Note: This is a reference cited in *AP 42, Compilation of Air Pollutant Emission Factors, Volume I Stationary Point and Area Sources.* AP42 is located on the EPA web site at www.epa.gov/ttn/chief/ap42/

The file name refers to the reference number, the AP42 chapter and section. The file name "ref02_c01s02.pdf" would mean the reference is from AP42 chapter 1 section 2. The reference may be from a previous version of the section and no longer cited. The primary source should always be checked.

AP-42 Section 12.2
Reference
Report Sect. 4
Reference 203

PARTICULATE TESTING P4 COMBUSTION STACK

J&L STEEL CORPORATION
PITTSBURGH WORKS

April 16 and 17, 1980

WFI Sciences

510727

WFI SCIENCES NO. 98308

PARTICULATE TESTING P4 COMBUSTION STACK

J&L STEEL CORPORATION
PITTSBURGH WORKS

April 16 and 17, 1980

Submitted to:

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May 16, 1980

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I. INTRODUCTION

This report presents the results of the coke oven combustion stack testing of the P4 stack of J&L Steel Corporation's Pittsburgh Works. The objective of the testing was to determine the difference in particulate concentrations as determined by in-stack and out-of-stack filtration methods. This difference would be indicative of the sulfate condensation which would contribute to EPA Method 5 results.

Testing was performed by Joseph Marnik, Senior Field Technician, and John Campbell, Field Technician of WFI Sciences on April 16 and 17, 1980. Messrs. Tony Lukas and Bob Eshbach of J&L coordinated overall test activities.

II. SUMMARY

Tables 1 and 2 present the main results of the testing performed on the P4 combustion stack. The average flow measured in the stack was 137,000 ACFM and 58,300 SDCFM at a stack temperature of 568°F. The EPA Method 17 in-stack filtration produced an average particulate concentration of 0.0024 Gr/ACF or 0.0057 Gr/SDCF. The EPA Method 5 train, in total, produced an average concentration of 0.0083 Gr/ACF or 0.0195 Gr/SDCF. The EPA Method 5 results include the EPA Method 17 results.

Chemical analysis of the particulate collected indicates a significant amount of sulfate condensation in the stainless steel probe liner. The high amount of $SO_4^=$ on the 4-inch filter also indicates a large amount of sulfate deposition.

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TABLE 1
SUMMARY OF PARTICULATE RESULTS

J&L STEEL CORPORATION, PITTSBURGH WORKS
P-4 COMBUSTION STACK
April 16 and 17, 1980

TEST NUMBER	UNITS	TEST 1		TEST 2		TEST 3		AVERAGE	
DATE		4-16-80		4-16-80		4-17-80			
TIME START FINISH		9:03am 1:43pm		2:30pm 4:46pm		8:37am 10:52am			
Static Pressure	in. H_2O W.G.	-1.2		-1.15		-1.0		-1.1	
Stack Temperature	^oF	571		569		563		568	
CO_2	%	4.5		5.2		4.5		4.7	
O_2	%	8.0		8.2		8.0		8.1	
H_2O	%	16.0		15.7		15.1		15.6	
Volumetric Flow	ACFM	130,000		137,000		144,000		137,000	
Volumetric Flow	SDCFM	54,900		58,200		61,900		58,300	
PARTICULATE EMISSION RATES		EPA 17	EPA 5*	EPA 17	EPA 5*	EPA 17	EPA 5*	EPA 17	EPA 5*
Gr/ACF		0.0047	0.0114	0.0016	0.0077	0.0010	0.0058	0.0024	0.0083
Gr/SDCF		0.0111	0.0269	0.0038	0.0182	0.0022	0.0134	0.0057	0.0195
Lb/Hr		5.3	12.7	1.9	9.1	1.2	7.1	2.8	9.6

* Includes EPA 17 results

TABLE 2
CHEMICAL ANALYSIS

J&L STEEL CORPORATION, PITTSBURGH WORKS
P-4 COMBUSTION STACK
April 16 and 17, 1980

TEST NUMBER	UNITS	TEST 1	TEST 2	TEST 3	AVERAGE
Total Weight	mg	112.5	80.5	63.5	—
NOZZLE WASH					
Weight	mg	12.7	3.2	2.4	—
SO_4	%	14.2	56.2	20.8	30.4
pH		4.6	7.8	5.5	—
47mm FILTER					
Weight	mg	33.9	13.7	8.2	
SO_4	%	26.5	58.4	51.2	45.4
pH		6.5	6.9	4.5	
PROBE WASH					
Weight	mg	16.8	44.1	36.0	
SO_4	%	19.6	26.8	32.5	26.3
Fe	%	34.5	72.1	59.4	55.3
pH		3.7	3.5	3.5	
4" FILTER					
Weight	mg	49.1	19.5	16.9	
SO_4	%	42.4	65.6	72.2	60.1
pH		3.5	3.2	3.2	

III. TEST DESCRIPTION

J&L Steel Corporation at their Pittsburgh Works operates a series of coke ovens and combustion stacks. Stack P4 was sampled in triplicate. Two hour tests were performed. Two tests were performed on April 16, 1980 and a third test was performed on April 17, 1980.

The test train consisted of a stainless steel gooseneck nozzle; a 47 mm Gelman type AE fiber filter; a heated stainless steel probe; a heated EPA box containing a 4" Gelman type AE glass fiber filter and a series of four impingers, the first two containing distilled water, the third empty, and the fourth silica gel as a desiccant. An unheated umbilical cord connected to an EPA-type meter control box controlled flow through the entire train. A more complete description of the sampling train is presented in Appendix B.

The combustion stack on the P4 battery at the point of sampling had a 10' 2" ID with a 13" outer wall thickness. A two-port traverse was performed. The ports were 4" in diameter and 90° apart. Six points were sampled through each port for 10 minutes per point thus yielding a total test time of 120 minutes.

Following collection, the samples were returned to our Pittsburgh laboratory where they were dried at 105°C, desiccated and weighed to a constant weight. Upon obtaining a constant weight, the samples were analyzed for sulfate content. Details of the laboratory procedure are also presented in Appendix B.

Testing proceeded well with few equipment difficulties. A process delay occurred during the first test because of insufficient electrical power at the test site. This delay was dealt with as expeditiously as possible. Testing then continued with no difficulties.

IV. TEST RESULTS/CONCLUSIONS

It appears from the results presented in Tables 1 and 2 that there is a significant amount of sulfate condensation taking place in the reduced temperature zone of the probe and 4" filter of the test train. For all three tests, there was no indication of any leakage around the initial in-stack filter. Thus, it is highly unlikely that any solid particulate would have passed through the 4" filter and been deposited on the stainless steel probe liner and 4" filter. As it appears that solid particulate is not the cause of the weight collected from the probe and 4" filter, the conclusion can be reached that there is a significant amount of condensation occurring due to the temperature reduction from 570° at the stack to 250° at which the probe and heated box were heated. The main objective of the test program was to determine if there was a significant amount of condensation occurring in the EPA 5 stack train. The results obtained by the test program indicate very strongly that this is the case.

In order to determine the constituents of the gas stream which condensed between the 47 mm filter and the 4" filter, chemical analysis was performed on all components of the stack train. This chemical analysis, as presented in Table 2, indicates that while there are varying amounts of sulfate in each component, the high percentage of sulfate in both the probe and 4" filter are indicative, not of particulate, but of sulfate condensation. Iron analysis was also performed on the probe wash to determine that portion which was due to corrosion of the stainless

steel liner caused by the sulfate condensation. As Table 2 indicates, a significant amount of iron was found. It is highly doubtful that this iron is caused by particulate which passed through or around the in-stack filter. The conclusion can thus be reached that the sulfate condensation is attacking the stainless steel liner and thus adding significantly to the probe wash.

A third factor which argues for significant sulfate condensation in the train following the 47 mm filter is the low pH's obtained in both probe wash and the 4" filter. These pH's of approximately 3.5 would indicate a significant amount of acid being deposited in those portions of the train. As sulfate and iron were determined to comprise the bulk of the probe wash and sulfate to comprise the bulk of the 4" filter catch, it can be assumed that this acid originated from sulfate condensation. It should be noted that these pH's were determined following determination of weights by evaporation and drying before neutralization using NaOH.

