AP32 Section:	12.5.1
Background Chapter	3
Reference:	41
Title:	Stack test results memorandum and excerpts from test report for stack testing at Roanoke Electric Steel, Roanoke, VA. Testing conducted on April 9-10, 1992 and July 20-21, 1992. Received from Robina Jordan, Virginia Department of Environmental Quality.

Melanie Taylor

From: Jordan,Robina [rfjordan@deq.state.va.us]
Sent: Monday, July 22, 2002 3:23 PM
To: Melanie Taylor
Subject: RE: Roanoke Electric Steel

The stack test info seemed to imply that the #5 EAF was the only equipment controlled by the baghouse and by my own memory I was sure there was only oxygen lancing at that time. However, I checked with Raymond Goetz, one of our Engineers who was present at the test, just to be sure. He confirmed that the #5 EAF was the only piece of equipment controlled by that baghouse during the test and that they were using oxygen lancing during the test. At that time they did not have a ladle metallurgical station. He also reminded me that they were using natural gas supplemental burners during the test.

Hope this helps. Let me know if you need anything else.

> -----Original Message-----
> From: Melanie Taylor [SMTP:mtaylor@alpha-gamma.com]
> Sent: Thursday, July 18, 2002 12:10 PM
> To: Jordan,Robina
> Subject: RE: Roanoke Electric Steel
>
> Thanks. Also, I meant to ask whether the EAF had oxy-fuel burners or oxygen
> lancing during the testing, as that could potentially affect the CO
> emissions.
>
> -----Original Message-----
> From: Jordan,Robina [mailto:rfjordan@deq.state.va.us]
> Sent: Thursday, July 18, 2002 11:17 AM
> To: Melanie Taylor
> Subject: RE: Roanoke Electric Steel
>
>
> I got your message. I will see what I can confirm.
>
> > -----Original Message-----
> > From: Melanie Taylor [SMTP:mtaylor@alpha-gamma.com]
> > Sent: Thursday, July 18, 2002 11:21 AM
> > To: Jordan,Robina
> > Subject: Roanoke Electric Steel
> >
> > Robina,
> > I am a contractor working with the US EPA on updating emission factors for
> > iron and steel production facilities. Several months ago you sent me some
> > emissions data for Roanoke Electric Steel at my request. The tests were
> > done on April 9 through 10 and July 20 through 21, 1992. The documents
> you
> > sent state that the process tested was the #5 Electric Arc Furnace. I
> would
> > like to confirm that the emissions data in the report only includes
> > emissions from the Electric Arc Furnace and not from any other processes
> at
> > the facility, such as a ladle metallurgical station. Some minimills have
> > emissions from both an electric arc furnace and a ladle metallurgy process
> > vented to a common baghouse, so I would like to confirm that the 1992 test
> > data for this facility is for the EAF operations only. Any assistance you
> > can provide in this is greatly appreciated. If you have any questions, my
> > number is (919) 954-0033 x118.
> >
> > Thanks,
> > Melanie Taylor
> > Environmental Engineer

> > Alpha-Gamma Technologies, Inc.
> > 4700 Falls of Neuse Road
> > Suite 350
> > Raleigh, NC 27609
> > Phone: (919) 954-0033 ext. 118
> > Fax: (919) 954-0379
> > Email: mtaylor@alpha-gamma.com
> >

COMMONWEALTH OF VIRGINIA
Department of Air Pollution Control

INTRA-AGENCY MEMORANDUM

TO: REGIONAL FILES

FROM: John Lester

SUBJECT: STACK TEST RESULTS

DATE: Aug 16, 1994

Company/Locality: Roanoke Electric Steel
Registation No. : 20131
Test Date: 4(9-10) 1992
Process: Control System for #5 Electric Arc Furnace

Pollutants Measured	Test Methods
TSP	METHO 5
Silica PM 2.5	IN-situ - CASCADE IMPACTOR METH 5 Subp. AAa
SO_2	6C - Absorption Analyzer
CO	10 - CO Analyzer
opacity	METH 9

Reason for Stack Test

PermitDate(s): February 26, 1991
CA&O Date(s): _____ Other: _____

Stack Test Company/Personnel: ETS

DEQ Witnesses: Ray Goetz

Source Personnel: Karen Bates, Bill Warwick

Source Operation: was an increase from 50 to 60 TPH

	During Test	Allowable	% of Allowable
Thruput tons/hr	60 tons (I)	60 (I)	
Thruput			
Thruput			

Process Operating Conditions: Report contains operating conditions of furnace during the test.
58.3, 61.9, 60.4 - Avg 60.2 Tons/hr thru-put.

Emission Controls/Test Conditions: Dust Collector -

Stack Sampling and Report:

Stack sampling details acceptable? Yes Comments

Stack test report acceptable? Yes Comments

TEST RESULTS:

POLLUTANT		MEASURED	ALLOWABLE	% OF ALLOW	PASS?
particulate	lb/hr:	12.69	8.14	156%	No
particulate	grain/dscf:	.0049	.0052	94%	yes
particulate	lb/mm btu:				
CO	lb/hr:	67.89	76.2	89%	yes
SO_2	lb/hr:	9.96	42.0	23%	yes
NO_x	:		7.2		
Silica	lbs/day:	6.8	10.4 lbs. day	65%	yes
VOC	lbs/hr:		25.2		
PM 10	lb/hr:		6.19		
LEAD	lb/hr:		.3		
% opacity:	EAF DC	0%	3%	0%	yes

Comments: gr/dscf = .0049 @ 12.69 lbs/hr

Silica assumed as % of daily total 6.8 (4%

CONCLUSION: PASS/FAIL/OTHER: mass rate passed all other portions of the test

Sign/date: John F Lentz 8-16-94

REPORT CERTIFICATION

The sampling and analysis performed for this report were carried out under my direction and supervision.

DATE: 05-13-92

SIGNATURE: Chris Ferguson

Chris Ferguson
Test Team Leader
ETS, Inc.

I have reviewed all testing details and results in this report and hereby certify that the test report is authentic and accurate.

DATE: May 13, 1992

SIGNATURE: James E Wright

James E. Wright
Manager/Technical Services
ETS, Inc.

I have reviewed all testing details and results in this report and hereby certify that the test report is authentic and accurate.

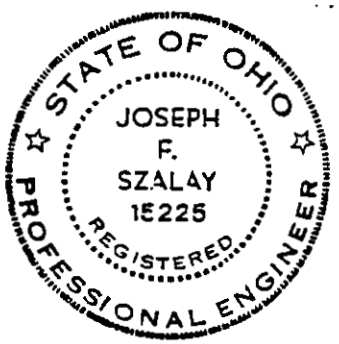
DATE: MAY 13, 1992

SIGNATURE: Joseph F. Szalay

Joseph F. Szalay

P.E.: E-015225

STATE OF: Ohio



1.0 INTRODUCTION

1.1 Background: Air emissions testing was performed on the #5 electric arc furnace baghouse stack outlet at Roanoke Electric Steel Corporation on April 9 through 10, 1992. Sampling was conducted by Chris Ferguson, Travis Parker and David Seabolt of ETS, Inc. Visible emissions evaluations were performed by Walter Laing of ETS, Inc. Process coordination was provided by Bill Warwick and Karen Bates of Roanoke Electric Steel. Ray Goetz of the Virginia Department of Air Pollution Control witnessed the test program.

1.2 Objective: The purpose of testing was to evaluate the compliance of the #5 electric arc furnace pollution control system with respect to the following emissions:

- total suspended particulate (TSP)
- silica smaller than 3.5 microns ($PM_{3.5}$)
- sulfur dioxide (SO_2)
- carbon monoxide (CO)
- opacity of visible emissions.

1.3 Test Program: The test program included three series of measurements for each pollutant. Particulate sampling was conducted in accordance with EPA Method 5 and Subpart AAa of 40 CFR 60. Testing for silica smaller than 3.5 microns was performed by utilizing an in-situ cascade impactor to separate the total particulate into several size fractions. The fraction below 3.5 microns was assumed to consist entirely of silica.

Sulfur dioxide and carbon monoxide measurements were made instrumentally in accordance with EPA Reference Methods 6C and 10, respectively. The opacity of the visible emissions was determined in accordance with EPA Reference 9.

All of the tests were performed concurrently at the baghouse stack outlet. Three test runs were performed for each pollutant. Each test run for total particulate, silica, and opacity was conducted over an integral number of furnace heats (minimum of four hours total duration), as required by Subpart AAa. The tests for SO_2 and CO were performed for one hour each, and were performed during the particulate tests. Appendix A contains a test log which includes the exact times for each test run.

2.0 SUMMARY OF RESULTS

Table I summarizes the results of the particulate, silica, and opacity tests. SO_2 and CO emissions are summarized in Table II. Appendix B contains detailed flow measurement and particulate results. Appendix C contains the data and results from the particle sizing tests, including particle size distribution plots used to determine the particle fractions less than 3.5 microns. Appendix D contains the continuous emissions monitoring results, while Appendix E contains the opacity data and results. Facility operating data collected throughout the test program are included in Appendices L and M.

The particulate emissions averaged 0.0049 grains per dry

standard cubic foot (gr/dscf) at a mass rate of 12.69 pounds per hour (lb/hr). The total particulate emissions smaller than 3.5 microns averaged 0.0028 gr/dscf at a rate of 7.14 lb/hr. Sulfur dioxide emissions averaged 3.31 ppmdv at a rate of 9.96 lb/hr. Carbon monoxide emissions averaged 51.63 ppmdv at a rate of 67.88 lb/hr. Visible emissions averaged 0% for the entire test program.

3.0 DISCUSSION OF RESULTS

The emissions measured for SO_2 and CO were below the permit limits of 42.0 lb/hr and 76.2 lb/hr, respectively.

The TSP emissions for the #5 furnace are limited to a concentration of 0.0052 gr/dscf and a mass rate of 8.14 lb/hr. Although the measured TSP emissions were below the concentration limit, they exceeded the mass rate limit.

The silica emissions are limited to 10.4 lb/day. The measured hourly emissions rate of $PM_{3.5}$ is equivalent to 171 lb/day based on a 24-hour day. By assuming all of the $PM_{3.5}$ consists of silica, the reported silica emissions are possibly much higher than real. Previous analyses of the particulate at the facility have indicated that only approximately four percent of the total dust exists as silica. Using this gives a silica emissions rate of only 6.8 lb/day, which would be within the permitted limit.

4.1.4 Flue Gas Moisture Content - EPA Method 4: The flue gas moisture was measured in conjunction with each of the particulate tests according to the sampling and analytical procedures outlined in EPA Method 4. The flue gas moisture for each test was determined by gravimetric analyses of the water collected in the impinger condensers of the particulate sampling train. All impingers were contained in an ice bath throughout the testing in order to assure complete condensation of the moisture in the flue gas stream. Any moisture which was not condensed in the impingers was captured in the silica gel contained in the final impinger.

4.1.5 Total Suspended Particulate - EPA Method 5: Sampling for total particulate was performed in accordance with EPA Method 5 and Subpart AAa of 40 CFR 60.

4.1.5.1 Sampling Train Description: Figure 2 shows the major components of the particulate sampling train. Stack gas was pulled through a Teflon-lined stainless steel liner equipped with a stainless steel nozzle, sized appropriately for isokinetic sample withdrawal. After passing through the liner, the sample gases were passed through a heated fiberglass filter, and into an impinger train consisting of four glass impingers immersed in an ice bath. The first two impingers initially each contained 100 milliliters of deionized, distilled water. The third impinger was initially empty, and the fourth initially contained approximately 200 grams of silica gel.

4.1.5.2 Sampling Train Operation: Sampling was done in accordance with EPA Method 5 procedures and specifications, including leak checking, isokinetic sampling rate and stack traversing. According to the specifications outlined in Subpart AAa, a minimum of four hours sampling time is required on electric arc furnaces. Other criteria outlined in the subpart required an integral number of heats to be sampled, and a minimum sampling volume of 160 dry standard cubic feet. During the sampling runs, sampling was conducted for 11 minutes at each of the 24 traverse points, resulting in a 264-minute test per run, excluding the time required to change ports. Isokinetic adjustments were made twice per sampling point, or once every 5.5 minutes.

4.1.5.3 Sample Recovery and Clean-up: Recovery of the Method 5 sampling nozzle and liner was accomplished using a teflon-fiber probe brush. Each was rinsed with acetone three times and brushed between rinsings. Exposed filters and thimbles were placed into petri dishes, which were then sealed with Teflon tape. The impinger contents were measured for moisture gain and discarded. The silica gel from the fourth impinger was transferred back to its original Nalgene container. The amount of moisture collected in the sampling train was quantified in order to determine the stack gas moisture content in accordance with EPA Method 4.

4.1.6 Opacity of Visible Emissions - EPA Method 9: Three visible emissions evaluation runs were conducted simultaneously with the outlet particulate sampling runs, with readings taken once every 15 seconds. The visible emissions evaluations were conducted in accordance with EPA Reference Method 9 by an EPA-certified observer.

4.1.7 Silica ($PM_{3.5}$) - Cascade Impactor: Sampling for silica smaller than 3.5 microns was performed using an eight-stage Andersen-style cascade impactor, following the general procedures recommended by the impactor manufacturer.

4.1.7.1 Sampling Train Description: Figure 3 shows the major components of the impactor sampling train. Stack gas was pulled through an appropriately sized stainless steel nozzle to insure isokinetic sampling. From the nozzle, sample gas was pulled through an Andersen Mark III Cascade Impactor consisting of eight fiberglass filters and a single back-up filter. Each filter was supported on a perforated stainless steel disc designed to separate particles according to their terminal velocity through the perforations in the disc. The gases then passed into an impinger train consisting of four glass impingers immersed in an ice bath. The first two impingers initially each contained 100 milliliters of deionized, distilled water. The third impinger was initially empty, and the fourth initially contained approximately 200 grams of silica gel.

4.1.7.2 Sampling Train Operation: Sampling was done in accordance with the procedures recommended by Andersen 2000 for leak checking, isokinetic sampling rate and stack traversing. During the sampling runs, sampling was conducted for 11 minutes at each of the 24 traverse points, resulting in a 264-minute test per run, excluding the time required to change ports.

4.1.7.3 Sample Recovery and Clean-up: Recovery of the cascade impactor sampling nozzle was accomplished using a teflon-fiber probe brush. The nozzle was rinsed with acetone three times and brushed between rinsings. The impactor filters were individually collected and placed back into their original tared containers. The impinger contents were measured for moisture gain and discarded. The silica gel from the fourth impinger was transferred back to its original Nalgene container. The amount of moisture collected in the sampling train was quantified in order to determine the stack gas moisture content in accordance with EPA Method 4.

