File

ALTH OF PENNSYLVANIA

DATE: December 30, 1992

SUBJECT: **"A" BATTERY SCRUBBER STACK TEST**
Bethlehem Coke Works
Bethlehem Steel Corp.
Bethlehem, Northampton County

TO: L. Blaine DeHaven
Source Testing & Monitoring Section

THRU: Thomas A. DiLazaro
Acting Air Quality
Program Manager

FROM: Ronald D. Mordosky RDM
Air Quality Specialist

Please review the attached stack test to determine if the procedures used comply with the Department's regulations.

RDM/bas

Attachment

2/26

PARTICULATE EMISSIONS EVALUATION

"A" BATTERY SCRUBBER STACK

AT

BETHLEHEM STEEL CORPORATION
BETHLEHEM, PENNSYLVANIA 18061

BCM NO. 00-4021-37

DECEMBER 10, 1992

PREPARED BY

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Engineers, Planners, Scientists and Laboratory Services
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1.0 EXECUTIVE SUMMARY

Bethlehem Steel Corporation retained BCM Engineers Inc. (BCM) to perform a particulate emissions test on the "A" Coke Battery Pushing Scrubber Exhaust Stack located in Bethlehem, Pennsylvania. Testing and analyses were conducted in accordance with EPA Methods One through Five and Pennsylvania Department of Environmental Resources (PADER) methodology. The test results are to be used to demonstrate compliance with limitations set forth by PADER. The measured particulate emission was 0.76 lb/hr. The compliance limit was 4.71 lb/hr.

2.0 SCOPE AND OBJECTIVES

The scope of this project was outlined in BCM Proposal No. 13-8590-01. The following parameters were determined for the test run:

• Gas Flow	acfm and dscfm
• Gas Temperature	^oF
• Gas Moisture	% by Volume
• Particulate Emissions	gr/dscf and lb/hr

3.0 PROCEDURES

The field sampling program was performed on November 24, 1992. The BCM test personnel consisted of Messrs. Paul Jadlowiec, Nick Charno, and Karl Brenton. Mr. Lawrence Kreiger served as plant coordinator.

3.1 FIELD WORK

3.1.1 Field Data Sheets

All field data sheets are contained in Appendix A.

3.1.2 Testing Station and Traverse Locations

The exhaust stack has an internal diameter of 96 inches at the test location. The test elevation is located approximately 50 feet or 6 stack diameters downstream from the inlet breeching and approximately 16 feet or 2 stack diameters upstream from the stack outlet. EPA Method One was utilized to determine the number and location of the traverse points. Sixteen (16) points were sampled, 4 at each of 4 sample ports located 90 degrees to center.

3.1.3 Gas Flow and Gas Temperature Measurements

The flow rate and temperature profiles for the gas streams were measured by conducting simultaneous velocity and temperature traverses. Gas velocity head was measured with a calibrated "S"-type Pitot tube which was connected to an inclined manometer. The static pressure was measured using the same Pitot tube and manometer. A Chrome-Alumel thermocouple attached to a digital potentiometer was used to measure the gas temperature at each of the traverse points. The gas flow and gas temperature measurements followed EPA Method Two.

3.1.4 Molecular Weight Determination

A Bacharach Fyrite analyzer was used to determine the molecular weight of the flue gas. Fyrite gas analyzers give accurate readings within +/- 0.5% Carbon Dioxide or Oxygen up to 538°C. Readings are unaffected by most other gases. The following parameters were measured in order to calculate molecular weight: volume percent carbon dioxide and volume percent oxygen; the volume percent of carbon monoxide and nitrogen was determined by difference. These parameters were measured using the principle of gas absorption in specific absorbing solutions.

3.1.5 Moisture Content Sampling

Moisture sampling was conducted employing the principles presented in EPA Method Four and concurrently with particulate sampling. Parameters evaluated in order to determine the gas stream 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 Four train to allow concurrent particulate and moisture content sampling; these modifications involve no deviations from sampling principles. Modifications such as the substitution of a glass fiber filter for Pyrex wool as a filtering medium and the substitution of a calibrated orifice for a rotameter as a flow metering device were incorporated.

3.1.6 Determination of Particulate Emissions

Sampling procedures followed those described in EPA Method Five and PADER Bureau of Air Quality Control, Division of Technical Services and Monitoring, "Source Testing Manual." A schematic of the sampling train is presented in Figure 1.

3.1.7 Sample Recovery Procedure

Sample recovery was conducted onsite in the BCM test van.

3.1.8 Operational Data

The coke production rate of 1,850 tons/day for "A" Coke Battery was provided by Bethlehem Steel.

3.2 ANALYSIS

All analytical data sheets are contained in Appendix B. All sample analyses were conducted by BCM at their Pittsburgh office.

