AP-42 Section 12.2
Reference
Report Sect. 4
Reference 42

Reviewed

FINAL REPORT

TO

BETHLEHEM STEEL CORPORATION
BETHLEHEM, PENNSYLVANIA

FOR

COMPLIANCE PARTICULATE EMISSION DETERMINATION OF THE COKE BATTERY "A" SCRUBBER STACK

OCTOBER 1990

PREPARED BY

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TECHNICIAN III

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VICE PRESIDENT

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Commonwealth of Pennsylvania
Environmental Resources
January 11, 1991

Subject: Source Test Review

To: Data File
Bethlehem Steel Corporation
Bethlehem, Northampton County

From: Richard St. Louis, Chief
Source Testing Unit
Division of Technical Services and Monitoring
Bureau of Air Quality Control

Through: Chief, Source Testing and Monitoring Section

The Bethlehem Steel Corporation operates a coke oven battery at its Bethlehem plant. The "A" battery consists of 80 ovens, 6 meters high. The coke is pushed from the ovens into a conventional moving quench car. A hood mounted on the door machine captures the emissions generated during the pushing process. This effluent passes through a venturi scrubber and cyclonic separator system located at the west end of the battery. The effluent is exhausted through the induced draft fan to the stack.

BCM Engineers, Inc. conducted a particulate test of the coke "A" battery scrubber outlet stack on August 30, 1990. On the day of the test, the average net coking time was 24 hours and the average tonnage of coke pushed during the test was 23.0 tons per oven. The test was conducted in accordance with standard procedures for the isokinetic collection of a particulate sample. The test results are acceptable to the Department and the calculations are correct.

The following results were extracted from the test report:

Test Date	August 30, 1990
Effluent Moisture Content (percent)	3.0
Effluent Temperature (degrees F)	137
Volumetric Flowrate (DSCFM)	117,328
Particulate Concentration (GR/DSCF)	0.0150
Actual Particulate Emission Rate (lb/hr)	0.917
Allowable Particulate Emission Rate (lb/hr)	4.662
Percent Isokinetic	111.7

cc: Thomas DiLazaro, Bethlehem District Office
AP File through Doug Lesher
EPA/RSL
Reading File

RSL:taw

Bethlehem
STRUCTURAL PRODUCTS DIVISION

BETHLEHEM STEEL CORPORATION
BETHLEHEM, PA 18016

November 7, 1990

Mr. Gerald Zvirblis
PA Department of Environmental Resources
Bureau of Air Quality Control
90 E. Union Street
Wilkes-Barre, PA 18701

Dear Mr. Zvirblis:

Pursuant to the requirements of DER Regulations Chapter 139, attached is a report of the particulate emissions testing conducted on the Structural Products Division's "A" Coke Oven Battery pushing emission control system stack for the year 1990. The results show that the particulate emissions are within the allowable limit as stipulated in Section 123.13(b) of PA title 25.

Very truly yours,

BETHLEHEM STEEL CORPORATION

T E Kreichelt/ars

T. E. Kreichelt
Superintendent
Environment, Safety and Health

Attachment

cc: Mr. T. A. DiLazaro

RECEIVED
NOV 9 1990
BETHLEHEM DIST. OFFICE
BUREAU OF ENV. RES.

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BETHLEHEM STEEL CORPORATION
STRUCTURAL PRODUCTS DIVISION

"A" Battery Pushing Emission Control System
Particulate Emissions Evaluation

Pursuant to the requirement of DER Regulations Chapter 139, particulate emission tests were conducted on the "A" Coke Oven Battery pushing emission control system stack on August 30, 1990. Testing and analyses were performed according to procedures as outlined in US EPA Reference Methods 1 through 5 of the Federal Register, Volume 42, Number 160.

Source Description

"A" Battery is an 80 oven battery of 6 meter high ovens having double gas collector mains. Coke is pushed from the ovens into a conventional moving quench car. The emissions generated during the pushing operation are captured by a hood mounted on the door machine. This hood is connected to a land based duct system which conveys the captured gases and particulate to a venturi scrubber and cyclonic separator system at the west end of the battery. The gases from the system are then exhausted through the induced draft fans to the stack.

On the day of the test the average net coking time was approximately 24 hours. The ovens pushed during the testing periods are identified on Attachment 1. The average tonnage of coke pushed on the battery during the test was 23.0 tons per oven.

Venturi pressure drops during the test were between 33 to 40 inches of water on the north and south scrubber. During the test, water flow rates averaged 855 GPM to each of the venturis.