4.1.8 Continuous Monitoring for SO_2, CO, O_2, and CO_2 - Instrumental Methods: Instrumental monitoring of the flue gases was performed in accordance with the following procedures:

GAS	REFERENCE METHOD	INSTRUMENT TYPE
SO_2	Method 6C	Western Research 721AT UV Absorption SO_2 Analyzer
CO	Method 10	TECO Model 48 NDIR CO Analyzer
O_2	Method 3A	Teledyne Model 320A Chemical Cell Portable O_2 Analyzer

Appendix D contains this data.

4.1.8.3 Calibration: At the beginning of each test run, each monitor was zeroed, using Zero Nitrogen, and spanned, using a certified calibration gas with a concentration of 80-90% of the instrument span. Following calibration a mid range gas, 50-60% of the instrument span, was introduced to each monitor. The mid range response error never exceeded 2% of the instrument span as required by EPA Reference Method 6C.

After calibrating the monitors, calibration gas was introduced remotely through the probe in order to verify the absence of sampling system bias. The bias error never exceeded 5% of the instrument span as required by EPA Reference Method 6C.

Calibration gases were either EPA Protocol 1 certified or ± 1% Traceable Standards. Gas certification data was available at the time of the tests.

4.2 Analytical Procedures

4.2.1 Particulate Analysis - EPA Method 5: Particulate concentrations were determined in accordance with EPA Method 5. Each filter was analyzed gravimetrically to a constant weight. Each front half acetone rinse was evaporated and analyzed gravimetrically to a constant weight. The total suspended particulate catch equals the sum of the front half acetone rinse

plus the filter weight. Appendix J contains the laboratory data for the particulate tests.

4.2.2 Cascade Impactor Analysis: Mass gains for the filters of each stage of the cascade impactor were also determined in accordance with EPA Method 5 procedures. Each filter was analyzed gravimetrically to a constant weight. Appendix J includes the laboratory data for the impactor tests.

4.3 Data Analysis: All calculations related to particulate sampling, including gas flow rates, temperatures, percent isokinetics, and moisture content are shown in Appendix F.

Silica smaller than 3.5 microns in size was determined by graphing the cumulative percentage by weight versus the particle diameter size-cut of each impactor stage. The percentage of particulate matter smaller than 3.5 microns was then read from the plotted data curve. The silica emissions smaller then 3.5 microns was derived by multiplying this percentage by the total particulate emissions obtained from the Method 5 tests.

TABLE I

SUMMARY OF TSP AND $PM_{3.5}$ EMISSIONS

RUN I.D.	RES-M5-R1	RES-M5-R2	RES-M5-R3	AVERAGE
DATE	04/09/92	04/10/92	04/10/92	
TIME STARTED	08:39	08:45	14:10	
TIME ENDED	14:18	13:32	18:49	
SAMPLING PARAMETERS				
Metered Volume - dcf	184.085	188.219	191.851	188.052
Corrected Volume - dscf	174.280	172.905	176.737	174.641
Total Test Time - min	264	264	264	264
% Isokinetics	97.4	97.0	98.5	97.6
GAS PARAMETERS				
Gas Temperature - °F	180.7	192.7	188.5	187.3
Oxygen - %	20.4	20.3	20.5	20.4
Carbon Dioxide - %	0.6	0.5	0.5	0.5
Moisture - %	1.56	1.48	1.31	1.45
GAS FLOWRATE				
Velocity - ft/sec	67.55	68.43	68.34	68.11
Actual Volume - acfm	385196	390178	389689	388354
Standard Volume - dscfm	301371	300209	302343	301308
TOTAL PARTICULATE EMISSIONS				
Concentration - gr/dscf	0.0061	0.0051	0.0035	0.0049
Mass Rate - lb/hr	15.79	13.09	9.19	12.69
OPACITY - %	0.0	0.0	0.0	0.0
$PM_{3.5}$ EMISSIONS				
% of Total Emissions	58	58	51	56
Concentration - gr/dscf	0.0035	0.0030	0.0018	0.0028
Mass Rate - lb/hr	9.16	7.59	4.68	7.14

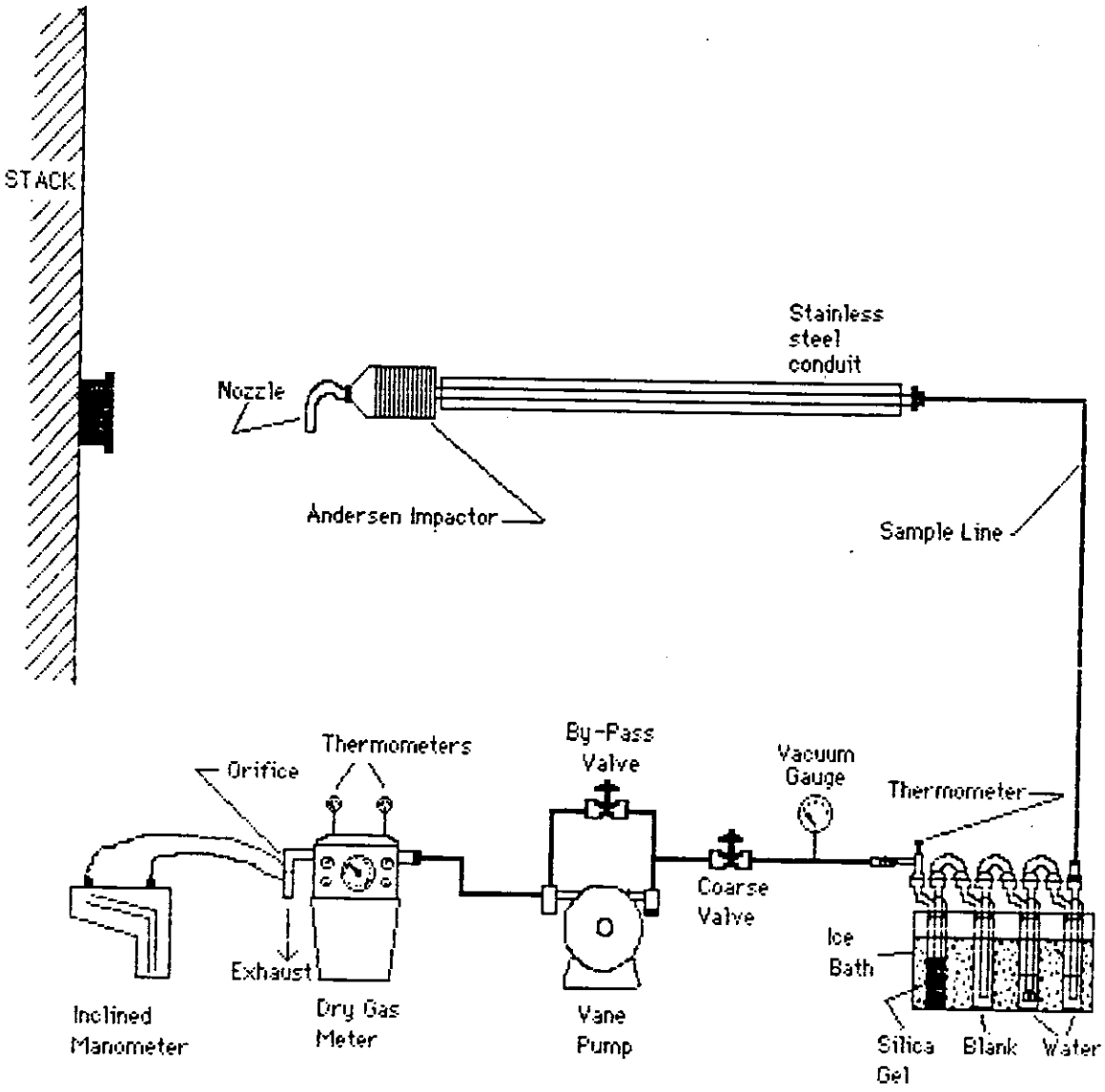


Figure 3 - In-Situ Andersen Impactor Sampling Train

EPA METHOD 5 DATA
RUN NUMBER RES-M5-R1

COMPONENT	TARE (grams)	FINAL (grams)	NET (grams)	VOLUME (ml)
Probe Wash	64.62326	64.66282	0.03956	130.0
Corr. for Blank			0.03861	
Filter	0.40876	0.43920	0.03044	
Back Half	0.00000	0.00000	0.00000	
TOTAL			0.06905	

ACETONE BLANK

Actual Residue	0.00088 grams
Allowable Residue	0.00094 grams
Volume	120.0 ml

PARTICULATE EMISSIONS

Actual Grain Loading	0.00611	gr/dscf
Corrected to 7% O2	0.16664	gr/dscf @ 7% O2
Corrected to 12% CO2	0.12435	gr/dscf @ 12% CO2
Corrected to 50% Excess Air	0.18043	gr/dscf @ 50% EA
Mass Rate	15.7936	lb/hr

SAMPLING QA/QC

Isokinetics	97.4 %
Corrected Meter Volume	174.280 dscf

RUN NUMBER	RES-M5-R2					
DATE	04/10/92					
START TIME	08:45					
END TIME	13:32		METHOD 4 DATA			
STACK DIAM.	132	inches		INIT.	FINAL	NET
NOZZLE I.D.	0.198	inches		(ml)	(ml)	(ml)
METER BOX GAMMA	0.9958		IMP.1	100.0	112.0	12.0
METER BOX dH@	1.7586		IMP.2	100.0	110.0	10.0
BAROMETRIC	28.845	in.Hg	IMP.3	0.0	4.0	4.0
Cp	0.84		IMP.4			0.0
TEST DURATION	264	minutes	IMP.5			0.0
			IMP.6			0.0
			IMP.7			0.0
METHOD 1-4 RESULTS			TOTAL	200.0	226.0	26.0
Metered Volume	188.219	dcf	S.G.	200.0	229.3	29.3
Volume @ Std.Cond.	172.905	dscf				
% Water	1.48	%	METHOD 3 DATA			
% Isokinetics	97.0	%	%O2	20.3	Md	28.90
Velocity	68.43	ft/sec	%CO2	0.5	Ms	28.74
Actual Flow	390178	acfm	%CO	0.0	Ps	28.89
Std. Flow	304732	scfm	%N2	79.1	Fo	1.057
Dry Std. Flow	300209	dscfm	O2+CO2	20.9	%EA	3696

POINT	STACK TEMP (DegF)	STATIC (in.WC)	DP (in.WC)	DH (in.WC)	METER VOLUME (dcf)	METER TEMPERATURE INLET (DegF)	OUTLET (DegF)
1	79	0.62	0.82	1.07	129.943	66	65
2	79	0.52	0.91	1.15		73	74
3	161		1.20	1.50		74	74
4	162		1.10	1.40		74	74
5	196		1.10	1.40		75	74
6	198		1.20	1.50		77	75
7	216		1.10	1.40		82	77
8	224		1.10	1.40		85	78
9	217		1.10	1.40		85	80
10	209		1.10	1.40		86	81
11	198		1.10	1.40		85	81
12	179		1.00	1.28		88	84
13	183		0.88	1.13		85	85
14	162		1.00	1.28		83	85
15	203		1.00	1.28		85	86
16	202		1.10	1.40		89	88
17	215		1.10	1.40		96	92
18	212		1.00	1.28		94	93
19	234		1.10	1.40		98	94
20	215		1.10	1.40		101	96
21	207		1.10	1.40		106	99
22	196		1.10	1.40		104	98
23	196		0.99	1.25		105	99
24	183		1.00	1.28		103	98
25	134		1.10	1.40		99	98
26	160		1.10	1.40		102	98
27	179		1.40	1.80		104	99
28	213		1.20	1.50		102	97
29	225		1.20	1.50		101	97
30	217		1.30	1.70		100	96
31	222		1.10	1.40		100	96
32	206		1.30	1.70		104	98
33	218		1.20	1.50		106	99
34	215		1.20	1.50		105	99
35	200		1.20	1.50		105	99
36	194		1.00	1.28		104	99
37	123		1.30	1.70		97	98
38	131		1.30	1.70		101	99
39	196		1.50	1.90		104	99
40	193		1.50	1.90		106	100
41	225		1.40	1.80		107	100
42	228		1.50	1.90		108	101
43	195		1.60	2.00		108	101
44	203		1.30	1.70		105	99
45	232		1.10	1.40		107	101
46	214		1.20	1.50		107	101
47	206		1.10	1.40		104	100
48	195		1.30	1.70	318.162	102	99
AVG.	193	0.57	1.16	1.48	188.219	94	

EPA METHOD 5 DATA
RUN NUMBER RES-M5-R2

COMPONENT	TARE (grams)	FINAL (grams)	NET (grams)	VOLUME (ml)
Probe Wash	65.02516	65.06796	0.04280	110.0
Corr. for Blank			0.04199	
Filter	0.41312	0.42814	0.01502	
Back Half	0.00000	0.00000	0.00000	
TOTAL			0.05701	

ACETONE BLANK

Actual Residue	0.00088	grams
Allowable Residue	0.00094	grams
Volume	120.0	ml

PARTICULATE EMISSIONS

Actual Grain Loading	0.00509	gr/dscf
Corrected to 7% O2	0.12631	gr/dscf @ 7% O2
Corrected to 12% CO2	0.11521	gr/dscf @ 12% CO2
Corrected to 50% Excess Air	0.12878	gr/dscf @ 50% EA
Mass Rate	13.0942	lb/hr

SAMPLING QA/QC

Isokinetics	97.0	%
Corrected Meter Volume	172.905	dscf

RUN NUMBER	HES-M5-R3					
DATE	04/10/92					
START TIME	14:10					
END TIME	18:49		METHOD 4 DATA			
STACK DIAM.	132	inches		INIT. (ml)	FINAL (ml)	NET (ml)
NOZZLE I.D.	0.198	inches				
METER BOX GAMMA	0.9958		IMP.1	100.0	109.0	9.0
METER BOX dH@	1.7586		IMP.2	100.0	110.0	10.0
BAROMETRIC	28.845	in.Hg	IMP.3	0.0	4.0	4.0
Cp	0.84		IMP.4			0.0
TEST DURATION	264	minutes	IMP.5			0.0
			IMP.6			0.0
			IMP.7			0.0
METHOD 1-4 RESULTS			TOTAL	200.0	223.0	23.0
Metered Volume	191.851	dcf	S.G.	200.0	226.6	26.6
Volume @ Std.Cond.	176.737	dscf				
% Water	1.31	%	METHOD 3 DATA			
% Isokinetics	98.5	%	%O2	20.5	Md	28.90
Velocity	68.34	ft/sec	%CO2	0.5	Ms	28.75
Actual Flow	389689	acfm	%CO	0.0	Ps	28.89
Std. Flow	306342	scfm	%N2	79.0	Fo	0.875
Dry Std. Flow	302343	dscfm	O2+CO2	21.0	%EA	5298

