AD-A195 220 COMPLIANCE TESTING OF GRISSOM AFB CENTRAL HEATING PLANT 1/2
COAL-FIRED BOILER..(U) AIR FORCE OCCUPATIONAL AND
ENVIRONMENTAL HEALTH LAB BROOKS AF.. J A GARRISON
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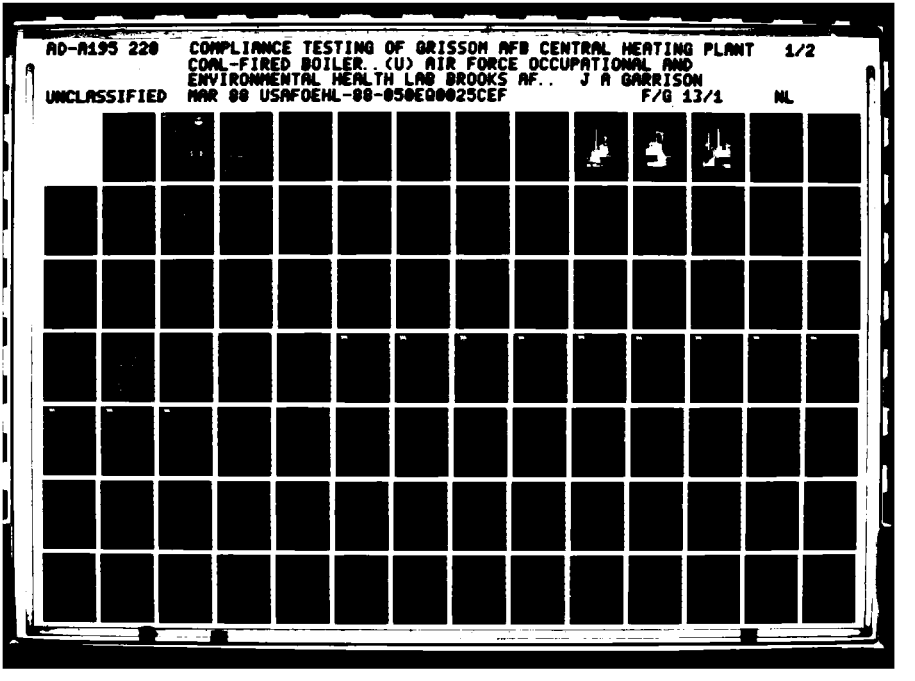

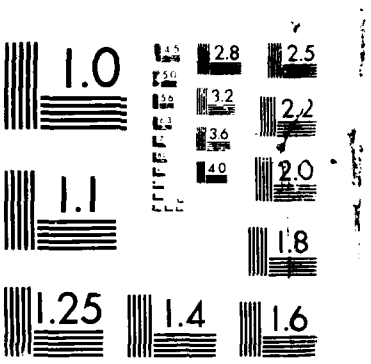

USAFOEHL REPORT

88-050EQ0025CEF

Compliance Testing of Grissom AFB Central Heating Plant Coal-Fired Boilers 3 and 4, Grissom AFB IN

JAMES A. GARRISON, Maj, USAF, BSC

March 1988

Final Report

USAF Occupational and Environmental Health Laboratory
Human Systems Division (AFSC)
Brooks Air Force Base, Texas 78235-5501

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This report has been reviewed and is approved for publication.

JOHN J. COUGHLIN, Colonel, USAF, BSC
Commander

Reviewed by:

MARLIN L. SWEIGART, Lt Col, USAF, BSC
Chief, Environmental Quality Branch

Prepared by:

JAMES A. GARRISON, Maj, USAF, BSC
Chief, Air Quality Function

SHELTON R. BIRCH, Col, USAF, BSC
Chief, Consultant Services Division

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form Approved
OMB No 0704-0188

1a REPORT SECURITY CLASSIFICATION Unclassified	1b RESTRICTIVE MARKINGS N A
2a. SECURITY CLASSIFICATION AUTHORITY N/A	3 DISTRIBUTION / AVAILABILITY OF REPORT Distribution is unlimited; approved for public release
2b. DECLASSIFICATION / DOWNGRADING SCHEDULE N/A	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) USAFOEHL Report 88-050E00025CEF	5 MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION USAF Occupational and Environmental Health Laboratory 6b OFFICE SYMBOL (If applicable)	7a. NAME OF MONITORING ORGANIZATION
6c. ADDRESS (City, State, and ZIP Code) Brooks AFB TX 78235-5501	7b ADDRESS (City, State, and ZIP Code)
8a. NAME OF FUNDING / SPONSORING ORGANIZATION Same as 6a 8b OFFICE SYMBOL (If applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
8c. ADDRESS (City, State, and ZIP Code) Same as 6c	10 SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO / PROJECT NO / TASK NO / WORK UNIT ACCESSION NO
11. TITLE (Include Security Classification) Compliance Testing of Grissom AFB Central Heating Plant Coal-Fired Boilers 3 and 4, Grissom AFB IN	
12. PERSONAL AUTHOR(S) Maj James A. Garrison	
13a. TYPE OF REPORT Final 13b TIME COVERED FROM 18-23 Nov 87	14. DATE OF REPORT (Year, Month, Day) March 1988 15 PAGE COUNT 16
16. SUPPLEMENTARY NOTATION	

17. COSATI CODES			18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)
FIELD	GROUP	SUB-GROUP	Compliance Testing, Grissom, Source Emission Testing, Stack Sampling, Particulates, Boiler, Stack Emission(s), Garrison, Air Pollution

19 ABSTRACT (Continue on reverse if necessary and identify by block number)

At the request of HQ SAC/SGPB, compliance testing (particulate emissions) of coal-fired boilers 3 and 4 in the Grissom AFB central heating plant was performed on 18-23 Nov 1987. The survey was conducted to determine compliance with Indiana Administrative Code, Title 325--Air Pollution Control Board, Articles 5 and 6. Results indicate Boiler 3 met particulate standards while exhausting through the bypass stack, but failed to meet standards when exhausting through the scrubber stack. Boiler 4 met particulate standards when exhausting through both the bypass and scrubber stacks.

20 DISTRIBUTION / AVAILABILITY OF ABSTRACT ☐ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT ☐ DTIC USERS	21 ABSTRACT SECURITY CLASSIFICATION Unclassified
22a NAME OF RESPONSIBLE INDIVIDUAL James A. Garrison, Major, USAF, BSC	22b TELEPHONE (Include Area Code) (512) 536-2891 22c OFFICE SYMBOL USAFOEHL/ECQ

DD Form 1473, JUN 86 *Previous editions are obsolete*

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

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ILLUSTRATIONS

I. INTRODUCTION

On 18-23 Nov 87, a stationary source sampling survey for particulate emissions was conducted on coal-fired boilers 3 and 4 at the Grissom AFB Central Heating Plant, by the Air Quality Function of the USAF Occupational and Environmental Health Laboratory (USAFOEHL). This survey was requested by HQ SAC/SGPB to determine particulate emission compliance status with regards to Indiana Administrative Code, Title 325 - Air Pollution Control Board, Article 5, Opacity Regulations (325 IAC 5), and Article 6, Particulate Regulations (325 IAC 6). Personnel involved with on-site testing are listed in Appendix A.

II. DISCUSSION

A. Background

On 7 Nov 1986, the Director, Air and Radiation Division, U.S. Environmental Protection Agency (EPA), Region V, issued a notice of violation (NOV) to Grissom AFB for violation of 325 IAC 5, Opacity Regulations. The NOV was based on information submitted by the State of Indiana Department of Environmental Management and by the EPA. Observations indicated that boilers 3 and 4 and oil-fired boiler 1 were out of compliance with respect to visible emissions.

To demonstrate and maintain compliance with 325 IAC 5 and other rules set forth by the Indiana Air Pollution Control Board, EPA, Region V required Grissom AFB to: (1) conduct stack particulate emission testing on boilers 3 and 4 as specified in Title 40, Code of Federal Regulations, Part 60(40 CFR 60), Appendix A, Reference Method 5, (2) determine visible emissions from boilers 1-4 as specified in 40 CFR 60, Appendix A, Reference Method 9 and (3) request stack testing following future major modifications to the central heating plant.

B. Site Description

The Central Heating Plant operates a total of five boilers for steam production:

Boiler No.	Manufacturer	Steam Capacity lb/hr	Year Installed	Fuel
1	Springfield Boiler Co.	40,000	1955	oil
2	Springfield Boiler Co.	40,000	1955	oil
3	Springfield Boiler Co.	40,000	1955	coal
4	E. Keeler Co.	40,000	1960	coal
5	Zurn Ind.	65,000	1980	coal

Boilers 3 and 4 are spreader-stoker fired units with each having forced-draft and induced-draft fans and mechanical fly-ash collection systems. The purpose of the forced-draft fan is to supply air for combustion and that of the induced-draft fan is to maintain a negative draft condition in the furnace part of the boiler for combustion and removal of gases and to provide a positive static pressure at flue gas exhaust discharge points. The ash system pneumatically removes ash from bottom-ash hoppers, sifting hoppers and mechanical collector hoppers. Both units are fitted with a steam-operated soot blower to remove fly-ash and soot from heat exchanger tubing.

Air pollution control consists of individual cyclonic dust collectors on each boiler and a wet scrubber common to the three coal-fired boilers. The multiclone dust collector, Model 9VM-10, is manufactured by Western Precipitation Division - Joy Manufacturing Co. Each collector consists of 36 nine-inch diameter cyclonic collectors operating in parallel. The units are located in the boiler exhaust duct upstream of the induced-draft fan. Ash collected by the multiclones is carried by gravity to a hopper.

The exhaust effluent from each boiler is ducted to a common breeching and can be routed to the wet-scrubber or to a bypass stack. The scrubber is a double-alkali flue-gas desulfurization system using soda ash(sodium carbonate) in the scrubbing fluid and lime (calcium hydroxide) slurry for regeneration of the scrubbing liquid. The primary purpose of the unit is to remove sulfur from the flue gases; a secondary purpose is to remove particulates from the flue gases. The system has two identical scrubber units each designed to handle 50% of the flue gases from the three coal-fired boilers. Each unit has a 5 ft diameter stack and terminates about 70 feet above the ground. There is no requirement at this time to use the scrubber system because of the low-sulfur coal being used by the plant. The bypass stack has a 5.5 ft diameter and terminates approximately 70 ft above ground level. The scrubber stacks and the bypass stack can be seen in Figures 1, 2 and 3. A flue gas flow diagram is shown in Figure 4.

C. Applicable Standards

The monitoring requirements, opacity regulations and particulate regulations are defined under 325 IAC 3, 5 and 6 respectively. Article 5 states that visible emissions shall not exceed an average of 40% opacity in 24 consecutive readings or 60% opacity for more than a cumulative total of 15 minutes (60 readings) in a 6-hour period.

Under 325 IAC 6, the maximum allowable particulate emission rate from the combustion of fuel for indirect heating is determined by the following equation:

$$Pt = \frac{C \times a \times h}{76.5 \times Q^{0.75} \times N^{0.25}}$$

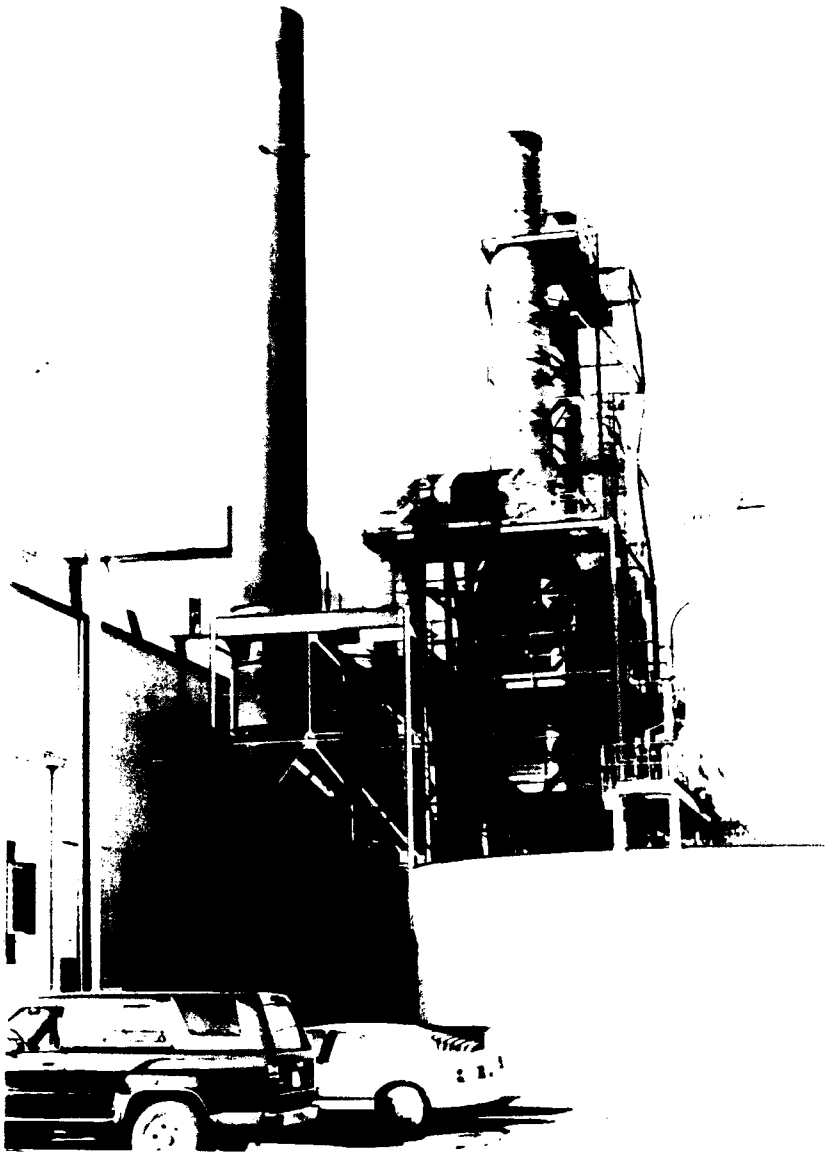

Figure 1. View of Bypass and Scrubber Stacks

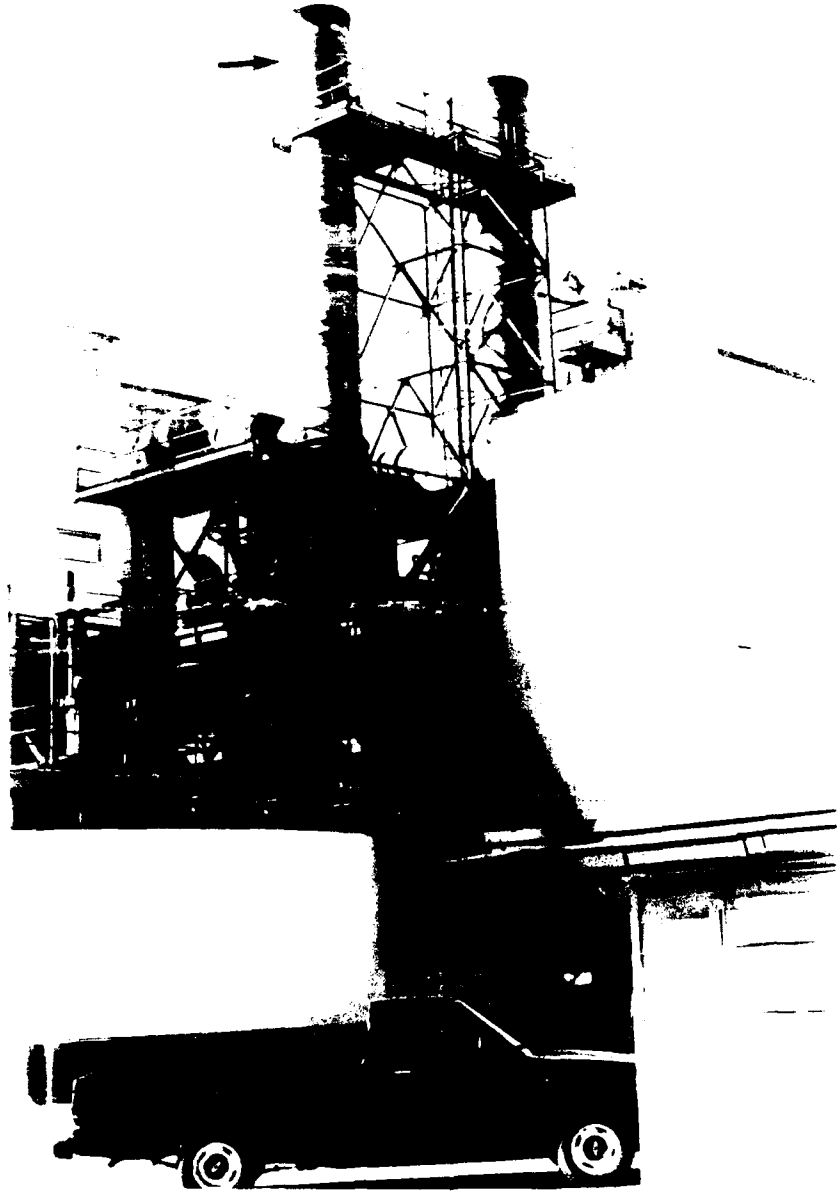

Figure 2. Scrubber Stacks (Scrubber B noted by arrow)

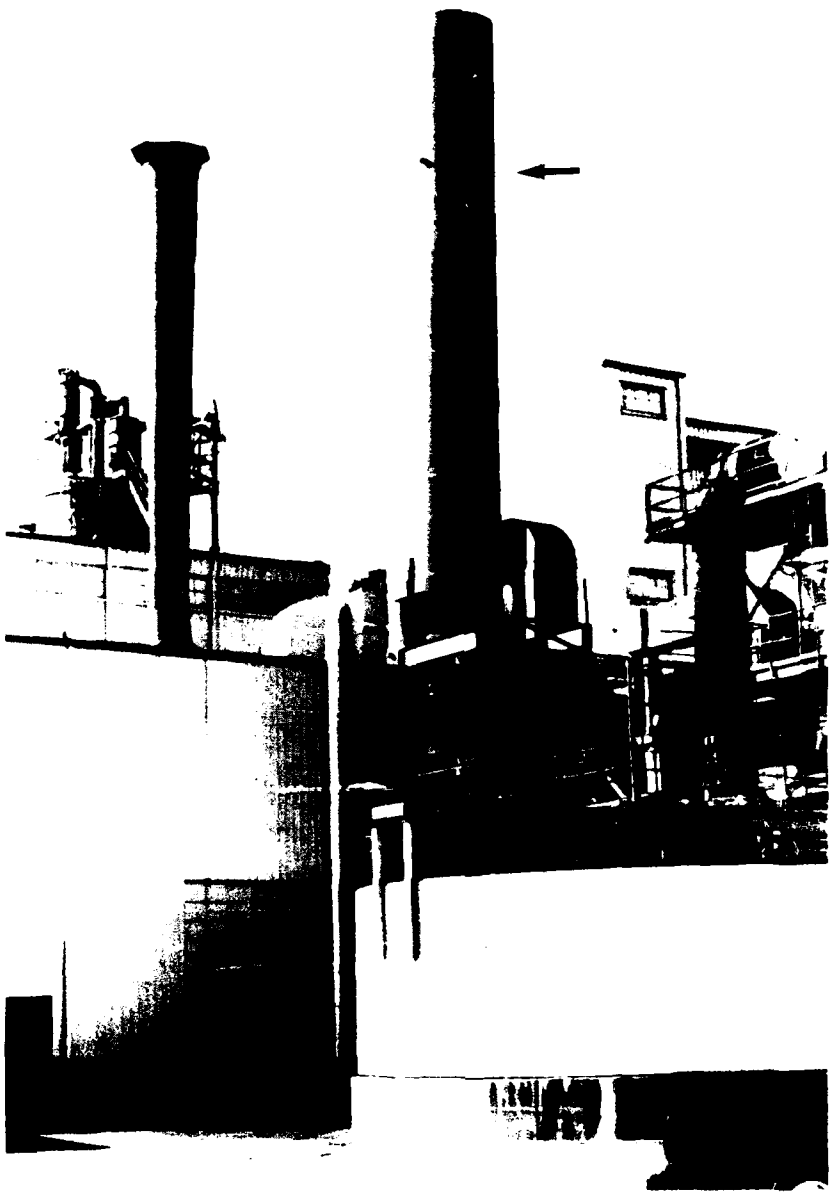

Figure 3. Bypass Stack (Noted by arrow)

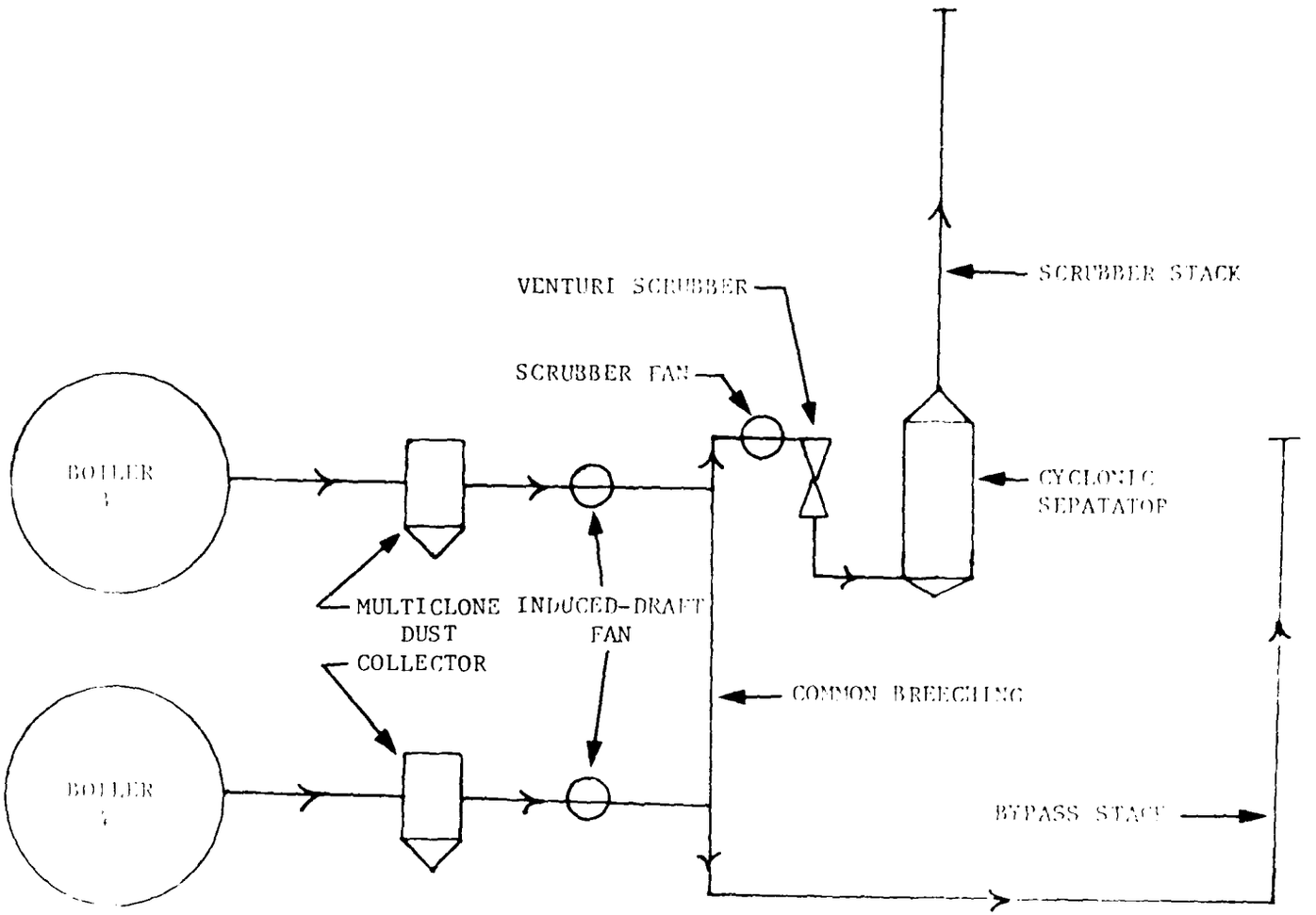

Figure 4. Flue Gas Flow Diagram

Where:

Pt = Pounds of particulate matter emitted per million Btu heat input (lb/mmBtu).

C = Maximum ground level concentration with respect to distance from the point source at the "critical" wind speed for level terrain (50 micrograms per cubic meter-provided in standard).

Q = Total source maximum operating capacity rating in million Btu per hour(mmBtu/hr) heat input (50.8 mmBtu/hr determined from plant operation).

N = Number of stacks in fuel burning operation (1).

a = Plume rise factor (0.67 used for Q less than or equal to 1,000 mmBtu/hr) heat input.

h = Stack height in feet (70 ft).

The limit on particulate emissions determined by the above equation and values of the variables applicable to this facility is 1.6 lb/mmBtu. However, particulate emissions from facilities used for indirect heating purposes which were existing and in operation on or before June 8,1972, shall in no case exceed 0.8 lb/mmBtu heat input. State regulations are presented in Appendix B.

D. Sampling Methods and Procedures

Boilers 3 and 4 were tested through both the scrubber and bypass stacks. Only scrubber B was tested since we assumed that it mimicked the operation of scrubber A. Coordination was made with plant personnel to operate each boiler at 95% capacity or greater during testing. One of the three runs which comprised a complete test included a soot blow; this is indicated on the field data sheets. Boiler operating logs for the test periods are provided in Appendix C. These logs indicate hourly steam output and coal usage. Laboratory results for the coal analysis are provided in Appendix D. Each coal sample represents an integrated sample collected over a particular one hour test run as noted on the analysis sheet.

325 IAC 3 requires that all emissions tests be conducted in accordance with the procedures and analysis methods specified in 40 CFR 60, Appendix A, Methods 1-5. Therefore, test methods, equipment, sample train preparations, sampling and recovery, calibration requirements and quality assurance were done in accordance with the methods and procedures outlined in 40 CFR 60, Appendix A.

Inspection of the stacks indicated that sampling ports had already been installed on the scrubber stack and were located 1.4 stack diameters upstream from the stack exit and 5.6 stack diameters downstream from any disturbance (cyclonic separator). Based on a 5 ft inside stack diameter, port location and type of sample (particulate), a total of twenty traverse points were determined for emission evaluation. Sampling ports had to be installed on the bypass stack and were located 2 stack diameters upstream from the stack exit and 7 stack diameters downstream from the nearest disturbance (common breeching inlet). Based on a 5.5 ft inside stack diameter, port location and type of sample (particulate), a total of twelve traverse points were determined for emission evaluation. The sampling time for each sampling run was 60 minutes; therefore, the sampling time for each point in the scrubber stack was 3 minutes and the time for each point in the bypass stack was 5 minutes. Illustrations showing port locations and sampling points are provided in Appendixes E - H.

Prior to every sample run on each stack, a preliminary velocity pressure traverse was accomplished and cyclonic flow was determined. For acceptable flow conditions to exist in a stack, the average of the absolute value of the flow angle taken at each traverse point must be less than or equal to 20 degrees. The flow angle in the bypass stack averaged 15-17 degrees which indicated an acceptable flow condition. Initially, the flow angle in the scrubber stack averaged 24 degrees. This was caused by the tangential entry of the flue gas into the cyclonic separator. Straightening vanes were installed directly above the cyclonic separator which brought the average flow angle to 9 degrees.

During each sample run, a flue gas sample for orsat analysis (measures oxygen, and carbon dioxide for stack gas molecular weight determination) was taken. Orsat sampling and analysis equipment are shown in Figures 5 and 6. Flue gas moisture content, also needed for determination of gas molecular weight, was obtained during particulate sampling.

Particulate samples were collected using the sampling train shown in Figure 7. The train consisted of a button-hook probe nozzle, heated inconel probe, heated glass filter, impingers and pumping and metering device. The nozzle was sized prior to each sample run so that the gas stream could be sampled isokinetically; in other words, the velocity at the nozzle tip was the same as the stack gas velocity at each point sampled. Flue gas velocity pressure was measured at the nozzle tip using a Type-S pitot tube connected to a ten inch inclined-verticle manometer. Type K thermocouples were used to measure flue gas as well as sampling train temperatures. The probe was heated to minimize moisture condensation. The heated filter was used to collect particulate materials. The impinger train(first, third and fourth impingers: modified Greenburg-Smith type, second impinger: standard Greenburg-Smith design) was used as a condenser to collect stack gas moisture. The pumping and metering system was used to control and monitor the sample gas flow rate.

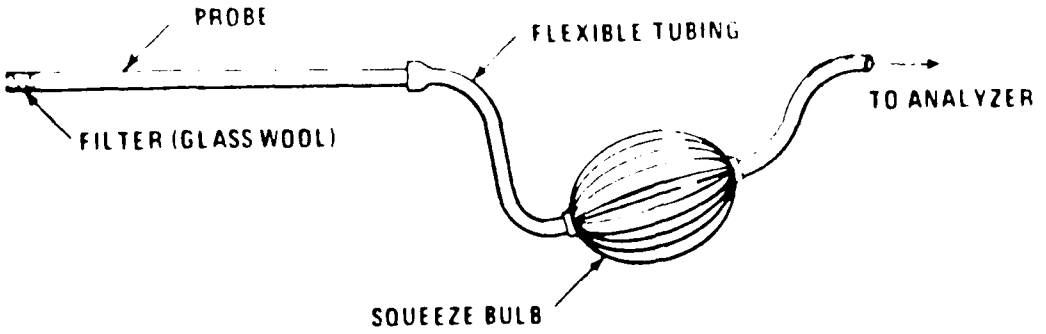

Figure 5. ORSAT Sampling Train

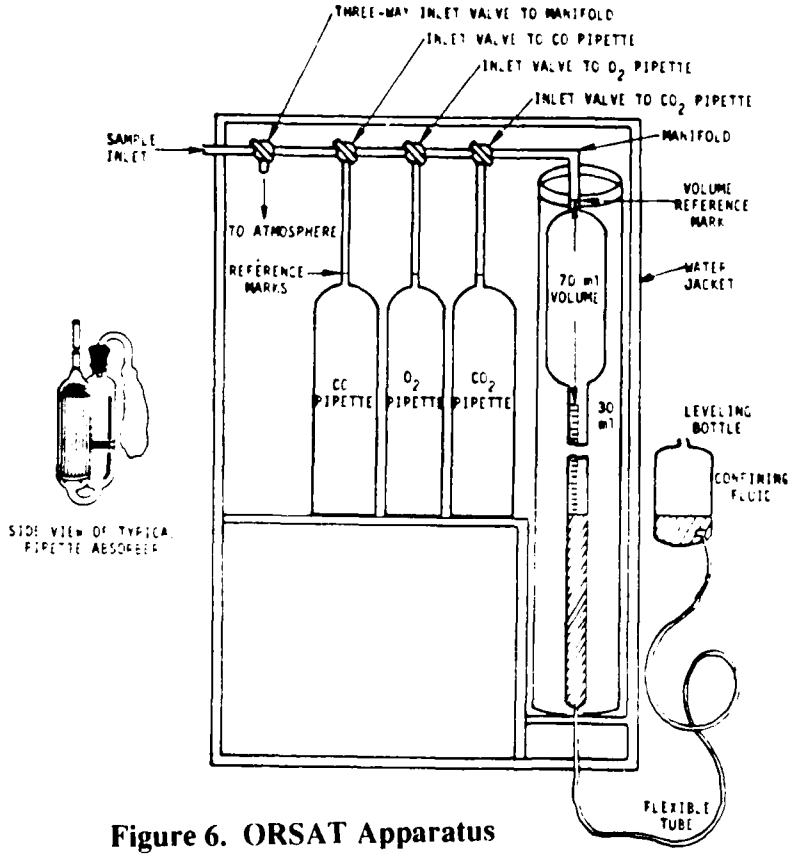

Figure 6. ORSAT Apparatus

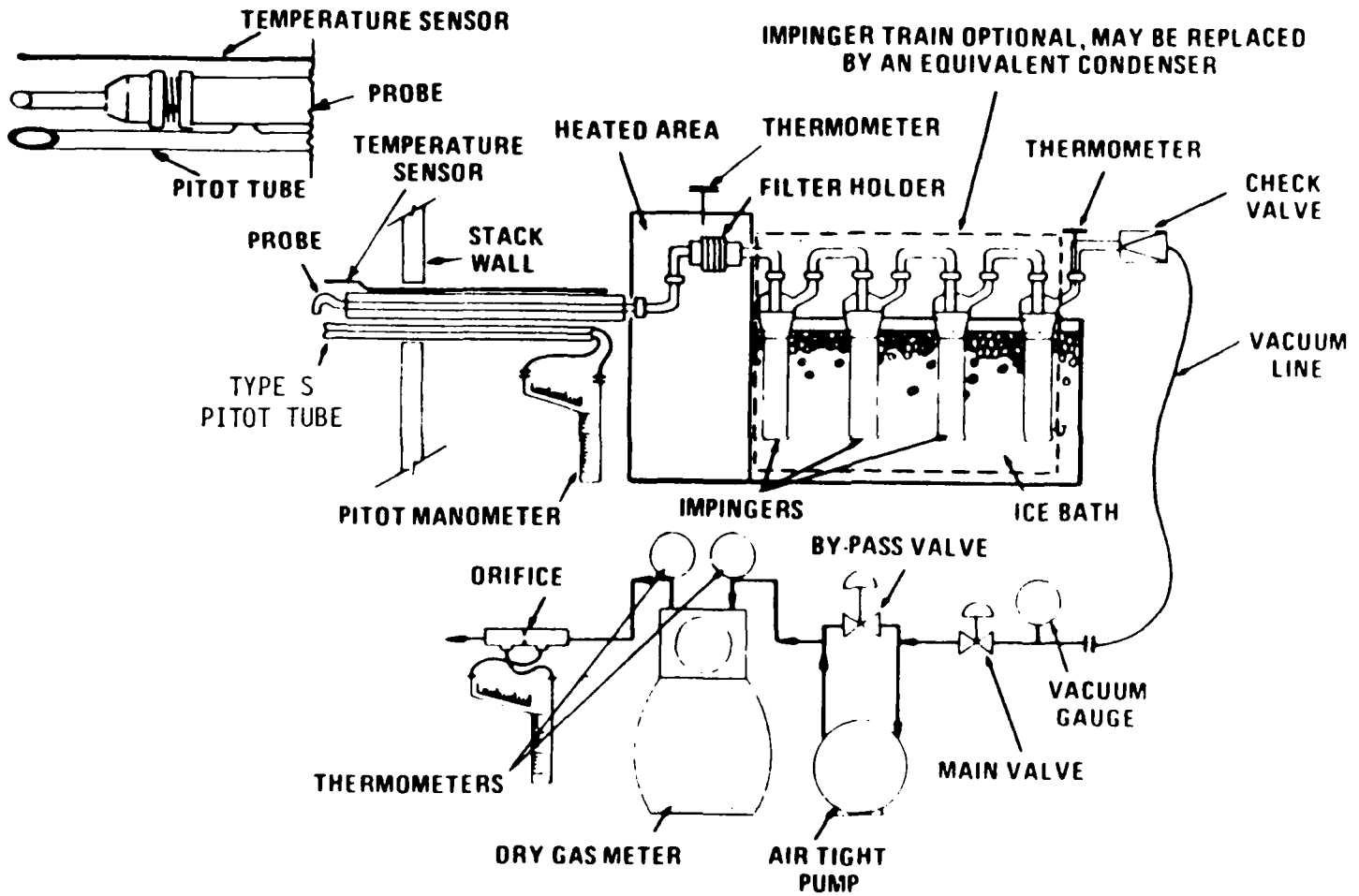

Figure 7. Particulate Sampling Train

Emission calculations were done using two different computer packages. The first of these is entitled "Source Test Calculation and Check Programs for Hewlett-Packard 41 Calculators" (EPA-340/1-85-018) developed by the EPA's Office of Air Quality Planning and Standards, Research Triangle Park NC. This has been our standard method for calculating emission data. The second package is entitled "Stack-Pack" and was developed by Mr B.B. Booth, Shasta County Air Quality Management District, Redding CA. Stack-Pack is made for the minicomputer. Since Stack-Pack runs on the minicomputer and provides resultant calculations in a simple report format, we decided to use it for this project. First, however, it was compared to the EPA program for accuracy. We found it compared very favorably and was even slightly more conservative than the EPA programs. Therefore, calculations for this project were made with Stack-Pack. All sampling data and resulting calculations from the Stack-Pack program are presented in Appendixes E-H; calculations from the EPA programs are found in Appendix I. Calibration data is presented in Appendix J.