3.3 CALCULATIONS

The BCM Computation Sheets contained in Appendix C show the coke production rate and allowable and actual emission rate calculations. The coke production rate of 77.08 tons per hour was calculated using the production value of 1850 tons of coke per day and 80 ovens pushed in 24 hours. The allowable emission rate was calculated according to 123.13(b)(2) of the Pennsylvania Air Pollution Control Act. 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.

Particulate emission calculations were completed using a Lotus 123 spreadsheet format. The results of each pertinent parameter are detailed on the spreadsheet. The averages for the sampling data were time weighted.

3.4 CALIBRATIONS

The following field equipment calibrations are contained in Appendix D:

- Dry Gas Meter and Orifice
- Thermocouple
- Pitot Tube
- Nozzle Diameter

4.0 SUMMARY OF RESULTS

A summary of the test results 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.

The actual emission rate measured was 0.76 lb/hr. The allowable emission rate was 4.71 lb/hr.

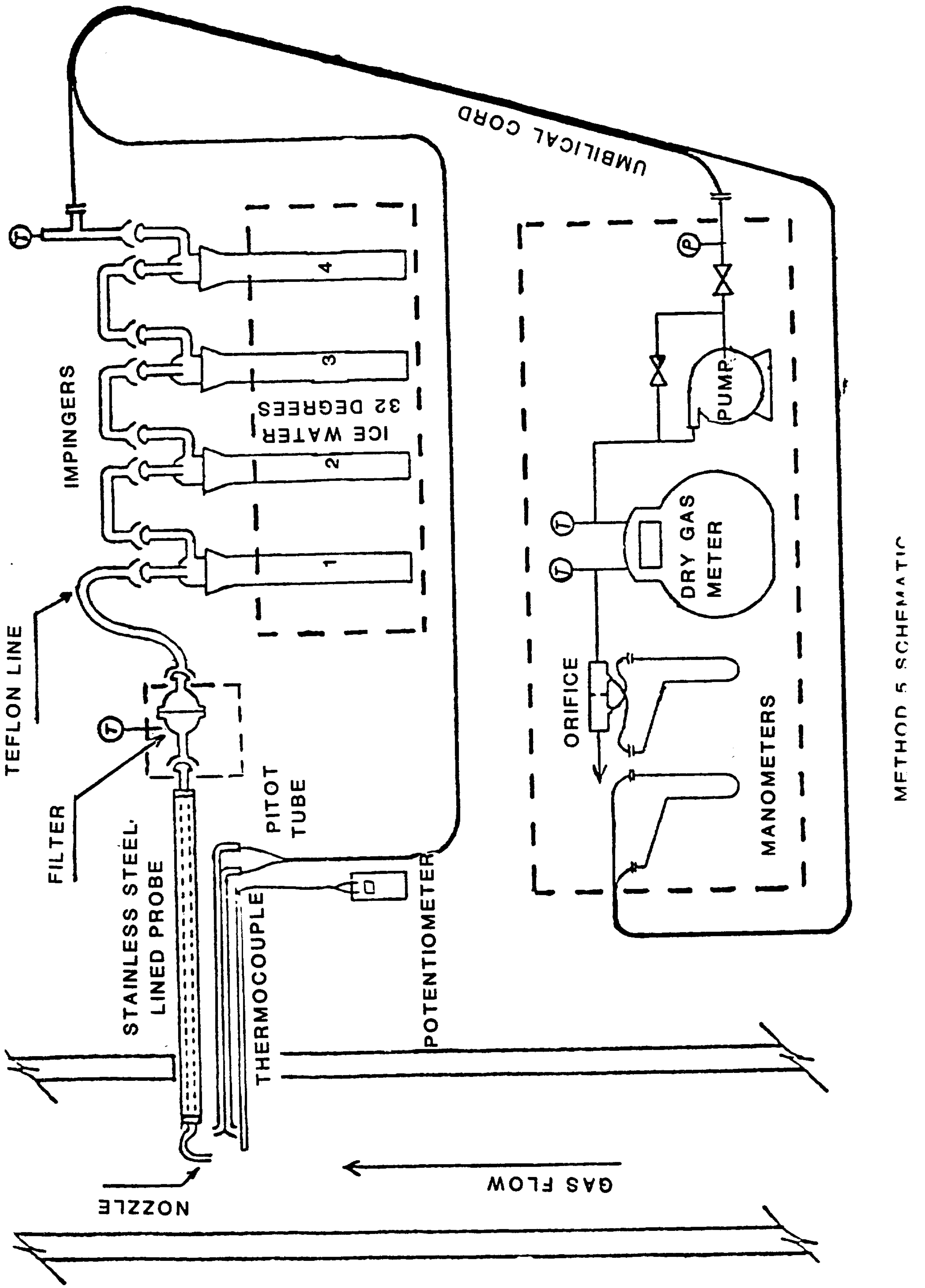
TABLE 1

SUMMARY OF RESULTS

"A" BATTERY SCRUBBER STACK

Parameter	Results
Gas Flow (acfm)	143,812
Gas Flow (dscfm)	133,760
Gas Temperature (^{o}F)	93.9
Gas Moisture (%)	0.6
Isokinetic (%)	99.5
Actual Particulate Emissions:	
gr/dscf	0.00900
lb/hr	0.76
Allowable Particulate Emissions:	
lb/hr	4.71
Backhalf Soluble Emissions:	
gr/dscf	0.00111

