AP42 Section:	12.2
Reference:	95
Title:	Particulate Emission Evaluation of the Envirotech/Chemico One Spot Quench Car at the Coke Oven Batteries of Republic Steel Corporation Youngstown Works, Youngstown, Ohio, Betz, Converse, Murdoch, Inc., Pittsburgh, PA, January 1982.

AP-42 Section 12.2
Reference
Report Sect. 4
Reference 95

PARTICULATE EMISSION EVALUATION OF THE ENVIROTECH/CHEMICO ONE SPOT QUENCH CAR AT THE COKE OVEN BATTERIES OF REPUBLIC STEEL CORPORATION YOUNGSTOWN WORKS YOUNGSTOWN, OHIO

JANUARY 1982

BCM PROJECT NO. 00-4683-02

PREPARED BY:

Mark D. Mueller for EWB

EDWARD W. BLANAR
ENGINEER I

APPROVED BY:

Peter R Charrington

PETER R CHARRINGTON, P.E.
ASSISTANT VICE PRESIDENT

BETZ•CONVERSE•MURDOCH•INC.
5777 BAUM BOULEVARD
PITTSBURGH, PENNSYLVANIA 15206

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Report Title: Particulate Emission Evaluation of the Envirotech/Chemico One Spot Quench Car at the Coke Oven Batteries of Republic Steel Corp., Youngstown Works, Youngstown, OH

Plant and Location: Republic Steel Corp., Youngstown, OH

SCC: 30300303

Testing Date(s): 10/27-29/81

By Whom: BCM

Stack Test Review Attached: No

Reviewed By:

Problems Seen by Reviewer:

Confidentiality Status: NO

If status is confidential, list confidential pages or sections:

Source of Determination of the Confidentiality Status:

Report Encoded By:

Date Encoded:

Form Numbers:

Comments:

CONTENTS

1.0 EXECUTIVE SUMMARY

Republic Steel Corporation (RSC) retained Betz•Converse•Murdoch•Inc. (BCM) to evaluate its Envirotech/Chemico one spot quench car installed at the Coke Oven Batteries at the Youngstown 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) and the State of Ohio. Three 24 push tests, incorporating both push and travel modes, were performed by BCM. In addition, opacity observations were noted for each oven that was pushed during the particulate testing program. The rounded average of the results of the three runs comprising the test demonstrates compliance with the allowable particulate emission rate of 0.03 pounds per ton of coke pushed.

2.0 SCOPE AND OBJECTIVES

The scope of the project was outlined in BCM proposal of January 29, 1981, a copy of 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, and N_2 (by difference)
- Particulate concentration - G/DSCF, Lbs/hr, and Lbs/ton of coke pushed
- Opacity - % Opaque

3.0 PROCEDURES

3.1 Field Work

Field testing was conducted October 27 through October 29, 1981. The sampling team consisted of the following BCM personnel:

- Edward W. Blanar - Engineer I
- Philip C. Burg - Scientist I
- Daniel Petrovay - Technician III

Messrs. Pat Thomas and Don Monaco of Republic Steel acted as liaison between BCM and Republic Steel and Mr. Joe Bryant of Chemico ensured that the scrubber car was operating normally during the test period. Mr. Bryant also 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 as per agreement with the Ohio 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 Method Five of the 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 U. S. Environmental Protection Agency (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 Enviromental Protection Agency (EPA) and State of Ohio testing methods are contained in the computer printout at the end of Appendix 3. Pertinent test results are listed in Table 1.

TABLE 1

PARTICULATE EMISSIONS RESULTS

Run Number	Concentration (Grains/DSCF)	Emission Rate (Lbs/Hr)	Emission Rate* (Lbs/Ton of Coke Pushed)
1	.0149	9.95	.0370
2	.0117	7.57	.0309
3	.0107	6.56	.0293

* Based on 275.52 tons of coke pushed during each 24 oven tests.

4.2 Visible Emissions

The opacity observations were performed in agreement with methodology approved by Chemico and the Ohio 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. The starting time for Test No. 1 was delayed one hour while the temperatures and the pressures of the Chemico quench car were brought up to the proper settings. Tests No. 1 and No. 2 proceeded smoothly with no further problems. Test No. 3 experienced a 1/2 hour delay due to a break in the coke oven guide at push number D-6, oven C-23. Fortunately, this did not effect the testing results and the final test was completed with no further difficulties.

The results of the testing program shown in Table 1 indicate compliance with the allowable emission rate of 0.03 lbs/ton of coke pushed.

5.2 Visible Emissions Procedure

The opacity was observed during all three testing programs. All observations were recorded in accordance with guidelines established in EPA Reference Method Nine of the Federal Register, with the exception of the guideline that the sun be located in a 140° arc to the observer's back. This guideline could not be met because of the location of the coke ovens with respect to the sun's location. 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 approximately two minutes. There were 24 pushes per test, each push occurring approximately 12 to 15 minutes apart.

APPENDIX 1

BCM PROPOSAL

Betz • Converse • Murdoch • Inc.

PROPOSAL

TO

REPUBLIC STEEL CORPORATION
MAHONING VALLEY DISTRICT
1040 PINE AVENUE, S.E.
WARREN, OHIO 44481

FOR

A SOURCE EMISSION TESTING OF THE
ENVIROTECH/CHEMICO
ENCLOSED QUENCH CAR SYSTEMS
AT THE
WARREN AND YOUNGSTOWN MILLS
OF
REPUBLIC STEEL CORPORATION

Report Pertains to:

BCM PROJECT NO. 00-4683-02

JANUARY 29, 1981

PREPARED BY:

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

BETZ•CONVERSE•MURDOCH•INC.
ONE PLYMOUTH MEETING MALL
PLYMOUTH MEETING, PENNSYLVANIA 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 Warren and Youngstown plants 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 three 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

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, Youngstown Ohio

DATE 10-27-81

SAMPLING LOCATION Q-CAR

CALIBRATED PRESSURE DIFFERENTIAL ACROSS ORIFICE, in. H_2O	$\Delta H_@$	1.75
AVERAGE METER TEMPERATURE (AMBIENT + 20 °F), °F	$T_{m\,avg.}$	80
PERCENT MOISTURE IN GAS STREAM BY VOLUME	B_{wo}	20
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	29.49
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ x STACK GAUGE PRESSURE in in. H_2O)	P_s	-3.1
RATIO OF STATIC PRESSURE TO METER PRESSURE	P_s/P_m	-0.105
AVERAGE STACK TEMPERATURE, °F	$T_{s\,avg.}$	150
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.70
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	1.4
C FACTOR		0.70
CALCULATED NOZZLE DIAMETER, in.		0.250
ACTUAL NOZZLE DIAMETER, in.		0.203
REFERENCE Δp, in. H_2O		1.6

