AP42 Section:	12.2
Reference:	97
Title:	Republic Steel Corporation, Cleveland, Ohio, Particulate Emission Evaluation, Envirotech/Chemico No. 22 One Spot Quench Car at the Coke Oven Battery, Betz, Converse, Murdoch, Inc., Plymouth Meeting, PA, June 1981.

REPORT

6A

AP-42 Section 12.2
Reference
Report Sect. 4
Reference 97

Republic Steel Corporation
Cleveland, Ohio

Particulate Emission Evaluation
Envirotech/Chemico
No. 22 One Spot Quench Car

BCM Betz·Converse·Murdoch·Inc.
Consulting Engineers, Planners and Computer Scientists

SOTDAT/STEEL LIBRARY SYSTEM

Report Title: See Title Page

Plant and Location: Republic Steel Corp., Cleveland Ohio

SCC: 30300303

Testing Date(s): 4/14,15/81

By Whom: Betz Converse and Murdoch

Stack Test Review Attached: No

Reviewed By:

Problems Seen by Reviewer:

Confidentiality Status: Unknown

If status is confidential, list confidential pages or sections:

Source of Determination of the Confidentiality Status:

Report Encoded By:

Date Encoded:

Form Numbers:

Comments:

PARTICULATE EMISSION EVALUATION
OF THE
ENVIROTECH/CHEMICO NO. 22 ONE SPOT QUENCH CAR

AT THE

COKE OVEN BATTERY
OF
REPUBLIC STEEL CORPORATION
CLEVELAND WORKS
CLEVELAND, OHIO

JUNE 1981

BCM PROJECT NO. 00-4178-12

PREPARED BY

Robert Alfred

ROBERT ALFRED, SCIENTIST II

APPROVED BY

PETER R. CHARRINGTON, P.E.
ASSISTANT VICE PRESIDENT

BETZ•CONVERSE•MURDOCH•INC.
ONE PLYMOUTH MEETING MALL
PLYMOUTH MEETING, PENNSYLVANIA 19462

CONTENTS

1.0 EXECUTIVE SUMMARY

Republic Steel Corporation (RSC) retained Betz•Converse•Murdoch•Inc. (BCM) to evaluate its No. 22 Envirotech/Chemico one spot quench car installed at the Coke Oven Batteries Nos. 6 and 7 at the Cleveland facility. The emission data were evaluated in accordance with the Envirotech/Chemico specifications and testing was performed as per the procedures established by the Environmental Protection Agency (EPA), the State of Ohio, and the City of Cleveland. Three 24 push tests, incorporating push and travel modes, were performed by BCM. In addition, opacity observations were noted for each oven that was pushed during the particular testing program.

2.0 SCOPE AND OBJECTIVES

The scope of the project was outlined in BCM Proposal No. 00-4178-12 which is contained in Appendix 1. The following parameters were determined for each test:

- Gas flow - ACFM and SCFM
- Gas temperature - °F
- Moisture - % by volume
- Flue gas analysis - % by volume CO_2, O_2, CO + N_2 (by difference)
- Particulate emissions - grains/dry standard cubic feet (g/dscf), lbs/hr, lbs/ton of coke pushed, lbs/ton of coal charged
- Opacity - % Opaque

3.0 PROCEDURES

3.1 Field Work

Field testing was conducted April 14 and 15, 1981. The sampling team consisted of the following BCM personnel:

- Robert Alfred - Scientist II
- Edward W. Blanar - Engineer I
- Nassar Oshkoohi - Scientist II

Mr. Gene John of Republic Steel acted as liaison between BCM and Republic Steel, and Mr. Bill Weiss of Chemico ensured that the scrubber car was operating normally during the test periods. Mr. Joe Bryant of Chemico observed the testing performed on the test car.

The following methods of sampling were employed in the test program:

1. Sampling and traverse locations were determined at a pre-test meeting on March 24, 1981, attended by personnel from the City of Cleveland DAPC and the EPA.

2. Gas flow, gas temperature and static pressure measurements were made per Method Two of the Federal Register, Volume 42, Number 160, August 18, 1977; the methodology is outlined in Appendix 2.

3. Particulate testing was conducted as per a modified Methods Five Federal Register, Volume 42, Number 160, August 18, 1977. These procedures are outlined in Appendix 2.

4. Fyrite oxygen (O_2) and carbon dioxide (CO_2) indicators (manufactured by the Bacharach Instrument Company) were used to determine the molecular weight of the flue gas. The Fyrite directly determines percent carbon dioxide and oxygen. The volume percent CO plus nitrogen was determined by difference. All of these parameters were used to calculate the molecular weight of the dry flue gas.

5. Moisture content sampling was conducted per Method Four of the Federal Register, Volume 42, Number 160, August 18, 1977; the methodology is outlined in Appendix 2.

3.2 Equipment Calibration

In accordance with the accepted procedures published by the EPA, all gas velocity measuring equipment, volume metering equipment, temperature measuring equipment, and flow rate metering equipment had been calibrated within 60 days of the actual test date. Calibration data are contained in Appendix 4.

3.3 Analytical Methods

All samples generated during the sampling program were returned to the BCM Laboratory in Norristown, Pennsylvania. Laboratory data are contained in Appendix 3, Table 3-1.

3.4 Calculations

All particulate concentrations, moisture content, gas flow, and molecular weight calculations were accomplished through the use of a computer. Raw data generated from the field sampling program and the results of the laboratory analyses were introduced into equations presented in Methods Two, Three, Four, and Five of the Federal Register, Volume 42, No. 160, August 18, 1977. Computer input and all other data appear in Appendix 3.

4.0 SUMMARY

4.1 Particulate Emissions Results

The parameters evaluated using the EPA and State of Ohio testing methods are contained in the computer printout at the end of Appendix 3. Test results are listed in Table 1.

TABLE 1

PARTICULATE EMISSIONS RESULTS

Run Number	Concentration (Grains/DSCF)	Particulate Emissions Pounds/Hour	Particulate Emissions Lbs/Ton of Coke Pushed*	Particulate Emissions Lbs/Ton of Coal Charged**
1	.012	6.8	0.020	0.015
2	.011	6.5	0.021	0.016
3	.015	8.9	0.027	0.020

* Based on 280.8 tons of coke pushed for each 24 oven tests; see Appendix 3 computation sheet

** Based on typical yield of 0.75 tons of coke pushed per ton of coal charged

4.2 Visible Emissions

The opacity observations were performed in conjunction with the City of Cleveland DAPC, Chemico, and the EPA. The readings are contained in Appendix 2.

5.0 DISCUSSION

5.1 Particulate Testing Results

The testing for the quench car particulate emissions was performed with minimal field difficulties. Test Run No. 1 was delayed because of electrical problems on the quench car. Test No. 2 went smoothly; however, a hydraulic line broke on the test car about one-third of the way through Test Run No. 3. This delayed testing for about one hour. During Test Run Nos. 1 and 3, the hot coke began "sticking" in the ovens; therefore, the pushing machine was unable to push the coke out. This was not evident to the operator of the quench car who initiated the scrubbing cycle. This situation occurred for approximately 160 seconds on Test Run No. 2 and 36 seconds on Test Run No. 3. Because the scrubber was only scrubbing ambient air, the cubic feet of gas sampled and the sampling times from these pushes were subtracted from the appropriate totals. If they were to be included in the calculations, the gas flow (ACFM) and grains (DSCF) would drop in value and the isokinetics would be slightly higher.

5.2 Visible Emissions Procedures

The opacity was observed during two of the three testing programs. All observations were recorded in accordance with guidelines established in EPA Federal Method Nine of the Federal Register, with the exception of the guideline that the sun be located 140° to the observer's back. This guideline could not be met because of the location of the coke ovens; this is a well-established practice. All observations were recorded by a certified BCM observer.

Opacity readings were taken above the coke car with blue sky as background. Observations began at the start of the push cycle of the quench car and continued until the quench car cycle completed its run, which lasted two minutes. There were 24 pushes per test, each push occurring approximately eight minutes apart.

APPENDIX 1

BCM PROPOSAL

-LYM

-ILL
-ILVANIA 19462

TECHNICAL SCOPE

It is the desire of Republic Steel Corporation (Republic) to have the emissions from the ENVIROTECH/CHEMICO Enclosed Quench Car Systems located at the Cleveland plant of the Republic Steel Corporation evaluated and quantified. The intent of this proposal is to present Betz·Converse·Murdoch·Inc.'s (BCM) approach to fulfilling Republic's request for determining the above information.

The project will involve emission sampling from the outlet of two Quench Car Systems in order to generate compliance data for submission to the Ohio Environmental Protection Agency (EPA). A maximum of three runs will be performed during a four-day period at each location. The project is subdivided as noted below.

For ease of discussion and mutual understanding of the BCM services to be provided, the suggested scope is subdivided into the steps as noted below.

1.0 PROJECT PLANNING

Upon acceptance of the proposal, the Section Manager of the Air Quality Section or the Field Project Engineer will meet with Republic Steel to accomplish the following:

- Establish lines of communication for the testing
- Discuss the project scope to ensure Republic and BCM are in agreement
- Ensure that the sampling site is prepared for testing (see Client Responsibility Section)

2.0 SAMPLING AND ANALYSIS

2.1 Test Procedures

All particulate testing procedures to be followed during the three 24 push tests for each car are those prescribed by the Environmental Protection Agency (EPA) and the Ohio EPA. The procedures to be followed during testing are outlined below:

- Use an out-of-stack glass fiber filter, followed by a full impinger train (which consists of two distilled water filled impingers), followed by an empty impinger, and then a silica gel-filled final impinger. A glass lined probe heated to 250°F ± 25°F will be used for the testing.

- Sample point location and velocity traverses will consist of four six-point sampling traverses.
- EPA Method 5 sampling procedures will be followed for the particulate sampling with the following exceptions:

  (1) A sample rate of approximately 0.3 scfm will by used for each test

  (2) A back half particulate loading will be generated by evaporating all water washes at 105°C ± 5°C, and the residue weight determined

2.2 Parameters

The following parameters will be evaluated and reported for each of three test runs for each Quench Car.

- Gas flow - ACFM - ACFM and SCFM
- Gas temperature -°F
- Gas molecular weight - Orsat analysis - (CO_2, O_2, CO and N_2 by difference) - % by volume
- Moisture content - % by volume
- Particulate concentration -gr/dscf (front-half and back-half of sampling train reported separately)
- Particulate emission rate - lbs/hr (front-half and back-half of sampling train reported separately)
- Visible emissions - % opaque (optional)

2.3 For each car, BCM will provide two men on-site for four days with the necessary sampling equipment to complete the testing. If visible emissions are required, BCM will provide three men during the program.

3.0 ANALYTICAL

All samples will be returned to our laboratory in Pittsburgh, PA for analysis.

4.0 REPORT

Five copies of the reports (one report for each car) will be submitted within 30 working days of field testing completion. Preliminary data should be available within 15 working days of the completion of the sampling. The reports will include all field data sheets, analytical reports, and sampling methodologies from the testing of the cars.

BUSINESS SCOPE

COMPENSATION

It is proposed that the outlined project scope be performed on a Lump Sum basis. This fee is firm and cannot be changed unless it is mutually agreed that the scope of the work has changed from what is outlined in this project. Costs are based on 10 hour field days and hours in excess of 10 are considered as overtime.

LUMP SUM COSTS

Mobilization(1)
Report Preparation
Each 24-push test
Opacity Observer/10-hour day
Each Delay/OT Hour per 2-man crew
Each Delay/OT Hour per 3-man crew

---

(1) Include Pre-test Meeting, completion of Intent to test forms.

DELAYS/OVERTIME

Delays caused by conditions beyond BCM's control, such as partial or complete process shutdowns or irregularities, strikes, floods or fires which delay the project's completion, constitute a Change-of-Scope. Also, unfavorable weather conditions which BCM's Field Project Engineer considers a threat to crew safety and/or sample quality, constitute a Change-of-Scope and will be charged at the delay/overtime rate. In addition, the field work is based on a 10-hour day (excluding travel). Any hours necessary for the successful completion of the project in excess of 10 per day will be charged at the delay/overtime rate described in the compensation section. Any expenses incurred as a result of project delays/overtime will be billed at cost plus 10%. The BCM Field Project Engineer will notify you of such Changes of Scope. At your request, BCM will outline the type of shelter, as required, to minimize weather delays. If the project is postponed within 72 hours of the scheduled start date, you may be charged a fee (not to exceed the mobilization charge).