FIGURE 1


UMBILICAL CORD
IMPINGERS
ICE WATER
32 DEGREES
1
2
3
4
TEFLON LINE
FILTER
STAINLESS STEEL
LINED PROBE
PITOT
TUBE
THERMOCOUPLE
POTENTIOMETER
NOZZLE
GAS FLOW
PUMP
DRY GAS
METER
ORIFICE
MANOMETERS
T
P

APPENDIX A

FIELD DATA SHEETS

PLANT: Bethlehem Steel

DATE: 11·24·92

SAMPLING LOCATION: BATTERY A Scrubber Outlet

SAMPLE TYPE: PA. PARTICULATE

RUN NUMBER: 1 OPERATOR: KD/AC

BAROMETRIC PRESSURE: 29.35 STATIC PRESSURE:

FILTER NUMBER(S):

GEL NUMBER(S): + 3.3

THIMBLE NUMBER: PLATE NUMBER:

H_2O PICKUP (ml): ~1 ml

BCM

ORSAT:

CO_2: 0

O_2: 21

CO: 0

PYROMETER NUMBER:

THERMOCOUPLE NUMBER:

PROBE NUMBER: TYPE: GLASS

NOZZLE NUMBER: .250 I.D.:

METER BOX NUMBER: A1 $\Delta H_@$: 1.88

PITOT NUMBER: C_p: .84

SAMPLE BOX NUMBER(S):

ASSUMED MOISTURE (%): 2

ASSUMED METER TEMPERATURE: 60

C FACTOR: 1.10 REFERENCE Δp: .44

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	0755	525.993	.65	2.60	2.60	90	50	48	7	250	48
1	1'20"	0757	527.275								260	48
		0803		.70	2.90	2.90	91	55	48	7		
2	1'19"	0804	528.493								262	46
		0813		.70	2.90	2.90	91	57	48	7		
3	1'25"	0815	529.799								263?	46
		0827		.68	2.80	2.80	95	57	49	7		
4	1'28"	0829	531.089	—	—	—	—	—	—	—	—	—
B	—	0838	531.089								265	46
1	1'20"	0839	532.208	.62	2.80	2.80	94	58	50	7	266	46
		0915		.68	2.80	2.80	92	57	51	7		
2	1'04"	0916	533.189								255	46
		0928		.70	2.90	2.90	92	56	51	7		
3	1'26"	0930	534.608								256	46
		0947		.70	2.90	2.90	91	59	51	7	—	—
4	1'20	0948	535.776	—	—	—	—	—	—		260	46
C	—	1004	535.776									
1	1'16"	1005	536.898	.62	2.80	2.80	90	59	54	7	261	48
		1021		.70	2.90	290	92	60	55	7		
2	1'21	1023	538.050									

PLANT Bethlehem Steel DATE 11-24-92 RUN NUMBER BATTERY A Scrubber OUTLET Run 1

BCM

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
C		1032										
3	1'15"	1033	539.161	.72	3.0	3.6	96	63	56	8	262	48
		1042										
4	1'22"	1044	540.485	.70	2.9	2.9	98	64	56	8	263	48
D	—	—	540.485	—	—	—	—	—	—	—	—	—
1	1'19	1055	541.602	.42	1.8	1.8	96	66	58	8	264	48
		1104										
2	1'13	1105	542.671	.72	3.0	3.0	98	64	59	7	265	48
		1117										
3	1'22	1119	543.924	.74	3.1	3.1	98	66	57	8	266	48
		1128										
4	1'21	1129	545.178	.74	3.1	3.1	98	65	58	8	264	48
				Leak	CHK	= Ø	CFM @	12" Hg				
				0.820								