Test Procedure

All equipment and analytical procedures conformed to EPA Method 5. Sixteen pushes were sampled during the tests. Sampling commenced at the movement of the coke mass and terminated approx. 30 seconds after the completion of the push. Each push was sampled at a different point, with 8 points on each diameter.

Sampling Results

Test results are summarized in BCM's test report, Attachment 2. The total particulate loading (front half plus back half insolubles) for the test was calculated at 0.917 lb./hr. The calculated allowable limit is 4.662 lb./hr.

Attachment 1

"A" Battery Scrubber Test 8/30/90
Ovens Pushed

Oven No.	Time
6	9:48:45
16	10:06:35
26	10:24:53
46	10:51:50
56	11:00:57
66	11:15:55
76	11:29:55
86	11:45:12
8	11:56:00
18	12:06:23
38	3:10:00
48	3:19:00
58	3:28:50
68	3:40:33
78	3:57:18
88	4:13:45

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CONTENTS

TABLES

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1.0 EXECUTIVE SUMMARY

Bethlehem Steel Corporation (Bethlehem Steel) retained BCM Engineers Inc. (BCM) to conduct a compliance emission determination at its facility in Bethlehem, Pennsylvania. A single test run was performed at the coke battery "A" scrubber outlet stack to determine the compliance status of the coke battery with respect to Pennsylvania Department of Environmental Resources (PADER) particulate emission standards.

Results show that the actual emission rate of 0.917 pounds per hour (lb/hr) is below the allowable emission rate of 4.662 lb/hr. Complete results of the testing program can be found in Table 1 of Section 5.0.

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2.0 SCOPE AND OBJECTIVES

The scope of the project included a single particulate emission test at the scrubber outlet stack. The objectives of the sampling were to determine the following parameters:

- Gas flow - acfm and dscfm
- Gas temperature - °F
- Gas moisture content - percent by volume
- Gas velocity - fpm
- Particulate emissions - grains/dscf and lb/hr

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3.0 PROCEDURES

3.1 FIELD WORK

Field testing was conducted on August 30, 1990. The sampling team consisted of the following BCM personnel:

Karl Brenton - Technician III
Edward DiEgidio - Scientist II

Mr. Robert Leonard of Bethlehem Steel acted as liaison between BCM and Bethlehem Steel and ensured process operating conditions were suitable for testing.

Emission testing was conducted according to procedures as outlined in U.S. Environmental Protection Agency (EPA) Reference Methods 1 through 5 of the Federal Register, Volume 42, Number 160. Descriptions of these methodologies can be found in Appendix A of this report.

3.2 ANALYTICAL METHODS

All samples generated during the sampling program were returned to the laboratory for analysis. An outline of the analytical methodologies is contained in Appendix B. Laboratory data are also presented in Appendix B.

3.3 CALCULATIONS

BCM's HP 3000 computer, programmed to accept input data in accordance with EPA calculation procedures, was used to perform most calculations. The reduced data appear on the computer input sheet, which is presented in Appendix B. Appendix B also contains the equations used to determine the test results and the BCM computation sheets which show the allowable and actual particulate emission rate calculations.

3.4 EQUIPMENT CALIBRATION

In accordance with accepted procedures published by the EPA, all gas velocity measuring equipment, gas volume metering equipment, and temperature measuring equipment had been calibrated prior to the test program. Appendix C provides calibration data.

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4.0 CONTROL SYSTEM OPERATION AND TESTING PROCEDURE

4.1 CONTROL SYSTEM OPERATION

The control system operates in a manner such that particulate emissions from the coke pushing operation are captured by a hood and routed to the scrubber for removal. Air dampers in the system remain closed and are opened only during the coke pushing operations. Air flow through the scrubber, therefore, only occurs during coke pushing.

4.2 TESTING PROCEDURE

A total of 16 traverse points (four per port) were sampled during the test run. Each point was sampled during an individual oven push. Sampling at a particular traverse point corresponded to the pushing time and commenced when coke began falling into the car and continued for 30 seconds after all coke was pushed or until the dampers were closed, whichever came first. The total sampling time, therefore, equals the amount of time required for 16 pushes and was used to determine the average duration of a single pushing operation.

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5.0 TEST RESULTS

All gas flow rate and particulate emission data determined during the testing are contained in Table 1. All data were collected during the 16 separate oven pushes. Values as presented in Table 1, therefore, represent stack conditions during pushing operations. The particulate emission rate, however, was calculated to represent the actual pounds of particulate emitted in an hour period, based on the minutes per hour of pushing time. Appendix B contains a description of the allowable and actual particulate emission calculations.

