AP42 Section:	12.2
Reference:	93
Title:	Republic Steel Corporation, Warren, Ohio, Particulate Emission Evaluation of the No. 1 Envirotech/Chemico One Spot Quench Car at the Coke Oven Battery, Betz, Converse, Murdoch, Inc., Pittsburgh, PA, January 1982.

Betz • Converse • Murdoch • Inc.

AP-42 Section 12.2
Reference
Report Sect. 4
Reference 92

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: No. 1 Car

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

SOTDAT/STEEL LIBRARY SYSTEM

Report Title: Source Emission Testing of the Envirotech/Chemico Enclosed Quench Car Systems at the Warren and Youngstown Mills of Republic Steel Corp.

Plant and Location: Republic Steel, Warren, OH

SCC: 30300303

Testing Date(s): 10/12-16/81

By Whom: BCM

Stack Test Review Attached: No

Reviewed By:

Problems Seen by Reviewer:

Confidentiality Status: NP

If status is confidential, list confidential pages or sections:

Source of Determination of the Confidentiality Status:

Report Encoded By:

Date Encoded:

Form Numbers:

Comments:

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

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(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 Warren

DATE 9-28-81

SAMPLING LOCATION Q-CAR #1

(initials)

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}	.00
BAROMETRIC PRESSURE AT METER, in. Hg	P_m	
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ 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	$T_{s\,avg.}$	150
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.7
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	1.4
C FACTOR	.7	
CALCULATED NOZZLE DIAMETER, in.	.250	
ACTUAL NOZZLE DIAMETER, in.	.203	
REFERENCE Δp, in. H_2O	1.6	

BCM

FIELD DATA SHEET

PLANT Republic Warren

DATE 90-13-81

SAMPLING LOCATION Q. CAR #1

SAMPLE TYPE 5

RUN NUMBER ONE OPERATOR EWB / BA

BAROMETRIC PRESSURE 29.49 STATIC PRESSURE

FILTER NUMBER(S)

GEL NUMBER(S)

THIMBLE NUMBER PLATE NUMBER

H_2O PICKUP (ml) 16.5

ORSAT:

CO_2 2.0

O_2 18.0

CO

PYROMETER NUMBER Micromite

THERMOCOUPLE NUMBER

PROBE NUMBER 6 TYPE SS/Glass

NOZZLE NUMBER 4 I.D. .203

METER BOX NUMBER 8 $\Delta H_@$ 1.77

PITOT NUMBER 6 C_p .82

SAMPLE BOX NUMBER(S) 3

ASSUMED MOISTURE (%) 24

ASSUMED METER TEMPERATURE 80

C FACTOR REFERENCE Δp 1.7

READ AND RECORD ALL DATA EVERY ______ MINUTES

Leak Check .002cfm 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
			929.89							2		
A-6	50		9	.54	.56	.56						
	75		930.69	.48	.49	.49	138	60	60	2	225	65
A-5	44									3	250	
	72		931.5	.85	.92	.92						
				.45	.47	.47	134	61	60	2		65
										3		
A-4	54	919		.62	64	.64						
	81		932.3	.40	.42	.42	134	62	60	2		
										4	260	66
A-3	44	943		.92	.98	.98						
	75		933.2	.48	.49	.49	135	62	61	2		
										4		
A-2	48	951		.82	.90	.90						
	60		934.0	.48	.49	.49	138	63	61	2	265	66
										6		
A-1	54	1002		1.4	1.5	1.5						
	64		935.4	.84	.80	.86	135	64	62	3	240	67
										4		
B-6	50	1011	936.2	.82	.90	.90						
	70			.45	.47	.47	136	66	62	2	250	64

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
			936.2									
B-5	50	1023		1.4	1.5	1.5				3	250	65
	62		937.3	.48	.49	49	136	68	66	>2		
B-4	51	1103	939.097	2.6	2.7	2.7	137			4	250	66
	99			.77	.81	.81		68	66	2		
B-3	47	1118	940.67	3.3	3.5	3.5	136	68	66	7	240	
	92			.79	.80	.80				2		66
B-2	46	1127	942.145	2.5	2.6	2.6	134	68	67	6	255	
	81			.85	.89	.89				3		66
B-1	50	1140	944.075	4.0	4.2	4.2	132	68	67	10	255	
	45			1.1	1.2	1.2				4		68
C-6	47	1150	945.01	.70	.72	.72	137	68	68	2	250	
	80			.46	.47	.47				2		66
C-5	43	1203	946.205	2.1	2.2	2.2	137	69	69	5	250	
	62			.95	1.0	1.0						68
C-4	40	1214	948.125	3.0	3.1	3.1	140	69	69	7	255	
	81			1.1	1.2	1.2				4		68
C-3	52	1223	949.93	4.5	4.7	4.7	139	69	69	11	270	
	41			1.3	1.4	1.4				4		65
C-2	50	1232	951.73	4.9	5.0	5.0	142	69	69	12	250	
	60			1.3	1.3	1.3				4		65
C-1	45	1248	950.64	4.6	4.8	4.8	141	69	69	12	250	
	80			1.2	1.25	1.25				4		65
B-6	8	1300	953.675	ABANDONED			136	69	69	2	250	
	44			.22	.24	.24				2	250	65
	66		954.26	.24	.25	.25						

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
			954.26									
D-5	51	1310	954.89	.15	.16	.16	142	69	69	>2	250	69
	64			.20	.21	.21				>2		
~~D-4~~ D-4	46	1323	956.035	1.6	1.6	1.6	140	69	68	5	255	69
	80			.50	.52	.52				2		
D-3	52	1336	957.50	2.0	2.1	2.1	141	69	69	6	255	69
	83			.61	.62	.62				2		
		ABANDON RUN TWICE, 8 SEC THAN 5 SEC + 35 = 51 SEC										
D-2	51	1348	958.464	.85	.90	.90	138	70	70	3	250	69
	56			.75	.80	.80				3		
D-1	54	1357	960.155	2.5	2.7	2.7	139	70	70	7	250	69
	116			.45	.46	.46				3		
	300 58.1 min.		20.265	.997	~~[illegible]~~ 1.236		107		66.5			

Leak Check 0.01 cfm at 10" Hg

BCM

FIELD DATA SHEET

PLANT Republic Steel
DATE Oct 14, 1981
SAMPLING LOCATION Quench Car / #1
SAMPLE TYPE Particulate
RUN NUMBER Two   OPERATOR EWB / BA
BAROMETRIC PRESSURE ____   STATIC PRESSURE ____
FILTER NUMBER(S) ____
GEL NUMBER(S) ____
THIMBLE NUMBER ____   PLATE NUMBER ____
H_2O PICKUP (ml) 165

ORSAT:
CO_2 1.5
O_2 17.5
CO ____

PYROMETER NUMBER ____
THERMOCOUPLE NUMBER ____
PROBE NUMBER ____ TYPE ____
NOZZLE NUMBER ____ I.D. ____
METER BOX NUMBER 8 $\Delta H_@$ ____
PITOT NUMBER ____ C_p ____
SAMPLE BOX NUMBER(S) ____
ASSUMED MOISTURE (%) ____
ASSUMED METER TEMPERATURE ____
C FACTOR ____   REFERENCE Δp ____

READ AND RECORD ALL DATA EVERY ____ MINUTES

Leak Check ≤.02 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
	7:00	8:47	960.545				131	50	50	>2	255	74
D-6	58	8:51	961.14	.25	.26	.26				>2		
				.16	.17	.17						
	72											
							135	52	53	2	260	72
D-5	50	9:01	962.014	.80	.82	.82				>2		
				.26	.27	.27						
	85											
							138	52	54	4	260	70
D-4	52	9:11	963.12	1.3	1.3	1.3				2		
				.49	.51	.51						
	73											
							125	60	62	5	270	70
D-3	51	9:23	964.565	2.0	2.1	2.1				2		
				.60	.61	.61						
	103											
							136	62	64	5	270	70
D-2	53	9:46	965.45	1.9	2.0	2.0				2		
				.60	.61	.61						
	77											
							138	62	64	5	250	70
D-1	51	9:58	967.23	2.2	2.3	2.3						
				.65	.69	.69						
	58											
							137	64	66	3	245	70
C-6	50	10:09	968.564	1.0	1.1	1.1				2		
				.67	.69	.69						
	103											

797.57528
56.969662

PLANT / TRAVERSE POINT NUMBER	DATE / SAMPLING TIME, min	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	ORIFICE PRESSURE DIFFERENTIAL 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
			968.564									
C-5	50	1018	970.065	2.2	2.3	2.3	139	64	64	5	235	20
	95			.95	1.0	1.0				2		
[illegible]	[illegible]	1030	971.55	3.2	3.3	3.3	137	68	69	7	250	20
	[illegible]			1.0	1.1	1.1				2½		
C-3	52	1114	973.46	3.9	4.1	4.1	133	62	63	9	245	20
	90			1.1	1.2	1.2				3		
C-2	52	1125	975.625	4.6	4.8	4.8	125	64	64	12	255	20
	93			1.2	1.25	1.25				4		
C-1	50	11:34	977.34	4.1	4.3	4.3	139	64	66	12	260	71
	71			1.1	1.15	1.15				4		
B-6	49	1151	978.463	1.3	1.35	1.35	136	69	70	4	270	71
	105			.25	.26	.26				>2		
B-5	51	1208	979.545	1.4	1.5	1.5	139	70	72	4	260	71
	72			.35	.37	.37				2		
B-4	50	1216	980.59	1.2	1.25	1.25	141	70	72	4	260	71
	60			.55	.56	.56				2		
B-3	51	1227	982.138	3.0	3.1	3.1	141	70	72	6	260	71
	86			.60	.62	.62				2		
B-2	49	1236	983.366	3.8	4.0	4.0	142	72	74	7	265	71
	80			.75	.80	.80				2		
B-1	52	1246	985.60	3.3	3.5	3.5	139	72	74	6	260	71
	96			.98	1.0	1.0				3		
A-6	51	1258	986.38	.35	.36	.36	140	76	78	2	260	71
	93			.10	.11	.11				2		

