STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

January 18, 1985

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. William D. Myers
Administrative Services Director
Florida State Hospital
Highway 90
Chattahoochee, Florida 32324

Dear Mr. Myers:

RE: Modification/Amendment to Construction Permit
AC 20-49787: Conversion of Boiler Nos. 7 & 8

The Department is in receipt of your letter with attachments, dated July 19, 1984, which introduced additional modifications that are a part of the current boiler conversions permitted in the above referenced construction permits. Because particulate matter (PM) emissions and visible emissions (VE) are expected from the wood pellet pulverizer and the flue gas ash handling system, the bureau will establish emission limits for each affected source, which are reflected in the applications. It was also requested that the No. 6 Fuel Oil sulfur content be increased from 2.0 to 2.5 percent, by weight, which is the level that boiler Nos. 7 and 8 were permitted to burn in their previous operating permits. The bureau agrees with the requests and the following shall be changed and added:

SPECIFIC CONDITIONS

No. 2.

From: Maximum No. 6 Fuel Oil sulfur content shall not exceed 2.0% by weight.

To: Maximum No. 6 Fuel Oil sulfur content shall not exceed 2.5% by weight.

No. 3.

From: The maximum allowable emission limits, not to be exceeded, are in the following table:

Boiler	Fuel Type No. 6 FO:WP	Pollutant	Maximum Allowable Emission Limit (lb/10^6 Btu heat input)	(lb/hr)	(TPY)
7	12% : 88%	PM	0.1 : 0.2	13.08	57.3
8	12% : 88%	PM	0.1 : 0.2	13.07	57.2
7 & 8	100%	VE	not greater than 20% opacity, except 40% opacity for not more than 2 minutes in any one hour		
	12% : 88%		not greater than 30% opacity, except 40% opacity for not more than 2 minutes in any one hour		
7 & 8		SO_2	Fuel sulfur content shall not exceed 2.0% by weight		

Note: No. 6 FO: No. 6 Fuel Oil
WP: Wood Pellets

No. 3. (continued)

To: The maximum allowable emission limits and fuel sulfur limit, not to be exceeded, are in the following table:

Boiler	Fuel Type No. 6 FO:WP	Pollutant	Maximum Allowable Emission Limit ($lb/10^6$ Btu heat input)	(lb/hr)	(TPY)
7	12% : 88%	PM	0.1 : 0.2	13.08	57.3
8	12% : 88%	PM	0.1 : 0.2	13.07	57.2
7 & 8	100%	VE	not greater than 20% opacity, except 40% opacity for not more than 2 minutes in any one hour		
	12% : 88%		not greater than 30% opacity, except 40% opacity for not more than 2 minutes in any one hour		
			Fuel Sulfur Limit		
7 & 8		SO_2	Fuel sulfur content shall not exceed 2.5% by weight		

Note: No. 6 FO: No. 6 Fuel Oil
WP: Wood Pellets

No. 10. (new)

The pollutant allowable emission limits are:

Source	Pollutant	Allowable Emission Limit	
		lb/hr	TPY
Wood Pellet Pulverizer			
° Baghouse	PM	0.4	1.7
	VE	less than 20% Opacity	
Flue Gas Ash Handling System			
° Baghouse	PM	0.5	2.2
	VE	less than 20% Opacity	
° Baghouse Hopper Load-out	VE	10% Opacity, not to be exceeded	

No. 11. (new)

Annual pollutant compliance tests shall be required of the sources in Specific Condition No. 10 in accordance with FAC Rule 17-2.700 and shall be DER Method 9 for VE and DER Method 5 for PM. All compliance test reports shall be submitted to the DER's Northwest District office within 15 days after the last test run. The DER's Northwest District office shall be notified in writing 15 days prior to compliance tests. Compliance tests shall be conducted at 90 to 100% of the maximum rated product capacity (both boilers No. 7 and No. 8 are rated at 60,000 pounds per hour steam product).

No. 12. (new)

The compliance tests for the pollutants required by Specific Condition No. 11 for the wood pellet pulverizer baghouse and the flue gas ash handling system baghouse may be waived by accepting an alternative VE standard of 5% opacity, not to be exceeded. The DER Method 9, in accordance with FAC Rule 17-2.700, shall be used to verify compliance with this alternative VE standard.

Notification of the compliance test, operation during the compliance test, and reporting of such tests shall be as specified in Specific Condition No. 11.

Upon failure to comply with this alternative VE standard, the Department shall require compliance tests, as specified in Specific Condition No. 11, to verify that the emission limits specified in Specific Condition No. 10 are being achieved.

Attachments to be incorporated are:

12. Fred W. Dougherty's letter with attachments, dated 7/19/84.
13. Fred W. Dougherty's letter, dated 7/30/84.
14. C.H. Fancy's letter, dated 8/15/84.
15. William D. Myer's letter, dated 8/23/84.
16. Victoria J. Tschinkel's letter with attachments, dated 10/11/84.
17. Fred W. Dougherty's letter of transmittal, dated 11/9/84, with Applications to Construct Air Pollution Sources: DER Form 17-2.202.

This letter must be attached to you construction permit, AC 20-49787, and shall become a part of that permit.

Sincerely,

for Victoria J. Tschinkel
Secretary

VJT/rw
cc: Dan Thompson
Tom Moody
Jerry Neubauer
Tom Parker
Harrel Bolden
Steve Helentjaris
Fred Dougherty

ATTACHMENT 12

[illegible] copied [illegible] 7/23/84 [illegible]

TOMLINSON and DOUGHERTY Consulting Engineers, Inc.
Mechanical & Electrical
468 West Tennessee St.
Tallahassee, FL 32301
(904) 222-5403

DER
JUL 23 1984
BAQM

July 19, 1984

John C. Tomlinson, P.E.
Fred W. Dougherty, P.E.

Department of Environmental Regulation
2652 Executive Center Circle East
Tallahassee, Florida 32301

Attention: Bruce Mitchell

Subject: Florida State Hospital - Chattahoochee, Permit #AC20-49787, Boilers #7 and #8.

Dear Mr. Mitchell:

The Florida State Hospital wishes to obtain an extension of the subject construction permits. This permit currently requires that an application to construct/modify an air pollution source must be made not later than August 31, 1984. However, it will not be possible to meet this date because of unavoidable delays in construction and because of the experimental nature of the program. At the date of this letter, control methodology has not been established and performance acceptance testing has not been performed.

It is expected that a Certification of Completion can be made within 60 days. However, because this is an experimental program, there is substantial uncertainty regarding this time frame. We would therefore like to have the extension to August 31, 1985 to cover all contingencies.

I am enclosing some drawings describing the project for your information and use. Drawing 1737-8 is a shop drawing showing the dust control system for the wood pellet crusher. The Zurn drawing D60295 shows the general arrangement of the new wet scrubbers. The drawings ASH-1 and ASH-2 show the primary dry ash conveyor and dust control systems.

Attached also is the operating permit renewals for boilers #6 and #9. I am including these to show you that these boilers are permitted for oil with 2.5% sulfur content. The subject construction permit for boilers #7 and #8 limits sulfur content in the fuel oil to 2.0%. This has not caused any problems as yet, because FSH has been receiving oil that tests at less than 2%. However, in order to avoid additional problems during construction, we would like to have the maximum sulfur content increased from 2.0 to 2.5% by weight. It is our intention to ask for this also when we apply for the operating permit.

cont.....

Thank you for considering this request. Please call me if you require more information.

Very truly yours,

TOMLINSON AND DOUGHERTY CONSULTING ENGINEERS, INC.

Fred W. Dougherty

copy: (w/no attach.) Harrell Bolden, DGS
Steve Hellentjaris, HRS
Tom Parker, FSH

FWD/drd

BEST AVAILABLE COPY

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

NORTHWEST DISTRICT
160 GOVERNMENTAL CENTER
PENSACOLA, FLORIDA 32501

GRAHA
GOVERNO

VICTORIA J. TSCHINKE
SECRETAR

ROBERT V. KRIEGE
DISTRICT MANAGE

APPLICATION FOR RENEWAL OF PERMIT TO OPERATE AIR POLLUTION SOURCE(S)

If major alterations have occurred, the applicant should complete the Standard Air Permit Application Form.

Source Type: Electric Power Generation Renewal of DER Permit No. A020-18161

Company Name: Florida State Hospital County: Gadsden

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):

Boiler #6, Oil Fired

Source Location: Street: U. S. Highway 90 City: Chattahoochee

UTM: East 707400 M North 3398500 M

Latitude: 30° 42' 16"N. Longitude: 84° 50' 10"W.

---

1. Attach a check made payable to the Department of Environmental Regulation in accordanc with operation permit fee schedule set forth in Florida Administrative Code Rul 17-4.05.

2. Have there been any alterations to the plant since last permitted? [ ] Yes [X] No If minor alterations have occurred, describe on a separate sheet and attach.

3. Attach the last compliance test report required per permit conditions if not submitte previously.

4. Have previous permit conditions been adhered to? [X] Yes [ ] No If no, explain on separate sheet and attach.

5. Has there been any malfunction of the pollution control equipment during tenure of cur- rent permit? [ ] Yes [X] No If yes, and not previously reported, give brief detai and what action was taken on a separate sheet and attach.

6. Has the pollution control equipment been maintained to preserve the collection effi- ciency last permitted by the Department? [X] Yes [ ] No

7. Has the annual operating report for the last calendar year been submitted? [ ] Ye [X] No If no, please attach.

BEST AVAILABLE COPY

8. Please provide the following information if applicable:

A. Raw Materials and Chemical Used in Your Process:

Description	Contaminant Type	Contaminant %Wt	Utilization Rate lbs/hr

B. Product Weight (lbs/hr): __________

C. Fuels

Type (Be Specific)	Consumption* Avg/hr*	Consumption* lbs/hr Max/hr**	Maximum Heat Input (MMBTU/hr)
#6 Fuel Oil	816	2631	48.674

D. Normal Equipment Operating Time: hrs/day 24 ; days/wk 7 ; wks/yr 52 ;

hrs/yr (power plants only) 8736 ; if seasonal, describe __________

The undersigned owner or authorized representative*** of __________ is fully aware that the statements made in this application for a renewal of a permit t operate an air pollution source are true, correct and complete to the best of his knowledg and belief. Further, the undersigned agrees to maintain and operate the pollution sourc and pollution control facilities in such a manner as to comply with the provisions of Chap ter 403, Florida Statutes, and all the rules and regulations of the Department. He als understands that a permit, if granted by the Department, will be non-transferable and h will promptly notify the Department upon sale or legal transfer of the permitted facility.

*During actual time of operation.
**Units: Natural Gas-MMCF/hr; Fuel Oils-barrels/hr; Coal-lbs/hr.
***Attach letter of authorization if not previously submitted

Signature, Owner or Authorized Representative
(Notarization is mandatory)

William D. Meyers, Asst. Supt./Admin.
Typed Name and Title

Highway 90
Address

Chattahoochee, Florida 32324
City State Zip

March 26, 1984
Date

904-663-4311
Telephone No.

DER Form 17-1.202(4)
Effective November 30, 1982

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

ANNUAL OPERATIONS REPORT FORM FOR AIR EMISSIONS SOURCES

For each permitted emission point, please submit a separate report for calendar year 1983 prior to March 1st of the following year.

I GENERAL INFORMATION:

1. Source Name: Florida State Hospital
2. Permit Number: A020-18161
3. Source Address: Chattahoochee, Florida 32324
4. Description of Source: Boiler #6

II OPERATING SCHEDULE:

24 hrs/day 7 days/wk 52 wks/yr

III RAW MATERIAL INPUT PROCESS WEIGHT:

Raw Material	Input Process Weight	
		tons/yr
		tons/yr
		tons/yr
		tons/yr
		tons/yr

IV TOTAL FUEL USAGE, including standby fuels. If fuel is oil, specify weight and sulfur content (e.g., No. 6 oil with 1%S).

	10^6 cubic feet Natural Gas	862	10^3 gallons No. 6 Oil, 2.5 %S
	10^3 gallons Propane		10^3 gallons Kerosene
	tons Coal		10^6 lb Black Liquor Solids
	tons Carbonaceous		tons Refuse

Other (Specify type and units)

V EMISSION LEVEL (tons/yr):

A.

	Particulates		Carbon Monoxide
	Nitrogen Oxide		Total Reduced Sulfur
	Hydrocarbon		Flouride
	Sulfur Dioxide		

Other (Specify type and units)

B. Method of calculating emission rates (e.g., use of fuel analysis and materials balance, emission factors drawn from AP 42, etc.)

VI CERTIFICATION:

I hereby certify that the information given in this report is correct to the best of my knowledge.

Signature of Owner or Authorized Representative

William D. Meyers, Asst. Supt./Admin.

Typed Name and Title

March 26, 1984

Date

BEST AVAILABLE COPY

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

NORTHWEST DISTRICT

160 GOVERNMENTAL CENTER
PENSACOLA, FLORIDA 32501

GRAHA
GOVERNO

VICTORIA J. TSCHINKE
SECRETAR

ROBERT V. KRIEGE
DISTRICT MANAGE

APPLICATION FOR RENEWAL OF PERMIT TO OPERATE AIR POLLUTION SOURCE(S)

If major alterations have occurred, the applicant should complete the Standard Air Permit Application Form.

Source Type: Electric Power Generation Renewal of DER Permit No. A020-20009

Company Name: Florida State Hospital County: Gadsden

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):

Boiler #9, Oil Fired

Source Location: Street: U. S. Highway 90 City: Chattahoochee

UTM: East 707400 M North 3398500 M

Latitude: 30° 42' 16"N. Longitude: 84° 50' 10"W.

---

1. Attach a check made payable to the Department of Environmental Regulation in accordanc with operation permit fee schedule set forth in Florida Administrative Code Rul 17-4.05.
2. Have there been any alterations to the plant since last permitted? [ ] Yes [X] No If minor alterations have occurred, describe on a separate sheet and attach.
3. Attach the last compliance test report required per permit conditions if not submitte previously.
4. Have previous permit conditions been adhered to? [X] Yes [ ] No If no, explain on separate sheet and attach.
5. Has there been any malfunction of the pollution control equipment during tenure of cur rent permit? [ ] Yes [X] No If yes, and not previously reported, give brief detail and what action was taken on a separate sheet and attach.
6. Has the pollution control equipment been maintained to preserve the collection effi ciency last permitted by the Department? [X] Yes [ ] No
7. Has the annual operating report for the last calendar year been submitted? [ ] Ye [X] No If no, please attach.

BEST AVAILABLE COPY

8. Please provide the following information if applicable:

A. Raw Materials and Chemical Used in Your Process:

Description	Contaminant Type	%Wt	Utilization Rate lbs/hr

B. Product Weight (lbs/hr): __________

C. Fuels

Type (Be Specific)	Consumption* lbs/hr Avg/hr*	Max/hr**	Maximum Heat Input (MMBTU/hr)
#6 Fuel Oil, 2.5% SO_2	312	3624	67.044

D. Normal Equipment Operating Time: hrs/day 24; days/wk 7; wks/yr 52;

hrs/yr (power plants only) 8736; if seasonal, describe __________

The undersigned owner or authorized representative*** of __________ is fully aware that the statements made in this application for a renewal of a permit to operate an air pollution source are true, correct and complete to the best of his knowledge and belief. Further, the undersigned agrees to maintain and operate the pollution source and pollution control facilities in such a manner as to comply with the provisions of Chapter 403, Florida Statutes, and all the rules and regulations of the Department. He also understands that a permit, if granted by the Department, will be non-transferable and he will promptly notify the Department upon sale or legal transfer of the permitted facility.

*During actual time of operation.
**Units: Natural Gas-MMCF/hr; Fuel Oils-barrels/hr; Coal-lbs/hr.
***Attach letter of authorization if not previously submitted

Signature, Owner or Authorized Representative
(Notarization is mandatory)

William D. Meyers, Asst. Supt./Admin.
Typed Name and Title

Highway 90
Address

Chattahoochee, Florida 32324
City State Zip

March 26, 1984
Date

904-663-4311
Telephone No.

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

ANNUAL OPERATIONS REPORT FORM FOR AIR EMISSIONS SOURCES

For each permitted emission point, please submit a separate report for calendar year 1983 prior to March1st of the following year.

I GENERAL INFORMATION:

1. Source Name: Florida State Hospital
2. Permit Number: A020-20009
3. Source Address: Chattahoochee, Florida 32324
4. Description of Source: Boiler #9

II OPERATING SCHEDULE:

24 hrs/day 7 days/wk 52 wks/yr

III RAW MATERIAL INPUT PROCESS WEIGHT:

Raw Material	Input Process Weight
N/A	tons/yr
	tons/yr
	tons/yr
	tons/yr
	tons/yr

IV TOTAL FUEL USAGE, including standby fuels. If fuel is oil, specify weight and sulfur content (e.g., No. 6 oil with 1%S).

______ 10^6 cubic feet Natural Gas
329 10^3 gallons No. 6 Oil, 2.5 %S
______ 10^3 gallons Propane
______ 10^3 gallons Kerosene
______ tons Coal
______ 10^6 lb Black Liquor Solids
______ tons Carbonaceous
______ tons Refuse
Other (Specify type and units) ______

V EMISSION LEVEL (tons/yr):

A. ______ Particulates
______ Carbon Monoxide
______ Nitrogen Oxide
______ Total Reduced Sulfur
______ Hydrocarbon
______ Flouride
______ Sulfur Dioxide
Other (Specify type and units) ______

B. Method of calculating emission rates (e.g., use of fuel analysis and materials balance, emission factors drawn from AP 42, etc.)

VI CERTIFICATION:

I hereby certify that the information given in this report is correct to the best of my knowledge.

Signature of Owner or Authorized Representative

William D. Meyers, Asst. Supt./Admin.
Typed Name and Title

March 26, 1984
Date

DER Form PERM 12-15 (Jan 78)

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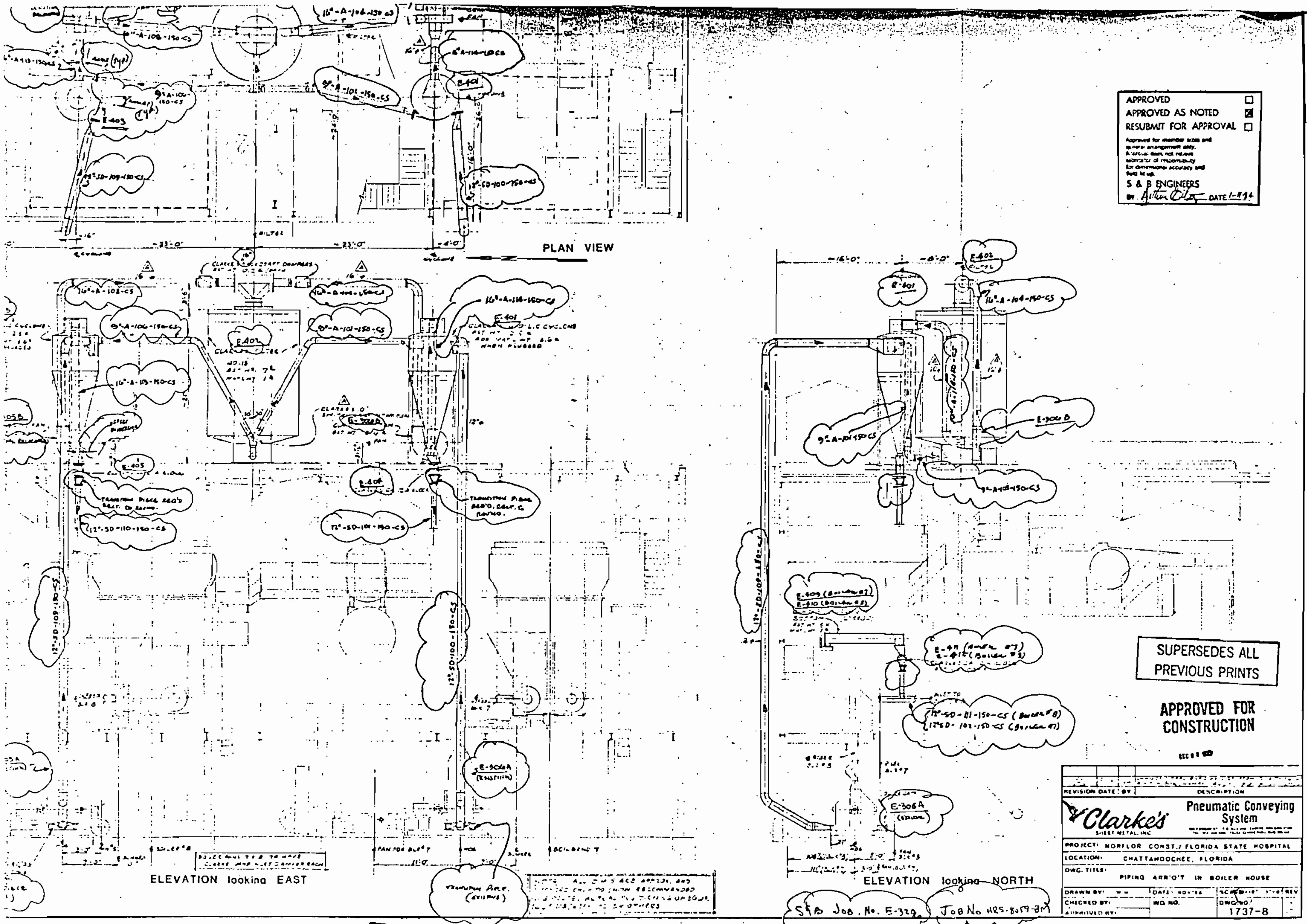


APPROVED ☐
APPROVED AS NOTED ☒
RESUBMIT FOR APPROVAL ☐

Approved for member sizes and general arrangement only. Approval does not relieve subcontractor of responsibility for dimensional accuracy and field fit-up.

S & B ENGINEERS
BY. Arthur Oil DATE 1-[illegible]

SUPERSEDES ALL PREVIOUS PRINTS

APPROVED FOR CONSTRUCTION

S&B Job. No. E-329

Job No. HRS-8519-BM

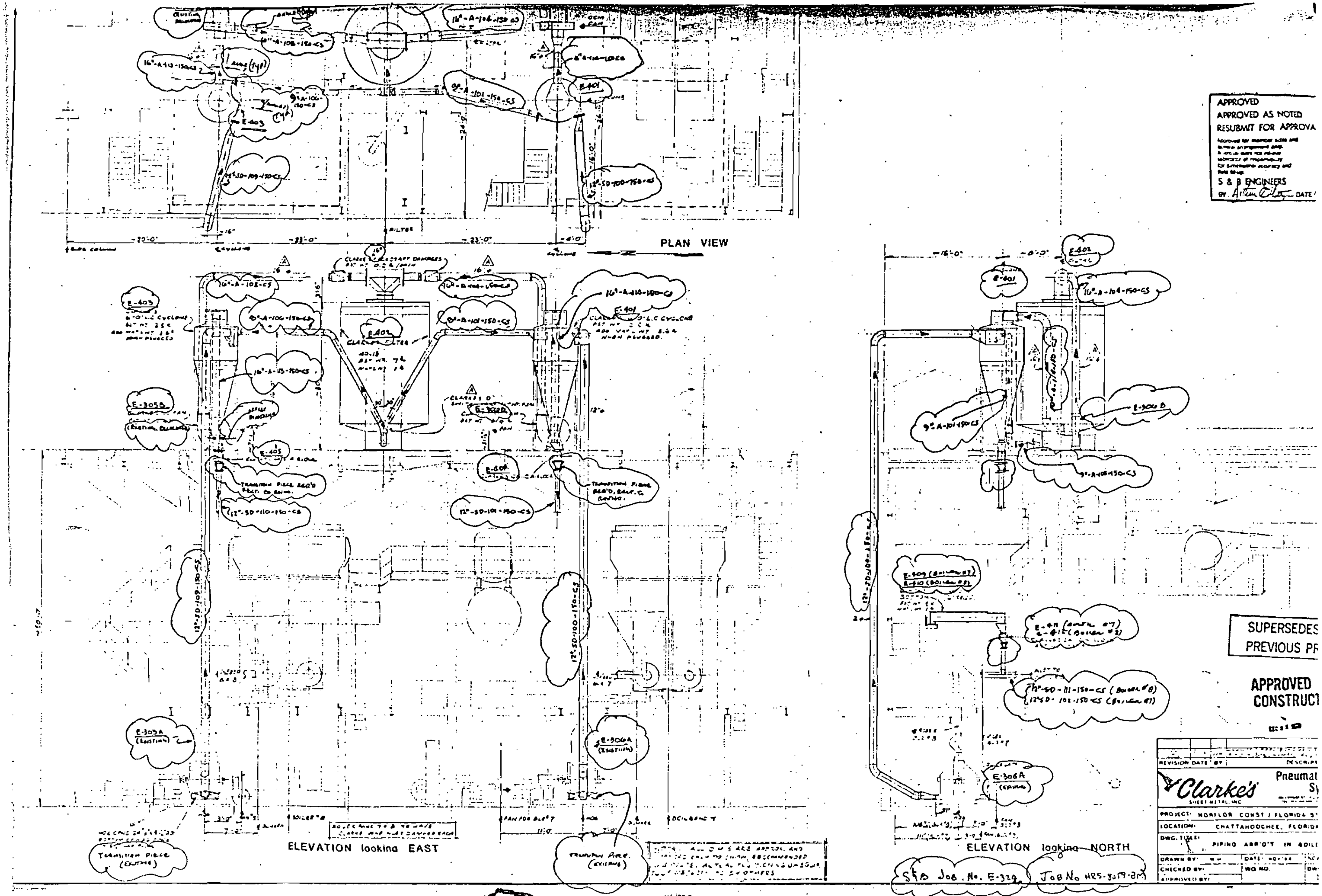
REVISION	DATE	BY	DESCRIPTION

Clarke's SHEET METAL, INC

Pneumatic Conveying System

PROJECT: NORFLOR CONST./FLORIDA STATE HOSPITAL
LOCATION: CHATTANOOCHEE, FLORIDA
DWG. TITLE: PIPING ARR'G'T IN BOILER HOUSE
DRAWN BY: W.H. DATE: NOV '86 SCALE: 1/8" = 1'-0" REV
CHECKED BY: WO NO. DWG NO. 1737-8
APPROVED BY:

BEST AVAILABLE COPY



S&B Job. No. E-329

Job No HRS-8059-BM

APPROVED
APPROVED AS NOTED
RESUBMIT FOR APPROVA
S & B ENGINEERS
BY Arthur C. [illegible] DATE

SUPERSEDES
PREVIOUS PR

APPROVED
CONSTRUCT

REVISION	DATE	BY

Clarke's
SHEET METAL, INC

Pneumat
Sy

PROJECT: NORFLOR CONST / FLORIDA S
LOCATION: CHATTANOOCHEE, FLORIDA
DWG. TITLE: PIPING ARR'G'T IN BOILE
DRAWN BY: W.H. DATE: NOV '68
CHECKED BY: WO NO.
APPROVED BY:

ATTACHMENT 13

TOMLINSON and DOUGHERTY Consulting Engineers, Inc.
Mechanical & Electrical
468 West Tennessee St.
Tallahassee, FL 32301
(904) 222-5403

John C. Tomlinson, P.E.
Fred W. Dougherty, P.E.

July 30, 1984

Department of Environmental Regulation
2652 Executive Center Circle East
Tallahassee, Florida 32301

Attention: Bruce Mitchell

Subject: Florida State Hospital - Chattahoochee, Permit #AC20-49787

Reference: My letter to you dated July 19, 1984

Dear Mr. Mitchell:

This will confirm our telephone conversation of July 27 regarding my use of the term "control methodology" in the referenced letter. I was not referring to pollution control methodology, but to the electro-pneumatic controls that set boiler trim. The air pollution controls are as depicted in the drawings I sent to you.

Please don't hesitate to call if you require further clarification

Very truly yours,

TOMLINSON AND DOUGHERTY CONSULTING ENGINEERS, INC.

Fred W. Dougherty

copy: Harrell Bolden
Steve Helentjaris
Tom Parker

ATTACHMENT 14

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

August 15, 1984

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. William D. Meyers
Assistant Superintendent
Florida State Hospital
Highway 90
Chattahoochee, Florida 32324

Dear Mr. Meyers:

Re: Review of the Request to Modify the Air Construction Permit No. AC 20-49787

The department has received Fred W. Dougherty's letter requesting an extension of the expiration date and a modification to the above referenced construction permit. The letter also referenced three sources of air pollution emissions, the dust control systems for the wood pellet crusher and the two dry ash conveyors, of which we have no data. Before acting upon your requests, the bureau will have to receive the following information/material.

1. Quantify the potential pollutant emissions from the three referenced pollutant emitting sources, including all assumptions, reference material and calculations. Submit the data in the appropriate sections of an application.

2. The bureau has no evidence that Fred W. Dougherty has been authorized to represent the applicant. A notarized "letter of authorization" would be sufficient.

3. Submit another set of drawings for the ASH-1, ASH-2, and the Venturi Scrubber System Installation to the bureau.

4. Copy Mr. Tom Moody with the Northwest District office on all future correspondence. H's address is:

Mr. Thomas Moody, P.E.
Northwest District Office
Department of Environmental Regulation
160 Governmental Center
Pensacola, Florida 32561

If there are any questions, please call Bruce Mitchell at (904)488-1344 or write to me at the above address.

Sincerely,

Steve Smallwood

for C. H. Fancy, P.E.
Deputy Chief
Bureau of Air Quality
Management

CHF/BM/s

cc: Fred W. Dougherty
Tom Moody
Harrell Bolden
Steve Hellentjaris
Tom Parker
Dan Thompson
Nancy Wright

ATTACHMENT 15

HRS STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

August 23, 1984

Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, Florida 32301

Attention: C. H. Fancy, P.E.

SUBJECT: Authorized Representative for Air Pollution Control - Boilers No. 7 and 8.

Dear Mr. Fancy,

In reference to your letter of August 15, 1984 this will notify you that Fred W. Dougherty, P.E. is authorized to represent Florida State Hospital as our Engineer with respect to air pollution control matters relating to boilers No. 7 and 8.

Sincerely,

William D. Myers

William D. Myers
Hospital Administrative Services Director

WDM/dk

Doris F. Kirkland
NOTARY

NOTARY PUBLIC, STATE OF FLORIDA AT LARGE
MY COMMISSION EXPIRES JAN. 9, 1987
BONDED THROUGH MUROSKI-ASHTON, INC.

DISTRICT TWO • FLORIDA STATE HOSPITAL • CHATTAHOOCHEE, FLORIDA 32324
BOB GRAHAM, GOVERNOR

ATTACHMENT 16

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

October 11, 1984

CERTIFIED MAIL-RETURN RECEIPT REQUESTED

Mr. William D. Myers
Administrative Services Director
Florida State Hospital
Highway 90
Chattahoochee, Florida 32324

Dear Mr. Myers:

RE: Extension of the Expiration Date of the Construction Permit: AC 20-49787

The department is in receipt of Mr. Fred W. Dougherty's letter dated October 8, 1984, in which you requested an extension of the expiration date. The bureau is in agreement with the request and the following shall be changed and added:

Expiration Date:

From: September 30, 1984
To: September 30, 1985

Attachments to be incorporated:

10. William D. Myers' letter dated August 23, 1984.
11. Fred W. Dougherty's letter dated October 8, 1984.

This letter must be attached to your construction permit, AC 20-49787, and shall become a part of that permit.

Sincerely,

Terry Cole for
Victoria J. Tschinkel
Secretary

VJT/agh

Enclosure

cc: Dan Thompson
Nancy Wright
Tom Moody
Jerry Neubauer
Harrel Bolden
Tom Parker
Steve Helentjaris
Fred Dougherty

ATTACHMENT 10

HRS
STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

August 23, 1984

Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, Florida 32301

Attention: C. H. Fancy, P.E.

SUBJECT: Authorized Representative for Air Pollution Control - Boilers No. 7 and 8.

Dear Mr. Fancy,

In reference to your letter of August 15, 1984 this will notify you that Fred W. Dougherty, P.E. is authorized to represent Florida State Hospital as our Engineer with respect to air pollution control matters relating to boilers No. 7 and 8.

Sincerely,

William D. Myers

William D. Myers
Hospital Administrative Services Director

WDM/dk

Doris J. Kirkland
NOTARY

NOTARY PUBLIC, STATE OF FLORIDA AT LARGE
MY COMMISSION EXPIRES JAN. 9, 1987
BONDED THROUGH MUROSKI-ASHTON, INC

DISTRICT TWO • FLORIDA STATE HOSPITAL • CHATTAHOOCHEE, FLORIDA 32324

ATTACHMENT 11

DOUGHERTY ENGINEERING COMPANY, INC.
Mechanical Engineers
318 Williams Street • Tallahassee, Florida 32303 • (904) 681-0610

October 8, 1984

Bruce Mitchell
Department of Environmental Regulation
Bureau of Air Quality Management
2600 Blair Stone Road
Tallahassee, Florida 32301

Subject: Extension of Construction Permit # AC 20-49787.

Dear Mr. Mitchell:

As representative of the Florida State Hospital for Engineering relating to Air Pollution Sources, Boilers #7 and #8, I hereby request an extension of the subject permit to September 30, 1985. Because of unanticipated delays, construction is not complete, and additional time is required for trimming electro-pneumatic controls and general boiler system debugging.

Very truly yours,

DOUGHERTY ENGINEERING COMPANY, INC.

Fred W. Dougherty, P.E.

copy: Tom Parker
Harrel Bolden
Steve Helentjaris
Tom Moody } 10/9/84
Margaret Elligett }

FWD/drd

ATTACHMENT 17

BEST AVAILABLE COPY

DOUGHERTY ENGINEERING CO.
318 Williams Street
TALLAHASSEE, FLORIDA 32303
(904) 681-0610

LETTER OF TRANSMITTAL

DATE November 9, 1984
JOB NO 1001
ATTENTION Bruce Mitchell
RE Application to Operate/Construct Air Pollution Sources, Florida State Hospital, Boilers #7 and #8

TO Bruce Mitchell
2600 Blair Stone Road
Tallahassee, Florida 32301
Department of Environmental Regulation

WE ARE SENDING YOU ☒ Attached ☐ Under separate cover via ________ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications
☐ Copy of letter ☐ Change order ☐ ________

COPIES	DATE	NO.	DESCRIPTION
1	11-6-84	17	Application - Wood Pulverizer Baghouse
1	11-6-84	17	Application - Dry Ash Collector Baghouse

THESE ARE TRANSMITTED as checked below:

☐ For approval ☐ Approved as submitted ☐ Resubmit ____ copies for approval
☒ For your use ☐ Approved as noted ☐ Submit ____ copies for distribution
☐ As requested ☐ Returned for corrections ☐ Return ____ corrected prints
☐ For review and comment ☐ ________
☐ FOR BIDS DUE ________ 19____ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS ________

COPY TO ________

SIGNED:

BEST AVAILABLE COPY

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

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

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

SOURCE TYPE: Air Pollution [X] New[1] [ ] Existing[1]

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

COMPANY NAME: Florida State Hospital COUNTY: Gadsden

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) Wood Pulverizer Baghouse Boilers #7 & #8

SOURCE LOCATION: Street U. S. Hwy 90 City Chattahoochee

UTM: East 707400M North 3398500M

Latitude 30° 42' 16"N Longitude 84° 50' 10"W

APPLICANT NAME AND TITLE: William D. Myers, Administrative Services Director

APPLICANT ADDRESS: Florida State Hospital, Chattahoochee, Florida 32324

SECTION I: STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

I am the undersigned owner or authorized representative* of Florida State Hospital

I certify that the statements made in this application for a Air Pollution 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: William D. Myers

William D. Myers, Administrative Services Director
Name and Title (Please Type)

Date: 11-06-84 Telephone No. (904)663-4311

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)

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

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

Signed ______________________

Fred W. Dougherty, P.E.
Name (Please Type)

Dougherty Engineering Company
Company Name (Please Type)

318 Williams Street, Tallahassee, FL 32303
Mailing Address (Please Type)

Florida Registration No. **15124** Date: __________ Telephone No. **(904)681-0610**

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.

Project consists of two boilers with steam capacity of 60,000 pph @ 415 psia, 575 deg F. Boilers fire pelletized wood and #6 oil in ratio 95/5 by weight. Stack emission control consists of wet scrubbers in series behind parallel dry cyclones. Cyclone ash is conveyed to a secondary cyclone and filter. Hoppers of dry (cont. nx

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

Start of Construction **Jan. 1982** Completion of Construction **Sept. 1985**

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.)

1,250,000 (scrubbers, new I.D. Fans, dry ash collection, pulverizer dust collection)

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

Construction Permit Number AC 20-49787 issued 1/24/83, expired 9/30/84. Previous operating permits for fossil fuels not available.

ash secondary collection discharge into closed container for disposal in land fill. Prior to firing, wood is pulverized. Dust from pulverizer is conveyed to cyclones and filter on powerhouse roof. All of the dust collected in these hoppers is injected into burner. Emission points are: two boilers stacks, one "dry ash" conveyor filter, and one pulverizer dust filter.

E. 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. No

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

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

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

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

   a. If yes, for what pollutants? ____________

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

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

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

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

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

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)

Wood Dust (Pulverizer) Baghouse

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	
PM	.4	1.6	Visible	20% OPAC			④

[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 - Clark 4-15	Wood Dust	98.5	5-50	See Suppl.
Cyclone - Clark	Wood Dust	83	20-250	See Suppl.

E. Fuels See Permit AC 20-49787 - No significant change

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

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

Fuel Analysis:

Percent Sulfur: ______________ Percent Ash: ______________

Density: ______________ lbs/gal Typical Percent Nitrogen: ______________

Heat Capacity: ______________ BTU/lb ______________ BTU/gal

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

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

Annual Average ______________ Maximum ______________

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

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

Description of Waste ______________________________

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

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

Manufacturer ______________________________

Date Constructed ______________ Model No. ______________

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

Stack Height: __________ ft. Stack Diamter: __________ Stack Temp. __________

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

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

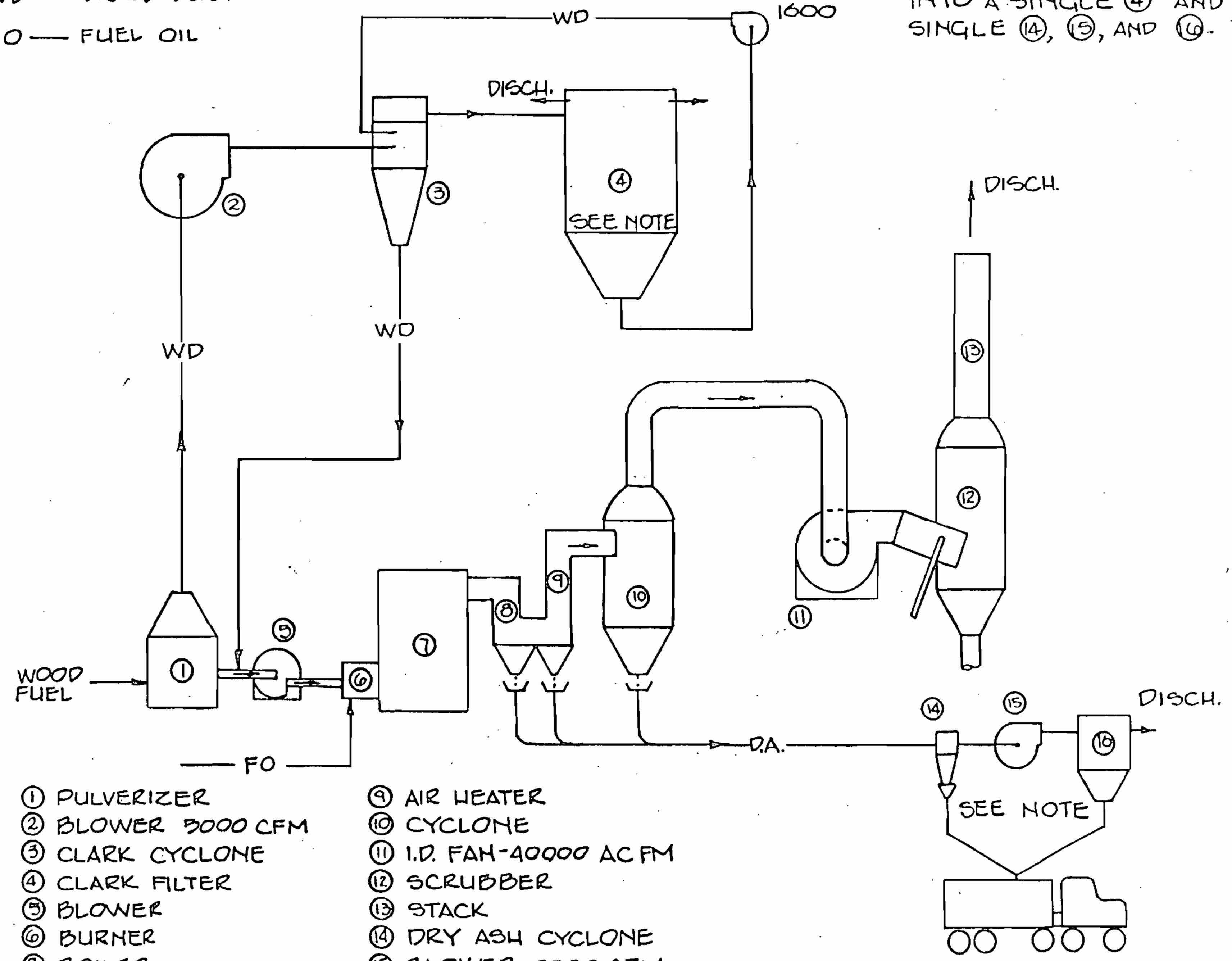
Type of pollution control device: [ ] Cyclone [ ] Wet Scrubber [ ] Afterburner

[ ] Other (specify) ______________

BOILER FLOW DIAGRAM
BOILER NO. 7 OR NO. 8

LEGEND
— DA — DRY ASH
— WD — WOOD DUST
— FO — FUEL OIL

NOTE: BOTH BOILERS DISCHARGE INTO A SINGLE ④ AND A SINGLE ⑭, ⑮, AND ⑯.



① PULVERIZER
② BLOWER 3000 CFM
③ CLARK CYCLONE
④ CLARK FILTER
⑤ BLOWER
⑥ BURNER
⑦ BOILER
⑧ DOWNPASS

⑨ AIR HEATER
⑩ CYCLONE
⑪ I.D. FAN-40000 ACFM
⑫ SCRUBBER
⑬ STACK
⑭ DRY ASH CYCLONE
⑮ BLOWER 3500 CFM
⑯ FARR FILTER

FWD/VMR

DOUGHERTY ENGINEERING COMPANY, INC.
TALLAHASSEE, FLORIDA

JOB 1001 Boilers 7 & 8, FSH
SHEET NO. 1 OF 5
CALCULATED BY FWD DATE 10-4-84
CHECKED BY DATE
SCALE

CONSTRUCTION PERMIT MODIFICATION AND EXTENSION

Reference: 1. Permit Number AC 20-49787, dated November 3, 1983

2. "Technical Evaluation and Preliminary Determination", Florida State Hospital, Gadsden County, Chattahoochee, Florida, Nos 7 and 8 Boiler Conversion, Permit Number AC 20-49787

I. Steam side conditions - both boilers:

steam header press = 415 psia
" " temp = 575 °F
h_{out} = 1290 Btu/lb
Feedwater temp. = 300 °F
hin = 270 Btu/lb

II. Heat Input:

Efficiency on #6 F.O. by ASME short form (ref applications dated March 9, 1979)

Boiler #7	87.93%
Boiler #8	88.08%
ave	88.00%

$$\text{Btu/hr heat input} = \frac{60{,}000 \text{ lbs/hr} \times (1290 - 270) \text{ Btu/lb}}{.88}$$

$$= 69.5 \times 10^6 \text{ B/h} \quad \text{each boiler}$$

DOUGHERTY ENGINEERING COMPANY, INC.
TALLAHASSEE, FLORIDA

JOB 1001 Boilers #7 & #8
SHEET NO. 2 OF 5
CALCULATED BY ____ DATE ____
CHECKED BY ____ DATE ____
SCALE ____

III Fuel Input - each boiler

A. 12% #6 F.O. 88% pelletized wood by heat content

Total F.O. heat input = .12 x 69.5 = 8.34 x10⁶ B/h

Total wood heat input = .88 x 69.5 = 61.16 x10⁶ B/h

F.O. input = $\frac{8.34 \times 10^6}{1.5355 \times 10^5}$ = 54.3 gallons per hour

wood input = $\frac{61.16 \times 10^6}{8.2 \times 10^3}$ = 7,486 lbs/hr

see attached test report for backup
of wood heat value = 8,200 Btu/lb.

B. 100% #6 F.O.

F.O. Input = $\frac{69.5 \times 10^6}{1.5355 \times 10^5}$ = 452.6 gph

IV SO_2 Emissions - Each Boiler

A. 12% #6 F.O. 88% pelletized wood

WP - AP42 Tab 1.6-1, 1.5 lbs SO_2/ton wood
FO - stoichiometric, 2.5% by weight: 400 lbs/1000 gal

7,486 x 1.5/2000 = 5.61 lbs/hr
54.3 x 400/1000 = 21.72 lbs/hr
27.33 119.7 TPY

B. 100% #6 F.O.

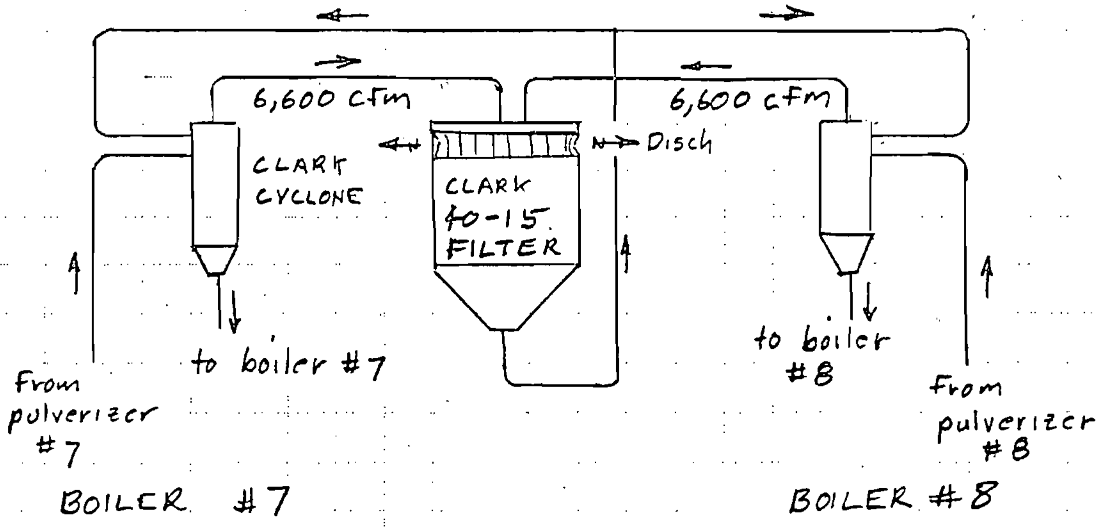
452.6 x 400/1000 = 181.04 793.0 TPY

JOB 1001 Boilers #7 & #8 FSH
SHEET NO. 3 OF 5
CALCULATED BY FWD DATE
CHECKED BY DATE
SCALE

V Particle Emissions – Baghouses

A. Diagrams

1. Wood Pulverizer Baghouse

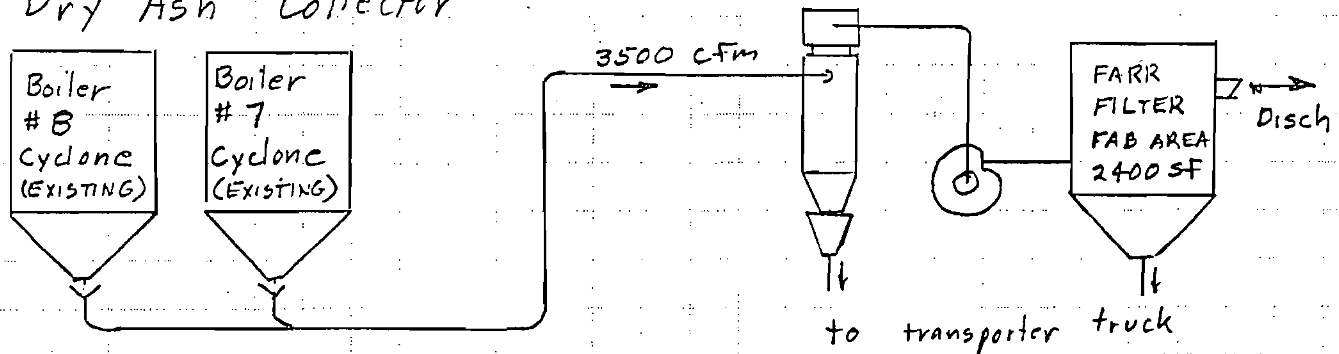


TOTAL AIR FLOW INTO FILTER 13,200 cfm

CYCLONES: CLARK MEDIUM EFFICIENCY, HIGH THROUGH-FLOW, 6' CONE, P.D. 4.5" W.C. @ 6,600 cfm

FILTER: CLARK 40-15, 1915 sf cloth area, air-to-cloth ratio 5.2 cfm/sf

2. Dry Ash Collector



CYCLONE: FISCHER-KLOSTERMAN XQ-465-19 "HIGH EFFICIENCY"
FILTER: FARR "TENKAY" SIZE 12, AIR TO FABRIC RATIO = 3500/2400 = 1.5

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DOUGHERTY ENGINEERING COMPANY, INC.
TALLAHASSEE, FLORIDA

JOB Boi[illegible] 7 & 8 [illegible]
SHEET NO. 4 OF 5
CALCULATED BY ______ DATE 9-13-84
CHECKED BY ______ DATE ______
SCALE ______

B. WOOD DUST COLLECTOR

Emmission from filter (each boiler)

$$\dot{W}_{EWD} = \dot{W}_{WF} \times a \times \frac{(1-\eta_{WDC})}{100} \times \frac{(1-\eta_{WDF})}{100}$$

$\dot{W}_{WF}$ = MAXIMUM WOOD FUEL FEED RATE, lbs/hr

a = ENGINEER'S ESTIMATE OF FRACTION OF WOOD FUEL COLLECTED AS DUST

η_{WDF} = EFFICIENCY OF WOOD DUST FILTER

η_{WDC} = EFFICIENCY OF WOOD DUST CYCLONE

Filter Efficiency (Based on Figure 11-1 Industrial Ventilation Manual)

Estimated a	2%
Ave Particle size entering cyclone (est)	50μ
Cyclone efficiency (Fig 11-3 IVM)	83%
Ave Particle size entering Filter	10μ
Filter efficiency	98.5%

| $\dot{W}_{EWD}$ = (7,486) × .02 × .17 × .015 = .38 lbs/hr

× 4.38 => 1.7 TPY (1.664

C. DRY ASH COLLECTOR

1. TOTAL AIR FLOW 3,500 cfm

2. CYCLONE Fisher-Klosterman XQ 465-19

cyclone efficiency:

$$\eta_{ac} = 100 - F_1$$

$$F_1 = F(D)$$

| Rev 10-3-85

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DOUGHERTY ENGINEERING COMPANY, INC.
TALLAHASSEE, FLORIDA

JOB Boilers 7 & 8 Calculations
SHEET NO. 5 OF 5
CALCULATED BY ______ DATE 9-13-84
CHECKED BY ______ DATE ______
SCALE ______

C. DRY ASH COLLECTOR (CONT)

$$D = f(k, \mu_g, N^3, \lambda_d, Q)$$

see attached excerpt pg 8 and 9 for further details of calculation procedure

$Q = 3500$ cfm $\quad \mu_g = 1.28 \times 10^{-5}$ lbs/ft^3

$\lambda_d = 1.7$

$N = 19$

$D = 4.8 \quad f_1 = 11 \quad \eta_{ac} = 89\%$

3. Baghouse is Farr "TENKAY" size 12, Fabric area 2400 sf

air to fabric ratio 1.5

baghouse efficiency, estimated 5μ average particle size: 99% (Industrial Ventilation Handbook, Fig 11-1) $\quad \eta_{aF} = 99\%$

4. Emission

$$\dot{W}_{EDA} = \dot{W}_{da} \times \frac{(1 - \eta_{ac})}{100} \times \frac{(1 - \eta_{aF})}{100}$$

$\dot{W}_{da}$ = estimated rate of generation of dry ash. Based on operations to date, this is 225 lbs/hr per boiler.

$\dot{W}_{eda} = [[2 \times 225] \times .11] \times .01 = .25$ lbs/hr

0.495 x 4.38 ⇒ 2.2 TPY (2.1681)

Technical Guide to the Selection of Fisher-Klosterman XQ Series High-Performance Cyclones

This section is intended for use by the Application Engineer in specifying the correct XQ Series Cyclone for his needs. Naturally, Fisher-Klosterman will be happy to provide all the assistance needed, or to undertake the complete engineering project, if desired.

Selection Factors

Three factors must be considered in selecting a cyclone for any application:

1. Inlet Velocity
2. Pressure Loss
3. Collection Efficiency.

Proper calculation of these variables insures the selection of an XQ Series Cyclone that will perform with maximum efficiency and cost effectiveness.

Inlet Velocity

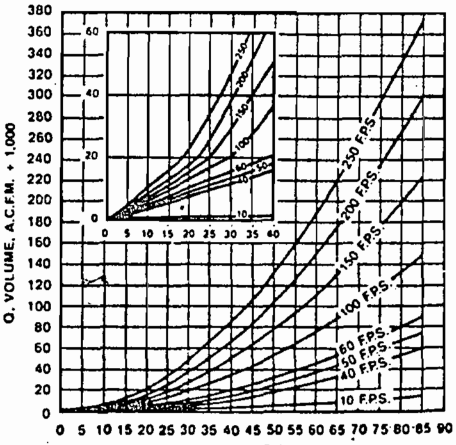
Most cyclone literature assumes an inlet velocity range from 20 to 100 feet per second. Most industrial applications have historically fallen in the 40 to 60 f.p.s. range. However, the range you consider need not be so narrow. Extensive testing and field experience have shown that Fisher-Klosterman XQ Series Cyclones perform predictably at velocities as low as 10 f.p.s. and well beyond 150 f.p.s.

The choice of inlet velocity is generally dictated by the aerodynamic characteristics of the particulates to be collected and the possibility of abrasion, as well as available space, equipment cost and power consumption.

Figure 1 shows the relationship between cyclone size (N), volumetric gas flow rate (Q) in ACFM, and inlet velocity (v_i) in f.p.s.

Application Engineers should consider that collection efficiency will increase as a complex exponential function of the inlet velocity. (This will be discussed in greater detail in a later section on collection efficiency.) Power consumption will increase approximately as the square of the inlet velocity. When abrasion is not a significant factor, these two criteria alone will determine the proper cyclone for the intended application.

FIG. 1

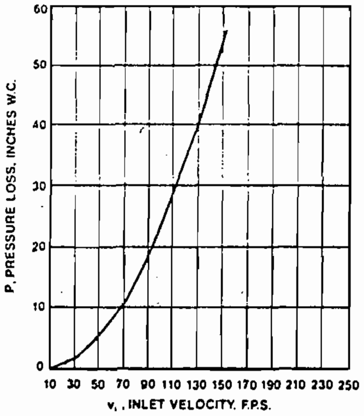


Pressure Loss

Energy is consumed in the passage of the gas through the cyclone. This is expressed as the pressure drop between the gas inlet and gas outlet of the cyclone, and is usually measured in inches of water column (in. w.c.). In any cyclone, the pressure loss increases approximately as the square of either the volumetric flow rate (Q) or the inlet velocity (v_i), and directly as the density (λ_g) of the gas.

Figure 2 shows the relationship between inlet velocity (v_i) and pressure loss (ΔP) in an XQ Series Cyclone with air at 70 F and 14.7 p.s.i.a.

FIG. 2



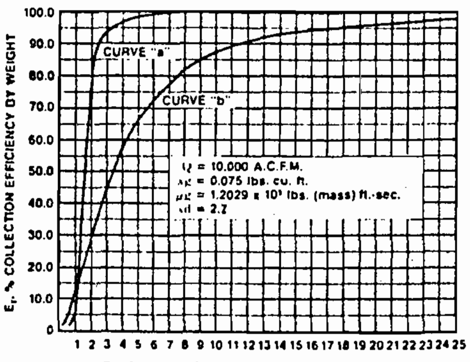
Fractional Efficiency

Efficiency is expressed in percentage by weight. In the Fractional or Particle Size or Grade Efficiency (E_f) Curve, the independent variable is the Stokes Equivalent Particle Diameter (D_p), in microns. The curve is a complex exponential function of:

1. inlet velocity (v_i) and absolute gas viscosity (μ_g).
2. particle mass, particle size, shape and surface roughness, usually measured as terminal velocity, feet sec., in still air, and expressed as Stokes Equivalent Diameters (D_p) in microns.
3. cyclone size and proportions (shape).

Figure 3 illustrates two cyclone fractional efficiency curves. Each is for a single cyclone. Both are plotted at identical conditions: gas flow rates, densities and absolute viscosities are equal, as are cyclone pressure drops and particle density for both cyclones. Curve "a" is for an XQ120 cyclone, and Curve "b" is for an XQ465.

FIG. 3



Manual calculation of a fractional efficiency curve for just a single case is a complex and tedious problem, even for an experienced engineer. Fisher-Klosterman, however, has reduced this task to simplicity itself by the use of the digital computer. To determine a fractional efficiency curve, the following data are required:

- Volumetric gas flow rate, A.C.F.M., Q
- Gas density, lbs./cu. ft., λ_g
- Gas absolute viscosity, lbs. (mass)/ft.—sec., μ_g
- Particle specific gravity (dimensionless), or true particle density, gms/c.c., λ_d

If gas density and viscosity are not known, the gas analysis plus its temperature and pressure should be specified. Also, to aid in the selection of the best and most economical cyclone for your needs, either or both of the following should be specified:

- Maximum pressure drop, inches w.c.
- Desired efficiency at some specified particle size.

Helpful, but not mandatory, the following data should be furnished if available:

- Dust fineness, typically expressed as % by weight finer than 1.5 microns
- Inlet dust loading, grains/A.C.F.

With this information, our experienced application engineers can provide complete computer-calculated fractional efficiency curves in a matter of minutes.

Total Efficiency

Total Collection Efficiency (E_t) is defined as the percent by weight of the gas-borne particulate separated by the cyclone. To calculate Total Efficiency, not only must the Fractional Efficiency curve of the cyclone be known, but also the size distribution of the particulate.

The independent variable in the particle size distribution should be Stokes Equivalent Diameters, usually expressed in microns (one-millionth of a meter). This is a hypothetical aerodynamic diameter which accounts for the size, shape, mass and texture of the particle.

One word of caution: Optical techniques, screening, analytical instrumentation which measures particle size by determining the amount of liquid a particle displaces and other non-standardized methods do not give data which can be used with any degree of confidence or accuracy in calculating cyclone performance. If you have any doubts about your data, you should utilize our laboratory services. (See page 3).

The dependent variable in the Particle Size Distribution is generally expressed as "percent by weight finer" than a specified Stokes Equivalent Diameter in microns. Equally usable is data specifying the percent by weight falling in the range between two specified diameters.

The calculation of Total Efficiency involves the following steps:

- If it is not already in that form, convert the Particle Size Distribution to a cumulative % by weight finer than any specified diameter.
- Find the derivative of the Particle Size Distribution.
- Multiply the derivative by the Cyclone Fractional Efficiency Curve.
- Integrate the resulting product from zero particle diameter to infinity to find Total Collection Efficiency.

Although the above process sounds straightforward, the product to be integrated does not, in fact, have a rational integral. The problem must therefore be solved by one of three techniques:

- Graphical methods, or;
- Express the product as an infinite series which can be integrated term by term, or;
- Find the integral of the product by Numerical Calculus.

The latter method lends itself ideally to the digital computer. Given the same data as outlined for the computation of the Fractional Efficiency Curve (see page 8), plus the Particle Size Distribution, we can calculate and report Total Collection Efficiency to you in just a few minutes.

However, in many cases, you may wish to make an approximate calculation of Total Collection Efficiency yourself. A method for doing so involves the use of an "Average Limit Particle," and its use permits you to examine the consequences of varying both the type of cyclone and the number in parallel that you are considering. You must be aware that this method is only an approximation. Its accuracy decreases in two cases:

- When the particle size distribution is very narrow. Much more accurate results are obtained if the distribution ranges, for example, between 1.0 and 100.0 microns than if all particles fall between 1.0 and 10.0 microns.
- The lower the Total Collection Efficiency (the finer the particulate), the lower the accuracy of this method.

The Average Limit Particle size is calculated by:

$$D_l = k\sqrt{\frac{\mu_g \times N^3}{\lambda_d \times Q}},$$

where D_l = Average Limit Particle, microns.

μ_g = Absolute viscosity of gas, lbs. (mass)/ft.—sec.

N = Cyclone size.

λ_d = Particulate specific gravity, or true particle density, grams/c.c.

Q = Volumetric gas flow rate, A.C.F.M.

k, a constant, is given in Table 1 for each family of cyclones in the XQ Series.

Table 1

Cyclone Family	XQ465	XQ405	XQ340	XQ240	XQ170	XQ120
k	1254 27	1069 19	923 120	741.378	621.110	543.522

The approximate Total Collection Efficiency is calculated by:

$$\varepsilon_t = 100.0 - f_l,$$

where ε_t = Approximate Total Collection Efficiency, % by weight.

f_l = The percent finer by weight, in the Particle Size Distribution at the Average Limit Particle Size.

Examples of Cyclone Calculations

Example #1

Given:

Q = 6,800 A.C.F.M.

Gas = Air at 460° F. and 14.7 p.s.i.a.

λ_g = 0.036 lbs./cu. ft.

$\mu_g = 1.76 \times 10^{5}$ lbs. (mass) ft.—sec.

Specifications:

v_i = 70. f.p.s., maximum

ΔP = 3.0 in. w.c., maximum

Calculations:

1. From Figure 1, smallest single cyclone at $v_i \leq 70.$ f.p.s. is SIZE 22.
2. Allowable maximum pressure drop at specified conditions must be corrected to the gas density of air at 70°F. and 14.7 p.s.i.a., 0.075 lbs./cu. ft. $\Delta P_{(corr)}$ = 0.075 × 3.0/0.036 = 6.25 in. w.c.
3. From Figure 2, at $\Delta P_{(corr)}$ = 6.25 in. w.c., v_i = 53. f.p.s. The cyclone will have to be resized to this inlet velocity.
4. Returning to Figure 1, smallest single cyclone at v_i 53. f.p.s. is SIZE 25.

Example #2

Given:

Q = 12,500 A.C.F.M.

λ_g = 0.075 lbs./cu. ft.

$\mu_g = 1.2029 \times 10^{5}$ lbs. (mass)/ft.—sec.

λ_d = 3.15

Particle Size Distribution: See Figure 4.

Specifications:

Required Total Efficiency by weight, ε_t = 86.5%

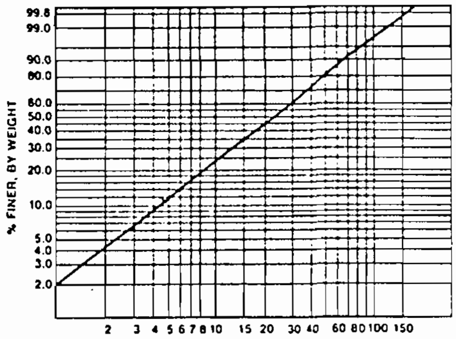
Maximum allowable pressure drop, ΔP = 7.5 in. w.c.

Maximum allowable inlet velocity, v_i = 55 f.p.s.

Calculations:

1. Assume cyclone will be type XQ340
2. From Figure 1 at v_i = 55 f.p.s., Size = 33
3. From Figure 2 at v_i = 55 f.p.s., ΔP = 6.8 in. w.c.
4. From Table 1, k = 923.120
5. By equation (1). $$D_l = 923.120 \times \sqrt{\frac{1.2029 \times 10^{5} \times 33^3}{3.15 \times 12500}}$$ $$= 3.03$$
6. From Figure 4, f_l = 7.1
7. By equation (2), $\varepsilon_t = 100.0 - 7.1$ $= \underline{92.9\%}$

FIG. 4



A typical XQ Series Model Number and What it Means

$$\underbrace{\text{XQ465}}_{A}\text{-}\underbrace{\text{20}}_{B}\text{-}\underbrace{\text{2}}_{C}\text{-}\underbrace{\text{CR1}}_{D}$$

A. "XQ" *plus a 3-digit number* designates the family of the cyclone.

B. "-" *plus a number* designates the cyclone size which equals the height of the cyclone inlet in inches. This may be a 1- or 2-digit number, or a decimal.

C. "-" *plus an integer* indicates the number of cyclones in parallel that make up the complete collection system.

D. "-" *plus a special suffix* designates special construction features. Some examples are:

PV = Pressure Vessel

CR1 = 1-inch Castable Refractory Lining

CR2 = 2-Inch Castable Refractory Lining

RB3 = 3-Inch Refractory Brick Lining

RB9 = 9-Inch Refractory Brick Lining

C.5 = ½-Inch Alumina Ceramic Tile Lining

C1 = 1-Inch Alumina Ceramic Tile Lining

Use the above information when specifying your XQ Series Cyclone. In addition, orders should specify separately:

Material(s) of Construction or (if Fisher-Klosterman is to determine the materials) special construction considerations such as high abrasion or corrosive conditions.

Special Construction Features, such as:

Break-Apart Construction for installations requiring cleaning and maintenance.

Externally Replaceable Wear Plates/Sections or special linings for highly abrasive dusts.

Access Doors (not recommended for the active portion of the cyclone when collection performance is critical).

Explosion Reliefs for use with explosive dusts.

Plus a variety of other features demanded by the individual cyclone's application.

TECHNICAL SERVICES, INC.
ENVIRONMENTAL CONSULTANTS — INDUSTRIAL CHEMISTS
OFFICE 2471 SWAN ST. — P.O. BOX 52329
LABORATORIES 103-107 STOCKTON STREET
JACKSONVILLE, FLORIDA 32201
(904) 353-5761

Laboratory No. 61124

August 29, 1984

Sample of WOOD PELLETS

Date Received August 28, 1984

For STATE OF FLORIDA, DEPT. OF GENERAL SERVICES, BUREAU OF STANDARDS, LARSON BUILDING, ROOM 613, TALLAHASSEE, FLORIDA 32301

Marks: Attn: Mr. H. P. Barker, Jr., C.P.M. Chief

CERTIFICATE OF ANALYSIS OR TESTS

	BTU/lb.
1.	8188
2.	8160
3.	8183
4.	8244
5.	8240
Average	8203

Respectfully submitted,

TECHNICAL SERVICES, INC.

BY Henry C. Gray, Jr.

LABORATORY I.D. NO. 82145

HRS STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

August 23, 1984

Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, Florida 32301

Attention: C. H. Fancy, P.E.

SUBJECT: Authorized Representative for Air Pollution Control - Boilers No. 7 and 8.

Dear Mr. Fancy,

In reference to your letter of August 15, 1984 this will notify you that Fred W. Dougherty, P.E. is authorized to represent Florida State Hospital as our Engineer with respect to air pollution control matters relating to boilers No. 7 and 8.

Sincerely,

William D. Myers

William D. Myers
Hospital Administrative Services Director

WDM/dk

Doris J. Kirkland
NOTARY

NOTARY PUBLIC, STATE OF FLORIDA AT LARGE
MY COMMISSION EXPIRES JAN. 9, 1987
BONDED THROUGH MUROSKI-ASHTON, INC

DISTRICT TWO • FLORIDA STATE HOSPITAL • CHATTAHOOCHEE, FLORIDA 32324

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STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

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

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

SOURCE TYPE: Air Pollution [X] New[1] [ ] Existing[1]

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

COMPANY NAME: Florida State Hospital COUNTY: Gadsden

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) Dry Ash Collector Baghouse Boilers #7 & #8

SOURCE LOCATION: Street U. S. Hwy 90 City Chattahoochee

UTM: East 707400M North 3398500M

Latitude 30 ° 42 ' 16 "N Longitude 84 ° 50 ' 10 "W

APPLICANT NAME AND TITLE: William D. Myers, Administrative Services Director

APPLICANT ADDRESS: Florida State Hospital, Chattahoochee, Florida 32324

SECTION I: STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

I am the undersigned owner or authorized representative* of Florida State Hospital

I certify that the statements made in this application for a Air Pollution 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: William D. Myers

William D. Myers, Administrative Services Director
Name and Title (Please Type)

Date: 11-26-84 Telephone No. (904)663-4311

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)

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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: ____________________

Fred W. Dougherty, P.E.
Name (Please Type)

Dougherty Engineering Company
Company Name (Please Type)

318 Williams Street, Tallahassee, FL 32303
Mailing Address (Please Type)

Florida Registration No. 15124 Date: ________ Telephone No. (904)681-0610

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.

Project consists of two boilers with steam capacity of 60,000 pph @ 415 psia, 575 deg F. Boilers fire pelletized wood and #6 oil in ratio 95/5 by weight. Stack emission control consists of wet scrubbers in series behind parallel dry cyclones. Cyclone ash is conveyed to a secondary cyclone and filter. Hoppers of dry (cont. nx pg.

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

Start of Construction Jan. 1982 Completion of Construction Sept. 1985

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.)

1,250,000 (scrubbers, new I.D. Fans, dry ash collection, pulverizer dust collection)

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

Construction Permit Number AC 20-49787 issued 1/24/83, expired 9/30/84. Previous operating permits for fossil fuels not available.

ash secondary collection discharge into closed container for disposal in land fill. Prior to firing, wood is pulverized. Dust from pulverizer is conveyed to cyclones and filter on powerhouse roof. All of the dust collected in these hoppers is injected into burner. Emission points are: two boilers stacks, one "dry ash" conveyor filter, and one pulverizer dust filter.

E. 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. No
3. Does the State "Prevention of Significant Deterioriation" (PSD) requirement apply to this source? If yes, see Sections VI and VII. No
4. Do "Standards of Performance for New Stationary Sources" (NSPS) apply to this source? No
5. Do "National Emission Standards for Hazardous Air Pollutants" (NESHAP) apply to this source? No

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

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

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

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

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

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

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)

Dry Ash Collector Baghouse

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	
PM	**.25**	**1.0**	**Visible**	**20% OPAC**			⑯

[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 - Farr Tenday 12	Dry Ash	99	5-10	See Supl.
Cyclone - FC XQ 465-19	Dry Ash	89	8-100	See Suppl.

E. Fuels **See Permit AC-20-49787 - No significant change**

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

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

Fuel Analysis:

Percent Sulfur: ____________________ Percent Ash: ____________________

Density: ____________________ lbs/gal Typical Percent Nitrogen: ____________________

Heat Capacity: ____________________ BTU/lb ____________________ BTU/gal

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

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

Annual Average ____________________ Maximum ____________________

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

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 (Patholog-ical)	Type V (Liq.& Gas By-prod.)	Type VI (Solid By-prod.)
Actual lb/hr Inciner-ated							
Uncon-trolled (lbs/hr)							

Description of Waste ________

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

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

Manufacturer ________

Date Constructed ________ Model No. ________

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

Stack Height: ________ ft. Stack Diamter: ________ Stack Temp. ________

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

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

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

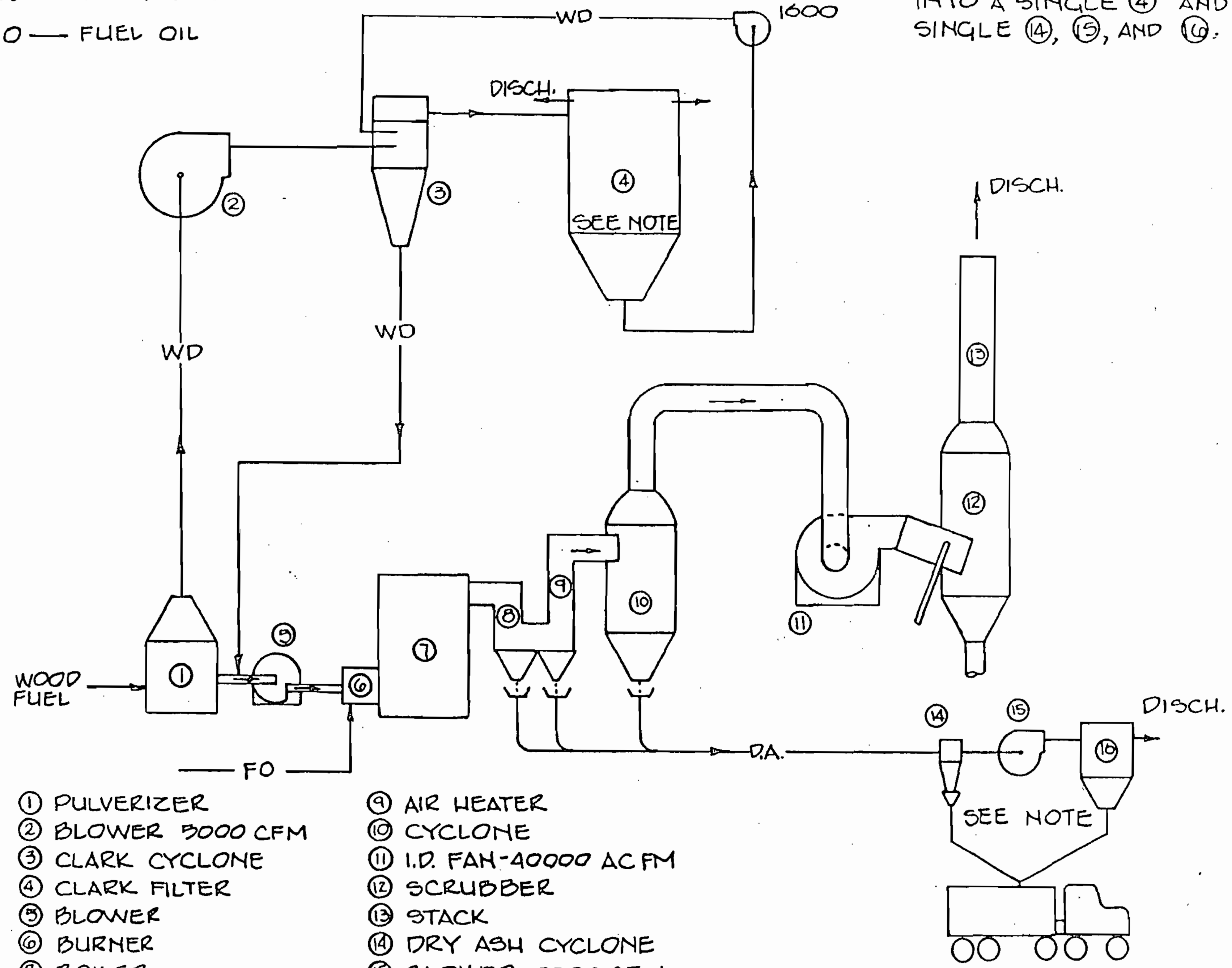
[ ] Other (specify) ________

DER Form 17-1.202(1)
Effective November 30, 1982

BOILER FLOW DIAGRAM
BOILER NO. 7 OR NO. 8

LEGEND
—— DA —— DRY ASH
—— WD —— WOOD DUST
—— FO —— FUEL OIL

NOTE: BOTH BOILERS DISCHARGE INTO A SINGLE ④ AND A SINGLE ⑭, ⑮, AND ⑯.



① PULVERIZER
② BLOWER 5000 CFM
③ CLARK CYCLONE
④ CLARK FILTER
⑤ BLOWER
⑥ BURNER
⑦ BOILER
⑧ DOWNPASS

⑨ AIR HEATER
⑩ CYCLONE
⑪ I.D. FAN-40000 ACFM
⑫ SCRUBBER
⑬ STACK
⑭ DRY ASH CYCLONE
⑮ BLOWER 3500 CFM
⑯ FARR FILTER

FWD/VMR

DOUGHERTY ENGINEERING COMPANY, INC.
TALLAHASSEE, FLORIDA

JOB 1001 Boilers 7 & 8, FSH
SHEET NO. 1 OF 5
CALCULATED BY FWD DATE 10-4-84
CHECKED BY DATE
SCALE

CONSTRUCTION PERMIT MODIFICATION AND EXTENSION

Reference: 1. Permit Number AC 20-49787, dated November 3, 1983

2. "Technical Evaluation and Preliminary Determination", Florida State Hospital, Gadsden County, Chattahoochee, Florida, Nos 7 and 8 Boiler Conversion, Permit Number AC 20-49787

I. Steam side conditions - both boilers:

steam header press = 415 psia
" " temp = 575 °F
h_{out} = 1290 Btu/lb
Feedwater temp. = 300 °F
hin = 270 Btu/lb

II. Heat Input:

Efficiency on #6 F.O. by ASME short form (ref applications dated March 9, 1979)

Boiler # 7	87.93%
Boiler # 8	88.08%
ave	88.00%

$$\text{Btu/hr heat input} = \frac{60{,}000 \text{ lbs/hr} \times (1290 - 270) \text{ Btu/lb}}{.88}$$

$$= 69.5 \times 10^6 \text{ B/h. each boiler}$$

JOB 1001 Boilers #7 & #8 [illegible]
SHEET NO. 2 OF 5
CALCULATED BY ______ DATE ______
CHECKED BY ______ DATE ______
SCALE ______

III Fuel Input - each boiler

A. 12% #6 F.O. 88% pelletized wood by heat content

Total F.O. heat input = .12 x 69.5 = 8.34×10^6 B/h

Total wood heat input = .88 x 69.5 = 61.16×10^6 B/h

F.O. input = $\frac{8.34 \times 10^6}{1.5355 \times 10^5}$ = 54.3 gallons per hour

wood input = $\frac{61.16 \times 10^6}{8.2 \times 10^3}$ = 7,486 lbs/hr

see attached test report for backup
of wood heat value = 8,200 Btu/lb.

B. 100% #6 F.O.

F.O. Input = $\frac{69.5 \times 10^6}{1.5355 \times 10^5}$ = 452.6 gph

IV. SO_2 Emissions - Each Boiler

A. 12% #6 F.O. 88% pelletized wood

WP - AP42 Tab 1.6-1, 1.5 lbs SO_2/ton wood
FO - stoichiometric, 2.5% by weight: 400 lbs/1000 gal

7,486 x 1.5/2000 = 5.61 lbs/hr
54.3 x 400/1000 = 21.72 lbs/hr
27.33 119.7 TPY

B. 100% #6 F.O.

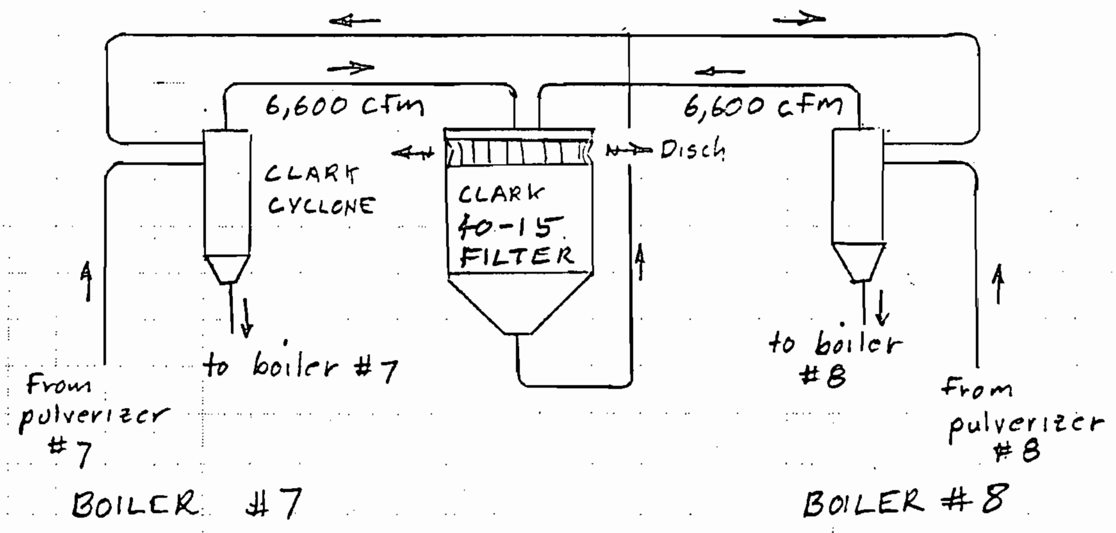
452.6 x 400/1000 = 181.04 793.0 TPY

JOB 1001 Boilers #7 & #8 FSH
SHEET NO. 3 OF 5
CALCULATED BY FWD DATE
CHECKED BY DATE
SCALE

V Particle Emissions — Baghouses

A. Diagrams

1. Wood Pulverizer Baghouse

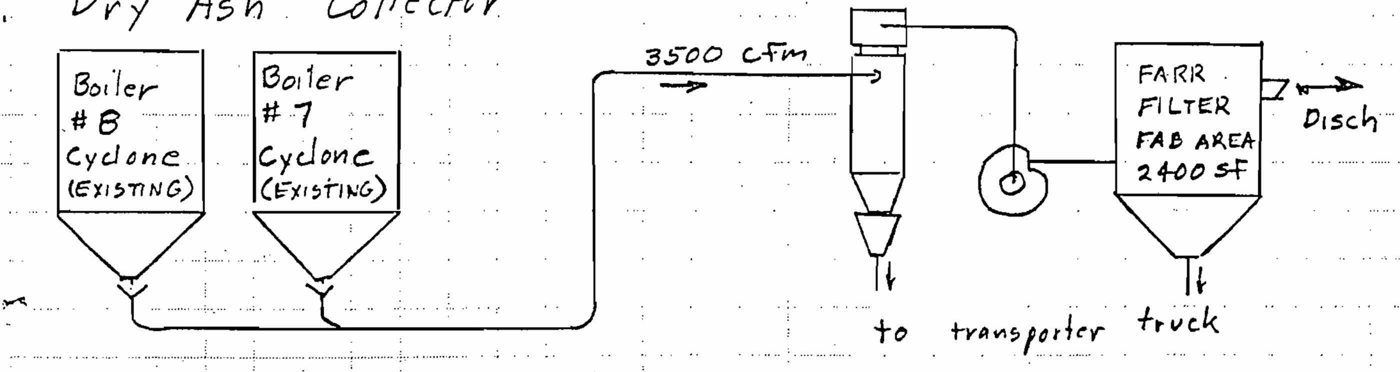


TOTAL AIR FLOW INTO FILTER 13,200 cfm

CYCLONES: CLARK MEDIUM EFFICIENCY, HIGH THROUGH-FLOW, 6' CONE, P.D. 4.5" W.C. @ 6,600 cfm

FILTER: CLARK 40-15, 1915 sf cloth area, air-to-cloth ratio 5.2 cfm/sf

2. Dry Ash Collector



CYCLONE: FISCHER-KLOSTERMAN XQ-465-19 "HIGH EFFICIENCY"
FILTER: FARR "TENKAY" SIZE 12, AIR TO FABRIC RATIO = 3500/2400 = 1.5

JOB Boi[illegible] 7 & 8 [illegible]
SHEET NO. 4 OF 5
CALCULATED BY ______ DATE 9-13-84
CHECKED BY ______ DATE ______
SCALE ______

B. WOOD DUST COLLECTOR

Emmission from filter (each boiler)

$$\dot{W}_{EWD} = \dot{W}_{WF} \times a \times \frac{(1-\eta_{WOC})}{100} \times \frac{(1-\eta_{WDF})}{100}$$

$\dot{W}_{WF}$ = MAXIMUM WOOD FUEL FEED RATE, lbs/hr
a = ENGINEER'S ESTIMATE OF FRACTION OF WOOD FUEL COLLECTED AS DUST
η_{WDF} = EFFICIENCY OF WOOD DUST FILTER
η_{WOC} = EFFICIENCY OF WOOD DUST CYCLONE

Filter Efficiency (Based on Figure 11-1 Industrial Ventilation Manual)

Estimated a	2%
Ave Particle size entering cyclone (est)	50 μ
cyclone efficiency (Fig 11-3 IVM)	83%
Ave Particle size entering Filter	10 μ
Filter efficiency	98.5%

$$\dot{W}_{EWD} = (7,486) \times .02 \times .17 \times .015 = .38 \text{ lbs/hr}$$

C. DRY ASH COLLECTOR

1. TOTAL AIR FLOW 3,500 cfm

2. CYCLONE Fisher-Klosterman XQ 465-19

cyclone efficiency:

$$\eta_{ac} = 100 - F_1$$

$$F_1 = F(D)$$

Rev 10-3-85

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JOB Boilers 7 & 8 Calculations
SHEET NO. 5 OF 5
CALCULATED BY ________ DATE 9-13-84
CHECKED BY ________ DATE ________
SCALE ________

C. DRY ASH COLLECTOR (CONT)

$$D = f(k, \mu_g, N^3, \delta_d, Q)$$

see attached excerpt pg 8 and 9 for further details of calculation procedure

$Q = 3500$ cfm $\qquad \mu_g = 1.28 \times 10^{-5}$ lbs/ft^3

$\lambda_d = 1.7$

$N = 19$

$D = 4.8 \qquad f_1 = 11 \qquad \eta_{ac} = 89\%$

3. Baghouse is Farr "TENKAY" size 12, Fabric area 2400 sf

air to fabric ratio 1.5

baghouse efficiency, estimated 5 μ average particle size : 99% (Industrial Ventilation Handbook, Fig 11-1) $\eta_{aF} = 99\%$

4. Emission

$$\dot{W}_{EDA} = \dot{W}_{da} \times \frac{(1-\eta_{ac})}{100} \times \frac{(1-\eta_{aF})}{100}$$

$\dot{W}_{da}$ = estimated rate of generation of dry ash. Based on operations to date, this is 225 lbs/hr per boiler.

$\dot{W}_{eda} = 225 \times .11 \times .01 = .25$ lbs/hr

Technical Guide to the Selection of Fisher-Klosterman XQ Series High-Performance Cyclones

This section is intended for use by the Application Engineer in specifying the correct XQ Series Cyclone for his needs. Naturally, Fisher-Klosterman will be happy to provide all the assistance needed, or to undertake the complete engineering project, if desired.

Selection Factors

Three factors must be considered in selecting a cyclone for any application:

1. Inlet Velocity
2. Pressure Loss
3. Collection Efficiency.

Proper calculation of these variables insures the selection of an XQ Series Cyclone that will perform with maximum efficiency and cost effectiveness.

Inlet Velocity

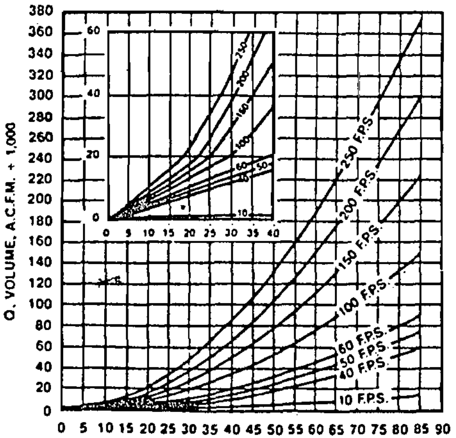
Most cyclone literature assumes an inlet velocity range from 20 to 100 feet per second. Most industrial applications have historically fallen in the 40 to 60 f.p.s. range. However, the range you consider need not be so narrow. Extensive testing and field experience have shown that Fisher-Klosterman XQ Series Cyclones perform predictably at velocities as low as 10 f.p.s. and well beyond 150 f.p.s.

The choice of inlet velocity is generally dictated by the aerodynamic characteristics of the particulates to be collected and the possibility of abrasion, as well as available space, equipment cost and power consumption.

Figure 1 shows the relationship between cyclone size (N), volumetric gas flow rate (Q) in ACFM, and inlet velocity (v_i) in f.p.s.

Application Engineers should consider that collection efficiency will increase as a complex exponential function of the inlet velocity. (This will be discussed in greater detail in a later section on collection efficiency.) Power consumption will increase approximately as the square of the inlet velocity. When abrasion is not a significant factor, these two criteria alone will determine the proper cyclone for the intended application.

FIG. 1

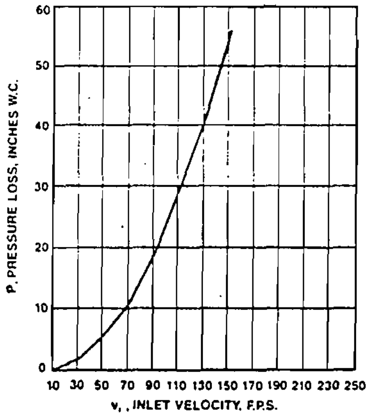


Pressure Loss

Energy is consumed in the passage of the gas through the cyclone. This is expressed as the pressure drop between the gas inlet and gas outlet of the cyclone, and is usually measured in inches of water column (in. w.c.). In any cyclone, the pressure loss increases approximately as the square of either the volumetric flow rate (Q) or the inlet velocity (v_i), and directly as the density (λ_g) of the gas.

Figure 2 shows the relationship between inlet velocity (v_i) and pressure loss (ΔP) in an XQ Series Cyclone with air at 70°F and 14.7 p.s.i.a.

FIG. 2



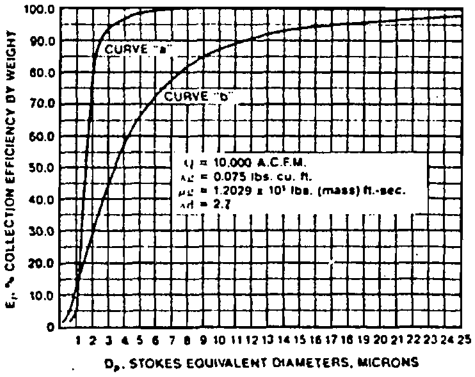
Fractional Efficiency

Efficiency is expressed in percentage by weight. In the Fractional or Particle Size or Grade Efficiency (E_f) Curve, the independent variable is the Stokes Equivalent Particle Diameter (D_p), in microns. The curve is a complex exponential function of:

1. inlet velocity (v_i) and absolute gas viscosity (μ_g).
2. particle mass, particle size, shape and surface roughness, usually measured as terminal velocity, feet sec., in still air, and expressed as Stokes Equivalent Diameters (D_p) in microns.
3. cyclone size and proportions (shape).

Figure 3 illustrates two cyclone fractional efficiency curves. Each is for a single cyclone. Both are plotted at identical conditions: gas flow rates, densities and absolute viscosities are equal, as are cyclone pressure drops and particle density for both cyclones. Curve "a" is for an XQ120 cyclone, and Curve "b" is for an XQ465.

FIG. 3



Manual calculation of a fractional efficiency curve for just a single case is a complex and tedious problem, even for an experienced engineer. Fisher-Klosterman, however, has reduced this task to simplicity itself by the use of the digital computer. To determine a fractional efficiency curve, the following data are required:

- Volumetric gas flow rate, A.C.F.M., Q
- Gas density, lbs./cu. ft., λ_g
- Gas absolute viscosity, lbs. (mass)/ft.—sec., μ_g
- Particle specific gravity (dimensionless), or true particle density, gms/c.c., λ_d

If gas density and viscosity are not known, the gas analysis plus its temperature and pressure should be specified. Also, to aid in the selection of the best and most economical cyclone for your needs, either or both of the following should be specified:

- Maximum pressure drop, inches w.c.
- Desired efficiency at some specified particle size.

Helpful, but not mandatory, the following data should be furnished if available:

- Dust fineness, typically expressed as % by weight finer than 1.5 microns
- Inlet dust loading, grains/A.C.F.

With this information, our experienced application engineers can provide complete computer-calculated fractional efficiency curves in a matter of minutes.

Total Efficiency

Total Collection Efficiency (E_t) is defined as the percent by weight of the gas-borne particulate separated by the cyclone. To calculate Total Efficiency, not only must the Fractional Efficiency curve of the cyclone be known, but also the size distribution of the particulate.

The independent variable in the particle size distribution should be Stokes Equivalent Diameters, usually expressed in microns (one-millionth of a meter). This is a hypothetical aerodynamic diameter which accounts for the size, shape, mass and texture of the particle.

One word of caution: Optical techniques, screening, analytical instrumentation which measures particle size by determining the amount of liquid a particle displaces and other non-standardized methods do not give data which can be used with any degree of confidence or accuracy in calculating cyclone performance. If you have any doubts about your data, you should utilize our laboratory services. (See page 3).

The dependent variable in the Particle Size Distribution is generally expressed as "percent by weight finer" than a specified Stokes Equivalent Diameter in microns. Equally usable is data specifying the percent by weight falling in the range between two specified diameters.

The calculation of Total Efficiency involves the following steps:

- If it is not already in that form, convert the Particle Size Distribution to a cumulative % by weight finer than any specified diameter.
- Find the derivative of the Particle Size Distribution.
- Multiply the derivative by the Cyclone Fractional Efficiency Curve.
- Integrate the resulting product from zero particle diameter to infinity to find Total Collection Efficiency.

Although the above process sounds straightforward, the product to be integrated does not, in fact, have a rational integral. The problem must therefore be solved by one of three techniques:

- Graphical methods, or;
- Express the product as an infinite series which can be integrated term by term, or;
- Find the integral of the product by Numerical Calculus.

The latter method lends itself ideally to the digital computer. Given the same data as outlined for the computation of the Fractional Efficiency Curve (see page 8), plus the Particle Size Distribution, we can calculate and report Total Collection Efficiency to you in just a few minutes.

However, in many cases, you may wish to make an approximate calculation of Total Collection Efficiency yourself. A method for doing so involves the use of an "Average Limit Particle," and its use permits you to examine the consequences of varying both the type of cyclone and the number in parallel that you are considering. You must be aware that this method is only an approximation. Its accuracy decreases in two cases:

- When the particle size distribution is very narrow. Much more accurate results are obtained if the distribution ranges, for example, between 1.0 and 100.0 microns than if all particles fall between 1.0 and 10.0 microns.
- The lower the Total Collection Efficiency (the finer the particulate), the lower the accuracy of this method.

The Average Limit Particle size is calculated by:

$$D_l = k\sqrt{\frac{\mu_g \times N^3}{\lambda_d \times Q}},$$

where D_l = Average Limit Particle, microns.
μ_g = Absolute viscosity of gas, lbs. (mass)/ft.—sec.
N = Cyclone size.
λ_d = Particulate specific gravity, or true particle density, grams/c.c.
Q = Volumetric gas flow rate, A.C.F.M.

k, a constant, is given in Table 1 for each family of cyclones in the XQ Series.

Table 1

Cyclone Family	XQ465	XQ405	XQ340	XQ240	XQ170	XQ120
k	1254 27	1069 19	923 120	741 378	621.110	543.522

The approximate Total Collection Efficiency is calculated by:

$$\varepsilon_t = 100.0 - f_l,$$

where ε_t = Approximate Total Collection Efficiency, % by weight.
f_l = The percent finer by weight, in the Particle Size Distribution at the Average Limit Particle Size.

Examples of Cyclone Calculations

Example #1

Given:

Q = 6,800 A.C.F.M.
Gas = Air at 460° F. and 14.7 p.s.i.a.
λ_g = 0.036 lbs./cu. ft.
$\mu_g = 1.76 \times 10^{5}$ lbs. (mass) ft.—sec.

Specifications:

v_i = 70. f.p.s., maximum
ΔP = 3.0 in. w.c., maximum

Calculations:

1. From Figure 1, smallest single cyclone at $v_i \leq 70$. f.p.s. is SIZE 22.
2. Allowable maximum pressure drop at specified conditions must be corrected to the gas density of air at 70°F. and 14.7 p.s.i.a., 0.075 lbs./cu. ft. $\Delta P_{(corr)} = 0.075 \times 3.0/0.036 = 6.25$ in. w.c.
3. From Figure 2, at $\Delta P_{(corr)}$ = 6.25 in. w.c., v_i = 53. f.p.s. The cyclone will have to be resized to this inlet velocity.
4. Returning to Figure 1, smallest single cyclone at v_i 53. f.p.s. is SIZE 25.

Example #2

Given:

Q = 12,500 A.C.F.M.
λ_g = 0.075 lbs./cu. ft.
$\mu_g = 1.2029 \times 10^{5}$ lbs. (mass)/ft.—sec.
λ_d = 3.15
Particle Size Distribution: See Figure 4.

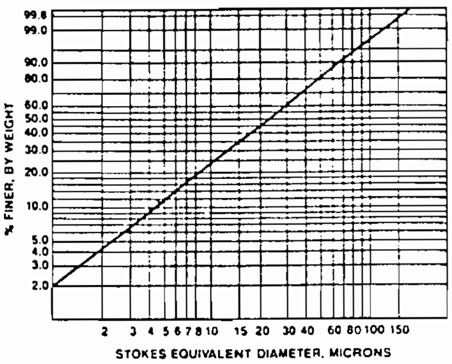
Specifications:

Required Total Efficiency by weight, ε_t = 86.5%
Maximum allowable pressure drop, ΔP = 7.5 in. w.c.
Maximum allowable inlet velocity, v_i = 55 f.p.s.

Calculations:

1. Assume cyclone will be type XQ340
2. From Figure 1 at v_i = 55 f.p.s., Size = 33
3. From Figure 2 at v_i = 55 f.p.s., ΔP = 6.8 in. w.c.
4. From Table 1, k = 923.120
5. By equation (1), $D_l = 923.120 \times \sqrt{\frac{1.2029 \times 10^{5} \times 33^3}{3.15 \times 12500}}$ = 3.06
6. From Figure 4, f_l = 7.1
7. By equation (2), $\varepsilon_t = 100.0 - 7.1$ $\underline{= 92.9\%}$

FIG. 4



A typical XQ Series Model Number and What it Means

$$\underbrace{\text{XQ465}}_{A}\text{-}\underbrace{20}_{B}\text{-}\underbrace{2}_{C}\text{-}\underbrace{\text{CR1}}_{D}$$

A. "XQ" *plus a 3-digit number* designates the family of the cyclone.

B. "-" *plus a number* designates the cyclone size which equals the height of the cyclone inlet in inches. This may be a 1- or 2-digit number, or a decimal.

C. "-" *plus an integer* indicates the number of cyclones in parallel that make up the complete collection system.

D. "-" *plus a special suffix* designates special construction features. Some examples are:

PV = Pressure Vessel
CR1 = 1-inch Castable Refractory Lining
CR2 = 2-Inch Castable Refractory Lining
RB3 = 3-Inch Refractory Brick Lining
RB9 = 9-Inch Refractory Brick Lining
C.5 = ½-Inch Alumina Ceramic Tile Lining
C1 = 1-Inch Alumina Ceramic Tile Lining

Use the above information when specifying your XQ Series Cyclone. In addition, orders should specify separately:

Material(s) of Construction or (if Fisher-Klosterman is to determine the materials) special construction considerations such as high abrasion or corrosive conditions.

Special Construction Features, such as:

Break-Apart Construction for installations requiring cleaning and maintenance.

Externally Replaceable Wear Plates/Sections or special linings for highly abrasive dusts.

Access Doors (not recommended for the active portion of the cyclone when collection performance is critical).

Explosion Reliefs for use with explosive dusts.

Plus a variety of other features demanded by the individual cyclone's application.

TECHNICAL SERVICES, INC.
ENVIRONMENTAL CONSULTANTS — INDUSTRIAL CHEMISTS
OFFICE 2471 SWAN ST. — P.O. BOX 52329
LABORATORIES 103-107 STOCKTON STREET
JACKSONVILLE, FLORIDA 32201
(904) 353-5761

Laboratory No. 61124

August 29, 1984

Sample of WOOD PELLETS

Date Received August 28, 1984

For STATE OF FLORIDA, DEPT. OF GENERAL SERVICES, BUREAU OF STANDARDS, LARSON BUILDING, ROOM 613, TALLAHASSEE, FLORIDA 32301

Marks: Attn: Mr. H. P. Barker, Jr., C.P.M. Chief

CERTIFICATE OF ANALYSIS OR TESTS

		BTU/lb.
1.		8188
2.		8160
3.		8183
4.		8244
5.		8240
	Average	8203

Respectfully submitted,

TECHNICAL SERVICES, INC.

BY Harvey C. Gray, Jr.

LABORATORY I.D. NO. 82145

HRS
STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

August 23, 1984

Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, Florida 32301

Attention: C. H. Fancy, P.E.

SUBJECT: Authorized Representative for Air Pollution Control - Boilers No. 7 and 8.

Dear Mr. Fancy,

In reference to your letter of August 15, 1984 this will notify you that Fred W. Dougherty, P.E. is authorized to represent Florida State Hospital as our Engineer with respect to air pollution control matters relating to boilers No. 7 and 8.

Sincerely,

William D. Myers

William D. Myers
Hospital Administrative Services Director

WDM/dk

Doris F. Kirkland
NOTARY

NOTARY PUBLIC, STATE OF FLORIDA AT LARGE
MY COMMISSION EXPIRES JAN. 9, 1987
BONDED THROUGH MUROSKI-ASHTON, INC

DISTRICT TWO • FLORIDA STATE HOSPITAL • CHATTAHOOCHEE, FLORIDA 32324

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

August 28, 1985

CERTIFIED MAIL - RETURN RECEIPT REQUESTED

Mr. William D. Myers
Administrative Services Director
Florida State Hospital
Highway 90
Chattahoochee, Florida 32324

Dear Mr. Myers:

Re: Extension of the Expiration Date of the Construction Permit: AC 20-49787

The department is in receipt of Mr. Stephen Helentjaris' letter dated August 7, 1985, in which you requested an extension of the expiration date. The bureau is in agreement with the request and the following shall be changed and added:

Expiration Date:

From: September 30, 1985
To: April 30, 1987

Attachments to be Incorporated:

18. Stephen Helentjaris' letter dated August 7, 1985.

This letter must be attached to your construction permit, AC 20-49787, and shall become a part of that permit.

Sincerely,

Victoria

Victoria J. Tschinkel
Secretary

VJT/ks

cc: Gary Early
Tom Moody
Jerry Neubauer
Tom Parker

enclosure

ATTACHMENT 18

HRS
STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

August 7, 1985

Mr. C. H. Fancy, P.E.
Deputy Chief
Bureau of Air Quality Management
Department of Environmental Regulation
Twin Towers Office Building
2600 Blairstone Road
Tallahassee, Florida 32301-8241

SUBJECT: Permit No. AC 20-49787
Florida State Hospital

Dear Mr. Fancy:

An appropriation was received July 1984, which will provide various improvements to the wood fuel utilization systems under the subject permit. The design phase is currently in progress. Based on the attached project schedule, we request an extension of the subject construction permit until February 28, 1987.

As a result of violations to permit No. IC 20-68122, we will de-activate the scrubber system for boilers 7 & 8 as indicated by tasks 1,2, and 3 on the attached schedule. Boilers 7 & 8 will burn only oil while the scrubber system is de-activated.

Please contact me if there are any questions.

Sincerely,

SAMarshall for

Stephen Helentjaris, P.E.
Medical Facilities Engineer

Copy to: Thomas W. Moody, P.E. w/attachment
Chuck Chapman, Florida State Hospital w/attachment
Stephen Poole, Department of General Services w attachment

SH/mmm

DER
AUG 12 1985
BAQM

1317 WINEWOOD BLVD. • TALLAHASSEE, FL 32301
BOB GRAHAM, GOVERNOR

Project Schedule
Boiler System Improvements
Project No. HRS-8432

Task	Completion Date
1. New Stacks Installed	September 9, 1985
2. Scrubber System De-activated	September 16, 1985
3. Scrubber Water Disposal	September 27, 1985
4. Design Development Phase	September 30, 1985
5. Construction Document Phase	January 9, 1986
6. Bidding	February 18, 1986
7. Construction Contract Awarded	February 28, 1986
8. Construction	October 21, 1986
9. System Start-up	November 21, 1986
10. Operating Permit Requested	November 21, 1986
11. Compliance Testing	December 18, 1986
12. Operating Permit Received	February 28, 1987

DOUGHERTY ENGINEERING CO.
318 Williams Street
TALLAHASSEE, FLORIDA 32303
(904) 681-0610

LETTER OF TRANSMITTAL

DATE November 9, 1984
JOB NO. 1001
ATTENTION Bruce Mitchell
RE Application to Operate/Construct Air Pollution Sources, Florida State Hospital, Boilers #7 and #8

TO Bruce Mitchell
2600 Blair Stone Road
Tallahassee, Florida 32301
Department of Environmental Regulation

WE ARE SENDING YOU ☒ Attached ☐ Under separate cover via ________ the following items:

☐ Shop drawings ☐ Prints ☐ Plans ☐ Samples ☐ Specifications
☐ Copy of letter ☐ Change order ☐ ________

COPIES	DATE	NO.	DESCRIPTION
1	11-6-84	17	Application - Wood Pulverizer Baghouse
1	11-6-84	17	Application - Dry Ash Collector Baghouse

THESE ARE TRANSMITTED as checked below:

☐ For approval ☐ Approved as submitted ☐ Resubmit ____ copies for approval
☒ For your use ☐ Approved as noted ☐ Submit ____ copies for distribution
☐ As requested ☐ Returned for corrections ☐ Return ____ corrected prints
☐ For review and comment ☐ ________
☐ FOR BIDS DUE ________ 19____ ☐ PRINTS RETURNED AFTER LOAN TO US

REMARKS ________

COPY TO ________

SIGNED:

If enclosures are not as noted, kindly notify us at once.

BEST AVAILABLE COPY

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

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

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

SOURCE TYPE: Air Pollution ☒ New[1] ☐ Existing[1]

APPLICATION TYPE: ☐ Construction ☐ Operation ☐ Modification

COMPANY NAME: Florida State Hospital COUNTY: Gadsden

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) Wood Pulverizer Baghouse Boilers #7 & #8

SOURCE LOCATION: Street U. S. Hwy 90 City Chattahoochee

UTM: East 707400M North 3398500M

Latitude 30 ° 42 ' 16 "N Longitude 84 ° 50 ' 10 "W

APPLICANT NAME AND TITLE: William D. Myers, Administrative Services Director

APPLICANT ADDRESS: Florida State Hospital, Chattahoochee, Florida 32324

SECTION I: STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

I am the undersigned owner or authorized representative* of Florida State Hospital

I certify that the statements made in this application for a Air Pollution 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: William D. Myers

William D. Myers, Administrative Services Director
Name and Title (Please Type)

Date: 11-06-84 Telephone No. (904)663-4311

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)

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

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

Signed ____________________

Fred W. Dougherty, P.E.
Name (Please Type)

Dougherty Engineering Company
Company Name (Please Type)

318 Williams Street, Tallahassee, FL 32303
Mailing Address (Please Type)

Florida Registration No. **15124** Date: ________ Telephone No. **(904)681-0610**

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.

Project consists of two boilers with steam capacity of 60,000 pph @ 415 psia, 575 deg F. Boilers fire pelletized wood and #6 oil in ratio 95/5 by weight. Stack emission control consists of wet scrubbers in series behind parallel dry cyclones. Cyclone ash is conveyed to a secondary cyclone and filter. Hoppers of dry (cont. nx pg

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

Start of Construction **Jan. 1982** Completion of Construction **Sept. 1985**

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.)

1,250,000 (scrubbers, new I.D. Fans, dry ash collection, pulverizer dust collection)

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

Construction Permit Number AC 20-49787 issued 1/24/83, expired 9/30/84. Previous operating permits for fossil fuels not available.

ash secondary collection discharge into closed container for disposal in land fill. Prior to firing, wood is pulverized. Dust from pulverizer is conveyed to cyclones and filter on powerhouse roof. All of the dust collected in these hoppers is injected into burner. Emission points are: two boilers stacks, one "dry ash" conveyor filter, and one pulverizer dust filter.

E. 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. No

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

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

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

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

   a. If yes, for what pollutants? ______

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

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

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

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

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

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)

Wood Dust (Pulverizer) Baghouse

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	
PM	.4	1.6	Visible	20% OPAC			④

[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 - Clark 4-15	Wood Dust	98.5	5-50	See Suppl.
Cyclone - Clark	Wood Dust	83	20-250	See Suppl.

E. Fuels **See Permit AC 20-49787 - No significant change**

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

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

Fuel Analysis:

Percent Sulfur: ______ Percent Ash: ______

Density: ______ lbs/gal Typical Percent Nitrogen: ______

Heat Capacity: ______ BTU/lb ______ BTU/gal

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

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

Annual Average ______ Maximum ______

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

BEST AVAILABLE COPY

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

Description of Waste ______________________________

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

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

Manufacturer ______________________________

Date Constructed ______________ Model No. ______________

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

Stack Height: __________ ft. Stack Diamter: ______________ Stack Temp. __________

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

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

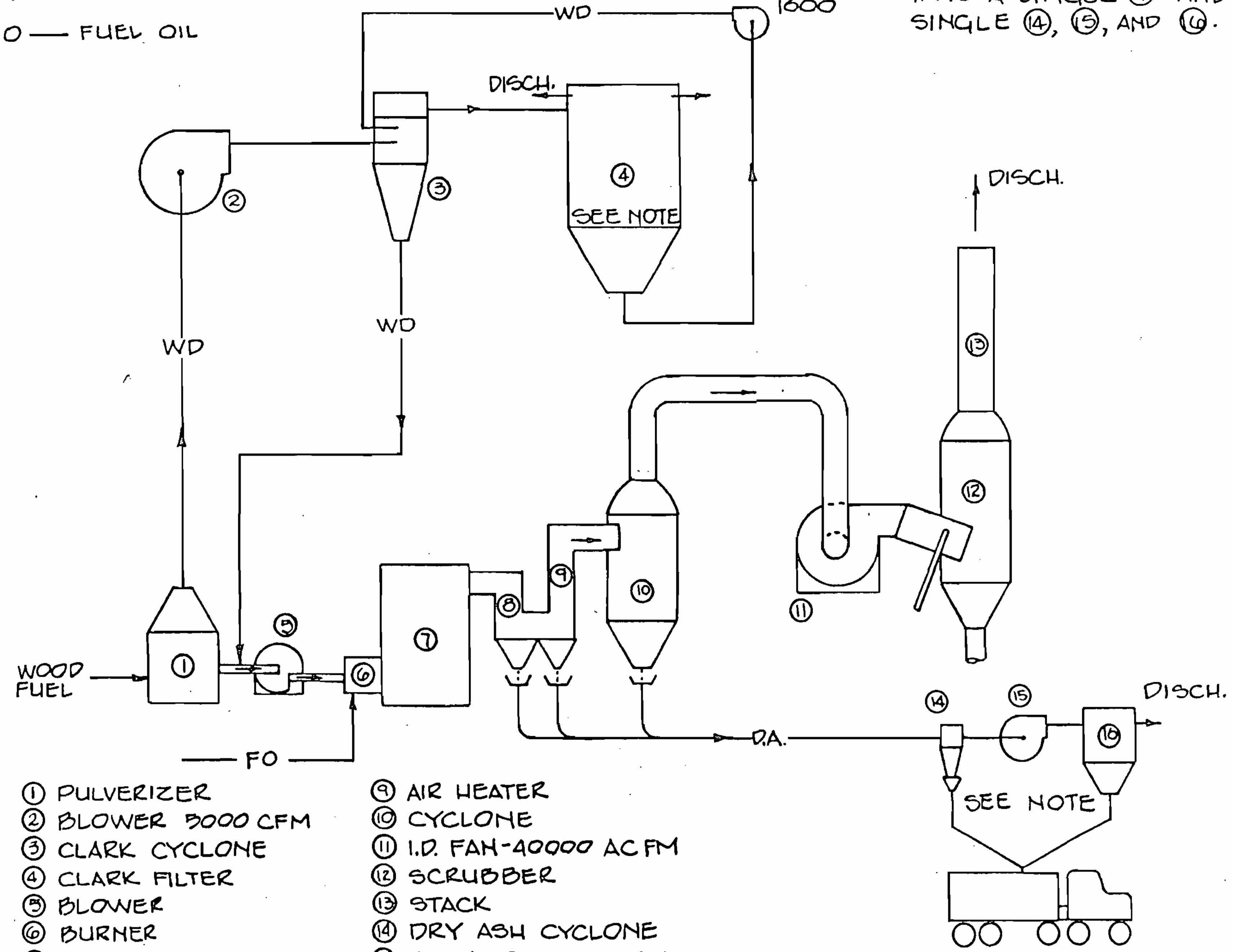
Type of pollution control device: ☐ Cyclone ☐ Wet Scrubber ☐ Afterburner

☐ Other (specify) ______________________________

BOILER FLOW DIAGRAM
BOILER NO. 7 OR NO. 8

LEGEND
—— DA —— DRY ASH
—— WD —— WOOD DUST
—— FO —— FUEL OIL

NOTE: BOTH BOILERS DISCHARGE INTO A SINGLE ④ AND A SINGLE ⑭, ⑮, AND ⑯.



① PULVERIZER
② BLOWER 5000 CFM
③ CLARK CYCLONE
④ CLARK FILTER
⑤ BLOWER
⑥ BURNER
⑦ BOILER
⑧ DOWNPASS
⑨ AIR HEATER
⑩ CYCLONE
⑪ I.D. FAN-40000 ACFM
⑫ SCRUBBER
⑬ STACK
⑭ DRY ASH CYCLONE
⑮ BLOWER 3500 CFM
⑯ FARR FILTER

FWD/VMR

DOUGHERTY ENGINEERING COMPANY, INC.
TALLAHASSEE, FLORIDA

JOB 1001 Boilers 7 & 8, FSH
SHEET NO. 1 OF 5
CALCULATED BY FWD DATE 10-4-84
CHECKED BY DATE
SCALE

CONSTRUCTION PERMIT MODIFICATION AND EXTENSION

Reference: 1. Permit Number AC 20-49787, dated November 3, 1983

2. "Technical Evaluation and Preliminary Determination", Florida State Hospital, Gadsden County, Chattahoochee, Florida, Nos 7 and 8 Boiler Conversion, Permit Number AC 20-49787

I. Steam side conditions - both boilers:

steam header press = 415 psia
" " temp = 575 °F
h_{out} = 1290 Btu/lb
Feedwater temp. = 300 °F
hin = 270 Btu/lb

II. Heat Input:

Efficiency on #6 F.O. by ASME short form (ref applications dated March 9, 1979)

Boiler # 7	87.93%
Boiler # 8	88.08%
ave	88.00%

$$\text{Btu/hr heat input} = \frac{60{,}000 \text{ lbs/hr} \times (1290-270) \text{ Btu/lb}}{.88}$$

$= 69.5 \times 10^6$ B/h. each boiler

JOB 1001 Boilers #7 & #8 FS
SHEET NO. 2 OF 5
CALCULATED BY ______ DATE ______
CHECKED BY ______ DATE ______
SCALE ______

III Fuel Input - each boiler

A. 12% #6 F.O. 88% pelletized wood by heat content

Total F.O. heat input = .12 x 69.5 = 8.34×10^6 B/h

Total wood heat input = .88 x 69.5 = 61.16×10^6 B/h

F.O. input = $\frac{8.34 \times 10^6}{1.5355 \times 10^5}$ = 54.3 gallons per hour

wood input = $\frac{61.16 \times 10^6}{8.2 \times 10^3}$ = 7,486 lbs/hr

see attached test report for backup
of wood heat value = 8,200 Btu/lb.

