Commonwealth of Pennsylvania
Environmental Resources
January 8, 1987

Subject: Source Test Review

To: Data File
Highway Materials, Inc.
Whitemarsh Township, Montgomery County

From: John N. Mitchell
Air Pollution Control Engineer
Division of Technical Services and Monitoring
Bureau of Air Quality Control

Through: Chief, Source Testing and Monitoring Section

Particulate and visible emission tests were conducted by Gilbert/Commonwealth Inc. on October 22-23, 1986 for the asphalt batch plant located at the Plymouth Meeting facility. The plant is a McCarter Corporation Model M-300-18 batch asphalt plant and is fired by natural gas. The particulate air contaminant emissions from the plant are controlled by a McCarter Corporation Model McC 10x10 KOB setting chamber pre-cleaner, followed by a McCarter Corporation Model McC-756-S post jet cleaning type fabric collector.

The batch asphalt plant is rated a capacity of 300 tons per hour. During the testing the plant was operated at a rate of about 10% higher than the rated capacity.

The particulate test and opacity test observations were conducted in accordance with the preapproved test protocol and are acceptable to the Department.

The following is a summary of the test results:

RUN NO.	1	2	3
Material Processed, Tons/hr.	348	336	330
Particulate Concentration, Grains/DSCF	0.0045	0.0156	0.0276
Allowable Concentration, Grains/DSCF	0.04	0.04	0.04
Particulate Emission Rate, lbs./hr.	1.31	4.12	7.28

cc: Jim Donnelly, Norristown Regional Office
File 46-30-019
Reading File
RSL/EPA

JNM:fsa

SOURCE SAMPLING REPORT FOR MEASUREMENT OF PARTICULATE AND VISIBLE EMISSIONS

HIGHWAY MATERIALS, INC.
PLYMOUTH MEETING FACILITY
ASPHALT BATCH PLANT

PLYMOUTH MEETING
G/C, INC. REPORT R-10-0500-000-1
OCTOBER, 1986

Application No. 46-305-019

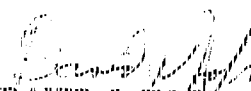
SOURCE SAMPLING REPORT FOR MEASUREMENT OF PARTICULATE AND VISIBLE EMISSIONS

HIGHWAY MATERIALS, INC.
PLYMOUTH MEETING FACILITY
ASPHALT BATCH FACILITY

PLYMOUTH MEETING
G/C, INC. REPORT R-10-0500-000-1
OCTOBER, 1986

PREPARED BY

GILBERT/COMMONWEALTH, INC.
QUALITY ASSURANCE DIVISION
P.O. BOX 1498
READING, PENNSYLVANIA 19603



DAVID J. HOFMANN
PROJECT COORDINATOR
TESTING SERVICES GROUP

Gilbert/Commonwealth engineers and consultants

GILBERT/COMMONWEALTH, INC., P.O. Box 1498, Reading, PA 19603/Tel. 215 775-2600/Cable Gilasoc/Telex 836-431

December 8, 1986

Highway Materials, Inc
Plymouth Meeting, Pennsylvania

Attention: Mr. Vincent Angelo

RE: Submittal of Source Sampling Report
for Measurement of Particulate Emissions
Asphalt Batch Plant
Highway Materials, Inc.
Plymouth Meeting Facility
G/C, Inc. Report R-10-0500-000-1

Gentlemen:

We are pleased to submit four copies of our Report R-10-0500-000-1 dated December 8, 1986. This report contains results of source sampling for particulate emissions and determination of flue gas characteristics for the asphalt batch plant scrubber located at you Plymouth Meeting facility, as conducted on October 22-23, 1986.

The source sampling program defined by this report incorporates standard sampling procedures. The results of the sampling program are representative of flue gas emissions at the stack outlet of the scrubber under referenced normal operating conditions.

Information contained in this report and the accompanying Apppendices includes field data, laboratory analyses, and a computer printout of all results developed by the testing program. We have attempted to present this information in a form that is readily discernible and suitable for your continued use.

Gilbert/Commonwealth, Inc., is pleased to have been of service to Highway Materials, Inc., and trusts that this report will meet your complete acceptance.

Very truly yours,

David Hoffmann
Project Coordinator
Testing Services

DH:dh

FOREWORD

The source sampling program as defined by this report was confined to measurement of particulate emissions and pertinent flue gas characteristics at the stack test location of the asphalt batch plant scrubber during referenced operating conditions.

TABLE OF CONTENTS

TABLES AND FIGURES

Tables

Figures

SECTION I - SUMMARY OF TEST RESULTS

A summary of test results from the source sampling program is presented in Table 1. As such, the results are considered representative of emission characteristics from the asphalt batch plant baghouse during referenced operating conditions. The results show the particulate emissions are well below the limit of 0.04 gr/SCF.

TABLE 1

SUMMARY OF TEST RESULTS
HIGHWAY MATERIALS, INC.
ASPHALT BATCH PLANT

G/C, INC. REPORT R-10-0500-000-1

LOCATION	EXHAUST STACK		
DATE	10/22/86	10/23/86	10/23/86
RUN NO.	HM-1	HM-2	HM-3
OPERATING DATA			
Material Processed, Tons/Min.	5.8	5.6	5.5
FLUE GAS CHARACTERISTICS			
DSCFM	33,928	31,146	31,154
ACFM	52,355	53,533	51,918
Temperature, °F	261	271	242
Moisture Content, %	11.7	19.4	20.1
PARTICULATE EMISSIONS			
gr/dscf	0.0045	0.0156	0.0276
Allowable, gr/dscf	0.04	0.04	0.04
lbs/hr.	1.31	4.12	7.28
VISIBLE EMISSIONS			
Opacity, %	0.6	1.2	0.1

SECTION II - ANALYSIS

1. Introduction

The data presented in this report represents the results of source sampling exhaust emissions at the stack outlet location of the asphalt batch plant during referenced operating conditions.

Specific requirements of this source sampling program include the following:

a. Identification of final particulate and visible emissions from the asphalt batch plant baghouse control system.

b. Average flue gas temperature, moisture, and volume of flow at the sampling location.

c. Orsat analysis of flue gas conditions at the point of sampling.

d. Record of pertinent operating conditions during period of the test run.

The sampling program was completed on October 22-23 1986 by the Gilbert field test crew, with the assistance of personnel assigned by Highway Materials and witnessed by the PADER.

2. Description of Asphalt Batch Plant Exhaust System

The facility uses a McCarter Model M-300-18 asphalt plant rated at 300 tons per hour. The system uses a knock-out box followed downstream by baghouse to control emissions.

3. Sampling Program Procedures

To satisfy the objectives established for this project, the sampling program was set-up on the basis of using an individual test train positioned at the stack and completing three separate test runs. All procedures for the determination of velocity, molecular weight, moisture content, particulate loading, and visible emissions of the exhaust flue gases were made according to standard test methods as referenced in Appendix 2.

The location and number of sampling ports and traverse points are detailed in Figure 1.

4. Operating Conditions

In the execution of this sampling program, an attempt was made to achieve near normal load for the asphalt batch plant. The amount of asphalt generated was recorded by the operator. This record is included in the summary table (see Table 1).

5. Results

Test data developed by each test run, together with analytical results from laboratory analysis of samples generated by the field sampling program, are reproduced in the Appendices included with this report. Information on basic gas characteristics developed by each test run is contained in the printout of the computer program included as Appendix B.

A summary of pertinent test results and essential information to evaluate test results developed for each test run is included with this report as Table 1.

6. Discussion

6.1 Sampling Conditions

All field sampling work was completed out of doors and subject to prevailing weather conditions; however, there were no interruptions in the operation of individual test trains due to equipment or weather problems.

During the completion of this test program, the asphalt batch plant was maintained near the normal load condition.

6.2 Exhaust Flue Gas Volume and Composition

Test data for measurement of exhaust flue gas volume and related velocities developed by traversing of the stack show that the measured gas volumes between tests were consistent with expected values. For purposes of this report, indicated emissions are based on these measured gas volumes.

6.3 Unit Operating Conditions

This sampling program was undertaken as a compliance test program for the new scrubber system on the asphalt batch during representative load operating conditions. In the execution of this program, all applicable operation conditions were referenced.

Operating conditions were monitored throughout the duration of the sampling program by Highway Materials personnel.

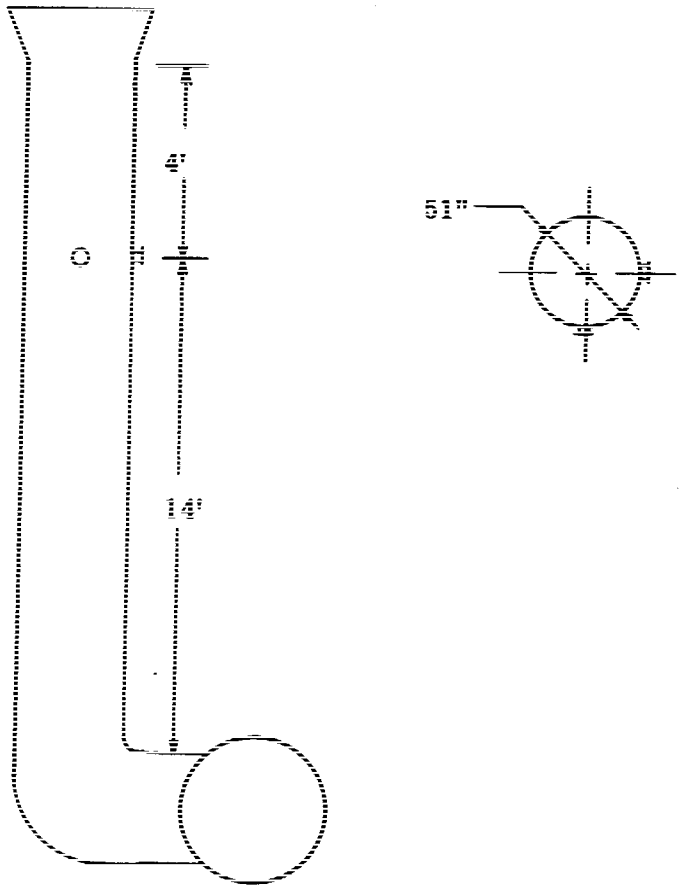
6.4 Emissions

6.4.1 Particulate

The reported particulate emissions as summarized in Table 1 are expressed as a concentration (grains/ACF, and grains/SCF) and emission rate (lbs/hour) as measured. The particulate emissions for all three runs are within any applicable limitations.