III. CONCLUSIONS

The following table provides operating parameters for boilers 3 and 4 during testing and the resultant particulate emission rates determined from these tests. Results indicate that boiler 3 and 4 emissions through the bypass stack were well below the emission standard of 0.80 lb/mmBtu with particulate emission rates of 0.32 lb/mmBtu and 0.48 lb/mmBtu respectively. Boiler 3 emissions through the scrubber were above the standard with an emission rate of 4.18 lb/mmBtu. Boiler 4 emissions through the scrubber were below the standard with an emission rate of 0.69 lb/mmBtu.

We believe a number of factors contributed to the high particulate loading experienced with boiler 3 scrubber emissions: (1) the low percentage of carbon dioxide(CO_2) in the effluent and (2) the fact that material collected on the filter probably contained soda ash residue from the scrubber. The low percentage of CO_2 found in the flue gas contributed to the high emission rate since this rate is corrected to 12% CO_2. Probable cause of the low CO_2 value was: (1) scrubber liquid absorbing CO_2 from the flue gas and (2) outside air being drawn into the scrubber through the bypass stack. However, low CO_2 was not the primary factor since boiler 4 emissions through the scrubber were below the standard with essentially the same low percentage of CO_2 in the gas stream. Also, boilers 3 and 4 performed essentially the same through the bypass stack.

It appears that the primary cause for the high emission rate was an upset in the operation of the scrubber such as too high a concentration of soda ash in the scrubbing liquid, thereby causing a carry-over of lime out of the stack.

STACK EMISSION TESTING RESULTS

DATE	TIME (MILITARY)	BOILER NO.	STACK NO.	RUN NO.	BOILER OPERATING CAPACITY (%)	SOOT BLOW	COAL HEAT VALUE (Btu/lb)	COAL USE (lb/hr)	HEAT INPUT (mmBtu/hr)	*PM EMISSIONS (lb/hr)	PM EMISSIONS (lb/mmBtu)
18 NOV 87	1430	3	**BP	1	100.0		11,066	4,444	49.2	14.27	0.29
19 NOV 87	1002	3	BP	2	100.0		11,162	4,427	49.4	14.56	0.29
20 NOV 87	0855	3	BP	3	99.0	X	11,571	4,389	50.8	19.41	0.38
					AVG = 100.0					AVG = 16.07	AVG = 0.32
23 NOV 87	0830	3	***SC	1	98.0	X	11,439	4,333	49.6	359.87	7.26
23 NOV 87	1000	3	SC	2	90.0		11,409	4,000	45.6	140.16	3.07
23 NOV 87	1136	3	SC	3	93.0		11,474	4,111	47.2	103.80	2.20
					AVG = 94.0					AVG = 201.23	AVG = 4.18
21 NOV 87	0924	4	BP	1	98.0		10,834	4,363	47.3	23.02	0.49
21 NOV 87	1201	4	BP	2	98.0	X	11,302	4,375	49.4	29.85	0.60
21 NOV 87	1415	4	BP	3	97.0		11,464	4,305	49.4	17.57	0.36
					AVG = 98.0					AVG = 23.48	AVG = 0.48
22 NOV 87	1115	4	SC	1	96.0		11,334	4,278	48.5	41.65	0.86
22 NOV 87	1313	4	SC	2	98.0	X	11,356	4,333	49.2	49.57	1.01
22 NOV 87	1500	4	SC	3	94.0		11,495	4,183	48.1	9.48	0.20
					AVG = 96.0					AVG = 33.57	AVG = 0.69

* PARTICULATE EMISSIONS
** BYPASS STACK
*** SCRUBBER STACK

IV. RECOMMENDATIONS

It is our recommendation that flue gas from the coal-fired boilers continue to be routed through the bypass stack and that the scrubber not be used until retesting conducted to determine the high stack emissions. The scrubber system will be evaluated when we conduct stack emission testing on boiler 5 during March 1988. At this time we will evaluate inlet/outlet flue gas composition to scrubber B(the one tested) and A, as well as evaluating boiler emissions through both scrubber systems(this includes a retest of boiler 3 through the scrubber).

REFERENCES

1. "Standards of Performance for New Stationary Sources," Title 40, Part 60, Code of Federal Regulations, July 1, 1986.

2. Quality Assurance Handbook for Air Pollution Measurement Systems - Volume III, Stationary Source Specific Methods, U.S. Environmental Protection Agency, EPA-600/4-77-027-b, Research Triangle Park, North Carolina, December 1984.

3. Source Test Calculation and Check Programs for Hewlett-Packard 41 Calculators. U.S. Environmental Protection Agency, EPA-340/1-85-018, Research Triangle Park, North Carolina, May 1987.

4. Booth, B.B. "Stack-Pack." Shasta County Air Quality Management District, Redding CA

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APPENDIX A

Personnel Information

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1. USAFOEHL Test Team

Maj James Garrison, Chief, Air Quality Function

Capt Tim Fagin, Consultant, Air Quality Engineer

Capt Mary Daly, Consultant, Air Quality Engineer

2Lt Robert Tetla, Consultant, Hazardous Waste Engineer

Sgt Robert Davis, Environmental Engineering Technician

USAFOEHL/ECQ
Brooks AFB TX 78235-5501

Phone: AUTOVON 240-2891
Commercial (512) 536-2891

2. Grissom AFB On-site Representatives

1Lt Anthony Spriggs	USAF Clinic Grissom/SGPB AUTOVON 928-3017 Commercial (317) 689-3017
Howard Holdsclaw Ruel Burns	305 CSG/DEEV AUTOVON 928-2225 Commercial (317) 689-2225
Smedley Graham	305 CES/DEMMHZ AUTOVON 928-3253 Commercial (317) 689-3253

3. Environmental Protection Agency, Region V on-site representative

Gerald R. Golubske
Phone: (312) 886-1968

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APPENDIX B

State Regulations

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(B) When the owner or operator elects under Section 8(a) *[325 IAC 3-2-8(1)]* of this Rule to measure carbon dioxide in the flue gases, the measurement of the pollutant concentration and the carbon dioxide concentration shall each be on a consistent basis (wet or dry) and the following conversion procedure used;

$$E = CF_c \quad \frac{(100)}{(\%\ CO_2)}$$

(C) When the owner or operator elects under Section 8(a) *[325 IAC 3-1-8(1)]* of this Rule to measure sulfur dioxide or nitrogen oxides in the flue gases, the measurement of the pollutant concentration and the sulfur dioxide and/or the nitrogen oxides concentration(s) shall each be on a wet basis and the following conversion procedure used except where wet scrubbers are employed or where moisture is otherwise added to the stack gases;

$$E = C_{ws}F_w \quad \frac{(20.9)}{(20.9\ (1\text{-}B_{wa})\text{-}\%0_{2ws})}$$

(D) When the owner or operator elects under Section 8(a) *[325 IAC 3-1-8(1)]* of this Rule to measure sulfur dioxide or nitrogen oxides in the flue gases, the measurement of the pollutant concentration and the sulfur dioxide and/or the nitrogen oxides concentrations(s) shall each be on a wet basis and the following conversion procedure used where wet scrubbers or moisture is otherwise present in the stack gases provided water vapor content of the stack gas is measured at least once every fifteen minutes at the same point as the pollutant and oxygen measurements are made;

$$E = C_{ws}F \quad \frac{(20.9)}{(20.9\ (1\text{-}B_{ws}) - \%0_{2ws})}$$

(E) The values used in the equations under this Section are derived as follows:

C_{ws} = pollutant concentration at stack conditions, g/wscm (grams/wet standard cubic meter), lb/wscm (pounds/wet standard cubic meter), determined by multiplying the average concentration (ppm) for each one hour period by 4.15 X 10^{-5} Mg/wscm per ppm (2.59 X 10^{-8} M lb/wscm per ppm) where M is pollutant molecular weight, g/g-mole (lb/lb-mole). M = 64.07 for sulfur dioxide and 46.01 for nitrogen oxides.

C = as above but measured in terms of pounds/dry standard cubic meter (lb/dscm) or grams/dry standard cubic meter (g/dscm).

F, F_c = a factor representing a ratio of the volume of dry flue gases generated to the calorific value of the fuel combusted (F), and a factor representing a ratio of the volume of carbon dioxide generated to the calorific value of the fuel combusted (F_c), respectively. Values of F and F_c are given in Section 60.45(f) of 40 CFR Part 60, as applicable.

F_w = a factor representing a ratio of the volume of wet flue gases generated to the calorific value of the fuel combusted. Values of F_w are:

(i) For anthracite coal as classified according to A.S.T.M. D388-66, F_w = 1.188 wscm/million calories (10580) wscf/million BTU).

(ii) For sub-bituminous and bituminous coal as classified according to A.S.T.M. D388-66, F_w = 1.200 wscm/million calories (10680 wscf BTU).

(iii) For liquid fossil fuels including crude, residual, and distillate oils, F_w = 1.164 wscm/million calories (10360 wscf/million BTU).

(iv) For gaseous fossil fuels: for natural gas, F_w = *1.196 wscm/million calories* (10650 wscf/milion BTU; for propane, F_w = 1.150 wscm/million calories (10240 wscf/million Btu); for butane F_w = 1.172 wscm/million calories (10430 wscf/million BTU).

B_{wa} = proportion by volume of water vapor in the ambient air.

B_{ws} = proportion by volume of water vapor in the stack gas.

$\%0_2$, $\%CO_2$ = Oxygen or carbon dioxide volume (expressed as percent) determined with equipment specified under Section 8 *[325 IAC 3-1-8]* of this Rule.

E = pollutant emission, lb/million BTU.

(2) For sulfuric acid plants the owner or operator shall:

(A) Establish a conversion factor three times daily according to the procedures of Section 60.84(b) of 40 CFR Part 60;

(B) Multiply the conversion factor by the average sulfur dioxide concentration in the flue gases to obtain average sulfur dioxide emissions in lb/ton; and

(C) Report the average sulfur dioxide emission for each 3-hour period in excess of the emission standard set forth in 325 IAC 7-1 (formerly known as APC-13), in the quarterly summary.

(3) For nitric acid plants the owner or operator shall:

(A) Establish a conversion factor according to the procedurders of Section 60.73(b) of 40 CFR Part 60;

(B) Multiply the conversion factor by the average nitrogen oxides concentration in the flue gases to obtain nitrogen oxides emissions in lb/ton;

(C) Report the average nitrogen oxides for each averaging period in excess of the emission standard set forth in 325 IAC 10-1 (formerly known as APC-17), in the quarterly summary.

(4) Alternate Data Reporting and Reduction Procedures.

(A) Alternate procedures for computing emission averages that do not require integration of data may be approved by the APCB if the owner or operator shows that his procedures are at least as accurate as those in this Rule *[325 IAC 3-1]*.

(B) Alternative methods of converting pollutant concentration measurements to units of the emission standard may be approved by the APCB if the owner or operator shows that his procedures are at least as accurate as those in this Rule *[325 IAC 3-1]*.

Rule 2. Source Sampling Procedures

Sec. 1. Applicability. this rule applies to any emissions testing performed in the State to determine compliance with applicable emission limits contained in this Title (Air Pollution Control Board Rules), or for any other purpose requiring review and approval by the APCB.

Sec. 2. Adoption of Federal Test Procedures. Emissions tests subject to this Rule shall be conducted in accordance with the procedures and analysis methods specified in Title 40, Code of Federal Regulations Part 60, Appendix A and Part 61 Appendix B, as in effect on December 2, 1981. Such test methods, equipment, calibration requirements, and analysis must be strictly followed unless otherwise approved by the Board or the Technical Secretary. If any test method is

revised as contained in the Code of Federal Regulations, this Rule is subject to change pursuant to IC 4-22-2.

Sec. 3. Requirements Prior to Conducting Tests. (a) When a test is to be performed by any person other than staff, a test protocol form shall be completed and received by the Board no later than 35 days prior to the intended test date. Such test protocol shall be on a form approved by the Board. Any special or unique information relative to the scheduled test shall be included with the form.

(b) After evaluating the completed test protocol form, the Board or the Technical Secretary.

(1) Inspect the test site.

(2) Require additional conditions, including, but not limited to the following:

(A) Reasonable modifications to the stack or duct to obtain acceptable test conditions.

(B) A pretest meeting to resolve an acceptable test protocol,

(C) Additional tests to allow for adverse conditions such as interferences, nonsteady or cyclic processes.

(D) The keeping of process operating parameter records, operating logs or charts during the test,

(E) Conditions on control equipment operation to make it representative of future normal operation, or

(F) The recording of specified control equipment operating parameters during the test.

(c) If the Board or the Technical Secretary requires modifications to the test methods, analytical methods, operational parameters or other matters included in the test protocol, or if a pretest meeting is required, the source operator and the testing firm shall be notified by letter or telephone at least 25 days prior to the proposed test date. The source operator will receive notice of the acceptability of the test protocol from the Board or the Technical Secretary within 10 days of its receipt. If the source operator or test firm desires to change any previously submitted procedures or conditions, the Board must be notified of such change at least 25 days prior tot he intended test date, and such changes cannot be made unless approved by the Board or the Technical Secretary prior to the test. Changes in the test protocol that result from emergency conditions must be approved by an authorized on-site staff member.

(d) The Board or the Technical Secretary reserves the right to conduct any portion of the reference method tests. In such case, a 25-day notice of proper test procedures will be given to the company and their testing representative.

(e) The source operator must notify the Board of the actual test date at least two weeks prior to the date.

Sec. 4. Performance of Test. (a) Staff may observe the field test procedures and plant operation during the test.

(b) All tests shall be conducted while the source is operating at between 95% to 100% of its maximum operating capacity, or under other capacities or conditions specified and approved by the Board or the Technical Secretary. For the purpose of this rule, maximum operating capacity means the maximum design capacity of the source or other maximum operating capacities agreed to by the source and the Board or the Technical Secretary.

(c) Sources subject to Article 12 of this Title (New Source Performance Standards) shall be tested under conditions as specified in the applicable Rule.

(d) Calibration results of the various sampling components must be available for examination at the test site. The information must include dates, methods used, data and results. All components requiring calibration must be calibrated within 60 days prior to the actual test date. Post test calibrations must be performed on the components within 45 days after the actual test date or before the equipments' next field use whichever comes first. Components requiring calibration are listed in the Federal test methods specified in Section 2 above. Calibration need not be done between tests when several facilities at one location are tested in series, as long as the units are calibrated prior to the first test and after the last test in the series which is conducted at that site.

Sec. 5. Test Results and Reports. (a) All tests shall be reported to the Board or the Technical Secretary in the form of a test report containing the following information (which can be kept confidential upon request):

(1) Certification by team leader and reviewer.

(2) Introduction, containing:

(A) Date and type of tests,

(B) Type of process and control equipment,

(C) Plant name and location,

(D) Purpose of test, and

(E) Test participants and titles.

(3) Results summary, containing:

(A) Tabulated data and results of each test run, process weight rate or heat input rate, the stack gas flow rate, the measured emissions given in units consistent with the applicable emission limits, and the visible emissions or average opacity readings, and

(B) Allowable emission rate.

(4) Process information, including:

(A) Description of process and control device,

(B) Process flow diagram,

(C) Maximum design capacities,

(D) Fuel analysis and heat value for heat input rate determination,

(E) Process and control equipment operating conditions during tests,

(F) Discussion of variations from normal plant operations, and

(G) Stack height, exit diameter, volumetric flow rate (acfm), exit temperature, and exit velocity.

(5) Sampling information, including:

(A) Description of sampling methods used,

(B) Brief discussion of the analytical procedures with justification for any variance from standard procedures,

(C) Specification of the number of sampling points, time per point, and total sampling time per run,

(D) Cross sectional diagram showing sampling points, diagram showing stack dimensions, sampling location and distance from the nearest flow disturbance upstream and downstream of the sampling points, and

(E) Sampling train diagram.

(6) Appendix, containing:

(A) Sampling and analytical procedures

(B) Results and calculations — One complete calculation using actual data for each type of test performed must be shown. Results must be stated to units consistent with the applicable emission limitation.

(C) Raw production data signed by plant official.

(D) Photocopies of all actual field data or original raw field data.

(E) Laboratory report with chain of custody shown.

(F) Copies of all calibration data,

(G) Applicable regulations showing emission limitation, and

(H) Copies of visible emissions observations or opacity monitor readings (for TSP tests).

(b) Unless previously agreed to in writing by the Board or the Technical Secretary, all test reports must be received by the Board within forty-five (45) days of the completion of the testing.

Sec. 6. Special Requirements for Testing Certain Pollutants. (a) Particulate matter tests shall be conducted in accordance with the following procedures:

(1) Method 5, Title 40 Code of Federal Regulations, Part 60, Appendix A, as in effect on December 2, 1981, or other procedures approved by the Board or the Technical Secretary shall be used.

(2) Visible emissions (VE) evaluation shall be performed in conjunction with a particulate emissions test by a qualified observer in accordance with the procedures contained in 325 IAC 5-1-4. VE readings shall be continuously recorded for at least 30 minutes per hour of sampling time for each sampling repetition. A variance from this requirement may be granted by the on-site staff person for one repetition only and provided that adverse conditions exist which would invalidate the VE readings. Sources equipped with continuous opacity monitors may submit the monitor's instantaneous or six-minute integrated readings during the sampling period, in lieu of performing VE observations; provided,

(A) The monitoring system meets the Performance Specifications Tests I as specified in 40 CFR 60, Appendix B as in effect on December 2, 1981, and

(B) The monitor readings submitted with the test include a zero and span calibration check at the start and end of each test.

(3) At least three (3) repetitions of the test must be performed under identical source operating conditions unless otherwise allowed by the Board or the Technical Secretary,

(4) During each of the repetitions, each sampling point shall be sampled for a minimum of two (2) minutes.

(5) The total test time per repetition shall be no less than sixty (60) minutes.

(6) The total sample volume per repetition shall be no less than thirty (30) dry standard cubic feet (dscf).

(7) The total particulate weight collected from the sampling nozzle, probe, cyclone (if used), filter holder (front half), filter and connecting glassware shall be reported. Particulate analysis of the impinger catch is not required unless specified by staff.

(b) Sulfur dioxide (SO_2) tests shall be conducted in accordance with the following procedures:

(1) Method 6 or Method 8, Title 40 Code of Federal Regulations, Part 60, Appendix A, as in effect on December 2, 1981, or other procedures approved by the Board or the Technical Secretary shall be used.

(2) At least three (3) repetitions of two (2) samples, each of Method 6 or three (3) repretitions of Method 8 performed under identical source operting conditions, shall constitute a test.

(3) During each of the repetitions for Method 8, each sampling point shall be sampled for a minimum of two (2) minutes.

(4) The total test time per repetition shall be as follows:

(A) Method 6 — a minimum of 20 minutes per run with a 30 minute interval between each run, or

(B) Method 8 — a minimum of 60 minutes per run.

(5) The total sample volume per repetition under Method 8 shall be no less than 40 dry standard cubic feet (dscf).

(c) Nitrogen oxide tests shall be conducted in accordance with the following procedures:

(1) Method 7, Title 40, Code of Federal Regulations, Part 60, Appendix A as in effect on December 2, 1981, or other procedures approved by the Board or the Technical Secretary shall be used.

(2) At least three (3) repetitions of four (4) samples each shall constitute a test.

(d) Volatile Organic Compounds (VOC) emissions tests shall be conducted in accordance with the following procedures:

(1) Method 25, Title 40 Code of the Federal Regulations, Part 60, Appendix A as in effect on December 2, 1981, or other procedures approved by the Board or duly authorized staff member shall be used for the total non-methane organic (TNMO) emissions.

(2) At least three (3) duplicate samples must be collected and analyzed.

(3) The total test time per repetition shall be a minimum of sixty (60) minutes.

Sec. 7. Invalid Tests. Any tests not meeting the requirements of this Rule may be treated by staff and the Board as invalid for any and all purposes.

Sec. 8. Board Resolves Disputes. A source operator or testing firm may appeal to the Board any decision made by staff under the discretionary terms of this Rule. Any person desiring to make such an appeal shall notify staff of the matters to be appealed, and, if agreement cannot be reached, the matter shall be presented to the Board for a final determination. The Board may appoint one of its members to hear the matter and make recommendations for a final decision by the full Board.

ARTICLE 4. BURNING REGULATIONS

Rule 1. Open Burning

Sec. 1. Applicability—This Rule *[325 IAC 41-]* establishes standards for the open burining of material which would result in emissions of regulated pollutants and applies everywhere in the State. However, this Rule *[325 IAC 4-1]* shall not apply in areas where acts permitted by Section 3 *[325 IAC 4-1-3]* or authorized by variance pursuant to Section 4 *[325 IAC 4-1-4]* are prohibited by other State and/or local laws, regulations, or ordinances such as IC 13-7-4-1(g).

Sec. 2. Prohibition—No persons shall open burn any material except as provided in Section 3 *[325 IAC 4-1-3]* or Section 4 *[325 IAC 4-1-4]*.

Sec. 3. Exemptions. (a) The following types of fires are permitted:

(1) Fires celebrating Twelfth Night Ceremonies.

(2) Fires celebrating school pep rallies.

(3) Fires celebrating scouting activities.

(4) Camp fires.

(5) Residential burning—where residence contains four or fewer units. Burning shall be in a noncombustible container with enclosed sides a bottom, and a mesh covering with openings no larger than 1/4" square. Burning is prohibited in apartment complexes and mobile home parks.

(6) Farm burning—wood products derived from farming operations. Clearing operations (Section 4(a)(4) *[325 IAC 4-1-4(a)(4)]* are not considered farm burning.

(7) Waste oil burning—where the waste oil has been collected in a properly constructed and located pit as prescribed in 310 IAC 7-1-37(A) (Rule 37A of the Division of Oil and Gas, Department of Natural Rersouces) at an oil well. Each oil pit may be burned once every two (2) months and all the oil must be completely burned within thirty (30) minutes after ignition.

(b) All exemptions shall be subject to the following:

(1) Only wood products shall be burned unless otherwise stated above.

(2) Fires shall be attended at all times until completely extinguished.

(3) If fires create an air pollution problem, a nuisance, or a fire hazard, they shall be extinguished.

(4) All residential, farm operation, and waste oil burning shall occur during daylight hours during which the fires may be replenished, but only in such a manner that nearly all of the burning material is consumed by sunset.

(5) No burning shall be conducted during unfavorable meteorological conditions such as temperature inversions, high winds, air stagnation, etc.

Sec. 4. Variances. (a) Burning with prior approval of the board or its designated agent may be authorized for the following:

(1) Emergency burning of petroleum products.

(2) Burning of refuse consisting of material resulting from a natural disaster.

(3) Burning for the purpose of fire training.

(4) Burning of natural growth derived from a clearing operation, i.e., removal of natural growth for change in use of the land.

(5) Burning of highly explosive or other dangerous materials.

(b) Burning not exempted by Section 3 *[325 IAC 4-1-3]* may be permitted with prior receipt of a variance application and approval of the Board. *(Air Pollution Control Board)*

Sec. 5. Liability—Any person who allows the accumulation or existence of combustible material which constitutes or contributes to a fire causing air pollution shall not be excused from responsibility therefore on the basis that said fire was accidental or an act of God.

Rule 2. Incinerator

Sec. 1. Applicability—This Rule *[325 IAC 4-2]* establishes standards for the use of incinerators which emit regulated pollutants. This rule *[325 IAC 4-2]* does not apply to incinerators in residential units consisting of four or fewer families. All other incinerators are subject to this rule. *[325 IAC 4-2]*.

Sec. 2. Stationary Incinerators—All stationary incinerators shall:

(1) Consist of primary and secondary chambers or the equivalent.

(2) Be equipped with a primary burner unless burning wood products.

(3) Comply with 325 IAC 5-1 (formerly known as APC 3) and 325 IAC Article 2 (formerly known as APC 19).

(4) Be maintained properly as specified by the manufacturer and approved by the Board or its designated agent.

(5) Be operated according to the manufacturer's recommendations and only burn waste approved by the Board or its designated asgent.

(6) Comply with other state and/or local regulations or ordinances regarding installation and operation.

(7) Be operated so emissions of hazardous material including, but not limited to, viable pathogenic bacteria, dangerous chemicals or gases, or noxious odors are prevented

(8) Not emit particulate matter in excess of the following:

(A) Incinerators with a maximum refuse-burning capacity of 200 or more pounds per hour: 0.3 pounds of particulate matter per 1,000 pounds of dry exhaust gas at standard conditions as corrected to 50% excess air.

(B) All other incinerators: 0.5 pounds of particulate matter per 1,000 pounds of dry exhaust gas at standard conditions corrected to 50% excess air.

(9) Not create an air pollution problem, a nuisance or a fire hazard. If any of the above result, the burning shall be terminated immediately

Sec. 3. Portable Incinerators—All portable incinerators shall be subject to the following conditions:

(1) Approval of the Board or its designated agent must be obtained prior to operation at a new project site.

(2) Only wood products shall be burned.

(3) Merchantable material shall be salvaged where practicable.

(4) The local health department shall be notified prior to any burning.

(5) All burning shall be conducted under favorable meteorological conditions.

(6) Burning shall occur during daylight hours and all material shall be consumed by sunset.

(7) If burning creates an air pollution problem, a nuisance or a fire hazard, the burning shall be terminated immediately.

(8) The incinerator shall be maintained and operated according to the manufacturer's recommendations and in a manner approved by the Board or its designated agent.

(9) The installation and operation of such an apparatus shall comply with all other state and/or local regulations or ordinances.

(10) A portable incinerator shall comply with both 325 IAC 5-1 (formerly known as APC 3) and 325 IAC, Article 2 (formerly known as APC 19).

ARTICLE 5. OPACITY REGULATIONS

Rule 1. Opacity Limitations

Sec. 1. Applicability. (a) This rule *[325 IAC 5-1]* shall apply to all visible emissions (not including condensed water vapor) emitted by or from any facility or source except those sources or facilities for which specific visible emission limitations are established by 325 IAC, Article 11, 325 IAC, Article 12, or 325 IAC, Article 6.

(1) The requirements of Section 2(a)(1) *[325 IAC 5-1-2(a)]* shall apply to sources or facilities located in attainment areas for particulate matter, designated in 325 IAC 1.1-3 (formerly known as APC 22).

(2) The requirements of Section 2(a)(2) *[325 IAC 5-1-2(a)(2)]* shall apply to sources or facilities located in nonattainment areas for particulate matter as designated in 325 IAC 1.1-3 (formerly known as APC 22).

(b) Sources or facilities located in areas

designated as unclassifiable or attainment areas in 325 IAC 1.1-3 (formerly Regulation APC 22) which became subject to more stringent limitations as a result of said area being redesignated as a nonattainment area by the Board, shall comply with such limitations as expeditiously as practable, but no later than December 31, 1982. No later than 60 days after the promulgation of the nonattainment designation in 325 IAC 1.1-3, all sources or facilities subjected to more stringent visible emission limitations by their redesignation shall submit to the Board for approval a schedule for attaining compliance with this Rule *[325 IAC 5-1]*.

Sec. 2. Emission Limitations. (a) Visible emissions from any source or facility shall not exceed any of the following limitations. Unless otherwise stated, all visible emissions shall be observed in accordance with the procedures set forth in Section 4 *[325 IAC 5-1-4]* of this rule:

(1) Sources or facilities of visible emissions located in attainment areas for particulate matter shall meet the following limitations:

(A) Visible emissions shall not exceed, an average of 40% opacity in 24 consecutive readings.

(B) Visible emissions shall not exceed 60% opacity for more than a cumulative total of 15 minutes (60 readings) in a 6-hour period.

(2) Sources or facilities of visible emissions located in nonattainment areas shall meet the following limitations:

(A) Visible emissions shall not exceed, an average of 30% opacity in 24 readings.

(B) Visible emisions shall not exceed 60% opacity for more than a cumulatie total of 15 minutes (60 readings) in a 6-hour period.

(3) Sources and facilities of visible emissions located in both attainment or nonattainment areas, for which an alternate visible emission limitation has been established pursuant to Secton 5(b) *[325 IAC 5-1-5(b)]* herein, shall comply with said limitations in lieu of the limitations set forth in subsection 2(a)(1) and 2(a)(2) *[subsections (a)(1) and (a)(2) of this section]* preceding.

Sec. 3. Temporary Exemptions. (a) Boiler Startup and Shutdown—When building a new fire in a boiler, or shutting down a boiler, visible emissions may exceed the applicable opacity limit established in Section 2(a) *[325 IAC 5-1-2(a)]*; however, visible emissions shall not exceed an average of 60% opacity and emissions in excess of the applicable opacity limit shall not continue for more than 10 continuous minutes on one occasion in any 24-hour period.

(b) Cleaning Boilers—When removing ashes from the fuel bed or furnace in a boiler or blowing tubes, visible emissions may exceed the applicable opacity limit established in Section 2(a) *[325 IAC 5-1-2(a)]*; however, visible emissions shall not exceed 60% opacity and visible emissions in excess of the applicable opacity limit shall not continue for more than five continuous minutes on one occasion in any 60-minute period. Such emissions shall not be permitted on more than three occasions in any 12-hour period.

(c) Facilities not temporarily exempted by Subsections (a) and (b) above may be granted special temporary exemptions by the Board of the same duration and type authorized therein provided that the facility proves to the satisfaction of the Board that said exemptions are needed and that during periods of startup and shutdown, owners and operators shall, to the extent practicable, maintain and operate any affected facility including air pollution control equipment in a manner consistent with good air pollution control practice for minimizing emissions. Determination of whether acceptable operating and maintenance procedures are being used will be based on information available to the Board, which may include, but is not limited to, monitoring results, opacity observations, review of operating and maintenance procedures and inspection of the source.

(d) Sources or facilities not exempted through subsections (a), (b), or (c) above may also be granted special exemptions by the Board, provided that the source or facility owner or operator proves to the satisfaction of the Board that said exemption is justifiable. Said exemption(s) may be of longer duration and may apply to other types of facilities not provided for in subsections (a) and (b) above.

Sec. 4. Procedure to Determine Compliance. (a) Determination of visible emissions from sources or facilities to which this Rule *[325 IAC 5-1]* applies may be made in accordance with subsections (1) and (2) below.

(1) Determination of visible emissions by means of a qualified observer shall be made according to the following provisions (A) through (H).

(A) Position—The qualified observer shall stand at a distance sufficient to provide a clear view of the emissions with the sun, if visible, oriented in the 140° sector to his back. Consistent with maintaining the above requirement, the observer shall, as much as possible, make his observations from the position such that his line of vision is approximately perpendicular to the direction of the visible emissions (plume where applicable), and when observing opacity of emissions from rectangular outlets (e.g., monitors open baghouses, noncircular stacks), approximately perpendicular to the longer axis of the outlet. The observer's line of sight should not include more than one plume at a time when multiple stacks are involved, and in any case the observer should make his observations with his line of sight perpendicular to the longer axis of such a set of multiple stacks (e.g., stub stacks on baghouses).

(B) Field Records—The observer shall record the name of the plant, emission location, type of facility, observer's name and affiliation, and the date on a field data sheet. Time, estimated distance to the emission location, approximate wind direction, estimated wind speed, description of the sky conditions (presence and color of clouds), and visible emissions (plume where applicable) background are recorded on a field data sheet at the time opacity readings are initiated and completed.

(C) Observations—Opacity observations shall be made at the point of greatest opacity in that portion of the visible emissions, (plume where applicable) where condensed water vapor is not present. The observer shall not look continuously at the visible emissions, (plume where applicable) but instead shall observe the visible emissions, (plume where applicable) mometarily at 15-second intervals.

(D) Recording Observations—Opacity observations shall be recorded to the nearest 5% at 15-second intervals on an observational record sheet. A minimum of 24 observations shall be recorded. Each

momentary observation shall be deemed to represent the average opacity of emissions for a 15-second period.

(E) Determination of Opacity As An Average of 24 Consecutive Observations—Opacity shall be determined as an average of 24 consecutive observations recorded at 15-second intervals. Divide the observations recorded on the record sheet into sets of 24 consecutive observations. A set is composed of any 24 consecutive observations. Sets need not be consecutive in time and in no case shall two sets overlap. For each set of 24 observations, calculate the average by summing the opacity of the 24 observations and dividing this sum by 24. Record the average opacity on a record sheet. For the purpose of determining an alternative visible emission limit in accordance with Section 5(b) *[325 IAC 5-5-5(b)]* following, an average of 24 consecutive readings or more may be used to calculate the alternative visible emissions limit.

