Dept. of Environmental Resources

October 3, 1979

Stack Test Review
Keystone Coke Company
Conshohocken, PA

Lab File 13.3363

Larry L. Sawyer
Air Pollution Control Engineer
Division of Technical Services and Monitoring
Bureau of Air Quality Control

Thru: Chief, Source Testing and Monitoring Section

The stack test report submitted by Betz-Converse-Murdoch, Inc., containing particulate emission tests conducted on No. 3 and No. 4 coke oven batteries of Keystone Coke has been reviewed and is acceptable to the Department.

The following information was extracted from the test report:

	Stack #3	Stack #4
Volumetric Flow Rate	24,469 DSCFM	19,099 DSCFM
Rated Capacity (coal charged)	11.8 tons	11.8 tons
Capacity During Test (coal charged)	11.8 tons	11.8 tons
Concentration	0.047 gr/DSCF	0.067 gr/DSCF
Concentration (Less Soluble Sulfates)	0.040 gr/DSCF	0.059 gr/DSCF
Concentration (Less Soluble Back Half)	0.032 gr/DSCF	0.052 gr/DSCF
Allowable Concentration	0.04 gr/DSCF	0.04 gr/DSCF

The calculations are correct and the results appear to be valid.

LLS:tkn

cc: Region I, Norristown
File 46-305-005

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Betz • Converse • Murdoch • Inc. BCM
Consulting Engineers, Planners and Architects

August 29, 1979

Keystone Coke Company
River Road
Conshohocken, PA 19428

Attention: Mr. Stan Makowski
Superintendent Engineering & Maintenance

Subject: Source Emission Testing Program
No. 4 Battery Stack
Run 4A
- Final Report -
BCM Project No. 00-4989-08

Gentlemen:

As requested in your conversation with Mr. Peter Charrington, I am enclosing the results of the uncompleted Run 4A conducted on the No. 4 Battery Stack of Keystone Coke Company on July 24, 1979.

In summary the results are as follows:

Run No.	Emission Rate Grains/DSCF	Lb./Hr.	Max. Allowable Emission Rate Grains/DSCF	Sulfates Grains/DSCF
4A	0.0257	5.23	0.04	0.028

Should there be any questions concerning the information contained herein, please do not hesitate to call.

Very truly yours,

Patrick J. Ford
Scientist

PJF/mm
encls.
cc: P.R. Charrington
R.A. Holstine
M.D. Mueller

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PARAMETERS		#A
AREA OF BREECHING	(SQ IN)	12272.00
SAMPLE VOLUME(DRY)	(STD CU FT)	32.13
MOISTURE	(%)	8.6502
MOLECULAR WEIGHT	STACK GASES	27.87
GAS TEMPERATURE	(F)	393
GAS VELOCITY	(FPM)	491
GAS VOLUME	(SCFM)(DRY)	23705
GAS VOLUME	(ACFM)	41886
PARTICULATE CONC :		
GRAINS/STD CU.	FOOT (DRY BASIS)	.0257
GRAINS/STD CU.	FOOT (WET BASIS)	.0235
GRAINS/STD CU.	FOOT 12% CO2	.3080
GRAINS/CU.	FOOT (STK COND)	.0146
POUNDS/HOUR		5.2286
ORSAT ANALYSIS :		
CARBON DIOXIDE	(VOL %)	1.00
CARBON MONOXIDE	(VOL %)	.00
OXYGEN	(VOL %)	16.00
NITROGEN	(VOL %)	83.00
EXCESS AIR	(%)	270.68
ISOKINETIC	(%)	102.65

Beiz • Converse • Murdoch • Inc. ECM

NOMOGRAPH DATA

PLANT Keystone Coke

DATE 7/24/79

SAMPLING LOCATION Battery Stack No. 4

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in H_2O	$\Delta H_@$	1.60
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m_{avg.}}$	95
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	8%
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	
STATIC PRESSURE IN STACK, in. Hg $P_m \pm 0.073$ x STACK GAUGE PRESSURE in. H_2O)	P_s	29.99
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s / P_m	
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	370
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.0104
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	.015
C FACTOR		.82
CALCULATED NOZZLE DIAMETER, in.		.76
ACTUAL NOZZLE DIAMETER, in.		.5
REFERENCE Δp, in. H_2O		.055

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BCM

FIELD DATA SHEET

PLANT Keystone Coke
DATE 7/24/79
SAMPLING LOCATION 62 Heavy Stack No 4
SAMPLE TYPE Particulate
RUN NUMBER 4A OPERATOR PJF
BAROMETRIC PRESSURE ____ STATIC PRESSURE -.64 in H_2O
FILTER NUMBER(S) E323
GEL NUMBER(S) D138
THIMBLE NUMBER ____ PLATE NUMBER ____
H_2O PICKUP (ml) 155 ml

ORSAT:
CO_2 1%
O_2 16%
CO 0%

PYROMETER NUMBER ____
THERMOCOUPLE NUMBER ____
PROBE NUMBER 7.2 TYPE 9/255 lined
NOZZLE NUMBER Set 2 I.D. .508
METER BOX NUMBER 3 $\Delta H_@$ 1.60
PITOT NUMBER 6.5 C_p .817
SAMPLE BOX NUMBER(S) ____
ASSUMED MOISTURE (%) 8%
ASSUMED METER TEMPERATURE 95
C FACTOR .82 REFERENCE Δp .055

READ AND RECORD ALL DATA EVERY 5 MINUTES

51093I

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
				DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
	00 ~~1302~~	035.732									
A 1	05	038.0	.014	.45	.45	360	82	84	1	250	80
A 1	10	040.0	.02	.65	.65	360	84	86	1	250	70
A 1	15	042.5	.02	.65	.65	400	85	87	1	260	64
A 2	20	044.2	.015	.5	.5	405	90	92	1	275	63
A 2	25	046.8	.012	.39	.39	400	92	94	1	275	64
A 2	30	048.3	.01	.35	.35	400	93	95	1	270	64
A 3	35	050.6	.014	.45	.45	410	95	98	1	275	65
A 3	40	051.9	.01	.35	.35	415	96	100	1	260	66
A 3	45	053.853									
		054.376	Change Ports leak check								
B 1	50	057.6	.02	.65	.65	400	96	100	1	270	64
B 1	55	059.4	.014	.45	.45	406	96	102	1	275	65
B 1	60	061.0	.014	.45	.45	375	98	105	1	275	65
B 2	65	062.8	.01	.35	.35	380	99	108	1	270	67
B 2	70	064.5	.01	.35	.35	395	99	110	1	265	67
B 2	75	066.5	.01	.35	.35	390	100	110	1	265	68
B 3	80	068.5	.012	.39	.39	400	100	110	1	260	67
			Shut down - electrical storm								
			.116								

Sichis,
Let's discuss this with Rao.
Bob

KEYSTONE COKE COMPANY

River Road

Conshohocken, Pa. 19428

September 7, 1979

Mr. Robert Schlosser
Montgomery County Supervisor
Pennsylvania Department of Environmental Resources
1875 New Hope Street
Norristown, Pennsylvania 19401

Dear Mr. Schlosser:

Re: Keystone Coke Company

Enclosed are two copies of stack testing results performed by the Betz-Converse-Murdoch, Inc., at Keystone Coke Company during the month of July, 1979.