6.4.2 Visible

The reported visible emissions as summarized in Table 1 are expressed as a percent (%). The visible emissions for all three runs are within any applicable limitations.



Sample Point	Distance From Port, Inches
1	1.07
2	3.42
3	6.02
4	9.03
5	12.75
6	18.16
7	32.84
8	38.25
9	41.97
10	44.98
11	47.58
12	49.93

Figure 1
Sample Ports and Traverse Point Locations
Asphalt Batch Plant
Highway Materials, Inc.
Plymouth Meeting, PA
C/C, Inc. W.O. 10-0500-000-1

SECTION III

APPENDICES

SECTION III - APPENDICES

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APPENDIX 1

PROJECT PARTICIPANTS

APPENDIX I
PROJECT PARTICIPANTS

The following members of Gilbert/Commonwealth's staff participated in the planning and execution of this project and preparation of this report.

Field Sampling Crews:

Dave Hofmann	Project Coordinator
Ed Burger	Engineering Technician
Don Wary	Engineering Technician

Laboratory Participants:

Carl J. Wummer	Chemist
Vaughan O'Neill	Laboratory Technician

All field tests were completed with the assistance of technical personnel from Highway Materials and witnessed by the PADER.

APPENDIX 2

TESTING AND ANALYTICAL PROCEDURES

2.1 STANDARD EPA TEST METHODS

2.2 ACTUAL SAMPLING PROCEDURES/PARTICULATES

2.3 ANALYTICAL METHODS/PARTICULATES

APPENDIX 2

TESTING AND ANALYTICAL PROCEDURES

2.2 ACTUAL SAMPLING PROCEDURES/PARTICULATES

APPENDIX 2

TESTING AND ANALYTICAL PROCEDURES

2.2 ACTUAL SAMPLING PROCEDURES/PARTICULATES

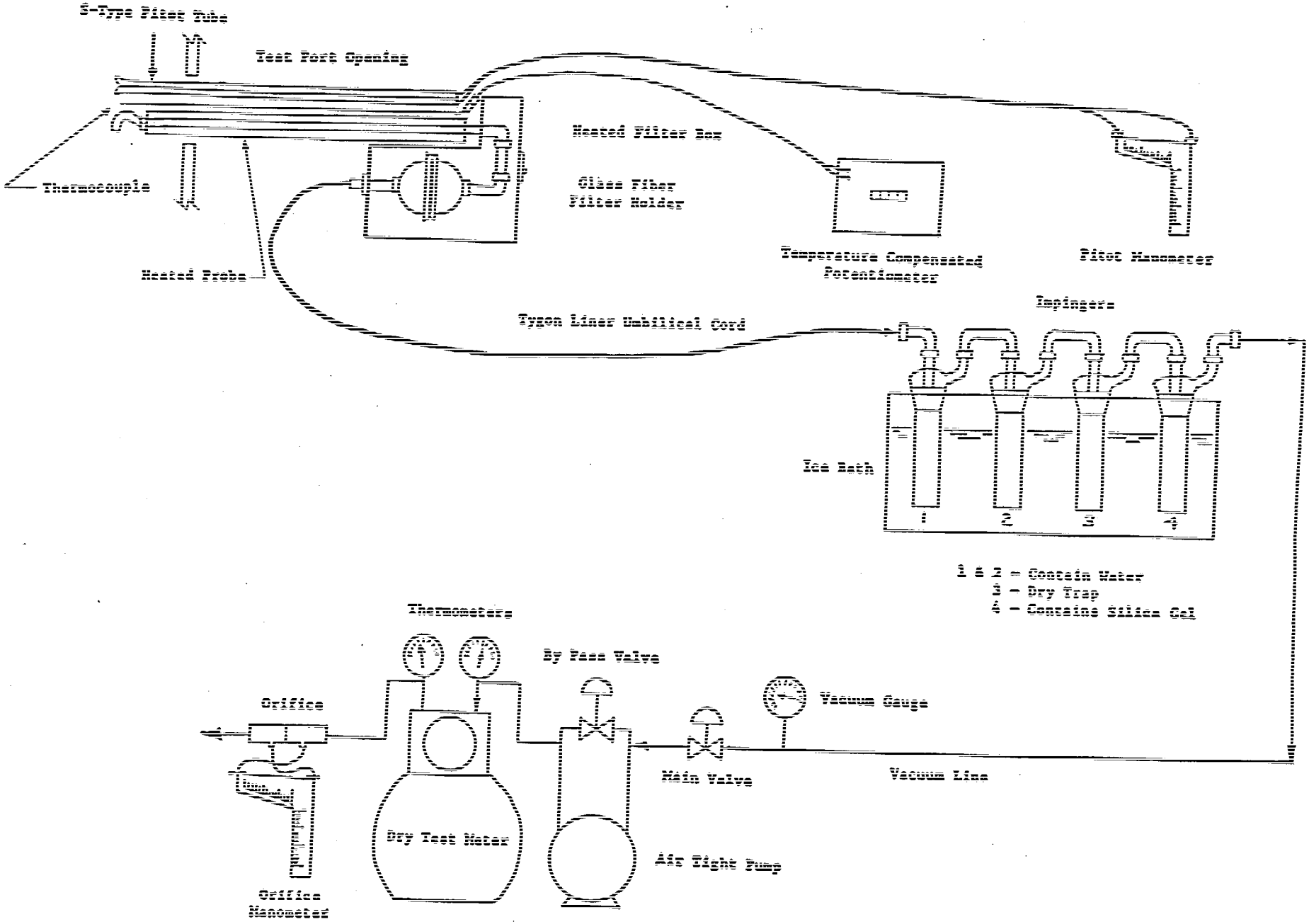
Particulate matter in the exhaust flue gas stream at the stack sampling location was sampled according to procedures and type of equipment as basically described in EPA Method 5 (see Appendix 2.1 for a complete description).

In place of the fragile glass material, the in-stack probe liner was constructed of high corrosion resistant Inconel stainless steel, which was enclosed in an outer protective sheath and heat traced to minimize condensation within the probe.

The basic test train consisted of a stainless steel nozzle followed by a heated Inconel probe liner, heated glass fiber filter, and glass impingers with all glass connectors.

The required sampling time for the compliance test, in terms of time per traverse point and overall sampling time per individual test run, was selected on the basis of maintaining a minimum sampling time of 4.5 minutes during the first test and 3 minutes for the last two tests at each of the traverse points at each sampling location.

The test program was completed with one test train located at the stack. All sampling activities were halted in the event of any test equipment malfunction or at the report of any operational problem. There was no planned interruption or extensive delay during the completion of the test runs.


S-Type Pitot Tube
Test Port Opening
Heated Filter Box
Thermocouple
Glass Fiber Filter Holder
Heated Probe
Temperature Compensated Potentiometer
Pitot Manometer
Impingers
Tygon Liner Umbilical Cord
Ice Bath
1
2
3
4
1 & 2 = Contain Water
3 = Dry Trap
4 = Contains Silica Gel
Thermometers
By Pass Valve
Orifice
Vacuum Gauge
Main Valve
Vacuum Line
Dry Test Meter
Air Tight Pump
Orifice Manometer

APPENDIX 2

TESTING AND ANALYTICAL PROCEDURES

2.3 ANALYTICAL METHODS/PARTICULATES

APPENDIX 2

TESTING AND ANALYTICAL PROCEDURES

2.3 ANALYTICAL METHODS/PARTICULATES

The reported particulate emissions included the total particulate catch from the acetone wash of the nozzle and probe, plus accumulations on the glass fiber filter. The impinger water was filtered through a .22 micron filter. These results along with the probe wash and glass fiber filter are considered particulate emissions in the Commonwealth of Pennsylvania.

The soluable water from the impingers was dried down and weighed. This particulate weight is only reported and is not counted toward the particulate weight.

In the clean-up of the front half of the sampling equipment, the nozzle from the front of the probe was removed, brushed out, and washed with acetone. The probe liner was then brushed out and washed with water then acetone. All of the acetone wash solutions for the probe and filter holder were combined into a single sample for anlysis. The glass fiber filter was removed from the fritted disc of the filter holder and replaced in its petri dish. All adhering filter particles were removed from the silicone rubber gasket and placed in the same petri dish prior to sealing for transport back to the Gilbert assigned laboratory for final analysis.

The clean-up procedure for the back half of the sampling train initially involved removal of the silica gel from the last impinger and replacement in its orginal container for final weighing to determine moisture pickup. Water collected in the impingers and glass connectors were rinsed with water then acetone. This rinse was also placed in sample bottles to be analyzed.

Laboratory analysis of samples collected during the test run proceeded according to EPA Method 5 (Appendix 2.1).

All critical items of sampling or analytical equipment were certified and/or calibrated for accuracy and results considered within acceptable limits for source sampling operations (see Appendix 7).

