AP-42 Section 12.2
Reference
Report Sect. 4
Reference 44

Reviewed

PARTICULATE EMISSIONS EVALUATION

"A" BATTERY SCRUBBER STACK

AT

BETHLEHEM STEEL CORPORATION
BETHLEHEM, PENNSYLVANIA 18061

BCM NO. 00-4021-37

DECEMBER 10, 1992

PREPARED BY

Paul A. Jadlowiec
PAUL A. JADLOWIEC
SECTION MANAGER

APPROVED BY

John L. Schaude
JOHN L. SCHAUDE, P.E.
ASSISTANT VICE PRESIDENT

BCM

Engineers, Planners, Scientists and Laboratory Services
5777 Baum Boulevard • Pittsburgh, PA 15206 • (412) 361-6000

COMMONWEALTH 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 ₭Ð·ₘ
Air Quality Specialist

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

RDM/bas

Attachment

TABLE OF CONTENTS

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 ^{o}F
- 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 (^{0}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

METHOD 5 SCHEMATIC

6

APPENDIX A

FIELD DATA SHEETS

BCM

PLANT: Bethlehem Steel
DATE: 11-24-92
SAMPLING LOCATION: Battery A Scrubber Outlet
SAMPLE TYPE: PA Particulate   OPERATOR: RS/AC
RUN NUMBER: 1
BAROMETRIC PRESSURE: 29.35   STATIC PRESSURE: +3.3
FILTER NUMBER(S): ___
GEL NUMBER(S): +3.3
THIMBLE NUMBER: ___
H_2O PICKUP (mL): ___ —mL

PITOMETER NUMBER: ___
THERMOCOUPLE NUMBER: ___
PROBE NUMBER: ___   TYPE: GLASS
NOZZLE NUMBER: .250 I.D.
METER BOX NUMBER: A1 $\Delta H@$ 1.88
PITOT NUMBER: P4
SAMPLE BOX NUMBER(S): ___
ASSUMED MOISTURE (%): 3
ASSUMED METER TEMPERATURE: 60
C FACTOR: 1.10   REFERENCE Δs: ___

ORSAT'S:
CO_2: 0
O_2: 21
CO: 0

READ AND RECORD ALL DATA EVERY ___ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DGM INLET $(T_{m\,in})$, °F	DGM OUTLET $(T_{m\,out})$, °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
A	60	0755	525.993	.65	2.60	2.60	90	50	48	7	250	48
1	1:30"	0757 / 0803	527.275	.70	2.90	2.90	91	55	48	7	260	48
2	1:19"	0804 / 0813	528.493	.70	2.90	2.90	91	57	48	7	262	46
3	1:25"	0815 / 0827	529.799	.68	2.80	2.80	95	57	49	7	263?	46
4	1:28"	0829 / 0836	531.089	—	—	—	—	—	—	—	—	—
B 1	1:20"	0838 / 0839	531.889	.62	2.80	2.80	94	58	50	7	265	46
		0915	532.208	.68	2.80	2.80	93	57	51	7	266	46
2	1:04"	0916	533.189	.70	2.90	2.90	92	56	51	7	255	46
3	1:24"	0928 / 0930	534.608	.72	2.90	2.90	91	59	51	7	258	46
4	1:26"	0947 / 0948	535.776	—	—	—	—	—	—	—	—	—
C	1:16"	1001 / 1005	535.776	.62	2.80	2.80	90	59	54	7	260	46
1		1021 / 1023	536.998	.70	2.90	2.90	92	60	55	7	261	48
2		1131	538.050									

Bethlehem
Steel

PLANT 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 (Vm), ft³	VELOCITY HEAD (ΔPs), in. H2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H2O		STACK TEMPERATURE (Ts), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET (Tm in), °F	OUTLET (Tm out), °F			
C		1032										
3	1'5"	1033	539.161	.72	3.6	3.6	96	63	52	8	262	48
		1042										
4	1'22"	1044	540.485	.70	2.9	2.9	98	64	56	8	263	48
D	—	1055	540.485	—	—	—	—	—	—	—	—	—
1	1'19	1055	541.602	.42	1.8	1.8	96	66	58	3	264	48
2	1'13	1105	542.671	.72	3.0	3.0	98	64	59	7	265	48
		117			3							
3	1'22	1119	543.924	.74	3.1	3.1	98	66	57	8	266	48
		1128										
4	1'21	1179	545.178	.74	3.1	3.1	98	65	58	6	264	48

