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EMISSION TEST REPORT
METHOD DEVELOPMENT AND
TESTING FOR CHROMIUM

CHROMIUM ELECTROPLATING INDUSTRY
STEEL HEDDLE CO.
GREENVILLE, SOUTH CAROLINA
ESED Project No. 85/2a
(86-CEP-2)

by

PEI Associates Inc.
11499 Chester Road
P.O. Box 46100
Cincinnati, Ohio 45246-0100

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Task Manager

Mr. Frank Clay
Emission Standards and Engineering Division

U.S. ENVIRONMENTAL PROTECTION AGENCY
EMISSION MEASUREMENT BRANCH
RESEARCH TRIANGLE PARK, NORTH CAROLINA 27711

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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 Steel Heddle manufacturing facility in Greenville, South Carolina, on June 24 and 25, 1986. Triplicate tests to determine Cr^{+6} and total Cr emissions were performed at the inlet and outlet of a double packed-bed scrubber controlling chromic acid emissions from three hard chromium plating tanks.

In addition, particle size distribution measurements were taken at sampling points before and after the scrubber in an effort to characterize Cr^{+6} and total Cr emissions by size fraction. Samples of the plating tank solution and scrubber water were also collected during each test 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 determining 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 scrubber 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 13 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 13, July 1985.

TABLE 2-1. SAMPLE/ANALYTICAL MATRIX FOR THE STEEL HEDDLE COMPANY

Run No.	Date (1986) and time (24)	Location	Sample parameters: Modified Method 13 for Cr^{+6} and total Cr[a]	Sample parameters: Particle size distribution	Analytical parameters: Cr^{+6} diphenyl-carbazide colorimetric method[b]	Analytical parameters: Total Cr by ICAP	Analytical parameters: Particle size distribution (gravimetric) total Cr by ICAP
SIC-1	6/24 (0827-1145)	Inlet	X	-	X	X	-
SOC-1	6/24 (0833-1148)	Outlet	X	-	X	X	-
SIC-2	6/25 (0808-1132)	Inlet	X	-	X	X	-
SOC-2	6/25 (0811-1134)	Outlet	X	-	X	X	-
SIC-3	6/25 (1245-1633)	Inlet	X	-	X	X	-
SOC-3	6/25 (1247-1635)	Outlet	X	-	X	X	-
SIPS-1	6/24 (1209-1340)	Inlet	-	X	-	-	X
SOPS-1	6/24 (1055-1503)	Outlet	-	X	-	-	X
SIPS-2	6/24 (1430-1548)	Inlet	-	X	-	-	X
SIPS-3	6/24 (1643-1803)	Inlet	-	X	-	-	X
SOPS-2	6/25 (0746-1202)	Outlet	-	X	-	-	X
SOPS-3	6/25 (1217-1655)	Outlet	-	X	-	-	X
All	6/24-25	Process samples					
		° Tank Soln.	-	-	X	X	-
		° Scrubbed water	-	-	X	X	-

[a]Method 13 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 plasmography (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 Plasmography (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 SW-846.*

Samples were collected for particle size distribution measurements at the scrubber 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, scrubber water and operational plating tank solutions were collected. Grab samples were obtained approximately every 30 minutes during the Modified Method 13 tests. These grab samples were placed

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

in a 1-gallon polyethylene container so that one composite sample of each type was available for analysis.

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 for the chromium tests, and Table 2-3 presents the Cr^{+6} and total Cr emission results.

Sample volumes are expressed in dry normal cubic meters (dNm^3) and dry standard cubic feet (dscf). Volumetric flow rates are corrected to standard conditions [20°C and 760 mm Hg (68°F and 29.92 in.Hg) and zero percent moisture] and are expressed as dry normal cubic meters per minute (dNm^3/min) and dry standard cubic feet per minute (dscfm). Actual flow rates at stack conditions may be found in the computer printouts in Appendix A of this report.

Concentrations of Cr^{+6} and total Cr are expressed in milligrams per dry normal cubic meter (mg/dNm^3) and grains per dry standard cubic feet (gr/dscf). Mass emission rates are expressed in kilograms per hour (kg/h) and pounds per hour (lb/h). Note that the Cr concentrations were calculated using the total content of Cr^{+6} and total Cr in the sample. Each recovered sample consisted of the nozzle and probe rinse as well as the impinger solutions and rinse of all connecting glassware.

As reported in Table 2-2, sample volumes were consistent and ranged from 4.85 to 4.93 dNm^3 for the inlet trains and from 5.22 to 5.38 dNm^3 for the outlet trains. Isokinetic sampling rates ranged between 94.5 and 97.7 percent, which is within the acceptable range of 90 to 110 percent.

TABLE 2-2. SUMMARY OF SAMPLE AND FLUE GAS CONDITIONS
(Steel Heddle Co.)

Run No.	Date (1986)	Sample location	Sample parameter: Sample volume dNm³	Sample parameter: Sample volume dscf	Sample parameter: Percent isokinetic	Volumetric flow rate dNm³/min	Volumetric flow rate dscf/min	Flue gas condition: Temperature °C	Flue gas condition: Temperature °F	Flue gas condition: Moisture content, %	Flue gas condition: Static pressure, in. H_2O
SIC-1	6/24	Inlet	4.93	174.15	96.6	462	16,300	36	96	2.6	-3.3
SOC-1	6/24	Outlet	5.22	184.299	97.7	476	16,800	27	80	2.9	-0.35
SIC-2	6/25	Inlet	4.88	172.326	94.3	467	16,500	32	90	2.2	-3.55
SOC-2	6/25	Outlet	5.36	189.325	97.3	490	17,300	24	75	2.5	-0.36
SIC-3	6/25	Inlet	4.85	171.186	94.5	464	16,400	36	97	2.2	-3.5
SOC-3	6/25	Outlet	5.38	190.118	97.4	490	17,300	23	74	2.3	-0.26

TABLE 2-3. SUMMARY OF CR^{+6} AND TOTAL CR EMISSION DATA
(Steel Heddle Co.)

Run No.	Date (1986)	Sample location	Concentration: Cr^{+6} mg/dNm³	Concentration: Cr^{+6} gr/dscf	Concentration: Total Cr mg/dNm³	Concentration: Total Cr gr/dscf	Mass emission rate: Cr^{+6} kg/h	Mass emission rate: Cr^{+6} lb/h	Mass emission rate: Total Cr kg/h	Mass emission rate: Total Cr lb/h	Total Cr collection efficiency[a], %
SIC-1	6/24	Scrubber inlet	2.7	0.001	2.55	0.001	0.07	0.16	0.07	0.16	98.1
SOC-1	6/24	Outlet	0.05	0.00002	0.05	0.00002	0.001	0.003	0.001	0.003	
SIC-2	6/25	Inlet	1.2	0.0005	1.1	0.0005	0.03	0.07	0.03	0.07	95.7
SOC-2	6/25	Outlet	0.05	0.00002	0.05	0.00002	0.001	0.003	0.001	0.003	
SIC-3	6/25	Inlet	1.1	0.0005	1.1	0.0005	0.03	0.07	0.03	0.07	94.3
SOC-3	6/25	Outlet	0.05	0.00002	0.06	0.00002	0.002	0.0035	0.002	0.004	

[a] Total Cr collection efficiency calculated on mass rate basis.

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

At the scrubber inlet, the average volumetric flow at standard conditions was 464 dNm^3/min (16,400 dscfm). Flue gas temperatures ranged from 32° to 36°C (90° to 97°F) and averaged 35°C (94°F). The moisture content of the gas stream averaged 2.3 percent. The static pressure was continuously recorded using a 0- to 36-in. H_2O water manometer during each test. These pressures ranged between -3.3 and -3.6 in. H_2O. Prior to sampling, flue gas from the inlet was collected in a Tedlar bag and analyzed for oxygen (O_2) and carbon dioxide (CO_2) content using an Orsat gas analyzer. This analysis (20.9 percent O_2 and 0.0 percent CO_2) confirmed the basic ambient composition of the gas stream, and no further attempts were made to measure gas composition. The O_2 and CO_2 values determined from this sample were used to find the molecular weight in both the inlet and outlet sample runs.

The Cr^{+6} content of the inlet flue gas ranged between 1.1 and 2.7 mg/dNm^3 (0.0005 and 0.001 gr/dscf) and averaged 1.7 mg/dNm^3 (0.0007 gr/dscf) for the three tests. The average mass emission rate was 0.04 kg/h (0.1 lb/h). Total Cr concentration ranged between 1.1 and 2.55 mg/dNm^3 (0.0005 and 0.001 gr/dscf) with mass rates similar to those of Cr^{+6}.

The total amount of Cr^{+6} captured in the inlet trains ranged from a maximum of 13.3 mg (Test SIC-1) to a minimum of 5.48 mg (Test SIC-3). Total Cr content for these runs was 12.6 mg and 5.28 mg, respectively. Considering that Cr^{+6} and total Cr content of the samples was determined by two different analytical techniques, the data are comparable and indicate that the majority of Cr in these samples is in the form of Cr^{+6}.

At the scrubber outlet, the average gas flow rate at standard conditions was 485 dNm^3/min (17,133 dscfm), which is within 5 percent of the average inlet flow rate. Flue gas temperatures ranged from 23°C to 27°C (74°F to

80°F) and averaged 25°C (76°F). The moisture content of the gas stream averaged 2.6 percent. Outlet static pressure was consistent and ranged between -0.27 and -0.37 for the test series. The outlet Cr^{+6} concentrations averaged 0.05 mg/dNm^3 (0.00002 gr/dscf) with a corresponding average mass rate of 0.001 kg/h (0.003 lb/h). Total Cr concentrations averaged 0.053 mg/dNm^3 (0.00002 gr/dscf) with an average mass rate of 0.0013 kg/h (0.0033 lb/h).

The Cr^{+6} content of the outlet samples ranged between 0.265 and 0.293 mg, and the total Cr content ranged between 0.261 and 0.299 mg. Based on the mass rate data, the scrubber removed between 94 and 98 percent of the Cr^{+6} and total Cr entering the control device.

2.3 PROCESS SAMPLE ANALYSIS

Table 2-4 summarizes results for Cr^{+6} and total Cr from plating tank solutions and scrubber water collected during each test period. Plating tank solutions from operational tanks 1, 2, and 4 were collected separately during the first inlet particle size test (SIPS-1) and during each of the Cr^{+6}/total Cr emission tests. Scrubber water effluent was collected during the same basic periods. Results for both Cr^{+6} and total Cr are expressed in milligrams per liter (mg/liter). Analytical procedures were similar to those used for the actual emission samples with Cr^{+6} determined by the diphenylcarbazide colorimetric method and total Cr by ICAP.

2.4 PARTICLE SIZE DISTRIBUTION TEST RESULTS

A total of three particle-size measurements were made at the inlet and outlet test locations during the course of this study. These tests were designed to characterize Cr^{+6} and total Cr emissions by size fraction.

TABLE 2-4. SUMMARY OF PROCESS SAMPLE ANALYTICAL RESULTS

Laboratory No.	Run No./ description	Fraction	Chromium (VI), mg/liter	Total chromium, mg/liter
FT433	SIPS-1 Tank No. 1	Liquid	92,000	97,200
FT434	SIC-1 Tank No. 1	Liquid	97,400	98,600
FT435	SIC-2 Tank No. 1	Liquid	88,900	96,200
FT436	SIC-3 Tank No. 1	Liquid	90,300	98,600
FT437	SIPS-1 Tank No. 2	Liquid	101,900	106,800
FT438	SIC-1 Tank No. 2	Liquid	95,400	103,600
FT439	SIC-2 Tank No. 2	Liquid	97,400	103,400
FT440	SIC-3 Tank No. 2	Liquid	99,100	104,400
FT441	SIPS-1 Tank No. 4	Liquid	83,800	92,900
FT442	SIC-1 Tank No. 4	Liquid	82,700	91,100
FT443	SIC-2 Tank No. 4	Liquid	78,700	87,300
FT444	SIC-3 Tank No. 4	Liquid	81,700	90,300
FT445	SIPS-1 Scrubber	Liquid	16.3	11.1
FT446	SIC/SOC-1 Scrubber	Liquid	6.63	7.99
FT447	SIC/SOC-2 Scrubber	Liquid	5.33	6.74
FT448	SIC/SOC-3 Scrubber	Liquid	7.45	7.53

Initially, each individual sample was subjected to a gravimetric analysis as delineated in EPA Method 5.* At the completion of this analysis, filter media were combined by location and stage cutpoint and analyzed for Cr^{+6} and Total Cr. Andersen Mark III in-stack impactors were used to measure particle size at each location. The impactor consists of eight impaction stages followed by a backup filter. In these tests, glass-fiber filter media were used. All samples were collected at single points in the duct representing the average velocity and temperature as measured during the Cr^{+6}/total Cr tests.

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 cutpoint characteristics were maintained throughout the sampling period. Test times ranged from 75 to 90 minutes for the inlet, and were 240 minutes at the outlet.

Cumulative size distribution curves representing the total weight of particulate matter smaller than the indicated aerodynamic particle diameter [in micrometers (μm)] were established for each individual test. The cutpoints 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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* 40 CFR 60, Appendix A, Reference Method 5, July 1986.

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

The average isokinetic sampling 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).

Figures 2-1 through 2-6 present the size distribution curves for each individual test. These curves were developed using the net weight gain (or loss) of each filter as determined from the Method 5 gravimetric analysis. Actual impactor stage data points are depicted as solid dots, and the open dots represent an extrapolated best fit curve.

Although individual impactor stages looked evenly and (in some cases) heavily loaded upon recovery, the gravimetric data for each location show that the samples did not contain enough material on the various stages to yield reliable data (no more than 0.5 mg was collected on any stage, compared with a desired amount of between 1 and 10 mg).

For the three inlet tests (designated SIPS), the total material catch ranged between 9.3 and 15.9 mg; the majority of the material was found in the acetone rinse of the impactor nozzle and inlet chamber. These data show that between 3 and 8 percent of the particles (by weight) had diameters of 10 μm or less; between 2 and 4 percent had diameters of 2.5 μm or less. Since most of the collected material was found in the nozzle and impactor casing acetone rinse, the majority of the material would appear to be larger than 10 μm. This may or may not actually be the case. If particles smaller than 10 μm were collected in the nozzle or impactor casing, the cumulative percent less

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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.

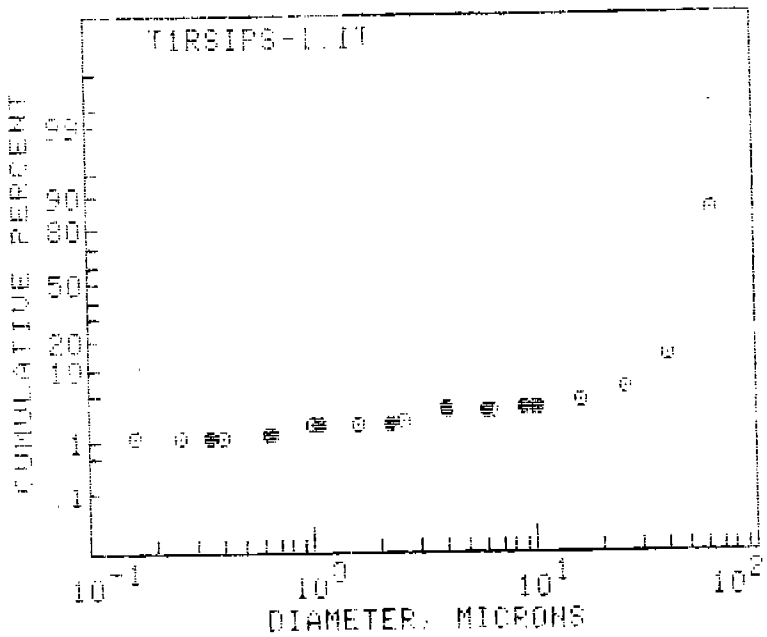

Figure 2-1. Particle size distribution test SIPS-1 (scrubber inlet).

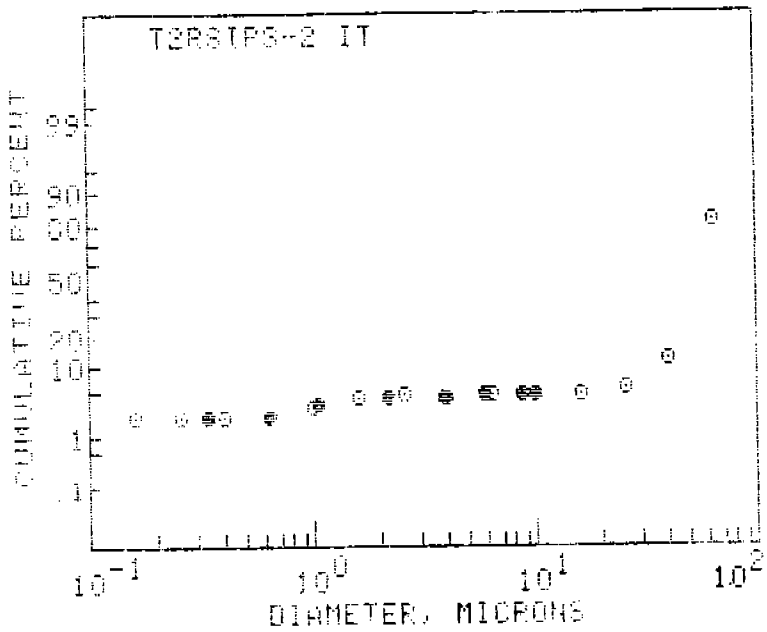

Figure 2-2. Particle size distribution test SIPS-2 (scrubber inlet).

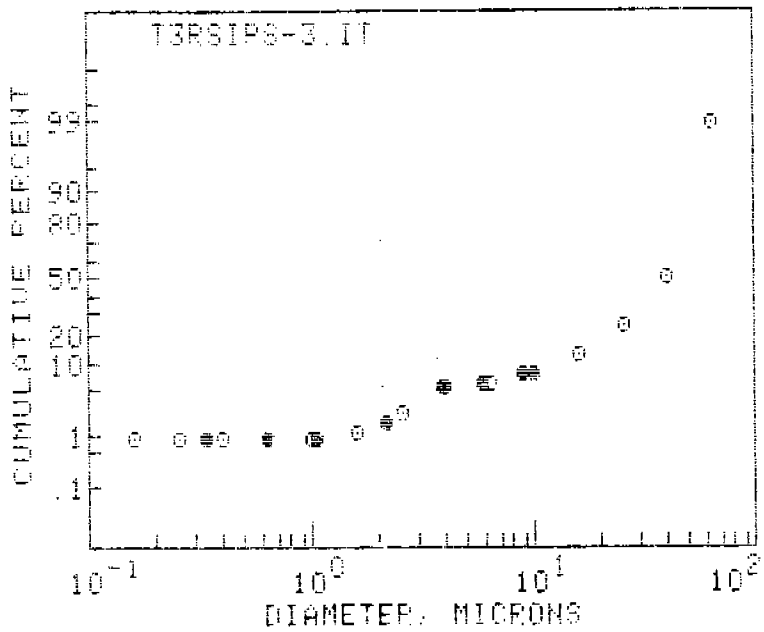

Figure 2-3. Particle size distribution test SIPS-3 (scrubber inlet).

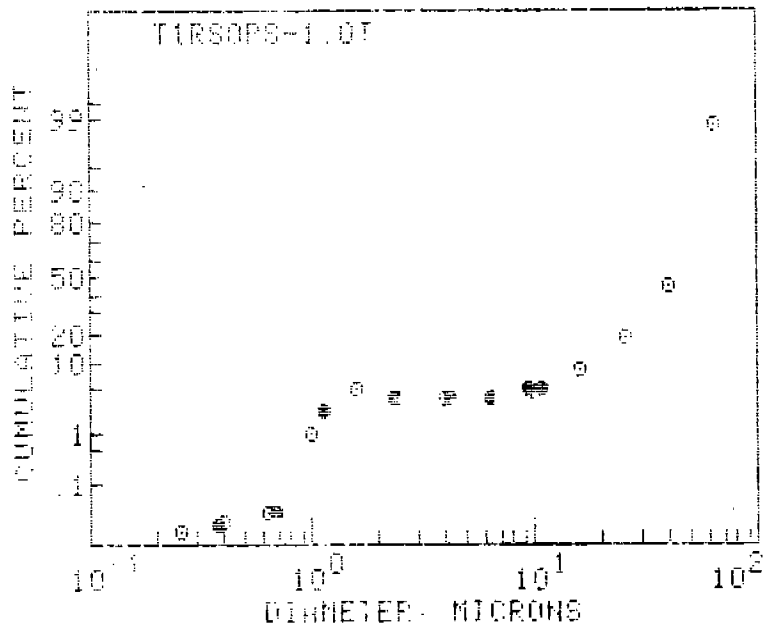

Figure 2-4. Particle size distribution test SOPS-1 (scrubber outlet).

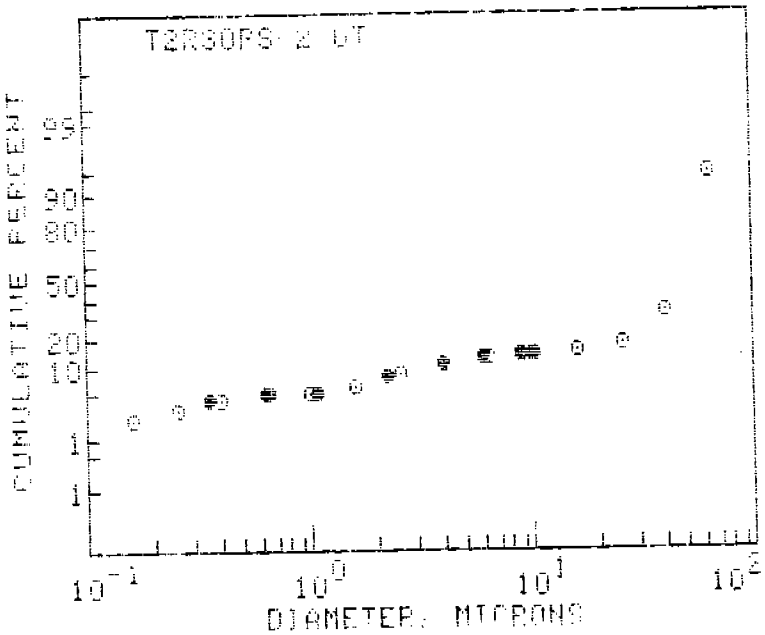

Figure 2-5. Particle size distribution test SOPS-2 (scrubber outlet).

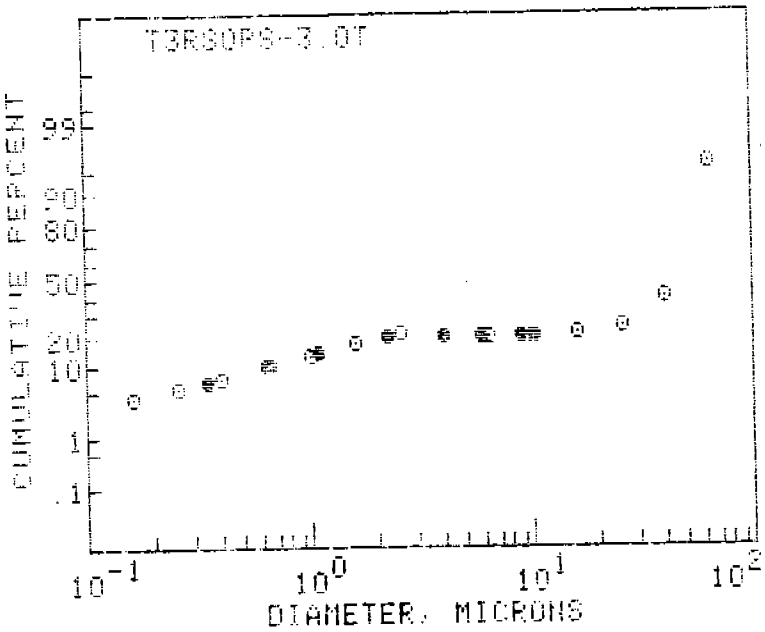

Figure 2-6. Particle size distribution test SOPS-3 (scrubber outlet).

than 10 μm would be biased low; the magnitude of which is unknown. This would be possible if the material collected was in the form of a mist which, from visual observation, appeared to be the case.

The outlet particle-size measurements are depicted in Figures 2-4 through 2-6. A similar pattern was observed for these samples as with the inlet samples; not enough material was collected on the various stages to yield reliable test data. The total catch for these runs ranged between 5.8 and 10.2 mg; the majority of the material was found in the impactor nozzle and inlet casing. The plotted data show that between 5 and 21 percent of the particles had nominal diameters of 10 μm or less, and between 3 and 21 percent had diameters of 2.5 μm or less. As with the inlet samples, the cumulative percent less than 10 μm may be biased low.

In an attempt to characterize Cr^{+6} and total Cr emissions by size fraction, inlet and outlet samples were composited by stage cutpoint into a single sample for each site.

The filters were cut into small pieces and digested using the alkaline digestion procedure. Analysis for Cr^{+6} followed the basic colorimetric procedures used for the Method 13 emission tests. The total Cr content was determined by digesting the filters and residue from the alkaline extract with analysis by ICP. Table 2-5 summarizes the results of this anlaysis. The size cutpoints were obtained from computer printouts for each individual test, and the range of cutpoints are presented for each stage. The blank corrected content of Cr^{+6} and total Cr (in micrograms [μg]) is also presented. For the inlet samples, the total content of Cr^{+6} and total Cr was found in the acetone rinse residue (>10 μm) and on stages 3 through 5 (1 to 3 μm). For the outlet samples, the Cr^{+6} and total Cr contents were 151 and 291 μg,

TABLE 2-5. PARTICLE SIZE CHARACTERIZATION OF Cr^{+6} AND TOTAL Cr

Run No.	Stage No.	Size cutpoint,[a] µm	Cr^{+6},[b] µg	Total Cr,[b] µg
Inlet SIPS-1-3	0	9.9 - 10.1	0.875	8.75
	1	8.7 - 8.9	1.3	10.9
	2	5.8 - 5.9	4.2	16.5
	3	3.8 - 3.9	13.5	26.8
	4	2.1 - 2.2	55.7	81.1
	5	1.04 - 1.06	32.4	51.4
	6	0.64 - 0.65	1.0	9.8
	7	0.34	0.3	8.3
	Backup filter	<0.34	0.875	0
	Acetone rinse	>10	840	1810
		Total	950.2	2023.6
Outlet SOPS 1-3	0	10.1 - 10.6	1.3	10.4
	1	8.8 - 9.4	1.5	8.8
	2	5.9 - 6.3	6.8	17.1
	3	3.9 - 4.0	26.1	41.7
	4	2.2 - 2.3	85.9	114.3
	5	1.1	25.1	48.2
	6	0.65 - 0.70	1.4	14.3
	7	0.35 - 0.37	0.8	9.2
	Backup filter	0.36	0.2	0
	Acetone rinse	>10	1.4	27.1
		Total	150.5	291.1

[a]Obtained from computer program calculations (see Appendix A).

[b]Cr^{+6} and total Cr content in micrograms (µg). Values have been blank-corrected.

respectively, the majority of which was found in stages 3 through 5 (1.1 to 4.0 μm). Note that the contents of Cr^{+6} and total Cr do not compare as well as the Method 13 test results. In these tests, the contents of each element were essentially identical, which indicated that most of the chromium in the samples is in the Cr^{+6} form. The particle size data indicate that a chemical reduction of Cr^{+6} is taking place on the filter media, in which case the total Cr results would be expected to be higher.

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 3-3 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 FB-9 FB-11 FT-1	Wet test meter	ΔH@ ± 0.15 (Y ± 0.05 Y post-test)	0.05; 2.25% 0.11; 0.91% 0.05; -0.204% 0.05; -1.2%	✓ ✓ ✓ ✓	
Pitot tube	242 504 015	Standard pitot tube	Cp ± 0.01		✓ ✓ ✓	Visually inspected onsite. Cp = 0.84 per Method 2.
Digital indicator	FT-1 219	Millivolt signals	0.5%	+0.22% +0.20%	✓ ✓	Maximum deviation.
Thermocouple and stack thermometers	101 412 409	ASTM-2F or 3F	1.5% (±2% saturated)	0.22% 0.3% 0.15%	✓ ✓ ✓	Maximum deviation.
Orsat analyzer	422	Standard gas	± 0.5%	CO: 0.2% O_2: 0.0 CO_2: 0.2%	✓	See Table 3-1.
Impinger thermocouple	I-15 I-1	ASTM-2F or 3F	± 2°F	+1°F +2°F	✓ ✓	
Trip balance	Mett-ler 1	Type S weight	± 0.5 g	0.0	✓	See Table 3-1.
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	4-112	Caliper	Dn ± 0.004 in.	0.002	✓	See Table 3-1.
	4-119			0.004	✓	
	3-110			0.00	✓	
	3-104			0.001	✓	

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 FB-11 FT-1 FB-9	Critical orifice	Y ± 0.05 Y ΔH@ ± 0.15	-2.03; - 0.01 +2.7; -0.08 -1.55; -0.03 -2.1; - 0.04	✓ ✓ ✓ ✓	PEI constructed critical orifices used for this audit.
Pitot tube		(Geometrical specs) (Cylinder pitot tube)	Cp ± 0.01		✓	Visually inspected on site.
Digital indicator	FT-1 219	Millivolt signals	1.0%	<0.2% <0.25%	✓ ✓	
Thermocouple and stack thermometers	101 412	ASTM-3F	± 7°F (±2°F saturated)	-4°F -2°F	✓ ✓	See Table 3-1.
Orsat analyzer	422	Ambient air O_2	± 0.7%	NA	✓	See Table 3-1.
Impinger thermocouple	I-1 I-15	ASTM-3F	± 2°F	-2°F -1°F	✓ ✓	
Trip balance		Type S weight	± 0.5 g	NA	✓	See Table 3-1.
Dry gas thermometer		ASTM-3F	± 5°F	-3°F; ±2°F	✓	Maximum deviation
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
SIC-3	100.3, Cr(VI)	-
SOC-2	92.3, total Cr	-
SIPS 1-3, acetone	105.8, Cr(VI)	-
SIPS 1-3, backup	85.5, total Cr	-
SOPS 1-3, acetone	89.4, total Cr	-
SIPS-1, Tank No. 1	96.2, Cr(VI)	-
SIC-3, Tank No. 2	92.8, total Cr	-
SIPS-1, Scrubber water	-	11.1, 10.2, total Cr 16.3, 11.9, Cr(VI)
SIC-1, Scrubber water	- -	7.99, 7.80, total Cr 6.63, 8.48, Cr(VI)
SIC-2, Scrubber water	- -	6.74, 6.38, Total Cr 5.33, 6.97, Cr(VI)

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

SECTION 4

SAMPLE LOCATIONS AND TEST METHODS USED

4.1 SAMPLE LOCATIONS

Samples were simultaneously extracted from the inlet and outlet ducts of the scrubber. Figure 4-1 depicts a simplified process flow diagram and Figures 4-2 and 4-3 show the inlet and outlet sample locations.

At the inlet, two sampling ports were located 90 degrees off-center, approximately 2.6 duct diameters (dd) downstream and 0.53 dd upstream from the nearest flow disturbance in the 32-inch i.d. round duct. A total of 24 traverse points (12 per port) were used to traverse the nonsectional area of the duct. Each point was isokinetically sampled for 7.5 minutes to yield a total test time of 180 minutes.

At the outlet, two sampling ports were located 90 degrees off-center, approximately 1.5 dd downstream and 0.45 dd upstream from the nearest flow disturbances in the 32-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 scrubber 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 outlet flow rate data indicates that this problem did not adversely affect test results.