APPENDIX B

ANALYTICAL DATA SHEETS

BLANK ANALYTICAL DATA

Plant BETHLEHEM STEEL

Sample location "A" BATTERY STACK

Type of blank ACETONE

Container number 16W

Density of blank (pa) .7850 g/ml

Blank volume (Va) 150 ml

Gross wt. 112148.65 mg

Tare wt. 112148.60 mg

Weight of blank (ma) .05 mg

$$Ca = \frac{ma}{Va\ pa} = \frac{(.05)}{(150)(.7850)} = .0004 \text{ mg/g}$$

BLANK ANALYTICAL DATA

Plant BETHLEHEM STEEL

Sample location "A" BATTERY STACK

Type of blank WATER

Container number 17C

Density of blank (pa) .9982 g/ml

Blank volume (Va) 150 ml

Gross wt. 108457.40 mg

Tare wt. 108459.75 mg

Weight of blank (ma) 0.00 mg

$$Ca = \frac{ma}{Va\ pa} = \frac{(0.00)}{(150)(.9982)} = 0.00\ mg/g$$

ANALYTICAL PARTICULATE DATA

PADER METHODOLOGY

Client BETHLEHEM STEEL Project No. 00-4021-37

Date 11-24-92 Run No. 1

FRONT HALF CATCH

Acetone rinse container No. 16J

Acetone rinse volume (Vaw) 88

Acetone blank residue concentration (Ca) .0004 mg/g

Wa = Ca Vaw pa = (.0004) (88) (.7850) = .028 mg

Gross wt	113106.35	mg
Tare wt	113100.20	mg
Less acetone blank wt (Wa)	.028	mg
Weight of particulate in acetone rinse	6.122	mg

Water rinse container No. 16Z

Water rinse volume (Vww) 84

Water blank residue concentration (Cw) 0.0 mg/g

Ww = Ca Vww pa = (0.0) (84) (.9982) = 0.0 mg

Gross wt	99946.35	mg
Tare wt	99942.60	mg
Less water blank wt (Ww)	0.00	mg
Weight of particulate in water rinse	3.75	mg

Filter No. 545

Gross wt	410.75	mg
Tare wt	409.05	mg
Weight of particulate on filter	1.700	mg
Weight of particulate in acetone rinse	6.122	mg
Weight of particulate in water rinse	3.750	mg
Total weight of particulate	11.572	mg

BACK HALF CATCH

Filter No. 506 (.45) 503 (.22)

Gross wt	167.90	mg
Tare wt	168.45	mg
Weight of particulate on filter	0.00	mg

TOTAL PARTICULATE CATCH

Front half	11.572	mg
Back half	0.00	mg
Total	11.572	mg

ANALYTICAL PARTICULATE DATA

PADER METHODOLOGY

Client BETHLEHEM STEEL Project No. 00-4021-37

Sample location "A" BATTERY STACK

Date 11-24-92 Run No. 1

SOLUBLE BACKHALF

Acetone rinse container No. 16Y

Acetone rinse volume (Vaw) 77

Acetone blank residue concentration (Ca) .0004 mg/g

Wa = Ca Vaw pa = (.0004) (77) (.9982) = .024 mg

Gross wt 102291.25 mg

Tare wt 102289.85 mg

Less acetone blank wt (Wa) .024 mg

Weight of particulate in acetone rinse 1.38 mg

Water filtrate container No. 16L

Water filtrate volume (Vww) 227

Water blank residue concentration (Cw) 0.00 mg/g

Ww = Ca Vww pa = (0.00) (227) (.9982) = 0.00 mg

Gross wt 112012.10 mg

Tare wt 112013.70 mg

Less water blank wt (Ww) 0.00 mg

Weight of particulate in water filtrate 0.00 mg

Weight of particulate in acetone rinse 1.38 mg

Total weight of particulate 1.38 mg

APPENDIX C

CALCULATIONS

BETHLEHEM STEEL CORPORATION
BETHLEHEM PENNSYLVANIA
"A" BATTERY SCRUBBER EXHAUST

11-24-92
RUN 1

PARTICULATE EMISSIONS

SYMBOL		DESCRIPTION		VALUE
Theta	=	Duration of test, min.	=	21.18
Vm	=	Dry sample volume (meter conditions), dcf	=	19.185
SQRT(dP)	=	Average of square roots of pitot pressure differential, in. H2O	=	0.820
dH	=	Orifice pressure drop, in. water	=	2.830
Ts	=	Average stack temperature, deg. F	=	93.9
Tm	=	Average dry gas meter temperature, deg. F	=	56.4
CO2	=	CO2 in stack gas, %	=	0.00
O2	=	O2 in stack gas, %	=	20.90
CO	=	CO in stack gas, %	=	0.00
N2	=	N2 in stack gas, %	=	79.10
Pbar	=	Barometric pressure, in. Hg	=	29.35
Ps	=	Stack pressure (absolute), in. Hg.	=	29.37
Cp	=	Pitot correction factor, dimensionless	=	0.84
Y	=	Dry gas meter correction factor	=	0.987
Dn	=	Diameter of nozzle, in.	=	0.250
Ds	=	Diameter of stack, ft.	=	8.000
Vlc	=	Volume of liquid collected in impingers and silica gel, ml	=	2.3
Mn	=	Front half particulate catch, mg	=	11.57
Mn	=	Back half insoluble part. catch, mg	=	0.00
Mn	=	Back half soluble part. catch, mg	=	1.38
Mn	=	Total particulate catch, mg	=	11.57

