am test inc.

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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.

SOURCE EMISSION EVALUATION

MAY 31, 1988

Prepared For:

RECEIVED
JUN - 7 1988
OAPCA

LAKESIDE INDUSTRIES
BARBER GREEN ASPHALT PLANT
ABERDEEN , WASHINGTON
MAY 25, 1988

Submitted by:

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We certify that the information contained herein is accurate and complete to the best of our knowledge.

TABLE OF CONTENTS

	Pages
INTRODUCTION	1
SUMMARY OF RESULTS	2-3
Methods 1-5 Summary of Results	3
SOURCE OPERATION	4
DISCUSSION	5-9
SAMPLING PROCEDURES - OVERVIEW	5
SAMPLING PROCEDURES - SPECIFIC	5-6
SAMPLE TRAIN	6-7
SAMPLE CLEAN-UP AND ANALYSIS	8-9
QUALITY ASSURANCE	10
CALCULATION OF RESULTS	11
Method 5 Computer Printouts of Results	12-14
APPENDIX	
Figure 1. Location of sample ports and traverse points	15
Method 1 - Minimum Number of Traverse Points	16
Method 1 - Location of Traverse Points	17
Method 2 - Stack Gas Velocity	18
Method 3 - Molecular Weight & Excess Air Calc.	18
Method 4 - Stack Gas Moisture	19
Method 5 - Particulate Emission Conc. Calc.	20-21
Sample Calculation Sheet	22
Figure 2. Particulate Sampling Train Schematic	23
Dry Gas Meter Calibration Information	24
Air Quality Division Organizational Structure	25
Professional Resumes of Project Personnel	26-28
Am Test Laboratory - Information and Services	29-31
Air Quality Division Quality Assurance Plan	32-35
Am Test Laboratory Quality Assurance and Quality Control	36-39
Process Information	40
Field Data Sheets	41-43
Sampling Port Diagram	44

INTRODUCTION

The purpose of this source emission evaluation performed at Lakeside Industries' asphaltic concrete plant located in Aberdeen, Washington was to quantify the particulate matter emission concentration at the inlet to the baghouse ID fan. This batch asphalt plant was manufactured by Barber Green, and is equipped with a WAG baghouse for controlling particulate matter emissions. The plant was producing approximately 165 tons per hour of mix on the day of testing. Three (3) particulate emission concentration tests were performed by Am Test, Inc. on May 25, 1988 utilizing Environmental Protection Agency (EPA) procedures specified in the July 1, 1987 Title 40 Code of Federal Regulations, Part 60 (40 CFR 60), Appendix A, Methods 1-5. Methods 1 and 2 were performed to determine the stack gas velocity and volumetric flow rate. Method 3 was performed to determine the stack gas molecular weight and composition of the stack gas (carbon monoxide, carbon dioxide, and oxygen content). Method 4 was performed to determine the moisture content of the stack gas. Method 5 was performed to determine the particulate emission concentration of the stack gas. The sampling and analysis procedures used for these tests meet with Olympic Air Pollution Control Authority (OAPCA) procedures. Mr. James A. Guenthoer of the Air Quality Division of Am Test, Inc., Redmond, Washington performed the field sampling and in-field analysis. Data reduction and final report preparation was performed by Mr. Kris A. Hansen, Ms. Angela F. Blaisdell, and Ms. Jan M. Widmeyer of Am Test. This project was coordinated by Mr. Harold Nickel of Lakeside Industries. Mr. Ron Kok was the plant operator for Lakeside Industries on the test day. Mr. James P. Werner of the Olympic Air Pollution Control Authority (OAPCA) observed the field testing and read opacity.

SUMMARY OF RESULTS

The results of the three (3) Method 1-5 compliance tests for determining particulate matter emission concentration, collected at Lakeside Industries batch plant located in Aberdeen, Washington on May 25, 1988 are summarized in Table 1 below, and on page 3 on a computer printout titled "Methods 1-5 Summary of Results".

Table 1. Summary of particulate matter emission concentration from samples collected May 25, 1988 at Lakeside Industries batch asphalt plant located in Aberdeen, Washington.

Sample Run #	Am Test Lab #	Total Partic. Conc. gr/dscf	Total Partic. Conc. mg/dscm	Mass Emission Rate lb/hr	Air Flow dscf/min	
1	808068	0.009	19.9	1.62	21741	21769
2	808069	0.007	16.3	1.28	20918	20,794
3	808070	0.006 .0066	14.8	1.05	18874	18,902
Average		0.007	17.0	1.32	20511	

JPW = 0.0075 1.33 pounds/hour

The total particulate emission concentration is presented in units of grains per dry standard cubic foot (gr/dscf) and milligrams per dry standard cubic meter (mg/dscm). The mass emission rate is presented in units of pounds per hour (lb/hr). Airflow is also presented in units of dry standard cubic feet per minute (dscf/min). An acceptable leak check of less than 0.02 cfm at the highest vacuum rate (or greater) used during the test preceded and followed each run. The average percentage isokinetics for each run were within the acceptable limits of 100 ± 10%. Computer printouts which detail the complete results of runs 1-3 may be found following the "Calculation of Results" section of this report on pages 12-14. Field data sheets are included in the Appendix.

METHODS 1-5 - SUMMARY OF RESULTS
AM TEST, INC. - AIR QUALITY DIVISION

FILE NAME: METHOD5\LAKE-SUM
CLIENT: LAKESIDE INDUSTRIES
LOCATION: ABERDEEN, WASH
SAMPLE SITE: ID FAN INLET
OPERATORS: JIM GUENTHOER
CONTACT: HAROLD NICKEL

	RUN #1	RUN #2	RUN #3	AVERAGE
LAB #:	808068	808069	808070	
DATE:	5/25/88	5/25/88	5/25/88	
START TIME:	0722	0907	1037	
STOP TIME:	0836	1007	1137	
SAMPLE TIME (Minutes):	60.0	60.0	60.0	
VOLUME SAMPLED (Cubic Feet):	38.179	39.008	54.720	43.969
VOLUME SAMPLED (Dry Std. Cubic Feet):	38.377	38.105	53.261	43.248
STACK GAS MOISTURE (Percent):	27.76	28.93	31.65	29.45
BAROMETRIC PRESURE (Inches of Hg):	30.24	30.24	30.25	30.24
STATIC PRESSURE (Inches of H2O):	-11.00	-11.00	-11.00	-11.00
STACK PRESSURE (Inches of Hg):	29.43	29.43	29.44	29.43
STACK TEMPERATURE (Degrees F.):	235.6	251.3	251.8	246.2
STACK TEMPERATURE (Degrees R.):	695.6	711.3	711.8	706.2
CARBON DIOXIDE (Percent):	4.0	3.5	3.5	3.7
OXYGEN (Percent):	14.3	14.6	13.7	14.2
CARBON MONOXIDE (Percent):	0.0	0.0	0.0	0.0
MOLECULAR WEIGHT (Dry, Lb/Lb-Mole):	29.21	29.14	29.11	29.15
MOLECULAR WEIGHT (Wet, Lb/Lb-Mole):	26.10	25.92	25.59	25.87
AVERAGE VELOCITY HEAD (Inches of H2O):	0.60	0.59	0.51	0.57
PITOT TUBE Cp:	0.845	0.845	0.845	0.845
VELOCITY (Feet/Second):	53.5	53.5	50.2	52.4
STACK DIAMETER (Inches):	48.00	48.00	48.00	48.00
STACK AREA (Square Feet):	12.566	12.566	12.566	12.566
AIRFLOW (Dry Std. Cubic Feet per Min.):	21741	20918	18874	20511
AIRFLOW (Actual Cubic Feet per Min.):	40307	40306	37828	39481
NOZZLE DIAMETER (Inches):	0.254	0.254	0.317	0.275
ISOKINETICS (Percent):	105	108	108	107
PARTICULATE EMISSION CONC. (gr/dscf):	0.009	0.007	0.006	0.007
PARTICULATE EMISSION CONC. (mg/dscm):	19.9	16.3	14.8	17.0
MASS EMISSION RATE (Lb/Hr):	1.62	1.28	1.05	1.32

SOURCE OPERATION

Lakeside Industries' batch asphalt plant located in Aberdeen, Washington was manufactured by Barber Green. This plant (model BE42x240), rebuilt in 1988, is equipped with a WAG baghouse to control particulate matter emissions. The WAG baghouse contains 800 Nomex bags. The pressure drop across the baghouse during these tests was 3 inches of water pressure. According to plant personnel, the plant operated at an average production rate of 165 tons/hour, with a gravel moisture of approximately 6-7 percent, and an asphalt discharge temperature of 312° F. Process and production conditions were considered to be representative, according to plant personnel. A process information sheet, completed by Mr. Ron Kok of Lakeside Industries, is included in the Appendix of this report.

DISCUSSION

SAMPLING PROCEDURES - OVERVIEW

Sampling procedures specified in the July 1, 1987 Title 40 Code of Federal Regulations, Part 60 (40 CFR 60), Appendix A, Methods 1-5 were followed throughout this project. Methodology suggested in the EPA's Air Pollution Training Institute "Course 450 - Source Sampling For Particulate Pollutants" and quality assurance procedures outlined in the EPA's reference manual titled Quality Assurance Handbook for Air Pollution Measurement Systems, Volume 3, EPA-600/4-77-027b, along with current updates, were used with respect to quality assurance and testing protocol.

SAMPLING PROCEDURES - SPECIFIC

The 48 inch diameter circular duct had one (1) available sampling port. The stack axis is horizontal, therefore, only one (1) sample traverse is required by Olympic Air Pollution Control Authority (OAPCA). See page 44 for diagrams provided to Lakeside by OAPCA. The sample port was located 97 inches upstream and 30 inches downstream from the nearest flow disturbance. Twelve (12) traverse points were selected according to Method 1 criteria (40 CFR 60, July 1, 1987). Figure 1 located in the Appendix of this report is a schematic of the stack and the point locations selected. Each point was sampled for 5 minutes, for a total sampling time for each Method 5 run of 60 minutes. The sample probe was marked with heat resistant tape to indicate the proper point location.

Stack condition measurements were performed prior to testing. A sample nozzle was chosen and isokinetic operating parameters were established utilizing a Hewlett-Packard 41CX programmable calculator. The sampling nozzle, probe and

prefilter connective glassware were all cleaned and rinsed prior to use. The sample train was assembled and determined to be leak free following the procedures outlined in Method 5. Before each test, a final check was made to assure that the plant was operating at the desired production rate and the desired operating parameters. A final check was made of the sample box and probe heat temperatures. Ice was added to the condenser section. The sample nozzle was positioned in the stack at the first sample point. The sample pump was then turned on and the gas sampling rate was adjusted for isokinetic sampling. Sampling proceeded isokinetically at each of the 12 traverse points. The sample probe was removed from the stack and a post-test leak check was performed according to Method 5 procedures. Care was taken to assure that the nozzle tip did not touch the port nipple. Combustion gas analyses were performed utilizing automatic analyzers. Integrated bag samples were collected during each run to be analyzed using the analyzers for calculating the molecular weight of the stack gas. ok pw

SAMPLE TRAIN

The sample train used for collecting particulate matter samples was an EPA Method 5 design with modifications as shown in Figure 2 which is located in the Appendix of this report. The stainless steel button hook nozzle used during runs 1 and 2 had a diameter of 0.254 inches as measured on-site with inside calipers. The nozzle used during run 3 had a diameter of 0.317 inches. A stainless steel probe with a heated stainless steel liner was used for these tests. The probe was equipped with "S" type pitot tubes and a thermocouple sensor. A thermocouple indicator was used to measure the stack gas temperature at each sample point. The Fluke digital thermocouple indicator has been re-certified by the manufacturer to be accurate within ±1 degree Fahrenheit. A field check with 32 degree icewater was performed. A glass filter assembly containing a 125 millimeter Whatman 934-AH

glass fiber filter was enclosed in a temperature-controlled heated sample box. The average box temperature was maintained at 248° F ± 25° F. The nozzle, probe liner, prefilter connective glassware and filter is often referred to as the "front-half" of the sample train. Following the filter is a condenser section which, by convention, is referred to as the "back-half". The condenser section consisted of a modified Greenburg-Smith bubbler containing 100 milliliters (ml) of deionized, distilled water, an impinger also containing 100 ml of water, an empty bubbler, and a bubbler containing indicating silica gel desiccant. The back-half was maintained at a temperature below 68° F by adding ice to the condenser section throughout sampling. The sample train was connected to a control box by means of an umbilical cord which contains a vacuum hose, pitot lines, thermocouple wires and a 4-wire electrical cord. The control box (meter box) was used to monitor stack conditions and to facilitate isokinetic sampling. The control box consists of a diaphragm pump which is used to pull the stack gas through the sample train, fine and coarse metering valves to control the sampling rate, a vacuum gauge which measures the pressure drop from the sampling nozzle to the metering valves, and a dry gas meter. The dry gas meter was recently calibrated using a spirometer at the Washington State Department of Ecology laboratory in Redmond, Washington. At the outlet of the dry gas meter is a calibrated orifice which is used to isokinetically control the flow of gas through the metering system. The pressure drop across the orifice was monitored with both low and high range magnehelic gauges. The pitot tubes utilized to measure stack gas velocity are connected to the control box via the umbilical cord. The control box contains low and high range magnehelic gauges which are used for the velocity measurement.