1777.5441

PLANT TRAVERSE POINT NUMBER	DATE SAMPLING TIME min	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	ORIFICE PRESSURE DIFFERENTIAL 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
			986.38									
A-5	51	1309	986.926	.64	.66	.66	141	76	78	2	260	70
	60			.15	.16	.16				2		
				1.1	1.15	1.15				4	260	70
A-4	52	13 19	988.305				130	76	78			
*	T1	G-CAL	PROBLEM DURING	TRAVEL MODE						2		
	34.7	START UP	- STOP @ .647 ft³	.80	.82	.82		76	78	2		
~~A-3~~	31	START-UP	FINISH	.65	.68	.68	142	76	78	4	260	70
A-3	53	13:31	989.42	1.3	1.4	1.4				2		
	91			.14	.15	.15		77	79	4	260	
A-2	51	13:41	990.40	1.1	1.15	1.15	143			22		70
	81			.13	.13	.13						
				2.2	2.3	2.3	141	80	80	6	260	
A-1	33	13:51	991.92	1.9	2.0	2.0				6		70
	30			.38	.39	.32				2		
	74											
			LEAK CHECK ≤.020 cfm @ AT 10" Hg									
									68 ~~68~~			
			31.375	.9654	1.194		137					
	315		-.647									
	51.92 min		30.728									
			30.728									

315
.66422
166.422

BCM

FIELD DATA SHEET

PLANT Republic Steel, Warren
DATE OCT 15, 1981
SAMPLING LOCATION Q-CAR
SAMPLE TYPE PARTICULATE
RUN NUMBER THREE OPERATOR EWB 184
BAROMETRIC PRESSURE 29.2 STATIC PRESSURE -2.5
FILTER NUMBER(S)
GEL NUMBER(S)
THIMBLE NUMBER PLATE NUMBER
H_2O PICKUP (ml) 165

ORSAT:
CO_2 1.5
O_2 17.5
CO —

PYROMETER NUMBER MIRCO MITE
THERMOCOUPLE NUMBER 10' A
PROBE NUMBER 6' SS CLAS TYPE
NOZZLE NUMBER I.D.
METER BOX NUMBER 8 $\Delta H_@$ 1.77
PITOT NUMBER C_p
SAMPLE BOX NUMBER(S)
ASSUMED MOISTURE (%) 24
ASSUMED METER TEMPERATURE 80
C FACTOR REFERENCE Δp 1.7

READ AND RECORD ALL DATA EVERY ______ MINUTES

Leak Check 0.02cfm @ 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
		8:34	992.205									
A-6	51	8:36	992.87	.52	.54	.54	131	58	59	>2	245	70
	72			.20	.21	.21				>2		
A-5	52	845	993.69	.75	.76	.76	134	60	61	>2	255	72
	93			.15	.16	.16				>2		
A-4	53	856	994.62	1.0	1.1	1.1	133	60	61	2	255	72
	81			.23	.24	.24				2		
A-3	52	905	995.53	1.1	1.2	1.2	136	60	61	3	260	73
	65			.28	.29	.29				>2		
A-2	49	915	996.57	1.1	1.2	1.2	137	60	62	3	265	74
	95			.30	.32	.32				2		
A-1	51	924	997.835	2.1	2.2	2.2	137	66	68	4	250	
	82			.45	.46	.46				2		
B-6	52	934	998.77	1.1	1.2	1.2	134	66	68	4	245	
	66			.34	.34	.36				2		

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	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
			998.77									
B-5	50	945	999.955	1.4	1.5	1.5	137	66	68	4	265	76
	99			.41	.43	.43				2		
B-4	52	9:54	001.375	2.4	2.5	2.5	125	68	69	5	270	78
	85			.65	.68	.68				2		
B-3	55	10:05	002.765	2.9	3.0	3.0	135	68	69	5	270	78
	63			.76	.82	.82				2		
B-2	51	1027	004.26	2.4	2.7	2.7	142	70	72	5	250	80
	86			.74	.78	.78						
B-1	50	1101	006.01	3.7	3.8	3.8	134	68	68	10	255	76
	98			.98	1.0	1.0				4		
C-6	59	1123	006.89	.84	.89	.89	135	68	68	2	260	74
	76			.74	.78	.79				2		
C-5	51	1131	008.445	2.3	2.4	2.4	136	69	69	5	265	70
	103			.86	.90	.90				2		
C-4	52	1141	010.08	3.3	3.5	3.5	137	70	71	7	255	70
	70			1.1	1.2	1.2				3		
C-3	54	1153	011.72	3.7	3.9	3.9	137	70	72	7	255	70
	58			1.3	1.4	1.4				4		
C-2	48	1204	013.765	4.6	4.9	4.9	138	70	72	9	255	72
	80			1.5	1.7	1.7				4		
C-1	57	1214	015.65	4.0	4.3	4.3	135	76	78	8	255	74
	71			1.1	1.2	1.2				3		
B-6	56	1225	016.37	.52	.54	.54	138	78	78	2	255	
	64			.28	.30	.30				2		

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
			016.37									
D-5	54 ~~D-5~~	1255	017.50	1.1	1.2	1.2	135	79	80	3	255	76
	87			.40	.42	.42				2		
D-4	54 ~~D-4~~	1244	018.765	1.1	1.2	1.2	141	80	82	3	260	79
	90			.55	.57	.57				2		
D-3	44 ~~D-3~~	1256	020.205	2.1	2.2	2.2	138	80	82	4	250	80
	41			.69	.71	.71				2		
D-2	53 ~~D-2~~	1311	021.52	1.5	1.6	1.6	136	80	82	4	250	83
	82			.75	.80	.80				2		
D-1	52 ~~D~~	1321	022.765	1.9	2.1	2.1	135	80	82	4	250	80
	53			.68	.70	.70						
	0212		LEAK CHECK < 0.02				~~136~~		~~70~~			
	53.53 avg											
			30.560	.991	1.228		136		70			

Leak Check <.01 cfm at 12"Hg

1 of 2

Betz • Converse • Murdoch • Inc. BCM

Consulting Engineers, Planners and Architects

Date 10/13/81 Location Name REPUBLIC STEEL WARREN, OHIO

Observer DANIEL PETROVAN Address

Observation Point WEST OF COKE OVENS Weather SUNNY CLEAR SKIES

Oven Distance From 20 YDS Height 30' 0% CLOUD COVER

Wind Speed 3-5 M/H Direction SE

Observation Began 9:08 Ended 13 57

Type of Installation

TEST #1

Time of Quench	Push	Oven	Seconds 0 ≥20% Opacity Per Push	Seconds ≥20% Opacity Per Push	Seconds ≥40% Opacity Per Push	Maximum Opacity	Remarks
9:08 50 9:09 42	1	B-13	0 To 5%			5%	
9:17:11	2	C-13	15%			15%	
9:30 [illegible] 9:30 50	3	A-15	0% To 15%			15%	
9:40 [illegible] 9:48 [illegible]	4	B-15	0% To 10%			10%	
9:47 [illegible] 9:48	5	C-15	0% To 20%	7.10 sec		20%	
9:59 [illegible] 10:00 59	6	A-17	—			—	NO READING INTERFERANCE FROM WASHER
10:10 [illegible] 10:11.21	7	B-17	0% To 15%			15%	
10:20 28 10:21.17	8	C-17	0% To 20%	18.14 sec		20%	C-14 DOOR LEAK MIX WITH OPACITY
11.01.52 11.02.40	9	A-19	0% To 20%	3.34 sec		20%	
11:16 [illegible] 11:17.32	10	B-14	0% To 20%	6.42 sec		20%	

Comments: SUN IN EYES WHILE READING SMOKE FROM PUSHING OF COKE
WIND SETUP OF COKES BLOWING IN TOWARD OVEN

10/13/81

TEST 1

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Time of Quench	Push	Oven	Seconds ≥ 20 % Opacity Per Push	Seconds ≥ 20 % Opacity Per Push	Seconds ≥ 40 % Opacity Per Push	Maximum Opacity	Remarks
11:27:05 11:28:05	11	C-19	0% TO 20%	15.23 SEC		20%	
11:40:10 11:41:10	12	A-21	0% TO 20%	4.11 SEC		20%	
11:49:46 11:50:46	13	B-21	0% TO 20%	12.21 SEC		20%	
12:02:35 12:03:32	14	C-21	0% TO 25%	8.61 SEC.		25%	
12:11:59 12:12:59	15	A-23	—	—		—	NO READING INTERFERENCE FROM WHARF EMMISSIONS
12:22:04 12:23:04	16	B-23	0% TO 25%	13.44 SEC		25%	
12:31:44 12:32:44	17	C-23	0% TO 20%	10.74 SEC		20%	
12:47:24 12:48:22	18	A-25	0% TO 30%	19.08 SEC.		30%	SCRUBBER NOT TURN ON IN TIME
12:59:59 13:00:40	19	B-25	0% TO 20%	7.61 SEC.		20%	
13:09:15 13:10:28	20	C-25	0% TO 20%	13.40 SEC		20%	
13:22:49 13:23:34	21	A-27	0% TO 20%	8.07 SEC		20%	B.
13:35:44 13:36:05	22	B-27	0% TO 25% 0% TO 45%	11.03 SEC 29.05 SEC		20% 45%	B-25 OVEN SMOKING CAUSE SOME PROBLEM READING.
13:46:44 13:41:30	23	C-27					SCRUBBER NOT OPERATE PROPERLY START+STOP NOT FULL CAPACITY
13:56:03 13:57:29	24	A-29	0% TO 25%	15.22 SEC		25%	

Comments:

Betz • Converse • Murdoch • Inc.

