Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

For this performance test the plant began operating at 200 tons per hour at 6:48 PM with a bagfilter magnehelic reading of 2 inches and an exit gas temperature of 200 F. The moisture content of the aggregate material was 3.7 % which was a little wetter than normal (3 %) due to earlier rain. The plant is producing asphalt for the resurfacing of I-85, and thus, operates at night; however, an initial obserrvation showed a detached steam plume with 0 % opacity visible emissions. During the test there appeared to only be a steam plume.

Source test information is on the attached observer's checklist. During the test the following data was gathered:

| | RUN # 1 | RUN # 2 | RUN # 3 |
|---|---|---|---|
| Production Rates (tph) | | | |
| Instantaneous start/finish | 272/302 | 315/326 | 333/335 |
| Average during run | 282 | 325 | 330 |
| Burner capacity | 50 % | 60 % | 75 % |
| Bagfilter exhaust temp (F) | 225-248 | 256-265 | 270-272 |
| Bagfilter magnehelic (") | 2.8-3.0 | 3.0-3.2 | 3.0-3.4 |

The plant's permitted production rate of 300 tons per hour was exceded during Runs No. 2 and 3 but was explained as due to the higher moisture content of the materials.

During Run No. 2 the test was stopped for 4 - 5 minutes when the aggregate materials chute clogged up. Also, during the test rather large particles of rusted metal were being exhausted out the stack. Mr. Hager said that they have observed that the inside of the bagfilter is already rusting out and they are having the manufacturer investigate.

Compliance with NSPS Subpart I will be determined upon review of this particulate emissions test.

Air Quality Action Request

Computer yes

RECEIVED OCT 22 1990 AIR QUALITY TECH SERVICES

Shannon Vogel AQ

**Name:** Blythe Industries **Location:** Graham Alamance Co **m. No.** 0

**Contact:** Jon Hager, Plant Supervisor / John Barrett, Pl **ne:** 357

**Type Action:** CI EE X SR PC VE PI Other

**Air Program Status:** 03 9W **Class:** A2P **Change:** X

**Action Request By:** WSRO **Address/Phone:** **Rec'd Date:**

**Last Insp. Date:** **Action Date:** 8-29-90 **Next Insp.Date:** 7-31-91

**Permit No.:** 6795 **Issued:** 4-25-90 **Expires:** 3-31-95

| **Recommendations:** | **Signature** | **Date:** |
|---|---|---|
| Send NOV on NSPS notification | Brent S. Rockett BSR | 10-2-90 mw |

This facility is a No. 2 oil fired, rotary drum dryer, asphalt mix plant (300 tons per hour maximum permitted production capacity), whose air emissions are controlled with a bagfilter (9,900 square feet of filter area). However, the burner is also capable of firing natural gas and is their main fuel with No. 2 as backup.

Our office was infomed by letter dated August 2, 1990 that this plant began operation on June 28, 1990 and first reached its maximum operating capacity on July 31, 1990. The only prior notification was dated May 16, 1990 informing us that the proposed start up date would be June 15, 1990. A Notice of Violation is to be sent for failing to provide proper notification of:

(1) the date construction commenced within 30 days of such date and
(2) the actual date of initial startup within 15 days after such date

as required in 40 CFR 60.7 (a)(1) and (a)(3), respectively.

A performance test for particulate emissions was being conducted on this date as required by NSPS Subpart I within the 60 days after achieving the maximum production rate. The plant's maximum capacity was not immediately reached upon initial startup due to problems with the flights within the drum, the immediate drum, the auger and the screen deck because of poor plant set-up to handle the necessary volume of materials. Also, the facility attempted to conduct this test on two previous dates but they were cancelled due to equipment failure on the day prior to the July 26th scheduled date and due to heavy rains on August 16, 1990.

The plant was running surface material at this time. There are three different materials, surface, binder and base, that are produced by an asphalt plant for highway paving. Presently, they are not using any recycled asphalt until they receive DOT approval of their mix design (24 % recycled asphalt).

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# SOURCE SAMPLING REPORT

# FOR

# BLYTHE INDUSTRIES, INC.

# Graham, North Carolina


Reviewed by:
PACE INC.
Charlotte, North Carolina

Paul R. Jenkins, Jr.
August 1990

Performed by:
PACE INC.
Charlotte, North Carolina

Rodney H. Lang
August 1990

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| SUMMARY OF RESULTS | 3 |
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| LOCATION OF SAMPLING POINTS | 6 |
| SAMPLING AND ANALYTICAL PROCEDURES | 8 |
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A. Summary of Results

B. Field Data

C. Process Data

D. Test Participants

E. Sampling and Analytical Procedures

F. Calibration Data

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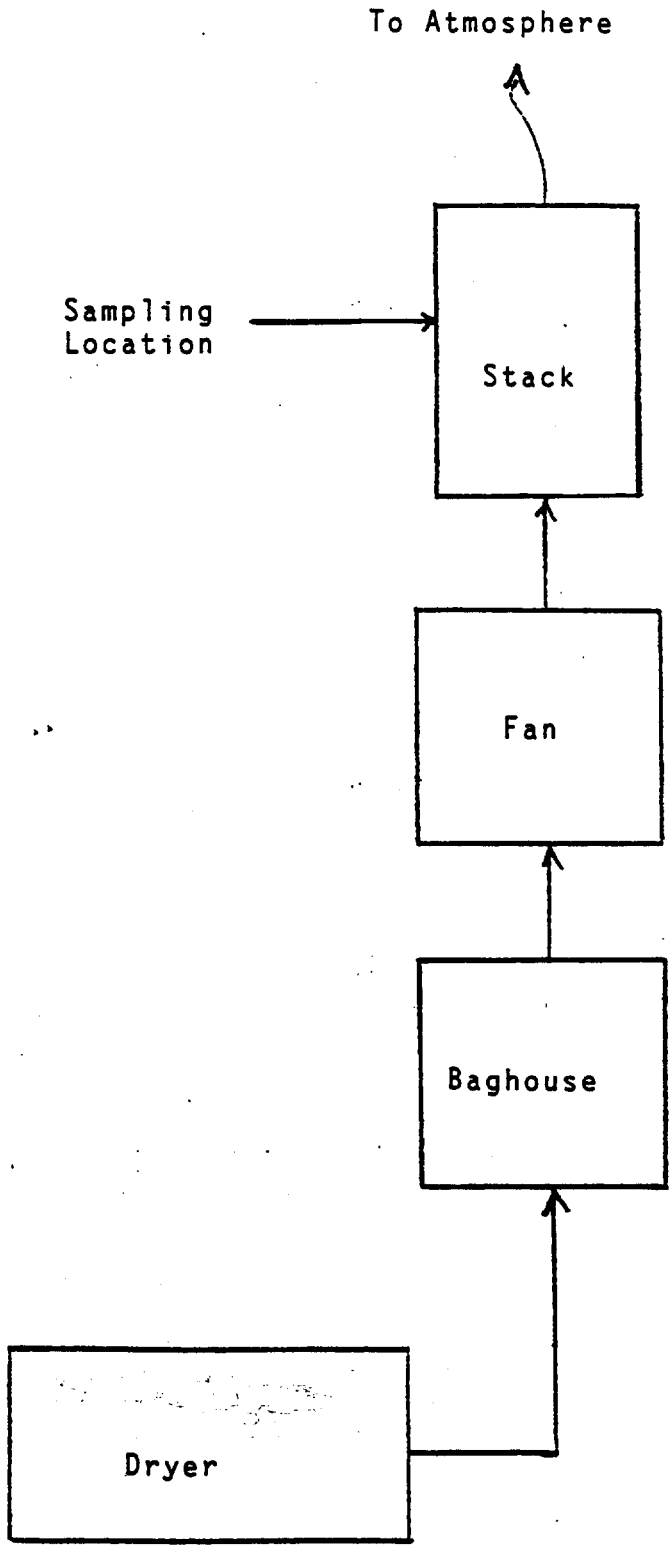
# INTRODUCTION

Source sampling was performed for Blythe Industries, Inc. Graham, North Carolina. The purpose of the sampling was to determine compliance with the permit limitations of 0.04 grains per dry standard cubic foot as required by the State of North Carolina. Three sampling runs were made on August 29, 1990 at the sampling locations shown on Figure 1.

The measurements of stack gas flow rate and pollutant concentrations were made according to U.S. Environmental Protection Agency and the North Carolina Department of Natural Resources and Community Development (DNRCD) recommendations. Mr. Brent S. Rockett, N.C. DNRCD, was present to observe the test.

The following sections of the report treat the summary of results, the process and its operation, the location of the sampling points and the sampling and analytical procedures used.




FLOW DIAGRAM

Figure 1

## SUMMARY OF RESULTS

Table 1 presents the summary of results from the particulate sampling. The mean particulate concentration was 0.0113 grains per dry standard cubic foot and the mean particulate emission rate was 1.690 pounds per hour. The average process weight was approximately 312 tons per hour.

Based on the results of the particulate sampling, the Blythe Industries, Inc., Graham, North Carolina asphalt plant was in compliance with the regulations of the State of North Carolina which allowed for an emission rate of 0.04 grains per dry standard cubic foot.

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## TABLE 1

## SUMMARY OF RESULTS, PARTICULATE SAMPLING

| Run Number | 1 | 2 | 3 |
|---|---|---|---|
| Date | 08/29/90 | 08/29/90 | 08/29/90 |
| % Isokinetic | 115.26 | 121.88 | 121.91 |
| Volume of Gas Sampled, SCF * Dry | 56.516 | 38.396 | 40.432 |
| Stack Gas Flow Rate, SCFM * Dry | 17111.0 | 16839.7 | 17845.3 |
| Stack Gas Flow Rate, ACFM | 36660.3 | 38026.4 | 40710.5 |
| Particulate: | | | |
| Catch, mgrams | 23.206 | 29.20 | 42.10 |
| Concentration, grains/ SCF * Dry | 0.0063 | 0.0117 | 0.0160 |
| Emission Rate, lbs/hr | 0.927 | 1.690 | 2.452 |

*68°F, 29.92 in. Hg
**Nozzle, probe, filter

## PROCESS DESCRIPTION AND OPERATION

The Blythe Industries, Inc. asphalt plant in Graham, North Carolina is a Gencorbitumina Asphalt Plant. It produces hot mix asphalt made from asphalt cement, sand, granite screenings and granite aggregates. The materials are dried in a rotary dryer fired with No. 6 fuel oil. The material mix was conveyed to a storage silo. Air was introduced at the burner and passed through the dryer, baghouse, fan and stack to the atmosphere. The plant was rated at 300 tons per hour.

## LOCATION OF SAMPLING POINTS

The dimensions of the stack and the location of the sampling points are shown in Figure 2. The stack cross section was divided into 20 equal areas. The ports were labeled A, B, C, D, and E. Each point was sampled for a period of 3.0 minutes per point which yielded a total test time of 60 minutes per run. The number of sampling points was determined by the distance from the last disturbance in the gas flow as outlined in Method 1, Federal Register, Volume 48, No. 191, 30 September 1983.

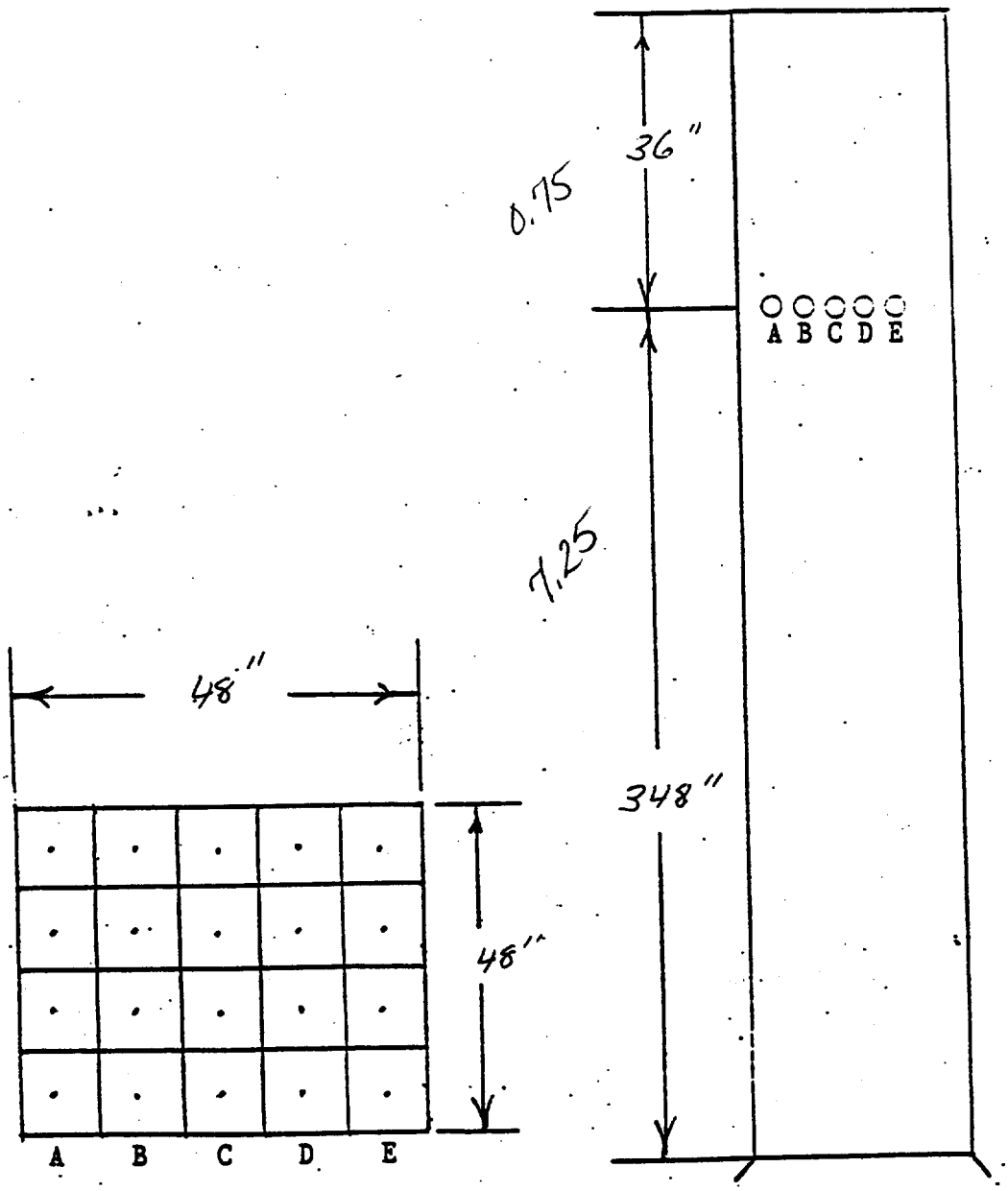


**Figure: 2**
**SAMPLING PORT AND POINT LOCATIONS**

## SAMPLING AND ANALYTICAL PROCEDURES

All sampling and analytical procedures used were those recommended by the U.S. Environmental Protection Agency and the N.C. DNRCD. Complete details are found in Appendix E which is a copy of the Federal Register, Volume 42, Number 160, dated 18 August 1977, the Federal Register, Volume 48, No. 191, 30 September 1983 (Methods 1 - 5), and 40 CFR Chapter 1, Part 60, Appendix A, dated 01 July 1989 .