B. 100% #6 F.O.

F.O. Input = $\frac{69.5 \times 10^6}{1.5355 \times 10^5}$ = 452.6 gph

IV SO_2 Emissions - Each Boiler

A. 12% #6 F.O. 88% pelletized wood

WP - AP42 Tab 1.6-1, 1.5 lbs SO_2/ton wood
FO - stoichiometric, 2.5% by weight: 400 lbs/1000 gal

7,486 x 1.5/2000 = 5.61 lbs/hr
54.3 x 400/1000 = 21.72 lbs/hr
27.33 119.7 TPY

B. 100% #6 F.O.

452.6 x 400/1000 = 181.04 793.0 TPY

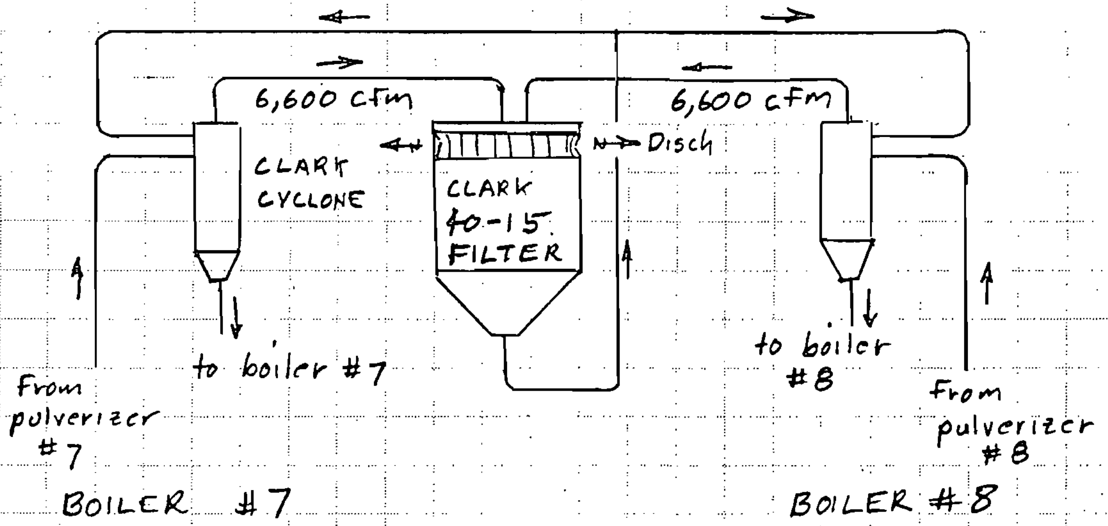
DOUGHERTY ENGINEERING COMPANY, INC.
TALLAHASSEE, FLORIDA

JOB 1001 Boilers #7 & #8 FSH
SHEET NO. 3 OF 5
CALCULATED BY FWD DATE
CHECKED BY DATE
SCALE

V Particle Emissions – Baghouses

A. Diagrams

1. Wood Pulverizer Baghouse

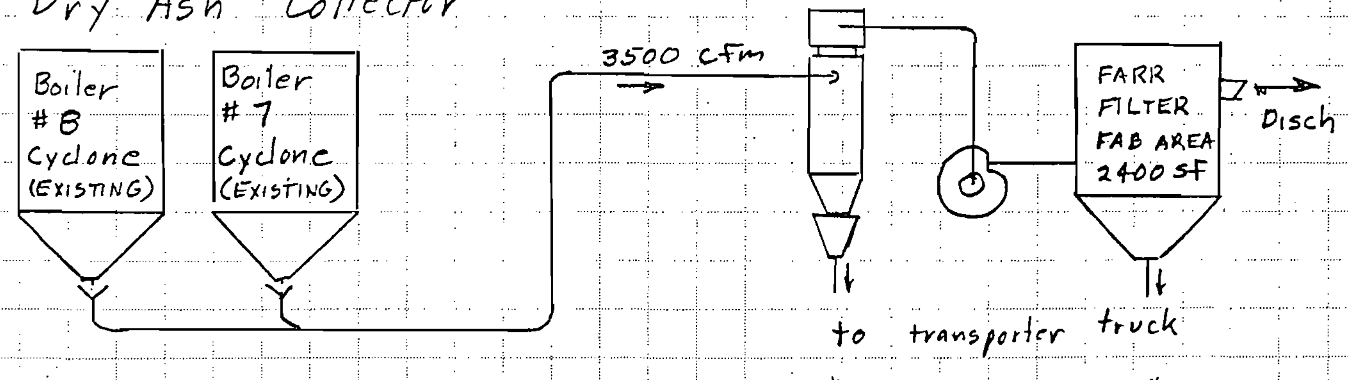


TOTAL AIR FLOW INTO FILTER 13,200 cfm

CYCLONES: CLARK MEDIUM EFFICIENCY, HIGH THROUGH-FLOW, 6' CONE, P.D. 4.5" W.C. @ 6,600 cfm

FILTER: CLARK 40-15, 1915 sf cloth area, air-to-cloth ratio 5.2 cfm/sf

2. Dry Ash Collector



CYCLONE: FISCHER-KLOSTERMAN XQ-465-19 "HIGH EFFICIENCY"

FILTER: FARR "TENKAY" SIZE 12, AIR TO FABRIC RATIO = 3500/2400 = 1.5

JOB Boilers 7 & 8 [illegible]
SHEET NO. 4 OF 5
CALCULATED BY ______ DATE 9-13-84
CHECKED BY ______ DATE ______
SCALE ______

B. WOOD DUST COLLECTOR

Emmission from filter (each boiler)

$$\dot{W}_{EWD} = \dot{W}_{WF} \times a \times \frac{(1 - \eta_{WDC})}{100} \times \frac{(1 - \eta_{WDF})}{100}$$

$\dot{W}_{WF}$ = MAXIMUM WOOD FUEL FEED RATE, lbs/hr
a = ENGINEER'S ESTIMATE OF FRACTION OF WOOD FUEL COLLECTED AS DUST
η_{WDF} = EFFICIENCY OF WOOD DUST FILTER
η_{WDC} = EFFICIENCY OF WOOD DUST CYCLONE

Filter Efficiency (Based on Figure 11-1 Industrial Ventilation Manual):

Estimated a	2%
Ave Particle size entering cyclone (est)	50μ
cyclone efficiency (Fig 11-3 IVM)	83%
Ave Particle size entering Filter	10μ
Filter efficiency	98.5%

1 $\dot{W}_{EWD}$ = (7,486) × .02 × .17 × .015 = .38 lbs/hr

×4.38 => 1.7 TPY (1.6644)

C. DRY ASH COLLECTOR

1. TOTAL AIR FLOW 3,500 cfm

2. CYCLONE Fisher-Klosterman XQ 465-19

cyclone efficiency:

$$\eta_{ac} = 100 - F_1$$

$$F_1 = F(D)$$

1 Rev 10-3-85

DOUGHERTY ENGINEERING COMPANY, INC.

TALLAHASSEE, FLORIDA

JOB Boilers 7 & 8 Calculations

SHEET NO. 5 OF 5

CALCULATED BY ______ DATE 9-13-84

CHECKED BY ______ DATE ______

SCALE ______

C. DRY ASH COLLECTOR (CONT)

$$D = f(\lambda, \mu_g, N^3, \lambda_d, Q)$$

See attached excerpt pg 8 and 9 for further details of calculation procedure

$Q = 3500$ cfm $\qquad \mu_g = 1.28 \times 10^{-5}$ lbs/ft^3

$\lambda_d = 1.7$

$N = 19$

$D = 4.8 \qquad f_1 = 11 \qquad \eta_{ac} = 89\%$

3. Baghouse is Farr "TENKAY" size 12, Fabric area 2400 sf

air to fabric ratio 1.5

baghouse efficiency, estimated 5μ average particle size: 99% (Industrial Ventilation Handbook, Fig 11-1) $\eta_{aF} = 99\%$

4. Emission

$$\dot{W}_{EDA} = \dot{W}_{da} \times \frac{(1 - \eta_{ac})}{100} \times \frac{(1 - \eta_{aF})}{100}$$

$\dot{W}_{da}$ = estimated rate of generation of dry ash. Based on operations to date, this is 225 lbs/hr per boiler.

$\dot{W}_{eda} = \left[\left[2a\,225\right] \times .11\right] \times .01 = .25$ lbs/hr

0.495 x 4.38 ⇒ 2.2 TPY (2.1681)

Technical Guide to the Selection of Fisher-Klosterman XQ Series High-Performance Cyclones

This section is intended for use by the Application Engineer in specifying the correct XQ Series Cyclone for his needs. Naturally, Fisher-Klosterman will be happy to provide all the assistance needed, or to undertake the complete engineering project, if desired.

Selection Factors

Three factors must be considered in selecting a cyclone for any application:

1. Inlet Velocity
2. Pressure Loss
3. Collection Efficiency.

Proper calculation of these variables insures the selection of an XQ Series Cyclone that will perform with maximum efficiency and cost effectiveness.

Inlet Velocity

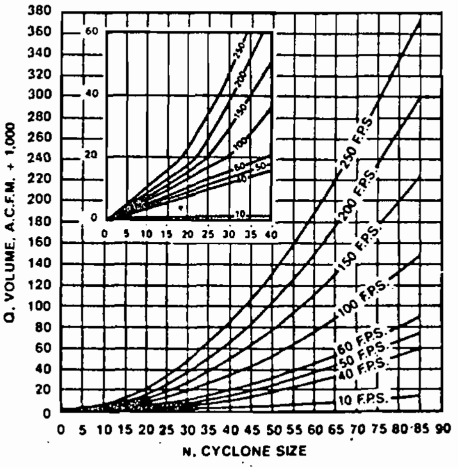
Most cyclone literature assumes an inlet velocity range from 20 to 100 feet per second. Most industrial applications have historically fallen in the 40 to 60 f.p.s. range. However, the range you consider need not be so narrow. Extensive testing and field experience have shown that Fisher-Klosterman XQ Series Cyclones perform predictably at velocities as low as 10 f.p.s. and well beyond 150 f.p.s.

The choice of inlet velocity is generally dictated by the aerodynamic characteristics of the particulates to be collected and the possibility of abrasion, as well as available space, equipment cost and power consumption.

Figure 1 shows the relationship between cyclone size (N), volumetric gas flow rate (Q) in ACFM, and inlet velocity (v_i) in f.p.s.

Application Engineers should consider that collection efficiency will increase as a complex exponential function of the inlet velocity. (This will be discussed in greater detail in a later section on collection efficiency.) Power consumption will increase approximately as the square of the inlet velocity. When abrasion is not a significant factor, these two criteria alone will determine the proper cyclone for the intended application.

FIG. 1

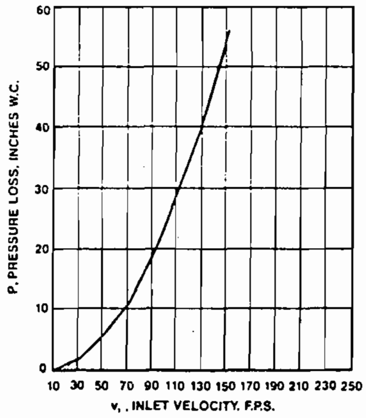


Pressure Loss

Energy is consumed in the passage of the gas through the cyclone. This is expressed as the pressure drop between the gas inlet and gas outlet of the cyclone, and is usually measured in inches of water column (in. w.c.). In any cyclone, the pressure loss increases approximately as the square of either the volumetric flow rate (Q) or the inlet velocity (v_i), and directly as the density (λ_g) of the gas.

Figure 2 shows the relationship between inlet velocity (v_i) and pressure loss (ΔP) in an XQ Series Cyclone with air at 70°F and 14.7 p.s.i.a.

FIG. 2



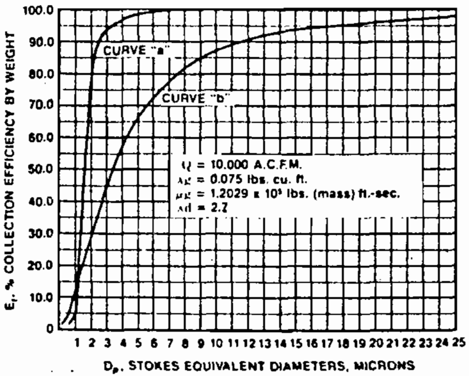
Fractional Efficiency

Efficiency is expressed in percentage by weight. In the Fractional or Particle Size or Grade Efficiency (E_f) Curve, the independent variable is the Stokes Equivalent Particle Diameter (D_p), in microns. The curve is a complex exponential function of:

1. inlet velocity (v_i) and absolute gas viscosity (μ_g).
2. particle mass, particle size, shape and surface roughness, usually measured as terminal velocity, feet/sec., in still air, and expressed as Stokes Equivalent Diameters (D_p) in microns.
3. cyclone size and proportions (shape).

Figure 3 illustrates two cyclone fractional efficiency curves. Each is for a single cyclone. Both are plotted at identical conditions: gas flow rates, densities and absolute viscosities are equal, as are cyclone pressure drops and particle density for both cyclones. Curve "a" is for an XQ120 cyclone, and Curve "b" is for an XQ465.

FIG. 3



Manual calculation of a fractional efficiency curve for just a single case is a complex and tedious problem, even for an experienced engineer. Fisher-Klosterman, however, has reduced this task to simplicity itself by the use of the digital computer. To determine a fractional efficiency curve, the following data are required:

- Volumetric gas flow rate, A.C.F.M., Q
- Gas density, lbs./cu. ft., λ_g
- Gas absolute viscosity, lbs. (mass)/ft.—sec., μ_g
- Particle specific gravity (dimensionless), or true particle density, gms/c.c., λ_d

If gas density and viscosity are not known, the gas analysis plus its temperature and pressure should be specified. Also, to aid in the selection of the best and most economical cyclone for your needs, either or both of the following should be specified:

- Maximum pressure drop, inches w.c.
- Desired efficiency at some specified particle size.

Helpful, but not mandatory, the following data should be furnished if available:

- Dust fineness, typically expressed as % by weight finer than 1.5 microns
- Inlet dust loading, grains/A.C.F.

With this information, our experienced application engineers can provide complete computer-calculated fractional efficiency curves in a matter of minutes.

Total Efficiency

Total Collection Efficiency (E_t) is defined as the percent by weight of the gas-borne particulate separated by the cyclone. To calculate Total Efficiency, not only must the Fractional Efficiency curve of the cyclone be known, but also the size distribution of the particulate.

The independent variable in the particle size distribution should be Stokes Equivalent Diameters, usually expressed in microns (one-millionth of a meter). This is a hypothetical aerodynamic diameter which accounts for the size, shape, mass and texture of the particle.

One word of caution: Optical techniques, screening, analytical instrumentation which measures particle size by determining the amount of liquid a particle displaces and other non-standardized methods do not give data which can be used with any degree of confidence or accuracy in calculating cyclone performance. If you have any doubts about your data, you should utilize our laboratory services. (See page 3).

The dependent variable in the Particle Size Distribution is generally expressed as "percent by weight finer" than a specified Stokes Equivalent Diameter in microns. Equally usable is data specifying the percent by weight falling in the range between two specified diameters.

The calculation of Total Efficiency involves the following steps:

- If it is not already in that form, convert the Particle Size Distribution to a cumulative % by weight finer than any specified diameter.
- Find the derivative of the Particle Size Distribution.
- Multiply the derivative by the Cyclone Fractional Efficiency Curve.
- Integrate the resulting product from zero particle diameter to infinity to find Total Collection Efficiency.

Although the above process sounds straightforward, the product to be integrated does not, in fact, have a rational integral. The problem must therefore be solved by one of three techniques:

- Graphical methods, or;
- Express the product as an infinite series which can be integrated term by term, or;
- Find the integral of the product by Numerical Calculus.

The latter method lends itself ideally to the digital computer. Given the same data as outlined for the computation of the Fractional Efficiency Curve (see page 8), plus the Particle Size Distribution, we can calculate and report Total Collection Efficiency to you in just a few minutes.

However, in many cases, you may wish to make an approximate calculation of Total Collection Efficiency yourself. A method for doing so involves the use of an "Average Limit Particle," and its use permits you to examine the consequences of varying both the type of cyclone and the number in parallel that you are considering. You must be aware that this method is only an approximation. Its accuracy decreases in two cases:

- When the particle size distribution is very narrow. Much more accurate results are obtained if the distribution ranges, for example, between 1.0 and 100.0 microns than if all particles fall between 1.0 and 10.0 microns.
- The lower the Total Collection Efficiency (the finer the particulate), the lower the accuracy of this method.

The Average Limit Particle size is calculated by:

$$D_l = k\sqrt{\frac{\mu_g \times N^3}{\lambda_d \times Q}},$$

where D_l = Average Limit Particle, microns.

μ_g = Absolute viscosity of gas, lbs. (mass)/ft.—sec.

N = Cyclone size.

λ_d = Particulate specific gravity, or true particle density, grams/c.c.

Q = Volumetric gas flow rate, A.C.F.M.

k, a constant, is given in Table 1 for each family of cyclones in the XQ Series.

Table 1

Cyclone Family	XQ465	XQ405	XQ340	XQ240	XQ170	XQ120
k	1254.27	1069 19	923.120	741.378	621.110	543.522

The approximate Total Collection Efficiency is calculated by:

$$\varepsilon_t = 100.0 - f_l,$$

where ε_t = Approximate Total Collection Efficiency, % by weight.

f_l = The percent finer by weight, in the Particle Size Distribution at the Average Limit Particle Size.

Examples of Cyclone Calculations

Example #1

Given:

Q = 6,800 A.C.F.M.

Gas = Air at 460° F. and 14.7 p.s.i.a.

λ_g = 0.036 lbs./cu. ft.

$\mu_g = 1.76 \times 10^{-5}$ lbs. (mass)/ft.—sec.

Specifications:

v_i = 70. f.p.s., maximum

ΔP = 3.0 in. w.c., maximum

Calculations:

1. From Figure 1, smallest single cyclone at $v_i \leq 70.$ f.p.s. is SIZE 22.
2. Allowable maximum pressure drop at specified conditions must be corrected to the gas density of air at 70° F. and 14.7 p.s.i.a., 0.075 lbs./cu. ft. $\Delta P_{(corr)} = 0.075 \times 3.0/0.036 = 6.25$ in. w.c.
3. From Figure 2, at $\Delta P_{(corr)} = 6.25$ in. w.c., v_i = 53. f.p.s. The cyclone will have to be resized to this inlet velocity.
4. Returning to Figure 1, smallest single cyclone at v_i 53. f.p.s. is SIZE 25.

Example #2

Given:

Q = 12,500 A.C.F.M.

λ_g = 0.075 lbs./cu. ft.

$\mu_g = 1.2029 \times 10^{-5}$ lbs. (mass)/ft.—sec.

λ_d = 3.15

Particle Size Distribution: See Figure 4.

Specifications:

Required Total Efficiency by weight, ε_t = 86.5%

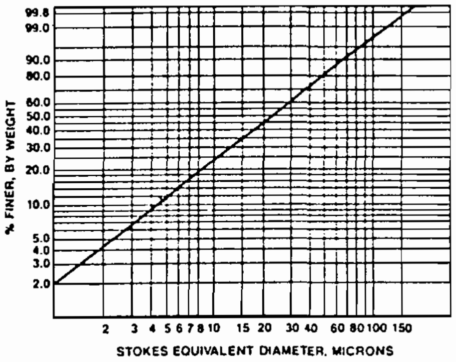
Maximum allowable pressure drop, ΔP = 7.5 in. w.c.

Maximum allowable inlet velocity, v_i = 55 f.p.s.

Calculations:

1. Assume cyclone will be type XQ340
2. From Figure 1 at v_i = 55 f.p.s., Size = 33
3. From Figure 2 at v_i = 55 f.p.s., ΔP = 6.8 in. w.c.
4. From Table 1. k = 923.120
5. By equation (1).
   $$D_l = 923.120 \times \sqrt{\frac{1.2029 \times 10^{-5} \times 33^3}{3.15 \times 12500}}$$
   $= 3.06$
6. From Figure 4, f_l = 7.1
7. By equation (2), $\varepsilon_t = 100.0 - 7.1$
   $= \underline{92.9\%}$

FIG. 4



A typical XQ Series Model Number and What it Means

$$\underbrace{\text{XQ465}}_{A}\text{-}\underbrace{\text{20}}_{B}\text{-}\underbrace{\text{2}}_{C}\text{-}\underbrace{\text{CR1}}_{D}$$

A. "XQ" *plus a 3-digit number* designates the family of the cyclone.

B. "-" *plus a number* designates the cyclone size which equals the height of the cyclone inlet in inches. This may be a 1- or 2-digit number, or a decimal.

C. "-" *plus an integer* indicates the number of cyclones in parallel that make up the complete collection system.

D. "-" *plus a special suffix* designates special construction features. Some examples are:

PV	= Pressure Vessel
CR1	= 1-inch Castable Refractory Lining
CR2	= 2-Inch Castable Refractory Lining
RB3	= 3-Inch Refractory Brick Lining
RB9	= 9-Inch Refractory Brick Lining
C.5	= ½-Inch Alumina Ceramic Tile Lining
C1	= 1-Inch Alumina Ceramic Tile Lining

Use the above information when specifying your XQ Series Cyclone. In addition, orders should specify separately:

Material(s) of Construction or (if Fisher-Klosterman is to determine the materials) special construction considerations such as high abrasion or corrosive conditions.

Special Construction Features, such as:

Break-Apart Construction for installations requiring cleaning and maintenance.

Externally Replaceable Wear Plates/Sections or special linings for highly abrasive dusts.

Access Doors (not recommended for the active portion of the cyclone when collection performance is critical).

Explosion Reliefs for use with explosive dusts.

Plus a variety of other features demanded by the individual cyclone's application.

TECHNICAL SERVICES, INC.
ENVIRONMENTAL CONSULTANTS — INDUSTRIAL CHEMISTS
OFFICE 2471 SWAN ST. — P.O. BOX 52329
LABORATORIES 103-107 STOCKTON STREET
JACKSONVILLE, FLORIDA 32201
(904) 353-5761

Laboratory No. 61124

August 29, 1984

Sample of WOOD PELLETS

Date Received August 28, 1984

For STATE OF FLORIDA, DEPT. OF GENERAL SERVICES, BUREAU OF STANDARDS,
LARSON BUILDING, ROOM 613, TALLAHASSEE, FLORIDA 32301

Marks: Attn: Mr. H. P. Barker, Jr., C.P.M. Chief

CERTIFICATE OF ANALYSIS OR TESTS

	BTU/lb.
1.	8188
2.	8160
3.	8183
4.	8244
5.	8240
Average	8203

Respectfully submitted,

TECHNICAL SERVICES, INC.

BY Henry C. Gray, Jr.

LABORATORY I.D. NO. 82145

STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

August 23, 1984

Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, Florida 32301

Attention: C. H. Fancy, P.E.

SUBJECT: Authorized Representative for Air Pollution Control - Boilers No. 7 and 8.

Dear Mr. Fancy,

In reference to your letter of August 15, 1984 this will notify you that Fred W. Dougherty, P.E. is authorized to represent Florida State Hospital as our Engineer with respect to air pollution control matters relating to boilers No. 7 and 8.

Sincerely,

William D. Myers

William D. Myers
Hospital Administrative Services Director

WDM/dk

Doris J. Kirkland
NOTARY

NOTARY PUBLIC, STATE OF FLORIDA AT LARGE
MY COMMISSION EXPIRES JAN. 9, 1987
BONDED THROUGH MUROSKI-ASHTON, INC

DISTRICT TWO • FLORIDA STATE HOSPITAL • CHATTAHOOCHEE, FLORIDA 32324
BOB GRAHAM, GOVERNOR

BEST AVAILABLE COPY

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

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

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

SOURCE TYPE: Air Pollution [X] New[1] [ ] Existing[1]

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

COMPANY NAME: Florida State Hospital COUNTY: Gadsden

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) Dry Ash Collector Baghouse Boilers #7 & #8

SOURCE LOCATION: Street U. S. Hwy 90 City Chattahoochee

UTM: East 707400M North 3398500M

Latitude 30° 42' 16" N Longitude 84° 50' 10" W

APPLICANT NAME AND TITLE: William D. Myers, Administrative Services Director

APPLICANT ADDRESS: Florida State Hospital, Chattahoochee, Florida 32324

SECTION I: STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

I am the undersigned owner or authorized representative* of Florida State Hospital

I certify that the statements made in this application for a Air Pollution 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: William D. Myers

William D. Myers, Administrative Services Director
Name and Title (Please Type)

Date: 11-26-84 Telephone No. (904)663-4311

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

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

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

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

Signed:

Fred W. Dougherty, P.E.
Name (Please Type)

Dougherty Engineering Company
Company Name (Please Type)

318 Williams Street, Tallahassee, FL 32303
Mailing Address (Please Type)

Florida Registration No. **15124** Date: Telephone No. **(904)681-0610**

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.

Project consists of two boilers with steam capacity of 60,000 pph @ 415 psia, 575 deg F. Boilers fire pelletized wood and #6 oil in ratio 95/5 by weight. Stack emission control consists of wet scrubbers in series behind parallel dry cyclones. Cyclone ash is conveyed to a secondary cyclone and filter. Hoppers of dry (cont. nx pg.)

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

Start of Construction **Jan. 1982** Completion of Construction **Sept. 1985**

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.)

1,250,000 (scrubbers, new I.D. Fans, dry ash collection, pulverizer dust collection)

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

Construction Permit Number AC 20-49787 issued 1/24/83, expired 9/30/84. Previous operating permits for fossil fuels not available.

ash secondary collection discharge into closed container for disposal in land fill. Prior to firing, wood is pulverized. Dust from pulverizer is conveyed to cyclones and filter on powerhouse roof. All of the dust collected in these hoppers is injected into burner. Emission points are: two boilers stacks, one "dry ash" conveyor filter, and one pulverizer dust filter.

E. 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. No
3. Does the State "Prevention of Significant Deterioriation" (PSD) requirement apply to this source? If yes, see Sections VI and VII. No
4. Do "Standards of Performance for New Stationary Sources" (NSPS) apply to this source? No
5. Do "National Emission Standards for Hazardous Air Pollutants" (NESHAP) apply to this source? No

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

- a. If yes, for what pollutants? ______
- b. If yes, in addition to the information required in this form, any information requested in Rule 17-2.650 must be submitted.

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

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

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

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

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)

Dry Ash Collector Baghouse

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	
PM	125	1.0	Visible	20% OPAC			⑯

---

[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 - Farr Tenday 12	**Dry Ash**	**99**	**5-10**	**See Supl.**
Cyclone - FC XQ 465-19	**Dry Ash**	**89**	**8-100**	**See Suppl.**

E. Fuels **See Permit AC-20-49787 - No significant change**

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

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

Fuel Analysis:

Percent Sulfur: ____________ Percent Ash: ____________

Density: ____________ lbs/gal Typical Percent Nitrogen: ____________

Heat Capacity: ____________ BTU/lb ____________ BTU/gal

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

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

Annual Average ____________ Maximum ____________

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

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							
Uncontrolled (lbs/hr)							

Description of Waste ______________________________

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

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

Manufacturer ______________________________

Date Constructed ______________ Model No. ______________

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

Stack Height: __________ ft. Stack Diamter: ______________ Stack Temp. __________

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

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

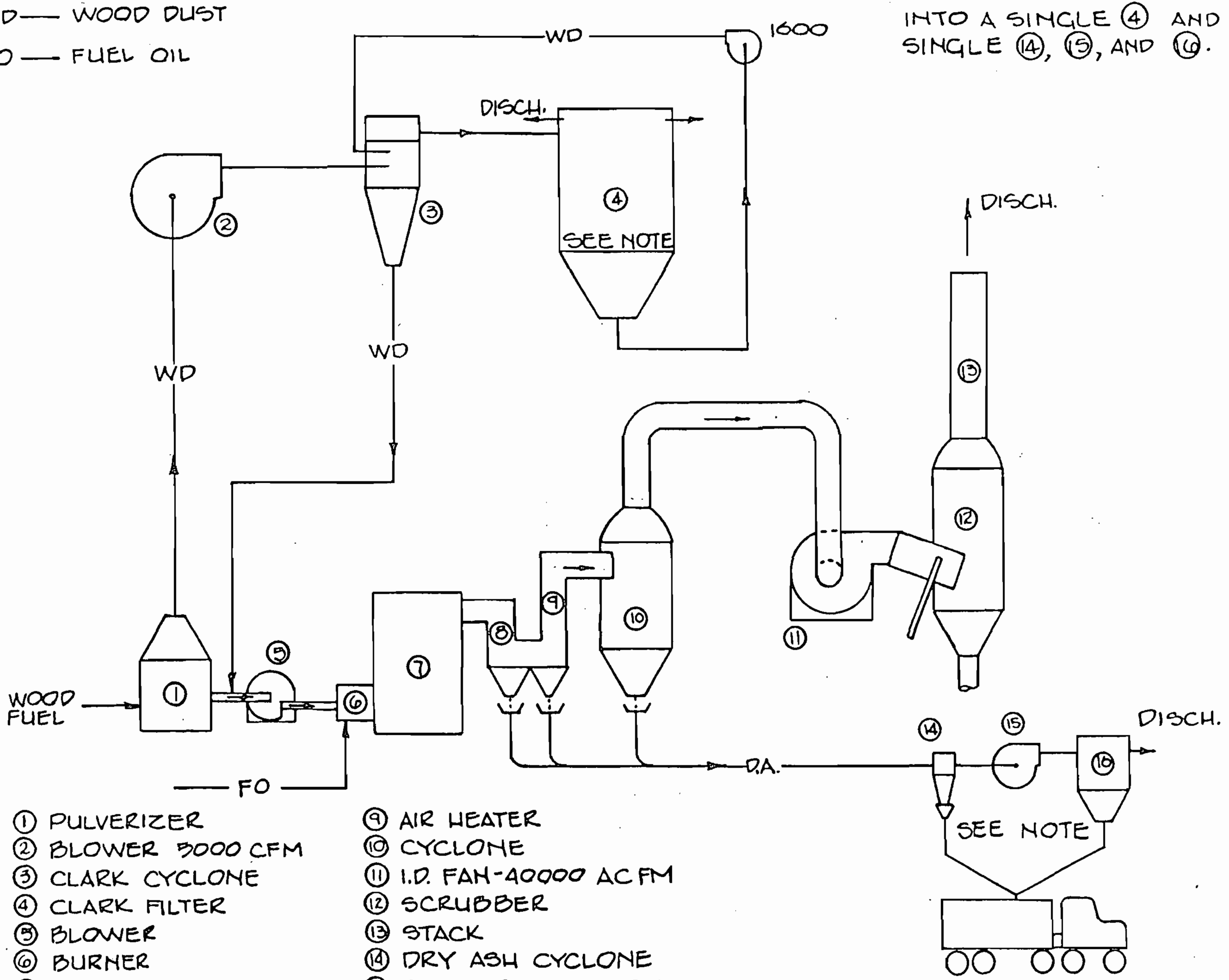
Type of pollution control device: [ ] Cyclone [ ] Wet Scrubber [ ] Afterburner

[ ] Other (specify) ______________________________

BOILER FLOW DIAGRAM
BOILER NO. 7 OR NO. 8

LEGEND
—— DA —— DRY ASH
—— WD —— WOOD DUST
—— FO —— FUEL OIL

NOTE: BOTH BOILERS DISCHARGE INTO A SINGLE ④ AND A SINGLE ⑭, ⑮, AND ⑯.



① PULVERIZER
② BLOWER 3000 CFM
③ CLARK CYCLONE
④ CLARK FILTER
⑤ BLOWER
⑥ BURNER
⑦ BOILER
⑧ DOWNPASS
⑨ AIR HEATER
⑩ CYCLONE
⑪ I.D. FAN-40000 ACFM
⑫ SCRUBBER
⑬ STACK
⑭ DRY ASH CYCLONE
⑮ BLOWER 3500 CFM
⑯ FARR FILTER

FWD/VMR
[illegible]

DOUGHERTY ENGINEERING COMPANY, INC.

TALLAHASSEE, FLORIDA

JOB 1001 Boilers 7 & 8, FSH

SHEET NO. 1 OF 5

CALCULATED BY FWD DATE 10-4-84

CHECKED BY DATE

SCALE

CONSTRUCTION PERMIT MODIFICATION AND EXTENSION

Reference: 1. Permit Number AC 20-49787, dated November 3, 1983

2. "Technical Evaluation and Preliminary Determination", Florida State Hospital, Gadsden County, Chattahoochee, Florida, Nos 7 and 8 Boiler Conversion, Permit Number AC 20-49787

I. Steam side conditions - both boilers:

steam header press = 415 psia
" " temp = 575 °F
h_{out} = 1290 Btu/lb
Feedwater temp. = 300 °F
h_{in} = 270 Btu/lb

II. Heat Input:

Efficiency on #6 F.O. by ASME short form (ref applications dated March 9, 1979)

Boiler # 7	87.93 %
Boiler # 8	88.08 %
ave	88.00 %

$$\text{Btu/hr heat input} = \frac{60{,}000 \text{ lbs/hr} \times (1290 - 270) \text{ Btu/lb}}{.88}$$

$$= 69.5 \times 10^6 \text{ B/h. each boiler}$$

PRODUCT 204-1 NEBS Inc., Groton, Mass. 01471.

DOUGHERTY ENGINEERING COMPANY, INC.
TALLAHASSEE, FLORIDA

JOB 1001 Boilers #7 & #8 FSH
SHEET NO. 2 OF 5
CALCULATED BY ______ DATE ______
CHECKED BY ______ DATE ______
SCALE ______

III Fuel Input - each boiler

A. 12% #6 F.O. 88% pelletized wood by heat content

Total F.O. heat input = .12 x 69.5 = 8.34×10^6 B/h

Total wood heat input = .88 x 69.5 = 61.16×10^6 B/h

F.O. input = $\frac{8.34 \times 10^6}{1.5355 \times 10^5}$ = 54.3 gallons per hour

wood input = $\frac{61.16 \times 10^6}{8.2 \times 10^3}$ = 7,486 lbs/hr

see attached test report for backup of wood heat value = 8,200 Btu/lb.

B. 100% #6 F.O.

F.O. Input = $\frac{69.5 \times 10^6}{1.5355 \times 10^5}$ = 452.6 gph

IV SO_2 Emissions - Each Boiler

A. 12% #6 F.O. 88% pelletized wood

WP - AP42 Tab 1.6-1, 1.5 lbs SO_2/ton wood
FO - stoichiometric, 2.5% by weight: 400 lbs/1000 gal

7,486 x 1.5/2000 = 5.61 lbs/hr
54.3 x 400/1000 = 21.72 lbs/hr
27.33 119.7 TPY

B. 100% #6 F.O.

452.6 x 400/1000 = 181.04 793.0 TPY

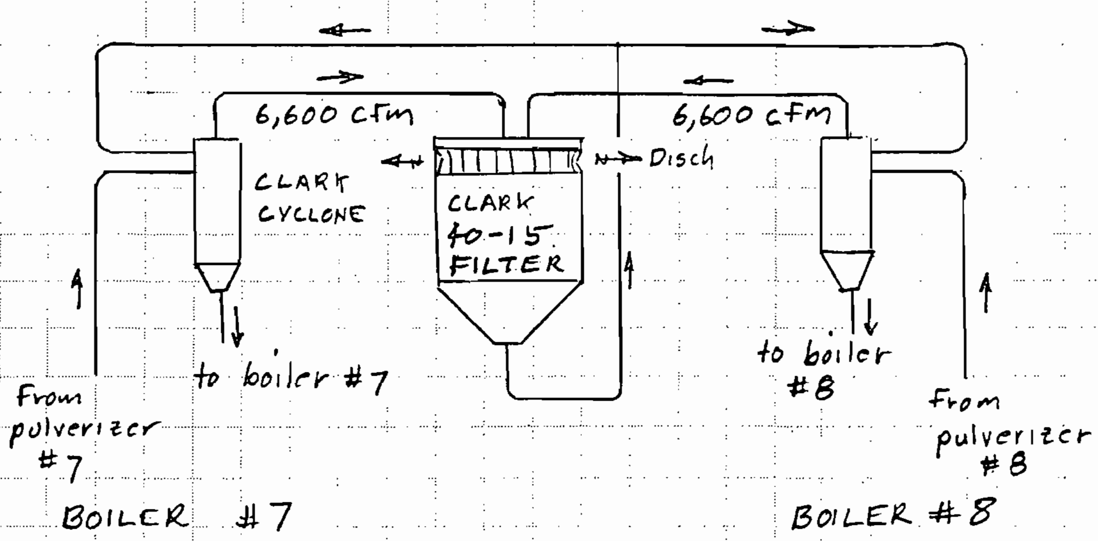
PRODUCT 204-1 NEBS Inc., Groton, Mass. 01471.

JOB 1001 Boilers #7 & #8 FSH
SHEET NO. 3 OF 5
CALCULATED BY FWD DATE
CHECKED BY DATE
SCALE

V Particle Emissions – Baghouses

A. Diagrams

1. Wood Pulverizer Baghouse

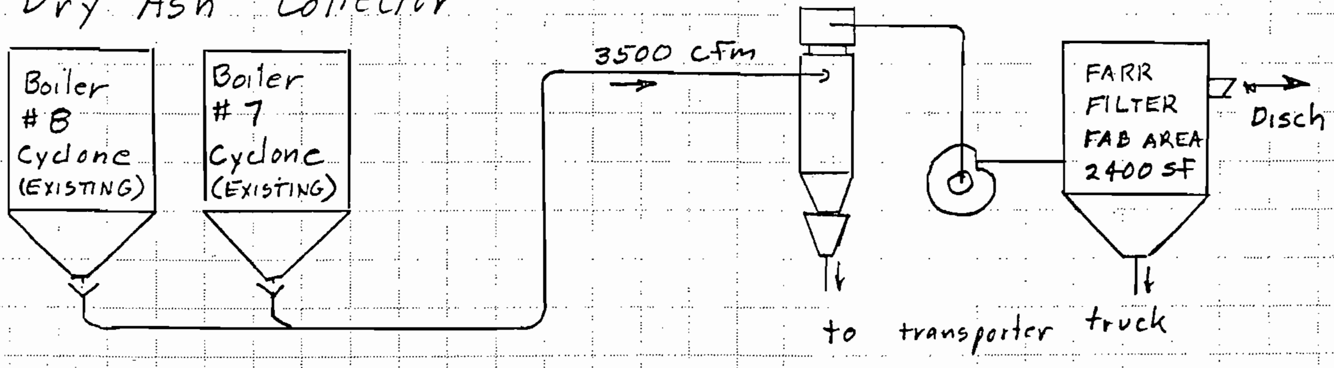


TOTAL AIR FLOW INTO FILTER 13,200 cfm

CYCLONES: CLARK MEDIUM EFFICIENCY, HIGH THROUGH-FLOW, 6' CONE, P.D. 4.5" W.C. @ 6,600 cfm

FILTER: CLARK 40-15, 1915 sf cloth area, air-to-cloth ratio 5.2 cfm/sf

2. Dry Ash Collector



CYCLONE: FISCHER-KLOSTERMAN XQ-465-19 "HIGH EFFICIENCY"
FILTER: FARR "TENKAY" SIZE 12, AIR TO FABRIC RATIO = 3500/2400 = 1.5

DOUGHERTY ENGINEERING COMPANY, INC.
TALLAHASSEE, FLORIDA

JOB Boilers 7 & 8 Calculations
SHEET NO. 4 OF 5
CALCULATED BY
DATE 9-13-84
CHECKED BY
DATE
SCALE

B. WOOD DUST COLLECTOR

Emmission from filter (each boiler)

$$\dot{W}_{EWD} = \dot{W}_{WF} \times a \times \frac{(1-\eta_{WDC})}{100} \times \frac{(1-\eta_{WDF})}{100}$$

$\dot{W}_{WF}$ = MAXIMUM WOOD FUEL FEED RATE, lbs/hr
a = ENGINEER'S ESTIMATE OF FRACTION OF WOOD FUEL COLLECTED AS DUST
η_{WDF} = EFFICIENCY OF WOOD DUST FILTER
η_{WDC} = EFFICIENCY OF WOOD DUST CYCLONE

Filter Efficiency (Based on Figure 11-1 Industrial Ventilation Manual)

Estimated a	2%
Ave particle size entering cyclone (est)	50μ
cyclone efficiency (Fig 11-3 IVM)	83%
Ave particle size entering filter	10μ
Filter efficiency	98.5%

1 $\dot{W}_{EWD} = (7,486) \times .02 \times .17 \times .015 = .38$ lbs/hr

C. DRY ASH COLLECTOR

1. TOTAL AIR FLOW 3,500 cfm

2. CYCLONE Fisher-Klosterman XQ 465-19

cyclone efficiency:

$$\eta_{ac} = 100 - f_1$$

$$f_1 = f(D)$$

1 Rev 10-3-85

JOB Boilers 7 & 8 Calculations
SHEET NO. 5 OF 5
CALCULATED BY
DATE 9-13-84
CHECKED BY
DATE
SCALE

C. DRY ASH COLLECTOR (CONT)

$$D = f(\lambda, \mu_g, N^3, \delta d, Q)$$

see attached excerpt pg 8 and 9 for further details of calculation procedure

$Q = 3500$ cfm $\qquad \mu_g = 1.28 \times 10^{-5}$ lbs/ft^3
$\lambda d = 1.7$
$N = 19$

$D = 4.8 \qquad f_1 = 11 \qquad \eta_{ac} = 89\%$

3. Baghouse is Farr "TENKAY" size 12, Fabric area 2400 sf

air to fabric ratio 1.5

baghouse efficiency, estimated 5μ average particle size: 99% (Industrial Ventilation Handbook, Fig 11-1) $\eta_{aF} = 99\%$

4. Emission

$$\dot{W}_{EDA} = \dot{W}_{da} \times \frac{(1-\eta_{ac})}{100} \times \frac{(1-\eta_{aF})}{100}$$

$\dot{W}_{da}$ = estimated rate of generation of dry ash. Based on operations to date, this is 225 lbs/hr per boiler.

$\dot{W}_{eda} = 225 \times .11 \times .01 = .25$ lbs/hr

Technical Guide to the Selection of Fisher-Klosterman XQ Series High-Performance Cyclones

This section is intended for use by the Application Engineer in specifying the correct XQ Series Cyclone for his needs. Naturally, Fisher-Klosterman will be happy to provide all the assistance needed, or to undertake the complete engineering project, if desired.

Selection Factors

Three factors must be considered in selecting a cyclone for any application:

1. Inlet Velocity
2. Pressure Loss
3. Collection Efficiency.

Proper calculation of these variables insures the selection of an XQ Series Cyclone that will perform with maximum efficiency and cost effectiveness.

Inlet Velocity

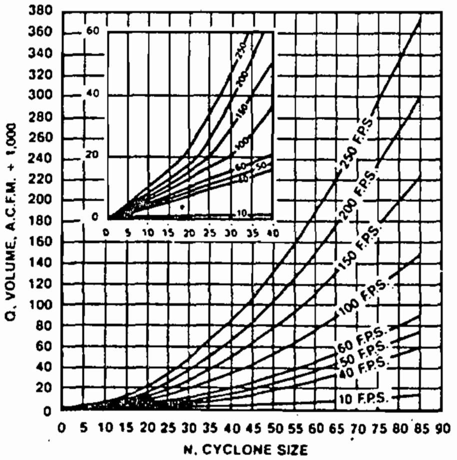
Most cyclone literature assumes an inlet velocity range from 20 to 100 feet per second. Most industrial applications have historically fallen in the 40 to 60 f.p.s. range. However, the range you consider need not be so narrow. Extensive testing and field experience have shown that Fisher-Klosterman XQ Series Cyclones perform predictably at velocities as low as 10 f.p.s. and well beyond 150 f.p.s.

The choice of inlet velocity is generally dictated by the aerodynamic characteristics of the particulates to be collected and the possibility of abrasion, as well as available space, equipment cost and power consumption.

Figure 1 shows the relationship between cyclone size (N), volumetric gas flow rate (Q) in ACFM, and inlet velocity (v_i) in f.p.s.

Application Engineers should consider that collection efficiency will increase as a complex exponential function of the inlet velocity. (This will be discussed in greater detail in a later section on collection efficiency.) Power consumption will increase approximately as the square of the inlet velocity. When abrasion is not a significant factor, these two criteria alone will determine the proper cyclone for the intended application.

FIG. 1

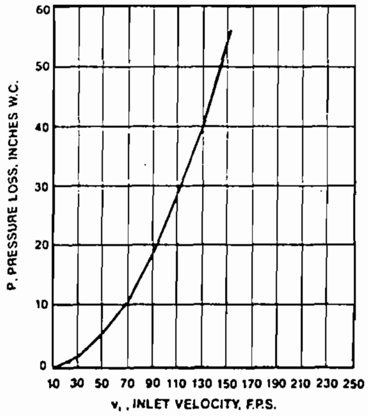


Pressure Loss

Energy is consumed in the passage of the gas through the cyclone. This is expressed as the pressure drop between the gas inlet and gas outlet of the cyclone, and is usually measured in inches of water column (in. w.c.). In any cyclone, the pressure loss increases approximately as the square of either the volumetric flow rate (Q) or the inlet velocity (v_i), and directly as the density (λ_g) of the gas.

Figure 2 shows the relationship between inlet velocity (v_i) and pressure loss (ΔP) in an XQ Series Cyclone with air at 70°F and 14.7 p.s.i.a.

FIG. 2



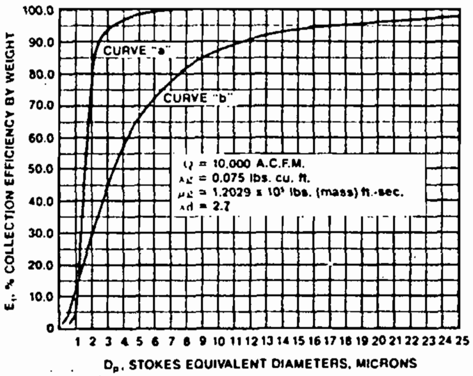
Fractional Efficiency

Efficiency is expressed in percentage by weight. In the Fractional or Particle Size or Grade Efficiency (E_f) Curve, the independent variable is the Stokes Equivalent Particle Diameter (D_p), in microns. The curve is a complex exponential function of:

1. inlet velocity (v_i) and absolute gas viscosity (μ_g).
2. particle mass, particle size, shape and surface roughness, usually measured as terminal velocity, feet/sec., in still air, and expressed as Stokes Equivalent Diameters (D_p) in microns.
3. cyclone size and proportions (shape).

Figure 3 illustrates two cyclone fractional efficiency curves. Each is for a single cyclone. Both are plotted at identical conditions: gas flow rates, densities and absolute viscosities are equal, as are cyclone pressure drops and particle density for both cyclones. Curve "a" is for an XQ120 cyclone, and Curve "b" is for an XQ465.

FIG. 3



Manual calculation of a fractional efficiency curve for just a single case is a complex and tedious problem, even for an experienced engineer. Fisher-Klosterman, however, has reduced this task to simplicity itself by the use of the digital computer. To determine a fractional efficiency curve, the following data are required:

- Volumetric gas flow rate, A.C.F.M., Q
- Gas density, lbs./cu. ft., λ_g
- Gas absolute viscosity, lbs. (mass)/ft.—sec., μ_g
- Particle specific gravity (dimensionless), or true particle density, gms/c.c., λ_d

If gas density and viscosity are not known, the gas analysis plus its temperature and pressure should be specified. Also, to aid in the selection of the best and most economical cyclone for your needs, either or both of the following should be specified:

- Maximum pressure drop, inches w.c.
- Desired efficiency at some specified particle size.

Helpful, but not mandatory, the following data should be furnished if available:

- Dust fineness, typically expressed as % by weight finer than 1.5 microns
- Inlet dust loading, grains/A.C.F.

With this information, our experienced application engineers can provide complete computer-calculated fractional efficiency curves in a matter of minutes.

Total Efficiency

Total Collection Efficiency (E_t) is defined as the percent by weight of the gas-borne particulate separated by the cyclone. To calculate Total Efficiency, not only must the Fractional Efficiency curve of the cyclone be known, but also the size distribution of the particulate.

The independent variable in the particle size distribution should be Stokes Equivalent Diameters, usually expressed in microns (one-millionth of a meter). This is a hypothetical aerodynamic diameter which accounts for the size, shape, mass and texture of the particle.

One word of caution: Optical techniques, screening, analytical instrumentation which measures particle size by determining the amount of liquid a particle displaces and other non-standardized methods do not give data which can be used with any degree of confidence or accuracy in calculating cyclone performance. If you have any doubts about your data, you should utilize our laboratory services. (See page 3).

The dependent variable in the Particle Size Distribution is generally expressed as "percent by weight finer" than a specified Stokes Equivalent Diameter in microns. Equally usable is data specifying the percent by weight falling in the range between two specified diameters.

The calculation of Total Efficiency involves the following steps:

- If it is not already in that form, convert the Particle Size Distribution to a cumulative % by weight finer than any specified diameter.
- Find the derivative of the Particle Size Distribution.
- Multiply the derivative by the Cyclone Fractional Efficiency Curve.
- Integrate the resulting product from zero particle diameter to infinity to find Total Collection Efficiency.

Although the above process sounds straightforward, the product to be integrated does not, in fact, have a rational integral. The problem must therefore be solved by one of three techniques:

- Graphical methods, or;
- Express the product as an infinite series which can be integrated term by term, or;
- Find the integral of the product by Numerical Calculus.

The latter method lends itself ideally to the digital computer. Given the same data as outlined for the computation of the Fractional Efficiency Curve (see page 8), plus the Particle Size Distribution, we can calculate and report Total Collection Efficiency to you in just a few minutes.

However, in many cases, you may wish to make an approximate calculation of Total Collection Efficiency yourself. A method for doing so involves the use of an "Average Limit Particle," and its use permits you to examine the consequences of varying both the type of cyclone and the number in parallel that you are considering. You must be aware that this method is only an approximation. Its accuracy decreases in two cases:

- When the particle size distribution is very narrow. Much more accurate results are obtained if the distribution ranges, for example, between 1.0 and 100.0 microns than if all particles fall between 1.0 and 10.0 microns.
- The lower the Total Collection Efficiency (the finer the particulate), the lower the accuracy of this method.

The Average Limit Particle size is calculated by:

$$D_l = k\sqrt{\frac{\mu_g \times N^3}{\lambda_d \times Q}},$$

where D_l = Average Limit Particle, microns.

μ_g = Absolute viscosity of gas, lbs. (mass)/ft.—sec.

N = Cyclone size.

λ_d = Particulate specific gravity, or true particle density, grams/c.c.

Q = Volumetric gas flow rate, A.C.F.M.

k. a constant, is given in Table 1 for each family of cyclones in the XQ Series.

Table 1

Cyclone Family	XQ465	XQ405	XQ340	XQ240	XQ170	XQ120
k	1254.27	1069 19	923.120	741.378	621.110	543.522

The approximate Total Collection Efficiency is calculated by:

$$\varepsilon_t = 100.0 - f_l,$$

where ε_t = Approximate Total Collection Efficiency, % by weight.

f_l = The percent finer by weight, in the Particle Size Distribution at the Average Limit Particle Size.

Examples of Cyclone Calculations

Example #1

Given:

Q = 6,800 A.C.F.M.

Gas = Air at 460° F. and 14.7 p.s.i.a.

$\lambda_g = 0.036$ lbs./cu. ft.

$\mu_g = 1.76 \times 10^{\,5}$ lbs. (mass)/ft.—sec.

Specifications:

v_i = 70. f.p.s., maximum

ΔP = 3.0 in. w.c., maximum

Calculations:

1. From Figure 1, smallest single cyclone at $v_i \leq 70.$ f.p.s. is SIZE 22.
2. Allowable maximum pressure drop at specified conditions must be corrected to the gas density of air at 70°F. and 14.7 p.s.i.a., 0.075 lbs./cu. ft. $\Delta P_{(corr)} = 0.075 \times 3.0/0.036 = 6.25$ in. w.c.
3. From Figure 2, at $\Delta P_{(corr)} = 6.25$ in. w.c., v_i = 53. f.p.s. The cyclone will have to be resized to this inlet velocity.
4. Returning to Figure 1, smallest single cyclone at v_i 53. f.p.s. is <u>SIZE 25</u>.

Example #2

Given:

Q = 12,500 A.C.F.M.

$\lambda_g = 0.075$ lbs./cu. ft.

$\mu_g = 1.2029 \times 10^{-5}$ lbs. (mass)/ft.—sec.

$\lambda_d = 3.15$

Particle Size Distribution: See Figure 4.

Specifications:

Required Total Efficiency by weight, $\varepsilon_t = 86.5\%$

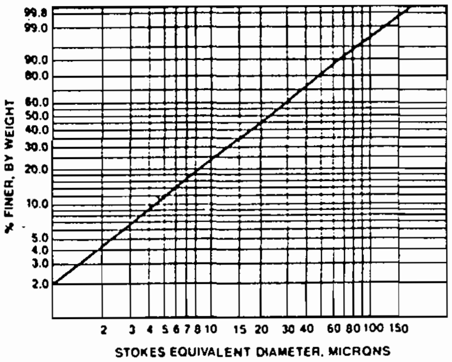
Maximum allowable pressure drop, ΔP = 7.5 in. w.c.

Maximum allowable inlet velocity, v_i = 55 f.p.s.

Calculations:

1. Assume cyclone will be type XQ340
2. From Figure 1 at v_i = 55 f.p.s., Size = 33
3. From Figure 2 at v_i = 55 f.p.s., ΔP = 6.8 in. w.c.
4. From Table 1. k = 923.120
5. By equation (1).
   $$D_l = 923.120 \times \sqrt{\frac{1.2029 \times 10^{\,5} \times 33^3}{3.15 \times 12500}} = 3.06$$
6. From Figure 4, f_l = 7.1
7. By equation (2), $\varepsilon_t = 100.0 - 7.1 = \underline{92.9\%}$

FIG. 4



A typical XQ Series Model Number and What it Means

$$\underbrace{XQ465}_{A}\text{-}\underbrace{20}_{B}\text{-}\underbrace{2}_{C}\text{-}\underbrace{CR1}_{D}$$

A. "XQ" *plus a 3-digit number* designates the family of the cyclone.

B. "-" *plus a number* designates the cyclone size which equals the height of the cyclone inlet in inches. This may be a 1- or 2-digit number, or a decimal.

C. "-" *plus an integer* indicates the number of cyclones in parallel that make up the complete collection system.

D. "-" *plus a special suffix* designates special construction features. Some examples are:

PV = Pressure Vessel

CR1 = 1-inch Castable Refractory Lining

CR2 = 2-Inch Castable Refractory Lining

RB3 = 3-Inch Refractory Brick Lining

RB9 = 9-Inch Refractory Brick Lining

C.5 = ½-Inch Alumina Ceramic Tile Lining

C1 = 1-Inch Alumina Ceramic Tile Lining

Use the above information when specifying your XQ Series Cyclone. In addition, orders should specify separately:

Material(s) of Construction or (if Fisher-Klosterman is to determine the materials) special construction considerations such as high abrasion or corrosive conditions.

Special Construction Features, such as:

Break-Apart Construction for installations requiring cleaning and maintenance.

Externally Replaceable Wear Plates/Sections or special linings for highly abrasive dusts.

Access Doors (not recommended for the active portion of the cyclone when collection performance is critical).

Explosion Reliefs for use with explosive dusts.

Plus a variety of other features demanded by the individual cyclone's application.

TECHNICAL SERVICES, INC.
ENVIRONMENTAL CONSULTANTS — INDUSTRIAL CHEMISTS
OFFICE 2471 SWAN ST. — P.O. BOX 52329
LABORATORIES 103-107 STOCKTON STREET
JACKSONVILLE, FLORIDA 32201
(904) 353-5761

Laboratory No. 61124

August 29, 1984

Sample of WOOD PELLETS

Date Received August 28, 1984

For STATE OF FLORIDA, DEPT. OF GENERAL SERVICES, BUREAU OF STANDARDS, LARSON BUILDING, ROOM 613, TALLAHASSEE, FLORIDA 32301

Marks: Attn: Mr. H. P. Barker, Jr., C.P.M. Chief

CERTIFICATE OF ANALYSIS OR TESTS

	BTU/lb.
1.	8188
2.	8160
3.	8183
4.	8244
5.	8240
Average	8203

Respectfully submitted,

TECHNICAL SERVICES, INC.

BY Henry C. Gray, Jr.

LABORATORY I.D. NO. 82145

HRS STATE OF FLORIDA
DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES

August 23, 1984

Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, Florida 32301

Attention: C. H. Fancy, P.E.

SUBJECT: Authorized Representative for Air Pollution Control - Boilers No. 7 and 8.

Dear Mr. Fancy,

In reference to your letter of August 15, 1984 this will notify you that Fred W. Dougherty, P.E. is authorized to represent Florida State Hospital as our Engineer with respect to air pollution control matters relating to boilers No. 7 and 8.

Sincerely,

William D. Myers

William D. Myers
Hospital Administrative Services Director

WDM/dk

Doris J. Kirkland
NOTARY

NOTARY PUBLIC, STATE OF FLORIDA AT LARGE
MY COMMISSION EXPIRES JAN. 9, 1987
BONDED THROUGH MUROSKI-ASHTON, INC

DISTRICT TWO • FLORIDA STATE HOSPITAL • CHATTAHOOCHEE, FLORIDA 32324
BOB GRAHAM, GOVERNOR

AC 20-49787

CONTRACT DOCUMENTS AND SPECIFICATIONS

FOR

CONVERSION OF BOILERS TO BURN WOOD AS FUEL

AT THE

FLORIDA STATE HOSPITAL
CHATTAHOOCHEE, FLORIDA
STATE PROJECT NO. HRS-8059

TO BE CONSTRUCTED FOR

DEPARTMENT OF HEALTH AND REHABILITATIVE SERVICES
DIVISION OF MENTAL HEALTH

BY

STATE OF FLORIDA
DEPARTMENT OF GENERAL SERVICES
DIVISION OF BUILDING CONSTRUCTION & PROPERTY MANAGEMENT
BUREAU OF CONSTRUCTION

SET NO. 29
DATE ISSUED 14 July 81

Sverdrup

Sverdrup & Parcel
and Associates, Inc.
Jacksonville, Florida
Engineers Architects Planners

ENGINEER'S JOB NUMBER 7207

JULY 1, 1981

ATTACHMENT NO. 8

SECTION 15620

BOILER CONVERSION SYSTEM

PART 1 - GENERAL

1.01 DESCRIPTION

A. Related Work Specified Elsewhere:
   1. Demolition and Removal (Section 02050)
   2. Concrete for Pads and Grout (Section 03300)
   3. Metal Supports and Steelwork (Section 05100)
   4. Miscellaneous Bolts, Anchors, Supports, & Metal Fabrications (Section 05500)
   5. Controls and Instrumentation (Section 15900)
   6. Painting (Section 09900)

B. Description of System: Furnish, deliver FOB job-site, Chattahoochee, Florida, unload, completely convert, test, and leave ready for operation, steam generating units No. 7 and 8 to use pelletized wood as a primary fuel, consisting of boiler refractories modifications to accommodate new burners, new combination burners for refined wood, No. 6 oil, and coal on an emergency basis, new wood pulverizers, feeders, primary air fans and drives, air and gas duct modifications and additions, combustion, safety, and feedwater controls with new control panel, so specified herein. Any items not specifically mentioned which are necessary to form a complete unit shall be furnished.
   1. Any boiler unit repair or maintenance work required to obtain the Design Requirements but not resulting from the conversion work is not included in this contract.

1.02 QUALITY ASSURANCE

A. Design Criteria: It is the intention of these plans and specifications to provide for a complete, workable, and satisfactory wood fuel conversion package. The converted boiler shall be able to meet the following conditions:
   1. Capacity - 60,000 lb/hr of steam continuous.
   2. Operating pressure at superheater outlet - 425 psig.
   3. Steam total temperature 575°F at primary superheater outlet, from full load to 50% load when operating on wood/oil fuel combination, the wood portion being equal to or greater than 87 percent.
   4. Feedwater temperature - 300^{o}F.
   5. Primary fuel - refined wood in the form of pulverized pellets.
   6. Secondary and sustaining fuel - No. 6 oil.
   7. Emergency fuel - coal.
   8. Furnace heat release - 22,000 Btu/cu.ft at 60000 lb/hr. steam, based on the total furnace volume of 3340 cubic feet.
   9. Boiler range - 30,000 to 60,000 lb/hr continuous operation.
   10. Total heat input to the boiler shall not be greater than 75 million BTU/hr.

11. The boiler shall be capable of operating at 50% load with only one single burner in operation.

B. Fuel Criteria:

1. The wood fuel for which the boiler conversion shall be designed is refined wood in the form of pellets. Its analysis shall be assumed as follows:

a. Proximate Analysis (dry basis weight)

Volatile Matter	73-79%
Fixed Carbon	20-24%
Ash	4% avg.

b. Ultimate Analysis

Carbon	46%
Hydrogen	5%
Sulfur	0%
Oxygen	35%
Nitrogen	0%
Moisture	10%
Ash	4%

c. Heating value = 7500 BTU/lb avg.

2. The fuel oil for which the oil burners shall be designed is Commercial Grade No. 6 (Bunker "C"). Its analysis shall be assumed as follows:

Water	0.5%
Carbon	87.53%
Hydrogen	10.28%
Oxygen	0.17%
Nitrogen	0.17%
Sulfur	0.4 to 3.5%
Ash	0.04%
Gravity, A.P.I.	10.1 to 14.8
Pounds per gal.	8.32
BTU per pound	18,264

C. Applicable Standards: The steam generating unit shall be designed, constructed, and tested in conformity with the ASME Code for Power Boilers and the applicable portions of the latest edition of the standards of the following:

American Society of Mechanical Engineers
American National Standards Institute
American Institute of Electrical and Electronic Engineers
American Society for Testing and Materials
National Electrical Association
Underwriters' Laboratories, Inc.
American Institute of Steel Construction
American Boiler Manufacturers' Association
National Electrical Manufacturers' Association
Instrument Society of America
Factory Mutual Insurance
National Electrical Code
Applicable Federal Codes and Regulations
Applicable Codes and Regulations of the State of Florida and Gadsden County, Florida.

1.03 SUBMITTALS

A. Shop Drawings and Product Data: Before any material or equipment is installed, shop drawings, manufacturer's printed data and/or certified information shall be submitted for approval of the Engineer in accordance with Section E "INSTRUCTIONS TO CONTRACTORS".

1. Physical dimensions, capacities, speeds, operating characteristics of temperatures, pressures and any other information pertinent to the operation and function of the equipment or material shall be furnished.
2. In the event any material or equipment submitted for approval fails to conform to the intent of the specification requirements, as determined by the Engineer, such items may be rejected.
3. It shall be the responsibility of the Contractor that equipment submitted for approval will fit into the space or spaces provided with adequate space for service, removal of components and installation of controls.
4. Shop drawings shall be submitted for each item listed in the specifications. Control and wiring diagrams shall be included with equipment and sequences of operation.

B. Operation and Maintenance Data: The manufacturer shall furnish, for each piece of equipment, four (4) complete bound maintenance manuals giving the following information:

1. Clear and concise instructions for the operation, adjustment, and lubrication and other maintenance of the equipment. These instructions shall include a complete lubrication chart.
2. List of all parts for the equipment, with catalog numbers and other data necessary for the ordering or replacement of parts.
3. Such instructions and parts lists shall have been prepared for the specific equipment furnished and shall not refer to other sizes and types or models of similar equipment.
4. Submittal shall be in accordance with Section E "INSTRUCTIONS TO CONTRACTORS".

C. Maintenance Materials (Spare Parts: The supplier shall furnish a complete spare parts list. The parts list shall recommend what parts should be stocked for a one-year-operation. A manufacturer, part number, price, and delivery time for spare parts shall also be included.

D. Tools: Any special tools required for operation and maintenance shall be provided to the Owner's operating personnel by the Contractor. Provide list with shop drawing submittal.

1.04 JOB CONDITIONS

A. Existing Conditions: Existing boilers 6, 7, and 8 are front pulverized coal fired, water wall cooled, bottom hopper, balanced draft units rated at 60,000 lb/hr continuous capacity each at 425 psig and 575°F. steaming conditions.

1. Each boiler has two (2) burners, an FD and ID fan, pulverizer, tubular air heater, superheater, and exit gas cyclone separator.
2. Boiler No. 6 is a Babcock & Wilcox unit installed in 1949.
3. Boiler No. 7 is a Riley Stoker unit installed in 1954.
4. Boiler No. 8 is a Riley Stoker unit installed in 1958.

B. Sequencing, Scheduling: Since the boilers must be available to supply steam as the demands of the Florida State Hospital dictate, coordination of the conversion work between the Contractor and the Institution is essential to the execution of the work. It shall be the Contractor's responsibility to clear all scheduling of the work of this section with the Institution prior to proceeding with any phase of the wood fuel conversion.

PART 2 - PRODUCTS

2.01 CASING:

A. Any steam generating unit casing material required due to this design shall be 10 gauge steel, welded seams and joints wherever possible.

2.02 INSULATION AND METAL LAGGING

A. Provide insulation and metal lagging, so outer lagging surface temperature does not exceed 140°F with still air ambient temperature at 100°F of any ducting or breeching modified or added under this design. Insulation shall be fiberglass similar to Johns-Manville Spinglass 1000 Series 3 lb/ft^3 complying with ASTM E 136, C612, Class 3 for 850°F operation with a minimum thickness of 2 inches. Lagging shall be similar to and comparable with existing materials.

2.03 PULVERIZER/BURNER DESIGN: Equipment shall be furnished by the Contractor which will pulverize wood fuel and burn it in suspension in the existing steam generating units furnace. The following specifications apply as to design and capacity.

A. Each steam generator No. 7 and 8 shall be provided with pulverizer units directly feeding turbulent-type burners located in the existing furnaces. The quantity of pulverizer and burner units shall be as approved by the Engineer, but shall be a minimum of one (1) each per furnace. If more than one burner is installed the design shall provide for single burner operation, similar to the arrangement shown on the design.

B. Wood Fineness: Each pulverizer unit shall be guaranteed to deliver its maximum rated capacity, using wood fuel whose extreme characteristics are within the limits set forth herein under the Paragraph 3.02-F. The pulverized wood fuel shall have a finess of not less than 95 percent through 20 mesh. The mesh shall be in accordance with U.S. Standard Sieve.

C. Capacity of pulverizers: Each pulverizer unit shall have a capacity of not less than 100 percent of the total pulverized wood fuel required by the steam generator when operating at the design steam generating capacity of 60,000 pounds per hour, and when using wood fuels whose extreme characteristics are within the limit set forth herein under the Paragraph 3.02-F.

D. Type of Pulverizers: All pulverizers shall be of the same type and size where possible. The pulverizers shall be of the reversible hammermill type with separate heavy duty exhauster fans. Any other types must be approved by the Engineer. Representative suppliers are Gruendler, Williams, C-E Raymond, Schutte and Jacobsen.

2.04 PULVERIZER/BURNER EQUIPMENT: The pulverizing and burning equipment shall include the complete system from the bunker outlet to the burner outlets, together with all air ducts required. This shall include the following:

A. Bunker shut-off gate and inlet transition section to feeder with raw wood fuel flow observation window in transition.

B. Raw wood fuel feeder and motor drive.

C. Pulverizer motor drive.

D. Classifier with airlock feeder to pulverizer inlet.

E. Fan, or exhauster, with motor drive for each burner.

F. Pulverized wood fuel and air piping to classifier, fans and burners sized to maintain approximately 4500 fpm minimum velocity at all operating conditions.

G. Ducts for providing preheated air to pulverizer base and inlet.

H. Tempering air connection and dampers for regulating temperature of preheated air to pulverizer.

I. Automatic feeder controls adapted and suitable for inter-connection with the automatic combustion control system furnished by the Contractor.

J. Turbulent, forced draft combination pulverized wood fuel, coal and oil burners.

2.05 PULVERIZER UNIT: The pulverizer unit shall consist of the pulverizer proper with an integral reduction gear, or V-belt drive, driving motor, flexible couplings, feeder, magnetic separator, classifier, primary air fan for each burner, tempering dampers, pulverizer sweeping air supply dampers, and discharge diverter valves.

A. The feeders and their drives shall be located on the operating floor.

B. The pulverizers and their drives and the primary air exhauster fans and their drives will be located on the basement floor.

C. The Contractor shall prefabricate and furnish all necessary pulverized fuel piping from pulverizers to burners; complete with ample connections. This piping shall be of schedule 40 seamless or butt-welded pipe, and each provided with flexible and dust tight joints. All bend radii shall be 1-1/2 diameters or greater.

D. The equipment shall be provided with necessary means for connecting automatic combustion control. Proposals shall describe in detail in the proposal the arrangement incorporated with the equipment in order to be compatible with the combustion control design drawings.

E. The raw fuel feeder shall be of the volumetric screw type. Regulation of feed is to be effected by mechanical speed adjustment, and it shall be readily adapted for automatic control. The existing raw fuel gates shall be retained. The feeder shall be similar to the Metalfab Inc. Model DB-4, KTRON Corp. Model S400 or equal.

F. The pulverizers shall operate under a negative pressure. It shall be provided with a self-contained lubrication system. The frame shall be made of heavy cast iron or welded steel plate. The base shall be fabricated as a unit with enclosed discharge pan. The unit shall be provided with dampers which regulate the amount of primary air passing through the pulverizer. The unit shall be constructed to minimize dust leakage.

2.06 CLASSIFIER: Classifier shall be provided which separates all coarse fuel from the primary air and fuel stream, recycling the coarse fuel through the pulverizer. The classifier shall be adjustable so as to regulate the finess of the wood fuel leaving the unit over the operating range of the steam generator, and its efficiency shall be such that when grinding wood no more than 5 percent by weight of acceptable wood fuel leaving the unit will be greater than 20 mesh. The classifier shall be similar to the Clarke's Sheetmetal Variable Geometry Classifier, C-E Raymond Dual Cone, or equal.

2.07 PRIMARY AIR FAN: The primary air fans shall be independent units located on the basement floor level. They shall be of heavy duty construction. The entire structure of the primary air fan shall be made of sufficient strength to resist unbalanced condition of the rotor caused by wear. One fan shall be provided for each burner. Each fan shall have a belt drive and outlet damper with manual control to provide maximum trim capability or balanced direct drive units to provide uniform and stable performance. The capacity of the primary air fan units shall be designed to supply no more than 35 percent of the total combustion air at the steam generator design load. The fan shall be similar to that supplied by Buffalo Forge, Gruendler, or equal.

2.08 BURNERS: Each burner shall be provided with adjustable feature for controlling the length and shape of the flame while the burner is in operation. Each burner shall be provided with secondary air control damper for manual and automatic operation. The burner shall be simple and contain as few parts as possible and be accessible for repairs, maintenance and adjustment. Arrangement of burners shall be such that they produce a turbulent flame for mixing secondary air and pulverized fuel and to permit the degree of flare to be controlled conveniently and in a manner to provide an equal distribution of heat throughout the furnace and to avoid flame impingement on the tubes in the furnace walls.

A. Each burner shall be of the multi-purpose-type for burning pulverized wood, coal, or No. 6 fuel oil and shall have capacity to burn sufficient oil to generate the same quantity of steam as when burning pulverized fuel, but under normal operation supplies only 12½ percent of the full load, burner capacity in the form of a sustaining flame. Discharge of pulverized fuel and air shall be uniform so as to produce a symmetrical flame.

B. Burners shall be supplied with integral ignition device, stabilizing flame, associated piping trains, and flame safeguard system. The igniter system shall be designed for remote light-off.

C. Burners shall have sufficient capacity to develop the maximum continuous boiler rating of 60,000 pounds of steam per hour at 425 psig and 575 degrees F with 300 degree F feed-water and an overall efficient of 80 percent, and each shall have a range of regulation of at least one (1) to two (2). Each burner shall be capable of continuously maintaining not less than 70 percent of the maximum continuous boiler rating when multiple burners are installed.

D. All parts shall be constructed with a minimum of metal parts exposed to radiant heat of the furnace. Parts of burner so exposed shall be shielded or protected by approved means.

E. Each burner shall be provided with two (2) observation windows and lighter ports, necessary venturi throat file, register assembly with automatic controls, pulverized fuel distributor, any special openings required to fire with oil, fuel piping trains, control valves, fuel safety shut-off valve, and all other accessories to make a complete and operable burner installation.

F. Burners shall be similar to Coen DAZ Scroll Feed Burner or other equivalent equipment.

2.09 WINDBOXES

A. Furnish substantial windboxes as required, constructed of steel and steel structural shapes, in which the burners are mounted and to which the air ducts connect. The windboxes shall be constructed the same as the hot air ducts, having an inner steel sheet 3/16-inch thick, spun fiberglass for 850° operation or equal core and an outer steel sheet of ample thickness for the service. All air connections to the windbox shall be with steel flanges and gaskets for air tight operation.

PART 3 - EXECUTION

3.01 INSPECTION

A. Equipment Modifications: Rearrangement of any heat transfer surfaces due to the conversion so as to minimize slagging, fouling or excessive heating with the fuels as specified, regardless of whether used separately or in combination, shall require a written request defining the work and subsequent written approval of Owner/Engineer before initiating any phase of the work.

B. Field Measurements: Contractor shall provide templates for setting of anchor bolts. Drawings are schematic and only indicate the arrangement of the systems. Contractor shall inspect the site and coordinate the work of trades involved for clearances, fitting and installation of work.

3.02 INSTALLATION

A. Equipment: Installation shall be in accordance with approved shop drawings and product data sheets.

B. Cutting and Fitting: Cutting and fitting of work of other trades required by the work of this section shall be performed by the trades involved.

C. All pulverized fuel piping, complete with hangers, and flexible connections between the pulverizers and the burners shall be furnished and installed by the Contractor. Flexible connections shall be provided on equipment at all locations subject to thermal expansion loads.

D. Terminal Points: The Contractor shall furnish all equipment, piping, insulation, supports, etc., as required within the following points:

Forced draft fan inlet
Feedwater valve inlet
Termination at all drain tie-ins
Existing fuel bunkers
Exhaust gas stack exit
Inlet and outlet oil and steam supply connection to fuel oil, water, and pump set
Fuel oil, gas, air connections to headers at burner front

E. Ignition: Provide all necessary piping, controls, and appurtenances for propane/electric ignition.

F. Performance: The converted generating unit, including feeders, pulverizers, fans, motors, burners and related equipment, must be furnished and guaranteed to operate satisfactorily at maximum continuous generating capacity stated herein, with wood fuels having characteristics within the limits of each unit as follows:

Total moisture content (as delivered)	Maximum	12%
Volatiles	Minimum	60%
Ash	Maximum	5%
Heating value (as delivered)	Minimum	7500 BTU/lb
Bulk density	Minimum	35 lb/ft^3

Fuel size: cylinders whose maximum dimensions shall not exceed ½" diameter x 1½" long.
Fragments passing through a No. 10 sieve shall not exceed 7% by weight as delivered.

3.03 FIELD QUALITY CONTROL

A. Tests: The boilers will be subjected to a performance test to demonstrate:

1. The accuracy, range, and smoothness of operation of all the boiler automatic controls throughout the entire firing range specified.

2. The boiler efficiency and capacity and the steam quality shall meet all the requirements of these specifications. The control and operation shall meet the conditions under varying load conditions from start-up through full load to shutdown. It shall also be shown that load swings, of at least 15% per minute, can be accommodated without evidence of faulty operation.

3. Documents of all tests shall be submitted to the Owner/Engineer.

B. Electrical Requirements: Equipment and accessories furnished under this equipment specification shall meet the requirements of the Electrical Standards contained in Section 16100.

3.04 PAINTING

A. Primer: Primer shall be as specified in the PAINTING Section 09900.

B. - Painting: Field finish and/or touch-up painting shall be as specified in the PAINTING Section 09900.

END OF SECTION

PERMITTED
BY
NORTHWEST DISTRICT
DEPT. OF ENVIRONMENTAL REGULATION
PERMIT NO. AC20-2049-2050
DATE 21 JUN 76

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STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION
APPLICATION TO ~~OPERATE~~/[✓ CONSTRUCT] AIR POLLUTION SOURCES

Source Type **Air Pollution** [X] **Incinerator** [ ]
Type application: [ ] Operation [X] Construction
Source Status: [ ] New [ ] Existing [X] Modification

Source Name: Florida State Hospital County Gadsden

Source Location: Street Highway 90 City Chattahoochee

UTM: East 707400M North 3398500M

Appl. Name and Title: William D. Myers, Asst. Supt., Administrative
Appl. Address: Florida State Hospital, Chattahoochee, Florida 32324

STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

The undersigned owner or authorized representative of * Florida State Hospital is fully aware that the statements made in this application for a Air Pollution permit are true, correct and complete to the best of his knowledge and belief. Further, the undersigned agrees to maintain and operate the pollution control source and pollution control facilities in such a manner as to comply with the provisions of Chapter 403, Florida Statutes, and all the rules and regulations of the Department or revisions thereof. He also understands that a permit, if granted by the Department, will be non-transferable and he will promptly notify the Department upon sale or legal transfer of the permitted establishment.

William D Myers
Signature of the Owner or Authorized Representative

Date: April 15, 1976 Telephone No.: (904) 663-4311

*Attach a letter of authorization. If applicant is a corporation, a Certificate of Good Standing must be submitted with application. This may be obtained, for a $5.00 charge, from the Secretary of State, Bureau of Corporate Records, Tallahassee, Florida 32304.

B. PROFESSIONAL ENGINEER REGISTERED IN FLORIDA

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 profesional judgment, that 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 the applicant a set of instructions for the proper maintenance and operation of the pollution control facilities and, if applicable, pollution sources.

Signature
Name Larry M. Simmons, P.E.
(Please Type)
Company Name Tidewater Engineers, Inc.
Florida Registration Number 17964
(Affix Seal)

Mailing Address 3207 West Tharpe Street
Tallahassee, Florida 32303
Telephone No.: (904) 576-7133
Date April 15, 1976

DETAILED DESCRIPTION OF SOURCE

A. Describe the nature and extent of the project. Refer to existing pollution control facilities, expected improvement in performance of the facilities and state whether the project will result in full compliance. Attach additional sheet if necessary.

The Florida State Hospital operates four 60,000 lb/hr watertube boilers to provide steam for electrical power generation, air conditioning and building heating systems. These boilers have combination type burners for firing pulverized coal as a primary fuel and No. 6 oil as a secondary fuel. The existing burners, fuel oil pumping system and storage facilities are not adequate for operation with 100% oil. This construction project consists of converting the burners of boilers 6, 7 and 8 to fire No. 6 fuel oil as a primary fuel; new fuel oil transfer pumps; new 750,000 gallon storage tank; new fuel oil piping; demolition of existing boiler No. 5; and installation of a new 60,000 lb/hr package boiler for firing No. 6 oil. Conversion of this facility will result in full compliance with air pollution requirements.

B. Schedule of Project Covered in this Application (Construction Permit Application Only).

Start of Construction June 1, 1976

Completion of Construction March 1, 1977

C. Costs of Construction (Show a breakdown of costs for individual components/units of the project serving pollution control purpose only). Information on actual costs shall be furnished with the application for operation permit.

Conversion of boilers No. 6, 7 and 8 from primary firing of coal to primary firing No. 6 fuel oil	$270,000
Addition of New Boiler No. 9	285,000
Replace Boiler No. 6 steel stack	20,000
Repair existing steel stacks	3,000
Repair existing 184 ft. brick stack	20,000

D. For this source indicate any previous DER permit: issuance dates, and expiration dates; and orders and notices.

No previous DER permit - operated under the following DPC permits:

AO-20-713 Boiler No. 6, issued 9-25-72, expired 9-15-73

AO-20-716 Boiler No. 5, issued 9-25-72, expired 9-15-73

AO-20-717 Boiler No. 8, issued 9-25-72, expired 9-15-73

AO-20-718 Boiler No. 7, issued 9-25-72, expired 9-15-73

E. Is this application associated with or part of a Development of Regional Impact (DRI) pursuant to Chapter 380, Florida Statutes, and Chapter 22F-2, Florida Administrative Code? ....Yes ...X...No

AIR POLLUTION SOURCES & CONTROL DEVICES
(other than incinerators)

A. Identification of Air Contaminants

1) ☐ Particulates
   a) ☐ Dust b) ☐ Fly Ash c) ☐ Smoke d) ☐ Other (Identify)

2) ☐ Sulfur Compounds
a) a) ☒ SO_x as SO_2 b) ☐ Reduced Sulfur as H_2S c) ☐ Other (Identify)

3) ☐ Nitrogen Compounds
   a) ☐ NO_x as NO_2 b) ☐ NH_3 c) ☐ Other (Identify)

4) ☐ Flourides 5) ☐ Acid Mist 6) ☐ Odor

7) ☐ Hydrocarbons 8) ☐ Volatile Organic Compounds

9) ☐ Other (Specify) ______________________________

B. Raw Materials and Chemicals Used (Be Specific)

Description	Utilization Rate lbs./hr.	Approximate Contaminant Content		Relate to Flow Diagram
		Type	% Wt.	
No. 6 Fuel Oil	6350*	SO_2	2.5	Fuel inlet to boilers
	10440**			

* Average conditions
** Peak conditions

C. Process Rate:

1) Total Process input Rate* 6350 lb/hr __________ Units. (No. 6 fuel oil @ average conditions)
2) Product Weight* 88,177 lb/hr (steam @ average conditions Units.
3) Normal Operating Time full time __________, if seasonal describe: __________
   hrs./day 24 __________ days/wk. 7 __________ wks/yr. 52

D. Airborne Contaminants Discharged:

Name of Contaminant	Actual** Discharge		Discharge Criteria Rate*	Allowable Discharge Lbs./hr.	Relate to Flow Diagram
	lbs./hr.	T/yr.			
SO_2	316.8	1387.6	#/MBTU/HR	Latest Avail. Tech.	Exit gases

*Refer to Chapter 17-2.04(2), Florida Administrative Code.
(Discharge Criteria: Rate=#/ton P_2O_5, #/M BTU/hr., etc.)
**Estimate only if this is an application to construct.

D. Airborne Contaminants Discharged. (Cont'd.)

Name of Contaminant	Hourly Emission (lb./hr.)	Daily Emission (lb./day)	Yearly Emission (T/yr.)	Basis for Emission Estimate (Test Data, Material Balance)

E. Control Devices: N/A

Name and Type (Model and Serial No.)	Contaminant	Efficiency*	Conditions of Operations	Basis for Efficiency Operational Data, Test, Design, Data)

*See required supplement.
(Include any test data and/or design data for efficiency substantiation)

F. Fuels Fuel Oil

Type (Be Specific, includes %S, etc.)	Daily Consumption *		Maximum Heat Input MBTU/hr.
	Avg./hr.	Max./hr.	
No. 6	6336	10,440	193,140

* Units: Natural Gas - MCF/hr.; Fuel Oils, Coal--lbs./hr.

Fuel Analysis:

Percent Sulfur 2.5 Percent Ash 0.05

Density 8.3 lb./gal.

Heat Capacity 18,500 BTU/lb. 153,550 BTU/gal.

Other Fuel Contaminants None

G. Describe briefly, without revealing trade secrets, the processes/operations generating the airborne emissions identified in this application.

The operation of this facility consists of using No. 6 fuel oil to fire four 60,000 lb/hr watertube boilers for generation of steam utilized in a power plant process.

H. Indicate liquid or solid wastes generated and method of disposal. N/A

I. Emission Stack Geometry and Flow Characteristics, (Provide Date for each Stack).

Stack Height 1 brick stack - 184 ft. 3 steel stacks - 92 ft ea. ft, Stack Diameter 1 brick stack 7 ft 3 steel stacks 4 ft. each

Gas Flow Rate 40,000 CFM (each) ACFM, Gas Exit Temperature 340 °F

J. Required Supplements:

1. Total process input rate and product weight – show deviation.
2. Efficiency Estimation.
3. An 8½" x 11" flow diagram, which will, without revealing trade secrets, identify the individual operations and/or processes. Indicate whether raw materials enter, where solid and liquid waste exit, where gaseous emissions and/or airborne particulates are evolved and where finished products are obtained.
4. An 8½" x 11" plot plan showing the exact location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.
5. An 8½" x 11" plot plan showing the exact location of the establishment, and points of airborne emissions in relation to the surrounding area, residences and other permanent structures and roadways.
6. If applicable, provide a brief description of the control device or treatment system serving the discharge point for airborne contaminants identified in this application. Include details of the manufacturer, model, size, type and capacity for control/treatment device and the features of the discharge point (height above ground, diameter, period(s) of discharge and discharge temperature).
7. Plans for storm water control during and after construction.

INCINERATOR INFORMATION

N/A

Type of Waste	Type O (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq. & Gas By-prod.)	Type VI (Solid By-prod.)
Lbs./Hr. incinerated							

Description of Waste ______________________________

Total Weight Incinerated lbs./hr. ______________ Design Capacity lbs./hr. ______________

Approximate Number of Hours of Operation per Day ______________, days/week ______________

Manufacturer ______________ Model No.: ______________

Date Constructed: ______________

	Volume (ft.*)³	Heat Release (BTU/hr.)	Fuel		Temp. (° F)
			Type	BTU/hr.	
Primary Chamber					
Secondary Chamber					

Stack Height: ______________ ft. Stack Diameter: ______________ Stack Temp.: ______________ °F

Type of Pollution Control Device ☐ Cyclone ☐ Wet scrubber ☐ Afterburner
☐ Other (Specify): ______________

Brief Description of Operating Characteristics of Control Device: ______________

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

1. Total process input and product weight.

The product weight for this facility is the total amount of steam generated. The steam generated for one year of operation is 772,433,000 lbs.*

Average hourly steam generated in boilers,

$$m_1 = \frac{772{,}433{,}000 \text{ lbs.}}{8760 \text{ hrs.}} = 88{,}177 \text{ lb/hr.}$$

(88,177 lb of steam/hr)(0.072 lb. fuel oil/lb. of steam) = 6350 lb. fuel oil/hr.

Peak hourly steam generated in boilers is 145,000 lb/hr.*

(145,000 lb of steam/hr)(0.072 lb fuel oil/lb of steam)

= 10,440 lb. fuel oil/hr.

*From Florida State Hospital records.

2. Efficiency Estimation.

The efficiency of the system is

$$E_{ff} = \frac{\text{Boiler output, BTU/hr}}{\text{Fuel input, BTU/hr}} = \frac{h_1 - h_5 \text{ BTU/hr}}{h_f \text{ BTU/hr}}$$

The fuel input based on past records indicates that the total amount of fuel oil required for one year's operation is 6,703,240 gallons, therefore

$$\frac{(6{,}703{,}240 \text{ gallons})(153{,}550 \text{ BTU/gallon})}{8760 \text{ hours}}$$

$$h_f = 117{,}478{,}000 \text{ BTU/hr}$$

The total steam generated in one year is 772,433,000 lbs, therefore

$$\frac{(772{,}433{,}000 \text{ lbs. of steam})(1290 \text{ BTU/lb})}{8760 \text{ hours}}$$

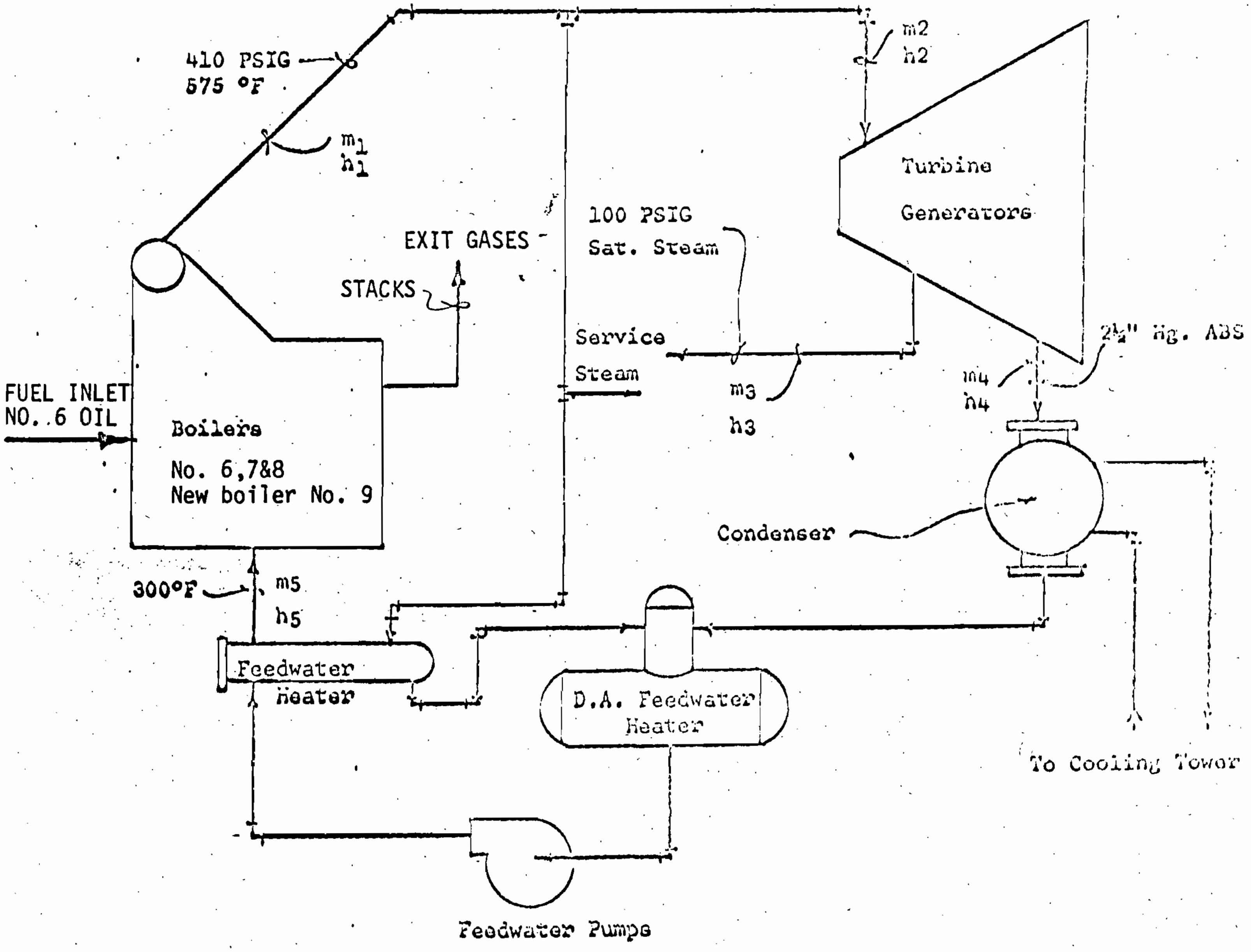
$$h_1 = 113{,}748{,}695 \text{ BTU/hr}$$

$$h_5 = (88{,}177 \text{ lb/hr})(269 \text{ BTU/lb})$$

$$= 23{,}719{,}613 \text{ BTU/hr}$$

$$E_{ff} = \frac{113{,}748{,}695 - 23{,}719{,}613}{117{,}498{,}000}$$

$$E_{ff} = .77$$



h_1 = 1290 Btu/# m_1 = 88,177 #/Hr

h_2 = 1290 Btu/# m2 = 71,469 #/Hr

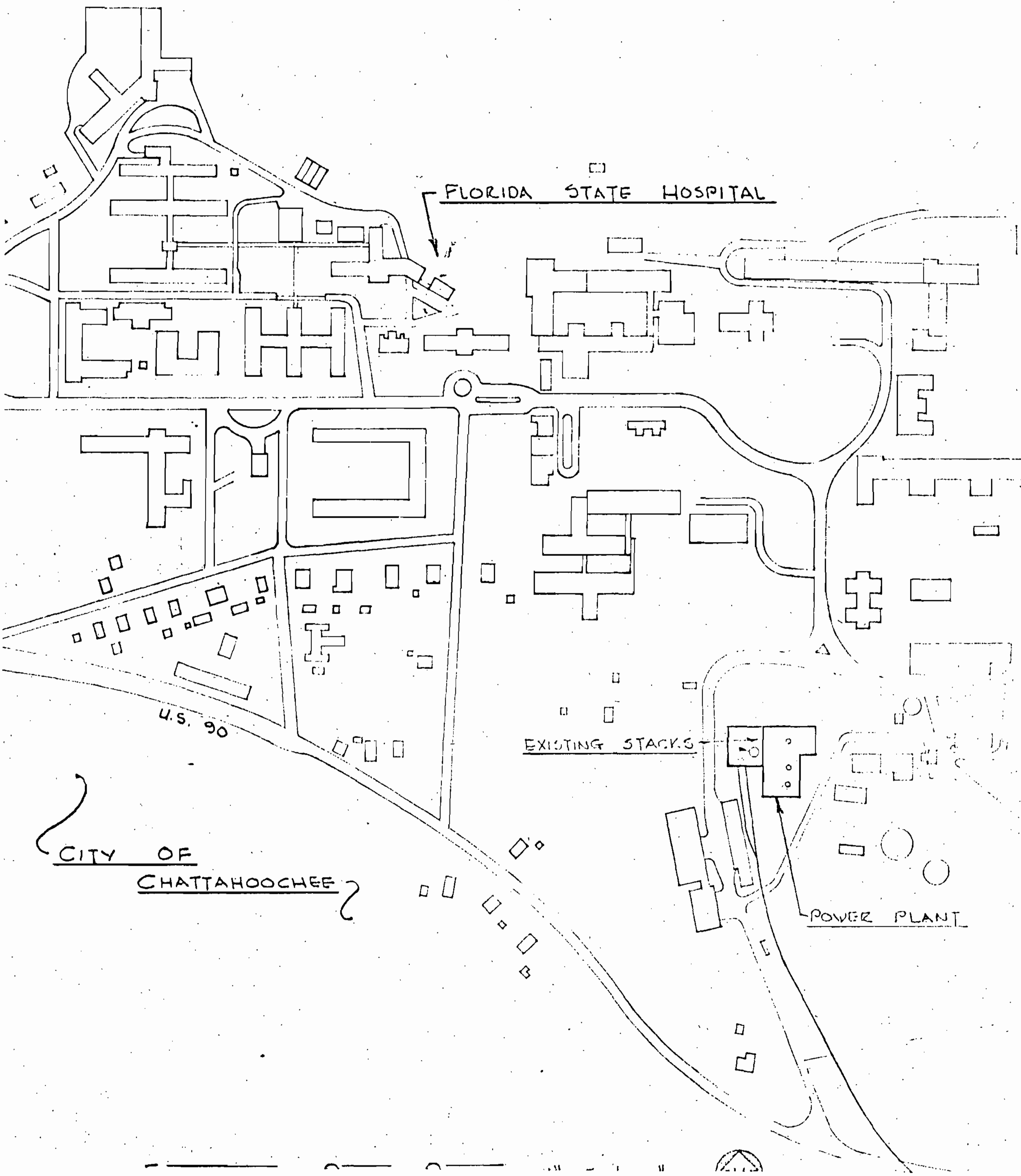
h_3 = 1189 Btu/# m3 = 44,156 #/Hr

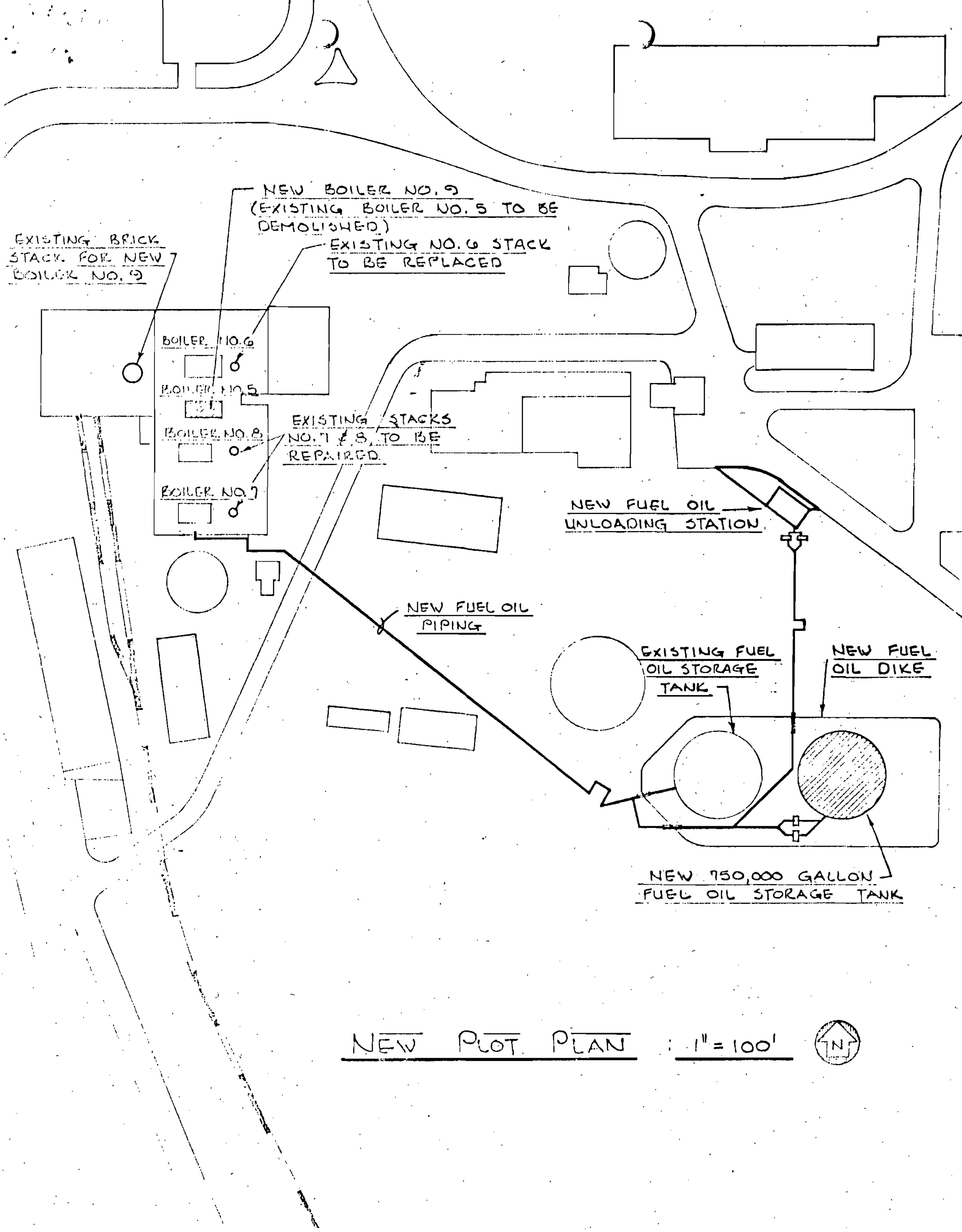
h_4 = 77 Btu/# m_4 = 27,313 #/Hr

h_5 = 269 Btu/# m5 = 88,177 #/Hr

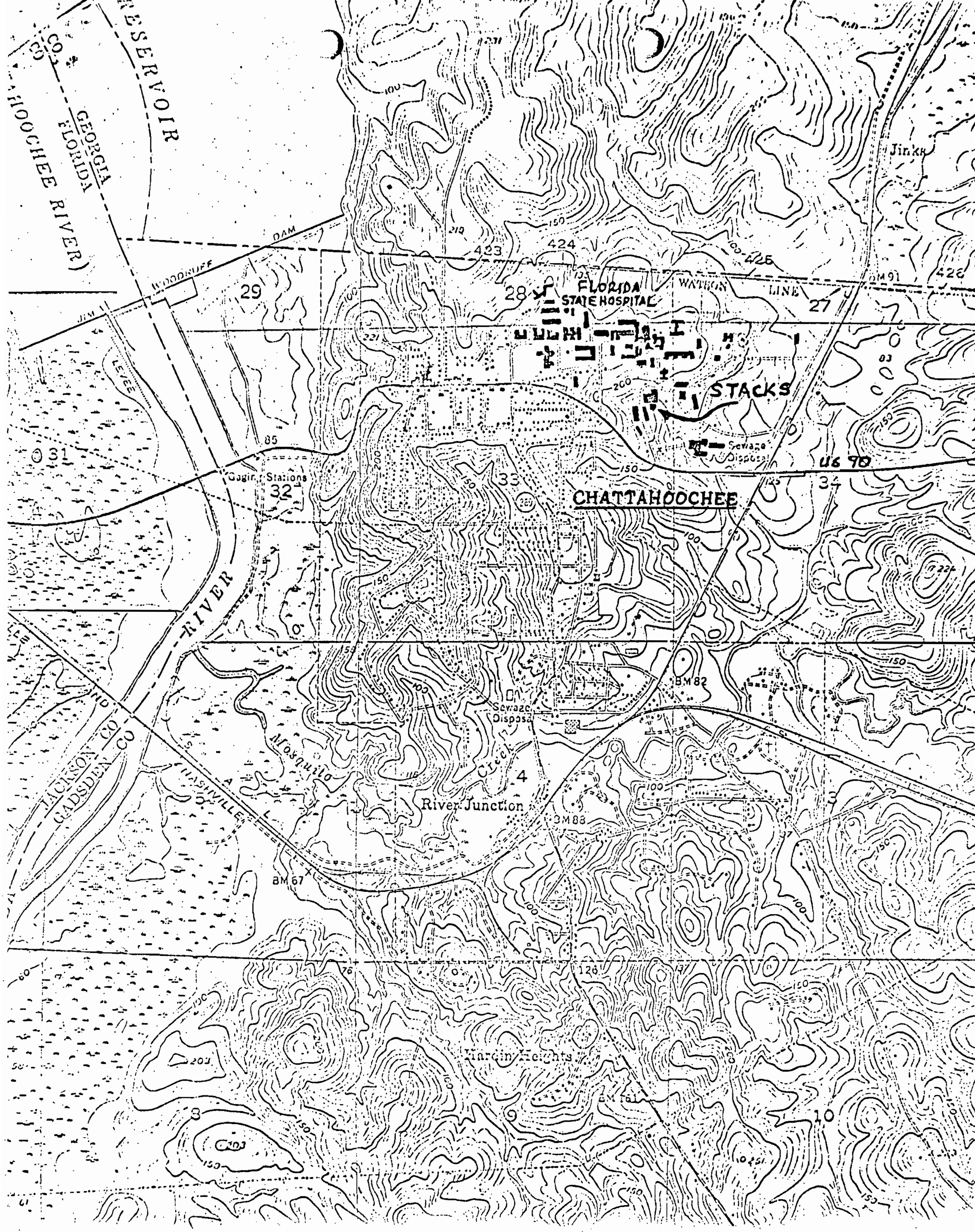
SCHEMATIC FLOW DIAGRAM

BEST AVAILABLE COPY





NEW PLOT PLAN : 1" = 100'


RESERVOIR
CO.
CO
GEORGIA
FLORIDA
HOOCHEE RIVER)
DAM
JIM WOODRUFF
LEVEE
29
28
423
424
426
426
BM 91
FLORIDA
STATE HOSPITAL
WATSON LINE
27
Jinks
STACKS
Sewage Disposal
US 90
85
31
Gaging Stations
32
33
34
CHATTAHOOCHEE
RIVER
BM 82
Sewage Disposal
Mosquito Creek
4
River Junction
BM 88
BM 67
JACKSON CO
GADSDEN CO
NASHVILLE
Hardin Heights
3
9
10
100
150
200

Central File Copy

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION
POST OFFICE BOX 838
1391 SHORELINE DRIVE
GULF BREEZE, FLORIDA 32561

JOSEPH W. LANDERS JR.
SECRETARY

June 29, 1976

Gadsden County - AP
Florida State Hospital

Mr. William D. Myers
Assistant Superintendent, Administrative
Florida State Hospital
Chattahoochee, Florida 32324

Dear Mr. Myers:

With reference to your recent applications, please find enclosed the permits to operate the air pollution sources stated in your applications.

These permits will expire as indicated and may be renewed after complying with the conditions and requirements checked or indicated otherwise in the attached sheet entitled "Operation Permit Conditions".

These permits are issued under the authority of Florida Statute 403.061 (16). The time limits imposed herein are a condition to these permits and are enforceable under Florida Statute 403.161 (1) (b). You are hereby placed on notice that the Department will review these permits before the scheduled date of expiry and will seek court action for violation of the conditions and requirements of these permits.

You have ten days from the date of receipt, hereof, within which to seek a review of the conditions and requirements contained in these permits.

Your continued cooperation in this matter is appreciated.

Mr. William D. Myers
June 29, 1976
Page two

The following permits for the subject air pollution sources are attached:

Permit Number	Source
AC20-2049	Boiler No. 9
AC20-2050	Modification to Boilers 6, 7 and 8

Sincerely,

P. J. Doherty, P. E.
District Engineer

PJD:CPS:ls

cc: Mr. Larry M. Simmons

Expires June 30, 1977

SERIAL № 00007

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

CONSTRUCTION PERMIT

FOR Florida State Hospital
Chattahoochee
Florida 32324

PERMIT NO. AC20-2049 DATE OF ISSUE June 21, 1976

PURSUANT TO THE PROVISIONS OF SECTIONS 403.061 (16) AND 403.707 OF CHAPTER 403 FLORIDA STATUTES AND CHAPTERS 17–4 AND 17–7 FLORIDA ADMINISTRATIVE CODE, THIS PERMIT IS ISSUED TO:

Mr. William D. Myers, Assistant Superintendent, Administrative

FOR THE CONSTRUCTION OF THE FOLLOWING:

Air Pollution Source: Boiler No. 9, a new 60,000 lb./hr. steam boiler, fired by No. 6 fuel oil. Unit replaces existing Boiler No. 5.

LOCATED AT Highway 90, Chattahoochee, Gadsden County, Florida.

IN ACCORDANCE WITH THE APPLICATION DATED April 15, 1976

ANY CONDITIONS OR PROVISOS WHICH ARE ATTACHED HERETO ARE INCORPORATED INTO AND MADE A PART OF THIS PERMIT AS THOUGH FULLY SET FORTH HEREIN. FAILURE TO COMPLY WITH SAID CONDITIONS OR PROVISOS SHALL CONSTITUTE A VIOLATION OF THIS PERMIT AND SHALL SUBJECT THE APPLICANT TO SUCH CIVIL AND CRIMINAL PENALTIES AS PROVIDED BY LAW.

THIS PERMIT SHALL BE EFFECTIVE FROM THE DATE OF ISSUE UNTIL June 30, 1977 OR UNLESS REVOKED OR SURRENDERED AND SHALL BE SUBJECT TO ALL LAWS OF THE STATE AND THE RULES AND REGULATIONS OF THE DEPARTMENT.

P. J. Doherty, P. E.
District Engineer

JOSEPH W. LANDERS, JR.
SECRETARY

DISTRICT MANAGER
Robert B. Dillard, Jr.

DER Form PERM 11–1 (Mar. 76)

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

CONSTRUCTION PERMIT PROVISOS

AIR POLLUTION SOURCES

Permit No. AC20-2049 Date: June 21, 1976

(x) 1. Construction of this installation shall be completed by June 30, 1977. Application for Permit to Operate to be submitted by June 30, 1977.

(x) 2. This construction permit expires on June 30, 1977 following an initial period of operation for appropriate testing to determine compliance with the Rules of the Department of Environmental Regulation.

(x) 3. All applicable rules of the Department including design discharge limitations specified in the application shall be adhered to. The permit holder may also need to comply with county, municipal, federal, or other state regulations prior to construction.

(x) 4. The applicant shall continue the retention of the engineer of record for the inspection of the construction of this project. Upon completion the engineer shall inspect for conformity to construction permit applications and associated documents. A report of such inspection shall be submitted by the engineer to the Department of Environmental Regulation for consideration toward the issuance of an operation permit.

(X) 5. This Boiler #9 shall be tested* for particulates and sulfur dioxide within 60 days after it is placed in operation. These test results are required prior to our issuance of an operation permit and shall be submitted in duplicate to the DER Northwest Florida District Office 1391 Shoreline Drive, RxxxxOffixxxxBxxxxxx Gulf Breeze, Florida 32561.
*FUEL ANALYSIS MAY BE SUBMITTED FOR REQUIRED SULFUR DIOXIDE EMISSION TEST.

(X) 6. The operation of this installation shall be observed for visible emissions in accordance with Method 9 - Visible Determination of the Opacity of Emissions from Stationary Sources (36FR24895; Federal Register, December 23, 1971). The observation results are required prior to our issuance of an operation permit, and shall be submitted in duplicate to the DER Northwest Florida District Office, 1391 Shoreline Drive, XXXXXXBXXXXXX, Gulf Breeze, Florida 32561.

(X) 7. Satisfactory ladders, platforms and other safety devices shall be provided/available as well as necessary ports to facilitate the carrying out of an adequate sampling program.

(x) 8. The maximum allowable emission of particulates is 4.70 pounds per hour based upon a total heat input of 47.0 million BTU per hour. At any lesser rates the allowable will be 0.1 pounds per million BTU from oil.

(x) 9. Visible emmision shall not exceed an opacity of 20% except that an opacity of 40% is permissible for not more than two (2) minutes in any hour.

(x) 10. Section 17-2.04 (6) (e) 2.c allows 2.75 pounds of sulfur dioxide per million BTU heat input when liquid fuel is burned. The maximum allowable emission of sulfur dioxide is 129.25 pounds per hour when totally fired by fuel oil at a heat input of 47.0 million BTU per hour. This section expires July 1, 1977 and these limits will be revised if this rule is changed.

Expires June 30, 1977

SERIAL № 00008

STATE OF FLORIDA DEPARTMENT OF ENVIRONMENTAL REGULATION

CONSTRUCTION PERMIT

FOR Florida State Hospital
Chattahoochee
Florida 32324

PERMIT NO. AC20-2050 DATE OF ISSUE June 21, 1976

PURSUANT TO THE PROVISIONS OF SECTIONS 403.061 (16) AND 403.707 OF CHAPTER 403 FLORIDA STATUTES AND CHAPTERS 17–4 AND 17–7 FLORIDA ADMINISTRATIVE CODE, THIS PERMIT IS ISSUED TO:

Mr. William D. Myers, Assistant Superintendent, Administrative

FOR THE CONSTRUCTION OF THE FOLLOWING:

Air Pollution Source: Modification of Boilers No. 6, 7 and 8 from firing pulverized coal to No. 6 fuel oil.

LOCATED AT Highway 90, Chattahoochee, Gadsden County, Florida.

IN ACCORDANCE WITH THE APPLICATION DATED April 15, 1976

ANY CONDITIONS OR PROVISOS WHICH ARE ATTACHED HERETO ARE INCORPORATED INTO AND MADE A PART OF THIS PERMIT AS THOUGH FULLY SET FORTH HEREIN. FAILURE TO COMPLY WITH SAID CONDITIONS OR PROVISOS SHALL CONSTITUTE A VIOLATION OF THIS PERMIT AND SHALL SUBJECT THE APPLICANT TO SUCH CIVIL AND CRIMINAL PENALTIES AS PROVIDED BY LAW.

THIS PERMIT SHALL BE EFFECTIVE FROM THE DATE OF ISSUE UNTIL June 30, 1977 OR UNLESS REVOKED OR SURRENDERED AND SHALL BE SUBJECT TO ALL LAWS OF THE STATE AND THE RULES AND REGULATIONS OF THE DEPARTMENT.

P. J. Doherty, P. E.
District Engineer

J W Landers Jr
JOSEPH W. LANDERS, JR.
SECRETARY

Robert B Dillard, Jr.
DISTRICT MANAGER
Robert B. Dillard, Jr.

DER Form PERM 11–1 (Mar. 76)

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

CONSTRUCTION PERMIT PROVISOS

AIR POLLUTION SOURCES

Permit No. AC20-2050 Date: June 21, 1976

(x) 1. Construction of this installation shall be completed by June 30, 1977. Application for Permit to Operate to be submitted by June 30, 1977.

(x) 2. This construction permit expires on June 30, 1977 following an initial period of operation for appropriate testing to determine compliance with the Rules of the Department of Environmental Regulation.

(x) 3. All applicable rules of the Department including design discharge limitations specified in the application shall be adhered to. The permit holder may also need to comply with county, municipal, federal, or other state regulations prior to construction.

(x) 4. The applicant shall continue the retention of the engineer of record for the inspection of the construction of this project. Upon completion the engineer shall inspect for conformity to construction permit applications and associated documents. A report of such inspection shall be submitted by the engineer to the Department of Environmental Regulation for consideration toward the issuance of an operation permit.

(x) 5. This Boiler 6, 7 & 8 shall be tested* for particulates and sulfur dioxide within 60 days after it is placed in operation. These test results are required prior to our issuance of an operation permit and shall be submitted in duplicate to the DER Northwest Florida District Office 1391 Shoreline Drive, ~~Post Office Box 838~~, Gulf Breeze, Florida 32561.
*FUEL ANALYSIS MAY BE SUBMITTED FOR REQUIRED SULFUR DIOXIDE EMISSION TEST.

(x) 6. The operation of this installation shall be observed for visible emissions in accordance with Method 9-- Visible Determination of the Opacity of Emissions from Stationary Sources (36FR24895; Federal Register, December 23, 1971). The observation results are required prior to our issuance of an operation permit, and shall be submitted in duplicate to the DER Northwest Florida District Office, 1391 Shoreline Drive, ~~P.O. Box 838~~, Gulf Breeze, Florida 32561.

(x) 7. Satisfactory ladders, platforms and other safety devices shall be provided/available as well as necessary ports to facilitate the carrying out of an adequate sampling program.

(x) 8. The maximum allowable emission of particulates is 4.70 pounds per hour based upon a total heat input of 47.0 million BTU per hour. At any lesser rates the allowable will be 0.1 pounds per million BTU from oil. (each boiler)

(x) 9. Visible emmision shall not exceed an opacity of 20% except that an opacity of 40% is permissible for not more than two (2) minutes in any hour.

(x) 10. Section 17-2.04 (6) (e) 2.c allows 2.75 pounds of sulfur dioxide per million BTU heat input when liquid fuel is burned. The maximum allowable emission of sulfur dioxide is 129.25 pounds per hour when totally fired by fuel oil at a heat input of 47.0 million BTU per hour. This section expires July 1, 1977 and these limits will be revised if this rule is changed. (each boiler)

(x) 11. An individual application must be filed to operate each boiler once the modification is complete (3 applications).

DER BAQM 80-003

STATE OF FLORIDA
DEPARTMENT OF
ENVIRONMENTAL REGULATION

FEBRUARY, 1980

COMPLIANCE TEST
CHATTAHOOCHEE STATE HOSPITAL
NO. 8 BOILER
WOODEX, COAL, COAL/WOODEX BURN

DER BAQM 80-003

STATE OF FLORIDA
DEPARTMENT OF
ENVIRONMENTAL REGULATION

FEBRUARY 1980
COMPLIANCE TEST
CHATTAHOOCHEE STATE HOSPITAL
NO. 8 BOILER
WOODEX, COAL, COAL/WOODEX BURN

PREPARED BY
BUREAU OF AIR QUALITY MANAGEMENT
OPERATIONS AND EVALUATION
SECTION

TABLE OF CONTENTS

Introduction

A series of particulate emission tests were performed on the Department of Health and Rehabilitation Service's (DHRS) steam boiler number eight, at the Chattahoochee State Hospital on January 21 through 25 and January 29. Fourteen test runs were performed on a variety of boiler fuels. EPA Method 5 was used for each test run (Standard Sampling Techniques and Methods for Analysis for the Determination of Air Pollutants from Point Sources, July, 1975). A number of additional tests, to be described, were performed on the samples collected.

The emission tests were conducted at the request of Mr. Jim Ford, DHRS Facilities Services. DHRS and Florida Department of Agriculture are exploring the possibility of converting steam boilers from oil to wood or wood-coal fuels in response to shortages of oil.

DISCLAIMER

The mention of trade names or commercial products in this report does not constitute an endorsement or recommendation by the Florida Department of Environmental Regulation.

LIST OF TABLES

Summary

Particulate Emissions

The steam boiler and associated equipment at Chattahoochee State Hospital was originally designed to burn pulverized coal which is blown into the boiler through two burners. The coal burners were modified to accept oil guns when the unit was unable to meet particulate emission levels. During the current test period the boiler was unable to meet emission standards at half load or full load while burning oil (Table one). Half load wood particulate emission rates were six times higher than oil. Coal emission rates were about twenty-two times higher than oil emissions at half load. The combined wood-coal emissions were in proportion to the weight of each fuel burned. There was no evidence of any interaction effect, whereby emissions were increased or decreased by burning wood and coal simultaneously.

In order to meet particulate compliance limits, additional pollution control devices would have to be installed on the boiler. Wood-waste fuels are used extensively in Florida's pulp and paper industry. Emission levels of 0.1 lbs./million BTU or better are routinely attained with convential equipment. A number of pollution control systems are available depending on boiler conditions and fuel characteristics.[1] The sugar industry in South Florida operates a large number of small boilers fired on sugar cane residue which closely resembles the wood fuel used at Chattahoochee. Most sugar mill boilers use low-energy wet scrubbers to comply with emission limiting standards. Selection of suitable control equipment at Chattahoochee appears to be a straight forward engineering problem with a range of suitable solutions.

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1. Wood Residue-Fired Steam Generator Particulate Matter Control Technology Assessment. EPA, 450/2-78-044, October, 1978.

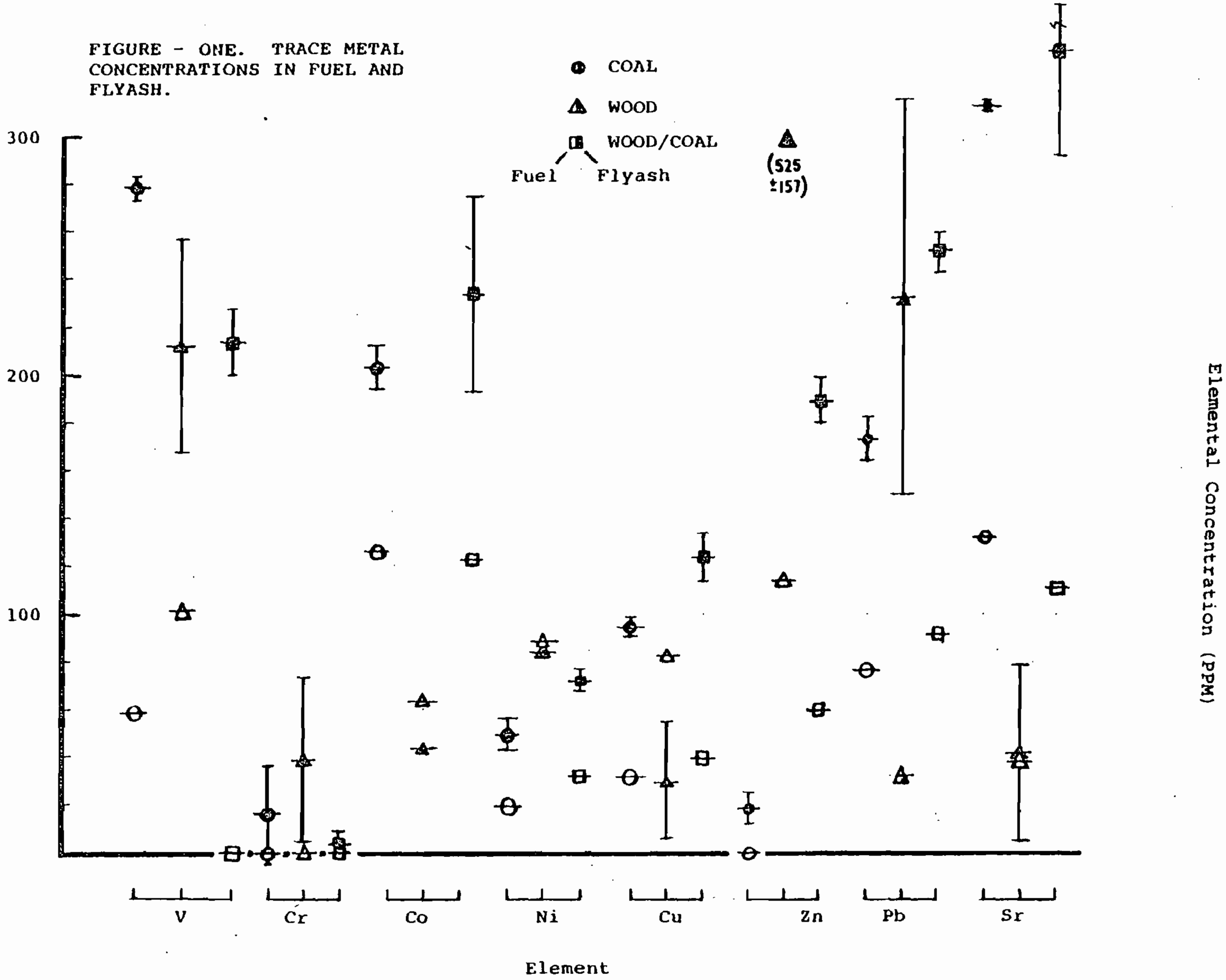
Three solid fuel samples and 11 flyash samples were analyzed for 22 elements using PIXE[1] analysis (Table Five). The average concentrations of eight metals and the corresponding fuel metal contents are displayed in Figure One. In 17 cases metals were concentrated in the flyash. In 6 cases fuel and flyash concentrations were approximately equal and in one case flyash concentrations were lower. This is consistent with other findings for coal-fired emissions.[2] The metal content of flyash emissions can be expected to be relatively higher than the metal content of fuel burned. Since fossil fuels generally have higher metal contents than wood fuels their emissions will be correspondingly more toxic.