It is our recommendation that in subsequent test programs that it would be highly desirable for the probe liner to be of some material which is inert to sulfate attack such as glass or Teflon. As the length of the probe makes the use of glass probes difficult and the high temperatures encountered approach the melting point of Teflon, it may be difficult to find a suitable material. Should a suitable material not be found, it is recommended that all compliance tests be run with the in-stack filter determining the particulate contribution of the coke oven combustion process to the atmosphere and not the normal EPA Method 5.

APPENDIX A

NOMENCLATURE AND FORMULAS

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NOMENCLATURE

Units	Description
Percent	Column identification for traverse point distance on circular stack or duct
In. H_2O	Column identification for ΔP
----	Port identification
Ft^3	Actual cubic feet: volume of gas sampled at dry test meter temperature, pressure, and moisture
Ft^3	Actual volume of gas sampled at stack conditions
Ft^3/Min	Gas volumetric flow rate at stack conditions
Ft^2	Actual nozzle opening area
Ft^2	Area of duct or stack
In.	Column identification for (a) expressed in inch units
-----	Column identification for k_I
In.	Column identification for probe marking distance, decimal and nearest 1/4 inch
ml	Liquid moisture volume condensed in condenser/impinger and desiccant together
Ft^3	Moisture volume in gas phase, metered through dry test meter at STP
-----	Condenser
Ft^3	C expressed as gas-phase moisture at STP
Ft^3	Total gas-phase moisture volume at STP
Lb/Ft^3	Density of wet stack gas
In.	Actual nozzle diameter
In.	Calculated nozzle diameter
Ft.	Diameter of stack or duct
In.	Diameter of stack or duct
Ft^3	Final dry test meter gas volume reading
Ft^3	Initial dry test meter gas volume reading
-----	Federal Environmental Protection Agency
-----	Equation
-----	Filter holder
-----	Greenburg-Smith
Grains Per Ft^3	Mass of particulate matter in grains per one cubic foot of sampled gas at stack conditions
Grains Per Ft^3	Mass of particulate matter in grains per one cubic foot of sampled gas at standard dry conditions
In.	Measure of wall thickness and probe holder length together
In. H_2O	Orifice differential indicating the sampling train flow rate
-----	Velocity correction factor
-----	Water or moisture
Percent	Moisture content of stack gas (by volume)
Percent	Isokinetic sampling rate

Symbol	Units	Description
IB	-----	Ice bath
IMP	-----	Impinger
γ	-----	Constant
γ_{CO_2}	-----	Velocity correction for molecular weight
γ_F	-----	Flow correction
k_I	-----	Isokinetic sampling correction excluding pressure correction
k_I^f	-----	Isokinetic sampling correction including pressure correction
k_m	-----	Isokinetic meter temperature correction
γ_w	-----	Isokinetic moisture correction
$k_{moisture}$	-----	Velocity correction for moisture
k_p	-----	Pitot tube constant
$k_{pressure}$	-----	Velocity correction for static pressure
γ_P	-----	Isokinetic orifice constant
k_s	-----	Isokinetic stack temperature correction
tw	Percent	Moisture in dry test meter gas (by volume)
M_m	Lb/Lb Mole	Molecular weight at meter conditions
M_s	Lb/Lb Mole	Molecular weight at stack conditions
MW_{dry}	Lb/Lb Mole	Molecular weight of dry stack gas
MW_{wet}	Lb/Lb Mole	Molecular weight of wet stack gas
N	-----	Number of points to be traversed
N,S,E,W	-----	Directions: north, south, east, and west, respectively
ΔP	In. H_2O	Velocity of stack gas
P_a	In. Hg	Ambient, barometric pressure
P_s	In. H_2O	Static pressure of stack gas (P_s may be In. Hg; check pertinent equation).
Q	Ft^3/Min	Stack gas sampling rate
SB	-----	Sample box
SCF	Ft^3	Gas volume at 68°F 29.92 in. Hg
SDCF	Ft^3	SCF gas volume without any moisture
SDCFM	Ft^3/Min	Gas volumetric flow rate at standard conditions
STP	-----	Standard conditions: 68°F and 29.92 In. Hg
t	Minutes	Actual sampling time
t_a	°F	Ambient, dry bulb temperature
t_i	°F	Dry test meter inlet gas temperature
t_s	°F	Stack gas dry bulb temperature
V_{act}	Ft/Min	Actual stack gas velocity at stack temperature, pressure, and moisture
V_{ref}	Ft/Min	V_{act} as determined from partial traverse of the duct
V_{std}	Ft/Min	Stack gas velocity corrected to 68°F to 29.92 In. Hg
V_{uc}	Ft/Sec	Velocity from tables, uncorrected
WT	Grams	Weight of particulate collected in sampling train
Y	-----	DTM calibration factor

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WFI Sciences

CALCULATION FORMULAS

SCF $= 17.64 \text{ acf} \left[\frac{P_a + \Delta H/13.6}{460 + t_m}\right]$

SDCF $= \frac{SCF(100-\%M)}{100}$

CP $= 0.0471\ C$

CM $= \frac{SCF(\%M)}{100}$

CT $= CP + CM$

$\%H_2O$ $= \frac{100\ CT}{SDCF + CT}$

D $= 0.0458\ MW_{wet} \left[\frac{P_a + P_s/13.6}{460 + t_s}\right]$

V_{act} $= \frac{1097.8\ k_p \sqrt{\Delta P}}{\sqrt{D}}$

V_{std} $= 17.64\ V_{ref} \left[\frac{P_a + P_s/13.6}{460 + t_s}\right]$

I $= \frac{(SDCF + CT)6000}{(t)\ (V_{std})\ (60A_n)}$

ACFM $= V_{act}(A_s)$

SDCFM $= 0.1764\ (100 - \%H_2O) \left[\frac{P_a + P_s/13.6}{460 + t_s}\right] \cdot ACFM$

Lb/Hr = ACFM x Density x 60. . . . . (GAS FLOW RATE)

Gr/SDCF $= \frac{15.43\ WP}{SDCF}$

Gr/ACF $= 0.1764\ (100 - \%H_2O) \left[\frac{P_a + P_s/13.6}{460 + t_s}\right] \cdot Gr/SDCF$

$Lb/10^3 Lb$ Dry Gas $= \frac{55.04\ Gr/SDCF}{MW_{dry}}$

$Lb/10^3 Lb$ Wet Gas $= \frac{55.04\ Gr/SDCF}{MW_{wet}} \times \left[\frac{100 - \%H_2O}{100}\right]$

Lb/Hr $= 8.57 \times 10^{-3} \times Gr/SDCF \times SDCFM$. . . . . (EMISSION RATE)

Standard Conditions are 68°F and 29.92" Hg Barometric Pressure

APPENDIX B

SAMPLING PROCEDURES

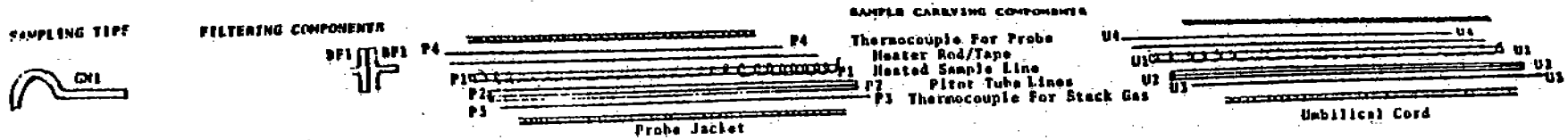
PARTICULATE SAMPLING

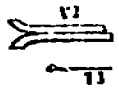
Figure P-1 is a schematic of the test equipment used to determine particulate emissions. Samples were extracted from the duct isokinetically by drawing the flue gas through a tapered, stainless steel nozzle and then through the collecting components. The nozzle was mounted adjacent to a pitot tube and thermocouple to allow simultaneous velocity measurement and sampling.

Before each test commences, the complete sampling train is leak tested by plugging the sampling nozzle, turning on the pump and adjusting the pump by-pass valve to a system vacuum of 15" Hg. The amount of inleakage is determined using the dry test meter. A maximum inleakage rate of 0.02 CFM is acceptable.