POINT	STACK TEMP (DegF)	STATIC (in.WC)	DP (in.WC)	DH (in.WC)	METER VOLUME (dcf)	METER TEMPERATURE INLET (DegF)	OUTLET (DegF)
1	193	0.55	1.30	1.70	310.416	100	97
2	200	0.58	1.00	1.28		102	98
3	221	0.65	1.20	1.50		103	98
4	212	0.69	1.50	1.90		103	98
5	220		1.30	1.70		102	97
6	215		1.30	1.70		102	97
7	210		1.10	1.40		102	96
8	200		1.20	1.50		102	96
9	183		1.20	1.50		102	96
10	181		1.10	1.40		101	95
11	160		1.10	1.40		98	94
12	156		1.10	1.40		97	93
13	163		1.10	1.40		89	90
14	166		1.00	1.28		92	89
15	201		1.20	1.50		92	88
16	210		1.20	1.50		91	87
17	195		1.20	1.50		90	85
18	193		1.40	1.70		90	84
19	190		1.20	1.50		91	85
20	192		1.10	1.40		93	85
21	181		1.30	1.70		95	87
22	182		1.20	1.50		96	87
23	175		1.10	1.40		94	87
24	163		1.10	1.40		94	88
25	106		0.90	1.12		89	87
26	100		0.93	1.17		91	87
27	182		1.30	1.70		93	88
28	191		1.00	1.28		95	88
29	218		1.00	1.28		94	88
30	219		1.10	1.40		95	89
31	200		0.88	1.11		96	90
32	221		1.10	1.40		93	89
33	212		1.10	1.40		93	88
34	197		1.20	1.50		94	89
35	199		1.10	1.40		93	88
36	190		1.10	1.40		94	89
37	120		1.10	1.40		91	88
38	121		1.30	1.70		93	89
39	162		1.40	1.80		94	89
40	191		1.40	1.80		94	88
41	198		1.40	1.80		95	89
42	191		1.50	1.90		93	88
43	224		1.10	1.40		91	87
44	218		1.20	1.50		90	86
45	222		1.10	1.40		90	86
46	193		1.20	1.50		90	85
47	186		0.99	1.23		90	85
48	227		1.00	1.28	510.267	88	84
AVG.	189	0.62	1.16	1.48	191.851	92	

EPA METHOD 5 DATA
RUN NUMBER RES-M5-R3

COMPONENT	TARE (grams)	FINAL (grams)	NET (grams)	VOLUME (ml)
Probe Wash	65.18576	65.21075	0.02499	110.0
Corr. for Blank			0.02418	
Filter	0.41091	0.42732	0.01641	
Back Half	0.00000	0.00000	0.00000	
TOTAL			0.04059	

ACETONE BLANK

Actual Residue	0.00088	grams
Allowable Residue	0.00094	grams
Volume	120.0	ml

PARTICULATE EMISSIONS

Actual Grain Loading	0.00354	gr/dscf
Corrected to 7% O2	0.11731	gr/dscf @ 7% O2
Corrected to 12% CO2	0.08861	gr/dscf @ 12% CO2
Corrected to 50% Excess Air	0.12756	gr/dscf @ 50% EA
Mass Rate	9.1857	lb/hr

SAMPLING QA/QC

Isokinetics	98.5	%
Corrected Meter Volume	176.737	dscf

RUN 1

Particle Sizing Results

Roanoke Electric Steel
Compliance
04/09/92

Time: 08:39

Stage	Cumulative % Less than Dia.	50% Cut-point Diameter (microns) Physical	50% Cut-point Diameter (microns) Aerodynamic*
1	89.06	8.067	11.408
2	74.68	7.603	10.753
3	65.88	4.734	6.694
4	57.84	3.152	4.458
5	40.63	1.760	2.490
6	21.27	0.782	1.106
7	4.13	0.468	0.662
8	4.13	0.244	0.345

* Aerodynamic Diameter uses a particle density of 1 gm/cm3.

Impactor Data

Roanoke Electric Steel

Location: Electric Arc Furnace
Condition: Compliance
Date: 04/09/92
Time: 08:39
Impactor: Anderson

File Name: 597r1.imp

CO2	0.59	Molecular Wt. of Gas Dry	28.91
O2	20.40	Molecular Wt. of Gas Wet	28.76
N2	79.01	% Excess Air	%4447.92
CO	0.00	% Water	1.41

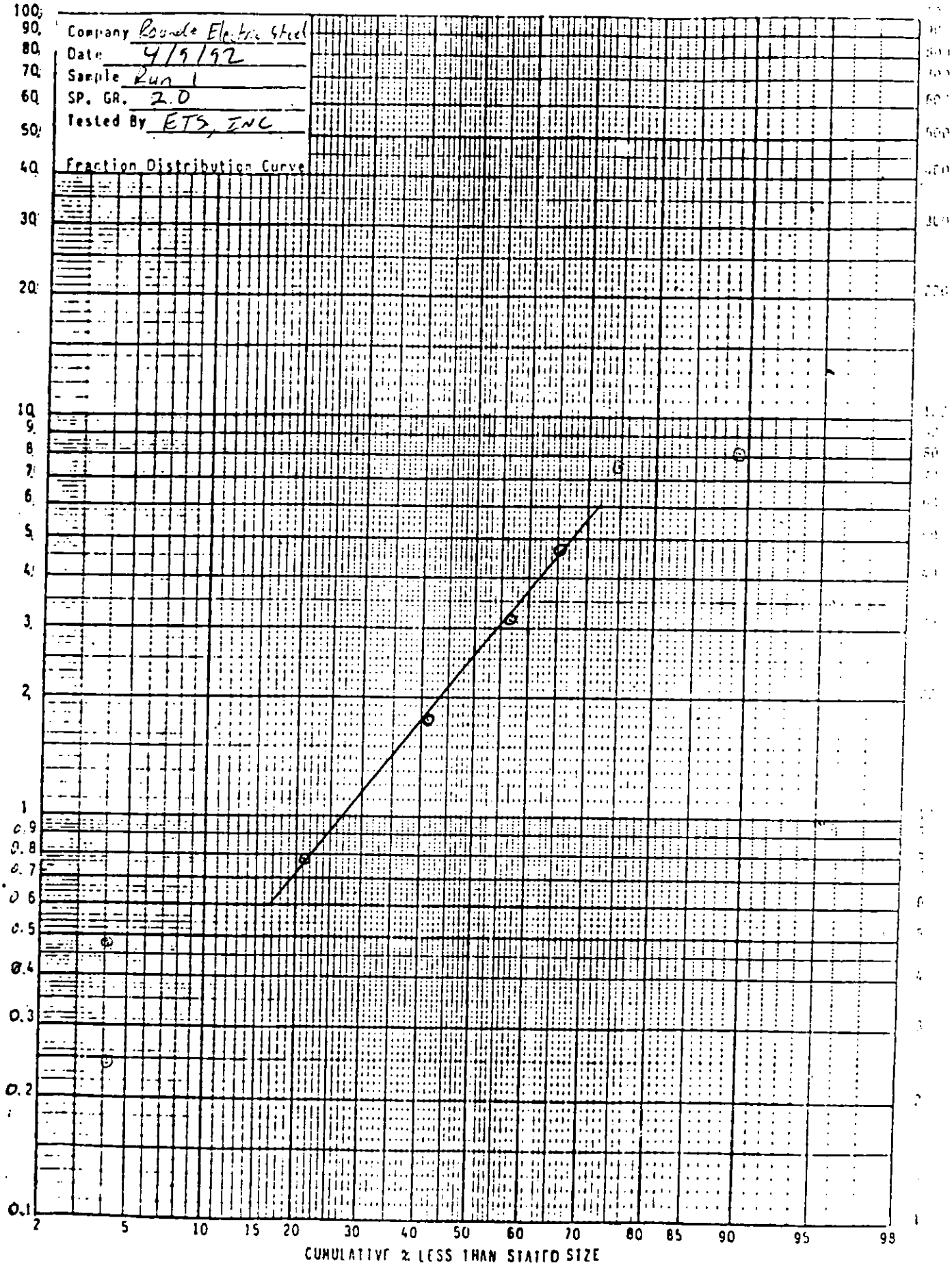
Impactor Flow Rate	0.496	ACFM
Nozzle Diameter	0.150	inches
% Isokinetics	94.68	%
Particle Density	2.00	(gm/cm3)
Sample Time	264.00	minutes

Meter Volume	108.117	cubic feet
Meter Temperature	72.0	°F
Stack Temperature	175.0	°F
Impactor Temperature	175.0	°F
Barometric Pressure	28.81	in. Hg
Impactor Pressure (vac.)	0.0	in. Hg
Static Pressure	0.66	in. H2O
Meter Pressure Delta H	0.50	in. H2O
Pitot Delta P	1.290	in. H2O
Viscosity of Gas	0.0002048	poise
Particulate Conc.	0.0019	gr./scf

Mass Gain in Stage	1	0.00143	grams
Mass Gain in Stage	2	0.00188	grams
Mass Gain in Stage	3	0.00115	grams
Mass Gain in Stage	4	0.00105	grams
Mass Gain in Stage	5	0.00225	grams
Mass Gain in Stage	6	0.00253	grams
Mass Gain in Stage	7	0.00224	grams
Mass Gain in Stage	8	0.00000	grams
Back-up Filter		0.00054	grams
Total Mass		0.01307	grams

Stages 8 are assumed zero because of negative weight gain.

PARTICLE SIZE DISTRIBUTION



RUN 2

Particle Sizing Results

RUN 2
Compliance
04/10/92 Time: 08:45

Stage	Cumulative % Less than Dia.	50% Cut-point Diameter (microns) Physical	50% Cut-point Diameter (microns) Aerodynamic*
1	82.28	7.321	11.342
2	65.21	6.900	10.689
3	57.76	4.291	6.648
4	53.86	2.853	4.421
5	53.86	1.588	2.459
6	9.71	0.699	1.082
7	9.71	0.413	0.640
8	7.89	0.210	0.326

* Aerodynamic Diameter uses a particle density of 1 gm/cm3.

Impactor Data

R

Location: Electric Arc Furnace
Condition: Compliance
Date: 04/10/92
Time: 08:45
Impactor: Anderson

File Name: 597r2.imp

CO2	0.53	Molecular Wt. of Gas Dry	28.90
O2	20.34	Molecular Wt. of Gas Wet	28.70
N2	79.13	% Excess Air	%3696.04
CO	0.00	% Water	1.84

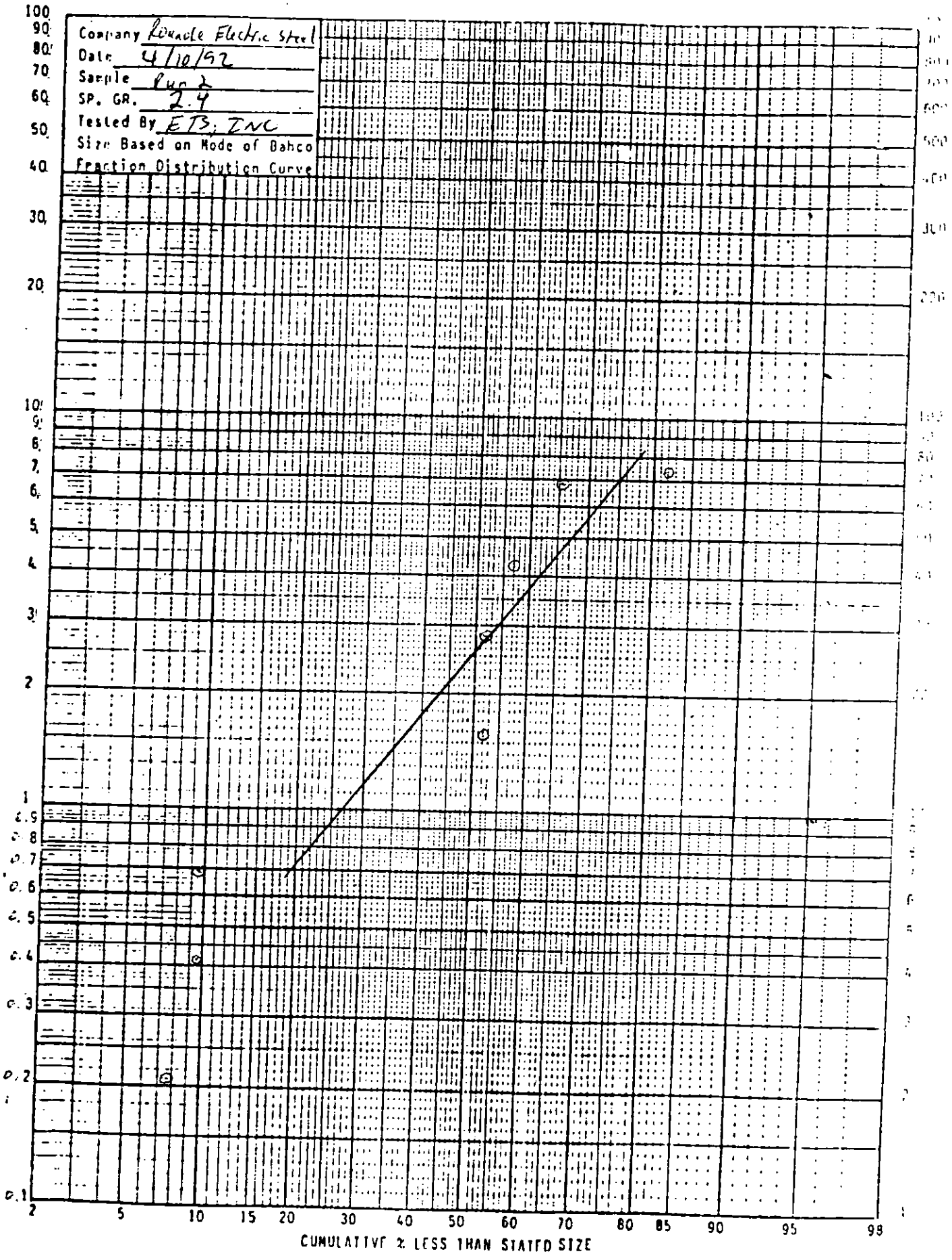
Impactor Flow Rate	0.512	ACFM
Nozzle Diameter	0.150	inches
% Isokinetics	96.37	%
Particle Density	2.40	(gm/cm3)
Sample Time	264.00	minutes

Meter Volume	111.023	cubic feet
Meter Temperature	91.0	°F
Stack Temperature	199.0	°F
Impactor Temperature	199.0	°F
Barometric Pressure	28.84	in. Hg
Impactor Pressure (vac.)	0.0	in. Hg
Static Pressure	0.71	in. H2O
Meter Pressure Delta H	0.50	in. H2O
Pitot Delta P	1.280	in. H2O
Viscosity of Gas	0.0002099	poise
Particulate Conc.	0.0035	gr./scf

Mass Gain in Stage	1	0.00409	grams
Mass Gain in Stage	2	0.00394	grams
Mass Gain in Stage	3	0.00172	grams
Mass Gain in Stage	4	0.00090	grams
Mass Gain in Stage	5	0.00000	grams
Mass Gain in Stage	6	0.01019	grams
Mass Gain in Stage	7	0.00000	grams
Mass Gain in Stage	8	0.00042	grams
Back-up Filter		0.00182	grams
Total Mass		0.02308	grams

Stages 5 , 7 are assumed zero because of negative weight gain.