On July 24, 1979, while sampling the No. 4 stack, the test was aborted after 75 minutes run time due to the occurrence of an electrical storm. The calculations from the aborted test indicated compliance with the Pennsylvania regulations; however, a subsequent test performed on the following day on the same stack indicated a grain loading of .0577 which exceeds the maximum allowable of .04 grains per DSCF. While of course we are concerned over these results, it should be considered that the coking time during this test was longer than usual. Such circumstance will tend to deplete the carbon from the walls of the ovens, which carbon provides sealing against penetration of gases from the oven to the combustion flues. In reviewing these test results with our company management, they are of the opinion that such was the case on the day of re-sampling (July 25) and that this excess could have been caused by one bad oven.

Hence, we respectfully request that, based upon the visible emission readings made by your department (nothing greater than 5% opacity) as well as the aborted stack test, the Keystone Coke Company stack sampling test made on July 24, 1979 be accepted and that we not be required to retest this stack until our annual test date in 1980.

Your consideration of this request will be greatly appreciated.

Sincerely,

Moyer B. Edwards
Director Environmental Control

MBE:rl
Attachments

510932

PARTICULATE EMISSION EVALUATION
FOR
KEYSTONE COKE COMPANY
OF
CONSHOHOCKEN, PENNSYLVANIA

JULY 24-26, 1979

B•C•M PROJECT NO. 00-4989-08

Submitted by: Patrick J. Ford

Patrick J. Ford
Scientist

Approved by: Peter R Charrington

Peter R. Charrington, P.E.
Section Manager,
Air Quality

William P. May, Jr., P.E.
Assistant Vice President
Concept Design and Operations
Department

TABLE OF CONTENTS

ABSTRACT

A particulate emission testing program was conducted at the KEYSTONE COKE COMPANY's No. 3 & 4 coke oven battery exhaust stacks during July 24-26, 1979.

The No. 3 battery stack had an emission concentration of .0393 grains/SCFD or 98% of the allowable PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES (PADER) regulations of .04 grains/SCFD and the No. 4 battery stack had an emission concentration of .0577 grains/SCFD or 44% above the allowable PADER emission concentration.

1.0 INTRODUCTION

The KEYSTONE COKE COMPANY retained BETZ·CONVERSE·MURDOCH, INC. (BCM) to conduct an outlet particulate emission evaluation of their No. 3 and No. 4 coke oven batteries located at their facility in Conshohocken, Pennsylvania. The outlet values obtained are herein compared to the appropriate allowable emission limits established by the PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL RESOURCES.

2.0 SCOPE AND OBJECTIVES

In summary, sampling was conducted to determine the following parameters:

1. Gas Flow - ACFM & SCFM
2. Moisture - % by volume
3. Particulate concentration - G/DSCF & LBS/HR.
4. Gas Temperature - ^{o}F
5. Combustion Gas Analysis - % by volume of O_2, CO_2, CO and N_2.

3.0 PROCEDURES

3.1 Field Work

The field testing was conducted on July 24-26, 1979 on Battery stacks No. 3 and 4. Both stacks were of the natural draft design.

The BCM sampling team consisted of the following personnel:

Patrick J. Ford - Scientist
Geoffrey A. Rogalsky - Technician
G. William Bainton - Technician IV
Chris Bullis - Technician

Mr. Stan Makowski of KEYSTONE COKE COMPANY was present to observe testing procedures and inform the test team of process conditions.

The following methods of field sampling were employed in the test program:

1. Gas flow, gas temperature and static pressure measurements were made as per Method Two of the Federal Register, Volume 42, No. 160, August 18, 1977 and are outlined in Appendix B, page B1.

2. Particulate sampling was conducted as per Method Five of the Federal Register, Volume 42, No. 160, August 18, 1977 and is outlined in Appendix B, pages B1 through B3.

3. A Fischer - type B No. 10-605 Orsat gas analyzer was used to determine the molecular weight of the flue gas. The following parameters were measured in order to calculate molecular weight of the dry flue gas: volume % carbon dioxide, oxygen and carbon monoxide. The volume % nitrogen was determined by difference. The specific procedure is outlined in Appendix B, pages B3 to B4.

3.2 Equipment Calibration

In accordance with accepted procedures established by the UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (E.P.A.) and the Pennsylvania Department of Environmental Resources, all gas velocity measuring equipment, volume metering equipment, temperature measuring equipment, and flow rate metering equipment had been calibrated immediately prior to the actual test date. Calibration data is listed in Appendix D

3.3 Analytical Methods

All samples generated during the sampling program were returned to B·C·M LABORATORIES, Plymouth Meeting, Pennsylvania for analysis. Refer to Appendix C, for a detailed description of the methodology utilized in the analyses of the samples.

3.4 Calculations

All calculations were performed primarily through the use of a computer. Raw data from the sampling program was developed through the use of the equations presented in the Federal Register, Volume 42, No. 160, August 18, 1977. The reduced data appears on the computer input sheet which is presented on page C4 of Appendix C. Pages C5 through C8 of the same Appendix contain a list of the equations employed in the determination of the test results.

4.0 SUMMARY OF RESULTS

A summary of pertinent test results and allowable emissions for each test is presented in Table I as follows:

TABLE I

PARTICULATE EMISSION RESULTS

Location	Emission Rate* Grains/DSCF	LB/HR	Max. Allowable Emissions** Grains/DSCF	Sulfates Grains/DSCF
Battery No. 3	.0393	8.24	.04	.0065
Battery No. 4	.0577	9.44	.04	.0077

* Based on total particulate catch minus sulfates.

** Based on Pennsylvania DER Regulation 123.13 C

5.0 DISCUSSION OF RESULTS

During the period tested, the No. 3 coke oven battery stack was within compliance (while the No. 4 coke oven battery stack was out of compliance) with current applicable PENNSYLVANIA DER air pollution regulations.

Emissions from the No. 3 battery were .0393 grains/SCFD or 8.24 lb/hr while the emissions from the No. 4 battery were .0577 grains/SCFD or 9.44 lb/hr.

Isokinetic testing conditions were maintained within the prescribed 100 ± 10% for both tests.

FIELD SAMPLING PROGRAM

APPENDIX A

1.0 TEST SITE LOCATION

Four (4) sampling ports spaced ninety degrees apart were located at approximately the 100 foot level of each stack. A sampling pattern of three (3) points per test port was utilized in each case for a total of twelve (12) sampling points. A 144 minute test run at 12 points per run (12 minutes per point) was conducted at each of the testing locations. The length of sampling time was due to the fact that Pennsylvania DER requires 50 DSCF of sampled gas for a valid test. This requirement was met in each case.