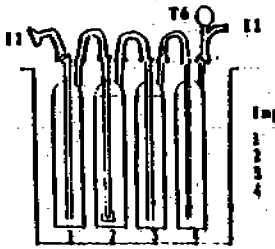
To start the test, the initial dry gas meter reading is recorded and the nozzle is placed at the first test point. The velocity pressure and temperature is then recorded and an isokinetic flow rate is determined. The pump is then turned on and the flows adjusted using the orifice meter on the discharge side of the pump. Sampling is continued at this point for a specified time period and then the probe is moved to the next test point where the same procedure is implemented. This is continued until all points of this port have been sampled. The sampling pump is then shutdown and the probe moved to the next port and the test continued. Sampling is concluded when all points have been sampled.

The test train is dismantled and each collection component is cleaned. Table P-1 is a synopsis of the sample treatment and analysis.





In-Stack Components



Out-of-Stack Components

Condensing Components

FIGURE P-1a
PARTICULATE SAMPLING TRAIN

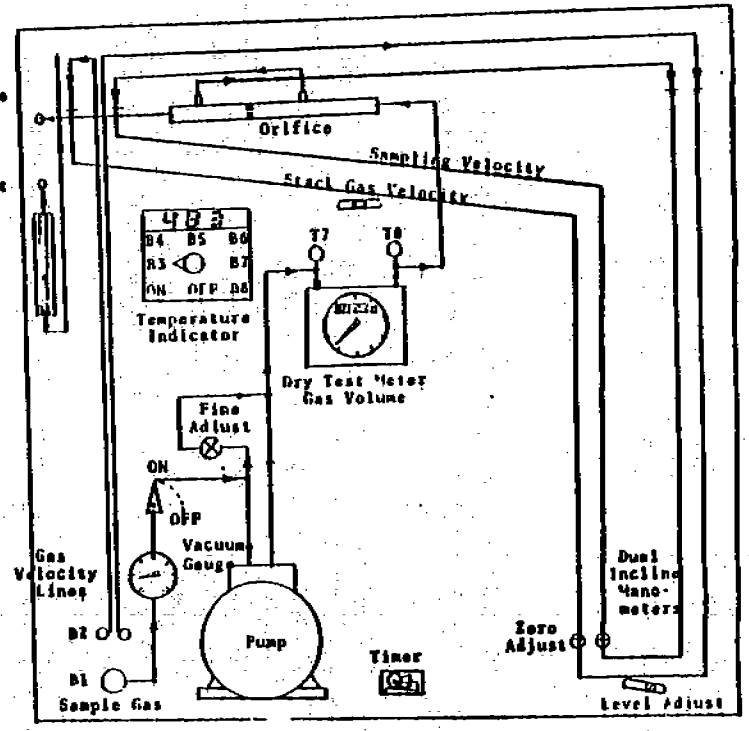


FIGURE P-1b
METER BOX SCHEMATIC

PARTICULATE TRAIN

GN1-BF1-P1-U1-SF1-I1-MB

VELOCITY TRAIN

V2-P2-U2-MB

TEMPERATURE

T3-P3-U3-MB

Component Connections

1 Sample Carrying Line
2 Stack Gas Velocity Lines V2-P2-U2-B2
3 Stack Gas Temperature Wire T3-P3-U3-B3
4 Probe Temperature Wire P4-U4-B4
5 Condenser Gas Temperature Wire T5-B5
6 Last Impinger Gas Temperature Wire T6-B6
7 Meter Gas Inlet Temperature Wire T7-B7
8 Meter Gas Outlet Temperature Wire T8-B8

Component Identification

GN1 Gooseneck Nozzle
SN1 Standard Nozzle
V2 S-Type Pitot Tube

TF1 Tubular Filter
AF1 Alundum Thimble
BF1 Back-Up Filter (47mmϕ)
OF1 Out-of-Stack Filter (6"ϕ)
HF1 Hi-Vol Filter (8" x 10")
CY1 Cyclone
SF1 Sample Box Filter (4"ϕ)

P Probe Items
U Umbilical Cord Items
T Temperature Indicators/Thermocouples
C Condenser
D Desiccator
I Impinger Set
B Meter Box Components

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WFI Sciences Contract No. 8308

J&L Laboratory Procedures for
Coke-oven Battery Stacks where Non-Desulfurized Coke Ovens Gas is in Use
Combination EPA 17 and 5 Trains

1. Dry all glass fiber filters and sample beakers @ 105°C for 3 hours, desiccate till cool and weigh to nearest 0.1 milligram. These are tare weights.

2. The nozzle and front half 47 mm filter wash from Method 17 and the wash from the back half 47 mm filter holder, probe, and front half 4" filter holder from Method 5 are placed in individual tared beakers. The washes are evaporated to dryness at room temperature, dried at 105°C for 2-3 hours, desiccated and weighed to constant weight (± 0.5 mg.). The residue weight is the amount of the particulate collected in these parts of the sample train. A blank sample of acetone will be analyzed in the same manner to be used as a blank correction.

3. Dry all filters at 105°C for 2-3 hours, desiccate till cool and weigh to constant weight (± 0.5 mg.).

4. A wet chemistry sulfate analysis is performed on the samples from steps 2 and 3. The sulfate weights are the amount of particulate present as free sulfates in the samples.

5. The total particulate weight corrected for free sulfate content will be the weights from steps 2 (corrected for blank) and 3, minus the weights in step 4.

6. The wet chemistry sulfate analysis is performed in the following manner:

Dissolve sample in water and neutralize using NaOH solution of known normality to a pH of about 8.5. Record ml of NaOH solution used. Calculate weight of Na^+ in the solution used. (The NaOH should react with any free H_2SO_4 to tie up the SO_4 as a fixed salt). Evaporate the neutralized solution to constant weight at 105°C. Record weight. (This weight should include Na^+ added plus $SO_4^=$ in sample). Redissolve in distilled water and use turbidometric method for determination of sulfate ion ($SO_4^=$). Calculate weight of sulfate.

GAS ANALYSIS

An integrated gas sample is collected over a period of 10 to 15 minutes during each test in a plastic sample bag. Each bag is then analyzed in duplicate for CO_2, O_2, and CO using an Orsat Analyzer. The nitrogen content of the gas is then determined by difference.

The orsat analysis gives results on a dry gas basis. The orsat data and gas moisture data from the particulate tests are combined to a wet gas composition to calculate the stack gas molecular weight on a wet gas basis.

MOISTURE CONTENT

The moisture content of the gas sampled is determined from the volume of gas sampled and the amount of water condensed and absorbed out of the gas. The condenser consists of a stainless steel coil condenser-tube welded to a collection reservoir with exhaust tube or a series of glass impingers which bubble the sample through a known volume of impinger liquid. Both types of condensers are immersed in an ice bath to maintain the temperature of exit gases between 40°F and 60°F. Any remaining moisture is removed by passing the gas stream through a container of tared silica gel desiccant. The total liquid moisture volume is then calculated from the moisture (liquid volume) collected in the condenser or impingers and the weight increase in the desiccant.

The total gaseous moisture volume is computed from the liquid volume using the density of liquid water, its molecular weight, and the molar volume at standard conditions (68°F and 29.92 inches Hg). This volume is added to the standard volume of dry gas sampled and the sum divided back into the gaseous moisture volume. The result is the percent H_2O, by volume, in the actual gas stream.