(F) Determination of Opacity As A Cumulative Total of 15 Minutes—For emissions from intermittent sources, opacity shall be determined in accordance with subsections (1), (2), (3), and the first sentence of (4). Each momentary observation shall be deemed to represent the average opacity of emissions for a 15 second period. All readings greater than the specified limit in Section 2 *[325 IAC 5-1-2]* shall be accumulated as 15 second segments for comparison with the limit.

(G) Attached Steam Plumes—When condensed water vapor is present within the plume as it emerges from the emission outlet, opacity observations shall be made beyond the point in the plume at which condensed water vapor is no longer visible. The observer shall record the approximate distance from the emission outlet to the point in the plume at which the observations are made.

(H) Detached Steam Plumes—When water vapor in the plume condenses and becomes visible at a distinct distance from the emission outlet, the opacity of emissions should be evaluated at the emission outlet priror to the condensation of water vapor and the formation of the steam plume.

(2) Determination of compliance with visible emission limitations established in this Rule *[325 IAC 5-1]* may also be made in accordance with a source's or facility's continuous monitoring equipment, for any source or facility in compliance with the requirements of 325 IAC 3-1.

(b) If the compliance determination procedures set forth in subsection (1) and (2) preceding results in any conflict in visible emission readings, the determination made in accordance with subsection (2) above shall prevail for the purpose of compliance, provided that it can be shown that the continuous monitor has met the performance specifications as set forth in the U.S. EPA Federal Reference 40 CFR, Part 60, specifically Performance Specification 1.

Sec. 5. Special Considerations. (a) A violation of this Rule *[325 IAC 5-1]* shall constitute prima facie evidence of a violation of other applicable particulate emission control regulations. A violation of any such regulation can be refuted by a performance test conducted in accordance with paragraph (b), below. Such test shall refute the mass emission violation only if the source is shown to be in compliance with the allowable mass emission limit. An exceedance of the allowable opacity emission limit will not be treated as a violation if, during the test described in (b) below, the source demonstrates compliance with the allowable mass emission limit while simultaneously having visible emissions more than or equal to the reading at which the exceedance was originally observed.

(b) Establishment or Alternate Visible Emission Limits—The owner or operator of a source or facility which believes it can operate in compliance with the applicable mass emission limitation, but exceeds the limits specified in Section 2 *[325 IAC 5-1-2]* of this Rule, may submit a written petition to the Technical Secretary requesting that an alternate opacity limitation be established pursuant to the following provisions Additionally, if the Board has issued a Notice of Violation to an owner or operator of a source or facility for violation of the applicable opacity limitation, such owner or operator may, propose in Notice of Violation resolution, to disprove said violation by establishing an alternate opacity limit pursuant to the following provisions. This alternate limit shall be based upon a mass emission performance test conducted according to a method designated by the Board, and a visible emission test conducted simultaneously, according to Section 4 *[325 IC 5-1-4]* of this Rule. Where the Board determines there is no acceptable test method available, a request for an alternate visible emission limit shall be denied.

(1) The alternate emission limit shall be equal to that level of opacity at which the source or facility will be able, as indicated by the performance and opacity tests, to meet the opacity standard at all times during which the source or facility is meetng the mass emission limitation. However, the Board shall also reserve the right to determine the alternate visible emissions limit in the following manner:

(A) If a performance test of a source or facility demonstrates (i) that said source or facility is in compliance with the allowable mass emissions limit (as defined in 325 IAC 1.1.-1) at the time that the test is done, and: (ii) simultaneously, said source's or facility's test demonstrates that the allowable opacity emission limit is being exceeded, then, the enforceable opacity limitation shall be equal to that level of opacity at which the source or facility will be able as indicated by the performance and opacity tests to meet the opacity standard at all times during which the source or facility is meeting the mass emission limitation.

(B) If a performance test of a source or facility demonstrates (i) that said source of facility is in compliance with the allowable mass emission limit, and the test mass emission rate is within 10% of the allowable emissions limit for that source or facility, and; (ii) simultaneously, said source's or facility's test demonstrates that the opacity observed is below the allowable opacity emission limit, the enforceable opacity limitation shall be equal to that level of opacity at which the source or facility will be able as indicated by the performance and opacity tests, to meet the opacity standard at all times during which the source or facility is meeting the mass emission limitation.

(C) If a performance test of a source or facility demonstrates (i) that said source or facility is in compliance with the allowable mass emission limit, and the test mass emission rate is less than 90% of the allowable emissions limit and; (ii)

simultaneously, said source's or facility's test demonstrates that the opacity observed is below the allowable opacity emission limit, the enforceable opacity limitation shall remain the existing allowable opacity emission limitation for that source or facility.

(2) Compliance with 325 IAC 6-2 (formerly known as APC 4R), 325 IAC 6-3 (formerly known as APC 5), 325 IAC 11-1 (formerly known as APC 6), and 325 IAC 6-1 (formerly known as APC 23), and other applicable regulations must be demonstrated by the performance test.

(3) The Board may require a performance test in any case where it is necessary to determine the compliance status for a facility. However, the Board will not request a performance test for any facility which is known to be in compliance with the allowable opacity limitation.

(4) All alternate visible emission limits shall be established on a source or facility-specific basis. No limitation for any facility or source shall be established by reference to a similar or identical facility or source.

(5) The owner or operator of the source or facility shall notify the Board at least fifteen days prior to conducting a test for the purposes of demonstrating an alternate visible emission limit.

(6) A staff member who is a qualified observer, approved by the Board or other consultant approved by the Board shall be present during any performance tests.

(7) The cost of the performance test shall be at the expense of the owner or operator.

(8) Any alternate visible emission limit established for any source or facility shall not become effective until said limitation is established in the applicable operating permit. Said limitation will be incorporated, by amendment, into the operating permit for said source or facility and submitted to the U.S. EPA as a SIP revision.

(9) Where a visible emission limitation is based upon a New Source Performance Standard, any new limitation must comply with the provisions of said standard.

Sec. 6. Compliance Timetables—Sources newly subject to more stringent limitations at the promulgation date of this Rule *[325 IAC 5-1]* by Section 2 *[325 IAC 5-2-1]* shall comply with the compliance schedule of 325 IAC 6-1 (formerly known as APC 23).

Sec. 7. SIP Revision—Any exemptions given or provisions granted to this rule *[325 IAC 5-1]* by the Board in Sections 3 (c) *[325 IAC 5-3-2(c)]* or 5(b) *[325 IAC 5-1-5(b)]* shall be submitted to the U.S. EPA as revisions to the State Implementation Plan.

ARTICLE 6. PARTICULATE REGULATIONS

Rule 1. Nonattainment Area Limitations

Sec. 1. Applicability. Sources or facilities specifically listed in Appendix A *[325 IAC 6-1-7]* of this Rule shall comply with the limitations contained therein. Sources or facilities that are (1) located in the nonattainment counties listed in Appendix A *[325 IAC 6-1-7]*, (2) but which sources or facilities are not specifically listed in Appendix A *[325 IAC 6-1-7]*, and (3) have the potential to emit 100 tons or more of particulate matter per year or have actual emissions of 10 tons or more of particulate matter per year, shall comply with the limitations of Section 2 *[325 IAC 6-1-2]*, hereof.

Sec. 2. Emission Limitations. (a) General Sources—Facilities not limited by paragraphs (b) through (g) below shall not allow or permit discharge to the atmosphere any gases which contain particulate matter in excess of 0.07 gram per dry standard cubic meter (g/dscm) (0.03 grain per dry standard cubic foot (dscf)). Where this limitation is more stringent than the applicable limitations of paragraphs (b) through (g) of this section, for facilities in existence prior to the applicability dates, or of a size not applicable to said paragraphs, emission limitations for those facilities shall be determined by the Board and will be established in accordance with the procedures set forth in paragraph (h) of this section.

(b) Fuel Combustion Steam Generators —No person shall operate a fossil fuel combustion steam generator (any furnace or boiler used in the process of burning solid, liquid, or gaseous fuel or any combination thereof for the purpose of producing steam by heat transfer) so as to discharge or cause to be discharged any gases unless such gases are limited to:

(1) A particulate matter content of no greater than 0.18 grams per million calories (0.10 pounds per million Btu) for solid fuel fired generators of greater than 63 million kilocalories (kcal) per hour heat input (250 million Btu);

(2) A particulate matter content of no greater than 0.63 grams per million calories (0.35 pounds per million Btu) for solid fuel fired generators of equal to or greater than 6.3 but less than or equal to 63 million kcal per hour heat input (25 but less than or equal to 250 million Btu);

(3) A particulate matter content of no greater than 1.08 grams per million calories (0.6 pounds per million Btu) for solid fuel fired generators of less than 6.3 million kcal per hour heat input (25 million Btu);

(4) A particulate matter content of no greater than 0.27 grams per million kcal (0.15 pounds per million Btu) for all liquid fuel fired steam generators.

(5) A particulate matter content of no greater than .01 grains per dry standard cubic foot for all gaseous fuel-fired steam generators.

(c) Aspalt Concrete Plants—The requirements of this provision shall apply to any asphalt concrete plant (any facility used to manufacture asphalt concrete by heating and drying aggregate and mixing with asphalt cement). An asphalt concrete plant is deemed to consist only of the following: driers, systems for screening, handling, storing, and weighing hot aggregate; systems for loading, transferring, and storing mineral filler; systems for mixing asphalt concrete; and the loading, transfer, and storage systems associated with emission control systems.

(1) No person shall operate the affected facilities of an asphalt concrete plant which existed on or prior to June 11, 1973, so as to discharge or cause to be discharged into the atmosphere any gases unless such gases are limited to:

(A) A particulate matter content of no greater than 230 mg per dscm (0.10 grain per dscf).

(d) Grain Elevators—No person shall operate a grain elevator (a grain elevator is defined as any plant or installation at which grain is unloaded, handled, cleaned, dried, stored or loaded) without meeting the provisions of this Section. Paragraph (1) below shall apply to any grain storage elevator located at any grain processing source which has a permanent

Rule 2. [Repealed]

Rule 2.1. Particulate Emission Limitations for Sources of Indirect Heating

Sec. 1. Applicability. This rule establishes limitations for sources of indirect heating. (a) Particulate emissions from the combustion of fuel for indirect heating from all facilities located in Lake, Porter, Marion, Boone, Hamilton, Hendricks, Johnson, Morgan, Shelby, and Hancock Counties which were existing and in operation or which received permit to construct prior to the effective date of this rule (325 IAC 6-2.1) shall be limited by section 2 below.

(b) Particulate emissions from the combustion of fuel for indirect heating from all facilities not specified in (a) which were existing and in operation or which received permits to construct prior to the effective date of this rule (325 IAC 6-2.1) shall be limited by section 3 below.

(c) Particulate emissions from the combustion of fuel for indirect heating from all facilities receiving permits to construct on or after the effective date of this rule (325 IAC 6-2.1) shall be limited by section 4 below.

(d) If any limitation established by this rule (325 IAC 6-2.1) is inconsistent with applicable limitations contained in 325 IAC 6-1, then the limitations contained in 325 IAC 6-1 prevail.

(e) If any limitation established by this rule (325 IAC 6-2.1) is inconsistent with applicable limitations contained in 325 IAC article 12.1 (New Source Performance Standards) then the limitations contained in 325 IAC article 12.1 prevail.

(f) If any limitation established by this rule (325 IAC 6-2.1) is inconsistent with a limitation contained in a facility's construction or operation permit as issued pursuant to 325 IAC article 2 (Permit Review Regulations), then the limitations contained in the source's current permits prevail.

(g) If any limitation established by this rule (325 IAC 6-2.1) is inconsistent with a limitation required by 325 IAC article 2 (Permit Review Regulations) to prevent a violation of the Ambient Air Quality Standards set forth in 325 IAC 1.1-3, then the limitations required by 325 IAC article 2 prevail.

(h) The addition of a new facility at a source does not affect the limitations of the existing facilities unless such changes in the limitations are required by the provisions of 325 IAC article 2 or 325 IAC 6-1.

Sec. 2. Emission limitations for facilities specified in 325 IAC 6-2.1-1(a). (a) Particulate emissions from existing indirect heating facilities located in the specified counties shall be limited by the following equation.

$$Pt = \frac{0.87}{Q^{0.16}}$$

Where:

Pt = Pounds of particulate matter emitted per million Btu (lb/mmBtu) heat input.

Q = Total source maximum operating capacity rating in million Btu per hour (mmBtu/hr) heat input. The maximum operating capacity rating is defined as the maximum capacity at which the facility is operated or the nameplate capacity, whichever is specified in the facility's operation permit application, except when some lower capacity is contained in the facility's operation permit, in which case, the capacity specified in the operation permit shall be used.

For Q less than 10 mmBtu/hr, Pt shall not exceed 0.6.

For Q greater than or equal to 10,000 mmBtu/hr, Pt shall not exceed 0.2. Figure 1 may be used to estimate allowable emissions.

(b) The emission limitations for those indirect heating facilities which were existing and in operation on or before June 8, 1972, shall be calculated using the equation contained in subsection 2(a) where: Q shall reflect the total source capacity on June 8, 1972. The resulting Pt is the emission limitation for each facility existing on that date and will not be affected by the addition of any subsequent facility. The particulate emissions from all of the facilities which were in existence on June 8, 1972, may be allocated in any way among these facilities provided that they will not result in a significantly greater air quality impact level at any receptor than that which would result if the particulate emissions from each of these facilities were limited to Pt; and provided that the emission limitations for each facility are specified in its operation permit. Significant impact levels are defined in 325 IAC 2-3, section 2(d).

(c) The emission limitations for those indirect heating facilities which began operation after June 8, 1972, and before the effective date of this rule (325 IAC 6-2.1), and those facilities which receive permits to construct prior to the effective date of this rule (325 IAC 6-2.1) shall be calculated using the equation contained in subsection 2(a) where: Q includes the capacity for the facility in question and the capacities for those facilities which were previously constructed or received prior permits to construct. The limitations for all previously permitted facilities do not change. The Q and Pt for each facility at a source which begins operation or receives a construction permit during this time period will be different.

Sec. 3. (a) Particulate emissions from indirect heating facilities existing and in operation before the effective date of this rule shall be limited by the following equation:

$$Pt = \frac{C \times a \times h}{76.5 \times Q^{0.75} \times N^{0.25}}$$

Where:

C = Maximum ground level concentration with respect to distance from the point source at the "critical" wind speed for level terrain. This shall equal 50 micrograms per cubic meter (ug/m³) for a period not to exceed a 60-minute time period.

Pt = Pounds of particulate matter emitted per million Btu heat input (lb/mmBtu).

Q = Total source maximum operating capacity rating in million Btu per hour (mmBTU/hr) heat input. The maximum operating capacity rating is defined as the maximum capacity at which the facility is operated or the nameplate capacity, whichever is specified in the facility's operation permit application, except when some lower capacity is contained in the facility's operation permit; in which case, the capacity specified in the operation permit shall be used.

N = Number of stacks in fuel burning operation.

a = Plume rise factor which is used to make allowance for less than theoretical

plume rise. The value 0.67 shall be used for Q less than or equal to 1,000 mmBtu/hr heat input. The value 0.8 shall be used for Q greater than 1,000 mmBtu/hr heat input.

h = Stack height in feet. If a number of stacks of different heights exist, the average stack height to represent "N" stacks shall be calculated by weighing each stack height with its particulate matter emission rate as follows:

$$h = \frac{\sum_{i=1}^{N} H_i \times pa_i \times Q_i}{\sum_{i=1}^{N} pa_i \times Q_i}$$

Where:

pa=the actual controlled emission rate in lb/mmBtu using the emission factor from AP-42 or stack test data. Stacks constructed after January 1, 1971, shall be credited with GEP stack height only. GEP stack height shall be calculated as specified in rule 325 IAC 1.1-6.1

(b) The emission limitations for those indirect heating facilities which were existing and in operation on or before June 8, 1972, shall be calculated using the equation contained in subsection 3(a) where: Q, N, and h shall include the parameters for all facilities in operation on June 8, 1972. The resulting Pt is the emission limitation for each facility existing on that date and will not be affected by the addition of any subsequent facility. The particulate emissions from all of the facilities which were in existence on June 8, 1972, may be allocated in any way among these facilities provided that they will not result in a significantly greater air quality impact level at any receptor than that which would result if the particulate emissions from each of these facilities were limited to Pt; and provided that the emission limitations for each facility are specified in its operation permit. Significant impact levels are defined in 325 IAC 2-3 section 2(d).

(c) The emission limitations for those indirect heating facilities which began operation after June 8, 1972, and before the effective date of this rule (325 IAC 6-2.1). and those facilities which receive permits to construct prior to the effective date of this rule (325 IAC 6-2.1) shall be calculated using the equation contained in subsection 3(a) where: Q, N, and h shall include the parameters for the facility in question and for those facilities which were previously constructed or received prior permits to construct. The limitations for all previously permitted facilities do not change. The Q, N, h, and Pt for each facility at a source which begins operation or receives a construction permit during this time period will be different.

(d) Particulate emissions from all facilities used for indirect heating purposes which were existing and in operation on or before June 8, 1972, shall in no case exceed 0.8 lb/mmBtu heat input.

(e) Particulate emissions from any facility used for indirect heating purposes which has 250 mmBtu/hr heat input or less and which began operation after June 8, 1972, shall in no case exceed 0.6 lb/mmBtu heat input.

Sec. 4. Emission limitations for facilities specified in 325 IAC 6-2.1-1(c) (a) Particulate emissions from indirect heating facilities constructed after the effective date of this rule (325 IAC 6-2.1) shall be limited by the following equation:

$$Pt = \frac{1.09}{Q^{0.26}}$$

Where:

Pt = Pounds of particulate matter emitted per million Btu (lb/mmBtu) heat input.

Q = Total source maximum operating capacity rating in million Btu per hour (mmBtu/hr) heat input. The maximum operating capacity rating is defined as the maximum capacity at which the facility is operated or the nameplate capacity, whichever is specified in the facility's permit application, except when some lower capacity is contained in the facility's operation permit; in which case, the capacity specified in the operation permit shall be used.

For Q less than 10 mmBtu/hr, Pt shall not exceed 0.6.

For Q greater than or equal to 10,000 mmBtu/hr, Pt shall not exceed 0.1. Figure 2 may be used to estimate allowable emissions.

(b) As each new indirect heating facility is added to a plant Q will increase. As a result, the emission limitation for each progressively newer facility will be more stringent until the total plant capacity reaches 10,000 mmBtu/hr after which the emission limit for each newer facility will be 0.1 lb/mmBtu heat input. The rated capacities for facilities regulated by article 12.1, New Source Performance Standards, shall be included when calculating Q for subsequent facilities.

Rule 3. Process Operations

Sec. 1. Applicability—This Rule *[325 IAC 6-3]* establishes emission limitations for particulate emissions from process operations located anywhere in the State. The following processes and their attendant emissions are exempt from this Rule *[325 IAC 6-3]:*

(1) Combustion for indirect heating
(2) Incinerators
(3) Open burning
(4) Existing Foundry Cupolas

If any limitation established by this Rule *[325 IAC 6-3]* is inconsistent with applicable limitations contained in 325 IAC 6-1 (formerly known as APC 23), or contained in 325 IAC, Article 12 (New Source Performance Standards), then the limitation contained herein shall not apply; but the limit in such sections shall apply.

Sec. 2. Emission Limitations. (a) Cement Kilns—No owner or operator of a cement manufacturing operation commencing operation prior to December 6, 1968, equipped with electrostatic

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APPENDIX C

Plant Operating Data

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BOILER #3, BYPASS, RUN #1

DAILY STEAM BOILER PLANT OPERATING LOG

1 COMMAND SAC — 2 BASE AND LOCATION GR,550th AEB JN [illegible] — 3 BUILDING NO AND NAME 215 RCM — 4 DATE 15 [illegible] 47

	TIME HOUR	STEAM PRESS (PSI)	STEAM PRODUCED (1000 Pounds) C — BOILER NO 1	2	3	4	FUEL USED D — COAL - BTU/LB; OIL - BTU/GAL; GAS - BTU/1000CF — BOILER NO 1	2	3	4	FLUE GAS E — O2 OR CO2 (Ave %) — BOILER NO 1	2	3	4	TEMP (Degree F) — BOILER NO 1	2	3	4	FUEL OIL F — PRESS (PSIG)	TEMP (°F)	FEEDWATER HEATER G — PRESS (PSIG)	TEMP (°F)	FEEDWATER FLOW (Gals) H — START	STOP	GALS	MAKE UP WATER FLOW (Gals) I — START	STOP	GALS	CONDENSATE RETURN TEMP (°F) J	FEEDWATER PUMP PRESSURES (PSIG) K — DUCT	DISCH	OUTSIDE TEMPERATURE (°F) L
FIRST SHIFT	0030	105	14150		39500		125		4389		12.0		14.0		420		420				6	218			6464	903	911	800	160		205	42
	0130	107	15350		40000		136		4444		12.0		14.0		420		420				6	219			6669		916	500	160		205	48
	0230	118	16450		38000		146		4223		12.0		14.2		420		420				6	218			6560		928	700	160		205	40
	0330	117	16050		36000		142		4000		12.0		13.3		420		420				6	218			6271		929	600	160		205	40
	0430	118	15850		37000		140		4111		12.0		14.0		420		420				6	218			6367		937	500	160		205	40
	0530	120	15250		37500		136		4167		12.1		14.5		420		420				6	218			6367		941	700	160		205	38
	0630	120	18450		40000		163		4444		12.5		15.0		420		420				6	218			7042		947	600	160		205	38
	0730	106	18400		33500		163		4278		12.0		14.0		420		420				6	218			6855		953	600	160		205	38
	TOTAL	912	130050		304500		1151		34655		96.5		113		3360		3360				48	1744			52595			1156	1200		1640	316
	AVG	114	16256		38313		144		4257		12.1		14.1		420		420				6	218			6574			145	160		205	40
SECOND SHIFT	0830	94	21806		49000		193		4444		12.3		14.5		420		420				7	218			7446	953	958	500	160		205	50
	0930	90	22400		41500		198		4611		12.5		14.5		420		420				7	218			7699		964	600	160		205	80
	1030	82	21450		42000		291		[illegible]		13.0		14.5		420		420				7	218			9018		971	700	160		205	36
	1130	89	29750		41500		257		4611		12.5		14.5		420		420				7	218			9552		978	700	160		205	36
	[illegible]	114	25100		[illegible]		224		4611		12.3		14.5		[illegible]		[illegible]				7	218			9181		985	700	160		225	42
	[illegible]		23450		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]		[illegible]				7	218			[illegible]		992	700	[illegible]		[illegible]	[illegible]
	[illegible]	98	24350		40000		216		4444		11.5		14.5		420		420				7	218			7741		995	300	160		205	44
	[illegible]		[illegible]		[illegible]		192		[illegible]		11.3		14.2		[illegible]		[illegible]				7	211			[illegible]		003	[illegible]	[illegible]		[illegible]	44
	TOTAL	765	201100		327500		1790		36745		96.5		116.5		3360		3360				56	1744			[illegible]			800	1280		1640	326
	AVG	96	25138		40938		224		4593		12.1		14.6		420		420				7	218			[illegible]			[illegible]	160		205	41
THIRD SHIFT	[illegible]	[illegible]	[illegible]		[illegible]		242		4444		11.0		14.5		420		420				7	218			6824		009	[illegible]	[illegible]		205	[illegible]
	17 0	114	[illegible]		[illegible]		243		4167		11.5		[illegible]		[illegible]		[illegible]				7	218			7637		015	[illegible]	[illegible]		[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]		[illegible]		244		3833		11.2		[illegible]		500		420				7	218			7182		[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]		36500		222		4000		11.0		13.0		[illegible]		420				7	218			7560		025	[illegible]	160		[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]		34500		239		3833		10.0		12.5		500		420				7	218			7410		034	[illegible]	160		[illegible]	[illegible]
	[illegible]	109	[illegible]		35000		262		3889		10.5		13.0		[illegible]		420				7	218			7283		037	[illegible]	[illegible]		[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]		33500		263		3722		10.5		13.0		[illegible]		420				7	218			[illegible]		[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	[illegible]	[illegible]	[illegible]		33500		250		3722		11.0		13.5		[illegible]		[illegible]				7	218			7436		[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	TOTAL	325	[illegible]		284500		1974		31610		95		109		4090		3360				56	1744			61150		[illegible]	[illegible]	[illegible]		[illegible]	[illegible]
	AVG	108	[illegible]		35563		247		3951		11.9		13		511		420				7	218			7644		[illegible]	[illegible]	158		205	55
DAILY	TOTAL	2062	[illegible]		918500		4905		[illegible]		284.5		338.5		11110		10080				160	5232			[illegible]		1960	2800	3918		4930	919
	AVG	114	33542		38271		204		4252		12.0		13.9		463		420				7	218			7563		[illegible]	117	159		206	38

OPERATING DATA

	FIRST SHIFT	SECOND SHIFT	THIRD SHIFT	TOTAL
A STEAM FLOW FINAL (Integrator)	329925 959467	326947 [illegible]	[illegible] 969764	[illegible] 554200
B STEAM FLOW START	-02241 954377	[illegible]	[illegible]	03 918500
C TOTAL STEAM PRODUCED	130050 304500	[illegible]	223650 264150	1,472,700
D LBS STEAM PER UNIT OF FUEL				
E SOOT BLOWN	0345 - 2346 0350 - 0953		[illegible] 940	
F BLOW DOWN	TIME 00 15 GALS 24 [illegible] 3804	TIME [illegible] GALS 264	TIME [illegible] GALS [illegible] EIA 1637	
G DEGREE DAY				
H OPERATOR	RICHARD BATES HARRY TOWER	[illegible]	[illegible]	
I FIREMAN		[illegible]	[illegible]	
J TOTAL MANHOURS OPERATION	32	32	16	96

13 REMARKS (Underline un-reverse)

WC 66 0020

Fuses [illegible] 280

0640

Pool on at 0900-1030

Chlorine #3

(Signature) [illegible]

DATE

SIGNATURE OF CHIEF OPERATING ENGINEER

14 PLANT COMBUSTION EFFICIENCY (Percent) #1 80 #2 [illegible]

15 PLANT STU OUTPUT (Millions) 1474,320,000

16 PLANT STU INPUT (Millions) 1,601,247,360

17 OVERALL EFFICIENCY (Percent) 73%

18 PEAK DEMAND FACTOR (Percent)

19 MAKEUP WATER (Percent) 5.16%

20 TOTAL FUEL USED

COAL LBS 1275687 [illegible] 51015

OIL GALS 14455

GAS MCF

AF FORM OCT 81 1458 PREVIOUS EDITION WILL BE USED

BOILER #3, BYPASS, RUN #2

DAILY STEAM BOILER PLANT OPERATING LOG

TIME HOUR	STEAM PRESSURE	STEAM PRODUCED (1000 Pounds) C — BOILER NO 1	2	3	4	FUEL USED D — COAL BTU/LB; OIL BTU/GAL; GAS BTU/1000CF — BOILER NO 1	2	3	4	FLUE GAS L — O_2 OR CO_2 (As %) BOILER NO 1	2	3	4	TEMP (Degrees F) BOILER NO 1	2	3	4	FUEL OIL F — PRESS (PSIG)	TEMP (°F)	FEEDWATER HEATER G — PRESS (PSIG)	TEMP (°F)	FEEDWATER FLOW (Flow) H — START	STOP	GALS	MAKE UP WATER FLOW (Flow) I — START	STOP	GALS	CONDENSATE RETURN TEMP	FEEDWATER PUMP PRESSURES (PSIG) A — SUCT	DISCH	OIL SUPPLY TEMP
0030	100	9500		38000		261		3667		12.5	11.5	520	440							6	218											
0130	100	30450		34000		271		4278		12.5	12.5	520	420							6	216											
0230	100	32450		33000		287		3667		12.5	12.5	520	420							6	213	7286										
0330	100	31000		32000		274		3556		12.5	13.5	520	420							6	215	7590										
0430	100	28600		32000		248		3556		12.5	12.5	520	430							6	218	7227										
0530	100	29700		28000		311		3111		12.5	12.5	520	420							6	217	7602										
0630	100	36500		32000		323		3556		11.5	13.0	530	430							6	218	8253										
0730	166	31100		40000		275		4444		11.5	13.0	520	426							6	218	8366										
TOTAL	800	254300		264000		2350		29332		98	100	4160	3360							48	1744	62745										
AVG	.25	31788		33000		294		3667		12.3	12.5	520	420							6	218	7806										
0830	98	28500		38000		252		4226		11.0	14.6	526	420							5	210	8256	166									
0930	110	30850		40000		266		4444		10.8	14.5	520	426							5	210	7490		1317	630	1467						
1030	114	29160		40000		263		4667		12.4	15.4	520	420							5	210	6419		1423	530	1453						
1130	104	27510		36000		249		4000		12.4	15.4	520	420							5	210	6550		1526	700	1462						
1230	104	27600		36000		249		4000			15.0	540	420							5	210	6550		1543	700	1462						
1330	110	21100		30000		187		4333		9.2	14.5	520	426							5	210	4971		1553	700	1462						
1430	100	20500		40000		196		4667		10.0	14.0	506	420							5	210	7771		1553	700	1462						
TOTAL	856	247350		170000		1983		25274		86	117.5	4178	3360							40	1680	49391		1553	700	1462						
AVG	107	27706		19625		240		4403		10.8	14.7	515	420							5	210	8246										
1530	98	20450		38000		269		4222		12.0	14.5	480	420							6	218	12000										
1630	100	29700		40000		269		4167		12.0	14.0	470	420							6	216	8157										
1730	104	33600		36000		293		4000		14.0	13.0	470	420							6	218	7747										
1830	104	33600		36000		293		4000		13.0	12.5	460	420							6	216	6199										
1930	100	34500		32000		311		4211		13.0	13.0	460	420							6	216	8102										
2030	100	34500		32000		316		4211		12.5	13.0	460	420							6	216	7801										
2130	104	36600		34000		292		4778		12.5	13.0	476	410							6	216	8066										
2230	104	36600		36000		292		4000		11.5	13.5	466	420							6	216	8175										
TOTAL	822	278600		290000		2711		32161		96.5	103	3730	3360							48	1744	62747										
AVG	103	34825		36313		264		4058		12.1	12.9	466	420							6	218	7968										
TOTAL	2178	710450		871500		6284		96617		290.5	330.5	12010	10080								5168	190561										
AVG	103	29590		36313		262		4026		11.7	13.91	500	420								215	7940										

OPERATING DATA

	FIRST SHIFT	SECOND SHIFT	THIRD SHIFT	TOTAL
A STEAM FLOW FINAL (Integrator)	336444	346837	345611	#1 770150
B STEAM FLOW START	336440	336440	340839	#3 611500
C TOTAL STEAM PRODUCED	2397	217250	210700	1561650
D LBS STEAM PER UNIT OF FUEL				
E SOOT BLOWN				
F BLOW DOWN	TIME	TIME 3815	TIME	
G DEGREES DAY				
H OPERATOR				
I FIREMAN				
J TOTAL MANHOURS OPERATION	32	40	24	96

K REMARKS (Continue on reverse)

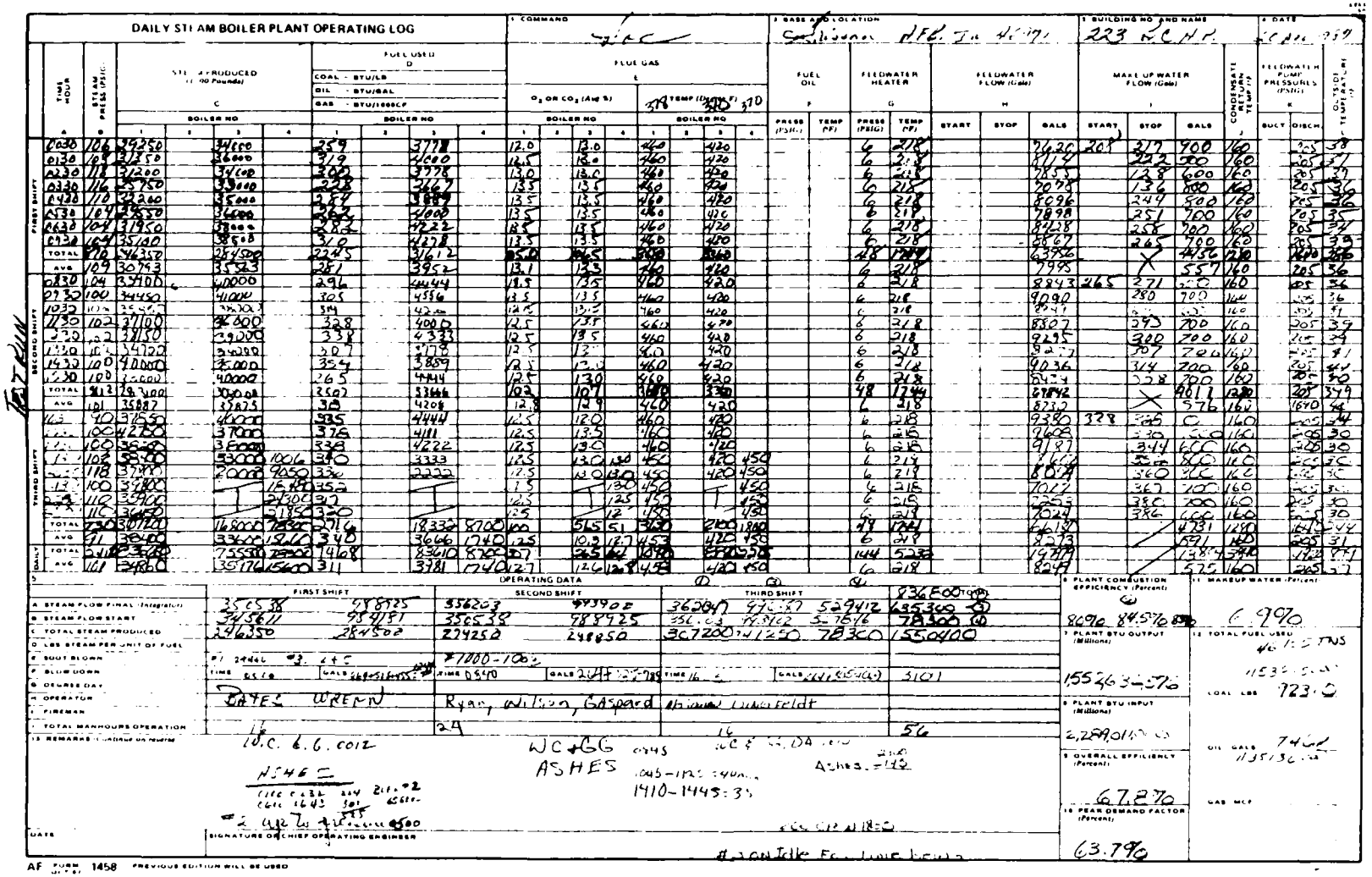
DATE

SIGNATURE OF CHIEF OPERATING ENGINEER

8 PLANT COMBUSTION EFFICIENCY (Percent)	#1 84% #3 43.5%
9 PLANT BTU OUTPUT (Millions)	1,583,427,316
10 PLANT BTU INPUT (Millions)	2,162,850,000
11 OVERALL EFFICIENCY (Percent)	73%
12 PEAK DEMAND FACTOR (Percent)	84.2%
11 MAKEUP WATER (Percent)	4.8%
12 TOTAL FUEL USED	1,207,712,000
COAL LBS	96617
OIL GALS	4284
GAS MCF	