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

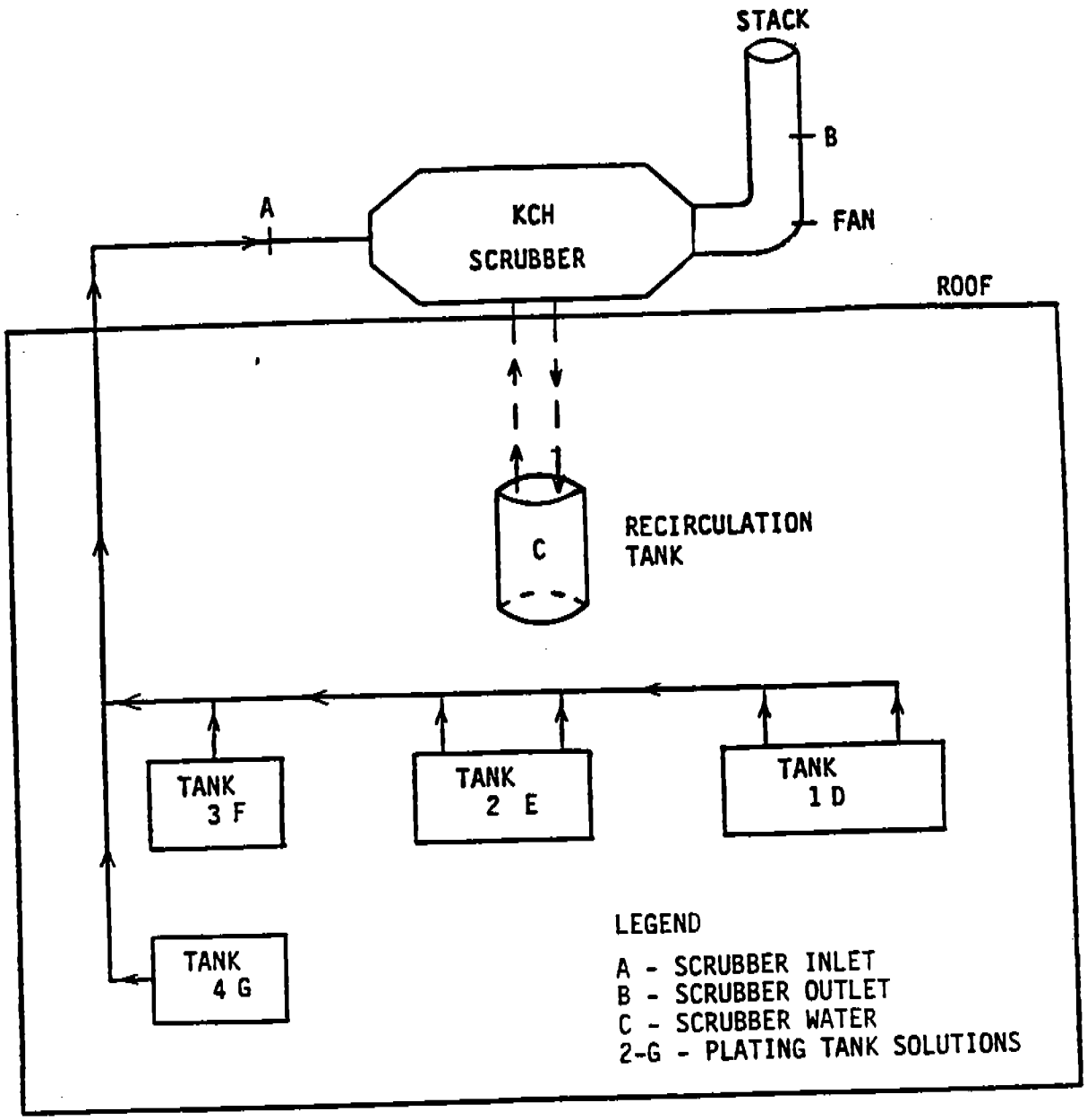


Figure 4-1. Process flow diagram, Steel Heddle Co.

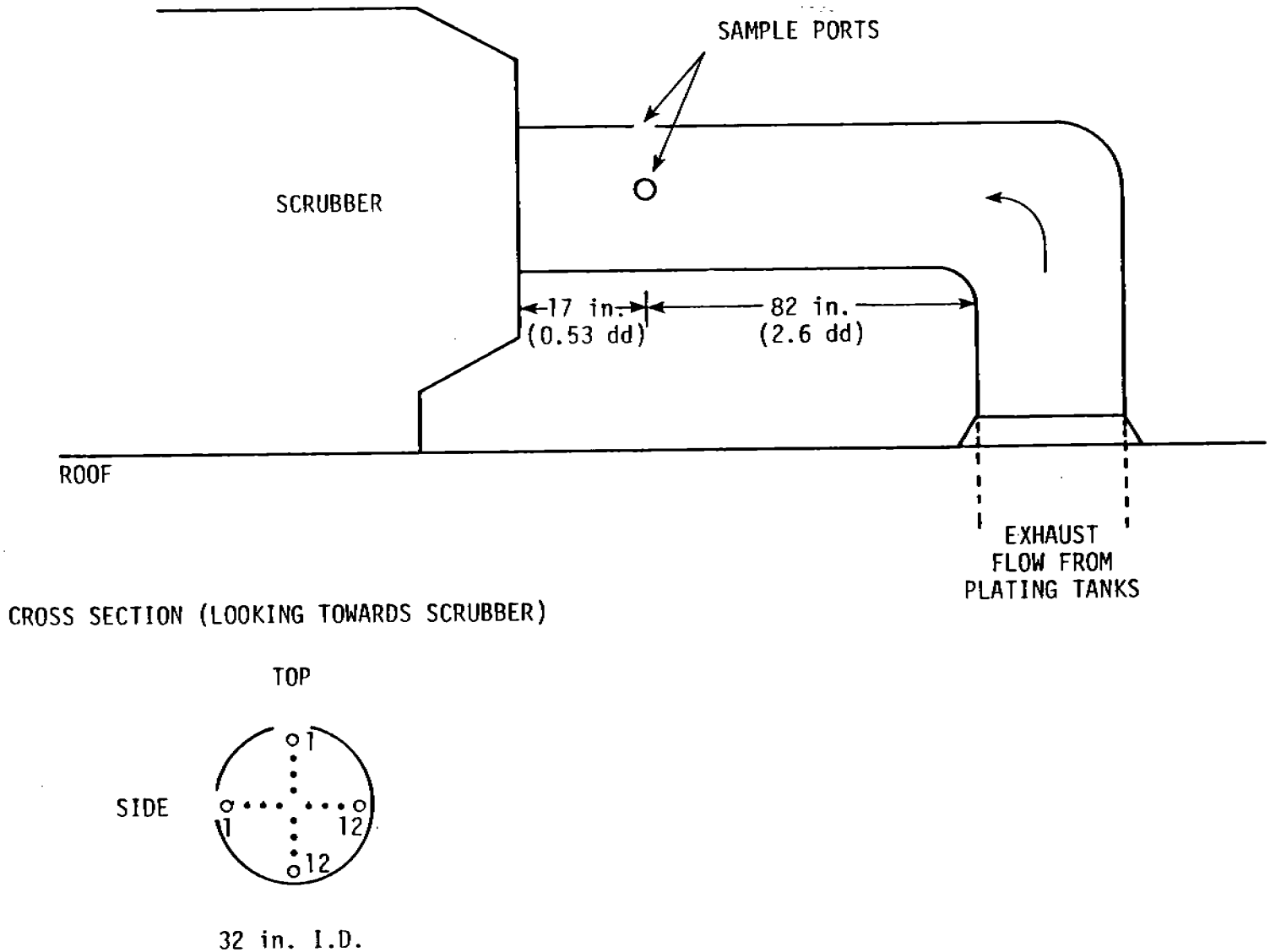
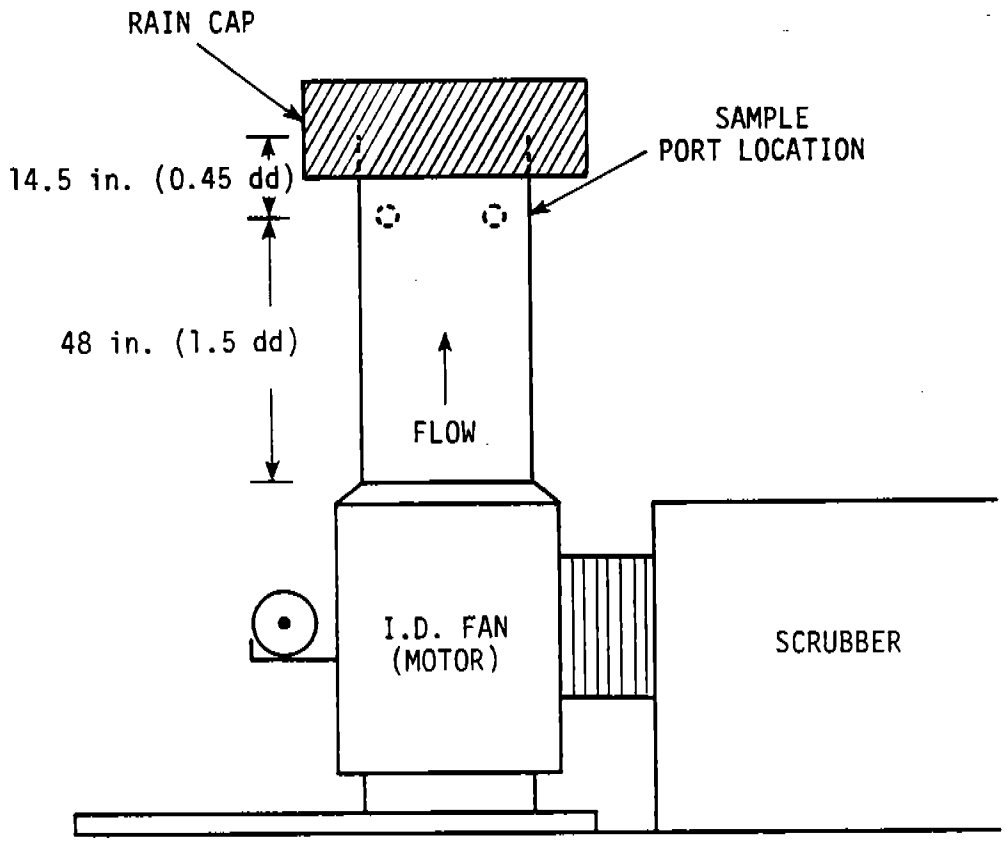
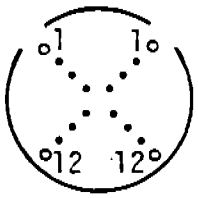


Figure 4-2. Scrubber inlet test location, Steel Heddle Co.



CROSS SECTION



32 in. I.D.

Figure 4-3. Scrubber outlet test location, Steel Heddle Co.

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 scrubber 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.

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

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

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 Cr emissions by size fraction. All size distribution tests were performed in accordance with procedures detailed in the equipment manufacturer's operations

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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.

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 precutter. Particles with sufficient inertia are impacted against the sides of the precutter. Smaller particles flow with the gas stream, exit the precutter, 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 240 minutes at the outlet and between 75 and 90 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 (scrubber water and plating tank solutions) were collected by PEI personnel during each test period. Each sample was collected at least

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* 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.

four times during the 3-hour test period and placed in polyethylene containers. 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

The Steel Heddle plant in Greenville, South Carolina, is an original equipment manufacturer of steel heddles for textile looms. The plating facility is operated both on a captive and a job shop basis. Metal finishing operations at the plant include chromium, zinc, copper, nickel, and copper/sulfate plating; chemical polishing; and sulfuric acid anodizing. Reeds and combs for textile looms and miscellaneous parts from outside customers undergo hard chromium plating. The plating facility is operated 16 hours per day, 5 days per week.

The chromium plating facility consists of four tanks, arranged as shown in Figure 5-1. Based on size; operating parameters such as current, voltage, and plating time; and chromic acid concentration, all four tanks are typical of other hard chromium plating tanks used in the electroplating industry. During this source test program, tanks 1, 2, and 4 were operated. The dimensions and operating parameters for these tanks are presented in Table 5-1. The plating solution used in the tanks is a conventional hard chromium plating solution containing about 250 grams per liter (g/ℓ) (33 ounces per gallon [oz/gal]) of chromic acid and about 2.5 g/ℓ (0.33 oz/gal) of sulfuric acid.

5.2 AIR POLLUTION CONTROL

Tanks 1 and 4 are equipped with push-pull emission capture systems. The push side of the capture system consists of a 5.0-centimeter (cm) [2-inch (in.)] diameter pipe along the entire length of each tank. The pipe on tank 1 contains 54 holes spaced about 6.4 cm (2.5 in.) apart and the pipe on tank 4 contains 36 holes spaced about 5.0 cm (2 in.) apart. Each hole is 0.32 cm (0.125 in.) in diameter. The pull or exhaust side of the capture system consists of a side draft hood. The hood on tank 1 is 3.8 meters (m) [12.5 feet (ft)] long and the hood on tank 4 is 2.1 m (6.8 ft) long. Each hood has two rows of slots with four slots per row. The slot dimensions for tank 1 are 45.7 cm (18 in.) long by 2.54 cm (1 in.) wide and for tank 4 are 50.8 cm (20 in.) long by 2.54 cm (1 in.) wide.

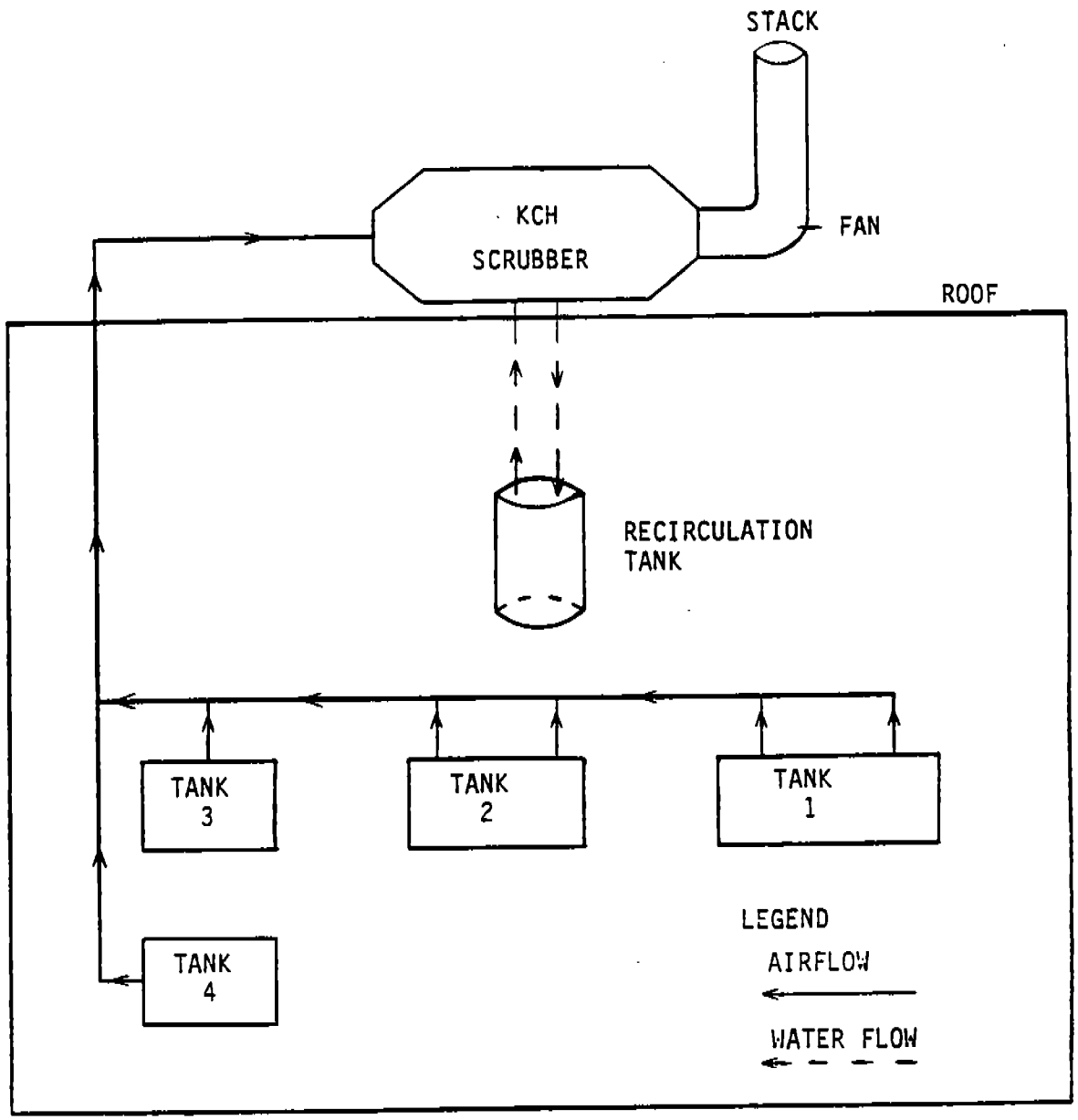

Figure 5-1. Schematic of Steel Heddle chromium plating operation.

TABLE 5-1. DIMENSIONS AND OPERATING PARAMETERS OF HARD CHROMIUM PLATING TANKS 1, 2, AND 4 AT STEEL HEDDLE, GREENVILLE, SOUTH CAROLINA

Tank No.	Dimensions, l,w,d m (ft)	Capacity, ℓ (gal)	Voltage, volts[a]	Current, amperes[a]	Method of cooling	Constituents, g/ℓ (oz/gal) CrO_3	Constituents, g/ℓ (oz/gal) H_2SO_4
1	3.8,0.9,0.9 (12.5,3.0,3.0)	3,180 (840)	15	10,000	Water	250 (33)	2.5 (0.33)
2	3.0,0.5,0.9 (10.0,1.8,3.0)	1,476 (390)	15	6,000	Water	250 (33)	2.5 (0.33)
4	2.1,0.8,0.9 (6.8,2.5,3.0)	1,438 (380)	30	5,000	Water	250 (33)	2.5 (0.33)

[a]Maximum operating values.

Tank 2 is equipped with a single-sided draft hood that is 3.0 m (10.0 ft) long. The hood is located on the back of the tank and has two rows of slots with eight slots per row. The slots are 38.1 cm (15 in.) long and 2.54 cm (1 in.) wide.

Emissions from all three tanks are ducted to a fume scrubber system that is located on the roof of the plating shop. The scrubber is a horizontal-flow double-packed-bed unit manufactured by KCH Services, Inc. (Model No. H-2000). The scrubber was installed in 1981. It has a design gas flow rate of 538 cubic meters per minute (19,000 cubic feet per minute) and a water flow rate of 439 liters per minute (116 gallons per minute). The pressure drop is rated at 0.75 kilopascals (kPa) (3 inches of water column [in. w.c.]). Removal of chromium mist from the gas stream is accomplished by first reducing the velocity of the gas stream to less than 152 meters per minute (500 feet per minute) at the scrubber inlet. Then water is sprayed from six spray nozzles located in front of each packed bed countercurrent to the flow of the gas stream and chromium mist impinges on the packing material and is washed to the bottom of the scrubber. The packed beds are 30.5 cm (12 in.) deep and are filled with polypropelene spherical-type mass packing that is continuously washed with water from the spray nozzles. The scrubber also contains a two-stage mist elimination section located downstream of the second packed bed. The first stage allows larger droplets to settle by gravity to the bottom of the scrubber. The second stage contains a series of vertically mounted chevron blades made of polyvinyl chloride that change the direction of the gas flow four times at 30° angles which forces chromium mist to impinge on the blades. The scrubber water flows by gravity from the scrubber to a 910-liter (240-gallon) recirculation tank located inside the plating shop. Clean water is used to make up evaporation losses from the system. The ductwork is washed down once per month with water that subsequently drains into the plating tanks.

5.3 PROCESS CONDITIONS DURING TESTING

Mass emission and particle size distribution testing was conducted at the inlet and outlet of the scrubber to characterize the uncontrolled emissions from all three hard chromium plating tanks and the performance of the scrubber. 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. Also recorded were descriptions (dimensions and surface area) and plating requirements (current and plating time) of each individual job or item being plated during each test run. Data sheets documenting the process parameters recorded during each mass emission test run (Nos. SIC-1 through 3 and SOC-1 through 3) are presented in Appendix H. Data on the average operating parameters recorded are presented in Table 5-2. In addition, the pressure drop across the scrubber was also monitored. The pressure drop averaged 0.7 kPa (2.9 in. w.c.) during run 1 and 0.8 kPa (3.2 in. w.c.) during runs 2 and 3.

Grab samples were taken from each tank tested and from the scrubber recirculation tank to determine the chromic acid concentration of the plating solution and recirculation water during each mass emission test run. The chromic acid concentration of the grab samples is reported in Section 2.3 of this report.

Sampling interruptions during the test runs were very limited. All three test runs were interrupted for 15 to 20 minutes for port changes. Runs 2 and 3 were interrupted one additional time for 30 and 45 minutes, respectively, during shift changes.

The total amount of current supplied to the tank during each test run is calculated in terms of ampere-hours and included in Appendix E. A summary of the total current values is presented in Table 5-3.

TABLE 5-2. AVERAGE OPERATING PARAMETERS RECORDED DURING EACH MASS EMISSION SOURCE TEST RUN

Test No. Inlet/outlet	Tank No.	Operating voltage, volts	Operating current, amperes	Temperature of plating solution, °C (°F)
SIC-1/SOC-1	1	5.7	2,234	52 (125)
	2	6.0	1,363	52 (125)
	4	6.3	864	43 (110)
SIC-2/SOC-2	1	5.3	400	52 (125)
	2	5.8	1,200	52 (125)
	4	6.8	609	43 (110)
SIC-3/SOC-3	1	6.0	1,518	52 (125)
	2	6.2	1,500	52 (125)
	4	7.0	654	43 (110)

TABLE 5-3. TOTAL CURRENT SUPPLIED TO TANKS 1, 2, AND 4 DURING EACH MASS EMISSION SOURCE TEST RUN

Test Run No. Inlet/Outlet	Tank No.	Total current, ampere-hours Inlet	Outlet
SIC-1/SOC-1	1	5,408	5,398
	2	3,409	3,394
	4	2,575	2,575
	TOTAL	11,392	11,367
SIC-2/SOC-2	1	1,014	979
	2	3,435	3,427
	4	1,824	1,821
	TOTAL	6,273	6,227
SIC-3/SOC-3	1	3,203	3,163
	2	3,546	3,486
	4	1,955	1,959
	TOTAL	8,704	8,608

APPENDIX A

COMPUTER PRINTOUTS

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

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

P_{bar} = barometric pressure, in.Hg

P_s = absolute stack gas pressure, in.Hg

pmr = particulate matter emission rate, lb/h

Q_s = volumetric flow rate, wet basis, stack conditions

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

(continued)

Nomenclature and Dimensions (continued)

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

$V_{w_{std}}$ = 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.

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.

$$V_{w_{std}} = 0.04707 V_{1_c} =$$

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.

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

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.

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

11. Isokinetic variation.

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

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 .....STEEL HEDDLE
Sampling location .....INLET
Test time (start-stop) 0827-1145

Date .....5/14/8[illegible]
Run number SIC-1

Sample type .....CR+6
Bar. pressure (in-Hg) 29.55
Static pressure (in-H2O) .....-3.3
Filter number(s) .....NA
Stack inside dia. (in) 33
Pitot tube coeff. 0.84
Total H2O collected (ml) 100.0
Percent O2 by volume (dry) ...20.9

Leakage (cu-ft) 111
Meter calibration factor 0.978
Data interval (min) 7.5
Nozzle dia. .....0.2[illegible]
Meter box number .....P[illegible]-11
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	378.740					
7.5	386.400	0.700	1.81	90	84	82
15.0	394.700	0.950	2.50	89	92	85
22.5	403.800	1.050	2.75	93	100	87
30.0	412.800	0.930	2.45	94	105	89
37.5	421.400	0.950	2.55	93	109	92
45.0	430.000	0.900	2.40	94	112	95
52.5	437.700	0.750	2.00	94	115	97
60.0	445.400	0.720	1.95	95	117	101
67.5	453.600	0.720	1.95	95	120	103
75.0	461.000	0.760	2.05	95	122	106
82.5	469.300	0.800	2.20	96	124	108
90.0	476.952	0.720	1.95	96	125	110
97.5	486.500	1.200	3.30	96	125	113
105.0	495.700	1.100	3.00	97	124	115
112.5	504.100	0.900	2.45	97	126	115
120.0	512.100	0.810	2.20	98	128	117
127.5	520.300	0.880	2.40	98	132	118
135.0	528.300	0.800	2.20	98	134	120
142.5	535.900	0.730	2.00	98	135	122
150.0	543.700	0.770	2.15	99	136	122
157.5	551.500	0.790	2.20	100	136	122
165.0	559.400	0.820	2.25	100	136	122
172.5	567.400	0.820	2.25	99	136	122
180.0	575.225	0.820	2.25	99	136	122
180.0	176.549	0.845	2.30	95	122	108

P E T 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: STEEL HEDDLE
TEST: SIC-1 , INLET

TEST DATE: 6/24/88
TEST TIME: 0827-1145

TT	.....	Net time of test (min)	180.0
NP	.....	Net sampling points	12
Y	.....	Meter calibration factor	0.975
DN	.....	Sampling nozzle dia (in)	0.250
CP	.....	Pitot tube coefficient	0.840
PM	.....	Average orifice pressure drop (in-H2O)	2.30
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft) (corrected for leakage)	192.400
TM	.....	Average gas meter temperature (deg F)	114.7
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	174.150
VLC	.....	Total H2O collected in impingers and silica gel (ml)	100.0
VWC	.....	Volume of water vapor at standard conditions (scf)	4.707
BWC	.....	Percent moisture by volume	2.57
FMD	.....	Mole fraction of dry gas	0.97
PCO2	.....	Percent CO2 by volume (dry)	0.000
PCO	.....	Percent CO by volume (dry)	20.900
PO2	.....	Percent O2 by volume (dry)	0.000
PN2	.....	Percent N2 by volume (dry)	79.100
MD	.....	Molecular weight of dry stack gas	28.84

TEST RESULTS

PAGE NO: 2
RUN NO: [illegible]

MWS	.....	Molecular weight - stack gas	28.55
PB	.....	Barometric pressure (in-HG)	29.25
PSI	.....	Static pressure of stack gas (in-H2O)	-0.300
PS	.....	Stack pressure - absolute (in-HG)	[illegible]
TS	.....	Average stack temperature (deg F)	[illegible]
VP	.....	Average square root of velocity head (in-H2O)	0.919
VS	.....	Average stack gas velocity (fps)	54.0
AS	.....	Stack area (sq in)	304
QS	.....	Actual stack flow rate (acfm)	18,092
QSSTD	.....	Stack flow rate - dry (scfm)	16,273
ISO	.....	Percent isokinetic	96.6
MN	.....	HEXAVALENT CR+6, MG	10.0
CS	.....	HEXAVALENT CR+6, GR/DSCF	1.1784E-03
PMR	.....	HEXAVALENT CR+6 Emission rate, lb/hr	0.164
MN	.....	TOTAL CR, MG	12.6
CS	.....	TOTAL CR, GR/DSCF	1.1164E-03
PMR	.....	TOTAL CR Emission rate, lb/hr	0.156

J. Fiore

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 .....STEEL HEDDLE
Sampling location .....INLET
Test time (start-stop) 0808-1132

Date 6/25/86
Run number EIC-1

Sample type .....S-type
Bar. pressure (in-HG) 29.41
Static pressure (in-H2O) .....-0.55
Filter number(s) .....NA
Stack inside dia. (in) 22
Pitot tube coeff. 0.84
Total H2O collected (ml) 81.4
Percent O2 by volume (dry) ...20.9

Leakage (cu-ft) 0.386
Meter calibration factor 0.973
Data interval (min) 7.5
Nozzle dia. 0.251
Meter box number PB-11
Number of traverse points 24
Percent CO2 by volume (dry) ..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	577.318					
7.5	585.200	0.890	2.30	87	81	78
15.0	594.100	0.920	2.55	86	91	83
22.5	602.200	0.830	2.20	86	99	88
30.0	610.600	0.880	2.35	86	105	89
37.5	619.000	0.820	2.20	89	110	93
45.0	626.700	0.830	2.25	88	117	96
52.5	634.400	0.780	2.10	90	115	99
60.0	642.300	0.800	2.20	89	116	102
67.5	650.300	0.840	2.30	89	117	104
75.0	658.600	0.870	2.40	89	119	107
82.5	666.700	0.880	2.40	90	120	109
90.0	674.957	0.890	2.45	90	121	110
97.5	684.400	1.100	3.05	92	122	116
105.0	693.100	1.000	2.75	92	123	116
112.5	701.400	0.920	2.55	92	127	116
120.0	709.500	0.940	2.60	92	125	117
127.5	718.200	0.970	2.70	92	125	117
135.0	726.600	0.940	2.60	92	125	117
142.5	734.000	0.750	2.01	92	126	117
150.0	741.100	0.657	1.90	92	127	117
157.5	748.500	0.720	2.00	92	128	117
165.0	755.900	0.720	2.00	92	129	118
172.5	763.300	0.750	2.10	92	130	119
180.0	770.522	0.752	2.10	92	131	119
180.0	777.318	0.852	2.34	90	115	107

J. Fiori 7/7/86

P.E.I. ASSOCIATES, INC.
EMISSION TEST REPORT

TEST RESULTS

PLANT: STEEL HEDDLE
TEST: SIC-2 / INTLET

TEST DATE: 6/25/86
TEST TIME: 0808-1132

TT	.....	Net time of test (min)	181.0
NP	.....	Net sampling points	24
Y	.....	Meter calibration factor	0.975
DN	.....	Sampling nozzle dia (in)	0.250
CP	.....	Pitot tube coefficient	0.840
PM	.....	Average orifice pressure drop (in-H2O)	2.34
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft) (corrected for leakage)	172.114
TM	.....	Average gas meter temperature (deg F)	112.1
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	170.026
VLI	.....	Total H2O collected in impingers and silica gel (ml)	21.4
VWI	.....	Volume of water vapor at standard conditions (scf)	0.801
BWI	.....	Percent moisture by volume	1.19
FNI	.....	Mole fraction of dry gas	0.98
FCOI	.....	Percent CO2 by volume (dry)	0.000
FOI	.....	Percent O2 by volume (dry)	20.99
FCI	.....	Percent CO by volume (dry)	0.001
FNI	.....	Percent N2 by volume (dry)	79.11
MI	.....	Molecular weight of dry stack gas	28.94

TEST RESULTS

PAGE NO: 1
RUN NO: 810-1

MWS	.....	Molecular weight - stack gas	28.60
PB	.....	Barometric pressure (in-HG)	29.41
PSI	.....	Static pressure of stack gas (in-H2O)	-3.550
PS	.....	Stack pressure - absolute (in-HG)	29.15
TS	.....	Average stack temperature (deg F)	92
VH	.....	Average square root of velocity head (in-H2O)	0.523
VS	.....	Average stack gas velocity (fps)	57.9
AS	.....	Stack area (sq ft)	804
QS	.....	Actual stack flow rate (acfm)	15,049
QSSTD	.....	Stack flow rate - dry (scfm)	16,509
ISO	.....	Percent isokinetic	94.3
MN	.....	HEXAVALENT CR-6, MG	5.2
CS	.....	HEXAVALENT CR-6, GR/DSCF	5.22E-04
EMF	.....	HEXAVALENT CR+6 Emission rate, lb/hr	0.074
MN	.....	TOTAL CR, MG	5.4
CS	.....	TOTAL CR, GR/DSCF	4.86E-04
EMR	.....	TOTAL CR Emission rate, lb/hr	0.069

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 .....STEEL HEDDLE
Sampling location .....INLET
Test time (start-stop) 1245-1633

Date 6/25/86
Run number SID-3

Sample type .....CR+6
Bar. pressure (in-HG) 29.44
Static pressure (in-H2O) .....-3.5
Filter number(s) .....NA
Stack inside dia. (in) 32
Pitot tube coeff. 0.84
Total H2O collected (ml) 82.1
Percent O2 by volume (dry) ...20.9

Leakage (cu-ft) 297
Meter calibration factor 0.978
Data interval (min) 7.5
Nozzle dia. 0.251
Meter box number FB-11
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	771.075					
7.5	780.400	1.150	3.15	95	121	115
15.0	789.500	1.100	3.00	94	121	117
22.5	798.500	1.050	2.90	95	124	117
30.0	807.000	0.920	2.50	94	125	117
37.5	815.650	0.970	2.70	94	126	117
45.0	823.750	0.850	2.35	95	127	117
52.5	831.300	0.750	2.05	95	129	117
60.0	838.700	0.700	1.95	95	130	117
67.5	846.000	0.700	1.95	95	131	117
75.0	853.400	0.700	1.95	95	130	117
82.5	860.900	0.720	2.00	95	129	117
90.0	868.286	0.720	2.00	96	129	117
97.5	876.300	0.750	2.05	97	124	117
105.0	885.100	0.980	2.70	96	123	116
112.5	893.550	0.950	2.60	98	124	115
120.0	901.750	0.840	2.35	99	124	115
127.5	910.000	0.870	2.35	100	124	114
135.0	917.900	0.820	2.25	99	124	113
142.5	925.500	0.750	2.05	99	123	113
150.0	933.500	0.770	2.10	99	123	113
157.5	941.200	0.850	2.30	99	117	113
165.0	949.500	0.870	2.35	99	113	117
172.5	957.700	0.850	2.30	99	116	117
180.0	965.350	0.750	2.10	99	118	117
187.5	974.390	0.847	2.33	97	124	115

J. Fu 7/7/86

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: STEEL HEDDLE
TEST: EIO-3 / INLET