Sample point locations and velocity measurements were made by Methods 1 and 2. Gas composition was determined by Fyrite and Method 3 on continuous bag samples. Method 5 was used for the particulate determination.

# APPENDICES

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# APPENDIX A

## SUMMARY OF RESULTS

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Appendix A

Summary of Method 5 Particulate Results

Blythe Construction Company Graham NC

| Run Number | | 1 | 2 | 3 |
|---|---|---|---|---|
| Date | | 8/29/90 | 8/29/90 | 8/29/90 |
| DN | Sample nozzle dia., in. | 0.375 | 0.303 | 0.302 |
| TT | Net time of test | 60 | 60 | 60 |
| PB | Barometric pressure, in. Hg. | 29.20 | 29.20 | 29.20 |
| PM | Average orifice pressure drop, in. H2O | 3.655 | 1.530 | 1.701 |
| VM | Volume of dry gas sampled, cu. ft. at meter conditions | 61.62 | 41.74 | 43.93 |
| TM | Average gas meter temp. in degrees F. | 106.77 | 102.10 | 102.05 |
| VMSTD | Volume of dry gas sampled at standard conditions*, SCF | 56.516 | 38.396 | 40.432 |
| VW | Total water collected in impingers + silica gel, ML. | 705.8 | 500.1 | 518.2 |
| VMV | Volume of water vapor at standard conditions*, SCF | 33.236 | 23.550 | 24.402 |
| PMV | Percent moisture by volume | 37.031 | 38.016 | 37.638 |
| MD | Mole fraction dry gas | 0.6297 | 0.6198 | 0.6236 |
| PCO2 | Percent CO2 by volume, dry | 5.43 | 5.00 | 5.07 |
| PO2 | Percent O2 by volume, dry | 9.53 | 10.53 | 11.30 |
| PCO | Percent CO by volume, dry | 0.00 | 0.00 | 0.00 |
| PN2 | Percent N2 by volume, dry | 85.03 | 84.53 | 83.63 |
| MWD | Molecular weight-dry stack gas | 29.247 | 29.238 | 29.263 |
| MW | Molecular weight-stack gas | 25.082 | 24.966 | 25.024 |
| CP | Pitot tube coefficient | 0.84 | 0.84 | 0.84 |
| DPS | Average velocity head of stack gas, inches water | 0.5437 | 0.5524 | 0.5873 |
| TS | Average stack temperature, F | 235.15 | 261.20 | 273.05 |

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| | | | | |
|---|---|---|---|---|
| PSI | Static pressure of stack gas, inches Hg. | 0.013 | 0.013 | 0.013 |
| PS | Stack pressure, absolute | 29.210 | 29.210 | 29.210 |
| VS | Average stack velocity, FPM | 2282.0 | 2367.0 | 2534.1 |
| AS | Stack area, inches sqrd. | 2304.0 | 2304.0 | 2304.0 |
| QS | Stack flow rate, dry, standard conditions, DSCFM | 17111.0 | 16839.7 | 17845.3 |
| QSW | Stack flow rate, wet, standard conditions, WSCFM | 27173.7 | 27168.1 | 28615.6 |
| QA | Actual stack flow rate, ACFM | 36660.3 | 38026.4 | 40710.5 |
| PERI | Percent isokinetic | 115.26 | 121.88 | 121.91 |
| FMF | Particulate, Mg., front | 23.20 | 29.20 | 42.10 |
| CAN | Particulate, GR/DSCF front | 0.0063 | 0.0117 | 0.0160 |
| CAM | Particulate, GR/WSCF front | 0.0100 | 0.0189 | 0.0257 |
| CAT | Particulate, GR/ACF front | 0.0030 | 0.0052 | 0.0070 |
| CAW | Particulate, LB/HR front | 0.927 | 1.690 | 2.452 |
| FNP | Net sampling points | 20 | 20 | 20 |

*68 Degrees F. 29.92 Inches Hg.

Method 5 Particulate Calculations Test Number 1

Blythe Construction Company Graham NC

Volume of Dry Gas Sampled at Standard Conditions

$$VMSTD = \frac{17.64 * VM * (PB + PM / 13.6)}{TM + 460} = 56.516$$

Volume of Water Vapor at Standard Conditions

$$VMV = 0.04709 * VW = 33.236$$

Percent Moisture in Stack Gas

$$PMV = \frac{100 * VMV}{VMSTD + VMV} = 37.031$$

Mole Fraction of Dry Gas

$$MD = \frac{100 - PMV}{100} = 0.6297$$

Average Molecular Weight of Dry Stack Gas

$$MWD = 0.44 * PCO2 + 0.32 * PO2 + 0.28 * (PN2+PCO) = 29.247$$

Molecular Weight of Stack Gas

$$MW = MWD * MD + 18 * (1-MD) = 25.082$$

Stack Gas Velocity at Stack Conditions

$$VS = 5129.4 * CP * DPS * SQRT(TS + 460)/(PS * MW) = 2282.0$$

Stack Gas Volumetric Flow at Standard Conditions, Dry

$$QS = \frac{0.123 * VS * AS * PS * MD}{TS + 460} = 17111.0$$

Stack Gas Volumetric Flow at Stack Conditions

$$QA = \frac{QS * (TS + 460)}{17.64 * PS * MD} = 36660.3$$

Percent Isokinetic

$$PERI = \frac{1039 * (TS + 460) * VMSTD}{VS * TT * PS * MD * DN * DN} = 115.26$$

Particulate Loading -- Probe, Cyclone, Filter
( At Standard Conditions )
CAN = 0.0154 * FMF / VMSTD = 0.0063

Particulate Loading -- Probe, Cyclone, Filter
( At Stack Conditions )

$$CAT = \frac{17.64 * CAN * PS * MD}{TS + 460} = 0.0030$$

Particulate Lb/Hr -- Probe, Cyclone, Filter
( At Standard Conditions )
CAW = 0.00857 * CAN * QS = 0.927

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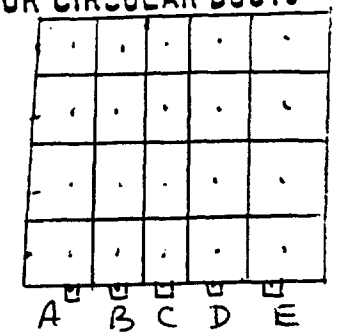
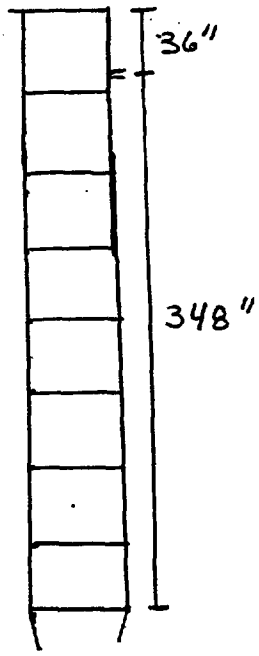
# APPENDIX B

## FIELD DATA

# TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS




Plant Blythe Construction Co, Graham N.C.

Date 8-28-90

Sampling location Asphalt Stack

Inside of far wall to outside of nipple (I) 49.5"

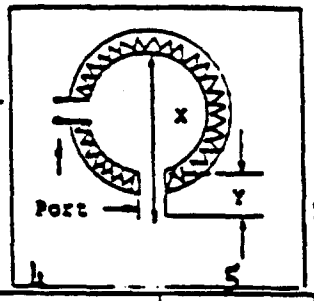
Inside of near wall to outside of nipple (nipple length) (I) 1.5"

Stack I.D. (I-I) 48"

Nearest upstream disturbance .75 dd

Nearest downstream disturbance 7.25 dd

Calculated by RHL




SCHEMATIC OF SAMPLING LOCATION

| 1 | 2 | 3 | | 4 | 5 |
|---|---|---|---|---|---|
| TRAVERSE POINT NUMBER | FRACTION OF STACK I D | STACK I D | PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH) | NIPPLE LENGTH | TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5) |
| 1 | | 48 | | 1½ | 6 |
| 2 | | 48 | | 1½ | 18 |
| 3 | | 48 | | 1½ | 30 |
| 4 | | 48 | | 1½ | 42 |

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# METHOD 2 GAS VELOCITY AND CYCLONIC FLOW DETERMINATION

Plant and City Blythe Construction, Graham NC Run Date 8-29-90

Sampling Location stack Clock Time 2200

Run Number 1 Operator RHL Amb. Temp., °F 88

Bar. Press., in. Hg 29.20 Static Press., in. $H_2O$ 0.17

Stack Press., in. Hg 29.21 Static Press., in. Hg 0.013

Stack Dimension, in. - Diam. or side 1 48 side 2 48

Pitot Tube ($C_p$) .84 Pitot Tube Leak Check <0.1 @ 3.0 in. $H_2O$

Field data — Square Stack

| | Traverse point number | Position, in. | Velocity head ($\Delta p_s$), in. $H_2O$ | Stack temp., °F | Cyclonic flow determination: $\Delta p_s$ at 0° reference | Cyclonic flow determination: Angle (α) which yields a null Δp |
|---|---|---|---|---|---|---|
| .18 | A 1 | 6 | | | | |
| .28 | 2 | 18 | | | | |
| .34 | 3 | 30 | | | | |
| .36 | 4 | 42 | | | | |
| .25 | B 1 | 6 | | | | |
| .31 | 2 | 18 | | | | |
| .33 | 3 | 30 | | | | |
| .31 | 4 | 42 | | | | |
| .25 | C 1 | 6 | | | | |
| .27 | 2 | 18 | | | | |
| .24 | 3 | 30 | | | | |
| .21 | 4 | 42 | | | | |
| .21 | D 1 | 6 | | | | |
| .22 | 2 | 18 | | | | |
| .19 | 3 | 30 | | | | |
| .14 | 4 | 42 | | | | |
| .13 | E 1 | 6 | | | | |
| .16 | 2 | 18 | | | | |
| .12 | 3 | 30 | | | | |
| .09 | 4 | 42 | | | | |
| .23 | | | | | | |
| | | | | | Average angle (α)[a] | |

[a] Average of (α) must be < 10 degrees to be acceptable.