AF FORM 1458 PREVIOUS EDITION WILL BE USED

BOILER #3, BYPASS, RUN #3



DAILY STEAM BOILER PLANT OPERATING LOG

1 COMMAND: AFC

2 BASE AND LOCATION: Schriever AFB, Colo

3 BUILDING NO AND NAME: 223 CE Maint

4 DATE: 1 Dec 1959

TIME HOUR	STEAM PRESS (PSIG)	STEAM PRODUCED (1,000 Pounds) C — BOILER NO 1	2	3	4	FUEL USED D — COAL - BTU/LB; OIL - BTU/GAL; GAS - BTU/1000CF — BOILER NO 1	2	3	4	FLUE GAS E — O2 OR CO2 (Aug %) — BOILER NO 1	2	3	4	FLUE GAS E — TEMP (Degrees F) — BOILER NO 1	2	3	4	FUEL OIL F — PRESS (PSIG)	TEMP (°F)	FEEDWATER HEATER G — PRESS (PSIG)	TEMP (°F)	FEEDWATER FLOW (Gals) H — START	STOP	GALS	MAKE UP WATER FLOW (Gals) I — START	STOP	GALS	CONDENSATE RETURN TEMP °F J	FEEDWATER PUMP PRESSURES (PSIG) K — SUCT	DISCH	OIL TEMP °F L — SUCT	DISCH
A	B																																		
FIRST SHIFT																																			
0030	106	99250		34500		259		3778		12.0	13.0	460	420					6	218			20696	209	277	700	160			205	38
0130	108	33550		36000		319		4000		11.5	13.0	460	420					6	218			4114		283	900	160			205	37
0230	118	34200		34500		300		3778		13.0	13.0	460	420					6	218			7855		138	600	160			205	37
0330	116	35750		35000		228		3667		13.5	13.5	460	420					6	218			2078		136	800	160			205	36
0430	110	33200		35000		257		3889		13.5	13.5	460	420					6	218			8096		244	900	160			205	36
0530	104	34850		34000		262		4000		13.5	13.5	460	420					6	218			7898		251	700	160			205	35
0630	104	31950		33000		282		4222		13.5	13.5	460	420					6	218			8428		258	700	160			205	34
0730	104	35100		35000		310		4278		13.5	13.5	460	420					6	218			8867		265	700	160			205	33
TOTAL	870	346350		284000		2245		31612		850	865	3680	3360					48	1744			63926			4456	1280			1640	286
AVG	109	30793		35500		281		3952		13.1	13.3	460	420					6	218			7998			557	160			205	36
0830	104	33400		40000		296		44444		13.5	13.5	460	420					6	218			8843	265	271	700	160			205	36
0930	100	34450		41000		305		4556		13.5	13.5	460	420					6	218			9090		280	700	160			205	36
1030	102	35500		39000		314		4222		12.5	13.5	460	420					6	218			8841		289	700	160			205	37
1130	102	37100		38000		328		4000		12.5	13.5	460	420					6	218			8807		293	700	160			205	37
1230	102	32150		39000		338		4333		12.5	13.5	460	420					6	218			9295		300	700	160			205	37
1330	101	34700		39000		307		4178		12.5	13.5	460	420					6	218			8827		307	700	160			205	37
1430	100	37000		35000		354		3889		12.5	13.5	460	420					6	218			9036		314	700	160			205	37
1530	100	32000		40000		265		4444		12.5	13.0	460	420					6	218			8274		328	700	160			205	36
TOTAL	913	328300		392000		3007		35663		103	107	3680	3360					48	1744			67842			5011	1280			1640	329
AVG	101	35867		39825		318		4208		12.8	13.4	460	420					6	218			8232			576	160			205	36
1630	90	31650		46000		335		4444		12.5	13.0	460	420					6	218			9380	328	335	C	160			205	34
1730	100	42700		37000		376		4111		12.5	13.5	460	420					6	218			9609		330	800	160			205	30
1830	100	36400		36000		339		4222		12.5	13.0	460	420					6	218			9187		344	600	160			205	30
1930	106	38400		33000	1006	340		3333		12.5	13.0	460	420	450				6	218			8628		360	800	160			205	30
2030	118	37400		42000	9050	332		2222		12.5	13.0	460	420	450				6	218			8028		360	900	160			205	30
2130	100	39800			16480	352				12.5	13.0	460		450				6	218			7042		367	700	160			205	30
2230	110	39900			21300	327				12.5	12.5	460		450				6	218			7253		380	700	160			205	30
2330	116	36450			21854	320				12.5	12.5	460		450				6	218			7624		386	600	160			205	30
TOTAL	950	307200		168000	78834	2771		18332	8700	100	515	3680	2100	1800				48	1744			64181			6281	1280			1640	294
AVG	91	38400		33600	15769	346		3666	1740	12.5	10.3	460	420	450				6	218			8273			691	160			205	37
TOTAL	3411	1343450		1175500	236000	11468		83610	8700	307	965	10960	8820	3600				144	5238			194111			13887	4320			1640	971
AVG	101	39807		34868	7000	340		3781	1740	12.7	12.8	460	420	450				6	218			8241			579	160			205	37

OPERATING DATA

	FIRST SHIFT	SECOND SHIFT	THIRD SHIFT	
A STEAM FLOW FINAL (Integrator)	35 C5 38 — 258925	356203 — 993902	362847 — 976387 — 529412	836E00 (illegible)
B STEAM FLOW START	346511 — 958181	356538 — 788925	356 623 — 976387 — 529412 — 3646	78300 00
C TOTAL STEAM PRODUCED	296350 — 284500	274252 — 248450	3C7200 — 941250 — 78300	650400
D LBS STEAM PER UNIT OF FUEL				
E SOOT BLOWN	P) 24461 #3, 4 & C	#7000-10C2		
F BLOW DOWN	TIME 05:10 GALS 2685-2545=140	TIME 0540 GALS 2685-2545=140	TIME 16 : 2 GALS 2685-2545=140	3101
G DEGREE DAY	DATE: WREMN	Ryan, Wilson, GAspard	Thomas Linderfeldt	
H OPERATOR				
I FIREMEN				
J TOTAL MANHOURS OPERATION	17	24	16	56

10 REMARKS (Unusual or routine)

10.C. 6.6. coil2

NJ46 =

Fire cycle 344 2hr #2
Cycle 1645 301 Gals
= 2 42 2 4500

WC & GG 0345 ASHES 1045-1125 1400...
1410-1445: 35

Ashes. = 142

JC & [illegible] 0400

#3 on Idle For time being

DATE

SIGNATURE OR CHIEF OPERATING ENGINEER

8 PLANT COMBUSTION EFFICIENCY (Percent): 86.96 84.57%

9 PLANT BTU OUTPUT (Millions): 155263.576

10 PLANT BTU INPUT (Millions): 2,289.01

11 OVERALL EFFICIENCY (Percent): 67.87%

12 PEAK DEMAND FACTOR (Percent): 63.79%

11 MAKEUP WATER (Percent): 6.99%

13 TOTAL FUEL USED: 46 1/2 TONS; 11535.5 [illegible]; COAL LBS 723.0; OIL GALS 7402 11351.36; GAS MCF

AF FORM 1458 PREVIOUS EDITION WILL BE USED

PRIMER #3, SCRUBBER, RINGS #1, 2, 3

DAILY STEAM BOILER PLANT OPERATING LOG

1 COMMAND: SAC
2 BASE AND LOCATION: GRISSOM AFB IN 46971
3 BUILDING NO. AND NAME: 223 BCHP
4 DATE: 23 NOV 1987

A Time	B	C Steam Produced (1,000 Pounds) Boiler No. 1	Boiler No. 3	Boiler No. 4	D Fuel Used (Coal BTU/LB, Oil BTU/GAL, Gas BTU/1000CF) Boiler No. 1	Boiler No. 3	Boiler No. 4	E Flue Gas O2 or CO2 (%) Boiler No. 1	Boiler No. 3	Boiler No. 4	Flue Gas Temp (Degree F) Boiler No. 1	Boiler No. 3	Boiler No. 4	F Fuel Oil Press (PSIG)	Fuel Oil Temp (F)	G Feedwater Heater Press (PSIG)	Feedwater Heater Temp (F)	H Feedwater Flow (Gals) Start	Stop	Gals	I Make Up Water Flow (Gals) Start	Stop	Gals	J Condensate Return Temp (F)	K Feedwater Pump Pressures (PSIG) Suct	Disch	Temperature
0030											441	420									122			16		205	
											440	420															
											440	420															
0230		2490	37000		241	3556		13.0	14.6		440	420				6	215			2819		730		160		205	
0330	100	31400	33000		278	3667		13	12.0		440	420				6	218			7759		760	1000	160		205	42
0530	100	24300	33000		259	3667					440	420				6	218			7506		769	400	160		205	44
0630	100	31500	36000		279	4000		14.5	14.0		440	420				6	218			8133		776	700	160		205	44
0730	100	32000	58000		283	4222		14.0	14.0		440	420				6	218			8434		783	700	160		205	46
TOTAL	800	250450	270000		2216	30002		107	101		3500	3360				48	1744			62705			3906	1280		1640	343
AVG	100	31306	33750		277	3750		13.4	12.6		440	420				6	218			7838			488	160		205	43
0850	102	2460	35000		218	3889		13.5	13.0		420	420				6	218			7180	783	790	[illegible]	160		205	42
[illegible]		25510	37000		225	4333		[illegible]	14.0		[illegible]	420				6	218			7313		797	700	160		205	46
[illegible]		27000	37000		235	4111		12.5	16.0		[illegible]	420				[illegible]	218			7711		804	700	160		205	44
[illegible]		24500	[illegible]		216	3888		12.5	15		420	420					218			7161		812	800	160		205	[illegible]
[illegible]		22050	37000		19.5	4111		[illegible]	14.5		[illegible]	420								7114		818	600	160		205	
1330	112	[illegible]	[illegible]		220	3555			[illegible]			420				6	218			6555		828	100	160		205	
1430						3222						[illegible]															
1530			[illegible]		177	3000														[illegible]		840	70			205	
TOTAL	840	194[illegible]	[illegible]		1717	3011		1025	1123		3360	3360				45	1744			[illegible]			316	1280		1640	460
AVG			33375		215	3764		[illegible]	14.0		420	420											471	157			
[illegible]						3111															840						
[illegible]	116	[illegible]			306	3111		11.5	13.0		430	420				1				7151		850	700				
		[illegible]	62000		217	3000																					
									14.5				450														
			300	7500		3000	3056					420	410							7300		870	800	155		205	47
TOTAL					1023	33025		58.0	101.5	41.5	2090	3360	1640			48	1744										
AVG					205	[illegible]		11.6			418	420														205	
TOTAL	2544	[illegible]			4958	[illegible]		2625	[illegible]		8970	10080				144	5232										
AVG		26663			236	3592		12.7			427	420												158		205	50

OPERATING DATA

	First Shift		Second Shift		Third Shift		
a. Steam Flow Final (Integrator)	395689	012150	379564		401887		#1 340350
b. Steam Flow Start	[illegible]	[illegible]	395689	012150	[illegible]	016570	#3 256500
c. Total Steam Produced	250450	270000	194[illegible]		11300		
d. LBS Steam per Unit of Fuel							
e. Soot Blown			#3 [illegible] 2230		#3 1055 2100		TOTAL 1110850
f. Blow Down	TIME 0040	GALS 264-430-2194	TIME	GALS 641	TIME	GALS	
g. Degree Day							
h. Operator	[illegible]		Shawn Renner [illegible]		[illegible]		
i. Fireman							
j. Total Manhours Operation							

k. REMARKS (Continue on reverse)

DT 9'3"

TRANSFERRED 0

MCT GG 0045

ASPES 0545 0635 7.80

MCT [illegible]

[illegible] 0135 — 10'00 [illegible]

[illegible] #2 60 126

#4 60 [illegible] 660 [illegible] 935

[illegible] #2 150 1650

6 PLANT COMBUSTION EFFICIENCY (Percent): [illegible]

7 PLANT BTU OUTPUT (Millions): [illegible]

8 PLANT BTU INPUT (Millions): [illegible]

9 OVERALL EFFICIENCY (Percent): [illegible]

10 PEAK DEMAND FACTOR (Percent): [illegible]

11 MAKEUP WATER (Percent): [illegible]

12 TOTAL FUEL USED: COAL LBS [illegible]; OIL GALS; GAS MCF

DATE

SIGNATURE OF CHIEF OPERATING ENGINEER

AF FORM 1458 PREVIOUS EDITION WILL BE USED

BOILER #4, BYPASS, RUNS #1, 2, 3

DAILY STEAM BOILER PLANT OPERATING LOG

1 COMMAND: GAC

2 BASE AND LOCATION: Grissom IN 46971

3 BUILDING NO AND NAME: 2538 CHP

4 DATE: 2 NOV 87

TIME HOUR A	STEAM PRESS (PSIG) B	STEAM PRODUCED (1000 Pounds) C	FUEL USED D	FLUE GAS E	FUEL OIL F	FEEDWATER HEATER G	FEEDWATER FLOW (Gals) N	MAKE UP WATER FLOW (Gals) I	CONDENSATE RETURN TEMP (°F) J	FEEDWATER PUMP PRESSURES (PSIG) K	OUTSIDE AIR TEMPERATURE (°F)
		BOILER NO 1 2 3 4	BOILER NO 1 2 3 4	BOILER NO 1 2 3 4 / TEMP (Degrees F) BOILER NO 1 2 3 4	PRESS (PSIG) TEMP (°F)	PRESS (PSIG) TEMP (°F)	START STOP GALS	START STOP GALS		SUCT DISCH	
0030	110	39450 28800 10700	3479 3111	12.5 13.0 440 420 380		6 218		386 297 2700	160	305 30	
0130	118	36550 30000 6200	3323 3393	12.5 13.6 440 430 320		6 216		297 397 6900	160	305 30	
0230	116	36900 31500 5750	3379 3767	13.0 13.0 440 420 401		6 218		468 900	160	305 28	
0330	116	36340 31440 4900	3323 3383	12.5 12.5 440 420 401		6 218		413 560	160	305 28	
0430	118	36350 17400 18600	3372 1933	12.5 6.0 440 220 450		6 218		422 800	160	305 28	
0530	118	30490 23800 6690	2773	12.0 13.0 440 520		6 218		496 900	160	305 28	
0630	118	34700 29750 4950	3108	12.0 13.0 440 520		6 218		439 700	160	305 28	
0730	116	33650 33350 297		12.5 16.0 440 590		6 218		346 900	160	305 28	
TOTAL	180	372400	102850 128050 34498	14877 14328 395 575 41.0 8800 A00 8800		48 7799		6607	1280	8800 228	
AVG	114	35243	20570 25610 3712	2975 2866 79 115 8.2 1760 380 433		6 218		6251	160	305 29	
0830	118	31,200 40050 2774	4450 14.5 14.5 4450 540			6 218		6476 386 455 900	160	305 28	
0930	118	37,250 38450 3530	4272 12.5 13.0 440 540			6 218		8518 462 700	160	305 28	
1030	118	29,650 39200 2411	4367 11.0 13.5 440 540			6 218		7994 467 700	160	305 28	
1130	96	34650 40600 3071	4511 11.5 13.0 450 540			6 218		7982 477 1000	160	305 47	
1230	102	40850 38350 3862	4250 12.0 13.5 450 540			6 218		9410 482 800	160	305 47	
1330	100	32050 40500 3894	4300 12.0 13.5 440 520			6 216		9741 492 500	160	305 52	
1430	104	28550 38000 2333	4223 13.0 14.5 440 520			6 218		8180 501 900	160	305 56	
1530	100	20000 37.000 177	4333 13.0 13.3 440 520			6 218		7108 506 700	160	265 53	
TOTAL	1201	256400	31460 3388	99709 93.5 [illegible] 8800 4040		48 12744		63409 5691	4280	8800 339	
AVG	109	32300	39268 286	4363 12.9 13.6 443 533		6 218		8176 711	160	305 42	
1630	100	31630 35000 257	3820 13.0 13.0 440 520			6 216		7787 516 800	180	305 56	
1730	102	27650 32000 244	3555 13.0 13.0 440 500			6 218		7187 523 700	160	305 56	
1830	100	31150 31000 275	3444 13.0 13.0 440 500			6 218		7489 530 700	160	305 56	
1930	100	33100 33000 293	3555 13.0 13.0 440 500			6 218		7843 536 600	160	305 54	
2030	100	33550 31000 297	3444 13.0 13.0 420 500			6 218		7771 542 600	160	305 54	
2130	100	35000 32000 311	3555 13.0 13.0 430 500			6 214		8076 548 600	160	305 54	
2230	100	36300 33000 321	3777 13.0 13.0 430 500			6 218		8319 555 700	160	305 32	
2330	100	32400 31000 287	5277 13.0 13.0 430 500			6 218		7411 561 600	160	305 32	
TOTAL	802	258550	26100 2285	28950 104 104 4640		48 12744		6274	1300	4756 270	
AVG	100	32319	32625 286	3624 13 13 431		6 218		7844	163	595 34	
TOTAL	2682	799050	1028850 1053000 7071	14877 78128 1903 1756		144 5592		19384	3440	15018 837	
AVG	107	33294	20570 29300 295	2975 2681 106 115 13.4 438		6 218		8077	161	601 35	

OPERATING DATA

	FIRST SHIFT	SECOND SHIFT	THIRD SHIFT	
A STEAM FLOW FINAL (Integrator)	367989 699792 531973	3231157 5372114	3788388 5441429	7990500 TOTAL
B STEAM FLOW START	362347 577735 [illegible]	3679889 5317973	3731157 5372114	1028850
C TOTAL STEAM PRODUCED	282760 102850 128050	2581400 240080	2585500 2357500	15277750
D LBS STEAM PER UNIT OF FUEL				
E SOOT BLOWN	C4:18	#4 - 1200 HRS	2285-2308 2310-2314	
F BLOW DOWN	TIME 1315 GALS 264+245=509	TIME 0555 GALS 264+245=509	TIME 1415 GALS 264+280=544	2407
G DEGREE DAY				
H OPERATOR	BATES II REILLY	Ryan, Wilson	ILKowski - DingFelder	
I FIREMAN				
J TOTAL MANHOURS OPERATION	16	16	16	48

13 REMARKS (Continue on reverse)

W.E. 66. 1121

[illegible] 0615 0725

W.C. + GS0830

ASHES 1105 - 1125
1320 - 1335

Pool offat 1395

WC GG, LA

Ashes 2120

DATE

SIGNATURE OF CHIEF OPERATING ENGINEER

6 PLANT COMBUSTION EFFICIENCY (Percent)
85% 83.8%

7 PLANT BTU OUTPUT (Millions)
15211447760

8 PLANT BTU INPUT (Millions)
24886200000

9 OVERALL EFFICIENCY (Percent)
61.19%

10 PEAK DEMAND FACTOR (Percent)

11 MAKEUP WATER (Percent)
7.7%

12 TOTAL FUEL USED
TNS 463.75
14135E000

COAL LBS 933.15

OIL GALS 7071
1074792000

GAS MCF

FORM OF 93 1458 PREVIOUS EDITION WILL BE USED

TEST RUN

BOILER #4, SCRUBBER, RUNS #1, 2, 3

DAILY STEAM BOILER PLANT OPERATING LOG

1 COMMAND: SAC
2 BASE AND LOCATION: GRIFFISS AFB NY 13441
3 BUILDING NO AND NAME: 2236 Chp
4 DATE: 22 Nov 87

A TIME HOUR	B STEAM PRESS (PSIG)	C STEAM PRODUCED (1000 Pounds) BOILER NO 1	2	3	4	D FUEL USED: COAL - BTU/LB; OIL - BTU/GAL; GAS - BTU/1000CF — BOILER NO 1	2	3	4	E FLUE GAS: O_2 OR CO_2 (Aug %) BOILER NO 1	2	3	4	TEMP (Degrees F) BOILER NO 1	2	3	4	F FUEL OIL: PRESS (PSIG)	TEMP (°F)	G FEEDWATER HEATER: PRESS (PSIG)	TEMP (°F)	H FEEDWATER FLOW (Gals): START	STOP	GALS	I MAKE UP WATER FLOW (Gals): START	STOP	GALS	J CONDENSATE RETURN TEMP (°F)	K FEEDWATER PUMP PRESSURES (PSIG): SUCT	DISCH	L OUTSIDE AIR TEMPERATURE (°F)
FIRST SHIFT 0030	100	34000			32000	301			3556	13.0			13.0	430			500			6	218			7952	561	70	900	160		205	32
0130	100	33000			32000	299			3556	13.0			13.0	430			500			6	218			7928		77	700	160		205	32
0230	100	33000			32000	299			3556	13.0			13.0	430			500			6	218			7928		84	700	160		205	30
0330	100	33600			32000	297			3556	13.0			13.0	430			500			6	218			7904		93	800	160		205	30
0430	100	31500			32000	279			3556	13.0			13.0	430			500			6	218			7451		99	700	160		205	30
0530	100	31500			32000	279			3556	13.0			13.0	430			500			6	218			7451		1605	600	160		205	30
0630	100	34700			34000	307			3778	13.0			13.0	430			500			6	218			7977		611	600	160		205	30
0730	100	35300			33000	312			3556	13.0			13.0	430			500			6	218			8108		618	700	160		205	30
TOTAL	800	268300			258000	2373			28670	104.0			104.0	3440			4000			48	1744			63399		1906	1200	1280		1640	244
AVG	100	33535			32250	297			3584	13.0			13.0	430			500			6	218			7925		488	700	160		205	31
SECOND SHIFT 0830	98	30850			35000	273			3809	11.0			11.0	430			500			6	218			7934	561	923	700	160		205	30
0930	104	32650			36000	289			4002	12.5			14.5	420			500			6	218			7967		631	600	160		205	40
1030	112	39400			36000	341			4002	12.0			13.0	420			500			6	218			7967		633	700	160		205	42
1130	103	23500			37000	208			4111	10.5			15.0	420			500			6	218			7289		646	700	160		205	50
1230	106	19350			35000	171			4113	10.0			15.0	420			500			6	218			7000		711	600	160		205	56
1330	106	20550			37000	182			4113	11.5			15.0	420			500			6	218			6934		721	600	160		205	56
1430	116	19350			35000	165			4113	11.0			14.5	420			500			6	218			6934		727	600	160		205	56
1530	108	17400			35000	155			4113	11.0			14.5	420			500			6	218			6934		737	600	160		205	56
TOTAL	844	190250			355000	1795			33312	91.5			116.5	3360			4000			48	1744			58477			5400	1280		1640	464
AVG	105	23781			36250	224			4167	11.4			14.6	421			500			6	218			7310			675	160		205	58
THIRD SHIFT 2330	116	21300			37000	180			4167	11.0			14.0	419			520			7	218			7317	561	826	1000	160		260	64
2430	112	19400			36000	180			4167	11.5			14.0	420			520			7	218			7317		834	1000	160		260	57
0130	114	18250			35000	166			3559	11.5			14.0	420			520			6	218			6176		837	900	160		260	54
0230	114	20100			36000	174			3559	11.5			14.0	420			520			6	218			6176		837	900	160		260	54
0330	114	20100			36000	180			3559	11.5			14.0	420			520			6	218			6176		837	900	160		260	54
TOTAL	570	119150			216000	1040			21351	68.0			84.0	2519			3120			38	1308			43162			5700	960		1560	337
AVG	114	23830			36000	173			3559	11.3			14.0	420			520			6	218			7194			950	160		260	56
DAILY TOTAL	1514	417700			609000	5464			83333	288			365	10238			12120			144	5232			164643			13112	3440		4920	1237
AVG	107	65733			32450	228			3606	12			13.5	430			505			6	218			7300			546	160		205	52

5 OPERATING DATA

	FIRST SHIFT	SECOND SHIFT	THIRD SHIFT #4	TOTAL
A STEAM FLOW FINAL (Integrator)	28 36 92 5466 51	391 55 1145	390680 007627 556105	#3 616 50
B STEAM FLOW START	328328 547429	395692 546661	384677 006474 551945	#4 778 800
C TOTAL STEAM PRODUCED	268200 259000	19035 [illegible]	[illegible]	[illegible]
D LBS STEAM PER UNIT OF FUEL				
E SOOT BLOWN	#3 0045		#4 0830 / #3 1110	
F BLOW DOWN	TIME 0015 GALS 364+1530+1797	TIME 0130 GALS 2645+1610	TIME 1620 GALS 2+3736+194	4054
G DEGREE DAY				
H OPERATOR	Richard=Toner	[illegible]	[illegible]	
I FIREMAN				
J TOTAL MANHOURS OPERATION	16	24	24	64

13 REMARKS (Continue on reverse)

WC-GG 0010
Ashes 2000 #30 20

Blow Down #3 1205 1330

WC-GG 0015
Ashes 1010 1220 70

Blow Down #2 74 = 770

WC-GG 0015
[illegible]
Ashes 2195 2235 450
In Fire #3 @ 800 on 1 700
#4 Side Headers #4 2 - 1630 2 - [illegible]

DATE

SIGNATURE OF CHIEF OPERATING ENGINEER

6 PLANT COMBUSTION EFFICIENCY (Percent): #1 #3 #4 — 81% 81% 82%
7 PLANT STU OUTPUT (Millions)
8 PLANT STU INPUT (Millions)
9 OVERALL EFFICIENCY (Percent)
10 PEAK DEMAND FACTOR (Percent) 61%
11 MAKEUP WATER (Percent) 7.5%
12 TOTAL FUEL USED: 1,167,310 [illegible]
COAL LBS
OIL GALS
GAS MCF

AF FORM 1458 OCT 82 PREVIOUS EDITION WILL BE USED

Test Run

APPENDIX D

Coal Analysis

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A Litton/Dresser Company

CORE LABORATORIES

CORE LABORATORIES, INC.

ANALYTICAL REPORT

2315 GLENVIEW AVE.
EVANSVILLE, IN 47712
(812) 424-2909

04-JAN-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121487
SAMPLE NO. : 0001
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION
CAN NUMBER 4279
{BOILER #3
BYPASS
RUN #1}

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	18.75	4.44	---
% ASH	4.30	5.06	5.29
% VOLATILE	28.78	33.85	35.42
% FIXED CARBON	48.17	56.66	59.29
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.80	0.95	0.99
BTU/LB.	11,066	13,015	13,620
MAF BTU/LB.	---	---	14,380
LBS SULFUR/MM BTU	0.72		
LBS WATER/MM BTU	16.94		
LBS ASH/MM BTU	3.89		

ASH SOFTENING TEMP: 2675 DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil

KEVIN J. WEIL

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04-JAN-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121087
SAMPLE NO. : 0002
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION
CAN NUMBER 1300
{BOILER #3
BYPASS
RUN #2}

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	17.76	4.82	---
% ASH	5.27	6.10	6.41
% VOLATILE	29.42	34.05	35.77
% FIXED CARBON	47.55	55.03	57.82
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.76	0.88	0.92
BTU/LB.	11,162	12,919	13,573
MAF BTU/LB.	---	---	14,501
LBS SULFUR/MM BTU	0.68		
LBS WATER/MM BTU	15.91		
LBS ASH/MM BTU	4.72		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil

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(812) 424-2909

17-DEC-87

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121087
SAMPLE NO. : 0003
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION
CAN NUMBER 2284
{BOILER #3 BYPASS RUN #3}

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	14.70	4.43	---
% ASH	5.23	5.86	6.13
% VOLATILE	30.69	34.39	35.98
% FIXED CARBON	49.38	55.33	57.89
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.74	0.83	0.87
BTU/LB.	11,571	12,964	13,565
MAF BTU/LB.	---	---	14,451
LBS SULFUR/MM BTU	0.64		
LBS WATER/MM BTU	12.70		
LBS ASH/MM BTU	4.52		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

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04-JAN-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121487
SAMPLE NO. : 0002
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION
CAN NUBMER 2442

{ BOILER # 3
SCRUBBER
RUN # 1 }

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	15.90	5.21	---
% ASH	4.51	5.08	5.36
% VOLATILE	29.69	33.46	35.30
% FIXED CARBON	49.90	56.25	59.34
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.74	0.83	0.88
BTU/LB.	11,439	12,893	13,602
MAF BTU/LB.	---	---	14,372
LBS SULFUR/MM BTU	0.65		
LBS WATER/MM BTU	13.90		
LBS ASH/MM BTU	3.94		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

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17-DEC-87

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121087
SAMPLE NO. : 0001
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION
CAN NUMBER 2388
{BOILER #3 SCRUBBER RUN #2}

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	15.76	3.16	---
% ASH	5.33	6.13	6.33
% VOLATILE	30.79	35.40	36.55
% FIXED CARBON	48.12	55.32	57.12
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.75	0.86	0.89
BTU/LB.	11,409	13,116	13,544
MAF BTU/LB.	---	---	14,458
LBS SULFUR/MM BTU	0.66		
LBS WATER/MM BTU	13.81		
LBS ASH/MM BTU	4.67		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

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DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121587
SAMPLE NO. : 0001
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION

CAN #3648
BOILER #3
SCRUBBER
RUN #3

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	15.41	3.54	- -
% ASH	5.30	6.04	6.26
% VOLATILE	31.00	35.35	36.65
% FIXED CARBON	48.29	55.07	57.09
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.73	0.83	0.86
BTU/LB.	11,474	13,084	13,564
MAF BTU/LB.	---	---	14,469
LBS SULFUR/MM BTU	0.64		
LBS WATER/MM BTU	13.43		
LBS ASH/MM BTU	4.62		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil

KEVIN J. WEIL

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04-JAN-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121587
SAMPLE NO. : 0002
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION

CAN #3872
{BOILER #4
BYPASS
RUN# 1}

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	18.97	5.09	---
% ASH	5.65	6.62	6.97
% VOLATILE	29.00	33.97	35.79
% FIXED CARBON	46.38	54.33	57.24
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.97	1.14	1.20
BTU/LB.	10,834	12,689	13,370
MAF BTU/LB.	---	---	14,371
LBS SULFUR/MM BTU	0.90		
LBS WATER/MM BTU	17.51		
LBS ASH/MM BTU	5.21		

ASH SOFTENING TEMP: 2590 DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil

KEVIN J. WEIL

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17-DEC-87

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121087
SAMPLE NO. : 0004
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION
CAN NUMBER 2448
{BOILER# 4 BYPASS RUN# 2}

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	16.36	4.80	---
% ASH	5.52	6.28	6.60
% VOLATILE	30.10	34.26	35.99
% FIXED CARBON	48.02	54.65	57.41
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.74	0.84	0.88
BTU/LB.	11,302	12,864	13,513
MAF BTU/LB.	---	---	14,467
LBS SULFUR/MM BTU	0.65		
LBS WATER/MM BTU	14.47		
LBS ASH/MM BTU	4.88		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil

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04-JAN-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121487
SAMPLE NO. : 0004
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION
CAN NUMBER 29
{BOILER#4 BYPASS RUN#3}

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	15.08	4.95	---
% ASH	5.37	6.01	6.32
% VOLATILE	30.21	33.82	35.58
% FIXED CARBON	49.34	55.22	58.10
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.74	0.83	0.87
BTU/LB.	11,464	12,832	13,500
MAF BTU/LB.	---	---	14,410
LBS SULFUR/MM BTU	0.65		
LBS WATER/MM BTU	13.15		
LBS ASH/MM BTU	4.68		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

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DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121587
SAMPLE NO. : 0004
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION

CAN #3035

BOILER #4
SCRUBBER
RUN #1

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	16.66	3.95	---
% ASH	5.33	6.15	6.40
% VOLATILE	29.97	34.54	35.96
% FIXED CARBON	48.04	55.36	57.64
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.73	0.85	0.88
BTU/LB.	11,334	13,063	13,600
MAF BTU/LB.	---	---	14,529
LBS SULFUR/MM BTU	0.64		
LBS WATER/MM BTU	14.70		
LBS ASH/MM BTU	4.70		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

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ANALYTICAL REPORT

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04-JAN-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121587
SAMPLE NO. : 0003
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION

CAN #4264
BOILER #4
SCRUBBER
RUN #2

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	16.47	2.46	---
% ASH	5.23	6.11	6.26
% VOLATILE	30.64	35.78	36.68
% FIXED CARBON	47.66	55.66	57.06
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.71	0.83	0.85
BTU/LB.	11,356	13,261	13,595
MAF BTU/LB.	---	---	14,502
LBS SULFUR/MM BTU	0.63		
LBS WATER/MM BTU	14.50		
LBS ASH/MM BTU	4.61		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil

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ANALYTICAL REPORT

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04-JAN-88

DEPT. OF THE AIR FORCE
305 CSG/DE
GRISSOM A.F.B., IN 46971-500

FILE NUMBER: GA121487
SAMPLE NO. : 0003
INVOICE JOB #: C71928
LOCATION #: 63120

IDENTIFICATION
CAN NUMBER 0624
BOILER #4
SCRUBBER
RUN #3

	AS RECEIVED BASIS	AIR DRIED BASIS	DRY BASIS
% MOISTURE	15.19	3.74	---
% ASH	5.44	6.18	6.42
% VOLATILE	30.06	34.11	35.44
% FIXED CARBON	49.31	55.97	58.14
TOTAL PERCENTAGE	100.00	100.00	100.00
% SULFUR	0.73	0.83	0.86
BTU/LB.	11,495	13,047	13,554
MAF BTU/LB.	---	---	14,484
LBS SULFUR/MM BTU	0.64		
LBS WATER/MM BTU	13.21		
LBS ASH/MM BTU	4.73		

ASH SOFTENING TEMP: 2700+ DEGREE F.

