EMISSION TEST REPORT
METHOD DEVELOPMENT AND
TESTING FOR CHROMIUM

CHROMIUM ELECTROPLATING INDUSTRY
ABLE MACHINE COMPANY
TAYLORS, SOUTH CAROLINA

ESED Project No. 85/2a
(86-CEP-3)

by

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ACKNOWLEDGMENT

This test program was conducted for the Emission Standards and Engineering Division of the U.S. Environmental Protection Agency's Office of Air Quality Planning and Standards.

Mr. Frank Clay, Emission Measurements Branch Task Manager, provided overall project coordination and guidance. Mr. Michael Hamlin of EMB observed the test program. Mr. Randy Strait and Ms. Robin Barker, representing Midwest Research Institute (MRI), monitored process and control equipment operation throughout the test period. Mr. Charles Bruffey was the PEI Project Manager. Principal authors were Messrs. Charles Bruffey and Thomas Wagner.

SECTION 1

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) is currently evaluating chromium and several other potentially toxic metals and their compounds. Chromium emissions are not included in New Source Performance Standards (NSPS) for stationary sources or National Emissions Standards for Hazardous Air Pollutants (NESHAP).

As part of this study, EPA is evaluating atmospheric emissions of chromium from hard chromium plating operations. The purpose of these tests is to characterize uncontrolled and controlled emissions and size distribution of hexavalent chromium (Cr^{+6}) and total chromium (Cr) from a representative industrial operation.

The Emission Measurement Branch (EMB) of EPA's Environmental Standards and Engineering Division (ESED) requires contractor assistance in obtaining chromium emissions data from a representative source so that an accurate assessment of the potential problems can be made and appropriate regulatory action developed.

PEI Associates, Inc., under contract to EMB, conducted a testing program at the Able Machine Co. in Taylors, South Carolina, on June 30 and July 1 and 2, 1986. Triplicate tests to determine Cr^{+6} and total Cr emissions were performed at the inlet and outlet of a Duall mist eliminator controlling chromic acid emissions from one hard chromium plating tank.

In addition, particle size distribution measurements were taken at sampling points before and after the mist eliminator in an effort to characterize Cr^{+6} and total Cr emissions by size fraction. Samples of the plating tank solution and mist eliminator wash water were also collected during testing and analyzed for Cr^{+6} and total Cr.

The objectives of this project were met, and no major problems were encountered during the test project. Section 2 of this report presents a summary and discussion of test results; Section 3 addresses quality assurance; Section 4 describes the sampling locations and test procedures; and Section 5 describes source operation. Appendix A presents sample calculations and computer printouts; Appendices B and C contain the field data sheets and laboratory analytical results, respectively; Appendix D details sampling and analytical procedures; Appendix E summarizes equipment calibration procedures and results; Appendix F contains a list of project participants and a sampling log; and Appendix G describes the draft test method for analyzing hexavalent chromium emissions from stationary sources.

SECTION 2

SUMMARY OF TEST RESULTS

This section details the results of the sampling program. Subsections are used to identify results from each test type (i.e., Cr^{+6}, total Cr particle size distribution, etc.); results are expressed in both metric and English units where applicable.

2.1 TEST PROTOCOL

Table 2-1 presents the sampling and analytical protocol followed throughout this project, the test identification, and the sampling times for each specific test type.

In summary, triplicate tests were conducted simultaneously at the mist eliminator inlet and outlet to characterize uncontrolled and controlled Cr^{+6} and total Cr emissions from this type of source. Procedures detailed in EPA Test Methods 1 through 4* were used to measure flue gas flow rate, temperature, moisture content, and gas composition.

A Method 13B sampling train modified by eliminating the filter and placing 0.1 N NaOH in the impinger section was used to extract samples.** This methodology was developed by EPA during previous studies on similar plating operations. Cross-sectional, isokinetic sampling techniques were used in each case.

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* 40 CFR 60, Appendix A, EPA Reference Methods 1 through 4, July 1985.

** 40 CFR, Appendix A, Reference Method 13B, July 1985.

TABLE 2-1. SAMPLE/ANALYTICAL MATRIX FOR THE ABLE MACHINE COMPANY

Run No.	Date (1986) and time (24 h)	Location	Sample parameters: Modified Method 13b for Cr^{+6} and total Cr[a]	Sample parameters: Particle size distribution	Analytical parameters: Cr^{+6} diphenylcarbazide colorimetric method[b]	Analytical parameters: Total Cr by ICAP	Analytical parameters: Particle size distribution (gravimetric) Cr^{+6} and total Cr by size fraction
MEI-1	6/30 (1207-1609)	Inlet	X	-	X	X	-
MEO-1	6/30 (1208-1606)	Outlet	X	-	X	X	-
MEI-2	7/1 (0816-1143)	Inlet	X	-	X	X	-
MEO-2	7/1 (0815-1127)	Outlet	X	-	X	X	-
MEI-3	7/1 (1200-1500)	Inlet	X	-	X	X	-
MEO-3	7/1 (1209-1507)	Outlet	X	-	X	X	-
PSI-1	6/30 (1440-1540)	Inlet	-	X	-	-	X
PSO-1	6/30 (1209-1610)	Outlet	-	X	-	-	X
PSI-2	7/1 (0817-0932)	Inlet	-	X	-	-	X
PSO-2	7/1 (0817-1226)	Outlet	-	X	-	-	X
PSI-3	7/1 (1400-1515)	Inlet	-	X	-	-	X
PSO-3	7/2 (0836-1202)	Outlet	-	X	-	-	X
All	6/30-7/1 and 2	Process samples ° Tank solution	-	-	X	X	-
		° Mist eliminator wash water	-	-	X	X	-

[a]Method 13B sampling train modified by eliminating the sample filter and charging the impingers with 0.1 N NaOH. Cross-sectional, isokinetic sampling techniques were used.

[b]Test Methods for Evaluating Solid Waste. U.S. EPA SW-846, 2nd ed., July 1982.

[c]Inductively coupled argon spectroscopy (ICAP).

Hexavalent chromium content was determined by procedures recently developed by EPA for determining Cr^{+6} content in source emission samples. These latter procedures entail extraction of the sample fractions with an alkaline solution, followed by the diphenylcarbazide colorimetric method.*

Each emission sample was also analyzed for total chromium by use of Inductively Coupled Argon Spectroscopy (ICP) analytical techniques. A Perkin-Elmer Plasma II instrument was used for this analysis, which followed the general procedures outlined in EPA Method 3050 of EPA SW846.*

Samples were collected for particle size distribution measurements at the mist eliminator inlet and outlet by the use of in-stack cascade impactors. The Andersen Mark III multistage impactor was used at both locations.

Three particle size samples were collected at each location. Initially, the acetone rinse and filter fraction were subjected to gravimetric analysis using EPA Method 5 analytical procedures. At the completion of the gravimetric analysis, individual rinse and filter fractions were combined by stage cutpoint and location so that one composite sample was available for analysis of Cr^{+6} and total Cr. The filters were digested and analyzed for Cr^{+6} by use of procedures detailed in Appendix D of this report. Total Cr was determined from the digestion procedure filtrate using ICP analytical techniques.

During each emission test, plating tank solutions were collected. Grab samples were obtained approximately every 30 to 40 minutes during the Modified Method 13B tests. These grab samples were placed in a 1-gallon polyethylene container so that one composite sample of each type was available for analysis. Mist eliminator wash water was collected by MRI personnel at the end of each test day.

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* Test Methods for Evaluating Solid Waste. U.S. EPA SW-846, 2nd ed., July 1982.

All collected samples were analyzed for Cr^{+6} and total Cr by use of procedures similar to those used in the analysis of the Modified Method 13B samples. The following subsections detail the results of the sampling program.

2.2 HEXAVALENT AND TOTAL CHROMIUM EMISSION RESULTS

Table 2-2 summarizes pertinent sample and flue gas data, and Table 2-3 presents the results of the Modified Method 13B testing.

Sample volumes corrected to standard conditions [20°C and 760 mm Hg (68°F and 29.92 in.Hg) and zero percent moisture] are expressed in dry normal cubic meters (dNm^3) and dry standard cubic feet (dscf). Volumetric flow rates corrected to standard conditions are expressed as dry normal cubic meters per minute (dNm^3/min) and dry standard cubic feet per minute (dscf/min). Hexavalent and total chromium emission concentrations are expressed as milligrams per normal cubic meter (mg/dNm^3). Mass emission rates are expressed as kilograms per hour (kg/h) and pounds per hour (lb/h).

As reported in Table 2-2, sample volumes ranged between 3.16 and 4.66 dNm^3 for the inlet tests and between 2.21 and 3.48 dNm^3 for the outlet tests. Note that the first set of tests (MEI and MEO-1) were conducted for 180 minutes, while the remaining two tests were conducted for 120 minutes. Isokinetic sample rates ranged between 93.4 and 100.1 percent for all tests, which is within the applicable range of 90 to 110 percent.

At the mist eliminator inlet, volumetric gas flow rates ranged between 156 and 167 dNm^3/min and averaged 161 dNm^3/min (5680 dscf/min) for the three tests. Gas temperature and moisture content averaged 33°C (92°F) and 2.8

TABLE 2-2. SUMMARY OF SAMPLE AND FLUE GAS CONDITIONS
(Able Machine Co.)

Run No.	Date (1986)	Sample location	Sample parameter			Volumetric flow rate		Flue gas condition			
			Sample volume		Percent isokinetic			Temperature		Moisture content, %	Static pressure, in. H_2O
			dNm^3	dscf		dNm^3/min	dscf/min	°C	°F		
MEI-1	6/30	Inlet	4.66	164.603	98.3	156	5,524	34	94	2.9	-1.9
MEO-1	6/30	Outlet	3.48	122.753	98.8	163	5,743	37	99	3.8	+1.5
MEI-2	7/1	Inlet	3.30	116.365	97.8	167	5,890	30	86	2.7	-1.7
MEO-2	7/1	Outlet	2.38	84.093	100.1	163	5,742	35	95	3.8	+1.5
MEI-3	7/1	Inlet	3.16	111.707	98.3	159	5,628	36	97	2.7	-1.65
MEO-3	7/1	Outlet	2.21	78.135	93.4	162	5,715	39	102	2.4	+1.5

ate	1 Cr	lb/h	Total Cr collection efficiency*, %
		0.21	98.6
	4	0.003	
		0.15	98.0
	4	0.003	
		0.14	98.6
	9	0.002	

ROUTING AND TRANSMITTAL SLIP Date 3/6/89

TO: (Name, office symbol, room number, building, Agency/Post)	Initials	Date
1. R. Barker		
2.		
3.		
4.		
5.		

Action	File	Note and Return
Approval	For Clearance	Per Conversation
As Requested	For Correction	Prepare Reply
Circulate	For Your Information	See Me
Comment	Investigate	Signature
Coordination	Justify	

REMARKS

Attached is the field summary sheet for Able that I asked F. Clay to calculate since we couldn't read the emnfo in the test report. Steel Heddle is forthcoming.

DO NOT use this form as a RECORD of approvals, concurrences, disposals, clearances, and similar actions

FROM: (Name, org. symbol, Agency/Post) Rudy

Room No.—Bldg.

Phone No.

5041-102 ☆ GPO : 1984 O -421-529 (408)

OPTIONAL FORM 41 (Rev. 7-76) Prescribed by GSA FPMR (41 CFR) 101-11.206

* Total Cr collection efficiency calculated on mass rate basis:

$$\frac{\text{lb/h (in)} - \text{lb/h (out)}}{\text{lb/h (in)}} \times 100$$

percent, respectively. The static pressure of the inlet flue gas was continuously monitored using a 0- to 36-in. water manometer. Static pressures ranged between -1.65 and -1.90 in.H_2O.

At the mist eliminator outlet, volumetric gas flow rates averaged 163 dNm^3/min (5733 dscf/min) for the three tests, which compares to within 5 percent of the average inlet flow rate. Average temperature and moisture contents were 37°C (99°F) and 3.3 percent, respectively. The average static pressure measured during each outlet test was +1.5 in.H_2O.

The concentration of Cr^{+6} measured at the inlet to the mist eliminator ranged between 6.84 and 10.2 mg/dNm^3 (0.003 and 0.004 gr/dscf) and averaged 7.96 mg/dNm^3 (0.0033 gr/dscf) for the three tests. Mass rates for Cr^{+6} ranged between 0.064 and 0.095 kg/h (0.14 and 0.21 lb/h). Total Cr concentrations ranged between 6.76 and 10.0 mg/dNm^3 (0.003 and 0.004 gr/dscf) and averaged 7.89 mg/dNm^3 (0.0033 gr/dscf) for the three tests. Total Cr mass rates were essentially the same as the Cr^{+6} mass rates.

The content of Cr^{+6} in the inlet sample ranged between 21.6 and 47.4 mg, compared with values of 21.8 and 46.5 mg of total Cr. The overall comparability of the data suggests that the majority of Cr in the samples is in the form of Cr^{+6}.

Concentrations of Cr^{+6} measured at the mist eliminator outlet ranged between 0.10 and 0.14 mg/dNm^3 (0.000045 and 0.00006 gr/dscf). Mass rates for Cr^{+6} averaged 0.0012 kg/h (0.0027 lb/h). Total Cr concentrations ranged between 0.11 and 0.15 mg/dNm^3 (0.00005 and 0.00006 gr/dscf) with an average mass rate similar to that of Cr^{+6}. The content of Cr^{+6} in the outlet samples ranged between 0.226 and 0.451 mg and the content of total Cr ranged between 0.248 and 0.484 mg. On a mass rate basis, the overall Cr collection efficiency of the mist eliminator was 98 percent or greater for the three tests conducted.

2.3 PARTICLE SIZE DISTRIBUTION TEST RESULTS

Andersen Mark III in-stack impactors were used to measure particle size at each location. Each impactor consists of eight impaction stages followed by a backup filter. In these tests, glass-fiber filter media were used. A total of three samples were collected at each location at points in the duct(s) representing the average velocity and temperature.

Each test was conducted according to the procedures described in the Mark III operations manual supplied by the manufacturer. Isokinetic sampling rates were set initially, and constant cut-point characteristics were maintained throughout the sampling period. Test times were 180 minutes at the outlet location and between 60 and 75 minutes for the inlet samples.

At the completion of each test, the impactor samples were recovered according to procedures descriged in the Mark III operations manual.

Each individual impactor stage and acetone rinse of the sample nozzle and impactor casing was subjected to a gravimetric analysis using procedures similar to those in EPA Method 5. Cumulative size distribution data points representing the total weight of particulate matter smaller than the indicated aerodynamic particle diameter [in micrometers (μm)] were established for each individual test. The cut points for each test were calculated by computer programs contained in "A Computer-Based Cascade Impactor Data Reduction System"* (CIDRS) developed for U.S. EPA by Southern Research Institute (SRI). All particle-size results are based on a particle density of 1 g/cm.^{3} Data reduction for the particle-size tests was performed by computer programming; data on flue gas moisture and molecular weight were obtained from the Method 13B tests.

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* Southern Research Institute. A Computer-Based Impactor Data Reduction System. Prepared for U.S. EPA under Contract No. 68-022-131, Revised March 1980.

Figures 2-1 through 2-6 depict individual size distributon curves by test location. These curves were plotted using size cutpoint and cumulative percent weight data from CIDRS computer programs. Actual impactor stage data points are depicted by the solid dots, and the open dots represent an extrapolated best-fit curve. (See Appendix A.)

For the inlet impactor runs (Figures 2-1 through 2-3), individual impactor stages did not contain enough particulate matter to yield reliable data (no more than 0.4 mg was collected on any one stage, compared with a desired amount of between 1 and 10 mg). Although the total catch for these runs ranged between 15.9 and 42.4 mg, the majority of material was collected in the sample nozzle and impactor casing prior to the filter media. Since the collected material was observed to be a liquid mist, particles that normally would be collected on the various stages may have been collected in the nozzle and casing, which would tend to bias the cumulative percent less than 10 to 15 μm on the low side. The cumulative size distribution curves for these runs show that the percent less than 10 μm ranged from about 2 to 5 percent with about 2 to 3 percent less than 2.5 μm. The validity of this data is questionable.

For the outlet impactor runs (Figures 2-4 through 2-6), individual impactor stage loadings ranged between zero and 0.4 mg, which is less than the desired loadings of between 1 and 10 mg per stage.

Once again, the majority of the total catch for these runs was found in the sample nozzle and impactor casing prior to the filter media. The total catch ranged between 0.9 and 6.0 mg. It should be noted that 0.1 N NaOH was inadvertently used to rinse the nozzle and impactor casing for Test PSO-1; therefore, only the filter weights are reported, which (for all practical purposes) are considered void. For Tests PSO-2 and 3, the cumulative percent

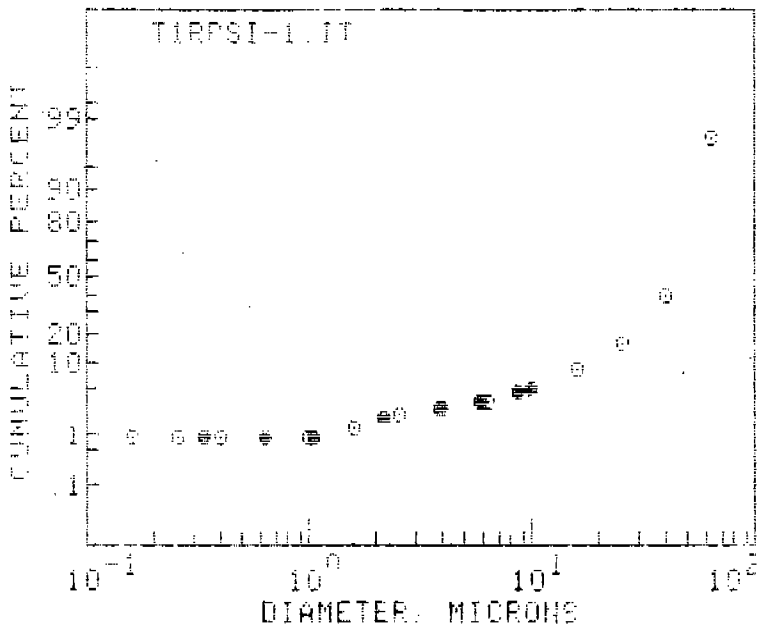

Figure 2-1. Particle size distribution for mist eliminator inlet Run PSI-1.

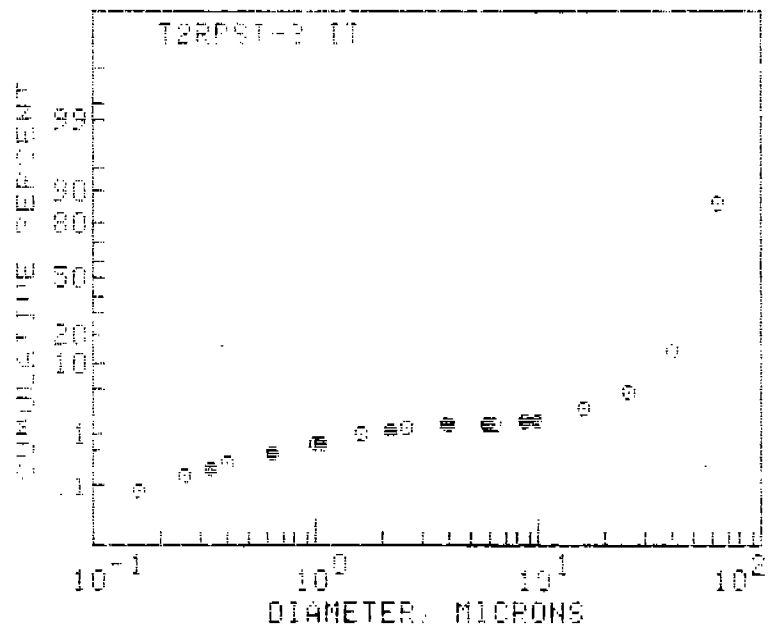

Figure 2-2. Particle size distribution for mist eliminator inlet Run PSI-2.

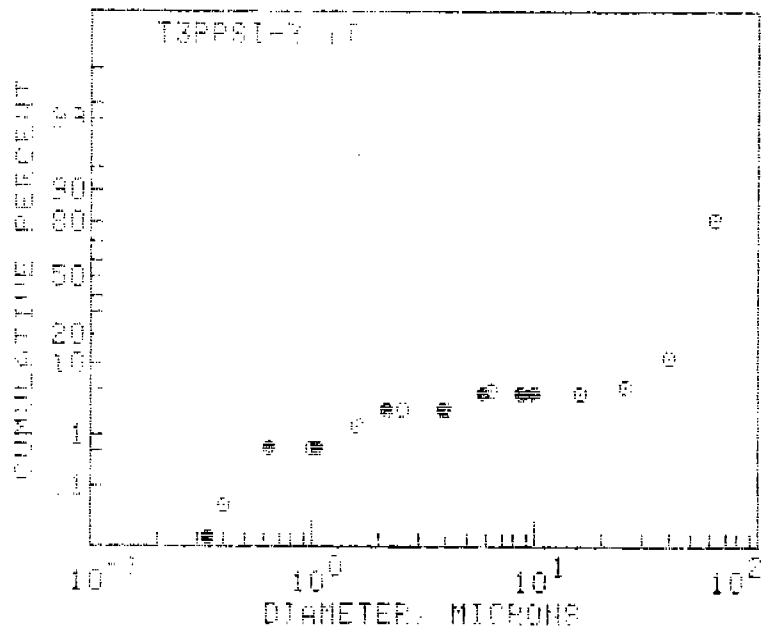

Figure 2-3. Particle size distribution for mist eliminator inlet Run PSI-3.

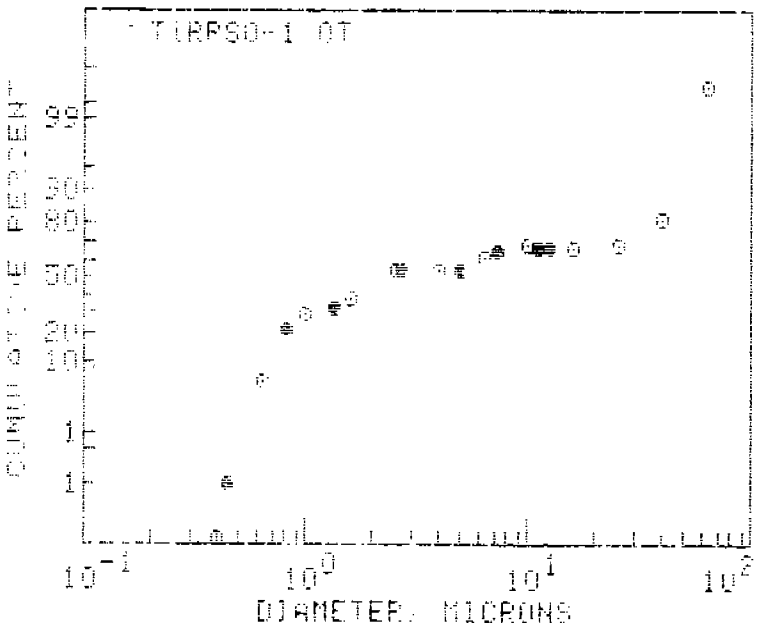

Figure 2-4. Particle size distribution for mist eliminator outlet Run PSO-1.

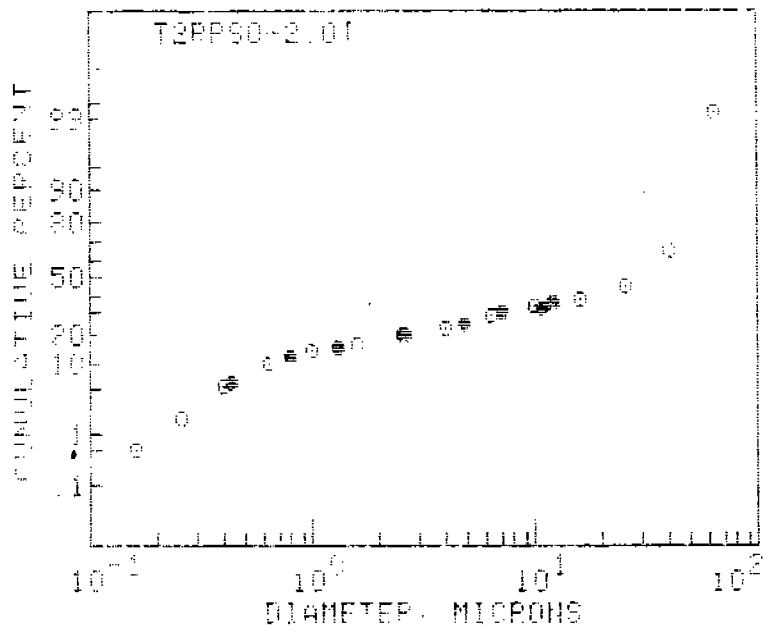

Figure 2-5. Particle size distribution for mist eliminator outlet Run PSO-2.

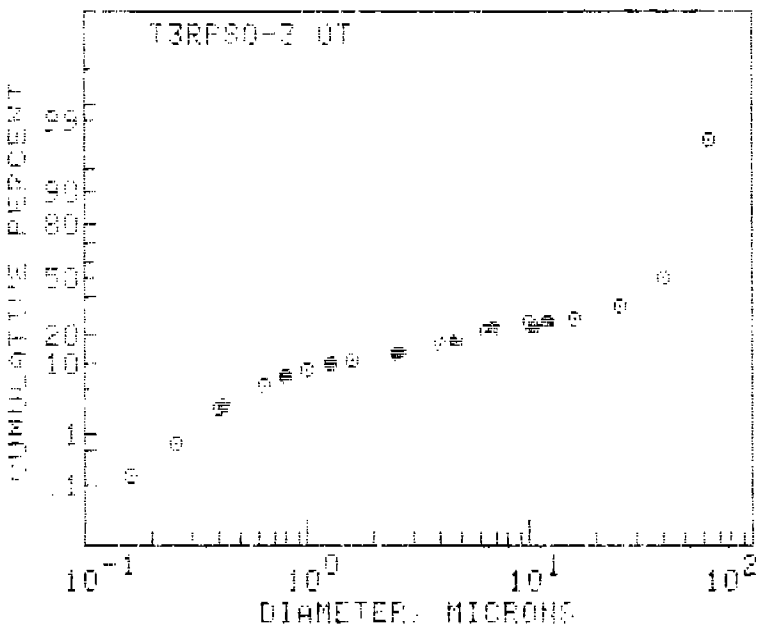

Figure 2-6. Particle size distribution for mist eliminator outlet Run PSO-3.

less than 10 μm ranged between 26 and 35 percent, while the percent less than 2.5 μm ranged between 13 and 20 percent.

The average isokinetic sample rates* were all within the acceptable range of the IP Protocol (80 to 120 percent), and the impactor sampling rates were all within the manufacturer's suggested operating limits (0.3 to 0.75 acfm).

In an attempt to characterize Cr^{+6} and total Cr by size fraction, inlet and outlet samples were combined by stage cutpoint into a single composite sample from each location and analyzed for Cr^{+6} and total Cr. Combined filters were digested following procedures described in Method 3060 of EPA SW-846 (alkaline digestion method) and analyzed for Cr^{+6} using the diphenol-carbazide colorimetric method. The alkaline extract residue was then digested using Method 3050 of EPA SW-846 and analyzed for total Cr using ICP analytical techniques. Table 2-4 summarizes the analytical results. The inlet data show the majority of Cr^{+6} and total Cr in the acetone rinse as greater than 10 μm in diameter. These data correspond to the gravimetric data presented in this section. The remainder of Cr^{+6} and total Cr is concentrated on stages 2 through 6 with cutpoints ranging from 3.8 to less than 1.0 μm.

For the outlet sample, the majority of Cr^{+6} and total Cr (exclusive of the acetone rinse) is concentrated on stages 4 through 7 with cutpoints ranging from 2.6 to less than 0.5 μm. Note that the total amount of Cr^{+6} and total Cr on each stage do not compare favorably as did the results of the

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* Southern Research Institute. Procedures Manual for Inhalable Particulate Sampler Operation. Prepared for U.S. EPA under Contract No. 68-02-3118, November 1979.

TABLE 2-4. SUMMARY OF Cr^{+6} AND TOTAL Cr SIZE DISTRIBUTION DATA

Run No.	Stage No.	Range of size cutpoints,[a] µm	Cr^{+6}, µg (blank corrected)	Total Cr, µg (blank corrected)
PSI 1-3	0	9.7 - 9.8	4.6	18.25
	1	8.6 - 8.7	6.5	18.0
	2	5.8	27.8	51.45
	3	3.8 - 3.9	64.8	101.1
	4	2.1	78.4	125.25
	5	1.03 - 1.04	35.9	61.4
	6	0.64	22.4	42.75
	7	0.34	13.8	30.9
	Backup	<0.34	1.3	0
	Acetone	>10 µm	13,800	24,800
PSO 1-3	0	11.8 - 12.1	4.3	15.85
	1	10.4 - 10.6	2.2	10.8
	2	6.9 - 7.1	3.1	14.1
	3	4.6 - 4.7	3.8	15.8
	4	2.6	20.1	40.1
	5	1.3	68.9	102.1
	6	0.8	30.6	50.5
	7	0.43	25.9	45.8
	Backup	<0.43	5.2	15.6
	Acetone	>12 µm	121	164

[a] Range of size cutpoints as determined from the CIDRS computer program. (See Appendix A.)

modified Method 13B samples. This probably results from a reduction of Cr^{+6} to a lower valence state on the glass-fiber filter media.

2.4 PROCESS SAMPLE ANALYTICAL RESULTS

Samples of plating tank solution were collected during each modified Method 13B emission test and analyzed for Cr^{+6} and total Cr using procedures similar to those used for the emission samples. Mist eliminator washwater was collected at the end of each day (6/30 and 7/1) on which the Method 13B tests were conducted. Table 2-5 summarizes the analytical results.

TABLE 2-5. PROCESSS SAMPLE ANALYTICAL RESULTS

Laboratory No.	Run No./ description	Fraction	Chromium(VI), mg/liter	Total chromium, mg/liter
FT499	ME wash water, 6/30	Liquid	2,790	3,490
FT450	ME wash water, 7/1	Liquid	3,470[a]	4,220
FT451	MEI (MEO) -1 tank	Liquid	79,000	84,500
FT452	MEI (MEO) -2 tank	Liquid	81,000	85,800
FT453	MEI (MEO) -3 tank	Liquid	82,700	85,100

[a] Spike recovery was 105.8 percent for Cr(VI) and 70.5 percent for total Cr. In the total chromium spike, 2 µg was added to the 40 µg present in the sample. This spike level was too low for the amount already in the sample and probably explains the lower recovery determined for this sample.

SECTION 3

PROJECT QUALITY ASSURANCE

The application of quality assurance procedures to source emission measurements ensures accurate emission-testing results. Quality assurance guidelines provide the detailed procedures and actions necessary for defining and producing acceptable data. In this project, four documents were used in the preparation of a source-specific test plan that would ensure the collection of acceptable data: 1) EPA Quality Assurance Handbook, Volume II, EPA-600/4-77-0271; 2) PEI Emission Test Quality Assurance Plan; 3) PEI Laboratory Quality Assurance Plan; and 4) Determination of Hexavalent Chromium Emissions From Stationary Sources, December 13, 1984. Two of these are PEI's general guideline manuals that define the standard operating procedures followed by the company's emission testing and laboratory groups.

In this specific test program, which was reviewed by EPA's Emission Measurement Branch, the following steps were taken to ensure that the testing and analytical procedures produced quality data:

- Onsite quality assurance checks, such as leak checks of the sampling train, pitot tube, and Orsat line. Onsite quality assurance checks of all test equipment prior to its use.
- Use of designated analytical equipment and sampling reagents.
- Internal and external audits to ensure accuracy in sampling and analysis.
- Calibration of all field sampling equipment.
- Checks of train configuration and calculations.

Table 3-1 lists the specific sampling equipment used to perform the Cr^{+6}, total Cr, and particle size distribution tests as well as the calibration guidelines and limits. In addition to the pre- and post-test calibrations, a field audit was performed on the metering systems and temperature-measurement devices used during sampling. These data are summarized in Table 3-2, and copies of the field audit data sheets are presented in Appendix B of this report.

The PEI project manager and EPA Task Manager performed the onsite sample calculations, and computer programming was used to validate the data upon return to PEI's Cincinnati laboratory. Minor discrepancies between the hand calculations and computer printouts are due primarily to rounding off of values. Computerized example calculations are presented in Appendix A.

The following subsections summarize the quality assurance activities performed during the analytical phase of this project. As a check of the gravimetric analytical procedure for particle sizing, a blank set of filters and a reagent (acetone) were analyzed in a fashion similar to that used for the actual field samples. Table 3-3 summarizes the blank analysis data, which indicate good gravimetric analytical technique.

Emission and process samples were analyzed in two separate batches. Table 3-4 summarizes the linear regression data of the spectrophotometer calibration for these samples. Standards containing 0, 5, 10, 15, 20, and 25 µg of chromium(VI) per 50 ml were analyzed with each batch of samples. The detection limits listed in Table 3-4 are based on an absorbance value of 0.005.

TABLE 3-1. FIELD EQUIPMENT CALIBRATION

Equipment	ID No.	Calibrated against	Allowable error	Actual error	Within allowable limits	Comments
Meter box	FB-3	Wet test meter	ΔH@ ± 0.15 (Y ± 0.05 Y post-test)	0.05; 2.25%	✓	
	FB-9			0.11; 0.91%	✓	
	FB-11			0.05; -0.204%	✓	
	FT-1			0.05; -1.2%	✓	
Pitot tube	242	Standard pitot tube	Cp ± 0.01		✓	Visually inspected onsite. Cp = 0.84 per Method 2.
	504				✓	
	015				✓	
	016				✓	
Digital indicator	FT-1	Millivolt signals	0.5%	+0.22%	✓	Maximum deviation.
	219			+0.20%	✓	
Thermocouple and stack thermometers	411	ASTM-2F or 3	1.5% (±2% saturated)	0.40%	✓	Maximum deviation.
	101			0.22%	✓	
	412			0.3%	✓	
	409			0.15%	✓	
Orsat analyzer	422	Standard gas	± 0.5%	CO: 0.2% O_2: 0.0 CO_2: 0.2%	✓	
Impinger thermocouple	I-15	ASTM-2F or 3F	± 2°F	+1°F	✓	
	I-1			+2°F	✓	
Trip balance	Mett-ler 1	Type S weight	± 0.5 g	0.0	✓	
Barometer	406	NBS traceable barometer	± 0.10 in.Hg (0.20 post-test)	+0.01	✓	

(continued)

TABLE 3-1 (continued)

Equipment	ID No.	Calibrated against	Allowable error	Actual error	Within allowable limits	Comments
Dry gas thermometer	FB-3	ASTM-2F or 3F	± 0.5°F	In: +2°F; Out: +1°F	✓	Maximum deviation
	FB-9			In: +3°F; Out: +2°F	✓	
	FB-11			In: +2°F; Out: +2°F	✓	
	FT-1			In: +2°F; Out: +2°F	✓	
Probe nozzle	MEO Caliper		Dn ± 0.004 in.	0.001	✓	
	MEI Caliper			0.003	✓	
	3-110			0.004	✓	
	3-104			0.000	✓	

TABLE 3-2. ON-SITE FIELD EQUIPMENT CALIBRATION VERIFICATION

Equipment	ID No.	Calibrated against	Allowable deviation	Actual deviation	Within allowable limits	Comments
Meter box	FB-3	Critical orifice	Y ± 0.05 Y	-3.10; + 0.06	✓	PEI constructed critical orifices used for this audit.
	FB-11		ΔH@ ± 0.15	-0.81; -0.05	✓	
	FT-1			-0.01; +0.03	✓	
	FB-9			-2.7; - 0.01	✓	
Pitot tube		(Geometrical specs) (Cylinder pitot tube)	Cp ± 0.01		✓	Visually inspected on site.
Digital indicator	FT-1	Millivolt signals	1.0%	NA	✓	
	219			-0.45	✓	
Thermocouple and stack thermometers	411	ASTM-3F	± 7°F (±2°F saturated)	NA		
	101			NA	✓	See Table 3-1.
	412			NA	✓	
Orsat analyzer	422	Ambient air O_2	± 0.7%	NA	✓	See Table 3-1.
Impinger thermocouple	I-1	ASTM-3F	± 2°F	-2°F	✓	
	I-15			-1°F	✓	
Trip balance		Type S weight	± 0.5 g	NA	✓	
Dry gas thermometer		ASTM-3F	± 5°F	NA	✓	
Probe nozzle		Caliper	Dn ± 0.004 in.		✓	See Table 3-1.

TABLE 3-3. FILTER AND REAGENT BLANK ANALYSIS DATA

Sample type	PEI lab No.	Tare weight, mg	Average gross weight, mg	Net difference, mg
Acetone[a]	FT337	98,791.3	98,799.2	7.9 mg (0.0410 mg/g)
Andersen filter set				
Stage 0, No. AS-37	FT328	159.6	159.7	0.1
Stage 1, No. AP-37	FT329	164.2	164.2	0.1
Stage 2, No. AS-19	FT330	162.4	161.9	0.5
Stage 3, No. AS-49	FT331	163.0	162.6	0.4
Stage 4, No. AM-32	FT332	144.1	143.7	0.4
Stage 5, No. AP-90	FT333	142.3	142.5	-0.2
Stage 6, No. AP-88	FT334	142.5	142.5	0
Stage 7, No. AO-06	FT335	149.3	149.3	0
Backup, No. A-294	FT336	220.2	219.6	0.6

[a] If a blank residue value greater than 0.01 mg/g or 0.001 percent of the blank weight was obtained, a maximum value of 0.01 mg/g was subtracted from the sample weight.

TABLE 3-4. LINEAR REGRESSION DATA FOR SPECTROPHOTOMETER CALIBRATION

Date (1986)	Y-Intercept	Slope	Correlation coefficient	Duplicate curves	Detection limit, µg/ml
7/20	-0.0045	0.0293	0.9998	No	<0.4
8/12	-0.0000	0.0265	0.9999	Yes	<0.2

The ICP was also calibrated for each of the two batches. The initial calibration consists of a blank and a 5-ppm standard, both containing 50 ppm of scandium as an internal standard. The internal standard is also added to all samples at the same concentration. Table 3-5 summarizes the results of the ICP QC check sample (1.00 ppm) analyzed after approximately every tenth sample.

TABLE 3-5. QC CHECK SAMPLE DATA FOR ICP

Date (1986)	Value determined, ppm
7/23	1.00
	1.02
	1.06
	1.05
8/15	0.93
	0.92
	0.97
	0.93
	0.92
	0.94

Table 3-6 summarizes all blank data for chromium(VI) and total chromium analyses.

TABLE 3-6. SUMMARY OF BLANK DATA

Description	Chromium(VI), µg	Total chromium, µg
Reagent blank for particulate	<0.4	<2
Acetone blank	0.6	<2
Filter stages 0, 2, 4, 6	0.9	11.0
Filter stages 1, 3, 5, 7	0.8	11.6
Backup filter	1.5	19.8
Method 5 sample blank	<6[a]	<20[a]

[a] Based on largest volume of sample received.

Two fractions were analyzed for the modified Method 5 samples and the process: the liquid and the digested solids. The amount of solids were small, and the amount of chromium(VI) and total chromium in the solids were insignificant compared with that in the liquid.

Table 3-7 summarizes the results of the spike sample and duplicate sample analysis for chromium(VI) and total chromium.

TABLE 3-7. RESULTS OF SPIKE AND DUPLICATE ANALYSES[a]

Run No.	Spike recovery, %	Duplicate results, mg/liter
PSI 1-3 Stage 5	87.4 total Cr	-
PSI 1-3 acetone	88.4 Cr(VI)	-
MEI-3	101.0 Cr(VI)	-
MEO-1	92.5 total Cr	-
MEI wash water 7/1	105.8 Cr(VI) 70.5 total Cr[b]	3,470, 4070 mg/liter Cr(VI) 4,220, 3,950 mg/liter total Cr
MEI wash water 6/30	- -	2,790, 3,270 mg/liter Cr(VI) 3,490, 3,320 mg/liter total Cr

[a] Spike recoveries on solid samples were within the same range.

[b] Spike level was inappropriate for accurate recovery determination (2 µg were spiked in 40 µg).

SECTION 4

SAMPLE LOCATIONS AND TEST METHODS USED

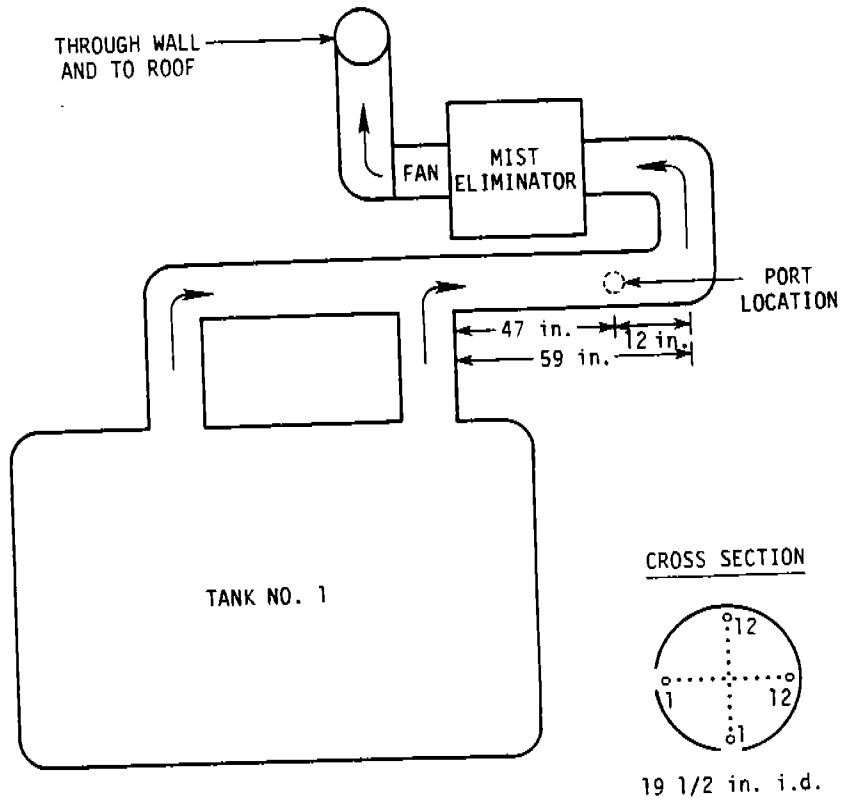
4.1 SAMPLE LOCATIONS

Samples were simultaneously extracted from the inlet and outlet ducts of the mist eliminator. Figures 4-1 and 4-2 show the inlet and outlet sample locations.

