FDER FORM 17-1.202(1)

APPLICATION TO OPERATE/CONSTRUCT

AIR POLLUTION SOURCES

ROTARY WATERWALL DESIGN

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

APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

SOURCE TYPE: Energy Recovery Facility (ERF) [XX] New[1] [ ] Existing[1]

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

COMPANY NAME: Lee County COUNTY: Lee

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) * See footnote below

SOURCE LOCATION: Street Buckingham Rd. & State Route 82 City Lee County

UTM: East 424 Km North 2946 Km

Latitude 26 ° 37 ' 54 "N Longitude 81 ° 45 ' 41 "W

APPLICANT NAME AND TITLE: Lee County

APPLICANT ADDRESS: 2178 McGregor Blvd., Ft. Myers, FL 33902

SECTION I: STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

I am the undersigned owner or authorized representative* of Lee County

I certify that the statements made in this application for a construction and operation 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:

George E. Reilly, P.E. Administrative Director
Name and Title (Please Type)

Date: 6/25/90 Telephone No. 813-335-2276

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)

* Mass-burn rotary waterwall combustor with staged combustion/low excess air, dry scrubber and fabric filter.

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 Michael J. Ihnat

Michael J. Ihnat, P.E.
Name (Please Type)

Camp Dresser & McKee, Inc.
Company Name (Please Type)

1620 Medical Lane, Suite 221
Fort Myers, Florida 33907
Mailing Address (Please Type)

Michael J. Ihnat
6/27/90

Florida Registration No. 39126 Date: 6/27/90 Telephone No. (813) 939-3775

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.

See Attachment I

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

Start of Construction August 1991 Completion of Construction January 1994

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.)

See PSD Permit Application Section 4.0

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

Not Applicable

ATTACHMENT I

The Lee County RRF will combust 2400 tons per day of municipal solid waste in five (5) mass-burn rotary waterwall combustors and generate steam for electrical production. Each of the Facility's combustors will use staged combustion/low excess air to control nitrogen oxides, a dry scrubber to remove acid gases and a baghouse to remove particulate matter. The proposed emission limits will meet existing state and federal standards and satisfy BACT requirements for all applicable pollutants.

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

if power plant, hrs/yr 8760 ; 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. Yes
3. Does the State "Prevention of Significant Deterioriation" (PSD) requirement apply to this source? If yes, see Sections VI and VII. Yes
4. Do "Standards of Performance for New Stationary Sources" (NSPS) apply to this source? Yes
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.

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

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

Description	Contaminants		Utilization Rate - lbs/hr	Relate to Flow Diagram
	Type	% Wt		
Lime Silo	Pebble Lime		3,000	See Section 4.0 of the
Ash Handling Bldg.	Ash Residue		55,500	PSD Permit Application

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

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	
Pebble Lime	.129	.033					See
Ash Residue*	1.6	7.01					Section
	*Ash residue wetted to 30 percent moisture to						4.0 of PSD
	suppress dust formation						Permit
							Application

[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)

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles Size Collected (in microns) (If applicable)	Basis for Efficiency (Section V Item 5)
Baghouse *	Pebble Lime			Manufacture
Baghouse *	Ash Residue			Specificatio
	* Additional information to be provided later by vendor			

E. Fuels

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	avg/hr	max./hr	
Refuse *	200,000 lb/hr	220,000 lb/hr	1100 MMBtu/hr
Propane Gas **	0.006 MMcf/hr	0.185 MMcf/hr	430 MMBtu/hr
* Facility Processing Totals			
** Facility Totals - Used for Auxiliary Purposes			

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

Fuel Analysis: (Refuse)

Percent Sulfur: 0.10 (wet basis) Percent Ash: 20.9 (wet basis)

Density: N/A lbs/gal Typical Percent Nitrogen: 0.50 (wet basis)

Heat Capacity: 5000 BTU/lb N/A BTU/gal

Other Fuel Contaminants (which may cause air pollution): Chlorine 0.40 (wet basis)

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

Annual Average ____________ Maximum ____________

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

Spent/Reacted lime and combustion ash which will be landfilled.

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

Stack Height: ______ ft. Stack Diameter: ______ ft.

Gas Flow Rate: ______ ACFM ______ DSCFM Gas Exit Temperature: ______ °F.

Water Vapor Content: ______ % Velocity: ______ FPS

SECTION IV: INCINERATOR INFORMATION

Type of Waste	Type 0 (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Incinerated		200,000					
Uncontrolled (lbs/hr)		200,000					

Description of Waste Municipal Solid Waste

Total Weight Incinerated (lbs/hr) 200,000 Design Capacity (lbs/hr) 220,000 (110%)

Approximate Number of Hours of Operation per day 24 day/wk 7 wks/yr. 52

Manufacturer Vendor not yet selected

Date Constructed ______ Model No. ______

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

Stack Height: 265 ft. Stack Diamter: * Stack Temp. 239.9°F

Gas Flow Rate: ** ACFM *** DSCFM* Velocity: 65 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

[XX] Other (specify) Staged Combustion/Low Excess Air
Dry Scrubber and Baghouse

* 57 in per flue (4 flues)
66 in per flue (1 flue)

** 69331 per flue (4 flues)
92441 per flue (1 flue)

*** 41156 per flue (4 flues)
54874 per flue (1 flue)

Brief description of operating characteristics of control devices:

See Attachment II

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

Ash residue will be sent to Lee/Hendry Counties' landfill

Wastewater effluent will be treated at the Facility to meet the City of Fort Myers industrial pretreatment standards.

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)]
2. To a construction application, attach basis of emission estimate (e.g., design calculations, design drawings, pertinent manufacturer's test data, etc.) and attach proposed methods (e.g., FR Part 60 Methods 1, 2, 3, 4, 5) to show proof of compliance with applicable standards. To an operation application, attach test results or methods used to show proof of compliance. Information provided when applying for an operation permit from a construction permit shall be indicative of the time at which the test was made.
3. Attach basis of potential discharge (e.g., emission factor, that is, AP42 test).
4. With construction permit application, include design details for all air pollution control systems (e.g., for baghouse include cloth to air ratio; for scrubber include cross-section sketch, design pressure drop, etc.)
5. With construction permit application, attach derivation of control device(s) efficiency. Include test or design data. Items 2, 3 and 5 should be consistent: actual emissions = potential (1-efficiency).
6. An 8 1/2" x 11" flow diagram which will, without revealing trade secrets, identify the individual operations and/or processes. Indicate where raw materials enter, where solid and liquid waste exit, where gaseous emissions and/or airborne particles are evolved and where finished products are obtained.
7. An 8 1/2" x 11" plot plan showing the location of the establishment, and points of airborne emissions, in relation to the surrounding area, residences and other permanent structures and roadways (Example: Copy of relevant portion of USGS topographic map).
8. An 8 1/2" x 11" plot plan of facility showing the location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.

ATTACHMENT II

Each of the Facility's mass-burn rotary waterwall combustors shall operate using staged combustion/low excess air and shall each have a dry scrubber and a baghouse. The combustors shall inhibit the information of nitrogen oxides (NO_x) through the use of staged combustion/low excess air. A dry scrubber shall remove SO_2 and other acid gases from the flue gas stream through the injection of a lime slurry into a reaction vessel. The lime slurry reacts with the acid gases to form calcium based salts which are removed downstream by a baghouse. Through physical filtration, the baghouse collects and removes particulate matter and calcium based salts from the flue gas that accumulates on the fabric filter media.

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

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

SECTION VI: BEST AVAILABLE CONTROL TECHNOLOGY

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

[XX] Yes [ ] No

Contaminant	Rate or Concentration
Particulate Matter	0.08 grains per dry standard cubic foot
	(gr/dscf) corrected to 12% CO_2

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

[ ] Yes [XX] No

Contaminant	Rate or Concentration
See Section 4.0 of PSD Application	

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

Contaminant	Rate or Concentration
Carbon Monoxide, Nitrogen Oxides	See PSD Permit Application
Sulfur Dioxide, Volatile Organic Substances,	Section 4.0 & Attachment A
Particulate Matter, Lead, Beryllium, Mercury,	
Fluorides and Sulfuric Acid Mist	

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: °F.

e. Velocity: FPS

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

1. See Attachment III

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.

ATTACHMENT III

1. a. Control Device: Dry Scrubber
   b. Operating Principles: Acid gas neutraliztion with lime slurry
   c. Efficiency: i) 95% HCl removal by weight or 25 ppmdv @ 7% O_2, both over an 8-hour average.

      ii) 80% SO_2 removal by weight or 30 ppmdv @ 7% O_2, both over a 24-hour average.
   d. Capital Cost: $8,301,000 (includes bond burden)
   e. Useful Life: 20 years
   f. Operating Cost: $1,910,000
   g. Energy: 3,145,000 kWh/yr
   h. Maintenance Cost: $107,500
   i. Availability of Materials Construction and Process Chemicals: Readily Available
   j. Applicability to Manufacturing Processes: Not Applicable
   k. Ability to construct with control device, install in available space and operate within proposed levels: Site and design are adequate

2. a. Control Device: Baghouse (also known as fabric filter)
   b. Operating Principles: Fabric filtration and removal of particulate matter.
   c. Efficiency: 0.010 gr/dscf @ 7% O_2
   d. Capital Cost: See PSD Permit Application Section 4.0 Best demonstrated control technology applied with top down BACT level of control
   e. Useful Life: 20 years
   f. Operating Cost: See above, 2d. Capital Cost
   g. Energy: See above, 2d. Capital Cost
   h. Maintenance Costs: See above 2d. Capital Cost
   i. Availability of Construction Materials and Process Chemicals: Readily Available
   j. Applicability to Manufacturing Processes: Not Applicable
   k. Ability to construct with control device, install available space, and operate within proposed levels: Site and design are adequate

3. a. Control Device: Electrostatic Precipitator (ESP)
   b. Operating Principles: Dry collection by electrically charging particles on oppositely charged surfaces
   c. Efficiency: 0.010 gr/dscf @ 7% O_2
   d. Capital Cost: See PSD Permit Application Section 4.0
   e. Useful Life: 20 years
   f. Operating Cost: See above, 3d. Capital Cost
   g. Energy: See above, 3d. Capital Cost
   h. Maintenance Costs: See above, 3d. Capital Cost
   i. Availability of Construction Materials and Process Chemicals: Readily Available
   j. Applicability to Manufacturing Processes: Not Applicable
   k. Ability to construct with control device, install available space, and operate within proposed levels: Site and design are adequate

4. a. Control Device: Selective Non-catalytic Reduction System
   b. Operating Principles: Nitrogen oxide reduction to elemental nitrogen with ammonia or other nitrogen based compound
   c. Efficiency: See PSD Permit Application Section 4.0 Technical infeasibility and incompatibility with the mass-burn rotary waterwall combustor demonstrated in the BACT analysis.
   d. Capital Cost: See above, 4c. Efficiency
   e. Useful Life: See above, 4c. Efficiency
   f. Operating Cost: See above, 4c. Efficiency
   g. Energy: See above, 4c. Efficiency
   h. Maintenance Costs: See above, 4c. Efficiency
   i. Availability of Construction Materials and Process Chemicals: See above, 4c. Efficiency
   j. Applicability to Manufacturing Process: Not Applicable
   k. Ability to construct with control device, install in available space and operate within proposed levels: Not Applicable

5. a. Control Device: Mass-burn Rotary Waterwall Combustor
   b. Operating Principles: Nitrogen oxide formation inhibited through combustor's inherent staged combustion/low excess air operating mode - See PSD Permit Application Section 4.0
   c. Efficiency: 150 ppmdv of NO_x corrected to 7% O_2 over a 24-hour average and 220 ppmdv of NO_x corrected to 7% O_2 over a 1-hour average
   d. Capital Cost: See above, 5b. Operating Principles
   e. Useful Life: See above, 5b. Operating Principles
   f. Operating Cost: See above, 5b. Operating Principles
   g. Energy: See above, 5b. Operating Principles
   h. Maintenance Cost: See above, 5b. Operating Principles
   i. Availability of Construction Materials and Process Chemicals: See above, 5b. Operating Principles
   j. Applicability to Manufacturing Processes: Not Applicable
   k. Ability to construct with control device, install available space, and operate within proposed levels: Not Applicable

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: See Attachment IV

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.

ATTACHMENT IV

A. 1. Control Device: Dry Scrubber
2. Efficiency: i) 95% HCl removal by weight or 25 ppmdv @ 7% O_2, both over an 8-hour average

ii) 80% SO_2 removal by weight or 30 ppmdv @ 7% O_2, both over a 24-hour average
3. Capital Cost: $8,301,000 (includes bond burden)
4. Useful Life: 20 years
5. Operating Cost: $1,910,000
6. Energy: 3,145,000 KWh/yr
7. Maintenance Cost: $107,500
8. Manufacturer: Not yet selected
9. Other locations where employed on similar processes:

Kent County
1500 Scribner Ave. N.W.
Grand Rapids, MI 49504

York County
Manchester Township
2801 North George St.
York, PA 17402

B. 1. Control Device: Baghouse (also known as fabric filter)
2. Efficiency: 0.010 gr/dscf @ 7% O_2
3. Capital Cost: See PSD Permit Application Section 4.0
Best demonstrated control technology applied with top down BACT level of control
4. Useful Life: 20 years
5. Operating Cost: See above, B.3, Capital Cost
6. Energy: See above, B.3, Capital Cost
7. Maintenance Cost: See above, B.3, Capital Cost
8. Manufacturer: Not yet selected
9. Other locations where employed on similar processes:

Kent County
1500 Scribner Ave. N.W.
Grand Rapids, MI 49504

York County
Manchester Township
2801 North George St.
York, PA 17402

C. 1. Control Device: Mass-burn Rotary Waterwall Combustor
2. Efficiency: 150 ppmdv of NO_x corrected to 7% O_2 over a 24-hour average and 220 ppmdv of NO_x corrected to 7% O_2 over a 1-hour average
3. Capital Cost: See PSD Permit Application, Section 4.0
Best demonstrated control technology
4. Useful Life: 20 years
5. Energy: See above, C.3, Capital Cost
6. Energy: See above, C.3, Capital Cost
7. Maintenance Cost: See above, C.3, Capital Cost
8. Manufacturer: Not yet selected
9. Other locations where employed on similar processes:

York County
Manchester Township
2801 North George St.
York, PA 17402

Bay Resource Management Center
P.O. Box 1818
Panama City, FL 32402

(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: See Section 4.0 of PSD Permit Application

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

SECTION VII - PREVENTION OF SIGNIFICANT DETERIORATION

A. Company Monitored Data

1. ________ 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. 5 Year(s) of data from 01 / 01 / 82 (month day year) to 12 / 30 / 86 (month day year)

2. Surface data obtained from (location) Ft. Myers (Page Field)

3. Upper air (mixing height) data obtained from (location) Tampa International Airport

4. Stability wind rose (STAR) data obtained from (location) Not Used

C. Computer Models Used

1. Industrial Source Complex (ISC) Version - 6 Modified? NO If yes, attach description.

2. VISCREEN Modified? NO 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.

. Applicants Maximum Allowable Emission Data Total Facility Emissions

Pollutant	Emission Rate	
TSP	2.44	grams/sec
SO^2	18.78	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.

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STOKER WATERWALL DESIGN

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

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Signed:

George E. Reilly, P.E. Administrative Director
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Date: 6/25/90 Telephone No. 813-335-2276

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Signed Michael J. Ihnat

Michael J. Ihnat
6/27/90

Michael J. Ihnat, P.E.
Name (Please Type)

Camp Dresser & McKee, Inc.
Company Name (Please Type)
1620 Medical Lane, Suite 221
Fort Myers, Florida 33907
Mailing Address (Please Type)

Florida Registration No. 39126 Date: 6/27/90 Telephone No. (813) 939-3775

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See Attachment I

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

Start of Construction August 1991 Completion of Construction January 1994

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.)

See PSD Permit Application Section 4.0

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

Not Applicable

ATTACHMENT I

The Lee County RRF will combust 2400 tons per day of municipal solid waste in four (4) mass-burn stoker waterwall combustors and generate steam for electrical production. Each of the Facility's combustors will use a SNCR system to reduce nitrogen oxides, a dry scrubber to remove acid gases and a baghouse to remove particulate matter. The proposed emission limits will meet existing state and federal standards and satisfy BACT requirements for all applicable pollutants.

. Requested permitted equipment operating time: hrs/day 24 ; days/wk 7 ; wks/yr 52 ;
if power plant, hrs/yr 8760 ; 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. Yes
3. Does the State "Prevention of Significant Deterioriation" (PSD) requirement apply to this source? If yes, see Sections VI and VII. Yes
4. Do "Standards of Performance for New Stationary Sources" (NSPS) apply to this source? Yes
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.

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

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

Description	Contaminants Type	Contaminants % Wt	Utilization Rate - lbs/hr	Relate to Flow Diagram
Lime Silo	Pebble Lime		3,000	See Section 4.0 of the
Ash Handling Bldg.	Ash Residue		55,500	PSD Permit Application

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

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] Maximum lbs/hr	Emission[1] Actual T/yr	Allowed[2] Emission Rate per Rule 17-2	Allowable[3] Emission lbs/hr	Potential[4] Emission lbs/yr	Potential[4] Emission T/yr	Relate to Flow Diagram
Pebble Lime	.129	.033					See
Ash Residue*	1.6	7.01					Section
	*Ash residue wetted to 30 percent moisture to						4.0 of PSD
	suppress dust formation						Permit
							Application

[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)

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles Size Collected (in microns) (If applicable)	Basis for Efficiency (Section V Item 5)
Baghouse *	Pebble Lime			Manufacturer
Baghouse *	Ash Residue			Specification
	* Additional information to be provided later by vendor			

E. Fuels

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	avg/hr	max./hr	
Refuse *	200,000 lb/hr	220,000 lb/hr	1100 MMBtu/hr
Propane Gas **	0.006 MMcf/hr	0.185 MMcf/hr	430 MMBtu/hr
* Facility Processing Totals			
** Facility Totals - Used for Auxiliary Purposes			

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

Fuel Analysis: (Refuse)

Percent Sulfur: 0.10 (wet basis) Percent Ash: 20.9 (wet basis)

Density: N/A lbs/gal Typical Percent Nitrogen: 0.50 (wet basis)

Heat Capacity: 5000 BTU/lb N/A BTU/gal

Other Fuel Contaminants (which may cause air pollution):

Chlorine 0.40 (wet basis)

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

Annual Average ______ Maximum ______

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

Spent/Reacted lime and combustion ash which will be landfilled.

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

Stack Height: ____________ ft. Stack Diameter: ____________ ft.

Gas Flow Rate: ________ ACFM ________ DSCFM Gas Exit Temperature: ____________ °F.

Water Vapor Content: ____________ % Velocity: ____________ FPS

SECTION IV: INCINERATOR INFORMATION

Type of Waste	Type 0 (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Incinerated			200,000				
Uncontrolled (lbs/hr)			200,000				

Description of Waste Municipal Solid Waste

Total Weight Incinerated (lbs/hr) 200,000 Design Capacity (lbs/hr) 220,000 (110%)

Approximate Number of Hours of Operation per day 24 day/wk 7 wks/yr. 52

Manufacturer Vendor not yet selected

Date Constructed ____________ Model No. ____________

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

Stack Height: 265 ft. Stack Diamter: 74 in per flue (4 flues) Stack Temp. 239.9°F

Gas Flow Rate: 116943 per flue (4 flues) ACFM 72039 DSCFM* Velocity: 65 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

[XX] Other (specify) Selective Non-catalytic Reduction
Dry Scrubber and Baghouse

Brief description of operating characteristics of control devices:

See Attachment II

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

Ash residue will be sent to Lee/Hendry Counties' landfill

Wastewater effluent will be treated at the Facility to meet the City of Fort Myers industrial pretreatment standards.

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)]

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

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

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

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

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

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

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

ATTACHMENT II

Each of the Facility's mass-burn stoker waterwall combustors shall have a dedicated selective non-catalytic reduction (SNCR) system, a dry scrubber and a baghouse. The SNCR system shall reduce nitrogen oxides (NO_x) in the flue gas stream to elemental nitrogen (N_2) through the injection of ammonia (NH_3) in the boiler. A dry scrubber shall remove SO_2 and other acid gases from the flue gas stream through the injection of a lime slurry into a reaction vessel. The lime slurry reacts with the acid gases to form calcium based salts which are removed downstream by a baghouse. Through physical filtration, the baghouse collects and removes particulate matter and calcium based salts from the flue gas that accumulates on the fabric filter media.

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

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

SECTION VI: BEST AVAILABLE CONTROL TECHNOLOGY

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

[XX] Yes [ ] No

Contaminant	Rate or Concentration
Particulate Matter	0.08 grains per dry standard cubic foot
	(gr/dscf) corrected to 12 % CO_2

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

[ ] Yes [XX] No

Contaminant	Rate or Concentration
See Section 4.0 of PSD Application	

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

Contaminant	Rate or Concentration
Carbon Monoxide, Nitrogen Oxides	See PSD Permit Application
Sulfur Dioxide, Volatile Organic Substances,	Section 4.0 & Attachment A
Particulate Matter, Lead Beryllium, Mercury,	
Fluorides and Sulfuric Acid Mist	

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: °F.

e. Velocity: FPS

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

1. See Attachment III

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.

ATTACHMENT III

1. a. Control Device: Dry Scrubber
   b. Operating Principles: Acid gas neutraliztion with lime slurry
   c. Efficiency: i) 95% HCl removal by weight or 25 ppmdv @ 7% O_2, both over an 8-hour average.

      ii) 80% SO_2 removal by weight or 30 ppmdv @ 7% O_2, both over a 24-hour average.
   d. Capital Cost: $8,301,000 (includes bond burden)
   e. Useful Life: 20 years
   f. Operating Cost: $1,910,000
   g. Energy: 3,145,000 kWh/yr
   h. Maintenance Cost: $107,500
   i. Availability of Materials Construction and Process Chemicals: Readily Available
   j. Applicability to Manufacturing Processes: Not Applicable
   k. Ability to construct with control device, install in available space and operate within proposed levels: Site and design are adequate

2. a. Control Device: Baghouse (also known as fabric filter)
   b. Operating Principles: Fabric filtration and removal of particulate matter.
   c. Efficiency: 0.010 gr/dscf @ 7% O_2
   d. Capital Cost: See PSD Permit Application Section 4.0
      Best demonstrated control technology applied with top down BACT level of control
   e. Useful Life: 20 years
   f. Operating Cost: See above, 2d. Capital Cost
   g. Energy: See above, 2d. Capital Cost
   h. Maintenance Costs: See above, 2d. Capital Cost
   i. Availability of Construction Materials and Process Chemicals: Readily Available
   j. Applicability to Manufacturing Processes: Not Applicable
   k. Ability to construct with control device, install available space, and operate within proposed levels: Site and design are adequate

3. a. Control Device: Electrostatic Precipitator (ESP)
   b. Operating Principles: Dry collection by electrically charging particles on oppositely charged surfaces
   c. Efficiency: 0.010 gr/dscf @ 7% O_2
   d. Capital Cost: See PSD Permit Application Section 4.0
   e. Useful Life: 20 years
   f. Operating Cost: See above, 3d. Capital Cost
   g. Energy: See above, 3d. Capital Cost
   h. Maintenance Costs: See above, 3d. Capital Cost
   i. Availability of Construction Materials and Process Chemicals: Readily Available
   j. Applicability to Manufacturing Processes: Not Applicable
   k. Ability to construct with control device, install available space, and operate within proposed levels: Site and design are adequate

4. a. Control Device: Selective Non-catalytic Reduction System
b. Operating Principles: Nitrogen oxide reduction to elemental nitrogen with ammonia or other nitrogen based compound
c. Efficiency: 45% NOx removal
d. Capital Cost: See PSD Permit Application Section 4.0 - Best demonstrated control technology applied with top down BACT level of control
e. Useful Life: 20 years
f. Operating Cost: See above, 4d. Capital Cost
g. Energy: See above, 4d. Capital Cost
h. Maintenance Costs: See above, 4d. Capital Cost
i. Availability of Construction Materials and Process Chemicals: Readily Available
j. Applicability to Manufacturing Process: Not Applicable
k. Ability to construct with control device, install in available space and operate within proposed levels: Site and design are adequate.

5. a. Control Device: Mass-burn Rotary Waterwall Combustor
b. Operating Principles: Nitrogen oxide formation inhibited through combustor's inherent staged combustion/low excess air operating mode
c. Efficiency: Not applicable since Facility shall use a Mass-burn Stoker Waterwall Combustor
d. Capital Cost: See above, 5c. Efficiency
e. Useful Life: See above, 5c. Efficiency
f. Operating Cost: See above, 5c. Efficiency
g. Energy: See above, 5c. Efficiency
h. Maintenance Cost: See above, 5c. Efficiency
i. Availability of Construction Materials and Process Chemicals: See above, 5c. Efficiency
j. Applicability to Manufacturing Processes: Not Applicable
k. Ability to construct with control device, install available space, and operate within proposed levels: Not Applicable

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: See Attachment IV

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.

ATTACHMENT IV

A.

1. Control Device: Dry Scrubber
2. Efficiency:
   - i) 95% HCl removal by weight or 25 ppmdv @ 7% O_2, both over an 8-hour average
   - ii) 80% SO_2 removal by weight or 30 ppmdv @ 7% O_2, both over a 24-hour average
3. Capital Cost: $8,301,000 (includes bond burden)
4. Useful Life: 20 years
5. Operating Cost: $1,910,000
6. Energy: 3,145,000 KWh/yr
7. Maintenance Cost: $107,500
8. Manufacturer: Not yet selected
9. Other locations where employed on similar processes:

Kent County
1500 Scribner Ave. N.W.
Grand Rapids, MI 49504

York County
Manchester Township
2801 North George St.
York, PA 17402

B.

1. Control Device: Baghouse (also known as fabric filter)
2. Efficiency: 0.010 gr/dscf @ 7% O_2
3. Capital Cost: See PSD Permit Application Section 4.0 Best demonstrated control technology applied with top down BACT level of control
4. Useful Life: 20 years
5. Operating Cost: See above, B.3, Capital Cost
6. Energy: See above, B.3, Capital Cost
7. Maintenance Cost: See above, B.3, Capital Cost
8. Manufacturer: Not yet selected
9. Other locations where employed on similar processes:

Kent County
1500 Scribner Ave. N.W.
Grand Rapids, MI 49504

York County
Manchester Township
2801 North George St.
York, PA 17402

C.

1. Control Device: Selective Non-catalytic Reduction System
2. Efficiency: 45% NOx reduction
3. Capital Cost: See PSD Permit Application, Section 4.0 Best demonstrated control technology applied with top down BACT level of control
4. Useful Life: 20 years
5. Energy: See above, C.3, Capital Cost
6. Energy: See above, C.3, Capital Cost
7. Maintenance Cost: See above, C.3, Capital Cost
8. Manufacturer: Not yet selected
9. Other locations where employed on similar processes:

Stanislaus County
P.O. Box 642
Modesto, CA 95353

SERRF
333 W. Ocean Blvd.
Long Beach City Hall
Long Beach, CA 90802

(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: See Section 4.0 of PSD Permit Application

---

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

SECTION VII - PREVENTION OF SIGNIFICANT DETERIORATION

A. Company Monitored Data

1. ________ 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. 5 Year(s) of data from 01 / 01 / 82 (month day year) to 12 / 30 / 86 (month day year)

2. Surface data obtained from (location) Ft. Myers (Page Field)

3. Upper air (mixing height) data obtained from (location) Tampa International Airport

4. Stability wind rose (STAR) data obtained from (location) Not Used

C. Computer Models Used

1. Industrial Source Complex (ISC) Version - 6 Modified? NO If yes, attach description.

2. VISCREEN Modified? NO 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.

Applicants Maximum Allowable Emission Data Total Facility Emissions

Pollutant	Emission Rate	
TSP	2.44	grams/sec
SO^2	18.78	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.

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ACRONYMS AND ABBREVIATIONS

AAL	Acceptable Ambient Level
ACFM	Actual Cubic Feet per Minute
ACGIH	American Conference of Governmental and Industrial Hygienists
AQCR	Air Quality Control Region
AQRV	Air Quality Related Value
As	Arsenic
BACT	Best Available Control Technology
BAQM	Bureau of Air Quality Management
Be	Beryllium
BH	Baghouse
Btu	British Thermal Unit
Ca_2F	Calcium Fluoride
CARB	California Air Resources Board
CDM	Camp Dresser & McKee
CEM	Continuous Emission Monitor
CFR	Code of Federal Regulations
CO	Carbon Monoxide
CO_2	Carbon Dioxide
DER	(Florida) Department of Environmental Regulation
DS	Dry Scrubber
EPA	U.S. Environmental Protection Agency
ERF	Energy Recovery Facility
ESP	Electrostatic Precipitator

ACRONYMS AND ABBREVIATIONS
Continued

FAA	Federal Aviation Administration
FAAQS	Florida Ambient Air Quality Standards
FAC	Florida DER Air Pollution Administrative Code
Facility	Lee County Energy Recovery Facility
FF	Fabric Filter
FGDn	Wet Flue Gas Denitrification
FR	Federal Register
GEP	Good Engineering Practice
GLC	Ground Level Concentrations
gr/dscf	Grains per Dry Standard Cubic Foot
g/s	Grams per Second
HC	Non-Methane Hydrocarbons
HCL	Hydrogen Chloride
HF	Hydrogen Fluoride
Hg	Mercury
HHV	Higher Heating Value
H_2SO_4	Sulfuric Acid
ISC	Industrial Source Complex
ISCST-6	Industrial Source Complex - Short Term, UNAMAP Version 6
LAER	Lowest Achievable Emission Rate
lb/hr	Pounds per Hour

ACRONYMS AND ABBREVIATIONS
Continued

MCR	Maximum Continuous Rating
MSW	Municipal Solid Waste
MMBtu	Million Btu
MW	Megawatts
MWC	Municipal Waste Combustor
NAAQS	National Ambient Air Quality Standards
NaF	Sodium Fluoride
NESHAPS	National Emission Standards for Hazardous Air Pollutants
ng/Nm^3	Nanograms per Normal Meter Cubed
NMHC	Non-Methane Hydrocarbons
NO	Nitrogen Oxide
NO_2	Nitrogen Dioxide
NO_x	Nitrogen Oxides
NPS	National Park Service
NSPS	New Source Performance Standards
NSR	New Source Review
O_2	Oxygen
O_3	Ozone
OSHA	Occupational Safety and Health Administration
PAH	Polynuclear Aromatic Hydrocarbons
Pb	Lead
PCB	Polychlorinated Biphenyls
PCDD	Polychlorinated Dibenzo-p-dioxin

ACRONYMS AND ABBREVIATIONS
Continued

PCDF	Polychlorinated Dibenzofurans
PM	Particulate Matter
PM_{10}	Particulate Matter with a Diameter of Less than 10 Microns
ppm	Parts per Million
ppmdv	Parts per Million Dry Volume
PPSA	Power Plant Siting Act
PSD	Prevention of Significant Deterioration
SCR	Selective Catalytic Reduction
SIL	Significant Impact Level
SIP	State Implementation Plan
SNCR	Selective Non-Catalytic Reduction
SO_2	Sulfur Dioxide
TCDD	Tetrachlorodibenzo-p-dioxin
TEF	Toxic Equivalency Factor
TLV	Threshold Limiting Value
tpd	Tons per Day
tpy	Tons per Year
TSP	Total Suspended Particles
ug/m^3	Micrograms per cubic meter
UNAMAP	Users Network for the Applied Modeling of Air Pollution
UTM	Universal Traverse Mercator
VISCREEN	Visual Impact Screening and Analysis
VOC	Volatile Organic Compounds

SECTION 1.0

SUMMARY OF THE PROJECT AND IMPACTS

1.0 SUMMARY OF THE PROJECT AND IMPACTS

1.1 INTRODUCTION

For several years, Lee County has been investigating alternative methods for long-term solid waste disposal. The County began its investigation in 1979, after the State of Florida enacted legislation (Chapter 403.706, Florida Statutes) requiring the County to submit solid waste resource recovery and management plans. The current solid waste disposal method of sanitary landfilling is becoming inadequate as a primary disposal method due to environmental and siting constraints. Land areas in the region which are suitable for landfills are quickly diminishing.

In accordance with Florida law, the County intends to reduce the amount of waste requiring disposal by 30 percent through an aggressive recycling program. However, this still leaves 70 percent of the waste which must be disposed of. Studies commissioned by Lee County since 1987 have concluded that a mass-burn energy recovery system is the most prudent long-term primary solid waste disposal method for the waste which remains after recycling.

Lee and Hendry Counties have entered into an agreement that provides for the use of an integrated waste management system. The system will consist of an aggressive recycling program, the energy recovery facility (the "Facility") described in this document, and a new landfill to be constructed in Hendry County. These facilities will serve the solid waste disposal needs of both Lee and Hendry counties. The sanitary landfill/ashfill in Hendry County and the recycling program will be permitted separately from the energy recovery facility. The power produced by the combustion of refuse will be sold to the Florida Power & Light Company (FP&L). Revenues from the sale of this energy will help offset the cost of owning and operating the Facility.

A site selection report was completed on February 6, 1990 which evaluated a number of potential sites for the development of the Facility. The Board of County Commissioners ultimately chose a site on Buckingham Road, off State Route 82, as the location for the Lee County Energy Recovery Facility (ERF). The general location of this site is shown in Figure 1-1.

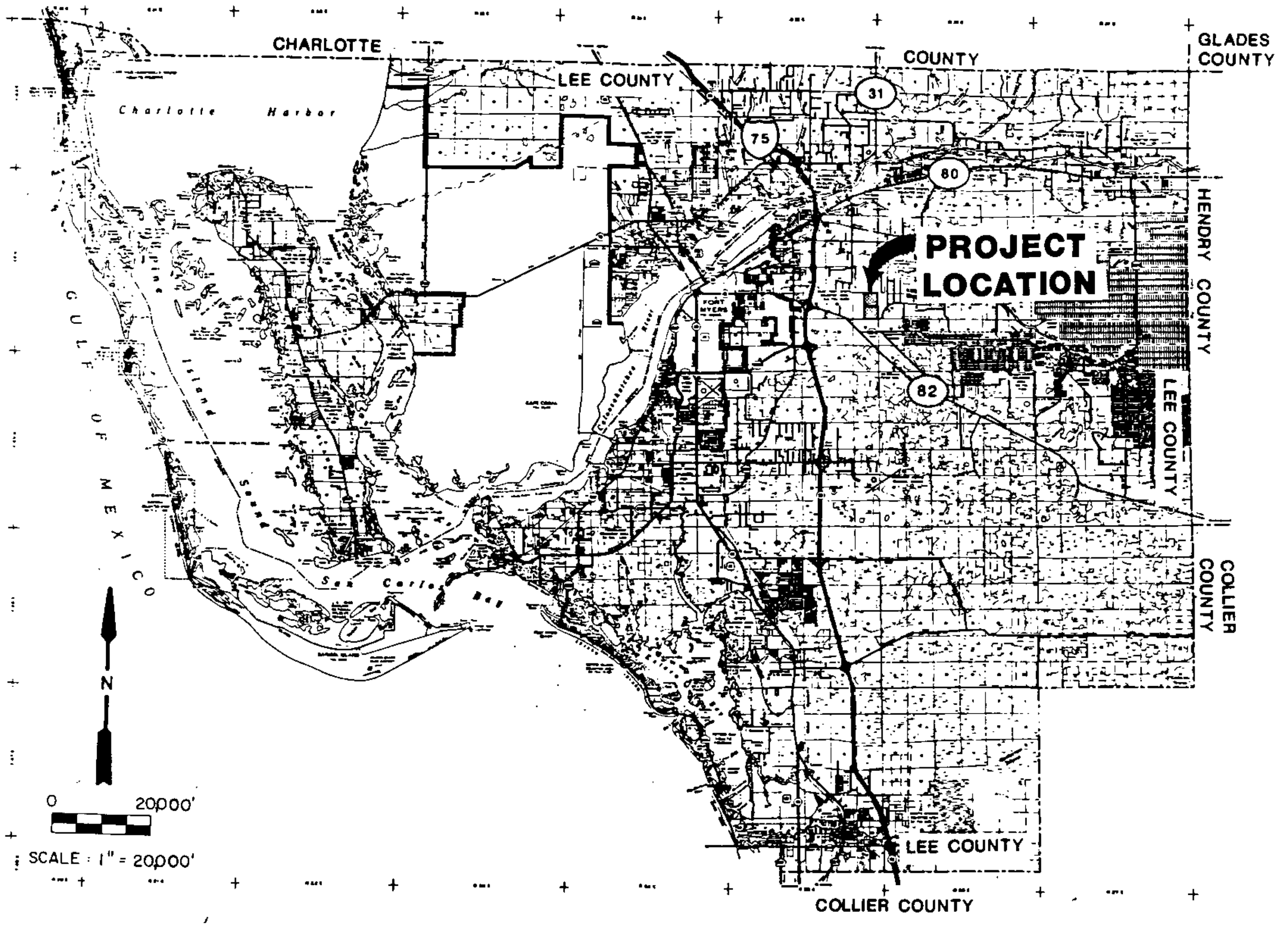
1.2 FACILITY DESCRIPTION

After evaluating several technologies, the County has concluded that an energy recovery facility incorporating a mass-burn technology and operated by a full-service vendor under contract to the County would best fit its present and foreseeable needs. The energy recovery facility is anticipated to have a nameplate generating capacity of approximately 45 megawatts (MW), using 1,800 tons per day (tpd) of municipal solid waste (MSW) as fuel. However, certification for an ultimate site capacity of about 60 MW, capable of processing 2,400 tpd of MSW, is being sought in anticipation of future solid waste disposal requirements. The energy produced would be used to satisfy internal power demands, with the surplus going to an electric utility.

When determining the appropriate size of the Facility, the County assumed that it would meet the state recycling goal of 30 percent by 1994. The Facility is sized to handle the waste that will remain after 30 percent is removed for recycling.

Because the proposed Facility will use mass-burn technology, there will be no complex preprocessing of wastes at the Facility prior to combustion. Sludge from wastewater treatment plants and any materials, such as construction waste, containing asbestos or other potentially hazardous materials, will not be accepted at the Facility. Inadvertently delivered oversized items will be separated from the incoming refuse by an overhead crane.

Two possible conceptual schematic diagrams of the Facility are presented in Figures 1-2 and 1-3. The first diagram shown is for a rotary waterwall combustor design in which the waste is combusted in a rotating cylindrical chamber. The second figure shows a stoker waterwall combustor design, which uses a fixed combustion chamber, in which the waste is combusted as

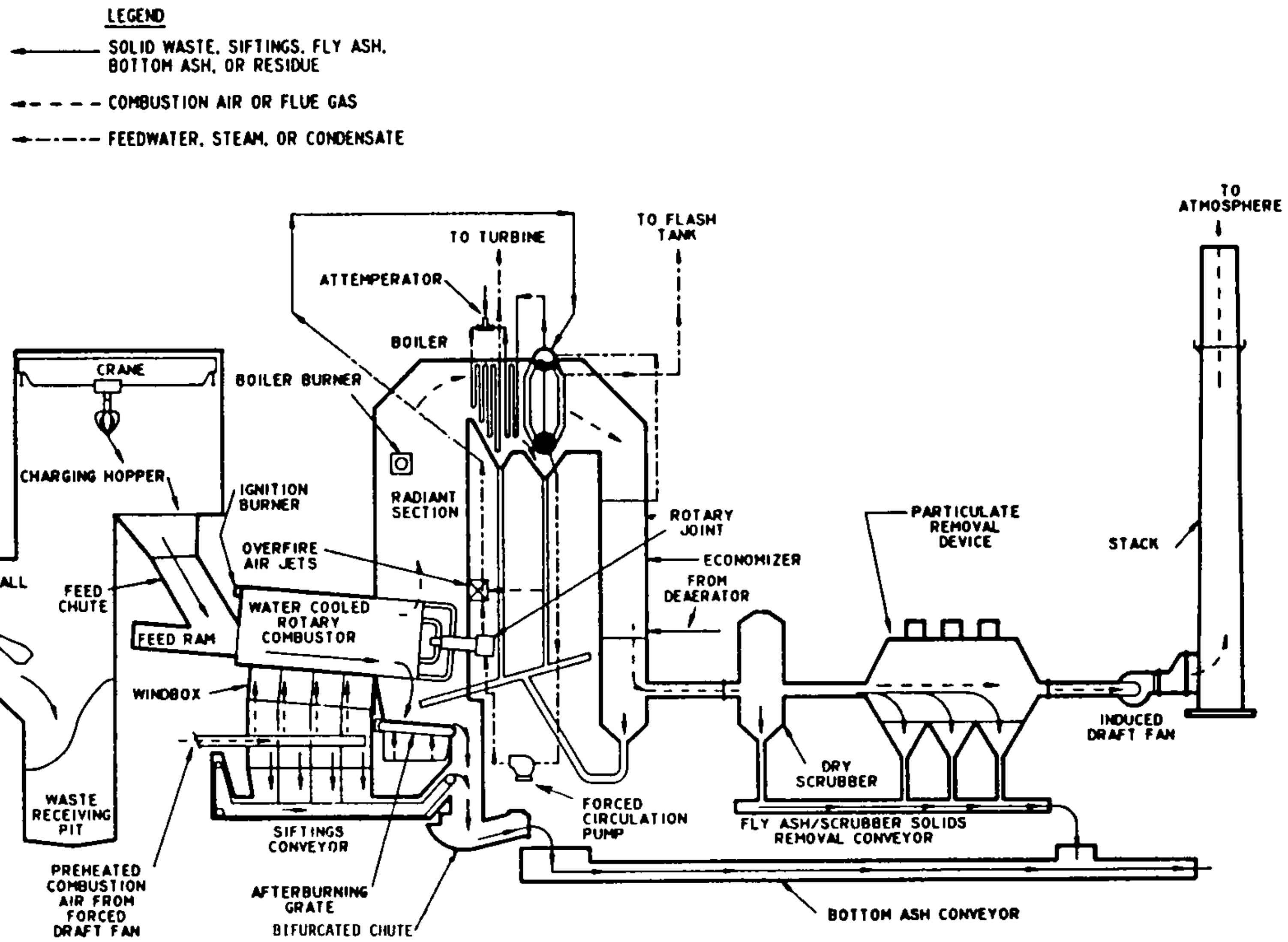


SOURCE: MAP BASED ON LEE COUNTY DOT GENERAL HIGHWAY MAP, JAN. 1976

CDM

General Location Map - Lee County Energy Recovery Facility

FIGURE 1-1



LEE COUNTY
ENERGY RECOVERY FACILITY
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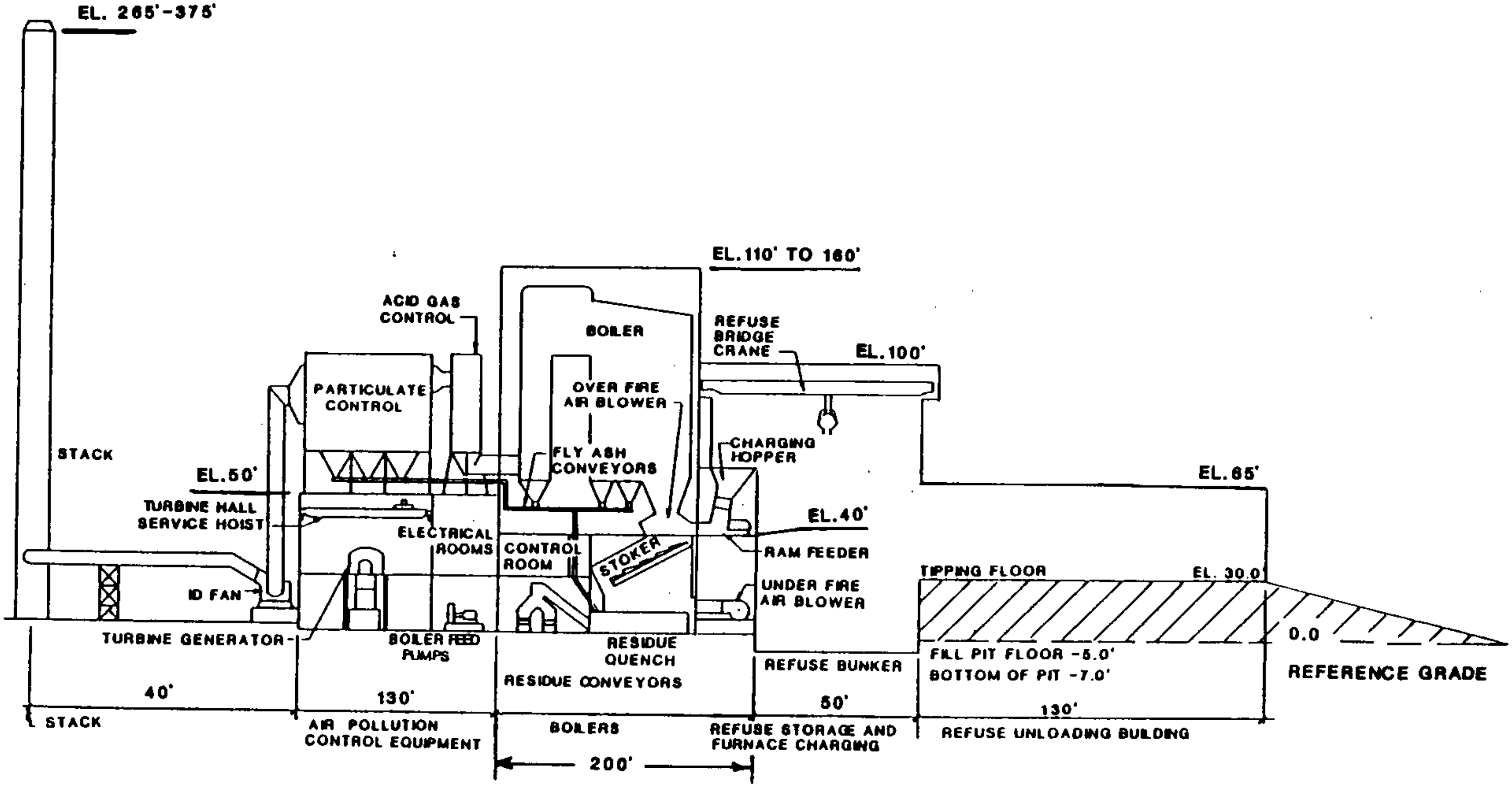
Camp Dresser & McKee Inc.

FIGURE 1-2
TYPICAL FACILITY CROSS-SECTION
(Rotary Waterwall Design)



NOTE

O.O REFERENCE GRADE IS 20 TO 25 FEET ABOVE MSL. ALL DIMENSIONS ARE APPROXIMATE. NOT TO SCALE.

CDM

FIGURE 1-3

Lee County Energy Recovery Facility
Typical Facility Cross-Section (Stoker Water Wall Design)

it falls over a stoker grate. The combustor design used at the Facility will depend on the vendor selected. Both a rotary waterwall and a stoker waterwall design were considered in the screening modeling analyses (see Section 6.4). The results of the screening modeling show that the combustor design with the lowest air flow rate, the rotary waterwall design, produces the highest ground-level pollutant concentrations. Therefore, the rotary waterwall design was carried through the refined dispersion modeling as the postulated "worst case" in this application.

A 2,400-tpd facility based on a stoker waterwall design would likely consist of four 600-tpd combustor units. A 2,400-tpd facility based on a rotary waterwall design would likely consist of four 450-tpd combustor units plus one 600-tpd unit. (This is because the vendor for the rotary waterwall design can currently meet bidding qualifications for a maximum unit size of 450 tpd. The vendor will likely be able to meet qualifications for construction of the future additional 600-tpd unit.) In either case, each combustor unit would have its own flue with a pollution control system train. The total of four or five flues would be grouped together in a single stack shell.

Truck transport will be used to deliver municipal solid waste (MSW) to the Facility and to remove ash residue from the Facility. MSW would be dumped into the refuse bunker directly from packer trucks. All waste will be stored inside the fully enclosed building prior to combustion. No waste will be visible from the outside. The waste will be kept under negative air pressure by withdrawing combustion air from the storage pit area. As a result, fugitive dust and odors will be contained within the building, and drawn into the furnace, where they will be eliminated or removed from the air stream. The overhead cranes will mix MSW in the bunker and load the four or five charging hoppers as required. Each combustor train will be equipped with a dry scrubber and fabric filter (baghouse) for acid gas and particulate air emission control.

A dry scrubber is a flue gas chamber into which lime slurry is injected to react with acidic compounds in the flue gases. Pebble lime is mixed with water to form a lime slurry which is injected into the vessel through spray nozzles or a rotary atomizer. The water in the slurry evaporates, cooling the flue gases, while the lime reacts with SO_2, HCl, and other acidic compounds. The salts formed by this reaction and any residual lime are collected in the particulate control device.

A fabric filter collects particulate matter by filtering flue gases through a fabric filter media. Multiple fabric filters are contained in a series of modular units which compose the total fabric filter system. Initial collection forms a thick porous cake of collected particulate on the filters. This cake then acts as the filter collection medium, with the fabric filter serving to support the particulate cake. As the cake builds, the pressure drop across the fabric filter also increases. Periodically, the cake is removed by reversing the air flow of each modular unit, blowing a pulse of compressed air through the filters, or shaking the filters, depending on the type of filter unit employed. The fabric filter for this Facility will be designed to achieve an emission limitation for particulate matter of 0.010 grains per dry standard cubic foot (gr/dscf) corrected to 7 percent O_2. The flue gas will be drawn through the fabric filter by an induced draft fan which will be located between the stack and the fabric filter.

Bottom ash from the furnace and fly ash from the fabric filters will be mixed prior to removal from the Facility. Ash will comprise approximately 10 percent of the volume and 25 percent of the weight of the MSW processed by the facility. The ash will be quenched with water prior to transport to a landfill in Hendry County. The ash handling area is fully enclosed. Emissions of particulate matter are not likely to be generated during the handling of the wet ash, but any such emissions will be controlled through a particulate control device before building air is vented to the atmosphere.

1.3 GOOD ENGINEERING PRACTICE STACK HEIGHT EVALUATION

The 1977 Clean Air Act Amendments sought to require that pollutant emission limitations were not affected by the stack height which exceeds good engineering practice (GEP) or by any other dispersion technique. The GEP stack height was that "height necessary to insure that emissions from the stack do not result in excessive concentrations of any air pollutant in the immediate vicinity of the source as a result of atmospheric downwash, eddies, and wakes which may be created by the source itself, nearby structures, or nearby terrain obstacles" (PL 95-11). The Act does not restrict the actual height of any stack; it only limits the theoretical stack height used in determining a source's allowable emission rate for pollutants regulated under the Act.

The U.S. Environmental Protection Agency (EPA) promulgated regulations to implement Section 123 of the Clean Air Act on July 8, 1985 (50 FR 27892). The GEP stack height is the greater of 65 meters or the height calculated from:

$$H_G = H + 1.5L$$

where:

H_G = the maximum GEP stack height
H = the height of the structure
L = the lesser dimension (height or maximum projected width) of the structure

This formula is applicable to any structure located within five times dimension "L," but not exceeding 0.8 km, of the proposed stack. The height and width of a structure is based on the frontal area of the structure projected onto a plane perpendicular to a line originating from the stack and following the direction of the wind. The stack height may be less than the maximum GEP height if excess concentrations do not result due to aerodynamic downwash and/or would not result in a violation of applicable ambient air quality standards.

The location of the proposed Facility on the site, shown in Figure 2-6 of Volume I of this application, is in a relatively flat rural environment; thus, only the furnace and boiler building is within the area of influence of the plume. This structure is anticipated to be a squat building, one for which the height is the lesser dimension in comparison with the width. The selected vendor will be required to construct a stack of GEP height. Therefore, of all the vendor designs under consideration, the one which would produce the shortest boiler building, and the shortest resulting GEP stack, was selected for the dispersion modeling analysis. This represents a conservative scenario and will produce the greatest ground-level concentrations; thus, it will be the worst case assumed for dispersion modeling. Of the boiler building designs likely to be proposed, the shortest one is 106 feet tall. The GEP stack height equation, as applied to this Facility, is two and one-half times the building height. The GEP stack height for this building is calculated to be 265 feet. Because the stack height will be set equal to the GEP stack height, the effects of downwash do not need to be considered in predicting ground-level concentrations.

1.4 BOILER OPERATING CONDITIONS

The energy recovery facility will fire at design capacity when processing 2,400 tpd of 5,000 Btu/lb reference waste. This firing rate is based on the average higher heating value (HHV). The waste firing rate will be adjusted as the heat content of the waste changes. This variability occurs as the plant maintains the heat load to the boiler by providing a constant heat release in the combustor. When the HHV is low (higher moisture and ash fractions, lower combustibles fraction), more waste will be processed (up to 3,473 tpd at 110 percent of the design heat release). Likewise, when the HHV is high, less waste will be processed.

The boiler operating conditions selected for modeling were based on identifying minimum, maximum, and typical load conditions, as well as identifying high and low values of the HHV. These are shown in Section 6.4.

Auxiliary burners will be used primarily during start-up and shut-down to assure that furnace temperatures sufficient to achieve good combustion are maintained. The propane gas fired burners will also be used if combustion temperatures fall below a predetermined set point when firing refuse with a low heat content. Because combustion of propane gas results in the release of lower NO_x and CO on a pound per million Btu basis than the combustion of refuse, the operation of the auxiliary burner during start-up, shut-down, or operation for temperature maintenance would result in the release of pollutants no greater than when firing refuse alone.

1.5 AIR QUALITY IMPACT ASSESSMENT

An air quality impact assessment was conducted on pollutant emissions from the Lee County ERF. The Industrial Source Complex (ISC) dispersion model was used to predict the potential air quality impacts in accordance with the modeling protocol (dated May 9, 1990) approved by the Florida Department of Environmental Regulation (DER). The refined dispersion modeling analysis was conducted using surface meteorological data from the Ft. Myers Airport (Page Field), and mixing height meteorological data from Tampa International Airport, both for the five-year period from 1982 to 1986. The Fort Myers/ Tampa data are the most representative data that are available of conditions at the Facility site. They were provided by Mr. Thomas Rogers of DER for use in this permit application.

Two worst-case operating conditions for the rotary waterwall design were selected on the basis of screening modeling (see Section 6.4) for the prediction of maximum air quality impacts:

- 2,400-tpd throughput with a refuse heat content of 5,000 Btu/lb (design capacity, or 100 percent of design heat release) for long-term (annual average) periods; and
- 2,200-tpd throughput with a refuse heat content of 6,000 Btu/lb for short-term (24 hours or less) periods. (This condition results in the minimum flue gas flow rate which was coupled with the maximum emission rates calculated at 110 percent of design heat release.)

A comparison was conducted of the maximum predicted ground-level concentrations and the background concentrations to the Florida and National Ambient Air Quality Standards. This comparison demonstrated that the Lee County ERF would not violate ambient air quality standards. In fact, maximum ground-level concentrations due to the Facility alone would be no more than 1.1 percent of any of the standards. When Facility concentrations are added to existing background pollutant concentrations, the resulting maximum concentration would be no more than 60 percent of any of the standards. A comparison between the maximum air quality impacts to the PSD Class II increments demonstrates that the Lee County ERF would have an insignificant impact on Class II increment consumption, by consuming no more than 2.9 percent of any applicable increment.

The predicted pollutant ground-level concentrations are compared to PSD de minimis monitoring levels in Table 6-8. The highest predicted impacts are below the de minimis monitoring levels. Therefore, in accordance with 40 CFR 52.21(i)(8), the Facility should be exempt from pre-construction monitoring requirements. In light of the modeling results shown in Table 6-8, the County requests the DER to concur in this determination that pre-construction monitoring is not required.

An analysis was also conducted of Facility impacts at the nearest Class I (pristine) air quality area: the Everglades National Park, 92 kilometers to the southeast of the Facility. The results show that no more than 4.5 percent of any Class I increment would be consumed there, and that visibility (clarity of the air) at this area would not be impaired. A similar analysis was conducted for the Big Cypress National Preserve, which although not an officially designated Class I Area, is a sensitive area nearer to the site: about 61 kilometers to the southeast. The modeled results for this location show that the Facility would consume no more than 5.8 percent of any Class I increment, and would not impair visibility. A detailed discussion of air quality impacts from the Facility is provided in Section 6.0.

The proposed Lee County ERF maximum expected emission rates, based on results obtained from Best Available Control Technology (BACT) analyses are summarized in Table 1-1. The basis for these emission rates is described in Section 4.0, Emission Control Technology Evaluation, and in Attachment A of this Volume, Emission Factor Support Document.

TABLE 1-1

LEE COUNTY ENERGY RECOVERY FACILITY

SUMMARY OF PROPOSED MAXIMUM EXPECTED STACK EMISSION RATES BASED ON RESULTS OBTAINED FROM BACT ANALYSES

Pollutant	Emission Rate and Associated Averaging Time[a]
Carbon Monoxide (CO)	
Rotary waterwall	(a) 150 ppmdv @ 7% O_2, 4-hr (0.148 lb/MMBtu) (b) 400 ppmdv @ 7% O_2, 1-hr (0.395 lb/MMBtu)
Stoker waterwall	(a) 100 ppmdv @ 7% O_2, 4-hr (0.099 lb/MMBtu) (b) 400 ppmdv @ 7% O_2, 1-hr (0.395 lb/MMBtu)
Nitrogen Oxides (NO_x)	
Rotary waterwall	(a) 150 ppmdv @ 7% O_2, 24-hr (0.243 lb/MMBtu) (b) 220 ppmdv @ 7% O_2, 1-hr (0.356 lb/MMBtu)
Stoker waterwall	(a) 200 ppmdv @ 7% O_2, 24-hr (0.324 lb/MMBtu) (b) 220 ppmdv @ 7% O_2, 1-hr (0.356 lb/MMBtu)
Sulfur Dioxide (SO_2)	(a) 80% reduction by weight of uncontrolled SO_2 emissions or 30 ppmdv @ 7% O_2, both 24-hr (b) 66 ppmdv @ 7% O_2, 24-hr (0.149 lb/MMBtu) (c) 82.5 ppmdv @ 7% O_2, 3-hr (0.186 lb/MMBtu)
Particulate Matter (TSP or PM_{10})	0.010 gr/dscf @ 7% O_2 (0.0194 lb/MMBtu)
VOC (non-methane HC)	
Rotary waterwall	71.7 ppmdv @ 7% O_2, (0.0406 lb/MMBtu)
Stoker waterwall	37.3 ppmdv @ 7% O_2, (0.0210 lb/MMBtu)
Lead (Pb)	6.0×10^{-4} lb/MMBtu
Beryllium (Be)	1.35×10^{-7} lb/MMBtu
Fluorides (as HF)	5 ppmdv @ 7% O_2 (0.0035 lb/MMBtu)
Mercury (Hg)	8.0×10^{-4} lb/MMBtu
Sulfuric Acid Mist (H_2SO_4)	0.0358 lb/MMBtu
Hydrogen Chloride (HCl)	(a) 95% reduction by weight of uncontrolled HCL emissions or 25 ppmdv @ 7% O_2, both 8-hr (b) 50 ppmdv @ 7% O_2, 8-hr (0.0643 lb/MMBtu)

TABLE 1-1
(continued)

Pollutant	Emission Rate and Associated Averaging Time[a]
Arsenic (As)	9.1×10^{-6} lb/MMBtu
PCDD & PCDF expressed as 2,3,7,8 - TCDD (EPA 1987 toxic equivalent dioxin)	2.0 ng/Nm^3 (dry) @ 7% O_2 (1.58×10^{-9} lb/MMBtu)

SOURCE: Camp Dreser & McKee Inc., 1990 (see Section 4.0 and Attachment A of this volume).

[a] Compliance with these proposed emission rates is to be based on either CEM measurement data and/or compliance stack testing data, as appropriate for the given pollutant.

SECTION 2.0

REGULATORY REVIEW

2.0 REGULATORY REVIEW

2.1 APPLICABLE REGULATIONS

Air quality regulations promulgated by the U.S. EPA and the Florida Department of Environmental Regulation (DER) define ambient air quality standards and regulate the sources of air contaminants in order to achieve and maintain these ambient standards. The Lee County ERF will be subject to the following rules and regulations.

- Prevention of Significant Deterioration (PSD)
- New Source Performance Standards (NSPS)
- National Emission Standards for Hazardous Air Pollutants (NESHAP)
- Florida DER Rules (Chapter 17-2, Florida Administrative Code) governing air pollution
- Federal Aviation Administration (FAA) Regulations governing stack height

In many cases, the Florida DER air pollution rules reflect the standards established by EPA. For those cases where the Florida rules represent a more restrictive requirement, the Florida regulation has been applied.

2.2 PREVENTION OF SIGNIFICANT DETERIORATION

In general, a PSD permit application must contain the following basic components.

- A complete description of the nature and operation of the source.
- A Best Available Control Technology (BACT) review and application.

- An analysis of existing ambient air quality.
- An impact assessment demonstrating that emissions from the new source will not cause a violation of ambient air quality standards or PSD increments.
- An assessment of the source's impact on air quality-related values including soils, vegetation, and visibility.

2.2.1 SOURCE APPLICABILITY

The proposed Facility is a major stationary source subject to PSD review because: (1) it is a combustion facility that is capable of burning more than 250 tons per day (tpd) of waste, and (2) at least one (or more) of the PSD-regulated pollutants will be emitted at a rate that exceeds 100 tons per year (tpy). Emission rates for both PSD-regulated pollutants and additional non-regulated pollutants (i.e., metals and trace organic compounds such as toxic equivalent dioxin) were developed for the proposed Facility. The rationale for the selected pollutant emission factors is presented in Attachment A.

PSD requirements apply to new major sources or major modifications located in areas which have been designated attainment or unclassified for a particular pollutant. New major sources proposing to locate in nonattainment areas are also subject to DER's New Source Review requirements. Lee County has been designated as in attainment or unclassified for all PSD-regulated pollutants (see Section 5.1), so New Source Review would not apply.

2.2.2 POLLUTANT APPLICABILITY

Under the PSD program, if the potential annual emission rate exceeds EPA's PSD significant emission rates designated in 40 CFR Part 52.21, then a best available control technology (BACT) analysis and air quality modeling need to be conducted for each affected pollutant for the PSD permit application.

Table 2-1 compares projected annual Facility emission rates, presented in Section 3.0, with the corresponding EPA PSD significant emission rates, and identifies those pollutants for which BACT analyses must be performed. The detailed approaches and considerations for performing BACT analyses are presented in Section 4.0. As shown in Table 2-1, formal PSD analyses (including a BACT analysis) are required for nitrogen oxides, sulfur dioxide, carbon monoxide, particulate matter including PM_{10}, volatile organic compounds, lead, beryllium, mercury, fluorides, sulfuric acid mist, and arsenic.

The maximum annual emission rates presented in Table 2-1 were calculated assuming that each combustor operates 365 days per year at 100 percent load. This throughput would be equivalent to combusting 876,000 tpy (2,400 tpd) of MSW. This assumption is conservative, because the Facility is expected to have an annual availability factor of approximately 85 percent of its nameplate capacity due to scheduled and unscheduled downtime. In addition to BACT analyses for applicable PSD pollutants, an air quality modeling analysis, an assessment of existing background air quality levels, and additional impact analyses are included.

An air quality modeling analysis is performed to show that applicable Florida and National Ambient Air Quality Standards (FAAQS and NAAQS), and PSD increments, will be met. Table 6-8 (see Section 6.6) lists the NAAQS, which have been adopted by Florida, as well as the more stringent Florida standards for sulfur dioxide, and the PSD increments to be considered in this evaluation. Approaches employed and results obtained from the PSD modeling studies are presented in Section 6.0.

Section 7.0 presents the additional impact analysis required as part of the PSD review. An impact analysis is performed to ascertain the potential impact of modeled Facility emissions on soils, vegetation, and visibility.

The PSD regulations establish mandatory Class I, or pristine, areas in the United States. The regulations require that any major source proposing to locate near (generally accepted to be within 100 kilometers) a Class I Area have an assessment performed of the source's effect on visibility

TABLE 2-1

PSD POLLUTANT APPLICABILITY FOR THE LEE COUNTY ENERGY RECOVERY FACILITY

PSD Pollutant	EPA Significant Emission Rates (tpy)[a]	Proposed Facility Emission Rate (tpy)[b]	Need for Formal PSD Analysis (X)
Carbon Monoxide	100	648**	X
Nitrogen Oxides	40	1,419**	X
Sulfur Dioxide	40	653	X
Particulate Matter (total)	25	85	X
Particulate Matter (PM_{10})	15	85	X
Ozone (as volatile organic compounds)	40	178**	X
Lead	0.6	2.6	X
Asbestos	0.007	---*	
Beryllium	$4.0x10^{-4}$	$5.9x10^{-4}$	X
Mercury	0.1	3.5	X
Vinyl Chloride	1	---*	
Fluorides	3	15.3	X
Sulfuric Acid Mist	7	157	X
Hydrogen Sulfide (H_2S)	10	---*	
Total Reduced Sulfur (including H_2S)	10	---*	
Reduced Sulfur Compounds (including H_2S)	10	---*	
Hydrogen Chloride	NA[c]	282	
Arsenic	AER[d]	0.04	X
Dioxins and Furans[c]	NA[c]	$6.9x\ 10^{-6}$	
Benzene	AER[d]	---*	
Radionuclides	AER[d]	---*	
Radon 222	AER[d]	---*	

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[a] SOURCE: FAC 17.2, Part V, Table 500.2, or 40 CFR 52.21.

[b] Emission rates (annual average basis) assume 100 percent load and continuous unit availability using the expected maximum emission rates for appropriate averaging periods as discussed in Attachment A. The Facility is assumed to be firing at a rate of $1.0x10^9$ Btu/hr, and burning 2,400 tpd of MSW with a reference waste higher heating value (HHV) of 5,000 Btu/lb, resulting in 876,000 tpy of MSW being combusted by the Facility.

[c] Not applicable. These pollutants are not regulated under the PSD regulations, but are provided to DER for review. These pollutants have been included in the EPA-proposed New Source Performance Standards for municipal waste combustors.

TABLE 2-1
(continued)

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[d] Any emission rate. These pollutants (benzene, radionuclides, arsenic, and radon 222) are regulated by the Clean Air Act under the NESHAPS program, and any emission rate is considered a significant emission rate.

[e] Emission rates for these pollutants are negligible because these emissions are not expected from an MSW combustion environment or are not considered to be part of an MSW stream (e.g., asbestos).

**The higher emission rate of either the stoker waterwall or rotary waterwall combustor design is indicated.

(clarity of the air) at the Class I Area, and on Class I increment consumption. The Everglades National Park, a designated Class I Area, is 92 kilometers from the Facility site. A visibility impacts analysis and Class I increment consumption demonstration for this and other sensitive areas is presented in Section 7.0.

2.3 NEW SOURCE PERFORMANCE STANDARDS

The Florida Administrative Code, Chapter 17-2, Part VI, incorporates the federal New Source Performance Standards (NSPS) by reference. EPA originally promulgated standards of performance for new municipal incinerators on December 23, 1971. These standards are contained in 40 CFR 60, Subpart E. EPA is in the process of promulgating final revised NSPS for municipal waste combustors. These proposed regulations were published in the Federal Register on December 20, 1989 (54 FR 52209). When, after public comment and possible modification, the proposed regulations become final, it will be necessary to confirm that the proposed BACT in this PSD application is no less stringent than the applicable new air emission standards. EPA held a series of public hearings during early 1990 regarding their proposed regulations. Following these hearings, and upon incorporating applicable comments and making the necessary or appropriate revisions to the regulations, EPA plans to sign the final promulgation of the new regulations by December 31, 1990. A summary of EPA's proposed air emission standards for new municipal waste combustors is shown in Table 2-2.

The applicability and incorporation of the proposed new air emission standards for this project is being evaluated by the applicant. Many of the new air emission standards for specific pollutants are cited by EPA to have a range of values in their current proposed form. Prior to promulgating the regulations in December 1990, EPA expects to select a single emission standard per pollutant per source size category.

The current industry consensus appears to be that some of EPA's proposed new air emission standards appear to be overly stringent, and may be difficult to achieve on a continuous basis even for a well-designed,

TABLE 2-2

EPA-PROPOSED NEW SOURCE PERFORMANCE STANDARDS FOR MUNICIPAL WASTE COMBUSTORS[a]

Pollutant	Proposed Standard	Basis
Particulate Matter	0.015 gr/dscf (@7% O_2) 10% opacity (6-min. avg.)	Fabric filter
Hydrogen Chloride	95% reduction or 25 ppmdv (@7% O_2)	Spray dryer plus fabric filter
Sulfur Dioxide	85% reduction or 30 ppmdv (@7% O_2), 24-hour block average	Spray dryer plus fabric filter
Nitrogen Oxides	120-200 ppmdv (@7% O_2), 24-hour block average	Selective Non-catalytic Reduction (SNCR) and/or good combustion practice[b]
Carbon monoxide	150 ppmdv (@7% O_2), 4-hour block average (rotary waterwall)	Good combustion practice
	100 ppmdv (@7% O_2), 4-hour block average (stoker waterwall)	Good combustion practice
Total Dioxins and Furans	5-30 ng/Nm^3 (@7% O_2)	Good combustion practice, spray dryer plus fabric filter

SOURCE: 54 FR 52209, December 20, 1989.

[a] This is a summary of emissions standards proposed for new facilities with throughputs of more than 250 tons per day. There are also proposed materials separation objectives, combustion parameters, operator certification, and stack test requirements. The proposed standards are draft, and were the subject of hearings in early 1990. The standards for NO_x and total dioxins are also shown as a range of values. Prior to promulgation of the final standards in December 1990, EPA expects to make revisions, and select a single emission standard for each pollutant for each source size category.

[b] EPA will determine the emission level(s) and/or percent reductions achievable prior to promulgation of a single emission limit. Alternatively, EPA may promulgate different emission limits and associated control requirements for different subcategories of municipal waste combustor technologies.

well-operating municipal waste combustor. Nevertheless, if more stringent air emission standards are later imposed upon this Facility, the resultant air quality impacts would be lower than shown in Sections 4.0, 6.0, and 7.0 of this application.

On December 16, 1987, EPA promulgated revised standards of performance for industrial-commercial-institutional steam generating units. These standards are contained in 40 CFR 60, Subpart Db and set emissions limitations for particulate matter, as well as nitrogen oxide and sulfur dioxide, for steam generating units having heat input capacities greater than 100 million Btus per hour. The nominal heat input rating for the proposed Facility's combustors is approximately 250 million Btu/hr for a 600-tpd unit, and 187.5 million Btu/hr for a 450-tpd unit.

40 CFR Section 60.43b(c)(1) limits particulate matter emissions from each unit firing primarily municipal type solid waste (having an annual capacity factor for auxiliary fuels of 10 percent or less) to 0.1 pounds per million Btus of heat input. The Facility will comply with this limit by emitting no more than 0.0194 pounds per million Btu. Section 60.43b(e) limits the opacity of the exhaust gases from the units. Specifically, it prohibits the discharge of gases exhibiting greater than 20 percent opacity (six-minute average), except for one six-minute period per hour of not more than 27 percent opacity. The Facility will comply with this limit. The particulate matter and opacity standards apply at all times, except during periods of start-up, shut-down, or malfunction.

Section 60.44b(d) sets a nitrogen oxide emission standard of 0.2 pounds per million Btu of heat input which would be applicable to the Facility's combustors should the annual capacity factor for any unit firing propane exceed 10 percent. This standard applies at all times including periods of start-up, shut-down, or malfunction. The annual capacity factor is defined as the actual heat input to the unit resulting from the firing of the auxiliary fuels during a calendar year to the total potential heat input to the unit had it operated 8,760 hours per year at maximum steady state design heat input capacity. For the proposed Facility, propane gas will be used during start-up and shut-down situations, which are expected to occur infrequently, and as a supplemental fuel on limited occasions when decreased combustor temperature conditions occur due to causes such as high moisture content wastes.

Based on the Facility design MSW feed rate of 2,400 tons per day, the Facility could fire up to 8.76 x 10^{11} Btu/year of auxiliary fuel before reaching 10 percent of the design heat input. Under no circumstances should the annual capacity factor for the propane gas fired in each of the Facility's combustors exceed 10 percent. Therefore, the 0.2 pounds per million Btu of heat input NO_x limitation will not be applicable. The Facility is expected to fire approximately 1.43 x 10^{10} Btu/yr of propane gas for start-up, shut-down, and maintaining proper furnace combustion temperature, or 0.16 percent of the annual design heat input.

40 CFR, Section 60.42b, sets forth emission limitations for sulfur dioxide. However, such limitations only apply to facilities which combust coal or oil, which is not the case for the proposed Facility.

2.4 NATIONAL EMISSION STANDARDS FOR HAZARDOUS AIR POLLUTANTS

Pursuant to Section 112 of the Clean Air Act, the U.S. EPA originally promulgated National Emission Standards for Hazardous Air Pollution (NESHAPS) on April 6, 1973. These standards are contained in 40 CFR 61. Some of the PSD pollutants identified in Table 2-1 are also regulated under NESHAPS. 40 CFR Subpart C, Section 61.32 contains a stationary source limitation for facilities firing beryllium-containing industrial waste of 10 grams over a 24-hour period, or a 30-day ambient air incremental impact of 0.01 ug/m^3. Subpart E, Section 61.50 regulations for mercury do not apply since the proposed Facility will not combust or dry wastewater treatment plant sludge. Other NESHAPS, such as Subpart F for vinyl chloride, and Subparts N, O, and P for inorganic arsenic emissions, do not apply to municipal waste combustion facilities.

The proposed maximum expected beryllium emission factor of 1.35×10^{-6} pounds per ton of MSW fired results in a projected beryllium emission rate of 1.5 grams over a 24-hour period at design capacity, which is below the applicable NESHAPS of 10 grams for 24 hours. In addition, in Section 6.6, the proposed Facility maximum 24-hour average emission of 3.8×10^{-6} ug/m^3 is below the applicable 0.01 ug/m^3, 30-day limitation. This standard also applies only to those combustion facilities which would accept beryllium-containing industrial waste, which will not be the case for the proposed Facility.

2.5 FEDERAL AVIATION ADMINISTRATION NOTIFICATION REQUIREMENTS

The Federal Aviation Administration (FAA) requires a Notice of Proposed Construction or Alteration for any proposed structure affecting navigable air space. Structures 200 feet or taller above ground are subject to the FAA notification requirements (CFR Sections 77.13, 77.23). The stack for the Lee County Facility will be at least 265 feet, and at most 375 feet above ground elevation. The Notice of Proposed Construction or Alteration for the Facility was filed with the FAA in April 1990. The FAA has not yet acted on the notice, but the County expects a determination that the proposed Facility stack will not be a hazard to air navigation if it is marked and lighted in accordance with FAA Advisory Circular 70/7460-1, Chapters 3, 4, 5, and 9.

2.6 DER AIR POLLUTION CONTROL REGULATIONS

The Florida Administrative Code, Chapter 17-2, for the most part has incorporated federal regulations for each of the air programs previously discussed. Some slight differences which are applicable to this study do exist, however.

2.6.1 EMISSION LIMITATIONS

Florida sets a specific limitation that incinerators emit no objectionable odor. The proposed Facility will comply with this requirement by storing all waste prior to combustion inside the fully enclosed ERF. The building will be kept under negative pressure by withdrawing combustion air from the storage pit area. Odors from the refuse will be drawn into the furnace, and will be destroyed in the combustors, and/or vented through the stack.

The general opacity rule found in Florida Administrative Code (FAC) Rule 17-2.610 does not apply to a source for which either a specific particulate standard or a specific opacity standard is provided elsewhere in the rules. Because the energy recovery facility is subject to the specific particulate standard in FAC 17-2.600(1)(c), the general opacity standard does not apply, although it is anticipated that a specific opacity limit will be a condition of the permit.

2.6.2 AMBIENT AIR QUALITY STANDARDS

The Florida Ambient Air Quality Standards (FAAQS) contained in FAC 17-2.300 are more stringent than the National Ambient Air Quality Standards (NAAQS) for sulfur dioxide. The 24-hour average SO_2 FAAQS is 260 ug/m^3 (versus an NAAQS of 365 ug/m^3), and the annual average FAAQS is 60 ug/m^3 (versus 80 ug/m^3). The predicted maximum ground-level concentration due to the Facility would be no more than 1.3 percent of either of these standards. When combined with existing background SO_2 concentrations, the maximum concentration would be no more than 26 percent of either standard (see Section 6.6).

2.6.3 PERMIT REQUIREMENTS

Site certification to construct and operate an air pollution source can be obtained from DER by the owner of a new energy recovery facility prior to construction, in accordance with FAC 17-2, Part V, and the Florida Electric Power Plant Siting Act, Section 403.501 et. seq., Florida Statutes. On October 27, 1986, EPA published a notice allowing DER to review applications and issue PSD construction permits to sources subject to the Power Plant Siting Act (PPSA) (51 FR 37972). This notice was effective as of July 1, 1986, when the Florida Legislature amended the PPSA to allow the concurrent issuance of PSD construction permits and site certification.

SECTION 3.0

AIR POLLUTANT EMISSIONS

3.0 AIR POLLUTANT EMISSIONS

3.1 INTRODUCTION

The combustion of refuse to produce energy in the boilers of energy recovery facilities results in the emission of some air pollutants as a consequence of several mechanisms and processes. Emissions generated in the system either depend upon the composition of the waste stream or reflect the character of the combustion process. The quantity of each compound released also depends on whether or not it is controlled through the use of air pollution control technology.

The discussion of emission factors and rates presented in this section focuses primarily on those pollutants of public health and regulatory concern. The review compares the proposed Facility's emission rates estimated by the applicant's consultant, CDM, with recently permitted energy recovery facilities in Florida. The emission estimates for the Lee County ERF are based on stack testing data from existing facilities, and are discussed in greater detail in Attachment A.

Emission of acid gases will be minimized through the use of a dry scrubber, while particulate matter will be controlled through the use of a fabric filter. Use of the dry scrubber-fabric filter will also serve to minimize emission of trace metals and organic compounds. Composition-dependent emissions are minimized by controlling the composition of the waste stream (e.g., trace metals, SO_2, HCl, and HF). Identifiable contaminants, such as those found in asbestos-containing construction material and other hazardous waste, will not be accepted at the Facility.

Emissions such as carbon monoxide, oxides of nitrogen, hydrocarbons, and trace organic compounds are principally influenced by the combustion process. Combustion controls (for the rotary waterwall design), or post combustion flue gas NO_x control (for the stoker waterwall design), will be employed to minimize these emissions.

3.2 COMBUSTION OF MUNICIPAL SOLID WASTE

Waste composition is an important consideration in developing emission estimates, especially any unique or unusual aspects that would prohibit the use of emissions data obtained from similar operating facilities. The understanding of combustion chemistry is not always sufficient to allow the calculation of emission rates based on waste composition alone. Reference waste composition is typically used in combustion calculations to predict flue gas flow rates, which are used to calculate pollutant emission rates from empirical flue gas concentrations. Table 3-1 shows an ultimate analysis of refuse expected to be processed at the Lee County ERF.

MSW is a heterogeneous mixture of materials, and the physics and chemistry of its combustion is very complex. Broadly speaking, describing the combustion process involves chemical reaction kinetics and equilibrium, combustor fluid mechanics, and heat transfer rates. The applicant's consultant, CDM, has developed a computer model which performs mass-balance modeling of the combustion process for a "reference waste." Model results can then be used to estimate pollutant emission rates of the particulate and gaseous products of combustion. Emissions of products of combustion include nitrogen oxides, carbon monoxide, volatile organic compounds, hydrogen chloride, and sulfur dioxide. These are calculated using the output from this model. The model output is contained in Attachment D to this Volume. The results are corroborated with monitoring test data from comparable facilities.

Other compounds present in the flue gas are mainly a function of the amount of the compounds or elements present in the waste itself. This is true for trace metals and some trace organic compounds. For these emissions, reasonable upper limit emission factors are predicted on the basis of empirical data obtained from other similar sources.

3.3 COMPARISON TO OTHER PERMITTED FACILITIES

In order to determine the air quality impacts of the Lee County ERF, estimates of pollutant emissions must be established. The emission factors

TABLE 3-1

REFERENCE WASTE ULTIMATE ANALYSIS
(as received)

Waste Category	Nominal Percent by Weight (dry basis)
Total Inerts	26.36
Carbon	35.94
Hydrogen	4.79
Nitrogen	0.63
Sulfur	0.13
Chlorine	0.50
Oxygen	31.65
TOTAL	100.00
Moisture	20.70
Higher Heating Value (HHV)	5,000 Btu/lb

SOURCE: Camp Dresser McKee Inc., 1990.

(in terms of mass of pollutant per mass of refuse burned) contained in this section are based on numerous literature sources which were reviewed to obtain current emission data from representative energy recovery facilities that incorporate similar technology. "Criteria" pollutants are those for which National Ambient Air Quality Standards (NAAQS) have been established. "Non-criteria" pollutants do not have ambient air quality standards. Both "criteria" and "non-criteria" pollutants known to be emitted from energy recovery facilities burning refuse are quantified in this section.

Data have been compiled on emissions from several existing mass-burn MSW energy recovery facilities, and through research activities conducted by such agencies as EPA. These were reviewed to determine their applicability for use in predicting emission factors for various pollutants.

To compare the data presented in these studies and reports, it was necessary to convert all emission rates to uniform units of measure. Usually, data from stack testing activities appear as pollutant concentrations in the stack gas [e.g., parts per million (ppm)]. From the relationship of the flue gas flow rate to the waste burning rate, pounds of pollutant emitted per ton of refuse fired (lb/ton) can be calculated. If the Btu value of the refuse is known, it is also possible to describe pollutant emission rates as pounds of pollutant emitted per million Btu of heat input (lb/MMBtu).

The maximum expected emission factors (expressed as lb/ton of refuse and lb/MMBtu of heat input) for the Lee County ERF are shown in Table 3-2. The numbers presented in Table 3-2 are based in part on the available stack testing data from representative existing facilities. The selected emission factors represent reasonable upper bound estimates projected for the Lee County ERF. A more detailed description of the basis for the emission factors shown in Table 3-2 is presented in Attachment A.

The emission factors for the Lee County ERF are compared to other energy recovery facilities recently permitted in Florida in Table 3-3. Because the Lee County ERF will incorporate acid gas scrubbers and high efficiency fabric filters, the emissions of sulfur dioxide, sulfuric acid mist,

TABLE 3-2

CONTROLLED EMISSION FACTORS FOR THE LEE COUNTY ENERGY RECOVERY FACILITY

Pollutant		Emission Factor	
		lb/ton Refuse	lb/MMBtu*
Particulate Matter		0.194	0.0194
Sulfur Dioxide	(24-hour)	1.49	0.149
	(3-hour)	1.86	0.186
Nitrogen Oxides (as NO_2)			
Rotary waterwall	(24-hour)	2.43	0.243
	(1-hour)	3.56	0.356
Stoker waterwall	(24-hour)	3.24	0.324
	(1-hour)	3.56	0.356
Carbon Monoxide			
Rotary waterwall	(4-hour)	1.48	0.148
	(1-hour)	3.95	0.395
Stoker waterwall	(4-hour)	0.99	0.099
	(1-hour)	3.95	0.395
Non-Methane Hydrocarbons			
Rotary waterwall	(1-hour)	0.406	0.0406
Stoker waterwall	(1-hour)	0.211	0.0211
Lead		0.006	6.0×10^{-4}
Sulfuric Acid Mist		0.358	0.0358
Hydrogen Chloride		0.643	0.0643
Fluoride (as HF)		0.035	0.0035
Beryllium		1.35×10^{-6}	1.35×10^{-7}
Mercury		8.0×10^{-3}	8.0×10^{-4}
Inorganic Arsenic		9.1×10^{-5}	9.1×10^{-6}
Asbestos		**	**
Vinyl Chloride		**	**
Total Reduced Sulfur		**	**
Reduced Sulfur Compounds		**	**
Benzene		**	**
Radionuclides		**	**
Dioxin (as 2,3,7,8 TCDD equivalent)		1.58×10^{-8}	1.58×10^{-9}

SOURCE: Camp Dresser McKee Inc., 1990 (see Emission Factor Support Document, Attachment A of this volume).

*Based on a higher heating value of 5000 Btu/lb.

**Negligible emission rate, the numerical value of which is strongly dependent on the composition of the refuse incinerated. Lee County municipal solid waste is not expected to contain these compounds.

TABLE 3-3

COMPARISON OF ESTIMATED EMISSION FACTORS TO PERMITTED VALUES AT OTHER REGIONAL MASS-BURN FACILITIES
(lb/ton of refuse)[a]

Pollutants	Lee	Pasco[b]	Hillsborough[c]	North Broward[d]	Pinellas 3[e]	Palm Beach[f]	Bay County[b]	South Broward[g]
Particulate matter	0.194	0.309	0.42	0.42	0.5	0.33	0.56	—
Sulfur dioxide (24-hr)	1.49	2.15	8.5	2.79*	4.08	7.7	2.8	2.79
Nitrogen oxides (24-hr)	3.24**	6.17	6.4	5.04	6.1	4.0	2.2	5.0
Carbon monoxide (4-hr)	1.48**	0.470	1.8	0.81	1.58	12.0	11.4	0.8
Hydrocarbons (1-hr)	0.406**	0.202	0.2	0.12	0.3	0.20	0.232	—
Lead	0.006	0.0067	0.02	0.018	0.067	0.005	0.0036	0.018
Mercury	0.008	0.0077	0.004	0.0083	0.01	0.003	0.00171	—
Beryllium	1.35x10^{-6}	1.30 x 10^{-6}	1.31x10^{-5}	8.4x10^{-6}	1.3x10^{-6}	9.0x10^{-6}	48x10^{-6}	—
Arsenic	9.1x10^{-5}	8.74x10^{-5}	—	—	—	—	—	—
Fluorides	0.035	0.077	0.06	0.16	0.1	0.04	—	—
Sulfuric acid mist	0.358	0.344	1.38	0.42	—	0.0004	—	—
Hydrogen chloride	0.643	1.22	4.0	—	4.0	3.5	—	—

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[a] Note that the heat content (Btu/lb) of the reference waste for each facility differs. Relative emission rates will change if converted to a lb/MMBtu basis.

[b] Pasco County, Power Plant Site Certification, PA 87-23, August 23, 1988.

[c] Hillsborough County, Power Plant Site Certification, PA 83-19 - Requested Modification May 1, 1987.

[d] North Broward, Power Plant Site Certification, February 1, 1986.

[e] Pinellas County Unit 3, Power Plant Site Certification, PA 83-18 and an August 87, telephone conversation with the DER.

[f] Palm Beach, Power Plant Site Certification, February 11, 1986, per telephone conversation with Barry Andrews DER, October 8, 1987.

[g] South Broward, August 87 telephone conversation with the Florida DER.

*Based on a SO_2 upper limit of 0.31 lb/MMBtu and a refuse heat content of 4,500 Btu/lb, telephone conversation with Barry Andrews of DER, August 26, 1987.

**Emission factor presented represents the higher value for either a rotary or stoker waterwall combustor.

hydrogen chloride, and particulate matter will be the same or lower than those for any other permitted energy recovery facility in Florida. The emission limits for sulfuric acid mist from the Pasco County, Broward County, and Hillsborough County facilities were deleted from the final permits for those facilities because EPA Region IV determined there was no reliable testing method for this pollutant. Because the Lee County ERF will be employing a dry scrubber which will effectively minimize sulfuric acid emissions, an emission limitation for sulfuric acid mist should not be required.

Minor short-term variations in emissions can be expected due to the heterogeneous nature of MSW. Therefore, the short-term emission rates presented in Table 3-4 and expressed in pounds per hour are based on the postulated worst-case operating condition at 110 percent of design heat release: 2,200 tpd at 6,000 Btu per pound waste. The annual emission rates presented in Table 3-4 are higher than the expected annual averages because the Facility will operate at less than 100 percent of its capacity during both scheduled and unscheduled down-time.

TABLE 3-4

ESTIMATED EMISSION RATES FOR THE LEE COUNTY ERF

Pollutant	Controlled Emission Rate	
	Tons/year[a]	Pounds/hour[b]
Particulate Matter (PM)	85	21.3
Sulfur Dioxide (SO_2)	653	164[c]
Nitrogen Dioxide (NO_2)	1,419*	356*[c]
Carbon Monoxide (CO)[3]	648*	163*[d]
Hydrocarbons (VOC)	178*	44*
Lead (Pb)	2.6	0.66
Arsenic (As)	0.04	0.01
Mercury (Hg)	3.5	0.88
Beryllium (Be)	5.9×10^{-4}	1.49×10^{-4}
Fluoride (as HF)	15.3	3.85
Sulfuric Acid (H_2SO_4)	157	39.4
Hydrogen Chloride (HCl)	282	70.4
Dioxin (as 2,3,7,8 TCDD toxic equivalent)	6.9×10^{-6}	1.74×10^{-6}

SOURCE: Camp Dresser McKee Inc., 1990 (see Emission Factor Support Document, Attachment A of this volume, for basis for emission factors).

[a] Annual emission rate based on 100 percent of the design heat release rate firing reference waste at 5,000 Btu/lb.

[b] Short-term maximum emission rates based on 110 percent of design heat release rate (lb/MMBtu), 2,200 tpd throughput of 6,000 Btu/lb waste.

[c] NO_x and SO_2 lb/hr emission rates based on Table 3-2 24-hour average value for lb/MMBtu.

[d] CO lb/hr emission rate based on Table 3-2 4-hour average value for lb/MMBtu.

*These values are the higher emission rate of either rotary waterwall or stoker waterwall mass-burn combustor designs, which are both under consideration.

SECTION 4.0

EMISSION CONTROL TECHNOLOGY EVALUATION

4.0 EMISSION CONTROL TECHNOLOGY EVALUATION

4.1 DESCRIPTION OF BACT REVIEW

The proposed Facility is considered a major stationary source and is subject to PSD review since it will emit quantities above the PSD significant emission rate for particulate matter (PM), sulfur dioxide (SO_2), carbon monoxide (CO), nitrogen oxides (NO_x), lead (Pb), fluorides (as HF), mercury (Hg), beryllium (Be), volatile organic compounds (VOC), arsenic (As), and sulfuric acid mist (H_2SO_4). Consequently, the Facility will be subject to the Best Available Control Technology (BACT) evaluation for the pollutants which are subject to Prevention of Significant Deterioration (PSD) review.

In accordance with EPA's present policy of determining BACT (EPA, December 1987, May 1989, and March 1990), the analysis involves the identification of all applicable emission control alternatives for the pollutants subject to PSD review and any others requested by the governing regulatory agency. The alternatives are evaluated using a "top down" approach where they are ranked in descending order of effectiveness. A "top down" analysis first examines the most stringent or "top" alternative to determine if technical considerations or energy, environmental, or economic impacts justify a conclusion that it is not BACT. If the most stringent or "top" technology is determined not to be BACT using this methodology, then the next most stringent alternative is considered until BACT is determined. If no available control strategy is better than the one which the applicant has proposed, the applicant must still consider countervailing non-air environmental impacts (this point was noted in EPA's 1978 guidelines for determining BACT and 1980 PSD workshop handbook, and was reiterated in a May 1989 EPA draft document on "top down" BACT). Equipment with similar control capabilities do not require an evaluation. For those pollutants which have applicable air pollutant emission standards [e.g., New Source Performance Standards (NSPS)], BACT needs to be at least as stringent.

4.1.1 ENERGY IMPACTS

Where additional control equipment is required (such as scrubbers for SO_2 and HCl control), the cost of the energy consumed by the equipment is determined. If the best method to control a pollutant is proper furnace operation or the hardware design features of the Facility (such as controlling CO by properly distributing the over- and under-fire combustion air, and furnace temperature maintenance), then no additional costs for energy will be incurred to control the pollutant.

As in the economic analysis described below, energy impacts (million Btu or kwh/year) have been determined for applicable pollution control strategies to complete the BACT engineering and economic evaluations in the subsequent subsections. An incremental analysis would not apply in a "top down" BACT analysis if only a single control case has been considered to be the "top" level of control.