SAMPLE CLEAN-UP AND ANALYSIS

Following sample collection, the Method 5 sample box was transferred to a room free from air disturbances and airborne particulate matter. The filter was transferred to a petri dish labeled with the sample date, client name and run number. This filter portion of the particulate catch is referred to as the "A" section. Care was taken to assure that any loose particulate matter and filter mat were quantitatively transferred to the petri dish. The filters were then placed in an oven and baked at 103° C for 2 hours, then they were transferred to a desiccator containing indicating silica gel desiccant for at least 6 hours of desiccation prior to obtaining weights. The same baking and weighing procedure was followed to obtain the tare weights for the filters. The tare and final weights were made using a Mettler AE163 electronic balance set to a time integrating mode with a readability of 0.1 milligrams. The filters containing particulate matter were weighed to a constant weight of ± 0.5 milligrams. The interval between weighings was at least 6 hours. These weights were recorded in a bound laboratory notebook.

The contents of the nozzle, probe liner and prefilter connective glassware were quantitatively transferred to the "B" section storage container labeled with sample date, client name, and run number following each run. Several rinses of acetone, with simultaneous loosening of particulate matter using a clean nylon brush, were used for the front-half clean-up. An iodine flask with a female ball joint end was attached to the male ball joint end of the probe to assure that no particulate matter was lost during the rinsing and brushing of the probe. The contents of the iodine flask were quantitatively transferred to the "B" section storage container. The contents of this "B" section acetone rinse was transferred to a tared, graduated 150 milliliter beaker. The volume of acetone was recorded and the beakers were placed on a hot plate with the temperature set on low. The acetone was evaporated

under close supervision at a temperature lower than the boiling point of acetone. A tared beaker with 100 milliliters of acetone from the same lot was handled in an identical fashion to the "B" section samples as a control. The tare and final weights of the beakers were obtained following at least 6 hours of desiccation. The samples and acetone blanks were weighed to a constant weight of ± 0.5 milligrams at 6 hour or greater intervals.

The bubblers and impingers utilized for the condenser section, or "back-half" of the sample train were weighed with a readability of ± 0.1 grams before and after sampling on a Mettler electronic top loading balance. The difference between the initial and final weights of the condenser section constitute the amount of moisture gain during the run. The percent moisture was calculated and did not exceed the theoretical psychrometric chart value. The particulate and moisture determination weights are included on the "Method 5 - Particulate Emission Concentration Results" computer printouts which follow the "Calculation of Results" section.

QUALITY ASSURANCE

A strict quality assurance program was followed throughout preparation, sampling, analysis, and report preparation. This program includes recent equipment calibrations, careful chain-of-custody procedures, the use of ACS quality or better reagents, analysis of control samples, and "by-hand" calculation checks of computerized results.

The sample nozzle used for these tests was calibrated on-site before sampling using inside calipers readable to 0.001 inches. The dry gas meter used was recently calibrated against a spirometer at the Washington State Department of Ecology (DOE) in Redmond, Washington. The "S" type pitot tubes used have been recently calibrated at the DOE laboratory utilizing a wind tunnel and a standard "P" type pitot tube. The digital Fluke thermocouple indicator used to obtain temperature measurements has been recertified by the manufacturer to have an accuracy of ± 1 degree Fahrenheit.

In addition to quantitative clean-up and analysis procedures, acetone, and filter blanks were carried throughout the analysis procedures. All gravimetric samples were weighed to constant weights of ± 0.5 milligrams after desiccation. Additional information with respect to the Am Test, Inc. laboratory quality assurance and quality control protocol is included in the Appendix of this report.

CALCULATION OF RESULTS

The Method 1-5 test results were calculated in accordance with current EPA 40 CFR 60 Method 1-5 and Olympic Air Pollution Control Authority (OAPCA) criteria. Copies of these equations are included in the Appendix. Final result calculations were performed using Hewlett-Packard Vectra computer systems. A sample "by-hand" calculation was completed for run 1 using a Hewlett-Packard 41CX calculator, and may be found in the Appendix of this report.

METHOD 5 - PARTICULATE EMISSION CONCENTRATION RESULTS
AM TEST, INC. - AIR QUALITY DEPARTMENT

FILE NAME:	LAKEABR1	LAB #:	808068
CLIENT:	LAKESIDE INDUSTRIES	START TIME:	07:22 O'CLOCK
LOCATION:	ABERDEEN, WA	STOP TIME:	08:36 O'CLOCK
SAMPLE SITE:	ID FAN INLET	SAMPLE TIME:	60.0 MINUTES
SAMPLE DATE:	MAY 25, 1988	PRODUCTION RATE:	165 TONS/HOUR
RUN #:	1-METHOD 5		
OPERATORS:	J. GUENTHOER		
CONTACT:	HAROLD NICKEL		

FINAL WT. OF H2O G.	INIT.WT. OF H2O G	NET WT. OF H2O G.
784.9	581.4	203.5
668.5	592.6	75.9
508.1	489.4	18.7
842.8	827.6	15.2
TOTAL H2O GAIN:		313.3
TOTAL VOLUME (SCF)		14.75
PERCENT MOISTURE:		27.76
Bws:		0.2776

PITOT Cp:	0.845
NOZZLE DIA INCHES:	0.254
NOZZLE AREA FT^2:	0.0004
STACK DIA. INCHES:	48.00
STACK AREA FT^2:	12.566
METER TEMP. DEG F:	61.2
BAROM. PRES. "HG:	30.24
STATIC PRES. "H2O:	-11.00
STACK PRES. "HG:	29.43
ORIFICE PRES "H2O:	0.733
METER PRES. "HG:	29.49

INIT. METER VOLUME	745.861
FINAL METER VOLUME	784.040
VOLUME SAMPLED:	38.179
STD VOLUME (DSCF):	38.377
STD VOLUME (DSCM):	1.087
Y FACTOR:	0.98

AVERAGE % CO2:	4.0
AVERAGE % O2:	14.3
AVERAGE % CO:	0.0
STACK GAS MW. DRY:	29.21
STACK GAS MW. WET:	26.10

****

SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.	SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.
1	0.45	219	7	0.64	245
2	0.50	200	8	0.68	247
3	0.66	211	9	0.58	248
4	0.52	226	10	0.80	251
5	0.45	234	11	0.80	252
6	0.64	241	12	0.60	253

****

PERCENT ISOKINETICS:	105 %		
STACK TEMPERATURE:	235.6 DEG. F.	695.6	DEG. R.
AVERAGE VELOCITY HEAD:	0.60 " OF H2O		
STACK GAS VELOCITY:		53.5	FT/SEC
STACK GAS AIR FLOW:	40306.8 ACF/MIN	21740.9	DSCF/MIN
PARTICULATE EMISSION CONCENTRATION:		0.009	GR/DSCF
PARTICULATE EMISSION CONCENTRATION:		19.9	MG/DSCM
PARTICULATE MATTER EMISSION RATE:		1.62	LB/HR

FRONTHALF PARTICULATE MASS LOADING

FILTER NUMBER: #125-209	
TARE WEIGHT OF FILTER IN GMS.:	0.7945
FINAL WEIGHT OF FILTER IN GMS.:	0.8105
NET WEIGHT OF PARTIC. MATTER IN GMS.:	0.0160
BEAKER NUMBER: #88-977	
TARE WEIGHT OF BEAKER IN GMS.:	68.1260
FINAL WEIGHT OF BEAKER IN GMS.:	68.1319
NET WEIGHT OF PARTIC. MATTER IN GMS.:	0.0059
VOLUME OF ACETONE IN MLS.:	120.0
TARE WEIGHT OF ACETONE IN GMS.:	79.4549
FINAL WEIGHT OF ACETONE IN GMS.:	79.4551
VOLUME OF ACETONE IN MLS.:	100.0
NET CONTRIBUTION OF ACETONE IN MG/ML:	0.0020
TOTAL FRONTHALF PARTIC. MATTER IN GMS.:	0.0217

0.0219 g

12

METHOD 5 - PARTICULATE EMISSION CONCENTRATION RESULTS
AM TEST, INC. - AIR QUALITY DEPARTMENT

FILE NAME:	LAKEABR2	LAB #:	808069
CLIENT:	LAKESIDE INDUSTRIES	START TIME:	09:07 O'CLOCK
LOCATION:	ABERDEEN, WA	STOP TIME:	10:07 O'CLOCK
SAMPLE SITE:	ID FAN INLET	SAMPLE TIME:	60.0 MINUTES
SAMPLE DATE:	MAY 25, 1988	PRODUCTION RATE:	165 TONS/HOUR
RUN #:	2-METHOD 5		
OPERATORS:	J. GUENTHOER		
CONTACT:	HAROLD NICKEL		

FINAL WT. OF H2O G.	INIT.WT. OF H2O G	NET WT. OF H2O G.
832.2	565.6	266.6
640.8	592.0	48.8
494.3	490.3	4.0
780.8	770.7	10.1
TOTAL H2O GAIN:		329.5
TOTAL VOLUME (SCF)		15.51
PERCENT MOISTURE:		28.93
Bws:		0.2893

PITOT Cp:	0.845
NOZZLE DIA INCHES:	0.254
NOZZLE AREA FT^2:	0.0004
STACK DIA. INCHES:	48.00
STACK AREA FT^2:	12.566
METER TEMP. DEG F:	76.3
BAROM. PRES. "HG:	30.24
STATIC PRES. "H2O:	-11.00
STACK PRES. "HG:	29.43
ORIFICE PRES "H2O:	0.722
METER PRES. "HG:	29.48

INIT. METER VOLUME	784.426
FINAL METER VOLUME	823.434
VOLUME SAMPLED:	39.008
STD VOLUME (DSCF):	38.105
STD VOLUME (DSCM):	1.079
Y FACTOR:	0.98

AVERAGE % CO2:	3.5
AVERAGE % O2:	14.6
AVERAGE % CO:	0.0
STACK GAS MW. DRY:	29.14
STACK GAS MW. WET:	25.92

****

SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.	SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.
1	0.42	207	7	0.56	259
2	0.45	234	8	0.64	263
3	0.50	243	9	0.68	262
4	0.62	251	10	0.60	261
5	0.56	255	11	0.78	261
6	0.52	258	12	0.78	261

****

PERCENT ISOKINETICS:	108 %		
STACK TEMPERATURE:	251.3 DEG. F.	711.3	DEG. R.
AVERAGE VELOCITY HEAD:	0.59 " OF H2O		
STACK GAS VELOCITY:		53.5	FT/SEC
STACK GAS AIR FLOW:	40306.4 ACF/MIN	20918.2	DSCF/MIN
PARTICULATE EMISSION CONCENTRATION:		0.007	GR/DSCF
PARTICULATE EMISSION CONCENTRATION:		16.3	MG/DSCM
PARTICULATE MATTER EMISSION RATE:		1.28	LB/HR

FRONTHALF PARTICULATE MASS LOADING

FILTER NUMBER: #125-210	
TARE WEIGHT OF FILTER IN GMS.:	0.7867
FINAL WEIGHT OF FILTER IN GMS.:	0.7924
NET WEIGHT OF PARTIC. MATTER IN GMS.:	0.0057
BEAKER NUMBER: #88-978	
TARE WEIGHT OF BEAKER IN GMS.:	65.4225
FINAL WEIGHT OF BEAKER IN GMS.:	65.4347
NET WEIGHT OF PARTIC. MATTER IN GMS.:	0.0122
VOLUME OF ACETONE IN MLS.:	140.0
TARE WEIGHT OF ACETONE IN GMS.:	79.4549
FINAL WEIGHT OF ACETONE IN GMS.:	79.4551
VOLUME OF ACETONE IN MLS.:	100.0
NET CONTRIBUTION OF ACETONE IN MG/ML:	0.0020
TOTAL FRONTHALF PARTIC. MATTER IN GMS.:	0.0176

.0179

METHOD 5 - PARTICULATE EMISSION CONCENTRATION RESULTS
AM TEST, INC. - AIR QUALITY DEPARTMENT

FILE NAME:	LAKEABR3	LAB #:	808070
CLIENT:	LAKESIDE INDUSTRIES	START TIME:	10:37 O'CLOCK
LOCATION:	ABERDEEN, WA	STOP TIME:	11:37 O'CLOCK
SAMPLE SITE:	ID FAN INLET	SAMPLE TIME:	60.0 MINUTES
SAMPLE DATE:	MAY 25, 1988	PRODUCTION RATE:	165 TONS/HOUR
RUN #:	3-METHOD 5		
OPERATORS:	J. GUENTHOER		
CONTACT:	HAROLD NICKEL		