2.0 SAMPLING PROCEDURES

2.1 Gas Flow and Gas Temperature Measurements

The gas flow rate and the gas temperature profile were measured by conducting a simultaneous velocity and temperature traverse. Gas velocity heads and static pressure were measured with a calibrated "S" type Pitot tube which was connected to an inclined manometer. A Chromel-Alumel thermocouple attached to a THERMO-ELECTRIC CORPORATION potentiometer was used to measure the gas temperature at each of the traverse points. The gas flow and gas temperature measurements followed Method Two of the Federal register, Volume 42, Number 160, August 18, 1977.

2.2 Particulate Sampling

All sampling procedures and sample equipment in the test program were those outlined in Method Five of the Federal Register, Volume 42, Number 160, August 18, 1977.

The size of the nozzle required to maintain isokinetic sampling was calculated from the results of the initial velocity and temperature traverse.

The sampling train utilized a stainless steel (316) probe which was maintained above 250°F by an internal heating element. A nozzle of the calculated size was attached at the end of the probe which was inserted into the stack. A calibrated "S" type Pitot tube and a Chromel-Alumel thermocouple were clamped to the probe and were used to monitor the velocity head and the temperature at the traverse points during the sampling period. Sampled gas at the outlet passed through the nozzle and the probe and then through a glass fiber filter for the removal of the suspended particulates. The Method 5 filter was housed in a heated chamber whose temperature was maintained above 250°F. From the filter the gas passed to the impinger train. The first two impingers each contained 150 ml of deionized water. The third impinger contained no reagents and was the knockout impinger. The fourth impinger contained approximately 200 grams of coarse silica gel which collected any moisture and/or vapors which had not been captured in the preceding impingers.

The second impinger was a 500 ml Greenburg-Smith impinger, while the first, third and fourth impingers were 500 ml impingers of the Greenburg-Smith design, modified by replacing the tip with a 1/2" ID glass tube.

From the impinger train the gas passed through an umbilical cord to the control console, a Model 2343 RAC Stak Samplr which contained the following pieces of equipment (listed in the order in which sampled gas passed through them): a main valve, a by-pass valve for flow adjustment, an air-tight vacuum pump, and a calibrated orifice. The orifice was equipped with pressure taps which were connected across an inclined manometer used to insure that isokinetic conditions were maintained during the test. A schematic diagram is depicted on page B-14 of this Appendix.

The entire sampling train was subjected to a leak check prior to and after each sample run. Prior to the run, the nozzle was plugged and the pump vacuum was held at 15 in. Hg for one minute. After the run was completed, the train was again leak checked at a vacuum greater than the highest vacuum recorded during the sample run. After the train was leak checked the system was purged with clean ambient air for fifteen minutes.

Upon the completion of a test, the soiled glass fiber filter was removed from its holder and placed in a Petri dish which was subsequently sealed. The probe and the nozzle were washed internally with distilled water; the particulate matter remaining in the probe was removed with a nylon brush attached to a polyethylene line. The brush was rinsed, and the washings were added to the nozzle and probe washings. The front half of the glass filter holder was also rinsed with distilled water, and the washings obtained were added to those collected from the nozzle and the probe. Following the distilled water wash, all of the above mentioned components were rinsed with acetone in a similar manner. All washings were stored in sealed sample bottles. The contents of the first, second, and third impingers were measured volumetrically and then stored in a sealed sample bottle. The impinger glassware was first rinsed with deionized water and then acetone and these washings were stored in sealed sample bottles. The silica gel used in the fourth impinger was removed and placed in a sealed polyethylene sample bottle. Samples of the deionized water and acetone reagents used in the test program were stored in separate sample bottles to be analyzed as blanks.

2.3 Molecular Weight Determinations

A Fischer-type (b) No. 10-605 Orsat gas analyzer was used to determine the molecular weight of the flue gas. The following parameters were measured in order to calculate molecular weight: volume percent carbon dioxide (CO_2), volume percent oxygen (O_2), and volume percent carbon monoxide (CO); the volume percentage of nitrogen (N_2) was determined by difference. These parameters were measured using the principle of gas absorption in specific absorbing solutions. A 100 ml flue gas sample was drawn from the stack through the glass manifold by the use of the leveling bottle following aspiration of the sample lines. The system was then closed by adjusting the stopcock at the inlet of the manifold. The sample was bubbled through three (3) absorbing solutions which selectively collected different gaseous components of the flue gas in the following manner: carbon dioxide was collected by a potassium hydroxide solution in the first absorber, oxygen was collected by a potassium pyrogallate solution in the second absorber and carbon monoxide was collected by a cupric chloride solution in the third absorber.

3.0 FIELD DATA

The gas velocity head, gas temperature, inlet and outlet dry gas meter temperatures, elapsed time, orifice pressure, and the sample gas volume were recorded during the testing program. The field data sheets for the sample runs follow:

Betz • Converse • Murdoch • Inc. BCM

VELOCITY DETERMINATIONS

Client: Keystone Coke

Location: Battery Stack No. 4

Date: 7/24/79

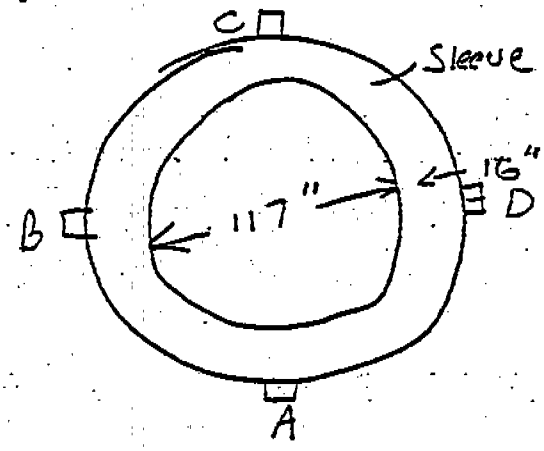
Stack Pressure: -0.64 "H_2O

Barometric Pressure: _____

Pitot Factor: 6.5 (.817)

Engineer: PJF, GWB, GAR

Sample Port Location:



Pitot/Temperature Readings

Point No.	Distance (Inches)	Port A		Port B		Port C		Port D		Port	
		ΔP	T	ΔP	T	ΔP	T	ΔP	T	ΔP	T
1	5.1	.01	340	.01	355	.01	380	.01	375		
2	17.1	.01	350	.015	350	.01	400	.01	390		
3	34.6	.01	340	.01	360	.01	395	.01	408		
TOTAL		0.125	4443								
AVG.		.010	370.25								

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Dalz • Converse • Murdoch • Inc. DCM