BCM

FIELD DATA SHEET

PLANT Republic Steel, Youngstown, Ohio
DATE 10-27-81
SAMPLING LOCATION Q-CAL
SAMPLE TYPE Particulate
RUN NUMBER ONE   OPERATOR EWB
BAROMETRIC PRESSURE 29.49   STATIC PRESSURE -3.1
FILTER NUMBER(S) 701
GEL NUMBER(S) A-42
THIMBLE NUMBER —   PLATE NUMBER —
H_2O PICKUP (ml) 190

ORSAT:
CO_2 1.5
O_2 18.5
CO —

PYROMETER NUMBER Mircomite
THERMOCOUPLE NUMBER
PROBE NUMBER 6' SS Glass   TYPE
NOZZLE NUMBER 60   I.D. .263
METER BOX NUMBER 8 $\Delta H_@$ 1.78
PITOT NUMBER 6' C_p .856
SAMPLE BOX NUMBER(S) 9
ASSUMED MOISTURE (%) 24
ASSUMED METER TEMPERATURE 60
C FACTOR 0.67   REFERENCE Δp 1.76

READ AND RECORD ALL DATA EVERY v12.5 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
		9:00	106.96									
A-6	51	10:06	107.33	.68	.70	.70	149	68	68	2	255	70
	90			.20	.21	.21				2		
A-5	63	10:20	108.25	.68	.70	.70	153	74	74	2	250	74
	91			.19	.20	.20				2		
A-4	67	10:31	109.325	.85	.90	.90	150	80	80	3	250	76
	90			.31	.32	.32				2		
A-3	71	10:42	110.53	1.5	1.6	1.6	155	82	82	5	270	76
	80			.28	.29	.29				2		
A-2	63	10:58	111.565	1.1	1.2	1.2	145	82	82	4	245	68
	90			.22	.23	.23				2		
A-1	71	11:12	112.805	1.7	1.8	1.8	150	82	82	5	260	76
	76			.36	.38	.38				2		
D-6	70	11:24	114.12	1.2	1.3	1.3	146	82	82	5	260	76
	77			.40	.41	.41				2		

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
			114.12									
B-5	58	1154	115.77	2.2	2.3	2.3	148	82	82	6	265	70
	129			.50	.51	.51				2		
B-4	60	1216	117.23	1.7	1.8	1.8	145	82	83	5	260	72
	96			.41	.41	.41				2		
B-3	58	1234	118.70	2.5	2.7	2.7	148	83	84	7	260	72
	95			.40	.41	.41				3		
B-2	59	1250	120.285	3.6	3.7	3.7	148	83	84	9	265	71
	86			.45	.46	46				3		
B-1	61	1300	121.90	3.4	3.6	3.6	145	83	84	10	265	71
	79			48	.50	.50				3		
C-6	59	1312	123.79	2.5	2.6	2.6	145	82	83	8	265	73
	80			.65	.70	.70				3		
C-5	62	1325	125.48	3.0	3.2	3.2	144	82	83	9	250	74
	88			.70	.72	.72				3		
C-4	64	1341	127.435	3.9	4.1	4.1	145	82	84	13	250	74
	80			.86	.89	.89				4		
C-3	56	1359	129.56	4.9	5.0	5.0	143	82	84	15	250	75
	94			.85	.90	.90						
C-2	64	1414	131.86	4.9	5.0	5.0	140	82	84	15	250	73
	106			.90	.94	.94				3		
C-1	67	1428	133.89	4.8	5.0	5.0	145	82	84	15	255	72
	87			.15	.70	.70				3		
D-6	61	1437	134.78	.15	.16	.16	142	83	85	2	255	
	93			.21	.23	.23				2		

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
			134.78									
D-5	60	1449	135.97	.50	.52	.52	145	82	84	2 1/2	250	70
	105			.33	.35	.35				2		
D-4	59	1506	137.375	.85	.90	.90	141	82	83	4	255	70
	104			.45	.47	.47				2		
				~~2.8~~	~~2.3~~	~~2.3~~						
D-3	60	1517	139.18	2.1	2.3	2.3	150	82	84	6	255	70
	113			.70	.73	.73				3		
D-2	62	1532	141.015	2.5	2.6	2.6	157	82	84	7 1/2	255	72
	106			.70	.73	.73				3		
D-1	61	1542	142.565	2.1	2.3	2.3	144	82	84	7	250	70
	87			.62	.64	.64						
3(?)7			LEAK CHECK - ≤0.02 @ 11"									
6145				3605.764	% 11 12							
				~~3605~~			149		82			
				~~.457~~								
				.478								
					1.35							
			36.105	.978	~~1.44~~							

BCM

FIELD DATA SHEET

PLANT REPUBLIC STEEL, YOUNGSTOWN, OHIO
DATE 10-28-81
SAMPLING LOCATION Q-CAR
SAMPLE TYPE PARTICULATE
RUN NUMBER TWO OPERATOR EWB
BAROMETRIC PRESSURE 29.82 STATIC PRESSURE -3.3
FILTER NUMBER(S) E644
GEL NUMBER(S) A-32
THIMBLE NUMBER ____ PLATE NUMBER ____
H_2O PICKUP (ml) 183 ml

ORSAT:
CO_2 1.5
O_2 18.5
CO ____

PYROMETER NUMBER MIRCO MITE
THERMOCOUPLE NUMBER –
PROBE NUMBER L' SS. TYPE GLASS, SS'
NOZZLE NUMBER ____ I.D. .2[illegible]
METER BOX NUMBER 8 $\Delta H_@$ 1.75
PITOT NUMBER Ld C_p .8[illegible]2
SAMPLE BOX NUMBER(S) 8
ASSUMED MOISTURE (%) 24
ASSUMED METER TEMPERATURE 80
C FACTOR [illegible] REFERENCE Δp 1.7