Consulting Engineers, Planners and Architects

Date 10/14/81 Location Name REPUBLIC STEEL WARREN, OHIO

Observer DANIEL PETROJAV Address

Observation Point WEST OF COKE OVENS Weather 10% CLOUD COVER

Oven Distance From 20 YDS Height 30' BLUE SKIES CALLING FOR

Wind Speed 3-5 MPH Direction S 10% SHOWERS

Observation Began 0850 Ended

Type of Installation

TEST # 2

Time of Quench	Push	Oven	Seconds 0 ≥ 20% Opacity Per Push	Seconds ≥ 20% Opacity Per Push	Seconds ≥ 40% Opacity Per Push	Maximum Opacity	Remarks
8:50.37 8:51.42	1	C-27	0% TO 10%			10%	A-27 BATTERY SMOKING COULD CAUSE HIGHER READINGS
9:00.59 9:01.49	2	A-29	0% TO 15%			15%	
9:11.32 9:12.66	3	B-29	0% TO 15%			10%	
9:32.44 9:33.80	4	A-2	0% TO 10%				
9:45.95 9:47.42	5	B-2	0% TO 20%	3.64 SEC.		20%	A-29 BATTERY SMOKING COULD CAUSE HIGHER READINGS.
9:58.15 9:59.08	6	C-2	0% TO 20%	2.58 SEC		20% 15%	
10:09.47 10:10.27	7	A-4	0% TO 15%			—	INTERFERENCE FROM WHARF SMOKING
10:19.37 10:20.00	8	B-4	—	—			
10:30.56 10:31.47	9	C-4	0% TO 25%	7.96 SEC		25%	
11:14.42 11:15.31	10	A-6	0% TO 20%	3.69 SEC		20%	
11:25.02 11:25.58	11	B6	—	—		—	INTERFERENCE FROM WHARF SMOKING ON TO TOP OF BATTERY

Comments: SUN COMING UP RIGHT BEHIND COKE OVEN BATTERIES DIRECTLY IN OBSERVER'S EYES

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BCM

Consulting Engineers, Planners and Architects

TEST No 2 10/14/81

Time of Quench	Push	Oven	Seconds 0 ≥ 20 % Opacity Per Push	Seconds ≥ 20 % Opacity Per Push	Seconds ≥ 40 % Opacity Per Push	Maximum Opacity	Remarks
11:34.55 11:35.42	12	C-6	0% TO 20%	9.61 SEC		20 %	
11:51.35 11:52.22	13	A-8	0% TO 25%	6.34 SEC		25 %	
12:08.25 12:09.19	14	B-8	0% TO 20%	7.83 SEC		20 %	
12.16 54 12.18.01	15	C-8	0% TO 10%			10 %	
12:27.28 12:28.17	16	A-10	0% TO 20%	6.02 SEC		20 %	
12:36 23 12:37.10	17	B-10	—	—		—	SMOKE FROM WHARF INTERFERENCE
12:45.40 12:46 51	18	C-10	0% TO 30%	34.81 SEC		30 %	PITZ SAID COLDSPOT IN COKE
12.58 22 12.59 41	19	A-12	0% TO 30%	20.64 SEC		30 %	
13:08 45 13:10 11	20	B-12	—	—		—	SMOKE FROM WHARF INTERFERENCE
13:20 50 13:22.39	21	C-12	0% TO 25%	14.27 SEC		25 %	HARD PUSH SCRUBBER ON NO COKE PUSHED FOR 30 SEC. THEN PUSHED EN.
13:31 54 13:33.13	22	A-14	—	—		—	A-13 DOOR LEAK UNABLE TO TAKE GOOD READING INTERFERENCE
13 40 54 13 42.00	23	B-14	0% TO 20%	2.50 SEC		20%	
13.51 45 13:	24	C-14	0% TO 35%	15.75 SEC		35 %	HARD PUSH SCRUBBER ON NO COKE FOR 30 SEC. THEN PUSHED

Comments: WIND SHIFT FROM S TO SE 12.50

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Consulting Engineers; Planners and Architects

Date 10/15/81 Location Name REPUBLIC STEEL

Observer DANIEL PETROVAY Address WARREN, OHIO

Observation Point WEST OF COKE OVENS Weather 90% CLOUD LEVEL

Oven Distance From 30 YDS Height 30' DRIZZLE WITH 30% CHANCE OF RAIN

Wind Speed 5-10 MPH Direction SE

Observation Began 8 35 Ended

Type of Installation COKE OVEN BATTERIES

TEST #3

	Time of Quench	Push	Oven	Seconds ≥ 30 % Opacity Per Push	Seconds ≥ % Opacity Per Push	Seconds ≥ % Opacity Per Push	Maximum Opacity	Remarks
1	8:35:24 8:36:51	1	C-14	0% TO 20%	5.52 sec		20%	
2	8:45:00 8:46:40	2	A-16	0% TO 10%			10%	
3	8:55:53 8:56:50	3	B-16	0% TO 5%			5%	
4	9:05:20 9:05:51	4	C-16	0% TO 5%			5%	
5	9:14:40 9:15:36	5	A-18	0% TO 5%			5%	INTERFERENCE FROM STEAM SMOKE FROM WHARF
6	9:24:06 9:25:06	6	B-18	—	—		—	
7	9:34:21 9:35:00	7	C-18	0% TO 25%	5.71 SEC		25%	
	9:44:45 9:45:10	8	A-20	0% TO 15%			15%	
	9:54:24 9:55:20	9	B-20	0% TO 20%	3.00 SEC		20%	
	10:05:55 10:06:50	10	C-20	0% TO 20%	7.11 SEC		20%	
	10:27:51 10:28:54	11	A-22	0% TO 30%	7.61 SEC		30%	

Comments: READING FROM TOP OF COLLECTOR MAIN

TEST #3
10/15/81

Betz • Converse • Murdoch • Inc.

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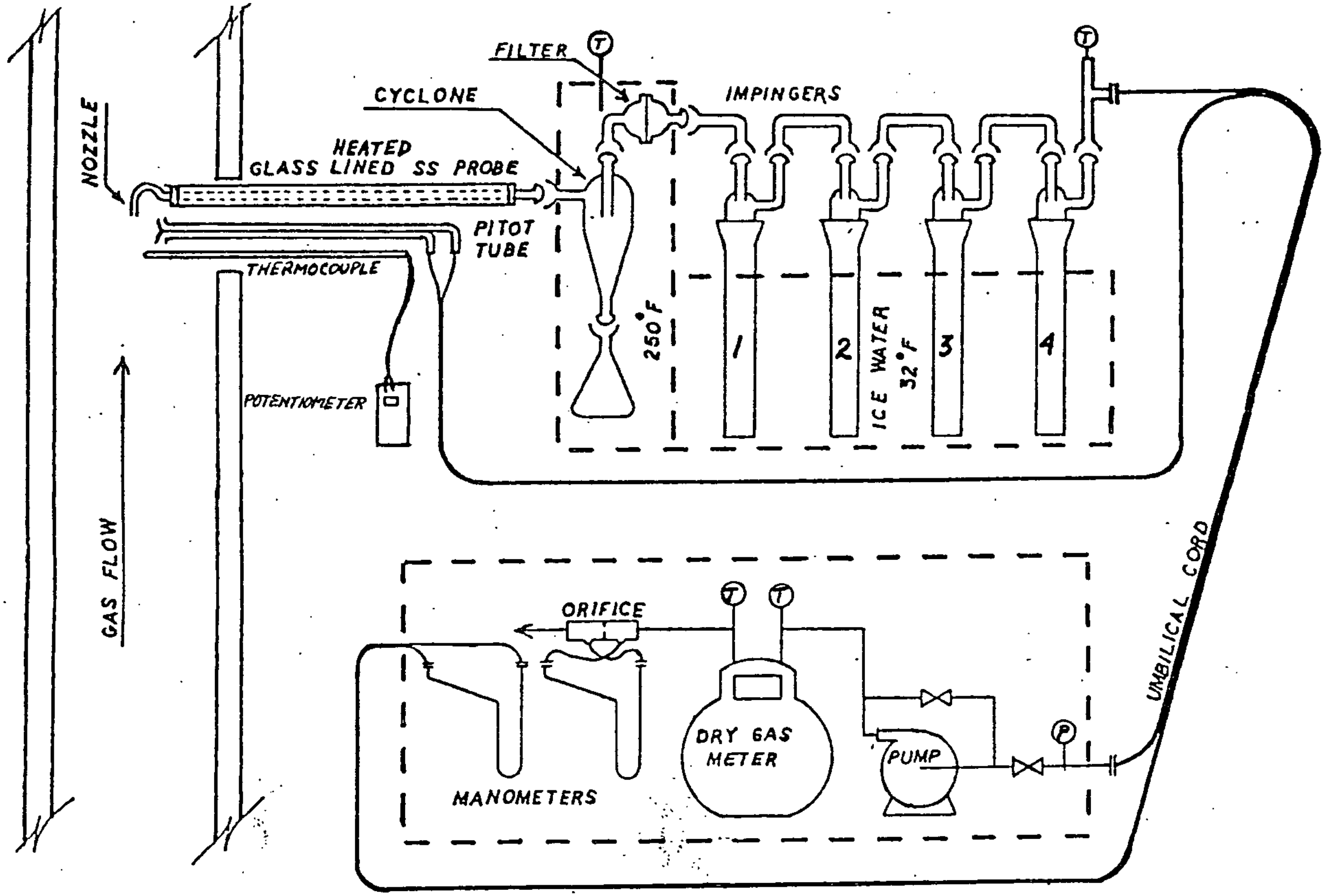
Consulting Engineers, Planners and Architects