WORK SCHEDULE

Work on this project can be started within 10 calendar days of your authorization to proceed and can be completed within 30 working days of completion of the field work. This schedule is our best estimate based on our anticipated laboratory and engineering workload. At the time of your authorization to proceed, it may be possible to improve this schedule if necessary. On the other hand, an unexpected increase in our laboratory and engineering workload may cause a few days' delay in starting the project.

INVOICES

Invoices will be submitted monthly for work completed, with terms net thirty (30) days with past-due balances subject to interest at the rate of one and one-quarter percent (1-1/4%) per month, effective forty-five (45) days after date of invoice. This represents an annual interest charge of fifteen percent (15%).

VALIDITY

This proposal is valid for 60 days. Subsequent to that date, BCM may review the basis of payment to allow for changing costs and adjust starting and completion dates to conform to our workload.

INSURANCE

BCM will maintain insurance coverage in the following amounts and, upon request of the client, will provide a Certificate of Insurance so indicating:

Type of Policy	Limits of Liability
(a) Standard Worker's Compensation and Employer's Liability	Statutory
(b) General Liability	
Bodily Injury	$500,000 Each Occurrence and Aggregate
Property Damage	$500,000 Each Occurrence and Aggregate
(c) Automobile Liability Combined Single Limit (Bodily Injury and Property Damage)	$1,000,000 Each Occurrence

SAFETY

BCM personnel always endeavor to conduct field activities in such a manner as to protect themselves and others from accidents and injury. When special safety equipment is required, the client should so specify. BCM personnel use their own safety equipment (hard hats, goggles) unless otherwise instructed.

PROJECT MANAGEMENT

BCM will assign key personnel who are fully qualified and experienced with similar studies. Their duties are briefly described below.

Section Manager - Air Quality

Mr. P. R. Charrington, P.E., will be responsible for all field studies and analytical determinations. Mr. Charrington has been involved in over four-hundred source emission programs.

Project Engineer - Air Quality

Mr. D. E. Seely will be assigned as the project engineer for the field sampling project. He will be responsible for the data evaluation and sampling system design. Mr. Seely has been involved in the J&L Pittsburgh Works Quench Car testing and several Bethlehem Steel Quench Car programs.

CLIENT RESPONSIBILITY

To successfully complete the field testing, it shall be the responsibility of Republic Steel to provide the following:

1. A plant liaison for the BCM field testing team during the field testing
2. Access to the sampling location
3. Electric power (110V and 20 amp service) to within 50' of the sampling location
4. All operating data of the coke oven battery during field testing

QUALIFICATIONS

BCM has performed over 40 tests on the ENVIROTECH/CHEMICO Quench Car during the past two years. Provided below are the locations of the projects with plant contacts and phone numbers which Republic should feel free to contact.

- Jones and Laughlin Steel Corporation - Pittsburgh Works

  May - July, 1978
  August - September, 1979
  Mr. S. W. Kretz - (412) 378-5447

- Bethlehem Steel Corporation - Bethlehem, PA

  February - March, 1979
  Mr. Ed Rekai and Mr. Robert Alpago - (215) 694-3878

- Bethlehem Steel Corporation - Sparrows Point, MD

  October, 1980
  Bill Bogart - (301) 477-7886

- Bethlehem Steel Corporation - Lackawanna, NY

  April, 1981 - Tentative Schedule
  Ron Riefler - (716) 821-2504

- Jones and Laughlin Steel Corporation - Indiana Harbor Works

  November, 1980
  Andrew Wichlinski - (219) 391-2818

- Shenango Coke Corporation

  March 1981
  Jim Zwikle - (412) 777-6654

- Republic Steel Corporation - Warren and Youngstown

  April, 1981
  Tom Kachur - (216) 841-8200

- United States Steel Corporation

  April, 1981
  Frank Bowiski - (412) 233-2594

APPENDIX 2

FIELD SAMPLING PROGRAM

APPENDIX 2

FIELD SAMPLING PROGRAM

1.0 SAMPLING PROCEDURES

1.1 Test Station and Traverse Locations

The locations of the sampling stations and traverse points are critical to the performance of the project. A description of the sampling location follows. The outlet duct of the scrubber measured 72 by 64 inches. Four test ports each contained 6 test points, for a total of 24 points.

1.2 Gas Flow and Gas Temperature Determinations

The gas flow rate and temperature profiles were measured by conducting a simultaneous velocity and temperature traverse in conjunction with the particulate testing program. Gas velocity heads were measured with a calibrated "S"-type Pitot tube which was connected to an inclined manometer. A Chromel-Alumel thermocouple connected to a potentiometer was used to determine the gas temperature.

1.3 Moisture Content

Sampling was conducted concurrently with particulate sampling using the principles presented in EPA Method Four. The following parameters were evaluated in order to determine the gas stream's moisture content: sample gas volume, sample gas temperature, sample gas pressure, impinger moisture gain, and silica gel moisture gain. Some minor modifications were made to the Method Four train to allow simultaneous particulate and moisture content sampling. These modifications did not deviate from established sampling principles.

The substitution of a glass fiber filter for Pyrex wool as a filtering medium and the substitution of a calibrated orifice for a rotameter as a flow metering device were the primary modifications.

1.4 Particulate Sampling

The sampling procedures and sampling equipment used are outlined in Method Five of the Federal Register, Volume 42, Number 160, August 18, 1977.

The size of the nozzle required to maintain isokinetic sampling was calculated from the results of a previously completed velocity and temperature traverse. The sampling train used a glass-lined probe, which was heated to 250°F by an internal heating element. A nozzle of the calculated size was attached to the end of the probe which was inserted into the stack. A calibrated "S"-type Pitot tube and a Chromel-Alumel thermocouple were attached to the probe and used to monitor the velocity head and the temperature at the traverse points during the sampling period. Sampled gas passed through the nozzle and the probe to a glass fiber filter for the removal of the suspended particulates. The filter was housed in a heated chamber whose temperature was maintained at 248°F ±25 degrees. From the filter, the stack gas passed to the impinger train. The first two impingers each contained 150 ml of deionized water. The third impinger contained no reagents and acted as a knockout impinger. The fourth impinger contained approximately 200 grams of coarse silica gel which collected any moisture and/or vapors which had not been captured in the preceding impingers.

The second impinger was a 500 ml Greenburg-Smith inpinger, while the first, third and fourth were 500 ml impingers of the Greenburg-Smith design, modified by replacing the tip with a 1/2-inch ID glass tube. Note that the impinger train was immersed in an ice bath for the entire test period so that the exist gas temperature would not exceed 68°F.

From the impinger train, the gas was conducted through an umbilical cord to the control console, a Model 2343 RAC Stak Samplr, which contained the following pieces of equipment (listed in the order in which sampled gas passed through them): a main valve; a by-pass valve for flow adjustment; an airtight vacuum pump; a dry gas meter; and a calibrated orifice. The orifice was equipped with pressure taps which were connected across the inclined manometer used to ensure that isokinetic conditions were maintained. A schematic diagram of the sampling train is presented at the end of this appendix.

The sampling train was subjected to a leak check prior to and after each sample run. The inlet of the nozzle was plugged and the pump vacuum was held at the highest vacuum attained during that period of testing. In all cases, the leakage rate was minimal and did not exceed the maximum allowable leakage rate of 0.02 cfm.

Upon completion of a test, the soiled glass fiber filter was removed from its filter holder and placed in a petri dish which was subsequently sealed. The probe and nozzle were washed internally with acetone; the particulate matter remaining in the probe was removed with a nylon brush attached to a polyethylene line. The front half of the glass filter holder was also rinsed with acetone and the washings obtained were added to those collected from the nozzle and the probe. All washings were stored in sealed polyethylene sample bottles for transfer to the laboratory. The silica gel used in the fourth impinger was removed and stored in a sealed sample bottle. The contents of the first, second and third impingers were combined and measured volumetrically.

1.5 Field Data Sheets

The flue gas velocity head, the flue gas temperature, the inlet and outlet dry gas meter temperatures, the orifice pressure differential, the sample volume, the sampling time, the pump vacuum, the filter temperature, and the impinger train outlet gas temperature were recorded during the sampling program. The field data sheets generated during the program follow.

Betz • Converse • Murdoch • Inc. BCM

NOMOGRAPH DATA

PLANT Republic Steel Cleveland

DATE 7-14-81

SAMPLING LOCATION Chemico Q-CAR

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	#? $\Delta H_@$	1.78
AVERAGE METER TEMPERATURE (AMBIENT + 20°F), °F	$T_{m\,avg.}$	80
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	25%
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	
STATIC PRESSURE IN STACK, in. Hg (P_m ± 0.073 x STACK GAUGE PRESSURE in in. H_2O)	P_s	
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	
AVERAGE STACK TEMPERATURE, °F	$T_{s_{avg.}}$	140
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	1.
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	3.0
C FACTOR	.67	
CALCULATED NOZZLE DIAMETER, in.	.22	
ACTUAL NOZZLE DIAMETER, in.	.195	
REFERENCE Δp, in. H_2O	1.8	

BCM

FIELD DATA SHEET

PLANT [illegible] Steel

DATE 4-14-81

SAMPLING LOCATION Q-CAR #22

SAMPLE TYPE Method 5

RUN NUMBER 1 OPERATOR BA

BAROMETRIC PRESSURE 29.94 STATIC PRESSURE

FILTER NUMBER(S) 703

GEL NUMBER(S) D693

THIMBLE NUMBER PLATE NUMBER

H_2O PICKUP (ml) 165

ORSAT:

CO_2 5

O_2 20.0

CO 0

PYROMETER NUMBER

THERMOCOUPLE NUMBER

PROBE NUMBER TYPE

NOZZLE NUMBER I.D. .195

METER BOX NUMBER $\Delta H_@$ 1.78

PITOT NUMBER C_p .84

SAMPLE BOX NUMBER(S) 7

ASSUMED MOISTURE (%) 25

ASSUMED METER TEMPERATURE 80

C FACTOR .62 REFERENCE Δp

READ AND RECORD ALL DATA EVERY ____ MINUTES

Leak Check <.001 cfm at 15" Hg

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	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\ in}$), °F	OUTLET ($T_{m\ out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	
		0940	55.395										
A-1	68			2.0	70								59
	58		256.65	.78	.78		156	70	70	2	190	68	
		0951											
A-2	63			1.7	1.7		180	70	70	6	110	62	69
	60		257.93	.74	.74								
		1004											2
A-3	58			1.5	1.5		146	70	70		190	60	
	50		259.0	.52	.52								
		100											
A-4	60			.98	.98								
	68		260.06	.59	.59		140	68	68	5	200	62	84
		1027											
A-5	66			.68	.68		142						
	74		261.01	.40	.40			68	68	4	190	62	94
		1034											12
A-6	64			.46	.46		147						
	38		261.62	.38	.38			68	68	3	210	62	
		1042											
B 1		32	262.38	2.8			ABORTED	[illegible]					104
	61			2.8	2.8		146			2	210	62	
	73		264.08	.91	.91		146	66	64				

400.25

PLANT DATE RUN NUMBER

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24 hr. CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET $(T_{m\,in})$, °F	OUTLET $(T_{m\,out})$, °F	PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	
		1051											
B-2	61			2.6	2.6			6		6			
	73		265.53	.61	.61		130	66	66		240	62	20
		1058											
B3	62			1.7	1.7		150			4	200	62	
	68		266.87	.49	.49			68	66				114
		1108											
B-4	61			.96	.96								
	81		267.90	.32	.32		154	68	68	4	240	58	124
		1117											
B-5	60			.45	.45								134
	92		268.81	.39	.39		145	66	66	3	220	58	
		1136											
B-6	60			.43	.43								
	63		269.43	.21	.21		147	66	66	3	260	58	76
		1149											
C-1	60			2.7	2.7								32
	61		270.88	.89	.89		145	66	66	3	250	60	
		1201											
C-2	39		271.31	1.7		ABORTED							42
	60			1.7	1.7								
	64		272.66	.52	.52		138	64	64	3	250	60	
		1215											
C-3	58			1.1	1.1								52
	60		273.62	.35	.35		142	64	64	5	250	60	
		1226											
C-4	58			.56	.56								62
	58		274.32	.22	.22		149	64	64	4	240	59	
		1233											
C-5		46	274.9	.43	.43		~~ABORTED~~	ABORTED					86
		43	275.1				137						
		1257											
C-5	60			.43	.43								4
	42		275.69	.23	.23		137	64	64	3	240	59	

PLANT DATE RUN NUMBER

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24 hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
	1304										
C-6	54		.30	.30							
	66	276.33	.18	.18		138	64	64	2	240	58
	1312										
D-1	60		2.4	2.4							
	44	277.55	.68	.68		140	64	64	7	243	60
	1320										
D-2	58		1.5	1.5							
	77	278.67	.42	.42		135	66	65	6	250	60
	1328										
D-3	64		1.3	1.3							
	41	279.52	.30	.30		130	67	66	6	250	60
	1333										
D-4	66		.63	.63							
	115	280.49	.13	.13		130	68	66	4	256	60
	1342										
D-5	63		.38	.38							
	36	280.98	.15	.15		130	68	66	4	250	60
	1348										
D-6	60		.32	.32							
	94	281.662	.19	.19		140	68	66	3	280	60
		LEAK CHECK	<.001 CFM	AT 8" Hg							
	3181 TOTAL	26.303	820	~~834~~		149	66.7	66.2			
	-89	-.76		.822							
	-39	.78									
	-32	.49									
	3021 50.35	24.273									

BCM

FIELD DATA SHEET

PLANT: Republic STeel Clevp

DATE: 4-15-81

SAMPLING LOCATION: Q-CAR #22

SAMPLE TYPE: Method 5

RUN NUMBER: 2 OPERATOR: BA

BAROMETRIC PRESSURE: 30.12 STATIC PRESSURE: ______

FILTER NUMBER(S): 706

GEL NUMBER(S): ______

THIMBLE NUMBER: ______ PLATE NUMBER: ______

H_2O PICKUP (ml): 155.