APPENDIX 3

OPERATING DATA

OPERATING DATA

Run No. 1

Time	Minutes	Weight	Tons	Tons/Minute
1032-1037	5	55,849	27.9	5.58
1235-1250	15	175,880	87.9	5.86
1250-1252	2	23,356	11.7	5.84
1256-1259	6	68,174	34.1	5.68
1259-1311	11	132,740	66.4	6.04
Average				5.8

Run No. 2

0804-0811	7	94,695	47.3	6.76
0811-0824	13	126,313	63.2	4.86
-0857	15	180,246	90.1	6.01
0857-0903	6	59,782	29.9	4.98
0903-0911	7	65,999	33.0	4.71
-1010	9	93,670	46.8	5.85
1010-1026	16	176,337	88.2	5.51
1026-1028	2	23,540	11.77	5.89
Average				5.57

Run No. 3

Time	Minutes	Batch Weight	Tons	Tons/Minute
1235	4	43,875	21.9	5.48
1240	4	43,875	21.9	5.48
1245	4	43,818	21.9	5.48
1249	4	43,958	22.0	5.50
1253	4	44,117	22.1	5.53
1257	4	43,607	21.8	5.45
1301	4	44,030	22.0	5.50
1305	4	43,938	22.0	5.50
1310	4	44,464	22.2	5.55
1317	4	44,001	22.0	5.50
1340	4	43,923	22.0	5.50
1346	4	44,248	22.1	5.53
1352	4	43,888	21.9	5.48
1356	4	43,894	21.9	5.48
1401	4	43,910	22.0	5.50
1406	4	43,891	21.9	5.48
1411	4	43,969	22.0	5.50
Average				5.50

APPENDIX 4

ANALYTICAL RESULTS FOR PARTICULATES

(CLEAN-UP SHEETS)

GILBERT ASSOCIATES, INC.
AIR POLLUTION CONTROL DEPT.
PARTICULATE CLEAN UP AND REPORT SHEET

Run Date: 10/28/86
Run No.: MM-1
Sample Run No.:
Operator: DM

Client: Highway Materials Inc
W. O. No.: 10-2590-000
Plant: Plymouth Meeting
Sampling Location: Stack

FRONT HALF

		Laboratory Results
~~Nozzle-Acetone Wash~~	Lab No. 4366-1	Residue 2.5 mg
Probe, Nozzle Holder, Cyclone (bypass), Flask, Front Half Filter Holder-Acetone Wash	Lab No. 4366-1	Residue 5.0 mg

Thimble No.	Lab No.	Sample Weight
		mg
		mg
		mg
		mg

Thimble particulate weight ________ mg

Filter No.	Lab No.	Sample Weight
S-174	4366-1	11.4 mg
		mg
		mg
		mg

Filter particulate weight 11.4 mg

FRONT HALF Sub Total 18.9 mg

BACK HALF

Impinger Content and Water Wash of Impingers Connectors and Back Half of Filter Holder

Lab No. 4366-1 Ether-Chloroform Extract ________ mg
Collected on 0.22μ Filter 8.8 mg
Aqueous Residue 2.7 mg

Impinger, Connectors and Back Half of Filter Holder - Acetone Wash

Lab No. 4366-1 Residue 1.0 mg

BACK HALF Sub Total 12.5 mg

TOTAL WEIGHT 31.4 mg

MOISTURE

Impingers: 158
320
154

Final Volume 632
Initial Volume 300
Net Volume 332

Silica Gel

Weight after test: 265
Weight before test: 232
Net Weight 33
Container No.: 1. K-57 2. ____ 3. ____ 4. ____

TOTAL WEIGHT-Silica Gel 33 gm
TOTAL VOLUME-Impinger 332 ml
TOTAL MOISTURE 365 gm

Comments:

LAB: DATE RECEIVED 10/29/86
DATE REPORTED 11/4/86

ANALYTICAL CHEMIST

EPS/APC 12/76

GILBERT ASSOCIATES, INC.
AIR POLLUTION CONTROL DEPT.
PARTICULATE CLEAN UP AND REPORT SHEET

Run Date: 10/23/86
Run No.: HM-2
Sample Box No.:
Operator: DH

Client: Highway Materials
W. O. No.: 12-9553-000
Plant: Plymouth Meeting
Sampling Location: Stack

FRONT HALF

		Laboratory Results
Nozzle-Acetone Wash	Lab No. 4366-2	Residue [illegible] mg
Probe, Thimble Holder, Cyclone (bypass), Flask, Front Half Filter Holder-Acetone Wash	Lab No. 4366-2	Residue 3.5 mg

Thimble No.	Lab No.	Thimble Residue
		mg
		mg
		mg
		mg

Thimble particulate weight ______ mg

Filter No.	Lab No.	Filter Residue
	4366-2	mg
		mg
		mg
		mg

Filter particulate weight 10.6 mg

FRONT HALF Sub Total 18.3 mg

BACK HALF

Impinger Content and Water Wash of Impingers Connectors and Back Half of Filter Holder — Lab No. 4366-2
- Ether-Chloroform Extract ______ mg
- Collected on 0.45µ Filter 39.4 mg
- Aqueous Residue 14.6 mg

Impinger, Connectors and Back Half of Filter Holder - Acetone Wash — Lab No. 4366-2 Residue 278.2 mg

BACK HALF Sub Total 332.2 mg

TOTAL WEIGHT 350.5 mg

MOISTURE

Impingers:
240
206
121

Final Volume 567
Initial Volume 300
Net Volume 267

Silica Gel

Weight after test:	255			
Weight before test:	230			
Net Weight	25			
Container No.:	1.	2.	3.	4.

TOTAL WEIGHT-Silica Gel 25 gm
TOTAL VOLUME Impingers 267 ml
TOTAL MOISTURE 292 gm

Comments:

LAB: DATE RECEIVED 10/28/86
DATE REPORTED 11/6/86

ANALYTICAL CHEMIST

GAI/APC 11/74

GILBERT ASSOCIATES, INC.
AIR POLLUTION CONTROL DEPT.
PARTICULATE CLEAN UP AND REPORT SHEET

Run Date: 10/23/86
Run No.: HM-3
Sample Box No.:
Operator: CH

Client: Highway Materials
W. O. No.: 19-5785-002
Plant: Plymouth Meeting
Sampling Location: Stack

FRONT HALF

Laboratory Blanks

Double-Acetone Wash — Lab No. 4366-3 — Residue 2.0 mg

Probe, Thimble Holder, Cyclone (Bypass), Flask, Front Half Filter Holder-Acetone Wash — Lab No. 4366-3 — Residue 2.3 mg

Thimble No.	Lab No.	Weight Results
		mg
		mg
		mg
		mg

Thimble particulate weight ______ mg

Filter No.	Lab No.	Weight Results
5-115	4366-3	mg
		mg
		mg
		mg

Filter particulate weight 11.3 mg

FRONT HALF Sub Total 16.7 mg

BACK HALF

Impinger Content and Water Wash of Impingers Connectors and Back Half of Filter Holder — Lab No. 4366-3 — Ether-Chloroform Extract ______ mg

Collected on 0.22μ Filter 86.4 mg

Aqueous Residue 255.9 mg

Impinger, Connectors and Back Half of Filter Holder - Acetone Wash — Lab No. 4366-3 Residue 242.4 mg

BACK HALF Sub Total 352.7 mg

TOTAL WEIGHT 369.4 mg

MOISTURE

Impingers: 224, 100, 222

Final Volume 581

Initial Volume 300

Net Volume 281

Silica Gel

Weight after test: 258

Weight before test: 232

Net Weight 26

Container No.: 1. A-13 2. ______ 3. ______ 4. ______

TOTAL WEIGHT-Silica Gel 26 gm

TOTAL WATER-Impingers 281 ml

TOTAL MOISTURE 307 gm

Comments:

LAB: DATE RECEIVED 10/27/86

DATE REPORTED 11/3/86

ANALYTICAL CHEMIST

EPI/APC 12/74

APPENDIX 5

RAW FIELD DATA

Sheet 1 of 2

PARTICULATE FIELD DATA

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point

SKETCH

Client	Highway Materials
W. O. No.	10-0500-000
Plant	Plymouth Meeting
Run No.	HM-1
Location	Stack
Date	10/22/86
Operator	McCman
Sample Box No.	
Meter Box No.	1386
Meter ΔH	2.15
C Factor	

Pitot Calibration	0.84
Thimble No.	-
Filter No.	S-114
Ambient Temp. °F	
Bar. Press. "Hg	29.90
Assumed Moisture %	
Heater Box Setting, °F	
Probe Tip Dia., In.	0.260
Probe Length	
Probe Heater Setting	
Avg. ΔP	
Avg. ΔH	

Sketch notes:

B		A	
1	.15	1	.25
2	.21	2	.30
3	.31	3	.33
4	.33	4	.31
5	.31	5	.25
6	.30	6	.29
7	.17	7	.44
8	.28	8	.53
9	.30	9	
10		10	
11		11	
12		12	

499.

POINT	DISTANCE IN INCHES	CLOCK TIME ACTUAL	CLOCK TIME RUN	DRY GAS METER, CF	PITOT IN. H2O ΔP	ORIFICE ΔH IN. H2O DESIRED	ORIFICE 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	O2 STACK PRESS IN. Hg	STACK TEMP. °F
A1		1033	0.0	970.771	0.62	2.00	2.00	78	68	7.0				224
2			4.5	973.9	0.63	1.86	1.80	84	70	2.0	250	75		236
3			9.0	977.2	0.40	1.40	1.40	70	70	1.0	255	75	9.5	206
4			13.5	979.9	0.74	2.60	2.60	80	70	3.5	260	70	11.7	222
5			18.0	983.6	0.95	3.40	3.40	92	70	4.5	260	70	15.9	232
6			22.5	987.6	1.00	3.50	3.50	100	72	8.0	275	72	15.4	243
7			27.0	992.1	1.02	3.70	3.76	110	76	3.0	276	70		254
8			31.5	996.2	1.20	4.10	4.20	113	80	5.0	275	70	15.2	258
9			36.0	1000.8	1.16	[illegible]	4.10	116	82	6.0	275	70	14.9	266
10			40.5	[illegible]	1.10	3.90	3.90	120	84	7.0	285	72	15.5	265
11			45.0	1010.2	1.30	4.80	4.80	122	89	17.0	285	72	15.0	266

Comments:

1041 8° pm sp
1159. start

CO2	O2
3.6	15.5
3.8	14.5
5.2	13.7
4.5	14.7

Stack - 72 (87/6m)

Approx 7:00 ...
7:30 ...