RESPECTFULLY SUBMITTED,

Kevin J. Weil

KEVIN J. WEIL

APPENDIX E

Boiler 3, Bypass Stack

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****

S O U R C E T E S T R E P O R T

SOURCE :
GRISSOM AFB CENTRAL HEATING PLANT

GRISSOM AFB, IN 46971

DEVICE TESTED : BOILER #3:BYPASS STACK

DATE TESTED : 18-20 NOV 87

SUBMITTING AGENCY :
USAFOEHL/ECQ

BROOKS AFB, TX 78235

****

DETERMINATION OF MINIMUM NUMBER OF TRAVERSE POINTS

Stack ID: BYPASS Stack diameter at ports: 5.5 (ft)

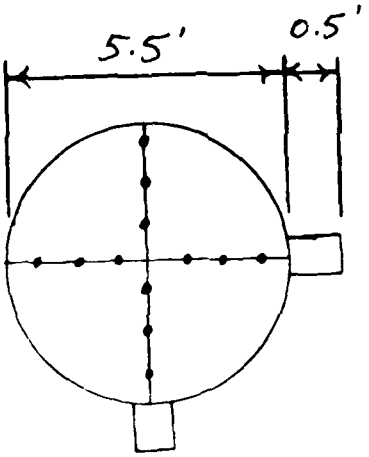
Distance A (ft) 11.5 (duct diameters) 2.1

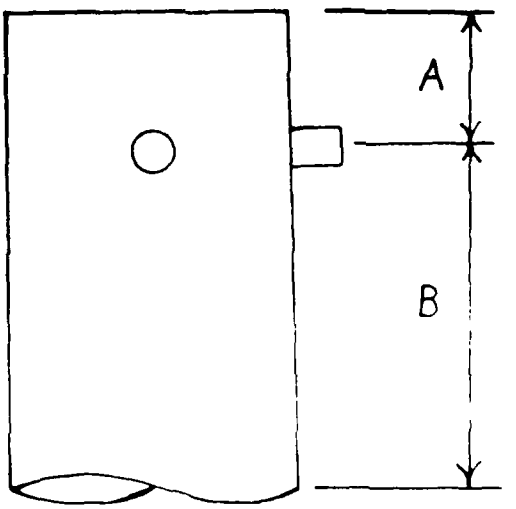
Recommended number of traverse points as determined by distance A: 12

Distance B (ft) 39.5 (duct diameters) 7.2

Recommended number of traverse points as determined by distance B: 12

Number of traverse points used: 12





****

T E S T T R A V E R S E P O I N T L O C A T I O N

STACK DIAM. (IN.) = 66
STACK RADIUS (IN.) = 33
STACK DIAM. (FT.) = 5.5
STACK AREA (SQ.FT) = 23.75828

POINT #	DISTANCE IN.
1	2.875261
2	9.665478
3	19.52781
4	46.4722
5	56.33452
6	63.12474

THE ABOVE DISTANCES PROCEED FROM THE TEST PORT ACROSS THE
TRAVERSE TO THE OPPOSITE WALL OF THE STACK.
THESE DISTANCES SHOULD BE ROUNDED OFF TO THE NEAREST 1/4 INCH.
THAT'S ABOUT AS ACCURATE AS YOU CAN GET WITH AN EPA METHOD 5
PROBE.

STANDARD CONDITIONS (TEMP. AND PRESSURE)

STD.TEMP (F) = 68
STD.TEMP (R) = 528
STD. PRESSURE (IN.HG) = 29.92

****

***** R U N # 1 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.
AMBIENT DRY BULB (K) = 279.2611
AMBIENT WET BULB (K) = 276.4833
SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 31.467 DEG. F.
VAPOR PRESSURE (IN.HG) = .1766514
SATURATION VAPOR PRESS. (IN.HG) = .2770307
RELATIVE HUMIDITY (%) = 63.76599
SPECIFIC HUMIDITY (pp1000) = 3.792975

M E T E R D A T A P R O G R A M

OF TEST POINTS = 12
AMBIENT PRESS. (IN.HG) = 29.42

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	47	47	47	1.88
2	49	47	48	1.69
3	53	48	50.5	2.08
4	56	49	52.5	1.9
5	57	50	53.5	1.33
6	57	50	53.5	1.52
7	51	51	51	1.13
8	50	50	50	1.32
9	52	50	51	1.7
10	55	50	52.5	2.09
11	57	51	54	2.28
12	58	51	54.5	1.71

FINAL AVG. METER TEMP (R) = 511.5
DELTA H@ VALUE = 2.11
FINAL AVG. METER PRESS. (IN.HG) = 29.54641

****

H 2 O T E S T D A T A

START METER READING = 41.3
END METER READING = 77.093
TOTAL CONDENSATE VOL (ML) = 50.08
H2O VAPOR GAS VOLUME @ STP = 2.373792
TOTAL METER GAS VOL (uncorrected CF) = 35.793
AVG. METER TEMP (R) = 511.5
TOTAL DRY SAMPLE VOL (CF @ STP) = 36.48628
MOLE FRACTION DRY AIR = .9389143
% H2O BY VOL = 6.108565

G A S D E N S I T Y

% CO2 = 10.17
% O2 = 9.37
% CO = 0
% N2 = 78

GAS DENSITY = .9886743

DRY MOL. WT. = 29.3132

****

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .498
NOZZLE AREA (FT2) = 1.352651E-03
PITOT FACTOR = .84
ATMOS. PRESS (IN.HG) = 29.42
STACK PRESS (IN.HG) = 29.4237
TEST START TIME = 1437

PT/DELTA P # / IN.H20	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H20	TIME MINS
1 / .05	880 / 507	16.38736	1.88	5
2 / .045	880 / 508	15.54642	1.69	5
3 / .055	880 / 510.5	17.18721	2.08	5
4 / .05	880 / 512.5	16.38736	1.9	5
5 / .035	880 / 513.5	13.71065	1.33	5
6 / .04	880 / 513.5	14.6573	1.52	5
7 / .03	880 / 511	12.6936	1.13	5
8 / .035	880 / 510	13.71065	1.32	5
9 / .045	880 / 511	15.54642	1.7	5
10 / .055	880 / 512.5	17.18721	2.09	5
11 / .06	880 / 514	17.95146	2.28	5
12 / .045	880 / 514.5	15.54642	1.71	5

TOTAL METER VOLUME = 35.793
AVG. STACK TEMP (R) = 880
AVG. STACK VEL (FT/SEC) = 15.54267
AVG. STACK VEL (FT/MIN) = 932.5603
AVG. METER TEMP (R) = 511.5
AVG. METER DELTA H (IN.H20) = 1.719167
AVG. METER PRESSURE (IN.HG) = 29.54641
TOTAL MINS OF TEST = 60
STACK ACFM = 22156.02
STACK DSCFM = 12272.98

****

I S O K I N E T I C A N A L Y S I S

TOTAL CONDENSATE VOLUME (ML) = 50.08
AVERAGE STACK TEMPERATURE (R) = 880
TOTAL METER GAS VOL (uncorrected CF) = 35.793
AVG METER TEMP (R) = 511.5
BAROMETRIC PRESSURE (IN.HG) = 29.42
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 1.719167
AVG. STACK VEL (FT/MIN) = 15.54267
STACK PRESSURE (IN.HG) = 29.4237
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 1.352651E-03
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 93.70332 %

P A R T I C U L A T E E M I S S I O N R A T E

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .2719
SAMPLE WT. (GMS) = .2719
SAMPLE VOL. (DSCFM) = 36.48628
CONCENTRATION (GR/DSCF) = .1149862
% CO2 = 10.17
CONCENTRATION @ 12% CO2 (GR/DSCF) = .1356769
STACK DSCFM = 12272.98
PM EMISSIONS (stk conds) (LB/HR) = 12.09559
PM EMISSIONS (@ 12% CO2) (LB/HR) = 14.27209

******* END OF ANALYSIS FOR RUN # 1 *******

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***** R U N # 2 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.
AMBIENT DRY BULB (K) = 279.8167
AMBIENT WET BULB (K) = 277.8722
SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 36.48698 DEG. F.
VAPOR PRESSURE (IN.HG) = .2154221
SATURATION VAPOR PRESS. (IN.HG) = .2877726
RELATIVE HUMIDITY (%) = 74.85843
SPECIFIC HUMIDITY (pp1000) = 4.627782

M E T E R D A T A P R O G R A M

OF TEST POINTS = 12
AMBIENT PRESS. (IN.HG) = 29.387

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	53	50	51.5	1.4
2	52	50	51	1.4
3	55	51	53	1.6
4	57	50	53.5	2.01
5	58	52	55	2.01
6	59	53	56	2.01
7	51	51	51	1.4
8	51	50	50.5	1.6
9	52	50	51	2.01
10	51	50	50.5	1.99
11	56	51	53.5	1.6
12	58	51	54.5	1.2

FINAL AVG. METER TEMP (R) = 512.5833
DELTA H0 VALUE = 2.11
FINAL AVG. METER PRESS. (IN.HG) = 29.51096

****

H 2 O T E S T D A T A

START METER READING = 77.441
END METER READING = 112.782
TOTAL CONDENSATE VOL (ML) = 60.34
H2O VAPOR GAS VOLUME @ STP = 2.860116
TOTAL METER GAS VOL (uncorrected CF) = 35.341
AVG. METER TEMP (R) = 512.5833
TOTAL DRY SAMPLE VOL (CF @ STP) = 35.90624
MOLE FRACTION DRY AIR = .9262217
% H2O BY VOL = 7.377831

G A S D E N S I T Y

% CO2 = 10.67
% O2 = 8.07
% CO = 0
% N2 = 78

GAS DENSITY = .9774436

DRY MOL. WT. = 29.1172

****

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .498
NOZZLE AREA (FT2) = 1.352651E-03
PITOT FACTOR = .84
ATMOS. PRESS (IN.HG) = 29.387
STACK PRESS (IN.HG) = 29.3936
TEST START TIME = 1002

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .035	878 / 511.5	13.78057	1.4	5
2 / .035	878 / 511	13.78057	1.4	5
3 / .04	887 / 513	14.80736	1.6	5
4 / .05	897 / 513.5	16.64819	2.01	5
5 / .05	892 / 515	16.60172	2.01	5
6 / .05	892 / 516	16.60172	2.01	5
7 / .035	880 / 511	13.79625	1.4	5
8 / .04	883 / 510.5	14.77393	1.6	5
9 / .05	885 / 511	16.53645	2.01	5
10 / .05	891 / 510.5	16.59242	1.99	5
11 / .04	891 / 513.5	14.84071	1.6	5
12 / .03	880 / 514.5	12.77285	1.2	5

TOTAL METER VOLUME = 35.341
AVG. STACK TEMP (R) = 886.1667
AVG. STACK VEL (FT/SEC) = 15.12773
AVG. STACK VEL (FT/MIN) = 907.6636
AVG. METER TEMP (R) = 512.5833
AVG. METER DELTA H (IN.H2O) = 1.685834
AVG. METER PRESSURE (IN.HG) = 29.51096
TOTAL MINS OF TEST = 60
STACK ACFM = 21564.52
STACK DSCFM = 11688.72

****

I S O K I N E T I C A N A L Y S I S

TOTAL CONDENSATE VOLUME (ML) = 60.34
AVERAGE STACK TEMPERATURE (R) = 886.1667
TOTAL METER GAS VOL (uncorrected CF) = 35.341
AVG METER TEMP (R) = 512.5833
BAROMETRIC PRESSURE (IN.HG) = 29.387
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 1.685834
AVG. STACK VEL (FT/MIN) = 15.12773
STACK PRESSURE (IN.HG) = 29.3936
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 1.352651E-03
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 96.71302 %

P A R T I C U L A T E E M I S S I O N R A T E

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .3003
SAMPLE WT. (GMS) = .3003
SAMPLE VOL. (DSCFM) = 35.90624
CONCENTRATION (GR/DSCF) = .129048
% CO2 = 10.67
CONCENTRATION @ 12% CO2 (GR/DSCF) = .1451337
STACK DSCFM = 11688.72
PM EMISSIONS (stk conds) (LB/HR) = 12.92855
PM EMISSIONS (@ 12% CO2) (LB/HR) = 14.54007

******* END OF ANALYSIS FOR RUN # 2 *******

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***** R U N # 3 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.
AMBIENT DRY BULB (K) = 272.5944
AMBIENT WET BULB (K) = 270.3722
SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 19.01367 DEG. F.
VAPOR PRESSURE (IN.HG) = .1060571
SATURATION VAPOR PRESS. (IN.HG) = .1733842
RELATIVE HUMIDITY (%) = 61.16885
SPECIFIC HUMIDITY (pp1000) = 2.275113

M E T E R D A T A P R O G R A M

OF TEST POINTS = 12
AMBIENT PRESS. (IN.HG) = 29.2

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	38	36	37	1.54
2	39	37	38	1.93
3	41	37	39	1.93
4	42	37	39.5	1.93
5	42	37	39.5	1.16
6	42	38	40	1.16
7	37	36	36.5	1.16
8	38	37	37.5	1.54
9	39	36	37.5	1.54
10	39	36	37.5	1.93
11	40	36	38	1.74
12	38	35	36.5	1.59

FINAL AVG. METER TEMP (R) = 498.0417
DELTA H@ VALUE = 2.11
FINAL AVG. METER PRESS. (IN.HG) = 29.31734

****

H 2 0 T E S T D A T A

START METER READING = 113.276
END METER READING = 147.475
TOTAL CONDENSATE VOL (ML) = 56.75
H20 VAPOR GAS VOLUME @ STP = 2.68995
TOTAL METER GAS VOL (uncorrected CF) = 34.19901
AVG. METER TEMP (R) = 498.0417
TOTAL DRY SAMPLE VOL (CF @ STP) = 35.52587
MOLE FRACTION DRY AIR = .9296116
% H20 BY VOL = 7.03884

G A S D E N S I T Y

% CO2 = 10.1
% O2 = 8.53
% CO = 0
% N2 = 78

GAS DENSITY = .9754186

DRY MOL. WT. = 29.0136

****

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .498
NOZZLE AREA (FT2) = 1.352651E-03
PITOT FACTOR = .84
ATMOS. PRESS (IN.HG) = 29.2
STACK PRESS (IN.HG) = 29.205
TEST START TIME = 855

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .04	885 / 497	14.85373	1.54	5
2 / .05	911 / 498	16.84915	1.93	5
3 / .05	920 / 499	16.93218	1.93	5
4 / .05	919 / 499.5	16.92297	1.93	5
5 / .03	887 / 499.5	12.87824	1.16	5
6 / .03	879 / 500	12.82003	1.16	5
7 / .03	885 / 496.5	12.86371	1.16	5
8 / .04	890 / 497.5	14.89563	1.54	5
9 / .04	901 / 497.5	14.9874	1.54	5
10 / .05	904 / 497.5	16.78429	1.93	5
11 / .045	901 / 498	15.89654	1.74	5
12 / .04	890 / 496.5	14.89563	1.59	5

TOTAL METER VOLUME = 34.19901
AVG. STACK TEMP (R) = 897.6667
AVG. STACK VEL (FT/SEC) = 15.13163
AVG. STACK VEL (FT/MIN) = 907.8975
AVG. METER TEMP (R) = 498.0417
AVG. METER DELTA H (IN.H2O) = 1.595833
AVG. METER PRESSURE (IN.HG) = 29.31734
TOTAL MINS OF TEST = 60
STACK ACFM = 21570.08
STACK DSCFM = 11510.48

****

I S O K I N E T I C A N A L Y S I S

TOTAL CONDENSATE VOLUME (ML) = 56.75
AVERAGE STACK TEMPERATURE (R) = 897.6667
TOTAL METER GAS VOL (uncorrected CF) = 34.19901
AVG METER TEMP (R) = 498.0417
BAROMETRIC PRESSURE (IN.HG) = 29.2
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 1.595833
AVG. STACK VEL (FT/MIN) = 15.13163
STACK PRESSURE (IN.HG) = 29.205
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 1.352651E-03
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 97.20239 %

P A R T I C U L A T E E M I S S I O N R A T E

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .3812
SAMPLE WT. (GMS) = .3812
SAMPLE VOL. (DSCFM) = 35.52587
CONCENTRATION (GR/DSCF) = .1655671
% CO2 = 10.1
CONCENTRATION @ 12% CO2 (GR/DSCF) = .1967134
STACK DSCFM = 11510.48
PM EMISSIONS (stk conds) (LB/HR) = 16.33424
PM EMISSIONS (@ 12% CO2) (LB/HR) = 19.40702

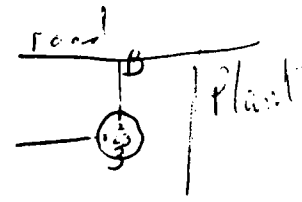
******* END OF ANALYSIS FOR RUN # 3 *******

****

PARTICULATE SAMPLING DATA SHEET

RUN NUMBER: B3 Bypass Run (1)
DATE: 18 NOV
PLANT:
BASE: Grissom
SAMPLE BOX NUMBER: Nutech
METER BOX NUMBER: RAC
Qw/Qm:
Co:

SCHEMATIC OF STACK CROSS SECTION



zero leak/min @ 13" Hg Vac
5 min/pt

EQUATIONS

$^{o}R = {}^{o}F + 460$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$

Stop 77.093

AMBIENT TEMP: 47 °F
STATION PRESS: 29.42 in Hg
HEATER BOX TEMP: °F
PROBE HEATER SETTING:
PROBE LENGTH: .448 in
NOZZLE AREA (A): sq ft
Cp:
DRY GAS FRACTION (Fd):

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H20)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
Port A 1	1437	.05 Vac	5" 420		0.05	1.88	41.300	47	47	47	270	49
2	5		4" 430		0.045	1.69		46	48	47		49
3	10		5" 420		0.055	2.03		53	50.5	48	248	47
4	15		6" 430		.05	1.90	51.0	56	52.5	49	261	49
5	20		6" 420	0.035	~~0.035~~ 0.04	1.33		57	53.5	50	271	
6	25		6" 420		0.04	1.52	57.8	57	53.5	50	271	53
			~~42~~		~~0.03~~	~~1.13~~		~~54~~		~~51~~		
Port E 1	1545		5 420		0.03	1.13		51	51	51	265	48
2	5		5 420		0.035	1.32	62	50	50	50	271	48
3	10		6 420		0.045	1.70		52	51	50	275	54
4	15		6 420		.055	2.09	68.6	55	52.5	50	269	54
5	20		9 420		0.060	2.28		57	54	51	272	51
6	25		12 420		0.045	1.71		58	54.5	51	275	51
	1615						77.093					
							41.300					
							35.793					
									51.5			
						.7192						
						1.72						

PARTICULATE SAMPLING DATA SHEET

RUN NUMBER: Bypass Boiler 3 Run 2

DATE: 19 Nov 87

PLANT:

BASE: Grissom

SAMPLE BOX NUMBER: Att RHC

METER BOX NUMBER: Nutrick

Qw/Qm:

Co:

SCHEMATIC OF STACK CROSS SECTION

(a) 21" Hg
Leak: Zero leak/min
Check
5 min/pt

EQUATIONS

$^{\circ}R = {}^{\circ}F + 460$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$

(1.2)

II

I .2755

AMBIENT TEMP: 39 °F

STATION PRESS: 29.387 in Hg

HEATER BOX TEMP: °F

PROBE HEATER SETTING:

PROBE LENGTH: in

NOZZLE AREA (A): 0.495 sq ft

Cp: .84

DRY GAS FRACTION (Fd): ~ 770

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H20)	STACK TEMP (Ts) (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
1	1002	3	418	0.035	0.035	1.40	97.441	53	51.5	50	236	45
2	5	4	418		0.035	1.4		52	51	50	251	45
3	10	6	427		0.04	1.6		55	53	51	261	
4	15	8	431		0.05	2.01		57	54.5	52	271	
5	20	14	432		0.05	2.01		58	55	52	275	
6	25	19	432		0.05	2.01		59	56	53	270	43
	1032 30						25.235					
1	1033	17	421		0.035	1.4		51	51	51	263	43
2	5	21	423		0.04	1.6		51	50.5	50		
3	10	4	425		0.05	2.01		52	51	50		
4	15	5	431		0.05	1.93		51	50.5	50	264	42
5	20	5	431		0.04	1.6		56	53.5	51	265	43
6	25	5	420		0.03	1.2		53	54	51	266	
	1054 30						113.001					
			420.2									
						1.69	35.50		52.1			
			415									
			419				5.341					
	1056 Pitot out				Top	103.38						
	Pitot out		420		Start	102.60						

OEHL FORM MAY '78 18

PARTICULATE SAMPLING DATA SHEET

RUN NUMBER #3

DATE 2/10-11/87

PLANT Boiler 3 Inlet for 3

BASE Gossett

SAMPLE BOX NUMBER RJC

METER BOX NUMBER Little Red

Qa Qs

Cs

SCHEMATIC OF STACK CROSS SECTION

FILTER WT TARE 0.2799 mg

Stop

EQUATIONS

$°R = °F + 460$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Cs}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$

+ 2.09

Stop #147.475

AMBIENT TEMP 25 °F

STATION PRESS 29.20 in Hg

HEATER BOX TEMP °F

PROBE HEATER SETTING

PROBE LENGTH

NOZZLE AREA (A) .1475 sq ft

Cp .84

DRY GAS FRACTION (Fd) ~1

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H2O)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
A 1		3	425		0.04	1.54	127	35	37	36	233	63
					0.05	1.63			38			
					0.05	1.63			39			
					0.05	1.63			39.5			
					0.03	1.16			39.5			
			419		0.03	1.16			40			
	30				0.03	1.16	130.519	37				
					0.03	1.16			36.5			
					0.04	1.54			37.5			
					0.04	1.54			37.5			
				0.05	0.04	1.63			37.5			
					0.045	1.74			38			
					0.04	1.54			37.5			
	36						143.475					
				1	0.04	15			13			
				2	0.055	17	1.59					
				3	0.055	17						
				4	0.05	17						
				5	0.04	15	34.1990					
				6	0.055	14 (17)						
					0.5130	16						

OEHL FORM MAY 78 18

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
Boiler 3 Grissom	18 Nov	#1

BUILDING NUMBER	SOURCE NUMBER
Bypass Run #1	

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER #1	0.5137	0.2717	0.2420
ACETONE WASHINGS (Probe, Front Half Filter)	105.1850	105.1551	0.0299
BACK HALF (If needed)			
	Total Weight of Particulates Collected		0.2719 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H20)	129	100	29
IMPINGER 2 (H20)	110	100	10
IMPINGER 3 (Dry)	1	0	1
IMPINGER 4 (Silica Gel) 237.7 tare 21.3	216.4	206.32	10.08
216.4	Total Weight of Water Collected		50.08 gm

III. GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	10.05	10.2	10.25		10.17
VOL % O_2	9.2	9.3	9.6		9.37
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

AMD FORM FEB 84 651 REPLACES DEML 20, MAY 74 [illegible]

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
	8/(1/14)	#2

BUILDING NUMBER	SOURCE NUMBER
Boiler 3 Run #2 Bypass	

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER used 2 filters #2	0.8309	0.2755 0.2746	0.2808
ACETONE WASHINGS (Probe, Front Half Filter)	97.6224	97.6029	0.0195
BACK HALF (If needed)			
	Total Weight of Particulates Collected		.3003 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H20)	136 ~~107~~	100	36
IMPINGER 2 (H20)	112	100	12
IMPINGER 3 (Dry)	1	0	1
IMPINGER 4 (Silica Gel) 259.65 Tare 21.3	218.35	207.01	11.34
100 10 0.5 JOK 218.35	Total Weight of Water Collected		60.34 gm

III. GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	10.6	10.6	10.8		
VOL % O_2	8.0	8.0	8.2		
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
Boiler 3 Run 3 Bypass	2/[illegible]	# 3

BUILDING NUMBER	SOURCE NUMBER

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER #3	0.6446	2.3799 ~~0.2799~~	.3647
ACETONE WASHINGS (Probe, Front Half Filter)	98.8491	98.8326	0.0165
BACK HALF (If needed)			
	Total Weight of Particulates Collected		.3812 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H20)	138	100	38
IMPINGER 2 (H20)	109	100	9
IMPINGER 3 (Dry)	1	0	1
IMPINGER 4 (Silica Gel) 237.35 tare 21.3	218.05	209.30	8.75
100 wt ✓ 10 ✓	Total Weight of Water Collected		56.75 gm

III. [illegible] → .57 ✓

GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	~~10.4~~	10.2	9.9 ~~10.2~~	10.2	10.1
VOL % O_2	~~8.8~~	8.7	8.5	8.4	853
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

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APPENDIX F

Boiler 3, Scrubber Stack

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S O U R C E T E S T R E P O R T

SOURCE :

GRISSOM AFB CENTRAL HEATING PLANT

GRISSOM AFB, IN 46971

DEVICE TESTED : BOILER #3:SCRUBBER STACK

DATE TESTED : 23 NOV 87

SUBMITTING AGENCY :

USAFOEHL/ECQ

BROOKS AFB, TX 78235

****

DETERMINATION OF MINIMUM NUMBER OF TRAVERSE POINTS

Stack ID: SCRUBBER STACK B Stack diameter at ports: 5.0 (ft)

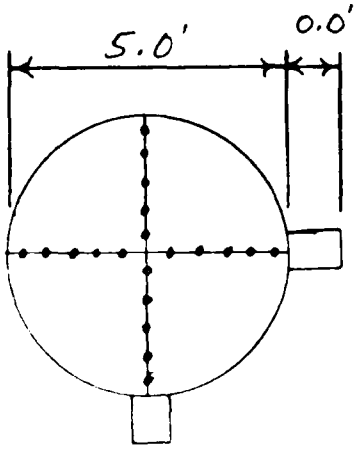
Distance A (ft) 7.0 (duct diameters) 1.4

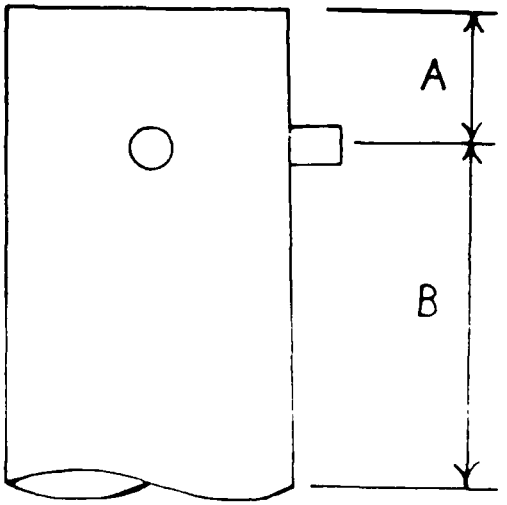
Recommended number of traverse points as determined by distance A: 20

Distance B (ft) 28 (duct diameters) 5.6

Recommended number of traverse points as determined by distance B: 20

Number of traverse points used: 20





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T E S T T R A V E R S E P O I N T L O C A T I O N

STACK DIAM. (IN.) = 60
STACK RADIUS (IN.) = 30
STACK DIAM. (FT.) = 5
STACK AREA (SQ.FT) = 19.63494

POINT #	DISTANCE IN.
1	1.539501
2	4.9002
3	8.786797
4	13.56832
5	20.51317
6	39.48683
7	46.43168
8	51.21321
9	55.0998
10	58.4605

THE ABOVE DISTANCES PROCEED FROM THE TEST PORT ACROSS THE
TRAVERSE TO THE OPPOSITE WALL OF THE STACK.
THESE DISTANCES SHOULD BE ROUNDED OFF TO THE NEAREST 1/4 INCH.
THAT'S ABOUT AS ACCURATE AS YOU CAN GET WITH AN EPA METHOD 5
PROBE.

STANDARD CONDITIONS (TEMP. AND PRESSURE)

STD.TEMP (F) = 68
STD.TEMP (R) = 528
STD. PRESSURE (IN.HG) = 29.92

****

***** R U N # 1 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.
AMBIENT DRY BULB (K) = 280.9278
AMBIENT WET BULB (K) = 279.2611
SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 39.89329 DEG. F.
VAPOR PRESSURE (IN.HG) = .2459105
SATURATION VAPOR PRESS. (IN.HG) = .3103822
RELATIVE HUMIDITY (%) = 79.22828
SPECIFIC HUMIDITY (pp1000) = 5.28485

M E T E R D A T A P R O G R A M

OF TEST POINTS = 20
AMBIENT PRESS. (IN.HG) = 29.02

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	47	47	47	1.84
2	50	48	49	2.14
3	52	48	50	2.53
4	55	49	52	2.78
5	57	49	53	3.21
6	59	50	54.5	3.32
7	61	51	56	3.23
8	61	51	56	3.14
9	63	53	58	3.15
10	63	53	58	2.36
11	63	54	58.5	2.16
12	62	55	58.5	2.36
13	63	55	59	2.46
14	64	55	59.5	2.67
15	65	56	60.5	3.19
16	66	57	61.5	3.28
17	66	57	61.5	3.38
18	67	58	62.5	3.28
19	67	58	62.5	3.47
20	67	58	62.5	2.67

FINAL AVG. METER TEMP (R) = 517
DELTA H@ VALUE = 2.11
FINAL AVG. METER PRESS. (IN.HG) = 29.22816

****

H 2 O T E S T D A T A

START METER READING = 380.784
END METER READING = 428.108
TOTAL CONDENSATE VOL (ML) = 80.8
H2O VAPOR GAS VOLUME @ STP = 3.82992
TOTAL METER GAS VOL (uncorrected CF) = 47.32401
AVG. METER TEMP (R) = 517
TOTAL DRY SAMPLE VOL (CF @ STP) = 47.21335
MOLE FRACTION DRY AIR = .9249672
% H2O BY VOL = 7.503282

G A S D E N S I T Y

% CO2 = 3.37
% O2 = 16.83
% CO = 0
% N2 = 78

GAS DENSITY = .9639005

DRY MOL. WT. = 28.7084

****

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .313
NOZZLE AREA (FT2) = 5.343376E-04
PITOT FACTOR = .84
ATMOS. PRESS (IN.HG) = 29.02
STACK PRESS (IN.HG) = 29.0288
TEST START TIME = 830

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .19	570 / 507	26.2145	1.84	3
2 / .22	571 / 509	28.23299	2.14	3
3 / .26	571 / 510	30.69249	2.53	3
4 / .3	571 / 512	32.96902	2.78	3
5 / .33	574 / 513	34.66892	3.21	3
6 / .34	575 / 514.5	35.22093	3.32	3
7 / .33	574 / 516	34.66892	3.23	3
8 / .32	574 / 516	34.13959	3.14	3
9 / .32	573 / 518	34.10984	3.15	3
10 / .24	574 / 518	29.56575	2.36	3
11 / .22	574 / 518.5	28.30706	2.16	3
12 / .24	574 / 518.5	29.56575	2.36	3
13 / .25	574 / 519	30.17542	2.46	3
14 / .27	573 / 519.5	31.33189	2.67	3
15 / .32	570 / 520.5	34.02043	3.19	3
16 / .33	572 / 521.5	34.60847	3.28	3
17 / .34	572 / 521.5	35.12893	3.38	3
18 / .33	573 / 522.5	34.63871	3.28	3
19 / .35	574 / 522.5	35.70404	3.47	3
20 / .27	575 / 522.5	31.38653	2.67	3

TOTAL METER VOLUME = 47.32401
AVG. STACK TEMP (R) = 572.9
AVG. STACK VEL (FT/SEC) = 32.26751
AVG. STACK VEL (FT/MIN) = 1936.051
AVG. METER TEMP (R) = 517
AVG. METER DELTA H (IN.H2O) = 2.831
AVG. METER PRESSURE (IN.HG) = 29.22816
TOTAL MINS OF TEST = 60
STACK ACFM = 38014.24
STACK DSCFM = 31431.38

****

I S O K I N E T I C A N A L Y S I S

TOTAL CONDENSATE VOLUME (ML) = 80.8
AVERAGE STACK TEMPERATURE (R) = 572.9
TOTAL METER GAS VOL (uncorrected CF) = 47.32401
AVG METER TEMP (R) = 517
BAROMETRIC PRESSURE (IN.HG) = 29.02
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 2.831
AVG. STACK VEL (FT/MIN) = 32.26751
STACK PRESSURE (IN.HG) = 29.0288
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 5.343376E-04
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 98.92119 %

P A R T I C U L A T E E M I S S I O N R A T E

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = 1.1479
SAMPLE WT. (GMS) = 1.1479
SAMPLE VOL. (DSCFM) = 47.21335
CONCENTRATION (GR/DSCF) = .3751502
% CO2 = 3.37
CONCENTRATION @ 12% CO2 (GR/DSCF) = 1.335847
STACK DSCFM = 31431.38
PM EMISSIONS (stk conds) (LB/HR) = 101.0649
PM EMISSIONS (@ 12% CO2) (LB/HR) = 359.8749

******* END OF ANALYSIS FOR RUN # 1 *******

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***** R U N # 2 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.
AMBIENT DRY BULB (K) = 285.3722
AMBIENT WET BULB (K) = 281.4833
SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 40.28562 DEG. F.
VAPOR PRESSURE (IN.HG) = .2496591
SATURATION VAPOR PRESS. (IN.HG) = .4175718
RELATIVE HUMIDITY (%) = 59.78831
SPECIFIC HUMIDITY (pp1000) = 5.365673

M E T E R D A T A P R O G R A M

OF TEST POINTS = 20
AMBIENT PRESS. (IN.HG) = 29.02

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	59	59	59	2.18
2	61	59	60	2.44
3	64	59	61.5	2.8
4	66	60	63	2.99
5	66	60	63	3.28
6	68	60	64	2.99
7	68	61	64.5	3.08
8	69	61	65	3.03
9	69	61	65	3.06
10	70	62	66	2.47
11	69	63	66	2.26
12	68	63	65.5	2.36
13	69	64	66.5	2.45
14	71	64	67.5	2.62
15	72	65	68.5	2.97
16	73	65	69	3.04
17	74	66	70	3.14
18	75	66	70.5	3.05
19	76	67	71.5	3.09
20	76	68	72	2.85

FINAL AVG. METER TEMP (R) = 525.9
DELTA H@ VALUE = 2.11
FINAL AVG. METER PRESS. (IN.HG) = 29.22644

****

H 2 0 T E S T D A T A

START METER READING = 428.304
END METER READING = 475.886
TOTAL CONDENSATE VOL (ML) = 81.63
H2O VAPOR GAS VOLUME @ STP = 3.869262
TOTAL METER GAS VOL (uncorrected CF) = 47.582
AVG. METER TEMP (R) = 525.9
TOTAL DRY SAMPLE VOL (CF @ STP) = 46.66461
MOLE FRACTION DRY AIR = .9234323
% H2O BY VOL = 7.656769