READ AND RECORD ALL DATA EVERY 2-1.5 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 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
		8:00	142.75									
D-6	67	8:21	143.45	.28	.30	.30	130	58	58	>2	250	62
	94			.15	.16	.16				>2		
D-5	60	8:31	144.375	.43	.46	.46	135	59	60	2	255	64
	91			.24	.25	.25				2		
D-4	60	8:47	145.56	1.1	1.2	1.2	146	60	61	4	255	66
	81			.55	.58	.58				2		
D-3	67	908	147.18	2.3	2.4	2.4	139	66	68	6	255	69
	90			.80	.84	.84				3		
D-2	65	9:27	148.915	2.4	2.5	2.5	140	72	72	7	255	70
	101			.53	.55	.55				2		
D-1	61	9:45	150.56	2.5	2.7	2.7	150	72	73	7	255	62
	122			.40	.42	.42				2		
~~D-8~~ C-6	65	1002	151.945	2.5	2.7	2.7	135	74	75	7	255	62
	64			.51	.53	.53				2		

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
			151.945									
C-5	63	1017	153.715	2.6	2.7	2.7	139	84	75	8	255	62
	98			.75	.79	.79				3		
C-4	57	1029	155.625	3.6	3.7	3.7	150	74	75	9	255	62
	98			.76	.80	.80				3		
C-3	62	1047	158.24	4.8	5.0	5.0	142	74	75	16	255	67
	140			.91	.93	.93				3		
C-2	58	1101	160.52	4.2	4.4	4.4	140	74	75	15	255	63
	94			2.2	2.3	2.3				5		
C-1	59	1113	162.91	4.5	4.7	4.7	135	78	80	16	250	69
	147			.60	.62	.62				2		
B-6	66	1128	164.05	1.1	1.2	1.2	137	78	80	5	250	69
	111			.15	.16	.16				>2		
B-5	60	1145	165.515	1.5	1.6	1.6	140	78	80	6	255	69
	128			.35	.37	.37	140			2		
B-4	61	1157	166.935	2.0	2.1	2.1	141	78	80	6	255	70
	93			.49	.51	.51				2		
B-3	64	1209	168.49	1.9	2.0	2.0	142	78	80	6	250	71
	119			.15	.16	.16				2		
B-2	65	1222	170.07	2.9	3.0	3.0	136	84	85	8	250	71
	111			.42	.44	.44				2		
B-1	67	1236	171.945	4.0	4.3	4.3	135	84	85	12	250	71
	103			.41	.43	.43				2		
A-6	64	1250	172.685	.30	.32	.32	134	84	85	2	250	71
	95			.13	.14	.14				2		

PLANT TRAVERSE POINT NUMBER	SAMPLING TIME min	DATE CLOCK TIME (24 hr CLOCK)	RUN NUMBER 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
			172.685	.34	.36	.36	132	84	85	>2	250	70
A-5	60	1305	173.545	.20	.21	.21				>2		
	96											
							138	84	85	3	255	76
A-4	63	1316	174.965	.67	.70	.70				>2		
	107			.30	.32	.32						.72
							140	84	85	5	255	72
A-3	65	1329	176.47	1.6	1.7	1.7				2		
	157			.32	.34	.34						
							140	86	88	3	250	72
A-2	61	1338	177.50	.84	.87	.87				2		
	93			.28	30	.30						
							141	86	88	6	250	72
A-1	59	1348	178.455	1.8	1.9	1.9				2		
	125			.44	.46	.46						
		LEAK CHECK	< 0.02 @ 16"									
	67.52		36.205	.919		1.134	139		76.6			

PLANT REPUBLIC STEEL, YOUNGSTOWN, OHIO

DATE 10-29-81

SAMPLING LOCATION Q-CAR

SAMPLE TYPE PARTICULATE

RUN NUMBER THREE OPERATOR EWB/PCD

BAROMETRIC PRESSURE 29.85 STATIC PRESSURE -2.1

FILTER NUMBER(S) E614

GEL NUMBER(S) A-31

THIMBLE NUMBER — PLATE NUMBER —

H_2O PICKUP (ml) 183

BCM

FIELD DATA SHEET

ORSAT:

CO_2 1.5

O_2 18.5

CO —

PYROMETER NUMBER MIRCO MITE

THERMOCOUPLE NUMBER

PROBE NUMBER 6' TYPE S.S. GLASS

NOZZLE NUMBER I.D. .250

METER BOX NUMBER 8 $\Delta H_@$ 1.75

PITOT NUMBER 6A C_p [illegible]

SAMPLE BOX NUMBER(S) 8

ASSUMED MOISTURE (%) 24

ASSUMED METER TEMPERATURE 80

C FACTOR 0.67 REFERENCE Δp 1.6

READ AND RECORD ALL DATA EVERY 12-15 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 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
		8:10	179.275					42	42	<2	290	60
A-6	67	8:21	180.21	.33	.35	.35	132			<2		
	100			.30	.32	.32						
								42	42	<2	250	62
A-5	60	8:32	181.00	.35	.37	.37	132			<2		
	110			.18	.20	.20						
				.90	.96	.96	133	52	52	<2	250	62
A-4	95	8:44								<2		
	47		182.114	.28	.30	.30						
				.96	1.0	1.0	134	56	54	3	245	62
A-3	60	8:59										
	90		183.065	.25	.25	.25						
											255	60
A-2	65	9:24		.95	1.0	1.0	133	60	58	3		
	125		184.096	.09	.10	.10						
							135	60	58	4	255	58
A-1	60	9:38	185.250	1.1	1.2	1.2						
	132			.20	.21	.21						
							139	66	64	4	260	58
B-6	62	9:50	186.504	.75	.80	.80						
	135			.30	.32	.32						