FINAL WT. OF H2O G.	INIT.WT. OF H2O G	NET WT. OF H2O G.
754.3	562.6	191.7
780.7	606.3	174.4
646.1	506.7	139.4
817.5	799.1	18.4
TOTAL H2O GAIN:		523.9
TOTAL VOLUME (SCF)		24.66
PERCENT MOISTURE:		31.65
Bws:		0.3165

PITOT Cp:	0.845
NOZZLE DIA INCHES:	0.317
NOZZLE AREA FT^2:	0.0005
STACK DIA. INCHES:	48.00
STACK AREA FT^2:	12.566
METER TEMP. DEG F:	79.4
BAROM. PRES. "HG:	30.25
STATIC PRES. "H2O:	-11.00
STACK PRES. "HG:	29.44
ORIFICE PRES "H2O:	1.470
METER PRES. "HG:	29.55

INIT. METER VOLUME	824.259
FINAL METER VOLUME	878.979
VOLUME SAMPLED:	54.720
STD VOLUME (DSCF):	53.261
STD VOLUME (DSCM):	1.509
Y FACTOR:	0.98

AVERAGE % CO2:	3.5
AVERAGE % O2:	13.7
AVERAGE % CO:	0.0
STACK GAS MW. DRY:	29.11
STACK GAS MW. WET:	25.59

% N_2 =

SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.	SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE DEGREES F.
1	0.42	205	7	0.50	262
2	0.45	230	8	0.56	263
3	0.45	245	9	0.56	264
4	0.54	250	10	0.50	261
5	0.40	253	11	0.64	263
6	0.50	261	12	0.64	264

PERCENT ISOKINETICS:	108 %	
STACK TEMPERATURE:	251.8 DEG. F.	711.8 DEG. R.
AVERAGE VELOCITY HEAD:	0.51 " OF H2O	
STACK GAS VELOCITY:		50.2 FT/SEC
STACK GAS AIR FLOW:	37828.3 ACF/MIN	18873.9 DSCF/MIN
PARTICULATE EMISSION CONCENTRATION:		0.006 GR/DSCF
PARTICULATE EMISSION CONCENTRATION:		14.8 MG/DSCM
PARTICULATE MATTER EMISSION RATE:		1.05 LB/HR

FRONTHALF PARTICULATE MASS LOADING

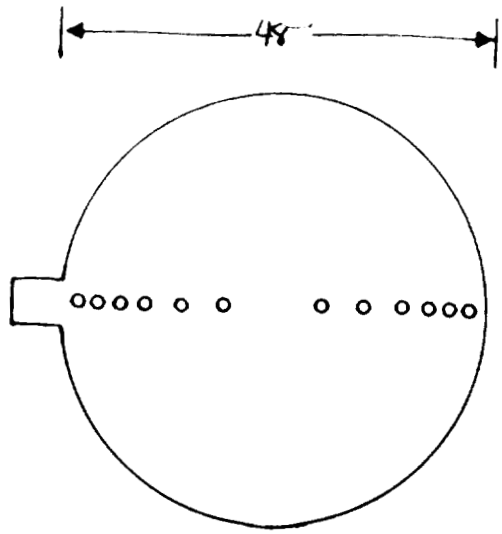
FILTER NUMBER: #125-211	
TARE WEIGHT OF FILTER IN GMS.:	0.7861
FINAL WEIGHT OF FILTER IN GMS.:	0.7944
NET WEIGHT OF PARTIC. MATTER IN GMS.:	0.0083
BEAKER NUMBER: #88-979	
TARE WEIGHT OF BEAKER IN GMS.:	66.9609
FINAL WEIGHT OF BEAKER IN GMS.:	66.9752
NET WEIGHT OF PARTIC. MATTER IN GMS.:	0.0143
VOLUME OF ACETONE IN MLS.:	140.0
TARE WEIGHT OF ACETONE IN GMS.:	79.4549
FINAL WEIGHT OF ACETONE IN GMS.:	79.4551
VOLUME OF ACETONE IN MLS.:	100.0
NET CONTRIBUTION OF ACETONE IN MG/ML:	0.0020
TOTAL FRONTHALF PARTIC. MATTER IN GMS.:	0.0223

0.0226

APPENDIX

CROSS SECTIONAL AREA

Traverse Point	Distance (inches)
1	1.01
2	3.22
3	5.66
4	8.50
5	12.00
6	17.08
7	30.91
8	36.00
9	39.50
10	42.34
11	44.78
12	46.99



STACK DIMENSIONS

48 inch diameter circular stack

1 port

A = 30 inches

B = 97 inches

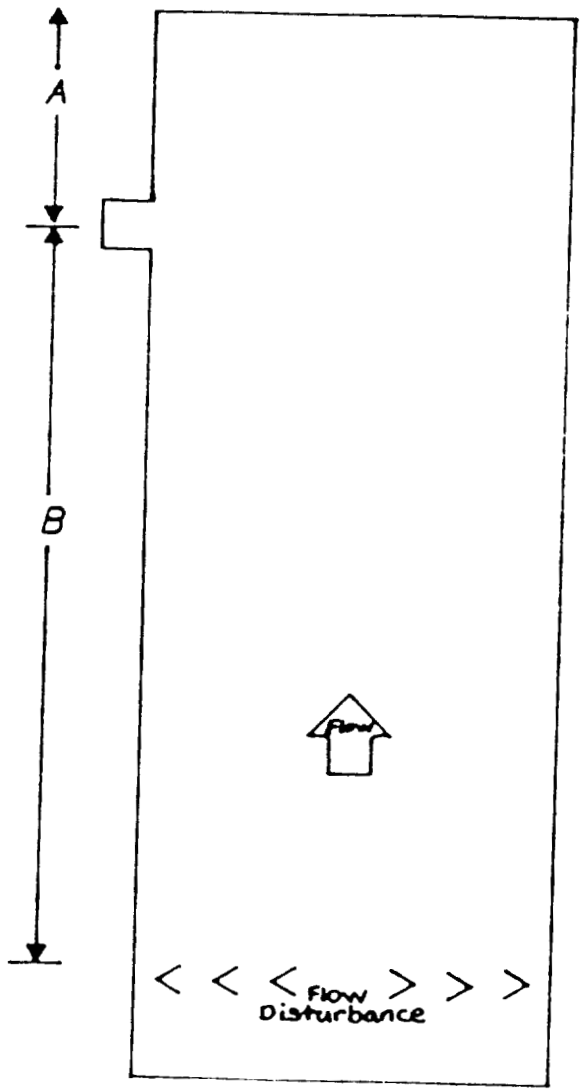
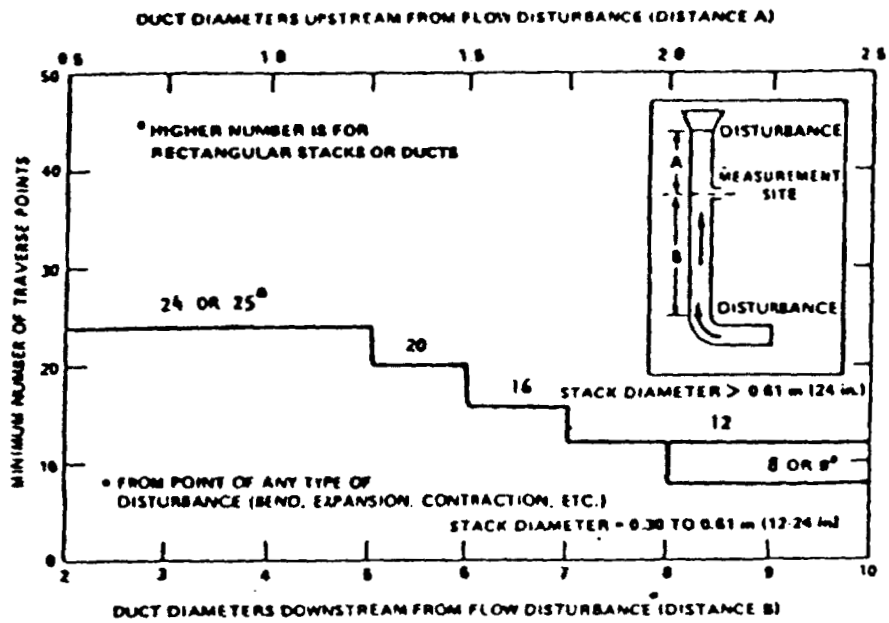
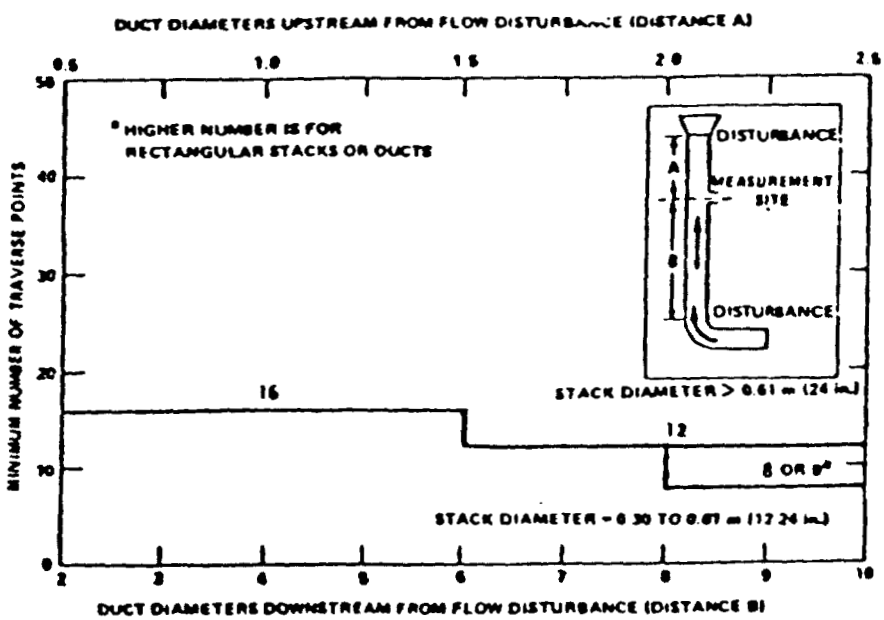


Figure 1. Location of sampling ports and traverse points.

METHOD 1 - MINIMUM NUMBER OF TRAVERSE POINTS



Minimum number of traverse points for particulate traverses.



Minimum number of traverse points for velocity (nonparticulate) traverses.

METHOD 1 - LOCATION OF TRAVERSE POINTS

Circular Stacks

TRAVERSE POINT	DISTANCE % of diameter
1	4.4
2	14.7
3	29.5
4	70.5
5	85.3
6	95.6

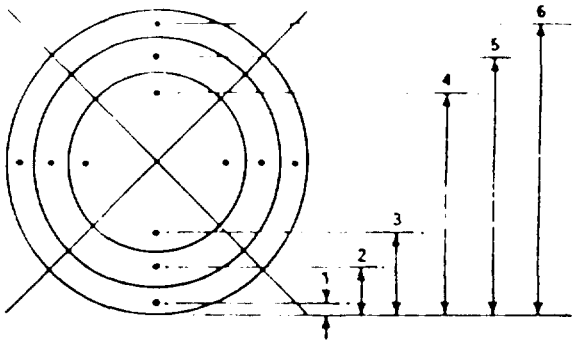


Figure 1-3. Example showing circular stack cross section divided into 12 equal areas, with location of traverse points indicated.

TABLE 1-2. LOCATION OF TRAVERSE POINTS IN CIRCULAR STACKS

(Percent of stack diameter from inside wall to traverse point)

Traverse point number on a diameter	Number of traverse points on a diameter— 2	4	6	8	10	12	14	16	18	20	22	24
1	14.6	6.7	4.4	3.2	2.6	2.1	1.8	1.6	1.4	1.3	1.1	1.1
2	85.4	25.0	14.6	10.5	8.2	6.7	5.7	4.9	4.4	3.9	3.5	3.2
3		75.0	29.6	19.4	14.6	11.8	9.9	8.5	7.5	6.7	6.0	5.5
4		93.3	70.4	32.3	22.6	17.7	14.6	12.5	10.9	9.7	8.7	7.9
5			85.4	67.7	34.2	25.0	20.1	16.9	14.6	12.9	11.6	10.5
6			95.6	80.6	65.8	35.6	26.9	22.0	18.8	16.5	14.6	13.2
7				89.5	77.4	64.4	36.6	28.3	23.6	20.4	18.0	16.1
8				96.8	85.4	75.0	63.4	37.5	29.6	25.0	21.8	19.4
9					91.8	82.3	73.1	62.5	38.2	30.6	26.2	23.0
10					97.4	88.2	79.9	71.7	61.8	38.8	31.5	27.2
11						93.3	85.4	78.0	70.4	61.2	39.3	32.[illegible]
12						97.9	90.1	83.1	76.4	69.4	60.7	39.8
13							94.3	87.5	81.2	75.0	68.5	60.2
14							98.2	91.5	85.4	79.6	73.8	67.7
15								95.1	89.1	83.5	78.2	72.8
16								98.4	92.5	87.1	82.0	77.0
17									95.6	90.3	85.4	80.6
18									98.6	93.3	88.4	83.9
19										96.1	91.3	86.8
20										98.7	94.0	89.5
21											96.5	92.1
22											98.9	94.5
23												96.8
24												98.9

Rectangular Stacks

For a rectangular cross section, an equivalent diameter (D_e) shall be calculated from the following equation, to determine the upstream and downstream distances:

$$D_e = \frac{2LW}{(L+W)}$$

where L = length and W = width.