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TABLE 1

TEST RESULTS

Parameter	Test Result
Gas Moisture Content (%)	3.0
Gas Temperature (°F)	137
Gas Velocity (ft/min)	2,764
Gas Volume (dry scfm)	117,328
Gas Volume (acfm)	138,937
Particulate Emission Concentration (gr/dscf)	0.0150
Actual Particulate Emission Rate (lb/hr)	0.917
Allowable Particulate Emission Rate (lb/hr)	4.662

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6.0 DISCUSSION OF RESULTS

6.1 GENERAL

With the exception of a damper malfunction during testing at Point No. 3 of Port A, no other process problems were encountered. Testing was stopped, then resumed when the malfunction was corrected. Only a single push, therefore, was sampled during the damper malfunction.

During data reduction and emission calculations, it was discovered that the isokinetic deviation was 111.7 percent, which is not in the 90 to 110 percent allowable range. However, due to the fact that the demonstrated emission rate was well below the allowable emission rate, BCM feel that the slightly high isokinetic deviation of the test run did not affect the indicated compliance status of the source.

6.2 CALCULATIONS

The BCM Computation Sheets contained in Appendix B show the coke production rate and allowable and actual emission rate calculations. The coke production rate of 75.10 tons per hour was calculated using the historical values of 22.53 tons of coke per oven and 80 ovens pushed in 24 hours. The allowable emissions rate was calculated according to Section 123.13(b)(2) of the Pennsylvania Air Pollution Control Act utilizing these historical operating values. The actual particulate emission rate was calculated from the particulate concentration (gr/dscf), the stack gas flow rate (dscf/min), and the coke pushing time (min/hr). The coke push time was calculated from the average duration of a single push determined during the test run and the historical number of ovens pushed in 24 hours.

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APPENDIX A

FIELD SAMPLING PROGRAM

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APPENDIX A

FIELD SAMPLING PROGRAM

1.0 SAMPLING PROCEDURES

1.1 Test Station and Traversy Location

The internal diameter of the "A" Battery Push Emission Scrubber exhaust stack is 96 inches. Four test ports, located 90 degrees apart, were used for particulate sampling. Sixteen traverse points were selected (four per port) to account for each of the 16 oven pushes.

1.2 Gas Flow Temperature Determinations

The gas flow rate and temperature profiles were measured by conducting velocity and temperature traverses simultaneously with the particulate sampling. Gas velocity heads were measured with an "S" type pitot tube connected to an inclined manometer. A Chromel-Alumel thermocouple connected to a potentiometer was used to determine the gas temperatures.

1.3 Moisture Content

Sampling was conducted employing the principles presented in EPA Method 4 and concurrently with particulate sampling. The parameters evaluated to determine the gas stream's moisture content were: sample gas volume, sample gas temperature, sample gas pressure, impinger moisture gain, and silica gel moisture gain. Some minor modifications were made to the Method 4 train to allow for concurrent sampling of particulate and moisture content. These modifications did not deviate from sampling principles.

The modifications made included the substitution of a glass fiber filter for a Pyrex wool filter as a filtering medium and the substitution of a calibrated orifice for a rotameter as a flow metering device.

1.4 Particulate Sampling

The sampling procedures and sampling equipment used are those outlined in Method 5 of Appendix 1, 40 CFR 60. This methodology also complies with the Pennsylvania Department of Environmental Resources (PADER) testing regulations.

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The size of the nozzle required to maintained isokinetic sampling was calculated from the results of a previously completed velocity and temperature traverse. The sampling train used a glass-lined stainless steel probe, which was heated by an internal heating element. A nozzle of the calculated size was attached to the end of the probe, which was inserted into the stack. Sample gas passed through the nozzle and the probe to a glass fiber filter for the removal of the suspended particulates. The filter was housed in a heated chamber with the temperature maintained at 225 + 25°F. From the filter, the stack gas passed to the impinger train. The first two impingers each contained 150 milliliters (ml) of deionized (DI) water. The third impinger contained no reagents and was a knockout impinger. The fourth impinger contained approximately 200 grams of coarse silica gel, which collected any moisture and/or vapors that had not been captured in the preceding impingers.

The second impinger was a 500-ml Greenburg-Smith impinger, while the first, third, and fourth were 500-ml impingers of the Greenburg-Smith design, modified by replacing the tip with a 1/2-inch inside diameter (ID) glass tube. Note: the impinger train was immersed in an ice bath for the entire test period so that the exiting gas temperature would not exceed 68°F.

From the impinger train, the gas was conducted through an umbilical cord to the control console which contained the following pieces of equipment (listed in the order in which sampled gas pass through them): a main valve, a bypass valve for flow adjustment, an airtight vacuum pump, a dry gas meter, and a calibrated orifice. The orifice was equipped with pressure taps which were connected across the inclined manometer used to ensure that isokinetic conditions were maintained. A schematic diagram of the sampling train is depicted following the data sheets.