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
B-5	65	10:02	~~18~~ 187.872	1.5	1.6	1.6	139	66	64	5	245	58
	121			.28	.28	.28				<2		
B-4	70	10:21	189.378	1.6	1.8	1.8	145	70	68	6	255	58
	112			.30	.30	.30				<2		
B-3	58	10:44	190.954	2.4	2.5	2.5	143	72	70	7	250	58
	152			.20	.22	.22				<2		
B-2	68	10:57	192.640	2.3	2.5	2.5	140	72	70	7	250	58
	140			.32	.33	.33				<2		
B-1	69	11:11	194.505	2.9	3.1	3.1	132	72	70	9	250	58
	181			.25	.25	.25				2		
C-6	55	11:23	196.122	~~2.6~~ 2.9	2.2	2.2	135	72	70	7	250	58
	103			.48	.50	.50				2		
C-5	58	11:36	197.664	2.8	2.9	2.9	142	72	70	9	255	58
	65			.52	.55	.55				2		
C-4	65	11:48	199.510	4.0	4.3	4.3	152	98	76	14	255	59
	86			.66	.70	.70				3		
C-3	69	12:00	202.015	4.4	4.6	4.6	151	80	78	16	260	60
	134			.71	.75	.75				3		
		Stopped push for 4 sec.										
C-2	100	12:15	205.082	4.0	4.3	4.3	142	80	78	14	260	60
	160			.65	.68	.68				3		
C-1	66	12:34	~~80~~ 207.300	4.2	4.6	4.6	140	82	80	16	250	60
	122			.48	.50	.50						

PLANT TRAVERSE POINT NUMBER	DATE SAMPLING TIME min	CLOCK TIME (24 hr CLOCK)	RUN NUMBER 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
			Push Mode interupted Then continued After 15 sec delay									
D-6	66	12:58	~~208~~ 207.98	.80	.85	.80	130	82	80	3	240	62
	100			.95	1.0	1.0				4		
	51		209.006	.38	.40	.40				2		
D-5	75	1:44		.36	.38	.38	138	82	80	2	270	62
	103		210.000	.24	.25	.25				<2		
D-4	68	1:55	211.382	.78	.82	.82	132	82	80	3	250	64
	113			.55	.58	.58				2		
D-3	68	2:07	213.108	2.1	2.2	2.2	135	82	80	7	255	62
	107			.60	.62	.62				2		
D-2	67	2:19	214.700	2.6	2.8	2.8	129	82	80	8	250	62
	89			.55	.57	.57				2		
D-1	65	2:30	216.102	1.8	1.9	1.9	136	82	80	6	245	62
	90			.43	.45	.45				2		
			Leak check @ 18" = .004 CFM									
	4365 sec											
	72.75 min											
				3312.7	4493.53							
	[illegible]		36.827	Δp = .813	ΔH = 1.029		137		69			

OHIO EPA
Field Reading Chart
for
Visible Emissions

Date 10/27/81

Facility Name REPUBLIC STEEL CORP

Observer DAN PETROVAY

Address YOUNGSTOWN, OHIO.

Affiliation ~~N-OHIO~~ B.C.M

Source No. Chemico Q-CAR TEST #1

Observation Point NORTH OF COKE OVENS

Distance from Stack 20 YDS

Wind Speed 3-7 MPH Direction NW

Sky Condition BLUE & WHITE & GRAY
(Presence & Color of Clouds)

Plume Background

Plume Color

Observation began ~~09:45~~ 10:00 Ended 10:52

Source Description Chemico Q-CAR

Stack Description COKE OVENS

	Min	0	15	30	45		Min	0	15	30	45
Run	C-46 ~~0~~	~~0~~	~~0~~	~~0~~	~~0~~	C-41	30	0	0	0	0
	~~1~~	~~0~~	~~0~~				31	0	X	X	X
RUN 1	C-56 ~~2~~	~~0~~	~~0~~	~~0~~	~~0~~	C-51	32	0	0	0	5
	~~3~~	~~0~~	~~10~~	~~0~~			33	0	X	X	X
Run 1	C-8 4	0	5	0	5	B-29	34	5	5	5	0
10:07	5	5	10	X	X		35	0	X	X	X
RUN 2	C-18 6	I	I	I	I	B-39	36	0	0	10	0
	7	I	X	X	X		37	0	X	X	X
RUN 3	C-28 8	0	5	0	0	C-3	38	0	0	5	0
	9	0	X	X	X		39	0	X	X	X
RUN 4	C-38 10	5	10	5	5	C-13	40	0	0	0	0
1042	11	10	X	X	X		41	0	X	X	X
RUN 5	C-48 12	0	0	0	15	C-23	42	I	I	I	I
1054	13	0	X	X	X		43	I	X	X	X
RUN 6	C-58 14	0	0	15	15	C-33	44	0	0	0	0
1113	15	10	X	X	X		45	0	X	X	X
RUN 7	C-6 16	0	0	0	10	C-43	46	0	0	5	5
	17	0	X	X	X		47	0	X	X	X
RUN 8	C-17 18	5	0	0	0	C-53	48	0	0	0	0
	19	X	X	X	X		49	0	X	X	X
RUN 9	B-47 20	0	0	10	0		50	0	5	5	0
1218	21	0	X	X	X		51	0	X	X	X
RUN 10	B-4 22	0	0	5	0		52				
	23	0	X	X	X		53				
RUN 11 1250	C-11 24	0	0	0	0		54				
	25	0	X	X	X		55				
RUN 12 1300	C-21 26	0	0	0	0		56				
	27	0	X	X	X		57				
RUN 13 1312	C-31 28	0	0	0	0		58				
	29	0	X	X	X		59				

SUMMARY OF COMPLIANCE

Total Minutes Observed

Total Minutes Equal to or Above 20% Opacity

Total Minutes Above 60% Opacity

Remarks: SUN IN READERS EYES IF SUN IS OUT
X-NO READINGS, TIME LEFT AFTER READINGS [illegible]
I-INTERFERENCE FROM SMOKE ON WHARF

S
E W
N

B·C·M

G[illegible]A

Field Reading Chart for Visible Emissions

Date ~~[illegible]~~ 10/28/81

Facility Name REPUBLIC STEEL CORP.