ORSAT:

CO_2: .5

O_2: 20

CO: 0

PYROMETER NUMBER: ______

THERMOCOUPLE NUMBER: ______

PROBE NUMBER: ______ TYPE: S

NOZZLE NUMBER: ______ I.D.: .195

METER BOX NUMBER: ______ $\Delta H_@$: 1.78

PITOT NUMBER: ______ C_p: .84

SAMPLE BOX NUMBER(S): ______

ASSUMED MOISTURE (%): 25

ASSUMED METER TEMPERATURE: 80

C FACTOR: .67 REFERENCE Δp: 1.8

Leak Check <.001 cfm AT 15" Hg

READ AND RECORD ALL DATA EVERY ______ MINUTES

TRAVERSE POINT NUMBER	SAMPLING TIME, min	CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft³	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	DRY GAS METER TEMPERATURE OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	
		0315	237.21										
A-1	60			2.5	2.5								104
	85		240.56	.89	.89			46	46	8	160	40	
		0323											
A-2	60			1.8	1.8								22
	62		241.88	.82	.82			48	48	7	240	45	
		0331											
A-3	62			1.6	1.6								
	91		243.39	.68	.68			50	50	6	240	48	114
		0348											
A-4	59			1.1	1.1								~~32~~ ~~124~~
	57		244.21	.51	.51		110	48	48	5	246	52	32
		0901											
A-5	60			.65	[illegible]								
	72		245.16	.35	.35		125	49	49	4	222	60	124
		0910											
A-6	57			.63	.63								42
	50		245.86	.39	.39		112	50	50	3	265	60	
		0924											52
B-1	58			2.9	2.9								76 134
	63		247.40	1.1	1.1		115	50	50	8	262	62	

PLANT | DATE | RUN NUMBER

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	
		0931											134
B-2	60 197		300.08	2.7 .96	2.7 .96		128	52	50	7	260	62	
		0944											
	59 55		301.28	1.9 .78	1.9 .78		115	52	50	6	230	56	62
		0952											
B-4	59 49		302.12	.93 .48	.93 .48		110	52	50	4	246	62	4
B-5	57 62	1003	302.83	.60 .30	.60 .30		115	52	50	3	255	62	14
		1013											76
B-6	57 62		303.48	.35 .35	.35 .25		118	52	50	3	260	62	
		1032											
C-1	60 81		305.04	2.9 1.0	2.9 1.0		125	52	50	8	225	60	
		1033											[illegible]
C-2	57 57		306.03	1.5 .57	1.5 .57		130	58	51	7	240	60	
		1046											96
C-3	56 87		307.02	.78 .38	.78 .38		144	52	51	5	230	54	
		1056											34
C-4	60 63		307.69	.50 .28	.50 .28		110	52	51	3	240	54	
		1103											
C-5	60 136		308.56	.32 .17	.32 .17		130	52	51	3	250	54	
		1143											
C-6	61 70		309.08	.29 .12	.29 .12		115	52	51	2	260	58	

PLANT DATE RUN NUMBER

TRAVERSE POINT NUMBER	SAMPLING TIME, min / CLOCK TIME (24-hr CLOCK)	GAS METER READING (V_m), ft^3	VELOCITY HEAD (Δp_s), in. H_2O	ORIFICE PRESSURE DIFFERENTIAL (ΔH), in. H_2O DESIRED	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	
	1153											
D-1	61		2.2	2.2								
	64	310.44	.75	.75		110	52	51	7	260	60	54
	1206											
D-2	61		1.6	1.6								64
	76	311.56	.47	.47		120	52	51	6	240	60	
	1223											
[illegible]	60		.56	.56								
	82	312.52	.29	.29		118	54	52	4	240	60	
	1233											
D-4	58		.48	.48								
	83	313.21	.15	.15		125	54	[illegible]		258	60	124
	1243											
D-5	58		.21	.21								
	64	313.71	.11	.11		130	54	52	2	240	60	6
	1253											
D-6	63		.15	.15								88
	25	314.208	.10	.10		138	54	52	2	240	60	
		Leak Check	0.001 CFM At 10" Hg									
	3256 sec											
	54.27 min	24.998	.8308		5237	119.6	51.8	50.2				

2

BCM

FIELD DATA SHEET

PLANT Republic Steel Cleve

DATE 4-16-81

SAMPLING LOCATION Q-CAR 22

SAMPLE TYPE Method 5

RUN NUMBER 3 OPERATOR BA

BAROMETRIC PRESSURE 30.12 STATIC PRESSURE

FILTER NUMBER(S)

GEL NUMBER(S)

THIMBLE NUMBER PLATE NUMBER

H_2O PICKUP (ml) 160

ORSAT:

CO_2 .5

O_2 20

CO 0

PYROMETER NUMBER

THERMOCOUPLE NUMBER

PROBE NUMBER TYPE Glass/SS

NOZZLE NUMBER I.D.

METER BOX NUMBER 7 $\Delta H_@$ 1.78

PITOT NUMBER C_p .84

SAMPLE BOX NUMBER(S)

ASSUMED MOISTURE (%) 25

ASSUMED METER TEMPERATURE 80

C FACTOR .61 REFERENCE Δp 1.8

Leak Check <.001 cfm at 15" Hg

READ AND RECORD ALL DATA EVERY 2 MINUTES

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	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	
	1426	314.81										
A-1	60		2.5	2.5								
	97	316.35	.57	.57		125	54	53	5	230	50	128
	1435											
A-2	60		2.4	2.4								
	76	317.8	.78	.78		140	54	53	5	240	50	46
	1446											
A-3	60		1.9	1.9								71
	81	319.14	.59	.59		130	54	53	5	246	60	
	1454											56
A-4	60		1.1	1.1								
	59	320.10	.45	.45		140	54	53	5	246	60	
	1510											
A-5	60		.72	.72								81
	96	321.12	.34	.34		110	54	53	3	230	60	
	1519											
A-6	59		.49	.49								
	66	321.81	.20	.20		115	54	53	2	245	60	
	1527								1			
B-1	58		3.4	3.4								
	61	323.33	1.1	1.1		121	55	53	6	240	60	

PLANT DATE RUN NUMBER

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	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET $(T_{m\,in})$, °F	OUTLET $(T_{m\,out})$, °F	PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	
		1535											
B-2	61			2.5	2.5								101
	73		324.86	.79	.79		130	58	56	5	230	60	
		1621	-.16	DelAY	LeAK CHECK		FOR	LONG	DelAY	LeAK	2.001cfm	A	
B-3	61		-	1.6	1.6								8
	47		325.96	.68	.68		120	58	56	4	230	60	
		1628											
B-4	61			.69	.69								111
	90		326.92	.31	.31		120	56	55	4	250	60	
		1636											18
B-5	59			.50	.50								
	36		327.58	.22	.22		130	56	55	3	240	60	
		1648											121
B-6	60			.39	.39								
	93		328.25	.13	.13		131	56	54	3	262	60	
		1649											28
C-1	60			3.4	3.4								
	45		329.64	.93	.93		124	56	54	3	264	60	
		1656											131
C-2	63			1.8	1.8								
	92		331.14	.51	.51		125	56	54	5	260	64	
		1711											38
C-3	58			.78	.78								
	46		331.89	.40	.40		131	56	54	5	250	61	
		1719											76
C-4	66			.51	.51								
	86		332.73	.21	.21		127	56	54	5	263	61	
		1727											48
C-5	57			.36	.36								
	60		333.30	.19	.19		121	56	54	3	250	60	
		1734											83
C-6	63			.26	.26								
	105		333.90	.18	.18		124	55	54	3	260	61	
		1744											58
D-1	60			2.9	2.9								
	50		335.16	.75	.75		126	56	54		265	62	

PLANT DATE RUN NUMBER

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	ACTUAL	STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE INLET ($T_{m\,in}$), °F	OUTLET ($T_{m\,out}$), °F	PUMP VACUUM, in Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F	
		1751											
D-2	36		335.56	1.4	1.4		ABORTED SCRUB						
D-2	51			1.4	1.4								
	84		336.79	.49	.49		123	58	56	6	245	63	3
		1800											
D-3	58			.81	.81		1						
	64		337.60	.41	.41		129	58	56	4	240	68	68
		1806											
D-4	59			.52	.52								
	86		338.35	.20	.20		132	58	56	3	248	68	
		1814											
D-5	51			.36	.36								
	40		338.86	.19	.19		133	56	56	3	240	68	1
		1820											
D-6	55			.26	.26								113
	81		339.51	.18	.18		133	58	56	3	240	68	
				Leak Check			<.001 CFM AT 10" Hg						
	3163 sec		24.7				127	56	54.4				
	-.36		-.56										
	3127		24.14				*						
	52.12 min			8260		8354							

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Consulting Engineers, Planners and Architects

Date *4-15-81* Location Name *REPUBLIC STEEL*

Observer *E.J. BLANAR* Address *CLEVELAND, OHIO*

TEST #2

Observation Point *OFF COKE OVENS ⊥ TO QUENCH CAR*

Stack-Distance from *25'* Height *25'*

Wind-Speed *5-10* Direction *VARIABLE*

Type of Installation *COKE OVEN QUENCH CAR #22*

Fuel *COKE GAS*

Observation Began *8:15* Ended *12:55*

Weather: *HIGH PRESSURE SYSTEM CLEAR SKIES.*

Remarks: *NUMBER UNDERLINED SIGNIFIES OVEN NUMBER IE. 104 READINGS TAKEN ABOVE COKE OVENS OVER QUENCH CAR USING BLUE SKY AS CONTRAST.*

Percent (%) Smoke Density

Comments		0	15	30	45		0	15	30	45	Comments
PUSH 1 104	0	0	0	0	0	30	0	0	0	0	16 34
815	1	0	0			31	10	5			10:56
2 22	2	0	0	0	0	32	0	0	0	10	17 116
823	3	0	0			33	10	0			11:03
3 114	4	0	0	0	0	34	0	0	0	0	18 44
8:33	5	0	0			35	5	0			11:43
4 32	6	0	0	5	0	36	0	0	0	0	19 54
848	7	0	0			37	0	0			11:54
5 124	8	0	0	0	0	38	0	0	0	5	20 64
9:03	9	0	0			39	0	0			12:06
6 42	10	0	5	0	0	40	0	0	5	5	21 126
9:11	11	0	0			41	0	0			12:23
7 52	12	0	0	0	0	42	0	0	0	0	22 [illegible]
9:21	13	0	0			43	5	0			12:34
8 134	14	0	10	10	10	44	0	0	0	0	23 [illegible]
9:34 LATE PUSH	15	0	0			45	5	5			12:43
9 52	16	0	0	0	0	46	0	0	5	5	24 88
9:45	17	0	0			47	0	0			12:54
10 4	18	0	0	0	0	48					
9:52	19	0	0			49					
11 14	20	0	0	5	0	50					
10:03 LATE	21	10	5			51					
12 76	22	0	0	0	0	52					
10:14	23	0	0			53					
13 96	24	0	0	5	0	54					
10:27	25	0	0			55					
PUSH 14 24	26	0	0	0	0	56					
10:38	27	0	0			57					
15 106	28	0	0	0	0	58					
10:46	29	0	0			59					

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Consulting Engineers, Planners and Architects

Date 4-15-81 Location Name REPUBLIC STEEL

Observer E.W. BLANAR Address CLEVELAND, OHIO

TEST #3

Observation Point OFF COKE OVENS ⊥ TO QUENCH CAR

Stack-Distance from 25' Height 55'

Wind-Speed 5-10 Direction VARIABLE

Type of Installation COKE OVEN QUENCH CAR #22

Fuel COKE GAS

Observation Began 1426 Ended 1822

Weather: CLEAR SKIES, HIGH PRESSURE SYSTEM

Remarks:
NUMBER UNDERLINED SIGNIFIES OVEN NUMBER I.E. 128

READING TAKEN ABOVE QUENCH CAR AND COKE OVENS USING BLUE SKY AS CONTRAST.