The sampling train was subjected to a leak check prior to and after each sample run. The inlet of the nozzle was plugged and the pump vacuum was held at the highest vacuum attained during that period of testing. In all cases the leakage rate was minimal and did not exceed the maximum allowable leakage rate of 0.02 cubic feet per minute (cfm). Upon completion of a test, the soiled glass fiber filter was removed from its filter holder and placed in a Petri dish, which was subsequently sealed. The probe and nozzle were washed internally first with DI water and then with acetone. The particulate matter remaining in the probe was removed with a nylon brush attached to polyethylene line. The front half of the glass filter holder was also rinsed with DI water, then acetone, and the washings obtained were added to those collected from the nozzle and the probe. All water and acetone washings were stored in separate sealed polyethylene sample bottles for transfer to the laboratory.

The silica gel used in the fourth impinger was removed and stored in a sealed sample bottle. The contents of the first, second, and third impingers were combined, measured volumetrically, and stored in sealed sample bottles for transfer to the BCM Laboratory. The first, second, and third impingers were finally rinsed with acetone and the washings placed in separate bottles.

1.5 Molecular Weight Determination

A Fyrite gas analyzer was used to determine the molecular weight of the exhaust gas at each source. 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 nitrogen (N_2), determined by difference.

2.0 FIELD DATA SHEETS

The following data were recorded during the sampling program: the flue gas velocity head, flue gas temperature, inlet and outlet dry gas meter temperatures, orifice pressure differential, sample volume, sampling time, pump vacuum, filter temperature, and the impinger train outlet gas temperature. The field data sheets generated during the program appear at the end of this appendix.

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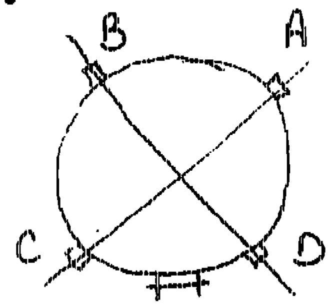
TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

PLANT: Bethlehem Steel
DATE:
SAMPLING LOCATION: Coke Battery "A" Scrubber Stack
INSIDE OF FAR WALL TO OUTSIDE OF NIPPLE, (DISTANCE A):
INSIDE OF NEAR WALL TO OUTSIDE OF NIPPLE, (DISTANCE B):
STACK I.D., (DISTANCE A - DISTANCE B): 96"
NEAREST UPSTREAM DISTURBANCE:
NEAREST DOWNSTREAM DISTURBANCE:
CALCULATOR:



SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	DISTANCE B	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	0.032	96"	3.1	5"	8.1
2	0.105	↓	10.1	↓	15.1
3	0.194	↓	18.6	↓	23.6
4	0.323	↓	31.0	↓	36.0

PLANT Bethlehem Steel

DATE 8-30-90

SAMPLING LOCATION Battery A Ascension Outlet

SAMPLE TYPE P.A. Particulate

RUN NUMBER 1 OPERATOR KB/ED

BAROMETRIC PRESSURE 29.42 STATIC PRESSURE -.26

FILTER NUMBER(S)

GEL NUMBER(S) +5g

NOZZLE NUMBER PLATE NUMBER

H_2O DIFF (ml) +6 ml

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ORSAT:

CO_2 0

O_2 21

CO 0

PYROMETER NUMBER

THERMOCOUPLE NUMBER 4-12

PROBE NUMBER TYPE Glass

NOZZLE NUMBER I.D. .260

METER BOX NUMBER E-285 ΔH@ 1.80

PITOT NUMBER Cp .84

SAMPLE BOX NUMBER(S)

ASSUMED MOISTURE (%) 3

ASSUMED METER TEMPERATURE 75

C FACTOR 1.0 REFERENCE Δp .40

READ AND RECORD ALL DATA EVERY ____ 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 DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
A	00	0955	769.256									
1	1'00"	0956	770.900	.68	3.2	3.2	126	71	72	15	250	55
		1011										
2	1'15"	1012	772.318	.68	3.2	3.2	130	72	71	15	255	55
		1039										
3	30"	1039	772.600	.18	.84	.84	135	72	71	8	260	55
		1056										
4	1'0"	1057	773.359	.43	2.0	2.0	134	72	74	10	260	55
B	-	1120										
1	1'0"	1121	774.534	.68	3.2	3.2	135	76	74	15	245	56
		1134										
2	1'15"	1135	775.750	.65	3.0	3.0	135	77	75	15	250	56
		1149										
3	1'15"	1150	776.678	.60	2.8	2.8	150	77	75	14	251	58
		1200										
4	30"	1201	777.351	.34	1.8	1.8	135	78	75	14	247	59
	θ = 17.5		V_m = 17.297	$\sqrt{\Delta p}$ = .761	ΔH =	2.828	T_s = 136.6	T_m =	77			