4.1.2 ECONOMIC IMPACTS

Where control equipment is required, the capital and annual operating costs, and the total and incremental control effectiveness (in dollars per ton of pollutant removed), were determined. If the best method to control a pollutant is proper furnace operation or the proper design of the Facility, then no additional capital or operating costs would be incurred to control the pollutant.

When performing a "top down" BACT economic analysis, the cost-effectiveness of each control strategy is determined by dividing the total annual cost of each strategy by the amount of emissions controlled by each strategy. Similarly, incremental cost-effectiveness is determined by dividing the incremental annual costs by the incremental emission reductions. This procedure was identified in EPA's 1980 PSD workshop handbook. The incremental cost-effectiveness value is a measure of comparing residual emissions of one control alternative to another control alternative with higher emission reduction potential. This value is especially important when evaluating the reasonableness of emission control costs. The analysis would not apply in a "top down" BACT analysis if the "top" or LAER control is selected.

4.1.3 ENVIRONMENTAL IMPACTS

The applicable environmental impacts for each control alternative were completed using the "top down" BACT approach. The potential environmental impacts considered in the BACT analysis concentrated on those not involving air quality since they are discussed separately as noted below. Both beneficial and adverse impacts were evaluated.

Using the proposed stack parameters, EPA-approved dispersion modeling was performed for the evaluated pollution control strategy. The impacts on air quality are determined by comparing the dispersion modeling results, the ground level concentrations (GLC), to the PSD allowable increments, National Ambient Air Quality Standards (NAAQS), and Florida Ambient Air Quality Standards (FAAQS) where applicable. A refined dispersion modeling analysis was performed for the proposed air pollution control system and is included in Section 6.0 of the permit application.

4.1.4 POLLUTANT APPLICABILITY

The initial Facility will have a throughput capacity of 1,800 tons per day (tpd); however, the site certification, BACT evaluation, and air quality analyses have been performed for a 2,400-tpd Facility in anticipation of future solid waste disposal requirements. The County currently has not contracted a full-service vendor to design the Facility, thus the required BACT analysis evaluates individual emission and throughput capacity differences of the combustor technology design.

Two possible mass-burn combustor technology designs are currently being considered by the County. The proposed Facility will likely have either a mass-burn stoker waterwall or mass-burn rotary waterwall combustor design. If a mass-burn stoker waterwall design is used, the Facility will have three combustors each with a throughput capacity of 600 tpd and ultimately an additional combustor of identical capacity (i.e., certification for 2,400 tpd). Due to current capacity qualification restrictions, a mass-burn rotary waterwall design would initially require the proposed

Facility to have four combustors each with a throughput capacity of 450 tpd. A future mass-burn rotary waterwall combustor would have a 600-tpd capacity (i.e., certification for 2,400 tpd).

The differing total number of combustors, design, and throughput capacity are taken into account in the BACT analysis. Pollutants which required flue gas technology evaluations were considered for both possible mass-burn combustor designs. Overall Facility emissions, except for NO_x, VOC, and CO, are identical and independent of the mass-burn technology. A BACT analysis for NO_x, VOC, and CO was completed as they apply to each combustor design.

On December 20, 1989, EPA published proposed New Source Performance Standards (NSPS) for regulating air emissions from Municipal Waste Combustors (MWC) in the Federal Register. The intent of the proposed standards is to require new MWCs to control emissions to the level achievable by applying the best demonstrated system. Pollutants regulated under the proposed standards include: (1) MWC organics which impose a limit for dioxin/furan and CO emissions; (2) MWC trace metals which impose a limit for PM and opacity; (3) MWC acid gases which impose a limit for HCl and SO_2; and (4) Nitrogen Oxides (NO_x). The control level required for these pollutants is differentiated in the proposed rule by the size of the MWC. More stringent control requirements exist for those MWC plants that combust more than 250 tpd of refuse. In addition to regulating pollutants, the proposed standards include a materials separation requirement which would apply to all new MWCs regardless of their capacity. The materials separation provision requires a 25 percent reduction of the refuse generated prior to combustion, with a 10 percent maximum credit for yard waste.

The PSD regulations state, in 40 CFR Part 52.21, that any major source must perform a formal BACT analysis for each PSD pollutant emitted in quantities greater than the PSD significant emission rates. The PSD significant emission rates and the total projected emissions from the Facility are shown in Table 4-1. Since the Facility may have either a mass-burn stoker waterwall or a mass-burn rotary waterwall combustor design, the emission

TABLE 4-1

LEE COUNTY ENERGY RECOVERY FACILITY
BACT SUMMARY
COMPARISON OF THE PROJECTED EMISSION RATES
TO PSD SIGNIFICANCE VALUES AND PROPOSED CONTROL TECHNOLOGY

Pollutant	PSD Significant Emission Rate (tpy)	Proposed BACT Emission Rate (lbs/ton)	(tpy)[a]	Proposed Control Technology
Carbon Monoxide (CO)[c] (rotary waterwall)	100	1.48	648	Furnace Design & Proper Operation
Carbon Monoxide (CO)[d] (stoker waterwall)	100	0.987	432	Furnace Design & Proper Operation
Nitrogen Oxides (NO_x)[e] (rotary waterwall)	40	2.43	1,064	Furnace Design & Proper Operation
Nitrogen Oxides (NO_x)[f] (stoker waterwall)	40	3.24	1,419	Thermal DeNO_x
Sulfur Dioxide (SO_2)[g]	40	1.49	653	Dry Scrubber/Fabric Filter, least stringent 80% removal by weight or 30 ppmdv @ 7% O_2, both over a 24-hour block average
Particulate Matter (PM)	25 (TSP) 15 (PM_{10})	0.194	85	Fabric Filter - 0.010 gr/dscf @ 7% O_2
Ozone (VOC)[l] (rotary waterwall)	40	0.40	178	Furnace Design & Proper Operation
Ozone (VOC)[m] (stoker waterwall)	40	0.21	92	
Lead (Pb)	0.6	$6.0x10^{-3}$	2.6	Dry Scrubber/Fabric Filter
Asbestos[k]	0.007	Nil	Nil	
Beryllium (Be)	0.0004	$1.35x10^{-6}$	$5.9x10^{-4}$	Dry Scrubber/Fabric Filter

TABLE 4-1
(continued)

Pollutant	PSD Significant Emission Rate (tpy)	Proposed Bact Emission Rate (lbs/ton)	(tpy)[a]	Proposed Control Technology
Fluorides (as HF)[n]	3	0.035	15.3	Dry Scrubber/Fabric Filter
Mercury (Hg)	0.1	8.0×10^{-3}	3.5	Dry Scrubber/Fabric Filter
Vinyl Chloride[k]	1	Nil	Nil	
Sulfuric Acid Mist (H_2SO_4)	7	0.358	157	Dry Scrubber/Fabric Filter
Hydrogen Sulfide[k]	10	Nil	Nil	
Total Reduced Sulfur[k]	10	Nil	Nil	
Hydrogen Chloride (HCl)[h]	NA[b]	0.643	282	Dry Scrubber/Fabric Filter, least stringent of at least 95% removal by weight or 25 ppmdv @ 7% O_2; both over an 8-hour average
Arsenic (As)	AER[i]	9.1×10^{-5}	4.0×10^{-2}	Dry Scrubber/Fabric Filter
PCDD & PCDF expressed as 2,3,7,8 TCDD (equiv.) (EPA-1987 equiv.)	NA[b]	1.58×10^{-8}	6.9×10^{-6}	Furnace Design, Proper Operation, Dry Scrubber and Fabric Filter
Benzene[k]	AER[i]	Nil	Nil	
Radionuclides[k]	AER[i]	Nil	Nil	
Radon 222[k]	AER[i]	Nil	Nil	
MWC Emissions	10[j]	___[j]	___[j]	Dry Scrubber/Fabric Filter

TABLE 4-1
(continued)

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[a] Assumes 100 percent annual facility availability at the design capacity of 2,400 tpd; however, the accepted industry standard for on-line availability of a energy recovery facility is 85 percent. Facility emission rates for NO_x, VOC, and CO have been listed twice to differentiate among the two possible combustor designs (i.e., mass-burn stoker waterwall and mass-burn rotary waterwall). The total Facility emission rates for all other pollutants shall be the same for the different combustor designs. The tpy emission rates have been rounded off.

[b] Not applicable. These pollutants are not regulated under the PSD regulations, but were provided for review to the Florida Department of Environmental Regulation (FDER). Recently, these pollutants were included in the proposed NSPS with emission limitations assigned to organics (specifically PCDD and PCDF), metals via particulate control, and acid gases (specifically HCl and SO_2). The indicated toxic equivalent dioxin BACT emission rate is 2 ng/Nm^3 at 7% O_2.

[c] The mass-burn rotary waterwall combustor design is the basis of this CO emission rate. The BACT tpy emission rate is based on 150 ppmdv @ 7% O_2, 4-hour block average, as required by the proposed NSPS which differentiates among combustor design with a 400 ppmdv @ 7% O_2, maximum 1-hour average allowance.

[d] The mass-burn stoker waterwall combustor design is the basis of this CO emission rate. The BACT tpy emission rate is based on 100 ppmdv @ 7% O_2, 4-hour block average, as required by the proposed NSPS which differentiates among combustor design with a 400 ppmdv @ 7% O_2, maximum 1-hour average allowance.

[e] The mass-burn rotary waterwall combustor design is the basis of this NO_x emission rate. The BACT tpy emission rate is based on 150 ppmdv @ 7% O_2, over a 24-hour average with a 220 ppmdv @ 7% O_2, maximum 1-hour average allowance.

[f] The mass-burn stoker waterwall combustor design is the basis of this NO_x emission rate. The BACT tpy emission rate is based on 200 ppmdv @ 7% O_2 over a 24-hour average with a 220 ppmdv @ 7% O_2 maximum, 1-hour average allowance.

[g] The proposed BACT tpy emission rate is based on 66 ppmdv @ 7% O_2 over a 24-hour average from a 330 ppmdv @ 7% O_2 scrubber inlet SO_2 concentration with 80% removal; there is a 82.5 ppmdv @ 7% O_2 maximum 3-hour average from 330 ppmdv @ 7% O_2 scrubber inlet SO_2 concentration with 75% removal allowance.

[h] The proposed BACT tpy emission rate is based on 50 ppmdv @ 7% O_2 over an 8-hour average from a 1,000 ppmdv @ 7% O_2 scrubber inlet HCl concentration with 95% removal.

[i] Any emission rate (AER). These pollutants (i.e., benzene, radionuclides, arsenic, and radon 222) are regulated by the Clean Air Act under NESHAPS, and any emission is considered a significant emission rate. Footnote "k" also applies except for arsenic.

TABLE 4-1
(continued)

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[j] The recently proposed NSPS would amend Part 52 of the Federal Regulations by adding to the end of the list appearing in Section 52.21, paragraph (b)(23)(i) the following entry: Municipal waste combustor (MWC) emissions, 10 tpy. The constituents of MWC emissions represent a broad range of pollutants that are categorized into three subclasses: MWC organics (includes PCDD and PCDF), MWC metals (condensibles on particulate matter), and MWC acid gases (includes SO_2 and HCl). In the proposed NSPS, EPA was unclear whether the proposed BACT emission rate is a total of the three MWC subclass categories from the Facility, and how the computation should be made; final NSPS promulgation should address this consideration.

[k] A negligible emission rate was assigned to these pollutants since they are typically not found in the flue gas of refuse combustors or are not characteristic of a refuse waste stream. Representative stack test data are not available to support their presence in the flue gas of MWCs.

[l] The mass-burn rotary waterwall combustor design is the basis of this VOC emission rate, expressed as nonmethane hydrocarbons. The BACT tpy emission rate is based on 71.7 ppmdv at 7% O_2 hourly average concentration.

[m] The mass-burn stoker waterwall combustor is the basis of this VOC emission rate expressed as nonmethane hydrocarbons. The BACT tpy emission rate is based on 37.3 ppmdv at 7% O_2 hourly average concentration.

[n] The BACT tpy emission rate for HF is based on 5 ppmdv at 7% O_2 hourly average concentration.

rates for CO, VOCs, and NO_x are listed twice in the table to account for any differences between the two designs. BACT requirements apply only to pollutants emitted in areas designated as in attainment with respect to the NAAQS/FAAQS. The proposed Facility site is located in an area that has been designated as being in attainment or unclassified for NO_x, PM, Pb, CO, SO_2, and ozone. PSD regulated pollutants without established NAAQS are also subject to a formal BACT analysis if emissions exceed certain thresholds. From Table 4-1, the following regulated pollutants, with or without established NAAQS, are projected to be emitted in quantities greater than the designated PSD significant emission rates: PM, NO_x, SO_2, CO, Pb, Be, Hg, HF, VOCs, As, and H_2SO_4.

As a result of an EPA ruling promulgated on July 1, 1987, a PSD significant emission level and NAAQS for PM was developed to include only those particles with an equivalent aerodynamic diameter of less than or equal to 10 microns (meter x 10^{-6}) (PM_{10}). Thus, the BACT analysis for PM includes a dual review of PM_{10} and total suspended particulates (TSP). As shown in Table 4-1, the Facility will emit PM emissions in excess of both the TSP significant emission level, 25 tpy, and the significant emission level for PM_{10}, 15 tpy. For purposes of this BACT analysis, it is conservatively assumed all emitted TSP is PM_{10}.

Control technology reviews using the BACT methodology were performed on several other pollutants specified either in the proposed NSPS under the PSD regulations and at the request of FDER, or by EPA Region IV. These pollutants include: hydrogen chloride (HCl), dioxins (PCDD), and furans (PCDF). The HCl review was based on the December 1989 proposed NSPS.

Table 4-1 also lists pollutants, regulated by the Clean Air Act, which have been assigned a negligible emission rate based on the premise that they are typically not found in the flue gas of refuse combustors. Stack test data does not support their existence. These pollutants include: hydrogen sulfide, total reduced sulfur, vinyl chloride, asbestos, benzene, radionuclides, and radon 222. A control technology review using the BACT methodology was not completed for each of these pollutants.

4.1.5 MATERIAL SEPARATION

The projected emissions from the Facility, shown in Table 4-1, were determined from an emission database developed to include emission test data from existing refuse combustion facilities (refer to Emission Factor Support Document in Attachment A of this application) and, as such, the projected emissions do not reflect any potential emission reductions which may result from the recovery of reclable material as required in the proposed NSPS. Since there is a lack of current EPA or other reliable data on whether material separation would lead to a demonstrable and quantifiable reduction of pollutant emissions from the Facility, no adjustments or reductions in the projected emissions were made.

4.1.6 SELECTION AND EVALUATION OF ALTERNATIVE CONTROL STRATEGIES

The alternative control strategy analysis for economic impact is based on the following factors: capital equipment cost, bond burden, amortization, and operating and maintenance costs (i.e., power, labor, maintenance, and waste disposal). Capital and operating costs for the proposed air pollution control equipment have been supplied by established manufacturers. Facility design features that affect air pollutant emissions (e.g., carbon monoxide) but are primarily related to the furnace design and operational parameters (e.g., combustor design, excess air level) have not given a direct equipment and operation cost for the purposes of this analysis.

Relative to energy, the Facility would have a positive effect since it would produce steam for electric power generation. Because energy recovery from refuse represents a resource that would be wasted if not used, other sources of energy (e.g., coal, oil, or natural gas) may be conserved as a result of generating electricity from refuse. Based on the same electric power generation rate, the Facility would produce less SO_2 emissions than a coal-fired power plant.

Environmentally, the evaluation and ultimate selection of the air pollution control equipment is based on how effectively it controls certain regulated (criteria and non-criteria) PSD pollutants and non-regulated pollutants. Environmental benefits of the proposed Facility include the reduction of traditional landfilling practices that result in non-productive land use, fugitive dust emissions, odor emissions, toxic landfill off-gases, and potential groundwater pollution. The Facility will also reduce the need for acquiring additional landfill space.

4.2 REGULATORY PERMITTING BASIS FOR THE PROPOSED EMISSION CONTROL STRATEGIES

Lee County is proposing to equip the Facility with dry scrubbers and fabric filters (also referred to as baghouses), and maintain good combustion controls to achieve the BACT determined stack emission limitations.

Each air pollution control train will be equipped with instruments to continuously monitor and record O_2, CO, SO_2, NO_x, opacity, and temperature. The monitors will ensure compliance with the proposed NSPS pollutant emission requirements. The applicable averaging time requirements for each pollutant will be demonstrated by the continuous emission monitors (CEM). The NO_x and O_2 CEMs will be located downstream from the economizer, and the SO_2 CEMs will be located upstream of the dry scrubber and downstream of the fabric filter. Due to the inaccuracy of current HCl monitors, an SO_2 monitor shall be used as a surrogate. The opacity monitor shall be properly mounted and located to measure the light transmission characteristics of the exhaust gas. A thermocouple shall be installed at the PM control device inlet, in accordance with the proposed NSPS.

Development of the proposed control strategies is based on previously selected BACTs for other permitted facilities and the proven capabilities of various control technologies. The EPA's BACT/LAER Clearinghouse (EPA 1984, 1987b, 1988, and 1989) contains a partial list of permitted refuse combustion facilities. The emission rates and control technologies listed in the Clearinghouse (chronologically presented in Attachment C) are those which appeared in the original application for a facility, and do not necessarily represent a system's continuous performance or what control equipment presently exists (other examples of recently permitted facilities not currently in the Clearinghouse are listed in Table 4-2).

TABLE 4-2

LEE COUNTY ENERGY RECOVERY FACILITY
PERMITTING DATA FOR ADDITIONAL REFUSE COMBUSTION FACILITIES

Location	Size (tpd)	Air Pollution Control Equipment	Particulate Emissions (gr/dscf @ 12% CO_2)	Projected Emissions (lb/ton of MSW)				BACT for CO, VOC, and NO_x
				SO_2	NO_x	CO	P_b	
Bristol, CT	650	Dry Scr/FF	0.015	2.881	5.4	1.34	0.006	Furnace design combustion control
Bay County, FL	500	ESP	0.03	2.8	2.2	11.4	0.0036	Furnace design good operation proper excess air flow
Broward County, FL (north)	2,200	Dry Scr/ESP	0.015	4.95	5.0	0.8	0.018	Furnace design good operation
Hillsborough County, FL	1,200	ESP	0.021	8.5	6.4	1.8	0.002	Furnace design combustion control
Pinellas County, FL	3,000	ESP	0.03	4.08[a]	6.1[a]	1.6[a]	0.067[a]	Furnace design good operation proper excess air flow
Tulsa, OK	750	ESP	0.06	3.23	6.4	1.33	0.0064	Furnace design combustion controls
Millbury, MA	1,726	Dry Scr/ESP	0.03	1.88	5.29	0.79	0.0224	Combustion controls excess air flow

TABLE 4-2
(continued)

Location	Size (tpd)	Air Pollution Control Equipment	Particulate Emissions (gr/dscf @ 12% CO_2)	Projected Emissions (lb/ton of MSW)				BACT for CO, VOC, and NO_x
				SO_2	NO_x	CO	P_b	
Claremont, NH	100	Dry Inj Scr/FF	0.02	6.37	6.37	2.88	N/A	Furnace design combustion controls
Gloucester, NJ	575	Dry Scr/FF	0.015	2.14	5.49	3.79	0.023	Furnace design combustion controls
Marion County, OR	550	Dry Scr/FF	0.03	3.19	4.1	2.4	0.023	Furnace design combustion controls
Delaware County, PA	2,688	Dry Scr/FF	0.015	1.22	4.1	4.3	0.003	Furnace design combustion control
San Juan, PR	1,040	Dry Scr/FF	0.010	1.01	3.5	3.5	0.003	Furnace design combustion control

SOURCE: Camp Dresser & McKee Inc., 1990.

[a] The Facility consists of three 1,000-tpd mass-burn units. Permitted emissions are for the third unit.

Scr - Scrubber
FF - Fabric Filter
ESP - Electrostatic Precipitator
Dry Inj Scr - Dry Injection Scrubber

Although the Clearinghouse is a principal source of information, it is not always complete. The submittal of information from state permitting agencies to the Clearinghouse is voluntary. The Clearinghouse may not contain information on recently permitted facilities or those permitted before it was established. In addition, not all of the facilities listed as refuse combustion facilities by the Clearinghouse would necessarily be similar to the proposed Facility. A listed facility may use another fuel such as refuse-derived fuel (RDF), employ different combustion or air pollution control technologies, or operate at much lower or higher firing rates. Certain pollutant emission rates vary inversely with one another, (e.g., NO_x and CO), hence automatic reliance on the Clearinghouse for the lowest permitted values for each pollutant could result in an erroneous pollutant composite being applied in a "top down" BACT analysis.

In the past, electrostatic precipitators (ESPs) have been installed on many refuse combustion facilities for particulate control due primarily to their ability to operate at the higher gas temperatures typical of facilities that did not include a dry scrubber. This early trend is supported by Table 4-3 which shows ESPs alone to be the means of controlling particulate emissions prior to 1980. In recent years, the increased use of dry scrubbers which in effect lower flue gas temperatures and technology advancements in higher temperature fabrics have resulted in a greater acceptance of fabric filters to meet the stringent particulate emission limits of state regulations. The fabric filter's acceptance is supported by Attachment C, Table 4-2, and Table 4-3 (after 1980). Of the 40 facilities listed in Attachment C, 16 have been permitted with ESPs, 23 have been permitted with fabric filters, and one has the option of either.

It should be noted that some of the particulate data presented in Table 4-3 may not have been obtained by following EPA Method 5 particulate test procedures. The Lee County Facility will use EPA approved test procedures for compliance testing.

All of the facilities in Attachment C, except for the Long Beach, Stanislaus and Commerce refuse combustion facilities, each of which are in

TABLE 4-3

LEE COUNTY ENERGY RECOVERY FACILITY
PARTIAL LISTING OF ADVANCED PARTICULATE CONTROL EQUIPMENT APPLICATIONS TO MSW COMBUSTION FACILITIES
1970 TO 1988

Facility	Date	Air Pollution Control Equipment[b]	Particulate Test Data[a] gr/dscf
S.W. Brooklyn, NY	1970/71	ESP	.114/.146
South Shore, Brooklyn, NY	1970	ESP	.056
Dade County, FL	1970	ESP	.027
Braintree, MA	1970/78	ESP (1 field)	.108/.083
Montreal, Canada	1970/71	ESP	.013/.08
Chicago (NW), IL	1971/75	ESP	.025/.03
Washington, DC	1972	ESP	.0548
Harrisburg, PA	1974	ESP	.06
Quebec City, Canada	1974	ESP	.095
East Bridgewater, MA	1975	FF	.02
Pasadena, CA (pilot)	1975	FF	.008
Nashville, TN	1978	ESP	.018
Nashville, TN (pilot)	1980	FF	.008
Framingham, MA	1980	Dry Scr/FF	.02
Isogo, Japan	1980	Dry Scr/FF	.026[d]
Kure, Japan	1981	ESP	.03
Malmo, Sweden	1982	Dry Scr/FF	.02
Saugus, MA	1983	ESP	.025
Saugus, MA (pilot)	1983	FF	.008
Gallatin, TN	1983	FF (Electrostatic)	.029
Susanville, CA	1983	FF	.01
Tsushima, Japan	1983	Dry Scr/FF	.01
Bamberg, Germany	1983	Wet Scr/ESP	.0135
Munich North, Germany	1984	Dry Scr/ESP	.0104
Neustadt, Germany	1984	Dry Scr/ESP	.0084
Lausanne, Switzerland	1984	Elec/Scr/ESP	.0208
Albany, NY-RDF	1984/86/87	3-FIELD ESP	.131/.066/.02
Niagara Falls, NY-RDF	1985/86	4-FIELD ESP	.096/.012
Westchester County, NY	1985	3-FIELD ESP	.016
Avesta, Sweden	1985	Cond. Scr/ESP	.0178[c]
Ingolstadt, Germany	1985	Wet Scr/ESP	.02264
Quebec City, Canada (pilot)	1985	Dry Scr/FF	.0009
Copenhagen, Denmark (pilot)	1985	Dry Scr/FF	.0078
Malmo, Sweden	1985	Dry Inj. Scr/FF	.006[c]
Nurnberg, Germany	1985	SDA/ESP	.0028
Kempten, Germany	1985	Dry Inj. Scr/FF	.0025
Hogdalen, Sweden	1985	Dry Scr/FF	.006
Linkoping, Sw	1985	Dry Scr/FF	.0063[d]
Baltimore, MD	1985	4-FIELD ESP	.003
Wurzburg, Germany	1986	Dry Inj Scr/FF	.004
Tulsa, OK — Boiler 1	1986	3-FIELD ESP	.0095
— Boiler 2	1986	3-FIELD ESP	.0049

TABLE 4-3
(continued)

Facility	Date	Air Pollution Control Equipment [b]	Particulate Test Data[a] gr/dscf
Marion, OR — Boiler 1	1986	Dry Scr/FF	.011
— Boiler 2	1986	Dry Scr/FF	.0029
Montauban, France	1986	Scr/FF	.002[d]
Oneida County, NY	1986	ESP	.0263
Zurich, Switzerland	1986	SDA/Lg. SCA ESP	.0031
Hogdalen, Sweden	1986	Dry Inj.Scr/FF	.0008
Rosenheim, Germany	1986	SDA/FF	.0056
Iserlohn, Germany	1986	Wet Scr/Cycl/ESP	.0084
N.W. Frankfurt, Germany	1986	SDA/ESP	.028
N.W. Frankfurt, Germany	1986	SDA/ESP/FF	.0056
Frankfurt, Osthafen	1986	Wet Scr/Cycl	.0168
Schwandorf, Germany	1986	Dry Inj.Scr/ESP	.021
Leverkusen, Germany	1986/87	Dry Scr/3-FIELD ESP	.0025/.0009[c]
Commerce, CA	1987	Teller Scr/FF/ DeNO$_x$	.0043
Bay County, FL — Boiler 1	1987	3-FIELD ESP	.0193
— Boiler 2	1987	3-FIELD ESP	.0243
Manheim, Germany	1987	Wet Scr/ESP[e]	.0012
North Andover, MA	1987	3-FIELD ESP	.005
Rutland, VT	1988	Cond/Wet Scr/ 4-FIELD ESP	.003

SOURCE: Clarke, Marjorie J., "Debating The Virtues of ESPs," Waste Age, June 1988.

FF - Fabric Filter (Baghouse)
DeNO$_x$ - Thermal DeNO$_x$
Dry Scr - Dry Scrubber
Dry Inj - Dry Lime Injection

ESP - Electrostatic Presipitator
Wet Scr - Wet Scrubber
Cycl - Cyclone
SDA - Spray Dryer Absorber

[a] All values are corrected to 12% CO_2 or 7% O_2, "front catch" only unless otherwise noted.

[b] Unless otherwise specified, ESPs have two fields.

[c] Original correction factor assumed to be 11% O_2, corrected to 7% O_2.

[d] Original correction factor not known.

[e] Number of fields of ESP unknown.

California, have listed combustion control and furnace design as BACT for control of NO_x. The Commerce facility permit has since been updated and is permitted with "Innovative Technology" for controlling NO_x. The Commerce facility is the first U.S. refuse combustion facility to incorporate Exxon's patented Thermal DeNOx system (ammonia injection into the boiler) to reduce NO_x emissions. The Stanislaus and Long Beach facilities also have incorporated Exxon's ammonia injection system to control NO_x. The Commerce facility is located in a nonattainment area for NO_2 and ozone, while Stanislaus and Long Beach are in a nonattainment areas for PM, NO_2, and ozone. Recent permit decisions made for the Huntington, NY and Pennsanken, NJ facilities will require the use of a thermal $DeNO_x$ system. The BACT/LAER Clearinghouse compilation is normally updated either annually or bi-annually, thus it does not include some recently permitted facilities.

4.3 BACT REVIEW FOR SO_2 AND ACID GAS COMPOUNDS

4.3.1 PROPOSED CONTROL TECHNOLOGY

A growing number of state permitting agencies in the U.S. are requiring multipollutant, SO_2, and acid gas control systems on refuse combustion facilities. As with other refuse combustion facilities, Lee County's proposed Facility will generate SO_2 and various other acid gases, including HCl, HF, and H_2SO_4, during combustion.

The County proposes to use a dry scrubber for each of the Facility's combustors to control SO_2 and other acid gas emissions. As discussed earlier, if a mass-burn stoker waterwall design is used, then the Facility will have four identical dry scrubber systems. A mass-burn rotary waterwall design will have five combustors each with a dedicated dry scrubber system. Independent of the Facility's combustor design, each dry scrubber system will be capable of removing: (1) 95 percent (by weight) of the uncontrolled HCl emissions or reduce HCl to a concentration of 25 ppmdv at 7 percent O_2, both over 8-hour averages, whichever is less stringent, and determined by compliance testing; and (2) 80 percent (by weight) of the uncontrolled SO_2 emissions over a 24-hour average (75 percent by weight over a 3-hour average) or reduce SO_2 to a concentration of 30 ppmdv at 7 percent O_2 over a 24-hour average, whichever is less stringent. The dry scrubber system shall also reduce significantly the concentrations of H_2SO_4 and HF in the flue gas.

As indicated in Table 4-1, the Facility may emit the following maximum controlled annual SO_2 and other acid gas emissions: SO_2 - 653 tpy; HCl - 282 tpy; HF - 15.3 tpy; and H_2SO_4 - 157 tpy.

4.3.2 COMPLIANCE WITH APPLICABLE EMISSION STANDARDS

The intent of the recently proposed NSPS requires MWCs to control SO_2 and HCl emissions to the level achievable by applying the best demonstrated system. The emission limitations for these acid gas pollutants as they apply to large MWC plants (those plants that have an aggregate capacity to combust greater than 250 tons per day of refuse) are presented below.

- Sulfur dioxide (SO_2) emissions shall not exceed 30 ppmv, corrected to 7 percent O_2 on a dry basis; or be reduced 85 percent (by weight) both measured over a daily (block) 24-hour basis by CEMs.

- Hydrochloric acid (HCl) emissions shall not exceed 25 ppmv corrected to 7 percent O_2 on a dry basis; or be reduced 95 percent (by weight). Compliance demonstrated by annual performance tests.

It has been determined in this application that 80 percent rather than 85 percent reduction of SO_2 emissions is BACT. When the proposed NSPS become effective, it will be necessary to confirm that permitted BACT emission rates are no less stringent than the applicable new air emission standards.

The Facility shall have CEMs located upstream and downstream from the proposed dry scrubber/fabric filter to ensure that the SO_2 and HCl emission guidelines are met. Due to inaccuracy of HCl monitors, an SO_2 monitor will be used as a surrogate.

The County's planned material separation program, mandated by Florida's Solid Waste Management Act, may produce a beneficial effect on the amount of SO_2 and acid gases produced from the Facility. This program shall also meet the material separation requirements proposed in the NSPS. Since little data currently exists on whether material separation leads to a demonstrable and quantifiable reduction of SO_2 and acid gases, the projected emissions from the Facility do not recognize any potential benefits.

4.3.3 EMISSION OF GASEOUS SULFUR COMPOUNDS AND ACID GASES

Emission of Sulfur Compounds

The sulfur which contributes to pollutant emissions from refuse combustion is chemically bound to other elements in the refuse. During combustion, a fraction of these elements escapes from the furnace as gaseous sulfur compounds while the remainder leaves as bottom or fly ash. The type of sulfur compounds released from the furnace is dependent on the presence of other gaseous compounds, combustion temperatures, and chemical (oxidizing or reducing) conditions in the furnace. Furnace conditions (oxidizing or reducing) directly influence the types of sulfur compounds which may form and exit during combustion. Excess oxygen conditions, typical of a refuse combustor, generally result in the formation of SO_2 and SO_3 while reducing (oxygen deficient) conditions result in hydrogen sulfide (H_2S), carbonyl sulfide (COS) and elemental sulfur. Since the Facility will be operated under excess oxygen conditions, reduced forms of sulfur are not likely to form and their emissions, as indicated in Table 4-1, will be negligible.

Gaseous SO_2 is the predominate sulfur compound emitted during refuse combustion, with its rate of formation dependent upon the valence state and chemical bonding of the refuse sulfur content. The sulfur in refuse exists as organic sulfur and sulfates and, to a lesser extent, as sulfides. Organically bound sulfur or sulfide sulfur will oxidize to produce gaseous SO_2. The SO_2 emissions will also produce SO_3, which will either be gaseous or appear in the fly ash as sulfates.

The fraction and elemental type of sulfur contained in the refuse which is either converted to other compounds or passed through the furnace was discussed in a technical paper by Kaiser (1968). The paper was based on refractory-wall mass-burn facilities, and states that approximately one-half of the sulfur contained in the refuse appears in the bottom ash as sulfates (expressed as SO_3). Of the remaining fraction available for oxidation to SO_2 and SO_3, approximately one-half exits the stack as SO_2 (25 percent) and one-half further oxidizes to sulfates found in the fly ash. O'Connel (1982) reported SO_2 net conversion rates for refuse to be between 20 and 60 percent. The refuse combustion industry conservatively assumes that between 50 and 90 percent of the sulfur found in refuse is converted to sulfur emissions (SO_2 and SO_3) which could potentially exit the stack.

Emission of Acid Gases

Acid gases which are found in the flue gas of refuse combustion facilities include H_2SO_4, HCl, and HF. Reduced visibility, metal corrosion, and the formation of acid rain or fog, have been attributed to the emission of these compounds. H_2SO_4 is produced as an indirect result of the emission of SO_2.

The pyritic and organic sulfur in the refuse which oxidizes to SO_2 during combustion may further oxidize to SO_3 in the furnace or after exiting the stack. Once formed, a portion of the SO_3 reacts with water vapor in the flue gas or atmosphere to form H_2SO_4. In addition, the H_2SO_4 may further react to create sulfate salts which form a particulate aerosol.

Hydrogen chloride is the predominant equilibrium chlorine product from the combustion of refuse. The excess quantity of hydrogen present during the combustion process readily reacts with the chlorine in the refuse to form hydrogen chloride. Chlorinated plastic(s) and bleached paper products are major contributors of chlorine in the refuse and, therefore, have been considered as the primary sources of HCl emissions at refuse-burning facilities. The net conversion of chlorine contained in the refuse (organic and inorganic) to HCl, as determined in a study by Kaiser and

Carotti (1972) and in a Swedish study with similar findings, is approximately 60 to 65 percent. The remainder of the chlorine from the refuse exits with the bottom ash. Both studies indicate that the net yield of HCl (percentage of the chlorine in the refuse appearing as HCl) decreases as the chlorine content of the solid waste increases.

Fluoride emissions from refuse combustion are primarily from fluorinated plastics and other fluorocarbon products such as teflons, polyvinyl fluoride films, and fluorinated aerosol propellants. The mechanisms which govern fluorine release and HF formation from refuse combustion are considered much the same as HCl due to the chemical similarities between fluorine and chlorine. Little information, however, is available on the concentration of fluorine in today's refuse.

4.3.4 DESCRIPTION OF SO_2 AND OTHER ACID GAS CONTROL ALTERNATIVES

The emissions of SO_2 and acid gases (e.g., H_2SO_4, HCl, and HF) from refuse combustion can be reduced through the application of acid gas scrubbing devices. There are three general types of acid gas scrubbers offered by the air pollution control industry: wet scrubbers, dry scrubbers, and dry injection scrubbers. Although the specific operation of each of these scrubbers differs significantly, each incorporates the use of an alkaline reagent to react with and neutralize acid gases in the flue gas stream. Wet scrubbers and dry scrubbers subject flue gas to a sorbent water solution while dry injection scrubbers inject completely dry sorbent into the flue gas.

The relative removal efficiencies of these technologies for HCl, HF, and SO_2 are shown below. As the table shows, HCl and HF are generally better controlled than SO_2 because they are highly reactive acids. The higher removal efficiencies of dry scrubbers and wet scrubbers, in contrast to the dry injection scrubber, can be attributed to their lower operating temperatures and to their liquid-gas contact which provides better mass transfer of gaseous pollutants to the absorbing interface.

Scrubber Device	Pollutant (% Removal) HCl	HF	SO_2
Wet Scrubber	95-99	99	80-90
Dry Scrubber	90-99	99	70-90
Dry Injection Scrubber	70-99	98	40-85

The removal efficiencies shown in the above table are based on data contained in several reports including: EPA's report to Congress (USEPA, 1987a); reports by Marjorie Clarke of the New York City Department of Sanitation (Clarke, 1986, 1987a, and 1987b); the California Air Resources Board (Carb 1984); and the USEPA's BACT/LAER Clearinghouse (USEPA, 1984, 1987b, 1988, and 1989). A scrubber's ability to achieve consistent and continuous control of these pollutants is better represented by the values in the lower end of the control efficiency ranges noted above.

These acid gas scrubbing devices were each evaluated on the basis of their technical feasibility and the associated environmental, energy, and economic impacts of controlling SO_2, HCl, and other acid gas emissions. A comprehensive description and technical evaluation of each technology are presented in the following sections.

Wet Scrubbers

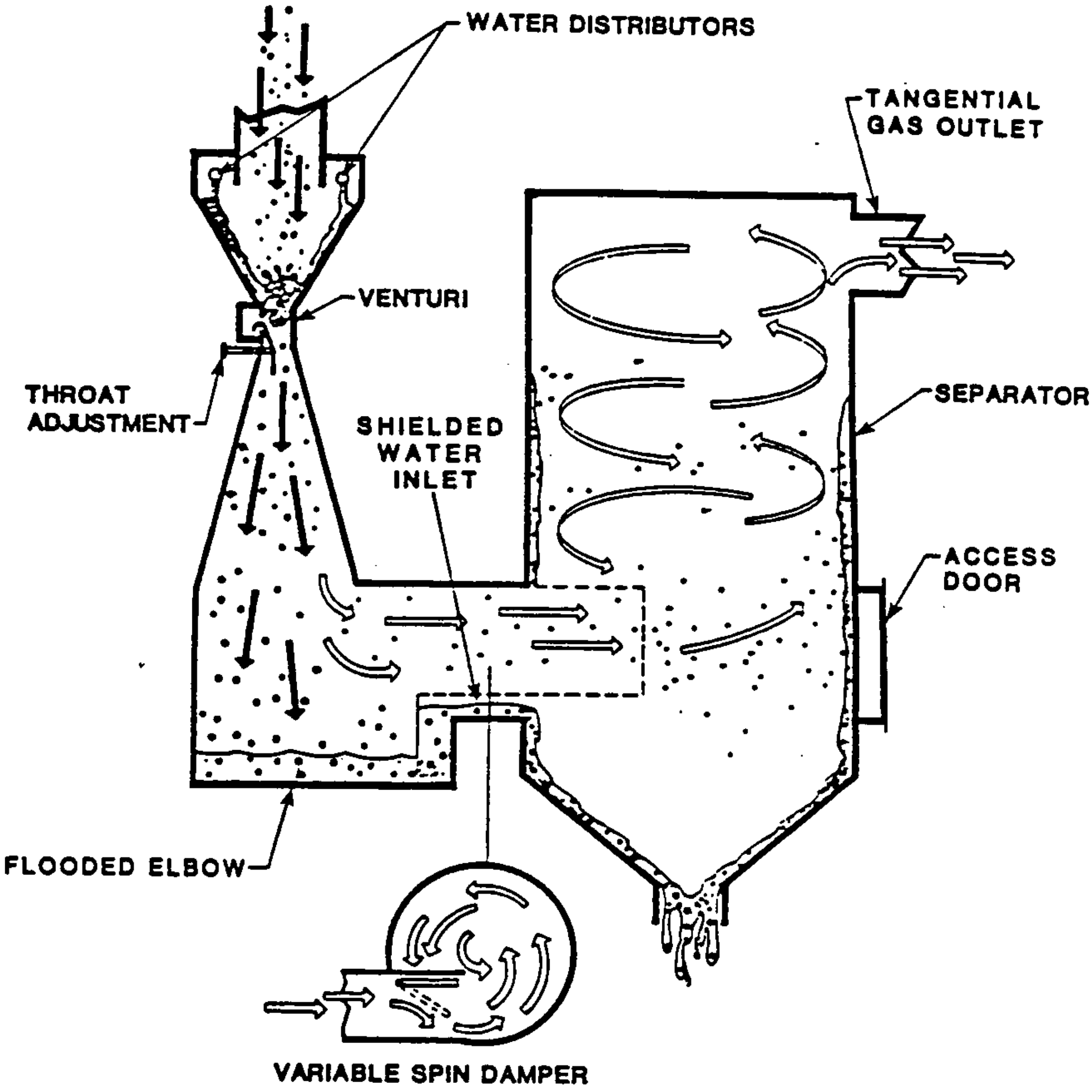
Wet scrubbers have been used on refuse combustion facilities in the past primarily as particulate control devices; however, they can also be designed to provide effective acid gas control. Acid gas wet scrubbers differ from particulate matter removal wet scrubbers in several ways. The dominant mechanism by which particulate is collected in a wet scrubber is inertial impaction of the particulates with the fluid, which is dependent on the pressure drop across the unit. Thus, particulate control wet scrubbers are typically high energy units with large pressure drops. In contrast, the process which governs the overall rate of acid gas absorption and control in a wet scrubber is the diffusion of an acid gas molecule into a liquid alkaline droplet for a reaction to occur. The design of an acid gas wet scrubber reflects this governing process since the emphasis is to increase the contact time of the liquid and gas, and the chemical composition of the liquid.

Wet scrubbers for acid gas control use an alkaline liquid which may consist of either caustic soda (sodium) solution or a lime slurry (calcium) to scrub the flue gases. In larger systems, the use of a lime slurry is common since the cost of the alkali favors using the less expensive lime instead of caustic soda in spite of the higher capital costs involved. Lime slurry systems react with the SO_2 and other acid gases to form calcium based salts which require clarifying, thickening, and vacuum filtering to avoid a concentration build-up of precipitated salts in the system. Sodium based systems produce a liquid waste with highly soluble sodium based salts which may require the use of large, carefully contained, holding pond(s) or wastewater treatment plants. The holding pond(s) are used to evaporate and concentrate the dissolved salts, thus they are feasible in warmer climates.

Many types of wet scrubber hardware may be used to remove acid gases. The most common devices in use are the packed tower, impingement tray scrubber, and the venturi scrubber. Figure 4-1 shows a wet venturi which uses Brownian motion, chemical reaction, and inertial impaction to remove acid gas pollutants as well as particulate matter.

Wet scrubbers have been used on a few European refuse combustion facilities to control acid gases, while those used on past U.S. facilities of the 1960s and 1970s were operated as particulate collection devices. European refuse combustion facilities equipped with wet scrubbing systems include the Kiel and Krefeld facilities in West Germany. Acceptance testing data for the original wet scrubber at Kiel show HCl and SO_2 control efficiencies of 98.0 percent and 80.9 percent, respectively (Feindler and Grimm, 1982). At the Krefeld facility, control efficiencies of 99.7 percent for HCl and 96.2 to 98.3 percent for SO_2 have been achieved (Beaumont Environmental, 1986).

The major advantage of an acid gas wet scrubber system over either a dry scrubber or a dry injection scrubber system is its high abatement efficiency. Data on a limited number of European installations show that acid gas wet scrubbers are very efficient and can achieve removal rates for SO_2 and acid gases that are greater than or equal to those of dry scrubbers (Ellison, 1988).



SOURCE: Sly Manufacturing Co.

LEE COUNTY
ENERGY RECOVERY FACILITY
Application for Power Plant Site Certification
Camp Dresser & McKee Inc

FIGURE 4-1
WET VENTURI SCRUBBER

Although wet scrubbers may provide very effective SO_2 and other acid gas control, the technology has several significant disadvantages which discourages its use on refuse combustion facilities. In addition to the extensive and expensive liquid effluent treatment required, wet scrubbers produce a saturated gas which increases the potential for corrosion of wet scrubber internals and downstream equipment. It also creates an aesthetically displeasing visible water vapor plume. The Kiel refuse combustor in West Germany has a wet scrubber which confirms these corrosion problems. The facility has been reported to have experienced severe corrosion of the wet scrubber's internals and the stack.

In addition to the aesthetically displeasing water vapor plume produced by the wet scrubber, localized acid deposition may result in the vicinity of the stack during periods of unfavorable meteorological conditions, such as, cool weather or high relative humidity. Since a wet scrubber system has a lower operating temperature than a dry scrubber or dry injection scrubber, the plume produced is less buoyant. Lower temperature results in reduced plume rise which will increase GLCs at equivalent emission concentrations. Reheating the stack gases prior to their exit will reverse this effect, but will decrease the Facility's net energy production and impose a significant economic disadvantage.

Presently, there are no refuse combustion facilities planned in the U.S. with a wet scrubber for acid gas control. The major reasons cited for this include:

- High wastewater treatment requirement resulting in increased energy and utility operating costs.
- Liquid effluent from the wet scrubber which requires pretreatment to meet regulatory requirements before discharge to a municipal sewer.
- Problems associated with the disposal of wet sludges resulting from the process. Extensive sludge thickening and dewatering equipment is required.

- Corrosion, scaling, and fouling of scrubber internals. Costly acid corrosion resistant construction materials are required for the scrubber and downstream equipment. These materials include high nickel chromium alloys, such as those in the Hastelloy and Inconel series, which are extremely expensive.

- Visible water vapor plume under most meteorological conditions, especially during periods of high relative humidity.

- A relatively low stack gas temperature resulting in reduced buoyancy. This reduced buoyancy results in lower plume rise and poorer plume dispersion of the residual pollutants. Hence, the potential for increased GLCs exists.

Because of these significant technical disadvantages, the wet scrubber alternative is not considered a viable means of acid gas control, and no further analysis of this option was performed. A more detailed analysis of various control options focuses on those technologies with fewer restricting features.

Dry Scrubbers

Dry scrubbers, also referred to as wet-dry, spray dryer, semi-dry, or spray dry scrubbers, offer an effective and practical means of controlling acid gas emissions from refuse combustion facilities. During operation of a dry scrubber system, the flue gases from the boiler are introduced into an absorbing chamber where the gases are contacted by a finely atomized alkaline lime slurry. Acid gases are absorbed by the slurry mixture and the alkaline component reacts with the gases to form salts. Evaporation of the water produces a finely divided particle of mixed salt and unreacted alkali and a flue gas having a lower temperature. A portion of the dry powder drops to the bottom of the scrubber vessel while the flue gases, containing the remaining powder with reacted acid gas salts and the particulates generated during refuse combustion, are delivered to the particulate collector (baghouse or ESP) for removal. A typical dry scrubber system is shown in Figure 4-2.

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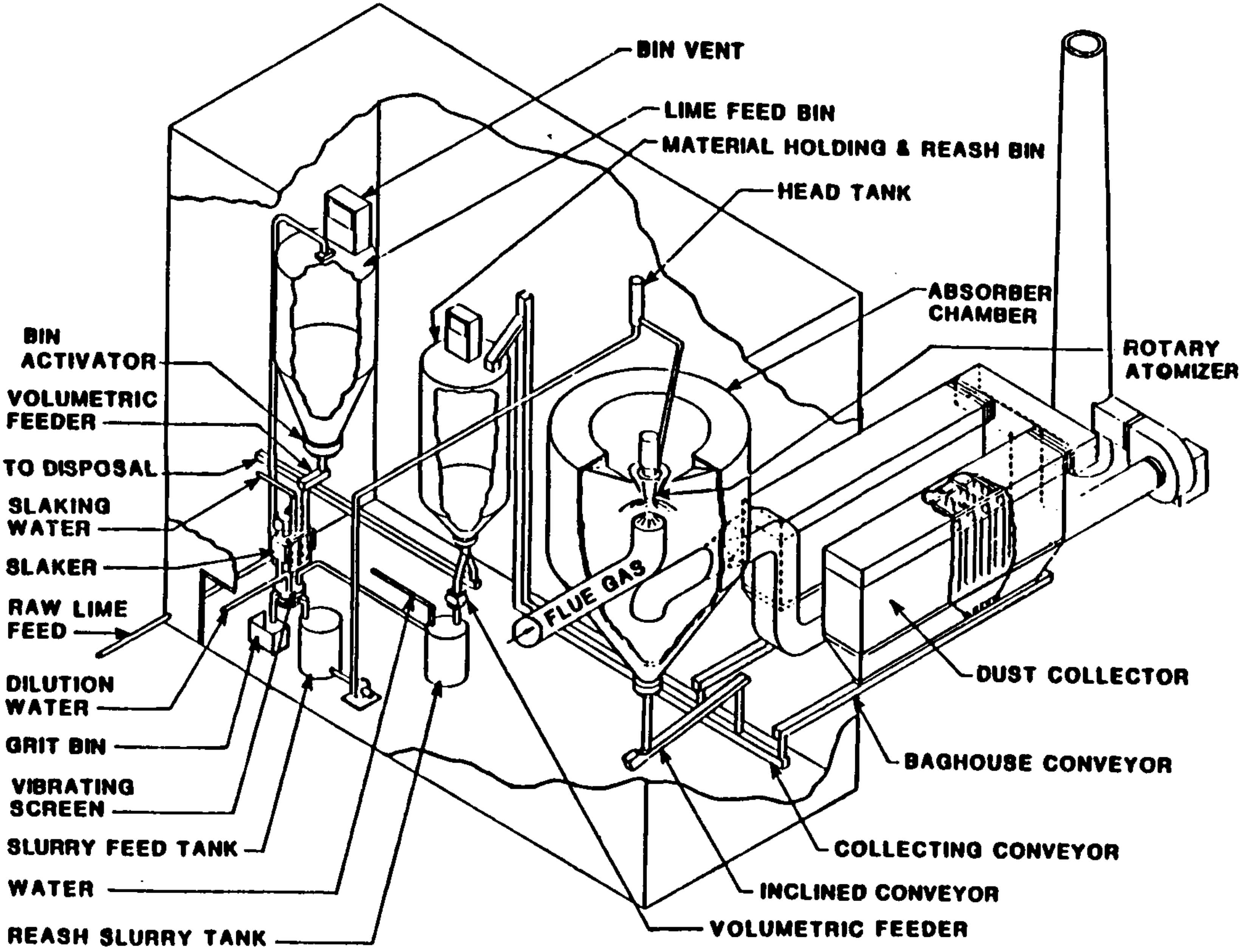


Source: Niro Atomizer, Inc.

FIGURE 4-2
DRY SCRUBBER

To form the lime slurry, pebble lime (CaO) is hydrated by slaking with water [$CaO + H_2O \rightarrow Ca(OH)_2$]. The slurry and any additional cooling water which may be required is then pumped to nozzles or to a rotary atomizer located inside the scrubber's contact chamber. The slurry contains greater than the stoichiometric quantity of lime required to neutralize the SO_2 and acid gases in the flue gas.

Most dry scrubbers used to date have employed either a rotary-type atomizer or a dual fluid nozzle with an external or internal mixing design. Experience shows that each system has pros and cons; however, both are capable of meeting performance specifications.

In the absorbing chamber, the water in the slurry droplets is rapidly evaporated by the hot flue gases. The reduction in flue gas temperature provided by the evaporating water has been shown to be a major factor influencing the removal of acid gases. Studies such as the 1986

Environment Canada Study (R. Klicius et al., 1987) have shown that SO_2 and other acid gas removal efficiencies are significantly higher when the scrubber is operated at temperatures approaching the saturation temperature of the flue gas.

As a result of the scrubbing process a dry, free-flowing powder is produced consisting of unreacted lime, salts (most prevalent being $CaCl_2$, $CaSO_3$, and $CaSO_4$), and fly ash. The largest of these dry particles are separated by gravity from the gas in the absorbing chamber and fall to the bottom. The smaller particles are carried to a particulate control device for separation from the flue gas. It is imperative that a flue gas cleaning system which uses a dry scrubber for acid gas removal also include a downstream particulate control device to remove suspended fly ash, calcium salts, and unreacted lime which result from the scrubbing process. The collected fly ash from the dry scrubber and particulate control device are combined with the bottom ash or residue from the Facility. The use of lime by a dry scrubber changes the characteristics of the combined bottom ash and fly ash since its alkaline nature increases pH.

Although the use of acid gas controls for refuse combustion facilities in the U.S. is relatively new, European and Japanese regulatory agencies have required acid gas controls for approximately ten years. Many of the acid gas control systems in Europe and Japan use dry scrubbers with lime as the neutralizing reagent. The acceptance of this technology can be seen in Table 4-4 from a report by Craig and O'Connell (1982) and Table 4-6. Table 4-4 lists 29 dry scrubber installations with eight reporting HCl and SO_2 emission and control efficiency data (see Table 4-5) ranging from 75 to 99 percent and 48 to 88 percent, respectively.

Table 4-6 lists nine U.S. facilities with dry scrubber systems which have been tested. Six of these facilities reported HCl control efficiencies ranging from 96.9 to 99.4 percent. SO_2 control efficiencies in the range of 73.2 to 98.5 percent were also reported from these facilities. Other refuse combustion facilities which are permitted and either are operating or will employ dry scrubbers include York County, PA; Kent County, MI; Indianapolis, IN; Babylon, NY; Huntington, NY; Rochester, MA; Millbury, MA;

TABLE 4-4

LEE COUNTY ENERGY RECOVERY FACILITY
REFUSE COMBUSTION FACILITIES WITH DRY SCRUBBERS

Facility	Manufacturer	Installed Date	Particulate Control Device	Size (tpd)
Dusseldorf, FRG	D.B.	1980	ESP	1-330
Hamburg, Stellinger Moor, FRG	D.B.	1979	ESP	2-386
Hamburg, FRG	D.B.	1973	ESP	2-516
Hamburg, FRG	Steinmuller	1978	BH	NA
Oberhausen, FRG	D.B.	1981	BH	600
Munich, FRG	D.B.	1980	NA	NA
Pinneburg, FRG	D.B.	1974	ESP	130
Isogo in Yokohama, Japan	T	1980	ESP	NA
Isogo in Yokohama, Japan	T	1980 (demo)	BH	150
Hokuhu in Yokohama, Japan	T	1981	ESP	NA
Sakai, Japan	T	1980	ESP	NA
Kohnan in Yokahama, Japan	T	1980	ESP	NA
Kumamoto, Japan	T	1981	BH	NA
Asahi in Yokohama, Japan	T	1980	ESP	NA
Ohojo in Yokohama, Japan	T	1980	ESP	NA
Minamintosuka in Yokohama, Japan	T	1981	ESP	NA
Sendai, Japan	T	1980	ESP	NA
Framingham, MA	T	1979	BH	250
Malmo, Sweden	F	1981	BH	300

SOURCE: Craig & O'Connell, 1982.

D.B. = D. B. Gas Cleaning
T = Teller Environmental Systems
F = Flakt
ESP = Electrostatic Precipitator
FRG = "West" Germany
NA = Not Available
BH = Baghouse

TABLE 4-5

LEE COUNTY ENERGY RECOVERY FACILITY
PERFORMANCE OF DRY SCRUBBERS ON REFUSE COMBUSTION FACILITIES

Location	Mfgr.	Particulate Collection Device	HCl			SO2			Size Day (Tpd)
			ppm in	ppm out	Control Efficiency %	ppm in	ppm out	Control Efficiency %	
Isogo, Japan	T	BH	650	4.5	99	150	17.5	88	150
Sakai, Japan	T	ESP	280	NA	88	38	NA	71	NA
Kumamoto, Japan	T	BH	700	NA	93	200	NA	88	NA
Ohmojo, Japan	T	ESP	725	NA	75	115	NA	48	NA
Sendai, Japan	T	ESP	700	NA	79	NA	NA	NA	NA
Framingham, MA	T	BH	400	NA	97	NA	NA	NA	250
Framingham, MA	T	BH	NA	29.4	NA	NA	NA	NA	250
Hamburg Stellinger, Moor, DFG	DB	ESP	860	74.0	91	210	80.0	62	2 @ 386
Oberhausen, DFG	DB	BH	850	65.0	92	260	33.0	87	600

SOURCE: Craig & O'Connell, 1982.

DB = DB Gas Cleaning
T = Teller Environmental Systems
ESP = Electrostatic Precipitator
BH = Baghouse
NA = Not Available

TABLE 4-6

LEE COUNTY ENERGY RECOVERY FACILITY PERFORMANCE OF DRY SCRUBBERS ON ADDITIONAL UNITED STATES REFUSE COMBUSTION FACILITIES

Facility	Number of Boilers	Total Design Capacity (tpd)	Particulate Collection Device	HCl @ 7% O_2			SO_2 @ 7% O_2		
				ppm in	ppm out	Control Efficiency %	ppm in	ppm out	Control Efficiency %
Commerce, CA[a]	1	400	FF	646	7.3	98.9	111	1.9	98.3
Bridgeport, CT[b]	3	2,250	FF						
Unit 1				708*	9.2	98.7	183*	14.2	92.2
Unit 2				709*	4.0	99.4	213*	3.3	98.5
Unit 3				683*	7.5	98.9	224*	8.1	96.4
Bristol, CT[c]	2	650	FF						
Unit 1				456*	7.0	99.0	NA*	5.0	NA
Unit 2				536*	9.0	98.0	NA*	22.0	NA
Long Beach, CA[d]	3	1,380	FF	NA	24.2	NA	170.5	6.8	96.0
Stanislaus, CA[e]	2	800	FF						
Unit 1				NA*	0.5	NA	65.3*	2.8	95.7
Unit 2				NA*	2.5	NA	33.1*	5.3	84.0
Millbury, MA[f]	2	1,500	ESP						
Unit 1				700	23.30	96.9	205	53.9	73.2
Unit 2				697	6.08	99.2	296	61.5	79.2
Portland, ME[f]	2	500	ESP						
Unit 1				NA	NA	NA	322	31.7	89.3
Unit 2				NA	NA	NA	281	48.9	85.7
Biddeford, ME[f]	2	600[g]	FF						
Unit 1				582	5.84	98.9	101.3	22.6	77.7
Unit 2				NA	NA	NA	NA	NA	NA

TABLE 4-6
(continued)

Facility	Number of Boilers	Total Design Capacity (tpd)	Particulate Collection Device	HCl @ 7% O_2			SO_2 @ 7% O_2		
				ppm in	ppm out	Control Efficiency %	ppm in	ppm out	Control Efficiency %
Marion Cty, OR[f]	2	550	FF						
Unit 1				571	17.7	97.0	183.0	31.0	82.7
Unit 2				NA	NA	NA	NA	NA	NA

FF = Fabric Filter

*ppmdv @ 12% CO_2

[a] "Results of Air Emission Tests During the Waste-To-Energy Demonstration Program at the Commerce Refuse-To-Energy Facility." Volume 1. Technical Report, Energy Systems Associates, December 1988.

[b] Bridgeport, Connecticut, Emission Test Results. ENTROPY, August 1988.

[c] Environmental Test Report, Bristol Resource Recovery Facility. Ogden Projects, Inc., January 1988.

[d] Air Emission Test Results at the Southeast Resource Recovery Facility, Unit 1. TRC Environmental Consultants, October-December 1988.

[e] "Hahn and Sofaer, "Air Emission Tests Results from the Stanislaus County, California Resource Recovery Facility," Ogden Projects Inc., 1989.

[f] U.S. Environmental Protection Agency, 1989; Municipal Waste Combustors - Background Information for Proposed Standards: Post Combustion Technology Performance, September 1989.

[g] RDF fired facility.

San Marcos, CA; Gloucester County, NJ; Pennsauken, NJ; Marion, OR; Alexandria, VA; Delaware County, PA; and San Juan, PR.

The dry scrubber (see Tables 4-5 and 4-6) has been shown to effectively remove SO_2 and other acid gases (e.g., H_2SO_4, HF, HCl, and SO_3). However, a potential secondary benefit of its use with a particulate control device involves the reduction of various condensable organic emissions, such as dioxins (PCDD), furans (PCDF), chlorobenzenes (CB), polychlorinated biphenyls (PCB), polynuclear aromatic hydrocarbons (PAH), and chlorophenols (CP), beyond that normally achieved by good combustion design and furnace operation.

A 1986 Canadian study by Environment Canada and a leading pollution control vendor was performed at the Quebec City refuse combustor to assess flue gas control technologies. Analysis of a slipstream from one of the four furnaces at the facility showed the secondary benefits of using scrubbers with particulate control devices in addition to their control of SO_2, other acid gases, and particulates. The slipstream was ducted to a large scale "pilot plant" air pollution control system of two possible scrubber systems (dry scrubber and dry injection scrubber) with a fabric filter. The data indicate that the removal of trace organic emissions (e.g., PCDD, PCDF, PAH, PCB, CB, and CP) by more than 99 percent was possible. The data suggests that the dry scrubber provides the cooling necessary for the adsorption and/or condensation of these trace organic pollutants onto particulates in the flue gas, which are then removed by a particulate control device such as a baghouse or an ESP. Dioxin removal efficiencies for the dry scrubber systems at the Marion County, Stockholm-Hogdalen, and Malmo facilities (see Table 4-7) confirm the results from the Quebec City refuse combustor.

Due to mechanisms believed to be similar to those affecting trace organics, it has been demonstrated that refuse combustion facilities equipped with both a dry scrubber and an efficient particulate control device are capable reducing heavy metal emissions, except for mercury (Hg), by as much as 99 percent. This removal can be achieved with a dry scrubber and an efficient particulate control device since the condensation temperatures of most

TABLE 4-7

LEE COUNTY ENERGY RECOVERY FACILITY DIOXIN REDUCTION ACROSS THE DRY SCRUBBER/FABRIC FILTER SYSTEMS AT REFUSE COMBUSTION FACILITIES*

Facility	Inlet Concentration	Outlet Concentration	Removal Efficiency (percentage)
	[ng TCDD-equiv. (Eadon et al)/Nm^3@12%CO$_R$]		
Marion County Boiler #1 (one test) September 1986	3.21	0.123	96.2
Stockholm-Hogdalen Boiler #3 (one test) August 1986	4.98	0.116	97.7
Stockholm-Hogdalen Boiler #3 (two tests) March 1986	2.20 2.60	0.179 < 0.427	91.9 > 83.6
Malmo Boiler #1 (one test) Spring 1986	≥ 3.60	< 0.094	≥ 97.4
Malmo Boiler #2 (one test) Spring 1986	≥ 10.80	< 0.094	≥ 99.1

*Preliminary data from the U.S. EPA and Radian Corporation.

Hahn, Jeffrey L. et al. "Recent Air Emission Test Data From Several Waste-To-Energy Facilities Utilizing Martin GMBH Stoker Combustion Systems and Advanced Air Pollution Control Equipment." APCA 80th Annual Meeting, 1988.

metal compounds emitted by refuse combustion facilities are above 392°F (200°C). The Quebec City dry scrubber/fabric filter tests indicate that the removal efficiency for heavy metals, including zinc, cadmium, lead, chromium, nickel, arsenic, and antimony, was approximately 99 percent at a dry scrubber outlet temperature of 284°F (140°C) (Environment Canada, 1986). These results confirm earlier data on removal efficiencies of over 99 percent reported for other dry scrubber/baghouse installations, such as Sysav, Sweden (1983) and Tsushima, Japan (1984). Test results for the Munich North facility (dry scrubber/ESP) indicated greater than 98 percent removal of Cd, Pb, and Zn.

Although the removal efficiency of all heavy metal pollutants is dependent upon flue gas temperature, Hg appears to be the most temperature sensitive of the metals tested. The dry scrubber/fabric filter collection efficiency of Hg from the Quebec City study was determined to be 95 percent at the fabric filter outlet temperature of 284°F (140°C). However, a lower percent reduction for Hg appears to be a more reasonable expectation based on recent data for facilities equipped with dry scrubbers/fabric filters. Thus, the data from the Quebec City study as well as other studies indicate that the use of a dry scrubber with a particulate control device provides positive environmental benefits in addition to the control of SO_2, other acid gases, and particulates. These benefits include the reduction of trace organic and heavy metal emissions.

The major disadvantages of dry scrubber systems include potential clogging of atomizers or spray nozzles and reagent accumulation on the dry scrubber walls. A dry scrubber system also requires a relatively greater quantity of sorbent and a relatively larger installation space than does a wet scrubber system.

The significant performance advantages of a dry scrubber system far outweigh its disadvantages, and include the following.

- Dry scrubbers provide effective SO_2 and other acid gas control. With the use of an efficient particulate control device, dry scrubbers also have the ability to reduce emissions of organics and metals.

- Unlike a wet scrubber, a dry scrubbing system produces a dry waste which is easier to handle and dispose of.

- Dry scrubber exhaust streams are not saturated; therefore, the potential for corrosion is greatly reduced when compared to a wet scrubber. Flue gas reheating which would increase energy costs is not required to prevent a saturated plume.

- Unlike a wet scrubber, a dry scrubber system may be easily used with currently available particulate control devices.

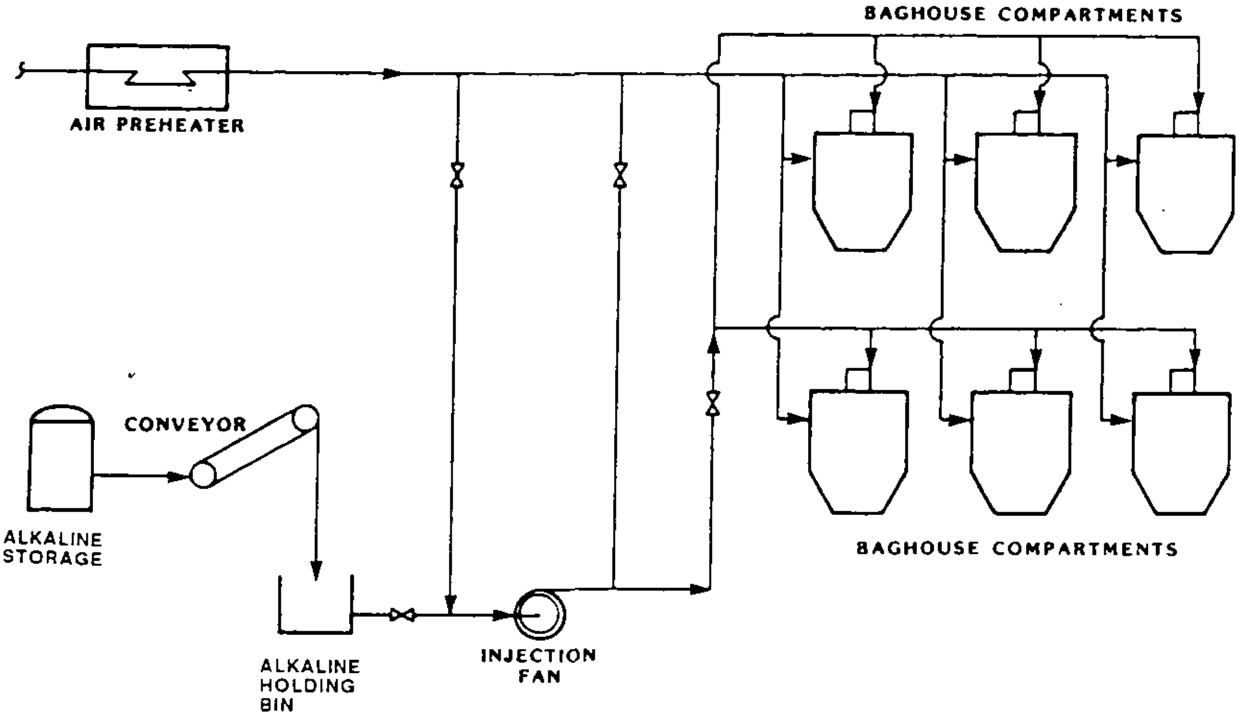
- Unlike a wet scrubber, a dry scrubber uses a small amount of water which evaporates and does not require treatment.

If a dry scrubber is used in conjunction with an efficient downstream particulate control device, its environmental and possible economic advantages, and technical feasibility far outweigh those of a wet scrubber. A dry scrubber is currently the technology accepted by EPA and the refuse combustion industry for controlling acid gases.

Dry Injection Scrubbers

Recently, the concept of injecting a dry alkaline sorbent (without water) into the gas stream duct work to control SO_2 and other acid gases has received some attention. The sorbent reacts with the acidic flue gas pollutants to produce neutral salts which are later collected in a particulate control device. Sorbent injection locations (downstream of the furnace) are selected to provide sufficient residence time for the acid gas adsorption reactions to proceed before the particulate matter is collected. Figure 4-3 is a process diagram of a typical dry injection scrubber.

These dry injection scrubber systems use either sodium (e.g., sodium carbonate, sodium bicarbonate, or nahcolite) or calcium based hydrated lime (calcium hydroxide) alkaline reagents. The test data show that sodium based reagents appear to be more reactive with SO_2 than hydrated lime.



SOURCE: Survey of Dry Sulphur Dioxide Control System, EPA
Report 600/7 - 80 - 030, Feb 1980

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FIGURE 4-3
DRY INJECTION SCRUBBER AND
PARTICULATE MATTER COLLECTION DEVICE

However, the sodium based reagents are also more expensive, harder to obtain and exhibit poorer handling characteristics than hydrated lime. Thus, hydrated lime is the preferred sorbent.

Dry injection scrubbers have been installed on refuse combustion facilities in Europe and Japan, and more recently in the U.S. and Canada. Installations in the U.S. have been mostly on smaller sized boilers (those which combust 250 tpd or less of refuse), and are related to lower capital costs. Data from U.S. installations, (e.g., Dayton, OH; Claremont, NH; Dutchess County, NY; Springfield, MA; and St. Croix, WI) indicate HCl and SO_2 removal efficiencies in the range of approximately 70 to 99 percent and 40 to 85 percent, respectively.

Because the dry sorbent can be injected directly into existing duct work, capital costs for installation of the system are minimal. Thus, a dry injection scrubber may be ideal for retro-fitting older combustion facilities which have no acid gas control and where control goals are modest.

The disadvantages of a dry injection scrubber system for use on a new refuse combustion unit are as follows.

- Dry injection scrubbers require the use of large quantities of hydrated lime which is more expensive than the pebble lime used for dry scrubbers. The larger amount of sorbent is necessary in order to meet today's stringent SO_2 removal requirements. Thus, the operating cost differential resulting from the poor reagent utilization for a dry injection scrubber is significant.
- More scrubber waste is produced by a dry injection scrubber in comparison to a dry scrubber system because of the large quantities of sorbent which must be injected.
- The high residual alkalinity of the waste from a dry injection scrubber may require special handling.

- The use of a larger quantity of sorbent than that used in a dry scrubber system results in the need for more frequent fabric filter cleaning which accelerates wear-out of the filter bags.
- The increased solids loading and altered properties of the particulate matter may result in decreased particulate control device efficiency (Offen, McElroy, and Muzio, 1987).
- Sorbent injected into the economizer may result in fouling of the convective heat transfer surfaces.
- Dry injection scrubbers, such as the system used at the Claremont, NH facility, do not decrease the flue gas temperature as much as wet scrubbers and dry scrubbers. Thus, while plume buoyancy (enhanced plume dispersion) is maintained, the secondary benefit of removing condensable trace heavy metals or organic emissions is reduced.
- With currently available sorbents, dry injection scrubbers provide lower SO_2 removal efficiencies than do wet scrubbers and dry scrubbers.

Variations of the dry injection scrubber are emerging which may increase the efficiency of SO_2 removal when using hydrated lime instead of sodium sorbents as the reagent. One such variation involves the use of a water quench chamber ahead of the dry injection system to cool and humidify the flue gas and possibly increase pollutant removal efficiencies. This was done during the Quebec City refuse combustion facility study with results which came close to those obtained using a dry scrubber. Results from this study indicate that if the quench was used to obtain the same outlet temperature as the dry scrubber, SO_2 removal efficiencies were 13 percent less than with a dry scrubber (58 percent removal) and the removal of trace organic and heavy metal emissions were comparable. If the quench was not used, the dry injection scrubber outlet temperature was 108°F higher than the dry scrubber outlet, and SO_2 removal efficiencies were 57 percent less (29 percent removal). The test was on a pilot scale and further testing on full-scale facilities is necessary.

In addition to the work being done to design new dry injection scrubber processes, work is also being done to develop new, more reactive sorbents. These new technologies hold future promise for enhanced SO_2 removal. However, until such time as these improved sorbents and processes are developed and tested on full-scale refuse combustion facilities, dry injection alone cannot be considered as BACT for control of SO_2 and acid gases because of lower control efficiencies and minimal application to U.S. facilities.

4.3.5 EVALUATION OF SO_2 AND ACID GAS CONTROL

A dry scrubber, from the above evaluation, has the capability of achieving SO_2 and other acid gas control efficiencies which are similar to those of a wet scrubber (see Tables 4-5 and 4-6). A dry injection scrubber presently provides the lowest control efficiency when compared to both a dry scrubber and a wet scrubber. A dry scrubber has numerous advantages which make it more desirable than both a wet scrubber and a dry injection scrubber.

In accordance with the "top down" BACT methodology established by an EPA memorandum and draft guidelines in December 1987, May 1989, and March 1990, a wet scrubber or dry scrubber can both be considered the most stringent or "top" control strategy for controlling acid gases and SO_2. The Facility is proposing to install a dry scrubber instead of a wet scrubber as BACT for these pollutants due to its technical advantages, established operating performance history, and acceptance by EPA as indicated in the proposed NSPS. The current "top down" BACT methodology which updates the 1978 EPA guideline for determining BACT indicates that since the proposed control technology, a dry scrubber can provide emission reductions similar to a wet scrubber and no outstanding issues regarding collateral environmental impacts exist, no further analysis is required and the technology should be accepted as BACT. Equipment with similar control capabilities, as stated in the guidelines, need not be presented (e.g., wet scrubber versus dry scrubber). As discussed previously, there appear to be fewer non-air environmental impacts associated with the dry scrubber alternative compared to the wet scrubber alternative.

Although a dry scrubber has been determined to be BACT using a "top down" methodology, an economic, environmental, and energy impact analysis is still necessary to determine what SO_2 and other acid gas emission limitations are BACT. As noted earlier, the proposed NSPS would regulate SO_2 and HCl emissions from MWCs and differentiate the control level required by the amount of refuse combusted. The emission standards proposed would limit SO_2 emissions as not being able to exceed the least stringent of 30 ppmv or a reduction of 85 percent by weight, and HCl emissions as not being able to exceed the least stringent of 25 ppmv or a reduction of 95 percent by weight (both corrected to 7 percent O_2 and on a dry basis). The necessary economic, operating and performance data to complete the BACT analysis were obtained from experienced vendors.

An evaluation of recently permitted refuse combustion facilities in the BACT/LAER Clearinghouse, refuse combustion facility test data (see Tables 4-5 and Table 4-6), and technical data with the proposed NSPS for SO_2 and HCl indicate that a potential exists for achieving very high SO_2 pollutant removal on a continuous basis using a dry scrubber. HCl test data and recent BACT determinations indicate that the proposed NSPS pollutant limitation can be achieved on a continuous basis. The continuous removal of SO_2 by a dry scrubber is more difficult and variable in refuse combustion applications since HCl is also present in the flue gas. In competing with HCl for lime, SO_2 is less reactive and its removal is adversely effected by an HCl concentration increase in the flue gas. Test data shown in Tables 4-5 and 4-6 support a greater difficulty and variability of removing SO_2 (73 to 98 percent) in the presence of HCl. To determine what continuous SO_2 removal rate is achievable, an impact analysis involving energy, economic, and environmental criteria was completed in accordance with a "top down" methodology. The dry scrubber systems evaluated would also be required to simultaneously control HCl emissions (at least 95 percent removal) and other acid gas emissions.

As discussed earlier, the number of combustors and consequently the number of dry scrubber trains is currently not known since the proposed Facility will have one of two possible combustor designs, mass-burn stoker waterwall or mass-burn rotary waterwall. Although a mass-burn rotary waterwall design, as opposed to a mass-burn stoker waterwall design, would require an additional combustor and dry scrubber train, the total energy, economic, and environmental impacts would not differ for either design. A mass-burn rotary waterwall design operates at approximately half the excess air required for a mass-burn stoker waterwall, thus any adverse economic impacts associated with the use of an additional dry scrubber train are offset since proportionally less flue gas must be controlled. The impact analysis presented in the following paragraphs is independent of the combustor design used and represents the total impacts of the proposed Facility.

Energy

The total annual amount of energy consumed (kw) was calculated for dry scrubber systems designed to achieve between 75 and 90 percent SO_2 removal, while simultaneously reducing other acid gas emissions, including HCl, by at least 95 percent. The energy required by the systems include: (1) the I.D. fan to overcome the pressure drop across the dry scrubber; (2) the compressed air for the atomizing system; and (3) the motors required for the lime handling and atomizing systems. The power consumption of dry scrubber systems designed to achieve 90, 85, 80, and 75 percent SO_2 removal, while simultaneously achieving at least 95 percent HCl removal, were calculated to be 924, 724, 683, and 642 kW, respectively. These calculated values represent those of the Facility and, as discussed earlier, are independent of the combustor design selected.

The dry scrubber systems designed to achieve 90 percent SO_2 removal, while simultaneously reducing HCl by at least 95 percent, clearly has the highest energy consumption impact. A higher SO_2 removal rate requires more energy to pump, slake, and atomize the larger amount of lime, and overcome a larger pressure drop across the dry scrubber.

Economic

The annual capital and operating costs for dry scrubbing systems with various SO_2 control levels were calculated and are shown in Table 4-8.

TABLE 4-8

LEE COUNTY ENERGY RECOVERY FACILITY
CAPITAL AND OPERATIONS/MAINTENANCE COSTS FOR SO_2 CONTROL STRATEGY
CAPITAL COSTS, ANNUALIZED FIRST YEAR CAPITAL COSTS, POWER REQUIREMENTS AND ANNUAL O&M COSTS (in 1990 1000's $)

		Equipment		Operating Cost					
Control Technology	SO_2[a] Removal Efficiency (Percent)	Capital[b] Cost (Installed)	Annualized[c] Capital Cost	Power[d] Cost	Labor[e] Cost	Materials[f] & Supplies	Chemical[g] Cost	Special[h] Costs	Total[i] Annual Cost
Dry Scrubber	90	11,067	1,211.9	485.5	91	238.9	1,257.4	645.4	3,930
Dry Scrubber	85	9,223	1,009.9	380.7	91	119.4	1,042.4	564.6	3,208
Dry Scrubber	80	8,301	908.9	359.0	91	107.5	858.5	494.0	2,819
Dry Scrubber	75	7,378	807.9	337.2	91	95.5	766.5	453.5	2,552

[a] Assumed over an annual averaging time.

[b] Total capital costs for all scrubber trains, including a 43 percent bond burden.

[c] Annualized capital costs assume 20 years amortization and interest rate equals 9% (capital recovery factor = 0.1095).

[d] Power costs assume plant operation 24 hours/day, 365 days/year. Power cost = $0.06/kWh.

[e] Labor costs assume two full-time persons at $45,500/year each.

[f] Maintenance costs include atomizer replacements, slaker liners, and other miscellaneous parts.

[g] Chemical cost assumes lime at $70/ton and based on a lime consumption rate ranging from 25 to 41 pounds/ton for the various control levels.

[h] Includes landfill disposal costs @ $23/ton for spent and unreacted lime, and scrubber water costs.

[i] Total annual cost equals the sum of the annualized capital cost and the first-year operating costs.

These costs include: (1) amortized (20 years at 9 percent) installed capital equipment cost with bond burden included; (2) consumption of power, water, and lime; (3) preventive maintenance; and (4) scrubber related disposal costs. The economic data shown in Table 4-8 indicate that a dry scrubber system's capital and operating costs begin to increase significantly as SO_2 is controlled beyond 80 percent. The operating costs affected the most with increasing SO_2 removal are the chemical cost (pebble lime) and the disposal cost of reacted and spent lime from the scrubber. Greater SO_2 removal requires that a larger stoichiometric ratio of lime to SO_2 and acid gas be used. The total annual cost of dry scrubber systems designed to achieve 90, 85, 80, and 75 percent SO_2 removal, while each simultaneously achieving at least 95 percent HCl removal, are shown in Table 4-8 to be approximately $3,929,700, $3,208,200, $2,818,800, and $2,551,700, respectively. These annual costs represent those of the Facility and, as discussed earlier, are independent of the combustor design selected.

The dry scrubber system designed to achieve 90 percent SO_2 removal (it should be noted this has not been proven on a continuous basis) while simultaneously removing HCl by at least 95 percent clearly has the highest annual cost of control. The higher SO_2 removal rate requires the systems which store, pump, slake, and atomize the larger lime quantity to have more capacity.

Environmental

The environmental impacts associated with operation of the proposed dry scrubber at the BACT determined control level are expected to be minimal. The lime used by the dry scrubber to control SO_2 will adversely affect available landfill space since its operation requires the disposal of spent lime in addition to ash.

A dry scrubber also has positive environmental impacts associated with its operation. Emissions of unregulated EPA pollutants including certain trace metals and organics, and HCl should decrease from its operation. The dry scrubber operation will also ensure that the Facility will not cause or contribute to a violation of the NAAQS, the PSD allowable increments, and the PSD significance levels for applicable acid gas pollutants and SO_2.

4.3.6 BACT DETERMINATION FOR SO_2 AND OTHER ACID GASES

The dry scrubber has minimal operating disadvantages when compared to a wet scrubber, and significantly more operating experience and pollutant removal efficiency than a dry injection scrubber. Past applications on other refuse combustion facilities in the U.S., as well as numerous others in Europe and Japan, demonstrate confidence in the dry scrubber's ability to effectively control SO_2 and acid gas pollutants. In addition to controlling SO_2 and HCl emissions, the dry scrubber will effectively control other noncriteria pollutants (HF and H_2SO_4). The dry scrubber may also help to control non-regulated pollutants including trace organics (e.g., PCDD, PCDF, and PAH) and trace heavy metals. The dry scrubber may effectively control these pollutants if a highly efficient particulate control device is used in conjunction, as will be the case for the proposed Facility. It should be noted that the dry scrubber is not guaranteed to remove these non-regulated pollutants. Minimal test data do not show confidence in the removal of the non-regulated pollutants, and additional rigorous testing is needed to confirm the present data and test results. Also, any refuse variations which cause furnace turndown will not effect the operation of the dry scrubbers.

An evaluation of recently permitted refuse combustion facilities and stack test data from refuse combustion facilities indicates a possibility of controlling SO_2 to extremely high levels using a dry scrubber (see Tables 4-5 and 4-6). The current available data, however, is not extensive enough to determine if these higher control levels may be achieved on a consistent and continuous basis, and their effects on the operating equipment. The ability to achieve higher SO_2 control is a function of numerous factors which may not depend on one another (e.g., dry scrubber operating temperature, lime stoichiometric ratio, and HCl concentration). Dry scrubber operation at a specified stoichiometric lime ratio becomes more efficient and effective as the operating temperature approaches the flue gas saturation temperature; however, droplet drying becomes retarded at the lower temperatures and potential dry scrubber and particulate control device corrosion and plugging increases. Higher operating temperatures decrease the potential for dry scrubber corrosion and plugging. If the dry scrubber operating temperature is too high, then the ability to achieve higher SO_2 control becomes more difficult and requires large quantities of lime.

A more in-depth analysis (as indicated in the 1980 PSD workshop handbook) which integrates both economic and environmental criteria was completed to determine BACT for controlling SO_2 and acid gases using the dry scrubber technology. The analysis (shown in Table 4-9) compares the economic impact of a dry scrubbing system designed to achieve varying levels of SO_2 control (between 75 and 90 percent), while simultaneously achieving an HCl removal of at least 95 percent. The possibility of achieving higher SO_2 removal was explored due to current test data and a review of currently permitted (not operational) refuse combustion facilities.

The values in Table 4-9 indicate that the overall and incremental cost per ton of pollutant removed is significantly affected beyond the 80 percent SO_2 removal level. The table demonstrates that 85 percent SO_2 control as opposed to 80 percent SO_2 control will remove an additional 163 tpy; however, the control cost for this incremental removal is $2,387 per ton. The same comparison for achieving 90 percent control as opposed to 85 percent SO_2 control show the incremental control cost to be $4,429 per ton. The incremental SO_2 emissions removed for a system designed to achieve 85 and 90 percent removal is not justified by the incremental cost required (no long-term data to verify 85 and 90 percent SO_2 removal on a continuous basis is available). Based on the limited operating data available at the higher SO_2 control levels, and the incremental removal cost associated with 85 and 90 percent SO_2 removal, BACT is determined to be 80 percent control for SO_2.

A dry scrubber system has been determined to be BACT for SO_2 and other acid gases which include HCl, H_2SO_4, and HF. The system proposed for the Facility shall achieve the following.

- SO_2 controlled to 30 ppmv (dry) corrected to 7 percent O_2 or 80 percent weight reduction, whichever is less stringent, both over a 24-hour block average; and

TABLE 4-9

LEE COUNTY ENERGY RECOVERY FACILITY FIRST-YEAR SO_2 CONTROL STRATEGY COSTS

(DIFFERENT SO_2 REMOVAL LEVELS CONSIDERED)

Pollutant	System Removal Efficiency (%)[a]	Controlled Exit Emissions (tpy)[b]	Total Removed Pollutant Emissions (tpy)	Incremental Controlled Emissions (tpy)	Annual Control Costs 1,000's ($/yr)[c]	Incremental Annual Cost 1,000's ($/yr)	Control Costs ($/ton) of SO_2[d]	Incremental Control Costs ($/ton of SO_2)	Tipping Fee ($/ton of refuse)[e]
SO_2	90	326.0	2,934	163	3,930	722	1,339	4,429	4.49
SO_2	85	489.0	2,771	163	3,208	389	1,158	2,387	3.66
SO_2	80	652.0	2,608	163	2,819	367	1,081	1,639	3.22
SO_2	75	815.0	2,445	___	2,552	___	1,044	___	2.91

[a] Assumed over an annual averaging time.

[b] Assumes a dry scrubber SO_2 inlet concentration of 330 ppmv (dry) @ 7% O_2. Emissions are the total for all units.

[c] From Table 4-8.

[d] Control costs (SO_2 controlled) equals the annual control costs in 1990 dollars divided by the total removed pollutant emissions (tpy) (e.g., 2,552 x 10^3/2,445 equals $1,044/ton of pollutant controlled).

[e] Tipping fee ($/ton) equals the annual control costs in 1990 dollars divided by the tons of waste processed (2,400 tpd x 365 days/year = 876,000 tpy) (e.g., 2,552 x 10^3/876,000 = $2.91/ton).

- HCl controlled to 25 ppmv (dry) corrected to 7 percent O_2 or at least 95 percent weight reduction, whichever is less stringent, as determined by compliance testing.

The above SO_2 control level was determined to be BACT based on an evaluation of the economic, environmental, and energy impacts, and the lack of extensive operating data at higher SO_2 control levels. Since a full-service contractor and not an equipment supplier would be responsible for the dry scrubber's performance, a greater level of risk and uncertainty exists at the higher SO_2 control levels. Ultimately, the cost of the dry scrubber to the applicant, Lee County, reflects the risk and uncertainty which exists in achieving higher SO_2 control.

4.4 BACT REVIEW FOR PARTICULATE MATTER (PM)

4.4.1 PROPOSED CONTROL TECHNOLOGY

The County proposes to use a fabric filter (baghouse) system with a particulate outlet grain loading of 0.010 gr/dscf corrected to 7 percent O_2 (front half catch), as measured by EPA Method 5 (40 CFR Part 60), to control the emission of particulate matter (PM) from each combustor/boiler train at the Facility. PM is defined for the purpose of this BACT analysis as total suspended particulate matter (TSP) and particulate having an equivalent aerodynamic diameter of less than 10 microns (PM_{10}). The proposed fabric filter control system will effectively and efficiently reduce fly ash generated from refuse combustion and reaction products generated by the dry scrubber system (e.g., calcium sulfate and calcium chloride). The fabric filter will also reduce trace heavy metals and organic compounds which have been theorized to preferentially absorb onto fine PM.

At design operating conditions, the Facility shall emit a maximum controlled annual PM emission of 85 tpy. It was conservatively assumed that all emitted PM from the Facility shall be PM_{10}.

A fabric filter particulate control system will also be used for the dry scrubber lime silo(s), and will be designed to achieve an outlet particulate loading of 0.015 grains per actual cubic foot (gr/acf).

4.4.2 COMPLIANCE WITH APPLICABLE EMISSION STANDARDS

The Facility's fabric filter system shall be more stringent than the current federal emission standards for particulates (NSPS) set at 0.08 gr/dscf @ 12 percent CO_2, and the recently proposed NSPS for MWCs set at 0.015 gr/dscf @ 7 percent O_2. The fabric filter system for the Facility shall be designed to obtain the BACT determined outlet grain loading for PM of 0.010 gr/dscf corrected to 7 percent O_2.

4.4.3 RATIONALE FOR PROPOSED BACT DETERMINATION

Particulate matter (PM) is emitted as a result of incomplete combustion of fuel as well as the entrainment of noncombustible inert matter in the flue gases. Particulate emissions may be solid or condensable substances. Solid PM generally consists of noncombusted inert matter, inorganic oxides, unburned combustibles, and heavy metals. A fraction of the vapor phase trace organics which were not completely converted to CO_2 and H_2O during the combustion process and the vaporized heavy metals make up the condensable portion of PM. In addition, it has been theorized that trace heavy metals and organic compounds adsorb and/or condense onto the fine particulate fraction since they are very porous and have an extremely large surface area. These gas-solid particulate adsorption reactions have also been postulated as a possible dioxin formation theory; however, the interpretation of recent experimental evidence suggests a different conclusion. In a study by Dickson and Karasek (1987), particle size surface area was not an important factor in producing trace organics such as dioxin. The study involved a series of laboratory experiments with various fly ash samples and pentachlorophenol as the known precursor.

The size and quantity of particulates emitted from refuse combustion depend upon such factors as flue gas residence time, underfire air velocity through the combustor system, oxidizing/reducing conditions within the furnace, temperature, flue gas mixing, boiler tube spacing, boiler configuration, flue gas velocity, and the chemistry of the fuel which is burned. If combustion takes place at higher temperatures and with the proper quantity of oxygen, the result will be more complete combustion of the fuel and a decreased particle mass. High combustion temperatures and long residence times allow for more complete burning of organic particles with a commensurate decrease in particle size. Boiler configuration (180 degree turns) and decreased gas velocity will allow the larger, heavier particles to fall out of the flue gases as they pass through the boiler. The various operating and design parameters cause the particles in the flue gas to have a large distribution range (0.10 micron to more than 500 micron). The submicron range, less than 1.0 micron, may be inhaled, and is of public health concern. EPA has addressed the necessity of controlling those particles which are smaller than 10 microns, referred to as PM_{10}, and requires their review in determining BACT. The PM_{10} emitted from the Facility is difficult to quantify since limited fractional collection efficiency data on refuse combustion facilities exists, thus the air quality modeling and BACT analysis conservatively assumes the particulate emissions to be all PM_{10}.

4.4.4 DESCRIPTION OF PARTICULATE CONTROL TECHNOLOGY ALTERNATIVES

Particulate matter may be removed from the combustion gases by various types of air pollution control devices. Technologies which have been used on refuse combustors include fabric filters (also referred to as baghouses), ESPs, and wet scrubbers. One of the initial particulate control devices used on U.S. refuse combustion facilities was a wet venturi scrubber. During the 1970s and early 1980s, however, ESPs were the more predominantly used particulate control device on refuse combustion facilities. The shift to ESPs was mainly due to the inability of the wet scrubber to meet the stringent particulate emission control requirements initially set by the NSPS (0.08 gr/dscf), and then further decreased by various states.