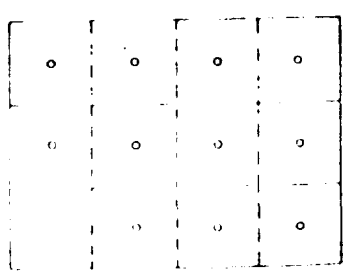


Figure 1-4. Example showing rectangular stack cross section divided into 12 equal areas, with a traverse point at centroid of each area.

METHOD 2 - STACK GAS VELOCITY AND VOLUMETRIC FLOW CALCULATIONS

Nomenclature

A = Cross-sectional area of stack, m^2 (ft^2).
$B_{w,s}$ = Water vapor in the gas stream (from Method 5 or Reference Method 4), proportion by volume.
C_p = Pitot tube coefficient, dimensionless.
K_p = Pitot tube constant.

$$34.97 \frac{m}{sec}\left[\frac{(g/g\text{-mole})(mm\ Hg)}{(°K)(mm\ H_2O)}\right]^{1/2}$$

for the metric system and

$$85.49 \frac{ft}{sec}\left[\frac{(lb/lb\text{-mole})(in.\ Hg)}{(°R)(in.\ H_2O)}\right]^{1/2}$$

for the English system.

M_d = Molecular weight of stack gas, dry basis (see Section 3.6) g/g-mole (lb/lb-mole).
M_s = Molecular weight of stack gas, wet basis, g/g-mole (lb/lb-mole).
$= M_d(1 - B_{w,s}) + 18.0\ B_{w,s}$

Equation 2-5

P_{bar} = Barometric pressure at measurement site, mm Hg (in. Hg).
P_g = Stack static pressure, mm Hg (in. Hg).

P_s = Absolute stack gas pressure, mm Hg (in. Hg).
$= P_{bar} + P_g$

Equation 2-6

P_{std} = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).
Q_{sd} = Dry volumetric stack gas flow rate corrected to standard conditions, dscm/hr (dscf/hr).
t_s = Stack temperature, °C (°F).
T_s = Absolute stack temperature, °K, (°R).
$= 273 + t_s$ for metric

Equation 2-7

$460 + t_s$ for English

Equation 2-8

T_{std} = Standard absolute temperature, 293 °K (528° R)
v_s = Average stack gas velocity, m/sec (ft/sec).
Δp = Velocity head of stack gas, mm H_2O (in. H_2O).
3,600 = Conversion factor, sec/hr.
18.0 = Molecular weight of water g/g-mole (lb/lb-mole).

5.2 Average stack gas velocity.

$$v_s = K_p C_p (\sqrt{\Delta p})_{avg} \sqrt{\frac{T_{s(avg)}}{P_s M_s}}$$

Equation 2-9

5.3 Average stack gas dry volumetric flow rate.

$$Q_{sd} = 3{,}600\ (1 - B_{w,s}) v_s A \left(\frac{T_{std}}{T_{s(avg)}}\right)\left(\frac{P_s}{P_{std}}\right)$$

Equation 2-10

METHOD 3 - MOLECULAR WEIGHT AND EXCESS AIR CALCULATIONS

Nomenclature.

M_d = Dry molecular weight, g/g-mole (lb/lb-mole).
%EA = Percent excess air.
$\%CO_2$ = Percent CO_2 by volume (dry basis).
$\%O_2$ = Percent O_2 by volume (dry basis).
%CO = Percent CO by volume (dry basis).
$\%N_2$ = Percent N_2 by volume (dry basis).
0.264 = Ratio of O_2 to N_2 in air, v/v.
0.280 = Molecular weight of N_2 or CO, divided by 100.
0.320 = Molecular weight of O_2 divided by 100.
0.440 = Molecular weight of CO_2 divided by 100.

6.2 Percent Excess Air. Calculate the percent excess air (if applicable), by substituting the appropriate values of percent O_2, CO, and N_2 (obtained from Section 4.1.3 or 4.2.4) into Equation 3-1.

$$\%EA = \left[\frac{\%O_2 - 0.5\%CO}{0.264\%N_2 - (\%O_2 - 0.5\%CO)}\right]100$$

Equation 3-1

Note: The equation above assumes that ambient air is used as the source of O_2 and that the fuel does not contain appreciable amounts of N_2 (as do coke oven or blast furnace gases). For those cases when appreciable amounts of N_2 are present (coal, oil, and natural gas do not contain appreciable amounts of N_2) or when oxygen enrichment is used, alternate methods, subject to approval of the Administrator, are required.

6.3 Dry Molecular Weight. Use Equation 3-2 to calculate the dry molecular weight of the stack gas.

$$M_d = 0.440(\%CO_2) + 0.320(\%O_2) + 0.280(\%N_2 + \%CO)$$

Equation 3-2

METHOD 4 - STACK GAS MOISTURE CALCULATIONS

Nomenclature.

B_{ws} = Proportion of water vapor, by volume, in the gas stream.

M_w = Molecular weight of water, 18.0 g/g-mole (18.0 lb/lb-mole).

P_m = Absolute pressure (for this method, same as barometric pressure) at the dry gas meter, mm Hg (in. Hg).

P_{std} = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).

R = Ideal gas constant, 0.06236 (mm Hg)(m³)/(g-mole)(°K) for metric units and 21.85 (in. Hg)(ft³)/(lb-mole)(°R) for English units.

T_m = Absolute temperature at meter, °K (°R).

T_{std} = Standard absolute temperature, 293° K (528°R).

V_m = Dry gas volume measured by dry gas meter, dcm (dcf).

ΔV_m = Incremental dry gas volume measured by dry gas meter at each traverse point, dcm (dcf).

$V_{m(std)}$ = Dry gas volume measured by the dry gas meter, corrected to standard conditions, dscm (dscf).

$V_{wc(std)}$ = Volume of water vapor condensed corrected to standard conditions, scm (scf).

$V_{wg(std)}$ = Volume of water vapor collected in silica gel corrected to standard conditions, scm (scf).

V_f = Final volume of condenser water, ml.

V_i = Initial volume, if any, of condenser water, ml.

W_f = Final weight of silica gel or silica gel plus impinger, g.

W_i = Initial weight of silica gel or silica gel plus impinger, g.

Y = Dry gas meter calibration factor.

ρ_w = Density of water, 0.9982 g/ml (0.002201 lb/ml).

2.3.2 Volume of water vapor condensed.

$$V_{wc(std)} = \frac{(V_f - V_i)\rho_w R T_{std}}{P_{std} M_w} = K_1 (V_f - V_i)$$

Equation 4-1

where:

K_1 = 0.001333 m³/ml for metric units
= 0.04707 ft³/ml for English units

2.3.3 Volume of water vapor collected in silica gel.

$$V_{wg(std)} = \frac{(W_f - W_i) R T_{std}}{P_{std} M_w} = K_2 (W_f - W_i)$$

Equation 4-2

where:

K_2 = 0.001335 m³/g for metric units
= 0.04715 ft³/g for English units

2.3.4 Sample gas volume.

$$V_{m(std)} = V_m Y \frac{(P_m)(T_{std})}{(P_{std})(T_m)} = K_3 Y \frac{V_m P_m}{T_m}$$

Equation 4-3

where:

K_3 = 0.3858 °K/mm Hg for metric units
= 17.64 °R/in. Hg for English units

NOTE: If the post-test lead rate (Section 2.2.6) exceeds the allowable rate, correct the value of V_m in Equation 4-3, as described in Section 6.3 of Method 5.

2.3.5 Moisture Content.

$$B_{ws} = \frac{V_{wc(std)} + V_{wg(std)}}{V_{wc(std)} + V_{wg(std)} + V_{m(std)}}$$

Equation 4-4

NOTE: In saturated or moisture droplet laden gas streams, two calculations of the moisture content of the stack gas shall be made, one using a value based upon the saturated conditions (see Section 1.2), and another based upon the results of the impinger analysis. The lower of these two values of B_{ws} shall be considered correct.

METHOD 5 - PARTICULATE EMISSION CONCENTRATION CALCULATIONS - (1)

Nomenclature

A_n = Cross-sectional area of nozzle, m^2 (ft^2).
B_{ws} = Water vapor in the gas stream, proportion by volume.
C_a = Acetone blank residue concentration, mg/g.
c_s = Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions, g/dscm (g/dscf).
I = Percent of isokinetic sampling.
L_a = Maximum acceptable leakage rate for either a pretest leak check or for a leak check following a component change; equal to 0.0057 m^3/min (0.02 cfm) or 4 percent of the average sampling rate, whichever is less.
L_i = Individual leakage rate observed during the leak check conducted prior to the "i^{th}" component change (i = 1, 2, 3,...n), m^3/min (cfm).
L_p = Leakage rate observed during the post-test leak check, m^3/min (cfm).
m_a = Total amount of particulate matter collected, mg.
M_w = Molecular weight of water, 18.0 g/g-mole (18.0lb/lb-mole).
m_a = Mass of residue of acetone after evaporation, mg.
P_{bar} = Barometric pressure at the sampling site, mm Hg (in. Hg).
P_s = Absolute stack gas pressure, mm Hg (in. Hg).
P_{std} = Standard absolute pressure, 760 mm Hg (29.92 in. Hg).
R = Ideal gas constant, 0.06236 mm Hg-m^3/°K-g-mole (21.85 in. Hg-ft^3/°R-lb-mole).
T_m = Absolute average dry gas meter temperature (see Figure 5-2), °K (°R).
T_s = Absolute average stack gas temperature (see Figure 5-2), °K (°R).
T_{std} = Standard absolute temperature, 293° K (528° R).
V_a = Volume of acetone blank, ml.
V_{aw} = Volume of acetone used in wash, ml.
V_{lc} = Total volume of liquid collected in impingers and silica gel (see Figure 5-3), ml.
V_m = Volume of gas sample as measured by dry gas meter, dcm (dscf).
$V_{m(std)}$ = Volume of gas sample measured by the dry gas meter, corrected to standard conditions, dscm (dscf).
$V_{w(std)}$ = Volume of water vapor in the gas sample, corrected to standard conditions, scm (scf).
v_s = Stack gas velocity, calculated by Method 2, Equation 2-9, using data obtained from Method 5, m/sec (ft/sec).
W_a = Weight of residue in acetone wash, mg.
Y = Dry gas meter calibration factor.
ΔH = Average pressure differential across the orifice meter (see Figure 5-2), mm H_2O (in. H_2O).
ρ_a = Density of acetone, mg/ml (see label on bottle).
ρ_w = Density of water, 0.9982 g/ml (0.002201 lb/ml).
θ = Total sampling time, min.
θ_i = Sampling time interval, from the beginning of a run until the first component change, min.
θ_i = Sampling time interval, between two successive component changes, beginning with the interval between the first and second changes, min.
θ_p = Sampling time interval, from the final (n^{th}) component change until the end of the sampling run, min.
13.6 = Specific gravity of mercury.
60 = Sec/min.
100 = Conversion to percent.

6.2 Average dry gas meter temperature and average orifice pressure drop. See data sheet (Figure 5-2).

6.3 Dry Gas Volume. Correct the sample volume measured by the dry gas meter to standard conditions (20° C, 760 mm Hg or 68° F, 29.92 in. Hg) by using Equation 5-1.

$$V_{m(std)} = V_m Y \left(\frac{T_{std}}{T_m}\right)\left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{P_{std}}\right]$$

$$= K_1 V_m Y \frac{P_{bar} + (\Delta H/13.6)}{T_m}$$

Equation 5-1

where:
K_1 = 0.3858 °K/mm Hg for metric units
= 17.64 °R/in. Hg for English units

NOTE: Equation 5-1 can be used as written unless the leakage rate observed during any of the mandatory leak checks (i.e., the post-test leak check or leak checks conducted prior to component changes) exceeds L_a. If L_p or L_i exceeds L_a, Equation 5-1 must be modified as follows:

(a) Case I. No component changes made during sampling run. In this case, replace V_m in Equation 5-1 with the expression:

$$V_m - (L_p - L_a)\theta]$$

(b) Case II. One or more component changes made during the sampling run. In this case, replace V_m in Equation 5-1 by the expression:

$$\left[V_m - (L_1 - L_a)\theta_1 - \sum_{i=2}^{n} (L_i - L_a)\theta_i - (L_p - L_a)\theta_p\right]$$

METHOD 5 - PARTICULATE EMISSION CONCENTRATION CALCULATIONS - (2)

and substitute only for those leakage rates (L_i or L_p) which exceed L_a.

