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.

AIR QUALITY, INC.

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SOURCE

EMISSION

EVALUATION

AUGUST 24, 1993

Prepared For:

RECEIVED
AUG 2 1993
CARB

ACE PAVING COMPANY, INC.
BARBER GREENE ASPHALT PLANT
BAGHOUSE STACK
METHOD 5 TESTING
SHELTON, WASHINGTON
JULY 21, 1993

Submitted by:

Kris A. Hansen
Project Manager

James A. Guenthoer
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Am Test-Air Quality, Inc.
Preston, Washington

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

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1.0
INTRODUCTION

The purpose of this source emission evaluation was to quantify particulate matter emissions at the baghouse exhaust of a batch asphalt plant located at Ace Paving Company, Inc.'s Shelton, Washington facility. The asphalt plant was manufactured by Barber Greene and is equipped with a Barber Greene baghouse to control particulate matter emissions prior to exhausting to the atmosphere. Ace Paving Company, Inc. contracted Am Test-Air Quality, Inc. based in Preston, Washington to conduct these source tests. These tests were performed to demonstrate compliance with Olympic Air Pollution Control Authority (OAPCA) permit requirements.

Testing and analysis procedures used for this project are presented in the July 1, 1992 edition of the Environmental Protection Agency (EPA) document Title 40, Code of Federal Regulations, Parts 53-60 (40 CFR 60), Appendix A, Methods 1, 2, 3, 4 and 5, and the Puget Sound Air Pollution Control Agency (PSAPCA) Regulation I. Methods 1 and 2 were performed to measure the stack gas temperature and velocity for calculating volumetric flow rate. Method 3A was performed to determine the molecular weight of the stack gas based on measurements of the oxygen (O_2) and carbon dioxide (CO_2). Method 4 was performed to measure the moisture content of the stack gas. Method 5 was performed to quantify particulate and condensible matter emissions. OAPCA requires that the condensible particulate matter present in the gas stream be quantified by performing an extraction of the back-half portion of the Method 5 sample train. PSAPCA back-half analysis procedures were used for the condensible

matter analysis. Two (2) 60-minute Method 1, 2, 3, 4 and 5 samples were collected at the baghouse exhaust on July 21, 1993.

Mr. James A. Guenthoer and Mr. Stanley B. Moye of Am Test-Air Quality, Inc. performed the field sampling. Sample recovery and laboratory analysis of the Method 5 samples were performed by Mr. Stanley B. Moye and Ms. Wendy A. Linn of Am Test. Data reduction, quality assurance review and final report preparation were performed by Mr. Kris A. Hansen, Ms. Angela F. Blaisdell, Ms. Cassie B. Heaton, Ms. Jan W. Alden, Ms. Amy M. Brotherton and Ms. Linn of Am Test. This testing program was coordinated by Mr. Gary Swanson of Ace Paving. Testing was observed by Mr. Jim Werner of the Olympic Air Pollution Control Authority (OAPCA).

2.0

SUMMARY OF RESULTS

The results of the two (2) 60-minute Method 5 tests for quantifying particulate matter emissions at the asphalt plant baghouse exhaust are summarized in Table 2.0 below, and on page 5 in a computer printout titled "Summary of Results - Methods 1, 2, 3A, 4 and 5". The plant did not have enough paving work scheduled on the test day to perform three runs, so Jim Werner of OAPCA approved performing only two runs.

Table 2.0. Summary of particulate matter emission test results from samples collected on July 21, 1993 at the baghouse exhaust at Ace Paving Company, Inc.'s facility in Shelton, Washington.

Sample Run #	Front-Half P.M. Emission Conc. (gr/dscf)	Back-Half P.M. Emission Conc. (gr/dscf)	Total P.M. Emission Conc. (gr/dscf)	Total P.M. Emission Rate (lb/hr)
1	0.028	0.002	0.030	4.77
2	0.026	0.002	0.028	5.15
Average	0.027	0.002	0.029	4.96

The front-half, back-half and total particulate matter emission concentrations in Table 2.0 are presented in units of grains per dry standard cubic foot (gr/dscf). The total particulate matter emission rate is presented in units of pounds per hour (lb/hr). 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 $\pm$ 10%. Computer printouts of the results from the individual Method 5 tests are included in

Appendix A of this report. Appendix B of this report contains example calculations of the results, along with copies of original field data sheets.

AMTEST
AIR QUALITY, INC.

SUMMARY OF RESULTS - METHODS 1, 2, 3A, 4 AND 5
AM TEST - AIR QUALITY, INC.

FILE NAME: 201B\ACEM5SUM
CLIENT: ACE PAVING COMPANY, INC.
LOCATION: SHELTON, WASHINGTON

	BARBER GREENE ASPHALT PLANT BAGHOUSE STACK		
	RUN #1	RUN #2	AVERAGE
LAB #:	4136	4137	
DATE:	7/21/93	7/21/93	
START TIME:	08:27	12:35	
STOP TIME:	09:32	13:40	
SAMPLE LENGTH (minutes):	60.0	60.0	
PROCESS RATE (tons/hr):	210	210	210
VOLUME SAMPLED (cubic feet):	50.893	53.691	52.292
VOLUME SAMPLED (dry std. cubic feet):	51.902	53.722	52.812
VOLUME SAMPLED (dry std. cubic meters):	1.470	1.521	1.496
STACK GAS MOISTURE (percent):	31.02	23.57	27.30
BAROMETRIC PRESSURE (inches of Hg):	30.00	29.95	29.98
STATIC PRESSURE (inches of H2O):	0.22	0.21	0.22
STACK PRESSURE (inches of Hg):	30.02	29.97	30.00
STACK TEMPERATURE (degrees F.):	236.0	193.0	214.5
STACK TEMPERATURE (degrees R.):	696.0	653.0	674.5
CARBON DIOXIDE (percent):	8.7	6.6	7.6
OXYGEN (percent):	11.2	13.5	12.4
MOLECULAR WEIGHT (dry, g/g-mole):	29.84	29.60	29.72
MOLECULAR WEIGHT (wet, g/g-mole):	26.17	26.86	26.52
AVERAGE VELOCITY HEAD (inches of H2O):	1.23	1.30	1.27
PITOT TUBE Cp:	0.84	0.84	
STACK GAS VELOCITY (feet per second):	74.9	73.8	74.4
STACK DIAMETER (inches):	36x31.5	36x31.5	
STACK AREA (square feet):	7.88	7.88	
STACK GAS AIRFLOW (dry std. cubic feet per min.):	18580.5	21574.1	20077.3
STACK GAS AIRFLOW (actual cubic feet per min.):	35390.5	34856.5	35123.5
NOZZLE DIAMETER (inches):	0.255	0.255	
ISOKINETICS (percent):	103	92	
FRONT-HALF PARTICULATE EMISSION CONC. (gr/dscf):	0.028	0.026	0.027
BACK-HALF PARTICULATE EMISSION CONC. (gr/dscf):	0.002	0.002	0.002
TOTAL PARTICULATE EMISSION CONC. (gr/dscf):	0.030	0.028	0.029
TOTAL PARTICULATE EMISSION CONC. (mg/dscm):	68.6	63.8	66.2
TOTAL PARTICULATE MATTER EMISSION RATE (lb/hr):	4.77	5.15	4.96

3.0
SOURCE OPERATION

The Barber Greene Model DC70 (I.D. X456) batch asphalt plant located at Ace Paving Company, Inc.'s facility in Shelton, Washington was constructed and installed in 1992. Emissions from the asphalt plant are controlled by a Barber Greene Pulsjet baghouse prior to exhausting to the atmosphere. The plant was fired with propane at a rate of 2.5 gallons per ton of asphalt produced. The baghouse contains 600, 96-inch by 60-inch Nomex bags. The pressure drop across the baghouse averaged 8 inches of water column ("H_2O) on the day of testing. According to plant personnel, the plant operated at an average asphalt production rate of 200 tons per hour (ton/hr), with a gravel moisture content of 5.5%, gravel containing 5.2% fines and an asphalt discharge temperature of 300° F. A process information sheet, completed by Mr. Gary R. Swanson of Ace Paving Company, is included in Appendix C of this report.

4.0

METHODOLOGY REFERENCES

Sampling procedures specified in the July 1, 1992 edition of the EPA document Title 40, Code of Federal Regulations, Parts 53-60 (40 CFR 60), Appendix A, Methods 1, 2, 3A, 4 and 5 were used for these tests. Sampling and analysis procedures specified in the Puget Sound Air Pollution Control Agency (PSAPCA) "Particulate Source Test Procedures" adopted by the PSAPCA Board of Directors, August 11, 1983, in accordance with section 9.09 of Regulation I, PSAPCA, were utilized in conjunction with the EPA Method 5 procedures for "back-half" analysis for extracting condensible matter. Methodology suggested in the EPA 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.

5.0
SAMPLING AND ANALYSIS PROCEDURES

5.1 EPA Methods 1 and 2 - Velocity, Temperature and Airflow

EPA Method 1 procedures were used to assure that representative measurements of volumetric flow rate were obtained by dividing the cross-section of the exhaust stack into a number of equal areas, and then locating a traverse point within each of the equal areas. Method 2 was performed to measure the stack gas velocity using a pitot tube, and the gas temperature using a thermocouple. The S-type pitot tubes were connected with tubing to an oil-filled inclined manometer to obtain velocity measurements. The pitot tube lines were leak-checked and the inclined manometer was leveled and zeroed prior to use. Temperatures were measured using calibrated thermocouple probes connected to a digital thermocouple indicator.

Emissions from the baghouse exhaust to the atmosphere through a 36-inch by 31.5-inch rectangular stack which has four (4) sample ports located at the same elevation along the 31.5-inch side. The sample ports are located 67 inches from the nearest upstream flow disturbance, and 53 inches from the nearest downstream flow disturbance. Four (4) velocity and temperature traverses of six (6) points each were performed during each Method 5 test. Each point was sampled for 2.5 minutes for a total sampling time of 60 minutes per run. Figure 1 located in Appendix C of this report is a schematic of the stack and the point locations selected. The sample probe was marked with felt pen and heat resistant tape to indicate the proper point location.