Mc Donnelly

PARTICULATE FIELD DATA
(continued)

Client Hercules(?) Aqu[illegible]

W.O. No. 10-0500-000

Plant Plymouth Meeting

Run No. HM-1

Location Stack

Date 10/22/86

POINT	DISTANCE IN INCHES	CLOCK TIME ACTUAL	CLOCK TIME RUN	DRY GAS METER, CF	PITOT IN. H_2O ΔP	ORIFICE ΔH IN. H_2O DESIRED	ORIFICE 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 PRESS IN. Hg	STACK TEMP. °F
Avg			49.5	—	1.30	4.80	4.80	128.	90.	13.0	275	70		266.
Stop			54.0	1020.320										
B1		1257.	0.0	1020.320	0.52	1.90	1.90	102.	90.	1.0	270.	72		
2			4.5	1023.7	0.53	1.90	1.90	102.	90.	1.0	275.	72		250.
3			9.0	1027.2	0.65	2.40	2.40	110.	90.	2.0			14.1	255
4			13.5	1030.8	0.62	2.25	2.25	110.	90.	1.0	265	70		269.
5			18.0	1034.3	0.65	2.40	2.40	110	90.	1.0	265	70	14.3	275.
6			22.5	1038.0	0.65	2.40	2.40	108.	90	1.0	260	70	10.1	291.
7			27.0	1041.5	0.83	3.00	3.00	111.	90.	1.0	260	70	13.7	295.
8			31.5	1045.7	0.97	3.50	3.50	113.	92.	2.5	265	70		293.
9			36.0	1049.6	1.00	3.70	3.70	120.	92.	3.0	265	70	14.2	297
10			40.5	1054.1	0.97	3.60	3.60	122.	93.	2.5	260	70	14.7	297.
11			45.0	1058.7	0.98	3.70	3.70	122.	94.	3.5	260	65	14.7	297.
12			49.5	1063.2	1.00	3.70	3.70	122.	95.	3.5			15.0	259
Stop			54.0	1067.504										257

COMMENTS:

18:30' broken bypass Static – .55

1218

Leak 0.015 @ 12" Hg

Sheet 1 of _____

Client Highway Materials

W. O. No. 10-6764-000

Plant Plymouth Meeting

Run No. HM-2

Location Spuk

Date 10/13/82

Operator Holmes A

Sample Box No. 5

Meter Box No. 13B2

Meter ΔH _____

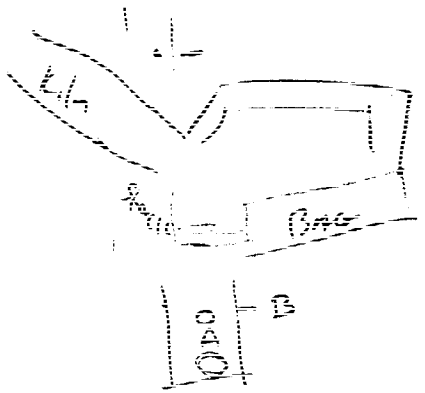
C Factor _____

PARTICULATE FIELD DATA

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point

SKETCH



Pitot Calibration 0.84

Thimble No. _____

Filter No. S-110

Ambient Temp. °F _____

Bar. Press. "Hg 29.82

Assumed Moisture % 11%

Heater Box Setting, °F _____

Probe Tip Dia., In. 0.260

Probe Length _____

Probe Heater Setting _____

Avg. ΔP _____ Avg. ΔH _____

POINT	DISTANCE IN INCHES	CLOCK TIME ACTUAL	CLOCK TIME RUN	DRY GAS METER, CF	PITOT IN. H2O ΔP	ORIFICE ΔH IN. H2O DESIRED	ORIFICE 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 PRESS IN. Hg	STACK TEMP. °F
A 1		0800	0.0	68238	0.72	2.50	2.50	60	55	8.0	225	58	14.6	252
2			3.0	70.4	0.76	2.60	2.60	68	56	9.0	230	58	14.3	276
3			6.0	72.8	0.79	2.75	2.75	74	58		230	60	13.6	309
4			9.0	75.1	0.82	2.60	2.60	82	60	9.5	235	62	13.3	326
5			12.0	77.4	0.90	2.80	2.86	85	60	9.0	240	61	13.8	322
6			15.0	79.9	0.95	3.00	3.00	92	66	11.0	260	62	14.4	319
7			18.0	82.2	0.94	3.00	3.00	95	62	11.0	260	62	14.4	319
B		0830	21.0	84.8	0.96	3.50	3.50	80	64	12.0	225	62	14.2	318
9			24.0	87.1	1.00	4.10	4.10	92	64	15.0	275	65		321
10			27.0	90.0	1.10	3.80	3.80	98	65	18.5	260	65	13.3	333
11			30.0	92.6	1.10	3.80	3.80	101	66	18.5	260	65	13.1	329

Comments:

Box 14 - Heating Elm.

* changed nomograph

4.2 13.8
3.6 14.2

Static - .79

2637" sp
0825
0836

Client Highway Materials

PARTICULATE FIELD DATA
(continued)

W.O. No. 10-0500-000

Plant Plymouth Meeting

Location Stack

Run No. HM-2

Date 10/23/86

POINT	DISTANCE IN INCHES	CLOCK TIME ACTUAL	CLOCK TIME RUN	DRY GAS METER, CF	PITOT IN. H_2O ΔP	ORIFICE ΔH IN. H_2O DESIRED	ORIFICE 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	O_2 STACK PRESS IN. Hg	STACK TEMP. °F
12			33.0	95.2	1.10	3.80	3.80	108	68.	18.5	245.	65	12.0	260.
Stop			36.0	98.010										
B 1		0859.	0.0	98.010	0.35	1.20	1.20	93.	70.	3.5	245.	62		250.
2			3.0	99.7	0.54	1.80	1.80	95.	70.	5.0	245.	62	13.7	254.
3			6.0		0.60	2.05	2.05	100.	72	6.0	240.	61	13.6	284.
4			9.0	103.7	0.62	2.10	2.10	105	73.	6.5	246	61	13.6	292.
5			12.0	105.6	0.62	2.20	2.20	110.	74.	7.0	245	61		295.
6		1013.	15.0	107.7	0.61	2.10	2.10	70.	76.	6.5	250.	58		260.
7			18.0	110.0	0.85	2.96	2.96	86.	76.	7.0	250	58	15.8	222.
8			21.0	112.2	1.10	3.80	3.80	97.	76.	15.0	245	58	12.8	234.
9			24.0	114.9	1.05	3.66	3.60	100.	76.	14.5	245	58	13.4	253.
10			27.0	117.6	1.00	3.40	3.40	106.	74.	16.0	246	58	12.6	275.
11			30.0	120.0	0.98	3.40	3.40	110	75.	16.0	240.	59	13.1	288.
12			33.0	122.5	0.98	3.40	3.40	110.	76.	16.0	245	59	12.5	289.
Stop			36.0	125.276										
OK														

COMMENTS:

{0913. 1431" dam
{1012.

4.2 13.6
4.0 13.5

−.52

leak check @ 20" Hg

Sheet 1 of 2

Client Holcim Materials

W. O. No. 10-0969-008

Plant Plymouth Meeting

Run No. HM-3

Location Smoke

Date 10/13/86

Operator McMinn

Sample Box No.

Meter Box No. 1386

Meter ΔH

C Factor 7.15

PARTICULATE FIELD DATA

VERY IMPORTANT - FILL IN ALL BLANKS

Read and record at the start of each test point

SKETCH

Pitot Calibration 0.84

Thimble No.

Filter No. S-15

Ambient Temp. °F

Bar. Press. "Hg 29.81

Assumed Moisture %

Heater Box Setting, °F

Probe Tip Dia., In. 0.160

Probe Length

Probe Heater Setting

Avg. ΔP Avg. ΔH

POINT	DISTANCE IN INCHES	CLOCK TIME ACTUAL	CLOCK TIME RUN	DRY GAS METER, CF	PITOT IN. H_2O ΔP	ORIFICE ΔH IN. H_2O DESIRED	ORIFICE 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	O_2 STACK PRESS IN. Hg	STACK TEMP. °F
A1		1235	0.0	125.587	0.47	1.60	1.60	80.	76.	0	236	57	14.7	280
2			3.0	127.4	0.58	2.00	2.00	84.	78.	2	238	57	13.6	282
3			6.0	129.4	0.62	2.10	2.10	90.	76.	2	235	57	13.6	276
4			9.0	131.5	0.65	2.20	2.20	96.	80.	2	235	57	11.8	282
5			12.0	133.6	0.64	2.20	2.20	100.	80.		240	57	11.7	285
6			15.0	135.7	0.66	2.30	2.30	104.	80.	4	245	58	13.3	286
7			18.0	137.8	0.75	2.60	2.60	108.	82.	4.0	245	58	13.8	285
8			21.0	140.0	0.82	2.80	2.80	104.	82.	4	250	59	12.8	286
9			24.0	←	0.87	3.00	3.00	112	85.	2	255	59	11.7	288
10			27.0	144.7	1.06	4.10	4.10	112	86.	3	250	59	12.5	286
11			30.0	147.4	1.10	3.80	3.80	115	88	3.0	245	59	12.5	287

Comments:

5.0 11.7

4.8 12.0

4.0 13.2

-.62

PARTICULATE FIELD DATA (continued)

Client: Highway Materials
W.O. No.: 16-0500-000
Plant: Plymouth Meeting Plant #4
Location: Stack
Run No.: HM-3
Date: 10/23/86