Time of Quench	Push	Oven	Seconds 0 ≥ 30 % Opacity Per Push	Seconds ≥ % Opacity Per Push	Seconds ≥ % Opacity Per Push	Maximum Opacity	Remarks
11 07 35 11 08 31	12	B-22	0% TO 20%	7.21 SEC		20% 25%	
11.22.36 11.23 36	13	C-22	0% TO 25%	14.12 SEC			INTERFERENCE FROM SMOKE FROM WHARF
11:31.30 11.32.35	14	A-24	—	—		—	INTERFERENCE FROM SMOKE FROM WHARF
11:41.42 11:42.38	15	B-24	—	—		—	
11:52.47 11:53.50	16	C-24	0% TO 15%			15%	INTERFERENCE FROM SMOKE FROM WHARF
12:03.28 12:04.21	17	A-26	—	—		—	
12:13.48 12:14.52	18	B-26	0% TO 20%	2.36 sec.		20%	
12:24.54 12:25.52	19	C-26	0% TO 15%			15%	
12:35.[illegible] 12:36.[illegible]	20	A-28	0% TO 20%	3.26 SEC		20%	
12:45.57 12:46.[illegible]	21	B-28	0% TO 10%			10%	
12:56.[illegible] 12:57.28	22	A-1	0% TO 20%	4.16 SEC		20%	
13:11.35 13:12.36	23	B-1	0% TO 15%			15%	
15:21.04 15:22.03	24	C-1	0% TO 15%			15%	

Comments:



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

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	34.8	35.9	70.7
2	7.3	13.5	20.8
3	7.2	16.3	23.5

* Blank corrected

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

00 - 7...

1	Heading	REPUBLIC Q-CAR - WARREN			
2	Number of tests	4			
		1	2	3	
3	Test type	"EPA"	"EPA"	"EPA"	"EPA"
4	Test identification	QC1-1	QC1-2	QC1-3	QC2-1
5	Stack area, in^2	4608	4608	4608	4608
6	Stack temperature, ^oF	137	137	136	133
7	Sample volume, ft^3	30.265	30.738	30.560	33.04
8	Meter temperature, ^oF	66.5	68	70	81
9	Orifice (ΔH), in. H_2O	1.236	1.194	1.228	1.86
10	Nozzle diameter, in	.203	.203	.203	.203
11	Duration of test, min.	50.1	51.92	53.53	43.65
12	Volume of CO_2, %	2.0	1.5	1.5	2.0
13	Volume of CO, %	0.0	0.0	0.0	0.0
14	Volume of O_2, %	18.0	17.5	17.5	18.0
15	Static pressure, in. H_2O	-2.5	-2.5	-2.5	-1.4
16	Barometric pressure, in. Hg	29.49	29.49	29.20	29.94
17	Pitot correction factor	.82	.82	.82	.82
18	Traverse (Avg.$\sqrt{\Delta p}$), in. H_2O	.997	.965	.991	1.20
19	Volume H_2O collected, ml	171.8	175.7	174.2	181
20	Weight collected, mg	58.7	11.1	13.9	147.6
21	Volume titrant, SO_3, ml	[illegible] 0	[illegible] 0	[illegible] 0	0
22	Volume titrant, SO_2, ml	0	0	0	0
23	Normality titrant, SO_3	0	0	0	0
24	Normality titrant, SO_2	0	0	0	0
25	Meter calibration factor	1	1	1	1
26	Avg. Cosine of angle	1	1	1	1
27	Post leak check rate, CFM	0	0	0	0
28	Leak check rate no. 1, CFM	0	0	0	0
29	Leak check time no. 1, min.	0	0	0	0

QUENCH, UNN

TEST #4 LABELED

REPUBLIC Q-CAR XT 6

Q OCT 6, UNN

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

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

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

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

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

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 1 of 1
Date 10-28-81
J. O. Number 00- 4683 -02
Computed by BA
Checked by

Name of Client: Republic Steel
Project: Q-CAR #1
Description: 3RD week of Testing OCT 12-16

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

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

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

RUN	TONS/ OVEN	OVENS/ TEST	TONS COKE/ TEST	TEST TIME	TONS COKE/HR	Lbs PART/ hr	Lbs PART/ TON COKE
1	12.65	24	303.6	50.1	363.6	21.30	.0586
2	12.65	24	303.6	51.92	350.8	7.23	.0206
3	12.65	24	303.6	53.53	340.3	8.56	.0252

REPUBLIC Q-CAR - WARREN [illegible]

PARAMETERS:		QC-1	QC-2	QC-3
AREA OF BREECHING	(SQ FT)	32.00	32.00	32.00
SAMPLE VOLUME	(DSCF)	29.995	30.364	29.792
MOISTURE	(%)	16.5	18.5	18.0
MOLECULAR WEIGHT	(LB/LB-MOLE)	27.00	26.92	26.97
GAS TEMPERATURE	(F)	137.0	137.0	136.0
GAS VELOCITY	(FT/MIN)	3642.5	3530.9	3637.6
GAS VOLUME	(DRY SCFM)	82264.0	79763.5	81970.8
GAS VOLUME	(ACFM)	116560.1	112989.6	16402.4
PARTICULATE EMISSIONS:				
CONCENTRATION	(GRAINS/DSCF)	.0302	.0106	.0122
CONC. @ 12% CO2	(GRAINS/DSCF)	.1612	.0846	.0974
CONC. @ STK COND.	(GRAINS/CF)	.0206	.0072	.0082
EMISSION RATE	(LB/HR)	21.3063	7.2295	8.5553
ORSAT ANALYSIS:				
CARBON DIOXIDE	(VOL %)	2.0	1.5	1.5
CARBON MONOXIDE	(VOL %)	.0	.0	.0
OXYGEN	(VOL %)	18.0	17.5	17.5
NITROGEN	(VOL %)	80.0	81.0	81.0
EXCESS AIR	(%)	570.9	450.6	450.6
ISOKINETICS	(%)	107.2	108.3	101.1

THE FOLLOWING RUNS WERE UNDER SATURATED CONDITIONS:
QC-1
QC-2
QC-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

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

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

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

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

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

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

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

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

BCM

METER BOX CALIBRATION SHEET

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

Pump OK Oil CHANGED Wick CHANGED Pump Serial No. A 72-325281

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 °F Out 96 °F Ambient 92

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	$\frac{(10.000)(29.53)(89.9+460)}{(10.554)(29.53+0.147)(72+460)}$

Pitot No. 0-A Date 6-25-81 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	0	.052	.777	.005	
	2	.032	.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	.65	.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. $\leq$ 0.01

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

DIF. $\leq$ 0.01

JANUARY 1982

REPORT

AP-42 Section 12.2
Reference
Report Sect. 4
Reference 93
Same as 92!

Mary, Keep this duplicate. Dris 9/19/85

Republic Steel Corporation
Warren, Ohio

Particulate Emission Evaluation of the No. 1 Envirotech/Chemico One Spot Quench Car at the Coke Oven Battery

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

PARTICULATE EMISSION EVALUATION
OF THE
NO. 1 ENVIROTECH/CHEMICO ONE SPOT QUENCH CAR

AT THE

COKE OVEN BATTERY
OF
REPUBLIC STEEL CORPORATION
WARREN, OHIO

JANUARY 1982

BCM PROJECT NO. 00-4683-02

PREPARED BY

ROBERT ALFRED, SCIENTIST II

APPROVED BY

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

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

CONTENTS

TABLES

1.0 INTRODUCTION

Republic Steel Corporation (RSC) retained Betz•Converse•Murdoch•Inc. (BCM) to evaluate its No. 1 Envirotech/Chemico one spot quench car installed at the new Coke Oven Battery at their Warren, Ohio 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 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 the BCM confirming Proposal of January 29, 1981, 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 emissions - grains/dry standard cubic foot (g/dscf), lbs/hr and lbs/ton of coke pushed
- Opacity - % Opaque

3.0 PROCEDURES

3.1 Field Work

Field testing was conducted October 12 through October 15, 1981. The sampling team consisted of the following BCM personnel:

- Robert Alfred - Scientist II
- Edward W. Blanar - Engineer I
- Dan Petrovay - Technician III

Mr. Tom Kachur 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 Ohio EPA was present during the testing of the No. 1 Quench Car.

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

1. Sampling and traverse locations were determined 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 per a modified 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 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)	Emission Rate (Pounds/Hour)	Lbs/Ton of Coke Pushed*
1	.0302	21.3	.0586
2	.0106	7.22	.0206
3	.0122	8.55	.0252
			.0348 lbs/ton ave.