Leak check = 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 16 W

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

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

BLANK ANALYTICAL DATA

Plant <u>BETHLEHEM STEEL</u>

Sample location <u>"A" BATTERY STACK</u>

Type of blank <u>WATER</u>

Container number <u>17C</u>

Density of blank (pa) <u>.9982</u> g/ml

Blank volume (Va) <u>150</u> ml

Gross wt. <u>108457.40</u> mg

Tare wt. <u>108457.75</u> mg

Weight of blank (ma) <u>0.00</u> mg

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

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

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

                  .45   .22
Filter No. __506   503__

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

BETHLEHEM STEEL CORPORATION   11-24-92
BETHLEHEM PENNSYLVANIA   RUN 1
"A" BATTERY SCRUBBER EXHAUST

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

PARTICULATE EMISSIONS

SYMBOL		DESCRIPTION		VALUE
Q_s	=	Stack gas flow, acfm	=	143812
Q_{sd}	=	Stack gas flow, dscfm	=	133760
B_{ws}	=	Moisture content of the gas stream, %	=	0.6
CO_2	=	CO_2 in stack gas, %	=	0.00
O_2	=	O_2 in stack gas, %	=	20.90
CO	=	CO in stack gas, %	=	0.00
N_2	=	N_2 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

COMPUTATION SHEET

BCM

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

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

23.12 Tons/oven × 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 = F×W, lb/hr
F = Process Factor (table 1), 1 lb/Ton
W = Production Rate, 77.07 Tons/hour

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

COMPUTATION SHEET

BCM

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

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

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

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

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

APPENDIX D

CALIBRATIONS

BCM

METER BOX CALIBRATION SHEET

Man. Orifice	CF_w	CF_d	T_w	IT_d	OT_d	T_d	Time θ
0.5	⅞6.506 6.513	73	104	87	94	15:40 / 15:47
1.0	⅞6.500 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: $1.6 \leq \Delta H_@ \leq 2.1$

$$\gamma = \frac{(CF_w)(P_b)(T_d+460)}{(CF_d)(P_b+\Delta H/13.6)(T_w+460)}$$

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

$$\Delta H_@ = 1.62 \qquad \frac{(0.0317)(0.5)}{(29.70)(84+460)\ 544}\left[\frac{(73+460)(15.67)\ 533}{(6.506)}\right]^2 \qquad \gamma = .991 \qquad \frac{(6.506)(29.7)(94+460)\ 554}{(6.813)(29.7+0.0368)(73+460)\ 533}{29.7368}$$

$$\Delta H_@ = 1.58 \qquad \frac{(0.0317)(1.0)}{(29.7)(82+460)\ 542}\left[\frac{(73+460)(11.9)\ 533}{(6.5)}\right]^2 \qquad \gamma = .987 \qquad \frac{(6.5)(29.7)(90+460)\ 550}{(6.782)(29.7+0.0737)(73+460)\ 533}{29.7737}$$

$$\Delta H_@ = .94 \qquad \frac{(0.0317)(2.0)}{(29.7)(87+460)\ 547}\left[\frac{(73+460)(13.25)\ 533}{(10.006)}\right]^2 \qquad \gamma = .989 \qquad \frac{(10.006)(29.7)(106+460)\ 562}{(10.610)(29.7+0.147)(73+460)\ 533}{29.847}$$

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

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

REF. NO.: 5-10   PAGE NO.: 1 of 4

PITOT CONSTRUCTION CALIBRATIONS

(b)

Dt = _____ .375 _____

P_A = _____ .46 _____

P_B = _____ .46 _____

(f)

(g)

Z = _____ 0 _____

W = _____ 0 _____

(e)