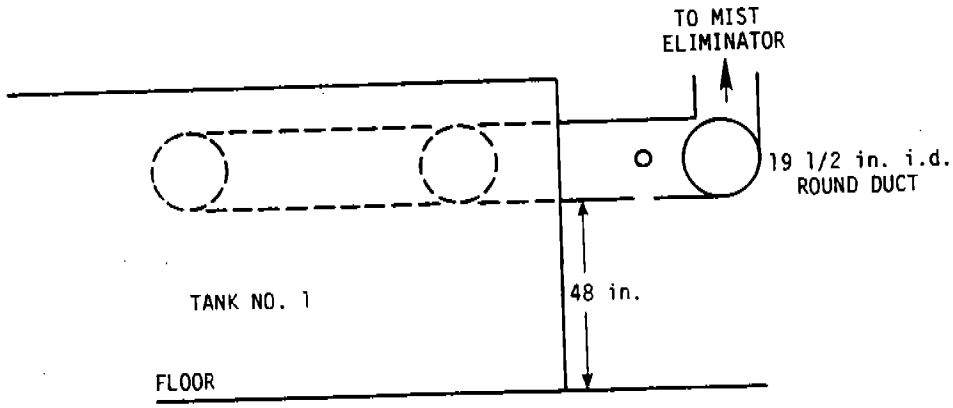
At the inlet, two sampling ports were located 90 degrees off-center, approximately 2.4 duct diameters (dd) downstream and 0.62 dd upstream from the nearest flow disturbance in the 19½-inch i.d. round duct. A total of 24 traverse points (12 per port) were used to traverse the cross-sectional area of the duct. Sample times were 180 minutes (7.5 minutes per point) for the first test (MEI-1) and 120 minutes (5 minutes per point) for the remaining two tests (MEI-2 and -3).

At the outlet, two sampling ports were located 90 degrees off-center, approximately 1.33 dd downstream and 0.58 dd upstream from the nearest flow disturbances in the 24-inch i.d. round duct. A total of 24 sample points were used to traverse the cross-sectional area of the stack. Sample times were identical to those used at the inlet. The minimum port location criteria specified in EPA Method 1* could not be met at the mist eliminator outlet location; however, this was the only feasible location to extract samples. As detailed in Section 2 of this report, the quality of inlet and

* 40 CFR 60, Appendix A, Reference Method 1, July 1985.



PLAN VIEW



ELEVATION AND CROSS-SECTION

Figure 4-1. Tank No. 1 Inlet Sample Location, Able Machine Co.

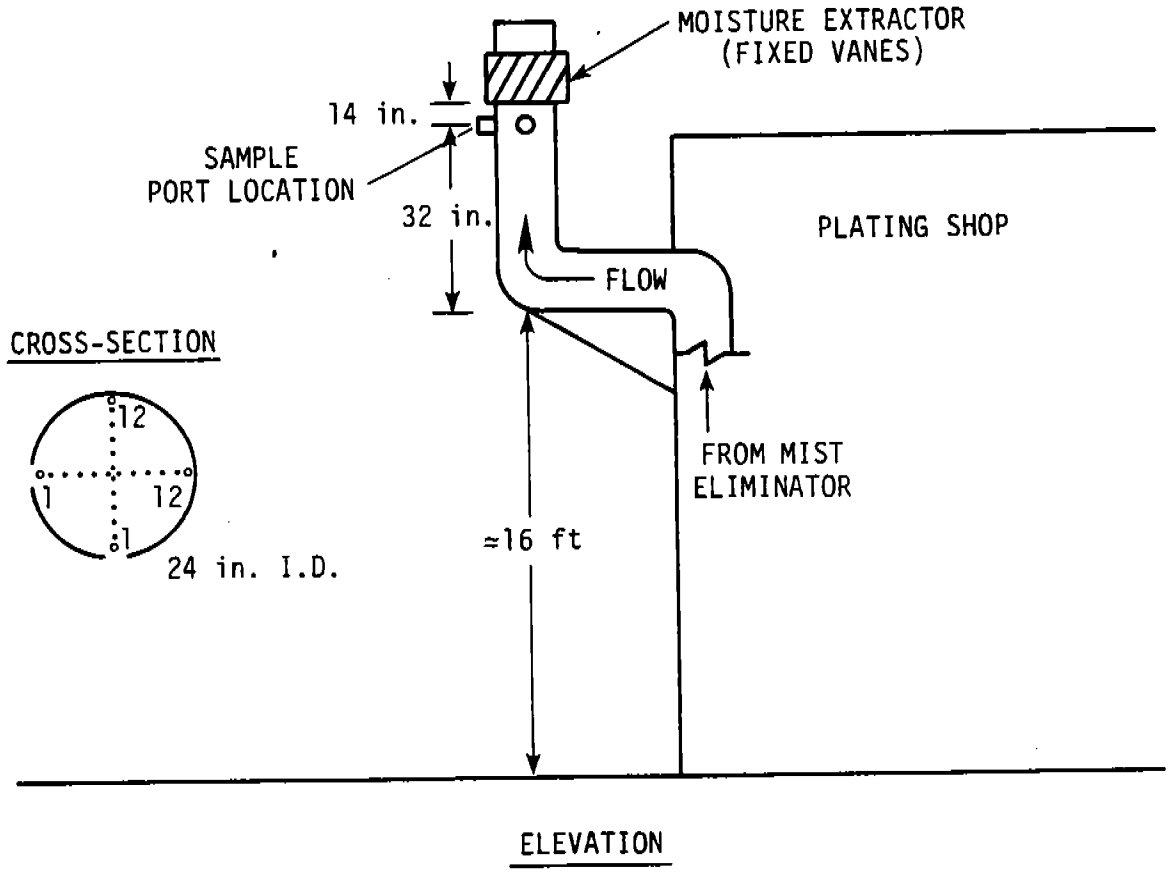


Figure 4-2. Tank No. 1 Outlet Sample Location, Able Machine Co.

outlet flow rate data indicates that this problem did not adversely affect test results. Note also that samples were extracted after the mist eliminator but before a fixed vane moisture extractor designed to remove mist which may pass through the mist eliminator.

4.2 HEXAVALENT AND TOTAL CHROMIUM SAMPLE EXTRACTION AND ANALYSIS

As shown previously in Table 2-1, three tests were conducted at points located before and after the mist eliminator in order to determine the Cr^{+6} and total Cr content.

Prior to sampling, velocity, static pressure, molecular weight, moisture content, and temperature were measured to define sampling rates and nozzle sizes as described in EPA Reference Methods 1 through 4.* In addition, the degree of turbulent flow at each location was assessed based on procedures described in EPA Reference Method 2. In this method, the face openings of the Type-S pitot tube are aligned perpendicularly to the duct cross-sectional plane, designated "0-degree reference." Null (zero) pitot readings obtained at 0-degree reference indicate an acceptable flow condition at a given point.

If the pitot reading is not zero at 0-degree reference, the pitot is rotated (up to 90 degrees ± yaw angle) until a null reading is obtained. The value of the rotation angle (yaw) is recorded for each point and averaged across the duct. Method 2 criteria stipulate that average angular rotations greater than ±10 degrees indicate turbulent (nonaxial) flow conditions in the duct(s). Angular rotations of less than 10 degrees were observed at each location, which indicated acceptable flow patterns and enabled the extraction of representative samples from this source.

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* 40 CFR 60, Appendix A, Reference Methods 1 through 5, July 1985.

An EPA Method 13B sampling train was used to extract samples. The train was modified by eliminating the sample filter and placing 300 ml of 0.1 N NaOH in the impinger section. Each train consisted of a heated, glass-lined probe followed by a series of four Greenburg-Smith impingers, a calibrated orifice, a dry gas meter, and associated equipment to measure gas flow and temperature and maintain isokinetic sampling conditions.

The impingers were weighed before and after each test to determine the moisture content of the flue gas stream. The contents of the impingers were placed in a polyethylene container, and all glassware including the sampling nozzle and probe were rinsed with 0.1 N NaOH; this rinse was added to the same container. Appropriate blank solutions (0.1 N NaOH) were also taken for analysis. Upon return to the laboratory, each sample (including blanks) was analyzed for Cr^{+6} using analytical methodology recently developed by EPA. A copy of the draft method entitled "Determination of Hexavalent Chromium Emissions From Stationary Sources" is contained in Appendix G of this report. In summary, this method entails the extraction of the sample with an alkaline solution, followed by the diphenylcarbazide colorimetric method.*

At the completion of the Cr^{+6} analysis, a separate portion of each sample was digested and analyzed for total Cr by use of ICP analytical techniques.** Appendix D of this report contains the detailed analytical methodology used for these analyses.

4.3 PARTICLE SIZE DISTRIBUTION

Three samples were collected at each test location to determine particle size distribution. These tests were designed to characterize Cr^{+6} and total

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* Test Methods for Evaluating Solid Waste. U.S. EPA SW-846, 2nd ed., July 1982. Method 3060.

** Test Methods for Evaluating Solid Waste. U.S. EPA SW-846, 2nd ed., July 1982. Method 3050.

Cr emissions by size fraction. All size distribution tests were performed in accordance with procedures detailed in the equipment manufacturer's operations manual. Guidelines established in the IP Protocol* were used to evaluate collected data.

Samples for particle-size distribution measurements were collected using an Andersen Mark III impactor with glass-fiber filters as the substrated media. This in-stack impactor consists of eight cut-point stages and a backup filter. The sampled gas stream enters the system through the pre-cutter. Particles with sufficient inertia are impacted against the sides of the precutter. Smaller particles flow with the gas stream, exit the pre-cutter, and enter the main impactor. Then, particles with sufficient inertia are impacted on the front of the zero stage plate (no filter), smaller particles pass through the holes in the zero stage plate, and the portion of these particles with sufficient inertia impacts on the zero stage filter. The remainder of the particles pass through the holes in the first stage plate and similarly on to each succeeding stage. Finally, a glass-fiber backup filter removes all particles remaining in the gas stream downstream of the final, seventh stage plate.

A single impactor was used to collect samples at each location. Two points of average velocity were selected at the outlet location and a single point of average velocity was selected at the inlet. Sampling times were 180 minutes at the outlet and between 60 and 75 minutes for the inlet samples.

Isokinetic sampling rates were set initially based on the expected average gas velocity at the selected sample points, and constant cutpoint characteristics were maintained throughout the sampling period. The average

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* Procedures Manual for Inhalable Particulate Sampler Operation. Prepared by Southern Research Institute for EPA, Contract No. 68-02-3118, November 1979.

isokinetic sampling rate for each run was based on the actual flue gas velocity pressures and temperatures measured at each of the test points. At the completion of each test, the impactor samples were recovered according to procedures described in the mark III operations manual.

Each recovered fraction was subjected to a gravimetric analysis using procedures similar to those in EPA Method 5, except that the "constant weight" criteria for the filters was ±0.2 mg instead of ±0.5 mg. At the completion of the gravimetric analysis, samples were combined by location and stage cutpoint for analyses of Cr^{+6} and total Cr. Analytical procedures followed those previously described.

Cut-points for the eight Mark III impactor stages were calculated by computer programs contained in "A Computer-Based Cascade Impactor Data Reduction System" (CIDRS) developed by Southern Research Institute (SRI).* All particle size results are based on a particle density of 1 g/cm^3. Data reduction and intermediate results calculations were performed by the CIDRS program, and moisture contents and gas molecular weights were obtained from the Cr^{+6}/total Cr tests. Size distribution curves were established to represent the total weight percent of particulate matter smaller than the indicated aerodynamic particle diameter in micrometers.

4.4 PROCESS SAMPLES

Process samples (plating tank solution) were collected by PEI personnel during each test period. Each sample was collected at least four times

* Southern Research Institute. A Computer-Based Cascade Impactor Data Reduction System. Prepared for U.S. Environmental Protection Agency under Contract No. 68-022-131, Revised March 1980.

during the test period and placed in polyethylene containers. A sample of mist eliminator wash water was collected at the end of each test day and placed in a polyethlyene container. These samples were analyzed for Cr^{+6} and total Cr according to procedures similar to those used for the actual emission samples.

SECTION 5

PROCESS DESCRIPTION AND OPERATION

5.1 PROCESS DESCRIPTION

Able Machine Company is a small-sized job shop that performs hard chromium electroplating of industrial rolls. Hard chromium plating of industrial rolls provides a wear-resistant surface and protection from corrosion. The plating facility consists of two tanks, a new tank and an old tank. The old tank, however, is used only when the new tank is down for repairs or otherwise unavailable. The emission measurements documented in this report were performed on the new tank (see Figure 5-1) and its associated control device.

The new tank was installed in July 1985. Based on size; operating parameters such as current, voltage, plating time; and chromic acid concentration, the tank is typical of other hard chromium plating tanks used in the electroplating industry. The tank is 4.3 meters (m) (14.0 feet [ft]) long, 1.2 m (4.0 ft) wide, and 3.0 m (10.0 ft) deep, and holds about 15,820 liters (ℓ) (4,180 gallons [gal]) of plating solution. The plating bath used is a conventional hard chromium plating solution containing about 210 grams per liter (g/ℓ) (28 ounces per gallon [oz/gal]) of chromic acid and 1.3 g/ℓ (0.18 oz/gal) of sulfuric acid. The normal operating temperature of the plating bath ranges from 43 to 60°C (110° to 140°F). The tank is cooled with circulating water. The tank is equipped with a transformer rectifier rated at 12 volts and 12,000 amperes.

The plating tank is operated 8-hours (h) per day, 5 days per week. However, the tank is sometimes operated overnight to plate rolls that require a thick metal deposit. Typically, the tank is operated at full capacity (12 rolls). An overhead hoist is used to transport rolls to and from the plating tank. After plating, the rolls are rinsed with water from a hose over the top of the plating tank. This rinsing allows excess plating solution on the rolls to drain into the plating tank, thus reducing drag-out. It takes a total of about 40 minutes to unload and load the plating tank.

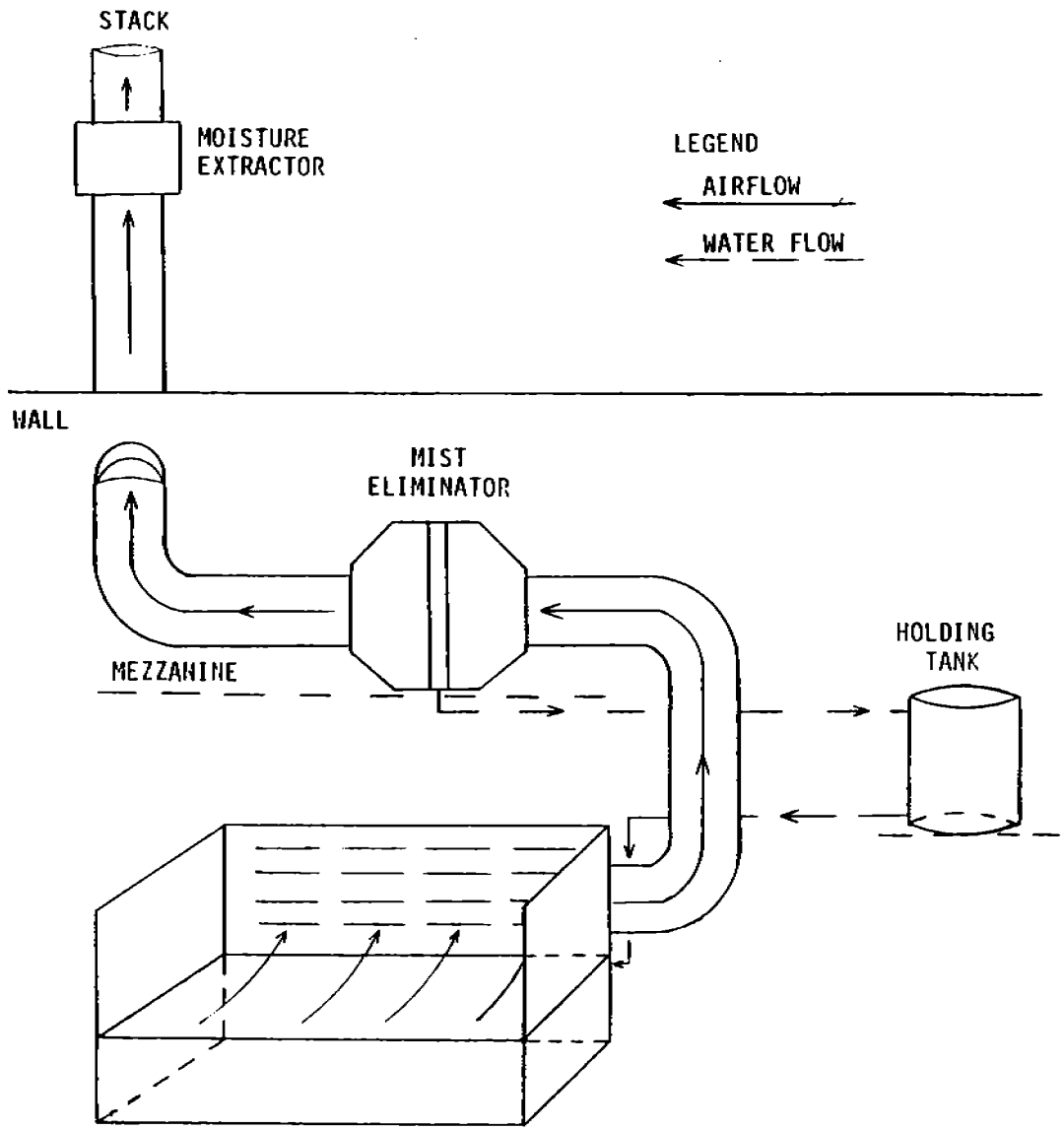

Figure 5-1. Schematic of new hard chromium plating tank at Able Machine Company.

5.2 AIR POLLUTION CONTROL

The plating tank is equipped with a push-pull capture system and a chevron-blade mist eliminator that were manufactured and installed in July 1985 by Duall Industries, Incorporated. The push side of the capture system consists of a 5.1-cm (2-in.) diameter pipe along the entire length of the tank. The pipe contains 72 holes that are each 0.32 cm (0.125 in.) in diameter. The holes are spaced 5.1 cm (2 in.) apart. The pull side of the capture system consists of an exhaust hood installed on the back of the tank. The hood measures 3.6 m (12 ft) in length and 1.8 m (6 ft) in height and contains 3 rows of slots with 15 slots per row. The slots are 25.4 centimeters (cm) (10 in.) in length and 2.54 cm (1 in.) in width. Both sides of the tank are equipped with baffles 1.2 m (4 ft) in length and 1.8 m (6 ft) in height. Removable panels are placed over the top of the tank during plating to enclose the surface of the plating solution to maximize capture efficiency.

Chromium emissions from the tank are vented to a chevron-blade mist eliminator located on a mezzanine structure behind the tank. The mist eliminator contains two sets of chevron blades. Each set changes the direction of gas flow four times at thirty degree angles. The gas flow rate of the system is 170 cubic meters per minute (6,000 actual cubic feet per minute). The pressure drop of the mist eliminator is rated at 0.5 kilopascals (2 in. of water column). A moisture extractor is installed in the stack downstream of the mist eliminator. The moisture extractor consists of a stationary set of blades that centrifugally forces acid mist or droplets entrained in exhaust gas to impinge against the sides of the extractor wall. The droplets drain down the sides of the extractor into collection areas. The moisture extractor was installed at the company's request to control chromium emissions that might be drawn through the mist eliminator. The mist eliminator and moisture extractor are washed down with about 284 liters (ℓ) (75 gallons [gal]) of water at the end of each work day, and at the beginning of the work day if the tank was operated overnight. Washdown water is drained into a 606-ℓ (160-gal) holding tank inside the plating shop. The plating tank is equipped with a float that regulates the flow of makeup water from the holding tank to the plating tank.

5.3 PROCESS CONDITIONS DURING TESTING

Mass emission and particle size distribution tests were conducted at the inlet and outlet of the mist eliminator on the new tank to characterize the uncontrolled emissions from the hard chromium plating tank and the performance of the mist eliminator. The first and second mass emission and particle size distribution runs were conducted concurrently. The third particle size distribution run was conducted after the third mass emission run was completed. The process was operating normally during the tests.

Process operating parameters such as the voltage, current, and plating solution temperature were monitored and recorded during each mass emission test run. Descriptions (dimensions and surface areas) and plating requirements (current and plating time) of each individual part plated also were recorded for each test run. Process data sheets documenting the process and control device operating parameters during mass emission testing (test run Nos. MEI-1 through 3 and MEO-1 through 3) are presented in Appendix H. Data on the average operating parameters recorded during the mass emission test runs are presented in Table 5-1. The pressure drop across the mist eliminator was not monitored; however, there were no indications of any malfunctions in the mist eliminator or capture system during testing.

Grab samples were taken from the tank to determine the chromic acid concentration of the plating solution during each mass emission run. Grab samples of the mist eliminator and moisture extractor washdown water also were taken at the end of the day. The mist eliminator and moisture extractor were washed down with about 318 ℓ (84 gal) of water after the first mass emission test run and with about 254 ℓ (67 gal) of water after the third mass emission test run. The chromic acid concentration of the grab samples is reported in Section 2.4 of this report.

Test run Nos. 1, 2, and 3 were each interrupted for approximately 45 minutes to unload and reload the tank.

The total amount of current supplied to the tank during each test run is calculated in terms of ampere-hours and included in Appendix H. A tabular summary of the total current values is presented in Table 5-2.

TABLE 5-1. AVERAGE OPERATING PARAMETERS FOR THREE MASS EMISSION SOURCE TEST RUNS

Test Run No. Inlet/Outlet	Operating voltage, volts	Operating current, amperes	Temperature of plating solution, °C (°F)
MEI-1/MEO-1	7.5	8,579	52 (125)
MEI-2/MEO-2	7.1	9,527	52 (125)
MEI-3/MEO-3	7.5	7,054	52 (126)

TABLE 5-2. TOTAL CURRENT SUPPLIED TO THE TANK DURING THREE MASS EMISSION SOURCE TEST RUNS

Test Run No. Inlet/Outlet	Total current, ampere-hours	
	Inlet	Outlet
MEI-1/MEO-1	25,790	24,367
MEI-2/MEO-2	18,717	18,773
MEI-3/MEO-3	14,868	13,771

APPENDIX A

COMPUTER PRINTOUTS

Example Calculations for Particulate Emissions

1. Volume of dry gas samples corrected to standard conditions. Note: V_m must be corrected for leakage if any leakage rates exceed L_a.

$$V_{m_{std}} = 17.65 \times V_m \times Y \left[\frac{P_{bar} + \frac{\Delta H}{13.6}}{T_m} \right]$$

2. Volume of water vapor at standard conditions, ft^3.

$$V_{w_{std}} = 0.04707 V_{l_c}$$

3. Moisture content in stack gas.

$$B_{ws} = \frac{V_{w_{std}}}{V_{m_{std}} + V_{w_{std}}}$$

4. Dry molecular weight of stack gas.

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

5. Molecular weight of stack gas.

$$M_s = M_d\ (1-B_{ws}) + 18\ B_{ws}$$

6. Stack velocity at stack conditions, fps.

$$V_s = 85.49\ Cp \left(\sqrt{\Delta P} \right)_{avg.} \sqrt{\frac{T_s}{P_s\ M_s}}$$

7. Stack gas volumetric flow rate at stack conditions, cfm.

$$Q_s = 60 \times V_s \times A_s$$

(continued)

Example Calculations for Particulate Emissions (continued)

8. Dry stack gas volumetric flow rate at standard conditions, cfm.

$$Q_{s_{std}} = 17.65\ Q_s \frac{P_s}{T_s} \left(1-B_{ws}\right)$$

9. Concentration in gr/dscf.

$$C's = (0.01543) \frac{M_n}{V_{m_{std}}}$$

10. Particulate mass emission rate, lbs/h.

$$pmr = \frac{C's}{7000} \times Q_{s_{std}} \times 60$$

11. Particulate mass emission rate, lbs/10^6 Btu.

$$E = \frac{C's}{7000} \times F \times \left(\frac{20.9}{20.9 - \%O_2}\right)$$

12. Isokinetic variation.

$$I = \frac{100\ T_s \left[0.002669\ V_{l_c} + \frac{V_m}{T_m}\ Y \left(P_{bar} + \frac{\Delta H}{13.6}\right)\right]}{60\ \theta\ V_s\ P_s\ A_n}$$

Nomenclature and Dimensions

A_s = cross-sectional area of stack, ft^2

A_n = area of sampling nozzle, ft^2

B_{ws} = proportional by volume of water vapor in the gas stream, dimensionless

C_p = pitot tube coefficient, dimensionless

C's = concentration of particulate matter in stack gas, g/scf, dry basis

% CO = percent of carbon monoxide by volume, dry basis

% CO_2 = percent of carbon dioxide by volume, dry basis

E = particulate mass emission rate, $lb/10^6$ Btu

F = F-factor, $dscf/10^6$ Btu

ΔH = average pressure drop across the orifice meter, $in.H_2O$

I = percent of isokinetic sampling

L_a = maximum acceptable leakage rate for either a pretest leak or for a leak check following a component change; equal to 0.00057 m^3/min (0.02 cfm) or 4 percent of the average sampling rate, whichever is less

M_d = dry molecular weight, lb/lb-mole.

M_n = total amount of particulate matter collected, mg

M_s = molecular weight of stack gas (wet basis), lb/lb-mole

% N_2 = percent of nitrogen by volume, dry basis

% O_2 = percent of oxygen by volume, dry basis

ΔP = velocity head of stack gas, $in.H_2O$

P_{bar} = barometric pressure, in.Hg

P_s = absolute stack gas pressure, in.Hg

pmr = particulate matter emission rate, lb/h

(continued)

Nomenclature and Dimensions (continued)

Q_s = volumetric flow rate, wet basis, stack conditions

$Q_{s_{std}}$ = volumetric flow rate, dry basis, standard conditions

T_m = average temperature of dry gas meter, °R

T_s = average temperature of stack gas, °R

V_{l_c} = total volume of liquid collected in impingers and silica gel, ml

V_m = volume of sample through the dry gas meter at meter conditions, ft^3

$V_{m_{std}}$ = volume of gas sample through the dry gas meter at standard conditions, ft^3

V_s = stack gas velocity at stack conditions, fps

$V_{wc_{std}}$ = volume of water vapor collected in impingers and silica gel corrected to standard conditions, scf

Y = dry as meter calibration factor

θ = total sampling time, minutes

Note: Standard conditions = 68°F and 29.92 in.Hg.

P E I ASSOCIATES, INC.

E M I S S I O N T E S T R E P O R T

F I E L D D A T A

Plant .....ABLE MACHINE CO.
Sampling location .....ME INLET
Test time (start-stop) 1207-1609

Date .....6/30/8[illegible]
Run number MEI-1

Sample type .....CF
Bar. pressure (in-Hg) 25.3
Static pressure (in-H2O) .....-2.0
Filter number(s) .....NA
Stack inside dia. (in) 19.5
Pitot tube coeff. 84
Total H2O collected (ml) 105.1
Percent O2 by volume (dry) ...20.9

Leakage (cu-ft) 0.145
Meter calibration factor 981
Data interval (min) 7.5
Nozzle dia. 253
Meter box number FT-1
Number of traverse points 24
Percent CO2 by volume (dry) ..0.0
Percent CO by volume (dry) ...0.0

Sample time (min)	Gas meter reading (cu. ft.)	Velocity head (in. H2O)	Orifice drop-act. (in. H2O)	Stack temp. (deg. F)	Dry gas meter temp (deg. F) inlet	outlet
0.0	334.233					
7.5	341.350	0.650	3.80	90	90	91
15.0	348.400	0.600	3.44	91	96	90
22.5	357.300	0.820	3.56	91	100	92
30.0	365.200	0.800	3.50	92	108	93
37.5	373.550	0.890	3.84	93	110	93
45.0	381.750	0.840	3.68	94	113	95
52.5	388.550	0.650	2.41	95	114	97
60.0	395.100	0.630	2.32	95	113	99
67.5	401.950	0.560	2.45	95	114	101
75.0	409.140	0.620	2.73	95	115	100
82.5	416.570	0.670	2.94	97	115	100
90.0	424.087	0.680	3.00	96	116	102
97.5	432.000	0.750	3.25	94	93	98
105.0	438.700	0.630	2.73	94	101	98
112.5	446.700	0.700	3.04	94	102	97
120.0	454.100	0.680	2.93	93	108	96
127.5	461.100	0.600	2.63	95	112	100
135.0	468.400	0.550	2.41	96	114	100
142.5	475.600	0.750	3.29	96	114	102
150.0	483.850	0.850	3.74	95	116	100
157.5	491.900	0.800	3.53	92	115	101
165.0	499.300	0.750	3.33	92	116	102
172.5	507.400	0.780	3.45	93	115	102
180.0	515.935	0.780	3.45	92	114	101
180.0	181.702	0.705	3.10	94	110	98

E S I ASSOCIATES, INC.

E M I S S I O N T E S T R E P O R T

T E S T R E S U L T S

PLANT: ABLE MACHINE CO.
TEST: MEI-1 / ME INLET

TEST DATE: 6/30/86
TEST TIME: 1207-1605

TT	.....	Net time of test (min)	180.0
NP	.....	Net sampling points	24
Y	.....	Meter calibration factor	0.931
DN	.....	Sampling nozzle dia (in)	0.253
CP	.....	Pitot tube coefficient	0.840
PM	.....	Average orifice pressure drop (in-H2O	3.19
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft) (corrected for leakage)	181.557
TM	.....	Average gas meter temperature (deg F)	107.3
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	164.813
VLC	.....	Total H2O collected in impingers and silica gel (ml)	105.1
VWS	.....	Volume of water vapor at standard conditions (scf)	4.947
BWO	.....	Percent moisture by volume	2.91
FMS	.....	Mole fraction of dry gas	0.97
PCO2	.....	Percent CO2 by volume (dry)	0.000
PO2	.....	Percent O2 by volume (dry)	20.93
PCO	.....	Percent CO by volume (dry)	0.000
PN2	.....	Percent N2 by volume (dry)	79.07
MS	.....	Molecular weight - dry stack gas	28.84

TEST RESULTS

MWS	.....	Molecular weight - stack gas	28.82
PB	.....	Barometric pressure (in-HG)	29.30
PSI	.....	Static pressure of stack gas (in-H2O)	-2.000
PS	.....	Stack pressure - absolute (in-HG)	29.15
TS	.....	Average stack temperature (deg F)	94
VH	.....	Average square root of velocity head (in-H2O)	0.84)
VS	.....	Average stack gas velocity (fps)	49.2
AS	.....	Stack area (sq in.	2[illegible]
QS	.....	Actual stack flow rate (acfm)	6.135
QSSTI	.....	Stack flow rate - dry (scfm)	5.524
ISO	.....	Percent isokinetic	95.0
MH	.....	HEX. CHROMIUM, MG	47.4
CS	.....	HEX. CHROMIUM, GR/DSCF	4.4[illegible]E-03
PMF	.....	HEX. CHROMIUM Emission rate, lb/hr	0.210
MT	.....	TOTAL CHROMIUM, MG	4[illegible].3
CS	.....	TOTAL CHROMIUM, GR/DSCF	4.358[illegible]E-03
PMF	.....	TOTAL CHROMIUM Emission rate, lb/hr	0.20[illegible]

P E I ASSOCIATES, INC.
E M I S S I O N T E S T R E P O R T

F I E L D D A T A

Plant .....ABLE MACHINE CO.
Sampling location .....ME INLET
Test time (start-stop) 0816-1143

Date 7/1/86
Run number ME1-1

Sample type .....CR
Bar. pressure (in-Hg) 29.35
Static pressure (in-H2O) .....-1.5
Filter number(s) N4
Stack inside dia. (in) 19.5
Pitot tube coeff. 84
Total H2O collected (ml) 69.2
Percent O2 by volume (dry) ...20.9

Leakage (cu-ft) 0.123
Meter calibration factor 981
Data interval (min) 5.0
Nozzle dia. 253
Meter box number FT-1
Number of traverse points 24
Percent CO2 by volume (dry) ..0.0
Percent CO by volume (dry) ...0.0

Sample time (min)	Gas meter reading (cu. ft.)	Velocity head (in. H2O)	Orifice pres. diff. (in. H2O)	Stack temp. (deg. F)	Dry gas meter temp (deg. F) inlet	outlet
0.0	516.142					
5.0	521.100	0.750	3.22	81	80	80
10.0	526.600	0.850	3.66	81	83	81
15.0	531.600	0.730	3.14	84	88	82
20.0	536.700	0.750	3.25	81	92	84
25.0	541.700	0.730	3.15	96	95	85
30.0	546.800	0.750	3.25	86	97	84
35.0	551.450	0.600	2.61	87	100	85
40.0	556.800	0.800	3.50	87	102	87
45.0	562.400	0.830	3.61	88	103	88
50.0	567.870	0.900	3.93	88	105	89
55.0	573.800	1.000	4.38	88	106	90
60.0	579.987	1.100	4.83	89	108	91
65.0	585.200	0.750	3.24	91	94	91
70.0	590.500	0.800	3.46	91	99	91
75.0	596.000	0.850	3.68	93	102	92
80.0	601.200	0.800	3.47	94	105	93
85.0	606.900	0.900	3.92	95	107	92
90.0	612.700	0.980	4.28	95	110	94
95.0	617.350	0.630	2.76	93	111	95
100.0	622.000	0.620	2.66	95	94	93
105.0	626.800	0.650	2.79	95	97	93
110.0	631.700	0.700	3.03	95	100	93
115.0	636.900	0.750	3.24	96	102	93
120.0	642.150	0.770	3.34	96	103	95
120.0	12e.000	0.757	3.43	86	101	89

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

TEST RESULTS

TEST DATE: 7/1/86
TEST TIME: 0815-1143

TT	.....	Net time of test (min)	120.0
NP	.....	Net sampling points	24
Y	.....	Meter calibration factor	0.981
DN	.....	Sampling nozzle dia (in)	0.253
CP	.....	Pitot tube coefficient	0.840
PM	.....	Average orifice pressure drop (in-H2O)	3.43
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft) (corrected for leakage)	125.895
TM	.....	Average gas meter temperature (deg F)	94.4
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	116.385
VLC	.....	Total H2O collected in impingers and silica gel (ml)	69.1
VWC	.....	Volume of water vapor at standard conditions (scf)	3.257
BWO	.....	Percent moisture by volume	2.72
FMD	.....	Mole fraction of dry gas	0.97
PCO2	.....	Percent CO2 by volume (dry)	0.000
PO2	.....	Percent O2 by volume (dry)	20.900
PCO	.....	Percent CO by volume (dry)	0.000
PNC	.....	Percent NC by volume (dry)	79.100
MD	.....	Molecular weight - dry stack gas	28.84

TEST RESULTS

MWS	.....	Molecular weight - stack gas	28.54
PB	.....	Barometric pressure (in-HG)	29.35
PSI	.....	Static pressure of stack gas (in-H2O)	-1.900
PS	.....	Stack pressure - absolute (in-HG)	29.21
TS	.....	Average stack temperature (deg F)	86
VH	.....	Average square root of velocity head (in-H2O)	0.887
VS	.....	Average stack gas velocity (fps)	51.6
AS	.....	Stack area (sq in)	299
QS	.....	Actual stack flow rate (acfm)	6.416
QSSTD	.....	Stack flow rate - dry (scfm)	5.890
ISO	.....	Percent isokinetic	97.8
MN	.....	HEX. CHROMIUM, MG	23.5
CS	.....	HEX. CHROMIUM, GR/DSCF	2.996EE-03
EMR	.....	HEX. CHROMIUM Emission rate, lb/hr	0.151
MN	.....	TOTAL CHROMIUM, MG	23.3
CS	.....	TOTAL CHROMIUM, GR/DSCF	2.957E-03
EMR	.....	TOTAL CHROMIUM Emission rate, lb/hr	0.149

P E I ASSOCIATES, INC.
E M I S S I O N T E S T R E P O R T

F I E L D D A T A

Plant .....ABLE MACHINE CO.
Sampling location .....ME INLET
Test time (start-stop) 1200-1500

Date 7/1/86
Run number MEI-3

Sample type .....GR
Bar. pressure (in-Hg) 29.35
Static pressure (in-H2O) .....-1.7
Filter number(s) .....NA
Stack inside dia. (in) 19.5
Pitot tube coeff. 84
Total H2O collected (ml) 65.7
Percent O2 by volume (dry) ...20.9

Leakage (cu-ft) 109
Meter calibration factor 981
Data interval (min) 5
Nozzle dia. 253
Meter box number FT-1
Number of traverse points 24
Percent CO2 by volume (dry) ..0.0
Percent CO by volume (dry) ...0.0

Sample time (min)	Gas meter reading (cu. ft.)	Velocity head (in. H2O)	Orifice drop-act. (in. H2O)	Stack temp. (deg. F)	Dry gas meter temp (deg. F) inlet	outlet
0.0	642.337					
5.0	646.990	0.670	2.89	98	102	97
10.0	652.000	0.650	2.80	99	104	98
15.0	657.100	0.720	3.12	98	106	97
20.0	662.330	0.750	3.26	99	111	99
25.0	667.900	0.900	3.92	98	113	98
30.0	673.400	0.850	3.71	99	114	99
35.0	677.900	0.550	2.40	99	113	100
40.0	682.600	0.560	2.45	98	115	100
45.0	687.130	0.600	2.63	99	117	101
50.0	692.000	0.650	2.84	99	117	101
55.0	696.940	0.660	2.90	98	117	102
60.0	701.880	0.670	2.94	98	117	102
65.0	707.100	0.750	3.27	93	99	100
70.0	712.400	0.800	3.46	96	102	99
75.0	717.800	0.800	3.48	96	106	99
80.0	722.600	0.650	2.83	97	110	99
85.0	727.500	0.600	2.62	96	111	99
90.0	731.990	0.600	2.62	96	111	99
95.0	737.230	0.750	3.29	96	113	100
100.0	742.850	0.880	3.86	96	115	100
105.0	748.600	0.910	4.00	96	117	101
110.0	754.200	0.850	3.74	96	118	101
115.0	759.990	0.910	4.01	96	118	102
120.0	765.855	0.960	4.22	97	118	103
126.0	123.518	0.780	3.22	97	112	100

P E I ASSOCIATES, INC.
E M I S S I O N T E S T R E P O R T

T E S T R E S U L T S

PLANT: ABLE MACHINE CO.
TEST: MEI-3 / ME INLET

TEST DATE: 7/1/96
TEST TIME: 1200-1500

TT	.....	Net time of test (min)	120.0
NP	.....	Nev sampling points	24
Y	.....	Meter calibration factor	0.991
DN	.....	Sampling nozzle dia (in)	0.257
CP	.....	Pitot tube coefficient	0.840
PM	.....	Average orifice pressure drop (in-H2O)	3.23
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft) (corrected for leakage)	123.409
TM	.....	Average gas meter temperature (deg F)	105.7
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	111.707
VLC	.....	Total H20 collected in impingers and silica gel (ml)	65.7
VWC	.....	Volume of water vapor at standard conditions (scf)	3.092
BWO	.....	Percent moisture by volume	2.69
FND	.....	Mole fraction of dry gas	0.97
PCO2	.....	Percent CO2 by volume (dry)	0.000
PO2	.....	Percent O2 by volume (dry)	20.900
PCO	.....	Percent CO by volume (dry)	0.000
PNC	.....	Percent N2 by volume (dry)	79.111
MD	.....	Molecular weight - dry stack gas	28.84

T E S T R E S U L T S

MWS	.....	Molecular weight - stack gas	28.54
PB	.....	Barometric pressure (in-HG)	29.33
PSI	.....	Static pressure of stack gas (in-H2O)	-1.700
PS	.....	Stack pressure - absolute (in-HG)	29.22
TS	.....	Average stack temperature (deg F)	57
VH	.....	Average square root of velocity head (in-H2O)	0.856
VS	.....	Average stack gas velocity (fps)	58.3
AS	.....	Stack area (sq in)	299
QS	.....	Actual stack flow rate (acfm)	6.249
QSSTD	.....	Stack flow rate - dry (scfm)	5.625
ISO	.....	Percent isokinetic	95.7

MH	.....	HEX. CHROMIUM. MG	21.9
CS	.....	HEX. CHROMIUM. GR/DSCF	2.9836E-03
PMR	.....	HEX. CHROMIUM Emission rate, lb/hr	0.144

MT	.....	TOTAL CHROMIUM. MG	21.9
CS	.....	TOTAL CHROMIUM. GR/DSCF	3.0112E-03
PMR	.....	TOTAL CHROMIUM Emission rate, lb/hr	0.145

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

FIELD DATA

Plant .....ABLE MACHINE CO.
Sampling location .....ME OUTLET
Test time (start-stop) 1206-1606

Date 6/30/86
Run number MEO-1

Sample type .....GR
Bar. pressure (in-HG 29.25
Static pressure (in-H2O) .....-1.5
Filter number(s) .....NF
Stack inside dia. (in) 24
Pitot tube coeff. 84
Total H2O collected (ml) 105.3
Percent O2 by volume (dry) ...20.9

Leakage (cu-ft) 0.0
Meter calibration factor 977
Data interval (min) 7.5
Nozzle dia. 265
Meter box number FB-3
Number of traverse points 24
Percent CO2 by volume (dry) ..0.0
Percent CO by volume (dry) ...0.0

Sample time (min)	Gas meter reading (cu. ft.)	Velocity head (in. H2O)	Orifice drop-act. (in. H2O)	Stack temp. (deg. F)	Dry gas meter temp (deg. F) inlet	outlet
0.0	168.309			96	110	108
7.5	176.535	0.620	3.77	97	110	108
15.0	184.230	0.600	3.05	97	112	10e
22.5	191.710	0.560	2.85	97	114	10e
30.0	198.800	0.490	2.50	98	115	10e
37.5	205.563	0.450	2.29	99	118	106
45.0	211.725	0.370	1.89	99	119	108
52.5	216.250	0.190	0.92	100	119	10E
60.0	220.275	0.150	0.76	100	118	108
67.5	223.940	0.120	0.61	100	118	109
75.0	227.540	0.120	0.61	101	118	108
82.5	230.835	0.100	0.51	100	118	109
90.0	234.597	0.120	0.61	98	111	108
97.5	241.735	0.520	2.64	99	112	107
105.0	249.050	0.500	2.63	99	115	108
112.5	255.720	0.420	2.14	99	115	108
120.0	261.865	0.370	1.88	99	115	107
127.5	267.765	0.340	1.72	100	115	106
135.0	272.665	0.330	1.67	99	114	106
142.5	278.200	0.310	1.57	99	113	105
150.0	282.775	0.280	1.42	99	112	104
157.5	288.470	0.320	1.62	97	110	103
165.0	293.450	0.400	2.02	97	109	102
172.5	298.495	0.460	2.33	97	107	100
177.5	306.250	0.460	2.33			
177.5	107.941	0.377	1.95	99	114	10E

E E I ASSOCIATES, INC.