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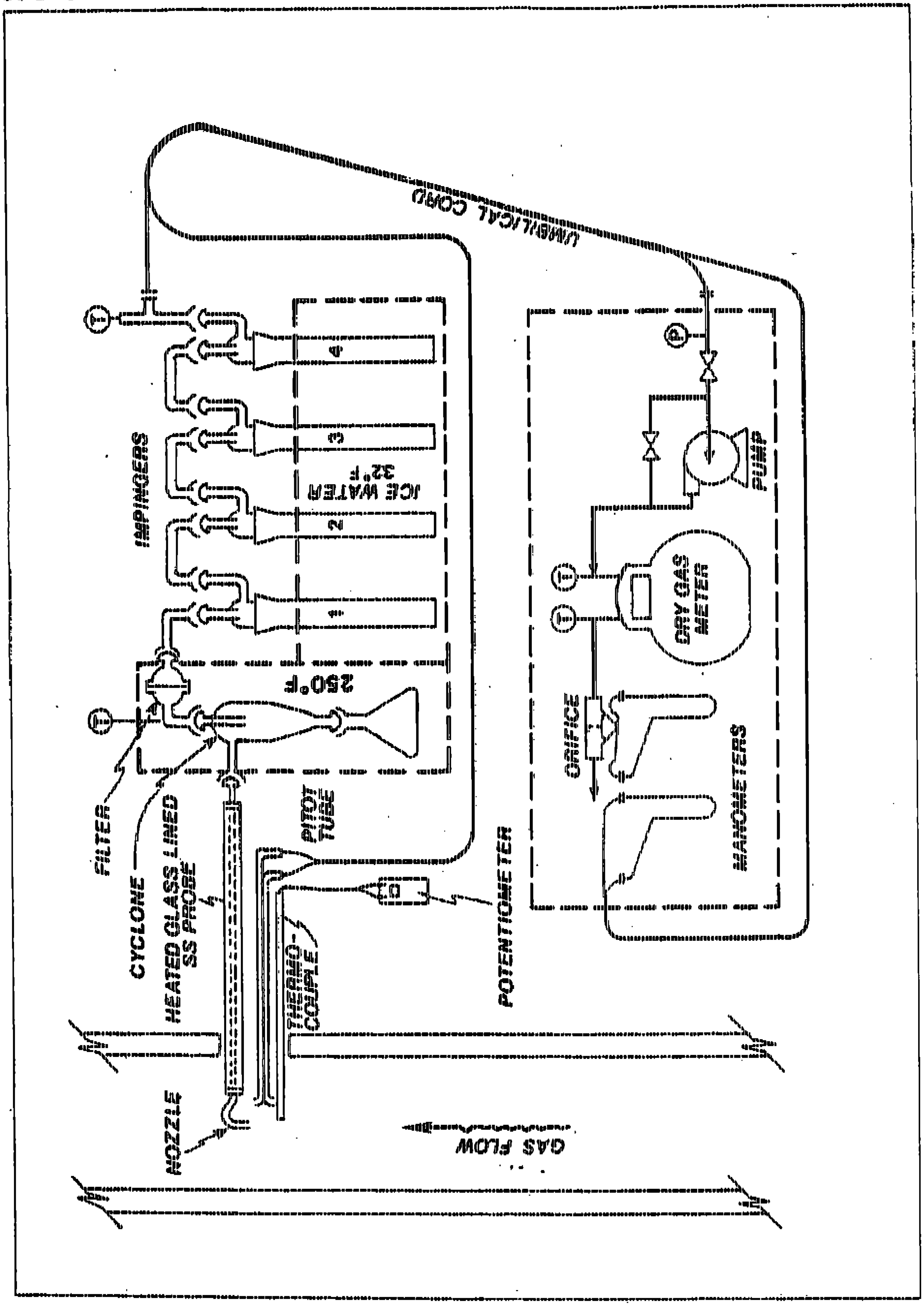
Tillaham
NT Ator 2 DATE 8-30-90 RUN NUMBER 1