NOMOGRAPH DATA

PLANT Keystone Coke

DATE 7/25/79

SAMPLING LOCATION Battery Stack No. 4

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	ΔH	1.76
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	102
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{ws}	8
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	30.15
STATIC PRESSURE IN STACK, in. Hg $P_s = \pm 0.073 \times$ STACK GAUGE PRESSURE (in. H_2O)	P_s	30.1
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s / P_m	
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	370
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.0104
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	.015
C FACTOR		.9
CALCULATED NOZZLE DIAMETER, in.		
ACTUAL NOZZLE DIAMETER, in.		0.508
DIFFERENTIAL, in. H_2O		.05

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PLANT Kaintone Coke
DATE 7/26/79
SAMPLING LOCATION Battery Stack
SAMPLE TYPE Particulate
RUN NUMBER 4B OPERATOR PJF
BAROMETRIC PRESSURE 30.05↓ STATIC PRESSURE -.64" H_2O
FILTER NUMBER(S) E266
GEL NUMBER(S) D085
THIMBLE NUMBER PLATE NUMBER
H_2O PICKUP (ml) none
Start. Leak rate 0.002 cfm

BCM

FIELD DATA SHEET

ORSAT:
CO_2 4, 2.8
O_2 14.2, 15.4
CO 0.0, 0.0

PYROMETER NUMBER
THERMOCOUPLE NUMBER
PROBE NUMBER #7. TYPE glass lined
NOZZLE NUMBER Set 3 I.D. .503
METER BOX NUMBER 7 $\Delta H_@$ 1.76
PITOT NUMBER 6.5 C_p .817
SAMPLE BOX NUMBER(S)
ASSUMED MOISTURE (%) 8
ASSUMED METER TEMPERATURE 102
C FACTOR .9 REFERENCE Δp .05

READ AND RECORD ALL DATA EVERY 4 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-h CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	00	0935	008.959									
A 1	04	0939	010.4	.01	.37	.37	295	83	84	2	250	70
A 1	08	0943	012.0	.012	.44	.44	340	85	86	3	250	65
A 1	12	0947	013.6	.015	.55	.55	350	88	88	3	260	64
A 1	16	0951	015.1	.01	.37	.37	340	90	92	3	260	64
A 2	20	0955	016.6	.01	.37	.37	350	92	92	3	270	65
A 2	24	0959	018.2	.01	.37	.37	430	94	94	3	275	67
A 3	28	1003	019.6	.012	.44	.44	445	98	94	4	275	67
A 3	32	1007	021.4	.012	.44	.44	440	100	96	4	275	64
A 3	36	1011	023.120	.014	.52	.52	430	102	98	4	275	65
		1024		Change Ports								
B 1	40	1028	024.8	.008	.3	.3	370	96	98	3	270	69
B 1	44	1032	026.3	.01	.37	.37	385	98	98	4	275	63
B 1	48	1036	027.6	.01	.37	.37	340	100	97	4	265	63
B 2	52	1040	029.2	.012	.44	.44	400	102	100	4	270	64
B 2	56	1044	030.8	.012	.44	.44	405	103	100	4	270	64
B 2	60	1048	032.6	.012	.44	.44	405	104	102	4	270	64
B 3	64	1052	034.1	.012	.44	.44	425	106	103	4	275	65
B 3	68	1056	035.8	.014	.52	.52	425	108	104	4	265	66
B 3	72	1100	037.644	.015	.55	.55	430	108	104	4	265	66
				Change Ports								

No. 4 Battery Stack

PLANT Cromby DATE 7/25/79 RUN NUMBER 1C

TRAVERSE POINT NUMBER	SAMPLING TIME min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	72	1112	037.644									
C 1	76	1116	038.9	.008	.3	.3	375	104	102	3	270	70
C 1	80	1120	040.5	.01	.37	.37	380	106	104	4	275	68
C 1	84	1124	042.0	.01	.37	.37	390	108	106	4	265	68
C 2	88	1128	043.5	.011	.39	.39	390	108	106	4	275	68
C 2	92	1132	045.1	.011	.39	.39	390	108	107	4	270	68
C 2	96	1136	046.8	.012	.44	.44	420	108	107	4	275	64
C 3	100	1140	048.4	.015	.55	.55	410	108	106	4	270	64
C 3	104	1144	050.3	.015	.55	.55	430	108	106	5	275	64
C 3	108	1148	052.190	.015	.55	.55	435	110	108	5	280	63
		1158			Change Port							
D 1	112	1202	053.8	.012	.44	.44	375	108	106	4	275	68
D 1	116	1206	055.3	.013	.47	.47	390	108	106	4	270	65
D 1	120	1210	057.1	.011	.39	.39	390	109	107	4	285	64
D 2	124	1214	058.9	.01	.37	.37	395	110	108	4	280	63
D 2	128	1218	060.1	.01	.37	.37	395	110	108	4	275	63
D 2	132	1222	061.8	.01	.37	.37	400	110	108	4	270	64
D 3	136	1226	063.2	.012	.44	.44	410	110	108	4	275	65
D 3	140	1230	065.1	.015	.55	.55	430	112	110	4	270	66
D 3	144	1234	066.805	.015	.55	.55	420	114	110	5	275	65
				End			leak rate	0.0 cfm				
			57.846 ft^3	0.108	.430		397.22	102.35				

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5109948

Betz • Converse • Murdoch • Inc. BCM

VELOCITY DETERMINATIONS

Client: Keystone Coke Battery #3

Location: Conshohocken

Date: 7/25/79

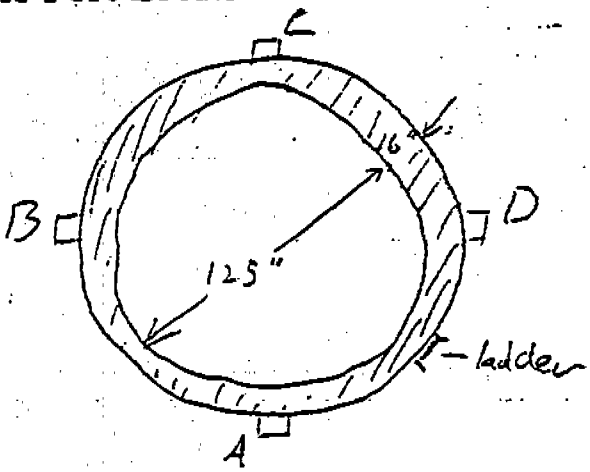
Stack Pressure: -.60 in H_2O

Barometric Pressure: [illegible]

Pitot Factor: #6-5

Engineer: PJF, GAR, GWB

Sample Port Location:



Pitot/Temperature Readings

Point No.	Distance (Inches)	Port A		Port B		Port C		Port D		Port __	
		ΔP	T	ΔP	T	ΔP	T	ΔP	T	ΔP	T
1	5.5	.005	390	.01	385	.01	390	.025	405		
2	18.3	.01	400	.01	410	.015	410	.01	400		
3	37.0	.0125	415	.01	405	.015	410	.015	415		
TOTAL		.1475	4835								
AVG.		0.012	402.92								