POINT	DISTANCE IN INCHES	CLOCK TIME ACTUAL	CLOCK TIME RUN	DRY GAS METER, CF	PITOT IN. H_2O ΔP	ORIFICE ΔH IN. H_2O DESIRED	ORIFICE 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 PRESS IN. Hg	STACK TEMP. °F
12			33.0	150.3	1.20	4.20	4.20	113	88.	3.0	235	60.	12.7	265.
Stop			36.0	152.700										
B1	4	1316	0.0	152.700	0.40	1.40	1.40	87.	80.	0	230	60.	—	212
2			3.0	154.9	0.65	2.25	2.25	90.	81	0	230	60	13.2	220
3			6.0	—	0.67	2.35	2.35	96.	81.	0	235	61.	15.3	221.
4			9.0	157.8	0.64	2.25	2.25	100	81.	1	235	61	14.1	231.
5			12.0	161.1	0.68	2.40	2.46	104.	82	1	240	62	15.3	231.
6			15.0	163.3	0.68	2.40	2.40	106.	82	1	240	62		238.
7			18.0	165.5	0.99	3.40	3.40	108	84.	2	240	62	15.3	240
8			21.0	—	1.05	3.50	3.50	116.	86	2	246	62	14.9	243.
9			24.0	170.8	1.20	4.30	4.30	118.	86.	2.5	245	62	17.3	238
10			27.0	173.9	1.26	4.20	4.20	118	86.					228
11			30.0	176.5	1.30	4.50	4.50	122	90.	3.0	250	62		212
12			33.0	179.7	1.30	4.50	4.50	123.	91.	3.0	250	63		213.
Stop			36.0	182.429										
End														

COMMENTS:

Down until trucks arrive

leak .008 @ 4" Hg

1417

APPENDIX 6

VISIBLE EMISSION DATA

APPENDIX 7

CALIBRATION DATA

METER BOX CALIBRATION

Date 10/28/86

Meter box number 13 86

Barometric pressure, P_b = 29.79 / 29.74 in Hg

Calibrated by [illegible]

Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft^3	Gas volume: Dry gas meter (V_d), ft^3	Temperatures: Wet test meter (t_w), °F	Temperatures: Dry gas meter: Inlet (t_{d_i}), °F	Temperatures: Dry gas meter: Outlet (t_{d_o}), °F	Temperatures: Dry gas meter: Avg[a] (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$
0.5	4.999	5.059	67	98	85.5	91.8	13.23	1.03	2.04
1.0	5.015	5.056	67	95	84	89.5	9.20	1.03	2.18
1.5	10.002	10.112	67	104.5	83	93.3	15.22	1.03	2.19
2.0	9.995	9.963	70.5	95.5	79.5	85	13.65	1.03	2.21
3.0	11.022	11.366	69	105	88	96.5	13.45	1.01	2.43
4.0	9.999	10.075	70.5	102	78	90	10.30	1.02	2.19
5.0	10.000	10.127	70.5	104.5	82	95.8	8.85	1.02	2.21
							Avg	1.03	

$$Y_i = \frac{V_w P_b (t_d + 460)}{V_d \left(P_b + \frac{\Delta H}{13.6}\right)(t_w + 460)}$$

ΔH	$\frac{H}{13.6}$		
0.5	0.0368	Y_i =	$\frac{4.999 \times 29.74 \times 551.8}{5.059 \times 29.78 \times 527}$ = 1.03
1.0	0.0737	Y_i =	$\frac{5.015 \times 29.74 \times 549.5}{5.056 \times 29.81 \times 527}$ = 1.03
1.5	0.110	Y_i =	$\frac{10.002 \times 29.74 \times 553.3}{10.112 \times 29.85 \times 527}$ = 1.03
2.0	0.147	Y_i =	$\frac{9.995 \times 29.94 \times 545}{9.963 \times 30.09 \times 530.5}$ = 1.03
3.0	0.221	Y_i =	$\frac{11.022 \times 29.74 \times 556.5}{11.366 \times 29.96 \times 529}$ = 1.01
4.0	0.29	Y_i =	$\frac{9.999 \times 29.99 \times 550}{10.075 \times 30.13 \times 530.5}$ = 1.02

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

CLIENT

PROJECT

SYSTEM

CALCULATION FOR

ΔH Box 1386

FILING CODE

W.O. | PAGE | OF

ENGINEER: Albright

DATE 6/28/86

REVIEWED BY: DGW

DATE

ΔH	Q_m	K_m	ΔH
ΔH	$Q_m = \frac{V_m (T_{std}\,°R)}{Q_{std} (T_{avg}\,°R)}$	$K_m = Q_m \sqrt{\frac{(P_b)(2.9)}{(T_m\,°R)(\Delta H)}}$	$\Delta H = \frac{0.931}{(K_m)^2}$
0.5	$Q_m = \frac{5.014\,(545.5)}{(4.23)(592.5)} = 0.338$	$K_m = 0.378 \sqrt{\frac{29.24}{545.5} \frac{(2.9)}{(0.5)}} = 0.622$	$\Delta H = \frac{0.931}{(K_m)^2} = 2.04$
1.0	$Q_m = \frac{5.888\,(549)}{(9.70)\,542.5} = 0.574$	$K_m = 0.574 \sqrt{\frac{29.24}{549} \frac{(2.9)}{(1.0)}} = 0.650$	$\Delta H = \frac{0.931}{(K_m)^2} = 2.18$
1.5	$Q_m = \frac{10.072\,(543)}{15.77\,(537.3)} = 0.630$	$K_m = 0.650 \sqrt{\frac{29.24}{543} \frac{(2.9)}{(1.5)}} = 0.628$	$\Delta H = \frac{0.931}{(K_m)^2} = 2.19$
2.0	$Q_m = \frac{11.23\,(545.5)}{13.65\,(549)} = 0.716$	$K_m = 0.716 \sqrt{\frac{29.24}{534.5} \frac{(2.9)}{(2.0)}} = 0.655$	$\Delta H = \frac{0.931}{(K_m)^2} = 2.21$
3.0	$Q_m = \frac{13.366\,(548)}{15.45\,(554.5)} = 0.857$	$K_m = 0.857 \sqrt{\frac{29.24}{548} \frac{(2.9)}{(3.0)}} = 0.646$	$\Delta H = \frac{0.931}{(K_m)^2} = 2.43$
4.0	$Q_m = \frac{16.075\,(538)}{16.56\,(555)} = 0.952$	$K_m = 0.952 \sqrt{\frac{29.24}{538} \frac{(2.9)}{(4.0)}} = 0.608$	$\Delta H = \frac{0.931}{(K_m)^2} = 2.44$
5.0	$\frac{15.127\,(542)}{8.85\,(555.8)} = 1.116$	$1.116 \sqrt{\frac{29.24}{542} \frac{(2.9)}{(5.0)}} = 0.632$	$\frac{0.931}{(0.632)^2} = 2.31$

FILING CODE

METER BOX CALIBRATION

Date 10/20/86 Meter box number 1386

Barometric pressure, P_b = 30.15 in Hg Calibrated by Bruce Jones

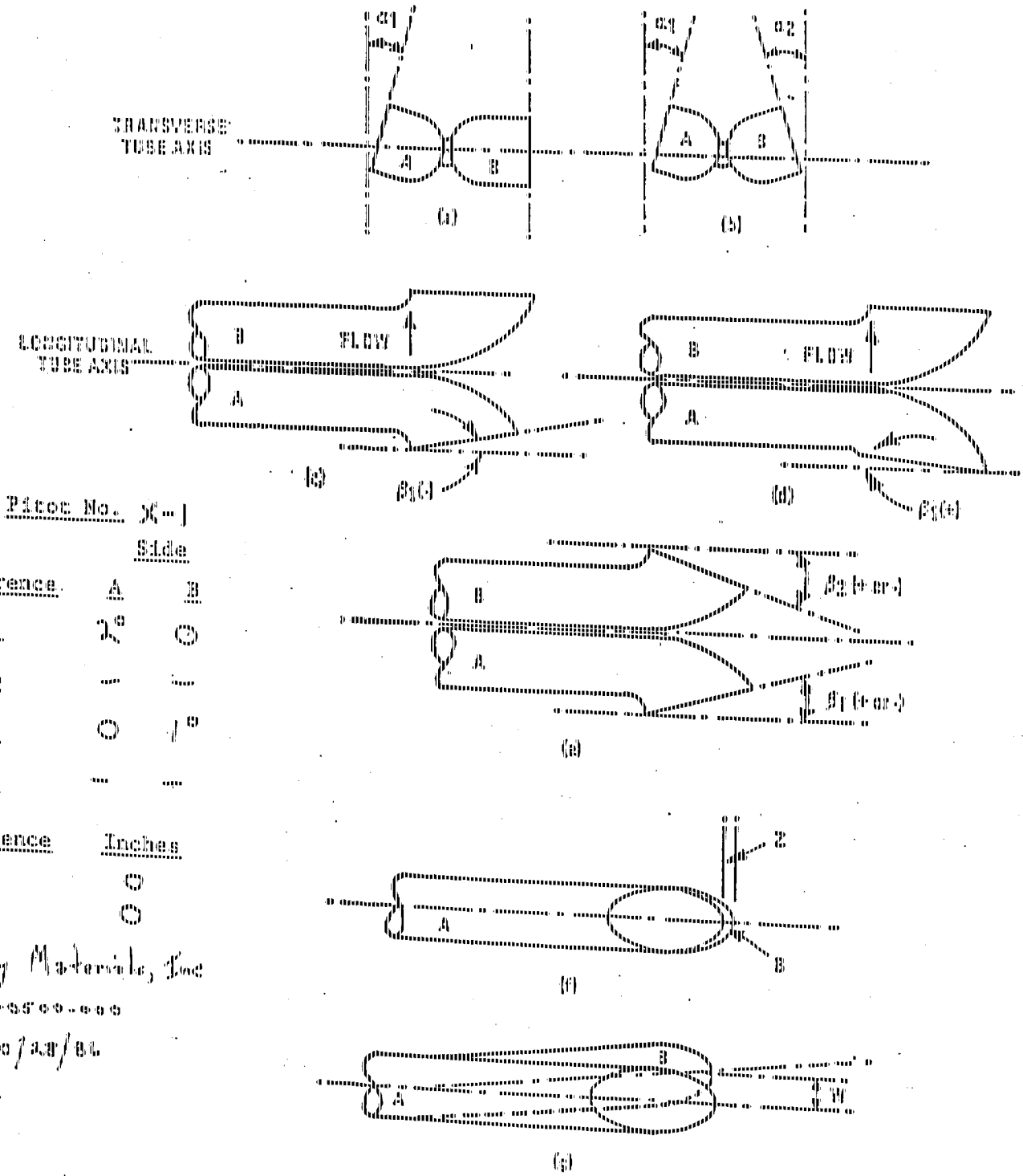
Orifice manometer setting (ΔH), in. H_2O	Gas volume: Wet test meter (V_w), ft³	Gas volume: Dry gas meter (V_d), ft³	Temperatures: Wet test meter (t_w), °F	Temperatures: Dry gas meter: Inlet (t_{d_i}), °F	Temperatures: Dry gas meter: Outlet (t_{d_o}), °F	Temperatures: Dry gas meter: Avg^a (t_d), °F	Time (θ), min	Y_i	$\Delta H@_i$
0.5	5.0	5.105	68	88.	78	83	13.22	1.01	1.93
1.0	5.25	5.359	68	92.	79	88	10.07	1.01	3.97
1.5	10.0	10.251	69	94.	81.	87.5	16.0	1.02	3.17
2.0	10.0	10.213	69	107.	84.	95.5	13.9	1.02	3.81
3.0	11.25	11.604	69	110.	96.	98.	13.38	1.02	3.40
4.0	10.0	10.44	69	114.	88.	101.	10.43	1.01	3.41
		53.114						Avg 1.01	

$$\Delta H \quad \frac{H}{13.6} \qquad Y_i = \frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6})(t_w + 460)}$$