## NOMAGRAPH DATA

$\Delta H_@$ _____ $T_m$ _____ %M _____ $P_s/P_m$ _____ C _____ $D_b$ _____

$\overline{\Delta p}$ _____ $T_s$ _____ $DN_c$ _____ $DN_a$ _____ Ref. Δp _____ $W_b$ _____

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# METHOD 5 PARTICULATE FIELD DATA

Plant: Blythe Construction Co. Graham NC
Run No.:
Location: Stack
Date: 8-29-90
Operator: RHL
Sample Box No.: 2
Meter Box No.: 1264
Filter No.: 58
Probe No.: 2
Pitot Tube Cp: .84

Very Important — Fill In All Blanks
Leak Checks. Beg. @ 15": .011
End @ 15": .006
Pitot Tube: <0.1 @ 7.4 "H₂O
<0.1 @ 7.4 "H₂O
Static Pressure: .17 "H₂O
Start: 2250
Finish: 2358
Observer: Rocket Agency:

Bar. Press. "Hg: 29.20
Meter Box ΔH@: 1.81 Y = 1.00
Assumed Tm, °F: 100
Dry Bulb, °F: 203
Wet Bulb, °F: 157
Db - Wb, °F: 46
Assumed Moisture %: 22
Ps/Pm: 1.00
C Factor: .76

Ambient Temp., °F: 88
Heater Box Setting, °F: 250
Probe Tip Dia., in.: .375
Probe Length: 6'
Probe Heater Setting: 80%
Average Δp: .23 Δp Rel: .15
Average ΔH: 2.8 ΔH Rel:
Process Weight: 252 tons/hr
Steam Load: NA
Steam Pressure: NA

| Point | Clock Time | Dry Gas Meter, Cu. Ft. | Pitot Manometer (Δp) in H₂O | Orifice Manometer (ΔH) in H₂O Desired | Orifice Manometer (ΔH) in H₂O Actual | Dry Gas Temp °F Inlet | Dry Gas Temp °F Outlet | Pump Vacuum in Hg Gauge | Box Temp. °F | Impinger Temp °F | Stack Temp °F | % $CO_2$ | % $O_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A1 | 0 | 046.20 | .23 | 2.8 | 2.8 | 86 | 86 | 7.0 | 225 | 75 | 216 | | |
| 2 | 3 | 049.97 | .29 | 3.5 | 3.5 | 94 | 94 | 10.0 | 225 | 74 | 216 | | |
| 3 | 6 | 051.94 | .36 | 4.4 | 4.4 | 102 | 86 | 14.0 | 225 | 73 | 218 | | |
| 4 | 9 | 055.18 | .32 | 3.9 | 3.9 | 110 | 86 | 12.0 | 230 | 71 | 227 | | |
| B1 | 0 | 058.44 | .22 | 2.8 | 2.8 | 111 | 89 | 6.5 | 225 | 70 | 222 | | |
| 2 | 3 | 061.20 | .25 | 4.2 | 4.2 | 116 | 90 | 12.0 | 230 | 69 | 223 | | |
| 3 | 6 | 064.48 | .35 | 4.2 | 4.2 | 122 | 92 | 12.0 | 230 | 70 | 233 | | |
| 4 | 9 | 067.66 | .36 | 4.4 | 4.4 | 125 | 94 | 14.0 | 230 | 70 | 234 | | |
| C1 | 0 | 071.17 | .25 | 3.0 | 3.0 | 120 | 94 | 8.0 | 235 | 68 | 234 | | |
| 2 | 3 | 073.90 | .33 | 4.0 | 4.0 | 122 | 95 | 12.0 | 240 | 67 | 233 | | |
| 3 | 6 | 077.10 | .34 | 4.2 | 4.2 | 123 | 96 | 15.0 | 240 | 65 | 237 | | |
| 4 | 9 | 080.45 | .33 | 4.0 | 4.0 | 126 | 97 | 15.0 | 225 | 62 | 245 | | |
| D1 | 0 | 083.77 | .28 | 3.4 | 3.4 | 125 | 98 | 10.0 | 225 | 61 | 240 | | |
| 2 | 3 | 086.80 | .34 | 4.2 | 4.2 | 128 | 98 | 14.0 | 225 | 61 | 245 | | |
| 3 | 6 | 090.11 | .34 | 4.2 | 4.2 | 130 | 99 | 14.0 | 225 | 68 | 255 | | |
| 4 | 9 | 093.42 | .32 | 3.9 | 3.9 | 132 | 100 | 14.0 | 230 | 68 | 254 | | |
| E1 | 0 | 096.70 | .13 | 1.6 | 1.6 | 128 | 99 | 4.0 | 240 | 65 | 246 | | |
| 2 | 3 | 098.87 | .19 | 2.3 | 2.3 | 128 | 99 | 5.0 | 250 | 64 | 234 | | |
| 3 | 6 | 101.35 | .34 | 4.2 | 4.2 | 125 | 101 | 14.0 | 245 | 63 | 245 | | |
| 4 | 9 | 104.55 | .32 | 3.9 | 3.9 | 124 | 101 | 13.0 | 250 | 65 | 246 | | |
| | 12 | 107.82 | | | | | | | | | | | |
| | | | .2995 | | | | | | | | | | |

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# METHOD 5 PARTICULATE FIELD DATA

Plant: Blythe Construction Co., Graham, NC.
Run No.: 2
Location: Stack
Date: 8-29-90
Operator: RHL
Sample Box No.: 3
Meter Box No.: 1264
Filter No.: 7
Probe No.: 3
Pilot Tube Cp: .84

Very Important — Fill In All Blanks
Leak Checks. Beg. @ 15" 0.012
End @ 6" 0.022
Pilot Tube: <0.1 @ 7.4 "H2O
<0.1 @ 7.4 "H2O
Static Pressure: .17 "H2O
Start: 0030
Finish: 0138
Observer: Rocket Agency: DEM

Bar. Press. "Hg: 29.20
Meter Box ΔH@: 1.81 Y = 1.00
Assumed Tm, °F: 110
Dry Bulb, °F: 203
Wet Bulb, °F: 157
Db - Wb, °F: 46
Assumed Moisture %: 22
Ps/Pm: 1.00
C Factor: .76

Ambient Temp., °F: 80
Heater Box Setting, °F: 250
Probe Tip Dia., in.: .303
Probe Length: 6'
Probe Heater Setting: 80%
Average Δp: .30 Δp Rel: .38
Average ΔH: 1.48 ΔH Rel
Process Weight: 325 tons/hr
Steam Load: NA
Steam Pressure: NA

| Point | Clock Time | Dry Gas Meter, Cu. Ft. | Pitot Manometer (Δp) in H2O | Orifice Manometer (ΔH) in H2O Desired | Orifice Manometer (ΔH) in H2O Actual | Dry Gas Temp °F Inlet | Dry Gas Temp °F Outlet | Pump Vacuum in Hg Gauge | Box Temp. °F | Impinger Temp. °F | Stack Temp °F | % CO2 | % O2 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A 1 | 0 | 108.40 | .14 | .71 | .71 | 96 | 91 | 2.0 | 200 | 63 | ~~313~~ 250 | | |
| 2 | 3 | 109.86 | .21 | 1.0 | 1.0 | 99 | 92 | 3.0 | 225 | 65 | 258 | | |
| 3 | 6 | 110.36 | .26 | 1.25 | 1.25 | 101 | 93 | 4.0 | 240 | 62 | 258 | | |
| 4 | 9 | 113.57 | .19 | 0.94 | 0.94 | 108 | 94 | 3.0 | 250 | 62 | 258 | | |
| B 1 | 0 | 115.20 | .25 | 1.20 | 1.20 | 110 | 95 | 4.0 | 255 | 65 | 259 | | |
| 2 | 3 | 117.11 | .36 | 1.75 | 1.75 | 108 | 95 | 4.0 | 260 | 64 | 261 | | |
| 3 | 6 | 119.27 | .34 | 1.70 | 1.70 | 111 | 94 | 5.0 | 250 | 64 | 262 | | |
| 4 | 9 | 121.45 | .28 | 1.40 | 1.40 | 112 | 94 | 4.0 | 260 | 63 | 263 | | |
| C 1 | 0 | 123.50 | .35 | 1.70 | 1.70 | 111 | 92 | 4.0 | 265 | 62 | 264 | | |
| 2 | 3 | 125.79 | .33 | 1.60 | 1.60 | 114 | 92 | 5.0 | 265 | 62 | 265 | | |
| 3 | 6 | 127.85 | .39 | 1.90 | 1.90 | 115 | 94 | 6.0 | 250 | 62 | 265 | | |
| 4 | 9 | 130.13 | .37 | 1.80 | 1.80 | 115 | 95 | 5.0 | 270 | 62 | 266 | | |
| D 1 | 0 | 132.42 | .42 | 2.05 | 2.05 | 114 | 94 | 5.0 | 250 | 64 | 264 | | |
| 2 | 3 | 134.81 | .29 | 1.45 | 1.45 | 116 | 95 | 3.0 | 245 | 62 | 267 | | |
| 3 | 6 | 136.92 | .34 | 1.70 | 1.70 | 110 | 94 | 3.5 | 245 | 65 | 253 | | |
| 4 | 9 | 139.12 | .35 | 1.75 | 1.75 | 111 | 96 | 4.0 | 265 | 58 | 258 | | |
| E 1 | 0 | 141.35 | .34 | 1.75 | 1.75 | 112 | 95 | 4.0 | 245 | 63 | 262 | | |
| 2 | 3 | 143.57 | .34 | 1.75 | 1.75 | 113 | 95 | 4.0 | 245 | 65 | 265 | | |
| 3 | 6 | 145.88 | .32 | 1.60 | 1.60 | 114 | 94 | 4.0 | 245 | 62 | 262 | | |
| 4 | 9 | 147.97 | .32 | 1.60 | 1.60 | 116 | 94 | 4.0 | 250 | 63 | 265 | | |
| | | 150.14 | | | | | | | | | | | |

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# METHOD 5 PARTICULATE FIELD DATA

Plant: Blythe Construction Co. Graham
Run No.: 3
Location: Stack
Date: 08-30-90
Operator: LHL
Sample Box No.: 1
Meter Box No.: 1264
Filter No.: 6
Probe No.: 1
Pilot Tube Cp: .84

Very Important — Fill In All Blanks
Leak Checks. Beg. @ 15": .007
End @ : .003
Pilot Tube: <0.1 @ 5.8 "H₂O
<0.1 @ 5.8 "H₂O
Static Pressure: .17 "H₂O
Start: 0212
Finish: 0316
Observer: B. Lockett Agency: DEM

Bar. Press. "Hg: 29.20
Meter Box ΔH@: 1.81 Y = 1.00
Assumed Tm, °F: 110
Dry Bulb, °F: 203
Wet Bulb, °F: 157
Db - Wb, °F: 46
Assumed Moisture %: 22
Ps/Pm: 1.00
C Factor: .76

Ambient Temp., °F: 76
Heater Box Setting, °F: 250
Probe Tip Dia., in.: .302
Probe Length: 6'
Probe Heater Setting: 80%
Average Δp: .30 Δp Rel: .38
Average ΔH: 1.48 ΔH Rel
Process Weight: 330 tons/hr
Steam Load: NA
Steam Pressure: NA

| Point | Clock Time | Dry Gas Meter, Cu. Ft. | Pitot Manometer (Δp) in $H_2O$ | Orifice Manometer (ΔH) in $H_2O$ Desired | Orifice Manometer (ΔH) in $H_2O$ Actual | Dry Gas Temp °F Inlet | Dry Gas Temp °F Outlet | Pump Vacuum in Hg Gauge | Box Temp. °F | Impinger Temp °F | Stack Temp °F | % $CO_2$ | % $O_2$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| A 1 | 0 | 151.20 | .24 | 1.05 | 1.05 | 94 | 90 | 4.0 | 225 | 70 | 265 | | |
| 2 | 3 | 153.13 | .26 | 1.25 | 1.25 | 98 | 90 | 5.0 | 225 | 67 | 273 | | |
| 3 | 6 | 155.00 | .26 | 1.25 | 1.25 | 102 | 90 | 5.0 | 225 | 67 | 272 | | |
| 4 | 9 | 157.01 | .22 | 1.02 | 1.02 | 104 | 91 | 4.0 | 240 | 67 | 271 | | |
| B 1 | 0 | 158.77 | .34 | 1.75 | 1.75 | 108 | 91 | 6.0 | 250 | 65 | 270 | | |
| 2 | 3 | 160.84 | .37 | 1.80 | 1.8 | 112 | 92 | 7.0 | 245 | 64 | 274 | | |
| 3 | 6 | 163.02 | .34 | 1.75 | 1.75 | 112 | 92 | 8.0 | 250 | 66 | 275 | | |
| 4 | 9 | 165.25 | .29 | 1.40 | 1.40 | 115 | 92 | 6.0 | 260 | 65 | 274 | | |
| C 1 | 0 | 167.32 | .39 | 1.90 | 1.90 | 115 | 92 | 8.0 | 260 | 63 | 275 | | |
| 2 | 3 | 169.60 | .34 | 1.75 | 1.75 | 115 | 92 | 8.0 | 260 | 60 | 280 | | |
| 3 | 6 | 171.86 | .41 | 2.00 | 2.00 | 116 | 92 | 8.0 | 275 | 65 | 280 | | |
| 4 | 9 | 174.21 | .38 | 1.85 | 1.85 | 116 | 93 | 7.0 | 275 | 64 | 277 | | |
| D 1 | 0 | 176.55 | .43 | 2.2 | 2.2 | 115 | 94 | 8.0 | 240 | 65 | 270 | | |
| 2 | 3 | 179.01 | .39 | 1.90 | 1.90 | 115 | 95 | 8.0 | 250 | 63 | 275 | | |
| 3 | 6 | 181.42 | .44 | 2.2 | 2.2 | 117 | 94 | 9.0 | 250 | 62 | 272 | | |
| 4 | 9 | 183.91 | .40 | 1.95 | 1.95 | 118 | 94 | 8.0 | 245 | 61 | 270 | | |
| E 1 | 0 | 186.38 | .34 | 1.75 | 1.75 | 116 | 92 | 5.0 | 250 | 64 | 271 | | |
| 2 | 3 | 188.52 | .34 | 1.75 | 1.75 | 116 | 93 | 5.0 | 250 | 64 | 272 | | |
| 3 | 6 | 190.73 | .39 | 1.90 | 1.90 | 117 | 92 | 7.0 | 255 | 64 | 273 | | |
| 4 | 9 | 192.28 | .32 | 1.60 | 1.60 | 117 | 93 | 6.0 | 250 | 64 | 271 | | |
| | | 195.13 | | | | | | | | | | | |