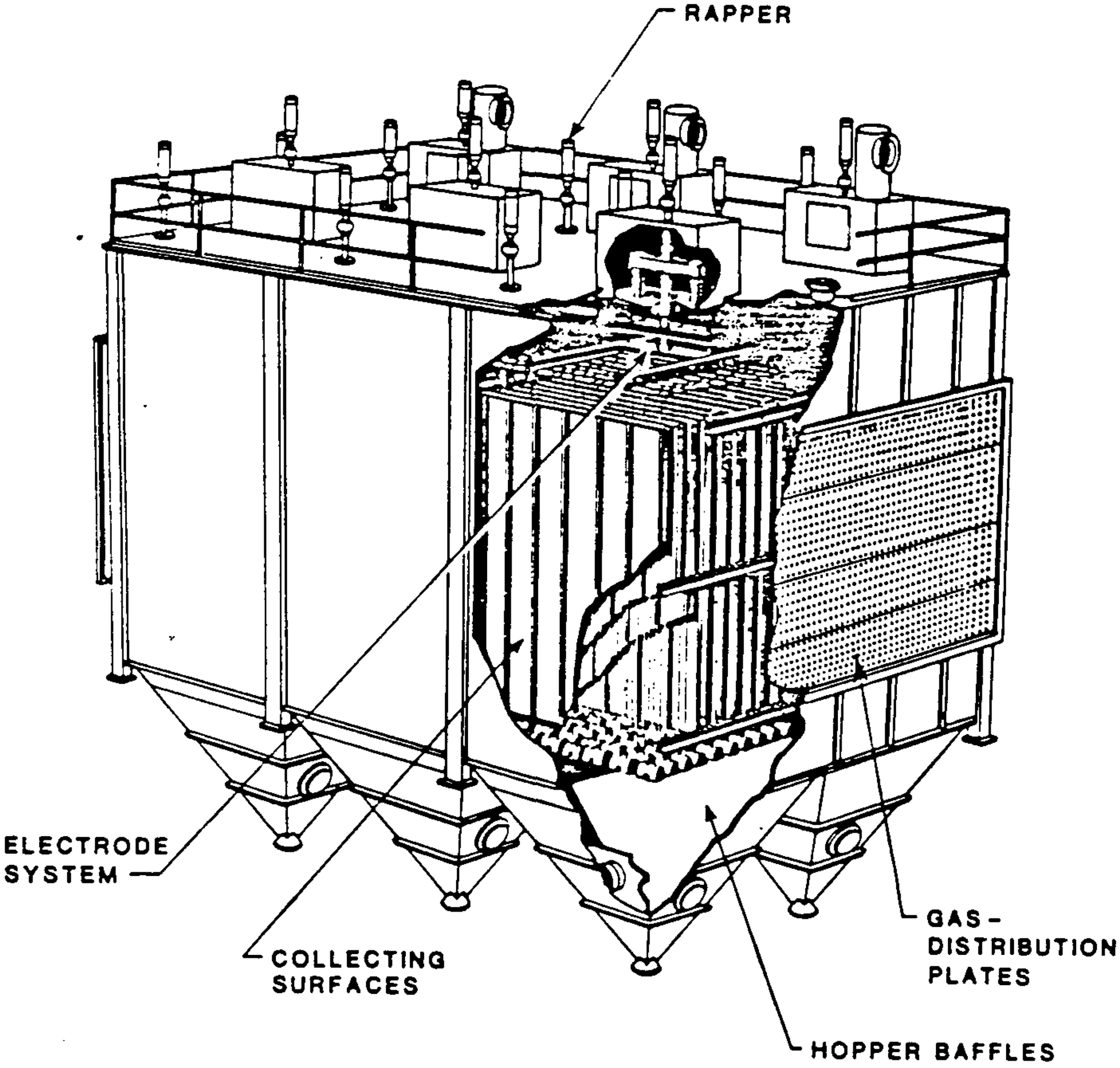
The recent trend for U.S. refuse combustion facilities is to install fabric filters instead of ESPs. The application of fabric filters has been made possible by the installation of acid gas scrubbers which decrease flue gas temperature excursions to limits which are acceptable for the bag fabric, and make the possibility of a fire due to incandescent particles igniting the fabric negligible. The trend of using a fabric filter rather than an ESP is due to a combination of factors. Although both of these technologies may be designed and operated to achieve the same outlet grain loading, it is theorized that the fabric filter is better able to control the finer PM emitted which have been theorized as a source for trace heavy metal and organic emissions.

Electrostatic Precipitators (ESPs)

An ESP uses an electrostatic field for precipitating or removing entrained solid or liquid particles from gas streams by particle ionization. An ESP consists of an alternating array of negatively-charged wires or grids and grounded collection plates.

Particulate collection is accomplished by applying a high voltage across the negative electrodes, thereby establishing a corona around it. The corona ionizes the PM entrained in the gas stream, thereby negatively charging the particles. The charged particles precipitate out of the gas stream by migration to the grounded collection plates where they are deposited. Precipitated PM is removed from the collecting electrode plate by "rappers" with a sharp, hammer-like blow or vibration to cause the collected dust to dislodge and fall into the ash hoppers below. Re-entrainment of the collected PM is inhibited by the electrostatic field, properly designed collection plates, the agglomerated particulate mass, and low flue gas velocities through the ESP. Proper design of the rapping mechanisms and collecting plates, and the maintenance of uniform and sufficient low gas velocities, are also required for optimum ESP operation. A typical ESP is shown in Figure 4-4.

The collection efficiency of ESPs is very high, normally designed to exceed 99 percent, which is primarily a function of flue gas flow rate and humidity, strength of the electrostatic field, residence time of the flue gas in the electrostatic field, resistivity, particle size, inlet grain



SOURCE: Joy Manufacturing Co.

LEE COUNTY
ENERGY RECOVERY FACILITY
Application for Power Plant Site Certification
Camp Dresser & McKee Inc

FIGURE 4-4
ELECTROSTATIC PRECIPITATOR

loading of the particulates being removed, and surface area of the collection electrodes. Collection efficiency may be enhanced by installing additional stages of precipitation in series (fields) and optimizing the gas flow rates, and/or increasing the specific collection plate area (SCA) of the electrodes.

The critical property affecting the performance of ESPs is the resistivity (the reciprocal of conductivity) of the particulate to be collected. If the resistivity is excessive, then the particulate cake acts to reduce the effective field strength within the ESP by retaining its charge, thus building an insulating layer around the collecting plates. The insulating layer decreases current flow from the discharge electrodes to the collection plates, thereby reducing collection efficiencies. If the resistivity is too low, the charge on the dust cake dissipates quickly. Thus, without the cake attraction forces to hold them, the surface particles are re-entrained by the gas, increasing outlet emissions.

Advantages of ESPs are:

- Demonstrated high collection efficiency.
- Ability to operate over a wide range of gas temperatures.
- Minimal gas pressure drop across the ESP results in lower power consumption by the flue gas mover (such as an induced draft fan).
- No liquid effluents requiring treatment are generated since the PM is, unlike the wet scrubber, collected dry.
- Longest operating record on refuse combustion facilities.
- High reliability with low maintenance.
- Capability to operate in a relatively high humidity gas stream.
- Efficiency increases if operated at gas flow rates which are lower than design (good response to turndown).

Some of the disadvantages are:

- Changes in flue gas properties and particle size distributions may adversely affect collection efficiencies.
- Some particles are not efficiently removed by a precipitator because of extremely high or low resistivity.
- ESPs cannot effectively remove gaseous heavy metals unless they condense prior to entering the unit.
- Changes in the chemical composition of the fuel may reduce ESP performance by altering particle resistivity.
- ESP collection efficiencies decrease in the 0.1 to 1.0 micron range (CARB, 1984). This may be mitigated by increasing the number of fields to three, four, or even five.
- Special precautions are required to safeguard personnel from the high voltage present in the ESP units. High voltage sparks could cause fires if the collected particulate is combustible or if a combustible gas were to enter the ESP.
- There is a potential for corrosion of the ESP internals if the flue gas temperature falls below the dew point of the acid gases.

ESPs have been used in the United States for more than 50 years on a wide variety of applications. Many of the modern municipal refuse combustion facilities use ESPs for particulate emission control. Some major refuse combustion facilities equipped with ESPs are located in Harrisburg, PA; Chicago, IL; Nashville, TN; Norfolk, VA; Westchester County, NY,; Hillsborough County, FL; Saugus, MA; Baltimore, MD; Tampa, FL; Dade County, FL; Tulsa, OK; Bay County, FL; and Pinellas County, FL. Throughout the U.S. and the world, refuse combustion facilities are successfully utilizing, with high reliability, ESPs for the efficient control of PM.

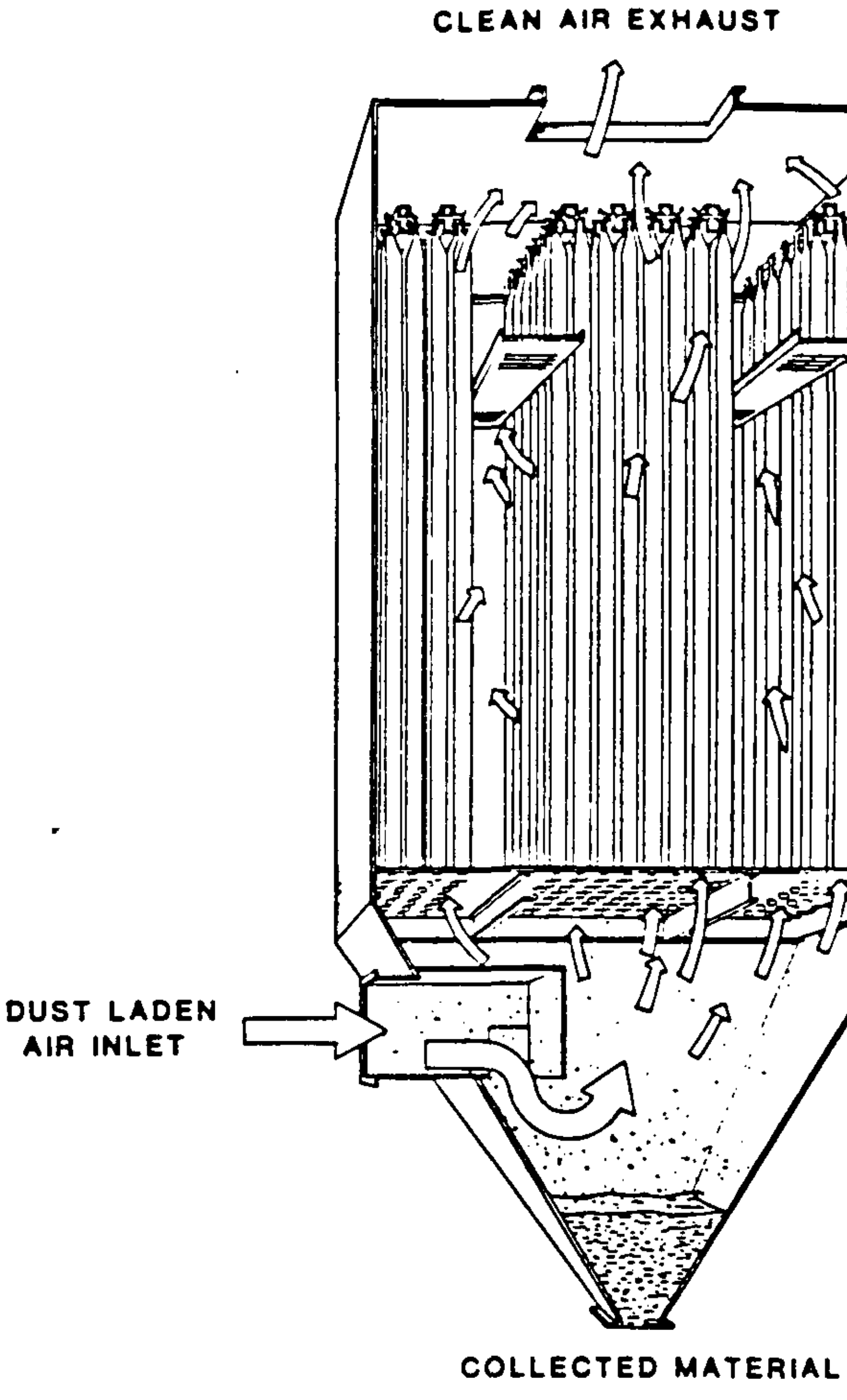
An ESP or a fabric filter is technically capable of meeting the recently proposed NSPS limitation of 0.015 gr/dscf corrected to 7 percent O_2. Although both technologies are capable of meeting stringent particulate control levels, the fabric filter is theorized to better control fine PM, as well as the pollutants which are believed to be found on these particles. These pollutants, trace heavy metals and organic emissions, are believed to have a preference towards the finer PM as they condense and/or adsorb.

Fabric Filters (Baghouses)

Fabric filters, also referred to as baghouses, have the capability of producing high removal efficiencies under the varying inlet conditions encountered from refuse combustion. The stringent particulate emission limitations of today have had a significant impact on the use of the fabric filter as a particulate control device. Fabric filters have been used for years on a variety of sources and, more recently, have been applied to refuse combustors.

The basic components of a fabric filter include a filter medium (bag) made of various cloth fabrics with special coatings or laminates, bag support systems (cages or rings), a gas tight enclosure or shell, collection hoppers, and a mechanism to remove accumulated particulate. A typical fabric filter is shown in Figure 4-5. Operation involves allowing a particulate laden gas stream to enter the lower portion of the fabric filter near the collection hoppers and then flow upward through the gas-tight enclosure on the inside or outside of the bags, depending upon the fabric filter design used. Cleaning of the bags takes place periodically, and usually incorporates one of three mechanical processes: (1) reverse air cleaning, (2) vibration or shaking of the bags, and (3) pulse air jets. The bags are gently cleaned in a manner that leaves the primary dust cake on the bags after the cleaning process. Particulate matter removed from the bags falls by gravity into a dust hopper for removal and ultimate disposal.

Several parameters used in the design and sizing of a fabric filter include the particular process application, air-to-cloth ratio (A/C), cleaning



SOURCE: Micropul Corporation

LEE COUNTY
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FIGURE 4-5
FABRIC FILTER OPERATION

method, filter media, particulate characteristics, and pressure drop. The A/C ratio is defined as the volumetric flow rate expressed as cubic feet per minute divided by the filter cloth area expressed in square feet, resulting in a velocity value expressed in feet per minute. Higher pressure drops result in increased power consumption by the prime air mover (such as an I.D. fan). To avoid these problems the maximum pressure drop across the filter media is normally limited to between 6.0 and 8.0 inches of H_2O.

There are three fundamental types of fabric filter designs based on the cleaning method: (1) reverse air, (2) shaker, and (3) pulse jet units. A discussion of each type is included herein.

Reverse Air Fabric Filters. Reverse air fabric filters are characterized by low A/C ratios and collect PM on the inside of the filter bags. The flue gas is first introduced through a manifold into the hopper section of the bag compartments. The gas then flows upward and into the inside of the filter bags to the outside. Once the collected material builds up to a point where the flow (pressure drop) is too great, the filter bags are cleaned using a low energy reverse air cleaning process. The air flow is periodically reversed, causing the bag to slightly collapse, thus dislodging the filter cake and allowing the collected particulate to fall into the collection hoppers for disposal.

Shaker Unit Fabric Filters. A second type of fabric filter is a shaker unit which is not typically used on refuse combustion facilities. These units, like reverse air, have low A/C ratios and also collect the PM on the inside of the bags. To clean the filter bags, the top portion of the bag is mechanically shaken to release the dust cake to the hoppers below. The mechanical shaking causes excessive stress on the type of bags employed on fabric filters and could cause short bag life because of reduced structural integrity.

Pulse Jet Unit Fabric Filters. Pulse jet units generally have A/C ratios which are higher than those of reverse air and shaker units. In contrast to reverse air and shaker units, the gas flow in a pulse jet fabric filter flows from the outside of the filter bag to the inside. Consequently, the PM is collected on the outside of the filter bags. When the cleaning process is initiated, a module compartment is taken off-line and bags are cleaned one row at a time with a high pressure burst (pulse jet) of compressed air into the open end of the bag. This action causes the bag to flex away from the supporting cage releasing the PM from the outside of the bag. The dust then falls into the collection hoppers below.

Lee County will select either a pulse jet or a reverse air fabric filter to control PM at the proposed Facility. The system will be designed to accept flue gases from the proposed scrubbing system at not only the normal operating flue gas temperature of approximately 260°F, but also at temperatures in excess of 500°F. The fabric filter's ability to continuously accept flue gases at the higher temperature ensures that it will not sustain damage in the event of scrubber failure since the boiler gas exit temperature is less than 500°F.

Advantages and Disadvantages

The Facility is proposing to use a fabric filter to control the PM generated during combustion. Some advantages of using this technology are presented below.

The advantages are:

- The dry collection of particle matter by physical filtration.
- The ability to attain high collection efficiencies.
- Because it is a physical filtration device, it is less sensitive to process variations (inlet particulate loading, particle size distribution, variability in waste composition, variability in flue gas flow rates, and particulate resistivity).
- The ability to perform unit maintenance, such as bag replacement without having to shut down the combustion system.

- Fabric filters are more easily adaptable should more stringent emission limitations be mandated.
- The potential for additional SO_2 and other acid gas scrubbing by the unreacted alkaline sorbent (lime) which is removed from the flue gas and builds up on the bag surface.

The disadvantages are:

- High sensitivity to relative humidity. The formation of a hard crust on the filter fabric, "cementation" of the bags, can occur in a highly humid gas stream with low temperatures. Cemented bags must be replaced which causes down-time and high maintenance costs.
- Inability to accept high temperature gases. Loss of structural integrity of the bags from temperature surges above 550°F (288°C) can reduce bag life and cause lost operating time and high maintenance costs.
- Susceptibility of the filters and metal surfaces to chemical attack and corrosion by condensed acid gases should temperatures fall below the acid gas dew point.
- High gas pressure drop across the fabric filter results in higher energy consumption by the gas mover (induced draft fan).
- Long-term reliability of fabric filters on U.S. refuse combustors has not been demonstrated.

Wet Scrubbers

Wet venturi scrubbers were discussed in Section 4.3 as an acid gas and SO_2 control technology; however, they had also been used on some of the earlier refuse combustors as a particulate control technology. During the 1970s and early 1980s, ESPs were used instead primarily due to the wet scrubber's inability to meet the more stringent particulate emission control requirements set by the existing NSPS and the individual states.

Currently there are no new refuse combustion facilities being designed in the U.S. which will use the wet venturi scrubber technology to control particulates. A wet venturi scrubber is not considered a viable means of controlling particulate emissions, as indicated by the following list of disadvantages.

- High operating costs from electrical consumption (ESPs and fabric filters use less energy).
- Liquid effluent from the wet scrubber requires pretreatment to meet regulatory requirements before discharge to a municipal sewer.
- A saturated steam plume visible under most meteorological conditions.

Because of these significant disadvantages, the wet venturi scrubber alternative is not considered a viable means of particulate control, and no further analysis of this option was performed.

Evaluation of PM Control Alternatives

The proposed PM control strategy for the Facility, a fabric filter, offers similar control capabilities to an ESP with both systems being able to meet, at a minimum, the proposed NSPS for particulates. A fabric filter is considered to be better capable of removing finer particulates (PM_{10}) than other technologies and the condensable heavy metals and trace organics which are believed to prefer the finer particulate. In addition, use of a fabric filter should promote additional removal of SO_2 and other acid gases. Particle size fractional removal efficiency studies on fabric filters and ESPs to support these conclusions have primarily come from the combustion of coal and not refuse.

The proposed NSPS conclude that a fabric filter is the best demonstrated technology for controlling particulate emissions from large MWC plants. These standards would require all MWC plants to meet a particulate emission limit of 0.015 gr/dscf corrected to 7 percent O_2.

An evaluation of recently permitted refuse combustion facilities in the BACT/LAER Clearinghouse, refuse combustion facility test data, and technical data from the proposed NSPS background documents indicate a potential for achieving a more stringent particulate limitation than that in the proposed NSPS. A fabric filter designed to achieve a limitation of 0.010 gr/dscf corrected to 7 percent O_2 is considered the most stringent or "top" particulate control strategy. In agreement with the current EPA "top down" BACT methodology, since the Facility shall install the "top" particulate control strategy designed at the "top" control level (i.e., 0.010 gr/dscf @ 7 percent O_2), an impact analysis of energy, economic, and environmental criteria was not completed.

4.4.5 BACT DETERMINATION OF TOTAL SUSPENDED PARTICULATE MATTER (TSP)

The NAAQS for TSP has been rescinded and replaced with a new standard for particles with an equivalent aerodynamic diameter of less than 10 microns (PM_{10}). However, the PSD increments for TSP remain. To address the requirements for permitting particulate emissions based on two indicators, EPA has established a transition policy. Because both TSP and PM_{10} are regulated under the Clean Air Act, the transition policy requires that the BACT analysis be performed for both.

Past applications on other refuse combustion facilities in the U.S., as well as numerous others in Europe and Japan, and the recent increase in the number of U.S. facilities permitted with fabric filters demonstrate confidence in the fabric filter to effectively control particulates. In addition to controlling inert PM, the fabric filter can also control other non-criteria pollutants which are present in solid or particulate form. As previously discussed, the use of a dry scrubber with the fabric filter has shown the increased possibility of acid gas control and a subsequent decrease in reagent consumptions when compared with an ESP.

The information and analysis presented on the fabric filter is adequate and sufficient to determine that it be BACT in controlling PM. The fabric filter for the Facility shall be designed and guaranteed by the County to achieve an outlet loading of 0.010 gr/dscf @ 7 percent O_2. This control level is more stringent than the limitation set forth in the proposed NSPS of 0.015 gr/dscf @ 7 percent O_2.

Secondary Sources

In addition to the PM emitted from the furnace, the Facility will have two secondary sources of particulate emissions. These sources are located at the top of the lime storage silo vent(s) and at the ash handling building vent. The vents are minor particulate emission points and the methods used to control them are discussed below.

Since the County has not yet selected a full-service vendor, the exact number of lime storage silos is not known. Depending on the vendor's preferred design, the Facility will likely have either one or two lime silos for pebble lime (CaO) storage. The lime storage capacity will likely be the same and independent of the number of silos used.

The pebble lime silo is a storage vessel for lime and is used by the dry scrubbers to control SO_2 and acid gas emissions. Particulate lime emissions will occur from the silo(s) when lime is loaded by a pneumatic conveying truck equipped with a pneumatic unloading system. The loading of lime causes the air in the silo(s) which contains entrained lime dust emissions to be displaced through a silo roof vent. Each lime silo will have a dedicated vent fabric filter (slaker dust collector) mounted on its roof to control lime dust emissions to 0.015 grains per actual cubic foot (gr/acf) during loading periods. The fabric filter(s) will be designed to discharge collected dust directly back into the storage bin.

The deliveries of lime to the silos will be made approximately every seven days. In normal practice, the truck operator will require about 1 to 1.5 hours to unload the pebble lime and about five minutes to clear the trailer hoppers and piping of any residual lime. The air flow rates during the transfer process are estimated to be between 250 and 1,000 ACF per minute. Assuming that the lime will be unloaded at the higher air flow rate, the maximum total hourly emission is estimated at 0.129 pounds per hour of particulate matter. If a maximum of five truck deliveries, each requiring 2.0 hours of duration, are made per week, the maximum annual emission rate (irrespective of whether one or two silos are used) would be approximately 67.1 pounds per year of particulate matter (0.033 tpy).

Particulate emissions from the ash handling building vent are expected to be negligible. The ash handling building will be maintained under negative pressure, and a fabric filter will be mounted on the top of the building and vented to the atmosphere to control fugitive particulate emissions. The outlet grain loading from the fabric filter shall be 0.015 grains per actual cubic foot (gr/acf). The fabric filter shall be designed to have a maximum hourly emission rate of 1.6 pounds per hour of particulate matter which calculates to 7.01 tpy assuming continuous operation. Since this represents a conservative design calculation, actual tpy emissions should be considerably lower.

The ash handling practices at the Facility will limit the resuspension of ash residue. Ash residue from the furnace exit (bottom ash) and the air pollution control system (fly ash) are combined and quenched with water (20 to 30 percent by weight H_2O) to prevent fugitive emissions. This ash handling practice is successfully performed at most modern refuse combustion facilities.

4.4.6 BACT DETERMINATION OF PM_{10}

In a July 1987 EPA ruling on PM, the NAAQS for TSP was rescinded and replaced with a standard for particles with an equivalent aerodynamic diameter of less than 10 microns (PM_{10}). This standard was promulgated because it represents the fraction of the emitted PM which is inhalable, and it is a better indicator of a potential impact on human health. The ruling on PM_{10} requires major stationary sources, such as the Facility, to consider the application of BACT for PM_{10} emissions.

The regulation seeks to establish an emission limitation, but it is contingent upon the availability of emission factor and control efficiency data. The regulation, however, states "Where a quantifiable PM_{10} emission limit is not yet feasible, the Administrator intends to allow the use of TSP based emission limitations, provided that the reduction of PM_{10} emissions—and not just PM emissions--has been considered to the extent possible in the BACT determination."

The amount of PM_{10} expected from the Facility is difficult to quantify due to the limited data available. Published particle size distribution is available, however, from three mass-burn facilities located abroad—Tsushima, Japan; Munich North, West Germany; and Wurzburg, West Germany—and from a refuse-derived fuel (RDF) facility in Biddeford, Maine. The data from these facilities, shown in Table 4-10, are based on cascade impact measurements on acid gas scrubber/fabric filter air pollution control systems except for Munich North which employs an ESP.

An analysis comparing the uncontrolled or controlled PM emissions from mass-burn boilers with RDF fired boilers has not been documented. The particle size data from these processes are not expected to be appreciably different although inlet loading may be greater for RDF firing. The particle size data from RDF would be expected to be of the same or smaller size.

From the limited available particle size data given in Table 4-10, there does not appear to be any distinct advantage to either an ESP or a fabric filter for controlling PM_{10} emissions. Both are considered to be viable PM_{10} control devices. The observed variations in mass fraction by particle size data for the facilities employing fabric filters (Tsushima, Wurzburg, and Biddeford) may be attributed to differences in sampling and analytical methods used at each site or to the operating baghouse conditions during testing. Although the percentage of PM_{10} emitted from the Facility is expected to be similar to the Biddeford, Maine facility, the air quality modeling analysis conservatively assumes that the particulate emissions will be 100 percent PM_{10}.

TABLE 4-10

LEE COUNTY ENERGY RECOVERY FACILITY PARTICLE SIZE DISTRIBUTION DATA

Tsushima, Japan		Munich, North Germany		Wurzburg, Germany		Biddeford, Maine Run 1		Biddeford, Maine Run 2		Biddeford, Maine Run 3	
Particle Mass Size Fraction (Microns)	%	Particle Mass Size Fraction (Microns)	%	Particle Mass Size Fraction (Microns)	%	Particle Mass Size Fraction (Microns)	%	Particle Mass Size Fraction (Microns)	%	Particle Mass Size Fraction (Microns)	%
<0.6	0.0	<0.4	9.1	<0.47	52.6	<0.63	2.4	<0.63	2.4	<0.63	5.5
0.6	0.0	0.4	10.1	0.58	1.0	1.0	0.8	1.0	2.9	1.0	4.3
1.0	0.0	0.7	16.2	0.9	0.5	1.25	0.5	1.25	1.4	1.25	3.1
1.6	6.3	1.1	10.1	1.7	2.0	2.0	3.9	2.0	4.8	2.0	6.8
3.2	28.7	2.3	8.1	2.9	3.6	2.5	3.9	2.5	3.8	2.5	1.8
5.0	15.0	3.7	6.0	4.3	1.5	6.0	26.3	6.0	49.9	6.0	33.9
7.3	23.7	5.4	4.8	6.3	1.0	10.0	21.5	10.0	30.6	10.0	22.6
10.8	17.5	8.0	7.4	>12.0	37.8	15.0	23.1	15.0	4.2	15.0	14.7
17.5	8.8	12.9	9.1	—	—	20.0	17.6	20.0	0.0	20.0	7.3
>17.5	0.0	>12.9	19.1	—	—	>20.0	0.0	>20.0	0.0	>20.0	0.0
% Mass Fraction PM_{10}		% Mass Fraction PM_{10}		% Mass Fraction PM^{10}		% Mass Fraction PM_{10}		% Mass Fraction PM_{10}		% Mass Fraction PM_{10}	
	87.2[a]		75.5[a]		61.8[a]		59.3		95.8		78.0

SOURCE: Combustion Engineering, Inc., 1989.

[a] Approximation based on linear interpolation.

The control for PM_{10} as well as TSP at the Facility will be through the use of a fabric filter. As discussed in Section 4.4, the past application of fabric filters on refuse combustion facilities in the United States, Canada, Europe, and Japan, and the recent increase in those which are being either permitted or proposed in the U.S. demonstrates confidence in its ability to effectively control PM. An increase in the number of refuse combustion facilities which are proposing to use fabric filters can be partly attributed to the theory that they can more effectively control the emission of submicron particulate PM_{10}. The finer PM is believed to contain a greater concentration of heavy metals and trace organics. This theory is shared by many state regulatory agencies which require its use on refuse combustion facilities.

Consequently, the information and BACT analysis presented on the fabric filter is adequate and sufficient to determine that it also be BACT in controlling PM_{10}. The fabric filter for the Facility shall be designed and guaranteed to achieve an outlet loading of 0.010 gr/dscf corrected to 7 percent O_2. This control level is more stringent than the limitation set forth in the proposed NSPS of 0.015 gr/dscf @ 7 percent O_2. A review of the EPA's BACT/LAER Clearinghouse shows currently permitted particulate control limits for refuse combustion facilities to be in agreement with the proposed control level for the Facility.

4.5 BACT REVIEW FOR TRACE HEAVY METAL EMISSIONS

4.5.1 PROPOSED CONTROL TECHNOLOGY

Lee County proposes that a fabric filter and a dry scrubber be BACT for regulated and non-regulated trace heavy metals. The Facility's fabric filter shall be designed and guaranteed to achieve an outlet loading of 0.010 gr/dscf corrected to 7 percent O_2. The maximum projected emission rates for these pollutants are listed in Table 4-1 of this document.

4.5.2 COMPLIANCE WITH THE APPLICABLE STANDARDS

The Facility's emissions of regulated heavy metals (e.g., Hg, Pb, Be, and As) shall be below their applicable NAAQS or NESHAPS federal requirements, and pose no adverse potential health risks.

The proposed NSPS require the control of metal emissions from MWCs by limiting particulate emissions to 0.015 gr/dscf @ 7 percent O_2. The standards conclude that this would ensure good control of metals, and would be a more practical approach than setting individual limits for every metal.

The County's planned material separation program, mandated by Florida's Solid Waste Management Act, may produce a beneficial effect on the amount of heavy metal emissions emitted from the Facility. The program shall also meet the material separation requirements proposed in the NSPS. Since little data currently exists on whether material separation leads to a demonstrable and quantifiable reduction of trace heavy metal emissions, the projected emissions from the Facility do not recognize any potential benefits.

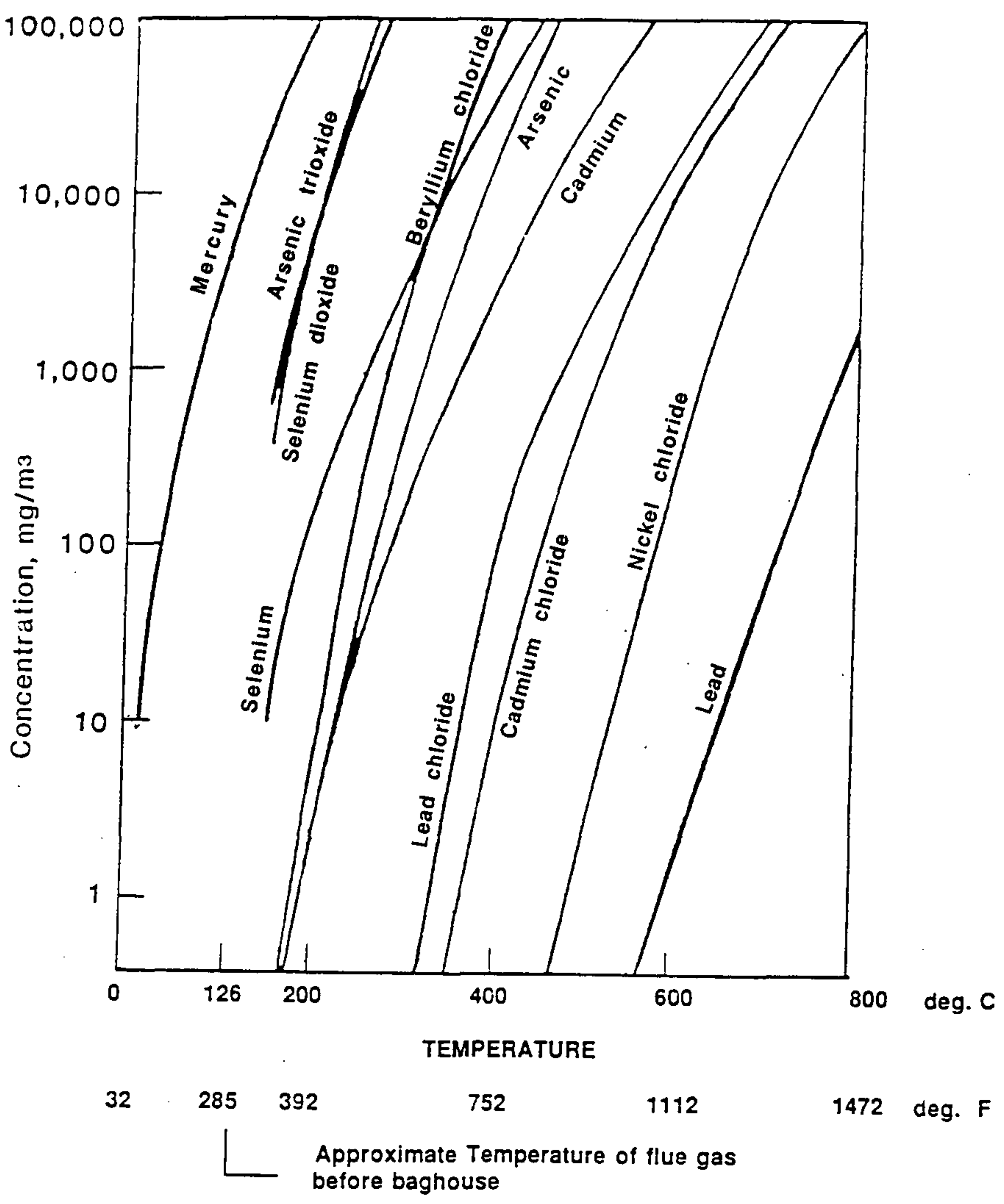
4.5.3 RATIONALE FOR PROPOSED BACT DETERMINATION

Many metals and metallic compounds are found throughout municipal refuse in various forms. Metals such as silver (Ag), chromium (Cr), lead (Pb), tin (Sn), and zinc (Zn) are used in metallic surface coatings and processes including electroplating, galvanizing, and soldering, and as stabilizers in plastics. Inks and paint pigments used for color on paper, fabric, and plastic substrates may also include such metals as cadmium (Cd), Cr, and Pb. Discarded batteries could be primary sources of mercury (Hg) and may also be a source of Pb, nickel (Ni), and cadmium (Cd).

The combustion of refuse at the Facility will result in the trace emission of various metals. The quantity and characteristics of these pollutants depend on the composition of the waste, chemical and physical properties of the trace metals, operational features of the combustion process, and performance of the particulate and acid gas control devices. Trace heavy metals and their compounds found in the incombustible (inert) waste fraction may change phase, volatilize in their elemental forms, or form new compounds (e.g., sulfates, oxides, and chlorides) during the combustion process. These compounds are not, however, destroyed by the combustion process and may leave the furnace as particulate (adsorbed and/or condensed onto fly ash), vapor, or in the bottom ash residue.

The metals and metallic compounds in the flue gas will enter the proposed particulate control device (baghouse) as solids, liquids, or vapors, depending on what temperature the flue gas has been cooled to by the proposed dry scrubber. The vaporized metal portion, if cooled to its saturation temperature, will condense and form a collectable liquid or solid. Figure 4-6 illustrates various heavy metals as they would appear in the flue gas and their relative theoretical concentrations as a function of saturation temperature. The Facility's dry scrubber will be designed to lower the flue gas temperature to approximately 260°F (127°C) before entering the fabric filter. Figure 4-6 suggests that most metal and metal compounds shall have condensed before reaching this temperature and will likely be collected by the Facility's fabric filter. The more volatile Hg, As, and selenium (Se) metal and metal compounds will be more difficult to control at this temperature.

Test data from a slipstream at the Quebec City, Canada, and Marion County, Oregon refuse combustion facilities confirm the arguments that flue gas temperature and an efficient air pollution control system (dry scrubber/ particulate control device) are critical in the removal of heavy metals. Test reports from the Quebec City study, discussed earlier in the dry scrubber description of Section 4.3, indicate that over 99 percent removal (with the exception of Hg) of heavy metals [e.g., Zn, Cd, Pb, Cr, Ni, antimony (Sb), and As] by a dry scrubber/fabric filter control system was achieved. These tests indicated that Hg removal was approximately 95 percent, however, a lower percent reduction appears to be a more reasonable based on recent data evaluation. The high Hg removal efficiency data observed from the Quebec Cty test is believed to be due to the ash having an unusually high carbon content. Mercury is believed to adsorb onto fly



SOURCE: Moeller, J.T., Jorgenson, C, And Fallenkamp, F., Feb 1983
"Dry Scrubbing Of Toxic Incinerator Flue Gas By Spray Adsorption"

LEE COUNTY
ENERGY RECOVERY FACILITY
Application for Power Plant Site Certification
Camp Dresser & McKee Inc

FIGURE 4-6
SATURATION TEMPERATURE OF
METAL COMPOUNDS

ash more readily if it contains carbon. Table 4-11 presents heavy metal removal efficiency test data across the dry scrubber/baghouse system at the Marion County, Oregon refuse combustion facility. The Tsushima, Japan refuse combustion facility is also equipped with a scrubber/baghouse and has demonstrated a removal efficiency of over 99 percent for a total of 12 heavy metals at a baghouse outlet temperature of about 410°F (210°C) (also with the exception of Hg).

The trace heavy metals from the proposed Facility which are being reviewed include Pb, Hg, Be, and As. The EPA PSD regulated pollutants, Pb, Hg, and Be, are subject to the BACT requirements of the PSD regulations since their maximum projected annual emissions are greater than the PSD significant emission limits. The pollutant As is regulated by the Clean Air Act under the NESHAPS regulations. Thus, under the PSD requirements, any emission is considered significant and subject to the BACT requirements.

Of those metals which are being reviewed, As and Hg are two of the more volatile metals and are more difficult to control after being volatilized by combustion. The volatility of these metals results from the low boiling point temperatures of many of their compounds. As discussed, portions of these as well as other trace metals are expected to condense and/or adsorb onto PM as the flue gas temperature decreases. The dry scrubber will aid in their removal by cooling the gas stream, thus allowing for condensation and/or adsorption to occur. The fabric filter will then be able to remove a portion of these condensed metals.

4.5.4 BACT DETERMINATION

A fabric filter designed with an outlet loading of 0.010 gr/dscf corrected to 7 percent O_2 is proposed as BACT for PM (TSP and PM_{10}), and is proposed as BACT for trace heavy metals from the Facility when used in conjunction with a dry scrubber.

The maximum Pb emission rate from the Facility is estimated to be 6.0×10^{-3} pounds per ton of refuse which equates to 2.6 tpy with 100 percent availability. From the air quality analysis, this emission rate results in

TABLE 4-11

LEE COUNTY ENERGY RECOVERY FACILITY INLET AND OUTLET HEAVY METAL EMISSION DATA ACROSS THE DRY SCRUBBER/FABRIC FILTER AIR POLLUTION CONTROL SYSTEM AT THE MARION COUNTY FACILITY

Substance	Inlet Concentration ($\mu g/Nm^3$)	Outlet Concentration ($\mu g/Nm^3$)	Removal Efficiency (percent)
Pb	21,408	25	99.88
Cd	1,170	3.4	99.71
Cr	465	0.2	99.96
Ni	93	3.2	96.56

SOURCE: APCA Paper: Annual Meeting June 21-26, 1987.

[a] These concentrations have been corrected to 12 percent CO_2 and are from testing at the economizer outlet.

NOTE: Average of three tests for TSP were 0.011 and 0.003 gr/dscf at 12 percent CO_2 excluding condensibles for units 1 and 2, respectively, during source testing from December 5, 1987.

an incremental GLC of 0.017 $\mu g/m^3$ for a 24-hour average. Since the NAAQS for Pb is 1.5 $\mu g/m^3$ for a 3-month period, the Facility 24-hour maximum GLC for Pb, being a more conservative measure, is approximately 1.1 percent of the standard. Therefore, the Facility is expected to have a minimal impact on ambient air quality with respect to Pb.

The maximum Be emission rate from the Facility is estimated to be 1.35 x 10^{-6} pounds per ton of refuse which equates to 5.9 x 10^{-4} tpy. The resulting incremental GLC of Be from the Facility is estimated to be 3.8 x 10^{-6} $\mu g/m^3$ for a 24-hour averaging time. Although no NAAQS exists for Be, the National Emission Standard for Hazardous Air Pollutants (NESHAP) for Be is based on an acceptable concentration of 0.01 $\mu g/m^3$ for a 30-day averaging period (40 CFR 61.32) for facilities combusting beryllium containing industrial waste, which does not apply to the Facility. Therefore, the Facility is expected to have a minimal impact on ambient air quality with respect to Be since its more conservative GLC, with respect to average time, is less than the NESHAP requirement.

The Hg emissions are typically not well controlled by particulate control devices. As indicated in the proposed NSPS, observed Hg removal efficiencies vary widely among MWCs. The maximum expected Hg emission rate from the Facility is estimated to be 8.0 x 10^{-3} pounds per ton of refuse which equates to 3.5 tpy of Hg with 100 percent availability. From the air quality analysis, this emission rate results in an incremental GLC of 0.023 $\mu g/m^3$ for a 24-hour average. The NESHAP for mercury (when co-firing with sludge which is not the case for this Facility) is based on an acceptable concentration of 1.0 $\mu g/m^3$ for a 30-day averaging period (40 CFR 48297). The Facility is expected to have a minimal impact on ambient air quality for Hg since its more conservative GLC, with respect to averaging time, is less than the NESHAP requirement.

The maximum As emission rate from the Facility is estimated to be 9.1 x 10^{-5} pounds per ton of refuse which equates to 4.0 x 10^{-2} tpy. The pollutant, As, does not have a NAAQS and, although it is regulated by the Clean Air Act under NESHAP, it is applicable only to glass manufacturing plants, primary copper smelters, and metallic arsenic production facilities. The Facility's emission of As is expected to have a minimal impact on ambient air quality, and the control of particulate to 0.010 gr/dscf corrected to 7 percent O_2 is determined to be BACT.

BACT for these heavy metals is a dry scrubber/fabric filter with the fabric filter having a maximum outlet grain loading of 0.010 gr/dscf corrected to 7 percent O_2.

4.6 BACT REVIEW FOR BY-PRODUCTS OF COMBUSTION (CO, VOCS, NO_x)

As a part of EPA's Report to Congress on the Municipal Waste Combustion Study (EPA, 1987a), a set of combustion strategy elements termed "good combustion practices" were developed to minimize emissions of trace hydrocarbons which include PCDD and PCDF from MWCs. The report identified the components of good combustion practices and made "preliminary recommendations" on the values (i.e., combustion, temperature, overfire air, flue gas oxygen, and CO concentration) of these individual components. The following practices have been reviewed by trade and professional organizations such as the American Society of Mechanical Engineers and the American Boiler Manufacturers Association.

Practice	Mass-Burn Preliminary Target
Design temperature	1,800°F at fully mixed height.
Underfire air control	At least four separately adjustable plenums. One each under the drying and burnout zones, and at least two separately adjustable plenums under the burning zone.
Overfire air capacity	40 percent of total air.
Overfire air injector design	That required for penetration and coverage of furnace cross-section.

Practice	Mass-Burn Preliminary Target
Auxiliary fuel capacity	That required to meet start-up temperature and 1,800°F criteria under part-load operations.
Excess Air	6 to 12 percent excess oxygen (dry basis).
Turndown restrictions	80 to 110 percent of design; lower limit may be extended with verification tests.
Start-up procedures	On auxiliary fuel to design temperature.
Use of auxiliary fuel	On prolonged high CO or low furnace temperature.
Carbon monoxide in flue gas (continuous monitor)	50 ppm on four-hour average corrected to 12 pecent CO_2.
Furnace temperature (continuous monitor)	Minimum of 1,800°F (mean) at fully mixed height across furnace.
Adequate air distribution	Verification test.

Although the combustion optimization strategy recommends preliminary values for carbon monoxide and hydrocarbon compounds, combustion optimization is expected to have little beneficial impact on acid gas and particulate matter emissions, and may increase emissions of NO_x and metals. EPA's proposed NSPS recognizes emission levels for specific pollutants (e.g., CO) that differentiate among combustion technology designs, as opposed to the preliminary levels determined in EPA's 1987 Report to Congress.

4.6.1 BACT DETERMINATION FOR NITROGEN OXIDES (NO_x)

Proposed Control Technology

As discussed in Section 4.1 under Pollutant Applicability, the Facility will have either a mass-burn stoker waterwall design consisting of four units each at 600 tpd, or a mass-burn rotary waterwall design consisting of four units each at 450 tpd and one rated at 600 tpd. Both combustor design strategies provide the same total throughout capacity of 2,400 tpd.

If a mass-burn rotary waterwall design is chosen, then the County will propose to use the combustor to inhibit the formation of NO_x emissions. The combustor will incorporate staged combustion techniques with low excess air (i.e., 50 percent) to achieve as much as 50 to 60 percent less NO_x emissions than those generated from other combustion technologies operating without flue gas NO_x controls (Oakland County Permit Application, December 1989).

If a mass-burn stoker waterwall design is chosen, then the County will propose to install SNCR flue gas technology to effectively remove 45 percent of the NO_x emissions from the flue gas. This control level is based on short-term testing and continuous emission monitoring data from three MWC plants in California with SNCR as indicated in the proposed NSPS background documents. The proposed NSPS indicates that SNCR at 45 percent NO_x removal is the best demonstrated flue gas control technology.

To account for different maximum emissions, Table 4-1 listed NO_x emissions twice, with the first entry representing a mass-burn rotary waterwall design and the second entry representing a mass-burn stoker waterwall design. The proposed BACT tpy emission rate for the mass-burn rotary waterwall and the mass-burn stoker waterwall is based on a 150 ppmdv and 200 ppmdv stack concentration, respectively, both corrected to 7 percent O_2 over a 24-hour average.

The County's planned material separation program, mandated by Florida's Solid Waste Management Act, may reduce the amount of NO_x emissions emitted from the Facility. The program shall also meet the material separation requirements proposed in the NSPS. Data to demonstrate any potential benefits is currently limited and not sufficient, thus no adjustment or reduction was made to the Facility's projected NO_x emissions (see Table 4-1).

Compliance with Applicable Emission Standards

The Facility's NO_x emissions, independent of the combustor technology selected, will be below the applicable NAAQS/FAAQS requirements, and will be required to meet applicable final promulgated NSPS requirements for MWCs. Currently, the proposed NSPS gives a NO_x emission limitation as a range (i.e., 120 to 200 ppmdv @ 7 percent O_2) which will be better defined when the NSPS is promulgated in final form. Properly located and installed NO_x CEMs will comply with the NO_x monitoring requirements established in the proposed NSPS.

4.6.2 EMISSION OF NITROGEN OXIDES

Nitrogen oxides (NO_x) are products of all air-oxidized combustion processes including refuse combustion. The predominant form of NO_x which is produced during combustion is nitric oxide (NO); nitrogen dioxide (NO_2) is also produced in lesser amounts. Upon exiting the stack essentially all of the NO formed during combustion is further oxidized to form NO_2. The resulting NO_2 is a brownish-red gas which, in the presence of sunlight and hydrocarbons, can react to form ozone (photochemical smog) and other secondary pollutants.

NO_x emissions are classified according to the source of the nitrogen from which the NO_x is formed. Nitrogen from combustion air produces "thermal NO_x," while that which originates from organically bound components in refuse produces "fuel NO_x." Though the precise mechanisms involved in converting fuel nitrogen to NO_x are not completely understood, the relative quantities of fuel NO_x and thermal NO_x produced are known to be functions of furnace design, refuse composition, and plant operating conditions.

The two major factors affecting the formation of thermal NO_x are the oxygen concentration present in the combustion zone and the flame temperature. The rate of NO_x formation has been shown to be linearly dependent on the oxygen concentration when temperature is constant. Additionally, NO_x formation tends to increase significantly with increasing temperature (at temperatures approximately above 2,100°F) in the presence of O_2. In addition to these characteristics, NO_x formation increases linearly with increasing residence time at temperatures conducive to thermal NO_x formation (Russell and Roberts, 1984).

The mechanisms involved in the formation of fuel NO_x appear to be very complex and are not yet well understood. Studies have correlated the rate of fuel nitrogen conversion with the fuel oxygen-to-nitrogen ratio (Singer, 1981). In addition, fuel NO_x formation is dependent on underfire and overfire combustion air, total excess air rates, and mixing of the fuel and combustion air (CARB, 1984).

Local combustion conditions in the combustor, specifically how and at what temperature combustion air and refuse are mixed, directly affect the levels of thermal and fuel NO_x produced. NO_x levels from various refuse combustors are given in Table 4-12. The data summarize test results from recently constructed refuse combustion facilities which employ mass-burn stoker waterwall and mass-burn rotary waterwall design (EPA, August 1989). Average NO_x emissions from mass-burn waterwall facilities were approximately 236 ppm corrected to 7 percent O_2.

Current combustion practices emphasize furnace operation at high temperatures with thorough mixing to minimize emission of organic compounds (PCDD/PCDF). Consequently, NO_x emissions tend to be higher from modern facilities (EPA, May 1987). Also, NO_x is one of the more difficult and expensive pollutants to control from the combustion process because of the low reactivity and low solubility of NO which comprises 95 percent or more of the total uncontrolled NO_x (Brna et al., 1988).

TABLE 4-12

LEE COUNTY ENERGY RECOVERY FACILITY AVERAGE NO_x EMISSIONS FROM RECENTLY CONSTRUCTED REFUSE COMBUSTION FACILITIES

Facility[a]	Unit Size, tpd	Test Date	Percent O_2	NO_x ppm	NO_x ppm @ 7% O_2
Mass-Burn Rotary Waterwall:					
Gallatin	100	02/81	9.1	124.2	146.1
Kure	165	11/80	12.0	105.6	164.9
Mass-Burn Waterwall:					
Peekskill	750	11/85	11.7	156.7	236.3
Hampton 2	100	06/88	9.5	194.7	238.6
Marion County 2	275	06/87	9.6	196.9	244.3
Long Beach (deNO_x off)	460	11/88	10.2	52.4	68.2
Commerce (deNO_x off)	300	06/87	10.0	121.0	154.3
Baltimore 3	750	01/85	11.1	136.3	193.7
Baltimore 2	750	01/85	12.1	122.3	193.9
Alexandria	325	12/87	9.4	171.3	207.8
Claremont 2	100	05/87	11.4	144.9	210.2
Peekskill	750	04/85	NR	NR	218.3
Hampton 1	100	06/88	11.0	156.3	219.2
Nashville Thermal	360	NR	10.6	164.0	221.4
Baltimore 1	750	01/85	12.0	141.8	222.0
Millbury 2	750	02/88	10.5	169.3	225.7
Millbury 1	750	02/88	10.3	177.5	233.7
Claremont 1	100	05/87	12.2	161.0	258.8
Wurzburg	330	12/85	NR	NR	260.7
Marion County 2	275	09/86	10.6	211.8	284.9
Pinellas County	1,000	02/87	9.2	240.8	285.7
Stanislaus 1 (deNO_x off)	400	12/88	NR	NR	297.0[b]
Stanislaus 2 (deNO_x off)	400	12/88	NR	NR	304.0[b]
Quebec City	250	03/85	11.6	205.4	314.0
Tulsa 1	375	06/86	9.2	308.5	367.7
Tulsa 2	375	06/86	8.6	328.2	372.2

SOURCE: EPA NSPS Background Document, Control of NO_x Emissions, August 1989.

[a] The number following the site name indicates the combustor train number. It is provided if different combustor trains were evaluated as part of the same test. (Presume data from the other combustor trains were not available to report.)

[b] ppm NO_x at 12 percent CO_2.

NR = Not Reported

4.6.3 DESCRIPTION OF NO_x CONTROL TECHNIQUES

Emissions of NO_x from refuse combustion can potentially be reduced by three methods: reducing the refuse nitrogen content (material separation); minimizing the quantity of NO_x produced during combustion (combustion modification); and reducing the quantity of NO_x in the post combustion flue gas stream (flue gas controls).

Table 4-13 is a summary of the potential NO_x control techniques which may be used at refuse combustion facilities. The information also presents the current status and the projected control efficiency of each method.

Summarizing, since current EPA or other data on material separation is not sufficient, combustion modifications and flue gas controls for minimizing NO_x emissions were the only NO_x controlling methods evaluated. Each method was evaluated using "top down" BACT methodology. A comprehensive description and technical evaluation of each technology is presented in the following paragraphs.

Flue Gas NO_x Controls

Flue gas controls appear to offer the greatest potential for reducing NO_x emissions from combustion processes, though their application on refuse combustion facilities has been limited. The controls which have been applied to combustion processes are selective catalytic reduction (SCR) and selective non-catalytic reduction (SNCR). The SNCR process involves the intimate contact of a nitrogen containing reagent such as ammonia (NH_3) or urea with flue gas NO_x in the boiler through the use of injectors located in the boiler's wall. Like SNCR, the SCR technology also injects NH_3 into the flue gas, however, the reaction of NH_3 with NO_x occurs at a lower temperature and is enhanced by using a catalyst bed.

SCR - The SCR process reduces NO to water and elemental nitrogen by injecting anhydrous NH_3 into the flue gas and then passing the flue gas through a catalyst bed. The function of the catalyst is to effectively lower the activation energy of the NO in its decomposition reaction to N_2.

TABLE 4-13

LEE COUNTY ENERGY RECOVERY FACILITY ALTERNATE NO_x CONTROL TECHNIQUES

Control Method	Percent Reduction	Status
Flue Gas Controls:		
1) Selective catalytic reduction	25-80	Not yet applied successfully on a refuse combustion facility in the U.S., and significant technical disadvantages associated with application.
2) Selective non-catalytic reduction (SNCR, for example Thermal $DeNO_x$)	30-50	Somewhat successful, but with limited application, as explained in text.
3) Wet flue gas denitrification (FGDn)	Unknown	Not yet applied successfully to refuse combustion facility.
Combustion Modification:		
1) Staged combustion/low excess air	30-60	Effective. The percent reduction values in the high end of the range represent those of the mass-burn rotary waterwall combustor.
2) Gas (pilot program) reburning	10-60	Has shown considerable promise on pilot programs. Not yet applied to a full-scale refuse combustion facility.
3) Flue gas recirculation	10-20	Somewhat effective.
Material Separation	Unknown	Not demonstrated.

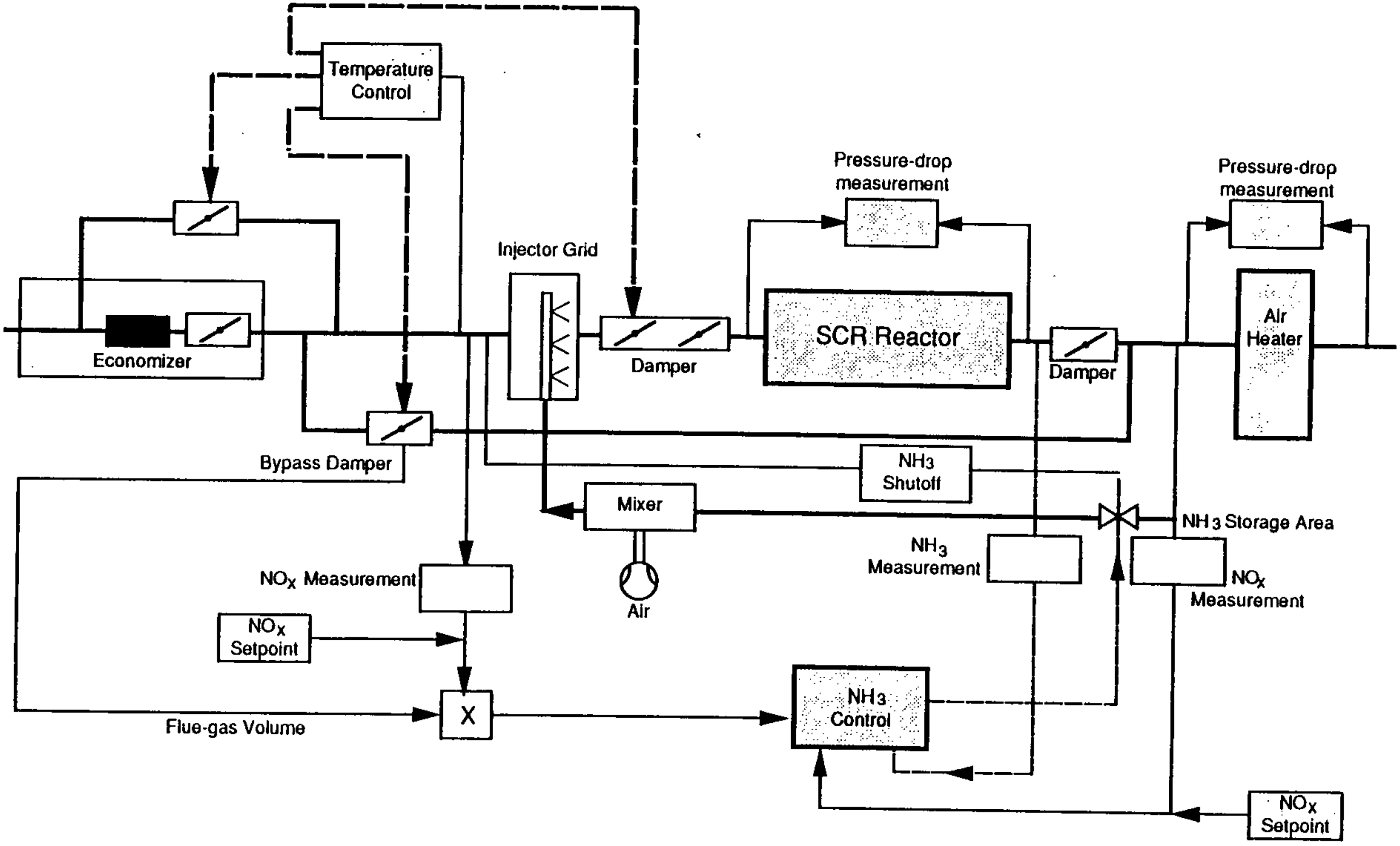
This lower energy allows the reaction to proceed in a lower and broader temperature range than would otherwise be possible. The optimum temperature for NO_x reduction using SCR is between 288 and 399°C (550 and 750°F) (Hahn, 1986). Lower temperatures yield slow reaction rates; higher temperatures result in a shortened catalyst life.

In a typical SCR system, anhydrous NH_3 is injected into the flue gas stream and allowed to pass through a catalyst bed located, depending on the application, just downstream of the economizer or after the air pollution control equipment. Figure 4-7 presents a typical SCR process which would likely be applied on a fossil fuel boiler. Important parameters for successful NO_x removal using the SCR technology include adequate mixing of the flue gas with NH_3, as well as control of the NH_3 injected based on inlet NO_x concentration and removal rate (Makansi, 1988).

Currently, there is considerable worldwide commercial experience with SCR technology on oil, gas, and coal-fired boilers. Depending on the application, removal efficiencies of up to 90 percent have been achieved (Makansi, 1988). SCR experience on refuse combustors, on the other hand, is extremely limited with no applications in the United States.

Application of SCR technology to refuse combustors is difficult mainly due to the acid gas content and relatively high particulate grain loading of the flue gas. These flue gas components erode the catalyst and substrate material as well as poison or blind the catalyst rendering the bed ineffective for NO_x removal. If these problems are to be avoided, then the SCR reactor must be located downstream of the air pollution control equipment, however, the gas is then below the optimal SCR temperatures. Therefore, SCR operation with the catalyst bed after the pollution control equipment would have significant economic disadvantages since it would require reheating of the flue gas prior to entering the bed (Radian, 1989).

Although there are no refuse combustors in the United States which employ SCR technology, it is currently being used to control NO_x emissions from two refuse combustors in Japan and is being installed at a facility in West Germany. The Tokyo-Hikarigaoka facility was retrofitted with an SCR system



Makansi, J.: *Reducing NOx Emissions.* Power. *September 1988*

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FIGURE 4-7
SCHEMATIC OF A TYPICAL SCR PROCESS

designed to achieve a NO_x removal efficiency of 51 percent. The system, operating since December of 1986, has not always been able to meet its design removal efficiency. Test data (see Table 4-14) show control efficiencies ranging from 25 to 57 percent. The Twatsuki refuse combustor was equipped with SCR technology in February of 1987. This system was designed for a control efficiency of 80 percent but has performed with an average efficiency of 77 percent (Mitsubishi, 1987). The first West German SCR installation associated with a refuse combustor is currently under construction on the Martin Munich-South plant.

The SCR technology currently offers the greatest potential for controlling NO_x emissions from refuse combustion facilities; however, its application has been limited due mainly to technical difficulties. A more detailed discussion of the technical disadvantages associated with the SCR technology are presented as follows.

- <u>Emission of Unreacted NH_3</u> - A small amount of residual ammonia will be emitted as the result of SCR operation. This "ammonia slip" is likely to increase over time as the catalyst loses activity, thus increasing quantities of NH_3 must be injected into the boiler to maintain the desired NO_x removal. If the SCR system is installed downstream of the air pollution control (APC) system, the APC system cannot be relied on to remove residual NH_3.

- <u>Potential for Undesirable Side Reactions</u> - The catalyst used to enhance the conversion of NO to nitrogen and water tends to convert SO_2 to SO_3 which may further react with residual NH_3 and water to form ammonium bisulfate and ammonium sulfate. These solids can foul and plug downstream equipment (if the catalyst is installed upstream of pollution control equipment) or create a blue haze plume (Makansi, 1988). Also, in refuse combustion applications there exists the potential for ammonium chloride formation which is difficult to remove with current air pollution control technologies and has caused a visible plume (Russell and Roberts, 1986).

TABLE 4-14

LEE COUNTY ENERGY RECOVERY FACILITY
OBSERVED CONTROL EFFICIENCY ASSOCIATED WITH SCR INSTALLATIONS AT TWO REFUSE COMBUSTORS IN JAPAN

Facility	Reactor Inlet Temp (°C)	NO_x Emissions (ppm)[a] Inlet	Outlet	Removal Efficiency(%)
Twatsuki	196	123	30.2	75.4
	198	129	25.6	80.2
	204	129	29.4	77.2
	198	195	38.0	70.2
	202	173	26.2	84.9
	205	138	41.2	70.2
	202	110	15.0	86.4
	205	100	16.0	84.0
	200	130	30.0	76.9
	207	120	45.0	62.5
	200	160	36.0	77.5
	203	130	29.0	77.7
Tokyo-Hikarigaoka	248	96	63.0	34.4
	248	95	47.0	50.5
	246	106	79.0	25.5
	244	104	60.0	42.3
	245	93	42.0	57.1
	246	101	47.0	53.5

SOURCE: Mitsubishi, 1987.

[a] Corrected to 12 percent CO_2.

- Poisoning and Degradation of the Catalyst by Particulate - Particulate matter in the flue gas generated by refuse combustors will erode the catalyst and substrate material. In addition, constituents of particulate matter, particularly the metals, may poison the catalyst. Both catalyst erosion and poisoning dramatically reduce the life of the catalyst resulting in lower NO_x removal efficiencies and high catalyst replacement costs. These problems are avoided if the catalyst bed is installed after the pollution control equipment; however, flue gas reheating is necessary at a significant economic disadvantage.

- Disposal of Toxic Catalysts - Most of the catalysts which are currently available for SCR applications are made of various metals including copper, chromium, nickel, molybdenum, cobalt, platinum, and vanadium, and may be considered hazardous waste (Makansi, 1988).

- High Cost of SCR Technology - Both initial capital cost and annual operating costs for SCR technology are high. The available catalysts are extremely expensive, and when replaced can cost 50 percent or more of the initial total capital cost (Russell and Roberts, 1986). In addition, because the application of SCR on a refuse combustor requires locating the catalyst bed downstream of the air pollution control system, reheating of the flue gas stream is required. This reheat is a significant economic disadvantage and can account for as much as eight percent of the heat released from the furnace (Clarke, 1989).

Currently, new and improved catalysts are being studied to remedy the major disadvantages of applying the SCR technology to refuse combustors. Until the time when such catalysts are introduced, SCR will remain a very impractical and expensive NO_x control method for refuse combustors.

In conclusion, due to the significant disadvantages, the SCR technology can not be considered as a viable means of controlling NO_x emissions from refuse combustors. Therefore, in accordance with the "top down" BACT methodology, the technology is determined not to be feasible on MWCs and no further analysis on this technology was performed.

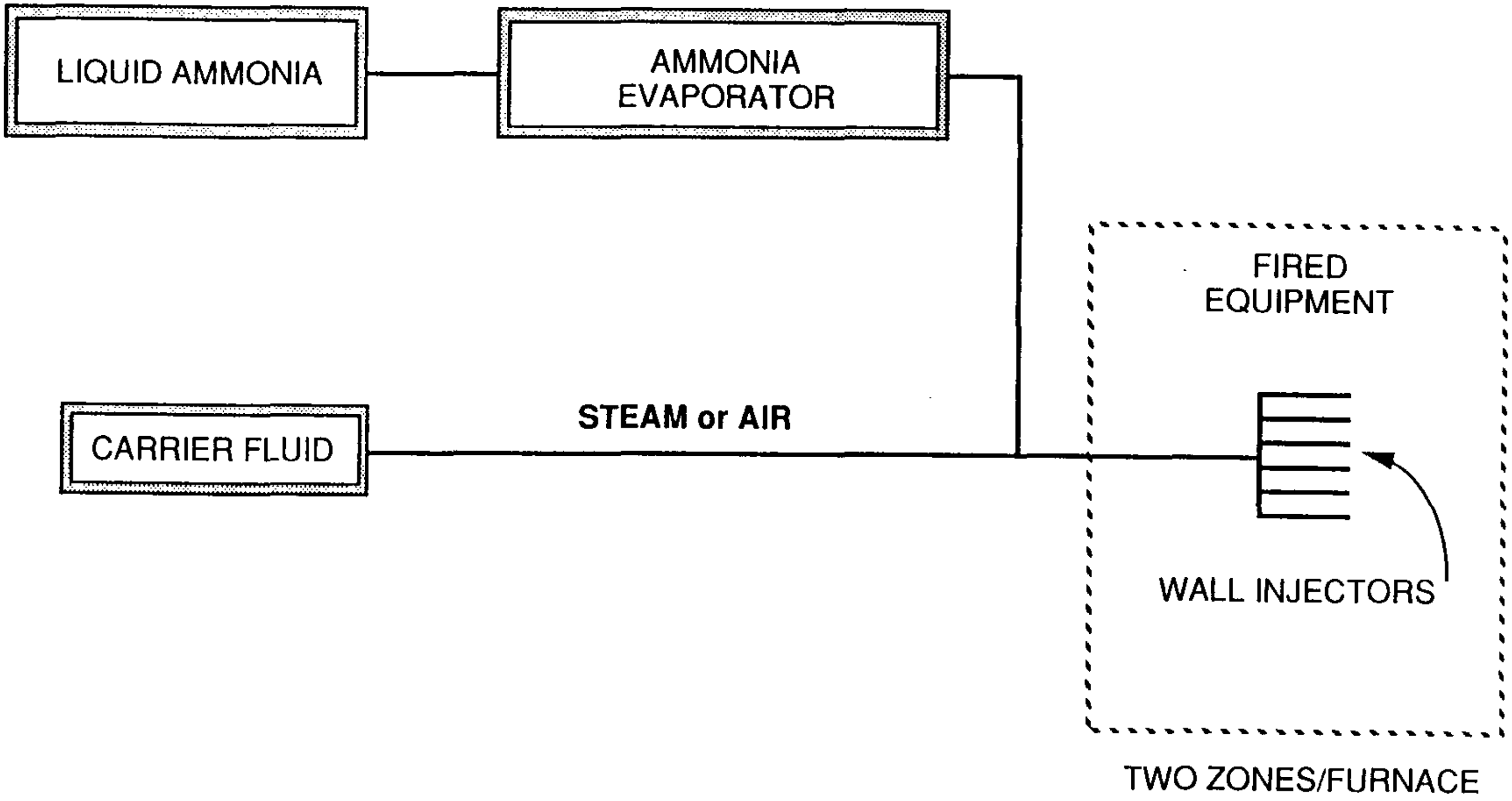
<u>SNCR</u> - The SNCR technology is currently the only other commercially available NO_x flue gas control technology. The process involves the contact and reaction of flue gas NO_x with NH_3 or another nitrogen based compound such as urea. Currently, commercially available SNCR processes are offered by Exxon and Fuel Tech under the tradenames of "Thermal $DeNO_x$" and "NOxOUT," respectively. The proposed NSPS technical support document on NO_x identifies these SNCR processes; however, the EPA focused only on Thermal $DeNO_x$.

In Exxon's Thermal $DeNO_x$ process, anhydrous NH_3 is injected into the hot flue gas with either air or steam acting as a carrier gas (see Figure 4-8). The following two reactions govern the NO_x control process:

(1) $NO + NH_3 + 1/4\ O_2 \rightarrow N_2 + 3/2\ H_2O$
(2) $NH_3 + 5/4\ O_2 \rightarrow NO + 3/2\ H_2O$

Critical to the success of the SNCR process is the prevailing flue gas temperature at the point of NH_3 injection. Over the optimum temperature range of approximately 870 to 980°C (1,600 to 1,800°F), the first reaction dominates and NO is reduced without any further NO production. At temperatures above 980°C (1,800°F), the second reaction becomes more significant, and at temperatures above 1,200°C (2,200°F), the second reaction dominates creating more NO than is reduced. In addition, at flue gas temperatures below 870°C (1,600°F), the rate of both reactions slows down such that NH_3 does not react, and instead passes through the system and potentially into the ambient atmosphere.

Fuel Tech's NOxOUT is a relatively new technology in which urea, instead of NH_3, is fed to the boiler as a 50 percent-by-weight solution cut with water to maintain the required volumetric flow rate to give adequate distribution across the boiler. NO_x control is affected using essentially the same net chemistry as Exxon's Thermal DeNOx. The overall reaction between urea and NO can be expressed as follows:



Makansi, J. Traditional Control Processes Handle New Pollutants. Power. October, 1987.

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FIGURE 4-8
GENERAL SCHEMATIC OF THE THERMAL DeNOx PROCESS

$$CO(NH_2)_2 + 2NO + 1/2O_2 \rightarrow 2N_2 + CO_2 + 2H_2O$$

The NOxOUT reaction takes place at a temperature range similar to that of Thermal $DeNO_x$ (i.e., approximately 870 to 980°C); however, NOxOUT's technology manufacturer claims to be able to expand the temperature range to 700°C (1,300°F) with the use of a proprietary urea additive.

While the chemistry of the urea reaction with NO_x is not understood as well as the NH_3 reactions, some experts feel that the mechanics of the urea injection process may have some advantages over NH_3 injection. Urea/water injection parameters such as droplet size and concentration can be more easily matched to furnace temperature, thus this method may have better load-following capability.

The manufacturer of the NOxOUT technology claims to achieve NO_x removal efficiencies similar to, if not greater than, those achieved by Exxon's Thermal $DeNO_x$ process, and to operate at a wider flue gas temperature range without effecting efficiency. To date, the NOxOUT process has been only tested on a limited number of MWCs worldwide and has not included the mass-burn rotary waterwall combustor. The Millbury, MA mass-burn stoker waterwall combustor was tested in August of 1989 for only one week with the NOxOUT technology and obtained removal efficiency results comparable to the Thermal $DeNO_x$ process. The purpose of the test was to determine overall NO_x removal efficiencies, and no data was obtained to support the manufacturer's claim of being able to operate over a wider flue gas temperature range without effecting efficiency. Claims made by the NOxOUT manufacturer can not be supported without long-term operating data on full-scale and representative MWCs. Since Fuel Tech's NOxOUT technology has not been installed and proven on a refuse combustor and only limited short-term data exists, the remainder of the SNCR analysis concentrates on Thermal $DeNO_x$.

Thermal $DeNO_x$ has been commercially applied to both utility and industrial boilers burning fuels such as wood waste, oil, coal, and used tires. Virtually all of the installations are located in the United States

(California), Japan, and West Germany. The process was installed on an oil-fired utility boiler rated at 230 MW in Los Angeles, California during 1985 and showed varying removal efficiency with boiler load. NO_x concentration reductions from 28 to 45 percent were observed at 160 MW, while higher efficiencies of 30 to 53 percent were observed at the maximum boiler load of 230 MW (ESA, 1986). Below 160 MW, temperatures at the NH_3 injection zones were too low to support the NH_3-NO reaction, and resulted in unacceptably high ammonia emissions. Therefore, NH_3 was injected into the boiler at loads above 160 MW.

Thermal $DeNO_x$ has been installed on several refuse combustion facilities in Japan and recently on three facilities in southern California—Commerce, Stanislaus, and Long Beach. All three California facilities are located in nonattainment areas for NO_2 and/or ozone and Thermal $DeNO_x$ represents lowest achievable emission rate (LAER) technology. The Commerce facility was the first U.S. refuse combustor installation to use the SNCR technology and was permitted as an "Innovative Technology."

In many applications, and especially refuse combustion, the major limitation of the SNCR technology is the fact that the chemistry works well only in a very narrow temperature range. While the chemistry is capable of achieving very high NO_x reductions at its ideal optimum temperature, in application it must be used on a flue gas whose temperature varies. In practice, flue gas temperature variations make the NO_x reduction that the SNCR technology can provide significantly less than could be achieved at optimum temperatures.

The adverse effect of temperature variations on NO_x removal is of particular concern in the application of SNCR on refuse combustion. The BTU content of refuse is far more variable than that of fossil fuels. If a fossil fuel fired unit is operated at a constant fuel rate, then the rate at which heat is released is also constant, and the temperature in the unit is more uniform than that observed from refuse combustors. A refuse combustor operated at a constant feed rate will have a variable rate of heat release, and therefore the temperature at any given point will vary considerably. In short, temperature variations will adversely affect the NO_x reduction achieved by the SNCR process.

The BTU content of refuse varies from one ton to the next, and even within a single ton of refuse there are regions of varying BTU content. Thus, when the refuse burns, it does not produce a combustion gas of uniform temperature, but rather a random mixture of hot and cool gases. As combustion gases pass the point at which NH_3 or other nitrogen containing reactant is injected from the SNCR process, temperature variations from one point in the injection plane to another continously occur.

The composition of the gas stream also determines the effectiveness of the SNCR process. The presence of CO, above approximately 100 ppm, adversely effects SNCR chemistry. The presence of CO in the combustion gases causes a shift and reduction in the effective NO_x/NH_3 reaction temperature range. The CO interference adversely effects the NO_x percent reduction that would have otherwise been expected. Further, the presence of injected NH_3 in the combustion gas can retard and/or inhibit the final oxidation of CO to CO_2, thereby potentially leading to increased CO stack emissions. This phenomenon occurs because the critical step in CO oxidation, $CO + OH \rightarrow CO_2 + H$, is retarded because NH_3 competes effectively for OH via the reaction $NH_3 + OH \rightarrow NH_2 + H_2O$ (Lyon, 1987).

Because of the limitations and concerns mentioned above, the applicability of SNCR must be addressed as applied to specific refuse combustion technologies (e.g., mass-burn stoker waterwall or mass-burn rotary waterwall). The temperature profile, gas mixing characteristics, and $NO_x/CO/O_2$ levels of a given combustion system will determine the ultimate applicability and effectiveness of this process. A more detailed evaluation of this technology is presented further in this analysis.

Although the SNCR technology was installed, due to nonattainment conditions, at three refuse combustion facilities in California, the technology presents several environmental and technical disadvantages for use on a refuse combustion system. These disadvantages are as follows.

- o Residual NH_3 or other nitrogen containing reactant may react with acid gases in the boiler to form by-product ammonium salts. Two of the salts formed, ammonium sulfate and ammonium bisulfate, could potential cause fouling and corrosion problems in the boiler. A third salt, ammonium chloride, forms a visible blue-white plume downstream of the facility stack and has been witnessed at all three facilities in California (EPA, August 1989). The formation of a visible ammonium chloride plume has also been reported at Japanese refuse combustion facilities, particularly at the Kawasaki facility.

- The process inhibits and/or halts the oxidation of CO emissions. During testing at the Commerce facility, increased CO emissions were observed during operation of the Thermal DeNOx system. This issue will be addressed later in this analysis in greater detail.
- Residual reactant emissions (ammonia or other nitrogen containing compounds) are emitted as a result of the SNCR process.
- Achieving and maintaining the required reaction temperature is difficult in refuse combustion applications. If the temperature range is not maintained, then efficiency is effected.
- As shown later in this analysis, the use of the SNCR process on the mass-burn rotary waterwall design is not applicable due to its minimal effectiveness.

Wet Flue Gas Denitrification (FGDn) - FGDn systems may be divided into at least four major process systems: (1) absorption-reduction, (2) oxidation-absorption, (3) absorption-oxidation, and (4) oxidation-absorption-reduction (OAR). Absorption-reduction has only been bench-scale or pilot-scale tested on emissions from oil-fired units. Oxidation-absorption and absorption-oxidation are even less developed than absorption-reduction. Therefore, OAR, a derivative of an already established flue gas desulfurization system, shall be the only FGDn technique examined further.

OAR operates by injecting oxidizing agents such as ozone (CARB, 1984) into the flue gas upstream of wet scrubbers. The relatively insoluble NO oxidizes to the more soluble NO_2 which, when in solution, reduces to N_2 by consuming some of the absorbed SO_2.

It is possible to modify conventional flue gas desulfurization systems that use water soluble SO_2 absorbents by adding oxidizing agents which circulate with the scrubber fluid. Simultaneous NO_x and SO_2 removal efficiencies as high as 90 percent may be achieved (CARB, 1984). Such modified flue gas desulfurization systems may be applicable to refuse-fired boilers (Beaumont, 1986). For example, a municipal refuse/sewage sludge combustor at the Krefield Plant in West Germany is equipped with a two-field ESP upstream of a multi-stage acid gas wet scrubbing tower. As reported by Beaumont, test results have shown 97.0 percent SO_2 removal and 63.9 percent NO_2 removal using Na_2CO_3 as the reagent. Other performance data are scarce because few commercial scale refuse-fired boilers are equipped with these systems.

Disadvantages of these systems stem from the cost of the oxidizing agents, wastewater treatment associated with wet scrubber effluent, and flue gas reheat requirements. The oxidation-absorption-reduction processes have not been demonstrated on a wide-scale to be technically reliable nor economically sound, and therefore cannot be considered BACT.

Combustion Modifications

Combustion modification techniques can be used to reduce the conversion rate of fuel nitrogen to NO_x and suppress thermal NO_x formation as well. Three methods—staged combustion/low excess air, flue gas recirculation (FGR), and natural gas reburning—are means to reduce NO_x emissions.

Staged Combustion/Low Excess Air - These techniques may be used separately or together to control NO_x emissions. During staged combustion, air and fuel mixtures are combusted in two separate zones. In one zone, the fuel is fired with less than a stoichiometric amount of air thereby preventing the oxidation of fuel bound nitrogen. This creates a fuel rich local zone in the regions of the primary flame. The second zone is an air rich zone where the remainder of the combustion air is introduced to complete the combustion of the fuel. The heat in the primary flame zone is not as intense as with normal firing because combustion is incomplete. The air mixed with fuel is sub-stoichiometric in the NO_x forming region of the flame, thus creating a low NO_x condition (Joseph and Beachler, 1981).

Similar to staged combustion, combustor operation at low excess air reduces the oxygen available in the NO_x forming region of the flame, thereby inhibiting the formation of thermal NO_x.

Staged combustion reduces NO_x emissions by a combination of several factors. First, a lack of available oxygen for NO_x formation in the fuel rich stage is due to off-stoichiometric firing. Second, the flame temperature may be lower in the first stage than with single-stage combustion. Third, the peak temperature in the second stage (air rich) is lower. This slow combustion air and fuel (refuse) mixing process assists in converting fuel bound nitrogen to molecular nitrogen rather than NO_x.

The mass-burn rotary waterwall design incorporates staged combustion techniques along with low excess air to achieve NO_x emissions which are much lower than those from a mass-burn stoker waterwall design. The fuel/air mixing process in the mass-burn rotary waterwall design is different than other mass-burn combustor designs (such as stoker or refractory) used for refuse combustion. The overfire air in the rotary combustor enters with very low radial velocity and slowly mixes with hot fuel gases coming up from the burning bed. The volatile fuel fragments, including volatile fuel nitrogen components, are driven from the bed early—near the entrance to the barrel—and then must flow down the barrel toward the radiant chamber. Not only does the overfire air slowly mix, but the more slowly evolving fuel fragments are constantly being added to the gases giving an excellent opportunity for the fuel-bound nitrogen to be converted to N_2.

Control of both fuel NO_x and thermal NO_x is accomplished by the mass-burn rotary waterwall combustor using staged and low excess air combustion techniques. Heat generated by refuse combustion is transferred to the water inside the tubes which make up the combustor barrel. This heat removal mechanism moderates peak combustion temperatures, alleviating the need for large amounts of excess air. Since less excess air is required for the mass-burn rotary waterwall combustor (i.e., 50 percent) than other mass-burn systems which typically use 100 percent excess air for grate cooling, less oxygen is available for NO_x production. Maintaining lower peak temperatures in the combustor without supplying large amounts of excess air reduces NO_x emissions. Higher instantaneous local temperatures may exist within the combustor, but NO_x formation rates are relatively slow.

NO_x emission test data from refuse combustion facilities which employ the mass-burn rotary waterwall design are shown to be lower than those observed at other facilities (see Table 4-12). Data from two refuse combustion facilities which employ the mass-burn rotary waterwall design with combustion control techniques (Bay County, Florida and Dutchess County, New York) indicate consistently lower NO_x emissions.

During a test program conducted in March of 1988 at the Bay County facility, the NO_x emission levels averaged in the range of 100 to 160 ppm corrected to 7 percent O_2 (hourly average). Additional data were obtained from August through October 1989 from the Bay County facility through the use of CEMs for NO_x. The data, shown in Figure 4-9, indicates NO_x emissions in the range of 60 to 120 ppm corrected to 7 percent O_2 (daily average), and confirm the data obtained during the 1988 test program. Compliance testing conducted at the Dutchess County facility in January and February 1989 indicated NO_x emissions (see Table 4-15) which were in agreement with those from Bay County. The data in Table 4-15 are from each of the combustor boiler trains (Beachler and Hirko, 1989).

<u>FGR</u> - In FGR, a portion of the flue gas stream is extracted and returned to the furnace. The system consists of an FGR fan assembly, air apportioning and mixing system, and necessary ductwork. Because the recirculated flue gas is relatively cool, the bulk furnace temperature decreases, resulting in a reduced thermal NO_x formation. FGR reduces NO_x emissions by lowering the flame temperature and reducing available oxygen. Although FGR is a technique designed to reduce thermal NO_x, the system can also aid in slightly reducing fuel NO_x by providing a means of staging the combustion process.

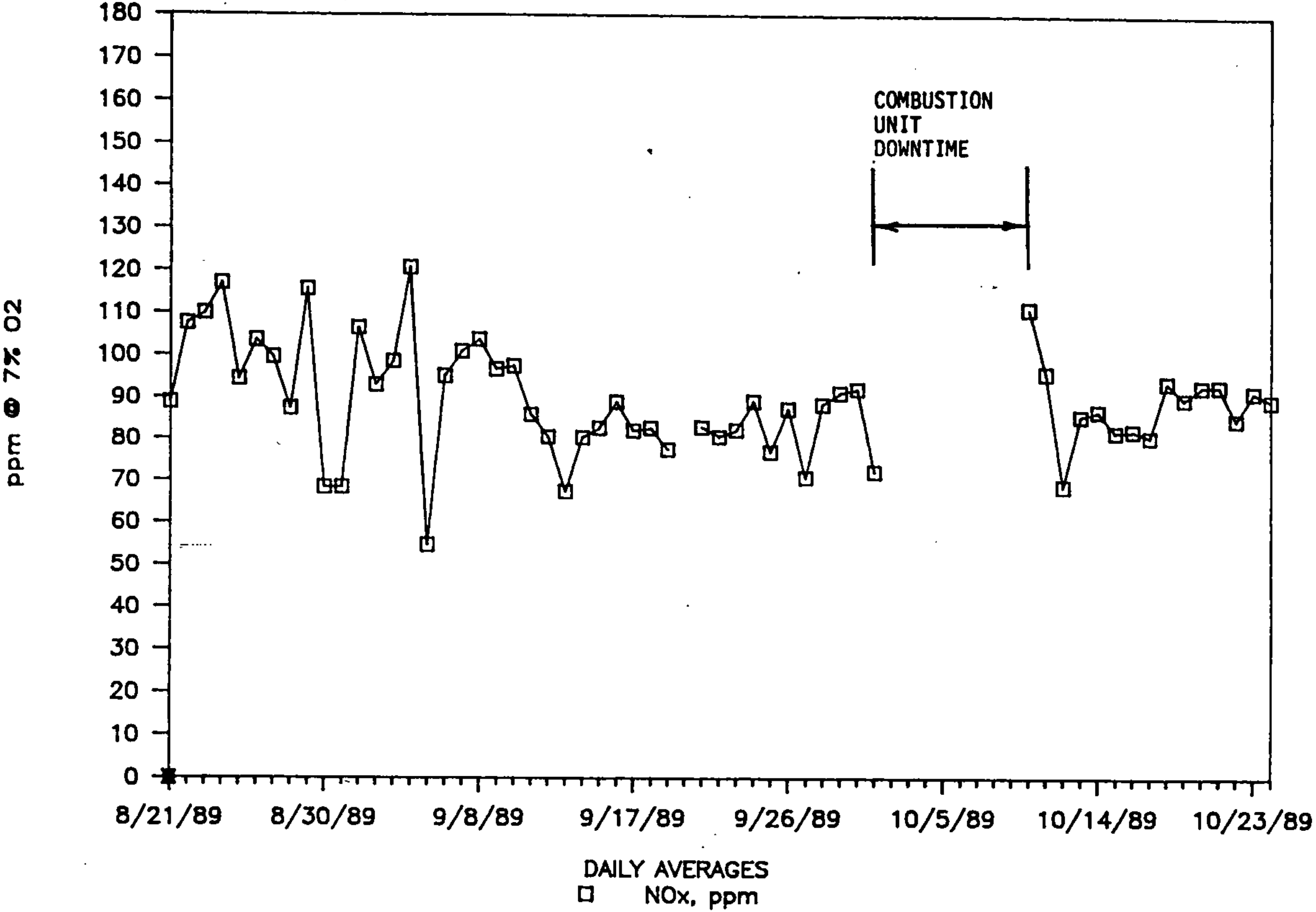

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FIGURE 4-9
NOx EMISSIONS DATA FROM THE BAY COUNTY, FL
REFUSE COMBUSTION FACILITY UNIT #1

TABLE 4-15

LEE COUNTY ENERGY RECOVERY FACILITY
SUMMARY OF NO_x EMISSIONS
(One-Hour Averages)
DUTCHESS COUNTY RESOURCE RECOVERY FACILITY - 1989
(Mass-Burn Rotary Waterwall Combustor)

Date	Unit	Gas Flow Rate (dscfm)	Concentration (ppmdv @ 7% O_2)	Mass Rate (lb/hr)	Permit Limit (lb/hr)
1/31	1	22,604	114	10.2	25
1/31	1	22,604	127	11.5	25
1/31	1	20,242	67	7.0	25
1/31	1	20,153	87	7.1	25
1/31	1	20,153	96	9.2	25
1/31	1	21,700	92	9.4	25
1/31	1	21,700	88	8.7	25
1/31	1	21,700	101	9.8	25
1/31	1	21,700	97	10.3	25
1/31	1	21,700	58	6.8	25
2/1	1	22,268	108	10.4	25
2/2	1	24,032	105	14.1	25
2/2	1	24,032	94	13.4	25
2/2	1	24,215	97	14.2	25
2/3	1	22,874	79	12.8	25
Average Unit 1:			94	10.3	25
2/1	2	23,032	88	13.7	25
2/1	2	23,032	91	9.5	25
2/1	2	26,550	100	15.6	25
2/1	2	26,550	101	15.8	25
2/1	2	26,550	101	15.1	25
2/2	2	24,482	107	15.2	25
2/2	2	24,482	109	15.5	25
2/5	2	23,193	88	13.7	25
2/5	2	23,193	90	14.0	25
2/5	2	23,193	109	15.6	25
2/5	2	23,757	107	16.0	25
2/5	2	23,757	96	15.0	25
2/5	2	23,757	91	13.8	25
2/6	2	23,644	108	13.2	25
2/6	2	23,644	113	14.1	25
2/6	2	23,644	104	14.6	25
2/6	2	23,644	90	12.8	25
2/7	2	22,004	113	13.2	25
2/7	2	22,004	112	15.2	25
Average Unit 2:			101	14.3	25

To date, FGR has been employed on a limited basis on refuse combustion facilities in the United States; however, FGR has been applied on refuse combustion facilities in Japan and Europe by ducting cool flue gas from a point after the air pollution control device back to the underfire air fan.

Results from tests conducted at the 660-tpd Volund refractory wall furnace at the Kita refuse combustion facility in Japan indicated that 10 to 25 percent NO_x emission reductions were achievable (Radian, 1989). This level of NO_x reduction was achieved by recirculating an amount of flue gas equivalent to 20 percent of the combustion air. Other full-scale applications of FGR technology include the Copenhagen Amager and Copenhagen West facilities, where flue gases from 293 to 349°C (560 to 660°F) are recirculated to the furnace from the exit of the ESPs with successful results (Clarke, 1989).

The disadvantages of using FGR technology for controlling of NO_x emissions from refuse combustion facilities include the following.

- Recirculation of the cooled flue gas stream reduces the boiler efficiency by decreasing the furnace gas temperature, and could cause unstable combustion.
- Reduced flame temperature and dilution of available oxygen may result in conditions which are conducive to higher emissions of incomplete combustion.

Little data is available to support that FGR will substantially improve NO_x control when used in conjunction with the proposed combustion technologies. Thus, FGR is not considered BACT for this Facility.

Natural Gas Reburning - Gas reburning is a NO_x control technique that overlaps combustion modification techniques. Low excess air (LEA) is provided at the combustor grate, with recirculated flue gas introduced above the grate. Natural gas is added to this LEA zone to generate a fuel-rich zone. Air is supplied above the fuel-rich zone to complete combustion. This process is designed to reduce NO_x formation without increasing CO emissions.

Natural gas reburning is a new technology being evaluated by the Gas Research Institute for possible use on refuse combustors. The goal of gas reburning is to achieve up to 75 percent NO_x reduction. To date, most of the data on natural gas reburning are for pulverized coal-fired boilers. (Radian, 1989).

Gas reburning has achieved 10 to 60 percent reduction of NO_x emissions on a pilot facility. This new technique has not been demonstrated on a full-scale refuse combustor at this time. Although the technology is promising, it can not be considered as BACT.

4.6.4 EVALUATION OF NO_x CONTROL TECHNIQUES

The NO_x control techniques discussed earlier indicate that the SCR technology can be considered the "top" control method; however, it is not considered to be a viable BACT alternative. An evaluation of the SCR technology revealed that it has not been applied and demonstrated successfully on a refuse combustion facility in the U.S., and its application presents significant technical and economic disadvantages as stated in the proposed NSPS. Hence, the SCR is not considered BACT.

The application of staged combustion/low excess air through the use of a mass-burn rotary waterwall combustor design or SNCR can be considered the next "top" or most stringent NO_x control techniques. The possible application of the SNCR technology on a mass-burn rotary waterwall design which inherently applies staged combustion/low excess air combustion control techniques is deemed not applicable due to its technical incompatibility and minimal effectiveness. The following subsection addresses the applicability of the SNCR technology on a mass-burn rotary waterwall combustor.