510949

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NOMOGRAPH DATA

PLANT Keystone Coke

DATE 7/26/79

SAMPLING LOCATION Bailey Stack No. 3

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.76
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m_{avg.}}$	100
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	5
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	29.99
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	422
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	0.52
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	.825
C FACTOR		.97
CALCULATED NOZZLE DIAMETER, in.		
ACTUAL NOZZLE DIAMETER, in.		.501
REFERENCE Δp, in. H_2O		.69

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PLANT Keystone Coke

DATE 7/26/29

SAMPLING LOCATION Coke Stack No 3

SAMPLE TYPE Particulate

RUN NUMBER 3A OPERATOR WWS

BAROMETRIC PRESSURE 29.99 STATIC PRESSURE -.60 "H_2O

FILTER NUMBER(S)

GEL NUMBER(S)

THIMBLE NUMBER PLATE NUMBER

H_2O PICKUP (ml) 100 ml

BCM

FIELD DATA SHEET

ORSAT:

CO_2 3.6 %

O_2 14.5 %

CO 0 %

PYROMETER NUMBER

THERMOCOUPLE NUMBER

PROBE NUMBER 7-2 TYPE Glass

NOZZLE NUMBER 4 I.D. .503

METER BOX NUMBER 7 $\Delta H_@$ 1.76

PITOT NUMBER 6.5 C_p .817

SAMPLE BOX NUMBER(S)

ASSUMED MOISTURE (%) 5%

ASSUMED METER TEMPERATURE 100

C FACTOR .97 REFERENCE Δp .048

READ AND RECORD ALL DATA EVERY 4 MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F			
A1	00	0940	071.177	.02	.28		355	88	88	4.0	200	70
A1	04	0944	073.6	.02	.28		357	91	89	4.0	225	68
A1	08	0948	075.3	.02	.28		385	95	90	4.0	235	68
A2	12	0952	077.9	.015	.57		395	99	91	3.5	240	65
A2	16	0956	079.4	.015	.57		395	101	93	3.5	240	66
A2	20	1000	081.2	.015	.57		410	102	95	3.5	245	66
A3	24	1004	082.9	.01	.38		385	104	97	3.0	260	67
A3	28	1008	084.6	.01	.38		395	105	99	3.0	290	69
A3	32	1012	086.0	.01	.38		425	106	100	3.0	275	67
OFF	36	1016	087462	CHANGE PORTS								
B1	36	1025	087462	.012	.46		400	104	101	5.6	275	70
B1	40	1029	089.3	.012	.46		410	104	103	3.0	260	66
B1	44	1033	090.9	.012	.46		405	104	102	3.0	245	66
B2	48	1037	092.4	.015	.57		395	106	104	4.0	270	66
B2	52	1041	094.5	.015	.57		390	108	104	4.0	225	67
B2	56	1045	096.3	.015	.57		400	109	105	4.0	280	68
B3	60	1049	098.3	.02	.78		415	110	106	5.0	290	69
B3	64	1053	099.8	.02	.78		432	111	106	5.0	292	69
B3	68	1057	101.0	.02	.78		432	112	107	5.0	290	69
OFF	72	1101	104.070	.015	.57			106	104			
C1	72	1114	104.670	.015	.57		385	106	104	4.0	270	69

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5109C1

PLANT KEYSTONE COAL DATE 7/26/24 RUN NUMBER 34 CONTINUED

TRAVERSE POINT NUMBER	CLOCK TIME (24 hr CLOCK) / SAMPLING TIME min		GAS METER READING (V_m) ft^3	VELOCITY HEAD (Δp_s) in H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH) in. H_2O		STACK TEMPERATURE (T_s) °F	DRY GAS METER TEMPERATURE		PUMP VACUUM in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET ($T_{m\,in}$) °F	OUTLET ($T_{m\,out}$) °F			
C1	26	1128	106.4	.015	.57		400	106	105	5.0	290	63
C1	80	1132	108.0	.015	.57		410	106	105	5.0	285	63
C2	84	1126	110.2	.011	.41		410	108	105	5.0	295	64
C2	88	1130	111.7	.011	.41		335	110	106	5.0	295	66
C2	92	1134	113.3	.011	.41		325	109	106	5.0	290	64
C3	96	1138	114.6	.015	.57		380	109	101	5.0	270	62
C3	100	1142	116.5	.015	.57		410	116	106	5.0	265	61
C3	104	1146	118.2	.015	.57		415	110	106		265	61
OFF	108	1150	120.128	OFF	RAIN DELAY							
D1	108	1302	120.128	.01	.38		410	82	82	3.0	255	65
D1	112	1306	121.5	.01	.38		403	82	83	3.0	275	60
D1	116	1310	123.1	.01	.38		406	86	83	3.0	285	62
D2	120	1314	124.4	.017	.64		395	90	86	5.0	280	64
D2	124	1318	126.2	.017	.64		360	94	87	5.0	290	62
D2	128	1322	128.2	.017	.64		385	097	89	5.0	290	61
D3	132	1326	130.3	.015	.57		405	100	90	5.0	290	65
D3	136	1330	132.2	.015	.57		405	102	92	5.0	275	66
D3	140	1334	133.9	.015	.57		410	104	95	5.0	280	65
OFF	144	1350	135.890									
					END		leak rate 0.0 cfm					
			64.713 FT3	0.120	0.557		396.5	99.81				

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510952

LABORATORY ANALYSIS AND DATA REDUCTION

APPENDIX B

1.0 ANALYTICAL METHODS

All particulate samples generated in the sampling program were returned to BCM LABORATORIES, INC. of Plymouth Meeting, Pennsylvania for analysis. The following discussion describes the analytical methods employed.

1.1 Particulate Samples

All glass fiber filters used in the particulate sampling program had been tare-weighed following a twenty-four hour drying period at 105°C and desiccation prior to their use in the field. Upon their return to the laboratory, they were dried for twenty-four (24) hours, desiccated and reweighed. The weight difference was the amount of sample collected on the filter.

Nozzle, probe and filter holder distilled water and acetone washings were evaporated to dryness in a tared beaker. The amount of residue remaining was then multiplied by the blank factor to attain the net particulate matter collected at these locations in the sampling train.

Impinger catches and distilled water washings were first filtered through a tared 0.22 micron filter and any weight gain was reported as insoluble particulates. The filtrate was then evaporated to dryness in a tared beaker, the amount of residue remaining being used to calculate the water soluble particulate catch. A turbidimetric sulfate analysis was performed on this residue.

The backnalf acetone washings were evaporated to dryness in as tared beaker. The weignt difference being the acetone soluble particulate catch.

Distilled water and acetone blanks were evaporated to dryness in tared beakers. Any residue which remained was a contaminant in the reagent and was considered as a blank weight in subsequent calculations.