PARTICLE SIZE DISTRIBUTION



RUN 3

Particle Sizing Results

Roanoke Electric Steel
Compliance
04/10/92 Time: 14:10

Stage	Cumulative % Less than Dia.	50% Cut-point Diameter (microns) Physical	50% Cut-point Diameter (microns) Aerodynamic*
1	65.40	7.362	11.404
2	59.05	6.938	10.748
3	53.98	4.315	6.684
4	48.33	2.869	4.445
5	43.48	1.596	2.473
6	35.64	0.702	1.088
7	25.49	0.415	0.643
8	15.22	0.212	0.328

* Aerodynamic Diameter uses a particle density of 1 gm/cm3.

Impactor Data

Roanoke Electric Steel

Location: Electric Arc Furnace
Condition: Compliance
Date: 04/10/92
Time: 14:10
Impactor: Anderson

File Name: 59/r3.imp

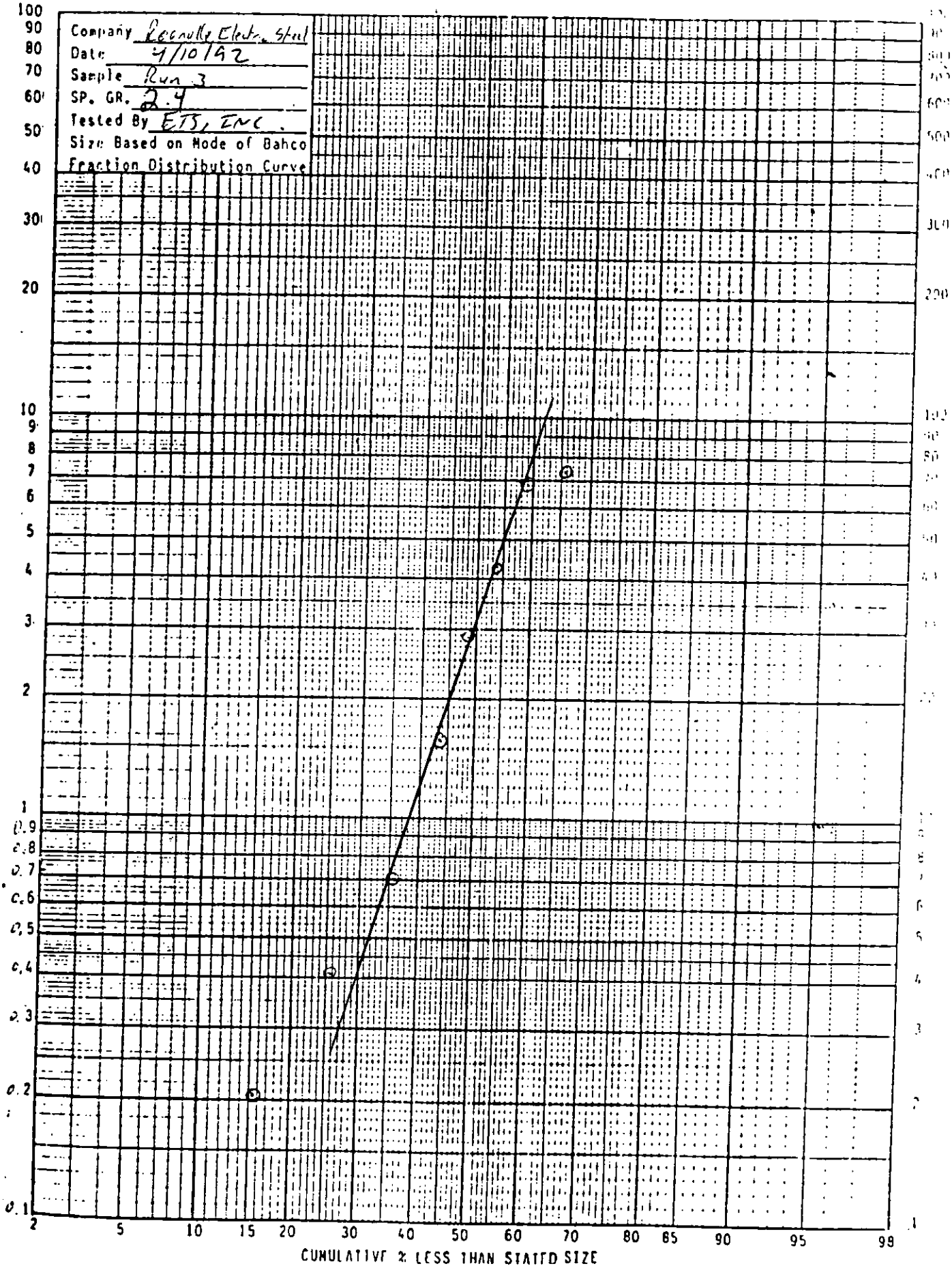
CO2	0.48	Molecular Wt. of Gas Dry	28.90
O2	20.48	Molecular Wt. of Gas Wet	28.73
N2	79.04	% Excess Air	%5298.00
CO	0.00	% Water	1.53

Impactor Flow Rate	0.508	ACFM
Nozzle Diameter	0.150	inches
% Isokinetics	92.71	%
Particle Density	2.40	(gm/cm3)
Sample Time	264.00	minutes

Meter Volume	111.587	cubic feet
Meter Temperature	98.0	°F
Stack Temperature	201.0	°F
Impactor Temperature	201.0	°F
Barometric Pressure	28.84	in. Hg
Impactor Pressure (vac.)	0.0	in. Hg
Static Pressure	0.52	in. H2O
Meter Pressure Delta H	0.50	in. H2O
Pitot Delta P	1.360	in. H2O
Viscosity of Gas	0.0002107	poise
Particulate Conc.	0.0013	gr./scf

Mass Gain in Stage	1	0.00300	grams
Mass Gain in Stage	2	0.00055	grams
Mass Gain in Stage	3	0.00044	grams
Mass Gain in Stage	4	0.00049	grams
Mass Gain in Stage	5	0.00042	grams
Mass Gain in Stage	6	0.00068	grams
Mass Gain in Stage	7	0.00088	grams
Mass Gain in Stage	8	0.00089	grams
Back-up Filter		0.00132	grams
Total Mass		0.00867	grams

PARTICLE SIZE DISTRIBUTION



PARTICULATE EMISSION CALCULATIONS

Particulate emission concentrations are calculated by:

$$C_{sd} = \frac{15.43}{V_{m(std)}} \times \sum_{i}^{n} m_i \qquad (1)$$

where C_{sd} is the particulate concentration - grains/dscf.
Σm_i is particulate mass gained in sampling train - grams.
15.43 is a conversion factor - grains/grams

Correcting particulate concentration to 7% O_2 is done by:

$$C_{sd@7\%} = C_{sd} \times \frac{20.9 - 7.0}{20.9 - \%O_2} \qquad (2)$$

where $C_{sd@7\%}$ is the particulate concentration at 7% O_2 - grains/dscf
$\%O_2$ is the percent volume of oxygen within the flue gas.

Correcting particulate concentration to 12% CO_2 involves:

$$C_{sd@12\%} = C_{sd} \times \frac{12}{\%CO_2} \qquad (3)$$

where $C_{sd@12\%}$ is the particulate concentration at 12% CO_2 - grains/dscf.
$\%CO_2$ is the volume percent of carbon dioxide in the flue gas.

The particulate concentration corrected to 50% excess air is:

$$C_{sd@50\%EA} = C_{sd} \times \frac{100 + \%EA}{150} \qquad (4)$$

where $C_{sd@50\%}$ is concentration at 50% excess air - grains/dscf.
%EA is volume percent excess air.

The mass emissions rate on a time basis is calculated by:

$$M_p = \frac{C_{sd} \times Q_{sd} \times 60}{7000} \quad (5)$$

where M_p is the time based mass particulate emissions rate - lb/hr
Q_{sd} is the standardized volumetric - dscfm
60 is a conversion factor - min/hr
7000 is a conversion factor - grains/lb

Mass emissions based upon fuel usage is calculated by:

$$M_{pf} = \frac{C_{sd} \times Q_s \times F_d}{7000} \times \frac{20.9}{(20.9 - \%O_2)} \quad (6)$$

where M_{pf} fuel based particulate mass emissions - lb/MMBtu
20.9 is ambient volumetric percent oxygen - %
F_d is the dry basis fuel factor - dscf/MMBtu

Percent Isokinetics (%Iso) are derived by the following:

$$\%Iso = \frac{0.09450 \times (T_s + 460) \times V_{m(std)}}{P_s \times v_s \times A_n \times time \times (1 - B_{ws})} \quad (7)$$

where T_s is the stack temperature - °F
$V_{m(std)}$ is the standardized sample volume - dscf
P_s is the average stack pressure - in. Hg
v_s is average stack gas velocity - ft/s
A_n is the nozzle cross section area - ft^2
time is defined as the net Method 5 sampling time - min
B_{ws} is volumetric water vapor fraction of the flue gas
460 converts degrees Fahrenheit to Rankine.

Particulate Sizing Theory and Equations Used in Calculations

The plates of each stage in the impactor have calibrated orifices. The area of the orifices on each plate are progressively smaller from stage to stage causing the jet velocities to increase over each stage. The theory on particle behavior is to calculate the particle size required to produce the inertia to overcome the aerodynamic drag of the air stream. If the particle is large enough, the inertia will be great enough to deposit the particle on the given stage. Thus, the larger particles will deposit towards the beginning of the impactor. Equations 1 and 2 model this theory.

Eq. 1 $$D_{50} = \frac{18 \times U \times DJ_{(x)}}{rho \times VJ_{(x)} \times C} \times SI_{(x)}$$

Eq. 2 $$C = 1 + \frac{2L}{D_{50}} \quad 1.23 + 0.41\exp(-.44D_{50}/L)$$

C = Cunningham Factor

D_{50} is the particle diameter at which the stage achieves 50% collection efficiency. Particle distribution is done on a cummulative weight basis.

Eq. 3 $$\text{wt.\% less then } D_{50i} = \frac{m_i}{m_{total}} \times 100\%$$

The cut-off diameter is reported by Physical Diameter and Aerodynamic Diameter. The Physical Diameter assumes a spherical particle and the true density of the particles are estimated. The Aerodynamic Diameter assumes a spherical particle and a unit density.

L is the mean free path. The mean free path is the distance the particle travels before it collides and the path is interupted.

Eq. 4 $$L_{(x)} = \frac{.337 \times U}{P5_i} \quad \frac{T_{imp}}{mw}$$

The viscosity is calculated as a function of gas temperature. The individual viscosity components are calculated using formulas derived at Southern Research Institute.

Eq. 5 $$U = \sum_{i=1}^{-} \{U_i \times 10E\text{-}6/[1 + \sum_{\substack{j=1 \\ j \neq i}}^{-} (F_i \times O_{ij})/F_i]\}$$

Eq. 6-9 $$U_{co2} = 138.494 + T(.449 + T(-.286E^{-3} + T \times .972E^{-7}))$$

$$U_{n2} = 168.086 + T(.417 + T(-.139E^{-3}))$$

$$U_{02} = 190.187 + T(.558 + T(-.336E^{-3} + T \times .139E^{-6}))$$

$$U_{h20} = 87.8 + T(.374 + T(-.283E^{-4}))$$

Eq. 10 $$O_{ij} = \frac{\{1 + U_i/U_j \sqrt{}^{4} mw_j/mw_i\}^2}{4 \times (1 + mw_i/mw_j)/2}$$

Equations 11-14 determine the jet velocity and pressure drop for each stage. Only the total pressure drop is known, therefore the pressure at each stage is estimated. This is done by relating the square of the velocity to the pressure drop.

Eq. 11 $$VJ^7 = \sum_{i-1}^{-} (471.95 \times Q_I/JA_i/JN_i)^2$$

Eq. 12 $$DP_i = \frac{(VJ^7_i)^2 \times DP}{VJ^7}$$

Eq. 13 $$Ps_i = (P_b + P/13.6) - \sum_{j-1}^{i} DP_j$$

Eq. 14 $$VJ_{(x)} = VJ^7_i \times (P_b + P/13.6)/Ps_i$$

Calculation format and equations were taken from Southern Research Institute papers and the impactor operation manuals.

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

FACILITY Roanoke Electric Steel TEST LOCATION #5 Electric Arc Furnace DATE 04-09-92

START TIME 08:39 POLLUTANT Particulate RUN I.D. RES -M5 -R1

	Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp. Inlet	Meter Temp. Outlet	Filter Temp.	Imp. Temp.	Meter Vac.
A	1	0	8:39		121	.92	1.2	937.621	65	65	220	61	3.5
		5.5		+.55	123	.93	1.2	941.1	68	65	233	48	3.5
	2	11			182	1.1	1.4	944.5	73	68	250	48	4
		16.5			180	1.1	1.4	948.1	74	69	253	52	4.3
	3	22			184	1.1	1.4	951.9	74	70	259	56	4.3
		27.5			182	1.1	1.4	955.7	75	70	259	57	4.3
	4	33			179	1.1	1.4	959.5	75	71	260	58	4.5
		38.5			191	1.1	1.4	963.4	77	72	260	56	4.5
	5	44			179	1.2	1.5	967.2	76	72	263	60	4.8
		49.5			181	1.1	1.4	971.2	75	73	264	58	4.5
	6	55			199	.98	1.25	975.0	78	74	267	59	4
		60.5			198	.92	1.2	978.5	78	75	269	58	4
		66	9:45					982.220					
B	1	0 66	10:35		159	.86	1.1	982.220	69	67	220	64	3.8
		5 5715			154	.77	1.0	985.5	75	71	224	48	3.5
	2	11 77			198 ~~196~~	1.3	1.7	988.8	77	72	228	54	4.8
		16 5820			201	1.3	1.7	992.9	81	75	234	56	5
	3	22 88		+0.4	200	1.4	1.8	997.0	84	78	240	55	5
		27 5925			191	1.5	1.9	1001.3	85	79	243	56	5.2
	4	33 99			177	1.3	1.7	1005.6	86	80	246	56	5
		28 6045			172	1.2	1.5	1009.7	82	79	244	54	4.5
	5	44 110			195	1.1	1.4	1013.7	81	79	243	53	4.3
		49 6165			190	1.1	1.4	1017.5	80	78	242	52	4.3
	6	55 121			194	.96	1.2	1021.4	76	76	239	51	4