5.2 EPA Method 3A - Gas Composition

The stack gas composition was determined using EPA Method 3A procedures, which allow the use of instrumental analyzers. A Servomex Model 1420B paramagnetic analyzer was used to measure the percent oxygen (O_2). A Servomex Model 1410B non-dispersive infrared (NDIR) analyzer was used to measure the percent carbon dioxide (CO_2). O_2 was measured on a continuous basis. CO_2 and O_2 were also determined from integrated bag samples. The gas composition measurements made during each test period were used to calculate the molecular weight of the stack gas.

5.3 EPA Method 4 - Moisture

The percent moisture in the gas stream was quantified by weighing the impingers to 0.1 grams before and after each Method 5 run on a digital top-loading balance. The net weight (final minus initial) was used to calculate the amount of moisture condensed from the known volume of stack gas which was collected.

5.4 EPA Method 5 - Particulate Matter

The sample train used for particulate matter sampling was an EPA Method 5 design as illustrated in Figure 2 in Appendix C of this report. The stainless steel button hook nozzles used for these tests were measured on-site with inside calipers. A stainless steel probe sheath with a heated stainless steel liner was used to draw gas from the stack. The probe was equipped with S-type pitot tubes for measuring gas velocity and a thermocouple sensor for measuring stack gas temperature. The thermocouple sensor was connected to a digital thermocouple indicator which was used to measure the stack gas temperature at each sample point. A glass filter assembly containing a 125 millimeter Whatman QM-A ultrapure quartz microfibre 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 are 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 of the Method 5 sample train consisted of a modified Greenburg-Smith bubbler containing 100 milliliters (mL) of deionized water, an impinger also containing 100 mL of deionized 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 during sampling.

The Method 5 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 calibrated dry gas meter readable to 0.001 cubic feet. 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 pitot tubes utilized to measure stack gas velocity are connected to the control box via the umbilical cord. The control box contains an oil-filled inclined manometer which was used for the velocity measurement and for monitoring orifice pressure.

Stack condition measurements were made prior to collecting a sample, including measurements of velocity, temperature and a check for cyclonic flow in the stack. A sample nozzle was chosen and isokinetic operating parameters were established

utilizing a Hewlett-Packard 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 process 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. Crushed 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. Isokinetic sampling proceeded at each of the traverse points. Upon completion of the test, 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.

Following sample collection, the Method 5 sample was transferred to an area free from air disturbances and airborne particulate matter. The filters were transferred to petri dishes labeled with the sample date, client name and run number. Am Test refers to the front-half filter portion of the particulate catch as the "A" section. Care was taken to assure that any loose particulate matter and filter mat were quantitatively transferred to the petri dish. In the laboratory, the filters were placed in an oven and baked at 105° C for two (2) hours, then they were transferred to a constant humidity desiccator containing silicon dioxide (SiO_2) for at least 24 hours of desiccation prior to obtaining weights. The same weighing procedures were followed to obtain the tare weights for the filters. The tare and final weights were made using an 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 $\pm$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 were transferred to a tared, graduated 150 milliliter beaker. The volume of acetone was recorded and the beakers were placed in an evaporation chamber at a temperature of approximately 75-80^{o} F. A tared beaker with 150 milliliters of acetone 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 24 hours of desiccation. The samples and acetone blanks were weighed to a constant weight of $\pm$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 using an 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 contents of the bubblers and impingers were transferred to a 1000 mL graduated cylinder. The bubblers and impingers were rinsed with deionized water into the graduated cylinder and the liquid level was recorded. This liquid was transferred to a separatory funnel and the contents were extracted with three (3) 50

mL portions of dichloromethane (CH_2Cl_2). The organic layer was transferred to a tared 150 mL beaker labeled the "C_x" section and this beaker's contents were allowed to evaporate to dryness in an evaporation chamber at a temperature of 75-80° F. The water layer was transferred to a tared 150 mL beaker with glass boiling beads labeled the "C" section, and this beaker's contents were heated on a hot plate to boiling until approximately 20 milliliters remained in the beaker. The remaining 20 milliliters in the beaker was evaporated to dryness in an evaporation chamber set at 75-80° F. The acetone rinses of the bubblers, impingers, and graduated cylinder were inadvertently omitted, however, the amount of condensible matter typically found in the acetone impinger rinse is insignificant. Sample blanks containing deionized water, dichloromethane, and acetone were analyzed in an identical fashion as the representative "section". All beakers were desiccated for at least 24 hours and weighed to constant weights of ± 0.5 milligrams at 6 hour or greater intervals after their contents had evaporated. The total particulate matter weight is the sum of the net weights of the particulate matter found on the filter, plus the net weights found in the B, C and Cx section beakers, minus the acetone, water, and dichloromethane blank concentrations. The particulate matter weights are included on the Method 5 computer printouts which are included in Appendix A of this report, and on the laboratory analysis data sheets in Appendix B of this report.

6.0
QUALITY ASSURANCE PLAN

The purpose of the quality assurance plan is to provide guidelines for achieving quality control in air pollution measurements. The detailed procedures which were utilized are included in the Environmental Protection Agency's (EPA's) reference manual titled Quality Assurance Handbook for Air Pollution Measurement Systems, Volume 3, EPA-600/4-77-027b. Procedures were followed throughout equipment preparation, field sampling, sample recovery, analysis and data reduction. Am Test-Air Quality, Inc.'s quality assurance procedures are discussed below.

6.1 Calibration Procedures and Frequency

Field equipment utilized for on-site measurements is calibrated at a frequency as recommended by the equipment manufacturer or industry practice. Prior to field use, each instrument is calibrated and the calibration value is recorded. If any measuring or test device requiring calibration cannot immediately be removed from service, the Project Manager may extend the calibration cycle providing a review of the equipment's history warrants the issuance of an extension. No equipment will be extended more than twice a calibration cycle, nor will the extension exceed one-half the prescribed calibration cycle. Test equipment consistently found to be out of calibration will be repaired or replaced.

The sample nozzles used to collect isokinetic samples were calibrated on-site before sampling using digital inside calipers readable to 0.001 inch. Three (3) measurements were taken at varying points around the inside of the nozzle tip and averaged. The dry gas meter used to accurately measure sample volumes was

calibrated using a standard laboratory dry gas meter. Calibration data for the dry gas meters used for this project are included in Appendix C of this report. The S-type pitot tubes utilized for velocity determination have been calibrated using Method 2, Section 4.1, and are inspected regularly for wear. The digital thermocouple indicator used for temperature measurement has a readability of 1 degree Fahrenheit and has been re-certified by the manufacturer. Each thermocouple probe used to monitor temperature is checked periodically at three (3) temperature settings. Thermocouples are checked in the field with ambient air and ice water. Additional calibration information for pressure and temperature recording devices is included in Appendix C of this report. A barometer readable to 0.01 inches of mercury was used in the field to obtain barometric pressure readings.

In the laboratory, ACS grade acetone, dichloromethane, deionized water and filter blanks were carried throughout the gravimetric analysis procedures. The samples were weighed to constant weights of ± 0.5 milligrams following desiccation in a cabinet desiccator. This desiccator is an electronic dehumidifier which automatically maintains the humidity inside the desiccator. The dehumidifier automatically recharges the internal desiccant every 5.5 hours. An Airguide humidity indicator accurate to $\pm 1\%$ is used to check the humidity inside the desiccator when obtaining tare and final weights. A small container of indicating silica gel is placed in the desiccators to maintain the desired humidity. The Mettler AE163 electronic balance used to obtain weights was set to a time integrating mode (100,000 readings per minute) with a readability of 0.01 milligrams. The balance was calibrated prior to every weighing session and an audit is performed with class S weights once a week. The calibration of Am Test's Mettler balances is checked by the manufacturer on a yearly basis.

Support equipment is defined as all equipment, not previously discussed that is required for completing an environmental monitoring or measurement task. This equipment may include storage and transportation containers, sample recovery glassware, and communications gear. Support equipment is periodically inspected to maintain the performance standards necessary for proper and efficient execution of all tasks and responsibilities.

During the project, a systems audit was performed, consisting of an on-site qualitative inspection and review of the total measurement system. This inspection was conducted on a daily basis by the Project Leader. During the systems audit, the auditor observed 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

Visual inspections of pitot tubes, glassware, and other equipment were also made. The main purpose of a systems audit is to ensure that the measurement system will generate valid data, if operated properly.

6.2 Sample Recovery and Field Documentation

Data relative to samples, collected during each test, were immediately inspected for completeness and placed under the custody of the Project Leader until custody is transferred when the samples are returned to the Air Quality laboratory. Sample recovery was carried out in a suitable area free from particulate matter contamination.

6.3 Data Reduction, Validation and Reporting

Raw data are handled according to strict guidelines when being transposed into computer files or to other logs. The guidelines include document receipt control procedures, file review, and sign-off by a checker. Raw data were entered into the appropriate software package by a "processor", then the entered figures were checked for accuracy by a "checker," different from the "processor". Any mistakes were corrected, and figures were rechecked and signed off by the "checker". In addition, by-hand calculation checks were made to validate the computer output. All data generated by each phase of a laboratory or field sampling program were reviewed by the senior reviewer. The data package was signed off by the senior reviewer prior to releasing the data for report preparation.

7.0
CALCULATION OF RESULTS

The Method 1, 2, 3A, 4 and 5 test results were calculated in accordance with current EPA 40 CFR 60 and Olympic Air Pollution Control Authority (OAPCA) criteria. Copies of the pertinent equations used to derive these results are included in Appendix C of this report. Final result calculations were performed using custom-written spreadsheet programs run on Hewlett-Packard Vectra computer systems. The "by-hand" was performed to check the integrity of the computer programs which were used to reduce the data. A sample "by-hand" calculation was completed for run 2, using a Hewlett Packard 42S calculator, and may be found in Appendix B of this report.

APPENDIX A

Computer Printouts of Results

METHODS 1, 2, 3A, 4, AND 5
AM TEST-AIR QUALITY, INC.