Percent (%) Smoke Density

Comments		0	15	30	45		0	15	30	45	Comments
Push 1 128	0	0	0	0	0	30	0	0	0	0	16 73
1426	1	0	0			31	5	5			1722
2 46	2	0	0	0	0	32	0	0	0	0	17 48
1430	3	0	0			33	0	0			1728
3 71	4	0	5	0	5	34	0	0	0	0	18 83
1447	5	0	0			35	0	0			1735
4 56	6	0	0	0	0	36	0	0	0	0	19 58
1455	7	0	0			37	0	0			1745
5 81	8	–	–	–	–	38	0	0	0	0	20 23
MISSED IT	9	–	–			39	0	0			17:51
6 91	10	0	5	5	0	40	0	0	0	0	21 68
1520	11	0	0			41	0	0			1801
7 66	12	0	0	0	0	42	0	0	0	0	22 103
1528	13	0	0			43	0	0			18:07
8 101	14	0	0	0	0	44	0	0	0	0	23 1
1535	15	0	0			45	0	0			18:15
9 8	16	0	0	0	0	46	0	0	0	0	24 113
1622	17	0	0			47	0	0			18:21
10 111	18	0	0	0	0	48					
1629	19	0	0			49					
11 18	20	0	0	0	0	50					
1636	21	0	0			51					
12 121	22	0	0	0	0	52					
1642	23	0	0			53					
13 28	24	0	0	0	0	54					
1650	25	0	0			55					
14 131	26	0	0	0	0	56					
1658	27	0	0			57					
15 38	28	0	0	0	0	58					
1765	29	0	0			59					

VISIBLE EMISSIONS EVALUATOR

This is to certify that

Edward W. Blanar

met the specifications of Federal Reference Method "9" and qualified as a visible emissions evaluator. Maximum deviation on white and black smoke did not exceed 7.5% opacity and no single error exceeding 15% opacity was incurred during the certification test conducted by Eastern Technical Associates of Raleigh, North Carolina. This certificate is valid for six months from date of issue.

D. E. Brande
Course Moderator

Raleigh, North Carolina
Location

810002
Certificate Number

A. B. Savage
Field Instructor

January 7, 1981
Date of Issue

APPENDIX 3

LABORATORY ANALYSIS AND DATA REDUCTION

APPENDIX 3

LABORATORY ANALYSIS AND DATA REDUCTION

1.0 ANALYTICAL METHODS

All samples generated during the test program were analyzed at the BCM Laboratory in Norristown, Pennsylvania. The following discussions describe the analytical methods employed.

1.1 Particulate Samples

All glass fiber filters used in the sampling program had been tare-weighed following a 24-hour desiccation period prior to their use in the field. Upon their return to the laboratory, they were desiccated and reweighed. The weight difference was the amount of sample collected.

Nozzle, probe, and filter holder acetone washings were evaporated to dryness in separate tared beakers. The residue was desiccated and the beakers were reweighed to a constant weight. The weight difference was the amount of particulate matter collected at these locations in the sampling train.

Acetone blanks were evaporated to dryness in tared beakers, and were desiccated and reweighed. Any residue which remained was a contaminant in the reagent and was considered a blank weight used as a correction factor in subsequent calculations. The laboratory results of the particulate sampling program are listed in Table 3-1.

1.2 Moisture Content

Silica gel had been tare-weighed prior to its use in the field. Upon its return to the laboratory, the silica gel was reweighed. The entire weight gain was due to water vapor. The total volume of the impinger solutions, minus the original volume of water in the impingers, plus the volume of moisture and/or vapors collected by the silica gel, equaled the total moisture gain of the sampling train. This volume was used as the basis for percent moisture by volume calculations.

2.0 COMPUTER INPUT SHEET

The reduced data calculated from the field data sheets were combined with the laboratory results on the computer input data sheet to facilitate programming. The computer input data sheet follows Table 3-1.

3.0 EQUATIONS FOR THE CALCULATIONS OF TEST RESULTS

The equations following the data input sheets were programmed into the computer to facilitate the calculation of the test program results. The equations were prescribed in Methods 2, 3 and 5 of the Federal Register, Volume 42, Number 160, August 8, 1977, appropriately amended, and used to calculate the results of particulate testing and flow, temperature, and static pressure testing.

4.0 PARTICULATE TEST RESULTS

The complete results of the computer analyses of the data generated from the particulate test program are presented on the computer printout at the end of this appendix.

TABLE 3-1

LABORATORY RESULTS*

Run Number	Particulate Results Filter (mg)	P&C** (mg)	Total Catch (mg)
1	8.8	10.5	18.7
2	8.4	9.7	18.1
3	8.3	15.9	24.2

* Blank corrected

** P&C = probe and cyclone; includes acetone wash of nozzle, probe, cyclone, and front-half of filter holder

No.	Item															
10	Number of Tests	3														
20	Test Identification	"1"	"2"	"3"			"1A"		"3A"							
30	Stack Area, IN^2	4608	4608	4608												
40	Stack Temperature, °F	149	119.6	122												
50	Sample Volume, Dry, CF	24.27	24.99	24.14			26.30		24.7							
60	Avg. Meter Temperature, °F	66.4	50.8	55.2												
70	Avg. Orifice (Δ H) IN H_2O	.822	.824	.835												
80	Nozzle, Dia. IN	.195	.195	.195												
90	Duration of Test, Min.	50.35	54.27	52.12			53.02		52.72							
100	CO_2	.5	.5	.5												
110	CO	0	0	0												
120	O_2	20.0	20.0	20.0												
130	N_2	79.5	79.5	79.5												
140	Stack Pressure, IN Hg	29.64	30.32	30.32												
150	Barometric Pressure, IN Hg	29.44	30.12	30.12												
160	Pitot Correction Factor	.84	.84	.84												
170	Pitot Traverse (Avg.$\sqrt{\Delta P}$) IN H_2O	.820	.830	.826												
180	Volume, H_2O Collected, ml	173.9	163	165.1												
190	Ml, SO_3	0	0	0												
200	Ml, SO_2	0	0	0												
210	Total Collected Weight, mg	18.7	18.1	24.2												
220	Normality of SO_3	0	0	0												
230	Normality of SO_2	0	0	0												
240	Meter Calibration Factor	.97	.97	.97												

CLIENT: Republic Steel
LOCATION: Cleveland Ohio Q-CAR 22
JOB NO.: 00-4178-12

NAME OF FILE: RэP 2 RэP2A

AIRPOL 1 INPUT DATA SHEET

PIS include
STD APPENDIX

11

BCM

COMPUTATION SHEET

Sheet Number 1 of 1

Date

J. O. Number 00 – 4178 – 12

Computed by BA

Checked by

Name of Client Republic Steel

Project

Description Quench Car

$$11.7 \frac{\text{TONS}}{\text{OVEN}} \times \frac{24\text{ OVENS}}{\text{TEST}} = 280.8 \text{ TONS COKE/TEST}$$

$$\frac{280.8 \text{ TONS COKE}}{\text{TEST}} \times \frac{\text{TEST}}{\text{MIN}} \times \frac{60 \text{ min}}{\text{HR}} = \frac{\text{TONS COKE}}{\text{HR}}$$

$$\text{Lbs. PARTICULATE/hr} \times \frac{\text{HR}}{\text{TONS COKE}} = \frac{\text{Lbs PARTICULATE/}}{\text{TON COKE}}$$

EXAMPLE: RUN 1

$$\frac{280.8 \text{ TONS COKE}}{\text{TEST}} \times \frac{\text{TEST}}{50.35 \text{ min}} \times \frac{60 \text{ min}}{\text{hR}} = 334.6 \frac{\text{TONS COKE}}{\text{hR}}$$

$$6.76 \text{ Lbs PARTICULATE/hR} \times \frac{\text{HR}}{334.6 \text{ TONS COKE}} = .020 \frac{\text{Lbs PARTICULATE/}}{\text{TON COKE}}$$

RUN	TONS/OVEN	OVENS/TEST	TONS COKE/TEST	TEST TIME	TONS COKE/HR	Lbs PART/hr	Lbs PART / TON COKE
1	11.7	24	280.8	50.35	334.6	6.76	.020
2	11.7	24	280.8	54.27	310.4	6.52	.021
3	11.7	24	280.8	52.12	323.2	8.90	.027

PARAMETERS		1	2	3
REA OF BREECHING	(SQ IN)	4608.00	4608.00	4608.00
AMPLE VOLUME(DRY)	(STD CU FT)	23.27	25.26	24.20
OISTURE	(%)	26.0322	23.3055	24.3206
OLECULAR WEIGHT	STACK GASES	26.05	26.34	26.23
AS TEMPERATURE	(F)	149	120	127
AS VELOCITY	(FPM)	3138	3046	3057
AS VOLUME	(SCFM)(DRY)	63795	69019	67490
AS VOLUME	(ACFM)	100414	97483	97836
ARTICULATE CONC :				
GRAINS/STD CU.	FOOT (DRY BASIS)	.0124	.0110	.0154
GRAINS/STD CU.	FOOT (WET BASIS)	.0092	.0085	.0117
GRAINS/STD CU.	FOOT 12% CO2	.2970	.2648	.3696
GRAINS/CU.	FOOT (STK COND)	.0079	.0078	.0106
POUNDS/HOUR		6.7649	6.5258	8.9081
ORSAT ANALYSIS :				
CARBON DIOXIDE	(VOL %)	.50	.50	.50
CARBON MONOXIDE	(VOL %)	.00	.00	.00
OXYGEN	(VOL %)	20.00	20.00	20.00
NITROGEN	(VOL %)	79.50	79.50	79.50
EXCESS AIR	(%)	2024.29	2024.29	2024.29
ISOKINETIC	(%)	111.86	104.14	106.20

APPENDIX 4

EQUIPMENT CALIBRATION

Pls include
STD Appendix
8,9

PITOT CALIBRATION

The Pitot tubes were calibrated by measuring the velocity head in a duct with both an "S" type Pitot and a standard Pitot with a known coefficient. This calibration was performed at several different velocities. The Pitot tube coefficient can be calculated as follows:

$$C_{p(test)} = C_{p(std)} \sqrt{\frac{\Delta P_{std}}{\Delta P_{test}}}$$

where:

$C_{p(test)}$ = Pitot tube coefficient of "S" type Pitot

$C_{p(std)}$ = Pitot tube coefficient of standard Pitot

ΔP_{test} = Velocity head measured by "S" type Pitot

ΔP_{std} = Velocity head measured by standard Pitot

Coefficients were determined for each leg of the "S" type Pitot.