TEST DATE: 6/25/86
TEST TIME: 1245-1633

TT	.....	Net time of test (min)	180.0
NP	.....	Net sampling points	24
Y	.....	Meter calibration factor	0.975
DN	.....	Sampling nozzle dia (in)	0.251
CP	.....	Pitot tube coefficient	0.841
PM	.....	Average orifice pressure drop (in-H2O)	2.77
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft) (corrected for leakage)	150.977
TM	.....	Average gas meter temperature (deg F)	119.1
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	171.186
VLC	.....	Total H2O collected in impingers and silica gel (ml)	21..
VWC	.....	Volume of water vapor at standard conditions (scf)	0.994
BWO	.....	Percent moisture by volume	2.1.
FMD	.....	Mole fraction of dry gas	1.95
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)	79.1..
MD	.....	Molecular weight - dry stack gas	28.84

TEST RESULTS

PAGE NO: 2
RUN NO: EII-3

MWS	.....	Molecular weight - stack gas	28.60
PB	.....	Barometric pressure (in-HG)	29.44
PSI	.....	Static pressure of stack gas (in-H2O)	-3.500
PS	.....	Stack pressure - absolute (in-HG)	29.15
TS	.....	Average stack temperature (deg F)	97
VH	.....	Average square root of velocity head (in-H2O)	0.720
VS	.....	Average stack gas velocity (fps)	54.1
AS	.....	Stack area (sq in)	804
QS	.....	Actual stack flow rate (acfm)	18,033
QSSTD	.....	Stack flow rate - dry (scfm)	16,360
ISO	.....	Percent isokinetic	94.5
MN	.....	HEXAVALENT CR+6, MG	5.5 ✓
CS	.....	HEXAVALENT CR+6, GR/DSCF	4.9395-04
PMR	.....	HEXAVALENT CR+6 Emission rate, lb/hr	0.067
MT	.....	TOTAL CR, MG	5.5 ✓
CS	.....	TOTAL CR, GR/DSCF	4.7595-04
PMF	.....	TOTAL CR Emission rate, lb/hr	0.067

✓ J. Fidri

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 .....STEEL HEDDLE
Sampling location .....OUTLET
Test time (start-stop) 0833-1148

Date .....6/24/8[illegible]
Run number SOD-1

Sample type CR/DA-5
Bar. pressure (in-Hg) 29.35
Static pressure (in-H2O) .....-0.35
Filter number(s) .....NA
Stack inside dia. (in) .....[illegible]
Pitot tube coeff. 0.84
Total H2O collected (ml) 113.4
Percent O2 by volume (dry) ...20.5

Leakage (cu-ft) 0.000
Meter calibration factor 0.921
Data interval (min) 7.5
Nozzle dia. 0.255
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	645.598					
7.5	651.000	0.550	1.45	77	85	87
15.0	658.400	0.650	3.00	75	89	88
22.5	666.000	0.680	3.00	75	97	90
30.0	673.500	0.680	3.05	75	103	91
37.5	680.800	0.630	2.85	78	105	93
45.0	688.200	0.630	2.85	79	105	95
52.5	696.000	0.650	2.95	80	112	95
60.0	703.500	0.740	3.35	80	114	100
67.5	712.400	0.900	4.10	80	117	102
75.0	722.000	1.050	4.80	81	120	106
82.5	731.300	1.100	5.05	80	121	106
90.0	741.114	1.150	5.30	80	122	108
97.5	750.000	0.860	3.95	80	116	111
105.0	758.600	0.950	4.35	80	117	111
112.5	767.600	0.880	4.05	81	120	111
120.0	776.000	0.830	3.85	81	124	113
127.5	784.300	0.820	3.80	80	126	114
135.0	792.500	0.830	3.85	80	127	115
142.5	801.200	0.790	3.70	80	128	117
150.0	810.400	0.970	4.55	80	129	118
157.5	820.000	1.050	4.90	79	129	116
165.0	830.100	1.200	5.60	80	128	118
172.5	840.450	1.250	5.85	80	130	118
180.0	850.792	1.250	5.85	80	131	118
[illegible]	[illegible]	[illegible]	[illegible]	81	[illegible]	[illegible]

F.E.J. ASSOCIATES, INC.
EMISSION TEST REPORT

TEST RESULTS

PLANT: STEEL NEEDLE
TEST: SCD-1 / OUTLET

TEST DATE: 6/24/86
TEST TIME: 0833-1146

TT	.....	Net time of test (min)	180.0
NP	.....	Net sampling points	12
Y	.....	Meter calibration factor	0.981
DN	.....	Sampling nozzle dia (in)	0.250
CP	.....	Pitot tube coefficient	0.840
PM	.....	Average orifice pressure drop (in-H2O)	4.00
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft)	205.194
TM	.....	Average gas meter temperature (deg F)	111.4
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	184.255
VLC	.....	Total H2O collected in impingers and silica gel (ml)	118.4
VWC	.....	volume of water vapor at standard conditions (scf)	5.573
BWO	.....	Percent moisture by volume	2.94
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
PN2	.....	Percent N2 by volume (dry)	79.100
MD	.....	Molecular weight - dry stack gas	28.84

TEST RESULTS

MWS	.....	Molecular weight - stack gas	28.51
PB	.....	Barometric pressure (in-HG)	29.35
PSI	.....	Static pressure of stack gas (in-H2O)	-0.350
PS	.....	Stack pressure - absolute (in-HG)	29.33
TS	.....	Average stack temperature (deg F)	80
VH	.....	Average square root of velocity head (in-H2O)	1.[illegible]
VS	.....	Average stack gas velocity (fps)	5[illegible].7
AS	.....	Stack area (sq ft)	904
QS	.....	Actual stack flow rate (acfm)	1[illegible]
QSSTD	.....	Stack flow rate - dry (scfm)	16.76[illegible]
ISO	.....	Percent isokinetic	[illegible].7
MN	.....	HEXAVALENT CR+6, MG	0.3 ✓
CS	.....	HEXAVALENT CR+6, GR/DSCF	0.[illegible]E-15
PMR	.....	HEXAVALENT CR+6 Emission rate, lb/hr	0.1888E-07
MN	.....	TOTAL CR, MG	0.3 ✓
CS	.....	TOTAL CR, GR/DSCF	0.1[illegible]E-[illegible]
PMR	.....	TOTAL CR Emission rate, lb/hr	0.141[illegible]E-1[illegible]

J. Fiori

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 .....STEEL HEDDLE
Sampling location .....OUTLET
Test time (start-stop) 0811-1134

Date 6/25/86
Run number SOC-1

Sample type .....CR/CR+6
Bar. pressure (in-HG) 29.41
Static pressure (in-H2O) .....-0.36
Filter number(s) .....NA
Stack inside dia. (in) 32
Pitot tube coeff. 0.84
Total H2O collected (ml) 102.8
Percent O2 by volume (dry) ...20.9

Leakage (cu-ft) 0.000
Meter calibration factor 0.981
Data interval (min) 7.5
Nozzle dia. 0.250
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	851.357					
7.5	858.300	0.610	2.65	75	83	82
15.0	865.900	0.710	3.15	75	89	85
22.5	873.600	0.710	3.20	75	100	87
30.0	881.200	0.700	3.15	75	104	91
37.5	888.700	0.660	2.95	74	110	94
45.0	896.200	0.670	3.05	75	111	97
52.5	903.900	0.690	3.15	75	114	100
60.0	912.100	0.750	3.60	75	116	102
67.5	921.000	0.910	4.20	75	116	104
75.0	929.900	1.000	4.60	75	117	105
82.5	939.300	1.050	4.85	76	120	107
90.0	948.975	1.100	5.10	76	121	108
97.5	958.000	0.970	4.50	75	117	113
105.0	967.200	1.000	4.65	76	119	113
112.5	976.000	0.900	4.20	76	122	114
120.0	984.500	0.840	3.90	75	124	114
127.5	993.000	0.840	3.90	76	123	114
135.0	1001.500	0.820	3.85	75	124	114
142.5	1010.700	1.000	4.70	76	125	115
150.0	1020.300	1.100	5.15	76	125	115
157.5	1030.300	1.150	5.40	75	125	115
165.0	1040.500	1.250	5.85	75	125	114
172.5	1050.900	1.300	6.10	75	127	115
180.0	1061.355	1.300	6.10	75	125	115
180.0	209.998	0.908	4.25	75	[illegible]	[illegible]

E.P.I. ASSOCIATES, INC.
EMISSION TEST REPORT

TEST RESULTS

PLANT: STEEL HEDDLE
TEST: SOC-2 / OUTLET

TEST DATE: 6/25/86
TEST TIME: 0911-1134

TT	.....	Net time of test (min)	180.0
NP	.....	Net sampling points	24
Y	.....	Meter calibration factor	0.991
DN	.....	Sampling nozzle dia (in)	0.187
CP	.....	Pitot tube coefficient	0.840
PM	.....	Average orifice pressure drop (in-H2O)	4.25
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft)	205.955
TM	.....	Average gas meter temperature (deg F)	110.7
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	195.728
VLC	.....	Total H2O collected in impingers and silica gel (ml)	112.5
VWC	.....	Volume of water vapor at standard conditions (scf)	4.309
BWO	.....	Percent moisture by volume	2.45
FMC	.....	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
MD	.....	Molecular weight - dry stack gas	28.84

TEST RESULTS

PAGE NO: 2
RUN NO: SCC-2

MWS	.....	Molecular weight - stack gas	28.57
PB	.....	Barometric pressure (in-HG)	29.41
PSI	.....	Static pressure of stack gas (in-H2O)	-0.360
PS	.....	Stack pressure - absolute (in-HG)	29.39
TS	.....	Average stack temperature (deg F)	75
VH	.....	Average square root of velocity head (in-H2O)	0.957
VS	.....	Average stack gas velocity (fps)	54.5
AS	.....	Stack area (sq in)	504
QS	.....	Actual stack flow rate (acfm)	15.709
QSSTD	.....	Stack flow rate - dry (scfm)	17.397
ISO	.....	Percent isokinetic	97.7
MN	.....	HEXAVALENT CR+6, MG	0.0
CS	.....	HEXAVALENT CR+6, GR/DSCF	2.158E-05
PMR	.....	HEXAVALENT CR+6 Emission rate, lb/hr	3.0354E-05
MT	.....	TOTAL CR, MG	0.7
CS	.....	TOTAL CR, GR/DSCF	2.148E-02
PMR	.....	TOTAL CR Emission rate, lb/hr	3.1763E-03

J. Fiori

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 .....STEEL HEDDLE
Sampling location .....OUTLET
Test time (start-stop) 1247-1535

Date 6/25/86
Run number .....[illegible]

Sample type .....CR/CR+6
Bar. pressure (in-Hg) 29.44
Static pressure (in-H2O) .....-0.26
Filter number(s) N4
Stack inside dia. (in) 22
Pitot tube coeff. 0.84
Total H2O collected (ml) 96.8
Percent O2 by volume (dry) ...20.9

Leakage (cu-ft) 0.000
Meter calibration factor 0.921
Data interval (min) 7.5
Nozzle dia. .....[illegible]
Meter box number PT-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	61.501					
7.5	70.450	0.950	4.40	72	105	103
15.0	79.650	1.000	4.65	72	114	109
22.5	88.750	0.970	4.50	72	119	109
30.0	97.650	0.910	4.25	75	121	109
37.5	106.200	0.850	3.95	75	122	110
45.0	115.000	0.840	3.90	75	122	110
52.5	123.100	0.790	3.70	74	124	111
60.0	132.200	0.970	4.55	75	125	111
67.5	141.700	1.050	4.90	74	125	112
75.0	152.100	1.250	5.85	74	125	112
82.5	162.700	1.350	6.30	76	125	112
90.0	173.342	1.350	6.30	76	125	112
97.5	181.200	0.700	3.25	75	119	110
105.0	189.050	0.710	3.30	73	117	108
112.5	196.950	0.700	3.25	73	121	108
120.0	204.650	0.680	3.15	74	122	108
127.5	212.200	0.650	3.00	74	122	108
135.0	219.800	0.640	2.95	76	123	107
142.5	228.000	0.680	3.15	75	121	106
150.0	235.900	0.800	3.70	74	120	105
157.5	244.500	0.920	4.15	74	103	98
165.0	253.800	1.050	4.80	74	107	98
172.5	263.700	1.100	5.00	75	113	99
180.0	273.650	1.150	5.30	75	117	99
180.0	211.589	0.908	4.26	74	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: STEEL HEDDLE
TEST: SOC-3 / OUTLET

TEST DATE: 6/25/9[illegible]
TEST TIME: 1247-1635

TT	.....	Net time of test (min)	180.0
NP	.....	Net sampling points	24
Y	.....	Meter calibration factor	0.981
DN	.....	Sampling nozzle dia (in)	0.255
CP	.....	Pitot tube coefficient	0.841
PM	.....	Average orifice pressure drop (in-H2O)	4.26
VM	.....	Volume of dry gas sampled at meter conditions (cu-ft)	211.559
TM	.....	Average gas meter temperature (deg F)	1[illegible].7
VMSTD	.....	Volume of dry gas sampled at standard conditions (scf)	190.119
VLC	.....	Total H2O collected in impingers and silica gel (ml	5[illegible].5
VWC	.....	Volume of water vapor at standard conditions (scf)	4.55[illegible]
BWC	.....	Percent moisture by volume	2.74
FMD	.....	Mole fraction of dry gas	0.9[illegible]
PCO2	.....	Percent CO2 by volume (dry)	0.000
PO2	.....	Percent O2 by volume (dry)	20.9[illegible]
PCO	.....	Percent CO by volume (dry)	0.0[illegible]
PN2	.....	Percent N2 by volume (dry)	79.1[illegible]
MD	.....	Molecular weight - dry stack gas	28.8[illegible]

TEST RESULTS

MWS	.....	Molecular weight - stack gas	28.58
PB	.....	Barometric pressure (in-HG)	29.44
PSI	.....	Static pressure of stack gas (in-H2O)	-0.266
PS	.....	Stack pressure - absolute (in-HG)	29.40
TS	.....	Average stack temperature (deg F)	74
VP	.....	Average square root of velocity head (in-H2O)	0.580
VS	.....	Average stack gas velocity (fps)	54.5
AS	.....	Stack area (sq in)	804
QS	.....	Actual stack flow rate (acfm)	18,271
QSSTD	.....	Stack flow rate - dry (scfm)	17,340
ISO	.....	Percent isokinetic	97.4
MN	.....	HEXAVALENT CR+6, MG	0.0 ✓
CS	.....	HEXAVALENT CR+6, GR/DSCF	1.355E-05
EMR	.....	HEXAVALENT CR+6 Emission rate, lb/hr	3.07555E-03
MN	.....	TOTAL CR, MG	0.0 ✓
CS	.....	TOTAL CR, GR/DSCF	2.479E-05
EMR	.....	TOTAL CR Emission rate, lb/hr	5.60775E-03

✓ J. Fiori

PARTICLE SIZE DISTRIBUTION

MMH

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:	Steel Heddle	Run no:	SIPS-1
Sampling		Date:	6/24/86
Location:	Inlet	Start-stop, 24h:	1305-1340
Sample type:	Particle size	Barometric	
Operator:	JP/DE	pressure, in.Hg:	29.35
Filter ID:		Static	
Meter box ID:	Fp-3	pressure, in.H2O:	-3.30
Y Factor:	.977	Stack area, Sa in:	802.25
Moisture, %:	2.34	Nozzle diameter, in:	.197
Number of sample		Pitot tube, Cp:	.84
points:	3	CO2 percent:	0
Sample time, min:	90.60	O2 percent:	20.9
Volume correction, cu-ft:	3		

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	971.152						
30.00	991.31	.75	1.25	99	115	115	99
60.00	1011.6	.75	1.25	99	118	112	99
90.6	1032.262	.75	1.25	99	119	117	99
90.6	61.07	.75	1.25	99	117	117	99

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:Steel Heddle Run no.:SIP5-1

TT...	Net time of test,min	90.60
NP...	Net sampling points	3
Y...	Meter calibration factor	.977
DN...	Sampling nozzle diameter,in	.197
CP...	Pitot tube coefficient	.84
PM...	Avg. orifice pressure,in H2O	1.25
VM...	Volume of dry gas sampled at meter conditions,cu-ft	81.07
TM...	Avg. gas meter temp.,deg F	115.00
VMSTD...	Volume of dry gas sampled at standard conditions, scf	83.91
BWO...	Percent moisture by volume	2.34
MFD...	Mole fraction of dry gas	.9766
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	28.58
PB...	Barometric pressure, in Hg	29.35
SP...	Static pressure, in H2O	-3.30
PS...	Stack pressure, in Hg	29.11
TS...	Avg. stack temperature,deg F	99.00
TI...	Avg. impactor temp.,deg F	99.00
VM...	Avg. Sqrt of velocity head	.97
VS...	Avg. stack velocity,fps	51.98
ISO...	Percent isokinetic	102.48

7/8/86

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

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

1) PART. DIAMETER CLASSICAL AERODYNAMIC
2) DATE OF TEST: 6/24/86
3) TIME OF TEST: 1209-1340
4) LOCATION OF TEST: SCRUBBER INLET
5) TEST NUMBER 1
6) TEST TYPE INLET
7) RUN NUMBER: 81FS-1-FILE NAME: TIRSIPS-1.IT
8) RUN REMARKS:
9) IMPACTOR TYPE: ANDERSEN GENERIC
ANDERSEN II WITH GENERIC CAL.

9) WATER VAPOR 2.54%
CO2 .00% CO .00%
O2 20.90% N2 76.56%
11) ORIFICE ID (CATIONAL):
12) SUBSTRATE MATERIAL: GLASS FIBER

1) GAS METER VOL. 20.910 CUBIC FEET
2) IMPACTOR DELTA P .00 IN. HG.
3) ORIFICE DELTA P -1.3 INCHES H2O
4) STACK PRESSURE -7.50 INCHES H2O
5) BAROMETRIC PRES 29.38 INCHES HG
6) STACK TEMP 96 DEGREES F
7) METER TEMP 115 DEGREES F
8) IMPACTOR TEMP 99 DEGREES F
9) SAMPLE TIME 90.00 MINUTES
10) AVG GAS VEL. 50.98 FEET/SEC
11) ORIFICE PRES .00 INCHES HG
12) NOZZLE DIA .197 INCHES
13) MAX PART DIA 100.0 MICRONS
14 WATER VOLUME .0 CC
15 METER FACTOR .577

MASS GAIN OF STAGE 1 15.40 MG
MASS GAIN OF STAGE 2 .00 MG
MASS GAIN OF STAGE 3 .00 MG
MASS GAIN OF STAGE 4 .00 MG
MASS GAIN OF STAGE 5 .20 MG
MASS GAIN OF STAGE 6 .00 MG
MASS GAIN OF STAGE 7 .10 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 DM
9/14/86

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

TEST NUMBER: 1 RUN NUMBER: 81P6-1

ACTUAL FLOW RATE .565 CFM
FLOW RATE AT STANDARD CONDITIONS .525 CFM
PERCENT ISOKINETIC 90.411 %
VISCOSITY 186.2E-06GM/CM SEC
CALCULATED IMPACTOR DELTA P = .51 IN. HG

STAGE	CUNN. CORR.	DP (CLAS AERO)	DP (IMP AERO)	CUM FREQ.	RE. NO.	V*DSD UM-M/S
1	1.017	10.054	10.141	3.1751	45	5.3
2	1.020	8.578	8.965	3.1668	62	7.8
3	1.030	5.716	6.002	3.1625	82	8.8
4	1.044	3.951	4.038	3.1562	103	9.1
5	1.080	2.192	2.277	1.8988	147	10.7
6	1.164	1.063	1.147	1.8725	221	12.1
7	1.271	.653	.734	1.2578	303	12.5
8	1.500	.345	.426	1.3575	521	12.1

STAGE CUT DIAMETERS BASED ON FILE VALUES OF STAGE CONSTANTS

TOTAL MASS CONCENTRATION = 1.18E-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/DLOGI
.100	- 2.2433	1.24	1.47E-01	2.63E-03
.157	- 2.2419	1.25	1.47E-01	2.66E-03
.251	- 2.2405	1.25	1.48E-01	2.67E-03
.398	- 2.2391	1.26	1.48E-01	2.68E-03
.631	- 2.2377	1.26	1.47E-01	1.95E-01
1.000	- 2.0903	1.83	2.16E-01	3.16E-01
1.585	- 2.0762	1.89	2.24E-01	2.36E-03
2.512	- 2.0340	2.10	2.48E-01	5.22E-01
3.981	- 1.9572	2.16	3.73E-01	3.65E-01
6.310	- 1.8576	3.16	3.73E-01	1.47E-01
10.000	- 1.8563	3.17	3.74E-01	6.85E-01
15.850	- 1.7572	3.94	4.65E-01	6.14E-01
25.120	- 1.5711	5.81	6.85E-01	1.95E+00
39.810	- 1.0471	14.71	1.74E+00	1.22E+01
63.100	1.0459	85.54	1.01E+01	6.13E+01
100.00	1000000	100.00	1.18E+01	0.00E+00
158.50	1000000	100.00	1.18E+01	0.00E+00
251.20	1000000	100.00	1.18E+01	0.00E+00
398.10	1000000	100.00	1.18E+01	0.00E+00
631.00	1000000	100.00	1.18E+01	0.00E+00

**** RESULTS CONTINUED ****

TEST NUMBER: 1 RUN NUMBER: SIFS-1

*** INHALABLE PARTICULATE MATTER ***

CUM MASS LESS THAN 1.000 MICRON: .22 MG/DNM3 (1.83 %)
CUM MASS LESS THAN 2.512 MICRON: .25 MG/DNM3 (2.10 %)
CUM MASS LESS THAN 10.000 MICRON: .37 MG/DNM3 (3.17 %)
CUM MASS LESS THAN 15.850 MICRON: .47 MG/DNM3 (3.94 %)
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

LEAST SQUARES LINE: Y=-2.12 + .31X
MASS MEDIAN DIAMETER: 7075471.350
GEOMETRIC STANDARD DEVIATION: 1694.100
CORRELATION COEFFICIENT: .902

MMM

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:	Steel needle	Run no:	SIPS-1
Sampling Location:	Inlet	Date:	6/24/86
Sample type:	Particle size	Start-stop, 24h:	1430-1548
Operator:	JP/DS	Barometric pressure.in.Hg:	29.34
Filter ID:		Static pressure.in.H2O:	-3.30
Meter box ID:	Fb-3	Stack area.Sq in:	802.25
Y Factor:	.977	Nozzle diameter.in:	.197
Moisture, %:	2.34	Pitot tube.Cp:	.84
Number of sample points:	3	CO2 percent:	0
Sample time, min:	77.50	O2 percent:	20.9
Volume combustion, 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	32.43						
30.00	55.00	.75	1.25	109	117	109	108
60.00	74.4	.75	1.25	102	115	109	109
77.50	85.803	.75	1.25	109	116	05	108
77.5	53.373	.75	1.25	109	115	109	108

7/9/86

FEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:Foods Moccia — Run no.:SIPB-2

TT...	Net time of test.min	77.50
NP...	Net sampling points	3
Y...	Meter calibration factor	.977
DN...	Sampling nozzle diameter.in	.197
CP...	Pitot tube coefficient	.84
PM...	Avg. orifice pressure.in H2O	1.25
VM...	Volume of dry gas sampled at meter conditions.cu-ft	50.277
TM...	Avg. gas meter temp..deg F	111.67
VMSTD...	Volume of dry gas sampled at standard conditions. scf	47.35
BWC...	Percent moisture by volume	2.34
MFI...	Mole fraction of dry gas	.9766
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	28.58
PB...	Barometric pressure, in Hg	29.34
SP...	Static pressure, in H2O	-3.50
PS...	Stack pressure, in Hg	29.10
TS...	Avg. stack temperature.deg F	108.00
TI...	Avg. impactor temp..deg F	105.00
VH...	Avg. Bart or velocity head	.37
VS...	Avg. stack velocity.fps	21.46
ISO. .	Percent isokinetic	106.[illegible]

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

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

 1)PART. DIAMETER     CLASSICAL AERODYNAMIC
 2)DATE OF TEST: 6/24/86
 3)TIME OF TEST: 1400-1546
 4)LOCATION OF TEST: SCRUBBER INLET
 5)TEST NUMBER     2
 6)TEST TYPE          INLET
 7)RUN NUMBER: SIP5-2-FILE NAME:T2RSIP5-2.IT
 8)RUN REMARKS:
10)IMPACTOR TYPE: ANDERSEN GENERIC
ANDERSEN II WITH GENERIC CAL.

 [illegible])WATER VAPOR          3.34%
    CO2    .00%              CO    .00%
    O2   21.70%              N2   75.10%
[illegible]  ORIFICE ID (OPTIONAL):
[illegible]) SUBSTRATE MATERIAL: GLASS FIBER


 1)GAS METER VOL      47.380 CUBIC FEET
 2)IMPACTOR DELTA P     .34 IN. HG.
 3)ORIFICE DELTA P     -.17 INCHES H2O
 4)STACK PRESSURE     -3.30 INCHES H2O
 5)BAROMETRIC PRES    29.34 INCHES HG
 6)STACK TEMP         108   DEGREES F
 7)METER TEMP         112   DEGREES F
 8)IMPACTOR TEMP      103   DEGREES F
 9)SAMPLE TIME         77.50 MINUTES
10)AVG GAS VEL         31.40 FEET/SEC
11)ORIFICE PRES          .00 INCHES HG
12)NOZZLE DIA            .197 INCHES
13)MAX PART DIA      100.0  MICRONS
14)WATER VOLUME          .0  CC
15)METER FACTOR          .9770


 MASS GAIN OF STAGE 1     8.90 MG
 MASS GAIN OF STAGE 2      .00 MG
 MASS GAIN OF STAGE 3      .00 MG
 MASS GAIN OF STAGE 4      .00 MG
 MASS GAIN OF STAGE 5      .00 MG
 MASS GAIN OF STAGE 6      .10 MG
 MASS GAIN OF STAGE 7      .10 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
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OK DM
8/14/86

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

TEST NUMBER: 1 RUN NUMBER: SIPE-3

ACTUAL FLOW RATE .614 CFM
FLOW RATE AT STANDARD CONDITIONS .542 CFM
PERCENT ISOKINETIC 94.107 %
VISCOSITY 188.4E-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	1.015	9.869	9.957	4.3525	49	5.1
2	1.020	8.713	8.802	4.3418	64	7.8
3	1.024	5.805	5.893	4.3311	94	9.0
4	1.046	3.376	3.964	4.3202	175	9.4
5	1.067	1.147	3.236	4.3095	150	10.6
6	1.171	1.040	1.126	3.2345	233	12.4
7	1.382	.657	.721	2.1601	314	13.5
8	1.358	.331	.415	2.1494	511	13.1

STAGE CUT DIAMETERS BASED ON FILE VALUES OF STAGE CONSTANTS

TOTAL MASS CONCENTRATION = 7.52E+00 MG/DRY NORMAL CUBIC METER

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)	DUMFR (STDVE.)	CUMFR (PERCENT)	CUM.MASS (MG/DRY N.CU METER)	DM/DLOGDI
.100	- 2.0252	2.13	1.66E-01	3.78E-[illegible]
.154	- 2.0267	2.14	1.67E-01	1.74E-[illegible]
.251	- 2.0252	2.14	1.68E-01	3.[illegible]E-[illegible]
.398	- 2.0237	2.15	1.68E-01	3.01E-03
.631	- 2.0242	2.15	1.68E-01	2.03E-01
1.000	- 1.8620	3.13	2.45E-01	4.69E-01
1.585	- 1.7452	4.05	3.16E-01	2.35E-01
2.512	- 1.7[illegible]	4.35	3.40E-01	1.[illegible]E-02
3.981	- 1.7150	4.32	3.37E-01	4.78E-03
6.310	- 1.7134	4.33	3.39E-01	9.55E-07
10.000	- 1.7115	4.33	3.40E-01	7.37E-[illegible]
15.850	- 1.6[illegible]	4.37	3.49E-01	1.73E-01
25.120	- 1.5980	5.50	4.30E-01	8.71E-01
39.810	- 1.1542	[illegible]	9.63E-01	5.31E-[illegible]
63.100	[illegible]	60.74	6.31E+00	4.30E-01
100.00	1000000	100.00	7.83E+00	0.[illegible]E+0[illegible]
158.50	1000000	100.00	7.82E+00	0.00E+00
251.20	1000000	100.00	7.82E+00	0.00E+00
398.10	1000000	100.00	7.82E+00	0.00E+00
631.00	1000000	100.00	7.82E+00	0.00E+00