CHAIN OF CUSTODY INFORMATION

Container Number	Sample I.D.	Description
3	102	Imp 1 cond.
4	103	Imp 2 & 3 cond.
5	129	Imp 4 Silica gel
1	~~Blank~~ 104	Filter
2	~~ACT~~ 106	Acetone

LEAK CHECK

Vacuum	10"				
Rate	.018				

IMPINGER VOLUMES

	Initial	Final
#1	100 ml	108 ml
#2	100 ml	~~99~~ 112 ml
#3	0 ml	4 ml
#4		
#5		
#6		

NOZZLE SIZE	198
METER BOX I.D.	#6
GAMMA	0.9958
DELTA H@	1.7586
BAR. PRESS.:	28.815
FILTER I.D.	91-1039
OPERATOR	C. Ferguson

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

RUN I.D. RES -M 5 -R 1

Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp Inlet	Meter Temp Outlet	Filter Temp.	Imp Temp.	Meter Vac.
	126.5			204	.99	1.27	1024.8	78	75	247	52	4
	132	11:41					1028.315					
1	132	11:51		162	1.3	1.7	1028.315	70	67	246	63	5
	137.5			163	1.1	1.4	1032.3	69	68	248	52	4.5
2	143			184	1.4	0.8	1036.1	74	70	247	58	5
	148.5			188	1.4	1.8	1040.2	78	71	247	57	5
3	154			178	1.4	1.8	1044.4	75	71	248	58	5
	159.5		+.77	181	1.3	1.7	1048.6	76	72	249	58	5
4	165			186	1.5	1.9	1052.7	79	74	252	57	5.5
	170.5			188	1.3	1.7	1056.8	78	74	252	58	5
5	176			191	1.1	1.4	1061.2	83	77	252	56	4.5
	181.5			195	1.1	1.4	1065.1	82	78	247	55	4.5
6	187			197	1.0	1.26	1068.9	85	79	245	56	4
	192.5			225	.96	1.2	1072.4	88	81	244	56	4
	198	12:57			0		1075.883					
1	198	13:12		90	.85	1.1	1075.883	88	84	228	65	3.8
	203.5			78	.89	1.12	1079.4	87	84	247	57	3.8
2	209			185	1.2	1.5	1082.6	79	80	247	55	4.5
	214.5			189	1.4	1.8	1086.5	82	81	252	58	5
3	220			194	1.2	1.5	1090.6	77	77	250	56	4.8
	225.5			186	1.4	1.8	1094.6	79	77	254	58	5
4	231			167	1.4	1.8	1098.8	79	77	252	58	5
	236.5			197	1.2	1.5	1103.0	80	77	254	59	4.5
5	242			168	1.2	1.5	1106.8	85	79	257	61	4.5
	247.5			194	1.1	1.4	1110.6	85	80	258	59	4.5
6	253			214	.98	1.25	1114.3	84	79	258	60	4
	258.5			220	1.2	1.5	1118.3	84	80	256	60	4.5
	264	14:18					1121.706					

LEAK CHECK

Vacuum	10"				
Rate	.018				

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

FACILITY Roanoke Electric Steel TEST LOCATION #5 Electric Arc Furnace DATE 04-10-92

START TIME 08:45 POLLUTANT Particulate RUN I.D. RES -M5 -R2

	Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp. Inlet	Meter Temp. Outlet	Filter Temp.	Imp. Temp.	Meter Vac.
D	1	0	08:45		79	.82	1.0?	129.943	66	65	220	65	4.2
		5.5			79	.91	1.15	133.3	73	74	262	47	4.5
	2	11			161	1.2	1.5	136.7	74	74	262	49	5.3
		16.5			162	1.1	1.4	140.5	74	74	260	49	5.3
	3	22			196	1.1	1.4	144.4	75	74	263	51	5.3
		27.5			198	1.2	1.5	147.5	77	75	261	52	5.3
	4	33			216	1.1	1.4	152.2	82	77	262	56	5.3
		38.5			224	1.1	1.4	156.1	85	78	261	56	5.3
	5	44		+.62	217	1.1	1.4	159.9	85	80	261	57	5.3
		49.5			209	1.1	1.4	163.8	86	81	264	56	5.3
	6	55			198	1.1	1.4	167.7	85	81	262	54	5.3
		60.5			179	1.0	1.28	171.6	88	84	260	57	5
		66	08:51					175.228					
A	1	66	10:01		183	~~1.85~~ 1.0	~~1.13~~ 1.28	175.248	85	85	263	~~63~~ 63	4.8
		71.5			162	1.0	1.28	178.7	83	85	261	56	5
	2	77			203	1.0	1.28	182.3	85	86	261	60	5
		82.5			202	1.1	1.4	186.0	89	88	262	64	5.2
	3	88			215	1.1	1.4	189.8	96	92	258	64	5.2
		93.5		+52	212	1.0	1.28	193.6	94	93	252	~~62~~ 62	4.9
	4	99			224	1.1	1.4	197.3	98	94	248	61	5.2
		104.5			~~221~~ 215	1.1	1.4	201.1	101	96	245	61	5.2
	5	110			207	1.1	1.4	204.9	106	99	243	63	5.2
		115.5			196	1.1	1.4	208.8	104	98	238	62	5.2
	6	121			196	.99	1.25	212.6	105	99	238	60	5
		126.5			183	1.0	1.28	216.3	103	98	239	59	5

CHAIN OF CUSTODY INFORMATION

Container Number	Sample I.D.	Description
2	111	Acetone Rinse
3	107	Imp 1 Cont
4	108	Imp 2,3 Cont.
5	104	Silica gel
1	105	Filter

LEAK CHECK

Vacuum						
Rate						

IMPINGER VOLUMES

	Initial	Final
#1	100 ml	112 ml
#2	100 ml	110 ml
#3	0 ml	4 ml
#4		
#5		
#6		

NOZZLE SIZE	.198
METER BOX I.D.	#6
GAMMA	.9958
DELTA H@	1.7586
BAR. PRESS.	28.845
FILTER I.D.	91-1037
OPERATOR	C.F

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

RUN I.D. RES -M 5 -R 2

	Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp Inlet	Meter Temp Outlet	Filter Temp.	Imp Temp	Meter Vac.
		132	11:07					220.018					
B	1	132	11:14		134	1.1	1.4	220.018	99	28	244	64	5
		137.5			160	1.1	1.4	223.7	102	98	241	56	5
	2	143			179	1.4	1.8	227.5	104	99	238	58	6
		148.5			213	1.2	1.5	231.9	102	97	233	58	5.5
	3	154			225	1.2	1.5	235.9	101	97	229	59	5.5
		159.5		+.66	217	1.3	1.7	239.9	100	96	228	58	5.9
	4	165			222	1.1	1.4	244.1	100	96	232	59	5.3
		170.5			206	1.3	1.7	248.0	104	98	236	61	6
	5	176			218	1.2	1.5	252.1	106	99	238	62	5.5
		181.5			215	1.2	1.5	256.1	105	99	237	61	5.5
	6	187			200	1.2	1.5	260.0	105	99	236	62	5.5
		192.5			194	1.0	1.28	264.0	104	99	238	63	5
		198	12:20					267.731					
C	1	198	12:26		123	1.3	1.7	267.731	97	98	233	62	5.8
		203.5			131	1.3	1.7	271.4	101	99	235	66	6
	2	209			196	1.5	1.9	275.7	104	99	238	66	6.3
		214.5			193	1.5	1.9	280.1	106	100	241	63	6.3
	3	220			225	1.4	1.8	284.5	107	100	242	62	6.1
		225.5			228	1.5	1.9	288.8	108	101	242	61	6.3
	4	231			195	1.6	2.0	293.2	108	101	238	57	6.3
		236.5			203	1.3	1.7	297.8	105	99	236	57	6
	5	242		+.69	232	1.1	1.4	301.9	107	101	238	57	5.3
		247.5			214	1.2	1.5	305.9	107	101	239	58	5.5
	6	253			206	1.1	1.4	309.9	104	100	228	56	5.3
		258.5			195	1.3	1.7	313.9	102	99	227	58	6
		264	13:32					318.162					

LEAK CHECK

Vacuum	10"					
Rate	.017					

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

FACILITY Roanoke Electric Steel TEST LOCATION #5 Electric Arc Furnace DATE 04-10-92

START TIME 14:10 POLLUTANT Particulate RUN I.D. REI -M 5 -R 3

Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp. Inlet	Meter Temp. Outlet	Filter Temp.	Imp. Temp.	Meter Vac.
C 1	0	14:00		193	1.3	1.7	318.416	100	97	235	64	6.5
	5.5			200	1.0	1.28	322.5	102	98	246	58	5.8
2	11			221	1.2	1.5	326.3	103	98	254	63	6.1
	16.5			~~218~~ 213	1.5	1.9	330.3	103	98	253	63	7
3	22		4.55	220	1.3	1.7	334.7	102	97	250	64	6.5
	27.5			215	1.3	1.7	339.0	102	97	249	64	6.5
4	33			210	1.1	1.4	343.4	102	96	248	65	6
	38.5			208	1.2	1.5	347.3	102	96	250	65	6.1
5	44			183	1.2	1.5	351.3	102	96	244	66	6.1
	49.5			181	1.1	1.4	355.3	101	95	241	65	6
6	55			160	1.1	1.4	359.2	98	94	237	65	6
	60.5			156	1.1	1.4	363.8	97	93	235	64	6
	66	~~15:15~~ 15:16			~~1.1~~	~~1.4~~	367.102					
D 1	66	15:21		163	1.1	1.4	367.102	89	90	237	65	6
	71.5			166	1.0	1.28	371.0	92	89	237	59	5.8
2	77		4.58	201	1.2	1.5	374.6	92	88	230	60	6.1
	82.5			210	1.2	1.5	378.3	91	87	227	61	6.1
3	88			~~195~~ 193	1.2	1.5	382.4	90	85	226	59	6.1
	93.5			193	1.4	1.7	386.1	90	84	225	60	6.3
4	99			190	1.2	1.5	390.7	91	85	225	60	6.1
	104.5			192	1.1	1.4	395.4	93	85	227	61	6.1
5	110			185	1.3	1.7	399.8	95	87	234	60	6.2
	115.5			182	1.2	1.5	403.8	96	87	232	60	6.1
6	121			175	1.1	1.4	407.7	94	87	233	59	6.1
	126.5			163	1.1	1.4	411.7	94	88	234	60	6.1

CHAIN OF CUSTODY INFORMATION

Container Number	Sample I.D.	Description
3	112	Imp 1 Cont.
4	113	Imp. 2,3 Cont.
5	114	Imp 4 Silica Gel
2	116	Acetone Wash
1	110	Filter

LEAK CHECK

Vacuum						
Rate						

IMPINGER VOLUMES

	Initial	Final
#1	100 ml	~~159~~ 129
#2	100 ml	110
#3	0 ml	4
#4		
#5		
#6		

NOZZLE SIZE	.198
METER BOX I.D.	#6
GAMMA	.9958
DELTA H@	1.7586
BAR. PRESS.	28.845
FILTER I.D.	91-1034
OPERATOR	C.F.

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

FACILITY RES TEST LOCATION #5 Electric Arc Furnace DATE 4/5/92

START TIME 8:45 POLLUTANT S. lica < 3.5 RUN I.D. RES-MMP-R1

Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp. Inlet	Meter Temp. Outlet	Filter Temp.	Imp. Temp.	Meter Vac
E 1	0	8:45		104	1.1	.5	81.752	52	51		48	2
	5.5			107	1.1	.5	83.8	53	52		50	2
2	11.0			116	1.4	.5	85.9	56	53		51	2
	16.5			117	1.5	.5	88.2	57	53		54	2
3	22		+.72	121	1.4	.5	90.5	58	54		55	2
	27.5			120	1.5	.5	92.6	62	57		57	2
4	33.			146	1.4	.5	95.0	61	56		58	2
	38.5			154	1.3	.5	97.1	62	57		51	2
5	44.			185	1.3	.5	99.5	64	55		51	3
	49.5			170	1.2	.5	101.7	65	60		50	3
6	55.			185	1.2	.5	103.5	67	61		50	3
	60.5	9:51		188	1.1	.5	106.1	68	62		50	3
D 1	66.	9:58		164	1.1	.5	108.297	71	65		50	3
	71.5			178	.95	.5	110.5	75	68		52	3
2	77.			194	1.3	.5	112.7	75	71		55	3
	82.5			201	1.3	.5	114.9	79	71		53	3
3	88.			205	1.4	.5	117.3	84	75		55	3
	93.5			206	1.3	.5	119.6	83	75		54	3
4	99.			209	1.1	.5	121.5	85	79		55	3
	104.5			209	1.4	.5	124.2	83	77		56	3
5	110.			203	1.2	.5	126.5	86	79		54	3
	115.5			210	1.1	.5	128.8	95	79		53	3
6	121.		+.61	212	1.2	.5	131.1	84	80		60	3
	126.5			200	1.2	.5	133.4	83	79		55	3
A 1	132.						135.651					

CHAIN OF CUSTODY INFORMATION

Container Number	Sample I.D.	Description
200	1	FILTER
201	2	PROBE WASH
202	3	Impinger Catches
203	4	Silica Gel

LEAK CHECK

Vacuum	8				
Rate	.010				

IMPINGER VOLUMES

	Initial	Final
#1	100	100
#2	100	100
#3	0	0
#4		
#5		
#6		

NOZZLE SIZE	.150
METER BOX I.D.	#7
GAMMA	1.0031
DELTA H@	1.6781
BAR. PRESS.	28.85
FILTER I.D.	104
OPERATOR	Travis

RES

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

RUN I.D. RES -MImp-P 1

Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp Inlet	Meter Temp Outlet	Filter Temp.	Imp Temp	Meter Vac.
1	132	11:21		129	1.2	.5	135.745	74	75		60	3
	137.5			132	1.2	.5	137.949	69	73		54	3
2	143			140	1.4	.5	140.1	69	71		57	3
	148.5			184	1.3	.5	142.3	68	69		57	3
3	154		+.58	186	1.3	.5	144.4	66	66		50	3
	159.5			185	1.4	.5	146.6	74	69		56	3
4	165			189	1.4	.5	148.9	74	70		57	3
	170.5			193	1.3	.5	151.1	75	69		54	3
5	176			191	1.2	.5	153.3	77	71		54	3
	181.5			191	1.1	.5	155.7	76	71		53	3
6	187			193	1.2	.5	157.9	77	72		54	3
	192.5			191	1.2	.5	159.2	82	75		57	3
B 1	198	12:40		131	1.5	.5	162.613	76	74		60	3
	203.5			134	1.5	.5	164.8	75	74		55	3
2	209		+.74	178	1.3	.5	170.1	75	74		57	3
	214.5			182	1.7	.5	169.3	78	75		61	3
3	220			184	1.5	.5	170.5	79	75		61	3
	225.5			184	1.6	.5	172.7	80	75		62	3
4	231			190	1.4	.5	175.9	82	77		61	3
	236.5			191	1.4	.5	178.3	84	79		60	3
5	242			190	1.3	.5	180.6	87	80		60	3
	247.5			190	1.2	.5	182.8	87	80		57	3
6	253			187	1.3	.5	185.0	91	84		55	3
	258.5			189	1.4	.5	187.5	89	84		54	3
	264	13:46					189.909					