An	=	Area of the nozzle, sq. ft.	=	0.00034
As	=	Area of the stack, sq.ft.	=	50.27
Md	=	Dry molecular weight of stack gas, dry basis, lb/lb-mole	=	28.84
Vw(std)	=	Volume of liquid collected, cu .ft.	=	0.108
Ms	=	Molecular weight of stack gas, wet basis, lb/lb-mole	=	28.77
Vm(std)	=	Dry sample volume (standard conditions), dscf	=	19.119
Vs	=	Stack velocity, ft/sec	=	47.68

BETHLEHEM STEEL CORPORATION
BETHLEHEM PENNSYLVANIA
"A" BATTERY SCRUBBER EXHAUST

11-24-92
RUN 1

PARTICULATE EMISSIONS

SYMBOL		DESCRIPTION		VALUE
Qs	=	Stack gas flow, acfm	=	143812
Qsd	=	Stack gas flow, dscfm	=	133760
Bws	=	Moisture content of the gas stream, %	=	0.6
CO2	=	CO2 in stack gas, %	=	0.00
O2	=	O2 in stack gas, %	=	20.90
CO	=	CO in stack gas, %	=	0.00
N2	=	N2 in stack gas, %	=	79.10
I	=	Isokinetic ratio, percent	=	99.5
C's	=	Particulate concentration, gr/dscf	=	0.00900

PADER INFORMATION

C's	=	Part. conc. (front half), gr/dscf	=	0.00900
C's	=	Part. conc. (back half), gr/dscf	=	0.00000
C's	=	Part. conc. soluble, (back half), gr/dscf	=	0.00111

BCM

COMPUTATION SHEET

Sheet Number 1 Of 2
Date 11-8-92
Job Number 00-4021-37
Computed by PJ Checked by

Name of Client Bethlehem Steel Corporation
Project "A" Battery Scrubber Stack
Description Emission Rate Calculation

Coke Production Rate

1850 Tons/Day and 80 ovens Pushed/Day

$$\therefore \frac{1850 \text{ Tons/Day}}{80 \text{ ovens/Day}} = 23.12 \text{ Tons/oven}$$

23.12 Tons/oven x 80 ovens/24 hours = 77.07 Tons/hour

Allowable Emission Rate, as per 123.13 (b)(2) of PA Air Pollution Control Act

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

where: A = allowable emission rate, lb/hr
E = FxW, lb/hr
F = Process Factor (table 1), 1 lb/Ton
W = Production Rate, 77.07 Tons/hour

$$A = 0.76\,(1 \text{ lb/Ton} \times 77.07 \text{ Tons/hr})^{0.42} = \underline{4.71 \text{ lb/hr}}$$

BCM

COMPUTATION SHEET

Sheet Number 2 Of 2

Date 11-8-92

Job Number 00-4021-37

Computed by PJ Checked by

Name of Client Bethlehem Steel Corporation

Project "A" Battery Scrubber Stack

Description Emission Rate Calculation

$$\text{Actual Emission Rate (lb/hr)} = \frac{\left(\begin{array}{c}\text{Emission}\\\text{Concentration}\\\text{(gr/dscf)}\end{array}\right)\left(\begin{array}{c}\text{Flow Rate}\\\text{(dscf/min)}\end{array}\right)\left(\begin{array}{c}\text{Push Time}\\\text{(min/hour)}\end{array}\right)}{7000\ \text{gr/lb}}$$

where:

Emission Concentration = gr/dscf

Flow Rate = dscf/min

$$\text{Push Time} = \left(\frac{21.18\ \text{min total push time}}{16\ \text{Total ovens Pushed}}\right)\left(\frac{80\ \text{ovens pushed}}{24\ \text{hours}}\right)$$

$$= 4.41\ \text{min/hour}$$

$$\text{Actual Emission Rate (lb/hr)} = \frac{(0.009\ \text{gr/dscf})(133,760\ \text{dscf/min})(4.41\ \text{min/hr})}{7000\ \text{grains/lb}}$$

$$= \underline{\underline{0.76\ \text{lb/hr}}}$$

APPENDIX D

CALIBRATIONS

BCM

METER BOX CALIBRATION SHEET

Date 11-11-92 Box No. A-1 Inspector J STETINA

Pump OK Oil ADDED Wick CHANGED Pump Serial No. ____

Manometers OK Knobs OK Oil OK Tubing OK

Quick Connects OK LUBED, Vacuum Gage OK Valves OK

Dry Gas Meter OK Volume 485 ft^3 Serial No. ____

Thermometers ____ In 74 °F Out 74 °F Ambient 74 °F

Amphenol OK Lights OK Switches OK Variac OK

Leak Check - Max. Vacuum 26 in. Hg Leak Rate .004 CFM

Remarks changed Reservoir connection & pyrometer digital read out 29.70

Man. Orifice	CF_w	CF_d	T_w	IT_d	OT_d	T_d	Time θ
0.5	~~X~~ 6.506	6.813	73	104	84	94	15:40 / 15.67
1.0	~~X~~ 6.500	6.782	73	100	80	90	11:54 / 11.9
2.0	10.006	10.610	73	117	87	102	13:15 / 13.25