**** RESULTS CONTINUED ****

TEST NUMBER: 1 RUN NUMBER: SIPS-I

*** INHALABLE PARTICULATE MATTER ***

```
CUM MASS LESS THAN  1.000 MICRON:     .24 MG/DNM3 (  3.13 %)
CUM MASS LESS THAN  2.512 MICRON:     .34 MG/DNM3 (  4.35 %)
CUM MASS LESS THAN 10.000 MICRON:     .34 MG/DNM3 (  4.35 %)
CUM MASS LESS THAN 15.850 MICRON:     .35 MG/DNM3 (  4.47 %)
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.
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LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

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LEAST SQUARES LINE:  Y=-1.89 +    .25X
MASS MEDIAN DIAMETER:       41116930.100
GEOMETRIC STANDARD DEVIATION:       10498.112
CORRELATION COEFFICIENT:      .833
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PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:	Steel Heddle	Run no:	SIPS-3
Sampling Location:	Inlet	Date:	6/24/86
Sample type:	Particle size	Start-stop, 24h:	1643-1803
Operator:	JP/DS	Barometric pressure, in.Hg:	29.30
Filter ID:		Static pressure, in.H2O:	-3.30
Meter box ID:	Fo-3	Stack area, sq in:	802.25
Y Factor:	.977	Nozzle diameter, in:	.197
Moisture, %:	2.34	Pitot tube, Cp:	.84
Number of sample points:	3	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	Meter temp, deg F Outlet	Impactor temp, deg F
0.00	85.853						
40.00		.72	1.20	105	106	102	105
45.00	139.55	.72	1.20	105	106	101	105
60.00	139.572	.72	1.20	105	106	99	105
60	53.689	.72	1.20	105	107	102	105

(Page 2)

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant: Steel Heddle Run no.: SIPS-3

TT...	Net time of test, min	60.00
NP...	Net sampling points	3
Y...	Meter calibration factor	.977
DN...	Sampling nozzle diameter, in	.197
CP...	Pitot tube coefficient	.84
PM...	Avg. orifice pressure, in H2O	1.20
VM...	Volume of dry gas sampled at meter conditions, cu-ft	53.689
TM...	Avg. gas meter temp., deg F	104.17
VMSTD...	Volume of dry gas sampled at standard conditions, scf	48.22
BWS...	Percent moisture by volume	2.34
MFD...	Mole fraction of dry gas	.97[illegible]
PCO2...	Percent CO2 by volume, dry	0
PO2...	Percent O2 by volume, dry	2[illegible]

J Fion 7/9/86

MS...	Stack gas molecular weight	28.58
PB...	Barometric pressure, in Hg	29.3
SP...	Static pressure, in H2O	-0.30
PS...	Stack pressure, in Hg	29.06
TS...	Avg. stack temperature,deg F	105.00
TI...	Avg. impactor temp.,deg F	105.00
VH...	Avg. Sqrt of velocity head	.85
VS...	Avg. stack velocity,fps	50.26
ISO...	Percent isokinetic	106.56

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

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

 1)PART. DIAMETER     CLASSICAL AERODYNAMIC
 2)DATE OF TEST: 6/24/86
 3)TIME OF TEST: 1640-1803
 4)LOCATION OF TEST: SCRUBBER INLET
 5)TEST NUMBER     3
 6)TEST TYPE          INLET
 7)RUN NUMBER: SIPS-3-FILE NAME:TGRSIPS-3.IT
 8)RUN REMARKS:
10)IMPACTOR TYPE: ANDERSEN GENERIC
ANDERSEN II WITH GENERIC CAL.

 9)WATER VAPOR          2.34%
    CO2    .00%          CO    .00%
    O2   20.90%          N2  79.10%
12) ORIFICE ID (OPTIONAL):
13) SUBSTRATE MATERIAL: GLASS FIBER


 1)GAS METER VOL     48.220 CUBIC FEET
 2)IMPACTOR DELTA P    .00 IN. HG.
 3)ORIFICE DELTA P    -1.3 INCHES H2O
 4)STACK PRESSURE    -0.30 INCHES H2O
 5)BAROMETRIC PRES   29.50 INCHES HG
 6)STACK TEMP        175   DEGREES F
 7)METER TEMP        104   DEGREES F
 8)IMPACTOR TEMP     105   DEGREES F
 9)SAMPLE TIME        80.00 MINUTES
10)AVG GAS VEL        50.26 FEET/SEC
11)ORIFICE PRES         .00 INCHES HG
12)NOZZLE DIA           .197 INCHES
13)MAX PART DIA      100.0  MICRONS
14)WATER VOLUME         .0  CC
15)METER FACTOR         .9770


 MASS GAIN OF STAGE 1   10.50 MG
 MASS GAIN OF STAGE 2     .00 MG
 MASS GAIN OF STAGE 3     .20 MG
 MASS GAIN OF STAGE 4     .10 MG
 MASS GAIN OF STAGE 5     .40 MG
 MASS GAIN OF STAGE 6     .10 MG
 MASS GAIN OF STAGE 7     .00 MG
 MASS GAIN OF STAGE 8     .00 MG
 MASS GAIN OF FILTER      .10 MG

MASS GAIN OF BLANK SUBSTRATE      .00
MASS GAIN OF BLANK FILTER         .00
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8/14/86

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

TEST NUMBER: 3 RUN NUMBER: SIP8-3

ACTUAL FLOW RATE .611 CFM
FLOW RATE AT STANDARD CONDITIONS .542 CFM
PERCENT ISOKINETIC 95.726 %
VISCOSITY 187.7E-06GM/CM SEC
CALCULATED IMPACTOR DELTA P = .55 IN. HG

STAGE	CUNN CORR.	DP (CLAS AERO)	DP (IMP AERO)	CUM FREQ.	RE. NO.	V*D50 UM-M/S
1	1.015	9.876	9.965	7.9190	49	5.1
2	1.020	8.721	8.809	7.5102	64	7.7
3	1.031	5.810	5.898	6.1563	84	9.0
4	1.046	3.880	3.967	5.2773	105	9.4
5	1.082	2.151	2.238	1.7715	150	10.5
6	1.170	1.042	1.127	.8945	233	12.3
7	1.280	.638	.722	.9857	313	13.8
8	1.554	.336	.419	.8770	502	12.1

STAGE CUT DIAMETERS BASED ON FILE VALUES OF STAGE CONSTANTS

TOTAL MASS CONCENTRATION = 9.29E+00 MG/DRY NORMAL CUBIC METER

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)	CUMFR (STDEV)	CUMFR (PERCENT)	CUM.MASS (MG/DRY N.CU.METER)	DM/DLOGD
.100	- 2.7903	.87	8.05E-02	1.53E-03
.158	- 2.3785	.87	8.09E-02	1.53E-03
.251	- 2.7748	.87	8.12E-02	1.54E-03
.398	- 2.3731	.88	8.21E-02	7.05E-03
.631	- 2.3718	.89	8.23E-02	2.94E-03
1.000	- 2.3710	.89	8.25E-02	2.93E-02
1.585	- 2.2790	1.13	1.05E-01	1.47E-01
2.512	- 1.9696	2.45	2.27E-01	1.16E+00
3.981	- 1.6072	5.40	5.02E-01	9.74E-01
6.310	- 1.3299	6.30	5.86E-01	4.22E-01
10.000	- 1.4029	8.03	7.46E-01	2.02E+00
15.850	- 1.1011	13.54	1.26E+00	3.28E+00
25.120	- .7115	23.84	2.22E+00	7.04E+00
39.810	.0161	50.64	4.71E+00	2.05E+01
63.100	1.2334	99.01	9.20E+00	5.83E+00
100.00	1000000	100.00	9.29E+00	0.00E+00
158.50	1000000	100.00	9.29E+00	0.00E+00
251.20	1000000	100.00	9.29E+00	0.00E+00
398.10	1000000	100.00	9.29E+00	0.00E+00
631.00	1000000	100.00	9.29E+00	0.00E+00

**** RESULTS CONTINUED ****

TEST NUMBER: 1 RUN NUMBER: SIPS-3

*** INHALABLE PARTICULATE MATTER ***

CUM MASS LESS THAN 1.000 MICRON: .08 MG/DNM3 (.95 %)
CUM MASS LESS THAN 2.512 MICRON: .23 MG/DNM3 (2.45 %)
CUM MASS LESS THAN 10.000 MICRON: .75 MG/DNM3 (8.03 %)
CUM MASS LESS THAN 15.050 MICRON: 1.26 MG/DNM3 (13.54 %)
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

LEAST SQUARES LINE: Y=-2.19 + .77X
MASS MEDIAN DIAMETER: 716.583
GEOMETRIC STANDARD DEVIATION: 20.050
CORRELATION COEFFICIENT: .976

MMM

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:	Steel Heddle	Run no:	SOPB-1
Sampling Location:	Outlet	Date:	6/24/86
		Start-stop, 24h:	1055-1503
Sample type:	Particle size	Barometric pressure, in.Hg:	29.35
Operator:	JP/DS		
Filter ID:		Static pressure, in.H2O:	-.35
Meter box ID:	FB-9		
Y Factor:	.986	Stack area, Sq in:	802.25
Moisture, %:	2.59	Nozzle diameter, in:	.195
Number of sample points:	8	Pitot tube, Cp:	.84
		CO2 percent:	0
Sample time, min:	240.00	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	Impact temp deg
0.00	476.573	.62	1.10	80	114	110	80
30.00	494.96	.62	1.10	80	124	112	80
60.00	520	.62	1.10	80	134	120	80
90.00	532.1	.62	1.10	80	135	122	80
120.00	550.83	.62	1.10	80	138	125	80
150.00	569.7	.62	1.10	80	135	125	80
180.00	588.6	.62	1.10	80	130	123	80
210.00	606.84	.62	1.10	80	132	122	80
240.00	625.724	.62	1.10	80			
240	149.151	.62	1.10	80	130	120	80

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant: Steel needle

Run no.: 80SP-1

TT...	Net time of test, min	240.00
NP...	Net sampling points	8
Y...	Meter calibration factor	.986
DN...	Sampling nozzle diameter, in	.195
CP...	Pitot tube coefficient	.84
PM...	Avg. orifice pressure, in H2O	1.10
VM...	Volume of dry gas sampled at meter conditions, cu ft	149.151
TM...	Avg. gas meter temp., deg F	125.05
VMSTD...	Volume of dry gas sampled at standard conditions, scf	130.55
BWO...	Percent moisture by volume	1.57
MFD...	Mole fraction of dry gas	.9741
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	28.56
PB...	Barometric pressure, in Hg	29.35
SP...	Static pressure, in H2O	-.35
PS...	Stack pressure, in Hg	29.32
TS...	Avg. stack temperature, deg F	80.00
TI...	Avg. impactor temp., deg F	80.00
VH...	Avg. Sqrt of velocity head	.79
VS...	Avg. stack velocity, fps	45.41
ISO...	Percent isokinetic	103.15

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

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

 1)PART. DIAMETER     CLASSICAL AERODYNAMIC
 2)DATE OF TEST: 6/24/86
 3)TIME OF TEST: 1055-1503
 4)LOCATION OF TEST: SCRUBBER OUTLET
 5)TEST NUMBER     1
 6)TEST TYPE           OUTLET
 7)RUN NUMBER: EDFS-1-FILE NAME:TIREDFS-1.DT
 8)RUN REMARKS:
10)IMPACTOR TYPE: ANDERSEN GENERIC
ANDERSEN II WITH GENERIC CAL.

 9)WATER VAPOR          2.57% (KEYBOARD)
    CO2    .00%         CO    .00%
    O2   20.90%         N2  76.10%
12) ORIFICE ID (OPTIONAL):
13) SUBSTRATE MATERIAL: GLASS FIBER


 1)GAS METER VOL    130.55 CUBIC FEET
 2)IMPACTOR DELTA P    .00 IN. HG.
 3)ORIFICE DELTA P    -1.1 INCHES H2O
 4)STACK PRESSURE     -.35 INCHES H2O
 5)BAROMETRIC PRES   29.35 INCHES HG
 6)STACK TEMP         80     DEGREES F
 7)METER TEMP        125     DEGREES F
 8)IMPACTOR TEMP      80     DEGREES F
 9)SAMPLE TIME       240.00 MINUTES
10)AVG GAS VEL        45.41 FEET/SEC
11)ORIFICE PRES        .00 INCHES HG
12)NOZZLE DIA          .195 INCHES
13)MAX PART DIA     190.0  MICRONS
14)WATER VOLUME        .0  CC
15)METER FACTOR        .9860


 MASS GAIN OF STAGE 1    7.90 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     .00 MG
 MASS GAIN OF STAGE 6     .00 MG
 MASS GAIN OF STAGE 7     .20 MG
 MASS GAIN OF STAGE 8     .00 MG
 MASS GAIN OF FILTER      .00 MG

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

8/15/86

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

TEST NUMBER: 1 RUN NUMBER: SCFB 1

ACTUAL FLOW RATE .510 CFM
FLOW RATE AT STANDARD CONDITIONS .476 CFM
PERCENT ISOKINETIC 99.274 %
VISCOSITY 181.4E-06GM/CM SEC
CALCULATED IMPACTOR DELTA P = .49 IN. HG

STAGE	CUNN. CORR.	DP (CLAS AERO)	DP (IMP AERO)	CUM FREQ.	RE. NO.	V*D*C UM-M/S
1	1.016	10.640	10.727	4.8766	44	4.6
2	1.018	7.396	9.479	4.8645	58	6.9
3	1.027	6.164	6.346	3.6604	77	[illegible]
4	[illegible]	4.187	4.365	3.8458	96	9.4
5	1.071	[illegible]	3.408	3.6364	137	9.5
6	1.147	[illegible]	1.217	2.4322	212	11.2
7	[illegible]	.898	.777	.0243	267	12.6
8	1.760	.377	.481	.0122	456	11.4

STAGE CUT DIAMETERS BASED ON FILE VALUES OF STAGE CONSTANTS

TOTAL MASS CONCENTRATION = 1.57E+00 MG/DSCF NORMAL CUBIC METER

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)	CUMFR (STDDEV)	CUMFR (PERCENT)	CUM.MASS (MG/DSCF N.CU.METER)	DM/DLOGD
.101	- 4.0874	.00	6.54E-05	1.85E-04
.127	- 3.9291	.00	1.15E-04	3.14E-04
.25[illegible]	- 3.7857	.01	1.77E-04	5.25E-04
.399	- 3.6534	.01	3.34E-04	8.62E-04
.631	- 3.5201	.02	5.57E-04	6.85E-03
1.000	- 2.3260	1.00	2.57E-02	5.12E-01
1.585	- 1.6380	5.07	1.30E-01	1.52E-01
2.512	- 1.7947	3.64	9.33E-02	1.21E-03
3.98[illegible]	- 1.7934	3.64	9.35E-02	4.57E-01
6.3[illegible]	- 1.7913	3.66	9.40E-02	4.02E-02
10.000	- 1.6785	4.66	1.20E-01	1.95E-01
15.850	- 1.3378	9.05	2.32E-01	8.10E-01
2[illegible]	- [illegible]	15.13	4.78E-01	1.87E-01
39.810	- [illegible]	45.53	1.17E+00	5.85E-00
6[illegible]	[illegible]	98.7[illegible]	2.53E+00	1.98E-00
100.00	1000000	100.00	2.57E+00	0.00E+00
158.[illegible]	1000000	100.00	2.57E+00	0.00E+00
[illegible]	1000000	100.00	2.57E+00	0.00E+00
[illegible]	1000000	100.00	2.57E+00	0.00E+00
630.00	1000000	100.00	2.57E+00	[illegible]

**** RESULTS CONTINUED ****

TEST NUMBER: 1 RUN NUMBER: EOPS-1

*** INHALABLE PARTICULATE MATTER ***

CUM MASS LESS THAN 1.000 MICRON: .03 MG/DNM3 (1.00 %)
CUM MASS LESS THAN 2.512 MICRON: .09 MG/DNM3 (3.64 %)
CUM MASS LESS THAN 10.000 MICRON: .12 MG/DNM3 (4.66 %)
CUM MASS LESS THAN 15.850 MICRON: .23 MG/DNM3 (9.05 %)
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

LEAST SQUARES LINE: Y=-2.77 + 1.42X
MASS MEDIAN DIAMETER: 20.018
GEOMETRIC STANDARD DEVIATION: 5.067
CORRELATION COEFFICIENT: .736

FEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:	Steel needle	Run no:	SDPB-2
Sampling		Date:	6/25/86
Location:	Outlet	Start-stop, 24h:	746-1202
Sample type:	Particle size	Barometric	
Operator:	JP/DS	pressure,in.Hg:	29.41
Filter ID:		Static	
Meter box ID:	PB-9	pressure,in.H2O:	-.36
Y Factor:	.986	Stack area,sq in:	802.25
Moisture, %:	2.59	Nozzle diameter,in:	.195
Number of sample		Pitot tube,Cp:	.84
points:	9	CO2 percent:	0
Sample time, min:	238.00	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	635.899						
30.00	645.40	.53	1.30	71	60	75	71
60.00	655.575	.61	1.30	71	114	98	71
90.00	665.88	.82	1.30	71	124	107	71
120.00	706.206	.83	1.30	71	130	116	71
150.00	726.515	.73	1.30	76	133	122	71
180.00	746.75	.73	1.30	76	136	125	71
210.00	766.86	.73	1.30	76	139	126	71
238.00	785.222	.73	1.30	76	139	127	71
238	159.903	.78	1.30	74	124	112	71

7/9/86

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:Steel needle Run no.:SDSF-2

TT...	Net time of test,min	238.00
NP...	Net sampling points	8
Y...	Meter calibration factor	.986
DN...	Sampling nozzle diameter,in	.195
CP...	Pitot tube coefficient	.84
PM...	Avg. orifice pressure,in H2O	1.30
VM...	Volume of dry gas sampled at meter conditions,cu-ft	159.933
TM...	Avg. gas meter temp..deg F	115.19
VMSTD...	volume of dry gas sampled at standard conditions, scf	142.01
BWO...	Percent moisture by volume	2.59
MFD...	Mole fraction of dry gas	.9741
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	28.56
PB...	Barometric pressure, in Hg	29.41
SP...	Static pressure, in H2O	-.36
PS...	Stack pressure, in Hg	29.38
TS...	Avg. stack temperature,deg F	73.50
TI...	Avg. impactor temp.,deg F	71.00
VH...	Avg. Sqrt of velocity head	.88
VS...	Avg. stack velocity,fps	50.39
ISO...	Percent isokinetic	100.53

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

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

1) PART. DIAMETER CLASSICAL AERODYNAMIC
2) DATE OF TEST: 6/25/86
3) TIME OF TEST: 0746-1200
4) LOCATION OF TEST: SCRUBBER OUTLET
5) TEST NUMBER 2
6) TEST TYPE OUTLET
7) RUN NUMBER: SCPS-2-FILE NAME: TIPSCPS-2.DT
8) RUN REMARKS:
10) IMPACTOR TYPE: ANDERSEN GENERIC
ANDERSEN II WITH GENERIC CAL.

9) WATER VAPOR 2.5%
DIS [illegible] CL .000
CL 20.40% NO [illegible]
12) ORIFICE ID (OPTIONAL):
13) SUBSTRATE MATERIAL: GLASS FIBER

1) GAS METER VOL 142.010 CUBIC FEET
2) IMPACTOR DELTA P .00 IN. HG.
3) ORIFICE DELTA P -1.[illegible] INCHES H2O
4) STACK PRESSURE -.36 INCHES H2O
5) BAROMETRIC PRES 29.41 INCHES HG
6) STACK TEMP 74 DEGREES F
7) METER TEMP 115 DEGREES F
8) IMPACTOR TEMP 71 DEGREES F
9) SAMPLE TIME 239.00 MINUTES
10) AVG GAS VEL 50.39 FEET/SEC
11) ORIFICE PRES .00 INCHES HG
12) NOZZLE DIA .195 INCHES
13) MAX PART DIA 100.0 MICRONS
14) WATER VOLUME .0 CC
15) METER FACTOR .9860

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

MASS GAIN OF BLANK CUBITFAME .00
MASS GAIN OF BLANK FILTER .00

J. Fiori

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

TEST NUMBER: 2 RUN NUMBER: SCF8-1

ACTUAL FLOW RATE .557 CFM
FLOW RATE AT STANDARD CONDITIONS .530 CFM
PERCENT ISOKINETIC 89.360 %
VISCOSITY 179.2E-06GM/CM SEC
CALCULATED IMPACTOR DELTA P = .50 IN. HG

STAGE	CUNN. CORR.	DP (CLAS AERO)	DP (IMP AERO)	CUM FREQ.	RE. NO.	V*DP, UM-M/S
1	1.016	10.117	10.198	14.727	50	4.3
2	1.018	8.934	9.015	14.713	64	7.1
3	1.027	5.955	6.036	12.755	87	9.3
4	1.041	3.930	4.060	10.792	108	8.3
5	1.076	2.110	2.290	7.8512	151	9.9
6	1.153	1.075	1.153	4.9103	239	11.6
7	[illegible]	.661	.728	[illegible]	[illegible]	[illegible]
8	1.478	.353	.429	2.9109	547	[illegible]

STAGE CUT DIAMETERS BASED ON FILE VALUES OF STAGE CORRECTIONS

TOTAL MASS CONCENTRATION = 2.86E+00 MG/DRY NORMAL CUBIC METER

SPLINE FIT ON CLASSICAL AERODYNAMIC DIAMETER BASIS

PARTICLE DIA. (MICRONS)	CUMFR (STDEV)	CUMFR (PERCENT)	CUM.MASS (MG/DRY N.CU.METER)	DM/DLOGD (N.CU.METER)
.100	- 2.2076	1.36	3.89E-02	5.14E-02
.158	- 2.0444	2.05	5.84E-02	1.15E-0[illegible]
.251	- 1.8809	3.00	8.57E-02	1.57E-01
.398	- 1.7218	4.17	1.19E-01	1.35E-01
.631	- 1.6568	4.88	1.39E-01	3.76E-02
1.000	- 1.6841	4.91	1.40E-01	3.44E-02
1.585	- 1.5470	6.09	1.74E-01	3.03E-01
2.512	- 1.3704	8.53	2.43E-01	3.41E-01
3.981	- 1.2277	10.79	3.08E-01	3.23E-01
6.310	- 1.1283	13.00	3.71E-01	2.78E-01
10.000	- 1.0501	14.68	4.19E-01	2.23E-01
15.850	- 1.0216	15.35	4.38E-01	1.66E-01
25.120	- [illegible]	18.17	5.19E-01	7.95E-01
39.810	- .4605	32.24	9.21E-01	4.32E+00
63.100	1.5733	94.22	2.69E+00	7.43E-01
100.00	1000000	100.00	2.86E+00	0.00E+00
158.50	1000000	100.00	2.86E+00	0.00E+00
251.20	1000000	100.00	2.86E+00	0.00E+00
398.0	1000000	100.00	2.86E+00	0.00E+00
631.0	1000000	100.00	2.86E+00	0.00E+00

**** RESULTS CONTINUED ****

TEST NUMBER: 1 RUN NUMBER: 80F5-2

*** INHALABLE PARTICULATE MATTER ***

CUM MASS LESS THAN 1.000 MICRON:	.14 MG/DNM3	(4.91	%)
CUM MASS LESS THAN 2.512 MICRON:	.24 MG/DNM3	(8.33	%)
CUM MASS LESS THAN 10.000 MICRON:	.42 MG/DNM3	(14.68	%)
CUM MASS LESS THAN 15.850 MICRON:	.44 MG/DNM3	(15.35	%)

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

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

LEAST SQUARES LINE: Y= 1.57 - .53X
MASS MEDIAN DIAMETER: 1006.567
GEOMETRIC STANDARD DEVIATION: 80.833
CORRELATION COEFFICIENT: .971

FEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:	Steel Needle	Run no:	SDP5-3
Sampling		Date:	6/25/86
Location:	Outlet	Start-stop, 24h:	1217-1655
Sample type:	Particle size	Barometric	
Operator:	JP/DS	pressure, in.Hg:	29.44
Filter ID:		Static	
Meter box ID:	FB-9	pressure, in.H2O:	-.26
Y Factor:	.986	Stack area, Sq in:	802.25
Moisture, %:	2.59	Nozzle diameter, in:	.197
Number of sample		Pitot tube, Cp:	.84
points:	9	CO2 percent:	0
Sample time, min:	240.10	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	785.903						
30.00	807.00	.71	1.46	72	130	125	72
60.00	828.35	.71	1.46	72	138	126	72
90.00	849.6	.71	1.46	72	138	126	72
120.00	870.545	.71	1.46	72	138	125	72
150.00	891.9	.84	1.46	75	131	124	72
180.00	913.1	.84	1.46	75	136	122	72
185.00	916.68	.84	1.46	75	135	122	72
210.00	933.9	.84	1.46	75	120	111	72
240.10	954.838	.84	1.46	75	122	111	72
240.1	168.935	.78	1.46	74	132	121	72

J. Fiori
7/9/86

PEI ASSOCIATES, INC.
EMISSION TEST REPORT

Plant:Steel Heddle Run no.:SOSP-3

TT...	Net time of test,min	240.10
NP...	Net sampling points	9
Y...	Meter calibration factor	.986
DN...	Sampling nozzle diameter,in	.197
CP...	Pitot tube coefficient	.84
PM...	Avg. orifice pressure,in H2O	1.46
VM...	Volume of dry gas sampled at meter conditions,cu-ft	168.935
TM...	Avg. gas meter temp.,deg F	126.67
VMSTD...	Volume of dry gas sampled at standard conditions, scf	148.08
BWO...	Percent moisture by volume	2.59
MFD...	Mole fraction of dry gas	.9741
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	28.56
PB...	Barometric pressure, in Hg	29.44
SP...	Static pressure, in H2O	-.26
PS...	Stack pressure, in Hg	29.42
TS...	Avg. stack temperature,deg F	70.67
TI...	Avg. impactor temp.,deg F	72.00
VM...	Avg. Sqrt of velocity head	.88
VS...	Avg. stack velocity,fps	50.58
ISO...	Percent isokinetic	101.72

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

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

1 PART. DIAMETER CLASSICAL AERODYNAMIC
2)DATE OF TEST: 6/25/86
3)TIME OF TEST: 1217-1655
4)LOCATION OF TEST: SCRUBBER OUTLET
5)TEST NUMBER 3
6)TEST TYPE OUTLET
7)RUN NUMBER: SOPS-3-FILE NAME:T3RSOPS-3.OT
8)RUN REMARKS:
10)IMPACTOR TYPE: ANDERSEN GENERIC
ANDERSEN II WITH GENERIC CAL.

9)WATER VAPOR 2.59%
CO2 .00% CO .00%
O2 20.53% N2 79.10%
12) ORIFICE ID (OPTIONAL):
13) SUBSTRATE MATERIAL: GLASS FIBER

1)GAS METER VOL 148.050 CUBIC FEET
2)IMPACTOR DELTA P .00 IN. HG.
3)ORIFICE DELTA P -1.5 INCHES H2O
4)STAC. PRESSURE -.26 INCHES H2O
5)BAROMETRIC PRES 29.44 INCHES HG
6)STACK TEMP 74 DEGREES F
7)METER TEMP 127 DEGREES F
8)IMPACTOR TEMP 72 DEGREES F
9)SAMPLE TIME 240.10 MINUTES
10)AVE GAS VEL 50.58 FEET/SEC
11)ORIFICE PRES .00 INCHES HG
12)NOZZLE DIA .197 INCHES
13)MAX PART DIA 100.0 MICRONS
14)WATER VOLUME .0 CC
15)METER FACTOR .9860

MASS GAIN OF STAGE 1 4.50 MG
MASS GAIN OF STAGE 2 .00 MG
MASS GAIN OF STAGE 3 .00 MG
MASS GAIN OF STAGE 4 .00 MG
MASS GAIN OF STAGE 5 .00 MG
MASS GAIN OF STAGE 6 .40 MG
MASS GAIN OF STAGE 7 .20 MG
MASS GAIN OF STAGE 8 .20 MG
MASS GAIN OF FILTER .40 MG

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

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

TEST NUMBER: 2 RUN NUMBER: 80P5-3

ACTUAL FLOW RATE .568 CFM
FLOW RATE AT STANDARD CONDITIONS .540 CFM
PERCENT ISOKINETIC 89.772 %
VISCOSITY 179.5E-06GM/CM SEC
CALCULATED IMPACTOR DELTA P = .52 IN. HG

STAGE	CUNN. CORR.	DP (CLAS AERO)	DP (IMP AERO)	CUM FREQ.	RE. NO.	D50 UM-M S
1	1.016	10.025	10.106	20.772	51	4.2
2	1.018	8.252	8.934	20.724	67	7.1
3	1.026	5.901	5.981	20.703	58	8.5
4	1.041	3.943	4.023	20.686	110	8.9
5	1.074	2.190	2.269	20.668	157	10.0
6	1.[illegible]	1.[illegible]64	1.143	13.77[illegible]	3[illegible]	11.[illegible]
7	[illegible]	.655	.733	10.324	225	10.1
8	1.484	.741	.425	6.8[illegible]	[illegible]	11.5

STAGE 50% DIAMETERS BASED ON FILE VALUES OF STAGE DIAMETERS

TOTAL MASS CONCENTRATION = 1.56E+00 MG/DR: 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 -	1.9[illegible]2	2.75	4.34E-02	5.0[illegible]E-12
.158 -	1.7[illegible]5	3.53	6.31E-02	1.05E-01
.251 -	1.5[illegible]7	5.49	8.19E-02	1.41E-01
.398 -	1.2[illegible]70	7.54	1.17E-01	1.85E-01
.631 -	1.2754	10.11	1.60E-01	2.18E-01
1.000 -	1.1152	13.23	2.09E-01	3.07E-01
1.58E -	.9171	17.95	2.54E-01	3.68E-01
2.51[illegible] -	.8[illegible]	21.11	3.34E-01	5.51E-02
3.981 -	.8173	20.69	3.07E-01	1.56E-02
6.310 -	.8157	20.73	3.28E-01	1.18E-02
10.000 -	.8[illegible]41	21.78	3.23E-01	4.74E-03
15.850 -	.8011	21.12	3.34E-01	7.85E-02
25.120 -	.7032	24.08	3.81E-01	4.85E-01
39.810 -	.[illegible]	39.3[illegible]	6.23E-01	2.47E-[illegible]
63.100	1.[illegible]	96.02	1.52E+00	3.04E-0[illegible]
100.00	100000[illegible]	100.00	1.58E+00	0.00E+00
158.50	1000000	100.00	1.58E+00	0.00E+00
251.20	1000000	100.00	1.58E+00	0.00E+00
398.10	1000000	100.00	1.58E+00	0.00E+00
631.10	1000000	100.00	1.58E+00	0.00E+00

**** RESULTS CONTINUED ****

TEST NUMBER: I RUN NUMBER: SOPE-3

*** INHALABLE PARTICULATE MATTER ***