EMISSION TEST REPORT

TEST RESULTS

PLANT: ABLE MACHINE CO.
TEST: MEC-1 / ME OUTLET

TEST DATE: 6/30/86
TEST TIME: 1206-1606

TT	.....	Net time of test (min)	177.5
NP	.....	Net sampling points	24
Y	.....	Meter calibration factor	0.977
DN	.....	Sampling nozzle dia (in)	0.265
CP	.....	Pitot tube coefficient	0.840
PM	.....	Average orifice pressure drop (in-H2O)	1.85
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft)	137.941
TM	.....	Average gas meter temperature (deg F)	110.1
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	122.753
VLI	.....	Total H2O collected in impingers and silica gel (ml)	103.0
VWC	.....	Volume of water vapor at standard conditions (scf)	4.862
BWO	.....	Percent moisture by volume	3.81
FMD	.....	Mole fraction of dry gas	0.96
FCO2	.....	Percent CO2 by volume (dry)	0.000
FOI	.....	Percent O2 by volume (dry)	20.900
FCO	.....	Percent CO by volume (dry)	0.000
FNI	.....	Percent N2 by volume (dry)	79.100
MD	.....	molecular weight - dry stack gas	28.84

TEST RESULTS

MWE	.....	Molecular weight - stack gas	28.43
PB	.....	Barometric pressure (in-HG)	29.29
PSI	.....	Static pressure of stack gas (in-H2O)	1.500
PS	.....	Stack pressure - absolute (in-HG)	29.40
TS	.....	Average stack temperature (deg F.	99
VH	.....	Average square root of velocity head (in-H2O)	0.581
VS	.....	Average stack gas velocity (fps)	34.1
AS	.....	Stack area (sq in)	452
QS	.....	Actual stack flow rate (acfm)	6.427
QSSTD	.....	Stack flow rate - dry (scfm	5.743
ISO	.....	Percent isokinetic	95.8
%A	.....	HEX. CHROMIUM, MG	0.5
CS	.....	HEX. CHROMIUM, GR/DSCF	5.67E-05
PMH	.....	HEX. CHROMIUM Emission rate, lb/hr	2.77E-05
MA	.....	TOTAL CHROMIUM, MG	0.5
CS	.....	TOTAL CHROMIUM, GR/DSCF	5.66E-05
PMP	.....	TOTAL CHROMIUM Emission rate, lb/hr	2.77E-05

P E I ASSOCIATES, INC.

E M I S S I O N T E S T R E P O R T

F I E L D D A T A

Plant .....ABLE MACHINE CO.
Sampling location .....ME OUTLET
Test time (start-stop) 0815-1127

Date 7/1/86
Run number MED-2

Sample type .....CR
Bar. pressure (in-HG) 29.35
Static pressure (in-H2O) .....+1.5
Filter number(s) .....NA
Stack inside dia. (in) 24
Pitot tube coeff. 84
Total H2O collected (ml) 71
Percent O2 by volume (dry) ...20.9

Leakage (cu-ft) 0.0
Meter calibration factor 977
Data interval (min) 5.0
Nozzle dia. 265
Meter box number PB-3
Number of traverse points 24
Percent CO2 by volume (dry) ..0.0
Percent CO by volume (dry) ...0.0

Sample time (min)	Gas meter reading (cu. ft.)	Velocity head (in. H2O)	Orifice drop-act. (in. H2O)	Stack temp. (deg. F)	Dry gas meter temp (deg. F) inlet	outlet
0.0	306.406					
5.0	310.750	0.480	2.34	92	90	80
10.0	315.090	0.470	2.29	92	88	80
15.0	319.330	0.430	2.11	92	87	80
20.0	323.500	0.410	2.02	92	91	81
25.0	327.650	0.360	1.78	92	95	82
30.0	331.415	0.320	1.58	93	98	84
35.0	335.050	0.300	1.49	93	100	86
40.0	338.590	0.300	1.50	93	101	88
45.0	342.640	0.360	1.80	94	102	89
50.0	346.690	0.390	1.95	94	102	90
55.0	351.185	0.460	2.31	94	105	92
60.0	355.618	0.440	2.21	94	105	92
65.0	360.650	0.600	3.02	94	105	95
70.0	365.680	0.570	2.87	95	106	96
75.0	370.560	0.530	2.67	95	107	97
80.0	375.400	0.520	2.62	96	108	98
85.0	379.990	0.460	2.32	96	110	99
90.0	384.125	0.370	1.87	97	110	100
95.0	387.125	0.180	0.91	97	111	100
100.0	389.445	0.130	0.66	98	111	101
105.0	391.735	0.110	0.56	98	112	102
110.0	394.055	0.110	0.56	98	112	102
115.0	396.375	0.110	0.56	99	112	103
120.0	398.695	0.110	0.56	99	112	103
120.0	92.289	0.334	1.77	95	103	93

P.E.I. ASSOCIATES, INC.

EMISSION TEST REPORT

TEST RESULTS

PLANT: ABLE MACHINE CO.
TEST: MED-2 / ME OUTLET

TEST DATE: 7/1/86
TEST TIME: 0815-1127

TT	.....	Net time of test (min)	120.0
NP	.....	Net sampling points	24
Y	.....	Meter calibration factor	0.977
DN	.....	Sampling nozzle dia (in)	0.265
CP	.....	Pitot tube coefficient	0.840
PM	.....	Average orifice pressure drop (in-H2O)	1.77
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft)	92.195
TM	.....	Average gas meter temperature (deg F)	97.5
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	84.095
VLC	.....	Total H2O collected in impingers and silica gel (ml)	71.0
VWC	.....	Volume of water vapor at standard conditions (scf)	3.342
BWS	.....	Percent moisture by volume	3.82
FM2	.....	Mole fraction of dry gas	0.96
PCO2	.....	Percent CO2 by volume (dry)	0.000
PO2	.....	Percent O2 by volume (dry)	20.900
PCO	.....	Percent CO by volume (dry)	0.000
PN2	.....	Percent N2 by volume (dry)	79.100
MF	.....	Molecular weight - dry stack gas	28.84

TEST RESULTS

MWS	.....	Molecular weight - stack gas	28.42
PB	.....	Barometric pressure (in-HG)	29.35
PSI	.....	Static pressure of stack gas (in-H2O)	1.500
PS	.....	Stack pressure - absolute (in-HG)	29.46
TS	.....	Average stack temperature (deg F)	95
VH	.....	Average square root of velocity head (in-H2O)	0.578
VS	.....	Average stack gas velocity (fps)	33.8
AS	.....	Stack area (sq in)	452
QS	.....	Actual stack flow rate (acfm)	6.372
QSSTD	.....	Stack flow rate - dry (scfm)	5.742
ISO	.....	Percent isokinetic	100.1
MN	.....	HEX. CHROMIUM. MG	0.3
CS	.....	HEX. CHROMIUM. GR/DSCF	8.09E-05
EMR	.....	HEX. CHROMIUM Emission rate. lb/hr	2.99868-04
MN	.....	TOTAL CHROMIUM. MG	0.3
CS	.....	TOTAL CHROMIUM. GR/DSCF	8.39E-05
EMR	.....	TOTAL CHROMIUM Emission rate. lb/hr	3.1431E-04

P E I ASSOCIATES, INC.

E M I S S I O N T E S T R E P O R T

F I E L D D A T A

Plant .....ABLE MACHINE CO.
Sampling location .....ME OUTLET
Test time (start-stop) 1209-1507

Date 7/1/86
Run number MEO-3

Sample type .....DR
Bar. pressure (in-HG) 29.35
Static pressure (in-H2O) .....+1.5
Filter number(s) N4
Stack inside dia. (in) 24
Pitot tube coeff. 84
Total H2O collected (ml) 40.6
Percent O2 by volume (dry) ...20.9

Leakage (cu-ft) 0.0
Meter calibration factor 977
Data interval (min) 5
Nozzle dia. 265
Meter box number FB-3
Number of traverse points 24
Percent CO2 by volume (dry) ..0.0
Percent CO by volume (dry) ...0.0

Sample time (min)	Gas meter reading (cu. ft.)	Velocity head (in. H2O)	Orifice drop-act. (in. H2O)	Stack temp. (deg. F)	Dry gas meter temp (deg. F) inlet	outlet
0.0	399.05[illegible]					
5.0	403.995	0.490	2.50	103	110	108
10.0	409.000	0.550	2.80	103	111	108
15.0	414.045	0.560	2.86	103	113	108
20.0	418.820	0.490	2.51	103	115	108
25.0	423.385	0.440	2.25	103	116	109
30.0	427.630	0.370	1.90	103	118	109
35.0	430.740	0.190	0.97	103	118	108
40.0	433.005	0.120	0.58	104	119	108
45.0	435.250	0.120	0.59	104	116	108
50.0	437.490	0.120	0.49	104	115	109
55.0	439.735	0.130	0.53	104	117	109
60.0	441.930	0.120	0.49	101	110	106
65.0	445.700	0.480	1.97	101	110	106
70.0	449.865	0.479	1.92	102	110	105
75.0	453.800	0.410	1.68	101	112	105
80.0	457.600	0.370	1.52	101	112	105
85.0	461.445	0.410	1.68	100	114	105
90.0	465.295	0.390	1.60	101	115	105
95.0	468.955	0.360	1.48	101	116	106
100.0	472.390	0.300	1.24	101	116	106
105.0	475.775	0.290	1.20	100	116	106
110.0	479.365	0.340	1.40	101	116	106
115.0	482.800	0.360	1.49	101	118	107
120.0	486.865	0.400	1.65	101	120	108
120.0	87.809	0.328	1.55	102	115	107

P E I ASSOCIATES, INC.
E M I S S I O N T E S T R E P O R T

T E S T R E S U L T S

PLANT: ABLE MACHINE CO.
TEST: MED-3 / ME OUTLET

TEST DATE: 7/1/86
TEST TIME: 1209-1507

TT	.....	Net time of test (min)	120.0
NP	.....	Net sampling points	24
Y	.....	Meter calibration factor	0.977
DN	.....	Sampling nozzle dia (in)	0.265
CP	.....	Pitot tube coefficient	0.840
PM	.....	Average orifice pressure drop (in-H2O)	1.55
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft)	87.907
TM	.....	Average gas meter temperature (deg F)	110.9
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	79.135
VLC	.....	Total H2O collected in impingers and silica gel (ml)	40.3
VWC	.....	Volume of water vapor at standard conditions (scf)	1.920
BWO	.....	Percent moisture by volume	2.49
FMD	.....	Mole fraction of dry gas	0.98
PCO2	.....	Percent CO2 by volume (dry)	0.000
PO2	.....	Percent O2 by volume (dry)	20.900
PCO	.....	Percent CO by volume (dry)	0.000
PN2	.....	Percent N2 by volume (dry)	79.100
MS	.....	Molecular weight - dry stack gas	28.84

T E S T R E S U L T S

MWE	.....	Molecular weight - stack gas	28.58
PB	.....	Barometric pressure (in-HG)	29.35
PSI	.....	Static pressure of stack gas (in-H2O)	1.500
PS	.....	Stack pressure - absolute (in-HG)	29.46
TS	.....	Average stack temperature (deg F)	101
VH	.....	Average square root of velocity head (in-H2O)	0.572
VS	.....	Average stack gas velocity (fps)	33.5
AS	.....	Stack area (sq in)	452
QS	.....	Actual stack flow rate (acfm)	6.321
QSDT	.....	Stack flow rate - dry (scfm)	5.715
ISO	.....	Percent isokinetic	92.4
MN	.....	HEX. CHROMIUM, MG	0.2
CS	.....	HEX. CHROMIUM, GR/DSCF	4.46E-05
EMF	.....	HEX. CHROMIUM Emission rate, lb/hr	1.161E-02
MN	.....	TOTAL CHROMIUM, MG	0.2
CS	.....	TOTAL CHROMIUM, GR/DSCF	4.9E-05
EMR	.....	TOTAL CHROMIUM Emission rate, lb/hr	1.395E-02

PARTICLE SIZE DISTRIBUTION

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:	ABLE MACHINE CO	Run no:	PEI-1
Sampling		Date:	6/30/86
Location:	Inlet	Start-stop, 24h:	1440-1540
Sample type:	Particle size	Barometric	
Operator:	DS	pressure, in.Hg:	29.30
Filter ID:		Static	
Meter box ID:	PB-9	pressure, in.H2O:	-1.90
Y Factor:	.986	Stack area, sq in:	278.65
Moisture, %:	2.9	Nozzle diameter, in:	.151
Number of sample		Pitot tube, Cp:	.84
points:	5	CO2 percent:	0
Sample time, min:	60.00	O2 percent:	20.9
Volume correction, cu ft:	0		

Sampling time, minutes	Gas meter reading, cfm	Velocity head, in. H2O	Orifice pressure, in. H2O	Stack temp, deg F	Meter temp, deg F Inlet	Outlet	Impactor temp, deg F
0.00	50.525	.62	1.10	94	98	94	94
33.00	50.15	.62	1.1	94	110	96	94
46.00	57.95	.62	1.1	94	115	100	94
60.00	58.34	.62	1.10	94	118	102	94
60	58.015	.62	1.10	94	105	97	94

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:ABLE MACHINE CO Run no.:PSI-1

TT...	Net time of test,min	60.00
NP...	Net sampling points	3
Y...	Meter calibration factor	.986
DN...	Sampling nozzle diameter,in	.192
CP...	Pitot tube coefficient	.84
PM...	Avg. orifice pressure,in H2O	1.10
VM...	Volume of dry gas sampled at meter conditions,cu-ft	36.015
TM...	Avg. gas meter temp..deg F	102.17
VMSTD...	Volume of dry gas sampled at standard conditions, scf	32.75
BWO...	Percent moisture by volume	2.80
MFD...	Mole fraction of dry gas	.972
PCO2...	Percent CO2 by volume, dry	0
PO2...	Percent O2 by volume, dry	20.9
PN2...	Percent N2 by volume, dry	79.1
MD...	Dry molecular weight	28.84
MS...	Stack gas molecular weight	28.53
PB...	Barometric pressure, in Hg	29.3
SP...	Static pressure, in H2O	-1.90
PS...	Stack pressure, in Hg	29.16
TS...	Avg. stack temperature,deg F	94.00
TI...	Avg. impactor temp..deg F	94.00
VH...	Avg. Sqrt of velocity head	.79
VS...	Avg. stack velocity,fps	46.14
ISO...	Percent isokinetic	106.64

**********IMPACTOR VERSION 4.0**********

********** INPUT DATA **********

1)PART. DIAMETER CLASSICAL AERODYNAMIC
2)DATE OF TEST: 6/30/86
3)TIME OF TEST: 1440-1540
4)LOCATION OF TEST: INLET
5)TEST NUMBER 1
6)TEST TYPE INLET
7)RUN NUMBER: PSI-1-FILE NAME:T1RPSI-1.IT
8)RUN REMARKS:
10)IMPACTOR TYPE: ANDERSEN GENERIC
ANDERSEN II WITH GENERIC CAL.

9)WATER VAPOR 1.80% (KEYBOARD)
CO2 .00% CO .00%
O2 20.90% N2 77.10%
11) ORIFICE ID (OPTIONAL):
13) SUBSTRATE MATERIAL:

1)GAS METER VOL 36.015 CUBIC FEET
2)IMPACTOR DELTA P .00 IN. HG
3)ORIFICE DELTA P -1.1 INCHES H2O
4)STACK PRESSURE -1.90 INCHES H2O
5)BAROMETRIC PRES 27.20 INCHES HG
6)STACK TEMP 94 DEGREES F
7)METER TEMP 102 DEGREES F
8)IMPACTOR TEMP 94 DEGREES F
9)SAMPLE TIME 57.00 MINUTES
10)AVG GAS VEL 48.14 FEET/SEC
11)ORIFICE PRES .00 INCHES HG
12)NOZZLE DIA .192 INCHES
13)MAX PART DIA 100.0 MICRONS
14)WATER VOLUME .0 CC
15)METER FACTOR .9860

MASS GAIN OF STAGE 1 22.90 MG
MASS GAIN OF STAGE 2 .20 MG
MASS GAIN OF STAGE 3 .40 MG
MASS GAIN OF STAGE 4 .20 MG
MASS GAIN OF STAGE 5 .20 MG
MASS GAIN OF STAGE 6 .40 MG
MASS GAIN OF STAGE 7 .00 MG
MASS GAIN OF STAGE 8 .00 MG
MASS GAIN OF FILTER .30 MG

MASS GAIN OF BLANK SUBSTRATE .00
MASS GAIN OF BLANK FILTER .00

✓ OK fine
8/22/86

********** RESULTS **********

TEST NUMBER: 1 RUN NUMBER: PSI-1

ACTUAL FLOW RATE .605 CFM
FLOW RATE AT STANDARD CONDITIONS .545 CFM
PERCENT ISOKINETIC 108.652 %
VISCOSITY 184.6E-06GM/CM SEC
CALCULATED IMPACTOR DELTA P = .56 IN. HG

STAGE	CUNN. CORR.	DP (CLAS AERO)	DP (IMP AERO)	CUM FREQ.	RE. NO.	V=D50 UM-M/S
1	1.017	9.549	5.934	4.9183	90	5.1
2	1.020	8.696	8.782	4.3408	48	7.6
3	1.023	5.794	5.880	3.1645	87	8.4
4	1.045	3.870	1.985	2.6052	109	7.3
5	1.087	2.146	1.231	2.0250	154	10.4
6	1.166	1.041	1.123	.5729	240	12.2
7	1.271	.638	.719	.6699	327	10.6
8	1.552	.327	.419	.8670	548	10.2

STAGE CUT DIAMETERS BASED ON FILE VALUES OF STAGE CONSTANTS

TOTAL MASS CONCENTRATION = 3.73E-01 MG/DRY NORMAL CUBIC METER

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)		CUMFR (STDDEV)	CUMFR (PERCENT)	CUM.MASS (MG/DRY N.CU.METER)	DM/DLOGD
.00	- 2.3814	.85	3.22E-01	1.56E-03	
.159	- 1.7809	.86	3.23E-01	1.56E-03	
.231	- 1.3542	.87	3.23E-01	1.57E-03	
.396	- 1.0741	.88	3.26E-01	6.08E-03	
.831	- 1.0778	.87	3.25E-01	2.90E-03	
1.000	- 1.3778	.87	3.25E-01	3.37E-01	
1.585	- 2.1941	1.41	5.27E-01	1.47E+00	
2.511	- 3.0050	1.26	6.43E-01	1.01E+00	
3.981	- 1.7354	1.83	9.81E-01	7.82E-01	
6.310	- 1.6275	3.38	1.26E+00	2.17E+00	
10.000	- 1.5437	5.01	1.87E+00	5.47E+00	
15.850	- 1.3452	8.86	3.30E+00	9.51E+00	
25.120	- .9864	16.69	6.22E+00	2.55E+01	
39.810	- .2455	40.30	1.50E+01	7.53E+01	
63.100	1.0645	98.05	3.66E+01	4.21E+01	
100.00	10000000	100.00	3.73E+01	0.00E+00	
158.50	10000000	100.00	3.73E+01	0.00E+00	
251.20	10000000	100.00	3.73E+01	0.00E+00	
398.10	10000000	100.00	3.73E+01	0.00E+00	
631.00	10000000	100.00	3.73E+01	0.00E+00	

**** RESULTS CONTINUED ****

TEST NUMBER: 1 RUN NUMBER: PSI-1

*** INHALABLE PARTICULATE MATTER ***

CUM MASS LESS THAN 1.000 MICRON:	.33 MG/DNM3	(.87	%)
CUM MASS LESS THAN 2.512 MICRON:	.84 MG/DNM3	(2.24	%)
CUM MASS LESS THAN 10.000 MICRON:	1.87 MG/DNM3	(5.01	%)
CUM MASS LESS THAN 15.550 MICRON:	3.30 MG/DNM3	(6.86	%)

NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE ON CLASSICAL AERODYNAMIC BASIS.

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

LEAST SQUARES LINE: Y=-3.74 + .53X
MASS MEDIAN DIAMETER: 15.2.167
GEOMETRIC STANDARD DEVIATION: 7e.024
CORRELATION COEFFICIENT: .924

FEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:	ABLE MACHINE CO	Run no:	FEI-1
Sampling Location:	Inlet	Date:	7/1/86
Sample type:	Particle size	Start-stop, 24h:	0817-0932
Operator:	DS	Barometric pressure, in. Hg:	29.35
Filter ID:		Static pressure, in. H2O:	-1.90
Meter box ID:	FE-9	Stack area, Sq in:	298.65
Y Factor:	.986	Nozzle diameter, in:	.192
Moisture, %:	2.8	Pitot tube, Cp:	.84
Number of sample points:	4	CO2 percent:	0
Sample time, min:	75.00	O2 percent:	20.9
Volume correction, cu-ft:	0		

Sampling time, minutes	Gas meter reading, cfm	Velocity head, in. H2O	Orifice pressure, in. H2O	Stack temp. deg F	Meter temp. deg F Inlet	Outlet	Impactor temp. deg F
0.00	66.414	.69	1.10	84	93	82	84
20.00	73.57	.69	1.10	84	96	85	84
40.00	90.30	.69	1.10	84	96	85	84
60.00	102.5	.69	1.10	88	104	89	86
75.00	111.58	.69	1.10	88	110	94	88
75	45.172	.69	1.10	84	101	88	86

J Fiori
8/13

RGI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:ABLE MACHINE CO Run no.:PSI-2

TT...	Net time of test.min	75.00
NP...	Net sampling points	4
Y...	Meter calibration factor	.986
DN...	Sampling nozzle diameter.in	.152
CP...	Pitot tube coefficient	.84
PM...	Avg. orifice pressure.in H2O	1.10
VM...	Volume of dry gas sampled at meter conditions.cu-ft	45.172
TM...	Avg. gas meter temp..deg F	84.13
VMSTD...	Volume of dry gas sampled at standard conditions. scf	41.75
BWO...	Percent moisture by volume	2.80
MFD...	Mole fraction of dry gas	.972
PCO2...	Percent CO2 by volume. dry	0
PO2...	Percent O2 by volume. dry	20.9
PN2...	Percent N2 by volume, dry	79.1
MD...	Dry molecular weight	28.84
MS...	Stack gas molecular weight	28.53
PB...	Barometric pressure. in Hg	29.33
SP...	Static pressure. in H2O	-1.90
PS...	Stack pressure. in Hg	29.21
TS...	Avg. stack temperature.deg F	85.00
TI...	Avg. impactor temp..deg F	86.00
VP...	A.V. part of velocity head	.80
VS...	Avg. stack velocity..fps	46.35
ISO...	Percent isokinetic	104.1

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**********IMPACTOR VERSION 4.0**********

********** INPUT DATA **********

 1)PART. DIAMETER    CLASSICAL AERODYNAMIC
 2)DATE OF TEST: 7/1/86
 3)TIME OF TEST: 0817-0932
 4)LOCATION OF TEST: INLET
 5)TEST NUMBER     2
 6)TEST TYPE          INLET
 7)RUN NUMBER: PSI-2 FILE NAME:T2RPSI-2.IT
 8)RUN REMARKS:
10)IMPACTOR TYPE: ANDERSEN GENERIC
ANDERSEN II WITH GENERIC CAL.

 9) WATER VAPOR          3.80%
    SO2    .00%         CO    .00%
    O2   20.90%         N2  79.10%
11) ORIFICE ID (OPTIONAL):
12) SUBSTRATE MATERIAL:


 1)GAS METER VOL     45.172 CUBIC FEET
 2)IMPACTOR DELTA P    .00 IN. HG.
 3)ORIFICE DELTA P    1.1 INCHES H2O
 4)STACK PRESSURE    -1.90 INCHES H2O
 5)BAROMETRIC PRES   29.35 INCHES HG
 6)STACK TEMP          86   DEGREES F
 7)METER TEMP          94   DEGREES F
 8)IMPACTOR TEMP       85   DEGREES F
 9)SAMPLE TIME      75.00 MINUTES
10)AVG GAS VEL      45.25 FEET/SEC
11)ORIFICE PRES       .00 INCHES HG
12)NOZZLE DIA         .192 INCHES
13)MAX PART DIA    100.0 MICRONS
14)WATER VOLUME       .0 CC
15)METER FACTOR       .9860


 MASS GAIN OF STAGE 1   41.00 MG
 MASS GAIN OF STAGE 2     .00 MG
 MASS GAIN OF STAGE 3     .10 MG
 MASS GAIN OF STAGE 4     .00 MG
 MASS GAIN OF STAGE 5     .10 MG
 MASS GAIN OF STAGE 6     .20 MG
 MASS GAIN OF STAGE 7     .10 MG
 MASS GAIN OF STAGE 8     .10 MG
 MASS GAIN OF FILTER       .10 MG