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 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
0	00	1514	779.057									
1	1'35"	1516	780.711	.70	3.4	3.4	140	83	81	16	265	50
		1522										
2	50"	1523	781.673	.73	3.6	3.6	130	81	80	17	261	50
		1532										
3	1'15"	1533	782.979	.70	3.4	3.4	140	81	81	16	254	50
		1545										
4	1'15"	1546	784.103	.60	2.8	2.8	140	81	80	14	255	50
D	—	1602	[illegible]									
1	1'0"	1603	785.059	.80	3.8	3.8	140	80	79	14	250	51
		1618	[illegible]									
2	1'0"	1619	786.478	[illegible]	3.4	3.4	140	80	79	17	255	52
		1633										
3	1'15"	1634	787.715	[illegible]	3.2	3.2	134	81	79	16	256	54
		1702										
4	1'15"	1703	788.739	.45	2.2	2.2	142	79	78	10	250	56
				Leak chk	= .005	@		19"	Hg			


UMBILICAL CORD
IMPINGERS
ICE WATER 32°F
1
2
3
4
250°F
T
P
FILTER
CYCLONE
HEATED GLASS LINED SS PROBE
PITOT TUBE
THERMO-COUPLE
POTENTIOMETER
NOZZLE
GAS FLOW
ORIFICE
DRY GAS METER
MANOMETERS
PUMP

EPA METHOD 5

APPENDIX B

LABORATORY ANALYSIS AND DATA REDUCTION

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APPENDIX B

LABORATORY ANALYSIS AND DATA REDUCTION

1.0 ANALYTICAL METHODS

The following discussions describe the analytical methods employed.

1.1 Particulate Samples

Prior to their use in the field, all glass fiber filters used in the sampling program had been tare-weighed following a 24-hour desiccation period. Upon their return to the laboratory, the filters were desiccated and reweighed. The weight difference was the amount of sample collected.

The water and acetone washing of the nozzle, probe, and filter holder were evaporated to dryness in separate tared beakers. The residue was desiccated, and the beakers were reweighed. Any residue was considered the soluble back-half portion of the particulate catch.

Water and acetone blanks were evaporated to dryness in tared beakers and were desiccated and reweighed. Any residue that remained was a contaminant in the reagent and was considered a blank weight used as a correction factor in subsequent calculations.

Table B-1 contains the portions of the particulate catch which were used in accordance with PADER regulations to determine particulate emissions. These portions include the particulate contained on the filter, the front-half water and acetone washes, and the insoluble back-half particulate catch. Note that both the soluble and insoluble portions of the front-half water wash were determined. Table B-2 contains the soluble back-half particulate catch which was reported (in accordance PADER regulations) but not included in the emission calculations.

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1.2 Moisture Content

The silica gel had been tare-weighed prior to its use in the field. After its use, the silica gel was reweighed. The entire weight gain was due to water vapor. The total volume of the impinger solutions, minus the original volume of water in the impingers, plus the volume of moisture and/or vapor collected by the silica gel, equaled the total moisture gain of the sampling train. This volume was used as the basis for percent moisture by volume calculations.

2.0 COMPUTER INPUT SHEET

The reduced data calculated from the field data sheets were combined with the laboratory results on the computer input data sheets to facilitate programming. The computer input data sheets are included in this appendix.

3.0 EQUATIONS FOR THE CALCULATIONS OF TEST RESULTS

The equations following the data input sheet were programmed into the computer to facilitate the calculation of the test program results. The equations were prescribed in EPA Methods 2, 3, 4, and 5 of 40 CFR 60, Appendix 1, Reference Test Methods, and were used to calculate the results of particulate, flow, temperature, and static pressure testing.

4.0 PARTICULATE TEST RESULTS

The complete results of the computer analyses of the data generated from the particulate test program are presented on the computer printout following the equations.

5.0 BCM COMPUTATION SHEETS

The actual and allowable emission rate calculations are contained on the BCM Computation Sheets. Copies of the computation sheets follow the computer printout sheets.

BCM

TABLE B-1

LABORATORY RESULTS
PENNSYLVANIA PARTICULATE CATCH

Sample Fraction	Particulate Weight (mg)
Filter	4.2
Insoluble Front-Half Water Wash	0.8
Soluble Front-Half Water Wash	1.6
Front-Half Acetone Wash	5.4
Insoluble Back-Half (0.22 u filter)	4.4
TOTAL	16.4

TABLE B-2

LABORATORY RESULTS
SOLUBLE PARTICULATE CATCH

Sample Fraction	Particulate Weight (mg)
Impinger Acetone Wash	<1.8
Soluble Back-Half (impinger filtrate)	3.6
TOTAL	5.4