SNCR Incompatibility with the Mass-burn Rotary Waterwall Technology

The NO_x emission data presented earlier shows that the mass-burn rotary waterwall combustor design is capable of achieving emissions as low as or lower than other refuse combustion systems which use the SNCR technology. Although the SNCR technology has been successfully applied to many combustion sources, it is still questionable as to its general applicability to all refuse mass-burn combustor designs.

In addition to the operational concerns addressed earlier (see pages 4-77 and 4-79), there is considerable uncertainty about the technical compatibility of the SNCR technology with the mass-burn rotary waterwall combustor. In an analysis conducted by Energy and Environmental Research Corporation (EER), compatibility issues surrounding the application and operation of the SNCR process on a mass-burn rotary waterwall design were assessed. The issues of major concern are broken into two major categories:

1. Effectiveness of the SNCR technology on combustion gases with low initial NO_x levels.
2. SNCR reaction chemistry as related to a mass-burn rotary waterwall combustor:
   - Optimum temperature range for NH_3 injection
   - Effect of NH_3 injection on CO emission levels
   - Effect of CO levels on NO_x reduction

First, there is a potential problem associated with the initial NO_x level. It is well established that the percent effectiveness of the SNCR technology decreases with decreasing initial NO_x levels. Since a mass-burn rotary waterwall system already provides substantial NO_x reduction through staged combustion/low excess air, the SNCR system would be applied to an already controlled gas flow—a flow with NO_x levels approximately a factor of two lower than other mass-burn combustor systems. This could lead to lower effectiveness of the SNCR system when applied to a mass-burn rotary waterwall combustor.

The second issue is the effect of SNCR on CO emissions, and the corresponding impact of CO on the basic chemistry of the SNCR process. The injection of NH_3 into the combustion gases promotes NO_x destruction reactions in a relatively narrow temperature range. The presence of CO in the combustion gases causes a shift in the width and location of the effective NO_x reduction temperature range. Further, the presence of injected NH_3 in the combustion gas can retard and/or inhibit the final oxidation of CO to CO_2, thereby potentially leading to increased CO in the stack gases. These potential problems must be evaluated on a case-by-case basis.

To assess the above concerns, Dr. Richard K. Lyon (the inventor and patent holder of the Thermal $DeNO_x$ SNCR process) at EER Corporation performed a series of computer modeling studies. The model considers all of the key chemical reactions associated with the Thermal $DeNO_x$ SNCR process and predicts the flue gas composition for specified initial conditions. The actual set of chemical reactions considered in the model are presented in Table 4-16. The Arrhenius rate constants (A) are for the forward direction of the reaction as written. The reverse reactions are also included in the model with the kinetic rate calculated through use of the equilibrium constant. The model procedures used by Dr. Lyon in the current evaluation are similar to those he developed in process evaluations for the Exxon Research and Engineering Company. The first step in the analysis was to use the model with input conditions selected to simulate the refuse combustion facility in Commerce, California. This allows model predictions to be directly compared with experimental results from a full-scale refuse combustion facility, and also serves to illustrate some of the critical features of the Thermal $DeNO_x$ SNCR process. The following initial conditions were selected for that simulation:

$NO_{initial}$	- 232 ppm (as measured) - 295 ppm @ 7% O_2
O_2	- 10%
H_2O	- 10%
CO_2	- 7.5%
N_2	- Balance
Temperature	- Variable from 750 to 1,150°C (1,382 to 2,120°F)
NH_3 injection	- 2:1 molar with initial NO

The model allowed injected ammonia to react for a period of 0.2 seconds at the specified conditions, and the resultant change in NO concentration was

TABLE 4-16

LEE COUNTY ENERGY RECOVERY FACILITY
THERMAL $DeNO_x$ REACTION SET

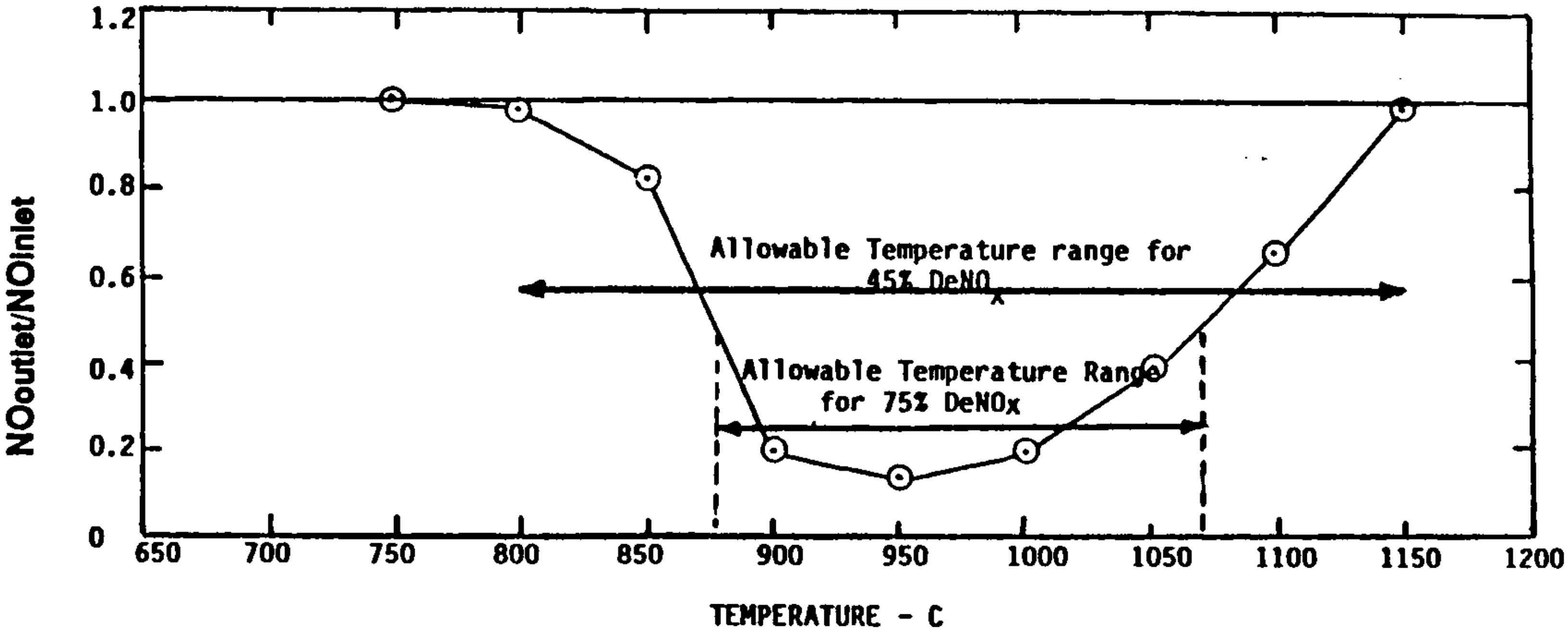
Reactions	References	A. cc/mole sec	n	E. Kcal/mole
$NH_3+M=NH_2+H+M$	(DENOX)	4.80E16	0.0	93900.0
$NH_3+H=NH_2+H_2$	(DENOX)	2.50E13	0.0	17100.0
$NH_3+O=NH_2+OH$	(DENOX)	1.5E12	0.0	6040.0
$NH_3+OH=NH_2+H_2O$	(DENOX)	3.3E12	0.0	2120.0
$NH_2+H=NH+H_2$	(DENOX)	5.0E11	0.5	2000.0
$NH_2+O=NH+OH$	(DENOX)	1.7E13	0.0	1000.0
$NH_2+OH=NH+H_2O$	(DENOX)	5.5E10	0.68	1290.0
$NH_2+O_2=HNO+OH$	(DENOX)	5.1E13	0.0	30000.0
$NH_2+NO=NNH+OH$	(DENOX)	6.1E19	-2.46	1866.0
$NH_2+NO=N_2+H_2O$	(DENOX)	9.1E19	-2.46	1866.0
$NH_2+HNO=NH_3+NO$	(DENOX)	1.8E14	0.0	1000.0
$NH_2+NNH=N_2+NH_3$	(DENOX)	1.0E13	0.0	0.0
$NNH+M=N_2+H+M$	(DENOX)	2.00E14	0.0	30000.0
$NNH+NO=N_2+HNO$	(DENOX)	9.10E11	0.0	0.0
$NNH+OH=N_2+H_2O$	(DENOX)	3.00E13	0.0	0.0
$HNO+M=H+NO+M$	(DENOX)	1.9E16	0.0	48680.0
$HNO+OH=NO+H_2O$	(DENOX)	3.6E13	0.0	0.0
$NH+O_2=HNO+O$	(DENOX)	3.00E13	0.0	3400.0
$OH+H_2=H_2O+H$	(DENOX)	2.2E13	0.0	5150.0
$H+O_2=OH+O$	(DENOX)	2.3E14	0.0	16880.0
$O+H_2=OH+H$	(DENOX)	1.8E10	1.0	8890.0
$2OH=O+H_2O$	(DENOX)	6.3E12	0.0	1090.0
$H+O_2+M=HO_2+M$	(DENOX)	1.5E15	0.0	-995.0
$H_2O/21./$				
$H+HO_2=2OH$	(DENOX)	2.5E14	0.0	1900.0
$O+HO_2=O_2+OH$	(DENOX)	4.8E13	0.0	1000.0
$OH+HO_2=H_2O+O_2$	(DENOX)	5.0E13	0.0	1000.0
$H_2O_2+M=2OH+M$	(W&D)	1.20E17	0.0	45500.0
$H_2O_2+H=HO_2+H_2+M$	(W&D)	1.70E12	0.0	3750.0
$H_2O_2+H=H_2O+OH$	(W&D)	3.15E14	0.0	8940.0
$H_2O_2+OH=H_2O+HO_2$	(W&D)	1.00E13	0.0	1800.0
$HO_2+NO=NO_2\,OH$	(DENOX)	3.40E12	0.0	-260.0
$NO_2+H=NO+OH$	(DENOX)	3.5E14	0.0	1500.0
$NO_2+O=NO+O_2$	(DENOX)	1.0E13	0.0	600.0
$NO_2+M=NO+O+M$	(DENOX)	1.1E16	0.0	66000.0
$O+O+M=O_2+M$	(DENOX)	1.4E18	-1.0	340.0
$N_2O+H=N_2+OH$	(HANSON)	7.59E13	0.0	15100.0
$N_2O+M=N_2+O+M$	(GLARBORG. 86)	1.6E14	0.0	51600.0
$N_2O+O=N_2+O_2$	(GLARBORG. 86)	1.0E14	0.0	28200.0
$N_2O+O=NO+NO$	(GLARBORG. 86)	1.0E14	0.0	28200.0
$CO+OH=CO_2+H$	(W&D)	1.50E7	1.3	-770.0
$CO+HO_2=CO_2+OH$	(W&D)	5.75E13	0.0	22930.0
$CO+O_2=CO_2+O$	(W&D)	2.41E12	0.0	47690.0
$CO+O+M=CO_2+M$	(W&D)	5.88E15	0.0	4100.0
END				

$DeNO_x$ = Lyon, 1987.
W&D = Westbrooke and Dryer. Progress in Energy and Combustion Science, pp. 1-57, 1984.
Hanson = R. Hanson in Combustion Chemist. Springer-Verlag New 1984 pp. 361.
Glarborg = Glarborg et al. Combustion Flame.

calculated. Model results are presented in Figure 4-10, and clearly show the strong temperature dependence of the Thermal DeNO$_x$ SNCR process. If the injected ammonia mixed and reacted with the entire flow field at 950°C (1,742°F), approximately 85 percent of the inlet NO would be reduced to elemental nitrogen. At temperatures above or below that optimum condition, the percent NO reduction decreases significantly.

Various reports describing the effectiveness of Thermal DeNO$_x$ SNCR process on the Commerce facility indicate that only about 45 percent NO$_x$ reduction [confirmed in the proposed NSPS background documents (EPA, August 1989)] is achieved—even for NH$_3$:NO molar ratios as high as 2.3 to 1. This reduced NO$_x$ destruction is a result of strong temperature variations (both spatial and temporal) in the furnace. Figure 4-11 was selected from the open literature to illustrate how temperature varies with location and time in refuse combustors similar to the Commerce facility. Figure 4-11 was taken from the 1987 EPA Municipal Waste Combustion Study, and shows lines of constant temperature (time mean) at two different load conditions for a Steinmueller refuse combustion system. Note that at the full-load condition, there is more than a 200°C (392°F) temperature variation. At this condition, the maximum NO$_x$ reduction would still be about 85 percent, and the minimum reduction could still be as high as 50 percent with an average NO$_x$ reduction of approximately 75 percent. The fact that the Commerce facility has achieved only 45 percent NO$_x$ reduction implies that the temperature variations are even greater than 200°C (392°F). The likely source of that additional temperature variation is the fluctuation of temperature with time.

The level of temperature variation experienced at the Commerce facility can be approximated by examination of the predictions in Figure 4-10. If the ammonia is injected at a location (or locations) such that the time-mean, spatial average temperature is near optimal, the extent of temperature variation that can be estimated would produce 45 percent NO$_x$ reduction.



232ppm NO, 464ppm NH_3, 10% O_2, 10% H_2O
7.5% CO_2, balance N_2,
reaction time = 0.2 sec.

Source: EER Corporation, 1989

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FIGURE 4-10
MODELING OF THERMAL DeNOx FOR THE COMMERCE REFUSE COMBUSTION FACILITY

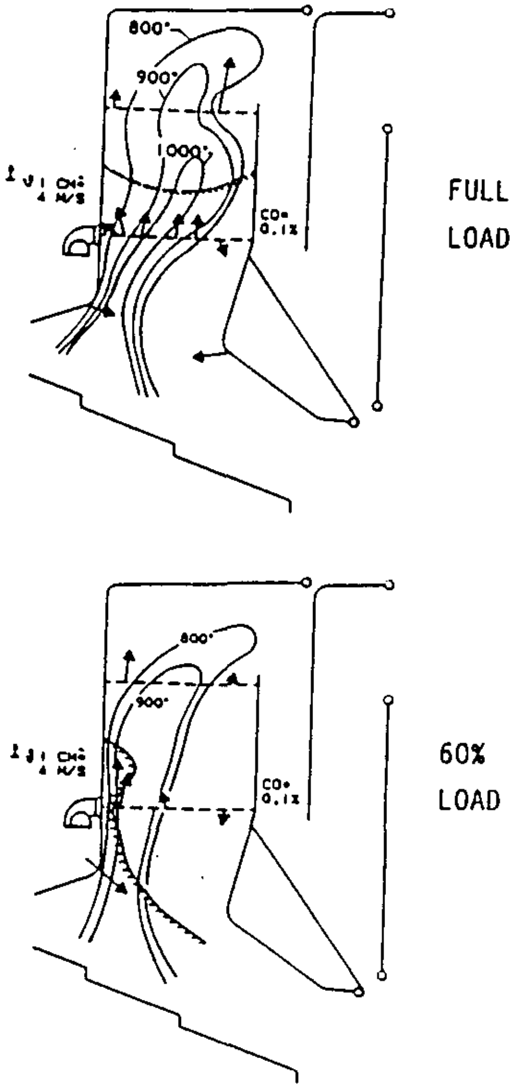
That condition is approximately achieved if the reaction temperature is greater than 800°C (1,472°F) and less than 1,150°C (2,102°F). Based on the temperature measurements in Figure 4-10 and 4-11, that extent of variation appears reasonable.

The major conclusions to be drawn from the above analysis is that the overall extent of NO_x reduction from the application of the Thermal $DeNO_x$ SNCR process is strongly dependent on the variation of temperature in the furnace. At the Commerce facility, temperature variations on the order of 350°C (630°F) are indicated. As will be shown later, similar temperature variations are anticipated for refuse combustion facilities which use the mass-burn rotary waterwall combustion design.

The next step in the analysis is to examine the influence of the inlet NO_x level. For the mass-burn rotary waterwall combustor, it has already been established that NO_x emissions of 150 ppm corrected to 7 percent O_2 will be achieved, as confirmed by Table 4-15 and Figure 4-9. The actual oxygen concentration of the flue gas from a mass-burn rotary waterwall combustor is maintained between 5 and 6 percent due to its low excess air operation. Unlike the mass-burn rotary waterwall combustor, other mass-burn combustors tend to operate at higher flue gas oxygen concentrations. The Thermal $DeNO_x$ model was used to calculate the extent of NO_x reduction under the following set of specified inlet conditions.

$NO_{initial}$ = 167 ppm as measured = 150 ppm @ 7% O_2
O_2 = 5.5%
H_2O = 13%
CO_2 = 8%
N_2 = balance
Temperature = variable from 750°C to 1,150°C (1,382 to 2,102°F)
NH_3 injection = 2:1 molar ratio

Model results are presented in Figure 4-12 comparing fractional NO_x reduction versus temperature for the above initial conditions with the earlier results from the Commerce facility. As shown, the predicted NO_x reduction for the two sets of conditions are nearly equal. This result was



Source: EPA, 1987

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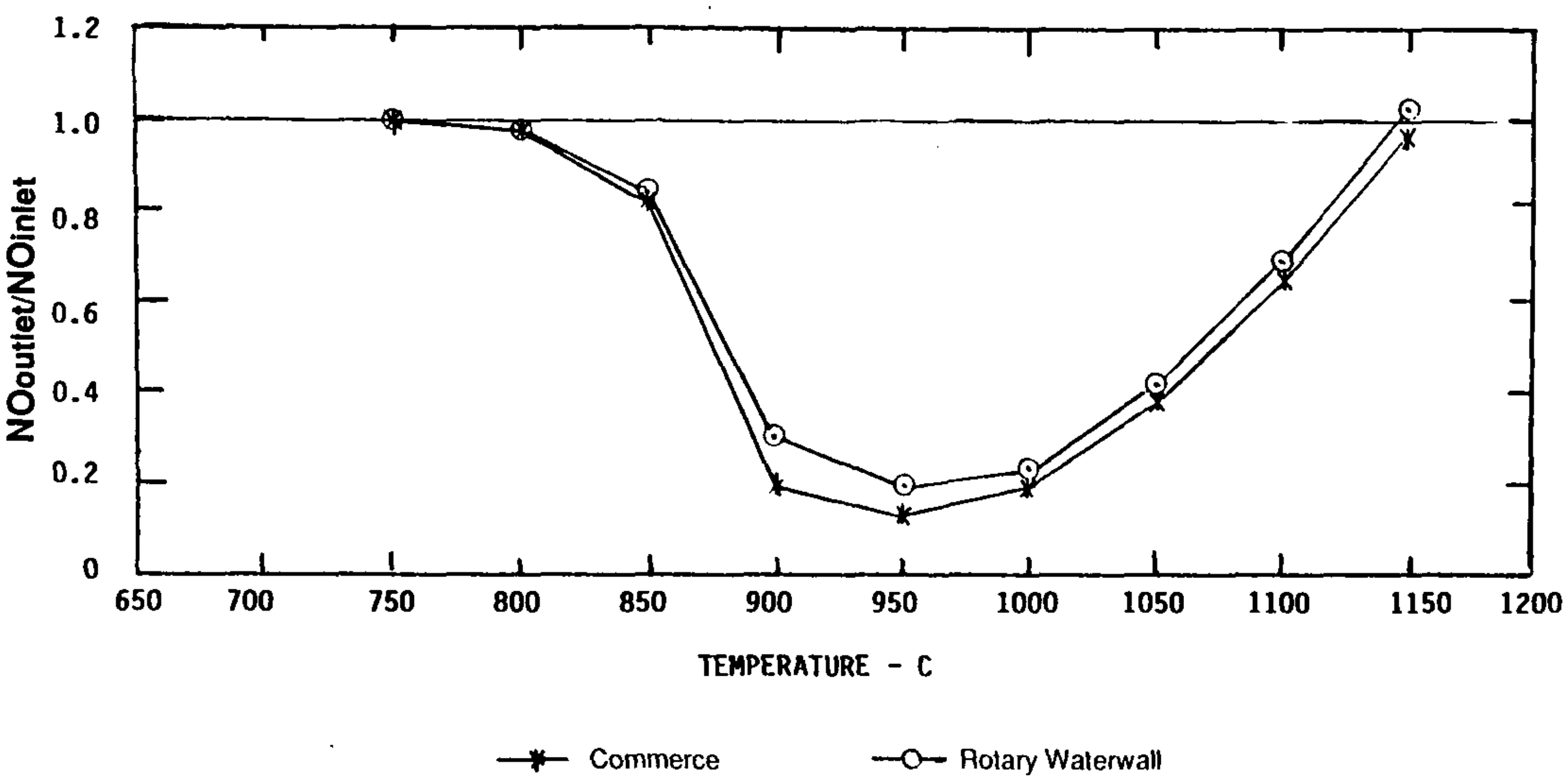
FIGURE 4-11
TEMPERATURE DISTRIBUTIONS IN AN OPERATING MASS-BURN REFUSE COMBUSTOR



O'Connor = 167 ppm NO, 334 ppm NH_3, 5.5% O_2
13% H_2O, 8.0% CO_2, balance N_2,
Reaction Time = 0.2 sec.

Source: EER Corporation, 1989

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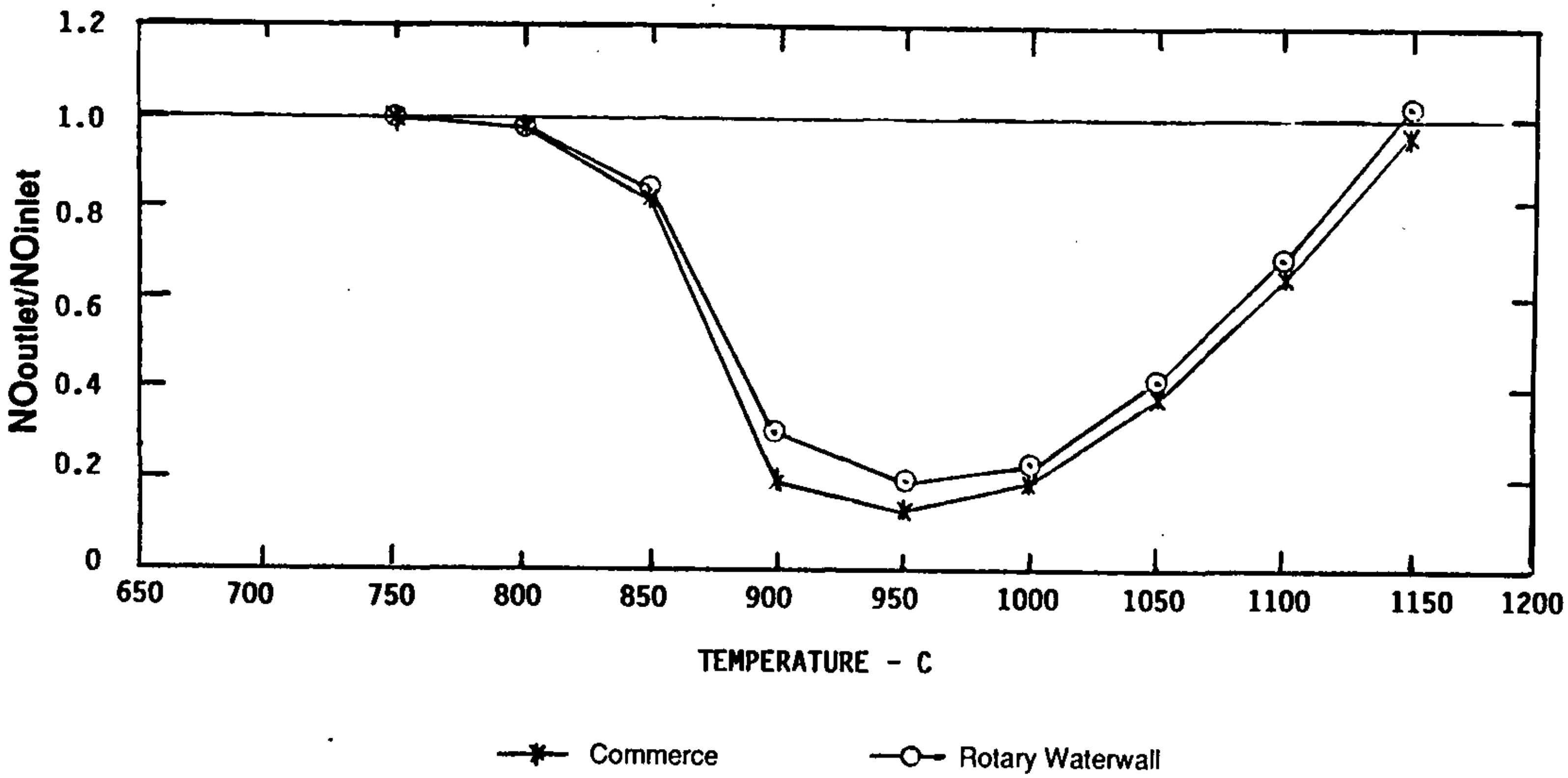
FIGURE 4-12
COMPARISON OF MASSBURN ROTARY WATERWALL COMBUSTOR WITH COMMERCE REFUSE COMBUSTOR



O'Connor = 167 ppm NO, 334 ppm NH_3, 5.5% O_2
13% H_2O, 8.0% CO_2, balance N_2,
Reaction Time = 0.2 sec.

Source: EER Corporation, 1989

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FIGURE 4-12
COMPARISON OF MASSBURN ROTARY WATERWALL COMBUSTOR WITH COMMERCE REFUSE COMBUSTOR

unexpected since the initial NO_x level for a mass-burn rotary waterwall combustor is approximately a factor of two less than the Commerce facility simulation (both NO_x levels expressed at the same excess O_2). The explanation for this result is that the Thermal $DeNO_x$ chemistry is driven by the actual NO concentration in the gas—not the concentration adjusted to a reference oxygen level of 7 percent. In the boiler, 295 ppm @ 7 percent O_2 for the Commerce facility is actually 232 ppm (at 10 percent O_2) while the 150 ppmm @ 7 percent O_2 for the mass-burn rotary waterwall combustor is actually 167 ppm (at 5.5 percent O_2). The conclusion to be drawn from this simulation is that the fractional reduction of NO_x by Thermal $DeNO_x$ should be approximately the same on a mass-burn rotary waterwall combustor as is achieved at the Commerce facility (mass-burn waterwall design) if, and only if:

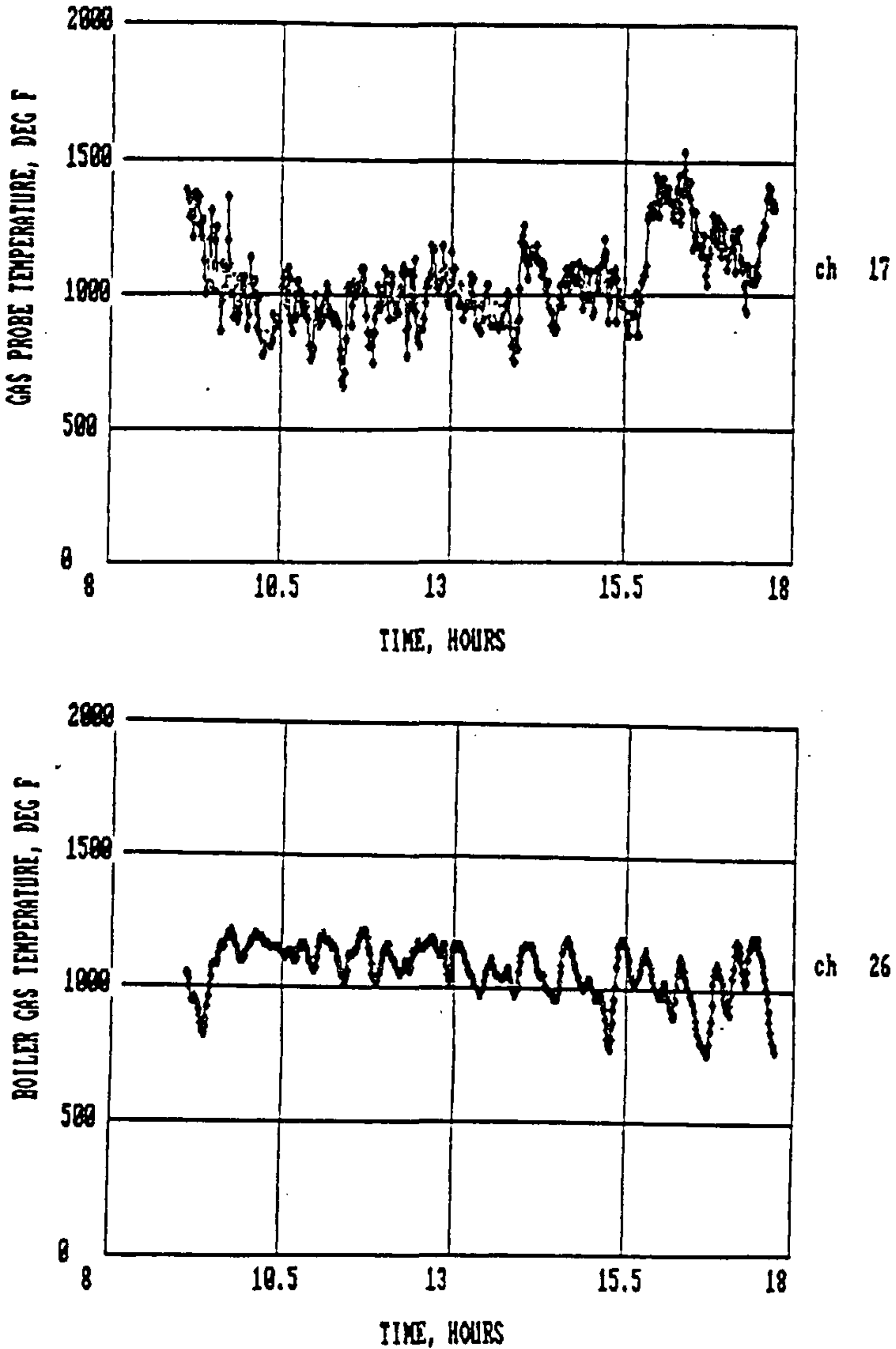
1. The magnitude of the temperature fluctuations are approximately the same for both combustor designs, and

2. The level of CO concentration at the location of the ammonia injection is approximately the same.

These critical issues are discussed and evaluated below.

Actual field test data and design calculations will be used to illustrate the thermal environment and anticipated in-furnace CO levels at the critical temperature region. Figure 4-13 shows the time variation of temperature as measured by two fixed position thermocouples in the boiler gas flow at the Gallatin, Tennessee facility which has a mass-burn rotary waterwall combustor design. As shown, the temperature measured by one of the probes (channel 17) varied by as much as 371 to 427°C (700 to 800°F), while the other probe (channel 26) indicated about 204 to 260°C (400 to 500°F) variation. Clearly the temporal temperature variation at the Gallatin facility is at least as great as that at the Commerce facility and probably larger.

Figure 4-14 provides a sketch of the mass-burn rotary waterwall combustion system in Bay County, Florida, and indicates the location of probing ports



Source: Westinghouse

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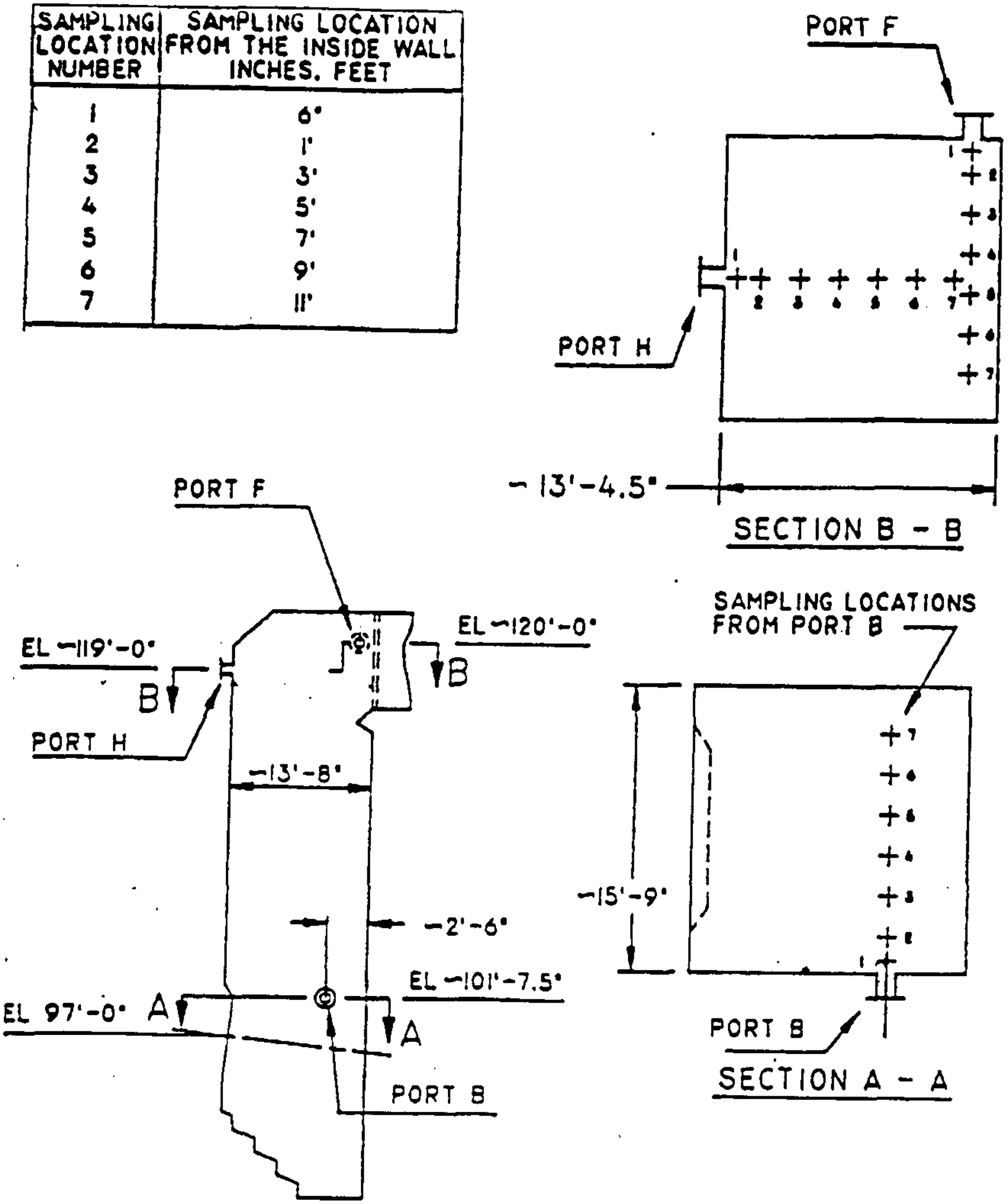
FIGURE 4-13
TEMPERATURE VARIATION DATA AT GALLATIN TENNESSEE REFUSE COMBUSTION FACILITY

SAMPLING LOCATION NUMBER	SAMPLING LOCATION FROM THE INSIDE WALL INCHES, FEET
1	6"
2	1'
3	3'
4	5'
5	7'
6	9'
7	11'



Source: Westinghouse

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FIGURE 4-14
BAY COUNTY, FL, NO. 2 BOILER
SUCTION PYROMETER SAMPLING LOCATIONS

(i.e., Port B, Port F, and Port H) for obtaining experimental results to determine time-mean temperature profiles as well as the concentrations of CO and O_2. As shown in Table 4-17, the temperature profiles are relatively flat at all three ports with spatial and temporal temperature fluctuations being on the order of 260 to 316°C (500 to 600°F) (100°F spatial plus 400 to 500°F temporal) which is generally consistent with that experienced at the Commerce facility.

A critical feature demonstrated in Table 4-17 is that the CO concentration at port B is typically between 1,000 and 2,000 ppm and is over 3,000 ppm on the left wall (sample location No. 7). Subsequent system developments have resulted in a decrease of the overall CO level from the supplier of the mass-burn rotary waterwall combustor, but there will still be a very substantial concentration of CO and large spatial variation in CO concentration in the furnace region where NH_3 would be injected. The presence of this CO is directly related to the staged combustion/low excess air and controlled mixing process in the mass-burn rotary waterwall combustor. Flue gases leave a mass-burn rotary waterwall combustor at a lower temperature than from other mass-burn refuse combustors, and thus cool more rapidly to the temperature appropriate for the SNCR system (Thermal $DeNO_x$). In other mass-burn combustors, CO escaping the primary combustion zone has a greater opportunity of oxidizing to CO_2 before reaching the SNCR reactant injection region than for a mass-burn rotary waterwall combustor. Further, the mass-burn rotary waterwall combustor, with its controlled mixing and less intense combustion zone, utilizes the boiler radiant section, in the absence of the SNCR system, to continue to oxidize the CO to very low levels prior to releasing flue gas to the atmosphere. The SNCR (Thermal $DeNO_x$) process, however, has a well known limitation (R.K. Lyon, Thermal $DeNO_x$: How it works, Hydrocarbon Processing 58.109.1979); while Thermal $DeNO_x$ does not produce CO, its use inhibits the oxidation of CO which is present in the flue gas when the NO_x is reduced with NH_3. This phenomenon occurs because the critical step in CO oxidation, $CO + OH \rightarrow CO_2 + H$, is retarded because NH_3 competes effectively for OH radicals via the reaction $NH_3 + OH \rightarrow NH_2 + H_2O$ (Lyon, 1987).

If a mass-burn combustion system allows CO oxidation prior to NH_3 injection into the boiler, use of the SNCR process will not inhibit CO oxidation and

TABLE 4-17

LEE COUNTY ENERGY RECOVERY FACILITY
BAY COUNTY, FLORIDA REFUSE COMBUSTOR
BOILER GAS TEMPERATURE AND CO/O_2
PROFILE DATA, SET POINT 2D
JANUARY 12, 1988

Sampling Point	Distance from the Boiler Wall (feet)	Port B			Port F			Port H		
		Temp. °F	O_2 %	CO ppm	Temp. °F	O_2 %	CO ppm	Temp. °F	O_2 %	CO ppm
1	0.5	1,560	6.0	1,200	1,300	9.0	150	1,270	7.0	150
2	1.0	1,700	3.5	1,000	1,370	8.7	180	1,250	8.5	240
3	3.0	1,640	6.4	700	1,400	7.5	180	1,220	9.0	300
4	5.0	1,700	5.0	1,350	1,320	8.7	200	1,280	10	300
5	7.0	1,750	6.2	1,950	1,380	7.0	150	1,360	7.0	150
6	9.0	1,750	5.0	>3,000	1,320	6.4	240	1,280	9.0	300
7	11.0	NA	NA	NA	1,280	6.4	300	1,250	9.5	480

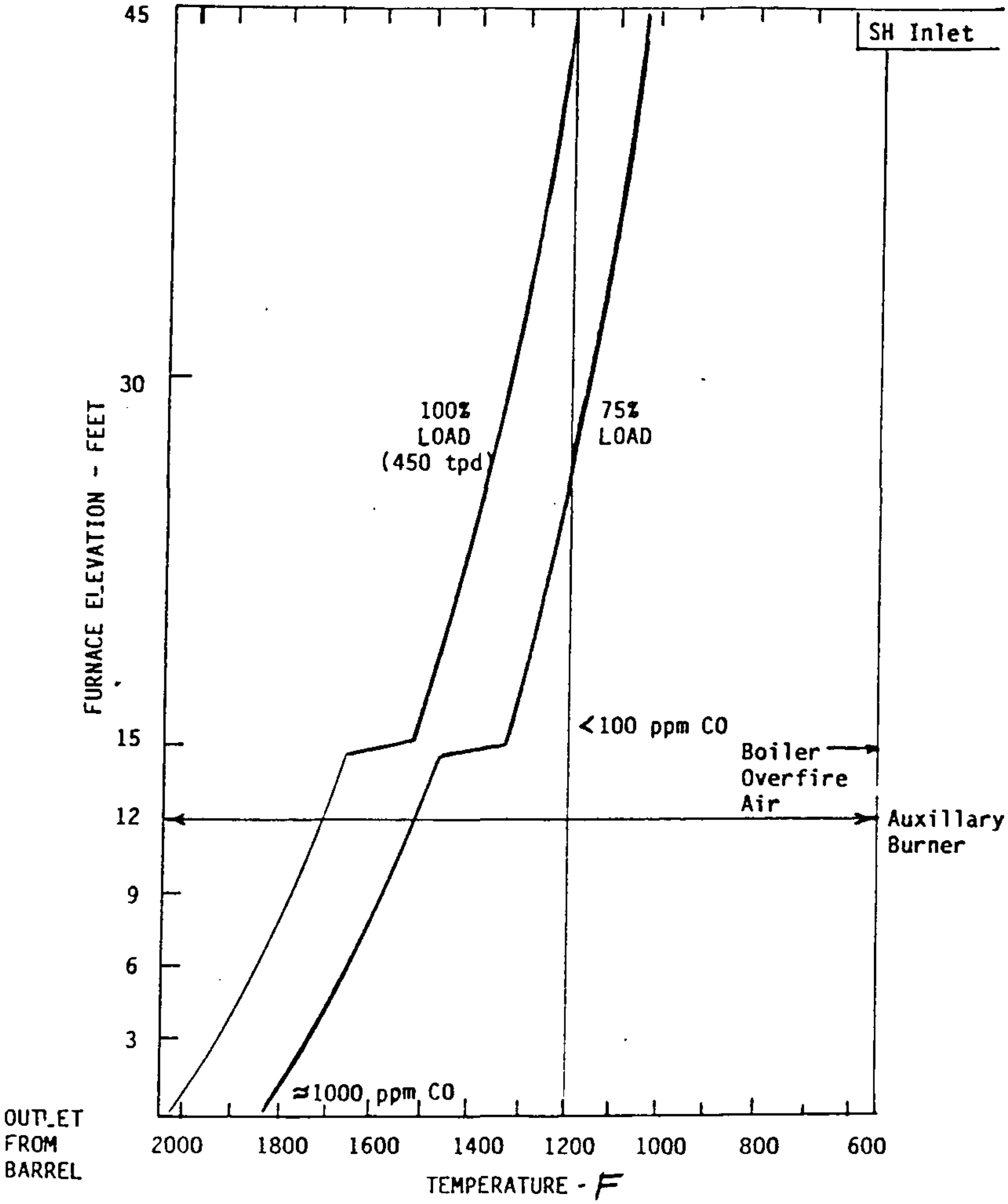
SOURCE: Oakland County Consolidated Permit Application, December 1989.

NA: Not available.

will not cause increased CO emissions. Data from the Commerce facility indicate that CO is allowed to oxidize prior to the SNCR (Thermal $DeNO_x$) process. In a mass-burn rotary waterwall combustor, a larger portion of the radiant boiler section is used to oxidize CO, thus a greater percentage of residual CO oxidation occurs downstream of the location that would be required for NH_3 injection in the SNCR (Thermal $DeNO_x$) process. Use of the SNCR technology in such a situation would inhibit CO oxidation and possibly adversely impact hydrocarbon emissions. In addition to the impact of NH_3 injection on the oxidation of CO emissions, CO has a strong adverse impact on the reaction between NH_3 and NO.

To assess the above concerns, additional model calculations were performed. As indicated in Table 4-17, the general CO level at the combustor exit of the mass-burn rotary waterwall combustor at the Bay County, Florida facility is on the order 1,000 to 2,000 ppm. Figure 4-15 illustrates the calculated mean temperature profile in the radiant furnace zone of the mass-burn rotary waterwall combustor at the York County facility. At the exit of the mass-burn rotary waterwall combustor barrel, and at full load, the temperature is expected to be about 2,000°F and the average CO level is expected to be about 1,000 ppm. CO is expected to continue to oxidize until the gas temperature drops to about 1,200°F. At full load, this temperature limit is reached at the superheater inlet, and the CO is expected to be less than about 100 ppm.

Using the above results, it is estimated that the average CO level will be on the order of 500 ppm in the general region of the SNCR (Thermal $DeNO_x$) application. Substantial spatial and perhaps temporal variation of CO is expected at that general location. The Thermal $DeNO_x$ model calculations presented earlier (Figure 4-12) were repeated, but with the addition of 500 ppm CO to the initial gas composition. Results from the runs with and without CO are presented in Figure 4-16 and clearly illustrates the severe impact on NO_x reduction chemistry. The level of NO_x reduction at the optimal temperature condition is slightly improved with CO present (90 percent reduction versus 85 percent reduction). More importantly, however, the location of the optimum NO_x control has been shifted to a lower temperature and the width of the temperature window is much more narrow.



Source: Westinghouse, 1989

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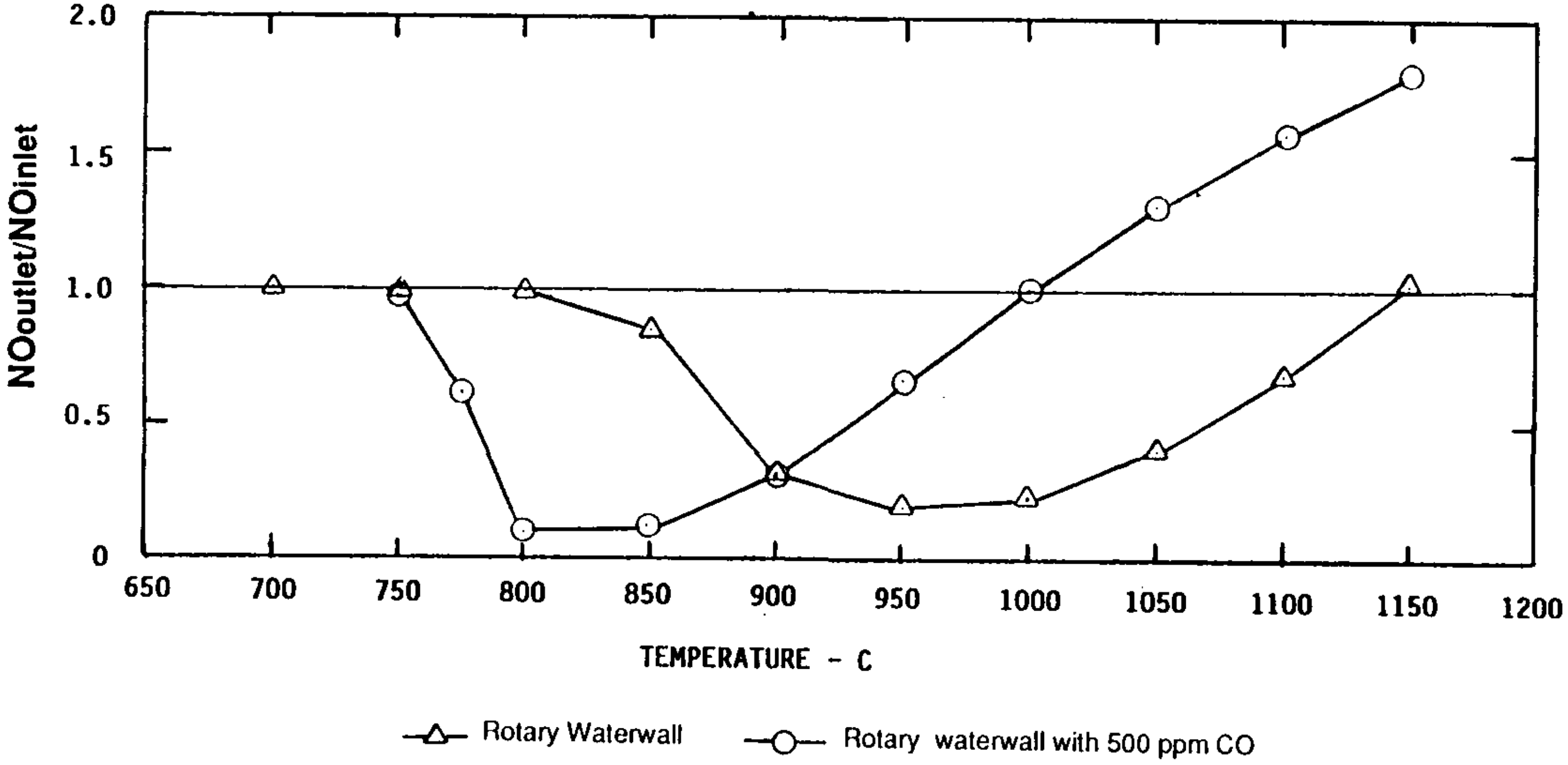
FIGURE 4-15
MEAN TEMPERATURE PROFILE FOR THE YORK COUNTY, PA REFUSE COMBUSTION FACILITY



167 ppm NO, 334 ppm NH_3, 5.5% O_2,
13% H_2O, 8.0% CO_2, balance N_2,
Reaction Time = 0.2 sec.

Source: EER Corporation, 1989

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FIGURE 4-16
EFFECT OF CO ON THE THERMAL DeNOx WHEN USED WITH MASSBURN ROTARY WATERWALL

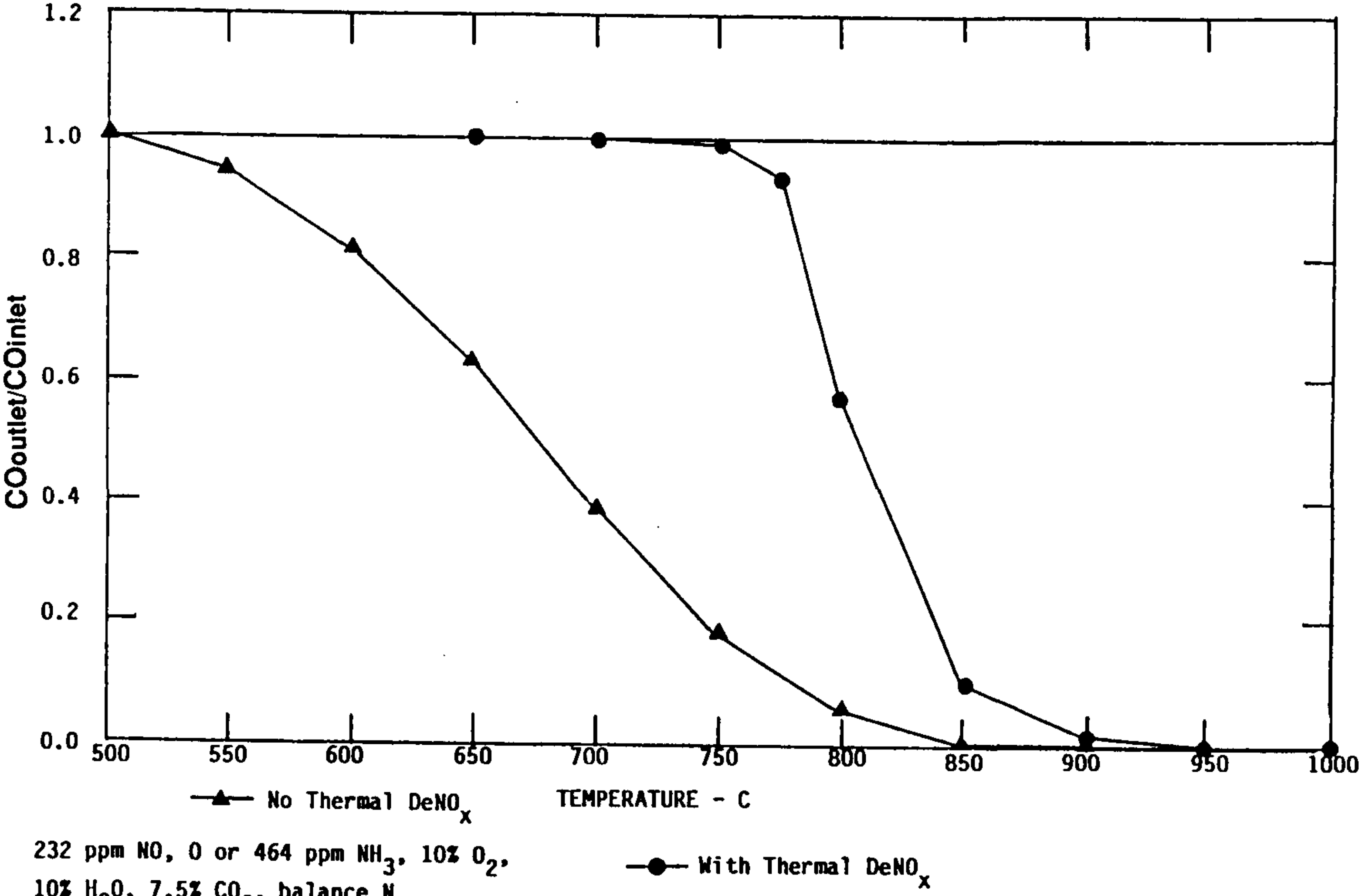
Without CO, NO_x reduction occurs between 800 and 1,150°C (1,472 and 2,102°F). With 500 ppm of CO, the temperature window contracts and becomes 750 to 1,000°C (1,382 to 1,832°F).

Because the temperature window contracts, temperature variations in the flow become even more significant. Extremes in expected temperature variation may result in zero NO_x reduction or even cause additional NO_x to form. The effect of CO concentration variations can be equally detrimental to the SNCR process. For example, at 800 to 850°C (1,472 to 1,562°F), if the CO concentration were to fluctuate from a few ppm to about 500 ppm, the expected level of NO_x reduction could drop from 90 percent control to zero control (see Figure 4-16).

The above calculations illustrate that the combined effects of high and varying CO concentrations in the critical SNCR injection region are extremely detrimental to the effectiveness of the NO_x control process. Sufficient data is not available to estimate the exact level of NO_x control that would be achieved by applying the SNCR process to the mass-burn rotary waterwall combustion system. Clearly, the level of control would be substantially less than is achieved at the Commerce facility.

Compounding the above situation is the fact that the SNCR process will also inhibit the oxidation of CO emissions, thus causing their emissions to increase. To put this statement on a more quantitative basis, calculations were performed to demonstrate the oxidation of 500 ppm of CO in 0.2 seconds at various temperatures in the presence and absence of NO_x reduction via the SNCR Thermal $DeNO_x$ process. As shown in Figure 4-17, the SNCR Thermal $DeNO_x$ process can significantly decrease the percent of CO oxidized to CO_2 in the 850 to 750°C (1,560 to 1,380°F) temperature range in the mass-burn rotary waterwall combustion system. A major portion of the CO is converted to CO_2 in this temperature window.

A possible method of controlling the CO emissions would be to inject hydrogen into the lower part of the boiler radiant section. The injection of hydrogen into the boiler could possibly shift the Thermal $DeNO_x$ temperature operating window. By shifting the operating window, CO may oxidize to CO_2 before



232 ppm NO, 0 or 464 ppm NH_3, 10% O_2,
10% H_2O, 7.5% CO_2, balance N_2,
Reaction Time = 0.2 sec.

Source: EER Corporation, 1989

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FIGURE 4-17
CO OXIDATION WITH AND WITHOUT THERMAL DeNOx OPERATION

reaching the NH_3 injection region, and NO_x removal could possibly increase. However, the hydrogen injection system is not a demonstrated or proven technology and has very limited operating data. Thus, hydrogen injection was not considered further.

Summarizing, based on the above analysis and the serious problems identified, the application and operation of the SNCR Thermal $DeNO_x$ process with the mass-burn rotary waterwall combustor cannot be regarded as a proven technology. The extent of NO_x control will be substantially less than achieved on other mass-burn combustor technologies. Further, the impact of applying the SNCR process is expected to inhibit CO oxidation, thus substantially increasing CO emissions in the exit stack gases. The technology would provide only minimal NO_x control while preventing CO oxidation.

4.6.5 BACT DETERMINATION FOR NO_x

The analysis presented on the different NO_x control techniques and technologies indicates that SCR has the potential of achieving LAER, however, its application on MWCs has significant operating and economic disadvantages. As stated in this analysis and reiterated in the proposed NSPS, the performance of SCR technology on MWCs, as opposed to oil or gas fired combustors, is detrementally effected by catalyst "poisoning." The flue gases from MWCs contain acid gases, metals, and high particulate loadings which poison the expensive catalyst causing it to be less effective and to require frequent replacement. SCR technology is not considered BACT.

As concluded by EPA in the proposed NSPS (see Federal Register, December 20, 1989, pp 52254), SNCR or achievement of NO_x emission levels comparable to the use of SNCR represents best demonstrated technology for reducing NO_x emissions. The evaluation of the different NO_x control techniques and technologies presented herein concurs with the NSPS conclusion. The County has decided that for a mass-burn stoker waterwall design, the best demonstrated technology, SNCR, would be installed at the LAER emission control level of 45 percent. If the Facility design is a mass-burn rotary waterwall, then the combustor's inherent staged combustion/low excess air mode of operation will achieve NO_x emission levels comparable to the use of SNCR. In addition, SNCR has been determined to be an inappropriate application for a mass-burn rotary waterwall combustor. Therefore, staged combustion/low excess air is determined to be the best demonstrated technology for NO_x emissions for the mass-burn rotary waterwall design.

On May 18, 1990, a PSD permit was issued by the North Carolina Department of Environment, Health and Natural Resources, for the Gaston, North Carolina MWC facility which will use the mass-burn rotary waterwall combustor design. With the concurrence of EPA Region IV, the Gaston facility's PSD permit concludes that BACT for NOx control at the facility is the mass-burn rotary waterwall combustor without the use of SNCR technology. The Gaston, North Carolina permit fixed a NO_x emission limit of 150 ppmdv @ 7 percent O_2 over a 24 hour average.

In accordance with the "top down" BACT methodology established by an EPA draft memorandum in December 1987 and May 1989, since the proposed Facility shall implement "top" determined NO_x control techniques and no outstanding issues regarding collateral environmental impacts exist, no further analysis is required. As stated, these NO_x control techniques, as they apply to the specified combustor design, are determined to be BACT.

The Facility's NO_x emissions, independent of the combustor technology, will be below the applicable NAAQS/FAAQS requirements, and will be required to meet applicable final promulgated NSPS requirements for MWCs. The Facility's NO_x emissions will be monitored through the use of properly located and installed CEMs.

4.6.6 BACT DETERMINATION FOR CARBON MONOXIDE (CO)

Proposed Control Technology

As discussed in Section 4.1 under Pollutant Applicability, the Facility will have either a mass-burn stoker waterwall design consisting of four units each of 600 tpd, or a mass-burn rotary waterwall design consisting of four units each of 450 tpd and one unit rated at 600 tpd. Both combustor design strategies shall provide the same total throughput capacity of 2,400 tpd.

Both combustors would be designed to minimize CO emissions; however, technology and operating mode differences contribute to different maximum emissions for each technology. These differences are accounted for in the proposed NSPS which specify different CO limitations for various combustor designs. In agreement with the proposed NSPS, the BACT emission rate for a mass-burn rotary waterwall design is 150 ppmdv while that for a mass-burn stoker waterwall design is 100 ppmdv. both emission rates are corrected to 7 percent O_2 and based on a four-hour block average as measured by CEMs. Table 4-1 lists both of these CO emission concentrations and their respective tpy emission rates.

The Facility's chosen combustor design shall have a combustion air control system which provides the necessary oxygen and turbulence to allow the combustible gases to mix thoroughly with oxygen and prevent stratification of the unburned gases. In addition to combustion air control, furnace temperatures will be maintained at a minimum of 1,800°F to provide for optimum burn-out of combustion gases.

The Facility shall be equipped with properly located thermocouples and CEMs for CO and O_2 to monitor and record the combustion conditions for optimizing combustion efficiency and ultimately controlling CO.

Compliance with Applicable Emission Standards

The Facility's CO emissions, regardless of which combustor technology is selected, will be below the applicable NAAQS/FAAQS requirements and shall meet the recently proposed NSPS requirements for MWCs. The proposed standards establish different CO limitations for different combustor designs requiring a mass-burn stoker waterwall combustor to meet a 100 ppmdv concentration and a mass-burn rotary waterwall combustor to meet a 150 ppmdv concentration. The CO emission limitations presented in the proposed NSPS are corrected to 7 percent O_2 and based on a four-hour block average as measured by CEMs.

Rationale for Proposed BACT Determination

Carbon monoxide (CO) is formed by incomplete oxidation of carbon compounds during combustion. The source of carbon compounds during combustion are the refuse, pyrolysis products formed near the fuel bed, or intermediate combustion products. The emission of relatively high concentrations of CO is largely dependent on the underfire air dispersion to the combustor, the underfire/overfire air ratio, the design of the overfire air jets, and furnace combustion temperature. Careful operation of the furnace is essential to maintain good combustion conditions. Thus, furnace operators will be fully trained to avoid potential combustion problems. A low CO concentration is a good indication that the furnace is achieving a high combustion efficiency, while a high CO concentration may indicate poor combustion and a potential increase in the level of trace organic emissions.

Specific add-on technologies for controlling CO in the flue gas have not been incorporated into any present-day refuse combustion designs. CO emissions are controlled in modern refuse combustion facilities using commonly employed combustion control measures (i.e., control of the combustion air to obtain a furnace temperature high enough to achieve a good burn-out of volatilized hydrocarbons, optimal placement of the overfire air grates jets, the use of high-pressure air to promote good mixing, and turbulence of unburned furnace gases with overfire air). Using these control measures, while continuously monitoring CO and O_2 to ensure good combustion, provides adequate control of CO, and no additional controls are normally employed. In addition, oxidation of CO to CO_2 increases the heat released by combustion; thus allowing CO to exit the combustion system is a loss of energy. Economically, a modest incentive exists to maintain CO at a minimum.

BACT Determination

Since no add-on CO control technologies have been incorporated into present-day refuse combustion facilities, the current combustors' designs and combustion control techniques are determined to be BACT for CO emissions. The proposed BACT tpy CO emission rates, respective of combustor design (i.e., mass-burn stoker waterwall or mass-burn rotary waterwall) are listed in Table 4-1. These emission rates are in agreement with the recently proposed NSPS limitations.

4.6.7 BACT DETERMINATION FOR VOLATILE ORGANIC COMPOUNDS (VOCs)

Proposed Control Technology

The mass-burn technology proposed for the Facility shall be designed to minimize emissions of VOCs. For either combustor technology design being considered, the combustor's combustion air control system will provide the necessary oxygen and turbulence to allow the combustible gases to mix thoroughly with oxygen and prevent stratification of the unburned gases. In addition to combustion air control, the furnace will be designed to maintain the combustion temperature at a minimum of 1,800°F to provide for optimum burn-out of organic compounds in the combustion gases.

The Facility shall be equipped with properly located and mounted thermocouples and CEMs to monitor and record the combustion conditions for optimum combustion efficiency and ultimately VOC control.

4.6.8 COMPLIANCE WITH APPLICABLE EMISSION STANDARDS

The Facility's combustor design and operation, regardless of which combustor technology is selected, is proposed as BACT. Because the area in which the Facility is to be located is in attainment of the ambient air quality standards for ozone, an emission limitation more stringent than BACT is not warranted.

Rationale for Proposed BACT Determination

Like carbon monoxide, VOCs are the products of incomplete combustion and consist of a wide variety of organic compounds. The furnace combustor and combustion air control systems of modern refuse combustion facilities are designed to maintain elevated oxygen levels, and therefore provide for a near complete burn-out of combustible organic compounds, thus limiting the formation of VOCs. As discussed in the BACT determination for CO, VOCs will be controlled by ensuring that adequate excess air and furnace temperature are maintained, and overfire air jets are properly located to produce adequate mixing of overfire air (O_2) with VOCs.

BACT Determination

Based on the design and past operation of both possible mass-burn combustor technologies, the Facility will emit a maximum (100 percent availability) of 175 tpy of VOCs (mass-burn rotary waterwall) or 92 tpy (mass-burn stoker waterwall). The proposed tpy emission rates are dependent on combustor design and are conservatively based on maximum hourly average concentrations of 71.7 ppmdv (mass-burn rotary waterwall) or 37.3 ppmdv (mass-burn stoker waterwall) of non-methane hydrocarbons (NMHC) expressed as CH_4 corrected to 7 percent O_2.

Since no add-on control system to reduce VOC emissions is currently available or has been incorporated in a refuse combustion facility, it is proposed that good furnace design and combustion control be employed at the Facility for the control of VOCs.

4.7 BACT REVIEW FOR TRACE ORGANIC COMPOUNDS

There are a number of organic compounds which have been measured in the flue gas from refuse combustion facilities as a result of incomplete or inefficient combustion of carbon compounds. Compounds measured include dioxins, furans, and polynuclear aromatic hydrocarbons (PAHs). These compounds may exit from the stack either in the vapor phase or condensed and/or adsorbed onto particulate matter. Although dioxins and furans comprise only a small portion of the many types of organics emitted from refuse combustion facilities, environmental concern is currently focused on these compounds.

Dioxin and furan are used as generic terms for two groups of closely related chemical compounds called polychlorinated dibenzo-p-dioxins (PCDD or dioxin) and polychlorinated dibenzofurans (PCDF or furan).

Structurally, they are similar with each composed of two benzene rings, joined by either two oxygen atoms (PCDD) or one oxygen atom (PCDF). Their release into the environment is of particular concern because of the potentially high toxicity of certain isomers. Tests data indicates that of the 75 PCDD and 135 PCDF isomers, 45 and 71, respectively, have been detected in refuse combustion emissions. The chemical, physical, and toxicological properties of each isomer vary according to their chemical structure. In general, the most toxic isomers are those with four chlorine atoms located at the lateral positions in the molecule. Consequently, attention and research have focused on 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD).

PAHs are a class of pollutants emitted as products of incomplete combustion, and are characterized by multiple-fused benzene rings. These pollutants include both non-carcinogenic compounds, such as naphthalene, and carcinogenic compounds, such as benzo-a-pyrene. Data on PAH emissions from mass-burn waterwall combustion facilities are limited. However, data from other types of combustion facilities suggests more than 90 percent of the total PAHs emitted are low toxicity compounds such as napthalene. Thus, the remainder of this discussion will focus on PCDD and PCDF emissions.

Numerous quantitative emission tests have been conducted for PCDD and PCDF from refuse combustion since 1977 when Olie reported their occurrence in the fly ash of three refuse combustion facilities in the Netherlands. Tests on refuse combustion facilities have been conducted mainly in the United States, Canada, Italy, France, West Germany, Sweden, and Japan, with results showing considerable emission variations. These variations have been attributed to a variety of factors including sampling protocol, analytical techniques, furnace design, and control technology design. Differences in furnace operation, control technology performance, and waste composition are also considered to have contributed to variations in PCDD/PCDF emissions. The exact affects of these design and operating parameters on PCDD/PCDF emissions have yet to be determined.

In an attempt to quantify the affects of design and operating parameters on PCDD/PCDF emissions, many studies have been performed to explain the mechanisms involved in the formation of PCDDs and PCDFs from combustion sources. Currently, four theories have been detailed in the literature explaining the mechanism for PCDD/PCDF emissions. The first theory suggests that PCDD and PCDF enter the refuse combustion process as trace components of the waste stream. This mechanism would require any dioxins entering the processing system to pass through the combustor unchanged. Because the flame temperatures found in refuse combustion facilities are capable of destroying 99 percent or more of PCDD/PCDF, this scenario is considered unlikely. Thus, the primary source of PCDD/PCDF emissions from refuse combustion facilities is most likely not the waste stream, rather, it is believed the compounds are formed during the combustion process. (Daly, 1985).

The second theory hypothesizes the production of PCDDs and PCDFs from precursors with similar structures such as PCBs and chlorophenols which undergo a modest chemical change during combustion. Although this theory is supported by laboratory studies, no evidence exists to support this for full-scale combustion facilities (Daly, 1985).

A third theory proposes that dioxins and furans are formed via "de novo" synthesis when a variety of unrelated organic materials become chlorinated during the combustion process. Synthesis from materials which are closely related to PCDD and PCDF, such as PAHs, would have simple reaction mechanisms. However, a full spectrum of plausible combustion intermediate chemistry could be proposed which would eventually lead to the synthesis of PCDD and PCDF.

The fourth and most recent theory explaining the formation of PCDD/PCDF was first suggested by Eiceman in 1982 and was supported by Vogg, Metsger, and Stieglitz in 1986. The theory presumes that dioxin and furan synthesis occurs between chemical precursors and chlorine donors on the fly ash surface rather than in the gaseous phase as suggested by the "de novo" theory. PCDD/PCDF precursors are believed to adsorb onto elemental carbon in the fly ash. Oxidation of the elemental carbon may then serve as a basis for the mechanism of PCDD/PCDF formation which is believed to be catalyzed by $CuCl_2$ found in the fly ash matrix. Because these reactions are expected to occur in the cooler downstream temperatures, this theory has been used to explain elevated PCDD/PCDF concentrations at the stack outlet of facilities such as the Pinellas County, Florida municipal waste combustor. Emission tests performed in 1987 measured an average uncontrolled PCDD/PCDF concentration of 69 ng/dscm and an average stack concentration of 132 ng/dscm (EER, 1988). The average ESP inlet temperatures for the Pinellas facility ranged from 523°F to 553°F. The Vogg studies indicate PCDD/PCDF formation at temperatures between 428°F and 752°F with a peak at 572°F.

In summary, theories on the mechanism of PCDD/PCDF formation include escape of PCDD/PCDF from the refuse during combustion, synthesis from structurally related precursors in the gas phase, and low temperature catalytic formation from precursors in the fly ash matrix. Thus, control of dioxin and furan emissions should focus not only on the maximum destruction of PCDD/PCDF in the furnace, but also on the destruction of their precursors, including PCBs, PAHs, and Chlorophenals.

Currently, the most effective means of PCDD/PCDF emission control is the optimization of combustion conditions to minimize formation and to maximize destruction of PCDD/PCDF and their precursors. Well operated modern facilities have achieved PCDD/PCDF emissions levels which approach or are below the detection limit. Recent studies on facilities such as Hamilton, Ontario; Issy, France; and Pittsfield, Massachusetts have produced a data base from which correlations between combustion parameters and PCDD/PCDF emissions are being developed. In two studies prepared for EPA (May 1987 and August 1988), Seeker, Lanier, and Kilgroe analyzed the existing emission data base, and interviewed the major furnace designers in the United States and Europe. They then combined this information with trace organic formation and destruction theory to define combustion control strategies for PCDD/PCDF and other trace organics. The initial strategy which has been developed addresses three elements of combustion practice: design, operation, and verification.

The strategy for optimization of refuse combustor design requires consideration of combustion temperatures, air flow, and mixing. In their good combustion practices, EPA recommends a mean temperature of 1,800°F and a minimum temperature of 1,650°F at the fully mixed height of the furnace (May 1987). These temperatures were selected not only to ensure destruction of PCDD/PCDF, but also to ensure destruction of organic precursors which can undergo chlorination downstream of the combustor. An additional temperature recommendation of less than 450°F at the economizer exit was added in the most recent EPA document (September 1988). This economizer exit temperature is intended to minimize PCDD/PCDF formation via the low temperature catalytic mechanism. In addition to the two temperature requirements, EPA has made recommendations for the design of underfire and overfire air streams to ensure an even distribution of oxygen in the refuse stream and optimal mixing of combustion gases.

Verification recommendations are used to alert operators to possible operation and control problems. Parameters which should be continuously monitored include flue gas oxygen and carbon monoxide levels, as well as furnace and economizer exit temperatures. In 1987, EPA issued an operational guidance document for new refuse combustors which was intended to serve as an interim tool to be used in BACT determinations. This guidance specifies that combustion controls are a necessary part of BACT for new refuse combustors.

It has been suggested that a dry scrubber and a highly efficient particulate control device may be used to remove the small concentrations of PCDD/PCDF which form in spite of efficient combustion controls. Studies show condensed PCDD/PCDF and other trace organics bind to the high surface areas of fine particulates in the flue gas. Thus, PCDD/PCDF emissions should be reduced by maximizing particulate control. Use of a dry scrubber results in the reduced flue gas temperatures required for condensation of toxic organics onto the fly ash. A high efficiency ESP or fabric filter will then remove any PCDD/PCDF with the collected particulate matter.

Data on full scale tests have shown the effectiveness of a high efficiency baghouse with a dry scrubber (Martin, 1986) in removing PCDD and PCDF from the flue gas. A recent study performed by Environment Canada at the Quebec

City refuse combustion facility showed high pollutant capture using a dry scrubber/fabric filter system. The Quebec City slipstream test data indicate that the removal of PCDD and PCDF approached 100 percent for a fabric filter inlet gas temperature of 284°F (140°C). The overall removal efficiencies for other trace organics (chlorobenzenes, chlorophenols, PCBs, and PAHs) were 99 percent or more at 284°F (140°C). Table 4-18 shows similar dioxin removal efficiencies at the Marion County, Stockholm-Hogdalen, and Malmo facilities.

In addition to removing particulates on which PCDD/PCDF have formed, use of a high efficiency particulate control device will also aid in the control of dioxin and furan emissions by removing particles on which precursors have bound and other particulate matter, thus preventing the possibility of PCDD/PCDF formation reactions taking place downstream of the filter fabric. The dry scrubber/baghouse control scheme proposed for the Facility will be used in conjunction with combustion control techniques to minimize the quantity of PCDD/PCDF which is transferred to the ash.

A final PCDD/PCDF control strategy which has been suggested is the source separation of chlorinated plastic products from the waste stream. This strategy assumes that a reduction of HCl levels in the flue gas will reduce the chlorination of PCDD/PCDF precursors. Studies have been performed which specifically examine the effect of chlorinated plastics on PCDD/PCDF emissions. A study done by Karasek in Paris found no increase in fly ash levels of PCDDs when three times the normal level of PVC was fed to a well operated refuse combustor (Steisel et al., 1985). Results of a similar test on the Pittsfield, Massachusetts facility also found no correlation between quantities of PVC fed with the refuse and PCDD/PCDF formation. The studies conclude that in well designed facilities, operated under optimal combustion conditions, the quantity of chlorine in the refuse is far in excess of the quantity of chlorine required to produce the very small concentrations of PCDD/PCDF which are emitted. Thus, although removal of all plastics would amount to a 50 percent reduction in the chlorine fed, the quantity of chlorine remaining would still be far greater than the concentrations of PCDD/PCDF formed (Visalli, 1987).

At this time, material separation of chlorinated plastics as a method of PCDD/PCDF control has been neither scientifically validated nor

TABLE 4-18

LEE COUNTY ENERGY RECOVERY FACILITY DIOXIN REDUCTION ACROSS THE DRY SCRUBBER/FABRIC FILTER SYSTEMS AT THE MARION COUNTY, STOCKHOLM-HOGDALEN AND MALMO FACILITIES*

Facility	Inlet Concentration	Outlet Concentration	Removal Efficiency (percentage)
	[ng TCDD-equiv. (Eadon et al)/Nmε@12%CO$_R$]		
Marion County Boiler #1 (one test) Sept. 1986	3.21	0.123	96.2
Stockholm-Hogdalen Boiler #3 (one test) August 1986	4.98	0.116	97.7
Stockholm-Hogdalen Boiler #3 (two tests) March 1986	2.20 2.60	0.179 $<$ 0.427	91.9 $>$ 83.6
Malmo Boiler #1 (one test) Spring 1986	$\geq$ 3.60	$<$ 0.094	$\geq$ 97.4
Malmo Boiler #2 (one test) Spring 1986	$\geq$ 10.80	$<$ 0.094	$\geq$ 99.1

*Preliminary data from the U.S. EPA and Radian Corporation.

Hahn, Jeffrey L. et.al. "Recent Air Emission Test Data From Several Waste-To-Energy Facilities Utilizing Martin GMBH Stoker Combustion Systems and Advanced Air Pollution Control Equipment." APCA 80th Annual Meeting, 1988.

demonstrated on a refuse combustion facility in the United States. For this reason, material separation will not be considered further in this analysis.

The emissions of PCDD, PCDF, and other trace organics will be controlled by proper design and operation of the furnace and combustion control system. The furnaces at the Facility will be designed to maintain the combustion gases at or above 1,800°F (982°C). Overfire air will be added in the quantities, locations, and velocities sufficient to cause turbulent mixing of the combustion gases. Finally, flue gas constituents, such as CO, O_2, and CO_2, as well as the combustion temperature will be continuously monitored to maximize the combustion efficiency of the furnaces. If PCDD/PCDF emissions are not destroyed in the furnace, they will be further controlled by lowering the flue gas temperature with a dry scrubber, allowing the dioxins and furans to condense and/or adsorb onto particulate and then capturing the particulate with a highly efficient particulate control device (fabric filter). Regardless of which combustor design is selected, a proposed BACT emission rate of 2 ng/NM^3 corrected to 7 percent O_2 for toxic equivalent dioxin (PCDD/PCDF expressed as 2,3,7,8 TCDD-EPA 1987 equivalent) has been determined. The emission of PCDD and PCDF from the Facility will be required to meet applicable final promulgated NSPS requirements for MWCs.

In summary, BACT for PCDD, PCDF, and other trace organics shall be the optimization of combustion conditions by proper design and operation of the furnace. In addition to combustion controls, a dry scrubber and a highly efficient fabric filter will be installed. The fabric filter will be designed to meet the outlet grain loading requirement of 0.010 gr/dscf corrected to 7 percent O_2. It has been estimated that 6.9×10^{-6} tpy of toxic equivalent dioxin PCDD/PCDF will be emitted from the Facility.

4.8 SUMMARY OF BACT DETERMINATIONS

Following EPA's current policy, the preceding "top down" BACT analysis was completed for site certification of a 2,400-tpd Energy Recovery Facility in Lee County, Florida. The BACT analysis takes into account two possible combustor designs for the Facility (i.e., mass-burn stoker waterwall design and mass-burn rotary waterwall design). Because the emissions of NO_x, CO, and VOCs are influenced by combustor design and operation, the BACT analysis had to account for any emission differences from both combustor designs as well as applicable pollution control technologies for the combustor designs.

A dry scrubber was determined to be BACT (as supported by the proposed NSPS "best demonstrated technology") following the "top down" methodology for acid gases. The BACT control level for SO_2 was determined to be 80 percent removal by weight or 30 ppmdv corrected to 7 percent O_2 (whichever is less stringent), both over a 24-hour average. The BACT control level for HCl was determined to be 95 percent removal by weight or 25 ppmdv corrected to 7 percent O_2 (whichever is less stringent), both over an 8-hour average. Additional references to these pollutants and other acid gases are found in Section 4.3.

Using the same methodology, the analysis concluded for PM that either an ESP or a fabric filter was BACT; however, the County has decided to use a fabric filter at the outlet grain loading of 0.010 gr/dscf corrected to 7 percent O_2, which is considered equivalent to a LAER particulate contorl level. The fabric filter is considered by the EPA in the proposed NSPS to be the "best demonstrated technology."

The application of a dry scrubber in conjunction with a fabric filter was determined to be BACT for metals, in particular, Hg, Be, and Pb.

Numerous NO_x control technologies were identified in the analysis involving both flue gas add-on controls and combustion modification controls. For the mass-burn stoker waterwall combustor design, SNCR was determined to be BACT at a 45 percent control level. For the mass-burn rotary waterwall design, the combustor itself which incorporates the use of staged combustion/low excess air was determined to be BACT. Both technologies represent "best demonstrated technology" for reducing NO_x emissions.

BACT for VOCs, CO, and organics was determined to be proper furnace design and operation, and combustion control techniques.

A comparison and summary of the BACT determined control technologies and emission rates to the PSD significant emission values is presented in Table 4-1. Supporting emission data and calculations are also presented in the Emissions Factor Support Document (Attachment A).

SECTION 5.0

EXISTING AMBIENT AIR QUALITY AND METEOROLOGY

5.0 EXISTING AMBIENT AIR QUALITY AND METEOROLOGY

5.1 NATIONAL AND FLORIDA AMBIENT AIR QUALITY STANDARDS

The U.S. Environmental Protection Agency (EPA) has established ambient standards for certain criteria pollutants as mandated by the Clean Air Amendments of 1970 (P.L. 91-604). These standards, known as the National Ambient Air Quality Standards (NAAQS), are set at two levels. Primary standards define levels that are necessary to protect the public health. Secondary standards define levels that are intended to protect the public welfare. The pollutants regulated under NAAQS are sulfur dioxide (SO_2), particulate matter (as particles with an equivalent aerodynamic diameter of less than 10 microns, PM_{10}), carbon monoxide (CO), ozone (O_3), nitrogen dioxide (NO_2), and lead (Pb).

On July 1, 1987, EPA promulgated final rules that replaced the TSP ambient air quality standards with standards for PM_{10} as an indicator of potential impacts to the public health and welfare from particulate matter (52 FR 24634). The PM_{10} ambient air quality standards were promulgated because they represent a direct measure of inhalable particulate matter and relate more closely than TSP to potential impacts on human health. A reference method for sampling ambient concentrations of PM_{10} was established and included in the regulations as Appendix J. EPA also promulgated Appendix K which describes the rule for applying the statistically-based PM_{10} standard. The new particulate standard became effective on July 31, 1987. On October 5, 1989, EPA proposed new Prevention of Significant Deterioration (PSD) PM_{10} increments that would replace the existing TSP increments; however, the implementation date for this change has not been established and the current TSP increments are still in effect. (A more detailed discussion of PSD increments for particulate matter is presented in Section 6.8.)

The Florida Ambient Air Quality Standards (FAAQS) are a single set of standards that incorporate both the federal primary and secondary standards. The FAAQS for SO_2 annual and 24-hour averaging periods are more stringent than the national standards. The Florida standards for particulate matter are expressed as TSP. The demonstration of compliance with ambient air quality standards was based on the more stringent of the NAAQS or FAAQS for each pollutant. The NAAQS and the corresponding FAAQS, as defined in the Florida Administrative Code (F.A.C.) 17-2.300, are presented in Table 5-1.

Each state has been given the primary responsibility for maintaining air quality by submitting a State Implementation Plan (SIP) to EPA. The state has defined geographic areas as attainment or nonattainment for the NAAQS based on ambient monitoring data in those areas. Areas that cannot be defined due to the lack of ambient air data are designated as unclassifiable. Areas designated unclassifiable are treated as attainment until further information becomes available.

To implement the PM_{10} standard, EPA has promulgated a transition policy. To avoid disruption of the existing particulate control program, the existing State Implementation Plan for TSP will remain in effect until a PM_{10} SIP is approved by EPA. The existing regulations will continue to be enforced during the transition period. The area designations of attainment or nonattainment for TSP will also remain. When the EPA approves the state control strategy sufficient to attain or maintain the PM_{10} NAAQS, it will also approve area redesignations based on PM_{10} attainment. An area designation for particulate matter based on TSP must be retained until EPA promulgates PM_{10} increments because the PSD increments depend on the existence of attainment area designations.

5.1.1 ATTAINMENT STATUS FOR CRITERIA POLLUTANTS

The NAAQS attainment status for portions of Lee, Hendry, Glades, and Charlotte counties within 30 km of the site is summarized in Table 5-2 (other regional counties are included for comparison). Florida as a whole is in attainment of the standards for sulfur dioxide (SO_2) and total suspended particulate (TSP). For ozone (O_3), carbon dioxide (CO), and nitrogen dioxide (NO_2), counties in the 30-km area cannot be classified or are in attainment of the standards. The standard for lead (Pb) has also been met at all lead monitoring stations in the state.

TABLE 5-1

STATE AND FEDERAL AIR QUALITY GUIDELINES AND STANDARDS

(Units: ug/m³)

Pollutant	Averaging Period	NAAQS/FAAQS[a]		De Minimis Monitoring[b]	Significant Impact Level[c]	PSD Increments[b]	
		Primary	Secondary			Class II	Class I
Sulfur Dioxide	3-hour	--/1,300	1,300	—	25	512	25
	24-hour	365/260	—	13	5	91	5
	Annual	80/60	—	—	1	20	2
Total Suspended Particulate Matter	24-hour	—	—	10	—	37	10
	Annual	—	—	—	—	19	5
PM_{10}	24-hour	150	150	10	5	30[e]	8[e]
	Annual[d]	50	50	—	1	17[e]	4[e]
Nitrogen Dioxide	Annual[d]	100	100	14	1	25	2.5
Carbon Monoxide	1-hour	40,000	40,000	—	2,000	—	—
	8-hour	10,000	10,000	575	500	—	—
Lead	Quarterly	1.5	1.5	0.1	—	—	—
Ozone	1-hour	235	235	—	—	—	—

[a] 17-2.300, FAC, as last officially amended in May 1988. Where standards are not shown with a "/", the NAAQS and FAAQS are the same.

[b] 40 CFR 52.21(i)(8).

[c] 40 CFR 51.151.

[d] Annual arithmetic mean.

[e] Proposed EPA standard (54 FR 41218; October 5, 1989).

TABLE 5-2

NAAQS ATTAINMENT STATUS FOR SELECT COUNTIES WITHIN THE SOUTHWEST FLORIDA INTRASTATE AQCR

County	SO_2	PM	NO_2	CO	O_3
Charlotte	A	A	U/A	U/A	U/A
Collier	A	A	U/A	U/A	U/A
De Soto	A	A	U/A	U/A	U/A
Glades	A	A	U/A	U/A	U/A
Hendry	A	A	U/A	U/A	U/A
Highlands	A	A	U/A	U/A	U/A
Lee	A	A	U/A	U/A	U/A
Sarasota	A	A	U/A	U/A	U/A

SOURCE: BNA State Air Laws 346:0516.2 (September 5, 1986) and 346:0517 (November 29, 1985) 40 CFR 81.310 (revised July 1, 1986).

Abbreviations: A = In attainment status for the specific pollutant.
U = Cannot be classified for the specific pollutant.

5.2 AVAILABLE AMBIENT MONITORING DATA

This application uses available Florida ambient air monitoring reports for 1986 through 1988 to develop background concentrations of PSD criteria pollutants in the vicinity of the Facility. This period represents the most recent three-year period for which complete ambient monitoring data is available. Limited data are available for 1989. Because there are few monitoring stations within Lee County, monitors outside of the county are also considered for determining background concentrations for some pollutants.

Monitoring sites are typically selected:

- To determine the highest concentration expected in a given area,
- To determine representative concentrations in areas of high population densities,
- To determine ambient pollutant impacts of significant sources, and
- To determine general background concentration levels.

For these reasons, most available monitoring sites in southern Florida are located in areas of heavy urban or industrial growth such as Broward, Dade, and Hillsborough counties. Therefore, many sites in the Florida monitoring network will be overly conservative when used to estimate background levels at the Facility site, which is more rural. Table 5-3 shows the monitoring stations used in this analysis by county and criteria pollutant. A map showing the associated counties is presented on Figure 5-1.

Preliminary background concentrations from representative monitors are listed in Table 5-4. The criteria pollutants TSP, SO_2, and O_3 are measured in Lee County at the Fort Myers Water Storage Tank on Princeton Street. This monitoring station's purpose is to measure maximum concentrations and

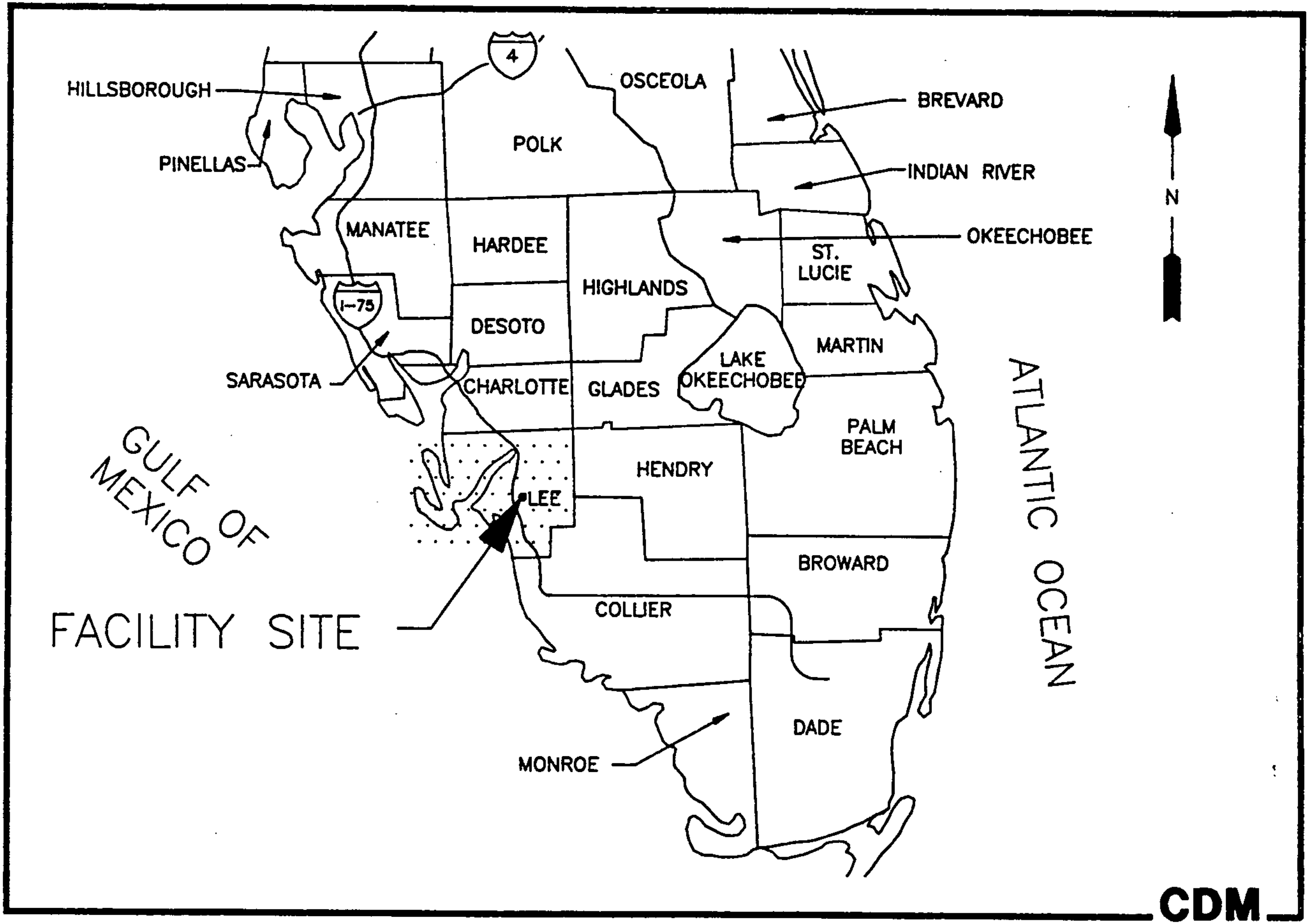
TABLE 5-3

AMBIENT AIR MONITORS SPECIFIED BY COUNTY AND CRITERIA POLLUTANTS (1986-1988)

	Pollutant						
County	SO_2	TSP	NO_x	CO	O_3	Pb	PM_{10}
Broward				X			X
Dade						X	
Hillsborough			X	X		X	X
Lee	X	X			X		
Manatee	X						
Pinellas				X			
Sarasota	X						

SOURCE: "Comparison of Air Quality Data with National Ambient Air Quality Standards," Florida Department of Environmental Regulation, 1986-1988.