FILE NAME:	206B\ACEM5R1	LAB #:	4136
CLIENT:	ACE PAVING CO., INC.	START TIME:	08:27 o'clock
LOCATION:	SHELTON, WASHINGTON	STOP TIME:	09:32 o'clock
SAMPLE SITE:	BARBER GREENE ASPHALT PLANT BAGHOUSE STACK	SAMPLE LENGTH:	60.0 minutes
		PROCESS RATE:	210 ton/hr
SAMPLE DATE:	JULY 21, 1993		
RUN #:	1 - METHOD 5		
OPERATORS:	GUENTHOER/MOYE		

IMPINGER WEIGHTS

FINAL grams	INITIAL grams	NET grams
927.2	629.65	297.55
799.0	631.35	167.65
553.8	540.25	13.55
749.8	733.55	16.25
TOTAL H2O GAIN:		495.00

TOTAL VOLUME (SCF):	23.34	PITOT TUBE Cp:	0.84
PERCENT MOISTURE:	31.02	NOZZLE DIAMETER:	0.255 inches
Bws:	0.3102	NOZZLE AREA:	0.0004 sq. feet
		STACK DIAMETER:	36 x 31.5 inches
		STACK AREA:	7.88 sq. feet
		METER TEMPERATURE:	66.3 degrees F
		BAROMETRIC PRES.:	30.00 inches Hg
		STATIC PRESSURE:	0.22 inches H2O
		STACK PRESSURE:	30.02 inches Hg
		ORIFICE PRESSURE:	2.358 inches H2O
		METER PRESSURE:	30.17 inches Hg
INIT. METER VOLUME:	421.792		
FINAL METER VOLUME:	472.685	AVERAGE CONC. CO2:	8.7 percent
VOLUME SAMPLED:	50.893	AVERAGE CONC. O2:	11.2 percent
STD VOLUME (DSCF):	51.902	AVERAGE CONC. CO:	NA ppm
STD VOLUME (DSCM):	1.470	MOLECULAR WEIGHT:	29.84 g/g-mole-dry
Y FACTOR:	1.008	MOLECULAR WEIGHT:	26.17 g/g-mole-wet

SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE °F	SAMPLE POINT	VELOCITY " OF H2O	TEMPERATURE °F
A 1	1.70	221	C 1	1.70	225
2	1.50	233	2	1.70	236
3	1.10	235	3	1.20	235
4	0.74	240	4	1.30	232
5	0.45	240	5	1.20	232
6	0.30	236	6	1.00	231
B 1	1.90	237	D 1	1.90	228
2	1.70	248	2	1.40	233
3	1.20	247	3	1.50	232
4	1.10	251	4	1.50	233
5	0.84	250	5	1.60	231
6	0.51	245	6	1.60	232

OK

PERCENT ISOKINETICS:	103 %	
STACK TEMPERATURE:	236.0 degrees F	696.0 degrees R
AVERAGE VELOCITY HEAD:	1.23 " of H2O	
STACK GAS VELOCITY:		74.9 ft/second
STACK GAS AIR FLOW:	35390.5 acf/min	18580.5 dscf/min
PARTICULATE EMISSION CONCENTRATION (front-half):		0.028 gr/dscf
PARTICULATE EMISSION CONCENTRATION (back-half):		0.002 gr/dscf
TOTAL PARTICULATE EMISSION CONC. (front & back-half):		0.030 gr/dscf
TOTAL PARTICULATE EMISSION CONCENTRATION:		68.6 mg/dscm
TOAL PARTICULATE MATTER EMISSION RATE:		4.77 lb/hr

FRONTHALF PARTICULATE MATTER MASS LOADING

FILTER NUMBER:	#125-539
TARE WEIGHT OF FILTER (grams):	0.8350
FINAL WEIGHT OF FILTER (grams):	0.8842
NET WEIGHT OF PARTICULATE MATTER (grams):	0.0492
BEAKER NUMBER:	#150-503
TARE WEIGHT OF BEAKER (grams):	82.5544
FINAL WEIGHT OF BEAKER (grams):	82.5997
NET WEIGHT OF PARTICULATE MATTER (grams):	0.0453
VOLUME OF ACETONE (milliliters):	245.0
WT./VOL. OF ACETONE BLANK (milligrams/ml):	0.004
NET WEIGHT OF PARTIC. DUE TO ACETONE (grams):	0.0010
TOTAL FRONTHALF PARTICULATE MATTER (grams):	0.0935

BACKHALF PARTICULATE MATTER MASS LOADING

"C" SECTION - CONDENSER PARTICULATE	#150-540
TARE WEIGHT OF BEAKER (grams):	66.1958
FINAL WEIGHT OF BEAKER (grams):	66.2019
NET WEIGHT OF PARTIC. MATTER (grams):	0.0061
TOTAL VOLUME OF WATER (milliliters):	845.0
VOLUME OF WATER CONDENSED (milliliters):	478.8
NET VOLUME OF WATER FOR BLANK (milliliters):	366.3
WT./VOL. OF WATER BLANK (milligrams/ml):	0.000
NET WEIGHT OF PARTIC. DUE TO WATER (grams):	0.0000
"Cx" SECTION - HYDROCARBON EXTRACTION	#150-500
TARE WEIGHT OF BEAKER (grams):	81.1553
FINAL WEIGHT OF BEAKER (grams):	81.1565
NET WEIGHT OF PARTIC. MATTER (grams):	0.0012
TOTAL VOLUME OF CH2Cl2 (milliliters):	150.0
WT./VOL. OF CH2Cl2 BLANK (milligrams/ml):	0.000
NET WEIGHT OF PARTIC. DUE TO CH2Cl2 (grams):	0.0000
TOTAL BACKHALF PARTICULATE MATTER (grams):	0.0073
TOTAL WEIGHT OF PARTICULATE MATTER (grams):	0.1008

METHODS 1, 2, 3A, 4, AND 5
AM TEST-AIR QUALITY, INC.

FILE NAME:	206B\ACEM5R2	LAB #:	4137	
CLIENT:	ACE PAVING CO., INC.	START TIME:	12:35	o'clock
LOCATION:	SHELTON, WASHINGTON	STOP TIME:	13:40	o'clock
SAMPLE SITE:	BARBER GREENE ASPHALT PLANT BAGHOUSE STACK	SAMPLE LENGTH:	60.0	minutes
		PROCESS RATE:	210	ton/hr
SAMPLE DATE:	JULY 21, 1993			
RUN #:	2 - METHOD 5			
OPERATORS:	GUENTHOER/MOYE			

IMPINGER WEIGHTS

FINAL grams	INITIAL grams	NET grams
907.5	639.05	268.45
696.4	640.05	56.35
529.9	522.90	7.00
748.8	729.15	19.65

TOTAL H2O GAIN:	351.45		
TOTAL VOLUME (SCF):	16.57		
PERCENT MOISTURE:	23.57		
Bws:	0.2357		
PITOT TUBE Cp:	0.84		
NOZZLE DIAMETER:	0.255	inches	
NOZZLE AREA:	0.0004	sq. feet	
STACK DIAMETER:	36 x 31.5	inches	
STACK AREA:	7.88	sq. feet	
METER TEMPERATURE:	75.9	degrees F	
BAROMETRIC PRES.:	29.95	inches Hg	
STATIC PRESSURE:	0.21	inches H20	
STACK PRESSURE:	29.97	inches Hg	
ORIFICE PRESSURE:	2.641	inches H20	
METER PRESSURE:	30.14	inches Hg	
INIT. METER VOLUME:	474.752		
FINAL METER VOLUME:	528.443		
VOLUME SAMPLED:	53.691		
STD VOLUME (DSCF):	53.722		
STD VOLUME (DSCM):	1.521		
Y FACTOR:	1.008		
AVERAGE CONC. CO2:	6.6	percent	
AVERAGE CONC. O2:	13.5	percent	
AVERAGE CONC. CO:	NA	ppm	
MOLECULAR WEIGHT:	29.60	g/g-mole-dry	
MOLECULAR WEIGHT:	26.86	g/g-mole-wet	

SAMPLE POINT	VELOCITY " OF H20	TEMPERATURE °F	SAMPLE POINT	VELOCITY " OF H20	TEMPERATURE °F
A 1	2.00	165	C 1	2.00	193
2	1.60	171	2	1.80	197
3	1.20	177	3	1.40	197
4	0.64	180	4	1.25	197
5	0.40	183	5	1.10	197
6	0.30	186	6	0.93	196
B 1	1.80	188	D 1	2.30	198
2	1.60	192	2	2.10	209
3	1.20	191	3	1.70	213
4	1.10	193	4	1.70	211
5	0.80	191	5	1.70	209
6	0.42	190	6	1.90	207

PERCENT ISOKINETICS:	92 %		
STACK TEMPERATURE:	193.0 degrees F	653.0	degrees R
AVERAGE VELOCITY HEAD:	1.30 " of H20		
STACK GAS VELOCITY:		73.8	ft/second
STACK GAS AIR FLOW:	34856.5 acf/min	21574.1	dscf/min
PARTICULATE EMISSION CONCENTRATION (front-half):		0.026	gr/dscf
PARTICULATE EMISSION CONCENTRATION (back-half):		0.002	gr/dscf
TOTAL PARTICULATE EMISSION CONC. (front & back-half):		0.028	gr/dscf
TOTAL PARTICULATE EMISSION CONCENTRATION:		63.8	mg/dscm
TOAL PARTICULATE MATTER EMISSION RATE:		5.15	lb/hr

FRONTHALF PARTICULATE MATTER MASS LOADING

FILTER NUMBER:	#125-540
TARE WEIGHT OF FILTER (grams):	0.8385
FINAL WEIGHT OF FILTER (grams):	0.9064
NET WEIGHT OF PARTICULATE MATTER (grams):	0.0679
BEAKER NUMBER:	#150-504
TARE WEIGHT OF BEAKER (grams):	81.1568
FINAL WEIGHT OF BEAKER (grams):	81.1794
NET WEIGHT OF PARTICULATE MATTER (grams):	0.0226
VOLUME OF ACETONE (milliliters):	170.0
WT./VOL. OF ACETONE BLANK (milligrams/ml):	0.004
NET WEIGHT OF PARTIC. DUE TO ACETONE (grams):	0.0007
TOTAL FRONTHALF PARTICULATE MATTER (grams):	0.0898