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1	Heading	Bethlehem Steel Battery A Scrubber Outlet Particulate Emissions								
2	Number of tests	1								
3	Test type ("EPA","PA","F",or "H2S")	EPA								
4	Test identification (ID's in qoutes)	1								
5	Stack area, in^2 (96" ID)	7238								
6	Stack temperature, °F	126.6								
7	Sample volume, ft^3	17.297								
8	Meter temperature, °F	77								
9	Orifice (ΔH), in. H_2O	2.826								
10	Nozzle diameter, in	.260								
11	Duration of test, min.	17.5								
12	Volume of CO_2, %	0								
13	Volume of CO, %	0								
14	Volume of O_2, %	21								
15	Static pressure, in. H_2O	+.26								
16	Barometric pressure, in. Hg	29.42								
17	Pitot correction factor	.84								
18	Traverse (Avg. $\sqrt{\Delta p}$), in. H_2O	.761								
19	Volume H_2O collected, ml	11								
20	Weight collected, mg	16.4								
21	Volume titrant, SO_3, ml	0								
22	Volume titrant, SO_2, ml	0								
23	Normality titrant, SO_3	0								
24	Normality titrant, SO_2	0								
25	Meter calibration factor	1.0								
26	Avg. Cosine of angle	1.0								
27	Post leak check rate, CFM	0								
28	Leak check rate no. 1, CFM	0								
29	Leak check time no. 1, min.	0								

Job Number 4021-29

File Name BSCA

7.50 1117

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

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

$\overline{\sqrt{\Delta P}}$ = 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.

BETHLEHEM STEEL BATERY A SCRUBBER OUTLET,PARTICULATE EMISSIONS

PARAMETERS:		1
AREA OF BREECHING	(SQ FT)	50.26
SAMPLE VOLUME	(DSCF)	16.834
MOISTURE	(%)	3.0
MOLECULAR WEIGHT	(LB/LB-MOLE)	28.52
GAS TEMPERATURE	(F)	136.6
GAS VELOCITY	(FT/MIN)	2764.1
GAS VOLUME	(DRY SCFM)	117327.9
GAS VOLUME	(ACFM)	138936.9
PARTICULATE EMISSIONS:		
CONCENTRATION	(GRAINS/DSCF)	.0150
CONC. @ STK COND.	(GRAINS/CF)	.0127
EMISSION RATE	(LB/HR)	15.1236
ORSAT ANALYSIS:		
CARBON DIOXIDE	(VOL %)	.0
CARBON MONOXIDE	(VOL %)	.0
OXYGEN	(VOL %)	21.0
NITROGEN	(VOL %)	79.0
EXCESS AIR	(%)	-14583.2
ISOKINETICS	(%)	111.7

BCM COMPUTATION SHEET

Sheet Number 1 of 2
Date 10/10/90
Job Number 4021-29
Computed by RCB Checked by

Name of Client Bethlehem Steel
Project Coke Battery "A"
Description Allowable Emission Rate calculation

A. Coke Production Rate

Historically: 22.53 tons coke/oven and 80 ovens pushed in 24 hours

Therefore:

$$\text{Coke production Rate (Ton/hr)} = \left(\frac{80 \text{ ovens}}{24 \text{ hours}}\right)\left(22.53 \frac{\text{tons}}{\text{oven}}\right) = 75.10 \text{ Tons/hr}$$

B. Allowable Emission Rate as per 123.13(b)(2) of the PA Air Pollution Control act

$$A = 0.76\, E^{0.42}$$

Where: A = allowable emission rate, lb/hr
E = F x W, lb/hr
F = Process factor (Table 1), 1 lb/hr
W = Production rate, 75.10 ton/hr

$$A = (0.76)(1 \text{ lb/ton} \times 75.10 \text{ ton/hr})^{0.42}$$

$$A = 4.662 \text{ lb/hr}$$

BCM

COMPUTATION SHEET

Name of Client: Bethlehem Steel Corp.
Project: Compliance Test
Description: Actual Emission Rate

Sheet Number 2 Of 2
Date 12/10/90
Job Number 9021-29
Computed by KB Checked by ACB

$$\text{Actual Emission Rate (lb/hr)} = \frac{\begin{pmatrix}\text{Particulate Concentration} \\ (\text{gr/dscf})\end{pmatrix}\begin{pmatrix}\text{Flow Rate} \\ (\text{dscf/min})\end{pmatrix}\begin{pmatrix}\text{Push Time} \\ \text{min/hr}\end{pmatrix}}{7000\ \text{gr/lb}}$$