G A S D E N S I T Y

% CO2 = 3.03
% O2 = 17.3
% CO = 0
% N2 = 78

GAS DENSITY = .9633582

DRY MOL. WT. = 28.7092

****

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .313
NOZZLE AREA (FT2) = 5.343376E-04
PITOT FACTOR = .84
ATMOS. PRESS (IN.HG) = 29.02
STACK PRESS (IN.HG) = 29.0288
TEST START TIME = 1000

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .22	570 / 519	28.21619	2.18	3
2 / .245	570 / 520	29.77626	2.44	3
3 / .28	569 / 521.5	31.80422	2.8	3
4 / .3	572 / 523	33.00717	2.99	3
5 / .33	573 / 523	34.64846	3.28	3
6 / .3	573 / 524	33.03601	2.99	3
7 / .31	575 / 524.5	33.64065	3.08	3
8 / .305	576 / 525	33.39726	3.03	3
9 / .31	579 / 525	33.75746	3.06	3
10 / .25	581 / 526	30.36741	2.47	3
11 / .225	570 / 526	28.53503	2.26	3
12 / .235	570 / 525.5	29.16225	2.36	3
13 / .245	573 / 526.5	29.85451	2.45	3
14 / .26	570 / 527.5	30.67424	2.62	3
15 / .295	572 / 528.5	32.73095	2.97	3
16 / .3	569 / 529	32.9205	3.04	3
17 / .31	570 / 530	33.49407	3.14	3
18 / .3	569 / 530.5	32.9205	3.05	3
19 / .305	571 / 531.5	33.25198	3.09	3
20 / .28	570 / 532	31.83216	2.85	3

TOTAL METER VOLUME = 47.582
AVG. STACK TEMP (R) = 572.1
AVG. STACK VEL (FT/SEC) = 31.85136
AVG. STACK VEL (FT/MIN) = 1911.082
AVG. METER TEMP (R) = 525.9
AVG. METER DELTA H (IN.H2O) = 2.8075
AVG. METER PRESSURE (IN.HG) = 29.22644
TOTAL MINS OF TEST = 60
STACK ACFM = 37523.97
STACK DSCFM = 31017.85

****

I S O K I N E T I C A N A L Y S I S

TOTAL CONDENSATE VOLUME (ML) = 81.63
AVERAGE STACK TEMPERATURE (R) = 572.1
TOTAL METER GAS VOL (uncorrected CF) = 47.582
AVG METER TEMP (R) = 525.9
BAROMETRIC PRESSURE (IN.HG) = 29.02
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 2.8075
AVG. STACK VEL (FT/MIN) = 31.85136
STACK PRESSURE (IN.HG) = 29.0288
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 5.343376E-04
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 99.06254 %

P A R T I C U L A T E E M I S S I O N R A T E

INITIAL FILTER WT. (GMS) = .4026
FINAL FILTER WT. (GMS) = .8052
SAMPLE WT. (GMS) = .4026
SAMPLE VOL. (DSCFM) = 46.66461
CONCENTRATION (GR/DSCF) = .1331227
% CO2 = 3.03
CONCENTRATION @ 12% CO2 (GR/DSCF) = .5272185
STACK DSCFM = 31017.85
PM EMISSIONS (stk conds) (LB/HR) = 35.39119
PM EMISSIONS (@ 12% CO2) (LB/HR) = 140.1631

******* END OF ANALYSIS FOR RUN # 2 *******

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***** R U N # 3 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.
AMBIENT DRY BULB (K) = 285.9278
AMBIENT WET BULB (K) = 282.5945
SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 43.74922 DEG. F.
VAPOR PRESSURE (IN.HG) = .2850438
SATURATION VAPOR PRESS. (IN.HG) = .4330654
RELATIVE HUMIDITY (%) = 65.82003
SPECIFIC HUMIDITY (pp1000) = 6.128993

M E T E R D A T A P R O G R A M

OF TEST POINTS = 20
AMBIENT PRESS. (IN.HG) = 29.02

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	68	69	68.5	2.22
2	72	69	70.5	2.41
3	72	69	70.5	2.8
4	73	69	71	3.1
5	74	70	72	3.37
6	75	69	72	3.15
7	77	70	73.5	3.05
8	77	71	74	3.09
9	78	71	74.5	3.08
10	78	71	74.5	2.53
11	76	71	73.5	2.53
12	75	71	73	2.53
13	76	71	73.5	2.54
14	76	70	73	2.79
15	76	70	73	2.99
16	75	70	72.5	3.24
17	76	70	73	3.57
18	76	70	73	3.39
19	76	70	73	3.42
20	76	70	73	3.35

FINAL AVG. METER TEMP (R) = 532.575
DELTA H@ VALUE = 2.11
FINAL AVG. METER PRESS. (IN.HG) = 29.23746

****

H 2 0 T E S T D A T A

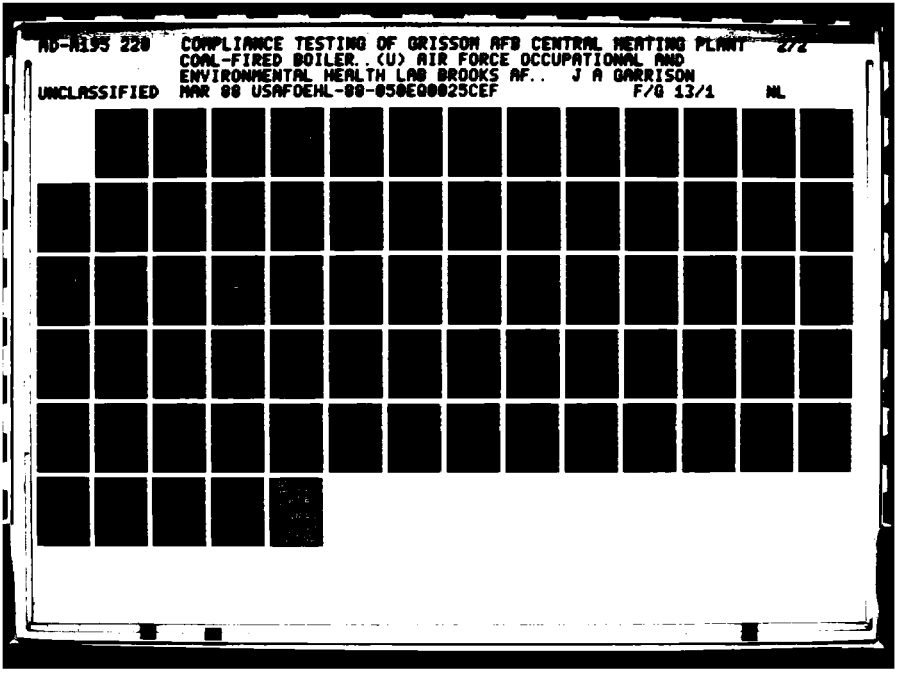
START METER READING = 476.041
END METER READING = 524.95
TOTAL CONDENSATE VOL (ML) = 82.26
H2O VAPOR GAS VOLUME @ STP = 3.899124
TOTAL METER GAS VOL (uncorrected CF) = 48.90903
AVG. METER TEMP (R) = 532.575
TOTAL DRY SAMPLE VOL (CF @ STP) = 47.38275
MOLE FRACTION DRY AIR = .9239668
% H2O BY VOL = 7.603319

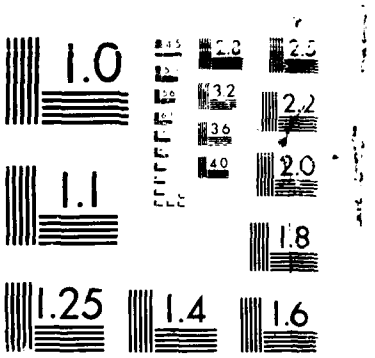
G A S D E N S I T Y

% CO2 = 3.1
% O2 = 17
% CO = 0
% N2 = 78

GAS DENSITY = .961475

DRY MOL. WT. = 28.644


AD-A195 220 COMPLIANCE TESTING OF GRISSOM AFB CENTRAL HEATING PLANT 2/2
COAL-FIRED BOILER..(U) AIR FORCE OCCUPATIONAL AND
ENVIRONMENTAL HEALTH LAB BROOKS AF.. J A GARRISON
UNCLASSIFIED MAR 88 USAFOEHL-88-050E00025CEF F/G 13/1 NL



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S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .313
NOZZLE AREA (FT2) = 5.343376E-04
PITOT FACTOR = .84
ATMOS. PRESS (IN.HG) = 29.02
STACK PRESS (IN.HG) = 29.0288
TEST START TIME = 1136

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .22	570 / 528.5	28.24381	2.22	3
2 / .24	575 / 530.5	29.6288	2.41	3
3 / .28	578 / 530.5	32.08614	2.8	3
4 / .31	578 / 531	33.76131	3.1	3
5 / .335	576 / 532	35.03549	3.37	3
6 / .315	580 / 532	34.09132	3.15	3
7 / .305	581 / 533.5	33.57473	3.05	3
8 / .31	584 / 534	33.93609	3.09	3
9 / .31	587 / 534.5	34.02315	3.08	3
10 / .255	588 / 534.5	30.88398	2.53	3
11 / .25	575 / 533.5	30.23977	2.53	3
12 / .25	575 / 533	30.23977	2.53	3
13 / .255	583 / 533.5	30.75239	2.54	3
14 / .28	584 / 533	32.25225	2.79	3
15 / .3	583 / 533	33.35565	2.99	3
16 / .325	583 / 532.5	34.71766	3.24	3
17 / .355	577 / 533	36.09746	3.57	3
18 / .34	583 / 533	35.50981	3.39	3
19 / .345	586 / 533	35.86187	3.42	3
20 / .34	589 / 533	35.69206	3.35	3

TOTAL METER VOLUME = 48.90903
AVG. STACK TEMP (R) = 580.75
AVG. STACK VEL (FT/SEC) = 32.99918
AVG. STACK VEL (FT/MIN) = 1979.951
AVG. METER TEMP (R) = 532.575
AVG. METER DELTA H (IN.H2O) = 2.9575
AVG. METER PRESSURE (IN.HG) = 29.23746
TOTAL MINS OF TEST = 60
STACK ACFM = 38876.22
STACK DSCFM = 31675.31

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I S O K I N E T I C A N A L Y S I S

TOTAL CONDENSATE VOLUME (ML) = 82.26
AVERAGE STACK TEMPERATURE (R) = 580.75
TOTAL METER GAS VOL (uncorrected CF) = 48.90903
AVG METER TEMP (R) = 532.575
BAROMETRIC PRESSURE (IN.HG) = 29.02
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 2.9575
AVG. STACK VEL (FT/MIN) = 32.99918
STACK PRESSURE (IN.HG) = 29.0288
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 5.343376E-04
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 98.50356 %

P A R T I C U L A T E E M I S S I O N R A T E

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .3033
SAMPLE WT. (GMS) = .3033
SAMPLE VOL. (DSCFM) = 47.38275
CONCENTRATION (GR/DSCF) = 9.876841E-02
% CO2 = 3.1
CONCENTRATION @ 12% CO2 (GR/DSCF) = .3823294
STACK DSCFM = 31675.31
PM EMISSIONS (stk conds) (LB/HR) = 26.81455
PM EMISSIONS (@ 12% CO2) (LB/HR) = 103.7982

******* END OF ANALYSIS FOR RUN # 3 *******

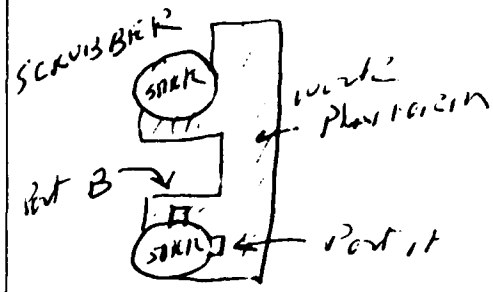
****

PARTICULATE SAMPLING DATA SHEET

RUN NUMBER: SCRUBBER/BOILER 3
DATE: 23 NOV '87
PLANT: POWER PLANT
BASE: CRISTOBAL HILL
SAMPLE BOX NUMBER: RHC
METER BOX NUMBER: METEC
Qw/Qm:
Co:

SCHEMATIC OF STACK CROSS SECTION

RUN 1
PITOT OK
LEAK CK @ 9" Hg = 0 cfm
SOOT BLOW
3 min/pt



EQUATIONS

$^{\circ}R = {}^{\circ}F + 460$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$

AMBIENT TEMP: 45 °F
STATION PRESS: 29.02 in Hg
HEATER BOX TEMP: °F
PROBE HEATER SETTING:
PROBE LENGTH: 6' GLASS in
NOZZLE AREA (A): .313 Sq ft
Cp: .84
DRY GAS FRACTION (Fd): ≈0.93 (1-Bwo)

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H2O)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
1	0830	.12	110		.19	1.84	380.784	47	47	47	230	56
2	3	3	111		.22	2.14		50	49	48	234	57
3	6	4	111		.26	2.53		52	50	48	242	55
4	9	5	111		.30	2.78		55	52	49	250	59
5	12	5	114		.33	3.21		57	53	49	248	55
6	15	6	115		.34	3.32		59	54.5	50	252	59
7	18	6	114		.33	3.23		61	56	51	252	56
8	21	6	114		.32	3.14		61	56	51	252	54
9	24	6	113		.32	3.15		63	58	53	256	53
10	27	5	114		.24	2.96	404.146	63	58	53	248	57
1	0905	5	114		.22	2.16		63	58.5	54	247	57
2	3	5	114		.24	2.36		62	58.5	55	247	58
3	6	5	114		.25	2.46		63	59	55	246	57
4	9	5	113		.27	2.67		64	59.5	55	243	56
5	12	6	110		.32	3.19		65	60.5	56	254	57
6	15	6	112		.33	3.28		66	61.5	57	244	55
7	18	7	112		.34	3.38		66	61.5	57	247	58
8	21	7	113		.33	3.28		67	62.5	58	257	60
9	24	7	114		.35	3.47		67	62.5	58	257	60
10	27	7	115		.27	2.67		67	62.5	56	266	63
	30						425.108					
		Pbar	12.8			avg 2.83						
		Ts	112.9				47.324	Tm	57			

Port B
Port A

OEHL FORM 18 MAY 78

PARTICULATE SAMPLING DATA SHEET

RUN NUMBER: SCRUBBER/BOILER 3

DATE: 23 NOV 84

PLANT: POWER PLANT

BASE: GASCON HF 13

SAMPLE BOX NUMBER: RHC

METER BOX NUMBER: NUTEC

Qw/Qm:

Co:

SCHEMATIC OF STACK CROSS SECTION

RUN 2

PITOT CK OK

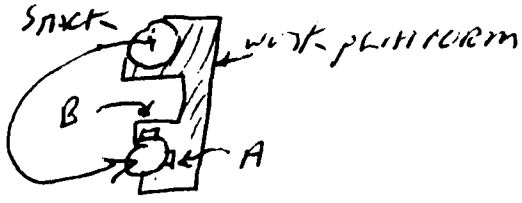
LEAK CK @ 14 "Hg = 3gpm 3 scf/min

3 min PT

EQUATIONS

$^{\circ}R = {}^{\circ}F + 460$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$



Start 428.304

AMBIENT TEMP: 45 °F

STATION PRESS: 29.02 in Hg

HEATER BOX TEMP: °F

PROBE HEATER SETTING:

PROBE LENGTH: 6' GLASS in

NOZZLE AREA (A): .313 sq ft

Cp: .84

DRY GAS FRACTION (Fd): ≈ 69% (1 to 14)

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H20) VAC	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
B 1	1000	.12 5	110		0.22	2.18	428.304	59	59	59	248	51
2	3	5	110		0.245	2.44		61	60	59	258	52
3	6	6	109		0.28	2.8		64	61.5	59	264	56
4	9	6	112		0.3	2.99		66	63	60	267	62
5	12	7	113		.33	3.28		66	63	60	268	65
6	15	6.5	113		.30	2.99		68	64	60	258	65
1	18	7	115		.31	3.08		68	64.5	61	256	65
2	21	7	116		.305	3.03		67	65	61	259	66
3	24	7	119		.31	3.06		69	65	61	258	65
4	27	6	121		.25	2.47		70	66	62	260	62
1	1034	5	110		.225	2.26	452.183	69	66	63	263	60
2	3	5.5	110		0.235	2.36		68	65.2	63	258	61
3	6	6	113		0.245	2.45		67	66.5	64	264	61
4	9	6.5	110		.26	2.62		71	67.5	64	267	66
5	12	7	112		.295	2.97		72	68.5	65	266	65
6	15	2.5	109		.30	3.04		73	69	65	258	64
1	18	8	110		.31	3.14		74	70	66	259	64
2	21	8	109		.30	3.05		75	70.5	66	258	64
3	24	8	111		.305	3.09		76	71.5	67	258	64
10	27	8	110		.28	2.85		76	72	68	260	64
	30					2.8075	475.886		65.59	67		
							47.582					

PARTICULATE SAMPLING DATA SHEET

RUN NUMBER: Scrubber Outlet 3 Run 3
DATE: 23 Nov 87
PLANT:
BASE: (Gibson)
SAMPLE BOX NUMBER: RAC
METER BOX NUMBER: Unitech
Qa / Qm:
Co:

SCHEMATIC OF STACK CROSS SECTION

leak check = .020 / min @ 12" Hg

EQUATIONS

$°R = °F + 460$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$

start 476.041

AMBIENT TEMP: 50 °F
STATION PRESS: 29.02 in Hg
HEATER BOX TEMP: °F
PROBE HEATER SETTING:
PROBE LENGTH: 6' 3 Cats in
NOZZLE AREA (A): .313 sq ft
Cp: .84
DRY GAS FRACTION (Fd): ~ 6%

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H20)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
Port 1 / 1	1136	.12 5	110		.27	2.22	476.041	68	68.5	69	228	63
2	3	6	116		.24	2.41		72	70.5	69	232	63
3	6	6.5	118		.28	2.80		72	70.5	69	227	62
4	9	8	118		.31	3.10		73	71	69	232	62
5	12	8.5	116		.335	3.37		74	72	70	231	63
6	15	8.5	120		.315	3.15		75	73	69	237	63
7	18	8.5	121		.305	3.05		77	73.5	76	237	63
8	21	8.5	124		.31	3.09		77	74	71	237	63
9	24	8.5	127		.31	3.08		78	74.5	71	237	63
10	27	8	128		.255	2.53		78	74.5	71	240	63
Port 1 / 1	1209 30	7	115		.28	2.53	500.188	76	73.5	71	242	62
2	3	7	115		.25	2.53		75	73	71	234	62
3	6	7	123		.255	2.54		76	73.5	71	237	62
4	9	8.5	124		.28	2.79		76	73	70	242	62
5	12	9	123		.3	2.99		76	73	70	249	62
6	15	10	123		.325	3.24		75	72.5	70	235	62
7	18	11.5	117		.355	3.57		76	73	70	238	62
8	21	11.5	123		.34	3.39		76	73	70	227	62
9	24	11.5	126		.345	3.42		76	73	70	236	62
10	27	11.5	129		.34	3.35		76	73	70	234	63
	30						524.950					
									72.53			
						2.9575	48.9090					

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OEHL FORM MAY 78 18

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
63 RI Seward		#11

BUILDING NUMBER	SOURCE NUMBER

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	0.2997	0.2756	0.0241
ACETONE WASHINGS (Probe, Front Half Filter)	103.5539	102.4301	1.1238
BACK HALF (If needed)			
	Total Weight of Particulates Collected		1.1479 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H20)	147	100	47
IMPINGER 2 (H20)	118	100	18
IMPINGER 3 (Dry)	2.8	0	2.8
IMPINGER 4 (Silica Gel)	214.05	201.05	13.0
	Total Weight of Water Collected		60.8 gm

III. GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	3.2	3.47			3.37
VOL % O_2	16.8	16.8	16		16.83
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

OEHL FORM MAY 78 20

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
F3 A 2 Scrubber		#12

BUILDING NUMBER	SOURCE NUMBER

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	0.3033	0.2775	0.0258
ACETONE WASHINGS *(Probe, Front Half Filter)*	105.7493	105.3725	0.3768
BACK HALF *(If needed)*			
	Total Weight of Particulates Collected		.4026 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 *(H20)*	133	100	33
IMPINGER 2 *(H20)*	125	100	25
IMPINGER 3 *(Dry)*	5.4	0	5.4
IMPINGER 4 *(Silica Gel)*	220.00	201.77	18.23
	Total Weight of Water Collected		81.63 gm

III. GASES *(Dry)*

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	2.9	3	3.2		3.03
VOL % O_2	17.3	17.2	17.4		17.3
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
K53R3 Sawdust		#13

BUILDING NUMBER	SOURCE NUMBER

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	0.3086	.2778	0.0308
ACETONE WASHINGS (Probe, Front Half Filter)	100.6792	100.4067	0.2725
BACK HALF (If needed)			
	Total Weight of Particulates Collected		.3033 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H20)	153	100	53
IMPINGER 2 (H20)	112	100	12
IMPINGER 3 (Dry)	2.2	0	2.2
IMPINGER 4 (Silica Gel) 237.8 / 21.3	216.5	201.44	15.06
	Total Weight of Water Collected		82.26 gm

III. GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	3.1	3.2	3.0		3.1
VOL % O_2	16.8	17.0	17.1		17.0
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

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APPENDIX G

Boiler 4, Bypass Stack

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S O U R C E T E S T R E P O R T

SOURCE :
GRISSOM AFB CENTRAL HEATING PLANT

GRISSOM AFB, IN 46971

DEVICE TESTED : BOILER #4:BYPASS STACK

DATE TESTED : 21 NOV 87

SUBMITTING AGENCY :
USAFOEHL/ECQ

BROOKS AFB, TX 78235

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DETERMINATION OF MINIMUM NUMBER OF TRAVERSE POINTS

Stack ID: BYPASS Stack diameter at ports: 5.5 (ft)

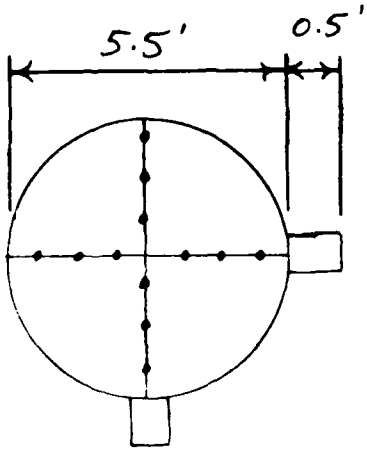
Distance A (ft) 11.5 (duct diameters) 2.1

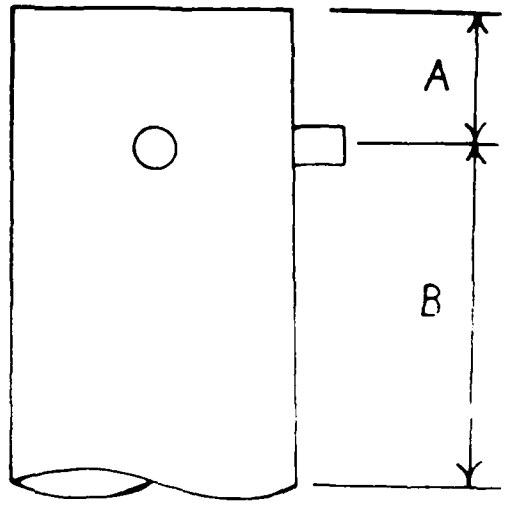
Recommended number of traverse points as determined by distance A: 12

Distance B (ft) 39.5 (duct diameters) 7.2

Recommended number of traverse points as determined by distance B: 12

Number of traverse points used: 12





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T E S T T R A V E R S E P O I N T L O C A T I O N

STACK DIAM. (IN.) = 66
STACK RADIUS (IN.) = 33
STACK DIAM. (FT.) = 5.5
STACK AREA (SQ.FT) = 23.75828

POINT #	DISTANCE IN.
1	2.875261
2	9.665478
3	19.52781
4	46.4722
5	56.33452
6	63.12474

THE ABOVE DISTANCES PROCEED FROM THE TEST PORT ACROSS THE
TRAVERSE TO THE OPPOSITE WALL OF THE STACK.
THESE DISTANCES SHOULD BE ROUNDED OFF TO THE NEAREST 1/4 INCH.
THAT'S ABOUT AS ACCURATE AS YOU CAN GET WITH AN EPA METHOD 5
PROBE.

STANDARD CONDITIONS (TEMP. AND PRESSURE)

STD.TEMP (F) = 68
STD.TEMP (R) = 528
STD. PRESSURE (IN.HG) = 29.92

****

***** R U N # 1 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.
AMBIENT DRY BULB (K) = 269.2611
AMBIENT WET BULB (K) = 268.15
SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 18.65837 DEG. F.
VAPOR PRESSURE (IN.HG) = .1044835
SATURATION VAPOR PRESS. (IN.HG) = .1359793
RELATIVE HUMIDITY (%) = 76.83784
SPECIFIC HUMIDITY (pp1000) = 2.24131

M E T E R D A T A P R O G R A M

OF TEST POINTS = 12
AMBIENT PRESS. (IN.HG) = 30.33

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	44	42	43	.79
2	48	43	45.5	1.58
3	52	45	48.5	1.59
4	55	46	50.5	1.59
5	57	47	52	1.195
6	57	49	53	1.4
7	50	48	49	.79
8	51	49	50	1.59
9	53	49	51	1.99
10	54	50	52	1.79
11	53	49	51	1.59
12	53	49	51	1.6

FINAL AVG. METER TEMP (R) = 509.7084
DELTA H@ VALUE = 2.11
FINAL AVG. METER PRESS. (IN.HG) = 30.4372

****

H 2 O T E S T D A T A

START METER READING = 147.777
END METER READING = 180.796
TOTAL CONDENSATE VOL (ML) = 58.42
H2O VAPOR GAS VOLUME @ STP = 2.769108
TOTAL METER GAS VOL (uncorrected CF) = 33.01901
AVG. METER TEMP (R) = 509.7084
TOTAL DRY SAMPLE VOL (CF @ STP) = 34.79521
MOLE FRACTION DRY AIR = .9262836
% H2O BY VOL = 7.371646

G A S D E N S I T Y

% CO2 = 9.13
% O2 = 9.2
% CO = 0
% N2 = 78

GAS DENSITY = .9673566

DRY MOL. WT. = 28.8012

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S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .498
NOZZLE AREA (FT2) = 1.352651E-03
PITOT FACTOR = .84
ATMOS. PRESS (IN.HG) = 30.33
STACK PRESS (IN.HG) = 30.3381
TEST START TIME = 924

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .02	880 / 503	10.31874	.79	5
2 / .04	880 / 505.5	14.59291	1.58	5
3 / .04	881 / 508.5	14.6012	1.59	5
4 / .04	883 / 510.5	14.61776	1.59	5
5 / .03	871 / 512	12.57304	1.195	5
6 / .035	875 / 513	13.61158	1.4	5
7 / .02	880 / 509	10.31874	.79	5
8 / .04	880 / 510	14.59291	1.59	5
9 / .05	882 / 511	16.3339	1.99	5
10 / .045	884 / 512	15.51326	1.79	5
11 / .04	881 / 511	14.6012	1.59	5
12 / .04	875 / 511	14.55139	1.6	5

TOTAL METER VOLUME = 33.01901
AVG. STACK TEMP (R) = 879.3333
AVG. STACK VEL (FT/SEC) = 13.85222
AVG. STACK VEL (FT/MIN) = 831.1331
AVG. METER TEMP (R) = 509.7084
AVG. METER DELTA H (IN.H2O) = 1.457917
AVG. METER PRESSURE (IN.HG) = 30.4372
TOTAL MINS OF TEST = 60
STACK ACFM = 19746.29
STACK DSCFM = 11133.22

****

I S O K I N E T I C A N A L Y S I S

TOTAL CONDENSATE VOLUME (ML) = 58.42
AVERAGE STACK TEMPERATURE (R) = 879.3333
TOTAL METER GAS VOL (uncorrected CF) = 33.01901
AVG METER TEMP (R) = 509.7084
BAROMETRIC PRESSURE (IN.HG) = 30.33
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H20) = 1.457917
AVG. STACK VEL (FT/MIN) = 13.85222
STACK PRESSURE (IN.HG) = 30.3381
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 1.352651E-03
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 98.39307 %

P A R T I C U L A T E E M I S S I O N R A T E

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .4139
SAMPLE WT. (GMS) = .4139
SAMPLE VOL. (DSCFM) = 34.79521
CONCENTRATION (GR/DSCF) = .1835448
% CO2 = 9.13
CONCENTRATION @ 12% CO2 (GR/DSCF) = .2412418
STACK DSCFM = 11133.22
PM EMISSIONS (stk conds) (LB/HR) = 17.51436
PM EMISSIONS (@ 12% CO2) (LB/HR) = 23.01996

******* END OF ANALYSIS FOR RUN # 1 *******

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***** R U N # 2 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.
AMBIENT DRY BULB (K) = 273.7055
AMBIENT WET BULB (K) = 270.9278
SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 18.03984 DEG. F.
VAPOR PRESSURE (IN.HG) = .1017945
SATURATION VAPOR PRESS. (IN.HG) = .1877665
RELATIVE HUMIDITY (%) = 54.21335
SPECIFIC HUMIDITY (pp1000) = 2.18355

M E T E R D A T A P R O G R A M

OF TEST POINTS = 12
AMBIENT PRESS. (IN.HG) = 30.33

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	51	50	50.5	1.2
2	53	50	51.5	1.6
3	55	50	52.5	2.2
4	57	51	54	2.41
5	59	52	55.5	1.81
6	60	52	56	1.41
7	55	53	54	1.2
8	60	55	57.5	1.62
9	64	57	60.5	1.62
10	66	58	62	1.63
11	66	59	62.5	1.65
12	67	60	63.5	1.46

FINAL AVG. METER TEMP (R) = 516.6667
DELTA H@ VALUE = 2.11
FINAL AVG. METER PRESS. (IN.HG) = 30.45138

****

H 2 0 T E S T D A T A

START METER READING = 181.07
END METER READING = 216.608
TOTAL CONDENSATE VOL (ML) = 65.54
H20 VAPOR GAS VOLUME @ STP = 3.106596
TOTAL METER GAS VOL (uncorrected CF) = 35.538
AVG. METER TEMP (R) = 516.6667
TOTAL DRY SAMPLE VOL (CF @ STP) = 36.96254
MOLE FRACTION DRY AIR = .9224691
% H20 BY VOL = 7.753089

G A S D E N S I T Y

% CO2 = 9.33
% O2 = 10.1
% CO = 0
% N2 = 78

GAS DENSITY = .9779143

DRY MOL. WT. = 29.1772

****

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .498
NOZZLE AREA (FT2) = 1.352651E-03
PITOT FACTOR = .84
ATMOS. PRESS (IN.HG) = 30.33
STACK PRESS (IN.HG) = 30.3381
TEST START TIME = 1201

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .03	880 / 510.5	12.56943	1.2	5
2 / .04	880 / 511.5	14.51392	1.6	5
3 / .055	868 / 512.5	16.90264	2.2	5
4 / .06	865 / 514	17.6237	2.41	5
5 / .045	879 / 515.5	15.38559	1.81	5
6 / .035	881 / 516	13.58424	1.41	5
7 / .03	880 / 514	12.56943	1.2	5
8 / .04	880 / 517.5	14.51392	1.62	5
9 / .04	862 / 520.5	14.36472	1.62	5
10 / .04	870 / 522	14.43122	1.63	5
11 / .04	868 / 522.5	14.41462	1.65	5
12 / .035	863 / 523.5	13.44476	1.46	5

TOTAL METER VOLUME = 35.538
AVG. STACK TEMP (R) = 873
AVG. STACK VEL (FT/SEC) = 14.52652
AVG. STACK VEL (FT/MIN) = 871.5909
AVG. METER TEMP (R) = 516.6667
AVG. METER DELTA H (IN.H2O) = 1.650833
AVG. METER PRESSURE (IN.HG) = 30.45138
TOTAL MINS OF TEST = 60
STACK ACFM = 20707.5
STACK DSCFM = 11711.43

****

I S O K I N E T I C A N A L Y S I S

TOTAL CONDENSATE VOLUME (ML) = 65.54
AVERAGE STACK TEMPERATURE (R) = 873
TOTAL METER GAS VOL (uncorrected CF) = 35.538
AVG METER TEMP (R) = 516.6667
BAROMETRIC PRESSURE (IN.HG) = 30.33
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 1.650833
AVG. STACK VEL (FT/MIN) = 14.52652
STACK PRESSURE (IN.HG) = 30.3381
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 1.352651E-03
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 99.33039 %

P A R T I C U L A T E E M I S S I O N R A T E

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .5538
SAMPLE WT. (GMS) = .5538
SAMPLE VOL. (DSCFM) = 36.96254
CONCENTRATION (GR/DSCF) = .2311836
% CO2 = 9.33
CONCENTRATION @ 12% CO2 (GR/DSCF) = .2973423
STACK DSCFM = 11711.43
PM EMISSIONS (stk conds) (LB/HR) = 23.2059
PM EMISSIONS (@ 12% CO2) (LB/HR) = 29.84682

******* END OF ANALYSIS FOR RUN # 2 *******

****

****

***** R U N # 3 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.
AMBIENT DRY BULB (K) = 274.2611
AMBIENT WET BULB (K) = 271.4833
SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 19.4752 DEG. F.
VAPOR PRESSURE (IN.HG) = .1081325
SATURATION VAPOR PRESS. (IN.HG) = .1953517
RELATIVE HUMIDITY (%) = 55.35275
SPECIFIC HUMIDITY (pp1000) = 2.319696

M E T E R D A T A P R O G R A M

OF TEST POINTS = 12
AMBIENT PRESS. (IN.HG) = 30.33

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	62	62	62	1.02
2	63	62	62.5	1.63
3	67	63	65	1.84
4	69	64	66.5	1.64
5	70	64	67	1.64
6	71	65	68	1.44
7	68	66	67	.82
8	68	66	67	1.44
9	67	66	66.5	2.05
10	68	66	67	1.85
11	68	65	66.5	1.64
12	68	65	66.5	1.23

FINAL AVG. METER TEMP (R) = 525.9583
DELTA H@ VALUE = 2.11
FINAL AVG. METER PRESS. (IN.HG) = 30.44177

****

H 2 0 T E S T D A T A

START METER READING = 216.808
END METER READING = 251.399
TOTAL CONDENSATE VOL (ML) = 60.36
H20 VAPOR GAS VOLUME @ STP = 2.861064
TOTAL METER GAS VOL (uncorrected CF) = 34.591
AVG. METER TEMP (R) = 525.9583
TOTAL DRY SAMPLE VOL (CF @ STP) = 35.33084
MOLE FRACTION DRY AIR = .9250871
% H20 BY VOL = 7.491285

G A S D E N S I T Y

% CO2 = 9.53
% O2 = 9.43
% CO = 0
% N2 = 78

GAS DENSITY = .9748861

DRY MOL. WT. = 29.0508

****

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .498
NOZZLE AREA (FT2) = 1.352651E-03
PITOT FACTOR = .84
ATMOS. PRESS (IN.HG) = 30.33
STACK PRESS (IN.HG) = 30.3381
TEST START TIME = 1415

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .025	880 / 522	11.49207	1.02	5
2 / .04	880 / 522.5	14.53645	1.63	5
3 / .045	887 / 525	15.47943	1.84	5
4 / .04	887 / 526.5	14.59415	1.64	5
5 / .04	886 / 527	14.58592	1.64	5
6 / .035	877 / 528	13.5744	1.44	5
7 / .02	880 / 527	10.27882	.82	5
8 / .035	880 / 527	13.5976	1.44	5
9 / .05	882 / 526.5	16.2707	2.05	5
10 / .045	888 / 527	15.48816	1.85	5
11 / .04	878 / 526.5	14.51992	1.64	5
12 / .03	866 / 526.5	12.48839	1.23	5

TOTAL METER VOLUME = 34.591
AVG. STACK TEMP (R) = 880.9167
AVG. STACK VEL (FT/SEC) = 13.90883
AVG. STACK VEL (FT/MIN) = 834.53
AVG. METER TEMP (R) = 525.9583
AVG. METER DELTA H (IN.H2O) = 1.52
AVG. METER PRESSURE (IN.HG) = 30.44177
TOTAL MINS OF TEST = 60
STACK ACFM = 19826.99
STACK DSCFM = 11144.21

****

I S O K I N E T I C A N A L Y S I S

TOTAL CONDENSATE VOLUME (ML) = 60.36
AVERAGE STACK TEMPERATURE (R) = 880.9167
TOTAL METER GAS VOL (uncorrected CF) = 34.591
AVG METER TEMP (R) = 525.9583
BAROMETRIC PRESSURE (IN.HG) = 30.33
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 1.52
AVG. STACK VEL (FT/MIN) = 13.90883
STACK PRESSURE (IN.HG) = 30.3381
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 1.352651E-03
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 99.7994 %

P A R T I C U L A T E E M I S S I O N R A T E

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .3345
SAMPLE WT. (GMS) = .3345
SAMPLE VOL. (DSCFM) = 35.33084
CONCENTRATION (GR/DSCF) = .1460859
% CO2 = 9.53
CONCENTRATION @ 12% CO2 (GR/DSCF) = .1839486
STACK DSCFM = 11144.21
PM EMISSIONS (stk conds) (LB/HR) = 13.95369
PM EMISSIONS (@ 12% CO2) (LB/HR) = 17.57023

******* END OF ANALYSIS FOR RUN # 3 *******

****

PARTICULATE SAMPLING DATA SHEET

RUN NUMBER: Bypass Run #1 Cont 4

DATE: 5/11/79 (Sat)

PLANT:

BASE: Wisconsin

SAMPLE BOX NUMBER: K11C

METER BOX NUMBER: Unit

Q_s/Q_m:

Cp:

SCHEMATIC OF STACK CROSS SECTION

Leak check pre Run @ 22 in Hg.