Sulfur in fuels primarily enters the atmosphere as SO^2, H_2S, SO_3, and H_2SO_4 with traces of metal sulfates. Wood contains relatively small amounts of sulfur compared to fossil fuels (Table Six) and therefore releases less sulfur when burned. Sulfur contents in fossil fuels are expected to increase as oil sources are depleted and as coal usage increases. Significant increases in wood use can help reduce levels of atmospheric sulfates and sulfur oxides.

[1] Proton Induced X-Ray Emission

[2] Davison, R. L., D. F. S. Natusch, J. R. Wallace, and C. A. Evans, Jr. Trace Elements in Fly Ash. Envir. Sci. and Tech 8 (13): 107-1113.

FIGURE - ONE. TRACE METAL CONCENTRATIONS IN FUEL AND FLYASH.



Carbon dioxide is produced by all combustion processes. The carbon dioxide from fossil fuels originated from the ancient atmosphere present when the fuels were deposited, and it is remixed into today's atmosphere upon burning. About 20 thousand million tons (20×10^9 tons/year) of carbon dioxide are added to the atmosphere each year.[1] The widespread and increasing use of fossil fuels has increased the amount of carbon dioxide in the air world-wide. This has resulted in a 10 to 18 percent increase since about 1850 and doubling is expected by 2050. Coal releases 25% more carbon dioxide than oil when burned. Increased coal usage will accelerate the rate of increase, leading to perhaps a five-fold increase as coal deposits are utilized over the next 1000 years. Unlike oxygen and nitrogen, carbon dioxide absorbs infrared radiation. This will probably result in an increase in average world temperature and other climatic changes.[2] New methods of managing fossil fuels may modify these results.

When wood is burned, the carbon dioxide released originates from the modern atmosphere. Forests convert atmospheric carbon dioxide into the plant body through photosynthesis. Thus burning wood fuels can help stabilize the increase of carbon dioxide by recycling carbon dioxide already present in the atmosphere.

1. Man's Global Redistribution of Carbon. A. Bjorkstrom. Ambio 8 (6): 245-259, 1979.

2. The Carbon Dioxide Report. G. M. Woodwell, G. O. MacDonald, R. Revelle, C. D. Kedling. The Bulletin of Atomic Scientists, 56-57, October, 1979.

Scanning electron micrography (SEM) of the fuels (page 5-9) reveals the amorphous, torn-fiber structure of the wood fuel (#3, #3) which sharply contrasts with discrete, angular broken crystalline coal powder (#6). The combined fuel photograph (#4) seems to indicate a high proportion of coal. This conclusion is also substantiated by comparing the fuel analysis for coal, wood, and wood/coal (pages 5-5, 6, 7), and also by the ratios of emissions for the corresponding runs.

The oil flyashes (page 5-10) at half load (#7, #9) contain unidentified fibrous particulate which was absent at full load (#13).

Wood flyash (page 5-11) contains three predominant particules types; small spherules (.001-.01 mm); spongy, amorphous masses; sharp-edged irregular particles. The small spheres again appear in the combined fuel flyash (page 5-12) along with much larger spherical particles (.037mm). The coal flyash (#5, 5A) consists mainly of fine, amorphous ash, spherical particles (.001-.01mm) and spongy irregular masses with spherical openings (#5). This latter particulate resembles the spongy particulate in the combined fuel flyash (#2, #12) although the openings are smaller in the coal flyash. An electron microprobe analysis would help determine the composition of the large spheres and the spongy particules which are apparently the result of interaction of the fuels.

SECTION 1

TEST CONDITIONS AND METHODS

SECTION 1

Test Conditions and Methods

The emission tests on the number eight boiler were performed to compare the particulate emissions for four fuel combinations: oil (present fuel); coal (boiler design fuel); wood and wood-coal (proposed fuels). The boiler was operated at approximately equivalent outputs and constant rate for each test run. The boiler output was maintained at approximately one half load[1] for each test run, since the coal pulverizers could only produce enough wood powder to run the boiler at this rate. The emission data produced are therefore suitable only for relative comparison of particulate outputs. Full load emission levels are expected to be higher by about the same proportion as the oil full load to half load tests.

Boiler calibrations and operation were monitored by Mr. Joe Mollick of Thermoelectron Corp., Orlando, Florida, and by Dr. James. K. Beck of the Univ. of Central Florida, Mechanical Engineering Departmant. Boiler operating characteristics are detailed in that group report.

Boiler heat output was estimated using the F-factor method for emission computations. Oxygen analysis of boiler flue gases was performed with a Lynn Oxygen Analyzer calibrated with air.

[1] 28,000 lbs. steam/hr., test load, 60,000 lbs. steam, rated full load.

The boiler was fired with "Woodex" for six runs "Woodex"is a proprietary product consisting of wood. wastes compacted into pellets for ease of handling and storage. The pellets are pulverized to approximately 200 mesh size immediately preceding injection into the boiler.

Fuel samples were collected immediately before the boiler burners for later analysis. A single grab sample was collected for the coal and wood burns. Integrated 30 gram samples were collected at 12 minute intervals during the entire wood/coal run series. The integrated samples were combined and thouroughly mixed before analysis. Trace element analysis[1] was performed at the Florida State University tandem Van de Graff accelerator by Dr. Sene Bauman. The powdered fuels were pelletized and treated as solid targets.

Small samples were removed from the stack filters for analysis scanning electron microscopy.

Stack sample filters were examined and photographed using scanning electron microscopy by Mr. William Miller, FSU Department of Biological Sciences. (pages 5-9 through 5-12). A small section of selected filters was removed and examined under the microscope and representative views were photographed. Bulk samples of the fuels and coal flyash which accumulated in the filter bell were removed and examined.

---

1. "PIXE" analysis was used. Proton induced X-ray Emission analysis.

SECTION 2

TEST RESULTS

SECTION 2

TEST RESULTS

The average emission levels for each fuel are presented in Table One. All tested emissions were in violation of FAC 17-2 particulate emission limiting standards. Visible emission levels as observed by Ms. Mary Jean O'Neil and Mr. Tom Amdrews (FDER) are tabulated.

Table One: Average Particulate Emissions and Visible Emissions for four fuels.

Fuel	Emission avg. (s.d.)	Number of Runs	Emission Limiting Standard lbs/10^6BTU	Visual Emission % Opacity
Oil	0.17 (0.03)	3	0.1	10
Oil[1]	0.22 -	1	0.1	-
Coal	3.76 -	1	0.1	47
Woodex	1.05 (0.10)	6	0.3	18.3
Wood/coal[2]	2.78 (0.01)	3	0.175	31

1. Oil emissions at full load, one test run.
2. Wood/coal mixed at 50%/50% by volume, 37.5%/62.5% by weight so E= .375(.3)+.625(.1)=.175.
3. s.d. - standard deviation.

Table Two

Particulate Emissions for Individual Test Runs

Date	Run	Fuel	Emission $lbs/10^6$ BTU
1-12-80	6	Oil	0.216*
1-21	6A	Oil	0.134
1-29	6B	Oil	0.183
1-29	6C	Oil	0.199
1-22	B101	Woodex^R	1.11
1-22	B102	Woodex	.977
1-22	B103	Woodex	1.19
1-23	B104	Woodex	.938
1-23	B105	Woodex	.956
1-23	B106	Woodex	1.11
1-24	Coal 1	Coal	3.76
1-25	CW 1	Coal/Woodex	2.79
1-25	CW 2	Coal/Woodex	2.77
1-25	CW 3	Coal/Woodex	2.77

*full load test

SECTION 3

CONCLUSIONS

Section 3

Conclusions

1. All emission levels tested exceeded FAC 17-2 emission limiting standards.

2. Wood particulate levels are intermediate between coal and oil.

3. A variety of pollution control equipment which can adequately control wood-fired boiler particulate emissions is available and in use throughout Florida.

4. Metals are generally concentrated in flyash emissions. Flyash metal levels correlate with fuel metal levels.

5. Wood sulfur emissions are lower than fossil fuel emissions.

6. Wood fuel carbon dioxide emissions consist entirely of recycled carbon dioxide and are therefore zero. Coal carbon dioxide emissions are 25% higher than oil carbon dioxide emissions.

SECTION 4

FIELD DATA SHEETS
ANALYTICAL DATA
AND EMISSION CALCULATIONS

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K= 2.3
PLANT FSH UNIT #8 Full Load DATE 1-21-80
RUN NO. OIL #6 FILTER.NO. 328 NOZZLE ID. 8 d 0.246 IN A_N .00033 FT2
P_b 30.07 ΔH 1.725 Y 0.999 PITOT ID. Nu-O C_p 0.84

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-2	546.345	0.04	0.09	0.09	75	87	1	231	69
2	4		0.05	0.12	0.12	92	88	1	237	65
3	6		0.06	0.14	0.14	270	89	1	242	62
4	8		0.08	0.19	0.19	295	89	1	245	60
5	10		0.09	0.21	0.21	320	89	1	245	60
6	12		0.09	0.21	0.21	322	89	1	249	59
7	14		0.08	0.19	0.19	322	90	1	250	59
8	16		0.09	0.21	0.21	322	90	1	252	59
9	18		0.11	0.26	0.26	322	90	1	254	59
10	20		0.13	0.31	0.31	322	90	1	255	59
11	22		0.12	0.28	0.28	321	90	1	257	60
12	24		0.12	0.28	0.28	321	91	1	259	60
13	26		0.13	0.31	0.31	321	91	1	260	63
14	28		0.14	0.33	0.33	321	91	1	260	63
15	30		0.14	0.33	0.33	320	91	1	260	63
16	2		0.14	0.33	0.33	319	91	1	260	63
1	0-2		0.12	0.28	0.28	289	91	1	259	65
2	4		0.11	0.26	0.26	315	91	1	255	61
3	6		0.12	0.28	0.28	315	91	1	255	59
4	8		0.12	0.28	0.28	320	91	1	253	59
5	10		0.12	0.28	0.28	322	91	1	252	59
6	12		0.12	0.28	0.28	324	91	1	251	59
7	14		0.13	0.31	0.31	327	90	1	251	59
8	16		0.12	0.28	0.28	329	90	1	249	59
9	18		0.17	0.40	0.40	332	90	2	249	59
10	20		0.25	0.59	0.59	334	90	3	249	57
11	22		0.24	0.57	0.57	334	90	3	248	55
12	24		0.24	0.57	0.57	330	90	3	245	57
13	26		0.24	0.57	0.57	290	90	3	245	59
14	28		0.23	0.54	0.54	175	90	3	244	60
15	30		0.16	0.38	0.38	104	90	2	243	62
16	2	567.288	0.11	0.26	0.26	94	90	2	242	62

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		12.3		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	230	718.0
INITIAL	200	716.2
CHANGE	30	1.8

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	JG	JG	
PITOT LINES	JG	JG	
CONSOLE			

DATE 1-21-80
PLANT FSH-CHATT
STACK #8
RUN 6 (oil)
FILTER 328

From Previous Run Data
$(1-B_{ws})$ ______
1 $\overline{T}_s$ ______ °R
2 $\overline{T}_m$ ______ °R

CALIBRATION
5 $\Delta H_@$ 1.72
4 C_p .84
17 Y .9987
6 D_n .246 IN
1 A_n .00033086 FT²

NEW DATA
16 P_b 30.07 "Hg
18 V_M 20.94 CF
15 $\overline{\Delta H}$ .310 "H_2O
14 $\overline{T}_m$ 550.06 °R
13 H_2O 30 ML
12 H_2O 1.8 g
11 CO_2 ______ %
10 O_2 12.3 %
6 $\sqrt{\Delta P}$ avg .355
5 $\overline{T}_s$ 944.96 °R
4 P_s 30.07 "Hg
3 A_s 11.74 FT²
2 θ 1.067 HR
5' M_n 88.9 Mg

$$K = 349.8\,(D_n)^4\,\Delta H_@\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$

$$= 349.8\,(.25)^4(1.72)(.84)^2(.90\ )^2\,\frac{(535)}{(750)} = \underline{2.3}$$

$$V_m(STD) = \frac{17.64\,V_m\,Y\left(P_b + \Delta H/13.6\right)}{T_m}$$

$$= \frac{17.64\,(2094)\,(.9987)\left(30.07 + \frac{.310}{13.6}\right)}{(\quad)} = \underline{20.18}\ \text{DSCF}$$

$$V_{wc}(STD) = 0.04707\,(H_2O_C) = 0.04707\,(30) = \underline{1.412}\ \text{SCF}$$

$$V_{wSG}(STD) = 0.04715\,(H_2O_{SG}) = 0.04715\,(1.8) = \underline{.085}\ \text{SCF}$$

$$V_w(STD)\ \underline{1.497}\ \text{SCF}$$

$$B_{ws} = \frac{V_w(STD)}{V_w(STD) + V_m(STD)} = \frac{(1.497)}{(1.497) + (2018)} = \underline{.069}$$

$$M_d = 0.44\,(\%CO_2) + 0.32\,(\%\ O_2) + 0.28\,(\%CO+N_2)$$
$$= 0.44\,(\quad) + 0.32\,(\quad) + 0.28\,(\quad) = \underline{30}$$

$$M_s = M_d\,(1-B_{ws}) + 18\,(B_{ws}) = (30)(.931) + 18(.069) = \underline{29.172}$$

$$\overline{V}_s = 85.49\,C_p\,(\sqrt{\Delta P})\,\text{avg.}\sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.49\,(.84)(.355)\sqrt{\frac{(944.96)}{(30.07)(29.172)}} = \underline{23.49}\ \text{FT/SEC}$$

$$\overline{Q}_s = 63500\,\overline{V_s}\,(1-B_{ws})\,A_s\,(P_s/T_s)$$

$$= 63500\,(23.49)(.931)(11.74)\frac{(30.07)}{(944.96)} = \underline{658\text{ k}}\ \text{CFH}$$

$$\%I = \frac{100\,V_m(STD)\,A_s}{\theta\,\overline{Q}_s\,A_n} = \frac{100\,(2018)(11.74)}{(1.067)(658k)(.00033086)} = \underline{101.9}$$

$$C_s = \frac{M_n}{454{,}000\,V_m(STD)} = \frac{(88.9)}{454{,}000\,(2018)} = \underline{9.70\times10^{-6}}\ \text{LB/CF}$$

$$PMR = C_s\,\overline{Q}_s = (9.7\times10^{-6})(658K) = \underline{6.38}\ \text{LB/HR}$$

$$E = C_s\,F_d\,\frac{20.9}{20.9-\%O_2} = (9.7\times10^{-6})(9190)\,\frac{20.9}{20.9-(12.3)} = \underline{.216}\ \text{LB}/10^6\,\text{BTU}$$

DATE 1-21-80

PLANT FSH - CHATTAHOOCHEE

STACK #8

RUN 6 (011)

FILTER 328

06	Dn		in
05	ΔH_a		"H_2O
04	Cp		const.
03	Bws		fract sat.
02	Tm		°R
01	Ts		°R

18	Vm	20.943	CF
17	γ	.99871	const.
16	Pb	30.07	"Hg
15	$\overline{\Delta H}$	.310	"H_2O..
14	Tm	550.06	°R
13	H_2Oc	30	Ml
12	H_2Osg	1.5	G.
11	% CO_2	1	%
10	% O_2	1	%
09	% CO	1	%
08	% N_2	103.43	%
07	Cp	.84	const.
06	$(\overline{N\Delta P})$ Ave	.355	"H_2O
05	Ts	744.96	°R
04	Ps	30.07	"Hg
03	As	11.74	Ft^2
02	θ	1.067	Hr
01	An	.00033086	Ft^2

05	Mn	58.9	Mg
04	$\underline{Vm}$(STD)	20.204	CF
03	$\overline{Qs}$	658K	SCFH
02	Fd	9190	dscf/10^6BTU
01	%O_2.	12.3	

B = Cs 9.69×10^{-6}

C = PMR 6.37

D = E 0.216

B = Vm(STD)	20.20	DSCF
C = Vw(STD)	1.49	SCF
D = Bws	.068	fract. sat.
E = Md	30.00	AMU
A' = $\underline{Ms}$	29.17	AMU
B' = $\overline{Vs}$	23.49	Ft/sec
C' = $\overline{Qs}$	658K	SCFH
D' = %I	102.04	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K=2.3

PLANT ESH UNIT #8 DATE 1-21-80

RUN NO. OIL #6A FILTER NO. 336 NOZZLE ID. 81 d ______ IN A_N ______ FT²

P_b 30.07 ΔH ______ Y ______ PITOT ID. ______ C_p ______

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-2	567.38	0.55	1.3	1.3	381	91	3	234	55
2	4		0.55	1.3	1.3	382	91	3	249	52
3	6		0.57	1.3	1.3	383	92	3	260	51
4	8		0.60	1.4	1.4	384	93	3	265	53
5	10		0.55	1.3	1.3	385	94	3	269	55
6	12		0.53	1.2	1.2	385	95	3	269	59
7	14		0.50	1.15	1.15	385	95	3	267	61
8	16		0.45	1.0	1.0	385	95	3	265	62
9	18	-	0.27	0.62	0.62	385	95	2.5	265	63
10	20		0.20	0.46	0.46	385	95	2	263	63
11	22		0.17	0.39	0.39	384	94	2	261	63
12	24		0.15	0.35	0.35	384	93	2	259	62
13	26		0.15	0.35	0.35	383	93	2	257	62
14	28		0.15	0.35	0.35	379	93	2	255	61
15	30		0.13	0.30	0.30	364	93	2	254	61
16	2	583.51	0.10	0.23	0.23	244	93	1.5	252	61
1	0-2		0.88	2.0	2.0	383	93	5	243	61
2	4		0.95	2.2	2.2	387	93	6	243	57
3	6		1.0	2.3	2.3	388	94	7	242	59
4	8		1.0	2.3	2.3	388	94	7	247	62
5	10		0.95	2.2	2.2	388	95	7	251	64
6	12		0.80	1.8	1.8	389	95	6.5	253	65
7	14		0.70	1.6	1.6	389	95	6	247	57
8	16		0.60	1.4	1.4	389	95	5.5	259	53
9	18		0.30	0.69	0.69	386	95	4	253	53
10	20		0.30	0.69	0.69	386	95	4	252	53
11	22		0.33	0.76	0.76	385	95	4	244	52
12	24		0.35	0.80	0.80	385	95	4	245	52
13	26		0.35	0.80	0.80	385	95	4	245	52
14	28		0.38	0.87	0.87	381	95	5	245	51
15	30		0.36	0.83	0.83	355	95	4.5	247	51
16	3	604.53	0.30	0.69	0.69	275	95	4	249	52

GAS ANALYSIS	%CO₂	%O₂	%CO	%N₂
		7.3		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	267	638.1
INITIAL	200	627.0
CHANGE	67	11.1

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	[illegible]	[illegible]	
PITOT LINES	[illegible]	[illegible]	
CONSOLE			

DATE 1-21-80
PLANT PSH-CHATT
STACK #8
RUN 6A (w/)
FILTER 336

From Previous Run Data
$(1-B_{ws})$ ______
1 $\overline{T}_s$ ______ °R
2 $\overline{T}_m$ ______ °R

CALIBRATION
5 $\Delta H_@$ 1.72
4 Cp .84
17 γ .99871
6 D_n .250 IN
1 A_n .00034 FT^2

NEW DATA
16 P_b 30.07 "Hg
18 V_M 37.15 CF
15 ΔH 1.051 "H_2O
14 $\overline{T}_m$ 554.03 °R
13 H_2O 67 ML
12 H_2O 11.1 g
11 CO_2 ______ %
10 O_2 7.3 %
6 $\sqrt{\Delta P}$ avg .659
5 $\overline{T}_s$ 835.53 °R
4 P_s 30.07 "Hg
3 A_s 11.74 FT^2
2 θ 1.067 HR
5' M_n 154 Mg

$$K = 849.8\,(D_n)^4 \Delta H_@ \,(C_p)^2(1-B_{ws})^2\, T_m/T_s$$

$$= 849.8\ (\quad)^4(\quad)(\quad)^2(\quad)^2 \frac{(\quad)}{(\quad)} = \_\_\_\_$$

$$V_{m(STD)} = \frac{17.64\, V_m\, \gamma\left(P_b + {\Delta H}/{13.6}\right)}{T_m}$$

$$= \frac{17.64\ (37.15)\,(.9987)\left(30.07 + \frac{1.051}{13.6}\right)}{(554.03)} = 35.61 \text{ DSCF}$$

$$V_{wc(STD)} = 0.04707\ (H_2O_C) = 0.04707\ (67) = 3.15 \text{ SCF}$$

$$V_{wSG(STD)} = 0.04715\ (H_2O_{SG}) = 0.04715\ (11.1) = .52 \text{ SCF}$$

$$V_{w(STD)}\ 3.67 \text{ SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(35.61)}{(3.67)+(35.61)} = .09$$

$$M_d = 0.44\ (\%CO_2) + 0.32(\%\ O_2) + 0.28(\%CO+N_2)$$

$$= 0.44\ (\quad) + 0.32(\quad) + 0.28(\quad) = 30$$

$$M_s = M_d\ (1-B_{ws}) + 18(B_{ws}) = (30\ )(.91) + 18(.09\ ) = 28.82$$

$$\overline{V}_s = 35.49\ C_p\ (\sqrt{\Delta P})\text{avg.} \sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.49\ (.84\ )(.659)\sqrt{\frac{(835.53)}{(30.07)\,(28.82)}} = 46.46 \text{ FT/SEC}$$

$$\overline{Q}_s = 63500\ \overline{V}_s\ (1-B_{ws})\ A_s\ (P_s/T_s)$$

$$= 63500\ (46.46)\,(.91\ )\,(11.74)\frac{(30.07\ )}{(835.53)} = 113\text{K CFH}$$

$$\%I = \frac{100 V_{m(STD)} A_s}{\theta\ \overline{Q}_s\ A_n} = \frac{100\,(35.61)\,(11.74)}{(1.067)\,(113K)\,(.00034 ft)} = 101.35$$

$$C_s = \frac{M_n}{454{,}000 V_{m(STD)}} = \frac{(154\ )}{454{,}000\,(35.61)} = 952\text{x}10^{-6} \text{ LB/CF}$$

$$PMR = C_s\ \overline{Q}_s = (9.52\text{x}10^{-6})(113K) = 10.79 \text{ LB/HR}$$

$$E = C_s\ F_d\ \frac{20.9}{20.9-\%O_2} = (9.52\text{x}10^{-6})\left(9190\ \frac{20.9}{20.9-7.3}\right) = .134 \text{ LB}/10^6\text{BTU}$$

DATE 1-21-80

PLANT FSH-CHATTAHOOCHEE

STACK #8

RUN 6A (oil)

FILTER 336

06 Dn		in
05 ΔHa		"H_2O
04 Cp		const.
03 Bws		fract sat.
02 Tm		°R
01 Ts		°R

18 Vm	37.15	CF
17 γ	.9987	const.
16 Pb	30.07	"Hg
15 ΔH	1.051	"H_2O
14 Tm	559.03	°R
13 H_2Oc	67	Ml
12 H_2Osg	11.1	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	103.43	%
07 Cp	.84	const.
06 $(N\overline{\Delta P})$ Ave	.657	"H_2O
05 Ts	835.53	°R
04 Ps	30.07	"Hg
03 As	11.74	Ft^2
02 θ	1.067	Hr
01 An	.00034088	Ft^2

05 Mn	154	Mg
04 Vm(STD)	35.619	CF
03 Cs	11298	SCFH
02 Fd	9190	dscf/10^6BTU
01 %O_2	7.3	

B = Cs 9.52×10^{-6}

C = PMR 10.75

D = E 0.134

B = Vm(STD)	35.61	DSCF
C = Vw(STD)	3.67	SCF
D = Bws	.093	fract. sat.
E = Md	30.00	AMU
A' = Ms	28.87	AMU
B' = Vs	46.41	Ft/sec
C' = Cs	11298	SCFH
D' = %I	101.80	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049 -0004
SER. NO. K= 2.4
PLANT FSH
UNIT #8
DATE 1-29-80
RUN NO. 016 6b
FILTER NO. 168
NOZZLE ID. 8
d 0.25 IN
A_N .00033 FT2
P_b 30.13
ΔH
Y
PITOT ID.
C_p

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-3	606.583	0.12	0.288		244	77	1	265	53
2	6		0.22	0.528		291	76	2	269	45
3	9		0.25	0.60		310	76	2	269	44
4	12		0.25	0.60		319	76	2	264	44
5	15		0.24	0.576		319	75	2	263	45
6	18		0.21	0.504		318	75	2	257	45
7	21		0.20	0.48		317	76	2	258	46
8	24		0.15	0.36		316	76	2	258	49
9	27		0.13	0.312		316	77	1.5	258	49
10	30		0.13	0.312		316	77	1.5	258	48
11	3		0.13	0.312		315	78	1.5	258	48
12	6		0.15	0.36		315	78	1.5	260	48
13	9		0.15	0.36		314	79	1.5	257	49
14	12		0.16	0.384		313	80	1.5	260	49
15	15		0.15	0.36		319	80	1.5	260	49
16	18	623.33	0.13	0.312		311	81	1.5	262	50
1	0-3		0.12	0.288		307	81	1.5	256	54
2	6		0.12	0.288		310	82	1.5	255	51
3	9		0.12	0.288		312	82	1.5	255	51
4	12		0.12	0.288		313	83	1.5	253	52
5	15		0.12	0.288		313	83	1.5	251	52
6	18		0.12	0.288		313	83	1.5	253	52
7	21		0.12	0.288		314	84	1.5	254	53
8	24		0.11	0.264		314	84	1.5	252	53
9	27		0.10	0.24		315	84	1.5	252	53
10	30		0.10	0.24		315	85	1.5	253	54
11	3		0.11	0.264		314	85	1.5	253	54
12	6		0.11	0.264		315	85	1.5	253	56
13	9		0.11	0.264		313	85	1.5	258	54
14	12		0.10	0.24		308	86	1.5	254	55
15	15		0.09	0.216		297	86	1.5	252	55
16	18	636.817	0.07	0.168		165	86	1.5	256	56

GAS ANALYSIS	$\%CO_2$	$\%O_2$	%CO	$\%N_2$
		10.0		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	250	622.8
INITIAL	200	616.8
CHANGE	50	6.0

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	BK	JG	
PITOT LINES	BK	JG	
CONSOLE			

DATE 1-29-80
PLANT FSU-CHATT
STACK #4
RUN 6b (oil)
FILTER 168

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION
5 ΔH_a ______
4 Cp .84
17 γ 1.013
6 D_n ______ IN
1 A_n .0003308 FT²

NEW DATA
16 P_b 30.13 "Hg
18 V_M 30.23 CF
15 ΔH .340 "H₂O
14 $\bar{T}_m$ 540.6 °R
13 H_2O 50 ML
12 H_2O 6 g
11 CO_2 ______ %
10 O_2 10 %
6 $\sqrt{\Delta P}$ avg .370
5 $\bar{T}_s$ 765.9 °R
4 P_s 30.13 "Hg
3 A_s 11.74 FT²
2 θ 1.6 HR
5' M_n 142 MG

$$K = 849.8\ (D_n)^4 \Delta H_a\ (C_p)^2 (1-B_{ws})^2\ T_m/T_s$$
$$= 849.8\ (\quad)^4 (\quad)(\quad)^2(\quad)^2 \frac{(\quad)}{(\quad)} = \_\_\_\_$$

$$V_{m(STD)} = \frac{17.64\ V_m\ \gamma \left(P_b + \Delta H/13.6\right)}{T_m}$$
$$= \frac{17.64\ (30.23)(1.013)\left(30.13 + \frac{.340}{13.6}\right)}{(540.6)} = \underline{30.13}\ \text{DSCF}$$

$$V_{wc(STD)} = 0.04707\ (H_2O_C) = 0.04707\ (50) = \underline{2.35}\ \text{SCF}$$
$$V_{wSG(STD)} = 0.04715\ (H_2O_{SG}) = 0.04715\ (6) = \underline{.28}\ \text{SCF}$$
$$V_{w(STD)}\ \underline{2.63}\ \text{SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.63)}{(2.63) + (30.13)} = \underline{.080}$$

$$M_d = 0.44\ (\%CO_2) + 0.32(\%\ O_2) + 0.28(\%CO+N_2)$$
$$= 0.44\ (\quad) + 0.32(\quad) + 0.28(\quad) = \underline{30}$$

$$M_s = M_d\ (1-B_{ws}) + 18(B_{ws}) = (30)(.92) + 18(.08) = \underline{29.04}$$

$$\bar{V}_s = 85.49\ C_p\ (\sqrt{\Delta P})\text{avg.} \sqrt{\frac{T_s}{P_s M_s}}$$
$$= 85.49\ (.84)(.370)\sqrt{\frac{(765.9)}{(30.13)(29.04)}} = \underline{24.85}\ \text{FT/SEC}$$

$$\bar{Q}_s = 63500\ \bar{V}_s\ (1-B_{ws})\ A_s\ (P_s/T_s)$$
$$= 63500\ (24.85)(.92)(11.74)\frac{(30.13)}{(765.9)} = \underline{670K}\ \text{CFH}$$

$$\%I = \frac{100 V_{m(STD)} A_s}{\theta\ \bar{Q}_s\ A_n} = \frac{100(30.13)(11.74)}{(1.6)(670K)(.0003308)} = \underline{99.68}$$

$$C_s = \frac{M_n}{454{,}000 V_{m(STD)}} = \frac{(142)}{454{,}000(30.13)} = \underline{1.03\times10^{-5}}\ \text{LB/CF}$$

$$PMR = C_s\ \bar{Q}_s = (1.03\times10^{-5})(670K) = \underline{6.90}\ \text{LB/HR}$$

$$E = C_s\ F_d\ \frac{20.9}{20.9 - \%O_2} = (1.03\times10^{-5})(9190)\frac{20.9}{20.9-(10)} = \underline{.181}\ \text{LB}/10^6\text{BTU}$$

DATE 1-29-80

PLANT FSH-CHATTAHOOCHEE

STACK #8

RUN 6 b (oil)

FILTER 168

06	Dn		in
05	$\Delta H_@$		"H_2O
04	Cp		const.
03	Bws		fract sat.
02	Tm		°R
01	Ts		°R

13	Vm	30.23	CF
17	γ	1.013	const.
16	Pb	30.13	"Hg
15	ΔH	.34	"H_2O
14	Tm	540.6	°R
13	H_2Oc	50	Ml
12	H_2Osg	6	G.
11	% CO_2	1	%
10	% O_2	1	%
09	% CO	1	%
08	% N_2	102.43	%
07	Cp	.84	const.
06	$(\overline{\sqrt{\Delta P}})$ Ave	.370	"H_2O
05	Ts	765.9	°R
04	Ps	30.13	"Hg
03	As	11.74	Ft^2
02	θ	1.6	Hr
01	An	.00033086	Ft^2

05	Mn	142	Mg
04	$\underline{Vm}$(STD)	30.149	CF
03	$\overline{Qs}$	671K	SCFH
02	Fd	9190	dscf/10^6BTU
01	%O_2	10	

B = Cs 1.04×10^{-5}

C = PMR 6.96

D = E 0.183

B = Vm(STD)	30.141	DSCF
C = Vw(STD)	2.63	SCF
D = Bws	.080	fract. sat.
E = Md	30.00	AMU
A' = $\underline{Ms}$	29.03	AMU
B' = $\overline{Vs}$	24.85	Ft/sec
C' = $\overline{Qs}$	670K	SCFH
D' = %I	99.69	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K = 2.2

PLANT FSH UNIT #8 DATE 1-29-80

RUN NO. 016 6C FILTER NO. 167 NOZZLE ID. 181 d ____ IN A_N .00033 FT^2

P_b 30.13 ΔH ____ Y ____ PITOT ID. ____ C_p ____

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-3	821.357	0.11	0.24	0.24	321	72	1	235	50
2	6		0.14	0.31	0.31	319	72	1	240	41
3	9		0.12	0.26	0.26	319	73	1	245	45
4	12		0.12	0.26	0.26	319	74	1	250	46
5	15		0.11	0.24	0.24	317	75	1	250	46
6	18		0.11	0.24	0.24	317	76	1	250	49
7	21		0.10	0.22	0.22	316	76	1	250	49
8	24		0.10	0.22	0.22	317	77	1	250	49
9	27		0.09	0.20	0.20	316	77	1	250	49
10	30		0.09	0.20	0.20	316	78	1	250	49
11	3		0.09	0.20	0.30	315	79	1	250	49
12	6		0.09	0.20	0.20	314	79	1	250	50
13	9		0.09	0.20	0.20	313	80	1	250	50
14	12		0.08	0.18	0.18	306	80	1	250	50
15	15		0.09	0.20	0.20	260	81	1	250	50
16	18	835.344	0.06	0.13	0.13	150	81	1	250	50
1	0-3		0.15	0.33	0.33	115	81	1	250	60
2	6		0.18	0.40	0.40	230	82	1	250	60
3	9		0.20	0.44	0.44	305	83	1	250	60
4	12		0.19	0.42	0.42	308	83	1	250	50
5	15		0.18	0.40	0.40	312	83	1	250	50
6	18		0.14	0.36	0.36	313	83	1	250	50
7	21		0.12	0.31	0.31	313	83	1	250	50
8	24		0.09	0.20	0.20	313	83	1	250	50
9	27		0.10	0.22	0.22	313	84	1	250	50
10	30		0.07	0.18	0.18	313	84	1	250	50
11	3		0.09	0.21	0.21	312	84	1	250	50
12	6		0.09	0.21	0.21	316	84	1	250	50
13	9		0.09	0.20	0.30	311	84	1	250	50
14	12		0.08	0.18	0.18	311	85	1	250	50
15	15		0.10	0.22	0.22	311	85	1	250	50
16	18	850.443	0.06	0.13	0.13	310	85	1	250	50

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		9.95		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	247	596.4
INITIAL	200	591.4
CHANGE	47	5.0

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	BK	JG	
PITOT LINES	BK	JG	
CONSOLE			

DATE 1-29-80
PLANT FSH -CHATT
STACK #8
RUN 6c (oil)
FILTER 167

From Previous Run Data
$(1-B_{ws})$ ______
1 $\overline{T}_s$ ______ °R
2 $\overline{T}_m$ ______ °R

CALIBRATION
5 $\Delta H_@$ ______
4 C_p .84
17 Y .9987
6 D_n ______ IN
1 A_n .00033275 FT^2

NEW DATA
16 P_b 30.13 "Hg
18 V_M 28.59 CF
15 ΔH .247 "H_2O
14 $\overline{T}_m$ 540.2 °R
13 H_2O 47 ML
12 H_2O 5 g
11 CO_2 ______ %
10 O_2 10.0 %
6 $\sqrt{\Delta P}$ avg .328
5 $\overline{T}_s$ 758.2 °R
4 P_s 30.13 "Hg
3 A_s 11.74 FT^2
2 θ 1.6 HR
5' M_n 144.7 Mg

$$K = 849.8\,(D_n)^4\,\Delta H_@\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$
$$= 849.8\ (\quad)^4(\quad)(\quad)^2(\quad)^2\ \frac{(\quad)}{(\quad)} = \underline{\qquad}$$

$$V_{m(STD)} = \frac{17.64\ V_m\,Y\left(P_b + \Delta H/13.6\right)}{T_m}$$
$$= \frac{17.64\ (28.59)(.9987)\left(30.13 + \frac{.247}{13.6}\right)}{(540.2)} = \underline{28.10}\ \text{DSCF}$$

$$V_{wc(STD)} = 0.04707\ (H_2O_c) = 0.04707\ (47) = \underline{2.21}\ \text{SCF}$$
$$V_{wsg(STD)} = 0.04715\ (H_2O_{sg}) = 0.04715\ (5) = \underline{.23}\ \text{SCF}$$
$$V_{w(STD)}\ \underline{2.44}\ \text{SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.44)}{(2.44)+(28.10)} = \underline{.079}$$

$$M_d = 0.44\ (\%CO_2) + 0.32(\%\ O_2) + 0.28(\%CO+N_2)$$
$$= 0.44\ (\quad) + 0.32(\quad) + 0.28(\quad) = \underline{30}$$

$$M_s = M_d\ (1-B_{ws}) + 18(B_{ws}) = (30)(.921)+18(.079) = \underline{29.05}$$

$$\overline{V}_s = 85.49\ C_p\ (\sqrt{\Delta P})\,\text{avg.}\sqrt{\frac{T_s}{P_s M_s}}$$
$$= 85.49\ (.84)(.328)\sqrt{\frac{(758.2)}{(30.13)(29.05)}} = \underline{21.92}\ \text{FT/SEC}$$

$$\overline{Q}_s = 63500\ \overline{V}_s\ (1-B_{ws})\ A_s\ (P_s/T_s)$$
$$= 63500\ (21.92)(.921)(11.74)\frac{(30.13)}{(758.2)} = \underline{598K}\ \text{CFH}$$

$$\%I = \frac{100 V_{m(STD)} A_s}{\theta\ \overline{Q}_s\ A_n} = \frac{100\,(28.10)(11.74)}{(1.6)(598K)(.00033275)} = \underline{103.6}$$

$$C_s = \frac{M_n}{454{,}000 V_{m(STD)}} = \frac{(144.7)}{454{,}000\,(28.10)} = \underline{113\times10^{-5}}\ \text{LB/CF}$$

$$PMR = C_s\ \overline{Q}_s = (1.13\times10^{-5})(598K) = \underline{6.75}\ \text{LB/HR}$$

$$E = C_s\ F_d\ \frac{20.9}{20.9-\%O_2} = (1.13\times10^{-5})(9190)\ \frac{20.9}{20.9-9.95} = .200\ \text{LB}/10^6\text{BTU}$$

DATE 1-29-80

PLANT FSH-CHATTAHOOCHEE

STACK #8

RUN 6c (oil 4)

FILTER 167

06 Dn		in
05 ΔH@		"H_2O
04 Cp		const.
03 Bws		fract sat.
02 Tm		°R
01 Ts		°R

18 Vm	28.59	CF
17 Y	.9987	const.
16 Pb	30.13	"Hg
15 ΔH	.247	"H_2O
14 Tm	540.2	°R
13 H_2Oc	47	Ml
12 H_2Osg	5	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	103.43	%
07 Cp	.84	const.
06 (NΔP) Ave	.328	"H_2O
05 Ts	758.2	°R
04 Ps	30.13	"Hg
03 As	11.74	Ft²
02 θ	66	Hr
01 An	.00033275	Ft²

05 Mn	144.7	Mg
04 Vm(STD)	28.127	CF
03 Cs	598 K	SCFH
02 Fd	9190	dscf/10^6BTU
01 %O_2	10	

B = Cs 1.13×10^{-5}

C = PMR 6.79

D = E 0.200

B = Vm(STD)	28.12	DSCF
C = Vw(STD)	2.44	SCF
D = Bws	.080	fract. sat.
E = Md	30.0	AMU
A' = Ms	29.03	AMU
B' = Vs	21.92	Ft/sec
C' = Cs	597 K	SCFH
D' = %I	103.75	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K= 2.2

PLANT FSH UNIT #8 DATE 1-24-80

RUN NO. COAL FILTER NO. 355 NOZZLE ID. 81 d ____ IN AN ____ FT2

P_b 30.00 ΔH ____ Y ____ PITOT ID. ____ C_p ____

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-4	748.60	0.06	0.13	0.13	310	70	1	250	65
2	8		0.09	0.19	0.19	310	70	1	253	61
3	12		0.09	0.19	0.19	311	71	1	255	59
4	16		0.08	0.17	0.17	311	72	1	259	59
5	20		0.08	0.17	0.17	311	72	1	259	59
6	24		0.08	0.17	0.17	312	72	1	261	59
7	28		0.07	0.15	0.15	312	72	1	261	59
8	2		0.06	0.13	0.13	312	73	1	263	61
9	6		0.06	0.13	0.13	312	73	1	262	62
10	10		0.07	0.15	0.15	312	74	1	261	61
11	14		0.08	0.17	0.17	310	73	1	260	59
12	18		0.08	0.17	0.17	310	73	1	260	59
13	22		0.08	0.17	0.17	307	74	1	259	59
14	26		0.07	0.15	0.15	292	74	1	259	59
15	30		0.07	0.15	0.15	264	75	1	257	59
16	4	763.92	0.07	0.15	0.15	205	75	1	257	61
1	0-4		0.10	0.22	0.22	305	74	1	257	59
2	8		0.14	0.30	0.30	309	75	1	255	52
3	12		0.12	0.26	0.26	309	75	1	255	51
4	16		0.14	0.30	0.30	309	74	1	253	50
5	20		0.12	0.26	0.26	309	74	1	252	50
6	24		0.10	0.22	0.22	309	74	1	250	50
7	28		0.10	0.22	0.22	309	72	1	250	50
8	2		0.10	0.22	0.22	309	70	1	252	51
9	6		0.10	0.22	0.22	309	69	1	253	51
10	10		0.15	0.33	0.33	309	69	2	254	50
11	14		0.17	0.37	0.37	309	68	2	254	50
12	18		0.20	0.44	0.44	309	69	3	253	50
13	22		0.20	0.44	0.44	309	70	3	252	49
14	26		0.22	0.48	0.48	305	70	3	252	50
15	30		0.20	0.44	0.44	299	71	3	253	51
16	4	784.33	0.16	0.35	0.35	254	71	2	252	51

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		8.4		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	247	735.1
INITIAL	200	729.1
CHANGE	47	6.0

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	RLV	RLV	
PITOT LINES	RLV	RLV	
CONSOLE			

DATE 1-24-80
PLANT FSH-CHATT
STACK #8
RUN COAL 1
FILTER 355

From Previous Run Data

$(1-B_{ws})$ ______

1 $\bar{T}_s$ ______ °R

2 $\bar{T}_m$ ______ °R

CALIBRATION

5 ΔH_a ______

4 C_p .84

17 γ .99871

6 D_n ______ IN

1 A_n .00033086 FT^2

NEW DATA

16 P_b 30.00 "Hg

18 V_M 35.73 CF

15 $\overline{\Delta H}$ .283 "H_2O

14 $\overline{T_m}$ 532.0 °R

13 H_2O 47 ML

12 H_2O 6 g

11 CO_2 ~ %

10 O_2 8.4 %

6 $\sqrt{\Delta P}$ avg 324

5 $\bar{T}_s$ 762.25 °R

4 P_s 30.00 "Hg

3 A_s 11.74 FT^2

2 θ 2.13 HR

5' M_n 3579 Mg

$$K = 849.8\,(D_n)^4\,\Delta H_a\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$

$$= 849.8\,(\quad)^4(\quad)(\quad)^2(\quad)^2\frac{(\quad)}{(\quad)} = \underline{\qquad}$$

$$V_{m(STD)} = \frac{17.64\,V_m\,\gamma\left(P_b + \Delta H/13.6\right)}{T_m}$$

$$= \frac{17.64\,(3573)\,(.99871)\left(30.00 + \frac{.283}{13.6}\right)}{(532)} = \underline{35.51}\ \text{DSCF}$$

$$V_{wc(STD)} = 0.04707\,(H_2O_c) = 0.04707\,(47) = \underline{2.21}\ \text{SCF}$$

$$V_{wSG(STD)} = 0.04715\,(H_2O_{SG}) = 0.04715\,(6) = \underline{.28}\ \text{SCF}$$

$$V_{w(STD)}\ \underline{2.49}\ \text{SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.49)}{(2.49)+(35.51)} = \underline{.065}$$

$$M_d = 0.44\,(\%CO_2) + 0.32\,(\%O_2) + 0.28\,(\%CO+N_2)$$

$$= 0.44\,(\quad) + 0.32\,(\quad) + 0.28\,(\quad) = \underline{30.06}$$

$$M_s = M_d\,(1-B_{ws}) + 18\,(B_{ws}) = (30)(.935)+18(.065) = \underline{29.22}$$

$$\bar{V}_s = 85.49\,C_p\,(\sqrt{\Delta P})\,avg.\sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.49\,(.84)(.324)\sqrt{\frac{(762.25)}{(30)(29.22)}} = \underline{21.69}\ \text{FT/SEC}$$

$$\bar{Q}_s = 63500\,\overline{V_s}\,(1-B_{ws})\,A_s\,(P_s/T_s)$$

$$= 63500\,(21.69)(.935)(11.74)\frac{(30.00)}{(762.25)} = \underline{595K}\ \text{CFH}$$

$$\%I = \frac{100\,V_{m(STD)}\,A_s}{6\,\bar{Q}_s\,A_n} = \frac{100\,(35.51)(11.74)}{(2.13)(595K)(.00033086)} = \underline{99.43}$$

$$C_s = \frac{M_n}{454{,}000\,V_{m(STD)}} = \frac{(3579)}{454{,}000\,(35.51)} = \underline{2.22\times10^{-4}}\ \text{LB/CF}$$

$$PMR = C_s\,\bar{Q}_s = (2.22\times10^{-4})(595K) = \underline{132.09}\ \text{LB/HR}$$

$$E = C_s\,F_d\,\frac{20.9}{20.9-\%O_2} = (2.22\times10^{-4})(10{,}190)\frac{20.9}{20.9-(8.4)} = \underline{3.76}\ \text{LB}/10^6\,\text{BTU}$$

STACK DATA SHEET

NEDS NO. 10-1400-049-0004

SER. NO. K= 2.3

PLANT FSH

UNIT #8

DATE 1-22-80

RUN NO. Bio. 1

FILTER NO. 329

NOZZLE ID. 8

d ______ IN A_N ______ FT²

P_b 29.74

ΔH ______

Y ______

PITOT ID. ______

C_p ______

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-2	604.895	0.05	0.11	0.11	310	71	1	251	62
2	4		0.07	0.16	0.16	318	71	1	253	58
3	6		0.07	0.16	0.16	321	72	1	254	52
4	8		0.08	0.18	0.18	322	72	1	255	57
5	10		0.07	0.16	0.16	323	73	1	256	57
6	12		0.05	0.11	0.11	323	74	1	258	58
7	14		0.05	0.11	0.11	323	74	1	256	60
8	16		0.06	0.13	0.13	324	74	1	259	60
9	18		0.05	0.11	0.11	324	75	1	259	62
10	20		0.06	0.13	0.13	324	75	1	259	61
11	22		0.06	0.13	0.13	324	75	1	261	61
12	24		0.07	0.16	0.16	323	75	1	264	61
13	26		0.07	0.16	0.16	322	75	1	262	59
14	28		0.06	0.13	0.13	311	75	1	263	62
15	30		0.05	0.11	0.11	265	75	1	263	64
16	2	611.93	0.04	0.09	0.09	255	75	1	257	65
1	0-[illegible]		0.08	0.18	0.18	319	75	1	259	61
2	4		0.09	0.20	0.20	321	75	1	257	52
3	6		0.09	0.30	0.20	323	75	1	257	50
4	8		0.10	0.23	0.23	323	75	1	259	50
5	10		0.08	0.18	0.18	324	75	1	259	50
6	12		0.07	0.16	0.16	324	75	1	259	50
7	14		0.07	0.16	0.16	324	75	1	260	51
8	16		0.05	0.11	0.11	324	76	1	262	55
9	18		0.06	0.13	0.13	325	76	1	263	59
10	20		0.09	0.20	0.20	325	76	2	264	55
11	22		0.11	0.25	0.25	325	76	2	259	53
12	24		0.15	0.34	0.34	325	76	2	259	53
13	26		0.14	0.32	0.32	324	77	2	259	52
14	28		0.14	0.32	0.32	322	77	2	259	53
15	30		0.12	0.27	0.27	300	78	2	260	53
16	2	620.795	0.12	0.27	0.27	252	78	2	260	54

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		8.1		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	239	720.9
INITIAL	200	718.0
CHANGE	39	2.9

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	RLV	RLV	
PITOT LINES	RLV	RLV	
CONSOLE			

DATE 1-24-80

PLANT CHATTAHOOCHEE

STACK #8

RUN COAL 1

FILTER 355

06 Dn		in
05 $\Delta H_@$		$''H_2O$
04 Cp		const.
03 Bws		fract sat.
02 Tm		°R
01 Ts		°R

18 Vm	35.73	CF
17 γ	.9987	const.
16 Pb	30.00	"Hg
15 $\overline{\Delta H}$	.238	$''H_2O$
14 Tm	532	°R
13 H_2Oc	47	Ml
12 H_2Osg	6	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	103.43	%
07 Cp	.84	const.
06 $(\overline{N\Delta P})$ Ave	.324	$''H_2O$
05 Ts	763.25	°R
04 Ps	30.00	"Hg
03 As	11.74	Ft²
02 θ	2.13	Hr
01 An	.00033086	Ft²

05 Mn	3579	Mg
04 $\overline{Vm}$(STD)	35.53	CF
03 $\overline{Qs}$	595K	SCFH
02 Fd	10,180	dscf/10^6BTU
01 % O_2	8.4	

B = Cs 2.21×10^{-4}

C = PMR 132.03

D = E 3.7%

B = Vm(STD)	35.53	DSCF
C = Vw(STD)	2.49	SCF
D = Bws	.065	fract. sat.
E = Md	30.00	AMU
A' = $\overline{Ms}$	29.21	AMU
B' = $\overline{Vs}$	21.69	Ft/sec
C' = $\overline{Qs}$	595K	SCFH
D' = %I	99.3	% Iso

DATE 1-22-80
PLANT EPA-CANT
STACK #8
RUN B.1
FILTER 329

From Previous Run Data
$(1-B_{ws})$ ____
1 $\bar{T}_s$ ____ °R
2 $\bar{T}_m$ ____ °R

CALIBRATION
5 $\Delta H_@$ 1.72
4 C_p .84
17 Y .99871
6 D_n .216 IN
1 A_n .00033066 FT²

NEW DATA
16 P_b 29.74 "Hg
18 V_M 15.95 CF
15 ΔH .177 "H₂O
14 $\bar{T}_m$ 534.875 °R
13 H_2O 39 ML
12 H_2O 2.9 g
11 CO_2 ____ %
10 O_2 8.1 %
6 $\sqrt{\Delta P}$ avg .276
5 $\bar{T}_s$ 775.375 °R
4 P_s 29.74 "Hg
3 A_s 11.74 FT²
2 θ 1.067 HR
5' M_n 509 Mg

$$K = 849.8\,(D_n)^4 \Delta H_@ \,(C_p)^2 (1-B_{ws})^2\, T_m/T_s$$
$$= 849.8\,(\quad)^4(\quad)(\quad)^2(\quad)^2 \frac{(\quad)}{(\quad)} = \text{SAME}$$

$$V_{m(STD)} = \frac{17.64\, V_m\, Y \left(P_b + \Delta H/13.6\right)}{T_m}$$
$$= \frac{17.64\,(15.95)(.99871)\left(29.74 + \frac{.177}{13.6}\right)}{(534.875)} = 15.63 \text{ DSCF}$$

$$V_{wc(STD)} = 0.04707\,(H_2O_c) = 0.04707\,(39) = 1.83 \text{ SCF}$$
$$V_{wSG(STD)} = 0.04715\,(H_2O_{SG}) = 0.04715\,(2.9) = .13 \text{ SCF}$$
$$V_{w(STD)} \quad 1.96 \text{ SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(1.96)}{(1.96)+(15.63)} = .111$$

$$M_d = 0.44\,(\%CO_2) + 0.32\,(\%\,O_2) + 0.28\,(\%CO+N_2)$$
$$= 0.44\,(\quad) + 0.32\,(\quad) + 0.28\,(\quad) = 30$$

$$M_s = M_d\,(1-B_{ws}) + 18\,(B_{ws}) = (30)(.89) + 18(.11) = 28.68$$

$$\bar{V}_s = 85.49\, C_p\, (\sqrt{\Delta P})\,\text{avg.} \sqrt{\frac{T_s}{P_s M_s}}$$
$$= 85.49\,(.84)(.276)\sqrt{\frac{775.375}{(29.74)(28.68)}} = 15.89 \text{ FT/SEC}$$

$$\bar{Q}_s = 63500\, \bar{V}_s\, (1-B_{ws})\, A_s\, (P_s/T_s)$$
$$= 63500\,(15.89)(.89)(11.74)\frac{(29.74)}{(775.375)} = 480\text{K CFH}$$

$$\%I = \frac{100 V_{m(STD)} A_s}{\theta\, \bar{Q}_s\, A_n} = \frac{100\,(15.63)(11.74)}{(1.067)(480K)(.00033066)} = 108.14$$

$$C_s = \frac{M_n}{454{,}000\, V_{m(STD)}} = \frac{(509)}{454{,}000\,(15.63)} = 7.17 \times 10^{-5} \text{ LB/CF}$$

$$PMR = C_s\, \bar{Q}_s = (7.17\times10^{-5})(480K) = 34.46 \text{ LB/HR}$$

$$E = C_s\, F_d\, \frac{20.9}{20.9-\%O_2} = (7.17\times10^{-5})(9460)\,\frac{20.9}{20.9-(8.1)} = 1.11 \text{ LB}/10^6\text{BTU}$$

DATE 1-22-80

PLANT FSH · CHATTAHOOCHEE

STACK #8

RUN Bio 1

FILTER 329

06 Dn		in
05 $\Delta H_@$		"H_2O
04 Cp		const.
03 Bws		fract sat.
02 Tm		°R
01 Ts		°R

18 Vm	15.95	CF
17 γ	.99871	const.
16 Pb	29.74	"Hg
15 $\overline{\Delta H}$	.177	"H_2O..
14 Tm	534.875	°R
13 H_2Oc	39.0	Ml
12 H_2Osg	2.9	G.
11 % CO_2	/	%
10 % O_2	/	%
09 % CO	/	%
08 % N_2	103.43	%
07 Cp	.84	const.
06 $(\overline{\sqrt{\Delta P}})$ Ave	.276	"H_2O
05 Ts	775.375	°R
04 Ps	29.74	"Hg
03 As	11.74	Ft^2
02 θ	1.067	Hr
01 An	.00033096	Ft^2

05 Mn	509	Mg
04 $\overline{Vm}$(STD)	15.646	CF
03 $\overline{Qs}$	480K	SCFH
02 Fd	9460	dscf/10^6BTU
01 %O_2	8.1	

B = Cs 7.17×10^{-5}

C = PMR 34.4

D = E ______

B = Vm(STD)	15.646	DSCF
C = Vw(STD)	1.97	SCF
D = Bws	.111	fract. sat.
E = Md	30.00	AMU
A' = $\underline{Ms}$	28.65	AMU
B' = $\overline{Vs}$	18.90	Ft/sec
C' = $\overline{Qs}$	490K	SCFH
D' = %I	108.34	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K=2.3

PLANT FSH UNIT #8 DATE 1-22-80

RUN NO. B10. 2 FILTER NO. 353 NOZZLE ID. 18 d ______ IN An ______ FT²

P_b 29.74 ΔH ______ Y ______ PITOT ID. ______ C_p ______

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-2	620.897	0.08	0.184		319	78	1	239	63
2	4		0.08	0.184		325	78	1	235	59
3	6		0.07	0.161		329	78	1	233	53
4	8		0.07	0.161		329	78	1	229	51
5	10	623.35	0.07	0.161		330	78	1	229	50
6	12		0.07	0.161		331	78	1	231	50
7	14	724.38	0.07	0.161		331	79	1	231	51
8	16		0.06	0.138		331	79	1	233	53
9	18		0.06	0.138		333	79	1	234	53
10	20		0.07	0.161		333	79	1	235	53
11	22		0.07	0.161		333	79	1	234	53
12	24	626.64	0.07	0.161		331	79	1	237	53
13	26		0.07	0.161		330	79	1	237	53
14	28		0.07	0.161		323	80	1	239	53
15	30		0.05	0.115		291	80	1	239	54
16	2	628.428	0.05	0.115		153	80	1	239	55
1	0-2		0.09	0.207		315	80	1	245	63
2	4		0.10	0.23		329	80	1	243	55
3	6		0.10	0.23		329	80	1	241	55
4	8		0.10	0.23		331	80	1	239	55
5	10	631.38	0.09	0.207		331	80	1	239	55
6	12		0.08	0.184		332	80	1	237	57
7	14		0.07	0.161		331	80	1	237	59
8	16		0.06	0.138		332	80	1	237	59
9	18		0.07	0.161		332	80	1	237	57
10	20		0.10	0.23		332	80	1.5	235	59
11	22		0.12	0.276		333	81	1.5	235	57
12	24		0.15	0.345		333	81	2	235	53
13	26	635.68	0.14	0.322		333	81	2	234	51
14	28		0.17	0.391		331	81	2	234	49
15	30		0.14	0.322		333	81	2	233	49
16	2	637.70	0.12	0.276		175	81	2	233	50

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		9.1		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	240	634.5
INITIAL	200	630.6
CHANGE	40	3.9

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	RLV	BK	
PITOT LINES	RLV	BK	
CONSOLE			

DATE 1-22-80
PLANT FSH-CHATT
STACK #8
RUN Bo2
FILTER 353

From Previous Run Data
$(1-B_{ws})$ ____
1 $\bar{T}_s$ ____ °R
2 $\bar{T}_m$ ____ °R

CALIBRATION
5 $\Delta H_@$ ____
4 Cp .84
17 γ .99871
6 D_n ____ IN
1 A_n .00034088 FT²

NEW DATA
16 P_b 29.74 "Hg
18 V_M 16.8 CF
15 ΔH .20 "H₂O
14 $\bar{T}_m$ 539.6 °R
13 H_2O 40 ML
12 H_2O 3.9 g
11 CO_2 ____ %
10 O_2 9.1 %
6 $\sqrt{\Delta P}$ avg .291
5 $\bar{T}_s$ 778.25 °R
4 P_s 29.74 "Hg
3 A_s 11.74 FT²
2 θ 1.067 HR
5' M_n 432 Mg

$$K = 849.8\,(D_n)^4\,\Delta H_@\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$
$$= 849.8\ (\quad)^4(\quad)(\quad)^2(\quad)^2\frac{(\quad)}{(\quad)} = \underline{\qquad}$$

$$V_{m(STD)} = \frac{17.64\,V_m\,\gamma\left(P_b + \Delta H/13.6\right)}{T_m}$$
$$= \frac{17.64\ (16.8)(.9987)\left(29.74\ \frac{.20}{13.6}\right)}{(539.6)} = \underline{16.32}\ \text{DSCF}$$

$$V_{wc(STD)} = 0.04707\ (H_2O_c) = 0.04707\ (40) = \underline{1.88}\ \text{SCF}$$
$$V_{wSG(STD)} = 0.04715\ (H_2O_{SG}) = 0.04715\ (3.9) = \underline{.18}\ \text{SCF}$$
$$V_{w(STD)}\ \underline{2.06}\ \text{SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.06)}{(2.06)+(16.32)} = \underline{.112}$$

$$M_d = 0.44\ (\%CO_2) + 0.32(\%\ O_2) + 0.28(\%CO+N_2)$$
$$= 0.44\ (\quad) + 0.32(\quad) + 0.28(\quad) = \underline{30}$$

$$M_s = M_d\ (1-B_{ws}) + 18(B_{ws}) = (30)(.888) + 18(.112) = \underline{28.656}$$

$$\bar{V}_s = 85.49\ C_p\ (\sqrt{\Delta P})\,\text{avg.}\sqrt{\frac{T_s}{P_s M_s}}$$
$$= 85.49\ (.84)(.291)\sqrt{\frac{(778.25)}{(29.74)(28.65)}} = \underline{19.96}\ \text{FT/SEC}$$

$$\bar{Q}_s = 63500\ \bar{V}_s\ (1-B_{ws})\ A_s\ (P_s/T_s)$$
$$= 63500\ (19.96)(.888)(11.74)\frac{(29.74)}{(778.25)} = \underline{505K}\ \text{CFH}$$

$$\%I = \frac{100\,V_{m(STD)}\,A_s}{\theta\ \bar{Q}_s\ A_n} = \frac{100(16.8)(11.74)}{(1.067)(505K)(.00034088)} = \underline{107.4}$$

$$C_s = \frac{M_n}{454{,}000\,V_{m(STD)}} = \frac{(432)}{454{,}000(16.32)} = \underline{5.83\times10^{-5}}\ \text{LB/CF}$$

$$PMR = C_s\ \bar{Q}_s = (5.83\times10^{-5}\ 505K) = \underline{29.4}\ \text{LB/HR}$$

$$E = C_s\ F_d\ \frac{20.9}{20.9-\%O_2} = \overset{5.83\times10^{-5}}{(\quad)}(9460)\left(\frac{20.9}{20.9-9.1}\right) = \underline{0.977}\ \text{LB}/10^6\text{BTU}$$

DATE 1-22-80

PLANT FSH-CHATTAHOOCHEE

STACK #8

RUN Bio 2

FILTER 353

06 Dn ______ in
05 ΔH_a ______ "H_2O
04 C_p ______ const.
03 B_{ws} ______ fract. sat.
02 Tm ______ °R
01 Ts ______ °R

13 Vm 16.8 CF
17 γ .99871 const.
16 Pb 29.74 "Hg
15 ΔH .20 "H_2O
14 Tm 539.6 °R
13 H_2Oc 40 Ml
12 H_2Osg 3.9 G.
11 % CO_2 1 %
10 % O_2 1 %
09 % CO 1 %
08 % N_2 103.47 %
07 Cp .84 const.
06 $(N\overline{\Delta P})$ Ave .291 "H_2O
05 Ts 778.25 °R
04 Ps 29.74 "Hg
03 As 11.74 Ft^2
02 θ 1.067 Hr
01 An .00034088 Ft^2

05 Mn 432 Mg
04 Vm(STD) 16.336 CF
03 Qs 505K SCFH
02 Fd 9460 dscf/10^6BTU
01 %O_2 9.1

B = Cs 5.82×10^{-5}
C = PMR 29.4
D = E ______

B = Vm(STD) 16.33 DSCF
C = Vw(STD) 2.06 SCF
D = Bws .112 fract. sat.
E = Md 30.00 AMU
A' = Ms 28.65 AMU
B' = Vs 19.96 Ft/sec
C' = Qs 505K SCFH
D' = %I 104.37 % Iso

STACK DATA SHEET

NEDS NO 10-1400-049-0004 SER. NO. K = 2.2
PLANT FSH UNIT #8 DATE 1-22-80
RUN NO. Bio. 3 FILTER NO. 344 NOZZLE ID. 81 d ____ IN A_N ____ FT^2
P_b 29.65 ΔH ____ Y ____ PITOT ID. ____ C_p ____

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-2	638.044	0.06	0.13	0.13	315	78	1	244	64
2	4		0.06	0.13	0.13	322	78	1	247	60
3	6		0.07	0.15	0.15	325	78	1	247	57
4	8		0.06	0.13	0.13	327	78	1	245	55
5	10		0.06	0.13	0.13	327	78	1	245	57
6	12		0.06	0.13	0.13	327	78	1	244	57
7	14		0.06	0.13	0.13	328	78	1	243	59
8	16		0.06	0.13	0.13	329	78	1	243	59
9	18		0.06	0.13	0.13	329	78	1	243	59
10	20		0.06	0.13	0.13	329	78	1	243	59
11	22		0.07	0.15	0.15	330	78	1	244	59
12	24		0.07	0.15	0.15	329	78	1	245	59
13	26		0.06	0.13	0.13	319	78	1	245	59
14	28		0.07	0.15	0.15	265	78	1	247	60
15	30		0.06	0.13	0.13	200	78	1	249	60
16	2		0.05	0.11	0.11	171	78	1	249	59
1	0-2		0.07	0.15	0.15	325	78	1	249	63
2	4		0.10	0.22	0.22	325	78	1	250	59
3	6		0.08	0.18	0.18	329	78	1	251	57
4	8		0.10	0.22	0.22	329	78	1	252	55
5	10		0.10	0.22	0.22	329	78	1	252	55
6	12		0.08	0.18	0.18	330	78	1	252	57
7	14		0.08	0.18	0.18	330	78	1	252	59
8	16		0.07	0.15	0.15	329	78	1	253	59
9	18		0.07	0.15	0.15	330	78	1	253	60
10	20		0.07	0.15	0.15	331	78	1	253	60
11	22		0.12	0.26	0.26	332	78	1	252	57
12	24		0.12	0.26	0.26	332	78	1	252	54
13	26		0.14	0.31	0.31	331	78	1	252	54
14	28		0.14	0.31	0.31	322	78	1	252	53
15	30		0.14	0.31	0.31	240	78	1	252	53
16	2	654.037	0.10	0.22	0.22	129	78	1	253	54

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		10.0		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	245	723.3
INITIAL	200	720.9
CHANGE	45	2.4

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	JG	JG	
PITOT LINES	JG	JG	
CONSOLE			

DATE FSH-CHATT
PLANT 1-22-80
STACK #5
RUN Bio 3
FILTER 344

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION
5 ΔH_a ______
4 Cp .84
17 γ .99871
6 D_n ______ IN
1 A_n .00034088 FT^2

NEW DATA
16 P_b 29.65 "Hg
18 V_M 15.99 CF
15 ΔH .175 "H_2O
14 $\bar{T}_m$ 538 °R
13 H_2O 45 ML
12 H_2O 2.4 g
11 CO_2 ______ %
10 O_2 10 %
6 $\sqrt{\Delta P}$ avg .280
5 $\bar{T}_s$ 767.66 °R
4 P_s 29.65 "Hg
3 A_s 11.74 FT^2
2 θ 1.067 HR
5' M_n 463.5 Mg

$$K = 849.3\ (D_n)^4 \Delta H_a\ (C_p)^2 (1-B_{ws})^2\ T_m/T_s$$
$$= 849.8\ (\quad)^4 (\quad)(\quad)^2(\quad)^2 \frac{(\quad)}{(\quad)} = \_\_\_\_$$

$$V_{m(STD)} = \frac{17.64\ V_m\ \gamma \left(P_b + \Delta H/13.6\right)}{T_m}$$
$$= \frac{17.64\ (15.99)\ (.99871)\ \left(29.65\ \frac{.175}{13.6}\right)}{(538)} = \underline{15.53}\ \text{DSCF}$$

$$V_{wc(STD)} = 0.04707\ (H_2O_c) = 0.04707\ (45) = \underline{2.11}\ \text{SCF}$$
$$V_{wSG(STD)} = 0.04715\ (H_2O_{SG}) = 0.04715\ (2.4) = \underline{.11}\ \text{SCF}$$
$$V_{w(STD)}\ \underline{2.22}\ \text{SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.22)}{(2.22) + (15.53)} = \underline{.125}$$

$$M_d = 0.44\ (\%CO_2) + 0.32(\%\ O_2) + 0.28(\%CO + N_2)$$
$$= 0.44\ (\quad) + 0.32(\quad) + 0.28(\quad) = \underline{30}$$

$$M_s = M_d\ (1-B_{ws}) + 18(B_{ws}) = (30)\ (.874) + 18(.125) = \underline{28.48}$$

$$\bar{V}_s = 85.49\ C_p\ (\sqrt{\Delta P})\ \text{avg.} \sqrt{\frac{T_s}{P_s M_s}}$$
$$= 85.49\ (.84)\ (.28) \sqrt{\frac{(767.66)}{(29.65)\ (28.48)}} = \underline{19.17}\ \text{FT/SEC}$$

$$\bar{Q}_s = 63500\ \bar{V}_s\ (1-B_{ws})\ A_s\ (P_s/T_s)$$
$$= 63500\ (19.17)\ (.874)\ (11.74) \frac{(29.65)}{(767.66)} = \underline{482\text{K}}\ \text{CFH}$$

$$\%I = \frac{100 V_{m(STD)} A_s}{\theta\ \bar{Q}_s\ A_n} = \frac{100\ (15.53)\ (11.74)}{(1.067)\ (482\text{K})\ (.00034088)} = \underline{103.90}$$

$$C_s = \frac{M_n}{454{,}000 V_{m(STD)}} = \frac{(463.5)}{454{,}000\ (15.53)} = \underline{6.57 \times 10^{-5}}\ \text{LB/CF}$$

$$PMR = C_s\ \bar{Q}_s = (6.57 \times 10^{-5})(482\text{K}) = \underline{31.66}\ \text{LB/HR}$$

$$E = C_s\ F_d\ \frac{20.9}{20.9 - \%O_2} = (6.57 \times 10^{-5})(\quad) \frac{20.9}{20.9 - (10)} = \underline{1.19}\ \text{LB}/10^6\ \text{BTU}$$

DATE 1-22-80

PLANT FSH-CHATTAHOOCHEE

STACK #8

RUN B/o 3

FILTER 344

06	Dn		in
05	ΔH@		"H_2O
04	Cp		const.
03	Bws		fract sat.
02	Tm		°R
01	Ts		°R

18	Vm	15.99	CF
17	γ	.99871	const.
16	Pb	29.65	"Hg
15	ΔH	.175	"H_2O..
14	Tm	538	°R
13	H_2Oc	45	Ml
12	H_2Osg	2.4	G.
11	% CO_2	1	%
10	% O_2	1	%
09	% CO	1	%
08	% N_2	103.93	%
07	Cp	.84	const.
06	$(\overline{N\Delta P})$ Ave	.28	"H_2O
05	Ts	767.66	°R
04	Ps	29.65	"Hg
03	As	11.74	Ft^2
02	θ	1.067	Hr
01	An	.00034088	Ft^2

05	Mn	463.5	Mg
04	Vm(STD)	15.54	CF
03	Qs	483 K	SCFH
02	Fd	9460	dscf/10^6BTU
01	%O_2	10	

B = Cs $6.57x10^{-5}$

C = PMR 31.7

D = E

B = Vm(STD)	15.54	DSCF
C = Vw(STD)	2.23	SCF
D = Bws	.125	fract. sat.
E = Md	30.00	AMU
A' = Ms	28.49	AMU
B' = Vs	19.16	Ft/sec
C' = Qs	462 K	SCFH
D' = %I	103.94	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K= 2.2

PLANT FSH UNIT #8 DATE 1-23-80

RUN NO. Bio. 4 FILTER NO. 338 NOZZLE ID. 8 d ____ IN A_N .00033 FT^2

P_b 29.75 ΔH ____ Y ____ PITOT ID. ____ C_p ____

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-4	654.339	0.05	0.11	0.11	311	56	1	239	39
2	8		0.07	0.15	0.15	315	57	1	230	35
3	12		0.07	0.15	0.15	315	58	1	231	35
4	16		0.06	0.13	0.13	315	58	1	245	35
5	20		0.06	0.13	0.13	315	59	1	239	35
6	24		0.05	0.11	0.11	317	60	1	248	35
7	28		0.04	0.09	0.09	317	61	1	250	37
8	2		0.04	0.09	0.09	317	61	1	253	37
9	6		0.04	0.09	0.09	319	62	1	253	37
10	10		0.06	0.13	0.13	329	61	1	252	37
11	14		0.05	0.11	0.11	329	62	1	249	39
12	18		0.04	0.09	0.09	325	63	1	244	39
13	22		0.04	0.09	0.09	319	63	1	250	39
14	26		0.04	0.09	0.09	319	63	1	255	39
15	30		0.04	0.09	0.09	283	64	1	259	39
16	4	666.43	0.04	0.09	0.09	283	64	1	259	39
1	0-4		0.06	0.13	0.13	310	65	1	259	44
2	8		0.04	0.09	0.09	317	66	1	260	40
3	12		0.05	0.11	0.11	317	66	1	257	41
4	16		0.06	0.13	0.13	319	67	1	257	40
5	20		0.05	0.11	0.11	317	66	1	255	41
6	24		0.05	0.11	0.11	317	66	1	255	41
7	28		0.04	0.09	0.09	315	67	1	254	43
8	2		0.02	0.04	0.04	315	66	1	252	45
9	6		0.03	0.07	0.07	315	65	1	249	45
10	10		0.06	0.13	0.13	317	65	1	249	44
11	14		0.06	0.13	0.13	315	65	1	247	42
12	18		0.08	0.18	0.18	315	64	1	249	41
13	22		0.10	0.22	0.22	315	64	1	249	40
14	26		0.10	0.22	0.22	312	64	1	247	40
15	30		0.10	0.22	0.22	304	63	1	245	41
16	4	681.592	0.10	0.22	0.22	285	63	1	243	40

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		8.15		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	260	639.4
INITIAL	200	634.5
CHANGE	60	4.9

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	JG	JG	
PITOT LINES	JG	JG	
CONSOLE			

DATE 1-23-80
PLANT FSH-CHATT
STACK #8
RUN Bio 4
FILTER 338

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION
5 $\Delta H_@$ ______
4 C_p .84
17 γ .9987
6 D_n ______ IN
1 A_n .00032686 FT^2

NEW DATA
16 P_b 29.75 "Hg
18 V_M 27.25 CF
15 ΔH .123 "H_2O
14 $\bar{T}_m$ 522.9 °R
13 H_2O 60 ML
12 H_2O 4.9 g
11 CO_2 ~ %
10 O_2 8.15 %
6 $\sqrt{\Delta P}$ avg .23
5 $\bar{T}_s$ 773.5 °R
4 P_s 29.75 "Hg
3 A_s 11.74 FT^2
2 θ 2.13 HR
5' M_n 750 MG

$$K = 849.8\ (D_n)^4\ \Delta H_@\ (C_p)^2 (1-B_{ws})^2\ T_m/T_s$$
$$= 849.8\ (\quad)^4 (\quad)(\quad)^2(\quad)^2 \frac{(\quad)}{(\quad)} = \underline{\qquad}$$

$$V_{m(STD)} = \frac{17.64\ V_m\ \gamma \left(P_b + \Delta H/13.6\right)}{T_m}$$
$$= \frac{17.64\ (27.25)(.9987)\left(29.75 + \frac{.123}{13.6}\right)}{(522.9)} = \underline{27.3}\ \text{DSCF}$$

$$V_{wc(STD)} = 0.04707\ (H_2O_c) = 0.04707\ (60) = \underline{2.82}\ \text{SCF}$$
$$V_{wSG(STD)} = 0.04715\ (H_2O_{SG}) = 0.04715\ (4.9) = \underline{.23}\ \text{SCF}$$
$$V_{w(STD)}\ \underline{3.05}\ \text{SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(3.05)}{(3.05)+(27.3)} = \underline{.100}$$

$$M_d = 0.44\ (\%CO_2) + 0.32(\%\ O_2) + 0.28(\%CO+N_2)$$
$$= 0.44\ (\quad) + 0.32(\quad) + 0.28(\quad) = \underline{30}$$

$$M_s = M_d\ (1-B_{ws}) + 18(B_{ws}) = (30)(.900) + 18(.100) = \underline{28.79}$$

$$\bar{V}_s = 85.49\ C_p\ (\sqrt{\Delta P})\ avg. \sqrt{\frac{T_s}{P_s M_s}}$$
$$= 85.49\ (.84)(.23)\sqrt{\frac{(773.5)}{(29.75)(28.79)}} = \underline{15.69}\ \text{FT/SEC}$$

$$\bar{Q}_s = 63500\ \bar{V}_s\ (1-B_{ws})\ A_s\ (P_s/T_s)$$
$$= 63500\ (15.69)(.900)(11.74)\frac{(29.75)}{(773.5)} = \underline{404K}\ \text{CFH}$$

$$\%I = \frac{100 V_{m(STD)} A_s}{\theta\ \bar{Q}_s\ A_n} = \frac{100\ (27.3)(11.74)}{(2.13)(404K)(.00032686)} = \underline{112.3}$$

$$C_s = \frac{M_n}{454{,}000 V_{m(STD)}} = \frac{(750)}{454{,}000\ (27.3)} = \underline{605 \times 10^{-5}}\ \text{LB/CF}$$

$$PMR = C_s\ \bar{Q}_s = (605 \times 10^{-5})(404K) = \underline{24.4}\ \text{LB/HR}$$

$$E = C_s\ F_d\ \frac{20.9}{20.9 - \%O_2} = (605 \times 10^{-5})(9460)\frac{20.9}{20.9-(8.15)} = \underline{.938}\ \text{LB}/10^6\ \text{BTU}$$

DATE 1-23-80

PLANT FSH-CHATTAHOOCHEE

STACK #8

RUN Bio4

FILTER 338

06 Dn		in
05 ΔH@		"H_2O
04 Cp		const.
03 Bws		fract sat.
02 Tm		°R
01 Ts		°R

18 Vm	27.25	CF
17 γ	.9987	const.
16 Pb	29.75	"Hg
15 $\overline{\Delta H}$	.123	"H_2O..
14 Tm	523.9	°R
13 H_2Oc	60	Ml
12 H_2Osg	4.9	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	103.43	%
07 Cp	.84	const.
06 ($\overline{\sqrt{\Delta P}}$) Ave	.23	"H_2O
05 Ts	775.5	°R
04 Ps	29.75	"Hg
03 As	11.74	Ft^2
02 θ	2.0	Hr
01 An	.00031086	Ft^2

05 Mn	750	Mg
04 $\underline{Vm}$(STD)	27.34	CF
03 $\overline{Qs}$	405K	SCFH
02 Fd	9460	dscf/10^6BTU
01 %O_2	8.15	

B = Cs 6.04×10^{-5}

C = PMR 24.5

D = E

B = Vm(STD)	27.34	DSCF
C = Vw(STD)	3.65	SCF
D = Bws	.100	fract. sat.
E = Md	30.00	AMU
A' = $\underline{Ms}$	28.79	AMU
B' = $\overline{Vs}$	15.69	Ft/sec
C' = $\overline{Qs}$	408K	SCFH
D' = %I	112.48	% Iso

STACK DATA SHEET

NEOS NO. 10-1400-049-0004 SER. NO. K = 2.2

PLANT FSH UNIT #8 DATE 1-23-80

RUN NO. Bio. 5 FILTER NO. 340 NOZZLE ID. 81 d ______ IN A_N ______ FT^2

P_b 29.79 ΔH ______ Y ______ PITOT ID. ______ C_p ______

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_t	T_m	Pump Vac.	Filter T	Impinger T
1	0-4	681.778	0.06	0.132		309	64	1	200	55
2	8		0.07	0.154		311	64	1	215	55
3	12		0.09	0.198		313	63	1	223	53
4	16		0.08	0.176		313	63	1	232	53
5	20		0.08	0.176		313	63	1	235	53
6	24		0.14	0.308		333	62	1	235	51
7	28		0.15	0.33		341	62	1.5	237	51
8	2		0.15	0.33		347	62	1.5	235	51
9	6		0.07	0.154		339	62	1	234	53
10	10		0.09	0.198		335	62	1.5	235	53
11	14		0.09	0.198		333	62	1.5	233	53
12	18		0.09	0.198		327	62	1.5	237	53
13	22		0.09	0.198		323	62	1.5	234	53
14	26		0.09	0.198		311	62	1.5	237	53
15	30		0.08	0.176		329	62	1.5	239	53
16	4	698.672	0.08	0.176		175	62	1.5	237	53
1	0-4		0.13	0.286		320	60	2	235	53
2	8		0.13	0.286		321	60	2	243	53
3	12		0.11	0.242		321	60	2	244	53
4	16		0.10	0.22		321	60	2	241	51
5	20		0.10	0.22		321	60	2	239	51
6	24		0.09	0.198		321	60	2	235	51
7	28		0.09	0.198		321	60	2	234	53
8	2		0.07	0.154		320	60	2	233	53
9	6		0.06	0.132		320	60	2	232	53
10	10		0.07	0.154		317	61	2	233	53
11	14		0.08	0.176		319	62	2	234	54
12	18		0.11	0.242		319	63	2	233	53
13	22		0.11	0.242		317	63	2	239	53
14	26		0.12	0.264		315	63	2	245	54
15	30		0.12	0.264		259	64	2	249	55
16	4	715.778	0.07	0.154		119	64	2	245	53

GAS ANALYSIS	$\%CO_2$	$\%O_2$	%CO	$\%N_2$
		8.9		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	255	729.1
INITIAL	200	723.3
CHANGE	55	5.8

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	BK	BK	
PITOT LINES	BK	BK	
CONSOLE			

DATE 1-23-80
PLANT PS H-CHATT
STACK #8
RUN No 5
FILTER 340

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION
5 $\Delta H_@$ ______
4 C_p .84
17 Y .9987
6 D_n ______ IN
1 A_n .0003408 FT²

NEW DATA
16 P_b 29.79 "Hg
18 V_M 34.0 CF
15 $\overline{\Delta H}$ .209 "H_2O
14 $\bar{T}_m$ 521.8 °R
13 H_2O 55 ML
12 H_2O 5.8 g
11 CO_2 — %
10 O_2 8.9 %
6 $(\sqrt{\Delta P})$ avg .306
5 $\bar{T}_s$ 769.4 °R
4 P_s 29.79 "Hg
3 A_s 11.74 FT²
2 θ 2.13 HR
5' M_n 901 Mg

$K = 849.8\,(D_n)^4 \Delta H_@ \,(C_p)^2 (1-B_{ws})^2\, T_m/T_s$

$= 3438\,(\quad)^4(\quad)(\quad)^2(\quad)^2\dfrac{(\quad)}{(\quad)} =$ ______

$$V_{m(STD)} = \frac{17.64\, V_m Y \left(P_b + \Delta H/13.6\right)}{T_m}$$

$$= \frac{17.64\,(34.0)(.9987)\left(29.79\ \frac{.209}{13.6}\right)}{(521.8)} = \underline{34.21}\ \text{DSCF}$$

$V_{wC(STD)} = 0.04707\,(H_2O_C) = 0.04707\,(55) = \underline{2.589}$ SCF

$V_{wSG(STD)} = 0.04715\,(H_2O_{SG}) = 0.04715\,(5.8) = \underline{.273}$ SCF

$V_{w(STD)}$ $\underline{2.862}$ SCF

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.86)}{(2.86)+(34.21)} = \underline{.077}$$

$M_d = 0.44\,(\%CO_2) + 0.32\,(\%\,O_2) + 0.28\,(\%CO+N_2)$

$= 0.44\,(\quad) + 0.32\,(\quad) + 0.28\,(\quad) = \underline{30}$

$M_s = M_d\,(1-B_{ws}) + 18(B_{ws}) = (30)(.923)+18(.077) = \underline{29.07}$

$$\bar{V}_s = 85.49\, C_p\, (\sqrt{\Delta P})\,\text{avg.}\sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.49\,(.84)(.306)\sqrt{\frac{(769.4)}{(29.79)(29.016)}} = \underline{20.71}\ \text{FT/SEC}$$

$\bar{Q}_s = 63500\ \bar{V}_s\,(1-B_{ws})\,A_s\,(P_s/T_s)$

$$= 63500\,(20.71)(.923)(11.74)\frac{(29.79)}{(769.4)} = \underline{552K}\ \text{CFH}$$

$$\%I = \frac{100 V_{m(STD)} A_s}{\theta\, \bar{Q}_s\, A_n} = \frac{100\,(34.21)(11.74)}{(2.13)(552K)(.0003408)} = \underline{100.2}$$

$$C_s = \frac{M_n}{454{,}000\, V_{m(STD)}} = \frac{(901)}{454{,}000\,(34.21)} = \underline{5.80\times10^{-5}}\ \text{LB/CF}$$

$PMR = C_s\,\bar{Q}_s = (5.8\times10^{-5})(552K) = \underline{32.0}$ LB/HR

$$E = C_s\, F_d\, \frac{20.9}{20.9-\%O_2} = (5.8\times10^{-5})(9460)\,\frac{20.9}{20.9-(8.9)} = \underline{0.956}\ \text{LB}/10^6\text{BTU}$$

DATE 1-23-80

PLANT FSH-CHATTAHOOCHEE

STACK #8

RUN BioS

FILTER 340

06 Dn ______ in

05 ΔH_a ______ "H_2O

04 C_p ______ const.

03 Bws ______ fract. sat.

02 Tm ______ °R

01 Ts ______ °R

18 Vm 34.0 CF

17 γ .9987 const.

16 Pb 29.79 "Hg

15 ΔH .209 "H_2O

14 Tm 521.8 °R

13 H_2Oc 55 Ml

12 H_2Osg 5.8 G.

11 % CO_2 1 %

10 % O_2 1 %

09 % CO 1 %

08 % N_2 103.43 %

07 C_p .84 const.

06 $(\sqrt{\Delta P})$ Ave .306 "H_2O

05 Ts 769.4 °R

04 Ps 29.79 "Hg

03 As 11.74 Ft^2

02 θ 2.13 Hr

01 An .000340[illegible] Ft^2

05 Mn 901 Mg

04 Vm(STD) 34.23 CF

03 Qs 552K SCFH

02 Fd 9460 dscf/10^6BTU

01 %O_2 8.9

B = Cs 5.80×10^{-5}

C = PMR 32.0

D = E ______

B = Vm(STD) 34.23 DSCF

C = Vw(STD) 2.86 SCF

D = Bws .077 fract. sat.

E = Md 30.00 AMU

A' = Ms 29.07 AMU

B' = Vs 20.70 Ft/sec

C' = Qs 552K SCFH

D' = %I 100.29 % Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K= 2.2

PLANT FSH UNIT #8 DATE 1-23-80

RUN NO. Bio. 6 FILTER NO. 345 NOZZLE ID. 181 d ____ IN A_N ____ FT2

P_b 29.81 ΔH ____ Y ____ PITOT ID. ____ C_p ____

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-4	715.83	0.05	0.11	0.11	312	62	1	259	42
2	8		0.06	0.13	0.13	313	62	1	249	38
3	12		0.06	0.13	0.13	314	62	1	245	38
4	16		0.07	0.15	0.15	315	61	1	249	39
5	20		0.07	0.15	0.15	315	61	1	251	38
6	24		0.08	0.18	0.18	317	61	1	253	38
7	28		0.07	0.15	0.15	317	60	1	253	37
8	2		0.06	0.13	0.13	318	60	1	253	38
9	6		0.06	0.13	0.13	319	61	1	253	38
10	10		0.07	0.15	0.15	319	61	1	260	38
11	14		0.07	0.15	0.15	318	60	1	261	38
12	18		0.08	0.18	0.18	317	60	1	265	38
13	22		0.06	0.13	0.13	316	60	1	268	38
14	26		0.07	0.15	0.15	308	60	1	272	38
15	30		0.06	0.13	0.13	287	60	1	269	38
16	4		0.05	0.11	0.11	236	60	1	266	40
1	0-4		0.08	0.18	0.18	295	59	1	262	41
2	8		0.08	0.18	0.18	313	58	1	261	39
3	12		0.10	0.22	0.22	316	58	2	260	38
4	16		0.10	0.22	0.22	316	58	2	260	40
5	20		0.10	0.22	0.22	317	58	2	259	40
6	24		0.10	0.22	0.22	317	58	2	260	41
7	28		0.09	0.20	0.20	317	57	2	259	41
8	2		0.08	0.18	0.18	317	57	2	259	41
9	6		0.10	0.22	0.22	318	57	2	259	42
10	10		0.11	0.24	0.24	318	57	2	259	42
11	14		0.14	0.31	0.31	318	57	2.5	259	42
12	18		0.16	0.35	0.35	318	57	3	258	42
13	22		0.17	0.37	0.37	316	57	3	257	42
14	26		0.17	0.37	0.37	309	57	3	256	43
15	30		0.17	0.37	0.37	246	57	3	256	43
16	4	748.54	0.16	0.35	0.35	246	57	3	256	43

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		10.0		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	275	644.7
INITIAL	200	639.4
CHANGE	75	5.3

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	OK	OK	
PITOT LINES	OK	OK	
CONSOLE			

DATE 1-23-80
PLANT FSH
STACK #8
RUN 810 6
FILTER 345

From Previous Run Data

$(1-B_{ws})$ ______

1 $\bar{T}_s$ ______ °R

2 $\bar{T}_m$ ______ °R

CALIBRATION

5 ΔH_a 0.201

4 Cp 0.84

17 γ 0.9987

6 D_n ______ IN

1 A_n .0003327 FT^2

NEW DATA

16 P_b 29.81 "Hg

18 V_M 32.71 CF

15 ΔH .201 "H_2O

14 $\bar{T}_m$ 519.0 °R

13 H_2O 75 ML

12 H_2O 5.3 g

11 CO_2 ______ %

10 O_2 10 %

6 $\sqrt{\Delta P}$ avg .298

5 $\bar{T}_s$ 767.43 °R

4 P_s 29.81 "Hg

3 A_s 11.74 FT^2

2 θ 2.13 HR

5' M_n 917.6 Mg

$$K = 849.8\,(D_n)^4\,\Delta H_a\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$

$$= 849.8\,(\quad)^4(\quad)(\quad)^2(\quad)^2\frac{(\quad)}{(\quad)} = \underline{\qquad}$$

$$V_{m(STD)} = \frac{17.64\,V_m\,\gamma\left(P_b + \Delta H/13.6\right)}{T_m}$$

$$= \frac{17.64\,(32.71)(.9987)\left(29.81 + \frac{.201}{13.6}\right)}{(519.0)} = \underline{33.11}\ \text{DSCF}$$

$$V_{wc(STD)} = 0.04707\,(H_2O_C) = 0.04707\,(75) = \underline{3.53}\ \text{SCF}$$

$$V_{wSG(STD)} = 0.04715\,(H_2O_{SG}) = 0.04715\,(5.3) = \underline{.25}\ \text{SCF}$$

$$V_{w(STD)}\ \underline{3.78}\ \text{SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(3.78)}{(3.78)+(33.11)} = \underline{.102}$$

$$M_d = 0.44\,(\%CO_2) + 0.32(\%\,O_2) + 0.28(\%CO+N_2)$$

$$= 0.44\,(\quad) + 0.32(\quad) + 0.25(\quad) = \underline{30}$$

$$M_s = M_d\,(1-B_{ws}) + 18(B_{ws}) = (30)(.898) + 18(.102) = \underline{28.77}$$

$$\bar{V}_s = 85.49\ C_p\ (\sqrt{\Delta P})\,\text{avg.}\sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.49\,(.84)(.298)\sqrt{\frac{(767.43)}{(29.81)(28.776)}} = \underline{20.24}\ \text{FT/SEC}$$

$$\bar{Q}_s = 63500\ \bar{V}_s\ (1-B_{ws})\ A_s\ (P_s/T_s)$$

$$= 63500\,(20.24)(.898)(11.74)\frac{(29.81)}{(767.43)} = \underline{526K}\ \text{CFH}$$

$$\%I = \frac{100\,V_{m(STD)}\,A_s}{\theta\ \bar{Q}_s\ A_n} = \frac{100(33.11)(11.74)}{(2.13)(526K)(.0003327)} = \underline{104.2}$$

$$C_s = \frac{M_n}{454{,}000\,V_{m(STD)}} = \frac{(917.6)}{454{,}000(33.11)} = \underline{6.10\times10^{-5}}\ \text{LB/CF}$$

$$PMR = C_s\ \bar{Q}_s = (6\times10^{-5})(526K) = \underline{32.13}\ \text{LB/HR}$$

$$E = C_s\ F_d\ \frac{20.9}{20.9-\%O_2} = (6\times10^{-5})(9460)\frac{20.9}{20.9-(10)} = \underline{1.11}\ \text{LB}/10^6\text{BTU}$$

DATE 1-23-80

PLANT FSH-CHATTAHOOCHEE

STACK #8

RUN Bio 6

FILTER 345

06 Dn ______ in

05 ΔH_a ______ "H_2O

04 Cp ______ const.

03 Bws ______ fract sat.

02 Tm ______ °R

01 Ts ______ °R

18 Vm 32.71 CF

17 γ .9987 const.

16 Pb 29.81 "Hg

15 $\overline{\Delta H}$ .201 "H_2O

14 Tm 519.0 °R

13 H_2Oc 75 Ml

12 H_2Osg 5.3 G.

11 % CO_2 1 %

10 % O_2 1 %

09 % CO 1 %

08 % N_2 102.42 %

07 Cp .84 const.

06 $(\overline{N\Delta P})$ Ave .399 "H_2O

05 Ts 767.43 °R

04 Ps 29.81 "Hg

03 As 11.74 Ft^2

02 θ 2.13 Hr

01 An .00033275 Ft^2

05 Mn 917.6 Mg

04 $\underline{Vm}$(STD) 33.13 CF

03 Qs 526 K SCFH

02 Fd 9460 dscf/10^6BTU

01 %O_2 10

B = Cs 6.10×10^{-5}

C = PMR 32.1

D = E 1.11

B = Vm(STD) 33.13 DSCF

C = Vw(STD) 3.78 SCF

D = Bws .102 fract. sat.

E = Md 30.00 AMU

A' = $\underline{Ms}$ 28.77 AMU

B' = $\underline{Vs}$ 20.24 Ft/sec

C' = $\overline{Qs}$ 526K SCFH

D' = %I 104.27 % Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K= 2.4

PLANT FSH UNIT #8 DATE 1-25-80

RUN NO. C/W #1 FILTER NO. 351 NOZZLE ID. 181 d ______ IN An ______ FT2

P_b 29.88 ΔH ______ Y ______ PITOT ID. ______ C_p ______

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-4	535.04	0.10	0.24	0.24	315	67	1	255	58
2	8		0.08	0.19	0.19	324	67	1	255	56
3	12		0.08	0.17	0.19	322	68	1	255	56
4	16		0.08	0.19	0.19	320	68	1	255	56
5	20		0.08	0.19	0.19	319	69	1	255	56
6	24		0.08	0.19	0.19	317	70	1	255	56
7	28		0.08	0.19	0.19	315	70	1	255	56
8	2		0.08	0.19	0.19	315	71	1	255	56
9	6		0.08	0.19	0.19	315	72	1	255	57
10	10		0.08	0.19	0.19	315	72	1	255	57
11	14		0.08	0.19	0.19	315	72	1	255	57
12	18		0.09	0.22	0.22	315	73	1	255	57
13	22		0.09	0.22	0.22	313	73	1	255	57
14	26		0.09	0.22	0.22	311	73	1	255	57
15	30		0.08	0.19	0.19	303	73	1	255	57
16	4	551.00	0.07	0.17	0.17	259	73	1	255	57
1	0-4		0.11	0.26	0.26	309	73	1	252	58
2	8		0.14	0.34	0.34	312	73	1	252	58
3	12		0.12	0.29	0.29	313	73	1	255	55
4	16		0.11	0.26	0.26	314	73	1	255	55
5	20		0.11	0.26	0.26	314	73	1	255	55
6	24		0.10	0.24	0.24	314	73	1	255	57
7	28		0.10	0.24	0.24	314	73	1	255	57
8	2		0.07	0.17	0.17	314	73	1	255	57
9	6		0.07	0.17	0.17	314	73	1	255	58
10	10		0.10	0.24	0.24	314	73	1	255	58
11	14		0.14	0.34	0.34	315	74	1	255	58
12	18		0.16	0.38	0.38	314	75	1	255	58
13	22		0.18	0.43	0.43	314	75	1	255	58
14	26		0.20	0.48	0.48	313	76	1	255	58
15	30		0.17	0.41	0.41	295	76	1	255	58
16	4	569.60	0.14	0.34	0.34	259	76	1	255	58

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		10.1		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	243	578.0
INITIAL	200	571.8
CHANGE	43	6.2

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	OPH		
PITOT LINES	BK		
CONSOLE			

DATE 1-25-80
PLANT FSA-CHATT
STACK #8
RUN Coal/wood 1
FILTER 357

From Previous Run Data
$(1-B_{ws})$ ____
1 $\bar{T}_s$ ____ °R
2 $\bar{T}_m$ ____ °R

CALIBRATION
5 $\Delta H_@$ ____
4 C_p .84
17 Y 1.013
6 D_n ____ IN
1 A_n .00033275 FT^2

NEW DATA
16 P_b 29.88 "Hg
18 V_M 34.56 CF
15 $\overline{\Delta H}$ .250 "H_2O
14 $\bar{T}_m$ 532.3 °R
13 H_2O 43 ML
12 H_2O 6.2 g
11 CO_2 ____ %
10 O_2 10.1 %
6 $\sqrt{\Delta P}$ avg 0.32
5 $\bar{T}_s$ 770.5 °R
4 P_s 29.88 "Hg
3 A_s 11.74 FT^2
2 θ 2.13 HR
5' M_n 2304 MG

$$K = 849.8\,(D_n)^4\,\Delta H_@\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$
$$= 849.8\,(\quad)^4(\quad)(\quad)^2(\quad)^2\frac{(\quad)}{(\quad)} = \_\_\_\_$$

$$V_m(STD) = \frac{17.64\,V_m\,Y\left(P_b + \Delta H/13.6\right)}{T_m}$$
$$= \frac{17.64\,(34.56)(1.013)\left(29.88 + \frac{.25}{13.6}\right)}{(532.3)} = 34.68 \text{ DSCF}$$

$$V_{wc}(STD) = 0.04707\,(H_2O_c) = 0.04707\,(43) = 2.02 \text{ SCF}$$
$$V_{wSG}(STD) = 0.04715\,(H_2O_{SG}) = 0.04715\,(6.2) = .29 \text{ SCF}$$
$$V_w(STD)\ 2.31 \text{ SCF}$$

$$B_{ws} = \frac{V_w(STD)}{V_w(STD) + V_m(STD)} = \frac{(2.31)}{(2.31)+(34.68)} = .062$$

$$M_d = 0.44\,(\%CO_2) + 0.32\,(\%\,O_2) + 0.28\,(\%CO+N_2)$$
$$= 0.44\,(\quad) + 0.32\,(\quad) + 0.28\,(\quad) = 30$$

$$M_s = M_d\,(1-B_{ws}) + 18\,(B_{ws}) = (30)(.938)+18(.062) = 29.25$$

$$\bar{V}_s = 85.49\,C_p\,(\sqrt{\Delta P})\text{ avg.}\sqrt{\frac{T_s}{P_s M_s}}$$
$$= 85.49\,(.84)(.32)\sqrt{\frac{(770.5)}{(29.88)(29.25)}} = 21.57 \text{ FT/SEC}$$

$$\bar{Q}_s = 63500\,\bar{V}_s\,(1-B_{ws})\,A_s\,(P_s/T_s)$$
$$= 63500\,(21.57)(.938)(11.74)\frac{(29.88)}{(770.5)} = 584K \text{ CFH}$$

$$\%I = \frac{100\,V_m(STD)\,A_s}{\theta\,\bar{Q}_s\,A_n} = \frac{100\,(34.68)(11.74)}{(2.13)(584)(.00033275)} = 98.2$$

$$C_s = \frac{M_n}{454{,}000\,V_m(STD)} = \frac{(2304)}{454{,}000\,(34.68)} = 1.46\times10^{-4}\ \text{LB/CF}$$

$$PMR = C_s\,\bar{Q}_s = (1.46\times10^{-4})(584K) = 85.53 \text{ LB/HR}$$

$$E = C_s\,F_d\,\frac{20.9}{20.9-\%O_2} = (1.46\times10^{-4})(9460)\,\frac{20.9}{20.9-10.1} = 2.79\ \text{LB}/10^6\text{BTU}$$

DATE 1-25-80

PLANT CHATTAHOOCHEE

STACK #8

RUN Coal/wood 1

FILTER 351

06 Dn		in
05 $\Delta H_@$		"H_2O
04 Cp		const.
03 Bws		fract sat.
02 Tm		°R
01 Ts		°R

18 Vm	34.56	CF
17 γ	1.013	const.
16 Pb	29.88	"Hg
15 ΔH	.25	"H_2O
14 Tm	532.7	°R
13 H_2Oc	43	Ml
12 H_2Osg	6.2	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	103.43	%
07 Cp	.84	const.
06 $(\overline{N\Delta P})$ Ave	.32	"H_2O
05 Ts	770.5	°R
04 Ps	29.85	"Hg
03 As	11.74	Ft^2
02 θ	2.13	Hr
01 An	.00033275	Ft^2

05 Mn	2304	Mg
04 $\underline{Vm}$(STD)	34.70	CF
03 $\overline{Qs}$	584K	SCFH
02 Fd	9889	dscf/10^6BTU
01 %O_2	10.1	

B = Cs 1.46×10^{-4}

C = PMR 85.53

D = E 2.79

B = Vm(STD)	34.70	DSCF
C = Vw(STD)	2.31	SCF
D = Bws	.062	fract. sat.
E = Md	30.00	AMU
A' = $\underline{Ms}$	29.24	AMU
B' = $\underline{Vs}$	21.57	Ft/sec
C' = $\overline{Qs}$	584K	SCFH
D' = %I	98.13	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K= 2.2

PLANT FSH UNIT #8 DATE 1-25-80

RUN NO. C/W #2 FILTER NO. 245 NOZZLE ID. 8 d ____ IN A_N .00033 FT2

P_b 29.88 ΔH ____ Y ____ PITOT ID. ____ C_p ____

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-4	784.582	0.19	0.418		215	66	1	250	51
2	8		0.18	0.396		299	67	1	246	47
3	12		0.22	0.484		319	68	1	249	47
4	16		0.20	0.44		315	69	1	247	49
5	20		0.17	0.374		319	70	1	245	50
6	24		0.14	0.308		319	70	1	245	51
7	28		0.13	0.286		317	71	1	244	51
8	2		0.09	0.198		315	71	1	244	50
9	6		0.07	0.154		314	71	1	244	53
10	10		0.09	0.198		314	72	1	244	53
11	14		0.10	0.22		313	72	1	244	52
12	18		0.12	0.264		313	72	1	244	53
13	22		0.13	0.286		313	73	1	243	53
14	26		0.13	0.286		313	73	1	244	53
15	30		0.13	0.286		313	73	1	244	53
16	4	805.208	0.13	0.286		311	73	1	244	53
1	0-4		0.06	0.132		229	72	1	244	63
2	8		0.07	0.154		279	72	1	244	57
3	12		0.09	0.198		302	72	1	244	57
4	16		0.09	0.198		304	72	1	244	57
5	20		0.09	0.198		313	72	1	244	55
6	24		0.09	0.198		313	72	1	244	55
7	28		0.09	0.198		313	72	1	244	55
8	2		0.08	0.176		313	73	1	244	55
9	6		0.08	0.176		313	73	1	244	55
10	10		0.09	0.198		314	73	1	243	55
11	14		0.08	0.176		313	74	1	244	55
12	18		0.08	0.176		313	74	1	244	55
13	22		0.08	0.176		311	74	1	244	57
14	26		0.09	0.198		311	75	1	244	55
15	30		0.09	0.198		310	75	1	245	55
16	4	821.595	0.09	0.198		309	75	1	244	55

GAS ANALYSIS	%CO2	%O2	%CO	%N2
		9.8		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	245	615.2
INITIAL	200	608.5
CHANGE	45	6.7

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	BK	BK	
PITOT LINES	BK	BK	
CONSOLE			

DATE 1-25-80
PLANT FS H-CHATT
STACK #8
RUN Coal/wood 2
FILTER 245

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION
5 $\Delta H_@$ ______
4 Cp .84
17 Y .9987
6 D_n ______ IN
1 A_n .00033086 FT^2

NEW DATA
16 P_b 29.88 "Hg
18 V_M 37.01 CF
15 ΔH .245 "H_2O
14 $\bar{T}_m$ 531.9 °R
13 H_2O 45 ML
12 H_2O 6.7 g
11 CO_2 ~ %
10 O_2 9.8 %
6 $\sqrt{\Delta P}$ avg .329
5 $\bar{T}_s$ 765.7 °R
4 P_s 29.88 "Hg
3 A_s 11.74 FT^2
2 θ 2.13 HR
5' M_n 2484 Mg

$$K = 849.8\,(D_n)^4\,\Delta H_@\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$
$$= 849.8\,(\quad)^4(\quad)(\quad)^2(\quad)^2\,\frac{(\quad)}{(\quad)} = \_\_\_\_$$

$$V_{m(STD)} = \frac{17.64\,V_m\,Y\left(P_b + \Delta H/13.6\right)}{T_m}$$
$$= \frac{17.64\,(37.01)(.9987)\left(29.88 + \frac{.245}{13.6}\right)}{(531.9)} = 36.64 \text{ DSCF}$$

$$V_{wc(STD)} = 0.04707\,(H_2O_c) = 0.04707\,(45) = 2.11 \text{ SCF}$$
$$V_{wsg(STD)} = 0.04715\,(H_2O_{sg}) = 0.04715\,(6.7) = .31 \text{ SCF}$$
$$V_{w(STD)}\ 2.42 \text{ SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.42)}{(2.42) + (36.64)} = .061$$

$$M_d = 0.44\,(\%CO_2) + 0.32\,(\%O_2) + 0.28\,(\%CO+N_2)$$
$$= 0.44\,(\quad) + 0.32\,(\quad) + 0.28\,(\quad) = 30$$

$$M_s = M_d\,(1-B_{ws}) + 18\,(B_{ws}) = (30)(.939) + 18(.061) = 29.26$$

$$\bar{V}_s = 85.49\,C_p\,(\sqrt{\Delta P})\,\text{avg.}\sqrt{\frac{T_s}{P_s M_s}}$$
$$= 85.49\,(.84)(.329)\sqrt{\frac{(765.7)}{(29.88)(29.26)}} = 28.11 \text{ FT/SEC}$$

$$\bar{Q}_s = 63500\,\bar{V}_s\,(1-B_{ws})\,A_s\,(P_s/T_s)$$
$$= 63500\,(28.11)(.939)(11.74)\frac{(29.88)}{(765.7)} = 603K \text{ CFM}$$

$$\%I = \frac{100\,V_{m(STD)}\,A_s}{\theta\,\bar{Q}_s\,A_n} = \frac{100\,(36.64)(11.74)}{(2.13)(603K)(.00033086)} = 101.07$$

$$C_s = \frac{M_n}{454{,}000\,V_{m(STD)}} = \frac{(2484)}{454{,}000\,(36.64)} = 1.49\times10^{-4}\ \text{LB/CF}$$

$$PMR = C_s\,\bar{Q}_s = (1.49\times10^{-4})(603K) = 89.94\ \text{LB/HR}$$

$$E = C_s\,F_d\,\frac{20.9}{20.9-\%O_2} = (1.49\times10^{-4})(9885)\,\frac{20.9}{20.9-(9.8)} = 2.77\ \text{LB}/10^6\,\text{BTU}$$

DATE 1-25-80

PLANT CHATTAHOOCHEE

STACK #8

RUN COAL/WOOD 2

FILTER 245

06	Dn		in
05	$\Delta H_@$		$"H_2O$
04	Cp		const.
03	Bws		fract sat.
02	Tm		^oR
01	Ts		^oR

18	Vm	37.01	CF
17	γ	.9987	const.
16	Pb	29.88	"Hg
15	$\overline{\Delta H}$	.295	$"H_2O$
14	Tm	531.9	^oR
13	H_2Oc	45	Ml
12	H_2Osg	6.7	G.
11	% CO_2	1	%
10	% O_2	1	%
09	% CO	1	%
08	% N_2	103.43	%
07	Cp	.84	const.
06	$(\overline{N\Delta P})$ Ave	.329	$"H_2O$
05	Ts	765.7	^oR
04	Ps	29.88	"Hg
03	As	11.74	Ft^2
02	θ	2.13	Hr
01	An	.00033096	Ft^2

05	Mn	24.84	Mg
04	Vm(STD)	36.66	CF
03	Qs	603K	SCFH
02	Fd	9865	$dscf/10^6BTU$
01	SO_2	9.8	

B = Cs 1.49×10^{-4}

C = PMR 90.06

D = E 2.77

B = Vm(STD)	36.66	DSCF
C = Vw(STD)	2.43	SCF
D = Bws	.062	fract. sat.
E = Md	30.00	AMU
A' = Ms	29.25	AMU
B' = $\overline{Vs}$	22.11	Ft/sec
C' = $\overline{Qs}$	603 K	SCFH
D' = %I	101.07	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K= 2.4

PLANT FSH UNIT #8 DATE 1-25-80

RUN NO. C/W #3 FILTER NO. 349 NOZZLE ID. 81 d ______ IN An ______ FT2

P_b 29.80 ΔH ______ Y ______ PITOT ID. ______ C_p ______

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-4	570.164	0.11	0.264		314	70	1	252	53
2	8		0.09	0.216		315	70	1	252	53
3	12		0.08	0.192		317	71	1	252	57
4	16		0.08	0.192		319	71	1	252	57
5	20		0.10	0.24		319	71	1	252	57
6	24		0.08	0.192		319	72	1	255	57
7	28		0.07	0.168		319	73	1	268	57
8	2		0.06	0.144		319	73	1	265	58
9	6		0.04	0.096		319	74	1	257	57
10	10		0.08	0.192		319	74	1	245	61
11	14		0.11	0.264		322	74	1	245	59
12	18		0.16	0.384		322	74	1	245	58
13	22		0.17	0.408		322	74	1	245	58
14	26		0.19	0.456		331	75	1.5	250	54
15	30		0.20	0.48		300	75	1.5	250	54
16	4	588.66	0.25	0.60		279	75	2	253	57
1	0-4		0.14	0.336		317	74	1.5	253	57
2	8		0.12	0.288		320	74	1.5	253	57
3	12		0.10	0.24		321	74	1.5	253	57
4	16		0.12	0.288		322	74	1.5	253	57
5	20		0.08	0.192		322	74	1.5	253	57
6	24		0.09	0.216		322	74	1.5	253	57
7	28		0.08	0.192		322	74	1.5	253	57
8	2		0.11	0.264		326	74	1.5	253	57
9	6		0.09	0.216		328	74	1.5	253	57
10	10		0.08	0.192		329	74	1.5	253	57
11	14		0.10	0.24		329	74	1.5	253	57
12	18		0.12	0.288		328	74	1.5	253	57
13	22		0.12	0.288		327	74	1.5	253	57
14	26		0.08	0.192		322	74	1.5	253	57
15	30		0.11	0.264		313	74	1.5	253	57
16	4	606.49	0.11	0.264		308	74	1.5	253	57

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		10.9		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	240	591.4
INITIAL	200	583.4
CHANGE	40	8.0

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	BK	BK	
PITOT LINES	BK	BK	
CONSOLE			

DATE 1-25-80
PLANT FSU-CHART
STACK #8
RUN WOOD/COAL #3
FILTER 349

From Previous Run Data
$(1-B_{ws})$ ____
1 $\overline{T}_s$ ____ ^oR
2 $\overline{T}_m$ ____ ^oR

CALIBRATION
5 $\Delta H_@$ ____
4 C_p .84
17 Y 1.013
6 D_n ____ IN
1 A_n .00034088 FT^2

NEW DATA
16 P_b 29.8 "Hg
18 V_m 36.30 CF
15 ΔH .264 "H_2O
14 $\overline{T}_m$ 533.44 ^oR
13 H_2O 40 ML
12 H_2O 6 g
11 CO_2 ~ %
10 O_2 10.9 %
6 $\sqrt{\Delta P}$ avg .326
5 $\overline{T}_s$ 778.78 ^oR
4 P_s 29.8 "Hg
3 A_s 11.74 FT^2
2 θ 2.13 HR
5' M_n 2214 Mg

$$K = 849.8\,(D_n)^4 \Delta H_@\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$
$$= 849.8\,(\quad)^4(\quad)(\quad)^2(\quad)^2\frac{(\quad)}{(\quad)} = \_\_\_\_$$

$$V_{m(STD)} = \frac{17.64\,V_m\,Y\left(P_b + \Delta H/13.6\right)}{T_m}$$
$$= \frac{17.64\,(36.30)(1.013)\left(29.8 + \frac{.264}{13.6}\right)}{(533.44)} = \underline{36.28}\ \text{DSCF}$$

$$V_{wc(STD)} = 0.04707\,(H_2O_c) = 0.04707\,(40) = \underline{1.88}\ \text{SCF}$$
$$V_{wsg(STD)} = 0.04715\,(H_2O_{sg}) = 0.04715\,(6) = \underline{.28}\ \text{SCF}$$
$$V_{w(STD)}\ \underline{2.16}\ \text{SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.16)}{(2.16)+(36.28)} = \underline{.056}$$

$$M_d = 0.44\,(\%CO_2) + 0.32\,(\%O_2) + 0.28\,(\%CO+N_2)$$
$$= 0.44\,(\quad) + 0.32\,(\quad) + 0.28\,(\quad) = \underline{30}$$

$$M_s = M_d\,(1-B_{ws}) + 18\,(B_{ws}) = (30)(.944) + 18(.056) = \underline{29.34}$$

$$\overline{V}_s = 85.49\,C_p\,(\sqrt{\Delta P})\,\text{avg.}\sqrt{\frac{T_s}{P_sM_s}}$$
$$= 85.49\,(.84)(.326)\sqrt{\frac{(778.78)}{(29.8)(29.34)}} = \underline{22.09}\ \text{FT/SEC}$$

$$\overline{Q}_s = 63500\,\overline{V_s}\,(1-B_{ws})\,A_s\,(P_s/T_s)$$
$$= 63500\,(22.09)(.944)(11.74)\frac{(29.8)}{(778.78)} = \underline{594K}\ \text{CFH}$$

$$\%I = \frac{100V_{m(STD)}\,A_s}{\theta\,\overline{Q}_s\,A_n} = \frac{100\,(36.28)(11.74)}{(2.13)(594)(.00034088)} = \underline{100.7}$$

$$C_s = \frac{M_n}{454{,}000\,V_{m(STD)}} = \frac{(2214)}{454{,}000\,(36.28)} = \underline{1.34\times10^{-4}}\ \text{LB/CF}$$

$$PMR = C_s\,\overline{Q}_s = (1.34\times10^{-4})(594K) = \underline{79.59}\ \text{LB/HR}$$

$$E = C_s\,F_d\,\frac{20.9}{20.9-\%O_2} = (1.34\times10^{-4})(9885)\frac{20.9}{20.9-10.9} = \_\_\_\_\ \text{LB}/10^6\text{BTU}$$

DATE 1-25-80

PLANT CHATTANOOGA

STACK #8

RUN WOOD/COAL #3

FILTER 349

06 Dn		in
05 ΔH_a		"H_2O
04 C_p		const.
03 Bws		fract sat.
02 Tm		°R
01 Ts		°R

18 Vm	36.22	CF
17 γ	1.013	const.
16 Pb	29.8	"Hg
15 ΔH	.264	"H_2O..
14 Tm	533.44	°R
13 H_2Oc	40	Ml
12 H_2Osg	8	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	108.43	%
07 $\overline{Cp}$	.84	const.
06 $(\overline{N\Delta P})$ Ave	.326	"H_2O
05 Ts	778.78	°R
04 Ps	29.8	"Hg
03 As	11.74	Ft^2
02 θ	2.0	Hr
01 An	.00034088	Ft^2

05 Mn	2214	Mg
04 Vm(STD)	36.30	CF
03 Qs	593K	SCFH
02 Fd	9885	$dscf/10^6BTU$
01 $\%O_2$	10.9	

B = Cs 1.34×10^{-4}

C = PMR 79.79

D = E 2.77

B = Vm(STD)	36.30	DSCF
C = Vw(STD)	2.26	SCF
D = Bws	.058	fract. sat.
E = Md	30.00	AMU
A' = Ms	29.29	AMU
B' = $\overline{Vs}$	22.10	Ft/sec
C' = $\overline{Qs}$	593K	SCFH
D' = %I	98.63	% Iso

DGK 2-6-80

CHATTAHOOCHEE

FILTER WEIGHTS

		FINAL	INITIAL	DIFFERENCE
(1)	OIL #6	0.46813	0.41333	0.05480
(2)	OIL #6A	0.48550	0.40747	0.07803
(3)	BIO #1	0.65219	0.42128	0.22801
(4)	BIO #2	0.65600	0.42701	0.22899
(5)	BIO #3	0.60706	0.40122	0.20584
(6)	BIO #4	0.75983	0.39766	0.36217
(7)	BIO #5	0.79219	0.39288	0.39931
(8)	BIO #6	0.86483	0.41550	0.44933
(9)	OIL #6B	0.50200	0.40045	0.10155
(10)	OIL #6C	0.49985	0.39881	0.10104

BEAKER WEIGHTS Acetone Probe Wash

		FINAL	INITIAL	DIFFERENCE
(1)	#7	104.98280	104.94867	0.03413
(2)	#8	102.38720	102.31132	0.07588
(3)	#6	112.00530	111.72453	0.28077
(4)	#9	107.28380	107.08059	0.20321
(5)	#10	104.87365	104.61602	0.25763
(6)	#5	110.01900	109.63141	0.38759
(7)	#4	108.64880	108.14741	0.50139
(8)	#3	110.26110	109.79279	0.46831
(9)	#2	103.47280	103.43221	0.04059
(10)	#1	110.42500	110.38136	0.04364

CHATTAHOOCHEE

FILTER WEIGHTS

	INITIAL	FINAL	DIFFERENCE
#355 Coal	0.41209	0.71574	0.30365
#351 Coal/wood #1	0.42847	1.55926	1.13079
#245 Coal/wood #2	0.40403	0.85400	0.44997
#349 Coal/wood #3	0.41251	1.29403	0.88152
#352 Blank	0.42902	0.42852	-0.0005

BEAKER WEIGHTS, Acetone Probe Wash

	INITIAL	FINAL	DIFFERENCE
#17 Coal	105.05771	108.33330	3.27559
#18 Coal/wood #1	109.85846	111.03215	1.17369
#19 Coal/wood #2	110.21370	112.24835	2.03465
#20 Coal/wood #3	104.57834	105.91145	1.33311
#21 Acetone Blank (200ml)	104.38848	104.39010	0.00162

Date	Run	Instantaneous O_2 Readings			O_2 Integrated Bag Readings		Run Times	
		start	middle	finish	Boiler	Flue	Start	Stop
1-21-80	Oil 1				10.1	12.3	11:30	12:30
	Oil 2				-	7.3	2:00	3:00
1-22-80	Bio 1				4.2	8.1	11:30	12:40
	Bio 2				-	9.1	2:00	3:12
	Bio 3					10.1	4:00	5:10
1-23-80	Bio 4	5.8-6.3,	3.6-6.9,	6.5-7.5	7.5	8.15	10:30	12:40
	Bio 5	6.5-7.5,	3.6-7.0,	4.6-6.8	7.8	8.9	1:35	3:50
	Bio 6	-	4.6-5.2,	-	4.9	10.0	4:00	6:10
1-24-80	Coal 1	7.7-9.0,	7.9-9.4,	6.6-9.4	8.6	8.4	12:30	2:40
1-25-80	C-W 1	1.0-3.0,	-	-	-	10.1	11:30	1:40
	C-W 2	Simultaneous with C-W 1			-	9.8	11:30	1:40
	C-W 3	5.1-5.8	-	-	8.05	10.9	3:50	6:00
1-24-80	Oil 3				Simultaneous with oil 4		1:00	2:35
	Oil 4				7.75	9.95	1:00	2:35

Flue bag and boiler bag samples were taken during the entire run period. Instantaneous readings were taken at the start, middle, and finish of the sample period.