ACAD FILE: FMAP.DWG 6/20/90



Study Area Location Map

TABLE 5-4

AMBIENT MONITORING DATA USED TO DERIVE BACKGROUND CONCENTRATIONS FOR THE LEE COUNTY ENERGY RECOVERY FACILITY

Pollutant	Monitoring Site	Averaging Time	Maximum Measured Concentration 1986	1987	1988
CO	Hillsborough County/ Davis Island	1-hr High (ppm)	5	4	4
		2nd High (ppm)	4	3	4
		8-hr High (ppm)	2	3	2
		2nd High (ppm)	2	2	2
	Pinellas County/ Largo	1-hr High (ppm)	16	7	6
		2nd High (ppm)	6	6	5
		8-hr High (ppm)	3	3	4
		2nd High (ppm)	3	3	3
	Broward County/ Pompano Beach	1-hr High (ppm)	7	6	6
		2nd High (ppm)	7*	6	5
		8-hr High (ppm)	5	5	3
		2nd High (ppm)	5*	5*	2
Pb	Hillsborough County/ Plant City	Max Qtr (ug/m^3)	0.0	—	—
	Dade County/ Thompson Park	Max Qtr (ug/m^3)	0.0	0.1^{a*}	—
NO_2	Hillsborough County/ Ybor City	Annual Arithmetic Mean (ug/m^3)	39	—^{b}	40*
TSP	Lee County/Fort Myers Water Storage Tank, Princeton Street	24-hr High (ug/m^3)	81	63	55
		2nd High (ug/m^3)	67	59	49
		Annual Arithmetic Mean	33*	31	30
		Annual Geometric Mean	30*	28	29
	Lee County/Fort Myers Backup Monitor, Water Storage Tank, Princeton Street	24-hr High (ug/m^3)	79	70	63
		2nd High (ug/m^3)	70*	54	60
		Annual Arithmetic Mean	32	30	31
		Annual Geometric Mean	30*	28	29
SO_2	Lee County/Fort Myers Water Storage Tank, Princeton Street	3-hr High (ug/m^3)	113	210	86^{a}
		2nd High (ug/m^3)	111	136*	75^{a}
		24-hr High (ug/m^3)	65	53	24^{a}
		2nd High (ug/m^3)	65*	27	24^{a}
		Annual Mean (ug/m^3)	5	6*	5^{a}

TABLE 5-4
(continued)

Pollutant	Monitoring Site	Averaging Time	Maximum Measured Concentration 1986	1987	1988
SO_2	Manatee County/ County Dam	3-hr High (ug/m^3)	—	—	—
		2nd High (ug/m^3)	—	—	—
		24-hr High (ug/m^3)	22	44	54
		2nd High (ug/m^3)	9	34	42
		Annual Mean (ug/m^3)	3	8	9
	Sarasota County/ Verna Well Field	3-hr High (ug/m^3)	273	148	396
		2nd High (ug/m^3)	151	126	199
		24-hr High (ug/m^3)	64	54	68
		2nd High (ug/m^3)	35	50	54
		Annual Mean (ug/m^3)	5	6	8
O_3	Lee County/Fort Myers Water Storage Tank, Princeton Street	1-hr High (ppm)	.101	.101	.102[c]
		2nd High (ppm)	.095	.090	.101[*]
PM_{10}	Hillsborough County/ Davis Island	24-hr High (ug/m^3)	—	—	64
		2nd High (ug/m^3)	—	—	58
		Annual Arithmetic Mean	—	—	30[*]
		Annual Geometric Mean	—	—	28
	Broward County/ 500 SW 14th Court #12 Ft. Lauderdale	24-hr High (ug/m^3)	72	85[d]	—
		2nd High (ug/m^3)	67	73[d*]	—
		Annual Arithmetic Mean	26	27[d]	—
		Annual Geometric Mean	24	24[d]	—

SOURCE: "Comparison of Air Quality Data with National Ambient Air Quality Standards," Florida Department of Environmental Regulation, 1986–1988.

[a] Discontinued during the year.

[b] Data not applicable; fewer than 75 percent of expected observations taken.

[c] Ozone monitoring site relocated from the water storage tank to Cape Coral about October/November 1988.

[d] Not run for a continuous year.

[*] Represents maximum long-term or maximum second-highest short-term concentration to be used as background in modeling analyses.

population exposures. For the remaining criteria pollutants without local monitoring data (CO, PM_{10}, Pb, and NO_2), background concentration monitors from the nearest areas were used as available.

5.3 SELECTION OF BACKGROUND POLLUTANT CONCENTRATIONS

The criteria pollutant background concentrations proposed for use in the refined modeling analysis for the Facility are summarized in Table 5-5. The methodology employed to calculate representative pollutant background concentrations is described below.

For each pollutant, the annual average background concentration has been set equal to the highest annual average concentration observed during the last three years. For each pollutant and each short-term averaging period, the background concentration has been set equal to the highest of the second-highest concentrations observed during the last three years, pursuant to EPA guidance. Values from monitors closest to the Facility site were chosen as representative of background concentrations at the Facility site.

The CO monitors closest to Lee County designated as background or population exposure monitors (and not near major roadways) are Hillsborough County/Davis Island Coast Guard Station, Pinellas County/Largo, and Broward County/Pompano Beach. Maximum second-highest concentrations, shown for CO on Table 5-5, are 7 ppm and 5 ppm for averaging times of one hour and eight hours, respectively. These ambient concentrations are approximately 20 percent of the one-hour CO standard (35 ppm) and 56 percent of the eight-hour CO standard (9 ppm).

Like CO, lead monitoring is concentrated near areas of major vehicular traffic outside Lee County. However, the Hillsborough County/Plant City and Dade County/Thompson Park sites are designed as background lead monitoring sites. Data for these two sites, given on Table 5-4, show a maximum quarterly average of 0.1 ug/m^3. This concentration is less than 7 percent of the quarterly lead standard of 1.5 ug/m^3. Since the recent

TABLE 5-5

PROPOSED BACKGROUND CONCENTRATIONS FOR CRITERIA POLLUTANTS EMITTED BY THE LEE COUNTY ENERGY RECOVERY FACILITY

Pollutant	Averaging Period	Monitor Site	Background Concentration ($\mu g/m^3$)	AAQS[a] ($\mu g/m^3$)	Background Concentration as Percent of NAAQS
PM_{10}[b]	24-Hour	500 SW 14th Court #12 Ft. Lauderdale, Broward County	73	150	48.7
	Annual	Davis Island, Hillsborough County	30	50	60.0
SO_2	3-Hour	Water Storage Tank, Princeton St., Fort Myers, Lee County	136	1,300	10.5
	24-Hour	Water Storage Tank, Princeton St., Fort Myers, Lee County	65	260	25.0
	Annual	Water Storage Tank, Princeton St., Fort Myers, Lee County	6	60	10.0
NO_2	Annual	Ybor City, Hillsborough County	40	100	40.0
CO (ppm)	1-Hour	Davis Island, Hillsborough County	7	35	20.0
	8-Hour	Davis Island, Hillsborough County	5	9	55.6
Pb	3-Month	Thompson Park, Dade County	0.1	1.5	6.7

TABLE 5-5
(continued)

SOURCE: "Comparison of Air Quality Data with National Ambient Air Quality Standards," Florida Department of Environmental Regulation, 1986-1988.

[a] More stringent of federal or state standard (see Table 5-1).

[b] TSP standard has been replaced with PM_{10} standard (52 FR 24634, July 1987). The State of Florida adopted these PM_{10} standards in May 1988 (17-2.300, FAC).

trend for lead concentrations is distinctly downward due to the phase-out of lead additives in gasoline, 1987 concentration data should conservatively represent current conditions.

The nearest continuous NO_2 monitoring stations are in Hillsborough County at Ybor City and Tampa (Bayway Street), both of which are designated as maximum concentration monitors. The maximum annual measurement for 1986 through 1988 at the two continuous Hillsborough County monitoring sites, given on Table 5-5, is 40 ug/m^3. This concentration is 40 percent of the annual NO_2 standard of 100 ug/m^3.

Most particulate monitoring data up to this time has been measured as total suspended particulates (TSP). TSP measurements are available from several monitoring stations in the Lee County area. The two Fort Myers monitors nearest the site, at the water storage tank on Princeton Street and the back-up monitor at the same location, are shown.

The TSP standard, however, has been replaced with the PM_{10} standard (July 1987). The state of Florida adopted these PM_{10} standards in May 1988. Florida started PM_{10} monitoring at three stations in 1986, increased the network to 15 stations in 1988, and currently has a network of 31 stations. The Broward County/Ft. Lauderdale and Hillsborough County/Davis Island monitoring sites are nearest to the Lee County site.

The maximum second-highest 24-hour concentration shown on Table 5-5 is 73 ug/m^3 which is 49 percent of the standard of 150 ug/m^3. The maximum annual arithmetic mean is 30 ug/m^3 which is 60 percent of the annual standard of 50 ug/m^3 for PM_{10}.

Only one SO_2 monitoring station exists in the immediate Facility site area. Located at the Fort Myers water storage tank on Princeton Street, the site is designated as a population exposure monitor. The next closest background sites shown for comparison are the Manatee County/Manatee County Dam and Sarasota County/Verna Well Field, over 100 km from the proposed Facility. Because local Fort Myers monitoring data is available, it is used to represent the ambient SO_2 concentrations at the Facility site.

Maximum second-highest 3-hour and 24-hour and maximum annual SO_2 concentrations for Ft. Myers, given in Table 5-5, are 136 ug/m^3, 65 ug/m^3, and 6 ug/m^3, respectively. These concentrations are 11 percent, 25 percent, and 10 percent of the 3-hour, 24-hour, and annual SO_2 standards of 1300 ug/m^3, 260 ug/m^3, and 60 ug/m^3, respectively.

Ozone is not directly emitted into the atmosphere, but results from a series of complex photochemical reactions. Ozone measurements are available from the Ft. Myers water treatment plant. The maximum second-highest one-hour concentration, shown on Table 5-4 for this site, is 0.101 ppm (198 ug/m^3). This concentration is 84 percent of the one-hour O_3 standard of 235 ug/m^3.

Arsenic, beryllium, fluorides, and mercury are PSD-regulated pollutants which the Facility is expected to emit in quantities exceeding the review threshold for a formal PSD analysis (see Table 2-1, Section 2.0 of this Volume). Identification of background concentrations is required as part of a formal PSD analysis. Because ambient air quality standards have not been established for these pollutants, the state and local air monitoring station network does not include monitoring of background concentrations of these pollutants. On the basis of pollutant emission inventory data provided by DER (Tom Rogers, DER, letter dated August 29, 1988, and subsequent conversation with Max Linn, DER, June 19, 1990), there are no industrial sources within 10 kilometers of the site likely also to be sources of arsenic, beryllium, fluorides, or mercury. Therefore, it is assumed that background concentrations of these pollutants are comparable to normal rural backgrounds.

5.4 AVAILABLE METEOROLOGICAL DATA

Mr. Thomas Rogers, Environmental Administrator for the Bureau of Air Monitoring and Assessment of DER, has indicated that surface wind, temperature, and cloud cover information from the National Weather Service (NWS) station at the Fort Myers Page Field Airport is most representative for the site. He has also indicated that upper air data from the NWS station at Tampa International Airport in Tampa, Florida should be used to estimate mixing heights. The Fort Myers station is about 10 miles southwest of the Facility site. The Tampa station, which is the closest upper air NWS station, is about 90 miles northwest of the Facility. The Fort Myers/Tampa data are the most representative data that are available of conditions at the Facility site.

Accordingly, the hourly meteorological data from these two weather stations for the most recent available years (1982 to 1986) have been provided by Mr. Rogers for use in this permit application (Thomas Rogers, 1989). The climatology and local meteorology of the Fort Myers area are discussed in Section 2.3.7 of Volume I, and wind roses for all years (1982 to 1986) and seasons, as well print-outs of the meteorological data, are provided in Attachment B of this volume.

SECTION 6.0

AIR QUALITY ANALYSIS

6.0 AIR QUALITY ANALYSIS

6.1 OVERVIEW

The purpose of this section is to present the predicted air quality impacts for the Lee County Energy Recovery Facility (ERF) in accordance with the protocol sent to DER on May 9, 1990. These pollutant concentrations were estimated using EPA guideline dispersion models and techniques discussed with and approved of by the Florida Department of Environmental Regulation prior to starting the analyses. The results obtained from the detailed modeling analysis have demonstrated that impacts from the Lee County ERF:

- Will not violate any Florida or National Ambient Air Quality Standards (FAAQS or NAAQS);
- Will not significantly consume total suspended particulate (TSP), sulfur dioxide (SO_2), or nitrogen oxide (NO_x) PSD Class II increments;
- Will not significantly consume TSP, SO_2, or NO_x PSD Class I increments at the Everglades National Park; and
- Will not significantly impact or prevent reasonable further progress toward attainment of NAAQS and FAAQS in SO_2 and TSP nonattainment areas elsewhere in the state.

Therefore, the proposed Facility will be in compliance with all applicable Florida and federal guidelines and standards regulating air quality impacts from energy recovery facilities.

Section 6.0 is organized to provide a logical progression from the development of emissions source characteristics to the presentation of modeled pollutant impacts associated with the Facility.

A summary of source parameters for potential operating conditions including stack parameters, exhaust gas conditions, and pollutant emission rates is presented in Section 6.2. The selection of a dispersion model and presentation of the screening modeling protocol used to evaluate impacts from potential operating conditions is included in Section 6.3.

Two levels of air quality impact assessment were conducted: a screening modeling analysis, and a detailed modeling analysis. Section 6.4 presents the results of the screening analysis, and identifies the operating conditions (i.e., 110 percent of design thermal load for short-term impact, and 100 percent of design thermal load for annual average impacts) that result in the highest ground-level impacts. Air quality impacts from these worst-case operating conditions are then evaluated using more detailed modeling techniques that require five years of hourly meteorological data and an extensive receptor grid. The results of the detailed analysis are presented in Section 6.5, and include a comparison of predicted impacts to the de minimis pre-construction monitoring levels. A demonstration of compliance with the FAAQS and NAAQS, based on the results for the detailed modeling analysis, is presented in Section 6.6. Section 6.7 assesses the potential impacts from non-criteria pollutants (i.e., those pollutants not regulated under the FAAQS and NAAQS). Section 6.8 provides a demonstration of facility compliance with PSD Class I and Class II increments.

6.2 SOURCE CHARACTERISTICS

The Lee County ERF will have an initial design capacity of 1,800 tons per day (tpd) of reference waste with a higher heating value (HHV) of 5,000 Btu per pound of waste. The Facility will have an ultimate capacity of 2,400 tpd of reference waste (which was modeled in this application). The primary source of pollutant emissions is the Facility stack, from which combustion process gases and particulate matter are emitted to the atmosphere. Potential secondary sources of pollutant emissions include the ash residue handling building and a lime silo servicing the acid gas scrubbers. These minor secondary sources of emissions will be enclosed and controlled through the use of particulate control devices. Secondary source emissions and impacts are discussed in Section 7.6. No significant quantifiable fugitive emissions will be generated from the proposed Facility.

The refuse received at the Facility will be combusted in either: (a) four mass-burn stoker waterwall combustor units of 600 tpd each, or (b) four 450-tpd plus one 600-tpd mass-burn rotary waterwall combustor units. At the design charging rate for reference waste, each 600-tpd combustor unit (either stoker waterwall or rotary waterwall) will have a heat release of 250 million Btu/hr (MMBtu/hr); each 450-tpd rotary waterwall unit will have a design heat release of 187.6 MMBtu/hr. Combustion temperatures will be in excess of 1,800°F. The exhaust gases from the boiler of each unit will pass through a dry scrubber and a fabric filter to collect particulate matter.

Each combustor unit (furnace and boiler) will be equipped with a separate acid gas scrubber followed by a fabric filter to collect particulate matter. The dry scrubber will be designed to remove sulfur dioxide (SO_2) at an efficiency of 80 percent or 30 ppmdv corrected to 7 percent O_2, whichever is less stringent (24-hour average). Hydrogen chloride (HCl) will likewise be removed at an efficiency of 95 percent or 25 ppmdv corrected to 7 percent O_2, whichever is less stringent (eight-hour average). The baghouse will be designed to result in a particulate emission not to exceed 0.010 grains per dry standard cubic foot corrected to 7 percent O_2 (gr/dscf @ 7% O_2).

The stack flues (hereinafter referred to as the "stack") from each of the four or five units will be co-located and enclosed in a single stack shell. The stack is assumed, for the dispersion modeling, to be 265 feet above the stack base elevation. This stack height is equal to the good engineering practice (GEP) stack height defined for a squat building with a building height of 106 feet. These are the minimum stack and building heights, respectively, of the designs under consideration. The proposed stack will be sufficiently high to avoid building aerodynamic wake and cavity effects. The method for determining the GEP stack height is outlined in Section 1.3.

Each flue for the stoker waterwall design facility will have an inside diameter of approximately six feet and two inches. An effective flue diameter of 12 feet and four inches was calculated from the total volumetric flow rate that maintains an exit velocity (of 65 feet per second) in the effective flue equal to that of the single six-foot, two-inch flue.

For the rotary waterwall design facility, there will be four flues each approximately four feet, nine inches (in side diameter) (450-tpd), and one larger (600-tpd) flue with an inside diameter of about five feet, six inches. All of these flues will have an exit velocity of about 65 feet per second. An effective flue diameter of about 11 feet was calculated as that which maintains this exit velocity for the combined volumetric flow rate of all five flues.

These "equivalent diameter" calculations are in accordance with U.S. EPA stack regulation provisions contained in 40 CFR 51.100 in that the stack is being originally designed to have merged flues. The combining of flue gas streams from a stack with multiple flues to form a single larger plume is also a real and observable phenomenon. The calculation of an effective diameter is thus allowable and correct because it accounts for this phenomenon without artificially increasing flue gas velocities and plume height.

While the Facility will have a design capacity of 2,400 tpd, the actual throughput will vary depending upon the season and planned maintenance activities. Each unit at the Facility could process waste at a rate between 50 and 110 percent of the nominal charging rate. The refuse heat content will also vary to some degree throughout the year. Operating conditions representing a broad range of possible refuse throughput for each of the combinations are presented in Table 6-1 and were modeled (Section 6.4) for their potential air quality impacts. The two postulated worst cases (those which produced the highest normalized ground-level concentrations) were then modeled for a range of possible waste heat contents. The source parameters for these cases are shown in Table 6-1a.

TABLE 6-1

SOURCE PARAMETERS OF 19 POTENTIAL OPERATING CONDITIONS FOR THE LEE COUNTY ERF

Facility Throughput (tpd)	Number of Units[a]	Total Heat Content (Btu/lb)	Total Heat Release (MMBtu/hr)	Normalized Emission Rate[b] (g/s)	Stack Height (m)	Exit Temp. (K)	Exit Velocity (m/s)	Effective Stack Diameter[c] (m)
STOKER WATERWALL DESIGN:								
2,640	4	5,000	1,100	1.10	80.77	388.7	21.8	3.77
2,400	4	5,000	1,000	1.00	80.77	388.7	19.9	3.77
1,800	3	5,000	750	0.75	80.77	388.7	19.9	3.26
1,200	2	5,000	500	0.50	80.77	388.7	19.9	2.66
600	1	5,000	250	0.25	80.77	388.7	19.9	1.88
1,800	4	5,000	750	0.75	80.77	388.7	14.9	3.77
1,200	4	5,000	500	0.50	80.77	388.7	9.9	3.77
ROTARY WATERWALL DESIGN:								
2,640	1, 4	5,000	1,100	1.10	80.77	388.7	21.8	3.35
2,400	1, 4	5,000	1,000	1.00	80.77	388.7	19.8	3.35
1,950	1, 3	5,000	813	0.81	80.77	388.7	19.8	3.02
1,500	1, 2	5,000	625	0.63	80.77	388.7	19.8	2.65
1,050	1, 1	5,000	438	0.44	80.77	388.7	19.8	2.22
600	1, 0	5,000	250	0.25	80.77	388.7	19.8	1.68
450	0, 1	5,000	188	0.19	80.77	388.7	19.8	1.45
900	0, 2	5,000	375	0.38	80.77	388.7	19.8	2.05
1,350	0, 3	5,000	563	0.56	80.77	388.7	19.8	2.51
1,800	0, 4	5,000	750	0.75	80.77	388.7	19.8	2.90
1,800	1, 4	5,000	750	0.75	80.77	388.7	14.9	3.35
1,200	1, 4	5,000	500	0.50	80.77	388.7	9.9	3.35

SOURCE: Camp Dresser & McKee Inc., 1990.

TABLE 6-1
(continued)

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[a] Number of combustor units assumed to be in operation for this case. For the rotary waterwall combustor design, which has two different unit sizes (big: 600 tpd; small: 450 tpd), the number of units in operation is shown as "big, small." The last two column entries for each of the combustor designs reflect the Facility operating at 75% and 50% of design thermal and throughput load.

[b] Normalized with respect to the nominal operating case (i.e., 2,400 tpd at 5,000 Btu/lb = 1,000 MMBtu/hr).

[c] Sample calculations of effective diameter for four flues of equal diameter: Define the effective stack diameter for four flues as $D = (4A/3.14159)^{0.5}$, where A is the combined area for four 6'2" diameter flues (e.g., D = 3.77 m for $A = 119.98\ ft^2$). The gas exit velocity for the effective diameter stack is equal to that for each individual flue.

TABLE 6-1a

SOURCE PARAMETERS OF 12 POTENTIAL WASTE HEAT CONTENT AND THROUGHPUT OPERATING CONDITIONS FOR THE LEE COUNTY ERF

Facility Throughput (tpd)	Number of Units[a]	Total Heat Content (Btu/lb)	Total Heat Release (MMBtu/hr)	Normalized Emission Rate[b] (g/s)	Stack Height (m)	Exit Temp. (K)	Exit Velocity (m/s)	Effective Stack Diameter[c] (m)
STOKER WATERWALL DESIGN:								
2,200	4	6,000	1,100	1.1	80.77	388.7	21.7	3.77
2,640	4	5,000	1,100	1.1	80.77	388.7	21.8	3.77
3,472	4	3,802	1,100	1.1	80.77	388.7	23.3	3.77
2,000	4	6,000	1,000	1.0	80.77	388.7	19.7	3.77
2,400	4	5,000	1,000	1.0	80.77	388.7	19.9	3.77
3,156	4	3,802	1,000	1.0	80.77	388.7	21.2	3.77
ROTARY WATERWALL DESIGN:								
2,200	1, 4	6,000	1,100	1.1	80.77	388.7	20.8	3.35
2,640	1, 4	5,000	1,100	1.1	80.77	388.7	21.7	3.35
3,472	1, 4	3,802	1,100	1.1	80.77	388.7	23.6	3.35
2,000	1, 4	6,000	1,000	1.0	80.77	388.7	18.9	3.35
2,400	1, 4	5,000	1,000	1.0	80.77	388.7	19.8	3.35
3,156	1, 4	3,802	1,000	1.0	80.77	388.7	21.5	3.35

SOURCE: Camp Dresser & McKee Inc., 1990.

[a] Number of combustor units assumed to be in operation for this case. For the rotary waterwall combustor design, which has two different unit sizes (big: 600 tpd; small: 450 tpd), the number of units in operation is shown as "big, small."

[b] Normalized with respect to the nominal operating case (i.e., 2,400 tpd at 5,000 Btu/lb = 1,000 MMBtu/hr).

[c] Sample calculations of effective diameter for four flues of equal diameter: Define the effective stack diameter for four flues as $D = (4A/3.14159)^{0.5}$, where A is the combined area for four 6'2" diameter flues (e.g., D = 3.77 m for $A = 119.98\ ft^2$). The gas exit velocity for the effective diameter stack is equal to that for each individual flue.

The emission rates presented in Table 6-2 are based on the design heat release of the Lee County ERF. The emission rates used in the detailed air quality modeling analyses are normalized and adjusted relative to the design heat release. Thus, the ground-level concentration for any pollutant can be obtained by multiplying the emission rate (in grams per second) from Table 6-2 by the normalized ground-level concentrations (i.e., the X/Q values) predicted by the air quality dispersion model and presented in later sections.

The stoker waterwall combustor design and the rotary waterwall combustor design are projected to have slightly different pollutant emission rates for nitrogen oxides, carbon monoxide, and non-methane hydrocarbons (see Section 3.0, especially Table 3-3, Section 4.0, and Attachment A). The highest pollutant emission rate, regardless of technology, has been selected for the dispersion modeling; these are shown with asterisks in Table 6-2. Technical support for the development of pollutant emission factors shown in Table 6-2 is contained in Attachment A.

6.3 MODELING METHODOLOGY

Computer-based mathematical dispersion models approved by DER and EPA were used to evaluate air quality impacts due to emissions from the Lee County ERF. Input data to these dispersion models were conservatively specified in order to prevent an under-estimation of impacts. A screening modeling analysis was used to simulate plume dispersion under a variety of possible meteorological and operating conditions, thereby identifying maximum pollutant ground-level concentrations. A detailed modeling analysis was performed to determine the maximum pollutant concentrations for the worst-case operating condition using recorded meteorological and site terrain data.

6.3.1 INDUSTRIAL SOURCE COMPLEX MODEL

The UNAMAP Version 6, Change 8 of EPA's Industrial Source Complex Short-Term Model (ISCST) was the sole model used in the air quality impact analysis. It was developed for EPA for the purpose of estimating impacts

TABLE 6-2

ANNUAL AVERAGE EMISSION RATE OF POLLUTANTS FOR THE LEE COUNTY ENERGY RECOVERY FACILITY

Pollutant[c]	Controlled Emission Rate[a]	
	(lb/hr)	(g/s)
Particulate Matter (as TSP or PM_{10})	19.4	2.44
Sulfur Dioxide (SO_2)		
(annual)	149	18.77
(3-hour)	186	23.44
Nitrogen Dioxide (NO_2)	324*	40.82*
Carbon Monoxide (CO)		
(8-hour)	148*	18.65*
(1-hour)	395*	49.77*
Hydrocarbons (VOC)	40	5.04
Lead (Pb)	0.6	0.076
Fluoride (as (HF)	3.5	0.441
Sulfuric Acid (H_2SO_4)	35.8	4.51
Hydrogen Chloride (HCl)	64.0	8.10
Mercury (Hg)	0.8	0.101
Beryllium (Be)	$1.35x10^{-4}$	$1.7x10^{-5}$
Arsenic (As)	$9.1x10^{-3}$	$1.15x10^{-3}$
Dioxin (as 2,3,7,8 TCDD toxic equivalent)	$1.58x10^{-6}$	$1.99x10^{-7}$

SOURCE: Camp Dresser & McKee Inc., 1990.

[a] Emission rates are based on 100% of the nominal capacity (i.e., 2,400 tpd at 5,000 Btu/lb) and continuous operation of the air pollution control system during reference waste firing. System availability is rated 100% (8,760 hrs/yr) for the modeling exercise. See Tables 3-2 and 3-3.

[b] Assumes total NO_x emissions are emitted as NO_2.

[c] Dioxins and hydrogen chloride are not PSD regulated pollutants (40 CFR 52.21).

*Higher emission rate of either rotary waterwall or stoker waterwall mass-burn combustor designs under consideration.

from industrial sources which may have complex geometries and multiple emission sources. It is the EPA-recommended impact assessment technique for regions comprised of "flat terrain," that is, where all terrain within the modeled site region is below stack-top elevation. Within 30 kilometers of the site, no terrain was found to exceed stack-top elevation. Therefore, ISCST was selected as the model most appropriate for the characteristics of the proposed source and surrounding site dispersion environment.

The ISCST model is a steady-state Gaussian plume dispersion model which can be used to assess pollutant concentrations from a wide variety of sources associated with an industrial complex. For this study, the ISCST model was used to calculate ground-level concentrations for all regulated pollutant concentration averaging periods. ISCST uses sequential hourly meteorological data to compute one-hour average concentrations. Average concentrations (for 3-hour, 8-hour, 24-hour, and annual periods) are computed as arithmetic averages of blocks of successive hourly concentrations.

6.3.2 ISC MODEL OPTIONS

An ISCST simulation of the Lee County ERF air quality impacts required an input of source parameters, receptor coordinates with terrain heights, and representative meteorological data. The ISCST model includes options or switches which may be selected to simulate the impacts from the Lee County ERF. The modeling options used in the dispersion analysis conformed to DER procedures and EPA modeling guidance as presented in the "Guideline on Air Quality Models -- Revised" (EPA, 1986) and included:

- Final plume rise. The ISC program is capable of evaluating the dispersion of a plume based on either final plume rise or transitional plume rise with distance. Final plume rise is the preferred option unless building wake effects are a possibility [i.e., if the stack height is not equal to a good engineering practice (GEP) stack height] or terrain above stack-tip occurs closer to the stack than the distance at which final plume height is realized.

The stack elevation included in the Lee County ERF design is a GEP stack height, and the terrain elevation does not exceed stack-top within the study area. Therefore, plume dispersion was evaluated based on final plume rise.

- Stack-tip downwash. This option was selected to allow modification of the stack height to account for downwash effects induced by the stack tip (Briggs, 1974) when the ratio of gas exit velocity to stack-top wind speed is less than 1.5.

- Buoyancy induced dispersion. The ISC model was programmed to increase the dispersion coefficients at the point of plume release to account for buoyancy enhancement of the plume from turbulent mixing and air entrainment, hence greater initial dispersion volume than without buoyancy. This option was selected as representative of actual conditions.

- Calm-processing. The model employed an EPA calm-processing routine (CALMPRO) to calculate blocked concentrations when there are "calm" hours of preprocessed data with wind speeds of 1 meter per second occurring with directional persistence. Calm hours are assigned a 1 m/s wind speed by the RAMMET preprocessor when the observed wind speed is less than 2 knots and the wind direction persists from the previous hour. Calm hours are treated as missing hours by CALMPRO. Short-term and long-term concentrations are estimated in an EPA prescribed manner to account for calms (EPA, 1986).

- Pollutant Half-Life. Recent EPA guidance suggests including a half-life of four hours for modeling of SO_2 dispersion in urban areas. This pollutant half-life option was not included in the present analysis because the study area is categorized as rural. Conservative estimates of SO_2 impacts will result.

These assumptions and conditions established the basis for evaluating air quality impacts from the Lee County ERF.

Land Use Classification

The dispersion environment was classified as rural based on a quantitative review of land use designations within a three-km (1.9 miles) radius of the proposed stack, and a comparison of the land use with Auer (1978) land use criteria. The Lee County land use map was used as the basis for calculation of total "urban" and "rural" areas in the three-km study area. This map shows existing land use designations, as well as areas where future development is permitted, but is not currently intensively developed. Use of this map, therefore, tends to favor inclusion of some currently "rural" areas into "urban" classifications, and is a very conservative approach. The map was digitized, using ARC/INFO geographic information systems (GIS) software. ARC/INFO computes total area for each designated land use type. The digitized version of the Lee Plan Future Land Use Map (adopted by the Board of County Commissioners, January 31, 1989, effective March 1, 1989) is shown in Figure 6-1. The following land use categories were assigned the "urban" designation, in accordance with Auer (1978): intensive development, central urban, urban community, industrial, general commercial, and industrial commercial. The following land use categories were designated "rural": rural, open lands, resource protection areas, new community, suburban, outlying suburban, and park. ARC/INFO computed the total resulting land use areas to be 37 percent urban and 63 percent rural. Therefore, the dispersion models were executed in the rural mode, incorporating dispersion coefficients developed by Turner (1970) and recommended by EPA for regulatory applications in rural areas (EPA, 1986).

Dispersion Meteorology

The rate of plume dispersion as defined with the ISCST model is determined by a set of atmospheric variables including wind speed, wind direction, ambient temperature, depth of the mixing layer, and the ambient turbulence level (i.e., atmospheric stability). These variables vary as functions of space and time. The selection of acceptable meteorological data representative of the site dispersion environment is necessary to correctly characterize downwind concentrations from the proposed source.

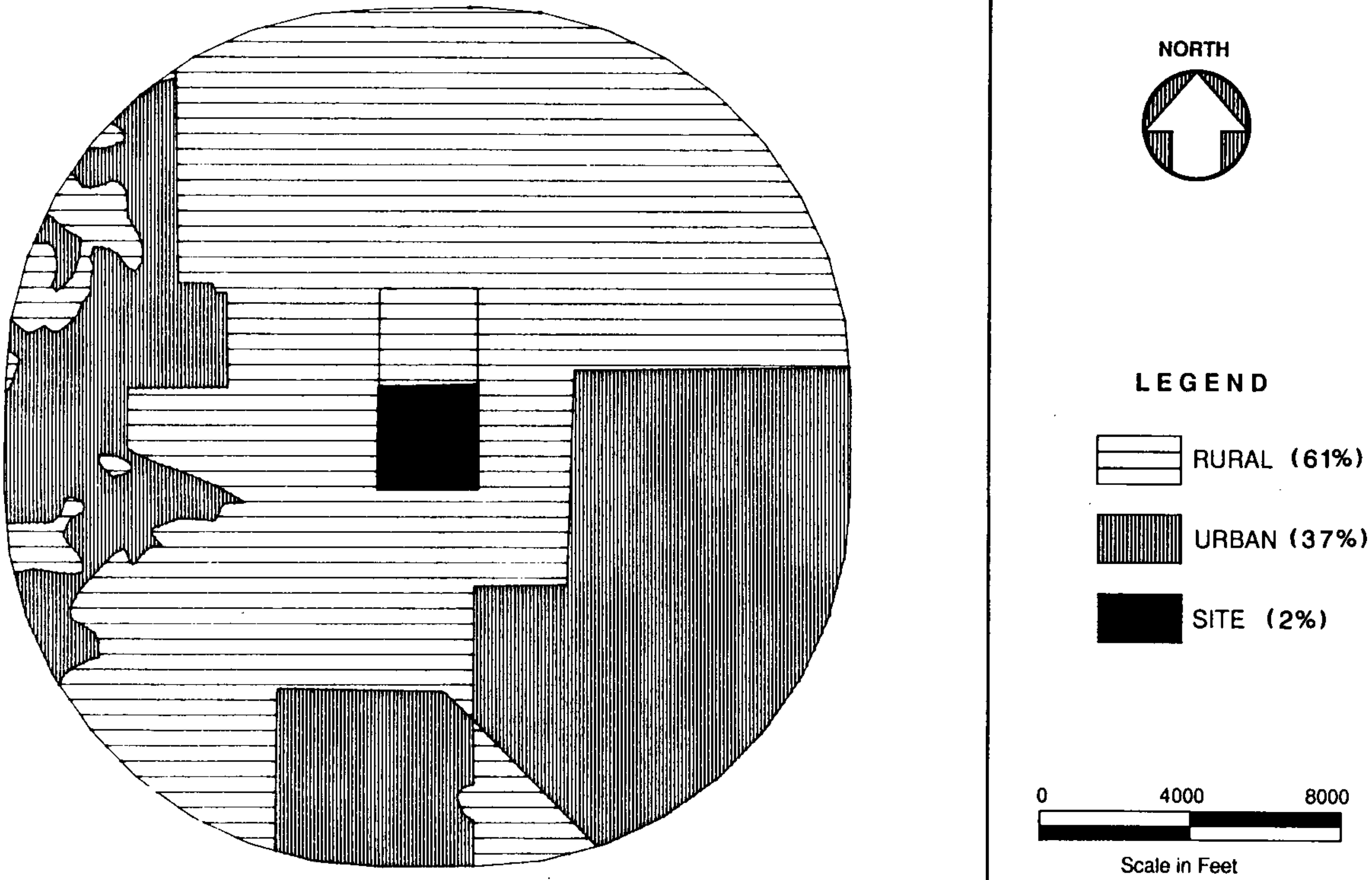

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FIGURE 6-1
AUER LAND USE CLASSIFICATION

Digitized meteorological data are available from the National Climatic Data Center (NCDC) which archives regular observations made at National Weather Service (NWS) stations. The refined modeling analysis used a recent five-year period of meteorological data provided by Mr. Thomas Rogers of DER (DER, 1989) as representative of the Lee County site. Surface data are from Ft. Myers (Page Field), and upper air data are from Tampa International Airport--both for the years 1982 to 1986. Surface data consist of hourly observations of wind speed, wind direction, temperature, cloud cover, and several other parameters. Mixing height is calculated from twice daily upper air soundings which measure atmospheric temperature profiles. Rural mode wind profile exponents and mixing heights were applied based on the above discussion on land use classification.

6.4 SCREENING ANALYSIS

An air quality screening analysis was conducted to identify the Facility operating condition from Tables 6-1 and 6-1a that produced the worst-case ground-level pollutant concentrations in the vicinity of the proposed Facility. The screening dispersion modeling is performed on the basis of simplified meteorology, and a single wind direction over composite worst-case terrain. EPA-approved dispersion modeling options and inputs for screening analyses are presented in Table 6-3. The modeling procedures are consistent with the "Guideline on Air Quality Models -- Revised" (EPA, 1986) and "Guideline for Air Quality Maintenance Planning and Analysis, Volume 10 (Revised): Procedures for Evaluating Air Quality Impacts of New Stationary Sources" (EPA, 1977).

A total of 29 operating conditions for waste throughput and waste heat content were identified for screening dispersion modeling in two steps. In the first step, waste heat content was held constant (at the design reference waste value of 5,000 Btu/lb), and a range of throughput levels was analyzed for each of the two combustor technologies under consideration. The range consisted of 50, 75, 100, and 110 percent of the design waste throughput for the Facility as a whole, as well as various combinations of individual combustors (each at 100 percent of design

TABLE 6-3

LEE COUNTY ENERGY RECOVERY FACILITY
SCREENING MODELING OPTIONS ISCST

	Option Description	EPA Dispersion Model ISCST
1.	Land Use Classification	Rural
2.	Wind Profile Exponents	Rural Default
3.	Vertical Potential Temperature Gradient	Default
4.	Stack-Tip Downwash	Yes
5.	Gradual Plume Rise	No
6.	Bouyancy-Induced Dispersion	Yes
7.	Pollutant Half-Life	No/Infinite
8.	Entrainment Coefficients	0.6
9.	Decalm	NA
10.	Meteorology	PTPLU-based Meteorological Conditions[a]
11.	Receptors	(footnote[b])
12.	Receptor Elevation	(A) Stack base elevation (B) Worst-case elevation
13.	Sector Averaging	No
14.	Terrain Adjustment Factor	None
15.	Anemometer Height (ft)	20
16.	Non-stable Mixing Height (m)	5,000

SOURCE: Camp Dresser & McKee Inc., 1990.

NA = Not Applicable

[a]

Meteorology Stability Class	Wind Speed (m/s)
A	0.5,0.8,1.0,1.5,2.0,2.5,3.0
B	0.5,0.8,1.0,1.5,2.0,2.5,3.0,4.0,5.0
C	1.0,2.0,2.5,3.0,4.0,5.0,7.0,10.0,12.0,15.0
D	1.0,1.5,2.0,2.5,3.0,4.0,5.0,7.0,10.0,12.0,15.0,20.0
E	2.0,2.5,3.0,4.0,5.0
F	2.0,2.5,3.0,4.0,5.0

[b]

ISCST Receptors x (km)	Increment (km)
0.1-2.0	0.1
2.2-4.0	0.2
4.5-10	0.5
11-15	1.0

throughput) in use and shut down. Dispersion model parameters for these conditions, for each of the two combustor technologies, are listed in Table 6-1 in Section 6.2. The two worst cases (those which produced the highest normalized ground-level concentrations in this first round of screening dispersion modeling) for each combustor design were then selected for analysis of the effects on flue gas flow rate of varying the waste heat content. The dispersion model parameters for these cases are shown in Table 6-1a. The results of the screening modeling for these 12 cases are shown in Table 6-4.

On the basis of the normalized ground-level concentrations shown in Table 6-4, the rotary waterwall combustor design was selected as the "worst case," and was carried into refined dispersion modeling. No further analysis was performed for the stoker waterwall design because its greater air flows will tend to produce ground-level impacts less than those predicted for the rotary waterwall design for the same emission rate. Table 6-4 also shows that the operating condition which produces the greatest impacts for the rotary waterwall design is a Facility throughput of 2,200 tpd of waste with a higher heating value of 6,000 Btu/lb. Since the heat release for this case can only be tolerated by the combustors for short periods, and is only expected to exist for short periods of time, this operating condition was applied to dispersion modeling for pollutants with averaging time standards of 24 hours and less. An additional operating case was selected to represent the worst case for pollutants with annual average standards: 2,400 tpd of waste at 5,000 Btu/lb (the design condition). The location of maximum impacts for the individual atmospheric stability classes are provided in Table 6-4.

6.5 DETAILED MODELING ANALYSIS

A detailed dispersion modeling analysis was conducted for the Lee County facility worst-case operating conditions (with the emission rate normalized to the design operating condition) to resolve the maximum impacts over a 1,681-receptor rectangular grid for each year of the 1982 to 1986 sequential hourly meteorological data base. EPA's ISCST dispersion model was used to model Facility impacts for 1-, 3-, 8-, 24-hour, and annual

TABLE 6-4

LEE COUNTY ERF SCREENING ANALYSIS RESULTS FOR VARIOUS OPERATING LOADS

(Concentrations in ug/m^3 using Normalized Emission Rate)

	Rotary Waterwall Design Cases					
Throughput (tpd)	2,200	2,640	3,472	2,000	2,400	3,156
Heat Content (Btu/lb)	6,000	5,000	3,802	6,000	5,000	3,802
Normalized[a] Emission Rate (g/s)	1.1	1.1	1.1	1.0	1.0	1.0
Stability Class	Maximum Normalized[a] 1-Hour-Average Concentrations and Downwind Distance (km) from Stack					
A	1.139 (0.9)	1.113 (0.8)	1.064 (0.8)	1.114 (0.7)	1.075 (0.7)	1.018 (0.8)
B	0.771 (1.3)	0.746 (1.4)	0.706 (1.4)	0.739 (1.4)	0.725 (1.3)	0.683 (1.4)
C	0.682 (2.2)	0.666 (2.2)	0.636 (2.2)	0.651 (2.2)	0.628 (2.2)	0.609 (2.2)
D	0.352 (2.2)	0.589 (1.4)	0.562 (1.4)	0.577 (1.3)	0.563 (1.4)	0.539 (1.4)
E	0.341 (14.0)	0.333 (14.0)	0.319 (15.0)	0.326 (14.0)	0.318 (14.0)	0.305 (14.0)
F	0.124 (15.0)	0.119 (15.0)	0.112 (15.0)	0.121 (15.0)	0.117 (15.0)	0.110 (15.0)

TABLE 6-4
(continued)

LEE COUNTY ERF SCREENING ANALYSIS RESULTS FOR VARIOUS OPERATING LOADS
(Concentrations in ug/m^3 using Normalized Emission Rate)

	Stoker Waterwall Design Cases					
Throughput (tpd)	2,200	2,640	3,472	2,000	2,400	3,156
Heat Content (Btu/lb)	6,000	5,000	3,802	6,000	5,000	3,802
Normalized[a] Emission rate (g/s)	1.1	1.1	1.1	1.0	1.0	1.0
Stability Class	Maximum Normalized[a] 1-Hour-Average Concentrations and Downwind Distance (km) from Stack					
A	0.971	0.980	0.925	0.937	0.933	0.896
	(0.8)	(2.2)	(0.8)	(0.8)	(0.8)	(0.8)
B	0.634	0.632	0.602	0.617	0.614	0.585
	(1.2)	(1.5)	(1.5)	(1.4)	(1.4)	(1.5)
C	0.581	0.579	0.554	0.560	0.558	0.536
	(2.2)	(2.2)	(2.2)	(2.2)	(2.2)	(2.2)
D	0.534	0.533	0.509	0.525	0.512	0.492
	(1.5)	(1.5)	(1.6)	(1.8)	(1.4)	(1.5)
E	0.294	0.293	0.282	0.282	0.280	0.270
	(15.0)	(15.0)	(14.0)	(15.0)	(15.0)	(15.0)
F	0.0986	0.098	0.093	0.097	0.096	0.0913
	(15.0)	(15.0)	(15.0)	(15.0)	(15.0)	(0.8)

SOURCE: Camp Dresser & McKee Inc., 1990.

[a] Normalized to 2,400 tpd at 5,000 Btu/lb. Assumes a dry scrubber and baghouse.

NOTE: Bold face indicates results for case selected for refined analysis.

average concentrations. All average concentrations are computed as block averages of 1-hour concentrations. The ISCST detailed modeling options are listed in Table 6-5. The points of maximum impact were included in a "refined analysis" in which they were analyzed with fine resolution grids to further resolve the location and magnitude of the predicted highest annual and highest, second-highest short-term pollutant concentrations for the five-year period. These concentrations were compared to the NAAQS and FAAQS. The modeling results demonstrate that the Facility has a less than significant impact for all criteria pollutants.

6.5.1 RECEPTOR GRIDS

A rectangular "coarse" grid for detailed modeling was developed based on the screening modeling results, and on guidance contained in Guidelines on Air Quality Models (EPA, 1986). The grid was extended outward from the stack location to 10 km in each of the four directions. Screening modeling had indicated that maximum impacts were likely to occur within five km (see Table 6-4). Half-kilometer spacing of gridlines in each direction was initially used. Receptor points were placed at each gridline crossing, for a total of 1,681 receptors. Terrain elevations were selected for each receptor point from the appropriate U.S. Geologic Survey (USGS) topographic maps (7.5-minute quadrangles) of the area. The maximum terrain within 250 meters of each receptor was assigned to that receptor. The coarse grid study area and receptor points are shown in Figure 6-2.

Fine resolution grids (with 100-meter resolution) were centered around the receptor locations where the highest, and the highest of the second-highest normalized ground-level impacts for each pollutant averaging period occurred. The purpose of this exercise was to account for the possibility that the highest and highest, second-highest impacts may "flip-flop" when going from a coarse to a fine grid. Fine grids spanned a 1.1-km square area centered on each coarse-grid receptor. Terrain corresponding to the fine grid spacing (i.e., highest within 50 meters of each receptor) was employed in the analysis. All five years of meteorological data were re-run for the modeling of each grid for added conservatism. The resultant predicted highest, second highest short-term and maximum long-term modeled

TABLE 6-5

LEE COUNTY ENERGY RECOVERY FACILITY DETAILED MODELING OPTIONS FOR ISCST

Option Description	ISCST
1. Land Use Classification	Rural
2. Wind Profile Exponents	0.07, 0.07, 0.10, 0.15, 0.35, 0.55 (rural default)
3. Vertical Potential Temperature Gradient	Default
4. Stack-tip Downwash	Yes
5. Gradual Plume Rise	No
6. Buoyancy-Induced Dispersion	Yes
7. Half-Life	Infinite
8. Extrainment Coefficients	0.6
9. Decalm (CALMPRO)[a]	Yes (internal)
10. Meteorology	1982-1986 Sequential-hourly
11. Receptors 21 km x 21 km 500-m spacing	Rectangular Grid
12. Terrain	Yes: all terrain is below stack-top elevation
13. Terrain Adjustment Factors	NA
14. Anemometer Height (m)	6.10

NA = Not Applicable

[a] The CALMPRO algorithm is either "hardwired" within the model (i.e., internal) or it is manually applied to the modeled concentrations (i.e., external).

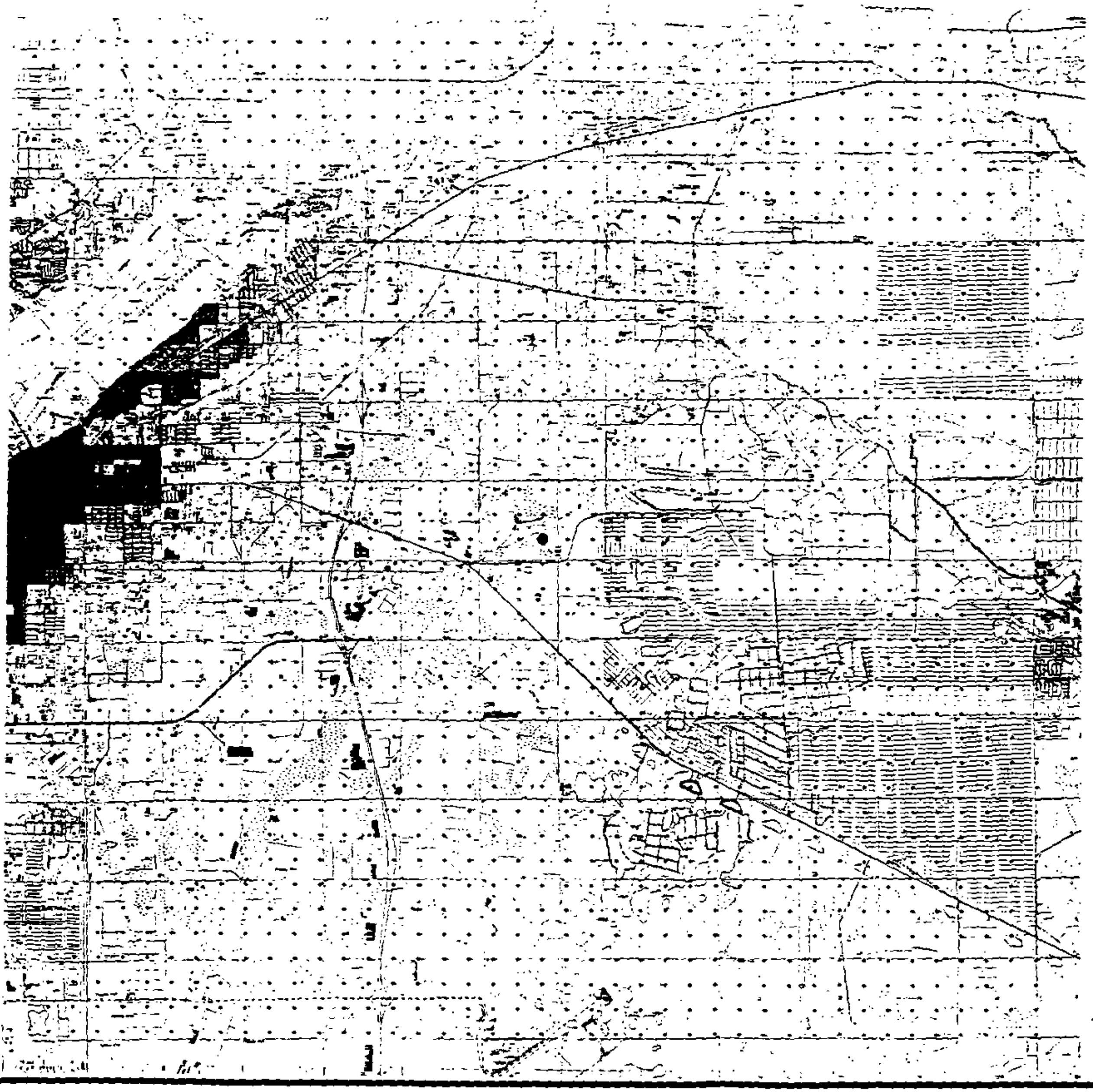

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FIGURE 6-2
COURSE GRID RECEPTOR ARRAY

fine resolution grid concentrations were used in the comparison of Facility impacts to ambient standards and increments for regulated pollutants.

Additional discrete receptors were positioned at the nearest boundary of the nearest PSD Class I area, the Everglades National Park, 88 km from the Lee County facility. At the request of the National Park Service (NPS, 1990), receptors were also placed at the nearest boundary of the Big Cypress National Preserve, 61 km from the Lee County facility. The Big Cypress National Preserve is considered sensitive to air quality impacts because of its pristine nature and the presence of unusual or endangered plant species (NPS, 1990). Four receptors were placed along the nearest boundary of each area. A detailed discussion of Class I area impacts is presented in Section 7.4.

6.5.2 DETAILED MODELING RESULTS

Results of the ISCST detailed modeling results are tabulated in Table 6-6. These are the highest and the highest of the second-highest predicted concentrations for the two worst-case operating conditions: (1) 110 percent of design thermal load for all short-term (24 hours and less) averaging times; and (2) 100 percent of design thermal load for annual averages. The predicted normalized impacts for the Facility stack emissions have been plotted to illustrate their distribution in the vicinity of the proposed site. Figures 6-3, 6-4, and 6-5 show the normalized unitized impacts predicted for annual, 24-hour, and 3-hour block-averaged periods, respectively. In each case, the distribution of impacts shown is based upon the specific year in which the limiting impact (highest annual average concentration or highest, second-highest short-term concentrations) was predicted.

The results of the fine grid analyses are summarized in Table 6-7. Comparisons to the significant impact levels, de minimis monitoring guidelines, and air quality standards are based on the results of the fine grid modeling. The limiting short-term (i.e., 1-, 3-, 8-, and 24-hour) impacts are based on the highest, second-highest (HSH) concentrations for comparisons to the significant impact levels, NAAQS and FAAQS, and PSD

TABLE 6-6

MAXIMUM COARSE GRID GROUND-LEVEL CONCENTRATIONS FOR THE LEE COUNTY ENERGY RECOVERY FACILITY

	Averaging Period	Rank[a]	1982	Normalized Ground-Level Concentrations ($\mu g/m^3$) 1983	1984	1985	1986
ISCST	1-hour[b]	H	**1.45**	1.33	1.22	1.31	1.20
		HSH	1.06	1.19	**1.21**	1.15	1.10
	3-hour[b]	H	0.691	0.637	0.683	0.649	**0.828**
		HSH	0.505	0.540	**0.605**	0.601	0.559
	8-hour[b]	H	0.350	0.402	0.507	**0.539**	0.466
		HSH	0.312	0.315	**0.410**	0.342	0.349
	24-hour[b]	H	0.145	0.165	0.2011	**0.2014**	0.176
		HSH	0.105	0.126	**0.182**	0.154	0.133
	Annual	H	0.00989	0.0125	**0.0128**	0.0100	0.0116

SOURCE: Camp Dresser & McKee Inc., 1990.

[a] Abbreviations: H = Highest
HSH = Highest, Second-Highest

[b] The short-term (24 hours and less) average normalized ground-level concentrations were computed with a 1.1 g/s normalized emission rate, thereby already including the 110% load factor assumed for short-term emissions (1.0 g/s was used for the annual average case). Therefore, to compute actual ground-level concentrations for each pollutant, select the 100% load emission rate for each pollutant from Table 6-2 for all applicable averaging times to multiply with the normalized concentrations shown above.

NOTE: The limiting year values for each averaging period shown in bold face were resolved further in the fine grid analyses.

TABLE 6-7

MAXIMUM NORMALIZED GROUND-LEVEL CONCENTRATIONS BASED ON THE FINE GRID ANALYSES FOR THE LEE COUNTY ENERGY RECOVERY FACILITY

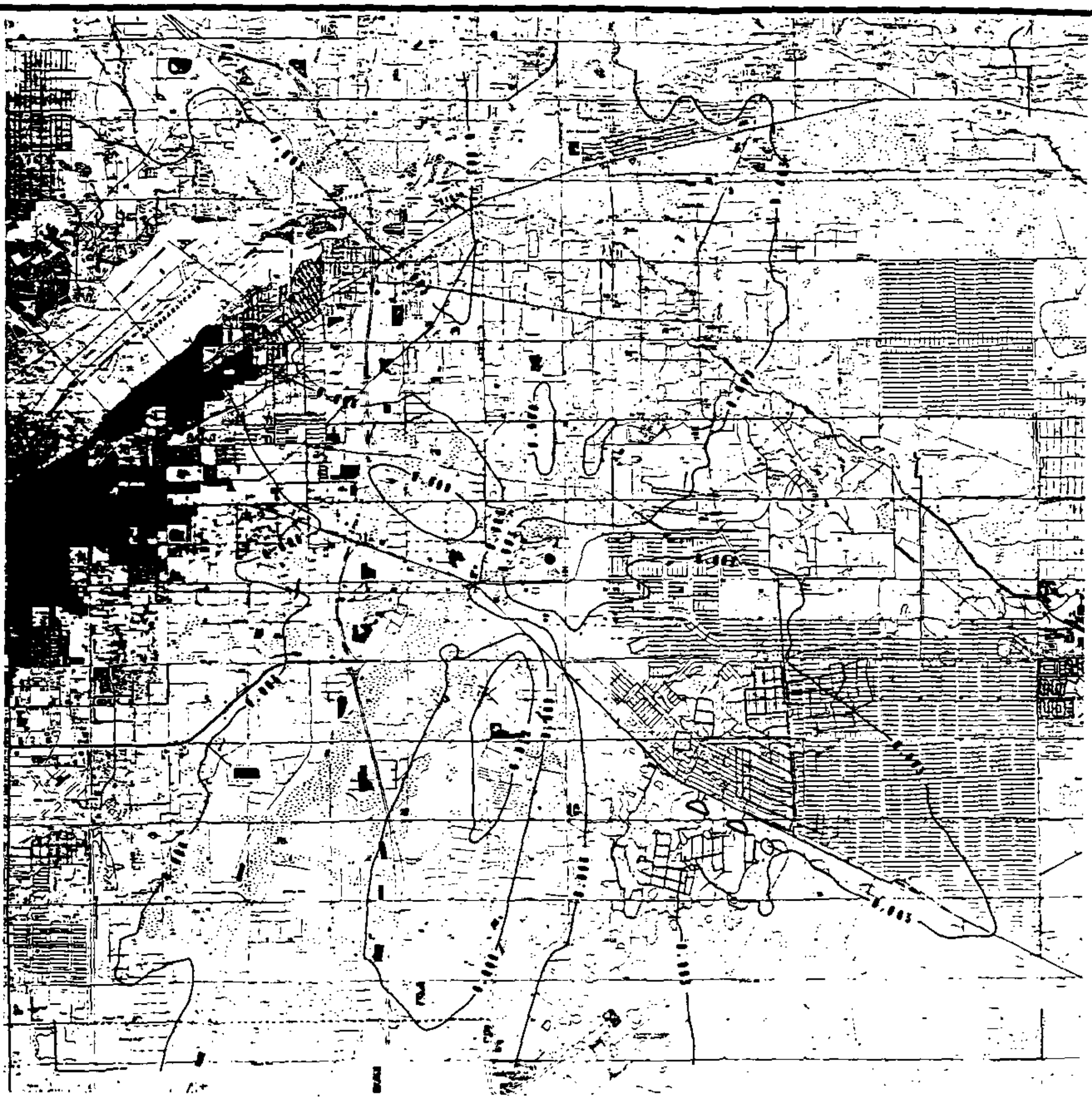
Averaging X/Q Period	Rank[a]	Normalized Ground Level Concentration ($\mu g/m^3$)	Receptor Location Grid Coordinates[b]		Meteorological Period		
			Distance East (m)	Distance North (m)	Year	Day	Period Ending
1-hour	H	1.930	700	500	1982	200	13
	HSH	1.267	300	-700	1986	195	13
						120	12
3-hour	H	0.905	0	800	1986	121	5
	HSH	0.629	-1,000	1,900	1985	88	4
8-hour	H	0.548	-100	-1,800	1984	229	2
	HSH	0.440	-100	-1,700	1984	228	2
24-hour	H	0.223	-100	-1,800	1984	229	1
	HSH	0.184	0	-2,100	1984	230	1
Annual	H	0.0133	-700	-2,700	1984	N/A	N/A

SOURCE: Camp Dresser & McKee Inc., 1990.

[a] Abbreviations:
H = Highest
HSH = Highest, Second-Highest
N/A = Not Applicable

[b] Receptor grid coordinates in meters north and east (south and west are presented as negative numbers) relative to Lee County facility stack.

NOTE: The short-term (24 hours and less) average normalized ground-level concentrations were computed with a 1.1 g/s normalized emission rate, thereby already including the 110% load factor assumed for short-term emissions (1.0 g/s was used for the annual average case). Therefore, to compute actual ground-level concentrations for each pollutant, select the 100% load emission rate for each pollutant from Table 6-2 for all applicable averaging times to multiply with the normalized concentrations shown above.



LEGEND

0.000 NORMALIZED CONCENTRATIONS IN MICROGRAMS PER CUBIC METER

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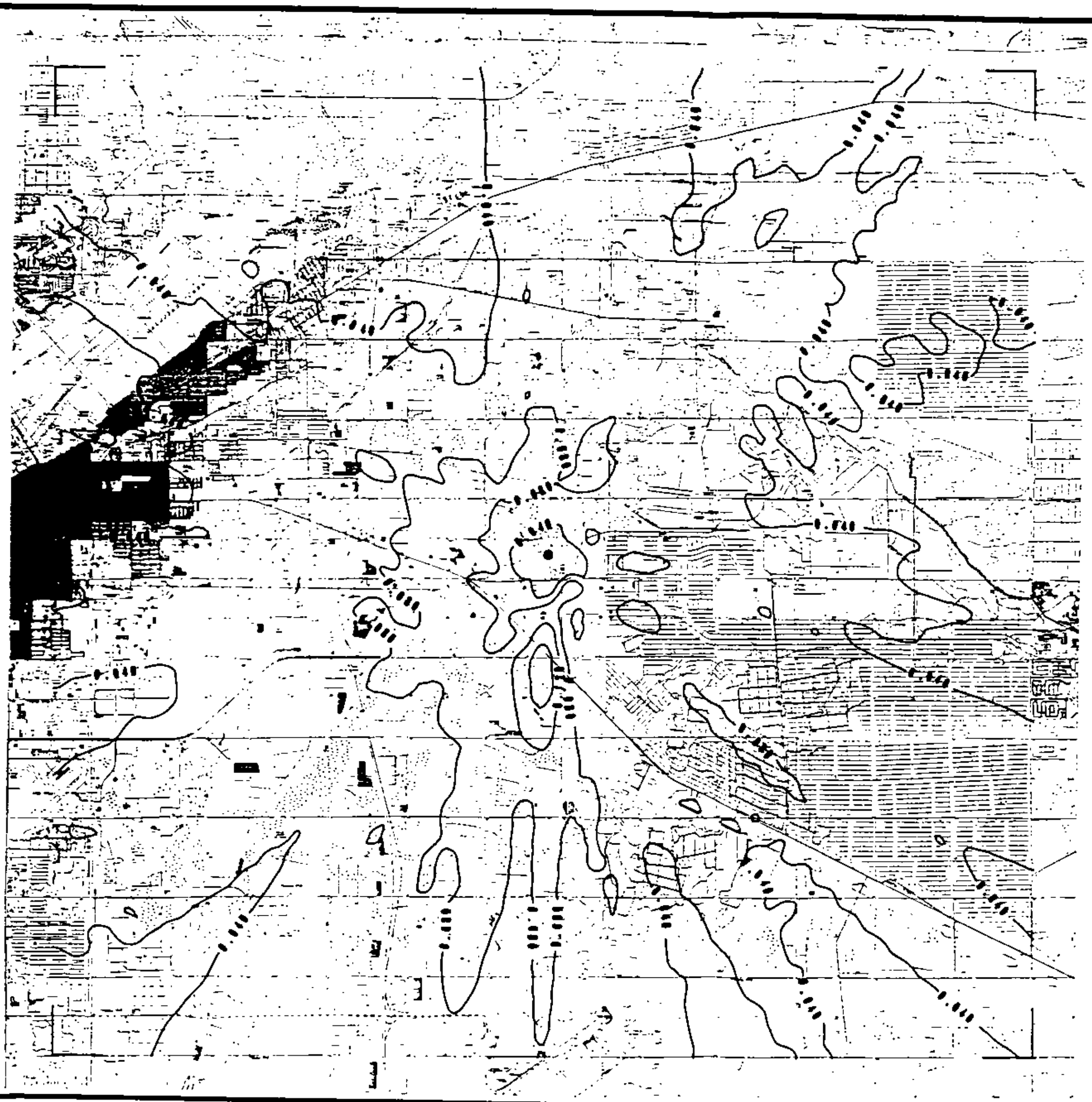
FIGURE 6-3
NORMALIZED GROUND-LEVEL CONCENTRATION ISOPLETHS: HIGHEST ANNUAL AVERAGE (1984)



LEGEND

0.000 NORMALIZED CONCENTRATIONS IN MICROGRAMS PER CUBIC METER

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FIGURE 6-4
NORMALIZED GROUND-LEVEL CONCENTRATION ISOPLETHS:
HIGH, SECOND HIGH 24-HOUR AVERAGE

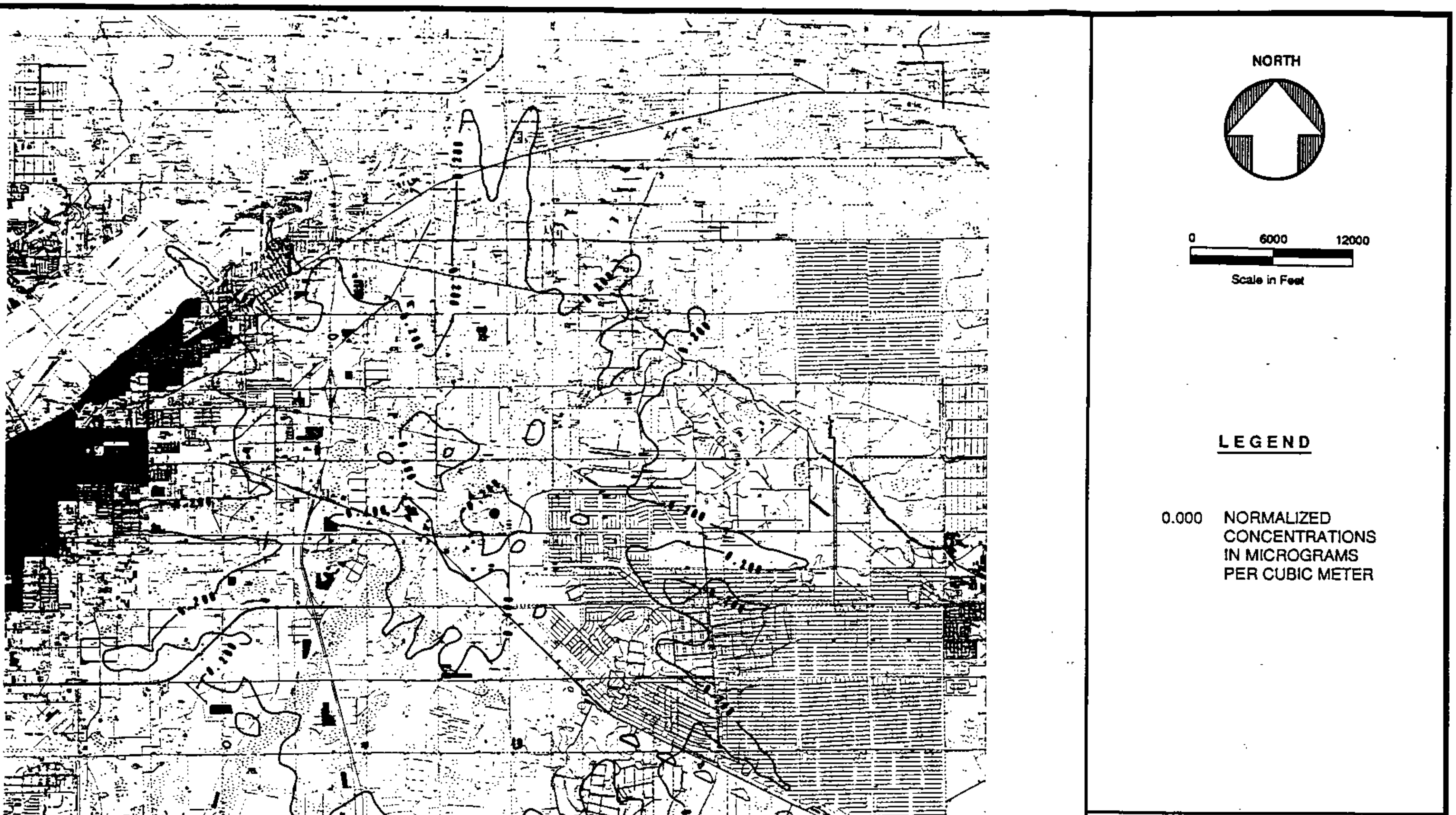

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FIGURE 6-5
NORMALIZED GROUND-LEVEL CONCENTRATION ISOPLETHS:
HIGH, SECOND HIGH 3-HOUR AVERAGE

increments. However, the highest concentrations were used conservatively for comparison to the de minimis monitoring guidelines (although EPA Region IV and DER do allow the use of HSH concentration). Limiting annual average impacts are based on the highest concentration predicted for the five years of meteorological data. The highest 24-hour concentration was also used as a conservative estimate of the quarterly lead impact and the 30-day average beryllium impact.

Predicted Air Quality Impacts

Ground-level concentrations were modeled for the pollutants anticipated to be emitted by the Lee County facility. The predicted pollutant ground-level concentrations are compared to PSD de minimis monitoring levels and significant impact levels (SIL) in Table 6-8. The predicted concentrations are determined by multiplying the 100 percent load pollutant emission rate (in grams per second) in Table 6-2 by the normalized ground-level concentration estimates (which include the load adjustment factors for the short-term averaging periods) presented in Table 6-7 for the appropriate averaging time. The highest predicted impacts are below the de minimis monitoring levels. Therefore, in accordance with 40 CFR 52.21(i)(8), the Facility should be exempted from pre-construction monitoring requirements. Thus, it has been assumed for purposes of processing this application that pre-construction monitoring will not be required for the proposed Facility. In light of the modeling results shown in Table 6-8, the Applicant requests DER to concur in this determination that pre-construction monitoring is not required.

The significant impact levels (SIL) are concentrations below which a Facility would not be considered to cause or contribute to a violation of the NAAQS (40 CFR 51.165(b)(2)). Table 6-8 shows that predicted impacts for all regulated pollutants emitted by the Lee County facility are below the corresponding SILs. Therefore, no further impact analysis of predicted cumulative effects of this Facility with other nearby major sources is required.

TABLE 6-8

LEE COUNTY ENERGY RECOVERY FACILITY COMPARISON OF MAXIMUM PREDICTED CONCENTRATIONS OF REGULATED POLLUTANTS TO SIGNIFICANT IMPACT AND DE MINIMIS MONITORING LEVELS

(concentrations in ug/m^3)

Pollutant	Averaging Period	Rank[a]	Maximum Predicted Concentration[b]	Significant Impact Level	PSD De Minimis Monitoring Level
Sulfur Dioxide (SO_2)	Annual	H	0.25	1	—
	24-hour	H	4.19	—	13
		HSH	3.46	5	—
	3-hour	H	21.0	—	—
		HSH	14.7	25	—
Nitrogen Dioxide (NO_2)	Annual	H	0.54	1	14
Particulate Matter (as TSP or PM_{10})	Annual	H	0.032	1	—
	24-hour	H	0.54	—	10
		HSH	0.45	5	—
Carbon Monoxide (CO)	8-hour	H	10.2	—	575
		HSH	8.2	500	—
	1-hour	H	96.0	—	—
		HSH	63.0	2,000	—
Lead (Pb)	3-month	H	0.017[c]	—	0.1
Mercury (Hg)	24-hour	H	0.023	—	0.25
Beryllium (Be)	24-hour	H	3.8×10^{-6}	—	0.001
Fluorides (as HF)	24-hour	H	0.098	—	0.25

SOURCE: Camp Dresser & McKee Inc., 1990.

[a] Abbreviations: H = Highest concentration
HSH = Highest, second-highest concentration

[b] Location and time-of-occurrence for maximum impacts (by rank) are provided in Table 6-7.

[c] The de minimis monitoring level for lead is a quarterly-averaged value. The 24-hour highest average concentration was substituted as a conservative estimate of the quarterly value.

NOTE: No significance guideline level is exceeded.

6.6 COMPARISON WITH AMBIENT AIR QUALITY STANDARDS

The purpose of the following analysis is to demonstrate that the proposed Facility will not cause or contribute to an exceedance of NAAQS/FAAQS. As shown in Section 6.5, the Facility has an insignificant impact for all criteria pollutants based on the modeling period 1982 to 1986. To conservatively demonstrate compliance with the NAAQS/FAAQS, the highest second-highest short-term, or highest annual modeled impacts of the Facility are added to the ambient background concentrations derived in Table 5-5. The comparison, presented in Table 6-9, is made with the more stringent of the federal or state standard.

The Facility impacts alone are very small in comparison to the ambient air quality standards. All Facility impacts consume less than 1.4 percent of the corresponding NAAQS/FAAQS. The highest 24-hour average lead impact is 0.017 ug/m^3, or 1.1 percent of the Florida quarterly standard. This percentage is inherently conservative because the highest 24-hour average concentration was used to estimate the quarterly impact. The highest, second-highest 3-hour and 24-hour SO_2 concentrations represent only 1.1 percent and 1.3 percent of the respective FAAQS. The highest annual SO_2 impact is only 0.4 percent of the FAAQS. The highest second-highest total PM_{10} 24-hour concentration is 0.3 percent of the 150 ug/m^3 ambient standard, whereas the highest annual PM_{10} concentration is 0.06 percent of the annual ambient standard of 50 ug/m^3. The modeled highest annual NO_2 concentration is 0.5 percent of the FAAQS. Predicted highest second-highest carbon monoxide concentrations for one- and eight-hour averaging periods consume only 0.16 and 0.08 percent of their respective NAAQS/FAAQS.

The tabulated total impacts shown in Table 6-9 suggest that the NAAQS/FAAQS will be maintained by substantial margins. The largest estimated total concentration as a percent of its NAAQS/FAAQS is obtained by adding the estimated PM_{10} annual impact and the monitored background concentration. The total annual PM_{10} impact is 60 percent of the FAAQS; however, the impact from the Facility alone is only 0.06 percent of the standard. While the total highest second-highest 24-hour PM_{10} impact is 49 percent of the FAAQS, the impact from the Facility alone is 0.45 ug/m^3, or 0.3 percent of the FAAQS.

TABLE 6-9

COMPARISON OF PREDICTED IMPACTS FROM THE LEE COUNTY ENERGY RECOVERY FACILITY AND AMBIENT BACKGROUND CONCENTRATIONS TO THE NAAQS/FAAQS

(concentration in ug/m^3)

Pollutant	Averaging Time	Rank[a]	NAAQS/ FAAQS[b]	Facility Impact	Facility Impact as Percent of Standard	Ambient Background Concentration	Total Impact	Total Impact as Percent of Standard
Sulfur Dioxide	3-Hour	HSH	1,300 (1300)	14.7	1.1	136	151.0	12
	24-Hour	HSH	260	3.46	1.3	65	68.5	26
	Annual	H	60	0.25	0.4	6	6.3	10
Nitrogen Dioxide	Annual	H	100 (100)	0.54	0.5	40	40.5	41
Particulate Matter (as PM_{10})	24-Hour	HSH	150 (150)	0.45	0.3	73	73.5	49
	Annual	H	50 (50)	0.032	0.06	30	30.0	60
Carbon Monoxide	1-Hour	HSH	40,000	63.1	0.16	7	70.1	0.18
	8-Hour	HSH	10,000	8.21	0.08	5	13.2	0.13
Lead	3-Month	H	1.5 (1.5)	0.017[c]	1.1	0.10	0.12	8

SOURCE: Camp Dresser & McKee Inc., 1990.

[a] Abbreviations:
H = Highest
HSH = Highest Second-Highest

[b] The more stringent of federal or state standard is given. Secondary standards are shown in parentheses.

[c] Highest 24-hour average concentration used to conservatively estimate 30-day or 3-month average concentration.

The highest total annual impact for nitrogen dioxide is 41 percent of the standard, whereas the impact for the Facility alone is only 0.5 percent of the FAAQS. The 3-hour, 24-hour, and annual total impacts for sulfur dioxide are all less than 27 percent of their respective NAAQS/FAAQS. The total three-month lead impact consumes only eight percent of the lead standard, while the total carbon monoxide one- and eight-hour impacts consume less than 0.2 percent of their respective NAAQS/FAAQS.

6.7 ASSESSMENT OF NON-CRITERIA POLLUTANT IMPACTS

In the context of this discussion the term "non-criteria pollutant" is used as a general term for all pollutants listed in Table 6-10. These pollutants do not have FAAQS or NAAQS, and the Florida Department of Environmental Regulation has not officially adopted a set of Acceptable Ambient Levels (AALs) applicable to energy recovery facilities for the assessment of acceptable ground-level concentrations.

6.7.1 ASSESSMENT METHODS

Guideline concentrations for short- and long-term periods, including industrial toxicological limits (eight-hour time-weighted averages) and threshold levels (24-hour and annual averages), from states which have air toxics management programs as part of their air pollution control regulations are listed in Table 6-10. These are compared with modeled ground-level concentrations of mercury, beryllium, hydrogen fluoride, sulfuric acid mist, arsenic, and hydrogen chloride.

Threshold limit values (TLVs) adopted by the American Conference of Governmental Industrial Hygienists (ACGIH) are presented for comparison with eight-hour average concentrations from the Facility. These limits are normally intended for use in the practice of industrial hygiene for eight-hour work day and 40-hour work week exposures, and not for estimating the toxic potential of continuous, uninterrupted exposures. It is believed that nearly all workers may be repeatedly exposed day after day to a TLV without adverse effects (Plunkett, 1976). The ACGIH TLV values are the most complete listing of quantified acceptable exposure levels available.

TABLE 6-10

MAXIMUM PREDICTED CONCENTRATION OF NON-CRITERIA POLLUTANTS RESULTING FROM LEE COUNTY ERF EMISSIONS

Pollutant[a]	Averaging Period	Highest Concentration (ug/m$_3$)	ACGIH TLV[b] (ug/m$_3$)	North Carolina AAL[c] (ug/m$_3$)	Kentucky AAL[d] (ug/m$_3$)
Mercury (Hg)	8-hour	5.5×10^{-2}	50	—	2.38
	24-hour	2.3×10^{-2}	—	0.6	—
	Annual	1.0×10^{-3}	—	—	—
Beryllium (Be)	8-hour	9.3×10^{-6}	2.0	—	BR
	24-hour	3.8×10^{-6}	—	—	—
	Annual	2.3×10^{-7}	—	4.1×10^{-3}	—
Fluorides (as HF)	1-hour	0.559	—	250	—
	8-hour	0.24	2,000	—	—
	24-hour	0.099	—	30	49,070
	Annual	5.85×10^{-3}	—	—	—
Sulfuric Acid Mist (H_2SO_4 aqueous)	1-hour	5.72	—	100	—
	8-hour	2.47	1,000	—	23.8
	24-hour	1.01	—	12	—
	Annual	0.06	—	—	—
Arsenic (As)	8-hour	6.3×10^{-4}	200	—	BR
	24-hour	2.6×10^{-4}	—	—	—
	Annual	1.5×10^{-5}	—	2.3×10^{-4}	—
Hydrogen Chloride[e]	1-hour	10.3	—	700	167
	8-hour	4.44	7,000	—	—
	24-hour	1.81	—	—	—
	Annual	0.11	—	—	—
Dioxins[e] (as 2,3,7,8-TCDD toxic equivalent)	Annual	2.7×10^{-9}	—	3.0×10^{-6}	BR

TABLE 6-10
(continued)

SOURCE: Camp Dresser & McKee Inc., 1990.

[a] Asbestos, vinyl chloride, and hydrogen sulfide are regulated (40 CFR 52.21) pollutants with nil emission rates from the proposed Lee County RRF. Therefore, the resulting ambient impacts are nil, and are not listed.

[b] American Conference of Governmental Industrial Hygienists, Threshold Limit Values and Biological Exposure Indices for 1989-1990.

[c] Acceptable Ambient Levels, North Carolina Adiministrative Code, Title 15A, Chapter 2, Subchapter 2D, effective May 1, 1990. 15-minute averaging times for the standards of acid gases have been applied to one-hour average Facility concentrations.

[d] "Y" values from Kentucky Air Regulation 401KAR63:022, "New or Modified Sources Emitting Toxic Air Pollutants." The "Y" values are a function of the number of Facility operating hours per week, assumed, in this case, to be 168. The fluoride standard shown is an approximation of the actual standard, 60 ppm for a 2-month averaging period, from Appendix A of Regulation 401KAR53:010.

[e] Hydrogen chloride and dioxins are not regulated under the Clean Air Act or NESHAPS, and thereby are not PSD regulated pollutants.

[f] Not specified as 2,3,7,8 - TCDD toxic equivalents. Standard applicable after May 1, 1991.

BR - BACT required if emission rate exceeds review threshold.

Of the eight states in the U.S. EPA Region IV (Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee), only North Carolina and Kentucky have toxic air pollutant acceptable ambient levels (AALs) adopted into their state air pollution control regulations (Kevin Eldridge, Meteorologist and Tom Allen, Environmental Engineer, North Carolina Division of Environmental Management, May 22, 1990) (Marjorie Mullen, Environmental Engineering Technologist, Principal, Kentucky Department of Environmental Protection, May 22, 1990). South Carolina has revised draft AALs, which are expected to be adopted next year (1991) (John Hursey, Environmental Engineer, South Carolina Department of Health and Environmental Control, May 22, 1990).

Tennessee uses as guidelines for the assessment of impacts, 25 percent of the ACGIH TLVs as an eight-hour standard (Ron Redus, Environmental Specialist, Tennessee Air Pollution Control Division, May 22, 1990). Alabama uses guidelines based on the ACGIH TLVs. The predicted one-hour screening concentrations are compared to the TLV divided by a factor of 40. The annual average concentrations, using the ISCLT model, are compared to TLV divided by a safety factor of 420. Each pollutant must comply with at least one of these guidelines (Bob Cowne, Environmental Engineer, Alabama Department of Environmental Management, May 25, 1990). Georgia has air toxic guidelines which compare most pollutant impacts to acceptable ambient concentrations (AACs), based on the standards set forth by the Occupational Safety and Health Administration (OSHA). Any values not specifically shown as AACs are compared to ACGIH standards. Both sets of guideline values are a function of the number of hours per week emissions would occur, and are divided by a safety factor of 300 for known human carcinogens, or by 100 for non-carcinogens. The Georgia AACs are set as 24-hour averages (Jean Drew, Chemical Engineer, Georgia Department of Natural Resources, May 25, 1990).

Mississippi uses toxic air pollutant guidelines which compare annual predicted ambient concentrations to one percent of the TLVs. Proposed new guidelines would change this approach to compare the 24-hour predicted concentrations to one percent of the TLVs. For pollutants which are known carcinogens, a risk assessment is also required. Where carcinogenic pollutant concentrations are found to be within a certain risk value range, permit approval is assessed on a case-by-case basis, taking into consideration actual population exposure (Connie Simmons, Environmental Engineer, Air Planning Division, Mississippi Department of Natural Resources, May 29, 1990).

Florida is in the process of developing draft "no-threat" levels for toxic air pollutants. It is expected that these will become policy guidelines in August or September 1990, although it is the Applicant's understanding that DER does not intend them to be applied to energy recovery facilities. Table 6-10 shows modeled maximum Facility ground-level concentrations of non-criteria pollutants in comparison with the ACGIH TLVs, and with the adopted standards established in North Carolina and Kentucky.

6.7.2 COMPARISON WITH ACGIH TLVs AND AALs

Highest impacts of non-criteria pollutants listed in Table 6-10 are substantially less than the ACGIH TLVs and the two sets of AALs. The proposed Lee County ERF emissions will not likely pose a health risk to the surrounding population because the ground-level concentrations do not exceed acceptable levels for short- or long-term periods, as established by agencies with established regulations and air toxics research and management programs.

6.8 COMPARISON WITH PSD INCREMENTS

The Lee County energy recovery facility is a major source of SO_2, NO_2, and TSP emissions as defined in 40 CFR 52.21(b)(1)(i), and as presented in this application in Table 2-1. As such, it is subject to a PSD increment consumption analysis to ensure compliance with all PSD increments. Lee County and all adjacent counties are designated as PSD Class II areas (FAC 17-2.440), except for the southwestern tip of Collier County, which is occupied by part of the Everglades National Park. The Everglades is the only PSD Class I area within 100 km of the proposed Facility. The closest border of this Class I Area is 92 km (or 57 miles) to the south-southeast.

At the request of the National Parks Service (NPS, 1990), the Big Cypress National Preserve, 58 km (about 36 miles) southeast of the proposed Facility, was treated as an air quality-sensitive area. Estimated maximum ground-level pollutant concentrations from the Facility were modeled for receptors at both parks, and compared to Class I area significant impact levels (SILs) and PSD increments.

The following sections discuss impacts on these areas, classified as in attainment of the FAAQS and NAAQS. A discussion of Facility impacts in non-attainment areas is presented in Section 7.7.

6.8.1 PSD CLASS II AREAS

The baseline date for TSP and SO_2 was triggered for the entire state of Florida on December 27, 1977 [FAC 17-500(4)(b)(2.c)]. The major source baseline data for NO_2 was set nationally on February 8, 1988 (53 FR 4061, October 17, 1988). All new sources and modifications subject to PSD review after these dates are assumed to be PSD-increment consuming sources. On October 5, 1989, EPA proposed to revise the maximum allowable increases for particulate matter (54 FR 41218). The proposed increments would define maximum allowable increments in concentrations of PM_{10} for Class I, II, and III areas. These changes are proposed because EPA believes that the increments for particulate matter should be measured by the same pollutant indicator as the NAAQS. The implementation date for this change from TSP to PM_{10} based increments has not been set, and may take 21 to 25 months to become effective once the date is set. Therefore, the TSP increments currently in effect will be used; comparison with proposed PM_{10} increments will be discussed.

Ground-level impacts predicted for the Lee County energy recovery facility are shown in Table 6-8 to be below the significant impact levels for each applicable averaging period at all modeled receptors within PSD Class II areas for the 1982 to 1986 period. Therefore, additional modeling to determine the effect of other PSD sources on the available Class II increments is not required. However, as a major post-baseline source of SO_2, NO_2, and TSP, the Facility is considered to consume PSD increments for these pollutants for the applicable averaging periods.

All dispersion modeling for the PSD Class II area was based on five years (1982 to 1986) of hourly meteorological data, and on the worst-case operating conditions and Cartesian receptor grid discussed in Section 6.5.

Modeling Results

No PSD Class II increment is exceeded by any of the modeled pollutants. Each pollutant consumes less than four percent of its PSD increment. The highest annual SO_2 impact, shown in Table 6-11, is 1.3 percent of the allowable increment. The highest, second-highest SO_2 impacts are 2.9 and 3.8 percent of the 3-hour and 24-hour increments, respectively. The highest annual TSP impact is 0.17 percent of the allowable increment, and the highest, second-highest 24-hour impact is 1.2 percent of the TSP allowable increment. The highest annual nitrogen dioxide impacts are 2.2 percent of the PSD increment.

The highest annual PM_{10} ground-level impact for the Class II areas is 0.032 ug/m^3, or 0.19 percent, of the proposed Class II PSD increment of 17 ug/m^3. The highest, second-highest 24-hour PM_{10} impact is 0.45 ug/m^3, or 1.5 percent, of the proposed increment of 30 ug/m^3.

6.8.2 PSD CLASS I AND SPECIAL RECEPTOR AREAS

The Federal PSD regulations, FAC Section 17-2.440, and Section 165(e) of the Clean Air Act, require that a proposed source subject to PSD review conduct a dispersion modeling analysis of its impacts on any PSD Class I areas located within a 100 km radius. In this case, there is one applicable formal Class I area, the Everglades National Park, located 88 km south-southeast of the proposed Facility. At the request of the National Park Service (NPS, 1990), impacts at Big Cypress National Preserve, a Class II area located 61 km southeast of the Facility, are also modeled. As a conservative comparison, highest annual and highest short-term impacts at both areas are compared to Class I area SILs and PSD increments.

TABLE 6-11

COMPARISON OF IMPACTS FROM THE LEE COUNTY ENERGY RECOVERY FACILITY TO PSD CLASS II INCREMENTS

Pollutant	Averaging Period	Rank[a]	Maximum Impacts from Facility (ug/m^3)	PSD Class II Increment	Maximum Impact as a Percent of Increment
Sulfur Dioxide (SO_2)	Annual	H	0.25	20	1.3
	24-hour	HSH	3.46	91	3.8
	3-hour	HSH	14.7	512	2.9
Total Suspended Particulate Matter (TSP)	Annual	H	0.032	19	0.17
	24-hour	HSH	0.45	37	1.2
Particulate[b] Matter (PM_{10})	Annual	H	0.032	17[c]	0.19
	24-hour	HSH	0.45	30[c]	1.5
Nitrogen Dioxide (NO_2)	Annual	H	0.54	25	2.2

SOURCE: Camp Dresser & McKee Inc., 1990.

[a] Abbreviations: H = Highest
HSH = Highest, Second-Highest

[b] Conservative estimate assuming all TSP is in the form of PM_{10}.

[c] Proposed EPA standard (54 FR 41218; October 5, 1989).

The air quality impact analysis was conducted using ISCST to demonstrate that the proposed Lee County Facility would not have a significant impact, or produce an exceedance of an allowable PSD increment. The modeling is consistent with the procedure outlined in Section 6.5, except for the use of the receptor grid. A set of discrete receptors, shown on Table 6-12 and in Figure 6-6, was placed along each park boundary closest to the proposed Facility. Receptors were spaced at a resolution of between two and five azimuth degrees from the Facility stack, and each was assigned a ground-level elevation of five feet (msl).

Modeling Results

The special receptor modeling results are presented in Table 6-13. The highest annual and highest 24-, 8-, 3-, and 1-hour normalized concentrations are given along with the date, time, and specific receptor point at which the impact occurred.

Maximum predicted concentrations for the Everglades and Big Cypress National Preserve are compared to significant impact levels and Class I PSD increments in Table 6-14. All of the impacts are below the corresponding SILs. The impacts are also well below the Class I PSD increments.

At the Everglades National Park, the maximum 3- and 24-hour SO_2 impacts are 4.5 and 3.3 percent of their PSD increments, respectively. The maximum annual SO_2, TSP, PM_{10}, and NO_2 impacts are all less than 0.7 percent of their allowable increments, and the maximum 24-hour impacts for TSP and PM_{10} are each less than 0.3 percent of the PSD increments.

At Big Cypress National Preserve, the SO_2 maximum impacts are 5.8 and 4.9 percent of the 3- and 24-hour Class I PSD increments, respectively. The maximum annual SO_2, TSP, PM_{10}, and NO_2 impacts are each less than 1.0 percent of the corresponding Class I PSD increments. The maximum 24-hour TSP and PM_{10} impacts are both less than 0.4 percent of the corresponding Class I PSD increments.

TABLE 6-12

SPECIAL DISCRETE RECEPTOR LOCATIONS USED IN THE PSD INCREMENT CONSUMPTION ANALYSIS

Special Receptor	Distance Relative to Facility (km)	Receptor Coordinates UTM-East (km)	Receptor Coordinates UTM-North (km)	Assigned Elevation (ft, msl)	Reference Letter
Everglades National Park (Class I Area)	90	452	2,860	5	A
	88	454	2,863	5	B
	95	460	2,858	5	C
	95	464	2,860	5	D
Big Cypress National Preserve	74	467	2,886	5	E
	67	467	2,894	5	F
	61	467	2,903	5	G
	72	480	2,901	5	H

SOURCE: Camp Dresser & McKee Inc., 1990

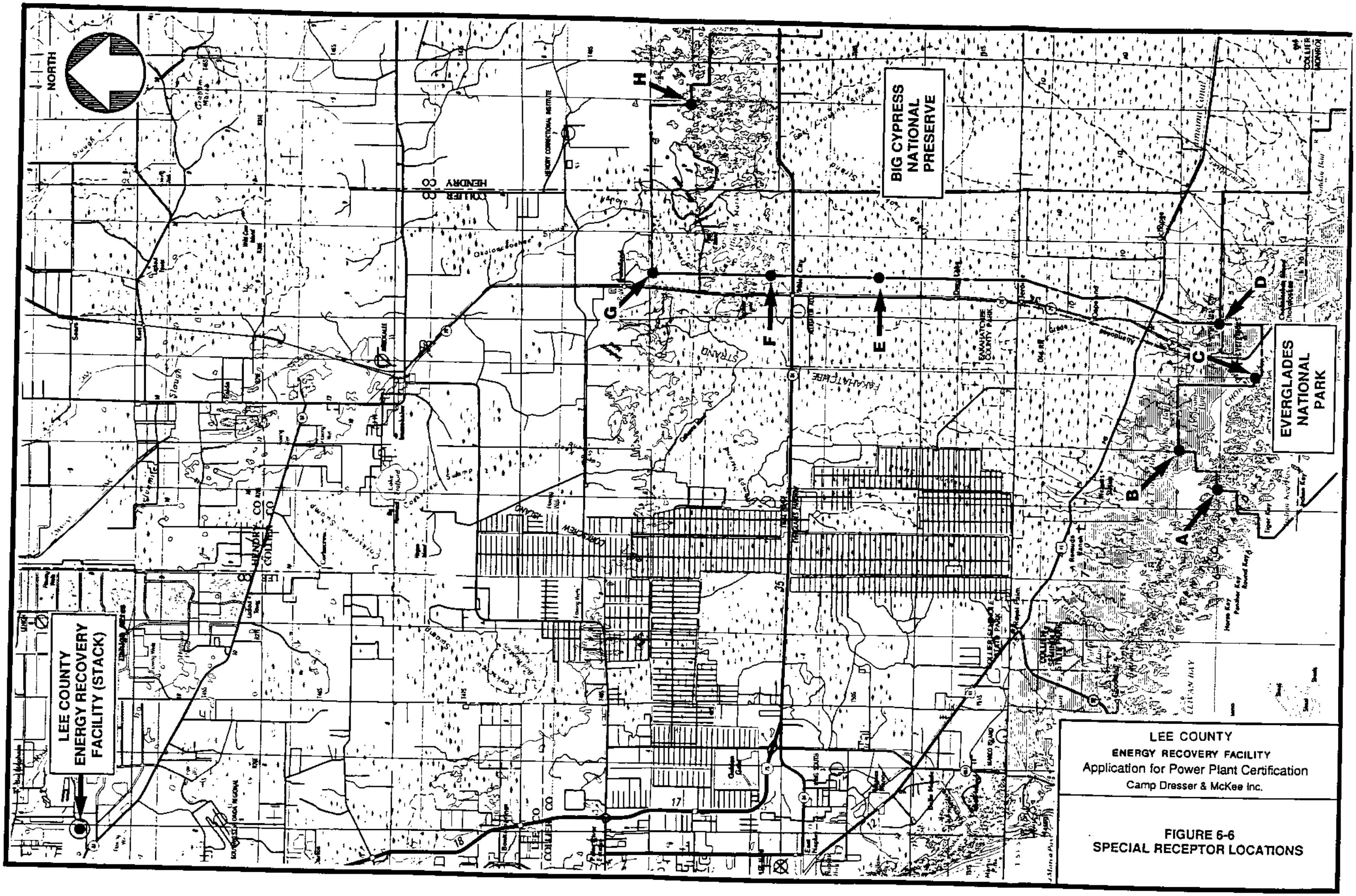

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FIGURE 6-6
SPECIAL RECEPTOR LOCATIONS

TABLE 6-13

SPECIAL RECEPTOR MODELING RESULTS

Averaging Period	Receptor	Reference Letter	Maximum Normalized Concentration[a] (ug/m^3)	Day	Period	Year
Annual	Everglades[b]	B	0.00043	—	—	1986
	Big Cypress[c]	H	0.00058	—	—	1983
24-hour	Everglades	A	0.00872	7	1	1984
	Big Cypress	G	0.01306	11	1	1983
8-hour	Everglades	A	0.02425	123	1	1986
	Big Cypress	G	0.03321	157	3	1986
3-hour	Everglades	A	0.04849	123	1	1986
	Big Cypress	G	0.06220	154	3	1985
1-hour	Everglades	A	0.08524	47	19	1984
	Big Cypress	H	0.12983	16	19	1984

SOURCE: Camp Dresser & McKee Inc., 1990.