LEAK CHECK

Vacuum	6	6			
Rate	.006	.008			

4/9/92

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

FACILITY RES TEST LOCATION #5 Electric Arc Furnace DATE 4/10/92

START TIME 8:45 POLLUTANT Silica < 3.5 μ RUN I.D. RES-MIMP-R2

Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp. Inlet	Meter Temp. Outlet	Filter Temp.	Imp. Temp.	Meter Vac.
1	0	8:45		131	1.2	.5	197.899	72	72		55	2
	5.5			133	1.1	.5	200.2	83	81		55	2
2	11		+.77	171	1.5	.5	202.4	84	81		54	2
	16.5			175	1.4	.5	204.7	87	84		53	2
3	22			184	1.4	.5	207.1	87	85		53	2
	27.5			183	1.6	.5	209.4	91	87		55	2
4	33			185	1.3	.5	211.7	93	91		54	2
	38.5			197	1.2	.5	214.2	92	91		54	2
5	44			195	1.3	.5	216.5	91	94		54	2
	48.5			188	1.4	.5	218.5	95	96		57	2
6	55			199	1.2	.5	220.8	100	98		57	2
	60.5			201	1.1	.5	223.2	100	100		56	2
1	66	9:51/9:58		141	1.2	.5	225.591	101	99		54	2
	71.5			144	1.1	.5	227.9	101	97		54	2
2	77			195	1.6	.5	230.3	100	95		52	2
	82.5			211	1.5	.5	232.6	102	96		53	2
3	88		+.81	222	1.5	.5	234.9	101	96		52	2
	93.5			224	1.4	.5	237.3	96	91		49	2
4	99			221	1.4	.5	239.6	93	92		53	2
	104.4			264	1.5	.5	241.9	96	95		54	2
5	110			208	1.2	.5	244.2	96	95		54	2
	115.5			209	1.3	.5	246.5	97	95		54	2
6	121			211	1.2	.5	248.7	97	95		54	2
	126.5			185	1.	.5	251.0	86	92		57	2
	132	11:04					253.300					

CHAIN OF CUSTODY INFORMATION

Container Number	Sample I.D.	Description
1	204	Filter
2	205	acetone Rinse
3	206	Impinger Catch
4	207	Silica Gel

LEAK CHECK

Vacuum	8				
Rate	.005				

IMPINGER VOLUMES

	Initial	Final
#1	100	122
#2	100	100
#3	0	0
#4	Silica	Gel
#5		
#6		

NOZZLE SIZE	.150
METER BOX I.D.	7
GAMMA	1.0051
DELTA H@	1.6781
BAR. PRESS.:	24.865
FILTER I.D.	105
OPERATOR	Travis

O_2 - 20.49

CO_2 - .41

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

RUN I.D. RES -MIM-R 2

Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp Inlet	Meter Temp Outlet	Filter Temp.	Imp Temp.	Meter Vac.
1	132	11:18		175	1.0	.5	253.362	88	90		52	2
2	137.5			183	1.1	.5	255.7	85	89		53	2
2	143			196	1.3	.5	258.0	90	91		55	2
3	148.5		+.54	200	1.4	.5	260.2	91	92		54	2
3	154			224	1.2	.5	262.5	82	86		57	2
	159.5			223	1.3	.5	264.8	84	88		57	2
4	165			222	1.3	.5	267.0	83	86		58	2
	170.5			209	1.5	.5	269.3	85	87		55	2
5	176			212	1.3	.5	271.6	86	87		56	2
	181.5			222	1.2	.5	273.9	85	87		57	2
6	187			205	1.1	.5	276.2	88	87		58	2
	192.5			195	1.2	.5	278.5	85	87		55	2
1	198	12:14 12:19		181	1.2	.5	280.824	85	87		60	2
	203.5			184	1.1	.5	283.1	85	86		56	2
2	209			215	1.4	.5	285.4	85	88		58	2
	214.5			222	1.3	.5	287.8	94	91		59	2
3	220		+.73	220	1.2	.5	290.1	90	85		58	2
	225.5			232	1.3	.5	292.4	92	89		60	2
4	231			233	1.4	.5	294.7	97	93		59	2
	236.5			194	1.4	.5	297.1	99	95		60	2
5	242			222	1.1	.5	299.4	94	95		61	2
	247.5			233	1.3	.5	301.7	96	95		60	2
6	253			206	1.4	.5	304.2	96	95		61	2
	258.5			209	1.2	.5	306.5	94	96		60	2
	264	13:25					308.922					

LEAK CHECK

Vacuum	5	5			
Rate	.004	.005			

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

PAGE 1

FACILITY RES TEST LOCATION #5 Electric Arc Furnace DATE 4/20/91

START TIME 14:10 POLLUTANT Silica < 3.5 A RUN I.D. RES-M IMP-R 3

	Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp. Inlet	Meter Temp. Outlet	Filter Temp.	Imp. Temp.	Meter Vac.
B	1	0	14:10		212	1.2	.5	309.287	93	92		54	2
		5.5			217	1.2	.5	311.5	100	95		55	2
	2	11			203	1.3	.5	313.8	102	96		54	2
		16.5			208	1.4	.5	316.1	104	97		54	2
	3	22			214	1.4	.5	318.4	103	97		54	2
		27.5			221	1.5	.5	320.7	107	100		54	2
	4	33		+.52	206	1.3	.5	323.2	105	100		54	2
		38.5			197	1.3	.5	325.5	105	100		55	2
	5	44			185	1.4	.5	327.9	106	100		55	2
		49.5			173	1.5	.5	330.2	107	100		57	2
	6	55			181	1.2	.5	332.5	103	100		57	2
		60.5			179	1.4	.5	334.8	101	99		58	2
A	1	66	15:16/15:00		192	1.1	.5	337.114	96	97		56	2
		71.5	/		191	1.2	.5	339.4	97	97		58	2
	2	77			212	1.3	.5	341.8	97	96		57	2
		82.5			217	1.4	.5	344.2	98	96		58	2
	3	88			201	1.6	.5	346.5	101	96		53	2
		93.5			201	1.4	.5	348.9	101	97		53	2
	4	99			185	1.3	.5	351.2	105	99		54	2
		104.5			150	1.4	.5	353.6	104	99		54	2
	5	110		+.63	190	1.2	.5	355.9	105	99		53	2
		115.5			181	1.3	.5	358.4	102	97		55	2
	6	121			179	1.2	.5	360.8	99	95		55	2
		126.5			161	1.3	.5	363.2	97	95		58	2
		132	16:26					365.519					

CHAIN OF CUSTODY INFORMATION

Container Number	Sample I.D.	Description
1	208 ✓	~~208~~ Filter
2	209 ✓	Probe Wash
~~3~~	~~210~~	~~Impinger Catch~~
4	211	Silica Gel

LEAK CHECK

Vacuum	4	5			
Rate	.010	.008			

IMPINGER VOLUMES

	Initial	Final
#1	100	120
#2	100	100
#3	0	0
#4	Silica	Gel
#5		
#6		

NOZZLE SIZE	.150
METER BOX I.D.	7
GAMMA	1.0031
DELTA H@	1.6781
BAR. PRESS.:	29.345
FILTER I.D.	106
OPERATOR	Travis

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

RUN I.D. RES -M Imp-R 3

	Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp. Inlet	Meter Temp. Outlet	Filter Temp.	Imp. Temp.	Meter Vac.
B	1	132	16:33		181	1.3	.5	365.623	96	94		60	2
		137.5			192	1.1	.5	367.9	97	95		59	2
	2	143			224	1.6	.5	370.2	99	96		60	2
		148.5			223	1.5	.5	372.5	102	97		61	2
	3	154			222	1.3	.5	374.8	107	102		64	2
		159.5		+.66	224	1.5	.5	377.1	103	97		59	2
	4	165			195	1.5	.5	379.4	102	97		57	2
		170.5			214	1.6	.5	381.7	96	94		57	2
	5	176			210	1.5	.5	384.0	96	93		58	2
		181.5			194	1.4	.5	386.3	101	95		60	2
	6	187			198	1.3	.5	388.6	100	96		61	2
		192.5			188	1.4	.5	390.9	99	94		57	2
C	1	198	17:23 17:34		182	1.3	.5	393.2	99	96		58	2
		203.5			188	1.4	.5	395.5	100	96		59	2
	2	209			208	1.5	.5	397.8	97	94		57	2
	3	214.5			217	1.4	.5	400.1	97	95		57	2
	3	220			205	1.6	.5	402.6	101	96		58	2
		225.5			199	1.7	.5	404.5	96	94		59	2
	4	231			187	1.4	.5	407.2	93	91		60	2
		236.5			206	1.5	.5	409.5	92	90		60	2
	5	242			202	1.4	.5	411.8	93	91		61	2
		247.5		+.25	211	1.0	.5	414.1	90	87		61	2
	6	253			195	1.3	.5	416.4	90	87		61	2
		258.5			233	1.4	.5	418.7	86	85		61	2
		264	18:45					420.874					

LEAK CHECK

Vacuum	5	5			
Rate	.008	.008			

D

COMMONWEALTH OF VIRGINIA
Department of Air Pollution Control

INTRA-AGENCY MEMORANDUM

TO: REGIONAL FILES

FROM: John Lester

SUBJECT: STACK TEST RESULTS

DATE: Jan 11, 1994

Company/Locality: Roanoke Electric Steel
Registation No. : 20131
Test Date: 7-(21,20) 92
Process: #5 Electric Arc Furnace

Pollutants Measured	Test Methods
TSP	Method 5
VE	Method 9

Reason for Stack Test

PermitDate(s): Feb 26, 1991
CA&O Date(s): Other: Retest

Stack Test Company/Personnel: ETS/Roanoke

DEQ Witnesses: Ray Goetz

Source Personnel: Bill Warwick
Karen Bates

Source Operation:

	During Test	Allowable	% of Allowable
Thruput tons/hr	60(±)	60 ±	100% ±
Thruput			
Thruput			

Process Operating Conditions: #5 EAF NEAR 100% thru-put VIA Subpart AAa of CFR

Emission Controls/Test Conditions: Dust Collector

Stack Sampling and Report:

Stack sampling details acceptable? yes Comments

Stack test report acceptable? yes Comments

TEST RESULTS:

POLLUTANT	MEASURED	ALLOWABLE	% OF ALLOW	PASS?
particulate lb/hr:	1.62	8.64	19%	yes
particulate grain/dscf:	.0007	.0052	13%	yes
particulate lb/mm btu:				
lb/hr:				
lb/hr:				
:				
:				
:				
:				
:				
% opacity:				

Comments: Retest passes for permit Feb 26, 91

CONCLUSION: PASS/FAIL/OTHER:

Sign/date: John F Lentz

REPORT CERTIFICATION

The sampling and analysis performed for this report were carried out under my direction and supervision.

DATE: Aug. 3, 1992

SIGNATURE: Chris Ferguson

Chris Ferguson
Test Team Leader
ETS, Inc.

I have reviewed all testing details and results in this report and hereby certify that the test report is authentic and accurate.

DATE: 8/3/92

SIGNATURE: C. X. Sharp

Cy X. Sharp
Operations Manager
ETS, Inc.

I have reviewed all testing details and results in this report and hereby certify that the test report is authentic and accurate.

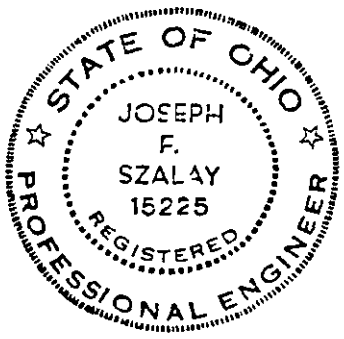
DATE: 8-03-92

SIGNATURE: Joseph F. Szalay

Joseph F. Szalay

P.E.: E-015225

STATE OF: Ohio



1.0 INTRODUCTION

1.1 Background: Air emissions testing was performed on the #5 electric arc furnace baghouse stack outlet at Roanoke Electric Steel Corporation on July 20 through 21, 1992. Sampling was conducted by Chris Ferguson and Ross Roberson of ETS, Inc. Visible emissions evaluations were performed by Walter Laing of ETS, Inc. Process coordination was provided by Bill Warwick and Karen Bates of Roanoke Electric Steel. Ray Goetz of the Virginia Department of Air Pollution Control witnessed the test program.

1.2 Objective: The purpose of testing was to evaluate the compliance of the #5 electric arc furnace pollution control system with respect to the following emissions:

- total suspended particulate (TSP)
- opacity of visible emissions.

1.3 Test Program: The test program included three series of measurements for each pollutant. Particulate sampling was conducted in accordance with EPA Method 5D and Subpart AAa of 40 CFR 60. The opacity of the visible emissions was determined in accordance with EPA Reference 9.

All of the tests were performed concurrently at the baghouse stack outlet. Three valid test runs were performed for each pollutant. Each test run for total particulate and opacity was conducted over an integral number of furnace heats (minimum of four hours total duration), as required by Subpart AAa. Appendix

A contains a test log which includes the exact times for each test run.

2.0 SUMMARY OF RESULTS

Table I summarizes the results of the particulate and opacity tests. Appendix B contains detailed flow measurement and particulate results. Appendix C contains the opacity data and results. Furnace operating data collected throughout the test program is included in Appendix I.

The particulate emissions averaged 0.0007 grains per dry standard cubic foot (gr/dscf) at a mass rate of 1.62 pounds per hour (lb/hr). Visible emissions averaged 0% for the entire test program.

3.0 SAMPLING AND ANALYTICAL PROCEDURES

All sampling and analytical procedures followed those recommended by the U.S. Environmental Protection Agency (EPA), Title 40, Part 60, Appendix A of the Code of Federal Regulations (40 CFR 60), or other methods generally accepted by the EPA. The following specific methods were used:

EPA Method 1 for determination of sampling and traverse points;

EPA Method 2 for flue gas velocity and volumetric flow rate;

EPA Method 3 for flue gas composition and molecular weight;

EPA Method 4 for flue gas moisture content;

EPA Method 5 (with the appropriate provisions required by 40 CFR 60, Subpart AAa) for determination of total particulate emissions;

EPA Method 9 for determination of opacity of visible emissions.

Appendices E through F contain all of the field sampling data. Laboratory data for the analyses are contained in Appendix G.

3.1 Sampling Procedures

3.1.1 Sampling Point Determination - EPA Method 1: Outlet sampling was conducted in the stack breeching duct, a 132-inch inside diameter round duct. A total of 24 sampling and traverse points (6 for each of four ports) were utilized for all particulate sampling, gas flow rate measurements. Figure 1 shows the location of the outlet sampling and traverse points.