BCM

METER BOX CALIBRATION SHEET

Date 2-5-81 Box No. 1 Inspector DM

Pump OK Oil OK Wick OK Pump Serial No. 0574

Manometers OK Knobs OK Oil OK Tubing OK

Quick Connects OK Vacuum Gage OK Valves OK

Dry Gas Meter OK Volume 20.8 ft^3 Serial No. 673629

Thermometers OK In 51 °F Out 51 °F Ambient 59 °F

Amphenol OK Lights OK Switches OK Variac OK

Leak Check - Max. Vacuum 25 in. Hg Leak Rate 000 CFM

Remarks

Man. Orifice	CF_w	CF_d	T_w	IT_d	OT_d	T_d	Time θ
0.5	5.000	5.150	58.5	58.0	54.0	56.0	12.800
1.0	5.000	5.212	58.5	65.0	59.5	62.3	9.029
2.0	10.253	10.713	58.5	73.7	64.7	69.2	13.408

Tolerances: $1.6 \le \Delta H_@ \le 2.1$

$\Delta H_@ =$	$\frac{(0.0317)(\Delta H)}{(P_b)(OT_d+460)}\left[\frac{(T_w+460)(\theta)}{(CF_w)}\right]^2$	$\gamma =$	$\frac{(CF_w)(P_b)(T_d+460)}{(CF_d)(P_b+\Delta H/13.6)(T_w+460)}$
1.806	$\frac{(0.0317)(0.5)}{(30.08)(54.0+460)}\left[\frac{(58.5+460)(12.800)}{(5)}\right]^2$	.965	$\frac{(5)(30.08)(56.0+460)}{(5.150)(30.08+0.0368)(58.5+460)}$
1.778	$\frac{(0.0317)(1.0)}{(30.08)(59.5+460)}\left[\frac{(58.5+460)(9.029)}{(5)}\right]^2$	.964	$\frac{(5)(30.08)(62.3+460)}{(5.212)(30.08+0.0737)(58.5+460)}$
1.847	$\frac{(0.0317)(2.0)}{(30.08)(64.7+460)}\left[\frac{(58.5+460)(13.408)}{(10.253)}\right]^2$	.972	$\frac{(10.253)(30.08)(69.2+460)}{(10.713)(30.08+0.147)(58.5+460)}$

PITOT CALIBRATION

Pitot No. 4-7 STRAIGHT   Date 11-17-80   Engineer JFA

Range	Run No.	ΔP_{std}	A SIDE ΔP	A SIDE C_p	A SIDE DEV.	B SIDE ΔP	B SIDE C_p	B SIDE DEV.	DIF.
1	1	.031	.045	.822	0	.044	.831	+.003	
	2	.031	.045	.822	0	.044	.831	+.003	
	3	.031	.045	.822	0	.045	.822	-.006	
	AVG.			.822			.828		.006
2	1	.19	.27	.830	0	.27	.830	0	
	2	.19	.27	.830	0	.27	.830	0	
	3	.19	.27	.830	0	.27	.830	0	
	AVG.			.830			.830		0
3	1	.45	.65	.824	+.002	.62	.843	-.002	
	2	.45	.65	.824	+.002	.62	.843	-.002	
	3	.45	.66	.817	-.005	.61	.850	+.005	
	AVG.			.822			.845		.023
4	1	.62	.91	.817	+.003	.90	.822	0	
	2	.62	.92	.813	-.001	.90	.822	0	
	3	.62	.92	.813	-.001	.90	.822	0	
	AVG.			.814			.820		.006
5	1	.85	1.35	.786	+.008	1.35	.786	+.004	
	2	.86	1.4	.776	-.002	1.35	.790	+.008	
	3	.85	1.4	.771	-.007	1.4	.771	-.011	
	AVG.			.778			.782		.004
6	1	1.25	1.75	.837	-.005	1.70	.849	-.006	
	2	1.3	1.75	.853	+.011	1.70	.866	+.011	
	3	1.25	1.75	.837	-.005	1.70	.849	-.006	
	AVG.			.842			.855		.013
7	1	1.45	1.95	.854	0	1.90	.865	0	
	2	1.45	1.95	.854	0	1.90	.865	0	
	3	1.45	1.95	.854	0	1.90	.865	0	
	AVG.			.854			.865		.011

$C_p = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{\text{"S"}}}}$

DEV. = $C_p - \overline{C_p}$

DEV. $\leq$ 0.01

DIF. = $\overline{C_{p(A)}} - \overline{C_{p(B)}}$

DIF. $\leq$ 0.01

Summary

SOTDAT/STEEL LIBRARY SYSTEM

Report Title:

Plant and Location: Republic / Cleveland

SCC: 30300303

Testing Date(s): 3/80

By Whom: Co.

Stack Test Review Attached: obs. by Acurex

Reviewed By:

Problems Seen by Reviewer:

Confidentiality Status:

If status is confidential, list confidential pages or sections:

Source of Determination of the Confidentiality Status:

Report Encoded By:

Date Encoded:

Form Numbers:

Comments:

Observation only

ACUREX Corporation

My Copy

Energy & Environmental Division

Mr. Daniel Bakk
Air Enforcement Branch
U.S., Environmental Protection Agency
230 South Dearborn Street
Chicago, Il. 60604

April 8, 1980

Ref: Republic Steel Corporation
Sampling Review of
Koppers One-Spot Gas Cleaning Car

Dear Mr. Bakk,

Accurex Corporation was requested by the U.S. EPA Region V, to witness the testing of a Koppers One-Spot Gas Cleaning Car, operating at Republic Steel Corporation's No. 1 Coke Battery, Located in Cleveland, OH. The purpose of the test witness was to assure that EPA Method's 1, 2, 3 and 5 were used in producing data to demonstrate an emission rate of 0.03 pounds per ton of coke pushed with 90% car capture efficiency.

The attached summary will outline the proceedings of the test program and comments.

If there are any questions regarding their report, they are to be directed to Accurex Corporation, Chicago operations, Phone 312-430-4545 Mr. Joseph V. Miceli, Manager.

Sincerely,

Joseph V. Miceli

Joseph V. Miceli
Accurex Corporation
Manager
Chicago Operations

JVM/MA

Attachments:

1.0 Introduction

This trip report summarizes information obtained during the testing of the one spot hot car and fume emission control at Republic Steel Corporation's No. 1 Coke Battery in Cleveland, OH.

On the morning of March 20, 1980, personnel representing EPA Region V (Martin Tembly) and Acurex arrived at the No. 1 Plant of Republic Steel Corporation. The purposes of the visit were:

(i) To observe the operation of the One Spot Hot Car and Fume Emission Control.

(ii) To determine the capture efficiency of the system.

(iii) To witness the sampling procedures employed by the Republic test crew.

(iv) To determine if said test procedures are acceptable to EPA Region V, for the determination of technological feasibility of compliance of the One Spot Hot Car and its Fume Emission Control.

This trip report will be concerned with all but item (ii). Mr. Martin Tembly will submitt a report to EPA Region V concerning this aspect of the program.

Mr. Tom Harlan of Republic Steel supervised the test program and crew. Mr. Roy Martin of Republic Steel provided information as to the operation of the Fume Emission Control Scrubber and its related equipment. Further information as to the scrubber operations was supplied by Mr. Yu-Fang Wang, Application Engineer of Riley Envirneering Inc., the manufacturer of the scrubber. Also on hand to witness overall operations and testing was Mr. Dave McGee of Koppers, the manufacturer of the One Spot Hot Car.

2.0 One Spot Hot Car and Fume Emission Control Operation

Basically, during a single point test run, the One Spot Hot Car is positioned in line to receive coke from an oven after the oven door is removed and the coke guide car is lined up to direct coke into the car. Attached to the coke guide is a retractable hood which makes a reasonably tight seal when extended down to the coke car. Once the hood is in place, coke is pushed from the oven through the guide and into the car. Before the coke is pushed into the car, dampers (or vanes) are opened on the scrubber system allowing a draft to be drawn from the one spot coke car, drawing particulate and gases from the car through the Riley venturi scrubber and vented to the atmosphere. The scrubber fan continues to draw this particulate ladden effulent through the scrubbing system until the coke car is positioned under sprays in the quench tower. Just prior to the quench, the fan dampers (or vanes) close and the coke is quenched. Quenched coke is then deposited on the wharf and the process is repeated at pre-determined ovens.

It is during the time period that the hood drops to the one spot coke car and then enters the quench tower that the Republic test tean sampled the gases exiting the scrubber outlet duct.

3.0 Sampling Equipment

Republic Steel's test team under the direction of Mr. Tom Harlan utilized a Research Appliance Company (RAC) sampling train. This particular sampling train is constructed with all the component parts required by the EPA Method 5 procedure. In order to adapt the sampling train to this particular environment, certain modifications were made by Republic. First, the probe had to make two ninety degree (90^{o}) turns due to the obsticals and clearances when the car passes through the quench tower. Second, the probe had two end pieces (short probes with nozzle and pitot tube) enabling the sampling of each of the twelve (12) points in the duct work. Third, the pitot lines passed through moisture traps due to the saturated stack gas.

As previously mentioned, the sampling train had all required component parts; nozzle (calibrated[1]), cyclone (w/ collection flask), filter holder (w/cyclone and filter encased in a heated oven), impinger train (complete w/greensberg smith and modified greensberg smith impingers filled with the required amounts of water and silica gel) impinger gas exit temperature gauge, imbilical cord, and control consule (calibrated) to constitute a EPA Method 5 sampling train.

The sampling train power supply was supplied by a gas generator mounted on top of the one spot coke car (see discussion for problem generated by generator).

During the testing integrated gas samples were obtained and analyzed by gas chromatrography.

Equipment used in sample recovery will be outlined in the discussion.

[1]The probe heat was calibrated and the declining heat curve will be included in Republic's test report.

4.0 Discussion

Each coke oven pushed from battery No. 1 consituted a sampled point. There were twelve points (12 pts.) in all (consequently 12 pushes). The duration of time at each point sampled, was dictated by the time it took for the guide hood to engage the one spot coke car at a particular oven, to the time the one spot coke car entered the quench tower. This time period varied between two (2) and six (6) minutes depending on the distance from oven to quench tower.

The Republic test crew stationed one man in the car operators control room to relay to the train operator (inside the electrical consule room) when the hood was in place by intercom. The sampling train operator would start his test at this point. He would then note the time coke was actually pushed from the oven, through the guide, and into the car. At this time the test crew member positioned in the control room would record the oven number being pushed, the time of engagement to the car and time the coke began entering the car.

At the beginning of a sampled point, the sampling train operator would shut down the probe heat and turn on the vacuum pump of the control consule.

It should be noted that during these twelve "test" personnel representing Koppers, Riley and Republic were monitoring the car and scrubber operations. Prior to the start of the tests several people under the direction of Roy Martin (of Republic) were inside the scrubber to inspect the rods, demister section and presumably the scrubber sump.

During this pre-survey it was discovered that the vanes which are before the fans (flow operation) did not respond to remote signals to open and close. Consequently, Roy Martin operated the vanes manually during the tests.

After six points (6 pts.) of the test were completed, the end section of the probe was replaced with a shorter section in order to sample the remaining points in the duct and to maintain a clearance of the spray nozzles in the quench tower. This portion of the probe was secured by capping both ends for pending sample recovery.

Following the eighth (8th) point sampled a delay of approximately two hours (2hrs.) was experienced due to quench tower sprays stuck in the quench mode.

Upon completion of the last point sampled a post-leak check was performed. The leak check was at a vacuum of twenty-one (21) inches of mercury instead of fifteen (15) and yielded a leak rate of 0.025 cubic feet in a one minute period. It was suggested that because of the wet filter (due to saturated gas) and the post-leak check being over the required limit that the sampled volume be corrected per section 6.3 (note) in the CFR 40 July 1, 1978 (Appendix A).

The sampling train was then disassembled, (with particular care), appropriately capped and secured in the Republic mobile trailer for transfer to their local laboratory.

Under the direction of Mr. Harlan the impinger volumes were measured, rinsed with water (retaining sample of rinse water for analysis) and rinsed with acetone (retaining a acetone sample for analysis). Included in the water and

Sampling Train

Nomagraph Pre-Test Input

Pitot tube Coeficient	0.85
ΔH@, Control Box #1917	1.92
Assumed %H_2O	10.0
Stack Pressure, (inches H_2O)	0.4
Estimated Temperature @ Meter, °F	120
Estimated Temperature @ Stack, °F	130
$\frac{\text{Pressure @ Stack}}{\text{Pressure @ Meter}}$	1.0
Diameter of nozzle, inches	3/16
Average ΔP, (inches H_2O)	1.5
Barometric Pressure, (inches Hg)	28.47

Process Test Data

Sample Point	Oven Number[1]	Scrubber ΔP[2] Hood Engaged	Scrubber ΔP[2] Coke Push	Test Time Start-Hood	Test Time Start-Coke
#1	223	30	32	9:55AM	9:56AM
2	213	34	33	10:07AM	10:10AM
3	175	36	33	10:32AM	10:33AM
4	185	34	31	10:47AM	10:47AM
5	195	36	32	11:10AM	11:12AM
6	205	35	31	11:23AM	11:26AM
7	215	36	32	11:43AM	11:46AM
8	225	36	33	1:37PM	1:38PM
9	177	36	31	2:00PM	2:01PM
10	187	34	32	2:10PM	2:14PM
11	197	35	32	2:23PM	2:27PM
12	207	36	32	2:45PM	2:47PM

[1] All ovens were battery No. 1.
[2] As indicated in operators cab.

acetone rinses were the back half of the filter holder and the "U" connectors that join the impingers. The silica gel was transferred to its orifinal pre-weighed container and weighed.