5 min/pt

EQUATIONS

$°R = °F + 460$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$

pitot (+) 3.3 ✓
pitot (−) 3.3 ✓
~~0.79~~

Start 147.777

AMBIENT TEMP: 36 °F

STATION PRESS: 30.33 in Hg

HEATER BOX TEMP: °F

PROBE HEATER SETTING:

PROBE LENGTH: 8' Wisconsin in

NOZZLE AREA (A): .498 sq ft

Cp: .84

DRY GAS FRACTION (Fd): .7

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H20)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP 6 IN (°F)	GAS METER TEMP 7 AVG (Tm) (°R)	GAS METER TEMP 7 OUT (°F)	SAMPLE BOX TEMP 3 (°F)	IMPINGER OUTLET TEMP 4 (°F)
1	0924	+0.11	420		0.02	0.79	142.227	44	43	42	270	46
2	5	5	420		0.04	1.58		48	47.5	43	265	45
3	10	5	421		0.04	1.54		52	51.5	45	259	45
4	15	5	423		0.04	1.56		52	51.5	46	268	45
5	20	3½	411		0.02 0.04	0.80 1.59	1.195	57	56	47	267	45
6	25	1½	415		.035	1.40		57	53	49	268	45
	30						163.783					
1	1004	9	420		.02	0.79		50	49	48	259	51
2	5	15	420		.04	1.59		51	50	49	257	60
3	10	20	422		.05	1.99		53	51	49	261	58
4	15	20	424		.045	1.79		54	52	50	258	53
5	20	19½	421		.04	1.59		53	51	49	257	51
6	25	20	415		.04	1.60		53	51	49	253	52
	30											
							180.769					
				prev Ts	5.631							
					419.3							
						1.46	32.9920			47.19		
		1	0.02		10	1.						
		2	0.035	0.04	14	~~1.43~~ 1.77			49.71			
		3	0.05	16	420							
		4	0.045	15	412							
		5	0.04	14								
		6	0.035	13	(420)							

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OEHL FORM 18 MAY 78

PARTICULATE SAMPLING DATA SHEET

RUN NUMBER: Bypass Run #2 Boiler #
DATE: 21 Nov (Sat)
PLANT:
BASE: Gr [illegible]
SAMPLE BOX NUMBER: Alpha
METER BOX NUMBER: Nutech
Qw/Qm:
Co:

SCHEMATIC OF STACK CROSS SECTION

Soot blow (intermittent)

Lakeshore - gas leak @ 12" Hg

5 min/pt

EQUATIONS

$°R = °F + 460$

$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$

⊕ pitot 2.8
⊖ pitot 2.1

[illegible] 131.070

AMBIENT TEMP: 46 °F
STATION PRESS: 30.33 in Hg
HEATER BOX TEMP: °F
PROBE HEATER SETTING:
PROBE LENGTH: 5' inconel in
NOZZLE AREA (A): .418 sq ft
Cp: .84
DRY GAS FRACTION (Fd): 1

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H20)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
1	1201	0.11 4	420		.03	1.2	131.070	51	50.5	50	258	58
2	5	4	420		.04	1.6		53	54.5	50	273	63
3	10	9	403		.025	2.2		55	56.5	50	259	64
4	15	12	405		0.06	2.71		57	54	51	261	64
5	20	14	419		0.045	1.81		59	58.5	52	263	64
6	25	16	421		0.035	1.41		60	58	52	267	
	30						139.336					
1	1244	7	420		0.03	1.2		55	54	53	264	47
2	5	10	420		0.04	1.62		60	59.5	52	266	50
3	10	10	403		0.04	1.62		61	60.5	53	265	50
4	15	11	410		0.04	1.63		63	62	53	267	51
5	20	11	403		0.04	1.63		66	65.5	54	263	52
6	25	11.5	403		0.035	1.46		67	65.5	60	265	53
	30						24.608					
Traverse	1	0.035										
	2	0.045				1.6525						
	3	0.035					35.5380		56.67			
	4	0.05										

OEHL FORM 18 MAY 78

PARTICULATE SAMPLING DATA SHEET

RUN NUMBER: #3 Run 4
DATE: 1 (1st Test)
PLANT:
BASE:
SAMPLE BOX NUMBER: PNC
METER BOX NUMBER: 1.0 C
Cp:

SCHEMATIC OF STACK CROSS SECTION

5 min/pt

EQUATIONS

$^{\circ}R = {}^{\circ}F + 460$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$

AMBIENT TEMP: 60 °F
STATION PRESS: 30.33 in Hg
HEATER BOX TEMP: °F
PROBE HEATER SETTING:
PROBE LENGTH: 8' 1.D. 0 in
NOZZLE AREA (A): .498 sq ft
Cp: .84
DRY GAS FRACTION (Fd): %

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H2O)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
2-7	415	0.11 3	420		0.025	1.02	216.803	62	62	62	251	52
	5	4	420		0.04	1.63		63	63	64	254	54
	10	5	427		0.045	~~1.64~~ 1.84		63	65	63	255	54
	15	5	422		0.04	1.64		63	64	64	256	54
	20	5	426		0.04	1.64		70	64	64	257	54
	25	3	417	0.11	~~0.07~~	.44		71	65	65	257	53
	30						234.134	63				
1	5520	5	420		0.02	0.83		63	66	66	256	53
	5	5	420		0.035	1.44		63	66	66	253	53
	10	11	422		0.05	2.03		63	66	66	256	53
	15	11	423		0.045	1.85		63	66	67	256	56
	20	11	419		0.04	1.64		63	66	65	256	53
	25	10	420		0.03	1.23		60	66	62	254	54
	30						251.327					
							34.5910					
									65.96			
						1.52						

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
Bypass 6 4 Run 1		Run #4

BUILDING NUMBER	SOURCE NUMBER

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	0.6394	0.2748 ~~0.2755~~	0.3646
ACETONE WASHINGS (Probe, Front Half Filter)	99.1560	99.1067	0.0493
BACK HALF (If needed)			
	Total Weight of Particulates Collected		.4139 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H20)	126	100	26
IMPINGER 2 (H20)	118	100	18
IMPINGER 3 (Dry)	3	0	3
IMPINGER 4 (Silica Gel) 236.7 Tare 21.3	215.4	203.98	11.42
215.4	Total Weight of Water Collected		58.42 gm

III. GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	9.2	9.0	9.2		9.13
VOL % O_2	9.2	9.2	9.2		9.2
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
64 K2 Bypass		#5

BUILDING NUMBER	SOURCE NUMBER

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER .	0.7675	0.2756	.4919
ACETONE WASHINGS (Probe, Front Half Filter)	98.4743	98.4124	0.0619
BACK HALF (If needed)			
	Total Weight of Particulates Collected		.5538 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H20)	125	100	25
IMPINGER 2 (H20)	120	100	20
IMPINGER 3 (Dry)	6	0	6
IMPINGER 4 (Silica Gel) TARE 243.4 − 221.3 = 22.1	229.1	207.56	14.54
	Total Weight of Water Collected		65.54 gm

III. GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	9.2	9.4	9.4		9.33
VOL % O_2	10.2	10.2	9.9		10.1
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% − % CO_2 − % O_2 − % CO)

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
64/K9 Bypass		#6

BUILDING NUMBER	SOURCE NUMBER

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	0.5701	0.2754 ~~0.2736~~	.2947
ACETONE WASHINGS *(Probe, Front Half Filter)*	96.3136	96.2738	0.0398
BACK HALF *(If needed)*			
	Total Weight of Particulates Collected		.3345 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 *(H20)*	138	100	38
IMPINGER 2 *(H20)*	110	100	10
IMPINGER 3 *(Dry)*	0	0	0
IMPINGER 4 *(Silica Gel)* 237.7 − 21.2 = 216.5	216.4	204.04	12.36
	Total Weight of Water Collected		60.36 gm

III. GASES *(Dry)*

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	9.6	9.6	9.4		9.53
VOL % O_2	9.6	9.4	9.3		9.43
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

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APPENDIX H

Boiler 4, Scrubber Stack

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S O U R C E T E S T R E P O R T

SOURCE :
GRISSOM AFB CENTRAL HEATING PLANT

GRISSOM AFB, IN 46971

DEVICE TESTED : BOILER #4:SCRUBBER STACK

DATE TESTED : 22 NOV 87

SUBMITTING AGENCY :
USAFOEHL/ECQ

BROOKS AFB, TX 78235

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DETERMINATION OF MINIMUM NUMBER OF TRAVERSE POINTS

Stack ID: SCRUBBER STACK B Stack diameter at ports: 5.0 (ft)

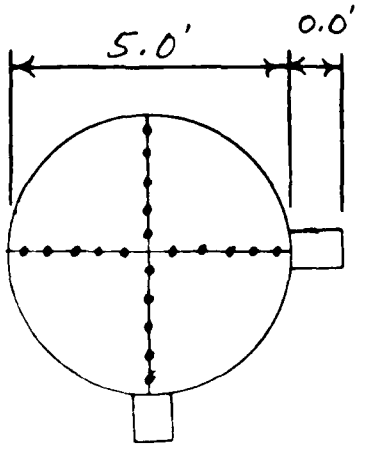
Distance A (ft) 7.0 (duct diameters) 1.4

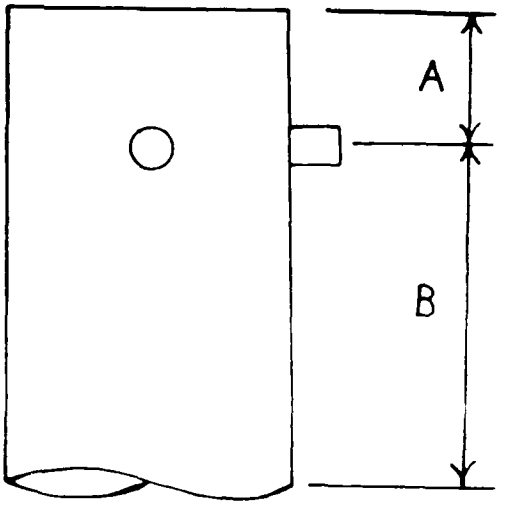
Recommended number of traverse points as determined by distance A: 20

Distance B (ft) 28 (duct diameters) 5.6

Recommended number of traverse points as determined by distance B: 20

Number of traverse points used: 20





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T E S T T R A V E R S E P O I N T L O C A T I O N

STACK DIAM. (IN.) = 60
STACK RADIUS (IN.) = 30
STACK DIAM. (FT.) = 5
STACK AREA (SQ.FT) = 19.63494

POINT #	DISTANCE IN.
1	1.539501
2	4.9002
3	8.786797
4	13.56832
5	20.51317
6	39.48683
7	46.43168
8	51.21321
9	55.0998
10	58.4605

THE ABOVE DISTANCES PROCEED FROM THE TEST PORT ACROSS THE
TRAVERSE TO THE OPPOSITE WALL OF THE STACK.
THESE DISTANCES SHOULD BE ROUNDED OFF TO THE NEAREST 1/4 INCH.
THAT'S ABOUT AS ACCURATE AS YOU CAN GET WITH AN EPA METHOD 5
PROBE.

STANDARD CONDITIONS (TEMP. AND PRESSURE)

STD.TEMP (F) = 68
STD.TEMP (R) = 528
STD. PRESSURE (IN.HG) = 29.92

****

***** R U N # 1 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.
AMBIENT DRY BULB (K) = 280.9278
AMBIENT WET BULB (K) = 275.9278
SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 23.2294 DEG. F.
VAPOR PRESSURE (IN.HG) = .1264235
SATURATION VAPOR PRESS. (IN.HG) = .3103822
RELATIVE HUMIDITY (%) = 40.73154
SPECIFIC HUMIDITY (pp1000) = 2.712726

M E T E R D A T A P R O G R A M

OF TEST POINTS = 20
AMBIENT PRESS. (IN.HG) = 30.13

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	55	55	55	1.69
2	59	55	57	2.04
3	61	56	58.5	2
4	63	56	59.5	2.22
5	64	57	60.5	2.36
6	66	58	62	2.49
7	68	59	63.5	2.49
8	69	60	64.5	2.52
9	70	60	65	2.53
10	71	62	66.5	1.94
11	69	62	65.5	1.37
12	69	63	66	1.82
13	69	63	66	2.16
14	70	63	66.5	2.25
15	70	63	66.5	2.66
16	70	63	66.5	2.57
17	70	63	66.5	2.57
18	70	63	66.5	2.59
19	69	63	66	2.8
20	69	63	66	2.2

FINAL AVG. METER TEMP (R) = 523.7
DELTA H@ VALUE = 2.11
FINAL AVG. METER PRESS. (IN.HG) = 30.29643

****

H 2 O T E S T D A T A

START METER READING = 251.672
END METER READING = 293.905
TOTAL CONDENSATE VOL (ML) = 75.13
H2O VAPOR GAS VOLUME @ STP = 3.561162
TOTAL METER GAS VOL (uncorrected CF) = 42.233
AVG. METER TEMP (R) = 523.7
TOTAL DRY SAMPLE VOL (CF @ STP) = 43.11548
MOLE FRACTION DRY AIR = .9237057
% H2O BY VOL = 7.629431

G A S D E N S I T Y

% CO2 = 4.43
% O2 = 15.1
% CO = 0
% N2 = 78

GAS DENSITY = .9606515

DRY MOL. WT. = 28.6212

****

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .313
NOZZLE AREA (FT2) = 5.343376E-04
PITOT FACTOR = .84
ATMOS. PRESS (IN.HG) = 30.13
STACK PRESS (IN.HG) = 30.1418
TEST START TIME = 1115

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .17	566 / 515	24.28976	1.69	3
2 / .205	575 / 517	26.88447	2.04	3
3 / .205	580 / 518.5	27.0011	2	3
4 / .225	575 / 519.5	28.16539	2.22	3
5 / .24	576 / 520.5	29.11437	2.36	3
6 / .255	582 / 522	30.16631	2.49	3
7 / .255	585 / 523.5	30.24395	2.49	3
8 / .255	579 / 524.5	30.08846	2.52	3
9 / .255	577 / 525	30.03644	2.53	3
10 / .195	577 / 526.5	26.26611	1.94	3
11 / .135	566 / 525.5	21.6454	1.37	3
12 / .18	566 / 526	24.99396	1.82	3
13 / .22	583 / 526	28.04376	2.16	3
14 / .23	587 / 526.5	28.77223	2.25	3
15 / .27	583 / 526.5	31.06753	2.66	3
16 / .26	581 / 526.5	30.43444	2.57	3
17 / .26	586 / 526.5	30.56511	2.57	3
18 / .267	592 / 526.5	31.132	2.59	3
19 / .29	594 / 526	32.49996	2.8	3
20 / .23	600 / 526	29.08909	2.2	3

TOTAL METER VOLUME = 42.233
AVG. STACK TEMP (R) = 580.5
AVG. STACK VEL (FT/SEC) = 28.52499
AVG. STACK VEL (FT/MIN) = 1711.499
AVG. METER TEMP (R) = 523.7
AVG. METER DELTA H (IN.H2O) = 2.2635
AVG. METER PRESSURE (IN.HG) = 30.29643
TOTAL MINS OF TEST = 60
STACK ACFM = 33605.19
STACK DSCFM = 28432.12

****

I S O K I N E T I C A N A L Y S I S

TOTAL CONDENSATE VOLUME (ML) = 75.13
AVERAGE STACK TEMPERATURE (R) = 580.5
TOTAL METER GAS VOL (uncorrected CF) = 42.233
AVG METER TEMP (R) = 523.7
BAROMETRIC PRESSURE (IN.HG) = 30.13
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 2.2635
AVG. STACK VEL (FT/MIN) = 28.52499
STACK PRESSURE (IN.HG) = 30.1418
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 5.343376E-04
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 99.84558 %

P A R T I C U L A T E E M I S S I O N R A T E

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .1763
SAMPLE WT. (GMS) = .1763
SAMPLE VOL. (DSCFM) = 43.11548
CONCENTRATION (GR/DSCF) = 6.309356E-02
% CO2 = 4.43
CONCENTRATION @ 12% CO2 (GR/DSCF) = .1709081
STACK DSCFM = 28432.12
PM EMISSIONS (stk conds) (LB/HR) = 15.37537
PM EMISSIONS (@ 12% CO2) (LB/HR) = 41.64887

******* END OF ANALYSIS FOR RUN # 1 *******

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***** R U N # 2 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.
AMBIENT DRY BULB (K) = 283.7055
AMBIENT WET BULB (K) = 277.5945
SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 24.42685 DEG. F.
VAPOR PRESSURE (IN.HG) = .1328173
SATURATION VAPOR PRESS. (IN.HG) = .374017
RELATIVE HUMIDITY (%) = 35.51102
SPECIFIC HUMIDITY (pp1000) = 2.850159

M E T E R D A T A P R O G R A M

OF TEST POINTS = 20
AMBIENT PRESS. (IN.HG) = 30.13

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	61	60	60.5	1.47
2	62	60	61	1.67
3	62	61	61.5	2.16
4	66	61	63.5	2.39
5	67	62	64.5	2.58
6	69	63	66	2.58
7	71	64	67.5	2.58
8	72	65	68.5	2.47
9	72	65	68.5	2.58
10	72	65	68.5	2.3
11	71	66	68.5	1.5
12	71	66	68.5	1.9
13	72	67	69.5	1.9
14	72	67	69.5	2.18
15	72	67	69.5	2.38
16	73	67	70	2.57
17	74	68	71	2.68
18	74	68	71	2.7
19	75	68	71.5	2.69
20	75	69	72	2.71

FINAL AVG. METER TEMP (R) = 527.55
DELTA H@ VALUE = 2.11
FINAL AVG. METER PRESS. (IN.HG) = 30.29908

****

H 2 0 T E S T D A T A

START METER READING = 294.253
END METER READING = 336.725
TOTAL CONDENSATE VOL (ML) = 82.74
H2O VAPOR GAS VOLUME @ STP = 3.921876
TOTAL METER GAS VOL (uncorrected CF) = 42.47202
AVG. METER TEMP (R) = 527.55
TOTAL DRY SAMPLE VOL (CF @ STP) = 43.04682
MOLE FRACTION DRY AIR = .9165002
% H2O BY VOL = 8.34998

G A S D E N S I T Y

% CO2 = 4.57
% O2 = 15.63
% CO = 0
% N2 = 78

GAS DENSITY = .9653274

DRY MOL. WT. = 28.8524

****

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .313
NOZZLE AREA (FT2) = 5.343376E-04
PITOT FACTOR = .84
ATMOS. PRESS (IN.HG) = 30.13
STACK PRESS (IN.HG) = 30.1418
TEST START TIME = 1313

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .15	580 / 520.5	23.04071	1.47	3
2 / .17	580 / 521	24.5287	1.67	3
3 / .22	580 / 521.5	27.90368	2.16	3
4 / .24	574 / 523.5	28.9933	2.39	3
5 / .26	576 / 524.5	30.22971	2.58	3
6 / .26	579 / 526	30.30834	2.58	3
7 / .26	581 / 527.5	30.36064	2.58	3
8 / .25	583 / 528.5	29.82225	2.47	3
9 / .26	583 / 528.5	30.41285	2.58	3
10 / .23	576 / 528.5	28.43226	2.3	3
11 / .15	576 / 528.5	22.96112	1.5	3
12 / .19	576 / 528.5	25.84189	1.9	3
13 / .19	582 / 529.5	25.97613	1.9	3
14 / .22	582 / 529.5	27.95175	2.18	3
15 / .24	581 / 529.5	29.16956	2.38	3
16 / .26	584 / 530	30.43892	2.57	3
17 / .27	584 / 531	31.01876	2.68	3
18 / .27	579 / 531	30.88569	2.7	3
19 / .27	582 / 531.5	30.9656	2.69	3
20 / .27	579 / 532	30.88569	2.71	3

TOTAL METER VOLUME = 42.47202
AVG. STACK TEMP (R) = 579.85
AVG. STACK VEL (FT/SEC) = 28.50638
AVG. STACK VEL (FT/MIN) = 1710.383
AVG. METER TEMP (R) = 527.55
AVG. METER DELTA H (IN.H2O) = 2.2995
AVG. METER PRESSURE (IN.HG) = 30.29908
TOTAL MINS OF TEST = 60
STACK ACFM = 33583.26
STACK DSCFM = 28223.52

****

I S O K I N E T I C A N A L Y S I S

TOTAL CONDENSATE VOLUME (ML) = 82.74
AVERAGE STACK TEMPERATURE (R) = 579.85
TOTAL METER GAS VOL (uncorrected CF) = 42.47202
AVG METER TEMP (R) = 527.55
BAROMETRIC PRESSURE (IN.HG) = 30.13
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 2.2995
AVG. STACK VEL (FT/MIN) = 28.50638
STACK PRESSURE (IN.HG) = 30.1418
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 5.343376E-04
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 100.3641 %

P A R T I C U L A T E E M I S S I O N R A T E

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .2177
SAMPLE WT. (GMS) = .2177
SAMPLE VOL. (DSCFM) = 43.04682
CONCENTRATION (GR/DSCF) = .0780339
% CO2 = 4.57
CONCENTRATION @ 12% CO2 (GR/DSCF) = .204903
STACK DSCFM = 28223.52
PM EMISSIONS (stk conds) (LB/HR) = 18.8767
PM EMISSIONS (@ 12% CO2) (LB/HR) = 49.56682

******* END OF ANALYSIS FOR RUN # 2 *******

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***** R U N # 3 *****

H U M I D I T Y D A T A

ALL TEMPS INPUT IN DEGREES FARENHEIT AND CONVERTED TO DEG. K.
AMBIENT DRY BULB (K) = 284.2611
AMBIENT WET BULB (K) = 278.15
SOURCE ALTITUDE (AMSL) (FT) = 870

DEW POINT = 26.14654 DEG. F.
VAPOR PRESSURE (IN.HG) = .1425087
SATURATION VAPOR PRESS. (IN.HG) = .3880618
RELATIVE HUMIDITY (%) = 36.72319
SPECIFIC HUMIDITY (pp1000) = 3.058516

M E T E R D A T A P R O G R A M

OF TEST POINTS = 20
AMBIENT PRESS. (IN.HG) = 30.13

POINT #	TEMP IN F	TEMP OUT F	AVG TEMP F	Delta H IN.H2O
1	68	68	68	1.31
2	68	68	68	1.81
3	69	68	68.5	2.09
4	70	68	69	2.36
5	71	68	69.5	2.79
6	72	68	70	2.67
7	74	68	71	2.57
8	74	68	71	2.77
9	74	68	71	2.65
10	75	68	71.5	2.33
11	73	68	70.5	1.81
12	73	68	70.5	2.07
13	73	68	70.5	2.18
14	73	68	70.5	2.37
15	74	69	71.5	2.58
16	75	69	72	2.78
17	75	69	72	2.88
18	75	69	72	2.87
19	75	69	72	2.86
20	75	69	72	2.65

FINAL AVG. METER TEMP (R) = 530.55
DELTA H@ VALUE = 2.11
FINAL AVG. METER PRESS. (IN.HG) = 30.30794

****

H 2 O T E S T D A T A

START METER READING = 336.853
END METER READING = 380.615
TOTAL CONDENSATE VOL (ML) = 93.58999
H2O VAPOR GAS VOLUME @ STP = 4.436166
TOTAL METER GAS VOL (uncorrected CF) = 43.762
AVG. METER TEMP (R) = 530.55
TOTAL DRY SAMPLE VOL (CF @ STP) = 44.11634
MOLE FRACTION DRY AIR = .9086316
% H2O BY VOL = 9.136842

G A S D E N S I T Y

% CO2 = 4.53
% O2 = 15.5
% CO = 0
% N2 = 78

GAS DENSITY = .9605196

DRY MOL. WT. = 28.7932

****

S O U R C E T E S T D A T A

NOZZLE DIAM (IN.) = .313
NOZZLE AREA (FT2) = 5.343376E-04
PITOT FACTOR = .84
ATMOS. PRESS (IN.HG) = 30.13
STACK PRESS (IN.HG) = 30.1418
TEST START TIME = 1500

PT/DELTA P # / IN.H2O	TS/TM R	VELOCITY FT/SEC	DELTA H IN.H2O	TIME MINS
1 / .13	572 / 528	21.35453	1.31	3
2 / .18	572 / 528	25.12781	1.81	3
3 / .21	579 / 528.5	27.3067	2.09	3
4 / .24	586 / 529	29.36803	2.36	3
5 / .28	580 / 529.5	31.55828	2.79	3
6 / .27	585 / 530	31.12291	2.67	3
7 / .26	586 / 531	30.56721	2.57	3
8 / .28	586 / 531	31.7211	2.77	3
9 / .27	590 / 531	31.25563	2.65	3
10 / .24	594 / 531.5	29.56781	2.33	3
11 / .18	574 / 530.5	25.1717	1.81	3
12 / .2	586 / 530.5	26.80922	2.07	3
13 / .22	585 / 530.5	28.09374	2.18	3
14 / .24	586 / 530.5	29.36803	2.37	3
15 / .26	585 / 531.5	30.54112	2.58	3
16 / .28	585 / 532	31.69402	2.78	3
17 / .29	585 / 532	32.25501	2.88	3
18 / .29	586 / 532	32.28257	2.87	3
19 / .29	588 / 532	32.33762	2.86	3
20 / .27	591 / 532	31.2821	2.65	3

TOTAL METER VOLUME = 43.762
AVG. STACK TEMP (R) = 584.05
AVG. STACK VEL (FT/SEC) = 29.43925
AVG. STACK VEL (FT/MIN) = 1766.355
AVG. METER TEMP (R) = 530.55
AVG. METER DELTA H (IN.H2O) = 2.42
AVG. METER PRESSURE (IN.HG) = 30.30794
TOTAL MINS OF TEST = 60
STACK ACFM = 34682.27
STACK DSCFM = 28689.09

****

I S O K I N E T I C A N A L Y S I S

TOTAL CONDENSATE VOLUME (ML) = 93.58999
AVERAGE STACK TEMPERATURE (R) = 584.05
TOTAL METER GAS VOL (uncorrected CF) = 43.762
AVG METER TEMP (R) = 530.55
BAROMETRIC PRESSURE (IN.HG) = 30.13
AVG PRESSURE DROP ACROSS ORIFICE METER (IN.H2O) = 2.42
AVG. STACK VEL (FT/MIN) = 29.43925
STACK PRESSURE (IN.HG) = 30.1418
TOTAL MINUTES OF TEST = 60
NOZZLE AREA (FT2) = 5.343376E-04
DRY GAS METER CALIBRATION FACTOR = 1.082

ISOKINETIC RATE FOR THIS RUN = 101.1234 %

P A R T I C U L A T E E M I S S I O N R A T E

INITIAL FILTER WT. (GMS) = 0
FINAL FILTER WT. (GMS) = .0416
SAMPLE WT. (GMS) = .0416
SAMPLE VOL. (DSCFM) = 44.11634
CONCENTRATION (GR/DSCF) = 1.454989E-02
% CO2 = 4.53
CONCENTRATION @ 12% CO2 (GR/DSCF) = 3.854276E-02
STACK DSCFM = 28689.09
PM EMISSIONS (stk conds) (LB/HR) = 3.577735
PM EMISSIONS (@ 12% CO2) (LB/HR) = 9.477442

******* END OF ANALYSIS FOR RUN # 3 *******

****

PARTICULATE SAMPLING DATA SHEET

RUN NUMBER: Unit 6 Run 4

DATE: 5/21/80 (Sun)

PLANT: LOWER PLANT

BASE: (Ash Pond)

SAMPLE BOX NUMBER: 1117

METER BOX NUMBER: Dick

Qw/Qm:

Co:

SCHEMATIC OF STACK CROSS SECTION

LEAK AT 7" Hg = 0 ft^3/min

5 min/pt

EQUATIONS

$°R = °F + 460$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$

(1.53)

actual nozzle: 0.3014

AMBIENT TEMP: 30 °F

STATION PRESS: 30.12 in Hg

HEATER BOX TEMP: °F

PROBE HEATER SETTING:

PROBE LENGTH: 6' / 1.85 m

NOZZLE AREA (A): .313 / .313 / .313 sq ft

Cp: .77

DRY GAS FRACTION (Fd): ≈ 6%

Start 251.673

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H20)	STACK TEMP (T) (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
Pt. 1 A	1115	-.16 3	106		.17	1.69	251.672	55	55	55	235	62
2	3	3	105		.205	2.07		59	57	55	235	63
3	6	3	120		.205	2.0		61	58	56	240	63
4	9	4	115		.225	2.22		63	59.5	56	256	61
5	12	4	116		.24	2.36		64	60.5	57	273	61
6	15	5	122		.255	2.49		66	62	58	265	61
7	18	5	125		.255	2.49		68	63.5	59	266	60
8	21	5	117		.255	2.52		69	64.5	60	267	60
9	24	5	117		.255	2.53		70	65	60	265	60
10	27	4	117		.195	1.94	272.727	71	66.5	62	265	61
Pt. 1 B	1143	3	106		.135	1.37		69	65.5	62	268	61
2	36	3	106		.18	1.83		69	66	63	267	61
3	6	4	123		.220	2.16		69	66	63	265	61
4	9	4.5	127		.23	2.25		70	66.5	63	264	64
5	12	5	123		.26	2.66		70	66.5	63	266	62
6	15	5	121		.26	2.57		70	66.5	63	264	66
7	18	5	126		.26	2.57		70	66.5	63	263	68
8	21	5	132		.267	2.59		70	66.5	63	260	68
9	24	6	134		.29	2.80		69	66	63	261	68
10	27	5	140		.23	2.20		69	66	63	263	65
	30						293.905					
				press	11.517	≈ 2.26			63.7			
				Ts	120.50		42.233					

OEHL FORM 18 MAY 78

PARTICULATE SAMPLING DATA SHEET

RUN NUMBER: SCRUBBER/BOILER 4

DATE: 22 NOV 87

PLANT: RILEY PLANT

BASE: GRISSOM AFB

SAMPLE BOX NUMBER: RHC

METER BOX NUMBER: NUTECH

Qw/Qm:

Co:

SCHEMATIC OF STACK CROSS SECTION

RUN 2

LEAK CK @ 7" Hg = 0.43 cfm

SOOT BLOW

3.0 IN/PT

EQUATIONS

$^{\circ}R = {}^{\circ}F + 460$

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$

AMBIENT TEMP: 45 °F

STATION PRESS: 30.13 in Hg

HEATER BOX TEMP: °F

PROBE HEATER SETTING:

PROBE LENGTH: 6' GLASS in

NOZZLE AREA (A): .313/.313/.313/ sq ft

Cp: .84

DRY GAS FRACTION (Fd): ≈ 0.9

Start 294.253

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H20)	VH	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
PKT B 1	1313	.16	3	120		.15	1.47	~~294.473~~	61	60.5	60	241	65
2	3		3	120		.17	1.67		62	61	60	262	61
3	6		4	120		.22	2.16		62	61.5	62	264	55
4	9		5	114		.24	2.39		66	63.5	61	275	57
5	12		5	116		.26	2.58		67	64.5	62	260	61
6	15		6	119		.26	2.58		69	66	63	247	64
7	18		6	121		.26	2.58		71	67.5	64	267	66
8	21		6	123		.25	2.47		72	68	65	267	66
9	24		6	123		.26	2.58		72	68	65	270	65
10	27		6	116		.23	2.30	315.219	72	68	65	252	65
LAT B 1	~~1945~~		5	118		.15	1.50		71	68.5	66	253	68
2	3		5	116		.19	1.90		71	68.5	66	252	68
3	6		5	122		.19	1.90		72	69.5	67	254	65
4	9		6	122		.22	2.18		72	69.5	67	253	68
5	12		7	121		.24	2.38		72	69.5	67	253	65
6	15		7	124		.26	2.57		73	70	67	251	68
7	18		7	124		.27	2.68		74	71	68	252	65
8	21			119		.27	2.70		74	71	68	250	65
9	24			122		.27	2.69		75	71.5	68	250	65
10	27			119		.27	2.71		75	72	69	252	68
	30							336.725					
		Pbar		11.54			2.30			T_A = 67.48			
		Ts		119.85				42.472					

OEHL FORM 18 MAY 78

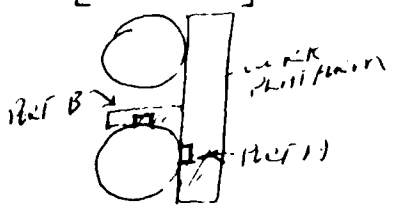
PARTICULATE SAMPLING DATA SHEET

RUN NUMBER: SCRUBBER/BOILER 4
DATE: 22 NOV 87
PLANT: LOUISVILLE GAS & ELECTRIC
BASE: CANE RUN
SAMPLE BOX NUMBER: RIC
METER BOX NUMBER: 1410 IEC
Ca/Qa:
Cc:

SCHEMATIC OF STACK CROSS SECTION
RUN # 3
LEAK CK @ 7" Hg = .ST/min
3.0 IN/PT

EQUATIONS
°R = °F + 460

$$H = \left[\frac{5130 \cdot Fd \cdot Cp \cdot A}{Co}\right]^2 \cdot \frac{Tm}{Ts} \cdot Vp$$



AMBIENT TEMP: [redacted]5 °F
STATION PRESS: 29.18 in Hg
HEATER BOX TEMP: °F
PROBE HEATER SETTING:
PROBE LENGTH: 6 GLASS in
NOZZLE AREA (A): .313/.313/.313 sq ft
Cp: 1.84/
DRY GAS FRACTION (Fd): 6%

TRAVERSE POINT NUMBER	SAMPLING TIME (min)	STATIC PRESSURE (in H2O)	STACK TEMP (°F)	STACK TEMP (Ts) (°R)	VELOCITY HEAD (Vp)	ORIFICE DIFF. PRESS. (H)	GAS SAMPLE VOLUME (cu ft)	GAS METER TEMP IN (°F)	GAS METER TEMP AVG (Tm) (°R)	GAS METER TEMP OUT (°F)	SAMPLE BOX TEMP (°F)	IMPINGER OUTLET TEMP (°F)
1	1500	.16 -.16	5 112		.13	1.37	336.853	68	68 65	65	225	67
2	3	3	112		.18	1.87		65	67	65	239	67
3	6	3	119		.21	2.09		69	66.5	68	248	67
4	9	4	126		.24	2.36		70	69	65	254	67
5	12	5	120		.28	2.79		71	69.5	68	259	67
6	15	5	125		.27	2.64		72	70	68	263	68
7	15	5	126		.26	2.57		74	71	68	248	68
8	21	5	126		.28	2.77		74	71	68	252	68
9	24	5	130		.27	2.65		74	71	68	250	68
10	27	5	134		.24	2.33	358.246	75	72	68	249	68
1	1535	5	114		.18	1.81		73	70.5	68	246	68
2	3	5	126		.26	2.07		73	70.5	68	252	68
3	6	5	125		.22	2.18		73	70.5	68	253	68
4	9	5	126		.24	2.37		73	70.5	68	252	68
5	12	6	125		.26	2.58		74	71.5	69	253	68
6	15	6	125		.28	2.78		75	72	69	250	68
7	18	6	125		.29	2.88		75	72	69	250	68
8	21	6	126		.29	2.87		75	72	69	256	68
9	24	6	128		.29	2.86		75	72	69	250	68
10	27	6	130		.27	2.65		75	72	69	252	68
	30						380.615					
									70.55			
			Pbar 11.89	Ts 124.05		2.42	43.7620					

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AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
B4R1 Scrubber		#7

BUILDING NUMBER	SOURCE NUMBER

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	0.2997	0.2766	0.0231
ACETONE WASHINGS (Probe, Front Half Filter)	100.2818	100.1286	0.1532
BACK HALF (If needed)			
	Total Weight of Particulates Collected		0.1763 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H20)	117	100	17
IMPINGER 2 (H20)	145	100	45
IMPINGER 3 (Dry)	2	0	2
IMPINGER 4 (Silica Gel) 237.4 tare 21.3	~~237.4~~ 216.10	204.97	11.13
	Total Weight of Water Collected		75.13 gm

III. GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	4.6	4.3	4.4		4.43
VOL % O_2	15.2	15.1	15.0		15.1
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
		#9

BOILER NUMBER	SOURCE NUMBER
Scrubber 6#4 K#2	

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	0.3085	0.2772	0.0313
ACETONE WASHINGS (Probe, Front Half Filter)	99.8000	99.6136	0.1864
BACK HALF (If needed)			
	Total Weight of Particulates Collected		0.2177 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 (H20)	126	100	26
IMPINGER 2 (H20)	134	100	34
IMPINGER 3 (Dry)	6.4	0	6.4
IMPINGER 4 (Silica Gel) 244.1 21.3	222.80	206.46	16.34
100 100.02 10 10.01 0.5 0.504	Total Weight of Water Collected		82.74 gm

III. GASES (Dry)

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	4.6	4.6	4.5		4.57
VOL % O_2	15.6	15.8	15.5		15.63
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

AIR POLLUTION PARTICULATE ANALYTICAL DATA

BASE	DATE	RUN NUMBER
B+R3 Scrubber		~~1~~ 10

BUILDING NUMBER	SOURCE NUMBER

I. PARTICULATES

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT PARTICLES (gm)
FILTER NUMBER	0.3011	0.2772	0.0239
ACETONE WASHINGS *(Probe, Front Half Filter)*	97.6740	97.6563	0.0177
BACK HALF *(If needed)*			
	Total Weight of Particulates Collected		0.0416 gm

II. WATER

ITEM	FINAL WEIGHT (gm)	INITIAL WEIGHT (gm)	WEIGHT WATER (gm)
IMPINGER 1 *(H20)*	158	100	58
IMPINGER 2 *(H20)*	118	100	18
IMPINGER 3 *(Dry)*	4	0	4
IMPINGER 4 *(Silica Gel)*	215.9	202.31	13.59
	Total Weight of Water Collected		93.59 gm

III. GASES *(Dry)*

ITEM	ANALYSIS 1	ANALYSIS 2	ANALYSIS 3	ANALYSIS 4	AVERAGE
VOL % CO_2	4.4 ~~4.6~~	4.6	4.6		4.53
VOL % O_2	15.6 ~~20.0~~	15.5 ~~20.1~~	15.4 20		15.5
VOL % CO					
VOL % N_2					

Vol % N_2 = (100% - % CO_2 - % O_2 - % CO)

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APPENDIX I

EPA Computer Program Emission Calculations

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```
XROM "METH-5"
RUN NUMBER
B3-BP-R1
                    RUN
METER BOX Y?
          1.0820    RUN
DELTA H?
          1.7200    RUN
BAR PRESS ?
         29.4200    RUN
METER VOL ?
         35.7930    RUN
MTR TEMP F?
         51.5000    RUN
STATIC H2O IN ?
           .0500    RUN
STACK TEMP.
        420.0000    RUN
ML. WATER ?
         50.0000    RUN


IMP. % H2O = 5.6

% H2O=5.6


% CO2?
         10.1700    RUN
% OXYGEN?
          9.3700    RUN
% CO ?
                    RUN

MWd =30.00
MW WET=29.33


SQRT PSTS ?
          6.2913    RUN
TIME MIN ?
         60.0000    RUN
NOZZLE DIA ?
           .4900    RUN
STK DIA INCH ?
         66.0000    RUN

* VOL MTR STD = 39.478
  STK PRES ABS = 29.42
  VOL H2O GAS = 2.36
  % MOISTURE = 5.63
  MOL DRY GAS = 0.944
  % NITROGEN = 80.46
  MOL WT DRY = 30.00
  MOL WT WET = 29.33
  VELOCITY FPS = 15.39
  STACK AREA = 23.76
  STACK ACFM = 21,924.
* STACK DSCFM = 12,208.
  % ISOKINETIC =  94.72


END OF FIELD DATA
```

```
XROM "MASSFLOW"
RUN NUMBER
B2-BP-R1
                    RUN

VOL MTR STD ?
         39.478     RUN
STACK DSCFM ?
       12,208.00    RUN
FRONT 1/2 MG ?
         271.90     RUN
BACK 1/2 MG ?
                    RUN


F  GR/DSCF = 0.11
F  MG/MMM = 243.22
F  LB/HR = 11.12
F  KG/HR = 5.04
```

```
XROM "MASSFLO"
RUN NUMBER
B3-BP-R2
                    RUN

VOL MTR STD ?
         38.842     RUN
STACK DSCFM ?
       11,596.00    RUN
FRONT 1/2 MG ?
         308.30     RUN
BACK 1/2 MG ?
                    RUN


F  GR/DSCF = 0.12
F  MG/MMM = 273.02
F  LB/HR = 11.86
F  KG/HR = 5.38
```

```
XROM "METH-5"
RUN NUMBER
B3-BP-R2
                    RUN
METER BOX Y?
          1.0820    RUN
DELTA H?
          1.6900    RUN
BAR PRESS ?
         29.3870    RUN
METER VOL ?
         35.3410    RUN
MTR TEMP F?
         52.7000    RUN
STATIC H2O IN ?
           .0900    RUN
STACK TEMP.
        426.2000    RUN
ML. WATER ?
         60.3400    RUN


IMP. % H2O = 6.8

% H2O=6.8


% CO2?
         10.6700    RUN
% OXYGEN?
          8.0700    RUN
% CO ?
                    RUN

MWd =30.03
MW WET=29.21


SQRT PSTS ?
          6.0854    RUN
TIME MIN ?
         60.0000    RUN
NOZZLE DIA ?
           .4930    RUN
STK DIA INCH ?
         66.0000    RUN

* VOL MTR STD = 38.842
  STK PRES ABS = 29.39
  VOL H2O GAS = 2.84
  % MOISTURE = 6.81
  MOL DRY GAS = 0.932
  % NITROGEN = 81.26
  MOL WT DRY = 30.03
  MOL WT WET = 29.21
  VELOCITY FPS = 14.91
  STACK AREA = 23.76
  STACK ACFM = 21,260.
* STACK DSCFM = 11,596.
  % ISOKINETIC =  98.11


END OF FIELD DATA
```

```
          XROM "METH 5"
RUN NUMBER
B3 BP R0
                    RUN
METER BOX Y?
        1.0020      RUN
DELTA H?
        1.5900      RUN
BAR PRESS ?
       29.2000      RUN
METER VOL ?
       34.1990      RUN
MTR TEMP F?
       38.1300      RUN
STATIC HOH IN ?
         .0700      RUN
STACK TEMP.
      437.7000      RUN
ML. WATER ?
       56.7500      RUN


IMP. % HOH = 6.5

% HOH=6.5


% CO2?
       10.1000      RUN
% OXYGEN?
        8.5300      RUN
% CO ?
                    RUN

MWd =29.96
MW WET=29.18


SQRT PSTS ?
        6.0611      RUN
TIME MIN ?
       60.0000      RUN
NOZZLE DIA ?
         .4980      RUN
STK DIA INCH ?
       66.0000      RUN

* VOL MTR STD = 38.431
  STK PRES ABS = 29.21
  VOL HOH GAS = 2.67
  % MOISTURE = 6.50
  MOL DRY GAS = 0.935
  % NITROGEN = 81.37
  MOL WT DRY = 29.96
  MOL WT WET = 29.18
  VELOCITY FPS = 14.91
  STACK AREA = 23.76
  STACK ACFM = 21,254.
* STACK DSCFM = 11,409.
  % ISOKINETIC =  98.67

END OF FIELD DATA
```

```
          XROM "MOSFLO"

RUN NUMBER
B3 BP R0
                    RUN

VOL MTR STD ?
         38.431     RUN
STACK DSCFM ?
      11,409.00     RUN
FRONT 1/2 MG ?
        381.20      RUN
BACK 1/2 MG ?
                    RUN


F  GR/DSCF = 0.15
F  MG/MMM = 350.28
F  LB/HR = 14.97
F  KG/HR = 6.79
```

```
RUN NUMBER
B3 SC R1
                    RUN

VOL MTR STD ?
         51.085     RUN
STACK DSCFM ?
      31,392.00     RUN
FRONT 1/2 MG ?
        1,147.00    RUN
BACK 1/2 MG ?
                    RUN


F  GR/DSCF = 0.35
F  MG/MMM = 792.90
F  LB/HR = 93.23
F  KG/HR = 42.29
```

```
          XROM "METH 5"
RUN NUMBER
B3 SC R1
                    RUN
METER BOX Y?
        1.0020      RUN
DELTA H?
        2.8300      RUN
BAR PRESS ?
       29.0200      RUN
METER VOL ?
       47.3240      RUN
MTR TEMP F?
       57.0000      RUN
% OTHER GAS
REMOVED BEFORE
DRY GAS METER ?
                    RUN
STATIC HOH IN ?
         .1200      RUN
STACK TEMP.
      112.9000      RUN
ML. WATER ?
       80.8000      RUN
SAT % = 9.7
IMP. % HOH = 6.9

% HOH=6.9


% CO2?
        3.3700      RUN
% OXYGEN?
       16.8300      RUN
% CO ?
                    RUN
MOL WT OTHER?
                    RUN

MWd =29.21
MW WET=28.44
SQRT PSTS ?
       12.8100      RUN
TIME MIN ?
       60.0000      RUN
NOZZLE DIA ?
         .3130      RUN
STK DIA INCH ?
       60.0000      RUN

* VOL MTR STD = 51.085
  STK PRES ABS = 29.03
  VOL HOH GAS = 3.80
  % MOISTURE = 6.93
  MOL DRY GAS = 0.931
  % NITROGEN = 79.00
  MOL WT DRY = 29.21
  MOL WT WET = 28.44
  VELOCITY FPS = 32.02
  STACK AREA = 19.63
  STACK ACFM = 37,721.
* STACK DSCFM = 31,392.
  % ISOKINETIC =  99.72

END OF FIELD DATA
```

```
          XROM "METH-5"
RUN NUMBER
B3-SC-R2
                    RUN
METER BOX Y?
         1.0820     RUN
DELTA H?
         2.0875     RUN
BAR PRESS ?
        29.8200     RUN
METER VOL ?
        47.5820     RUN
MTR TEMP F?
        65.3900     RUN
STATIC HOH IN ?
          .1200     RUN
STACK TEMP.
       112.1000     RUN
ML. WATER ?
        81.6300     RUN


SAT % = 9.5


IMP. % HOH = 7.1

% HOH=7.1


% CO2?
         3.0300     RUN
% OXYGEN?
        17.3000     RUN
% CO ?
                    RUN

MWd =29.18
MW WET=28.39


SQRT PSTS ?
        12.6409     RUN
TIME MIN ?
        60.0000     RUN
NOZZLE DIA ?
          .3130     RUN
STK DIA INCH ?
        60.0000     RUN

* VOL MTR STD = 50.540
  STK PRES ABS = 29.03
  VOL HOH GAS = 3.84
  % MOISTURE = 7.07
  MOL DRY GAS = 0.929
  % NITROGEN = 79.67
  MOL WT DRY = 29.18
  MOL WT WET = 28.39
  VELOCITY FPS = 31.62
  STACK AREA = 19.63
  STACK ACFM = 37,254.
* STACK DSCFM = 31,002.
  % ISOKINETIC =  99.98


END OF FIELD DATA
```

```
          XROM "MASSFLO"

RUN NUMBER
B3-SC-R2
                    RUN

VOL MTR STD ?
           50.54    RUN
STACK DSCFM ?
       31,002.00    RUN
FRONT 1/2 MG ?
          402.60    RUN
BACK 1/2 MG ?
                    RUN


F  GR/DSCF = 0.12
F  MG/MMM = 281.31
F  LB/HR = 32.67
F  KG/HR = 14.82
```

```
          XROM "MASSFLO"
RUN NUMBER
B3-SC-R3
                    RUN

VOL MTR STD ?
           51.272   RUN
STACK DSCFM ?
       31,619.00    RUN
FRONT 1/2 MG ?
          383.30    RUN
BACK 1/2 MG ?
                    RUN


F  GR/DSCF = 0.09
F  MG/MMM = 208.90
F  LB/HR = 24.74
F  KG/HR = 11.22
```

```
          XROM "METH-5"
RUN NUMBER
B3-SC-R3
                    RUN
METER BOX Y?
         1.0820     RUN
DELTA H?
         2.9575     RUN
BAR PRESS ?
        29.8200     RUN
METER VOL ?
        48.9890     RUN
MTR TEMP F?
        72.5300     RUN
STATIC HOH IN ?
          .1200     RUN
STACK TEMP.
       120.8000     RUN
ML. WATER ?
        82.2600     RUN


SAT % = 12.1


IMP. % HOH = 7.0

% HOH=7.0


% CO2?
         3.1000     RUN
% OXYGEN?
        17.0000     RUN
% CO ?
                    RUN

MWd =29.18
MW WET=28.39


SQRT PSTS ?
        13.0836     RUN
TIME MIN ?
        60.0000     RUN
NOZZLE DIA ?
          .3130     RUN
STK DIA INCH ?
        60.0000     RUN

* VOL MTR STD = 51.272
  STK PRES ABS = 29.03
  VOL HOH GAS = 3.87
  % MOISTURE = 7.02
  MOL DRY GAS = 0.930
  % NITROGEN = 79.90
  MOL WT DRY = 29.18
  MOL WT WET = 28.39
  VELOCITY FPS = 32.73
  STACK AREA = 19.63
  STACK ACFM = 39,556.
* STACK DSCFM = 31,619.
  % ISOKINETIC =  99.37
```

```
XROM "METH5"
RUN NUMBER
B4-BP-R1
                    RUN
METER BOX Y?
         1.0020     RUN
DELTA H?
         1.4600     RUN
BAR PRESS ?
        30.3300     RUN
METER VOL ?
        32.9920     RUN
MTR TEMP F?
        49.7100     RUN
STATIC H0H IN ?
          .1100     RUN
STACK TEMP.
       419.3000     RUN
ML. WATER ?
        58.4200     RUN


IMP. % H0H = 6.8

% H0H=6.8


% C02?
         9.1300     RUN
% OXYGEN?
         9.2000     RUN
% CO ?
                    RUN

MWd =29.83
MW WET=29.82


SQRT PSTS ?
         5.6318     RUN
TIME MIN ?
        60.0000     RUN
NOZZLE DIA ?
          .4980     RUN
STK DIA INCH ?
        66.0000     RUN

* VOL MTR STD = 37.618
  STK PRES ABS = 30.34
  VOL H0H GAS = 2.75
  % MOISTURE = 6.81
  MOL DRY GAS = 0.932
  % NITROGEN = 81.67
  MOL WT DRY = 29.83
  MOL WT WET = 29.82
  VELOCITY FPS = 13.63
  STACK AREA = 23.76
  STACK ACFM = 19,429.
* STACK DSCFM = 11,024.
  % ISOKINETIC =  99.95
```

```
XROM "MASSFLO"

RUN NUMBER
B4-BP-R1
                    CLX
                    RUN

VOL MTR STD ?
        37.618      RUN
STACK DSCFM ?
       11,024.00    RUN
FRONT 1/2 MG ?
          413.90    RUN
BACK 1/2 MG ?
                    RUN


F  GR/DSCF = 0.17
F  MG/MMM = 388.55
F  LB/HR = 16.04
F  KG/HR = 7.28
```

```
XROM "MASSFLO"
RUN NUMBER
B4-BP-R2
                    CLX
                    RUN

VOL MTR STD ?
        39.993      RUN
STACK DSCFM ?
       11,659.00    RUN
FRONT 1/2 MG ?
          553.80    RUN
BACK 1/2 MG ?
                    RUN


F  GR/DSCF = 0.21
F  MG/MMM = 489.01
F  LB/HR = 21.36
F  KG/HR = 9.69
```

```
XROM "METH5"
RUN NUMBER
B4-BP-R2
                    RUN
METER BOX Y?
         1.0020     RUN
DELTA H?
         1.6525     RUN
BAR PRESS ?
        30.3300     RUN
METER VOL ?
        35.5380     RUN
MTR TEMP F?
        56.6700     RUN
STATIC H0H IN ?
          .1100     RUN
STACK TEMP.
       413.0000     RUN
ML. WATER ?
        65.5400     RUN


IMP. % H0H = 7.2

% H0H=7.2


% C02?
         9.3300     RUN
% OXYGEN?
        10.1000     RUN
% CO ?
                    RUN

MWd =29.90
MW WET=29.84


SQRT PSTS ?
         5.9381     RUN
TIME MIN ?
        60.0000     RUN
NOZZLE DIA ?
          .4980     RUN
STK DIA INCH ?
        66.0000     RUN

* VOL MTR STD = 39.993
  STK PRES ABS = 30.34
  VOL H0H GAS = 3.08
  % MOISTURE = 7.16
  MOL DRY GAS = 0.928
  % NITROGEN = 80.57
  MOL WT DRY = 29.90
  MOL WT WET = 29.84
  VELOCITY FPS = 14.37
  STACK AREA = 23.76
  STACK ACFM = 20,478.
* STACK DSCFM = 11,659.
  % ISOKINETIC =  100.43
```

```
          XROM "METH-5"
RUN NUMBER
B4-BP-R3
                        RUN
METER BOX Y?
          1.0020        RUN
DELTA H?
          1.5200        RUN
BAR PRESS ?
         30.3300        RUN
METER VOL ?
         34.5910        RUN
MTR TEMP F?
         65.9600        RUN
STATIC H2O IN ?
           .1100        RUN
STACK TEMP.
        420.9000        RUN
ML. WATER ?
         60.3600        RUN



IMP. % H2O = 6.9

% H2O=6.9


% CO2?
          9.5300        RUN
% OXYGEN?
          9.4300        RUN
% CO ?
                        RUN

MWd =29.90
MW WET=29.08


SQRT PSTS ?
          5.6768        RUN
TIME MIN ?
         60.0000        RUN
NOZZLE DIA ?
           .4980        RUN
STK DIA INCH ?
         66.0000        RUN

* VOL MTR STD = 38.228
  STK PRES ABS = 30.34
  VOL H2O GAS = 2.84
  % MOISTURE = 6.92
  MOL DRY GAS = 0.931
  % NITROGEN = 81.04
  MOL WT DRY = 29.90
  MOL WT WET = 29.08
  VELOCITY FPS = 13.73
  STACK AREA = 23.76
  STACK ACFM = 19,565.
* STACK DSCFM = 11,068.
  % ISOKINETIC =  101.16

END OF FIELD DATA
```

```
          XROM "MASSPLO"

RUN NUMBER
B4-BP-R3
                        RUN

VOL MTR STD ?
         38.228         RUN
STACK DSCFM ?
        11,068.00       RUN
FRONT 1/2 MG ?
         334.50         RUN
BACK 1/2 MG ?
                        RUN


F  GR/DSCF = 0.14
F  MG/MMM = 309.00
F  LB/HP = 12.81
F  KG/HR = 5.81
```

```
                        CLX
          XROM "MASSFLO"

RUN NUMBER
B4-SC-R1
                        RUN

VOL MTR STD ?
          46.65         RUN
STACK DSCFM ?
        28,313.00       RUN
FRONT 1/2 MG ?
         176.30         RUN
BACK 1/2 MG ?
                        RUN


F  GR/DSCF = 0.06
F  MG/MMM = 133.46
F  LB/HP = 14.15
F  KG/HR = 6.42
```

```
          XROM "METH-5"
RUN NUMBER
B4-SC-R1
                        RUN
METER BOX Y?
          1.0020        RUN
DELTA H?
          2.2600        RUN
BAR PRESS ?
         30.1300        RUN
METER VOL ?
         42.2330        RUN
MTR TEMP F?
         63.7000        RUN
STATIC H2O IN ?
           .1600        RUN
STACK TEMP.
        120.5000        RUN
ML. WATER ?
         75.1300        RUN


SAT % = 11.6


IMP. % H2O = 7.0

% H2O=7.0


% CO2?
          4.4300        RUN
% OXYGEN?
         15.1000        RUN
% CO ?
                        RUN

MWd =29.31
MW WET=28.52


SQRT PSTS ?
         11.5195        RUN
TIME MIN ?
         60.0000        RUN
NOZZLE DIA ?
           .3139        RUN
STK DIA INCH ?
         60.0000        RUN

* VOL MTR STD = 46.650
  STK PRES ABS = 30.14
  VOL H2O GAS = 3.54
  % MOISTURE = 7.05
  MOL DRY GAS = 0.930
  % NITROGEN = 80.47
  MOL WT DRY = 29.31
  MOL WT WET = 28.52
  VELOCITY FPS = 28.22
  STACK AREA = 19.63
  STACK ACFM = 33,242.
* STACK DSCFM = 28,313.
  % ISOKINETIC =  100.97

END OF FIELD DATA
```

```
          XROM "METH-5"
RUN NUMBER
B4-SC-R2
                        RUN
METER BOX Y?
          1.0820        RUN
DELTA H?
          2.3000        RUN
BAR PRESS ?
         30.1300        RUN
METER VOL ?
         42.4720        RUN
MTR TEMP F?
         67.4800        RUN
STATIC HOH IN ?
           .1600        RUN
STACK TEMP.
        119.8500        RUN
ML. WATER ?
         82.7400        RUN


SAT % = 11.4


IMP. % HOH = 7.7

% HOH=7.7


% CO2?
          4.5700        RUN
% OXYGEN?
         15.6300        RUN
% CO ?
                        RUN

MWd =29.36
MW WET=28.48


SQRT PSTS ?
         11.5400        RUN
TIME MIN ?
         60.0000        RUN
NOZZLE DIA ?
           .3130        RUN
STK DIA INCH ?
         60.0000        RUN

* VOL MTR STD = 46.583
  STK PRES ABS = 30.14
  VOL HOH GAS = 3.89
  % MOISTURE = 7.72
  MOL DRY GAS = 8.923
  % NITROGEN = 79.60
  MOL WT DRY = 29.36
  MOL WT WET = 28.48
  VELOCITY FPS = 28.28
  STACK AREA = 19.63
  STACK ACFM = 33,322.
* STACK DSCFM = 28,289.
  % ISOKINETIC =  101.20


END OF FIELD DATA
```

```
          XROM "MASSFLO"

RUN NUMBER
B4-SC-R2
                        RUN

VOL MTR STD ?
          46.583        RUN
STACK DSCFM ?
       28,289.00        RUN
FRONT 1/2 MG ?
         217.70         RUN
BACK 1/2 MG ?
                        RUN


F  GR/DSCF = 0.07
F  MG/MMM = 165.04
F  LB/HR = 17.44
F  KG/HR = 7.91
```

```
          XROM "MASSFLO"
RUN NUMBER
B4-SC-R3
                        RUN

VOL MTR STD ?
          47.734        RUN
STACK DSCFM ?
       28,668.00        RUN
FRONT 1/2 MG ?
          41.60         RUN
BACK 1/2 MG ?
                        RUN


F  GR/DSCF = 0.01
F  MG/MMM = 30.78
F  LB/HR = 3.30
F  KG/HR = 1.50
```

```
          XROM "METH-5"
RUN NUMBER
B4-SC-R3
                        RUN
METER BOX Y?
          1.0820        RUN
DELTA H?
          2.4200        RUN
BAR PRESS ?
         30.1300        RUN
METER VOL ?
         43.7620        RUN
MTR TEMP F?
         70.5500        RUN
STATIC HOH IN ?
           .1600        RUN
STACK TEMP.
        124.8500        RUN
ML. WATER ?
         93.5900        RUN


SAT % = 12.7


IMP. % HOH = 8.4

% HOH=8.4


% CO2?
          4.5300        RUN
% OXYGEN?
         15.5000        RUN
% CO ?
                        RUN

MWd =29.34
MW WET=28.39


SQRT PSTS ?
         11.8879        RUN
TIME MIN ?
         60.0000        RUN
NOZZLE DIA ?
           .3130        RUN
STK DIA INCH ?
         60.0000        RUN

* VOL MTR STD = 47.734
  STK PRES ABS = 30.14
  VOL HOH GAS = 4.41
  % MOISTURE = 8.45
  MOL DRY GAS = 8.916
  % NITROGEN = 79.97
  MOL WT DRY = 29.34
  MOL WT WET = 28.39
  VELOCITY FPS = 29.19
  STACK AREA = 19.63
  STACK ACFM = 34,383.
* STACK DSCFM = 28,668.
  % ISOKINETIC =  102.03


END OF FIELD DATA
```

APPENDIX J

Calibration Data

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METER BOX CALIBRATION DATA AND CALCULATION FORM

(English units)

Date 28Oct 87 Meter box number Initial

Barometric pressure, P_b = 29.575 in. Hg Calibrated by Daly

Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature: Wet test meter (t_w), °F/R	Temperature: Dry gas meter: Inlet (t_{d_i}), °F	Temperature: Dry gas meter: Outlet (t_{d_o}), °F	Temperature: Dry gas meter: Avg[a] (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$ in. H_2O
VAC-									
6 0.5	5	4.672	74 74 534	77 75	79 73	535.5	13 25/60	1.072	2.056
6 1.0	5	4.684	73 74 533.5	85 81	75 81	540	9 33/60	1.078	2.096
6 1.5	10	9.376	73 74 533.5	90 86	90 86	543.75	15 48/60	1.083	2.067
6 2.0	10	9.400	73 73 533	93 91	93 91	547	13 49/60	1.086	2.126
6 3.0	10	9.441	73 73 533	97 95	97 95	550.5	11 1/60	1.086	2.126
6 4.0	10	9.433	74 73 533.5	99 98	88 87	553	9 55/60	1.088	2.171
							Avg	1.082	2.11

ΔH, in. H_2O	$\frac{\Delta H}{13.6}$	$Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t + 460)}$	$\Delta H@_i = \frac{0.0317\ \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\ \theta}{V_w} \right]^2$
0.5	0.0368		
1.0	0.0737		
1.5	0.110		
2.0	0.147		
3.0	0.221		
4.0	0.294		

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d.

Quality Assurance Handbook M4-2.3A (front side)

POSTTEST DRY GAS METER CALIBRATION DATA FORM (English units)

Test number 1 Date 24Nov87 Meter box number Nutech Plant Gaston

Barometric pressure, P_b 30.34 in. Hg Dry gas meter number nutech Pretest Y 1.082

Orifice manometer setting, (ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperature: Wet test meter (t_w), °F	Temperature: Dry gas meter: Inlet (t_{d_i}), °F	Temperature: Dry gas meter: Outlet (t_{d_o}), °F	Temperature: Dry gas meter: Average (t_d)[a], °F	Time (θ), min	Vacuum setting, in. Hg	Y_i	Y_i $\frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t_w + 460)}$
2	10	40.137 – 30.133 = 9.730	76 / 536.0	81	78	80 / 540	14 36/60	21	1.0781	
2	10	50.859 – 41.525 = 9.341	77 / 536.5	85	78	81.5 / 541.5	14 35/60	21	1.0789	
2	10	61.103 – 51.769 = 9.334	77 / 537.0	85	80	82.5 / 542.5	14 35/60	21	1.0771	
									Y = 1.078	

[a] If there is only one thermometer on the dry gas meter, record the temperature under t_d

where

V_w = Gas volume passing through the wet test meter, ft^3.

V_d = Gas volume passing through the dry gas meter, ft^3.

t_w = Temperature of the gas in the wet test meter, °F.

t_{d_i} = Temperature of the inlet gas of the dry gas meter, °F.

t_{d_o} = Temperature of the outlet gas of the dry gas meter, °F.

t_d = Average temperature of the gas in the dry gas meter, obtained by the average of t_{d_i} and t_{d_o}, °F.

ΔH = Pressure differential across orifice, in. H_2O.

Y_i = Ratio of accuracy of wet test meter to dry gas meter for each run.

Y = Average ratio of accuracy of wet test meter to dry gas meter for all three runs; tolerance = pretest Y $\pm 0.05Y$.

P_b = Barometric pressure, in. Hg.

θ = Time of calibration run, min.

NOZZLE CALIBRATION DATA FORM

Date See Below Calibrated by T. Daly

Nozzle identification number	Nozzle Diameter[a] D_1, mm (in.)	D_2, mm (in.)	D_3, mm (in.)	ΔD,[b] mm (in.)	D_{avg}[c]
Scrubber stack Boiler 3 + 4 d ≈ .325	0.313	0.313	0.313	0.000	0.313
Bypass stack Boiler 3+4 d ≈ 0.500	0.498	0.499	0.498	0.001	0.498

where:

[a] $D_{1,2,3}$ = three different nozzles diameters, mm (in.); each diameter must be within (0.025 mm) 0.001 in.

[b] ΔD = maximum difference between any two diameters, mm (in.), $\Delta D \leq$ (0.10 mm) 0.004 in.

[c] D_{avg} = average of D_1, D_2, and D_3.

ANALYTICAL BALANCE CALIBRATION FORM

Balance name See Below Number _____

Classification of standard weights Class S weights

Date	0.500 g	1.0000 g	10.0000 g	50.0000 g	100.0000 g	Analyst
Mettler PT 1200						
9 Nov 87	0.47	0.97	9.97	49.98	99.97	
Triple Beam Balance						
19 Nov	0.5		10.00		100.00	
20 Nov	0.515		10.00		100.00	
22 Nov	0.504		10.01		100.02	
Mettler AE-163						
10 Nov 87	0.4999	1.0000	10.0002	50.0009	100.0017	
18 Nov 87	0.5000	1.0001	10.0003			
28 Dec		1.0000	9.9996	49.9981		
29 Dec.		1.0000		49.9981	99.9964	
30 Dec		1.0000	9.9997			
1 Jan 88		0.9999	9.9996		99.9965	

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