APPENDIX C

CALCULATIONS

O=Output
I=Input

CALCULATION WORK SHEET - OFFICE OR FIELD
PARTICULATE EMISSION TESTS

Company J&L Plant Location HAZELWOOD Unit

Project No. 8308 Process COKE OVEN STACK Test Location 90'

FAR 17 ADDITIONAL FILS

PARAMETER	UNITS	SYMBOL		O	I	47MM-FOLDED	4" TO 47MM		
Test Number			1			1	1		
Sampling Station			2						
Date			3			4/16/90			
Time: Start			4			9:03			
Time: Finish			5			1:43			
Weight Collected	Grams	WP	6		X	.0466	.0659		
Pitot Tube Coefficient		K_p	7		X	.837			
Square Root of Velocity Head	In -Z W.G.	$\sqrt{\Delta P}$	8		X	.3292			
Nozzle Area X 60	Ft^2	$60A_n$	9		X	.0460			
Stack Area	Ft^2	A_s	10		X	81.12			
Test Duration	Minutes	τ	11		X	119			
Stack Pressure	In W.G.	P_s	12		X	-1.2			
Stack Temperature	°F	t_s	13		X	571			
Dry Test Meter: Volume	Ft^3	ACF	14		X	64.155			
Orsat Data	% by Volume	CO_2	15		X	4.5			
Orsat Data	% by Volume	O_2	16		X	2.0			
Barometric Pressure	In. Hg.	P_a	17		X	29.53			
Dry Test Meter: Temperature	°F	t_m	18		X	60.2			
Condensate	ml	C	19		X	261			
Dry Test Meter: Pressure	In. W.G.	ΔH	20		X	.92			
Gas Sample Volume	Ft^3	SDCF	21	X		54.3896			
Moisture In Gas	% by Volume	H_2O	22	X		16.0			
Dry Molecular Weight	Lb/Lb Mole	MW_{Dry}	23	X		29.04			
Wet Molecular Weight	Lb/Lb Mole	MW_{Wet}	24	X		27.27			
Stack Gas Density	Lb/Ft^3	D	25	X		.0357			
Stack Gas Velocity	Ft/Min	Vacf	26	X		1602			
Isokinetic Ratio	%	I	27	X		104.4			
Volumetric Flow Rate Actual	Ft^3/Min	ACFM	28	X		130,050			
Volumetric Flow Rate Standard Dry	Ft^3/Min	SDCFM	29	X		54820			
Particle Concentration	Gr/Ft^3	Gr/SDCF	30	X		.0111	.0158		
Particle Concentration	Gr/Ft^3	Gr/ACF	31	X		.0047	.0067		
Particle Emission Rate	$Lb/10^3$ Lb	OF WET GAS	32	X		.0124	.0267		
Particle Emission Rate	Lb/Hr	Lb/Hr	33	X		5.2529	7.4285		
Excess Air	% by Volume	EA	34	X					
F - Factor		F	35		X				
Particle Emission Rate	$Lb/10^6$ BTU	$Lb/10^6$ BTU	36	X					
			37						
			38						
			39						
			40						

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CALCULATION WORK SHEET - OFFICE OR FIELD
PARTICULATE EMISSION TESTS

Company U&L Plant Location [illegible] Unit

Project No. 2307 Process COKE OVEN STACK Test Location - 0

FRA 7 ADDITIONAL STACK

PARAMETER	UNITS	SYMBOL		O	I				
Number			1			3	3		
Sampling Station			2						
Date			3			4/17/80			
Start			4			8:27			
Finish			5			10:52			
Weight Collected	Grams	WP	6		X	0106	.0529		
Pitot Tube Coefficient		K_p	7		X	.837			
Average Root of Velocity Head	In -2 W.C.	$\sqrt{\Delta P}$	8		X	.3664			
Nozzle Area X 60	Ft^2	$60A_n$	9		X	.0460			
Stack Area	Ft^2	A_s	10		X	81.18			
Sampling Duration	Minutes	t	11		X	120			
Average Pressure	In W.G.	P_s	12		X	-1.			
Average Temperature	°F	t_s	13		X	563			
Dry Test Meter: Volume	Ft^3	ACF	14		X	73.702			
Orsat Data	% by Volume	CO_2	15		X	4.5			
Orsat Data	% by Volume	O_2	16		X	8.0			
Barometric Pressure	In. Hg.	P_a	17		X	29.53			
Average Test Meter: Temperature	°F	t_m	18		X	64			
Condensate	ml	C	19		X	275.1			
Average Test Meter: Pressure	In. W.G.	ΔH	20		X	1.2			
Dry Sample Volume	Ft^3	SDCF	21	X		72.7916			
Moisture In Gas	% by Volume	H_2O	22	X		15.1			
Dry Molecular Weight	Lb/Lb Mole	MW_{Dry}	23	X		29.04			
Wet Molecular Weight	Lb/Lb Mole	MW_{Wet}	24	X		27.37			
Stack Gas Density	Lb/Ft^3	D	25	X		.0361			
Stack Gas Velocity	Ft/Min	Vact	26	X		1772			
Isokinetic Ratio	%	I	27	X		103.8			
Volumetric Flow Rate Actual	Ft^3/Min	ACFM	28	X		143,900			
Volumetric Flow Rate Standard Dry	Ft^3/Min	SDCFM	29	X		61,900			
Particle Concentration	Gr/Ft^3	Gr/SDCF	30	X		.0022	.0112		
Particle Concentration	Gr/Ft^3	Gr/ACF	31	X		.0010	.0049		
Particle Emission Rate	$Lb/10^3$ Lb	OF WET GAS	32	X		.0027	.0191		
Particle Emission Rate	Lb/Hr	Lb/Hr	33	X		1.192	5.9422		
Excess Air	% by Volume	EA	34	X					
F - Factor		F	35		X				
Particle Emission Rate	$Lb/10^6$ BTU	$Lb/10^6$ BTU	36	X					
			37						
			38						
			39						
			40						

510749

O=Output
I=Input

CALCULATION WORK SHEET - OFFICE OR FIELD
PARTICULATE EMISSION TESTS

22

Company JSL

Plant Location

Project No. 8308 Process COKE OVEN STACK Date

Test Location 40'

PARAMETER	UNITS	SYMBOL		O	I	EPA 17 AVERAGE	EPA 5 AVERAGE		
Test Number			1						
Sampling Station			2						
Date			3						
Time: Start			4						
Time: Finish			5						
Weight Collected	Grams	WP	6		X				
Pitot Tube Coefficient		K_p	7		X				
Square Root of Velocity Head	In -2 W.C.	$\sqrt{\Delta P}$	8		X				
Nozzle Area X 60	Ft^2	$60A_n$	9		X				
Stack Area	Ft^2	A_s	10		X				
Test Duration	Minutes	t	11		X				
Stack Pressure	In W.C.	P_s	12		X				
Stack Temperature	°F	t_s	13		X				
Dry Test Meter: Volume	Ft^3	ACF	14		X				
Orsat Data	% by Volume	CO_2	15		X	4.7			
Orsat Data	% by Volume	O_2	16		X	8.1			
Barometric Pressure	In. Hg.	P_B	17		X				
Dry Test Meter: Temperature	°F	t_m	18		X				
Condensate	ml	C	19		X				
Dry Test Meter: Pressure	In. W.C.	ΔH	20		X				
Gas Sample Volume	Ft^3	SDCF	21	X					
Moisture In Gas	% by Volume	H_2O	22	X		15.7			
Dry Molecular Weight	Lb/Lb Mole	MW_{Dry}	23	X					
Wet Molecular Weight	Lb/Lb Mole	MW_{Wet}	24	X					
Stack Gas Density	Lb/Ft^3	D	25	X					
Stack Gas Velocity	Ft/Min	Vact	26	X					
Isokinetic Ratio	%	I	27	X					
Volumetric Flow Rate Actual	Ft^3/Min	ACFM	28	X		137000			
Volumetric Flow Rate Standard Dry	Ft^3/Min	SDCFM	29	X		58300			
Particle Concentration	Gr/Ft^3	Gr/SDCF	30	X		.0057	.0138		
Particle Concentration	Gr/Ft^3	Gr/ACF	31	X		.0024	.0059		
Particle Emission Rate	$Lb/10^6 Lb$	OF WET GAS	32	X					
Particle Emission Rate	Lb/Hr	Lb/Hr	33	X		2.79	6.76		
Excess Air	% by Volume	EA	34	X					
F - Factor		F	35		X				
Particle Emission Rate	$Lb/10^6 BTU$	$Lb/10^6 BTU$	36	X					
			37						
			38						
			39						
			40						

EPA 5 WILL GIVE 3.42 TIMES EPA 17 RESULT
OR
EPA 17 WILL GIVE 29% OF EPA 5 RESULT

510750

APPENDIX D

LAB DATA SHEETS

PARTICULATE GRAVIMETRIC ANALYSIS

CUSTOMER J+L HAZ CONTRACT NO. _____ LAB BOOK NO. _____

DATE _____ SAMPLE SOURCE _____ SAMPLE DATE _____

WASH PARTICULATE

Sample	T-1 NOZZLE	T-1 PROBE	T-2 NOZZLE	T-2 PROBE	
Liquid Volume	270	230	100	270	
Beaker Number	JL-1	JL-2	JL-3	JL-4	
Beaker + Particulate	93.2499	98.7744	97.8963	97.0160	
Tare Weight	93.2349	98.7562	97.8925	96.9705	
Particulate	0.0140	0.0182	0.0038	0.0455	
Blank	0.0013	0.0014	0.0006	0.0014	
Net Particulate	0.0127	0.0168	0.0032	0.0441	