The nozzle, probe (all four pieces) cyclone, cyclone flask and front half of the filter holder were rinsed and scrubbed by brush, with acetone until no visible particulates were present. This wash as well as all others were contained in pre-washed and pre-weighed breakers. The impinger solution and washings were contained in a teflon sealed jar and retained for chloriform/ether extraction.

At the last moment, I asked Mr. Harlan to wash the front half of the train with water and retain this washing for future evaporation. He agreed and this washing was also contained in a teflon sealed jar.

In all, I felt that all samples obtained during the test were handled withthe utmost care and professionalism for analysis.

The following chart will show the weights expected from samples generated by various portions of the sampling train.

FRONT HALF

(i) Filter

(ii) Nozzle, Probes, Cyclone (w/flask), Front Half of Filter Holder Acetone Wash

(iii) Nozzle, Probes, Cyclone (w/flask), Front Half of Filter Holder Water Wash

BACK HALF

(i) Chloriform/Ether Extraction of Impinger Water Solution, (Included condensed moisture and wash) Soluable and Insoluables

(ii) Barium Chloride Titration of Impinger Water Solution (Includes condensed moisture and wash) Sulfates

(iii) Impinger Acetone wash (evaporated and weighed)

(iv) Silica Gel (Moisture)

Accurex has supplied a flow chart for chloriform/ether sample analysis of the back half samples.

As requested, Accurex will review the final report of the test and subsequent analysis when submitted by Republic.

Summary

SOTDAT/STEEL LIBRARY SYSTEM

Report Title:

Plant and Location: Republic/Cleveland

SCC: 30300303

Testing Date(s): 5/19, 21, 23/80

By Whom: Co.

Stack Test Review Attached: NO

Reviewed By:

Problems Seen by Reviewer:

Confidentiality Status:

If status is confidential, list confidential pages or sections:

Source of Determination of the Confidentiality Status:

Report Encoded By:

Date Encoded:

Form Numbers:

Comments:

Republicsteel

Republic Steel Corporation
Cleveland District
3100 East 45th Street
Cleveland OH 44127

September 12, 1980

PH Ekberg
District Manager

Ms. Sandra Gardebring
Director of Enforcement
U.S. E.P.A. Region V
230 South Dearborn Street
Chicago, Illinois 60604

Subject: U.S. E.P.A. Consent Order #E.P.A. 5-77-A3

Dear Ms. Gardebring:

In accordance with the requirements of Paragraph VIII of the subject order, Republic Steel Corporation herewith submits its four month progress report for its Cleveland District plant.

Paragraph I-B - Applications for an Ohio E.P.A. permit to install and a U.S. E.P.A. PSD approval for a new Sinter (waste materials recycle) Plant at its Cleveland District were submitted by Republic on June 28, 1979. This plant is proposed as fulfillment of option (2) of Paragraph I-B of the subject Consent and Abatement Order.

Paragraph I-C-4 & II-D - Modifications have been made to the Koppers car along with scrubber modification recommended by Riley. The following test results were obtained:

May 19, 1980 - Car #11 - .05# Particulate/Ton Coke
May 21, 1980 - Car #12 - .04# Particulate/Ton Coke
May 23, 1980 - Car #13 - .04# Particulate/Ton Coke

A stipulation agreement is in progress with Federal EPA. This agreement will modify and amend the standard to .06# of filterable particulate/ton coke pushed for #1, #2, #3 and #4 Batteries. This change in the standard will reduce the total amount of particulate emitted to the atmosphere by approximately 30 tons per year from all four batteries.

All major equipment has been received for the control of pushing emmissions for #6 and #7 batteries. Construction of land base system is completed and the system is being debugged. The first Chemico car is to be installed by October 1, 1980, in accordance with the modified schedule set forth in the stipulation agreement.

We believe the above delays are beyond the control of Republic. Republic has made, and will continue to make, every effort to minimize further delays.

Very truly yours,

P. H. EKBERG
District Manager
Cleveland District

SL KRAMER/dl

cc: G. A. Johnson
W. L. West
C. M. Brown
J. D. Donohoe
R. C. Cobb, Jr.
H. F. Eisengrein
R. E. Cachat
L. Aguier
P. J. Kelley (U.S. E.P.A.)
File: U.S. E.P.A. #5-77-A3

S00042

404

SOTDAT/STEEL LIBRARY SYSTEM

Report Title: See Report

Plant and Location: Republic Steel, Cleveland OH

SCC: 30300303

Testing Date(s): 11/28-29/79

By Whom: Koppers/Company

Stack Test Review Attached: NO

Reviewed by:

Problems Seen by Reviewer:

Confidentiality Status: Clear (4)

If status is confidential, list confidential pages or sections:

Source of Determination of the Confidentiality Status: Memo entitled: "Steel Technical Support Materials", From: Edward Reich, Director DSSE, To: Tom Voltaggio

Report Encoded by:

Date Encoded:

Form Numbers:

Comments:

504869

①

Title: See Report

Plant and Location: Republic Steel Cleveland, Ohio

SCC: 30300303

Test Date: 11/28-29/79

By Whom: Koppers/Company

Koppess one spot gas cleaning car

Encoded By:

Date Encoded:

Completed By:

Form No.:

Republicsteel

Republic Steel Corporation
General Offices: Republic Building
Law Department
PO Box 6778
Cleveland OH 44101

February 14, 1980

Peter Kelly, Esq.
U.S. EPA
Enforcement Division
230 S. Dearborn Street
Chicago, Illinois 60604

Re: Republic Steel Corporation
Cleveland District -
Koppers One-Spot Cars

Dear Mr. Kelly:

As you requested, I am enclosing data from the Koppers-Republic test of the Koppers one-spot car November 28-29, 1979. Because the test was for internal use in assessing performance of the system, no test report was even written up. However, I will attempt to supply any additional data concerning the test that you request.

You will note that for No. 1 Battery over 96% of the particulate in the inlet gas was greater than 2.5 μ versus a design specification of 90%. From 85% to 89% of the particulate was greater than or equal to 16.8 μ.

We are continuing to work with the scrubber vendor to assess how the system might be improved. However, it is our conclusion, and that of Koppers, that the one-spot cars presently in use at Cleveland District Coke Batteries Nos. 1-4 certainly represented "best available control technology" at the time they were selected. In fact, when reliability is considered, we believe they may still represent the best available technology.

I am now preparing a formal notice to Region V concerning the delay in the repair of Coke Battery No. 6 and the consequent delay in the operation of the Chemico car at Coke Battery No. 7.

Chemico cars may not be able to reach .03 lb/ton emission.

Please call me if you have any questions concerning the testing of the Koppers car.

Very truly yours,

Roy C. Cobb/pls

Roy C. Cobb, Jr.
Assistant Counsel

RCC:pls
Enclosures

Lawrence R. Smith
Manager of Production

KOPPERS

January 24, 1980

Mr. M. J. Fowler
Materials Manager, Mechanical
Republic Steel Corporation
Republic Building
P. O. Box 6778
Cleveland, Ohio 44101

SUBJECT: NO. 1 COKE OVEN BATTERY
ONE SPOT HOT CAR AND
FUME EMISSION CONTROL
KOPPERS CONTRACT 2522
YOUR P.O. 400-694189-322
TEST RESULTS

Dear Marv:

As promised in our meeting of Wednesday, December 12, we review below for your information the results of the subject test work at Republic Steel's Cleveland No. 1 Plant.

I. INTRODUCTION:

Before going into the most recent experience with the pushing emission control system for No. 1 Coke Battery in Cleveland, a short review of the history of work involved is required to thoroughly understand the overall development of the system.

At the time the original proposal was submitted to Republic Steel by Koppers, the assumed standard to be met for the pushing emission discharge was 0.1 pound of particulate per ton of dry coal charged and a 20/60% opacity limitation. This standard has easily been satisfied with the system as it has operated to date. However, shortly after receiving the contract, Koppers was notified by RSC of a revised standard to be met under a U.S. EPA order--an allowable emission rate of 0.03 pound per ton of coke pushed with 90% collection. After reviewing this revised standard, Koppers determined that the standard would be met with the specified scrubber efficiency of 99.6%.

II. REVIEW OF TESTING:

Republic Steel initiated testing about one year ago with assistance from Koppers Engineering & Construction Group. Koppers formulated a test program by updating previous data obtained on a high-volume, land based system. The one-spot mobile pushing emission control system at the Republic plant represented Koppers first opportunity to obtain data on a system of this type.

II. REVIEW OF TESTING (cont'd)

After reviewing the test results through October of this year, Republic and Koppers agreed to a joint test whereby both the inlet and outlet loadings wou be measured on the same test ovens. In addition, inlet loadings and particle size distributions would be measured for pushes during three time periods, i. the pre-push time period, the actual push period and the travel time period t the quenching station.

A review of attachment "A" indicates that during our most recent test we achi an outlet loading of 0.067 pounds per ton of coke pushed which is still in ex of the allowable 0.03 pounds per ton of coke pushed. This corresponds to a system efficiency of 94% instead of the specified 99.6%, despite the fact tha the inlet loading parameters were within those given to the vendor that desig and built the scrubber. Previous tests have resulted in outlet loadings as l as 0.05 pound of particulate per ton of coke pushed.

III. CONCLUSION:

Despite the many costly and time consuming changes that have been made to the equipment to improve performance, Koppers concludes that we are now past the point of diminishing returns and that further improvement is not achievable w the existing system. In effect, to improve particulate capture at this time would require a complete revamping of the gas cleaning car; i.e., redesign and replacement of the gas cleaning scrubber and evacuating mechanisms, accompanying changes to their auxiliaries, drives and even lengthening of the car frame itself. Further, while we are pursuing with the scrubber vendor th failure of the scrubber to perform as specified, Koppers is of the opinion that even changes of this magnitude may still not result in an appreciable decrease in particulate emission or attainment of the revised standard. In s Koppers believes that RSC's coke side emission systems have, in fact, incorporated the best available control technology.

3 Koppers Scrubber Cars

It is, therefore, Koppers recommendation that these systems be left in their current state and that the regulatory authorities be advised that our maximu attainable effectiveness is approximately 6% short of the requirement. It sh also be pointed out that these cars are now operating at 94% reliability--a more important factor than particulate capture beyond the 94% now attainable. With the addition of the third car now in service, we believe RSC Cleveland Batteries 1, 2 3 and 4 will have a coke side emission control system with clo to 100% reliability.

Please review the above and advise us of your comments as soon as possible. mentioned earlier, Koppers is prepared to work with and accompany RSC to meet with the regulatory authorities to explain our conclusions concerning the syst

L. R. Smith

LRS:tym
Attachment - A
bcc: Mr. H. Clagg-RSC

REPUBLIC STEEL CORPORATION
CLEVELAND DISTRICT 1
ONE SPOT GAS CLEANING CAR
EMISSION TEST RESULTS

DESCRIPTION	OUTLET LOADING (in test duct)	INLET LOADING (before pre-cooling)
Date	11/29/79	11/29/79
Car Number	11	11
Average Duct Temperature (Degrees Fahrenheit)	99	528
Average Duct Velocity (FPS)	83	60
Average Flow Rate (ACFM)	28,500	35,930
(DSCFM at 68 degrees F, 29.92" hg.	25,000 (note air infiltration ?)	18,520
Particulate Loading		
Grains/DSCF	.051	1.254 ~ 96%
lb/ton dry coal	.047	0.783
lb/ton coke pushed	.067	1,119 ~ 94%
Percentage of particulate catch in probe wash	65 %	---
Venturi static pressure drop inches H_2O	34.8 "	---

.182 lbs/push per min. x 4 min.
.72857 lbs/push
~~[illegible]~~
2.716 tons coke/push x 4 mins.
11.53 tons / push

PLANT: Republic Steel Cleveland

PROJECT: Gas Cleaning Car tests 11/28-29/77

Inlet to Scrubber

Duct temp. °F	528
Avg. duct velocity fps	60
Avg. flow rate ACFM	35,930
dSCFM	18520

Particulate loading

grains / dSCF	1.254	~ .05
14.3/oven lb / ton coal	0.783	94%
10.01/oven lb / ton coke	1.119	

Particulate mass rate

lb emitted / hr scrubber operation 199.1

✓ Particle Size Measurements

During Push

Test	gr./dSCF	OVENS	<.7	<1.0	<1.6	<3.1	<4.9	<7.0	<10.4	<1[illegible]
1	7.4	199*, 176	1.37	.91	.61	.76	1.52	1.97	3.79	[illegible]
2	13.5	149, 159	1.87	1.10	2.12	2.72	1.61	1.70	2.12	[illegible]
3	8.8	222, 174	1.31	.39	.13	.78	1.18	2.22	3.14	[illegible]

Percentage in size range (μ)

During Travel

Test	gr/dSCF	OVENS	<.8	<1.2	<1.9	<3.7	<5.9	<8.4	<12.5	<[illegible]
4	0.39	209, 145, 155	25.0	4.46	0.	0.	0.	0.	3.57	[illegible]

During 'Prepush'

Test	gr/dSCF	OVENS	
5	0.17	172, 127, 192, 202	100% ≥ 14.7 μ

* green ?