Observer DANIEL R PETROVAY

Address POLAND AVE. YOUNGSTOWN, OHIO

Affiliation ~~M[illegible]A~~ B·C·M

Source No. Q-CAR TEST #2

Observation Point NORTH SIDE OF COKE OVENS

Distance from Stack 20YDS. HEIGHT 30'

Wind Speed 5-10 MPH Direction W SW

Sky Condition GRAY + WHITE MORNING, BLUE SKY AFTERNOON
(Presence & Color of Clouds)

Plume Background

Plume Color

Observation began 0820 Ended

Source Description CHEMICO Q-CAR

Stack Description COKE OVEN BATTERIES C + B

SUMMARY OF COMPLIANCE

Total Minutes Observed

Total Minutes Equal to or Above 20% Opacity

Total Minutes Above 60% Opacity

Remarks: SUN IN READERS EYES

I - INDICATES INTERFERENCE FROM THE SMOKE ON WHARF

X - INDICATES NO READING LEFTOVER SPACE FROM PUSHING TIME

S

E W

N

Run	Battery No. / Min	0	15	30	45	Battery No. / Min	0	15	30	45	Run
RUN #1	C-8 0	0	5	15	0	C-41 30	I	10	10	I	RUN 16
0820	1	0	X	X	X	31	I	X	X	X	120
RUN #2 0831	C-18 2	0	0	0	0	C-51 32	0	10	0	5	RUN 17
	3	0	X	X	X	33	5	X	X	X	122
RUN #3 0846	C-28 4	5	0	0	0	C-3 34	0	5	0	0	RUN 18
	5	0	X	X	X	35	0	X	X	X	12[illegible]
RUN #4 0907	C-38 6	0	0	0	0	C-13 36	0	0	5	5	RUN
	7	0	X	X	X	37	0	X	X	X	19 123
RUN #5 0925	C-48 8	0	0	5	5	B-9 38	0	10	5	5	RUN 20
	9	0	X	X	X	39	0	X	X	X	130
RUN #6 0943	C-58 10	0	5	0	I	B-19 40	0	5	5	0	RUN
	11	I	X	X	X	41	0	X	X	X	21 131
RUN #7 1003	C-[illegible] 12	5	0	10	0	B-29 42	0	0	0	5	RUN 22
	13	0	X	X	X	43	5	X	X	X	132
RUN #8 1016	C-65 14	0	0	0	10	C-23 44	I	I	I	I	RUN
	15	10	X	X	X	45	I	X	X	X	23 133
RUN #9 1028	C-[illegible] 16	0	0	0	0	C-33 46	I	I	I	I	RUN 24
	17	0	X	X	X	47	I	X	X	X	134
RUN #10 1045	B-9 18	0	0	5	0	48					
	19	0	X	X	X	49					
RUN #11 1100	C-21 20	5	0	5	5	50					
	21	0	X	X	X	51					
RUN #12 1112	B-17 22	5	5	5	10	52					
	23	5	X	X	X	53					
RUN #13 1123	B-27 24	0	10	0	5	54					
	25	0	X	X	X	55					
RUN #14 1144	B-37 26	0	5	0	0	56					
	27	0	X	X	X	57					
RUN #15 1157	C-31 28	5	10	5	10	58					
	29	5	X	X	X	59					

Betz • Converse • Murdoch • Inc. BCM

Consulting Engineers, Planners and Architects

Date 10/29/81 Location Name REPUBLIC STEEL CORP

Observer DANIEL PETROVAY Address YOUNGSTOWN, OHIO

Observation Point NORTH SIDE OF COKE OVENS Weather 100% CLOUD COVER MORNING GRAY + WHITE CLOUDS 10% CLOUD COVER AFTERNOON BLUE + WHITE SKIES

Oven Distance From 20 YDS Height 30'