3.1.2 Volumetric Measurements - EPA Method 2: EPA Reference Method 2 was used to determine the velocity and volumetric flow rates of the stack gases. Stainless steel Type-S pitot tubes were used to measure the gas velocity heads. The pitot tubes were calibrated against a NBS traceable pitot tube in accordance with Method 2. Calibrated Type-K thermocouples were used to determine gas temperatures.

Velocity and temperature measurements were made at each of the 24 traverse points as shown in Figure 1. These measurements were performed in conjunction with the particulate sampling described below.

3.1.3 Molecular Weight Determination - EPA Method 3: The average molecular weight according to Method 3 was 28.84 for the stack gases.

3.1.4 Flue Gas Moisture Content - EPA Method 4: The flue gas moisture was measured in conjunction with each of the pollutant tests according to the sampling and analytical procedures outlined in EPA Method 4. The flue gas moisture for each test was determined by gravimetric analyses of the water collected in the impinger condensers of the pollutant sampling train. All impingers were contained in an ice bath throughout the testing in order to assure complete condensation of the moisture in the flue gas stream. Any moisture which was not condensed in the impingers was captured in the silica gel contained in the final impinger.

3.1.5 Total Suspended Particulate - EPA Method 5: Sampling for total particulate was performed in accordance with EPA Method 5 and Subpart AAa of 40 CFR 60.

3.1.5.1 Sampling Train Description: Figure 2 shows the major components of the particulate sampling train. Stack gas was pulled through a Teflon-lined stainless steel liner equipped with a stainless steel nozzle, sized appropriately for isokinetic sample withdrawal. After passing through the liner, the sample gases were passed through a heated fiberglass filter, and into an impinger train consisting of four glass impingers immersed in an

ice bath. The first two impingers initially each contained 100 milliliters of deionized, distilled water. The third impinger was initially empty, and the fourth initially contained approximately 200 grams of silica gel.

3.1.5.2 Sampling Train Operation: Sampling was done in accordance with EPA Method 5 procedures and specifications, including leak checking, isokinetic sampling rate and stack traversing. According to the specifications outlined in Subpart AAa, a minimum of four hours sampling time is required on electric arc furnaces. Other criteria outlined in the subpart required an integral number of heats to be sampled, and a minimum sampling volume of 160 dry standard cubic feet. During the sampling runs, sampling was conducted for 11 minutes at each of the 24 traverse points, resulting in a 264-minute test per run, excluding the time required to change ports. Isokinetic adjustments were made twice per sampling point, or once every 5.5 minutes.

3.1.5.3 Sample Recovery and Clean-up: Recovery of the Method 5 sampling nozzle and liner was accomplished using a teflon-fiber probe brush. Each was rinsed with acetone three times and brushed between rinsings. Exposed filters were placed into petri dishes, which were then sealed with Teflon tape. The impinger contents were measured for moisture gain and discarded. The silica gel from the fourth impinger was transferred back to its original Nalgene container. The amount of moisture collected

in the sampling train was quantified in order to determine the stack gas moisture content in accordance with EPA Method 4.

3.1.6 Opacity of Visible Emissions - EPA Method 9: Three visible emissions evaluation runs were conducted simultaneously with the outlet particulate sampling runs, with readings taken once every 15 seconds. The visible emissions evaluations were conducted in accordance with EPA Reference Method 9 by an EPA-certified observer.

3.2 Analytical Procedures

3.2.1 Particulate Analysis - EPA Method 5: Particulate concentrations were determined in accordance with EPA Method 5. Each filter was analyzed gravimetrically to a constant weight. Each front half acetone rinse was evaporated and analyzed gravimetrically to a constant weight. The total suspended particulate catch equals the sum of the front half acetone rinse plus the filter weight. Appendix G contains the laboratory data for the particulate tests.

3.3 Data Analysis: All calculations related to particulate sampling, including gas flow rates, temperatures, percent isokinetics, and moisture content are shown in Appendix D.

3.4 Equipment Calibration: Field equipment was calibrated in accordance with the requirements of the applicable EPA Methods and those recommended within the "Quality Assurance Handbook for

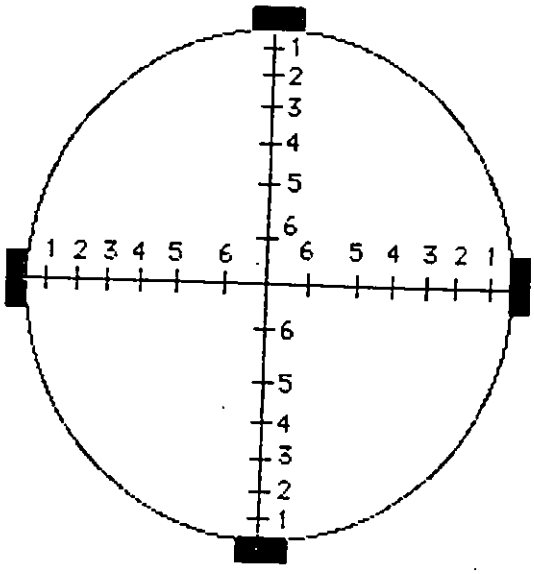
Air Pollution Measurement Systems: Volume III" (EPA-600/4-77-027b, August, 1977). Appendix H contains records for all of the calibrations.

TABLE I

ROANOKE ELECTRIC STEEL

SUMMARY OF PARTICULATE AND VISIBLE EMISSIONS

RUN I.D.	U4B-M5D-R1	U4B-M5D-R3	U4B-M5D-R4	AVERAGE
DATE	07/20/92	07/21/92	07/21/92	
TIME STARTED	10:35	10:16	15:55	
TIME ENDED	15:18	14:59	20:32	
SAMPLING PARAMETERS				
Metered Volume - dcf	177.940	177.503	181.705	179.049
Corrected Volume - dscf	164.690	164.504	169.985	166.393
Total Test Time - min	264	264	264	264
% Isokinetics	97.0	93.0	94.6	94.9
GAS PARAMETERS				
Gas Temperature - oF	213.4	214.4	209.8	212.5
Oxygen - %	20.9	20.9	20.9	20.9
Carbon Dioxide - %	0.0	0.0	0.0	0.0
Moisture - %	2.71	0.50	2.05	1.75
GAS FLOWRATE				
Velocity - ft/sec	64.64	64.72	66.30	65.22
Actual Volume - acfm	368561	369030	378046	371879
Standard Volume - dscfm	272087	283422	287822	281110
PARTICULATE EMISSIONS				
Concentration - gr/dscf	0.0009	0.0006	0.0006	0.0007
Mass Rate - lb/hr	2.02	1.47	1.37	1.62
METHOD 9 - VISIBLE EMISSIONS				
Percent - %	0.0%	0.0%	0.0%	0.0%



Point	%ID	Distance from Inside of Port (Inches)
1	2.1	2.8
2	6.7	8.8
3	11.8	15.6
4	17.7	23.4
5	25.0	33.0
6	35.6	47.0

Inside Stack Diameter	132 In.	11.0 ft.

Figure 1 - Sampling and Traverse Point Locations

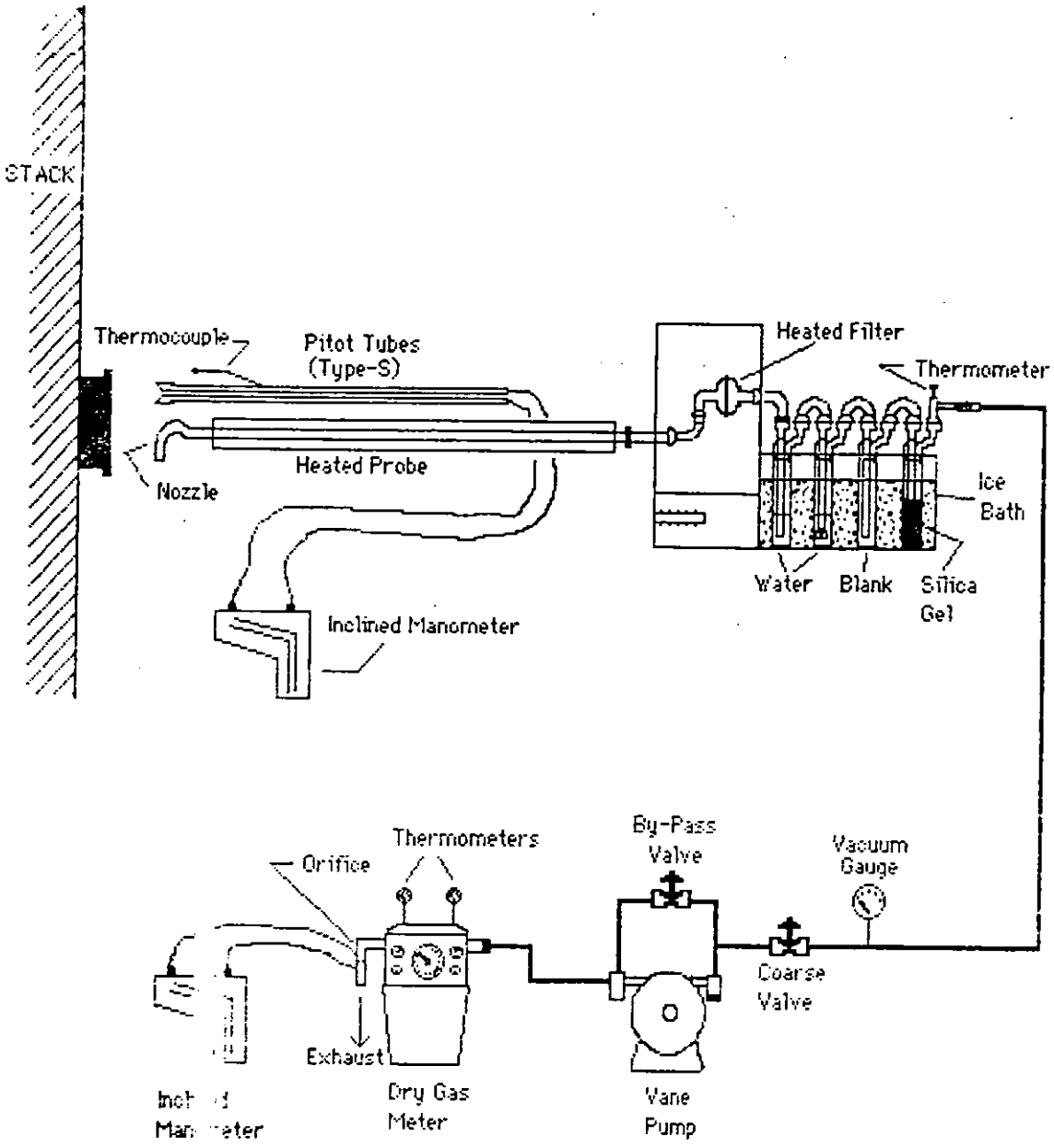


Figure 2 - EPA Method 5 Sampling Train

ROANOKE ELECTRIC STEEL

TEST LOG

RUN I.D.	DATE	START TIME	END TIME	COMMENTS
U4B-M5D-R1	07/20/92	10:35	15:18	
U4B-M5D-R2	07/20/92	15:55	18:05	Run Voided*
U4B-M5D-R3	07/21/92	10:16	14:59	
U4B-M5D-R3	07/21/92	15:55	20:32	
U4B-M9-R1	07/20/92	10:35	15:18	
U4B-M9-R2	07/20/92	16:00	18:05	Run Voided*
U4B-M9-R3	07/21/92	10:16	14:59	
U4B-M9-R3	07/21/92	15:55	20:32	

* Run voided due to plant shut down.

RUN NUMBER	U4B-M5D-R1					
DATE	07/20/92					
START TIME	10:35					
END TIME	15:18		METHOD 4 DATA			
STACK DIAM.	132	inches		INIT.	FINAL	NET
NOZZLE I.D.	0.203	inches		(ml)	(ml)	(ml)
METER BOX GAMMA	0.9923		IMP.1	100.0	153.0	53.0
METER BOX dH@	1.8357		IMP.2	100.0	97.0	-3.0
BAROMETRIC	28.99	in.Hg	IMP.3	0.0	15.0	15.0
Cp	0.84		IMP.4			0.0
TEST DURATION	264	minutes	IMP.5			0.0
			IMP.6			0.0
			IMP.7			0.0
METHOD 1-4 RESULTS			TOTAL	200.0	265.0	65.0
Metered Volume	177.940	dcf	S.G.	200.0	232.4	32.4
Volume @ Std.Cond.	164.690	dscf				
% Water	2.71	%	METHOD 3 DATA			
% Isokinetics	97.0	%	%O2	20.9	Md	28.84
Velocity	64.64	ft/sec	%CO2	0.0	Ms	28.54
Actual Flow	368561	acfm	%CO	0.0	Ps	28.95
Std. Flow	279662	scfm	%N2	79.1		
Dry Std. Flow	272087	dscfm	O2+CO2	20.9		

	STACK TEMP	STATIC	DP	DH	METER VOLUME	METER TEMPERATURE INLET	OUTLET
POINT	(DegF)	(in.WC)	(in.WC)	(in.WC)	(dcf)	(DegF)	(DegF)
1	179	-0.48	0.80	1.15	220.447	89	81
2	196	-0.46	0.87	1.23		93	80
3	218	-0.65	1.20	1.68		95	81
4	224	-0.44	1.20	1.68		100	83
5	223	-0.47	1.10	1.58		98	80
6	226	-0.52	1.10	1.58		94	83
7	226		1.10	1.58		94	83
8	234		1.00	1.40		92	83
9	197		0.92	1.30		95	83
10	229		0.95	1.38		94	84
11	238		0.95	1.38		99	85
12	222		0.96	1.39		98	85
13	198		1.00	1.40		89	85
14	195		1.00	1.40		94	85
15	176		1.30	1.80		99	85
16	200		1.10	1.58		102	87
17	219		1.00	1.40		103	86
18	209		1.10	1.58		102	86
19	210		0.99	1.39		99	84
20	218		1.00	1.40		98	85
21	200		1.10	1.58		98	86
22	204		0.95	1.38		97	85
23	227		0.95	1.38		99	85
24	238		0.78	1.08		97	85
25	225		0.95	1.38		81	89
26	205		0.83	1.14		80	89
27	209		1.00	1.40		83	91
28	227		0.99	1.39		87	93
29	205		1.00	1.40		84	92
30	181		1.00	1.40		88	92
31	203		0.95	1.38		87	92
32	224		1.00	1.40		88	91
33	237		1.00	1.40		88	91
34	215		0.85	1.19		89	92
35	229		0.80	1.15		90	95
36	224		0.83	1.14		90	93
37	203		0.91	1.28		86	88
38	226		0.85	1.19		86	92
39	209		1.20	1.68		88	94
40	194		1.10	1.58		88	95
41	214		1.10	1.58		90	96
42	212		1.10	1.58		89	96
43	216		1.10	1.58		88	96
44	211		1.00	1.40		91	95
45	231		0.95	1.38		92	96
46	219		1.10	1.58		90	95
47	203		0.90	1.25		88	96
48	214		0.95	1.38		89	93
49					398.387		
AVG.	213	-0.50	1.00	1.42	177.940	90	