```
CUM MASS LESS THAN  1.000 MICRON:     .21 MG/DNM3 ( 13.23 %)
CUM MASS LESS THAN  2.512 MICRON:     .33 MG/DNM3 ( 21.11 %)
CUM MASS LESS THAN 10.000 MICRON:     .33 MG/DNM3 ( 20.78 %)
CUM MASS LESS THAN 15.850 MICRON:     .33 MG/DNM3 ( 21.12 %)
NOTE: DIAMETERS FOR INHALABLE PARTICULATE MATTER ARE
ON CLASSICAL AERODYNAMIC BASIS.
```

LOG-NORMAL SIZE DISTRIBUTION PARAMETERS

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LEAST SQUARES LINE:  Y=-1.16 +   .47X
MASS MEDIAN DIAMETER:              278.535
GEOMETRIC STANDARD DEVIATION:          130.165
CORRELATION COEFFICIENT:      .845
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APPENDIX B

FIELD DATA SHEETS

ONSITE EQUIPMENT AUDITS AND
PRELIMINARY DATA

Plant Steel Heddle

Date 6/23/86

Sampling location Scrubber Inlet

Inside of far wall to outside of nipple 32 1/4"

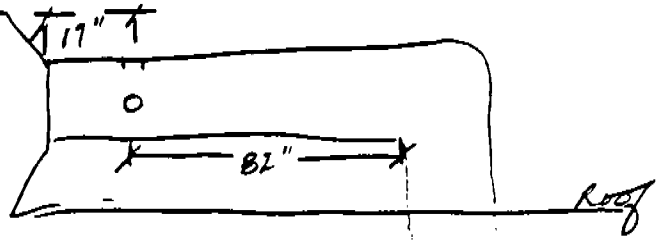
Inside of near wall to outside of nipple (nipple length) 1/4" (Wall Thickness)

Stack I.D. 32"

Nearest upstream disturbance .53 dd

Nearest downstream disturbance 2.6 dd

Calculated by CB/NS



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	32		1/4"	.92
2	.067				2.4
3	.118				4
4	.177				5.9
5	.250				8.25
6	.356				11.64
7	.644				20.86
8	.750				24.25
9	.823				26.59
10	.882				28.5
11	.933				30.1
12	.979				31.58

TRAVERSE POINT LOCATION FOR CIRCULAR DUCTS

Plant Steel Heddle

Date 6/23/86

Sampling location Scrubber Outlet

Inside of far wall to outside of nipple 32 1/4

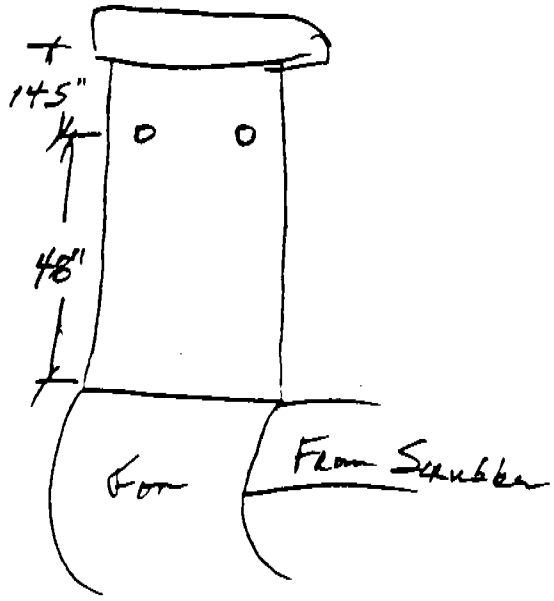
Inside of near wall to outside of nipple (nipple length) 1/4"

Stack I.D. 32

Nearest upstream disturbance .45 dd

Nearest downstream disturbance 1.5 dd

Calculated by CB



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		32		1/4"	Same as
2					inlet
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					

GAS VELOCITY AND VOLUMETRIC FLOW RATE

Plant and City STEEL HEDDLE — Date 6/27/81

Sampling Location OUTLET — Clock Time 1[illegible]

Run No. CYCLONE FLOW CHECK — Operator JF/DS

Barometric Pressure, in.Hg _____ Static Pressure, in.H_2O _____

Moisture, % _____ Molecular wt., Dry _____ Pitot Tube, Cp _____

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

FIELD DATA

TRAVERSE POINT NUMBER	°ROTATION TO NULL ~~VELOCITY HEAD (ΔP), in.H_2O~~	STACK TEMP., °F
W-1	0	
2	0	
3	+2°	
4	+2°	
5	+1	
6	+2	
7	-10°	
8	-15	
9	-15	
10	-16	
11	-12	
12	-13	
S-1	+20	
2	+15	
3	+13	
4	+5	
5	0	
6	-5	
7	-10	
8	-10	
9	-8	
10	-9	
11	-6	
12	-12	
	AVE = -8.5°	

Mr. [illegible] check 6/25

+ = Counter clockwise

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

$\sqrt{\Delta P} =$

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

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

$V_s =$ ft/s

$A_s =$ ft²

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

$Q_s = \quad \times \quad \times 60$

$Q_s =$ acfm

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

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

$Q_{s_{std}} =$ dscfm

GAS VELOCITY AND VOLUMETRIC FLOW RATE

Plant and City STEEL HEDDLE — Date 6/23/86

Sampling Location INLET — Clock Time 1345

Run No. S1-1 — Operator JF/DS

Barometric Pressure, in.Hg 29.45 — Static Pressure, in.H_2O -3.3

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

Stack Dimension, in. Diameter or Side 1 32 — Side 2

T/C 499 · AUDIT OK +5°F

PITOT ± — LEAK CHECK ✓+ -✓ zero ✓

FIELD DATA

TRAVERSE POINT NUMBER	VELOCITY HEAD (ΔP_s), in.H_2O	STACK TEMP., °F
V-1	1.05	97 165
2	0.83	97 165
3	0.87	97 165
4	0.88	97 165
5	0.85	97 165
6	0.80	97 165
7	0.65	96 165
8	0.59	97 165
9	0.63	97
10	0.66	97
11	0.70	97
12	0.60	97
L-1	0.85	
2	0.85	96
3	0.83	96
4	0.81	96
5	0.79	97
6	0.80	97
7	0.78	97
8	0.75	97
9	0.74	97
10	0.74	97
11	0.73	97
12	0.78	97
	$\Delta P_{avg.} = 0.77$	$T_{s\,avg.} = 96°F$

* BAD T/C CONNECTION — Temp. rechecked —

CALCULATIONS

$M_s = M_d \times (1 - \frac{H_2O}{100}) + 18 (\frac{H_2O_s}{100})$

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

$M_s =$

$T_s =$ °F = °R = (°F + 460)

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

$P_s =$ in.Hg

$\sqrt{\Delta P} =$

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

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

$V_s =$ ft/s

$A_s =$ ft²

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

$Q_s = \quad \times \quad \times 60$

$Q_s =$ acfm

$Q_{s_{std}} = Q_s \times 17.647 \times \frac{P_s}{T_s} \times (1 - \frac{H_2O_s}{100})$

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

$Q_{s_{std}} =$ dscfm

GAS VELOCITY AND VOLUMETRIC FLOW RATE

Plant and City STEEL NECOLE — Date 6/23/82

Sampling Location OUTLET — Clock Time 1355

Run No. 50-V — Operator JP/DS

Barometric Pressure, in.Hg 29.45 — Static Pressure, in.H_2O -0.27

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

Stack Dimension, in. Diameter or Side 1 32" — Side 2

FIELD DATA

TRAVERSE POINT NUMBER	VELOCITY HEAD (ΔP_s), in.H_2O	STACK TEMP., °F
S-1	0.72	85
2	1.0	84
3	1.05	83
4	0.95	83
5	0.85	83
6	0.82	82
7	0.72	82
8	0.95	82
9	1.05	82
10	1.15	82
11	1.15	82
12	1.25	82
W-1	0.55	83
2	0.60	84
3	0.63	84
4	0.61	83
5	0.54	83
6	0.52	82
7	0.54	82
8	0.61	82
9	0.80	82
10	0.96	82
11	0.96	82
12	1.15	82
	avg Δp = .85	T_s = 83°F

* Adjusted to null pt before measuring static

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

$\sqrt{CP} =$

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

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

$V_s =$ ft/s

$A_s =$ ft²

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

$Q_s = \quad \times \quad \times 60$

$Q_s =$ acfm

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

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

$Q_{s_{std}} =$ dscfm

GAS VELOCITY AND VOLUMETRIC FLOW RATE

Plant and City STEEL NEEDLE Date 6/27/86

Sampling Location INLET Clock Time 1450

Run No. CYCLONE CLEAN CHECK Operator JP/DC

Barometric Pressure, in.Hg _____ Static Pressure, in.H_2O _____

Moisture, % _____ Molecular wt., Dry _____ Pitot Tube, Cp _____

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

° ROTATION AT NULL READING

FIELD DATA

TRAVERSE POINT NUMBER	~~VELOCITY HEAD (ΔP_s), in.H_2O~~	STACK TEMP., °F
H-1	-1	
2	0	
3	0	
4	0	
5	0	
6	0	
7	0	
8	-5	
9	-3	
10	0	
11	0	
12	0	
V-1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		

* ANGLE FINDER TUBE NOT WORK WITH PITOT IN VERTICAL POSITION — NEEDLE RUBS INSIDE OF FACE.

CALCULATIONS

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

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

$M_s =$

$T_s =$ °F = °R = (°F + 460)

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

$P_s =$ in.Hg

$\sqrt{\Delta P} =$

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

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

$V_s =$ ft/s

$A_s =$ ft²

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

$Q_s = \qquad \times \qquad \times 60$

$Q_s =$ acfm

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

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

$Q_{s_{std}} =$ dscfm

FIELD AUDIT REPORT: DRY GAS METER
BY CRITICAL ORIFICE

DATE: 6/23/86 CLIENT: USEPA-EMB

BAROMETRIC PRESSURE (P_{bar}): 29.45 in.Hg METER BOX NO. FB-3

ORIFICE NO. 8 PRETEST Y: 0.977 ΔH@ 1.86 in.H_2O

ORIFICE K FACTOR: 4.725×10^{-4} AUDITOR: CB

Orifice manometer reading ΔH, in.H_2O	Dry gas meter reading V_i/V_f, ft^3	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.
1.9	957.20	120	115	119	113	116	15:22.17
	969.70	109		118	112		15.3695

Dry gas meter V_m, ft^3	$V_{m_{std}}$, ft^3	$V_{m_{act}}$, ft^3	Audit, Y	Y deviation, %	Audit ΔH@, in.H_2O	ΔH@ Deviation, in.H_2O
12.5	11.279	10.80	.958	-2.03	1.85	-.01

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

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

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

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

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: 6/23/86 CLIENT: USEPA-EMB

BAROMETRIC PRESSURE (P_{bar}): 29.45 in.Hg METER BOX NO. FB-11

ORIFICE NO. 3 PRETEST Y: .978 ΔH@ 1.16 in.H_2O

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

Orifice manometer reading ΔH, in.H_2O	Dry gas meter reading V_i/V_f, ft^3	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.
1.48	357.60 / 371.0	122 / 109	116	125 / 123	119 / 128	124	15.09 (15.154) 21

Dry gas meter V_m, ft^3	$V_{m_{std}}$, ft^3	$V_{m_{act}}$, ft^3	Audit, Y	Y deviation, %	Audit ΔH@, in.H_2O	ΔH@ Deviation, in.H_2O
13.40	11.969	12.03	1.00	2.7 ✓	1.24	-.08 ✓

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

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

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

$$\text{Audit } \Delta H@ = (0.0317)(\overset{1.48}{\Delta H})(P_{bar})(T_m + 460)\left[\frac{\emptyset}{Y\ (V_m)(P_{bar} + \Delta H/13.6)}\right]^2 = 1.24 \text{ in.}H_2O$$

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.

THERMOCOUPLE DIGITAL INDICATOR
AUDIT DATA SHEET

Date 6/23/86 Indicator No. FT-1 Operator CB

Test Point No.	Millivolt signal*	Equivalent temperature, °F*	Digital indicator temperature reading, °F	Difference, %
1		0	-2	—
2		200	199	-.15 ✓
3		400	399	.12 ✓
4		600	599	.09 ✓

CB 6/23

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.

THERMOCOUPLE DIGITAL INDICATOR
AUDIT DATA SHEET

Date 6/23/86 Indicator No. 219 Operator SB

Test Point No.	Millivolt signal*	Equivalent temperature, °F*	Digital indicator temperature reading, °F	Difference, %
1	Ø	-X 0	-1	—
2		200	199	.15
3		400	398	.23
4		600	598	.19

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.

FIELD AUDIT REPORT: DRY GAS METER
BY CRITICAL ORIFICE

DATE: 6/23/86

CLIENT: USEPA-EMB

BAROMETRIC PRESSURE (P_{bar}): 29.45 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: SG

Orifice manometer reading ΔH, in.H_2O	Dry gas meter reading V_i/V_f, ft^3	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.
1.80	632.5	118	122	122	117	120	15:05.49
	644.6	126		122	118		(15.0915)

Dry gas meter V_m, ft^3	$V_{m_{std}}$, ft^3	$V_{m_{act}}$, ft^3	Audit, Y	Y deviation, %	Audit ΔH@, in.H_2O	ΔH@ Deviation, in.H_2O
12.1	10,842	10.472	.966	-1.55 ✓	1.80	-0.03 ✓

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

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

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

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

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: 6/23/86 CLIENT: USEPA-EMB

BAROMETRIC PRESSURE (P_{bar}): 29.45 in.Hg METER BOX NO. F6-9

ORIFICE NO. 3 PRETEST Y: .986 ΔH@ 2.04 in.H_2O

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

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.
2.62	455.40	108	109	126	116	121.5	15:20.59
	469.50	112		126	118		(15.343)

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
14.1	12.684	12.253	.966	-2.1 ✓	2.00	-.04 ✓

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

$$V_{m_{act}} = \frac{1203(\overset{15.343}{\emptyset})(\overset{5.377\times10^{-4}}{K})(P_{bar})}{(T_a + 460)^{1/2}} = \quad ft^3$$

$$\text{Audit Y} = \frac{V_{m_{act}}}{V_{m_{std}}} = 0.966 \qquad \text{Y deviation} = \frac{\text{Audit Y} - \text{Pre-test Y}}{\text{Audit Y}} \times 100 =$$

$$\text{Audit } \Delta H@ = (0.0317)(\Delta H)(P_{bar})(T_m + 460)\left[\frac{\emptyset}{Y\,(V_m)(P_{bar} + \Delta H/13.6)}\right]^2 = 2.00 \text{ in.}H_2O$$

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.

ON-SITE AUDIT DATA SHEET

Audit Name: USEPA-EMB Date: 6/23/96 Auditor: CB

Equipment	Reference	Reference Value	Value Determined	Deviation	Max. Allowable Deviation
Meter box inlet thermo. FB-3 -9 -11 FT-1	ASTM-3F at ambient temp.	101 103 115 101	98 100 104 101	-3°F ✓ -3°F ✓ -11°F ✓ 0 ✓	5°F
Meter box outlet thermo. FB-3 -9 -11 FT-1	ASTM-3F at ambient temp.	99 95 100 101	99 100 101 101	0 ✓ +2°F ✓ +1°F ✓ 0 ✓	5°F
Impinger thermometer I-1 I-15	ASTM-3F at ambient temp.	97 97	95 96	-2°F ✓ -1°F ✓	2°F
Stack thermometer #101 or Thermocouple	ASTM-3F at ambient temp.	99 99	93 95	-4°F ✓ -2°F ✓	7°F
	ASTM-3F at stack temp.				See table
Orsat analyzer	% O_2 in ambient air	20.8%			0.7%
Trip balance	IOLM std. weight		NA		0.5 grams
Barometer	Corrected* NWS value		NA		0.20 in. Hg

Reference temp. °F	32-140	141-273	274-406	407-540	541-673	674-760
Max. deviation °F	7	9	11	13	15	17

* Correction factor:

NWS value (in. Hg) - [Altitude (ft)/1000(ft/in. Hg)] + 0.74 in. Hg**

** 0.74 in. Hg is the nominal correction factor for the reference barometer against which the field barometer was calibrated.

If it is not feasible to perform the audit on any piece of equipment, record "N/A" in the space provided for the data.

DRY MOLECULAR WEIGHT DETERMINATION

PLANT Steel Heddle
DATE 6/23/86 TEST NO P-1
SAMPLING TIME (24-hr CLOCK) ≈ 1445-1500
SAMPLING LOCATION Scrubber Inlet
SAMPLE TYPE (BAG, INTEGRATED, CONTINUOUS)
ANALYTICAL METHOD Orsat
AMBIENT TEMPERATURE 105°F
OPERATOR CB
ORSAT LEAK CHECKED ✓

COMMENTS: No. 422

RUN / GAS	1		2		3		AVERAGE NET VOLUME	MULTIPLIER	MOLECULAR WEIGHT OF STACK GAS (DRY BASIS) M_d, lb/lb-mole
	ACTUAL READING	NET	ACTUAL READING	NET	ACTUAL READING	NET			
CO_2	0	0	0	0			0	44/100	0
O_2 (NET IS ACTUAL O_2 READING MINUS ACTUAL CO_2 READING)	20.5	20.5	20.5	20.5			20.5	32/100	6.56
CO (NET IS ACTUAL CO READING MINUS ACTUAL O_2 READING)							0	28/100	0
N_2 (NET IS 100 MINUS ACTUAL CO READING)							79.5	28/100	22.26
								TOTAL	28.82

Cr^{+6}/Cr FIELD DATA SHEETS

EMISSION DATA

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
STERLING HARDWOOD, GREENVILLE	6/24/86	INLET	GR

STACK TC 101 Probe - Imp. H

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
SLGTH	JP/DS	80	29.36	-.33	HA	32	0.84		10.F.1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (%)	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 MINS
4 FT HEATED GLASS	0.257	4.7/4.2	2	N1	FB-11	1.16	0.9978	8.5	0.0000		2.63	250	NA		7.5

* NEW INITIAL METER READING AFTER PORT CHANGE + LEAK CHECKS — RE ZERO MANOMETER

LEAK CHECK VOLUME CORRECTION = ~~0.13~~ 0.11

FB-11 PRETEST 15 0.000

AFTER PORT 1 1.5 0.000

BEFORE PORT 2 10.0 0.005

PITOT LEAK check +V − ✓ zero ✓ #504

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 Probe	IMPINGER TEMPERATURE °F
	0	0827	378.740	0.70								
V-1	7.5		386.4	~~0.66~~	1.81	1.81	90	84	82	5.5	~~[illegible]~~ 213	
2	15.0		394.7	0.95	2.5	2.5	89	92	85	7.	225	76
3	22.5		403.8	1.05	2.77	2.75	93	100	87	8.5	235	78
4	30.0		412.6	0.93	2.44	2.45	94	105	89	8.	233	80
5	37.5		421.4	0.95	2.53	2.55	93	109	92	7.5	244	73
6	45.0		430.	0.90	2.40	2.40	94	112	95	7.5	246	72
7	52.5		437.7	0.75	2.00	2.00	94	115	97	6.	245	72
8	60.0		445.4	0.72	1.94	1.95	95	117	101	6.	249	73
9	67.5		453.6	0.72	1.95	1.95	95	120	103	6.	244	75
10	75.0		461.	0.76	2.06	2.05	96	122	106	6.	239	68
11	82.5		469.3	0.80	2.18	2.20	96	124	108	6.5	236	66
12	90.0	0957	476.958	0.72	1.96	1.95	96	125	110	6.	239	68
H-1	97.5	1015	482.065 → 486.5 *	1.20	3.29	3.3	96	125	116	8.5	308	65 ~~76~~
2	105.		495.7	1.10	3.01	3.00	97	124	116	8.5	258	66
3	112.5		504.1	0.90	2.47	2.45	97	126	116	7.5	246	70
4	120.		512.1	0.81	2.22	2.20	98	128	117	7.	260	69
5	127.5		520.3	0.88	2.42	2.40	98	132	118	7.5	268	68
6	135.		528.3	0.80	2.21	2.20	98	134	120	7.	268	67
7	142.5		535.9	0.73	2.02	2.00	98	135	122	6.5	267	70
8	150.		543.7	0.77	2.14	2.15	98	136	123	6.5	266	71
9	157.5		551.5	0.79	2.19	2.20	100	136	123	6.5	254	70
10	165 ~~165.5~~		559.4	0.82	2.27	2.25	100	136	125	7.	245	70
11	172.5		567.4	0.82	2.27	2.25	99	136	123	7.	241	70
12	180.	1145	575.289	0.82	2.27	2.25	99	136	123	7.	238	70

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

Plant Steel Heddle

Sample date 6/24/86

Sample location Scrubber Inlet

Recovery date 6/24/86

Run number SIC-1

Recovered by CB

Filter number(s) NA

MOISTURE

Impingers	#1	#2	#3	
Final volume (wt)	611.0	638.3	596.2	ml(g)
Initial volume (wt)	585.0	613.8	590.9	ml(g)
Net volume (wt)	26.0	24.5	5.3	ml(g)

Description of impinger water slightly yellow

Silica gel #4

Final wt 794.3 g

Initial wt 750.1 g

Net wt 44.2 g

100 % spent

Total moisture 100.0 g

RECOVERED SAMPLE

Filter container number(s) NA

Sealed

Description of particulate on filter NA

Probe rinse container no. NA

Liquid level marked NA

blank container no. NA

Liquid level marked NA

Impinger contents container no. 4675-A

Liquid level marked ✓

NaOH blank container no. 4676-A

Liquid level marked ✓

Samples stored and locked

Remarks PH Chk: 10.0 ✓
- sample had yellowish tint; from nozzle/probe line.

LABORATORY CUSTODY

Received by Laura Patel

Date 7/3/86

Remarks

Particulate sample recovery and integrity data sheet.

EMISSION TESTING FIELD DATA

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
STEELCASE HEIDDKE, GRAND RAPIDS	6/25/89	INLET	GR/EPA6

DI-219
TK #3
STACK,
Probe-6
IAP-I-
Pitot #
50
zero

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
SIE-21	JP/DD	75	29.44	-.55 -3.55	NA	32	0.84		60 F

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (%)	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 MINS
6 1/2 FT HIGH TEMP GLASS	0.255	4 1/2	2	NA	5/1	1.6	0.8785	3	0.000		26.3	250	NS		25

CHANGE PORTS + LEAK CHECKS - RE ZERO
RESTART @ 1002
LEAK CHECK VOLUME CORRECTION = 0.386 FT³
NEW START VOLUME READING = 675.343

	IN. Hg	CFM
PRETEST	14.5	0.000
AFTER PORT 1	3.0	0.000
BEFORE PORT 2	9.5	0.000

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 Probe	IMPINGER TEMPERATURE °F
	0	0808	577.318									
-1	7.5		585.6	0.89	2.31	2.30	87	81	78	2.5	310	68
2	15.0		594.1	0.98	2.57	2.55	86	91	82	3.	258	65
3	22.5		602.2	0.83	2.2	2.2	86	99	85	2.5	250	65
4	30.0		610.6	0.88	2.36	2.35	86	105	89	2.5	250	65
5	37.5		619.	0.82	2.22	2.2	89	110	93	2.5	247	66
6	45.0		626.7	0.83	2.25	2.25	88	113	96	2.5	246	69
7	52.5		634.4	0.78	2.11	2.10	90	116	99	2.5	243	68
8	60.0		642.3	0.80	2.18	2.2	89	116	102	2.5	228	69
9	67.5		650.3	0.84	2.29	2.30	89	117	104	2.5	226	70
10	75.0		658.6	0.87	2.39	2.40	89	119	107	2.5	226	69
11	82.5		666.7	0.88	2.42	2.40	90	120	109	2.5	223	70
12	90.0	0938-1002	674.957 - 675.343	0.89	2.44	2.45	90	121	110	2.5	225	66
-1	97.5		684.4	1.10	3.04	3.05	92	123	116	3.	305	63
2	105.		693.1	1.0	2.76	2.75	92	123	116	3.	232	64
3	112.5		701.4	0.92	2.54	2.55	92	123	116	2.5	244	65
4	120.0		709.5	0.94	2.60	2.60	92	125	117	2.5	246	67
5	127.5		718.2	0.97	2.68	2.70	92	125	117	3.	245	68
6	135.0		726.6	0.94	2.60	2.60	92	125	117	3.	245	68
7	142.5		734.	0.75	2.08	2.01	92	126	117	2.5	248	66
8	150.0		741.1	0.68	1.89	1.90	92	127	117	2.5	251	64
9	157.5		748.5	0.72	2.0	2.0	92	128	117	2.5	252	64
10	165.		755.8	0.72	2.0	2.0	92	129	118	2.5	251	65
11	172.5		763.3	0.75	2.09	2.10	92	130	119	2.5	240	66
12	180.0	1132	770.8	0.75	2.09	2.10	92	131	119	2.5	235	67

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

Plant Steel Heddle Sample date 6/25/86

Sample location Scrubber Inlet Recovery date 6/25/86

Run number SIC-2 Recovered by CB

Filter number(s) NA

MOISTURE

Impingers	#1	#2	#3	
Final volume (wt)	592.5	615.9	599.2	ml(g)
Initial volume (wt)	582.7	592.7	592.7	ml(g)
Net volume (wt)	9.8	23.2	6.5	ml(g)

Silica gel #4

Final wt 797.3 g

Initial wt 755.4 g

Net wt 41.9 g

100 % spent

Description of impinger water slightly Turbid

Total moisture 81.4 g

RECOVERED SAMPLE

Filter container number(s) NA Sealed

Description of particulate on filter NA

Probe rinse container no. NA Liquid level marked

blank container no. NA Liquid level marked

Impinger contents container no. 4678-A Liquid level marked ✓

NaOH blank container no. 4679-A Liquid level marked ✓

Samples stored and locked

Remarks

LABORATORY CUSTODY

Received by [illegible] Date 7/3/86

Remarks

Particulate sample recovery and integrity data sheet.

EMISSION TESTING FIELD DATA

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
SIVERAK WHEELER, INGREDIENTS	10/26/86	INLET	GR/GR6

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
SILICA-13	VIP/IDS	85	29.44	-1.25	NA	32	0.84		101

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (l)	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 MINS
4 FT WHEELED INCONEL	0.251	4	2	NA	FB1	1.6	0.987	4.0	0.000	2.63	2.58	NA			120

* CHANGE PORTS — LEAK CHK — ZERO ✓
— NEW INITIAL READING = 868.583 RESTART 1429
LEAK CHECK CORRECTION = 0.297 FT³

	IN. Hg	CFM
PRETEST	15.0	0.000
AFTER PORT 1	6.5	0.000
BEFORE PORT 2	10.0	0.000

PITOT # 504
ZERO — LEAK CHECK AT BACK PAGE

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 Probe	IMPINGER TEMPERATURE °F
	0	1245	771.075									
V-1	7.5		780.4	1.15	3.16	3.15	95	121	118	4.5	300	69
2	15.0		789.5	1.10	3.07	3.00	94	121	117	4.5	278	64
3	22.5		798.5	1.05	2.89	2.90	95	124	117	4.	238	64
4	30.		807.0	0.92	2.50	2.50	94	125	117	3.5	250	64
5	37.5		815.65	0.97	2.68	2.70	94	126	117	4.	261	63
6	45.		823.75	0.85	2.34	2.35	95	127	117	3.5	255	65
7	52.5		831.3	0.75	2.06	2.05	95	128	117	3.	268	65
8	60.		838.7	0.70	1.93	1.95	95	130	117	3.	265	66
9	67.5		846.0	0.70	1.93	1.95	95	130	117	3.	261	67
10	75.		853.4	0.70	1.93	1.95	95	130	117	3.	257	67
11	82.5		860.9	0.72	1.99	2.00	95	129	117	3.	260	65
12	90.	1415 *	868.286	0.72	1.99	2.00	96	129	117	3.	246	63
H-1	97.5	1429 -	876.3	0.75	2.06	2.05	97	124	117	3.	225	66
2	105.		885.1	0.98	2.68	2.70	96	123	116	4.	262	63
3	112.5		893.55	0.95	2.59	2.60	98	124	115	4.	258	65
4	120.		901.75	0.86	2.35	2.35	99	124	115	3.5	254	66
5	127.5		910.	0.87	2.36	2.35	100	124	114	3.5	262	68
6	135.		917.9	0.82	2.23	2.25	99	124	113	3.5	258	68
7	142.5	1527 = ~~[illegible]~~	925.5	0.75	2.06	2.05	99	123	113	3.	258	69
8	150.	1535 - ~~[illegible]~~	933.5	0.77	2.09	2.10	99	123	113	3.	260	70
9	157.5		941.2	0.85	2.28	2.30	98	113	108	3.5	278	63
10	165.		949.5	0.87	2.34	2.35	98	113	107	3.5	248	66
11	172.5		957.7	0.76	4.3	2.30	99	116	107	3.5	237	71
12	180.0	1633	965.3	0.78	2.18	2.18	99	118	107	3.0	242	61

[illegible] STOP 1528 — [illegible] DAY — START @ 1603 — 149 minutes (12 Run)

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

Plant Steel Heddle

Sample date 6/25/86

Sample location Scrubber Outlet