6.4 Volume of water vapor.

$$V_{w(std)} = V_{lc}\left(\frac{\rho_w}{M_w}\right)\left(\frac{RT_{std}}{P_{std}}\right) = K_2 V_{lc}$$

Equation 5-2

where:

K_2 = 0.001333 m³/ml for metric units
= 0.04707 ft³/ml for English units.

6.5 Moisture Content.

$$B_{ws} = \frac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$$

Equation 5-3

NOTE: In saturated or water droplet-laden gas streams, two calculations of the moisture content of the stack gas shall be made, one from the impinger analysis (Equation 5-3), and a second from the assumption of saturated conditions. The lower of the two values of B_{ws} shall be considered correct. The procedure for determining the moisture content based upon assumption of saturated conditions is given in the Note of Section 1.2 of Method 4. For the purposes of this method, the average stack gas temperature from Figure 5-2 may be used to make this determination, provided that the accuracy of the in-stack temperature sensor is ±1° C (2° F).

6.6 Acetone Blank Concentration.

$$C_a = \frac{m_a}{V_a \rho_a}$$

Equation 5-4

6.7 Acetone Wash Blank.

$$W_a = C_a V_{aw} \rho_a$$

Equation 5-5

6.8 Total Particulate Weight. Determine the total particulate catch from the sum of the weights obtained from containers 1 and 2 less the acetone blank (see Figure 5-3).

NOTE: Refer to Section 4.1.5 to assist in calculation of results involving two or more filter assemblies or two or more sampling trains.

6.9 Particulate Concentration.

$$c_s = (0.001\ g/mg)\ (m_n / V_{m(std)})$$

Equation 5-6

6.10 Conversion Factors:

From	To	Multiply by
scf	m³	0.02832
g/ft³	gr/ft³	15.43
g/ft³	lb/ft³	2.205×10^{-3}
g/ft³	g/m³	35.31

6.11 Isokinetic Varition.

6.11.1 Calculation From Raw Data.

$$I = \frac{100\, T_s [K_3 V_{lc} + (V_m / T_m)(P_{bar} + \Delta H/13.6)]}{60\, \theta v_s P_s A_n}$$

Equation 5-7

where:

K_3 = 0.003454 mm Hg-m³/ml-°K for metric units.
= 0.002669-in. Hg-ft³/ml-°R for English units.

6.11.2 Calculation From Intermediate Values.

$$I = \frac{T_s V_{m(std)} P_{std} 100}{T_{std} v_s \theta A_n P_s 60(1 - B_{ws})}$$

$$K_4 \frac{T_s V_{m(std)}}{P_s V_s A_n \theta (1 - B_{ws})}$$

Equation 5-8

where:

K_4 = 4.320 for metric units
= 0.09450 for English units.

6.12 Acceptable Results. If 90 percent I < 110 < percent, the results are acceptable. If the results are low in comparison to the standard and I is beyond the acceptable range, or, if I is less than 90 percent, the Administrator may opt to accept the results

SAMPLE CALCULATION SHEET

22

Client: Lakeside Industries Run #: 1 Date: 5-25-88

Particulate concentration

V_{std} = 17.647*38.179*.98*(30.24 + (.733/13.6))/521.2°R Equation 5-1

1 V_{std} = 38.377 dscf 1.087 dscm = 38.377 dscf/35.3 ft³/m³

Wa = ma*vaw/va Substitution of Equation 5-4 into 5-5

Wa = 0.2 * 100 / 100

Wa = 0.2 mg

mn = (net weight filter catch) + (net weight "B" section) - Wa + (Backhalf)

mn = 21.7 mg = 16.0 + 5.9 - 0.2 + NA

cs = [(0.001g/mg)*(15.43gr/ft)* 21.7 / 38.377 Equation 5-6

cs = 0.009 gr/dscf or NA gr/dscf@12% CO2 = cs * 12% / _____%

Moisture 19.9 mg/dscm = 21.7mg/1.087dscm

1.62 lb/hr = 0.009gr/dscf * 21740.9 dscf/min * lb/7000gr * 60min/hr

Vw(std) = 0.04707* 298.1 ml or grams of water condensed Equation 5-2

0.04715 * 15.2 gm of water in silica gel

Vw(std) = 14.75 scf

Bws = (14.75)/(14.75 + 38.377) Equation 5-3

2 Bws = .2776 %H2O = 27.76 %

Molecular weight

Md = 0.440(4.0) + 0.320(14.3) + 0.280(81.7) Equation 3-2

Md = 29.21 g/g-mole

Ms = 29.21 * (1 - .2776) + 18.0 * .2776

3 Ms = 26.10 g/g-mole

Stack gas velocity and volumetric flow rate

vs = 85.49* .845 * .77 * $\sqrt{695.6/26.10/29.43}$ Equation 2-9

6 vs = 53.46 ft/sec (std)

Qsd = 3600*(1-.2776)* 53.5*12.566*(528 / 695.6)*(29.43/29.92) Equation 2-10

Qsd = 1304443 dscf/hr / 60 min/hr

4 Qsd = 21740.9 dscf/min or 40307 acfm = 53.5 afps*12.566 sf*60

Isokinetic variation

I = 0.09450*38.377*695.6/(29.43*53.5*60 *.0003518*(1-.2776)) Equation 5-8

I = 105 % OK

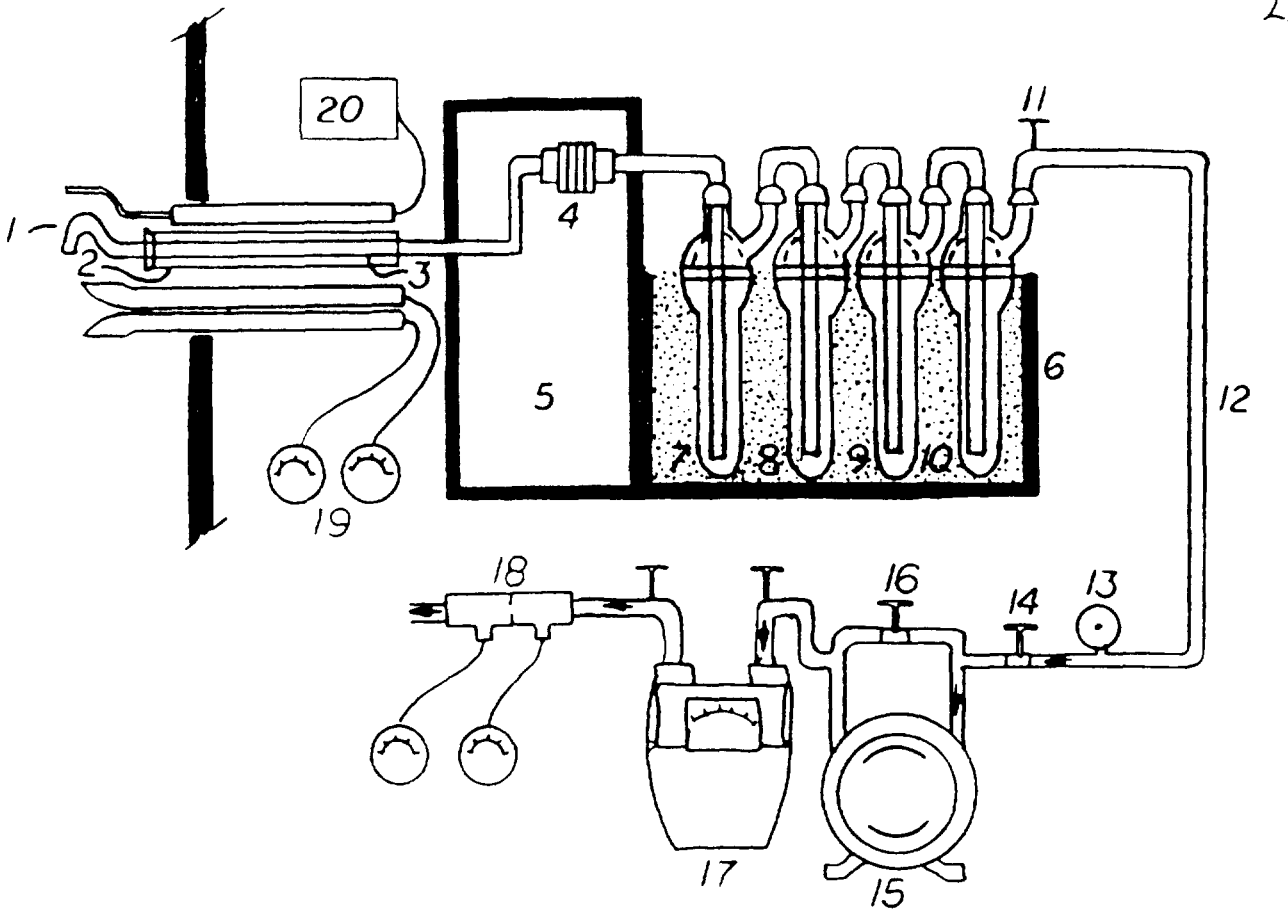


Figure 2. EPA Method 5 particulate sampling train.

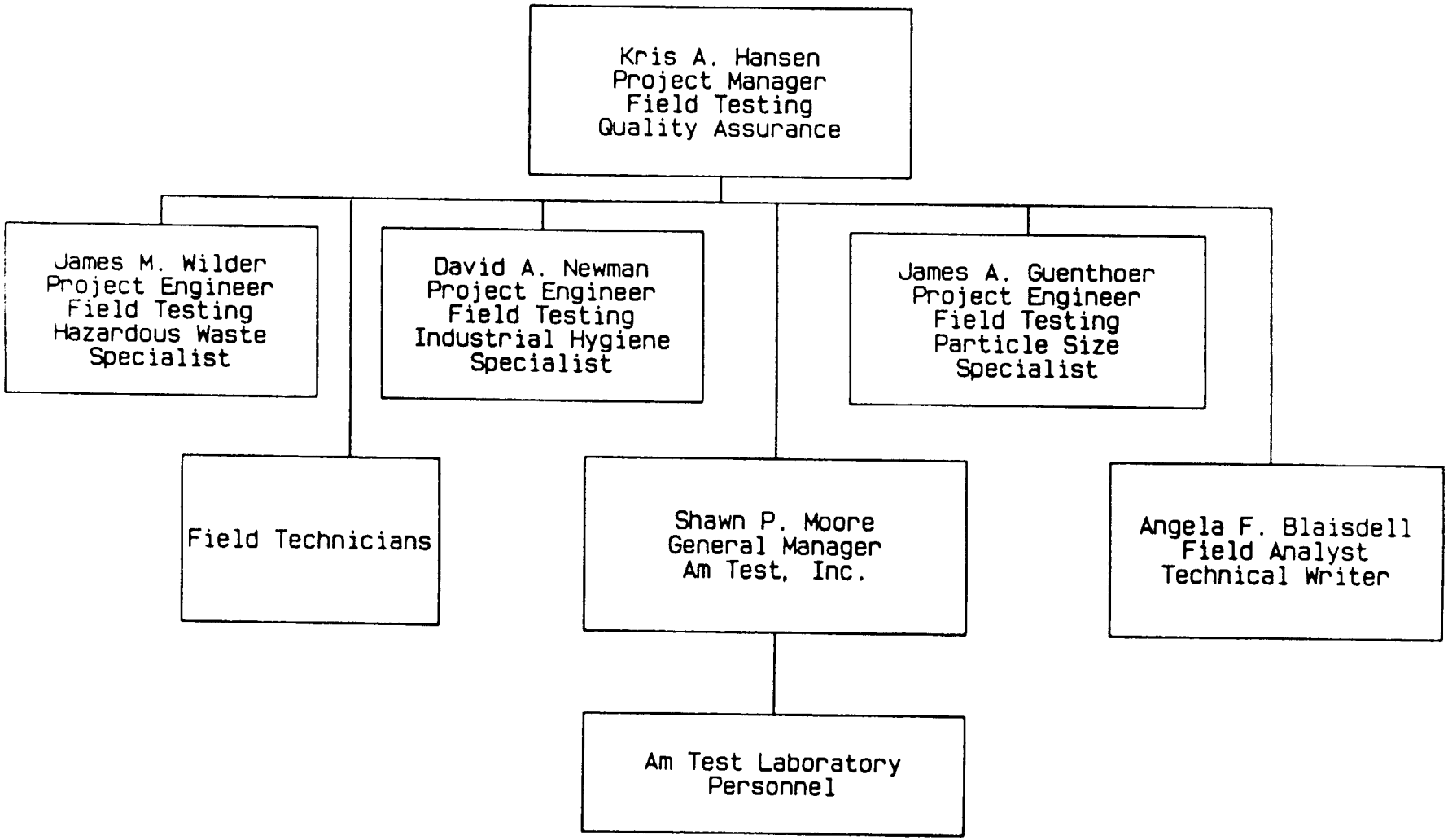
1. Sampling nozzle
2. Sampling probe sheath
3. Heated sample probe liner
4. Out of stack filter assembly
5. Heated filter compartment maintained at 248°F ± 25°F (or temperature specified in 40 CFR subpart)
6. Impinger case
7. First impinger containing 100 ml H_2O
8. Modified Greenburg-Smith impinger containing 100 ml H_2O
9. Third impinger - dry
10. Fourth impinger containing indicating silica gel desiccant
11. Impinger exit gas temperature sensor
12. Umbilical cord - vacuum line
13. Pressure gauge
14. Coarse adjustment valve
15. Leak free pump
16. By-pass valve
17. Dry gas meter with inlet and outlet temperature sensors
18. Orifice meter with magnehelic gauges
19. "S" type pitot tubes with magnehelic gauges
20. Thermocouple sensor