FILTERABLES 47--

Sample	T-1		T-2		
Filter Number	A-23-911		A-24-911		
Filter + Filterables	0.1651		0.1449		
Tare Weight	0.1312		0.1312		
Filterables	0.0339		0.0137		
Blank	—		—		
Net Filterables	0.0339		0.0137		

4" FILTER

Sample	T-1		T-2		
Number	X-16-02		X-17-02		
	0.7321		0.7128		
Tare Weight	0.6830		0.6933		
	0.0491		0.0195		
Blank	—		—		
Net	0.0491		0.0195		

DRYING DATA

Particulate _____ °C _____ Hours Solvent for washes _____

Filterables _____ °C _____ Hours

_____ _____ °C _____ Hours

510752

PARTICULATE GRAVIMETRIC ANALYSIS

CUSTOMER JTL HAZ CONTRACT NO. _____ LAB BOOK NO. _____

DATE _____ SAMPLE SOURCE _____ SAMPLE DATE _____

WASH PARTICULATE

	T-3	T-3			
Sample	NOZZLE	PROBE			
Liquid Volume	100	240			
Beaker Number	JL-5	JL-6			
Beaker + Particulate	93.3930	91.5207			
Tare Weight	93.3900	91.4833			
Particulate	0.0030	0.0374			
Blank	0.0006	0.0014			
Net Particulate	0.0024	0.0360			

FILTERABLES 47mm

Sample	T-3				
Filter Number	A-22911				
Filter + Filterables	0.1475				
Tare Weight	0.1393				
Filterables	0.0082				
Blank	—				
Net Filterables	0.0082				

4" Filter

Sample	T-3				
Number	X-22-03				
	0.6400				
Tare Weight	0.6231				
	0.0169				
Blank	—				
Net	0.0169				

DRYING DATA

Particulate _____ °C _____ Hours Solvent for washes _____

Filterables _____ °C _____ Hours

_____ _____ °C _____ Hours

PARTICULATE GRAVIMETRIC ANALYSIS

CUSTOMER JTC HAZELWOOD CONTRACT NO. 8308 LAB BOOK NO. _____

PLANT _____ SAMPLE SOURCE _____ SAMPLE DATE _____

WASH PARTICULATE

Sample					
Liquid Volume					
Beaker Number					
Beaker + Particulate					
Tare Weight					
Particulate					
Blank					
Net Particulate					

FILTERABLES (0.22) H_2O INSOLUBLES

Sample					
Filter Number	1		2		3
Filter + Filterables	0.0497		0.0506		0.0530
Tare Weight	0.0494		0.0505		0.0524
Filterables	0.0003		0.0001		0.0006
Blank	—		—		—
Net Filterables	0.0003		0.0001		0.0006

IMPINGER CATCH H_2O SOLUBLES

Sample					
	510/250		555/250		525/250
Number	JL-8		JL-9		JL-10
	91.8277		96.1985		92.7822
Tare Weight	91.8180		96.1827		92.7760
	0.0097		0.0158		0.0062
Blank	0.0008		0.0008		0.0008
Net SOLUBLE	0.0089		0.0150		0.0054
TOTAL SOLUBLES/SAMPLE	0.0182		0.0333		0.0113

DRYING DATA

Particulate _____ °C _____ Hours Solvent for washes _____

Filterables 105 °C 3 Hours

SOLUBLES 105 °C dry/3 Hours

510754

				$SO_4^=$	8308			$SO_4^=$		
WASH	wt. mg.			TOTAL VOL.	dilution	ABS.	mg/50ml	mg/~~[illegible]~~ TOTAL	mg H_2SO_4 18/96	% OH_2SO_4
T-1 NOZZLE	12.7	4.6		250ml	—	010	350	1.8	1.84	14.5
T-1 PROBE	16.8	3.7			—	.068	660	3.3	[illegible]	20.0
T-2 NOZZLE	3.2	7.8			—	.011	350	1.8	[illegible]	[illegible]
T-2 PROBE	44.1	3.5			—	.385	2350	11.8	[illegible]	[illegible]
T-3 NOZZLE	2.4	5.5			—	.005	100	0.5	[illegible]	[illegible]
T-3 PROBE	36.0	3.5			—	.380	2345	11.7	[illegible]	[illegible]

510755

		$SO_4^=$		8308				$SO_4^=$		
Filter	wt. mg.	pH		TOTAL VOL	dilution	ABS.	µg/50ml	mg/TOTAL	mg H_2SO_4 78/96	% H_2SO_4
T-1 47mm	33.9	6.5		250ml	—	.280	1800	9.0	9.19	27.1
T-2 47mm	13.7	6.7			—	.240	1600	8.0	[illegible]	[illegible]
T-3 47mm	8.2	4.5			—	.100	840	4.2	[illegible]	[illegible]
									[illegible]	[illegible]
T-1 4"	49.1	3.5			2X	.330	2080	20.8	[illegible]	[illegible]
T-2 4"	19.5	3.2			2X	.180	1280	12.8	[illegible]	[illegible]
T-3 4"	16.9	3.2			2X	.170	1220	12.2	[illegible]	[illegible]
									[illegible]	[illegible]

510756

8308

Fe ANALYSIS ON THE PROBE

ACETONE WASHES T1, T2, T3

TEST	TOTAL wt (mg)	wt Fe FOUND (mg)
T-1-PROBE	16.8	5.8
T-2-PROBE	44.1	31.8
T-3-PROBE	36.0	21.4

APPENDIX E

FIELD DATA SHEETS

EMISSION TEST FIELD DATA

Company/Plant JSL-STEEL Co	Source Name/No. COKE OVEN P-4-BATTERY	Test Date 1-16-80
Address HAZELWOOD-PLANT	Stack/Duct No. COMBUSTION STACK	Test No. #1
Plant Coordinator TONY LUCAS	Sampling Location OUTLET	

Test Program Personnel

Project No.

P.O. No.

Affiliation* P	M	W	E	R	Name	Title	Telephone Office	Telephone Home	Mailing Address	Dates of Field Presence
PRINCIPAL CONTACTS:										
✓					C. CICCARELLI	JSL-STEEL GENERAL FOREMAN				
✓					TONY LUCAS	R.D.				
✓					BOB ESHBACH	E.E.G.				
PARTICIPANTS:										
		✓			JEM	SR. TECH				
		✓			JS	SR. TECH				
		✓			JC	SR. TECH				

*CODE: P = Plant
M = Main Office/Headquarters
W = WPI Sciences
E = Equipment Manufacturer
R = Regulatory Agency

Test program conducted under Regulation No. _____

Objective of Testing (circle one): a) compliance; b) efficiency; c) guarantee; d) process study; e) other.

R 1, (11/1:arf)

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VELOCITY TRAVERSE DATA

Company/Plant JH-STEEL CO	Source Name/No. Coke Combustion Stack	Test Date # 4-16-80
Plant Coordinator TONY LUCAS	Stack/Duct No. P-4-BATTERY	Test No. #1
WFI Operator JEM JS	Sampling Location Outlet	

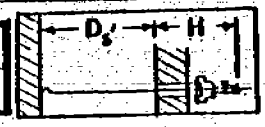
Ambient Pressure P_a = In. Hg	Duct Dimensions: 122" ID
Ambient Temperature t_a = 50 °F	Duct A_s = 0.7854 D_s^2 = Ft^2
Wind Velocity = 20 MPH; Direction	Duct A_s = Width x Depth = Ft^2
Sky: % Cloudy = 50 ; Other	Traverse: Points/Port; Ports

NOTES:

1. Do not sample closer than 1.0 inch from any wall. If too close on circular duct wall, mark the probe for (N+2) points and skip sampling first and last points.
2. State: a. Process operating capacity during sampling.
   b. Fan, damper and other prevailing conditions.