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# METHOD 3 - ORSAT AND DRY MOLECULAR WEIGHT DETERMINATION

Plant BLYTHE CONSTRUCTION Sample Location STACK

Sample Type - Continuous ✓ Pump Leakfree @ 10" ? ✓

Oxygen Check 20.9% ± 0.1% 20.9 Fuel Type No. 6

Orsat Leak Check @ 4 min.: Pipet Levels - Leakfree ? ✓

Buret 14.1 - 14.1 = <0.2 ml ? ✓

Run No. 1 Sample Date 8/29/90 Ambient Temp. °F 88

Sampling Time (24 - hr clock) 2250 - 2358 Analysis By TEW

| Gas \ Run | 1 Actual | 1 Net | 2 Actual | 2 Net | 3 Actual | 3 Net | Avg. % | Mult. | Molecular Wt. Dry lb/lb mole |
|---|---|---|---|---|---|---|---|---|---|
| $CO_2$ | 5.3 | 5.3 | 5.5 | 5.5 | 5.5 | 5.5 | 5.43 | .44 | 2.389 |
| $O_2$ | 15.1 | 9.8 | 14.9 | 9.4 | 14.9 | 9.4 | 9.53 | .32 | 3.050 |
| CO | 15.1 | 0.0 | 14.9 | 0.0 | 14.9 | 0.0 | 0.00 | .28 | 0.000 |
| $N_2$ | 100 | 84.9 | 100 | 85.1 | 100 | 85.1 | 85.03 | .28 | 23.808 |
| | | | | | | | | Total | 29.247 |

$F_o = \frac{20.9 - \%O_2}{\%CO_2}$ = NA

Run No. 2 Sample Date 8/29/90 Ambient Temp. °F 90

Sampling Time (24 - hr clock) 0030 - 0138 Analysis By TEW

| Gas \ Run | 1 Actual | 1 Net | 2 Actual | 2 Net | 3 Actual | 3 Net | Avg. % | Mult. | Molecular Wt. Dry lb/lb mole |
|---|---|---|---|---|---|---|---|---|---|
| $CO_2$ | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.00 | .44 | 2.200 |
| $O_2$ | 15.5 | 10.5 | 15.5 | 10.5 | 15.6 | 10.6 | 10.53 | .32 | 3.370 |
| CO | 15.5 | 0.0 | 15.5 | 0.0 | 15.6 | 0.0 | 0.00 | .28 | 0.000 |
| $N_2$ | 100 | 84.5 | 100 | 84.5 | 100 | 84.6 | 84.53 | .28 | 23.668 |
| | | | | | | | | Total | 29.238 |

$F_o = \frac{20.9 - \%O_2}{\%CO_2}$ = NA

Run No. 3 Sample Date 8/30/90 Ambient Temp. °F 76

Sampling Time (24 - hr clock) 0212 - 0316 Analysis By TEW

| Gas \ Run | 1 Actual | 1 Net | 2 Actual | 2 Net | 3 Actual | 3 Net | Avg. % | Mult. | Molecular Wt. Dry lb/lb mole |
|---|---|---|---|---|---|---|---|---|---|
| $CO_2$ | 5.1 | 5.1 | 4.9 | 4.9 | 5.2 | 5.2 | 5.07 | .44 | 2.231 |
| $O_2$ | 16.4 | 11.3 | 16.3 | 11.4 | 16.4 | 11.2 | 11.30 | .32 | 3.616 |
| CO | 16.4 | 0.0 | 16.3 | 0.0 | 16.4 | 0.0 | 0.00 | .28 | 0.000 |
| $N_2$ | 100 | 83.6 | 100 | 83.7 | 100 | 83.6 | 83.63 | .28 | 23.416 |
| | | | | | | | | Total | 29.263 |

| Fuel type | $F_o$ range |
|---|---|
| Coal: | |
| Anthracite and lignite | 1.016–1.130 |
| Bituminous | 1.083–1.230 |
| Wood | 1.000–1.120 |
| Wood bark | 1.003–1.130 |

$F_o = \frac{20.9 - \%O_2}{\%CO_2}$ = NA

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# METHOD 5 SAMPLE RECOVERY AND INTEGRITY SHEET

Plant Blythe Construction — Recovered By TEW/DMR
Sample Location stack — Recovery Date 8/30/90

| | | | |
|---|---|---|---|
| Run Number | 1 | 2 | 3 |
| Sample Date | 8/29/90 | 8/29/90 | 8/29/90 |
| Sample Box Number | 2 | 3 | 1 |
| Probe Number | 2 | 3 | 1 |
| Filter Number | 8 | 7 | 6 |

## MOISTURE RECOVERY

| | | | |
|---|---|---|---|
| Impingers Cont. Number | 2-1 | 2-2 | 2-3 |
| Description of Water | CLEAR | CLEAR | CLEAR |
| Liquid Level Marked | ✓ | ✓ | ✓ |
| Final Volume (wt.), ml | 870.0 | 680.0 | 690.0 |
| Initial Volume (wt.), ml | 200.0 | 200.0 | 200.0 |
| Net Volume (wt.), ml (g) | 670.0 | 480.0 | 490.0 |
| Silica Gel Cont. Number | 2-1 | 2-2 | 2-3 |
| Silica Gel % Spent | 100% | 90% | 100% |
| Final Weight, g | 235.8 | 220.1 | 228.2 |
| Initial Weight, g | 200.0 | 200.0 | 200.0 |
| Net Weight, g | 35.8 | 20.1 | 28.2 |
| Total Moisture, g | 705.8 | 500.1 | 518.2 |

## PARTICULATE RECOVERY

| | | | |
|---|---|---|---|
| Filter Cont. Number | 2-1 | 2-2 | 2-3 |
| Particulate Description | TAN | TAN | TAN |
| Filter Cont. Sealed | ✓ | ✓ | ✓ |
| Final Weight, mg | 524.8 .0 | 533.6 .65 | 537.9 |
| Final Weight Audit, mg | 524.8 | 533.7 | 538.0 |
| Initial Weight, mg | 501.6 .0 | 504.2 | 495.8 |
| Initial Weight Audit, mg | 501.6 | 504.6 | 496.0 |
| Filter Catch, mg | 23.2 | 29.2 | 42.1 |
| Probe Rinse Cont. Number | 2-1 | 2-2 | 2-3 |
| Liquid Level Marked | ✓ | ✓ | ✓ |
| Final Weight, mg | 98091.3 | 104725.2 | 100137.4 |
| Final Weight Audit, mg | 98091.5 | 104725.6 | 100137.6 |
| Initial Weight, mg | 98076.3 | 104713.3 | 100125.0 |
| Initial Weight Audit, mg | 98076.6 | 104712.8 | 100125.0 |
| Less Acetone Blank, mg | .4 | .4 | .4 |
| Acetone Rinse Catch, mg | 15.4 | 12.8 | 12.9 |
| Total Particulate, mg | 38.6 | 42.0 | 55.0 |

| | |
|---|---|
| Acetone Blank Number | B |
| Final Weight, mg | 104203.5 .4 |
| Final Weight Audit, mg | 104203.3 |
| Initial Weight, mg | 104204.0 |
| Initial Weight Audit, mg | 104203.5 |
| Acetone Residue, mg | .4 |
| Acetone Volume, ml | 150 |
| Concentration, mg/mg | .4 |

S/B .0034 mg/mg → 0.34%

**LABORATORY CUSTODY**

Received By: RHL
Date Received: 08-30-90
Stored & Locked: ✓
Remarks: None

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APPENDIX C

## PROCESS DATA

During the sampling the asphalt plant produced 282 tons per hour on the first run, 325 tons per hour on the second, and 330 tons per hour on the third. This resulted in average of 312.3 tons per hour for the test period.

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APPENDIX D

## TEST PARTICIPANTS

| | |
|---|---|
| Rodney H. Lang | Field Services Manager<br>Pace Inc. |
| Jay J. Qualtieri | Environmental Technician<br>Pace Inc. |
| Reggie E. Alston | Environmental Technician<br>Pace Inc. |

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# APPENDIX E

## SAMPLING AND ANALYTICAL PROCEDURES

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# APPENDIX F

## CALIBRATION DATA

# CALIBRATION INFORMATION

## NOZZLES

Each new set of nozzles purchased by Pace are first machined and calibrated before being put into field use. Thereafter, whenever it becomes apparent that a nozzle has been damaged, it is again machined and recalibrated. A set of three is matched to within 0.002 inches (Difference between high and low readings). Nozzles are checked prior to each source test.

## PITOT TUBES

All pitot tubes used by Pace whether separate or attached to a sampling probe were made by Pace personnel. Prior to being put into field use, they are calibrated. In general, if a type "S" pitot tube is constructed properly, and not positioned too closely to the probe nozzle or any other obstruction, it will have a Cp of 0.83 - 0.87. As long as the pitot tube is not damaged its calibration should not change. All Pace pitot tubes are made to have a Cp of 0.84. If a pitot tube does not initially have a Cp of 0.84, it is altered until a reading of 0.84 is obtained. Pitot tubes are checked before each source test and receive a complete calibration once a year.

## DRY GAS METER AND ORIFICE METER

Complete meter box calibrations are performed annually. One point calibrations at the average orifice meter and maximum vacuum readings encountered during the compliance test are performed after each source test. If the dry gas meter calibration factor differs from 1.00 by more than +\- 0.02 then the dry gas meter is repaired and given an annual calibration.

## THERMOMETERS, FYRITES, ORSAT AND ORSAT BAGS

Each new thermometer, pyrometer and thermocouple purchased or manufactured by Pace is checked and calibrated before being put into field use. After each source test each temperature sensing device used on the test receives a one point calibration check according to U.S. EPA guidelines.

Fyrites, orsat and orsat bags are checked before and after each source test. If they do not function according to U.S. EPA protocol that piece of equipment is either repaired or replaced.

## LABORATORY EQUIPMENT

Pace has a written quality assurance document that covers calibration and maintenance of laboratory equipment. This includes calibration of the analytical balance against Class S weights, and service contracts to maintain traceability to N.B.S. Calibration of thermometers, barometers, stopwatches and wet test meters are traceable to N.B.S. A copy of our quality assurance document may be obtained by written request.

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# PRETEST - POSTEST CALIBRATION CHECKS

Plant Blythe Construction Co. Graham NC. Calibrated by WQB
Meter box number 1264 Date 8-30-90

**Dry Gas Meter**

Pretest meter calibration factor, Y = 1.00 (within ± 2%)
Postest meter calibration factor, Y = 1.02 (within ± 5% of pretest)
Recalibration required? Circle one: yes or (no) If yes new Y = ——
Lower cal. factor, Y = —— for calculations (pretest or postest)

**Dry Gas Meter Thermometers**

Was a pretest temperature correction used? Circle one: yes or (no) If yes temperature correction —— (within ± 5.4°F over range)
Postest comparison with mercury-in-glass thermometer? (within ±10.8°F at ambient temperature) Recalibration required? Circle one: yes or (no)
Recalibration temperature correction? —— (within ±5.4°F over range
If yes, no correction necessary for calculations if meter thermometer temperature is higher; if calibration temperature is higher, add correction to average meter temperature for calculations

**Stack Temperature Sensor**

Was a pretest temperature correction used? Circle one: yes or (no) If yes temperature correction —— °F (within ±1.5% in °R over range)
Average stack temperature of compliance test, 760.47 °R
Temperature of ref. thermometer for recalibration #1 758 #2 758 °R
(within ± 10% of the average stack temperature)
Temperature of stack thermometer for recalibration #1 758 #2 756 °R
Diff. between ref. and stack thermometer temps. #1 0 #2 2 °R
Do the ref. and stack values agree within ±1.5%? Circle one: (yes) or no
If yes, no correction is necessary for calculations
If no, calculations must be done twice—once with the recorded values and once with the average stack temperature corrected to correspond to the reference temperature differential; both final result values must be reported since there is no way to determine which is correct

**Barometer**

Was the pretest field barometer reading correct? Circle one: (yes) or no
Postest comparison? 0.00 in. Hg (±0.1 in. Hg) Recalibration required? Circle one: yes or (no) If yes, no correction necessary for calculations when the field barometer has a lower reading; if the mercury-in-glass reading is lower, subtract the difference from the field data readings for the calculations.

| | Pretest | Postest |
|---|---|---|
| Hg in glass | 29.3 | 29.5 |
| Field | 29.3 | 29.5 |
| Difference | 0.0 | 0.0 |

**Nozzle**

Was the nozzle calibrated to the nearest .001 in.? Circle one: (yes) or no

| | | | | | | |
|---|---|---|---|---|---|---|
| Nozzle #1: | .375 | .374 | .376 | .375 | .374 | : Average .375 |
| Nozzle #2: | .304 | .303 | .304 | .303 | .307 | : Average .303 |
| Nozzle #3: | .307 | .307 | .302 | .302 | .307 | : Average .307 |

**Impinger Thermometer**

Was a pretest temperature correction used? Circle one: yes or (no) If yes temperature correction —— (within ±5.4°F over range)

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## POSTEST DRY GAS METER CALIBRATION DATA FORM (English Units)

Test Number 1 Date 8-30-90 Meter Box No. 1264 Plant BLYTHE CONSTRUCTION

Barometric Pressure, $P_b$ = 29.20 in. Hg Dry Gas Meter No. 212.05 Pretest Y 1.00

| Orifice manometer setting, inches $H_2O$ $\Delta H$ | Gas Volume: Wet test meter, ft³ $V_w$ | Gas Volume: Dry gas meter, ft³ $V_d$ | Temperature: Wet test meter, °F $t_w$ | Temperature: Dry Gas Meter: Inlet °F $t_{d_i}$ | Temperature: Dry Gas Meter: Outlet °F $t_{d_o}$ | Temperature: Dry Gas Meter: Average °F $t_d$ | Time min. $\theta$ | Vacuum setting in. Hg | $Y_i$ | $Y_i$ $\frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6})(t_w + 460)}$ |
|---|---|---|---|---|---|---|---|---|---|---|
| 2.29 | 10 | 10.36 | 72 | 112.5 | 84.5 | 98.5 | 11.79 | 10 | 1.01 | $\frac{10(29.20)(98.5+460)}{10.36(29.2+\frac{2.29}{13.6})(72+460)}$ |
| 2.29 | 10 | 10.38 | 72 | 124 | 85 | 104.5 | 11.8 | 10 | 1.02 | $\frac{10(29.20)(104.5+460)}{10.38(29.2+\frac{2.29}{13.6})(72+460)}$ |
| 2.29 | 10 | 10.51 | 72 | 131.5 | 96.5 | 114 | 11.8 | 10 | 1.02 | $\frac{10(29.20)(114+460)}{10.51(29.20+\frac{2.29}{13.6})(72+460)}$ |

$\bar{Y}$ = 1.02

$V_w$ = Gas volume passing through the wet test meter, ft.³

$V_d$ = Gas volume passing throught the dry gas meter, ft.³

$t_w$ = Temperature of the gas in the wet test meter, °F

$t_{d_i}$ = Temperature of the inlet gas of the dry gas meter, °F

$t_{d_o}$ = Temperature of the outlet gas of the dry gas meter, °F

$t_d$ = Average temperature of the gas in the dry gas meter, obtained by the average of $t_{d_i}$ and $t_{d_o}$, °F

$\Delta H$ = Pressure differentinl across orifice, in. $H_2O$

$Y_i$ = Ratio of acturacy of wet test meter to dry gas meter for each run

Y = Average ratio of accuracy of wet test meter to dry gas meter for all three runs; tolerance = pretest Y ± 0.05Y

$P_b$ = Barometric pressure, in. Hg

$\theta$ = Time of calibration run, min.