Wind Speed 3-7 mph Direction NW

Observation Began 0822 Ended

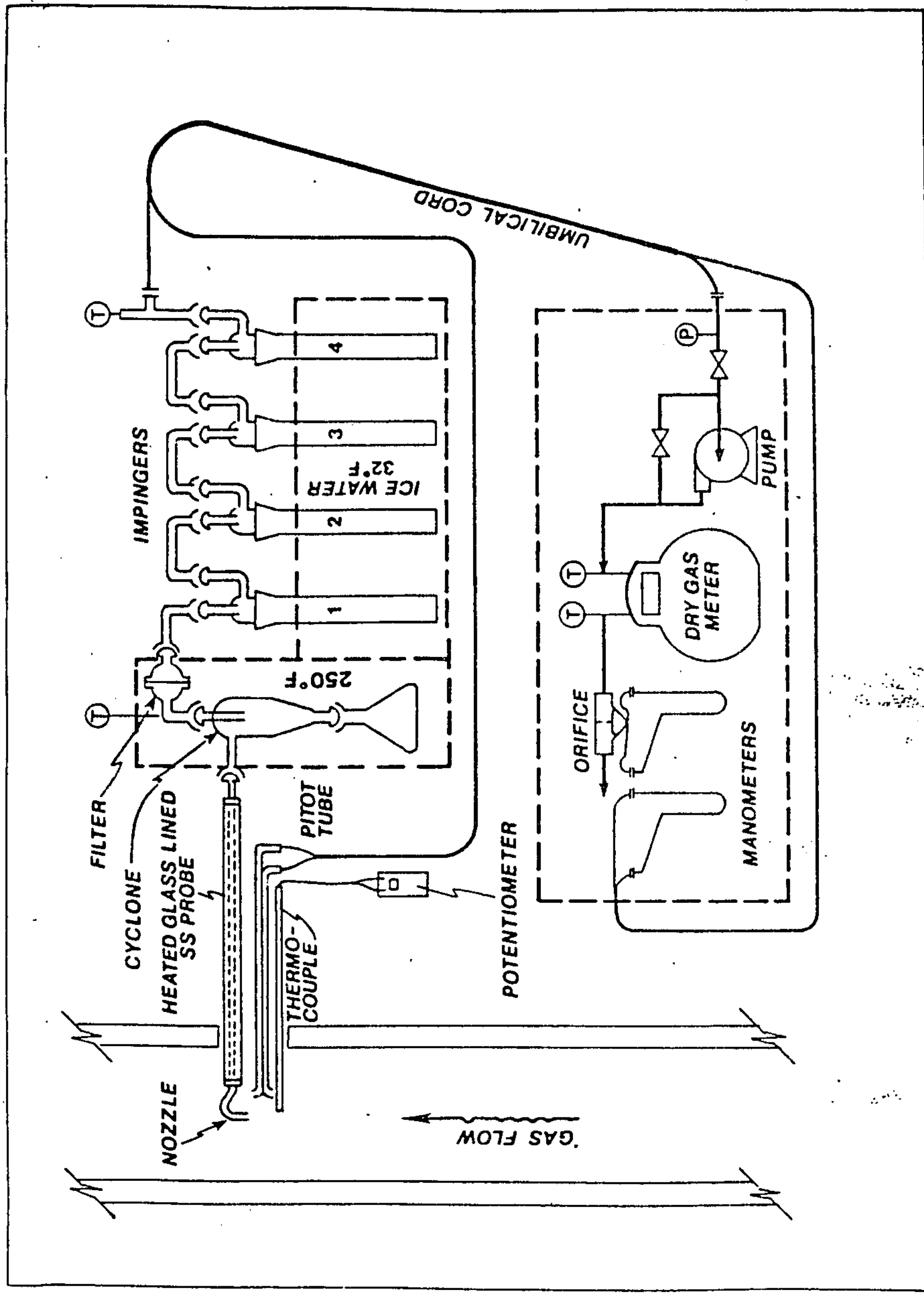
Type of Installation Chemico Q-CAR

TEST NO 3

Run# Oven	Time of Quench 0	Push 15	Oven 30	Seconds ≥ % Opacity Per Push 45	Seconds ≥ % Opacity Per Push 0	Seconds ≥ % Opacity Per Push 15	Maximum Opacity 30	Remarks 45	Run# Ov
Run No 1 C-38	0	0	5	5	5	3	5	50	RUN C- 13
0822	5	X	X	X	100	X	X	X	1123
2 C-48	I	I	0	I		MISSED	PUSH		RUN C- 14
0832	I	X	X	X					
#3 C-58	0	0	0	0	5	0	0	0	RUN C- 15
0843	0	X	X	X	5	X	X	X	1147
#4 C-1	5	5	5	0	0	5	10	0	RUN B- 16
0858	5	X	X	X	0	X	X	X	1208
#5 C-11	I	I	I	I	0	0	0	0	RUN B- 17
0924	I	X	X	X	0	5	5	5	12:13
#6 B-28	0	0	0	5	0	10	5	5	RUN B- 18
0937	0	X	X	X	0	X	X	X	1233
#7 C-65	0	0	0	5	0	10	5	0	RUN E-2 19
0947	5	5	X	X	15	15	X	X	1251
Run #8 B-9	5	10	5	0	0	5	0	10	RUN C-3 20
1002	5	X	X	X	10	X	X	X	1314
Run #9 B-19	0	10	5	5	5	0	5	15	RUN C-
1020	5	X	X	X	15	X	X	X	21 1359
Run #10 B-29	5	15	10	0	5	0	5	10	RUN C-5 22
1042	5	20	X	X	10	X	X	X	1406
Run #11 C-31	5	0	5	10	0	0	5	0	RUN C-5 23
1056	10	X	X	X	10	X	X	X	1418
Run 12 C-41	0	0	0	5	0	0	10	0	RUN C-
1111	0	X	X	X	0	X	X	X	24 142

Comments: I-INDICATES INTERFERENCE FROM SMOKE OR SMOKE ON WHARF
X-INDICATES NO READING LEFT IN THAT TIME PERIOD.
SUN IN READERS EYES
RUN 13 GREEN OVEN HIGH EMISSIONS AT END OF TEST.
RUN 19 SCRUBBER START ON THEN OFF THEN ON AGAIN GUIDE CAME OPEN

S
E W
N


UMBILICAL CORD
IMPINGERS
ICE WATER 32°F
250°F
1
2
3
4
T
P
FILTER
CYCLONE
HEATED GLASS LINED SS PROBE
NOZZLE
PITOT TUBE
THERMO-COUPLE
POTENTIOMETER
ORIFICE
MANOMETERS
DRY GAS METER
PUMP
GAS FLOW

EPA METHOD 5

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 sheet 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	9.4	24.2	33.6
2	7.6	19.4	27.0
3	7.5	18.0	25.5

* Blank corrected

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

1 Heading	Q-CAR REPUBLIC STEEL – YOUNGSTOWN		
2 Number of tests	3		
3 Test type	"EPA"	"EPA"	"EPA"
4 Test identification	"1"	"2"	"3"
5 Stack area, in^2	4608	4608	4608
6 Stack temperature, ^{o}F	147	139	137
7 Sample volume, ft^3	36.105	36.205	36.927
8 Meter temperature, ^{o}F	82	76.6	6.9
9 Orifice (ΔH), in. H_2O	1.25	1.134	1.029
10 Nozzle diameter, in	.203	.203	.203
11 Duration of test, min.	61.45	67.52	72.75
12 Volume of CO_2, %	1.5	1.5	1.5
13 Volume of CO, %	0	0	0
14 Volume of O_2, %	18.5	18.5	18.5
15 Static pressure, in. H_2O	-3.1	-3.3	-2.1
16 Barometric pressure, in. Hg	29.49	29.82	29.88
17 Pitot correction factor	.82	.82	.82
18 Traverse (Avg.$\sqrt{\Delta p}$), in. H_2O	.978	.919	.873
19 Volume H_2O collected, ml	198.9	191.9	195.7
20 Weight collected, mg	33.6	27.0	25.5
21 Volume titrant, SO_3, ml	–	–	–
22 Volume titrant, SO_2, ml	–	–	–
23 Normality titrant, SO_3	–	–	–
24 Normality titrant, SO_2	–	–	–
25 Meter calibration factor	1.0	1.0	1.0
26 Avg. Cosine of angle	1.0	1.0	1.0
27 Post leak check rate, CFM	0	0	0
28 Leak check rate no. 1, CFM	0	0	0
29 Leak check time no. 1, min.	0	0	0

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EQUATIONS FOR PARTICULATE, MOISTURE AND FLOW CALCULATIONS
(Based on Standard Conditions of 68°F and 29.92 inches Hg)

1. $V_{w(std)} = 0.0471\ V_{wc}$

2. $V_{m(std)} = 17.64\ V_m \left[\dfrac{P_{bar} + (.07355\ \Delta H)}{T_m + 460}\right] Y$

3. $B_{wo} = \dfrac{V_{w(std)}}{V_{m(std)} + V_{w(std)}}$

4. $M_d = 0.44(\%CO_2) + 0.28(\%CO) + 0.32(\%O_2) + 0.28(\%N_2)$

5. $M_s = M_d\ (1 - B_{wo}) + 18\ B_{wo}$

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

7. $V_s = (85.49)(60)(C_p)\ \sqrt{\Delta P}\ \sqrt{\dfrac{T_s + 460}{(P_s)(M_s)}}$