0.5	0.0368	$Y_i = \frac{5.0 \times 30.15 \times 533}{5.105 \times 30.79 \times 528} = 1.01$
1.0	0.0733	$Y_i = \frac{5.25 \times 30.15 \times 528}{5.359 \times 30.23 \times 528} = 1.01$
1.5	0.110	$Y_i = \frac{10.0 \times 30.15 \times 547.5}{10.251 \times 30.24 \times 529} = 1.02$
2.0	0.147	$Y_i = \frac{10.0 \times 30.15 \times 555.5}{10.213 \times 30.26 \times 529} = 1.02$
3.0	0.221	$Y_i = \frac{11.25 \times 30.15 \times 558}{11.604 \times 30.27 \times 529} = 1.02$
4.0	0.29	$Y_i = \frac{10.0 \times 30.15 \times 561}{10.44 \times 30.27 \times 529} = 1.01$

GILBERT ASSOCIATES, INC. ENGINEERS AND CONSULTANTS READING, PA.	CLIENT	FILING CODE
	PROJECT	NO. / PAGE / OF
SYSTEM		ENGINEER: Kurek
		DATE: 12/20/06
CALCULATION FOR: ΔH Box 1386		REVIEWED BY: OEW
		DATE

ΔH	$Q_m = \frac{V_m (C_m)(528)}{\theta_{min}(T_{avg}\,°R)}$	$K_m = Q_m \sqrt{\frac{(P_b)(29)}{(T_{avg}\,°R)(\Delta H)}}$	$\Delta H = \frac{0.921}{(K_m)^2}$	
0.5	$Q_m = \frac{5.105\,(539)}{(13.22)(543)} = .383$	$K_m = .383\sqrt{\frac{30.15}{598}\frac{(29)}{(0.5)}} = .691$	$\Delta H = \frac{0.921}{(K_m)^2}$	= 1.93
1.0	$Q_m = \frac{5.359\,(539)}{(10.03)(548)} = .524$	$K_m = .524\sqrt{\frac{30.15}{539}\frac{(29)}{(1.0)}} = .667$	$\Delta H = \frac{0.921}{(K_m)^2}$	= 2.07
1.5	$Q_m = \frac{10.157\,(541)}{(16.0)(543)} = .627$	$K_m = .627\sqrt{\frac{30.15}{541}\frac{(29)}{(1.5)}} = .651$	$\Delta H = \frac{0.921}{(K_m)^2}$	= 2.17
2.0	$Q_m = \frac{10.213\,(544)}{(13.9)(555.5)} = .720$	$K_m = .72\sqrt{\frac{30.15}{544}\frac{(29)}{(2.0)}} = .645$	$\Delta H = \frac{0.921}{(K_m)^2}$	= 2.21
3.0	$Q_m = \frac{11.604\,(546)}{(13.38)(558)} = .849$	$K_m = .849\sqrt{\frac{30.15}{546}\frac{(29)}{(3.0)}} = .620$	$\Delta H = \frac{0.921}{(K_m)^2}$	= 2.40
4.0	$Q_m = \frac{10.544\,(548)}{(10.93)(561)} = .978$	$K_m = .978\sqrt{\frac{30.15}{548}\frac{(29)}{(4.0)}} = .618$	$\Delta H = \frac{0.921}{(K_m)^2}$	= 2.41



Pitot No. X-1

Side

Reference	A	B
A_1	X	O
A_2	—	—
B_1	O	X
B_2	—	—

Reference	Inches
Z	0
W	0

Highway Materials, Inc

10-05-00-000

10/31/84

Figure 2-3. Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect the baseline value of $C_p(s)$ so long as $\alpha 1$ and $\alpha 2 < 10^\circ$, $\beta 1$ and $\beta 2 < 5^\circ$, $z < 0.32$ cm (1/8 in.) and $w < 0.08$ cm (1/32 in.) (citation 11 in Section 6).

GILBERT ASSOCIATES, INC.
ENGINEERS AND CONSULTANTS
READING, PA.

CLIENT: Highway Materials, Inc.

PROJECT: Asphalt Baghouse

FILING CODE: 1955000 00

W.O.

PAGE ___ OF ___

ENGINEER

DATE 10/28/82

REVIEWED BY

DATE

SYSTEM

CALCULATION FOR: Pot Meter-Thermocouple Calibration

Pot Meter #	1
Thermocouple Type	K
Ice Bath Temperature °F	34
Certified Mercury Bulb °F	34
Ambient Temperature °F	81
Certified Mercury Bulb °F	81
Boiling H_2O °F	211
Certified Mercury Bulb °F	212
Hot Synthetic Oil °F	408
Certified Mercury Bulb °F	402

Remarks:

FILING CODE

APPENDIX B

COMPUTER PRINTOUT

(FLUE GAS CHARACTERISTICS, ISOKINETIC CALCULATIONS, AND TEST RESULTS FOR PARTICULATE EMISSIONS)

ISOKINETIC SAMPLING ANALYSIS

PROGRAM - I005

CLIENT NAME - HIGHWAY MATERIALS, INC.

PROCESS - ASPHALT

SAMPLING POINT- STACK

PLANT LOCATION - PLYMOUTH MEETING, PA

CONTROL EQUIPMT - BAGHOUSE

POLLUTANTS - PARTICULATE

GILBERT ASSOCIATES, INC.
READING, PENNA.
100500000 11/05/86

RESULTS OF FLOW AND ISOKINETIC CALCULATIONS -

RUN NUMBER -			MM-1	MM-2	MM-3
DATE OF RUN =			10-22-86	10-23-86	10-23-86
TIME AT BEGINNING OF RUN			1033.0	804.0	1235.0
TIME AT END OF RUN			1547.0	1034.0	1412.0
DN	SAMPLING NOZZLE DIAMETER	IN.	0.260	0.260	0.260
Y	DRY GAS METER FACTOR	-	1.020	1.020	1.020
PB	BAROMETRIC PRESSURE	IN. HG. ABS.	29.90	29.82	29.81
TT	NET TIME OF TEST	MIN.	108.0	72.0	72.0
VM	SAMPLED GAS VOLUME	CU. FT.	76.816	57.058	58.842
TM	AVG. GAS METER TEMPERATURE	DEGR. F.	95.	79.	94.
PM	AVG. ORIFICE PRESSURE DROP	IN. H20	3.11	2.93	2.94
VMSTD	VOLUME OF DRY GAS SAMPLED	DSCF	94.546	57.186	57.444
VW	H20 FROM IMPINGER, SILICA GEL	ML	265.0	292.0	307.0
VWGAS	H20 COLLECTED AT STD.COND.	STD. CU. FT.	12.481	13.753	14.460
M	STACK GAS MOISTURE BY VOLUME	PERCENT	11.7	19.4	20.1
	CO2 IN DRY STACK GASES	PERCENT	4.3	4.0	4.6
	O2 IN DRY STACK GASES	PERCENT	14.6	13.6	12.9
	CO IN DRY STACK GASES	PERCENT	0.0	0.0	0.0
	N2 IN DRY STACK GASES	PERCENT	81.1	82.2	83.1
MD	MOL FRACTION OF DRY GAS	-	0.88	0.81	0.80
MWD	MOL WGT. OF STACK GAS, DRY	-	29.27	29.19	29.23
EA	EXCESS AIR	PERCENT	214.4	174.7	127.6
MW	MOL WGT. OF STACK GAS, WET	-	27.96	27.82	26.97
AS	STACK AREA	SQ. IN.	2042.8	2042.8	2042.8
PST	STATIC PRESSURE OF STACK GAS	IN. HG.	-0.85	-0.85	-0.85
PS	STACK GAS PRESSURE	IN. HG. ABS.	29.85	29.77	29.76
TS	AVG. STACK TEMPERATURE	DEGR. F.	261.	271.	242.
CP	PITOT TUBE COEFFICIENT	-	0.840	0.840	0.840
VS	STACK GAS VELOC., STACK COND.	AFPM	3691.	3774.	3668.
QS	STACK GAS VOL., DRY STD. COND.	DSCFM	311228.	311146.	311154.
QA	STACK GAS VOLUMN, STACK COND.	ACFM	52355.	53533.	51918.
I	ISOKINETIC RATIO	PERCENT	99.0	97.8	98.2