* Based on 303.6 tons of coke pushed for each 24 oven test

4.2 Visible Emissions

The opacity observations were performed in accordance with methodology approved by Chemico and the EPA. The readings are contained in Appendix 2.

5.0 DISCUSSION

5.1 Particulate Testing Results

The particulate emission testing for the No. 1 Quench Car was performed with minimal field difficulties. Testing on October 13, 1981 was delayed for a total of 59 seconds during two pushes and on October 14, a delay of 65 seconds was incurred. These delays occurred because of the hot coke "sticking" in the ovens and not being able to be pushed out. The operator of the Quench Car who initiated the scrubbing cycle was not aware of the problem. After learning of the ensuing problem, the scrubber system was then shut off. As the scrubber was only scrubbing clean air, the cubic feet of gas sampled and the sampling time for the pushes were subtracted from the appropriate totals. If these were to be included in the calculations, the isokinetics would rise approximately one percent and the emission concentration would be artifically depressed.

The final testing results indicate compliance with the allowable emission rate of 0.03 lb/ton of coke pushed.

5.2 Visible Emissions Procedures

The opacity for the No. 1 Quench Car 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 140° to the observer's back. This guideline could not be met as the location of the observer with respect to the coke ovens precluded this. All observations were recorded by an EPA Certified Emission 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 about two minutes. There were 24 pushes per test, each push occurring approximately 10 to 12 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

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

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

ones and Laughlin Steel Corporation - Pittsburgh Works

ay - July, 1978
.ugust - September, 1979
r. S. W. Kretz - (412) 378-5447

ethlehem Steel Corporation - Bethlehem, PA

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

Bethlehem Steel Corporation - Sparrows Point, MD

)ctober, 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

.0 SAMPLING PROCEDURES

.1 Test Station and Traverse Locations

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

.2 Gas Flow and Gas Temperature Determinations

'he gas flow rate and temperature profiles were measured by conducting a ;imultaneous velocity and temperature traverse in conjunction with the ›articulate testing program. Gas velocity heads were measured with a :alibrated "S"-type Pitot tube which was connected to an inclined manoieter. A Chromel-Alumel thermocouple connected to a potentiometer was ised to determine the gas temperature.

!.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 Warren

DATE 9-28-81

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	
STATIC PRESSURE IN STACK, in. Hg ($P_m \pm 0.073$ 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	$T_{s\,avg.}$	150
AVERAGE VELOCITY HEAD, in. H_2O	$\Delta p_{avg.}$	.7
MAXIMUM VELOCITY HEAD, in. H_2O	$\Delta p_{max.}$	1.4
C FACTOR	.7	
CALCULATED NOZZLE DIAMETER, in.	.250	
ACTUAL NOZZLE DIAMETER, in.	.203	
REFERENCE Δp, in. H_2O	1.6	

BCM
FIELD DATA SHEET

PLANT Republic Warren
DATE 90-13-81
SAMPLING LOCATION Q.CAR #1
SAMPLE TYPE 5
RUN NUMBER ONE OPERATOR EWB/BA
BAROMETRIC PRESSURE 29.49 STATIC PRESSURE
FILTER NUMBER(S)
GEL NUMBER(S)
THIMBLE NUMBER PLATE NUMBER
H_2O PICKUP (ml) 165
Leak Check .002 cfm at 15"Hg

ORSAT:
CO_2 2.0
O_2 18.0
CO

PYROMETER NUMBER Micromite
THERMOCOUPLE NUMBER
PROBE NUMBER 6 TYPE SS/Glass
NOZZLE NUMBER 4 I.D. .203
METER BOX NUMBER 8 $\Delta H_@$ 1.77
PITOT NUMBER 6 C_p .82
SAMPLE BOX NUMBER(S) 3
ASSUMED MOISTURE (%) 24
ASSUMED METER TEMPERATURE 80
C FACTOR REFERENCE Δp 1.7

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	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
			929.89									
A-6	50		9	.54	.56	.56				2		
	75		930.69	.48	.49	.49	132	60	60	2	225	65
A-5	44											
	72		931.5	.85	.92	.92				3	250	
				.45	.47	.47	134	61	60	2		65
A-4	54	919		.62	64	.64				3		
	81		932.3	.40	.42	.42	134	62	60	2		
A-3	44	943		.92	.98	.98				4	260	66
	75		933.2	.48	.49	.49	135	62	61	2		
A-2	48	951		.82	.90	.90				4		
	60		934.0	.48	.49	.49	138	63	61	2	265	66
A-1	54	1002		1.4	1.5	1.5				6		
	64		935.4	.84	.80	.80	135	64	62	3	240	67
B-6	50	1011	936.2	.82	.90	.90				4		
	70			.45	.47	.47	136	66	62	2	250	64

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
			936.2									
B-5	50	1023		1.4	1.5	1.5				3	250	65
	62		937.3	.48	.49	49	136	68	66	>2		
B-4	51	1103	939.097	2.6	2.7	2.7	137			4	250	66
	99			.77	.81	.81		68	66	>2		
B-3	47	1118	940.67	3.3	3.5	3.5	136	68	66	7	240	
	92			.79	.80	.80				2		66
B-2	46	1127	942.145	2.5	2.6	2.6	134	68	67	6	255	
	81			.85	.89	.89				3		66
B-1	50	1140	944.075	4.0	4.2	4.2	132	68	67	10	255	
	85			1.1	1.2	1.2				4		68
C-6	47	1150	945.01	.70	.72	.72	137	68	68	2	250	
	80			.46	.47	.47				2		66
C-5	43	1203	946.205	2.1	2.2	2.2	137	69	69	5	250	
	62			.95	1.0	1.0						68
C-4	40	1214	948.125	3.0	3.1	3.1	140	69	69	7	255	
	81			1.1	1.2	1.2				4		68
C-3	52	1223	949.93	4.5	4.7	4.7	139	69	69	11	270	
	91			1.3	1.4	1.4				4		68
C-2	50	1232	951.73	4.9	5.0	5.0	142	69	69	12	250	
	60			1.3	1.3	1.3				4		68
C-1	45	1248	950.64	4.6	4.8	4.8	141	69	69	12	250	
	80			1.2	1.25	1.25				4		68
D-6	8	1300	953.675	ABANDONED			136	69	69	2	250	
	44			.22	.24	.24				2	250	[illegible]
	66		954.26	.24	.25	.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	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
			954.26									
D-5	51	1310	954.89	.15	.16	.16	142	69	69	>2	250	69
	64			.20	.21	.21				>2		
~~D-4~~												
D-4	46	1323	956.035	1.6	1.6	1.6	140	69	68	5	255	69
	80			.50	.52	.52				2		
D-3	52	1336	957.50	2.0	2.1	2.1	141	69	69	6	255	69
	83			.61	.62	.62				2		
			ABANDON RUN TWICE, 8 SEC THAN 5 SEC + 36 = 51 SEC									
D-2	51	1348	958.464	.85	.90	.90	138	70	70	3	250	69
	56			.75	.80	.80				3		
D-1	54	1357	960.155	2.5	2.7	2.7	139	70	70	7	250	69
	116			.45	.46	.46				3		
	1006		30.265	.997	~~[illegible]~~		107		66.5			
	56.1 min.				1.236							
	LEAK Check		L.01 cfm AT 10" Hg									

BCM

FIELD DATA SHEET

PLANT Republic Steel,
DATE Oct 14, 1981
SAMPLING LOCATION Quench Car / #1
SAMPLE TYPE Particule
RUN NUMBER Two OPERATOR EWB / BA
BAROMETRIC PRESSURE ______ STATIC PRESSURE ______
FILTER NUMBER(S) ______
GEL NUMBER(S) ______
THIMBLE NUMBER ______ PLATE NUMBER ______
H_2O PICKUP (ml) 105

ORSAT:
CO_2 1.5
O_2 17.5
CO ______

PYROMETER NUMBER ______
THERMOCOUPLE NUMBER ______
PROBE NUMBER ______ TYPE ______
NOZZLE NUMBER ______ I.D. ______
METER BOX NUMBER 8 $\Delta H_@$ ______
PITOT NUMBER ______ C_p ______
SAMPLE BOX NUMBER(S) ______
ASSUMED MOISTURE (%) ______
ASSUMED METER TEMPERATURE ______
C FACTOR ______ REFERENCE Δp ______

Leak Check <.02 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	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
	7:00	8:47	960.545									
D-6	58	8:51	961.14	.25	.26	.26	131	50	50	>2	255	74
	72			.16	.17	.17				>2		
D-5	50	9:01	962.014	.80	.82	.82	135	52	53	2	260	72
	85			.26	.27	.27				>2		
D-4	52	9:11	963.12	1.3	1.3	1.3	138	52	54	4	260	70
	73			.49	.51	.51				2		
D-3	51	9:23	964.565	2.0	2.1	2.1	125	60	62	5	270	70
	103			.60	.61	.61				2		
D-2	53	9:46	965.45	1.9	2.0	2.0	136	62	64	5	270	
	77			.60	.61	.61				2		70
D-1	51	9:58	967.23	2.2	2.3	2.3	138	62	64	5	250	
	58			.65	.69	.69						70
C-6	50	10:09	968.564	1.0	1.1	1.1	137	64	66	3	245	
	103			.67	.69	.69				2		70