8. $Q_s = \dfrac{(V_s)(A_s)}{144}$

9. $Q_{s(std)} = Q_s(1 - B_{wo})\ 17.64\ \dfrac{P_s}{T_s + 460}$

10. $C'_s = 0.0154\ \dfrac{W_t}{V_{m(std)}}$

11. $C'_w = 0.0154\ \dfrac{W_t}{V_{m(std)} + V_{w(std)}}$

12. $C'_c = \dfrac{12\ C'_s}{\%CO_2}$

13. $C'_a = W_w\ \dfrac{(T_s + 460)(29.92)}{(528)(P_s)}$

14. $E = 0.00857\ Q_{s(std)}\ C'_s$

15. $A_n = \dfrac{(\pi)(D_n)^2}{(144)(4)}$

16. $I = \dfrac{(60)(1.667)(T_s + 460)(0.00267\ V_{wc} + V_{m(std)}/17.64)}{(\theta)(V_s)(P_s)(A_n)}$

LEGEND

A_n	= Area of nozzle, ft^2
A_s	= Area of stack, in^2
B_{wo}	= Moisture content of gas stream, dimensionless
C_p	= Pitot correction factor, dimensionless
C'_a	= Particulate concentration (stack conditions), gr/ft^3
C'_c	= Particulate concentration at 12% CO_s (dry), gr/dscf
C'_s	= Particulate concentration (dry), gr/dscf
C'_w	= Particulate concentration (wet), gr/scf
D_n	= Diameter of nozzle, inches
E	= Particulate emission rate, lb/hr
EA	= Excess air, percent
ΔH	= Orifice pressure drop, in. H_2O
I	= Isokinetic ratio, percent
M_d	= Dry molecular weight of stack gas, lb/lb-mole
M_s	= Molecular weight of stack gas, lb/lb-mole
P_{bar}	= Barometric pressure, in. Hg
P_s	= Stack pressure (absolute), in. Hg
$\sqrt{\Delta P}$	= Average of square roots of Pitot pressure differential, in. H_2O
Q_s	= Stack gas flow, acfm
$Q_{s(std)}$	= Stack gas flow, scfm
T_m	= Average dry gas meter temperature, °F
T_s	= Average stack temperature, °F

V_m	=	Dry sample volume (meter conditions), ft^3
$V_{m(std)}$	=	Dry sample volume (standard conditions), ft^3
V_s	=	Stack velocity, ft/min
V_{wc}	=	Volume of liquid collected in impingers and silica gel, ml
$V_{w(std)}$	=	Volume of liquid collected, ft^3
W_t	=	Total weight of particulates collected, mg
θ	=	Duration of test, minutes

BCM

COMPUTATION SHEET

Sheet Number ______ of ______	
Date	
J. O. Number __ - ______ - -	
Computed by	
Checked by	

Name of Client REPUBLIC STEEL, YOUNGSTOWN, OHIO

Project PARTICULATE TESTING

Description QUENCH CAR

TOTAL TONS

$$\frac{11.48 \text{ TONS}}{\text{OVEN}} \left| \frac{24 \text{ OVENS}}{\text{TEST}} \right. = \underline{\underline{275.52}} \text{ TONS}/\text{TEST}$$

TEST # 1

$$\frac{275.52 \text{ TONS}}{\text{TEST}} \left| \frac{\text{TEST}}{61.45 \text{ MINUTES}} \right| \frac{60 \text{ MINUTES}}{1 \text{ HOUR}} = \underline{269.02 \text{ TONS}}/\text{HOUR}$$

$$\therefore \frac{9.9507 \text{ lbs/HR}}{269.02 \text{ TONS/HR}} = \underline{\underline{0.0369 \text{ lbs/TON COKE PUSHED}}}$$

TEST # 2

$$\frac{275.52 \text{ TONS}}{\text{TEST}} \left| \frac{\text{TEST}}{67.52 \text{ MINUTES}} \right| \frac{60 \text{ MINUTES}}{1 \text{ HOUR}} = \underline{244.83} \text{ TONS/HR}$$

$$\therefore \frac{7.5657 \text{ lbs/HR}}{244.83 \text{ TON/HR}} = \underline{\underline{0.0309 \text{ lbs /TON COKE PUSHED}}}$$

TEST # 3

$$\frac{275.52 \text{ TONS}}{\text{TEST}} \left| \frac{\text{TEST}}{72.75 \text{ MINUTES}} \right| \frac{60 \text{ MINUTES}}{1 \text{ HOUR}} = \underline{227.23 \text{ TONS}}/\text{HR}$$

$$\therefore \frac{6.6586 \text{ lb/HR}}{227.23 \text{ TONS/HR}} = \underline{\underline{.0293 \text{ lbs/TON}}} \text{ CORE PUSHED}$$

AVERAGE OF TEST # 1, 2, 3 = $\underline{\underline{0.03 \text{ lbs/TON COKE PUSHED}}}$

Q-CAR REPUBLIC STEEL-YOUNGSTOWN

PARAMETERS:		1	2	3
AREA OF BREECHING	(SQ FT)	32.00	32.00	32.00
SAMPLE VOLUME	(DSCF)	34.761	35.591	36.803
MOISTURE	(%)	21.2	19.5	18.5
MOLECULAR WEIGHT	(LB/LB-MOLE)	26.65	26.84	26.95
GAS TEMPERATURE	(F)	147.0	139.0	137.0
GAS VELOCITY	(FT/MIN)	3629.2	3357.5	3169.8
GAS VOLUME	(DRY SCFM)	77803.8	75572.6	72629.7
GAS VOLUME	(ACFM)	116134.4	107438.5	101432.5
PARTICULATE EMISSIONS:				
CONCENTRATION	(GRAINS/DSCF)	.0149	.0117	.0107
CONC. @ 12% CO2	(GRAINS/DSCF)	.1193	.0937	.0855
CONC. @ STK COND.	(GRAINS/CF)	.0100	.0081	.0075
EMISSION RATE	(LB/HR)	9.9507	7.5657	6.6586
ORSAT ANALYSIS:				
CARBON DIOXIDE	(VOL %)	1.5	1.5	1.5
CARBON MONOXIDE	(VOL %)	.0	.0	.0
OXYGEN	(VOL %)	18.5	18.5	18.5
NITROGEN	(VOL %)	80.0	80.0	80.0
EXCESS AIR	(%)	706.1	706.1	706.1
ISOKINETICS	(%)	103.5	100.6	101.1

THE FOLLOWING RUNS WERE UNDER SATURATED CONDITIONS:
2
3

APPENDIX 4

EQUIPMENT CALIBRATION

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. No C_p may deviate more than ±0.01 from the average C_p, and the difference between the average C_p for each leg must be ≤ 0.01.