BACKHALF PARTICULATE MATTER MASS LOADING

"C" SECTION - CONDENSER PARTICULATE	#150-541
TARE WEIGHT OF BEAKER (grams):	67.2368
FINAL WEIGHT OF BEAKER (grams):	67.2407
NET WEIGHT OF PARTIC. MATTER (grams):	0.0039
TOTAL VOLUME OF WATER (milliliters):	785.0
VOLUME OF WATER CONDENSED (milliliters):	331.8
NET VOLUME OF WATER FOR BLANK (milliliters):	453.2
WT./VOL. OF WATER BLANK (milligrams/ml):	0.000
NET WEIGHT OF PARTIC. DUE TO WATER (grams):	0.0000
"Cx" SECTION - HYDROCARBON EXTRACTION	#150-501
TARE WEIGHT OF BEAKER (grams):	66.2207
FINAL WEIGHT OF BEAKER (grams):	66.2240
NET WEIGHT OF PARTIC. MATTER (grams):	0.0033
TOTAL VOLUME OF CH2Cl2 (milliliters):	150.0
WT./VOL. OF CH2Cl2 BLANK (milligrams/ml):	0.000
NET WEIGHT OF PARTIC. DUE TO CH2Cl2 (grams):	0.0000
TOTAL BACKHALF PARTICULATE MATTER (grams):	0.0072
TOTAL WEIGHT OF PARTICULATE MATTER (grams):	0.0970

APPENDIX B

Example Calculations and Field Data Sheets

SAMPLE CALCULATION SHEET
METHODS 1, 2, 3A, 4 AND 5

CLIENT: Ace Paving Company, Inc. DATE OF TEST: 7/21/93

LOCATION: Barber Greene Asphalt Plant Baghouse Stack, Shelton, Washington RUN #: 2 - Methods 1, 2, 3A, 4 and 5

Particulate Matter Emission Concentration - Equation 5-1

Vm_{std} = 17.647°R/"Hg * 53.691 ft³ * 1.008 * (29.95 "Hg + (2.641 "H_2O/13.6))/(460 + 75.9 °F)

= 53.722 dscf

dscm = 53.722 dscf/35.31 ft³/m³

= 1.521 dscm

Substitution of Equation 5-4 into 5-5

W_a = 0.6 mg * 170 ml / 150 ml

= 0.68 mg

M_n = (net weight filter catch) + (net weight "B" section) - Wa + Back-half

= 97.0 mg = 67.9 mg + 22.6 mg - 0.68 mg + 7.2 mg

C_s = (0.001 g/mg) * (15.43 grains/gram) * 97.0 mg / 53.722 dscf

= 0.028 gr/dscf (Equation 5-6)

gr/dscf @7% O_2 = _____ gr/dscf * (20.9% - 7%O_2)/(20.9% - _____ %O_2)

= NA gr/dscf @ 7% O_2

gr/dscf @ 12% CO_2 = _____ gr/dscf * 12% / _____ %CO_2

= NA gr/dscf @ 12% CO_2

mg/dscm = 97.0 mg/ 1.521 dscm

= 63.8 mg/dscm

Particulate Matter Emission Rate

pounds/hour = 0.028 gr/dscf * 21574.1 dscf/min * 60 min/hr * 1 lb/7000 grains

= 5.15 lb/hr

Moisture - Equation 5-2 and 5-3

Vw_{std} = 0.04715 ft³/g * 351.45 grams of H_2O collected in impingers

= 16.57 scf

SAMPLE CALCULATION SHEET (continued)
METHODS 1, 2, 3A, 4 and 5

B_{ws} = (16.57 scf)/(16.57 scf + 53.722 dscf)

= 0.2357

%Moisture = 0.2357 * 100

= 23.57 %

Molecular weight - Equation 3-2

M_d = 0.440 * (6.6 %CO_2) + 0.320 * (13.5 %O_2) + 0.280 * (79.9 % CO + %N_2)
(100-13.5-6.6)

M_d = 29.60 g/g-mole (dry)

M_s = 29.60 g/g-mole * (1 - 0.2357) + 18.0g/g-mole * 0.2357

M_s = 26.86 g/g-mole (wet)

Stack gas velocity and volumetric flow rate - Equation 2-9 and 2-10

V_s = 85.49 * 0.84 * $\sqrt{1.30 * \frac{653.0}{(460+193)}}$ ° R / 26.86 g/g-mole / $\frac{29.97}{29.95+(.21/13.6)}$ "Hg

V_s = 73.8 ft/sec

Q_{sd} = 3600 * (1 - 0.2357) * 73.8 ft/sec * 7.88 ft² * (528 ° R/653.0 ° R) *
(29.97"Hg/29.92"Hg)
36*31.5/144

= 1294444 dscf/hr / 60 min/hr

= 21574.1 dscf/min (dry standard cubic feet per minute)

acfm = 73.8 ft/sec * 7.88 ft²* 60 sec/min

= 348565 acfm (actual cubic feet per minute)

Isokinetic variation - Equation 5-8

I = 0.09450 * 53.722dscf * 653.0° R/(29.97 "Hg * 73.8 ft/sec * 60 min *
0.0004 ft² *(1 -0.2357))
.255²*π/4/144

I = 92 %

All of the above numbered equations are from the 40 CFR 60 and assume English units.

JWA

SAMPLE CALCULATION SHEET (2)

Backhalf particulate

"C" Section

3.9 mg particulate in "C" Section beaker

785 ml of water in condensers, including rinses

331.8 ml of condensation in 1st, 2nd and 3rd bubblers (final weight - initial weight, assumes 1g/1ml water density)

453.2 ml of deionized, distilled water used in bubblers including rinses

0.0 mg/ml blank partic. = (0.0 mg H2O blank / ~~100~~ 150 ml H2O)

0.0 mg of blank particulate

= 3.9 mg of "C" partic. = 3.9 mg of partic. in "C" - 0.0 mg of blank

"Cx" Section

3.3 mg of particulate in "Cx" Section beaker

0.0 mg/ml of blank partic. = (0.0 mg CH2Cl2 blank / 150 ml CH2Cl2)

0.0 mg of blank particulate = (150 ml * 0.0 mg/ml)

= 3.3 mg of "Cx" partic = 3.3 mg of partic in "Cx" - 0.0 mg of blank

"D" Section

_____ mg of particulate in "D" Section beaker

_____ mg/ml of blank particulate (same as "B" Section)

_____ mg of blank particulate = (_____ml * _____mg/ml)

= NA mg of "D" partic. = _____mg of partic. in "D" - _____mg of blank

Total Backhalf Particulate

+ 3.9 mg of "C" Section particulate

+ 3.3 mg of "Cx" Section particulate

+ NA mg of "D" Section particulate

+ NA mg of Backhalf filter (if applicable)

= 7.2 mg of Backhalf particulate

STACK SCHEMATIC AND LOCATION OF SAMPLE POINTS

Client ACE PAVING

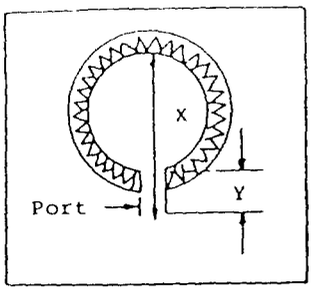
Location SHELTON, WA

Sampling Location BARBER-GREEN PLANT BAGHOUSE EXHAUST STACK

Inside of far wall to outside of port (distance, X) 3 5/8" x 31 1/2

Inside of near wall to outside of port (distance, Y) 2"

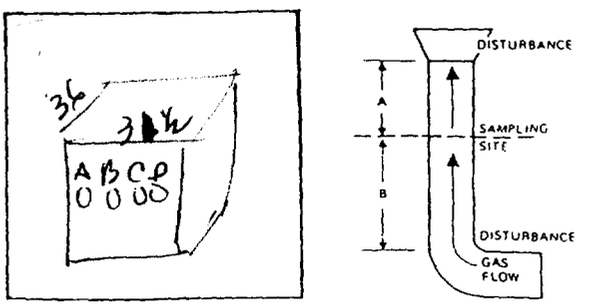
Stack I.D. (distance X - distance Y) 36"



Schematic of Sampling Location

1 Traverse Point #	2 Fractional Percent of Stack I.D.	3 Stack I.D. inches	4 Column 2 x 3	5 Distance Y	6 Traverse Point Location from Outside of Port columns 4 + 5
1		36"	3	2"	5
2			9		11
3			15		17
4			21		23
5			27		29
6			33		35
7					
8					
9					
10					
11					
12					

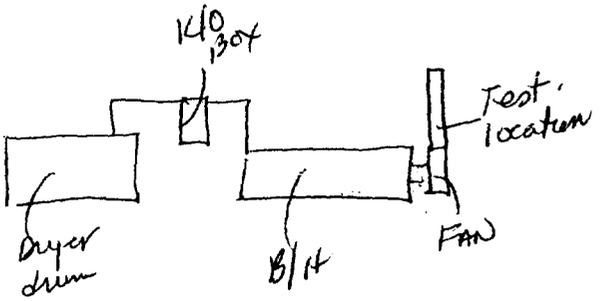
CROSS SECTION



Distance A = 53" downstream

Distance B = 67" upstream

STACK, CONTROL DEVICE AND PROCESS FLOW DIAGRAM



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TRAVERSE SAMPLING DATA SHEET

Page ___ of ___

Client ACE PAVING
Location SHELTON, WA
Sample Site BAGHOUSE STACK
Stack Diameter 36 x 31½
Date 7-21-93
Operators JM6 - SBM
Run I.D. 1 - MS

EQUIPMENT CHECKS

	Initial/Final
Leak Rate cfm	L.01 / 1,009
Leak Test Vacuum	14 / 12
✓ Pitots, Pre Leak Ck	
✓ Pitots, Post Leak Ck	
✓ Gas Sampling System	
Integrated Bag	
Thermocouples @ ___ °F	

QA FORMS COMPLETED
Stack Schematic ___
Sample Train ___
Pitot Tube Insp. ___
Magnehelic Cal. ___
Temp. Probe Cal. ___
Gas Meter Calib. ___

Filter # _____ Box # S-1

	Final Wt. gram	Initial Wt. gram	Net Wt. gram
#1 Imp.	927.2	- 629.65 =	297.55
#2 Imp.	799.0	- 631.35 =	167.65
#3 Imp.	553.8	- 540.25 =	13.55
#4 Imp.		- =	
#5 Imp.		- =	
#6 S.G.	749.8	- 733.55 =	✓ 16.25