GRAIN LOADING AND EMISSION CALCULATIONS -

RUN NUMBER -		HM-1	HM-2	HM-3
DATE OF RUN -		10-22-86	10-23-86	10-23-86
PROBE AND CYCLONE	MILLIGRAMS	7.50	5.90	7.50
	GRAINS/ACF	0.0008	0.0009	0.0012
	GRAINS/SCF	0.0012	0.0016	0.0020
	LB/HR - CONC	0.36	0.42	0.54
	LB/HR - AREA	0.35	0.42	0.53
	LB/HR - AVG	0.35	0.42	0.53
FILTER	MILLIGRAMS	20.20	52.00	95.60
TOTAL - ABOVE ITEMS	MILLIGRAMS	27.70	57.90	103.10
	GRAINS/ACF	0.0029	0.0090	0.0165
	GRAINS/SCF	0.0045	0.0156	0.0276
	LB/HR - CONC	1.31	4.16	7.38
	LB/HR - AREA	1.30	4.09	7.28
	LB/HR - AVG	1.31	4.12	7.33
TOTAL - INCL. IMPINGER CATCH	MILLIGRAMS	31.40	358.50	369.40
	GRAINS/ACF	0.0033	0.0547	0.0592
	GRAINS/SCF	0.0051	0.0944	0.0990
	LB/HR - CONC	1.49	25.19	26.44
	LB/HR - AREA	1.48	24.74	26.08
	LB/HR - AVG	1.48	24.97	26.26

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LISTING OF FIELD DATA AND RESULTS AT EACH POINT

POINT NO.	POINT DISTANCE (IN)	CLOCK TIME	TIME INCRMT (MINS)	DRY GAS METER (CF)	ORIFICE DELTA H (IN. H2O)	GAS TEMPERATURES IN (DEGREES F)	GAS TEMPERATURES OUT (DEGREES F)	VELOCITY HEAD (IN. H2O)	STACK PRESS (IN. H2O)	STACK TEMP (DEGR. F)	(VEL. HD.)X (STACK TEMP.) (IN. H2O-DEG R)	SQR ROOT OF PREVIOUS RESULT	STACK GAS VEL (AFPM)
RUN NO. - WM-1													
A-1	0.0	1035.0	0.0	970.770	2.00	78.0	68.0	0.620	-0.64	224.0	424.08	20.59	3071.7
A-2	0.0	1037.5	4.5	973.000	1.80	84.0	70.0	0.630	-0.64	236.0	458.48	20.94	3123.4
A-3	0.0	1042.0	9.0	977.200	1.40	78.0	70.0	0.400	-0.64	205.0	266.00	16.31	2432.7
A-4	0.0	1046.5	13.5	979.900	2.60	80.0	70.0	0.740	-0.64	222.0	504.68	22.47	3350.9
A-5	0.0	1051.0	18.0	983.600	3.40	92.0	70.0	0.950	-0.64	232.0	657.40	25.64	3824.5
A-6	0.0	1055.5	22.5	987.400	3.50	100.0	72.0	1.000	-0.64	245.0	705.00	26.55	3960.0
A-7	0.0	1100.0	27.0	992.100	3.70	110.0	76.0	1.020	-0.64	254.0	728.28	26.99	4025.3
A-8	0.0	1104.5	31.5	996.200	4.20	102.0	80.0	1.200	-0.64	258.0	861.60	29.35	4376.3
A-9	0.0	1109.0	36.0	1000.800	4.20	116.0	82.0	1.200	-0.64	266.0	871.20	29.52	4402.6
A-10	0.0	1113.5	40.5	1005.100	3.90	120.0	84.0	1.100	-0.64	265.0	797.50	28.24	4212.3
A-11	0.0	1118.0	45.0	1010.200	4.80	122.0	89.0	1.300	-0.64	266.0	943.80	30.72	4582.4
A-12	0.0	1122.5	49.5	0.0	4.80	128.0	90.0	1.300	-0.64	266.0	943.80	30.72	4582.4
STOP		1127.0	54.0	1020.320									
B-1	0.0	1253.0	0.0	1020.320	1.90	102.0	90.0	0.520	-0.64	258.0	369.20	19.21	2866.1
B-2	0.0	1257.5	4.5	1023.700	1.90	102.0	90.0	0.530	-0.64	255.0	378.95	19.47	2903.7
B-3	0.0	1302.0	9.0	1027.200	2.40	110.0	90.0	0.650	-0.64	269.0	473.85	21.77	3246.9
B-4	0.0	1306.5	13.5	1030.800	2.25	110.0	90.0	0.620	-0.64	275.0	455.78	21.35	3184.2
B-5	0.0	1311.0	18.0	1034.300	2.40	110.0	90.0	0.650	-0.64	291.0	488.15	22.09	3295.6
B-6	0.0	1315.5	22.5	1038.000	2.40	108.0	90.0	0.650	-0.64	295.0	498.75	22.33	3334.3
B-7	0.0	1320.0	27.0	1041.500	3.00	111.0	90.0	0.830	-0.64	297.0	628.31	25.07	3738.9
B-8	0.0	1324.5	31.5	1045.500	3.50	115.0	92.0	0.970	-0.64	297.0	734.29	27.10	4041.9
B-9	0.0	1329.0	36.0	1049.600	3.70	120.0	92.0	1.000	-0.64	297.0	757.08	27.51	4105.9
B-10	0.0	1333.5	40.5	1054.100	3.60	122.0	93.0	0.970	-0.64	277.0	714.89	26.74	3988.2
B-11	0.0	1338.0	45.0	1058.700	3.70	122.0	94.0	0.980	-0.64	259.0	704.62	26.54	3959.6
B-12	0.0	1342.5	49.5	1063.200	3.70	122.0	95.0	1.000	-0.64	259.0	719.00	26.81	3999.6
STOP		1347.0	54.0	1067.586									
OVERALL RESULTS		TT 108.0 (NET)		VM 96.816 (NET)	PM 3.11 (AVG)	TM 95.4 (AVG)		0.868 (AVG)	PST -0.64 (AVG)	TS 260.8 (AVG)	627.35 (AVG)	24.74 (AVG)	3690.8 (AVG)

POINT NO.	POINT DISTANCE (IN)	CLOCK TIME	TIME INCRMT (MINS)	DRY GAS METER (CF)	ORIFICE DELTA H (IN. H2O)	GAS TEMPERATURES IN (DEGREES F)	GAS TEMPERATURES OUT (DEGREES F)	VELOCITY HEAD (IN. H2O)	STACK PRESS (IN. H2O)	STACK TEMP (DEGR. F)	(VEL. HD.)X (STACK TEMP.) (IN. H2O-DEG R)	SQR ROOT OF PREVIOUS RESULT	STACK GAS VEL (AFPM)
RUN NO. - HM-2													
A-1	0.0	804.0	0.0	68.230	2.50	60.0	55.0	0.720	-0.66	252.0	512.64	22.64	3439.9
A-2	0.0	807.0	3.0	70.400	2.80	68.0	58.0	0.760	-0.66	275.0	558.88	23.63	3598.8
A-3	0.0	810.0	6.0	72.800	2.75	74.0	58.0	0.790	-0.66	309.0	607.51	24.65	3746.7
A-4	0.0	813.0	9.0	75.100	2.60	82.0	60.0	0.820	-0.66	320.0	639.60	25.29	3842.3
A-5	0.0	816.0	12.0	77.400	2.80	85.0	60.0	0.900	-0.66	323.0	704.70	26.55	4033.1
A-6	0.0	819.0	15.0	79.900	3.00	92.0	60.0	0.950	-0.66	319.0	740.85	27.20	4133.8
A-7	0.0	822.0	18.0	82.200	3.00	95.0	62.0	0.940	-0.66	318.0	731.32	27.04	4108.6
A-8	0.0	825.0	21.0	84.800	3.50	88.0	64.0	0.960	-0.66	321.0	753.76	25.57	3884.6
A-9	0.0	828.0	24.0	87.100	4.10	92.0	64.0	1.200	-0.66	335.0	851.60	28.84	4381.2
A-10	0.0	831.0	27.0	90.000	3.80	98.0	65.0	1.100	-0.66	334.0	785.40	28.02	4257.8
A-11	0.0	834.0	30.0	92.600	3.80	102.0	66.0	1.100	-0.66	336.0	787.60	28.06	4263.7
A-12	0.0	837.0	33.0	95.200	3.80	108.0	68.0	1.100	-0.66	338.0	800.80	28.30	4299.3
STOP		841.0	36.0	98.010									
B-1	0.0	859.0	0.0	98.010	1.20	93.0	70.0	0.350	-0.66	250.0	248.50	15.76	2395.8
B-2	0.0	902.0	3.0	99.700	1.80	95.0	70.0	0.540	-0.66	254.0	385.56	19.64	2983.2
B-3	0.0	905.0	6.0	0.0	2.05	100.0	72.0	0.600	-0.66	264.0	446.40	21.13	3209.9
B-4	0.0	908.0	9.0	103.700	2.10	105.0	73.0	0.620	-0.66	282.0	466.24	21.59	3280.5
B-5	0.0	911.0	12.0	105.600	2.20	110.0	74.0	0.620	-0.66	292.0	466.24	21.59	3280.5
B-6	0.0	1913.0	15.0	107.700	2.10	70.0	70.0	0.610	-0.66	295.0	468.10	21.64	3287.0
B-7	0.0	1916.0	18.0	110.000	2.90	80.0	70.0	0.850	-0.66	210.0	408.78	20.22	3071.4
B-8	0.0	1919.0	21.0	112.200	3.00	92.0	70.0	1.100	-0.66	222.0	579.78	24.08	3658.8
B-9	0.0	1922.0	24.0	114.900	3.80	100.0	70.0	1.050	-0.66	234.0	763.40	27.63	4197.7
B-10	0.0	1925.0	27.0	117.600	3.40	106.0	74.0	1.000	-0.66	255.0	730.75	27.40	4162.8
B-11	0.0	1928.0	30.0	120.000	3.40	110.0	75.0	0.980	-0.66	275.0	735.80	27.11	4118.9
B-12	0.0	1931.0	33.0	122.500	3.40	110.0	76.0	0.980	-0.66	288.0	733.04	27.07	4113.4
STOP		1934.0	36.0	125.276									
OVERALL RESULTS			TT 72.0 (NET)	VM 57.838 (NET)	PM 2.93 (AVG)		TM 79.3 (AVG)	0.860 (AVG)	PST -0.66 (AVG)	TS 270.7 (AVG)	625.84 (AVG)	24.84 (AVG)	3773.9 (AVG)