Tolerances: $1.6 \leq \Delta H_@ \leq 2.1$

$\Delta H_@ =$	$\frac{(0.0317)(\Delta H)}{(P_b)(OT_d+460)}\left[\frac{(T_w+460)(\theta)}{(CF_w)}\right]^2$	$\gamma =$	$\frac{(CF_w)(P_b)(T_d+460)}{(CF_d)(P_b+\Delta H/13.6)(T_w+460)}$
1.62	$\frac{(0.0317)(0.5)}{(29.70)(84+460)}\left[\frac{(73+460)(15.67)}{(6.506)}\right]^2$ (544; 533)	.991	$\frac{(6.506)(29.7)(94+460)}{(6.813)(29.7+0.0368)(73+460)}$ (554; 29.7368; 533)
1.88	$\frac{(0.0317)(1.0)}{(29.7)(80+460)}\left[\frac{(73+460)(11.9)}{(6.5)}\right]^2$ (540; 533)	.987	$\frac{(6.5)(29.7)(90+460)}{(6.782)(29.7+0.0737)(73+460)}$ (550; 29.7737; 533)
1.94	$\frac{(0.0317)(2.0)}{(29.7)(87+460)}\left[\frac{(73+460)(13.25)}{(10.006)}\right]^2$ (547; 533)	.989	$\frac{(10.006)(29.7)(102+460)}{(10.610)(29.7+0.147)(73+460)}$ (562; 29.847; 533)

CONSTRUCTION STANDARDS;

1. Dt = between .187" - .375" (3/16 - 3/8)
2. $P_A = P_B$; $1.05 \cdot Dt \leq P \leq 1.50 \cdot Dt$
3. a1 . a2 < 10°
4. B1 . B2 < 5°
5. Z ≤ 0.125" (1/8)
6. W ≤ 0.031" (1/32)

PITOT ALIGNMENT STANDARDS:

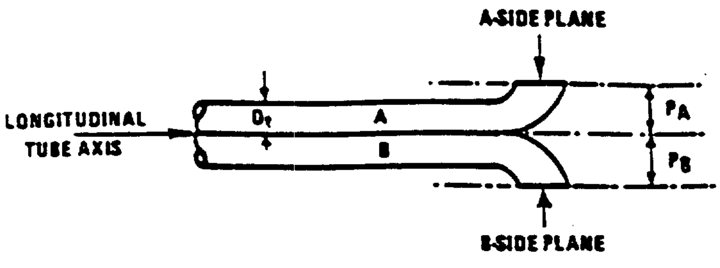
1. x ≥ 0.75" (3/4)
2. lp must be higher than Np
3. W ≥ 3.0"
4. Z ≥ 0.75" (3/4)
5. Z_1 ≥ 2.0"
6. Y ≥ 3.0"

TYPE S PITOT
CALIBRATION STANDARDS

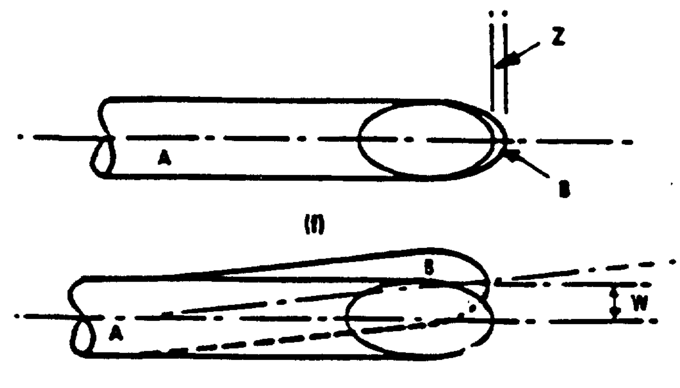
BCM Engineers
ENGINEERS, PLANNERS, SCIENTISTS and LABORATORY SERVICES
1850 Gravers Road • Norristown, PA 19401

DATE: 4-17-92 PITOT I.D.: 4-2
REF. NO.: 5-10

PITOT CONSTRUCTION CALIBRATIONS



(b)



(f)

(g)