Total H_2O Volume 495.0 ✓ g

Start Time 0827
Stop Time 0932
Barometric Pressure "Hg 30.00
Static Pres "H_2O +.20
Production Rate 210 T/hr
RED MAN. MS

SAMPLING PARAMETERS

% Moisture _____
Meter Temp. _____
Stack Temp. _____
ΔH@ 1.679 Y 1.008
Pitot # _____ Side # _____
Cp .84
Nozzle Diameter .253 inch
D_1 .253 D_2 .253 D_3 .254

K Factor _____

Sample Point		Elap Time Min.	Dry Gas Meter Reading Cu.Ft.	Pitot Reading Δ P " H_2O	Orifice Setting (Δ H) " H_2O Ideal	Orifice Setting (Δ H) " H_2O Actual	Gas Meter Temp °F In	Gas Meter Temp °F Out	Pump Vac. Gauge " Hg	Filter Box Temp °F	Imp. Exit Temp °F	Stack Temp °F	O_2 %
A	1	0	421.792	1.7	3.2	3.2	61	61	2½	229	56	221	11.2
	2			1.5	2.8	2.8	62	61	2½	234	57	233	11.2
	3	5		1.1	2.07	2.07	62	61	2	236	57	235	10.9
	4			.74	1.39	1.39	63	61	1½	233	60	240	11.0
	5	10		.45	.85	.85	63	61	1	237	55	240	10.7
	6			.30	.55	.55	64	62	1	241	60	236	11.0
B	1	15		1.9	3.48	3.48	65	62	3	232	57	237	10.3
	2			1.7	3.11	3.11	66	62	3	235	54	248	10.3
	3	20		1.2	2.20	2.20	66	63	2½	243	54	247	11.0
	4			1.1	2.01	2.01	67	63	2½	240	55	251	10.2
	5	25		.84	1.54	1.54	68	63	2	239	57	250	10.5
	6			.51	.93	.93	68	63	1½	235	58	245	10.6
C	1	30		1.7	3.11	3.11	69	64	3	233	56	225	11.4
	2			1.7	3.11	3.11	69	65	3	251	52	236	11.6
	3	35		1.2	2.2	2.2	70	65	2½	254	52	235	11.9
	4			1.3	2.38	2.38	71	65	2½	255	52	232	12.2
	5	40		1.2	2.2	2.2	71	66	2½	260	52	232	11.8
	6			1.0	1.83	1.83	72	67	2	262	52	231	11.9
D	1	45		1.9	3.53	3.53	72	67	4	260	54	248	11.3
	2			1.4	2.6	2.6	73	68	3	240	52	233	11.6
	3	50		1.5	2.78	2.78	73	68	3	244	52	232	11.4
	4			1.5	2.78	2.78	73	68	3	237	52	233	11.3
	5	55		1.6	2.97	2.97	74	69	3	236	53	231	11.3
	6			1.6	2.97	2.97	74	69	3	230	54	232	11.1
		60	472.685 ✓	1.108 ✓		2.358 ✓		66.3 ✓				236.0 ✓	
			50.893 ✓	$\sqrt{(\Delta P)^2}$		ΔH		T_m				T_s	

O_2 = 11.2 ✓ 8.7
CO_2

FINAL

METHOD 5
LABORATORY ANALYSIS

Client Ace Paving Run Number 1

Sample Location Baghouse Exhaust

Date 7-21-93

"A" Section (Filter)

Filter # 125-539

Tare Weight 0.8350 grams
Final Weight 0.8842 grams F ✓
Net Weight 0.0492 grams

"B" Section (Probe Wash)

Beaker # 503

Volume Acetone 245 mls

Tare Weight 82.5544 grams
Final Weight 82.5997 grams F
Net Weight 0.0453 grams ✓

Blank #505
Vol: 150ml
T: 83.0358
F: 83.0364 N: 0.0006

16/150 = 0.004 mg/ml − 0.98 mg | 245 mls

"C" Section (inorganic catch)

Beaker # 540
Vol. H_2O 845 mls

TARE WT. 66.1958 gms
Final WT. 66.2019 gmsF
NET WT 0.0061 gms ✓

Blank #542
Vol.: 150ml
T: 67.8203
F: 67.8193 N: 0.0

0.000 mg/ml ✓

"CX" section (organic catch)

Beaker # 500
Vol ~~H_2O~~ Acetone 150 mls

TARE WT. 81.1553 gms
Final WT. 81.1565 gmsF
NET WT. 0.0012 gms ✓

Blank: #502
Vol: 150 mls
T: 65.0518 gms
F: 65.0510 gms 0.000 mg/ml ✓
N: 0.0

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~~#36~~
#137

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TRAVERSE SAMPLING DATA SHEET

Page ___ of ___

Client ACB, PAUNG
Location Shelton, WA
Sample Site Baghouse Stack
Stack Diameter 36 x 31.5
Date 7-21-93
Operators JAG - SJM
Run I.D. 2-MS

EQUIPMENT CHECKS

	Initial	Final
Leak Rate cfm	.01	.012
Leak Test Vacuum	15	12

___ Pitots, Pre Leak Ck
___ Pitots, Post Leak Ck
___ Gas Sampling System
___ Integrated Bag
___ Thermocouples @ ___ °F

QA FORMS COMPLETED
Stack Schematic ___
Sample Train ___
Pitot Tube Insp. ___
Magnehelic Cal. ___
Temp. Probe Cal. ___
Gas Meter Calib. ___

Filter # _____ Box # S-2

	Final Wt. gram	Initial Wt. gram	Net Wt. gram
#1 Imp.	907.5	639.05	
#2 Imp.	696.4	640.05	
#3 Imp.	529.9	522.90	
#4 Imp.			
#5 Imp.			
#6 S.G.	748.8	729.15	✓

Total H_2O Volume 351.5 ✓ g

Start Time 1235
Stop Time 1340
Barometric Pressure "Hg 29.95
Static Pres "H_2O -1.2 (Pg)
Production Rate ≈ 210 t/hr

P_s = 29.97

SAMPLING PARAMETERS

% Moisture _____
Meter Temp. _____
Stack Temp. _____
ΔH@ 1.679 Y 1.008
Pitot # _____ Side # _____
Cp .84
Nozzle Diameter .255 inch
D_1 _____ D_2 _____ D_3 _____

K Factor _____

Sample Point	Elap Time Min.	Dry Gas Meter Reading Cu.Ft.	Pitot Reading ΔP " H_2O	Orifice Setting (ΔH) " H_2O Ideal	Orifice Setting (ΔH) " H_2O Actual	Gas Meter Temp °F In	Gas Meter Temp °F Out	Pump Vac. Gauge " Hg	Filter Box Temp °F	Imp. Exit Temp °F	Stack Temp °F	O_2 %	
A 1	0	474.752	2.0	3.94	3.94	74	73	2½	256	58	165	12.5	
2			1.6	3.14	3.14	73	73	2½	240	54	171	12.5	
3	5		1.2	2.36	2.36	74	73	2	260	52	177	12.8	
4			.64	1.27	1.27	74	73	1	255	54	180	13.0	
5	10		.40	.78	.78	74	74	1	256	55	183	13.6	
6			.30	.58	.58	75	74	1	250	56	186	13.6	
B 1	15		1.8	3.48	3.48	75	74	2½	258	55	188	13.6	
2			1.6	3.10	3.10	76	74	2½	250	54	192	14.0	O_2 = 13.5
3	20		1.2	2.32	2.32	76	74	2	244	55	191	14.0	$\overline{O_2}$ = 13.6
4			1.1	2.13	2.13	76	74	2	245	56	193	13.3	
5	25		.80	1.55	1.55	77	74	1½	254	56	191	14.0	
6			.41	.81	.81	77	75	1	259	57	190	13.9	
C 1	30		2.0	3.87	3.87	78	75	3	260	58	193	13.9	
2			1.8	3.48	3.48	78	75	3	266	58	197	13.8	
3	35		1.4	2.67	2.67	79	75	2½	257	58	197	14.0	
4			1.25	2.38	2.38	79	76	2	256	60	197	13.8	
5	40		1.1	2.1	2.1	79	76	2	250	61	197	14.0	
6			.93	1.77	1.77	79	76	1½	256	61	196	14.0	
D 1	45		2.3	4.38	4.38	79	76	3½	240	59	198	13.6	
2			2.1	4.0	4.0	79	77	3	246	59	209	13.4	
3	50		1.7	3.24	3.24	79	76	3	250	60	213	13.0	
4			1.7	3.24	3.24	79	76	3	249	60	211	12.8	
5	55		1.7	3.24	3.24	79	77	3	255	61	209	13.3	
6			1.9	3.56	3.56	79	77	3	244	63	207	13.7	
	60	528.443	1.141 ✓	✓	2.641		75.9 ✓			✓	193.0	13.5	✓
		53.691 ✓	$\sqrt{(\Delta P)^2}$		ΔH		T_m				T_s		

METHOD 5
LABORATORY ANALYSIS

Client ACE PAVING Run Number 2

Sample Location Baghouse Exhaust

Date 7/21/93

"A" Section (Filter)

Filter # 125-540

Tare Weight 0.8385 grams
Final Weight 0.9064 gramsF
Net Weight 0.0679 grams

"B" Section (Probe Wash)

Beaker # 504
Volume Acetone 170 mls

Tare Weight 81.1568 grams
Final Weight 81.1794 gramsF
Net Weight 0.0226 grams

"C" section (inorganic catch)

Beaker # 541
Vol. H_2O 785 mls

TARE WT. 67.2368 gms
Final WT. 67.2407 gmsF
Net WT. 0.0039 gms

"CX" section (organic catch)

Beaker # 501
Vol ~~H_2O~~ DCM 150 mls

TARE WT. 66.2207 gms
Final WT. 66.2240 gmsF
Net WT. 0.0033 gms

~~4136~~
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SAMPLE TRAIN INFORMATION

Fill Out One Sheet Per Site and Per Test Type

Client: ACE PAVING

Location: SHELTON, WA

Site: BARBER GREENE ASPHALT PLANT, BAGHOUSE STACK

Date(s): 7-21-93

Test Team: JAG, SBM

Number of Runs: 2 - M5 w/BH

If this information is not accurate for all runs, note all exceptions:

JAG 7/21/93

Thimble: ___yes ✓no **Nozzle type:** ___quartz ✓steel

Probe liner: ___quartz ___glass ✓steel ___teflon

Probe type: ✓regular ___water-cooled

Front-half filter: ✓yes ___no **Size (mm):** __90 __110 ✓125

Support: ___steel ✓glass frit ___teflon

Gasket: ✓silicon ✓teflon

Filter media: ✓quartz fiber ___glass fiber ___teflon

Impinger Train Solutions/Quantity of Solution Charged	
#1	100 ml D.I. H_2O
#2	100 ml D.I. H_2O
#3	Empty
#4	Silica GEL
#5	
#6	

Note: Show the back-half filter location with an arrow

Back-half filter type: quartz fiber glass fiber teflon

APPENDIX C

Supporting Information

AMTEST AIR QUALITY, INC.