DRY GAS METER CALIBRATION
AM TEST, INC. - AIR QUALITY DIVISION

METER BOX #: JAG RED #1
CALIBRATION DATE: NOVEMBER 12, 1987
LOCATION: STATE OF WASHINGTON DEPARTMENT OF ECOLOGY
METHOD OF CALIB.: SPIROMETER

TOTAL TIME min	DELTA H "H2O	METER VOL V1 cf	METER VOL V2 cf	TEMP OUT deg F	TEMP IN deg F	BARO. PRES. "Hg	VOLUME METER dscf	SPIRO H1 cm	SPIRO H2 cm	SPIRO TEMP deg C	VOLUME SPIRO dscf	Y FACTOR	KM^2	DELTA H@
8.00	0.25	32.300	35.33	73	74	29.85	3.001	80.5	13.85	23	3.108	0.97	0.93	0.99
5.00	0.5	35.800	38.493	73	75	29.85	2.666	80.0	21.25	23	2.739	0.97	0.94	0.98
4.00	0.75	40.200	42.865	74	78	29.85	2.630	80.0	22.9	22	2.671	0.98	0.96	0.96
4.00	1	44.100	47.175	76	80	29.85	3.025	80.0	13.8	22	3.097	0.98	0.95	0.97
3.50	1.25	48.700	51.698	77	82	29.85	2.943	80.0	15.8	22	3.004	0.98	0.94	0.98
3.00	1.5	52.800	55.615	78	83	29.85	2.760	80.0	19.8	22	2.816	0.98	0.94	0.98
3.00	1.75	59.300	62.303	78	82	29.85	2.949	80.0	15.5	22	3.018	0.98	0.92	1.00
3.00	2	63.600	66.827	79	85	29.85	3.159	80.0	10.6	22	3.247	0.97	0.93	0.99
8.00	0.25	67.700	70.792	80	82	29.85	3.020	80.0	14.7	22	3.055	0.99	0.96	0.96
5.00	0.5	71.600	74.342	80	82	29.85	2.679	80.0	21.9	22	2.718	0.99	0.96	0.96
4.00	0.75	75.100	77.765	81	83	29.85	2.601	80.0	23.4	22	2.648	0.98	0.95	0.97
4.00	1	78.600	81.692	81	85	29.85	3.014	80.0	14	22.5	3.083	0.98	0.95	0.97
3.50	1.25	82.600	85.606	81	86	29.85	2.929	80.0	15.9	22.5	2.994	0.98	0.94	0.98
3.00	1.5	86.600	89.393	81	81	29.85	2.736	80.0	19.7	22.5	2.816	0.97	0.93	0.99
3.00	1.75	90.700	93.715	81	84	29.85	2.947	80.0	15.3	22.5	3.022	0.98	0.92	1.00
3.00	2	95.100	98.32	81	86	29.85	3.144	80.0	10.8	22.5	3.232	0.97	0.92	1.00
8.00	0.25	98.800	101.863	81	83	29.85	2.986	80.0	15.1	22.5	3.031	0.98	0.94	0.98
5.00	0.5	102.600	105.34	81	83	29.85	2.673	80.0	21.8	22.5	2.718	0.98	0.96	0.96
4.00	0.75	106.100	108.794	82	84	29.85	2.624	80.0	22.8	22.5	2.672	0.98	0.96	0.95
4.00	1	109.700	112.79	82	85	29.85	3.009	80.0	14	22.5	3.083	0.98	0.95	0.97
3.50	1.25	113.800	116.807	82	86	29.85	2.928	80.0	15.9	22.5	2.994	0.98	0.94	0.98
3.00	1.5	118.200	121.002	83	88	29.85	2.722	80.0	20	22.5	2.802	0.97	0.93	1.00
3.00	1.75	122.300	125.314	83	89	29.85	2.927	80.0	15.3	22.5	3.022	0.97	0.92	1.00
3.00	2	126.700	129.925	84	90	29.85	3.128	80.0	10.8	22.5	3.232	0.97	0.92	1.00
AVERAGE												0.98	0.94	0.98

AM TEST, INC. - AIR QUALITY DIVISION
ORGANIZATIONAL STRUCTURE



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RESUME OF
KRIS A. HANSEN

DIRECTOR - AIR QUALITY DIVISION

EDUCATION

- B.S., Chemistry, Central Washington University, 1973
- Coursework and 2.5 years research completed towards M.S., Chemistry, Central Washington University
- Professional training courses and specialty conferences

PROFESSIONAL MEMBERSHIPS

- Air Pollution Control Association (APCA)
- American Association for Aerosol Research (AAAR)
- American Chemical Society (ACS)
- Pacific Northwest International Section of APCA (PNWIS)
- Source Evaluation Society (SES)

PROFESSIONAL EXPERIENCE

Am Test, Inc.'s Air Quality Division, developed and directed by Mr. Hansen, is in its sixth year. Mr. Hansen conducts full-service source testing activities including particulate matter concentration testing, particle size distribution (utilizing Pilat (U of W) Mark 3 and Mark 5 Cascade impactors), sulfur and nitrogen oxides, hydrogen sulfides, arsenic, semivolatile and volatile organic compounds testing, PCB and other toxic air pollutant characterization, opacity measurement, continuous emission monitor certification and other EPA methodology. Mr. Hansen has worked at all types of industrial facilities, including oil and gas refineries, gas, oil and coal-fired power plants, nuclear plants, wood products industries, smelters, incinerators, asphaltic concrete plants, and other industrial sources throughout the lower 48 states and Alaska. Mr. Hansen manages an experienced field testing and laboratory analysis staff and maintains a strict quality assurance program. Mr. Hansen manages all phases of project development, including cost estimation, scheduling, sample collection, analysis and report preparation.

Prior to joining Am Test, Inc., Mr. Hansen had 6.5 years of professional experience as the Manager of Laboratory services for an environmental consulting firm which specialized in air quality studies, and as a laboratory instructor while attending school at Central Washington University, where his research emphasis was in gas chemistry.

Mr. Hansen assists in the instruction of the EPA 450 "Source Sampling for Particulate Pollutants" and the EPA 468 "Source Sampling and Analysis of Gaseous Pollutants" courses offered yearly by the EPA in cooperation with the University of Washington. Students are represented by industry and governmental agency personnel from across the U.S. and other nations. Mr. Hansen was the recipient of the 1987 PNWIS/APCA "Hardhat Award" which was presented in recognition of his contributions to the advancement of source sampling technology.

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RESUME OF
JAMES A. GUENTHOER

PROJECT ENGINEER

EDUCATION

- B.S., Geology, Juniata College, Huntington, Pennsylvania, 1972
- M.S.E., Environmental Engineering Division, Department of Civil Engineering, University of Washington, Seattle, Washington, 1985
- Professional training courses and specialty conferences

PROFESSIONAL MEMBERSHIPS

- Air Pollution Control Association (national and local)
- Technical Association of the Pulp and Paper Industry
- American Institution of Chemical Engineers
- Source Evaluation Society

PROFESSIONAL EXPERIENCE

Mr. Guenthoer has been a Project Engineer for Am Test, Inc. for the past 4 years. Mr. Guenthoer specializes in particle size distribution studies and other air pollution engineering studies for Am Test's Air Quality Division. He was formerly the Operations Manager for Pollution Control Systems, Inc. of Seattle, Washington for 4 years and handled the design, technical services and sales of in-stack source test Cascade impactors. He assists in the instruction of EPA 450 and EPA 468 Source Sampling Short Courses for particulate and gaseous pollutants which are offered each year by the EPA in cooperation with the University of Washington. He also assists in instructing workshops to demonstrate the use of in-stack source test Cascade impactors. Mr. Guenthoer has had 12 years of professional experience, and is an Engineer in Training (EIT) and working towards a Professional Engineer Certification (P.E.).

Mr. Guenthoer was formerly associated with Air Pollution Systems of Kent, Washington conducting research and development studies on novel particulate control technology. Prior to his association with Air Pollution Systems, Mr. Guenthoer was the Testing Manager for Rossnagel and Associates of Medford, New Jersey and was in charge of all water quality, industrial hygiene, and source testing for 3 branch offices. During his 5 years with this environmental testing firm, Mr. Guenthoer conducted compliance source tests for local, state and federal government in over 20 states and served as a professional expert witness in environmental legal cases. Other professional experience with the State of Washington's Department of Ecology involved surface water quality studies. Mr. Guenthoer was also involved in statewide limnological investigations and bathymetric mapping over a period of 2 years with the United States Geological Survey in Tacoma, Washington.

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RESUME OF
ANGELA F. BLAISDELL

ENVIRONMENTAL CHEMIST/TECHNICAL WRITER

EDUCATION

- B.S., Marine Resources, Western Washington University, Bellingham, Washington, 1980
- Minors in Chemistry and Biology
- Professional training courses and specialty conferences

PROFESSIONAL EXPERIENCE

Ms. Blaisdell has been assisting Am Test, Inc.'s Air Quality Division for the past 3.5 years. She is responsible for pre-field preparation for Air Quality Division projects and assists in clean-up and analysis of source and ambient air samples collected by the test crew. On larger projects she travels with the test team to assist in sample collection and in-field analysis of samples and data reduction. Ms. Blaisdell is familiar with the analysis of particulate matter and particle size distribution samples, sulfur oxides (SO_2 and SO_3), nitrogen oxides (NO_x), hydrogen sulfide (H_2S), urea, ammonia, formaldehyde, arsenic, and biuret samples collected in air. She also assists in computerized data reduction and report preparation, including technical writing and word processor input.

Prior to joining Am Test, Ms. Blaisdell acted as a Project Leader and Office Manager for an environmental engineering consulting firm in the Seattle area for 2 years. Experience with that firm involved sample collection, analysis and report preparation for source and ambient air, water and industrial hygiene studies. Other professional experience includes a year long project with the Institute of Freshwater Studies in Bellingham, Washington which involved weekly sampling by boat and subsequent laboratory analysis of Lake Whatcom's water for various water quality parameters. She was also an Office and Property Manager for a property management firm, where responsibilities included word processing, computer program development, accounting duties and various executive secretarial duties. Ms. Blaisdell also worked on various research projects in the Chemistry department while attending Western Washington University.

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AM TEST LABORATORIES, INC.
AIR QUALITY DIVISION

Am Test, Inc.'s Air Quality Division has full service source testing capabilities. An experienced staff, utilizing quality equipment and a strict quality assurance program, conducts field testing and laboratory analysis. Testing and analysis capabilities include particulate matter, particle size distribution, sulfur oxides, nitrogen oxides, hydrogen sulfide, fluoride, semivolatile and volatile organic compounds, opacity measurement, continuous emission monitor certification, and other EPA methodology. All field sampling and laboratory analysis is completed in-house utilizing state-of-the-art instrumentation. Sources tested include oil and gas refineries, gas, oil, coal, and nuclear-fired power plants, chemical plants, wood products industries, smelters, incinerators, cement plants, and asphaltic concrete plants.

Services provided by the Air Quality Division of Am Test include:

- Source Industrial Atmospheric Emission Evaluations
- Particle Size Distribution Studies
- Continuous Emission Monitoring Certifications
- Vapor Recovery System Efficiency Evaluations
- Pilot Plant Studies
- Ambient Air Quality Evaluations
- Industrial Hygiene Studies
- Quantification of designated semivolatile and volatile principal organic hazardous constituents (POHCs)
- In-Field "Real Time" Gaseous Constituent Analysis
- In-Field Laboratory Analysis and Results
- Sophisticated Laboratory Analysis

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AM TEST LABORATORY

Am Test, Inc. is a full service analytical testing laboratory located in Redmond, Washington. It was organized to provide the highest caliber laboratory testing of environmental and industrial samples. Experienced environmental chemists and microbiologists have the best available equipment at their disposal. Experienced personnel, top-notch instrumentation, and a personal interest in your testing requirements assures:

Quick turnaround time for sample analysis
Maximum quality control on projects
Direct dialogue with the analytical staff
Reasonable rates

Am Test's laboratory is departmentalized into the following disciplines:

AIR MONITORING	Source and Ambient Testing
ENVIRONMENTAL	Water, Wastes, Tissue, Vegetation
INDUSTRIAL	Food, Materials Testing, Industrial Hygiene, Special Projects
OIL AND FUELS	Lubricating Oil, Fuel Analysis, Hydraulics, Contamination Analysis
TRACE ORGANICS	PCB's, Pesticides, Hazardous Wastes, Priority Pollutants
MICROBIOLOGY	Water, Wells, Food, Product Evaluation

Am Test's laboratory utilizes the following instrumentation:

Finnigan Incos 50 GC/MS	Atomic Absorption Spectrometer-Flame
Jarrell Ash ICP Plasma Emission Spectrometer	Atomic Absorption Spectrometer-Graphite Furnace
Gas Chromatographs: FID, EC, TC, N_2, P	Atomic Absorption Spectrometer-Hydride Generation
Jarrell Ash Arc, Spark Emission Spectrometer	UV/Visible Spectrometer
Xertex TOX Analyser	Infrared Spectrometer
Source Test Equipment-EPA Approved	High Performance Liquid Chromatograph

Am Test is one laboratory in a group of laboratories serving the West. Other facilities include:

Amtest, Inc., Portland, Oregon
Amtest of Arizona, Phoenix, Arizona
Can Test Ltd., Vancouver, B.C.
Canviro, Kitchener, Ontario
Loring Laboratories, Calgary, Alberta
Metropolitan Clinical Laboratories, Ltd., Vancouver, B.C.