[a] Highest annual and highest short-term values shown.

[b] The Everglades National Park, Class I area, 88 km south-southeast of the proposed Lee County Facility at the nearest point.

[c] Big Cypress National Preserve, 61 km southeast of the proposed Lee County Facility at the nearest point.

TABLE 6-14

COMPARISON OF MAXIMUM CONCENTRATIONS AT SPECIAL RECEPTOR LOCATIONS TO CLASS I SIGNIFICANT IMPACT LEVELS AND PSD INCREMENTS

(concentrations in ug/m^3)

Pollutant	Averaging Time	Maximum Predicted Concentration Everglades[a]	Maximum Predicted Concentration Big Cypress[b]	Class I Significant Impact Level[c]	PSD Class I Increments	Impact as % of PSD Increment Everglades	Impact as % of PSD Increment Big Cypress
SO_2	Annual	0.008	0.011	(1)[d]	2	0.4	0.6
	24-hour	0.164	0.245	1	5	3.3	4.9
	3-hour	1.137	1.458	(25)[d]	25	4.5	5.8
TSP	Annual	0.001	0.001	(1)[d]	5	0.02	0.02
	24-hour	0.021	0.032	1	10	0.2	0.3
PM_{10}	Annual	0.001	0.001	(1)[d]	4[•]	0.03	0.03
	24-hour	0.021	0.032	(5)[d]	8[•]	0.3	0.4
NO_2	Annual	0.018	0.024	(1)[d]	2.5	0.7	1.0

SOURCE: Camp Dresser & McKee Inc., 1990.

[a] Everglades National Park, Class I area.

[b] Big Cypress National Preserve, Class II area.

[c] FAC 71-2.100(170)

[d] Class II value is given. Class I value is not available.

[•] Proposed EPA Standard (54 FR 41218; October 5, 1989).

NOTE: No Class I Significant Impact Level is exceeded.

SECTION 7.0

ADDITIONAL IMPACT ANALYSES

7.0 ADDITIONAL IMPACT ANALYSES

7.1 INTRODUCTION

This section describes the analysis performed to assess the impact of the Lee County ERF on Air Quality Related Values (AQRVs) as required under the PSD regulations. The AQRVs assessed are:

- Visibility in Class I areas within 100 km of the Lee County ERF,
- Impacts from growth indirectly related to the Facility, and
- The potential for impacts to soil and vegetation.

Air quality impacts from criteria pollutants in the Everglades National Park Class I Area and the Big Cypress National Preserve are also presented. Other issues addressed in this section include an assessment of secondary sources from the Lee County ERF and an analysis of predicted impacts within pollutant non-attainment areas.

7.2 VISIBILITY IMPACTS

Visibility impairment can be quantified by determining the spectral light intensity at a given location in the atmosphere with known aerosol and pollutant concentrations. Visibility impairment includes such things as the reduction of visual range, the perceptibility of plume shapes and haze layers, atmospheric discoloration, and plume-modified visual contrast of distant objects. These effects are caused by changes in light intensity as a result of the scattering and absorption of light (radiation) by particles and/or atmospheric aerosols. When the physical and chemical properties of the plume are known, the impact on visibility can be estimated (Latimer and Ireson, 1980).

Visual Impact Screening and Analysis (EPA 450/4-88-015) known as VISCREEN (November, 22, 1988), the EPA-approved Level I visibility computer model based on the "Workbook for Plume," was used to estimate the impact of the stack emissions from the Lee County ERF upon visibility. The National Park

Service directed that VISCREEN be used for the analysis of the Facility's potential visibility impacts at the Everglades National Park (Bud Rolofson, National Park Service, April 1990). VISCREEN is designed to identify emission sources that have the potential of adversely affecting visibility. This analysis is based on conservative assumptions of pollutant emissions, atmospheric pollutant photochemistry, and worst-case meteorological conditions that would produce maximum in-plume pollutant concentrations. If a Level I analysis shows that a source would not cause adverse visibility impairment, then a more rigorous Level II analysis would not be required. If the visibility indices shown under "Plume" predicted for the Lee County ERF are below the threshold value of 0.05, as shown under "Criteria" in the tables, then the source is presumed to have a negligible impact on visibility at those locations.

The Level I modeling technique used for the Lee County ERF assesses the in-plume concentrations of nitrogen dioxide, primary sulfates, and particulate matter to determine indices of plume contrast against the sky, the plume contrast against terrain, and changes in sky/terrain contrast caused by primary and secondary precursor pollutants. Included as input to the analysis is the approximate distance of the source from a potentially affected Class I area, the vertical dispersion coefficient corresponding to the Pasquill-Gifford F stability category (Turner, 1970) for that distance, and Lee County ERF emission rates for NO_2, SO_2, and TSP.

The VISCREEN analysis was performed for Lee County ERF impacts on PSD Class I areas, and areas identified by the National Park Service (NPS, 1990) as "sensitive," within 100 km of the proposed site in accordance with FAC 17-2,500 (5)(e) 1. The Everglades National Park Class I area is located approximately 88 km south-southwest of the site. Big Cypress National Preserve, an area considered sensitive by the National Park Service, is located southeast of the site. Computations of the contrast parameters for the areas are presented in Tables 7-1a and 7-1b. Results of the Level I visibility impairment analysis for each area demonstrate that all contrast parameters have values much less than the 0.05 threshold value. Thus, emissions from the Lee County ERF will not have a significant impact on visibility at the Class I and sensitive areas.

TABLE 7-1a

VISUAL EFFECT SCREENING ANALYSIS FOR LEE COUNTY ENERGY RECOVERY FACILITY CLASS I AREA: EVERGLADES NATIONAL PARK

LEVEL-1 SCREENING

Input Emissions For:	Emission Rate (g/s)
Particulates	2.68
NO_x (as NO_2)	44.90
Primary NO_2	0
Soot	0
Primary SO_4	0

Input Parameters[a]

Background Ozone: 0.04 ppm
Background Visual Range: 40.00 km
Source-Observer Distance: 88.00 km
Min. Source-Class I Distance: 88.00 km
Max. Source-Class I Distance: 217.00 km
Plume-Source-Observer Angle: 11.25 degrees
Stability Factor: 6
Wind Speed: 1.00 m/s

RESULTS
Maximum Visual Impacts Inside Class I Area

					Delta E		Contrast	
Backgrnd	Theta	Azi	Distance (km)	Alpha	Criteria[b]	Plume	Criteria[b]	Plume
Sky	10	84	88.0	84	2.00	0.424	0.05	-0.002
Sky	140	84	88.0	84	2.00	0.148	0.05	-0.003
Terrain	10	84	88.0	84	2.00	0.037	0.05	0.001
Terrain	140	84	88.0	84	2.00	0.011	0.05	0.001

SOURCE: VISCREEN model output.

[a] Default particle characteristics.

[b] Screening criteria are not exceeded.

TABLE 7-1b

VISUAL EFFECT SCREENING ANALYSIS FOR LEE COUNTY ENERGY RECOVERY FACILITY SENSITIVE AREA: BIG CYPRESS NATIONAL PRESERVE

LEVEL-1 SCREENING

Input Emissions For:	Emission Rate (g/s)
Particulates	2.68
NO_x (as NO_2)	44.90
Primary NO_2	0
Soot	0
Primary SO_4	0

Input Parameters[a]

Background Ozone:	0.04 ppm
Background Visual Range:	40.00 km
Source-Observer Distance:	61.00 km
Min. Source-Class I Distance:	61.00 km
Max. Source-Class I Distance:	125.00 km
Plume-Source-Observer Angle:	11.25 degrees
Stability Factor:	6
Wind Speed:	1.00 m/s

RESULTS

Maximum Visual Impacts Inside Sensitive Area

					Delta E		Contrast	
Backgrnd	Theta	Azi	Distance (km)	Alpha	Criteria[b]	Plume	Criteria[b]	Plume
Sky	10	84	61.0	84	2.00	1.380	0.05	-0.004
Sky	140	84	61.0	84	2.00	0.495	0.05	-0.008
Terrain	10	84	61.0	84	2.00	0.186	0.05	0.002
Terrain	140	84	61.0	84	2.00	0.066	0.05	0.002

SOURCE: VISCREEN model output.

[a] Default particle characteristics.

[b] Screening criteria are not exceeded.

7.3 GROWTH ANALYSIS

The Lee County ERF, once operational, will employ approximately 50 persons. It is anticipated that the majority of these personnel requirements will be filled from within the local labor force. Significant in-migration to the area is therefore not anticipated. As a result, no increase in population in the area attributable to the Facility is expected to occur.

The project does not require the destruction, relocation, or alteration of any residential property in the area. In addition, since no net migration to the area is anticipated, there will be no change in demand for housing units in the area.

The construction and operation of the Lee County ERF will have a minor positive net effect on industrial and commercial development. The Facility will promote development by providing for solid waste disposal, and thereby be an integral part of the plans for development within Lee County. It is not anticipated that this effect will be significant when considered on a regional basis.

The growth analysis indicates that no net significant change in employment, populations, housing, or commercial/industrial development will be associated with the project. As a result, there will not be any significant increases in pollutant emissions indirectly associated with the Lee County ERF.

7.4 CLASS I AIR QUALITY ANALYSIS

The Class I area nearest to the Facility is the Everglades National Park located about 88 km to the south-southeast. Although the Big Cypress National Preserve is not a Class I area, it was also included in this assessment at the request of the National Park Service. An analysis of potential impacts on these areas was performed using the ISCST dispersion model, and the same five-year meteorological data set and source input values employed for the FAAQS and PSD increment compliance demonstration in

Section 6.0. The pollutants analyzed are those with specified significant impact levels, namely SO_2, TSP, NO_2, and CO.

Table 7-2 presents the results of this analysis for the averaging periods of interest. Normalized concentrations are presented in this table based on a normalized 1.0 g/s emission rate for annual concentrations and a normalized 1.1 g/s emission rate for short-term (24-, 8-, 3-, and 1-hour) concentrations. The higher short-term emission rate reflects the increased emissions from the short-term operating condition of 6,000 Btu/lb refuse at 110 percent of the design heat release operating conditions. Annual rates are based on 5,000 Btu/lb waste at 100 percent of design operating conditions. The Julian day and year of each predicted maximum are also listed. Table 7-3 details the maximum concentration and the appropriate significance level for the four pollutants at the proposed emission rates modeled for the 1982 to 1986 meteorological period. As can be noted from Table 7-3, all predicted impacts are at most 25 percent, and many are less than 1 percent of their respective Class I significant impact levels as defined in FAC 17-2.100(170). Therefore, no significant impact due to Lee County Energy Recovery Facility emissions is predicted at the Everglades National Park Class I area or at the Big Cypress National Preserve. A detailed assessment of PSD Class I increment consumption at the Everglades National Park is presented in Section 6.0.

7.5 SOILS AND VEGETATION IMPACT ANALYSIS

DER requires that an assessment be undertaken of the potential impacts of emissions from a proposed facility on soils and vegetation of commercial or recreational value [FAC 17-2.500(5)(e)]. Pollutant emissions from the Lee County ERF were used to compute potential impacts on soils and vegetation.

Vegetative impacts from airborne pollutants may result from deposition on leaf surfaces as particulate matter (dry deposition), from solutions in rainfall (wet deposition), or by gaseous exchange. Airborne components may also enter vegetation through roots following deposition to soils. Accumulation of airborne pollutants in soil can also lead to changes in soil characteristics.

TABLE 7-2

SPECIAL RECEPTOR MODELING RESULTS

Averaging Period	Receptor	Reference Letter	Maximum Normalized Concentration[a] (ug/m^3)	Day	Period	Year
Annual	Everglades[b]	B	0.00043	—	—	1986
	Big Cypress[c]	H	0.00058	—	—	1983
24-hour	Everglades	A	0.00872	7	1	1984
	Big Cypress	G	0.01306	11	1	1983
8-hour	Everglades	A	0.02425	123	1	1986
	Big Cypress	G	0.03321	157	3	1986
3-hour	Everglades	A	0.04849	123	1	1986
	Big Cypress	G	0.06220	154	3	1985
1-hour	Everglades	A	0.08524	47	19	1984
	Big Cypress	H	0.12983	16	19	1984

SOURCE: Camp Dresser & McKee Inc., 1990.

[a] Highest annual and highest short-term values shown.

[b] The Everglades National Park, Class I area, 88 km south-southeast of the proposed Lee County Facility at the nearest point.

[c] Big Cypress National Preserve, 61 km southeast of the proposed Lee County Facility at the nearest point.

TABLE 7-3

MAXIMUM CONCENTRATIONS AT SPECIAL RECEPTOR LOCATIONS

Pollutant	Averaging Time	Everglades Class I Area (ug/m^3)	Big Cypress National Preserve (ug/m^3)	PSD Class I Significant Impact Level[a]
SO_2	Annual	0.008	0.011	(1)[b]
	24-hour	0.164	0.245	1
	3-hour	1.137	1.458	(25)[b]
TSP	Annual	0.001	0.001	(1)[b]
	24-hour	0.021	0.032	1
NO_2	Annual	0.018	0.024	(1)[b]
CO	8-hour	0.452	0.619	(500)[b]
	1-hour	4.242	6.462	(2,000)[b]

SOURCE: Camp Dresser & McKee Inc., 1990.

[a] 17-2.100 (170), FAC.

[b] Class II value is given. Class I value is not available.

The vegetation in the project area includes both cultivated food crops and naturally-occurring forest, scrub, and grass land. Actively cultivated crops include tomatoes and strawberries, though the areas under cultivation include only a small percentage of the land in the project area. Some portions of the project area are also used as pasture for cattle and horses and have been extensively grazed. The majority of the area around the site includes forest and scrub dominated by slash pine growing on sandy soils of the Boca, Malabar, and Valkaris soil types (Soil Conservation Service). Dry areas are predominantly pine flat woods or palmetto prairie, while wetter areas include pine/cypress, cypress, wet pine, and wet prairie habitats. Additional detail on vegetation is provided in the Vegetation/ Land Use sections of the site characterization (see Section 2.3.5, Volume I).

7.5.1 PREDICTED AIR QUALITY IMPACTS

The ground-level concentrations used in this section are the maximum annual concentrations predicted in Section 6.0. Although the maximum concentration was predicted at only a single downwind location, it will be used to conservatively demonstrate that soils and vegetation surrounding the Facility should not be adversely affected by pollutant emissions from the Facility.

To evaluate the potential impacts of air pollutants on the soils and vegetation, a Level I screening analysis, as recommended by the California Air Resources Board (CARB) for conservatively estimating pollutant deposition rates, was performed. For particulate matter, pollutants that are emitted primarily as particles, and pollutants which can condense onto or form particles, a deposition velocity of 2 cm/s was assumed. This deposition velocity is greater than that determined in the field for SO_2 deposition on grass (0.8 cm/sec), and therefore provides a conservative estimate of potential impacts. The deposition rates were calculated by multiplying the deposition velocities by the annual ground-level concentrations at the point of maximum impact, and used to assess pollutant impacts throughout the study area.

Incremental soil concentrations were predicted by assuming that accumulation of pollutants within the first centimeter of soil would occur over the 30-year lifespan of the Facility, and that an average soil density is 1,500 kg/m^3.

7.5.2 SPECIFIC POLLUTANTS

The potential impacts to soil and vegetation resulting from the Facility's pollutant emissions are discussed for the following specific compounds and materials: total suspended particulates (TSP), carbon monoxide (CO), sulfuric acid (H_2SO_4), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), fluoride (F), lead (Pb), mercury (Hg), beryllium (Be), arsenic (As), and hydrogen chloride (HCl).

Total Suspended Particulates (TSP)

Particulates can adversely impact vegetation by coating foliage, thus blocking sunlight required for photosynthesis and/or interfering with gas exchange. The projected addition of particulates to ambient air by the Facility will consist entirely of relatively fine particles that will not be deposited in significant amounts. Based on the maximum concentration for TSP of 0.032 ug/m^3, deposition over a 30-year period would be 0.605 g/m^2 and would contribute less than 40 mg/kg to the top centimeter of soil. This is a small fraction of the settleable particulate matter that naturally occurs. The predicted particulate emissions from the Facility are less than one percent of the NAAQS, and are not expected to have a significant impact either on soils or on vegetation. Chemical species attached to particulates are generally recycled as nutrients or fixed in a form unavailable to vegetation. No significant coating of foliage, blockage of sunlight, or interference with plant gas exchange processes is expected. Particulate contribution to soils via settling from the air will be very minor, and no increase in soil depth, appearance, or texture is anticipated.

Carbon Monoxide (CO)

Plants appear to be resistant to high levels of CO. In most species tested, exposure to 115 mg/m^3 for up to three weeks did not produce visible injury (Zimmerman et al., 1983).

The proposed Facility will contribute a maximum annual average CO concentration of 0.25 ug/m^3. Total concentrations, as a result of Facility operations, will thus be far below concentrations which would cause visible injury to vegetation.

Sulfuric Acid (H_2SO_4)

H_2SO_4 is formed when gaseous SO_3 produced by the Facility reacts with atmospheric water vapor to form acidified water vapor which can create acidic (low-pH) precipitation. The Facility will add an estimated maximum annual average of 5.99×10^{-2} ug/m^3 of H_2SO_4. It is not anticipated that this concentration will contribute significantly to acidic precipitatio. It is very small when compared to existing concentrations from other sources such as fossil-fuel power plants. However, it is not possible to precisely predict the amount of acid deposition on plant surfaces, because: (1) H_2SO_4 aerosols are neutralized by the presence of ammonia in the atmosphere (Huntzicher et al., 1980); (2) observed effects of acid precipitation on vegetation may be positive due to fertilization impacts of sulfur, or negative due to the leaching of leaf surfaces; and (3) the impact of emissions of H_2SO_4 from a single facility on vegetation cannot be differentiated from the impacts of acid rain from background sources.

Sulfur Dioxide (SO_2)

A maximum annual ground-level concentration for SO_2 of 0.249 ug/m^3 is predicted from the Facility. This value, when added to a background level of 6 ug/m^3, is far below the 200-ug/m^3 threshold concentration which could cause a reduction in the relative growth rate of a pine species.

Sensitivity of plant species to SO_2 appears to vary not only with the climate of an area, but with the duration of exposure. Garsed and Rutter (1982) reported that various species of conifer (Pinus sp.) had markedly differing sensitivities to levels of SO_2, ranging from 200 ug/m^3 for 11 months to 8,000 ug/m^3 for six hours. A 14 percent reduction in relative growth rate was seen in one pine species at prolonged exposures to the 200 ug/m^3 dosage level. A number of oak and pine species (e.g., black and red oak, white pine) have been reported to develop visible injury when exposed to concentrations of SO_2 between 786 and 1,572 ug/m^3 for three hours (Jones et al., 1974).

Nitrogen Dioxide (NO_2)

Direct deposition of nitrogen oxides from the atmosphere to soils adds nitrogen to the soil, which is beneficial to plant growth. However, some nitrogen dioxide in the atmosphere can also be converted to nitric acid, and contribute to acid precipitation. It is estimated that the impacts on increased acid deposition due to the Facility will be negligible. The Facility will produce a maximum annual NO_2 concentration of 0.54 ug/m^3. The maximum annual ambient NO_2 concentration monitored for the project area was 40 ug/m^3 (to which the Facility would contribute only one percent). Total concentrations will thus be far below the estimated threshold level (120 ug/m^3) of injury to certain plants, as discussed below.

The short-term injury threshold for NO_2-tolerant species, such as corn and sorghum, has been found to be 24,400 ug/m^3 NO_2 for a one-hour exposure when grown in a controlled environment (Thompson et al., 1974). Continuous exposure throughout the growth period to 470 ug/m^3 NO_2 reduced size and productivity and increased senescence in tomatoes and navel oranges (Taylor et al., 1975). The concentration of NO_2 has been found to be a greater influence on the extent of injury than the length of exposure.

The greater-than-additive effect of NO_2 and SO_2 in combination on crops has been shown to vary between crop species and varieties. In a study of yield reduction in soybeans, no adverse effects were observed at atmospheric concentrations of 481 ug/m^3 SO_2 in combination with 155 ug/m^3 of NO_2

(Amundson, 1983). The results of these investigations indicate that the presence of elevated levels of NO_2 in the atmosphere in combination with SO_2 above a threshold level can lead to adverse crop response. NO_2 concentrations below 120 ug/m^3 have not been reported to produce injury in the absence of other pollutants (Thompson et al., 1974).

Fluoride (F Compounds)

Fluorides include a group of compounds such as HF, NaF, and Ca_2F formed through combination of fluorine with several elements. Fluoride emissions from high temperature furnaces can be either in the form of particulates or in a gaseous form, generally HF. The use of air pollution control equipment such as fabric filters acts to remove most particulates, and hence most fluoride emissions are as gases.

The maximum 24-hour ground-level concentration resulting from operation of the proposed Facility is estimated to be 0.098 $\mu g/m^3$. The annual average ground-level concentration to be produced by the Facility is estimated to be 5.85×10^{-3} ug/m^3, which is many times less than the concentration found to produce 40 ppm of fluoride in grass (discussed below). The deposition of flourides as particulate from the Facility would result in an estimated accumulation of 0.11 gm/m^2, which would produce a concentration in the top centimeter of soil of about 7.3 mg/kg over the 30-year lifespan of the Facility. These concentrations are not anticipated to produce adverse impacts to vegetation or grazing animals.

Fluoride is the most phytotoxic of the common air pollutants. Susceptible species can be injured at atmospheric concentrations 10 to 100 times lower (0.8 ug/m^3) than those of other major pollutants (Weinstein and Alscher-Herman, 1982). It accumulates in plants and can cause disease in herbivores which consume vegetation.

Fluorides can produce toxic side effects for vegetation and grazing animals which ingest such vegetation. Fluorosis has been shown to occur in dairy cows fed a diet containing 40 to 50 ppm of fluoride over a period of months to years. Hence, several states (Florida and New York, for example) have established standards that limit the level of fluoride in forage grown during the growing season (six months) to 40 ppm.

Exposures to high levels of fluorides generate no ill effects if the period of exposure is less than two months for young heifers, or four to six months for older animals. In Florida, cattle grazed on fields adjacent to fluoride emission sources such as phosphate plants show no ill effects if herds are routinely rotated to other fields on a monthly or bimonthly basis. The ground-level fluoride concentrations which produce a 40 ppm fluoride level in grasses will vary depending on the season, temperature, and grass species composition. Rainfall can act to wash off deposited particulate fluorides, reducing the concentration available for uptake during grazing. Canadian Forest Service data indicate that long-term ground-level fluoride concentrations in air of 0.90-1.0 ug/m^3 can produce fluoride concentrations in grasses of approximately 40 ppm (Sidhu, 1978).

Lead (Pb)

Lead toxicity has not been observed in plants growing under natural conditions, except in areas adjacent to heavy emission sources. The maximum annual predicted incremental ground-level concentration of lead resulting from the Facility is 0.001 ug/m^3. That is a low concentration when compared to heavy emission sources, such as freeway traffic, which can produce ground-level lead concentrations in the range of 0.1 to 1 ug/m^3 on a quarterly average. Deposition as particulate is estimated at 0.019 g/m^2, with soil concentrations in the top centimenter estimated at 1.23 mg/kg. These levels are not significant in comparison to naturally-occurring levels in soils.

Studies have shown that soils are capable of fixing large additions of lead compounds absorbed from the atmosphere (Chapman, 1966). Natural soils typically contain 2 to 200 ppm of lead (Allaway, 1968). Lead is strongly adsorbed in soils, therefore only minor amounts are available for uptake by vegetation.

Although lead in soils is largely unavailable to plants, the primary entryway of lead into vegetation is through the root system (Zimdahl, 1976). Lagerwerff (1971) found that in radishes grown in an area contaminated by auto emissions, nearly all of the lead in the roots and 60 percent of the lead in the leafy growth was attributable to soil, not air.

Mercury (Hg)

Mercurial compounds emitted to the atmosphere may affect plants by either foliar adsorption or by uptake and translocation from soils (CAST, 1976). In the study cited above, the environmental concentrations of mercury which result in elevated levels in soils and vegetation are considerably greater than the 0.0013 ug/m^3 annual average predicted for the Facility. Deposition as particulate would result in a maximum of 0.025 g/m^2 over the 30-year life of the Facility. The resulting soil concentration of mercury is conservatively estimated to be 1.67 mg/kg. Vegetative impacts are not expected to occur, nor is bioaccumulation due to this source expected to be a problem.

The accumulation of mercury by plants is more of concern due to bioaccumulation in the food chain than due to phytotoxic effects. An experiment to evaluate the uptake of Hg by bromegrass by applying 10 mg/kg of Hg to soils indicated that considerable accumulation of Hg was found in the plant root system, and only small amounts were translocated to the above-ground portions of the plant (Hogg et al., 1978). The environmental hazards associated with high levels of mercury deposition to soils at waste application sites have previously been identified as those related to ingestion of soil and plant parts by grazing animals.

Beryllium (Be)

Beryllium is toxic to plants due to poisoning of plant metabolic functions and nutrient depletion. Visible toxicity and decreases in growth rates have been observed in bean plants grown in nutrient solutions of 3 to 5 ppm. Since Be is more strongly immobilized in calcareous soils, the sensitivity of vegetation to Be is reduced as soil pH is increased (Lisk, 1972). Beryllium content in typical soils ranges from 0.5 to 10 mg/kg (Bohn et al., 1977).

The predicted maximum annual average Be ground-level concentration resulting from the Facility's emissions is 2.26×10^{-7} ug/m^3. The resulting deposition on study area soils is estimated to be 4.18×10^{-6} gm/m^2 over a 30-year period, which would produce a beryllium soil concentration of 2.79×10^{-4} mg/kg. This is so small compared to naturally occurring levels (0.5 to 10 mg/kg) that no toxic effects to vegetation are anticipated.

Arsenic (As)

The predicted maximum annual average arsenic ground-level concentration resulting from the Facility's emissions is 1.5×10^{-5} ug/m^3. The resulting deposition on study area soils is estimated to be 2.84×10^{-4} gm/m^2 over a 30-year period, which would produce an arsenic soil concentration of 1.89×10^{-2} mg/kg. This is so small compared to naturally occurring levels (a mean of 4.8 mg/kg) (Shacklette, H.T., and T.G. Boerngen, 1984) that no toxic effects to vegetation are anticipated.

Hydrogen Chloride (HCl)

Gaseous HCl will be emitted from the Facility as a result of the combustion of certain chlorine containing materials contained in the refuse. HCl fallout onto soil does not pose a serious risk to vegetation. HCl disassociates in soil and the Cl which occurs in a dissolved form is generally leached from the soil with precipitation. Since it is therefore unavailable for uptake through plant roots, indirect injury to vegetation through the soil is unlikely.

The Facility would increase HCl concentrations by a 24-hour maximum of 1.8 ug/m^3 and an annual average of 0.107 ug/m^3. Peak and long-term concentrations are well below levels specifically documented to cause injury and those proposed as adequate for vegetation protection. Therefore, HCl emissions are not expected to adversely impact local vegetation.

Studies of plant growth in an environment containing gaseous HCl have reported that exposures on the order of 10,000 ug/m^3 for one to two hours will produce plant injury. Intermittent exposure to concentrations of approximately 50 ug/m^3 was found to pose minimal risk to sensitive vegetation. It was suggested that concentrations ranging from approximately 6,000 ug/m^3 for 1.5 hours to 372 ug/m^3 for 120 hours or below would provide for adequate protection from HCl injury.

7.6 ASSESSMENT OF SECONDARY SOURCES

There are two secondary sources of particulate emissions associated with the Lee County facility. The vent on the top of the lime storage silo is a potential source of lime dust. The ash handling building vent is a potential source of ash residue emissions. These vents are minor point sources whose emissions are small compared to the particulate emissions from the stack and whose ambient impacts are expected to be insignificant. The nature of these sources and the manner in which they will be controlled is described below.

7.6.1 LIME SILO ROOF VENT

A lime silo(s) is included in the Facility to store the pebble lime used in the dry scrubber to control acid gas emissions. Lime is delivered in enclosed tractor-trailer trucks equipped with a dense phase pneumatic unloading system. Ambient air is used to fluidize and convey lime through pneumatic piping into the lime silo. The displaced air in the silo and air flow associated with the unloading operation are released through a roof vent into a fabric filter, which will be designed to have a particulate outlet loading of no more than 0.015 gr/acf for particles larger than one micron. The fabric filter will discharge the collected dust directly back into the storage bin.

The deliveries of lime are typically made every seven days. In normal practice, the truck operator will require about 1 to 1.5 hours to unload the lime, and about five minutes to clear the trailer hoppers and piping of any residual lime. The air flow rates during the transfer process range from 250 to 1,000 actual cubic feet per minute (ACFM). Assuming that the lime will be unloaded at the higher air flow rate, the maximum hourly emission is estimated at 0.129 pounds of particulate matter per hour. If a maximum of five deliveries each requiring 2.0 hours in duration are made per week, the annual emission rate would be approximately 67.1 pounds of particulate matter per year.

7.6.2 ASH HANDLING BUILDING VENT

Particulate emissions from the ash handling building are expected to be negligible. Ash from the end of the combustor grate or air pollution control equipment is quenched in a water tank and wetted to 15 to 25 percent moisture by weight. From the quench tank, the ash is conveyed to an ash handling building where the ash will enter a magnetic separator to remove ferrous material. The conveyor between the main building and the ash handling building is fully enclosed. Within the ash handling building, the ash is kept in bins until it can be taken to the ash landfill. The moisture content of the residue is maintained throughout the ash handling process to reduce resuspension of residue material. Any material that may become suspended is controlled through the use of a fabric filter on the ash handling building vent. Based on an airflow rate of 1,000 ACFM, the maximum hourly emission rate is estimated to be 0.015 gr/acf of particulate matter. This calculation represents a design value; actual emissions are expected to be considerably lower.

7.7 IMPACT WITHIN POLLUTANT NON-ATTAINMENT AREAS

In order to demonstrate that a new source will not prevent reasonable further progress toward attainment of the NAAQS, a source located outside a pollutant non-attainment area must show that it will have a less than significant impact within the non-attainment area. The Lee County ERF is not located within an area designated as non-attainment for any of the criteria pollutants. The nearest pollutant non-attainment areas (for ozone) are located in Palm Beach, Broward, and Dade counties. Palm Beach County is located 75 km to the east, while Broward and Dade counties are 80 and 110 km to the southeast, respectively. Pinellas County, 180 km northwest from the proposed site, is designated non-attainment for SO_2.

The ground-level concentrations for SO_2, PM^{10}, CO, and NO_x at the points of maximum impact, 0.7 to 3.0 km from the Lee County ERF, are well below their respective significant impact levels. Pollutant impacts at locations 75 km or more from the proposed Facility would be far less.

SECTION 8.0

REFERENCES

8.0 REFERENCES

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SECTION 9.0

ATTACHMENTS

ATTACHMENT A

EMISSION FACTOR SUPPORT DOCUMENT

ATTACHMENT A

EMISSION FACTOR SUPPORT DOCUMENT

A.1 INTRODUCTION

In this attachment, the emission factors for the Lee County Energy Recovery Facility (ERF) are derived based on stack testing data from existing facilities. Although several energy recovery facilities have recently received site certification, only three (Hillsborough County, Bay County, and the third unit in Pinellas County) have begun operation. Dade County has refurbished its existing facility which differs from the mass-burn technology to be employed by Lee County. Lake and Broward County facilities are still under construction. Therefore, the emission factors selected represent a reasonable upper limit of emissions based on the data available from other representative facilities.

The flue gas flow rates and composition used to calculate the following pollutant emission factors are based on the output of the BURN combustion model. BURN is a CDM proprietary mathematical model used to analyze combustion systems by specifying the operational parameters and waste characteristics. The output for this analysis, shown in Attachment D, is based on the combustion of 2,400 tons per day (tpd) of reference waste with a higher heating value of 5,000 Btus per pound (Btu/lb) of refuse.

Two BURN runs have been prepared—one for a rotary waterwall combustor and one for a stoker waterwall combustor—and are included in Attachment D. These BURN runs apply to the entire Facility (four stoker waterwall combustors or five rotary waterwall combustors). To be consistent with the air quality modeling analysis, the emission calculations for the rotary waterwall combustor are presented. Where emissions from the stoker waterwall combustor differ from the rotary waterwall combustor, these emissions are also presented.

A.2 PARTICULATE MATTER

Particulate matter generated during solid waste combustion is comprised of both unburned combustible material and inert material that was present in the solid waste. Because of the turbulent conditions in the combustor, this material becomes entrained in the flue gas stream as fly ash. Some of this fly ash settles from the flue gas as the gas passes through the heat recovery equipment. The remainder of the fly ash is carried to the air pollution control equipment.

A.2.1 TOTAL SUSPENDED PARTICULATE MATTER

It is expected that typical particulate loadings to the air pollution control equipment will average approximately 3.0 grains per dry standard cubic foot (gr/dscf) corrected to 7 percent O_2 with transient peak loadings of up to 5.0 gr/dscf corrected to 7 percent O_2. The proposed Facility shall have a fabric filter system dedicated to each mass-burn combustor, independent of design, to control particulate emissions. The guaranteed outlet particulate loading from the baghouse is 0.010 gr/dscf @ 7 percent O_2. Emission rates and factors based on this emission limitation are calculated as follows.

Basis: 0.010 grains per dry standard cubic foot
corrected to 7 percent oxygen (gr/dscf @ 7% O_2)

1. Adjust to actual O_2 as calculated by BURN

$$0.010\ \underset{@\ 7\%\ O_2}{\text{gr/dscf}}\ \frac{(21\% - 6.6\%\ O_2)}{(21\% - 7.0\%\ O_2)} = 0.0103\ \underset{\text{actual}}{\text{gr/dscf}}$$

2. Calculate the dry volumetric flow rate for the Facility

$$570.2\ \frac{\text{moles of flue gas}}{\text{min}}\ \left(385.3\ \frac{\text{dry std cu ft}}{\text{mole}}\right) = 219{,}698\ \frac{\text{dscf}}{\text{min}}$$

3. Calculate particulate emission rate for the Facility

$$0.0103\ \underset{\text{actual}}{\text{gr/dscf}}\ \left(219{,}698\ \frac{\text{dscf}}{\text{min}}\right)\left(\frac{\text{lb}}{7{,}000\ \text{gr}}\right)\left(\frac{60\ \text{min}}{\text{hr}}\right) =$$

$$19.4\ \frac{\text{lb PM}}{\text{hr}} = 85\ \frac{\text{tons PM}}{\text{yr}}$$

4. Calculate particulate emission factors

$$19.4\ \frac{\text{lb PM}}{\text{hr}}\ \left(\frac{\text{day}}{2{,}400\ \text{tons}}\right)\left(\frac{24\ \text{hr}}{\text{day}}\right) = 0.194\ \frac{\text{lb PM}}{\text{ton refuse}}$$

$$0.194\ \frac{\text{lb PM}}{\text{ton refuse}}\ \left(\frac{\text{lb}}{5{,}000\ \text{Btu}}\right)\left(\frac{\text{ton}}{2{,}000\ \text{lb}}\right) = 0.0194\ \frac{\text{lb PM}}{\text{MMBtu}}$$

Due to the low particulate outlet grain loading, the exhaust gases will comply with applicable state and federal opacity requirements. A continuous opacity monitor will be installed, calibrated, maintained, and operated in all of the stack's flues during Facility operation.

A.2.2 RESPIRABLE PARTICULATE MATTER

On July 1, 1987, EPA promulgated new standards for particulate matter having an effective diameter of less than 10 microns. This size range represents the respirable fraction of particulate matter and is referred to as PM_{10}. This standard is a better indicator of potential impacts to the public health and welfare from particulate matter than TSP.

Particulate size data is collected using an Anderson cascade impactor which expresses particle sizes as equivalent aerodynamic diameters. An equivalent aerodynamic diameter is defined as the diameter of a unit density sphere with the same settling velocity as the actual particle. This allows particles of varying sizes, shapes, and densities to be evaluated on the basis of their actual aerodynamic behavior.

The distribution of particulate mass by particle size is not certain since only a limited number of samples have been taken. For this analysis, particle size data from the Biddeford, Maine waste-to-energy facility will be used to characterize particulate emissions from the Lee County facility (see Table A-1). The Biddeford, Maine data was selected because Biddeford is a modern facility employing air pollution control equipment similar to the proposed Lee County facility. Three particle size distribution analyses were conducted at Biddeford.

TABLE A-1

LEE COUNTY ENERGY RECOVERY FACILITY PARTICLE SIZE DISTRIBUTION DATA FROM BIDDEFORD, MAINE

Run 1		Run 2		Run 3	
Particle Size (Microns)	Mass Fraction %	Particle Size (Microns)	Mass Fraction %	Particle Size (Microns)	Mass Fraction %
<0.63	2.4	<0.63	2.4	<0.63	5.5
1.0	0.8	1.0	2.9	1.0	4.3
1.25	0.5	1.25	1.4	1.25	3.1
2.0	3.9	2.0	4.8	2.0	6.8
2.5	3.9	2.5	3.8	2.5	1.8
6.0	26.3	6.0	49.9	6.0	33.9
10.0	21.5	10.0	30.6	10.0	22.6
15.0	23.1	15.0	4.2	15.0	14.7
20.0	17.6	20.0	0.0	20.0	7.3
>20.0	0.0	>20.0	0.0	>20.0	0.0
% Mass Fraction PM_{10}	59.3	% Mass Fraction PM_{10}	95.8	% Mass Fraction PM_{10}	78.0

SOURCE: Combustion Engineering, Inc., 1989.

As presented in Table A-1, particle size data from the Biddeford, Maine Facility, which is equipped with dry scrubbers and fabric filters, shows that PM_{10} emissions ranged from 59 percent to 96 percent of total particulate matter measured. Therefore, it was assumed that all of the particulate matter from the boiler stack would be PM_{10} for the calculation of mass emission rates.

A.2.3 LIME SILO VENT EMISSIONS

The lime storage silo at the proposed Facility will receive lime from delivery trucks. Lime will be pneumatically conveyed from the delivery truck to the storage silo. During this process, particulate emissions will be generated. The lime silo will be equipped with a baghouse filter, designed for 0.015 gr/acf, to control particulate emissions. Based on the expected delivery frequency, the estimated annual emissions would be approximately 67 pounds; therefore, this intermittent source was not included in the air quality modeling for the Facility.

A.2.4 ASH HANDLING BUILDING VENT EMISSIONS

The ash handling building ventilation exhaust system will be equipped with a fabric filter designed to achieve an outlet grain loading of 0.015 gr/acf. Fugitive particulate emissions will be controlled to levels not to exceed 7.01 tpy (based on the 0.015 gr/acf design emission rate, actual tpy emissions should be considerably lower). Due to the minor nature of the particulate emissions from this source, emissions from the ash handling building were not included in the air quality modeling.

A.3 SULFUR DIOXIDE

Sulfur dioxide (SO_2) formation is a function of the sulfur content of the fuel and the chemical form in which it occurs. Sulfur in solid waste occurs in several forms, as organic sulfur found in foods (proteins), rubber, leather, and textiles, and as inorganic sulfur found chiefly in coated papers as sulfides, sulfate, and sulfite. All of these compounds except sulfate, which typically accounts for two to three percent of the fuel sulfur content, can be converted to SO_2 during combustion. Sulfates generally do not disassociate and tend to remain in the bottom ash. During combustion, sulfur is oxidized to SO_2, with small amounts of the SO_2 being further oxidized to sulfur trioxide (SO_3). SO_3 will combine with water droplets to form sulfuric acid. Sulfuric acid emissions are discussed separately.

A dry scrubber system will be incorporated into each of the air pollution control trains dedicated for each of the Facility's combustors to control SO_2 and other acid gases. As discussed in the BACT analysis for SO_2, each air pollution control system will be designed to maintain an average stack outlet SO_2 concentration (independent of combustor design) of 30 ppmdv @ 7 percent O_2 or reduce SO_2 emissions by 80 percent (whichever is least stringent), both over a 24-hour block average as determined by CEMs.

The uncontrolled inlet SO_2 concentration of 330 ppmdv corrected to 7 percent O_2 is roughly equivalent to an upper bound refuse sulfur content of 0.25 percent with 75 percent conversion of sulfur to SO_2. The control system will reduce this inlet concentration by 80 percent to achieve an outlet SO_2 concentration of 66 ppmdv at 7 percent O_2 over a 24-hour average. Emission rates and factors based on the SO_2 emission limitation are calculated as follows.

Basis: 30 parts per million on a dry volume basis corrected to 7 percent oxygen (ppmdv @ 7% O_2)

1. Adjust to actual O_2 calculated by BURN

$$\begin{array}{c}30\text{ ppmdv}\\ @\ 7\%\ O_2\end{array}\ \frac{(21\% - 6.6\%\ O_2)}{(21\% - 7.0\%\ O_2)} = \begin{array}{c}30.9\text{ ppmdv}\\ \text{actual}\end{array}$$

2. Calculate sulfur dioxide emission rate for the Facility

$$\frac{30.9\text{ moles }SO_2}{1\times10^6\text{ moles}}\left(570.2\ \frac{\text{moles flue gas}}{\text{min}}\right)\left(64.07\ \frac{\text{lb }SO_2}{\text{mole }SO_2}\right)$$

$$\left(\frac{60\text{ min}}{\text{hr}}\right) = 67.8\ \frac{\text{lb }SO_2}{\text{hr}} = 297\ \frac{\text{tons }SO_2}{\text{yr}}$$

3. Calculate sulfur dioxide emission factor

$$67.8\ \frac{\text{lb } SO_2}{\text{hr}}\left(\frac{\text{day}}{2{,}400\text{ tons}}\right)\left(\frac{24\text{ hr}}{\text{day}}\right) = 0.678\ \frac{\text{lb } SO_2}{\text{ton refuse}}$$

$$0.678\ \frac{\text{lb } SO_2}{\text{ton refuse}}\left(\frac{\text{lb}}{5{,}000\text{ Btu}}\right)\left(\frac{\text{ton}}{2{,}000\text{ lb}}\right) = 0.0678\ \frac{\text{lb } SO_2}{\text{MMBtu}}$$

Basis: 330 parts per million on a dry volume basis corrected to 7 percent oxygen (ppmdv @ 7% O_2)

1. Apply 80 percent control efficiency

$$\begin{array}{c}330\text{ ppmdv } SO_2\\ @\ 7\%\ O_2\\ \text{uncontrolled}\end{array}(100\% - 80\%) = \begin{array}{c}66.0\text{ ppmdv } SO_2\\ @\ 7\%\ O_2\\ \text{controlled}\end{array}$$

2. Adjust to actual O_2 calculated by BURN

$$\begin{array}{c}66.0\text{ ppmdv } SO_2\\ @\ 7\%\ O_2\end{array}\frac{(21\% - 6.6\%\ O_2)}{(21\% - 7.0\%\ O_2)} = \begin{array}{c}68.1\text{ ppmdv } SO_2\\ \text{actual}\end{array}$$

3. Calculate sulfur dioxide emission rate for the Facility

$$\frac{68.1\text{ moles } SO_2}{1\text{x}10^6\text{ moles}}\left(570.2\ \frac{\text{moles flue gas}}{\text{min}}\right)\left(64.07\ \frac{\text{lb } SO_2}{\text{mole } SO_2}\right)$$

$$\left(\frac{60\text{ min}}{\text{hr}}\right) = 149\ \frac{\text{lb } SO_2}{\text{hr}} = 653\ \frac{\text{tons } SO_2}{\text{yr}}$$

4. Calculate sulfur dioxide emission factor

$$149.1\ \frac{\text{lb } SO_2}{\text{hr}}\left(\frac{\text{day}}{2{,}400\text{ tons}}\right)\left(\frac{24\text{ hr}}{\text{day}}\right) = 1.49\ \frac{\text{lb } SO_2}{\text{ton refuse}}$$

$$1.49\ \frac{\text{lb } SO_2}{\text{ton refuse}}\left(\frac{\text{lb}}{5{,}000\text{ Btu}}\right)\left(\frac{\text{ton}}{2{,}000\text{ lb}}\right) = 0.149\ \frac{\text{lb } SO_2}{\text{MMBtu}}$$

Because SO_2 emission rates and factors using the percent removal efficiency approach result in higher calculated values, the SO_2 emission factor of 0.149 lb SO_2/MMBtu and annual emission rate of 653 tons per year are proposed for the Facility in estimating impacts for averaging periods equal to or greater than 24 hours. The proposed Facility's total annual SO_2 emission rate is independent of the combustor design selected, even though the total number of combustors used and their throughput capacity is affected.

Due to variation in combustor operating conditions and refuse sulfur content, a short-term peak SO_2 concentration is projected to be 82.5 ppmdv corrected to 7 percent O_2. This short-term SO_2 outlet concentration is used to estimate air quality impacts for a three-hour average, and is based on a control system SO_2 reduction of 75 percent. Therefore, a short-term SO_2 emission factor of 0.186 lb/MMBtu is proposed for estimating impacts for the three-hour averaging period.

A.4 PRODUCTS OF COMBUSTION

Emissions of nitrogen oxides (NO_x), carbon monoxide (CO), and volatile organic compounds (VOC) are primarily a function of combustion conditions. The quantity of pollutant produced is dependent upon the design and operation of the furnace. Modern refuse combustors are designed to maximize air and fuel mixing effectiveness and combustion completion through proper furnace design and the ability to control the combustion process. Proper design of the overfire air jets, combustion temperature, and overfire air ratio promotes oxidation of the products of incomplete combustion.

A.4.1 NITROGEN OXIDES

Nitrogen oxides (NO_x) are products of all conventional combustion processes. Nitric oxide (NO) is the predominant form of NO_x produced, with lesser amounts of nitrogen dioxide (NO_2). However, once emitted into the atmosphere, NO converts rapidly to NO_2. Hence, NO and NO_2 are referred to collectively as NO_x. The state and federal air quality standards are based on NO_2. The generation of NO_x from the combustion of refuse is a result of two formation mechanisms, thermal NO_x and fuel NO_x.

The NO_x produced by the nitrogen contained in the combustion air supply (ambient air contains 79 percent nitrogen by volume) due to the high temperatures of combustion is referred to as thermal NO_x. Thermal NO_x formation is primarily a function of furnace temperature and excess air (oxygen availability).

Fuel NO_x, on the other hand, is formed when the nitrogen in the refuse is oxidized to NO. Fuel NO_x formation is strongly affected by the local oxygen concentration present in the flame, and also by the mixing rate of the refuse and combustion air. While the precise mechanism by which combustion air and fuel nitrogen are converted to NO_x (a function of furnace design, refuse composition, and facility operating parameters) is not completely understood, most of the NO_x emissions from modern municipal waste combustors are believed to result from the oxidation of fuel nitrogen.

As discussed in the BACT analysis for NO_x, the method used to minimize NO_x emissions is dependent upon the combustor design selected for the proposed Facility. If a rotary waterwall combustor is selected, NO_x control will be achieved through a staged combustion design. If a stoker waterwall design is selected, SNCR technology will be installed to reduce NO_x concentrations in the flue gas.

Rotary Waterwall Combustor

Emission rate projections for NO_x are based on testing at existing mass-burn rotary waterwall combustor installations. NO_x emissions were measured at the Bay County, Florida facility in May 1987 using a Theta Sensor continuous emission monitor (CEM) over a two-day period. NO_x levels measured by the CEM were verified during a six-hour period by simultaneously sampling the flue gas using EPA Reference Method 7. The Bay County facility incorporates two rotary waterwall combustor units with a throughput capacity of 510 tpd of refuse. The average flue gas concentration of NO_x from the CEM and Reference Method 7 were 180 and 157 ppmdv corrected to 12 percent CO_2, respectively.

Additional tests were conducted at the Bay County facility in March of 1988 and then again in April and August of 1989. The hourly sample averages for the test period during March 1988 ranges from approximately 100 to 160 ppmdv corrected to 7 percent O_2. The tests conducted in April of 1989 showed NO_x emissions in the range of 100 to 140 ppmdv corrected to 7 percent O_2.

NO_x emissions were measured at the Dutchess County facility located in Poughkeepsie, New York in February 1989 as part of an emission compliance test program. The hourly NO_x emissions averaged approximately 70 to 130 ppmdv corrected to 7 percent O_2. The Gallatin, Tennessee refuse combustion facility, which uses two rotary waterwall combustors, was tested in February of 1983. Although this is an older unit and was not equipped with combustion controls, measured NO_x levels were in the same range as those reported at the Bay County and Dutchess County plants.

The Gaston, NC facility recently received a NOx emission limit of 150 ppmdv @ 7 percent O_2 on a 24-hour block average by EPA Region IV. Therefore, a NO_x emission limit of 150 ppmdv @ 7 percent O_2 for a 24-hour block averaging is proposed for rotary waterwall combustors.

Stoker Waterwall Combustor

Emission rate projections for NO_x are based on recent stack test data at existing stoker waterwall combustors. For example, the Tulsa, Oklahoma facility incorporates two stoker waterwall combustors each with a throughput capacity of 375 tpd of refuse. A total of ten one-hour tests, five per boiler, were completed using CEMs in June 1986. The flue gas concentration of NO_x observed from the ten tests ranged from 347 to 390 ppmdv corrected to 7 percent O_2.

NO_x emissions were measured at the Marion County, Oregon facility in October 1986 as part of an emission compliance test program. The facility has two stoker waterwall combustors each with a throughput capacity of 275 tpd. Three one-hour tests were completed for each boiler using CEMs. Data from these tests indicated NO_x emissions ranging from 240 to 349 ppmdv corrected to 12 percent CO_2.

Recently, uncontrolled NO_x emissions data from the Stanislaus, California facility were obtained in December 1988 as part of an emission compliance test program. The facility has two 400-tpd stoker waterwall combustors, each with selective non-catalytic reduction (SNCR) flue gas NO_x control technology. Three NO_x emission tests, each approximately one hour long, were completed for each boiler with the SNCR system shut off prior to testing. The uncontrolled NO_x emissions data ranged from 290 ppmdv to 308 ppmdv corrected to 12 percent CO_2. The emissions projected for the stoker waterwall design take into consideration operation of the BACT determined SNCR technology having a control efficiency of up to 45 percent. Therefore, the proposed NO_x emission limitation for a stoker waterwall combustor is 200 ppmdv @ 7 percent O_2 on a 24-hour average using SNCR technology to reduce uncontrolled emissions.

The proposed Facility's NO_x emissions will be required to meet applicable final promulgated NSPS requirements for municipal waste combustors regardless of the combustor design selected. Emission rates and factors based on the NO_x emission limitations for both the rotary waterwall and stoker waterwall combustors are calculated as follows.

Basis: 150 ppmdv @ 7% O_2, 24-hour average, Rotary waterwall combustor
200 ppmdv @ 7% O_2, 24-hour average, Stoker waterwall combustor

1. Adjust to actual O_2 calculated by BURN

$$\frac{150\text{ ppmdv}}{@\ 7\%\ O_2}\ \frac{(21\% - 6.6\%\ O_2)}{(21\% - 7.0\%\ O_2)} = \frac{154.7\text{ ppmdv}}{\text{actual}}$$

2. Calculate nitrogen dioxide emission rate for the Facility

$$\frac{154.7\text{ moles }NO_x}{1\text{x}10^6\text{ moles}}\ \left(570.2\ \frac{\text{moles flue gas}}{\text{min}}\right)\ \left(46.01\ \frac{\text{lb }NO_x}{\text{mole }NO_x}\right)$$

$$\left(\frac{60\text{ min}}{\text{hr}}\right) = 243\ \frac{\text{lb }NO_x}{\text{hr}} = 1{,}064\ \frac{\text{tons }NO_x}{\text{yr}}$$

3. Calculate nitrogen dioxide emission factors

$$243\ \frac{\text{lb }NO_x}{\text{hr}}\ \left(\frac{\text{day}}{2{,}400\text{ tons}}\right)\ \left(\frac{24\text{ hr}}{\text{day}}\right) = 2.43\ \frac{\text{lb }NO_x}{\text{ton refuse}}$$

$$2.43\ \frac{\text{lb }NO_x}{\text{ton refuse}}\ \left(\frac{\text{lb}}{5{,}000\text{ Btu}}\right)\ \left(\frac{\text{ton}}{2{,}000\text{ lb}}\right) = 0.243\ \frac{\text{lb }NO_x}{\text{MMBtu}}$$

Rotary waterwall combustor = 0.243 lb NO_x/MMBtu, 24-hour average
Stoker waterwall combustor = 0.324 lb NO_x/MMBtu, 24-hour average

Compliance with the above emission limitations through the use of continuous emission monitors may show peak short-term concentrations that are greater than the 24-hour average levels. Therefore, a one-hour allowance of 220 ppmdv @ 7 percent O_2 is requested for either combustor design to account for these intermittent emission levels. For stoker waterwall combustors, this short-term allowance would correspond to an uncontrolled NO_x concentration of 400 ppmdv @ 7 percent O_2 and a SNCR removal efficiency of 45 percent. The short-term emission factor allowance is 0.356 lb NO_x/MMBtu.

A.4.2 CARBON MONOXIDE

Formation of carbon monoxide (CO) in the combustor results from the inability of the combustion system to complete the burnout of the combustible gases emitted from the burning refuse bed. The admission of overfire air provides for adequate oxygen levels and gas turbulence in the combustor which promotes oxidation of CO to CO_2, thereby minimizing emissions of CO. As discussed in the BACT analyses, proper combustor design combined with careful operation will promote good combustion conditions and thereby minimize emissions of CO.

Rotary Waterwall Combustor

CO emissions were measured at the Bay County, Florida facility on three separate days from November 1987 to January 1988 using a Land NDIR analyzer. Hourly average CO levels measured by the CEM ranged from 41 to 97 ppmdv corrected to 7 percent O_2. The average value for CO during this test program was 68 ppmdv corrected to 7 percent O_2. The CO emissions at the Bay County facility typically average in the range of 150 to 200 ppm as recorded by the continuous monitors. The Bay County facility permit limit is 800 ppm. Emission compliance tests were conducted at the Dutchess County, New York facility during the spring of 1989. Results of these tests show CO emissions in the range of 65 to 170 ppm. The facility permit limit is 170 ppm based on an eight-hour running average.

Therefore, the applicant proposes an emission limitation for CO of 150 ppmdv @ 7 percent O_2 for 4-hour block averages for rotary waterwall combustors.

Stoker Waterwall Combustor

O'Connell et al. (1982) reports that a modern stoker waterwall combustor incorporating overfire air and temperature monitoring can achieve an emission rate of 1.9 pounds of CO per ton of refuse. A four-day testing program conducted by Cooper Engineers (September 1983) at the older Chicago NW facility indicates an average emission factor from all the tests of 0.67 pounds of CO per ton of refuse. The proposed CO stack concentration for stoker waterwall combustors is 100 ppmdv @ 7 percent O_2, which corresponds to a emission factor of approximately 1.0 pound of CO per ton of refuse which is typical of these observed values.

Emission rates and factors based on the NO_x emission limitations for both the rotary waterwall and stoker waterwall combustors are calculated as follows.

Basis: 150 ppmdv @ 7% O_2, 4-hour average, Rotary waterwall combustor
100 ppmdv @ 7% O_2, 4-hour average, Stoker waterwall combustor

1. Adjust to actual O_2 calculated by BURN

$$\begin{array}{l} 150 \text{ ppmdv} \\ \text{@ } 7\%\ O_2 \end{array} \frac{(21\% - 6.6\%\ \text{O2})}{(21\% - 7.0\%\ \text{O2})} = \begin{array}{l} 154.7 \text{ ppmdv} \\ \text{actual} \end{array}$$

2. Calculate carbon monoxide emission rate for the Facility

$$\frac{154.7 \text{ moles CO}}{1\text{x}10^6 \text{ moles}} \left(570.2\ \frac{\text{moles flue gas}}{\text{min}}\right) \left(28.01\ \frac{\text{lb CO}}{\text{mole CO}}\right)$$

$$\left(\frac{60 \text{ min}}{\text{hr}}\right) = 148\ \frac{\text{lb CO}}{\text{hr}} = 648\ \frac{\text{tons CO}}{\text{yr}}$$

3. Calculate carbon monoxide emission factors

$$148\ \frac{\text{lb CO}}{\text{hr}} \left(\frac{\text{day}}{2{,}400\ \text{tons}}\right) \left(\frac{24\ \text{hr}}{\text{day}}\right) = 1.48\ \frac{\text{lb CO}}{\text{ton refuse}}$$

$$1.48\ \frac{\text{lb CO}}{\text{ton refuse}} \left(\frac{\text{lb}}{5{,}000\ \text{Btu}}\right) \left(\frac{\text{ton}}{2{,}000\ \text{lb}}\right) = 0.148\ \frac{\text{lb CO}}{\text{MMBtu}}$$

Rotary combustor = 0.148 lb CO/MMBtu, 4-hour average
Stoker combustor = 0.099 lb CO/MMBtu, 4-hour average

Compliance with the above emission limitations through the use of continuous emission monitors may show peak short-term concentrations that are greater than the four-hour average levels. Therefore, a one-hour allowance of 400 ppmdv @ 7 percent O_2 is requested to account for these intermittent emission levels. The short-term emission factor allowance is 0.395 lb CO/MMBtu.

A.4.3 HYDROCARBONS

Volatile organic compound (VOC) emissions are also a function of the combustion conditions rather than solid waste composition. They result from poor combustion at low temperatures with insufficient oxygen, turbulence, and residence time. Burnout of VOCs are accomplished through proper mixing of overfire air with the VOC at high temperatures for an adequate residence time.

Testing performed at the Bay County, Florida facility, which incorporates combustion controls, indicated hourly average flue gas concentrations of VOC in the range of 3 to 15 ppmdv @ 7 percent O_2, although recent tests from the Dutchess County, New York facility indicated levels as high as 53 ppmdv at 7 percent O_2. A maximum hourly average emission limit of 71.7 ppmdv @ 7 percent O_2 (expressed as methane) is proposed for the rotary waterwall combustor. Stoker waterwall combustors have consistently reported lower concentrations than this with most values falling below 10 ppmdv @ 7 percent O_2. Therefore, a lower one-hour average VOC stack concentration of 37.3 ppmdv @ 7 percent O_2 is proposed.

Emission rates and factors based on the hourly VOC emission limitations for both the rotary waterwall and stoker waterwall combustors are calculated as follows.

Basis: 71.7 ppmdv @ 7% O_2, 1-hour average, Rotary waterwall combustor
37.3 ppmdv @ 7% O_2, 1-hour average, Stoker waterwall combustor

1. Adjust to actual O_2 calculated by BURN

$$71.7 \underset{@\ 7\%\ O_2}{\text{ppmdv}}\ \frac{(21\% - 6.6\%\ O_2)}{(21\% - 7.0\%\ O_2)} = 73.9 \underset{\text{actual}}{\text{ppmdv}}$$

2. Calculate total hydrocarbons emission rate for the Facility

$$\frac{73.9 \text{ moles VOC}}{1\text{x}10^6 \text{ moles}} \left(570.2\ \frac{\text{moles flue gas}}{\text{min}}\right) \left(16.04\ \frac{\text{lb VOC}}{\text{mole VOC}}\right)$$

$$\left(\frac{60 \text{ min}}{\text{hr}}\right) = 40.6\ \frac{\text{lb VOC}}{\text{hr}} = 178\ \frac{\text{tons VOC}}{\text{yr}}$$

3. Calculate total hydrocarbon emission factors

$$40.6\ \frac{\text{lb VOC}}{\text{hr}} \left(\frac{\text{day}}{2{,}400 \text{ tons}}\right) \left(\frac{24 \text{ hr}}{\text{day}}\right) = 0.406\ \frac{\text{lb VOC}}{\text{ton refuse}}$$

$$0.406\ \frac{\text{lb VOC}}{\text{ton refuse}} \left(\frac{\text{lb}}{5{,}000 \text{ Btu}}\right) \left(\frac{\text{ton}}{2{,}000 \text{ lb}}\right) = 0.0406\ \frac{\text{lb VOC}}{\text{MMBtu}}$$

Rotary combustor = 0.0406 lb VOC/MMBtu, 1-hour average
Stoker combustor = 0.0210 lb VOC/MMBtu, 1-hour average

A.5 ACID GASES

The presence of acid gases in the combustion process is primarily a function of the composition of the refuse. Sulfides, chlorides, and fluorides in the flue gas stream are assumed to be emitted entirely as acidic compounds (i.e., sulfuric acid, hydrogen chloride, and hydrogen fluoride). Emissions of acidic compounds will be controlled through the use of a dry scrubber followed by fabric filter.

A.5.1 HYDROGEN CHLORIDE

Production of HCl depends on the quantity of chlorine in the solid waste and on the species of chlorine present. Not all of the chlorine in the solid waste will react to form gaseous HCl during combustion. Chlorine that is not volatilized or converted to HCl remains in the ash residue. The plastic component of solid waste, specifically polyvinyl chloride (PVC), is a major contributor to the generation of HCl in the stack gases. Plastics account for approximately 36 percent of the total chlorine content in solid waste (EPA, 1975). PVC, which contains 46 percent chlorine by weight, accounts for about five percent of the plastics found in solid waste. Essentially all of the PVC chlorine is converted to HCl. In addition to plastics, rubber and paper are significant sources of chlorine in solid waste.

Unabated HCl emissions vary depending on the composition of MSW. HCl emissions have been reported to vary from 100 to 1,100 ppm. The average of 18 unabated HCl flue gas concentrations from the Westchester County, New York facility is 575 ppmdv @ 7 percent O_2. The average of six runs conducted during the compliances tests for the Tulsa, Oklahoma facility is 420 ppmdv @ 7 percent O_2.

The dry scrubbing system will be designed to maintain an average outlet HCl flue gas concentration of 25 ppmdv @ 7 percent O_2 or reduce uncontrolled HCl emissions by 95 percent, whichever is least stringent on an eight-hour average basis. Peak uncontrolled HCl emissions of 1,000 ppmdv at 7 percent O_2 is roughly equivalent to an upper bound MSW chlorine content of 0.8 percent with a 90 percent conversion of chlorine to HCl. Emission rates and factors that correspond to these emission limitations are calculated below.

Basis: 25 parts per million on a dry volume basis corrected to 7 percent oxygen (ppmdv @ 7% O_2)

1. Adjust to actual O_2 calculated by BURN

$$\begin{array}{l}25\text{ ppmdv}\\ @\ 7\%\ O_2\end{array}\ \frac{(21\% - 6.6\%\ O_2)}{(21\% - 7.0\%\ O_2)} = \begin{array}{l}25.8\text{ ppmdv}\\ \text{actual}\end{array}$$

2. Calculate hydrogen chloride emission rate for the Facility

$$\frac{25.8\ \text{moles HCl}}{1\text{x}10^{6}\ \text{moles}}\left(570.2\ \frac{\text{moles flue gas}}{\text{min}}\right)\left(36.47\ \frac{\text{lb HCl}}{\text{mole HCl}}\right)$$

$$\left(\frac{60\ \text{min}}{\text{hr}}\right) = 32.2\ \frac{\text{lb HCl}}{\text{hr}} = 141\ \frac{\text{tons HCl}}{\text{yr}}$$

3. Calculate hydrogen chloride emission factor

$$32.2\ \frac{\text{lb HCl}}{\text{hr}}\left(\frac{\text{day}}{2{,}400\ \text{tons}}\right)\left(\frac{24\ \text{hr}}{\text{day}}\right) = 0.322\ \frac{\text{lb HCl}}{\text{ton refuse}}$$

$$0.322\ \frac{\text{lb HCl}}{\text{ton refuse}}\left(\frac{\text{lb}}{5{,}000\ \text{Btu}}\right)\left(\frac{\text{ton}}{2{,}000\ \text{lb}}\right) = 0.0322\ \frac{\text{lb HCl}}{\text{MMBtu}}$$

Basis: 1,000 parts per million on a dry volume basis corrected to 7 percent oxygen (ppmdv @ 7% O_2)

1. Apply 95 percent control efficiency

$$\underset{\substack{@\ 7\%\ O_2\\ \text{uncontrolled}}}{1{,}000\ \text{ppmdv HCl}}\ (100\% - 95\%) = \underset{\substack{@\ 7\%\ O_2\\ \text{controlled}}}{50.0\ \text{ppmdv HCl}}$$

2. Adjust to actual O2 calculated by BURN

$$\underset{@\ 7\%\ \text{O2}}{50.0\ \text{ppmdv HCl}}\ \frac{(21\% - 6.6\%\ O_2)}{(21\% - 7.0\%\ O_2)} = \underset{\text{actual}}{51.6\ \text{ppmdv HCl}}$$

3. Calculate hydrogen chloride emission rate for the Facility

$$\frac{51.6\ \text{moles HCl}}{1\text{x}10^{6}\ \text{moles}}\left(570.2\ \frac{\text{moles flue gas}}{\text{min}}\right)\left(36.47\ \frac{\text{lb HCl}}{\text{mole HCl}}\right)$$

$$\left(\frac{60\ \text{min}}{\text{hr}}\right) = 64.3\ \frac{\text{lb HCl}}{\text{hr}} = 282\ \frac{\text{tons HCl}}{\text{yr}}$$

4. Calculate hydrogen chloride emission factor

$$64.3\ \frac{\text{lb HCl}}{\text{hr}}\left(\frac{\text{day}}{2{,}400\ \text{tons}}\right)\left(\frac{24\ \text{hr}}{\text{day}}\right) = 0.643\ \frac{\text{lb HCl}}{\text{ton refuse}}$$

$$0.643\ \frac{\text{lb HCl}}{\text{ton refuse}}\left(\frac{\text{lb}}{5{,}000\ \text{Btu}}\right)\left(\frac{\text{ton}}{2{,}000\ \text{lb}}\right) = 0.0643\ \frac{\text{lb HCl}}{\text{MMBtu}}$$

A.5.2 SULFURIC ACID MIST

Trace amounts of sulfur trioxide (SO_3) gas are associated with the production of SO_2. The formation of SO_3 during combustion is dependent upon the SO_2 concentration and the combustion conditions supportive of oxidation of SO_2 to SO_3. In the moist flue gases, gaseous SO_3 reacts with water droplets to form sulfuric acid (H_2SO_4). Emissions of sulfuric acid mist are controlled though the use of a dry scrubber and fabric filter.

The stack test data from the Tulsa, Oklahoma facility shows the ratio of the uncontrolled H_2SO_4 to SO_2 emission rates for a three-hour average were 0.168 and 0.165 for units 1 and 2, respectively. Peak one-hour H_2SO_4/SO_2 ratios were 0.26 and 0.22 for units 1 and 2, respectively. Using a peak one-hour H_2SO_4/SO_2 conversion ratio of 0.24 and the SO_2 emission rate based on a control efficiency of 80 percent, the controlled H_2SO_4 emission factor is 0.0358 lb/MMBtu or 0.358 lb/ton of refuse. This corresponds to an annual emission rate of 157 tons of H_2SO_4 per year.

A.5.3 FLUORIDES

Production of fluorides from solid waste combustion facilities is a function of the fluorine (F) content of the waste as well as facility operation. Production of fluorides occur primarily as a result of the combustion of fluorinated plastics and other fluorocarbon products.

The average of nine sampling runs conducted at the Westchester County, New York facility resulted in an average HF concentration of 16.4 ppmdv @ 7 percent O_2. The peak HF concentration was 22 ppmdv @ 7 percent O_2. Compliance testing at the Tulsa, Oklahoma facility showed that the average uncontrolled concentration from the three runs conducted on each of the two units was 6.91 ppmdv @ 7 percent O_2. Controlled HF concentrations reported at the Marion County, Oregon facility were 0.51 ppmdv @ 7 percent O_2

Limited information on the removal efficiency of HF in dry scrubbing systems is available. However, if the uncontrolled HF concentrations at the Tulsa facility were representative of inlet concentrations to the scrubber at the Marion County facility, a removal efficiency of at least 90 percent, similar to that of HCl would be achieved.

As a reasonable upper limit, uncontrolled HF concentrations are estimated to be 50 ppmdv @ 7 percent O_2. Assuming that the dry scrubber will remove 90 percent of the uncontrolled emissions, an outlet gas concentration of 5.0 ppmdv @ 7 percent O_2 is projected. This is equivalent to 0.0035 lb HF per MMBtu or 0.035 lb per ton of MSW and an annual emission rate of 15.3 tons per year.

A.6 TRACE METALS

Because metals are present in solid waste, trace quantities of some metals will be emitted in the flue gases of the Facility. The amount of each metal emitted is a function of the quantity of the metal in the waste stream, the properties of the metal, combustion characteristics of the Facility, and the performance of the air pollution control equipment. The concentrations of trace metals in the waste stream may vary widely over short periods of time. Emission factors used to estimate trace metal emissions for the Lee County Energy Recovery Facility are based on stack tests conducted at recently permitted facilities because combustion conditions (high temperatures and long retention times) and air pollution control equipment (dry scrubber and fabric filters) employed at these facilities affect the mechanisms of volatilization, condensation, and agglomeration which will differ from those of older facilities.

Because of the high condensation temperatures, the volatilization and condensation of elemental metals and their compounds are expected to occur primarily in the furnace. Except for metals with low boiling points, such as mercury and arsenic, any further movement of metals from the gas phase to the particulate phase is expected to be negligible. Thus, a spray dryer followed by a baghouse provides for a high degree of metals removal from incinerator exhaust gas streams (NITEP, 1986).

Emission projections of trace metals presented in Table A-2 were derived from published tests of existing municipal waste combustors equipped with similar air pollution control technology. As can be seen from the data listed in Table A-3, considerable variability is present in the data base. Because of this variability and the fact that emission limits are established on a not-to-exceed basis, maximum expected emission factors developed for the Lee County facility represent a reasonable upper limit based on the available data and engineering judgment.

A.6.1 LEAD

Lead (Pb) is widespread as a trace metal in most components of the combustible fraction of solid waste and also appears in more concentrated metallic forms in ferrous cans, general solderings, and batteries. Lead is readily volatilized during combustion. The lead vapor will later solidify in the cooler areas of the heat recovery equipment by condensing on the surface of particles in the gas stream or will form particulate itself by self-nucleation. These particles are carried in the gas stream and delivered to the air pollution control equipment. Therefore, the capture of particulate matter in the control equipment results in the capture of lead. A fraction of the lead remains as a fine particulate and will escape capture in the control devices.

A few years ago, lead was assumed to make up 9 to 11 percent of the particulate emissions. Recent stack tests of facilities with high efficiency particulate control devices have shown lead making up a much smaller fraction of the total particulate emissions. The highest proportion of lead found in the Westchester County, New York facility sampling runs was 3.66 percent. Testing conducted on boiler number 1 at the Hillsborough County, Florida facility showed the faction of lead in the particulate was 2.8 percent.

The emission factors proposed for the Lee County facility are 0.0006 pounds of Pb per MMBtu or 0.006 pound of Pb per ton of refuse. These factors are about three percent of the total particulate emission factor and provide adequate margin compared to emission factors from other representative facilities presented in Table A-3. The estimated annual emission rate for lead is 2.6 tons per year.

TABLE A-2

LEE COUNTY ENERGY RECOVERY FACILITY EMISSION RATE CALCULATIONS FOR TRACE METALS

Pollutant	Emission Factor (lb/ton MSW)	Emission Factor (lb/MMBTu)	Total Facility Emission Rate (lb/hr)	Total Facility Emission Rate (tons per year)[a]
Lead	$6.0\text{x}10^{-3}$	$6.0\text{x}10^{-4}$	0.60	2.63
Beryllium	$1.35\text{x}10^{-6}$	$1.35\text{x}10^{-7}$	$1.35\text{x}10^{-4}$	$5.9\text{x}10^{-4}$
Mercury	$8.0\text{x}10^{-3}$	$8.0\text{x}10^{-4}$	0.80	3.50
Arsenic	$9.1\text{x}10^{-5}$	$9.1\text{x}10^{-6}$	$9.1\text{x}10^{-3}$	0.039

[a] Tpy based on 100 percent availability at nameplate design capacity, operating 8,760 hours per year.

TABLE A-3

EMISSION FACTORS IN LB/TON OF WASTE FIRED FOR SELECTED RESOURCE RECOVERY FACILITIES

Facility (name/location)	Type (Type of Comb. & Controls)	Size (tpd)	Test Date (year)	Be	Hg	As	Pb
Munich, N. Germany	MB/DS-ESP	1,060	1984	3.9×10^{-9}		3.6×10^{-6}	6.9×10^{-4}
Wurzburg, Germany	MB/DS-BH	662	1985			4.0×10^{-8}	7.8×10^{-5}
Bristol, CT	MB/DS-BH	650	1988	6.6×10^{-8}	9.0×10^{-4}	3.0×10^{-5}	2.2×10^{-4}
Biddeford, ME	RDF/DS-BH	600	1987		3.8×10^{-4}		6.6×10^{-4}
Marion Co., OR	MB/DS-BH	550	1986	2.1×10^{-8}	2.9×10^{-3}		2.9×10^{-4}
Commerce, CA	MB/DS-BH	380	1987	1.5×10^{-6}	3.2×10^{-4}	1.5×10^{-6}	1.6×10^{-5}
Mid-CT, CT	RDF/DS-BH	2,027	1988	ND	5.6×10^{-4}	ND	4.0×10^{-4}
Millbury, MA	MB/DS-ESP	1,500	1988	3.7×10^{-6}	1.2×10^{-2}	2.5×10^{-5}	2.8×10^{-3}
Bridgeport, CT	MB/DS-BH	2,250	1988	1.1×10^{-5}	3.0×10^{-3}	1.2×10^{-5}	2.3×10^{-5}
Tsuchima, Japan	MB/DS-BH	330	1983	2.0×10^{-6}	9.0×10^{-4}	2.0×10^{-6}	1.1×10^{-4}
Stanislaus, CA	MB/DS-BH	800	1988	4.9×10^{-9}	5.0×10^{-3}	1.3×10^{-5}	3.0×10^{-4}
Kent Co., MI	MB/DS-BH	625	1989	ND	1.7×10^{-3}	3.8×10^{-6}	ND
York Co., PA	MB(rotary)/ DS/BH	1,344	1990	ND	7.3×10^{-5}	ND	1.2×10^{-5}
Maximum Expected Value*				1.35×10^{-6}	8.0×10^{-3}	9.1×10^{-5}	6.0×10^{-3}

*Generally based on the highest mass-burn/dry scrubber-baghouse (MB/DS-BH) stack test data to provide adequate margin (if such representative data were available to make a determination). Additional test data for other facilities also provided for specific pollutants. Conservative values determined for As and Pb to account for waste stream variations and the fact that compliance with any permitted emission rates will be based on short-term emission tests. Long-term average emission rates are expected to be lower than the maximum expected values. Results from recent stack tests indicate that the maximum expected emission factor noted above for beryllium should be achievable despite the test value reported for Bridgeport, CT; the factor selected for Hg should also be achievable.

A.6.2 BERYLLIUM

Municipal solid waste is not a "beryllium containing waste" as described by the federal regulations for hazardous air pollutants. Beryllium (Be) is present only in trace quantities in refuse. Therefore, beryllium emissions are expected to be minimal.

Beryllium is much less volatile than lead and mercury; therefore, most of this metal will be retained in the ash. Emission of beryllium from energy recovery facilities are associated with particulate emissions and will be efficiently controlled through the use of a fabric filter. Beryllium emissions from existing facilities, if detected at all, are present only in small quantities. The emission data for beryllium presented in Table A-3 show emission factors which vary over three orders of magnitude. This variation is directly related to the amount of beryllium in the waste at the time testing was conducted.

The proposed emission factor for beryllium is $1.35\text{x}10^{-7}$ lb of Be per MMBtu or $1.35\text{x}10^{-6}$ lb of Be per ton of refuse, which corresponds to an annual emission rate of Be of $5.9\text{x}10^{-4}$ tons per year.

A.6.3 MERCURY

Only trace quantities of mercury (Hg) and its compounds are evident in municipal solid waste. Usually only a small portion of Hg is retained in the grate residue, as Hg is volatilized into the flue gas. As vaporized Hg passes through the boiler and air pollution control system, some Hg vapor condenses onto suspended particulate matter in the flue gas stream. Because fine particles have a high surface area to volume ratio, the fraction of Hg vapor that does condense would be preferentially associated with fine particulate matter.

Because of the lower outlet temperatures and the additional retention times between boiler outlet and fabric filter inlet, facilities incorporating a dry scrubber are assumed to have lower Hg emissions. However, a sufficient long-term data base does not exist to verify or quantify the degree of reduction that may be achieved. Some facilities equipped with just ESP particulate control have tested within the same range as those equipped with scrubber-baghouses; however, waste stream variations may have affected such tests.

The proposed emission factors for mercury are 8.0×10^{-4} lb Hg per MMBtu or 8.0×10^{-3} lb Hg per ton of refuse. These values represent some anticipated reduction of emissions compared to facilities using particulate control alone, while still representing an upper bound estimate of potential Hg emissions. The estimated annual emission rate for Hg is 3.5 tons per year.

A.6.4 ARSENIC

As with mercury emissions, arsenic (As) is expected to be emitted both as a vapor and particle. The St. Louis Demonstration (Gorman, 1977) calculated vapor metal emissions of arsenic. The study indicated that the fraction of metal in the vapor phase to metal in the particulate phase is 0.30. Because dry scrubbers are assumed to promote additional condensation and agglomeration, the vapor to particle ratio is expected to be lower and the fraction of arsenic controlled is expected to be greater.

The proposed emission factors for arsenic are 9.1×10^{-6} lb As per MMBtu or 9.1×10^{-5} lb As per ton of refuse. This value represents some anticipated reduction of emissions over facilities that do not have a dry scrubber, while still representing an upper bound estimate of potential As emissions. The estimated annual emission rate for As is 0.04 tons per year.

A.7 DIOXINS AND FURANS

PCDD and PCDF are two groups of structurally similar chemical compounds. Each is composed of two benzene rings which are connected by either one oxygen atom (PCDF) or two oxygen atoms (PCDD). There are 75 PCDD and 135 PCDF group members (or isomers). The chemical, physical, and toxicological properties of each isomer vary relative to its chemical structure. Generally, the most toxic isomers are those which have four chlorine atoms located in the lateral positions in the molecule (attached to the carbon atoms numbered 2, 3, 7, and 8).

Because of its high toxicity, more research has been performed on the health effects of 2,3,7,8 tetrachlorodibenzo-p-dioxin (2,3,7,8 - TCDD) than on any other PCDD or PCDF isomers. It is used as a basis for comparing the relative toxicity of the other PCDD and PCDF components. In 1987, EPA developed interim 2,3,7,8 - TCDD toxic equivalency factors (TEF), the use of which permit an evaluation of the overall toxicity of a mixture of PCDD and PCDF relative to the better known toxicity of 2,3,7,8 - TCDD. TEFs have also been developed by other agencies such as the New York State Department of Health.

This approach assumes that all isomers which have chlorine atoms in the 2, 3, 7, and 8 positions are more toxic than other isomers. It assigns relative weighting factors to the other isomers based on the ratio of estimated toxicity of the isomer to the 2,3,7,8 - TCDD isomer. The total emission rate of PCDD and PCDF is expressed as 2,3,7,8 - TDDD toxic equivalent. The 2,3,7,8 - TCDD toxic equivalent emission rate (based on EPA's 1987 TEFs) for the Facility is based on meeting 2 ng/Nm^3 corrected to 7% O_2. The annual Facility emission rate and emission factors are calculated below.

Basis: 2.0 nanograms per normal cubic meter
corrected to 7 percent O_2 (ng/Nm^3 @ 7% O_2)
(based on EPA, 1987 Toxic Equivalency Factors)

1. Adjust to actual O_2 as calculated by BURN

$$\underset{@\ 7\%\ O_2}{2\ \text{ng/Nm}^3}\ \left(\frac{21\% - 6.6\%\ O_2}{21\% - 7.0\%\ O_2}\right) = \underset{\text{actual (toxic equivalent)}}{2.06\ \text{ng/Nm}^3\ 2,3,7,8\ \text{TCDD}}$$

2. Calculate the dry volumetric flow rate for the Facility

$$570.2\ \frac{\text{moles of flue gas}}{\text{min}}\ \left(\frac{385.3\ \text{dry std cu ft}}{\text{mole}}\right) = \frac{219{,}698\ \text{dscf}}{\text{min}}$$

$$\frac{219{,}698\ \text{dscf}}{\text{min}}\ \left(\frac{0.0263\ \text{Nm}^3}{\text{dscf}}\right) = \frac{5{,}797\ \text{Nm}^3}{\text{min}}$$

3. Calculate 2,3,7,8 - TCDD (toxic equivalent) emission rate for the Facility

$$\underset{\text{actual}}{2.06\ \text{ng/Nm}^3}\ \left(\frac{5{,}797\ \text{Nm}^3}{\text{min}}\right)\left(\frac{1\text{x}10^{-9}\ \text{gm}}{\text{ng}}\right)\left(\frac{60\ \text{min}}{\text{hr}}\right)$$

$$\left(\frac{0.002205\ \text{lb}}{\text{gm}}\right) = 1.58\text{x}10^{-6}\ \frac{\text{lb}}{\text{hr}} = 6.9\text{x}10^{-6}\ \frac{\text{tons}}{\text{yr}}\ \text{2,3,7,8 TCDD (toxic equivalent)}$$

4. Calculate 2,3,7,8 - TCDD (toxic eqivalent) emission factors

$$1.58\text{x}10^{-6}\ \frac{\text{lb}}{\text{hr}}\left(\frac{\text{day}}{2{,}400\ \text{tons}}\right)\left(\frac{24\ \text{hr}}{\text{day}}\right) = \frac{1.58\text{x}10^{-8}}{\text{ton refuse}}\ \frac{\text{lb}}{}\ \text{2,3,7,8 TCDD (toxic equivalent)}$$

$$\frac{1.58\text{x}10^{-8}\ \text{lb}}{\text{ton refuse}}\left(\frac{\text{lb}}{5{,}000\ \text{Btu}}\right)\left(\frac{\text{ton}}{2{,}000\ \text{lb}}\right) = \frac{1.58\text{x}10^{-9}}{\text{MMBtu}}\ \frac{\text{lb}}{}\ \text{2,3,7,8 TCDD (toxic equivalent)}$$

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ATTACHMENT B

METEOROLOGICAL DATA

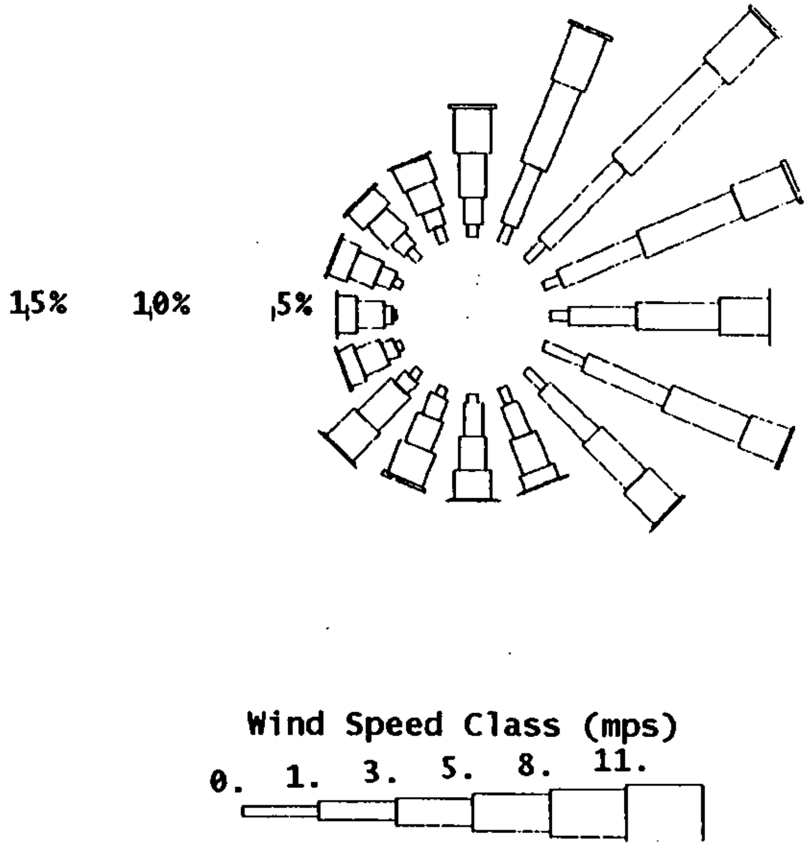
ATTACHMENT B

METEOROLOGICAL DATA

This attachment presents wind roses and wind speeds by stability class for each year (1982 to 1986) from National Weather Service Station Number 12835 at the Fort Myers Page Field Airport. These five years of surface wind data were used in the dispersion modeling analysis. The upper air data from National Weather Service Station Number 12842 at Tampa (Tampa International Airport) were used to estimate mixing heights during this period. The Fort Myers/Tampa data are the most representative data that are available of conditions at the Facility site. They were provided by Mr. Thomas rogers of DER for use in this permit application (Thomas Rogers, 1989).