SOURCE TEST OBSERVATION CHECKLIST
ASPHALT PLANTS WITH BAGHOUSE

CLIENT: ACE PAVING CO. INC.

LOCATION: BREMERTON, WASHINGTON

SAMPLE SITE: SHELTON WA.

TEST DATE: 7-19-93

TYPE OF PLANT: BATCH

EQUIPMENT MANUFACTURER: BARBER GREENE

MODEL: DC 70 CONSTRUCTED/INSTALLED: 1992

IDENTIFICATION NO.: X456 DATE LAST TESTED: UNKNOWN

PROCESS RATE: 200 TPH DISCHARGE TEMP °F: 300°

FUEL FIRING RATE: 2.5 GPT TYPE OF FUEL: PROPANE

A/C INJECTION LOCATION: PUGMILL

FINES IN GRAVEL (-200 mesh): 5.2 %

GRAVEL MOISTURE: 5.5 % ASPHALT TYPE: AR 4000 W

DENSITY _____ lb/gal FLASHPOINT °F _____

TYPE OF EMISSION CONTROL DEVICE: BAGHOUSE

EQUIPMENT MANUFACTURER: BARBER GREENE MODEL: PULS JET

IDENTIFICATION NO.: _____

BAG MATERIAL: NOMEX NO. OF BAGS: 500

BAG SIZE: 5"X 96" DATE BAGS LAST CHANGED: 10-92

TYPE OF BAG CLEANING: PULSJET

BAGHOUSE PRESSURE ΔP = 8 " H_2O (OR PRESSURE DROP ACROSS BAGHOUSE)

CLEANING CYCLE DURATION: _____

DISPOSITION OF COLLECTED DUST: RETURN TO ELEVATOR

ADDITIONAL INFORMATION: _____

SKETCH OF SYSTEM:

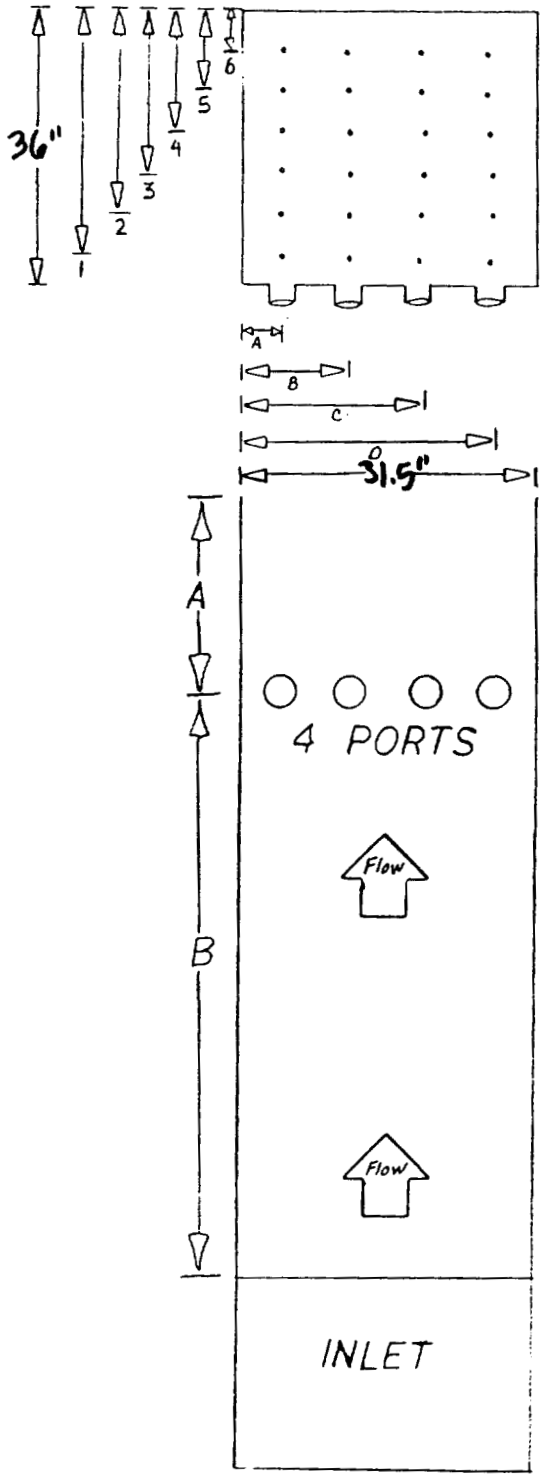
Gary L. Swanson Gen Mgr.

TDJ ... SIGNATURE

CROSS SECTIONAL AREA

Traverse Point	Distance (inches)
1	3.0
2	9.0
3	15.0
4	21.0
5	27.0
6	33.0

Port	Distance (inches)
A	3.9
B	11.8
C	19.7
D	27.6



STACK DIMENSIONS

36-inch x 31.5-inch rectangular stack

4 ports located along the 31.5 inch side

A = 53 inches downstream

B = 67 inches upstream

Figure 1. Location of sampling ports and traverse points.

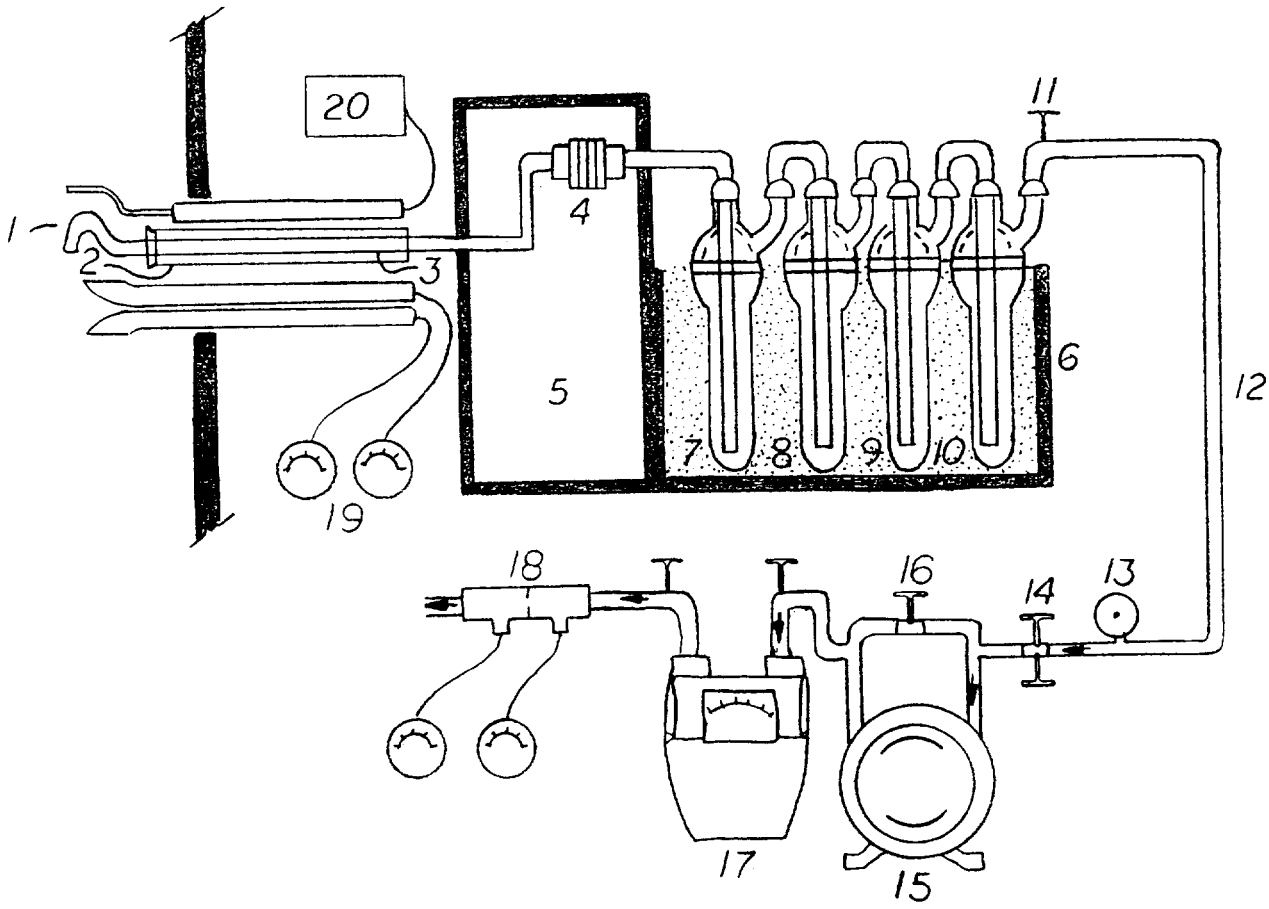


Figure 2. Method 5 Sample Train.

