adversely affected by large distances between the source and receptors of interest and valley-mountain, land-water, and urban-rural characteristics of the plant area.

As previously stated, the meteorological data required as a minimum to describe transport and dispersion in the atmosphere are wind direction, wind speed, atmospheric stability, and mixing height or related indicators of atmospheric turbulence and mixing. The U.S. EPA prefers that the meteorological data base used with air quality models include several years of data. Such a multi-year data base allows the consideration of variations in meteorological conditions that occur from year to year. The exact number of years needed to account for such variations in meteorological conditions is uncertain and depends on the climatic extremes in a given area. The EPA suggests that five years generally yield an adequate meteorological data base. Data from a single year should be supported by a demonstration of representativeness.

The St. Regis projects will be at Cantonment in Escambia County. The terrain is low-lying with little relief. The sandy soil supports the long-leaf pine for lumber and fuel, commercial groves and green truck farms. The annual temperature averages about 68°F, with an average maximum near 74°F and minimum near 61°F. The average annual rainfall of about 58 inches ranges from 4 inches per month in January to 7.65 inches per month in August. Prevailing winds are northerly in winter, southerly in summer. Sixty four percent of the maximum amount of sunshine possible at this latitude is experienced on the average.

The joint frequency distribution of wind speed and direction and stability (Table B-1) has been prepared for a ten-year period from observations made at Whiting Naval Air Station, Milton, Florida from 1962 to 1971. These data obtained from the National Climatic Center were the data input for the long-term AQDM modeling performed in this study. These observations provide stable estimates of the relative frequencies of these meteorological parameters and should give good confidence to the AQDM results.

Wind speed, direction and stability classification data were also obtained from the Climatic Center for 1964 for Pensacola. This was the most recent year for which surface observations have been transcribed on 24 obser-

TABLE B-1

1962-1971 JOINT FREQUENCY DISTRIBUTION OF WIND SPEED, WIND DIRECTION, AND STABILITY CLASS AT MILTON, FLORIDA (%)

	WIND SPEED (KTS)							AVERAGE	STABILITY CLASS				
DIRECTION	0-3	4-6	7-10	11-16	17-21	>21	TOTAL	WS	A	B	C	D	E
N	3.1	3.8	3.8	1.9	0.5	0.1	13.2	7.1	0.2	0.9	1.3	4.6	6.1
NNE	1.9	2.5	2.1	0.8	0.1	*	7.4	9.0	0.1	0.6	1.0	2.4	3.3
NE	1.7	2.0	1.5	0.5	0.1	*	5.8	5.8	0.1	0.4	0.7	1.8	2.7
ENE	1.4	1.9	1.6	0.5	0.1	*	5.5	6.2	0.1	0.5	0.8	2.0	2.1
E	2.5	3.4	2.7	0.9	0.1	*	9.6	6.6	0.1	0.8	1.4	3.8	3.5
ESE	1.2	1.7	1.3	0.5	0.1	*	4.8	6.2	0.1	0.4	0.6	2.1	1.5
SE	0.9	1.2	0.9	0.5	0.1	*	3.6	6.6	*	0.3	0.4	1.9	1.1
SSE	0.9	1.3	1.5	0.8	0.1	*	4.6	7.2	0.1	0.3	0.5	2.4	1.2
S	1.7	2.8	3.1	1.5	0.2	*	9.3	7.2	0.1	0.5	1.3	4.4	3.1
SSW	1.1	1.8	1.8	1.1	0.1	*	5.9	7.2	0.1	0.2	0.7	2.8	2.2
SW	1.1	1.4	0.9	0.4	0.1	*	3.9	6.0	*	0.2	0.4	1.3	2.0
WSW	1.5	1.7	1.1	0.4	0.1	*	4.8	5.7	0.1	0.3	0.5	1.4	2.6
W	2.0	1.9	1.1	0.3	0.1	*	5.4	5.0	0.1	0.4	0.6	1.3	3.0
WNW	1.0	1.1	0.9	0.4	0.1	*	4.6	4.8	0.1	0.3	0.5	1.2	1.5
NW	0.9	1.1	1.3	0.9	0.3	0.1	4.6	8.2	0.1	0.4	0.5	2.0	1.5
NNW	1.5	1.9	2.3	1.5	0.5	0.1	7.8	8.1	0.2	0.7	0.9	3.4	2.8
TOTAL	24.4	31.5	27.9	12.9	4.2	0.3			1.6	7.2	12.1	38.8	40.2
A	0.9	0.6	0.0	0.0	0.0	0.0							
B	2.7	3.0	1.4	0.0	0.0	0.0							
C	1.5	3.7	6.3	0.8	*	*							
D	2.4	7.0	14.3	12.3	2.3	0.6							
E	16.9	17.1	6.1	0.0	0.0	0.0							

* Less than 0.05%

vations per day basis for data analysis purposes. These surface data were used in conjunction with mixing height data obtained from twice-daily radiosonde observations made at Mobile, Alabama. This was the basic data input for the short-term modeling with CRSTER in this study. Mobile upper air data were considered to be the most representative of meteorological conditions at the plant location. Though Mobile is roughly 40 miles to the west, it too is dominated by the thermal influence of the Gulf of Mexico and the stability is characteristically the same for on and off gulf winds.

The joint frequency distribution of wind speed, wind direction and stability class for the 10-year period 1962-1971 is presented in Table B-1. This was meteorological input for the annual averages modeled by AQDM.