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LISTING OF FIELD DATA AND RESULTS AT EACH POINT

POINT NO.	POINT DISTANCE (IN)	CLOCK TIME	TIME INCRMT (MINS)	DRY GAS METER (CF)	ORIFICE DELTA H (IN. H2O)	GAS TEMPERATURES IN (DEGREES F)	GAS TEMPERATURES OUT (DEGREES F)	VELOCITY HEAD (IN. H2O)	STACK PRESS (IN. H2O)	STACK TEMP (DEGR. F)	(VEL. HD.)X (STACK TEMP.) (IN. H2O-DEG R)	SQR ROOT OF PREVIOUS RESULT	STACK GAS VEL (APPM)
RUN NO. - HM-3													
A-1	0.0	1235.0	0.0	125.587	1.60	80.0	78.0	0.470	-0.62	220.0	319.60	17.88	2719.8
A-2	0.0	1238.0	3.0	127.400	2.00	84.0	78.0	0.580	-0.62	222.0	395.56	19.89	3024.9
A-3	0.0	1241.0	6.0	129.400	2.10	90.0	78.0	0.620	-0.62	248.0	437.72	20.92	3182.8
A-4	0.0	1244.0	9.0	131.500	2.20	96.0	80.0	0.650	-0.62	264.0	485.40	21.57	3361.1
A-5	0.0	1247.0	12.0	133.600	2.20	100.0	80.0	0.640	-0.62	265.0	484.00	21.54	3276.2
A-6	0.0	1250.0	15.0	135.700	2.30	104.0	80.0	0.660	-0.62	266.0	478.16	21.89	3329.3
A-7	0.0	1253.0	18.0	137.800	2.60	108.0	82.0	0.750	-0.62	265.0	563.75	23.32	3546.6
A-8	0.0	1256.0	21.0	140.000	2.80	106.0	82.0	0.820	-0.62	266.0	595.32	24.40	3710.9
A-9	0.0	1259.0	24.0	0.0	3.10	112.0	85.0	0.870	-0.62	268.0	633.36	25.17	3827.7
A-10	0.0	1302.0	27.0	144.700	4.10	112.0	86.0	1.200	-0.62	268.0	873.60	29.56	4495.5
A-11	0.0	1305.0	30.0	147.400	5.80	115.0	88.0	1.100	-0.62	267.0	799.78	28.28	4301.8
A-12	0.0	1308.0	33.0	150.300	4.20	115.0	88.0	1.200	-0.62	265.0	870.00	29.50	4486.1
STOP		1311.0	36.0	152.700									
B-1	0.0	1336.0	0.0	152.700	1.40	82.0	80.0	0.400	-0.62	217.0	270.80	16.46	2502.8
B-2	0.0	1339.0	3.0	154.300	2.25	90.0	81.0	0.650	-0.62	220.0	442.88	21.02	3197.4
B-3	0.0	1342.0	6.0	0.0	2.35	96.0	81.0	0.670	-0.62	221.0	456.27	21.36	3248.8
B-4	0.0	1345.0	9.0	157.800	2.25	100.0	81.0	0.640	-0.62	231.0	442.24	21.03	3198.4
B-5	0.0	1348.0	12.0	161.100	2.40	104.0	82.0	0.680	-0.62	231.0	469.88	21.68	3298.9
B-6	0.0	1351.0	15.0	163.300	2.40	106.0	82.0	0.680	-0.62	238.0	474.64	21.79	3313.3
B-7	0.0	1354.0	18.0	165.500	3.40	108.0	84.0	0.990	-0.62	240.0	695.80	26.32	4003.0
B-8	0.0	1357.0	21.0	0.0	3.50	114.0	86.0	1.050	-0.62	243.0	738.15	27.17	4132.2
B-9	0.0	1400.0	24.0	170.800	4.30	118.0	86.0	1.200	-0.62	238.0	837.60	28.94	4401.7
B-10	0.0	1403.0	27.0	173.900	4.20	118.0	86.0	1.200	-0.62	228.0	825.60	28.73	4370.1
B-11	0.0	1406.0	30.0	176.500	4.50	122.0	90.0	1.300	-0.62	212.0	873.60	29.56	4496.3
B-12	0.0	1409.0	33.0	179.700	4.50	123.0	91.0	1.300	-0.62	213.0	874.90	29.58	4498.7
STOP		1412.0	36.0	184.429									
OVERALL RESULTS			TT 72.0 (NET)	VM 58.842 (NET)	PM 2.94 (AVG)	TM 93.7 (AVG)		0.847 (AVG)	PST -0.62 (AVG)	TS 241.9 (AVG)	594.85 (AVG)	24.06 (AVG)	3660.0 (AVG)

APPENDIX 9

SAMPLE CALCULATIONS

SAMPLE CALCULATIONS

Particulate Isokinetic Sampling

I. Calculations for stack volume and Isokinetic Ratio

Time	Dry Gas Meter Ft^3	Pitot ΔP, In. H_2O	Orifice ΔH, In. H_2O	Dry Gas Temp °F In	Out	Stack Static Pressure In. H_2O	Stack Temp °F
T	VM	ΔP	PM	TMI	TMO	PST	TS

1. DN = Nozzle Diameter, inches

2. PB = Barometric Pressure, inches Hg

3. TT = Net Sampling Time, minutes

4. VM = VM final - VM initial = Sample Gas Volume, ft^3

5. TM = Average Dry Gas Temperature at Meter, °F

$$TM = \frac{\text{Avg. TMI} + \text{Avg. TMO}}{2}$$

6. PM = Average Orifice Pressure Drop, inches H_2O

PM = Avg. ΔH

7. Volume of dry gas sampled at standard conditions[a], DSCF

$$VMSTD = \frac{17.65 \times VM \times Y \left(BP + \frac{PM}{13.6}\right)}{(TM + 460)}$$

8. VW = Total Water Collected = gm H_2O Silica gel + ml Imp. H_2O = ml

9. Volume of water vapor at standard conditions[b], SCF

VW gas = 0.0471 x VW = SCF

10. Percent moisture in stack gas

$$\%\ M = \frac{100 \times VW\ gas}{VM\ STD + VW\ gas}$$

11. Mole fraction of dry gas

$$MD = \frac{100 - \%M}{100}$$

12. Molecular weight of dry stack gas

$$MWD = \left(\%CO_2 \times \frac{44}{100}\right) + \left(\%O_2 \times \frac{32}{100}\right) + \left[\left(\%CO + \%N_2\right) \times \frac{28}{100}\right]$$

12A. %EA = % Excess Air $= \dfrac{[(\%\ O_2) - 0.5\ (\%CO)]}{0.264\ (\%N_2) - [(\%O_2) + 0.5\%\ (CO)]} \times 100$

13. Molecular weight of wet stack gas

$$MW = MWD \times MD + 18\ (1 - MD)$$

14. AS = Stack Area, square inches

15. PS = Stack Pressure, inches Hg

$$PS = PB \pm \text{Avg. PST}$$

NOTE: $\text{PST in. Hg.} = \dfrac{\text{PST in. } H_2O}{13.6}$

16. TS = Average Stack Temperature, °F

TS = Average TS

17. SDE = Average $\sqrt{\text{Velocity Head } (\Delta P) \times (\text{Stack Temperature} + 460)}$

(Calculated each line)

$$SDE = \text{Avg } \sqrt{\Delta P \times (TS + 460)}$$

18. Stack gas velocity at stack conditions, fpm

$$VS = 5130 \times Cp \times \text{Avg}(SDE) \times \left[\frac{1}{PS \times MW}\right]^{1/2} = FPM$$

Cp = pitot tube coefficient

19. Stack gas volumetric flow rate at standard conditions[c], DSCFM

$$Q_s = \frac{0.123 \times VS \times AS \times MD \times PS}{(TS + 460)} = DSCFM$$

20. Stack gas volumetric flow rate at stack conditions, ACFM

$$Q_a = \frac{.05667 \times QS\ (TS + 460)}{PS \times MD} = ACFM$$

21. Percent isokinetic

$$\%I = \frac{1.032 \times (TS + 460) \times VMSTD}{VS \times TT \times PS \times MD \times (DM)^2}$$

NOTES: [a]Dry standard cubic feet at 69°F, 29.92 in. Hg.

[b]Standard conditions at 68°F, 29.92 in. Hg.

[c]Dry standard cubic feet per minute at 68°F, 29.92 in. Hg.

II. Calculations for grain loading and emission rates

22. Particulate, gr/DSCF

$$\text{gr/DSCF} = 0.0154 \times \frac{\text{mg}}{\text{VMSTD}}$$

23. Particulate at stack conditions, gr/ACF

$$\text{gr/ACF} = \frac{17.65 \text{ gr/DSCF} \times \text{PS} \times \text{MD}}{(\text{TS} + 460)}$$

24. Particulate, lb/hr conc. method

$$\text{lb/hr} = 0.00857 \times \text{gr/DSCF} \times \text{QS}$$

25. Particulate lb/hr area method = $0.132 \times \frac{\text{gms particulate} \times \text{AS}}{\left(\frac{\text{DN}^2}{2}\right) \times \text{TT}}$

26. Particulate, combustion

$$\frac{\text{lb/hr}}{10^6 \text{ BTU/hr}}$$

27. Particulate, process lb/ton

$$\text{lb/ton} = \frac{\text{lb/hr}}{\text{tons/hr}}$$

28. Particulate, lb/MMBTU, F-Factor Method =

Using O_2 =

$$\frac{0.0154 \times \text{mg} \times \text{F-Factor} \times 20.9}{7000 \times \text{VMSTD} \times (20.9 - \%O_2)}$$

Using CO_2:

$$\frac{0.0154 \times \text{mg} \times \text{F-Factor} \times 100}{7000 \times \text{VMSTD} \times \% CO_2}$$

29. F-Factor, dscf/mmBtu

O_2 Format:

$$\text{F-Factor} = \frac{10^6(3.64(\%H)+1.53(\%C)+0.57(\%S)+0.14(\%N)-0.46(\%O_2))}{\text{GCV}}$$

CO_2 Format:

$$\frac{10^6(0.321)(\%C)}{\text{GCV}}$$