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## PRETEST - POSTEST THERMOMETER CALIBRATION

Client Blythe Construction Company Date 8-16-90

Location Stack Ref. Thermometer 5

| Thermometer | Pretest | | Postest | |
|---|---|---|---|---|
| | Temp., °F | Ref. Temp., °F | Temp., °F | Ref. Temp., °F |
| DGM # 1248 | 72 | 72 | 75 | 75 |
| DGM # 1248 | 72 | 72 | 75 | 75 |
| DGM # 1264 | 72 | 72 | 75 | 75 |
| DGM # 1264 | 72 | 72 | 75 | 75 |
| Impinger #1 | 72 | 72 | 75 | 75 |
| Impinger #2 | 71 | 72 | 75 | 75 |
| Impinger #3 | 72 | 72 | 75 | 75 |
| Impinger #4 | — | — | — | — |
| Impinger #5 | — | — | — | — |
| WB # | 72 | 72 | 75 | 75 |
| DB # | 72 | 72 | 75 | 75 |
| Box #1 | — | — | — | — |
| Box #2 | — | — | — | — |
| Box #3 | 71 | 72 | 74 | 75 |
| Box #4 | 73 | 72 | 76 | 75 |
| Box #5 | 72 | 72 | 75 | 75 |
| Box #6 | 72 | 72 | 75 | 75 |
| WB Omega 873 | 72 | 72 | 75 | 75 |
| DB Omega 873 | 72 | 72 | 75 | 75 |
| WB Omega # | — | — | — | — |
| DB Omega # | — | — | — | — |
| Probe 5' #1 | 72 | 72 | 75 | 75 |
| Probe 5' #2 | 72 | 72 | 75 | 75 |
| Probe 6' #1 | 72 | 72 | 75 | 75 |
| Probe 6' #2 | 72 | 72 | 75 | 75 |
| | | | | |

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# RAC STAKSAMPLR CALIBRATION SHEET

Meter Box Serial Number: 1264 Barometric Pressure ($P_b$): 29.344

Leak Check @ 6.0 in. $H_2O$: OK Date: 12-27-89 Calibrated by: JAB
Pump: OK Pump Oil: OK Clean Quick Connects: OK
Manometers: OK Dry Test Meter: OK Thermometers: OK
Lights: OK Electrical Check: OK Variac: OK
Vacuum Gauge: OK Leak Check @ 27" Hg.: <0.001 CFM

| Man. Orifice | $CF_w$ | $CF_d$ | $T_w$ | $IT_d$ | $OT_d$ | $T_d$ avg. | Time t |
|---|---|---|---|---|---|---|---|
| 0.5 | 5 | 5.35 | 67.5 | 113.5 | 96.0 | 104.75 | 12.36 |
| 1.0 | 5 | 5.37 | 67.5 | 120.0 | 97.5 | 108.75 | 9.02 |
| 1.5 | 10 | 10.76 | 67.5 | 122.5 | 98.5 | 110.50 | 15.24 |
| 2.0 | 10 | 10.78 | 67.5 | 125.5 | 100.0 | 112.75 | 13.64 |
| 3.0 | 10 | 10.78 | 67.5 | 129.0 | 101.0 | 115.00 | 10.94 |
| 4.0 | 10 | 10.78 | 67.5 | 130.0 | 102.0 | 116.00 | 9.92 |

Calculate Y and $\Delta H_@$ as follows:

$$Y = \frac{CF_w P_b (T_d \text{ avg.} + 460)}{CF_d (P_b + \Delta H/13.6)(T_w + 460)} = 1.00 \qquad \Delta H_@ = \frac{0.0317 \ \Delta H}{P_b (T_d + 460)} \left(\frac{(T_w + 460)\ t}{CF_w}\right)^2 = 1.81$$

<u>Tolerances</u>: Y = 0.90 - <u>1.00</u> - 1.10 Y +/- 0.02Y $\Delta H_@$ = 1.6 - <u>1.81</u> - 2.1 $\Delta H_{@i}$ +/- 0.15 in.

## CALIBRATION CALCULATIONS PUMP AND ORIFICE METER

Manometer Delta H 0.5 in. $H_2O$

$$Y = \frac{5 \times 29.344\ (104.75 + 460)}{5.35\ (29.344 + 0.0368)(67.5 + 460)} = 0.999 \qquad \Delta H_@ = \frac{0.01585}{29.344\ (104.75 + 460)} \left(\frac{(67.5 + 460)\ 12.36}{5}\right)^2 = 1.530$$

Manometer Delta H 1.0 in. $H_2O$

$$Y = \frac{5 \times 29.344\ (108.75 + 460)}{5.37\ (29.344 + 0.0737)(67.5 + 460)} = 1.001 \qquad \Delta H_@ = \frac{0.03170}{29.344\ (108.75 + 460)} \left(\frac{(67.5 + 460)\ 9.07}{5}\right)^2 = 1.648$$

Manometer Delta H 1.5 in. $H_2O$

$$Y = \frac{10 \times 29.344\ (110.50 + 460)}{10.76\ (29.344 + 0.1103)(67.5 + 460)} = 1.001 \qquad \Delta H_@ = \frac{0.04755}{29.344(110.50 + 460)} \left(\frac{(67.5 + 460)\ 15.24}{10}\right)^2 = 1.809$$

Manometer Delta H 2.0 in. $H_2O$

$$Y = \frac{10 \times 29.344\ (112.75 + 460)}{10.78\ (29.344 + 0.1471)(67.5 + 460)} = 1.002 \qquad \Delta H_@ = \frac{0.06340}{29.344\ (112.75 + 460)} \left(\frac{(67.5 + 460)\ 13.64}{10}\right)^2 = 1.979$$

Manometer Delta H 3.0 in. $H_2O$

$$Y = \frac{10 \times 29.344\ (115.00 + 460)}{10.78\ (29.344 + 0.2206)(67.5 + 460)} = 1.003 \qquad \Delta H_@ = \frac{0.09510}{29.344\ (115.00 + 460)} \left(\frac{(67.5 + 460)\ 10.94}{10}\right)^2 = 1.865$$

Manometer Delta H 4.0 in. $H_2O$

$$Y = \frac{10 \times 29.344\ (116.00 + 460)}{10.78\ (29.344 + 0.2941)(67.5 + 460)} = 1.003 \qquad \Delta H_@ = \frac{0.12680}{29.344\ (116.00 + 460)} \left(\frac{(67.5 + 460)\ 9.92}{10}\right)^2 = 2.053$$

# NOZZLE CALIBRATION

Date: 05-02-90
By: WQB

## Set Number 1

| Nozzle I.D. | $D_1$, in. | $D_2$, in. | $D_3$, in. | $D_4$, in. | $D_5$, in. | D, in. | $D_{ave.}$ |
|---|---|---|---|---|---|---|---|
| .187-1 | 0.187 | 0.187 | 0.188 | 0.188 | 0.187 | 0.001 | 0.187 |
| .187-2 | 0.188 | 0.189 | 0.188 | 0.189 | 0.189 | 0.001 | 0.189 |
| .187-3 | 0.186 | 0.186 | 0.187 | 0.187 | 0.187 | 0.001 | 0.187 |
| .208-1 | 0.209 | 0.208 | 0.208 | 0.207 | 0.209 | 0.002 | 0.208 |
| .250-1 | 0.251 | 0.252 | 0.251 | 0.252 | 0.252 | 0.001 | 0.252 |
| .250-2 | 0.253 | 0.253 | 0.251 | 0.252 | 0.251 | 0.002 | 0.252 |
| .250-3 | 0.251 | 0.249 | 0.250 | 0.249 | 0.251 | 0.002 | 0.250 |
| .300-1 | 0.302 | 0.301 | 0.300 | 0.300 | 0.300 | 0.002 | 0.301 |
| .300-2 | 0.304 | 0.304 | 0.304 | 0.304 | 0.304 | 0.000 | 0.304 |
| .300-3 | 0.299 | 0.300 | 0.299 | 0.300 | 0.301 | 0.002 | 0.300 |
| .336-1 | 0.336 | 0.338 | 0.336 | 0.337 | 0.337 | 0.002 | 0.337 |
| .375-1 | 0.373 | 0.375 | 0.374 | 0.375 | 0.374 | 0.002 | 0.374 |
| .375-2 | 0.374 | 0.376 | 0.375 | 0.374 | 0.374 | 0.002 | 0.375 |
| .375-3 | 0.374 | 0.374 | 0.374 | 0.375 | 0.374 | 0.001 | 0.374 |
| .400-1 | 0.403 | 0.405 | 0.403 | 0.405 | 0.403 | 0.002 | 0.404 |
| .500-1 | 0.505 | 0.503 | 0.504 | 0.505 | 0.504 | 0.002 | 0.504 |
| .500-2 | 0.502 | 0.503 | 0.501 | 0.501 | 0.502 | 0.002 | 0.502 |
| .500-3 | 0.501 | 0.500 | 0.500 | 0.500 | 0.501 | 0.001 | 0.500 |
| .625-1 | 0.619 | 0.619 | 0.619 | 0.619 | 0.619 | 0.000 | 0.619 |
| .775-1 | 0.781 | 0.780 | 0.779 | 0.781 | 0.780 | 0.002 | 0.780 |
| 1.00-1 | 0.995 | 0.996 | 0.995 | 0.996 | 0.996 | 0.001 | 0.996 |

## SET NUMBER 2

| Nozzle I.D. | $D_1$, in. | $D_2$, in. | $D_3$, in. | $D_4$, in. | $D_5$, in. | D, in. | $D_{ave.}$ |
|---|---|---|---|---|---|---|---|
| .187-1 | 0.186 | 0.186 | 0.186 | 0.186 | 0.186 | 0.000 | 0.186 |
| .187-2 | 0.187 | 0.187 | 0.187 | 0.187 | 0.187 | 0.000 | 0.187 |
| .187-3 | 0.186 | 0.187 | 0.186 | 0.186 | 0.186 | 0.001 | 0.186 |
| .207-2 | 0.206 | 0.207 | 0.206 | 0.208 | 0.208 | 0.002 | 0.207 |
| .250-1 | 0.250 | 0.249 | 0.251 | 0.250 | 0.250 | 0.002 | 0.250 |
| .250-2 | 0.250 | 0.251 | 0.250 | 0.251 | 0.250 | 0.001 | 0.250 |
| .250-3 | 0.248 | 0.249 | 0.250 | 0.249 | 0.250 | 0.002 | 0.249 |
| .300-1 | 0.304 | 0.303 | 0.304 | 0.303 | 0.302 | 0.002 | 0.303 |
| .300-2 | 0.302 | 0.302 | 0.302 | 0.302 | 0.302 | 0.000 | 0.302 |
| .300-3 | 0.306 | 0.306 | 0.306 | 0.304 | 0.306 | 0.002 | 0.306 |
| .336-2 | 0.336 | 0.335 | 0.337 | 0.335 | 0.336 | 0.002 | 0.336 |
| .375-1 | 0.375 | 0.376 | 0.377 | 0.375 | 0.376 | 0.002 | 0.376 |
| .375-2 | 0.375 | 0.374 | 0.376 | 0.375 | 0.374 | 0.002 | 0.375 |
| .375-3 | 0.376 | 0.374 | 0.374 | 0.375 | 0.374 | 0.002 | 0.375 |
| .500-1 | 0.493 | 0.491 | 0.493 | 0.491 | 0.491 | 0.002 | 0.492 |
| .500-2 | 0.496 | 0.497 | 0.495 | 0.496 | 0.495 | 0.002 | 0.496 |
| .500-3 | 0.495 | 0.497 | 0.496 | 0.497 | 0.497 | 0.002 | 0.496 |

Where:

$D_{1,2,3,4,5}$ = nozzle diameter measured on a different diameter, in.
Tolerance = measured within 0.002 in.
D = maxium difference in any two measurements, in.
Tolerance = 0.004 in.
$D_{ave}$ = average of $D_{1,2,3,4,5}$