DRY GAS METER AND ORIFICE METER

The dry gas meter and orifice were calibrated using a wet test meter. Gases were moved through the dry gas meter at orifice pressure differentials (ΔH) of 0.5, 1.0, and 2.0 inches of water. With the information obtained, γ, the ratio of the accuracy of the wet test meter to dry test meter, and $\Delta H_@$, the orifice pressure differential yielding 0.75 cfm of air at 68°F and 29.92 inches of mercury, were calculated. The γ has a tolerance of 1.00 ±0.01, and the $\Delta H_@$ has a tolerance of 1.84 + 0.26 - 0.24. The γ and $\Delta H_@$ are determined as follows:

$$\gamma = \frac{V_w P_b (t_d + 460)}{V_d [P_b + .07353(\Delta H)] (t_w + 460)}$$

$$\Delta H_@ = \frac{0.0317 (\Delta H)}{P_b (t_d + 460)} \left(\frac{(T_w + 460)^\theta}{V_w} \right)^2$$

where:

ΔH = Orifice pressure differential, in H_2O

P_b = Barometric pressure, in Hg

t_d = Average temperature of dry gas meter, °F

t_w = Average temperature of wet test meter, °F

θ = Duration of test, minutes

V_d = Dry gas meter volume, ft^3

V_w = Wet test meter volume, ft^3

POTENTIOMETER CALIBRATION

The Thermo-Electron potentiometers were calibrated by using a known voltage source as an input to the potentiometer.

PROBE CALIBRATION

The probes were calibrated by measuring the outlet temperatures at variable transformer settings while passing air through the probes at approximately 0.75 cubic feet per minute.

PITOT CALIBRATION

Pitot No. 6-A

Date 6-5-81

Engineer EWB/PCB

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	.032	.052	.777	-	.052	.777	.005	
	2	.052	.050	.777	0	.050	.792	0.01	
	3	.032	.050	.777	0	.052	.777	.005	
	AVG.			.777			.782		0.005
2	1	.19	.28	.816	0	.28	.816	0	
	2	.19	.28	.816	0	.28	.816	0	
	3	.19	.28	.816	0	.28	.816	0	
	AVG.			.816			.816		0.00
3	1	.45	.66	.824	.008	.67	.811	.008	
	2	.46	.65	.833	.0008	.66	.826	.007	
	3	.46	.64	.839	.006	.67	.820	.001	
	AVG.			.832			.819		0.012
4	1	.66	.88	.857	0.003	.88	.857	.002	
	2	.66	.89	.852	0.002	.88	.857	.002	
	3	.66	.89	.852	.002	.89	.852	.003	
	AVG.			.854			.855		.001
5	1	.88	1.35	.799	0	1.35	.799	0	
	2	.88	1.35	.799	0	1.35	.799	0	
	3	.88	1.35	.799	0	1.35	.799	0	
	AVG.			.799			.799		0.00
6	1	1.20	1.80	.808	0	1.80	.808	0	
	2	1.20	1.80	.808	0	1.80	.808	0	
	3	1.20	1.80	.808	0	1.80	.808	0	
	AVG.			.808			.808		0.00
7	1	1.31	1.98	.802	0	1.98	.802	0	
	2	1.31	1.98	.802	0	1.98	.802	0	
	3	1.31	1.98	.802	0	1.98	.802	0	
	AVG.			.802			.802		0.00

$C_p = 0.99\sqrt{\frac{\Delta P_{std}}{\Delta P_{s}}}$

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

DEV. ≤ 0.01

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

DIF. ≤ 0.01

BCM

METER BOX CALIBRATION SHEET

Date 9-15-81 Box No. 8 Inspector JFA

Pump OK Oil CHANGED Wick CHANGED Pump Serial No. A 72-325286

Manometers OK Knobs OK Oil OK Tubing OK

Quick Connects OK Vacuum Gage OK Valves OK

Dry Gas Meter OK Volume 785.7 ft³ Serial No. 677009

Thermometers OK In 96 Out 96 Ambient 99

Amphenol OK Lights OK Switches OK Variac OK

Leak Check - Max. Vacuum 26 in. Hg Leak Rate 0.003 CFM

Remarks

Man. Orifice	CF_W	CF_d	T_W	IT_d	OT_d	T_d	Time θ
0.5	4.998	5.174	71.5	81	79	80	12.68
1.0	5.000	5.206	71.8	88.3	81.5	84.9	8.89
2.0	10.000	10.554	72	94.8	85	89.9	13.03

Tolerances: $1.6 \le \Delta H_@ \le 2.1$ $0.99 \le \gamma \le 1.01$

$\Delta H_@ =$	$\frac{(0.0317)(\Delta H)}{(P_b)(OT_d+460)}\left[\frac{(T_W+460)(\theta)}{(CF_W)}\right]^2$	$\gamma =$	$\frac{(CF_W)(P_b)(T_d+460)}{(CF_d)(P_b+\Delta H/13.6)(T_W+460)}$
1.81	$\frac{(0.0317)(0.5)}{(29.53)(79+460)}\left[\frac{(71.5+460)(12.68)}{(4.998)}\right]^2$	0.98	$\frac{(4.998)(29.53)(80+460)}{(5.174)(29.53+0.0368)(71.5+460)}$
1.77	$\frac{(0.0317)(1.0)}{(29.53)(81.5+460)}\left[\frac{(71.8+460)(8.89)}{(5.000)}\right]^2$	0.98	$\frac{(5.000)(29.53)(84.9+460)}{(5.206)(29.53+0.0737)(71.8+460)}$
1.89	$\frac{(0.0317)(2.0)}{(29.53)(85+460)}\left[\frac{(72+460)(13.03)}{(10.000)}\right]^2$	0.97	$\frac{(10.000)(29.53)(89.9+460)}{(10.554)(29.53+0.147)(72+460)}$