PLANT Republic Steel Cleveland

SUBJECT Gas Cleaning Car Tests 11/28-29/79

Comparison of particle size found vs. venturi specification

Spec	Found — Battery 1+2	Found — Bat. 2 only
90% > 2.5 μ	96% > 2.5	94.8 > 2.5
6.5% 1.0-2.5 μ	2% 1.0-2.5	2.2% 1.0-2.5 μ
1.5% 0.5-1 μ	1% 0.5-1.0	1.2% 0.5-1.0
0.8% 0.25-0.5 μ	1% < .5	1.3% < 0.5
1.2% < 0.25		

The Koppers one-spot car has been designed to conform to very restrictive physical limitations. There is no realistic emission sampling point on the car in its normal operating state. An addition has been designed to take the exhaust from the scrubber and silencer and duct it back along the length of the scrubber car before being discharged to the outboard side of the scrubber car. The duct is altered from its circular cross section to a square cross section maintaining the same duct area. This permits sample extraction from the inboard side of the duct alone. A samplin platform is positioned just ahead of the resistor room on the scrubber car. A sampling slot will be provided vertically through the side of the duct. The unused portions of this slot will be covered when not needed. These details are shown in the accompanying figure. The resistor room will provide shelter for the sampling console and testers during trips through the quench station.

At this sampling location, U.S. EPA Method 1 requires sampling at 12 traverse points. The exhaust stream will be sampled according to U.S. EPA Method 5. Sampling will begin when the first coke falls into the quench car and will continue until the top door on the quench car is reopened and the q begins. The total sampling time per push will be recorded. The duration of one push will constitute the sample taken at one traverse point. It is expec that this will amount to approximately three minutes per point, or 36 minutes per replicate. Using design estimates, it is also expected that a nozzle of 1/8-inch diameter will be required and a standard metered volume of between 15 and 20 cubic feet will be sampled per replicate.

Samples will be taken on consecutive pushes as far as it is practical to do so.

Gas samples will be integrated throughout several pushes and will be analyzed by gas chromatography to determine molecular weight.

Standard Method 5 procedures will be followed in cleanup and analysis.

Three replicates between 90 percent and 110 percent isokinetic will constitute a complete test.

TJH:EJP
1-6-78

AGENCY USE ONLY
Date Received ______
No. Assigned ______
Premise # ______

INTENT TO TEST NOTIFICATION

I. SOURCE INFORMATION

NAME Republic Steel Corporation ADDRESS 3100 E 45th Street, Cleveland, Ohio 4412

PERSON TO CONTACT No. 1 Coke Plant, No. 1 Battery, Koppers One-Spot Gas Cleaning Car TELEPHONE ______

II. TESTING FIRM INFORMATION

NAME Republic Steel Corporation ADDRESS P.O. Box 6778 (519-R) Cleveland Ohio, 44

PERSON TO CONTACT Tom J. Harlan, Jr. TELEPHONE 574-4580

III. GAS STREAM SAMPLING INFORMATION. IDENTIFY ALL GAS STREAM POLLUTANTS TO BE SAMPLED.

Pollutants	Number of Sampling Points	Total Time Per Test	Number of Tests (minimum of 3)	Estimated Pollutant Concentration (Specify Units)	Method employed to e mate pollutant conce tion, i.e., material balance, emission fa reference, (specify)
1. Particulate	12	~36 min	3	0.05 gr/DSCF	Calculated from
2.					scrubber efficiency
3.					estimated inlet loa
4.					
5.					

IV. STACK INFORMATION

1. Approx. gas temp. 177 °F

2. Approx. gas flow 30,000 A.C

V. DATE OF LAST CALIBRATION

1. Velocity measuring equipment Just prior to test.
2. Gas volume metering equipment " " " "
3. Gas flow rate metering equipment " " " "
4. Gas temperature measuring equipment " " "

VI. SAMPLING TRAIN INFORMATION

1. A schematic diagram of each sampling train. The name, model number, and date of purchase of commercially manufactured trains should be included with the diagram. Research Appliance Co. Model #2343, Dec. 1974. Standard EPA Method 5 Train
2. The type or types of capture media to be used to collect each gas stream pollutant. Reeve Angel 900AF
3. Sample tube type, i.e., glass, teflon, stainless steel, etc.
4. Probe cleaning method and solvent to be used, if applicable. Standard Method 5, Acetone

VII. LABORATORY ANALYSIS

A description of the laboratory analysis methods to be used to determine the concentration of each pollutant. Method 5

VIII. DATA SHEETS

A sample of all field data sheets to be used in the test or tests.

IX. DESCRIPTION OF OPERATIONS

A description of any operation, process, or activity that could vent exhaust gasses to the test stack. This shall include the description and feed rate of all materials capable of producing pollutant emissions used in each separate operation.

NOTE: All testing shall be performed at maximum rated capacity as specified by the equipment manufacturer, or at the maximum rate actually used in the source operation, whichever is greater.

X. STACK AND VENT DESCRIPTION

A dimensional sketch or sketches showing the plan and elevation view of the entire ducting and stack arrangement. The sketch should include the relative position of all processes or operations venting to the stack or vent to be tested. It should also include the position of the sampling ports relative to the nearest upstream and downstream gas flow directional or duct dimensional change. The sketches should include the relative position, type, and manufacturer claimed efficiency of all gas cleaning equipment.

A cross sectional dimensional sketch of the stack or duct at the sampling ports, showing position of sampling points. In the case of a rectangular duct, show division of duct into equal areas

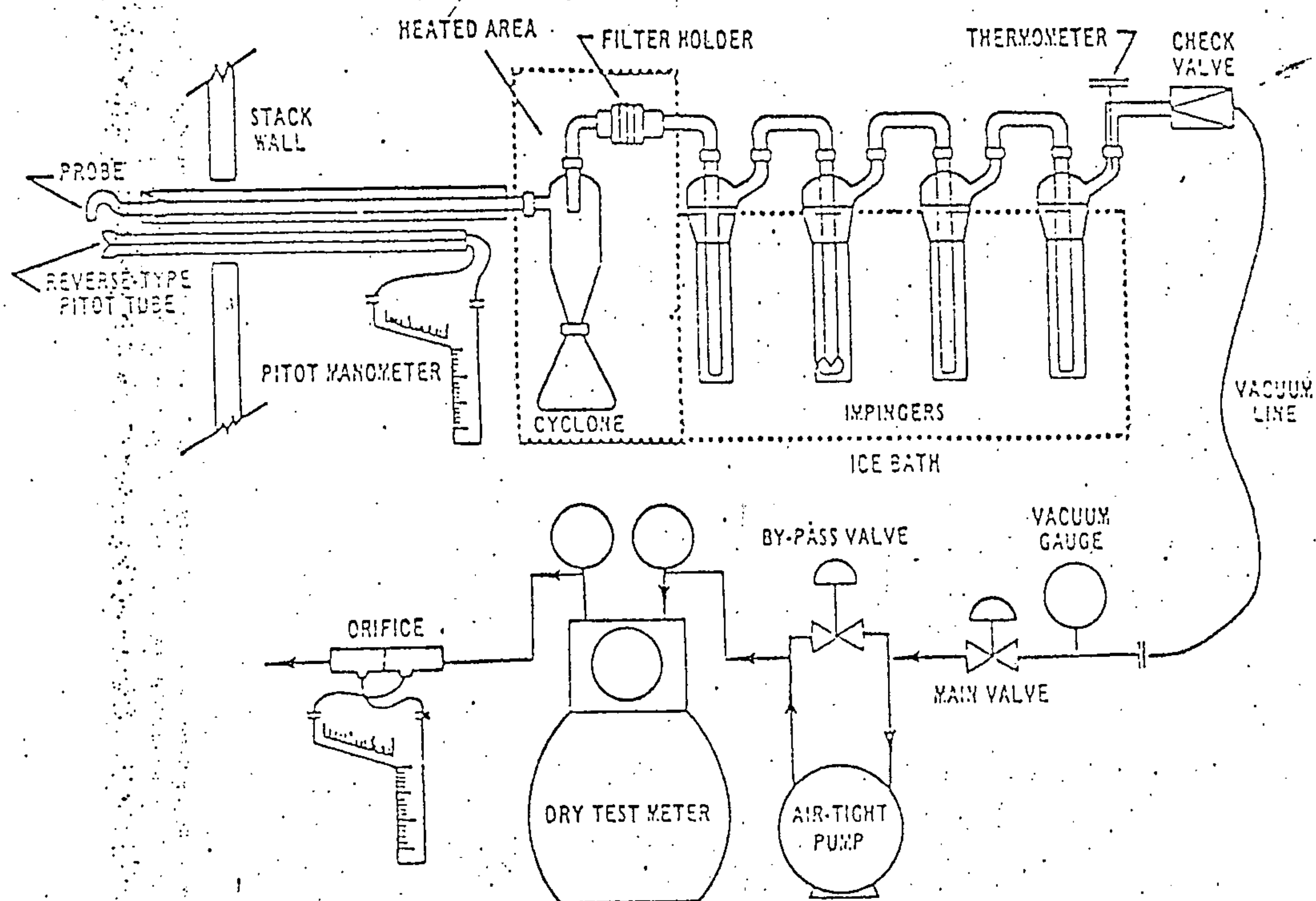

Figure No. 1 Particulate sampling train.

Attachment VI

FIELD DATA

PLANT ______________________
DATE ______________________
SAMPLING LOCATION ______________________
SAMPLE TYPE ______________________
RUN NUMBER ______________________
OPERATOR ______________________
AMBIENT TEMPERATURE ______________________
BAROMETRIC PRESSURE ______________________
STATIC PRESSURE, (P_s) ______________________
FILTER NUMBER (s) ______________________

PROBE LENGTH AND TYPE ______________________
NOZZLE I.D. ______________________
ASSUMED MOISTURE, % ______________________
SAMPLE BOX NUMBER ______________________
METER BOX NUMBER ______________________
METER $\Delta H_{@}$ ______________________
C FACTOR ______________________
PROBE HEATER SETTING ______________________
HEATER BOX SETTING ______________________
REFERENCE Δp ______________________

SCHEMATIC OF TRAVERSE POINT LAYOUT

READ AND RECORD ALL DATA EVERY ________ MINUTES

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		STACK TEMPERATURE (T_s), °F	DRY GAS METER TEMPERATURE		PUMP VACUUM, in. Hg	SAMPLE BOX TEMPERATURE, °F	IMPINGER TEMPERATURE, °F
					DESIRED	ACTUAL		INLET $(T_{m_{in}})$, °F	OUTLET $(T_{m_{out}})$, °F			

COMMENTS:

Incandescent coke is pushed from the oven through a hooded coke guide into the quench car. The top door of the quench car is closed and the quench car is exhausted through the gas cleaning car. The incoming gas at approximately 1850°F, 62,000 ACFM, and 11.5 grains/DSCF loading is cleaned in a high efficiency scrubber, passed through a fan and exhausted. The gas cleaning car operates until the quench car top is re-opened and the coke is quenched at the quench station.