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# TYPE S PITOT INSPECTION DATA FORM

Date: 05-02-90
By: WQB

Specifications:
1.) Pitot tube assembly must be level.
2.) If pitot tube is damaged explain under comments section.
3.) z = A sin Y (<0.125) and w = A sin θ (<0.03125)
4.) a <10° and B <5°

| I.D. | $a_1$° | $a_2$° | $B_1$° | $B_2$° | Y° | θ° | A, in. | z, in. | w, in. | $P_a$, in. | $P_b$, in. | $D_t$, in. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36"- 1 | 0.5 | 2.5 | 1.0 | 3.0 | 2.5 | 1.0 | 0.730 | 0.032 | 0.01270 | 0.365 | 0.365 | 0.373 |
| 36"- 2 | 1.0 | 1.0 | 1.0 | 1.0 | 0.0 | 1.0 | 1.065 | 0.000 | 0.01860 | 0.532 | 0.533 | 0.380 |
| 40"- 1 | 2.5 | 1.0 | 2.5 | 1.0 | 0.0 | 1.0 | 1.112 | 0.000 | 0.01940 | 0.556 | 0.556 | 0.385 |
| 54"- 1 | 3.5 | 1.0 | 2.0 | 0.0 | 0.0 | 1.0 | 0.916 | 0.000 | 0.01600 | 0.458 | 0.458 | 0.385 |
| 66"- 1 | 0.0 | 0.0 | 0.5 | 0.0 | 1.0 | 1.0 | 1.071 | 0.019 | 0.01870 | 0.535 | 0.536 | 0.380 |
| 96"- 1 | 3.0 | 3.0 | 1.0 | 2.0 | 1.0 | 1.0 | 0.887 | 0.015 | 0.01548 | 0.443 | 0.444 | 0.378 |
| 3'- 1 | 0.0 | 0.0 | 0.0 | 0.5 | 1.0 | 1.0 | 1.057 | 0.018 | 0.01845 | 0.529 | 0.528 | 0.380 |
| 3'- 2 | 1.0 | 1.5 | 0.0 | 1.0 | 0.0 | 1.5 | 1.044 | 0.000 | 0.02733 | 0.522 | 0.522 | 0.377 |
| 3'- 3 | 0.5 | 0.5 | 1.0 | 0.5 | 0.5 | 1.0 | 1.044 | 0.009 | 0.01822 | 0.522 | 0.522 | 0.378 |
| 4'- 1 | 0.0 | 0.0 | 0.0 | 0.0 | 0.5 | 0.0 | 0.938 | 0.008 | 0.00000 | 0.469 | 0.469 | 0.378 |
| 4'- 2 | 0.0 | 0.0 | 1.5 | 0.0 | 0.0 | 1.0 | 0.908 | 0.000 | 0.01585 | 0.454 | 0.454 | 0.374 |
| 4'- 3 | 0.5 | 0.0 | 1.5 | 2.5 | 0.0 | 1.0 | 0.880 | 0.000 | 0.01536 | 0.440 | 0.440 | 0.376 |
| 4'- 4 | 1.0 | 2.0 | 1.0 | 3.0 | 0.0 | 1.5 | 0.838 | 0.000 | 0.02194 | 0.419 | 0.419 | 0.378 |
| 4'- 5 | 0.5 | 1.5 | 0.0 | 1.5 | 1.5 | 0.0 | 0.863 | 0.023 | 0.00000 | 0.432 | 0.431 | 0.373 |
| 4'- 6 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.959 | 0.000 | 0.00000 | 0.480 | 0.479 | 0.372 |
| 5'- 1 | 0.0 | 0.5 | 1.0 | 1.5 | 2.0 | 0.0 | 1.017 | 0.035 | 0.00000 | 0.508 | 0.509 | 0.376 |
| 5'- 2 | 0.0 | 0.0 | 0.5 | 1.0 | 1.0 | 1.0 | 1.058 | 0.018 | 0.01846 | 0.529 | 0.529 | 0.373 |
| 5'- 3 | 0.5 | 1.0 | 1.0 | 2.0 | 2.5 | 1.5 | 1.054 | 0.046 | 0.02759 | 0.527 | 0.527 | 0.375 |
| 5'- 4 | 0.5 | 0.0 | 0.5 | 1.0 | 1.5 | 1.0 | 1.052 | 0.027 | 0.01836 | 0.526 | 0.526 | 0.377 |
| 6'- 1 | 0.5 | 1.5 | 0.5 | 2.5 | 0.5 | 0.5 | 1.006 | 0.009 | 0.00878 | 0.503 | 0.503 | 0.376 |
| 6'- 2 | 0.0 | 0.5 | 0.0 | 0.5 | 2.0 | 0.0 | 1.008 | 0.035 | 0.00000 | 0.504 | 0.504 | 0.377 |
| 6'- 3 | 0.0 | 0.0 | 0.0 | 1.0 | 1.0 | 0.5 | 1.018 | 0.018 | 0.00888 | 0.509 | 0.509 | 0.376 |
| 6'- 4 | 1.0 | 0.0 | 0.5 | 0.0 | 1.5 | 1.5 | 1.008 | 0.026 | 0.02639 | 0.504 | 0.504 | 0.375 |
| 8'- 1 | 0.0 | 0.5 | 0.5 | 1.0 | 3.0 | 0.0 | 0.837 | 0.044 | 0.00000 | 0.419 | 0.418 | 0.376 |
| 8'- 2 | 1.0 | 0.0 | 1.0 | 4.0 | 2.0 | 0.0 | 0.908 | 0.032 | 0.00000 | 0.454 | 0.454 | 0.393 |
| 8'- 3 | 0.5 | 1.0 | 1.0 | 2.5 | 0.0 | 0.0 | 0.932 | 0.000 | 0.00000 | 0.466 | 0.466 | 0.375 |
| 8'- 4 | 1.0 | 2.5 | 0.0 | 3.0 | 0.0 | 1.0 | 1.015 | 0.000 | 0.01771 | 0.508 | 0.507 | 0.376 |
| 8'- 5 | 0.5 | 0.0 | 0.5 | 0.0 | 1.0 | 1.5 | 0.989 | 0.017 | 0.02589 | 0.494 | 0.495 | 0.376 |
| 8'- 6 | 0.5 | 2.0 | 0.5 | 2.0 | 1.0 | 0.0 | 0.917 | 0.016 | 0.00000 | 0.458 | 0.459 | 0.383 |
| 8'9" | 1.0 | 2.0 | 1.5 | 1.5 | 1.0 | 2.0 | 0.895 | 0.016 | 0.03124 | 0.447 | 0.448 | 0.380 |
| 9'7"-1 | 0.5 | 1.0 | 0.5 | 0.5 | 0.5 | 1.0 | 0.914 | 0.008 | 0.01595 | 0.457 | 0.457 | 0.378 |
| 9'7"-2 | 0.5 | 0.0 | 2.0 | 3.0 | 1.0 | 1.0 | 0.983 | 0.017 | 0.01716 | 0.492 | 0.491 | 0.378 |
| 12'6" | 1.5 | 1.5 | 2.5 | 2.5 | 0.0 | 0.5 | 0.809 | 0.000 | 0.00705 | 0.405 | 0.404 | 0.377 |

Comments: Only minor filing and cleaning required.

Pitot tubes requiring furthering calibration: None.

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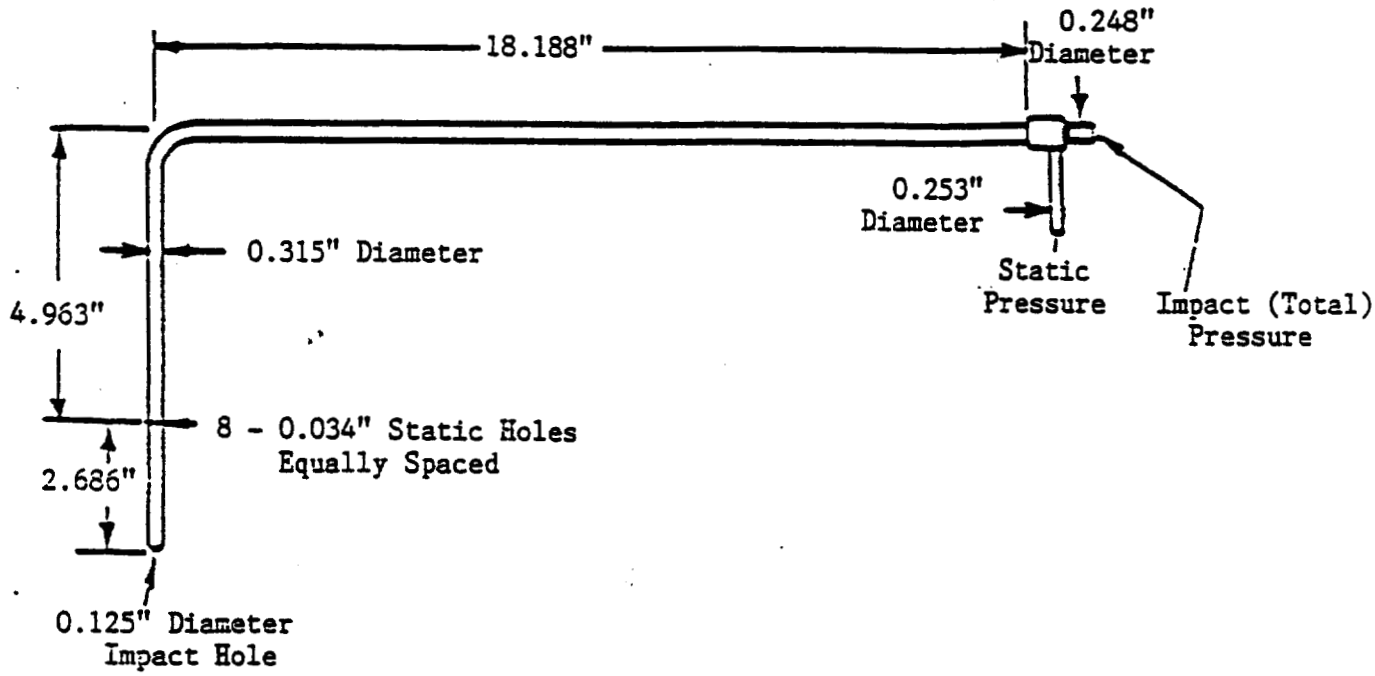
Standard Pitot Tube Calibration

Serial # 160 - 18 - 1




| | |
|---|---|
| 2.7.1 | Hemispherical Tip |
| 2.7.2 | 8.53 Diameters |
| 2.7.3 | 15.76 Diameters |
| 2.7.4 | 0.034" |
| 2.7.5 | 90° curved bend |

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PROBE THERMOCOUPLE
TEMPERATURE SENSOR CALIBRATION DATA FORM
TOLERANCE: +/- 5.4 F

DATE: 06/05/90
AMBIENT TEMPERATURE, F : 74
CALIBRATOR: WQB

BAROMETRIC PRESSURE: 29.18
REFERENCE THERMOMETER # 5

| REFERENCE POINT # | | SOURCE | REFERENCE THERMOMETER TEMPERATURE,F | THERMOCOUPLE POTENTIOMETER TEMPERATURE,F | TEMPERATURE DIFFERENCE, % |
|---|---|---|---|---|---|
| Probe - # | | | | | |
| 4'-1 | A. | oil bath | 110 | 110 | 0.00 |
| | B. | oil bath | 204 | 205 | -.15 |
| | C. | oil bath | 350 | 351 | -.12 |
| 4'-2 | A. | oil bath | 110 | 110 | 0.00 |
| | B. | oil bath | 204 | 204 | 0.00 |
| | C. | oil bath | 350 | 351 | -.12 |
| 5'-1 | A. | oil bath | 115 | 110 | 0.87 |
| | B. | oil bath | 208 | 202 | 0.90 |
| | C. | oil bath | 350 | 353 | -.37 |
| 5'-2 | A. | oil bath | 116 | 113 | 0.52 |
| | B. | oil bath | 209 | 208 | 0.15 |
| | C. | oil bath | 351 | 352 | -.12 |
| 6'-1 | A. | oil bath | 118 | 115 | 0.52 |
| | B. | oil bath | 210 | 211 | -.15 |
| | C. | oil bath | 351 | 353 | -.25 |
| 6'-2 | A. | oil bath | 118 | 115 | 0.52 |
| | B. | oil bath | 210 | 211 | -.15 |
| | C. | oil bath | 352 | 353 | -.12 |
| 8'-1 | A. | oil bath | 119 | 114 | 0.86 |
| | B. | oil bath | 214 | 210 | 0.59 |
| | C. | oil bath | 352 | 351 | 0.12 |
| 8'-2 | A. | oil bath | 119 | 118 | 0.17 |
| | B. | oil bath | 215 | 215 | 0.00 |
| | C. | oil bath | 352 | 352 | 0.00 |
| 8'-3 | A. | oil bath | 119 | 116 | 0.52 |
| | B. | oil bath | 216 | 216 | 0.00 |
| | C. | oil bath | 352 | 353 | -.12 |
| 8'-9" | A. | oil bath | 124 | 121 | 0.51 |
| | B. | oil bath | 217 | 216 | 0.15 |
| | C. | oil bath | 352 | 354 | -.25 |
| 9'-7" | A. | oil bath | 124 | 120 | 0.68 |
| | B. | oil bath | 229 | 231 | -.29 |
| | C. | oil bath | 352 | 355 | -.37 |
| 12'-6" | A. | oil bath | 124 | 123 | 0.17 |
| | B. | oil bath | 249 | 249 | 0.00 |
| | C. | oil bath | 352 | 353 | -.12 |

$$\text{TEMPERATURE DIFFERENCE} = \frac{(\text{REF TEMP, F} + 460) - (\text{TEST TEMP, F} + 460)}{\text{REF TEMP, F} + 460} \times 100 <= 1.5\%$$