B1 = _____ 0° _____

B2 = _____ 2° _____

(h)
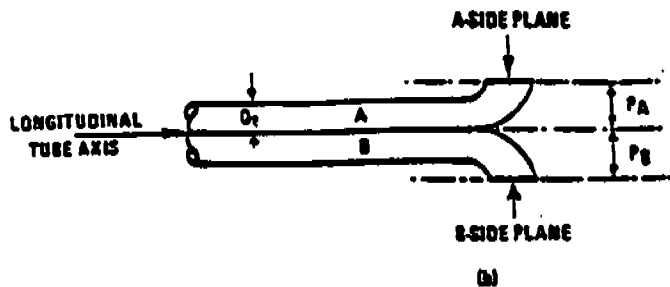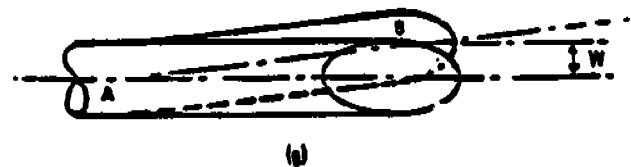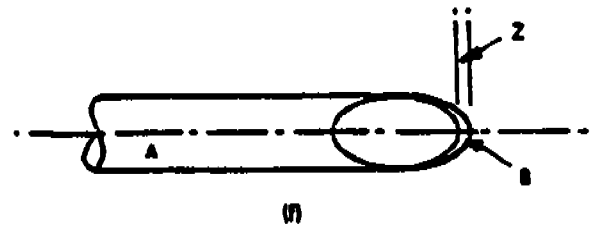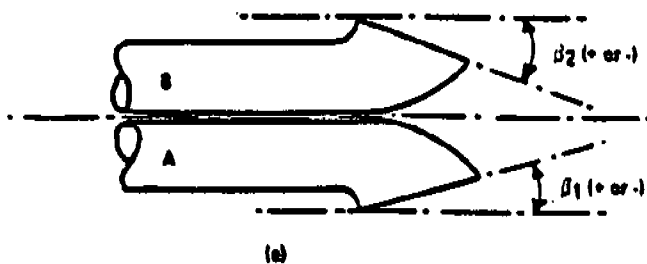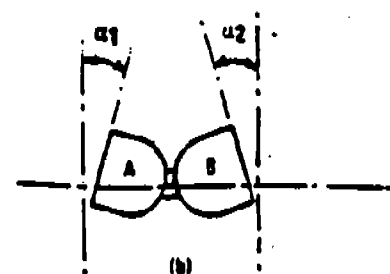
a1 = _____ 8° _____

a2 = _____ 4° _____

Performed by _____ JS _____ .

TYPE S PITOT
CALIBRATION STANDARDS

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

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

PITOT ALIGNMENT/NOZZLE CALIBRATIONS

TYPE S PITOT TUBE

D_t

$z \geq 1.90\ cm\ (3/4\ in.)\ FOR\ D_n = 1.3\ cm\ (1/2\ in.)$

SAMPLING NOZZLE

D_n

$X = \underline{\qquad .85 \qquad}$

SAMPLING PROBE

SAMPLING NOZZLE

STATIC PRESSURE OPENING PLANE

D_t

IMPACT PRESSURE OPENING PLANE

TYPE S PITOT TUBE

NOZZLE ENTRY PLANE
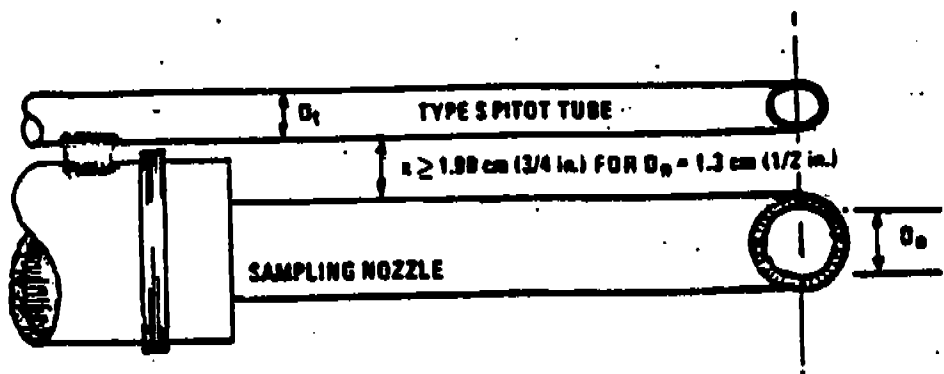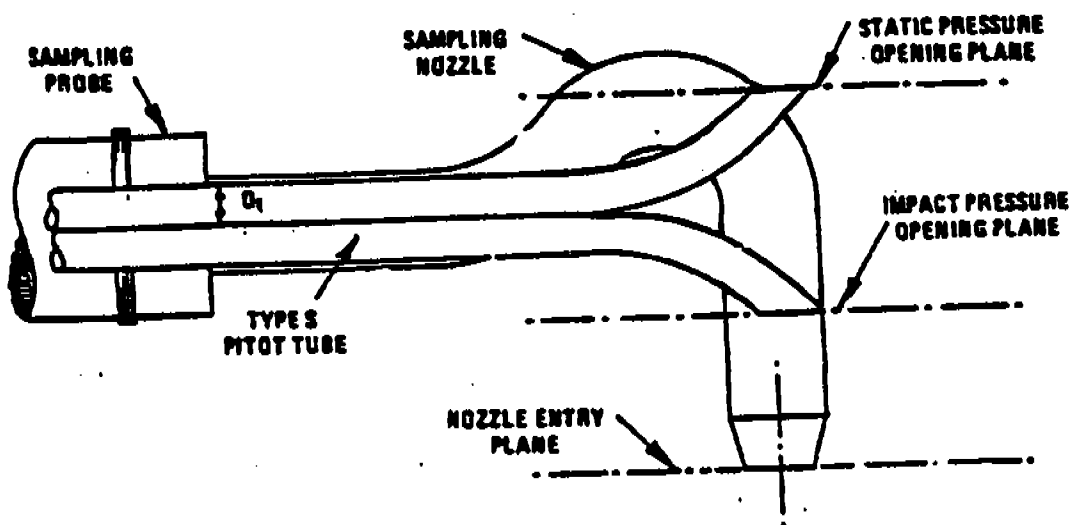
Is IP higher than NP? _____ YES _____