797.57528
56.9[illegible]662

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
			968.564									
C-5	50	1018	970.065	2.2	2.3	2.3	139	64	64	5	235	70
	85			.95	1.0	1.0				2		
C-4	51	1030	971.55	3.2	3.3	3.3	137	68	69	7	250	70
	64			1.0	1.1	1.1				2½		
C-3	52	1114	973.46	3.9	4.1	4.1	133	62	63	9	245	70
	90			1.1	1.2	1.2				3		
C-2	52	1125	975.625	4.6	4.8	4.8	125	64	64	12	255	80
	93			1.2	1.25	1.25				4		
C-1	50	11:34	977.34	4.1	4.3	4.3	139	64	66	12	260	71
	71			1.1	1.15	1.15				4		
B-6	49	1151	978.469	1.3	1.35	1.35	136	69	70	4	270	
	105			.25	.26	.26				2		71
B-5	51	1208	979.545	1.4	1.5	1.5	139	70	72	4	260	
	72			.35	.37	.37				2		71
B-4	50	1216	980.59	1.2	1.25	1.25	141	70	72	4	260	
	60			.55	.56	.56				2		71
B-3	51	1227	982.138	3.0	3.1	3.1	141	70	72	6	260	
	86			.60	.62	.62				2		71
B-2	49	1236	983.366	3.8	4.0	4.0	142	72	74	7	265	
	80			.75	.80	.80				2		71
B-1	52	1246	985.60	3.3	3.5	3.5	139	72	74	6	260	
	96			.98	1.0	1.0				3		71
A-6	51	1258	986.38	.35	.36	.36	140	76	78	2	260	71
	93			.10	.11	.11				2		

1777.8441
74.67[illegible]

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	ORIFICE PRESSURE DIFFERENTIAL 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
			986.38									
A-5	51	1309	986.926	.64	.66	.66	141	76	78	2	260	70
	60			.15	.16	.16				2		
A-4	57	1319	988.305	1.1	1.15	1.15				4	260	70
	7	G-CAR	PROBLEM, DURING	TRAVEL MODE			130	76	78			
	34.7?	START UP	- STOP .647 ft³	.80	.82	.82				2		
~~A-3~~	31	START-UP	FINISH [illegible]	.65	.68	.68		76	78	2		
A-3	53	13:31	989.42	1.3	1.4	1.4	142	76	78	4	260	70
	91			.14	.15	.15				2		
A-2	51	13:41	990.40	1.1	1.15	1.15	143	77	79	4	260	
	81			.13	.13	.13				>2		70
A-1	33	13:51	991.92	2.2	2.3	2.3	141	80	80	6	260	
	30			1.9	2.0	2.0				6		70
	74			.38	.39	.32				2		
			LEAK CHECK ≤.020 cfm @ AT 10" Hg									
									68			
	315		31.375	.9654	1.194		137		~~68~~			
	51.92 min		-.647									
			30.728									
			30.728									

3115

731.66422

43.166422

BCM

FIELD DATA SHEET

PLANT Republic Steel, Warren

DATE Oct 15, 1981

SAMPLING LOCATION Q-Car

SAMPLE TYPE Particulate

RUN NUMBER Three OPERATOR EWB 184

BAROMETRIC PRESSURE 29.2 STATIC PRESSURE -2.5

FILTER NUMBER(S)

GEL NUMBER(S)

THIMBLE NUMBER PLATE NUMBER

H_2O PICKUP (ml) 165

ORSAT:

CO_2 1.5

O_2 17.5

CO –

PYROMETER NUMBER Mirco Mite

THERMOCOUPLE NUMBER 10' A

PROBE NUMBER 6' SS Clas TYPE

NOZZLE NUMBER I.D.

METER BOX NUMBER 8 $\Delta H_@$ 1.77

PITOT NUMBER C_p

SAMPLE BOX NUMBER(S)

ASSUMED MOISTURE (%) 24

ASSUMED METER TEMPERATURE 80

C FACTOR REFERENCE Δp 1.7

Leak Check 0.02cfm @ 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	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
		8:34	992.205									
A-6	51	8:36	992.87	.52	.54	.54	131	58	59	>2	245	70
	72			.20	.21	.21				>2		
A-5	52	845	993.69	.75	.76	76	134	60	61	>2	255	72
	93			.15	.16	16				>2		
A-4	53	856	994.62	1.0	1.1	1.1	133	60	61	2	255	72
	81			.23	.24	.24				2		
A-3	52	905	995.53	1.1	1.2	1.2	136	60	61	3	260	73
	65			.28	.29	.29				>2		
A-2	49	915	996.57	1.1	1.2	1.2	137	60	62	3	265	74
	95			.30	.32	.32				2		
A-1	51	924	997.835	2.1	2.2	2.2	137	66	68	4	250	
	82			.45	.46	.46				2		
B-6	52	934	998.77	1.1	1.2	1.2	134	66	68	4	245	
	66			.34	.36	36				>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
			998.77									
B-5	50	945	999.955	1.4	1.5	1.5	137	66	68	4	245	76
	99			.41	.43	.43				2		
B-4	52	954	001.375	2.4	2.5	2.5	125	68	69	5	270	78
	85			.65	.68	.68				2		
B-3	55	10:05	002.765	2.9	3.0	3.0	135	68	69	5	270	78
	63			.76	.82	.82				2		
B-2	51	1027	004.26	2.4	2.7	2.7	142	70	72	5	250	80
	86			.74	.78	.78						
B-1	50	1101	006.01	3.7	3.8	3.8	134	68	68	10	255	76
	98			.98	1.0	1.0				4		
C-6	59	1123	006.89	.84	.89	.89	135	68	68	2	260	74
	76			.74	.79	.79				2		
C-5	51	1131	008.445	2.3	2.4	2.4	136	69	69	5	265	70
	103			.86	.90	.90				2		
C-4	52	1141	010.08	3.3	3.5	3.5	137	70	71	7	255	70
	70			1.1	1.2	1.2				3		
C-3	54	1153	011.72	3.7	3.9	3.9	137	70	72	7	255	70
	58			1.3	1.4	1.4				4		
C-2	48	1204	013.765	4.6	4.9	4.9	138	70	72	9	255	72
	80			1.5	1.7	1.7				4		
C-1	57	1214	015.65	4.0	4.3	4.3	135	76	78	8	255	74
	71			1.1	1.2	1.2				3		
B-6	56	1225	016.37	.52	.54	.54	138	78	78	2	255	
	64			.28	.30	.30				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
		016.37									
D-5	54 ~~D-5~~ 1235	017.50	1.1	1.2	1.2	135	79	80	3	255	76
	87		.40	.42	.42				2		
D-4	54 ~~D-4~~ 1244	018.765	1.1	1.2	1.2	141	80	82	3	260	79
	90		.55	.57	.57				2		
D-3	44 ~~D-3~~ 1256	020.205	2.1	2.2	2.2	138	80	82	4	250	80
	41		.69	.71	.71				2		
D-2	53 ~~D-2~~ 1311	021.52	1.5	1.6	1.6	136	80	82	4	250	80
	82		.75	.80	.80				2		
D-1	52 ~~D~~ 1321	022.765	1.9	2.1	2.1	135	80	82	4	250	80
	53		.68	.70	.70						
	3212	LEAK CHECK < 0.02				~~136~~		~~70~~			
	53.53 min										
		30.560	.991	1.228		136		70			
	Leak Check <.01 cfm AT 12" Hg										

1 of 2

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Consulting Engineers, Planners and Architects

Date 10/13/81 Location Name REPUBLIC STEEL WARREN, OHIO

Observer DANIEL PETROVAN Address

Observation Point WEST OF COKE OVENS Weather SUNNY CLEAR SKIES

Oven Distance From 20 YDS Height 30' 0% CLOUD COVER

Wind Speed 3-5 MPH Direction SE

Observation Began 9:08 Ended 13 57

Type of Installation

TEST #1

Time of Quench	Push	Oven	Seconds 0 ≥ 20% Opacity Per Push	Seconds ≥ 20% Opacity Per Push	Seconds ≥ 40% Opacity Per Push	Maximum Opacity	Remarks
9:08.50 9:09.42	1	B-13	0 To 5%			5%	
9:17.11	2	C-13	15%			15%	
9:30.[illegible] 9:30.50	3	A-15	0% To 15%			15%	
9:4[illegible] 9:4[illegible]	4	B-15	0% To 10%			10%	
9:47.[illegible] 9:48	5	C-15	0% To 20%	7.10 SEC		20%	
9:5[illegible] 10:00.[illegible]	6	A-17	—			—	NO READING [illegible] FROM WHARF
10:10.[illegible] 10:11.21	7	B-17	0% To 15%			15%	
10:20.23 10:21.17	8	C-17	0% To 20%	18.14 SEC		20%	C-14 DOOR LEAK MIX WITH OPACITY
11:01.50 11:02.40	9	A-19	0% To 20%	3.34 SEC		20%	
11:16.[illegible] 11:17.3[illegible]	10	B-19	0% To 20%	6.42 SEC		20%	

Comments: SUN IN EYES WHILE READING SMOKE FROM PUSHING OF COKE
WIND OFF TOP OF OVENS BLOWING IN TOWARD [illegible]