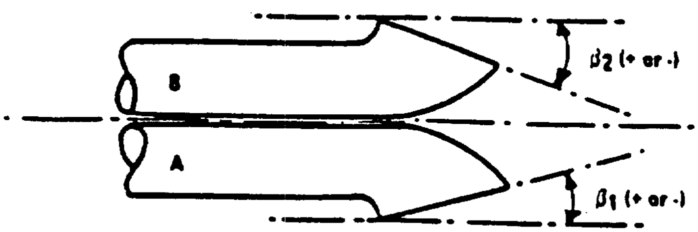
Dt = .375

P_A = .46

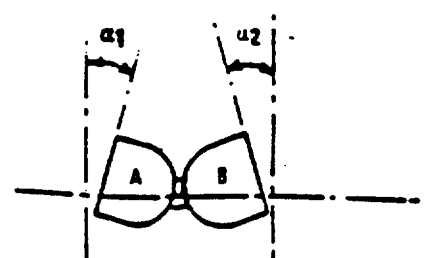
P_B = .46

Z = 0

W = 0



(e)



(h)

B1 = 0°

B2 = 2°

a1 = 8°

a2 = 4°

Performed by JS.

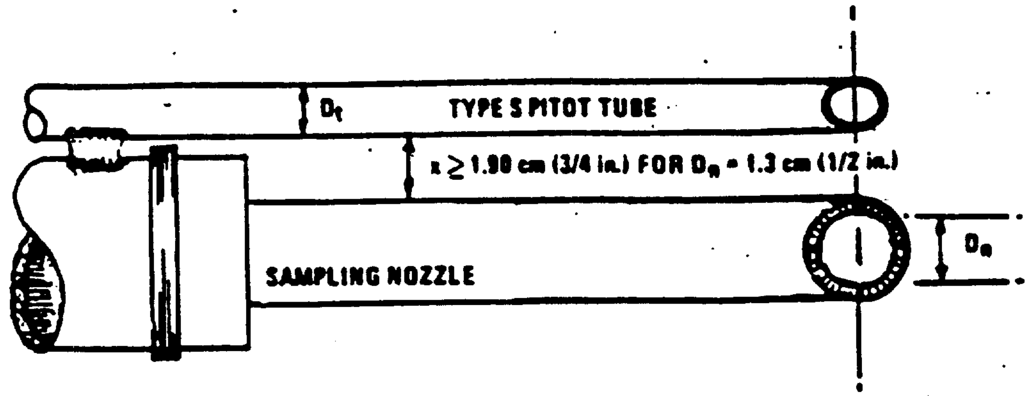
TYPE S PITOT
CALIBRATION STANDARDS

BCM Engineers
ENGINEERS, PLANNERS, SCIENTISTS and LABORATORY SERVICES
1850 Gravers Road • Norristown, PA 19401

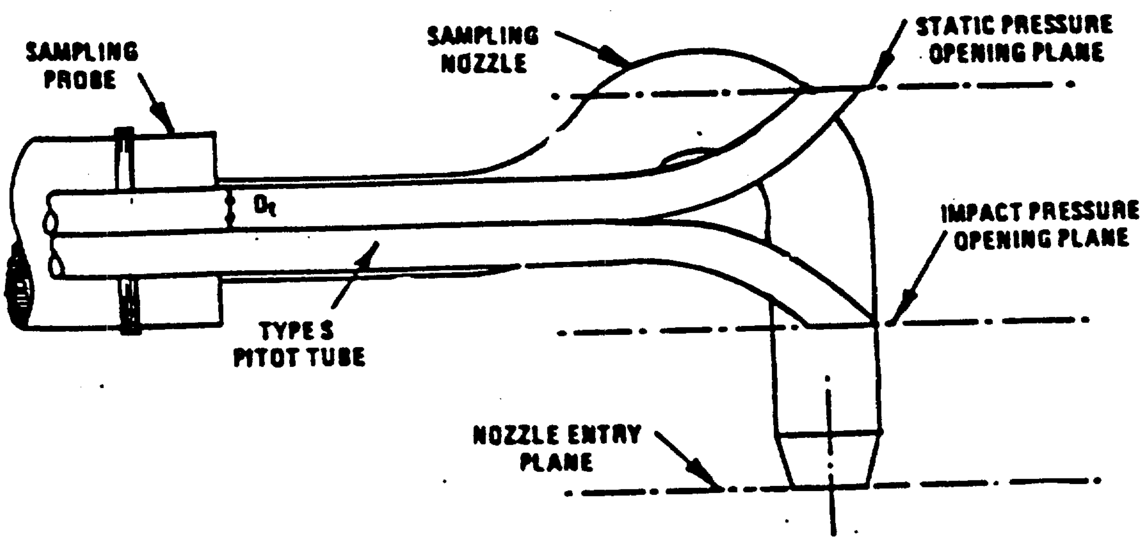
DATE: 4-17-92 PITOT I.D.: 4-2

REF. NO.: 5-10 PAGE NO.: 2 of 4

PITOT ALIGNMENT/NOZZLE CALIBRATIONS



X = .85



Is IP higher than NP? YES

Performed By J.S.