Phone Mr. Shawn Moore, General Manager or Mr. Mark Fugiel, Technical Director, at (206)885-1664 for more details or a price quotation.

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AM TEST, INC. is subdivided into six distinct departments. They include environmental, air quality, industrial, oil and fuels, microbiological, and trace organics. Each department is headed by a director who coordinates several technicians specifically trained for their line of analyses. This enables AM TEST to have maximum quality control on a wide variety of projects, as well as quick turn-around time for sample analysis.

The majority of the analyses performed at AMTEST are for environmental samples. Trace metals, nutrients and pollutant analyses of air, water, soil and vegetation are performed on a routine basis. Field sampling by professionals and trained technicians is available. Sampling containers with proper preservatives are available at no extra charge. The laboratory is certified by the State of Washington for all drinking water parameters. NPDES and EP toxicity testing is available.

The air quality division provides full-service source sampling and analysis. Testing and analysis capabilities include particulate, particle sizing, sulfur oxides, nitrogen oxides, hydrogen sulfides, volatile organic compounds (VOC's), urea, fluoride and other EPA methodology. All field and laboratory sampling and analysis is completed in-house utilizing state-of-the-art instrumentation. Air quality division personnel are highly trained and experienced professionals, including both chemists and engineers.

The industrial department performs a wide variety of analyses on a multitude of materials. Specific areas of expertise include spectrographic steel analysis, ferrous and non-ferrous metals testing, industrial hygiene, ambient air monitoring, asbestos analysis, particle identification, product quality assurance, research projects and investigations. This department is certified by the U.S. Navy for asbestos analysis and holds certificates from several suppliers to the nuclear industry. Quality assurance criteria for the latter is based on Federal regulations.

The oil and fuels department performs analyses on fuels, lubricants and hydraulic fluids. Most of these tests are ASTM standardized tests, and are performed for a wide variety of clientele.

The microbiology department performs bacterial analyses on a wide range of matrices from water to seafood. Shelf-life studies, contamination analysis and restaurant inspections are performed by this department.

The trace organics department performs analyses of pesticides, priority pollutants, herbicides, preservatives and other organic compounds in water, tissue, soil and vegetation. The analyses are performed according to EPA protocol. Only the most modern, sophisticated instrumentation is utilized for these analyses.

AMTEST, INC. is a member of the American Council of Independent Laboratories. It is also the approved laboratory for the Army Corps of Engineers and the U.S. Geological Survey. Experienced personnel, top-notch instrumentation and a personal interest in your testing requirements assures:

- Quick turn-around time on sample analysis
- Maximum quality control on the project
- Constant dialogue with the analytical staff

AM TEST, INC. - AIR QUALITY DIVISION

QUALITY ASSURANCE PLAN

Introduction

The purpose of the quality assurance plan is to provide guidelines for achieving quality control in air pollution measurements. The detailed procedures to be utilized are included in the Environmental Proctection Agency's (EPA's) reference manual titled Quality Assurance Handbook for Air Pollution Measurments Systems, Volume 3, EPA-600/4-77-027b, along with current updates. Additional quality assurance procedures are also included. The accuracy of data obtained by both the emissions testing and particle size testing depend upon the equipment performance and on the proficiency and conscientiousness with which the operators perform the various tasks. All aspects of testing, analysis, data reduction and report preparation should only be performed by experienced and well-trained personnel.

Methods

The Am Test, Inc. Air Quality Division normally uses published test methods; e.g., New Source Performance Test (NSPS) methods published in the most currently available publication of Title 40 Code of Federal Regulations, Part 60 (40 CFR 60), and the methods adopted for state and local code enforcement. Specialized test work, such as particle size testing, requires special test methods. Am Test uses those methodologies and sampling hardware which are considered by the experts in the field to be state-of-the-art. Procedures and protocol are updated regularly as research groups refine the testing methodology, analytical procedures and calibration techniques. A high level of quality control is maintained in both our standard NSPS testing and specialty testing areas.

Chain of Custody

Samples are recovered from the sampling train after each test. Sample recovery is carried out in a suitable area sheltered from wind and dust to prevent contamination of samples. Sample recovery procedures outlined in the applicable test method are followed in detail (usually 40 CFR 60). All sample containers are identified using a sample label. After recovery, all sample containers are sealed. Most sample analysis is performed in the field to prevent sample loss or contamination during shipment and to provide the client with preliminary results. The data is then input into the field computer and hard copy, disc copy and back-up are produced. Data relative to samples, collected during each test, are immediately inspected for completeness and placed under the custody of the Project Manager or Project Engineer until custody is transferred when the samples are turned over to the laboratory. Sample storage boxes with locks are used to store samples in the field prior to in-field analysis. A chain of custody sheet follows each sample through the above procedures. The samples are then turned over to the Am Test Laboratory or subcontract laboratory if additional analysis is to be performed. The chain of custody form must be signed each time the samples change hands to couriers or laboratory personnel

Quality Control

Reliability in stationary source testing is maintained through strict adherence to quality control procedures. Am Test's procedures are designed to control both the accuracy and precision of the test results.

Accuracy is maintained through rigorous calibration procedures using the standards specified in the methods and/or Volume III of the Quality Assurance Handbook for Air Pollution Measurement Systems, use of control samples where appropriate, and performance and systems audits. The accuracy of source test capabilities is monitored through voluntary participation in EPA's stationary source audits for coal and Methods 5, 6 and 7.

Performance audits are conducted during the sampling and analytical phases of the test program. The volumetric flow metering device is audited during the sampling phase using a standard dry gas meter. This audit is conducted once on each metering device during each set of field tests, using procedures outlined in Volume III of the Quality Assurance Handbook. Barometers, thermocouple indicators, nozzles, and other equipment used during the field test phase are audited periodically to ensure the collection of acceptable data.

Blanks of reagents used to collect, recover, and anlayze samples are collected to check the quality and ensure that reagents meet criteria established in the test methods. Filter blanks and substrate blanks are also carried through analysis procedures. When analyses are conducted in the field, blank samples are analyzed to ensure the accuracy of results. Samples analyzed in the laboratory are subject to the stringent quality controls exercised in the laboratory (see Am Test, Inc.'s Laboratory Quality Assurance/Quality Control Plan).

A systems audit will be performed which consists of an on-site qualitative inspection and review of the total measurement system. This inspection is conducted on a daily basis by the quality assurance coordinator. During the systems audit, the auditor observes the procedures and techniques of the field team in the following general areas:

- Setting up and leak testing the sampling train
- Isokinetic sampling check of the sampling train
- Final leak check of train
- Sample recovery

Results of the systems audit are summarized on the field data sheets and discussed in the final report.

Acceptable precision is maintained through strict adherence to acceptable limits of difference in replicate measurements at each step of the procedure from initial calibration of sampling equipment to the final analytical determinations. These limits are specified in the methods and in Volume III of the Quality Assurance Handbook.

Data Validation

Data validations are accomplished by using internal quality control checks and performing internal systems, performance, and data audits. For each major measurement parameter, the frequency and type of quality control checks with control limits and corrective action are established. An example of an internal quality control check would be to analyze a standard solution after every tenth analysis for projects requiring a large number of repetitious analyses. Audit samples are used in projects where appropriate. This applies most specifically to chemical analyses (i.e., Methods 6, 7). If the control sample analytical results are not within the control limits, corrective action is taken to identify and resolve the problem before continuing with analyses.

Field calibration checks are performed on the control box (using a standard dry gas meter), thermocouples, and digital readouts. Visual inspections of pitot tubes, glassware, and other equipment are also made. The main purpose of a systems audit is to ensure that the measurement system will generate valid data if operated properly. By performing pre-test, on-site, and post-test calibrations of the measurement systems, data validation checks on the performance of the test equipment can be easily performed.

Data reduction and reporting have been shown to be significant potential sources of system error. Most ofAm Test's calculations are performed by a validated computer program to minimize error. Data entry is performed by individuals familiar with testing procedures. The data printouts are then validated by comparison with the field and analytical data sheets. In addition, hand calculation checks are made to validate the computer output.

All data generated by each phase of a laboratory or field sampling program are reviewed by a senior reviewer. The data must be signed off by the senior reviewer prior to releasing the data for report preparation.

Calibration

All sample train components requiring calibration are calibrated at the recommended intervals using approved methods. Standardized calibration procedures are in accordance with calibration criteria outlined in the test method and Volume III of the Quality Assurance Handbook. The following sample train components are calibrated using standardized procedures:

- Pitot tubes
- Differential pressure gauge and magnehelic gauges
- Barometer
- Rotameter (rate meter)
- Digital indicators
- Thermocouples
- Meter box dry gas meters
- Sampling nozzles

Calibration procedures for special equipment and components such as the analytical system used in particle size determinations are calibrated using procedures tailored to the specific system based on accepted methods published in the literature, or manufacturer's specifications.

SOURCE TEST OBSERVATION CHECKLIST
ASPHALT BATCH PLANTS WITH BAGHOUSE

Client LAKESIDE IND Date 7-25-88

Location ABERDEEN, WA

Process Information

Type of Plant Batch

Manufacturer Barber Green

Model BG 42 X 240 Constructed/Installed Rebuilt 1988

Identification No. — Date Last Tested 1987

Operation Personnel Ron Kok

Process Rate 165 Tons/Hr Discharge Temp 312 °F

Type of Fuel #2 Heating Fuel Firing Rate 2 / ton Mix Gal/Hr

A/C Injection Location IN Pug MILL

Fines In Gravel (-200 mesh) 4.8

Gravel Moisture ≈ 6-7 % Asphalt Type AR4000

Density N/A #/Gal Flash Point 440 °F

Control Equipment

Manufacturer WAG Model —

Bag Material Nomex #Bags 800 Bag Size 4.5" X 12'

Date Bags Last Changed 1988 Air/Cloth Ratio

Type of Bag Cleaning pulse jet

Baghouse Press ΔP = 3 "H_2O Static Press — "H_2O

Cleaning Cycle Duration 21 secs / 80 ms

Disposition of Collected Dust Back into mix

Additional Information

Observer - Jim Werner OAPPA

Ron Kok

Authorized Signature

Sketch of System

AT

TRAVERSE SAMPLING DATA

Client LAKESIDE IND (Abandon)
Date 5-25-88
Sample Location FAN INLET
Operators JAG
Sample Box # L.L-1
Run # 1

EQUIPMENT CHECKS

Initial/Final

Leak Rate Cfm .021/.003
Leak Test Vac 16/16½
✓ Pitots, Pretest
✓ Pitots, Postest
✓ Orsat Sampling System
3 Tedlar Bag
_____ Thermocouple @ _____ °F

SCHEMATIC TRAVERSE LAYOUT

Stack Diameter 48" Ø
Distance Upstream 97"
Distance Downstream 30"

Filter # _____ tare _____ mgs

	Final Wt.		Initial Wt.		Net Wt.
#1 Bubbler	714.9	-	581.4	=	203.5
#2 Impinger	668.5	-	592.6	=	75.9
#3 Bubbler	508.1	-	489.4	=	18.7
#4 Silica Gel	842.8	-	827.6	=	15.2

TOTAL WATER VOLUME 313.3

Start Time 0722
Stop Time 0836
Barometric Pressure "Hg 30.24
Static Pres "H_2O -11.0
Production Rate _____

NOMOGRAPH SETUP

% Moisture 20
Meter Temp. 60
Stack Temp. 210
ΔH@ .50 Y .98
Pitot # _____ Side # _____
Cp .845
Nozzle Diameter .254
K Factor 1.24
Reference ΔP _____