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IMPINGER
TEMPERATURE SENSOR CALIBRATION DATA FORM
TOLERANCE: +/- 5.4 F

DATE: 06/05/90
AMBIENT TEMPERATURE, F : 74
CALIBRATOR: WQB/TEW

BAROMETRIC PRESSURE: 29.18
REFERENCE THERMOMETER # 5

| REFERENCE POINT # | | SOURCE | REFERENCE THERMOMETER TEMPERATURE, F | THERMOCOUPLE POTENTIOMETER TEMPERATURE, F | TEMPERATURE DIFFERENCE, % |
|---|---|---|---|---|---|
| Impinger | | | | | |
| #1 | A. | ice bath | 36 | 36 | 0.00 |
| | B. | water bath | 78 | 76 | 0.37 |
| | C. | water bath | 116 | 115 | 0.17 |
| | D. | water bath | 107 | 106 | 0.18 |
| #2 | A. | ice bath | 36 | 37 | -.20 |
| | B. | water bath | 78 | 76 | 0.37 |
| | C. | water bath | 116 | 115 | 0.17 |
| | D. | water bath | 107 | 106 | 0.18 |
| #3 | A. | ice bath | 36 | 38 | -.40 |
| | B. | water bath | 78 | 78 | 0.00 |
| | C. | water bath | 116 | 115 | 0.17 |
| | D. | water bath | 107 | 108 | -.18 |
| #4 | A. | ice bath | 36 | 35 | 0.20 |
| | B. | water bath | 78 | 76 | 0.37 |
| | C. | water bath | 116 | 114 | 0.35 |
| | D. | water bath | 107 | 105 | 0.35 |
| #5 | A. | ice bath | 36 | 36 | 0.00 |
| | B. | water bath | 78 | 77 | 0.19 |
| | C. | water bath | 116 | 115 | 0.17 |
| | D. | water bath | 107 | 106 | 0.18 |
| #6 | A. | ice bath | 36 | 36 | 0.00 |
| | B. | water bath | 78 | 77 | 0.19 |
| | C. | water bath | 116 | 115 | 0.17 |
| | D. | water bath | 107 | 106 | 0.18 |

$$\text{TEMPERATURE DIFFERENCE} = \frac{(\text{REF TEMP, F} + 460) - (\text{TEST TEMP, F} + 460)}{\text{REF TEMP, F} + 460} \times 100 \leq 1.5\%$$

pace. laboratories, inc.

METER BOX
TEMPERATURE SENSOR CALIBRATION DATA FORM
TOLERANCE: +/- 5.4 F

DATE: 06/05/90
AMBIENT TEMPERATURE, F : 74
CALIBRATOR: WQB/TEW

BAROMETRIC PRESSURE: 29.18
REFERENCE THERMOMETER # 5

| REFERENCE POINT # | | SOURCE | REFERENCE THERMOMETER TEMPERATURE,F | THERMOCOUPLE POTENTIOMETER TEMPERATURE,F | TEMPERATURE DIFFERENCE, % |
|---|---|---|---|---|---|
| Meter Box | | | | | |
| 1264A | A. | ice bath | 35 | 36 | -.20 |
| | B. | water bath | 70 | 69 | 0.19 |
| | C. | oil bath | 122 | 120 | 0.34 |
| | D. | oil bath | 170 | 169 | 0.16 |
| 1264B | A. | ice bath | 35 | 36 | -.20 |
| | B. | water bath | 70 | 70 | 0.00 |
| | C. | oil bath | 123 | 124 | -.17 |
| | D. | oil bath | 171 | 172 | -.16 |
| 1348A | A. | ice bath | 35 | 34 | 0.20 |
| | B. | water bath | 70 | 70 | 0.00 |
| | C. | oil bath125 | 125 | 127 | -.34 |
| | D. | oil bath | 171 | 171 | 0.00 |
| 1348B | A. | ice bath | 35 | 36 | -.20 |
| | B. | water bath | 70 | 70 | 0.00 |
| | C. | oil bath | 126 | 128 | -.34 |
| | D. | oil bath | 171 | 170 | 0.16 |
| 1401A | A. | ice bath | 35 | 36 | -.20 |
| | B. | water bath | 70 | 70 | 0.00 |
| | C. | oil bath | 128 | 128 | 0.00 |
| | D. | oil bath | 172 | 173 | -.16 |
| 1401B | A. | ice bath | 35 | 34 | 0.20 |
| | B. | water bath | 70 | 71 | -.19 |
| | C. | oil bath | 129 | 131 | -.34 |
| | D. | oil bath | 172 | 172 | 0.00 |
| 1965A | A. | ice bath | 35 | 34 | 0.20 |
| | B. | water bath | 70 | 69 | 0.19 |
| | C. | oil bath | 130 | 130 | 0.00 |
| | D. | oil bath | 172 | 174 | -.32 |
| 1965B | A. | ice bath | 35 | 35 | 0.00 |
| | B. | water bath | 70 | 70 | 0.00 |
| | C. | oil bath | 134 | 136 | -.34 |
| | D. | oil bath | 172 | 173 | -.16 |

$$\text{TEMPERATURE DIFFERENCE} = \frac{(\text{REF TEMP, F} + 460) - (\text{TEST TEMP, F} + 460)}{\text{REF TEMP, F} + 460} \times 100 <= 1.5\%$$

pace. laboratories, inc.

SAMPLE BOX
TEMPERATURE SENSOR CALIBRATION DATA FORM
TOLERANCE: +/- 5.4 F

DATE: 06/08/90
AMBIENT TEMPERATURE, F : 72
CALIBRATOR: TEW

BAROMETRIC PRESSURE: 29.18
REFERENCE THERMOMETER # 5

| REFERENCE POINT # | | SOURCE | REFERENCE THERMOMETER TEMPERATURE,F | THERMOCOUPLE POTENTIOMETER TEMPERATURE,F | TEMPERATURE DIFFERENCE, % |
|---|---|---|---|---|---|
| SAMPLE BOX | | | | | |
| #1 | A. | oil bath | 152 | 152 | 0.00 |
| | B. | oil bath | 200 | 195 | 0.76 |
| | C. | oil bath | 220 | 220 | 0.00 |
| | D. | oil bath | 260 | 255 | 0.69 |
| | E. | oil bath | 280 | 276 | 0.54 |
| #2 | A. | oil bath | 152 | 152 | 0.00 |
| | B. | oil bath | 200 | 195 | 0.76 |
| | C. | oil bath | 220 | 220 | 0.00 |
| | D. | oil bath | 260 | 255 | 0.69 |
| | E. | oil bath | 280 | 276 | 0.54 |
| #3 | A. | oil bath | 152 | 152 | 0.00 |
| | B. | oil bath | 200 | 200 | 0.00 |
| | C. | oil bath | 220 | 225 | -.74 |
| | D. | oil bath | 262 | 260 | 0.28 |
| | E. | oil bath | 280 | 280 | 0.00 |
| #4 | A. | oil bath | 152 | 152 | 0.00 |
| | B. | oil bath | 200 | 200 | 0.00 |
| | C. | oil bath | 222 | 225 | -.44 |
| | D. | oil bath | 262 | 260 | 0.28 |
| | E. | oil bath | 280 | 280 | 0.00 |
| #5 | A. | oil bath | 152 | 152 | 0.00 |
| | B. | oil bath | 200 | 200 | 0.00 |
| | C. | oil bath | 222 | 225 | -.44 |
| | D. | oil bath | 264 | 265 | -.14 |
| | E. | oil bath | 282 | 280 | 0.27 |
| #6 | A. | oil bath | 152 | 152 | 0.00 |
| | B. | oil bath | 200 | 195 | 0.76 |
| | C. | oil bath | 222 | 220 | 0.29 |
| | D. | oil bath | 264 | 260 | 0.55 |
| | E. | oil bath | 282 | 277 | 0.67 |

$$\text{TEMPERATURE DIFFERENCE} = \frac{(\text{REF TEMP, F} + 460) - (\text{TEST TEMP, F} + 460)}{\text{REF TEMP, F} + 460} \times 100 <= 1.5\%$$

pace. laboratories, inc.

WET-BULB & DRY-BULB: OMEGA TEMP
TEMPERATURE SENSOR CALIBRATION DATA FORM
TOLERANCE: +/- 5.4 F

DATE: 06/08/90
AMBIENT TEMPERATURE, F : 72
CALIBRATOR: TEW

BAROMETRIC PRESSURE: 29.18
REFERENCE THERMOMETER # 5

| REFERENCE POINT # | | SOURCE | REFERENCE THERMOMETER TEMPERATURE, F | THERMOCOUPLE POTENTIOMETER TEMPERATURE, F | TEMPERATURE DIFFERENCE, % |
|---|---|---|---|---|---|
| Omega Temp HH-2 #1 | | | | | |
| Db1 | A. | water bath | 75 | 76 | -.19 |
| | B. | oil bath | 150 | 151 | -.16 |
| | C. | oil bath | 228 | 231 | -.44 |
| | D. | oil bath | 286 | 286 | 0.00 |
| Wb1 | A. | water bath | 75 | 75 | 0.00 |
| | B. | oil bath | 150 | 151 | -.16 |
| | C. | oil bath | 228 | 229 | -.15 |
| | D. | oil bath | 286 | 285 | 0.13 |
| Omega Temp HH-2 #2 | | | | | |
| Db2 | A. | water bath | 78 | 78 | 0.00 |
| | B. | oil bath | 150 | 151 | -.16 |
| | C. | oil bath | 218 | 220 | -.29 |
| | D. | oil bath | 284 | 284 | 0.00 |
| Wb2 | A. | water bath | 78 | 77 | 0.19 |
| | B. | oil bath | 150 | 151 | -.16 |
| | C. | oil bath | 218 | 217 | 0.15 |
| | D. | oil bath | 284 | 284 | 0.00 |
| Omega Temp 873-F #1 | | | | | |
| Db1 | A. | water bath | 76 | 76 | 0.00 |
| | B. | oil bath | 150 | 149 | 0.16 |
| | C. | oil bath | 226 | 226 | 0.00 |
| | D. | oil bath | 286 | 287 | -.13 |
| Wb1 | A. | water bath | 76 | 76 | 0.00 |
| | B. | oil bath | 150 | 149 | 0.16 |
| | C. | oil bath | 226 | 227 | -.15 |
| | D. | oil bath | 286 | 286 | 0.00 |
| Omega Temp 873-F #2 | | | | | |
| Db2 | A. | water bath | 76 | 76 | 0.00 |
| | B. | oil bath | 150 | 152 | -.33 |
| | C. | oil bath | 222 | 221 | 0.15 |
| | D. | oil bath | 286 | 288 | -.27 |
| Wb2 | A. | water bath | 76 | 76 | 0.00 |
| | B. | oil bath | 150 | 152 | -.33 |
| | C. | oil bath | 222 | 221 | 0.15 |
| | D. | oil bath | 286 | 288 | -.27 |

$$\text{TEMPERATURE DIFFERENCE} = \frac{(\text{REF TEMP, F} + 460) - (\text{TEST TEMP, F} + 460)}{\text{REF TEMP, F} + 460} \times 100 \leq 1.5\%$$

WET BULB-DRY BULB-NOx & HOT BOX: BIMETALLIC
TEMPERATURE SENSOR CALIBRATION DATA FORM
TOLERANCE: +/- 5.4 F

DATE: 06/25/90
AMBIENT TEMPERATURE, F : 72
CALIBRATOR: TEW

BAROMETRIC PRESSURE: 29.18
REFERENCE THERMOMETER # 5

| REFERENCE POINT # | | SOURCE | REFERENCE THERMOMETER TEMPERATURE,F | THERMOCOUPLE POTENTIOMETER TEMPERATURE,F | TEMPERATURE DIFFERENCE, % |
|---|---|---|---|---|---|
| Bimetallic | | | | | |
| Wb1 | A. | water bath | 72 | 72 | 0.00 |
| | B. | oil bath | 185 | 184 | 0.16 |
| | C. | oil bath | 225 | 225 | 0.00 |
| | D. | oil bath | 264 | 264 | 0.00 |
| | E. | oil bath | 282 | 281 | 0.13 |
| Db1 | A. | water bath | 72 | 71 | 0.19 |
| | B. | oil bath | 185 | 185 | 0.00 |
| | C. | oil bath | 225 | 224 | 0.15 |
| | D. | oil bath | 264 | 263 | 0.14 |
| | E. | oil bath | 282 | 285 | -.40 |
| Wb2 | A. | water bath | 72 | 72 | 0.00 |
| | B. | oil bath | 185 | 184 | 0.16 |
| | C. | oil bath | 226 | 228 | -.29 |
| | D. | oil bath | 266 | 265 | 0.14 |
| | E. | oil bath | 284 | 282 | 0.27 |
| Db2 | A. | water bath | 72 | 70 | 0.38 |
| | B. | oil bath | 185 | 186 | -.16 |
| | C. | oil bath | 226 | 230 | -.58 |
| | D. | oil bath | 266 | 268 | -.28 |
| | E. | oil bath | 284 | 285 | -.13 |
| NOx | A. | water bath | 72 | 72 | 0.00 |
| | B. | oil bath | 90 | 91 | -.18 |
| | C. | oil bath | 105 | 105 | 0.00 |
| | D. | oil bath | 115 | 116 | -.17 |
| | E. | oil bath | 125 | 125 | 0.00 |
| Hot Box | A. | water bath | 72 | 70 | 0.38 |
| | B. | oil bath | 185 | 184 | 0.16 |
| | C. | oil bath | 225 | 225 | 0.00 |
| | D. | oil bath | 264 | 265 | -.14 |
| | E. | oil bath | 281 | 281 | 0.00 |

$$\text{TEMPERATURE DIFFERENCE} = \frac{(\text{REF TEMP, F} + 460) - (\text{TEST TEMP, F} + 460)}{\text{REF TEMP, F} + 460} \times 100 <= 1.5\%$$

**KIMBLE**
Division of
Owens-Illinois

December 11, 1986

Mr. Paul R. Jenkins
Environmental Testing, Inc.
1700 University Commercial Place
Charlotte, North Carolina 28213

REF: Calibration of volumetric glassware
Mr. P. Jenkins letter 12-5-86

Dear Mr. Jenkins,

Volumetric standards, utilized by Kimble for calibration of class A and B laboratory glassware, are designed to meet applicable calibration requirements of ASTM Standard E 542.