TABLE C-1

PARTICULATE LABORATORY RESULTS*

Run No.	Filter	P+C Wash (Water Wash)	P+C (Acetone Wash)	Total
3A	77.1	38.08	6.48	121.66
4B	123.3	50.01	4.48	177.79

TABLE C-2

PARTICULATE LABORATORY RESULTS*
BACK HALF PARTICULATE CATCH (mg)

Run No.	Water Insoluble	Water Soluble (Minus Sulfates)	Acetone Wash	Sulfates
3A	1.4	33.88	3.26	26.66
4B	2.1	24.49	6.23	28.14

2.0 COMPUTER INPUT DATA SHEET

The reduced data calculated from the particulate sampling data sheets and analytical laboratory results were combined on the following computer input sheet. This sheet is instrumental in utilizing the computer for the calculation and presentation for the relevent sampling program parameters.

10	Number of Tests	2																
20	Test Identification	3A	4B															
30	Stack Area, IN^2	12272	10151															
40	Stack Temperature, °F	397	397															
50	Sample Volume, Dry, CF	64.713	57.846															
60	Avg. Meter Temperature, °F	99.81	102.35															
70	Avg. Orifice (Δ H) IN H_2O	0.557	0.430															
80	Nozzle, Dia. IN	.508	.508															
90	Duration of Test, Min.	144	144															
100	CO_2	3.6	3.4															
110	CO	0.0	0.0															
120	O_2	14.5	14.8															
130	N_2	81.9	81.8															
140	Stack Pressure, IN Hg	29.95	30.00															
150	Barometric Pressure, IN Hg	29.99	30.05															
160	Pitot Correction Factor	.817	.817															
170	Pitot Traverse (Avg.$\sqrt{\Delta P}$) IN H_2O	.120	0.108															
180	Volume, H_2O Collected, ml	116.5	121.6															
190	Ml, SO_3	—	—															
200	Ml, SO_2	—	—															
210	Total Collected Weight, mg	151.1	210.61															
220	Normality of SO_3	—	—															
230	Normality of SO_2	—	—															
240	Meter Calibration Factor	1.03	1.03															

CLIENT: Keystone Coke
LOCATION: No. 3 + No 4 Battery Stacks
JOB NO.: 00-4434-08

NAME OF FILE: 1-24-M2

AIRPOL I INPUT DATA SHEET

3.0 EQUATIONS FOR THE CALCULATIONS OF TEST RESULTS

The following series of equations was programmed into the computer to facilitate the calculations leading to the results of the test program. The equations were prescribed in Methods 2, 3 and 5 of the Federal Register, Volume 46, Number 160, August 18, 1977, appropriately amended, and were used to calculate the results of particulate testing and the flow, temperature, and static pressure testing.

EQUATIONS FOR PARTICULATE, MOISTURE, AND FLOW CALCULATIONS

(BASED ON STANDARD CONDITIONS OF 68°F AND 29.92"Hg)

1. $V_{w(std)} = 0.0471\ V_{wc}$

2. $V_{m(std)} = 17.64\ V_m \dfrac{P_{bar} + .07355\ \Delta H}{T_m + 460}\gamma$

3. $B_{wo} = \dfrac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$

4. $M_d = 0.44(\%CO_2) + 0.28(\%CO) + 0.32(\%O_2) + 0.28(\%N_2)$

5. $M_s = M_d\ (1 - B_{wo}) + 18\ B_{wo}$

6. $EA = \dfrac{(\%O_2) - 0.5(\%CO)}{0.264(\%N_2) - (\%O_2) + 0.5(\%CO)}\ 100$

7. $V_s = (85.49)(60)(C_p)\sqrt{\Delta P}\sqrt{\dfrac{T_s + 460}{(P_s)(M_s)}}$

8. $Q_s = \dfrac{(V_s)(A_s)}{144}$

9. $Q_{s(std)} = Q_s(1 - B_{wo})\ 17.64\ \dfrac{P_s}{T_s + 460}$

10. $C'_s = 0.0154\ \dfrac{W_t}{V_{m(std)}}$

11. $C'_w = 0.0154\ \dfrac{W_t}{V_{m(std)} + V_{w(std)}}$

12. $C'_c = \dfrac{12\ C'_s}{\%CO_2}$

13. $C'_a = W_w\ \dfrac{(T_s + 460)(29.92)}{(528)(P_s)}$

14. $E = 0.00857\ Q_{s(std)}\ C'_s$

15. $A_n = \dfrac{(\pi)(D_n)^2}{(144)(4)}$

16. $I = \dfrac{(60)(1.667)(T_s + 460)(0.00267\ V_{wc} + V_{m(std)}/17.64)}{(\theta)(V_s)(P_s)(A_n)}$

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LEGEND

A_n	=	Area of nozzle, ft^2
A_s	=	Area of stack, in^2
B_{wo}	=	Moisture content of gas stream, dimensionless
C_p	=	Pitot correction factor, dimensionless
C'_a	=	Particulate concentration (stack conditions), gr/ft^3
C'_c	=	Particulate concentration at 12% CO_2 (dry), gr/dscf
C'_s	=	Particulate concentration (dry), gr/dscf
C'_w	=	Particulate concentration (wet), gr/scf
D_n	=	Diameter of nozzle, in.
E	=	Particulate emission rate, lb/hr
EA	=	Excess air, percent
ΔH	=	Orifice pressure drop, in. H_2O
I	=	Isokinetic ratio, percent
M_d	=	Dry molecular weight of stack gas, lb/lb-mole
M_s	=	Molecular weight of stack gas, lb/lb-mole
P_{bar}	=	Barometric pressure, in. Hg
P_s	=	Stack pressure (absolute), in. Hg
$\sqrt{\Delta P}$	=	Average of square roots of pitot pressure differential, in. H_2O
Q_s	=	Stack gas flow, acfm
$Q_{s(std)}$	=	Stack gas flow, scfm
T_m	=	Average dry gas meter temperarure, ^oF
T_s	=	Average stack temperature, ^oF
V_m	=	Dry sample volume (meter conditions), ft^3
$V_{m(std)}$	=	Dry sample volume (standard conditions), ft^3

V_s = Stack velocity, ft/min

V_{wc} = Volume of liquid collected in impingers and silica gel, ml

$V_{w(std)}$ = Volume of liquid collected, ft^3

W_t = Total weight of particulates collected, mg

θ = Duration of test, min.

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4.0 TEST RESULTS

The complete results of the computer analysis and data reduction of the input data generated from the sampling program is presented on page C-10.