10/13/81

TEST 1

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Time of Quench	Push	Oven	Seconds 0 ≥ 20 % Opacity Per Push	Seconds ≥ 20 % Opacity Per Push	Seconds ≥ 40 % Opacity Per Push	Maximum Opacity	Remarks
11:27.15 11:28.05	11	C-19	0% TO 20%	15.23 SEC		20%	
11:40.10 11:41.11	12	A-21	0% TO 20%	4.11 SEC 12.21 SEC		20% 20%	
11:49.46 11:50.46	13	B-21	0% TO 20%			25%	
12:02.35 12:03.32	14	C-21	0% TO 25%	8.61 SEC.			NO READING INTERFERENCE FROM WHARF EMMISSIONS
12:11.59 12:12.49	15	A-23	—	—		—	
12:22.24 12:23.09	16	B-23	0% TO 25%	18.44 SEC		25%	
12:31.44 12:32.29	17	C-23	0% TO 20%	10.79 SEC		20%	
12:47.41 12:48.22	18	A-25	0% TO 30%	19.08 SEC.		30% 20% ←	SCRUBBER NOT TURN ON IN TIME.
12:59.59 13:00.40	19	B-25	0% TO 20%	7.61 SEC.		20%	
13:09.35 13:10.28	20	C-25	0% TO 20%	13.40 SEC			
13:22.49 13:23.34	21	A-27	0% TO 20%	8.07 SEC		20%	B.
13:35.24 13:36.05	22	B-27	0% TO 25% 0% TO 45%	11.03 SEC 29.05 SEC		20% 45%	B-25 OVEN SMOKING CAUSE SOME PROBLEM READING.
13:46.46 13:47.30	23	C-27					SCRUBBER NOT OPERATING PROPERLY START+STOP NOT FULL CAPACITY
13:56.43 13:57.24	24	A-29	0% TO 25%	15.22 SEC		25%	

Comments:

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Consulting Engineers, Planners and Architects

Date 10/14/81 Location Name REPUBLIC STEEL WARREN, OHIO

Observer DANIEL PETROJAV Address

Observation Point WEST OF COKE OVENS Weather 10% CLOUD COVER BLUE SKIES CALLING FOR 10% SHOWERS

Oven Distance From 20 YDS Height 30'

Wind Speed 3-5mph Direction S

Observation Began 8:50 Ended

Type of Installation

TEST # 2

Time of Quench	Push	Oven	Seconds 0 ≥ 20% Opacity Per Push	Seconds ≥ 20% Opacity Per Push	Seconds ≥ 40% Opacity Per Push	Maximum Opacity	Remarks
8:50:37 8:51.42	1	C-27	0% TO 10%			10%	A-27 BATTERY SMOKING COULD CAUSE HIGHER READINGS.
9:00 54 9:01.48	2	A-29	0% TO 15%			15% 15%	
9:11.22 9:12.66	3	B-29	0% TO 15%			10%	
9:32.44 9:33.50	4	A-2	0% TO 10%				
9:45.45 9:47.42	5	B-2	0% TO 20%	3.64 SEC.		20%	A-29 BATTERY SMOKING COULD CAUSE HIGHER READINGS.
9:58 15 9:59.08	6	C-2	0% TO 20%	2.58 SEC		20% 15%	
10:09.47 10:10.27	7	A-4	0% TO 15%			—	INTERFERENCE FROM WHARF SMOKING
10:19.37 10:20.00	8	B-4	—	—			
10:30.56 10:31.29	9	C-4	0% TO 25%	7.96 SEC		25%	
11:09.42 11:15.31	10	A-6	0% TO 20%	3.69 SEC		20%	
11:25.07 11:25.58	11	B6	—	—		—	INTERFERENCE FROM WHARF SMOKING ON TO TOP OF BATTERY

Comments: SUN COMING UP RIGHT BEHIND COKE OVEN BATTERIES DIRECTLY IN OBSERVERS EYES

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TEST No. 2 10/14/81

Time of Quench	Push	Oven	Seconds 0 ≥ 20 % Opacity Per Push	Seconds ≥ 20 % Opacity Per Push	Seconds ≥ 40 % Opacity Per Push	Maximum Opacity	Remarks
11:34.55 11:35.42	12	C-6	0% TO 20%	4.61 SEC		20%	
11:51.35 11:52.22	13	A-8	0% TO 25%	6.34 SEC		25%	
12:08.25 12:09.19	14	B-8	0% TO 20%	7.83 SEC		20%	
12.16.59 12.18.01	15	C-8	0% TO 10%			10%	
12:27.20 12:28.17	16	A-10	0% TO 20%	6.02 SEC		20%	
12:36.23 12:37.10	17	B-10	—	—		—	SMOKE FROM WHARF INTERFERENCE
12:45.40 12:46.51	18	C-10	0% TO 30%	34.81 SEC		30%	PITZ SAID COLDSPOT IN COKE
12:58.22 12.59.41	19	A-12	0% TO 30%	20.64 SEC		30%	
13:08.45 13:10.11	20	B-12	—	—		—	SMOKE FROM WHARF INTERFERENCE
13:20.52 13:22.29	21	C-12	0% TO 25%	14.27 SEC		25%	HARD PUSH SCRUBBER ON NO COKE. PUSHED FOR 30 SEC. THEN PUSHED EN.
13:31.59 13:33.13	22	A-14	—	—		—	A-12 DOOR LEAK UNABLE TO TAKE GOOD READING INTERFERENCE
13:40.59 13:42.00	23	B-14	0% TO 20%	2.56 SEC		20%	
13:51.15 13:	24	C-14	0% TO 35%	15.75 SEC		35%	HARD PUSH SCRUBBER ON NO COKE FOR 20 SEC. THEN PUSHED

Comments: WIND SHIFT FROM S TO SE 12.50

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Consulting Engineers, Planners and Architects

Date 10/15/81 Location Name REPUBLIC STEEL

Observer DANIEL PETROVAY Address WARREN, OHIO

Observation Point WEST OF COKE OVENS Weather 90% CLOUD COVER DRIZZLE WITH 30% CHANCE OF RAIN

Oven Distance From 20 YDS Height 30'

Wind Speed 5-10 MPH Direction SE

Observation Began 8:35 Ended

Type of Installation COKE OVEN BATTERIES

TEST #3

Time of Quench	Push	Oven	Seconds ≥ 30 % Opacity Per Push	Seconds ≥ % Opacity Per Push	Seconds ≥ % Opacity Per Push	Maximum Opacity	Remarks
8:35:24 8:36:51	1	C-14	0% TO 20%	5.52 sec		20%	
8:45:55 8:46:46	2	A-16	0% TO 10%			10%	
8:55:53 8:56:50	3	B-16	0% TO 5%			5%	
9:05:00 9:05:51	4	C-16	0% TO 5%			5%	
9:14:40 9:15:36	5	A-18	0% TO 5%			5%	INTERFERENCE FROM STEAM SMOKE FROM WHARF
9:24:05 9:25:06	6	B-18	—	—		—	
9:34:01 9:35:00	7	C-18	0% TO 25%	5.71 SEC		25%	
9:44:45 9:45:40	8	A-20	0% TO 15%			15%	
9:54:24 9:55:20	9	B-20	0% TO 20%	3.00 SEC		20%	
10:05:55 10:06:50	10	C-20	0% TO 20%	7.11 SEC		20%	
10:27:51 10:28:54	11	A-22	0% TO 30%	7.61 SEC		20%	

Comments: READING FROM TOP OF COLLECTOR MAIN

TEST #3
10/15/81

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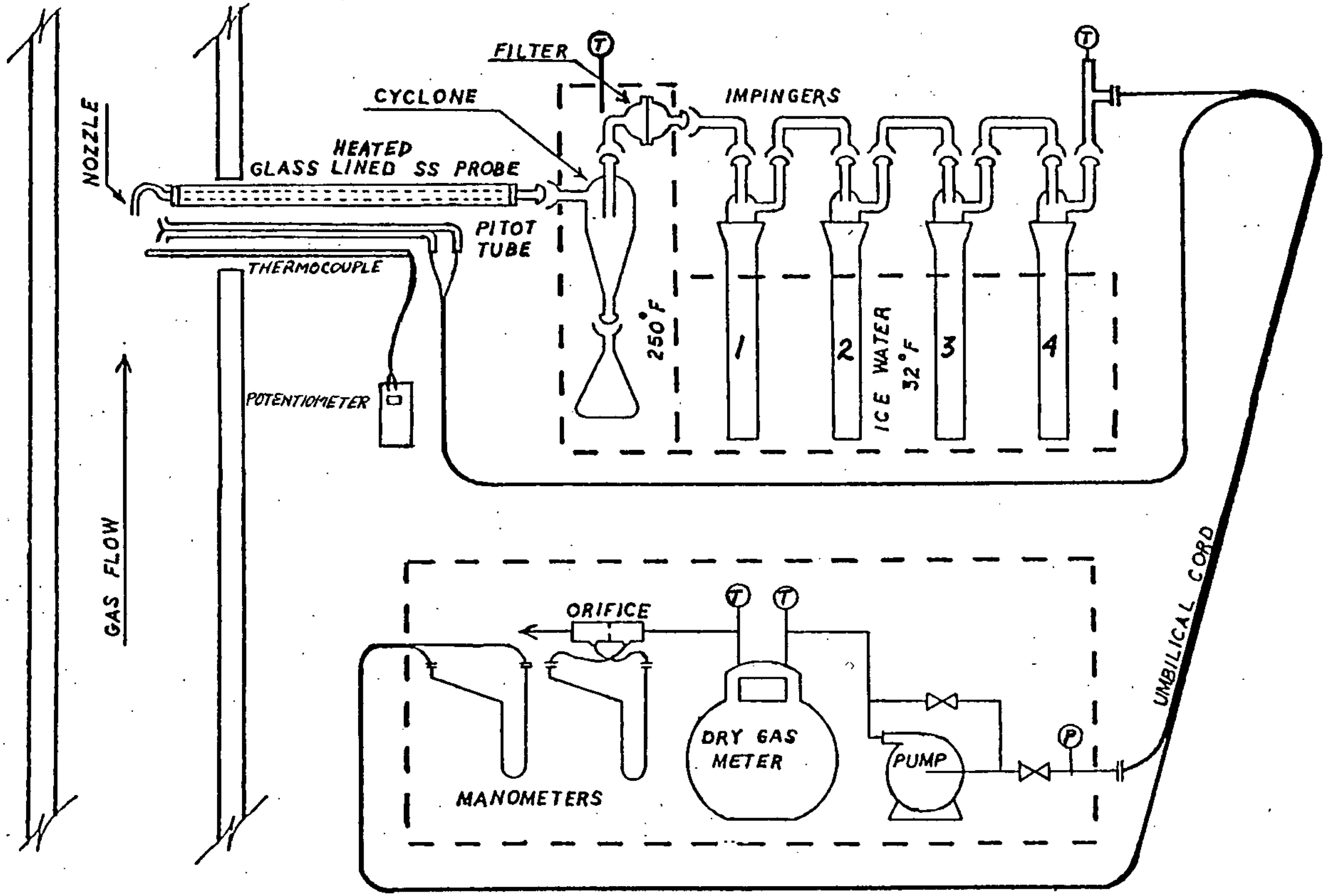
Consulting Engineers, Planners and Architects