MASS GAIN OF BLANK SUBSTRATE      .1
MASS GAIN OF BLANK FILTER         .00
```

J. Finn
8/22/86

TEST NUMBER: 2 RUN NUMBER: FB1-2

ACTUAL FLOW RATE .607 CFM
FLOW RATE AT STANDARD CONDITIONS .557 CFM
PERCENT ISOKINETIC 104.167 %
VISCOSITY 183.75-06GM/CM SEC
CALCULATED IMPACTOR DELTA P = .57 IN. HG

STAGE	CUMM. EFFR.	DP (CLAS AERO)	DP (TMP AERO)	CUM FREQ.	RE. NO.	W*D50 UM-M/S
1	1.017	9.782	9.367	1.6634	52	5.0
2	1.033	8.638	8.722	1.6210	68	7.4
3	1.029	5.756	5.840	1.4412	89	9.8
4	1.044	3.645	3.528	1.4388	116	12.2
5	1.078	2.152	2.216	1.1990	150	10.4
6	1.163	1.334	1.116	.7194	247	13.1
7	1.289	.634	.715	.4794	334	13.6
8	1.519	.336	.415	.2398	545	12.2

STAGE CUT DIAMETERS BASED ON FILE VALUES OF STAGE CONSTANTS

TOTAL MASS CONCENTRATION = 3.51E+01 MG/DRY NORMAL CUBIC METER

SPLINE FIT OF CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)			CUMER STDDEV	CUM.MASS (PERCENT)	DM/DLOGD (MG/DRY N.CU.METER)
.100	-	3.3545	.04	1.41E-02	5.14E-02
.159	-	3.1516	.08	2.88E-02	9.95E-02
.251	-	2.9437	.14	5.65E-02	1.85E-01
.398	-	2.7285	.29	1.03E-01	1.75E-01
.631	-	2.5054	.48	1.66E-01	3.62E-01
1.000	-	2.2774	.70	2.47E-01	4.48E-01
1.585	-	2.0438	1.00	3.51E-01	5.45E-01
2.512	-	2.2127	1.30	4.57E-01	3.41E-01
3.981	-	1.1564	1.44	5.05E-01	2.96E-02
6.310	-	2.1311	1.46	5.15E-01	1.25E-01
10.000	-	2.1167	1.72	6.05E-01	1.23E+00
15.850	-	1.9417	2.61	9.20E-01	2.12E+00
25.120	-	1.6772	4.67	1.65E+00	6.26E+00
39.810	-	1.0752	14.11	4.92E+00	3.87E+01
63.100	-	1.1171	86.91	3.06E+01	1.73E+02
100.000	-	100.000	100.00	3.53E+01	0.00E+00
158.500	-	100.000	100.00	3.53E+01	0.00E+00
251.200	-	100.000	100.00	3.53E+01	0.00E+00
398.100	-	100.000	100.00	3.53E+01	0.00E+00
631.000	-	100.000	100.00	3.53E+01	0.00E+00

**** RESULTS CONTINUED ****

TEST NUMBER: 2 RUN NUMBER: PS-2

*** INHALABLE PARTICULATE MATTER ***

CUM MASS LESS THAN 1.006 MICRON: .35 MG/DNM3 (.70 %)
CUM MASS LESS THAN 2.512 MICRON: .66 MG/DNM3 (1.30 %)
CUM MASS LESS THAN 10.000 MICRON: .80 MG/DNM3 (1.72 %)
CUM MASS LESS THAN 15.850 MICRON: .92 MG/DNM3 (2.61 %)
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

LEAST SQUARES LINE: Y=-2.51 + .47X
MASS MEDIAN DIAMETER: 241346.429
GEOMETRIC STANDARD DEVIATION: 140.743
CORRELATION COEFFICIENT: .934

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:	ABLE MACHINE CO	Run no:	PEI-3
Sampling Date:		Date:	7/1/86
Location:	Inlet	Start-stop, 24h:	1400-1515
Sample type:	Particle size	Barometric pressure, in.Hg:	29.35
Operator:	DB	Static pressure, in.H2O:	-1.90
Filter ID:		Stack area, Sq in:	298.65
Meter box ID:	PB-7	Nozzle diameter, in:	.193
Y Factor:	.986	Pitot tube, Cp:	.84
Moisture, %:	2.8	CO2 percent:	0
Number of sample points:	4	O2 percent:	20.9
Sample time, min:	75.00		
Volume correction, cu-ft:	0		

Sampling time, minutes	Gas meter reading, cfm	Velocity head, in. H2O	Orifice pressure, in. H2O	Stack temp, deg F	Meter temp, deg F Inlet	Meter temp, deg F Outlet	Impactor temp, deg F
0.00	111.75	.69	1.10	93	100	95	93
15.00	122.99	.69	1.10	95	102	99	96
45.00	136.10	.69	1.10	96	114	100	96
60.00	148	.69	1.10	96	118	104	96
75.00	157.26	.69	1.10	96	118	104	96
TE	45.51	.69	1.10	95	110	101	95

J. Fiori
8/15

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:ABLE MACHINE CO Run no.:PEI-3

TT...	Net time of test,min	75.00
NP...	Net sampling points	4
Y...	Meter calibration factor	.986
DN...	Sampling nozzle diameter,in	.192
CP...	Pitot tube coefficient	.84
PM...	Avg. orifice pressure,in H2O	1.10
VM...	Volume of dry gas sampled at meter conditions,cu-ft	45.51
TM...	Avg. gas meter temp..deg F	105.13
VMSTD...	Volume of dry gas sampled at standard conditions, scf	41.24
BWO...	Percent moisture by volume	2.80
MFD...	Mole fraction of dry gas	.972
PCO2...	Percent CO2 by volume, dry	0
PO2...	Percent O2 by volume, dry	20.9
PN2...	Percent N2 by volume, dry	79.1
MD...	Dry molecular weight	28.84
MS...	Stack gas molecular weight	28.53
PB...	Barometric preessure, in Hg	29.35
SP...	Static pressure, in H2O	-1.90
PS...	Stack pressure, in Hg	29.21
TS...	Avg. stack temperature,deg F	95.25
TI...	Avg. impactor temp..deg F	95.25
VH...	Avg. Sqrt of velocity head	.83
VS...	Avg. stack velocity,fps	48.59
ISO...	Percent isokinetic	105.77

********** IMPACTOR VERSION 4.0 **********

********** INPUT DATA **********

1) PART. DIAMETER CLASSICAL AERODYNAMIC
2) DATE OF TEST: 7/1/86
3) TIME OF TEST: 1400-1515
4) LOCATION OF TEST: INLET
5) TEST NUMBER 3
6) TEST TYPE INLET
7) RUN NUMBER: PSI-3 FILE NAME: TSPSI-3.IT
8) RUN REMARKS:
10) IMPACTOR TYPE: ANDERSEN GENERIC
ANDERSEN II WITH GENERIC CAL.

9) WATER VAPOR 3.90%
CO2 .00% CO .00%
O2 20.90% N2 79.10%
12) ORIFICE ID (OPTIONAL):
13) SUBSTRATE MATERIAL:

1) GAS METER VOL 45.510 CUBIC FEET
2) IMPACTOR DELTA P .00 IN. HG.
3) ORIFICE DELTA P -1.1 INCHES H2O
4) STACK PRESSURE -1.9 INCHES H2O
5) BAROMETRIC PRES 29.2 INCHES HG
6) STACK TEMP 85 DEGREES F
7) METER TEMP 109 DEGREES F
8) IMPACTOR TEMP 95 DEGREES F
9) SAMPLE TIME 75.0 MINUTES
10) AVG GAS VEL 28.89 FEET/SEC
11) ORIFICE PRES .00 INCHES HG
12) NOZZLE DIA .192 INCHES
13) MAX PART DIA 100.0 MICRONS
14) WATER VOLUME 0 CC
15) METER FACTOR .986

MASS GAIN OF STAGE 1 15.00 MG
MASS GAIN OF STAGE 2 .00 MG
MASS GAIN OF STAGE 3 .00 MG
MASS GAIN OF STAGE 4 .30 MG
MASS GAIN OF STAGE 5 .00 MG
MASS GAIN OF STAGE 6 .30 MG
MASS GAIN OF STAGE 7 .00 MG
MASS GAIN OF STAGE 8 .10 MG
MASS GAIN OF FILTER .01 MG

24) TARE OF GLASS SUBSTRATE .
25) GAIN OF GLASS FILTER .00

D. Fion
8/22/86

******** RESULTS **********

TEST NUMBER: 7 RUN NUMBER: PSI-7

ACTUAL FLOW RATE .609 CFM
FLOW RATE AT STANDARD CONDITIONS .550 CFM
PERCENT ISOKINETIC 103.718 %
VISCOSITY 184.9E-06GM/CM SEC
CALCULATED IMPACTOR DELTA P = .56 IN. HG

STAGE	CUNN. CORR.	DP (CLAS AERO)	DP (IMP AERO)	CUM FREQ.	RE. NO.	V*D50 UM-M/S
1	1.018	9.819	9.905	4.4890	51	5.1
2	1.020	8.670	8.756	4.4626	66	7.7
3	1.030	5.777	5.862	4.4762	97	5.9
4	1.043	3.838	3.943	2.5461	105	9.1
5	1.091	2.140	2.224	2.5597	155	10.4
6	1.166	1.037	1.120	.6495	241	12.2
7	1.275	.636	.717	.6431	326	13.7
8	1.537	.336	.416	.0064	551	12.3

STAGE CUT DIAMETERS BASED ON FILE VALUES OF STAGE CONSTANTS

TOTAL MASS CONCENTRATION = 1.34E+01 MG/DRY NORMAL CUBIC METER

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)		CUMFR STDDEV	CUMFR (PERCENT)	CUM.MASS (MG/DRY N.CU.METER)	DM/DLOGD
.100	-	9.2602	.00	0.00E+00	1.33E-17
.159	-	7.1963	.00	0.00E+00	3.14E-10
.251	-	5.1329	.00	1.96E-06	1.05E-04
.398	-	3.3644	.04	5.19E-03	1.14E-01
.631	-	2.4935	.63	8.51E-02	4.24E-01
1.000	-	2.4578	.64	8.65E-02	1.31E-02
1.585	-	2.1737	1.48	1.99E-01	1.12E-02
2.512	-	1.9293	2.69	3.61E-01	3.48E-02
3.981	-	1.9371	2.64	3.55E-01	8.27E-01
6.310	-	1.6687	4.79	6.44E-01	8.20E-01
10.000	-	1.6969	4.49	6.03E-01	7.67E-02
15.850	-	1.6847	4.60	6.19E-01	2.31E-01
25.120	-	1.5840	5.66	7.61E-01	1.53E+00
39.810	-	1.1448	12.61	1.70E+00	1.14E+01
63.100		.8824	81.76	1.09E+01	9.15E+01
100.00		1000000	100.00	1.34E+01	0.00E+00
158.50		1000000	100.00	1.34E+01	0.00E+00
251.20		1000000	100.00	1.34E+01	0.00E+00
398.10		1000000	100.00	1.34E+01	0.00E+00
631.00		1000000	100.00	1.34E+01	0.00E+00

*** RESULTS CONTINUED ***

TEST NUMBER: 3 RUN NUMBER: PSI-C

*** INHALABLE PARTICULATE MATTER ***

CUM MASS LESS THAN 1.000 MICRON:	.09	MG/DNM3	(.64 %)
CUM MASS LESS THAN 2.512 MICRON:	.36	MG/DNM3	(1.69 %)
CUM MASS LESS THAN 10.000 MICRON:	.60	MG/DNM3	(4.49 %)
CUM MASS LESS THAN 15.850 MICRON:	.62	MG/DNM3	(4.60 %)

NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE ON CLASSICAL AERODYNAMIC BASIS.

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

LEAST SQUARES LINE:	Y=-2.66 + 1.26X
MASS MEDIAN DIAMETER:	131.111
GEOMETRIC STANDARD DEVIATION:	6.246
CORRELATION COEFFICIENT:	.793

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:	ABLE MACHINE CO ✓	Run no:	PSD-1 ✓
Sampling location:	Outlet ✓	Date:	8/30/82 ✓
Sample type:	Particle size ✓	Start-stop, 24h:	1305-1615 ✓
Operator:	SM/JH ✓	Barometric pressure, in. Hg:	29.29 ✓
Filter ID:		Static pressure, in. H2O:	1.50 ✓
Meter box ID:	PB-11 ✓	Stack area, Sq in:	452.39 ✓
Y Factor:	.978 ✓	Nozzle diameter, in:	.196 ✓
Moisture, %:	3.5 ✓	Pitot tube, Cp:	.84 ✓
Number of sample points:	9 ✓	CO2 percent:	0 ✓
Sample time, min:	178.55 ✓	O2 percent:	20.9 ✓
Volume correction cu-ft:	0 ✓		

Sampling time, minutes	Gas meter reading, cfm	Velocity head, in. H2O	Orifice pressure, in. H2O	Stack temp, deg F	Meter temp, deg F Inlet	Meter temp, deg F Outlet	Impactor temp, deg F
0.00 ✓	6.379 ✓	.32 ✓	.35 ✓	96 ✓	110 ✓	108 ✓	96 ✓
20.00 ✓	14.20 ✓	.32 ✓	.35 ✓	99 ✓	112 ✓	108 ✓	97 ✓
40.00 ✓	21.73 ✓	.32 ✓	.35 ✓	99 ✓	112 ✓	108 ✓	97 ✓
60.00 ✓	29.745 ✓	.32 ✓	.35 ✓	100 ✓	115 ✓	108 ✓	100 ✓
80.00 ✓	37.56 ✓	.33 ✓	.35 ✓	100 ✓	115 ✓	108 ✓	100 ✓
100.00 ✓	45.7 ✓	.32 ✓	.35 ✓	100 ✓	115 ✓	108 ✓	98 ✓
120.00 ✓	53.625 ✓	.32 ✓	.35 ✓	99 ✓	114 ✓	108 ✓	99 ✓
140.00 ✓	60.8 ✓	.30 ✓	.35 ✓	98	113 ✓	106 ✓	99 ✓
160.00 ✓	68.385 ✓	.32 ✓	.35 ✓	99	108 ✓	101 ✓	97 ✓
178.55 ✓	75.83 ✓	.32 ✓	.35 ✓	100	108	105	95
178.55	68.481	.31	.35	99	112	107	98

✓ J. First 8/16

APEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:ABLE MACHINE CO Run no.:P3C-1

TT...	Net time of test,min	178.55
NP...	Net sampling points	5
Y...	Meter calibration factor	.978
DN...	Sampling nozzle diameter,in	.196
Cp...	Pitot tube coefficient	.84
Pm...	Avg. orifice pressure,in H2O	.35
VN...	Volume of dry gas sampled at meter conditions,dcf-ft	69.451
TM...	Avg. gas meter temp.,deg F	109.67
VMSTD...	Volume of dry gas sampled at standard conditions, scf	61.65
BWO...	Percent moisture by volume	3.30
MFD...	Mole fraction of dry gas	.967
PCOD...	Percent COD by volume, dry	0
PO2...	Percent O2 by volume, dry	20.9
PN2...	Percent N2 by volume, dry	79.1
MD...	Dry molecular weight	28.84
MS...	Stack gas molecular weight	28.48
PB...	Barometric pressure, in Hg	29.29
SP...	Static pressure, in H2O	1.50
PS...	Stack pressure, in Hg	29.40
TS...	Avg. stack temperature,deg F	98.89
TI...	Avg. impactor temp.,deg F	86.22
Vn...	Avg. fort or velocity head	.37
VS...	Avg. stack velocity,fps	33.19
ISO...	Percent isokinetic	92.2

**********IMPACTOR VERSION 4.**********

********** INPUT DATA **********

1)PART. DIAMETER CLASSICAL AERODYNAMIC
2)DATE OF TEST: 8/30/86
3)TIME OF TEST: 1209-1610
4)LOCATION OF TEST: OUTLET
5)TEST NUMBER 1
6)TEST TYPE OUTLET
7)RUN NUMBER: PSD-1 FILE NAME:T1RPSD-1.CT
8)RUN REMARKS:
10)IMPACTOR TYPE: ANDERSEN GENERIC
ANDERSEN II WITH GENERIC CAL.

9)WATER VAPOR 3.30% (KEYBOARD)
CO2 .06% CO .00%
O2 20.60% N2 75.10%
10) ORIFICE ID (OPTIONAL):
11) SUBSTRATE MATERIAL:

1)GAS METER VOL 69.450 CUBIC FEET
2)IMPACTOR DELTA P .30 IN. HG.
3)ORIFICE DELTA P -.35 INCHES H2O
4)STACK PRESSURE 1.50 INCHES H2O
5)BAROMETRIC PRES 29.29 INCHES HG
6)STACK TEMP 99 DEGREES F
7)METER TEMP 110 DEGREES F
8)IMPACTOR TEMP 98 DEGREES F
9)SAMPLE TIME 178.55 MINUTES
10)AVG GAS VEL 33.19 FEET/SEC
11)ORIFICE PRES .01 INCHES HG
12)NOZZLE DIA .196 INCHES
13)MAX PART DIA 100.0 MICRONS
14)WATER VOLUME .0 CC
15)METER FACTOR .9780

MASS GAIN OF STAGE 1 .30 MG
MASS GAIN OF STAGE 2 .00 MG
MASS GAIN OF STAGE 3 .00 MG
MASS GAIN OF STAGE 4 .10 MG
MASS GAIN OF STAGE 5 .00 MG
MASS GAIN OF STAGE 6 .20 MG
MASS GAIN OF STAGE 7 .10 MG
MASS GAIN OF STAGE 8 .20 MG
MASS GAIN OF FILTER .00 MG

MASS GAIN OF BLANK SUBSTRATE .0
MASS GAIN OF BLANK FILTER .0

J. Finn
8/22/86

********** RESULTS **********

TEST NUMBER: 1 RUN NUMBER: PSC-1

ACTUAL FLOW RATE .384 CFM
FLOW RATE AT STANDARD CONDITIONS .345 CFM
PERCENT ISOKINETIC 92.155 %
VELOCITY 165.1E-06M/SM SEC
CALCULATED IMPACTOR DELTA P = .22 IN. HG

STAGE	CUMN. CORR.	DP CLAS	DP AERO	DP (IMP AERO)	CUM PRES.	RE. NO.	V*DSC UM-M/S
1	1.014	12.389	12.485	66.914	33		4.7
2	1.015	10.951	11.037	66.704	42		6.1
3	1.021	7.304	7.385	66.593	65		7.1
4	1.036	4.006	4.071	55.531	51		7.4
5	1.049	2.719	2.804	58.426	99		8.4
6	1.084	1.339	1.412	53.397	151		9.9
7	1.110	.511	.605	22.255	235		11.1
8	1.079	.445	.536	.1106	347		10.2

STAGE CUT DIAMETERS BASED ON FILE VALUES OF STAGE CONSTANTS

TOTAL MASS CONCENTRATION = 5.18E-01 MG/DRY NORMAL CUBIC METER

SPECIAL FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)	DUMMY (STDDEV)	DUMMY (PERCENT)	DM/DLOGDP (MG/DSCM)	DM/DLOGDP (LB/DSCF)
.100	-17.7675	.00	0.00E+00	0.00E+00
.157	-11.4587	.00	0.00E+00	6.35E-24
.247	- 7.1567	.00	0.00E+00	2.52E-13
.388	- 3.8614	.01	1.94E-05	1.97E-07
.621	- 1.5749	.12	7.12E-02	5.50E-01
1.000	- .5758	25.21	1.55E-01	2.50E-01
1.585	- .3083	37.89	1.96E-01	3.97E-01
2.512	.1004	54.00	2.80E-01	1.70E-01
3.981	.1376	58.48	2.87E-01	1.25E-01
6.310	.3220	62.67	3.24E-01	3.75E-01
10.000	.4842	65.48	3.35E-01	4.37E-02
15.850	.6052	66.97	3.47E-01	1.62E-02
25.120	.6970	68.39	3.53E-01	1.39E-01
39.811	.8640	81.15	4.20E-01	5.17E-01
63.100	1.3210	90.75	5.16E-01	8.47E-02
100.00	10000000	100.00	5.18E-01	0.00E+00
158.50	10000000	100.00	5.18E-01	0.00E+00
251.20	10000000	100.00	5.18E-01	0.00E+00
398.10	10000000	100.00	5.18E-01	0.00E+00
631.00	10000000	100.00	5.18E-01	0.00E+00

**** RESULTS CONTINUED ****

TEST NUMBER: 1 RUN NUMBER: PSC-1

*** INHALABLE PARTICULATE MATTER ***

CUM MASS LESS THAN 1.000 MICRON: .15 MG/DNM3 (29.61 %)
CUM MASS LESS THAN 2.512 MICRON: .28 MG/DNM3 (54.00 %)
CUM MASS LESS THAN 10.000 MICRON: .35 MG/DNM3 (68.48 %)
CUM MASS LESS THAN 15.850 MICRON: .35 MG/DNM3 (66.97 %)
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

LEAST SQUARES LINE: Y=-1.24 + 2.00X
MASS MEDIAN DIAMETER: 4.145
GEOMETRIC STANDARD DEVIATION: 3.155
CORRELATION COEFFICIENT: .726

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:	ABLE MACHINE CO	Run no:	PBD-1
Sampling location:	Outlet	Date:	7/1/86
Sample type:	Particle size	Start-stop, 24h:	0817-1226
Operator:	GH/JN	Barometric pressure, in. Hg:	29.35
Filter ID:		Static pressure, in. H2O:	1.50
Meter box ID:	PB-11	Stack area, Sq in:	452.39
Y Factor:	.978	Nozzle diameter, in:	.196
Moisture, %:	3.7	Pitot tube, Cp:	.84
Number of sample points:	12	CO2 percent:	0
Sample time, min:	180.00	O2 percent:	20.9
Volume correction, cu-ft:	0		

Sampling time, minutes	Gas meter reading, cfm	Velocity head, in. H2O	Orifice pressure, in. H2O	Stack temp, deg F	Meter temp, deg F Inlet	Outlet	Impactor temp, deg F
0.00	75.4	.32	.35	92	80	80	92
15.00	82.31	.32	.35	93	90	85	93
30.00	85.085	.32	.35	93	100	90	93
45.00	94.14	.32	.35	93	105	94	94
60.00	100.1	.32	.35	94	105	94	94
75.00	106.24	.32	.35	94	105	98	94
90.00	112.37	.32	.35	96	110	100	96
105.00	118.295	.32	.35	97	115	106	97
120.00	124.535	.32	.35	98	110	108	98
135.00	130.53	.32	.35	99	117	109	99
150.00	136.595	.32	.35	99	118	110	99
165.00	143.135	.32	.35	102	119	110	102
180.00	149.276	.32	.35	102	119	111	102
180	70.37e	.32	.35	97	107	100	97

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:ABLE MACHINE CO Run no.:P30-2

TT...	Net time of test,min	180.00
NP...	Net sampling points	12
Y...	Meter calibration factor	.978
DN...	Sampling nozzle diameter,in	.196
CP...	Pitot tube coefficient	.84
PM...	Avg. orifice pressure,in H2O	.35
VM...	Volume of dry gas sampled at meter conditions,cu-ft	72.376
TM...	Avg. gas meter temp.,deg F	103.63
VMSTD...	Volume of dry gas sampled at standard conditions, scf	66.00
BWC...	Percent moisture by volume	3.30
MFI...	Mole fraction of dry gas	.967
PCO2...	Percent CO2 by volume, dry	0
PO2...	Percent O2 by volume, dry	20.9
PN2...	Percent N2 by volume, dry	79.1
MD...	Dry molecular weight	28.84
MS...	Stack gas molecular weight	28.48
PB...	Barometric pressure, in Hg	29.35
SP...	Static pressure, in H2O	1.50
PS...	Stack pressure, in Hg	29.46
TS...	Avg. stack temperature,deg F	96.67
TI...	Avg. impactor temp.,deg F	96.67
VH...	Avg. sqrt of velocity head	.57
VS...	Avg. stack velocity,fps	33.09
IEC...	Percent isokinetic	97.63

INPACTOR VERSION A.0

INPUT DATA

1)PART. DIAMETER: CLASSICAL AERODYNAMIC
2)DATE OF TEST: 7/1/86
3)TIME OF TEST: 0811-1126
4)LOCATION OF TEST: OUTLET
5)TEST NUMBER: 1
6)TEST TYPE: OUTLET
7)RUN NUMBER: P80-1 FILE NAME: T2RP80-1.DT
8)RUN REMARKS:
10)IMPACTOR TYPE: ANDERSEN GENERIC
ANDERSEN II WITH GENERIC CAL.

9)WATER VAPOR: 3.30%
CO2: .03% CO: .00%
O2: 20.90% N2: 75.10%
12) ORIFICE ID (OPTIONAL)
13) SUBSTRATE MATERIAL:

1)GAS METER VOL: 73.375 CUBIC FEET
2)IMPACTOR DELTA P: .04 IN. HG.
3)ORIFICE DELTA P: -.30 INCHES H2O
4)STACK PRESSURE: 1.50 INCHES H2O
5)BAROMETRIC PRES: 29.32 INCHES HG
6)STACK TEMP: 97 DEGREES F
7)METER TEMP: 104 DEGREES F
8)IMPACTOR TEMP: 97 DEGREES F
9)SAMPLE TIME: 120.00 MINUTES
10)AVG GAS VEL: 33.19 FEET/SEC
11)ORIFICE PRES: .00 INCHES HG
12)NOZZLE DIA: .196 INCHES
13)MIN PART DIA: 100.0 MICRONS
14)WATER VOLUME: .0 CC
15)METER FACTOR: .9750

MASS GAIN OF STAGE 1: 4.10 MG
MASS GAIN OF STAGE 2: .20 MG
MASS GAIN OF STAGE 3: .10 MG
MASS GAIN OF STAGE 4: .40 MG
MASS GAIN OF STAGE 5: .30 MG
MASS GAIN OF STAGE 6: .30 MG
MASS GAIN OF STAGE 7: .20 MG
MASS GAIN OF STAGE 8: .40 MG
MASS GAIN OF FILTER: .40 MG

[illegible] GAIN [illegible]: .0
MASS GAIN OF ALUMINUM FILTER: .0

O.F. Nov 8/22/86

********** RESULTS **********

TEST NUMBER: 2 RUN NUMBER: PSD-2

ACTUAL FLOW RATE . .406 CFM
FLOW RATE AT STANDARD CONDITIONS .387 CFM
PERCENT ISOKINETIC 97.598 %
VISCOSITY 184.9E-06 GM/CM SEC
CALCULATED IMPACTOR DELTA P = .24 IN. HG

STAGE	CUNN. CORR.	DP (CLAS AERO)	DP (IMP AERO)	CUM PRES.	RE. NO.	V-ISC UM-M/S
1	1.014	12.049	12.134	35.938	34	4.1
2	1.015	10.642	10.727	32.813	44	6.7
3	1.024	7.097	7.182	27.250	58	7.2
4	1.036	4.746	4.871	25.000	72	7.6
5	1.065	2.641	2.725	20.313	104	8.6
6	1.130	1.229	1.372	15.625	161	10.1
7	1.214	.797	.879	13.500	218	11.4
8	1.408	.431	.511	6.2500	328	10.5

STAGE CUT DIAMETERS BASED ON FILE VALUES OF STAGE CONSTANTS

TOTAL MASS CONCENTRATION = 2.4IE+00 MG/DRY NORMAL CUBIC METER

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)	CUMFR (STDDEV)	CUMFR (PERCENT)	CUM.MASS (MG/DRY N.CU.METER)	DM/DLOGD
.100 - 1.2622	.14	4.63E-02	3.61E-01	
.152 - 2.5077	.57	1.96E-01	1.28E-01	
.251 - 1.0723	1.52	5.27E-12	2.17E-01	
.398 - 1.0129	5.34	1.53E-01	8.50E-01	
.631 - 1.1738	10.14	3.47E-01	8.51E-01	
1.000 - 1.0738	14.17	4.86E-01	4.90E-01	
1.585 - .9521	16.90	5.79E-01	5.15E-01	
2.512 - .8417	20.00	6.85E-01	5.10E-01	
3.981 - .7750	23.12	7.92E-01	6.29E-01	
6.310 - .5402	29.45	1.01E+00	1.29E+00	
10.000 - .3923	34.74	1.19E+00	5.66E-01	
15.850 - .2903	38.59	1.32E+00	3.25E-01	
25.120 - .1114	48.07	1.65E+00	1.81E+00	
39.810 .3812	64.85	2.22E+00	5.45E+00	
63.100 2.4380	99.26	3.40E+00	1.58E+00	
100.00 1000000	100.00	3.43E+00	0.00E+00	
158.50 1000000	100.00	3.43E+00	0.00E+00	
251.20 1000000	100.00	3.43E+00	0.00E+00	
398.10 1000000	100.00	3.43E+00	0.00E+00	
631.00 1000000	100.00	3.43E+00	0.00E+00	

*** [illegible] CONTINUED ***

TEST NUMBER: [illegible] RUN NUMBER: PSD-3

*** INHALABLE PARTICULATE MATTER ***

SUM MASS LESS THAN	1.000 MICRON:	.49 MG/DNM3	(14.17 %)
SUM MASS LESS THAN	2.511 MICRON:	.69 MG/DNM3	(20.00 %)
SUM MASS LESS THAN	10.000 MICRON:	1.19 MG/DNM3	(34.74 %)
SUM MASS LESS THAN	15.850 MICRON:	1.32 MG/DNM3	(38.58 %)

NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE ON CLASSICAL AERODYNAMIC BASIS.

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

CHI SQUARED .1E:	(F=1.16 -	.7AY
MASS MEDIAN DIAMETER:		32.8a9
GEOMETRIC STANDARD DEVIATION:		20.5aa
CORRELATION COEFFICIENT:		.977

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:	ABLE MACHINE CO	Run no:	PSD-3
Sampling Location:	Outlet	Date:	7/2/86
Sample type:	Particle size	Start-stop. 24h:	0836-1202
Operator:	GH/JN	Barometric pressure.in.Hg:	29.35
Filter ID:		Static pressure.in.H2O:	1.50
Meter box ID:	FB-11	Stack area.Sq in:	452.39
Y Factor:	.978	Nozzle diameter.in:	.196
Moisture, %:	3.3	Pitot tube.Cp:	.84
Number of sample points:	12	CO2 percent:	0
Sample time, min:	180.00	O2 percent:	20.9
Volume correction, cu-ft:	0		

Sampling time, minutes	Gas meter reading,cfm	Velocity head, in. H2O	Orifice pressure, in. H2O	Stack temp, deg F	Meter temp, deg F Inlet	Meter temp, deg F Outlet	Impactor temp, deg F
0.00	149.338	.34	.35	99	90	84	99
15.00	155.64	.34	.35	99	98	89	99
30.00	161.805	.34	.35	99	103	91	99
45.00	167.885	.34	.35	99	106	96	99
60.00	174.11	.34	.35	100	110	100	100
75.00	180.475	.34	.35	100	113	104	100
90.00	186.8	.34	.35	100	112	105	100
105.00	193.135	.34	.35	100	114	106	100
120.00	199.795	.34	.35	100	116	107	100
135.00	206.24	.34	.35	100	117	108	101
150.00	212.635	.34	.35	101	119	110	101
165.00	219.015	.34	.35	101	119	110	101
180.00	225.333	.34	.35	101	119	110	101
180	75.998	.34	.35	100	110	101	100

J Fiori
8/15

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:ABLE MACHINE CO Run no.: PSD-2

TT...	Net time of test,min	180.00
NP...	Net sampling points	12
Y...	Meter calibration factor	.978
DN...	Sampling nozzle diameter,in	.196
CP...	Pitot tube coefficient	.84
PM...	Avg. orifice pressure,in H2O	.35
VM...	Volume of dry gas sampled at meter conditions,cu-ft	75.995
TM...	Avg. gas meter temp..deg F	105.21
VMSTD...	Volume of dry gas sampled at standard conditions, scf	68.17
BWC...	Percent moisture by volume	3.30
MFL...	Mole fraction of dry gas	.967
PCO2...	Percent CO2 by volume, dry	0
PO2...	Percent O2 by volume, dry	20.9
PN2...	Percent N2 by volume, dry	79.1
MD...	Dry molecular weight	28.84
MS...	Stack gas molecular weight	28.48
PB...	Barometric pressure, in Hg	29.32
SP...	Static pressure, in H2O	1.50
PS...	Stack pressure, in Hg	29.46
TS...	Avg. stack temperature,deg F	99.92
TI...	Avg. impactor temp..deg F	99.92
VH...	Avg. Sqrt of velocity head	.58
VS...	Avg. stack velocity,fps	34.31
ISI...	Percent isokinetic	98.10

**********IMPACTOR VERSION 4.0**********

********** INPUT DATA **********

1)PART. DIAMETER CLASSICAL AERODYNAMI
2)DATE OF TEST: 7/2/86
3)TIME OF TEST: 0826-1202
4)LOCATION OF TEST: OUTLET
5 TEST NUMBER 3
6)TEST TYPE OUTLET
7)RUN NUMBER: PSD-3 FILE NAME:T3PPSD-3.DT
8)RUN REMARKS:
10)IMPACTOR TYPE: ANDERSEN GENERIC
ANDERSEN I WITH GENERIC CAL.

9)WATER VAPOR 3.30%
CO2 .00% CO .00%
O2 20.90% N2 79.10%
12. ORIFICE ID (OPTIONAL):
13. SUBSTRATE MATERIAL:

1)GAS METER VOL 75.999 CUBIC FEET
2)IMPACTOR DELTA P .00 IN. HG.
3)ORIFICE DELTA P -.38 INCHES H2O
4)STACK PRESSURE 1.50 INCHES H2O
5)BAROMETRIC PRES 29.38 INCHES HG
6)STACK TEMP 100 DEGREES F
7)METER TEMP 105 DEGREES F
8)IMPACTOR TEMP 100 DEGREES F
9)SAMPLE TIME 180.00 MINUTES
10)AVG GAS VEL 24.11 FEET/SEC
11)ORIFICE PRES .00 INCHES HG
12)NOZZLE DIA .196 INCHES
13)MAX PART DIA 100.0 MICRONS
14)METER VOLUME .0 DCF
15)METER FACTOR .9720

MASS GAIN OF STAGE 1 5.00 MG
MASS GAIN OF STAGE 2 .20 MG
MASS GAIN OF STAGE 3 .00 MG
MASS GAIN OF STAGE 4 .40 MG
MASS GAIN OF STAGE 5 .30 MG
MASS GAIN OF STAGE 6 .30 MG
MASS GAIN OF STAGE 7 .20 MG
MASS GAIN OF STAGE 8 .00 MG
MASS GAIN OF FILTER .20 MG

MASS GAIN OF BLANK SUBSTRATE .00
MASS GAIN OF BLANK FILTER .00

J. Fiori 8/22/86

********** RESULTS **********

TEST NUMBER: 1 RUN NUMBER: PSD-5

ACTUAL FLOW RATE .422 CFM
FLOW RATE AT STANDARD CONDITIONS .379 CFM
PERCENT ISOKINETIC 95.125 %
VISCOSITY 185.6E-06GM/CM SEC
CALCULATED IMPACTOR DELTA P = .26 IN. HG

STAGE	CUM. CORR.	DP (CLAS AERO)	DP (IMP AERO)	CUM FREQ.	RE. NO.	V*D50 UM-M/S
1	1.018	11.839	11.935	26.481	75	4.1
2	1.018	10.456	10.542	23.541	45	6.4
3	1.035	7.972	7.058	23.526	60	7.5
4	1.077	4.663	4.748	17.545	72	7.8
5	1.131	1.593	1.678	13.232	107	8.8
6	1.176	1.255	1.349	10.292	166	10.3
7	1.221	.782	.864	7.3519	224	11.6
8	1.427	.421	.502	2.9407	272	10.5

STAGE CUT DIAMETERS BASED ON FILE VALUES OF STAGE CONSTANTS

TOTAL MASS CONCENTRATION = 3.53E+00 MG/DRY NORMAL CUBIC METER

SPLINE FIT OF CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)	DUMFR (STDDEV	CUMFR (PERCENT)	CUM.MASS (MG/DRY N.CU.METER)	DM/DLOGD
.100	- 3.4417	.03	1.02E-03	3.74E-03
.158	- 1.9448	.16	5.71E-03	4.57E-02
.250	- 1.4481	.72	1.30E-02	1.74E-01
.392	- 1.0513	2.55	8.98E-02	5.20E-01
.621	- 1.5854	5.67	1.00E-01	4.35E-01
1.000	- 1.0054	9.02	3.18E-01	4.90E-01
1.585	- 1.1120	11.37	3.97E-01	2.28E-01
2.512	+ 1.1220	12.09	4.61E-01	3.50E-01
3.981	- .8970	15.95	5.61E-01	7.43E-01
6.310	- .7668	22.16	7.80E-01	1.21E+00
10.000	- .6408	26.08	9.18E-01	2.58E-01
15.851	- .5737	28.51	9.97E-01	5.75E-01
25.120	- .4229	33.65	1.18E+00	1.54E+00
39.810	.0440	51.76	1.82E+00	5.85E+00
63.100	1.0778	98.11	3.45E+00	3.64E+00
100.00	10.0000	100.01	3.52E+00	0.00E+00
158.51	100.0000	100.01	3.52E+00	0.00E+00
251.20	1000.0000	100.01	3.52E+00	0.00E+00
398.11	10000.0000	100.01	3.52E+00	0.00E+00
631.00	100000.0000	100.01	3.52E+00	0.00E+00

**** RESULTS CONTINUED ****

TEST NUMBER: 3 RUN NUMBER: PSD-2

*** INHALABLE PARTICULATE MATTER ***

CUM MASS LESS THAN 1.000 MICRON: .32 MG/DNM3 (9.12 %)
CUM MASS LESS THAN 2.512 MICRON: .46 MG/DNM3 (13.19 %)
CUM MASS LESS THAN 10.000 MICRON: .92 MG/DNM3 (26.08 %)
CUM MASS LESS THAN 15.850 MICRON: 1.00 MG/DNM3 (28.31 %)
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

LEAST SQUARES LINE: Y=-1.45 + .82X
MASS MEDIAN DIAMETER: 58.86
GEOMETRIC STANDARD DEVIATION: 14.545
CORRELATION COEFFICIENT: .965

APPENDIX B

FIELD DATA SHEETS

ONSITE EQUIPMENT AUDITS AND PRELIMINARY DATA

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

Plant ABLE MANUFACTURING

Date 6/26/86

Sampling location INLET

Inside of far wall to outside of nipple ~~[illegible]~~ 19½"

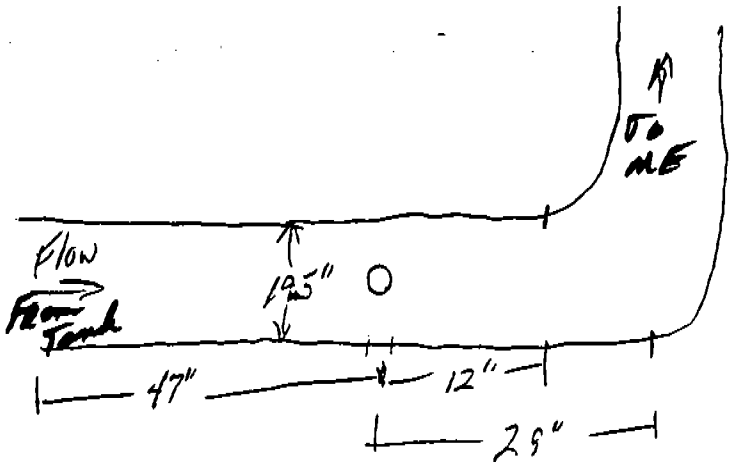
Inside of near wall to outside of nipple (nipple length) 1/8"

Stack I.D. 19.5

Nearest upstream disturbance 12" / 7.6 dd

Nearest downstream disturbance 47" / 2.4 dd

Calculated by DS/CD



SCHEMATIC OF SAMPLING LOCATION

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	NIPPLE LENGTH	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	.021	19½"	.41	NA	.5 = ½"
2	.067		1.31		1 5/16"
3	.118		2.30		2 5/16"
4	.177		3.45		3½"
5	.250		4.88		4 7/8"
6	.356		6.94		6 7/8"
7	.644		12.56		12½"
8	.753		14.63		14 5/8"
9	.823		16.05		16"
10	.892		17.4		17 3/16"
11	.933		18.19		18 3/16"
12	.979		19.1		19 1/8"

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

Plant ABIE Machine Co.

Date 6/26/86

Sampling location ME OUTLET

Inside of far wall to outside of nipple 24 1/4"

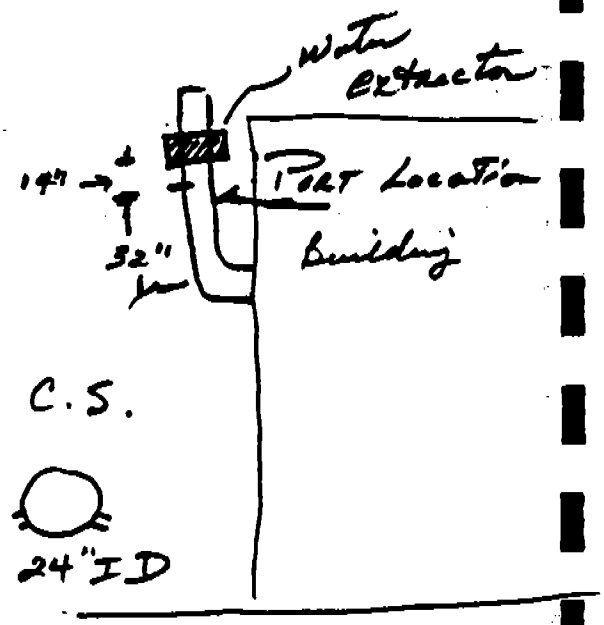
Inside of near wall to outside of nipple (nipple length) 1/4"

Stack I.D. 24

Nearest upstream disturbance 14" dd = .58

Nearest downstream disturbance 32" dd = 1.33

Calculated by CB



SCHEMATIC OF SAMPLING LOCATION

NA

TRAVERSE POINT NUMBER	FRACTION OF STACK I.D.	STACK I.D.	PRODUCT OF COLUMNS 2 AND 3 (TO NEAREST 1/8 INCH)	NIPPLE LENGTH	TRAVERSE POINT LOCATION FROM OUTSIDE OF NIPPLE (SUM OF COLUMNS 4 & 5)
1	.021	24	.504	[redacted]"	1/2"
2	.067		1.61		1 3/5"
3	.118		2.83		2 7/8"
4	.177		4.25		4 1/4"
5	.250		6.0		6"
6	.356		8.54		8 1/2"
7	.644		15.46		15 1/2"
8	.750		~~12.0~~ 18		~~12"~~ 18" JP/6-26-86
9	.823		19.75		19 3/4"
10	.882		21.17		21 1/8"
11	.933		22.39		22 3/8"
12	.979		23.5		23 1/2"

GAS VELOCITY AND VOLUMETRIC FLOW RATE

Plant and City ABG MACHINE CO Date _____

Sampling Location ME OUTLET Clock Time 9:07

Run No. PV-1 Operator G. Howard / Jony Neese

Barometric Pressure, in.Hg 29.29 Static Pressure, in.H_2O +1.50

Moisture, % 2 Molecular wt., Dry 29 Pitot Tube, Cp .84

Stack Dimension, in. Diameter or Side 1 24 Side 2 _____

FIELD DATA

TRAVERSE POINT NUMBER	VELOCITY HEAD (ΔP_s), in.H_2O	STACK TEMP., °F
ES 1	.46	92
2	.47	92
3	.42	91
4	.38	91
5	.32*	91
6	.30	91
7	.23	91
8	.27	91
9	.34	91
10	.41	91
11	.45	91
12	.42	91
W 1	.57	91
2	.54	91
3	.54	91
4	.53	91
5	.48	91
6	.40*	91
7	.15	91
8	.11	91
9	.09	91
10	.10	91
11	.08	91
12	.08	91
	$\bar{x}$ = .339	$\bar{x}$ = 91.1

* - impactor sample pts.

CALCULATIONS

$M_s = Mo \times (1 - \frac{H_2O}{100}) + 18 (\frac{H_2O}{100})$

$M_s = (\quad) \times (1 - \frac{\quad}{100}) + 18 (\frac{\quad}{100})$

$M_s =$

$T_s =$ °F = °R = (°F + 460)

$P_s = P_b + \frac{S.P.}{13.6} = (\quad) + \frac{\quad}{13.6}$

$P_s =$ in.Hg

$C_p =$

$V_s = 85.49 \times Cp \times \sqrt{\Delta P} \times \sqrt{\frac{T_s, °F}{P_s \times M_s}}$

$V_s = 85.49 \times (\quad) \times (\quad) \times \sqrt{\frac{\quad}{x}}$

$V_s =$ ft/s

$A_s =$ ft²

$Q_s = V_s \times A_s \times \frac{60\ s}{m}$

$Q_s =$ x x 60

$\bar{x} = 8.25$

$Q_s =$ acfm

$Q_{s_{std}} = Q_s \times 17.647 \times \frac{P_s}{T_s} \times (1 - \frac{H_2O\ \%}{100})$

$Q_{s_{std}} =$ x 17.647 x $\frac{\quad}{\quad}$ x $(1 - \frac{\quad}{100})$

$Q_{s_{std}} =$ dscfm

GAS VELOCITY AND VOLUMETRIC FLOW RATE

Plant and City ABLE MACHINE / GREENVILLE Date 6/30/86

Sampling Location INLET Clock Time 1030 -

Run No. V-1 Operator DB / CB

Barometric Pressure, in.Hg 29.3 Static Pressure, in.H_2O -1.9

Moisture, % 2 Molecular wt., Dry 29 Pitot Tube, Cp .84

Stack Dimension, in. Diameter or Side 1 19.5" Side 2 _____

FIELD DATA

TRAVERSE POINT NUMBER		VELOCITY HEAD (ΔP_s), in.H_2O	STACK TEMP., °F
V	1	.85	90
	2	1.05	
	3	.45	
	4	.60	
	5	.54	
	6	.45	
	7	.35	
	8	.60	
	9	.84	
	10	.70	
	11	.78	
	12	.80	
H	1	.85	
	2	.89	
	3	.89	
	4	.84	
	5	.84	
	6	.68	
	7	.50	
	8	.47	
	9	.46	
	10	.48	
	11	.51	
	12	.50	
		$\overline{\Delta P}$ = .69	$\overline{T_s}$ = 90

CALCULATIONS

$$M_s = Mo \times \left(1 - \frac{H_2O}{100}\right) + 18\left(\frac{H_2O}{100}\right)$$

$$M_s = (\quad) \times \left(1 - \frac{\quad}{100}\right) + 18\left(\frac{\quad}{100}\right)$$

M_s =

T_s = °F = °R = (°F + 460)

$$P_s = P_b + \frac{S.P.}{13.6} = (\quad) + \frac{\quad}{13.6}$$

P_s = in.Hg

$\sqrt{\overline{\Delta P}}$ =

$$V_s = 85.49 \times Cp \times \sqrt{\Delta P} \times \sqrt{\frac{T_s, °R}{P_s \times P_s}}$$

$$V_s = 85.49 \times (\quad) \times (\quad) \times \sqrt{\quad}$$

V_s = ft/s

A_s = ft²

$$Q_s = V_s \times A_s \times \frac{60\ s}{m}$$

Q_s = x x 60

Q_s = acfm

$$Q_{s_{std}} = Q_s \times 17.647 \times \frac{P_s}{T_s} \times \left(1 - \frac{H_2O\ \%}{100}\right)$$

$$Q_{s_{std}} = \quad \times 17.647 \times \frac{\quad}{\quad} \times \left(1 - \frac{\quad}{100}\right)$$

$Q_{s_{std}}$ = dscfm

FIELD AUDIT REPORT: DRY GAS METER BY CRITICAL ORIFICE

DATE: 6-30-86 CLIENT: EPA-EMB

BAROMETRIC PRESSURE (P_{bar}): 29.29 in.Hg METER BOX NO. EB-3

ORIFICE NO. 3 PRETEST Y: .977 ΔH@ 1.86 in.H_2O

ORIFICE K FACTOR: 5.377×10^{-4} AUDITOR: G. Howard

Orifice manometer reading ΔH, in.H_2O	Dry gas meter reading V_i/V_f, ft³	Temperatures: Ambient T_{ai}/T_{af}, °F	Ambient Average T_a, °F	Dry gas meter Inlet T_{ii}/T_{if}, °F	Dry gas meter Outlet T_{oi}/T_{of}, °F	Dry gas meter Average T_m, °F	Duration of run Ø min.
2.4	156.000	83	83.5	94	82	89	11 03.30 / 60 / 11.055
	166.000	84		96	84		

Dry gas meter V_m, ft³	$V_{m_{std}}$, ft³	$V_{m_{act}}$, ft³	Audit, Y	Y deviation, %	Audit ΔH@, in.H_2O	ΔH@ Deviation, in.H_2O
10.0	9.47 (5194.948)	8.984	.948	-3.1	1.92	0.06 (A)

$$V_{m_{std}} = \frac{17.647(V_m)(P_{bar} + \Delta H/13.6)}{(T_m + 460)} = 9.472 \text{ ft}^3$$

(29.466; 549)

$$V_{m_{act}} = \frac{1203(\text{Ø})(K)(P_{bar})}{(T_a + 460)^{1/2}} = 8.984 \text{ ft}^3$$

8.984; 23.3131

$$\text{Audit Y} = \frac{V_{m_{act}}}{V_{m_{std}}} = .948 \qquad \text{Y deviation} = \frac{\text{Audit Y} - \text{Pre-test Y}}{\text{Audit Y}} \times 100 = \text{~~1.92~~}$$

$$\text{Audit } \Delta H@ = (0.0317)(\Delta H)(P_{bar})(T_m + 460)\left[\frac{\text{Ø}}{Y\,(V_m)(P_{bar} + \Delta H/13.6)}\right]^2 = 1.92 \text{ in.}H_2O$$