Sample Point	Elap Time Min.	Dry Gas Meter Reading Cu. Ft.	Pitot Reading (ΔP), In. H_2O	Orifice Setting (ΔH), In H_2O Ideal	Actual	Gas Meter Temp °F In	Out	Pump Vacuum In. Hg Gauge	Filter Box Temp °F	Imp. Exit Temp °F	Stack Temp °F	Opacity or Orsat Values
1	0	745.861	.45	.52	.52	50	50	3	269	51	219	
2	5		.50	.62	.62	54	52	3½	254	46	200	
3	10		.66	.82	.82	57	52	4	230	45	211	
4	15		.52	.64	.64	60	53	4	258	48	226	
5	20		.45	.54	.54	62	54	3½	246	52	234	
6	25		.64	.76	.76	65	56	4	261	55	241	
7	30		.64	.76	.76	67	57	4	269	59	245	
8	35		.68	.80	.80	69	59	4½	265	63	247	
9	40		.58	.69	.69	72	60	4	261	60	248	
10	45		.80	.95	.95	74	62	5	266	61	251	
11	50		.80	.95	.95	76	64	5	271	60	252	
12	55		.60	.71	.71	77	66	4	252	64	253	
END	60	784.040										
		25.179	0.278		.733	61.2					235.6	

AT

TRAVERSE SAMPLING DATA

Client Lakeside (Aberdeen)
Date 5-25-88
Sample Location FAD INLET
Operators JAG
Sample Box # Pel-2
Run# 2

EQUIPMENT CHECKS

Initial/Final

Leak Rate Cfm .021 .010
Leak Test Vac 10 1/16
✓ Pitots, Pretest
_____ Pitots, Postest
_____ Orsat Sampling System
17 Tedlar Bag
_____ Thermocouple @ _____ °F

SCHEMATIC TRAVERSE LAYOUT

Stack Diameter _____
Distance Upstream _____
Distance Downstream _____

Filter # _____ tare _____ mgs

	Final Wt.		Initial Wt.		Net Wt.
#1 Bubbler	832.2	-	565.6	=	266.6
#2 Impinger	640.8	-	592.0	=	48.8
#3 Bubbler	994.3	-	490.3	=	504.0
#4 Silica Gel	780.8	-	770.7	=	10.1

TOTAL WATER VOLUME 329.5 ✓

Start Time 0907
Stop Time 1007
Barometric Pressure "Hg 30.24
Static Pres "H_2O -1.0
Production Rate _____

NOMOGRAPH SETUP

% Moisture _____
Meter Temp. _____
Stack Temp. _____
ΔH@ _____ Y _____
Pitot# _____ Side# _____
Cp _____
Nozzle Diameter .254
K Factor _____
Reference ΔP _____

Sample Point	Elap Time Min.	Dry Gas Meter Reading Cu. Ft.	Pitot Reading (ΔP), In. H_2O	Orifice Setting (ΔH), In H_2O Ideal	Orifice Setting (ΔH), In H_2O Actual	Gas Meter Temp °F In	Gas Meter Temp °F Out	Pump Vacuum In. Hg Gauge	Filter Box Temp °F	Imp. Exit Temp °F	Stack Temp °F	Opacity or Orsat Values
1	0	784.426	.42	.53	.53	68	69	2.4	272	56	207	
2	5		.45	.57	.57	71	69	3	270	46	234	
3	10		.50	.63	.63	74	70	3	266	45	243	
4	15		.62	.78	.78	77	71	3.4	243	46	251	
5	20		.56	.71	.71	79	72	3	262	48	255	
6	25		.52	.62	.62	80	73	3	267	51	258	
7	30		.56	.67	.67	81	74	3	268	53	259	
8	35		.64	.76	.76	82	75	3.4	267	55	263	
9	40		.68	.81	.81	83	76	4	262	57	262	
10	45		.60	.72	.72	84	77	3.4	269	57	261	
11	50		.78	.93	.93	85	78	4.4	271	58	261	
12	55		.78	.93	.95	86	78	4.4	270	58	261	
END	60	823.434										
						79.2	73.5					

39.008 0.766 0.722 .722 76.3 76.35 251

ATI

TRAVERSE SAMPLING DATA

Client: LAKESIDE (ABERDEEN)
Date: 5-25-88
Sample Location: FAN - Inlet
Operators: JAG
Sample Box #: [illegible]
Run #: 3

SCHEMATIC TRAVERSE LAYOUT

Stack Diameter _____
Distance Upstream _____
Distance Downstream _____

Start Time: 1037
Stop Time: 1137
Barometric Pressure "Hg: 30.25
Static Pres "H_2O: -11.0
Production Rate _____

EQUIPMENT CHECKS

Initial/Final

Leak Rate Cfm: 1.02 / 1.016
Leak Test Vac: 17 / 26
✓ Pitots, Pretest
✓ Pitots, Postest
_____ Orsat Sampling System
7 Tedlar Bag
_____ Thermocouple @ _____ °F

Filter # _____ tare _____ mgs

	Final Wt.		Initial Wt.		Net Wt.
#1 Bubbler	754.3	-	562.6	=	191.7
#2 Impinger	780.7	-	606.3	=	174.4
#3 Bubbler	646.1	-	506.7	=	139.4
#4 Silica Gel	817.5	-	799.1	=	18.4

TOTAL WATER VOLUME 523.9 ✓

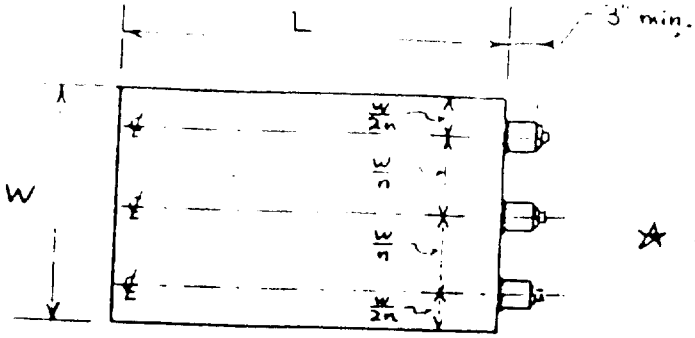
NOMOGRAPH SETUP

% Moisture _____
Meter Temp. _____
Stack Temp. _____
ΔH@ _____ Y _____
Pitot # _____ Side # _____
Cp _____
Nozzle Diameter .317
K Factor 2.8
Reference ΔP _____

Sample Point	Elap Time Min.	Dry Gas Meter Reading Cu. Ft.	Pitot Reading (ΔP), In. H_2O	Orifice Setting (ΔH), In H_2O Ideal	Orifice Setting (ΔH), In H_2O Actual	Gas Meter Temp °F In	Gas Meter Temp °F Out	Pump Vacuum In. Hg Gauge	Filter Box Temp °F	Imp. Exit Temp °F	Stack Temp °F	Opacity or Orsat Values
1	0	824.259	.42	1.25	1.25	71	74	8	240	45	205	
2	5		.45	1.34	1.34	74	73	9	272	51	230	
3	10		.45	1.34	1.34	78	73	9	270	52	245	
4	15		.54	1.54	1.54	81	73	10½	268	54	250	
5	20		.40	1.14	1.14	83	74	8½	271	57	253	
6	25		.50	1.42	1.42	84	74	9½	264	59	261	
7	30		.50	1.42	1.42	86	75	9½	266	59	262	
8	35		.56	1.59	1.59	88	76	11½	260	60	263	
9	40		.56	1.59	1.59	88	77	11½	261	60	264	
10	45		.50	1.42	1.42	89	78	10	262	61	261	
11	50		.64	1.82	1.82	90	78	13½	271	60	263	
12	55		.64	1.82	1.82	90	79	13½	268	61	264	
END	60	878.979										

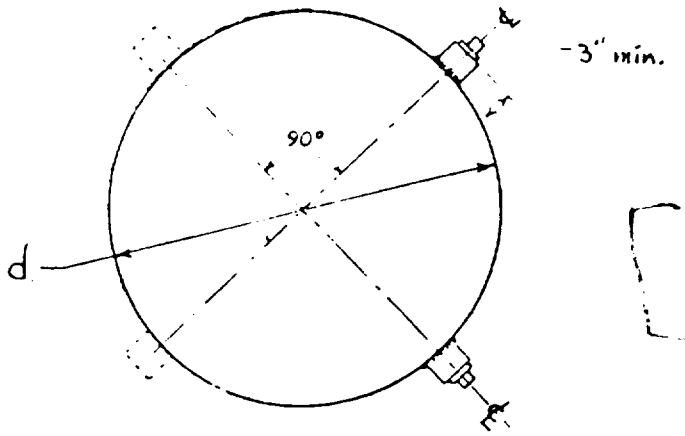
[illegible] 0.1146 — 1.47 ✓ 79.7 — 251.7 ✓
54.720 — 1.47 79.4

SAMPLING PORTS FOR RECTANGULAR STACK



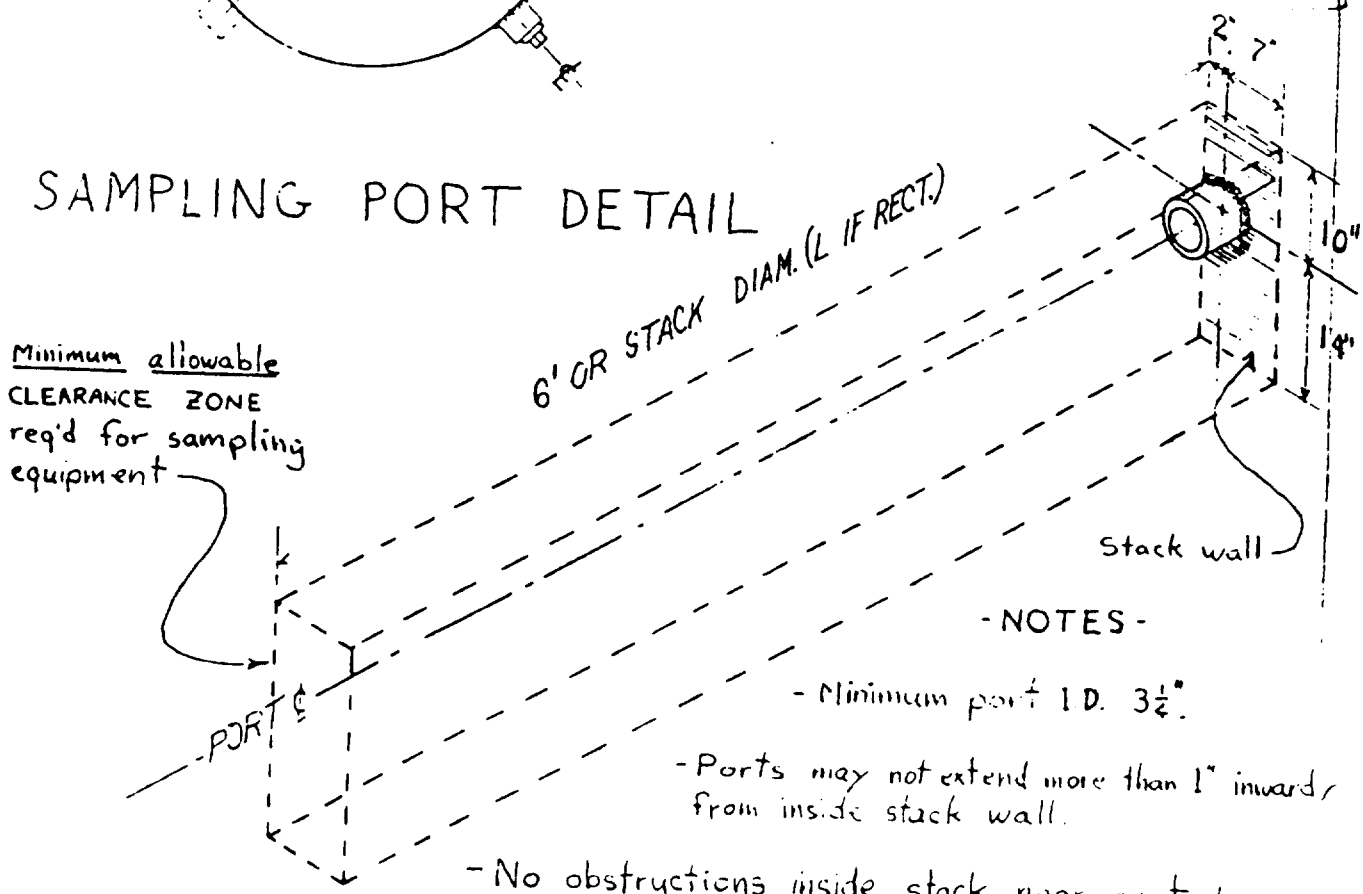
- Port ℄'s must be horizontal.
- Ports are 3" - 4" NPT couplings, welded to short side of stack.
- ★ Number of ports = n, with $2 \le n \le 6$, usually.

SAMPLING PORTS FOR CIRCULAR STACK



- Stack cross-section should be horizontal.
- Ports are 3"- 4" NPT couplings.
- If $d > 10'$, four ports req'd.
- If stack axis is horizontal only one port, with horizontal ℄ req'd.

SAMPLING PORT DETAIL



- NOTES -

- Minimum port I.D. $3\frac{1}{2}$".
- Ports may not extend more than 1" inward from inside stack wall.
- No obstructions inside stack near port ℄.

Diagram provided to Lakeside by Olympic Air