[illegible] ______ VELOCITY TRAVERSE DATA SEAL ______

[illegible] CHATTAHOOCHEE UNIT #8 DATE 1-21-80

STACK DIMEN. 46.4" EQUIV. DIA. NIPPLE = 5.5" SKETCH OF STACK

DISTANCE TO UPSTREAM RESTRICTION 5 Ø

DISTANCE TO DOWNSTREAM RESTRICTION 2 + Ø

NO. OF TRAVERSE PTS. 32

$$P_s \simeq 30 \pm \left(\frac{''H_2O}{13.6}\right) \simeq \_\_\_\_ ''Hg$$

		PORT ____		PORT ____	
PT.	DIST. TO WALL	ΔP	T_s	ΔP	T_s
1	~~6.75"~~	→ 6.5"	*		
2	7.75"				
3	9.4"				
4	11.3"				
5	13.3"				
6	15.7"				
7	18.6"				
8	22.9"				
9	34.5"				
10	38.75"				
11	41.7"				
12	44.0"				
13	46.1"				
14	48.0"				
15	49.6"				
16	50.9"	ADJ.*			
AVERAGE					

$$V_s \simeq 2.46\sqrt{T_s\,\Delta P}$$

$$2.46\sqrt{(\quad X\quad)} = \_\_\_\_ \text{FPS}$$

$$D_N \simeq \sqrt{\frac{0.956}{T_m(1-B_{ws})}}\sqrt{\frac{T_s}{\Delta P}}$$

$$\sqrt{\frac{0.956}{(\quad X 1- \quad)}}\sqrt{\frac{(\quad)}{(\quad)}} = \_\_\_\_ D$$

$$A_N = \pi\left(\frac{D_N}{2}\right)^2 = \frac{\pi}{4}(\quad)^2 =$$

$$\_\_\_\_ IN^2$$

$$\theta \simeq \frac{72\ \cancel{60}\ T_s}{V_s\,A_N\,(1-B_{ws})\,T_m}$$

$$\frac{60(\quad)}{(\quad X \quad X 1- \quad X \quad)} =$$

RECORD OF VISUAL DETERMINATION OF OPACITY

Page 1 of 6

I.D. 0477
Company Florida State Hospital
Location Gadsden Co.
Test Number 1
Date 1/22/80

Type Facility 'A' Source
Control Device multi-cyclone
Hrs Observation 40 min.
Observer Mary Jean O'Neil

Obs Certification Date 1/16/80
Obs Affiliation DER
Pt of Emissions Boiler #8
Hgt of Discharge Pt 50'

	Initial			Final
Clock Time	2:20			3:00
Observer Location Distance to Discharge	125'			135'
Direction from Discharge	SE			SE
Height of Observation Point	ground			ground
Background Description	smoke stack			smoke stack
Weather Conditions Wind Direction	SW			SW
Wind Speed	gusty			gusty
Ambient Temperature	69°			69°
Sky Conditions (clear, overcast % clouds, etc.)	overcast			overcast
Plume Description "black" Color	grey			grey
Distance Visible				
Other Information	Wcorder		26,000 lbs./st hr	

Summary of Average Opacity

Set Number	Time Start	Time End	Opacity Sum	Opacity Average
1	2:20	2:26	360	15
2	2:26	2:31	375	15.6
3	2:31	2:37	440	18.34
4	2:37	2:44	410	17.08
5	2:44	2:50	470	19.58
6	2:50	2:56	480	20
				17.6

Readings ranged from 10 to 25 % opacity

The source [✓ was] ~~was not~~ in compliance with DER at the time of evaluation

X Mary Jean O'Neil
Observer's signature

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
2:20	0	20	20	15	15		
	1	15	15	20	15		
	2	15	15	20	15		
	3	15	15	10	15		
	4	15	15	15	10		
	5	10	15	15	10		
2:26	6	15	15	15	10		
	7	15	15	10	15		
	8	15	15	10	15		
	9	15	20	20	15		
2:30	10	20	20	15	15		
2:31	11	15	20	15	20		
	12	15	20	15	15		
	13	20	20	15	20		
	14	15	15	20	15		
	15	15	20	25	20		
	16	15	20	20	25		
2:37	17	20	15	20	20		
	18	25	25	20	20		
	19	20	20	15	15		
2:40	20	20	15	15	20		
	21	20	15	15	15		
	22	15	15	15	15		
	23	10	15	15	15		
2:44	24	15	20	15	20		
	25	20	20	15	20		
	26	20	15	15	20		
	27	25	20	20	25		
	28	20	20	20	20		
	29	20	25	20	20		

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
2:50	30	20	20	25	20		
	31	20	20	20	20		
	32	20	20	20	20		
	33	15	20	20	20		
	34	20	15	20	20		
	35	20	20	25	20		
2:56	36	20	15	20	20		
	37	20	20	20	25		
	38	20	25	25	20		
	39	20	20	20	20		
3:00	40	20					
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RECORD OF VISUAL DETERMINATION OF OPACITY

Page 2 of 6

I D 0477
Company Florida State Hospital
Location Gadsden Co.
Test Number 1
Date 1/23/80

Type Facility 'A' Source
Control Device multicyclones
Hrs Observation one
Observer Mary Jean O'Neil

Obs Certification Date 1/11/80
Obs Affiliation DER
Pt of Emissions Boiler # 8
Hgt of Discharge Pt 50'

	Initial			Final
Clock Time	11:10am			12:10
Observer Location Distance to Discharge	125'			125'
Direction from Discharge	SE			SE
Height of Observation Point	ground			ground
Background Description	smoke stack			smoke stack
Weather Conditions Wind Direction	NW			SW
Wind Speed	light			light
Ambient Temperature	49°			49°
Sky Conditions (clear, overcast % clouds, etc.)	overcast			partly cloudy
Plume Description "black" Color	grey			grey
Distance Visible				
Other Information	Woodex			

Summary of Average Opacity

Set Number	Time		Opacity	
	Start	End	Sum	Average
1	11:10	11:20	575	14.37
2	11:20	11:30	660	16.5
3	11:30	11:40	745	18.6
4	11:40	11:50	665	16.6
5	11:50	12:00	630	15.75
6	12:20	12:10	635	15.9
				16.29

Readings ranged from 10 to 25 % opacity

The source [✓ was] ~~was not~~ in compliance with DER at the time of evaluation.

x Mary Jean O'Neil
Observer's signature

Hr	Min	Seconds				Steam Plume If applicable	
		0	15	30	45	Attached	Detached
11:10	0	15	10	15	15		
	1	10	10	15	15		
	2	15	15	15	20		
	3	15	15	15	15		
	4	10	15	20	15		
	5	15	15	15	15		
	6	10	15	15	15		
	7	15	10	15	15		
	8	15	15	10	15		
	9	15	15	15	15		
11:20	10	20	15	15	15		
	11	15	20	15	20		
	12	15	20	15	15		
	13	15	15	15	15		
	14	15	15	20	15		
	15	20	15	15	20		
	16	20	15	15	15		
	17	15	20	20	15		
	18	15	15	15	20		
	19	15	15	15	20		
11:30	20	20	15	15	15		
	21	15	15	20	20		
	22	20	15	15	20		
	23	20	20	15	20		
	24	20	20	25	20		
	25	20	25	20	20		
	26	25	25	20	20		
	27	20	20	15	15		
	28	15	15	20	20		
	29	20	15	15	15		

Hr	Min	Seconds				Steam Plume If applicable	
		0	15	30	45	Attached	Detached
11:40	30	15	15	15	15		
	31	15	15	20	20		
	32	20	15	15	15		
	33	15	15	15	15		
	34	15	15	20	15		
	35	20	20	20	15		
	36	15	15	15	20		
	37	20	15	15	15		
	38	20	20	15	15		
	39	15	15	20	20		
11:50	40	20	20	20	20		
	41	15	15	20	15		
	42	15	15	15	15		
	43	15	15	15	20		
	44	15	20	15	15		
	45	15	15	15	15		
	46	15	16	15	15		
	47	15	15	15	20		
	48	15	15	15	20		
	49	15	15	15	15		
12:00	50	15	15	15	10		
	51	10	15	15	20		
	52	20	20	15	15		
	53	15	15	15	15		
	54	15	20	20	20		
	55	20	16	15	15		
	56	15	15	15	15		
	57	15	20	20	15		
	58	15	15	15	15		
	59	15	15	15	15		

RECORD OF VISUAL DETERMINATION OF OPACITY

Page 3 of 6

I.D. C477
Company Florida State Hospital
Location Gadsden Co
Test Number 2
Date 1/23/80

Type Facility A Source
Control Device multicyclones
Hrs Observation one
Observer MJ O'Neil

Obs Certification Date 11/6/80
Obs Affiliation DER
Pt of Emissions Boiler #2
Hgt of Discharge Pt 50'

	Initial			Final
Clock Time	3:05 pm			3:05 pm
Observer Location Distance to Discharge	125'			125'
Direction from Discharge	SE			SE
Height of Observation Point	ground			ground
Background Description	smoke-stack			smoke-stack
Weather Conditions Wind Direction	N			NE
Wind Speed	light			light
Ambient Temperature	48°			48°
Sky Conditions (clear, overcast % clouds, etc.)	over-cast			over-cast
Plume Description "black" Color	grey			grey
Distance Visible				
Other Information	wittex		36 [illegible]	

Summary of Average Opacity

Set Number	Time Start	Time End	Opacity Sum	Opacity Average
1	2:05	2:15	720	18
2	2:15	2:25	815	20.37
3	2:35	2:35	850	21.25
4	2:35	2:45	855	21.37
5	2:45	2:55	895	22.37
6	2:55	3:05	890	22.25
				21.17

Readings ranged from 15 to 30 % opacity

The source [✓ was] ~~was not~~ in compliance with DER at the time of evaluation

X Mary Jean O'Neil
Observer's signature

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
2:05	0	20	20	15	15		
	1	20	20	15	15		
	2	15	15	15	15		
	3	20	15	15	15		
	4	20	20	20	15		
	5	15	20	20	20		
	6	20	15	15	15		
	7	20	20	25	25		
	8	20	20	15	15		
	9	20	20	20	20		
2:15	10	15	20	20	20		
	11	20	20	20	20		
	12	20	20	20	20		
	13	25	25	25	20		
	14	20	25	25	20		
	15	30	20	20	20		
	16	20	20	20	20		
	17	20	20	20	20		
	18	15	20	20	20		
	19	20	20	20	20		
2:25	20	20	25	25	20		
	21	20	20	25	25		
	22	20	25	20	20		
	23	20	20	20	20		
	24	20	20	25	25		
	25	25	25	25	25		
	25	20	20	20	20		
	27	20	20	20	20		
	28	25	20	20	20		
	29	20	15	20	15		

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
2:35	30	15	30	20	25		
	31	20	20	20	20		
	32	25	25	20	20		
	33	20	25	25	25		
	34	20	20	20	25		
	35	30	20	20	20		
	36	20	20	20	20		
	37	20	15	20	20		
	38	20	20	25	25		
	39	20	25	30	25		
2:45	40	25	25	20	20		
	41	20	20	20	25		
	42	25	25	25	20		
	43	20	25	25	25		
	44	20	20	20	20		
	45	20	25	25	20		
	46	20	20	20	20		
	47	20	25	20	20		
	48	20	25	25	25		
	49	20	25	25	30		
2:55	50	25	30	25	25		
	51	25	20	30	20		
	52	20	20	20	25		
	53	25	25	20	25		
	54	20	25	20	20		
	56	20	25	25	25		
	56	20	20	25	25		
	57	20	20	25	30		
	58	20	20	20	20		
	59	20	25	20	20		

RECORD OF VISUAL DETERMINATION OF OPACITY

Page 4 of 6

I D C477

Company Florida State Hospital

Location Gadsden Co.

Test Number

Date 1/24/80

Type Facility "A" Source

Control Device multicyclones

Hrs Observation .50

Observer MJ O'Neil

Obs Certification Date 11/dec

Obs Affiliation DER

Pt of Emissions Boiler #8

Hgt of Discharge Pt 50'

	Initial			Final
Clock Time	1:50pm			2:20pm
Observer Location Distance to Discharge	140'			140'
Direction from Discharge	S			S
Height of Observation Point	ground			ground
Background Description	blue sky			blue sky
Weather Conditions Wind Direction	SW			SW
Wind Speed	light			light
Ambient Temperature	49°			49°
Sky Conditions (clear, overcast, % clouds, etc.)	clear			clear
Plume Description Color	brown			brown
Distance Visible	100 yd			100 yd
Other Information	coal	28,000 lbs		steam/hr

Summary of Average Opacity

Set Number	Time Start	Time End	Opacity Sum	Opacity Average
1	1:50	2:00	1875	46.9
2	2:00	2:10	1955	48.9
3	2:10	2:20	1830	45.7
				47.16

Readings ranged from 40 to 75 % opacity

The source ~~was~~ [✓ was not] in compliance with DER at the time of evaluation

X Mary Jean O'Neil
Observer signature

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
1:50	0	40	45	40	45		
	1	55	75	60	50		
	2	45	40	45	45		
	3	50	50	45	45		
	4	50	55	45	45		
	5	45	40	40	40		
	6	45	50	45	50		
	7	55	50	55	50		
	8	45	45	45	40		
	9	40	40	45	40		
2:00	10	45	50	45	55		
	11	50	45	45	50		
	12	50	50	45	45		
	13	50	50	45	45		
	14	50	50	50	45		
	15	50	45	45	45		
	16	45	45	45	50		
	17	55	50	50	55		
	18	40	50	50	50		
	19	55	55	55	50		
2:10	20	50	50	50	45		
	21	45	45	40	45		
	22	45	50	45	40		
	23	40	45	45	45		
	24	40	45	45	45		
	25	50	45	40	45		
	26	50	50	50	45		
	27	45	45	45	50		
	28	45	45	50	45		
	29	45	45	50	45		

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
	30						
	31						
	32						
	33						
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	35						
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	37						
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RECORD OF VISUAL DETERMINATION OF OPACITY

Page 5 of 6

I.D. C177
Company FLORIDA STATE HOSPITAL
Location CHATTAHOOCHEE
Test Number
Date 1-25-80

Type Facility 'A' Source
Control Device
Hrs Observation ½
Observer T.P. ANDREWS

Obs Certification Date
Obs Affiliation DER
Pt of Emissions Boiler #8
Hgt of Discharge Pt 50'

		Initial			Final
Clock Time	1:50 PM-2:20 PM				
Observer Location Distance to Discharge					
Direction from Discharge	S.E.				
Height of Observation Point					
Background Description	STACK SKY				
Weather Conditions Wind Direction	SW				
Wind Speed	5				
Ambient Temperature					
Sky Conditions (clear, overcast, ½ clouds, etc.)	100				
Plume Description Color	GREY				
Distance Visible					
Other Information					

Summary of Average Opacity

Set Number	Time		Opacity	
	Start	End	Sum	Average
1	1:50	2:00	1315	32.9
2	2:00	2:10	1200	30
3	2:10	2:20	1170	29.25
				30.72

Readings ranged from ____ to ____ % opacity

The source was/was not in compliance with ____ at the time of evaluation

X Thomas P. Andrews
Observer's signature

Hr	Min	Seconds				Steam Plume If applicable	
		0	15	30	45	Attached	Detached
1:50	0	35	35	35	35		
--	1	35	35	35	35		
–	2	35	35	40	35		
	3	30	35	35	35		
	4	35	30	35	35		
	5	35	35	35	35		
	6	30	30	30	30		
	7	30	30	35	35		
	8	30	30	30	30		
	9	30	30	25	25		
2:00	10	25	25	25	25		
	11	25	25	25	25		
	12	30	30	30	30		
	13	30	30	30	30		
	14	30	35	35	30		
	15	30	30	30	30		
	16	35	35	35	30		
	17	30	30	30	30		
	18	30	35	35	35		
	19	30	30	30	30		
2:10	20	30	30	30	30		
	21	30	30	30	30		
	22	30	30	25	25		
	23	25	25	30	30		
	24	30	35	35	35		
	25	35	30	30	30		
	26	30	30	30	30		
	27	25	25	25	25		
	28	30	30	30	30		
	29	25	25	30	30		

Hr	Min	Seconds				Steam Plume If applicable	
		0	15	30	45	Attached	Detached
	30						
	31						
	32						
	33						
	34						
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	37						
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RECORD OF VISUAL DETERMINATION OF OPACITY

Page 6 of 6

I D 04/1/1

Company Florida State Hospital

Location Gadsden Co.

Test Number

Date 1/29/80

Type Facility A Source

Control Device multicyclone

Hrs Observation

Observer Mary Jean O'Neil

Obs Certification Date 1/16/80

Obs Affiliation DER

Pt of Emissions Boiler #8

Hgt of Discharge Pt 50'

	Initial			Final
Clock Time	12:30			1:00
Observer Location Distance to Discharge	[illegible]			
Direction from Discharge	S			
Height of Observation Point	ground			
Background Description	[illegible]			smoke stack
Weather Conditions Wind Direction	N			
Wind Speed				
Ambient Temperature	56°			
Sky Conditions (clear, overcast % clouds, etc.)	clear			
Plume Description "black" Color	grey			
Distance Visible				
Other Information	88,000 lb/hr [illegible]		fired oil	

Summary of Average Opacity

Set Number	Time Start	Time End	Opacity Sum	Opacity Average
1	12:30	12:40	395	9.87
2	12:40	12:50	520	13
3	12:50	1:00	355	8.87
				10.58

Readings ranged from 5 to 20 % opacity

The source [✓ was]/~~was not~~ in compliance with DER at the time of evaluation

x Mary Jean O'Neil
Observer's signature

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
12:30	0	15	15	10	10		
	1	10	10	15	10		
	2	15	10	15	10		
	3	15	15	10	10		
	4	10	15	15	15		
	5	10	10	10	5		
	6	5	5	5	5		
	7	5	5	10	10		
	8	10	10	10	5		
	9	5	5	10	10		
12:40	10	10	10	10	10		
	11	5	10	15	15		
	12	10	10	10	10		
	13	10	15	15	10		
	14	15	10	15	10		
	15	15	15	15	15		
	16	10	15	20	15		
	17	15	15	15	15		
	18	15	15	20	15		
	19	15	15	10	10		
12:50	20	10	10	10	5		
	21	5	5	10	10		
	22	10	5	5	10		
	23	10	5	10	10		
	24	10	10	5	5		
	25	5	5	10	10		
	26	10	10	10	15		
	27	10	15	10	10		
	28	10	10	10	10		
	29	10	10	5	10		

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
	30						
	31						
	32						
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	35						
	36						
	37						
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SECTION 5

FUEL AND FLYASH ANALYSIS

TABLE THREE: SOLID FUEL SAMPLES, TRACE METAL CONCENTRATIONS
(PPM by weight)

Element	COAL CSH 1	WOOD/COAL CSH 2	WOOD CSH 3
S	14095.	14942.35	2735.91
Ti	1750.98	1041.75	519.32
V	59.	0	101.33
Cr	0	0	0
Co	126.48	123.26	63.33
Ni	19.67	31.81	88.66
Cu	30.92	39.76	82.33
Zn	0	59.64	114.00
Pb	75.89	91.45	31.67
Sr	132.1	111.33	38.00

TABLE FOUR: AVERAGE FLYASH TRACE METAL CONCENTRATION (PPM by weight)

ELEMENT*	OIL		COAL		WOOD		WOOD/COAL	
	u	s.d.	u	s.d.	u		u	s.d
S	26702.	(11.76)	1308.5	(318.2)	4013.	(348)	3798.	(2070)
Ti	140.	(121)	1815.4	(44.4)	262.	(37.3)	1625.	(340.)
V	29350.	(616)	280.0	(4.1)	202.	(45.3)	214.	(14.5)
Cr	275.	(370)	15.72	(22.2)	39.1	(34.3)	2.6	(4.6)
Co	109.	(97.4)	203.6	(9.2)	43.5	(39.7)	234.	(41.6)
Ni	4131.	(417)	49.9	(6.7)	83.9	(11.7)	71.6	(5.4)
Cu	39.	(37.0)	94.6	(2.7)	28.8	(25.06)	124.	(9.3)
Zn	400.	(98.4)	17.91	(6.6)	525.	(157)	189.	(9.8)
Pb	1156.	(652)	172.	(9.3)	232.	(82.2)	252.	(7.1)
Sr	21.4	(22.5)	313.4	(.99)	42.4	(37.0)	336.	(42.4)

* S - sulfur, Ti - titanium, V- vanadium, Cr - chromium, Co - cobalt, Ni - nickel, Cu - cooper, Zn - zinc, Pb - lead, Sr - strontium.

TABLE FIVE: NORMALIZED DATA FOR FUEL AND FLYASH SAMPLES (PPM)

Element	BI02	BI03	BI06	OIL 1	OIL 2	OIL 3	COAL FILTER
Na	0.00	0.00	1672.17	0.00	0.00	12377.97	1065.49
Mg	675.78	826.72	1085.44	1514.28	596.21	1276.60	2644.22
Al	2923.04	3100.22	2926.29	875.84	667.83	909.47	29014.58
Si	10109.95	9033.89	8298.50	1729.23	1838.95	1355.86	31962.64
P	1788.68	1905.79	2035.20	1103.63	1509.87	1614.52	806.82
S	3636.36	4323.48	4081.41	14895.73	26802.17	38406.34	1083.97
Cl	2657.55	2944.00	3197.65	0.00	207.12	95.95	505.03
K	22432.29	24849.80	29053.91	352.90	423.93	438.05	3416.14
Ca	12056.85	11254.51	13047.30	1527.11	1233.06	988.74	2451.24
Sc	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ti	249.40	233.12	304.36	208.53	210.99	0.00	1784.03
V	233.31	223.50	150.35	29307.03	28757.26	29987.48	277.15
Cr	64.36	52.87	0.00	696.18	127.76	0.00	0.00
Mn	632.88	622.45	825.08	0.00	0.00	0.00	106.75
Fe	8382.94	8714.25	12882.29	975.30	667.83	1255.74	24990.76
Co	77.77	52.87	0.00	186.08	143.24	0.00	197.08
Ni	96.54	81.71	73.34	4597.37	3792.10	4005.01	45.17
Cu	45.59	40.86	0.00	73.79	42.59	0.00	96.49
Zn	407.62	463.83	704.07	484.44	423.93	292.03	22.58
Pb	176.99	192.26	326.37	1613.73	1444.06	408.84	178.61
Br	115.31	105.74	194.35	0.00	3.87	0.00	8.21
Sr	67.04	60.08	0.00	44.91	19.36	0.00	314.10
Total mass (mg)	3729.00	4161.00	2727.00	3117.00	5166.00	2397.00	4871.00

Element	COAL FUEL	WOOD/ COAL FUEL	WOOD FUEL	WOOD/ COAL 1	WOOD/ COAL 2	WOOD/ COAL 3	COAL FLYASH
Na	0.00	0.00	0.00	1704.48	1704.22	1528.67	1426.44
Mg	739.18	0.00	0.00	5959.36	2708.53	4020.50	3172.27
Al	18538.50	8739.56	1614.95	48362.72	18477.95	30539.60	35263.94
Si	28086.00	14473.16	15440.15	51358.21	17174.02	31790.02	42048.65
P	1242.27	1172.96	1665.61	2283.18	941.99	1392.36	830.71
S	14095.00	14942.35	2735.91	6079.53	2037.39	3278.13	1534.01
Cl	368.18	469.18	778.91	0.00	74.30	50.69	57.92
K	3507.59	2950.30	10481.32	11388.25	5373.92	6631.74	3625.68
Ca	2082.63	3602.39	15585.81	8552.45	4923.30	5650.56	2690.72
Sc	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ti	1750.98	1041.75	519.32	2000.95	1337.49	1537.68	1846.76
V	59.02	0.00	101.33	227.69	198.95	216.29	282.97
Cr	0.00	0.00	0.00	7.91	0.00	0.00	31.44
Mn	64.64	159.05	557.31	271.17	227.71	285.01	81.09
Fe	1720.07	20405.57	9145.03	28986.48	26632.31	30325.56	24557.34
Co	126.48	123.26	63.33	186.58	263.66	252.34	210.16
Ni	19.67	31.81	88.66	75.10	74.30	65.34	54.61
Cu	30.92	39.76	82.33	121.75	134.23	116.03	92.67
Zn	0.00	59.64	114.00	192.90	196.55	177.99	13.24
Pb	75.89	91.45	31.67	260.10	246.88	248.96	165.48
Br	14.05	15.90	19.00	20.55	210.93	21.40	14.89
Sr	132.10	111.33	38.00	383.43	325.98	300.78	312.76
Total mass (mg)	3558.00	2515.00	1579.00	12649.00	4172.00	8877.00	6043.00

TABLE SIX: FUEL SULFUR ANALYSIS

	COAL	WOOD	WOOD/COAL	OIL
FLA. STATE HOSPITAL	-	-	-	2.5
Gailbraith Labs	0.92	0.12	1.10	-
Industrial Test Lab	1.74	-	-	-
F. S. U. PIXE	1.41	0.27	1.49	-
Average	1.36	0.195	1.29	2.2

GALBRAITH LABORATORIES, INC.
P. O. BOX 4187, 2323 SYCAMORE DR., KNOXVILLE, TENNESSEE 37921 / 615 546-1335

CERTIFICATE OF ANALYSIS

Mr. David P. Harlos
Page 2
February 22, 1980

Your Sample No. Chattahoochee Coal Fuel Our No. J-9893 gave the following results:

Ultimate Analysis,	As Received,	Dry Basis,
% Moisture	0.34	
% Carbon	71.45	
% Hydrogen	4.79	
% Nitrogen	1.35	
% Chlorine	0.03	
% Sulfur	0.92	
% Ash	9.70	
% Oxygen (by diff.)	11.42	

Proximate Analysis,	As Received,	Dry Basis,
% Moisture		
% Ash		
% Volatile Matter		
% Fixed Carbon		

Sulfur Forms,	As Received,	Dry Basis,
% Pyritic Sulfur		
% Sulfate Sulfur		
% Organic Sulfur		
% Total Sulfur		

Mineral Analysis,	Ignited Basis,
% Phos. pentoxide, P_2O_5	
% Silica, SiO_2	
% Ferric Oxide, Fe_2O_3	
% Alumina, Al_2O_3	
% Titania, TiO_2	
% Lime, CaO	
% Magnesia, MgO	
% Sulfur Trioxide, SO_3	
% Potassium Oxide, K_2O	
% Sodium Oxide, Na_2O	
% Undetermined	

	As Received	Dry Basis,
BTU/lb.		

GALBRAITH LABORATORIES, INC.
P. O. BOX 4187, 2323 SYCAMORE DR., KNOXVILLE, TENNESSEE 37921 / 615 546-1335

CERTIFICATE OF ANALYSIS

Mr. David P. Harlos
Department of Environmental Regulation
Bureau of Air Quality Management
State of Florida
Twin Towers, 2600 Blair Stone Road
Tallahassee, Florida 32301

February 22, 1980

Received: Feb. 15th

Your Sample No. Chattahoochee Wood Fuel Our No. J-9892 gave the following results:

Ultimate Analysis,	As Received,	Dry Basis,
% Moisture	3.58	
% Carbon	49.31	
% Hydrogen	5.62	
% Nitrogen	0.68	
% Chlorine	0.07	
% Sulfur	0.12	
% Ash	6.08	
% Oxygen (by diff.)	34.54	

Proximate Analysis,	As Received,	Dry Basis,
% Moisture		
% Ash		
% Volatile Matter		
% Fixed Carbon		

Sulfur Forms,	As Received,	Dry Basis,
% Pyritic Sulfur		
% Sulfate Sulfur		
% Organic Sulfur		
% Total Sulfur		

Mineral Analysis,	Ignited Basis,
% Phos. pentoxide, P_2O_5	
% Silica, SiO_2	
% Ferric Oxide, Fe_2O_3	
% Alumina, Al_2O_3	
% Titania, TiO_2	
% Lime, CaO	
% Magnesia, MgO	
% Sulfur Trioxide, SO_3	
% Potassium Oxide, K_2O	
% Sodium Oxide, Na_2O	
% Undetermined	

	As Received	Dry Basis,
BTU/lb.		

GALBRAITH LABORATORIES, INC.
P. O. BOX 4187, 2323 SYCAMORE DR., KNOXVILLE, TENNESSEE 37921 / 615 546-1335

CERTIFICATE OF ANALYSIS

Mr. David P. Harlos
Page 3
February 22, 1980

Your Sample No. Chattahoochee Coal-Wood Mix Fuel Our No. J-9894 gave the following results:

Ultimate Analysis,	As Received,	Dry Basis,
% Moisture	0.83	
% Carbon	71.04	
% Hydrogen	5.09	
% Nitrogen	1.30	
% Chlorine	0.05	
% Sulfur	1.10	
% Ash	7.93	
% Oxygen (by diff.) rence	12.66	

Mineral Analysis,	Ignited Basis,
% Phos. pentoxide, P_2O_5	
% Silica, SiO_2	
% Ferric Oxide, Fe_2O_3	
% Alumina, Al_2O_3	
% Titania, TiO_2	
% Lime, CaO	
% Magnesia, MgO	
% Sulfur Trioxide, SO_3	
% Potassium Oxide, K_2O	
% Sodium Oxide, Na_2O	
% Undetermined	

Proximate Analysis,	As Received,	Dry Basis,
% Moisture		
% Ash		
% Volatile Matter		
% Fixed Carbon		

	As Received	Dry Basis,
BTU/lb.		

Sulfur Forms,	As Received,	Dry Basis,
% Pyritic Sulfur		
% Sulfate Sulfur		
% Organic Sulfur		
% Total Sulfur		

We regret that we were unable to reach you by telephone on February 22, 1980.

Gail R. Hutchens

Gail R. Hutchens, Exec. Vice-President

BEST AVAILABLE COPY

G. D. JACOBY BRIAN JACOBY

INDUSTRIAL TESTING LABORATORY

"SERVING THE COAL INDUSTRY"

2229 FIRST AVE., SO. • BIRMINGHAM, AL. 35233
TEL. 322-4236 — AREA CODE 205

ASTM
SUSTAINING MEMBER

September 27, 1976

FLORIDA STATE HOSPITAL
Chattahoochee, Florida 32324

Sample 1777
Received 9/20/76

Sample: Coal.

Identity: 1 car coal, 2" x 0" w/steam shipped to Florida State Hospital,
Chattahoochee, Florida from Brilliant Coal Co., Brilliant Ala.
Shipped via SL-SF 92264. Sampled by F.S.H.
Coal Co. purchase order number 04200.
Lab purchase order number 11745A.

ANALYSIS

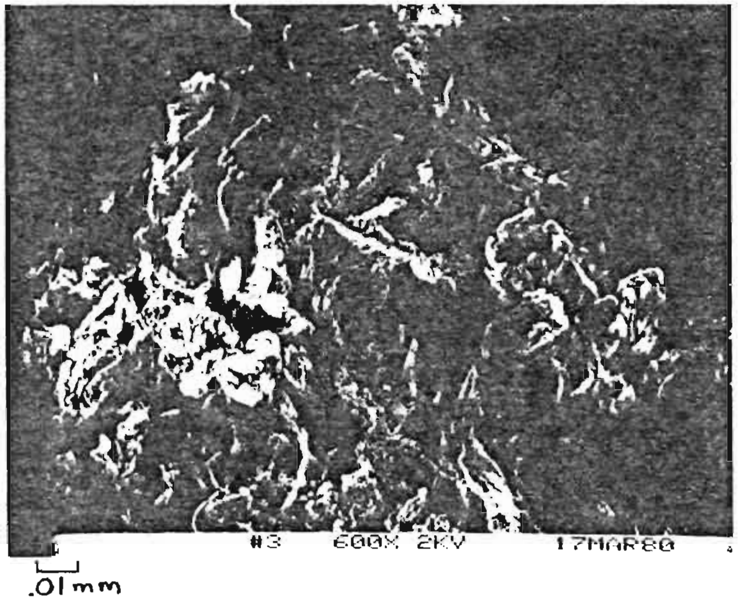
(AS RECEIVED)

MOISTURE	5.70	(DRY BASIS)
VOLATILE MATTER	33.95	36.00
FIXED CARBON	54.41	57.70
ASH	5.94	6.30
TOTAL	100.00%	100.00%
SULPHUR	1.74	1.84
B.T.U.	12,998	13,762

G. D. Jacoby Jr.

SCANNING ELECTRON MICROSCOPY
OF FUELS AND FLYASH

ANALYSIS BY
DEPARTMENT OF BIOLOGICAL SCIENCES,
FLORIDA STATE UNIVERSITY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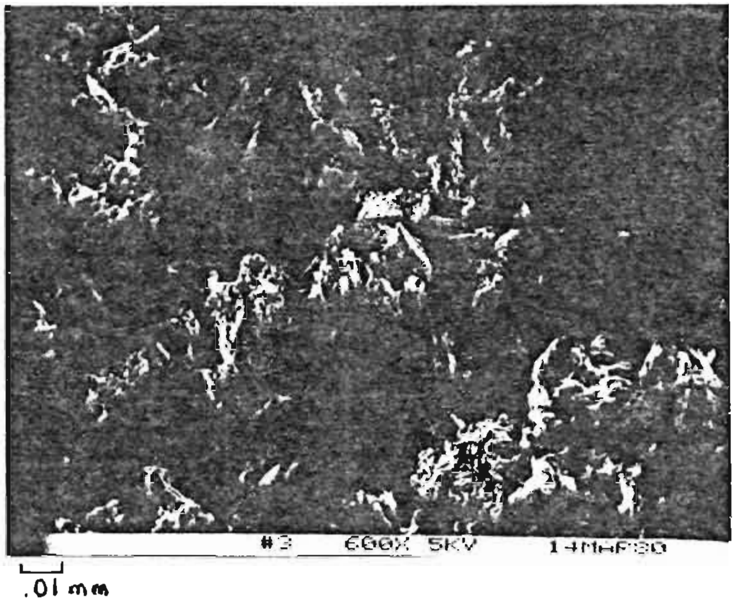
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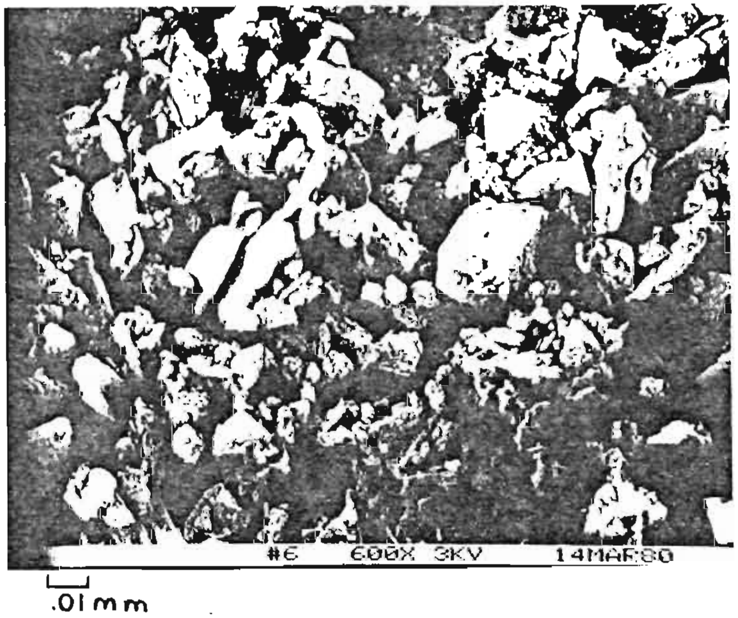
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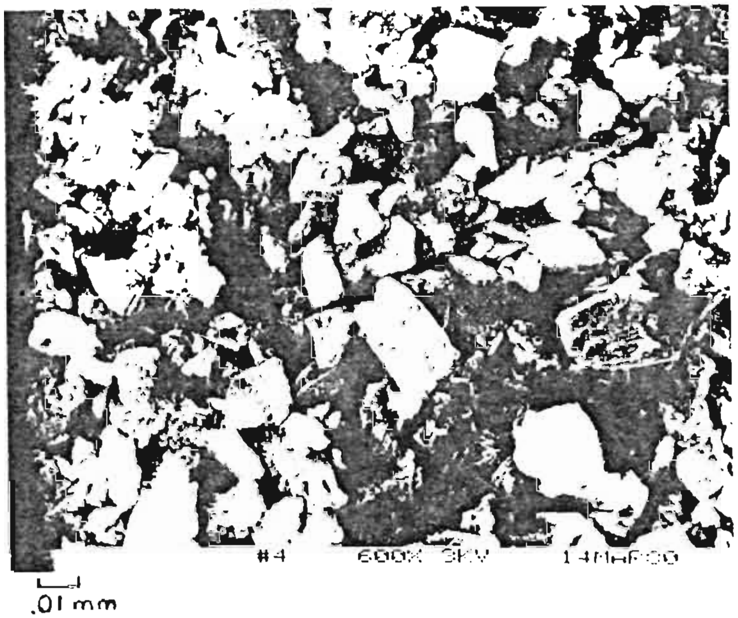
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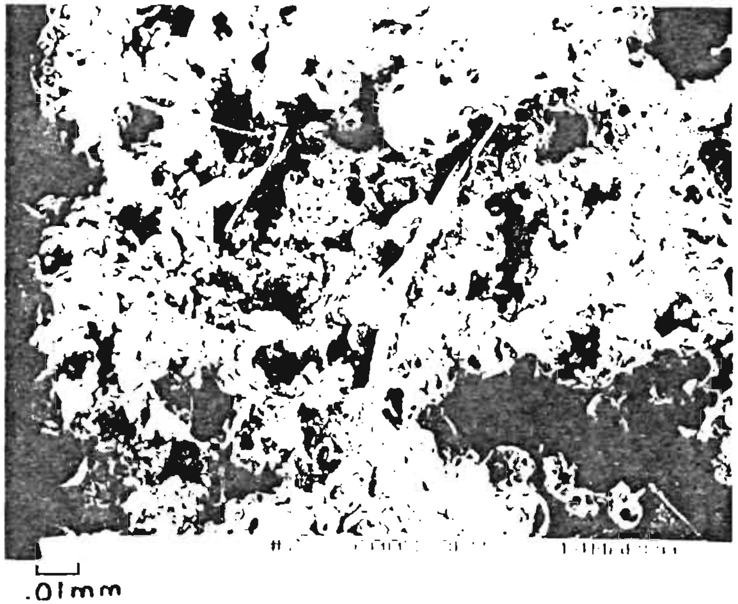
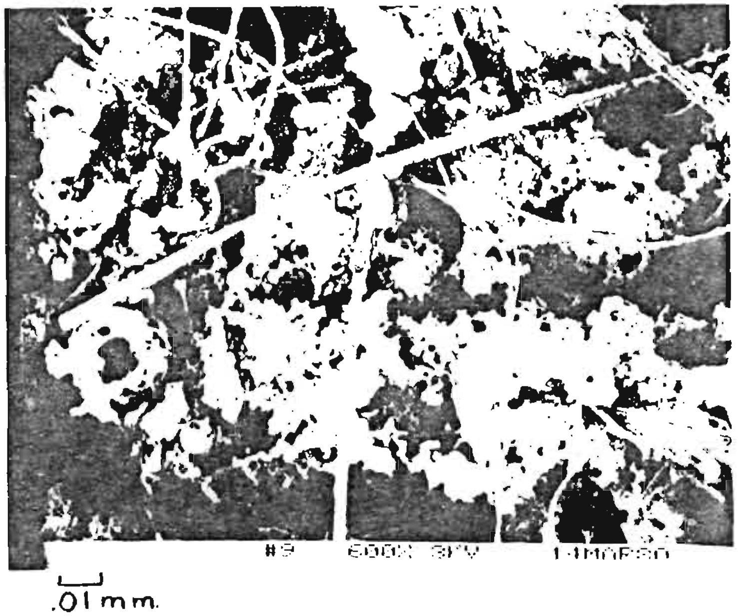
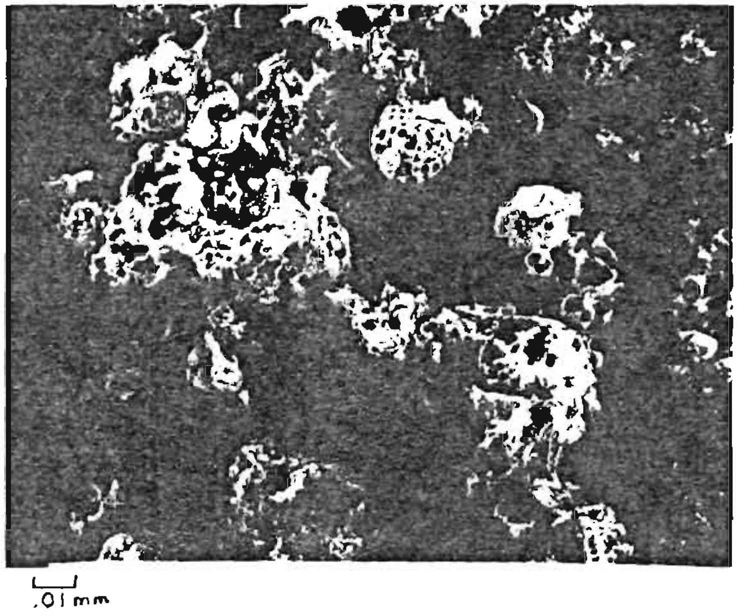
KEY TO PHOTOGRAPHS

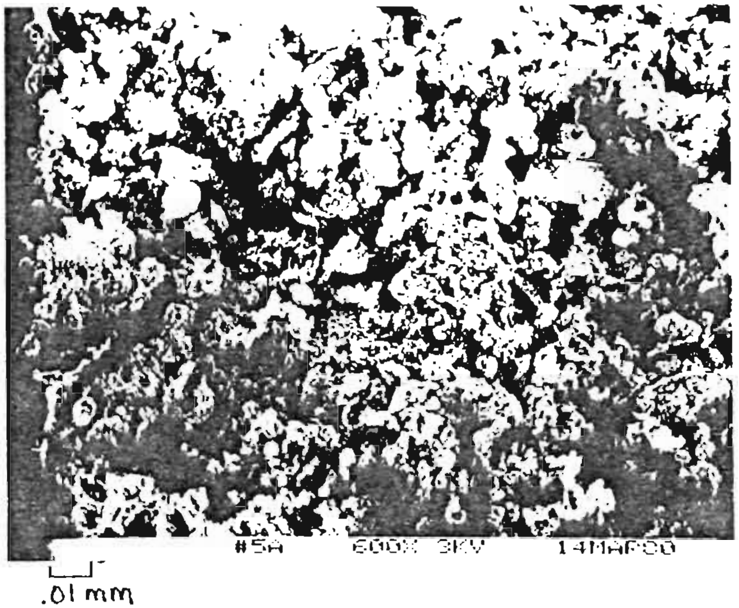
WOOD FUEL	WOOD FUEL
COAL FUEL	WOOD/COAL FUEL

KEY	OIL FLYASH HALF LOAD
OIL FLYASH HALF LOAD	OIL FLYASH FULL LOAD

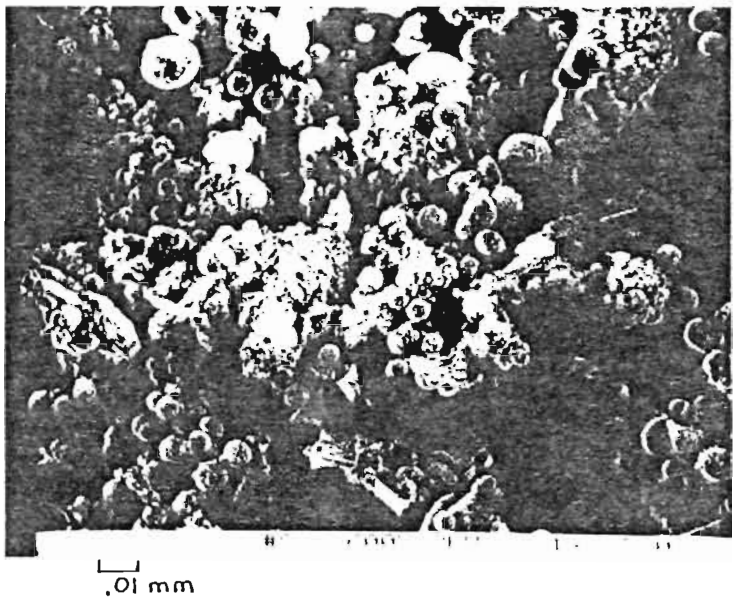




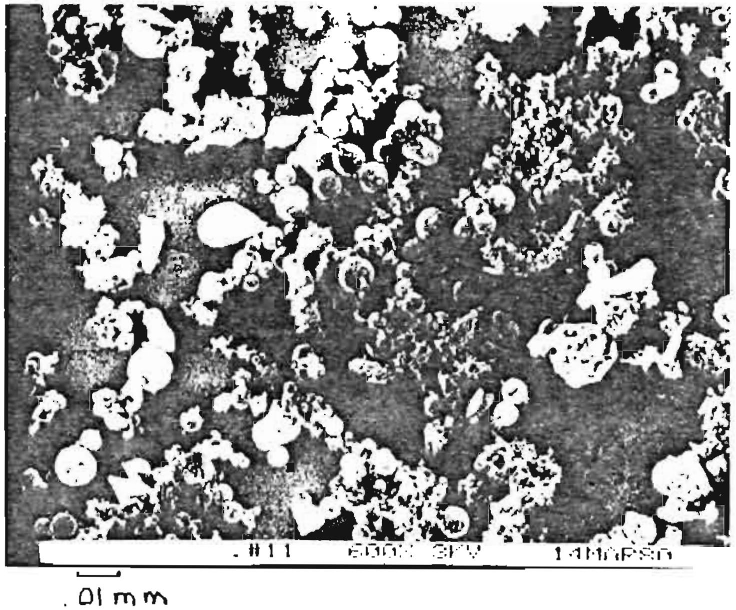




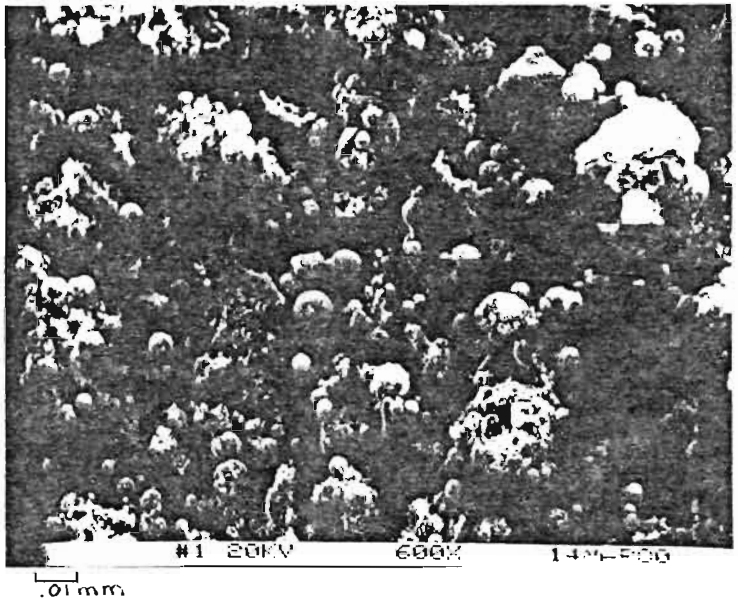
COAL FLYASH, BULK SAMPLE



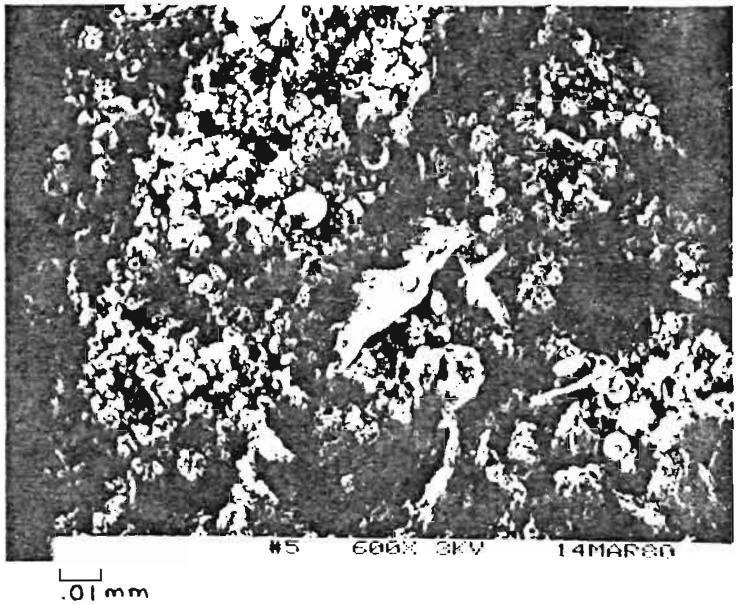
WOOD FLYASH,BIO 2



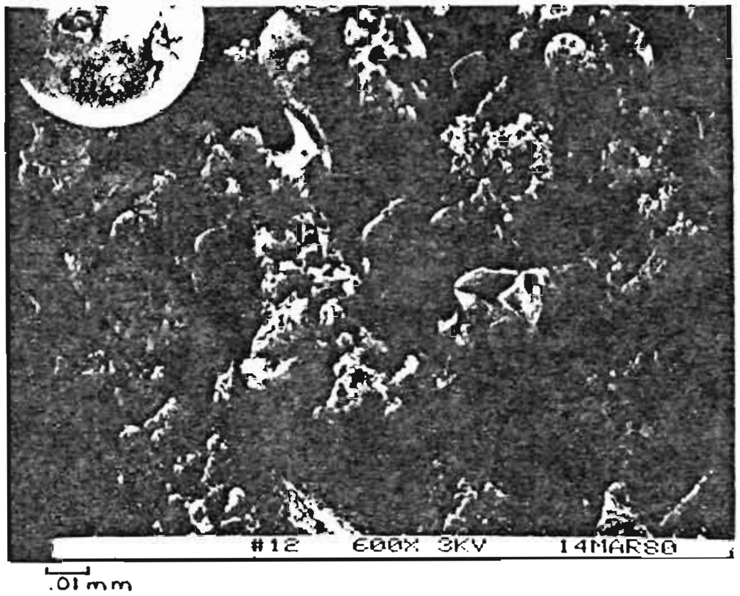
WOOD FLYASH, BIO 3



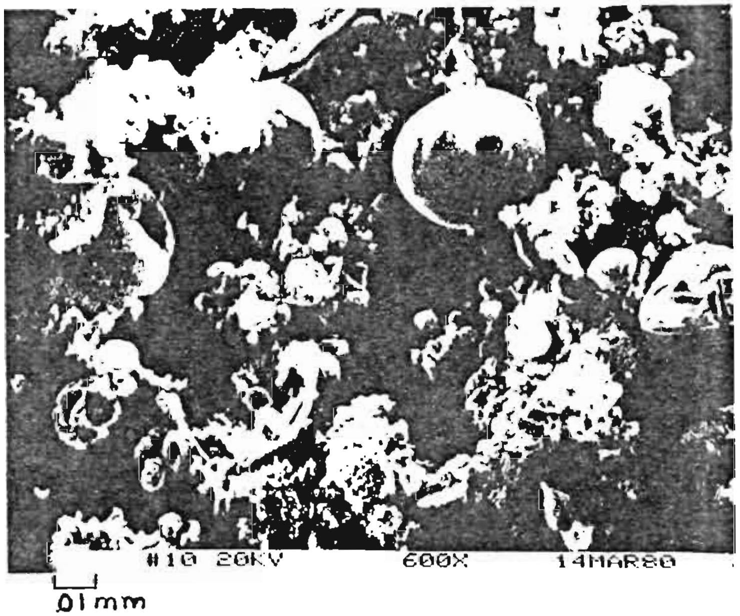
WOOD FLYASH, BIO 6



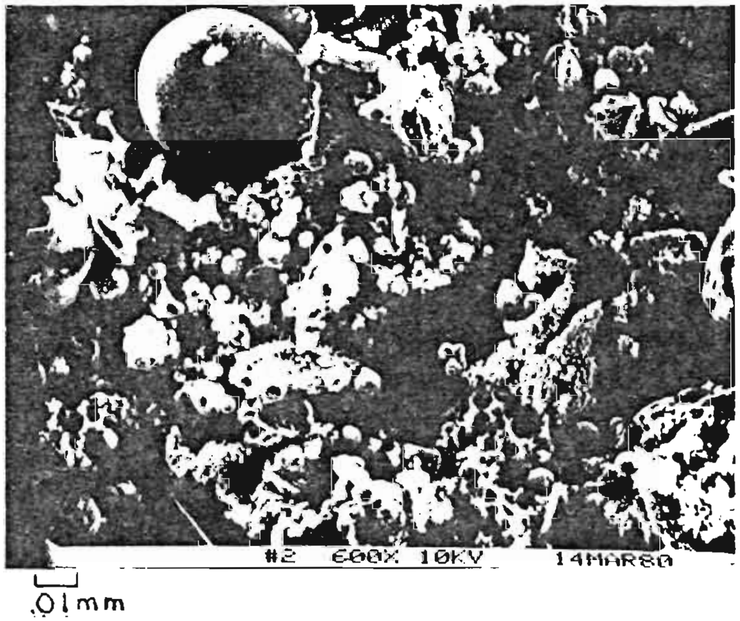
COAL FLYASH, COAL 1



WOOD COAL, FLYASH , WC 2



WOOD/COAL FLYASH, WC 1



WOOD COAL FLYASH, WC 3

SECTION 6

CALIBRATION DATA

DRY GAS METER
WET TEST METER
NOZZLES
PYROMETER
SCALES

Dry Gas Meter / Orifice Calibration Procedure

Dry Gas Meter Ident. Old Console #12524
Wet Test Meter Ident. # 9485
Uncorr. Baro Press. Pbar (07) 29.938
Correction Factor (E) 1.0329
Room Temp. 75 °F
Technician/Date J. Glunn 11/13/79

Final WTM	Initial WTM	Va = Corr Vwtm (06)	Final DGM	Initial DGM	Vol. Vdgm (05)	Temp. DGM Initial	Temp. DGM Final	Temp. DGM Ave °F	Temp. DGM Ave °R (04)	Temp. WTM °F	Temp WTM °R (03)	Mano Rdg ΔH "H2O (02)	Of Time θ (min) (01)	Y (B)	ΔH@ (C)
4.319	0	4.461	902246	897.9	4.346	76	77	76.5	536.5	75	535	0.25	15	1.0287	1.5967
6.020	0	6.218	909.17	903.0	6.17	78	79	78.5	538.5	75	535	0.50	15	1.0131	1.6376
4.710	0	4.865	922021	916.7	5.321	79	81	80	540	75	535	0.75	10	.9211	1.7785
5.538	0	5.720	928418	922.7	5.718	81	81	81	541	75	535	1.00	10	1.0091	1.7122
6.148	0	6.350	935362	929.0	6.362	81	82	81.5	541.5	75	535	1.25	10	1.0071	1.7350
6.706	0	6.927	942951	936.0	6.951	82	83	82.5	542.5	75	535	1.50	10	1.0068	1.7464
7.725	0	7.979	951624	943.6	8.024	83	84	83.5	543.5	75	535	2.00	10	1.0052	1.7518
9.350	0	9.658	96255	952.8	9.75	84	84	84	544	75	535	3.00	10	.9986	1.7918
10.850	0	11.207	975.02	963.7	11.32	84	86	85	545	75	535	4.00	10	.9987	1.771

$$Y = \frac{P_b \, V_a \, T_d}{V_d \, T_w \left(P_b + \frac{\Delta H}{13.6}\right)}$$

$$V_a = (\text{Final WTM} - \text{Initial WTM}) \, E$$

Comments

$$\Delta H@ = \frac{\Delta H \, (.0317)}{P_b \, T_d} \left[\frac{T_w \, \theta}{V_a}\right]^2$$

$\overline{\Delta H@}$ overall 1.72455

$\overline{\Delta H@}_{0.25-1.25}$ 1.692

$\overline{\Delta H@}_{1.50-4.00}$ 1.7652

$\overline{Y}$ .99871

Dry Gas Meter / Orifice Calibration Procedure

Dry Gas Meter Ident. New #13913 Uncorr. Baro Press. Pbar (07) 29.97 Room Temp. 74

Wet Test Meter Ident. Singer 9845 Correction Factor (E) 1.0329 Technician/Date 1/14/80

Final WTM	Initial WTM	Va = Corr Vwtm (06)	Final DGM	Initial DGM	Vol. Vdgm (05)	Temp. DGM Initial	Temp. DGM Final	Temp. DGM Ave °F	Temp. DGM Ave °R (04)	Temp. WTM °F	Temp WTM °R (03)	Mano. Rd. ΔH "H₂O (02)	OP Time T (min) (01)	Y (B)	ΔH@ (C)
4.122	00	4.2576	466.854	462.7	4.154	75	76	75.5	535.5	74	534	0.25	15	1.027	1.748
5.673	00	5.8596	472.198	467.2	5.748	76	77	76.5	536.5	74	534	0.50	15	1.014	1.842
4.582	00	4.7327	478.19	473.5	4.69	77	77	77	537[illegible]	74	534	0.75	10	1.013	1.856
5.275	00	5.4445	484.212	478.8	5.412	77	78	77.5	537.5	74	534	1.00	10	1.011	1.890
.787	00	7.0103	491.977	485.0	6.977	78	79	78.5	538.5	74	534	1.25	11.5 ~~10~~	1.010	1.884
.337	00	6.5455	499.031	492.5	6531	79	80	79.5	539.5	74	534	1.50	10	1.009	1.957
7.688	00	7.9409	508.307	500.4	7.907	80	81	80.5	540.5	74	534	2.00	10	1.012	1.770
.973	00	9.2682	519.307	510.1	9.207	81	82	81.5	541.5	74	534	3.00	10	1.013	1.945
10.3	00	10.6389	533.379	522.8	10.577	82	83	82.5	542.5	74	534	4.00	10	1.012	1.965

Bh

$$Y = \frac{Pb\ Va\ Td}{Vd\ Tw\ (Pb + \frac{\Delta H}{13.6})}$$

$$Va = (\text{Final WTM} - \text{Initial WTM})\ E$$

Comments

$$\Delta H@ = \frac{\Delta H\ (.0317)}{Pb\ \ Td} \left[\frac{Tw\ T}{Va}\right]^2$$

$\overline{\Delta H@}$ overall 1.873

$\overline{\Delta H@}_{0.25-1.25}$ 1.844

$\overline{\Delta H@}_{1.50-4.00}$ 1.909

$\overline{Y}$ 1.013

NOZZLE RECORD SHEET

	NOZZLE IDENTIFICATION AND DATE	DIAMETER(X-X) INCHES	DIAMETER(Y-Y) INCHES	AVERAGE DIAMETER INCHES	(Dia)^2 ~~(In2)~~ Ft 2	COMMENTS	TECHNICIAN
	C-6 1-18-80	.249, .251, .249		.2496	.0003382		JG
	B-3 1-18-80	.247, .248,	246	.247	.00033275		JG
	New #8 1-18-80	.248, .246,	245	.2463	.00033086		JG
	New #81 1-18-80	.248, .247, .246		.247	.00033275		JG
	New #81 1-17-80	.250, .250, .250		.250	.00034098		OK

Wet Test Meter Record Sheet

1 Liter = 0.0353 ft^3

Wet Test Meter Identification DPC 9485

Date	Baro Press	Rm. Temp.	Pressure Meter	Final WTM	Initial WTM	Vol. thru WTM	Ml Water	FT3 Water	Time (sec)	Rate CFM	E	Operator
7/27/80				1.50	0.83	0.67	6,000 6,000 6,000 1,700 19,700	0.6957			-.0369	Douglas Kiesling WTMCF = 1.0384
6/31/ 78				0.07 0.14 0.21 0.28 0.346 0.413 0.48	0	1.0256 0.48	2,000 2,000 2,000 2,000 2,000 2,000 2,000 14 Liters = 0.4942 ft^3	→ → → → →0.935 →0.949 →0.949	1.0086 1.0086 1.0086 1.0086	1.0086	1.0202	Douglas Kiesling WTMCF = 1.0296 average = 0.981 average = 1.0053
10/16					0	14.479(L) 14.479(L) 14.478(L)	14 Liter		.4944	ft^3	1.03215 1.03215 1.03480	J.G. Avg. 1.0329

BALANCE RECORD SHEET

Balance Identification OHAUS #14019 Standard Weight Identification BALANCE TARE WeighTS

DATE	(1) Weight of Impinger Water & Standard Weight	(2) Weight of Impinger & Water	(3) Difference of (1) & (2)	(4) Standard Weight	(5) Difference of (3) & (4)	(6) % Difference	Technician
1/18/80	295g	0	295g	295g	0	0%	R L Vail
	590g	0	590g	590g	0	0%	R L Vail

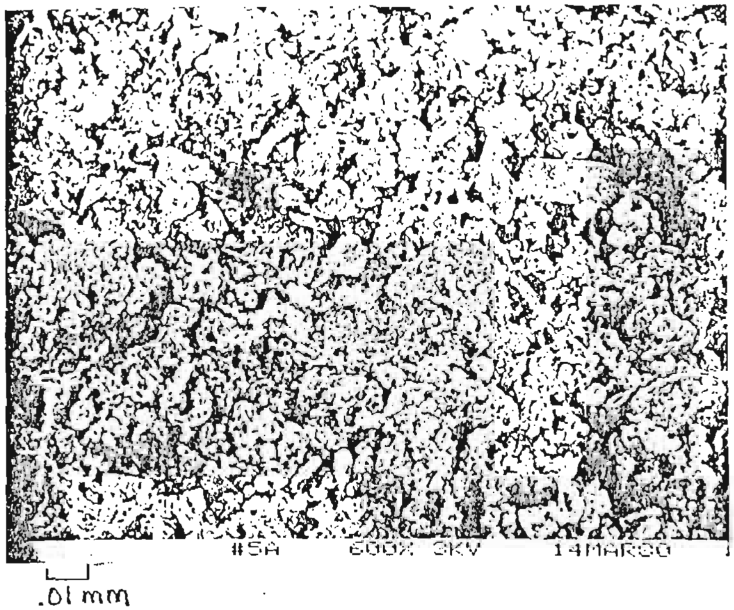
BAROMETER RECORD SHEET

DATE	UNCORRECTED STATION PRESSURE	ANEROID BAROMETER READING minus 0.123	DIFFERENCE	COMMENTS	TECHNICIAN
1/24/79	* 29.65	29.70	.05	adjusted to 29.65	R. L. V.
2/21/79	* 30.09	30.06	.03	adjusted to 30.09	R. L. V.
3/29/79	* 30.168	30.25	.06		
11/8/79	29.89 corrected	29.87	(-) 02	unadjusted, correction noted	J. Glunn
1/18/80	29.923	29.93	.007	none	B. Kerckhoff

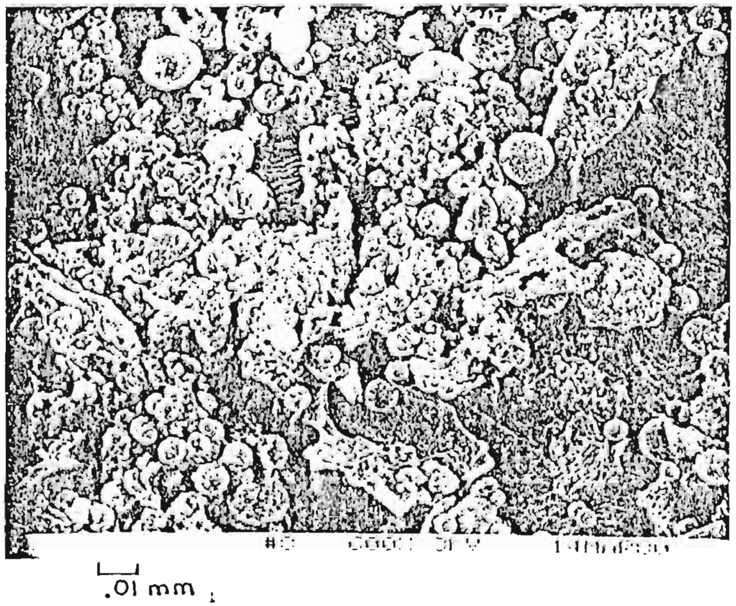
* for Blairstone rd location,

Dry Gas Meter Check

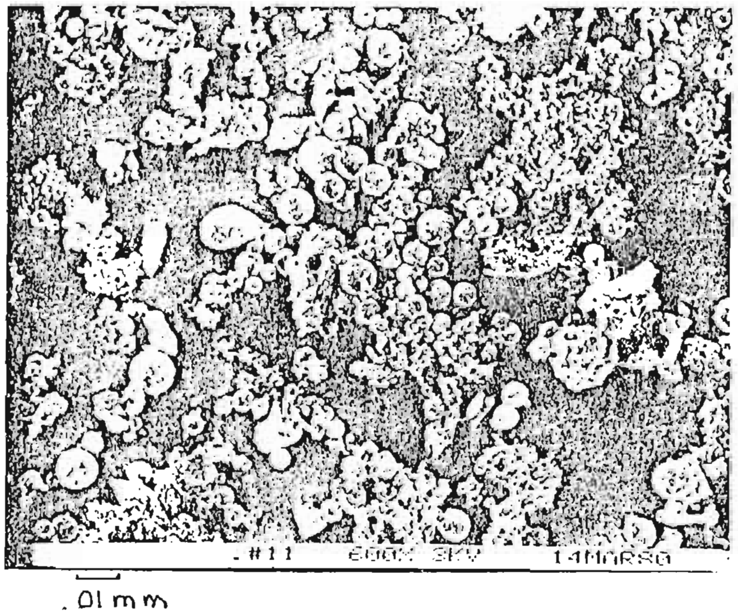
Date	$\Delta H@$ at $\Delta H=20$ last calibration record	$\Delta H@$ of check	% off	Name & Date
1/18/80	1.7518	1.75	00.103%	Brian [illegible] / 1/18/80



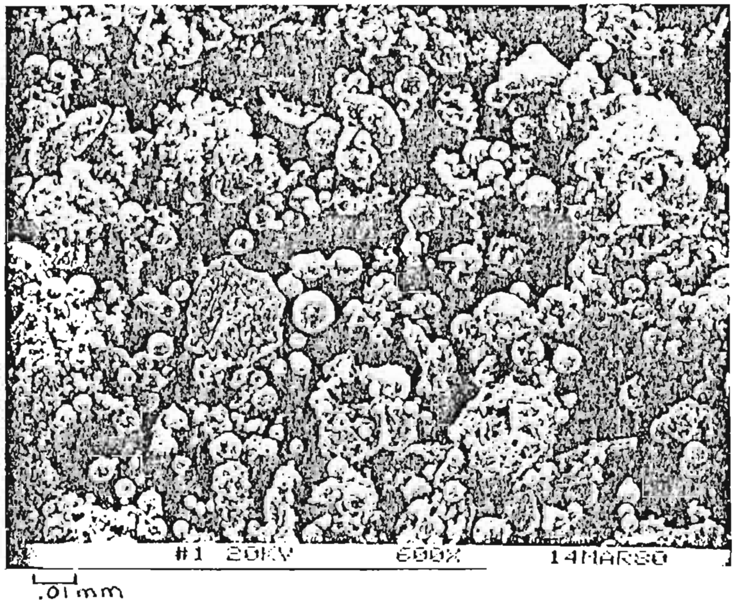
COAL FLYASH, BULK SAMPLE



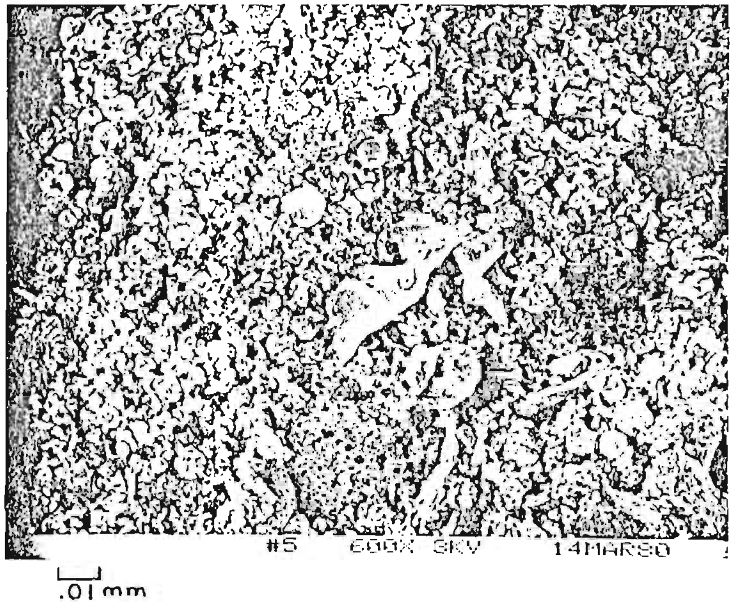
WOOD FLYASH,BIO 2



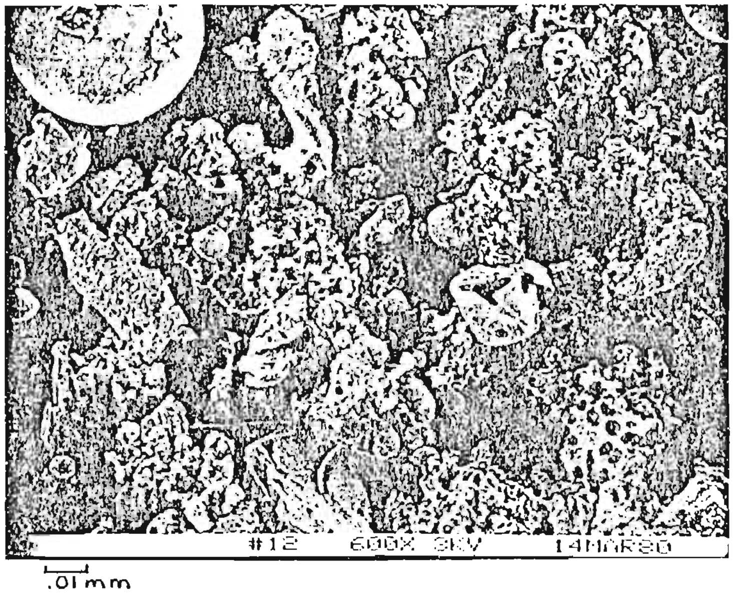
WOOD FLYASH, BIO 3



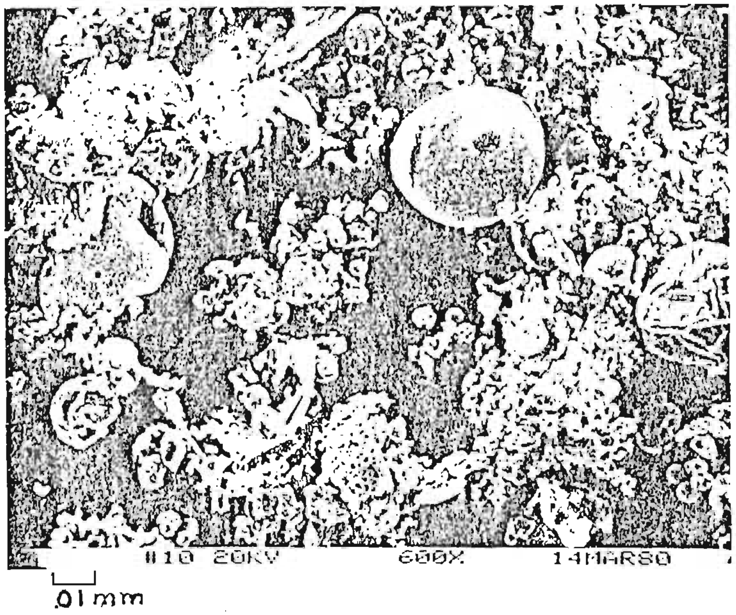
WOOD FLYASH, BIO 6



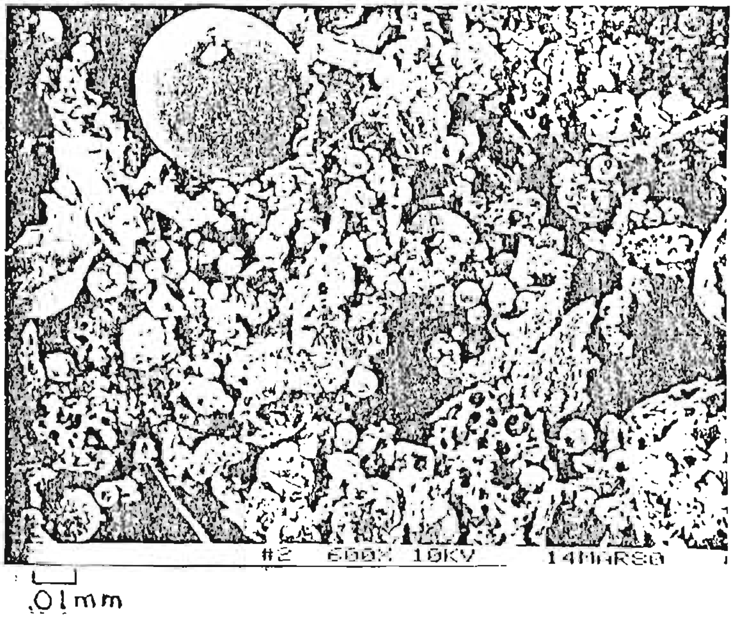
COAL FLYASH, COAL 1



WOOD/COAL, FLYASH, WC 2



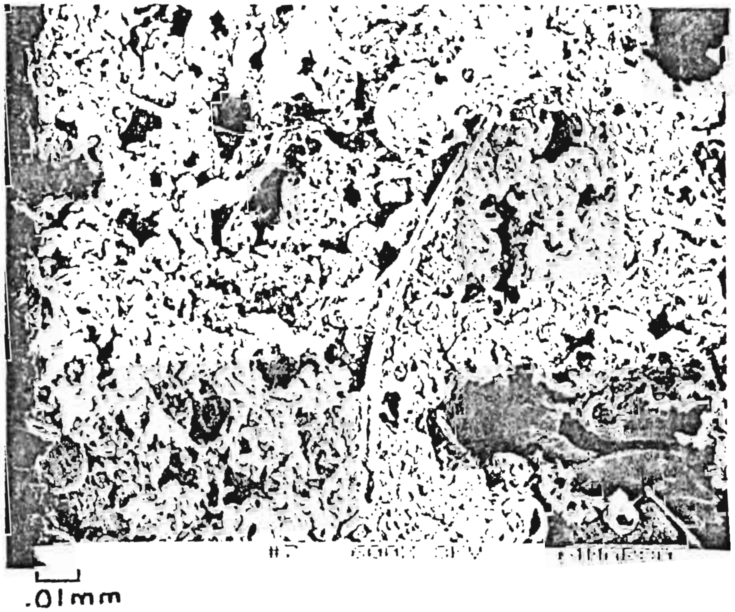
WOOD/COAL FLYASH, WC 1

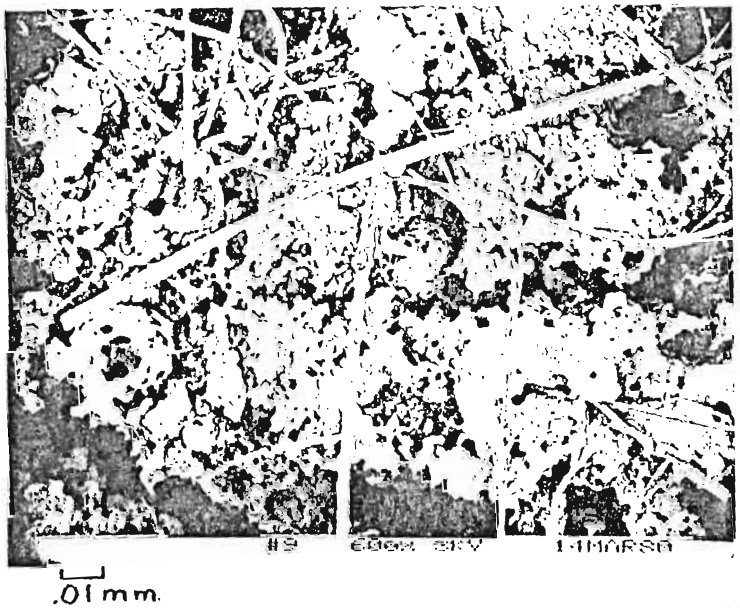


WOOD/COAL FLYASH, WC 3

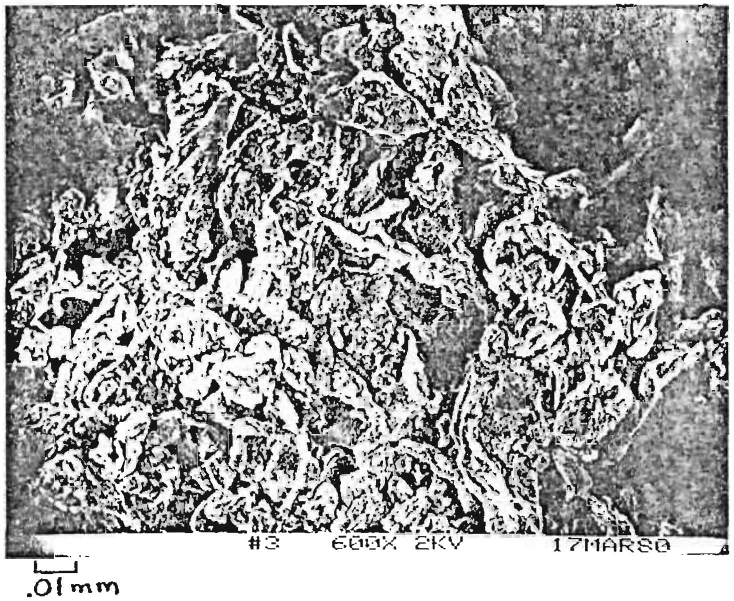
KEY TO PHOTOGRAPHS

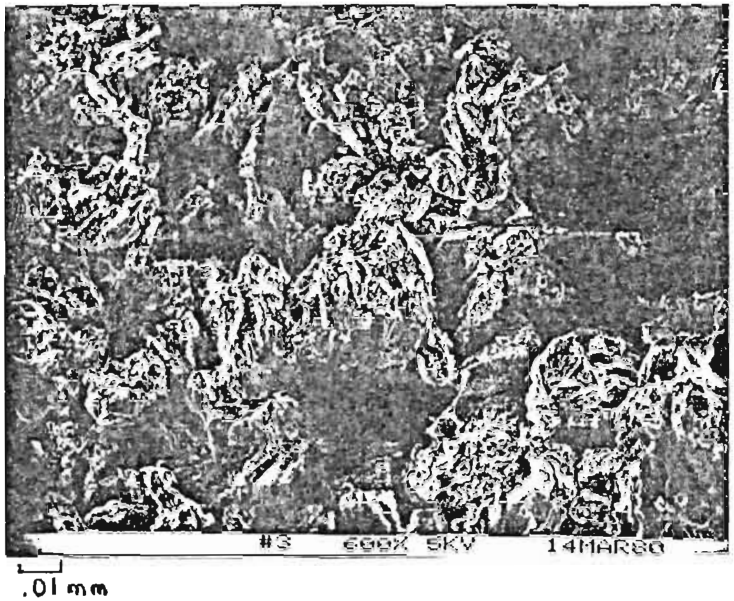
WOOD FUEL	WOOD FUEL
COAL FUEL	WOOD/COAL FUEL
KEY	OIL FLYASH HALF LOAD
OIL FLYASH HALF LOAD	OIL FLYASH FULL LOAD

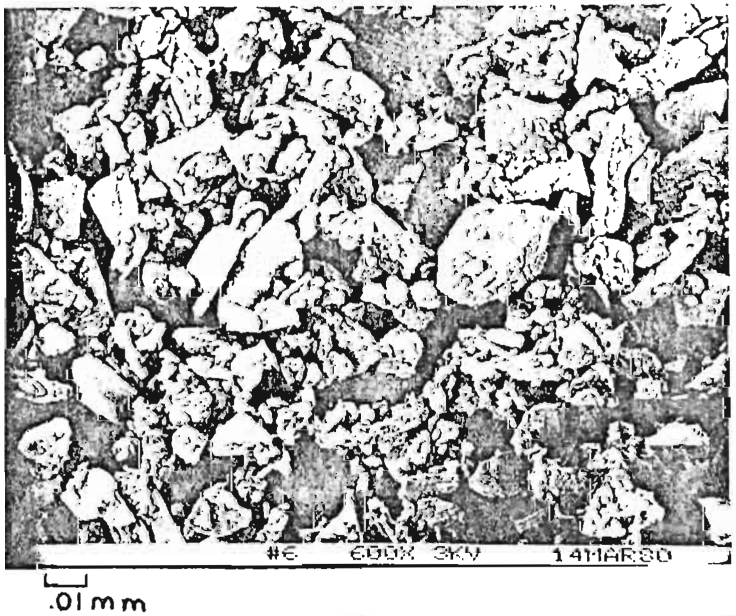


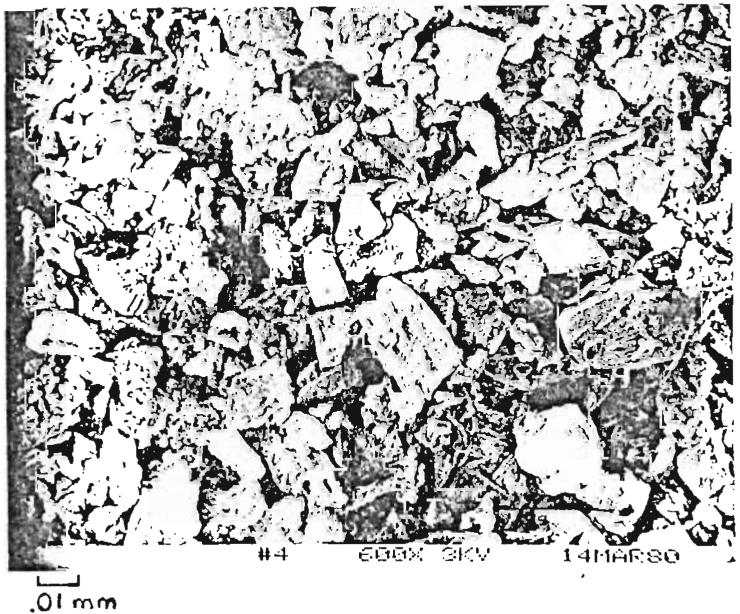


#13 600x 3kV


#3 600X 2KV 17MAR80
.01mm


#3 600X 5KV 14MAR80
.01mm


#6 600X 3KV 14MAR80
.01mm


#4 600X 3KV 14MAR80
.01mm

DER BAQM 80-003

STATE OF FLORIDA
DEPARTMENT OF
ENVIRONMENTAL REGULATION

FEBRUARY, 1980

COMPLIANCE TEST
CHATTAHOOCHEE STATE HOSPITAL
NO. 8 BOILER
WOODEX, COAL, COAL/WOODEX BURN

DER BAQM 80-003

STATE OF FLORIDA
DEPARTMENT OF
ENVIRONMENTAL REGULATION

FEBRUARY 1980
COMPLIANCE TEST
CHATTAHOOCHEE STATE HOSPITAL
NO. 8 BOILER
WOODEX, COAL, COAL/WOODEX BURN

PREPARED BY
BUREAU OF AIR QUALITY MANAGEMENT
OPERATIONS AND EVALUATION
SECTION

TABLE OF CONTENTS

Introduction

A series of particulate emission tests were performed on the Department of Health and Rehabilitation Service's (DHRS) steam boiler number eight, at the Chattahoochee State Hospital on January 21 through 25 and January 29. Fourteen test runs were performed on a variety of boiler fuels. EPA Method 5 was used for each test run (Standard Sampling Techniques and Methods for Analysis for the Determination of Air Pollutants from Point Sources, July, 1975). A number of additional tests, to be described, were performed on the samples collected.

The emission tests were conducted at the request of Mr. Jim Ford, DHRS Facilities Services. DHRS and Florida Department of Agriculture are exploring the possibility of converting steam boilers from oil to wood or wood-coal fuels in response to shortages of oil.

DISCLAIMER

The mention of trade names or commercial products in this report does not constitute an endorsement or recommendation by the Florida Department of Environmental Regulation.

LIST OF TABLES

Summary

Particulate Emissions

The steam boiler and associated equipment at Chattahoochee State Hospital was originally designed to burn pulverized coal which is blown into the boiler through two burners. The coal burners were modified to accept oil guns when the unit was unable to meet particulate emission levels. During the current test period the boiler was unable to meet emission standards at half load or full load while burning oil (Table one). Half load wood particulate emission rates were six times higher than oil. Coal emission rates were about twenty-two times higher than oil emissions at half load. The combined wood-coal emissions were in proportion to the weight of each fuel burned. There was no evidence of any interaction effect, whereby emissions were increased or decreased by burning wood and coal simultaneously.

In order to meet particulate compliance limits, additional pollution control devices would have to be installed on the boiler. Wood-waste fuels are used extensively in Florida's pulp and paper industry. Emission levels of 0.1 lbs./million BTU or better are routinely attained with convential equipment. A number of pollution control systems are available depending on boiler conditions and fuel characteristics.[1] The sugar industry in South Florida operates a large number of small boilers fired on sugar cane residue which closely resembles the wood fuel used at Chattahoochee. Most sugar mill boilers use low-energy wet scrubbers to comply with emission limiting standards. Selection of suitable control equipment at Chattahoochee appears to be a straight forward engineering problem with a range of suitable solutions.

1. Wood Residue-Fired Steam Generator Particulate Matter Control Technology Assessment. EPA, 450/2-78-044, October, 1978.

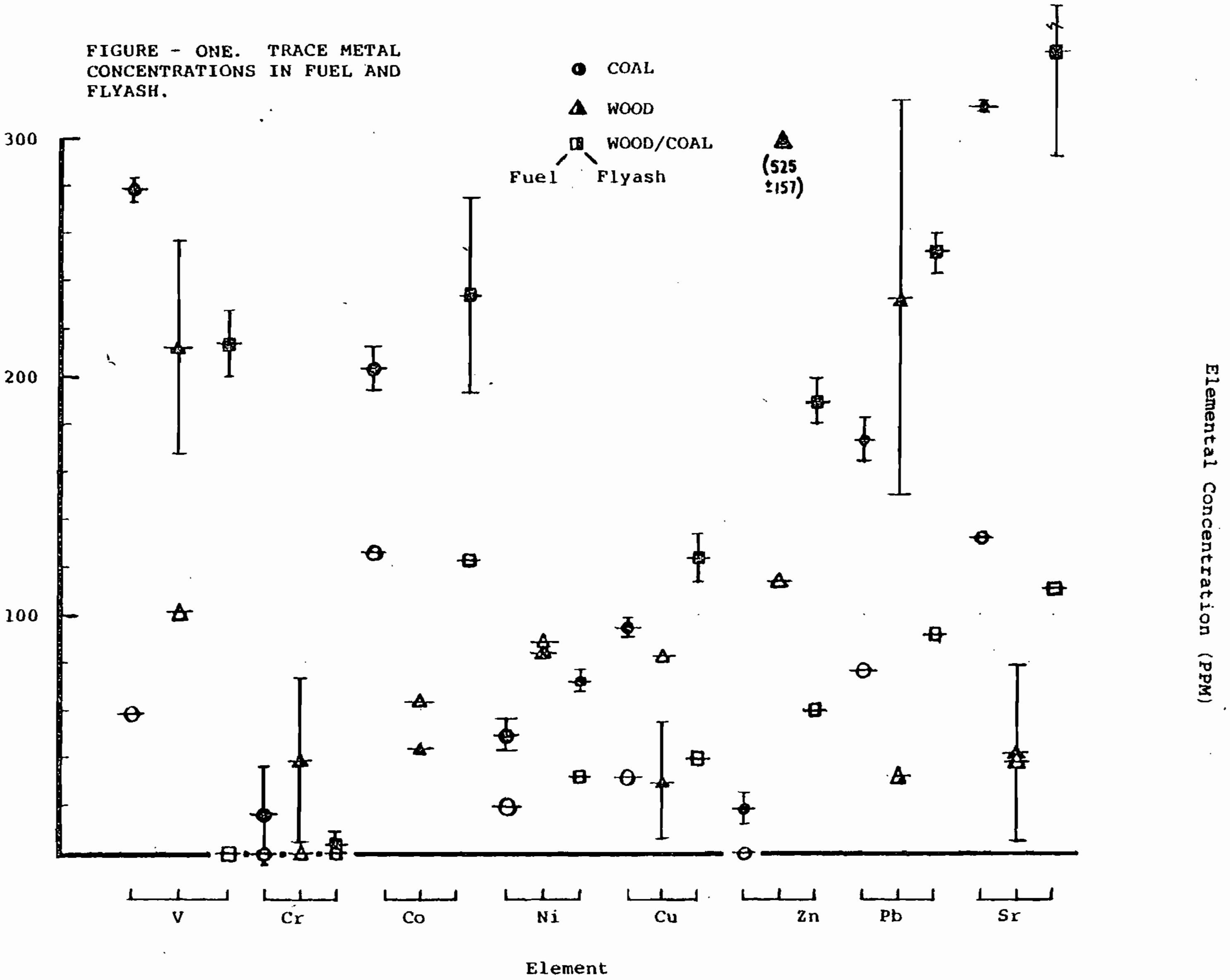
Three solid fuel samples and 11 flyash samples were analyzed for 22 elements using PIXE[1] analysis (Table Five). The average concentrations of eight metals and the corresponding fuel metal contents are displayed in Figure One. In 17 cases metals were concentrated in the flyash. In 6 cases fuel and flyash concentrations were approximately equal and in one case flyash concentrations were lower. This is consistent with other findings for coal-fired emissions.[2] The metal content of flyash emissions can be expected to be relatively higher than the metal content of fuel burned. Since fossil fuels generally have higher metal contents than wood fuels their emissions will be correspondingly more toxic.

Sulfur in fuels primarily enters the atmosphere as SO^2, H_2S, SO_3, and H_2SO_4 with traces of metal sulfates. Wood contains relatively small amounts of sulfur compared to fossil fuels (Table Six) and therefore releases less sulfur when burned. Sulfur contents in fossil fuels are expected to increase as oil sources are depleted and as coal usage increases. Significant increases in wood use can help reduce levels of atmospheric sulfates and sulfur oxides.

[1] Proton Induced X-Ray Emission

[2] Davison, R. L., D. F. S. Natusch, J. R. Wallace, and C. A. Evans, Jr. Trace Elements in Fly Ash. Envir. Sci. and Tech 8 (13): 107-1113.

FIGURE - ONE. TRACE METAL CONCENTRATIONS IN FUEL AND FLYASH.



Carbon dioxide is produced by all combustion processes. The carbon dioxide from fossil fuels originated from the ancient atmosphere present when the fuels were deposited, and it is remixed into today's atmosphere upon burning. About 20 thousand million tons (20×10^9 tons/year) of carbon dioxide are added to the atmosphere each year.[1] The widespread and increasing use of fossil fuels has increased the amount of carbon dioxide in the air world-wide. This has resulted in a 10 to 18 percent increase since about 1850 and doubling is expected by 2050. Coal releases 25% more carbon dioxide than oil when burned. Increased coal usage will accelerate the rate of increase, leading to perhaps a five-fold increase as coal deposits are utilized over the next 1000 years. Unlike oxygen and nitrogen, carbon dioxide absorbs infrared radiation. This will probably result in an increase in average world temperature and other climatic changes.[2] New methods of managing fossil fuels may modify these results.

When wood is burned, the carbon dioxide released originates from the modern atmosphere. Forests convert atmospheric carbon dioxide into the plant body through photosynthesis. Thus burning wood fuels can help stabilize the increase of carbon dioxide by recycling carbon dioxide already present in the atmosphere.

1. Man's Global Redistribution of Carbon. A. Bjorkstrom. Ambio 8 (6): 245-259, 1979.

2. The Carbon Dioxide Report. G. M. Woodwell, G. O. MacDonald, R. Revelle, C. D. Kedling. The Bulletin of Atomic Scientists, 56-57, October, 1979.

Scanning electron micrography (SEM) of the fuels (page 5-9) reveals the amorphous, torn-fiber structure of the wood fuel (#3, #3) which sharply contrasts with discrete, angular broken crystalline coal powder (#6). The combined fuel photograph (#4) seems to indicate a high proportion of coal. This conclusion is also substantiated by comparing the fuel analysis for coal, wood, and wood/coal (pages 5-5, 6, 7), and also by the ratios of emissions for the corresponding runs.

The oil flyashes (page 5-10) at half load (#7, #9) contain unidentified fibrous particulate which was absent at full load (#13).

Wood flyash (page 5-11) contains three predominant particules types; small spherules (.001-.01 mm); spongy, amorphous masses; sharp-edged irregular particles. The small spheres again appear in the combined fuel flyash (page 5-12) along with much larger spherical particles (.037mm). The coal flyash (#5, 5A) consists mainly of fine, amorphous ash, spherical particles (.001-.01mm) and spongy irregular masses with spherical openings (#5). This latter particulate resembles the spongy particulate in the combined fuel flyash (#2, #12) although the openings are smaller in the coal flyash. An electron microprobe analysis would help determine the composition of the large spheres and the spongy particules which are apparently the result of interaction of the fuels.

SECTION 1

TEST CONDITIONS AND METHODS

SECTION 1

Test Conditions and Methods

The emission tests on the number eight boiler were performed to compare the particulate emissions for four fuel combinations: oil (present fuel); coal (boiler design fuel); wood and wood-coal (proposed fuels). The boiler was operated at approximately equivalent outputs and constant rate for each test run. The boiler output was maintained at approximately one half load[1] for each test run, since the coal pulverizers could only produce enough wood powder to run the boiler at this rate. The emission data produced are therefore suitable only for relative comparison of particulate outputs. Full load emission levels are expected to be higher by about the same proportion as the oil full load to half load tests.

Boiler calibrations and operation were monitored by Mr. Joe Mollick of Thermoelectron Corp., Orlando, Florida, and by Dr. James. K. Beck of the Univ. of Central Florida, Mechanical Engineering Departmant. Boiler operating characteristics are detailed in that group report.

Boiler heat output was estimated using the F-factor method for emission computations. Oxygen analysis of boiler flue gases was performed with a Lynn Oxygen Analyzer calibrated with air.

[1] 28,000 lbs. steam/hr., test load, 60,000 lbs. steam, rated full load.

The boiler was fired with "Woodex" for six runs "Woodex"is a proprietary product consisting of wood. wastes compacted into pellets for ease of handling and storage. The pellets are pulverized to approximately 200 mesh size immediately preceding injection into the boiler.

Fuel samples were collected immediately before the boiler burners for later analysis. A single grab sample was collected for the coal and wood burns. Integrated 30 gram samples were collected at 12 minute intervals during the entire wood/coal run series. The integrated samples were combined and thouroughly mixed before analysis. Trace element analysis[1] was performed at the Florida State University tandem Van de Graff accelerator by Dr. Sene Bauman. The powdered fuels were pelletized and treated as solid targets.

Small samples were removed from the stack filters for analysis scanning electron microscopy.

Stack sample filters were examined and photographed using scanning electron microscopy by Mr. William Miller, FSU Department of Biological Sciences. (pages 5-9 through 5-12). A small section of selected filters was removed and examined under the microscope and representative views were photographed. Bulk samples of the fuels and coal flyash which accumulated in the filter bell were removed and examined.

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1. "PIXE" analysis was used. Proton induced X-ray Emission analysis.

SECTION 2

TEST RESULTS

SECTION 2

TEST RESULTS

The average emission levels for each fuel are presented in Table One. All tested emissions were in violation of FAC 17-2 particulate emission limiting standards. Visible emission levels as observed by Ms. Mary Jean O'Neil and Mr. Tom Amdrews (FDER) are tabulated.

Table One: Average Particulate Emissions and Visible Emissions for four fuels.

Fuel	Emission avg. (s.d.)	Number of Runs	Emission Limiting Standard lbs/10^6BTU	Visual Emission % Opacity
Oil	0.17(0.03)	3	0.1	10
Oil[1]	0.22 -	1	0.1	-
Coal	3.76 -	1	0.1	47
Woodex	1.05(0.10)	6	0.3	18.3
Wood/coal[2]	2.78(0.01)	3	0.175	31

1. Oil emissions at full load, one test run.
2. Wood/coal mixed at 50%/50% by volume, 37.5%/62.5% by weight so E= .375(.3)+.625(.1)=.175.
3. s.d. - standard deviation.

Table Two

Particulate Emissions for Individual Test Runs

Date	Run	Fuel	Emission lbs/10^6 BTU
1-12-80	6	Oil	0.216*
1-21	6A	Oil	0.134
1-29	6B	Oil	0.183
1-29	6C	Oil	0.199
1-22	B101	Woodex^R	1.11
1-22	B102	Woodex	.977
1-22	B103	Woodex	1.19
1-23	B104	Woodex	.938
1-23	B105	Woodex	.956
1-23	B106	Woodex	1.11
1-24	Coal 1	Coal	3.76
1-25	CW 1	Coal/Woodex	2.79
1-25	CW 2	Coal/Woodex	2.77
1-25	CW 3	Coal/Woodex	2.77

*full load test

SECTION 3

CONCLUSIONS

Section 3

Conclusions

1. All emission levels tested exceeded FAC 17-2 emission limiting standards.
2. Wood particulate levels are intermediate between coal and oil.
3. A variety of pollution control equipment which can adequately control wood-fired boiler particulate emissions is available and in use throughout Florida.
4. Metals are generally concentrated in flyash emissions. Flyash metal levels correlate with fuel metal levels.
5. Wood sulfur emissions are lower than fossil fuel emissions.
6. Wood fuel carbon dioxide emissions consist entirely of recycled carbon dioxide and are therefore zero. Coal carbon dioxide emissions are 25% higher than oil carbon dioxide emissions.

SECTION 4

FIELD DATA SHEETS
ANALYTICAL DATA
AND EMISSION CALCULATIONS

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K= 2.3

PLANT FSH UNIT #8 Full Load DATE 1-21-80

RUN NO. Oil #6 FILTER NO. 328 NOZZLE ID. 8 d 0.246 IN A_N .00033 FT2

P_b 30.07 ΔH 1.725 Y 0.999 PITOT ID. Nu-0 C_p 0.84

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-2	546.345	0.04	0.09	0.09	75	87	1	231	69
2	4		0.05	0.12	0.12	92	88	1	237	65
3	6		0.06	0.14	0.14	270	89	1	242	62
4	8		0.08	0.19	0.19	295	89	1	245	60
5	10		0.09	0.21	0.21	320	89	1	245	60
6	12		0.09	0.21	0.21	322	89	1	249	59
7	14		0.08	0.19	0.19	322	90	1	250	59
8	16		0.09	0.21	0.21	322	90	1	252	59
9	18		0.11	0.26	0.26	322	90	1	254	59
10	20		0.13	0.31	0.31	322	90	1	255	59
11	22		0.12	0.28	0.28	321	90	1	257	60
12	24		0.12	0.28	0.28	321	91	1	259	60
13	26		0.13	0.31	0.31	321	91	1	260	62
14	28		0.14	0.33	0.33	321	91	1	260	63
15	30		0.14	0.33	0.33	320	91	1	260	63
16	2		0.14	0.33	0.33	319	91	1	260	63
1	0-2		0.12	0.28	0.28	289	91	1	257	65
2	4		0.11	0.26	0.26	315	91	1	255	61
3	6		0.12	0.28	0.28	315	91	1	255	59
4	8		0.12	0.28	0.28	320	91	1	253	59
5	10		0.12	0.28	0.28	322	91	1	252	59
6	12		0.12	0.28	0.28	324	91	1	251	59
7	14		0.13	0.31	0.31	327	90	1	251	59
8	16		0.12	0.28	0.28	329	90	1	249	59
9	18		0.17	0.40	0.40	332	90	2	249	59
10	20		0.25	0.59	0.59	334	90	3	249	57
11	22		0.24	0.57	0.57	334	90	3	248	55
12	24		0.24	0.57	0.57	330	90	3	245	57
13	26		0.24	0.57	0.57	290	90	3	245	59
14	28		0.23	0.54	0.54	175	90	3	244	60
15	30		0.16	0.38	0.38	104	90	2	243	62
16	2	567.288	0.11	0.26	0.26	94	90	2	242	62

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		12.3		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	230	718.0
INITIAL	200	716.2
CHANGE	30	1.8

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	JG	JG	
PITOT LINES	JG	JG	
CONSOLE			

DATE 1-21-80
PLANT FSH-CHATT
STACK #8
RUN 6 (oil)
FILTER 328

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION
5 $\Delta H_@$ 1.72
4 C_p .84
17 γ .9987
6 D_n .246 IN
1 A_n .00033086 FT²

NEW DATA
16 P_b 30.07 "Hg
18 V_m 20.94 CF
15 $\overline{\Delta H}$ .310 "H_2O
14 $\bar{T}_m$ 550.06 °R
13 H_2O 30 ML
12 H_2O 1.8 g
11 CO_2 ______ %
10 O_2 12.3 %
6 $\sqrt{\Delta P}$ avg .355
5 $\bar{T}_s$ 944.96 °R
4 P_s 30.07 "Hg
3 A_s 11.74 FT²
2 θ 1.067 HR
5' M_n 88.9 Mg

$$K = 849.8\,(D_n)^4\,\Delta H_@\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$
$$= 849.8\,(.25)^4(1.72)(.84)^2(.90)^2\,\frac{(535)}{(750)} = \underline{2.3}$$

$$V_{m(STD)} = \frac{17.64\,V_m\,\gamma\left(P_b + \Delta H/13.6\right)}{T_m}$$
$$= \frac{17.64\,(20.94)(.9987)\left(30.07 + \frac{.310}{13.6}\right)}{(\quad)} = \underline{20.18}\text{ DSCF}$$

$V_{wc(STD)} = 0.04707\,(H_2O_c) = 0.04707\,(30) = \underline{1.412}$ SCF

$V_{wsg(STD)} = 0.04715\,(H_2O_{sg}) = 0.04715\,(1.8) = \underline{.085}$ SCF

$V_{w(STD)}$ $\underline{1.497}$ SCF

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(1.497)}{(1.497)+(20.18)} = \underline{.069}$$

$M_d = 0.44\,(\%CO_2) + 0.32\,(\%\ O_2) + 0.28\,(\%CO+N_2)$
$= 0.44\,(\quad) + 0.32\,(\quad) + 0.28\,(\quad) = \underline{30}$

$M_s = M_d\,(1-B_{ws}) + 18\,(B_{ws}) = (30)(.931) + 18\,(.069) = \underline{29.172}$

$$\bar{V}_s = 85.49\,C_p\,(\sqrt{\Delta P})\,avg.\sqrt{\frac{T_s}{P_s M_s}}$$
$$= 85.49\,(.84)(.355)\sqrt{\frac{(944.96)}{(30.07)(29.172)}} = \underline{23.49}\text{ FT/SEC}$$

$$\bar{Q}_s = 63500\,\bar{V}_s\,(1-B_{ws})\,A_s\,(P_s/T_s)$$
$$= 63500\,(23.49)(.931)(11.74)\frac{(30.07)}{(944.96)} = \underline{658\text{ K}}\text{ CFH}$$

$$\%I = \frac{100\,V_{m(STD)}\,A_s}{\theta\,\bar{Q}_s\,A_n} = \frac{100\,(20.18)(11.74)}{(1.067)(658K)(.00033086)} = \underline{101.9}$$

$$C_s = \frac{M_n}{454{,}000\,V_{m(STD)}} = \frac{(88.9)}{454{,}000\,(20.18)} = \underline{9.70\times10^{-6}}\text{ LB/CF}$$

$$PMR = C_s\,\bar{Q}_s = (9.7\times10^{-6})(658K) = \underline{6.38}\text{ LB/HR}$$

$$E = C_s\,F_d\,\frac{20.9}{20.9-\%O_2} = (9.7\times10^{-6})(9190)\,\frac{20.9}{20.9-(12.3)} = \underline{.216}\ \text{LB}/10^6\text{BTU}$$

DATE 1-21-80

PLANT FSH - CHATTAHOOCHEE

STACK #8

RUN 6 (011)

FILTER 328

06 Dn		in
05 ΔH_a		"H_2O
04 Cp		const.
03 Bws		fract sat.
02 Tm		°R
01 Ts		°R

18 Vm	20.943	CF
17 γ	.99871	const.
16 Pb	30.07	"Hg
15 ΔH	.310	"H_2O
14 Tm	550.06	°R
13 H_2Oc	30	Ml
12 H_2Osg	1.8	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	103.43	%
07 Cp	.84	const.
06 $(\overline{\sqrt{\Delta P}})$ Ave	.355	"H_2O
05 Ts	744.96	°R
04 Ps	30.07	"Hg
03 As	11.74	Ft^2
02 θ	1.067	Hr
01 An	.00023096	Ft^2

05 Mn	88.9	Mg
04 $\underline{Vm}$(STD)	20.204	CF
03 $\overline{Qs}$	658K	SCFH
02 Fd	9190	dscf/10^6BTU
01 % O_2	12.3	

B = Cs 9.69×10^{-6}

C = PMR 6.37

D = E 0.216

B = Vm(STD)	20.20	DSCF
C = Vw(STD)	1.49	SCF
D = Bws	.068	fract. sat.
E = Md	30.00	AMU
A' = $\underline{Ms}$	29.17	AMU
B' = $\overline{Vs}$	23.49	Ft/sec
C' = $\overline{Qs}$	658K	SCFH
D' = %I	102.04	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K=2.3

PLANT FSH UNIT #8 DATE 1-21-80

RUN NO. OIL #6A FILTER NO. 336 NOZZLE ID. 81 d ______ IN AN ______ FT2

Pb 30.07 ΔH ______ Y ______ PITOT ID. ______ Cp ______

PT.	TIME	Vm	ΔP	ΔH Desired	ΔH Actual	Ts	Tm	Pump Vac.	Filter T	Impinger T
1	0-2	567.38	0.55	1.3	1.3	381	91	3	234	55
2	4		0.55	1.3	1.3	382	91	3	249	52
3	6		0.57	1.3	1.3	383	92	3	260	51
4	8		0.60	1.4	1.4	384	93	3	265	53
5	10		0.55	1.3	1.3	385	94	3	269	55
6	12		0.53	1.2	1.2	385	95	3	269	59
7	14		0.50	1.15	1.15	385	95	3	267	61
8	16		0.45	1.0	1.0	385	95	3	265	62
9	18	-	0.27	0.62	0.62	385	95	2.5	265	63
10	20		0.20	0.46	0.46	385	95	2	263	63
11	22		0.17	0.39	0.39	384	94	2	261	63
12	24		0.15	0.35	0.35	384	93	2	257	62
13	26		0.15	0.35	0.35	383	93	2	257	62
14	28		0.15	0.35	0.35	379	93	2	255	61
15	30		0.13	0.30	0.30	364	93	2	254	61
16	2	583.51	0.10	0.23	0.23	244	93	1.5	252	61
1	0-2		0.88	2.0	2.0	383	93	5	243	61
2	4		0.95	2.2	2.2	387	93	6	243	57
3	6		1.0	2.3	2.3	388	94	7	242	59
4	8		1.0	2.3	2.3	388	94	7	247	62
5	10		0.95	2.2	2.2	388	95	7	251	64
6	12		0.80	1.8	1.8	389	95	6.5	253	65
7	14		0.70	1.6	1.6	389	95	6	247	57
8	16		0.60	1.4	1.4	389	95	5.5	259	53
9	18		0.30	0.69	0.69	386	95	4	253	53
10	20		0.30	0.69	0.69	386	95	4	252	53
11	22		0.33	0.76	0.76	385	95	4	244	52
12	24		0.35	0.80	0.80	385	95	4	245	52
13	26		0.35	0.80	0.80	385	95	4	245	52
14	28		0.38	0.87	0.87	381	95	5	245	51
15	30		0.36	0.83	0.83	355	95	4.5	247	51
16	3	604.53	0.30	0.69	0.69	275	95	4	249	52

GAS ANALYSIS	%CO2	%O2	%CO	%N2
		7.3		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	267	638.1
INITIAL	200	627.0
CHANGE	67	11.1

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN			
PITOT LINES			
CONSOLE			

DATE 1-21-80
PLANT PSH-CHATT
STACK #8
RUN 6A (oil)
FILTER 336

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION
5 $\Delta H_@$ 1.72
4 C_p .84
17 γ .99871
6 D_n .250 IN
1 A_n .00034 FT²

NEW DATA
16 P_b 30.07 "Hg
18 V_M 37.15 CF
15 ΔH 1.051 "H_2O
14 $\bar{T}_m$ 554.03 °R
13 H_2O 67 ML
12 H_2O 11.1 g
11 CO_2 ______ %
10 O_2 7.3 %
6 $\sqrt{\Delta P}$ avg .659
5 $\bar{T}_s$ 835.53 °R
4 P_s 30.07 "Hg
3 A_s 11.74 FT²
2 θ 1.067 HR
5' M_n 154 Mg

$$K = 849.8\,(D_n)^4 \Delta H_@\,(C_p)^2(1-B_{ws})^2\, T_m/T_s$$

$$= 849.8\,(\quad)^4(\quad)(\quad)^2(\quad)^2\frac{(\quad)}{(\quad)} = \_\_\_\_$$

$$V_{m(STD)} = \frac{17.64\, V_m\, \gamma \left(P_b + \Delta H/13.6\right)}{T_m}$$

$$= \frac{17.64\,(37.15)(.9987)\left(30.07 + \frac{1.051}{13.6}\right)}{(554.03)} = 35.61 \text{ DSCF}$$

$$Vw_{C(STD)} = 0.04707\,(H_2O_C) = 0.04707\,(67) = 3.15 \text{ SCF}$$

$$Vw_{SG(STD)} = 0.04715\,(H_2O_{SG}) = 0.04715\,(11.1) = .52 \text{ SCF}$$

$$V_{w(STD)}\ 3.67 \text{ SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(35.61)}{(3.67)+(35.61)} = .09$$

$$M_d = 0.44\,(\%CO_2) + 0.32\,(\%O_2) + 0.28\,(\%CO+N_2)$$

$$= 0.44\,(\quad) + 0.32\,(\quad) + 0.28\,(\quad) = 30$$

$$M_s = M_d\,(1-B_{ws}) + 18\,(B_{ws}) = (30)(.91) + 18\,(.09) = 28.82$$

$$\bar{V}_s = 85.49\, C_p\, (\sqrt{\Delta P})\,\text{avg.}\sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.49\,(.84)(.659)\sqrt{\frac{(835.53)}{(30.07)(28.82)}} = 46.46 \text{ FT/SEC}$$

$$\bar{Q}_s = 63500\,\bar{V}_s\,(1-B_{ws})\,A_s\,(P_s/T_s)$$

$$= 63500\,(46.46)(.91)(11.74)\frac{(30.07)}{(835.53)} = 113\text{K CFH}$$

$$\%I = \frac{100\,V_{m(STD)}\,A_s}{\theta\,\bar{Q}_s\,A_n} = \frac{100\,(35.61)(11.74)}{(1.067)(113K)(.00034)} = 101.35$$

$$C_s = \frac{M_n}{454{,}000\,V_{m(STD)}} = \frac{(154)}{454{,}000\,(35.61)} = 9.52\times10^{-6} \text{ LB/CF}$$

$$PMR = C_s\,\bar{Q}_s = (9.52\times10^{-6})(113K) = 10.79 \text{ LB/HR}$$

$$E = C_s\,F_d\,\frac{20.9}{20.9-\%O_2} = (9.52\times10^{-6})\left(9140\,\frac{20.9}{20.9-7.3}\right) = .134 \text{ LB}/10^6\text{BTU}$$

DATE 1-21-80

PLANT FSH-CHATTAHOOCHEE

STACK #4

RUN 6A (oil)

FILTER 336

06 Dn		in
05 ΔH@		"H_2O
04 Cp		const.
03 Bws		fract sat.
02 Tm		°R
01 Ts		°R

18 Vm	37.15	CF
17 γ	.9987	const.
16 Pb	30.07	"Hg
15 ΔH	1.051	"H_2O..
14 Tm	559.03	°R
13 H_2Oc	67	Ml
12 H_2Osg	11.1	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	103.43	%
07 Cp	.84	const.
06 ($\overline{\sqrt{\Delta P}}$) Avg	.657	"H_2O
05 Ts	835.53	°R
04 Ps	30.07	"Hg
03 As	11.74	Ft^2
02 θ	1.067	Hr
01 An	.00034088	Ft^2

05 Mn	154	Mg
04 Vm(STD)	35.619	CF
03 Cs	11296	SCFH
02 Fd	9190	dscf/10^6BTU
01 %O_2	7.3	

B = Cs 9.52×10^{-6}

C = PMR 10.75

D = E 0.134

B = Vm(STD)	35.61	DSCF
C = Vw(STD)	3.67	SCF
D = Bws	.093	fract. sat.
E = Md	30.00	AMU
A' = Ms	28.87	AMU
B' = Vs	46.41	Ft/sec
C' = Cs	11296	SCFH
D' = %I	101.80	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K= 2.4

PLANT FSH UNIT #8 DATE 1-29-80

RUN NO. 016 6b FILTER.NO. 168 NOZZLE ID. 8 d 0.25 IN A_N .00033 FT2

P_b 30.13 ΔH ______ Y ______ PITOT ID. ______ C_p ______

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-3	606.583	0.12	0.288		244	77	1	265	53
2	6		0.22	0.528		291	76	2	269	45
3	9		0.25	0.60		310	76	2	269	44
4	12		0.25	0.60		319	76	2	264	44
5	15		0.24	0.576		319	75	2	263	45
6	18		0.21	0.504		318	75	2	257	45
7	21		0.20	0.48		317	76	2	258	46
8	24		0.15	0.36		316	76	2	258	49
9	27		0.13	0.312		316	77	1.5	258	49
10	30		0.13	0.312		316	77	1.5	258	48
11	3		0.13	0.312		315	78	1.5	258	48
12	6		0.15	0.36		315	78	1.5	260	48
13	9		0.15	0.36		314	79	1.5	257	49
14	12		0.16	0.384		313	80	1.5	260	49
15	15		0.15	0.36		319	80	1.5	260	49
16	18	623.33	0.13	0.312		311	81	1.5	262	50
1	0-3		0.12	0.288		307	81	1.5	256	54
2	6		0.12	0.288		310	82	1.5	255	51
3	9		0.12	0.288		312	82	1.5	255	51
4	12		0.12	0.288		313	83	1.5	253	52
5	15		0.12	0.288		313	83	1.5	251	52
6	18		0.12	0.288		313	83	1.5	253	52
7	21		0.12	0.288		314	84	1.5	254	53
8	24		0.11	0.264		314	84	1.5	252	53
9	27		0.10	0.24		315	84	1.5	252	53
10	30		0.10	0.24		315	85	1.5	253	54
11	3		0.11	0.264		314	85	1.5	253	54
12	6		0.11	0.264		315	85	1.5	253	56
13	9		0.11	0.264		313	85	1.5	258	54
14	12		0.10	0.24		308	86	1.5	254	55
15	15		0.09	0.216		297	86	1.5	252	55
16	18	636.817	0.07	0.168		165	86	1.5	256	56

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		10.0		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	250	622.8
INITIAL	200	616.8
CHANGE	50	6.0

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	BK	JG	
PITOT LINES	BK	JG	
CONSOLE			

DATE 1-29-80
PLANT PSU-CHATT
STACK #4
RUN 6b (oil)
FILTER 168

From Previous Run Data
$(1-B_{ws})$ ______

1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION

5 ΔH_a ______
4 Cp .84
17 γ 1.013
6 D_n ______ IN
1 A_n .00033086 FT²

NEW DATA

16 P_b 30.13 "Hg
18 V_M 30.23 CF
15 ΔH .340 "H_2O
14 $\bar{T}_m$ 540.6 °R
13 H_2O 50 ML
12 H_2O 6 g
11 CO_2 ______ %
10 O_2 10 %
6 $\sqrt{\Delta P}$ avg .370
5 $\bar{T}_s$ 765.9 °R
4 P_s 30.13 "Hg
3 A_s 11.74 FT²
2 θ 1.6 HR
5' M_n 142 MG

$$K = 849.8\,(D_n)^4 \Delta H_a\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$
$$= 8498\,(\quad)^4(\quad)(\quad)^2(\quad)^2\,\frac{(\quad)}{(\quad)} = \_\_\_\_$$

$$V_{m(STD)} = \frac{17.64\,V_m\,\gamma\left(P_b + \Delta H/13.6\right)}{T_m}$$
$$= \frac{17.64\,(30.23)(1.013)\left(30.13 + \frac{.340}{13.6}\right)}{(540.6)} = \underline{30.13}\ \text{DSCF}$$

$$V_{wc(STD)} = 0.04707\,(H_2O_c) = 0.04707\,(50) = \underline{2.35}\ \text{SCF}$$
$$V_{wsg(STD)} = 0.04715\,(H_2O_{SG}) = 0.04715\,(6) = \underline{.28}\ \text{SCF}$$
$$V_{w(STD)}\ \underline{2.63}\ \text{SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.63)}{(2.63) + (30.13)} = \underline{.080}$$

$$M_d = 0.44\,(\%CO_2) + 0.32\,(\%O_2) + 0.28\,(\%CO+N_2)$$
$$= 0.44\,(\quad) + 0.32\,(\quad) + 0.28\,(\quad) = \underline{30}$$

$$M_s = M_d\,(1-B_{ws}) + 18\,(B_{ws}) = (30)(.92) + 18(.08) = \underline{29.04}$$

$$\bar{V}_s = 85.49\,C_p\,(\sqrt{\Delta P})\,\text{avg.}\sqrt{\frac{T_s}{P_s M_s}}$$
$$= 85.49\,(.84)(.370)\sqrt{\frac{(765.9)}{(30.13)(29.04)}} = \underline{24.85}\ \text{FT/SEC}$$

$$\bar{Q}_s = 63500\,\bar{V}_s\,(1-B_{ws})\,A_s\,(P_s/T_s)$$
$$= 63500\,(24.85)(.92)(11.74)\frac{(30.13)}{(765.9)} = \underline{670K}\ \text{CFH}$$

$$\%I = \frac{100\,V_{m(STD)}\,A_s}{\theta\,\bar{Q}_s\,A_n} = \frac{100\,(30.23)(11.74)}{(1.6)(670K)(.00033086)} = \underline{99.68}$$

$$C_s = \frac{M_n}{454{,}000\,V_{m(STD)}} = \frac{(142)}{454{,}000\,(30.13)} = \underline{1.03\times10^{-5}}\ \text{LB/CF}$$

$$PMR = C_s\,\bar{Q}_s = (1.03\times10^{-5})(670K) = \underline{6.90}\ \text{LB/HR}$$

$$E = C_s\,F_d\,\frac{20.9}{20.9 - \%O_2} = (1.03\times10^{-5})(9190)\,\frac{20.9}{20.9-(10)} = \underline{.181}\ \text{LB}/10^6\,\text{BTU}$$