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 - contains ice during sampling
7. First impinger containing 100 ml H_2O
8. Modified Greenburg-Smith impinger containing 100 ml H_2O
9. Third impinger - empty
10. Fourth impinger containing indicating silica gel desiccant
11. Impinger exit gas temperature sensor
12. Umbilical cord - vacuum line
13. Vacuum gauge
14. Fine and coarse adjustment valves
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 tube with magnehelic gauges
20. Fluke multi-channel digital thermocouple indicator

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

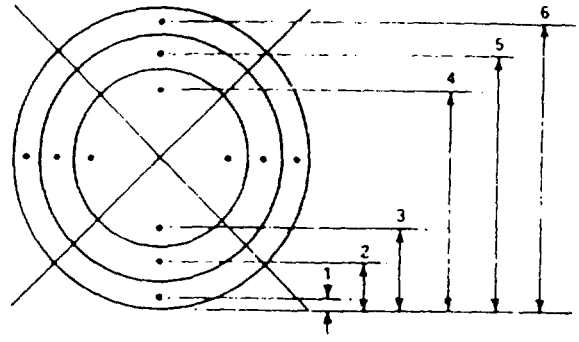


Figure 1-3. Example showing circular stack cross section divided into 12 equal areas, with location of traverse points indicated.

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	32.3
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

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.

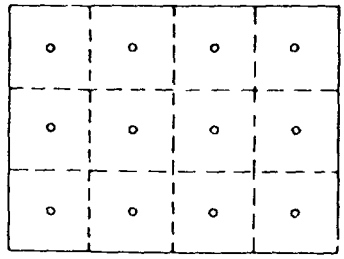


Figure 1-4. Example showing rectangular stack cross section divided into 12 equal areas, with a traverse point at centroid of each area.

METHOD 1 - MINIMUM NUMBER OF TRAVERSE POINTS

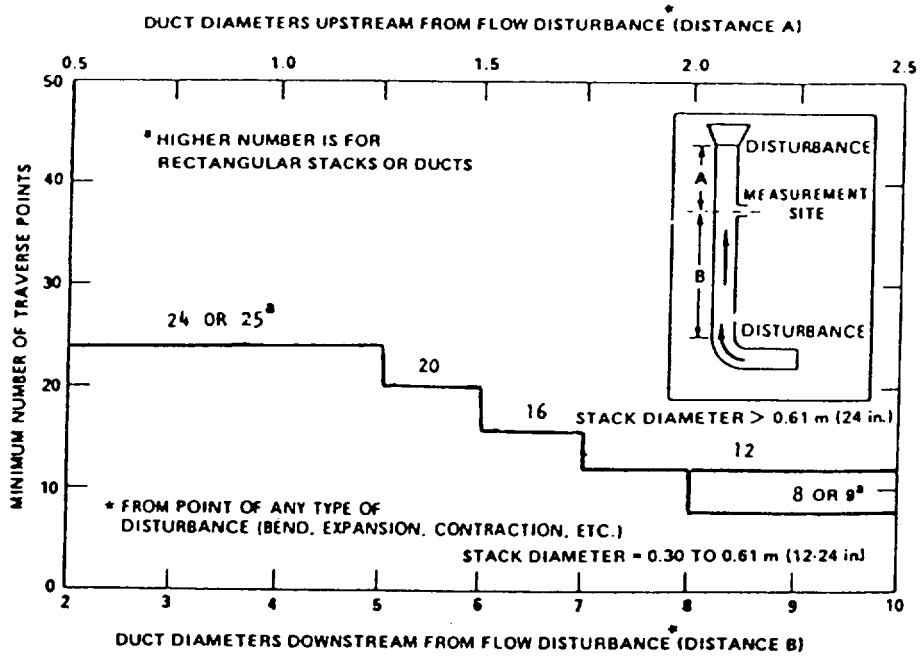


Figure 1-1. Minimum number of traverse points for particulate traverses.

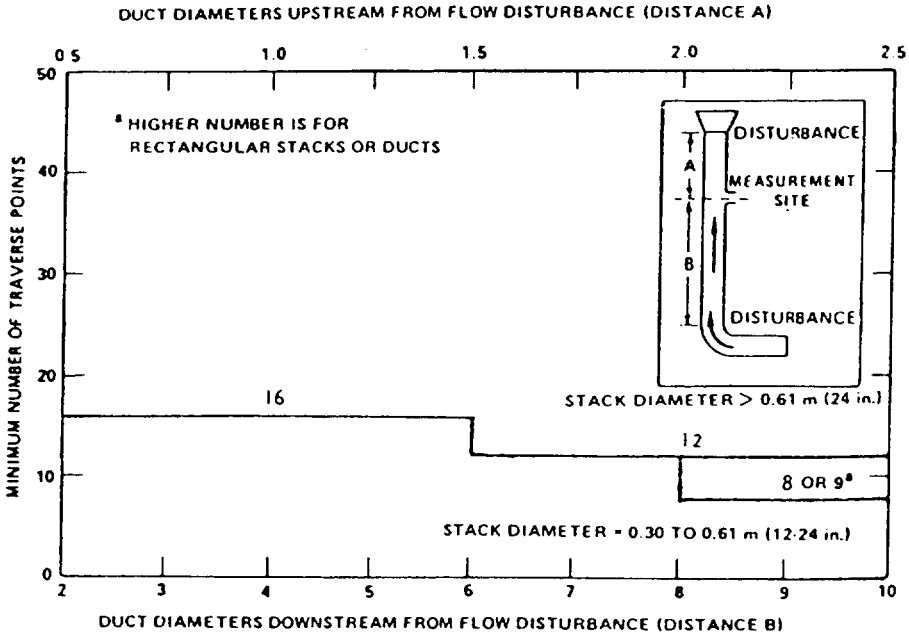


Figure 1-2. Minimum number of traverse points for velocity (nonparticulate) traverses.

METHOD 2 - STACK GAS VELOCITY AND VOLUMETRIC FLOW CALCULATIONS

5.1 Nomenclature.

A = Cross-sectional area of stack, m^2 (ft^2).
B_{ws} = 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,

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

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).

$$= M_d(1-B_{ws}) + 18.0\,B_{ws} \qquad \text{Eq. 2-5}$$

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).

$$= P_{bar} + P_g \qquad \text{Eq. 2-6}$$

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).

$$= 273 + t_s \text{ for metric.} \qquad \text{Eq. 2-7}$$

$$= 460 + t_s \text{ for English.} \qquad \text{Eq. 2-8}$$

T_{std} = Standard absolute temperature, 293 °K (528° R).
v_s = Average stack gas velocity, m/sec (ft/sec).
Δ_p = 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.

$$v_s = K_p C_p (\sqrt{\Delta p})_{avg} \sqrt{\frac{T_{s(avg)}}{P_s M_s}} \qquad \text{Equation 2-9}$$

5.3 Average Stack Gas Dry Volumetric Flow Rate.

$$Q_{sd} = 3{,}600(1-B_{ws})v_s A\left(\frac{T_{std}}{T_{s\,(avg)}}\right)\left(\frac{P_s}{P_{std}}\right) \qquad \text{Eq. 2-10}$$

METHOD 3 - MOLECULAR WEIGHT AND EXCESS AIR CALCULATIONS

6.1 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.

$$\%\,EA = \frac{\%O_2 - 0.5\%\ CO}{0.264\%\ N_2(\%O_2 - 0.5\%\ CO)} \times 100 \qquad \text{Eq. 3-1}$$

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

$$M_d = 0.440(\%CO_2) + 0.320(\%O_2) + 0.280(\%N_2 + \%CO) \qquad \text{Eq. 3-2}$$

METHOD 4 - STACK GAS MOISTURE CALCULATIONS

2.3.1 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) (m^3)/(g-mole) (°K) for metric units and 21.85 (in. Hg) (ft^3)/(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).

$V_{wsg(std)}$ = 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.

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

$$= K_1 (V_f - V_i)$$

Eq. 4-1

K_1 = 0.001333 m^3/ml for metric units
= 0.04707 ft^3/ml for English units

2.3.3 Volume of Water Vapor Collected in Silica Gel.

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

$$= K_2 (W_f - W_i)$$

Eq. 4-2

Where:

K_2 = 0.001335 m^3/g for metric units
= 0.04715 ft^3/g for English units

2.3.4 Sample Gas Volume.

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

$$= K_3 Y \frac{V_m P_m}{T_m}$$

Eq. 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 leak 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.

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

Eq. 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 CALCULATIONS - (1)

6.1 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 = Mass of residue of acetone after evaporation, mg.
m_n = Total amount of particulate matter collected, mg.
M_w = Molecular weight of water, 18.0 g/g-mole (18.0lb/lb-mole).
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:

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

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

6.4 Volume of Water Vapor.

METHOD 5 - PARTICULATE EMISSION CALCULATIONS - (2)

Equation 5-2

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

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

6.5 Moisture Content.

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

Eq. 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.

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

Eq. 5-4

6.7 Acetone Wash Blank.

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

Eq. 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.

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

Eq. 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 Variation.

6.11.1 Calculation From Raw Data.

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

Eq. 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 particulate results are low in comparison to the standard, and I is over 110 percent or less than 90 percent, the Administrator may accept the results.

NOMENCLATURE
METHOD 5 CALCULATIONS

Vm_{std} = Volume of gas sample measured by the dry gas meter, corrected to standard conditions, dscm (dscf).

Y = Dry gas meter calibration factor

P_b = Barometric pressure at the sampling site, mm Hg (in. Hg)

H = Average pressure differential across the orifice meter, mm H_2O (in.H_2O)

T_m = Absolute average dry gas meter temperature, ° K (° R)

dscm = Dry standard cubic meters

dscf = Dry standard cubic feet

W_a = Weight of residue in acetone wash

M_a = Mass of residue of acetone after evaporation, mg

C_a = Acetone blank residue concentration, mg/g

V_a = Volume of acetone blank

V_{aw} = Volume of acetone used in wash, ml

M_n = Total amount of particulate matter collected, mg

C_s = Concentration of particulate matter in stack gas, dry basis, corrected to standard conditions, mg/dscm (gr/dscf)

gr/dscf = grains per dry standard cubic foot

Vw_{std} = Volume of water vapor in the gas sample, corrected to standard conditions, scm (scf)

B_{ws} = Water vapor in the gas stream, proportion by volume

M_d = Molecular weight of stack gas, g/g-mole on dry basis

M_s = Molecular weight of stack gas, g/g-mole on wet basis

V_s = Stack gas velocity, calculated by Method 2, Equation 2-9, using data obtained from Method 5, m/sec (ft/sec)

C_p = Pitot tube coefficient, dimensionless

Δ_p = Velocity head of stack gas, mm H_2O (in. H_2O)

P_s = Absolute stack gas pressure, mm Hg (in. Hg)

NOMENCLATURE (continued)
METHOD 5 CALCULATIONS

Q_{std} = Dry volumetric stack gas flow rate corrected to standard conditions, dscm/hr (dscf/hr)

dscf/min = dry standard cubic feet per minute (also identified as dcfm or scfm)

acfm = actual cubic feet per minute

I = Percent of isokinetic sampling

A_n = Cross-sectional area of nozzle, m^2 (ft^2)

AMTEST
AIR QUALITY, INC.