Recovery date 6/25/86

Run number SJC-3

Recovered by CB

Filter number(s) NA

MOISTURE

Impingers	#1	#2	#3	
Final volume (wt)	578.4	643.5	599.9	ml(g)
Initial volume (wt)	561.6	626.6	597.8	ml(g)
Net volume (wt)	16.8	16.9	2.1	ml(g)

Description of impinger water slight yellow color

Silica gel #4

Final wt 829.9 g

Initial wt 783.6 g

Net wt 46.3 g

95 % spent

Total moisture 82.1 g

RECOVERED SAMPLE

Filter container number(s) NA Sealed —

Description of particulate on filter —

Probe rinse container no. NA Liquid level marked NA

blank container no. NA Liquid level marked NA

Impinger contents container no. 4806-A Liquid level marked ✓

NaOH blank container no. 4679-A Liquid level marked ✓

Samples stored and locked

Remarks

LABORATORY CUSTODY

Received by Laura Ridell Date 7/8/86

Remarks

Particulate sample recovery and integrity data sheet.

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
STIGLER IRONDALE, GAGGNVILLE	6/24/86	OUTLET	GR

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
SG-1	JP/DS	80	29.15	~~29.95~~ −0.35	NA	32	.984		10F1

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 NEWS
3 FT GLASS, HEATED	0.2513	HT/1	2		FT/1	1.883	0.981	4	0.000		432	250	NA		7.5
						PRETEST		15.0	0.002						

PORT CHANGE; ZERO MANOMETERS

PITOT LEAK chk ✓ − ✓ #242 zero

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	0833	645.598								PAGE	
W-1	7.5		657.0	0.55	1.47	1.45	77	85	87	<2	240	66
2	15.0		658.4	0.68	2.97	3.00	78	88	88	2.5	260	67
3	22.5		666.	0.68	3.02	3.00	78	97	90	2.5	255	77
4	30.0		673.5	0.68	3.06	3.05	78	103	91	2.5	254	79
5	37.5		680.8	0.63	2.83	2.85	78	105	93	2.5	260	81
6	45.0		688.2	0.63	2.83	2.85	79	109	95	2.5	255	22
7	52.5		696.	0.65	2.94	2.95	80	112	98	2.5	250	67
8	60.0		703.5	0.74 ~~0.65~~	3.36	3.35	80	114	100	2.5	255	65
9	67.5		712.4	0.90	4.10	4.10	80	117	103	3.	255	65
10	75.00		722.	1.05	4.80	4.80	81	120	106	3.	251	64
11	82.5		731.3	1.10	5.05	5.05	80	121	106	3.5	255	64
12	90.0	1003	741.114	1.15	5.29	5.30	80	122	108	3.5	260	67
S-1	97.5	1018	750.	0.86	3.96	3.95	80	116	111	2.5	256	62
2	105		758.6	0.95	4.36	4.35	80	117	111	3.	255	66
3	112.5		767.6	0.88	4.04	4.05	81	120	110	3.	262	69
4	120.0		776.	0.83	3.83	3.85	81	124	113	2.5	260	71
5	127.5		784.3	0.82	3.80	3.80	80	126	114	2.5	252	71
6	135.		792.8	0.83	3.86	3.85	80	127	115	2.5	260	73
7	142.5		801.2	0.79	3.68	3.70	80	128	117	2.5	254	70
8	150.0		810.4	0.97	4.53	4.55	80	129	118	3.	250	70
9	157.5		820.0	1.05	4.92	4.90	79	129	118	3.5	252	70
10	165.		830.1	1.20	5.61	5.60	80	129	118	3.5	260	70
11	172.5		840.45	1.25	5.84	5.85	80	130	118	3.5	260	69
	180.0	1148	850.792	1.25	5.84	5.85	80	131	118	3.5	249	69

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

Plant Steel Heddle

Sample date 6/24/86

Sample location Scrubber Outlet

Recovery date 6/24/86

Run number SOC-1

Recovered by CB

Filter number(s) NA

MOISTURE

Impingers	#1	#2	#3	
Final volume (wt)	632.1	627.4	595.0	ml(g)
Initial volume (wt)	594.2	603.1	587.5	ml(g)
Net volume (wt)	37.9	24.3	7.5	ml(g)

Description of impinger water Clear

Silica gel #4

Final wt 786.6 g

Initial wt 737.9 g

Net wt 48.7 g

100 % spent

Total moisture 118.4 g

RECOVERED SAMPLE

Filter container number(s) NA

Sealed

Description of particulate on filter NA

Probe rinse container no. NA

Liquid level marked NA

blank container no. NA

Liquid level marked NA

Impinger contents container no. 4677-A

Liquid level marked ✓

NaOH blank container no. 4676-A

Liquid level marked ✓

Samples stored and locked

Remarks pH checked: 11.0

Probe liner to container: yellowish color

LABORATORY CUSTODY

Received by Laura Ribble

Date 7/3/86

Remarks

Particulate sample recovery and integrity data sheet.

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
STIGEL THEODORE, KANSAS CITY	10/25/86	OUTLET	GR/GAS

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
5019-2d	NP/DS	75	29.41	-0.36 -0.36	NA	38	0.84		10.F

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (%)	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 MINS
3 FT THERTIGO GLASS	42513	4 1/8	12	NA	FT1	1.83	0.981	14	0.002		4.32	250	NA	NA	120

4 change ports - Restart @ 100 4 - Re zero Part out PITOT LEAK check + ✓ - ✓

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 Probe	IMPINGER TEMPERATURE °F
	0	0811	851.357									
W -1	7.5		858.3	0.61	2.67	2.65	75	83	82	4.5	265	57
2	15.0		865.9	0.71	3.14	3.15	75	89	85	5.5	261	56
3	22.5		873.6	0.71	3.19	3.2	73	100	87	5.5	262	60
4	30.0		881.2	0.70	3.15	3.15	75	104	91	5.5	265	60
5	37.5		888.7	0.66	2.97	2.95	74	110	94	5.5	257	60
6	45.0		896.2	0.67	3.05	3.05	75	111	97	5.5	255	60
7	52.5		903.9	0.69	3.16	3.15	75	114	100	5.5	260	62
8	60.0		912.1	0.78	3.58	3.60	75	116	102	6.5	255	62
9	67.5		921.0	0.91	4.19	4.20	75	116	104	7.5	280	62
10	75.0		929.9	1.0	4.61	4.60	75	117	105	8.	260	61
11	82.5		939.3	1.05	4.87	4.85	76	120	107	8.5	251	63
12	90.0	0941-100Y	948.978	1.10	5.09	5.10	76	121	108	9.	253	63
S -1	97.5		958.	0.97	4.50	4.50	75	117	113	7.5	258	61
2	105.		967.2	1.0	4.64	4.65	76	119	113	8.	255	64
3	112.5		976.0	0.90	4.19	4.20	76	122	114	7.	260	66
4	120.		984.5	0.84	3.82	3.90	75	124	117	6.5	258	69
5	127.5		993.0	0.84	3.92	3.90	76	123	114	6.5	258	68
6	135.		1001.5	0.82	3.83	3.85	75	124	114	6.5	260	63
7	142.5		1010.7	1.0	4.68	4.70	76	125	115	8.	260	62
8	150.		1020.3	1.1	5.14	5.15	76	125	115	8.5	251	60
9	157.5		1030.3	1.15	5.38	5.40	75	125	115	9.	262	60
10	165.		1040.5	1.25	5.86	5.85	75	125	114	10.5	260	59
11	172.5		1050.9	1.30	6.10	6.10	75	129	115	11.	250	61
12	180.0	1137	1061.35	1.30	6.10	6.10	75	125	115	11.	255.0	61

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

Plant Steel Heddle Sample date 6/25/86
Sample location Sampler Outlet Recovery date 6/25/86
Run number SOC-2 Recovered by CB
Filter number(s) NA

MOISTURE

Impingers	#1	#2	#3	
Final volume (wt)	614.7	614.6	601.7	ml(g)
Initial volume (wt)	587.3	594.7	593.5	ml(g)
Net volume (wt)	27.4	19.9	8.2	ml(g)

Description of impinger water clear

Silica gel #4
Final wt 795.6 g
Initial wt 748.3 g
Net wt 47.3 g
100 % spent

Total moisture 102.8 g

RECOVERED SAMPLE

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

Probe rinse container no. NA Liquid level marked
_____ blank container no. NA Liquid level marked
Impinger contents container no. 4680-A Liquid level marked ✓
NaOH blank container no. 4679-A Liquid level marked ✓
Samples stored and locked
Remarks

LABORATORY CUSTODY

Received by [illegible] Date 7/3/86
Remarks

Particulate sample recovery and integrity data sheet.

PLANT & CITY	DATE	SAMPLING LOCATION	SAMPLE TYPE
SIMPLOT HEADDOLF, MAGEMVILLE	6/26/86	OUTLET	CR/KRB

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
SOLU-3	NP/DS	95	29.44	-0.26	NA	132	0.84		1 of 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (%)	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 MINS
3' FTI GLASS, HEATED	0.253	4-V	19	12	NA	FTI	1.83	0.988	Hg	0.000		343	250	NA	120

PRETEST 15 0.005

PITOT Leak check + ✓ − ✓ zero ✓

* change ports RESTART 1431

* 5708 @ 1528 - Process Delay - RESTART @ 1602 (147.2 minutes into run)

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	1247	61.501									
3-1	7.5		70.45	0.95	4.41	4.40	72	109	108	3.	250	60
2	15.0		79.65	1.0	4.64	4.65	72	114	109	3.	260	54
3	22.5		88.75	0.97	4.52	4.50	72	118	109	3.	260	62
4	30.0		97.65	0.91	4.25	4.25	75	121	109	3.	260	64
5	37.5		106.2	0.85	3.95	3.95	75	122	110	2.5	260	67
6	45.0		115.	0.84	3.91	3.90	75	123	110	2.5	250	66
7	52.5		123.1	0.79	3.69	3.70	74	124	111	2.5	260	66
8	60.0		132.2	0.97	4.54	4.55	73	126	111	3.	253	68
9	67.5		141.7	1.05	4.92	4.90	74	125	112	3.	260	69
10	75.0		152.1	1.25	5.85	5.85	74	125	112	3.5	257	63
11	82.5		162.7	1.35	6.31	6.30	76	125	112	3.5	253	62
12	*90.0	1417	173.342	1.35	6.31	6.30	76	125	112	3.5	258	62
W-1	97.5	1431-	181.2	0.70	3.24	3.25	75	116	110	2.5	257	60
2	105.0		189.05	0.71	3.30	3.30	73	117	108	2.5	250	61
3	112.5		196.95	0.70	3.25	3.25	73	121	108	2.5	250	64
4	120.0		204.65	0.68	3.16	3.15	74	122	108	2.5	262	69
5	127.5		212.2	0.65	3.02	3.00	74	122	108	2.5	252	65
6	135.		219.8	0.64	2.97	2.95	76	123	107	2.5	260	65
7	142.5		227.6	0.68	3.16	3.15	73	121	106	2.5	252	66
8	150.	1539 - NA	235.9	0.80	3.70	3.70	74	120	105	2.5	258	67
9	157.5		244.5	0.97	4.47	4.15	74	103	98	3.	247	62
10	165.		253.8	1.05	4.78	4.80	74	107	98	3.	260	64
11	172.5		263.3	1.10	5.02	5.00	75	113	98	3.	252	68
12	180.0	1635	273.0	1.15	5.28	5.30	75	117	99	3.5	255	69

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

Plant Steel Heddle Sample date 6/25/86
Sample location Scrubber Outlet Recovery date 6/25/86
Run number SOC-3 Recovered by CP
Filter number(s) NA

MOISTURE

Impingers	#1	#2	#3	
Final volume (wt)	618.6	628.1	595.6	ml(g)
Initial volume (wt)	596.6	605.9	590.3	ml(g)
Net volume (wt)	22.0	22.2	5.3	ml(g)

Description of impinger water clear

Silica gel #4
Final wt 830.2 g
Initial wt 787.9 g
Net wt 47.3 g
90 % spent

Total moisture 96.8 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. 4807-A Liquid level marked
_____ blank container no. 4679-A Liquid level marked ✓
Samples stored and locked
Remarks

LABORATORY CUSTODY

Received by [illegible] Date 7/3/86
Remarks

Particulate sample recovery and integrity data sheet.

PARTICLE SIZE DISTRIBUTION
(Gravimetric)

Plant & City	Date	Sampling Location	Sample Type
STEEL MADDLE, KREEMWICK	6/24/86	INLET	PART SIZING

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.	T/M/P	Page
SIPS-1	HP/DS	90	29.35	-.33	ANDERSEN MARK III	32				1 of 1

Probe Length and Type	Nozzle I.D.	Nozzle No.	H.O. (%)	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
5 FT STEEL	0.187	3-1/VP	2		FB3	1.86	.9970	15	.0004			NA	NA		30

ΔH=1.28 @ ΔP=.77 - PT. 7 & 8 - HR.

(M5 P, TOT + T/C) DI=219

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	Impactor Temperature °F	Condenser Temperature °F
	0	1209	971.192									ICED?
H-7	30.0	1239	991.310	0.25	1.25	1.25	99	115	113	<2	99	✓
	60.	1309	1011.6	.75	1.25	1.25	99	118	112	<2	99	✓
	90.6	1340	1032.262	.75	1.25	1.25	99	119	113	<2	99	✓

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant STEEL HEDDLE

Sample date 6/24/86

Sample location INLET

Recovery date 6/24/86

Run number S1PS-1

Recovered by [illegible]

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 4681A

Liquid level marked ✓

Acetone blank container number 4674A

Liquid level marked ✓

Filters

Stage	Filter number	Container number	Container sealed	Comments
0	A019	4681B	✓	no load
1	AM62		✓	no load
2	A027		✓	no load
3	AM96		✓	~~[illegible]~~
4	A049		✓	"
5	AM44		✓	"
6	AP25		✓	"
7	AM66		✓	light "
Backup	A234	✓	✓	no visible load

Samples stored and locked ✓

Remarks ~~FILTER F~~ FILTER BLANK "SET" 4674B
- Nozzle/Cyclone rinse → yellowish tint

LABORATORY CUSTODY

Received by [illegible]

Date [illegible]

Remarks

STEEL HEDDLE, GREENVILLE	6/27/84	INLET	PARTSIZE, GA/GR6

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
SIPST2	IP/DS	90	29.34	-.33	ANDERSEN MARK III	32				1 OF 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (l)	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
5' FT SS/STEEL	0.180	3-110	2	NA	FB3	1.86	0.9871	10	0.004			NA	NA		

* STOP 77.5 MINUTES INTO SAMPLING FOR FACIAL delay (1548) - RESTARTED

ΔH=1.28 @ ΔP=.77 @ Tm=115 @ Dn=.197 (3-110) PT 7/8 Hor.

DI 219

TC-409

PITOT-015

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	1430	32.430									ICED?
H-7	30.		55.0	0.75	1.25	1.25	108	113	109	2.	108	✓
	60.		74.4	.75	1.25	1.25	108	115	108	2.		✓
	77.5	*1548	85.803	.75	1.25	1.25	108	116	109	2.		✓

* Dryers Down Test completed

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant Steel Heddle

Sample date 6/24/86

Sample location Scrubber Inlet

Recovery date 6/24/86

Run number S1PS-2

Recovered by GD

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 4677-A Liquid level marked ✓

Acetone blank container number 4674-A Liquid level marked ✓

Filters

Stage	Filter number	Container number	Container sealed	Comments
0	A097	4679-C	✓	no sample load
1	A082		✓	" " "
2	A095		✓	" " "
3	A004		✓	very light
4	A091		✓	even; dots
5	A010		✓	" "
6	A561		✓	" "
7	A028		✓	lightest; dots
Backup	A-258		✓	no sample load.

Samples stored and locked _____

Remarks _____

LABORATORY CUSTODY

Received by [illegible] Date 7/3/86

Remarks _____

[redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted] [redacted]

STEEL HOOPLA 6/24/86 / M4 98 PARTS V 129, 129/129 16

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
SILAS-13	M/DS	88	29.38	-.33	HOOD GASIGN MARK 1	33	A		A	01

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H_2O (S)	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	MET. ΔP	RECORD DATA MINS
8 FT STEEL	0.187	3-1/1/10	2	MA	F83	1.86	0.97	10	0.000			NA	NA		

Ready @ 1630 - WAITING FOR PROBE DELAY ΔH = 1.28 @ ΔP = .77 ; T_m = 115 ; D_N = .197 PT. 7 & 8 HAR- D1-219 PITOT #015 T/C #409

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	1643	85.883									
	~~40~~			0.72	1.22	1.20	105	108	105	<2	105	✓
	~~65~~	1748	129.55	.72	1.22	1.20	105	106	101	<2	105	✓
	~~80~~	1803	139.572	.72	1.22	1.20	105	106	99	<2	105	✓
	80.0											

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant: Steel Heddle
Sample location: Scrubber Inlet
Run number: SIP8-3

Sample date: 6/24/86
Recovery date: 6/25/86
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: 4808-A — Liquid level marked: ✓

Acetone blank container number: 4674-A — Liquid level marked: ✓

Filters

Stage	Filter number	Container number	Container sealed	Comments
0	AM-11	4808-B	✓	No visible load
1	Am 46	↓	✓	" " "
2	AM-01		✓	Barely visible
3	AN-60		✓	visible
4	AM-69		✓	even; dist. data
5	AO-28		✓	" " "
6	AO-65		✓	" " "
7	AO-00		✓	very light
Backup	A245			No visible load

Samples stored and locked: ✓

Remarks: Yellowish tint in nozzle/connecting line.

LABORATORY CUSTODY

Received by: [illegible] — Date: 7/3/86

Remarks:

[redacted] [redacted] [redacted] [redacted] [redacted] DA[redacted] [redacted] SAM[redacted]OCATI[redacted] [redacted] SAMPLE TYPE [redacted]

STEEL HEDDLE, GREENVILLE — 6/27/80 OPTILETT — PART 5/1/29 - CR

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 N P	PAGE
T0FS-1	JP/DS/GB	90	29.35	T P35	ANDERSEN MARK III	32				10 F 1

PROBE LENGTH AND TYPE	NOZZLE I.D.	NOZZLE NO.	H.O. (ft)	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
4' FT STEEL	0.195	3-1 CH	2		FB92	2.4 H	0.986	15	.0000			NA			

ΔH = 1.53 @ ΔP = .85 - PTS - 5 OR 6 - South

1.22 / 1.11 .68 / .62

PITOT # 015

T/C # 409-03-FT1

* STOP @ 1342 - PROCESS DELAY - 167.7 SAMPLE MINUTES - RESTART @ 1350

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	IMPACTOR TEMPERATURE °F	CONDENSER TEMPERATURE °F
	0	1055	476.573					114	110	22	80	ICED ✓
W-4	30	1125	494.96	0.62	1.11	1.10	80	124	112	22	80	✓
	70	1205	520	.62	1.10	1.10	80	134	120	22	80	✓
	90	1225	532.10	.62	1.10	1.10	80	135	122	2	80	✓
	120	1255	550.83	.62	1.10	1.10	80	138	125	2	80	✓
	150	1325	569.7	.62	1.10	1.10	80	135	125	22	80	✓
	180	1342* / 1403	588.6	.62	1.10	1.10	80	130	123	22	80	✓
	210	1433	616.84	.62	1.10	1.10	80	132	122	2	80	✓
	270	1503	625.724	.62	1.10	1.10						

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant STEEL HEDDLE
Sample date 6/24/86
Sample location OUTLET
Recovery date 6/24/86
Run number SOPS-1
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 4682-A
Liquid level marked

Acetone blank container number 4694 A
Liquid level marked ✓

Filters

Stage	Filter number	Container number	Container sealed	Comments
0	A003	4682 B	✓	no visible load
1	A004		✓	" " "
2	AM27		✓	" " "
3	AM52		✓	very light
4	AP23		✓	brown; dirt dots.
5	AM72		✓	" " "
6	A065		✓	lighter; " "
7	AM34		✓	" " "
Backup	A066	✓	✓	no visible load

Samples stored and locked

Remarks Acetone Rinse → clear

LABORATORY CUSTODY

Received by [illegible]
Date [illegible]

Remarks

PLANT	DATE	SAMPLING LOCATION	SAMPLE TYPE
STEEK HEDDLE, GREENWICH	6/25/86	OUTLET	PARTSIZING 144/146

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
5-915-2	WP/DS	70	29.41	~~-5.56~~ -0.36	ANDERSEN MARK III	132				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	OVEN HEAT SET	REF. ΔP	RECORD DATA MINS
4 FT STEEL	.195	3-1/8	2	MA	FB9	2.041	0.986	9	0.000		1.687	MA	MA		30

~~ΔH=1.53 @ ΔP=.85~~ ~~1T 526 South = TR=115, ΔH=.195~~

0730 ; S #6 - 0.82 W #3 = 0.70 T_s = 71°F ⇒ $\overline{\Delta P}$ = 0.76

Pitot @ 015 TK4[illegible] Leak check ✓ ✓ ze[illegible]

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	IMPACTOR TEMPERATURE °F	CONDENSER TEMPERATURE °F
	0	0746	625.889									ICED
S-6	30	0816	645.4	0.82	1.4	1.30	71	80	75	2	71	✓
	60	0846	665.575	0.82		1.30		114	98	2		✓
	90	0916	685.88	.82		1.30		124	107	2		✓
	120	0946	706.208	.82		1.30		130	116	2		✓
W-3*	150	1034	726.515	0.73		1.30	76	133	122	2		✓
	180	1104	746.750	.73		1.30		136	125	2		✓
	210	1134	766.860	.73		1.30		139	126	2		✓
	~~240~~	~~1204~~	785.822	.73		1.30		139	127	2		✓
	238	1202										

* Change Ports @ 0946

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant: Steel Mill
Sample date: 6/25/86
Sample location: Scrubber Outlet
Recovery date: 6/25/86
Run number: 50PS-2
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: 4700-A
Liquid level marked: ✓

Acetone blank container number: 4674-A
Liquid level marked: ✓

Filters

Stage	Filter number	Container number	Container sealed	Comments
0	A045	4700-B	✓	None visible
1	AN46		✓	" "
2	AS21		✓	" "
3	ANOD		✓	visible; dist. dots (light)
4	AS41		✓	seen; " " (heavy)
5	AN26		✓	" " "
6	AP45		✓	very light dots
7	AN22		✓	" " "
Backup	A239		✓	more visible

Samples stored and locked: ✓

Remarks

LABORATORY-CUSTODY

Received by: [illegible]
Date: 7/3/86

Remarks

Plant	Date	Sampling Location	Sample Type
STEGG HEADLEY, GAGONVILLE [illegible]	6/25/86	OUTLET	PARTICLE SIZE KRG/GRG [illegible]

Run No.	Operator	Amb. Temp (°F)	Bar. Press. (in. Hg)	Static Press (in. H_2O)	Impactor Type	Stack Inside Dimen. (inches)	Pitot Tube C_p	Therm No.	NMP	Page
SOPS13	KP/DS	95	29.44	-.036 -0.76	ANDERSON MARK IIIA	32				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	B Factor	C Factor	Probe Heat Set	Oven Heat Set	Ref. ΔP	Record Data Mins
5' FIT STEEL	0.197	3-1/10	4	NA	FB9	2.04	0.986	10	0.006		1.253	NA	NA		

CHANGE PORTS – RESTART 1423

~~ΔH = 1.53~~ @ ΔP = .85, ~~Tm = 115~~] Dn = 0.195 (3-104)

(use average ΔP 0.76)

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 (<60?)
	0	1217	785.903									
W-3	30	1247	807.0	0.71	1.36	1.46	72	130	125	<2	72	✓
	60	1317	828.35			1.46	~~72~~	138	126	2		✓
	90	1347	849.6			1.46		138	126	2		✓
	120	1417 *	870.545			1.46		138	125	2		✓
S-6	150	1453	891.90	0.84 **		1.46	75 **	131	124	<2		✓
	180	1523	913.10			1.46		136	122	2		✓
*	185 [illegible]	1588 [illegible]	916.62			1.46		135	122	2		✓
	210	1625	933.90			1.46		100 [illegible]	111	2		✓
	240	1655	954.838			1.46		122	111	2		

* Stopped Test, ? [illegible]

** From SOC-3

ANDERSEN IMPACTOR RECOVERY AND INTEGRITY SHEET

Plant Steel Kettle

Sample date 6/25/86

Sample location Scrubber Outlet

Recovery date 6/25/86

Run number 50PS-3

Recovered by [illegible]

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 4605-A

Liquid level marked ✓

Acetone blank container number 4674-A

Liquid level marked 4674-A ✓

Filters

Stage	Filter number	Container number	Container sealed	Comments
0	A015	4605-B	✓	No load
1	AN54	↓	✓	" "
2	A011	↓	✓	" "
3	AN58	↓	✓	" "
4	A099	↓	✓	even load
5	AN52	↓	✓	" "
6	AS47	↓	✓	light
7	AN56	↓	✓	"
Backup	A253	↓	✓	

Samples stored and locked

Remarks

LABORATORY CUSTODY

Received by [illegible]

Date 7/3/86

Remarks

APPENDIX C

LABORATORY DATA SHEETS

PEI Associates, Inc. LABORATORY REPORT FORM

Sample type: Stack samples

Client: US EPA EMB

Steel Heddle Company

attn:

Project no: 3615-22
Requisition: 9496
Received: 7/3/86
Sampled by: PEI
Reported: 8/20/86

Lab No.	Run Number	Fraction	Chromium (VI),mg	Total Chromium,mg
FT 338	SIC-1	liquid	13.3	12.6
FT 339	SIC-2	liquid	5.84	5.43
FT 340	SIC-3	liquid	5.48*	5.28
FT 341	SOC-1	liquid	0.265	0.261
FT 342	SOC-2	liquid	0.276	0.263*
FT 343	SOC-3	liquid	0.293	0.299
FT 344	blank SIC-1,SOC-1	liquid	<0.006**	<0.020 **
FT 345	blank SIC-2,3 SOC-2,3	liquid	<0.006**	<0.020 **

*Spike recovery was 100.3% for chromium (VI) and 92,3% 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

T.A.

PEI Associates, Inc. LABORATORY REPORT FORM

Sample type: Particle size samples

Client: US EPA EMB

Steel Heddle Company

Project no: 3615-22
Requisition: 9496
Received: 7/3/86
Sampled by: PEI
Reported: 8/20/86

attn:

Lab Number	Run No.	Stage No.	Chromium (VI),ug	Total Chromium,ug
FT 268,278,288	SIPS 1-3	0	1.1	11.5
FT 269,279,289		1	1.5	13.8
FT 270,280,290		2	4.4	19.2
FT 271,281,291		3	13.7	29.5
FT 272,282,292		4	55.9	84.0
FT 273,283,293		5	32.6	54.1
FT 274,284,294		6	1.2	12.5
FT 275,285,295		7	0.5	11.2
FT 276.286,296		back-up	1.1	18.0*
FT 277,287,297		acetones	840*	1810
FT 298,308,318	SOPS 1-3	0	1.6	13.1
FT 299,309,319		1	1.7	11.7
FT 300,310,320		2	7.0	19.8
FT 301,311,321		3	26.3	44.6
FT 302,312,322		4	86.1	117
FT 303,313,323		5	25.3	51.1
FT 304,314,324		6	1.6	17.0
FT 305,315,325		7	1.0	12.1
FT 306,316,326		back-up	1.7	12.3
FT 307,317,327		acetones	1.4	27.1*
FT 308,318,328	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 105.8% for chromium VI and 85.5% and 89.4% 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

Steel Heddle Company

attn:

Project no: 3615-22
Requisition: 9504
Received: 7/3/86
Sampled by: PEI
Reported: 8/20/86

Lab No.	Run Number	Fraction	Chromium (VI) mg/l	Total Chromium, mg/l
FT 433	SIPS-1 tank 1	liquid	92000*	97200
FT 434	SIC-1 tank 1	liquid	97400	98600
FT 435	SIC-2 tank 1	liquid	88900	96200
FT 436	SIC-3 tank 1	liquid	90300	98600
FT 437	SIPS-1 tank 2	liquid	101900	106800
FT 438	SIC-1 tank 2	liquid	95400	103600
FT 439	SIC-2 tank 2	liquid	97400	103400
FT 440	SIC-3 tank 2	liquid	99100	104400*
FT 441	SIPS-1 tank 4	liquid	83800	92900
FT 442	SIC-1 tank 4	liquid	82700	91100
FT 443	SIC-2 tank 4	liquid	78700	87300
FT 444	SIC-3 tank 4	liquid	81700	90300
FT 445	SIPS-1 scrubber	liquid	16.3, 11.9	11.1, 10.2