DATE 1-29-80

PLANT FSH-CHATTAHOOCHEE

STACK #8

RUN 6 b (oil)

FILTER 168

06 Dn		in
05 ΔH_a		"H_2O
04 Cp		const.
03 Bws		fract sat.
02 Tm		°R
01 Ts		°R

18 Vm	30.23	CF
17 γ	1.013	const.
16 Pb	30.13	"Hg
15 ΔH	.34	"H_2O..
14 Tm	540.6	°R
13 H_2Oc	50	Ml
12 H_2Osg	6	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	102.43	%
07 Cp	.84	const.
06 $(\overline{N\Delta P})$ Ave	.370	"H_2O
05 Ts	765.9	°R
04 Ps	30.13	"Hg
03 As	11.74	Ft^2
02 θ	1.6	Hr
01 An	.00033086	Ft^2

05 Mn	142	Mg
04 Vm(STD)	30.149	CF
03 Qs	671 K	SCFH
02 Fd	9190	dscf/10^6BTU
01 %O_2	10	

B = Cs 1.04×10^{-5}

C = PMR 6.96

D = E 0.183

B = Vm(STD)	30.141	DSCF
C = Vw(STD)	2.63	SCF
D = Bws	.080	fract. sat.
E = Md	30.00	AMU
A' = Ms	29.03	AMU
B' = Vs	24.85	Ft/sec
C' = Qs	670K	SCFH
D' = %I	99.69	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K = 2.2
PLANT FSH UNIT #8 DATE 1-29-80
RUN NO. 016 6C FILTER.NO. 167 NOZZLE ID. 181 d ____ IN A_N .00033 FT2
P_b 30.13 ΔH ____ Y ____ PITOT ID. ____ C_p ____

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-3	821.357	0.11	0.24	0.24	321	72	1	235	50
2	6		0.14	0.31	0.31	319	72	1	240	41
3	9		0.12	0.26	0.26	319	73	1	245	45
4	12		0.12	0.26	0.26	319	74	1	250	46
5	15		0.11	0.24	0.24	317	75	1	250	46
6	18		0.11	0.24	0.24	317	76	1	250	49
7	21		0.10	0.22	0.22	316	76	1	250	49
8	24		0.10	0.22	0.22	317	77	1	250	49
9	27		0.09	0.20	0.20	316	77	1	250	49
10	30		0.09	0.20	0.20	316	78	1	250	49
11	3		0.09	0.20	0.20	315	79	1	250	49
12	6		0.09	0.20	0.20	314	79	1	250	50
13	9		0.09	0.20	0.20	313	80	1	250	50
14	12		0.08	0.18	0.18	306	80	1	250	50
15	15		0.09	0.20	0.20	260	81	1	250	50
16	18	835.344	0.06	0.13	0.13	150	81	1	250	50
1	0-3		0.15	0.33	0.33	115	81	1	250	60
2	6		0.18	0.40	0.40	230	82	1	250	60
3	9		0.20	0.44	0.44	305	83	1	250	60
4	12		0.19	0.42	0.42	308	83	1	250	50
5	15		0.18	0.40	0.40	312	83	1	250	50
6	18		0.14	0.36	0.36	313	83	1	250	50
7	21		0.12	0.31	0.31	313	83	1	250	50
8	24		0.09	0.20	0.20	313	83	1	250	50
9	27		0.10	0.22	0.22	313	84	1	250	50
10	30		0.07	0.18	0.18	313	84	1	250	50
11	3		0.09	0.21	0.21	312	84	1	250	50
12	6		0.09	0.21	0.21	316	84	1	250	50
13	9		0.09	0.20	0.20	311	84	1	250	50
14	12		0.08	0.18	0.18	311	85	1	250	50
15	15		0.10	0.22	0.22	311	85	1	250	50
16	18	850.443	0.06	0.13	0.13	310	85	1	250	50

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		9.95		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	247	596.4
INITIAL	200	591.4
CHANGE	47	5.0

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	BK	JG	
PITOT LINES	BK	JG	
CONSOLE			

DATE 1-29-80
PLANT PSH -CHATT
STACK #9
RUN 6c (oil)
FILTER 167

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION

5 $\Delta H_@$ ______
4 Cp .84
17 γ .9987
6 D_n ______ IN
1 A_n .00633275 FT^2

NEW DATA

16 P_b 30.13 "Hg
18 V_M 28.59 CF
15 ΔH .247 "H_2O
14 $\bar{T}_m$ 540.2 °R
13 H_2O 47 ML
12 H_2O 5 g
11 CO_2 ______ %
10 O_2 10.0 %
6 $\sqrt{\Delta P}$ avg .328
5 $\bar{T}_s$ 758.2 °R
4 P_s 30.13 "Hg
3 A_s 11.74 FT^2
2 θ 1.6 HR
5' M_n 144.7 Mg

$$K = 849.8\,(D_n)^4\,\Delta H_@\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$

$$= 849.8\,(\quad)^4(\quad)(\quad)^2(\quad)^2\frac{(\quad)}{(\quad)} = \underline{\qquad}$$

$$V_{m(STD)} = \frac{17.64\,V_m\,\gamma\left(P_b + \Delta H/13.6\right)}{T_m}$$

$$= \frac{17.64\,(28.59)(.9987)\left(30.13 + \frac{.247}{13.6}\right)}{(540.2)} = \underline{28.10}\ \text{DSCF}$$

$$V_{wc(STD)} = 0.04707\,(H_2O_c) = 0.04707\,(47) = \underline{2.21}\ \text{SCF}$$

$$V_{wSG(STD)} = 0.04715\,(H_2O_{SG}) = 0.04715\,(5) = \underline{.23}\ \text{SCF}$$

$$V_{w(STD)}\ \underline{2.44}\ \text{SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.44)}{(2.44) + (28.10)} = \underline{.079}$$

$$M_d = 0.44\,(\%CO_2) + 0.32\,(\%\,O_2) + 0.28\,(\%CO+N_2)$$

$$= 0.44\,(\quad) + 0.32\,(\quad) + 0.28\,(\quad) = \underline{30}$$

$$M_s = M_d\,(1-B_{ws}) + 18\,(B_{ws}) = (30)(.921) + 18(.079) = \underline{29.05}$$

$$\bar{V}_s = 85.49\ C_p\ (\sqrt{\Delta P})\text{avg.}\sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.49\,(.84)(.328)\sqrt{\frac{(758.2)}{(30.13)(29.05)}} = \underline{21.92}\ \text{FT/SEC}$$

$$\bar{Q}_s = 63500\ \bar{V}_s\ (1-B_{ws})\ A_s\ (P_s/T_s)$$

$$= 63500\,(21.92)(.921)(11.74)\frac{(30.13)}{(758.2)} = \underline{598k}\ \text{CFH}$$

$$\%I = \frac{100\,V_{m(STD)}\,A_s}{\theta\ \bar{Q}_s\ A_n} = \frac{100\,(28.10)(11.74)}{(1.6)(598k)(.00633275)} = \underline{103.6}$$

$$C_s = \frac{M_n}{454{,}000\,V_{m(STD)}} = \frac{(144.7)}{454{,}000\,(28.10)} = \underline{1.13\times10^{-5}}\ \text{LB/CF}$$

$$PMR = C_s\ \bar{Q}_s = (1.13\times10^{-5})(598k) = \underline{6.75}\ \text{LB/HR}$$

$$E = C_s\ F_d\ \frac{20.9}{20.9-\%O_2} = (1.13\times10^{-5})(9190)\ \frac{20.9}{20.9-9.95} = .200\ \text{LB}/10^6\text{BTU}$$

DATE 1-29-80

PLANT FSH-CHATTAHOOCHEE

STACK #8

RUN 6c (oil 4)

FILTER 167

06 Dn		in
05 $\Delta H_@$		"H_2O
04 Cp		const.
03 Bws		fract sat.
02 Tm		°R
01 Ts		°R

18 Vm	28.59	CF
17 γ	.9987	const.
16 Pb	30.13	"Hg
15 ΔH	.247	"H_2O
14 Tm	540.2	°R
13 H_2Oc	47	Ml
12 H_2Osg	5	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	103.43	%
07 Cp	.84	const.
06 $(\overline{N\Delta P})$ Ave	.328	"H_2O
05 Ts	758.2	°R
04 Ps	30.13	"Hg
03 As	11.74	Ft^2
02 θ	66	Hr
01 An	.00033275	Ft^2

05 Mn	144.7	Mg
04 $\underline{Vm}$(STD)	28.127	CF
03 $\overline{Cs}$	598 K	SCFH
02 Fd	9190	dscf/10^6BTU
01 %O_2	10	

B = Cs 1.13×10^{-5}

C = PMR 6.79

D = E 0.200

B = Vm(STD)	28.12	DSCF
C = Vw(STD)	2.44	SCF
D = Bws	.080	fract. sat.
E = Md	30.0	AMU
A' = $\underline{Ms}$	29.03	AMU
B' = $\overline{Vs}$	21.92	Ft/sec
C' = $\overline{Cs}$	597 K	SCFH
D' = %I	103.75	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K = 2.2

PLANT FSH UNIT #8 DATE 1-24-80

RUN NO. COAL FILTER NO. 355 NOZZLE ID. 81 d ____ IN A_N ____ FT^2

P_b 30.00 ΔH ____ Y ____ PITOT ID. ____ C_p ____

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-4	748.60	0.06	0.13	0.13	310	70	1	250	65
2	8		0.09	0.19	0.19	310	70	1	253	61
3	12		0.09	0.19	0.19	311	71	1	255	59
4	16		0.08	0.17	0.17	311	72	1	259	59
5	20		0.08	0.17	0.17	311	72	1	259	59
6	24		0.08	0.17	0.17	312	72	1	261	59
7	28		0.07	0.15	0.15	312	72	1	261	59
8	2		0.06	0.13	0.13	312	73	1	263	61
9	6		0.06	0.13	0.13	312	73	1	262	62
10	10		0.07	0.15	0.15	312	74	1	261	61
11	14		0.08	0.17	0.17	310	73	1	260	59
12	18		0.08	0.17	0.17	310	73	1	260	59
13	22		0.08	0.17	0.17	307	74	1	259	59
14	26		0.07	0.15	0.15	292	74	1	259	59
15	30		0.07	0.15	0.15	264	75	1	257	59
16	4	763.92	0.07	0.15	0.15	205	75	1	257	61
1	0-4		0.10	0.22	0.22	305	74	1	257	59
2	8		0.14	0.30	0.30	309	75	1	255	52
3	12		0.12	0.26	0.26	309	75	1	255	51
4	16		0.14	0.30	0.30	309	74	1	253	50
5	20		0.12	0.26	0.26	309	74	1	252	50
6	24		0.10	0.22	0.22	309	74	1	250	50
7	28		0.10	0.22	0.22	309	72	1	250	50
8	2		0.10	0.22	0.22	309	70	1	252	51
9	6		0.10	0.22	0.22	309	69	1	253	51
10	10		0.15	0.33	0.33	309	69	2	254	50
11	14		0.17	0.37	0.37	309	68	2	254	50
12	18		0.20	0.44	0.44	309	69	3	253	50
13	22		0.20	0.44	0.44	309	70	3	252	49
14	26		0.22	0.48	0.48	305	70	3	252	50
15	30		0.20	0.44	0.44	299	71	3	253	51
16	4	784.33	0.16	0.35	0.35	254	71	2	252	51

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		8.4		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	247	735.1
INITIAL	200	729.1
CHANGE	47	6.0

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	RLV	RLV	
PITOT LINES	RLV	RLV	
CONSOLE			

DATE 1-24-80
PLANT FSH-CHATT
STACK #8
RUN COAL 1
FILTER 355

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION
5 $\Delta H_@$ ______
4 Cp .84
17 γ .99871
6 D_n ______ IN
1 A_n .00033056 FT^2

NEW DATA
16 P_b 30.00 "Hg
18 V_M 35.73 CF
15 ΔH .283 "H_2O
14 $\bar{T}_m$ 532.0 °R
13 H_2O 47 ML
12 H_2O 6 g
11 CO_2 ~ %
10 O_2 8.4 %
6 $\sqrt{\Delta P}$ avg 324
5 $\bar{T}_s$ 762.25 °R
4 P_s 30.00 "Hg
3 A_s 11.74 FT^2
2 θ 2.13 HR
5' M_n 3579 Mg

$$K = 849.8\,(D_n)^4\,\Delta H_@\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$

$$= 849.8\,(\quad)^4(\quad)(\quad)^2(\quad)^2\frac{(\quad)}{(\quad)} = \_\_\_\_$$

$$V_{m(STD)} = \frac{17.64\,V_m\,\gamma\left(P_b + \Delta H/13.6\right)}{T_m}$$

$$= \frac{17.64\,(35.73)(.99871)\left(30.00 + \frac{.283}{13.6}\right)}{(532)} = \underline{35.51}\text{ DSCF}$$

$$V_{wc(STD)} = 0.04707\,(H_2O_c) = 0.04707\,(47) = \underline{2.21}\text{ SCF}$$

$$V_{wSG(STD)} = 0.04715\,(H_2O_{SG}) = 0.04715\,(6) = \underline{.28}\text{ SCF}$$

$$V_{w(STD)}\ \underline{2.49}\text{ SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.49)}{(2.49)+(35.51)} = \underline{0.065}$$

$$M_d = 0.44\,(\%CO_2) + 0.32(\%\ O_2) + 0.28(\%CO+N_2)$$

$$= 0.44\,(\quad) + 0.32(\quad) + 0.28(\quad) = \underline{30.06}$$

$$M_s = M_d\,(1-B_{ws}) + 18(B_{ws}) = (30)(.935)+18(.065) = \underline{29.22}$$

$$\bar{V}_s = 85.49\,C_p\,(\sqrt{\Delta P})\text{avg.}\sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.49\,(.84)(.324)\sqrt{\frac{(762.25)}{(30)(29.22)}} = \underline{21.69}\text{ FT/SEC}$$

$$\bar{Q}_s = 63500\,\bar{V}_s\,(1-B_{ws})\,A_s\,(P_s/T_s)$$

$$= 63500\,(21.69)(.935)(11.74)\frac{(30.00)}{(762.25)} = \underline{595K}\text{ CFH}$$

$$\%I = \frac{100V_{m(STD)}A_s}{\theta\,\bar{Q}_s\,A_n} = \frac{100(35.51)(11.74)}{(2.13)(595K)(.00033056)} = \underline{99.43}$$

$$C_s = \frac{M_n}{454{,}000V_{m(STD)}} = \frac{(3579)}{454{,}000(35.51)} = \underline{2.22\times10^{-4}}\text{ LB/CF}$$

$$PMR = C_s\,\bar{Q}_s = (2.22\times10^{-4})(595K) = \underline{132.09}\text{ LB/HR}$$

$$E = C_s\,F_d\,\frac{20.9}{20.9-\%O_2} = (2.22\times10^{-4})(10{,}190)\frac{20.9}{20.9-(8.4)} = 3.76\ \text{LB}/10^6\text{BTU}$$

DATE 1-24-80

PLANT CHATTAHOOCHEE

STACK #8

RUN COAL 1

FILTER 355

06 Dn		in
05 ΔH@		"H_2O
04 Cp		const.
03 Bws		fract sat.
02 Tm		°R
01 Ts		°R

18 Vm	35.73	CF
17 γ	.9987	const.
16 Pb	30.00	"Hg
15 ΔH	.238	"H_2O..
14 Tm	532	°R
13 H_2Oc	47	Ml
12 H_2Osg	6	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	103.41	%
07 Cp	.84	const.
06 ($\sqrt{\Delta P}$) Ave	.324	"H_2O
05 Ts	763.25	°R
04 Ps	30.00	"Hg
03 As	11.74	Ft^2
02 θ	2.13	Hr
01 An	.00033086	Ft^2

05 Mn	3579	Mg
04 Vm(STD)	35.53	CF
03 Qs	595K	SCFH
02 Fd	10,100	dscf/10^6BTU
01 %O_2	8.4	

B = Cs 2.21×10^{-4}

C = PMR 132.03

D = E 3.7%

B = Vm(STD)	35.53	DSCF
C = Vw(STD)	2.49	SCF
D = Bws	.065	fract. sat.
E = Md	30.00	AMU
A' = Ms	29.21	AMU
B' = $\overline{Vs}$	21.69	Ft/sec
C' = Qs	595K	SCFH
D' = %I	99.3	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K= 2.3

PLANT FSH UNIT #8 DATE 1-22-80

RUN NO. Bio. 1 FILTER NO. 329 NOZZLE ID. 8 d ______ IN AN ______ FT2

Pb 29.74 ΔH ______ Y ______ PITOT ID. ______ Cp ______

PT.	TIME	Vm	ΔP	ΔH Desired	ΔH Actual	Ts	Tm	Pump Vac.	Filter T	Impinger T
1	0-2	604.895	0.05	0.11	0.11	310	71	1	251	62
2	4		0.07	0.16	0.16	318	71	1	253	58
3	6		0.07	0.16	0.16	321	72	1	254	52
4	8		0.08	0.18	0.18	322	72	1	255	57
5	10		0.07	0.16	0.16	323	73	1	256	57
6	12		0.05	0.11	0.11	323	74	1	258	58
7	14		0.05	0.11	0.11	323	74	1	256	60
8	16		0.06	0.13	0.13	324	74	1	259	60
9	18		0.05	0.11	0.11	324	75	1	259	62
10	20		0.06	0.13	0.13	324	75	1	259	61
11	22		0.06	0.13	0.13	324	75	1	261	61
12	24		0.07	0.16	0.16	323	75	1	264	61
13	26		0.07	0.16	0.16	322	75	1	262	59
14	28		0.06	0.13	0.13	311	75	1	263	62
15	30		0.05	0.11	0.11	265	75	1	263	64
16	2	611.93	0.04	0.09	0.09	255	75	1	259	65
1	0-[illegible]		0.08	0.18	0.18	319	75	1	259	61
2	4		0.09	0.20	0.20	321	75	1	257	52
3	6		0.09	0.20	0.20	323	75	1	257	50
4	8		0.10	0.23	0.23	323	75	1	259	50
5	10		0.08	0.18	0.18	324	75	1	259	50
6	12		0.07	0.16	0.16	324	75	1	259	50
7	14		0.07	0.16	0.16	324	75	1	260	51
8	16		0.05	0.11	0.11	324	76	1	262	55
9	18		0.06	0.13	0.13	325	76	1	263	59
10	20		0.09	0.20	0.20	325	76	2	264	55
11	22		0.11	0.25	0.25	325	76	2	259	53
12	24		0.15	0.34	0.34	325	76	2	259	53
13	26		0.14	0.32	0.32	324	77	2	259	52
14	28		0.14	0.32	0.32	322	77	2	259	53
15	30		0.12	0.27	0.27	300	78	2	260	53
16	2	620.795	0.12	0.27	0.27	252	78	2	260	54

GAS ANALYSIS	%CO2	%O2	%CO	%N2
		8.1		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	239	720.9
INITIAL	200	718.0
CHANGE	39	2.9

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	RLV	RLV	
PITOT LINES	RLV	RLV	
CONSOLE			

DATE 1-22-80
PLANT FSA-CHAT
STACK #8
RUN B-1
FILTER 329

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION
5 $\Delta H_@$ 1.72
4 C_p .84
17 Y .99871
6 D_n .246 IN
1 A_n .00033086 FT^2

NEW DATA
16 P_b 29.74 "Hg
18 V_M 15.95 CF
15 ΔH .177 "H_2O
14 $\bar{T}_m$ 534.875 °R
13 H_2O 39 ML
12 H_2O 2.9 g
11 CO_2 ______ %
10 O_2 8.1 %
6 $\sqrt{\Delta P}$ avg .276
5 $\bar{T}_s$ 775.375 °R
4 P_s 29.74 "Hg
3 A_s 11.74 FT^2
2 θ 1.067 HR
5' M_n 509 Mg

$$K = 849.8\ (D_n)^4 \Delta H_@\ (C_p)^2 (1-B_{ws})^2\ T_m/T_s$$
$$= 849.8\ (\quad)^4(\quad)(\quad)^2(\quad)^2 \frac{(\quad)}{(\quad)} = \underline{\text{SAME}}$$

$$V_{m(STD)} = \frac{17.64\ V_m Y \left(P_b + \Delta H/13.6\right)}{T_m}$$
$$= \frac{17.54\ (15.95)(.99871)\left(29.74 + \frac{.177}{13.6}\right)}{(534.875)} = \underline{15.63}\ \text{DSCF}$$

$$V_{wc(STD)} = 0.04707\ (H_2O_c) = 0.04707\ (39) = \underline{1.83}\ \text{SCF}$$
$$V_{wsg(STD)} = 0.04715\ (H_2O_{sg}) = 0.04715\ (2.9) = \underline{.13}\ \text{SCF}$$
$$V_{w(STD)}\ \underline{1.96}\ \text{SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(1.96)}{(1.96)+(15.63)} = \underline{.111}$$

$$M_d = 0.44\ (\%CO_2) + 0.32(\%\ O_2) + 0.28(\%CO+N_2)$$
$$= 0.44\ (\quad) + 0.32(\quad) + 0.28(\quad) = \underline{30}$$

$$M_s = M_d\ (1-B_{ws}) + 18(B_{ws}) = (30)(.89) + 18(.11) = \underline{28.68}$$

$$\bar{V}_s = 85.49\ C_p\ (\sqrt{\Delta P})\ \text{avg.} \sqrt{\frac{T_s}{P_s M_s}}$$
$$= 85.49\ (.84)(.276)\sqrt{\frac{775.375}{(29.74)(28.68)}} = \underline{15.89}\ \text{FT/SEC}$$

$$\bar{Q}_s = 63500\ \bar{V}_s\ (1-B_{ws})\ A_s\ (P_s/T_s)$$
$$= 63500\ (18.89)(.89)(11.74)\frac{(29.74)}{(775.375)} = \underline{480\text{K}}\ \text{CFH}$$

$$\%I = \frac{100 V_{m(STD)} A_s}{\theta\ \bar{Q}_s\ A_n} = \frac{100\ (15.63)(11.74)}{(1.067)(480\text{K})(.00033086)} = \underline{108.14}$$

$$C_s = \frac{M_n}{454{,}000 V_{m(STD)}} = \frac{(509)}{454{,}000\ (15.63)} = \underline{7.17 \times 10^{-5}}\ \text{LB/CF}$$

$$PMR = C_s\ \bar{Q}_s = (7.17 \times 10^{-5})(480\text{K}) = \underline{34.46}\ \text{LB/HR}$$

$$E = C_s\ F_d\ \frac{20.9}{20.9-\%O_2} = (7.17\times10^{-5})(9460)\ \frac{20.9}{20.9-(8.1)} = \underline{1.11}\ \text{LB}/10^6\ \text{BTU}$$

DATE 1-22-80

PLANT FSH · CHATTAHOOCHEE

STACK #8

RUN B10 1

FILTER 329

06	Dn		in
05	$\Delta H_@$		"H_2O
04	Cp		const.
03	Bws		fract sat.
02	Tm		°R
01	Ts		°R

18	Vm	15.95	CF
17	γ	.99871	const.
16	Pb	29.74	"Hg
15	$\overline{\Delta H}$	.177	"H_2O..
14	Tm	534.875	°R
13	H_2Oc	37.0	Ml
12	H_2Osg	2.9	G.
11	% CO_2	/	%
10	% O_2	/	%
09	% CO	/	%
08	% N_2	103.43	%
07	Cp	.84	const.
06	$(\overline{N\Delta P})$ Ave	.276	"H_2O
05	Ts	775.375	°R
04	Ps	29.74	"Hg
03	As	11.74	Ft^2
02	θ	1.067	Hr
01	An	.00033096	Ft^2

05	Mn	509	Mg
04	$\overline{Vm}$(STD)	15.646	CF
03	$\overline{Qs}$	490K	SCFH
02	Fd	9460	dscf/10^6BTU
01	%O_2	8.1	

B = Cs 7.17×10^{-5}

C = PMR 34.4

D = E

B = Vm(STD)	15.646	DSCF
C = Vw(STD)	1.97	SCF
D = Bws	.111	fract. sat.
E = Md	30.00	AMU
A' = $\underline{Ms}$	28.65	AMU
B' = $\overline{Vs}$	18.90	Ft/sec
C' = $\overline{Qs}$	490K	SCFH
D' = %I	108.34	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004
SER. NO. K=2.3
PLANT FSH
UNIT #8
DATE 1-22-80
RUN NO. B10. 2
FILTER NO. 353
NOZZLE ID. 18
d ______ IN AN ______ FT²
P_b 29.74
ΔH ______
Y ______
PITOT ID. ______
C_p ______

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-2	620.897	0.08	0.184		319	78	1	239	63
2	4		0.08	0.184		325	78	1	235	59
3	6		0.07	0.161		329	78	1	233	53
4	8		0.07	0.161		329	78	1	229	51
5	10	623.35	0.07	0.161		330	78	1	229	50
6	12		0.07	0.161		331	78	1	231	50
7	14	224.38	0.07	0.161		331	79	1	231	51
8	16		0.06	0.138		331	79	1	233	53
9	18		0.06	0.138		333	79	1	234	53
10	20		0.07	0.161		333	79	1	235	53
11	22		0.07	0.161		333	79	1	234	53
12	24	626.64	0.07	0.161		331	79	1	237	53
13	26		0.07	0.161		330	79	1	237	53
14	28		0.07	0.161		323	80	1	239	53
15	30		0.05	0.115		391	80	1	239	54
16	2	628.428	0.05	0.115		153	80	1	239	55
1	0-2		0.09	0.207		315	80	1	245	63
2	4		0.10	0.23		329	80	1	243	55
3	6		0.10	0.23		329	80	1	241	55
4	8		0.10	0.23		331	80	1	239	55
5	10	631.38	0.09	0.207		331	80	1	239	55
6	12		0.08	0.184		332	80	1	237	57
7	14		0.07	0.161		331	80	1	237	59
8	16		0.06	0.138		332	80	1	237	59
9	18		0.07	0.161		332	80	1	237	59
10	20		0.10	0.23		332	80	1.5	235	59
11	22		0.12	0.276		333	81	1.5	235	57
12	24		0.15	0.345		333	81	2	235	53
13	26	635.68	0.14	0.322		333	81	2	234	51
14	28		0.17	0.391		331	81	2	234	49
15	30		0.14	0.322		333	81	2	233	49
16	2	637.70	0.12	0.276		175	81	2	233	50

GAS ANALYSIS	%CO₂	%O₂	%CO	%N₂
		9.1		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	240	634.5
INITIAL	200	630.6
CHANGE	40	3.9

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	RLV	BK	
PITOT LINES	RLV	BK	
CONSOLE			

DATE 1-22-80
PLANT FSH-CHATT
STACK #8
RUN 8-2
FILTER 353

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION
5 $\Delta H_@$ ______
4 Cp .84
17 Y .9981
6 D_n ______ IN
1 A_n .0003408 FT²

NEW DATA
16 P_b 29.74 "Hg
18 V_M 16.8 CF
15 ΔH .20 "H_2O
14 $\bar{T}_m$ 539.6 °R
13 H_2O 40 ML
12 H_2O 3.9 g
11 CO_2 ______ %
10 O_2 9.1 %
6 $\sqrt{\Delta P}$ avg .291
5 $\bar{T}_s$ 778.25 °R
4 P_s 29.74 "Hg
3 A_s 11.74 FT²
2 θ 1.067 HR
5' M_n 432 Mg

$$K = 849.8\ (D_n)^4\ \Delta H_@\ (C_p)^2 (1-B_{ws})^2\ T_m/T_s$$

$$= 849.8\ (\quad)^4 (\quad)(\quad)^2(\quad)^2 \frac{(\quad)}{(\quad)} = \underline{\qquad}$$

$$V_{m(STD)} = \frac{17.64\ V_m\ Y \left(P_b + \Delta H/13.6\right)}{T_m}$$

$$= \frac{17.64\ (16.8)(.998)\left(29.74 + \frac{.20}{13.6}\right)}{(539.6)} = \underline{16.32}\ \text{DSCF}$$

$$Vw_{c(STD)} = 0.04707\ (H_2O_c) = 0.04707\ (40) = \underline{1.88}\ \text{SCF}$$

$$Vw_{SG(STD)} = 0.04715\ (H_2O_{SG}) = 0.04715\ (3.9) = \underline{.18}\ \text{SCF}$$

$$V_{w(STD)}\ \underline{2.06}\ \text{SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.06)}{(2.06) + (16.32)} = \underline{.112}$$

$$M_d = 0.44\ (\%CO_2) + 0.32(\%\ O_2) + 0.28(\%CO+N_2)$$
$$= 0.44\ (\quad) + 0.32(\quad) + 0.28(\quad) = \underline{30}$$

$$M_s = M_d\ (1-B_{ws}) + 18(B_{ws}) = (30)(.888 + 18(.112) = \underline{28.656}$$

$$\bar{V}_s = 35.49\ C_p\ (\sqrt{\Delta P})\text{avg}. \sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.49\ (.84)(.291)\sqrt{\frac{778.25}{(29.74)(28.65)}} = \underline{19.96}\ \text{FT/SEC}$$

$$\bar{Q}_s = 63500\ \bar{V}_s\ (1-B_{ws})\ A_s\ (P_s/T_s)$$

$$= 63500\ (19.96)(.888)(11.74)\frac{(29.74)}{(778.25)} = \underline{505K}\ \text{CFH}$$

$$\%I = \frac{100 V_{m(STD)} A_s}{\theta\ \bar{Q}_s\ A_n} = \frac{100(16.8)(11.74)}{(1.067)(505K)(.0003408)} = \underline{107.4}$$

$$C_s = \frac{M_n}{454{,}000 V_{m(STD)}} = \frac{(432)}{454{,}000(16.32)} = \underline{5.83\times10^{-5}}\ \text{LB/CF}$$

$$PMR = C_s\ \bar{Q}_s = (5.83\times10^{-5})(505K) = \underline{29.4}\ \text{LB/HR}$$

$$E = C_s\ F_d\ \frac{20.9}{20.9-\%O_2} = \overset{5.83\times10^{-5}}{(\cancel{\quad})}(9460)\ \frac{20.9}{20.9-9.1} = \underline{0.977}\ \text{LB}/10^6\text{BTU}$$

DATE 1-22-80

PLANT FSH-CHATTAHOOCHEE

STACK #8

RUN Bio 2

FILTER 353

06 Dn ______ in

05 ΔH_a ______ "H_2O

04 Cp ______ const.

03 Bws ______ fract sat.

02 Tm ______ °R

01 Ts ______ °R

13 Vm 16.8 CF

17 γ .99871 const.

16 Pb 29.74 "Hg

15 ΔH .20 "H_2O

14 Tm 539.6 °R

13 H_2Oc 40 Ml

12 H_2Osg 3.9 G.

11 % CO_2 / %

10 % O_2 / %

09 % CO / %

08 % N_2 103.47 %

07 Cp .84 const.

06 $(\overline{\sqrt{\Delta P}})$ Ave .291 "H_2O

05 Ts 778.25 °R

04 Ps 29.74 "Hg

03 As 11.74 Ft^2

02 θ 1.067 Hr

01 An .00034068 Ft^2

05 Mn 432 Mg

04 $\underline{Vm}$(STD) 16.336 CF

03 Qs 505 K SCFH

02 Fd 9460 dscf/10^6BTU

01 %O_2 9.1

B = Cs 5.82×10^{-5}

C = PMR 29.4

D = E ______

B = Vm(STD) 16.33 DSCF

C = Vw(STD) 2.06 SCF

D = Bws .112 fract. sat.

E = Md 30.00 AMU

A' = $\underline{Ms}$ 28.65 AMU

B' = $\overline{Vs}$ 19.96 Ft/sec

C' = Qs 505 K SCFH

D' = %I 104.37 % Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004
SER. NO. K= 2.2
PLANT ESH
UNIT #8
DATE 1-22-80
RUN NO. BIO. 3
FILTER.NO. 344
NOZZLE ID. 81
d ______ IN A_N ______ FT2
P_b 29.65
ΔH ______
Y ______
PITOT ID. ______
C_p ______

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-2	638.044	0.06	0.13	0.13	315	78	1	244	64
2	4		0.06	0.13	0.13	322	78	1	247	60
3	6		0.07	0.15	0.15	325	78	1	247	57
4	8		0.06	0.13	0.13	327	78	1	245	55
5	10		0.06	0.13	0.13	327	78	1	245	57
6	12		0.06	0.13	0.13	327	78	1	244	57
7	14		0.06	0.13	0.13	328	78	1	243	59
8	16		0.06	0.13	0.13	329	78	1	243	57
9	18		0.06	0.13	0.13	329	78	1	243	59
10	20		0.06	0.13	0.13	329	78	1	243	59
11	22		0.07	0.15	0.15	330	78	1	244	59
12	24		0.07	0.15	0.15	329	78	1	245	59
13	26		0.06	0.13	0.13	319	78	1	245	59
14	28		0.07	0.15	0.15	265	78	1	247	60
15	30		0.06	0.13	0.13	200	78	1	249	60
16	2		0.05	0.11	0.11	171	78	1	249	59
1	0-2		0.07	0.15	0.15	325	78	1	249	63
2	4		0.10	0.22	0.22	325	78	1	250	59
3	6		0.08	0.18	0.18	329	78	1	251	57
4	8		0.10	0.22	0.22	329	78	1	252	55
5	10		0.10	0.22	0.22	329	78	1	252	55
6	12		0.08	0.18	0.18	330	78	1	252	57
7	14		0.08	0.18	0.18	330	78	1	252	59
8	16		0.07	0.15	0.15	329	78	1	253	59
9	18		0.07	0.15	0.15	330	78	1	253	60
10	20		0.07	0.15	0.15	331	78	1	253	60
11	22		0.12	0.26	0.26	332	78	1	252	57
12	24		0.12	0.26	0.26	332	78	1	252	54
13	26		0.14	0.31	0.31	331	78	1	252	54
14	28		0.14	0.31	0.31	322	78	1	252	53
15	30		0.14	0.31	0.31	240	78	1	252	53
16	2	654.037	0.10	0.22	0.22	129	78	1	253	54

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		10.0		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	245	723.3
INITIAL	200	720.9
CHANGE	45	2.4

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	JG	JG	
PITOT LINES	JG	JG	
CONSOLE			

DATE FSH-CHATT
PLANT 1-22-80
STACK #8
RUN Bio 3
FILTER 344

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION
5 $\Delta H_@$ ______
4 Cp .84
17 γ .99871
6 D_n ______ IN
1 A_n .00034088 FT²

NEW DATA
16 P_b 29.65 "Hg
18 V_M 15.99 CF
15 ΔH .175 "H_2O
14 $\bar{T}_m$ 538 °R
13 H_2O 45 ML
12 H_2O 2.4 g
11 CO_2 ______ %
10 O_2 10 %
6 $\sqrt{\Delta P}$ avg .280
5 $\bar{T}_s$ 767.66 °R
4 P_s 29.65 "Hg
3 A_s 11.74 FT²
2 θ 1.067 HR
5' M_n 463.5 Mg

$$K = 849.8\,(D_n)^4\,\Delta H_@\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$

$$= 849.8\,(\quad)^4(\quad)(\quad)^2(\quad)^2\frac{(\quad)}{(\quad)} = \_\_\_\_$$

$$V_{m(STD)} = \frac{17.64\,V_m\,\gamma\left(P_b + \Delta H/13.6\right)}{T_m}$$

$$= \frac{17.64\,(15.99)(.9987)\left(29.65 + \frac{.175}{13.6}\right)}{(538)} = \underline{15.53}\ \text{DSCF}$$

$$V_{wc(STD)} = 0.04707\,(H_2O_c) = 0.04707\,(45) = \underline{2.11}\ \text{SCF}$$

$$V_{wsg(STD)} = 0.04715\,(H_2O_{SG}) = 0.04715\,(2.4) = \underline{.11}\ \text{SCF}$$

$$V_{w(STD)}\ \underline{2.22}\ \text{SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.22)}{(2.22)+(15.53)} = \underline{.125}$$

$$M_d = 0.44\,(\%CO_2) + 0.32\,(\%O_2) + 0.28\,(\%CO+N_2)$$

$$= 0.44\,(\quad) + 0.32\,(\quad) + 0.28\,(\quad) = \underline{30}$$

$$M_s = M_d\,(1-B_{ws}) + 18\,(B_{ws}) = (30)(.874) + 18(.125) = \underline{28.48}$$

$$\bar{V}_s = 85.49\,C_p\,(\sqrt{\Delta P})\,\text{avg.}\sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.49\,(.84)(.28)\sqrt{\frac{(767.66)}{(29.65)(28.48)}} = \underline{19.17}\ \text{FT/SEC}$$

$$\bar{Q}_s = 63500\,\bar{V}_s\,(1-B_{ws})\,A_s\,(P_s/T_s)$$

$$= 63500\,(19.17)(.874)(11.74)\frac{(29.65)}{(767.66)} = \underline{482\text{K}}\ \text{CFH}$$

$$\%I = \frac{100\,V_{m(STD)}\,A_s}{\theta\,\bar{Q}_s\,A_n} = \frac{100\,(15.53)(11.74)}{(1.067)(482\text{K})(.00034088)} = \underline{103.90}$$

$$C_s = \frac{M_n}{454{,}000\,V_{m(STD)}} = \frac{(463.5)}{454{,}000\,(15.53)} = \underline{6.57\times10^{-5}}\ \text{LB/CF}$$

$$PMR = C_s\,\bar{Q}_s = (6.57\times10^{-5})(482\text{K}) = \underline{31.66}\ \text{LB/HR}$$

$$E = C_s\,F_d\,\frac{20.9}{20.9-\%O_2} = (6.57\times10^{-5})(\quad)\,\frac{20.9}{20.9-(10)} = \underline{1.19}\ \text{LB}/10^6\,\text{BTU}$$

DATE 1-22-80

PLANT FSH-CHATTAHOOCHEE

STACK #8

RUN Bio 3

FILTER 344

06 Dn		in
05 ΔH_g		"H_2O
04 Cp		const.
03 Bws		fract. sat.
02 Tm		°R
01 Ts		°R

18 Vm	15.99	CF
17 γ	.99871	const.
16 Pb	29.65	"Hg
15 $\overline{\Delta H}$	.175	"H_2O
14 Tm	538	°R
13 H_2Oc	45	Ml
12 H_2Osg	2.4	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	107.93	%
07 Cp	.84	const.
06 $(\overline{\sqrt{\Delta P}})$ Ave	.28	"H_2O
05 Ts	767.66	°R
04 Ps	29.65	"Hg
03 As	11.74	Ft^2
02 θ	1.067	Hr
01 An	.00034088	Ft^2

05 Mn	463.5	Mg
04 Vm(STD)	15.54	CF
03 Qs	483 K	SCFH
02 Fd	9460	dscf/10^6BTU
01 %O_2	10	

B = Cs $6.57 x 10^{-5}$
C = PMR 31.7
D = E

B = Vm(STD)	15.54	DSCF
C = Vw(STD)	2.23	SCF
D = Bws	.125	fract. sat.
E = Md	30.00	AMU
A' = Ms	28.49	AMU
B' = $\overline{Vs}$	19.16	Ft/sec
C' = $\overline{Qs}$	462 K	SCFH
D' = %I	103.94	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K= 2.2

PLANT FSH UNIT #8 DATE 1-23-80

RUN NO. Bio. 4 FILTER NO. 338 NOZZLE ID. 8 d ____ IN AN .00033 FT2

P_b 29.75 ΔH ____ Y ____ PITOT ID. ____ C_p ____

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-4	654.339	0.05	0.11	0.11	311	56	1	239	39
2	8		0.07	0.15	0.15	315	57	1	230	35
3	12		0.07	0.15	0.15	315	58	1	231	35
4	16		0.06	0.13	0.13	315	58	1	245	35
5	20		0.06	0.13	0.13	315	59	1	239	35
6	24		0.05	0.11	0.11	317	60	1	248	35
7	28		0.04	0.09	0.09	317	61	1	250	37
8	2		0.04	0.09	0.09	317	61	1	253	37
9	6		0.04	0.09	0.09	319	62	1	253	37
10	10		0.06	0.13	0.13	329	61	1	252	37
11	14		0.05	0.11	0.11	329	62	1	249	39
12	18		0.04	0.09	0.09	325	63	1	244	39
13	22		0.04	0.09	0.09	319	63	1	250	39
14	26		0.04	0.09	0.09	319	63	1	255	39
15	30		0.04	0.09	0.09	283	64	1	259	39
16	4	666.43	0.04	0.09	0.09	283	64	1	259	39
1	0-4		0.06	0.13	0.13	310	65	1	259	44
2	8		0.04	0.09	0.09	317	66	1	260	40
3	12		0.05	0.11	0.11	317	66	1	257	41
4	16		0.06	0.13	0.13	319	67	1	257	40
5	20		0.05	0.11	0.11	317	66	1	255	41
6	24		0.05	0.11	0.11	317	66	1	255	41
7	28		0.04	0.09	0.09	315	67	1	254	43
8	2		0.02	0.04	0.04	315	66	1	252	45
9	6		0.03	0.07	0.07	315	65	1	249	45
10	10		0.06	0.13	0.13	317	65	1	249	44
11	14		0.06	0.13	0.13	315	65	1	247	42
12	18		0.08	0.18	0.18	315	64	1	249	41
13	22		0.10	0.22	0.22	315	64	1	249	40
14	26		0.10	0.22	0.22	312	64	1	247	40
15	30		0.10	0.22	0.22	304	63	1	245	41
16	4	681.592	0.10	0.22	0.22	285	63	1	243	40

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		8.15		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	260	639.4
INITIAL	200	634.5
CHANGE	60	4.9

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	JG	JG	
PITOT LINES	JG	JG	
CONSOLE			

DATE 1-23-80
PLANT FSH-WATT
STACK #8
RUN Bio 4
FILTER 338

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION
5 $\Delta H_@$ ______
4 Cp .84
17 γ .9987
6 D_n ______ IN
1 A_n .0003386 FT^2

NEW DATA
16 P_b 29.75 "Hg
18 V_M 27.25 CF
15 ΔH .123 "H_2O
14 $\bar{T}_m$ 522.9 °R
13 H_2O 60 ML
12 H_2O 4.9 g
11 CO_2 ~ %
10 O_2 8.15 %
6 $\sqrt{\Delta P}$ avg .23
5 $\bar{T}_s$ 773.5 °R
4 P_s 29.75 "Hg
3 A_s 11.74 FT^2
2 θ 2.13 HR
5' M_n 750 Mg

$K = 849.8\,(D_n)^4\,\Delta H_@\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$

$= 849.8\,(\quad)^4(\quad)(\quad)^2(\quad)^2\left(\frac{\quad}{(\quad)}\right) =$ ______

$V_{m(STD)} = \frac{17.64\,V_m\,\gamma\left(P_b + \Delta H/13.6\right)}{T_m}$

$= \frac{17.64\,(27.25)(.9987)\left(29.75 + \frac{.123}{13.6}\right)}{(522.9)} = 27.3$ DSCF

$V_{wc(STD)} = 0.04707\,(H_2O_C) = 0.04707\,(60) = 2.82$ SCF

$V_{wsg(STD)} = 0.04715\,(H_2O_{SG}) = 0.04715\,(4.9) = .23$ SCF

$V_{w(STD)}$ 3.05 SCF

$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(3.05)}{(3.05)+(27.3)} = .100$

$M_d = 0.44\,(\%CO_2) + 0.32\,(\%\,O_2) + 0.28\,(\%CO+N_2)$
$= 0.44\,(\quad) + 0.32\,(\quad) + 0.28\,(\quad) = 30$

$M_s = M_d\,(1-B_{ws}) + 18\,(B_{ws}) = (30)(.900) + 18\,(.100) = 28.79$

$\bar{V}_s = 85.49\,C_p\,(\sqrt{\Delta P})_{avg.}\sqrt{\frac{T_s}{P_s M_s}}$

$= 85.49\,(.84)(.23)\sqrt{\frac{(773.5)}{(29.75)(28.79)}} = 15.69$ FT/SEC

$\bar{Q}_s = 63500\,\bar{V}_s\,(1-B_{ws})\,A_s\,(P_s/T_s)$

$= 63500\,(15.69)(.900)(11.74)\frac{(29.75)}{(773.5)} = 404K$ CFH

$\%I = \frac{100\,V_{m(STD)}\,A_s}{\theta\,\bar{Q}_s\,A_n} = \frac{100\,(27.3)(11.74)}{(2.13)(404K)(.0003386)} = 112.3$

$C_s = \frac{M_n}{454{,}000\,V_{m(STD)}} = \frac{(750)}{454{,}000\,(27.3)} = 605\times10^{-5}$ LB/CF

$PMR = C_s\,\bar{Q}_s = (605\times10^{-5})(404K) = 24.4$ LB/HR

$E = C_s\,F_d\,\frac{20.9}{20.9-\%O_2} = (605\times10^{-5})(9460)\,\frac{20.9}{20.9-(8.15)} = .938$ LB/10^6BTU

DATE 1-23-80

PLANT FSH-CHATTAHoochee

STACK #8

RUN Bi04

FILTER 338

06 Dn		in
05 ΔH@		"H_2O
04 Cp		const.
03 Bws		fract sat.
02 Tm		°R
01 Ts		°R

13 Vm	27.25	CF
17 γ	.9987	const.
16 Pb	29.75	"Hg
15 ΔH	.123	"H_2O..
14 Tm	543.9	°R
13 H_2Oc	60	Ml
12 H_2Osg	4.9	G.
11 % CO_2	/	%
10 % O_2	/	%
09 % CO	/	%
08 % N_2	103.43	%
07 Cp	.84	const.
06 $(\overline{\sqrt{\Delta P}})$ Ave	.23	"H_2O
05 Ts	775.5	°R
04 Ps	29.15	"Hg
03 As	11.74	Ft^2
02 Θ	2.13	Hr
01 An	.00033086	Ft^2

05 Mn	750	Mg
04 Vm(STD)	27.34	CF
03 Qs	405K	SCFH
02 Fd	9460	dscf/10^6BTU
01 %O_2	8.15	

B = Cs 6.04×10^{-5}

C = PMR 24.5

D = E

B = Vm(STD)	27.34	DSCF
C = Vw(STD)	3.05	SCF
D = Bws	.100	fract. sat.
E = Md	30.00	AMU
A' = Ms	28.79	AMU
B' = Vs	15.69	Ft/sec
C' = Qs	408K	SCFH
D' = %I	112.48	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K = 2.2

PLANT FSH UNIT #8 DATE 1-23-80

RUN NO. Bio. 5 FILTER NO. 340 NOZZLE ID. 81 d ____ IN A_N ____ FT2

P_b 29.79 ΔH ____ Y ____ PITOT ID. ____ C_p ____

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-4	681.778	0.06	0.132		309	64	1	200	55
2	8		0.07	0.154		311	64	1	215	55
3	12		0.09	0.198		313	63	1	223	53
4	16		0.08	0.176		313	63	1	232	53
5	20		0.08	0.176		313	63	1	235	53
6	24		0.14	0.308		333	62	1	235	51
7	28		0.15	0.33		341	62	1.5	237	51
8	2		0.15	0.33		347	62	1.5	235	51
9	6		0.07	0.154		339	62	1	234	53
10	10		0.09	0.198		335	62	1.5	235	53
11	14		0.09	0.198		333	62	1.5	233	53
12	18		0.09	0.198		327	62	1.5	237	53
13	22		0.09	0.198		323	62	1.5	234	53
14	26		0.09	0.198		311	62	1.5	237	53
15	30		0.08	0.176		329	62	1.5	239	53
16	4	698.672	0.08	0.176		175	62	1.5	237	53
1	0-4		0.13	0.286		320	60	2	235	53
2	8		0.13	0.286		321	60	2	243	53
3	12		0.11	0.242		321	60	2	244	53
4	16		0.10	0.22		321	60	2	241	51
5	20		0.10	0.22		321	60	2	239	51
6	24		0.09	0.198		321	60	2	235	51
7	28		0.09	0.198		321	60	2	234	53
8	2		0.07	0.154		320	60	2	233	53
9	6		0.06	0.132		320	60	2	232	53
10	10		0.07	0.154		317	61	2	233	53
11	14		0.08	0.176		319	62	2	234	54
12	18		0.11	0.242		319	63	2	233	53
13	22		0.11	0.242		317	63	2	239	53
14	26		0.12	0.264		315	63	2	245	54
15	30		0.12	0.264		259	64	2	249	55
16	4	715.778	0.07	0.154		119	64	2	245	53

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		8.9		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	255	729.1
INITIAL	200	723.3
CHANGE	55	5.8

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	BK	BK	
PITOT LINES	BK	BK	
CONSOLE			

DATE 1-23-80
PLANT PS H-CHATT
STACK #8
RUN No 5
FILTER 340

From Previous Run Data

$(1-B_{ws})$ ______

1 $\bar{T}_s$ ______ °R

2 $\bar{T}_m$ ______ °R

CALIBRATION

5 $\Delta H_@$ ______

4 C_p .84

17 Y .9987

6 D_n ______ IN

1 A_n .00034086 FT^2

NEW DATA

16 P_b 29.79 "Hg

18 V_M 34.0 CF

15 ΔH .209 "H_2O

14 $\bar{T}_m$ 521.8 °R

13 H_2O 55 ML

12 H_2O 5.8 g

11 CO_2 ~ %

10 O_2 8.9 %

6 $\sqrt{\Delta P}$ avg .306

5 $\bar{T}_s$ 769.4 °R

4 P_s 29.79 "Hg

3 A_s 11.74 FT^2

2 θ 2.13 HR

5' M_n 901 Mg

$K = 849.8\,(D_n)^4\,\Delta H_@\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$

$= 849.8\ (\ \ )^4(\ \ )(\ \ )^2(\ \ )^2\ \frac{(\ \ )}{(\ \ )} =$ ______

$$V_{m(STD)} = \frac{17.64\ V_m\,Y\left(P_b + \Delta H/13.6\right)}{T_m}$$

$$= \frac{17.64\ (34.0)(.9987)\left(29.79\ \frac{.209}{13.6}\right)}{(521.8)} = \underline{34.21}\ \text{DSCF}$$

$V_{wc(STD)} = 0.04707\ (H_2O_c) = 0.04707\ (55) = \underline{2.589}$ SCF

$V_{wsg(STD)} = 0.04715\ (H_2O_{sg}) = 0.04715\ (5.8) = \underline{.273}$ SCF

$V_{w(STD)}$ $\underline{2.862}$ SCF

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.86)}{(2.86)+(34.21)} = \underline{.077}$$

$M_d = 0.44\ (\%CO_2) + 0.32(\%\ O_2) + 0.28(\%CO+N_2)$
$= 0.44\ (\ \ ) + 0.32(\ \ ) + 0.28(\ \ ) = \underline{30}$

$M_s = M_d\ (1-B_{ws}) + 18(B_{ws}) = (30)(.923)+18(.077) = \underline{29.07}$

$$\bar{V}_s = 85.49\ C_p\ (\sqrt{\Delta P})\,\text{avg.}\sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.49\ (.84)(.306)\sqrt{\frac{(769.4)}{(29.79)(29.07)}} = \underline{20.71}\ \text{FT/SEC}$$

$$\bar{Q}_s = 63500\ \bar{V}_s\ (1-B_{ws})\ A_s\ (P_s/T_s)$$

$$= 63500\ (20.71)(.923)(11.74)\frac{(29.79)}{(769.4)} = \underline{552K}\ \text{CFH}$$

$$\%I = \frac{100 V_{m(STD)} A_s}{\theta\ \bar{Q}_s\ A_n} = \frac{100(34.21)(11.74)}{(2.13)(552K)(.00034086)} = \underline{100.2}$$

$$C_s = \frac{M_n}{454{,}000 V_{m(STD)}} = \frac{(901)}{454{,}000(34.21)} = \underline{5.80\times10^{-5}}\ \text{LB/CF}$$

$$PMR = C_s\ \bar{Q}_s = (5.80\times10^{-5})(552K) = \underline{32.0}\ \text{LB/HR}$$

$$E = C_s\ F_d\ \frac{20.9}{20.9-\%O_2} = (5.80\times10^{-5})(9460)\ \frac{20.9}{20.9-8.9} = \underline{0.956}\ \text{LB}/10^6\text{BTU}$$

DATE 1-23-80

PLANT FSH-CHATTAHOOCAEE

STACK #8

RUN Bio5

FILTER 340

06 D_n		in
05 ΔH_a		"H_2O
04 C_p		const.
03 B_{ws}		fract sat.
02 T_m		^oR
01 T_s		^oR

18 V_m	34.0	CF
17 γ	.9987	const.
16 P_b	29.79	"Hg
15 ΔH	.209	"H_2O
14 T_m	521.8	^oR
13 H_2Oc	55	Ml
12 H_2Osg	5.8	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	103.43	%
07 C_p	.84	const.
06 $(\sqrt{\Delta P})$ Ave	.306	"H_2O
05 T_s	769.4	^oR
04 P_s	29.79	"Hg
03 A_s	11.70	Ft^2
02 θ	2.13	Hr
01 A_n	.00034085	Ft^2

05 M_n	901	Mg
04 V_m(STD)	34.23	CF
03 Q_s	552K	SCFH
02 F_d	9460	dscf/10^6BTU
01 %O_2	8.9	

B = Cs 5.80×10^{-5}

C = PMR 32.0

D = E

B = V_m(STD)	34.23	DSCF
C = V_w(STD)	2.86	SCF
D = B_{ws}	.077	fract. sat.
E = M_d	30.00	AMU
A' = M_s	29.07	AMU
B' = V_s	20.70	Ft/sec
C' = Q_s	552K	SCFH
D' = %I	100.29	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K= 2.2

PLANT FSH UNIT #8 DATE 1-23-80

RUN NO. Bio. 6 FILTER.NO. 345 NOZZLE ID. 181 d ______ IN A_N ______ FT2

P_b 29.81 ΔH ______ Y ______ PITOT ID. ______ C_p ______

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-4	715.83	0.05	0.11	0.11	312	62	1	259	42
2	8		0.06	0.13	0.13	313	62	1	249	38
3	12		0.06	0.13	0.13	314	62	1	245	38
4	16		0.07	0.15	0.15	315	61	1	249	39
5	20		0.07	0.15	0.15	315	61	1	251	38
6	24		0.08	0.18	0.18	317	61	1	253	38
7	28		0.07	0.15	0.15	317	60	1	253	37
8	2		0.06	0.13	0.13	318	60	1	253	38
9	6		0.06	0.13	0.13	319	61	1	253	38
10	10		0.07	0.15	0.15	319	61	1	260	38
11	14		0.07	0.15	0.15	318	60	1	261	38
12	18		0.08	0.18	0.18	317	60	1	265	38
13	22		0.06	0.13	0.13	316	60	1	268	38
14	26		0.07	0.15	0.15	308	60	1	272	38
15	30		0.06	0.13	0.13	287	60	1	269	38
16	4		0.05	0.11	0.11	236	60	1	266	40
1	0-4		0.08	0.18	0.18	295	59	1	262	41
2	8		0.08	0.18	0.18	313	58	1	261	39
3	12		0.10	0.22	0.22	316	58	2	260	38
4	16		0.10	0.22	0.22	316	58	2	260	40
5	20		0.10	0.22	0.22	317	58	2	259	40
6	24		0.10	0.22	0.22	317	58	2	260	41
7	28		0.09	0.20	0.20	317	57	2	259	41
8	2		0.08	0.18	0.18	317	57	2	259	41
9	6		0.10	0.22	0.22	318	57	2	259	42
10	10		0.11	0.24	0.24	318	57	2	259	42
11	14		0.14	0.31	0.31	318	57	2.5	259	42
12	18		0.16	0.35	0.35	318	57	3	258	42
13	22		0.17	0.37	0.37	316	57	3	257	42
14	26		0.17	0.37	0.37	309	57	3	256	43
15	30		0.17	0.37	0.37	246	57	3	256	43
16	4	748.54	0.16	0.35	0.35	246	57	3	256	43

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		10.0		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	275	644.7
INITIAL	200	639.4
CHANGE	75	5.3

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	DGK	DGK	
PITOT LINES	DGK	DGK	
CONSOLE			

DATE 1-23-80
PLANT FSH
STACK #8
RUN 8106
FILTER 345

From Previous Run Data
$(1-B_{ws})$ ____
1 $\bar{T}_s$ ____ °R
2 $\bar{T}_m$ ____ °R

CALIBRATION
5 ΔH_a 0.201
4 Cp 0.84
17 γ 0.9987
6 D_n ____ IN
1 A_n .000332 FT²

NEW DATA
16 P_b 29.81 "Hg
18 V_M 32.71 CF
15 ΔH .201 "H_2O
14 $\bar{T}_m$ 519.0 °R
13 H_2O 75 ML
12 H_2O 5.3 g
11 CO_2 ____ %
10 O_2 10 %
6 $\sqrt{\Delta P}$ avg .298
5 $\bar{T}_s$ 767.43 °R
4 P_s 29.81 "Hg
3 A_s 11.74 FT²
2 θ 2.13 HR
5' M_n 917.6 Mg

$$K = 849.8\,(D_n)^4 \Delta H_a\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$

$$= 349.8\,(\quad)^4(\quad)(\quad)^2(\quad)^2\frac{(\quad)}{(\quad)} = \_\_\_\_$$

$$V_m(STD) = \frac{17.64\,V_m\,\gamma\left(P_b + \Delta H/13.6\right)}{T_m}$$

$$= \frac{17.64\,(32.71)(.9987)\left(29.81 + \frac{.201}{13.6}\right)}{(519.0)} = 33.11\text{ DSCF}$$

$$V_{wc}(STD) = 0.04707\,(H_2O_c) = 0.04707\,(75) = 3.53\text{ SCF}$$

$$V_{wSG}(STD) = 0.04715\,(H_2O_{SG}) = 0.04715\,(5.3) = .25\text{ SCF}$$

$$V_w(STD)\ 3.78\text{ SCF}$$

$$B_{ws} = \frac{V_w(STD)}{V_w(STD) + V_m(STD)} = \frac{(3.78)}{(3.78)+(33.11)} = .102$$

$$M_d = 0.44\,(\%CO_2) + 0.32(\%O_2) + 0.28(\%CO+N_2)$$

$$= 0.44\,(\quad) + 0.32(\quad) + 0.28(\quad) = 30$$

$$M_s = M_d\,(1-B_{ws}) + 18(B_{ws}) = (30)(.898) + 18(.102) = 28.77$$

$$\bar{V}_s = 35.49\,C_p\,(\sqrt{\Delta P})\text{avg}.\sqrt{\frac{T_s}{P_s M_s}}$$

$$= 85.49\,(.84)(.298)\sqrt{\frac{(767.43)}{(29.81)(28.77)}} = 20.24\text{ FT/SEC}$$

$$\bar{Q}_s = 63500\,\bar{V}_s\,(1-B_{ws})\,A_s\,(P_s/T_s)$$

$$= 63500\,(20.24)(.898)(11.74)\frac{(29.81)}{(767.43)} = 526K\text{ CFH}$$

$$\%I = \frac{100\,V_m(STD)\,A_s}{\theta\,\bar{Q}_s\,A_n} = \frac{100(33.11)(11.74)}{(2.13)(526K)(.000332)} = 104.2$$

$$C_s = \frac{M_n}{454{,}000\,V_m(STD)} = \frac{(917.6)}{454{,}000(33.11)} = 6.10\times10^{-5}\text{ LB/CF}$$

$$PMR = C_s\,\bar{Q}_s = (6\times10^{-5})(526K) = 32.13\text{ LB/HR}$$

$$E = C_s\,F_d\,\frac{20.9}{20.9-\%O_2} = (6\times10^{-5})(9460)\frac{20.9}{20.9-(10)} = 1.11\text{ LB}/10^6\text{BTU}$$

DATE 1-23-80

PLANT FSH-CHATTAHOOCHEE

STACK #8

RUN Bio 6

FILTER 345

06 Dn		in
05 ΔH_a		"H_2O
04 Cp		const.
03 Bws		fract sat.
02 Tm		°R
01 Ts		°R

18 Vm	32.71	CF
17 γ	.9987	const.
16 Pb	29.81	"Hg
15 ΔH	.201	"H_2O
14 Tm	519.0	°R
13 H_2Oc	75	Ml
12 H_2Osg	5.3	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	102.43	%
07 $\overline{Cp}$	.84	const.
06 $(\overline{\sqrt{\Delta P}})$ Ave	.298	"H_2O
05 Ts	767.43	°R
04 Ps	29.81	"Hg
03 As	11.74	Ft^2
02 θ	2.13	Hr
01 An	.00033275	Ft^2

05 Mn	917.6	Mg
04 $\underline{Vm}$(STD)	33.13	CF
03 Qs	526 K	SCFH
02 Fd	9460	dscf/10^6BTU
01 %O_2	10	

B = Cs 6.10×10^{-5}

C = PMR 32.1

D = E 1.11

B = Vm(STD)	33.13	DSCF
C = Vw(STD)	3.78	SCF
D = Bws	.102	fract. sat.
E = Md	30.00	AMU
A' = $\underline{Ms}$	28.77	AMU
B' = $\underline{Vs}$	20.24	Ft/sec
C' = Qs	526K	SCFH
D' = %I	104.37	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K= 2.4

PLANT FSH UNIT #8 DATE 1-25-80

RUN NO. C/W #1 FILTER.NO. 351 NOZZLE ID. 181 d ____ IN AN ____ FT2

P_b 29.88 ΔH ____ Y ____ PITOT ID. ____ C_p ____

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-4	535.04	0.10	0.24	0.24	315	67	1	255	58
2	8		0.08	0.19	0.19	324	67	1	255	56
3	12		0.08	0.17	0.19	322	68	1	255	56
4	16		0.08	0.19	0.19	320	68	1	255	56
5	20		0.08	0.19	0.19	319	69	1	255	56
6	24		0.08	0.19	0.19	317	70	1	255	56
7	28		0.08	0.19	0.19	315	70	1	255	56
8	2		0.08	0.19	0.19	315	71	1	255	56
9	6		0.08	0.19	0.19	315	72	1	255	57
10	10		0.08	0.19	0.19	315	72	1	255	57
11	14		0.08	0.19	0.19	315	72	1	255	57
12	18		0.09	0.22	0.22	315	73	1	255	57
13	22		0.09	0.22	0.22	313	73	1	255	57
14	26		0.09	0.22	0.22	311	73	1	255	57
15	30		0.08	0.19	0.19	303	73	1	255	57
16	4	551.00	0.07	0.17	0.17	259	73	1	255	57
1	0-4		0.11	0.26	0.26	309	73	1	252	58
2	8		0.14	0.34	0.34	312	73	1	252	58
3	12		0.12	0.29	0.29	313	73	1	255	55
4	16		0.11	0.26	0.26	314	73	1	255	55
5	20		0.11	0.26	0.26	314	73	1	255	55
6	24		0.10	0.24	0.24	314	73	1	255	57
7	28		0.10	0.24	0.24	314	73	1	255	57
8	2		0.07	0.17	0.17	314	73	1	255	57
9	6		0.07	0.17	0.17	314	73	1	255	58
10	10		0.10	0.24	0.24	314	73	1	255	58
11	14		0.14	0.34	0.34	315	74	1	255	58
12	18		0.16	0.38	0.38	314	75	1	255	58
13	22		0.18	0.43	0.43	314	75	1	255	58
14	26		0.20	0.48	0.48	313	76	1	255	58
15	30		0.17	0.41	0.41	295	76	1	255	58
16	4	569.60	0.14	0.34	0.34	259	76	1	255	58

GAS ANALYSIS	$\%CO_2$	$\%O_2$	%CO	$\%N_2$
		10.1		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	243	578.0
INITIAL	200	571.8
CHANGE	43	6.2

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	OPH		
PITOT LINES	BK		
CONSOLE			

DATE 1-25-80
PLANT FSA-CHAT
STACK #8
RUN Coal/wood 1
FILTER 357

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION
5 $\Delta H_@$ ______
4 C_p .84
17 Υ 1.013
6 D_n ______ IN
1 A_n .00033275 FT²

NEW DATA
16 P_b 29.88 "Hg
18 V_M 34.56 CF
15 $\overline{\Delta H}$ .250 "H₂O
14 $\bar{T}_m$ 532.3 °R
13 H_2O 43 ML
12 H_2O 6.2 g
11 CO_2 ______ %
10 O_2 10.1 %
6 $\sqrt{\Delta P}$ avg 0.32
5 $\bar{T}_s$ 770.5 °R
4 P_s 29.88 "Hg
3 A_s 11.74 FT²
2 θ 2.13 HR
5' M_n 2304 MG

$$K = 349.8\,(D_n)^4\,\Delta H_@\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$
$$= 349.8\ (\quad)^4(\quad)(\quad)^2(\quad)^2\,\frac{(\quad)}{(\quad)} = \_\_\_\_$$

$$V_{m(STD)} = \frac{17.64\ V_m\,\Upsilon\left(P_b + \Delta H/13.6\right)}{T_m}$$
$$= \frac{17.64\ (34.56)(1.013)\left(29.88 + \frac{.25}{13.6}\right)}{(532.3)} = 34.68 \text{ DSCF}$$

$$V_{wc(STD)} = 0.04707\ (H_2O_c) = 0.04707\ (43) = 2.02 \text{ SCF}$$
$$V_{wSG(STD)} = 0.04715\ (H_2O_{SG}) = 0.04715\ (6.2) = .29 \text{ SCF}$$
$$V_{w(STD)}\ 2.31 \text{ SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.31)}{(2.31) + (34.68)} = .062$$

$$M_d = 0.44\ (\%CO_2) + 0.32(\%\ O_2) + 0.28(\%CO+N_2)$$
$$= 0.44\ (\quad) + 0.32(\quad) + 0.28(\quad) = 30$$

$$M_s = M_d\ (1-B_{ws}) + 18(B_{ws}) = (30)(.938) + 18(.062) = 29.25$$

$$\bar{V}_s = 85.49\ C_p\ (\sqrt{\Delta P})\text{avg.}\sqrt{\frac{T_s}{P_s M_s}}$$
$$= 85.49\ (.84)(.32)\sqrt{\frac{(770.5)}{(29.88)(29.25)}} = 21.57 \text{ FT/SEC}$$

$$\bar{Q}_s = 63500\ \bar{V}_s\ (1-B_{ws})\ A_s\ (P_s/T_s)$$
$$= 63500\ (21.57)(.938)(11.74)\frac{(29.88)}{(770.5)} = 584K \text{ CFH}$$

$$\%I = \frac{100 V_{m(STD)} A_s}{\theta\ \bar{Q}_s\ A_n} = \frac{100(34.68)(11.74)}{(2.13)(584)(.00033275)} = 98.2$$

$$C_s = \frac{M_n}{454{,}000 V_{m(STD)}} = \frac{(2304)}{454{,}000(34.68)} = 1.46\times10^{-4} \text{ LB/CF}$$

$$PMR = C_s\ \bar{Q}_s = (1.46\times10^{-4})(584K) = 85.53 \text{ LB/HR}$$

$$E = C_s\ F_d\ \frac{20.9}{20.9-\%O_2} = (1.46\times10^{-4})(9460)\ \frac{20.9}{20.9-10.1} = 2.79 \text{ LB}/10^6\text{BTU}$$

DATE 1-25-80

PLANT CHATTAHOOCHEE

STACK #8

RUN COAL/WOOD 1

FILTER 351

06 Dn		in
05 ΔH_{a}		"H_2O
04 Cp		const.
03 Bws		fract. sat.
02 Tm		°R
01 Ts		°R

18 Vm	34.56	CF
17 γ	1.013	const.
16 Pb	29.88	"Hg
15 ΔH	.25	"H_2O..
14 Tm	532.7	°R
13 H_2Oc	43	Ml
12 H_2Osg	6.2	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	103.43	%
07 Cp	.84	const.
06 $(\sqrt{\Delta P})$ Ave	.32	"H_2O
05 Ts	770.5	°R
04 Ps	29.88	"Hg
03 As	11.74	Ft²
02 θ	2.13	Hr
01 An	.00033275	Ft²

05 Mn	2304	Mg
04 Vm(STD)	34.70	CF
03 Qs	584 K	SCFH
02 Fd	9889	dscf/10^6BTU
01 %O_2	10.1	

B = Cs 1.46×10^{-4}

C = PMR 85.53

D = E 2.79

B = Vm(STD)	34.70	DSCF
C = Vw(STD)	2.31	SCF
D = Bws	.062	fract. sat.
E = Md	30.00	AMU
A' = Ms	29.24	AMU
B' = Vs	21.57	Ft/sec
C' = Qs	584K	SCFH
D' = %I	98.13	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004

SER. NO. K=2.2

PLANT FSH

UNIT #8

DATE 1-25-80

RUN NO. C/W #2

FILTER NO. 245

NOZZLE ID. 8

d ______ IN

A_N .00033 FT2

P_b 29.88

ΔH ______

Y ______

PITOT ID. ______

C_p ______

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-4	784.582	0.19	0.418		215	66	1	250	51
2	8		0.18	0.396		299	67	1	246	47
3	12		0.22	0.484		319	68	1	249	47
4	16		0.20	0.44		315	69	1	247	49
5	20		0.17	0.374		319	70	1	245	50
6	24		0.14	0.308		319	70	1	245	51
7	28		0.13	0.286		317	71	1	244	51
8	2		0.09	0.198		315	71	1	244	50
9	6		0.07	0.154		314	71	1	244	53
10	10		0.09	0.198		314	72	1	244	53
11	14		0.10	0.22		313	72	1	244	52
12	18		0.12	0.264		313	72	1	244	53
13	22		0.13	0.286		313	73	1	243	53
14	26		0.13	0.286		313	73	1	244	53
15	30		0.13	0.286		313	73	1	244	53
16	4	805.208	0.13	0.286		311	73	1	244	53
1	0-4		0.06	0.132		229	72	1	244	63
2	8		0.07	0.154		279	72	1	244	57
3	12		0.09	0.198		302	72	1	244	57
4	16		0.09	0.198		304	72	1	244	57
5	20		0.09	0.198		313	72	1	244	55
6	24		0.09	0.198		313	72	1	244	55
7	28		0.09	0.198		313	72	1	244	55
8	2		0.08	0.176		313	73	1	244	55
9	6		0.08	0.176		313	73	1	244	55
10	10		0.09	0.198		314	73	1	243	55
11	14		0.08	0.176		313	74	1	244	55
12	18		0.08	0.176		313	74	1	244	55
13	22		0.08	0.176		311	74	1	244	57
14	26		0.09	0.198		311	75	1	244	55
15	30		0.09	0.198		310	75	1	245	55
16	4	821.595	0.09	0.198		309	75	1	244	55

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		9.8		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	245	615.2
INITIAL	200	608.5
CHANGE	45	6.7

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	BK	BK	
PITOT LINES	BK	BK	
CONSOLE			

DATE 1-25-80
PLANT FS H-CHATT
STACK #8
RUN Coal/wood 2
FILTER 245

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION
5 $\Delta H_@$ ______
4 C_p .84
17 Y .9987
6 D_n ______ IN
1 A_n .0003386 FT²

NEW DATA
16 P_b 29.88 "Hg
18 V_M 37.01 CF
15 $\overline{\Delta H}$ .245 "H_2O
14 $\bar{T}_m$ 531.9 °R
13 H_2O 45 ML
12 H_2O 6.7 g
11 CO_2 ~ %
10 O_2 9.8 %
6 $\sqrt{\Delta P}$ avg .329
5 $\bar{T}_s$ 765.7 °R
4 P_s 29.88 "Hg
3 A_s 11.74 FT²
2 θ 2.13 HR
5' M_n 2484 Mg

$$K = 849.8\,(D_n)^4\,\Delta H_@\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$
$$= 849.8\;(\quad)^4(\quad)(\quad)^2(\quad)^2\,\frac{(\quad)}{(\quad)} = \underline{\qquad}$$

$$V_{m(STD)} = \frac{17.64\,V_m\,Y\left(P_b + \overline{\Delta H}/13.6\right)}{T_m}$$
$$= \frac{17.64\,(37.01)(.9987)\left(29.88 + \frac{.245}{13.6}\right)}{(531.9)} = \underline{36.64}\text{ DSCF}$$

$$V_{wc(STD)} = 0.04707\,(H_2O_c) = 0.04707\,(45) = \underline{2.11}\text{ SCF}$$
$$V_{wSG(STD)} = 0.04715\,(H_2O_{SG}) = 0.04715\,(67) = \underline{.31}\text{ SCF}$$
$$V_{w(STD)}\;\underline{2.42}\text{ SCF}$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.42)}{(2.42)+(36.64)} = \underline{.061}$$

$$M_d = 0.44\,(\%CO_2) + 0.32(\%\,O_2) + 0.28(\%CO+N_2)$$
$$= 0.44\,(\quad) + 0.32(\quad) + 0.28(\quad) = \underline{30}$$

$$M_s = M_d\,(1-B_{ws}) + 18(B_{ws}) = (30)(.939)+18(.061) = \underline{29.26}$$

$$\bar{V}_s = 85.49\,C_p\,(\sqrt{\Delta P})\,avg.\sqrt{\frac{T_s}{P_s M_s}}$$
$$= 85.49\,(.84)(.329)\sqrt{\frac{(765.7)}{(29.88)(29.26)}} = \underline{28.11}\text{ FT/SEC}$$

$$\bar{Q}_s = 63500\,\bar{V}_s\,(1-B_{ws})\,A_s\,(P_s/T_s)$$
$$= 63500\,(28.11)(.939)(11.74)\frac{(29.88)}{(765.7)} = \underline{603K}\text{ CFH}$$

$$\%I = \frac{100\,V_{m(STD)}\,A_s}{\theta\,\bar{Q}_s\,A_n} = \frac{100\,(36.64)(11.74)}{(2.13)(603K)(.0003386)} = \underline{101.07}$$

$$C_s = \frac{M_n}{454{,}000\,V_{m(STD)}} = \frac{(2484)}{454{,}000\,(36.64)} = \underline{1.49\times10^{-4}}\text{ LB/CF}$$

$$PMR = C_s\,\bar{Q}_s = (1.49\times10^{-4})(603K) = \underline{89.94}\text{ LB/HR}$$

$$E = C_s\,F_d\,\frac{20.9}{20.9-\%O_2} = (1.49\times10^{-4})(9885)\left(\frac{20.9}{20.9-9.8}\right) = \underline{2.77}\text{ LB}/10^6\text{ BTU}$$

DATE 1-25-80

PLANT CHATTAHOOCHEE

STACK #8

RUN COAL/WOOD 2

FILTER 245

06	Dn		in
05	ΔH_a		"H_2O
04	Cp		const.
03	Bws		fract sat.
02	Tm		°R
01	Ts		°R

18	Vm	37.01	CF
17	γ	.9987	const.
16	Pb	29.88	"Hg
15	ΔH	.245	"H_2O..
14	Tm	531.9	°R
13	H_2Oc	45	Ml
12	H_2Osg	6.7	G.
11	% CO_2	1	%
10	% O_2	1	%
09	% CO	1	%
08	% N_2	103.43	%
07	Cp	.84	const.
06	($\overline{\sqrt{\Delta P}}$) Ave	.329	"H_2O
05	Ts	765.7	°R
04	Ps	29.88	"Hg
03	As	11.79	Ft^2
02	θ	2.13	Hr
01	An	.00033096	Ft^2

05	Mn	24.84	Mg
04	Vm(STD)	36.66	CF
03	Qs	603K	SCFH
02	Fd	9885	dscf/10^6BTU
01	%O_2	9.8	

B = Cs 1.49×10^{-4}

C = PMR 90.06

D = E 2.77

B = Vm(STD)	36.66	DSCF
C = Vw(STD)	2.43	SCF
D = Bws	.062	fract. sat.
E = Md	30.00	AMU
A' = Ms	29.25	AMU
B' = Vs	22.11	Ft/sec
C' = Qs	603 K	SCFH
D' = %I	101.07	% Iso

STACK DATA SHEET

NEDS NO. 10-1400-049-0004 SER. NO. K= 2.4

PLANT FSH UNIT #8 DATE 1-25-80

RUN NO. C/W #3 FILTER NO. 349 NOZZLE ID. 81 d ____ IN A_N ____ FT^2

P_b 29.80 ΔH ____ Y ____ PITOT ID. ____ C_p ____

PT.	TIME	V_m	ΔP	ΔH Desired	ΔH Actual	T_s	T_m	Pump Vac.	Filter T	Impinger T
1	0-4	570.164	0.11	0.264		314	70	1	252	53
2	8		0.09	0.216		315	70	1	252	53
3	12		0.08	0.192		317	71	1	252	57
4	16		0.08	0.192		319	71	1	252	57
5	20		0.10	0.24		319	71	1	252	57
6	24		0.08	0.192		319	72	1	255	57
7	28		0.07	0.168		319	73	1	268	57
8	2		0.06	0.144		319	73	1	265	58
9	6		0.04	0.096		319	74	1	257	57
10	10		0.08	0.192		319	74	1	245	61
11	14		0.11	0.264		322	74	1	245	59
12	18		0.16	0.384		322	74	1	245	58
13	22		0.17	0.408		322	74	1	245	58
14	26		0.19	0.456		331	75	1.5	250	54
15	30		0.20	0.48		300	75	1.5	250	54
16	4	588.66	0.25	0.60		279	75	2	253	57
1	0-4		0.14	0.336		317	74	1.5	253	57
2	8		0.12	0.288		320	74	1.5	253	57
3	12		0.10	0.24		321	74	1.5	253	57
4	16		0.12	0.288		322	74	1.5	253	57
5	20		0.08	0.192		322	74	1.5	253	57
6	24		0.09	0.216		322	74	1.5	253	57
7	28		0.08	0.192		322	74	1.5	253	57
8	2		0.11	0.264		326	74	1.5	253	57
9	6		0.09	0.216		328	74	1.5	253	57
10	10		0.08	0.192		329	74	1.5	253	57
11	14		0.10	0.24		329	74	1.5	253	57
12	18		0.12	0.288		328	74	1.5	253	57
13	22		0.12	0.288		327	74	1.5	253	57
14	26		0.08	0.192		322	74	1.5	253	57
15	30		0.11	0.264		313	74	1.5	253	57
16	4	606.49	0.11	0.264		308	74	1.5	253	57

GAS ANALYSIS	%CO_2	%O_2	%CO	%N_2
		10.9		
AVG.				
COLL. RATE				

CONDENSATE	IMPINGER-ML	DESS-GRAMS
FINAL	240	591.4
INITIAL	200	583.4
CHANGE	40	8.0

LEAK RATE	INITIAL	FINAL	OTHERS
TRAIN	OK	OK	
PITOT LINES	OK	OK	
CONSOLE			

DATE 1-25-80
PLANT FSU-CHART
STACK #8
RUN WOOD/COAL #3
FILTER 349

From Previous Run Data
$(1-B_{ws})$ ______
1 $\bar{T}_s$ ______ °R
2 $\bar{T}_m$ ______ °R

CALIBRATION
5 ΔH_a ______
4 C_p .84
17 Y 1.013
6 D_n ______ IN
1 A_n .00034088 FT^2

NEW DATA
16 P_b 29.8 "Hg
18 V_M 36.30 CF
15 ΔH .264 "H_2O
14 $\bar{T}_m$ 533.44 °R
13 H_2O 40 ML
12 H_2O 6 g
11 CO_2 – %
10 O_2 10.9 %
6 $\sqrt{\Delta P}$ avg .326
5 $\bar{T}_s$ 778.78 °R
4 P_s 29.8 "Hg
3 A_s 11.74 FT^2
2 θ 2.13 HR
5' M_n 2214 Mg

$$K = 849.8\,(D_n)^4\,\Delta H_a\,(C_p)^2(1-B_{ws})^2\,T_m/T_s$$
$$= 849.8\ (\quad)^4(\quad)(\quad)^2(\quad)^2\,\frac{(\quad)}{(\quad)} = \_\_\_\_$$

$$V_{m(STD)} = \frac{17.64\,V_m\,Y\left(P_b + \Delta H/13.6\right)}{T_m}$$
$$= \frac{17.64\ (36.30)(1.013)\left(29.8 + \frac{.264}{13.6}\right)}{(533.44)} = \underline{36.28}\ DSCF$$

$$V_{wc(STD)} = 0.04707\ (H_2O_c) = 0.04707\ (40) = \underline{1.88}\ SCF$$
$$V_{wsg(STD)} = 0.04715\ (H_2O_{sg}) = 0.04715\ (6) = \underline{.28}\ SCF$$
$$V_{w(STD)}\ \underline{2.16}\ SCF$$

$$B_{ws} = \frac{V_{w(STD)}}{V_{w(STD)} + V_{m(STD)}} = \frac{(2.16)}{(2.16)+(36.28)} = \underline{.056}$$

$$M_d = 0.44\ (\%CO_2) + 0.32\,(\%\ O_2) + 0.28\,(\%CO+N_2)$$
$$= 0.44\ (\quad) + 0.32\,(\quad) + 0.28\,(\quad) = \underline{30}$$

$$M_s = M_d\ (1-B_{ws}) + 18\,(B_{ws}) = (30)(.944) + 18(.056) = \underline{29.34}$$

$$\bar{V}_s = 85.49\ C_p\ (\sqrt{\Delta P})\,avg.\sqrt{\frac{T_s}{P_s M_s}}$$
$$= 85.49\ (.84)(.326)\sqrt{\frac{(778.78)}{(29.8)(29.34)}} = \underline{22.09}\ FT/SEC$$

$$\bar{Q}_s = 63500\ \bar{V}_s\ (1-B_{ws})\ A_s\ (P_s/T_s)$$
$$= 63500\ (22.09)(.944)(11.74)\frac{(29.8)}{(778.78)} = \underline{594K}\ CFH$$

$$\%I = \frac{100 V_{m(STD)} A_s}{\theta\ \bar{Q}_s\ A_n} = \frac{100\,(36.28)(11.74)}{(2.13)(594)(.00034088)} = \underline{100.7}$$

$$C_s = \frac{M_n}{454{,}000 V_{m(STD)}} = \frac{(2214)}{454{,}000\,(36.28)} = \underline{1.34\times10^{-4}}\ LB/CF$$

$$PMR = C_s\ \bar{Q}_s = (1.34\times10^{-4})(594K) = \underline{79.59}\ LB/HR$$

$$E = C_s\ F_d\ \frac{20.9}{20.9-\%O_2} = (1.34\times10^{-4})(9885)\ \frac{20.9}{20.9-(10.9)} = \_\_\_\_\ LB/10^6 BTU$$

DATE 1-25-80

PLANT CHATTAHOOCHEE

STACK #8

RUN WOOD/COAL #3

FILTER 349

06 Dn		in
05 ΔH_a		"H_2O
04 Cp		const.
03 Bws		fract sat.
02 Tm		°R
01 Ts		°R

18 Vm	36.22	CF
17 γ	1.013	const.
16 Pb	29.8	"Hg
15 ΔH	.264	"H_2O..
14 Tm	533.44	°R
13 H_2Oc	40	Ml
12 H_2Osg	8	G.
11 % CO_2	1	%
10 % O_2	1	%
09 % CO	1	%
08 % N_2	103.43	%
07 Cp	.84	const.
06 ($\overline{N\Delta P}$) Ave	.326	"H_2O
05 Ts	778.78	°R
04 Ps	29.8	"Hg
03 As	11.74	Ft^2
02 θ	2.13	Hr
01 An	.00034088	Ft^2

05 Mn	2214	Mg
04 Vm (STD)	36.30	CF
03 Qs	593K	SCFH
02 Fd	9885	dscf/10^6BTU
01 % O_2	10.9	

B = Cs 1.34×10^{-4}

C = PMR 79.79

D = E 2.77

B = Vm (STD)	36.30	DSCF
C = Vw (STD)	2.26	SCF
D = Bws	.058	fract. sat.
E = Md	30.00	AMU
A' = Ms	29.29	AMU
B' = $\overline{Vs}$	22.10	Ft/sec
C' = Qs	593K	SCFH
D' = %I	98.63	% Iso

DGK 2-6-80

CHATTAHOOCHEE

FILTER WEIGHTS

		FINAL	INITIAL	DIFFERENCE
(1)	OIL #6	0.46813	0.41333	0.05480
(2)	OIL #6A	0.48550	0.40747	0.07803
(3)	BIO #1	0.65219	0.42128	0.22801
(4)	BIO #2	0.65600	0.42701	0.22899
(5)	BIO #3	0.60706	0.40122	0.20584
(6)	BIO #4	0.75983	0.39766	0.36217
(7)	BIO #5	0.79219	0.39288	0.39931
(8)	BIO #6	0.86483	0.41550	0.44933
(9)	OIL #6B	0.50200	0.40045	0.10155
(10)	OIL #6C	0.49985	0.39881	0.10104

BEAKER WEIGHTS Acetone Probe Wash

		FINAL	INITIAL	DIFFERENCE
(1)	#7	104.98280	104.94867	0.03413
(2)	#8	102.38720	102.31132	0.07588
(3)	#6	112.00530	111.72453	0.28077
(4)	#9	107.28380	107.08059	0.20321
(5)	#10	104.87365	104.61602	0.25763
(6)	#5	110.01900	109.63141	0.38759
(7)	#4	108.64880	108.14741	0.50139
(8)	#3	110.26110	109.79279	0.46831
(9)	#2	103.47280	103.43221	0.04059
(10)	#1	110.42500	110.38136	0.04364

CHATTAHOOCHEE

FILTER WEIGHTS

	INITIAL	FINAL	DIFFERENCE
#355 Coal	0.41209	0.71574	0.30365
#351 Coal/wood #1	0.42847	1.55926	1.13079
#245 Coal/wood #2	0.40403	0.85400	0.44997
#349 Coal/wood #3	0.41251	1.29403	0.88152
#352 Blank	0.42902	0.42852	-0.0005

BEAKER WEIGHTS, Acetone Probe Wash

	INITIAL	FINAL	DIFFERENCE
#17 Coal	105.05771	108.33330	3.27559
#18 Coal/wood #1	109.85846	111.03215	1.17369
#19 Coal/wood #2	110.21370	112.24835	2.03465
#20 Coal/wood #3	104.57834	105.91145	1.33311
#21 Acetone Blank (200ml)	104.38848	104.39010	0.00162

Date	Run	Instantaneous O_2 Readings			O_2 Integrated Bag Readings		Run Times	
		start	middle	finish	Boiler	Flue	Start	Stop
1-21-80	Oil 1				10.1	12.3	11:30	12:30
	Oil 2				-	7.3	2:00	3:00
1-22-80	Bio 1				4.2	8.1	11:30	12:40
	Bio 2				-	9.1	2:00	3:12
	Bio 3					10.1	4:00	5:10
1-23-80	Bio 4	5.8-6.3,	3.6-6.9,	6.5-7.5	7.5	8.15	10:30	12:40
	Bio 5	6.5-7.5,	3.6-7.0,	4.6-6.8	7.8	8.9	1:35	3:50
	Bio 6	-	4.6-5.2,	-	4.9	10.0	4:00	6:10
1-24-80	Coal 1	7.7-9.0,	7.9-9.4,	6.6-9.4	8.6	8.4	12:30	2:40
1-25-80	C-W 1	1.0-3.0,	-	-	-	10.1	11:30	1:40
	C-W 2	Simultaneous with C-W 1			-	9.8	11:30	1:40
	C-W 3	5.1-5.8	-	-	8.05	10.9	3:50	6:00
1-24-80	Oil 3				Simultaneous with oil 4		1:00	2:35
	Oil 4				7.75	9.95	1:00	2:35

Flue bag and boiler bag samples were taken during the entire run period. Instantaneous readings were taken at the start, middle, and finish of the sample period.

Best Available Copy

VELOCITY TRAVERSE DATA

R. ___________ SEAL ___________

CHATTAHOOCHEE UNIT #8 DATE 1-21-80

STACK DIMEN. 46.4" EQUIV. DIA. NIPPLE = 55" SKETCH OF STACK

ISTANCE TO UPSTREAM RESTRICTION 5 Ø

ISTANCE TO DOWNSTREAM RESTRICTION 2 + Ø

O. OF TRAVERSE PTS. 32

$P_s \simeq 30 \pm \left(\frac{"Hg}{13.6}\right) \simeq$ ______ "Hg

		PORT ____		PORT ____	
PT.	DIST. TO WALL	ΔP	T_s	ΔP	T_s
1	~~6.25"~~ →	6.5"	*		
2	7.75"				
3	9.4"				
4	11.3"				
5	13.3"				
6	15.7"				
7	18.6"				
8	22.9"				
9	34.5"				
10	38.75"				
11	41.7"				
12	44.0"				
13	46.1"				
14	48.0"				
15	49.6"				
16	50.9"	ABJ.*			
AVERAGE					

$$V_s \simeq 2.46\sqrt{T_s\,\Delta P}$$

$$2.46\sqrt{(\quad X\quad)} = \_\_\_\_ \text{FPS}$$

$$D_N \simeq \sqrt{\frac{0.956}{T_m(1-B_{ws})}}\sqrt{\frac{T_s}{\Delta P}}$$

$$\sqrt{\frac{0.956}{(\quad X 1-\quad)}}\sqrt{\frac{(\quad)}{(\quad)}} = \_\_\_\_ \text{D}$$

$$A_N = \pi\left(\frac{D_N}{2}\right)^2 = \frac{\pi}{4}(\quad)^2 =$$

$$\_\_\_\_ \text{IN}^2$$

$$\Theta \simeq \frac{72\ \cancel{60}\ T_s}{V_s\,A_N\,(1-B_{ws})\,T_m}$$

$$\frac{60(\quad)}{(\quad X\quad X 1-\quad X\quad)} =$$

RECORD OF VISUAL DETERMINATION OF OPACITY

Page 1 of 6

I D 0477

Company Florida State Hospital

Location Gadsden Co.

Test Number 1

Date 1/22/80

Type Facility 'A' Source

Control Device multi-cyclone

Hrs Observation 40 min.

Observer Mary Jean O'Neil

Obs Certification Date 1/10/80

Obs Affiliation DER

Pt of Emissions Boiler #8

Hgt of Discharge Pt 50'

	Initial			Final
Clock Time	2:20			3:00
Observer Location Distance to Discharge	125'			135'
Direction from Discharge	SE			SE
Height of Observation Point	ground			ground
Background Description	smoke stack			smoke stack
Weather Conditions Wind Direction	SW			SW
Wind Speed	gusty			gusty
Ambient Temperature	69°			69°
Sky Conditions (clear, overcast % clouds, etc.)	over cast			over cast
Plume Description "black" Color	grey			grey
Distance Visible				
Other Information	Woodex		26,000 lbs./st hr	

Summary of Average Opacity

Set Number	Time Start	Time End	Opacity Sum	Opacity Average
1	2:20	2:26	360	15
2	2:26	2:31	375	15.6
3	2:31	2:37	440	18.34
4	2:37	2:44	410	17.08
5	2:44	2:50	470	19.58
6	2:50	2:56	480	20
				17.6

Readings ranged from 10 to 25 % opacity

The source [✓ was] ~~was not~~ in compliance with DER at the time of evaluation

X Mary Jean O'Neil
Observer's signature

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
2:20	0	20	20	15	15		
	1	15	15	20	15		
	2	15	15	20	15		
	3	15	15	10	15		
	4	15	15	15	10		
	5	10	15	15	10		
2:26	6	15	15	15	12		
	7	15	15	10	15		
	8	15	15	10	15		
	9	15	20	20	15		
2:30	10	20	20	15	15		
2:31	11	15	20	15	20		
	12	15	20	15	15		
	13	20	20	15	20		
	14	15	15	20	15		
	15	15	20	25	20		
	16	15	20	20	25		
2:37	17	20	15	20	20		
	18	25	25	20	20		
	19	20	20	15	15		
2:40	20	20	15	15	20		
	21	20	15	15	15		
	22	15	15	15	15		
	23	10	15	15	15		
2:44	24	15	20	15	20		
	25	20	20	15	20		
	26	20	15	15	20		
	27	25	20	20	25		
	28	20	20	20	20		
	29	20	25	20	20		

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
2:50	30	20	20	25	20		
	31	20	20	20	20		
	32	20	20	20	20		
	33	15	20	20	20		
	34	20	15	20	20		
	35	20	20	25	20		
2:56	36	20	15	20	20		
	37	20	20	20	25		
	38	20	25	25	20		
	39	20	20	20	20		
3:00	40	20					
	41						
	42						
	43						
	44						
	45						
	46						
	47						
	48						
	49						
	50						
	51						
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	56						
	57						
	58						
	59						

RECORD OF VISUAL DETERMINATION OF OPACITY

Page 2 of 6

I D 0477
Company Florida State Hospital
Location Gadsden Co.
Test Number 1
Date 1/23/80

Type Facility 'A' Source
Control Device multicyclones
Hrs Observation one
Observer Mary Jean O'Neil

Obs Certification Date 1/16/80
Obs Affiliation DER
Pt of Emissions Boiler # 8
Hgt of Discharge Pt 50'

	Initial			Final
Clock Time	11:10 am			12:10
Observer Location Distance to Discharge	125'			125'
Direction from Discharge	SE			SE
Height of Observation Point	ground			ground
Background Description	smoke stack			smoke stack
Weather Conditions Wind Direction	NW			SW
Wind Speed	light			light
Ambient Temperature	49°			47°
Sky Conditions (clear, overcast % clouds, etc.)	overcast			partly cloudy
Plume Description "black" Color	grey			grey
Distance Visible				
Other Information	Woodex			

Summary of Average Opacity

Set Number	Time		Opacity	
	Start	End	Sum	Average
1	11:10	11:20	575	14.37
2	11:20	11:30	660	16.5
3	11:30	11:40	745	18.6
4	11:40	11:50	665	16.6
5	11:50	12:00	630	15.75
6	12:00	12:10	635	15.9
				16.27

Readings ranged from 10 to 25 % opacity

The source [✓ was] ~~was not~~ in compliance with DER at the time of evaluation.

X Mary Jean O'Neil
Observer's signature

Hr	Min	Seconds				Steam Plume If applicable	
		0	15	30	45	Attached	Detached
11:10	0	15	10	15	15		
	1	10	10	15	15		
	2	15	15	15	20		
	3	15	15	15	15		
	4	10	15	20	15		
	5	15	15	15	15		
	6	10	15	15	15		
	7	15	10	15	15		
	8	15	15	10	15		
	9	15	15	15	15		
11:20	10	20	15	15	15		
	11	15	20	15	20		
	12	15	20	15	15		
	13	15	15	15	15		
	14	15	15	20	15		
	15	20	15	15	20		
	16	20	15	15	15		
	17	15	20	20	15		
	18	15	15	15	20		
	19	15	15	15	20		
11:30	20	20	15	15	15		
	21	15	15	20	20		
	22	20	15	15	20		
	23	20	20	15	20		
	24	20	20	25	20		
	25	20	25	20	20		
	26	25	25	20	20		
	27	20	20	15	15		
	28	15	15	20	20		
	29	20	15	15	15		

Hr	Min	Seconds				Steam Plume If applicable	
		0	15	30	45	Attached	Detached
11:40	30	15	15	15	15		
	31	15	15	20	20		
	32	20	15	15	15		
	33	15	15	15	15		
	34	15	15	20	15		
	35	20	20	20	15		
	36	15	15	15	20		
	37	20	15	15	15		
	38	20	20	15	15		
	39	15	15	20	20		
11:50	40	20	20	20	20		
	41	15	15	20	15		
	42	15	15	15	15		
	43	15	15	15	20		
	44	15	20	15	15		
	45	15	15	15	15		
	46	15	15	15	15		
	47	15	15	15	20		
	48	15	15	15	20		
	49	15	15	15	15		
12:00	50	15	15	15	10		
	51	10	15	15	20		
	52	20	20	15	15		
	53	15	15	15	15		
	54	15	20	20	20		
	55	20	15	15	15		
	56	15	15	15	15		
	57	15	20	20	15		
	58	15	15	15	15		
	59	15	15	15	15		

RECORD OF VISUAL DETERMINATION OF OPACITY

Page 3 of 6

I.D. C-177
Company Florida State Hospital
Location Gadsden Co
Test Number 2
Date 1/23/80

Type Facility "A" Source
Control Device multicyclones
Hrs Observation one
Observer MJ O'Neil

Obs Certification Date 1/10/80
Obs Affiliation DER
Pt of Emissions Boiler #2
Hgt of Discharge Pt 50'

	Initial			Final
Clock Time	3:05 pm			3:05 pm
Observer Location Distance to Discharge	185'			175'
Direction from Discharge	SE			SE
Height of Observation Point	ground			ground
Background Description	smoke stack			smoke stack
Weather Conditions Wind Direction	N			NE
Wind Speed	light			light
Ambient Temperature	48°			48°
Sky Conditions (clear, overcast % clouds, etc.)	over-cast			over-cast
Plume Description "black" Color	grey			grey
Distance Visible				
Other Information	woodex		36 ctr lb steam/hr	

Summary of Average Opacity

Set Number	Time Start	Time End	Opacity Sum	Opacity Average
1	2:05	2:15	720	18
2	2:15	2:25	815	20.37
3	2:35	2:35	850	21.25
4	2:35	2:45	855	21.37
5	2:45	2:55	895	22.37
6	2:55	3:05	890	22.25
				21.93

Readings ranged from 15 to 30 % opacity

The source [✓ was] ~~was not~~ in compliance with DER at the time of evaluation

x Mary Jean O'Neil
Observer's signature

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
2:05	0	20	20	15	15		
	1	20	20	15	15		
	2	15	15	15	15		
	3	20	15	15	15		
	4	20	20	20	15		
	5	15	20	20	20		
	6	20	15	15	15		
	7	20	20	25	25		
	8	20	20	15	15		
	9	20	20	20	20		
2:15	10	15	20	20	20		
	11	20	20	20	20		
	12	20	20	20	20		
	13	25	25	25	20		
	14	20	25	25	20		
	15	20	20	20	20		
	16	20	20	20	20		
	17	20	20	20	20		
	18	15	20	20	20		
	19	20	20	20	20		
2:25	20	20	25	25	20		
	21	20	20	25	25		
	22	20	25	20	20		
	23	20	20	20	20		
	24	20	20	25	25		
	25	25	25	25	25		
	25	20	20	20	20		
	27	20	20	20	20		
	28	25	20	20	20		
	29	20	15	20	15		

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
2:35	30	15	20	20	25		
	31	20	20	20	20		
	32	25	25	20	20		
	33	20	25	25	25		
	34	20	20	20	25		
	35	20	20	20	20		
	38	20	20	20	20		
	37	20	15	20	20		
	38	20	20	25	25		
	39	20	25	30	25		
2:45	40	25	25	20	20		
	41	20	20	20	25		
	42	25	25	25	20		
	43	20	25	25	25		
	44	20	20	20	20		
	45	20	25	25	20		
	46	20	20	20	20		
	47	20	25	20	20		
	48	20	25	25	25		
	49	20	25	25	30		
2:55	50	25	30	25	25		
	51	25	20	20	20		
	52	20	20	20	25		
	53	25	25	20	25		
	54	20	25	20	20		
	55	20	25	25	25		
	56	20	20	25	25		
	57	20	20	25	20		
	58	20	20	20	20		
	59	20	25	20	20		

RECORD OF VISUAL DETERMINATION OF OPACITY

Page 4 of 6

I D C477

Company Florida State Hospital

Location Gadsden Co

Test Number

Date 1/24/80

Type Facility "A" Source

Control Device multicyclones

Hrs Observation .50

Observer MJ O'Neil

Obs Certification Date 11/1/80

Obs Affiliation DER

Pt of Emissions Boiler #8

Hgt of Discharge Pt 50'

	Initial			Final
Clock Time	1:50pm			2:20pm
Observer Location Distance to Discharge	140'			140'
Direction from Discharge	S			S
Height of Observation Point	ground			ground
Background Description	blue sky			blue sky
Weather Conditions Wind Direction	SW			SW
Wind Speed	light			light
Ambient Temperature	49°			49°
Sky Conditions (clear, overcast, % clouds, etc.)	clear			clear
Plume Description Color	brown			brown
Distance Visible	100 yd			100 yd
Other Information	coal	28,000 lbs steam/hr		

Summary of Average Opacity

Set Number	Time Start	Time End	Opacity Sum	Opacity Average
1	1:50	2:00	1875	46.9
2	2:00	2:10	1955	48.9
3	2:10	2:20	1830	45.7
				47.16

Readings ranged from 40 to 75 % opacity

The source ~~was~~ [✓ was not] in compliance with DER at the time of evaluation

x Mary Jean O'Neil
Observer's signature

Hr	Min	Seconds 0	15	30	45	Steam Plume (If applicable) Attached	Detached
1:50	0	40	45	40	45		
	1	55	75	60	50		
	2	45	40	45	45		
	3	50	50	45	45		
	4	50	55	45	45		
	5	45	40	40	40		
	6	45	50	45	50		
	7	55	50	55	50		
	8	45	45	45	40		
	9	40	40	45	40		
2:00	10	45	50	45	45		
	11	50	45	45	50		
	12	50	50	45	45		
	13	50	50	45	45		
	14	50	50	50	45		
	15	50	45	45	45		
	16	45	45	45	50		
	17	55	50	50	55		
	18	40	50	50	50		
	19	55	55	55	50		
2:10	20	50	50	50	45		
	21	45	45	40	45		
	22	45	50	45	40		
	23	40	45	45	45		
	24	40	45	45	45		
	25	50	45	40	45		
	26	50	50	50	45		
	27	45	45	45	50		
	28	45	45	50	45		
	29	45	45	50	45		

Hr	Min	Seconds 0	15	30	45	Steam Plume (If applicable) Attached	Detached
	30						
	31						
	32						
	33						
	34						
	35						
	36						
	37						
	38						
	39						
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RECORD OF VISUAL DETERMINATION OF OPACITY

Page 5 of 6

I D C177

Company FLORIDA STATE HOSPITAL

Location CHATTAHOOCHEE

Test Number

Date 1-25-80

Type Facility A' Source

Control Device

Hrs Observation 1/2

Observer T. P. ANDREWS

Obs Certification Date

Obs Affiliation DER

Pt of Emissions Boiler #8

Hgt of Discharge Pt 50'

Initial | Final

Clock Time 1:50 PM-2:20 PM

Observer Location

Distance to Discharge

Direction from Discharge SE

Height of Observation Point

Background Description STACK SKY

Weather Conditions

Wind Direction SW

Wind Speed 5

Ambient Temperature

Sky Conditions (clear, overcast, % clouds, etc.) fog

Plume Description

Color GREY

Distance Visible

Other Information

Summary of Average Opacity

Set Number	Time Start	Time End	Opacity Sum	Opacity Average
1	1:50	2:00	1315	32.9
2	2:00	2:10	1200	30
3	2:10	2:20	1170	29.25
				30.72

Readings ranged from ______ to ______ % opacity

The source was/was not in compliance with ______ at the time of evaluation

X Thomas P. Andrews

Observer's signature

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
1:50	0	35	35	35	35		
	1	35	35	35	35		
	2	35	35	40	35		
	3	30	35	35	35		
	4	35	30	35	35		
	5	35	35	35	35		
	6	30	30	30	30		
	7	30	30	35	35		
	8	30	30	30	30		
	9	30	30	25	25		
2:00	10	25	25	25	25		
	11	25	25	25	25		
	12	30	30	30	30		
	13	30	30	30	30		
	14	30	35	35	30		
	15	30	30	30	30		
	16	35	35	35	30		
	17	30	30	30	30		
	18	30	35	35	35		
	19	30	30	30	30		
2:10	20	30	30	30	30		
	21	30	30	30	30		
	22	30	30	25	25		
	23	25	25	30	30		
	24	30	35	35	35		
	25	35	30	30	30		
	26	30	30	30	30		
	27	25	25	25	25		
	28	30	30	30	30		
	29	25	25	30	30		

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
	30						
	31						
	32						
	33						
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	35						
	36						
	37						
	38						
	39						
	40						
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RECORD OF VISUAL DETERMINATION OF OPACITY

Page 6 of 6

I D 04111
Company Florida State Hospital
Location Gadsden Co.
Test Number
Date 1/29/80

Type Facility "A" Source
Control Device multicyclone
Hrs Observation
Observer Mary Jean O'Neil

Obs Certification Date 1/16/80
Obs Affiliation DER
Pt of Emissions Boiler #8
Hgt of Discharge Pt 50'

	Initial			Final
Clock Time	12:30			1:00
Observer Location Distance to Discharge	[illegible]			
Direction from Discharge	S			
Height of Observation Point	ground			
Background Description	cloudy			smoke stack
Weather Conditions Wind Direction	N			
Wind Speed				
Ambient Temperature	56°			
Sky Conditions (clear, overcast % clouds, etc.)	clear			
Plume Description "black" Color	grey			
Distance Visible				
Other Information	88,000 lb [illegible]			fired oil

Summary of Average Opacity

Set Number	Time Start	Time End	Opacity Sum	Opacity Average
1	12:30	12:40	395	9.87
2	12:40	12:50	520	13
3	12:50	1:00	355	8.37
				10.58

Readings ranged from 5 to 20 % opacity

The source [✓ was] ~~/was not~~ in compliance with DER at the time of evaluation

x Mary Jean O'Neil
Observer's Signature

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
12:30	0	15	15	10	10		
	1	10	10	15	10		
	2	15	10	15	10		
	3	15	15	10	10		
	4	10	10	15	15		
	5	10	10	10	5		
	6	5	5	5	5		
	7	5	5	10	10		
	8	10	10	10	5		
	9	5	5	10	10		
12:40	10	10	10	10	10		
	11	5	10	15	15		
	12	10	10	10	10		
	13	10	15	15	10		
	14	15	10	15	10		
	15	15	15	15	15		
	16	10	15	20	15		
	17	15	15	15	15		
	18	15	15	20	15		
	19	15	15	10	10		
12:50	20	10	10	10	5		
	21	5	5	10	10		
	22	10	5	5	10		
	23	10	5	10	10		
	24	10	10	5	5		
	25	5	5	10	10		
	26	10	10	10	15		
	27	10	15	10	10		
	28	10	10	10	10		
	29	10	10	5	10		

Hr	Min	Seconds 0	15	30	45	Steam Plume If applicable Attached	Detached
	30						
	31						
	32						
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SECTION 5

FUEL AND FLYASH ANALYSIS

TABLE THREE: SOLID FUEL SAMPLES, TRACE METAL CONCENTRATIONS
(PPM by weight)

Element	COAL CSH 1	WOOD/COAL CSH 2	WOOD CSH 3
S	14095.	14942.35	2735.91
Ti	1750.98	1041.75	519.32
V	59.	0	101.33
Cr	0	0	0
Co	126.48	123.26	63.33
Ni	19.67	31.81	88.66
Cu	30.92	39.76	82.33
Zn	0	59.64	114.00
Pb	75.89	91.45	31.67
Sr	132.1	111.33	38.00

TABLE FOUR: AVERAGE FLYASH TRACE METAL CONCENTRATION (PPM by weight)

ELEMENT*	OIL		COAL		WOOD		WOOD/COAL	
	u	s.d.	u	s.d.	u		u	s.d
S	26702.	(11.76)	1308.5	(318.2)	4013.	(348)	3798.	(2070)
Ti	140.	(121)	1815.4	(44.4)	262.	(37.3)	1625.	(340.)
V	29350.	(616)	280.0	(4.1)	202.	(45.3)	214.	(14.5)
Cr	275.	(370)	15.72	(22.2)	39.1	(34.3)	2.6	(4.6)
Co	109.	(97.4)	203.6	(9.2)	43.5	(39.7)	234.	(41.6)
Ni	4131.	(417)	49.9	(6.7)	83.9	(11.7)	71.6	(5.4)
Cu	39.	(37.0)	94.6	(2.7)	28.8	(25.06)	124.	(9.3)
Zn	400.	(98.4)	17.91	(6.6)	525.	(157)	189.	(9.8)
Pb	1156.	(652)	172.	(9.3)	232.	(82.2)	252.	(7.1)
Sr	21.4	(22.5)	313.4	(.99)	42.4	(37.0)	336.	(42.4)

* S - sulfur, Ti - titanium, V- vanadium, Cr - chromium, Co - cobalt, Ni - nickel, Cu - cooper, Zn - zinc, Pb - lead, Sr - strontium.

TABLE FIVE: NORMALIZED DATA FOR FUEL AND FLYASH SAMPLES (PPM)

Element	BI02	BI03	BI06	OIL 1	OIL 2	OIL 3	COAL FILTER
Na	0.00	0.00	1672.17	0.00	0.00	12377.97	1065.49
Mg	675.78	826.72	1085.44	1514.28	596.21	1276.60	2644.22
Al	2923.04	3100.22	2926.29	875.84	667.83	909.47	29014.58
Si	10109.95	9033.89	8298.50	1729.23	1838.95	1355.86	31962.64
P	1788.68	1905.79	2035.20	1103.63	1509.87	1614.52	806.82
S	3636.36	4323.48	4081.41	14895.73	26802.17	38406.34	1083.97
Cl	2657.55	2944.00	3197.65	0.00	207.12	95.95	505.03
K	22432.29	24849.80	29053.91	352.90	423.93	438.05	3416.14
Ca	12056.85	11254.51	13047.30	1527.11	1233.06	988.74	2451.24
Sc	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ti	249.40	233.12	304.36	208.53	210.99	0.00	1784.03
V	233.31	223.50	150.35	29307.03	28757.26	29987.48	277.15
Cr	64.36	52.87	0.00	696.18	127.76	0.00	0.00
Mn	632.88	622.45	825.08	0.00	0.00	0.00	106.75
Fe	8382.94	8714.25	12882.29	975.30	667.83	1255.74	24990.76
Co	77.77	52.87	0.00	186.08	143.24	0.00	197.08
Ni	96.54	81.71	73.34	4597.37	3792.10	4005.01	45.17
Cu	45.59	40.86	0.00	73.79	42.59	0.00	96.49
Zn	407.62	463.83	704.07	484.44	423.93	292.03	22.58
Pb	176.99	192.26	326.37	1613.73	1444.06	408.84	178.61
Br	115.31	105.74	194.35	0.00	3.87	0.00	8.21
Sr	67.04	60.08	0.00	44.91	19.36	0.00	314.10
Total mass (mg)	3729.00	4161.00	2727.00	3117.00	5166.00	2397.00	4871.00

Element	COAL FUEL	WOOD/ COAL FUEL	WOOD FUEL	WOOD/ COAL 1	WOOD/ COAL 2	WOOD/ COAL 3	COAL FLYASH
Na	0.00	0.00	0.00	1704.48	1704.22	1528.67	1426.44
Mg	739.18	0.00	0.00	5959.36	2708.53	4020.50	3172.27
Al	18538.50	8739.56	1614.95	48362.72	18477.95	30539.60	35263.94
Si	28086.00	14473.16	15440.15	51358.21	17174.02	31790.02	42048.65
P	1242.27	1172.96	1665.61	2283.18	941.99	1392.36	830.71
S	14095.00	14942.35	2735.91	6079.53	2037.39	3278.13	1534.01
Cl	368.18	469.18	778.91	0.00	74.30	50.69	57.92
K	3507.59	2950.30	10481.32	11388.25	5373.92	6631.74	3625.68
Ca	2082.63	3602.39	15585.81	8552.45	4923.30	5650.56	2690.72
Sc	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Ti	1750.98	1041.75	519.32	2000.95	1337.49	1537.68	1846.76
V	59.02	0.00	101.33	227.69	198.95	216.29	282.97
Cr	0.00	0.00	0.00	7.91	0.00	0.00	31.44
Mn	64.64	159.05	557.31	271.17	227.71	285.01	81.09
Fe	1720.07	20405.57	9145.03	28986.48	26632.31	30325.56	24557.34
Co	126.48	123.26	63.33	186.58	263.66	252.34	210.16
Ni	19.67	31.81	88.66	75.10	74.30	65.34	54.61
Cu	30.92	39.76	82.33	121.75	134.23	116.03	92.67
Zn	0.00	59.64	114.00	192.90	196.55	177.99	13.24
Pb	75.89	91.45	31.67	260.10	246.88	248.96	165.48
Br	14.05	15.90	19.00	20.55	210.93	21.40	14.89
Sr	132.10	111.33	38.00	383.43	325.98	300.78	312.76
Total mass (mg)	3558.00	2515.00	1579.00	12649.00	4172.00	8877.00	6043.00

TABLE SIX: FUEL SULFUR ANALYSIS

	COAL	WOOD	WOOD/COAL	OIL
FLA. STATE HOSPITAL	-	-	-	2.5
Gailbraith Labs	0.92	0.12	1.10	-
Industrial Test Lab	1.74	-	-	-
F. S. U. PIXE	1.41	0.27	1.49	-
Average	1.36	0.195	1.29	2.2

GALBRAITH LABORATORIES, INC.
P. O. BOX 4187, 2323 SYCAMORE DR., KNOXVILLE, TENNESSEE 37921 / 615 546-1335

CERTIFICATE OF ANALYSIS

Mr. David P. Harlos
Page 2
February 22, 1980

Your Sample No. Chattahoochee Coal Fuel Our No. J-9893 gave the following results:

Ultimate Analysis,	As Received,	Dry Basis,
% Moisture	0.34	
% Carbon	71.45	
% Hydrogen	4.79	
% Nitrogen	1.35	
% Chlorine	0.03	
% Sulfur	0.92	
% Ash	9.70	
% Oxygen (by diff.)	11.42	

Mineral Analysis,	Ignited Basis,
% Phos. pentoxide, P_2O_5	
% Silica, SiO_2	
% Ferric Oxide, Fe_2O_3	
% Alumina, Al_2O_3	
% Titania, TiO_2	
% Lime, CaO	
% Magnesia, MgO	
% Sulfur Trioxide, SO_3	
% Potassium Oxide, K_2O	
% Sodium Oxide, Na_2O	
% Undetermined	

Proximate Analysis,	As Received,	Dry Basis,
% Moisture		
% Ash		
% Volatile Matter		
% Fixed Carbon		

	As Received	Dry Basis,
BTU/lb.		

Sulfur Forms,	As Received,	Dry Basis,
% Pyritic Sulfur		
% Sulfate Sulfur		
% Organic Sulfur		
% Total Sulfur		

GALBRAITH LABORATORIES, INC.

P. O. BOX 4187, 2323 SYCAMORE DR., KNOXVILLE, TENNESSEE 37921 / 615 546-1335

CERTIFICATE OF ANALYSIS

Mr. David P. Harlos
Department of Environmental Regulation
Bureau of Air Quality Management
State of Florida
Twin Towers, 2600 Blair Stone Road
Tallahassee, Florida 32301

February 22, 1980

Received: Feb. 15th

Your Sample No. Chattahoochee Wood Fuel Our No. J-9892 gave the following results:

Ultimate Analysis,	As Received,	Dry Basis,
% Moisture	3.58	
% Carbon	49.31	
% Hydrogen	5.62	
% Nitrogen	0.68	
% Chlorine	0.07	
% Sulfur	0.12	
% Ash	6.08	
% Oxygen (by diff.)	34.54	

Mineral Analysis,	Ignited Basis,
% Phos. pentoxide, P_2O_5	
% Silica, SiO_2	
% Ferric Oxide, Fe_2O_3	
% Alumina, Al_2O_3	
% Titania, TiO_2	
% Lime, CaO	
% Magnesia, MgO	
% Sulfur Trioxide, SO_3	
% Potassium Oxide, K_2O	
% Sodium Oxide, Na_2O	
% Undetermined	

Proximate Analysis,	As Received,	Dry Basis,
% Moisture		
% Ash		
% Volatile Matter		
% Fixed Carbon		

	As Received	Dry Basis,
BTU/lb.		

Sulfur Forms,	As Received,	Dry Basis,
% Pyritic Sulfur		
% Sulfate Sulfur		
% Organic Sulfur		
% Total Sulfur		

GALBRAITH LABORATORIES, INC.
P. O. BOX 4187, 2323 SYCAMORE DR., KNOXVILLE, TENNESSEE 37921 / 615 546-1335

CERTIFICATE OF ANALYSIS

Mr. David P. Harlos
Page 3
February 22, 1980

Your Sample No. Chattahoochee Coal-Wood Mix Fuel Our No. J-9894 gave the following results:

Ultimate Analysis,	As Received,	Dry Basis,
% Moisture	0.83	
% Carbon	71.04	
% Hydrogen	5.09	
% Nitrogen	1.30	
% Chlorine	0.05	
% Sulfur	1.10	
% Ash	7.93	
% Oxygen (by diff.) [illegible]	12.66	

Proximate Analysis,	As Received,	Dry Basis,
% Moisture		
% Ash		
% Volatile Matter		
% Fixed Carbon		

Sulfur Forms,	As Received,	Dry Basis,
% Pyritic Sulfur		
% Sulfate Sulfur		
% Organic Sulfur		
% Total Sulfur		

Mineral Analysis,	Ignited Basis,
% Phos. pentoxide, P_2O_5	
% Silica, SiO_2	
% Ferric Oxide, Fe_2O_3	
% Alumina, Al_2O_3	
% Titania, TiO_2	
% Lime, CaO	
% Magnesia, MgO	
% Sulfur Trioxide, SO_3	
% Potassium Oxide, K_2O	
% Sodium Oxide, Na_2O	
% Undetermined	

	As Received	Dry Basis,
BTU/lb.		