SITE 01 FROM 01/02/82 TO 12/31/82

WIND SPEED AND DIRECTION ROSE



NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX A

FROM JAN. 1 1982 THROUGH DEC. 31 1982

	+--------WIND SPEED CLASSES (MPS)-------+							
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	AVERAGE WIND SPEED
N	0.01	0.08	0.00	0.00	0.00	0.00	0.09	2.31
NNE	0.00	0.02	0.00	0.00	0.00	0.00	0.02	2.31
NE	0.01	0.06	0.00	0.00	0.00	0.00	0.07	2.06
ENE	0.03	0.10	0.00	0.00	0.00	0.00	0.14	1.97
E	0.00	0.02	0.00	0.00	0.00	0.00	0.02	2.57
ESE	0.01	0.03	0.00	0.00	0.00	0.00	0.05	1.67
SE	0.00	0.02	0.00	0.00	0.00	0.00	0.02	2.31
SSE	0.00	0.01	0.00	0.00	0.00	0.00	0.01	2.06
S	0.00	0.05	0.00	0.00	0.00	0.00	0.05	2.31
SSW	0.00	0.03	0.00	0.00	0.00	0.00	0.03	2.40
SW	0.00	0.06	0.00	0.00	0.00	0.00	0.06	2.06
WSW	0.01	0.03	0.00	0.00	0.00	0.00	0.05	2.19
W	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WNW	0.00	0.01	0.00	0.00	0.00	0.00	0.01	2.57
NW	0.00	0.05	0.00	0.00	0.00	0.00	0.05	2.19
NNW	0.00	0.02	0.00	0.00	0.00	0.00	0.02	2.31
TOTAL	0.08	0.61	0.00	0.00	0.00	0.00	0.69	2.15
AVG SPD	0.88	2.32	0.00	0.00	0.00	0.00	2.15	2.15

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX B

FROM JAN. 1 1982 THROUGH DEC. 31 1982

	+-------WIND SPEED CLASSES (MPS)-------+							AVERAGE
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	WIND SPEED
N	0.02	0.09	0.20	0.00	0.00	0.00	0.31	3.09
NNE	0.02	0.10	0.22	0.01	0.00	0.00	0.36	3.04
NE	0.06	0.11	0.25	0.00	0.00	0.00	0.42	2.95
ENE	0.03	0.07	0.40	0.00	0.00	0.00	0.51	3.18
E	0.02	0.07	0.26	0.00	0.00	0.00	0.36	3.19
ESE	0.01	0.13	0.42	0.00	0.00	0.00	0.56	3.25
SE	0.02	0.11	0.40	0.00	0.00	0.00	0.54	3.10
SSE	0.01	0.07	0.23	0.01	0.00	0.00	0.32	3.29
S	0.02	0.10	0.22	0.01	0.00	0.00	0.36	3.12
SSW	0.01	0.10	0.24	0.00	0.00	0.00	0.36	3.37
SW	0.00	0.03	0.36	0.02	0.00	0.00	0.41	3.54
WSW	0.00	0.05	0.17	0.01	0.00	0.00	0.23	3.47
W	0.00	0.05	0.29	0.06	0.00	0.00	0.39	3.81
WNW	0.01	0.09	0.17	0.01	0.00	0.00	0.29	3.15
NW	0.02	0.05	0.20	0.02	0.00	0.00	0.29	3.40
NNW	0.01	0.07	0.16	0.00	0.00	0.00	0.24	3.16
TOTAL	0.29	1.30	4.19	0.16	0.00	0.00	5.94	3.25
AVG SPD	1.09	2.35	3.59	5.44	0.00	0.00	3.25	3.25

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX C

FROM JAN. 1 1982 THROUGH DEC. 31 1982

	+-------WIND SPEED CLASSES (MPS)-------+							AVERAGE
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	WIND SPEED
N	0.02	0.08	0.24	0.16	0.01	0.00	0.52	4.07
NNE	0.03	0.09	0.42	0.42	0.00	0.00	0.98	4.45
NE	0.09	0.08	0.84	0.51	0.00	0.00	1.52	4.21
ENE	0.08	0.15	0.55	0.53	0.01	0.00	1.32	4.20
E	0.03	0.10	0.41	0.55	0.00	0.00	1.10	4.49
ESE	0.07	0.17	0.68	0.44	0.00	0.00	1.36	4.00
SE	0.03	0.21	0.55	0.40	0.00	0.00	1.19	4.00
SSE	0.02	0.09	0.41	0.10	0.00	0.00	0.63	3.82
S	0.03	0.15	0.41	0.30	0.01	0.00	0.91	4.05
SSW	0.03	0.09	0.31	0.37	0.08	0.00	0.88	4.91
SW	0.03	0.05	0.51	0.45	0.00	0.00	1.03	4.60
WSW	0.01	0.11	0.49	0.25	0.01	0.00	0.88	4.24
W	0.00	0.03	0.26	0.41	0.00	0.00	0.71	4.75
WNW	0.01	0.06	0.20	0.17	0.00	0.00	0.44	4.35
NW	0.00	0.03	0.26	0.17	0.00	0.00	0.47	4.39
NNW	0.01	0.10	0.18	0.10	0.00	0.00	0.40	3.69
TOTAL	0.53	1.61	6.74	5.34	0.13	0.00	14.34	4.27
AVG SPD	0.85	2.36	3.96	5.48	8.65	0.00	4.27	4.27

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX D

FROM JAN. 1 1982 THROUGH DEC. 31 1982

	+--------WIND SPEED CLASSES (MPS)--------+							AVERAGE WIND
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	SPEED
N	0.03	0.18	0.61	1.34	0.09	0.00	2.26	5.27
NNE	0.03	0.38	1.03	1.70	0.13	0.00	3.27	5.02
NE	0.09	0.40	1.52	2.06	0.15	0.00	4.21	4.92
ENE	0.06	0.40	1.14	1.60	0.16	0.00	3.35	4.86
E	0.06	0.30	0.91	1.26	0.02	0.01	2.56	4.77
ESE	0.07	0.46	0.94	1.16	0.08	0.00	2.71	4.62
SE	0.06	0.29	0.96	1.36	0.06	0.01	2.73	4.91
SSE	0.03	0.24	0.61	0.51	0.06	0.01	1.46	4.50
S	0.01	0.24	0.56	0.79	0.13	0.01	1.75	5.11
SSW	0.01	0.15	0.44	1.02	0.08	0.00	1.70	5.43
SW	0.00	0.15	0.61	1.06	0.09	0.01	1.92	5.24
WSW	0.00	0.13	0.31	0.44	0.03	0.00	0.91	4.70
W	0.00	0.11	0.24	0.32	0.01	0.00	0.69	4.42
WNW	0.00	0.08	0.22	0.59	0.07	0.00	0.95	5.51
NW	0.01	0.08	0.30	0.62	0.10	0.00	1.11	5.51
NNW	0.00	0.11	0.32	0.80	0.09	0.00	1.33	5.50
TOTAL	0.47	3.71	10.71	16.62	1.36	0.06	32.92	4.99
AVG SPD	0.54	2.34	3.80	6.14	8.81	11.94	4.99	4.99

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX E

FROM JAN. 1 1982 THROUGH DEC. 31 1982

	+-------WIND SPEED CLASSES (MPS)-------+							AVERAGE WIND
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	SPEED
N	0.03	0.21	0.57	0.33	0.00	0.00	1.15	3.88
NNE	0.06	0.49	1.19	0.24	0.00	0.00	1.99	3.45
NE	0.17	0.86	1.76	0.20	0.00	0.00	2.99	3.23
ENE	0.15	0.76	1.23	0.17	0.00	0.00	2.31	3.17
E	0.13	0.52	1.15	0.22	0.00	0.00	2.01	3.39
ESE	0.08	0.80	0.99	0.11	0.00	0.00	1.99	3.11
SE	0.13	0.67	0.41	0.02	0.00	0.00	1.23	2.61
SSE	0.03	0.25	0.18	0.01	0.00	0.00	0.48	2.73
S	0.03	0.29	0.22	0.02	0.00	0.00	0.56	2.72
SSW	0.01	0.13	0.30	0.07	0.00	0.00	0.51	3.55
SW	0.02	0.11	0.36	0.05	0.00	0.00	0.54	3.44
WSW	0.02	0.09	0.08	0.00	0.00	0.00	0.20	2.57
W	0.01	0.06	0.16	0.01	0.00	0.00	0.24	3.28
WNW	0.01	0.18	0.40	0.05	0.00	0.00	0.64	3.42
NW	0.01	0.15	0.30	0.09	0.00	0.00	0.55	3.56
NNW	0.01	0.08	0.37	0.11	0.00	0.00	0.57	4.02
TOTAL	0.92	5.65	9.67	1.71	0.00	0.00	17.95	3.27
AVG SPD	0.57	2.34	3.73	5.19	0.00	0.00	3.27	3.27

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

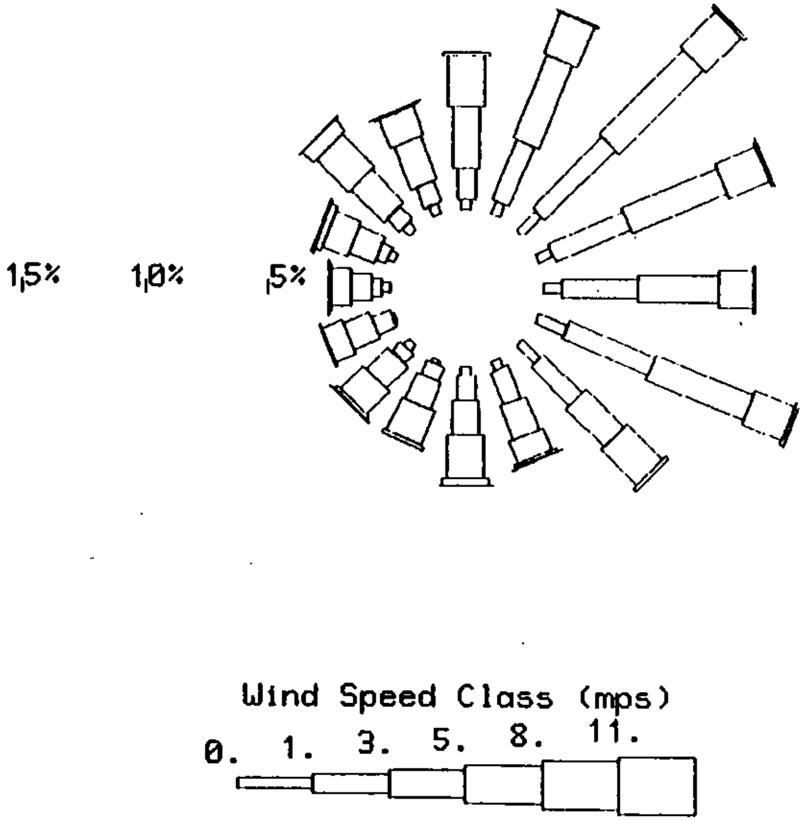
STABILITY INDEX F

FROM JAN. 1 1982 THROUGH DEC. 31 1982

	+-------WIND SPEED CLASSES (MPS)-------+							
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	AVERAGE WIND SPEED
N	0.32	0.32	0.22	0.00	0.00	0.00	0.86	1.70
NNE	0.95	1.34	0.72	0.00	0.00	0.00	3.02	1.86
NE	1.75	2.32	1.15	0.01	0.00	0.00	5.23	1.86
ENE	1.26	1.73	0.98	0.00	0.00	0.00	3.97	1.85
E	1.16	1.23	0.73	0.00	0.00	0.00	3.12	1.79
ESE	1.46	1.62	0.46	0.01	0.00	0.00	3.55	1.64
SE	1.22	1.00	0.25	0.00	0.00	0.00	2.47	1.46
SSE	0.63	0.55	0.09	0.00	0.00	0.00	1.27	1.49
S	0.52	0.36	0.06	0.00	0.00	0.00	0.93	1.24
SSW	0.34	0.34	0.08	0.00	0.00	0.00	0.77	1.46
SW	0.20	0.16	0.13	0.00	0.00	0.00	0.48	1.67
WSW	0.20	0.06	0.05	0.00	0.00	0.00	0.30	1.13
W	0.16	0.15	0.09	0.00	0.00	0.00	0.40	1.69
WNW	0.23	0.20	0.10	0.00	0.00	0.00	0.53	1.54
NW	0.28	0.22	0.14	0.00	0.00	0.00	0.63	1.70
NNW	0.23	0.30	0.09	0.00	0.00	0.00	0.62	1.65
TOTAL	10.90	11.90	5.34	0.02	0.00	0.00	28.16	1.71
AVG SPD	0.35	2.32	3.10	6.43	0.00	0.00	1.71	1.71

SITE 01 FROM 01/01/83 TO 12/31/83

WIND SPEED AND DIRECTION ROSE



NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX A

FROM JAN. 1 1983 THROUGH DEC. 31 1983

DIRECTION	+--------WIND SPEED CLASSES (MPS)--------+						TOTAL	AVERAGE WIND SPEED
	0-2	2-3	3-5	5-8	8-11	>11		
N	0.01	0.06	0.00	0.00	0.00	0.00	0.07	1.01
NNE	0.02	0.04	0.00	0.00	0.00	0.00	0.05	1.62
NE	0.02	0.06	0.00	0.00	0.00	0.00	0.08	1.13
ENE	0.03	0.11	0.00	0.00	0.00	0.00	0.14	1.16
E	0.01	0.03	0.00	0.00	0.00	0.00	0.04	1.48
ESE	0.02	0.05	0.00	0.00	0.00	0.00	0.07	1.36
SE	0.01	0.04	0.00	0.00	0.00	0.00	0.05	1.57
SSE	0.01	0.02	0.00	0.00	0.00	0.00	0.03	1.63
S	0.00	0.05	0.00	0.00	0.00	0.00	0.05	1.57
SSW	0.00	0.03	0.00	0.00	0.00	0.00	0.03	1.41
SW	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.69
WSW	0.01	0.03	0.00	0.00	0.00	0.00	0.04	1.34
W	0.00	0.02	0.00	0.00	0.00	0.00	0.02	2.06
WNW	0.00	0.01	0.00	0.00	0.00	0.00	0.01	2.57
NW	0.00	0.03	0.00	0.00	0.00	0.00	0.03	1.14
NNW	0.00	0.04	0.00	0.00	0.00	0.00	0.04	2.09
TOTAL	0.13	0.64	0.00	0.00	0.00	0.00	0.77	1.36
AVG SPD	0.26	1.34	0.00	0.00	0.00	0.00	1.36	1.36

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX B

FROM JAN. 1 1983 THROUGH DEC. 31 1983

	+--------WIND SPEED CLASSES (MPS)-------+							AVERAGE WIND SPEED
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	
N	0.03	0.09	0.20	0.00	0.00	0.00	0.32	1.70
NNE	0.03	0.09	0.22	0.01	0.00	0.00	0.35	1.60
NE	0.06	0.10	0.28	0.00	0.00	0.00	0.45	1.67
ENE	0.04	0.07	0.41	0.01	0.00	0.00	0.52	1.82
E	0.04	0.06	0.34	0.00	0.00	0.00	0.44	2.03
ESE	0.02	0.14	0.46	0.00	0.00	0.00	0.63	1.86
SE	0.04	0.11	0.33	0.00	0.01	0.00	0.48	1.59
SSE	0.01	0.06	0.16	0.01	0.00	0.00	0.24	1.28
S	0.02	0.07	0.16	0.01	0.00	0.00	0.25	1.06
SSW	0.01	0.06	0.14	0.02	0.00	0.00	0.23	1.19
SW	0.01	0.04	0.25	0.01	0.00	0.00	0.31	1.33
WSW	0.00	0.07	0.18	0.01	0.00	0.00	0.26	2.00
W	0.00	0.02	0.18	0.04	0.00	0.00	0.24	1.02
WNW	0.01	0.05	0.15	0.01	0.00	0.00	0.22	1.28
NW	0.01	0.05	0.19	0.02	0.00	0.00	0.26	1.83
NNW	0.01	0.07	0.15	0.01	0.00	0.00	0.23	1.67
TOTAL	0.32	1.16	3.81	0.13	0.01	0.00	5.43	1.62
AVG SPD	0.42	1.16	1.77	2.54	9.77	0.00	1.62	1.62

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX C

FROM JAN. 1 1983 THROUGH DEC. 31 1983

	+--------WIND SPEED CLASSES (MPS)--------+							AVERAGE WIND SPEED
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	
N	0.03	0.08	0.27	0.21	0.02	0.00	0.61	2.67
NNE	0.07	0.12	0.47	0.30	0.00	0.00	0.95	2.03
NE	0.12	0.13	0.83	0.41	0.01	0.00	1.49	2.06
ENE	0.10	0.13	0.57	0.41	0.01	0.00	1.22	1.95
E	0.05	0.13	0.48	0.48	0.00	0.00	1.14	2.28
ESE	0.11	0.23	0.71	0.53	0.02	0.00	1.60	2.52
SE	0.06	0.14	0.42	0.44	0.01	0.00	1.07	2.17
SSE	0.04	0.07	0.33	0.14	0.01	0.00	0.60	2.11
S	0.04	0.09	0.31	0.26	0.02	0.00	0.72	1.99
SSW	0.04	0.07	0.27	0.31	0.04	0.00	0.73	2.04
SW	0.02	0.04	0.42	0.37	0.01	0.00	0.86	2.10
WSW	0.01	0.11	0.44	0.26	0.01	0.00	0.83	2.18
W	0.02	0.04	0.25	0.29	0.00	0.00	0.60	2.02
WNW	0.02	0.03	0.16	0.17	0.01	0.00	0.39	2.43
NW	0.01	0.04	0.24	0.17	0.02	0.01	0.47	2.67
NNW	0.02	0.06	0.22	0.12	0.01	0.00	0.42	2.38
TOTAL	0.75	1.50	6.39	4.88	0.17	0.01	13.70	2.20
AVG SPD	0.27	1.22	2.05	2.81	6.22	11.83	2.20	2.20

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX D

FROM JAN. 1 1983 THROUGH DEC. 31 1983

	+--------WIND SPEED CLASSES (MPS)-------+							
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	AVERAGE WIND SPEED
N	0.05	0.14	0.62	1.29	0.10	0.00	2.19	2.79
NNE	0.10	0.31	1.01	1.45	0.07	0.00	2.94	2.26
NE	0.17	0.40	1.34	1.58	0.14	0.00	3.63	2.05
ENE	0.13	0.37	1.06	1.33	0.13	0.01	3.02	2.22
E	0.11	0.31	0.77	0.95	0.06	0.01	2.21	2.06
ESE	0.14	0.44	1.04	0.96	0.07	0.00	2.66	2.17
SE	0.11	0.26	0.78	1.24	0.08	0.01	2.48	2.40
SSE	0.06	0.19	0.54	0.56	0.09	0.01	1.45	2.64
S	0.04	0.17	0.54	1.02	0.17	0.01	1.95	3.31
SSW	0.04	0.10	0.47	1.01	0.11	0.00	1.72	3.02
SW	0.01	0.11	0.51	0.93	0.12	0.01	1.68	2.68
WSW	0.02	0.14	0.28	0.44	0.06	0.00	0.93	2.78
W	0.02	0.07	0.23	0.39	0.07	0.01	0.78	3.47
WNW	0.01	0.07	0.29	0.64	0.14	0.04	1.20	4.02
NW	0.02	0.11	0.35	0.96	0.31	0.01	1.76	4.45
NNW	0.02	0.13	0.40	0.77	0.07	0.01	1.40	2.79
TOTAL	1.05	3.30	10.23	15.51	1.78	0.12	32.00	2.66
AVG SPD	0.26	1.15	1.98	3.14	5.86	10.53	2.66	2.66

NWS SURFACE METEOROLOGICAL DATA
STATION #   12835

STABILITY WIND ROSE

STABILITY INDEX E

FROM JAN. 1 1983 THROUGH DEC. 31 1983

DIRECTION	WIND SPEED CLASSES (MPS) 0-2	2-3	3-5	5-8	8-11	>11	TOTAL	AVERAGE WIND SPEED
N	0.05	0.22	0.58	0.28	0.00	0.00	1.13	1.95
NNE	0.11	0.45	0.99	0.15	0.00	0.00	1.71	1.41
NE	0.24	0.77	1.49	0.19	0.00	0.00	2.70	1.49
ENE	0.21	0.67	1.04	0.14	0.00	0.00	2.06	1.37
E	0.17	0.44	0.92	0.15	0.00	0.00	1.68	1.36
ESE	0.19	0.65	0.95	0.11	0.00	0.00	1.89	1.46
SE	0.15	0.52	0.42	0.07	0.00	0.00	1.16	1.48
SSE	0.06	0.22	0.26	0.02	0.00	0.00	0.56	1.77
S	0.06	0.25	0.26	0.03	0.00	0.00	0.59	1.60
SSW	0.05	0.12	0.24	0.04	0.00	0.00	0.45	1.33
SW	0.03	0.09	0.25	0.02	0.00	0.00	0.39	1.06
WSW	0.03	0.09	0.11	0.01	0.00	0.00	0.24	1.74
W	0.02	0.05	0.14	0.01	0.00	0.00	0.22	1.56
WNW	0.03	0.12	0.32	0.06	0.00	0.00	0.52	1.55
NW	0.04	0.14	0.46	0.14	0.00	0.00	0.78	2.51
NNW	0.03	0.10	0.46	0.17	0.00	0.00	0.76	2.51
TOTAL	1.47	4.90	8.90	1.59	0.00	0.00	16.86	1.58
AVG SPD	0.22	1.11	1.85	2.64	0.00	0.00	1.58	1.58

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

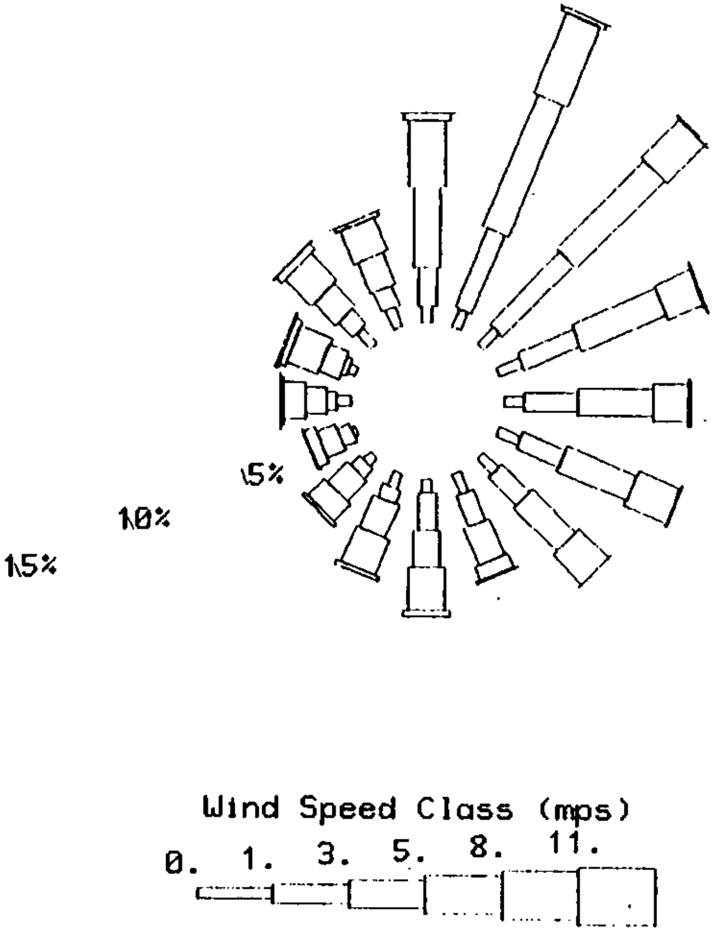
STABILITY INDEX F

FROM JAN. 1 1983 THROUGH DEC. 31 1983

DIRECTION	+--------WIND SPEED CLASSES (MPS)--------+ 0-2	2-3	3-5	5-8	8-11	>11	TOTAL	AVERAGE WIND SPEED
N	0.61	0.35	0.32	0.01	0.00	0.00	1.27	1.00
NNE	1.46	1.13	0.65	0.00	0.00	0.00	3.25	0.74
NE	2.51	1.88	0.83	0.01	0.00	0.00	5.23	0.60
ENE	1.94	1.44	0.83	0.00	0.00	0.00	4.21	0.69
E	1.74	1.20	0.61	0.00	0.00	0.00	3.55	0.74
ESE	2.11	1.46	0.44	0.01	0.00	0.00	4.02	0.65
SE	1.62	0.82	0.27	0.00	0.00	0.00	2.71	0.56
SSE	0.91	0.52	0.09	0.00	0.00	0.00	1.52	0.63
S	0.72	0.35	0.09	0.00	0.00	0.00	1.16	0.62
SSW	0.48	0.23	0.07	0.00	0.00	0.00	0.77	0.39
SW	0.31	0.15	0.07	0.00	0.00	0.00	0.52	0.44
WSW	0.33	0.08	0.03	0.00	0.00	0.00	0.45	0.50
W	0.24	0.13	0.07	0.00	0.00	0.00	0.44	0.61
WNW	0.33	0.17	0.10	0.00	0.00	0.00	0.60	0.65
NW	0.38	0.20	0.14	0.00	0.00	0.00	0.73	0.73
NNW	0.41	0.27	0.14	0.00	0.00	0.00	0.82	0.87
TOTAL	16.10	10.38	4.76	0.02	0.00	0.00	31.25	0.67
AVG SPD	0.13	1.10	1.51	3.86	0.00	0.00	0.67	0.67

SITE 01 FROM 01/01/84 TO 12/31/84

WIND SPEED AND DIRECTION ROSE



NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX A

FROM JAN. 1 1984 THROUGH DEC. 31 1984

	+--------WIND SPEED CLASSES (MPS)--------+							AVERAGE WIND SPEED
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	
N	0.01	0.06	0.00	0.00	0.00	0.00	0.07	0.91
NNE	0.02	0.04	0.00	0.00	0.00	0.00	0.06	0.83
NE	0.03	0.06	0.00	0.00	0.00	0.00	0.09	0.57
ENE	0.03	0.08	0.00	0.00	0.00	0.00	0.11	0.35
E	0.03	0.03	0.00	0.00	0.00	0.00	0.05	0.69
ESE	0.03	0.03	0.00	0.00	0.00	0.00	0.06	0.21
SE	0.02	0.03	0.00	0.00	0.00	0.00	0.04	0.44
SSE	0.01	0.02	0.00	0.00	0.00	0.00	0.04	0.76
S	0.00	0.04	0.00	0.00	0.00	0.00	0.04	0.71
SSW	0.00	0.02	0.00	0.00	0.00	0.00	0.02	0.57
SW	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.76
WSW	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.72
W	0.00	0.01	0.00	0.00	0.00	0.00	0.01	1.16
WNW	0.00	0.01	0.00	0.00	0.00	0.00	0.01	1.71
NW	0.00	0.04	0.00	0.00	0.00	0.00	0.04	1.16
NNW	0.00	0.04	0.00	0.00	0.00	0.00	0.04	1.07
TOTAL	0.20	0.56	0.00	0.00	0.00	0.00	0.76	0.68
AVG SPD	0.08	0.76	0.00	0.00	0.00	0.00	0.68	0.68

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX B

FROM JAN. 1 1984 THROUGH DEC. 31 1984

	+--------WIND SPEED CLASSES (MPS)--------+							
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	AVERAGE WIND SPEED
N	0.02	0.10	0.23	0.00	0.00	0.00	0.36	1.43
NNE	0.04	0.11	0.22	0.01	0.00	0.00	0.37	1.21
NE	0.06	0.08	0.26	0.00	0.00	0.00	0.41	0.96
ENE	0.04	0.07	0.30	0.00	0.00	0.00	0.41	0.62
E	0.04	0.06	0.30	0.00	0.00	0.00	0.40	1.02
ESE	0.04	0.11	0.39	0.00	0.00	0.00	0.54	0.87
SE	0.04	0.10	0.30	0.00	0.00	0.00	0.44	0.98
SSE	0.02	0.07	0.15	0.01	0.00	0.00	0.25	1.24
S	0.02	0.07	0.15	0.00	0.00	0.00	0.24	1.08
SSW	0.01	0.06	0.12	0.02	0.00	0.00	0.21	1.21
SW	0.01	0.04	0.18	0.01	0.00	0.00	0.24	0.62
WSW	0.00	0.06	0.13	0.01	0.00	0.00	0.20	0.68
W	0.00	0.03	0.13	0.03	0.00	0.00	0.18	0.73
WNW	0.01	0.04	0.11	0.01	0.00	0.00	0.17	0.74
NW	0.01	0.04	0.15	0.01	0.00	0.00	0.21	0.80
NNW	0.01	0.06	0.11	0.01	0.00	0.00	0.20	0.90
TOTAL	0.37	1.09	3.24	0.11	0.00	0.00	4.82	0.96
AVG SPD	0.12	0.85	1.04	1.94	9.77	0.00	0.96	0.96

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX C

FROM JAN. 1 1984 THROUGH DEC. 31 1984

	+-------WIND SPEED CLASSES (MPS)-------+							
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	AVERAGE WIND SPEED
N	0.04	0.08	0.35	0.22	0.01	0.00	0.70	1.89
NNE	0.09	0.11	0.56	0.38	0.01	0.00	1.16	2.08
NE	0.15	0.12	0.70	0.39	0.00	0.00	1.36	1.22
ENE	0.12	0.11	0.53	0.33	0.00	0.00	1.09	1.12
E	0.09	0.09	0.46	0.41	0.00	0.00	1.05	1.30
ESE	0.13	0.16	0.62	0.51	0.01	0.00	1.43	1.32
SE	0.09	0.12	0.45	0.39	0.01	0.00	1.05	1.48
SSE	0.06	0.05	0.31	0.14	0.01	0.00	0.56	1.40
S	0.06	0.08	0.25	0.26	0.03	0.00	0.69	1.57
SSW	0.04	0.05	0.25	0.30	0.04	0.00	0.68	1.71
SW	0.03	0.04	0.35	0.31	0.01	0.00	0.73	1.35
WSW	0.02	0.08	0.31	0.20	0.00	0.00	0.61	0.70
W	0.02	0.04	0.20	0.25	0.00	0.00	0.50	1.27
WNW	0.02	0.02	0.15	0.15	0.01	0.00	0.35	1.64
NW	0.02	0.04	0.21	0.15	0.03	0.00	0.45	1.62
NNW	0.02	0.06	0.19	0.12	0.00	0.00	0.40	1.47
TOTAL	0.97	1.24	5.90	4.52	0.17	0.00	12.80	1.44
AVG SPD	0.09	0.64	1.36	1.95	3.44	11.83	1.44	1.44

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX D

FROM JAN. 1 1984 THROUGH DEC. 31 1984

	+-------WIND SPEED CLASSES (MPS)-------+							AVERAGE WIND SPEED
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	
N	0.07	0.14	0.61	1.34	0.15	0.01	2.32	2.34
NNE	0.16	0.30	1.07	1.56	0.09	0.00	3.19	2.11
NE	0.25	0.37	1.19	1.39	0.10	0.00	3.29	1.37
ENE	0.19	0.34	0.92	1.13	0.09	0.01	2.69	1.30
E	0.17	0.28	0.76	0.85	0.06	0.00	2.11	1.48
ESE	0.21	0.31	0.86	0.90	0.06	0.00	2.34	1.31
SE	0.15	0.21	0.62	1.06	0.05	0.00	2.10	1.26
SSE	0.08	0.17	0.47	0.46	0.07	0.01	1.26	1.20
S	0.07	0.20	0.49	0.96	0.17	0.01	1.90	1.87
SSW	0.05	0.11	0.41	0.91	0.11	0.00	1.59	1.83
SW	0.02	0.09	0.42	0.75	0.11	0.01	1.40	1.46
WSW	0.04	0.11	0.26	0.35	0.04	0.00	0.80	1.26
W	0.02	0.07	0.22	0.41	0.08	0.01	0.82	2.29
WNW	0.02	0.05	0.22	0.69	0.16	0.05	1.20	2.62
NW	0.04	0.08	0.32	0.92	0.26	0.01	1.62	2.06
NNW	0.04	0.12	0.34	0.78	0.09	0.01	1.38	2.10
TOTAL	1.57	2.94	9.19	14.47	1.70	0.12	29.99	1.71
AVG SPD	0.05	0.76	1.24	2.16	3.29	5.38	1.71	1.71

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX E

FROM JAN. 1 1984 THROUGH DEC. 31 1984

DIRECTION	WIND SPEED CLASSES (MPS) 0-2	2-3	3-5	5-8	8-11	>11	TOTAL	AVERAGE WIND SPEED
N	0.08	0.22	0.63	0.27	0.00	0.00	1.20	1.51
NNE	0.18	0.48	1.10	0.17	0.00	0.00	1.93	1.48
NE	0.33	0.71	1.33	0.17	0.00	0.00	2.54	0.97
ENE	0.26	0.56	0.96	0.11	0.00	0.00	1.90	0.89
E	0.22	0.38	0.75	0.10	0.00	0.00	1.45	0.71
ESE	0.25	0.48	0.77	0.08	0.00	0.00	1.58	0.64
SE	0.20	0.40	0.43	0.06	0.00	0.00	1.09	0.84
SSE	0.10	0.19	0.24	0.02	0.00	0.00	0.54	0.88
S	0.09	0.24	0.23	0.04	0.00	0.00	0.60	1.00
SSW	0.06	0.11	0.25	0.03	0.00	0.00	0.46	1.18
SW	0.05	0.07	0.21	0.02	0.00	0.00	0.35	0.88
WSW	0.04	0.09	0.12	0.00	0.00	0.00	0.25	1.01
W	0.03	0.05	0.16	0.01	0.00	0.00	0.25	1.36
WNW	0.04	0.08	0.28	0.06	0.00	0.00	0.45	1.05
NW	0.05	0.12	0.41	0.11	0.00	0.00	0.69	1.06
NNW	0.05	0.08	0.40	0.13	0.00	0.00	0.67	1.03
TOTAL	2.04	4.25	8.28	1.37	0.00	0.00	15.94	1.01
AVG SPD	0.03	0.71	1.32	1.54	0.00	0.00	1.01	1.01

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

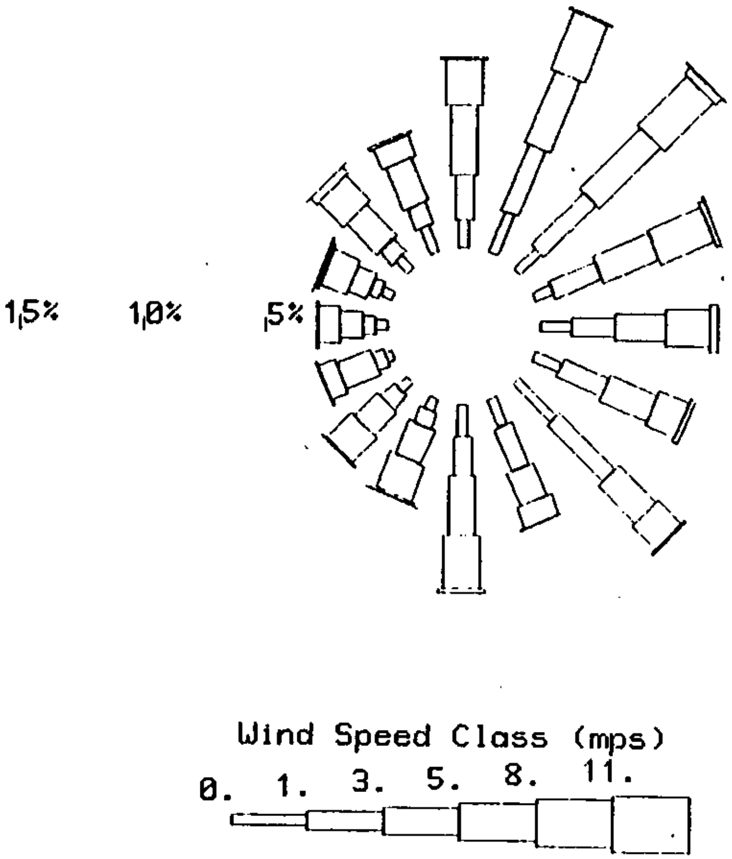
STABILITY INDEX F

FROM JAN. 1 1984 THROUGH DEC. 31 1984

	+-------WIND SPEED CLASSES (MPS)--------+							
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	AVERAGE WIND SPEED
N	0.90	0.36	0.28	0.00	0.00	0.00	1.55	0.43
NNE	2.09	1.17	0.69	0.00	0.00	0.00	3.95	0.53
NE	3.42	1.74	0.81	0.00	0.00	0.00	5.97	0.41
ENE	2.65	1.19	0.70	0.00	0.00	0.00	4.54	0.31
E	2.28	1.04	0.49	0.00	0.00	0.00	3.80	0.30
ESE	2.81	1.18	0.40	0.00	0.00	0.00	4.39	0.27
SE	2.07	0.71	0.24	0.00	0.00	0.00	3.02	0.25
SSE	1.20	0.50	0.11	0.00	0.00	0.00	1.81	0.35
S	1.01	0.34	0.10	0.00	0.00	0.00	1.46	0.32
SSW	0.64	0.18	0.08	0.00	0.00	0.00	0.90	0.24
SW	0.45	0.14	0.06	0.00	0.00	0.00	0.64	0.30
WSW	0.47	0.09	0.05	0.00	0.00	0.00	0.61	0.36
W	0.33	0.11	0.06	0.00	0.00	0.00	0.50	0.27
WNW	0.43	0.14	0.09	0.00	0.00	0.00	0.66	0.28
NW	0.55	0.23	0.11	0.00	0.00	0.00	0.89	0.39
NNW	0.59	0.25	0.17	0.00	0.00	0.00	1.01	0.48
TOTAL	21.89	9.37	4.43	0.01	0.00	0.00	35.70	0.35
AVG SPD	0.02	0.78	1.09	2.25	0.00	0.00	0.35	0.35

SITE 01 FROM 01/01/85 TO 12/31/85

WIND SPEED AND DIRECTION ROSE



NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX A

FROM JAN. 1 1985 THROUGH DEC. 31 1985

	+-------WIND SPEED CLASSES (MPS)-------+							
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	AVERAGE WIND SPEED
N	0.01	0.05	0.00	0.00	0.00	0.00	0.06	0.35
NNE	0.03	0.04	0.00	0.00	0.00	0.00	0.07	0.40
NE	0.05	0.04	0.00	0.00	0.00	0.00	0.09	0.13
ENE	0.04	0.06	0.00	0.00	0.00	0.00	0.10	0.01
E	0.04	0.02	0.00	0.00	0.00	0.00	0.06	0.18
ESE	0.04	0.03	0.00	0.00	0.00	0.00	0.07	0.29
SE	0.03	0.03	0.00	0.00	0.00	0.00	0.05	0.30
SSE	0.02	0.02	0.00	0.00	0.00	0.00	0.04	0.29
S	0.01	0.03	0.00	0.00	0.00	0.00	0.04	0.47
SSW	0.01	0.03	0.00	0.00	0.00	0.00	0.03	1.06
SW	0.00	0.03	0.00	0.00	0.00	0.00	0.03	0.87
WSW	0.00	0.02	0.00	0.00	0.00	0.00	0.03	0.57
W	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.83
WNW	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.86
NW	0.01	0.03	0.00	0.00	0.00	0.00	0.04	0.46
NNW	0.01	0.04	0.00	0.00	0.00	0.00	0.05	0.70
TOTAL	0.30	0.49	0.00	0.00	0.00	0.00	0.79	0.37
AVG SPD	0.01	0.54	0.00	0.00	0.00	0.00	0.37	0.37

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX B

FROM JAN. 1 1985 THROUGH DEC. 31 1985

	+--------WIND SPEED CLASSES (MPS)-------+							AVERAGE WIND
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	SPEED
N	0.03	0.10	0.19	0.00	0.00	0.00	0.32	0.64
NNE	0.05	0.09	0.20	0.01	0.00	0.00	0.35	0.71
NE	0.08	0.08	0.23	0.00	0.00	0.00	0.39	0.66
ENE	0.06	0.06	0.25	0.00	0.00	0.00	0.37	0.56
E	0.05	0.05	0.23	0.00	0.00	0.00	0.33	0.35
ESE	0.06	0.09	0.30	0.00	0.00	0.00	0.44	0.40
SE	0.05	0.09	0.25	0.00	0.00	0.00	0.39	0.61
SSE	0.03	0.07	0.14	0.01	0.00	0.00	0.24	0.80
S	0.03	0.08	0.17	0.00	0.00	0.00	0.29	1.24
SSW	0.01	0.04	0.14	0.01	0.00	0.00	0.21	1.08
SW	0.01	0.05	0.18	0.01	0.00	0.00	0.25	1.16
WSW	0.01	0.05	0.16	0.01	0.00	0.00	0.23	1.36
W	0.00	0.03	0.13	0.02	0.00	0.00	0.18	1.10
WNW	0.01	0.03	0.10	0.01	0.00	0.00	0.15	0.76
NW	0.01	0.04	0.15	0.01	0.00	0.00	0.21	1.03
NNW	0.02	0.06	0.11	0.00	0.00	0.00	0.20	0.88
TOTAL	0.50	1.01	2.92	0.10	0.00	0.00	4.53	0.78
AVG SPD	0.08	0.67	0.91	1.33	9.77	0.00	0.78	0.78

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX C

FROM JAN. 1 1985 THROUGH DEC. 31 1985

	+-------WIND SPEED CLASSES (MPS)-------+							AVERAGE WIND
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	SPEED
N	0.06	0.07	0.35	0.21	0.01	0.00	0.70	1.25
NNE	0.13	0.12	0.47	0.31	0.00	0.00	1.05	0.78
NE	0.20	0.11	0.57	0.34	0.01	0.00	1.22	0.75
ENE	0.16	0.09	0.41	0.29	0.00	0.00	0.95	0.69
E	0.12	0.09	0.37	0.33	0.00	0.00	0.91	0.68
ESE	0.17	0.14	0.50	0.39	0.01	0.00	1.20	0.54
SE	0.12	0.12	0.42	0.31	0.01	0.00	0.98	0.91
SSE	0.08	0.06	0.29	0.12	0.01	0.00	0.55	0.97
S	0.08	0.10	0.27	0.25	0.02	0.00	0.72	1.30
SSW	0.04	0.06	0.24	0.26	0.03	0.00	0.63	1.17
SW	0.03	0.04	0.31	0.30	0.01	0.00	0.68	1.22
WSW	0.03	0.06	0.29	0.18	0.00	0.00	0.56	1.09
W	0.02	0.03	0.18	0.22	0.00	0.00	0.45	1.17
WNW	0.02	0.02	0.13	0.15	0.01	0.00	0.33	1.27
NW	0.03	0.04	0.19	0.13	0.02	0.00	0.41	0.98
NNW	0.03	0.05	0.20	0.11	0.00	0.00	0.40	1.15
TOTAL	1.33	1.20	5.20	3.88	0.13	0.00	11.75	0.93
AVG SPD	0.03	0.73	0.94	1.25	1.52	11.83	0.93	0.93

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX D

FROM JAN. 1 1985 THROUGH DEC. 31 1985

	+-------WIND SPEED CLASSES (MPS)-------+							AVERAGE WIND
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	SPEED
N	0.10	0.16	0.59	1.12	0.12	0.00	2.09	1.14
NNE	0.22	0.28	0.87	1.37	0.08	0.00	2.82	1.05
NE	0.34	0.33	0.96	1.28	0.13	0.00	3.05	1.19
ENE	0.26	0.28	0.73	1.08	0.10	0.01	2.46	1.23
E	0.22	0.22	0.61	0.82	0.10	0.00	1.98	1.30
ESE	0.27	0.26	0.69	0.78	0.08	0.00	2.08	0.95
SE	0.20	0.21	0.51	0.89	0.04	0.00	1.87	0.92
SSE	0.12	0.16	0.40	0.43	0.05	0.00	1.17	1.08
S	0.10	0.19	0.47	0.95	0.15	0.00	1.86	1.59
SSW	0.06	0.09	0.35	0.83	0.10	0.00	1.42	1.35
SW	0.04	0.09	0.36	0.68	0.09	0.00	1.27	1.30
WSW	0.05	0.09	0.25	0.32	0.04	0.00	0.74	1.21
W	0.03	0.07	0.19	0.37	0.07	0.01	0.74	1.28
WNW	0.04	0.05	0.18	0.61	0.13	0.04	1.05	1.40
NW	0.05	0.08	0.28	0.84	0.24	0.01	1.50	1.58
NNW	0.06	0.12	0.31	0.64	0.08	0.00	1.21	1.12
TOTAL	2.17	2.68	7.75	13.02	1.61	0.10	27.33	1.21
AVG SPD	0.02	0.63	0.79	1.60	2.61	2.63	1.21	1.21

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX E

FROM JAN. 1 1985 THROUGH DEC. 31 1985

DIRECTION	+-------WIND SPEED CLASSES (MPS)-------+ 0-2	2-3	3-5	5-8	8-11	>11	TOTAL	AVERAGE WIND SPEED
N	0.11	0.20	0.57	0.23	0.00	0.00	1.11	0.86
NNE	0.25	0.42	0.94	0.19	0.00	0.00	1.81	0.78
NE	0.44	0.58	1.14	0.20	0.00	0.00	2.36	0.70
ENE	0.33	0.44	0.82	0.13	0.00	0.00	1.72	0.66
E	0.28	0.33	0.63	0.10	0.00	0.00	1.34	0.63
ESE	0.34	0.39	0.61	0.07	0.00	0.00	1.41	0.45
SE	0.25	0.38	0.38	0.06	0.00	0.00	1.07	0.65
SSE	0.13	0.19	0.22	0.02	0.00	0.00	0.56	0.71
S	0.13	0.21	0.26	0.03	0.00	0.00	0.63	0.85
SSW	0.08	0.10	0.23	0.03	0.00	0.00	0.44	0.78
SW	0.06	0.07	0.17	0.01	0.00	0.00	0.31	0.47
WSW	0.06	0.08	0.11	0.01	0.00	0.00	0.25	0.69
W	0.04	0.05	0.14	0.01	0.00	0.00	0.24	0.85
WNW	0.05	0.06	0.25	0.06	0.00	0.00	0.42	0.85
NW	0.07	0.10	0.37	0.09	0.00	0.00	0.63	0.78
NNW	0.07	0.08	0.37	0.11	0.00	0.00	0.64	0.93
TOTAL	2.69	3.71	7.20	1.36	0.00	0.00	14.95	0.71
AVG SPD	0.01	0.54	0.87	1.68	0.00	0.00	0.71	0.71

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

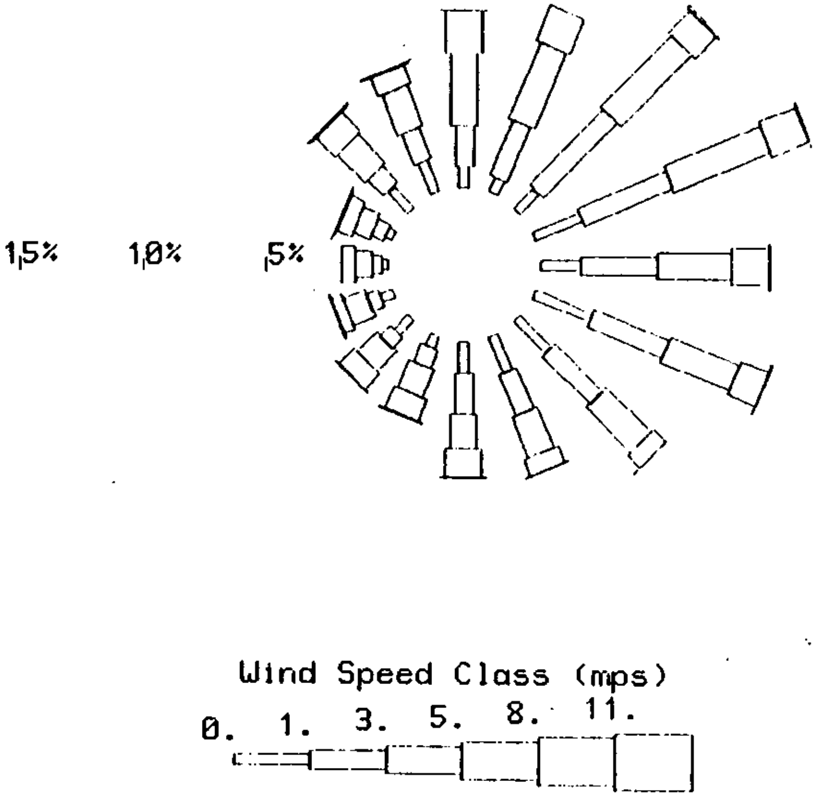
STABILITY INDEX F

FROM JAN. 1 1985 THROUGH DEC. 31 1985

DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	AVERAGE WIND SPEED
	+-------WIND SPEED CLASSES (MPS)-------+							
N	1.25	0.37	0.25	0.00	0.00	0.00	1.89	0.30
NNE	2.82	1.04	0.55	0.00	0.00	0.00	4.42	0.21
NE	4.45	1.43	0.64	0.00	0.00	0.00	6.53	0.15
ENE	3.45	1.00	0.53	0.00	0.00	0.00	4.99	0.14
E	2.92	0.86	0.38	0.00	0.00	0.00	4.16	0.14
ESE	3.58	0.97	0.33	0.00	0.00	0.00	4.88	0.13
SE	2.69	0.77	0.21	0.00	0.00	0.00	3.67	0.24
SSE	1.58	0.49	0.09	0.00	0.00	0.00	2.16	0.21
S	1.36	0.32	0.10	0.00	0.00	0.00	1.77	0.17
SSW	0.82	0.16	0.07	0.00	0.00	0.00	1.06	0.15
SW	0.59	0.12	0.04	0.00	0.00	0.00	0.76	0.10
WSW	0.62	0.09	0.04	0.00	0.00	0.00	0.75	0.11
W	0.44	0.11	0.05	0.00	0.00	0.00	0.60	0.18
WNW	0.55	0.14	0.07	0.00	0.00	0.00	0.77	0.21
NW	0.73	0.21	0.13	0.00	0.00	0.00	1.06	0.29
NNW	0.80	0.23	0.16	0.00	0.00	0.00	1.20	0.25
TOTAL	28.66	8.32	3.65	0.02	0.00	0.00	40.65	0.18
AVG SPD	0.01	0.57	0.59	2.85	0.00	0.00	0.18	0.18

SITE 01 FROM 01/01/86 TO 12/31/86

WIND SPEED AND DIRECTION ROSE



NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX A

FROM JAN. 1 1986 THROUGH DEC. 31 1986

	+--------WIND SPEED CLASSES (MPS)--------+							
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	AVERAGE WIND SPEED
N	0.02	0.04	0.00	0.00	0.00	0.00	0.06	0.33
NNE	0.04	0.03	0.00	0.00	0.00	0.00	0.08	0.21
NE	0.07	0.03	0.00	0.00	0.00	0.00	0.10	0.12
ENE	0.05	0.05	0.00	0.00	0.00	0.00	0.10	0.21
E	0.05	0.03	0.00	0.00	0.00	0.00	0.07	0.46
ESE	0.05	0.03	0.00	0.00	0.00	0.00	0.08	0.22
SE	0.04	0.03	0.00	0.00	0.00	0.00	0.06	0.34
SSE	0.02	0.02	0.00	0.00	0.00	0.00	0.05	0.54
S	0.02	0.03	0.00	0.00	0.00	0.00	0.05	0.51
SSW	0.01	0.02	0.00	0.00	0.00	0.00	0.03	0.40
SW	0.01	0.02	0.00	0.00	0.00	0.00	0.03	0.19
WSW	0.01	0.02	0.00	0.00	0.00	0.00	0.03	0.28
W	0.00	0.01	0.00	0.00	0.00	0.00	0.02	0.34
WNW	0.00	0.01	0.00	0.00	0.00	0.00	0.02	1.10
NW	0.01	0.03	0.00	0.00	0.00	0.00	0.04	0.37
NNW	0.01	0.04	0.00	0.00	0.00	0.00	0.05	0.55
TOTAL	0.41	0.45	0.00	0.00	0.00	0.00	0.86	0.33
AVG SPD	0.03	0.58	0.00	0.00	0.00	0.00	0.33	0.33

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX B

FROM JAN. 1 1986 THROUGH DEC. 31 1986

	+-------WIND SPEED CLASSES (MPS)--------+							AVERAGE
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	WIND SPEED
N	0.03	0.08	0.19	0.00	0.00	0.00	0.30	0.68
NNE	0.06	0.08	0.17	0.01	0.00	0.00	0.32	0.45
NE	0.10	0.09	0.21	0.00	0.00	0.00	0.40	0.66
ENE	0.07	0.05	0.23	0.00	0.00	0.00	0.35	0.62
E	0.06	0.06	0.22	0.00	0.00	0.00	0.33	0.75
ESE	0.07	0.09	0.27	0.00	0.00	0.00	0.43	0.67
SE	0.06	0.08	0.23	0.00	0.00	0.00	0.37	0.62
SSE	0.04	0.07	0.13	0.01	0.00	0.00	0.24	0.77
S	0.04	0.08	0.15	0.00	0.00	0.00	0.27	0.62
SSW	0.02	0.05	0.12	0.01	0.00	0.00	0.19	0.69
SW	0.01	0.04	0.15	0.00	0.00	0.00	0.22	0.51
WSW	0.01	0.05	0.14	0.01	0.00	0.00	0.20	0.53
W	0.01	0.02	0.11	0.02	0.00	0.00	0.16	0.76
WNW	0.01	0.03	0.08	0.01	0.00	0.00	0.13	0.60
NW	0.01	0.04	0.13	0.01	0.00	0.00	0.19	0.62
NNW	0.02	0.06	0.10	0.00	0.00	0.00	0.19	0.67
TOTAL	0.62	0.97	2.62	0.08	0.00	0.00	4.30	0.64
AVG SPD	0.05	0.64	0.76	0.98	9.77	0.00	0.64	0.64

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX C

FROM JAN. 1 1986 THROUGH DEC. 31 1986

	+--------WIND SPEED CLASSES (MPS)--------+							
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	AVERAGE WIND SPEED
N	0.08	0.07	0.29	0.18	0.01	0.00	0.63	0.65
NNE	0.17	0.10	0.42	0.25	0.00	0.00	0.94	0.56
NE	0.26	0.11	0.50	0.27	0.01	0.00	1.14	0.59
ENE	0.20	0.10	0.42	0.25	0.00	0.00	0.97	0.89
E	0.16	0.08	0.35	0.31	0.00	0.00	0.89	0.90
ESE	0.21	0.12	0.46	0.34	0.01	0.00	1.12	0.73
SE	0.15	0.12	0.39	0.25	0.01	0.00	0.93	0.70
SSE	0.09	0.06	0.28	0.12	0.00	0.00	0.56	0.98
S	0.09	0.09	0.24	0.22	0.02	0.00	0.65	0.70
SSW	0.05	0.05	0.22	0.22	0.02	0.00	0.57	0.81
SW	0.04	0.04	0.27	0.26	0.01	0.00	0.61	0.84
WSW	0.03	0.06	0.25	0.14	0.00	0.00	0.50	0.69
W	0.02	0.03	0.16	0.18	0.00	0.00	0.39	0.73
WNW	0.03	0.03	0.13	0.12	0.01	0.00	0.31	0.94
NW	0.04	0.04	0.17	0.13	0.01	0.00	0.40	1.05
NNW	0.05	0.05	0.18	0.09	0.00	0.00	0.37	0.78
TOTAL	1.66	1.14	4.74	3.33	0.11	0.00	10.98	0.76
AVG SPD	0.03	0.62	0.88	0.97	1.18	13.72	0.76	0.76

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX D

FROM JAN. 1 1986 THROUGH DEC. 31 1986

	+--------WIND SPEED CLASSES (MPS)-------+							AVERAGE WIND
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	SPEED
N	0.13	0.16	0.52	0.95	0.09	0.00	1.85	0.82
NNE	0.28	0.24	0.75	1.11	0.06	0.00	2.45	0.61
NE	0.43	0.31	0.84	1.03	0.10	0.00	2.71	0.57
ENE	0.34	0.26	0.68	0.91	0.08	0.00	2.28	0.78
E	0.28	0.22	0.54	0.70	0.07	0.00	1.82	0.74
ESE	0.34	0.23	0.60	0.63	0.06	0.00	1.87	0.58
SE	0.26	0.21	0.46	0.69	0.03	0.00	1.66	0.54
SSE	0.15	0.14	0.35	0.36	0.04	0.00	1.05	0.64
S	0.14	0.17	0.41	0.77	0.12	0.00	1.61	0.68
SSW	0.08	0.09	0.31	0.67	0.07	0.00	1.22	0.71
SW	0.05	0.08	0.31	0.54	0.07	0.00	1.06	0.62
WSW	0.06	0.08	0.22	0.27	0.03	0.00	0.66	0.73
W	0.04	0.06	0.16	0.30	0.05	0.00	0.62	0.57
WNW	0.05	0.05	0.15	0.49	0.10	0.03	0.87	0.67
NW	0.07	0.07	0.26	0.68	0.18	0.01	1.27	0.73
NNW	0.08	0.11	0.28	0.53	0.06	0.00	1.07	0.81
TOTAL	2.78	2.48	6.87	10.64	1.21	0.08	24.06	0.67
AVG SPD	0.02	0.57	0.76	0.82	0.54	0.96	0.67	0.67

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX E

FROM JAN. 1 1986 THROUGH DEC. 31 1986

	+-------WIND SPEED CLASSES (MPS)-------+							AVERAGE WIND SPEED
DIRECTION	0-2	2-3	3-5	5-8	8-11	>11	TOTAL	
N	0.15	0.18	0.54	0.18	0.00	0.00	1.05	0.69
NNE	0.33	0.36	0.80	0.16	0.00	0.00	1.64	0.48
NE	0.54	0.50	0.93	0.15	0.00	0.00	2.12	0.35
ENE	0.41	0.43	0.70	0.10	0.00	0.00	1.63	0.45
E	0.34	0.31	0.52	0.08	0.00	0.00	1.25	0.41
ESE	0.41	0.37	0.51	0.06	0.00	0.00	1.36	0.41
SE	0.31	0.35	0.33	0.04	0.00	0.00	1.04	0.42
SSE	0.18	0.18	0.18	0.02	0.00	0.00	0.55	0.38
S	0.16	0.20	0.19	0.02	0.00	0.00	0.58	0.31
SSW	0.10	0.09	0.18	0.02	0.00	0.00	0.39	0.29
SW	0.07	0.07	0.14	0.01	0.00	0.00	0.29	0.39
WSW	0.07	0.07	0.09	0.01	0.00	0.00	0.23	0.32
W	0.05	0.05	0.11	0.01	0.00	0.00	0.22	0.35
WNW	0.06	0.05	0.19	0.05	0.00	0.00	0.35	0.28
NW	0.09	0.09	0.32	0.07	0.00	0.00	0.57	0.56
NNW	0.09	0.08	0.34	0.10	0.00	0.00	0.61	0.72
TOTAL	3.36	3.36	6.07	1.08	0.00	0.00	13.87	0.44
AVG SPD	0.01	0.53	0.60	0.59	0.00	0.00	0.44	0.44

NWS SURFACE METEOROLOGICAL DATA
STATION # 12835

STABILITY WIND ROSE

STABILITY INDEX F

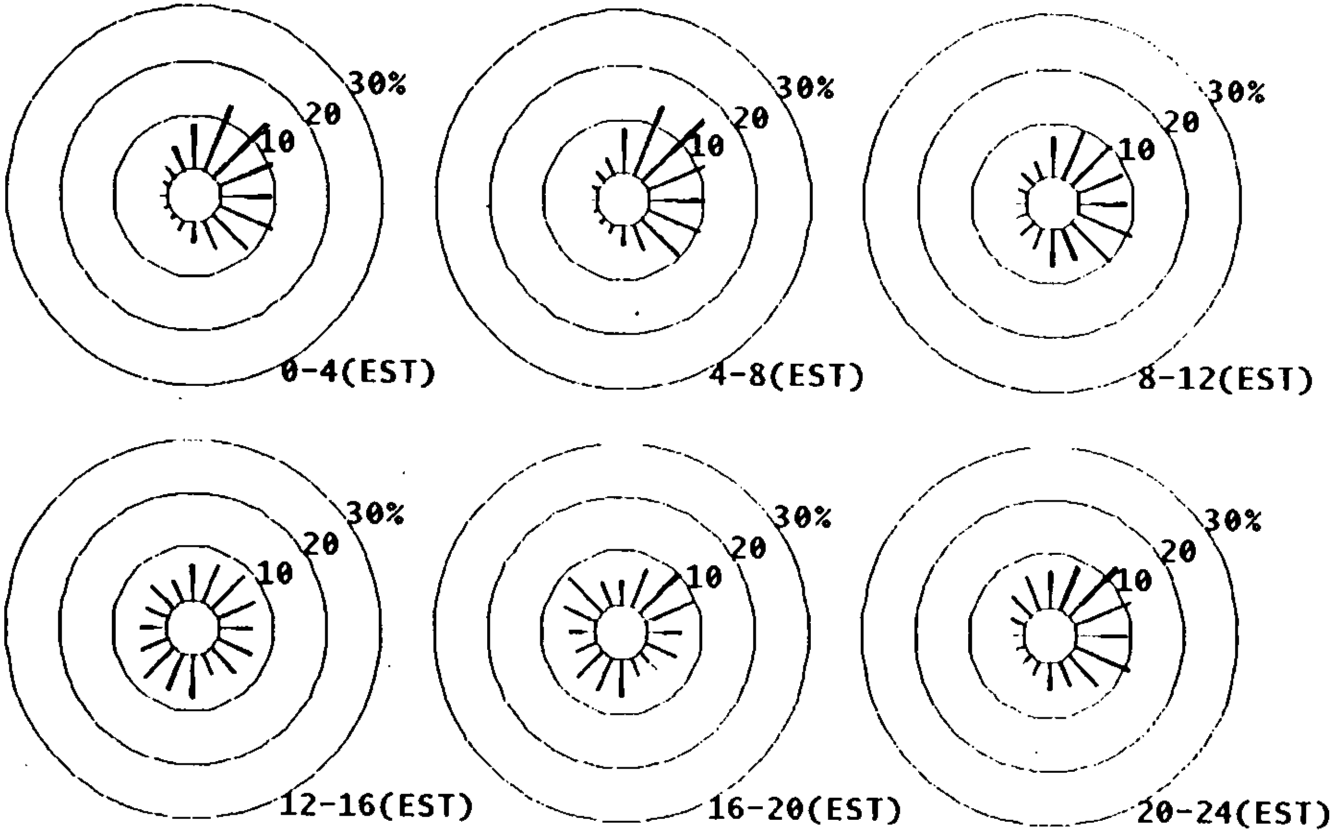
FROM JAN. 1 1986 THROUGH DEC. 31 1986

DIRECTION	+-------WIND SPEED CLASSES (MPS)-------+ 0-2	2-3	3-5	5-8	8-11	>11	TOTAL	AVERAGE WIND SPEED
N	1.60	0.34	0.22	0.00	0.00	0.00	2.16	0.15
NNE	3.52	0.88	0.44	0.00	0.00	0.00	4.85	0.11
NE	5.48	1.27	0.55	0.00	0.00	0.00	7.30	0.13
ENE	4.25	0.94	0.47	0.00	0.00	0.00	5.66	0.16
E	3.56	0.79	0.34	0.00	0.00	0.00	4.69	0.15
ESE	4.37	0.88	0.27	0.00	0.00	0.00	5.51	0.11
SE	3.30	0.66	0.17	0.00	0.00	0.00	4.14	0.10
SSE	1.94	0.45	0.08	0.00	0.00	0.00	2.47	0.12
S	1.71	0.28	0.08	0.00	0.00	0.00	2.07	0.08
SSW	1.01	0.15	0.06	0.00	0.00	0.00	1.22	0.08
SW	0.74	0.11	0.03	0.00	0.00	0.00	0.88	0.08
WSW	0.76	0.07	0.03	0.00	0.00	0.00	0.86	0.02
W	0.54	0.09	0.04	0.00	0.00	0.00	0.67	0.05
WNW	0.67	0.12	0.07	0.00	0.00	0.00	0.85	0.10
NW	0.90	0.20	0.12	0.00	0.00	0.00	1.22	0.17
NNW	1.02	0.25	0.13	0.00	0.00	0.00	1.40	0.19
TOTAL	35.38	7.46	3.09	0.01	0.00	0.00	45.93	0.12
AVG SPD	0.01	0.50	0.51	0.89	0.00	0.00	0.12	0.12

Diurnal Wind Roses for the Five-Year Meteorological Database

0100/ SITE 01 FROM 01/01/82 TO 12/31/86

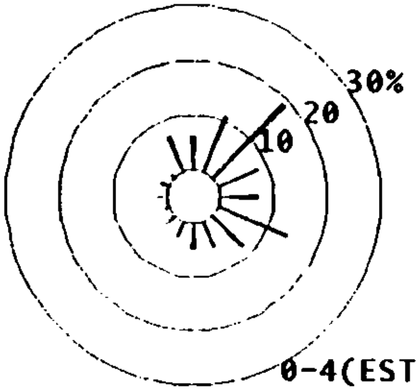
DIURNAL WIND DIRECTION ROSES



Seasonal Diurnal Wind Roses

01@@/ SITE 01 FROM 01/02/82 TO 03/31/82

DIURNAL WIND DIRECTION ROSES



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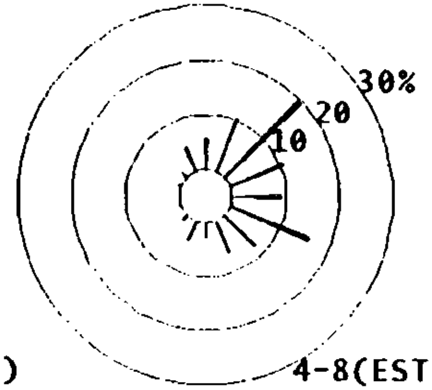
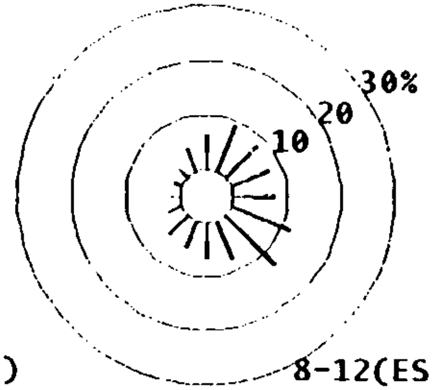
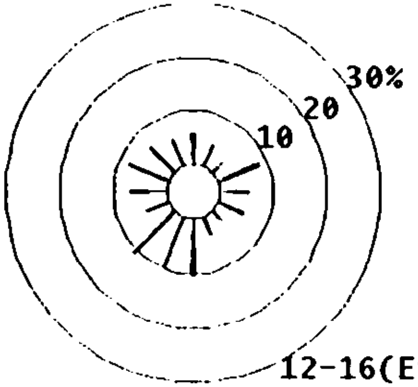


4-8(EST)



8-12(EST)



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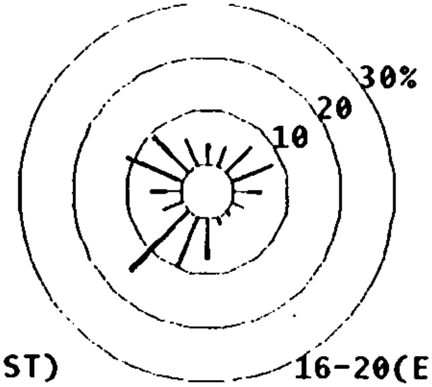

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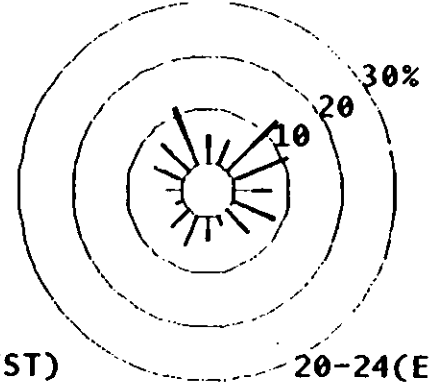
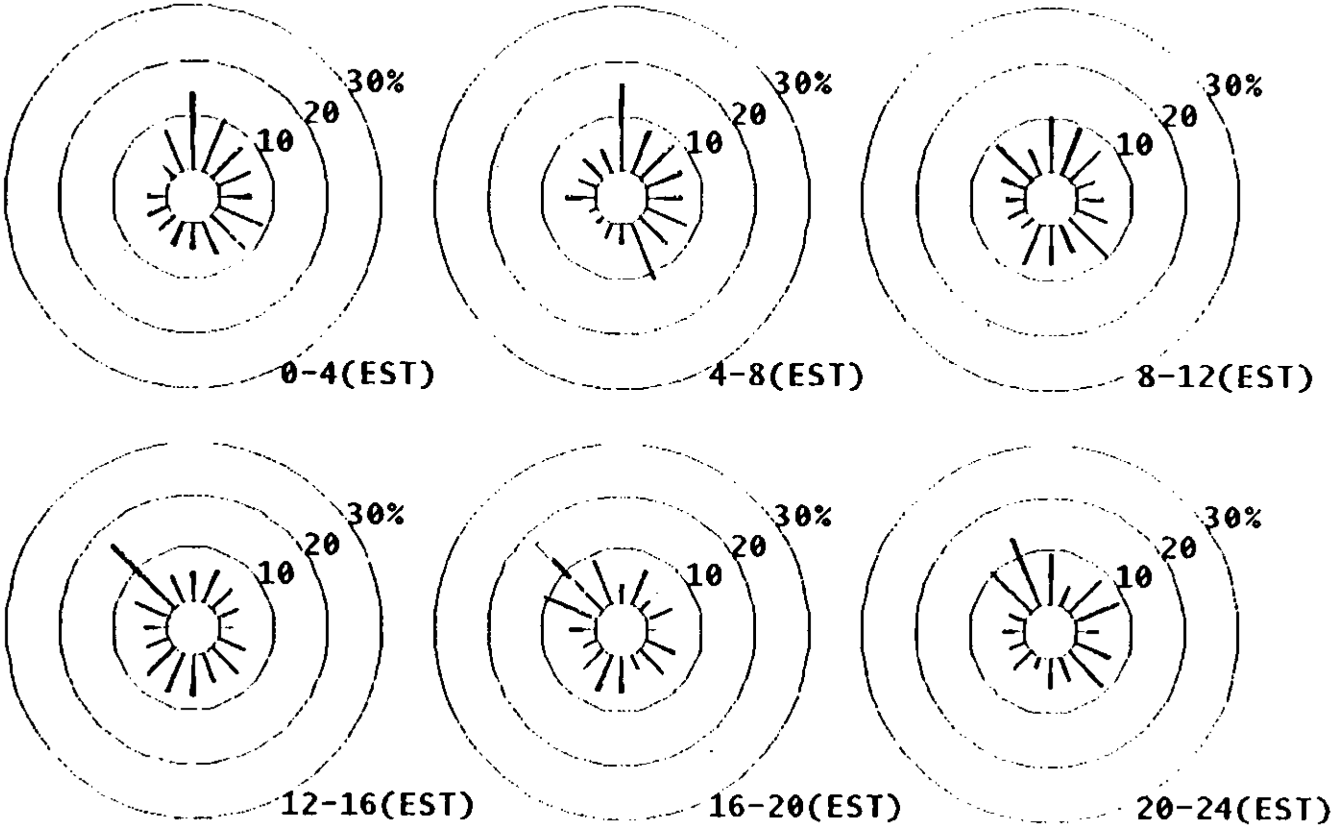


20-24(EST)

01@@/ SITE 01 FROM 01/01/83 TO 03/31/83

DIURNAL WIND DIRECTION ROSES



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4-8(EST)

8-12(EST)

12-16(EST)

16-20(EST)

20-24(EST)

01@@/ SITE 01 FROM 01/01/84 TO 03/31/84

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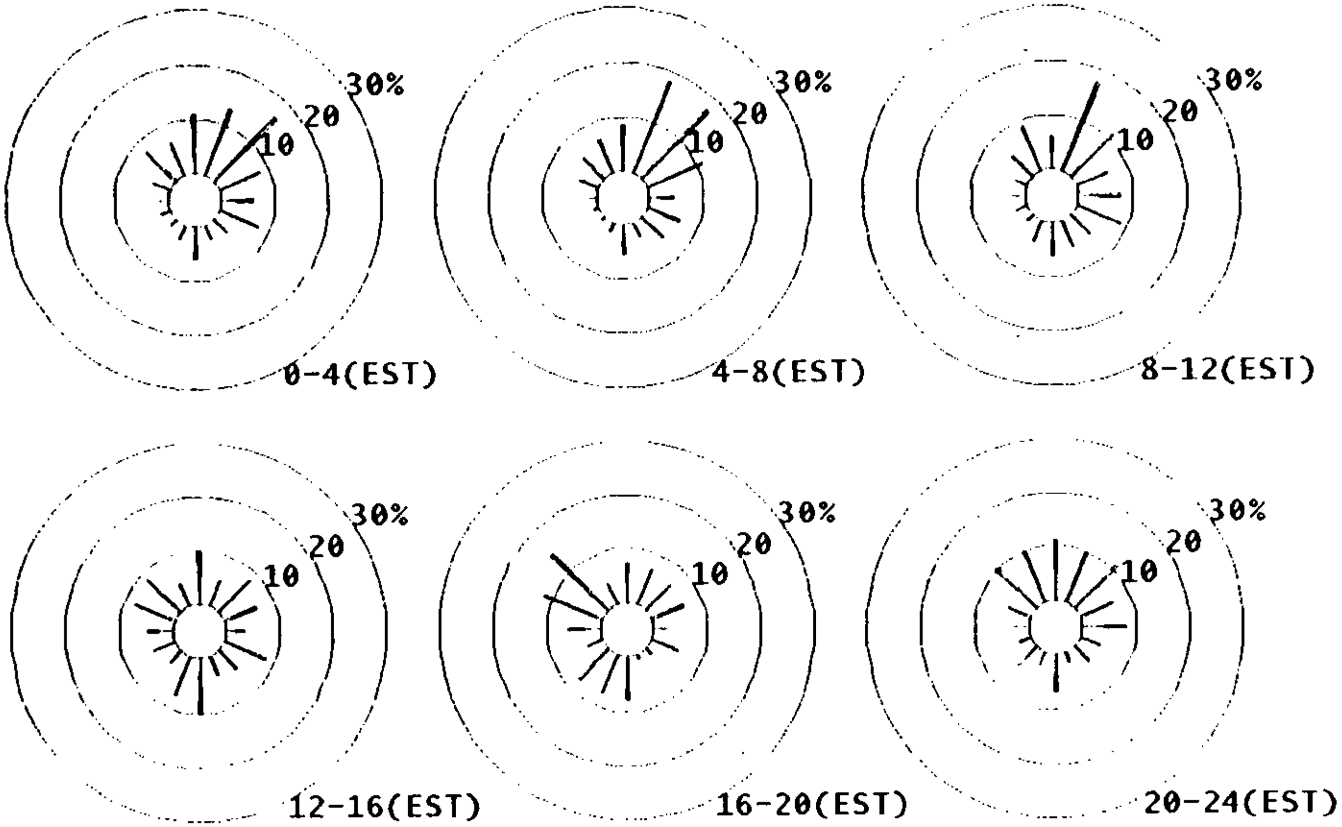

01@@/ SITE 01 FROM 01/01/85 TO 03/31/85

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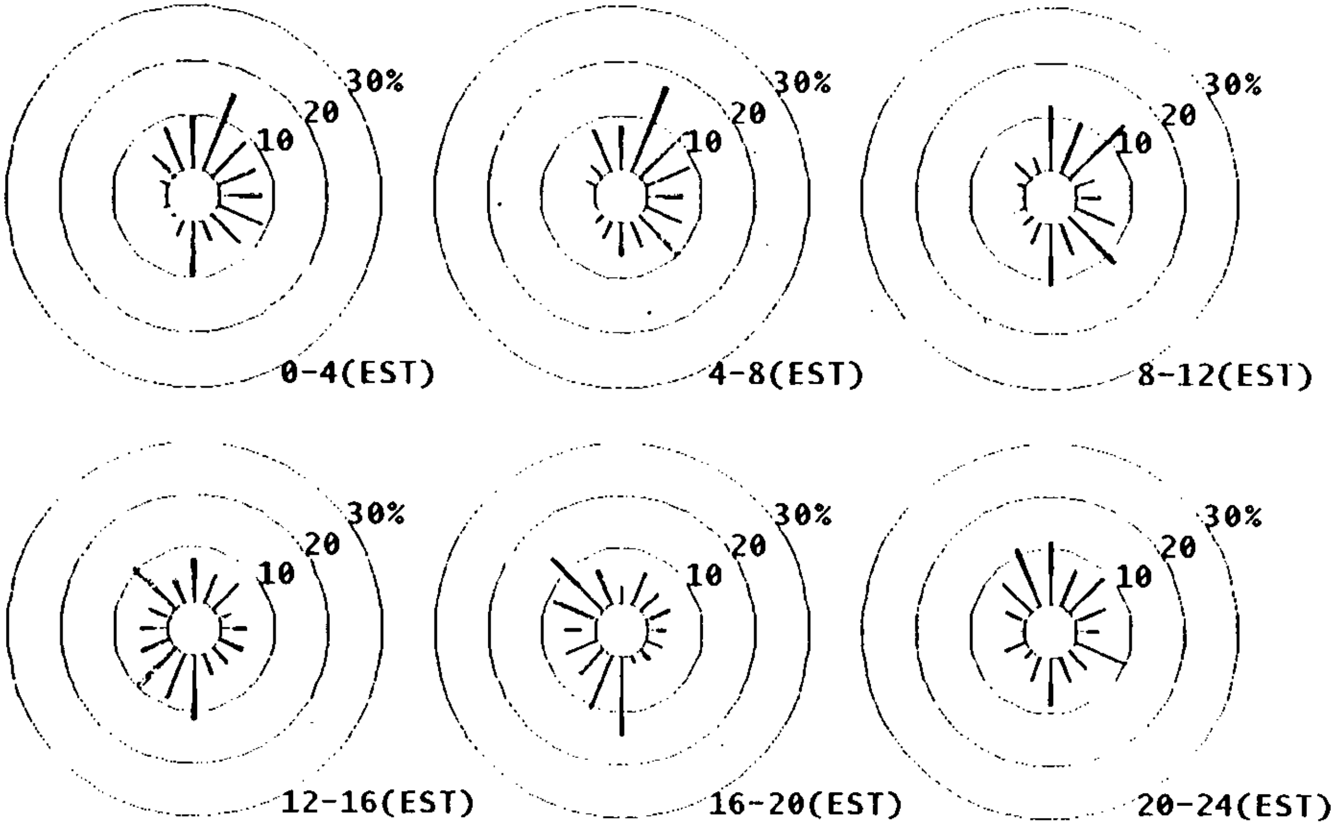
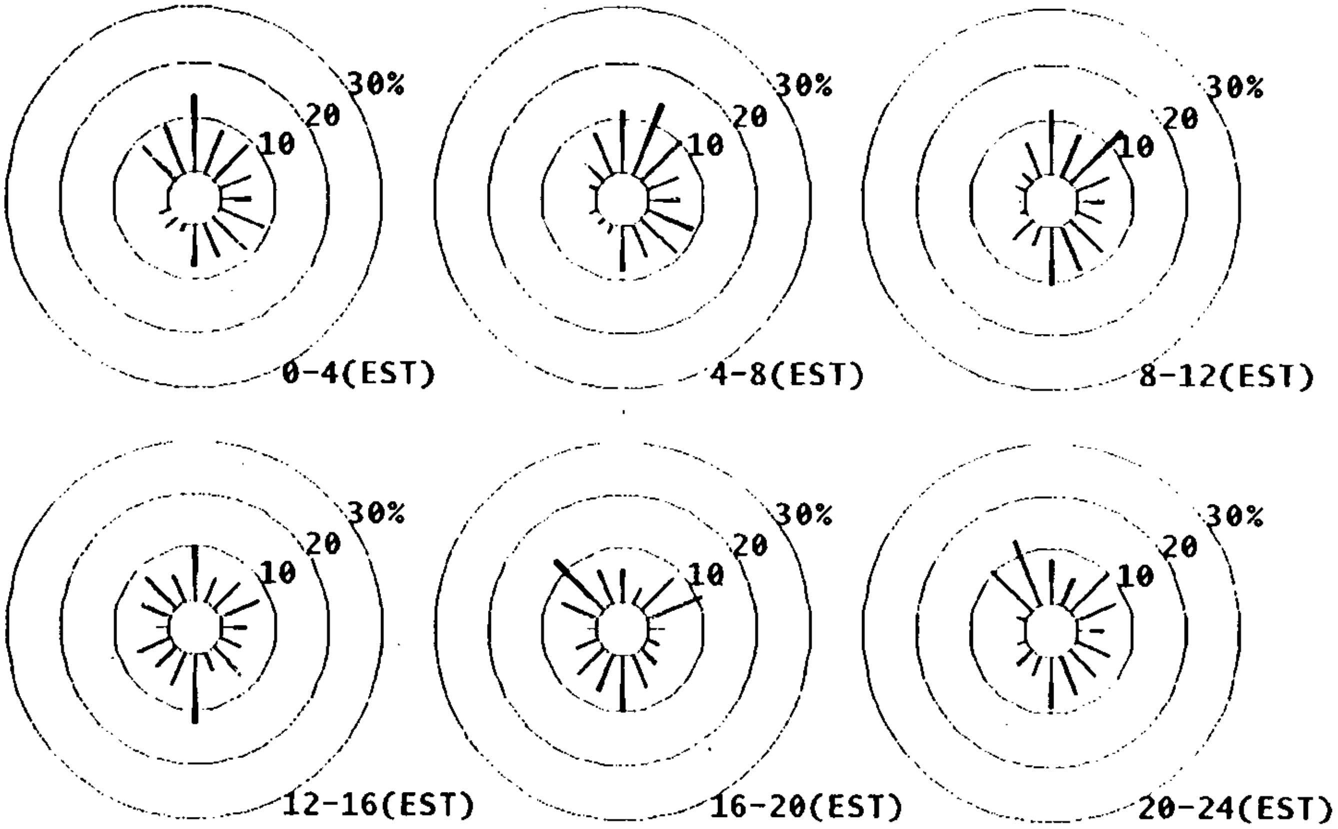


0-4(EST)
4-8(EST)
8-12(EST)
12-16(EST)
16-20(EST)
20-24(EST)

0100/ SITE 01 FROM 01/01/86 TO 03/31/86

DIURNAL WIND DIRECTION ROSES



0100/ SITE 01 FROM 04/01/82 TO 06/30/82

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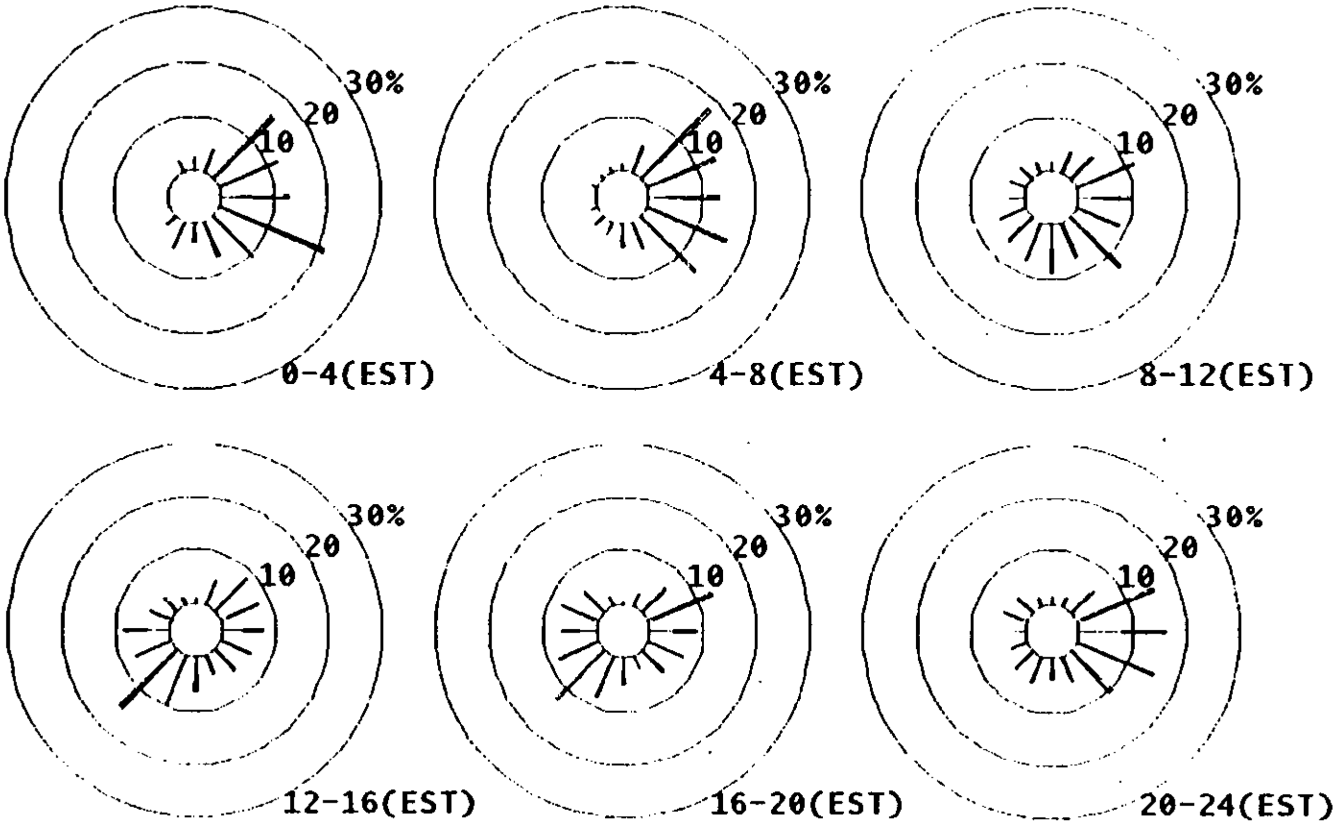

0100/ SITE 01 FROM 04/01/83 TO 06/30/83

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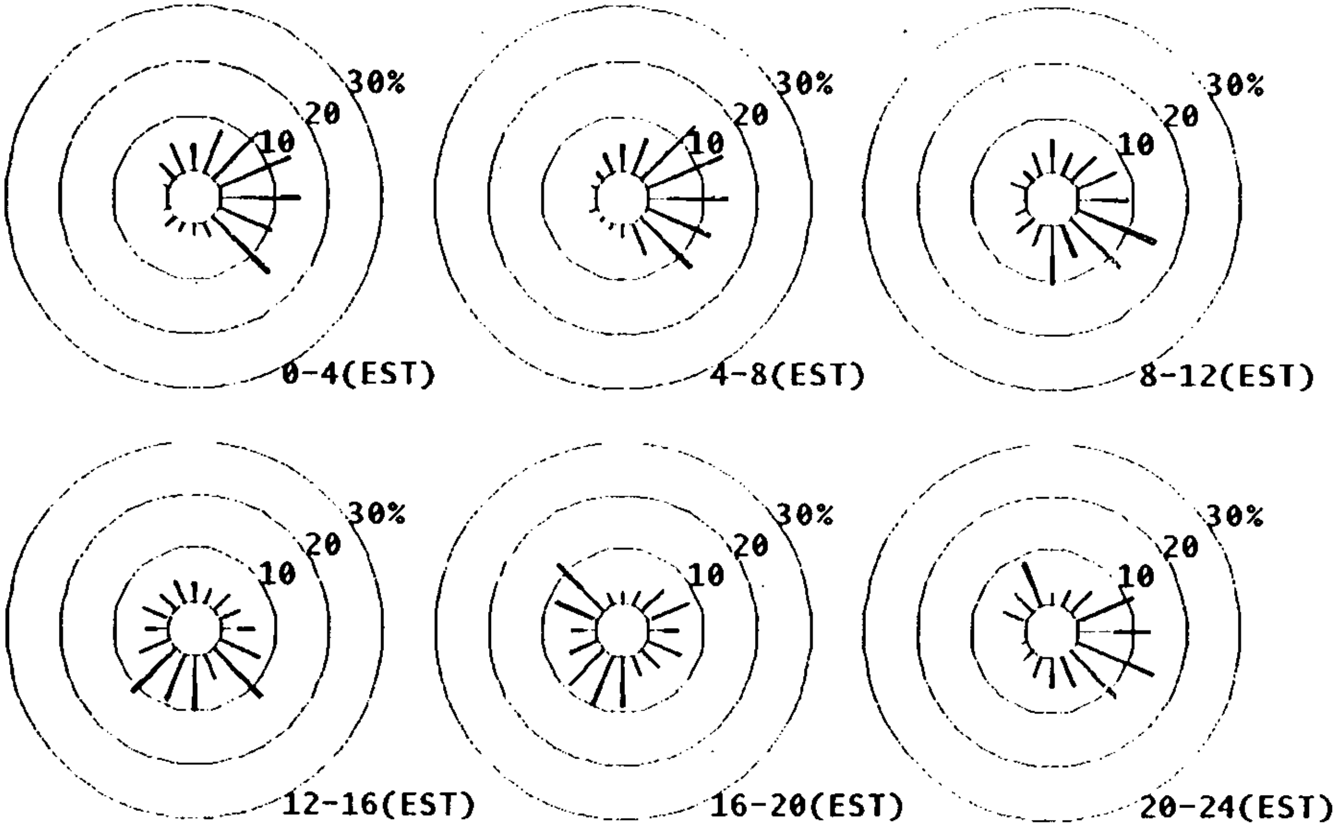

0-4(EST) 4-8(EST) 8-12(EST)

12-16(EST) 16-20(EST) 20-24(EST)

01@@/ SITE 01 FROM 04/01/84 TO 06/30/84

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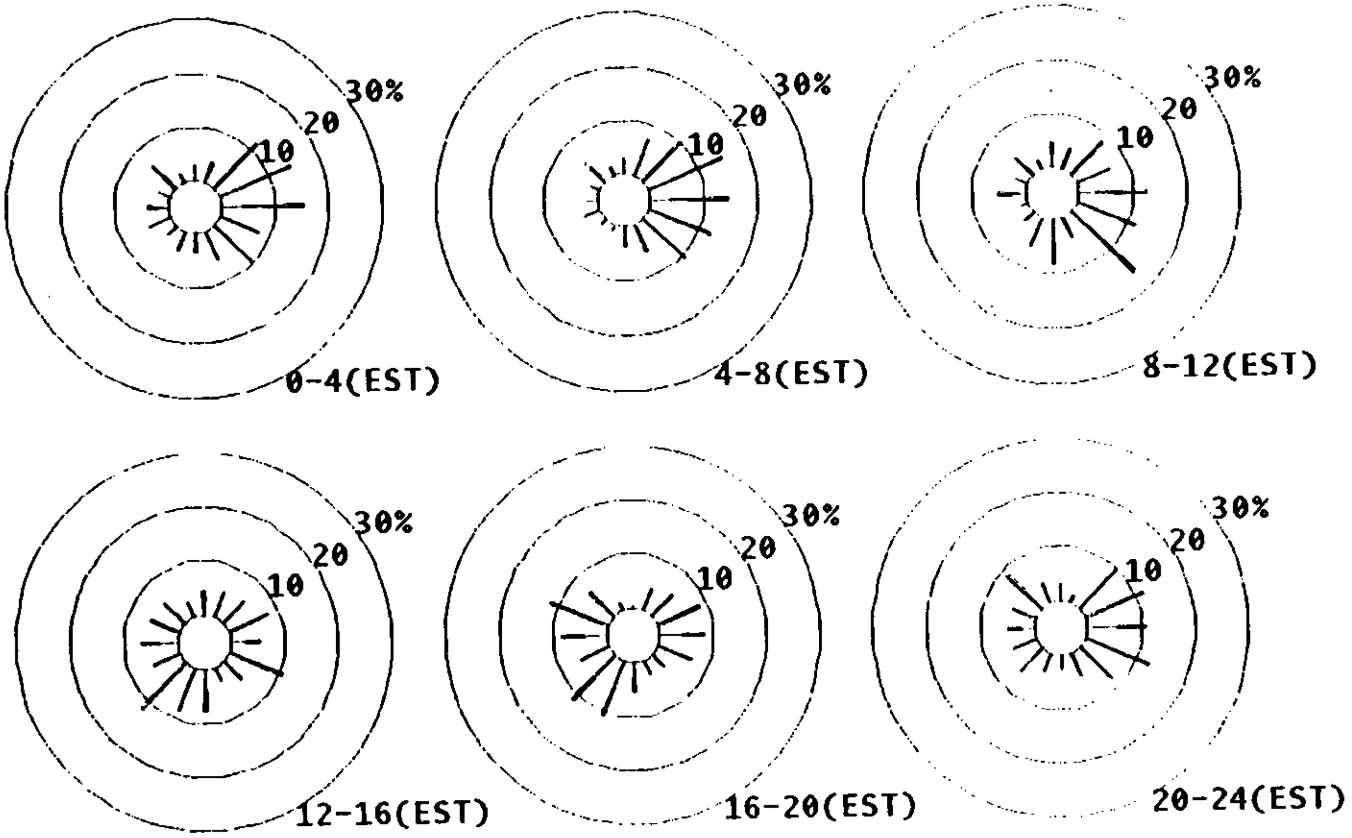

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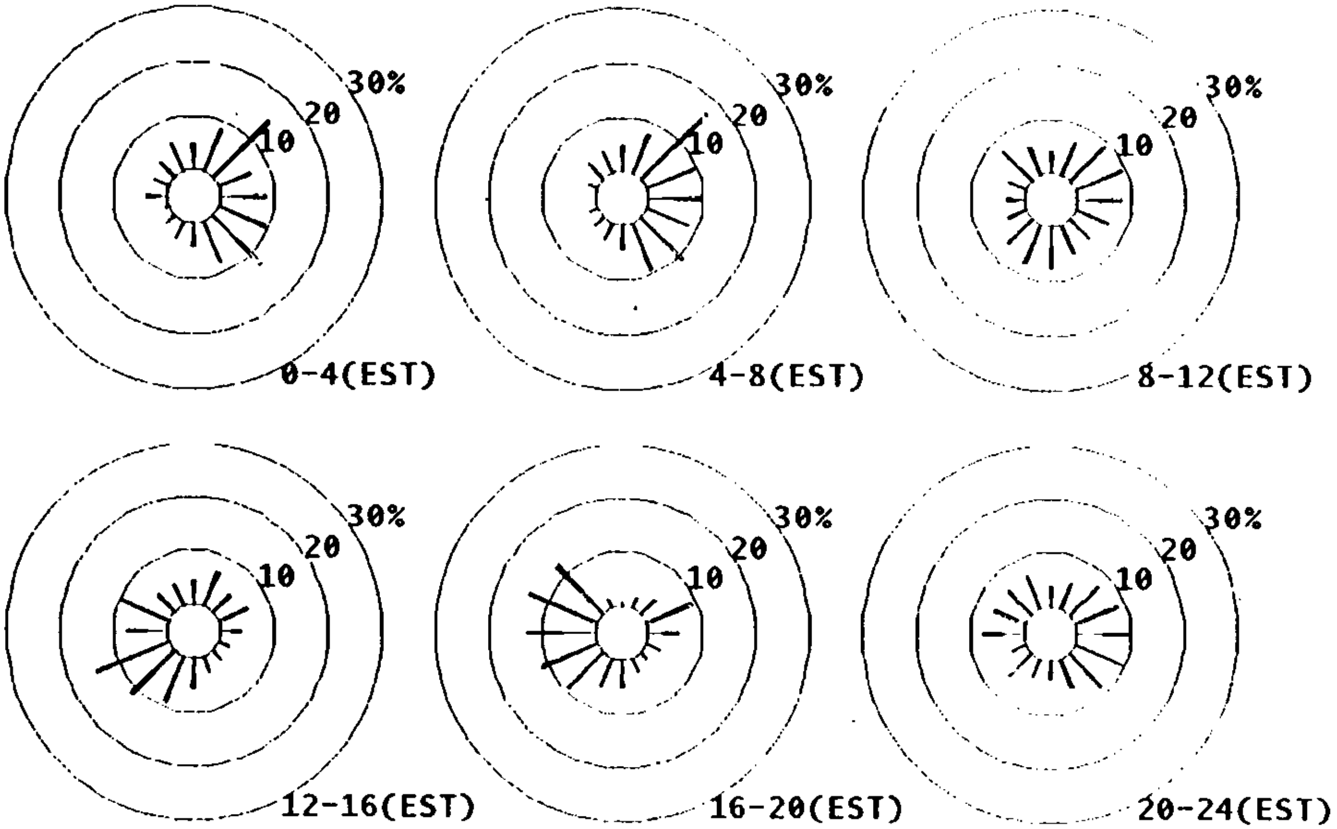
DIURNAL WIND DIRECTION ROSES