ATTACHMENT X

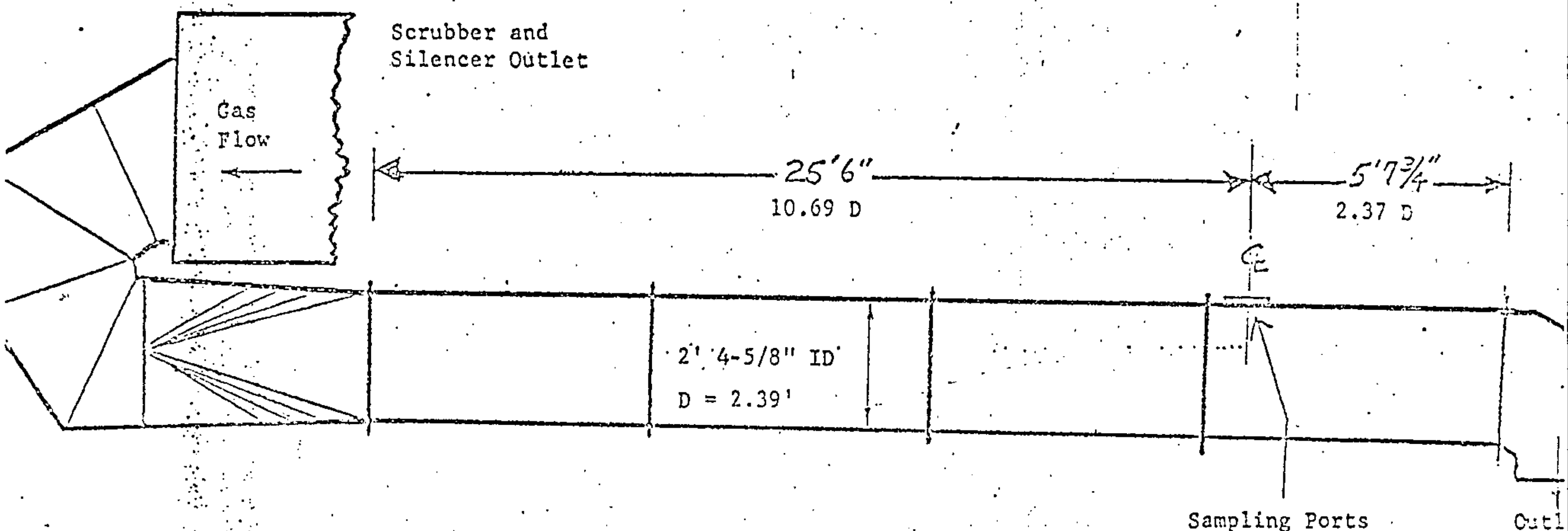

Figure No. 2   Gas Cleaning Car Test Duct

ATTACHMENT X

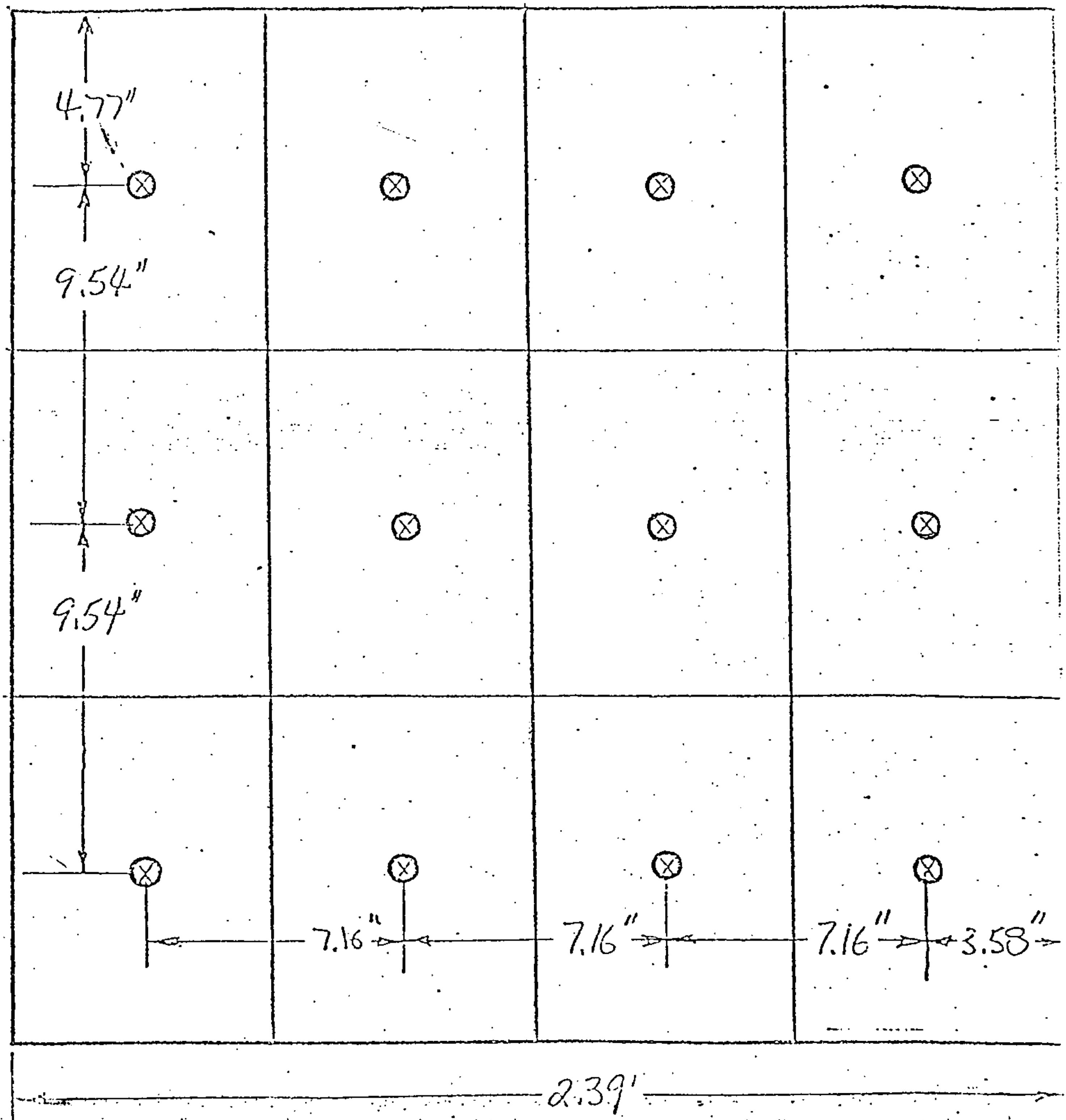

Figure No. 3 Gas Cleaning Car Test Duct Cross Section Showing Traverse Point Locat

Stack and scrubber sump cleaned prior to test

Koppers inlet test is performed

$V_{m(std)} = 30.128 \left(\frac{528}{29.92}\right)\left(\frac{29.36 + \frac{1.3731}{13.6}}{508.69}\right)$

A) $V_{m(std)} = 30.782$ dscf

$V_{wc} = 0.04707(17) = 0.8002$ scf

$V_{wsg} = 0.04715(7.5) = 0.3536$ scf

B) $B_{ws} = \frac{1.1538}{1.1538 + 30.782} = .036 = 3.6$ %

$M_d = .44(1) + .32(21) + .28(78) =$

C) $M_s = 29.0(.964) + 18(.036) = 28.603$

$V_s = 85.48(.85)\left[\frac{559.38}{29.45 \times 28.603}\right]^{1/2}(1.4035)$

D) $V_s = 83.101$ ft/sec $= 4986$ ft/min

E) $Q_A = (4986)(5.690) = 28,370$ ACFM

$Q_s = 3600(83.101)(5.690)(.964)\left(\frac{528}{29.92}\right)\left(\frac{29...}{559...}\right)$

F) $Q_s = 1,524,575$ DSCFH $= 25,409$ DSCFM

$\%I = \frac{(559.38)(30.782)(29.92)(1.00)}{(0.002181668)(83.101)(29.45)(.964)(528)(60)(.35...)}$

G) $\%I = 94.9\%I$

$$PMR = \frac{.1003 \text{ gm}}{30.782 \text{ dscf}} \times \frac{1,524,575 \text{ dscfh}}{454 \text{ gm/\#}} = 10.^{c}$$

$$Conc = \frac{.1003 \text{ gm}}{30.782 \text{ dscf}} \times .002205 \text{ \#/gm} = 7.\cancel{28} \times 10^{-6}$$

$\times 7000$ grain/# = 0.0508

$$Conc = \frac{7.18 \times 10^{-6} \text{ \#/dscf} \times 25,409 \text{ dscfm} \times 3.24 \text{ min/}}{14.3 \text{ tons dry coal/oven}}$$

= 0.0473 $\frac{\text{\# particulate}}{\text{ton dry coal charged}}$

$$Conc = \frac{\text{\#/ton coal}}{0.70} = \cancel{0.0587} \quad 0.0591$$

\# part / ton coke

Box & Test Duct cleaned out
one hour passed for system heat up

15psi [illegible] pressure

1 [illegible] 133
2 .23
3 0
4 7.5 [illegible]

12	11	6	5
10	9	4	3
8	7	2	1

PARTICULATE FIELD DATA

VERY IMPORTANT - FILL IN ALL BLANKS

Plant: RSC #1 Coke Plant
Run No.: 13
Location: 11 Koppers Co. Stack
Date: 11/29/79
Operator: ______
Sample Box No. ______
Meter Box No. 1917
Meter $\Delta H_@$: 1.92
C Factor: .92

Test Start Time: 9:46
Stop Time: 1:25
Filter No. 172
Filter Tare Weight ______
Orsat No. ______
Date Rebuilt ______
Fyrite No. ______
Date Rebuilt ______
Nomograph ID. No. ______

Ambient Temp. °F: 30
Bar. Press. in.Hg.: 29.95 - 0.60 = 29.35
Assumed Moisture %: 10
Heater Box Setting, °F: 250
Probe Tip Dia., In.: 3/16
Probe Length: 1 + 2 + 10
Probe Heater Setting: 60
Avg. ΔP ______ Avg. ΔH ______
Leak Rate @ 15" Hg: 0 Post-Test ______

Oven	Point	Clock Time (min)	Dry Gas Meter CF	Pitot in H_2O ΔP	Orifice ΔH in H_2O Desired	Orifice ΔH in H_2O Actual	Dry Gas Temp. °F Inlet	Dry Gas Temp. °F Outlet	Pump Vacuum In. Hg. Gauge	Box Temp. °F	Impinger Temp. °F	Stack Press. in.Hg.	Stack Temp. °F	ΔP across box "H_2O / Fyrite % CO_2
			269.400											
DFF 195	1	9:46	270.730	1.5	1.0	1.0	46	42	6	250	45 68			
		[illegible]											134	33
215	2	[illegible]	272.65	1.7	1.2	1.2	49	44	5					
		[illegible]											119	34
225	3	10:15	274.113	2.3	1.6	1.6	51	48	6					
		[illegible]											113	34.2
187	4	[illegible]		2.3	1.6	1.6	54	50	6					
		[illegible]		2.0	1.4	1.4	54	51	6				94	
		[illegible]	279.416										103	33.3
197	5	[illegible]		2.0	1.4	1.4	56	54	6					
DFF		[illegible]	284.310										98	34.9
207	6	[illegible]		2.0	1.4	1.4	50	52	6					
		[illegible]	284.079										87	34.7
217	7	[illegible]		2.0	1.4	1.4	52	52	6					
		[illegible]	290.939										103	34.9
193	8	12:26		1.3	1.35	1.35	54	52	6					
		[illegible]	293.908										104	34.6
159	9	12:39		1.9	1.3	1.3	56	54	6					
		[illegible]	294.700										110	35.0
153	10	12:52		2.1	1.45	1.45	55	56	6					
DFF	11	[illegible]	296.441										113	34.5

SUBJECT One spot Con Test #13 of 11/29/79 Outlet DATE 11/30/79

No

Beaker #		Tare wt				
147	Front half	99.6877	.0090	.0403		.0652
25	acetone	96.7594	.0148	.0249		
267	Back half water	96.2613	.0002	.0103	.0178	
102		107.8942	-.0026	.0075		
105	Back half acetone	109.1824	.0029	.0130	.0130	
154	Blank	105.3375	-.0101	+.0101	.0000	

Filter 172	0.6888	0.7246	0.0358 - 0.0007 = 0.0350
Blank	0.6611	0.6604	0.0007 - 0.0007

	Probe wash	Filter	Total
Front Half	~~.0652~~	~~+.0350~~	~~= .1002~~
	.0652	+ .0351	= .1003

$\frac{.0350}{.0652}$ = 65% probe wash

Back Half

water	.0178
acetone	.0130
Total	.0308 g

W...

Pile 25