We regret that we were unable to reach you by telephone on February 22, 1980.

Gail R. Hutchens

Gail R. Hutchens, Exec. Vice-President

G. D. JACOBY BRIAN JACOBY

INDUSTRIAL TESTING LABORATORY

"SERVING THE COAL INDUSTRY"

2229 FIRST AVE., SO. • BIRMINGHAM, AL. 35233

TEL. 322-4236 — AREA CODE 205

ASTM

SUSTAINING MEMBER

September 27, 1976

FLORIDA STATE HOSPITAL
Chattahoochee, Florida 32324

Sample 1777
Received 9/20/76

Sample: Coal.

Identity: 1 car coal, [illegible]" x 0" w/stem shipped to Florida State Hospital,
Chattahoochee, Florida from Brilliant Coal Co., Brilliant Ala.
Shipped via SL-SF 92764. Sampled by F.S.H.
Coal Co. purchase order number 04200.
Lab purchase order number 11745[illegible].

ANALYSIS

(AS RECEIVED)

		(DRY BASIS)
MOISTURE	5.70	
VOLATILE MATTER	33.95	36.00
FIXED CARBON	54.41	57.70
ASH	5.94	6.30
TOTAL	100.00%	100.00%
SULPHUR	1.74	1.84
B.T.U.	12,998	13,762

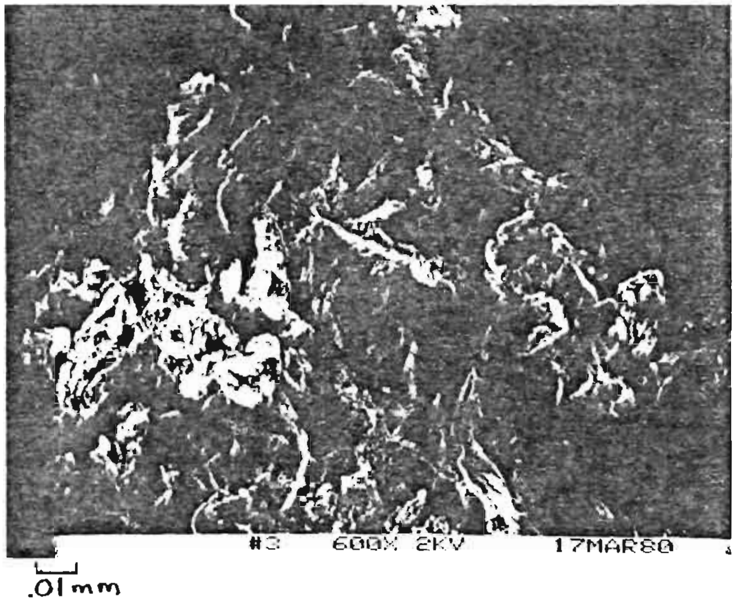
G. D. Jacoby Jr.

SCANNING ELECTRON MICROSCOPY
OF FUELS AND FLYASH

ANALYSIS BY

DEPARTMENT OF BIOLOGICAL SCIENCES,

FLORIDA STATE UNIVERSITY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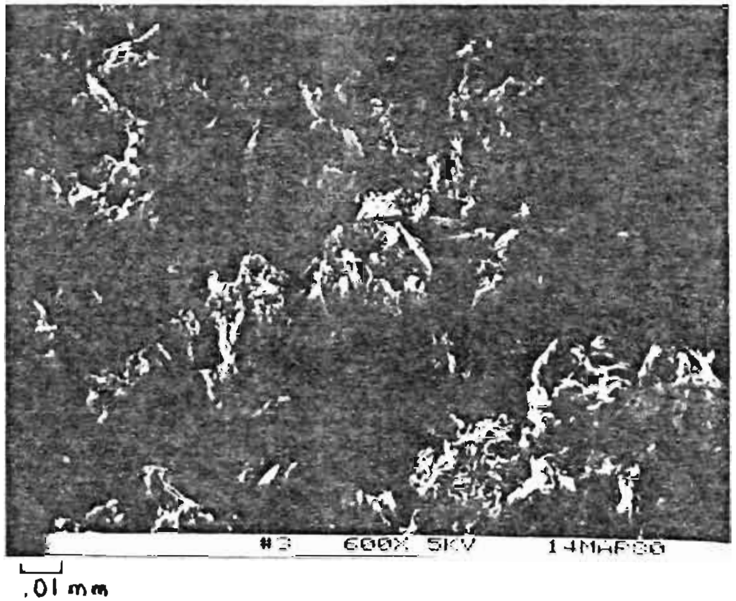
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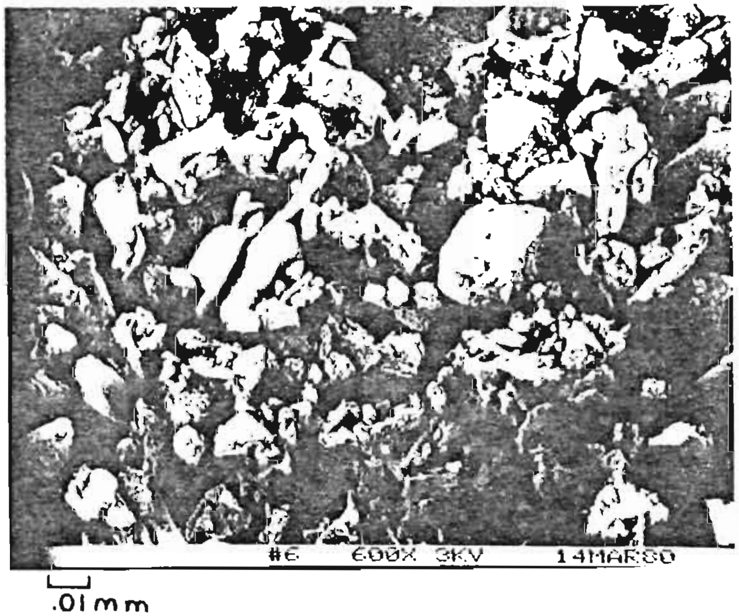
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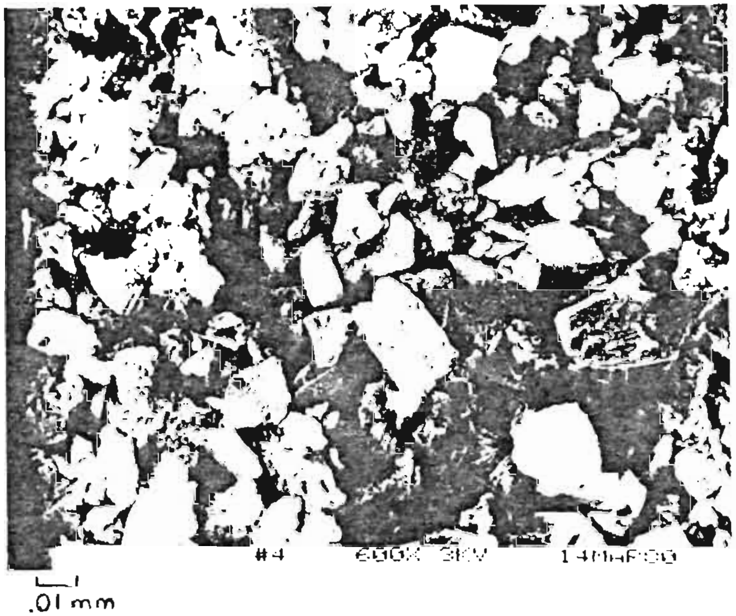
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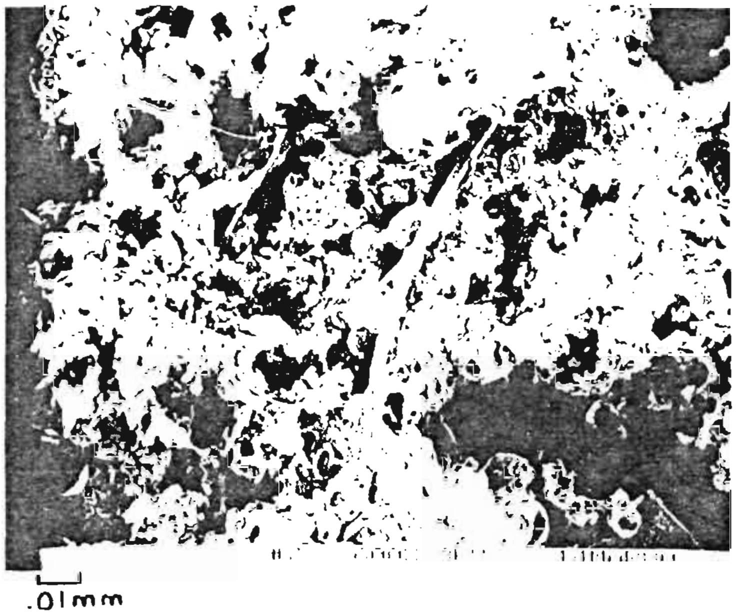
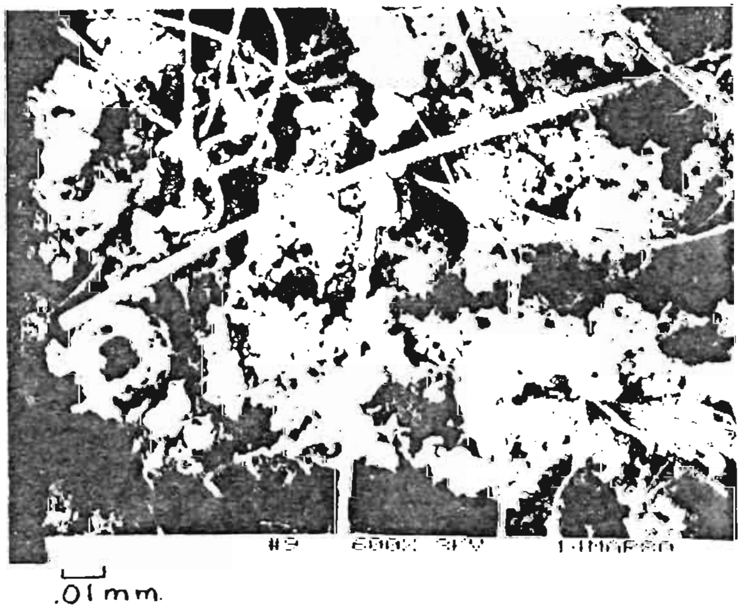
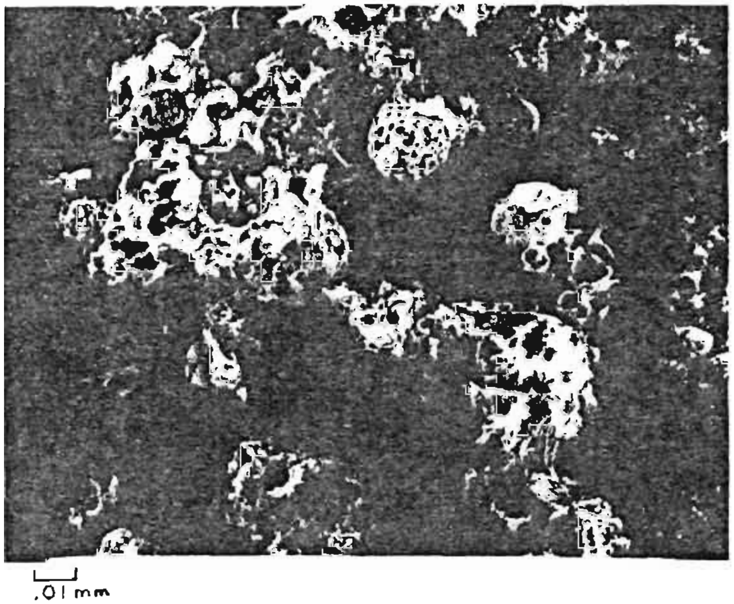
KEY TO PHOTOGRAPHS

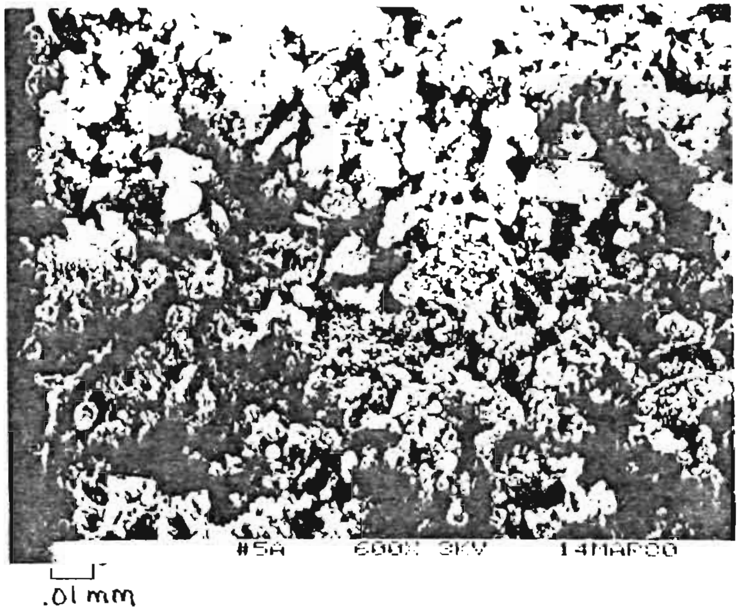
WOOD FUEL	WOOD FUEL
COAL FUEL	WOOD/COAL FUEL

KEY	OIL FLYASH HALF LOAD
OIL FLYASH HALF LOAD	OIL FLYASH FULL LOAD

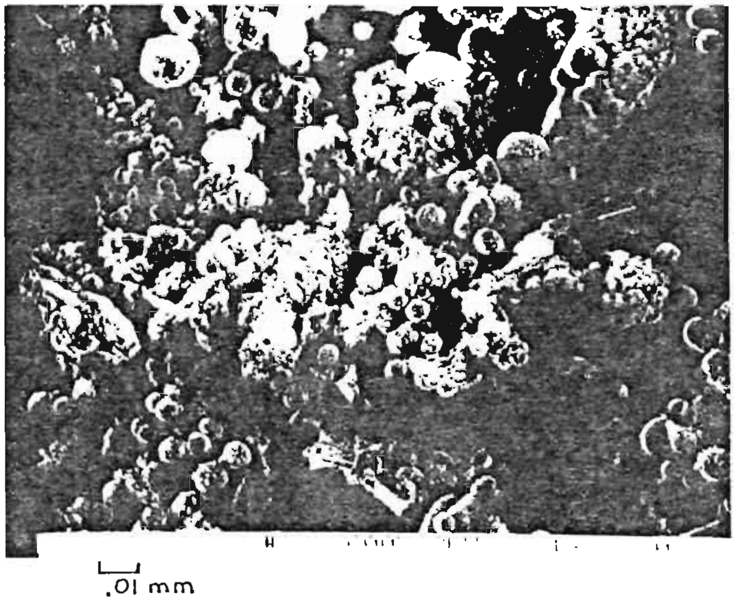




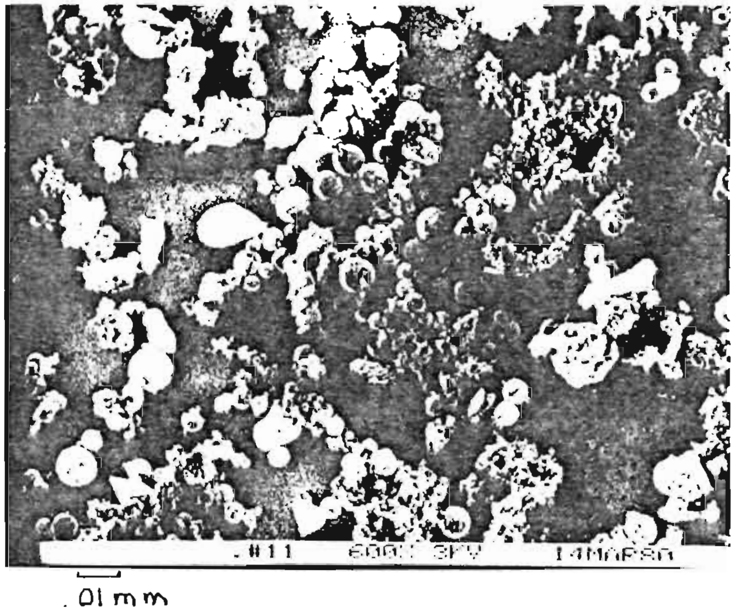




COAL FLYASH, BULK SAMPLE



WOOD FLYASH,BIO 2



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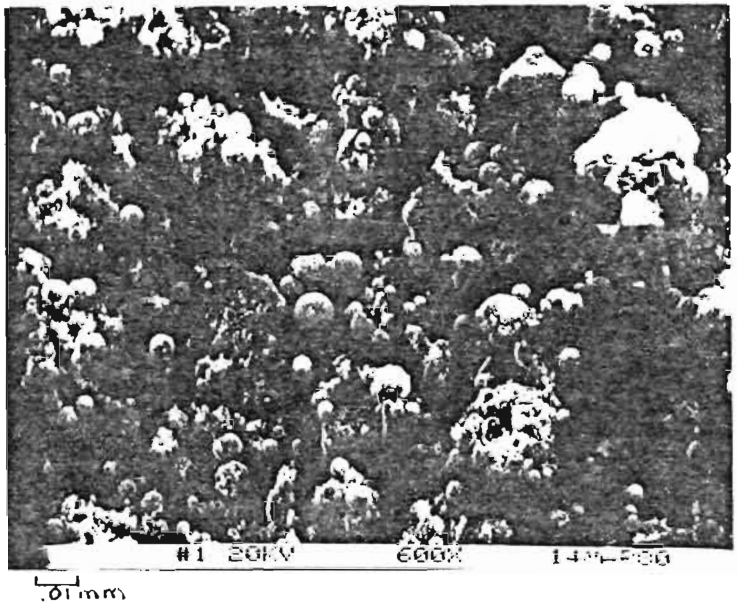
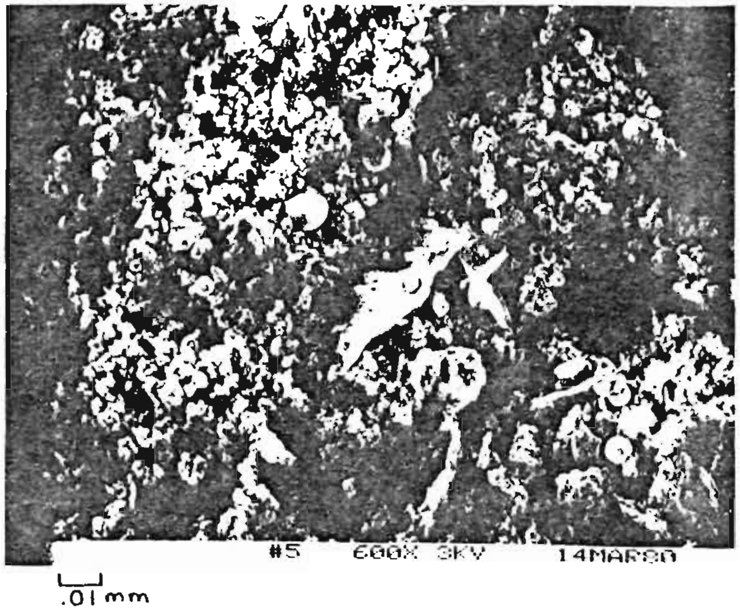
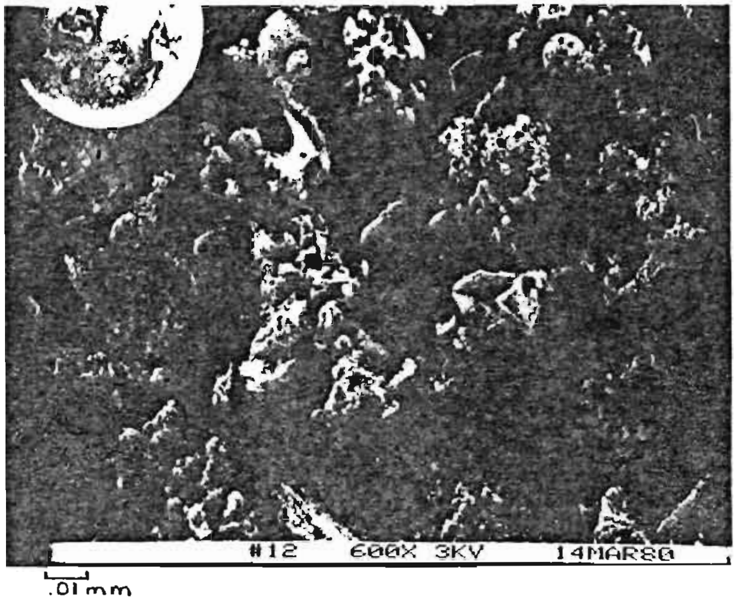


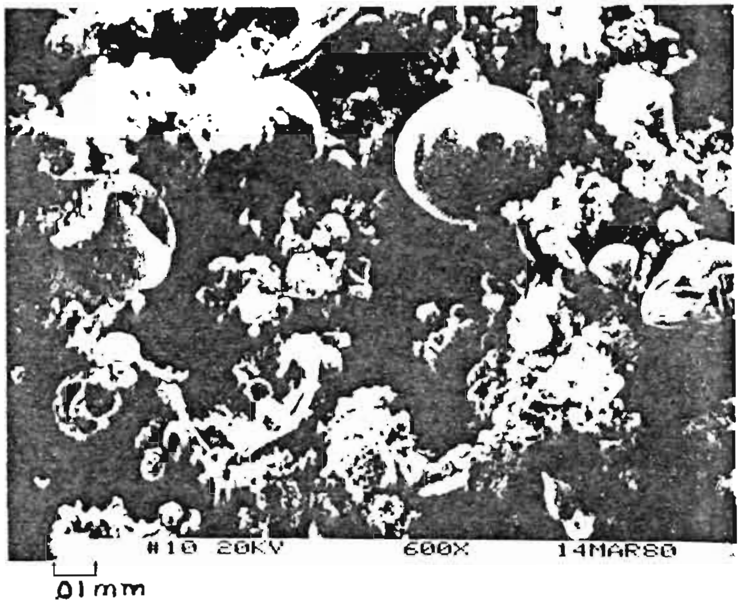
WOOD FLYASH, BIO 6



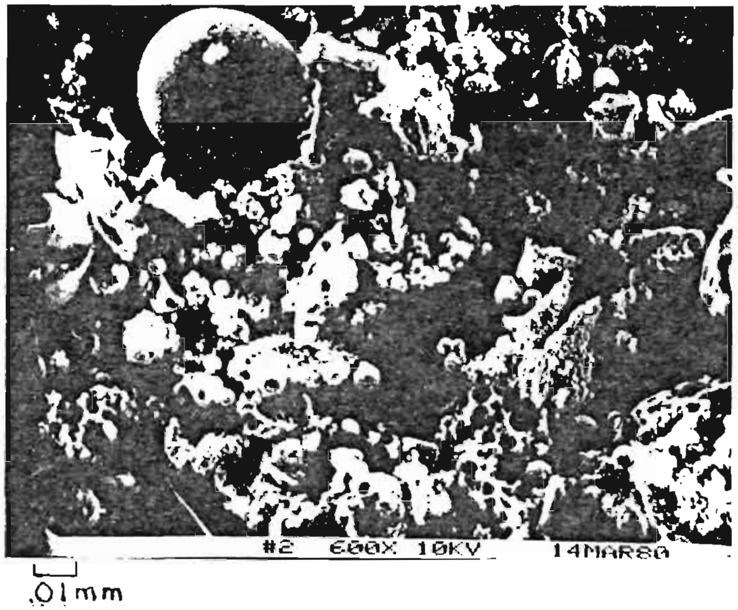
COAL FLYASH, COAL 1



WOOD COAL, FLYASH , WC 2



WOOD/COAL FLYASH, WC 1



WOOD COAL FLYASH, WC 3

SECTION 6

CALIBRATION DATA

DRY GAS METER

WET TEST METER

NOZZLES

PYROMETER

SCALES

Dry Gas Meter / Orifice Calibration Procedure

Dry Gas Meter Ident. old Console #12524
Wet Test Meter Ident. # 9485

Uncorr. Baro Press. Pbar (07) 29.938
Correction Factor (E) 1.0329

Room Temp. 75 °F
Technician/Date J. Glunn 11/18/79

Final WTM	Initial WTM	V_a = Corr V_{wtm} (06)	Final DGM	Initial DGM	Vol. V_{dgm} (05)	Temp. DGM Initial	Temp. DGM Final	Temp. DGM Ave °F	Temp. DGM Ave °R (04)	Temp. WTM °F	Temp. WTM °R (03)	Mano Rd ΔH "H_2O (02)	Of Time θ (min) (01)	Y (B)	ΔH@ (C)
4.319	0	4.461	90224	897.9	4.346	76	77	76.5	536.5	75	535	0.25	15	1.0287	1.5967
6.020	0	6.218	909.17	903.0	6.17	78	79	78.5	538.5	75	535	0.50	15	1.0131	1.6376
4.710	0	4.865	92201	916.7	5.321	79	81	80	540	75	535	0.75	10	.9211	1.7785
5.538	0	5.720	92840	922.7	5.718	81	81	81	541	75	535	1.00	10	1.0091	1.7122
6.148	0	6.350	935362	929.0	6.362	81	82	81.5	541.5	75	535	1.25	10	1.0071	1.7350
6.706	0	6.927	942851	936.0	6.951	82	83	82.5	542.5	75	535	1.50	10	1.0068	1.7464
7.725	0	7.979	951627	943.6	8.024	83	84	83.5	543.5	75	535	2.00	10	1.0052	1.7518
9.350	0	9.658	96255	952.8	9.75	84	84	84	544	75	535	3.00	10	.9986	1.7918
10.850	0	11.207	975.02	963.7	11.32	84	86	85	545	75	535	4.00	10	.9987	1.771

$$Y = \frac{Pb\ Va\ Td}{Vd\ Tw\ (Pb + \frac{\Delta H}{13.6})}$$

$$V_a = (\text{Final WTM} - \text{Initial WTM})\ E$$

Comments

$$\Delta H@ = \frac{\Delta H\ (.0317)}{Pb\ \ Td}\left[\frac{Tw\ \theta}{V_a}\right]^2$$

$\overline{\Delta H@}$ overall 1.72455

$\overline{\Delta H@}$ 0.25-1.25 1.698

$\overline{\Delta H@}$ 1.50-4.00 1.7652

$\overline{Y}$ .99871

Dry Gas Meter / Orifice Calibration Procedure

Dry Gas Meter Ident. New #13913 Uncorr. Baro Press. Pbar (07) 29.97 Room Temp. 74

Wet Test Meter Ident. Singer 9845 Correction Factor (E) 1.0329 Technician/Date 1/14/80

Final WTM	Initial WTM	V_a = Corr V_{wtm} (06)	Final DGM	Initial DGM	Vol. V_{dgm} (05)	Temp. DGM Initial	Temp. DGM Final	Temp. DGM Ave °F	Temp. DGM Ave °R (04)	Temp. WTM °F	Temp WTM °R (03)	Mano. P. ΔH "H_2O (02)	Of Time θ (min) (01)	Y (B)	ΔH@ (C)
4.122	00	4.2576	466.854	462.7	4.154	75	76	75.5	535.5	74	534	0.25	15	1.027	1.748
5.673	00	5.8596	472.948	467.2	5.748	76	77	76.5	536.5	74	534	0.50	15	1.014	1.842
4.582	00	4.7327	478.19	473.5	4.69	77	77	77	537	74	534	0.74	10	1.013	1.856
5.275	00	5.4485	484.212	478.8	5.412	77	78	77.5	537.5	74	534	1.00	10	1.011	1.890
.787	00	7.0103	491.978	485.0	6.977	78	79	78.5	538.5	74	534	1.25	11.5	1.010	1.884
.337	00	6.5455	499.031	492.5	6.531	79	80	79.5	539.5	74	534	1.50	10	1.009	1.957
7.688	00	7.9409	508.307	500.4	7.907	80	81	80.5	540.5	74	534	2.00	10	1.012	1.770
.973	00	9.2682	519.307	510.1	9.207	81	82	81.5	541.5	74	534	3.00	10	1.013	1.945
10.3	00	10.6389	533.379	522.8	10.577	82	83	82.5	542.5	74	534	4.00	10	1.012	1.965

Bh

$$Y = \frac{P_b \; V_a \; T_d}{V_d \; T_w \left(P_b + \frac{\Delta H}{13.6}\right)}$$

$$V_a = (\text{Final WTM} - \text{Initial WTM})\, E$$

Comments

$$\Delta H@ = \frac{\Delta H \; (.0317)}{P_b \; T_d} \left[\frac{T_w \; \theta}{V_a}\right]^2$$

$\overline{\Delta H@}$ overall 1.873

$\overline{\Delta H@}_{0.25-1.25}$ 1.844

$\overline{\Delta H@}_{1.50-4.00}$ 1.909

$\overline{Y}$ 1.013

NOZZLE RECORD SHEET

r	NOZZLE IDENTIFICATION AND DATE	DIAMETER(X-X) INCHES	DIAMETER(Y-Y) INCHES	AVERAGE DIAMETER INCHES	(Dia)^2 ~~(In2)~~ Ft^2	COMMENTS	TECHNICIAN
	C-6 1-18-80	.249, .251, .249		.2496	.0003382		JG
	B-3 1-18-80	.247, .248, .246		.247	.00033275		JG
	New #8 1-18-80	.248, .246, .245		.2463	.00033046		JG
	New #81 1-18-80	.248, .247, .246		.247	.00033275		JG
	New #81 1-17-80	.250, .250, .250		.250	.00034098		OK

Wet Test Meter Record Sheet 1 Liter = 0.0353 ft^3

Wet Test Meter Identification DPC 9485

Date	Baro Press	Rm. Temp.	Pressure Meter	Final WTM	Initial WTM	Vol. thru WTM	Ml Water	FT3 Water	Time (sec)	Rate CFM	E	Operator
7/27/80				1.50	0.83	0.67	6,000 6,000 6,000 1,700 19,700	0.6957			-.0369	Douglas Kiesling WTMCF = 1.0384
6/31/ 78				0.07 0.14 0.21 0.28 0.346 0.413 0.48	0	1.0256 0.48	2,000 2,000 2,000 2,000 2,000 2,000 2,000 14 Liters =	→ → → → →0.935 →0.949 →0.949	1.0086 1.0086 1.0086 1.0086 0.4942	1.0086 ft^3	1.0202	Douglas Kiesling WTMCF = 1.0296 average = 0.981 average = 1.0053
10/16					0	14.479(L) 14.479(L) 14.478(L)	14 Liter		.4944	ft^3	1.03215 1.03215 1.03430	J.G. Avg. 1.0329

BALANCE RECORD SHEET

Balance Identification OHAUS #14019 Standard Weight Identification BALANCE TARE Weights

DATE	(1) Weight of Impinger Water & Standard Weight	(2) Weight of Impinger & Water	(3) Difference of (1) & (2)	(4) Standard Weight	(5) Difference of (3) & (4)	(6) % Difference	Technician
1/18/80	295g	0	295g	295g	0	0%	R L Vail
	590g	0	590g	590g	0	0%	R L Vail

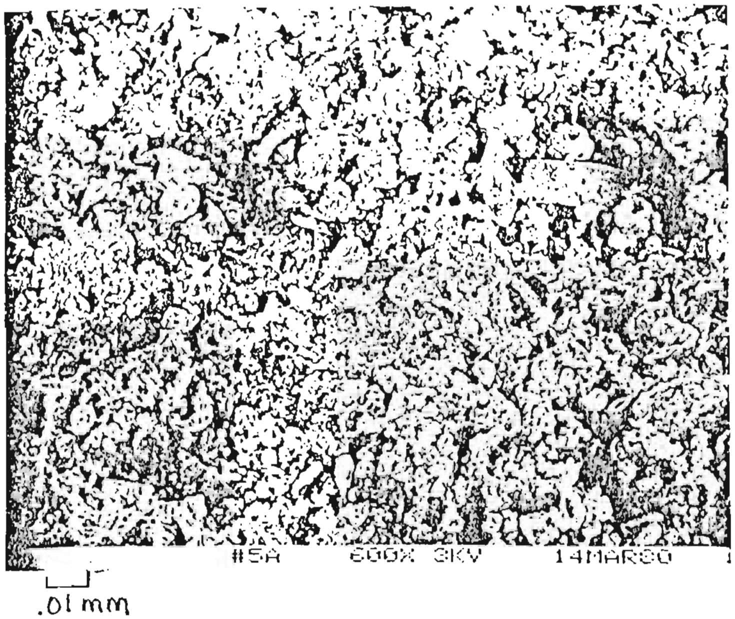
BAROMETER RECORD SHEET

DATE	UNCORRECTED STATION PRESSURE	ANEROID BAROMETER READING minus 0.123	DIFFERENCE	COMMENTS	TECHNICIAN
1/24/79	* 29.65	29.70	.05	adjusted to 29.65	R. L. V.
2/21/79	* 30.09	30.06	.03	adjusted to 30.09	R. L. V.
3/29/79	* 30.168	30.25	.06		
11/8/79	29.89 corrected	29.87	(-) 02	unadjusted, correction noted	J. Glunn
1/18/80	29.923	29.93	.007	none	B. Kerckhoff

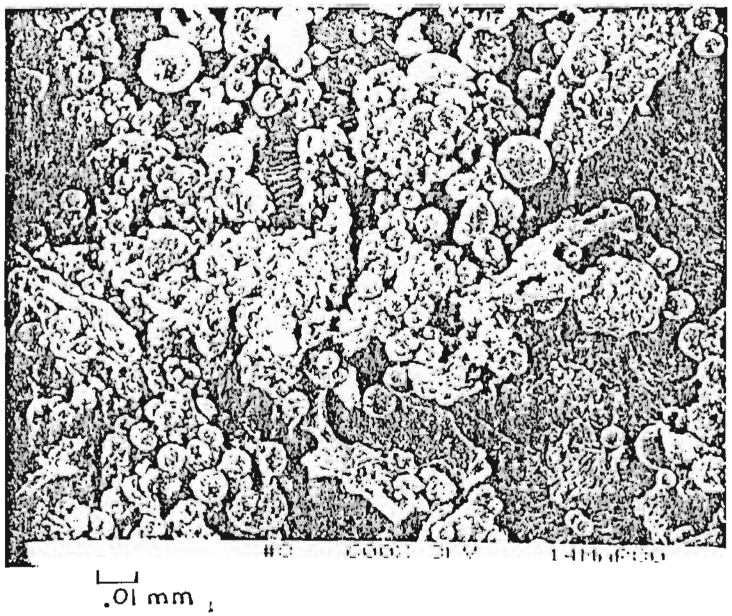
* for Blairstone rd location,

Dry Gas MeTer Check

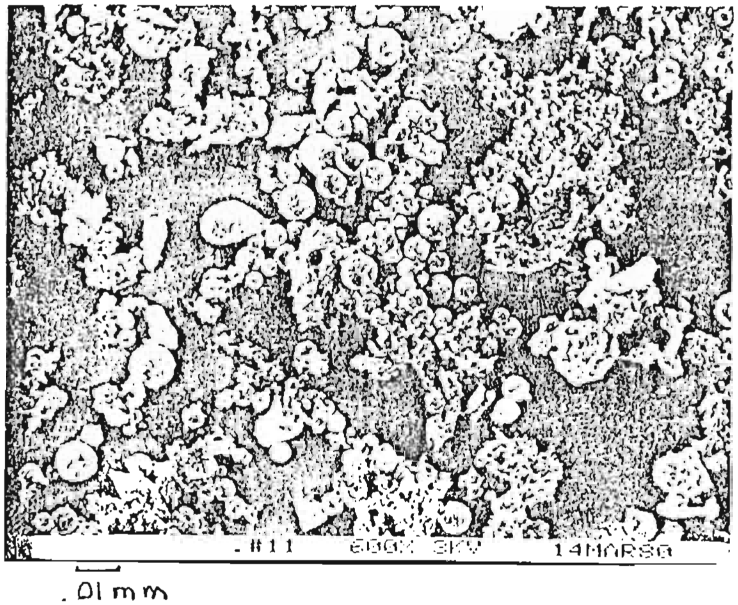
DaTe	ΔH@ aT ΔH=2.0 lasT calibration record	ΔH@ of check	% off	Name & DaTe
1/18/80	1.7518	1.75	00.103%	Brian Kerckhoff / 1/18/80



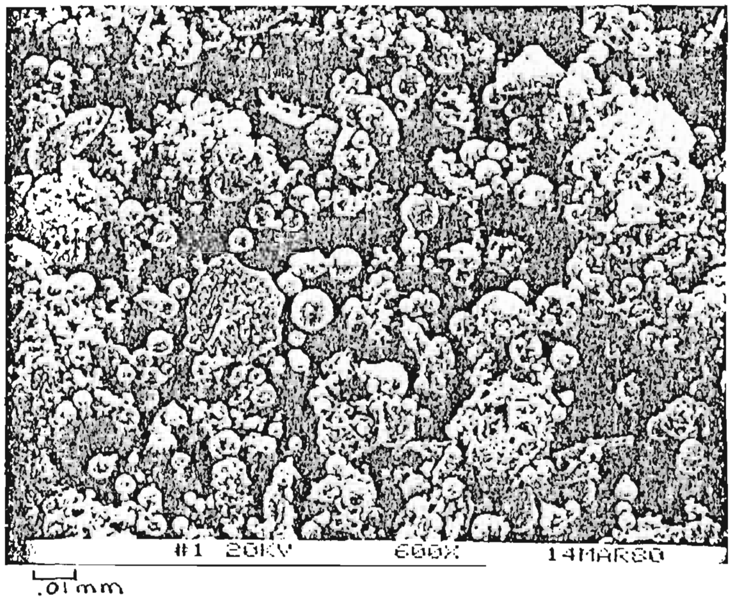
COAL FLYASH, BULK SAMPLE



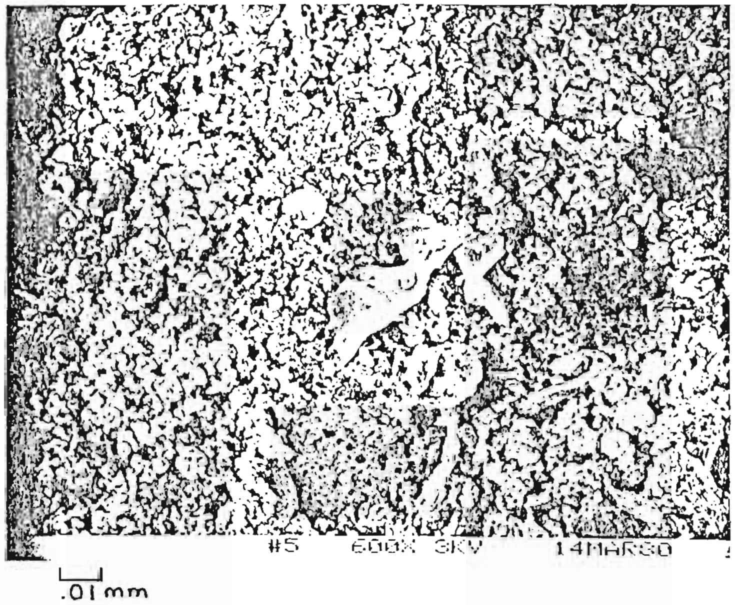
WOOD FLYASH,BIO 2



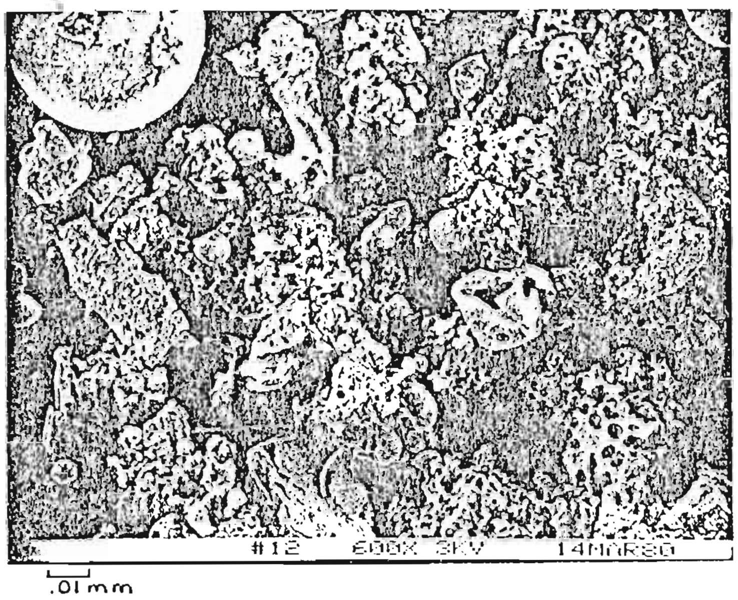
WOOD FLYASH, BIO 3



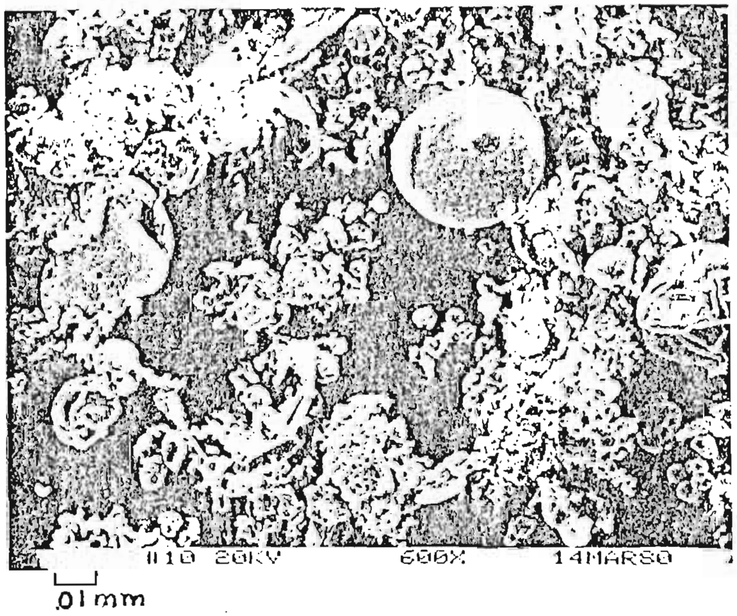
WOOD FLYASH, BIO 6



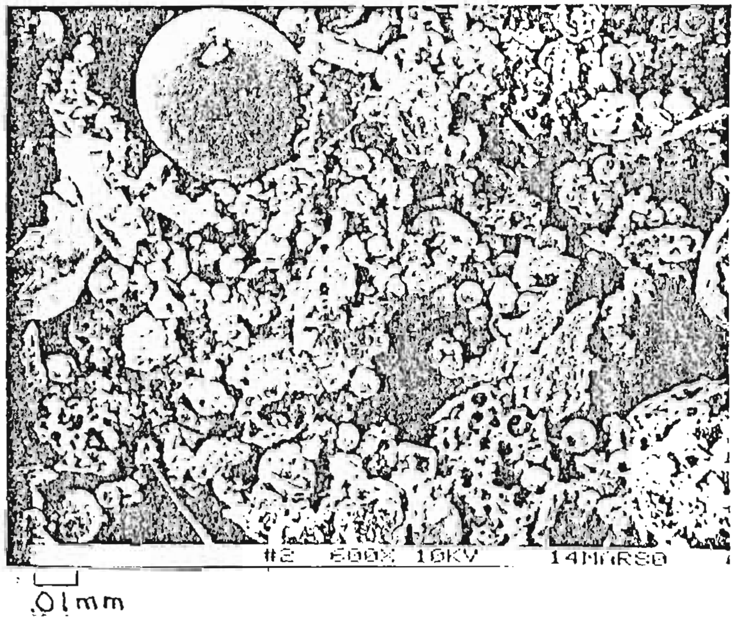
COAL FLYASH, COAL 1



WOOD/COAL, FLYASH, WC 2



WOOD/COAL FLYASH, WC 1

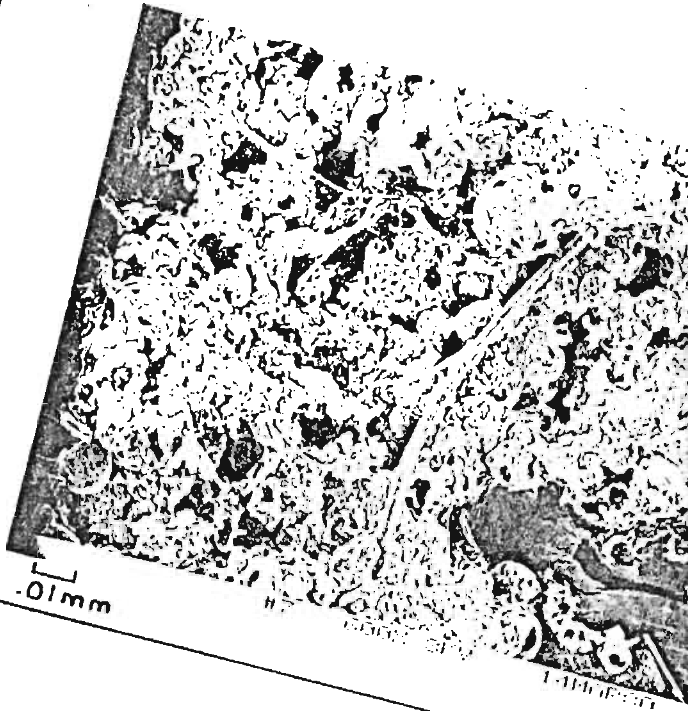


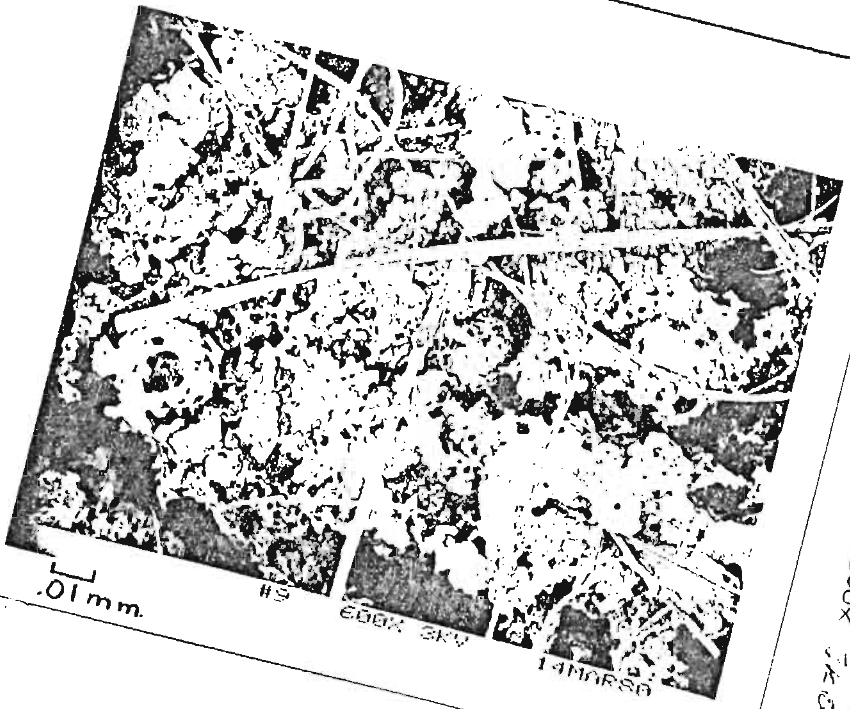
WOOD/COAL FLYASH, WC 3

BEST AVAILABLE COPY

KEY TO PHOTOGRAPHS

WOOD FUEL COAL FUEL	WOOD FUEL WOOD/COAL FUEL
KEY OIL FLYASH HALF LOAD	OIL FLYASH HALF LOAD OIL FLYASH FULL LOAD





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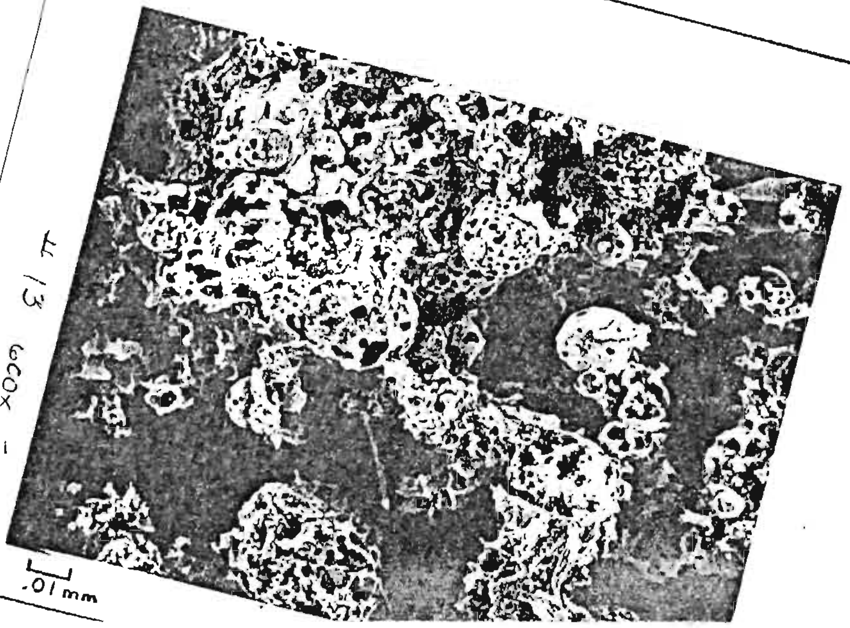

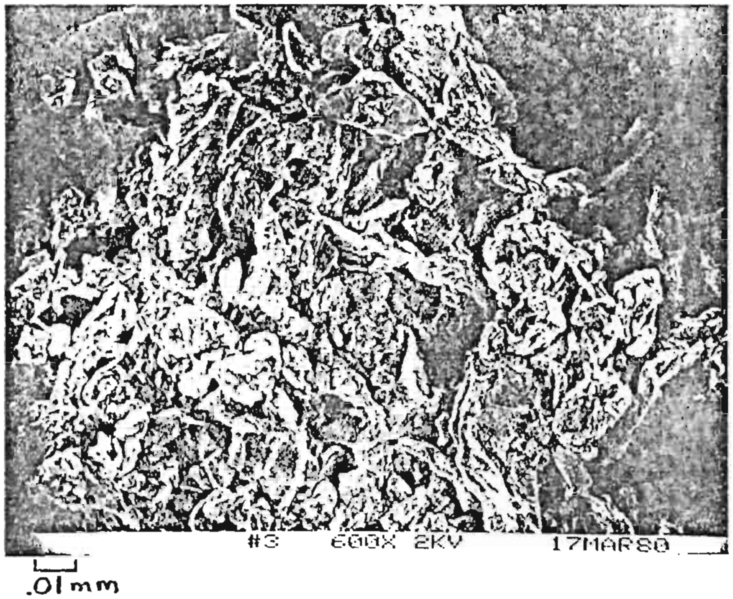
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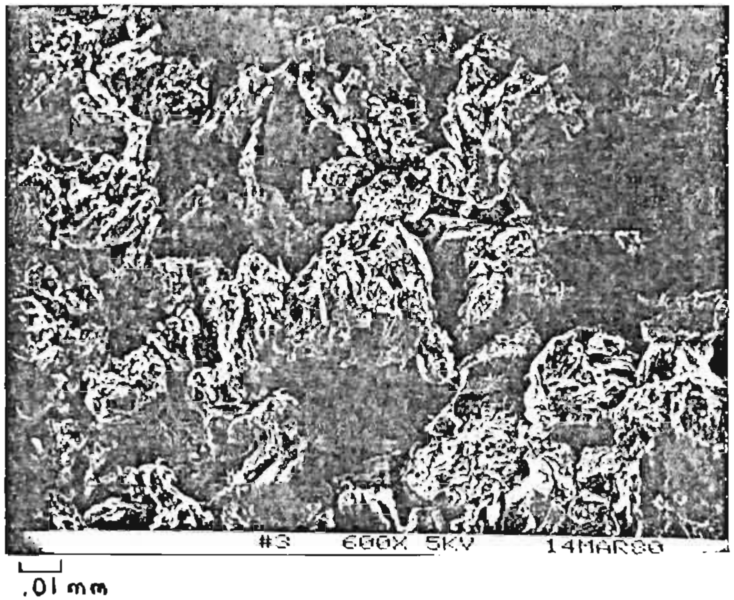
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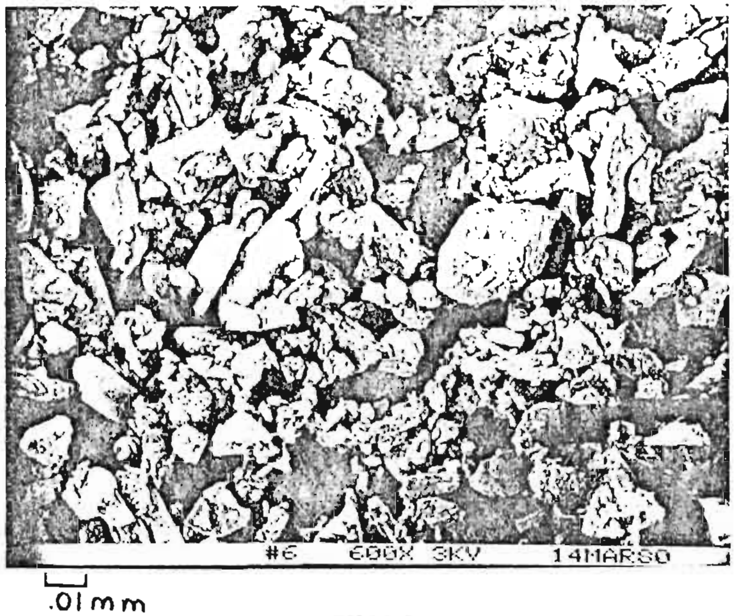
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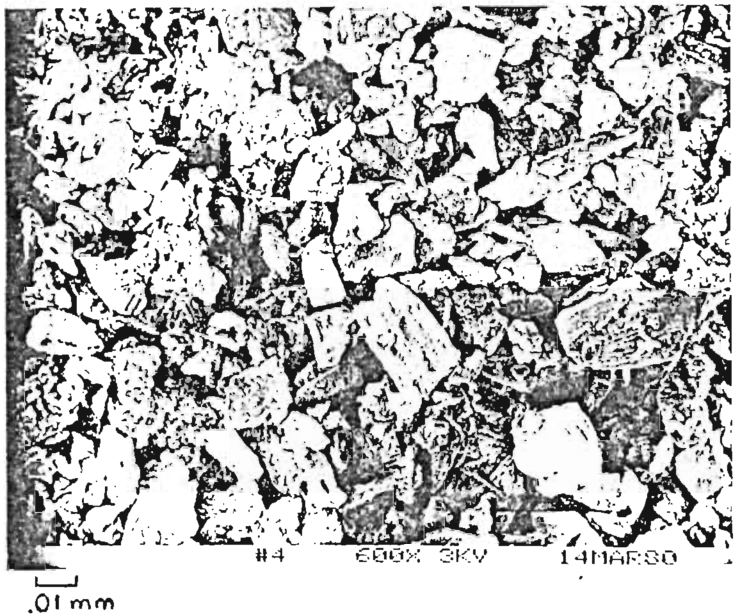
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Technical Evaluation

and

Preliminary Determination

Florida State Hospital

Gadsden County

Chattahoochee, Florida

Permit Numbers:

State: AC 20-49787
Federal: PSD-FL-093

Florida Department of Environmental Regulation

Bureau of Air Quality Management

Central Air Permitting

PUBLIC NOTICE

The Florida Department of Environmental Regulation (FDER) has received an application from and intends to issue a construction permit to Florida State Hospital-Chattahoochee for the modification of two(2) water-tube power boilers, Nos. 7 and 8, to test burn pelletized wood (88%) and No. 6 Fuel Oil (12%) at its existing steam power generating plant in Gadsden County. The modification requires Best Available Control Technology (BACT) as well as both State and Federal review for Prevention of Significant Deterioration (PSD)(Chapter 17-2.500, Florida Administrative Code (FAC), and Federal Regulation, 40 CFR 52.21).

The modification will increase emissions of air pollutants by the following amounts, for a period of time not to exceed two years:

Particulate matter (PM)	331 tons/year(TPY)
Hydrocarbons (HC)	34 TPY
Carbon monoxide (CO)	51 TPY

By authority of the USEPA, the Florida Department of Environmental Regulation (FDER) has reviewed the proposed modification project under federal PSD regulations (40 CFR 52.21). The FDER has made a preliminary determination that the modifications can be approved provided certain conditions are met. A summary of the basis for this determination and the application for a permit submitted by Florida State Hospital-Chattahoochee are available for public review at the Chattahoochee Public Library, Chattahoochee, Florida, and the following FDER offices:

Northwest District
160 Governmental Center
Pensacola, Florida 32501

Bureau of Air Quality Management
2600 Blair Stone Road
Tallahassee, Florida 32301

Any person may submit written comments to FDER regarding the proposed construction/modification. All comments postmarked not later than 30 days from the date of this notice will be considered by FDER in making a final determination regarding approval of this project. These comments will be made available for public review at the above locations. All comments should be addressed to:

Mr. C. H. Fancy, Deputy Bureau Chief
Central Air Permitting Section
Bureau of Air Quality Management
Florida Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, Florida 32301

Furthermore, a public hearing can be requested by any person. Such requests should be submitted in writing within 14 days of the date of this notice. Letters should be addressed to:

Ms. Martha Harrell Hall
Office of General Counsel
Florida Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, Florida 32301

RULES OF THE ADMINISTRATIVE COMMISSION
MODEL RULES OF PROCEDURE
CHAPTER 28-5
DECISIONS DETERMINING SUBSTANTIAL INTERESTS

28-5.15 Requests for Formal and Informal Proceedings

(1) Requests for proceedings shall be made by petition to the agency involved. Each petition shall be printed typewritten or otherwise duplicated in legible form on white paper of standard legal size. Unless printed, the impression shall be on one side of the paper only and lines shall be double spaced and indented.

(2) All petitions filed under these rules should contain:

- (a) The name and address of each agency affected and each agency's file or identification number, if known;
- (b) The name and address of the petitioner or petitioners;
- (c) All disputed issues of material fact. If there are none, the petition must so indicate;
- (d) A concise statement of the ultimate facts alleged, and the rules, regulations and constitutional provisions which entitle the petitioner to relief;
- (e) A statement summarizing any informal action taken to resolve the issues, and the results of that action;
- (f) A demand for the relief to which the petitioner deems himself entitled; and
- (g) Such other information which the petitioner contends is material.

Technical Evaluation
and
Preliminary Determination

CONTENTS

I. PROJECT DESCRIPTION

A. Applicant

Florida State Hospital
Highway 90
Chattahoochee, Florida 32324

B. Project and Location

The applicant plans to convert two of its existing boilers, Nos. 7 and 8, to test burn refined wood (pellets) as a fuel, supplemented (12%) with No. 6 Fuel Oil (maximum 2.0% sulfur content by weight). The design incorporates replacement burners, fuel pulverizers, air pollution control equipment additions (retrofitting of wet scrubbers in series with existing cyclones), fuel receiving and handling systems, and auxiliaries for safe and reliable operation. The existing ash pond will be modified to accommodate the quantities of wood ash to be generated.

The Florida State Hospital steam plant is located on the north side of Hwy. 90 just east of Chattahoochee, Florida. The UTM coordinates are Zone 17-707.4 km. east and 3398.5 km. north. Hours of operation will be 8,760 hours per year.

C. Process and Control

The operation of the steam plant, burning refined wood as fuel, will require approximately eight 25-ton truck loads daily at peak periods. The existing coal receiving area will be modified to receive, unload, store, and convey the wood pellets to the existing holding bunkers inside the boiler plant building. A wood pellet conveying system will be installed between the unloading area and the gantry. Other modifications will include a truck scale station, fuel receiving hopper-bottom bunkers, a tramp iron magnet, a scalping-type classifier, automatic conveyors, storage facilities, pulverizing and burning equipment, instrumentation, and controls.

Particulate emissions will be controlled by using the existing cyclone dust collectors in series with wet scrubbers (to be retrofitted). The existing ash removal system, utilizing a wet sluice and settling pond, will be modified to receive the quantities of wood ash to be generated.

Utilizing wood and reducing No. 6 Fuel Oil consumption will reduce the current SO_2 and NO_x emissions by approximately 1014 and 84 tons per year (TPY), respectively.

II. SUMMARY OF EMISSIONS

The current actual emissions (based on 100% firing of No. 6 Fuel Oil), the potential/interim emissions (after partial cyclonic separator control-assumed a 60% removal efficiency for particulate matter (PM)), and design goal emission limits (after BACT) for the proposed project are in the following table and reflect the total emissions from both boilers.

Pollutant	Current Actual Emissions tons/year	Interim Emissions tons/year	Design Goal Emission Limits tons/year
PM	88.91	419.82	114.52
Sulfur dioxide	1213.92	199.99	199.99
Nitrogen oxides	231.96	148.39	148.39
Hydrocarbon	3.86	37.99	37.99
Carbon monoxide	19.33	69.94	69.94

Note: Boilers No. 6 and 9 are not included in the table because they are not being modified.

At the end of the two-year testing period, the design goal emission limits should be attainable by the installation/retrofitting of additional control equipment.

III. RULE APPLICABILITY

A. State Rule

The proposed project is subject to preconstruction review under the provisions of Chapter 403, Florida Statutes (FS) and Chapter 17-2, Florida Administrative Code (FAC).

Again, this project is the conversion of No. 7 and No. 8 boilers to test wood pellets as a fuel, supplemented (12%) with No. 6 Fuel Oil (maximum 2.0% sulfur content by weight). Since the operation of boilers No. 6 and No. 9 will not change, their emissions are not included in this determination.

The proposed project will also be a less than two-year duration. The firing of wood pellets has not yet been demonstrated to the extent that the particulate quality and quantity in the flue gas are documented. Therefore, the proposed project will test for these parameters in order to design the best control device and then be retrofitted.

For construction or modification of air pollutant emitting facilities in those parts of the state in which the state ambient air quality standards are being met, a review for prevention of significant deterioration (PSD) applicability is required according to Chapter 17-2.500, FAC. Because the net emissions increase of the proposed modification would not exceed two years and the Department of Health and Rehabilitative Services (DHRS) has provided the Department of Environmental Regulation (DER) with reasonable assurance that the emissions from the facility or net emissions increase of the modification would not cause or contribute to a violation of any ambient air quality standard or have a significant impact on any Class I area, the proposed project will be permitted in accordance with Chapter 17-2.500(3)(c)1. and 2., FAC, Temporary Emissions. New Source Review (NSR) requirements of this section shall be in accordance of Chapter 17-2.500(5)(a) (b), and (c), FAC, Preconstruction Review Requirements, which requires compliance with all applicable emission limitations contained in Part VI of Chapter 17-2, FAC, and 40 CFR Parts 60 and 61, and the application of Best Available Control Technology (BACT) for each pollutant subject to NSR requirements as set forth in Chapter 17-2.500(2)(f), FAC. For the proposed project, PSD review is required for particulate matter (PM) only.

Since there are emission limiting standards in Part VI of Chapter 17-2, FAC, the BACT imposed emission limit for PM will be at least as stringent and in accordance with Chapter 17-2.600 (10), FAC, Carbonaceous Fuel Burning Equipment. The wood pellets are a carbonaceous fuel as defined in Chapter 17-2.100(28), FAC. The No. 6 Fuel Oil is a fossil fuel as defined in Chapter 17-2. 100(68), FAC. Because of the individual boiler sizes (Nos. 7 and 8 are both <250 x 10^6 Btu/hr heat input), the proposed project is not subject to the federal New Source Performance Standards (NSPS) for fossil-fuel steam generators (40 CFR 60.40, Subpart D) adopted by reference under Chapter 17-2.660, FAC. Under current operating permits and while burning liquid fossil fuel only, the boilers are subject to a visible emissions limit of 20% opacity, not to be exceeded, and a sulfur content restriction (maximum 2.0% content by weight).

B. Federal Rule

The proposed temporary project is subject to federal PSD review because it is a major modification according to 40 CFR 52.21 (b)(2). The net increases for the pollutants emitted and the significant emissions rates are listed below:

Regulated Pollutant	Net Emission Increase tons/year	Significant Emission Rate tons/year
PM	330.91*	25
SO_2	-1013.93	40
NO_x	-83.57	40
HC	34.13	40
CO	50.61	100

*This value incorporates the assumed 60% cyclone separator removal efficiency.

Since the proposed project is a change in the method of operation of an existing major stationary source which would result in a significant net emissions increase of at least one regulated pollutant for less than two years, it constitutes a major modification subject to review under federal PSD regulations (40 CFR 52.21(i)(6)). PSD review consists of a determination of Best Available Control Technology (BACT) and, unless otherwise exempted, an air quality impact analysis for each attainment pollutant that would be emitted in a significant net amount. For the proposed project, PSD review is required for PM only. Since the project duration will not exceed two years, the Bureau's Air Modeling Section has demonstrated that the PM emissions will not violate ambient air quality standards and PSD Class I increment. The BACT determination for PM takes into account that the proposed project is a test program of limited duration.

Since boilers No. 7 and No. 8 have a maximum heat input rate less than 250 million Btu/hr, the project is not subject to the federal New Source Performance Standards (NSPS) for fossil-fuel steam generators (40 CFR 60.40, Subpart D).

IV. CONTROL TECHNOLOGY

For each facility and each regulated pollutant subject to PSD review, a Best Available Control Technology (BACT) emissions standard is required as a PSD permit condition. The only pollutant requiring a BACT review is particulate matter.

A. Particulate Matter (PM)

Both of the boilers being modified have existing cyclone separators. After upgrading, their projected/assumed removal efficiency will be 60%.

The flue gas will be tested for PM quality and quantity after cyclone separator pretreatment. The data gathered will be evaluated and used to design a retrofit control device that will further clean the flue gas to meet the BACT goal emission limits.

The following modification and testing schedule was presented by the applicant for the proposed project:

1. Complete conversion of Boiler No. 7 by 11/82,
2. Upgrade cyclone, Boiler No. 7 by 11/82,
3. Complete conversion of Boiler No. 8 by 4/83,
4. Upgrade cyclone, Boiler No. 8 by 4/83,
5. Stack test for emissions, Boiler No. 7: 12/82 to 2/83,
6. Prepare and testify for Fixed Capital Outlay request: 10/82-5/83,
7. Prepare program for air quality controls: 4/83-6/83,
8. Contract for corrective Architectural/Engineering steps: 7/83-8/83,
9. Design of control equipment: 8/83-11/83,
10. Bid/award contract: 12/83-1/84,
11. Install controls, Boiler No. 7: 1/84-4/84, and
12. Install controls, Boiler No. 8: 4/84-7/84.

The following table displays the "interim projected emissions", which have been reviewed by the Bureau's Air Modeling Section and will not violate any ambient air quality standard, impact any PSD Class I area, nor affect any area of known increment violations.

Boiler	Pollutant	Interim Projected Emissions[1] lbs/hr	 TPY
No. 7	PM	47.96	210.06
No. 8	PM	47.89	209.76

[1] IPE - Value is after cyclone separator flue gas pretreatment having an assumed 60% removal efficiency.

Upon completion of the proposed project or no later than November 30, 1984, the BACT goal emission limitations should be attainable, and those limitations are:

Fuel	PM Goal Emission Limitations
Wood pellets (carbonaceous)	0.2 lb/10^6 Btu heat input
No. 6 Fuel Oil	0.1 lb/10^6 Btu heat input
Visible Emissions	not to exceed 20% opacity, except that 40% opacity is permissible for not more than two minutes in any one hour

Since both boilers, Nos. 7 and 8, are less than 250 x 10^6 Btu/hr heat input, 40 CFR 60.40, Subpart D, New Source Performance Standards (NSPS), is not applicable. Therefore, the emission limitations imposed as BACT were based on Chapter 17-2.600(10), Florida Administrative Code (FAC), Carbonaceous Fuel Burning Equipment (>30 x 10^6 Btu/hr heat input). The visible emissions limit is the same limit that would be imposed on fossil-fuel fired steam generators (>250 x 10^6 Btu/hr heat input, 17-2.600(5), FAC) and by the General Particulate Emission Limiting Standard (17-2.610(2), FAC).

V. AIR QUALITY IMPACT ANALYSIS

The FDER is proposing to issue a temporary permit to the Florida State Hospital to burn wood pellets and number 6 fuel oil in their number 7 and 8 boilers. The provisions of the new and modified source review requirements, (Rule 17-2.500) for temporary emissions require that no State or federal ambient air quality standard or Class I PSD increment be violated as a result of the temporary emissions increase. The modifications to boilers 7 and 8 will result in a significant emissions increase for particulate matter (PM) only. The FDER has provided the necessary analysis needed to show that, subject to the conditions of approval described in this permit, FDER has reasonable assurance that the Florida State Hospital modification will not cause or contribute to a violation of any State or federal ambient air quality standard or Class I PSD increment.

Modeling Methodology

Two FDER and EPA-approved dispersion models were used in the State and federal air quality impact analysis. These were the Single-Source (CRSTER) and Industrial Source Complex Short Term (ISCST) models.

These models were used to predict maximum ground-level concentrations for annual and short-term (24 hour) averaging times.

The CRSTER model was run first, using four years of meteorological data. The surface data used were National Weather Service data collected at Tallahassee, Florida, during the period 1977-80. Upper air meteorological data used were collected during the same time period at Waycross, Georgia. The year of data (1980) which predicted the highest concentrations was then used in the ISCST model.

The annual mean and highest 24-hour concentrations as determined by the ISCST model were used in conjunction with an appropriate background concentration to compare with the ambient air quality standards. A background concentration of PM was estimated from monitors located in Leon County (the county adjacent to Gadsden County) as 45 ug/m^3.

The stack parameters for all emission units at the facility which emit PM are contained in the following table.

Stack Parameters for the Florida State Hospital

Emission Unit	Stack Height	Stack Dia.(m)	Exit Temp.(K)	Exit Vel.(m/s)	Emission Rate PM(g/s)
Boiler 6	28.0	1.22	400.	8.44	1.12
Boiler 7	28.0	1.22	494.	14.64	6.04(1)
Boiler 8	28.0	1.22	458.	9.87	6.03(1)
Boiler 9	56.1	2.13	408.	4.66	1.30

(1) Assuming 60% removal by control equipment.

Ambient Air Quality Standards Analysis

Both the State and federal regulations require that no ambient air quality standard be violated. As shown in the following table, modeling results predict the maximum ground-level concentrations for PM will be below the Florida Ambient Air Quality Standards (FAAQS) and National Ambient Air Quality Standards (NAAQS).

Pollutant	Averaging Time	Projected Maximum Concentration(ug/m^3)	NAAQS (ug/m^3)	FAAQS (ug/m^3)
PM	Annual	52 (1)	75	60
	24-hour	72 (1)	260	150

(1) Background concentration of 45 ug/m^3 included.

Class I PSD Increment Analysis

The Florida State Hospital is located approximately 60 kilometers northwest of Bradwell Bay, the nearest Class I area. A screening analysis using the methods described in the Guidelines for Air Quality Maintenance Planning and Analysis, Volume 10 (revised), determined the impact of the increment consuming sources on the Class I area.

The following table lists the increment consuming sources at the Florida Hospital along with the portion of each source's emission rate that consumes increment.

Emission Unit	Increment Emissions PM(g/s)
Boiler 7	4.73 (1)
Boiler 8	4.72 (1)
Boiler 9	1.30

(1) Assuming 60% removal by control equipment.

The results of the screening calculations show a maximum 24-hour increment consumption in the Class I area of 2 ug/m^3 and a maximum annual increment consumption of less than 1 ug/m^3. The allowable increments are 10 ug/m^3 and 5 ug/m^3 for the 24-hour and annual averaging periods, respectively.

VI. CONCLUSIONS

The emissions projected by the applicant are reasonable for the test period (<2 years). Upon conclusion of the modifications and testing program, the design goal emission limitations as described in the BACT determination shall become effective. The project schedule as well as additional provisions outlined in the BACT determination shall become conditions of the permit.

The state construction permit and the federal PSD permit are temporary permits, less than two-year duration, and are not renewable. If, after completion of the proposed project, the applicant desires to continue the use of wood pellets as a fuel, the applicant must submit an application to construct/modify an air pollution source.

The Specific and General conditions stated in the proposed state permit (AC 20-49787) and federal permit (PSD-FL-093), respectively, will assure no violations of ambient air quality standards, nor impact PSD Class I areas or areas of known increment violations. The Specific conditions for the state permit will be the same for the federal permit.

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

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

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

APPLICANT:

Florida State Hospital-Chattahoochee
Department of Health and Rehabilitative Services
Highway 90
Chattahoochee, Florida 32324

PERMIT/CERTIFICATION NO. AC 20-49787

COUNTY: Gadsden

PROJECT: Less Than Two Year Test Project/Boiler Modification for No. 7 and No. 8

This permit is issued under the provisions of Chapter 403, Florida Statutes, and Chapter 17-2 17-4, Florida Administrative Code. The above named applicant, hereinafter called Permittee, is hereby authorized to perform the work or operate the facility shown on the approved drawing(s), plans, documents, and specifications attached hereto and made a part hereof and specifically described as follows:

The project consists of modifying boilers No. 7 and No. 8 to test burn wood pellets, supplemented (12%) with No. 6 Fuel Oil (maximum 2.0% sulfur content by weight). The project is a modification to an existing major facility located east of Chattahoochee, Gadsden County, Florida. The UTM coordinates are Zone 17-707.4 km. east and 3398.5 km. north.

Boilers No. 7 and No. 8 are rated at 69.6 and 69.5 million Btu per hour heat input, respectively. Both boilers have a maximum capacity of 60,000 lbs/hr. of steam product.

Construction shall be in accordance with the attached permit application, plans, documents and drawings except as otherwise noted in the specific conditions.

Attachments are as follows and, where applicable, a part of this permit:

1. Listing of attachments.

PERMIT NO.: AC 20-49787
APPLICANT: Florida State Hospital- Chattahoochee

GENERAL CONDITIONS:

1. The terms, conditions, requirements, limitations, and restrictions set forth herein are "Permit Conditions:, and as such are binding upon the permittee and enforceable pursuant to the authority of Section 403.161(1), Florida Statutes. Permittee is hereby placed on notice that the department will review this permit periodically and may initiate court action for any violation of the "Permit Conditions" by the permittee, its agents, employees, servants or representatives.

2. This permit is valid only for the specific processes and operations indicated in the attached drawings or exhibits. Any unauthorized deviation from the approved drawings, exhibits, specifications, or conditions of this permit shall constitute grounds for revocation and enforcement action by the department.

3. If, for any reason, the permittee does not comply with or will be unable to comply with any condition or limitation specified in this permit, the permittee shall immediately notify and provide the department with the following information: (a) a description of and cause of non-compliance; and (b) the period of non-compliance, including exact dates and times; or, if not corrected, the anticipated time the non-compliance is expected to continue, and steps being taken to reduce, eliminate, and prevent recurrence of the non-compliance. The permittee shall be responsible for any and all damages which may result and may be subject to enforcement action by the department for penalties or revocation of this permit.

4. As provided in subsection 403.087(6), Florida Statutes, the issuance of this permit does not convey any vested rights or any exclusive privileges. Nor does it authorize any injury to public or private property or any invasion of personal rights, nor any infringement of federal, state or local laws or regulations.

5. This permit is required to be posted in a conspicuous location at the work site or source during the entire period of construction or operation.

6. In accepting this permit, the permittee understands and agrees that all records, notes, monitoring data and other information relating to the construction or operation of this permitted source, which are submitted to the department, may be used by the department as evidence in any enforcement case arising under the Florida Statutes or department rules, except where such use is proscribed by Section 403.111, F.S.

7. In the case of an operation permit, permittee agrees to comply with changes in department rules and Florida Statutes after a reasonable time for compliance, provided, however, the permittee does not waive any other rights granted by Florida Statutes or department rules.

8. This permit does not relieve the permittee from liability for harm or injury to human health or welfare, animal, plant, or aquatic life or property and penalities therefore caused by the construction or operation of this permitted source, nor does it allow the permittee to cause pollution in contravention of Florida Statutes and department rules, except where specifically authorized by an order from the department granting a variance or exception from department rules or state statutes.

9. This permit is not transferable. Upon sale or legal transfer of the property or facility covered by this permit, the permittee shall notify the department within thirty (30) days. The new owner must apply for a permit transfer within thirty (30) days. The permittee shall be liable for any non-compliance of the permitted source until the transferee applies for and receives a transfer of permit.

10. The permittee, by acceptance of this permit, specifically agrees to allow access to permitted source at reasonable times by department personnel presenting credentials for the purposes of inspection and testing to determine compliance with this permit and department rules.

11. This permit does not indicate a waiver of or approval of any other department permit that may be required for other aspects of the total project.

12. This permit conveys no title to land or water, nor constitutes state recognition or acknowledgement of title, and does not constitute authority for the reclamation of submerged lands unless herein provided and the necessary title or leasehold interests have been obtained from the state. Only the Trustees of the Internal Improvement Trust Fund may express state opinion as to title.

13. This permit also constitutes:

☒ Determination of Best Available Control Technology (BACT)
☒ Determination of Prevention of Significant Deterioration (PSD)
☐ Certification of Compliance with State Water Quality Standards (Section 401, PL 92-500)

PERMIT NO.: AC 20-49787
APPLICANT: Florida State Hospital- Chattahoochee

SPECIFIC CONDITIONS:

1. This permit is temporary and is not renewable.
2. Hours of operation are 8760 annually.
3. From the firing of any fuel(s), maximum heat input for boilers No. 7 and No. 8 shall not exceed 69.6 and 69.5 million Btu/hr., respectively, to produce a maximum 60,000 lbs/hr of turbine steam product each.
4. During the test period, the interim particulate matter (PM) projected emissions from No. 7 and No. 8 boilers are:

Boiler	Fuel	Pollutant	Interim Projected Emissions lbs/hr	 TPY
No. 7	88% Wood Pellets 12% No. 6 Fuel Oil	PM	47.96	210.06
No. 8	88% Wood Pellets 12% No. 6 Fuel Oil	PM	47.89	209.76

5. The visible emissions (VE), while firing wood pellets (88%) and No. 6 Fuel Oil (12%), shall not exceed 20% opacity (except during a test), and 40% opacity is permissible for not more than two minutes in any one hour. While firing 100% No. 6 Fuel Oil, the VE shall not exceed 20% opacity, except 40% opacity is permissible for not more than two minutes in any one hour.

6. The maximum sulfur content of the No. 6 Fuel Oil shall not exceed 2.0% by weight.

7. The VE compliance test shall be DER Method 9.

8. The compliance test for PM shall be DER Method 5, Acetone wash.

9. The compliance for SO_2 emissions shall be by submission of the fuel oil analysis at the time of the PM compliance test.

PERMIT NO.: AC 20-49787
APPLICANT: Florida State Hospital-Chattahoochee

10. The test plan and schedule, as submitted by the applicant, shall be reasonably adhered to and is as follows:

    a. Complete conversion of Boiler No. 7 by 11/82,
    b. Upgrade cyclone, Boiler No. 7 by 11/82,
    c. Complete conversion of Boiler No. 8 by 4/83,
    d. Upgrade cyclone, Boiler No. 8 by 4/83,
    e. Stack test for emissions, Boiler No. 7: 12/82 to 2/83,
    f. Prepare and testify for Fixed Capital Outlay request: 10/82-5/83,
    g. Prepare program for air quality controls: 4/83-6/83,
    h. Contract for corrective Architectural/Engineering steps: 7/83-8/83,
    i. Design of control equipment: 8/83-11/83,
    j. Bid/award contract: 12/83-1/84,
    k. Install controls, Boiler No. 7: 1/84-4/84, and
    l. Install controls, Boiler No. 8: 4/84-7/84.

11. A project progress report is to be submitted every ninety (90) days to the DER Northwest District Office, to the attention of Mr. Jack Preece/Air Engineer.

12. If the applicant desires to continue to fire wood pellets as a fuel after the test project is concluded, the applicant must submit an application to construct/modify an air pollution source to the DER Bureau of Air Quality Management/ Central Air Permitting Section not later than August 31, 1984.

13. The applicant can continue 100% No. 6 Fuel Oil, maximum 2.0% sulfur content by weight, in boilers No. 7 and No. 8, with the current operating permit conditions applicable.

Expiration Date: September 30, 1984

Issued this ______ day of ______________, 19______.

______ Pages Attached.

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

____
Signature

FEDERAL PERMIT
GENERAL CONDITIONS

1. The permittee shall notify the permitting authority in writing of the beginning of construction of the permitted source within 30 days of such action and the estimated date of start-up of operation.

2. The permittee shall notify the permitting authority in writing of the actual start-up of the permitted source within 30 days of such action and the estimated date of demonstration of compliance as required in the specific conditions.

3. Each emission point for which an emission test method is established in this permit shall be tested in order to determine compliance with the emission limitations contained herein within sixty (60) days of achieving the maximum production rate, but in no event later than 180 days after initial start-up of the permitted source. The permittee shall notify the permitting authority of the scheduled date of compliance testing at least thirty (30) days in advance of such test. Compliance test results shall be submitted to the permitting authority within forty-five (45) days after the complete testing. The permittee shall provide (1) sampling ports adequate for test methods applicable to such facility, (2) safe sampling platforms, (3) safe access to sampling platforms, and (4) utilities for sampling and testing equipment.

4. The permittee shall retain records of all information resulting from monitoring activities and information indicating operating parameters as specified in the specific conditions of this permit for a minimum of two (2) years from the date of recording.

5. If, for any reason, the permittee does not comply with or will not be able to comply with the emission limitations specified in this permit, the permittee shall immediately notify the State District Manager by telephone and provide the District Office and the permitting authority with the following information in writing within four (4) days of such conditions:

    (a) description for noncomplying emission(s),

    (b) cause of noncompliance,

    (c) anticipated time the noncompliance is expected to continue or, if corrected, the duration of the period of noncompliance,

(d) steps taken by the permittee to reduce and eliminate the noncomplying emission,

and

(e) steps taken by the permittee to prevent recurrence of the noncomplying emission.

Failure to provide the above information when appropriate shall constitute a violation of the terms and conditions of this permit. Submittal of this report does not constitute a waiver of the emission limitations contained within this permit.

6. Any change in the information submitted in the application regarding facility emissions or changes in the quantity or quality of materials processed that will result in new or increased emissions must be reported to the permitting authority. If appropriate, modifications to the permit may then be made by the permitting authority to reflect any necessary changes in the permit conditions. In no case are any new or increased emissions allowed that will cause violation of the emission limitations specified herein.

7. In the event of any change in control or ownership of the source described in the permit, the permittee shall notify the succeeding owner of the existence of this permit by letter and forward a copy of such letter to the permitting authority.

8. The permittee shall allow representatives of the State environmental control agency or representatives of the Environmental Protection Agency, upon the presentation of credentials:

   (a) to enter upon the permittee's premises, or other premises under the control of the permittee, where an air pollutant source is located or in which any records are required to be kept under the terms and conditions of the permit;

   (b) to have access to any copy at reasonable times any records required to be kept under the terms and conditions of this permit, or the Act;

   (c) to inspect at reasonable times any monitoring equipment or monitoring method required in this permit;

(d) to sample at reasonable times any emission of pollutants;

and

(e) to perform at reasonable times an operation and maintenance inspection of the permitted source.

9. All correspondence required to be submitted to this permit to the permitting agency shall be mailed to:

Mr. James T. Wilburn
Chief, Air Management Branch
Air & Waste Management Division
U.S. EPA, Region IV
345 Courtland Street, NE
Atlanta, GA 30365

10. The conditions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be affected thereby.

The emission of any pollutant more frequently or at a level in excess of that authorized by this permit shall constitute a violation of the terms and conditions of this permit.

ATTACHMENT I

Attachments

1. The List of Attachments.
2. Application to Construct/Modify Air Pollution Sources, DER FORM 17-1.122(16)
3. State Construction Permit BACT signed November 9, 1982.
4. Incompleteness letter dated December 29, 1981.
5. K. L. Anderson letter dated February 1, 1982.
6. Status letter dated April 8, 1982.
7. Status letter dated May 3, 1982.
8. Incompleteness letter dated July 12, 1982.
9. Homer A. Ooten letter dated July 12, 1982.
10. Status letter dated September 2, 1982.
11. Homer A. Ooten letter dated September 9, 1982.
12. Incompleteness letter dated September 20, 1982.
13. Homer A. Ooten letter dated October 7, 1982.
14. Status letter dated October 27, 1982.
15. Projected Source(s) Emissions dated October 29, 1982.

ATTACHMENT 2

AC 20 - 49787

DAN FARLEY & ASSOCIATES, P.A.
WATER'S EDGE, 1910 CAPITAL CIRCLE S.W., TALLAHASSEE, FLORIDA 32304 (904) 576-4110

AIR PERMIT
APPLICATION
TO THE
DEPARTMENT OF ENVIRONMENTAL
REGULATION
BY
THE FLORIDA STATE HOSPITAL
*** BOILER CONVERSION PROJECT ***

DAN FARLEY & ASSOCIATES, P.A.
ENVIRONMENTAL SERVICES
CONSULTANTS & PUBLIC RELATIONS
GOVERNMENTAL LIAISON

Water's Edge Executive Center
1910 Capital Circle, S.W.
Tallahassee, Florida 32304

Telephone: (904) 576-4110

November 9, 1981

Mr. Jack Preece
Department of Environmental
Regulation
160 Governmental Center
Pensacola, Florida 32561

Dear Mr. Preece:

RE: Transmittal of application for Air Permit
Boiler Conversion Project
Florida State Hospital
Chattahoochee, Florida

This is to transmit an application by the Florida State Hospital for the conversion of two boilers from No. 6 Fuel Oil to Pelletized Wood.

The existing facility consists of 4 boilers, Numbered 6, 7, 8, and 9, which are currently using No. 6 Fuel Oil. The project involves converting two of these boilers Nos. 7 and 8, to pelletized wood fuel. A small percentage of the fueling would remain No. 6 Fuel Oil (up to 12%).

This application package consists of the application form itself together with 9 attachments. Attachments 1-7 are bound together with the application into a pamphlet, four copies of which are enclosed. Attachments 8 and 9 are the contract documents and specifications and project blueprints, respectively, and one copy of each is being transmitted for your utilization.

As the firm of Dan Farley and Associates is under contract to handle all aspects of the DER Air Permit Processing, please contact me directly if you have any questions whatsoever concerning the application.

I look forward to working with you on this matter.

Sincerely,

Doug Jones

Doug Jones

cc: Reginald Davis, P.E.
Paul Kazcorowski, P.E.
Bob Mohrfeld, P.E.

BEST AVAILABLE COPY

NO FEE REQUIRED

AC 20-49787

RECEIVED
NOV 18 1981
NORTHWEST FLORIDA
DER

Mr. Tommy Parker
Eng. Office
904/663-7228

Mr. W.D. Murray
[illegible] Maintenance
904/663-7565
% Engineering [illegible]
F.S.H.
Chatt., Fla.

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

SOURCE TYPE: STEAM GENERATING PLANT [ ] New[1] [XX] Existing[1]

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

COMPANY NAME: FLORIDA STATE HOSPITAL COUNTY: GADSDEN

Identify the specific emission point source(s) addressed in this application (i.e. Lime Kiln No. 4 with Venturi Scrubber; Peeking Unit No. 2, Gas Fired) BOILERS NO. 7 & 8

SOURCE LOCATION: Street HIGHWAY 90 City CHATTAHOOCHEE

UTM: East 707400M North 3398500M

Latitude 30 ° 42 ' 16 "N Longitude 84 ° 50 ' 10 "W

APPLICANT NAME AND TITLE: WILLIAM D. MYERS, ADMINISTRATIVE SERVICES DIRECTOR

APPLICANT ADDRESS: FLORIDA STATE HOSPITAL, CHATTAHOOCHEE, FLORIDA 32324

SECTION I: STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

I am the undersigned owner or authorized representative* of FLORIDA STATE HOSPITAL

I certify that the statements made in this application for a MODIFICATION/CONSTRUCTION/AIR 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: William D. Myers

WILLIAM D. MYERS, ADMINISTRATIVE SERVICES DIRECTOR
Name and Title (Please Type)

Date: Nov. 4 1981 Telephone No. 904-663-7728

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 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.

Prepared by Doug Jones
Dan Farley & Associates, P.A.
1910 Capitol Circle, S.W.
Tallahassee, Fla. 32304

(Affix Seal)

DOUG JONES 25 SEP 81

Signed: Richard B. Williams

Richard B. Williams
Name (Please Type)

Sverdrup & Parcel and Associates, Inc.
Company Name (Please Type)

11 East Forsyth St., Jacksonville, Fl. 32202
Mailing Address (Please Type)

Florida Registration No. 9055 Date: 9/25/81 Telephone No. (904)356-5503

---

[1] See Section 17-2.02(15) and (22), Florida Administrative Code, (F.A.C.)

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 1

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

Start of Construction November 30, 1981 Completion of Construction March, 1983

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.)

$453,958 for emission control equipment. 2 wet scrubbers with ancilliary equipment.

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

PREVIOUS PERMITS: BOILER NO. 6: A020-4727; NO. 7: A020-4754; NO. 8: A020-4755; NO. 9: A020-4756. EXISTING PERMITS: BOILER NO. 6: A020-18161 (6-7-79/5-1-84); NO. 7: A020-20007 (6-6-79/5-1-84); NO. 8: A020-20008 (6-6-79/5-1-84); NO. 9: A020-20009 (6-6-79/5-1-84).

E. Is this application associated with or part of a Development of Regional Impact (DRI) pursuant to Chapter 380, Florida Statutes, and Chapter 22F-2, Florida Administrative Code? ____ Yes XX No

F. Normal equipment operating time: hrs/day 24; days/wk 7; wks/yr 52; if power plant, hrs/yr 8760;

if seasonal, describe: N/A

G. 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?	N/A
b. If yes, has "Lowest Achievable Emission Rate" been applied?	N/A
c. If yes, list non-attainment pollutants.	
2. Does best available control technology (BACT) apply to this source? If yes, see Section VI.	NO
3. Does the State "Prevention of Significant Deterioriation" (PSD) requirements apply to this source? If yes, see Sections VI and VII.	NO
4. Do "Standards of Performance for New Stationary Sources" (NSPS) apply to this source?	NO
5. Do "National Emission Standards for Hazardous Air Pollutants" (NESHAP) apply to this source?	NO

Attach all supportive information related to any answer of "Yes". Attach any justification for any answer of "No" that might be considered questionable. SEE ATTACHMENT 2.

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

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

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

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

1. Total Process Input Rate (lbs/hr):
2. Product Weight (lbs/hr):

C. Airborne Contaminants Emitted:

BOILER NO. 7, 67.8MMBTU/hr.

Name of Contaminant	Emission[1]* (1)		Allowed Emission[2] Rate per Ch. 17-2, F.A.C.	Allowable[3] Emission lbs/hr	Potential Emission[4] *SEE ATTCH 2		Relate to Flow Diagram
	Maximum lbs/hr	Actual T/yr			lbs/hr	T/yr	
Particulate	157.47	689.71	*See note (2)	12.75	157.47	689.71	exit gases
SO_2	23.11	101.20	N/A		23.11	101.20	
NO_x	16.95	74.24	N/A		16.95	74.24	
HC	4.34	19.01	N/A		4.34	19.01	
CO	8.60	37.66	N/A		8.60	37.66	

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

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles[5] Size Collected (in microns)	Basis for Efficiency (Sec. V, It[5]
Wet scrubbers with	Particulate	Adequate to	Majority .5 to 10	
ash pond. Name and		meet 17-2.05	microns	
type to be determined		(6) Standards		
by contractor				

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[1] See Section V, Item 2. *Note(1): Due to the lack of specific data re pelletized wood fuel, these estimates are taken from the DER letter of July 23, 1981 (Attch 2)

[2] Reference applicable emission standards and units (e.g., Section 17-2.05(6) Table II, E. (1), F.A.C. – 0.1 pounds per million BTU heat input) Note(2): §§17-2.05(6), Table II, I, FAC--0.2 lbs/MMBTU (carbonaceous) +0.1 lbs/MMBTU (fossil fuel)

[3] Calculated from operating rate and applicable standard

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

[5] If Applicable

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

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

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

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

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

2. Product Weight (lbs/hr): ________

C. Airborne Contaminants Emitted:

BOILER NO. 8 67.7 MMBTU/hr

Name of Contaminant	Emission*(1)		Allowed Emission[2] Rate per Ch. 17-2, F.A.C.	Allowable[3] Emission lbs/hr	Potential Emission[4]		Relate to Flow Diagram
	Maximum lbs/hr	Actual T/yr			lbs/hr *See ATTCH 2	T/yr	
Particulate	157.47	689.71	*See Note (2)		157.47	689.71	exit gases
SO_2	23.08	101.07	N/A		23.08	101.07	
NO_x	16.93	74.15	N/A		16.93	74.15	
HC	4.33	18.97	N/A		4.33	18.97	
CO	8.59	37.66	N/A		8.59	37.66	

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

Name and Type (Model & Serial No.)	Contaminant	Efficiency	Range of Particles[5] Size Collected (in microns)	Basis for Efficiency (Sec. V, It[5]
Same as for Boiler No. 7				

---

[1] See Section V, Item 2. *Note(1): Due to the lack of specific data re pelletized wood fuel, these estimates are taken from the DER letter of July 23, 1981 (ATTCH 2)

[2] Reference applicable emission standards and units (e.g., Section 17-2.05(6) Table II, E. (1), F.A.C. – 0.1 pounds per million BTU heat input) Note (2): §§17-2.05(6), Table II, I, FAC--0.2 lbs/MMBTU (carbonaceous) +0.1 lbs/MMBTU (fossil fuel).

[3] Calculated from operating rate and applicable standard

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

[5] If Applicable

E. Fuels

FOR BOTH BOILER 7 & 8 100% wood - 88% wood

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	avg/hr	max./hr	
1) Pelletized wood; pine and	16,667 lbs/hr	16/6671bs/hr	133.33
hardwood sawdust, shavings,			
chips and bark			
2) No. 6 Fuel Oil		1117 lbs/hr	18.18

*Units Natural Gas, MMCF/hr; Fuel Oils, barrels/hr; Coal, lbs/hr

Fuel Analysis:

Percent Sulfur: (1) 0.0 (2) 2.0 Percent Ash: (1)less than 3% (2) 0.05

Density: (1) (2) 8.3 lbs/gal Typical Percent Nitrogen: (1) 0.0 (2) .17%

Heat Capacity: (1)7500/8500 (2) 18500 BTU/lb (1) N/A (2) 153,550 BTU/gal

Other Fuel Contaminants (which may cause air pollution): N/A

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

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

Slurry to ash pond

H. Emission Stack Geometry and Flow Characteristics (Provide data for each stack): (EXISTING DATA FOR NOS. 7 & 8)

Stack Height: (7) 92 (8) 92 ft. Stack Diameter: (7) 4 (8) 4 ft.

Gas Flow Rate: (7)20,184(8)13,289 ACFM Gas Exit Temperature: (7)430 (8) 365 ºF.

Water Vapor Content: (7) 6.1 (8) 15.0 % Velocity: (7)48.04 (8) 32.39 FPS

SECTION IV: INCINERATOR INFORMATION

N/A

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

Description of Waste

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

Approximate Number of Hours of Operation per day days/week

Manufacturer

Date Constructed Model No.

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

Stack Height: ______________ ft. Stack Diameter ______________ Stack Temp. ______________

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

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

Type of pollution control device: [ ] Cyclone [ ] Wet Scrubber [ ] Afterburner [ ] Other (specify) ______________

Brief description of operating characteristics of control devices: ______________

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

SECTION V: SUPPLEMENTAL REQUIREMENTS

Please provide the following supplements where required for this application.

N/A 1. Total process input rate and product weight — show derivation.

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. See Attachments 2, 3, and 8 (Sections 15617 and 15620).

3. Attach basis of potential discharge (e.g., emission factor, that is, AP42 test).
   See Attachment 2 (Sections 2, 3, & 4).

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, etc.). See Attachments 4 and 8 (Sections 15617 and 15620).

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).
   See Attachment 2.2.V and Attachment 3.

6. An 8½" 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.
   See Attachments 5 and 9.

7. An 8½" 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).
   See Attachment 6.

8. An 8½" x 11" plot plan of facility showing the location of manufacturing processes and outlets for airborne emissions. Relate all flows to the flow diagram.
   See Attachments 7 and 9.

9. An application fee of $20, unless exempted by Section 17-4.05(3), F.A.C. The check should be made payable to the Department of Environmental Regulation. N/A per §17-4.05(3), FAC.

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. N/A

SECTION VI: BEST AVAILABLE CONTROL TECHNOLOGY

A. Are standards of performance for new stationary sources pursuant to 40 C.F.R. Part 60 applicable to the source?
☐ Yes ☐ No

Contaminant	Rate or Concentration

B. Has EPA declared the best available control technology for this class of sources (If yes, attach copy) ☐ Yes ☐ No

Contaminant	Rate or Concentration

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

Contaminant	Rate or Concentration

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

1. Control Device/System:
2. Operating Principles:
3. Efficiency:*
4. Capital Costs:
5. Useful Life:
6. Operating Costs:
7. Energy:
8. Maintenance Cost:
9. Emissions:

Contaminant	Rate or Concentration

*Explain method of determining D 3 above.

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.

a. Control Device:

b. Operating Principles:

c. Efficiency*: d. Capital Cost:

e. Useful Life: f. Operating Cost:

g. Energy*: 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*: d. Capital Cost:

e. Useful Life: f. Operating Cost:

g. Energy**: h. Maintenance Costs:

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:

*Explain method of determining efficiency.

**Energy to be reported in units of electrical power — KWH design rate.

3.

a. Control Device:

b. Operating Principles:

c. Efficiency*: d. Capital Cost:

e. Life: f. Operating Cost:

g. Energy: h. Maintenance Cost:

*Explain method of determining efficiency above.

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*:
d. Capital Cost:

e. Life:
f. Operating Cost:

g. Energy:
h. Maintenance Cost:

i. Availability of construction materials and process chemicals:

j. Applicability to manufacturing processes:

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

F. Describe the control technology selected:

1. Control Device:
2. Efficiency*:
3. Capital Cost:
4. Life:
5. Operating Cost:
6. Energy:
7. Maintenance Cost:
8. Manufacturer:
9. Other locations where employed on similar processes:

a.

(1) Company:

(2) Mailing Address:

(3) City:
(4) State:

(5) Environmental Manager:

(6) Telephone No.:

*Explain method of determining efficiency above.

(7) Emissions*:

Contaminant	Rate or Concentration

(8) Process Rate*:

b.

(1) Company:

(2) Mailing Address:

(3) City:
(4) State:

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

(5) Environmental Manager:

(6) Telephone No.:

(7) Emissions*:

Contaminant	Rate or Concentration

(8) Process Rate*:

10. Reason for selection and description of systems:

*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.

2. Instrumentation, Field and Laboratory

a) Was instrumentation EPA referenced or its equivalent? _____ Yes _____ No

b) Was instrumentation calibrated in accordance with Department procedures? _____ Yes _____ No _____ Unknown

B. Meteorological Data Used for Air Quality Modeling

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

2. Surface data obtained from (location) ______________________________

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

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

C. Computer Models Used

1. ______________________________ Modified? If yes, attach description.

2. ______________________________ Modified? If yes, attach description.

3. ______________________________ Modified? If yes, attach description.

4. ______________________________ Modified? If yes, attach description.

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

D. Applicants Maximum Allowable Emission Data

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

E. Emission Data Used in Modeling

Attach list of emission sources. Emission data required is source name, description on 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.

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

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.

FLORIDA STATE HOSPITAL BOILER CONVERSION

ATTACHMENT 1

Sect. II.

A.
Florida State Hospital operates four water tube power boilers to provide utility steam for in-house power generation. These boilers fire No. 6 fuel oil as the primary fuel for compliance with State and Federal Air Pollution requirements. Boilers 6,7, and 8 have the capability of firing pulverized coal, however, the system is not in use at this time. Boiler No. 9 fires No. 6 oil only.

The modification proposed by this application is to convert boilers 7 & 8 to a combination of pelletized wood (88%) and No. 6 Fuel Oil (12%). Existing pollution control equipment.

It is proposed that within two years from the issuance of this modification/construction permit wet scrubbers shall be added to the system as additional pollution control devices.

The provision of the wet scrubbers will be subject to the availability of appropriations to be made by the Florida Legislature.

ATTACHMENT NO. 1

ADDENDUM
TO
APPLICATION

SECTION III. D. (pg 3 of 10)

Two scenarios are possible: The first is for the boiler conversion with the wet scrubbers installed at the outset. The second is for the boiler conversion with the wet scrubbers to be installed within two years of the conversion. The actual operating scenario will be decided by the outcome of the bidding process, and we would like to be permitted to follow either option.

In either case, the installation of the wet scrubbers will be subject to the availability of funding to be appropriated by the Florida Legislature.

Florida State Hospital
Boiler Conversion

ATTACHMENT 2

CONTENTS

1. Copy of previous application for Existing Operation Permit.

2. Copy of July 17, 1981, letter: Doug Jones to C. Fancy transmitting "Emissions Matrix" (Matrix and back-up calculations attached).

3. Copy of July 23, 1981, letter: C. Fancy to D. Jones.

4. Calculations for Section III, C (Airborne Contaminants Emitted) of the Application Form.

5. Calculations for Section III, E (Fuels) of the Application Form.

ATTACHMENT NO. 2

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

APPLICATION TO OPERATE/CONSTRUCT AIR POLLUTION SOURCES

Source Type: [X] Air Pollution [ ] Incinerator

Application Type: [ ] Construction [ ] Operation [ ] Modification [X] Renewal of DER Permit No. A020-4727 A020-4754, A020-4755 A020-4756

Company Name: Florida State Hospital County: Gadsden

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): Boilers No. 6, 7, 8, & 9

Source Location: Street: Highway 90 City: Chattahoochee

UTM: East 707400 M North 3398500 M

Latitude: 3 0 ° 4 2 ' 1 6 "N. Longitude: 8 4 ° 5 0 ' 1 0 "W.

Appl. Name and Title: William D. Myers, Asst. Supt., Administrative

Appl. Address: Florida State Hospital, Chattahoochee, Florida 32324

SECTION I: STATEMENTS BY APPLICANT AND ENGINEER

A. APPLICANT

I am the undersigned owner or authorized representative of* Florida State Hospital

I certify that the statements made in this application for a Air Pollution 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 provisions 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 nontransferable and I will promptly notify the Department upon sale or legal transfer of the permitted establishment.

William D. Myers
Name of Person Signing (please Type or Print)

Signature of the Owner or Authorized Representative and Title

Date: 3-9-79 Telephone No.: (904) 663-4311

*Attach a letter of authorization.

B. PROFESSIONAL ENGINEER REGISTERED IN FLORIDA

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 judgement, that 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 the applicant a set of instructions for the proper maintenance and operation of the pollution control facilities and, if applicable, pollution sources.

Signature:

Name: Larry M. Simmons, P.E.
(Please Type)

Company Name: Tidewater Engineers, Inc.

Florida Registration Number: 17964

(Affix Seal)

Mailing Address: 3207 West Tharpe Street
Tallahassee, Florida 32303

Telephone No.: (904) 576-7133

Date: March 9, 1979

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.

Florida State Hospital operates four water tube power boilers to provide utility steam for in-house power generation. These boilers fire No. 6 fuel oil as the primary fuel for compliance with State and Federal Air Pollution requirements. Boilers 6, 7, and 8 have the capability of firing pulverized coal, however, the system is not in use at this time. Boiler No. 9 fires No. 6 oil only.

B. Schedule of Project Covered in this Application (Construction Permit Application Only).

Start of Construction: N/A Completion of Construction: N/A

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

N/A

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

Boiler No. 6 A020-4727; No. 7 - A020-4754; No. 8 - A020-4755; No. 9 - 020-4756

E. Is the emission point considered to be a New* or Existing* source, as defined in Chapter 17-2.02(5) & (6), Florida Administrative Code?
______ New X______ Existing

F. Is this application associated with or part of a Development of Regional Impact (DRI) pursuant to Chapter 380, Florida Statutes, and Chapter 22F-2, Florida Administrative Code? ______ Yes X______ No

G. Normal Equipment Operating Time: hrs/day: 24 ; days/wk: 7 ; wks/yr: 52 ; If seasonal, describe:

*Note

New Source: any source which came into existence, began operation or construction, or received a permit for the latter on or after January 18, 1972.

Existing Source: any source in existence, operating or under construction (or with a permit to construct) prior to January 18, 1972.

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES

(other than incinerators)

A. Raw Materials and Chemicals Used in Your Process:

Description	Utilization Rate lbs./hr.	Relate to Flow Diagram
Boiler No. 6 Fuel input. No. 6 fuel	2631	Fuel inlet to boilers
oil with an average of 2.0% sulfur		

Boiler tested by ASME short form for 85.76%

B. Process Rate:

1) Total Process Input Rate (lbs./hr.): 2631 lbs/hr of No. 6 fuel oil

2) Product Weight (lbs/hr): 42,000 lbs/hr of turbine steam operates at full load 10% of the time.

C. Airborne Contaminants Discharged:

Name of Contaminant	Actual Discharge*		Allowed Discharge Rate Per Ch. 17-2, F.A.C.**	Allowable Discharge*** (lbs./hr.)	Relate to Flow Diagram
	lbs./hr.	T/yr.			
SO_2	5	21.84	#/MBTU/HR	Latest	Exit gases
				available	
				tech.	
Particulates	5.09				

D. Control Devices: N/A

Name and Type (Model and Serial No.)	Contaminant	Efficiency†	Range of Particles Size Collected (in microns)	Basis for Efficiency††

*Estimate only if this is an application to construct.

**Specify units in accordance with emission standards prescribed within Section 17-2.04, F.A.C. (e.g. Section 17-2.04(6)(e)1.a. specifies that new fossil fuel steam generators are allowed to emit particulate matter at a rate of 0.1 lbs. per million BTU heat input computed as a maximum 2-hour average.)

***Using above example for a source with 260 million BTU per hour heat input: $\frac{0.1 \text{ lbs}}{\text{MMBTU}} \times \frac{260 \text{ MMBTU}}{\text{hr.}} = 26$ lbs./hr.

†See Supplemental Requirements, page 5, number 2.

††Indicate whether the efficiency value is based upon performance testing of the device or design data.

JOB FLORIDA STATE HOSPITAL STACK #6 DATE NOV. 8, 1917

TEST PERFORMED BY PAUL J. CAZENAVETTE & H. O. GRANTHAM.

STACK DIAMETER 4.0 FT.

STACK AREA 12.57 SQ.FT.

STACK GAS TEMP. 260° °F

PROBE DIAMETER 3/8" IN.

TYPE PITOT "S"

CONDENSATE COLLECTED 50 ml

PLANT OPERATION CLEAR DAY

EA. BOILER OPENED UP TO MAX.

VELOCITY TRAVERSE

POINT	DIST. (IN.)	H (IN. H_2O)	$\sqrt{H}$
1	1"	.18	.424
2	4"	.20	.447
3	7"	.24	.489
4	11"	.25	.500
5	16 1/2"	.21	.458
6	31 1/2"	.18	.424
7	37"	.17	.412
8	41"	.16	.400
9	44"	.14	.374
10	47"	.14	.374
		AVERAGE	.430

STACK GAS VELOCITY:

$V_S = 2.4(\sqrt{H})_{AVG}\sqrt{T_S}$

$= 2.4(.430)\sqrt{720} = 27.69$ FPS

ESTIMATED METER RATE:

$R_{m_E} = 0.33 \frac{T_m}{T_S} V_S d^2 \frac{30}{25}$

$= 0.33 \frac{(545)}{(720)} (27.69)(.1466) \frac{30}{25} = 1.16$ CFM

WATER VAPOR VOLUME:

$V_V = 0.00267 \cdot \frac{V_W\ T_M}{P_b - P_m} = 0.00267 \frac{(50)(540.5)}{30 - (9.2)} = 3.47$ CU. FT.

MOISTURE CORRECTION FACTOR:

$M_C = \frac{V_M}{V_M + V_V} = \frac{(34.38)}{(34.38) + (3.47)} = .908$

CALCULATED METER RATE:

$R_{M_C} = 0.33\ V_S d^2 \frac{T_m\ P_S}{T_S (P_b - P_m)} = 0.33(27.69)(.1406) \frac{(540.5)(30)}{(720)(30 - 9.2)} = 1.39$ CFM

CORRECTED METER RATE:

$R_M = R_{M_C} \times M_C = (1.39)(.908) = 1.26$ CFM

FIELD DATA

STACK #6

TIME	SAMPLE No.	GAS METER			MIN.	CFM	METER TEMP °F	METER VAC. IN. Hg	STACK TEMP. °F
		START	END	CU. FT.					
#1									
1:18		0					82°		260°
1:23			5.86				82°	9.2	
1:28			11.50				82°	9.2	
1:33			17.30				81°	9.2	
1:38			23.10				80°	9.2	
1:43			28.68				79°	9.2	
1:48			34.38	34.38			79°	9.2	
					AVERAGE		80.5°	9.2	
#2	THIMBLE No 2.								
2:01		34.38					80°		
2:06			40.12				80°	9.8	
2:11			45.98				79°	10.0	
2:16			52.48				79°	11.2	
2:21			58.68				79°	10.9	
2:26			64.88				79°	10.9	
2:31			71.01	36.63			79°	10.9	
					AVERAGE		79°	10.6	
#3	THIMBLE No. 8								
2:35		71.01					79°		
2:40			77.02				80°	12.4	
2:45			83.32				80°	13.1	
2:50			89.64				80°	13.3	
2:55			95.90				80°	13.5	
3:00			102.26				80°	13.7	
3:05			108.28	37.27			80°	13.6	
					AVERAGE		80°	13.3	

JOB FLORIDA STATE HOSPITAL STACK #6 DATE NOV. 8, 1977

ANALYSIS

MOISTURE IN METERED GAS: $M_M = \frac{V.P. \times V_M}{P_b - P_M}$

RUN	METER TEMP.	VAPOR PRESS.
1	80.5	1.049
2	79	.9989
3	80	1.032

$M_{M_1} = \frac{(1.049)(34.38)}{(30)-(9.2)}$ = 1.734 CU. FT.

$M_{M_2} = \frac{(.9989)(36.63)}{(30)-(10.6)}$ = 1.886 CU. FT.

$M_{M_3} = \frac{(1.032)(37.27)}{(30)-(13.3)}$ = 2.303 CU. FT.

MOISTURE CONTENT:

$\% \text{ MOISTURE} = \frac{V_V + M_M}{V_V + V_M}(100) = \frac{(3.47)+(1.734)}{(3.47)+(34.38)}$ = 13.7 %

CORRECTED STACK VOLUME: (NOTE: TS DURING VELOCITY TRAVERSE)

$\text{FLOW RATE (SC)} = V_S (60) A_S \frac{(100 - \text{MOISTURE})}{100} \frac{528}{T_S} \frac{P_S}{29.9}$

$= \frac{(27.61)60(12.57)(100-13.7)528(1)}{100(720)}$ = 13,217 CFM

CORRECTED METER VOLUME: (CU. FT.)

$V_{DRY} = V_M - M_M$ $\qquad V_{COR} = V_{DRY} \times \frac{528}{T_M} \times \frac{P_b - P_M}{29.9}$

RUN 1: $V_{DRY} = (34.38)-(1.734) = 32.646$ $\quad V_{COR} = (32.646)\frac{528}{(540.5)} \times \frac{(30)-(9.2)}{29.9} = 22\ 19$

RUN 2: $V_{DRY} = (36.63)-(1.886) = 34.744$ $\quad V_{COR} = (34.144)\frac{528}{(539)} \times \frac{(30)-(10.6)}{29.9} = 22.10$

RUN 3: $V_{DRY} = (37.27)-(2.303) = 34.967$ $\quad V_{COR} = (34.961)\frac{528}{(540)} \times \frac{(30)-(13.3)}{29.9} = 19.09$

SAMPLE	VCOR	GRAMS	GRAINS	GRAINS/CU. FT.	LB/HOUR
#2	22 10	.0532	.820816	.03714371	4.2079
#3	19.09	.0652	1.006036	.05269963	5.9702
					AVG.= 5.08905

(GRAINS = GRAMS × 15.43)

(LB/HOUR = GRAINS/CU.FT × FLOW RATE (SC) × $\frac{60}{7000}$)

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Stack No. 6

52

#8

30	500
10	100
1	50
	60
[illegible]	[illegible]

[illegible]

4.[illegible]

.10602

#2 50

[illegible]

.0[illegible]72

SEC. N III: AIR POLLUTION SOURCES & CONTROL DE ES

(other than incinerators)

A. Raw Materials and Chemicals Used in Your Process:

Description	Utilization Rate lbs./hr.	Relate to Flow Diagram
Boiler No. 7 fuel input. No. 6	3666	Fuel inlet to boilers
fuel oil with an average of 2.0%		
sulfur.		

Boiler tested by ASME short form for87.93%

B. Process Rate:

1) Total Process Input Rate (lbs./hr.): 3,666 lbs/hr of No. 6 fuel oil

2) Product Weight (lbs/hr): 60,000 lbs/hr of turbine steam
operates at full load 75% of the time

C. Airborne Contaminants Discharged:

Name of Contaminant	Actual Discharge*		Allowed Discharge Rate Per Ch. 17-2, F.A.C.**	Allowable Discharge*** (lbs./hr.)	Relate to Flow Diagram
	lbs./hr.	T/yr.			
SO_2	53.4	233.3	#/MBTU/HR	Latest	exit gases
				available	
				tech.	
Particulates	12.3				

D. Control Devices: N/A

Name and Type (Model and Serial No.)	Contaminant	Efficiency†	Range of Particles Size Collected (in microns)	Basis for Efficiency††

*Estimate only if this is an application to construct.

**Specify units in accordance with emission standards prescribed within Section 17-2.04, F.A.C. (e.g. Section 17-2.04(6)(e)1.a. specifies that new fossil fuel steam generators are allowed to emit particulate matter at a rate of 0.1 lbs. per million BTU heat input computed as a maximum 2-hour average.)

***Using above example for a source with 260 million BTU per hour heat input: $\frac{0.1 \text{ lbs}}{\text{MMBTU}} \times \frac{260 \text{ MMBTU}}{\text{hr.}} = 26$ lbs./hr.

†See Supplemental Requirements, page 5, number 2.

††Indicate whether the efficiency value is based upon performance testing of the device or design data.

JOB FLORIDA STATE HOSPITAL STACK #7 DATE NOV 8, 1977

TEST PERFORMED BY PAUL J. CAZENAVETTE & H.O. GRANTHAM

STACK DIAMETER 4.0 FT.

STACK AREA 12.57 SQ.FT.

STACK GAS TEMP. 430 °F

PROBE DIAMETER 1/4" IN.

TYPE PITOT "S"

CONDENSATE COLLECTED 14 ml

PLANT OPERATION CLEAR DAY

EA. BOILER OPENED UP TO MAX.

VELOCITY TRAVERSE

POINT	DIST.(IN.)	$H (in. H_2O)$	$\sqrt{H}$
1	1"	.45	.670
2	4"	.64	.800
3	7"	.64	.800
4	11"	.65	.806
5	16½"	.50	.707
6	31½"	.25	.500
7	37"	.30	.547
8	41"	.40	.632
9	44"	.40	.632
10	47"	.38	.616
		AVERAGE	.671

STACK GAS VELOCITY:

$$V_S = 2.4(\sqrt{H})_{AVG}\sqrt{T_S}$$

$$= 2.4(.671)\sqrt{890} = 48.04 \text{ FPS}$$

ESTIMATED METER RATE:

$$R_{m_E} = 0.33 \frac{T_m}{T_S} V_S d^2 \frac{30}{25}$$

$$= 0.33 \frac{(545)}{(890)}(48.04)(.0625)\frac{30}{25} = .726 \text{ CFM}$$

WATER VAPOR VOLUME:

$$V_V = 0.00267 \frac{V_W \; T_m}{P_b - P_m} = 0.00267 \frac{(14)(526)}{30-(4.96)} = .785 \text{ CU.FT.}$$

MOISTURE CORRECTION FACTOR:

$$M_C = \frac{V_M}{V_M + V_V} = \frac{(20.62)}{(20.62)+(.785)} = .963$$

CALCULATED METER RATE:

$$R_{M_C} = 0.33 \; V_S d^2 \frac{T_m \; P_S}{T_S (P_b - P_m)} = 0.33 \frac{(48.04)(.0625)(526)(30)}{(890)(30-4.96)} = .702 \text{ CFM}$$

CORRECTED METER RATE:

$$R_M = R_{M_C} \times M_C = (.702)(.963) = .676 \text{ CFM}$$

FIELD DATA

STACK #1

TIME	SAMPLE No.	GAS METER START	GAS METER END	GAS METER CU. FT.	MIN.	CFM	METER TEMP °F	METER VAC. IN. Hg	STACK TEMP. °F
									430°
#1									
7:11		0					65°		
7:16			3.26				65°	5.5	
7:21			6.04				65°	4.8	
7:26			9.80				65°	5.3	
7:31			13.44				65°	5.3	
7:36			16.90				66°	5.3	
7:41			20.62	20.62			68°	5.6	
					AVERAGE		66°	4.96	
#2	THIMBLE No. 3								
8:00		20.62					71°		
8:05			23.98				70°	5.3	
8:10			27.33				71°	5.4	
8:15			30.68				72°	5.6	
8:20			34.06				74°	5.8	
8:25			37.60				75°	5.8	
8:30			40.84	20.22			75°	5.8	
					AVERAGE		73°	5.6	
#3	THIMBLE No. 6								
8:42		40.84					77°		
8:47			43.74				76°	5.9	
8:52			46.75				76°	6.5	
8:57			49.92				77°	6.9	
9:02			53.06				78°	7.0	
9:07			56.28				77°	7.2	
9:12			59.96	19.12			78°	7.1	
					AVERAGE		77°	6.7	

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JOB FLORIDA STATE HOSPITAL STACK #7 DATE NOV. 8, 1977

ANALYSIS

MOISTURE IN METERED GAS: $M_M = \frac{V.P. \times V_M}{P_b - P_M}$

RUN	METER TEMP.	VAPOR PRESS.		
1	66°	,6442	$Mm_1 = \frac{(,6442)(20.62)}{(30)-(4.96)}$ =	.530 CU. FT.
2	73°	,8183	$Mm_2 = \frac{(,8183)(20.22)}{(30)-(5.6)}$ =	.678 CU. FT.
3	77°	,9352	$Mm_3 = \frac{(,9352)(19.12)}{(30)-(6.7)}$ =	.767 CU. FT.