Performed By _____ JS _____

TYPE S PITOT TUBE CALIBRATION STANDARDS	
BCM Engineers ENGINEERS, PLANNERS, SCIENTISTS and LABORATORY SERVICES	DATE: 4-17-92 PITOT I.D.: 4-2
1850 Gravers Road • Norristown, PA 19401	REF. NO.: 5-10 PAGE NO.: 3 of 4

PITOT ALIGNMENT/THERMOCOUPLE CALIBRATION

THERMOCOUPLE

W ≥ 7.62 cm
(3 in.)

Z ≥ 1.90 cm (3/4 in.)

D_t

TYPE S PITOT TUBE

SAMPLE PROBE

OR

4-S
THERMOCOUPLE

Z ≥ 6.00 cm
(2 in.)

TYPE S PITOT TUBE

SAMPLE PROBE

W = _____

Z_1 = ___2___

Z' = _____

D_t

TYPE S PITOT TUBE

SAMPLE PROBE ← Y ≥ 7.62 cm (3 in.) →
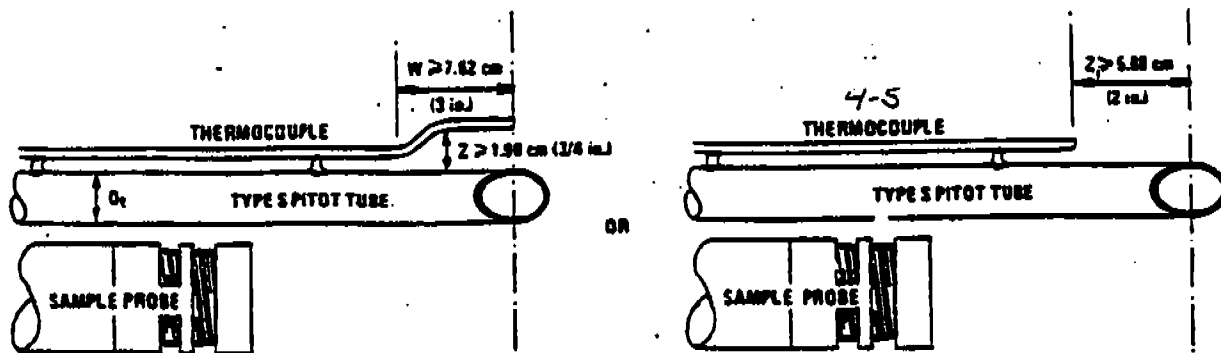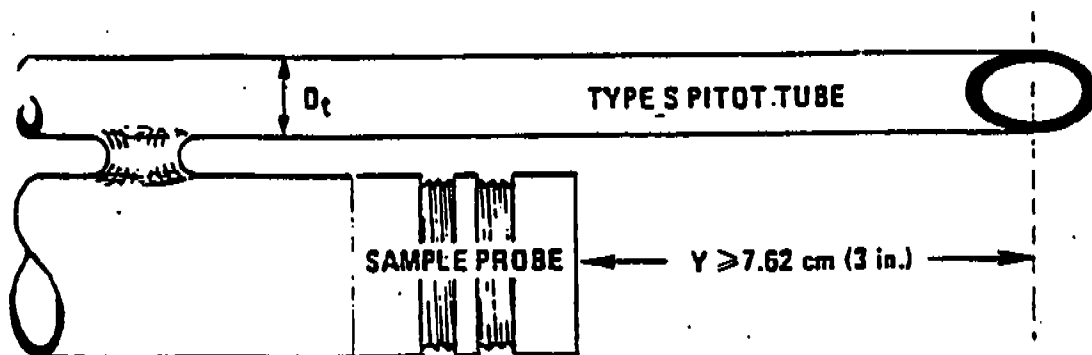
Y = ___3___

Determined Coefficient ___.84___

Performed by ___JS___

TYPE S PITOT TUBE
CALIBRATION STANDARDS

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

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

PYROMETER CALIBRATION SHEET

Pyrometer _Meterbox A-1_   Date _11-13-92_   Inspector _J. Stenna_

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 Jablowiec

Nozzle identification number	D_1, in.	D_2, in.	D_3, in.	ΔD, in.	D_{avg}
Bath. Steel A Battery Surveon 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.