Audit Y must be in the range, pre-test Y ±0.05 Y.
Audit ΔH@ must be in the range pre-test ΔH@ ±0.15 inches H_2O.

FIELD AUDIT REPORT: DRY GAS METER BY CRITICAL ORIFICE

DATE: 6/30/86 CLIENT: EPA-EMB

BAROMETRIC PRESSURE (P_{bar}): ____ in.Hg METER BOX NO. EB-11

ORIFICE NO. ____ PRETEST Y: .978 ΔH@ 1.16 in.H_2O

ORIFICE K FACTOR: 5.377×10^{-4} AUDITOR: G Howard

Orifice manometer reading ΔH, in.H_2O	Dry gas meter reading V_i/V_f, ft³	Temperatures: Ambient T_{ai}/T_{af}, °F	Ambient Average T_a, °F	Dry gas meter Inlet T_{ii}/T_{if}, °F	Dry gas meter Outlet T_{oi}/T_{of}, °F	Dry gas meter Average T_m, °F	Duration of run Ø, min.
1.40	982.000	86	86	97	86	94.25	13 25.90/6
	994.800	86	546	102	92	554.25	13.43

Dry gas meter V_m, ft³	$V_{m_{std}}$, ft³	$V_{m_{act}}$, ft³	Audit, Y	Y deviation, %	Audit ΔH@, in.H_2O	ΔH@ Deviation, in.H_2O
11.8	11.04	10.89	.986	-.81	1.11	-05 ✓

$$V_{m_{std}} = \frac{17.647(V_m)(P_{bar} + \Delta H/13.6)}{(T_m + 460)} \quad \begin{matrix} 29.39 \\ 554.25 \end{matrix} = 11.04 \text{ ft}^3$$

$$V_{m_{act}} = \frac{1203(\text{Ø})(K)(P_{bar})}{(T_a + 460)^{1/2}} \quad 23.366 = 10.89 \text{ ft}^3$$

$$\text{Audit Y} = \frac{V_{m_{act}}}{V_{m_{std}}} = .986 \qquad \text{Y deviation} = \frac{\text{Audit Y - Pre-test Y}}{\text{Audit Y}} \times 100 =$$

$$\text{Audit } \Delta H@ = (0.0317)(\Delta H)(P_{bar})(T_m + 460)\left[\frac{\text{Ø}}{Y\,(V_m)(P_{bar} + \Delta H/13.6)}\right]^2 = 1.11 \text{ in.}H_2O$$

Audit Y must be in the range, pre-test Y ±0.05 Y.
Audit ΔH@ must be in the range pre-test ΔH@ ±0.15 inches H_2O.

FIELD AUDIT REPORT: DRY GAS METER BY CRITICAL ORIFICE

DATE: 6/30/86 CLIENT: ABLE MACHINE

BAROMETRIC PRESSURE (P_{bar}): 29.3 in.Hg METER BOX NO. FB-9

ORIFICE NO. 8 PRETEST Y: .986 ΔH@ 2.04 in.H_2O

ORIFICE K FACTOR: 4.726×10^{-4} AUDITOR: D Scheffel

Orifice manometer reading ΔH, in.H_2O	Dry gas meter reading V_i/V_f, ft³	Temperatures: Ambient T_{ai}/T_{af}, °F	Ambient Average T_a, °F	Dry gas meter Inlet T_{ii}/T_{if}, °F	Dry gas meter Outlet T_{oi}/T_{of}, °F	Dry gas meter Average T_m, °F	Duration of run Ø min.
1.95	15.660	92	93.5	98	90	95.5	18 (1207–1225)
	29.845	95		100	94		

Dry gas meter V_m, ft³	$V_{m_{std}}$, ft³	$V_{m_{act}}$, ft³	Audit Y	Y deviation, %	Audit ΔH@, in.H_2O	ΔH@ Deviation, in.H_2O
14.185	13.269	12.742	.960	-2.7 ✓	2.03	-.01 ✓

$$V_{m_{std}} = \frac{17.647(V_m)(P_{bar} + \Delta H/13.6)}{(T_m + 460)} \quad \text{(29.93, 555.5)} = 13.269 \text{ ft}^3$$

$$V_{m_{act}} = \frac{1203(\text{Ø})(K)(P_{bar})^{1/2}}{(T_a + 460)} \quad \text{(18, } 4.726\times10^{-4}\text{, 29.3, 23.527)} = 12.942 \text{ ft}^3$$

$$\text{Audit Y} = \frac{V_{m_{act}}}{V_{m_{std}}} = .960 \qquad \text{Y deviation} = \frac{\text{Audit Y} - \text{Pre-test Y}}{\text{Audit Y}} \times 100 = -2.7$$

$$\text{Audit } \Delta H@ = (0.0317)(\Delta H)(P_{bar})(T_m + 460)\left[\frac{\text{Ø}}{Y\,(V_m)(P_{bar} + \Delta H/13.6)}\right]^2 = 2.03 \text{ in.}H_2O$$

Audit Y must be in the range, pre-test Y ±0.05 Y.
Audit ΔH@ must be in the range pre-test ΔH@ ±0.15 inches H_2O.

FIELD AUDIT REPORT: DRY GAS METER BY CRITICAL ORIFICE

DATE: 6/30/86 CLIENT: ABLE MACHINE

BAROMETRIC PRESSURE (P_{bar}): 29.3 in.Hg METER BOX NO. FT 1

ORIFICE NO. 8 PRETEST Y: .981 ΔH@ 1.83 in.H_2O

ORIFICE K FACTOR: 4.725×10^{-4} AUDITOR: D. Scheffel

Orifice manometer reading ΔH, in.H_2O	Dry gas meter reading V_i/V_f, ft³	Temperatures: Ambient T_{ai}/T_{af}, °F	Ambient Average T_a, °F	Dry gas meter Inlet T_{ii}/T_{if}, °F	Dry gas meter Outlet T_{oi}/T_{of}, °F	Dry gas meter Average T_m, °F	Duration of run Ø min.
1.8	316.600	85	86	73	86	90.5	18
	330.470	87		95	88		

Dry gas meter V_m, ft³	$V_{m_{std}}$, ft³	$V_{m_{act}}$, ft³	Audit Y	Y deviation, %	Audit ΔH@, in.H_2O	ΔH@ Deviation, in.H_2O
13.87	13.085	12.829	.980	-.005 ✓	1.86	-.03 ✓

$$V_{m_{std}} = \frac{17.647(V_m)(P_{bar} + \Delta H/13.6)}{(T_m + 460)} = \frac{17.647(13.87)(29.43 + 1.8/13.6)}{550.5} = 13.085 \text{ ft}^3$$

$$V_{m_{act}} = \frac{1203(\text{Ø})(K)(P_{bar})^{1/2}}{(T_a + 460)} = \frac{1203(18)(4.725\times10^{-4})(29.3)^{1/2}}{23.367} = 12.829 \text{ ft}^3$$

$$\text{Audit Y} = \frac{V_{m_{act}}}{V_{m_{std}}} = .980 \qquad \text{Y deviation} = \frac{\text{Audit Y} - \text{Pre-test Y}}{\text{Audit Y}} \times 100 = -.005$$

$$\text{Audit } \Delta H@ = (0.0317)(\Delta H)(P_{bar})(T_m + 460)\left[\frac{\text{Ø}}{Y\,(V_m)(P_{bar} + \Delta H/13.6)}\right]^2 = \frac{18}{.981\,(13.87)(29.43 + 1.8/13.6)}\Bigg]^2 = 1.86 \text{ in.}H_2O$$

Audit Y must be in the range, pre-test Y ±0.05 Y.
Audit ΔH@ must be in the range pre-test ΔH@ ±0.15 inches H_2O.

4.279

THERMOCOUPLE DIGITAL INDICATOR
AUDIT DATA SHEET

Date 6-30-86 Indicator No. 219 Operator G. Howard

Test Point No.	Millivolt signal*	Equivalent temperature, °F*	Digital indicator temperature reading, °F	Difference, %
1		0	0	0
2		100	100	0
3		200	203	
4		500	500	0

Percent difference must be less than or equal to 0.5%.

Percent difference:

$$\frac{(\text{Equivalent temperature } °R - \text{Digital indicator temperature reading } °R)(100\%)}{(\text{Equivalent temperature } °R)}$$

Where °R = °F + 460°F

* These values are to be obtained from the calibration data sheet for the calibration device.

Cr^{+6}/Cr FIELD DATA SHEETS

[redacted] EM[redacted]ION[redacted]ST[redacted] F1[redacted] DA[redacted]

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
ABGIE MACHINING / GREENVILLE	6/30/86	INLET	CB

RUN NO.	OPERATOR	AMB. TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS. (IN. H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
MGI-1	DS	90	28.81	-.75		18.5	.84		1 OF 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (%)	SAMPLE BOX NO	METER BOX NO	METER ΔH@	METER CAL. FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
3 FT PYREX	.250		2	N/A	2B	1.881	.981	6	.009	4.299		250			7.5

Imp I-1
Therm #103
Pitot #016 + ✓ - ✓

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F
	0	1207	334.233								N/A	
1	7.5	1214.5	341.350	.65	2.80	2.80	90	90	91	2.		62
2	15.		349.400	.80	3.44	3.44	91	96	90	2.		65
3	22.5		357.300	.82	3.56	3.56	91	103	92	2.5		67
4	30.		365.200	.86	3.50	3.50	92	108	93	3.		67
5	37.5		373.550	.88	3.84	3.84	93	110	93	3.		68
6	45.		381.750	.84	3.68	3.68	94	113	95	3.		68
7	52.5		388.550	.55	2.41	2.41	93	114	97	2.		68
8	60.		395.100	.53	2.32	2.32	95	113	97	2.		68
9	67.5		401.150	.56	2.46	2.46	95	114	101	2.		67
10	75.		409.140	.62	2.73	2.73	95	115	100	2.		67
11	82.5		416.570	.67	2.94	2.94	97	116	100	3.		68
* 12	90.	1337	424.087	.68	3.00	3.00	96	116	102	3.		68
1	97.5		432.000	.75	3.25	3.25	94	98	98	3.		69
2	105.		436.700	.63	2.23	2.23	94	101	98	3.		68
3	112.5		446.700	.70	3.04	3.04	94	102	97	3.		67
4	120.		454.100	.68	2.93	2.93	93	108	97	3.		68
5	127.5		461.100	.60	2.63	2.63	95	112	100	3.		67
6	135.		468.400	.55	2.41	2.41	96	118	100	3.		67
7	142.5		475.610	.75	3.21	3.29	96	114	102	3.		68
8	150.		483.850	.85	3.74	3.74	95	116	100	3.		68
9	157.5		491.900	.80	3.52	3.52	94	115	101	3.		67
10	165.		499.800	.75	3.32	3.32	92	116	102	3.		67
11	172.5		507.400	.78	3.46	3.46	92	115	102	3.		67
12	180.	1609.	515.935	.78	3.45	3.45	92	114	102	3.		67

STAT -1.1 -1.7 -1.9 -2.

START @ 1439 2nd PORT

* Between Port LEAK Check (424.232 - 424.087)

Cr+6/TOTAL Cr SAMPLE RECOVERY AND INTEGRITY DATA SHEET

Plant Able Machine Co. Sample date 6/30/86

Sample location ME INLET Recovery date 6/30/86

Run number MEI-1 Recovered by CB

Filter number(s) NA

MOISTURE

Impingers	#1	#2	#3	Silica gel #4	
Final volume (wt)	618.5	620.5	(604.1) ml(g)	Final wt	858.6 g
Initial volume (wt)	584.0	601.4	598.3 ml(g)	Initial wt	815.9 g
Net volume (wt)	34.5	22.1	5.8 ml(g)	Net wt	42.7 g

Description of impinger water slightly yellow

90 % spent

Total moisture 105.1 g

RECOVERED SAMPLE

Filter container number(s) N/A Sealed —

Description of particulate on filter —

Probe rinse container no.	NA	Liquid level marked	—
____ blank container no.	NA	Liquid level marked	—
Impinger contents container no.	4701-A	Liquid level marked	✓
____ blank container no.	4703-A	Liquid level marked	✓

Samples stored and locked

Remarks

LABORATORY CUSTODY

Received by L Cottrell Date 7/31/86

Remarks

Figure 3-6. Particulate sample recovery and integrity data sheet.

[redacted] PLANT & CITY: ARGE MACHINING — DATE: 10/1/86 — [redacted] SAMPLE [redacted] TION [redacted] — [redacted] SAMP [redacted] — CR

RUN NO.	OPERATOR	AMB. TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS (IN. H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
MET-1	D. Richards	85	29.30	-1.9		1.95	.82		0 F

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (f)	SAMPLE BOX NO.	METER BOX NO.	METER Δ H @	METER CAL FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. Δ P	RECORD DATA MINS
6 FT. STAINLESS	.253		2		1	1.63	.981	7	.0000	.843			A	A	60

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F
	0	0816	516.142									
(1) V 1	5.		521.100	.75	3.22	3.22	81	80	80	4.	—	68
2	10.		526.600	.85	3.66	3.66	84	83	81	4.5		68
3	15.		531.600	.73	3.14	3.14	84	88	82	4.		68
4	20.		536.700	.75	3.25	3.25	84	92	84	4.		68
5	25.		541.700	.73	3.15	3.15	86	95	83	4.		68
6	30.		546.800	.75	3.25	3.25	86	97	84	4.		68
7	35.		551.730	.60	2.61	2.61	87	100	85	4.		68
8	40.		556.800	.80	3.50	3.50	87	102	87	4.5		63
9	45.		562.400	.83	3.61	3.61	88	103	86	4.5		62
10	50.		567.870	.90	3.93	3.93	88	105	88	5.		65
11	55.		573.800	1.00	4.38	4.38	88	106	90	5.		67
(2) 12	60.	0916	579.987	1.10	4.83	4.83	88	108	91	5.5		67
H 1	65.	0940	585.200	.75	3.24	3.24	91	94	91	4.		67
2	70.		590.500	.80	3.46	3.46	91	98	91	4.		65
3	75.		596.100	.85	3.68	3.68	93	102	92	4.		66
4	80.		601.200	.80	3.47	3.47	94	105	93	4.		64
5	85.		606.900	.90	3.92	3.92	93	107	93	5.		64
6	90.	1005	612.701	.98	4.28	4.28	93	110	94	5.		65
(3) 7	95.	1118	617.350	.63	2.76	2.76	93	111	95	4.		59
8	100.		622.01	.62	2.66	2.66	95	94	93	4.		59
9	105.		626.80	.65	2.79	2.79	95	97	93	4.		59
10	110.		631.70	.70	3.02	3.02	95	102	93	4.		59
11	115.		636.90	.75	3.24	3.24	96	105	94	4.		40
12	120.	1143	642.150	.77	3.34	3.34	96	108	95	4.		

(1) IN VERTICAL PORT - PITOT line (Mg. leg) CONSTANTLY filling with process fluid.

Cr^{+6}/TOTAL Cr SAMPLE RECOVERY AND INTEGRITY DATA SHEET

Plant Able Machine Co. Sample date 7/1/86
Sample location ME INLET Recovery date 7/1/86
Run number MEI-2 Recovered by CS
Filter number(s) NA

MOISTURE

Impingers	#1	#2	#3	
Final volume (wt)	616.5	624.1	592.3	ml(g)
Initial volume (wt)	587.7	615.5	592.4	ml(g)
Net volume (wt)	28.8	8.6	0.9	ml(g)

Silica gel
Final wt 835.0 g
Initial wt 804.1 g
Net wt 30.9 g
45 % spent

Description of impinger water Yellowish tint

Total moisture 69.2 g

RECOVERED SAMPLE

Filter container number(s) NA Sealed —
Description of particulate on filter

Probe rinse container no. NA Liquid level marked
____ blank container no. NA Liquid level marked
Impinger contents container no. 4708-A Liquid level marked ✓
NaOH blank container no. 4703-A Liquid level marked ✓
Samples stored and locked ✓
Remarks

LABORATORY CUSTODY

Received by L Rotzoll Date 7/3/86
Remarks

Figure 3-6. Particulate sample recovery and integrity data sheet.

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
ABLE MACHINE / GABANKVILLE	7/1/86	INLET	CR

RUN NO.	OPERATOR	AMB. TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS (IN. H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
MET-3	D. Schaefer	90	29.86	-1.7		185	.84		1 OF 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (%)	SAMPLE BOX NO.	METER BOX NO.	METER ΔH@	METER CAL. FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
8 FT GLASS	.253		2		FT 1	1.83	.984		.000			250			5

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	STATIC	IMPINGER TEMPERATURE °F
	0	1200	642.337									
F 1	5.		646.99	.67	2.89	2.89	98	102	97	4.	-1.5	68
2	10.		652.0	.65	2.80	2.80	99	104	96	3.5	-1.5	65
3	15.		657.10	.72	3.12	3.12	98	108	97	3.5	-1.4	64
4	20.		662.33	.75	3.26	3.26	99	111	98	3.5	-1.7	64
5	25.		667.90	.90	3.92	3.92	98	113	98	4.0	-1.8	65
6	30.		673.40	.85	3.71	3.71	99	114	99	4.	-1.8	65
7	35.		677.90	.55	2.40	2.40	99	115	100	3.	-1.8	65
8	40.		682.60	.56	2.45	2.45	98	115	100	3.	-1.7	66
9	45.		687.13	.60	2.63	2.63	99	117	101	3.	-1.6	66
10	50.		692.00	.65	2.84	2.84	99	117	101	3.5	-1.7	66
11	55.		696.94	.66	2.90	2.90	98	117	102	3.5	-1.7	65
① 12	60.	1300	701.880	.67	2.94	2.94	98	117	102	3.5	-1.7	65
√ 1	65.		707.100	.75	3.27	3.27	93	99	100	4.	-1.2	65
2	70.		712.400	.80	3.46	3.46	96	102	99	4.	-1.2	65
3	75.		717.800	.80	3.48	3.48	96	106	99	4.	-1.7	65
4	80.		722.600	.65	2.83	2.83	97	110	99	3.5	-1.6	66
5	85.		727.500	.60	2.62	2.62	96	111	99	3.5	-1.6	66
6	90.		731.99	.60	2.62	2.62	96	111	99	3.	-1.6	66
7	95.		737.230	.75	3.29	3.29	96	113	100	3.5	-1.6	66
8	100.		742.850	.88	3.86	3.86	96	115	100	4.	-1.9	67
9	105.		748.660	.91	4.00	4.00	96	117	101	4.	-1.9	66
10	110.		754.200	.85	3.74	3.74	96	118	101	4.	-1.9	66
11	115.		759.990	.91	4.01	4.01	96	118	102	4.	-1.9	66
12	120.	1510	765.75	.96	4.22	4.22	97	118	103	4.	-1.9	67

① PORT CHANGE LEAK CHECK (701.969 - 701.880) RESTARTED @ 1410

Cr^{+6}/TOTAL Cr SAMPLE RECOVERY AND INTEGRITY DATA SHEET

Plant Able Machine Co. Sample date 7/1/86

Sample location ME Inlet Recovery date 7/1/86

Run number MEI-3 Recovered by CB

Filter number(s) NA

MOISTURE

Impingers	#1	#2	#3	
Final volume (wt)	619.1	608.4	582.8	ml(g)
Initial volume (wt)	593.6	599.6	582.4	ml(g)
Net volume (wt)	25.5	8.8	0.4	ml(g)

Description of impinger water Yellowish tint

Silica gel

Final wt 838.0 g

Initial wt 807.0 g

Net wt 31.0 g

45 % spent

Total moisture 65.7 g

RECOVERED SAMPLE

Filter container number(s) NA Sealed

Description of particulate on filter

Probe rinse container no. NA Liquid level marked

____ blank container no. NA Liquid level marked

Impinger contents container no. 4747-A Liquid level marked ✓

____ blank container no. 4703-A Liquid level marked ✓

Samples stored and locked ✓

Remarks

LABORATORY CUSTODY

Received by L Postell Date 7/3/86

Remarks

Figure 3-6. Particulate sample recovery and integrity data sheet.

PLANT & CITY	DATE	SAMPLING LOCATION	TYPE
ADLER MACHINE CO., GREER, SC	6/30/86	MIST ELIMINATOR OUTLET	OUTLET

RUN NO.	OPERATOR	AMB. TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS (IN. H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
1	M. GOSA, B. HOWARD, J. NEESE	90	29.29	+1.50		24	.84		(O, F)

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	V_m (ft³)	SAMPLE BOX NO	METER BOX NO	METER Δ H@	METER CAL. FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA RUNS
3' Heated Glass	.265	4166	20		FB3	1.86	0.977	3.0	0.000	Hot		250			P/S

PRETEST LEAK CHECK - 0.000 cfm @ 15" Hg

B-19

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F	STATIC P, in. H_2O
	0	12:03	168.309				96	110	108	2.0	NA	70	+1.4
E1	7.5	12:16	176.535	.62	3.77	3.77	96	110	108	2.0		68	+1.4
2	15.0	12:23	184.230	.60	3.05	3.05	97	110	108	2.0		68	+1.4
3	22.5	12:31	191.710	.56	2.85	2.85	97	112	106	2.0		67	+1.4
4	30.0	12:38	198.800	.49	2.50	2.50	97	114	106	2.0		67	+1.4
5	37.5	12:46	205.563	.45	2.29	2.29	98	115	106	1.5		68	+1.4
6	45.0	12:53	211.725	.37	1.89	1.89	99	118	106	1.0		68	+1.5
7	52.5	13:01	216.250	.18	.92	.92	99	119	108	1.0		68	+1.5
8	60.0	13:09	220.275	.15	.76	.76	100	118	108	1.0		67	+1.5
9	67.5	13:16	223.940	.12	.61	.61	100	118	108	1.0		67	+1.5
10	75.0	13:23	227.540	.12	.61	.61	100	118	108	1.0		68	+1.6
11	82.5	13:30	230.935	.10	.51	.51	101	118	108	1.0		66	+1.6
12	90.0	13:38	234.597	.12	.61	.61	100	118	109	1.0		63	+1.7
1 *	97.5	14:46	241.735	.52	2.64	2.64	98	111	108	2.0		59	+1.7
2	105.0	14:53	248.050	.50	2.63	2.63	99	112	107	2.0		62	+1.5
3	112.5	15:01	255.720	.42	2.14	2.14	99	115	108	2.0		64	+1.5
4	120.0	15:08	261.865	.37	1.88	1.88	99	115	108	2.0		63	+1.4
5	127.5	15:16	267.765	.3634	1.72	1.72	99	115	107	1.0		64	+1.5
6	135.0	15:23	273.665	.33	1.67	1.67	100	115	106	1.0		66	+1.4
7	142.5	15:31	[illegible]	.31	1.57	1.57	99	114	106	1.0		62	+1.4
8	150.0	15:38	282.735	.28	1.42	1.42	99	113	105	1.0		63	+1.4
9	157.5	15:46	288.470	.32	1.62	1.62	98	112	104	1.0		64	+1.4
10	165.0	15:51	293.650	.40	2.02	2.02	97	110	102	1.0		64	+1.4
11	172.5	15:58	299.495	.46	2.32	2.32	97	107	101	1.0		64	+1.4
12	180.0	16:06	306.299	.46	2.32	2.32	97	107	100	1.0		64	+1.4

* — port change

Cr^{+6}/TOTAL Cr SAMPLE RECOVERY AND INTEGRITY DATA SHEET

Plant Able Machine Co. Sample date 6/30/86

Sample location NE Outlet Recovery date 6/30/86

Run number NEO-1 Recovered by CB

Filter number(s) NA

MOISTURE

Impingers 633.6 #1 / #2 / #3

Final volume (wt) ~~[illegible]~~ 617.8 / 594.9 ml(g)

Initial volume (wt) 591.3 / 607.5 / 591.4 ml(g)

Net volume (wt) 54.3 / 10.3 / 3.5 ml(g)

Description of impinger water - slight yellow tint -

Silica gel

Final wt 855.1 g

Initial wt 821.9 g

Net wt 33.2 g

75 % spent

Total moisture 103.3 g

RECOVERED SAMPLE

Filter container number(s) NA Sealed —

Description of particulate on filter —

Probe rinse container no. NA Liquid level marked —

blank container no. NA Liquid level marked —

Impinger contents container no. 4702-A Liquid level marked ✓

NaOH blank container no. 4703-A Liquid level marked ✓

Samples stored and locked

Remarks

LABORATORY CUSTODY

Received by [illegible] Date 7/3/86

Remarks

Figure 3-6. Particulate sample recovery and integrity data sheet.

EMISSION TESTING FIELD DATA

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
ABLE MACHINE CO. GREER, NC	7/1/86	MIST ELIMINATOR OUTLET	CAT 6, TOTAL Cr

RUN NO.	OPERATOR	AMB. TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS (IN. H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	NOZZLE NO.	PAGE
MEO-2	G HOWARD / J MEEKS	90°	29.36	-1.5	N/A	24	.84		1 OF 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (I)	SAMPLE BOX NO	METER BOX NO	METER ΔH@	METER CAL. FACTOR Y	LEAK CHECK (IN. Hg)	LEAK CHECK (CFM)	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
6' EQUIV. GLASS	.266 (.265)	T-149	20		FB3/86	1.712		0.092	1498			250			30

PRETEST LEAKAGE RATE - 0.004 cfm @ 15" Hg

B-21

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F	
	0	8:16	306.406				92	80	80	3.5		67	±1.5
E 1	5.	8:20	310.750	.48	2.34	2.34	92	82	80	3.5		67	
2	10.	8:25	315.090	.47	2.29	2.29	92	87	80	3.5		67	±1.5
3	15.	8:30	319.330	.43	2.10	2.11	92	91	81	3.5		68	
4	20.	8:35	323.500	.41	2.02	2.02	92	95	82	3.5		68	±1.5
5	25.	8:40	327.650	.36	1.78	1.78	92	95	82	3.5		67	
6	30.	8:45	331.415	.32	1.58	1.58	93	98	84	3.0		66	±1.5
7	35.	8:50	335.050	.30	1.49	1.49	93	100	86	2.5		66	
8	40.	8:55	338.690	.30	1.50	1.50	93	101	88	2.5		67	±1.5
9	45.	9:00	342.640	.36	1.80	1.80	94	102	89	3.0		69	
10	50.	9:05	346.690	.39	1.95	1.95	94	102	90	3.0		67	±1.4
11	55.	9:10	351.185	.46	2.31	2.31	94	105	92	4.0		65	
12	60.	9:15	355.618	.44	2.21	2.21	94	106	92	3.5		62	±1.5
W 1	*65.	9:20	360.650	.60	3.02	3.02	94	105	95	5.0		62	
2	70.	9:30	365.680	.57	2.87	2.87	95	106	96	5.0		62	
3	75.	9:35	370.560	.53	2.67	2.67	95	107	97	4.5		63	±1.4
4	80.	9:40	375.400	.52	2.62	2.62	96	108	98	4.0		62	
5	85.	9:45	379.990	.46	2.32	2.32	96	110	99	4.0		60	±1.5
6	90.	9:50	384.123	.37	1.87	1.87	97	110	100	3.0		60	
7	95.	9:55	387.125	.18	.91	.91	97	111	100	1.0		61	±1.5
8	100.	10:00	389.445	.13	.66	.66	98	111	101	1.0		60	
9	105.	10:05	391.733	.11	.56	.56	98	112	102	1.0		63	±1.5
10	110.	11:11	394.055	.11	.56	.56	98	112	102	1.0		63	
11	115.	11:22	396.375	.11	.56	.56	99	112	108	1.0		66	±1.5
12	120.	11:27	398.695	.11	.56	.56	99	112	108	1.0		67	

Cr^{+6}/TOTAL Cr SAMPLE RECOVERY AND INTEGRITY DATA SHEET

Plant Able Machine Co. Sample date 7/1/86

Sample location ME Outlet Recovery date 7/1/86

Run number ME0-2 Recovered by GB

Filter number(s) NA

MOISTURE

Impingers	#1	#2	#3	Silica gel
Final volume (wt)	~~609.8~~	616.3	598.1 ml(g)	Final wt 910.7 g
Initial volume (wt)	~~580~~	598.9	593.9 ml(g)	Initial wt 889.3 g
Net volume (wt)	~~29.0~~	17.4	4.2 ml(g)	Net wt 21.4 g
Description of impinger water	Clear			40 % spent

Total moisture 71 g

RECOVERED SAMPLE

Filter container number(s) NA Sealed —

Description of particulate on filter —

Probe rinse container no. NA Liquid level marked —

____ blank container no. NA Liquid level marked —

Impinger contents container no. 4707-A Liquid level marked ✓

N_aOH blank container no. 4703-A Liquid level marked ✓

Samples stored and locked ✓

Remarks

LABORATORY CUSTODY

Received by [signature] Date 7/3/86

Remarks

Figure 3-6. Particulate sample recovery and integrity data sheet.

[redacted] PLANT & CITY [redacted] DATE [redacted] SAMPLING LOCATION [redacted] TYPE [redacted]

AXLE MACHINE CO. GUSER, SC | 7/1/86 | MIST ELIMINATOR | CR-16, TOTAL GR

RUN NO.	OPERATOR	AVG. TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS (IN. H_2O)	FILTER NUMBER(S)	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	PAGE
MEQ-3	G. HOWARD/T. NEESE	93	29.36	-1.50		24	.84		1 OF 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	Y.D. (E)	SAMPLE BOX NO	METER BOX NO	METER Δ H@	METER CAL. FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA RUN#
6' FOOT GLASS	.259 (.265)	A-16			B3	1.86	9.77	10	.000	3.0417		250			50

*PRETEST LEAKAGE RATE - 0.000 cfm @ 15 "Hg

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE °F	IMPINGER TEMPERATURE °F	STATIC P "H_2O
	0	12:09	399.056									65	+1.3
W1	5.0	12:14	403.995	.49	2.50	2.50	103	110	108	1.0		61	+1.4
2	10.0	12:19	408.000	.55	2.80	2.80	103	111	108	2.0		63	
3	15.0	12:24	413.045	.56	2.86	2.86	103	113	108	2.0		65	
4	20.0	12:29	418.820	.49	2.51	2.51	103	115	108	2.0		68	+1.4
5	25.0	12:34	423.385	.44	2.25	2.25	103	116	108	2.0		67	
6	30.0	12:39	427.630	.37	1.90	1.90	103	118	108	1.0		67	+1.6
7	35.0	12:44	430.740	.19	.97	.97	103	118	105	1.0		68	
8	40.0	12:49	433.005	.12	.58	.58	104	118	108	1.0		68	
9	45.0	12:54	435.250	.12	.59	.59	104	118	108	1.0		67	+1.6
10	50.0	12:59	437.490	.12	.49	.47	104	118	109	1.0		67	
11	55.0	13:39	439.735	.13	.53	.53	104	117	109	1.0		68	+1.6
12	60.0	13:44	441.980	.12	.39	.49	101	110	106	1.0		67	
13	65.0	14:32	445.700	.48	1.97	1.97	101	110	106	1.0		66	+1.6
2	70.0	14:17	449.865	.47	1.92	1.92	102	110	105	1.0		62	
3	75.0	14:22	453.800	.41	1.68	1.68	101	112	105	1.0		64	+1.5
4	80.0	14:27	457.600	.37	1.52	1.52	101	112	105	1.0		64	
5	85.0	14:32	461.445	.41	1.68	1.68	100	114	105	1.0		66	+1.5
6	90.0	14:37	465.295	.39	1.60	1.60	101	115	105	1.0		68	
7	95.0	14:42	468.955	.36	1.48	1.48	101	116	106	1.0		68	
8	100.0	14:47	472.390	.30	1.24	1.29	101	116	106	1.0		68	+1.4
9	105.0	14:52	475.775	.29	1.20	1.20	100	116	106	1.0		67	
10	110.0	14:57	479.363	.34	1.40	1.40	101	116	106	1.0		68	+1.5
11	115.0	15:02	482.800	.36	1.49	1.49	101	118	107	1.0		68	
12	120.0	15:07	486.865	.40	1.66	1.66	101	120	107	1.0			

Cr^{+6}/TOTAL Cr SAMPLE RECOVERY AND INTEGRITY DATA SHEET

Plant Able Machine Co. Sample date 7/1/86

Sample location ME Outlet Recovery date 7/1/86

Run number ME0-3 Recovered by CB

Filter number(s) NA

MOISTURE

Impingers	#1	#2	#3	Silica gel
Final volume (wt)	617.3	611.7	590.2 ml(g)	Final wt 822.8 g
Initial volume (wt)	596.7	608.4	589.5 ml(g)	Initial wt 806.6 g
Net volume (wt)	20.6	3.3	0.7 ml(g)	Net wt 16.2 g

Description of impinger water - Clear - 40 % spent

Total moisture 40.8 g

RECOVERED SAMPLE

Filter container number(s) NA Sealed

Description of particulate on filter

Probe rinse container no. NA Liquid level marked

____ blank container no. NA Liquid level marked

Impinger contents container no. 4746-A Liquid level marked ✓

____ blank container no. 4703-A Liquid level marked ✓

Samples stored and locked

Remarks

LABORATORY CUSTODY

Received by L Rotello Date 7/3/86

Remarks

Figure 3-6. Particulate sample recovery and integrity data sheet.

PARTICLE SIZE DISTRIBUTION

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
ABLE MACHINING / GREENVILLE	6/30/92	STACK EXIT	PARTICULATE

RUN NO.	OPERATOR	AMB. TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS (IN. H_2O)	IMPACTOR TYPE	STACK INSIDE DIAM. (INCHES)	PITOT TUBE Cp	THERM NO.	I.D. NO.	PAGE
POST-1	J.D. SCHLEGEL	84	29.3	-1.9	ANDERSON	19.5	.84			1 of 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	N.O. (I)	SAMPLE BOX NO	METER BOX NO	METER Δ H @	METER CAL. FACTOR Y	LEAK CHECK lb. Hg	LEAK CHECK CFM	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	NOZZLE ΔP	RECORD DATA EVERY
5 FEET S	.192	3			208	2.04	.998								5 MIN

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	IMPACTOR TEMPERATURE °F	CONDENSER TEMPERATURE °F
	0	1440	030.325									
	33.0		050.150	.62	1.10	1.10	94	98	94	2	94	68
	46.0		057.950	.62	1.10	1.10	94	110	96	2		
	60 ±	1547	066.340	.62	1.10	1.10	94	115	100	2		

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant Able Machine Co. Sample date 6/30/86

Sample location ME INLET Recovery date 6/30/86

Run number PSI-1 Recovered by CB

RECOVERY SAMPLE

Cyclone particulate container number — Liquid level marked

Cyclone and nozzle rinse container number — Liquid level marked

Nozzle (or inlet chamber) rinse container number 4705-A Liquid level marked ✓

Acetone blank container number 4706-A Liquid level marked ✓

Filters

Stage	Filter number	Container number	Container sealed	Comments
0	AP87	4705-B	✓	no visible loading
1	AO32			" " "
2	AF67			Light; even deposit
3	AN48			" " "
4	AM35			" " "
5	AN38			" " "
6	AP03			" " "
7	AR98			" " "
Backup	A248			None visible

Samples stored and locked ✓

Remarks Very heavy brownish tint in nozzle/cooling rinse

LABORATORY CUSTODY

Received by PRotondo Date 7/3/86

Remarks

IMPACTOR EMISSION [illegible]

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
AACE [illegible] / GREENVILLE	[illegible]	[illegible]	PARTICLE SIZE

RUN NO.	OPERATOR	AMB. TEMP (°F)	BAR. PRESS. (in. Hg)	STATIC PRESS (in. H_2O)	IMPACTOR TYPE	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	THERM NO.	I M P	PAGE
PSA-2	[illegible]	[illegible]	[illegible]	[illegible]	ANDERSEN	[illegible]	[illegible]			[illegible]

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (%)	SAMPLE BOX NO	METER BOX NO	METER ΔH@	METER CAL. FACTOR Y	LEAK CHECK in. Hg	LEAK CHECK CFM	B FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA MINS
6 FT SS	.192		2		[illegible]	[illegible]	[illegible]	15	0.002						

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	IMPACTOR TEMPERATURE °F	CONDENSER TEMPERATURE °F
												Tsed ✓
	0	0817	66.414									
	20	0837	78.570	.69	1.10	1.10	84	93	82	2	84	68
	40		90.300	.67	1.10	1.10	84	96	85	2	84	68
	60		102.500	.69	1.10	1.10	88	104	89	2	88	68
	75	0932	111.586	.69	1.10	1.10	88	110	44	2	88	68

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant Able Machine Co.
Sample location ME INLET
Run number PSI-2

Sample date 7/1/86
Recovery date 7/1/86
Recovered by CB

RECOVERY SAMPLE

Cyclone particulate container number NA — Liquid level marked

Cyclone and nozzle rinse container number NA — Liquid level marked

Nozzle (or inlet chamber) rinse container number 4709-A — Liquid level marked ✓

Acetone blank container number 4706-A — Liquid level marked ✓

Filters

Stage	Filter number	Container number	Container sealed	Comments
0	A053	4708-B	✓	no number Good
1	AM68		✓	" " "
2	AP05		✓	light ; reverse dots
3	AM50		✓	" " "
4	A043		✓	chevron ; " "
5	AI90		✓	light ; " "
6	AM49		✓	very light ; " "
7	AJ42		✓	no VC
Backup	A062	✓	✓	

Samples stored and locked

Remarks

LABORATORY CUSTODY

Received by R Patil — Date 7/3/86

Remarks

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
ABBLE MACHINE / KALAMAZOO, MI	6/1/86	INLET	PARTICULATE

RUN NO.	OPERATOR	AMB. TEMP (°F)	BAR. PRESS. (in. Hg)	STATIC PRESS (in. H_2O)	IMPACTOR TYPE	STACK INSIDE DIAM. (INCHES)	PITOT TUBE Cp	THERM NO.	I M P	PAGE
P86-13	D SCHIEFFER				ANDERSON	19.5	.84			1 OF 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	M.B. (g)	SAMPLE BOX NO	METER BOX NO	METER Δ H @	METER CAL. FACTOR Y	LEAK CHECK (IN. Hg)	LEAK CHECK (CFM)	K FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF Δ P	RECORD DATA HERE
6 FT	.192		72		788	2.04	.986	10	.0024						

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	IMPACTOR TEMPERATURE °F	CONDENSER TEMPERATURE °F
	0	1400	171.750									
	20		173.990		1.10	1.10	93	100	98	2	93	68
	40		176.100		1.10	1.10	96	108	99	2	96	68
	60		178.261		1.10	1.10	96	114	100	2	96	68
	75	1515	179.761		1.10	1.10	96	118	104	2	96	68

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant Hale Machine Co. Sample date 7/1/86

Sample location ME Inlet Recovery date 7/1/86

Run number PSI-3 Recovered by CB

RECOVERY SAMPLE

Cyclone particulate container number NA Liquid level marked

Cyclone and nozzle rinse container number NA Liquid level marked

Nozzle (or inlet chamber) rinse container number 4748-A Liquid level marked ✓

Acetone blank container number 4706-A Liquid level marked ✓

Filters

Stage	Filter number	Container number	Container sealed	Comments
0	A063	4748-B		no visible Cond
1	AN02			" " "
2	AN79			light, even deposit
3	AN24			heavy, " "
4	AN81			" " "
5	AN50			light " "
6	AN27			" " "
7	AN28			Barely visible
Backup	A193			" "

Samples stored and locked

Remarks

LABORATORY CUSTODY

Received by D Rivin Date 7/3/86

Remarks

IMPACTOR EMISSION TESTING FIELD DATA

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
ABLE MACHINE CO	6/30/86	MIST ELIMINATOR OUTLET	PART. SIZE

RUN NO.	OPERATOR	AMB. TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS (IN. H_2O)	IMPACTOR TYPE	STACK INSIDE DIMEN. (INCHES)	PITOT TUBE Cp	NOZZLE DIA.	I.D. P	PAGE
1	G. HOWARD/D. NEESE	81	28.39	-1.60			.841			1 OF 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (I)	SAMPLE BOX NO	METER BOX NO	METER Δ H @	METER CAL. FACTOR Y	LEAK CHECK (IN. Hg)	LEAK CHECK (CFM)	S FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	NOZ. ΔP	RECORD DATA (MIN)
6'	.196	3	1.10	20	FAN	1.76	.978								20

PRETEST LEAKAGE RATE - 0.000 cfm @ 10" Hg

TRAVERSE POINT NUMBER	SAMPLING TIME, min θ	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	IMPACTOR TEMPERATURE °F	CONDENSER TEMPERATURE °F
	0	12:09	006.379									
1	20.0	12:29	014.200	.32	.35	.35	96	110	108	1.0	96	56
	40.0	12:49	021.930	.32	.35	.35	99	112	108	1.0	97	58
	60.0	13:09	029.745	.32	.35	.35	100	115	108	1.0	100	60
	80.0	13:29	037.560	.32	.35	.35	100	115	108	1.0	100	
	100.0	14:51	045.300		.35	.35	100	115	108	1.0	98	
2*	120.0	15:11	053.025		.35	.35	98	114	106	1.0	99	
	140.0	15:31	060.800		.35	.35		113	106	1.0	99	
	160.0	15:51	068.585		.35	.35		108	105	1.0	97	
178.55	~~180~~ 178.55	16:10	075.830		.35	.35						
	200.0											
	220.0											
	240.											

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant: Able Machine Co. — Sample date: 6/30/86
Sample location: ME Outlet — Recovery date: 6/30/86
Run number: P50-1 — Recovered by: CB

RECOVERY SAMPLE

Cyclone particulate container number: _____ — Liquid level marked: _____

Cyclone and nozzle rinse container number: _____ — Liquid level marked: _____

Nozzle (or inlet chamber) rinse container number: 4704-A — Liquid level marked: /

Acetone blank container number: 4706-A — Liquid level marked: /