Time of Quench	Push	Oven	Seconds 0 ≥ 30 % Opacity Per Push	Seconds ≥ % Opacity Per Push	Seconds ≥ % Opacity Per Push	Maximum Opacity	Remarks
11 07 35 11 08 31	12	B-22	0% TO 20%	7.21 SEC		20% 25%	
11,22.36 11.23 36	13	C-22	0% TO 25%	14.12 SEC			
11:31.36 11.32.35	14	A-24	—	—		—	INTERFERENCE FROM SMOKE FROM WHARF
11:41.42 11:42.38	15	B-24	—	—		—	INTERFERANCE FROM SMOKE FROM WHARF
11:52.47 11:53.50	16	C-24	0% TO 15%			15%	
12:03.28 12:04.21	17	A-26	—	—		—	INTERFERENCE FROM SMOKE FROM WHARF
12:13.48 12:14.52	18	B-26	0% TO 20%	2.36 SEC.		20%	
12:24.54 12:25.52	19	C-26	0% TO 15%			15%	
12:35.[illegible] 12:36.[illegible]	20	A-28	0% TO 20%	3.26 SEC		20%	
12:44.57 12:44.58	21	B-28	0% TO 10%			10%	
12.56.56 12.57.28	22	A-1	0% TO 20%	4.16 SEC		20%	
13:11.35 13:12.36	23	B-1	0% TO 15%			15%	
13 21 01 13 22.03	24	C-1	0% TO 15%			15%	

Comments:


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

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	34.8	35.9	70.7
2	7.3	13.5	20.8
3	7.2	16.3	23.5

* Blank corrected

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

00-4683-02

1	Heading	REPUBLIC Q-CAR - WARREN									
2	Number of tests	4,	2	3							
3	Test type	"EPA"	"EPA"	"EPA"	"EPA"						
4	Test identification	QC1-1	QC1-2	QC1-3	QC2-1						
5	Stack area, in^2	4608	4608	4608	4608						
6	Stack temperature, ^oF	137	137	136	133						
7	Sample volume, ft^3	30.265	30.728	30.560	33.04						
8	Meter temperature, ^oF	66.5	68	70	81						
9	Orifice (ΔH), in. H_2O	1.236	1.194	1.228	1.86						
10	Nozzle diameter, in	.203	.203	.203	.203						
11	Duration of test, min.	50.1	51.92	53.53	43.65						
12	Volume of CO_2, %	2.0	1.5	1.5	2.0						
13	Volume of CO, %	0.0	0.0	0.0	0.0						
14	Volume of O_2, %	18.0	17.5	17.5	18.0						
15	Static pressure, in. H_2O	-2.5	-2.5	-2.5	-1.4						
16	Barometric pressure, in. Hg	29.49	29.49	29.20	29.94						
17	Pitot correction factor	.82	.82	.82	.82						
18	Traverse (Avg. $\sqrt{\Delta p}$), in. H_2O	.997	.765	.991	1.20						
19	Volume H_2O collected, ml	171.8	175.7	174.2	181						
20	Weight collected, mg	7 58.7	11.1	13.9	147.6						
21	Volume titrant, SO_3, ml	70.7 0	20.8 0	23.5 0	0						
22	Volume titrant, SO_2, ml	0	0	0	0						
23	Normality titrant, SO_3	0	0	0	0						
24	Normality titrant, SO_2	0	0	0	0						
25	Meter calibration factor	1	1	1	1						
26	Avg. Cosine of angle	1	1	1	1						
27	Post leak check rate, CFM	0	0	0	0						
28	Leak check rate no. 1, CFM	0	0	0	0						
29	Leak check time no. 1, min.	0	0	0	0						

QUENCH, UNN

TEST #4 LABELED

REPUBLIC Q-CAR XT 6

Q OCT 6, UNN

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

EGEND

n = Area of nozzle, ft^2

s = Area of stack, in^2

wo = Moisture content of gas stream, dimensionless

) = Pitot correction factor, dimensionless

a = Particulate concentration (stack conditions), gr/ft^3

c = Particulate concentration at 12% CO_s (dry), gr/dscf

s = Particulate concentration (dry), gr/dscf

w = Particulate concentration (wet), gr/scf

= Diameter of nozzle, inches

= Particulate emission rate, lb/hr

= Excess air, percent

= Orifice pressure drop, in. H_2O

= Isokinetic ratio, percent

= Dry molecular weight of stack gas, lb/lb-mole

= Molecular weight of stack gas, lb/lb-mole

r = Barometric pressure, in. Hg

= Stack pressure (absolute), in. Hg

5 = Average of square roots of Pitot pressure differential, in. H_2O

= Stack gas flow, acfm

:td) = Stack gas flow, scfm

= Average dry gas meter temperature, °F

= Average stack temperature, °F

	= Dry sample volume (meter conditions), ft^3
(std)	= Dry sample volume (standard conditions), ft^3
	= Stack velocity, ft/min
	= Volume of liquid collected in impingers and silica gel, ml
(std)	= Volume of liquid collected, ft^3
	= Total weight of particulates collected, mg
	= Duration of test, minutes

BCM

COMPUTATION SHEET

Sheet Number	1 of 1
Date	10-28-81
J. O. Number	00-4683-02
Computed by	BA
Checked by	

Name of Client: Republic Steel

Project: Q-CAR #1

Description: 3RD week of Testing OCT 12-16

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

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

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

RUN	TONS/OVEN	OVENS/TEST	TONS COKE/TEST	TEST TIME	TONS COKE/HR	Lbs PART/hr	Lbs PART/TON COKE
1	12.65	24	303.6	50.1	363.6	21.30	.0586
2	12.65	24	303.6	51.92	350.8	7.23	.0206
3	12.65	24	303.6	53.53	340.3	8.56	.0252

REPUBLIC Q-CAR - WARREN

PARAMETERS:		QC-1	QC-2	QC-3
AREA OF BREECHING	(SQ FT)	32.00	32.00	32.00
SAMPLE VOLUME	(DSCF)	29.995	30.364	29.792
MOISTURE	(%)	18.5	18.5	18.0
MOLECULAR WEIGHT	(LB/LB-MOLE)	27.00	26.92	26.97
GAS TEMPERATURE	(F)	137.0	137.0	136.0
GAS VELOCITY	(FT/MIN)	3642.5	3530.9	3637.6
GAS VOLUME	(DRY SCFM)	82284.0	79763.5	81970.8
GAS VOLUME	(ACFM)	116560.1	112989.6	16402.4
PARTICULATE EMISSIONS:				
CONCENTRATION	(GRAINS/DSCF)	.0302	.0106	.0122
CONC. @ 12% CO2	(GRAINS/DSCF)	.1612	.0846	.0974
CONC. @ STK COND.	(GRAINS/CF)	.0266	.0072	.0082
EMISSION RATE	(LB/HR)	21.3063	7.2295	8.5553
ORSAT ANALYSIS:				
CARBON DIOXIDE	(VOL %)	2.0	1.5	1.5
CARBON MONOXIDE	(VOL %)	.0	.0	.0
OXYGEN	(VOL %)	18.0	17.5	17.5
NITROGEN	(VOL %)	80.0	81.0	81.0
EXCESS AIR	(%)	576.9	450.6	450.6
ISOKINETICS	(%)	107.2	108.3	101.1

THE FOLLOWING RUNS WERE UNDER SATURATED CONDITIONS:

QC-1
QC-2
QC-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:

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

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

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

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

BCM

METER BOX CALIBRATION SHEET

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

Pump OK Oil CHANGED Wick CHANGED Pump Serial No. A 72-325281

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 °F Out 96 °F Ambient 77

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	$\frac{(0.0317)(0.5)}{(29.53)(79+460)}\left[\frac{(71.5+460)(12.58)}{(4.998)}\right]^2$	0.98	$\frac{(4998)(29.53)(80+460)}{(5.174)(29.53+0.0368)(71.5+460)}$
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	$\frac{(10.000)(29.53)(89.9+460)}{(10.554)(29.53+0.147)(72+460)}$

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	0	.052	.777	.005	
	2	.052	.050	.777	0	.050	.792	0.01	
	3	.052	.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	.65	.824	.008	.67	.811	.008	
	2	.46	.65	[illegible]	0.008	.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