Accuracy of balances, weights and thermometers employed for calibration of volumetric standards is traceable to National Bureau of Standards.

Sincerely,

Lew Horan
Standards Dept.

Mike Mollick
Quality Control

cc: Mr. N. DeBello - M.O.
Mr. E. Trasoras - Q.A.

Crystal Avenue Vineland, New Jersey 08360-0230 (609) 692-3600

CORNING

Science Products
Corning Glass Works
Corning, New York 14831 USA
Tel: 607-974-9000

a CORNING Laboratory Sciences Company

November 18, 1986

Mr. Paul Jenkins
Environmental Testing Inc.
1700 University Commercial Place
Charlotte, NC 28213

Dear Mr. Jenkins:

Confirming our telephone conversation, our volumetric apparatus is calibrated in conformance with ASTM Standard E 542.

Very truly yours,

Allen R. Fuller
Product Engineering Supervisor

b10012

Whatman Inc.

Whatman Inc. • 9 Bridewell Place, Clifton, New Jersey 07014 • Telephone: (201) 777-4825
Telex: 133426 • Cable: REEVEPAP

February 1, 1979

Mr. Paul R. Jenkins, Jr.
Vice-President
Environmental Testing Inc.
1700 University Commercial Place
Charlotte, North Carolina 28213

Dear Mr. Jenkins:

Further to our telephone conversation on January 15, 1979 Reeve Angel Grade 900AF is tested with a Q128 DOP Penetrometer manufactured by the Air Technology Association to measure DOP. This is a more sophisticated unit than that listed in the Federal Register, Part II, Thursday, August 18, 1977, Environmental Protection Agency, Standards of Performance for New Stationary Sources.

Grade 900AF will meet the EPA DOP requirements of 0.05 ≤ percent penetration on a 0.3 micron dioctyl phthalate smoke particles as listed on page 41778 of the Federal Register, Vol. 42, No. 160, Thursday, August 18, 1977 under 3. Reagent, 3.1.1 Filters.

I hope this will satisfy your inquiry. If we can be of any further service, please contact us at your convenience.

Very truly yours,

John Zacharias
Vice President
Business Manager, Paper Division, N. A.

JZ/mpm

Whatman
AIR POLLUTION FILTERS

TECHNICAL DATA ON

# EPM 2000 AIR SAMPLING FILTERS

## SELECTED AS THE EPA STANDARD

EPM 2000 is the new Whatman filter which has been specifically developed for use in high volume air samplers, and has been chosen by the EPA for its technical excellence and overall suitability for use in the nationwide network of Hi-Vol air samplers. The high air flow rate and excellent particle retention characteristics make EPM 2000 the filter of choice for high volume sampling.

- Specifically developed for use with high volume air samplers.
- Chosen by the EPA for their National Air Surveillence Network (Contract No. 68-02-3709).
- Manufactured from 100% borosilicate glass microfibres under strictly controlled conditions.
- Retention efficiency 99.999% for NaCl particles, mass median 0.6 microns.
- Heat-treated after manufacture to remove organic traces.
- No binder used in manufacture for maximum purity.
- Each sheet individually numbered for rapid identification and recording.

## EPM 2000 – THE STATE OF THE ART FILTER MEDIUM FOR HI-VOL AIR SAMPLING

Today, more than ever before, concern over the potential effects on human life of toxic particulates in the air, is running high. The sampling and analytical methods employed in the monitoring of air quality are becoming ever more sophisticated.

EPM 2000, as successor to the popular EPM 1000, has been developed to complement these methods as a technically advanced air filtration medium, suitable for both quantitative and qualitative measurements.

## HIGH PURITY – HIGH PERFORMANCE

The EPA place specific requirements on the purity and performance of the glass microfibre filters which are used throughout their National Air Surveillence Network of pollution monitoring stations.

EPM 2000 is manufactured from 100% pure borosilicate glass microfibres, with no added binder, under strictly controlled conditions. Maximum purity is ensured by the use of heat treatment after manufacture to remove any traces of organic material which may interfere with subsequent analyses, and closely monitored quality assurance methods are employed. Detailed chemical analyses of trace pollutants can thus be carried out with utmost accuracy and minimum background interference.

EPM 2000 offers high flow rates while simultaneously providing exceptionally high particle retention efficiencies. Complete reliance can be placed on EPM 2000 to provide optimum results in airborne particulate collection.

Each 8" × 10" sheet of EPM 2000 is individually numbered for rapid identification and recording.

## AVAILABILITY

Two sizes are available as standard

| | |
|---|---|
| 8" x 10" sheets (packs of 100) | Cat. No. 1882 866 |
| 4.7 cm circles (packs of 100) | Cat. No. 1882 047 |

PUBLICATION NO 888 EPM A

## PROCEDURES

Air pollution monitoring is normally carried out by measurement at two stages to determine the general level of airborne pollution, and then to analyse the specific types and amounts of pollutants. The internationally standardized technique is to pass a high volume (approx 2000 $m^3$) of air through a filter for up to 24 hours. The filter is weighed before and after exposure to give the mass of particulate for a known volume of air and a calculated value for air pollution levels in $\mu g/m^3$ of air.

## CONTROL TECHNIQUES

Before weighing each filter should be conditioned for 24 hours in a specific environment between 15°C and 35°C (± 1°C) and of relative humidity below 50%.

EPM 2000 is suited to all commercial high volume sampling apparatus and the usual sample of 2200 $m^3$ over 24 hours at an average flow rate of 1.7 $m^3$/min (60 $ft^3$/min) through the approximate 400 $cm^2$ area of filter exposed is well within the capability of the filter. It is recommended that the 8" × 10" filter should be installed rough side uppermost in the holder and handled carefully by the edges only. After sampling under carefully monitored air flow and time, the filter should be removed with care to prevent loss of particulate. It is usual to fold it in half lengthwise, the exposed sides together, for transport. The filter should be conditioned again for 24 hours before reweighing to determine the total weight of captured particulate.

Analyses most frequently carried out on the collected particulate are for metals (especially heavy and toxic elements), ammonium ions, fluoride ions, nitrate and sulfate, organic materials including hydrocarbons, and Beta activity.

## TECHNICAL CHARACTERISTICS

(Typical values – subject to normal manufacturing tolerances)

Thickness (mean value in microns) .....430

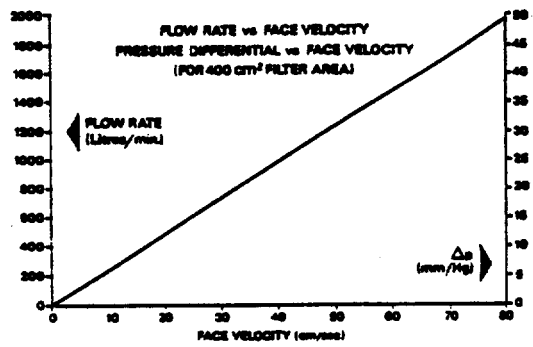
Retention efficiency (Sodium flame penetrometer at 5cm/sec fce velocity)..99.999%

Approx. equivalent DOP retention efficiency .....99.99%

Tensile strength (1.5 cm strip – gms.) .....700

Weight loss on ignition.....0.2%

## EPM 2000 FILTER FLOW RATE




## CHEMICAL CHARACTERISTICS

| Trace Element | Typical level* (micrograms per sheet) | Trace Element | Typical level* (micrograms per sheet) |
|---|---|---|---|
| Arsenic | 5 | Manganese | 2 |
| Beryllium | 0.5 | Molybdenum | 2 |
| Bismuth | 20 | Nickel | 5 |
| Cadmium | 2 | Lead | 10 |
| Cobalt | 5 | Antimony | 2 |
| Chromium | 5 | Tin | 5 |
| Copper | 10 | Titanium | 2 |
| Iron | 50 | Vanadium | 2 |
| | | Zinc | 100 |

*Typical values subject to manufacturing tolerances

Whatman PAPER DIVISION

Whatman Laboratory Products Inc 9 Bridewell Place, Clifton, New Jersey 07014 USA Tel: (201) 773-5800 Telex: 133426

METTLER

# Weight Traceability Certificate

To: Pace Laboratory Inc
1700 Univ Commercial
Charlotte N.C. 28213

The balances listed below have been serviced by our representative on
Jan 24th 1990

This is to certify that the test weights used are traceable to the National Bureau of Standards.

| | Analytical | Precision |
|---|---|---|
| METTLER identification number of test weights used: | 348 | |
| METTLER calibration date of test weights used: | 04/01/89 | |
| National Bureau of Standards test number: | 737/0670-Met49 | |

Model and serial number of balances serviced:

| | |
|---|---|
| AE163 | C57742 |
| H54 | 677277 |
| AK160 | A44922 |

Michael D Rod
METTLER Service Representative

Jan 24th 1990
Date of issue

GCA

GCA CORPORATION
**Precision Scientific Group**

3737 West Cortland Street
Chicago, Illinois 60647
Telephone: 312-227-2660
Telex: 254028

February 2, 1984

Environmental Testing
1700 University Commercial Place
Charlotte, N.C. 28213

Attn: Mr. Paul Jenkins

Subj: Certification Wet Test Meter

Dear Mr. Jenskins:

In lieu of any printed certification from our company, we offer as follows our statement on the referenced subject.

> "The Wet Test Meter catalog number 63123, has been tested at our plant facilities using a Meter Prover Bottle NBS registration No. 4897. The Meter was found to perform to our advertised specifications of plus or minus 1/2% error in flow rate and conforms to specifications of ASTM D-1071."

Respectfully,

Bob Husberg

Bob Husberg
Supervisor, Customer Service

BH/mg

WALTER H. KESSLER COMPANY, INC.

THERMOMETERS KESSLER HYDROMETERS

ONE-SIXTY HICKS STREET • WESTBURY, LONG ISLAND, NEW YORK • 516 EDGEWOOD 4-4064

# MANUFACTURERS CERTIFICATE OF CALIBRATION

This is to certify that the instrument listed below has been tested in our temperature calibration laboratory in accordance with the latest procedures in the finest constant temperature equipment available, against National Bureau of Standards certified master standards.

Certified for: Fisher Scientific Company

Description: Thermometer #15-041D -1/201°C in 0.2° Div Total Immersion

Instrument Serial No. 811 007 Date Certified: January 30, 1981

| Reading of This Instrument | Reading of N.B.S. Standard (True Temperature) |
|---|---|
| +0.02C | 0.00C |
| 20.00C | 20.00C |
| 40.00C | 40.00C |
| 59.96C | 60.00C |
| 79.98C | 80.00C |
| 100.02C | 100.00C |
| 119.92C | 120.00C |
| 139.98C | 140.00C |
| 160.00C | 160.00C |
| 180.00C | 180.00C |
| 199.86C | 200.00C |

The tabulated readings apply provided the ice-point reading taken after exposure for not less than 3 days to a temperature of about 25° C (77° F) is +0.02C . If the ice-point reading is found to be higher (or lower) than stated, all other readings will be higher (or lower) by the same amount.

Serial & Test numbers of National Bureau of Standards certified instruments referenced in certification of the thermometer listed above:

NBS Standard M44165,78A-227,M44451,78A-220,78A-601/602

NBS Test No 176240,219883,176240,219883,219606

WALTER H. KESSLER COMPANY, INC.

Irene Ciulla

the OMEGA Group

DATE: 12-10-85

CERTIFICATE OF CALIBRATION

CUSTOMER: ENVIRONMENTAL TESTING INC
1700 UNIV COMMERICAL PL
CHARLOTTE NC 28213

Customer Purchase Order: 2861RO
OMEGA Work Order No: SO 511268760
MODEL: HH-2
SERIAL NO: 14403

OMEGA ENGINEERING certifies that the above instrumentation has been calibrated and tested to meet or exceed the published specifications. This calibration and testing was performed using instrumentation and standards that are traceable to the U.S. National Bureau of Standards.

Reference: NATIONAL BUREAU OF STANDARDS TEST NO(s): 36320

Tony D'Inverno
Supervisor, Instrumentation

CAL-3

OMEGA ENGINEERING, INC.
OMEGA PRESS
OMEGA INTERNATIONAL CORP.
BIOMEGA
One Omega Drive, Box 4047, Stamford, CT 06907-0047 (203) 359-1660 Telex 996404 Cable OMEGA FAX (203) 359-7700