MOISTURE CONTENT:

$$\% MOISTURE = \frac{V_V + Mm}{V_V + V_M}(100) = \frac{(.785)+(.530)}{(.785)+(20.62)} = 6.1 \%$$

CORRECTED STACK VOLUME: (NOTE: Ts DURING VELOCITY TRAVERSE)

$$FLOW\ RATE\ (SC) = V_S (60) A_S \frac{(100 - MOISTURE)}{100} \frac{528}{T_S} \frac{P_S}{29.9}$$

$$= \frac{(48.64)60(12.57)(100-6.1)528(1)}{100\ (840)} = 20,184\ CFM$$

CORRECTED METER VOLUME: (CU. FT.)

$V_{DRY} = V_M - M_M$

$V_{COR.} = V_{DRY} \times \frac{528}{T_M} \times \frac{P_b - P_M}{29.9}$

RUN 1: $V_{DRY} = (20.62)-(,530) = 20.09$ $V_{COR} = (20.09)\frac{528}{(526)} \times \frac{(30)-(4.96)}{29.9} = 16.8$

RUN 2: $V_{DRY} = (20.22)-(,678) = 19.54$ $V_{COR} = (19.54)\frac{528}{(533)} \times \frac{(30)-(5.6)}{29.9} = 15.7$

RUN 3: $V_{DRY} = (19.12)-(,767) = 18.35$ $V_{COR} = (18.35)\frac{528}{(531)} \times \frac{(30)-(6.7)}{29.9} = 14.0$

SAMPLE	VCOR	GRAMS	GRAINS	GRAINS/CU.FT.	LB/HOUR
#2	15.79	.0582	,848026	,05687308	9.8393
#3	14.06	.0778	1,200454	,0853808	14.7713
					AVG. = 12.3053

(GRAINS = GRAMS × 15.43)

(LB/HOUR = GRAINS/CU.FT × FLOW RATE(SC) × $\frac{60}{7000}$)

Stack #7

Thimble # 3

30
3
33

200
50
10
2600

33.2600
33.2018
.0582

Thimble # 6

30
5
2
37.

1
100
50
20
5
4
1790

37.1790
37.1012
.0778

SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES

(other than incinerators)

A. Raw Materials and Chemicals Used in Your Process:

Description	Utilization Rate lbs./hr.	Relate to Flow Diagram
Boiler No. 8 fuel input. No. 6	3660	Fuel inlet to boilers
fuel oil with an average of 2.0%		
sulfur.		

Boiler tested by ASME short form for 88.08%

B. Process Rate:

1) Total Process Input Rate (lbs./hr.): 3,660 lbs/hr of No. 6 fuel oil

2) Product Weight (lbs/hr): 60,000 lbs/hr of turbine steam operates at full load 72% of the time.

C. Airborne Contaminants Discharged:

Name of Contaminant	Actual Discharge*		Allowed Discharge Rate Per Ch. 17-2, F.A.C.**	Allowable Discharge*** (lbs./hr.)	Relate to Flow Diagram
	lbs./hr.	T/yr.			
SO_2	53.3	232.9	#/MBTU/HR	Latest	exit gases
				available	
				tech.	
Particulates	7.7				

D. Control Devices: N/A

Name and Type (Model and Serial No.)	Contaminant	Efficiency†	Range of Particles Size Collected (in microns)	Basis for Efficiency††

*Estimate only if this is an application to construct.

**Specify units in accordance with emission standards prescribed within Section 17-2.04, F.A.C. (e.g. Section 17-2.04(6)(e)1.a. specifies that new fossil fuel steam generators are allowed to emit particulate matter at a rate of 0.1 lbs. per million BTU heat input computed as a maximum 2-hour average.)

***Using above example for a source with 260 million BTU per hour heat input: $\frac{0.1 \text{ lbs}}{\text{MMBTU}} \times \frac{260 \text{ MMBTU}}{\text{hr.}} = 26 \text{ lbs./hr.}$

†See Supplemental Requirements, page 5, number 2.

††Indicate whether the efficiency value is based upon performance testing of the device or design data.

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JOB FLORIDA STATE HOSPITAL STACK #8 DATE NOV 8, 1977

TEST PERFORMED BY PAUL J. CAZENAVETTE & H. O. GRANTHAM.

STACK DIAMETER 4.0 FT.

STACK AREA 12.57 SQ.FT.

STACK GAS TEMP. 365 °F

PROBE DIAMETER 3/8 IN.

TYPE PITOT "S"

CONDENSATE COLLECTED 47 ml

PLANT OPERATION CLEAR DAY

EA. BOILER OPENED UP TO MAX.

VELOCITY TRAVERSE

POINT	DIST.(IN.)	$H(IN.H_2O)$	$\sqrt{H}$
1	1"	.15	.387
2	4"	.15	.381
3	7"	.22	.469
4	11"	.25	.500
5	16½"	.28	.529
6	31½"	.34	.583
7	37"	.28	.529
8	41"	.18	.424
9	44"	.20	.447
10	47"	.20	.447
		AVERAGE	.470

STACK GAS VELOCITY:

$$V_S = 2.4(\sqrt{H})_{AVG}\sqrt{T_S}$$

$$= 2.4(.470)\sqrt{825} = 32.39 \text{ FPS}$$

ESTIMATED METER RATE:

$$Rm_E = 0.33\frac{T_m}{T_S} V_S d^2 \frac{30}{25}$$

$$= 0.33\frac{(540)}{(825)}(32.39)(.1406)\frac{30}{25} = 1.18 \text{ CFM}$$

WATER VAPOR VOLUME:

$$V_V = 0.00267\frac{V_W\ T_M}{P_b - P_m} = 0.00267\frac{(47)(550)}{30-(9.45)} = 3.35 \text{ CU.FT.}$$

MOISTURE CORRECTION FACTOR:

$$M_C = \frac{V_M}{V_M + V_V} = \frac{(35.21)}{(35.21)+(3.35)} = .913$$

CALCULATED METER RATE:

$$R_{M_C} = 0.33\ V_S d^2 \frac{T_m\ P_S}{T_S(P_b - P_m)} = 0.33(32.39)(.1406)\frac{(550)(30)}{(825)(30-9.45)} = 1.46 \text{ CFM}$$

CORRECTED METER RATE:

$$R_M = R_{M_C} \times M_C = (1.46)(.913) = 1.33 \text{ CFM}$$

FIELD DATA

TIME	SAMPLE No.	GAS METER START	 END	 CU. FT.	MIN.	CFM	METER TEMP. °F	METER VAC. IN. Hg	STACK TEMP. °F
									365°
#1									
10:23		0					90°		
10:28			5.90				90°	10.0	
10:33			12.24				90°	10.0	
10:38			17.94				89°	9.0	
10:43			23.60				89°	9.1	
10:48			29.40				90°	9.3	
10:53			35.21	35.21			92°	9.3	
						AVERAGE	90°	9.45	
#2	THIMBLE No 5								
11:14		35.21					92°		
11:19			40.98				92°	10.2	
11:24			46.98				90°	10.9	
11:29			53.20				90°	11.3	
11:34			59.54				90°	11.6	
11:39			65.86				90°	11.6	
11:44			72.43	37.22			90°	12.0	
						AVERAGE	90°	11.2	
#3	THIMBLE No. 4								
11:50		72.43					90°		
11:55			78.76				92°	11.9	
12:00			85.31				94°	12.5	
12:05			91.90				96°	12.9	
12:10			98.53				96°	12.9	
12:15			105.16				95°	13.0	
12:20			111.76	39.33			94°	13.0	
						AVERAGE	93.5°	12.7	

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JOB FLORIDA STATE HOSPITAL STACK #8 DATE NOV. 8, 1977

ANALYSIS

MOISTURE IN METERED GAS: $M_M = \frac{V.P \times V_M}{P_b - P_M}$

RUN	METER TEMP.	VAPOR PRESS.	
1	90	1.422	$M_{M_1} = \frac{(1.422)(35.21)}{(30)-(7.45)} = $ 2.436 CU. FT.
2	90	1.422	$M_{M_2} = \frac{(1.422)(\text{[illegible]})}{(\text{[illegible]})-(\text{[illegible]})} = $ [illegible]
3	94.5	1.635	$M_{M_3} = \frac{(1.635)(37.33)}{(30)-(12.7)} = $ 3.715 CU. FT.

MOISTURE CONTENT:

$$\%\,MOISTURE = \frac{V_V + M_M}{V_V + V_M}(100) = \frac{(3.35)+(2.436)}{(3.35)+(35.21)} = 15.0\ \%$$

CORRECTED STACK VOLUME: (NOTE: T_S DURING VELOCITY TRAVERSE)

$$FLOW\ RATE\ (SC) = V_S(60)\,A_S\,\frac{(100-MOISTURE)}{100}\,\frac{528}{T_S}\,\frac{P_S}{29.9}$$

$$= \frac{(32.31)60(12.57)(100-15)528(1)}{100\,(825)} = 13{,}289\ CFM$$

CORRECTED METER VOLUME: (CU. FT.)

$V_{DRY} = V_M - M_M$ $\qquad V_{COR} = V_{DRY} \times \frac{528}{T_M} \times \frac{P_b - P_M}{29.9}$

RUN 1: $V_{DRY} = (35.21)-(2.436) = 32.774$ $\quad V_{COR} = (32.774)\frac{528}{(550)} \times \frac{(30)-(7.45)}{29.9} = 21.6$

RUN 2: $V_{DRY} = (31.22)-(2.815) = 34.405$ $\quad V_{COR} = (34.405)\frac{528}{(550)} \times \frac{(30)-(11.2)}{29.9} = 20.7$

RUN 3: $V_{DRY} = (39.33)-(3.715) = 35.615$ $\quad V_{COR} = (35.615)\frac{528}{(554.5)} \times \frac{(30)-(12.7)}{29.9} = 19.6$

SAMPLE	V_{COR}	GRAMS	GRAINS	GRAINS/CU.FT.	LB/HOUR
#2	20.76	.0757	1.152621	.05552124	6.3241
#3	19.62	.1010	1.55843	.07943068	9.0476
					AVG. = 7.6858

(GRAINS = GRAMS × 15.43)

(LB/HOUR = GRAINS/CU. FT × FLOW RATE (SC) × $\frac{60}{7000}$)

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Stack # 8

Middle 5

30
5
2

37

100
50
3

42

37.1572
37.0815

.0757

Middle 2

30
5
2
1

38

050
20
42
.0742

38.0742
37.97[illegible]2

.1010

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SECTION III: AIR POLLUTION SOURCES & CONTROL DEVICES

(other than incinerators)

A. Raw Materials and Chemicals Used in Your Process:

Description	Utilization Rate lbs./hr.	Relate to Flow Diagram
Boiler No. 9 fuel input. No. 6	3,624	Fuel inlet to boilers
fuel oil with an average of 2.0%		
sulfur.		

Boiler efficiency has not been determined at this time. Manufacturers estimated

B. Process Rate: overall efficiency is 86%.

1) Total Process Input Rate (lbs./hr.): 3,624 lbs/hr of No. 6 fuel oil

2) Product Weight (lbs/hr): 58,000 lbs/hr of turbine steam operates at full load 12% of the time.

C. Airborne Contaminants Discharged:

Name of Contaminant	Actual Discharge*		Allowed Discharge Rate Per Ch. 17-2, F.A.C.**	Allowable Discharge*** (lbs./hr.)	Relate to Flow Diagram
	lbs./hr.	T/yr.			
SO_2	7.8	35	#/MBTU/HR	Latest	exit gases
				available	
				tech.	
Particulates	4.42				

D. Control Devices: N/A

Name and Type (Model and Serial No.)	Contaminant	Efficiency†	Range of Particles Size Collected (in microns)	Basis for Efficiency††

*Estimate only if this is an application to construct.

**Specify units in accordance with emission standards prescribed within Section 17-2.04, F.A.C. (e.g. Section 17-2.04(6)(e)1.a. specifies that new fossil fuel steam generators are allowed to emit particulate matter at a rate of 0.1 lbs. per million BTU heat input computed as a maximum 2-hour average.)

***Using above example for a source with 260 million BTU per hour heat input: $\frac{0.1 \text{ lbs.}}{\text{MMBTU}} \times \frac{260 \text{ MMBTU}}{\text{hr.}} = 26 \text{ lbs./hr.}$

†See Supplemental Requirements, page 5, number 2.

††Indicate whether the efficiency value is based upon performance testing of the device or design data.

JOB FLORIDA STATE HOSPITAL STACK #9 DATE NOV. 8, 1977

TEST PERFORMED BY

STACK DIAMETER 4.5' x 6.0' FT.

STACK AREA 27 SQ.FT.

STACK GAS TEMP. 275° °F

PROBE DIAMETER 1/2" IN.

TYPE PITOT "S"

CONDENSATE COLLECTED 32 ml

PLANT OPERATION CLEAR DAY

EA. BOILER OPENED UP TO MAX.

VELOCITY TRAVERSE

POINT	DIST.(IN.)	H(IN.H_2O)	$\sqrt{H}$
(SEE	ATTACHED	SHEET)	
		AVERAGE	.235

STACK GAS VELOCITY:

$V_S = 2.4(\sqrt{H})_{AVG}\sqrt{T_S}$

$= 2.4(.235)\sqrt{735} =$ 15.29 FPS

ESTIMATED METER RATE:

$R_{m_E} = 0.33 \frac{T_m}{T_S} V_S d^2 \frac{30}{25}$

$= 0.33 \frac{(540)}{(735)} (15.29)(.250) \frac{30}{25} =$ 1.11 CFM

WATER VAPOR VOLUME:

$V_V = 0.00267 \frac{V_W\ T_m}{P_b - P_m} = 0.00267 \frac{(32)(537)}{30-(9.5)} =$ 2.238 CU. FT.

MOISTURE CORRECTION FACTOR:

$M_C = \frac{V_m}{V_m + V_V} = \frac{(33.24)}{(33.24)+(2.238)} =$ .937

CALCULATED METER RATE:

$R_{M_C} = 0.33\ V_S d^2 \frac{T_m\ P_S}{T_S(P_b - P_m)} = 0.33(15.29)(.250)\frac{(531)(30)}{(735)(30-9.5)} =$ 1.348 CFM

CORRECTED METER RATE:

$R_M = R_{M_C} \times M_C = (1.348)(.937) =$ 1.26 CFM

FIELD DATA

TIME	SAMPLE No.	GAS METER START	 END	 CU. FT.	MIN.	CFM	METER TEMP °F	METER VAC. IN. Hg	STACK TEMP. °F
									275°
#1									
4:43		0					77°		
4:48			5.48				77°	9.5	
4:53			11.30				77°	9.6	
4:58			16.62				77°	9.0	
5:03			22.66				77°	9.4	
5:08			27.68				77°	9.8	
5:13			33.26	33.26			77°	9.8	
				AVERAGE			77°	9.5	
#2	THIMBLE		No. 9						
5:24		33.26					77°		
5:29			38.59				77°	11.2	
5:34			44.12				76°	12.1	
5:39			49.96				76°	13.2	
5:44			55.98				76°	13.2	
5:49			61.83				76°	13.3	
5:54			68.04	34.78			76°	13.3	
				AVERAGE			76°	12.8	
#3	THIMBLE		No. 7						
6:05		68.04					76°		
6:10			74.16				76°	13.7	
6:15			80.38				76°	13.7	
6:20			86.26				76°	13.6	
6:25			92.36				76°	13.8	
6:30			98.42				76°	13.9	
6:35			104.68	36.64			76°	13.8	
				AVERAGE			76°	13.7	

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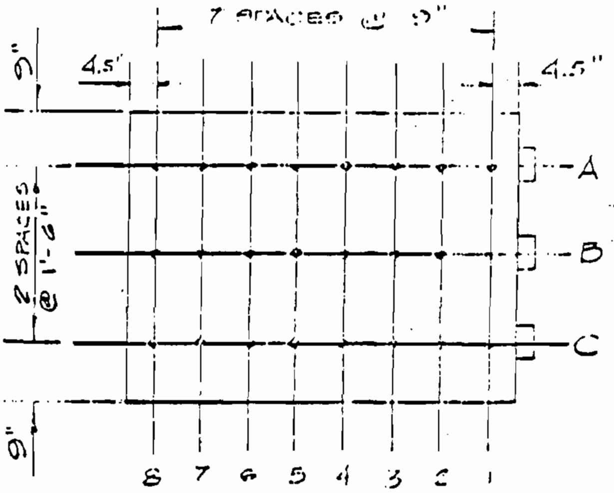

VELOCITY TRAVERSE

POINT	H (IN H_2O)	$\sqrt{H}$
A 1	.07	.264
2	.07	.264
3	.09	.300
4	.10	.316
5	.09	.300
6	.08	.282
7	.07	.264
8	.11	.331
TOTAL		2.321

POINT	H (IN H_2O)	$\sqrt{H}$
B 1	[illegible]	[illegible]
2	.04	.200
3	.04	[illegible]
4	[illegible]	[illegible]
5	[illegible]	[illegible]
6	[illegible]	[illegible]
7	[illegible]	[illegible]
8	.06	.244
TOTAL		1.611

POINT	H (IN H_2O)	$\sqrt{H}$
C 1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]
5	.03	[illegible]
6	.03	[illegible]
7	.04	
8	.06	.244
TOTAL		1.513

TOTAL A = 2.321
TOTAL B = 1.611
TOTAL C = 1.513
AVERAGE = .235

$$AVG. = \frac{\text{TOTAL } A+B+C}{24}$$

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JOB FLORIDA STATE HOSPITAL STACK #9 DATE NOV. 8, 1977

ANALYSIS

MOISTURE IN METERED GAS: $M_M = \frac{V.P. \times V_M}{P_b - P_M}$

RUN	METER TEMP.	VAPOR PRESS.	
1	77	.9352	$M_{M_1} = \frac{(.9352)(33.26)}{(30)-(9.5)} = 1.517$ CU. FT.
2	76	.9046	$M_{M_2} = \frac{(.9046)(34.78)}{(30)-(12.6)} = 1.829$ CU. FT.
3	76	.9046	$M_{M_3} = \frac{(.9046)(36.64)}{(30)-(13.7)} = 2.033$ CU. FT.

MOISTURE CONTENT:

$$\% \text{ MOISTURE} = \frac{V_V + M_M}{V_V + V_M}(100) = \frac{(2.236)+(1.517)}{(2.236)+(33.26)} = 10.5 \%$$

CORRECTED STACK VOLUME: (NOTE: TS DURING VELOCITY TRAVERSE)

$$\text{FLOW RATE (SC)} = V_S (60) A_S \frac{(100-\text{MOISTURE})}{100} \frac{528}{T_S} \frac{P_S}{29.9}$$

$$= \frac{(15.21)60(27)(100-10.5)528(1)}{100(735)} = 15,925 \text{ CFM}$$

CORRECTED METER VOLUME: (CU. FT.)

$V_{DRY} = V_M - M_M$ $V_{COR} = V_{DRY} \times \frac{528}{T_M} \times \frac{P_b - P_M}{29.9}$

RUN 1: $V_{DRY} = (33.26)-(1.517) = 31.743$ $V_{COR} = (31.743)\frac{528}{(537)} \times \frac{(30)-(9.5)}{29.9} = 21.39$

RUN 2: $V_{DRY} = (34.78)-(1.829) = 32.951$ $V_{COR} = (32.951)\frac{528}{(536)} \times \frac{(30)-(12.6)}{29.9} = 18.67$

RUN 3: $V_{DRY} = (36.64)-(2.033) = 34.607$ $V_{COR} = (34.607)\frac{528}{(536)} \times \frac{(30)-(13.7)}{29.9} = 18.58$

SAMPLE	VCOR	GRAMS	GRAINS	GRAINS/CU.FT.	LB/HOUR
#2	18.67	.0348	.534964	.02876079	3.9258
#3	18.58	.0435	.611205	.03642513	4.9310
					AVG.= 4.4284

(GRAINS = GRAMS × 15.43)

(LB/HOUR = GRAINS/CU.FT. × FLOW RATE (SC) × $\frac{60}{7000}$)

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Stack # 9

Thimble No. 9

30
10
3
1
44

100
50
25
1525

44.1525
- 44.1177
.0348

Thimble No. 7.

30
10
2
42

500
200
20
7
727

42.7270
- 42.6835
.0435

E. Fuels:

Type (Be Specific)	Consumption*		Maximum Heat Input (MMBTU/hr)
	avg./hr.	Max./hr.	
No. 6 fuel oil	5471 lbs/hr	9975 lbs/hr	159

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

Fuel Analysis:

Percent Sulfur: 2.0 Percent Ash: .05

Density: 8.3 lb./gal.

Heat Capacity: 18,500 BTU/lb. 153,550 BTU/gal.

Other Fuel Contaminants: None

F. If applicable, indicate the percent of fuel used for space heating: N/A Annual Average: ______ Maximum: ______

G. Indicate liquid or solid wastes generated and method of disposal: N/A

H. Emission Stack Geometry and Flow Characteristics (provide data for each stack): (See Schedule below)

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

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

Water Vapor Content: ______ %

Boiler No.	Stack Height	Diameter	Gas Flow Rate	Gas Exit Temp.	Water Vapor Content
6	92 ft.	4 ft.	13,217 ACFM	260°F	13.7%
7	92 ft.	4 ft.	20,184 ACFM	430°F	6.1%
8	92 ft.	4 ft.	13,289 ACFM	365°F	15.0%
9	184 ft.	7 ft.	15,925 ACFM	275°F	10.5%

SECTION IV: INCINERATOR INFORMATION

N/A

Type of Waste	Type O (Plastics)	Type I (Rubbish)	Type II (Refuse)	Type III (Garbage)	Type IV (Pathological)	Type V (Liq. & Gas By-prod.)	Type VI (Solid By-prod.)
Lbs./Hr. Incinerated							

Description of Waste: ______

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

Approximate Number of Hours of Operation per Day: ______ , days/week: ______

Manufacturer: ______

Date Constructed: ______ Model No.: ______

CALCULATIONS

A. TOTAL PROCESS INPUT RATE:

1. Boiler No. 6 42,000 lbs/hr maximum

$$\text{Fuel Input} = \frac{42{,}000 \text{ lbs/hr} \times (1290-296) \text{ Btu/lb}}{.8576}$$

$$= \frac{48{,}680{,}037 \text{ Btu/Hr}}{18{,}500 \text{ Btu/lb}}$$

$$= 2{,}631 \text{ lbs. of oil/hr}$$

2. Boiler No. 7 60,000 lbs/hr maximum

$$\text{Fuel Input} = \frac{60{,}000 \text{ lbs/hr} \times (1290-296) \text{ Btu/lb}}{.8794}$$

$$= \frac{67826680 \text{ Btu/hr}}{18{,}500 \text{ Btu/lb}}$$

$$= 3{,}666 \text{ lbs. of oil/hr}$$

3. Boiler No. 8 60,000 lbs/hr maximum

$$\text{Fuel Input} = \frac{60{,}000 \text{ lbs/hr} \times (1290-296) \text{ Btu/lb}}{.8808}$$

$$= \frac{67711172 \text{ Btu/hr}}{18{,}500 \text{ Btu/lb}}$$

$$= 3{,}660 \text{ lbs. of oil/hr}$$

4. Boiler No. 9 58,000 lbs/hr maximum

$$\text{Fuel Input} = \frac{58{,}000 \text{ lbs/hr} \times (1290-296) \text{ Btu/lb}}{.86}$$

$$= \frac{67{,}037{,}209 \text{ Btu/hr}}{18{,}500 \text{ Btu/lb}}$$

$$= 3{,}624 \text{ lbs. of oil/hr}$$

B. AVERAGE FUEL CONSUMPTION RATE;

The average steam generated for one year of operation is 775,500,000 lbs. (from Florida State Hospital records)
Average hourly steam generated in the boilers is:

$$\frac{775{,}500{,}000 \text{ lbs}}{8760 \text{ hrs}} = 88{,}527 \text{ lb/hr}$$

$$\text{Fuel Rate} = \frac{88{,}527 \text{ lb. of steam/hr} \times (1290-296) \text{ Btu/lb.}}{\dfrac{(.8576 + .8793 + .8808 + .86)}{4}}$$

$$\text{Fuel Rate} = \frac{101211534 \text{ Btu/hr}}{18{,}500 \text{ Btu/lb}}$$

$$\text{Fuel Rate} = 5{,}471 \text{ lbs/hr}$$

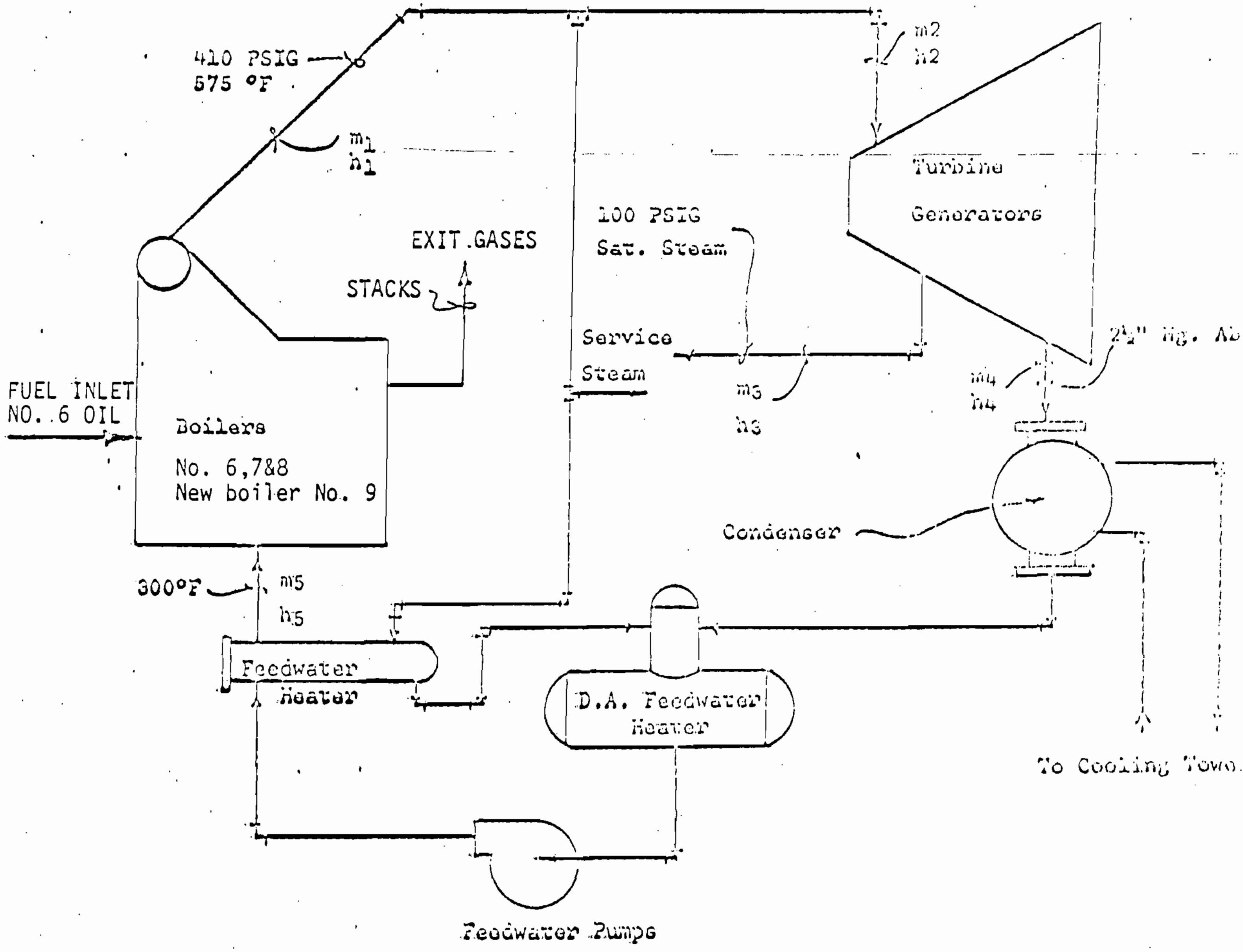
C. MAXIMUM FUEL CONSUMTPION RATE;

The maximum steam generated is recorded at 162,000 lbs/hr.

$$\text{Fuel Rate} = \frac{162{,}000 \text{ lbs/hr} \times (1290-296) \text{ Btu/lb}}{\dfrac{(.8576 + .8793 + .8808)}{3}}$$

$$\text{Fuel Rate} = \frac{184545211 \text{ Btu/hr}}{18{,}500 \text{ Btu/lb}}$$

$$\text{Fuel Rate} = 9{,}975 \text{ lbs/hr}$$



h_1 = 1290 Btu/# m_1 = 66,177 #/Hr

h_2 = 1290 Btu/# m_2 = 71,469 #/Hr

h_3 = 1139 Btu/# m_3 = 44,156 #/Hr

h_4 = 77 Btu/# m_4 = 27,313 #/Hr

h_5 = 269 Btu/# m_5 = 66,177 #/Hr

SCHEMATIC FLOW DIAGRAM

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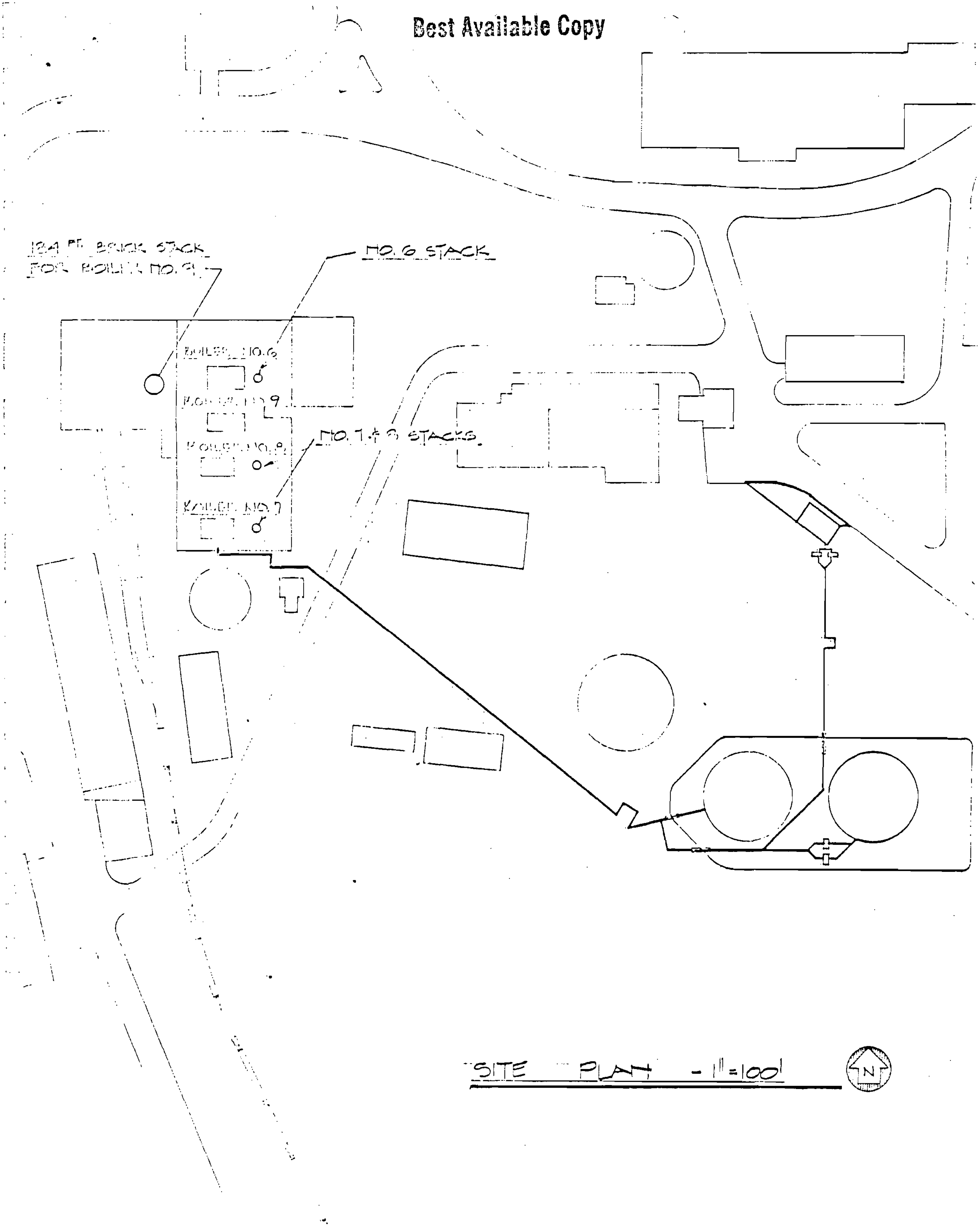

SITE PLAN - 1"=100'

SERVOIR
GEORGIA
FLORIDA
HOOCHEE RIVER)
DAM
WOODRUFF
JIM
LEVEE
29
28
27
FLORIDA STATE HOSPITAL
WATER TANK
423
424
STACKS
US 90
31
32
33
34
Gaging Stations
85
CHATTAHOOCHEE
RIVER
150
200
221
210
BM 82
Sewage Disposal
Mosquito Creek
4
River Junction
BM 60
BM 67
JACKSON CO
GADSDEN CO
NASHVILLE
Hardin Heights
8
9
10
203
Jinks

DAN FARLEY & ASSOCIATES, P.A.
ENVIRONMENTAL SERVICES
CONSULTANTS & PUBLIC RELATIONS
GOVERNMENTAL LIAISON

Water's Edge Executive Center
1910 Capital Circle, S.W.
Tallahassee, Florida 32304

Telephone: (904) 576-4110

July 17, 1981

Mr. Clair Fancy, P.E.
Deputy Bureau Chief
Bureau of Air Quality
Department of Environmental
Regulation
2600 Blair Stone Road
Tallahassee, Florida 32301

Dear Mr. Fancy:

RE: Boiler Conversion Project
Florida State Hospital
Chattahoochee, Florida

Pursuant to our meeting of June 30, 1981, I am transmitting a matrix of potential emissions together with back-up material, for the facility. This material should provide the data on which you can make your rule applicability determination; however, if during your review there are any questions whatsoever, please do not hesitate to call me at 576-4110.

I appreciate your assistance in this matter and look forward to working with you.

Sincerely,

Doug Jones

Enclosure

cc: Mr. Reginald Davis, P. E. (w/enclosure)
Mr. Paul Kazcorowski, P.E. (w/enclosure)
Mr. Bob Mohrfeld, P.E. (w/enclosure)

BOILER DATA FROM EXISTING OPERATION PERMIT FILE

Boiler No.	% of time at full load	Utilization Rate (lbs/hr)	Product Weight (lbs/hr)	MMBTU/ hr.	Particulates lbs/hr.	SO_2 lbs/ hr.	T/yr
6	10%	2,361	42,000	48.7	5.09	5	21.84
7	75%	3,666	60,000	67.8	12.3	53.4	233.3
8	72%	3,660	60,000	67.7	7.7	53.3	232.9
9	12%	3,624	58,000	67.0	4.42	7.8	35

FUEL DATA FOR EXISTING CONFIGURATION

No. 6 Fuel Oil: 2.0% Sulfur 0.05% ash
Density 8.3 lbs/gal.
Heat Capacity 18,500 BTU/lb, or 153,550 BTU/gal.

FUEL DATA FOR BOILER MODIFICATION PROJECT

Pellitized wood -- Pine and hardwood sawdust, shavings, chips & bark.
Heating value 7,500 - 8,000 BTU/lb.
100 T/day/boiler (for boilers 7 & 8)

POTENTIAL EMISSIONS
FROM
EXISTING FACILITY USING NO. 6 FUEL OIL*

BOILER NO.	6	7	8	9	Σ	
EMISSION						
PARTICULATE	7.29	10.16	10.14	10.04	37.63	lbs/hr
	31.94	44.49	44.42	43.98	164.83	t/yr.
SULFUR DIOXIDE	99.55	138.69	138.47	137.09	513.80	lbs/hr
	436.02	607.44	606.48	600.44	2250.38	t/yr.
SULFUR TRIOXIDE	1.27	1.77	1.76	1.75	6.55	lbs/hr.
	5.55	7.74	7.73	7.65	28.67	t/yr.
SO_x	100.82	140.46	140.23	138.84	520.35	lbs/hr.
	441.57	615.18	614.21	608.09	2279.05	t/yr.
NO_x	19.02	26.50	26.46	26.20	98.18	lbs/hr.
	83.31	116.07	115.89	114.77	430.04	t/yr.
HC	0.32	0.44	0.44	0.44	1.64	lbs/hr.
	1.39	1.93	1.93	1.91	7.16	t/yr.
CO	1.59	2.21	2.20	2.18	8.18	lbs/hr.
	6.94	9.67	9.66	9.56	35.83	t/yr.

*Calculations using factors in AP42. These figures represent maximum emissions assuming full load for each boiler 8760 hrs/yr.

CALCULATIONS FOR PROPOSED PROJECT's POTENTIAL EMISSIONS

I EMISSION FACTORS (from AP42)

	PART	SO_x	NO_x	HC	CO
WOOD/BARK BOILER (lbs emitted/tons burned)	37.5	1.50	10.0	2.00	2.00

II CALCULATIONS OF EMISSIONS: (100 t/day/boiler ≅ 4.17 t/hr/boiler)

BOILER NO.	6	7	8	9	
PARTICULATES	--	156.25	156.25	--	lbs/hr.
	--	684.37	684.37	--	t/yr.
SO_x	--	6.25	6.25	--	lbs/hr.
	--	27.37	27.37	--	t/yr.
NO_x	--	41.67	41.67	--	lbs/hr.
	--	182.50	182.50	--	t/yr.
HC	--	8.33	8.33	--	lbs/hr.
	--	36.50	36.50	--	t/yr.
CO	--	8.33	8.33	--	lbs/hr.
	--	36.50	36.50	--	t/yr.

III. It is assumed that boilers 7 & 8 will burn 12% No. 6 Fuel Oil. Thus the fuel oil will contribute the following emissions:

Boiler No.	7	8	
EMISSION			
PARTICULATE	1.22	1.22	lbs/hr.
	5.34	5.34	t/yr.
SO_x	16.86	16.83	lbs/hr.
	73.83	73.70	t/yr.
NO_x	3.18	3.18	lbs/hr.
	13.93	13.90	t/yr.
HC	0.05	0.05	lbs/hr.
	0.23	0.23	t/yr.
CO	0.27	0.26	lbs/hr.
	1.16	1.16	t/yr.

IV. Consequently, the potential emissions from the proposed project (without scrubbers)

BOILER NO.	6	7	8	9	Σ	
EMISSION						
PARTICULATE	7.29	157.47	157.47	10.04	332.27	lbs/hr.
	31.94	689.71	689.71	43.98	1455.34	
SO_x	100.82	23.11	23.08	138.84	285.85	lbs/hr.
	441.57	101.20	101.07	608.09	1251.93	t/yr.
NO_x	19.02	44.85	44.85	26.20	134.92	lbs/hr.
	83.31	196.43	196.40	114.77	590.91	t/yr.
HC	0.32	8.38	8.38	0.44	17.52	lbs/hr.
	1.39	36.73	36.73	1.91	76.76	t/yr.
CO	1.59	8.60	8.59	2.18	20.96	lbs/hr.
	6.94	37.66	37.66	9.56	91.82	t/yr.

V. Scrubber efficiency for particulates has been computed using the following data:

Inlet dust loading: 1.25 gr/scfd.
Exit dust rate: 0.14 gr/scfd.

This yields a Δ% of -88.8%. Consequently, the potential particulate emission from boilers 7 & 8, wood burning +12% No. 6 fuel oil, with scrubbers would be;

BOILER NO.	7	8	Σ	
PARTICULATE	17.64	17.64	35.28	lbs/hr.
	77.25	77.25	154.50	t/yr.

VI. Consequently, the potential particulate emission from the entire facility with boilers 7 & 8 wood burning +12% No. 6 fuel oil and with scrubbers on Nos. 7 & 8 would be;

BOILER NO.	6	7	8	9	Σ	
PARTICULATE	7.29	17.64	17.64	10.04	52.61	lbs/hr.
	31.94	77.25	77.25	43.98	230.42	t/yr.

SUMMARY OF HOURLY EMISSIONS FROM PLANT

EMISSION (lbs/hr.)	A	B	C	D
PARTICULATE	29.51	37.63	332.27	52.61
SO_x	119.5*	520.35	285.85	
NO_x	--	98.18	134.92	
HC	--	1.64	17.52	
CO	--	8.18	20.96	

COLUMN

A = Existing actual discharge from Operating Permit records.

B = Existing Potential Emissions (calculated from AP42).

C = Potential Emissions from Boiler Conversion (calculated from AP42, using emission factors for wood/bark boiler).

D = Improvement in particulate emission if scrubber is used (88.8% decrease in emission).

*Note: This figure represents SO_2 alone, but it should be very close to SO_x.

SUMMARY OF YEARLY EMISSIONS FROM ENTIRE PLANT

EMISSION (t/yr.)	A	B	C	D
PARTICULATE	129.46	164.83	1455.34	230.42
SO_x	523.04*	2279.05	1251.93	
NO_x	--	430.04	590.91	
HC	--	7.16	76.76	
CO	--	35.83	91.82	

COLUMN

A = Existing actual discharge from Operating Permit records.

B = Existing Potential Emissions (calculated from AP42).

C = Potential Emissions from Boiler Conversion (calculated from AP42, using emission factors for wood/bark boiler)

D = Improvement in particulate emission if scrubber is used (88.8% decrease in emission).

*Note: This figure represents SO_2 alone, but it should be very close to SO_x.

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

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

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

July 23, 1981

Mr. Doug Jones
Dan Farley & Associates, P.A.
Water's Edge Executive Center
1910 Capitol Circle, S.W.
Tallahassee, Florida 32304

Dear Mr. Jones:

In response to your letter of July 17, 1981, the Bureau of Air Quality Management has made a preliminary rule applicability determination for the boiler conversion project at the Florida State Hospital. Since the operation of boilers 6 and 9 will not change, those emissions are not included in this determination.

The applicable rule for this project is 17-2.05(6) FAC Table II I. Carbonaceous Fuel Burning Equipment. The wood pellets are a carbonaceous fuel as defined in 17-2.02(21) FAC. The maximum allowable particulate emissions from this rule are 0.2 lb/MMBTU heat input of carbonaceous fuel plus 0.1 lb/MMBTU heat input of fossil fuel. Using the heat input of both boilers plus 12% oil firing, the total maximum allowable particulate emissions for both boilers are calculated to be 25.48 pounds per hour and 111.61 tons per year. Using the potential particulate emissions that you used, the scrubber would be required to have an efficiency of at least 92% to meet this limitation.

The boiler conversion project was also evaluated to determine if the requirements of 17-2.04 FAC, Prevention of Significant Deterioration (PSD) applied. AP-42 was used to estimate emissions from the boilers when firing 2% sulfur No. 6 fuel oil. The emissions for the proposed project were estimated based upon the fuel use scenario presented by the applicant. Particulate emissions are based on the carbonaceous fuel regulation. Sulfur dioxide and carbon monoxide emissions were developed from AP-42. Hydrocarbon and nitrogen oxide emissions were based upon factors obtained from the Technical Association of the Pulp and Paper Industry (TAPPI) for wood-residue fired boilers. The emission factors of 0.064 lb of hydrocarbon/MMBTU heat input and 0.25 lb of NO_x/MMBTU heat input are felt to give a better estimate of emissions than those contained in AP-42. The comparison of current allowable emission, proposed emissions and de minimus levels are:

Pollutant	Current Allowable		Proposed Allowable		Change	Deminimus
	lb/hr	TPY	lb/hr	TPY	TPY	TPY
Particulate	20.30	88.91	25.48	111.61	22.70	25
SO_2	277.16	1213.92	45.67 46.19	199.99 202.27	-1013.93 -1011.65	40
NO_x	52.96	231.96	33.88	148.39	-83.57	40
HC	0.88	3.86	8.67	37.99	34.13	40
CO	4.41	19.33	15.98 17.19	69.94 75.32	50.61 55.99	100

Since the increases in emissions do not exceed the de minimus levels, this project is exempt from the requirements of the Federal PSD rule.

The Northwest District Office in Pensacola will handle the processing of this permit. If there are any questions concerning this determination, please contact John Svec at 488-1344.

Sincerely,

C. H. Fancy, P.E.
Deputy Chief
Bureau of Air Quality Management

CF:JS:caa

cc: Paul Kaczorowski, HRS
Jack Preece, Northwest District
John Svec, BAQM

4. CALCULATIONS FOR SECTION III, C, (AIRBORNE CONTAMINANTS EMITTED).

The numerical values for "Potential Emissions" are taken from the data developed for the "Emission Matrix" as modified by C. Fancy's letter of July 23, 1981.

A. Boiler No. 7 (67.8 MMBTU/hr)

1. PARAMETER: Particulate

The Potential Emission is determined from the Emission Matrix

a: Pelletized Wood Fuel: 100 t/day

AP42 Emission Factor for Wood/Bark Boiler: 37.5 lbs/ton.

Therefore

$$\frac{100\ \text{t/day}}{24\ \text{hr/day}} \times 37.5\ \text{lbs/t} = \underline{156.25\ \text{lbs/hr}}\ (684.37\ \text{t/yr.}).$$

b. Additionally, up to 12% firing will be using No. 6 Fuel Oil. The AP42 test uses an Emission Factor of lb/1000 gal=10(s) + 3 where S=2%. Thus the emission factor is

23 lbs/1000 gal = 0.023 lbs/gal.

Boiler No. 7 currently utilizes 3,666 lbs/hr of No. 6 Fuel Oil, which has a density of 8.3 lbs/gal.; thus, the particulate contribution of using 12% No. 6 Fuel Oil is:

$$\frac{0.12 \times 3{,}666\ \text{lbs/hr} \times 0.023\ \text{lbs/gal}}{8.3\ \text{lbs/gal.}} = \underline{1.22\ \text{lbs/hr}}\ (5.34\ \text{t/yr}).$$

Consequently, the particulate emission, calculated using the AP42 factors, is

<u>157.47 lbs/hr</u> (689.71 t/yr).

2. PARAMETER: SO_x

The Potential Emission is determined from the Emission Matrix:

a. Pelletized Wood Fuel: 100 t/day.

AP42 Emission Factor for Wood/Bark Boiler: 1.50 lbs/ton. Therefore,

$$\frac{100\ \text{t/day}}{24\ \text{hrs/day}} \times 1.50\ \text{lbs/t} = \underline{6.25\ \text{lbs/hr}}\ (27.37\ \text{t/yr}).$$

b. Additionally up to 12% firing will be using No. 6 Fuel Oil.

The AP42 test uses a Emission Factors of

157S lbs SO_2/1000 gal and

2S lbs SO_3/1000 gal.

Now S = 2% and Boiler No. 7 utilizes 3,666 lbs/hr of No. 6 Fuel Oil which has a density of 8.3 lbs/gal. Thus the contribution of SO_x given by burning Fuel Oil is:

$$0.12 \left(\frac{3.666\ \text{lbs/hr x } 0.314\ \text{lbs/gal}}{8.3\ \text{lbs/gal}} + \frac{3666\ \text{lbs/hr x } 0.004\ \text{lbs/gal}}{8.3\ \text{lbs/gal.}} \right)$$

$$= 0.12(138.69\ \text{lbs/hr} + 1.77\ \text{lbs/hr}) = \underline{16.86\ \text{lbs/hr}}\ (73.83\ \text{t/yr}).$$

Consequently, the SO_x emission, calculated using the AP42 factors, is

<u>23.11 lbs/hr</u> (101.20 t/yr).

3. PARAMETER: NO_x

The Potential Emission is determined using the factor of 0.25 lbs NO_x/MMBTU heat input, which is given in C. Fancy's letter of July 23, 1981:

$$0.25 \text{ lbs/MMBTU} \times 67.8 \text{ MMBTU/hr} = \underline{16.95 \text{ lbs/hr}} \ (74.24 \text{ t/yr}).$$

4. PARAMETER: Hydrocarbons

The Potential Emission is determined using the factor of 0.064 lbs hydrocarbon/MMBTU heat input, which is given in C. Fancy's letter of July 23, 1981:

$$0.064 \text{ lbs/MMBTU} \times 67.8 \text{ MMBTU/hr} = \underline{4.34 \text{ lbs/hr}} \ (19.01 \text{ t/yr}).$$

5. PARAMETER: CO

The Potential Emission is determined from the Emission Matrix:

a. Pelletized Wood Fuel: 100 t/day

AP 42 Emission Factor for Wood/Bark Boiler: 2 lbs/ton.

$$\frac{100 \text{ t/day}}{24 \text{ hrs/day}} \times 2 \text{ lbs/t} = \underline{8.33 \text{ lbs/hr}} \ (36.50 \text{ t/ yr}).$$

b. No. 6 Fuel Oil (12%)

AP 42 Emission Factor: 5 lbs/1000 gal.

$$\frac{0.12 \times 0.005 \text{ lbs/gal} \times 3666 \text{ lbs/hr}}{8.3 \text{ lbs/gal.}} = \underline{0.27 \text{ lbs/hr}} \ (1.16 \text{ t/yr}).$$

Consequently, the CO emission, calculated using the AP42 factor, is

8.60 lbs/hr (37.66 t/yr).

B. Boiler No. 8(67.7 MMBTU/hr).

1. PARAMETER: Particulate

a. Pelletized Wood Fuel: 100 t/day. AP42 factor: 37.5 lbs/t.

$$\frac{100 \text{ t/day} \times 37.5 \text{ lbs/t}}{24 \text{ hr/day}} = \underline{156.25 \text{ lbs/hr}} \ (684.37 \text{ t/yr}).$$

b. No. 6 Fuel Oil (12%) (Existing rate = 3,660 lbs/hr; density = 8.3 lbs/gal). AP42 factor:

10S + 3 lbs/1000 gal, (S= 2%)

or 0.023 lbs/gal.

$$\frac{0.12 \times 3{,}660 \text{ lbs/hr} \times 0.023 \text{ lbs/gal}}{8.3 \text{ lbs/gal.}} = \underline{1.22 \text{ lbs/hr}} \ (5.34 \text{ t/yr}).$$

Consequently, the particulate emission, using the AP42 factors, is

$$\underline{\underline{157.47 \text{ lbs/hr}}} \quad (689.71 \text{ t/yr}).$$

2. PARAMETER: SO_x

a. Pelletized Wood Fuel: 100 t/day

AP42 factor: 1.50 lbs/t

$$\frac{100 \text{ t/day} \times 1.50 \text{ lbs/t}}{24 \text{ hr/day}} = \underline{6.25 \text{ lbs/hr}} \quad (27.27 \text{ t/yr}).$$

b. No. 6 Fuel Oil (12%) (Existing rate = 3660 lbs/hr; density = 8.3 lbs/gal).

AP42 factors (S=2%):

157 S lbs SO_2/1000 gal = 03.14 lbs SO_2/gal.

2 S lbs SO_3/1000 gal = 0.004 lbs SO_3/gal.

$$0.12 \left(\frac{3{,}660 \text{ lbs/hr x } 0.314 \text{ lbs/gal}}{8.3 \text{ lbs/gal.}} + \frac{3{,}660 \text{ lbs/hr x } 0.004 \text{ lbs/gal}}{8.3 \text{ lbs/gal.}} \right)$$

= 0.12 (138.46 lbs/hr + 1.76 lbs/hr)= <u>16.83 lbs/hr</u> (73.70 t/yr).

Consequently, the SO_x emission, using the AP42 factors, is

<u>23.08 lbs/hr</u> (101.97 t/yr).

3. PARAMETER: NO_x

Emission Factor: 0.25 lbs/MMBTU (per DER letter of July 23).

0.25 lbs/MMBTU x 67.7 MMBTU/hr = 16.93 lbs/hr (74.15 t/yr)

4. PARAMETER: Hydrocarbons

Emission Factor: 0.064 lbs/MMBTU (per DER letter of July 23)

0.064 lbs/MMBTU x 67.7 MMBTU/hr = 4.33 lbs/hr (18.97 t/yr)

5. PARAMETER: CO

a. Pelletized Wood Fuel: 100 t/day

AP42 Emission Factor: 2lbs/ton

$$\frac{100\text{ t/day x }2\text{ lbs/t}}{24\text{ hrs/day}} = \underline{8.33\text{ lbs/hr}}\ (36.50\text{ t/yr}).$$

b. No. 6 Fuel Oil (12%). AP42 Emission Factor: 5 lbs/1000 gal.

$$\frac{0.12\text{ x }3{,}660\text{ lbs/hr x }0.005\text{ lbs/gal}}{8.3\text{ lbs/gal.}} = \underline{0.26\text{ lbs/hr}}\ (1.16\text{ t/yr}).$$

Thus the CO emission is

$$\underline{\underline{8.59\text{ lbs/hr}}}\ (37.63\text{ t/yr}).$$

This completes the calculations for the "Potential Emission" column in Section III C of the application form.

As the footnote on page 3 of 10 of the application form explains, the values listed in the "Emission" column are the best estimate that we have at this point in time, and that estimate is the same as the "Potential Emissions".

The "Allowable Emission" for Particulate Emission is calculated as follows:

A. Boiler No. 7 (67.8 MMBTU/hr.)

Standard: 0.2 lbs/MMBTU for carbonaceous fuel plus 0.1 lbs/MMBTU for fossil fuel. Pelletized wood will make up approximately 88% of the fuel and No. 6 Fuel Oil will make up approximately 12% of the fuel. Thus the formula used is:

$$\begin{aligned}&88\%\text{ x }0.2\text{ lbs/MMBTU x }67.8\text{ MMBTU/hr}\\&+ 12\%\text{ x }0.1\text{ lbs/MMBTU x }67.8\text{ MMBTU/hr} = \underline{12.75\text{ lbs/hr}}\ (55.85\text{ t/yr})\end{aligned}$$

B. Boiler No. 8 (67.8 MMBTU/hr)

88% x 0.2 lbs/MMBTU x 67.7 MMBTU/hr
+ 12% x 0.1 lbs/MMBTU x 67.7 MMBTU/hr = 12.73 lbs/hr (55.76 t/yr)

This concludes our calculations for Section III C.

5. CALCULATIONS FOR SECTION III, E (FUELS)

The values derived in this section are for the fueling of boilers 7 and 8.

A. PELLETIZED WOOD: It is planned to use, on the average 100t/day/boiler of wood. Since at this time we do not know what variation may occur, we are also listing this as the maximum consumption. The pelletized wood fuel will be supplemented by No. 6 Fuel Oil, up to 12%.

Thus,

$$\frac{200 \text{ t/day} \times 2000 \text{ lb/t}}{24 \text{ hrs/day}} \cong \underline{16,667 \text{ lbs/hr}}.$$

The heating value of the wood is between 7,000 -8,000 BTU/lb. Taking the max. value for purposes of this estimate:

$$\frac{16,667 \text{ lbs/hr} \times 8,000 \text{ BTU/lb}}{1,000,000} \cong \underline{133.33 \text{ MMBTU/hr}}.$$

B. NO. 6 FUEL OIL: The Pelletized Wood Fuel would provide approximately 133.33 MMBTU/hr. If this represents 88% of the total Max. Heat Input and y is the heat input from the Fuel Oil, then

$$\frac{Y}{133.33 + Y} = .12,$$

or

$$Y = \frac{.12}{.88} \times 133.33 \cong \underline{18.18 \text{ MMBTU/hr}}.$$

Now if Z lbs/hr is the fuel oil consumption, then

Z x fuel heat capacity x boiler efficiency = heat input.

Thus

$$Z \text{ lbs/hr} \times 18{,}500 \text{ BTU/lb} \times \frac{.8794 + .8808}{Z} \cong 18{,}181{,}818 \text{ BTU/hr}$$

and

$$Z = \underline{1117 \text{ lbs/hr}},$$

where .8794 and .8808 are the efficiencies of boilers 7 and 8, respectively, as stated in Item No. 1 of this attachment (copy of Operating Permit data). This completes the calculations for Section III, E.

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ENGINEERING DIVISION
TULLAHOMA, TENNESSEE

CALCULATIONS, SKETCHES, ASSUMPTIONS

BY ___ DATE 27JAN81 SUBJECT ___ SHEET NO. 1 OF ___
CHKD. BY ___ DATE ___ JOB NO. ___

POLLUTION CONTROL CALC. (PER BOILER UNIT)

ASH CONTENT OF FUEL:

BIO-MASS	CARBONACEOUS (MAX)	3%
NO. 6 FUEL OIL (#7 BOILER SPEC.)		0.04%

FUEL HEATING VALUES

BIOMASS	7500 BTU/LB
No. 6 FUEL OIL	18300 BTU/L

FUEL PROPORTION BY HEAT OUTPUT

BIOMASS	87.5%
NO. 6 FUEL OIL	12.5%

GROSS HEAT INPUT (FROM COMBUSTION CALC.)

BIOMASS	62.4 MM BTU
NO. 6 FUEL OIL	8.9 MM BTUH

FUEL RATE

BIOMASS	8320 LB/HR
NO. 6 FUEL OIL	486 LB/HR

TOTAL ASH

BIOMASS	8320 x .03	250 LB/HR
FUEL OIL	486 x .0004	.19 LB/HR

FLUE GAS BURDEN (ASSUME 100% OF ASH IS ENTRAINED IN FLUE GAS)

BIOMASS	250/62.4 =	4.01 LB/MM BTU
FUEL OIL	.19/8.9 =	.02 LB/MMBTU

ATTACHMENT NO. 3

CALCULATIONS, SKETCHES, ASSUMPTIONS

BY AA DATE 27JAN81 SUBJECT SHEET NO. 2 OF
CHKD. BY DATE JOB NO. 7207

POLLUTION CONTROL CALCULATIONS:

STATE OF FLA. ALLOWABLE EMISSIONS:

CARBONACEOUS FUEL	0.3 LB/MMBTU
FOSSIL FUEL	0.1 LB/MMBTU

ALLOWABLE RATE

BIOMASS = .3 × 62.4 = 18.72 LB/HR
FUEL OIL = .1 × 8.9 = .89 LB/HR
TOTAL = 19.61 LB/HR

COLLECTOR EFFICIENCY

$$\text{OVERALL EFF. (3\% ASH)} = \frac{250.2 - 19.61}{250.2} = 92\%$$

$$\text{OVERALL EFF (2\% ASH)} = \frac{8320(.02) - 19.61}{8320(.02)} = 88.2\%$$

PARTICLE SIZE DISTRIBUTION (FROM, "AN EVALUATION OF WOOD WASTE ENERGY CONVERSION SYSTEMS", B.H. LEVELTON & ASSOCIATES LTD., MAR. 78, U.S.D.C. NP 23555, P. 95)

75% < 10μ

ASSUME 98% COLLECTION EFF ABOVE 10μ = η_1

COLLECTION EFF REQ'D FOR PARTICLES BELOW 10μ., η_2

$$\text{TOTAL ALLOWABLE RATE, LB/HR} = \text{TOTAL LOADING}\left[1 - .25\eta_1 - .75\eta_2\right]$$

CALCULATIONS, SKETCHES, ASSUMPTIONS

BY DJ DATE 27JAN81 SUBJECT ______ SHEET NO. 3 OF ___
CHKD. BY ______ DATE ______ ______ JOB NO. ______

POLLUTION CONTROL CALC.

3% ASH $19.61 = 250.2\left[1 - .25(.98) - .75\eta_2\right]$

$.078 = .755 - .75\eta_2$

$\eta_2 = 90.3\%$

2% ASH $19.61 = 166.4\left[.755 - .75\eta_2\right]$

$\eta_2 = 85.0\%$ $\eta =$

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TULLAHOMA, TENNESSEE

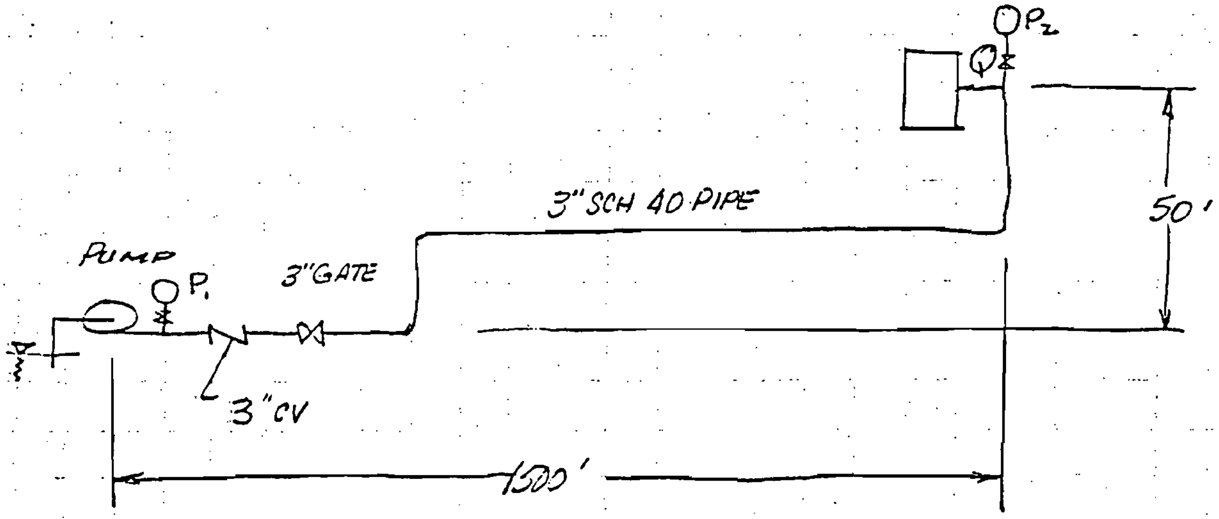
CALCULATIONS, SKETCHES, ASSUMPTIONS

BY DA DATE 11FEB81 SUBJECT ____ SHEET NO. 4 OF ____

CHKD. BY ____ DATE ____ ____ JOB NO. ____

SCRUBBER PUMP SIZING

ASSUMED MODEL



GIVEN: $Q = 320$ GPM WATER @ 70°F

$H_2 = P_2 = 20$ PSIG (46 FT H_2O)

$e_p = 0.7$

1. FROM BERNOULLI'S EQN.

$$H_1 = \Delta Z + H_2 + h_L$$

2. $h_L = .1863 f \frac{L}{d} v^2$

$$R_e = 123.9 \frac{d v \rho}{\mu}$$

$$v = \frac{.408 Q}{d^2}$$

$$K = f \frac{L}{D}$$

$$L = (40) D$$

ARO/ED-11 (10-77)

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TULLAHOMA, TENNESSEE

CALCULATIONS, SKETCHES, ASSUMPTIONS

BY AD DATE FEB 11, 1981 SUBJECT ______ SHEET NO. 5 OF ___
CHKD. BY ____ DATE ____ ______ JOB NO. 7207

$$BHP = \frac{QH_t\rho}{247000\,e_p}$$

3. $d = 3.068$ $d^2 = 9.413$
$D = 0.2557$

4. $v = \frac{.408 \times 320}{9.413} = 13.87$ fps

5. $\rho = 62.3$

6. $\mu = 0.95$

7. $Re = \frac{123.9 \times 3.068 \times 13.87 \times 62.3}{0.95}$

$Re = 3.46 \times 10^5$

8. $f = 0.019$

9. L/D 4-90° ELL $4 \times 30 = 120$
1 3" C.V $1 \times 135 = 135$
EXIT LOSS
$K = 1$
$L/D = K/f =$ 53
308

$L = (L/D)D = 308(.2557) = 78.8$

10. TOTAL EQUIV. LENGTH PIPE IS:
$L = 1500 + 50 + 78.8 = 1629$ FT

CALCULATIONS, SKETCHES, ASSUMPTIONS

BY DS DATE FEB 11, 1981 SUBJECT ______ SHEET NO. 6 OF ____

CHKD. BY ______ DATE ______ ______ JOB NO. ______

11. HEAD LOSS THRU FITTINGS, VALVES, PIPE, EXIT,

$$h_L = \frac{0.1863 \times 0.019 \times 1629 \times (13.87)^2}{3.068} = \underset{361}{\cancel{139.4}} \text{ FT}$$

12. TOTAL PUMP HEAD IS:

$$H_1 = 50 + 46 + \underset{361}{139.4} = \underset{457}{\cancel{235}} \text{ FT.}$$

13. BRAKE HORSEPOWER

$$BHP = \frac{320 \times 235 \times 62.3}{247000 \times 0.7} = \underset{53}{\cancel{27}} \quad \text{SAY } \underset{60}{30} \text{ HP}$$

OR 2 - 30 HP PUMPS 1 FOR EA. SCRUBBER

101-60 472

14. CHECK NPSH AVAILABLE: $NPSH_A$

$$NPSH_A = h_{ss} - h_{fs} - p$$

WHERE, h_{ss} = STATIC SUCTION HEAD, FT, (ABS. PRESSURE AT REF SOURCE LEVEL PLUS VERTICAL DISTANCE TO PUMP CENTER LINE.

h_{fs} = SUCTION FRICTION HD, FT.

p = VAPOR PRESSURE OF SOURCE, FT

CALCULATIONS, SKETCHES, ASSUMPTIONS

BY________ DATE ______ SUBJECT ____________ SHEET NO. 7 OF ____

CHKD. BY______ DATE ______ ____________ JOB NO. ______

15. FROM CRANE CENTRIFUGAL PUMP DATA FOR A-60 PUMP

INLET DIA = 3" PIPE SIZE

DISCHARGE = 2" PIPE SIZE

$NSPH_R$ AT 320 GPM = 17 FT.

16. $h_{fs} = .1863 f \frac{L}{d} v^2$

WHERE, $v = .408 \frac{Q}{d^2} = 13.9$ fps

EQUIV. LENGTH,

1-90° ELL $L_e = 30 \times .2557 = 7.67$

L, 3"φ PIPE 10.00

1 ENTRANCE $K = .5$ $\frac{L}{d}$ 6.70

23.37

$h_{fs} = .186\,(.019)\left(\frac{23.37}{3.068}\right)(13.9)^2 = 5.2$ ft.

17. $p_{@70} = 0.363$ PSIA $= .837$

18. ASSUME PUMP 5 FT ABOVE SOURCE

$h_{ss} = \frac{14.6 \times 144}{62.3} + 5 = 38.7$ FT

CALCULATIONS, SKETCHES, ASSUMPTIONS

BY ______ DATE ______ SUBJECT ______________________ SHEET NO. 8 OF ____
CHKD. BY ______ DATE ______ ______________________ JOB NO. __________

19. $NSPH_A = h_{ss} - h_{fs} - p$

$= 38.7 - 5.2 - .837$

$NSPH_A = 32.7$ FT.

$NSPH_R = 17$ FT SO INSTALLATION IS SUFFICIENT

PUMP CRANE A60 CENTRIFUGAL
ALL PURPOSE HD UNIVERSAL SERVICE

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TULLAHOMA, TENNESSEE

CALCULATIONS, SKETCHES, ASSUMPTIONS

BY N DATE Jan 29 1981 SUBJECT ESH · BOILER CONV. SHEET NO. 1 OF
CHKD. BY ____ DATE ____ JOB NO. 7207

ASH HANDLING CALCULATIONS:

FROM POLLUTION CALCULATIONS PG. 1

(MAX.) TOTAL ASH PRODUCED (3% ASH IN FUEL) = 250 LB/HR
TOTAL ASH PRODUCED (2% AVG ASH IN FUEL) = 166 LB/HR DESIGN

WITH OVERALL COLLECTION EFF. = 88% (POLLUTION CALC. PG 2

TOTAL ASH COLLECTED PER UNIT = .88 (166) = 146 LB/HR
3506 LB/DAY
1279661 LB/YR
640 TN/YR

VOLUME PER UNIT (ASSUMING ASH HAS BULK DENSITY OF 35 PCF)
36570 CFY

T 100% COLLECTION 3% ASH FUEL 250 LB/HR
2160000 LB/YR
61714 CF/YR

TOTAL ASH COLLECTED ASSUMING 2 UNITS ON LINE

2% 88% 73000 CF/YR

3% 100% (SCRUBBER) 124000
[illegible] CF/YR

POND VOLUME ~ 144,000 PER SPA SITE VISIT 2/81

CLEAN POND 4 TIMES PER YEAR

ZURN a step ahead of tomorrow

SPA E 405
SEPARATOR - E406
SCRUBBER E403
404

Proposal & Specifications: ARO Ltr of 1/20/81

Page 1 of 9
Date: February 6, 1981
Proposal No. 81-01

TO: ARO
Tullahoma, Tennessee

Change to Stainless steel - See memo, CL

Reference: Scrubbers for Wood Fired Boilers (2)

ITEM 1
Two (2) H/V Venturis, as detailed on the enclosed Description Sheets

ITEM 2
Two (2) Cyclonic Separators, with legs to grade, as detailed on the enclosed Description Sheets. Leg height based on Separator drain at 4' above grade.

ITEM 3
Two (2) Stacks, 36" diameter by 15' tall, fabricated from 3/16" C.S. Stack to be flanged to the top outlet of Item 2, and is provided with (2) 3" testports 36" from the top.

Approximate Weight: 1200 lbs. each

CONTRACT PRICE:

a) In 3/16" C.S. - $29,000

b) In 3/16" 304 S.S. or
10 ga. 316L S.S. - $58,000

17,

LEAD TIMES

Allow approximately one (1) month for approval drawings, and three (3) to four (4) months for shipment of equipment after certified drawings.

C. Menoher

Chuck Menoher
Product Manager - Scrubbers

ATTACHMENT NO. 4

OPERATING CONDITIONS (Each of 2 Boilers)

Inlet Volume (Test Block)	25000	ACFM	
Inlet Temperature	420	°F.	
Inlet Pressure, Max.	+10	"W.C.	
Inlet Humidity	0.038	# W. V./# D.G.	
Inlet Dust Loading	1.25	Gr/SCFD	
Saturated Volume	18675	ACFM	
Saturation Temperature	130	°F.	
Saturation Pressure	Atm	"W.C.	
Saturation Humidity	0.111	# W.V./ D.G.	
Gas Volume Density	0.065	# /Ft.^{3}	
Venturi Pressure Drop	7-8	"W.C.	
Separator Pressure Drop	2	"W.C.	
Scrubbing Water Rate At 20 psig	160	GPM	
Evaporation Rate	10	GPM	
Bleed Rate At 2 % Solids	20	GPM	*
Make Up Water Rate	30	GPM	*
Exit Dust Loading	0.14	Gr/SCFD	**

* If water is being recycled through a nearby settling pond, then Bleed Rate is 150 GPM and make-up is 160 GPM.

** Equal to 0.3#/10^6 BTU's heat input.

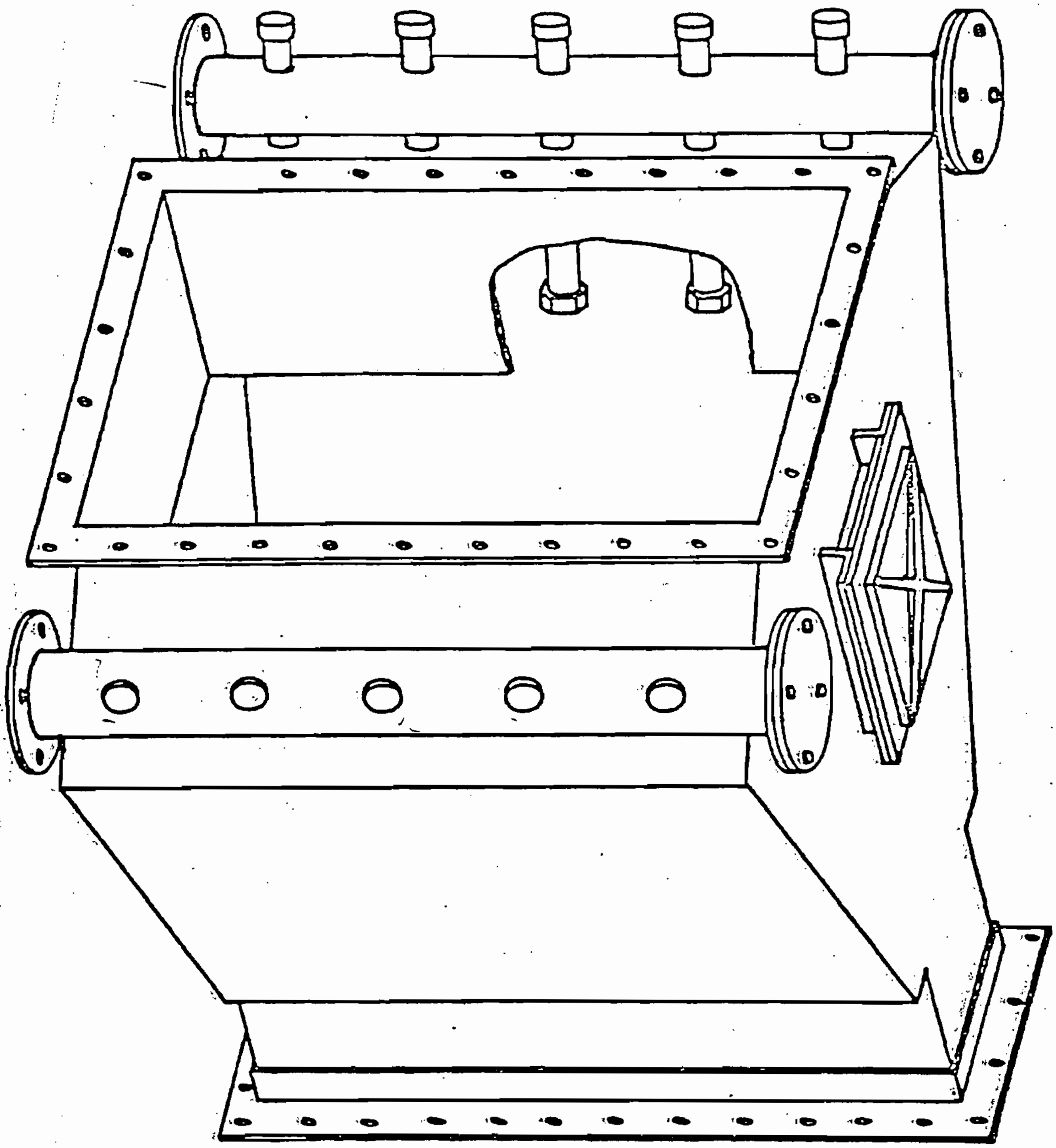
Date: February 6, 1981
Proposal No.: 81-01

VENTURI DESCRIPTION (2 Required)

Venturi Type	H/V
Shell Material	3/16" C.S.
Top Plate Size	36"L x 38" W.
Inlet Size	36"L x 24" W
Elbow Size	N/A
Outlet Size	36"L x 12" W
Overall Height	48"
Water Inlets	(6) 2"
Water Manifold	(2) 2"
Inspection Ports	N/A
Access Door	(1) 18"
Adjustable Throat	NO
Nominal Throat Area	36"L x 8" W
Type Actuator	N/A
Method of Actuation	N/A
Venturi Center Line To Outlet	N/A
Approximate Weight	600 lbs.
Transition To Separator	N/A

Note: Dimensions Are Approximate.

H/V VENTURI



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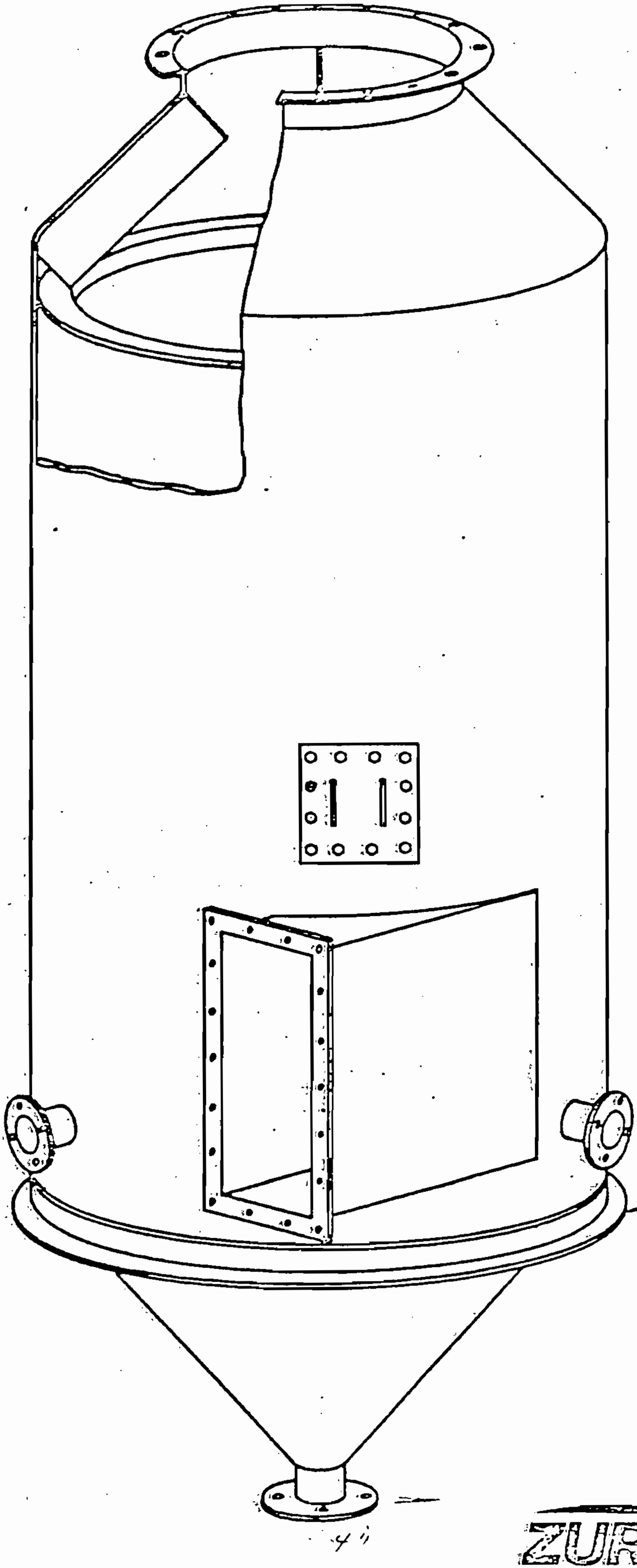
Page: 5 of 9
Date: February 6, 1981
Proposal No.: 81-01

CENTRIFUGAL SEPARATOR DESCRIPTION

Centrifugal Separator Type	CYCLONIC
Shell Material	3/16" C.S.
Lining Material	N/A
Inside Diameter	~~6'~~-6"
Straight Wall Height	~~10'~~
Overall Height	~~14'~~
Bottom Cone Angle	30°
Top Cone Angle	45°
~~Outlet Size~~	~~30"~~
Vortex Breakers	YES
Wear Plate	YES
Spin Breakers	YES
Access Doors	(1) 18"
Drain Size	4"
Overflow Size	4"
Make Up Water	N/A
Liquid Level Control	N/A
Separator Center Line To Inlet	4'
Approximate Weight, incl. legs to grade	4500 lbs.
Type Shipment	Assembled

Note: Dimensions Are Approximate.

CYCLONIC SEPARATOR



Legs to grade in lieu of basering.

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STANDARD ESCALATION/DE-ESCALATION POLICY

This Policy Applies To Zurn Products Only; Not To Construction and/or Erection

Proposal No. 81-01 Date 2-6-81 Page 7 of 9

The prices quoted herein are based on material costs and wage rates known to Zurn at the time of quotation that have been projected to cover a time span allowing shipment to be made within 7 months from date of proposal.

Prices are valid for 30 days and are firm if shipment is scheduled to be made within 7 months from date of proposal.

Applicable escalation/de-escalation will be calculated by use of a ratio of two Indexes published by the Bureau of Labor Statistics (BLS). The ratio will be created by the two Indexes as follows:

1. The first index known as the "BASE INDEX" is the Index published by the Bureau of Labor Statistics (BLS) for the month that is the Seventh Month from the date of Proposal. The BASE INDEX is the denominator of a fraction created by the two Indexes. There is a Base Index for Labor and a separate Base Index for Material.

2. The second index known as the "SHIP INDEX" is the Index published by the BLS for the month that the final Zurn Product or Item is shipped within. The SHIP INDEX is the numerator of a fraction created by the two Indexes. There is a Ship Index for Labor and a separate Ship Index for Material.

3. The SHIP INDEX divided by the BASE INDEX equals the RATIO to be used for Escalation/De-escalation Purposes. There is a Ratio for Labor and a separate Ratio for Material.

The LABOR INDEX is known as "Average Hourly and Weekly Earnings" for MACHINERY, EXCEPT ELECTRICAL per Table B-3 of BLS Report entitled "THE EMPLOYMENT SITUATION".

The MATERIAL INDEX is known as Intermediate Materials, Finished Steel Products (Commodity Code 10-13-02) per Table 2 of BLS Report entitled "PRODUCER PRICE INDEXES".

The applicable ratio of indexes will be used as a multiplier for the percentage of the total contract value in dollars: (1) That represents the labor portion of the contract and (2) That represents the material portion of the contract.

48% of this proposal represents the labor dollar portion.

52% of this proposal represents the material dollar portion.

The invoice price will be established when the total quoted or revised price is increased or decreased using the applicable multiplier or ratio times its percentage of the total contract value and adding respective totals, i.e. labor and material.

Progress payments can be used to offset escalation.

TERMS AND CONDITIONS OF SALE

Revised January 1980
20 Paragraphs

. DEFINITIONS

A. The Company: ZURN INDUSTRIES, INC., AIR SYSTEMS DIV., P.O. Box 2206, Birmingham, Alabama 35201.
B. The (This) Contract: These Terms and Conditions of Sale, all attachments and specifications,and any written additions, changes or supplements.
C. Notice: A notice in writing sent by registered or certified mail to the Company's P. O. Box in Birmingham, Alabama, effective on receipt.
D. The Purchaser: The Buyer under this Contract and its agents.

2. LIMITATIONS ON CONTRACT TERMS

THE COMPANY'S OFFER IS EXPRESSLY LIMITED TO THESE TERMS AND CONDITIONS. THE COMPANY'S ACCEPTANCE IS EXPRESSLY MADE CONDITIONAL ON PURCHASER'S ASSENT TO THESE TERMS AND CONDITIONS. NO TERM OR CONDITION STATED BY THE PURCHASER SHALL BE BINDING ON THE COMPANY UNLESS EXPRESSLY AGREED TO IN WRITING BY THE COMPANY. THE PRICE TERMS IN THIS PROPOSAL ARE SUBJECT TO CHANGE THIRTY (30) DAYS FROM PROPOSAL DATE UNLESS OTHERWISE SO AGREED.

3. WARRANTY

A. THE COMPANY WARRANTS THAT THE GOODS MANUFACTURED OR REPAIRED BY THE COMPANY UNDER THIS CONTRACT CONFORM TO SPECIFICATIONS. ALL OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MECHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE EXCLUDED. EQUIPMENT OR SERVICES SUPPLIED BY OTHER VENDORS ARE EXCLUDED FROM THE COMPANY'S WARRANTY AND ONLY CARRY SUCH WARRANTY AS PROVIDED BY THOSE VENDORS, BUT THE COMPANY AGREES TO ACT AS LIAISON FOR THE PURCHASER WITH THOSE VENDORS.

B. ALL EQUIPMENT MANUFACTURED BY THE COMPANY IS NEW AND WARRANTED AGAINST DEFECTS IN MATERIAL AND WORKMANSHIP FOR A PERIOD OF ONE YEAR FROM INITIAL OPERATION OR 18 MONTHS FROM THE DATE OF SHIPMENT, WHICHEVER OCCURS FIRST. IN THE EVENT OF DEFECTS IN MATERIAL OR WORKMANSHIP DURING THE WARRANTY PERIOD, THE PURCHASER'S SOLE REMEDY IS REPLACEMENT OR REPAIR OF THE EQUIPMENT, F.O. B. POINT OF SHIPMENT (OR OTHER APPROPRIATE LOCATION) ACCORDING TO THE SPECIFICATIONS AND TERMS AND CONDITIONS ESTABLISHED IN THE CONTRACT, AND IS LIMITED BY THE CONTRACT PRICE. IN AND OUT EXPENSES AND TRANSPORTATION CHARGES ARE FOR PURCHASER'S ACCOUNT. REPAIR OR REPLACEMENT DOES NOT ALTER OR EXTEND LIMITS ON LIABILITY AND WARRANTY ESTABLISHED AT SALE. NORMAL WEAR AND TEAR IS NOT COVERED UNDER THIS WARRANTY. THERE IS NO WARRANTY OF PERFORMANCE UNDER THIS CONTRACT BEYOND THAT APPLICABLE DURING START-UP.

C. THE COMPANY'S WARRANTY IS CONDITIONAL UPON THE PURCHASER's: (A) GIVING THE COMPANY NOTICE OF THE WARRANTY BREACH WITHIN SIXTY (60) DAYS FROM THE TIME IT OCCURS; (B) OPERATING THE EQUIPMENT ACCORDING TO THE MANNER PRESCRIBED BY THE COMPANY AND WITHOUT ALTERATION OR SUBSTITUTION TO THE EQUIPMENT, AND; (C) KEEPING ADEQUATE LOGS AND RECORDS TO ESTABLISH PROPER EQUIPMENT OPERATION. PROPER OPERATION INCLUDES, BUT IS NOT LIMITED TO, PROPER ERECTION; PROPER EQUIPMENT MAINTENANCE, AND AVOIDANCE OF DAMAGE FROM ABRASION, CORROSION, OR EXCESSIVE TEMPERATURE. FAILURE TO PROPERLY OPERATE THE EQUIPMENT VOIDS THIS WARRANTY.

D. EQUIPMENT MANUFACTURED BY OTHERS BUT REPAIRED BY THE COMPANY IS SUBJECT TO THE SAME LIMITATIONS ABOVE AND EQUIPMENT PERFORMANCE IS LIMITED BY DESIGN FACTORS BEYOND THE CONTROL OF THE COMPANY.

E. PURSUANT TO SECTION 2-725(1) OF THE UNIFORM COMMERCIAL CODE, THE STATUTE OF LIMITATIONS ON ACTIONS IN TORT OR CONTRACT IS LIMITED TO 18 MONTHS FROM TENDER OF DELIVERY OF THE GOODS.

4. LIMITATIONS OF LIABILITY

A. THE COMPANY SHALL, IN NO EVENT, BE LIABLE FOR BREACH OF CONTRACT OR IN NEGLIGENCE OR STRICT LIABILITY FOR CONSEQUENTIAL, SPECIAL, DIRECT OR INCIDENTAL DAMAGES OF ANY KIND INCLUDING BUT NOT LIMITED TO PURCHASER'S COST, LOST PROFITS, INJURY TO GOODWILL, PROPERTY DAMAGE, PERSONAL INJURY, OR LABOR CHARGES.

B. THE PURCHASER SHALL INDEMNIFY AND HOLD HARMLESS THE COMPANY FROM ALL CLAIMS, LOSSES AND DAMAGES TO PERSONS AND PROPERTY IN CONTRACT OR TORT IMPOSED UPON IT BY THIRD PERSONS, INCLUDING BUT NOT LIMITED TO, EMPLOYEES OF PURCHASER, UNLESS THE CONDUCT OF THE COMPANY WAS PROXIMATE CAUSE OF THE DAMAGE AND RESULTED EITHER FROM THE ACTIVE NEGLIGENCE OR WILLFUL MISCONDUCT OF THE COMPANY. THE LIMITATIONS OF THE PURCHASER'S CONTRACT AND TORT INDEMNITY DO NOT APPLY TO A NUCLEAR FACILITY WHERE THE INDEMNITY IS ABSOLUTE AS PROVIDED BY SECTION 170 OF THE ATOMIC ENERGY ACT OF 1954, AS AMENDED.

5. LIMITED LIABILITY OF COMPANY FOR FIELD WORK

A. At all times during which the Company's agents, laborers, engineers, or service technicians (representatives) perform services or install equipment at the jobsite, whether or not related to construction, start-up, testing, or equipment repairs, the Company shall provide a supervisor to whom the representatives shall report. Such supervisor shall direct the work of the representatives and shall be responsible for the operation of all equipment and appurtenances in the work area and for the safety of all persons and for the protection of property in the work area. No representative of the Company may operate the equipment.

B. The Purchaser shall indemnify and hold harmless the Company from all claims, losses and damages to persons and property in contract and in tort imposed upon it by third persons, including but not limited to, employees of the Purchaser unless the conduct of the representatives was the proximate cause of the damage and resulted either from the active negligence or willful misconduct of the representatives or was in violation of the explicit written instructions of the supervisor.

6. COMPANY ONLY BOUND BY HOME OFFICER OR AUTHORIZED EMPLOYEE

The Company is not bound by any offer or acceptance until made or ratified by the Company from its P. O. Box in Birmingham, Alabama or by an authorized Company employee at another location. Sales representatives are not authorized to bind the Company.

7. TAXES NOT INCLUDED

All Federal, State and Local taxes are for Purchaser's account and are in addition to the prices quoted in this Contract. It is the duty of the Purchaser to establish exemption to any taxes and to indemnify the Company if such information is incorrect.

FORCE MAJEURE

Neither the Company nor the Purchaser shall be liable for failure to deliver or delays in delivery, construction, or erection occasioned by causes beyond the control of the Company or the Purchaser, including strikes, labor slowdowns, lockouts, fires, floods, riots, thefts, accidents, embargoes, war or other outbreak of hostilities, acts of government, acts of God, acts of the public enemy, unusually severe weather, inability to obtain shipping space, machinery breakdowns, delays of carriers or suppliers, and governmental acts or regulations. In the event of any such delay, the time for performance shall be reasonably extended. The Company and Purchaser shall take reasonable steps to reestablish the timetable set out in the contract. If the Force Majeure results in contract termination through no fault of the Company, the Purchaser shall reimburse the Company for its costs plus Contract profit. If the Force Majeure results in delay through no fault of the Company, an adjustment shall be made for additional costs to the Company by Purchaser.

9. NOTICE AND INSPECTION FOR WARRANTY CLAIMS; BACKCHARGES; RESALE

A. Purchaser shall give the Company prompt notice of warranty claims and prompt and reasonable opportunity to inspect goods for which any claim o performance during normal working hours; the cost of work on premium time is not for the account of the Company. The Company shall repair or replace within a reasonable time of notice of the defect.

The Purchaser may not backcharge the Company for legitimate warranty claims since the Company has a duty to repair or replace the goods. No con-
ract modifications, including but not limited to, any price adjustments, are authorized unless signed by the Company.

sequent purchaser and leasees take subject to the limitations established in this Contract. This Purchaser (and all subsequent transferor purchasers and transferor leasees) shall make this a condition of any contract concerning this equipment. In the event of loss or damage to the Company beyond the limits established in this Contract, the Purchaser (and all subsequent tranferor purchasers and transferor leasees) shall indemnify and hold harmless the Company from all such loss or damage.

YMENT TERMS

Payment shall be made in full within thirty (30) days from the Contract date established for delivery, unless a progress payment schedule has been established. Equipment orders are F.O.B. shipping point. The Company reserves the right to change the terms of payment to sight draft, COD, CIA, or confirmed irrevocable letter of credit if, in the Company's judgement, the financial conditions of the Purchaser have changed prior to or at the time of shipment. The Company may charge interest at the rate of 1-1/2% per month on any past due balance. All orders are subject to progress billings at the time of Contract formation.

Any Contract requiring payment from outside the United States shall be accompanied by a confirmed irrevocable letter of credit drawn on an acceptable United States bank of sufficient value to cover the Contract. This letter of credit shall be opened by the Purchaser and is subject to acceptance by the Company.

If final completion of scheduled equipment or shipment of completed equipment is delayed due to Purchaser's failure to promptly inspect, to give shipping instructions, or to discharge any duty necessary for delivery, payment shall become due as if shipment had been made. In any such case, the Purchaser shall, in addition to the price, pay reasonable storage charges. Risk of loss from the initiation of storage shall be borne by the Purchaser.

SK OF LOSS; STORAGE CHARGES, FREIGHT CHARGES

er delivery or tender of delivery to the common carrier or licensed trucker, all risk, loss or damage shall be borne by Purchaser. Any charges or storage ts incurred by the Company after timely delivery or tender of delivery are for Purchaser's account. Any freight charges included in this offer are based on the existing freight rates, and any increases by the carrier prior to delivery are for Purchaser's account. Freight invoices are due upon receipt of oice.

JCLEAR INSTALLATION

is a condition precedent of this Contract that the Purchaser provide for complete Company protection pursuant to Section 170 of the Atomic Energy t of 1954, as amended. Purchaser shall indemnify and hold harmless the Company from any and all liabilities, costs, and damages connected with any idnet or incident occuring at a nuclear facility to the statutory limit of $560 million.

TENT INFRINGEMENT PROTECTION

e Company shall defend at its own expense any suit or action brought against the Purchaser based on a claim that the equipment constitutes an infringe-
nt of any patent of the United States, if notified promptly and in writing and given authority, information, and assistance for defense, and the Company ll pay all costs awarded against the Purchaser. In no event shall the Company be liable for damages beyond the unit price of any infringing equipment.

ELLATION CHARGES

aser's breach of Contract by cancellation before manufacture shall require the Purchaser to pay the Company liquidated damages of 15% of the ntract price plus the expense incurred by the Company prior to notice of cancellation. All reasonable collection costs shall be included in the recovery expenses.

NFIDENTIAL INFORMATION OF THE COMPANY

Any proprietary information received from the Company (including, but not limited to samples, designs, concepts and drawings) remains the property of the Company. The Purchaser shall maintain as secret and treat as confidential all proprietary information supplied by the Company and may not disclose such information to a thrid party without prior written consent of the Company. Proprietary information does not include information already lawfully known to the Purchaser at time of disclosure, public information, or information received by Purchaser from a third party under no obligation to the Company to hold the information as confidential . The Purchaser may not use any proprietary information received from the Company in performing work for itself or any third party at any time. The Purchaser shall return to the Company all proprietary information upon demand and in no event later than the completion of the work under this Contract.

In the event the Purchaser violates the terms of this paragraph, the Purchaser shall pay to the Company as liquidated damages, all damages including, but not limited to, profits and goodwill, directly or indirectly received from violation of this paragraph. Damages are presumed to equal 20% of the contract price unless the parties can establish different damages. The Purchaser shall also inform its buyers in writing of its breach of this contract and that the information is a proprietary right of the Company.

ESTING OF EQUIPMENT

ll equipment under this Contract shall be considered to have satisfactorily met any acceptance requirements of the Purchaser unless the Purchaser, with-
30 days after start-up: (A) gives the Company notice that the equipment is unacceptable; (B) carries out all the tests according to the Company's in-
ructions and prescribed corrective action, if any; and (C) establishes that all of its equipment is in proper operating condition. Once the equipment has et contract requirements at start-up, all performance warranties are satisfied.

LL CHANGES IN WRITING; NO WAIVER

he terms of this Contract may not be changed, terminated, or waived orally. No change, termination or waiver of any of its provisions shall be valid un-
ss signed by the Company. The minimum costs of any change is $150.

LL PREVIOUS UNDERSTANDINGS MERGED

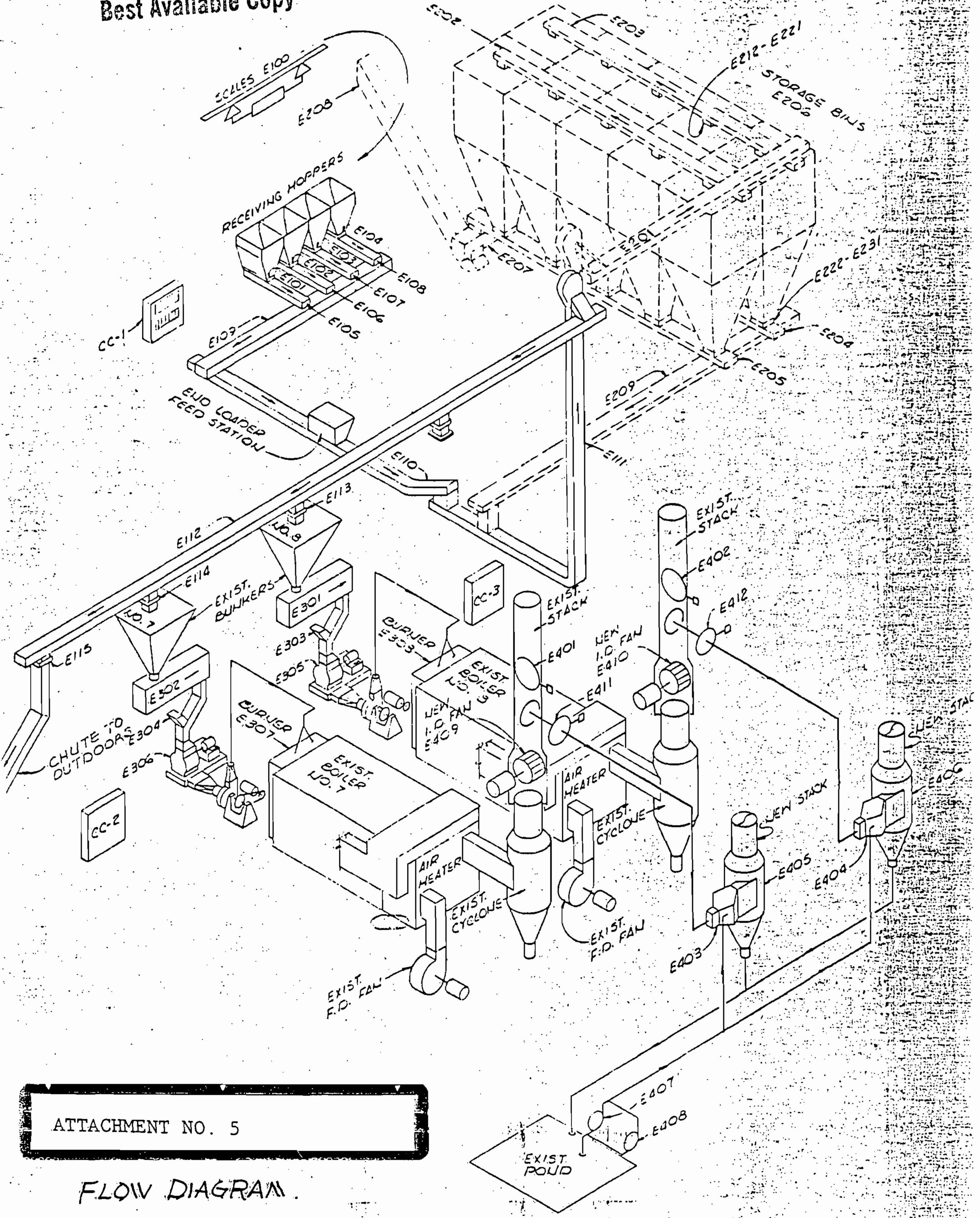
his Contract represents the complete understanding of all the parties regarding the terms and conditions. All previous oral or written understanding r representations are merged in this agreement and are void.

OMPLIANCE WITH LAWS

he Company is not responsible with laws in effect at the work place.

OCATION OF CONTRACT

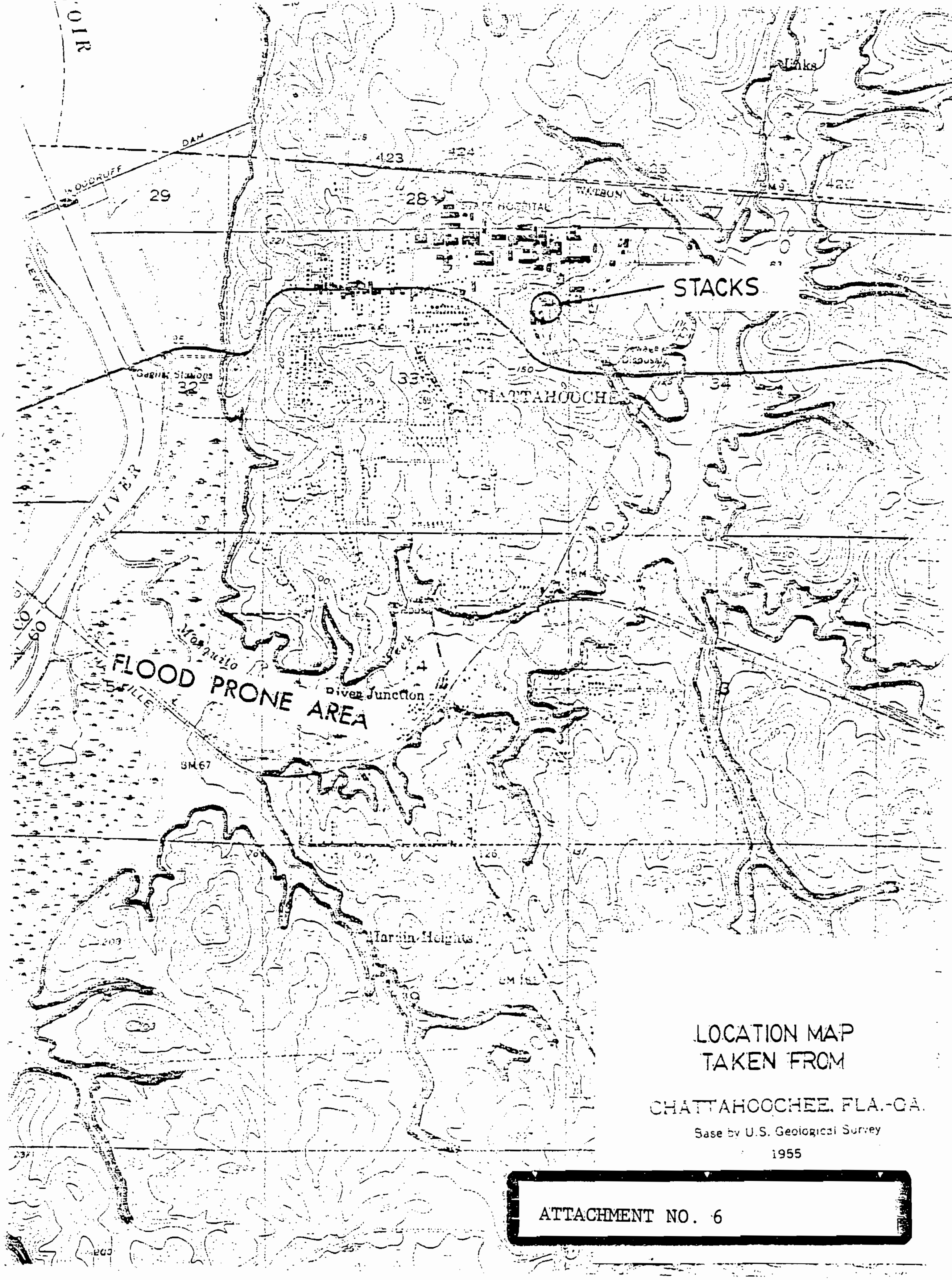
Contract is made in Birmingham, Alabama. This Contract shall be interpreted according to the laws of Alabama and all actions arising out of this tract shall be brought to and in Jefferson County, Alabama.



ATTACHMENT NO. 5

FLOW DIAGRAM.

PROCESS FLOW DIAGRAM



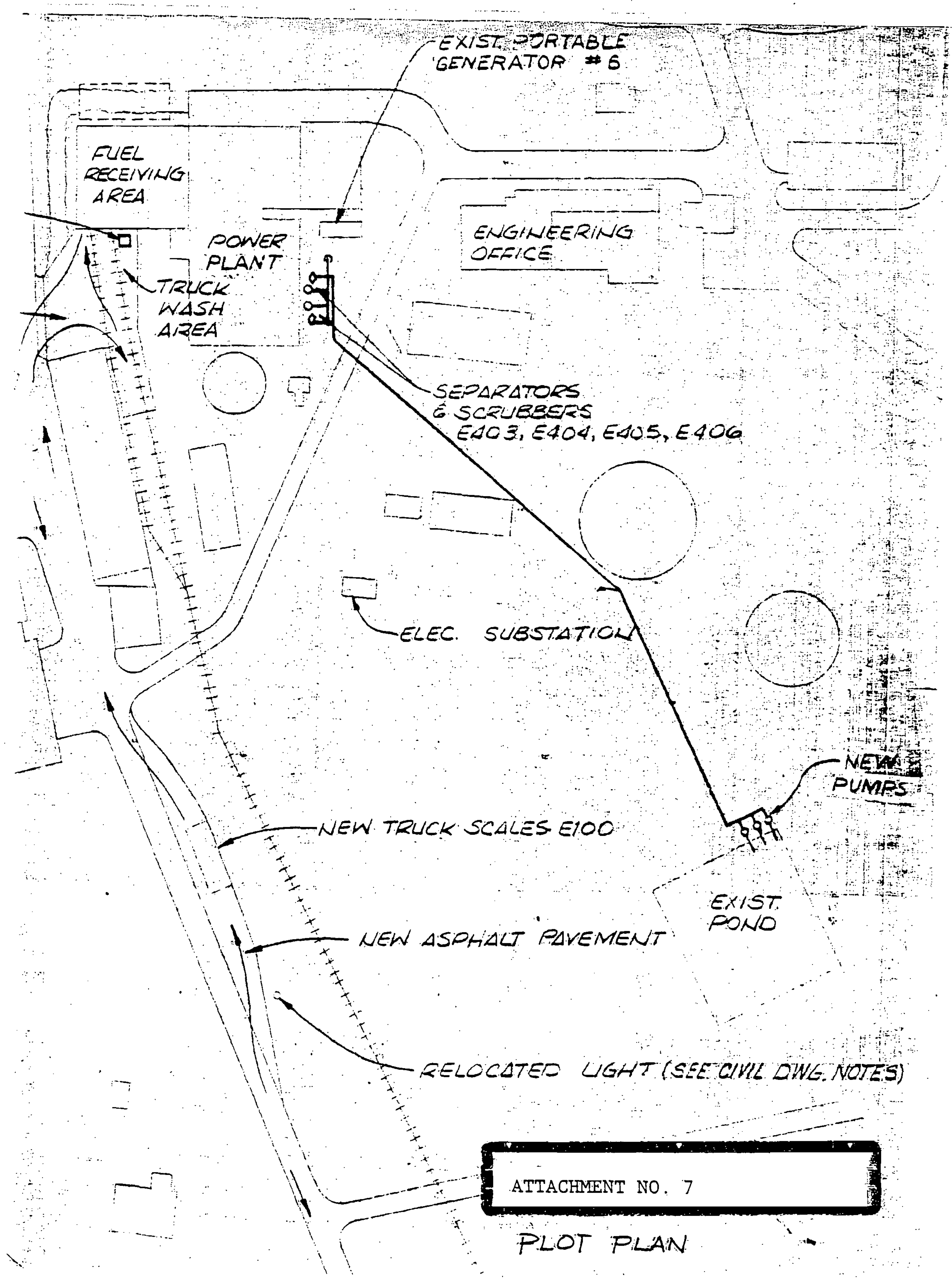
LOCATION MAP
TAKEN FROM

CHATTAHOOCHEE, FLA.-GA.

Base by U.S. Geological Survey

1955

ATTACHMENT NO. 6



ATTACHMENT NO. 7

PLOT PLAN

ATTACHMENT 3

State of Florida
DEPARTMENT OF ENVIRONMENTAL REGULATION

INTEROFFICE MEMORANDUM

For Routing To District Offices And/Or To Other Than The Addressee		
To:	Loctn.:	
To:	Loctn.:	
To:	Loctn.:	
From:	Date:	
Reply Optional [ ]	Reply Required [ ]	Info. Only [ ]
Date Due:	Date Due:	

RECEIVED
NOV 9 1982
Office of the Secretary

TO: Victoria J. Tschinkel

FROM: Steve Smallwood

DATE: November 10, 1982

SUBJ: BACT Determination for Florida State Hospital

Attach please find a BACT determination for a wood fired steam boiler to be constructed in Chattahoochee, Gadsden County, Florida.

We recommend that you approve and sign the determination, the results of which will be made specific conditions of the construction permit.

EP/ks

Best Available Control Technology (BACT) Determination
Florida State Hospital
Gadsden County

The applicant plans to modify two existing fossil fuel-fired steam generators located at the facility in Chattahoochee, Florida. Boiler No. 7 and boiler No. 8 presently fire No. 6 residual oil with a sulfur content of 2 percent by weight. The firebox on each boiler will be modified to fire pelletized wood as the principle fuel supplemented with No. 6 oil. Both boilers are rated at 69.5 million Btu per hour heat input and scheduled to operate 8760 hours per year.

Particulate emissions are to be controlled by installing wet scrubbers in series with existing cyclone separators. The wet scrubbers are to be retrofitted after design parameters are determined by actual field tests. Funds to purchase and install the scrubber systems must be appropriated by the State Legislature. The two modified sources will be allowed temporary emissions under the special provisions of 17-2.500(3)(c), FAC. After the two year period the emissions determined as BACT must not be exceeded.

Date of Receipt of a BACT Application:

November 3, 1982

Date of Publication in the Florida Administrative Weekly:

November 12, 1982

Review Group Members:

Comments were obtained from Bruce Mitchell in the New Source Review Section and Tom Rogers in the Air Modeling Section.

BACT Determined by DER:

Pollutant	Emission Limit
Particulates (wood)	0.2 lb/million Btu heat input
Particulates (oil)	0.1 lb/million Btu heat input
Visible Emissions	Not to exceed 20% opacity, except that 40% opacity is permissible for not more than two minutes in any one hour.

Compliance with the emission limitation of the two sources will be in accordance with DER Method 5, Acetone wash and DER Method 9 (17-2.700, FAC).

BACT Determination Rationale:

The wood pellets are defined as a carbonaceous fuel 17-2.100(28), FAC. The emissions generated from the two sources did not justify a more stringent emissions limit than set forth in 17-2.600 (10)(b) 2.b., FAC.

The emissions control device to be designed and installed is used in industry to successfully control similar type emissions, therefore, since the design will be based upon actual operating parameters there will be no problem meeting the limitations determined as BACT.

The two year period starts for each unit on the first day that wood pellets are fired in that unit. The time spent obtaining pollutant emission data is included in this two year period. The applicant must notify the DER Northwest District office the first day wood pellets are fired in boiler No. 7 and boiler No. 8.

Details of the Analysis May be Obtained by Contacting:

Edward Palagyi, BACT Coordinator
Department of Environmental Regulation
Bureau of Air Quality Management
2600 Blair Stone Road
Tallahassee, Florida 32301

Recommended By:

for Steve Smallwood, Chief BAQM

Date: 11/9/82

Approved:

Victoria J. Tschinkel

Victoria J. Tschinkel, Secretary

Date: 11/12/82

ATTACHMENT 4

State of Florida
DEPARTMENT OF ENVIRONMENTAL REGULATION

INTEROFFICE MEMORANDUM

For Routing To District Offices
And/Or To Other Than The Addressee

To: ______ Loctn.: ______
To: ______ Loctn.: ______
To: ______ Loctn.: ______
From: ______ Date: ______
Reply Optional [ ] Reply Required [ ] Info. Only [ ]
Date Due: ______ Date Due: ______

RECEIVED
JAN 4 1982
Dept. of Environmental Regulation
Office of General Counsel

TO: File - Florida State Hospital - Chattahoochee (FSH-C)
Permit #AC 20-49787

FROM: Bruce Mitchell BM

THRU: Bill Thomas BT
Clair Fancy CHF
Martha Hall MHH

DATE: December 29, 1981

SUBJ: Application to Construct/Modify Incompleteness Designation

As confirmed by phone conversation this AM with Mr. W. D. Murray, utility maintenance supervisor with FSH-C, the information received in the original application to construct/modify a pollution source does not accurately reflect the manner in which the Applicant intends to operate Boilers No. 7 & 8. Therefore, the Department deems the referenced application to be incomplete until the requested information, to be submitted in the form of an amendment to the original application, has been received.

That information requested was:

1). Proposal to be able to continue the capability of firing 100% Fuel Oil after modifications have been completed,

2). Calculations of the Potential Emissions of all pollutants to be emitted, and

3). Any other data that will be pertinent in understanding this proposal.

BM/bjm

cc: Mr. W. D. Murray, FSH-C
Mr. W. D. Myers, FSH-C
Jack Preece, N.W. District - Pensacola
Doug Jones, Dan Farley & Associates, P.A.

ATTACHMENT 5

STATE OF FLORIDA

DEPARTMENT OF
Health & Rehabilitative Services

Bob Graham, Governor

1317 WINEWOOD BOULEVARD
TALLAHASSEE, FLORIDA 32301

DER
FEB 8 1982
BAQM

February 1, 1982

Mr. Robert Mohrfeld
Project Director
Bureau of Construction
Department of General Services
512 Larson Building
Tallahassee, Florida 32301

RE: Project No. HRS 8059; Florida State Hospital, Boiler Conversion Meeting, January 29, with FDER Relative to Approval to Operate Wood Burning Conversion Facility

Dear Mr. Mohrfeld:

Insofaras you were not able to attend the full meeting refered to above or our post meeting with Mr. Ed Howard and our consultant Mr. Doug Jones, I have summarized the total as I see it.

The attendees at this meeting with DER were as indicated on the attached sheet.

We were informed by DER that our concept that we had their approval to proceed without the necessity of additional pollution control equipment, on an experimental basis for a period of 24 months, was erroneous.

The expectation, on our part, was that during this 24 month period a determination of the exact nature of the particulate pollutants could be made and appropriate measures taken to adjust to DER standards without hazarding unnecessary cost to the State.

It is our present understanding of DER that we will be expected to illustrate that we can reasonably meet their requirements prior to receiving their permission to operate.

As a first step in accomplishing this it was decided at our post meeting that Doug Jones and Sverdrup & Parcel and Associates, Inc. would contact the manufacturer of the existing cyclone separator and make an on site inspection of the equipment. From this they will determine what is necessary to bring the existing separator up to manufacturer's standards and determine the design performance characteristics. We hope these will prove to be sufficient to comply with DER's requirements.

Sincerely,

K. L. Anderson

K. L. Anderson
Medical Facilities Engineer

Attachment
Attendees List

Copy to: Mr. Jim Mayne
Mr. William Thomas, FDER

1/29/82 Meeting Florida State Hospital - Chattahoochee

R. Bruce Mitchell -	FDER, CAPS	488-1344
DOUG JONES		576-4110
Bill Thomas	FDER	488-1344
K.L. ANDERSON	HRS	8-5894
Ed Howard -	Dept. of Forestry	575-3576
Margaret Elliott		488-3704
Jim Mayne	HRS	488-3871
Martha Herrell Hall	DER-Legal	8-9730
Clair Fancy -	FDER	8-1344
Larry George -	FDER, Modeling	8-1344
Bob Moorehead -	DGS	

ATTACHMENT 6

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

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

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

MEMORANDUM

TO: Florida State Hospital File

FROM: Bruce Mitchell RBM via conversation with Doug Jones at the Twin Towers Building

DATE: April 8, 1982

SUBJ: Status of AC 20-49787, Boiler Conversion Project

I spoke with Doug Jones today, in the hallway of the 6th floor. He said that a study of potential control equipment was still being conducted.

RBM:rbm

cc: Doug Jones, Dan Farley & Associates, Inc.

ATTACHMENT 7

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

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

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

MEMORANDUM

TO: Florida State Hospital File

FROM: Bruce Mitchell RBM via conversation with Doug Jones at the Twin Towers Building

DATE: May 3, 1982

SUBJ: Status of AC 20-49787, Boiler Conversion Project

I spoke with Doug Jones today, in the hallway of the 6th floor. He said that a study of potential control equipment was still being conducted.

RBM/bjm

cc: Doug Jones, Dan Farley & Associates, Inc.

ATTACHMENT 8

State of Florida
DEPARTMENT OF ENVIRONMENTAL REGULATION

INTEROFFICE MEMORANDUM

For Routing To District Offices
And/Or To Other Than The Addressee

To: ______________ Loctn.: ______________
To: ______________ Loctn.: ______________
To: ______________ Loctn.: ______________
From: ______________ Date: ______________
Reply Optional [ ] Reply Required [ ] Info. Only [ ]
Date Due: ______________ Date Due: ______________

TO: Florida State Hospital File: AC 20-49787

THRU: Bill Thomas

FROM: Bruce Mitchell

DATE: July 12, 1982

SUBJECT: Application Completeness Review Meeting in the Conference Room at BAQM, Twin Towers Building, at 10:30 a.m., with Dr. Homer A. Ooten - Office of General Services/DHRS.

During the meeting, the following items were requested as points of incompleteness and shall be submitted as an amendment to the referenced construction/modification application:

1. Since the applicant wants to retain the option to fire 100% fuel oil, submit the maximum potential emissions for the pollutants particulate matter (PM), SO_2, NO_x, CO, and HC. Include the calculations, reference document(s) for emission factors, and the percent sulfur, nitrogen, and ash content, by weight (lab analysis if available). If the applicant desires to fire and test other fuels, then apply the same parameters to the potential fuel(s).

2. Submit a two-year schedule including all phases of construction, reworking and installation of associated control equipment, and testing the various fuel types for existing Boilers No. 7 and 8.

3. Check the condition of the existing control equipment, duct work, fans, etc. as an evaluation of the existing systems.

RBM:ras

cc: Homer A. Ooten
Martha Harrell Hall

ATTACHMENT 9

STAFF SUMMARY FORM

	TO	ACTION	SIGNATURE (Surname)		TO	ACTION	SIGNATURE (Surname)
1	ASA	Coordinate		6			
2	DPS	Coordinate		7			
3	SEC	Information		8			
4				9			
5				10			

Name of Action Official	Symbol	Phone	Typist's Initial	Suspense Date
Homer A. Ooten	ASG	488-6262	jcj	

SUBJECT Conversion of Boilers to Burn Wood as Fuel
Florida State Hospital, Project No. HRS 8059

DATE July 12, 1982

SUMMARY

I met with Bill Thomas and Bruce Mitchell of the Department of Environmental Regulation (DER) today regarding the subject project (Note: See attached July 9 Staff Summary for additional background).