TYPE S PITOT TUBE
CALIBRATION STANDARDS

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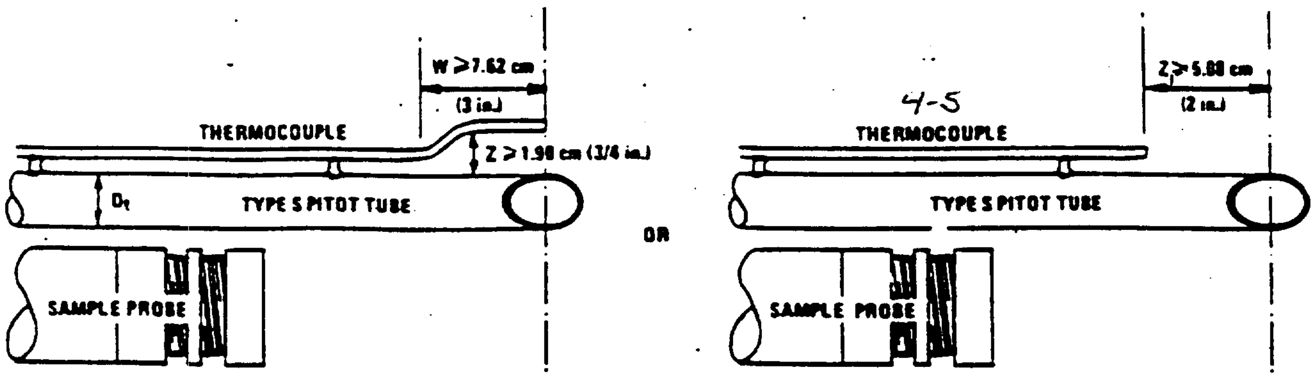
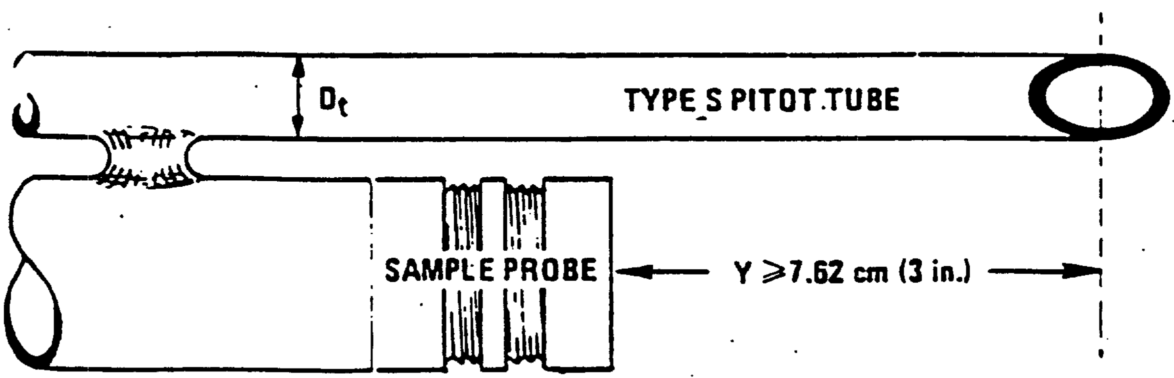
PITOT ALIGNMENT/THERMOCOUPLE CALIBRATION



W = ______

Z_1 = 2

Z = ______



Y = 3

Determined Coefficient .84

Performed by JS

TYPE S PITOT TUBE CALIBRATION STANDARDS

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PYROMETER CALIBRATION SHEET

Pyrometer Meterbox A-1 Date 11-13-92 Inspector J. STETINA

Indicated Temperature (From pyrometer)	Actual Temperature (From standard)	Difference
100	99	1
200	200	0
300	299	1
400	397	3
500	498	2
600	600	0
700	699	1
800	801	1
900	899	1
1000	1000	0
1100	1099	1
1200	1198	2
1300	1299	1
1400	1400	0
1500	1500	0
1600	1600	0
1700	1699	1
1800	1800	0
1900	1899	1
2000	2000	0
Avg.		

NOZZLE CALIBRATION

Date 11-24-92 Calibrated by Paul Jadlowiec

Nozzle identification number	D_1, in.	D_2, in.	D_3, in.	ΔD, in.	D_{avg}
Beth. Steel A Battery Scrubber Stack Test	.250	.250	.250	.000	.250

where:

$D_{1,2,3,}$ = nozzle diameter measured on a different diameter, in. Tolerance = measure within 0.001 in.

ΔD = maximum difference in any two measurements, in. Tolerance = 0.004 in.

D_{avg} = average of D_1, D_2, and D_3.

Nozzle calibration data.