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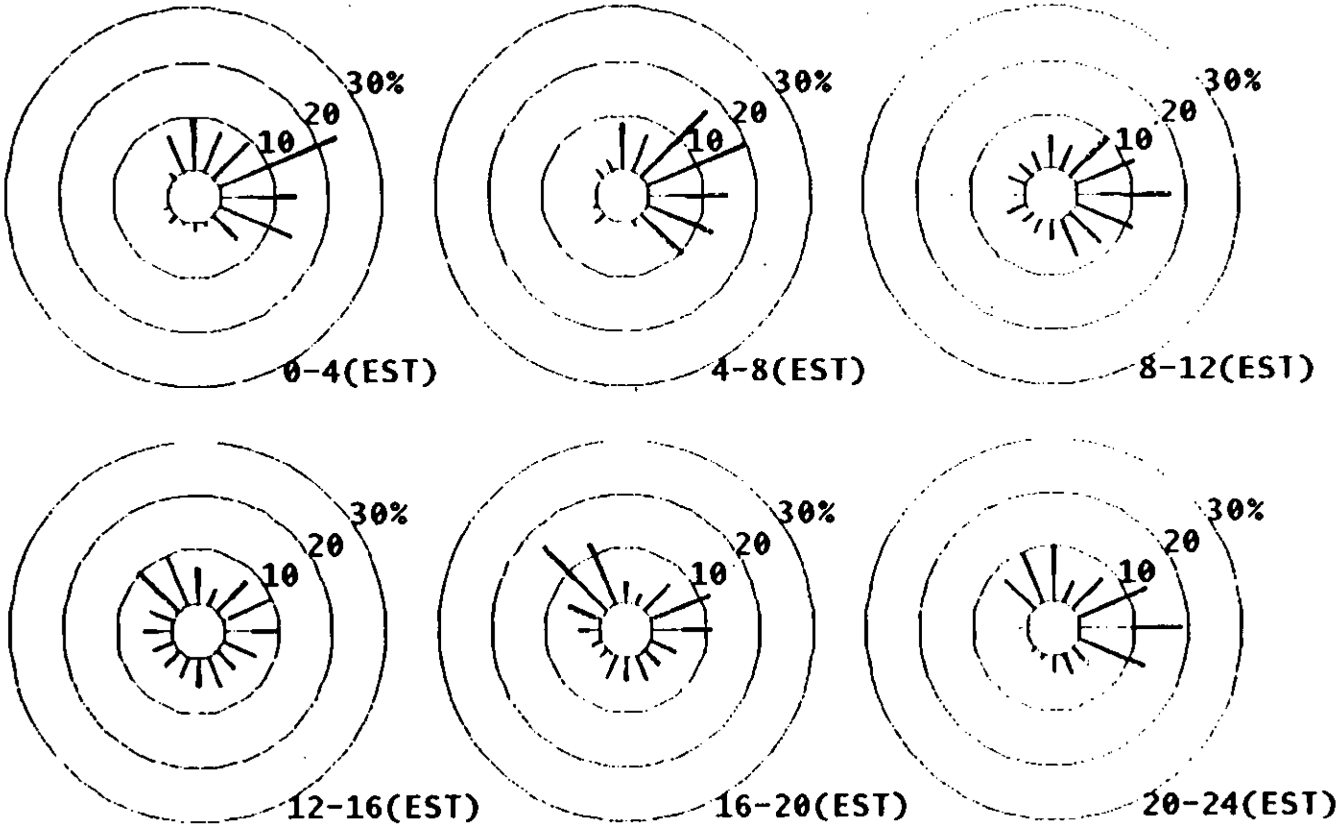
12-16(EST) 16-20(EST) 20-24(EST)

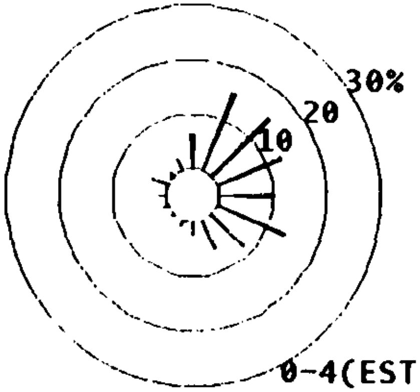
01@@/ SITE 01 FROM 04/01/86 TO 06/30/86

DIURNAL WIND DIRECTION ROSES



0100/ SITE 01 FROM 07/01/82 TO 09/30/82

DIURNAL WIND DIRECTION ROSES



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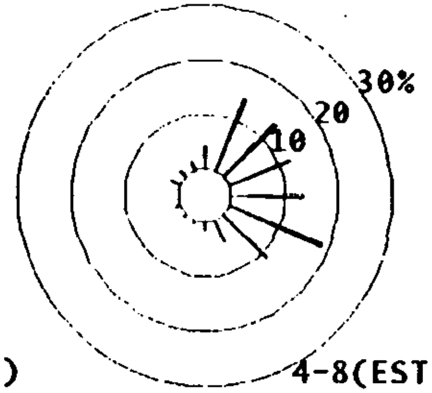

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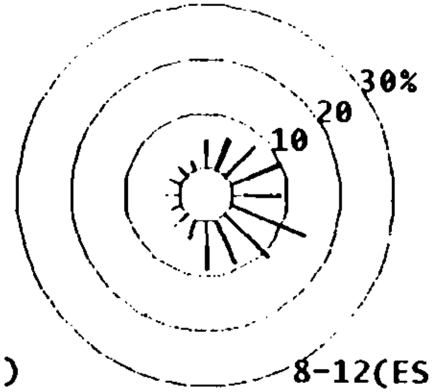

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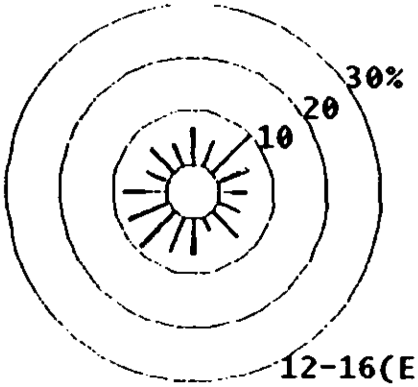

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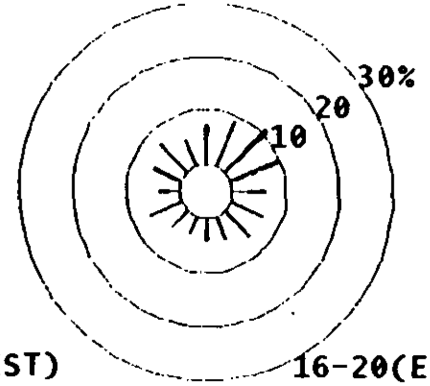

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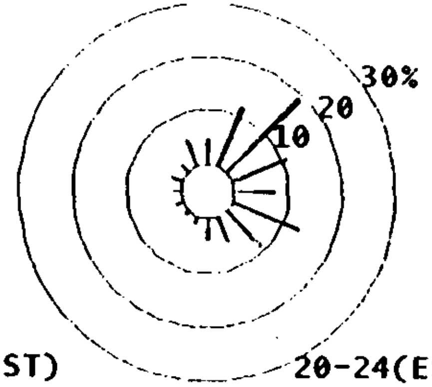
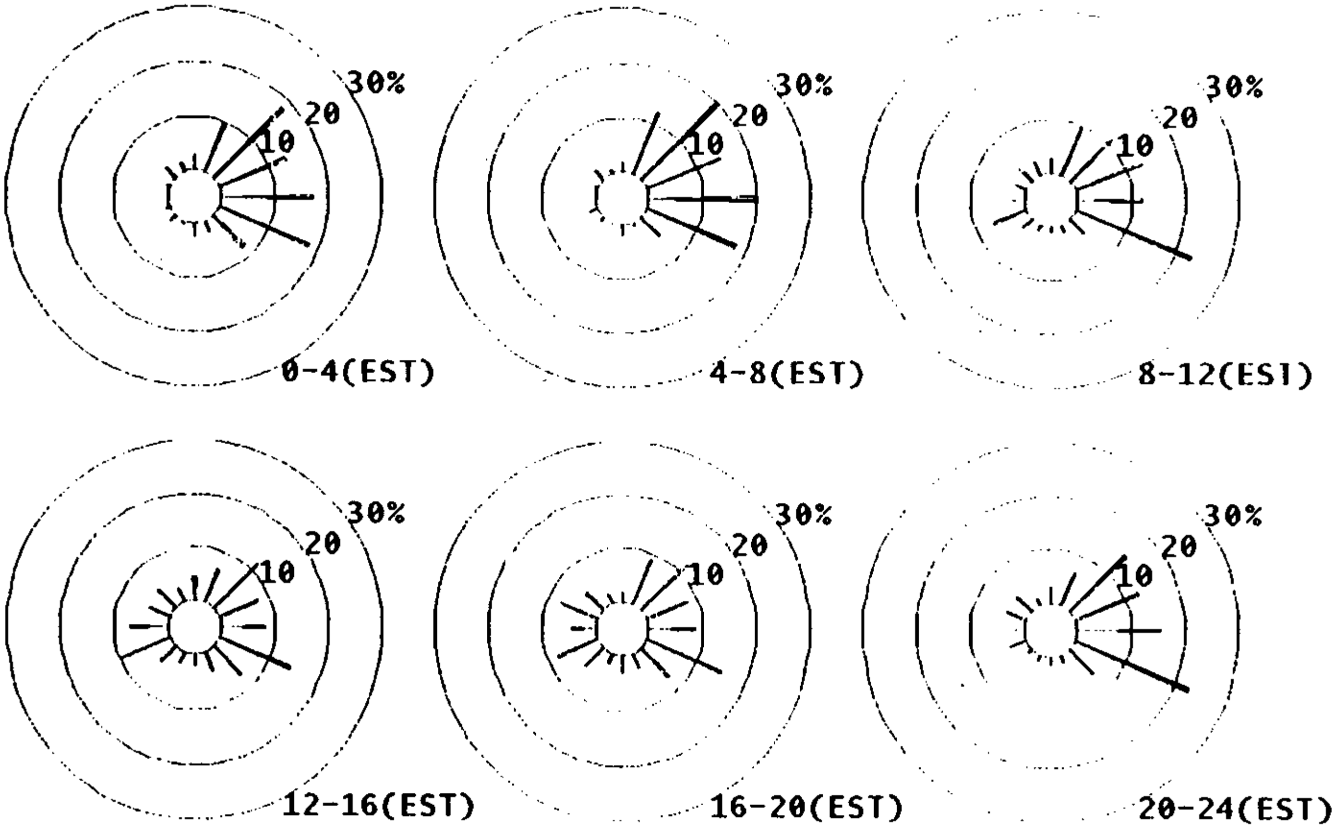


20-24(EST)

01@@/ SITE 01 FROM 07/02/83 TO 09/30/83

DIURNAL WIND DIRECTION ROSES



0-4(EST)

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0100/ SITE 01 FROM 07/01/84 TO 09/30/84

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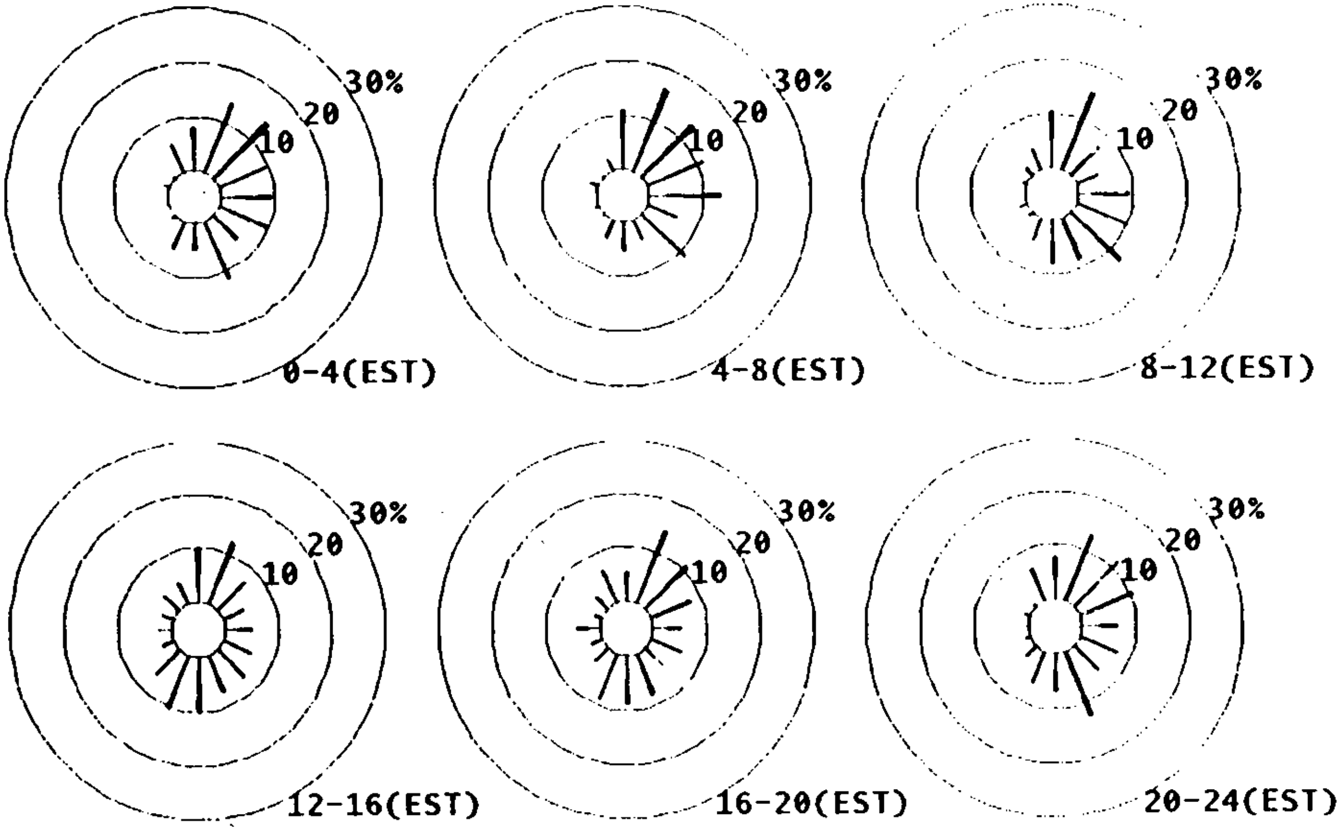

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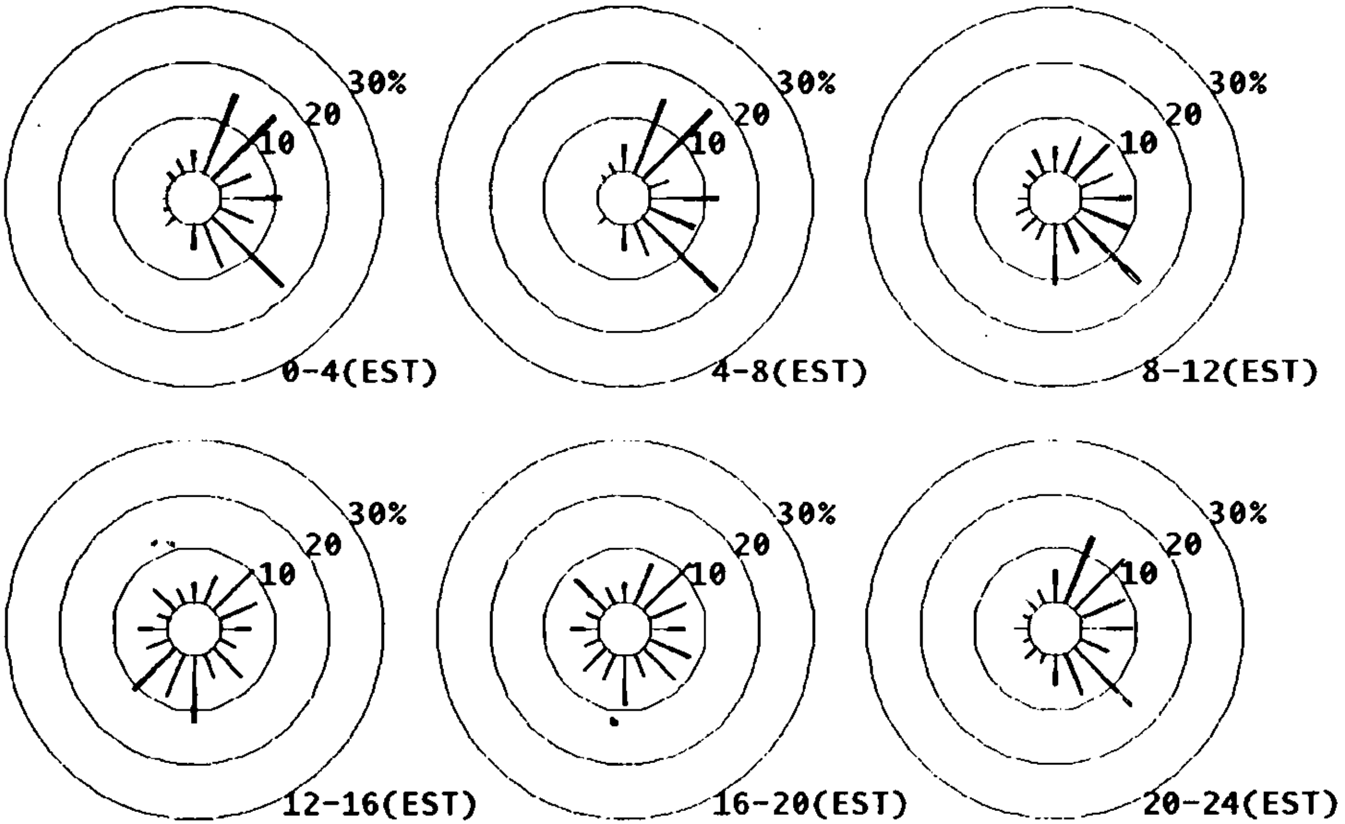

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4-8(EST)

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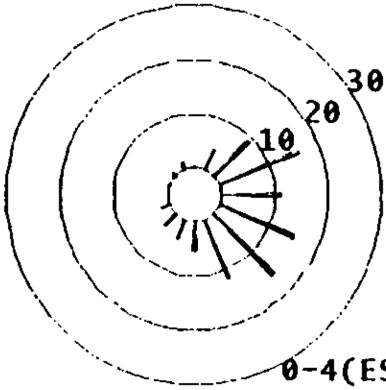
01@@/ SITE 01 FROM 07/01/86 TO 09/30/86

DIURNAL WIND DIRECTION ROSES



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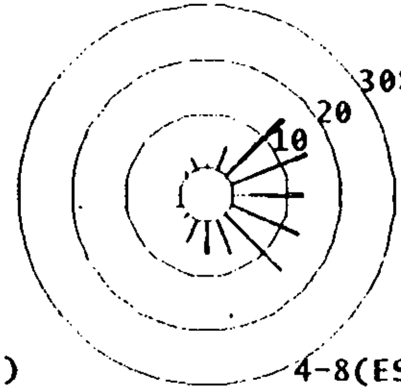

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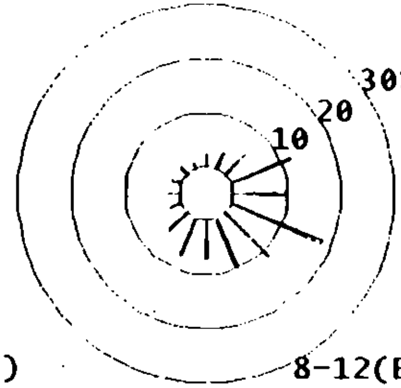

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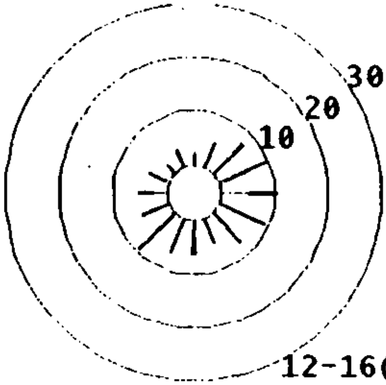

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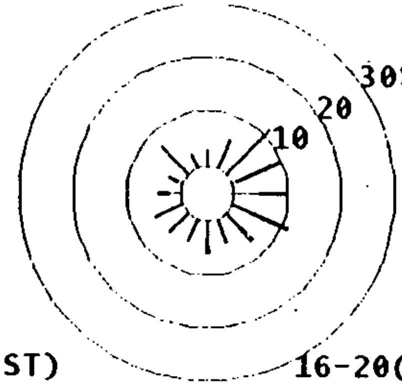

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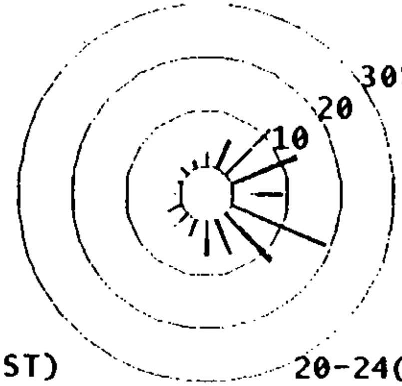
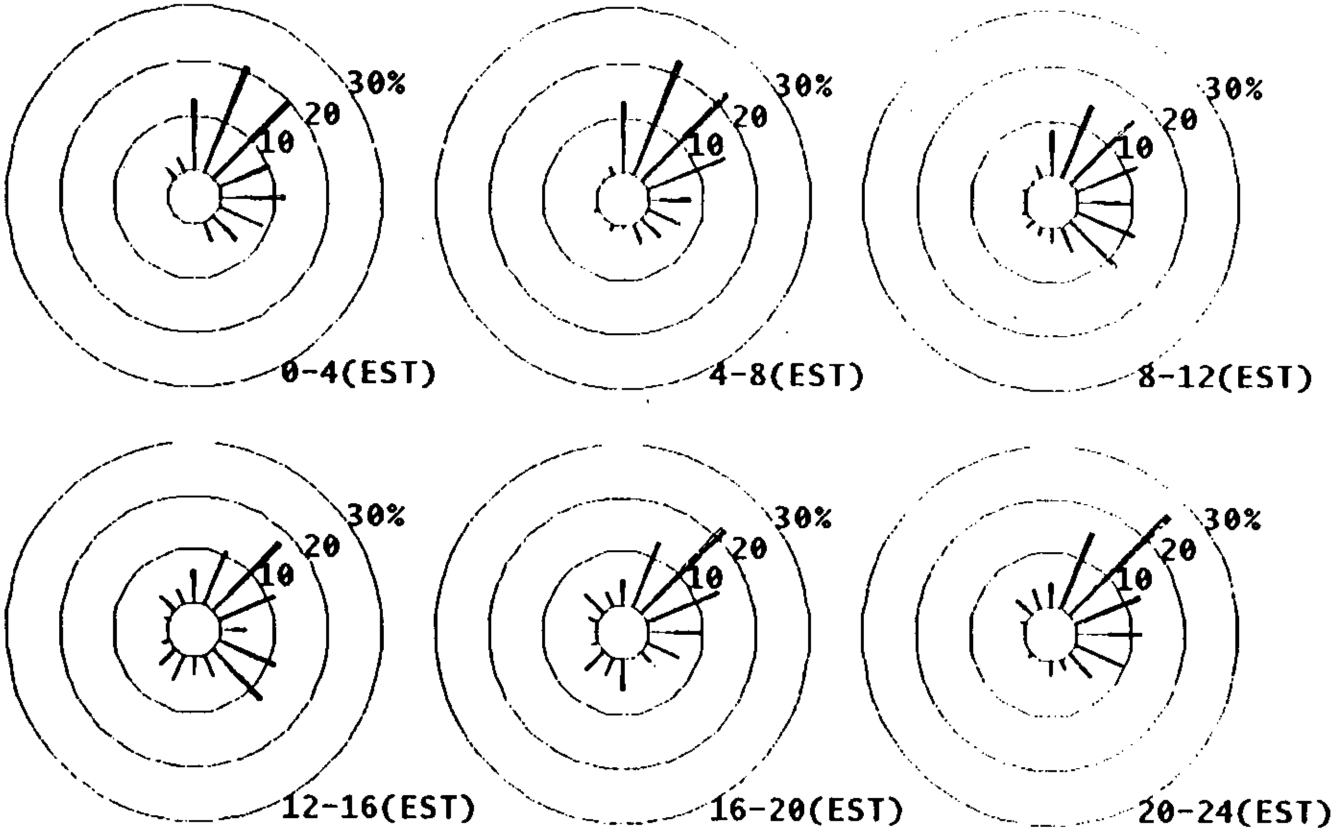


20-24(EST)

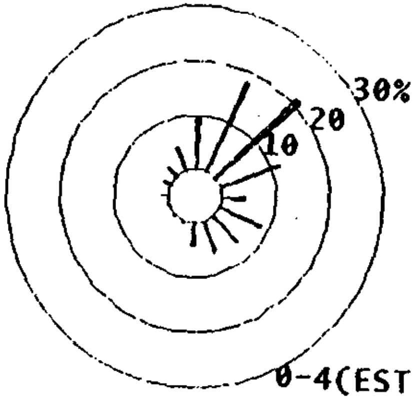
01@@/ SITE 01 FROM 10/01/82 TO 12/31/82

DIURNAL WIND DIRECTION ROSES



01@@/ SITE 01 FROM 10/01/83 TO 12/31/83

DIURNAL WIND DIRECTION ROSES



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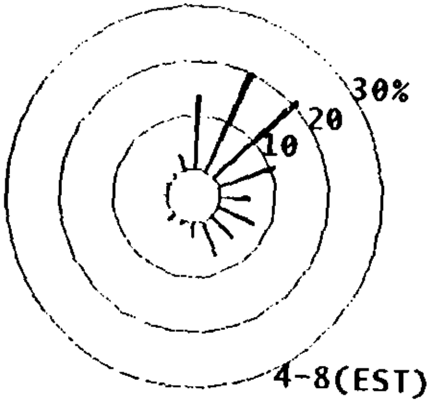

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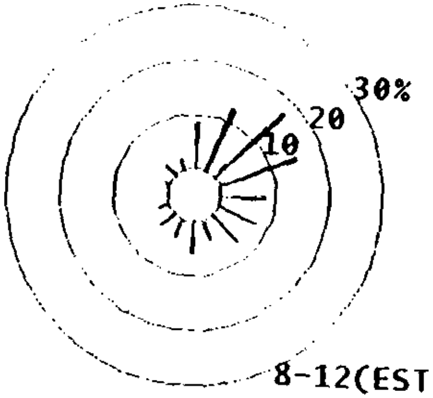

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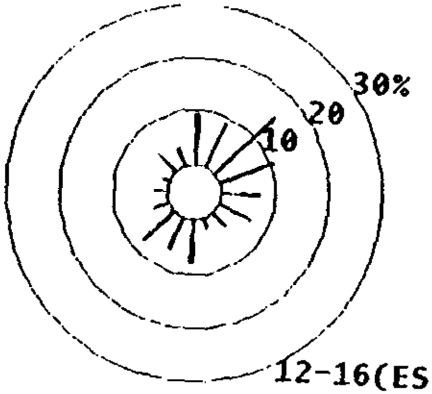

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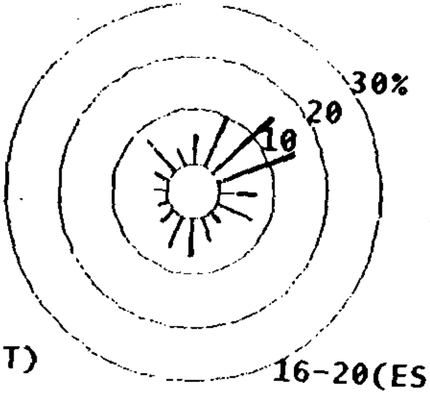

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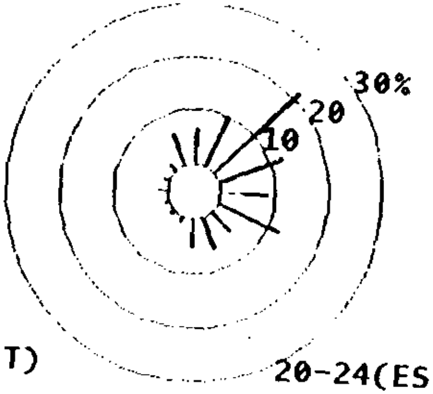
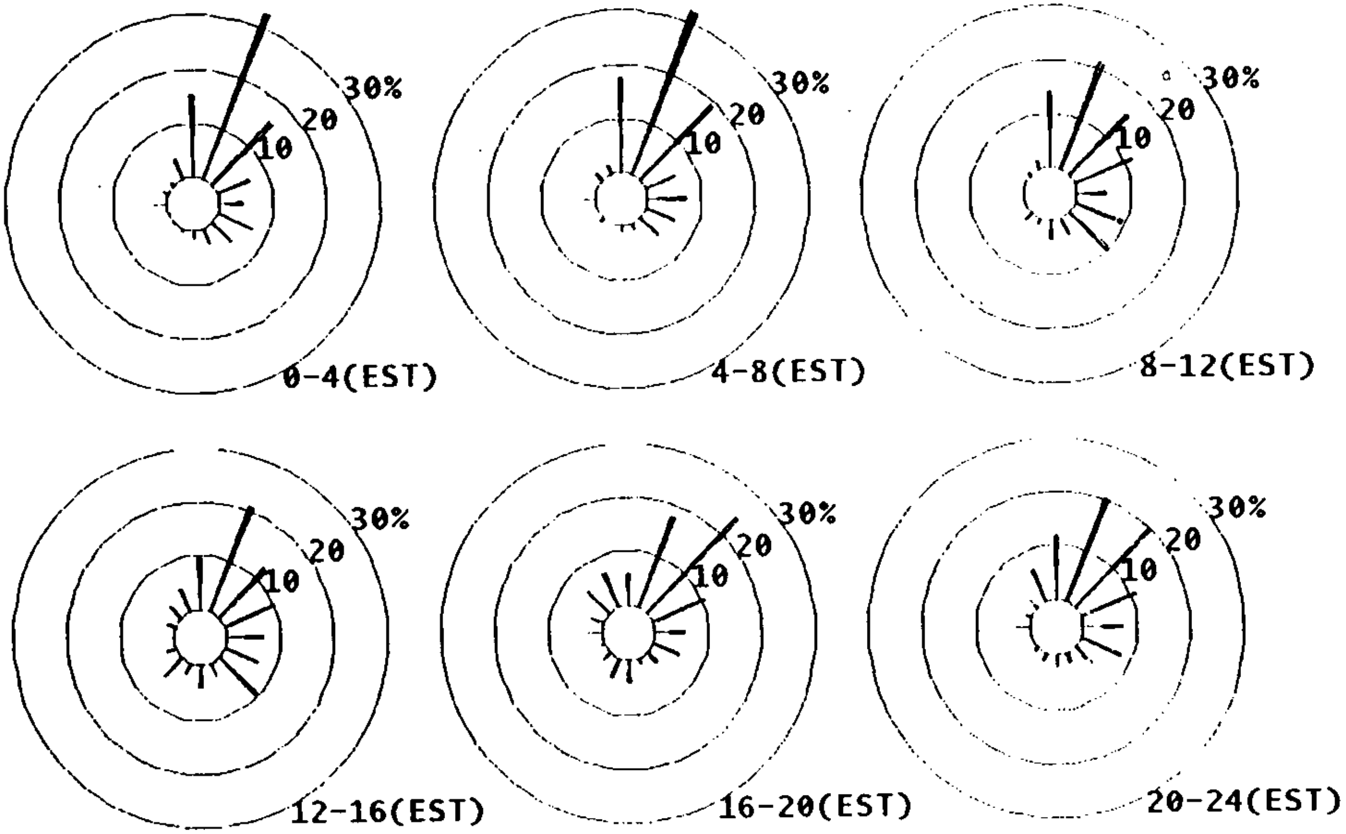


20-24(EST)

01@@/ SITE 01 FROM 10/02/84 TO 12/31/84

DIURNAL WIND DIRECTION ROSES



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4-8(EST)

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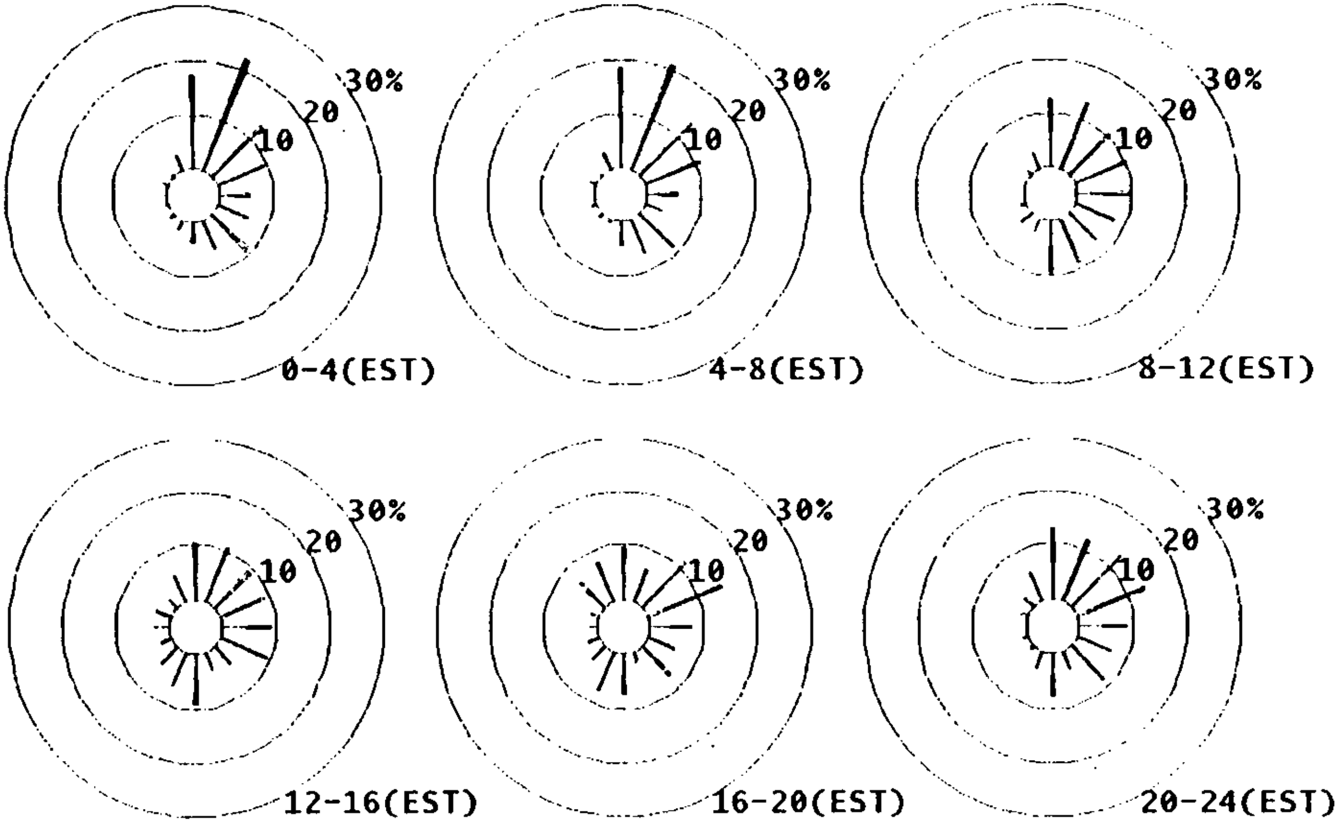
01@@/ SITE 01 FROM 10/01/85 TO 12/31/85

DIURNAL WIND DIRECTION ROSES

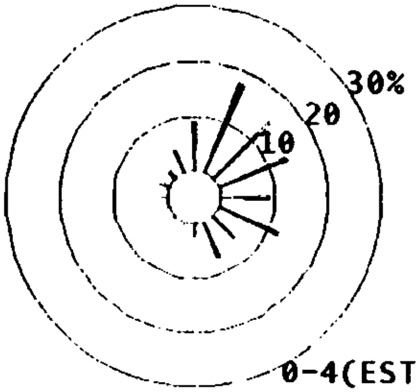


0-4(EST) 4-8(EST) 8-12(EST)

12-16(EST) 16-20(EST) 20-24(EST)

0100/ SITE 01 FROM 10/01/86 TO 12/31/86

DIURNAL WIND DIRECTION ROSES



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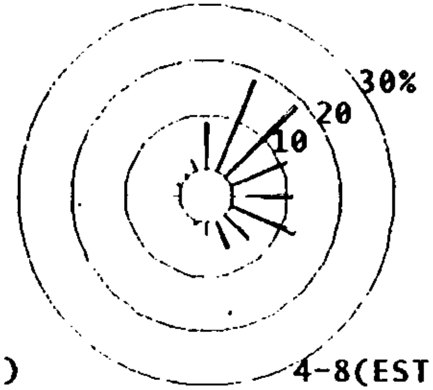
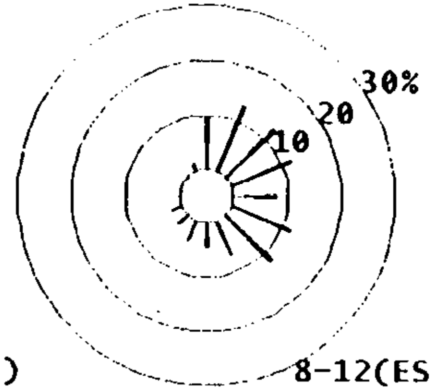


4-8(EST)



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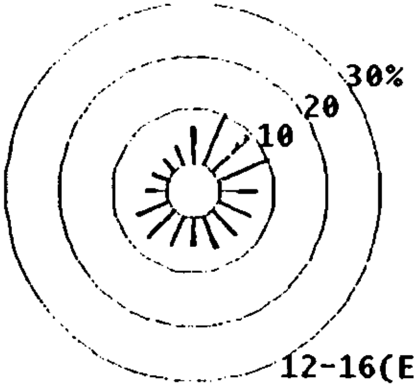

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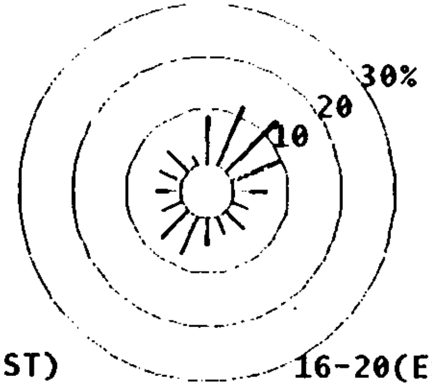
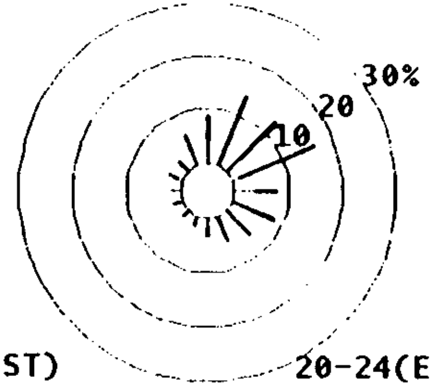


16-20(EST)



20-24(EST)

ATTACHMENT C

BACT DETERMINATIONS FOR FACILITIES BURNING REFUSE

ATTACHMENT C

LEE COUNTY ENERGY RECOVERY FACILITY
RECENT BACT DETERMINATIONS FOR FACILITIES BURNING REFUSE (Page 1 of 21)

SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/Energy Resources of Henrico, Inc. Henrico County, VA/50979 12/29/89	Two (2) RDF fired boilers with total capacity of 186.48 MMBTU/hr	Baghouse	PM: 0.0100 gr/dscf @ 12% CO_2
		Dry Scrubber	SO_2: 17.2 lb/hr max 70% reduction
			HCl: 2.94 lb/hr 70% reduction
			HF: 0.09 lb/hr 70% reduction
			HBr: 0.4 lb/hr 70% reduction
		Combustion Controls/Low Excess Air	NOx: 0.4140 lb/MMBTU
			CO: 38.7 lb/hr
			Pb: 0.03 lb/hr
			As: 7.9 EE-4 lb/hr
			Be: 1.6 EE-5 lb/hr
			Cd: 1.4 EE-3 lb/hr
			Cr: 5.2 EE-3 lb/hr
			Ni: 5.0 EE-4 lb/hr
			Hg: 0.033 lb/hr
			TCDD: 2.37 EE-5 lb/hr
			TCDF: 5.25 EE-5 lb/hr
			PCDD: 1.10 EE-5 lb/hr
			PCDF: 3.50 EE-5 lb/hr
			BEN: 0.001 lb/hr

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RECENT BACT DETERMINATIONS FOR FACILITIES BURNING REFUSE (Page 2 of 21)

SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/Lancaster County Solid Waste Management Conoy Township, PA/36-340-001 02/22/89	Three (3) mass burn boilers with total capacity of 1,200 tpd	Baghouse	PM: 0.012 gr/dscf @ 7% O_2 PM_{10}: 0.01 gr/dscf @ 7% O_2
		Dry Scrubber Furnace Inj.	SO_2: 29 ppmv 3Hr avg 30 ppmv 1Hr avg 90% reduction HCl: 30 ppmv 1Hr avg 90% reduction
		Combustion Control	CO: 50 ppmv 8Hr avg 200 ppmv 1Hr avg NOx: 300 ppmv daily avg PCDD: 2 ng/cubic meter
Refuse Incineration/Signal Brooklyn, New York, NY	Four (4) mass burn boilers with total capacity of 3,000 tpd	Baghouse	PM_{10}: 0.013 gr/dscf @ 12% CO_2 VE: 10% opacity
		Dry Scrubber	SO_2: 75% reduction HF: 90% reduction

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RECENT BACT DETERMINATIONS FOR FACILITIES BURNING REFUSE (Page 3 of 21)

SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/Chester Solid Waste Associates Chester, PA/23-340-002 09/23/88	Six (6) mass burn furnace with total capacity of 2,688 tpd (rotary)	Baghouse	PM: 0.015 gr/dscf
		Dry Scrubber	HCL: 30 ppmv 90% reduction SO_2: 30 ppmv 70% reduction
		Combustion Control	CO: 100 ppmv NOX: 235 ppmv PCDD: 2 ng/cu meter
Refuse Incineration/Ogden-Martin Systems of Alexandria Alexandria, VA/71895 07/26/88	Three (3) MSW furnace with total capacity of 325 tpd	ESP	PM: 0.03 gr/dscf @ 12% CO_2
		Dry Injection Scrubber	SO_2: 34 lb/hr HCl: 61 lb/hr HBr: 7.3 lb/hr HF: 1.7 lb/hr
		Combustion Control	VOC: 0.67 lb/hr NOX: 79.0 lb/hr CO: 68.5 lb/hr PB: 0.53 lb/hr PCDD: 2.0 ng/NM_3 @ 12% CO_2 Cd: 3.25 lb/hr Sb: 0.04 lb/hr As: 0.0093 lb/hr Hg: 0.22 lb/hr

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RECENT BACT DETERMINATIONS FOR FACILITIES BURNING REFUSE (Page 4 of 21)

SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/Ogden Martin Systems of San Bernardino Ontario, CA/LA87-01 03/29/88	Three (3) mass burn boilers with a total capacity of 1600 tpd	Baghouse	PM: 0.01 gr/dscf @ 12% CO_2
		Dry Scrubber	SO_2: 42 ppm @ 12% CO_2 80% reduction
		Dry Scrubber/ Baghouse	Hg: 0.0057 lb/hr each
Refuse Incineration/Signal Environmental Services Concord, NH/EPA-037-121NH03 12/09/87	Two (2) mass burn boilers with a total capacity of 500 tpd	Baghouse	PM: 0.02 gr/dscf @ 12% CO_2
		Dry Lime Injection System	HCl: 50 ppmdv @ 7% O_2 or 90% reduction SO_2: 21 lb/hr max
		Combustion Controls	NO_x: 0.61 lb/MMBtu CO: 0.11 lb/MMBtu 4 day average 0.25 lb/MMBtu 8 hour average Pb: 0.0034 lb/MMBtu

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RECENT BACT DETERMINATIONS FOR FACILITIES BURNING REFUSE (Page 5 of 21)

SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/City & County of Honolulu/Oahu, HI/HI84-01 11/19/87	Two (2) RDF fired furnaces having a total capacity of 1700 tpd	ESP	PM: 0.015 gr/dscf @ 12% CO_2
		Dry Scrubber	SO_2: 30 ppmdv @ 12% CO_2 84% reduction HF: 0.036 lb/ton
		Combustion Control	NO_x: 260 ppmdv @ 12% CO_2 CO: 377 ppmdv @ 12% CO_2 VOC: 21 ppmdv @ 12% CO_2 Pb: 0.0028 lb/ton Hg: 0.0022 lb/ton Be: 1.3×10^{-5} lb/ton
Refuse Incineration/Huntsville Solid Waste Authority Huntsville, AL/7-09-I104-X001 thru X006 10/06/87	Two (2) RDF furnaces with total capacity of 258.8 MMBTU/hr	Baghouse	PM: 0.015 gr/dscf @ 12% CO_2
		Dry Scrubber	SO_2: 50 PPM @ 7% O_2 70% reduction HCl: 90% reduction HF: 90% reduction H_2SO_4: 70% reduction
		Combustion Design	NOx: 0.46 lb/MMBTU 59.2 lb/hr CO: 50 ppm @ 12% CO_2 7.6 lb/hr Hg: 320 GPD

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SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Incineration/Kent Co. Department of Public Works Grand Rapids, MI/375-87 09/15/87	Two (2) solid waste furnaces with total capacity of 250 MMBTU/hr (625 tpd)	Baghouse	PM: 0.01 gr/dscf @ 12% CO$_2$
		Dry Scrubber	SO$_2$: 50 ppm or 75% reduction HCl: 50 ppm or 90% reduction Fl: 2.5 MG/DSCM SO$_3$: 39 MG/DSCM
		Combustion Controls	NOx: 400 ppmv 1 hr avg 350 ppmv 3 hr avg CO: 200 ppmv 1 hr avg 50 ppmv 4 hr avg VOC: 8.3 MG/DSCM Pb: 0.87 MG/DSCM Hg: 0.61 MG/DSCM Ar: 6.2 UG/DSCM Be: 0.16 UG/DSCM Cd: 37.0 UG/DSCM Cr: 4.2 UG/DSCM PCDD: 3.0 NG/DSCM VE: 10% opacity

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RECENT BACT DETERMINATIONS FOR FACILITIES BURNING REFUSE (Page 7 of 21)

SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/Dravo Energy Resources Montgomery, PA 46-340-002 07/23/87	Mass burn waterwall refuse fired boilers with a total capacity of 1200 tpd	ESP	PM: 0.0150 gr/dscf 99% removal
		Spray Dryer	HCl: 30.0 ppm 90% reduction SO_2: 30.0 ppm 70% reduction NO_x: 300.0 ppmv CO: 100.0 ppmv PCDD: 2.0 ng/Nm^3
Refuse Incineration/Vicon Recovery Systems Manchester NH/EPA-036-121NH03 05/22/87	Four (4) mass burn furnaces with a total capacity of 560 tpd	Baghouse	PM: 0.035 gr/dscf @ 12% CO_2
		Dry Lime Injection System	SO_2: 10.25 lb/hr (max) 65% removal HCl: 3.39 lb/hr
		Combustion Controls	NO_x: 17.5 lb/hr (max) CO: 5.73 lb/hr (max)
			Pb: 1.77 lb/hr (max) TCDD: 1.6×10^{-7} lb/hr TCDF: 5×10^{-6} lb/hr

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RECENT BACT DETERMINATIONS FOR FACILITIES BURNING REFUSE (Page 8 of 21)

SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/South Broward County Resource Recovery/ Broward County/PSD-FL-105 05/15/87	Three (3) mass burn waterwall furnaces with a total capacity of 2590 tpd	ESP	PM: 0.015 gr/dscf @ 12% CO_2
		Scrubber	SO_2: 0.31 lb/MMBtu 65% reduction HF: 0.004 lb/MMBtu 90% reduction
		Furnace Operation	NO_x: 0.56 lb/MMBtu CO: 0.09 lb/MMBtu Pb: 0.0015 lb/MMBtu Be: 9.3×10^{-7} lb/MMBtu Hg: 7.5×10^{-4} lb/MMBtu VE: 15% opacity
Refuse Incineration/Dravo Energy Resources Montgomery, PA 46-340-002 07/23/87	Mass burn waterwall refuse fired boilers with a total capacity of 1200 tpd	ESP	PM: 0.0150 gr/dscf 99% removal
		Spray Dryer	HCl: 30.0 ppm 90% reduction SO_2: 30.0 ppm 70% reduction NO_x: 300.0 ppmv CO: 100.0 ppmv PCDD: 2.0 ng/Nm^3

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SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/Vicon Recovery Systems Manchester NH/EPA-036-121NH03 05/22/87	Four (4) mass burn furnaces with a total capacity of 560 tpd	Baghouse	PM: 0.035 gr/dscf @ 12% CO_2
		Dry Lime Injection System	SO_2: 10.25 lb/hr (max) 65% removal HCl: 3.39 lb/hr
		Combustion Controls	NO_x: 17.5 lb/hr (max) CO: 5.73 lb/hr (max)
			Pb: 1.77 lb/hr (max) TCDD: 1.6×10^{-7} lb/hr TCDF: 5×10^{-6} lb/hr
Refuse Incineration/York County Solid Waste and Refuse Authority York County, PA/67-340-001 05/13/87	Mass burn rotary combuster with a total capacity of 1344 tpd	Baghouse	PM: 0.015 gr/dscf @ 7% O_2 VE: 10% opacity
		Spray Dryer	HCl: 30.0 ppmv 90% reduction SO_2: 30.0 ppmv 70% reduction CO: 100.0 ppmv PCDD: 2.0 ng/Nm^3 @ 7% O_2 Dry

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SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/ERIE Energy Resources, Inc. Erie, PA/ 25-340-001 02/05/87	RDF with a total capacity 710 tpd	Baghouse	PM: 0.015 gr/dscf @ 7% O_2 Dry VE: 10% opacity
		Limestone Injection	HCl: 30.0 ppmv 90% reduction SO_2: 50.0 ppmv 70% reduction CO: 32.0 lb/hr PCDD: 2.0 ng/Nm^3 @ 7% O_2 Dry
Refuse Incineration/Hennepin Energy Resource Co. Minneapolis, MN/2125 01/27/87	Two (2) mass burn water wall refuse fired boilers with a total capacity of 1212 tpd	Baghouse	PM: 0.02 gr/dscf @ 12% CO_2
		Spray Dryer	SO_2: 0.55 lb/ton (100 ton/yr limit) HCl: 50 ppmdv @ 12% CO_2 or 90% reduction
		Combustion Control	NO_x: 250 ppmdv @ 12% CO_2 CO: 100 ppmdv @ 12% CO_2 Pb: 0.007 lb/ton Hg: 0.002 lb/ton VOC: 0.12 lb/ton (40 ton/yr limit) PCDD: 3.0 ng/dscm @ 12% CO_2

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SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/I-95 Energy Resource Recovery Facility/ Fairfax, VA/71960 01/12/87	Four (4) mass burn units having a total capacity of 3000 tpd	ESP	PM: 0.010 gr/dscf @ 12% CO_2 7.500 lb/hr 99.0% removal
		Partial control by ESP	Hg: 0.33 lb/hr Pb: 1.7 lb/hr 99.0% removal Be: 2.0 EE-4 lb/hr Cd: 4.70 EE-2 lb/hr Sb: 0.1400 lb/hr As: 7.3 EE-3 lb/hr
		Acid Gas Control Device	HCl: 28.53 lb/hr 90% reduction SO_2: 44.4 lb/hr 70% reduction
		Combustion Controls	NO_x: 151.3 lb/hr CO: 158.1 lb/hr VOC: 1.70 lb/hr TCDD: 2.3 EE-6 lb/hr

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SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/American REF-Fuel of Hempstead, NY 11/06/86	Three (3) mass burn waterwall refuse fired boilers with a total capacity of 2250 tpd	Baghouse	PM: 0.015 gr/dscf @ 12% CO_2
		Spray Dryer	SO_2: 70% reduction HCl: 50 ppmdv @ 12% CO_2 or 90% reduction
		Furnace Design	NO_x: 255 ppmdv @ 12% CO_2 CO: 100 ppmdv @ 12% CO_2 VOC: 36 ppmdv @ 12% CO_2
Refuse Incineration/Vicon Recovery Systems Rutland, VT 09/11/86	Two (2) MSW furnaces with total capacity of 240 tpd	ESP	PM: 0.01 gr/dscf @ 12% CO_2
		Packed Tower Adsorber/ Scrubber	SO_2: 12 lb/hr HCl: 9.4 lb/hr HF: 0.3 lb/hr
		Combustion Controls	CO: 300 ppm @ 12% CO_2 1 hr avg 50 ppm @ 12% CO_2 24 hr avg NOx: 36 lb/hr PCDD: 6.3 lb/hr PB: 0.4 lb/hr Hg: 0.0045 lb/hr

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RECENT BACT DETERMINATIONS FOR FACILITIES BURNING REFUSE (Page 13 of 21)

SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/Stanislaus Waste Energy Co. Stanislaus County, CA/SJ 86-03 08/11/86	Two (2) mass burn waterwall with a total capacity of 800 tpd	Baghouse	PM: 0.01 gr/dscf @ 12% CO_2, 99% removal Hg: 0.083 lb/hr
		Dry Scrubber	SO_2: 42.0 ppm @ 12% CO_2, 80% removal
		Ammonia Injection	NO_x: 175.0 ppm @ 12% CO_2, 40% removal
		Combustion Control	CO: 400.0 ppm @ 12% CO_2
Refuse Incineration/Ogden Martin Systems of Indianapolis Indianapolis, IN/11065 03/24/86	Three (3) mass burn waterwall furnaces with a capacity of 2178 tpd	Baghouse	PM: 0.010 gr/dscf @ 12% CO_2 subject to LAER not BACT VE: 10% opacity Pb: 1.0 EE-3 gr/dscf @ 12% CO_2
		Dry Scrubber/ Baghouse	SO_2: Subject to LAER not BACT 80% removal HCl: 80% removal
		Combustion Control	NO_x: 272.0 ppmv @ 12% CO_2 CO: 135.0 ppmv @ 12% CO_2 VOC: 3.3 lb/hr

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SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/Jackson County Board of Public Works Jackson, MI/451-85 03/18/86	Two (2) mass burn boilers with a total capacity of 400 tpd	Baghouse	PM: 0.015 gr/dscf @ 12% CO_2
		Dry Scrubber	SO_2: 86 ppmv @ 12% CO_2 or 70% reduction HCl: 90% reduction NOx: 311 ppmdv @ 12% CO_2 CO: 113 ppmv @ 12% CO_2 Cd: 63 ug/dscm @ 12% CO_2 Cr: 47 ug/dscm @ 12% CO_2 As: 12 ug/dscm @ 12% CO_2 PCDD: 0.52 ug/dscm @ 12% CO_2 PCDF: 0.5 ug/dscm @ 12% CO_2
Refuse Incineration/Babylon Resource Recovery Facility 01/31/86	Two (2) mass burn furnaces having a total capacity of 750 tpd	Baghouse	PM: 0.02 gr/dscf @ 12% CO_2
		Dry Scrubber	SO_2: 70% reduction HCl: 50 ppmdv @ 12% CO_2 or 90% reduction
		Combustion Control	NO_x: 6.6 lb/ton CO: 99.8% minimum combustion efficiency

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SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/American Ref-Fuel of Essex County Newark, NJ 12/11/85	Three (3) mass burn waterwall furnaces with a total capacity of 2274 tpd	ESP	PM: 0.015 gr/dscf @ 7% O_2 Subject to LAER not BACT VE: 20% opacity
		Dry Scrubber/ ESP	SO_2: 100.0 ppmv @ 7% O_2 HCl: 50 PPMV @ 7% O_2 90% control HF: 0.820 lb/hr Pb: 0.50 lb/hr Hg: 0.053 lb/hr Be: 2.5 EE-4 lb/hr As: 5.10 EE-3 lb/hr Cd: 0.043 lb/hr Cr: 0.012 lb/hr Ni: 3.3 EE-3 lb/hr
		Aux Burners #2 Oil Automatic Air/ Fuel Control	CO: 126.0 lb/hr NMHC: 6.3 lb/hr PAH: 0.29 lb/hr NO_x: 95.0 lb/hr
Refuse Incineration/City of Long Beach Long Beach, CA/LA 83-01 10/23/85	Three (3) mass burn waterwall furnaces with a total capacity of 1350 tpd	Baghouse/ Dry Scrubber	SO_2: 26.0 PPM @ 12% CO_2, 80% removal Pb: 0.080 lb/hr Hg: 0.130 lb/hr
		Dry Scrubber	HF: 3.3 lb/hr 90% removal

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RECENT BACT DETERMINATIONS FOR FACILITIES BURNING REFUSE (Page 16 of 21)

SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/Katy Seghers Clearfield, UT 02/24/84	500 tpd Incinerator & Waste Heat Boiler	ESP	PM: 0.025 gr/dscf @ 12% CO_2 98.0% removal VE: 20% Opacity F: 1.1 lb/hr Hg: 0.12 lb/hr Pb: 0.22 lb/hr
		Lime Scrubber/ Injection	SO_2: 22.4 lb/hr 50% removal HCl: 31.8 lb/hr 50% removal
		Combustion Control	NO_x: 29.9 lb/hr CO: 35.5 lb/hr
Refuse Incineration/HMR Wallace, New Castle, DE APC 84/633-636 01/01/84	Five (5) furnaces with total capacity of 600 tpd	ESP	PM: 0.05 gr/dscf VE: 20% opacity
		Combustion Control	CO: 50 ppm

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SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/Trans Energy Brooks, OR 24-5398 12/19/83 Scrubber	2 Incinerators, 312 tpd total	Baghouse or ESP	PM: 0.03 gr/dscf @ 12% CO_2 VE: 10% Opacity HCl: 23.0 lb/hr 80% removal
		Equipment Design & Operation	NO_x: 94.0 lb/hr SO_2: 73.0 lb/hr CO: 55.0 lb/hr Hg: 0.17 lb/hr VOC: 3.1 lb/hr Pb: 0.52 lb/hr F: 1.6 lb/hr
Refuse Incineration/Dutchess Resource Recovery Poughkeepsie, NY/134601-0024 10/14/83	Waterwall combustion 200 tpd total	Baghouse	PM: 0.015 gr/dscf 99.5% removal
		Low S Fuel	SO_2: 25.0 lb/hr
		Lime Coating for Baghouse	HCl: 33.0 lb/hr, 80% removal
		Proper Boiler Design	NO_x: 25.0 lb/hr
		Good Combustion Control	CO: 13.0 lb/hr

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SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/NESWC North Andover, MA/029-121MA16 05/27/82	2 new mass burn waterwall refuse fired boilers with a total capacity of 1500 tpd	ESP	PM: 0.05 gr/dscf @ 12% CO_2
		Low S Fuel	SO_2: 0.34 lb/MMBTU
		Incinerator Design	NO_x: 0.32 lb/MMBTU CO: 0.07 lb/MMBTU 98% efficiency SO_2: 0.02 lb/MMBTU
Refuse Incineration/McKay Bay Tampa, FL PSD-FL-086 07/02/82	4 new refuse fired mass burn furnaces with a total capacity of 1000 tpd	ESP designed to comply with LAER	PM: Subject to LAER not BACT 99.0% efficiency VE: Continuous opacity monitor Be: 5.0 gr/day Hg: 0.6 lb/hr Pb: 3.1 lb/hr
		Low S Fuel	SO_2: 170 lb/hr
		Combustion Technique	NO_x: 300 lb/hr VOC: 9.0 lb/hr F: 6.0 lb/hr

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SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/Energy Answers Corp. SEMASS Project Rochester, MA/025-12MA14 03/15/82	3 new waterwall boilers rated at 600 tpd each firing refuse derived fuel	3 stage ESP with overall PM collection efficiency of 96%	PM: 0.05 gr/dscf @ 12% CO_2
		Dry Scrubbers	SO_2: 0.34 lb/MMBTU
		Boiler Design	NO_x: 0.5 lb/MMBTU
Refuse Incinerator/Westchester County, NY 02/22/82	New mass burn waterwall refuse fired boilers with a total capacity of 2250 tpd	ESP	PM: 0.03 gr/dscf @ 12% CO_2 98.5% efficiency Pb: 0.03 gr/dscf @ 12% CO_2 98.5% removal Hg: 0.03 gr/dscf @ 12% CO_2 98.5% removal Be: 0.03 gr/dscf @ 12% CO_2 98.5% removal
		Design, high excess air, good combustion	CO: 0.62 lb/ton
		Design, proper operation	NO_x: 3.0 lb/ton

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SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/N.E. Maryland Waste Disposal Authority Baltimore, MD/81MD01 09/01/81	3 waterwall incinerators 2010 tpd total	ESP	PM: 0.019 gr/dscf @ 12% CO Being considered as LAER SO_2: 335.0 lb/hr CO: 109.0 lb/hr NO_x: 227.0 lb/hr F: 4.2 lb/hr
Refuse Incineration/Refuse Fuels, Inc. Lawrence, MA/023-121MA12 03/23/81	New RDF waterwall furnace with a total capacity of 960 tpd	5 field ESP Low S Fuel Boiler Design	PM: Subject to LAER 0.25 gr/dscf @ 12% CO_2 98.0 efficiency SO_2: 1.2 lb/MMBTU NO_x: 0.7 lb/MMBTU
Refuse Incinerator/Resource Authority Gallatin, TN 08/01/80	2 new refuse mass burning waterwall boilers at 75 tpd each	Scrubber and fabric filters	PM: 0.04 gr/dscf NSPS 99.0% removal

Note: Due to problems encountered with the existing scrubber/fabric filter system, they have been replaced with ESPs.

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SOURCE TYPE/COMPANY NAME LOCATION/PERMIT NUMBER DATE OF ISSUE	SOURCE SIZE PROCESS DESCRIPTION	PROPOSED CONTROL TECHNOLOGY	BACT EMISSION LIMITATION DETERMINATION
Refuse Incineration/Municipal Incinerator Pulaski Highway Baltimore, MD/78MD-09 1/25/80	600 tpd municipal incinerator	ESP	PM: per SIP 0.03 gr/dscf @ 12% CO_2 98.0% removal
		Proper combustion techniques	SO_2: 35.1 lb/hr CO: 30.0 lb/hr VOC: 1.3 lb/hr NO_x: 2.6 lb/hr

Source: EPA BACT/LAER Clearinghouse (USEPA 1984, 1987b, 1988)

PM - Particulate Matter
ESP - Electrostatic Precipitator
VOC - Volatile Organic Compounds
NO_x - Nitrogen Oxides
SO_2 - Sulfur dioxide
CO_2 - Carbon Dioxide
Be - Beryllium
Cd - Cadmium
HCl - Hydrogen Chloride
Sb - Antimony
TCDD - Tetrachlorodibenzo-p-dioxins
SIP - State Implementation Plan

BACT - Best Available Control Technology
MMBTU - Million BTU
LAER - Lowest Achievable Emission Rate
F - Hydrogen Fluorides
CO - Carbon Monoxide
Hg - Mercury
Pb - Lead
Cr - CHROMIUM
VE - Visible Emissions
As - Arsenic
PAH - Polynuclear Aromatic Hydrocarbons
NSPS - New Source Performance Standards
NMHC - Non-methane Hydrocarbons

ATTACHMENT D

BURN MODEL OUTPUT

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BURN - Version 3.0 COMBUSTION ANALYSIS:
RUN #1 Rotary Combustors for Lee County, FL

     WASTE FEED STREAMS
     -----------------                           PERCENT (DRY BASIS)
            WEIGHT FIRED---------------------------------------------------------
     NAME   in Wet LB/Hr   Carbon     Hydrogen  Sulfur Fe(OH)3 Al(OH)3   Oxygen
    STOKER_GRATE  200000.0  35.940       4.790    .130  00.000  00.000   31.650
    -------------------------------------------------------------------------
    COMPOSITE (LB)  200000.  57000.84    7596.94  206.18     .00     .00 50196.90
    COMPOSITE MOLS       0.   4746.11    3768.32    6.44     .00     .00  1568.65
    COMPOSITE (% DRY BASIS)     35.94       4.79     .13     .00     .00    31.65

                                    PERCENT  (DRY BASIS)
                        -----------------------------------------------
     NAME      Nitrogen Chlorine  CaCO3   Inert    Iron Aluminum Pct.H2O BTU /LB
    STOKER_GRATE    .630     .500 00.000  26.360  00.000  00.000  20.700  6305.2
    ----------------------------------------------------------------------  ------
    COMPOSITE (LB)  999.18   793.00     .0041806.96     .00     .00 41400.0  5000.0
    COMPOSITE MOLS   35.66    22.37     .0041806.96     .00     .00  2300.0
    COMPOSITE (% DRY)  .63      .50     .00   26.36     .00     .00

                                              DRY BASIS        WET BASIS
                                            --------------   --------------
    THE MODIFIED DULONG HEATING VALUE IS:   6293.2 BTU/LB    4990.5 BTU/LB

    THE MODIFIED CHANG HEATING VALUE IS:    6392.5 BTU/LB    5069.2 BTU/LB

    THE BOIE HEATING VALUE IS:              6385.0 BTU/LB    5063.3 BTU/LB

    THE INPUT WASTE HEATING VALUE IS:       6305.2 BTU/LB    5000.0 BTU/LB

    DAILY CHARGE RATE EQUALS:      2400.0 TONS PER DAY.

                                 RUN CONDITIONS AS INPUT
                                 =======================
    AMBIENT AIR:   60.0 DEG. F  ; PRESSURE 1.0 ATM; ABSOLUTE HUMIDITY .007500
    AVAILABLE PREHEATED AIR         .0 ACFM      AT       .0 DEG. F
    OPERATING TEMPERATURES: MINIMUM OF  1800.0, MAXIMUM OF  2600.0 DEG. F
    FURNACE WATER COOLED, 100.00 % OF AREA; BOILER WATER COOLED, 100.00 % OF AREA
    TEMPERATURES MODERATED WITH  AIR  AND ELEVATED WITH GAS
    STEAM CONDITIONS: PRESSURE -  865. PSIA    ; TEMPERATURE -  830. DEG. F
    ENTHALPY CHANGE FROM FEEDWATER TO STEAM:  1196.0 BTU/LB
    TEMPERATURE (DEG. F  ): PROCESS WATER 60. FEEDWATER 290.
    FLUE GASES LEAVE THE BOILER AT:    425.0 DEG. F   , QUENCHER AT   241.0 DEG. F
    FLUE GASES LEAVE THE SUBCOOLER AT:     .0 DEG. F
    MAXIMUM SUBCOOLER WATER DISCHARGE TEMPERATURE IS:   95.0 DEG. F
    STACK DIAM. IS    1.0 FT, HEIGHT  180.0 FT, VELOCITY =    65.0 FT/SEC
       .00 % OF FEED ENTHALPY IS ABSORBED IN PRIMARY
    RESIDUE IS WATER QUENCHED AND LEAVES SYSTEM AT  350.0 DEG. F
    UNBURNED PERCENTAGES OF FEED - CARBON    1.5, IRON   00.0, ALUMINUM   00.0
    AFTERBURNER TEMPERATURE:       .0 DEG. F  ;OPERATING FACTOR: 100.00 % OF DESIGN
    ATMOSPHERIC STABILITY CLASS IS:  0; DESIGN % EXCESS AIR IS:   45.0
```

```
                 ************* NOTE **********
      GAS FLOW RATES EXPRESSED IN SCFM ARE AT 60 Deg. F AND 1.0 Atm.


      SUMMARY OF FURNACE OPERATIONS
      =============================

      Furnace Flue Gas Sensible Heat Content (SENH) as a Function of Tgas
               SENH = A + B*T + C*T*T + D*T*T*T

                         A =  -.1754973E+08          C =   .2896188E+02
                         B =   .2907669E+06          D =  -.2563568E-02

      At Tgas =    2543.24 DEG. F   , SENH =   .8670968E+09 BTU/HR


      GAS ANALYSIS AFTER FURNACE
                 VOLUME %   VOLUME %     MOLS
      COMPONENT  DRY BASIS  WET BASIS  PER MINUTE    LB/HR
      ---------- ---------  ---------  ---------  ---------

          CO2    13.66      11.49      77.92      205743.3
          SO2    .1883E-01  .1584E-01  .1074         412.8     158. PPMV - WET
          N2     79.69      67.01      454.4      763789.4
          O2     6.565      5.521      37.43       71874.5
          HCl    .6537E-01  .5497E-01  .3728         815.5     550. PPMV - WET
          H2O               15.91      107.9      116482.4
                 ---------  ---------  ---------  ---------
      TOTAL      100.0      100.0      678.1     1159118.0


                             PERCENT    DEWPOINT
                            SO2 TO SO3   DEG. F
                            ----------  --------
      SULFURIC ACID              1       257.00
      DEWPOINT FROM              3       275.02
      OXIDATION OF               5       283.71
      SO2 TO SO3                 8       291.89
      AFTER FURNACE             10       295.84
                                15       303.12


      PREHEATED AIR                 .00 ACFM
                                    .00 SCFM                 .00 LB/HR
      COMBUSTION AIR          220556.90 ACFM
                              220556.90 SCFM          1001807.00 LB/HR
      BURNER AIR                    .00 ACFM
                                    .00 SCFM                 .00 LB/HR
      COOLING AIR                   .00 ACFM
                                    .00 SCFM                 .00 LB/HR

      COOLING WATER                 .00 GAL/MIN              .00 LB/HR
```

```
WITHOUT COOLING OR FUEL USE BUT USING       0. ACFM    OF PREHEATED AIR, THE
FURNACE TEMPERATURE IS: 2543. DEG. F  ; A TEMPERATURE OF 2526.DEG. F  WAS
USED TO JUDGE POTENTIAL DISSOCIATION OF CaCO3, Fe(OH)3, AND Al(OH)3.

FLUE GAS           1485864.00 ACFM    AT     2543.2 DEG. F
                    257272.10 SCFM    AT       60.0 DEG. F

BURNER FUEL USE            .00 CFM     (     .00 FT3/HR  )  GAS

QUENCH TANK MAKEUP           28.40 GAL/MIN

RESIDUE ASSUMED TO LEAVE HOT ZONE AT      350.0  DEG. F
RESIDUE WEIGHT (75.00 % SOLIDS)         56882.63 LB/HR
                          (DRY)         42661.97 LB/HR

UNBURNED CARBON IN ASH:   2.002 PERCENT OF TOTAL ASH (INCLUDING CARBON)
HEATING VALUE OF RESIDUE (DRY BASIS):   282.5 BTU/LB

                            PERCENT OF           PERCENT OF
HEAT LOSSES     BTU/HR   FEED HEAT CONTENT   TOTAL HEAT RELEASE
-----------   ---------  -----------------   ------------------
  RADIATION    2847991.       .28 PERCENT         .28 PERCENT
  MOISTURE   123431900.     12.34 PERCENT       12.25 PERCENT
  DRY GAS    867096700.     86.71 PERCENT       86.03 PERCENT
  RESIDUE     15510550.      1.55 PERCENT        1.54 PERCENT

DESIGN EXCESS AIR (ON FEED) IS                  45.00 PERCENT
ACTUAL EXCESS AIR (ON FEED) IS                  45.00 PERCENT
ACTUAL EXCESS AIR (ON TOTAL COMBUSTIBLE) IS     45.00 PERCENT

EQUILIBRIUM THERMAL NOX CONCENTRATION IS     1288.9   PPM (VOLUME)
PERCENT FUEL NITROGEN CONVERTED TO NOx=        65.738 PERCENT
FUEL NITROGEN NOx (Estimated by Soete) =     1152.562 PPM (VOLUME)

SO2 UNCONTROLLED EMISSION RATE IS   52.06 GM/SEC   EQUAL TO   412.29 LB/HR
HCl UNCONTROLLED EMISSION RATE IS  102.85 GM/SEC   EQUAL TO   814.57 LB/HR

WITH ACID GAS CONTROL AT    .0 PERCENT,
SO2 CONTROLLED EMISSION RATE IS      52.06 GM/SEC   EQUAL TO   412.29 LB/HR
HCl CONTROLLED EMISSION RATE IS     102.85 GM/SEC   EQUAL TO   814.56 LB/HR
```

```
SUMMARY OF BOILER OPERATION CALCULATIONS
----------------------------------------
BOILER STEAM PRODUCTION        629755.9 LB/HR
     PRESSURE           865.0  PSIA
     TEMPERATURE        830.0  DEG. F

FEEDWATER TEMPERATURE:         290.0 DEG. F
FEEDWATER ENTHALPY:               .0 BTU/LB
PRODUCT STEAM ENTHALPY:           .0 BTU/LB
ENTHALPY CHANGE:              1196.0 BTU/LB

SATURATION TEMPERATURE AT PRODUCT STEAM PRESSURE:    .0 DEG. F
THE STEAM CARRIES:  830.0 DEG. F   OF SUPERHEAT

FLUE GAS TEMPERATURE AT BOILER EXIT  425. DEG. F

RADIATION LOSS   2847991. BTU/HR   OR   .33 % OF SENSIBLE HEAT AT BOILER INLET


WITH REFERENCE TO NET ENTHALPY INPUT TO THE COMBUSTION SYSTEM,
  THE BOILER EFFICIENCY IS:  76.24 PERCENT


WITH REFERENCE TO FEED ENTHALPY INPUT TO THE COMBUSTION SYSTEM,
  THE BOILER EFFICIENCY IS:  75.32 PERCENT


MEAN MOLECULAR WEIGHT OF GASES
     (DRY BASIS)   30.48
     (WET BASIS)   28.49

TOTAL GAS FLOW RATE     LB/MIN       LB/HR        ACFM
     (DRY BASIS)       17377.26    1042636.00     --
     (WET BASIS)       19320.36    1159222.00   437866.2

EFFLUENT GAS HUMIDITY .1118 (MASS H20/MASS BONE DRY GAS)

GAS DEW POINT IS 129.0 DEG. F
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SUMMARY OF DRY SCRUBBER OPERATIONS
-----------------------------------
DRY SCRUBBER EXIT TEMPERATURE      241.0 DEG. F

DRY SCRUBBER OPERATIONS SUMMARY
===============================

    CONTROL EFFICIENCY:  95.00 PERCENT HCL REMOVAL
                         80.00 PERCENT SO2 REMOVAL

    LIME ASSAY:                    90.00 PERCENT ACTIVE CaO
    SLURRY FEED STOICHIOMETRY: 170.00 PERCENT OF HCl + SO2
    SLURRY FEED AT:                 8.00 PERCENT SOLIDS

    LIME FEED RATE AT:        1867.07 LB/HR
    SLURRY FEED RATE AT:    179178.00 GAL/HR


    SUPPLEMENTAL WATER USE   57.     GAL/MIN


GAS ANALYSIS AFTER DRY SCRB
           VOLUME %   VOLUME %      MOLS
COMPONENT  DRY BASIS  WET BASIS  PER MINUTE    LB/HR
----------  ---------  ---------  ---------  ---------

    CO2    13.67      10.76      77.92      205743.3
    SO2    .3769E-02  .2966E-02  .2148E-01      82.6     30. PPMV - WET
    N2     79.75      62.76      454.4      763789.4
    O2     6.570      5.170      37.43       71874.5
    HCl    .3271E-02  .2574E-02  .1864E-01      40.8     26. PPMV - WET
    H2O               21.30      154.3      166590.7
           ---------  ---------  ---------  ---------
TOTAL      100.0      100.0      724.0     1208121.0

                     PERCENT   DEWPOINT
                   SO2 TO SO3   DEG. F
                   ----------  --------
SULFURIC ACID           1       237.54
DEWPOINT FROM           3       254.02
OXIDATION OF            5       261.95
SO2 TO SO3              8       269.41
AFTER QUENCHER         10       273.00
                       15       279.62
```

```
SUMMARY OF STACK CALCULATIONS AFTER SYSTEM
--------------------------------------------

STACK DIAMETER OF  10.99 FEET    USED FOR CALCULATIONS

NATURAL DRAFT 6.806E-01 IN H20
FRICTION LOSS 7.904E-01 IN H20
VELOCITY HEAD 7.241E-02 IN H20
MINIMUM FAN PRESSURE 1.822E-01 IN H20
EXIT VELOCITY      65.0 FT/SEC

TOTAL FLOW @ STACK CONDITIONS  369767.8 CFM
STACK TEMPERATURE IS:  239.9 DEG. F

FLOW CORRECTED TO 12% CO2 (DRY, 1 ATM, 68 F/20 C))   250147.9 CFM
FLOW CORRECTED TO  7% O2  (DRY, 1 ATM, 68 F/20 C))   226248.8 CFM

MEAN MOLECULAR WEIGHT OF GASES
     (DRY BASIS)   30.47
     (WET BASIS)   27.81

TOTAL GAS FLOW RATE      LB/MIN       LB/HR        ACFM
     (DRY BASIS)       17358.84    1041531.00      --
     (WET BASIS)       20137.82    1208269.00    370336.5

EFFLUENT GAS HUMIDITY .1601 (MASS H20/MASS BONE DRY GAS)

GAS DEW POINT IS 140.3 DEG. F

                          PERCENT    DEWPOINT
                        SO2 TO SO3   DEG. F
                        ----------  --------
SULFURIC ACID                1        237.54
DEWPOINT FROM                3        254.02
OXIDATION OF                 5        261.95
SO2 TO SO3                   8        269.41
AFTER STACK FOLLOWING       10        273.00
ALL PROCESSES               15        279.62


CALCULATIONS COMPLETE
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BURN - Version 3.0 COMBUSTION ANALYSIS:
RUN #2 Stoker Grate Combustors for Lee County, FL

    WASTE FEED STREAMS
    ------------------                       PERCENT (DRY BASIS)
           WEIGHT FIRED-----------------------------------------------------------
    NAME   in Wet LB/Hr   Carbon     Hydrogen  Sulfur Fe(OH)3 Al(OH)3    Oxygen
STOKER_GRATE   200000.0   35.940        4.790    .130  00.000  00.000    31.650
------------------------------------------------------------------------------
COMPOSITE (LB)  200000.  57000.84     7596.94  206.18     .00     .00 50196.90
COMPOSITE MOLS       0.   4746.11     3768.32    6.44     .00     .00  1568.65
COMPOSITE (% DRY BASIS)     35.94        4.79     .13     .00     .00    31.65

                                   PERCENT  (DRY BASIS)
                    -----------------------------------------------------
    NAME       Nitrogen Chlorine  CaCO3    Inert    Iron Aluminum Pct.H2O BTU /LB
STOKER_GRATE       .630     .500 00.000   26.360  00.000   00.000  20.700  6305.2
------------------------------------------------------------------------- ------
COMPOSITE (LB)  999.18   793.00     .0041806.96      .00      .00 41400.0  5000.0
COMPOSITE MOLS   35.66    22.37     .0041806.96      .00      .00  2300.0
COMPOSITE (% DRY)  .63      .50     .00   26.36      .00      .00

                                             DRY BASIS         WET BASIS
                                          ---------------   ---------------
THE MODIFIED DULONG HEATING VALUE IS:     6293.2 BTU/LB     4990.5 BTU/LB

THE MODIFIED CHANG HEATING VALUE IS:      6392.5 BTU/LB     5069.2 BTU/LB

THE BOIE HEATING VALUE IS:                6385.0 BTU/LB     5063.3 BTU/LB

THE INPUT WASTE HEATING VALUE IS:         6305.2 BTU/LB     5000.0 BTU/LB

DAILY CHARGE RATE EQUALS:      2400.0 TONS PER DAY.

                                  RUN CONDITIONS AS INPUT
                                  =======================
AMBIENT AIR:  60.0 DEG. F  ; PRESSURE 1.0 ATM; ABSOLUTE HUMIDITY .007500
AVAILABLE PREHEATED AIR          .0 ACFM       AT       .0 DEG. F
OPERATING TEMPERATURES: MINIMUM OF  1800.0, MAXIMUM OF  2200.0 DEG. F
FURNACE WATER COOLED, 100.00 % OF AREA; BOILER WATER COOLED, 100.00 % OF AREA
TEMPERATURES MODERATED WITH  AIR  AND ELEVATED WITH GAS
STEAM CONDITIONS: PRESSURE -  865. PSIA    ; TEMPERATURE -  830. DEG. F
ENTHALPY CHANGE FROM FEEDWATER TO STEAM:  1196.0 BTU/LB
TEMPERATURE (DEG. F  ): PROCESS WATER 60. FEEDWATER 290.
FLUE GASES LEAVE THE BOILER AT:    425.0 DEG. F  , QUENCHER AT   241.0 DEG. F
FLUE GASES LEAVE THE SUBCOOLER AT:     .0 DEG. F
MAXIMUM SUBCOOLER WATER DISCHARGE TEMPERATURE IS:   95.0 DEG. F
STACK DIAM. IS   1.0 FT, HEIGHT  180.0 FT, VELOCITY =    65.0 FT/SEC
   .00 % OF FEED ENTHALPY IS ABSORBED IN PRIMARY
RESIDUE IS WATER QUENCHED AND LEAVES SYSTEM AT  350.0 DEG. F
UNBURNED PERCENTAGES OF FEED - CARBON    1.5, IRON   00.0, ALUMINUM   00.0
AFTERBURNER TEMPERATURE:      .0 DEG. F  ;OPERATING FACTOR: 100.00 % OF DESIGN
ATMOSPHERIC STABILITY CLASS IS:  0; DESIGN % EXCESS AIR IS:   90.0
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                ************* NOTE **********
GAS FLOW RATES EXPRESSED IN SCFM ARE AT 60 Deg. F AND 1.0 Atm.


SUMMARY OF FURNACE OPERATIONS
=============================

Furnace Flue Gas Sensible Heat Content (SENH) as a Function of Tgas
         SENH = A + B*T + C*T*T + D*T*T*T

                   A =  -.2197686E+08          C =   .3439754E+02
                   B =   .3642281E+06          D =  -.3045939E-02

At Tgas =    2101.52 DEG. F   , SENH =    .8670968E+09 BTU/HR


GAS ANALYSIS AFTER FURNACE
           VOLUME %   VOLUME %     MOLS
COMPONENT  DRY BASIS  WET BASIS  PER MINUTE   LB/HR
---------- ---------  ---------  ---------  ---------

    CO2    10.41      9.076      77.92       205743.3
    SO2    .1435E-01  .1251E-01  .1074          412.8    125. PPMV - WET
    N2     79.52      69.33      595.2      1000517.0
    O2     10.00      8.721      74.87       143748.9
    HCl    .4980E-01  .4342E-01  .3728          815.5    434. PPMV - WET
    H2O               12.81      110.0       118795.7
           ---------  ---------  ---------  ---------
TOTAL      100.0      100.0      858.5      1470034.0


                      PERCENT   DEWPOINT
                     SO2 TO SO3  DEG. F
                     ---------- --------
SULFURIC ACID            1       248.83
DEWPOINT FROM            3       266.88
OXIDATION OF             5       275.58
SO2 TO SO3               8       283.78
AFTER FURNACE           10       287.73
                        15       295.03


PREHEATED AIR                .00 ACFM
                             .00 SCFM                   .00 LB/HR
COMBUSTION AIR         289005.60 ACFM
                       289005.60 SCFM            1312713.00 LB/HR
BURNER AIR                   .00 ACFM
                             .00 SCFM                   .00 LB/HR
COOLING AIR                  .00 ACFM
                             .00 SCFM                   .00 LB/HR

COOLING WATER                .00 GAL/MIN                .00 LB/HR
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WITHOUT COOLING OR FUEL USE BUT USING       0. ACFM    OF PREHEATED AIR, THE
FURNACE TEMPERATURE IS: 2102. DEG. F  ; A TEMPERATURE OF 1993.DEG. F  WAS
USED TO JUDGE POTENTIAL DISSOCIATION OF CaCO3, Fe(OH)3, AND Al(OH)3.

FLUE GAS             1604504.00 ACFM    AT     2101.5 DEG. F
                      325722.20 SCFM    AT       60.0 DEG. F

BURNER FUEL USE              .00 CFM     (     .00 FT3/HR  )  GAS

QUENCH TANK MAKEUP           28.40 GAL/MIN

RESIDUE ASSUMED TO LEAVE HOT ZONE AT      350.0  DEG. F
RESIDUE WEIGHT (75.00 % SOLIDS)         56882.63 LB/HR
                          (DRY)         42661.97 LB/HR

UNBURNED CARBON IN ASH:   2.002 PERCENT OF TOTAL ASH (INCLUDING CARBON)
HEATING VALUE OF RESIDUE (DRY BASIS):   282.5 BTU/LB

                             PERCENT OF          PERCENT OF
HEAT LOSSES       BTU/HR   FEED HEAT CONTENT   TOTAL HEAT RELEASE
-----------     ---------  -----------------   ------------------
  RADIATION     2847991.        .28 PERCENT         .28 PERCENT
  MOISTURE    125883200.      12.59 PERCENT       12.46 PERCENT
  DRY GAS     867096800.      86.71 PERCENT       85.82 PERCENT
  RESIDUE      15510550.       1.55 PERCENT        1.54 PERCENT

DESIGN EXCESS AIR (ON FEED) IS                        90.00 PERCENT
ACTUAL EXCESS AIR (ON FEED) IS                        90.01 PERCENT
ACTUAL EXCESS AIR (ON TOTAL COMBUSTIBLE) IS           90.01 PERCENT

EQUILIBRIUM THERMAL NOX CONCENTRATION IS            532.6    PPM (VOLUME)
PERCENT FUEL NITROGEN CONVERTED TO NOx=              69.762  PERCENT
FUEL NITROGEN NOx (Estimated by Soete) =            966.084  PPM (VOLUME)

SO2 UNCONTROLLED EMISSION RATE IS    52.06 GM/SEC    EQUAL TO    412.29 LB/HR
HCl UNCONTROLLED EMISSION RATE IS   102.85 GM/SEC    EQUAL TO    814.57 LB/HR

WITH ACID GAS CONTROL AT     .0 PERCENT,
SO2 CONTROLLED EMISSION RATE IS       52.06 GM/SEC    EQUAL TO    412.29 LB/HR
HCl CONTROLLED EMISSION RATE IS      102.85 GM/SEC    EQUAL TO    814.56 LB/HR
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SUMMARY OF BOILER OPERATION CALCULATIONS
----------------------------------------
BOILER STEAM PRODUCTION        606563.1 LB/HR
     PRESSURE          865.0  PSIA
     TEMPERATURE       830.0  DEG. F

FEEDWATER TEMPERATURE:         290.0 DEG. F
FEEDWATER ENTHALPY:               .0 BTU/LB
PRODUCT STEAM ENTHALPY:           .0 BTU/LB
ENTHALPY CHANGE:              1196.0 BTU/LB

SATURATION TEMPERATURE AT PRODUCT STEAM PRESSURE:    .0 DEG. F
THE STEAM CARRIES:  830.0 DEG. F   OF SUPERHEAT

FLUE GAS TEMPERATURE AT BOILER EXIT  425. DEG. F

RADIATION LOSS   2847991. BTU/HR   OR   .33 % OF SENSIBLE HEAT AT BOILER INLET


WITH REFERENCE TO NET ENTHALPY INPUT TO THE COMBUSTION SYSTEM,
  THE BOILER EFFICIENCY IS:  73.43 PERCENT


WITH REFERENCE TO FEED ENTHALPY INPUT TO THE COMBUSTION SYSTEM,
  THE BOILER EFFICIENCY IS:  72.54 PERCENT


MEAN MOLECULAR WEIGHT OF GASES
     (DRY BASIS)   30.09
     (WET BASIS)   28.54

TOTAL GAS FLOW RATE     LB/MIN       LB/HR        ACFM
     (DRY BASIS)       22520.63    1351238.00     --
     (WET BASIS)       24502.32    1470139.00   554365.3

EFFLUENT GAS HUMIDITY .0880 (MASS H20/MASS BONE DRY GAS)

GAS DEW POINT IS 121.4 DEG. F
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SUMMARY OF DRY SCRUBBER OPERATIONS
-----------------------------------
DRY SCRUBBER EXIT TEMPERATURE      241.0 DEG. F

DRY SCRUBBER OPERATIONS SUMMARY
===============================

    CONTROL EFFICIENCY:  95.00 PERCENT HCL REMOVAL
                         80.00 PERCENT SO2 REMOVAL

    LIME ASSAY:                 90.00 PERCENT ACTIVE CaO
    SLURRY FEED STOICHIOMETRY: 170.00 PERCENT OF HCl + SO2
    SLURRY FEED AT:              8.00 PERCENT SOLIDS

    LIME FEED RATE AT:        1867.07 LB/HR
    SLURRY FEED RATE AT:    179178.00 GAL/HR


    SUPPLEMENTAL WATER USE   82.     GAL/MIN


GAS ANALYSIS AFTER DRY SCRB
           VOLUME %  VOLUME %     MOLS
COMPONENT  DRY BASIS  WET BASIS  PER MINUTE    LB/HR
---------- --------- --------- --------- ---------

    CO2    10.42      8.507      77.92       205743.3
    SO2    .2871E-02  .2345E-02  .2148E-01       82.6     23. PPMV - WET
    N2     79.57      64.98      595.2      1000517.0
    O2     10.01      8.174      74.87       143748.9
    HCl    .2492E-02  .2035E-02  .1864E-01       40.8     20. PPMV - WET
    H2O               18.33      167.9       181322.2
           ---------  ---------  ---------  ---------
TOTAL      100.0      100.0      915.9      1531455.0

                             PERCENT    DEWPOINT
                           SO2 TO SO3   DEG. F
                           ----------  --------
SULFURIC ACID                  1        230.79
DEWPOINT FROM                  3        247.23
OXIDATION OF                   5        255.15
SO2 TO SO3                     8        262.59
AFTER QUENCHER                10        266.18
                              15        272.79
```

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SUMMARY OF STACK CALCULATIONS AFTER SYSTEM
--------------------------------------------

STACK DIAMETER OF  12.36 FEET    USED FOR CALCULATIONS

NATURAL DRAFT 6.806E-01 IN H20
FRICTION LOSS 7.027E-01 IN H20
VELOCITY HEAD 7.241E-02 IN H20
MINIMUM FAN PRESSURE 9.453E-02 IN H20
EXIT VELOCITY       65.0 FT/SEC

TOTAL FLOW @ STACK CONDITIONS  467776.2 CFM
STACK TEMPERATURE IS:  239.9 DEG. F

FLOW CORRECTED TO 12% CO2 (DRY, 1 ATM, 68 F/20 C))   250147.9 CFM
FLOW CORRECTED TO  7% O2  (DRY, 1 ATM, 68 F/20 C))   226248.8 CFM

MEAN MOLECULAR WEIGHT OF GASES
     (DRY BASIS)   30.08
     (WET BASIS)   27.87

TOTAL GAS FLOW RATE      LB/MIN       LB/HR        ACFM
     (DRY BASIS)        22502.22    1350133.00      --
     (WET BASIS)        25526.94    1531616.00   468495.7

EFFLUENT GAS HUMIDITY .1344 (MASS H20/MASS BONE DRY GAS)

GAS DEW POINT IS 134.9 DEG. F

                          PERCENT    DEWPOINT
                        SO2 TO SO3   DEG. F
                        ----------  --------
SULFURIC ACID               1        230.79
DEWPOINT FROM               3        247.23
OXIDATION OF                5        255.15
SO2 TO SO3                  8        262.59
AFTER STACK FOLLOWING      10        266.18
ALL PROCESSES              15        272.79


CALCULATIONS COMPLETE
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