It was agreed that I will submit an amendment to the November 9, 1981 application for the subject project. The amendment will include assumptions about the particulate emissions while using the existing cyclone arrestors, the inclusion of burning fuels other than wood pellets, and a tentative test schedule for determining what ultimate control devices are needed in order to meet DER standards.

A draft letter of amendment will be prepared and delivered to DER for review by July 15. Mr. Thomas and Mr. Mitchell appeared satisfied that the approach outlined herein will be satisfactory for DER to grant a "temporary permit, not to exceed 24 months."

Homer A. Ooten

HOMER A. OOTEN
Director, HRS General Services

Atch

Copy to: Larry Luken, DER, w/atch
Bill Thomas, DER, w/atch
✓Bruce Mitchell, DER, w/atch
Albert Bass, DGS, w/atch
Harrell Bolden, DGS, w/atch
John Awad, HRS District 2, w/atch
Bob Williams, Florida State Hospital, w/atch

STAFF SUMMARY FORM

	TO	ACTION	SIGNATURE (Surname)		TO	ACTION	SIGNATURE (Surname)
1	ASA	Coordinate		6			
2	DPS	Coordinate		7			
3	SEC	Information		8			
4				9			
5				10			

Name of Action Official	Symbol	Phone	Typist's Initial	Suspense Date
Homer A. Ooten	ASG	488-6262	jj	

SUBJECT Conversion of Boilers to Burn Wood as Fuel
Florida State Hospital, Project No. HRS 8059

DATE 7/9/82

SUMMARY

The subject project has been under construction since November 25, 1981. The project consists of converting two oil-burning boilers to allow them to burn wood pellets. The Legislative Appropriation was $2,038,800 and is a Section 2 (DGS) project. The design professional is Sverdrup & Parcel of Jacksonville; the contractor is Norflor of Orlando. One boiler is scheduled to be converted in November 1982 with the second boiler scheduled for conversion to be completed in April 1983.

The Department of Environmental Regulation (DER) provides permits for such boiler operations that put particulates in the air. A permit application for this project was submitted to DER on November 9, 1981. To date, DER has not approved a permit for this project due to the projected amounts of particulate.

On July 7, Larry Luken of DER stated to Deputy Secretary Howell that DER would grant HRS a temporary permit for both converted boilers, not to exceed 24 months, if the following conditions are met by HRS:

1. The existing cyclone arrestors are to be refurbished to operate as near as possible to their original operating efficiency.

2. The Department will request funds from the 1983 Legislature to install appropriate particulate controls.

DER and HRS will monitor the installation to determine the type of equipment needed to control the particulate emissions.

Albert Bass and Harrell Bolden (DGS) accompanyied me to Chattahoochee today (July 9) to inspect the cyclone arresters. DGS will ask the Project Engineer and Contractor to prepare a Change Order to refurbish the cyclone arrestors.

Continued

I have a meeting on Monday July 12 with Bill Thomas (DER) to formalize an addendum to the application to reflect these agreements.

Homer A. Ooten
HOMER A. OOTEN
Director, HRS General Services

Copy to: Larry Luken, DER
Albert Bass, DGS
Harrell Bolden, DGS
John Awad, HRS District 2
Bob Williams, Florida State Hospital

ATTACHMENT 10

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

MEMORANDUM

TO: Florida State Hospital-Chattahoochee File: AC 20-49787

THRU: Bill Thomas
Clair Fancy
Patty Adams

FROM: Bruce Mitchell

DATE: September 2, 1982

SUBJ: Status of application to modify/construct

I spoke with Dr. Homer Ooten this afternoon in the DER road entrance. He said that the requested data (incompleteness letter data request) was still being calculated and compiled.

RBM/bjm

cc: Homer Ooten, DHRS

ATTACHMENT 11

STATE OF FLORIDA
DEPARTMENT OF
Health & Rehabilitative Services
Bob Graham, Governor
1317 WINEWOOD BOULEVARD
TALLAHASSEE, FLORIDA 32301

September 9, 1982

DER
SEP 13 1982
BAQM

Mr. Bill Thomas, P.E.
Bureau of Air Quality Management
Department of Environmental Regulation
Twin Towers Office Building
2600 Blairstone Road
Tallahassee, Florida 32301

Re: Florida State Hospital, Chattahoochee
Air Construct Permit No. AC 20-49787

Dear Mr. Thomas:

This document is to amend the referenced application submitted on November 9, 1981.

The Department of Health and Rehabilitative Services (HRS) is in the process of converting Boiler No. 7 at Florida State Hospital (FSH) to burn wood as fuel. This conversion is being accomplished as part of a $2 million construction project (HRS 8059). The conversion of Boiler No. 7 is scheduled for completion by November 1982. This project will also fund the conversion of Boiler No. 8 in the same manner, with this conversion to be completed in April 1983. As a part of this project, the cyclone arrestors for both boilers will be renovated to peak operating efficiency. Attached is correspondence related to the cyclones.

The level of pollutant emissions that is expected from these two boilers is not certain at this time. Current plans call for Boilers No. 7 and 8 to burn 88 percent pelletized refined bio-mass and 12 percent No. 6 fuel oil. However, the testing and actual performance data for such configurations are virtually non-existant. Therefore, detailed stack testing will be necessary to verify pollutant emissions and to prescribe what control devices are needed to meet ambient air quality standards. The attached schedule lists major aspects of this project and the dates that each is to be accomplished.

Please understand that the capability to burn 100 percent fuel oil in Boilers No. 7 and 8 will be retained. The standard operating procedure will be to use Boilers No. 6 and 9 as primary, and Boilers No. 7 and 8 (fueled with bio-mass) to handle the balance of the load.

It is noted that when both boilers are fully operational, pelletized wood fuel is expected to be used at an annual rate of 50,000 tons per year. A private supplier is under contract to the State to provide wood fuel in these amounts.

I ask that the referenced application also be amended to reflect the potential future use of firing with 100 percent oil or 100 percent coal. The expected <u>uncontrolled</u> emissions pollutants for each fuel is as follows:

Pollutant (lb/hr)	88% Wood 12% Fuel Oil	No. 6 Fuel Oil	Pulverized Coal
Particulate	157.47	10.16	568.6
SO_2	23.11	138.69	105.9
NO_x	44.85	26.50	50.2
HC	8.38	1.33	0.08
CO	8.60	1.77	2.79

It is my hope that this information is adequate to enable your Department to approve the referenced application under test conditions. However, if additional information is needed, please call me at 488-6262.

Sincerely,

Homer A. Ooten

Homer A. Ooten, P.E.
Director, HRS General Services

Atch (2)

Copy to: Dr. James Howell, HRS Deputy Secretary, w/atch
Mr. Albert Bass, Department of General Services, w/atch

STATE OF FLORIDA
DEPARTMENT OF
GENERAL SERVICES
Larson Building, Tallahassee 32301
Thomas R. Brown, Executive Director

DIVISIONS
- ADMINISTRATION
- BOND FINANCE
- BUILDING CONSTRUCTION AND PROPERTY MANAGEMENT
- COMMUNICATIONS
- ELECTRONIC DATA PROCESSING
- MOTOR POOL
- PURCHASING
- SECURITY
- SURPLUS PROPERTY

Please address reply to: 512 Larson Building

August 16, 1982

Mr. Homer Ooten
Department of Health & Rehab. Services
1317 Winewood Boulevard
Tallahassee, Florida 32301

Re: Boiler Conversion
Florida State Hospital
Chattahoochee, Florida
Project No. HRS-8059

Dear Homer:

Since you are personally interested in this project, I am attaching correspondence pertaining to the cyclone separators which information is needed in order to secure the permit for the operation of these boilers after conversion.

Mr. Jim Berkstresser is hand-delivering two copies to Mr. Doug Jones with Dan Farley and Associates.

If we can assist you further in securing the operational permit, please advise.

Yours very truly,

Jack C. Koons, Administrator
Project Development Section

JCK/la

Attachments

Sverdrup

Sverdrup & Parcel
and Associates, Inc.
11 East Forsyth Street
Jacksonville, Florida 32202
904/356-5503

Engineers
Architects
Planners

August 13, 1982

Mr. Jack C. Koons, Administrator
Project Development
Department of General Services
512 Larson Building
Tallahassee, Florida 32301

Re: Project No. HRS-8059
Inspection of Cyclone Separators

Dear Mr. Koons:

In accordance with your request, a visual inspection of the cyclone separators on Boilers No. 7 and 8 was performed on August 6, 1982 by Mr. Fred Deig, our Construction Phase Field Representative. Mr. Deig was escorted by Mr. Murray of FSH, and accompanied during part of the inspection by Messrs. Shuford and Graham of HRS District II.

The separators are essentially sheet steel construction with exterior insulation. Both separators were inspected for exterior signs which might indicate leakage or holes in the equipment and for general condition. Suspicious spots in the insulation were probed with a steel rod down to the sheet steel surface. Both separators were found to be in good condition externally and no leaks or holes were found in the equipment metal walls.

The separator on Boiler No. 7 only was inspected internally because Boiler No. 8 was in operation. Mr. Deig entered the interior of the separator through an access panel and inspected the cone, or middle section. Interior surfaces were found to be clean and smooth with no evidence of significant irregularities caused by repairs or patching. Mr. Murray stated that these walls were relined with 1/4" stainless steel plate about four years ago. The interior surfaces of the unit on Boiler No. 8 are scheduled for similar replacement in December, 1982.

Our inspection revealed no reason why, based on Mr. Tenney's letter (attached) from the Mannufacturer, General Electric, that performance of these units should be significantly deteriorated from initial efficiency.

I am also enclosing a copy of Mr. R. B. Williams's letter to you of August 4th for reference.

Sverdrup & Parcel and Associates, Inc. is a Sverdrup Corporation company

I hope this information satisfies your requirements so that you can proceed with permit applications. If we can be of further assistance, please let me know.

Very truly yours,

SVERDRUP & PARCEL AND ASSOCIATES, Inc.

Fred A Deig

Fred A. Deig
Construction Phase Field Representative

Attachments

cc: Harrel Bolden
Carl Graham
Joe Shuford
Tom Parker
Danny Skelton (Sverdrup Technology)

GENERAL ELECTRIC

200 NORTH SEVENTH STREET, LEBANON, PA 17042, (717) 272-2001

GENERAL ELECTRIC
ENVIRONMENTAL
SERVICES, INC.

July 27, 1982

RECEIVED
AUG 2 1982
SVERDRUP/JAX

Sverdrup Technology, Inc.
Sverdrup Center
600 William Northern Boulevard
Tullahoma, Tennessee 37388

Attention: Mr. Daniel T. Skelton, P.E.

Subject: Cyclones at Florida State Hospital
Chattahoochee, Florida
GEESI Reference No. 82-7073
(Drawing No. C-7073-01)

Gentlemen:

In accordance with your letter of July 15, 1982, we are pleased to confirm the telephone conversation which you held with our Mr. James Miller on July 13.

Since cyclones do not include any moving parts, electrical equipment, or spray nozzles, items which tend to deteriorate with time, cyclones will continue to operate at approximately their initial efficiency provided the internal surfaces remain reasonably smooth and there are no holes or leaks in the cyclones. In most cases one can readily repair any rough internal surfaces and/or leaks by simply welding over these areas and grinding the internal surfaces smooth and flush.

I believe the above provides the information which you requested. However, if we can provide any additional information, please feel free to contact either James Miller or myself.

Very truly yours,

GENERAL ELECTRIC
ENVIRONMENTAL SERVICES, INC.

Edwin D. Tenney

Edwin D. Tenney
Manager
Mechanical Collector Marketing

EDT/smb

cc: James Miller
Jack C. Koons/Department of General Services
R. B. Williams/Sverdrup & Parcel

Sverdrup

Sverdrup & Parcel
and Associates, Inc.
11 East Forsyth Street
Jacksonville, Florida 32202
904/356-5503

Engineers
Architects
Planners

August 4, 1982

Mr. Jack C. Koons, Administrator
Project Development
Department of General Services
512 Larson Building
Tallahassee, Florida 32301

Re: Project No. HRS-8059
Inspection of Cyclone Separators

Dear Mr. Koons:

Mr. Edwin Tenney of General Electric, manufacturer of the cyclones originally installed as emission control for the coal-burning boilers at Chattahoochee, in his letter to our Mr. Skelton of July 27 described the factors which could cause a decrease from initial cyclone efficiency. These factors are of a structural nature and can be detected by inspection, as we have discussed by telephone.

We have concluded that this inspection can be conducted by our construction phase representative, Mr. Fred Deig, while at the next scheduled construction meeting on Friday, August 6, 1982. Mr. Deig has made arrangements with Mr. Parker and Mr. Murray for assistance at the site. An inspection report will be submitted to you the week of August 9, 1982.

Since it is no longer required that this inspection be made by Mr. Skelton of our Tullahoma, Tennessee office, the charges associated with that effort are not necessary, and, since Mr. Deig can combine this work with a regularly scheduled project effort, no charges will be assessed for this extra service.

Very truly yours,

SVERDRUP & PARCEL AND ASSOCIATES, Inc.

R. B. Williams
Project Manager

RBW/bim

cc: D. Skelton
Contract File
Deig/Project File

Sverdrup

Sverdrup & Parcel and Associates, Inc.
11 East Forsyth Street
Jacksonville, Florida 32202
904/356-5503

Engineers
Architects
Planners

August 13, 1982

Mr. Jack C. Koons, Administrator
Project Development
Department of General Services
512 Larson Building
Tallahassee, Florida 32301

Re: Project No. HRS-8059
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I am also enclosing a copy of Mr. R. B. Williams's letter to you of August 4th for reference.

Sverdrup & Parcel and Associates, Inc. is a Sverdrup Corporation company

I hope this information satisfies your requirements so that you can proceed with permit applications. If we can be of further assistance, please let me know.

Very truly yours,

SVERDRUP & PARCEL AND ASSOCIATES, Inc.

Fred A Deig
Fred A. Deig
Construction Phase Field Representative

Attachments

cc: Harrel Bolden
Carl Graham
Joe Shuford
Tom Parker
Danny Skelton (Sverdrup Technology)

GENERAL ELECTRIC

200 NORTH SEVENTH STREET, LEBANON, PA 17042, (717) 272-2001

GENERAL ELECTRIC
ENVIRONMENTAL
SERVICES, INC.

July 27, 1982

RECEIVED
AUG 2 1982
SVERDRUP/JAX

Sverdrup Technology, Inc.
Sverdrup Center
600 William Northern Boulevard
Tullahoma, Tennessee 37388

Attention: Mr. Daniel T. Skelton, P.E.

Subject: Cyclones at Florida State Hospital
Chattahoochee, Florida
GEESI Reference No. 82-7073
(Drawing No. C-7073-01)

Gentlemen:

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I believe the above provides the information which you requested. However, if we can provide any additional information, please feel free to contact either James Miller or myself.

Very truly yours,

GENERAL ELECTRIC
ENVIRONMENTAL SERVICES, INC.

Edwin D. Tenney

Edwin D. Tenney
Manager
Mechanical Collector Marketing

EDT/smb

cc: James Miller
Jack C. Koons/Department of General Services
R. B. Williams/Sverdrup & Parcel

Sverdrup

Sverdrup & Parcel
and Associates, Inc.
11 East Forsyth Street
Jacksonville, Florida 32202
904/356-5503

Engineers
Architects
Planners

August 4, 1982

Mr. Jack C. Koons, Administrator
Project Development
Department of General Services
512 Larson Building
Tallahassee, Florida 32301

Re: Project No. HRS-8059
Inspection of Cyclone Separators

Dear Mr. Koons:

Mr. Edwin Tenney of General Electric, manufacturer of the cyclones originally installed as emission control for the coal-burning boilers at Chattahoochee, in his letter to our Mr. Skelton of July 27 described the factors which could cause a decrease from initial cyclone efficiency. These factors are of a structural nature and can be detected by inspection, as we have discussed by telephone.

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Very truly yours,

SVERDRUP & PARCEL AND ASSOCIATES, Inc.

R. B. Williams
Project Manager

RBW/bim

cc: D. Skelton
Contract File
Deig/Project File

FLORIDA STATE HOSPITAL

Conversion of Boilers to Burn Wood As Fuel

Project No. HRS 8059

Air Construct Permit No. AC 20-49787

ACTIVITY	1982					1983												1984											
	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Complete Conversion of Boiler No. 7	■	■	■	■																									
Upgrade Cyclone, Boiler No. 7	■	■	■	■																									
Convert Boiler No. 8					■	■	■	■	■																				
Upgrade Cyclone, Boiler No. 8					■	■	■	■	■																				
Stack Test for Emissions					■	■	■																						
Prepare FCO Request		■	■																										
Testify for FCO Request				■	■	■	■	■	■	■																			
Prepare Program for Air Quality Controls									■	■	■																		
Contract for Corrective A/E Steps												■	■																
Design of Control Equipment													■	■	■	■													
Bid/Award Contract																	■	■											
Install Controls, Boiler No. 7																		■	■	■	■								
Install Controls, Boiler No. 8																					■	■	■	■					

08-03-82:HAO

ATTACHMENT 12

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

September 20, 1982

Dr. Homer A. Ooten
Director, HRS General Services
1317 Winewood Blvd.
Bldg. 3-320
Tallahassee, Florida 32301

Re: Florida State Hospital - Chattahoochee
Air Construction Permit No. AC 20-49787
Completeness Review

Dear Dr. Ooten:

The Bureau has received and reviewed the recent amendment to the referenced permit dated September 9, 1982. Again, referring to the document "to the file" dated July 12, 1982, condition No. 1 has not been completed as requested. Therefore, the incompleteness condition will be restated and the requested material will have to be submitted before further processing of the referenced permit can continue:

1. Since the applicant wants to retain the option to fire 100% fuel oil, submit the maximum potential emissions for the pollutants particulate matter (PM), SO_2, NO_x, CO, and HC. Include the calculations, reference document(s) for emission factors, and the percent sulfur, nitrogen, and ash content, by weight (lab analysis if available). If the applicant desires to fire and test other fuels, then apply the same parameters to the potential fuel(s).

If there are any questions, please call Bruce Mitchell at (904)488-1344 or write to me at the above address.

Sincerely,

C. H. Fancy, P.E.
Deputy Bureau Chief
Bureau of Air Quality
Management

CHF/RBM/bjm

Enclosure

cc: Steve Smallwood
Bill Thomas
Larry Lukin
Martha Harrell Hall

State of Florida
DEPARTMENT OF ENVIRONMENTAL REGULATION

INTEROFFICE MEMORANDUM

For Routing To District Offices
And/Or To Other Than The Addressee

To: ______________ Loctn.: ______
To: ______________ Loctn.: ______
To: ______________ Loctn.: ______
From: ______________ Date: ______
Reply Optional [ ] Reply Required [ ] Info. Only [ ]
Date Due: ______ Date Due: ______

TO: Florida State Hospital File: AC 20-49787

THRU: Bill Thomas BT

FROM: Bruce Mitchell RBM

DATE: July 12, 1982

SUBJECT: Application Completeness Review Meeting in the Conference Room at BAQM, Twin Towers Building, at 10:30 a.m., with Dr. Homer A. Ooten - Office of General Services/DHRS.

During the meeting, the following items were requested as points of incompleteness and shall be submitted as an amendment to the referenced construction/modification application:

1. Since the applicant wants to retain the option to fire 100% fuel oil, submit the maximum potential emissions for the pollutants particulate matter (PM), SO_2, NO_x, CO, and HC. Include the calculations, reference document(s) for emission factors, and the percent sulfur, nitrogen, and ash content, by weight (lab analysis if available). If the applicant desires to fire and test other fuels, then apply the same parameters to the potential fuel(s).

2. Submit a two-year schedule including all phases of construction, reworking and installation of associated control equipment, and testing the various fuel types for existing Boilers No. 7 and 8.

3. Check the condition of the existing control equipment, duct work, fans, etc. as an evaluation of the existing systems.

RBM:ras

cc: Homer A. Ooten
Martha Harrell Hall

ATTACHMENT 13

STATE OF FLORIDA
DEPARTMENT OF
Health & Rehabilitative Services
Bob Graham, Governor
1317 WINEWOOD BOULEVARD TALLAHASSEE, FLORIDA 32301

October 7, 1982

Mr. C. H. Fancy, P.E.
Deputy Bureau Chief
Bureau of Air Quality Management
Department of Environmental Regulation
Twin Towers Office Building
2600 Blairstone Road
Tallahassee, Florida 32301-8241

DER
OCT 7 1982
BAQM

Re: Florida State Hospital, Chattahoochee
Air Construction Permit No. AC 20-49787

Dear Mr. Fancy:

This responds to your September 20 letter regarding the same subject, and supplements my September 9 letter to Mr. Bill Thomas, P.E.

The numbers for pollutant emissions for 88% Wood/12% Fuel Oil in my September 9 letter were developed from AP-42 factors. However, your July 23, 1981 letter to Dan Farley & Associates provides alternative factors which "give a better estimate of emissions thru those contained in AP-42." Thus, I have re-calculated all numbers for 88% Wood/12% Fuel Oil. The expected uncontrolled emission pollutants for each of the three fuels are calculated as being:

Pollutant (lb/hr)	88% Wood 12% Fuel Oil	100% residual Fuel Oil	100% Pulverized Coal
Particulate	157.47	10.16	568.6
SO_2	22.89	138.69	105.9
NO_x	16.95	26.50	50.2
HC	4.34	1.33	0.08
CO	8.54	1.77	2.79

Attached are the following substantiating documents:

- Calculations for all three fuels (5 pages)
- Appropriate pages from AP-42, Appendix C, pages 4,5.
- July 23, 1981 letter from C. H. Fancy, P.E. to Dan Farley & Associates.

I hope this information is sufficient to enable your Department to approve the referenced application. However, if additional information is needed, please call me at 488-6262.

Sincerely,

Homer A. Ooten

Homer A. Ooten, P.E.
Director, HRS General Services

Attachments (3)

Copy to: Dr. James Howell, HRS Deputy Secretary, w/atch
Mr. Albert Bass, Department of General Services, w/atch

Oct. 7, 1982

Calculations for 88% Wood/12% Residual Fuel Oil

CO
~~NOx~~

Pelletized Wood Fuel Used: 100 t/day (88% of total fuel)
AP 42 Emission Factor for Wood/Bark Boiler: 2 lb/ton

$$\frac{100 \ \cancel{\text{tons}}/\cancel{\text{day}}}{24 \ \text{hours}/\cancel{\text{day}}} \times 2 \ \text{lb}/\cancel{\text{ton}} = \underline{8.33 \ \text{lb/hr.}}$$

No. 6 Fuel Oil (12% of total fuel)
AP 42 Emission Factor for No. 6 Fuel Oil: 4 lb/Kgal

Gallon currently burned per hour: $\frac{3{,}666 \text{ lb/hr}}{8.3 \text{ lb/gal}} = 441.69$ gal/hr

441.69 gal/hr × $.004$ lb/gal × $.12$ = $\underline{0.212}$ lb/hr

Total = $8.33 + 0.212$ = $\underline{\underline{8.54}}$ lb/hr

HC

AP ~~4~~42 Emission Factor: 2 lb/ton for wood/bark boiler
Thus, Emission = $\underline{8.33}$ lb/hr

AP 42 Emission Factor: 3 lb/1,000 gal for Residual Oil

441.69 gal/hr × $.003$ lb/gal × $.12$ = $\underline{0.159}$ lb/hr

Total = $8.33 + 0.16$ = $\underline{\underline{8.49}}$ lb/hr

But, the factor given in DER C.F. Fancy's letter of July 23, 1981 is "felt to give a better estimate of emissions than those contained in AP-42."
Thus, 0.064 lb/MMBTU × 67.8 MMBTU/hr = $\underline{\underline{4.34}}$ lb/hr

NO_x

AP 42 Emission Factor : 10 lb/ton for wood/bark boiler

$$\frac{100\ \cancel{\text{tons}}/\cancel{\text{day}}}{24\ \text{hrs}/\cancel{\text{day}}} \times 10\ \text{lb}/\cancel{\text{ton}} = \cancel{41.67}\quad \underline{41.6667\ \text{lb/hr}}$$

AP 42 Emission Factor : 60 lb/1000 gal. for Residual Oil

$$441.69\ \cancel{\text{gal}}/\text{hr} \times 0.060\ \text{lb}/\cancel{\text{gal}} \times .12 = \underline{3.18\ \text{lb/hr}}$$

$$\text{TOTAL} = \underline{\underline{44.85\ \text{lb/hr}}}$$

But the factor given by C. Fancy on July 23,'81 calculates as follows:

$$\cancel{\text{Oil}}\quad 0.25\ \text{lb/MMBTU} \times 67.8\ \text{MMBTU/hr} = \underline{\underline{16.95\ \text{lb/hr}}}$$

Particulate

AP 42 Emission Factor : 37.5 Lbs/ton for wood/bark boiler

$$\frac{100\ \cancel{\text{tons}}/\cancel{\text{day}}}{24\ \text{hrs}/\cancel{\text{day}}} \times 37.5\ \text{lb}/\cancel{\text{ton}} = \underline{156.25\ \text{lb/hr}}$$

AP 42 Emission Factor : 23 lb/1000 Gal for Residual Oil

$$441.69\ \text{gal/hr} \times 0.023\ \text{lb/gal} \times .12 = \underline{1.22\ \text{lb/hr}}$$

$$\text{Total} = 156.25 + 1.22 = \underline{\underline{157.47\ \text{lb/hr}}}$$

SOx

AP 42 Emission Factor : 1.5 lb/ton for wood/bark boiler

$$\frac{100\ \cancel{\text{tons}}/\cancel{\text{day}}}{24\ \text{hrs}/\cancel{\text{day}}} \times 1.5\ \text{lb}/\cancel{\text{ton}} = \underline{6.25\ \text{lb/hr}}$$

AP 42 Emission Factor : [157 × S] lb/1000 gal for Residual Oi

Sulfur = 2%

$$441.69\ \text{gal/hr} \times .157(2) \times .12 = \underline{16.64\ \text{lb/hr}}$$

$$\text{Total} = 6.25 + 16.64 = \underline{\underline{22.89\ \text{lb/hr}}}$$

Calculations for Section III, C, (Airborne Contaminants Emitted).

~~Col. I 88% + 12% Oil (Based on AP 42)~~
~~Extracted from original Air Permit~~
~~Application for the other Calculations Today~~
Replaced by Other Calculations
Oct. 7, 1982 Hamilton

Col. II 100% No. 6 Fuel Oil (Based on AP 42)
Using the same quality and quantity of
oil indicated in above for max. conditions, i.e., 3,866 gal burned/hr

$\frac{\text{gal/hr}}{\text{lb/gal}}$

Wt of oil/gal = 8.3
Gal burned/hr = $\frac{3,666}{8.3}$ = 441.69
S = 2%
From Appendix C-5:

1. Particulates – 23 × 0.4417 = 10.16 #/hr.

2. SO_x – 157(2) × 0.4417 = 138.69 #/hr

3. NO_x – 60 × 0.4417 = 26.50 #/hr

4. HC – 3.0 × 0.4417 = 1.33 #/hr

5. CO – 4.0 × 0.4417 = 1.77 #/hr.

(cont)

Coal (Pulverized) - 100%

Fuel: Bituminous (delivered @ $50.00/ton)

Btu/lb. — 12,500

S — 1%

ash — 12%

Quantity required:

Load conditions - 60,000#/hr. at 425 psig, & 525°F.

Boiler eff - 85% (assumed)

enthalpy of steam = 1257 btu/#

" of F.W. = 270

enthalpy added (by boiler) 987 btu/#

Total heat ~~out~~ input - $\frac{60,000 \times 987}{.85} = 69.67 \times 10^6$ btu/hr

Tons of coal required - $\frac{69.67 \times 10^6}{12,500 \times 2,000} = 2.7868$ T/h

III Emissions (from AP42)

1. Particulates - ~~13 × 12 × 2.787~~ = ~~454.9#/hr.~~

17 × 12 × 2.787 = 568.6#/hr

2. SOx - 38 × 1 × 2.787 = 105.9#/hr

3. NOx - ~~30 × 2.787 = 83.6#/hr~~

18 × 2.787 = 50.2#/hr.

4. HC - 0.03 × 2.787 = .084#/hr

5 CO - 1.0 × 2.787 = 2.79#/hr.

FU
~~7/15~~ 7/16

```
                                   NATIONAL EMISSIONS DATA SYSTEM
                                   SOURCE CLASSIFICATION CODES

                                   POUNDS EMITTED PER UNIT
                                     PART       SOX        NOX       HC        CO      UNITS
EXTCOMB BOILER    -INDUSTRIAL
****************  ****************

  PROCESS GAS        CONTINUED

    1-02-007-07  COKE OVEN >100                                                      MILLION CUBIC FEET BURNED
    1-02-007-08  COKE OVEN 10-100                                                    MILLION CUBIC FEET BURNED
    1-02-007-09  COKE OVEN <10                                                       MILLION CUBIC FEET BURNED
    1-02-007-99  OTHER/NOT CLASIFD                                                   MILLION CUBIC FEET BURNED

  COKE

    1-02-008-02  10-100MMBTU/HR       2.00 A     38.0  S    15.0      0.20      2.00  TONS BURNED
    1-02-008-03  <10MMBTU/HR          2.00 A     38.0  S    6.00      0.20      10.0  TONS BURNED

  WOOD/BARK WASTE

    1-02-009-01  BARK BOILER          75.0       1.50       10.0      2.00      2.00  TONS BURNED
    1-02-009-02  WOOD/BARK BOILER     37.5       1.50       10.0      2.00      2.00  TONS BURNED
    1-02-009-03  WOOD BOILER          10.0       1.50       10.0      5.00      10.0  TONS BURNED

  LIQ PETROLEUM GAS

    1-02-010-02  10-100MMBTU/HR       1.75       86.5  S    11.7      0.30      1.55  1000GALLONS BURNED
    1-02-010-03  <10MMBTU/HR          1.75       86.5  S    11.7      0.30      1.55  1000GALLONS BURNED

  BAGASSE

    1-02-011-01  >100 MMBTU/HR        22.0       0.         2.00      2.00      2.00  TONS BURNED
    1-02-011-02  10-100MMBTU/HR       22.0       0.         2.00      2.00      2.00  TONS BURNED
    1-02-011-03  <10MMBTU/HR          22.0       0.         2.00      2.00      2.00  TONS BURNED

  SLD WASTE-SPECIFY

    1-02-012-01  >100 MMBTU/HR                                                       TONS BURNED
    1-02-012-02  10-100 MMBTU/HR                                                     TONS BURNED
    1-02-012-03  <10 MMBTU/HR                                                        TONS BURNED

  LIQ WASTE-SPECIFY

    1-02-013-01  >100 MMBTU/HR                                                       1000 GALLONS BURNED
    1-02-013-02  10-100 MMBTU/HR                                                     1000 GALLONS BURNED
    1-02-013-03  <10 MMBTU/HR                                                        1000 GALLONS BURNED

  OTHER/NOT CLASIFD

    1-02-999-97  SPECIFY IN REMARK                                                   MILLION CUBIC FEET BURNED
    1-02-999-98  SPECIFY IN REMARK                                                   1000 GALLON BURNED (LIQUID)
    1-02-999-99  SPECIFY IN REMARK                                                   TONS BURNED (SOLID)

EXTCOMB BOILER    -COMMERCL-INSTUTNL
****************  ****************


  ANTHRACITE COAL

    1-03-001-05  10-100MMBTU PULVWT   13.0 A     38.0  S    30.0      0.03      1.00  TONS BURNED
    1-03-001-06  10-100MMBTU PULVDY   17.0 A     38.0  S    18.0      0.03      1.00  TONS BURNED
    1-03-001-07  10-100MMBTUSPRDSTK   13.0 A     38.0  S    15.0      1.00      2.00  TONS BURNED
    1-03-001-08  <10MMBTU PULVIZED    17.0 A     38.0  S    18.0      0.03      1.00  TONS BURNED
    1-03-001-09  <10MMBTU STOKER      2.00 A     38.0  S    6.00      0.20      10.0  TONS BURNED
    1-03-001-10  <10MMBTU SPDSTOKR    2.00 A     38.0  S    15.0      1.00      10.0  TONS BURNED
    1-03-001-99  OTHER/NOT CLASIFD    17.0 A     38.0  S    18.0      0.03      1.00  TONS BURNED

  BITUMINOUS COAL

    1-03-002-05  10-100MMBTU PULVWT   13.0 A     38.0  S    30.0      0.03      1.00  TONS BURNED
    1-03-002-06  10-100MMBTU PULVDY   17.0 A     38.0  S    18.0      0.03      1.00  TONS BURNED
    1-03-002-07  10-100MMBTU OFSTK    5.00 A     38.0  S    15.0      1.00      2.00  TONS BURNED
    1-03-002-08  10-100MMBTU UFSTK    5.00 A     38.0  S    15.0      1.00      2.00  TONS BURNED
    1-03-002-09  10-100MMBTUSPRDSTK   13.0 A     38.0  S    15.0      1.00      2.00  TONS BURNED
    1-03-002-10  10-100MMBTU HNDFR    20.0       38.0  S    3.00      20.0      90.0  TONS BURNED
    1-03-002-11  <10MMBTU OFSTOKER    2.00 A     38.0  S    6.00      3.00      10.0  TONS BURNED
    1-03-002-12  <10MMBTU UFSTOKER    2.00 A     38.0  S    6.00      3.00      10.0  TONS BURNED
    1-03-002-13  <10MMBTU SPDSTOKR    2.00 A     38.0  S    6.00      3.00      10.0  TONS BURNED
    1-03-002-14  <10MMBTU HANDFIRE    20.0       38.0  S    3.00      20.0      90.0  TONS BURNED
    1-03-002-99  OTHER/NOT CLASIFD    13.0 A     38.0  S    15.0      0.03      2.00  TONS BURNED

  LIGNITE

    1-03-003-05  10-100MMBTU PULVWT   6.50 A     30.0  S    13.0      1.00      2.00  TONS BURNED
    1-03-003-06  10-100MMBTU PULVDY   6.50 A     30.0  S    13.0      1.00      2.00  TONS BURNED
    1-03-003-07  10-100MMBTU OFSTK    6.50 A     30.0  S    13.0      1.00      2.00  TONS BURNED
    1-03-003-08  10-100MMBTU UFSTK    6.50 A     30.0  S    13.0      1.00      2.00  TONS BURNED
    1-03-003-09  10-100MMBTUSPRDSTK   6.50 A     30.0  S    13.0      1.00      2.00  TONS BURNED
    1-03-003-10  <10MMBTU PULV-DRY    6.50 A     30.0  S    13.0      1.00      10.0  TONS BURNED
    1-03-003-11  <10MMBTU OFSTOKER    6.50 A     30.0  S    13.0      1.00      10.0  TONS BURNED
    1-03-003-12  <10MMBTU UFSTOKER    6.50 A     30.0  S    13.0      1.00      10.0  TONS BURNED
    1-03-003-13  <10MMBTU SPDSTOKR    6.50 A     30.0  S    13.0      1.00      10.0  TONS BURNED
    1-03-003-14  <10MMBTU HANDFIRE    6.50 A     30.0  S    13.0      20.0      90.0  TONS BURNED

*A* INDICATES THE ASH CONTENT, *S* INDICATES THE SULFUR CONTENT OF THE FUEL, ON A PERCENT BASIS BY WEIGHT
```

BEST AVAILABLE COPY

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                              NATIONAL EMISSION DATA SYSTEM
                             SOURCE CLASSIFICATION CODES

                                 POUNDS EMITTED PER UNIT
                                 PART      SOX       NOX      HC      CO      UNITS
EXTCOMB BOILER    -COMMERCL-INSTUTNL
*****************  ****************

  RESIDUAL OIL

    1-03-004-01   >100MMBTU/HR       23.0     157.  S    60.0     3.00    5.00   1000 GALLONS BURNED
    1-03-004-02   10-100MMBTU/HR     23.0     157.  S    60.0     3.00    5.00   1000 GALLONS BURNED
    1-03-004-03   <10MMBTU/HR        23.0     157.  S    60.0     3.00    5.00   1000 GALLONS BURNED

  DISTILLATE

    1-03-005-01   >100MMBTU/HR       15.0     142.  S    60.0     3.00    5.00   1000 GALLONS BURNED
    1-03-005-02   10-100MMBTU/HR     15.0     142.  S    60.0     3.00    5.00   1000 GALLONS BURNED
    1-03-005-03   <10MMBTU/HR        15.0     142.  S    60.0     3.00    5.00   1000 GALLONS BURNED

  NATURAL GAS

    1-03-006-01   >100MMBTU/HR       10.0      0.60     230.      8.00    20.0   MILLION CUBIC FEET BURNED
    1-03-006-02   10-100MMBTU/HR     10.0      0.60     120.      8.00    20.0   MILLION CUBIC FEET BURNED
    1-03-006-03   <10MMBTU/HR        10.0      0.60     80.0      8.00    20.0   MILLION CUBIC FEET BURNED

  PROCESS GAS

    1-03-007-01   SEWAGE>100MMBTUHR                                              MILLION CUBIC FEET BURNED
    1-03-007-02   SEWAGE 10-100                                                  MILLION CUBIC FEET BURNED
    1-03-007-03   SEWAGE<10MMBTU/HR                                              MILLION CUBIC FEET BURNED
    1-03-007-99   OTHER/NOT CLASIFD                                              MILLION CUBIC FEET BURNED

  WOOD/BARK WASTE

    1-03-009-01   BARK BOILER        75.0      1.50     10.0      2.00    2.00   TONS BURNED
    1-03-009-02   WOOD/BARK BOILER   37.5      1.50     10.0      2.00    2.00   TONS BURNED
    1-03-009-03   WOOD BOILER        10.0      1.50     10.0      5.00    10.0   TONS BURNED

  LIQ PETROLEUM GAS

    1-03-010-02   10-100MMBTU/HR     1.85     86.5  S    9.50     0.75    1.95   1000 GALLONS BURNED
    1-03-010-03   <10MMBTU/HR        1.85     86.5  S    9.50     0.75    1.95   1000 GALLONS BURNED

  SLD WASTE-SPECIFY

    1-03-012-01   >100 MMBTU/HR                                                  TONS BURNED
    1-03-012-02   10-100 MMBTU/HR                                                TONS BURNED
    1-03-012-03   <10 MMBTU/HR                                                   TONS BURNED

  LIQ WASTE-SPECIFY

    1-03-013-01   >100 MMBTU/HR                                                  1000 GALLONS BURNED
    1-03-013-02   10-100 MMBTU/HR                                                1000 GALLONS BURNED
    1-03-013-03   <10 MMBTU/HR                                                   1000 GALLONS BURNED

  OTHER/NOT CLASIFD

    1-03-999-97   SPECIFY IN REMARK                                              MILLION CUBIC FEET BURNED
    1-03-999-98   SPECIFY IN REMARK                                              1000 GALLON BURNED (LIQUID)
    1-03-999-99   SPECIFY IN REMARK                                              TONS BURNED (SOLID)

EXTCOMB BOILER    -SPACE HEATER
*****************  ****************


  INDUSTRIAL

    1-05-001-01   ANTHRACITE COAL                                                TONS BURNED
    1-05-001-02   BITUMINOUS COAL                                                TONS BURNED
    1-05-001-03   LIGNITE                                                        TONS BURNED
    1-05-001-04   RESIDUAL OIL                                                   1000 GALLONS BURNED
    1-05-001-05   DISTILLATE OIL                                                 1000 GALLONS BURNED
    1-05-001-06   NATURAL GAS                                                    MILLION CUBIC FEET BURNED
    1-05-001-10   LIQ PETROLEUM GAS                                              1000 GALLONS BURNED
    1-05-001-97   OTHER-SPECIFY                                                  TONS BURNED
    1-05-001-98   OTHER-SPECIFY                                                  1000 GALLONS BURNED
    1-05-001-99   OTHER-SPECIFY                                                  MILLION CUBIC FEET BURNED

  COMMERCL-INSTL

    1-05-002-01   ANTHRACITE COAL                                                TONS BURNED
    1-05-002-02   BITUMINOUS COAL                                                TONS BURNED
    1-05-002-03   LIGNITE                                                        TONS BURNED
    1-05-002-04   RESIDUAL OIL                                                   1000 GALLONS BURNED
    1-05-002-05   DISTILLATE OIL                                                 1000 GALLONS BURNED
    1-05-002-06   NATURAL GAS                                                    MILLION CUBIC FEET BURNED
    1-05-002-10   LIQ PETROLEUM GAS                                              1000 GALLONS BURNED
    1-05-002-97   OTHER-SPECIFY                                                  TONS BURNED
    1-05-002-98   OTHER-SPECIFY                                                  1000 GALLONS BURNED
    1-05-002-99   OTHER-SPECIFY                                                  MILLION CUBIC FEET BURNED


'A' INDICATES THE ASH CONTENT, 'S' INDICATES THE SULFUR CONTENT OF THE FUEL ON A PERCENT BASIS (BY WEIGHT)
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STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

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

BOB GRAHAM
GOVERNOR
VICTORIA J. TSCHINKEL
SECRETARY

July 23, 1981

Mr. Doug Jones
Dan Farley & Associates, P.A.
Water's Edge Executive Center
1910 Capitol Circle, S.W.
Tallahassee, Florida 32304

Dear Mr. Jones:

In response to your letter of July 17, 1981, the Bureau of Air Quality Management has made a preliminary rule applicability determination for the boiler conversion project at the Florida State Hospital. Since the operation of boilers 6 and 9 will not change, those emissions are not included in this determination.

The applicable rule for this project is 17-2.05(6) FAC Table II I. Carbonaceous Fuel Burning Equipment. The wood pellets are a carbonaceous fuel as defined in 17-2.02(21) FAC. The maximum allowable particulate emissions from this rule are 0.2 lb/MMBTU heat input of carbonaceous fuel plus 0.1 lb/MMBTU heat input of fossil fuel. Using the heat input of both boilers plus 12% oil firing, the total maximum allowable particulate emissions for both boilers are calculated to be 25.48 pounds per hour and 111.61 tons per year. Using the potential particulate emissions that you used, the scrubber would be required to have an efficiency of at least 92% to meet this limitation.

The boiler conversion project was also evaluated to determine if the requirements of 17-2.04 FAC, Prevention of Significant Deterioration (PSD) applied. AP-42 was used to estimate emissions from the boilers when firing 2% sulfur No. 6 fuel oil. The emissions for the proposed project were estimated based upon the fuel use scenario presented by the applicant. Particulate emissions are based on the carbonaceous fuel regulation. Sulfur dioxide and carbon monoxide emissions were developed from AP-42. Hydrocarbon and nitrogen oxide emissions were based upon factors obtained from the Technical Association of the Pulp and Paper Industry (TAPPI) for wood-residue fired boilers. The emission factors of 0.064 lb of hydrocarbon/MMBTU heat input and 0.25 lb of NO_x/MMBTU heat input are felt to give a better estimate of emissions than those contained in AP-42. The comparison of current allowable emission, proposed emissions and de minimus levels are:

Pollutant	Current Allowable		Proposed Allowable		Change	Deminimus
	lb/hr	TPY	lb/hr	TPY	TPY	TPY
Particulate	20.30	88.91	25.48	111.61	22.70	25
SO_2	277.16	1213.92	46.19	202.27	-1011.65	40
NO_x	52.96	231.96	33.88	148.39	-83.57	40
HC	0.88	3.86	8.67	37.99	34.13	40
CO	4.41	19.33	17.19	75.32	55.99	100

Since the increases in emissions do not exceed the de minimus levels, this project is exempt from the requirements of the Federal PSD rule.

The Northwest District Office in Pensacola will handle the processing of this permit. If there are any questions concerning this determination, please contact John Svec at 488-1344.

Sincerely,

C. H. Fancy, P.E.
Deputy Chief
Bureau of Air Quality Management

CF:JS:caa

cc: Paul Kaczorowski, HRS
Jack Preece, Northwest District
John Svec, BAQM

ATTACHMENT 14

STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

TWIN TOWERS OFFICE BUILDING
2600 BLAIR STONE ROAD
TALLAHASSEE, FLORIDA 32301-8241

BOB GRAHAM
GOVERNOR

VICTORIA J. TSCHINKEL
SECRETARY

MEMORANDUM

TO: File - Florida State Hospital - Chattahoochee
AC 20-49787

THRU: Bill Thomas
Clair Fancy

FROM: Bruce Mitchell

DATE: October 27, 1982

SUBJ: Phone call conversation with Dr. Homer Ooten, DHRS, about a deletion of information contained in the "application to construct an air pollution source".

It has been confirmed that the proposed modification will not allow the use of coal as a fuel. Therefore, because of the potential pollution when firing coal, an "application to modify/construct an air pollution source" will be required if coal is to be used/fired at this facility.

BM/bjm

cc: Homer Ooten, DHRS
Jack Preece, Northwest District
Martha Harrell Hall, General Counsel

ATTACHMENT 15

Projected Source Emissions:

The following fuels will be test fired, 88% wood pellets and 12% No. 6 Fuel Oil, at the Florida State Hospital steam power plant in Chattahoochee, Gadsden County, Florida, for a period of time not to exceed two years:

No. 6 Fuel Oil	Wood Pellets
2.0% sulfur content by weight	7500-8000 Btu/lb
0.46% nitrogen content by weight	
0.05% ash content by weight	
18,500 Btu/lb	
153,550 Btu/gal	
8.3 lbs/gal	

Boilers No. 7 and No. 8 are both rated at a maximum of 60,000 lbs/hr of steam product and operate 8760 hours annually. The current estimated actual emissions on 100% No. 6 Fuel Oil and the projected interim emissions for the test project (<two year duration) are as follows:

Current Estimated Actual Emissions: 100% No. 6 Fuel Oil

		Pollutants				
Boiler		PM	SO_2	NO_x	HC	CO
7	lbs/hr	10.42	142.31	48.33	0.45	2.27
	TPY	45.66	623.34	211.70	1.99	9.93
8	lbs/hr	10.41	142.09	48.26	0.45	2.26
	TPY	45.59	622.35	211.36	1.98	9.91

Projected Interim Emissions:* 88% Wood Pellets & 12% No. 6 Fuel Oil

7	lbs/hr	47.96	23.01	21.11	3.97	8.18
	TPY	210.06	100.79	92.46	17.41	35.84
8	lbs/hr	47.89	22.97	21.08	3.96	8.17
	TPY	209.76	100.62	92.31	17.38	35.78

* PM emissions are those after 60% cyclone separator removal efficiency

Calculations:

1. Boiler No. 7

Assume: 87.94 efficiency

$$\text{Btu/hr heat input} = \frac{60{,}000\ \text{lbs/hr} \times (1290-270\ \text{Btu/lb})}{0.8794}$$

$$= 69{,}592{,}904\ \text{Btu/hr heat input}$$

a. 100% No. 6 Fuel Oil

$$\text{Consumption: } \frac{69{,}592{,}904\ \text{Btu/hr}}{153{,}550\ \text{Btu/gal}} = 453.23\ \text{gals/hr}$$

PM: AP-42 Table 1.3-1, 10(2)+3=23 lbs/1000 gals
23/1000 x 453.23 = 10.42 lbs/hr
= 45.66 TPY

SO_2: AP-42 Table 1.3-1, 157(2) = 314 lbs/1000 gals
314/1000 x 453.23 = 142.31 lbs/hr
= 623.34 TPY

NO_x: AP-42 Table 1.3-1, $22 + 400(0.46)^2 =$ 106.64 lbs/1000 gals

106.64/1000 x 453.23 = 48.33 lbs/hr
= 211.70 TPY

HC: AP-42 Table 1.3-1, 1 lb/1000 gals (total, as CH_4)
1/1000 x 453.23 = 0.45 lb/hr
= 1.99 TPY

CO: AP-42 Table 1.3-1, 5 lbs/1000 gals
5/1000 x 453.23 = 2.27 lbs/hr
= 9.93 TPY

b. 88% Wood Pellets and 12% No. 6 Fuel Oil

Consumption: 88% Wood Pellets (WP) = 61,241,756 Btu/hr
12% No. 6 Fuel Oil (FO) = 8,351,148 Btu/hr

$$\text{WP} = \frac{\dfrac{61{,}241{,}756\ \text{Btu/hr}}{7500\ \text{Btu/lb}} + \dfrac{61{,}241{,}756\ \text{Btu/hr}}{8000\ \text{Btu/lb}}}{2} = 7910.39\ \text{lbs/hr}$$

$$\text{FO} = \frac{8{,}351{,}148\ \text{Btu/hr}}{153{,}550\ \text{Btu/gal}} = 54.39\ \text{gals/hr}$$

PM: (WP) AP-42 Table 1.6-1, 30 lbs/ton wood
(FO) See l.a. , 23 lbs/1000 gals

7910.39 lbs/hr x 30 lbs/2000 lbs = 118.66 lbs/hr
54.39 gals/hr x 23 lbs/1000 gals = 1.25 lbs/hr
total = 119.91 lbs/hr

*Assume: 60% existing cyclone separator efficiency
40% penetration
therefore, 0.40 x 119.91 lbs/hr = 47.96 lbs/hr
= 210.06 TPY

SO$_2$: (WP) AP-42 Table 1.6-1, 1.5 lbs/ton wood
(FO) See l.a. , 314 lbs/1000 gals

7910.39 x 1.5/2000 = 5.93 lbs/hr
54.39 x 314/1000 = 17.08 lbs/hr
total = 23.01 lbs/hr
=100.79 TPY

NO$_x$: (WP) TAPPI Article(attached), 0.25 lbs/million Btu
(FO) See l.a. , 106.64 lbs/1000 gals

61,241,756 Btu/hr x 0.25 lbs/million Btu = 15.31 lbs/hr
54.39 x 106.64/1000 = 5.80 lbs/hr
total = 21.11 lbs/hr
= 92.46 TPY

HC: (WP) TAPPI Article, 0.064 lbs/million Btu
(FO) See l.a. , 1 lb/1000 gals

61,241,756 Btu/hr x 0.064/million Btu = 3.92 lbs/hr
54.39 x 1/1000 = 0.05 lbs/hr
total = 3.97 lbs/hr
=17.41 TPY

CO: (WP) AP-42 Table 1.6-1, 2 lbs/ton wood
(FO) See l.a. , 5 lbs/1000 gals

7910.39 x 2/2000 = 7.91 lbs/hr
54.39 x 5/1000 = 0.27 lbs/hr
total = 8.18 lbs/hr
=35.84 TPY

2. Boiler No. 8

Assume 88.08% efficiency

$$\text{Btu/hr heat input} = \frac{60{,}000 \text{ lbs/hr} \times (1290-270 \text{ Btu/lb})}{0.8808}$$

$$= 69{,}482{,}289 \text{ Btu/hr heat input}$$

a. 100% No. 6 Fuel Oil

$$\text{Consumption}: \frac{69{,}482{,}289}{153{,}550} = 452.51 \text{ gals/hr}$$

PM: 452.51 x 23/1000 = 10.41 lbs/hr
= 45.59 TPY

SO_2: 452.51 x 314/1000= 142.09 lb/hr
= 622.35 TPY

NO_x: 452.51 x 106.64/1000 = 48.26 lbs/hr
= 211.36 TPY

HC: 452.51 x 1/1000 = 0.45 lbs/hr
= 1.98 TPY

CO: 452.51 x 5/1000 = 2.26 lbs/hr
= 9.91 TPY

Note: Emission Factors are the same as Boiler No. 7 (1.a.) and based on AP-42 Table 1.3-1.

b. 88% Wood Pellets and 12% No. 6 Fuel Oil

Consumption: 88% WP = 61,144,414 Btu/hr heat input
12% No. 6 FO = 8,337,875 Btu/hr heat input

$$WP = \frac{\frac{61{,}144{,}414}{7500} + \frac{61{,}144{,}414}{8000}}{2} = 7897.82 \text{ lbs/hr}$$

$$FO = \frac{8{,}337{,}875}{153{,}550} = 54.30 \text{ gals/hr}$$

PM: (WP) 7897.82 x 30/2000 = 118.47 lbs/hr
(FO) 54.30 x 23/1000 = 1.25 lbs/hr
total = 119.72 lbs/hr

*Assume: 60% existing cyclone separator efficiency
40% penetration
therefore, 0.40 x 119.72 lbs/hr = 47.89 lbs/hr
=209.76 TPY

SO_2: (WP) 7897.82 x 1.5/2000 = 5.92 lbs/hr
(FO) 54.30 x 314/1000 = 17.05 lbs/hr
total = 22.97 lbs/hr
=100.62 TPY

NO_x: (WP) 61,144,414 x 0.25/million Btu = 15.29 lbs/hr
(FO) 54.30 x 106.64/1000 = 5.79 lbs/hr
total = 21.08 lbs/hr
= 92.31 TPY

HC: (WP) 61,144,414 x 0.064/million Btu = 3.91 lbs/hr
(FO) 54.30 x 1/1000 = 0.05 lbs/hr
total = 3.96 lbs/hr
=17.38 TPY

CO: (WP) 7897.82 x 2/2000 = 7.90 lbs/hr
(FO) 54.30 x 5/1000 = 0.27 lbs/hr
total = 8.17 lbs/hr
=35.78 TPY

Note: Emission Factors are the same as Boiler No. 7(1.b.) and based on AP-42 Tables 1.3-1 and 1.6-1 and TAPPI Article, 1981 Conference.

PROCEEDINGS
OF THE
TECHNICAL ASSOCIATION
OF THE
PULP AND PAPER INDUSTRY

ISSN 0272-7269

NO_x : See pg. 114

HC : See pg. 123

1981
Environmental Conference

TAPPI

NOx EMISSIONS FROM COMBUSTION SOURCES IN THE PULP AND PAPER INDUSTRY

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ABSTRACT

The body of information presented in this paper is directed to those individuals associated with the determination of NOx emissions from combustion processes used for the manufacture of pulp and paper and power generation from wood-residue firing. In order to expand a limited information base on these sources a total of ten wood-residue fired boilers, one wood-fired burner, ten kraft recovery units and five lime kilns were sampled for NOx. Sampling at eight sites firing roughly 50% moisture wood-residue determined that the NOx emissions on three-contiguous hour average basis ranged from 0.05 to 0.23 pounds NOx per million Btu's heat input. Wood-residue fired at 27% to 30% with wood fines at 8% to 10% moisture produced three-hour average maximums of 0.27 and 0.29 pounds NOx per million Btu at the two sites tested. Sampling conducted on small, medium and large kraft recovery furnaces indicated NOx emissions which ranged from 0.05 to 0.14 pounds per million Btu. A relationship found for the small and medium size recovery furnaces tested between NOx emissions and size based on black liquor solids fired was not indicated from further sampling conducted at large furnaces (greater than 1000 tons of pulp per day). Data generated during the lime kiln study ranged from 0.07 to 1.21 pounds NOx per million Btu heat input for kilns firing either oil or natural gas fuel. One natural gas-fired lime kiln site afforded the opportunity to study the relationship between combustion zone or burned lime (CaO) temperature and NOx emission levels.

INTRODUCTION

The United States Environmental Protection Agency has designated nitrogen dioxide (NO_2) as a criteria pollutant; therefore, reliable estimates of oxides of nitrogen (NOx) emissions are also required for carrying out the modelling of combustion source emissions required for satisfying Prevention of Significant Deterioration regulations. Since available information is limited relative to the potential for emission of NOx from combustion processes associated with the manufacture of pulp and paper and power generation from boilers fired on wood residue, the establishment of a larger data base is desirable.

The NCASI conducted a national program in cooperation with individual member mills designed to provide information on oxides of nitrogen emissions from "kraft recovery units" (defined as both the recovery furnace and boiler sections), lime kilns, and wood-residue fired power boilers.

BACKGROUND AND LITERATURE REVIEW

GENERAL

The emission of oxides of nitrogen (NOx) from combustion sources is influenced by a number of factors which include combustion temperature, "instantaneous flame temperature," fuel-bound nitrogen and operational parameters such as excess oxygen and the method of fuel firing. A comprehensive literature search representative of recent publications associated with NOx formation kinetic theory, measurement techniques, field sampling methodology, source control strategies, previously reported field results and the effects of these gases in the ambient was performed and is presented in NCASI Technical Bulletin No. 102 titled, "A Study of Nitrogen Oxides Emissions from Wood-Residue Boilers," November 1979. The presence in the literature of only two articles on NOx emissions (with the results determined from a limited number of short-interval "grab samples") from kraft recovery furnaces, lime kilns, and 100% wood-residue fired boilers points toward the void this particular field research addresses.

EXPERIMENTAL METHODS

GENERAL

The basic monitor used was the Monitor Labs Nitrogen Oxides Analyzer Model 8440E which was modified for stack concentrations with 0 to 200 ppm and 0 to 5000 ppm the low and high range, respectively. The unit was a gas phase device which utilized the chemiluminescence principle for continuous detection and reporting of Nitric Oxide (NO), Nitrogen Dioxide (NO_2), and Oxides of Nitrogen (NOx) on a ppm dry basis. The operation of the monitor was dependent on chemiluminescence of an activated molecular nitrogen dioxide species which was produced by the reaction between NO and O_3 in an evacuated reaction chamber. The use of a MOLYCON converter to chemically reduce the NO_2 fraction in the sample to NO was utilized in the monitor. This allowed a determination of the total oxides of nitrogen through a sample and detector system which was, except for the converter, identical to that used for the NO measurement. The NO_2 content was obtained by electronically subtracting the NO response from the total NOx response which represented the sum of the NO and NO_2 in the sampled gas.

MONITORING SYSTEM ADAPTATION TO SOURCE NOx MEASUREMENTS

The apparatus used for source NOx sampling is depicted in Figure 1. Several of the components noted as "optional" in the schematic were not found to be required for accurate sampling of some of the sources. The system was designed for consistent operation for vacuum or pressure source gas conditions through the use of a high sampling flow rate and a vented "buffering chamber." An additional pump was located on the cyclone condenser drop-out line to insure minimal water/gas contact and to protect the monitor against possible moisture carry-over.

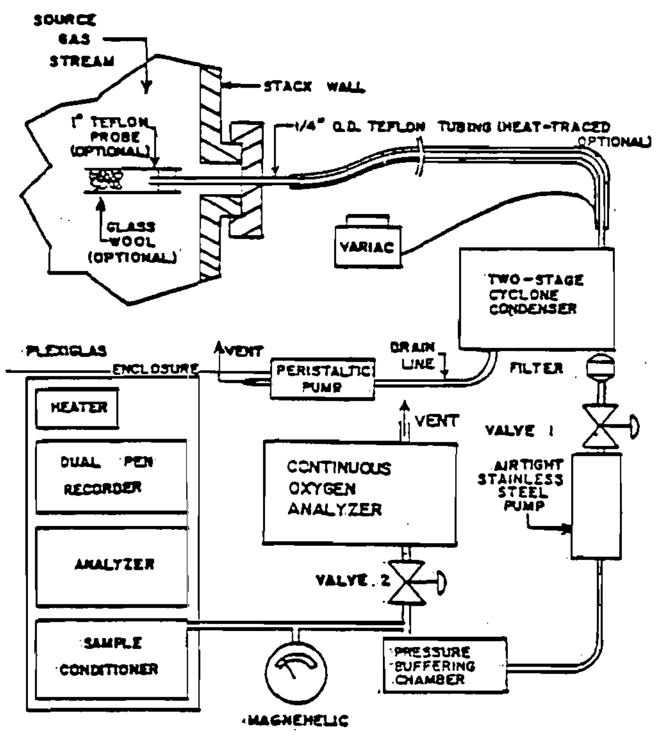

Figure 1. Schematic of NOx Source Measurement System.

CALIBRATION OF SOURCE NOx MONITOR

The span gas employed for instrument calibration was obtained from Airco Industrial Gases and contained in aluminum cylinders. Two standards were used, one at 100 and the other at 500 ppm nitric oxide (NO) packed in dry nitrogen. These gases are considered equivalent to primary standards or standard reference materials (SRM's) by the National Bureau of Standards (NBS).

For purposes of quality assurance, the sample system calibration was also augmented with spiking trials at sometime during the testing at a majority of the sites. These trials were carried out drawing pulling approximately half the usual combustion gas sample flow normally measured by the monitor with the balance of the flow supplied from calibrated cylinder span gas.

RESULTS

DESCRIPTION OF WOOD-RESIDUE FIRED SYSTEMS SURVEYED

The ten wood-residue fired boilers and one wood-residue fired cyclone burner investigated as part of the oxides of nitrogen survey included four boiler sites in the Southeast United States with the remainder in the Northwest. One of the ten boilers was a fluidized bed unit while the others were either normal spreader-stoker or a modified spreader-stoker configuration. The cyclone burner site sampled did not have a boiler section. The predominate fuel fired in all of the boilers during the study period was wood residue, although a portion of the data for some of the sources was collected during the firing of limited quantities of oil and natural gas with the balance wood residue.

WOOD RESIDUE COMBUSTION SITE NOx EMISSIONS

The nitrogen oxides emission results for the 11 wood-residue fired combustion sites sampled are presented in Table 1. Following the format of existing new source performance standards for large steam generation facilities the data was compiled into first, hourly averages and then into three-hour averages. The mean and limits for each site are noted in the table. The values noted in terms of pounds NOx per ton of wet wood fuel may be compared to EPA document "AP-42" which specifies an "emission factor" for wood-residue boilers of 10 pounds NOx per ton of wet wood fuel.

A level of 0.30 pounds NOx per million Btu is the current standard for oil-fired steam generators. Each three-hour average measured at the 11 wood-residue fueled boilers was found to be below this standard. The use of wood residue as fuel, then, represents lower nitrogen oxides emissions than that which would be expected from oil firing. The partial or total conversion of oil burning facilities to wood-residue firing would be expected to favorably address the overall reduction potential of NOx emissions based on alternative fuel use. No significant dependence of NOx emissions based on units of pounds per million Btu was found when compared to boiler size rated in terms of energy output.

A level of 0.25 pounds NOx per million Btu was judged to be representative for wood-residue firing as signified by the data in Table 1. The three exceptions which exceeded this criteria corresponded to first, the site symbolized as No. 1 and represented in Figure 2 was indicative of normal wood-residue firing with the fuel at 45 to 55 percent moisture. After installation of a rotary wood drying system at this location, the three-hour average NOx emission mean doubled to 0.22 pounds per million Btu heat input with a three-hour average upper limit of 0.27 pounds NOx per million Btu as shown in Table 1 for site 1A. The dried wood had an average moisture content of 26 percent with wood fines, produced from the drying process at 8 percent moisture, fired in the boiler overfire air ports. Another boiler fired on dried wood residue and indicated as site No. 9A also exceeded on occasion 0.25 pounds NOx per million Btu. Site No. 10 which represented a fluidized bed wood-residue boiler was the final exception.

Sampling Site and Boiler Type	NOx (3) Hour Average Mean			NOx (3) Hour Average Limits		
	$(lb/10^6$ Btu)	$(ng/J)^a$	$(lb/TWWF)^b$	$(lb/10^6$ Btu)	$(ng/J)^a$	$(lb/TWWF)^b$
1: S.S.[c]	0.11	48	1.10	0.09-0.17	37-72	0.84-1.65
1A: S.S.[d]	0.22	95	2.19	0.20-0.27	86-117	2.00-2.69
2: S.S.	0.14	61	1.14	0.11-0.16	46-69	0.86-1.28
3: S.S.	0.08	32	0.67	0.05-0.10	22-41	0.45-0.85
4: S.S.	0.13	57	1.18	0.08-0.18	36-77	0.75-1.60
5: S.S.	0.20	86	1.78	0.19-0.22	82-95	1.69-1.97
5B: S.S.	0.17	72	1.50	0.15-0.18	65-79	1.35-1.64
6A: S.S.	0.17	72	1.51	0.15-0.19	63-81	1.32-1.69
6B: S.S.	0.11	47	0.98	0.09-0.12	38-55	0.78-1.15
7A: S.S.	0.18	78	1.62	0.15-0.22	64-96	1.33-1.98
8A: S.S.	0.21	92	1.91	0.19-0.23	82-100	1.69-2.06
9A: S.S.(f)[e]	0.22	94	1.43	0.11-0.29	45-125	0.69-1.91
10: F.B.[f]	0.23	97	1.52	0.17-0.28	72-119	1.13-1.87
11: C.B.[g]	0.11	48	1.82	0.08-0.14	36-60	1.37-2.28

Table 1. Nox Emission Rate Summary for Wood Residue Boilers. a: 1 $lb/10^6$ Btu = 430 nanograms/Joule heat input; b: pounds NOx per ton wet wood fuel; c: spreader-stoker boiler; d: spreader-stoker boiler with rotary wood dryer and fines injection in overfire air; e: spreader-stoker boiler with fuel dryer and fines injection in overfire air (these results were based on bark fuel only from multiple regression of NOx total (y), steam from bark (x_1) and steam produced from oil (x_2); f: fluidized bed boiler; g: cyclone burner w/o boiler section.

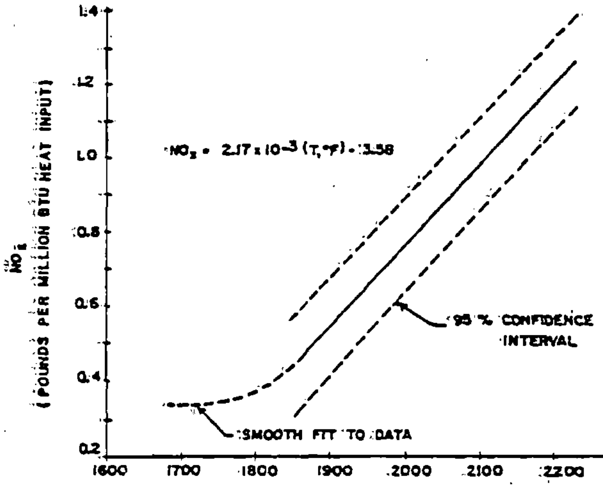

Figure 2. The Relationship Between Combustion Zone Temperature and NOx Emissions at Lime Kiln Site No. 5.

WET SCRUBBER INFLUENCE ON NOx EMISSIONS

The oxides of nitrogen reduction potential of wet scrubbers installed on wood-residue fired boilers was studied at two sites. The three-hour average means and limits for the inlet and outlet of the wet scrubbers at the two sources are depicted as sites No. 5A and 5B and No. 6A and 6B in Table 1. Higher flame temperatures in the combustion zone during sampling at the scrubber inlet were judged to be the probable cause of the higher mean NOx concentration found at both locations. From these findings it was concluded that the reduction of NOx across wet scrubbers on wood-residue fired boilers was not significant.

DESCRIPTION OF KRAFT RECOVERY FURNACE SYSTEMS SURVEYED

Four of the six kraft recovery units studied as part of the oxides of nitrogen survey (Nos. 1, 2, 4 and 5) and displayed in Table 2 were located in the Northwest United States with the balance (Nos. 3 and 6) in the Southeast. Three of the units employed non-direct contact evaporators (non-DCE) while the other three were of the direct contact evaporator (DCE) configuration. The predominate fuel fired in all of the recovery units during the study period was black liquor, although a portion of the data for source No. 6 was collected while a limited quantity of oil was fired with the balance black liquor.

KRAFT RECOVERY UNIT SITE NOx EMISSIONS

The nitrogen oxides emission results for the ten recovery units sampled are presented in Table 2. Following the structure of NOx regulation format for NOx emissions at other sources, the data was compiled into first, hourly averages and then into three-hour averages. The mean and limits for each site are noted in the table. Both the three-hour mean and limits are given in Table 2 with units of pounds NOx per million Btu heat input and nanograms NOx per Joule heat input for each of the ten sites. The NOx emission rate reported in (lb/ton pulp) are based on production estimated by mill personnel. All of the recovery unit sources represented in the table except site No. 6 were sampled when firing 100 percent black liquor. The one exception averaged 84 percent black liquor with oil contributing an average of 16 percent of the total Btu heat input for the study period. It was concluded from the sampling conducted at the ten sites that the operation of an electrostatic precipitator for particulate control did not have a significant impact on NOx emission rates from kraft recovery units.

Location & Furnace Type	Tons Pulp Per Day Mean	NOx (3) Hour Average Mean			NOx (3) Hour Average Limits		
		$(lb/10^6$ Btu)	(ng/J)	(lb/ton pulp)	$(lb/10^6$ Btu)	(ng/J)	(lb/ton pulp)
1:N.D.[a]	348	0.07	29	1.49	0.05-0.08	23-35	1.18-1.82
2:N.D.	573	0.08	33	1.31	0.05-0.09	23-39	0.92-1.53
3:N.D.	521	0.13	56	3.04	0.11-0.14	48-61	2.60-3.30
4: D.[b]	517	0.07	32	1.27	0.06-0.09	25-39	0.98-1.55
5: D.	773	0.11	48	1.92	0.10-0.13	42-55	1.69-2.19
6: D.	304[c]	0.11	49	2.67[c]	0.08-0.13	36-56	1.97[c]-3.04[c]
7:N.D.	1,118	0.09	36	1.73	0.06-0.11	26-48	1.24-2.25
8:N.D.	1,161	0.08	34	1.44	0.07-0.09	31-40	1.30-1.68
9: D.	1,308	0.09	38	1.63[c]	0.07-0.11	32-47	1.36[c]-2.20[c]
10: D.	1,680	0.08	36	1.23	0.07-0.10	31-43	1.06-1.46

Table 2. NOx Emission Rate Summary for Kraft Recovery Furnaces Sampled. a: non-direct contact evaporator system; b: direct contact evaporator system; c: based on black liquor solids fired only without adjustment for 16% oil firing.

The ten kraft recovery units represent two phases of study. Sites No. 1 through No. 6 correspond to small and medium size units investigation in the initial phase of sampling. Relationships determined from this work on a limited number of data points indicated NOx emissions to be dependent on the quantity of black liquor solids fired per hour. No such dependence was found upon further study at four additional sites characterized as large kraft recovery units in the 1,100 to 1,700 tons of pulp per day size.

Investigation into potential causes for NOx emission levels measured was undertaken at sites No. 7 and No. 9. No relationship was found between oxides of nitrogen emissions and the number of liquor burners employed, the type of burner tips used, or the liquor pressure measured at the burner tip of these sites. Examination of the NOx emission levels and black liquor solids fired indicated that the highest occurred when the furnace was operated at one-half to three-fourths of the maximum capacity. These peak NOx emissions were produced under identical furnace firing conditions (50% to 75% capacity) as were employed for the high NOx emissions found for the two medium size furnaces, as compared to lower relative emissions noted for the three small size furnaces firing at maximum capacity. The more recent data may suggest furnace firing rate, as a percentage of the total capacity, as a reason higher emissions were measured for medium size as compared to the small size furnaces testing in the Phase I study.

An emission level of 0.30 pounds NOx per million Btu corresponds to the existing standard for oil-fired steam generators. Each three-hour average measured at the ten kraft recovery unit sites was found to be below this existing standard. The use of kraft black liquor as an alternative to oil fuel, then, would represent lower oxides of nitrogen emissions than that which would be expected from oil firing in steam generators.

DESCRIPTION OF KRAFT MILL LIME KILN SYSTEMS SURVEYED

The emissions from a total of five lime kilns were sampled as part of the nitrogen oxides survey. Three of the kilns (Nos. 1, 2, and 4 as represented in Table 3) were located in the Northwest United States with the balance (Nos. 3 and 5) in the Southeast. Three of the lime kilns were fired on oil alone, one kiln fired natural gas and one could be fired on oil or natural gas. The NOx emission rates were determined for both fuel firing modes during the study interval at site No. 4.

LIME KILN SITE NOx EMISSIONS

The oxides of nitrogen emission results for the five kiln systems sampled are presented in Table 3. As specified in the Federal Register the data was compiled into first, hourly averages and then into three-hour averages. Both the three-hour mean and limits are given in Table 3 with units of pounds NOx per million Btu heat input and nanograms NOx per

Joule heat input for each of the five sites and six combustion modes studied. All of the lime kiln sources represented in the table except Nos. 4B and 5 corresponded to 100 percent oil firing. The two exceptions were kiln sites fired on 100 percent natural gas during the study period.

Location & Furnace Type	Tons Pulp Per Day Mean	NOx (3) Hour Average Mean (lb/10^6 Btu)	(ng/J)	(lb/ton pulp)	NOx (3) Hour Average Limits (lb/10^6 Btu)	(ng/J)	(lb/ton pulp)
1: Oil	360	0.92	395	2.21	0.18-1.07	348-458	1.95-2.57
2: Oil	735	0.17	72	0.39	0.07-0.31	31-131	0.17-0.71
3: Oil	351	0.17	73	0.42	0.09-0.23	39-99	0.23-0.57
4A: Oil	348	0.34	145	1.07	0.25-0.59	106-252	0.79-1.86
4B: Gas	348	0.31	135	0.79	0.21-0.42	90-180	0.70-1.40
5: Gas	428	0.84	361	2.79	0.37-1.21	159-520	1.23-4.01

Table 3. NOx Emission Rate Summary for Lime Kilns Sampled.

As noted previously, the current standard for oil-fired steam generators is 0.30 pounds NOx per million Btu. A lower value of 0.20 pounds NOx per million Btu corresponds to the current standard for natural gas-fired steam generators. As shown in the table, three out of four of the kilns fired on oil had at least one three-hour interval over 0.30 pounds NOx per million Btu. Two of these three sites were found to have data means over the oil-fired boiler standard. Both of the kilns which fired natural gas also had a majority of their three-hour NOx averages above the standard for natural gas-fired boilers.

The wide upper range and high three-hour average NOx emission upper limit representative of the natural gas-fired kiln at site No. 5 pointed toward a potential correlation between NOx emission rate and burner type and operating mode. A relationship between combustion zone or burned lime (CaO) temperature and NOx emission rate was obtained and is presented in Figure 2. The relationship in the figure was based on a total of 37 data points. The solid portion of the curve indicates the use of linear regression techniques performed on 33 of these data points which were judged to follow a close linear distribution. The regression gave the following equation having a correlation coefficient, R, of 0.965:

$$\frac{\text{lb NOx}}{10^6\text{Btu}} = 2.17 \times 10^{-3} \text{ (Temperature, °F)} - 3.58$$

The dashed portion of the center curve was a smooth fit approximation through the remaining four data points. Based on the data collected encompassing various modes of kiln operation, there was judged to be a potential for reduction of NOx emissions to less than 0.4 pounds per million Btu. Adjustment of the gas firing rate and the excess air levels supplied to the kiln's burner may enable the combustion zone or CaO temperature as measured by the radiation pyrometer to be controlled at less than 1850°F. Below this temperature the NOx to combustion zone temperature relationship was judged to be insignificant based on the limited amount of data collected on this burner.

Further sampling work is projected to address the correlation between lime kiln NOx emission production on combustion zone or burner zone flame temperatures as measured with radiation pyrometers and perhaps optical pyrometers.

CONCLUSIONS

1. Based on conventional firing of 100 percent wood residue at approximately 50 percent moisture, the NOx emissions on a three contiguous hour average basis were found to have lower and upper limits of 0.05 to 0.23 pounds NOx per million Btu heat input (25 ppm to 136 ppm NOx were the maximum lower and upper limits found for the eight boilers on an instack concentration basis). This corresponded to 0.45 to 2.06 pounds NOx per ton of wet wood. These values, then, represent the absolute minimum and maximum measurements determined from the sampling at eight boilers ranging from 80,000 to 380,000 pounds of steam per hour. These NOx emission rates are about 5 to 20% of those reported in EPA document "AP-42", a widely used source of emission estimates.

2. Sources Nos. 1A and 9 represented in Table 1 utilized dried wood residue as fuel that was considerably lower in moisture content. Higher NOx emissions were found for these locations as a possible consequence of this mode of operation. A three-hour average high of 0.27 pounds of NOx per million Btu heat input (118 ppm NOx) or 2.7 pounds of NOx per ton of wet wood fuel was found for site No. 1A. Site No. 9 was represented with a level of 0.29 pounds of NOx per million Btu heat input (117 ppm NOx) or 1.9 pounds NOx per ton of wet wood fuel was the highest three-hour average determined for this site. An additional combustion source was tested in order to address the relationship of lower wood fuel moisture content on the reduction of NOx emissions. The results from this testing are represented as site No. 11 in Table 1. Oxides of nitrogen ranged as high as 2.3 pounds per ton of wet wood fuel or 0.14 pounds per million Btu heat input (22 ppm NOx with 18% oxygen in the flue gas) at this burner

source. The effect of fuel drying practices on NOx emission production cannot be completely defined at this time, but may represent a potential for increased NOx emissions.

3. A fluidized bed wood boiler designated as site No. 10 was sampled when firing wood residue of 60 percent moisture content. The boiler produced 1.9 pounds NOx per ton of wet wood or 0.28 pounds per million Btu heat input (135 ppm NOx) based on the highest three-hour average found. This source may be an example of NOx emissions produced through high instantaneous peak flame temperatures.

4. Reductions in Nox emissions across wet scrubbers installed at two wood-residue boiler sites were judged to be, in part, a consequence of boiler operating conditions during the sampling interval at each location. This is equivalent with the effectiveness of wet scrubbers in NOx control at other sources.

5. The significance and impact of nitrogen emissions from wood-residue combustion may be addressed as follows: (a) the NOx formed from wood-residue firing in the United States is low when compared to the firing of other fossil fuels such as coal, oil, or even natural gas, (b) the total NOx contribution from all wood-residue fired sources is low, (c) of the 11 representative tested for NOx, only two boilers were in excess of 250 million Btu per hour capacity and (d) the majority of the wood-residue combustion sites are located in non-urban locations and outside heavily populated areas. Based on these criteria it is evident that NOx emissions from wood-residue fired sources incur minimal effects to NOx sensitive areas and population centers.

6. For the kraft recovery unit sampling with 100 percent black liquor firing, the NOx emissions ranged from 0.05 to 0.14 pounds NOx per million Btu heat input (26 ppm to 71 ppm NOx were the extremes found on an in-stack concentration basis) as shown in Table 2. The three-hour average limits found on a pulp production basis varied between 0.92 to 3.30 pounds of NOx per ton of pulp. There was no discernable difference in NOx emissions from furnaces with or without direct contact evaporators. In addition, no dependence of NOx on the quantity of black liquor solids fired per hour was found between the small or medium and large size (> 1000 tpd) kraft recovery units evaluated.

7. Sampling conducted before an electrostatic precipitator at kraft recovery unit site No. 2 was judged to be equivalent to results found for NOx emission levels after an electrostatic precipitator at sites Nos. 1 and 4.

8. The relationship between combustion zone temperature and NOx emission levels was studied at one site. The data supplied by mill personnel at this site indicated that combustion zone or burned lime (CaO) temperatures below 1850°F were required to reduce the NOx concentrations produced by the existing natural gas burners to less than 0.4 pounds per million Btu heat input.

9. The data generated during the lime kiln study indicated a three-hour mean emission rate ranging from 0.07 to 1.21 pounds of NOx per million Btu heat input (27 ppm to 428 ppm were the extremes found on an in-stack concentration basis) for kilns firing either oil or natural gas fuel. This corresponded to 0.17 to 4.01 pounds of NOx per ton of pulp production.

REFERENCES

1. "A Study of Nitrogen Oxides Emissions from Wood Residue Boilers," NCASI Atmospheric Quality Improvement Technical Bulletin No. 102, 1979.

2. "A Study of Nitrogen Oxides Emissions from Kraft Recovery Furnaces," NCASI Atmospheric Quality Improvement Technical Bulletin No. 105, 1979.

3. "A Study of Wood Residue Fired Power Boiler Total Gaseous Nonmethane Organic Emissions in the Pacific Northwest, NCASI Atmospheric Quality Improvement Technical Bulletin No. 109, 1980.

VOLATILE ORGANIC COMPOUND EMISSIONS FROM PACIFIC NORTHWEST PULP AND PAPER INDUSTRY COMBUSTION SOURCES *

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ABSTRACT

Total gaseous non-methane organic compounds (TGNMO) were measured from wood-residue fired boilers, kraft recovery furnaces, and kraft process lime kilns with the EPA Reference Method 25. An interference to EPA Method 25 on combustion sources was noted and corrected for.

Wood-residue fired boiler TGNMO emissions were found to correlate to overfire air use. Larger proportions of overfire air result in lower TGNMO emissions. Kraft recovery furnace TGNMO emission levels were influenced by the use of direct contact evaporators. Direct contact evaporators were found to contribute to TGNMO emissions. Emissions from lime kilns were difficult to measure. Lime kiln TGNMO emissions were found to depend upon the source of make-up water. Use of contaminated water in the lime kiln area contributed significantly to TGNMO emissions. Wet scrubbers did not remove TGNMO's from wood-residue fired boiler or lime kiln emissions.

INTRODUCTION

Volatile organic compounds are considered by the Environmental Protection Agency to be photo-oxidants resulting in the formation of ozone and are thereby designated criteria pollutants. Potential emissions of these criteria pollutants in amounts greater than a threshold tonnage per year results in classification of new sources as major. Major new sources and existing source modifications must satisfy non-attainment (NA) or prevention of significant deterioration (PSD) regulations mandated by the 1977 Clean Air Act Amendment.

To date, no definitive assessment has been made of total gaseous organic compounds emissions resulting from pulp and paper industry combustion sources. Modelling to satisfy non-attainment and PSD regulations is unreliable with the information presently available. It is also unknown which and what size new pulp and paper mill processes will be considered major sources with respect to gaseous organics.

Hydrocarbon emission factors expressed as methane for wood-residue fired boilers published in AP 42, 1979 (1) were 1 g hydrocarbon per kg (2 lb ton) of 50% moisture fuel fired. This value translates to 0.11 kg carbon per 10^9 J (.22 lb/10^6 Btu) fired assuming 2.08×10^6 J (9,000 Btu/lb) wood-residue heat value. The values published in the 1979 supplement are the same as published in the AP 42 1976 edition and no new references are listed. Consequently, little is known about the method used in obtaining this data or if the procedures used would yield data consistent with the EPA reference method for sampling hydrocarbon emissions. Any comparisons made between the data presented in this text and the value presented in AP 42, should consider the difference in methods by which the data was generated. No hydrocarbon emission factors for kraft recovery furnaces or kraft process lime kilns are listed in AP 42.

The National Council is conducting a survey of total gaseous organic emissions from the pulp and paper industry to provide a data base on potential emissions to be expected from various sources. It was the aim of this project to produce data consistent with the EPA reference method for the measurement of total gaseous nonmethane organic compounds (TGNMO). The sampling and analysis procedures used in this study were in accordance with EPA Method 25, published in the Federal Register October 3, 1980.[2]

SAMPLING AND ANALYSIS PROCEDURES

The EPA-25 analytical procedure yields values for carbon dioxide, carbon monoxide, methane and total gaseous organics. The analytical procedure was altered to produce results for ethane and ethylene. Methane and ethane are not photoreactive and were not included in the results. The TGNMO results were reported as methane.

The principle of EPA-25 is to separate the light compounds (those with vapor pressures at -78°C) from the less volatile organics by capture of less volatile compounds in a cold trap in the field. The light components are captured in an evacuated tank. The samples were returned to the laboratory for analysis where the trap containing condensed organics was heated red hot while purified air swept the trap contents through a catalytic oxidizer to convert organics to CO_2 for analysis. Prior to heating the cold trap is flushed with carbon compound free air to remove flue gas CO_2. The light organics captured in the evacuated tank were separated on a chromatographic column yielding concentrations for CO, CH_4, CO_2, C_2H_6, C_2H_4, and all other organics. Summation of the trap and tank organics gives results for calculating TGNMO stack concentrations. All results are reported as methane.

SAMPLING

Field samples were taken in duplicate through 1/4 stainless steel probes for one-hour duration. The stack end of the probe was filled with quartz glass wool before each sample was drawn to prevent collection of particles in the traps. Six feet of 1/8 in.

* Note: The Kg/10^9J figures in this paper are high by a factor of 10.

stainless steel tubing connected the probes to each trap which were submerged in granular dry ice. Schematics of the trap construction and sampling assembly are presented in Figures 1 and 2, respectively. Condensible organics and water vapor were captured in the traps. From the traps the gas flowed through a rotometer, a flow control valve, and into a 17-liter evacuated stainless steel tank. The sampling system was leak checked prior to commencement of sampling. After sampling the trap and sampling lines were transported to the laboratory packed in dry ice. Tank pressures were measured before and after sampling to determine sample size.

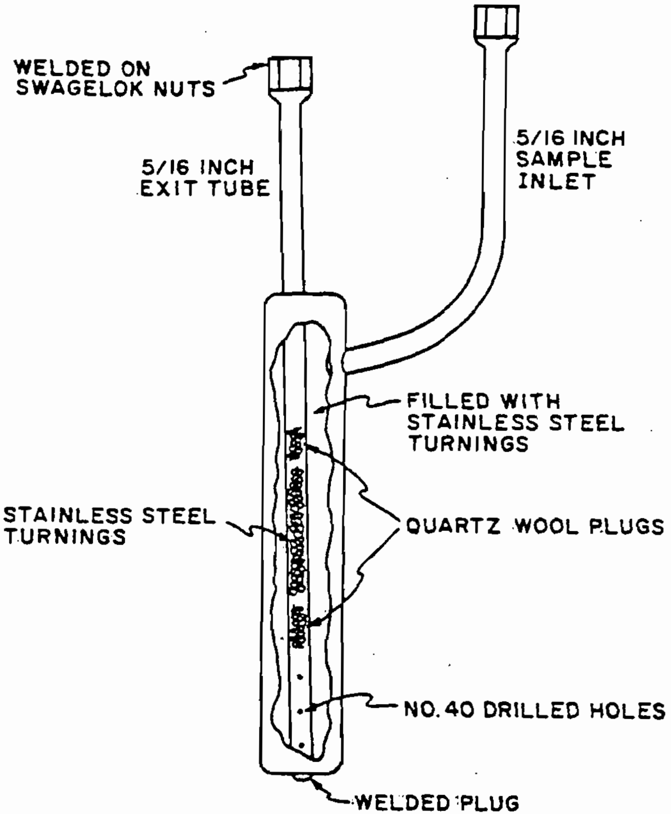


Figure 1. Condensate Trap.

SAMPLE PREPARATION

Upon returning to the laboratory, each trap and sample tank combination used in the field was connected to the trap burning system in the sequence of trap, oxidation tube furnace, U-tube water trap packed in dry ice and IR analyzer and sampling vessel as shown in Figure 3. The stack gas remaining in the trap was flushed into the tank with carbon compound free air (hereafter referred to as zero air) with the flow through the trap and oxidation furnace reversed.

Following sampling tank pressurization, an evacuated vessel was attached in the tank's place. Zero air was passed through the sampling line and trap while they were heated to a dull red color with an acetylene torch. Care was taken that the sampling line, trap, and lines to the oxidizer were heated sequentially so that incompletely oxidized organics that might recondense in the system would be revolatilized.

Zero air was prepared by further purifying zero grade air from cylinders. Air from the cylinder was passed over an oxidation catalyst to oxidize organic contents and then passed through ascarite for carbon dioxide removal. The nitrogen carrier gas used for the chromatographic column was cleaned by passing through a molecular sieve and through a catalytic oxidation column.

SAMPLE ANALYSIS

The analysis system components consisted of an injection port with an inert septum, a silicon SF-96 on Chromosorb W/Porapak Q column operated at -78°C, -30°C, 25°C, and 100°C with back flush capability, a MnO_2 oxidation furnace for oxidation of the CH_4, CO, and VOC's to CO_2, and hydrogen addition to the nitrogen carrier at a rhodium catalyst methanator to convert CO_2 to CH_4. The CH_4 was analyzed by a flame ionization detector (FID).

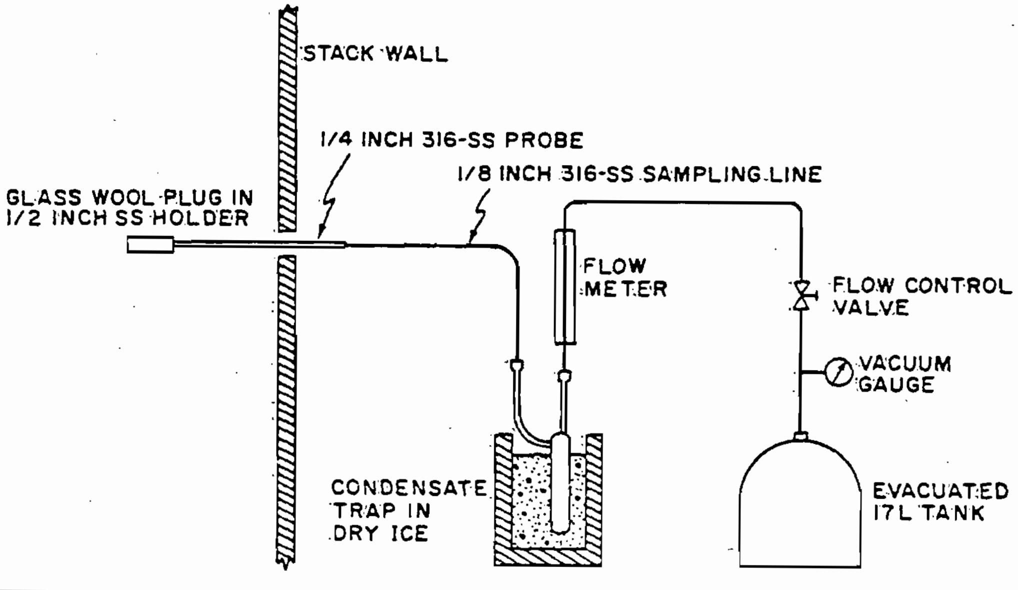
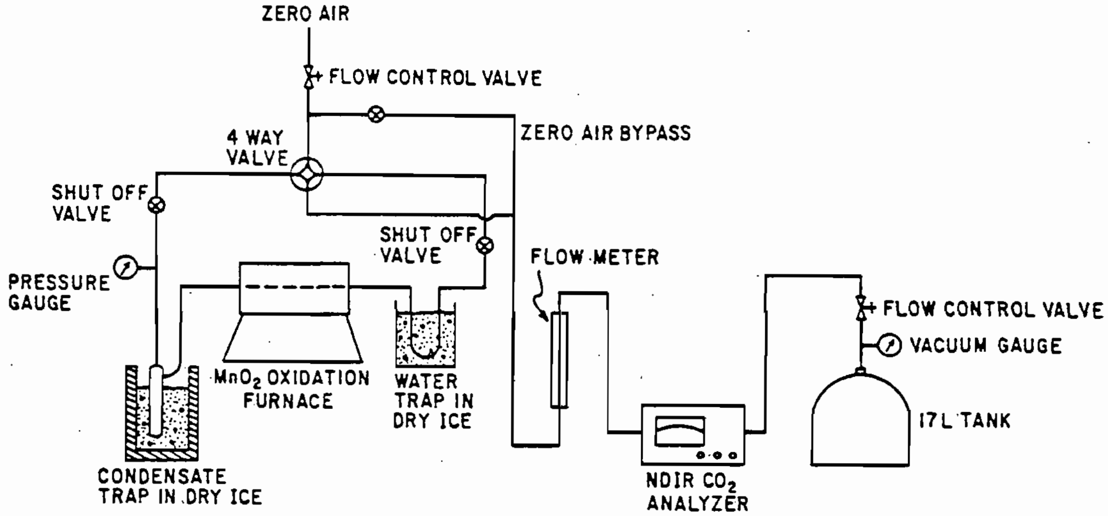


Figure 2. TGNMO Sampling Train.

The FID output was integrated with an electronic integrator. Figure 4 depicts the ystem.



igure 3. Revised Trap Burn Out System.

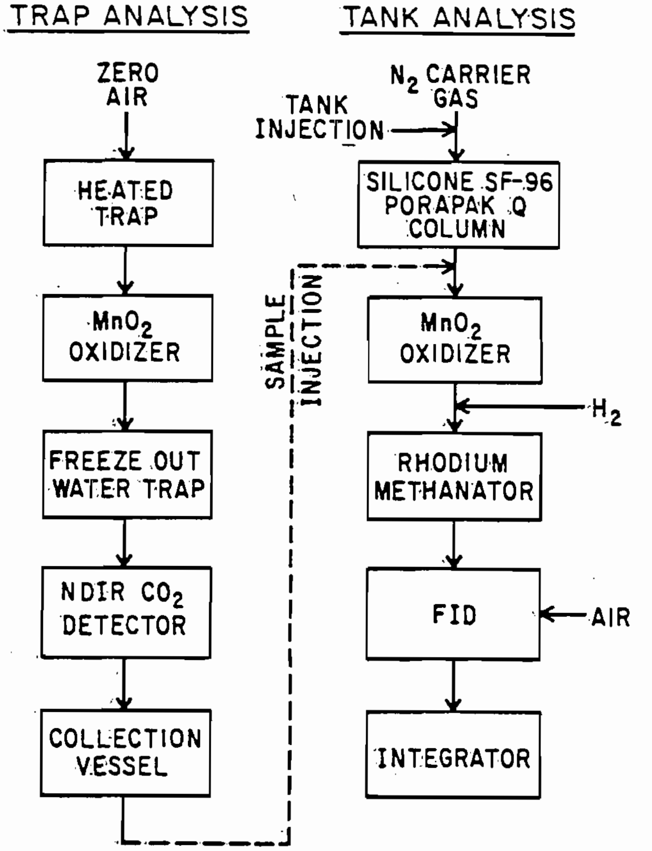


Figure 4. TGNMO Analytical Scheme.

Starting with the column submerged in a dry ice-isopropanol bath at -78°C, a 5 ml sample was drawn from the pressurized evacuated sampling tank and injected into the carrier gas to the column. Carbon monoxide and methane were separated. The column was then operated at -30°C for carbon dioxide, ethane, ethylene, and acetylene elution. After these compounds eluted, the column was placed in a boiling water bath and the carrier gas flow through the column reversed. The organic compounds were released from the column. If no C_2 compounds were found subsequent samples were analyzed at room temperature for CO_2 elution to speed analysis.

The trap burn-off vessel contents were analyzed by injecting 5 ml drawn from the vessel into the carrier gas bypassing the chromatographic column and entering the oxidation furnace.

CALCULATIONS

Laboratory results are in terms of ppm TGNMO as methane as found in the sampling tank or vessel. These were corrected to standard conditions in the stack. Summation of tank and vessel concentrations are presented as stack TGNMO concentration at standard conditions.

For wood-residue boilers stack TGNMO concentrations were converted to $Kg/10^9 J$ ($lb/10^6$ Btu) emissions through use of conversion formulas published in 40 CFR 121:1516, 60.45, Sections E and F. The conversion equation used was:

$$E = C F_c \frac{100}{\% CO_2}$$

where E = pollutant emissions, $Kg/10^9 J$ ($lb/10^6$ Btu)

where C = pollutant concentration, ng/DSCM (lb/DSCF)

and F_c = 0.494×10^{-7} SCM CO_2/J (1840 SCF $CO_2 10^6$ Btu) for wood-residue

For kraft recovery furnaces and lime kilns, stack TGNMO's were converted to $Kg/10^9 J$ ($lb/10^6$ Btu) emissions by multiplying stack concentrations by the stack gas flow rate and an appropriate units conversion factor. Stack flow rates were measured by S-type pitot tube traverses at the point of sampling each day samples were taken. Gas molecular weights were calculated from Orsat analysis results and moisture contents determined by measurement of the water found in the condensate traps.

QUALITY CONTROL

The TGNMO analysis system was checked for proper operation at frequent intervals. Daily checks were made for the FID sensitivity, zero air purity, column carrier gas purity and system leaks. Weekly checks were made on all catalysts efficiencies. Biweekly checks were made for evacuated sampling tank leaks and tank contamination. A thorough discussion of sampling and quality control procedures appears in the NCASI Atmospheric Quality Improvement Technical Bulletin No. 109.[3]

CARBON DIOXIDE ABSORPTION INTERFERENCE

The EPA-25 analysis scheme oxidizes all organics to CO_2 and subsequently reduces them to methane for detection. Any carbon dioxide lingering in the cold traps when the organics are burned will constitute a positive interference. Combustion sources contain high percentages of CO_2 and moisture which needs to be separated from the organics in the sample. This is normally accomplished by flushing the trap with zero air. However, when CO_2 becomes trapped in the ice matrix formed from freezing stack gas moisture it cannot be flushed from the trap.

This CO_2 interference was accounted for in this study by measuring in the laboratory the interference at different CO_2 and moisture levels in organic compound free simulated stack gases. The appropriate interference level was subtracted from the field sampling results. These interference studies are discussed in detail in NCASI Atmospheric Quality Improvement Technical Bulletin No. 109.[3]

SOURCE DESCRIPTION

During the course of this study four wood-residue boilers, five kraft recovery furnaces, and three lime kilns were sampled for TGNMO emissions.

All of the wood-residue fired boilers sampled were spreader-stokers. Boiler A is rated at 82000 Kg/hr (180,000 lb/hr) steam at 4100 k Pa (600 psi) while burning Douglas fir derived wood-residue at 45% moisture. Undergrate combustion air was preheated to 230°C (450°F). Overfire air makes up 4% of the total air and was not preheated. Boiler B is rated at 270,000 Kg/hr (600,000 lb/hr) steam at 7000 k Pa (1000 psig) burning a combination of Douglas fir wood-residue and oil or gas. Primary air was about 70% of the total air flow and overfire and windbox air was 30% of the total air flow, all of which was preheated. Boiler C is rated at 680,000 Kg/hr (150,000 lb/hr) steam at 4300 k Pa (625 psig) burning Douglas fir wood-residue and bark. Combustion air was preheated to about 270°C (520°F). Undergrate air was 75 to 80% of the total air flow and overfire air about 20 to 25% of the total air flow. Boiler D is rated at 182,000 Kg/hr (400,000 lb/hr) steam when burning Douglas fir derived wood-residue at 55% moisture. Primary air was about 60% and the overfire air about 40% of the total air flow, all of which was preheated.

The wood-residue fired boilers were sampled before wet scrubbers. Boiler D was sampled following a dry scrubber. The results from sampling wood-residue boilers represent uncontrolled emissions. One wood-residue boiler was sampled simultaneously prior to and following an impingement type wet scrubber to determine the effect of scrubbers on TGNMO's. The scrubber used fresh water as makeup.

Five kraft recovery furnaces were sampled for TGNMO emissions. Furnace A was equipped with a non-direct contact evaporator and rated to fire 28,000 Kg dry black liquor solids per hour (62,000 lb bls/hr). Furnace B was equipped with a direct contact evaporator and black liquor oxidizer and rated to fire 62,000 Kg bls/hr (137,000 lb bls/hr). Furnace C was equipped with a noncontact evaporator and rated to fire 10,000 Kg bls/hr (22,000 lb bls/hr). Recovery furnace D was equipped with a direct contact evaporator and a black liquor oxidizer and was rated at 45,400 Kg bls/hr (100,000 lb bls/hr). Furnace E was equipped with a noncontact evaporator and rated at 45,400 Kg bls/hr (100,000 lb bls/hr). All the recovery furnaces were sampled after electrostatic precipitators and ID fans.

Three lime kilns associated with the kraft recovery process were sampled. Lime Kiln A has a capacity to produce 7.8 metric tons (8.6 tons) lime per hour, but averaged 6.0 metric tons (6.6 tons) per hour. This kiln used fresh water in all of its systems and did not burn noncondensible gases. It did have problems with green liquor dregs carryover into the lime mud. Lime Kiln B had a capacity to produce 6.3 metric tons (7 tons) lime per hour, but averaged 5.3 metric tons (5.8 tons) per hour. Evaporator condensates were used to wash the lime mud and as makeup water elsewhere in the system. This lime kiln also burned noncondensible gases. Lime Kiln C had a capacity to produce 8.6 metric tons (9.5 tons) per hour lime, but averaged 6.2 metric tons (6.8 tons) per hour when the samples were taken. This kiln used all fresh water for all wash and makeup purposes and burned noncondensible gases from the digester. All the lime kilns were sampled both before and after wet scrubbers.

The sources studied in this program were considered representative of current boiler design and operating practices.

RESULTS

PRECISION

Using only data points where samples were collected in duplicate allowed for statistical estimates of the precision of the EPA-25 sampling procedure. The variation due to the sampling procedure was separated from the variation of the TGNMO emissions from the sources by a statistical technique called analyses of variance. Using a lumped relative standard deviation of 0.23 for wood-residue fired boilers and 0.20 for kraft recovery furnaces and using the appropriate z statistics it can be shown that the average of the duplicate samples taken at a source are within ±32% and ±28% of the true values at the 95% confidence level for wood-residue fired boilers and kraft recovery furnaces respectively.

The analysis of variance results also showed that only from boiler A and in furnaces C, D, and E was there significant enough variation in TGNMO emissions to be resolvable by the EPA sampling technique. In all other sources the variation within the EPA-25 sampling technique obscured what variation there may have been from the source.

WOOD-RESIDUE FIRED BOILERS

Average corrected TGNMO emissions from the wood-residue fired boilers studied expressed as methane equivalent were 0.43, 0.22, 0.31, 0.14 Kg/10^9 J (0.10, 0.050, 0.072, 0.032 lb/10^6 Btu) for boilers A through D respectively. Average CO_2 absorption interferences were 0.082, 0.066, 0.061 and 0.066 Kg/10^9 J (0.019, 0.015, 0.014 and 0.015 lb/10^6 Btu) for boilers A through D respectively. These average emission rates were found to be related to the percentage of the total air fired as overfire or secondary air. As illustrated in Figure 5 the greater the percentage of total air used as overfire, the lower the TGNMO emission rates were. Data corrected for CO_2 absorption interference was used for plotting Figure 5. When 12% overfire air was used, as in boiler A, an average TGNMO emission rate of 0.43 Kg/10^9 J (0.10 lb/10^6 Btu) was experienced. At 40% overfire air use, less than 0.13 Kg/10^9 J (0.03 lb/10^6 Btu) TGNMO emissions result.

CORRELATION TO BOILER OPERATION

The TGNMO emission data was searched for relationships to operating conditions such as steam production, flue gas moisture content and boiler flue gas exit temperature. No strong correlations could be found with any of the recorded operating parameters. Most of the boiler operations were over a narrow range of operating parameters.

Both boilers A and C showed a trend with higher TGNMO emissions higher stack oxygen levels as shown in Figures 6 and 7.

It is possible to postulate that in boilers A and C, where most of the combustion air was provided under the grates, uneven burning could result. An uneven fuel cover on the grate could allow combustion air to pass through some portions of the grate unreacted. High pressure drops elsewhere across the bed would prevent sufficient air to pass through the fuel for complete combustion. Inadequate gas turbulence would allow uncombusted organics to escape the combustion zone resulting in a TGNMO emission. Furnaces using overfire air are designed to induce turbulence for gas mixing and complete combustion. With low overfire air usage, evenness of the fuel on the grate would influence TGNMO emissions.

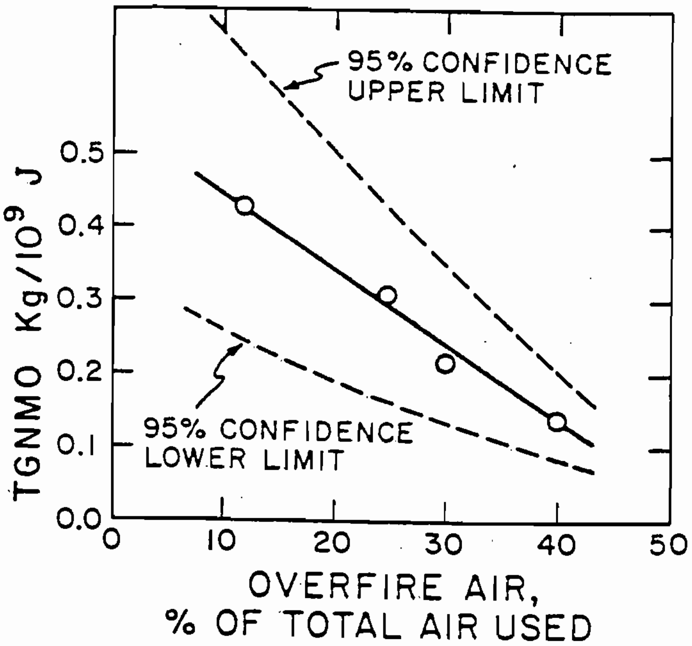


Figure 5. Relationship Between TGNMO and Overfire Air Use.

Avg = 0.0635 lbs/10^6 Btu ≃> 0.064 lbs/10^6 Btu

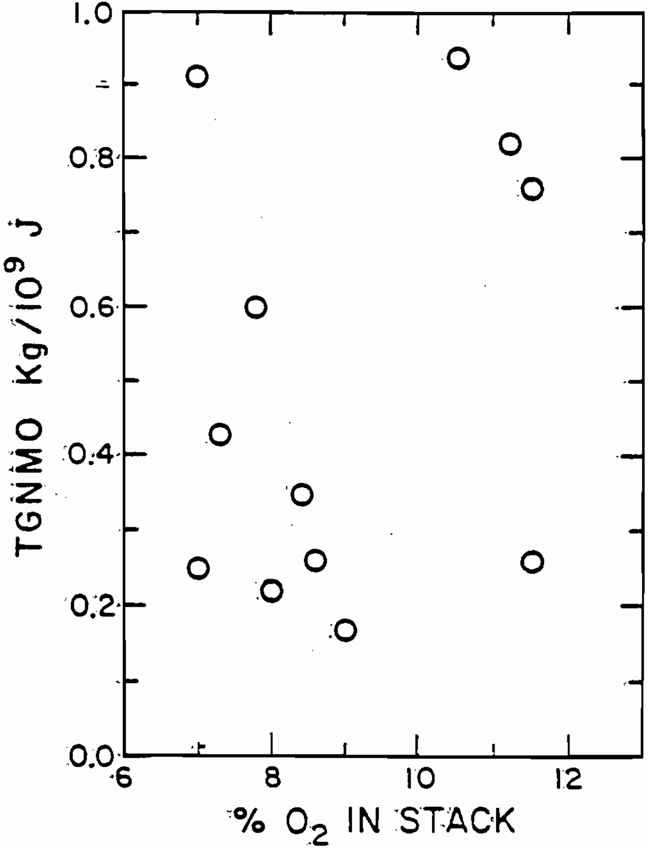


Figure 6. Relationship Between TGNMO and Stack % O_2 for Boiler A

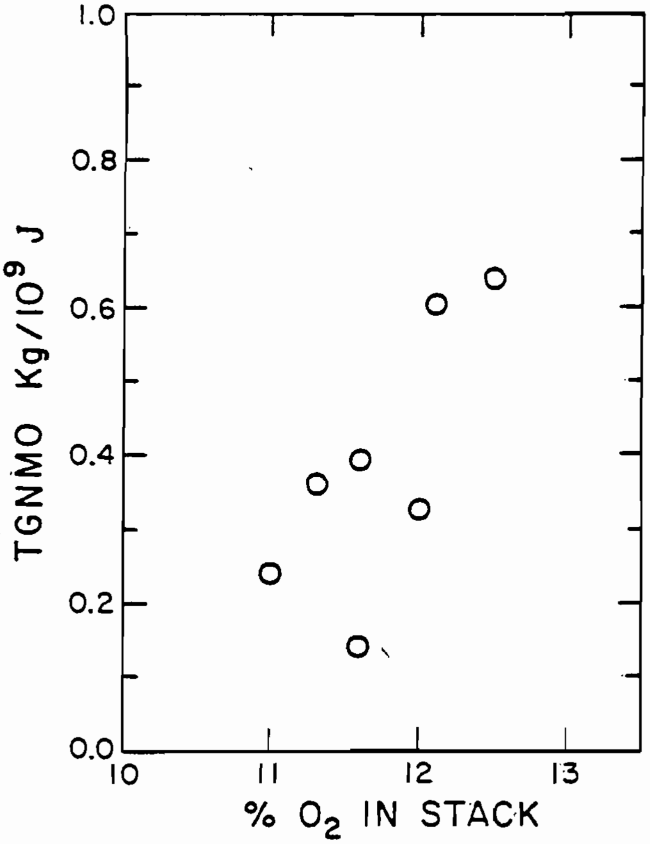


Figure 7. Relationship Between TGNMO and Stack % O_2 for Boiler C

Mills B and D showed no relationship between TGNMO's and flue gas oxygen content.

Carbon monoxide emissions correlated with stack gas moisture content and auxiliary fuel type for boiler B and with O_2 for boiler C. The high CO emissions for boiler B occurred when a large amount of oil was burned while flue gas oxygen content was high, indicating too short of a residence time for complete combustion of oil. Carbon monoxide emissions were always low when natural gas was burned as an auxiliary fuel in boiler B.

Both the carbon monoxide and TGNMO's for boiler C increased in proportion with flue gas oxygen content indicating a common mechanism and incomplete combustion of these materials.

EFFECT OF A WET SCRUBBER ON TGNMO EMISSIONS

Samples were taken simultaneously preceding and following an impingement type wet scrubber to determine if removal of TGNMO's occurred. There was a small reduction in TGNMO's across the scrubber averaging about 0.15 kg/10^9 J (0.012 lb/10^6 Btu).

No significant removal of TGNMO's should be expected from impingement type wet scrubbers used on wood-residue fired boilers. This type of scrubber is not designed for gas absorption and does not function well in that capacity. Any high boiling point organic compounds present in the flue gas may condense to form particulate organics will be removed from the scrubber water along with other solids. Lower boiling point soluble organics such as alcohols removed by the scrubber would likely be stripped from the recirculated scrubber water into the gas stream. However, if a contaminated water makeup (i.e., evaporator condensate) is used in the scrubber, evaporation and stripping of the contaminated water could lead to an increase in TGNMO emissions.

KRAFT RECOVERY FURNACE RESULTS

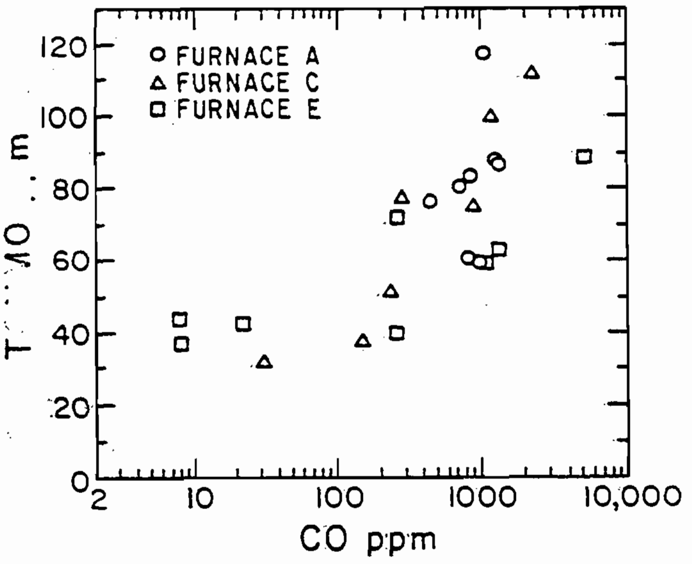
Average TGNMO emissions as methane collected from kraft recovery furnaces are shown in Table 1. The emissions are reported in terms of parts per million, Kg/10^9J (lb/10^6 Btu) fired, Kg/1000 Kg (lb/1000 lb) dry black liquor solids fired, and Kg/metric ton (lb/ton) pulp rated capacity. As expected, the magnitude of the TGNMO emissions separated into two levels corresponding to furnaces equipped with direct contact evaporators (DCE) and those not equipped with direct contact evaporators (NDCE). DCE furnaces averaged 0.45 kg/10^9 J (0.10 lb/10^6 Btu) emissions and NDCE furnaces averaged 0.18 kg/10^9 J (0.043 lb/10^6 Btu) emissions.

		TGNMO	TGNMO	TGNMO
Recovery Furnace	TGNMO ppm	Kg/10^9J (lb/10^6 Btu)	Kg/1000 Kg bls (lb/1000 lb bls)	Kg/Ton Pulp (lb/Ton Pulp)
A (NDCE)	82	0.17 (0.040)	0.24 (0.24)	0.4 (0.8)
B (DCE)	172	0.43 (0.100)	0.55 (0.55)	0.7 (1.4)
C (NDCE)	89	0.15 (0.035)	0.17 (0.17)	0.2 (0.4)
D (DCE)	169	0.46 (0.106)	0.63 (0.63)	1.0 (2.1)
E (NDCE)	61	0.23 (0.054)	0.32 (0.32)	0.5 (1.0)

Table 1. Average TGNMO Emissions From Kraft Recovery Furnaces.

Weak correlations could be found between TGNMO emissions in Kg/10^9J and stack gas flow rates and oxygen content. TGNMO emissions from furnace C weakly correlated with total stack flow at the point of measurement. Higher stack flow rates resulted in higher TGNMO emissions in Kg/10^9J fired. When stack gas flow rates were corrected to zero percent oxygen there was no correlation with TGNMO emissions. TGNMO emissions in Kg/10^9J also correlated with stack gas oxygen content for furnaces D and E. For furnace D higher emissions occurred at higher stack gas oxygen content. For furnace E higher TGNMO emissions in Kg/10^9J occurred at lower stack gas oxygen levels. When TGNMO emissions were compared to the flue gas oxygen levels as it left the furnace as measured by mill instruments, there was no correlation. No other correlations ould be found between TGNMO emissions and ecovery furnace operating parameters.

A strong correlation was noted between TGNMO and carbon monoxide for the NDCE recovery furnaces as shown in Figure 8. High ppm GNMO emissions were synonymous with high CO emissions. This relationship holds for TGNMO emissions expressed in Kg/10^9J and CO emissions expressed in ppm. The correlation of g/10^9J TGNMO emissions to ppm CO emissions as strongest for the small furnace C and weakest in the large furnace E. Furnace A's TGNMO missions did not vary enough to produce a elationship.



igure 8. Relationship Between TGNMO and CO missions from Kraft Recovery Furnaces

The lower ppm TGNMO values shown in igure 8 approach the limit of detectability f EPA Method 25 for NDCE recovery furnaces. limit of detectability was estimated to be 40 ppm TGNMO.

These correlations indicate that TGNMO d CO emissions are influenced by the same mechanism within the boiler. High CO emissions indicate incomplete combustion. Incomete combustion may result from improper air ixing in the furnace, insufficient combustion ime, or insufficient temperature allowing uncombusted gases to pass from the reduction one and through the oxidation zone to the ack uncombusted. Sufficient oxygen was alys present to allow for complete combustion.

The data indicate that control for minim CO emissions should result in minimum GNMO emissions.

Geometric means of carbon monoxide emisions from recovery furnaces were 3.8, 0.12, .1, 0.078, 1.6 Kg/10^9J (0.88, 0.025, 0.26, .018, and 0.37 lb/10^6 Btu) ror furnaces A through E, respectively. Variation in the ata could not be tied to any operational parameters. Carbon monoxide emissions need to be studied in more detail than time allowed in this study to elucidate factors controlling its emission.

KRAFT PROCESS LIME KILNS

Average TGNMO emissions as methane from three lime kilns both before and after wet scrubbers are shown in Table 2. The emissions are reported in terms of parts per million and Kg per metric ton (lb per ton) CaO produced. Kiln B produced the highest emissions. The high emissions from this kiln likely result from organics introduced into the lime production process with the contaminated water used to wash the lime mud and for makeup elsewhere in the system. These organics are driven into the gas stream when the lime mud is dried.

The TGNMO emissions from Kiln A are also likely due to organic compounds contained in the water associated with the lime mud rather than from uncombusted fuel. In a laboratory study, a measured quantity of lime mud from Kiln A was heated to drive off water and organic compounds into the sample preparation system in the TGNMO analysis procedure. Results showed 0.22 Kg (0.44 lb) TGNMO per ton lime produced when heated. Corrected field sampling results showed emissions of 0.18 Kg/metric ton (0.37 lb/ton) lime produced. The organics present in the lime mud are likely to result from carryover from the green liquor system. TGNMO emissions from Kiln C were below the minimum detectable level for EPA Method 25.

Kiln		TGNMO ppm	TGNMO Kg/Metric Ton Lime Produced (lb/Ton Lime Produced)
A.	Before Scrubber	122	0.28 (0.56)
A.	After Scrubber	102	0.26 (0.52)
B.	Before Scrubber	338	1.02 (2.05)
B.	After Scrubber	251	0.90 (1.80)
C.	Before Scrubber	31	0.11 (0.22)
C.	After Scrubber	48	0.18 (0.37)

Table 2. Average TGNMO From Lime Kilns.

CONCLUSIONS

(1) Hydrocarbon emission factors expressed as methane for wood-residue fired boilers published in AP 42, Supplement 9 in 1979 (1) were 1 g (2 lb/ton) hydrocarbon per kg of 50% moisture fuel fired. This value translates to 0.11 Kg (0.22 lb) hydrocarbon per 10^9J (million Btu) fired assuming 2080 J/ton (9,000 Btu per pound) wood-residue heat value. This is

two to four times the contribution indicated by this study conducted on wood-residue boilers fired with woods on the Pacific Northwest and considered as representative of current design practices. Any comparisons made between the data generated and presented in this text and the value presented in AP 42, Supplement 9 should consider the lack of knowledge concerning the difference in methods by which the data was generated.

(2) Little TGNMO emission reduction was observed across the wet impingement type scrubber on the wood-residue fired boiler samples. Due to the design of these units, no significant reduction or contribution would be expected for units operated with a fresh water feed.

(3) TGNMO emissions from non-direct contact evaporator recovery furnaces were found to correlate with CO emissions.

(4) The emissions of TGNMO from direct contact evaporator equipped kraft recovers furnaces was higher than from non-direct contact evaporator kraft recovery furnaces.

(5) TGNMO emissions from lime kilns did not appear to be related to combustion but to other process variables such as use of contaminated water for mud washing or kiln scrubber fluid makeup.

REFERENCES

(1) "Compilation of Air Pollutant Emission Factors," 3rd Edition, Supplement 9, AP-42 1977.

(2) Federal Register 45 (194) October 3, 1980.

(3) "A Survey of Wood-Residue Fired Power Boiler Total Gaseous Nonmethane Organic Emissions in the Pacific Northwest," NCASI Atmospheric Quality Improvement Technical Bulletin No. 109, September 1980.