PARAMETERS	3A	4B
AREA OF BREECHING (SQ IN)	12272.00	10751.00
SAMPLE VOLUME(DRY) (STD CU FT)	63.19	56.22
MOISTURE (%)	7.9900	9.2453
MOLECULAR WEIGHT STACK GASES	28.26	28.11
GAS TEMPERATURE (F)	397	397
GAS VELOCITY (FPM)	506	456
GAS VOLUME (SCFM)(DRY)	24469	19099
GAS VOLUME (ACFM)	43121	34066
PARTICULATE CONC :		
GRAINS/STD CU. FOOT (DRY BASIS)	.0393	.0577
GRAINS/STD CU. FOOT (WET BASIS)	.0361	.0524
GRAINS/STD CU. FOOT 12% CO2	.1309	.2036
GRAINS/CU. FOOT (STK COND)	.0223	.0323
POUNDS/HOUR	8.2380	9.4424
ORSAT ANALYSIS :		
CARBON DIOXIDE (VOL %)	3.60	3.40
CARBON MONOXIDE (VOL %)	.00	.00
OXYGEN (VOL %)	14.50	14.80
NITROGEN (VOL %)	81.90	81.80
EXCESS AIR (%)	203.61	217.80
ISOKINETIC (%)	108.65	108.50

510963

CALIBRATION DATA

APPENDIX C

1.0 PITOT CALIBRATION

The pitot tubes were calibrated by measuring the velocity head in a duct with both an "S" type pitot and a standard pitot with a known coefficient. This was done at several different velocities. The pitot tube coefficient can be calculated as follows:

$$C_{p(test)} = C_{p(std)} \sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$$

Where:

$C_{p(test)}$ = Pitot tube coefficient of "S" type pitot

$C_{p(std)}$ = Pitot tube coefficient of standard pitot

ΔP_{test} = Velocity head measured by "S" type pitot

ΔP_{std} = Velocity head measured by standard pitot

Coefficients were determined for each leg of the "S" type pitot. No C_p may deviate more than ± 0.01 from the average C_p, and the difference between the average C_p for each leg must be ≤ 0.01.

2.0 DRY GAS METER AND ORIFICE METER

The dry gas meter and orific were calibrated using a wet test meter. Gases were moved through the dry gas meter at orifice pressure differentials (ΔH's) of 0.5, 1.0, and 2.0 inches of water. With the information obtained, γ, the ratio of accuracy of wet test meter to dry test meter; and $\Delta H_@$, the orifice pressure

510965

differential that gives 0.75 cfm of air at 68°F and 29.92 inches of mercury, were calculated. The γ has a tolerance of 1.00 ±0.01 and the $\Delta H_@$ has a tolerance of 1.84 +0.26 -0.24. The γ and $\Delta H_@$ are determined as follows:

$$\gamma = \frac{V_w P_b (t_d + 460)}{V_d [P_b + .07353(\Delta H)](t_w + 460)}$$

$$\Delta H_@ = \frac{0.0317 (\Delta H)}{P_b (t_d + 460)} \left(\frac{(T_w + 460)\ \theta}{V_w} \right)^2$$

Where:

ΔH = Orifice pressure differential, in. H_2O

P_b = Barometric pressure, in Hg

t_d = Average temperature of dry gas meter, °F

t_w = Average temperature of wet test meter, °F

θ = Duration of test, min.

V_d = Dry gas meter volume, ft^3

V_w = Wet test meter volume, ft^3

3.0 POTENTIOMETER CALIBRATION

The Thermo - Electron potentiometers were calibrated by using a known voltage source as an input to the potentiometer.

4.0 PROBE CALIBRATION

The probes were calibrated by measuring the outlet temperatures at various variable transformer settings while passing air through at approximately 0.75 cubic feet per minute.

BCM

METER BOX CALIBRATION SHEET

Date 6/7/79 Box No. 3 Inspector J. Weiger

Pump OK Oil Changed Wick Changed Pump Serial No. _____

Manometers OK Knobs OK Oil Added Tubing Added

Quick Connects OK Vacuum Gage OK Valves OK

Dry Gas Meter Changed (Twice) Volume _____ ft³ Serial No. 677006

Thermometers OK In 70 °F Out 70 °F Ambient 70 °F

Amphenol OK Lights OK Switches OK Variac OK

Leak Check - Max. Vacuum 2.8 in. Hg Leak Rate 0.0 CFM

Remarks Replaced oil jar. Replaced fine adjust valve (Rea

Man. Orifice	CF_w	CF_d	T_w	IT_d	OT_d	T_d	Time θ
0.5	5.001	4.904	68.5	76	76	76	11.76
1.0	5.006	4.905	68.5	75.7	73.3	74.5	8.658
2.0	9.997 10	9.800	68.5	71.6	71.2	72.9	12.585

Tolerances: $1.6 \leq \Delta H_@ \leq 2.1$ $\quad 0.99 \leq Y \leq 1.01$

$\Delta H_@ =$	$\frac{(0.0317)(\Delta H)}{(P_b)(OT_d+460)}\left[\frac{(T_w+460)(\theta)}{(CF_w)}\right]^2$	$Y =$	$\frac{(CF_w)(P_b)(T_d+460)}{(CF_d)(P_b+\Delta H/13.6)(T_w+460)}$
1.53	$\frac{(0.0317)(0.5)}{(29.87)(76+460)}\left[\frac{(68.5+460)(11.76)}{(5.001)}\right]^2$	1.03	$\frac{(5.001)(29.87)(76+460)}{(4.904)(29.87+0.0368)(68.5+460)}$
1.66	$\frac{(0.0317)(1.0)}{(29.87)(73.3+460)}\left[\frac{(68.5+460)(8.658)}{(5.006)}\right]^2$	1.03	$\frac{(5.006)(29.87)(74.5+460)}{(4.905)(29.87+0.0737)(68.5+460)}$
1.76	$\frac{(0.0317)(2.0)}{(29.87)(71.2+460)}\left[\frac{(68.5+460)(12.585)}{(9.997)}\right]^2$	1.02	$\frac{(9.997)(29.87)(72.9+460)}{(9.800)(29.87+0.147)(68.5+460)}$

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BCM

METER BOX CALIBRATION SHEET

Date 7/31/79 Box No. 7 Inspector [illegible]

Pump OK Oil Changed Nick Changed Pump Serial No. 673029

Manometers OK Knobs Changed Oil Added Tubing OK

Quick Connects OK Vacuum Gage OK Valves OK

Dry Gas Meter Rebuilt Volume ____ ft³ Serial No. ____

Thermometers OK In 71 °F Out 71 °F Ambient 73 °F

Amphenol OK Lights OK Switches OK Variac OK

Leak Check - Max. Vacuum 25 in. Hg Leak Rate 0.0 CFM

Remarks ____

Man. Orifice	CF_w	CF_d	T_w	IT_d	OT_d	T_d	Time θ
0.5	5.005	4.997	66	82	75	78	12.72
1.0	5.002	4.992	66	78	71	75	8.8
2.0	10.002	9.967	66	73	68	71	13.037