FT 446	SIC-1 scrubber	liquid	6.63, 8.48	7.99, 7.80
FT 447	SIC-2 scrubber	liquid	5.33, 6.97	6.74, 6.38
FT 448	SIC-3 scrubber	liquid	7.45	7.53

*Spike recovery was 96.2% for chromium (VI) and 92.8% for total chromium

Submitted by: Ida Bennett

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

T.F.W.

Particle Size Distribution
(Gravimetric)

METHOD 5 BLANK ANALYTICAL DATA

Plant Steel Heddle 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. 4674A Lab No. 77337

Acetone blank volume (Va) 244 ml

Date and time of wt 7/6/86 8:00 A Gross wt 98790 mg

Date and time of wt 7/6/86 4:00 P Gross wt 98795 mg

Average Gross wt 98792 mg

Tare wt 98793 mg

Weight of blank (ma) 7.9 mg

$$Ca = \frac{(ma)}{(Va)\ (\rho a)} \quad \frac{(7.9)}{(244)(0.7899)} = 0.0410 \text{ mg/g}$$

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 A 0.01 (20) maximum allowable amount will be used in all calculations

Signature of analyst Steven Stephens

Signature of reviewer Kirk Mullet

ANDERSEN IMPACTOR ANALYTICAL DATA

Plant Steel Heddle Co. Run No. Blanks

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. 4674A Lab No. 77337

Acetone rinse volume (Vaw) 244 ml

Acetone blank residue concentration (Ca) 0.01 mg/g

Wa = Ca Vaw ρa = (0.01) (244) (0.7899) = 1.93 mg

Date and time of wt 7/16/86 8:00 A Gross wt 98799.0 mg

Date and time of wt 7/16/86 4:05 P Gross wt 98799.5 mg

Average Gross wt 98799.2 mg

Tare wt 98791.3 mg

Less acetone blank wt (Wa) 1.9 mg

Weight of particulate in acetone rinse 6.0 mg

Filters

Stage	Filter No.	Lab No.	Gross, mg	Tare, mg	Net, mg
0	AS-37	77328	159.7	159.6	0.1
1	AP-37	329	164.2	164.1	0.1
2	AS-19	330	162.4	161.9	0.5
3	AS-49	331	163.0	162.6	0.4
4	AM-32	332	144.1	143.7	0.4
5	AP-90	333	142.3	142.5	-0.2
6	AP-85	334	142.5	142.5	0
7	AS-06	335	149.3	149.3	0
Backup	A-294	336	220.2	219.6	0.6

Weight of particulate in acetone rinse 6.0

Total 8.1

Signature of analyst [illegible]

Signature of reviewer [illegible]

ANDERSEN IMPACTOR ANALYTICAL DATA

Plant Steel Heddle Co. Run No. SIPS-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. 4681A Lab No. 77277

Acetone rinse volume (Vaw) 124 ml

Acetone blank residue concentration (Ca) 0.01 mg/g

Wa = Ca Vaw ρa = (0.01) (124) (0.7899) = 0.98 mg

Date and time of wt 7/11/86 3:00 p Gross wt 100632.5 mg

Date and time of wt 7/14/86 10:20 a Gross wt 100632.0 mg

Average Gross wt 100632.2 mg

Tare wt 100616.0 mg

Less acetone blank wt (Wa) 1.0 mg

Weight of particulate in acetone rinse 15.2 mg

Filters

Stage	Filter No.	Lab No.	Gross, mg	Tare, mg	Net, mg
0	A0-19	77268	167.6	167.4	0.2
1	AM-62	269	143.4	143.5	-0.1
2	AC-27	270	168.3	168.6	-0.3
3	AN-96	271	141.3	141.4	-0.1
4	AC-49	272	165.1	164.9	0.2
5	AM-44	273	143.4	143.6	-0.2
6	AD-25	274	165.6	165.5	0.1
7	AN-66	275	144.5	144.6	-0.1
Backup	A-234	276	218.4	218.2	0.2

Weight of particulate in acetone rinse 15.2

Total 15.9

Signature of analyst [signature]

Signature of reviewer [signature] T.G.H.

ANDERSEN IMPACTOR ANALYTICAL DATA

Plant Steel Heddle Co. Run No. SIPS-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. 46 99P Lab No. 75287

Acetone rinse volume (Vaw) 38 ml

Acetone blank residue concentration (Ca) 0.01 mg/g

Wa = Ca Vaw ρa = (0.01) (38) (0.7899) = 0.30 mg

Date and time of wt 7/11/86 3:00 p Gross wt 95850.1 mg

Date and time of wt 7/14/86 10:30 p Gross wt 95849.8 mg

Average Gross wt 95850.0 mg

Tare wt 95841.3 mg

Less acetone blank wt (Wa) 0.3 mg

Weight of particulate in acetone rinse 8.4 mg

Filters

Stage	Filter No.	Lab No.	Gross, mg	Tare, mg	Net, mg
0	AC-97	75278	167.8	167.3	0.5
1	AC-82	279	149.2	149.2	0
2	AC-95	280	165.2	165.2	0
3	AD-04	281	145.9	145.9	0
4	AR-91	282	159.6	159.6	0
5	AD-10	283	149.3	149.2	0.1
6	AS-61	284	159.7	159.6	0.1
7	AC-28	285	149.3	149.3	0
Backup	A-258	286	219.2	219.0	0.2

Weight of particulate in acetone rinse 8.4

Total 9.3

Signature of analyst [illegible]

Signature of reviewer [illegible]

ANDERSEN IMPACTOR ANALYTICAL DATA

Plant Steel Heddle Co. Run No. SIPC-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. 4808A Lab No. FT297

Acetone rinse volume (Vaw) 72 ml

Acetone blank residue concentration (Ca) 0.01 mg/g

Wa = Ca Vaw ρa = (0.01) (72) (0.7899) = 0.57 mg

Date and time of wt 7/11/86 3:20 p Gross wt 102103.5 mg

Date and time of wt 7/14/86 10:20 a Gross wt 102103.4 mg

Average Gross wt 102103.4 mg

Tare wt 102092.4 mg

Less acetone blank wt (Wa) 0.6 mg

Weight of particulate in acetone rinse 10.4 mg

Filters

Stage	Filter No.	Lab No.	Gross, mg	Tare, mg	Net, mg
0	AN-11	FT288	161.8	161.7	0.1
1	AN-41	289	143.4	143.5	-0.1
2	AN-01	290	157.7	157.5	0.2
3	AN-60	291	142.7	142.6	0.1
4	AN-09	292	160.9	160.5	0.4
5	AC-20	293	148.7	148.6	0.1
6	AC-05	294	167.4	167.4	0
7	AC-00	295	145.8	145.0	-0.2
Backup	A-245	296	219.0	218.9	0.1

Weight of particulate in acetone rinse 10.4

Total 11.4

Signature of analyst [illegible]

Signature of reviewer [illegible]

ANDERSEN IMPACTOR ANALYTICAL DATA

Plant Steel Heddle Co. Run No. SUPS-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. 4682A Lab No. 77307

Acetone rinse volume (Vaw) 80 ml

Acetone blank residue concentration (Ca) 0.01 mg/g

Wa = Ca Vaw ρa = (0.01) (80) (0.7899) = 0.62 mg

Date and time of wt 7/11/86 3 pm Gross wt 111260.5 mg

Date and time of wt 7/14/86 10 20 Gross wt 111260.5 mg

Average Gross wt 111260.5 mg

Tare wt 111252.3 mg

Less acetone blank wt (Wa) 0.6 mg

Weight of particulate in acetone rinse 7.9 mg

Filters

Stage	Filter No.	Lab No.	Gross, mg	Tare, mg	Net, mg
0	A0-03	77298	161.4	161.4	0
1	A0-04	299	150.6	150.8	-0.2
2	A11-37	300	161.3	161.2	0.1
3	A11-52	301	143.4	143.4	0
4	A0-23	302	159.2	159.2	0
5	A11-72	303	144.6	144.0	0.1
6	A0-65	304	168.4	168.2	0.2
7	A11-32	305	144.5	144.5	0.1
Backup	A-066	306	214.2	214.2	0

Weight of particulate in acetone rinse 7.9

Total 8.4

Signature of analyst [illegible]

Signature of reviewer [illegible]

ANDERSEN IMPACTOR ANALYTICAL DATA

Plant Steel Heddle Co. Run No. 3[illegible]-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. [illegible] Lab No. 7T317

Acetone rinse volume (Vaw) 6.9 ml

Acetone blank residue concentration (Ca) 0.01 mg/g

Wa = Ca Vaw ρa = (0.01) (6.9) (0.7899) = 0.55 mg

Date and time of wt 7/11/86 3:00 p Gross wt 153622.5 mg

Date and time of wt 7/14/86 10:20 a Gross wt 153622.5 mg

Average Gross wt 153622.5 mg

Tare wt 153613.2 mg

Less acetone blank wt (Wa) 0.6 mg

Weight of particulate in acetone rinse 8.7 mg

Filters

Stage	Filter No.	Lab No.	Gross, mg	Tare, mg	Net, mg
0	A0-25	7T308	166.4	166.4	0
1	AN-26	309	142.0	142.1	-0.1
2	AS-21	310	161.8	161.6	0.2
3	AN-20	311	145.6	145.4	0.2
4	AS-21	312	159.9	159.6	0.3
5	AN-22	313	140.7	140.4	0.3
6	AN-25	314	163.5	162.[illegible]	-0.2
7	AN-22	315	140.4	140.3	0.1
Backup	A-239	316	218.8	218.4	0.4

Weight of particulate in acetone rinse 8.7

Total 10.2

Signature of analyst [illegible]

Signature of reviewer [illegible]

ANDERSEN IMPACTOR ANALYTICAL DATA

Plant Steel Heddle Co. Run No. SOAS-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. 4805A Lab No. 7T327

Acetone rinse volume (Vaw) 62 ml

Acetone blank residue concentration (Ca) 0.01 mg/g

Wa = Ca Vaw ρa = (0.01) (62) (0.7899) = 0.49 mg

Date and time of wt 7/11/84 3:45 Gross wt 1012970 mg

Date and time of wt 7/12/84 10:30 Gross wt 1012969 mg

Average Gross wt 1012970 mg

Tare wt 1012919 mg

Less acetone blank wt (Wa) 0.5 mg

Weight of particulate in acetone rinse 46 mg

Filters

Stage	Filter No.	Lab No.	Gross, mg	Tare, mg	Net, mg
0	A0-15	7T318	168.3	168.4	-0.1
1	AN-54	319	141.7	141.8	-0.1
2	A0-11	320	167.1	167.4	-0.3
3	AN-58	321	141.6	141.7	-0.1
4	A0-99	322	167.8	168.0	-0.2
5	AN-52	323	140.8	140.4	0.4
6	AS-47	324	159.6	159.4	0.2
7	AN-56	325	141.4	141.2	0.2
Backup	A-253	326	218.8	218.4	0.4

Weight of particulate in acetone rinse 46

Total 57.8

Signature of analyst [illegible]

Signature of reviewer [illegible]

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 scrubber 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).

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

Sampling Procedures

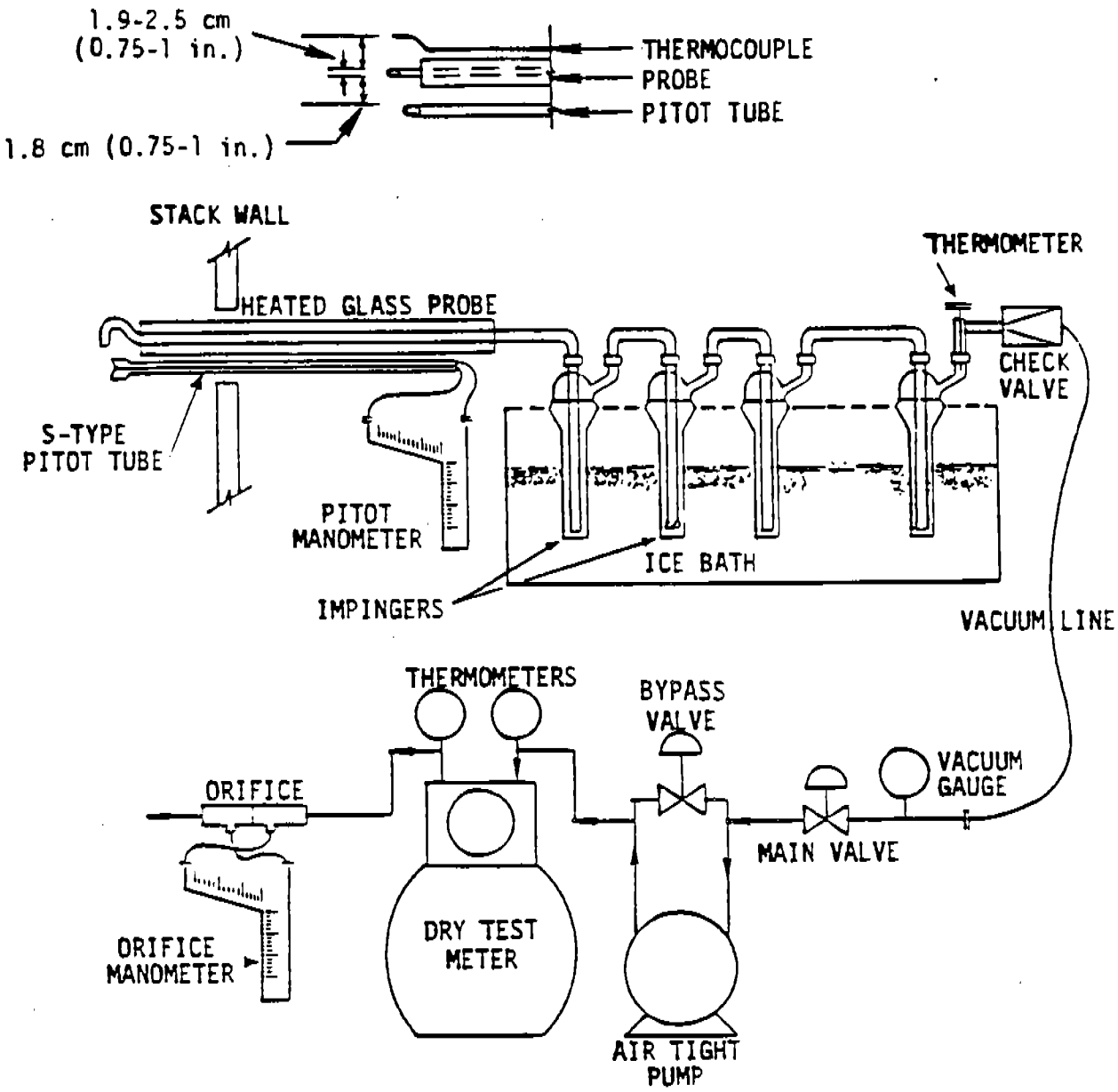
Prior to departure, all glassware used in this study was washed with acid to minimize the potential for contamination. One hundred ml of 0.1 N NaOH was placed in each of the first three impingers; 300 g of silica gel was added to the fourth impinger. The train was set up with the probe as shown in Figure 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 wastewater treatment 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

The filtrates from the impinger contents (Container No. 1) were 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 75 and 90 minutes at the inlet location and 240 minutes at the outlet. A post-test leak check was 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.

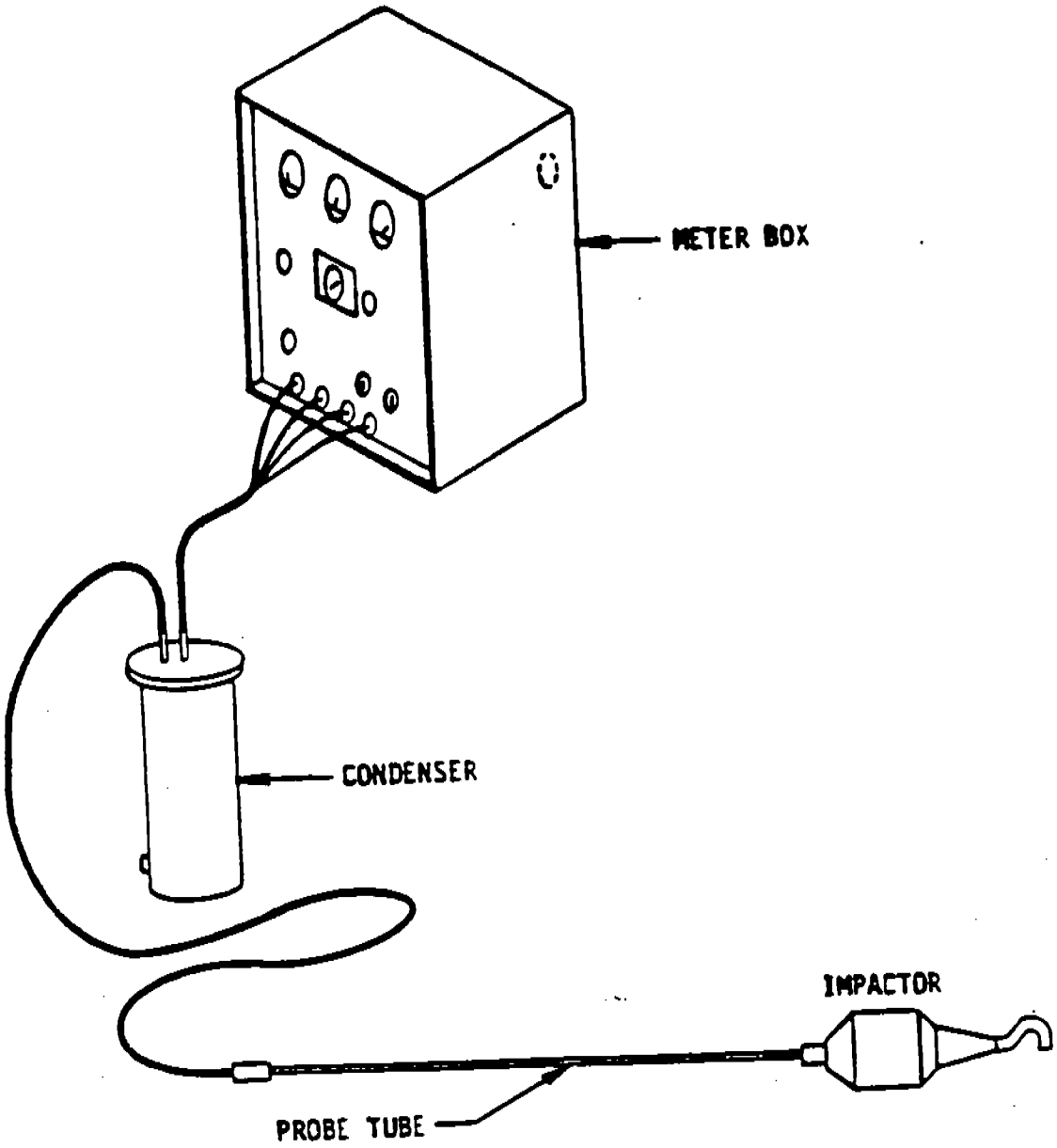


Figure D-2. Andersen Mark III impactor sampling train.

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 filer 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 (scrubber water and plating tank solution) were collected approximately 4 times during each Cr^{+6}/total Cr test. Scrubber water was collected from the holding tank located in the plating operations building. Plating tank solutions were collected individually from each operational tank using a ladle. All samples were placed in polyethylene containers. Analytical procedures for Cr^{+} and total Cr followed those procedures previously described for the actual 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-4c 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.

Date 6/23/86 Calibrated by CB

Nozzle identification number	D_1, in.	D_2, in.	D_3, in.	ΔD, in.	D_{avg}
Inlet #4-112	.252	.250	.251	.002	.251
Outlet #4-119	.255	.254	.251	.004	.253
Part. Size					
Inlet #3-118	0.197	0.197	0.197	0.0	0.197
Outlet #3-104	0.195	0.196	0.195	0.001	0.195

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.

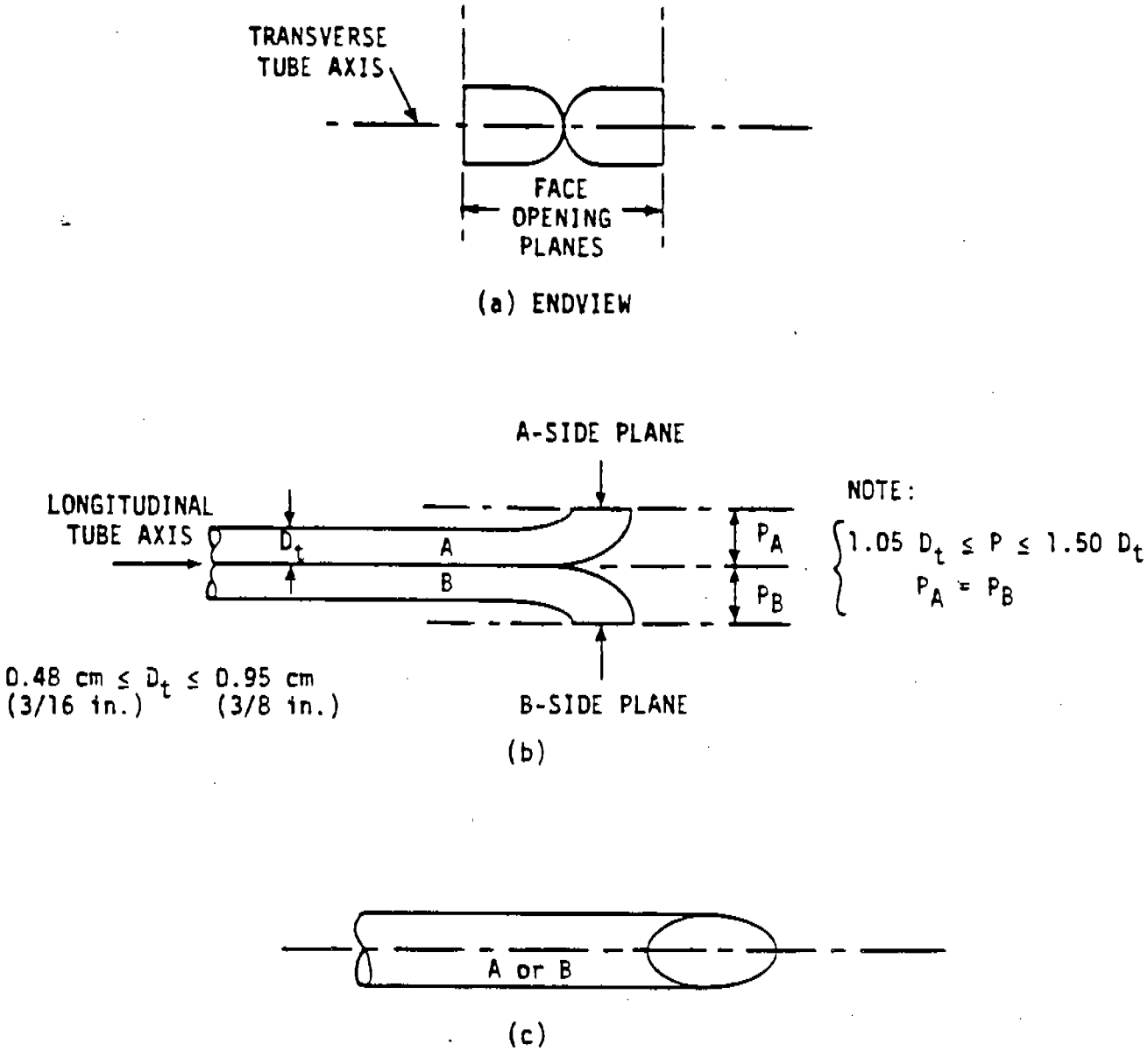

Figure E-2. Properly constructed Type S pitot tube, shown in: (a) end view; face opening planes perpendicular to transverse axis; (b) top view; face opening planes parallel to longitudinal axis; (c) side view; both legs of equal length and centerlines coincident, when viewed from both sides. Baseline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

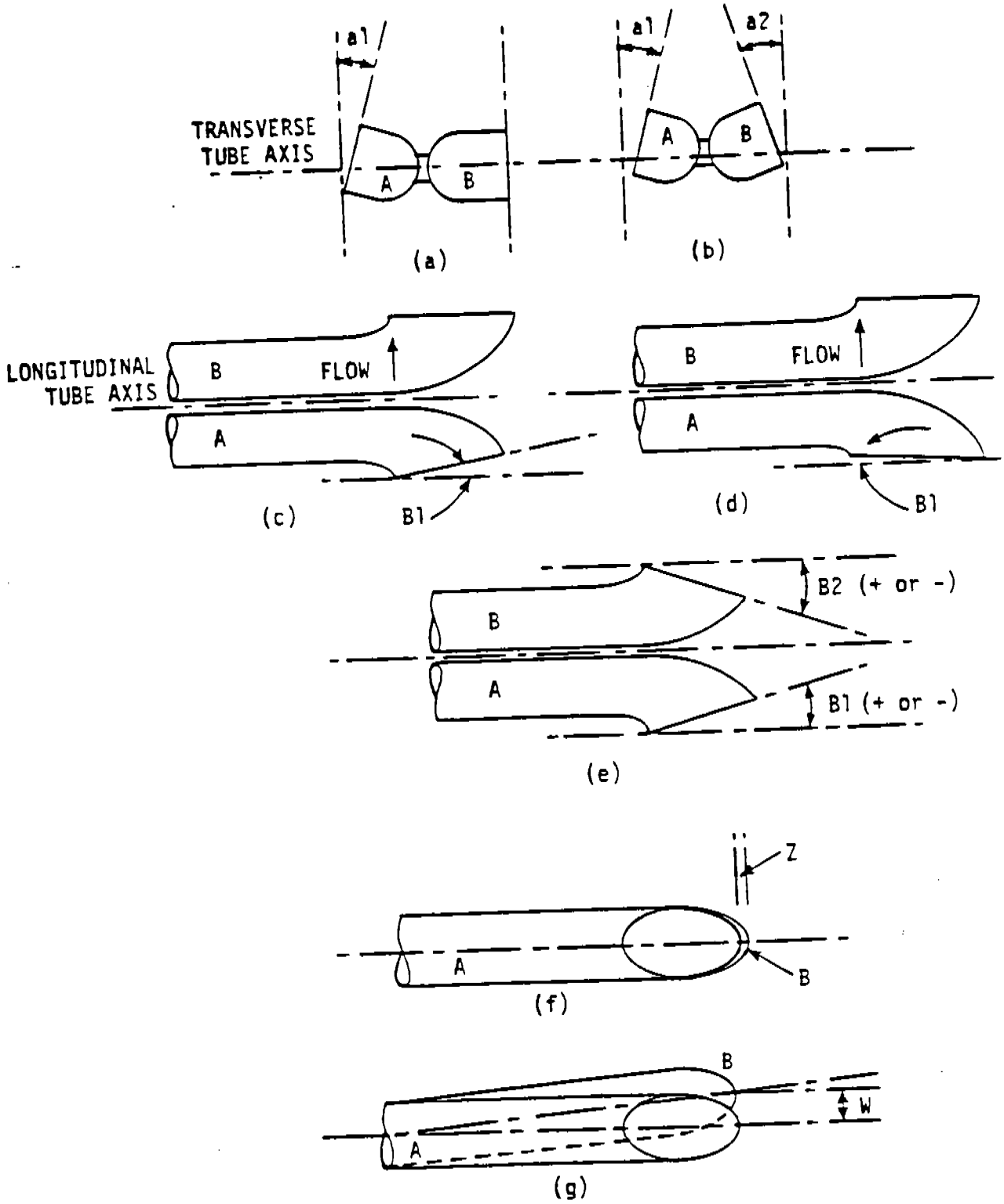

Figure E-3. Types of face-opening misalignment that can result from field use or improper construction of Type S pitot tubes. These will not affect Cp so long as a_1 and a_2 <10°, B_1 and B_2 <5°, z <0.32 (1/8 in.) and w <0.08 cm (1/32 in.).

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
$0.185 \leq P_t < 0.380$	-	-	-

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 3' Date 12-30-85 Inspector G Howard

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	✓
$1.05\ D_t < P_1 < 1.50\ D_t$	$1.05\ D_t < P_2 < 1.50\ D_t$	≤ 0.010	

Lower line in each table is limits for meeting specifications.

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

Pitot Tube No. C15 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	0.000
-	-	<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.

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.

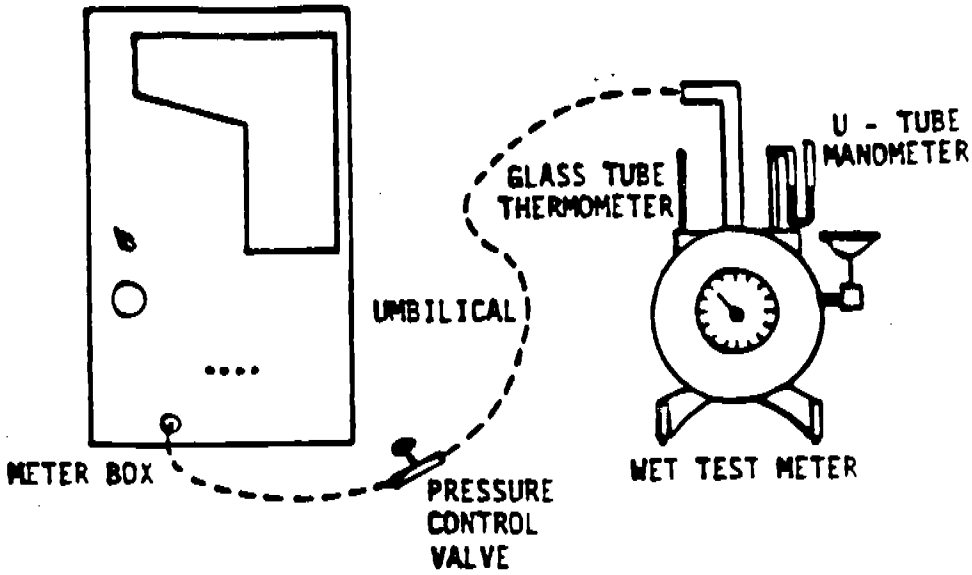

Figure E-5. Calibration setup.

DATE _____ METER BOX NO. _____

BAROMETRIC PRESSURE, P_b = _____ in. Hg. DRY GAS METER NO. _____

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	γ	$\Delta H@$
0.5	5								
1.0	5								
1.5	10								
2.0	10								
3.0	10								
4.0	10								

Average _____

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

γ = 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_2). Tolerance = ±0.15.

Figure E-6. Calibration data sheet.

DATE: 2-26-86 METER BOX NO. FT-1

CALIBRATOR: G Hewitt 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	Dry gas meter Inlet T_i °F	Dry gas meter Outlet T_o °F	Dry gas meter Average T_d °F	Duration of test θ min	Vacuum setting in Hg	γ	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
		943.434	70.0	93	83					
								Average	.981	1.83

γ must not deviate by more than ±0.02 γ.
ΔHθ must not deviate by more than 0.15 in H_2O.

ΔH	γ	ΔHθ
	$\frac{(V_w)(P_b)(T_d + 460)}{(V_d)(P_b + \Delta H/13.6)(T_w + 460)}$	$\frac{(0.0317)(\Delta H)}{(P_b)(T_d + 460)}\left[\frac{(T_w + 460)(\theta)}{(V_w)}\right]^2$
0.5	$\frac{(5.0)(28.96)(541.5)}{(5.199)(28.997)(530.5)}$	$\frac{(0.0317)(0.5)}{(28.96)(541.5)}\left[\frac{(530.5)(12.55)}{(5.0)}\right]^2$
1.0	$\frac{(12.0)(28.96)(541.5)}{(12.467)(29.034)(530.5)}$	$\frac{(0.0317)(1.0)}{(28.96)(541.5)}\left[\frac{(530.5)(21.42)}{(12.0)}\right]^2$
1.5	$\frac{(12.0)(28.96)(541.5)}{(12.467)(29.072)(530.5)}$	$\frac{(0.0317)(1.5)}{(28.96)(541.5)}\left[\frac{(530.5)(17.48)}{(12.0)}\right]^2$
2.0	$\frac{(14.01)(28.96)(543.75)}{(14.548)(29.107)(530.5)}$	$\frac{(0.0317)(2.0)}{(28.96)(543.75)}\left[\frac{(530.5)(17.78)}{(14.01)}\right]^2$
3.0	$\frac{(10.0)(28.96)(544.75)}{(10.369)(29.180)(530.5)}$	$\frac{(0.0317)(3.0)}{(28.96)(544.75)}\left[\frac{(530.5)(16.42)}{(10.0)}\right]^2$
4.0	$\frac{(10.0)(28.96)(547.75)}{(10.424)(29.25)(530.5)}$	$\frac{(0.0317)(4.0)}{(28.96)(547.75)}\left[\frac{(530.5)(19.12)}{(10.0)}\right]^2$

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

DATE: 7-8-86

BAROMETRIC PRESSURE (P_{bar}): 29.62 in. Hg

PLANT: Able Mach. Co / Steel Heddle

PROJECT MANAGER: C. Bruffou

METER BOX NO. FT-1

PRETEST Y: .981 ΔH@: 1.83

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	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	γ	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	80					
								Post-test average***	.993	1.78

γ	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 γ must be within the range, pre-test γ ±0.05γ
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. FB-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 0.005 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_D °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: 7-8-86

BAROMETRIC PRESSURE (P_{bar}): 29.62 in. Hg

PLANT: Steel Heddle / Able Mach. Co.

PROJECT MANAGER: C. Bruffen

METER BOX NO. FB-11

PRETEST Y: .978 ΔH@: 1.16

PROJECT NO. 3615.22

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	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 Ø min	γ	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

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

*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 ΔH@ ±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_i °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	76.328	73	95	86	90.5	13:34/60		.984	2.03
		81.571	73	95	86					
1.0	11	81.854	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	11:08/60		.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	$\frac{(5)(29.41)(550.5)}{(5.243)(29.45)(533)}$	$\frac{(.0317)(0.5)}{(29.41)(550.5)}\left[\frac{(533)(13.48)}{(5)}\right]^2$
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	$\frac{(10)(29.41)(554)}{(10.408)(29.70)(533)}$	$\frac{(.0317)(4.0)}{(29.41)(554)}\left[\frac{(533)(9.7)}{(10)}\right]^2$

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

DATE: 7-9-86 METER BOX NO. FR-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	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 Ø min	γ	ΔH@
1.3	10.0	218.338	71	99	86	92.5	4	16.24/60	.977	1.92
		228.954	71	99	86					
1.3	11.0	228.954	71	99	86	92.5	4	18.05/60	.977	1.93
		240.633	71	99	86					
1.3	10.0	240.633	71	99	86	92.5	4	16.29/60	.977	1.94
		251.244	71	99	86					
							Post-test average***		.977	1.93

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

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

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	$\frac{(5)(29.30)(537.25)}{(5.186)(29.34)(530.5)}$	$\frac{(.0317)(0.5)}{(29.30)(537.25)}\left[\frac{(530.5)(12.55)}{(5)}\right]^2$
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	$\frac{(10)(29.30)(543.5)}{(10.407)(29.45)(530.5)}$	$\frac{(.0317)(2.0)}{(29.30)(543.5)}\left[\frac{(530.5)(12.85)}{(10)}\right]^2$
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

METER BOX NO. FB-3

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

PRETEST Y: .977 ΔH@: 1.86

PLANT: Steel Heddle / Able Mach. Co.

PROJECT NO. 3615-22

PROJECT MANAGER: C. Beuffey

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	γ	ΔH@
1.5	10.0	509.813	71	86	74	81	3	14:39/60	.955	1.80
		520.438	71	88	76					
1.5	10.0	520.438	71	88	76	82.5	3	14:44/60	.955	1.82
		531.100	71	89	77					
1.5	12.0	531.100	71	89	77	83.5	3	17:40/60	.956	1.82
		543.899	71	89	79					
								Post-test average***	.955	1.81

γ	ΔH@
$\frac{(V_w)(P_{bar})(T_d + 460)}{(V_d)(P_{bar} + \Delta H/13.6)(T_w + 460)}$	$\frac{(0.0317)(\Delta H)}{(P_{bar})(T_d + 460)}\left[\frac{(T_w + 460)(\theta)}{(V_w)}\right]^2$
$\frac{(10)(29.39)(541)}{(10.625)(29.50)(531)}$	$\frac{(.0317)(1.5)}{(29.39)(541)}\left[\frac{(531)(14.63)}{(10)}\right]^2$
$\frac{(10)(29.39)(542.5)}{(10.662)(29.50)(531)}$	$\frac{(.0317)(1.5)}{(29.39)(542.5)}\left[\frac{(531)(14.73)}{(10)}\right]^2$
$\frac{(12)(29.39)(543.5)}{(12.799)(29.50)(531)}$	$\frac{(.0317)(1.5)}{(29.39)(543.5)}\left[\frac{(531)(17.67)}{(12)}\right]^2$

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

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

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-8c.

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: 12/31/85 Thermocouple No.: 101

Calibrator: G Thoess Reference: ASTM-3E

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

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

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 Turess 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: GThress 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

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

where °R = °F + 460

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

Figure E-8c. Thermocouple calibration data sheet.

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

OPERATOR: G. Fitzgerald SERIAL NO: ST03

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:

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

Where, deg. R = deg. F + 460

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

DATE: 9-14-85 INDICATOR NO: 219

OPERATOR: G Tuness 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

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

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	99.9	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
HL 32 # 758669	PE AD-2 # 65920
H31 # 614363	
H35AR # 668020	
PC 4400 # C26340	

Terry Hurst
Mettler Service Representative

10-17-85
Date of Issue

METTLER
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			
PRETEST	GTE 5463	P&G 5456		EMB 3615-22			
BAROMETER READING	29.53	29.88	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	[illegible]	[illegible]	[illegible]	J. Neese.			
POST-TEST				406			
BAROMETER READING	29.97	50.05		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	[illegible]		(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

1.5 2.0 2.5

Calibrator	Date	PN	Value determined
[illegible]	4/11/86	5445	1.8
[illegible]	4/17/86	5443-1	1.9
[illegible]	6/30/86	3615-22	1.8

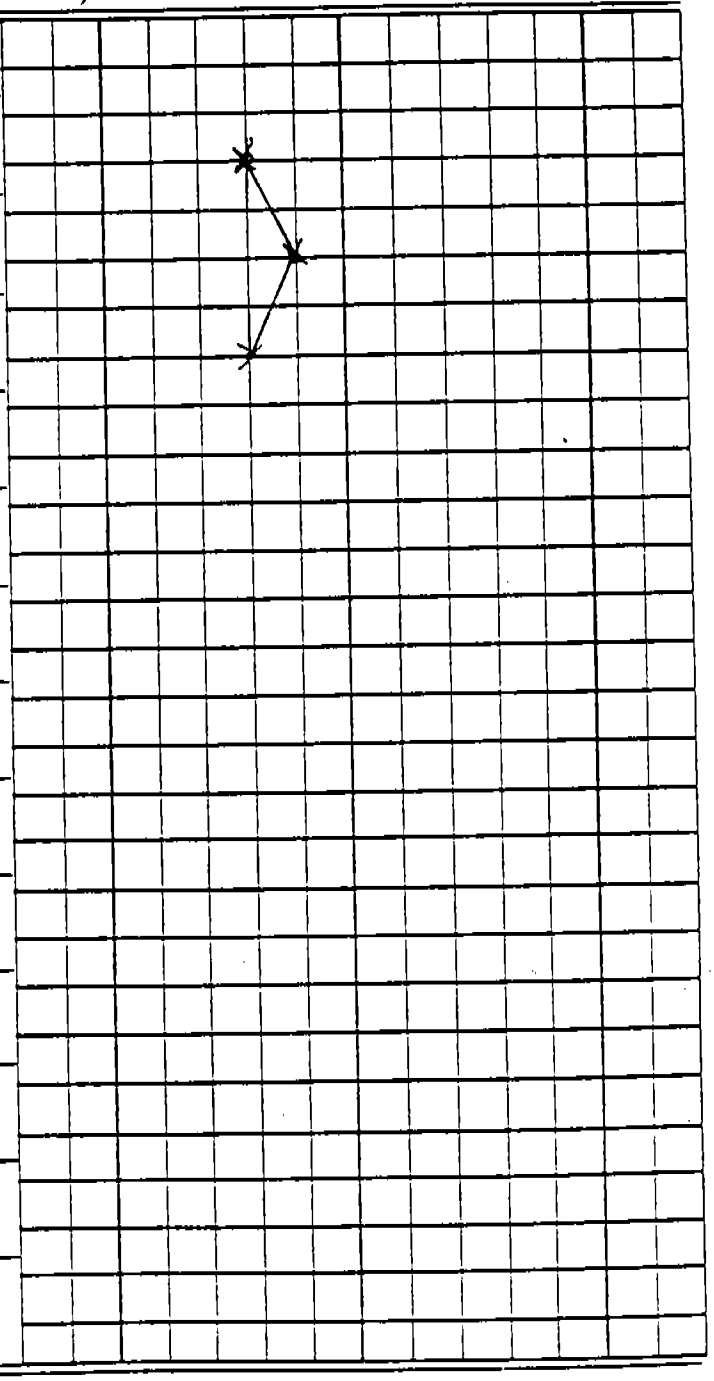

Figure E-15a. Orsat calibration data sheet.

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
[illegible]	4/17/86	5443-1	10.0
G.L. Howard	6/20/86		9.8

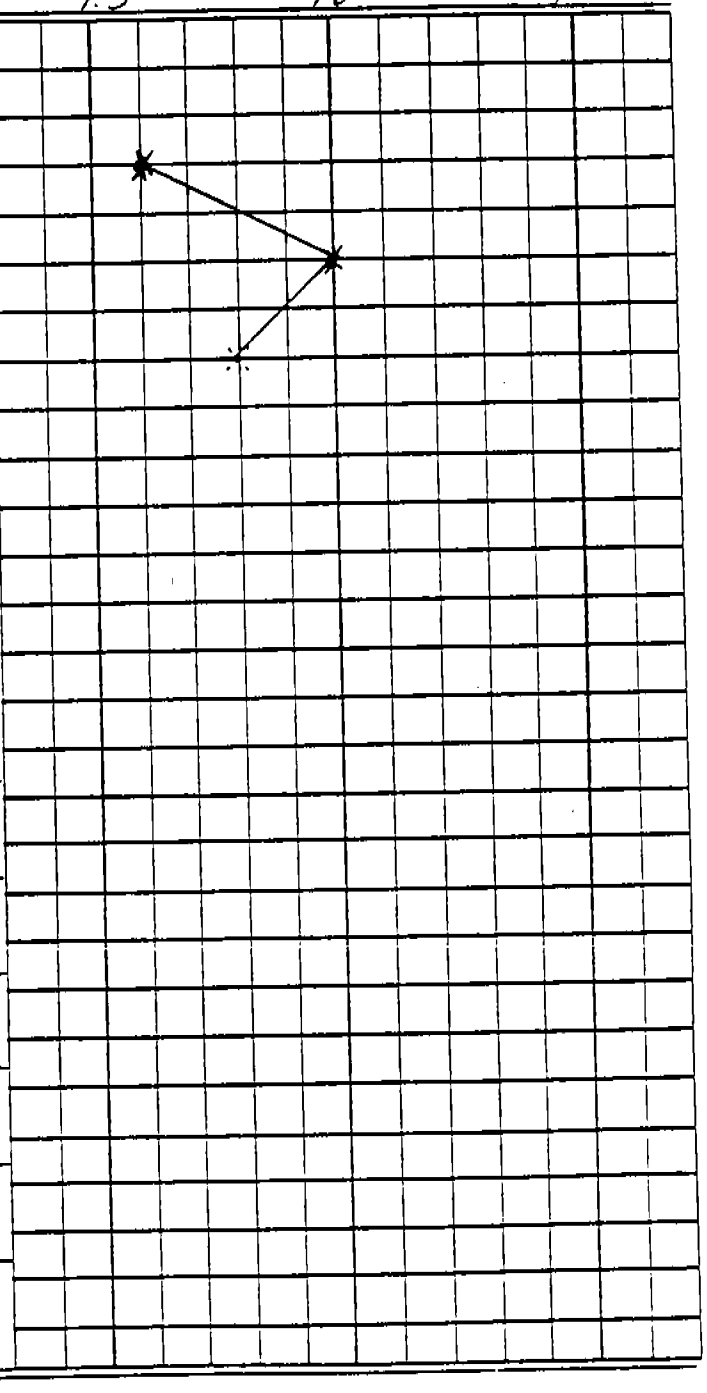

Figure E-15b. Orsat calibration data sheet.

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

Calibrator	Date	PN	Value determined
[illegible]	4/11/86	5448	9.5
[illegible]	4/17/86	5443-1	9.6
GK Howard	6/20/86	3445-22	9.8

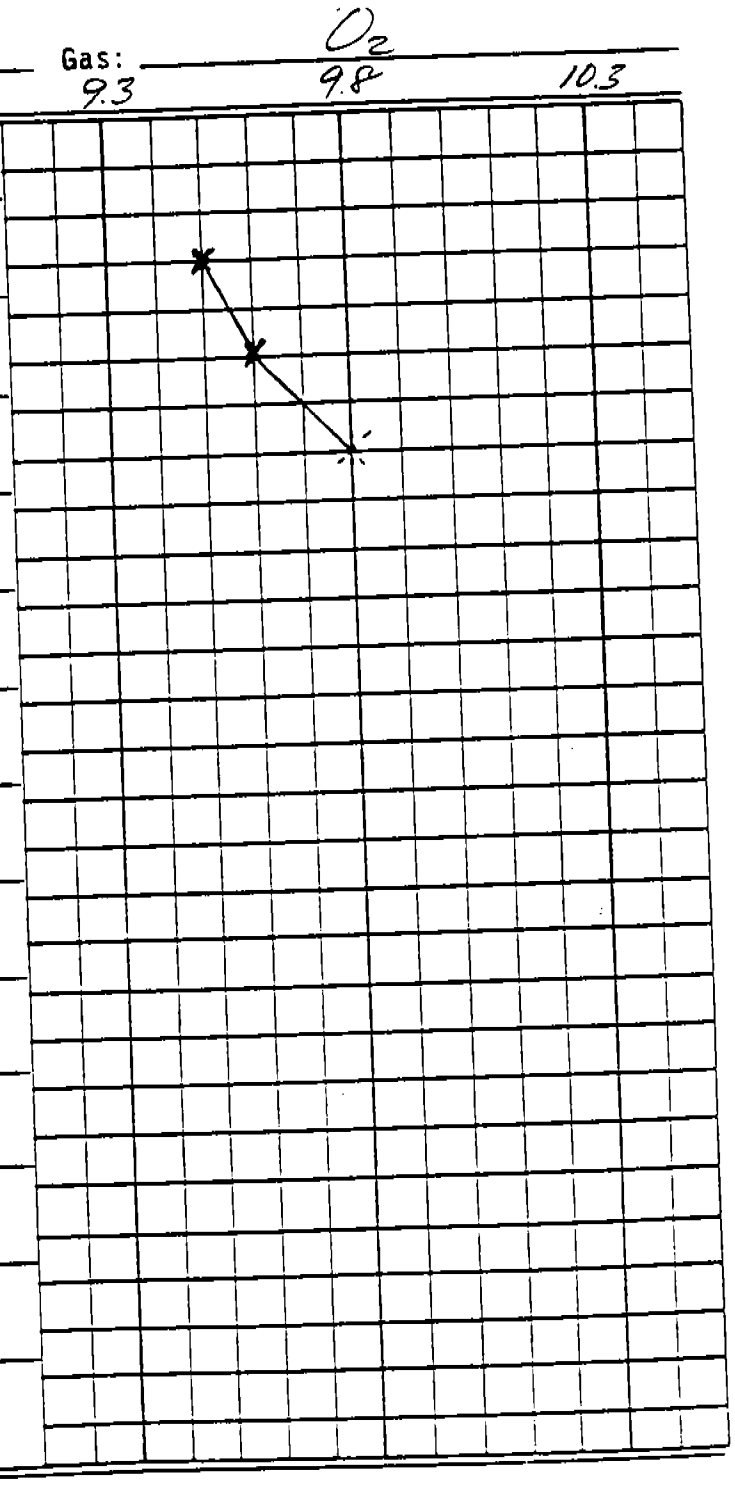

Figure E-15c. Orsat calibration data sheet.

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.
J. Prohaska	PEI Test Engineer	Site leader for scrubber inlet and outlet tests; assisted with cleanup/recovery of samples.
D. Scheffel	Environmental Scientist	Assisted with all tests at scrubber inlet and outlet.
F. Clay	Task Manager U.S. EPA-EMB	Coordinated test activity. Onsite data reduction and calculations.
R. Strait	MRI-NSPS Contractor	Monitored process operation and coordinated test activity.
R. Banker	MRI-NSPS Contractor	Monitored process operation and coordinated test activity.

TABLE F-2. SAMPLE LOG

Date (1986)	Activity
Sunday 6/22	Test crew and equipment travel to Greenville, SC
Monday 6/23	Equipment and site setup; conducted all preliminary measurements and equipment audits. Sample trains and impactors setup.
Tuesday 6/24	Conducted one Method 13B test at each location. Conducted one particle size run at outlet and three at inlet. Collected process samples.
Wednesday 6/25	Conducted two Method 13B tests at each location. Conducted two particle size tests at outlet location. Collected process samples. All samples were recovered, equipment packed, and test crew departs 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:

$$C_s = C_a \frac{A_s}{A_t - A_s} \qquad \text{Eq. G-1}$$

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:

$$K_c = 100 \frac{A_1 + 2A_2 + 3A_3 + 4A_4}{A_1^2 + A_2^2 + A_3^2 + A_4^2} \qquad \text{Eq. G-2}$$

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:

$$m = K_c \, 2AF \qquad \text{Eq. G -3}$$

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:

$$c_s = (0.001\ g/mg)(m/V_{m(std)}) \qquad \text{Eq. G-4}$$

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	Thallium
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.

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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: SIC-1; OUTLET: SOC-1
TANK 1

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Time interval, min Inlet	Time interval, min Outlet	Current, amperes	Ampere-hours Inlet	Ampere-hours Outlet