Pitot Tube: Leak NO ; Pinched NO ; Response Good

Manometer: Stable ✓ ; Level ✓ ; Zeroed ✓ ; On —



VELOCITY TRAVERSE TABLE

.837

Pitot Tube k_p = | Pitot/Probe Length 13FT | Probe Vertical / Duct Vertical | Port Dia. / Port Length | Wall Thickness & Probe Holder H = 16" inches

Port	Point	Probe Marking (a)* %	(b) = (a)·D_s'	(c) = (b)+H	Marking (c) In.	Time AM PM	Gas Velocity Pressure ΔP In. H_2O	$\sqrt{\Delta P}$	Static Pressure $\pm P_s$ In. H_2O	Temperature t_s °F
Average Values FIELD										
Average Values CHECKED										
E	1	4.4	5.36	16"	21.5	2:32	.10			560
H	2	14.7	17.93		34.0		.12			561
S	3	29.5	35.99		52.0		.14		-98	564
T	4	70.5	86.01		102		.22			557
	5	85.3	104.06		120		.13			551
	6	95.6	116.63		132.5		.11			551

Port	Point	Time AM PM	Gas Velocity Pressure ΔP In. H_2O	$\sqrt{\Delta P}$	Static Pressure $\pm P_s$ In. H_2O	Temperature t_s °F

*Refer to EPA Method 1.

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NOZZLE SIZING & ISOKINETIC CONSTANTS

Company/Plant	J&L STEEL	Source Name/No.	COKE OVEN PYBATTLE	Test Date	4-15-53
Plant Coordinator	BOB ESHBACH	Stack/Duct No.	COMBUSTION STACK	Test No.	#1
WFI Operator	JEM	Sampling Location	STACK		

Change	k_m ↑ / t_m ↑	k_s ↑ / t_s ↑	k_H ↑ / H_2O ↑	k_F ↑ / k_p ↑ k_R ↑	D_n^4 ↑ / D_n ↑	k_I
Usual Range	0.92 / 1.13	1.04 / 0.25	1.20 / 0.20	0.14 / 0.24	5.8 / 1,530	Check by EQN (9)
k	.93	.53	1.04	.172	95	8.37
Data	40	550	10%			
k	.94	.53				8.46
Data	50	560		16.99		
k	.94	.52				8.30
Data	50	580		16.99		
k	.94	.52				8.30
Data	50	590		16.99		
k	.96	.52				8.48
Data	60	590		16.99		
k	.97	.52				8.56
Data	65	590		16.99		
k	.97	.53				8.73
Data	65	560		16.99		
k	.96	.53				8.64
Data	60	560		16.99		
k	.97	.53				8.73
Data	65	560		16.99		
k						
Data						
k						
Data						

EQN No.	Nozzle Sizing for Isokinetic Sampling	
1	k_m	= .93 @ t_m = 40 °F
2	k_s	= .53 @ t_s = 550 °F
3	k_H	= 1.04 @ $\%H_2O$ = 10 % Vol.
4	k_F	= $k_p \cdot k_p \cdot k_R$ = .172 = (.832)(.857)(.246)
5	ΔP	= Measured/Estimated
6	D_n^4	= $\frac{\Delta H}{(k_m \cdot k_s \cdot k_H \cdot k_F) \cdot (\Delta P)}$ = $\frac{2}{(.172)(.16)}$ = .0275
7	D_n^4	= for D_n = in. nozzle
8	k_I	= $(k_m \cdot k_s \cdot k_H \cdot k_F) \cdot (D_n^4)$ =
9	ΔH	= $k_I \cdot \Delta P$ = ( )( ) = In. H_2O
		Limits: $1.5<\Delta H<2.5$ For 0.75 CFM; $2.3<\Delta H<3.5$ For 1.00 CFM
10	60 A_n	= $60(0.7854\ D_n^2)/144$
11	D_n^4	= $(D_n/12)^4 \cdot 10^8$
12	k_m	= $(460 + t_m)/(460 + 80)$
13	k_s	= $(460 + 80)/(460 + t_s)$
14	k_H	= $(100 - \%H_2O)M_m/8100M_s$
15	k_I'	= $k_I(P_a + P_s)/(P_a + P_m)$
		Use k_I' in place of k_I if "P" data is available
16	ΔH	= $7.3k_R$
17	% Accuracy	= $26.7\ (DTM_F - DTM_I)$

#7 NOZZLE 72.7

$$I_p = \frac{547}{t.60A_n} \cdot \frac{\sqrt{D}}{100-H_2O} \cdot \frac{acf}{k_p\sqrt{\Delta P}} \cdot \frac{T_s}{T_m}$$

1 Calculate ΔH as per EQN (9)
2 Set ΔH as per EQN (16) and run DTM for 5 minutes;
3 Calculate % accuracy;
4 % Accuracy = 25.9(-)
=

ETFD (11/1:arf)

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Company/Plant	3M STEEL CO	Source Name/No.	COAL OVEN - PY - GRINDER
Plant Coordinator	TONY ZIGOS - CROB	Stack/Duct No.	CONDENSER STACK
MFI Operator	ESHBACH	Sampling Location	OUTLET MAIN STACK
Test No.	#1		

Ambient Pressure	P_a = In. Hg	Pitot Tube	k_p = .83
Ambient Temperature	t_a = 33 °F	Orifice	k_p = .246
Wind Velocity	15 MPH, Direction	Meter	y = 1.073
Sky: % Cloudy	50 ; Other	Nozzle Size	#7

Traverse Data: 10 Minutes/Point; 6 Points/Port; 2 Ports/Test

Final Checks

Initial Checks

Pitot Tube: Leak NO ; Pinched NO ; Response —

Manometer: Stable — ; Level — ; Zeroed — ; On

Vacuum: In. Hg @ 2 Inch ΔH

Leak Rate: .002 CFM @ 15 In. Hg (≤0.02 CFM)

PORT DIA. 4"

PORT LENGTH 16"

Particulate	H_2O		Appearance	
Nozzle				Ice Bucket
Probe				Condenser
Cyclone				
Filter				Sample Box
Cord				
Impinger				
Condenser				

Cyclone NO

Filter Holder 4"

Meter Box #5

Process Operating Capacity During Test

Moisture Data

Impinger No.	1	2	3	4
Impinger Type	Open Stem	GBS	Open Stem	Open Stem
Actual Used	H_2O	H_2O	O	
Scrubbing Fluid				
Final Volume	285	156	5	
Initial Volume	100	100	0	
Collected Volume	185	56	5	

Condenser ml: Desiccant 15.0 ml; Total C 261 ml

PROBE LENGTH 13 FT; ~~Nozzle~~ A 23911

PROBE VERTICAL —; ~~Pitot~~ 47 mm

DUCT VERTICAL; Thimble

Metered Gas Volume Data

Final DTM Reading	261.931	Ft^3
Initial DTM Reading	202.140	Ft^3
Volume Metered	59.791	Ft^3
Idle Volume	0	Ft^3
Gas Metered	59.791	Ft^3
Gas Sampled ad. = y x Gas Metered =	64.155	Ft^3
Sampling Time t	120 119	Minutes
Sampling Rate Q		CFM
Filter	X-16-02	Desiccant P 45 9:2
Filter	(illegible)	Desiccant
Filter		Desiccant