Filters

Stage	Filter number	Container number	Container sealed	Comments
0	A091	4704-B	✓	no load
1	A094		✓	" "
2	A079		/	" "
3	AP02			" "
4	AC93		✓	Light deposit
5	A050		✓	even distribution
6	AQ35		✓	light "
7	AP26		/	uneven load
Backup	A096		/	yellowish discoloration

Samples stored and locked: ✓

Remarks: _____

LABORATORY CUSTODY

Received by: D Rotelli — Date: 7/3/86

Remarks: _____

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
ACME MACHINE CO., GREER, NC	7/1/86	MIST ELIMINATOR OUTLET	PARTICLE SIZE

RUN NO.	OPERATOR	AMB. TEMP (°F)	BAR. PRESS. (IN. Hg)	STATIC PRESS (IN. H_2O)	IMPACTOR TYPE	STACK INSIDE DIAM. (INCHES)	PITOT TUBE Cp	PROBE NO.	I N P	PAGE
1	PSDT2 G. HOWARD/J. NEES	80	27.35	-.50		24	.84			8 of 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	ΔH (I)	SAMPLE BOX NO	METER BOX NO	METER $\Delta H @$	METER CAL. FACTOR Y	LEAK CHECK IN. Hg	LEAK CHECK CFM	S FACTOR	C FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA EVERY
5 FOOT STAINLESS			2.0		FOUR	1.6	0.978	10	0.009						150

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	IMPACTOR TEMPERATURE °F	CONDENSER TEMPERATURE °F
	0	8:17	073.900				98 92	80	80	1.0	92	58
W	15	8:32	082.015	.32	.35	.35	93	90	85	1.0	93	58
	30	8:47	088.085	.32	.35	.35	93	100	90	1.0	93	58
	45	9:02	094.140	.32	.35	.35	94	105	94	1.0	94	59
	60	9:22	100.200	.32	.35	.35	94	108	98	1.0	94	60
*E	75	9:37	106.240	.32	.35	.35	96	110	100	1.0	96	60
	90	9:32	112.270	.32	.35	.35	97	115	106	1.0	97	60
	105	11:10	118.295	.32	.35	.35	98	110	108	1.0	98	62
	120	11:25	124.635	.32	.35	.35	99	113	109	1.0	99	62
	135	11:40	130.930	.32	.35	.35	99	118	110	1.0	99	63
	150	11:55	136.995	.32	.35	.35	102	119	110	1.0	102	64
	165	12:10	143.135	.32	.35	.35	103	119	110	1.0	103	64
	180	12:26	149.276	.32	.35	.35						

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant ABLE MACHINE CO
Sample location MIST ELIMINATOR OUTLET
Run number PSO-2

Sample date 7/1/86
Recovery date 7/1/86
Recovered by CB

RECOVERY SAMPLE

Cyclone particulate container number NA — Liquid level marked —

Cyclone and nozzle rinse container number NA — Liquid level marked —

Nozzle (or inlet chamber) rinse container number 4710-A — Liquid level marked ✓

Acetone blank container number 4706-A — Liquid level marked ✓

Filters

Stage	Filter number	Container number	Container sealed	Comments
0	A009	4710-B	✓	no visible loss
1	AN16		✓	" "
2	A007		✓	" " "
3	AD~~07~~ 17	AD	✓	bright, even deposit
4	A051		✓	" " "
5	AP16		✓	" " "
6	A001		✓	" " "
7	AN10		✓	yellowish tint
Backup	A061	✓	✓	

Samples stored and locked

Remarks

LABORATORY CUSTODY

Received by R. Lee — Date 7/3/86

Remarks

IMPACTOR EMISSION TESTING FIELD DATA

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
ABLE MACHINE CO	7/2/86	WEST ELIMINATOR OUTLET	PORT SIZE

RUN NO.	OPERATOR	AMB. TEMP (°F)	BAR. PRESS. (in. Hg)	STATIC PRESS (in. H_2O)	IMPACTOR TYPE	STACK DIAM. (INCHES)	PITOT TUBE Cp	NOZZLE NO.	IMP	PAGE
1501-3	G HOWARD/T NEESE			-.50		24				1 of 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	% O_2 (I)	SAMPLE BOX NO	METER BOX NO	METER $\Delta H@$	METER CAL. FACTOR Y	LEAK CHECK in. Hg	LEAK CHECK CFM	C_p FACTOR	C_p FACTOR	PROBE HEAT SET	BOX HEAT SET	REF. ΔP	RECORD DATA RUN
	A		NR		FAN	NR	0.78	10	0.002		A	A	A	A	1

TRAVERSE POINT NUMBER	SAMPLING TIME, min θ	CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m_{in}}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m_{out}}$), °F	PUMP VACUUM, in. Hg	IMPACTOR TEMPERATURE °F	CONDENSER TEMPERATURE °F
	0	8:36	149.338									
	15.0	8:51	155.637	.34	.35	.35	97	90	84	1.0	99	60
	30.0	9:06	161.805		.35	.35	99	98	87	1.0	99	60
	45.0	9:21	167.885		.35	.35	99	103	91	1.0	99	60
	60.0	9:36	174.160		.35	.35	99	106	96	1.0	99	61
	75.0	9:51	180.475		.35	.35	102	110	100	1.0	100	61
	90.0	10:12	186.800		.35	.35	100	113	104	1.0	100	62
	105.0	10:47	193.125		.35	.35	100	112	105	1.0	100	62
	120.0	11:02	199.795		.35	.35	100	114	106	1.0	100	63
	135.0	11:17	206.240		.35	.35	100	116	107	1.0	100	63
	150.0	11:32	212.635		.35	.35	101	117	108	1.0	101	63
	165.0	11:47	218.015		.35	.35	101	118	110	1.0	101	64
	180.0	12:02	225.333		.35	.35	101	118	110	1.0	101	65

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant Able Machine Co. Sample date 7/2/86

Sample location ME OUTLET Recovery date 7/2/86

Run number PSO-3 Recovered by GS

RECOVERY SAMPLE

Cyclone particulate container number _____ Liquid level marked _____

Cyclone and nozzle rinse container number _____ Liquid level marked _____

Nozzle (or inlet chamber) rinse container number 4749 ~~4705~~ -A Liquid level marked ✓

Acetone blank container number 4706-A Liquid level marked ✓

Filters

Stage	Filter number	Container number	Container sealed	Comments
0	A083	4749-B	"	No Moisture
1	A076			" "
2	AP89			" "
3	AP18			" "
4	A089			Moisture even after 5
5	A046			" "
6	A067			
7	AM58			
Backup	A275	↓		

Samples stored and locked _____

Remarks _____

LABORATORY CUSTODY

Received by L Patton Date 7/3/86

Remarks _____

APPENDIX C

LABORATORY DATA SHEETS

PEI Associates, Inc. LABORATORY REPORT FORM

Sample type: Stack samples

Client: US EPA EMB

Able Machine Company

attn:

Project no: 3615-22
Requisition: 9497
Received: 7/3/86
Sampled by: PEI
Reported: 8/20/86

Lab No.	Run Number	Fraction	Chromium (VI),mg	Total Chromium,mg
FT 407	MEI-1	liquid	47.4	46.5
FT 408	MEI-2	liquid	22.6	22.3
FT 409	MEI-3	liquid	21.6*	21.8
FT 410	MEO-1	liquid	0.451	0.484*
FT 411	MEO-2	liquid	0.332	0.348
FT 412	MEO-3	liquid	0.226	0.248
FT 413	blank	liquid	<0.006**	<0.021 **

*Spike recovery was 101.0% for chromium (VI) and 92.5% for total chromium

** Based on largest volume used for the samples

Submitted by: Ida Bennett

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513)-782-4700

PEI Associates, Inc. LABORATORY REPORT FORM

Sample type: Particle size samples

Client: US EPA EMB

Able Machine Company

attn:

Project no: 3615-22
Requisition: 9497
Received: 7/3/86
Sampled by: PEI
Reported: 8/20/86
d

Lab Number	Run No.	Stage No.	Chromium (VI),ug	Total Chromium,ug
FT 346,356,366	PSI 1-3	0	4.8	21.0
FT 347,357,367		1	6.7	20.9
FT 348.358.368		2	28.0	54.2
FT 349,359,369		3	65.0	104
FT 350,360,370		4	78.6	128
FT 351,361,371		5	36.1	64.3**
FT 352,362,372		6	22.6	45.5
FT 353,363,373		7	14.0	33.8
FT 354,364,374		back-up	2.8	19.2
FT 355,365,375		acetones	13800*	24800
FT 376,386,396	PSO 1-3	0	4.5	18.6
FT 377,387,397		1	2.4	13.7
FT 378,388,398		2	3.3	16.8
FT 379,389,399		3	4.0	18.7
FT 380,390,400		4	20.3	42.8
FT 381,391,401		5	69.1	105
FT 382,392,402		6	30.8	53.2
FT 383,393,403		7	26.1	48.7
FT 384,394,404		back-up	6.7	35.4
FT 385,395,405		acetones	121	164
FT 328,329,330	Blank	0,2,4,6	0.9	11.0
FT 332,333,334		1,3,5,7	0.8	11.6
FT 336		back-up	0.5 **	6.6**
FT 337		acetone	0.6	<2.0
Extraction		-	<0.4	<2.0

*Spike recovery 88.4% for chromium VI and 87.4% for total chromium
SAMPLES NOT BLANK CORRECTED
** Blank values must be multiplied by 3

Submitted by: Ida Bennett

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513)-782-4700

PEI Associates, Inc. **LABORATORY REPORT FORM**

Sample type: Process samples

Client: US EPA EMB

Able Machine Company

attn:

Project no: 3615-22
Requisition: 9505
Received: 7/3/86
Sampled by: PEI
Reported: 8/20/86

Lab No.	Run No., Description	Fraction	Chromium(VI), mg/l	Total Chromium, mg/l
FT 449	MEI/Wash water 6/30	liquid	2790, 3270	3490, 3320
FT 450	MEI/Wash water 7/1	liquid	3470*,4070	4220,* 3950
FT 451	MEI-1 tank	liquid	79000	84500
FT 452	MEI-2 tank	liquid	81000	85800
FT 453	MEI-3 tank	liquid	82700	85100

* Spike recovery was 105.8% for Cr (VI) and 70.5% for total chromium

The total chromium spike was 2 ug added to 40 ug present in the sample This spike level was too low for the amount already in the sample and probably explains the lower recovery determined for this sample.

Submitted by: Ida Bennett

PEI Associates, Inc.
11499 Chester Road
Cincinnati, Ohio 45246
(513)-782-4700

TJV

METHOD 5 BLANK ANALYTICAL DATA

Plant Able Machine Co.

Sample location

Relative humidity of laboratory 50%

Density of acetone (ρa) 0.7899 g/ml ✓

Blank type	Sample identifiable	Liquid level at mark and/or container sealed
Acetone	✓	✓
Filter		

Acetone blank container No. 4706-A Lab No. 7T406 ✓

Acetone blank volume (Va) 140 ml ✓

Date and time of wt 7/14/86 1526 Gross wt 103265.4 mg ✓

Date and time of wt 7/14/86 1535 Gross wt 103265.7 mg ✓

Average Gross wt 103265.6 mg ✓

Tare wt 103261.1 mg ✓

Weight of blank (ma) 4.5 mg ✓

$$Ca = \frac{(ma)}{(Va)(\rho a)} \quad \frac{(4.5)}{(140)(0.7899)} = 0.0407 \text{ mg/g}$$ ☆✓

Note: In no case should a blank residue greater than 0.01 mg/g or 0.001% of the blank weight be subtracted form the sample weight.

Filter blank container No. _____ Lab No. _____

Filter blank No. _____

Date and time of wt _____ Gross wt _____ mg

Date and time of wt _____ Gross wt _____ mg

Average gross wt _____ mg

Tare wt _____ mg

Difference _____ mg

Note: Difference must be less than ±5 mg of 2% of total sample weight, whichever is greater.

Remarks ☆ 0.01 is maximum allowable amount ✓

will be used to all calculations ✓

Signature of analyst Tim Stephens

Signature of reviewer Ken Walker T.S.

ANDERSEN IMPACTOR ANALYTICAL DATA

Plant Cole Machine Co. Run No. PSI-1

Sample location

Relative humidity 50%

Density of acetone (ρa) 0.7899 ✓

Sample type	Sample identifiable	Liquid level at mark and/or container sealed
Acetone rinse	✓	✓
filter(s)	✓	✓

Acetone rinse container no. 4705A Lab No. 77355 ✓

Acetone rinse volume (Vaw) 118 ml - ✓

Acetone blank residue concentration (Ca) 0.01 mg/g ✓

Wa = Ca Vaw ρa = (0.01) (118) (0.7899) = 0.93 mg - ✓

Date and time of wt 7/1-/86 10²⁰ A Gross wt 1002648 mg ✓

Date and time of wt 7/2/86 4³⁵ P Gross wt 1002650 mg ✓

Average Gross wt 1002649 mg ✓

Tare wt 1002312 mg - ✓

Less acetone blank wt (Wa) 0.9 mg - ✓

Weight of particulate in acetone rinse 32.8 mg - ✓

Filters

Stage	Filter No.	Lab No.	Gross, mg	Tare, mg	Net, mg
0	AD-87	77346	159.5 ✓	159.4 ✓	0.1 ✓
1	AD-02	347	145.4 ✓	145.2 ✓	0.2 ✓
2	AD-67	348	166.8 ✓	166.4 ✓	0.4 ✓
3	AN-48	349	140.9 ✓	146.5 ✓	0.2 ✓
4	AM-35	350	161.5 ✓	161.3 ✓	0.2 ✓
5	AN-38	351	142.8 ✓	142.4 ✓	0.4 ✓
6	AD-03	352	168.0 ✓	168.1 ✓	-0.1 ✓
7	AR-99	353	149.0 ✓	149.0 ✓	0 ✓
Backup	A-248	354	218.6 ✓	218.3 ✓	0.3 ✓

Weight of particulate in acetone rinse 32.8 - ✓

Total 34.6 - ✓

Signature of analyst Linda Stephens

Signature of reviewer Kim Shultz 7.2.86

ANDERSEN IMPACTOR ANALYTICAL DATA

Plant Able Machine Co. Run No. PSI-2

Sample location

Relative humidity 50%

Density of acetone (ρa) 0.7899 ✓

Sample type	Sample identifiable	Liquid level at mark and/or container sealed
Acetone rinse	✓	✓
filter(s)	✓	✓

Acetone rinse container no. 4709A Lab No. 77365 ✓

Acetone rinse volume (Vaw) 94 ml ✓

Acetone blank residue concentration (Ca) 0.01 mg/g ✓

Wa = Ca Vaw ρa = (0.01) (94) (0.7899) = 0.74 mg ✓

Date and time of wt 7/14/86 1020 Gross wt 94483.7 mg ✓

Date and time of wt 7/16/86 800 Gross wt 94483.4 mg ✓

Average Gross wt 94483.6 mg ✓

Tare wt 94441.2 mg ✓

Less acetone blank wt (Wa) 0.7 mg ✓

Weight of particulate in acetone rinse 41.7 mg ✓

Filters

Stage	Filter No.	Lab No.	Gross, mg	Tare, mg	Net, mg
0	AO-53	77-356	166.4 ✓	167.1 ✓	-0.7 ✓
1	AM-68	357	143.6 ✓	143.6 ✓	0 ✓
2	AP-05	358	163.2 ✓	163.1 ✓	0.1 ✓
3	AM-50	359	143.8 ✓	143.9 ✓	-0.1 ✓
4	AO-43	360	166.6 ✓	166.5 ✓	0.1 ✓
5	AI-90	361	149.4 ✓	149.2 ✓	0.2 ✓
6	AM-49	362	161.3 ✓	161.2 ✓	0.1 ✓
7	AJ-42	363	147.4 ✓	147.3 ✓	0.1 ✓
Backup	A-062	364	215.4 ✓	215.3 ✓	0.1 ✓

Weight of particulate in acetone rinse 41.7 ✓

Total 42.4 ✓

Signature of analyst [signature] T.J.N.

Signature of reviewer [signature]

ANDERSEN IMPACTOR ANALYTICAL DATA

Plant Able Machine Co. Run No. PSI-3

Sample location

Relative humidity 50%

Density of acetone (ρa) 0.7899 ✓

Sample type	Sample identifiable	Liquid level at mark and/or container sealed
Acetone rinse	✓	✓
filter(s)	✓	✓

Acetone rinse container no. 4748A Lab No. 7T375 ✓

Acetone rinse volume (Vaw) 78 ✓ ml ✓

Acetone blank residue concentration (Ca) 0.01 mg/g ✓

Wa = Ca Vaw ρa = (0.01) (78) 0.7899 = 0.62 mg ✓

Date and time of wt 7/14/84 1026 Gross wt 102002.9 mg ✓

Date and time of wt 7/14/84 1435 Gross wt 102002.7 mg ✓

Average Gross wt 102002.8 mg ✓

Tare wt 101987.0 mg ✓

Less acetone blank wt (Wa) 0.6 mg ✓

Weight of particulate in acetone rinse 15.2 mg ✓

Filters

Stage	Filter No.	Lab No.	Gross, mg	Tare, mg	Net, mg
0	AO-63	7T-366	167.6 ✓	167.8 ✓	-0.2 ✓
1	AN-42	367	140.7 ✓	140.9 ✓	-0.2 ✓
2	AN-79	368	158.6 ✓	158.6 ✓	0 ✓
3	AN-24	369	142.8 ✓	142.5 ✓	0.3 ✓
4	AN-81	370	157.0 ✓	157.0 ✓	0 ✓
5	AN-50	371	141.2 ✓	140.9 ✓	0.3 ✓
6	AN-27	372	158.7 ✓	158.9 ✓	-0.2 ✓
7	AN-28	373	140.2 ✓	140.1 ✓	0.1 ✓
Backup	A-193	374	208.8 ✓	208.8 ✓	0 ✓

Weight of particulate in acetone rinse 15.2 ✓

Total 15.9 ✓

Signature of analyst Linda Stephens

Signature of reviewer [illegible] T.J.N.

ANDERSEN IMPACTOR ANALYTICAL DATA

Plant Able Machine Co. Run No. FSC-1

Sample location

Relative humidity 50% ✓

Density of acetone (ρa) 0.7899 ✓

Sample type	Sample identifiable	Liquid level at mark and/or container sealed
Acetone rinse	✓	✓
filter(s)	✓	✓

Acetone rinse container no. 4704A Lab No. 77385 ✓

Acetone rinse volume (Vaw) 126 ml ✓

Acetone blank residue concentration (Ca) 0.01 mg/g ✓

Wa = Ca Vaw ρa = (0.01) (126) (0.7899) = _____ mg

Date and time of wt _____ Gross wt _____ mg

Date and time of wt _____ Gross wt _____ mg

Average Gross wt _____ mg

Tare wt _____ mg

Less acetone blank wt (Wa) _____ mg

Weight of particulate in acetone rinse ____ mg

Filters

Stage	Filter No.	Lab No.	Gross, mg	Tare, mg	Net, mg
0	AC-91	77376	168.5 ✓	168.2 ✓	0.3 ✓
1	AC-94	377	151.2 ✓	151.2 ✓	0 ✓
2	AC-79	378	167.2 ✓	167.3 ✓	-0.1 ✓
3	AC-82	379	151.5 ✓	151.4 ✓	0.1 ✓
4	AC-93	380	166.4 ✓	166.4 ✓	0 ✓
5	AC-76	381	150.2 ✓	150.0 ✓	0.2 ✓
6	AC-35	382	167.4 ✓	167.3 ✓	0.1 ✓
7	AC-26	383	142.2 ✓	142.0 ✓	0.2 ✓
Backup	AC-96	384	217.0 ✓	217.2 ✓	-0.2 ✓

Weight of particulate in acetone rinse ____

Total 0.9 ✓ filters only

VOID This Run T.J.W.

Signature of analyst _____

Signature of reviewer Thomas J. Warfel

ANDERSEN IMPACTOR ANALYTICAL DATA

Plant Able Machine Co. Run No. 736-2

Sample location

Relative humidity 50 %

Density of acetone (ρa) 0.7899 ✓

Sample type	Sample identifiable	Liquid level at mark and/or container sealed
Acetone rinse	✓	✓
filter(s)	✓	✓

Acetone rinse container no. 4710A Lab No. 7T395 ✓

Acetone rinse volume (Vaw) 50 ml ✓

Acetone blank residue concentration (Ca) 0.01 mg/g ✓

Wa = Ca Vaw ρa = (0.01) (50) (0.7899) = 0.39 mg ✓

Date and time of wt 7/11/86 3⁰⁰ P Gross wt 98612.3 mg ✓

Date and time of wt 7/14/86 10²⁰ A Gross wt 98612.4 mg ✓

Average Gross wt 98612.4 mg ✓

Tare wt 98608.2 mg ✓

Less acetone blank wt (Wa) 0.4 mg ✓

Weight of particulate in acetone rinse 3.8 mg ✓

Filters

Stage	Filter No.	Lab No.	Gross, mg	Tare, mg	Net, mg
0	A0-09	7T386	165.8 ✓	165.5 ✓	0.3 ✓
1	AN-16	387	144.4 ✓	144.2 ✓	0.2 ✓
2	A0-07	388	166.7 ✓	166.6 ✓	0.1 ✓
3	A0-14	389	150.8 ✓	150.4 ✓	0.4 ✓
4	A0-51	390	167.8 ✓	167.5 ✓	0.3 ✓
5	AP-16	391	141.4 ✓	141.1 ✓	0.3 ✓
6	A0-01	392	166.6 ✓	166.4 ✓	0.2 ✓
7	AN-10	393	141.8 ✓	141.4 ✓	0.4 ✓
Backup	A-061	394	215.4 ✓	215.0 ✓	0.4 ✓

Weight of particulate in acetone rinse 3.5 ✓

Total 6.4 ✓

Signature of analyst [signature]

Signature of reviewer [signature] 7/22

ANDERSEN IMPACTOR ANALYTICAL DATA

Plant Able Machine Co. Run No. 1236-3

Sample location

Relative humidity 50%

Density of acetone (ρa) 0.7894 ✓

Sample type	Sample identifiable	Liquid level at mark and/or container sealed
Acetone rinse	✓	✓
filter(s)	✓	✓

Acetone rinse container no. 4749A Lab No. 7T405 ✓

Acetone rinse volume (Vaw) 45 ml ✓

Acetone blank residue concentration (Ca) 0.01 mg/g

Wa = Ca Vaw ρa = (0.01) (45) (0.7899) = 0.36 mg ✓

Date and time of wt 7/11/86 300 p Gross wt 959935 mg ✓

Date and time of wt 7/14/86 1020 p Gross wt 959933 mg ✓

Average Gross wt 959934 mg ✓

Tare wt 959899 mg ✓

Less acetone blank wt (Wa) 0.4 mg ✓

Weight of particulate in acetone rinse 3.2 mg ✓

Filters

Stage	Filter No.	Lab No.	Gross, mg	Tare, mg	Net, mg
0	AO-83	7T-396	166.6 ✓	166.6 ✓	0 ✓
1	AO-76	397	150.0 ✓	149.8 ✓	0.2 ✓
2	AP-89	398	158.0 ✓	158.0 ✓	0 ✓
3	AP-18	399	141.2 ✓	140.8 ✓	0.4 ✓
4	AO-89	400	167.7 ✓	167.4 ✓	0.3 ✓
5	AO-46	401	149.6 ✓	149.4 ✓	0.2 ✓
6	AO-87	402	167.8 ✓	167.6 ✓	0.2 ✓
7	AM-58	403	144.8 ✓	144.5 ✓	0.3 ✓
Backup	A-275	404	219.0 ✓ T.J.W.	218.5 ✓	0.2 T.J.W.

Weight of particulate in acetone rinse 3.2 ✓

Total 5.0 ✓ T.J.W.

Signature of analyst [signature] T.J.W.

Signature of reviewer [signature]

APPENDIX D

SAMPLE AND ANALYTICAL PROCEDURES

DETERMINATION OF Cr^{+6} AND TOTAL Cr EMISSIONS

The following sample and analytical procedures were used during this test program. Sampling procedures generally followed those described in EPA Test Method 13B.* The sample train used at both the mist eliminator inlet and outlet test locations was assembled by PEI personnel and consisted of the following items:

Nozzle - Stainless steel (316) with sharp, tapered leading edge and accurately measured round opening.

Probe - Borosilicate glass with a heating system capable of maintaining a gas temperature of approximately 121°C (250°F) at the exit end during sampling.

Pitot tube - Type-S pitot tube that meets all geometric standards. It was attached to the probe to monitor stack gas velocity.

Thermocouple - Type-K thermocouple capable of measuring stack gas temperatures within 2 percent. It was attached to the probe.

Draft gauge - An inclined manometer made by Dwyer with a range of 0 to 10 in.H_2O.

Impingers - For impingers connected in series with glass ball joints. The second impinger was of the Greenburg-Smith design. The first, third, fourth, and fifth impingers were also of the Greenburg-Smith design, but modified by replacing the tip with a ½-in. i.d. glass tube extending to ½ in. from the bottom of the flask.

Metering system - Vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 5°F, dry gas meter with 2 percent accuracy, and related equipment to maintain an isokinetic sampling rate and to determine sampling volume. The dry gas meter is made by Rockwell and the fiber vane pump is made by Gast.

Barometer - Aneroid type to measure atmospheric pressures to within ±2.5 mmHg (±0.1 in.Hg).

* 40 CFR 60, Appendix A, Reference Method 13B, July 1985.

Sampling Procedures

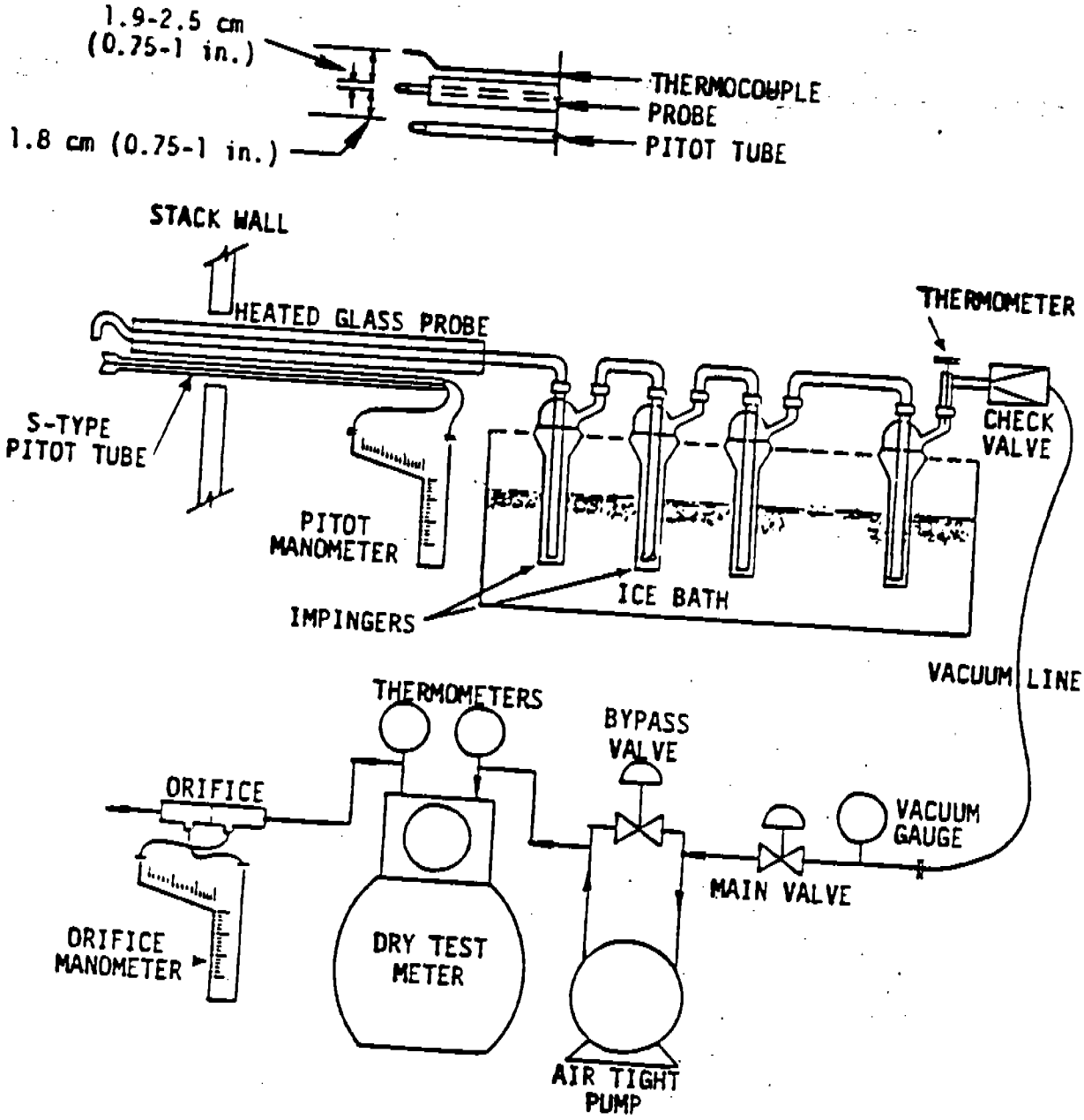
Prior to departure, all glassware used in this study was washed with acid to minimize the potential for contamination. One hundred ml of 0.1 N NaOH was placed in each of the first three impingers; 300 g of silica gel was added to the fourth impinger. The train was set up with the probe as shown in Figure D-1. The sampling train was leak checked at the sampling site prior to each test run by plugging the inlet to the nozzle and pulling a 15-in.Hg vacuum, and at the conclusion of the test by plugging the inlet to the nozzle and pulling a vacuum equal to the highest vacuum reached during the test run.

The pitot tube and lines were leak checked at the test site prior to and at the conclusion of each test run. The check was made by blowing into the impact opening of the pitot tube until 3 or more inches of water is recorded on the manometer and then capping the impact opening and holding it for 15 seconds to assure it is leak free. The static pressure side of the pitot tube was leak checked using the same procedure, except suction will be used to obtain the 3-in.H_2O manometer reading. Crushed ice was placed around the impingers to keep the temperature of the gases leaving the last impinger at 20°C (68°F) or less.

During sampling, stack gas and sampling train data were recorded at each sampling point and when significant changes in stack flow conditions occur. Isokinetic sampling rates were set throughout the sampling period with the aid of a programmable calculator.

Sampling Recovery Procedures

The sampling trains were moved carefully from the test sites to the designated cleanup/recovery area located in the plating operations building.



IMPINGER CONTENTS

1. 100 ml 0.1 N NaOH
2. 100 ml 0.1 N NaOH
3. 100 ml 0.1 N NaOH
4. 200 g SILICA GEL

Figure D-1. Cr^{+6}/Total Cr sampling train.

Each impinger was weighed after each test to determine the amount of moisture present. Sample fractions were recovered as follows:

Container No. 1 - All sample exposed surfaces prior to the first impinger (nozzle and probe) were rinsed with 0.1 N NaOH and brushed with a nylon brush. After they are weighed, the contents of each impinger were placed in this container and the impingers and connecting glassware rinsed with 0.1 N NaOH. This rinse was also placed in the container. The container was then sealed, labeled, and packed for shipment.

Container No. 2 - A minimum of 200 ml of 0.1 N NaOH was taken during each test for blank analysis.

The silica gel from the fourth impinger was weighed, and this value was recorded with other pertinent data on the Sample Recovery and Integrity Data Sheet.

Sample Analysis - Hexavalent Chromium

Each sample (including blanks) was analyzed for Cr^{+6} using analytical methodology recently developed by EPA. A copy of the draft method entitled "Determination of Hexavalent Chromium Emissions From Stationary Sources" is contained in Appendix G of this report. Procedures generally follow those described in EPA Method 3060.*

Prior to analysis, the volume of the impinger solutions was measured and an aliquot from Container 1 was filtered through Teflon to remove any solids present in the sample. The Teflon filter was cut into small pieces and placed in a 250-ml beaker. Twenty-five ml of $NaOH/NA_2CO_3$ digestion solution was added to the beaker. The beaker was covered with a watch glass and heated to near boiling on a hot plate. The solution was stirred constantly for 30 minutes, and was not allowed to evaporate to dryness.

* Test Methods for Evaluating Solid Waste. U.S. EPA SW-846, 2nd Edition. July 1982, Method 3060.

The solution was cooled and filtered through a 47-mm Teflon filter. The beaker was rinsed with deionized, distilled (DI) water, which was then filtered. The filtrate was transferred quantitatively from the filter flask to a 100-ml volumetric flask, and then brought to volume with DI water. Blank filter samples were digested and prepared in a similar manner.

A 50-ml or smaller aliquot of the prepared sample was transferred to a volumetric flask. A 2 percent volume-to-volume ratio of diphenylcarbazide solution was added. The solution was allowed to stand for about 10 minutes for color development. A portion of the sample was transferred to a 1-cm absorption cell, which was placed in the spectrophotometer. A Bausch and Lomb 100 spectrophotometer was used for this analysis. The absorbance was then measured at the optimum wavelength using the blank solution as a zero reference.

Sample Analysis--Total Chromium

A separate sample aliquot (Container No. 1) was analyzed for total Cr using preparation procedures described in EPA Method 3050.* Inductively Coupled Argon Plasma (ICP) spectroscopy techniques were used for sample analysis.

* Test Methods for Evaluating Solid Waste. U.S. EPA SW-846, 2nd Edition. July 1982, Method 3050.

DETERMINATION OF PARTICLE SIZE DISTRIBUTION

The following procedures were used to determine particle size distribution of Cr^{+6} and total Cr. The sampling train was assembled by PEI personnel and consisted of the following items:

Nozzle - Stainless steel (316) with sharp, tapered leading edge and accurately measured round opening.

Metering system - Vacuum gauge, Gast fiber-vane leak-free pump, thermometers capable of measuring temperatures to within 5°F, Rockwell dry-gas meter with 2 percent accuracy, and related equipment to maintain an isokinetic sampling rate and to determine sample volume.

Condenser - Moisture removal device capable of maintaining a temperature less than 20°C (68°F); it will be immersed in an ice water bath.

Impactor - An Andersen Mark III impactor with eight stages and a backup filter.

Barometer - Aneroid type to measure atmospheric pressures to ± 0.1 in.Hg.

Sampling Procedures--

Two points (one in each sample traverse) representing the average gas velocity and temperature in each duct were selected as the sampling points.

The Andersen mark III impactor was assembled by alternating the stage plates, collection media, flat crossbars, and Inconel spacer rings needed to provide eight cut sizes. The collection substrates were Reeve Angel 934 AH glass-fiber filters that were heated in a 204°C (400°F) oven for 1 or 2 hours, desiccated for 24 hours to a constant weight, and weighed to the nearest 0.1 mg on an analytical balance.

The sampling train was assembled as shown in Figure D-2. It was leak checked at the sampling site prior to each test run by plugging the inlet to the impactor and pulling a 10-in.Hg vacuum. When the desired vacuum was reached, the leakage rate was checked at the dry gas meter for 1 minute. If the leak rate was 0.02 ft^3/min, the sampling train was used to obtain the samples. Excessive leaks were corrected prior to sampling. The impactor was then placed at the selected sampling point(s). Sampling times ranged between 60 and 75 minutes at the inlet location and 180 minutes at the outlet. A post-test leak check was not performed to avoid the possibility of dislodging the particles on individual stages.

During sampling, stack gas and sampling train data were recorded at designated intervals depending on the length of the run. The isokinetic sampling rate was set initially, and constant cut-point characteristics were maintained throughout the sampling period.

Sampling Recovery Procedures--

After each test was completed, the impactors were removed from the probe and carefully moved to the designated cleanup area; the impactors were kept in an upright position. All pertinent data were recorded on the Impactor Recovery and Integrity Data Sheets.

Mark III:

Container No. 1 - The nozzle and inlet chamber were brushed and rinsed with acetone to remove particulate into a polyethylene container. After the container was sealed and labeled, the liquid level was marked.

Container Nos. 2 through 10 - Each filter was removed from its stage and carefully placed in a petri dish. Loose particulate from the bottom side of the previous stage plate, the Inconel spacer, flat crossbar, and top side of the plate directly under the filter were brushed into the same petri dish as the respective filter. Each petri dish was sealed and labeled.

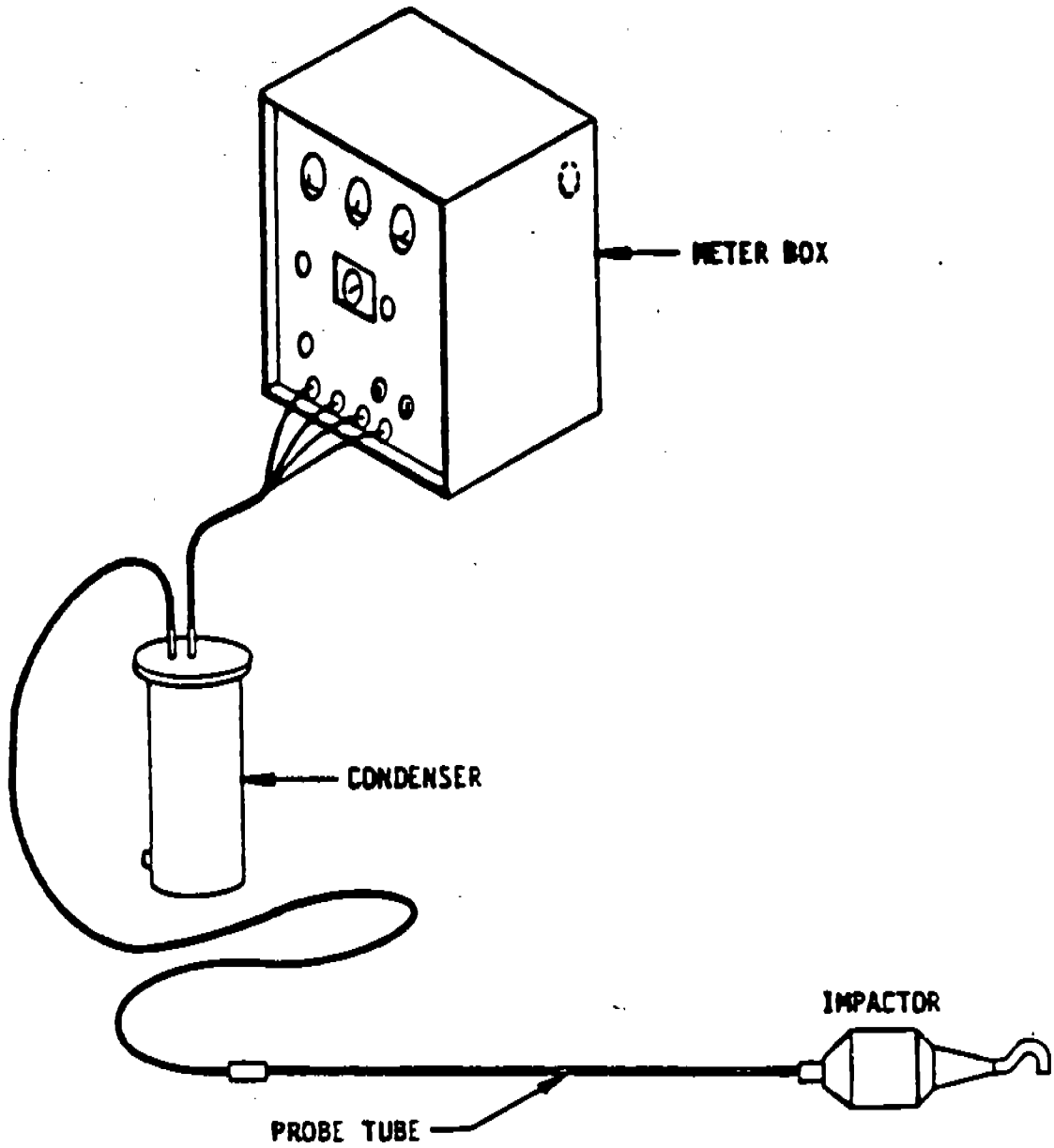


Figure D-2. Andersen Mark III impactor sampling train.

Gravimetric Analysis--

Filters - Each glass fiber filter was desiccated in its respective sample container for 24 hours to a constant weight and weighed to the nearest 0.1 mg on an analytical balance.

Acetone rinse - The volume of each acetone rinse was measured and transferred to a tared beaker. The sample was evaporated to dryness at ambient temperature and pressure, desiccated for 24 hours to a constant weight, and weighed to the nearest 0.1 mg.

The term "constant weight" means a difference of no more than 0.2 mg or 1 percent of total weight less tare weight (whichever is greater) between two consecutive weighings, with no less than 6 hours of desiccation between weighings.

Data Reduction--

For each test, size distribution curves were established representing the total weight percent of particulate matter smaller than the indicated aerodynamic particle diameter in micrometers (μm). Each data point was plotted by computer and indicates both the 50 percent effective cut-size of each impactor stage and the cumulative weight percent of material collected in subsequent stages. Inhalable (<10 μm) and fine (<2.5 μm) size fractions are also reported.

Cut-points for the eight Mark III impactor stages were calculated by computer programs contained in "A Computer-Based Cascade Impactor Data Reduction System" (CIDRS) developed for EPA by Southern Research Institute (SRI).* All

* Southern Research Institute. A Computer-Based Cascade Impactor Data Reduction System. Prepared for U.S. Environmental Protection Agency under Contract No. 68-022-131, Revised March 1980.

particle size results are based on a particle density of 1 g/cm^3. Data reduction and intermediate results calculations for the impactors were performed by the CIDRS programs, with moisture contents obtained from the Method 13B tests.

Cr^{+6} and Total Cr Analysis by Particle Size Fraction

Upon completion of the gravimetric analysis, samples from each location were composited by stage cutpoint into a single inlet and outlet sample. The following procedures were used to determine Cr^{+6} and total Cr by size fraction.

Hexavalent Cr

After the gravimetric analysis was completed, the Andersen run samples were prepped for Cr^{+6} by use of the alkaline digestion method (No. 3060 SW846). The filters in the inlet runs were combined by stages and cut into small pieces and placed in beakers. The filters in the outlet runs were treated in the same manner. The acetone rinses were combined by adding a small amount of acetone to the beakers and scraping the residue with a Teflon spatula and rinsing it into a beaker. The acetone evaporated off, leaving the combined residues. The blank Andersen filters were combined by taking three filters with small spacing between the filter rings and combining them in a beaker, and combining three filters with large spacing between filter rings in another beaker. The backup filter and blank acetone rinse were analyzed individually and then prepped in the same manner as the other Andersen samples. After the digestion was completed, the contents of the beaker was filtered using a 47-mm, 3.0-μm pore size Teflon filter. The filtrate was quantitatively transferred to a 100-ml volumetric flask and diluted to the mark with Type I H_2O. The Teflon filter and Andersen filters were saved for

digestion for total Cr. The Cr^{+6} concent of the filtrate was determined using the colorimetric method (Method 7196 SW846).

The volume of the impinger solutions was measured and then an aliquot was filtered using a 47-mm, 3.0-μm pore size Teflon filter. The filter and solids were digested using the alkaline digestion method with the final volume being 100 ml. The filtrate and alkaline extracts were then analyzed for Cr^{+6} using the colorimetric method.

The process samples were treated in the same manner as the impinger solutions with the exception that the total volume was not measured.

Total Cr