08:27	08:33					
08:35	08:35	8	2	1,000	133	33
08:40	08:40	5	5	1,000	83	83
Subtotal		13	7		216	116
08:54	08:54					
09:05	09:05	11	11	1,500	275	275
09:15	09:15	10	10	1,500	250	250
09:25	09:25	10	10	1,500	250	250
09:35	09:35	10	10	1,400	233	233
09:45	09:45	10	10	1,500	250	250
09:54	09:54	9	9	1,500	225	225
Subtotal		60	60		1,483	1,483
10:17	10:18					
10:25	10:25	8	7	3,000	400	350
10:35	10:35	10	10	2,750	458	458
10:45	10:45	10	10	3,000	500	500
10:55	10:55	10	10	2,900	483	483
11:05	11:05	10	10	2,900	483	483
11:14	11:14	9	9	2,900	435	435
Subtotal		57	56		2,759	2,709
11:25	11:25					
11:35	11:35	10	10	2,900	483	483
11:45	11:45	10	10	2,800	467	467
	11:48	0	3	2,800	0	140
Subtotal		20	23		950	1,090
TOTAL		150	146		5,408	5,398

AMPERE-HOUR CALCULATIONS
TEST RUN NO.:
INLET: SIC-1; OUTLET: SOC-1
TANK NO. 2

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Time interval, min Inlet	Time interval, min Outlet	Current, amperes	Ampere-hours Inlet	Ampere-hours Outlet
08:27						
08:30		3	0	1,300	65	0
Subtotal		3	0		65	0
08:35	08:33					
08:45	08:45	10	12	1,400	233	280
08:55	08:55	10	10	1,400	233	233
09:05	09:05	10	10	1,400	233	233
09:15	09:15	10	10	1,400	233	233
09:25	09:25	10	10	1,400	233	233
09:35	09:35	10	10	1,300	217	217
09:40	09:40	5	5	1,300	108	108
Subtotal		65	67		1,490	1,537
10:15	10:18					
10:25	10:25	10	7	1,250	208	146
10:35	10:35	10	10	1,200	200	200
10:41	10:41	6	6	1,200	120	120
Subtotal		26	23		528	466
10:45	10:45					
10:55	10:55	10	10	1,400	233	233
11:05	11:05	10	10	1,350	225	225
11:15	11:15	10	10	1,300	217	217
11:25	11:25	10	10	1,300	217	217
11:35	11:35	10	10	1,300	217	217
11:45	11:45	10	10	1,300	217	217
	11:48	0	3	1,300	0	65
Subtotal		60	63		1,326	1,391
TOTAL		154	153		3,409	3,394

AMPERE-HOUR CALCULATIONS
TEST RUN NO.:
INLET: SIC-1; OUTLET: SOC-1
TANK NO. 4

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
08:27	08:33			900	120	30
08:35	08:35	8	2	900	150	150
08:45	08:45	10	10	850	142	142
08:55	08:55	10	10	900	150	150
09:05	09:05	10	10	900	150	150
09:15	09:15	10	10	900	150	150
09:25	09:25	10	10	900	150	150
09:35	09:35	10	10	900	150	150
09:45	09:45	10	10	900	150	150
09:55	09:55	10	10	900	150	150
09:57	10:03	2	8	900	30	120
Subtotal		90	90		1,342	1,342
10:15	10:18			900	150	105
10:25	10:25	10	7	900	150	150
10:35	10:35	10	10	900	150	150
10:45	10:45	10	10	900	150	150
10:55	10:55	10	10	900	150	150
11:05	11:05	10	10	200	33	33
11:15	11:15	10	10	900	150	150
11:25	11:25	10	10	900	150	150
11:35	11:35	10	10	900	150	150
11:45	11:45	10	10	900	0	45
	11:48	0	3			
Subtotal		90	90		1,233	1,233
TOTAL		180	180		2,575	2,575

AMPERE-HOUR CALCULATIONS
TEST RUN NO.:
INLET: SIC-2; OUTLET: SOC-2
TANK NO. 1

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Time interval, min Inlet	Time interval, min Outlet	Current, amperes	Ampere-hours Inlet	Ampere-hours Outlet
08:08	08:11					
08:18	08:18	10	7	500	83	58
08:28	08:28	10	10	500	83	83
08:33	08:33	5	5	500	42	42
Subtotal		25	22		208	183
08:40	08:40					
08:48	08:48	8	8	400	53	53
08:58	08:58	10	10	400	67	67
09:08	09:08	10	10	400	67	67
09:18	09:18	10	10	400	67	67
09:28	09:28	10	10	300	50	50
09:34	09:34	6	6	300	30	30
Subtotal		54	54		334	334
10:02	10:04					
10:08	10:08	6	4	500	50	33
10:18	10:18	10	10	500	83	83
10:28	10:28	10	10	400	67	67
10:38	10:38	10	10	500	83	83
10:40	10:40	2	2	500	17	17
Subtotal		38	36		300	283
10:48	10:48					
10:58	10:58	10	10	250	42	42
11:08	11:08	10	10	250	42	42
11:18	11:18	10	10	250	42	42
11:28	11:28	10	10	200	33	33
11:32	11:34	4	6	200	13	20
Subtotal		44	46		172	179
TOTAL		161	158		1,014	979

AMPERE-HOUR CALCULATIONS
TEST RUN NO.:
INLET: SIC-2; OUTLET: SOC-2
TANK NO. 2

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
08:08	08:11					
08:18	08:18	10	7	1,100	183	128
08:28	08:28	10	10	1,100	183	183
08:38	08:38	10	10	1,100	183	183
08:45	08:45	7	7	1,100	128	128
Subtotal		37	34		677	622
08:50	08:50					
08:58	08:58	8	8	1,400	187	187
09:08	09:08	10	10	1,400	233	233
09:18	09:18	10	10	1,400	233	233
09:28	09:28	10	10	1,400	233	233
09:38	09:40	10	12	1,400	233	280
Subtotal		48	50		1,119	1,166
10:02	10:04					
10:08	10:08	6	4	1,100	110	73
10:18	10:18	10	10	1,200	200	200
10:28	10:28	10	10	1,200	200	200
10:38	10:38	10	10	1,200	200	200
10:46	10:46	8	8	1,200	160	160
Subtotal		44	42		870	833
10:50	10:50					
10:58	10:58	8	8	1,100	147	147
11:08	11;08	10	10	1,100	183	183
11:18	11:18	10	10	1,100	183	183
11:28	11:28	10	10	1,100	183	183
11:32	11:34	4	6	1,100	73	110
Subtotal		42	44		769	806
TOTAL		171	170		3,435	3,427

AMPERE-HOUR CALCULATIONS
TEST RUN NO.:
INLET: SIC-2; OUTLET: SOC-2
TANK NO. 4

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
08:08	08:11					
08:18	08:18	10	7	675	112	79
08:28	08:28	10	10	600	100	100
08:38	08:38	10	10	600	100	100
08:48	08:48	10	10	600	100	100
08:58	08:58	10	10	600	100	100
09:08	09:08	10	10	625	104	104
09:18	09:18	10	10	600	100	100
09:28	09:28	10	10	625	104	104
09:38	09:41	10	13	600	100	130
Subtotal		90	90		920	917
10:02	10:04					
10:08	10:08	6	4	600	60	40
10:18	10:18	10	10	600	100	100
10:28	10:28	10	10	625	104	104
10:38	10:38	10	10	600	100	100
10:48	10:48	10	10	600	100	100
10:58	10:58	10	10	600	100	100
11:08	11:08	10	10	600	100	100
11:18	11:18	10	10	600	100	100
11:28	11:28	10	10	600	100	100
11:32	11:34	4	6	600	40	60
Subtotal		90	90		904	904
TOTAL		180	180		1,824	1,821

AMPERE-HOUR CALCULATIONS
TEST RUN NO.:
INLET: SIC-3; OUTLET: SOC-3
TANK NO. 1

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
12:45	12:47					
12:50	12:50	5	3	200	17	10
13:00	13:00	10	10	200	33	33
Subtotal		15	13		50	43
13:05	13:05					
13:10	13:10	5	5	1,000	83	83
13:20	13:20	10	10	1,000	167	167
13:30	13:30	10	10	1,000	167	167
13:40	13:40	10	10	1,000	167	167
13:50	13:50	10	10	1,000	167	167
14;00	14:00	10	10	1,000	167	167
14:10	14:10	10	10	1,000	167	167
14:14	14:14	4	4	1,000	67	67
Subtotal		69	69		1,152	1,152
14:29	14:31					
14:40	14:40	11	9	1,000	183	150
14:50	14:50	10	10	1,000	167	167
15:00	15:00	10	10	1,000	167	167
15:10	15:10	10	10	1,000	167	167
15:20	15:20	10	10	1,000	167	167
15:27	15:27	7	7	1,000	117	117
Subtotal		58	56		968	935
16:02	16:02					
16:10	16:10	8	8	2,000	267	267
16:20	16:20	10	10	2,000	333	333
16:30	16:30	10	10	2,000	333	333
16:33	16:33	3	3	2,000	100	100
Subtotal		31	31		1,033	1,033
TOTAL		173	169		3,203	3,163

AMPERE-HOUR CALCULATIONS
TEST RUN NO:
INLET: SIC-3; OUTLET: SOC-3
TANK NO. 2

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
12:45	12.47					
12:50	12:50	5	3	1,000	83	50
12:55	12:55	5	5	1,000	83	83
Subtotal		10	8		166	133
12:58	12:58					
13:10	13:10	12	12	1,200	240	240
13:20	13:20	10	10	1,200	200	200
13:30	13:30	10	10	1,200	200	200
13:40	13:40	10	10	1,200	200	200
13:50	13:50	10	10	1,200	200	200
14:00	14:00	10	10	1,200	200	200
14:10	14:10	10	10	1,200	200	200
14:15	14:17	5	7	1,200	100	140
Subtotal		77	79		1,540	1,580
14:29	14:31					
14:40	14:40	11	9	2,000	367	300
14:50	14:50	10	10	2,000	333	333
15:00	15:00	10	10	1,800	300	300
15:10	15:10	10	10	1,800	300	300
15:20	15:20	10	10	1,800	300	300
15:28	15:28	8	8	1,800	240	240
Subtotal		59	57		1,840	1,773
TOTAL		146	144		3,546	3,486

AMPERE-HOUR CALCULATIONS
TEST RUN NO:
INLET: SIC-3; OUTLET: SOC-3
TANK NO: 4

Time (24-h clock)		Time interval, min		Current, amperes	Ampere-hours	
Inlet	Outlet	Inlet	Outlet		Inlet	Outlet
12:45	12:47					
12:50	12:50	5	3	600	50	30
13:00	13:00	10	10	650	108	108
13:10	13:10	10	10	650	108	108
13:20	13:20	10	10	650	108	108
13:30	13:30	10	10	650	108	108
13:40	13:40	10	10	650	108	108
13:50	13:50	10	10	650	108	108
14:00	14:00	10	10	650	108	108
14:10	14:10	10	10	650	108	108
14:15	14:17	5	7	650	54	76
Subtotal		90	90		968	970
14:29	14:31					
14:40	14:40	11	9	650	119	98
14:50	14:50	10	10	650	108	108
15:00	15:00	10	10	650	108	108
15:10	15:10	10	10	650	108	108
15:20	15:20	10	10	650	108	108
15:28	15:28	8	8	650	87	87
Subtotal		59	57		638	617
16:02	16:02					
16:10	16:10	8	8	675	90	90
16:20	16:20	10	10	675	112	112
16:30	16:30	10	10	675	112	112
16:33	16:35	3	5	700	35	58
Subtotal		31	33		349	372
TOTAL		180	180		1,955	1,959

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Steel Heddle
Date: June 24, 1986
Tank No.: 1
Sample type: Total and hexavalent chromium

Test Run No.		Test start time		Test stop time	
Inlet:	SIC-1	Inlet:	08:27	Inlet:	11:45
Outlet:	SOC-1	Outlet:	08:33	Outlet:	11:48

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
08:27	08:33	125	6.0	1,200	Started inlet testing: 08:27
08:35	08:35	125	6.0	1,000	Started outlet testing: 08:33
08:40	08:40	125	6.0	1,000	Work plated: textile comb for looms
					Surface area: 3.44 ft^2
					Stopped plating: 08:40
08:54	08:54	125	9.5	3,000	Started plating: 08:54
09:05	09:05	125	5.5	1,500	Work plated: textile comb for looms
09:15	09:15	125	5.5	1,500	Surface area: 4.54 ft^2
09:25	09:25	125	5.5	1,500	
09:35	09:35	125	5.5	1,400	Grab samples taken: 08:40 and 09:50
09:45	09:45	125	5.5	1,500	Stopped inlet testing: 09:57
09:54	09:54	125	5.5	1,500	Stopped plating: 09:54
					Stopped outlet testing: 10:03
10:17	10:18	125	5.5	3,000	Started plating: 10:17
10:25	10:25	125	5.5	3,000	Started inlet testing: 10:15
10:35	10:35	125	5.2	2,750	Started outlet testing: 10:18
10:45	10:45	125	5.2	3,000	Work plated: 10 lease bars for looms
10:55	10:55	125	5.3	2,900	Surface area: 15.38 ft^2
11:05	11:05	125	5.3	2,900	
11:14	11:14	125	5.3	2,900	Stopped plating: 11:14

(continued)

SOURCE SAMPLING PROGRAM PROCESS DATA SHEETS (continued)

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
11:25	11:25	125	5.5	2,900	Started plating: 11:25
11:35	11:35	125	5.5	2,900	Work plated: 10 lease bars for looms
11:45	11:45	125	5.3	2,800	Surface area: 15.38 ft^2
	11:48	125	5.2	2,800	Grab sample: 11:35
					Stopped inlet testing: 11:45
					Stopped outlet testing: 11:48

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Steel Heddle
Date: June 24, 1986
Tank No.: 2
Sample type: Total and hexavalent chromium

Test Run No.	Test start time	Test stop time
Inlet: SIC-1	Inlet: 08:27	Inlet: 11:45
Outlet: SOC-1	Outlet: 08:33	Outlet: 11:48

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
08:27	08:33	125	5.8	1,300	Started inlet testing: 08:27
08:35	08:35	125	8.0	2,000	Started outlet testing: 08:33
08:45	08:45	125	6.2	1,400	Stopped plating: 08:30
08:55	08:55	125	6.2	1,400	Work plated: comb for textile looms
09:05	09:05	125	6.0	1,400	Surface area: 4.17 ft^2
09:15	09:15	125	6.0	1,400	Started plating: 08:33
09:25	09:25	125	6.0	1,400	Work plated: textile combs
09:35	09:35	125	5.8	1,300	Surface area: 4.54 ft^2
09:40	09:40	125	5.8	1,300	Grab sample: 08:40 and 09:50
					Stopped inlet testing: 09:57
					Stopped outlet testing: 10:03
					Stopped plating: 09:40
10:15	10:18	125	5.8	1,300	Started plating: 09:50
10:25	10:25	125	5.6	1,250	Started inlet testing: 10:15
10:35	10:35	125	5.6	1,200	Started outlet testing: 10:18
10:41	10:41	125	5.6	1,200	Work plated: comb for textile looms
					Surface area: 4.56 ft^2
					Stopped plating: 10:41
10:45	10:45	125	6.0	1,400	Started plating: 10:45
10:55	10:55	125	6.0	1,400	Work plated: comb for textile looms
11:05	11:05	125	6.0	1,350	Surface area: 4.56 ft^2
11:15	11:15	125	6.0	1,300	

(continued)

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET (continued)

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
11:25	11:25	125	5.8	1,300	Grab sample: 11:35
11:35	11:35	130	5.5	1,300	
11:45	11:45	130	5.6	1,300	Stopped inlet testing: 11:45
	11:48	133	5.6	1,300	Stopped outlet testing: 11:48

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Steel Heddle
Date: June 24, 1986
Tank No.: 4
Sample type: Total and hexavalent chromium

Test Run No.	Test start time	Test stop time
Inlet: SIC-1	Inlet: 08:27	Inlet: 11:45
Outlet: SOC-1	Outlet: 08:33	Outlet: 11:48

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
08:27	08:33	110	7.0	900	Started inlet testing: 08:27
08:35	08:35	110	7.0	900	Started outlet testing: 08:33
08:45	08:45	110	7.0	900	Work plated: dummy part (expanded metal)
08:55	08:55	110	6.5	850	Surface area: 6.13 ft^2
09:05	09:05	110	6.5	900	
09:15	09:15	110	6.5	900	
09:25	09:25	110	6.5	900	Grab samples: 08:40 and 09:50
09:35	09:35	110	6.5	900	
09:45	09:45	110	6.5	900	Stopped inlet testing: 09:57
09:55	09:55	110	6.5	900	Stopped testing: 10:03
09:57	10:03	110	6.5	900	
10:15	10:18	110	6.5	900	Started inlet testing: 10:15
10:25	10:25	110	6.5	900	Started outlet testing 10:18
10:35	10:35	110	6.5	900	
10:45	10:45	110	6.5	900	
10:55	10:55	110	6.5	900	
11:05	11:05	110	6.5	900	
11:15	11:15	110	3.5	200*	*Operator inadvertently turned amperage down at 11:06 but was corrected at 11:15
11:25	11:25	110	6.5	900	
11:35	11:35	110	6.5	900	Grab sample: 11:35
11:45	11:45	110	6.5	900	Stoped inlet testing: 11:45
	11:48	110	6.5	900	Stopped outlet testing: 11:48

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Steel Heddle
Date: June 25, 1986
Tank No.: 1
Sample type: Total and hexavalent chromium

Test Run No.	Test start time	Test stop time
Inlet: SIC-2	Inlet: 08:08	Inlet: 11:32
Outlet: SOC-2	Outlet: 08:11	Outlet: 11:34

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
08:08	08:11	125	5.5	500	Started inlet testing: 08:08
08:18	08:18	125	5.5	500	Started outlet testing: 08:11
08:28	08:28	125	5.5	500	Work plated: comb for textile looms
08:33	08:33	125	5.5	500	Surface area: 4.30 ft^2
					Grab samples: 08:12
					Stopped plating: 08:33
08:40	08:40	125	5.0	400	Started plating: 08:40
08:48	08:48	125	5.0	400	Work plated: comb for textile looms
08:58	08:58	125	5.0	400	Surface area: 2.97 ft^2
09:08	09:08	125	5.0	400	
09:18	09:18	125	5.0	400	Stopped inlet testing: 09:38
09:28	09:28	125	5.0	300	Stopped outlet testing: 09:41
09:34	09:34	125	5.0	300	Stopped plating: 09:34
10:02	10:04	125	5.5	500	Started plating: 09:40
10:08	10:08	125	5.5	500	Started inlet testing: 10:02
10:18	10:18	125	5.5	500	Started outlet testing: 10:04
10:28	10:28	125	5.5	400	Work plated: comb for textile looms
10:38	10:38	125	5.5	500	Surface area: 3.03 ft^2
10:40	10:40	125	5.6	500	Stopped plating: 10:40

(continued)

SOURCE SAMPLING PROGRAM PROCESS DATA SHEETS (continued)

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
10:48	10:48	125	5.6	250	Started plating: 10:48
10:58	10:58	125	5.5	250	Work plated: comb for textile looms
11:08	11:08	125	5.6	250	Surface area: 1.67 ft^2
11:18	11:18	125	5.5	250	Grab samples: 11:02
11:28	11:28	125	4.8	200	
11:32	11:34	125	4.8	200	Stopped plating: 12:00
					Stopped outlet testing: 11:34
					Stopped inlet testing: 11:32

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Steel Heddle
Date: June 25, 1986
Tank No.: 2
Sample type: Total and hexavalent chromium

Test Run No.		Test start time		Test stop time	
Inlet:	SIC-2	Inlet:	08:08	Inlet:	11:32
Outlet:	SOC-2	Outlet:	08:11	Outlet:	11:34

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
08:08	08:11	125	5.8	1,100	Started inlet testing: 08:08
08:18	08:18	125	5.8	1,100	Started outlet testing: 08:11
08:28	08:28	125	5.8	1,100	Work plated: comb for textile looms
08:38	08:38	125	5.8	1,100	Surface area: 4.30 ft^2
08:45	08:45	125	5.8	1,100	Grab samples: 08:12
					Stopped plating: 08:45
08:50	08:50	125	6.0	1,400	Started plating: 08:50
08:58	08:58	125	6.0	1,400	Work plated: comb for textile looms
09:08	09:08	125	6.0	1,400	Surface area: 4.30 ft^2
09:18	09:18	125	6.0	1,400	Stopped inlet testing: 09:38
09:28	09:28	125	6.0	1,400	Stopped outlet testing: 09:41
09:38	09:40	125	6.0	1,400	Stopped plating: 09:40
10:02	10:04	125	5.5	1,100	Started plating: 09:50
10:08	10:08	125	5.5	1,100	Started inlet testing: 10:02
10:18	10:18	125	5.8	1,200	Started outlet testing: 10:04
10:28	10:28	125	5.7	1,200	Work plated: comb for textile looms
10:38	10:38	125	5.7	1,200	Surface area: 3.03 ft^2
10:46	10:46	125	5.7	1,200	Stopped plating: 10:46
10:50	10:50	125	5.8	1,100	Started plating: 10:50
10:58	10:58	125	5.8	1,100	Work plated: comb for textile looms
11:08	11:08	125	6.0	1,100	Surface area: 2.94 ft^2
11:18	11:18	125	5.8	1,100	Grab samples: 11:02
11:28	11:28	125	5.8	1,100	Stopped plating: 12:55
11:32	11:34	125	5.8	1,100	Stopped inlet testing: 11:32
					Stopped outlet testing: 11:34

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Steel Heddle
Date: June 25, 1986
Tank No.: 4
Sample type: Total and hexavalent chromium

Test Run No.	Test start time	Test stop time
Inlet: SIC-2	Inlet: 08:08	Inlet: 11:32
Outlet: SOC-2	Outlet: 08:11	Outlet: 11:34

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
08:08	08:11	110	6.5	650	Started inlet testing: 08:08
08:18	08:18	110	6.5	675	Started outlet testing: 08:11
08:28	08:28	110	7.0	600	Work plated: dummy part (expanded metal)
08:38	08:38	110	6.75	600	Surface area: 3.89 ft^2
08:48	08:48	110	7.0	600	Grab samples: 08:12
08:58	08:58	110	7.0	600	
09:08	09:08	110	6.75	625	
09:18	09:18	110	6.75	600	Stopped inlet testing: 09:38
09:28	09:28	110	7.0	625	Stopped outlet testing: 09:41
09:38	09:41	110	6.75	600	
10:02	10:04	110	6.75	600	Started inlet testing: 10:02
10:08	10:08	110	6.75	600	Started outlet testing: 10:04
10:18	10:18	110	6.75	600	Grab samples: 11:02
10:28	10:28	110	6.75	625	
10:38	10:38	110	6.75	600	
10:48	10:48	110	6.75	600	
10:58	10:58	110	6.75	600	
11:08	11:08	110	7.0	600	
11:18	11:18	110	6.75	600	
11:28	11:28	110	6.75	600	Stopped inlet testing: 11:32
11:32	11:34	110	6.75	600	Stopped outlet testing: 11:34

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Steel Heddle
Date: June 25, 1986
Tank No.: 1
Sample type: Total and hexavalent chromium

Test Run No.	Test start time	Test stop time
Inlet: SIC3	Inlet: 12:45	Inlet: 16:33
Outlet: SOC3	Outlet: 12:47	Outlet: 16:35

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
12:45	12:47	125	5.0	200	Started inlet testing: 12:45
12:50	12:50	125	5.0	200	Started outlet testing: 12:47
13:00	13:00	125	5.0	200	Work plated: 3 comb for textile looms
					Surface area: 0.23 ft^2
					Stopped plating 13:00
13:05	13:05	125	9.4	2,250	Started plating: 13:05
13:10	13:10	125	5.5	1,000	Work plated: comb for textile looms
13:20	13:20	125	5.5	1,000	Surface area: 3.94 ft^2
13:30	13:30	125	5.5	1,000	
13:40	13:40	125	5.5	1,000	
13:50	13:50	125	5.5	1,000	
14:00	14:00	125	5.5	1,000	Stopped inlet testing: 14:15
14:10	14:10	125	5.5	1,000	Stopped outlet testing: 14:17
14:14	14:14	125	5.5	1,000	Stopped plating: 14:14
14:29	14:31	125	5.5	900	Started inlet testing: 14:29
14:40	14:40	125	5.5	1,000	Startet outlet testing: 14:31
14:50	14:50	125	5.5	1,000	Started plating: 14:19 Grab sample: 14:40
15:00	15:00	125	5.5	1,000	Work plated: comb for textile looms
15:10	15:10	125	5.5	1,000	Surface area: 3.06 ft^2
15:20	15:20	125	5.5	1,000	Added water to tank
15:27	15:27	125	5.5	1,000	

(continued)

SOURCE SAMPLING PROGRAM PROCESS DATA SHEETS (continued)

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
					Stopped plating: 15:27 Stopped inlet and outlet testing: 15:28
					Started inlet and outlet testing: 16:02 Started plating: 16:00 Work plated: pinching washers Surface area: 36.14 ft^2
16:02	16:02	125	9.0	6,500	
16:10	16:10	125	5.0	2,000	
16:20	16:20	125	4.8	2,000	
16:30	16:30	125	5.0	2,000	
16:33	16:33	125	5.0	2,000	Stopped outlet testing: 16:35 Stopped plating: 16:33 Stopped inlet testing: 16:33

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Steel Heddle
Date: June 25, 1986
Tank No.: 2
Sample type: Total and hexavalent chromium

Test Run No.	Test start time	Test stop time
Inlet: SIC3	Inlet: 12:45	Inlet: 16:33
Outlet: SOC3	Outlet: 12:47	Outlet: 16:35

Time (24-h clock) Inlet	Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
12:45	12:47	125	5.7	1,000	Start inlet testing: 12:45
12:50	12:50	125	5.6	1,000	Start outlet testing: 12:47
12:55	12:55	125	5.6	1,000	Work plated: comb for textile looms
					Surface area: 2.94 ft^2
					Stopped plating: 12:55
12:58	12:58	125	6.7	2,000	Started plating: 12:58
13:10	13:10	125	5.6	1,200	Work plated: comb for textile looms
13:20	13:20	125	5.6	1,200	Surface area: 3.44 ft^2
13:30	13:30	125	5.6	1,200	
13:40	13:40	125	5.5	1,200	
13:50	13:50	125	5.5	1,200	
14:00	14:00	125	5.5	1,200	Stopped inlet testing: 14:15
14:10	14:10	125	5.4	1,200	Stopped outlet testing: 14:17
14:15	14:17	125	5.4	1,200	Stopped plating: 14:20
14:29	14:31	125	7.4	2,000	Started inlet testing: 14:29
14:40	14:40	125	7.6	2,000	Started plating: 14:24
14:50	14:50	125	7.6	2,000	Started outlet testing: 14:31
15:00	15:00	125	7.0	1,800	Work plated: comb for textile looms
15:10	15:10	125	6.8	1,800	Surface area: 6.08 ft^2

(continued)

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET (continued)

Time (24-h clock) Inlet	Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
15:20	15:20	125	6.8	1,800	Grab samples: 14.40
15:28	15:28	125	6.8	1,800	Added water to tank Stopped plating and inlet and outlet testing: 15:28

SOURCE SAMPLING PROGRAM PROCESS DATA SHEET

Place: Steel Heddle
Date: June 25, 1986
Tank No.: 4
Sample type: Total and hexavalent chromium

Test Run No.	Test start time	Test stop time
Inlet: SIC3	Inlet: 12:45	Inlet: 16:33
Outlet: SOC3	Outlet: 12:47	Outlet: 16:35

Time (24-h clock) Inlet	Time (24-h clock) Outlet	Temp., °F	Voltage, volts	Current, amperes	Notes
12:45	12:47	110	6.75	600	Started inlet testing: 12:45
12:50	12:50	110	6.75	600	Started outlet testing: 12:47
13:00	13:00	110	7.0	650	Work plated: dummy part (expanded metal)
13:10	13:10	110	7.0	650	Surface area: 3.89 ft^2
13:20	13:20	110	7.0	650	
13:30	13:30	110	7.0	650	
13:40	13:40	110	7.0	650	Grab samples: 14:40
13:50	13:50	110	7.0	650	
14:00	14:00	110	7.0	650	Stopped inlet testing: 14:15
14:10	14:10	110	7.0	650	
14:15	14:17	110	7.0	650	
					Stopped outlet testing: 14:17
					Port change
14:29	14:31	110	7.0	650	Started testing: 14:29
14:40	14:40	110	7.0	650	
14:50	14:50	110	7.0	650	
15:00	15:00	110	7.0	650	
15:10	15:10	110	7.0	650	
15:20	15:20	110	7.0	650	
15:28	15:28	110	7.0	650	Stopped testing: 15:28
16:02	16:02	110	7.0	675	Started inlet and outlet testing: 16:02
16:10	16:10	110	7.0	675	
16:20	16:20	110	7.0	675	
16:30	16:30	110	7.0	675	Stopped inlet testing: 16:33
16:33	16:35	110	7.0	700	Stopped outlet testing: 16:35