Where:

gr/dscf = 0.0150

Flow = 117,328

$$\text{Push Time} = \left(\frac{17.50\ \text{min push time}}{16\ \text{pushes}}\right)\left(\frac{80\ \text{ovens pushed}}{24\ \text{hrs}}\right) = 3.646\ \text{min/hr}$$

$$\text{Actual Emission Rate (lb/hr)} = \frac{(0.0150\ \text{gr/dscf})(117{,}328\ \text{dscfm})(3.646\ \text{min/hr})}{7{,}000\ \text{gr/lb}}$$

$$= \underline{\underline{0.917\ \text{lb/hr}}}$$

BCM

APPENDIX C

EQUIPMENT CALIBRATION

BCM

METER BOX CALIBRATION SHEET

Date 8-16-90 Box No. 285 Inspector KB

Pump OK Oil OK Wick OK Pump Serial No. ____

Manometers OK Knobs OK Oil OK Tubing OK

Quick Connects OK Vacuum Gage OK Valves OK

Dry Gas Meter OK Volume 700 ft³ Serial No. ____

Thermometers OK In 75 °F Out 75 °F Ambient 74 °F

Amphenol OK Lights OK Switches OK Variac ____

Leak Check - Max. Vacuum ____ in. Hg Leak Rate Ø CFM

Remarks ADDED Oil, Adjust GAS METER.

Man. Orifice	CF_w	CF_d	T_w	IT_d	OT_d	T_d	Time θ
0.5	5.004	5.160	72	97.5	82.5	90	12.08
1.0	5.005	5.206	72	100	84	92	8.83
2.0	10.007	10.514	72	110	88	99	12.76

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

$\Delta H_@ =$	$\frac{(0.0317)(\Delta H)}{(P_b)(OT_d+460)}\left[\frac{(T_w+460)(\theta)}{(CF_w)}\right]^2$	$\gamma =$	$\frac{(CF_w)(P_b)(T_d+460)}{(CF_d)(P_b+\Delta H/13.6)(T_w+460)}$
1.61	$\frac{(0.0317)(0.5)}{(29.92)(82.5+460)}\left[\frac{(72+460)(12.08)}{(5.004)}\right]^2$	1.001	$\frac{(5.004)(29.92)(90+460)}{(5.160)(29.92+0.0368)(72+460)}$
1.72	$\frac{(0.0317)(1.0)}{(29.92)(84+460)}\left[\frac{(72+460)(8.83)}{(5.005)}\right]^2$	.995	$\frac{(5.005)(29.92)(92+460)}{(5.206)(29.92+0.0737)(72+460)}$
1.78	$\frac{(0.0317)(2.0)}{(29.92)(88+460)}\left[\frac{(72+460)(12.76)}{(10.007)}\right]^2$	.995	$\frac{(10.007)(29.92)(99+460)}{(10.514)(29.92+0.147)(72+460)}$

PITOT CALIBRATION

Pitot No. 4-12 Date 11-9-89 Engineer KB/JS

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	.025	.035	.836	0	.035	.836	0	
	2	.025	.035	.836	0	.035	.836	0	
	3	.025	.035	.836	0	.035	.836	0	
	AVG.			.836			.836		0
2	1	.20	.28	.836	0	.28	.836	0	
	2	.20	.28	.836	0	.28	.836	0	
	3	.20	.28	.836	0	.28	.836	0	
	AVG.			.836			.836		0
3	1	.48	.66	.844	0	.67	.837	.004	
	2	.48	.66	.844	0	.66	.844	.003	
	3	.48	.66	.844	0	.66	.844	.003	
	AVG.			.844			.841		.003
4	1	.64	.88	.844	0	.87	.849	0	
	2	.64	.88	.844	0	.87	.849	0	
	3	.64	.88	.844	0	.87	.849	0	
	AVG.			.844			.849		.005
5	1	.88	1.25	.830	0	1.25	.830	0	
	2	.88	1.25	.830	0	1.25	.830	0	
	3	.88	1.25	.830	0	1.25	.830	0	
	AVG.			.830			.830		0
6	1	1.2	1.70	.831	0	1.70	.831	0	
	2	1.2	1.70	.831	0	1.70	.831	0	
	3	1.2	1.70	.831	0	1.70	.831	0	
	AVG.			.831			.831		0
7	1	1.4	2.0	.828	0	2.0	.828	0	
	2	1.4	2.0	.828	0	2.0	.828	0	
	3	1.4	2.0	.828	0	2.0	.828	0	
	AVG.			.828			.828		0

Ave = .84

$C_p = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{s}}}$

DEV. = $C_p - \bar{C}_p$

DEV. ≤ 0.01

DIF. = $\bar{C}_{p(A)} - \bar{C}_{p(B)}$

DIF. ≤ 0.01