The total Cr content of the Andersen filters was determined by means of digesting the filters and residue from the alkaline digestion using the acid digestion for sludges (Method 3050 SW846) and a final volume of 100 ml. The filters and residue from the alkaline digestion of the impinger solution solids and process sample solids were digested in the same manner. The digestates were analyzed for Cr using a Perkin Elmer Model Plasma II Inductively Coupled Plasma Emission Spectrometer. The instrument was calibrated and the calibration was checked using reference solution obtained from the EPA (ICAP-19 Concentrate 1 WP1083). The samples were analyzed with spiked samples, and 10 percent of the calibrations were checked. The filtrates from the impinger contents and process samples were analyzed in the same manner.

DETERMINATION OF Cr^{+6} AND TOTAL Cr CONTENT OF PROCESS SAMPLES

Process samples (mist eliminator wash water and plating tank solution) were collected during each Cr^{+6}/total Cr test. Wash water was collected from the holding tank located in the plating operations building at the end of each test day. Plating tank solutions were collected individually from the tank using a ladle. All samples were placed in polyethylene containers. Analytical procedures were as described for the emission samples.

APPENDIX E

EQUIPMENT CALIBRATION PROCEDURES AND RESULTS

CALIBRATION PROCEDURES AND RESULTS*

All of the equipment used for these tests was calibrated according to the procedures outlined in Maintenance, Calibration, and Operation of Isokinetic Source-Sampling Equipment.*

NOZZLE DIAMETER

The nozzles were calibrated by making three separate measurements with different inside diameters and calculating the average. If a deviation of more than 0.004 inch was found, the nozzle was either discarded or reamed out and remeasured. A micrometer was used for measuring. These calibration data are shown in Figure E-1.

PITOT TUBE CALIBRATION

The pitot tubes used in sampling were constructed by PEI Associates, Inc., and met all requirements of EPA Method 2.** Therefore, a baseline coefficient of 0.84 was assigned to each pitot tube. Figures E-2 and E-3 present the alignment requirements of Method 2, and Figures E-4a through E-4d present actual calibration and inspection data of the pitot tubes used during the test program.

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* Office of Air Programs Publication No. APTD-0576.

** 40 CFR 60, Appendix A, Reference Method 2, July 1985.

NOZZLE CALIBRATION

Date 6/30/86 Calibrated by CB

Nozzle identification number	D_1, in.	D_2, in.	D_3, in.	ΔD, in.	D_{avg}
#MEO-outlet	.265	.265	.264	.001	.265
#3-110 (outlet P.S.)	0.194	0.196	0.198	.004	0.196
MEI (INlet)	.255	.252	.253	.003	.253
#3-104 (Inlet P.S.)	0.192	0.192	0.192	0.0	0.192

where:

$D_{1,2,3}$ = nozzle diameter measured on a different diameter, in.
Tolerance = measure within 0.001 in.

ΔD = maximum difference in any two measurements, in.
Tolerance = 0.004 in.

D_{avg} = average of D_1, D_2, and D_3.

Figure E-1. Nozzle calibration data.

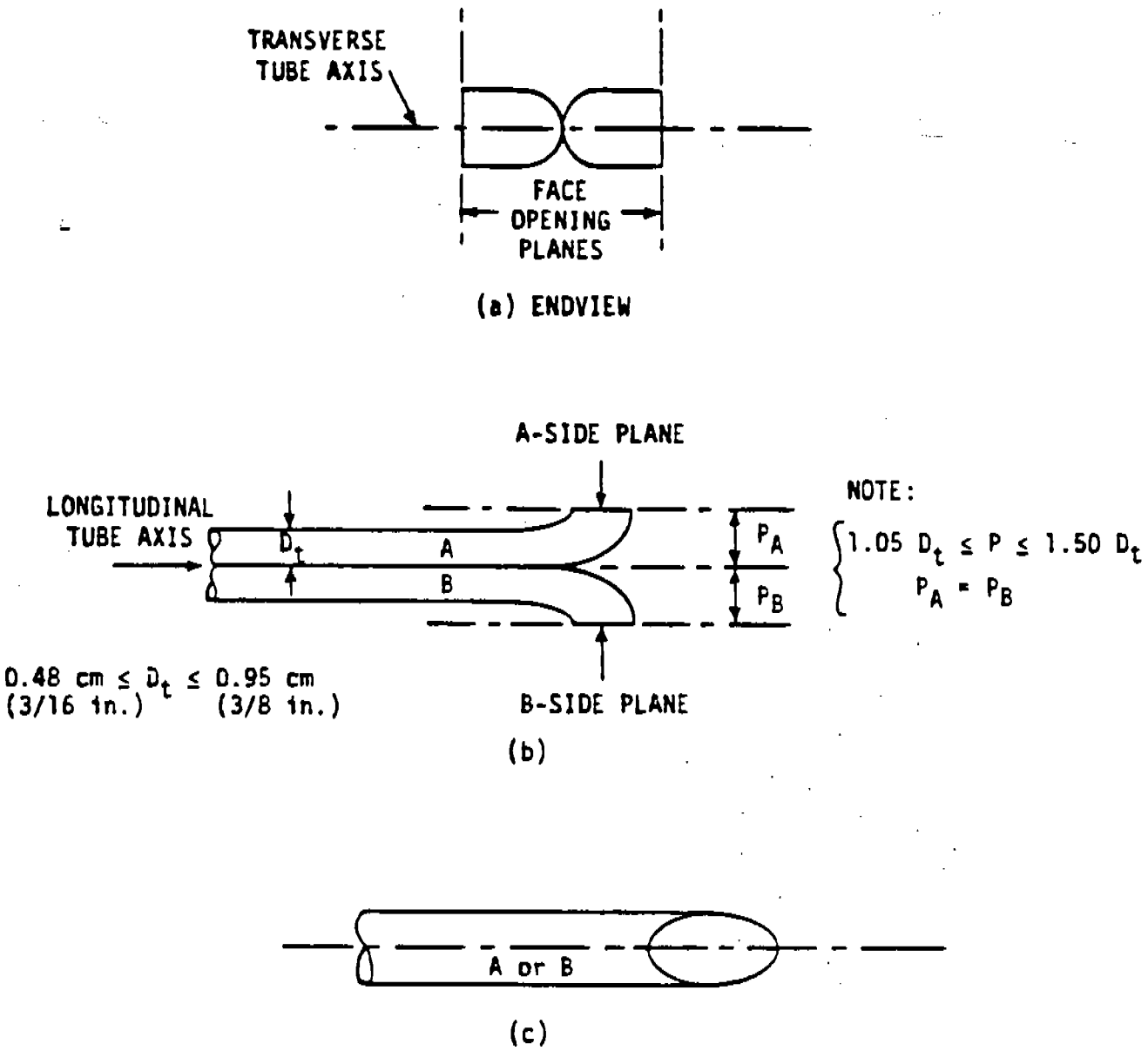

Figure E-2. Properly constructed Type S pitot tube, shown in: (a) end view; face opening planes perpendicular to transverse axis; (b) top view; face opening planes parallel to longitudinal axis; (c) side view; both legs of equal length and centerlines coincident, when viewed from both sides. Baseline coefficient values of 0.84 may be assigned to pitot tubes constructed this way.

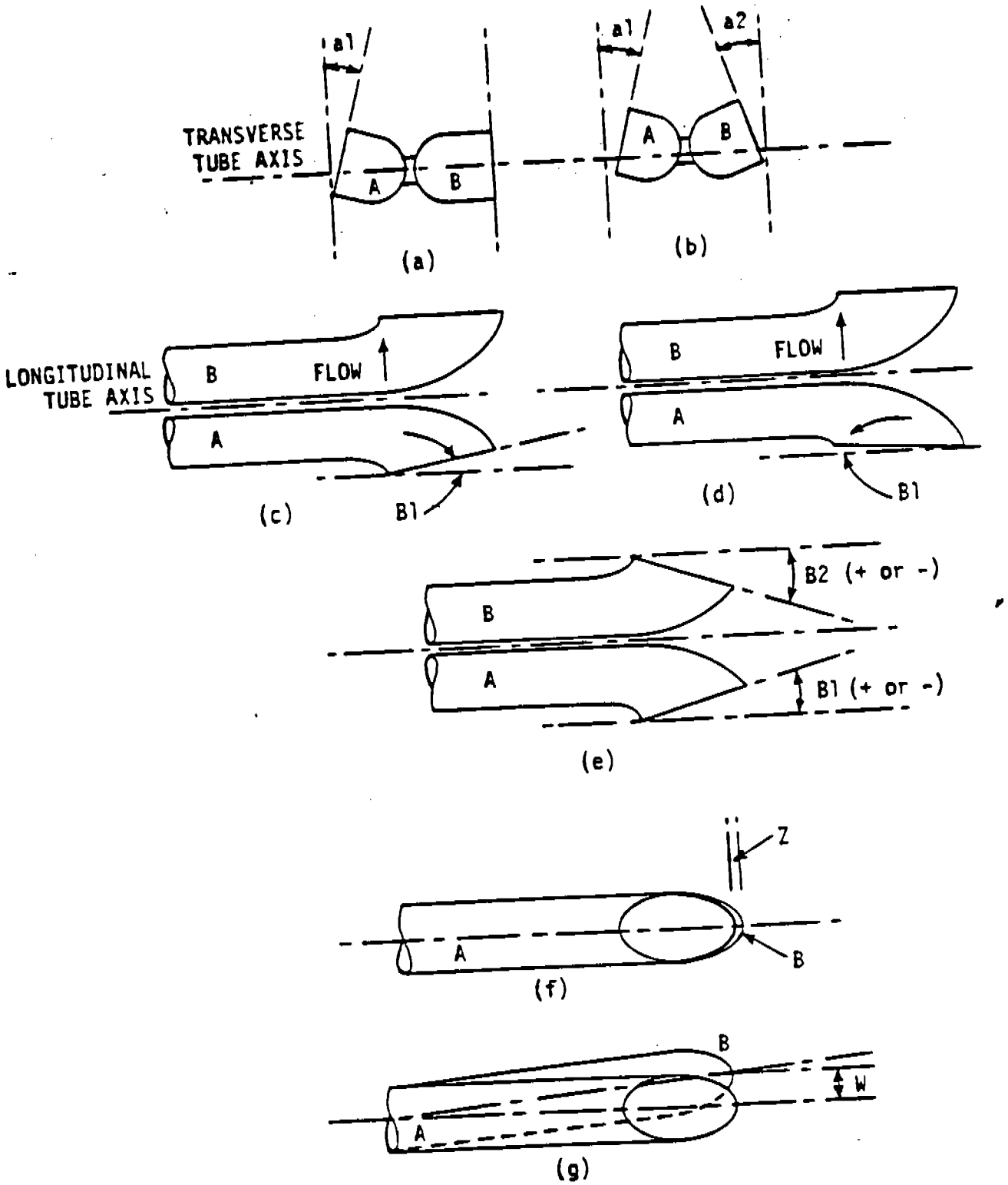

Figure E-3. Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect Cp so long as a_1 and a_2 <10°, B_1 and B_2 <5°, z <0.32 (1/8 in.) and w <0.08 cm (1/32 in.).

Pitot Tube No. 242/3' Date 12-30-85 Inspector G. Howard

α_1 Degrees	α_2 Degrees	β_1 Degrees	β_2 Degrees
1°	1°	1°	2°
<10°	<10°	<5°	<5°

D_t Inches	P Inches	1.05 D_t Inches	1.50 D_t Inches
.376	.985	.395	.564
0.185 ≤ P_t <0.380	-	-	-

γ Degrees	ϕ Degrees	P_{sin} (γ) Inches	P_{sin} (ϕ) Inches
0°	0°		
-	-	<0.125	<0.03125

P_1 Inches	P_2 Inches	$\lvert P_1 - P_2 \rvert$ Inches	Meet specifications
.493	.490	.003	✓
1.05 D_t <P_1 <1.50 D_t	1.05 D_t <P_2 <1.50 D_t	≤0.010	

Lower line in each table is limits for meeting specifications.

Figure E-4a. Pitot tube inspection data sheet.

Pitot Tube No. 504 Date 12-30-85 Inspector G Howard

3'

α_1 Degrees	α_2 Degrees	β_1 Degrees	β_2 Degrees
0°	0°	1°	0°
<10°	<10°	<5°	<5°

D_t Inches	P Inches	1.05 D_t Inches	1.50 D_t Inches
.375	1.000	.394	.563
$0.185 \leq P_t < 0.380$	-	-	-

γ Degrees	ϕ Degrees	P_{sin} (γ) Inches	P_{sin} (ϕ) Inches
0°	0°	0.000	0.000
-	-	<0.125	<0.03125

P_1 Inches	P_2 Inches	$\lvert P_1 - P_2 \rvert$ Inches	Meet specifications
.501	.499	.001	✓
1.05 D_t <P_1 <1.50 D_t	1.05 D_t <P_2 <1.50 D_t	$\leq$0.010	

Lower line in each table is limits for meeting specifications.

Figure E-4b. Pitot tube inspection data sheet.

Pitot Tube No. 015 (4') Date 12-30-85 Inspector G. Howard

α_1 Degrees	α_2 Degrees	β_1 Degrees	β_2 Degrees
1°	3°	0°	1°
<10°	<10°	<5°	<5°

D_t Inches	P Inches	1.05 D_t Inches	1.50 D_t Inches
.375	.358		
$0.185 \leq P_t < 0.380$	-	-	-

γ Degrees	ϕ Degrees	P_{sin} (γ) Inches	P_{sin} (ϕ) Inches
1°	0°	.0175	0.0000
-	-	<0.125	<0.03125

P_1 Inches	P_2 Inches	$\lvert P_1 - P_2 \rvert$ Inches	Meet specifications
.430	.429	.001	✓
$1.05\ D_t < P_1 < 1.50\ D_t$	$1.05\ D_t < P_2 < 1.50\ D_t$	≤ 0.010	

Lower line in each table is limits for meeting specifications.

Figure E-4c. Pitot tube inspection data sheet.

PITOT TUBE INSPECTION DATA SHEET

Pitot Tube No. 316 Date 12-30 85 Inspector G Howard

3'

α_1 Degrees	α_2 Degrees	β_1 Degrees	β_2 Degrees
0°	2°	2°	2°
<10°	<10°	<5°	<5°

D_t Inches	P Inches	1.05 D_t Inches	1.50 D_t Inches
.375	.944	.394	.563
$0.185 \leq P_t < 0.380$	-	-	-

γ Degrees	ϕ Degrees	P_{sin} (γ) Inches	P_{sin} (ϕ) Inches
0°	1°	0.000	.0175
-	-	<0.125	<0.03125

P_1 Inches	P_2 Inches	$\lvert P_1 - P_2 \rvert$ Inches	Meet specifications
.471	.473	.002	✓
$1.05\ D_t < P_1 < 1.50\ D_t$	$1.05\ D_t < P_2 < 1.50\ D_t$	≤0.010	

Lower line in each table is limits for meeting specifications.

Figure E-4d. Pitot tube inspection data sheet.

DRY GAS METER AND ORIFICE METER

Figure E-5 was the setup used for the initial and post-test calibration. A wet-test meter with a 2-cubic-feet-per-minute capacity and ± 1 percent accuracy was used. The pump was run for approximately 15 minutes at an orifice manometer setting of 0.5 in.H_2O to heat up the pump and wet the interior surface of the wet-test meter. The information in Figure E-6 (example calculation sheet) was gathered for the initial calibration; the ratio of accuracy of the wet-test meter to the dry-test meter and the ΔH@ were then calculated.

POST-TEST METER CALIBRATION CHECK

A post-test meter calibration check was made on the meter box used during the test to check its accuracy against its last calibration check. This post-test calibration must be within ± 5 percent of the initial calibration. The initial calibration was performed as described in APTD-0576. The same method was used for the post-test calibration as was used for the initial calibration. Three calibration runs were made with the average orifice setting obtained during the test series and with the vacuum set at the maximum value obtained during the test series. After the post-test calibration check was run, all three runs were within the ± 5 percent range allowed according to EPA Method 5.* The initial and post-test meter box calibration data are presented in Figures E-7a through E-7h.

STACK THERMOCOUPLES

The thermocouples were calibrated by comparison against an ASTM-3F thermometer at approximately 32°F, ambient temperature, 100°F, and 500°F.

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* 40 CFR 60, Appendix A, Reference Method 2, July 1985.

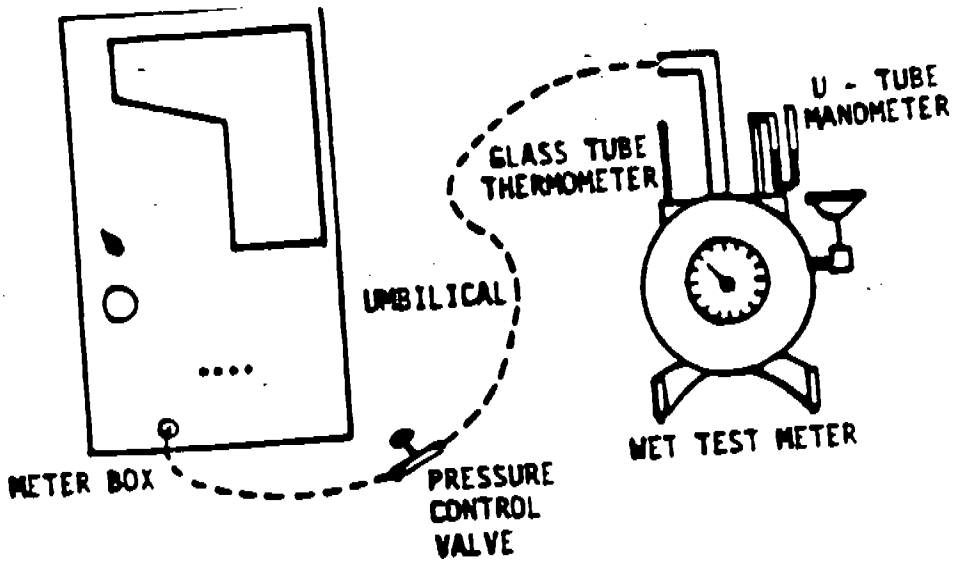

Figure E-5. Calibration setup.

METER BOX NO. _____

DATE _____ DRY GAS METER NO. _____

BAROMETRIC PRESSURE, P_b = _____ in. Hg.

Orifice manometer setting ΔH, in. H_2O	Gas volume wet test meter V_w, ft^3	Gas volume dry gas meter V_d, ft^3	Wet test meter t_w, °F	Dry gas meter Inlet t_{di}, °F	Dry gas meter Outlet t_{do}, °F	Dry gas meter Average t_d, °F	Time θ, min	Y	$\Delta H@$
0.5	5								
1.0	5								
1.5	10								
2.0	10								
3.0	10								
4.0	10								

Average _____

ΔH	$\frac{\Delta H}{13.6}$	Y: $\frac{V_w P_b (t_d + 460)}{V_d (P_b + \frac{\Delta H}{13.6}) (t_w + 460)}$	$\Delta H@$: $\frac{0.0317 \Delta H}{P_b (t_d + 460)} \left[\frac{(t_w + 460)\theta}{V_w} \right]^2$
0.5	0.0368		
1.0	0.0737		
1.5	0.110		
2.0	0.147		
3.0	0.221		
4.0	0.294		

Y = Ratio of accuracy of wet test meter to dry test meter. Tolerance = ± 0.01

$\Delta H@$ = Orifice of pressure differential that gives 0.75 cfm of air at 70°F and 29.92 inches of mercury, in H_2O. Tolerance = ±0.15.

Figure E-6. Calibration data sheet.

DATE: 2-26-86

CALIBRATOR: G Howard

METER BOX NO. FT-1

BAROMETRIC PRESSURE (P_b) 28.96 in. Hg

Leak Checks:

Positive (minimum 5 in. H_2O): ✓ @ 8.3" H_2O

Negative (within 3 in. Hg of absolute): 0.000 cfm* 27.0 in. Hg

*Not to exceed 0.001 cfm.

Orifice manometer setting ΔH in H_2O	Volume wet test meter V_w ft^3	Volume dry gas meter V_d ft^3	Temperatures: Wet test meter T_w °F	Temperatures: Dry gas meter Inlet T_1 °F	Temperatures: Dry gas meter Outlet T_o °F	Temperatures: Dry gas meter Average T_d °F	Duration of test θ min	Vacuum setting in Hg	Y	ΔHθ in H_2O
0.5	5.0	811.773	70.5	83	80	81.5	12 33/60	10.0	.9804	1.792
		816.772	70.5	84	79					
1.0	12.0	818.859	70.5	83	79	81.5	21 29/60	10.0	.9800	1.823
		831.326	70.5	86	78					
1.5	12.0	831.863	70.5	86	77	81.5	17 29/60	10.0	.9788	1.811
		844.330	70.5	88	78					
2.0	14.01	845.862	70.5	85	78	83.75	17 47/60	10.0	.9821	1.825
		860.410	70.5	92	80					
3.0	10.0	861.108	70.5	86	79	84.75	10 25/60	10.0	.9828	1.842
		871.477	70.5	93	81					
4.0	10.0	933.015	70.0	92	83	87.75	9 7/60	10.0	.9816	1.87
		943.439	70.0	93	83					
								Average	.981	1.83

Y must not deviate by more than ±0.02 Y.

ΔHθ must not deviate by more than 0.15 in H_2O.

ΔH	Y: $\frac{(V_w)(P_b)(T_d + 460)}{(V_d)(P_b + \Delta H/13.6)(T_w + 460)}$	ΔHθ: $\frac{(0.0317)(\Delta H)}{(P_b)(T_d + 460)}\left[\frac{(T_w + 460)(\theta)}{(V_w)}\right]^2$
0.5	$\frac{(5.0)(28.96)(541.5)}{(5.194)(28.997)(530.5)}$	$\frac{(.0317)(0.5)}{(28.96)(541.5)}\left[\frac{(530.5)(12.55)}{(5.0)}\right]^2$
1.0	$\frac{(12.0)(28.96)(541.5)}{(12.467)(29.034)(530.5)}$	$\frac{(.0317)(1.0)}{(2896)(541.5)}\left[\frac{(530.5)(21.48)}{(12.0)}\right]^2$
1.5	$\frac{(12.0)(28.96)(541.5)}{(12.467)(29.076)(530.5)}$	$\frac{(0.0317)(1.5)}{(2896)(541.5)}\left[\frac{(530.5)(17.48)}{(12.0)}\right]^2$
2.0	$\frac{(14.01)(28.96)(543.75)}{(14.548)(29.107)(530.5)}$	$\frac{(0.0317)(2.0)}{(2896)(543.75)}\left[\frac{(530.5)(17.78)}{(14.01)}\right]^2$
3.0	$\frac{(10.0)(28.96)(544.75)}{(10.369)(29.180)(530.5)}$	$\frac{(0.0317)(3.0)}{(2896)(544.75)}\left[\frac{(530.5)(16.42)}{(10.0)}\right]^2$
4.0	$\frac{(10.0)(29.96)(547.75)}{(10.424)(29.225)(530.0)}$	$\frac{(0.0317)(4.0)}{(2896)(547.75)}\left[\frac{(530.0)(9.12)}{(10.0)}\right]^2$

Figure E-7a. Particulate sampling meter box initial calibration.

DATE: 7-8-86 METER BOX NO. FT-1

BAROMETRIC PRESSURE (P_{bar}): 29.62 in. Hg PRETEST Y: .981 ΔH@: 1.93

PLANT: Able Mach. Co/Steel Heddle PROJECT NO. 3615-22

PROJECT MANAGER: C. Bruffey CALIBRATOR: J. Neese

Orifice manometer setting * ΔH in. H_2O	Wet test meter volume V_w ft^3	Dry gas meter volume V_d ft^3	Temperatures: Wet test meter T_w °F	Dry gas meter: Inlet T_{di} °F	Dry gas meter: Outlet T_{di} °F	Dry gas meter: Average T_d °F	Vacuum setting ** in. Hg	Duration of run θ min	Y	ΔH@
3.0	10.0	813.405	71	92	76	84.25	5	10:21/60	.994	1.78
		823.637	71	92	77					
3.0	10.0	823.637	71	92	77	85	5	10:22/60	.993	1.79
		833.898	71	93	78					
3.0	26.0	833.898	71	93	78	86	5	26:57/60	.993	1.78
		860.633	71	93	86					
								Post-test average***	.993	1.78

Y	ΔH@
$\frac{(V_w)(P_{bar})(T_d + 460)}{(V_d)(P_{bar} + \Delta H/13.6)(T_w + 460)}$	$\frac{(0.0317)(\Delta H)}{(P_{bar})(T_d + 460)}\left[\frac{(T_w + 460)(\theta)}{(V_w)}\right]^2$
$\frac{(10)(29.62)(544.25)}{(10.232)(29.84)(531)}$	$\frac{(.0317)(3.0)}{(29.62)(544.25)}\left[\frac{(531)(10.35)}{(10)}\right]^2$
$\frac{(10)(29.62)(545)}{(10.261)(29.84)(531)}$	$\frac{(.0317)(3.0)}{(29.62)(545)}\left[\frac{(531)(10.37)}{(10)}\right]^2$
$\frac{(26)(29.62)(546)}{(26.735)(29.84)(531)}$	$\frac{(.0317)(3.0)}{(29.62)(546)}\left[\frac{(531)(26.95)}{(26)}\right]^2$

*To be the average ΔH used during the test series.
**To be the highest vacuum used during the test series.
***Post-test Y must be within the range, pre-test Y ±0.05Y
Post-test ΔH@ must be within the range, pre-test ΔH@ ±0.15

Figure E-7b. Particulate sampling meter box post-test calibration.

DATE: 12-4-95 METER BOX NO. EB-11

CALIBRATOR: J. NEESE BAROMETRIC PRESSURE (P_b) 29.76 in. Hg

Leak Checks:

Positive (minimum 5 in. H_2O): ✓

Negative (within 3 in. Hg of absolute): .000 cfm* 27.0 in. Hg

*Not to exceed 0.00[illegible] cfm.

Orifice manometer setting ΔH in H_2O	Volume wet test meter V_w ft^3	Volume dry gas meter V_d ft^3	Temperatures: Wet test meter T_w °F	Dry gas meter: Inlet T_1 °F	Dry gas meter: Outlet T_2 °F	Dry gas meter: Average T_d °F	Duration of test θ min	Vacuum setting in Hg	γ	ΔHθ in H_2O
0.5	6	39.414	68.5	80	76	78.25	12:22/60	10	.985	1.17
		45.612	68.5	81	76					
1.0	10	46.012	68.5	81	76	78.75	14:43/60	10	.980	1.20
		56.387	68.5	82	76					
1.5	10	56.918	68.5	82	76	79.25	11:42/60	10	.977	1.13
		67.319	68.5	83	76					
2.0	10	67.714	68.5	83	76	80	10:11/60	10	.976	1.14
		78.131	68.5	84	77					
3.0	10	78.516	68.5	84	77	80.75	8:23/60	10	.975	1.16
		88.928	68.5	85	77					
4.0	10	89.364	68.5	85	77	81	7:16/60	10	.977	1.16
		99.743	68.5	85	77					
								Average	.978	1.16

γ must not deviate by more than ±0.02 γ.

ΔHθ must not deviate by more than 0.15 in H_2O.

ΔH	γ: $\frac{(V_w)(P_b)(T_d + 460)}{(V_d)(P_b + \Delta H/13.6)(T_w + 460)}$	ΔHθ: $\frac{(0.0317)(\Delta H)}{(P_b)(T_d + 460)}\left[\frac{(T_w + 460)(\theta)}{(V_w)}\right]^2$
0.5	$\frac{(6)(29.76)(538.25)}{(6.198)(29.80)(528.5)}$	$\frac{(.0317)(0.5)}{(29.76)(538.25)}\left[\frac{(528.5)(12.37)}{(6)}\right]^2$
1.0	$\frac{(10)(29.76)(538.75)}{(10.375)(29.83)(528.5)}$	$\frac{(.0317)(1.0)}{(29.76)(538.75)}\left[\frac{(528.5)(14.72)}{(10)}\right]^2$
1.5	$\frac{(10)(29.76)(539.25)}{(10.40)(29.87)(528.5)}$	$\frac{(.0317)(1.5)}{(29.76)(539.25)}\left[\frac{(528.5)(11.7)}{(10)}\right]^2$
2.0	$\frac{(10)(29.76)(540)}{(10.417)(29.91)(528.5)}$	$\frac{(.0317)(2.0)}{(29.76)(540)}\left[\frac{(528.5)(10.18)}{(10)}\right]^2$
3.0	$\frac{(10)(29.76)(540.75)}{(10.412)(29.98)(528.5)}$	$\frac{(.0317)(3.0)}{(29.76)(540.75)}\left[\frac{(528.5)(8.38)}{(10)}\right]^2$
4.0	$\frac{(10)(29.76)(541)}{(10.379)(30.05)(528.5)}$	$\frac{(.0317)(4.0)}{(29.76)(541)}\left[\frac{(528.5)(7.27)}{(10)}\right]^2$

Figure E-7c. Particulate sampling meter box initial calibration.

DATE: 7-8-96 METER BOX NO. FB-11

BAROMETRIC PRESSURE (P_{bar}): 29.62 in. Hg PRETEST Y: .978 ΔH@: 1.16

PLANT: Steel Heddle / Able Mach. Co PROJECT NO. 3615-22

PROJECT MANAGER: C. Bruffey CALIBRATOR: J. Noose

Orifice manometer setting * ΔH in. H_2O	Wet test meter volume V_w ft^3	Dry gas meter volume V_d ft^3	Temperatures: Wet test meter T_w °F	Temperatures: Dry gas meter Inlet T_{di} °F	Temperatures: Dry gas meter Outlet T_{di} °F	Temperatures: Dry gas meter Average T_d °F	Vacuum setting ** in. Hg	Duration of run θ min	Y	ΔH@
2.5	12	262.939	71	94	76	85.5	8.5	10:46/60	.974	1.11
		275.417	71	94	78					
2.5	19	275.417	71	94	78	87	8.5	17:04/60	.968	1.11
		295.512	71	96	80					
2.5	10	295.512	71	96	80	88.5	8.5	9:00/60	.999	1.11
		305.793	71	96	82					
						Post-test average***			.980	1.11

Y	ΔH@
$\frac{(V_w)(P_{bar})(T_d + 460)}{(V_d)(P_{bar} + \Delta H/13.6)(T_w + 460)}$	$\frac{(0.0317)(\Delta H)}{(P_{bar})(T_d + 460)}\left[\frac{(T_w + 460)(\theta)}{(V_w)}\right]^2$
$\frac{(12)(29.62)(545.5)}{(12.578)(29.80)(531)}$	$\frac{(.0317)(2.5)}{(29.62)(545.5)}\left[\frac{(531)(10.77)}{(12)}\right]^2$
$\frac{(19)(29.62)(547)}{(20.095)(29.80)(531)}$	$\frac{(.0317)(2.5)}{(29.67)(547)}\left[\frac{(531)(17.07)}{(19)}\right]^2$
$\frac{(10)(29.62)(548.5)}{(10.281)(29.80)(531)}$	$\frac{(.0317)(2.5)}{(29.62)(548.5)}\left[\frac{(531)(9.0)}{(10)}\right]^2$

*To be the average ΔH used during the test series.
**To be the highest vacuum used during the test series.
***Post-test γ must be within the range, pre-test γ ±0.05γ
Post-test ΔH@ must be within the range, pre-test $\overline{\Delta H@}$ ±0.15

Figure E-7d. Particulate sampling meter box post-test calibration.

DATE: 12-27-85 METER BOX NO. FB-9

CALIBRATOR: J. Neese BAROMETRIC PRESSURE (P_b) 29.41 in. Hg

Leak Checks:

Positive (minimum 5 in. H_2O): ✓

Negative (within 3 in. Hg of absolute): .001 cfm* 27.0 in. Hg

*Not to exceed 0.005 cfm.

Orifice manometer setting ΔH in H_2O	Volume wet test meter V_w ft^3	Volume dry gas meter V_d ft^3	Temperatures: Wet test meter T_w °F	Dry gas meter: Inlet T_1 °F	Dry gas meter: Outlet T_2 °F	Dry gas meter: Average T_d °F	Duration of test θ min	Vacuum setting in Hg	Y	ΔHθ in H_2O
0.5	5	76.328	73	95	84	90.5	13:39/60		.984	2.03
		81.571	73	75	86					
1.0	11	81.954	73	95	86	90.75	21:14/60		.984	2.07
		93.377	73	96	86					
1.5	10	93.812	73	96	86	91.75	15:27/60		.986	1.99
		104.274	73	98	87					
2.0	10	104.535	73	98	87	92.75	13:26/60		.987	2.00
		114.994	73	99	87					
3.0	10	115.325	73	99	87	93.5	11:06/60		.988	2.06
		125.758	73	100	88					
4.0	10	126.152	73	100	88	94	9:42/60		.989	2.08
		136.561	73	100	88					
								Average	.986	2.04

Y must not deviate by more than ±0.02 Y.

ΔHθ must not deviate by more than 0.15 in H_2O.

ΔH	Y: $\frac{(V_w)(P_b)(T_d + 460)}{(V_d)(P_b + \Delta H/13.6)(T_w + 460)}$	ΔHθ: $\frac{(0.0317)(\Delta H)}{(P_b)(T_d + 460)}\left[\frac{(T_w + 460)(\theta)}{(V_w)}\right]^2$
0.5	$\frac{(5)(29.41)(530.5)}{(5.243)(29.45)(533)}$	$\frac{(.0317)(0.5)}{(29.41)(530.5)}\left[\frac{(533)(13.48)}{(5)}\right]^2$
1.0	$\frac{(11)(29.41)(550.75)}{(11.523)(29.48)(533)}$	$\frac{(.0317)(1.0)}{(29.41)(550.75)}\left[\frac{(533)(21.23)}{(11)}\right]^2$
1.5	$\frac{(10)(29.41)(551.75)}{(10.462)(29.52)(533)}$	$\frac{(.0317)(1.5)}{(29.41)(551.75)}\left[\frac{(533)(15.45)}{(10)}\right]^2$
2.0	$\frac{(10)(29.41)(552.75)}{(10.459)(29.56)(533)}$	$\frac{(.0317)(2.0)}{(29.41)(552.75)}\left[\frac{(533)(13.43)}{(10)}\right]^2$
3.0	$\frac{(10)(29.41)(553.5)}{(10.433)(29.63)(533)}$	$\frac{(.0317)(3.0)}{(29.41)(553.5)}\left[\frac{(533)(11.13)}{(10)}\right]^2$
4.0	$\frac{(10)(29.41)(554)}{(10.409)(29.70)(533)}$	$\frac{(.0317)(4.0)}{(29.41)(554)}\left[\frac{(533)(9.7)}{(10)}\right]^2$

Figure E-7e. Particulate sampling meter box initial calibration.

DATE: 7-9-86 METER BOX NO. FB-9

BAROMETRIC PRESSURE (P_{bar}): 29.39 in. Hg PRETEST Y: .986 ΔH@: 2.04

PLANT: Steel Heddle/Able Mach. Co. PROJECT NO. 3615-22

PROJECT MANAGER: C Bruffey CALIBRATOR: J. Neese

Orifice manometer setting * ΔH in. H_2O	Wet test meter volume V_w ft^3	Dry gas meter volume V_d ft^3	Temperatures: Wet test meter T_w °F	Temperatures: Dry gas meter Inlet T_{di} °F	Temperatures: Dry gas meter Outlet T_{di} °F	Temperatures: Dry gas meter Average T_d °F	Vacuum setting ** in. Hg	Duration of run θ min	Y	ΔH@
1.3	10.0	218.338	71	99	86	92.5	4	$16.\frac{24}{60}$	.977	1.92
		228.954	71	99	86					
1.3	11.0	228.954	71	99	86	92.5	4	$18.\frac{05}{60}$	.977	1.93
		240.633	71	99	86					
1.3	10.0	240.633	71	99	86	92.5	4	$16.\frac{29}{60}$	.977	1.94
		251.244	71	99	86					
							Post-test average***		.977	1.93

Y	ΔH@
$\frac{(V_w)(P_{bar})(T_d + 460)}{(V_d)(P_{bar} + \Delta H/13.6)(T_w + 460)}$	$\frac{(0.0317)(\Delta H)}{(P_{bar})(T_d + 460)}\left[\frac{(T_w + 460)(\theta)}{(V_w)}\right]^2$
$\frac{(10)(29.39)(552.5)}{(10.616)(29.49)(531)}$	$\frac{(.0317)(1.3)}{(29.39)(552.5)}\left[\frac{(531)(16.4)}{(10)}\right]^2$
$\frac{(11)(29.39)(552.5)}{(11.679)(29.49)(531)}$	$\frac{(0317)(1.3)}{(29.39)(552.5)}\left[\frac{(531)(18.08)}{(11)}\right]^2$
$\frac{(10)(29.39)(552.5)}{(10.611)(29.49)(531)}$	$\frac{(.0317)(1.3)}{(29.39)(552.5)}\left[\frac{(531)(16.48)}{(10)}\right]^2$

*To be the average ΔH used during the test series.
**To be the highest vacuum used during the test series.
***Post-test Y must be within the range, pre-test Y ±0.05Y
Post-test ΔH@ must be within the range, pre-test ΔH@ ±0.15

Figure E-7f. Particulate sampling meter box post-test calibration.

DATE: 12-26-85 METER BOX NO. FR-3

CALIBRATOR: J. Neese BAROMETRIC PRESSURE (P_b) 29.30 in. Hg

Leak Checks:

Positive (minimum 5 in. H_2O): ✓

Negative (within 3 in. Hg of absolute): .002 cfm* 28.0 in. Hg

*Not to exceed 0.005 cfm.

Orifice manometer setting ΔH in H_2O	Volume wet test meter V_w ft^3	Volume dry gas meter V_d ft^3	Temperatures: Wet test meter T_w °F	Dry gas meter: Inlet T_1 °F	Dry gas meter: Outlet T_o °F	Dry gas meter: Average T_d °F	Duration of test θ min	Vacuum setting in Hg	Y	ΔHθ in H_2O
0.5	5	585.837	70.5	80	74	77.25	$12\frac{33}{60}$	10	.975	1.79
		591.032	70.5	81	74					
1.0	10	591.332	70.5	81	74	79.5	$18.\frac{06}{60}$	10	.974	1.85
		601.744	70.5	85	78					
1.5	10	602.023	70.5	85	78	82.25	$14.\frac{42}{60}$	10	.978	1.82
		612.436	70.5	87	79					
2.0	10	612.716	70.5	87	79	83.5	$12.\frac{53}{60}$	10	.979	1.86
		623.123	70.5	89	79					
3.0	10	623.458	70.5	89	79	84.5	$10.\frac{41}{60}$	10	.982	1.91
		633.836	70.5	90	80					
4.0	10	634.137	70.5	90	80	85	$9.\frac{18}{60}$	10	.973	1.93
		644.591	70.5	90	80					
								Average	.977	1.86

Y must not deviate by more than ±0.02 Y.

ΔHθ must not deviate by more than 0.15 in H_2O.

ΔH	Y: $\frac{(V_w)(P_b)(T_d+460)}{(V_d)(P_b+\Delta H/13.6)(T_w+460)}$	ΔHθ: $\frac{(0.0317)(\Delta H)}{(P_b)(T_d+460)}\left[\frac{(T_w+460)(\theta)}{(V_w)}\right]^2$
0.5	$\frac{(5)(29.30)(537.25)}{(5.186)(29.34)(530.5)}$	$\frac{(.0317)(0.5)}{(29.30)(537.25)}\left[\frac{(530.5)(12.55)}{(5)}\right]^2$
1.0	$\frac{(10)(29.30)(539.5)}{(10.412)(29.37)(530.5)}$	$\frac{(.0317)(1.0)}{(29.30)(539.5)}\left[\frac{(530.5)(18.1)}{(10)}\right]^2$
1.5	$\frac{(10)(29.30)(542.25)}{(10.413)(29.41)(530.5)}$	$\frac{(.0317)(1.5)}{(29.30)(542.25)}\left[\frac{(530.5)(14.7)}{(10)}\right]^2$
2.0	$\frac{(10)(29.30)(543.5)}{(10.407)(29.45)(530.5)}$	$\frac{(.0317)(2.0)}{(29.30)(543.5)}\left[\frac{(530.5)(12.86)}{(10)}\right]^2$
3.0	$\frac{(10)(29.30)(544.5)}{(10.378)(29.52)(530.5)}$	$\frac{(.0317)(3.0)}{(29.30)(544.5)}\left[\frac{(530.5)(10.68)}{(10)}\right]^2$
4.0	$\frac{(10)(29.30)(545)}{(10.454)(29.59)(530.5)}$	$\frac{(.0317)(4.0)}{(29.30)(545)}\left[\frac{(530.5)(9.3)}{(10)}\right]^2$

Figure E-7g. Particulate sampling meter box initial calibration.

DATE: 7-9-86

BAROMETRIC PRESSURE (P_{bar}): 29.39 in. Hg

PLANT: Steel Heddle / Able Mach. Co.

PROJECT MANAGER: C. Beuffey

METER BOX NO. FB-3

PRETEST Y: .977 ΔH@: 1.86

PROJECT NO. 3615-22

CALIBRATOR: J. Neese

Orifice manometer setting * ΔH in. H_2O	Wet test meter volume V_w ft^3	Dry gas meter volume V_d ft^3	Temperatures: Wet test meter T_w °F	Temperatures: Dry gas meter Inlet T_{di} °F	Temperatures: Dry gas meter Outlet T_{di} °F	Temperatures: Dry gas meter Average T_d °F	Vacuum setting ** in. Hg	Duration of run Ø min	Y	ΔH@
1.5	10.0	509.813	71	86	74	81	3	$14:\frac{38}{60}$	.955	1.80
		520.438	71	88	76					
1.5	10.0	520.438	71	88	76	82.5	3	$14:\frac{44}{60}$	.955	1.82
		531.100	71	89	77					
1.5	12.0	531.100	71	89	77	83.5	3	$17:\frac{40}{60}$	.956	1.82
		543.899	71	89	79					
								Post-test average***	.955	1.81

Y	ΔH@
$\frac{(V_w)(P_{bar})(T_d + 460)}{(V_d)(P_{bar} + \Delta H/13.6)(T_w + 460)}$	$\frac{(0.0317)(\Delta H)}{(P_{bar})(T_d + 460)}\left[\frac{(T_w + 460)(\emptyset)}{(V_w)}\right]^2$
$\frac{(10)(29.39)(541)}{(10.625)(29.50)(531)}$	$\frac{(.0317)(1.5)}{(29.39)(541)}\left[\frac{(531)(1463)}{10}\right]^2$
$\frac{(10)(29.39)(542.5)}{(10.662)(29.50)(531)}$	$\frac{(.0317)(1.5)}{(29.39)(542.5)}\left[\frac{(531)(1473)}{10}\right]^2$
$\frac{(12)(29.39)(543.5)}{(12.799)(29.50)(531)}$	$\frac{(.0317)(1.5)}{(29.39)(543.5)}\left[\frac{(531)(17.67)}{12}\right]^2$

*To be the average ΔH used during the test series.

**To be the highest vacuum used during the test series.

***Post-test Y must be within the range, pre-test Y ±0.05Y
Post-test ΔH@ must be within the range, pre-test ΔH@ ±0.15

Figure E-7h. Particulate sampling meter box post-test calibration.

Date: 12/31/85 Thermocouple No.: 101

Calibrator: G Thcss Reference: ASTM-3F

Range: 32 → 452

Reference point No.	Source,*	Reference thermometer temperature, °F	Thermocouple temperature, °F	Difference, %**
1	2	77	77	0
2	1	32	33	.2
3	3	210	211	.15
4	4	452	454	.22

*Source: 1) Ice Bath
2) Ambient
3) Water Bath
4) Oil Bath

**Percent difference

$$\frac{\text{Reference temp. °R - thermocouple temp. °R}}{\text{(Reference temp. °R)}} \times 100\%$$

where °R = °F + 460

Each percent difference must be less than or equal to 1.5%.

Figure E-8a. Thermocouple calibration data sheet.

Date: 12/30/85 Thermocouple No.: 412

Calibrator: G. Tuess Reference: ASTM-3F

Range: 33 → 470

Reference point No.	Source,*	Reference thermometer temperature, °F	Thermocouple temperature, °F	Difference, %**
1	2	76	76	0
2	1	33	34	.2
3	3	210	212	.3
4	4	468	469	.1

*Source: 1) Ice Bath
2) Ambient
3) Water Bath
4) Oil Bath

**Percent difference

$$\frac{\text{Reference temp. °R - thermocouple temp. °R}}{\text{(Reference temp. °R)}} \times 100\%$$

where °R = °F + 460

Each percent difference must be less than or equal to 1.5%.

Figure E-8b. Thermocouple calibration data sheet.

Date: 12/30/85 Thermocouple No.: 409

Calibrator: GTuess Reference: ASTM-3F

Range: 33→490

Reference point No.	Source,*	Reference thermometer temperature, °F	Thermocouple temperature, °F	Difference, %**
1	2	81	81	0
2	1	33	33	0
3	3	210	211	.15
4	4	490	491	.10

*Source: 1) Ice Bath
2) Ambient
3) Water Bath
4) Oil Bath

**Percent difference

$$\frac{\text{Reference temp. °R - thermocouple temp. °R}}{\text{(Reference temp. °R)}} \times 100\%$$

where °R = °F + 460

Each percent difference must be less than or equal to 1.5%.

Figure E-8c. Thermocouple calibration data sheet.

THERMOCOUPLE CALIBRATION DATA SHEET

Date: 12/30/85 Thermocouple No.: 411

Calibrator: G Theiss Reference: ASTM-3F

Range: 33 → 480

Reference point No.	Source,*	Reference thermometer temperature, °F	Thermocouple temperature, °F	Difference, %**
1	2	78	78	0
2	1	33	35	.40
3	3	211	213	.30
4	4	479	479	0

*Source: 1) Ice Bath
2) Ambient
3) Water Bath
4) Oil Bath

**Percent difference

$$\frac{\text{Reference temp. °R - thermocouple temp. °R}}{\text{(Reference temp. °R)}} \times 100\%$$

where °R = °F + 460

Each percent difference must be less than or equal to 1.5%.

Figure E-8d. Thermocouple calibration data sheet.

The thermocouples read within 1.5 percent of the reference thermometer value throughout the entire range when expressed in degrees Rankine. The thermocouples were checked at ambient temperature at the test sites to verify the calibration. Calibration data are presented in Figures E-8a through E-8d.

DIGITAL INDICATOR FOR THERMOCOUPLE READOUT

Each digital indicator was calibrated by feeding a series of millivolt signals to the input, and comparing the indicator reading with the reading the signal should have generated. Error did not exceed 0.5 percent when the temperatures were expressed in degrees Rankine. Calibration data are shown in Figure E-9a and E-9b.

DRY GAS THERMOMETERS AND IMPINGER THEMOCOUPLES

The dry gas thermometers were calibrated by comparison against an ASTM-3F thermometer at approximately 32°F, at ambient temperature, and at approximately 110°F. The thermometers agreed within 5°F of the reference thermometer. The impinger thermocouples were checked in similar manner at approximately 32°F and at ambient temperature and agreed within 2°F. The thermometers and thermocouples were checked at ambient temperature prior to the test series to verify calibration. Calibration data are included in Figures E-10a through E-10c and E-11a and E-11b.

BALANCE

The Mettler electronic balance was calibrated by comparison with Class-S standard weights and agreed within 0.5 g. A calibration is also performed yearly by the manufacturer. Calibration data are shown in Figures E-12 and E-13.

DATE: 10-22-85 INDICATOR NO: FT-1

OPERATOR: J.E. Fitzgerald SERIAL NO: 5T03

CALIBRATION DEVICE NO: 2 MANUFACTURER: Omega

TEST POINT NO:	MILLIVOLT SIGNAL	EQUIVALENT TEMPERATURE, deg. F	DIGITAL INDICATOR TEMPERATURE READING, deg. F	DIFFERENCE %
1	-0.692	0	-1	0.22
2	1.520	100	101	0.18
3	3.819	200	201	0.15
4	6.092	300	301	0.13
5	8.314	400	399	0.12
6	10.560	500	501	0.10
7	22.251	1000	1001	0.07
8	29.315	1300	1300	0.00
9	36.166	1600	1599	0.05
10	42.732	1900	1899	0.04

Percent difference must be less than of equal to 0.5%

Percent difference:

$$\frac{\text{(Equivalent temperature, deg. R - Digital indicator temperature, deg. R)(100\%)}}{\text{(Equivalent temperature, deg. R)}}$$

Where, deg. R = deg. F + 460

Figure E-9a. Thermocouple digital indicator calibration data sheet.

DATE: 9-14-95 INDICATOR NO: 219

OPERATOR: GThress SERIAL NO: 9450243-10

CALIBRATION DEVICE NO: #1 MANUFACTURER: Newport

TEST POINT NO#	MILLIVOLT SIGNAL	EQUIVALENT TEMPERATURE, deg. F	DIGITAL INDICATOR TEMPERATURE READING, deg. F	DIFFERENCE %
1	-0.692	0	0	0
2	1.520	100	99	-.17
3	3.819	200	201	.15
4	6.092	300	301	.13
5	8.314	400	399	-.11
6	10.560	500	500	0
7	22.251	1000	1002	.13
8	29.315	1300	1303	.17
9	36.166	1600	1604	.19
10	42.732	1900	1904	.17

Percent difference must be less than of equal to 0.5%

Percent difference:

$$\frac{(\text{Equivalent temperature, deg. R} - \text{Digital indicator temperature, deg. R})(100)}{(\text{Equivalent temperature, deg. R})}$$

Where, deg. R = deg. F + 460

Figure E-9b. Thermocouple digital indicator calibration data sheet.

Date: 8-19-85 Meter Box No.: FT-1

Calibrator: J. Neese Reference: ASTM-3F

Inlet

Reference point No.	Source *	Reference thermometer temperature, °F	Dry gas thermometer temperature, °F	Difference, °F**
1	2	70	70	0
2	1	32	33	1
3	3	200	198	2

Outlet

Reference point No.	Source *	Reference thermometer temperature, °F	Dry gas thermometer temperature, °F	Difference, °F**
1	2	70	72	2
2	1	32	33	1
3	3	200	200	0

*Source: 1) Ice bath
2) Ambient
3) Water bath

**Difference must be less than or equal to ±5°F.

Figure E-10a. Dry gas thermometer calibration data sheet.

Date: 12-4-85 Meter Box No.: FB-11

Calibrator: J. Neese Reference: ASTM-3F

Inlet

Reference point No.	Source *	Reference thermometer temperature, °F	Dry gas thermometer temperature, °F	Difference, °F**
1	2	70	70	0
2	1	32	32	0
3	3	186	184	2

Outlet

Reference point No.	Source *	Reference thermometer temperature, °F	Dry gas thermometer temperature, °F	Difference, °F**
1	2	70	72	2
2	1	32	33	1
3	3	186	184	2

*Source: 1) Ice bath
2) Ambient
3) Water bath