Fan, Damper, and other Prevailing Conditions

Particulate Traverse Table

Port	Point	Time AM PM	Assume/Halt	DTM Gas Volume Ft^3	Pitot ΔP (a) In. H_2O	k_p (b)	Orifice ΔH (a) In. H_2O	Orifice ΔH Actual In. H_2O	DTM Gas t_m In °F	DTM Gas t_m Out °F	Stack Gas t_s °F	Stack Static ΔP In. H_2O	Pump Vacuum In. Hg	IMP SB SOX °F	IMP CND IB °F	$\sqrt{\Delta P}$	Orsat	% Opacity	
Average Values FIELD																			
Average Values CHECKED								.92	60	2	571	-1.2				.3292			
N	6	9:03		202.140	.09	8.46	.761	.76	50	50	557		3.0	250	36	.300			LOST ALL POWER
O		9:05	H																
R		9:42	R	203.265	.09	8.46	.761	.76	50	50	571		3.0	250	36	.300			
T																			
H	5	9:49		206.710	.07	8.46	.592	.60	58	52	580		3.0	246	36	.264			
	4	9:59		211.300	.09	8.30	.242	.25	62	56	565		3.0	246	36	.300	*		ORSAT Started
	3	10:09		215.400	.11	8.30	.913	.91	68	60	575	-1.25	3.5	250	36	.331			
	2	10:19		220.800	.12	8.30	.996	1.0	70	60	580		3.5	246	36	.346			
	1	10:29		226.200	.11	8.30	.913	.91	70	60	580		3.0	246	36	.331			
		10:39	H	230.226															LOST ALL POWER 8 HR DELAY POWER REPAIRED
E	6	12:43	R	230.226	.10	8.46	.846	.85	50	50	560		3.5	245	37	.316			
H																			
S	5	12:53		235.100	.09	8.46	.761	.76	60	50	578		5.5	245	37	.300	*		ORSAT CON'T
T																			
	4	1:03		239.800	.12	8.46	1.01	1.0	64	52	561	-1.10	4.5	245	38	.346			
	3	1:13		243.600	.19	8.46	1.60	1.6	70	60	580		6.0	248	38	.435			

ETFD (11/1:arf)

510762

ADDITIONAL PARTICULATE TRAVERSE DATA

Company/Plant	JAL STEEL CO	Source Name/No.	COKE OVENS	Test Date	4-16-80
Plant Coordinator	BOB ESHBACH	Stack/Duct No.	COMBUSTION STACK	Test No.	#1
MFI Operator	JEM	Sampling Location	OUTLET STACK		

Supplementary Particulate Traverse Table

Part	Point	Time AM PM	Resume/Halt	DRM Gas Volume ft^3	Pitot ΔP (a) in. H_2O	h_i (b)	Orifice W (a)(b) in. H_2O	Actual in. H_2O	DRM Gas t_m In °F	DRM Gas t_m Out °F	Stack Gas t_s °F	Stack Static ΔP_s in. H_2O	Pump Vacuum in. Hg.	FM SB $\Delta P \Delta H$ °F	DP CHB IN °F	ΔH	Orsat	% Opacity
E	2	1:23		751.700	.12	8.30	.996	1.0	50	65	574		4.5	245	38	.346		
A																		
S	1	1:33		756.700	.13	8.30	1.07	1.1	82	66	568		6.0	245	38	.360		
T																		
		1:43		761.931														

Leak check good at 15" Hg .004 SEM

ETFD (11/1:ur(f)

510763

ORSAT ANALYSIS

Company Name JII - STEEL CO Plant Name COKE OVEN Test Date 4-16-80

Plant Address HAZELWOOD Unit No. Test Time

Site Elevation 80 FT Sampling Location MAIN STACK Test No. # 1, 2, 3

Plant Coordinator WFI Operator JEM

Bag/Sample/Repetition	Bag: 1 / Sam: 1 / Rep:			Bag: 2 / Sam: 2 / Rep:			Bag: / Sam: / Rep:		
Date: Sampling/Analysis	4-16-80 / TEST #1			4-16-80 / TEST #1			/		
Time: Sampling/Analysis	2 50/pm /			3 15/pm /			/		
Place: Sampling/Analysis	STACK /			STACK /			/		
Dry Gas Analysis	% CO_2	% O_2	% CO	% CO_2	% O_2	% CO	% CO_2	% O_2	% CO
Final Reading	4.5	12.5	12.5	4.5	12.5	12.5			
Initial Reading	0	4.5	12.5	0	4.5	12.5			
Dry Gas Volume	4.5	8.0	.0	4.5	8.0	.0			
Excess Air (%) by Equation or Graph	25m			25m					

Bag/Sample/Repetition	Bag: 3 / Sam: 3 / Rep:			Bag: 4 / Sam: 4 / Rep:			Bag: / Sam: / Rep:		
Date: Sampling/Analysis	4-16-80 / TEST #2			4-16-80 / TEST #2			/		
Time: Sampling/Analysis	4 30/pm /			4 45/pm /			/		
Place: Sampling/Analysis	STACK /			STACK /			/		
Dry Gas Analysis	% CO_2	% O_2	% CO	% CO_2	% O_2	% CO	% CO_2	% O_2	% CO
Final Reading	5.5	13.5	13.5	5.5	14.0	14.0			
Initial Reading	0	5.5	13.5	.0	5.5	14.0			
Dry Gas Volume	5.5	8.0	.0	5.0	8.5	.0			
Excess Air (%) by Equation or Graph	25m			25m					

Bag/Sample/Repetition	Bag: / Sam: / Rep:			Bag: / Sam: / Rep:			Bag: / Sam: / Rep:		
Date: Sampling/Analysis	TEST #3 /			/			/		
Time: Sampling/Analysis	4-18 8:- /			/			/		
Place: Sampling/Analysis	/			/			/		
Dry Gas Analysis	% CO_2	% O_2	% CO	% CO_2	% O_2	% CO	% CO_2	% O_2	% CO
Final Reading	4.5	12.5							
Initial Reading	0	4.5							
Dry Gas Volume	4.5	8.0							
Excess Air (%) by Equation or Graph									

NOTE: Sketch orsat train and sampling location on back.

$$\% \text{ Excess Air Dry Gas Basis} = \frac{(\%O_2 - \%CO/2) \times 100}{0.264\ \%N_2 - (\%O_2 - \%CO/2)}$$

PARTICULATE TRAVERSE DATA

Company/Plant	J&L STEEL CO	Source Name/No.	COKE OVEN P.4 - BATTERY
Plant Coordinator	BOB ESHBACH	Stack/Duct No.	COMBUSTION STACK
MFI Operator	JEM	Sampling Location	OUTLET

Test Date 4-16-80
Test No. #2

Ambient Pressure	P_a = in. Hg	Pitot Tube	b_p = .837
Ambient Temperature	t_a = 45 °F	Orifice	$\Delta H@$ = .246
Wind Velocity	20 MPH, Direction	Meter	γ = 1.073
Sky: % Cloudy	20 ; Other	Nozzle Size	#7

Traverse Data: 10 Minutes/Point; 6 Points/Port; 2 Ports/Test

Final Checks

PORT DIA. 4"
PORT LENGTH 16"
Cyclone NO
Filter Holder 4"
Meter Box #5

Initial Checks

Pitot Tube: Leak NO ; Plugged NO ; Response ✓
Manometer: Stable ✓ Level ✓ ; Zeroed ✓ ; On
Vacuum: 2.0 in. Hg @ 1 inch aH
Leak Rate: NONE CFM @ 15 in. Hg (±0.02 CFM)

Particulate	H_2O		Appearance
Nozzle			
Probe			
Cyclone			
Filter			
Cord			
Impinger			
Condenser			

Ice Bucket
Condenser
Sample Box
Process Operating Capacity During Test

Moisture Data

Impinger No.	1	2	3	4
Impinger Type	Open Stem	GBS	Open Stem	Open Stem
Actual Used	H_2O	H_2O		
Scrubbing Fluid				
Final Volume	248	150	5	
Initial Volume	100	100	0	
Collected Volume	148	50	5	
Condenser ml	Desiccant 15.2 ml		Total C ml	
PROBE LENGTH 13 FT	Thimble	H 24911		
PROBE VERTICAL ✓	Thimble	47 mm		
DUCT VERTICAL	Thimble			

Metered Gas Volume Data

Final DTM Reading	826.158	Ft^3
Initial DTM Reading	762.400	Ft^3
Volume Metered		Ft^3
Idle Volume		Ft^3
Gas Metered	63.412	Ft^3
Gas Sampled = γ x Gas Metered =		Ft^3
Sampling Time θ		Minutes
Sampling Rate Q		CFM
Filter		Desiccant
Silica	4"	Desiccant
Filter		Desiccant