Tolerances: $1.6 \leq \Delta H_@ \leq 2.1$ $\quad 0.99 \leq \gamma \leq 1.01$

$$\Delta H_@ = \frac{(0.0317)(\Delta H)}{(P_b)(OT_d+460)}\left[\frac{(T_w+460)(\theta)}{(CF_w)}\right]^2 \qquad \gamma = \frac{(CF_w)(P_b)(T_d+460)}{(CF_d)(P_b+\Delta H/13.6)(T_w+460)}$$

$\Delta H_@$ =	γ =
$\frac{(0.0317)(0.5)}{(29.69)(75+460)}\left[\frac{(66+460)(12.72)}{(5.005)}\right]^2$ = 1.79	$\frac{(5.005)(29.69)(78+460)}{(4.997)(29.69+0.0368)(66+460)}$ = 1.03
$\frac{(0.0317)(1.0)}{(29.69)(71+460)}\left[\frac{(66+460)(8.8)}{(5.002)}\right]^2$ = 1.72	$\frac{(5.002)(29.69)(75+460)}{(4.992)(29.69+0.0737)(66+460)}$ = 1.04
$\frac{(0.0317)(2.0)}{(29.69)(68+460)}\left[\frac{(66+460)(13.037)}{(10.002)}\right]^2$ = 1.98	$\frac{(10.002)(29.69)(71+460)}{(9.967)(29.69+0.147)(66+460)}$ = 1.01

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5109968

PITOT CALIBRATION

Pitot No. S-5 Date 7/17 Engineer DM

Range	Run No.	ΔP_{std}	A SIDE ΔP	A SIDE C_p	A SIDE DEV.	B SIDE ΔP	B SIDE C_p	B SIDE DEV.	DIF.
1	1	.027	.041	.812	0	.040	.822	0	
	2	.027	.041	.812	0	.040	.822	0	
	3	.027	.041	.812	0	.040	.822	0	
	AVG.			.812			.822		.010
2	1	.195	.29	.810	.003	.31	.793	.003	
	2	.195	.30	.806	.006	.305	.800	.001	
	3	.20	.305	.810	.002	.305	.810	.009	
	AVG.			.812			.801		.011
3	1	.42	.64	.810	.002	.65	.804	.001	
	2	.42	.64	.810	.002	.645	.807	.004	
	3	.415	.64	.805	.003	.65	.794	.004	
	AVG.			.808			.803		.005
4	1	.55	.85	.804	.002	.845	.797	.001	
	2	.545	.85	.801	.001	.86	.796	0	
	3	.545	.85	.801	.001	.86	.796	0	
	AVG.			.802			796		.006
5	1	.805	1.25	.802	.001	1.25	.802	.001	
	2	.91	1.25	.805	.002	1.25	.805	.002	
	3	.805	1.25	.802	.001	1.25	.802	.001	
	AVG.			.803			.803		0
6	1	1.15	1.65	.835	.004	1.65	.835	.004	
	2	1.15	1.65	.835	.004	1.60	.818	.009	
	3.	1.15	1.60	.848	.009	1.65	.835	.004	
	AVG.			.839			.839		0
7	1	1.20	1.90	.816	.002	1.85	.805	.006	
	2	1.20	1.85	.805	.013	1.85	.805	.006	
	3	1.25	1.80	.833	.015	1.95	.822	.011	
	AVG.			.818			.811		.007

$C_p = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{"S"}}}$ DEV. = $C_p - \overline{C_p}$ DEV. ≤ 0.01 DIF. = $\overline{C_{p(A)}} - \overline{C_{p(B)}}$ DIF. ≤ 0.01

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NOZZLE DIAMETER CALIBRATION SHEET

PRE-TEST

Set No. 4 Date 7/11/79 Inspector LH

Nominal Size	Micrometer Readings				Comments
	1	2	3	Ave.	
0.125	.135	.137	.136		
0.1875	.200	.201	.203		
0.250	.262	.261	.264		
0.3125	.312	.312	.312		
0.375	.375	.374	.372		
0.500	.507	.508	.508	.508	

POST-TEST

Set No. 4 Date 7/11/79 Inspector LE

Nominal Size	Micrometer Readings				Comments
	1	2	3	Ave.	
0.125					
0.1875					
0.250					
0.3125					
0.375					
0.500	.508	.509	.505	.508	

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Excerpted from PENNSYLVANIA DER Regulation 123.13

(c) No person shall cause, suffer, or permit the emission into the outdoor atmosphere of particulate matter from any process not listed in Table I in such a manner that the concentration of particulate matter in the effluent gas, at any time, exceeds:

(1) 0.04 grains per dry standard cubic foot, when the effluent gas volume is less than 150,000 dry standard cubic feet per minute.

(2) The rate determined by the formula:

$A = 6000E^{-1}$, where:
A = Allowable emissions in grains per dry standard cubic foot, and
E = Effluent gas volume in dry standard subic feet per minute,

when E is equal to or greater than 150,000 but less than 300,000.

(3) 0.02 grains per dry standard cubic foot, when the effluent gas volume is greater than 300,000 dry standard cubic feet per minute.

Allowable emissions under this subsection are graphically indicated in Figure 3 appended to this Chapter.

TABLE I

Process	Process Factor, F
1. Carbon black mfg.	500 lbs./ton of product
2. Charcoal mfg.	400 lbs./ton of product
3. Crushers or grinders or screens	20 lbs./ton of feed
4. Paint mfg.	0.05 lbs./ton of pigment handled
5. Phosphoric acid mfg.	6 lbs./ton of phosphorous burned
6. Detergent drying	30 lbs./ton of product
7. Alfalfa dehydration	30 lbs./ton of product
8. Grain elevators:	
Loading or unloading	90 lbs./ton of grain
9. Grain screening and cleaning	300 lbs./ton of grain
10. Grain drying	200 lbs./ton of product
11. Meat smoking	0.01 lbs./ton of meat
12. Ammonium nitrate mfg.:	
Granulator	0.1 lbs./ton of product
13. Ferroalloy production furnace	0.3 lbs./ton of product
14. Primary iron and/or steel making:	
Iron production	100 lbs./ton of product
Sintering: windbox	20 lbs./ton of dry solids feed
Steel production	40 lbs./ton of product
Scarfing	20 lbs./ton of product
15. Primary lead production:	
Roasting	0.004 lbs./ton of ore feed
Sintering: windbox	0.2 lbs./ton of sinter
Lead reduction	0.5 lbs./ton of product
16. Primary zinc production:	
Roasting	3 lbs./ton of ore feed
Sintering: windbox	2 lbs./ton of product
Zinc reduction	10 lbs./ton of product
17. Secondary aluminum production:	
Sweating	50 lbs./ton of aluminum product
Melting and refining	10 lbs./ton of aluminum feed
18. Brass and bronze production:	
Melting and refining	20 lbs./ton of product

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APPLICABLE REGULATIONS

APPENDIX D