**Difference must be less than or equal to ±5°F.

Figure E-10b. Dry gas thermometer calibration data sheet.

Date: 12-26-85 Meter Box No.: FB-9

Calibrator: J. Noose Reference: ASTM-3F

Inlet

Reference point No.	Source*	Reference thermometer temperature, °F	Dry gas thermometer temperature, °F	Difference, °F**
1	2	71	73	2
2	1	32	35	3
3	3	170	169	1

Outlet

Reference point No.	Source*	Reference thermometer temperature, °F	Dry gas thermometer temperature, °F	Difference, °F**
1	2	71	69	2
2	1	32	33	1
3	3	170	168	2

*Source: 1) Ice bath
2) Ambient
3) Water bath

**Difference must be less than or equal to ±5°F.

Figure E-10c. Dry gas thermometer calibration data sheet.

Date: 12-26-85 Meter Box No.: FB-3

Calibrator: J. Neese Reference: ASTM-3F

Inlet

Reference point No.	Source *	Reference thermometer temperature, °F	Dry gas thermometer temperature, °F	Difference, °F**
1	2	72	70	2
2	1	32	32	0
3	3	188	188	0

Outlet

Reference point No.	Source *	Reference thermometer temperature, °F	Dry gas thermometer temperature, °F	Difference, °F**
1	2	72	71	1
2	1	32	32	0
3	3	188	189	1

*Source: 1) Ice bath
2) Ambient
3) Water bath

**Difference must be less than or equal to ±5°F.

Figure E-10d. Dry gas thermometer calibration data sheet.

Date: 1-14 86 Thermocouple No: I-15

Calibrator: J Neese Reference: ASTM-3F

Reference point No.	Source'	Reference thermometer temperature deg. F	Thermocouple temperature deg. F	Difference deg. F''
1	1	74	73	1
2	2	33	34	1

'Source: 1) Ambient
2) Ice bath

''Difference must be less than 2 deg. F at both points

Figure E-11a. Impinger thermocouple calibration data sheet.

Date: 9-17-85 Thermocouple No.: I-1

Calibrator: [illegible] Reference: ASTM-3F

Range: _____

Reference point No.	Source,*	Reference thermometer temperature, °F	Thermocouple temperature, °F	Difference, %**
1	2	76	74	0.37
2	1	37	35	0.40
3	3	196	197	0.15
4	4	381	384	0.36

*Source: 1) Ice Bath
2) Ambient
3) Water Bath
4) Oil Bath

**Percent difference

$$\frac{\text{Reference temp. °R - thermocouple temp. °R}}{\text{(Reference temp. °R)}} \times 100\%$$

where °R = °F + 460

Each percent difference must be less than or equal to 1.5%.

Figure E-11b. Thermocouple calibration data sheet.

Balance No.	Date	Calibrator	Mass determined for					
			5 g	Error	50 g	Error	100 g	Error
194	3/25/86	G. Howard	5.1	0.1	49.8	0.2	99.9	0.1
196	3/25/86	G. Howard	5.2	0.2	50.0	0.0	999	0.1
198	3/25/86	G. Howard	5.0	0.0	49.8	0.2	99.7	0.3
396	3/25/86	G. Howard	5.0	0.0	50.0	0.0	999	0.1
Mettler	3/28/86	J. Neese	5.0	0.0	50.0	0.0	100.0	0.0

Error must not exceed 0.5 grams at each point.

Figure E-12. Trip balance calibration data sheet.

WEIGHT TRACEABILITY CERTIFICATE

TO: PET Associates
11499 Chester Rd
Cinc. Ohio 45246

The balances listed below have been serviced by our representative on 10-17-85

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

	Analytical	Precision
Mettler identification number of test weights used:	13	155
Mettler calibration date of test weights used:	5-14-85	1-16-85
National Bureau of Standards test number:	737/0670-45	737/0670-46

Model and serial number of balances serviced:

H35AR # 679025	PC 4400 # 743985
HL32 # 758669	PE AD-2 # 65920
H31 # 614363	
H35AR # 668020	
PC 4400 # C26340	

Terry Hurst
Mettler Service Representative

10-17-85
Date of Issue

Mettler Instrument Corporation
Box 71, Hightstown, NJ 08520
(609) 448-3000

Figure E-13. Weight traceability certificate.

BAROMETER

The field barometer was calibrated to within 0.1 in.Hg of an NBS-traceable mercury-in-glass barometer before the test series. It was checked against the reference after the test series to determine if it read within 0.2 in.Hg. The barometer read within the allowable limits each time. Calibration data are included in Figure E-14.

ORSAT ANALYZER

The Orsat analyzer was calibrated before the test series by determining the percentage of oxygen, carbon monoxide, and carbon dioxide in a calibrated gas containing known percentages of each. The analyzer read within 0.5 percent of the known value for the gas. Calibration data are shown in Figures E-15a through E-15c.

BAROMETER NO.	406	407	407	406			
	GTE	P&G		EMB			
PRETEST	5463	5456		3615-22			
BAROMETER READING	29.53	29.89	30.08	29.97			
REFERENCE BAROMETER READING	29.53	29.89	30.08	29.99			
DIFFERENCE*	0.00	.001	.00	0.02			
DATE	6/19/86	6/16/86	6/19/86	6/20/86			
CALIBRATOR				J. Neese			

POST-TEST				406			
BAROMETER READING	29.97	30.05		29.91			
REFERENCE BAROMETER READING	29.99	30.08		29.92			
DIFFERENCE**	.02	.03		.01			
DATE	6-20-86	6-19-86		7/5/86			
CALIBRATOR	J. Neese			CB			

*Barometer is adjusted so that difference does not exceed 0.05 in. Hg.
**Barometer is not adjusted. If difference exceed 0.10 in. Hg, inform project manager immediately.

Figure E-14. Barometer calibration log.

PEI ASSOCIATES, INC.
11499 CHESTER ROAD
CINCINNATI, OHIO 45246
(513) 782-4700

Reference Gas: Matheson Gas Products, Inc.
Cylinder No. 3828
Control No. 109-45979
Analysis: CO_2-10.03%
O_2-9.83%
CO-2.04%

Orsat No.: 422 Gas: CO

Calibrator	Date	PN	Value determined
[illegible]	4/11/86	5445	1.8
[illegible]	4/17/86	5443-1	1.9
[illegible]	6/20/86	3615-2	1.8

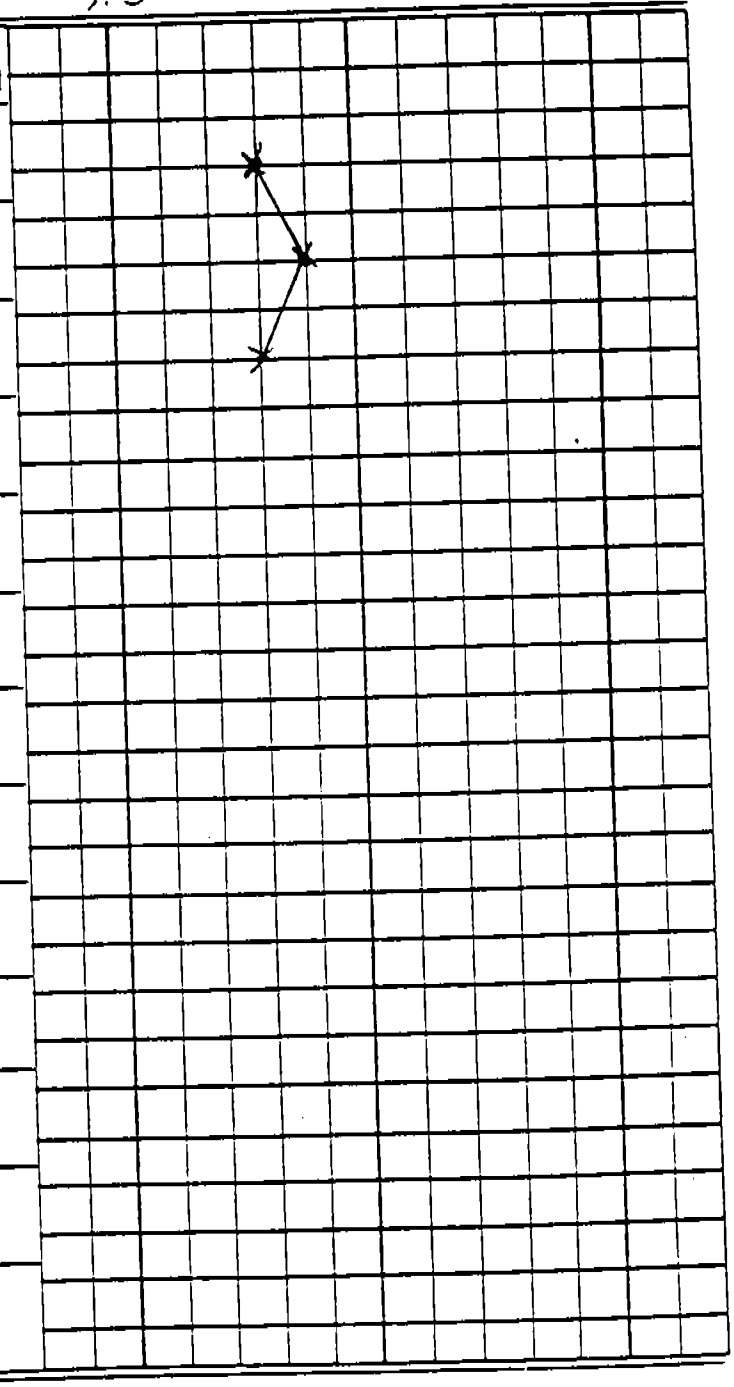

Figure E-15a. Orsat calibration data sheet.

PEI ASSOCIATES, INC.
11499 CHESTER ROAD
CINCINNATI, OHIO 45246
(513) 782-4700

Reference Gas: Matheson Gas Products, Inc.
Cylinder No. 3828
Control No. 109-45979
Analysis: CO_2-10.03%
O_2-9.83%
CO-2.04%

Orsat No.: 422 Gas: CO_2

Calibrator	Date	PN	Value determined
[illegible]	4/11/86	5448	9.6
E. Fitzgerald	4/17/86	5443-1	10.0
G.L. Howard	6/20/86		9.8

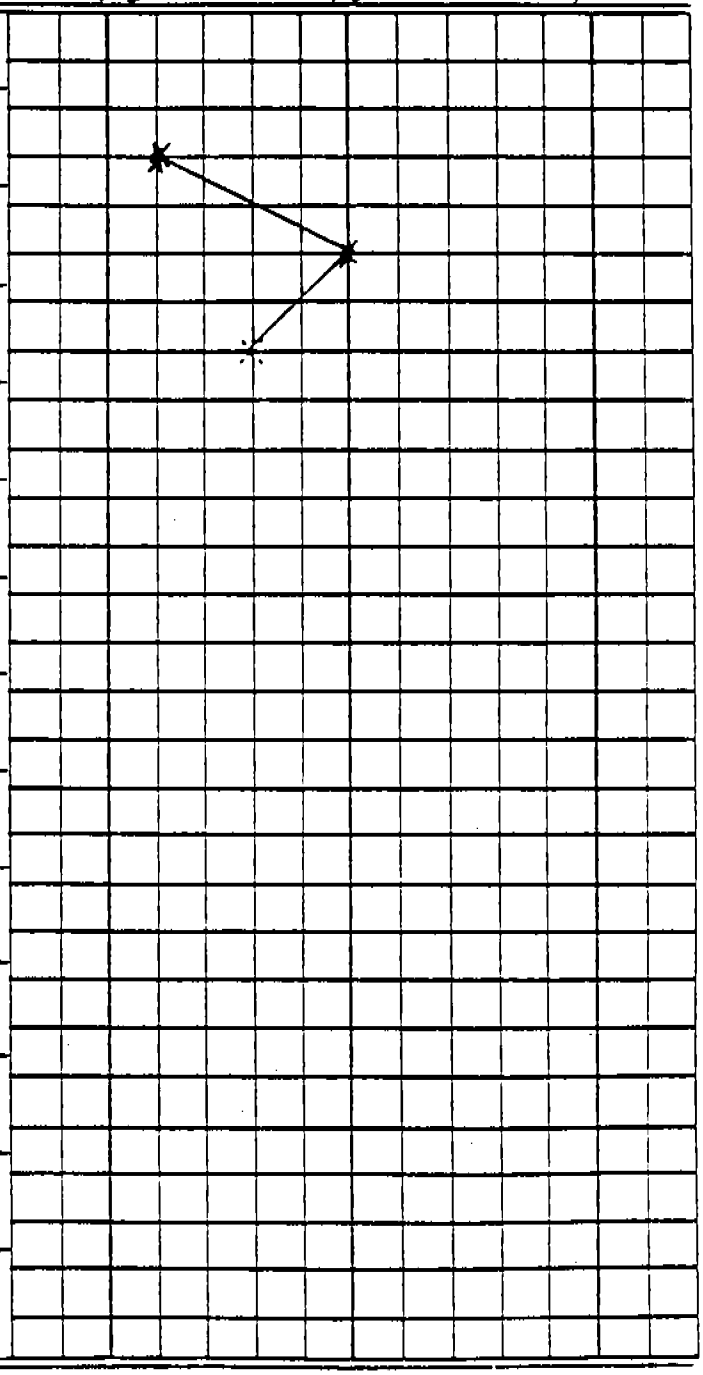

Figure E-15b. Orsat calibration data sheet.

PEI ASSOCIATES, INC.
11499 CHESTER ROAD
CINCINNATI, OHIO 45246
(513) 782-4700

Reference Gas: Matheson Gas Products, Inc.
Cylinder No. 3828
Control No. 109-45979
Analysis: CO_2-10.03%
O_2-9.83%
CO-2.04%

Orsat No.: 422 Gas: O_2

9.3 9.8 10.3

Calibrator	Date	PN	Value determined
GK	4/11/86	5448	9.5
W. Fitzgerald	4/17/86	5443-1	9.6
GK Howard	6/20/86	3445-22	9.8

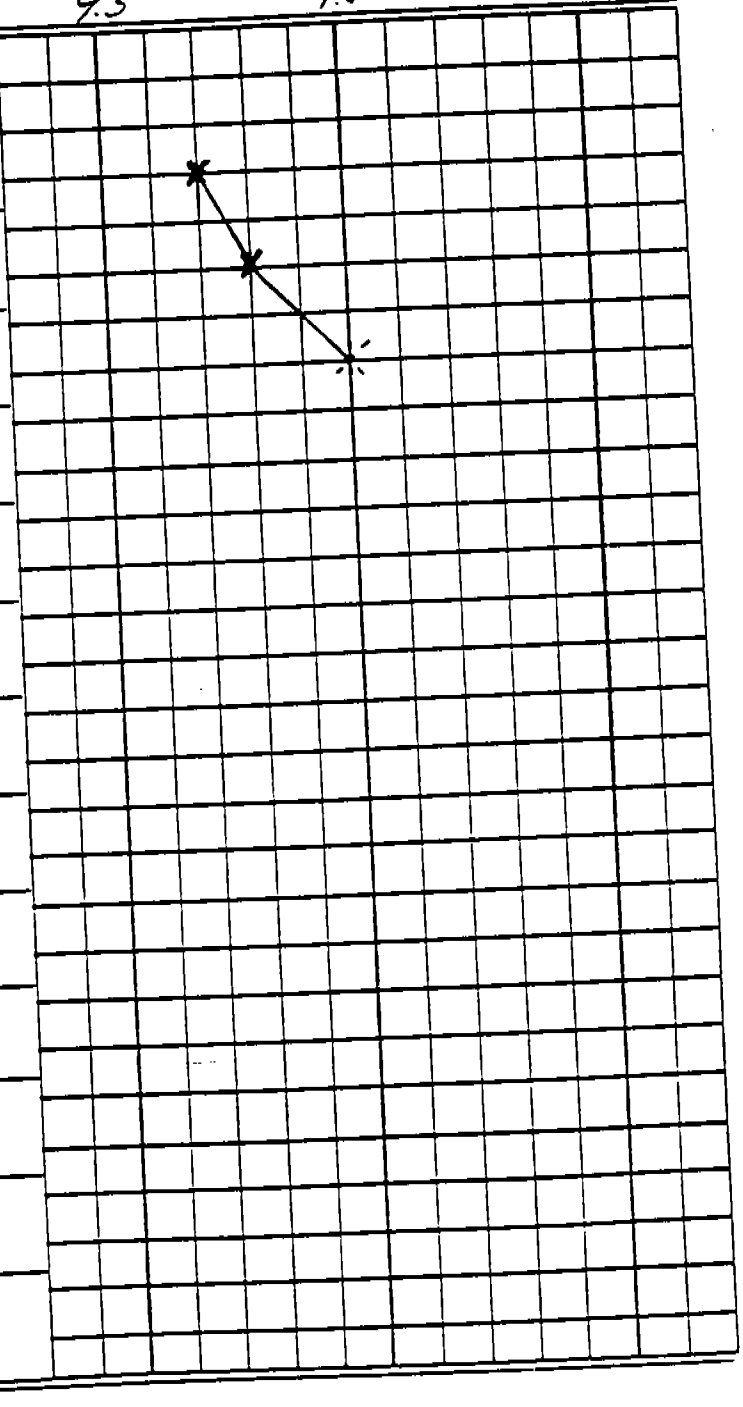

Figure E-15c. Orsat calibration data sheet.

APPENDIX F

PROJECT PARTICIPANTS AND SAMPLE LOG

TABLE F-1. PROJECT PARTICIPANTS

Name	Title	Responsibility
C. Bruffey	PEI Project Manager	Coordinated test activity; liaison with EPA, MRI, and plant personnel; calculations; Cr^{+6}/total Cr and particle size recovery; process sample collection.
D. Scheffel	Environmental Scientist	Was site leader for inlet tests; assisted with cleanup/recovery of samples.
G. Howard	Technician	Conducted all tests at scrubber outlet.
J. Neese	Technician	Conducted all tests at scrubber outlet.
M. Hamlin	U.S. EPA-EMB	Observed test.
R. Strait	MRI-NSPS Contractor	Monitored process operation and coordinated test activity.
R. Barker	MRI-NSPS Contractor	Monitored process operation.

TABLE F-2. SAMPLE LOG

Date (1986)	Activity
Sunday 6/29	Test crew and equipment travel to Greenville, SC
Monday 6/30	Equipment and site setup completed; all preliminary measurements and equipment audits were conducted. Sample trains and impactors set up. Method 13B and particle size test were conducted at each location.
Tuesday 7/1	One Method 13B test was conducted at each location. Process samples were collected. One particle size run was conducted at the outlet and one at the inlet. Process samples were collected.
Wednesday 7/2	One particle size test was conducted at outlet location. All samples were recovered, equipment packed, and test crew departed from the plant.

APPENDIX G

DRAFT TEST METHOD FOR HEXAVALENT CHROMIUM EMISSIONS FROM STATIONARY SOURCES

Method - Determination of Hexavalent Chromium Emissions from Stationary Sources

1. Applicability and Principle.

1.1 Applicability. This method applies to the determination of hexavalent chromium (Cr^{+6}) emissions from specified stationary sources only.

1.2 Principle. Particulate emissions are collected from the source by use of Method 5 (Appendix A, 40 CFR Part 60). The collected samples are digested in an alkaline solution and analyzed by the diphenylcarbazide colorimetric method.

2. Range, Sensitivity, Precision, and Interferences.

2.1 Range. A straight line response curve was obtained in the range 5 µg Cr^{+6}/100 ml to 250 µg Cr^{+6}/100 ml. For a minimum analytical accuracy of ±10 percent, the lower limit of the range is 50 µg/100 ml. The upper limit can be extended by appropriate dilution.

2.2 Sensitivity. A minimum detection limit of 1 µg Cr^{+6}/100 ml has been observed.

2.3 Precision. The overall precision for sample collection and analysis for Cr^{+6} was tested at a ferrochrome smelter, a chemical plant, and a refractory brick plant. Replicate Method 5 filters with both high and low particulate loadings were analyzed. The relative standard deviation was 4.4, 8.3, and 13.3 percent, respectively.

2.4 Interference. Very large quantities of iron, molybdenum, vanadium, and mercury can interfere with the analysis. No interference was observed at the sources listed in Section 2.3.

3. Apparatus.

3.1 Sampling Train. Same as Method 5, Section 2.1.

3.2 Sample Recovery. Same as Method 5, Section 2.2.

3.3 Analysis. The following equipment is needed.

3.3.1 Beakers. Borosilicate, 250 ml, with watchglass covers.

3.3.2 Filtration Apparatus. Vacuum unit with 47 mm diameter, 3.0 μ pore size Teflon filters.

3.3.3 Volumetric Flasks. 100 ml and other appropriate volumes.

3.3.4 Hot Plate.

3.3.5 Pipettes. Assorted sizes, as needed.

3.3.6 Spectrophotometer. To measure absorbance at 540 nm.

4. Reagents.

4.1 Sampling. Same as Method 5, Section 3.1.

4.2 Sample Recovery. Same as Method 5, Section 3.2.

4.3 Analysis. The following reagents are required.

4.3.1 Sodium Carbonate. Na_2CO_3, anhydrous, analytical reagent grade.

4.3.2 Sodium Hydroxide. NaOH, analytical reagent grade.

4.3.3 Potassium Dichromate. $K_2Cr_2O_7$, analytical reagent grade.

4.3.4 Water. Deionized distilled, meeting American Society for Testing and Materials (ASTM) specifications for type 3 reagent - ASTM Test Method D 1193-77 (incorporated by reference - see § 61.18). If high concentrations of organic matter are not expected to be present, the analyst may eliminate the $KMnO_4$ test for oxidizable organic matter.

4.3.5 Digestion Solution. Dissolve 20.0 g NaOH and 30.0 g Na_2CO_3 in deionized distilled water in a 1-liter volumetric flask and dilute to the mark. Store the solution in a tightly capped polyethylene bottle and prepare fresh monthly.

4.3.6 Potassium Dichromate Stock Solution. Dissolve 141.4 mg of dried $K_2Cr_2O_7$ in deionized distilled water and dilute to 1 liter (1 ml = 50 µg Cr^{+6}).

4.3.7 Potassium Dichromate Standard Solution. Dilute 10.00 ml $K_2Cr_2O_7$ stock solution to 100 ml (1 ml = 5 µg Cr^{+6}) with deionized distilled water.

4.3.8 Sulfuric Acid, 10 Percent (v/v). Dilute 10 ml of reagent grade H_2SO_4 to 100 ml in deionized distilled water.

4.3.9 Diphenylcarbazide Solution. Dissolve 250 mg of 1, 5-diphenylcarbizide in 50 ml acetone. Store in a brown bottle. Discard when the solution becomes discolored.

4.3.10 Acetone. Same as Method 5, Section 3.2.

5. Procedure.

5.1 Sampling. Same as Method 5, Section 4.1.

5.2 Sample Recovery. Same as Method 5, Section 4.2.

5.3 Preservation. Tests with the source samples described in Section 2.3 demonstrated that Cr^{+6} is stable in particulate form. Nevertheless, all samples should be protected from extreme heat, and should be analyzed within 1 month of collection.

5.4 Sample Digestion and Preparation. Place the contents of Container Number 1 (the filter) and Container Number 2 (the acetone probe rinse) in a 250 ml beaker. Evaporate to dryness. Add 40 ml of digestion solution (Section 4.2.5). Cover the beaker with the watchglass and heat to near boiling on a hot plate with constant stirring for 30 minutes. Do not allow the solution to evaporate to dryness.

Cool the solution and transfer it quantitatively to the filtration apparatus with deionized distilled water. Filter the solution through the 47 mm Teflon filter. Transfer the filtrate from the filter flask quantitatively to a 100 ml volumetric flask. Fill to the mark with deionized, distilled water.

5.5 Reagent Blank Preparation. Place a 47 mm diameter filter in a 100 ml beaker. Proceed as in Section 5.4.

5.6 Silica Gel Weighing. Weigh the spent silica gel (Container Number 3) or silica gel plus impinger to the nearest 0.5 g using a balance. This step may be conducted in the field.

5.7 Analysis.

5.7.1 Color Development and Measurement. Transfer 50 ml aliquot of the prepared sample to a 100 ml volumetric flask. Add 2.0 ml of diphenylcarbazide solution. Adjust the pH to 2 $\pm$ 0.5 with 10 percent H_2SO_4 and dilute to volume with deionized distilled water. Allow the solution to stand about 10 minutes for color development. Transfer a portion of the sample to a 1-cm absorption cell and measure the absorbance at the optimum wavelength (Section 6.2.1), using the blank solution as a zero reference.

Dilute the sample and the blank with equal volumes of deionized distilled water if the absorbance exceeds A_4, the absorbance of the 250 µg Cr^{+6} standard as determined in Section 6.2.2. Use deionized, distilled water to zero the instrument.

5.7.2 Check for Matrix Effects on the Cr^{+6} Results. Since the analysis for Cr^{+6} by colorimetry is sensitive to the chemical composition of the sample (matrix effects), the analyst shall check at least one sample from each source using the method of additions as follows:

Add or spike an equal volume of standard solution to an aliquot of the sample solution, then measure the absorbance of the resulting solution and the absorbance of an aliquot of unspiked sample.

Next, calculate the Cr^{+6} concentration C_s, in µg/ml of the sample solution by using the following equation:

$$C_s = C_a \frac{A_s}{A_t - A_s} \quad \text{Eq. — -1}$$

Where:

C_a = Cr^{+6} concentration of the standard solution g/ml.

A_s = Absorbance of the sample solution.

A_t = Absorbance of the spiked sample solution.

Volume corrections will not be required if the solutions as analyzed have been made to the same final volume. Therefore, C_s and C_a represent Cr^{+6}

concentrations before dilutions. If the results of the method of additions procedure used on the single source sample do not agree to within 5 percent of the value obtained by the routine spectrophotometric analysis, then reanalyze all samples from the source using this method of additions procedure.

6. Calibration.

6.1 Sampling Train. Perform all of the calibrations described in Method 5, Section 5.

6.2 Spectrophotometer Calibration.

6.2.1 Optimum Wavelength Determination. Calibrate the wavelength scale of the spectrophotometer every 6 months. The calibration may be accomplished by using an energy source with an intense line emission such as a mercury lamp, or by using a series of glass filters spanning the measuring range of the spectrophotometer. Calibration materials are available commercially and from the National Bureau of Standards. Specific details on the use of such materials should be supplied by the vendor; general information about calibration techniques can be obtained from general reference books on analytical chemistry. The wavelength scale of the spectrophotometer must read correctly within ± 5 nm at all calibration points; otherwise, the spectrophotometer shall be repaired and recalibrated. Once the wavelength scale of the spectrophotometer is in proper calibration, use 540 nm as the optimum wavelength for the measurement of the absorbance of the standards and samples.

Alternatively, a scanning procedure may be employed to determine the proper measuring wavelength. If the instrument is a double-beam spectrophotometer, scan the spectrum between 530 and 550 nm using a 250 µg Cr^{+6} standard solution in the sample cell and a blank solution in the reference cell. If a peak does not occur, the spectrophotometer is malfunctioning and should be repaired. When a peak is obtained within the 530 to 550 nm range, the wavelength at which this peak occurs shall be the optimum wavelength for the measurement of absorbance of both the standards and the samples. For a single-beam spectrophotometer, follow the scanning procedure described above, except that the blank and standard solutions shall be scanned separately. The optimum wavelength shall be the wavelength at which the maximum difference in absorbance between the standard and the blank occurs.

6.2.2 Determination of Spectrophotometer Calibration Factor K_C. Add 0.0 ml, 10 ml, 20 ml, 30 ml, and 50 ml of the working standard solution (1 ml = 5 µg Cr^{+6}) to a series of five 100-ml volumetric flasks. Analyze these calibration standards as in Section 5.7.1. This calibration procedure must be repeated on each day that samples are analyzed. Calculate the spectrophotometer calibration factor as follows:

$$K_C = 100 \frac{A_1 + 2A_2 + 3A_3 + 4A_4}{A_1^2 + A_2^2 + A_3^2 + A_4^2} \qquad \text{Eq. — -2}$$

Where:

K_c = Calibration factor.

A_1 = Absorbance of the 50 Cr^{+6} standard.

A_2 = Absorbance of the 100 Cr^{+6} standard.

A_3 = Absorbance of the 150 Cr^{+6} standard.

A_4 = Absorbance of the 250 Cr^{+6} standard.

7. Emission Calculations.

Carry out the calculations, retaining at least one extra decimal figure beyond that of the acquired data. Round off figures after final calculations.

7.1 Total Cr^{+6} in Sample. Calculate m, the total μg Cr^{+6} in each sample, as follows:

$$m = K_c \, 2AF \qquad \text{Eq. } \_\_ \text{-3}$$

Where:

2 = Factor to correct 50 ml aliquot analyzed to 100 ml total sample.

A = Absorbance of sample.

F = Dilution factor (required only if sample dilution was needed to reduce the absorbance into the range of calibration).

7.2 Average Dry Gas Meter Temperature and Average Orifice Pressure Drop. Same as Method 5, Section 6.2.

7.3 Dry Gas Volume, Volume of Water Vapor, Moisture Content. Same as Method 5, Sections 6.3, 6.4, and 6.5, respectively.

7.4 Cr^{+6} Emission Concentration. Calculate c_s (g/dscm), the Cr^{+6} concentration in the stack gas, dry basis, corrected to standard conditions, as follows:

$$c_s = (0.001 \text{ g/mg})(m/V_{m(std)}) \qquad \text{Eq. } \_\_ -4$$

7.5 Isokinetic Variation, Acceptable Results. Same as Method 5, Sections 6.11 and 6.12, respectively.

8. Bibliography.

1. Test Methods for Evaluating Solid Waste. U.S. Environmental Protection Agency. SW-846, 2nd Edition. July 1982.

2. Cox, X.B., R.W. Linton, F.E. Butler. Determination of Chromium Speciation in Environmental Particles - A Multitechnique Study of Ferrochrome Smelter Dust. Accepted for publication in Environmental Science and Technology.

3. Same as Method 5, Citations 2 to 5 and 7 of Section 7.

METHOD 3050

ACID DIGESTION OF SLUDGES

1.0 Scope and Application

1.1 Method 3050 is an acid digestion procedure used to prepare sludge-type and soil samples for analysis by flame or furnace atomic absorption spectroscopy (AAS) or by inductively coupled argon plasma spectroscopy (ICP). Samples prepared by Method 3050 may be analyzed by AAS or ICP for the following metals:

Antimony	Lead
Arsenic	Nickel
Barium	Selenium
Beryllium	Silver
Cadmium	Tnallium
Chromium	Zinc
Copper	

1.2 Method 3050 may also be applicable to the analysis of other metals in sludge-type samples. However, prior to using this method for other metals, it must be evaluated using the specific metal and matrix.

2.0 Summary of Method

2.1 A dried and pulverized sample is digested in nitric acid and hydrogen peroxide. The digestate is then refluxed with either nitric acid or hydrochloric acid. Hydrochloric acid is used as the final reflux acid for the furnace analysis of Sb or the flame analysis of Sb, Ba, Be, Cd, Cr, Cu, Pb, Ni, and Zn. Nitric acid is employed as the final reflux acid for the furnace analysis of As, Ba, Be, Cd, Cr, Cu, Pb, Ni, Se, Ag, Tl, and Zn or the flame analysis of Ag and Tl.

3.0 Interferences

3.1 Sludge samples can contain diverse matrix types, each of which may present its own analytical challenge. Spiked samples and any relevant standard reference material should be processed to aid in determining whether Method 3050 is applicable to a given waste. Nondestructive techniques such as neutron activation analysis may also be helpful in evaluating the applicability of this digestion method.

4.0 Apparatus and Materials

4.1 125-ml conical Phillips' beakers.

4.2 Watch glasses.

Revised 4/84

7.3 After the second reflux step has been completed and the sample has cooled, add 2 ml of Type II water and 3 ml of 30% hydrogen peroxide (H_2O_2). Return the beaker to the hot plate for warming to start the peroxide reaction. Care must be taken to ensure that losses do not occur due to excessively vigorous effervescence. Heat until effervescence subsides, and cool the beaker.

7.4 Continue to add 30% H_2O_2 in 1-ml aliquots with warming until the effervescence is minimal or until the general sample appearance is unchanged. (NOTE: Do not add more than a total of 10 ml 30% H_2O_2.)

7.5 If the sample is being prepared for the furnace analysis of Ag and Sb or direct aspiration analysis of Ag, Sb, Ba, Be, Cd, Cr, Cu, Pb, Ni, Tl, and Zn, add 5 ml of 1:1 HCl and 10 ml of Type II water, return the covered beaker to the hot plate, and heat for an additional 10 min. After cooling, filter through Whatman No. 42 filter paper (or equivalent) and dilute to 100 ml with Type II water (or centrifuge the sample). The diluted sample has an approximate acid concentration of 2.5% (v/v) HCl and 0.5% (v/v) HNO_3 and is now ready for analysis.

7.6 If the sample is being prepared for the furnace analysis of As, Ba, Be, Cd, Cr, Cu, Pb, Ni, Se, Tl, and Zn, continue heating the acid-peroxide digestate until the volume has been reduced to approximately 2 ml, add 10 ml of Type II water, and warm the mixture. After cooling, filter through Whatman No. 42 filter paper (or equivalent) and dilute to 100 ml with Type II water (or centrifuge the sample). The diluted digestate solution contains approximately 2% (v/v) HNO_3. For analysis, withdraw aliquots of appropriate volume, add any required reagent or matrix modifier, and analyze by method of standard additions.

8.0 Quality Control

8.1 For each group of samples processed, procedural blanks (Type II water and reagents) should be carried throughout the entire sample-preparation and analytical process. These blanks will be useful in determining if samples are being contaminated.

8.2 Duplicate samples should be processed on a routine basis. Duplicate samples will be used to determine precision. The sample load will dictate the frequency, but 10% is recommended.

8.3 Spiked samples or standard reference materials should be employed to determine accuracy. A spiked sample should be included with each group of samples processed and whenever a new sample matrix is being analyzed.

8.4 The concentration of all calibration standards should be verified against a quality control check sample obtained from an outside source.

8.5 The method of standard addition shall be used for the analysis of all EP extracts and whenever a new sample matrix is being analyzed.

4.3 Drying ovens that can be maintained at 30° C.

4.4 Thermometer that covers range of 0° to 200° C.

4.5 Whatman No. 42 filter paper or equivalent.

5.0 Reagents

5.1 ASTM Type II water (ASTM D1193): Water should be monitored for impurities.

5.2 Concentrated nitric acid: Acid should be analyzed to determine level of impurities. If impurities are detected, all analyses should be blank corrected.

5.3 Concentrated hydrochloric acid: Acid should be analyzed to determine level of impurities. If impurities are detected, all analyses should be blank corrected.

5.4 Hydrogen peroxide (30%): Oxidant should be analyzed to determine level of impurities. If impurities are detected, all analyses should be blank corrected.

6.0 Sample Collection, Preservation, and Handling

6.1 All samples must have been collected using a sampling plan that addresses the considerations discussed in Section One of this manual.

6.2 All sample containers must be prewashed with detergents, acids, and distilled deionized water. Plastic and glass containers are both suitable.

6.3 Nonaqueous samples shall be refrigerated when possible, and analyzed as soon as possible.

7.0 Procedure

7.1 Weigh and transfer to a 125-ml conical Phillips' beaker a 1.0-g portion of sample which has been dried at 60° C, pulverized, and thoroughly mixed.

7.2 Add 10 ml of 1:1 nitric acid (HNO_3), mix the slurry, and cover with a watch glass. Heat the sample at 95° C and reflux for 10 min. Allow the sample to cool, add 5 ml of conc. HNO_3, replace the watch glass, and reflux for 30 min. Do not allow the volume to be reduced to less than 5 ml while maintaining a covering of solution over the bottom of the beaker.

APPENDIX H

PROCESS DATA MONITORED DURING TESTS

AMPERE-HOUR CALCULATIONS
TEST RUN NO.
INLET: MEI-1; OUTLET: MEO-1

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
12:07	12:08					
12:18	12:18	11	10	8,400	1,540	1,400
12:28	12:28	10	10	8,400	1,400	1,400
12:38	12:38	10	10	8,600	1,433	1,433
12:48	12:48	10	10	8,600	1,433	1,433
12:58	12:58	10	10	8,600	1,433	1,433
13:08	13:08	10	10	8,600	1,433	1,433
13:18	13:18	10	10	8,600	1,433	1,433
13:28	13:28	10	10	8,600	1,433	1,433
13:37	13:38	9	10	8,600	1,290	1,433
Subtotal		90	90		12,828	12,831
14:39	14:46					
14:50	14:50	11	4	8,500	1,558	567
15:00	15:00	10	10	8,600	1,433	1,433
15:10	15:10	10	10	8,600	1,433	1,433
15:20	15:20	10	10	8,600	1,433	1,433
15:30	15:30	10	10	8,700	1,450	1,450
15:40	15:40	10	10	8,700	1,450	1,450
15:50	15:50	10	10	8,700	1,450	1,450
16:00	16:00	10	10	8,700	1,450	1,450
16:09	16:06	9	6	8,700	1,305	870
Subtotal		90	80		12,962	11,536
TOTAL		180	170		25,790	24,367

AMPERE-HOUR CALCULATIONS
TEST RUN NO.
INLET: MEI-2; OUTLET: MEO-2

Time (24-h clock)		Time interval, min		Current,	Ampere-hours	
Inlet	Outlet	Inlet	Outlet	amperes	Inlet	Outlet
08:16	08:15					
08:25	08:25	9	10	10,000	1,500	1,667
08:35	08:35	10	10	10,000	1,667	1,667
08:45	08:45	10	10	10,000	1,667	1,667
08:55	08:55	10	10	10,000	1,667	1,667
09:05	09:05	10	10	10,000	1,667	1,667
09:16	09:15	11	10	10,000	1,833	1,667
Subtotal		60	60		10,001	10,002
	09:20					
	09:25	0	5	10,000	0	833
09:37	09:35	0	10	10,000	0	1,667
09:45	09:45	8	10	10,000	1,333	1,667
09:55	09:55	10	10	10,000	1,667	1,667
10:07	10:05	12	10	10,000	2,000	1,667
Subtotal		30	45		5,000	7,501
11:14	11:17					
11:25	11:25	11	8	7,600	1,393	1,013
11:35	11:27	10	2	7,700	1,283	257
11:43		8	0	7,800	1,040	0
Subtotal		29	10		3,716	1,270
TOTAL		119	115		18,717	18,773

AMPERE-HOUR CALCULATIONS
TEST RUN NO.
INLET: MEI-3; OUTLET: MEO-3

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
12:00						
12:05	12:09	5	0	7,800	650	0
12:15	12:15	10	6	7,800	1,300	780
12:25	12:25	10	10	7,800	1,300	1,300
12:35	12:35	10	10	7,800	1,300	1,300
12:45	12:45	10	10	7,800	1,300	1,300
12:55	12:55	10	10	7,800	1,300	1,300
13:05	12:59	10	4	7,800	1,300	520
Subtotal		65	50		8,450	6,500
14:00	13:59					
14:10	14:10	10	11	6,400	1,067	1,173
14:20	14:20	10	10	6,400	1,067	1,067
14:30	14:30	10	10	6,500	1,083	1,083
14:40	14:40	10	10	6,400	1,067	1,067
14:50	14:50	10	10	6,400	1,067	1,067
15:00	15:00	10	10	6,400	1,067	1,067
	15:07	0	7	6,400	0	747
Subtotal		60	68		6,418	7,271
TOTAL		125	118		14,868	13,771

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Able Machine Company
Date: June 30, 1986
Tank No.: 1
Sample type: Total and hexavalent chromium

Test Run No.	Test start time	Test stop time
Inlet: MEI-1	Inlet: 12:07	Inlet: 16:09
Outlet: MEO-1	Outlet: 12:08	Outlet: 16:06

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
12:07	12:08	118	7.5	8,500	Started testing: 12:07
12:18	12:18	120	7.5	8,400	Work plated: 11 industrial rolls
12:28	12:28	122	7.5	8,400	Surface area: 36.00 ft^2
12:38	12:38	125	7.5	8,600	
12:48	12:48	126	7.5	8,600	
12:58	12:58	126	7.5	8,600	
13:08	13:08	127	7.5	8,600	
13:18	13:18	127	7.5	8,600	
13:28	13:28	128	7.5	8,600	
13:37	13:38	128	7.5	8,600	Stopped testing: 13:38 Stopped plating: 13:41 (changed work load)
14:39	14:46	122	7.5	8,400	Started testing: 14:39
14:50	14:50	125	7.5	8,500	Work plated: 12 industrial rolls
15:00	15:00	125	7.5	8,600	Surface area: 39.84 ft^2
15:10	15:10	126	7.5	8,600	
15:20	15:20	126	7.5	8,600	
15:30	15:30	126	7.5	8,700	
15:40	15:40	127	7.5	8,700	
15:50	15:50	127	7.5	8,700	
16:00	16:00	128	7.5	8,700	
16:09	16:06	128	7.5	8,700	Stopped testing: 16:09 Stopped plating: 16:10

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Able Machine Company
Date: July 1, 1986
Tank No.: 1
Sample type: Total and hexavalent chromium

Test Run No.	Test start time	Test stop time
Inlet: MEI-2	Inlet: 08:16	Inlet: 11:43
Outlet: MEO-2	Outlet: 08:15	Outlet: 11:27

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
08:16	08:15	120	7.0	10,000	Started testing: 08:15
08:25	08:25	124	7.0	10,000	Work plated: 11 industrial rolls
08:35	08:35	124	7.0	10,000	Surface area: 49.22 ft^2
08:45	08:45	125	7.0	10,000	
08:55	08:55	126	7.0	10,000	
09:05	09:05	126	7.0	10,000	
09:16	09:15	126	7.0	10,000	Stopped testing: 09:16 (test port change)
	09:20	127	7.0	10,000	Started testing: 09:20
	09:25	127	7.0	10,000	
09:37	09:35	127	7.0	10,000	
09:45	09:45	127	7.0	10,000	
09:55	09:55	127	7.0	10,000	
10:07	10:05	128	7.0	10,000	Stopped testing: 12:07 Stopped plating: 12:07 (changed work load)
11:14	11:17	122	7.5	7,600	Starting testing: 11:14
11:25	11:25	123	7.5	7,600	Work plated: 8 industrial rolls
11:35	11:27	125	7.5	7,700	Surface area: 29.90 ft^2
11:43		125	7.5	7,800	Stopped testing: 11:43

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Able Machine Company
Date: July 1, 1986
Tank No.: 1
Sample type: Total and hexavalent chromium

Test Run No.	Test start time	Test stop time
Inlet: MEI-3	Inlet: 12:00	Inlet: 15:00
Outlet: MEO-3	Outlet: 12:09	Outlet: 15:07

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., °F	Voltage volts	Current amperes	Notes
12:00		126	7.5	7,800	Started testing: 12:00
12:05	12:09	126	7.5	7,800	
12:15	12:15	126	7.5	7,800	Work plated: 8 industrial rolls
12:25	12:25	127	7.5	7,800	Surface area: 29.90 ft^2
12:35	12:35	127	7.5	7,800	
12:45	12:45	127	7.5	7,800	
12:55	12:55	127	7.5	7,800	
13:05	12:59	127	7.5	7,800	Stopped testing: 13:05
					Stopped plating: 13:05 (changed work load)
14:00	13:59	123	7.5	6,400	Started testing: 13:59
14:10	14:10	124	7.5	6,400	Work plated: 9 industrial rolls
14:20	14:20	125	7.5	6,400	Surface area: 23.60 ft^2
14:30	14:30	125	7.5	6,500	
14:40	14:40	126	7.5	6,400	
14:50	14:50	127	7.5	6,400	
15:00	15:00	127	7.5	6,400	
	15:07	127	7.5	6,400	Stopped testing: 15:07
					Stopped plating: 15:15