Fan, Damper, and other Prevailing Conditions

Particulate Traverse Table

Port	Point	Time AM PM	Resume/Halt	DTM Gas Volume Ft^3	Pitot ΔP (a) In. H_2O	k_p (b)	Orifice ΔH (a) In. H_2O	(b)	Actual In. H_2O	DTM Gas t_m In °F	Out °F	Stack Gas t_s °F	Stack Static $\pm P_s$ In. H_2O	Pump Vacuum In. Hg	FH SB °F	FM CND IB °F	ΔH	Orsat	% Opacity	
Average Values FIELD									1.01	60		569					.3453			
Average Values CHECKER																				
E	6	2:30		762.400	.10	8.46	.146	.85		50	50	550		3.0	264	38	.316			
H																				
S	5	2:40		767.200	.13	8.46	1.09	1.1		56	50	574		4.0	254	39	.360			
T																				
	4	2:50		772.200	.21	8.30	1.24	1.2		70	58	595	-1.10	5.0	254	39	.458			
	3	3:00		778.700	.12	8.48	1.01	1.0		80	60	556		4.0	254	40	.346	*	Failed Orsat	
	2	3:10		784.500	.11	8.56	.941	.94		80	60	566		4.0	248	40	.331			
	1	3:20		789.500	.10	8.56	.856	.86		80	60	578		4.0	248	40	.316			
		3:30		794.395																
N	6	3:46		794.395	.15	8.56	1.28	1.3		70	60	577		6.0	245	40	.382			
O																				
R	5	3:56		800.520	.16	8.56	1.36	1.4		74	62	566		7.0	245	41	.400			
T																				
H	4	4:06		806.800	.12	8.56	1.02	1.0		76	62	566	-1.20	5.5	245	41	.346			
	3	4:16		812.300	.09	8.56	.770	.77		78	64	573		5.0	245	41	.300	*	Stopped Orsat	
	2	4:26		817.200	.07	8.23	.611	.61		78	64	568		4.5	245	41	.264			

ETRD (11/1:arf)

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ADDITIONAL PARTICULATE TRAVERSE DATA

Company/Plant	JVL-STEEL CO	Source Name/No.	COKE OVEN	Test Date	4-16-80
Plant Coordinator	BOB ESHBACH	Stack/Duct No.	COMBUSTION STACK	Test No.	#2
WFI Operator	JEM	Sampling Location	OUTLET		

Supplementary Particulate Traverse Table

Port	Point	Time AM PM	Assume/Halt	DRM Gas Volume ft^3	Pitot ΔP (a) In. H_2O	h_i (b)	Orifice Wt (a)(b) In. H_2O	Actual In. H_2O	DRM Gas t_m In °F	DRM Gas t_m Out °F	Stack Gas t_s °F	Stack Static ΔP_s In. H_2O	Pump Vacuum In. Hg.	PM SD ρ_{dy} °F	DMP CMD IB °F	$\sqrt{\Delta P}$	Orsat	% Opacity	
	1	4:36		821.100	.10	8.73	.873	.87	78	64	561		6.0	.045	42	.316			
STOP		4:46		826.158															

ETFD (11/1:arf)

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PARTICULATE TRAVERSE DATA

Company/Plant: JOL-Steel	Source Name/No.: Coke OVEN P-4-BATTERY	Test Date: 4-17-80	
Plant Coordinator: BOB ESHBACH	Stack/Duct No.: COMBUSTION STACK	Test No.: #3	
DFS Operator: JEM	Sampling Location: STACK		

Ambient Pressure P_b = ___ In. Hg	Pitot Tube Δp = .837	Traverse Data: 10 Minutes/Point	Final Checks
Ambient Temperature t_a = 36 °F	Orifice ΔH = .246	6 Points/Port	
Wind Velocity 5 MPH, Direction	Meter γ = 1.023	2 Ports/Test	
Sky: % Cloudy Clear ; Other	Nozzle Size #7		

Initial Checks

Pitot Tube: Leak NO ; Pinched NO ; Response ✓

Manometer: Stable ✓ ; Level ✓ ; Zeroed ✓ ; On

Vacuum: 2 In. Hg @ 1 inch aH

Leak Rate: CFM @ 15 In. Hg (≤0.02 CFM)

Particulate	H_2O		Appearance
Nozzle			
Probe			
Cyclone			
Filter			
Cord			
Impinger			
Condenser			

Ice Bucket

Condenser

Sample Box

Process Operating Capacity During Test

PORT DIA. 4"

PORT LENGTH 16"

Cyclone NO

Filter Holder 4"

Meter Box #5

Moisture Data				
Impinger No.	1	2	3	4
Impinger Type	Open Stem	GBS	Open Stem	Open Stem
Actual Used				SO_2
Scrubbing Fluid	H_2O	H_2O	O	
Final Volume	255	180	20	
Initial Volume	100	100	0	
Collected Volume	155	80	20	

Condenser ml; Basic cent 20.1 ml; Total C ml

PROBE LENGTH 13 FT

PROBE VERTICAL

DUCT VERTICAL ✓

Thermocouple 4-22-911

Thimble

Metered Gas Volume Data		
Final DTM Reading	894.975	Ft^3
Initial DTM Reading	826.287	Ft^3
Volume Metered	68.688	Ft^3
Idle Volume		Ft^3
Gas Metered		Ft^3
Gas Sampled γ = Gas Metered =	73.702	ft^3
Sampling Time t		Minutes
Sampling Rate Q		CFM
Filter X-30-03	Desiccant P-56-03	
Filter 4"	Desiccant	
Filter	Desiccant	

Fan, Damper, and other Prevailing Conditions

Particulate Traverse Table

Port	Point	Time AM PM	Reverse/Halt	DTM Gas Volume Ft^3	Pitot ΔP (a) In. H_2O	h_i (b)	Orifice ΔH (a) In. H_2O	(b)	Actual In. H_2O	DTM Gas t_m In °F	Out °F	Stack Gas t_s °F	Stack Static ΔP_s In. H_2O	Pump Vacuum In. Hg	PB SB ΔH_A °F	IMP CND IB °F	$\sqrt{\Delta P}$	Orsat	% Opacity	
Average Values FIELD									1.2	69		561					.3664			
Average Values CHECKED																				
N	6	8:37	S	826.287	.15	8.46	1.26	1.3	50	50	560		3.0	246	36	.387				
O																				
R	5	8:47		832.600	.18	8.46	1.52	1.5	64	50	568	-1.2	4.0	248	37	.424	*		Started ORSAT	
T																				
H	4	8:57		839.200	.17	8.64	1.46	1.4	70	60	552		4.0	250	38	.412				
	3	9:07		844.900	.11	8.64	.950	.95	74	62	552		3.0	252	39	.331				
	2	9:17		850.400	.12	8.73	1.04	1.0	78	62	565		3.5	252	41	.346				
	1	9:27		855.600	.10	8.73	.828	.82	80	66	558		3.5	254	42	.316				
		9:37	N	861.028																
E	6	9:52	R	861.028	.11	8.64	.950	.95	68	65	569		3.5	250	43	.331				
A																				
S	5	10:02		866.400	.14	8.64	1.20	1.2	76	70	555		4.0	252	44	.374				
T																				
	4	10:12		872.100	.26	8.73	2.26	2.3	82	70	570	-1.4	7.0	254	45	.509				
	3	10:22		879.200	.10	8.73	.873	.87	84	72	578		4.5	254	45	.316	*		Stopped ORSAT	
	2	10:32		885.000	.12	8.73	1.04	1.0	84	72	560		4.5	254	45	.346				

ETED (11/1:arf)

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ADDITIONAL PARTICULATE TRAVERSE DATA

Company/Plant	J&L STEEL CO	Source Name/No.	Coke Oven Battery P-4	Test Date	4-13-80
Plant Coordinator	BOB ESHBACH	Stack/Duct No.	COMBUSTION STACK	Test No.	23
NFI Operator	JEM	Sampling Location	OUTLET STACK		

Supplementary Particulate Traverse Table

Part	Point	Time AM PM	Lesson/Halt	DRM Gas Volume Ft^3	Pitot ΔP (a) In. H_2O	h_i (b)	Orifice ΔH (a)(b) In. H_2O	Actual In. H_2O	DRM Gas t_m In °F	DRM Gas t_m Out °F	Stack Gas t_s °F	Stack Static ΔP_s In. H_2O	Pump Vacuum In. Hg.	PM SB QVA °F	DRP CHD IN °F	/HP	Orstat	% Opacity
	1	10:42		890.200	.09	8.73	.785	.79	84	72	564		40	254	42	.300		
STOP		10:52		894.975														

Leak Checked at 15" Hg .002 [illegible]

ETFD (11/1:arf)

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NOTES

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