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

FILE NAME: RED-593
METER BOX #: RED MANOMETER
CALIBRATION DATE: 5-10-93
METHOD OF CALIB.: STANDARD DRY GAS METER (Method 5 Section 7.1)

TOTAL TIME min	DELTA H "H2O	METER VOL V1 cf	METER VOL V2 cf	TEMP IN deg F	TEMP OUT deg F	BARO. PRES. "Hg	STD DGM V1	STD DGM V2	ST.DGM TEMP IN deg F	ST.DGM TEMP OUT deg F	ST.DGM Yds FACTOR	Y FACTOR	DELTA H@
14.680	0.5	631.416	637.641	69.0	64.0	29.30	857.500	863.700	60.0	60.0	1.001	1.0082	1.562
15.900	1.0	638.841	648.268	69.0	65.0	29.30	864.900	874.300	61.0	61.0	1.001	1.0071	1.597
9.870	1.5	657.851	664.626	66.0	65.0	29.30	877.700	884.500	64.0	64.0	1.001	1.0038	1.785
7.420	2.0	666.611	672.581	69.0	66.0	29.30	886.500	892.500	64.0	64.0	1.001	1.0077	1.724
6.580	2.5	673.568	679.519	70.0	66.0	29.30	893.500	899.500	65.0	64.0	1.001	1.0096	1.698
5.520	3.0	680.509	685.973	72.0	67.0	29.30	900.500	906.000	65.0	65.0	1.001	1.0086	1.706
AVERAGE												1.008	1.679

AMTEST
AIR QUALITY, INC.

STANDARD DRY GAS METER CALIBRATION DATA SUMMARY
AMTEST - AIR QUALITY, INC.

Run #	CAL. DGM IND. SCFM	PRIMARY STANDARD	Y std.	DEVIATION
1	0.249	0.250	1.004	0.001
2	0.349	0.350	1.003	0.001
3	0.448	0.450	1.004	0.002
4	0.498	0.500	1.004	0.002
5	0.598	0.600	1.003	0.002
6	0.799	0.800	1.001	0.001
7	0.900	0.900	1.000	0.000
8	1.001	1.000	0.999	-0.001
9	1.150	1.150	1.000	0.000
10	1.302	1.300	0.998	-0.002
11	1.506	1.500	0.996	-0.006
		AVG Y std. =	1.001	

DATE: 1/15/93
FILE NAME: STD-GASM

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 6-21-93 Thermocouple Indicator # RED 4/F

Ambient Temperature 65 °F Barometric Pressure 29.4 in Hg

THERMOCOUPLE # OR REFERENCE	REFERENCE THERMOMETER TEMPERATURE °F	THERMOCOUPLE TEMPERATURE °F	TEMPERATURE DIFFERENCE °F	TEMPERATURE DIFFERENCE %
Standard DGM				
Meter in	32	32	0.0°	0.0%
	212	214	2°	0.3%
Meter out	32	32	0.0°	0.0%
	212	213	1°	0.1%

$$\frac{(\text{ref temp, °F} + 460) - (\text{test therm. temp, °F} + 460)}{(\text{ref temp, °F} + 460)} \cdot 100 \leq 1.5\%$$

SP

DICK MUNNS COMPANY

Liquid and Gas - Flowmeter Calibration Service
10571 Calle Lee - 133 • Los Alamitos, California 90720
Telephone (213) 596-1559 • Telefax (714) 827-0823

CERTIFICATE OF CALIBRATION

Client Name:	KRIS A HANSEN CO	Calibration Date:	01-05-1993
Reference Number:	955	Calibration Due:	01-05-1994
Instrument Manufacturer:	QUIMETER	Calibration Fluid:	AIR 14.7 PSIA 70F
Instrument Description:	DRY GAS METER	Test Unit(s):	A3
Model Number:	T-110	NIST Traceability Per:	M-0122
Serial Number:	27688	Ambient Conditions:	54% RH
Rated Accuracy:	+/- .5%	Data File:	93KRQU7688
Accuracy Given:	AS RECEIVED		

	IND.SCFM	ACT.SCFM
1	0.249	0.250
2	0.349	0.350
3	0.448	0.450
4	0.498	0.500
5	0.598	0.600
6	0.799	0.800
7	0.900	0.900
8	1.001	1.000
9	1.150	1.150
10	1.302	1.300
11	1.506	1.500

Remarks:

All instruments used in the performance of the above calibration have direct traceability to the National Institute of Standards and Technology (NIST). Calibration has been performed in accordance with MIL-STD-45662A.

Calibration Performed By:

RA

Approved By:

R.MUNNS

ATA FILE NAME: N7688

CLIENT NAME: KRIS A. HANSEN CO
EFERENCE NUMBER / P.O.: 955
NSTRUMENT MANUFACTURER: KRIS A. HANSEN CO
INSTRUMENT DESCRIPTION: DRY GAS METER
MODEL NUMBER: T110
ERIAL NUMBER: 27688
ATED ACCURACY: +/- .5%
ACCURACY GIVEN: AS RECEIVED
CALIBRATION DATE: 01-05-1993
ALIBRATION DUE: 01-05-1994
ALIBRATION FLUID: AIR 14.7 PSIA 70F
TEST UNITS:
IST TRACEABILITY PER:
MBIENT CONDITIONS:
CALIBRATION BY:
APPROVED BY: R.MUNNS
-UNITS, Y-UNITS: IND.SCFM, ACT.SCFM

IND.SCFM	ACT.SCFM	K = ACT.SCFM/IND.SCFM	
0.25000	0.25100	1.00398	*
0.27000	0.27092	1.00339	
0.29000	0.29088	1.00302	
0.31000	0.31088	1.00284	
0.33000	0.33092	1.00279	*
0.35000	0.35101	1.00287	
0.37000	0.37117	1.00316	
0.39000	0.39141	1.00362	
0.41000	0.41167	1.00407	
0.43000	0.43189	1.00439	
0.45000	0.45201	1.00446	*
0.47000	0.47202	1.00431	
0.49000	0.49200	1.00409	
0.51000	0.51200	1.00393	
0.53000	0.53201	1.00380	
0.55000	0.55202	1.00368	
0.57000	0.57202	1.00355	
0.59000	0.59201	1.00341	
0.61000	0.61198	1.00324	
0.63000	0.63193	1.00306	
0.65000	0.65187	1.00288	
0.67000	0.67179	1.00268	
0.69000	0.69171	1.00247	
0.71000	0.71161	1.00226	
0.73000	0.73149	1.00204	
0.75000	0.75137	1.00182	
0.77000	0.77123	1.00159	
0.79000	0.79107	1.00136	
0.81000	0.81091	1.00112	
0.83000	0.83072	1.00086	
0.85000	0.85052	1.00061	
0.87000	0.87031	1.00035	
0.89000	0.89010	1.00011	
0.91000	0.90989	0.99988	
0.93000	0.92966	0.99964	
0.95000	0.94942	0.99939	
0.97000	0.96921	0.99918	
0.99000	0.98905	0.99904	
1.01000	1.00899	0.99900	*
1.03000	1.02905	0.99908	
1.05000	1.04922	0.99925	

1.07000	1.06943	0.99947
1.09000	1.08967	0.99969
1.11000	1.10986	0.99988
1.13000	1.12999	0.99999
1.15000	1.15000	1.00000 *
1.17000	1.16989	0.99991
1.19000	1.18971	0.99976
1.21000	1.20947	0.99956
1.23000	1.22918	0.99934
1.25000	1.24886	0.99909
1.27000	1.26853	0.99884
1.29000	1.28819	0.99860
1.31000	1.30787	0.99838
1.33000	1.32754	0.99815
1.35000	1.34719	0.99792
1.37000	1.36683	0.99769
1.39000	1.38646	0.99745
1.41000	1.40607	0.99721
1.43000	1.42567	0.99697
1.45000	1.44525	0.99672
1.47000	1.46482	0.99647
1.49000	1.48437	0.99622

* INDICATES LOCAL K-FACTOR MINIMUM / MAXIMUM

TYPE S PITOT TUBE INSPECTION DATA FORM

Date 8-6-93 Pitot Tube # P5G

Client Ace Paving

Location Shelton, Washington

Site(s) Baghouse Stack

Test Date(s) 7/21/93

Pitot tube assembly level? ✓ yes _____ no

Pitot tube openings damaged? _____ yes (explain below) ✓ no

α_1 = 2½ ° (<10°), α_2 = 1 ° (<10°), β_1 = 0 ° (<5°),

β_2 = 1 ° (<5°)

γ = .5 °, θ = 1.5 °, A = .96 cm (in.)

z = A sin γ = .008 cm (in.); <0.32 cm (<1/8 in.),

w = A sin θ = .025 cm (in.); <.08 cm (<1/32 in.)

P_A .48 cm (in.) P_b .48 cm (in.)

D_t = .375 cm (in.)

Comments:

_____

_____

_____

Calibration required? _____ yes* _____ no

*If yes, tag and take out of service until repaired.

STACK TEMPERATURE SENSOR CALIBRATION DATA FORM

Date 5-4-93 Thermocouple Indicator # Blue Controler

Ambient Temperature 65 °F Barometric Pressure 29.5 in Hg

THERMOCOUPLE # OR REFERENCE	REFERENCE THERMOMETER TEMPERATURE °F	THERMOCOUPLE TEMPERATURE °F	TEMPERATURE DIFFERENCE °F	%
T5A	32	32	0°F	0.0%
	212	210	2°F	0.30%
	334	331	3°F	0.40%

$$\frac{(\text{ref temp, °F} + 460) - (\text{test therm. temp, °F} + 460)}{(\text{ref temp, °F} + 460)} * 100 \leq 1.5\%$$

VP