ANALYTICAL DATA

EPA METHOD 5 DATA
RUN NUMBER **U4B-M5D-R1**

COMPONENT	TARE (grams)	FINAL (grams)	NET (grams)	VOLUME (ml)
Probe Wash	64.45366	64.46289	0.00923	65.0
Corr. for Blank			0.00923	
Filter	0.42233	0.42233 (Filter lost mass)	0.00000	
Back Half	0.00000	0.00000	0.00000	
TOTAL			0.00923	

ACETONE BLANK

Actual Residue	0.00000 grams
Allowable Residue	0.00094 grams
Volume	100.0 ml

PARTICULATE EMISSIONS

Actual Grain Loading	0.00086	gr/dscf
Mass Rate	2.0171	lb/hr

SAMPLING QA/QC

Isokinetics	97.0	%
Corrected Meter Volume	164.690	dscf

RUN NUMBER	U4B-M5D-R3
DATE	07/21/92
START TIME	10:16
END TIME	14:59
STACK DIAM.	132 inches
NOZZLE I.D.	0.203 inches
METER BOX GAMMA	0.9923
METER BOX dH@	1.8357
BAROMETRIC	29.54 in.Hg
Cp	0.84
TEST DURATION	264 minutes

METHOD 1-4 RESULTS

Metered Volume	177.503	dcf
Volume @ Std.Cond.	164.504	dscf
% Water	0.50	%
% Isokinetics	93.0	%
Velocity	64.72	ft/sec
Actual Flow	369030	acfm
Std. Flow	284859	scfm
Dry Std. Flow	283422	dscfm

METHOD 4 DATA

	INIT. (ml)	FINAL (ml)	NET (ml)
IMP.1	100.0	58.0	-42.0
IMP.2	100.0	128.0	28.0
IMP.3	0.0	6.0	6.0
IMP.4			0.0
IMP.5			0.0
IMP.6			0.0
IMP.7			0.0
TOTAL	200.0	192.0	-8.0
S.G.	200.0	225.7	25.7

METHOD 3 DATA

%O2	20.9	Md	28.84
%CO2	0.0	Ms	28.78
%CO	0.0	Ps	29.50
%N2	79.1		
O2+CO2	20.9		

POINT	STACK TEMP (DegF)	STATIC (in.WC)	DP (in.WC)	DH (in.WC)	METER VOLUME (dcf)	METER TEMPERATURE INLET (DegF)	METER TEMPERATURE OUTLET (DegF)
1	154	-0.44	0.83	1.12	484.884	81	81
2	174	-0.49	0.85	1.15		83	81
3	224	-0.50	1.00	1.36		86	83
4	235	-0.69	0.97	1.31		89	84
5	240		1.00	1.36		92	85
6	218		1.00	1.36		94	87
7	212		1.00	1.36		96	87
8	221		1.00	1.36		98	89
9	212		0.89	1.20		98	89
10	227		0.96	1.30		98	89
11	217		0.88	1.19		98	90
12	222		0.87	1.18		98	90
13	197		1.00	1.36		96	93
14	184		1.10	1.46		101	95
15	199		1.20	1.57		103	96
16	211		1.20	1.57		104	97
17	208		1.20	1.57		104	97
18	224		1.10	1.46		105	97
19	232		1.00	1.36		105	97
20	232		1.00	1.36		105	98
21	211		1.10	1.46		104	97
22	229		0.97	1.28		105	98
23	240		1.00	1.36		105	98
24	231		0.93	1.24		105	99
25	226		1.00	1.36		100	99
26	224		1.00	1.36		102	99
27	211		1.20	1.57		103	98
28	193		1.30	1.74		106	100
29	184		1.10	1.46		107	100
30	176		1.00	1.36		108	101
31	176		1.00	1.36		108	101
32	203		1.00	1.36		109	102
33	214		1.00	1.36		109	102
34	206		0.98	1.32		110	103
35	216		1.00	1.36		110	103
36	223		0.98	1.32		109	103
37	200		1.00	1.36		102	102
38	212		0.98	1.32		107	103
39	229		1.10	1.46		109	104
40	236		1.20	1.57		108	103
41	199		1.30	1.74		108	102
42	213		1.10	1.46		109	102
43	229		1.00	1.36		109	102
44	231		1.10	1.46		108	101
45	224		0.98	1.32		109	102
46	236		1.00	1.36		112	104
47	237		0.90	1.18		113	104
48	241		0.94	1.28		114	106
49							
AVG.	214	-0.53	1.03	1.38	662.387		
					177.503	100	

ANALYTICAL DATA

EPA METHOD 5 DATA
RUN NUMBER U4B-M5D-R3

COMPONENT	TARE (grams)	FINAL (grams)	NET (grams)	VOLUME (ml)
Probe Wash	64.63679	64.64322	0.00643	100.0
Corr. for Blank			0.00643	
Filter	0.40504	0.40504 (Filter lost mass)	0.00000	
Back Half	0.00000	0.00000	0.00000	
TOTAL			0.00643	

ACETONE BLANK

Actual Residue	0.00000	grams
Allowable Residue	0.00078	grams
Volume	100.0	ml

PARTICULATE EMISSIONS

Actual Grain Loading	0.00060	gr/dscf
Mass Rate	1.4654	lb/hr

SAMPLING QA/QC

Isokinetics	93.0	%
Corrected Meter Volume	164.504	dscf

RUN NUMBER	U4B-M5D-R4		
DATE	07/21/92		
START TIME	15:55		
END TIME	20:32		
STACK DIAM.	132	inches	
NOZZLE I.D.	0.203	inches	
METER BOX GAMMA	0.9923		
METER BOX dH@	1.8357		
BAROMETRIC	29.54	in.Hg	
Cp	0.84		
TEST DURATION	264	minutes	

METHOD 4 DATA

	INIT. (ml)	FINAL (ml)	NET (ml)
IMP.1	100.0	138.0	38.0
IMP.2	100.0	113.0	13.0
IMP.3	0.0	1.0	1.0
IMP.4			0.0
IMP.5			0.0
IMP.6			0.0
IMP.7			0.0
TOTAL	200.0	252.0	52.0
S.G.	200.0	223.6	23.6

METHOD 1-4 RESULTS

Metered Volume	181.705	dcf
Volume @ Std.Cond.	169.985	dscf
% Water	2.05	%
% Isokinetics	94.6	%
Velocity	66.30	ft/sec
Actual Flow	378046	acfm
Std. Flow	293848	scfm
Dry Std. Flow	287822	dscfm

METHOD 3 DATA

%O2	20.9	Md	28.84
%CO2	0.0	Ms	28.61
%CO	0.0	Ps	29.50
%N2	79.1		
O2+CO2	20.9		

POINT	STACK TEMP (DegF)	STATIC (in.WC)	DP (in.WC)	DH (in.WC)	METER VOLUME (dcf)	METER TEMPERATURE INLET (DegF)	METER TEMPERATURE OUTLET (DegF)
1	184	-0.66	1.01	1.36	663.449	100	100
2	193	-0.57	1.20	1.24		102	101
3	221	-0.56	1.20	1.57		106	102
4	221	-0.39	1.31	1.74		104	100
5	191	-0.49	1.30	1.74		104	100
6	225		1.25	1.45		107	101
7	234		1.00	1.36		109	101
8	239		1.00	1.36		111	103
9	230		1.00	1.36		108	101
10	230		1.00	1.36		108	101
11	223		1.00	1.36		107	101
12	211		1.00	1.36		106	101
13	177		1.00	1.36		102	101
14	188		1.10	1.46		99	99
15	215		1.30	1.74		102	100
16	217		1.30	1.74		100	99
17	203		1.20	1.57		101	99
18	223		1.20	1.57		97	97
19	237		1.00	1.36		99	98
20	217		1.10	1.46		98	97
21	220		0.97	1.31		100	98
22	230		0.94	1.24		99	98
23	231		0.98	1.32		101	99
24	222		1.00	1.36		97	95
25	179		1.00	1.36		89	89
26	161		0.94	1.24		85	87
27	210		1.20	1.57		84	86
28	215		1.30	1.74		82	84
29	199		1.30	1.74		83	83
30	169		1.20	1.57		84	83
31	196		1.10	1.46		87	83
32	217		1.10	1.46		86	84
33	225		1.00	1.36		88	84
34	231		1.00	1.36		87	84
35	228		0.96	1.30		90	86
36	231		1.00	1.36		90	86
37	185		1.00	1.36		89	88
38	171		1.00	1.36		91	88
39	175		1.00	1.36		92	89
40	205		1.00	1.36		93	89
41	200		1.10	1.46		90	88
42	208		1.20	1.57		90	88
43	209		1.10	1.46		92	89
44	214		1.00	1.36		94	90
45	209		1.00	1.36		93	90
46	217		0.97	1.31		94	90
47	224		0.89	1.22		95	91
48	209		1.00	1.36		94	91
49					845.154		
AVG.	210	-0.53	1.08	1.43	181.705	95	

ANALYTICAL DATA

EPA METHOD 5 DATA
RUN NUMBER U4B-M5D-R4

COMPONENT	TARE (grams)	FINAL (grams)	NET (grams)	VOLUME (ml)
Probe Wash	65.52576	65.53187	0.00611	80.0
Corr. for Blank			0.00611	
Filter	0.40549	0.40549	0.00000	
		(Filter lost mass)		
Back Half	0.00000	0.00000	0.00000	
TOTAL			0.00611	

ACETONE BLANK

Actual Residue	0.00000	grams
Allowable Residue	0.00078	grams
Volume	100.0	ml

PARTICULATE EMISSIONS

Actual Grain Loading	0.00055	gr/dscf
Mass Rate	1.3685	lb/hr

SAMPLING QA/QC

Isokinetics	94.6	%
Corrected Meter Volume	169.985	dscf

CALCULATIONS EPA METHODS 1-4

The meter volume at standard conditions (1 atm and 68 °F) is:

$$V_{m(std)} = V_m \times \gamma \times 17.64 \times \left[\frac{P_B + \frac{\Delta H}{13.6}}{T_m + 460} \right] \quad (1)$$

where V_m is the volume of gas sampled through the dry gas meter - dcf.
$V_{m(std)}$ is the gas sample volume corrected to standard conditions (68 °F, 1 atm) - dscf.
γ is the DGM calibration factor.
ΔH is the average DGM differential orifice pressure - in W.C.

The conversion from the amount of liquid water collected in the impingers and silica gel to an equivalent gas-phase, ideal gas volume respectively are:

$$V_{WC(std)} = (v_f - v_i) \times 0.04707 \quad (2)$$

$$V_{wsg(std)} = (w_f - w_i) \times 0.04715 \quad (3)$$

where $V_{wc(std)}$ is the gas-phase water volume of the impinger catch at standard conditions - scf.
$V_{wsg(std)}$ is the gas-phase water volumes of the silica gel absorbtion at standard conditions - scf.
v_i is the initial total impinger liquid volume - ml.
v_f is the final total impinger liquid volume - ml.
w_i is the initial silica gel weight - grams.
w_f is the final silica gel weight - grams.
0.04707 is the conversion from mls of liquid water to scf for an ideal gas at standard conditions.
0.04715 is the conversion from grams water to scf for an ideal gas at standard conditions.

The volume fraction of water vapor within the gas, B_{ws}, is:

$$B_{ws} = \frac{V_{wc(std)} + V_{wsg(std)}}{V_{wc(std)} + V_{wsg(std)} + V_{m(std)}} \quad (4)$$

Percent water within the gas-phase is given by:

$$\%H_2O = B_{ws} \times 100 \quad (5)$$

The absolute stack pressure, P_s (in inches Hg), is:

$$P_s = P_B + \frac{P_{static}}{13.6} \quad (6)$$

where P_B is the absolute barometric pressure - in. Hg
P_{static} is the stack static pressure - in. W.C.
13.6 convertes in. W.C. to in. Hg.

The nitrogen content, $\%N_2$, in percent dry basis of the stack gas is:

$$\%N_2 = 100 - (\%CO_2 + \%O_2 + \%CO) \quad (7)$$

where all gas percentages are on a dry basis.

Calculation of gas-phase dry molecular weight, M_d is:

$$M_d = 0.44 \times \%CO_2 + 0.32 \times \%O_2 + 0.28 \times (\%N_2 + \%CO) \quad (8)$$

Calculation to determine wet molecular weight, M_s, is:

$$M_s = M_d \times (1 - B_{ws}) + 18 \times B_{ws} \quad (9)$$

Fuel Factor determination is as follows:

$$F_o = \frac{20.9 - \%O_2}{\%CO_2} \quad (10)$$

Stack gas velocity, v_s (ft/s), determination is as follows:

$$v_s = 85.49 \times C_p \times (\Delta P)^{\frac{1}{2}}_{avg} \times \frac{(T_s + 460)^{\frac{1}{2}}}{(P_s \times M_s)^{\frac{1}{2}}} \quad (11)$$

where C_p is the pitot tube coefficient.
T_s is stack gas temperature - °F.
ΔP is pitot differential pressure - in W.C.

Stack area, A_s (ft^2), is determined from the following:

$$A_s = \frac{\pi \times D^2}{4 \times 144} \quad (12)$$

where D is the stack diameter (inches).
4 converts squared diameter to squared radius.
144 square inches in 1 square foot.

The actual gas flow rate, Q_a (acfm), is:

$$Q_a = v_s \times A_s \times 60 \quad (13)$$

The gas flow rate corrected to standard conditions (68°F, 1 Atm), Q_s (scfm):

$$Q_s = Q_a \times \left[\frac{P_s \times 528R}{(T_s + 460) \times 29.92 in.Hg} \right] \quad (14)$$

The dry standard gas flow rate, Q_{sd} (dscfm), is:

$$Q_{sd} = Q_s \times (1 - B_{ws}) \quad (15)$$

Percent excess air, %EA, is calculated by:

$$\%EA = \frac{\%O_2 - 0.5\%CO}{0.264\%N_2 - (\%O_2 - 0.5\%CO)} \times 100 \quad (16)$$

where $\%O_2$ is the dry volume percent of oxygen in the flue gas.
%CO is the dry volume percent of carbon monoxide in the flue gas.
$\%N_2$ is the dry volume percent of nitrogen in the flue gas.
0.264 is the ratio of O_2 to N_2 in air, v/v.

PARTICULATE EMISSION CALCULATIONS

Particulate emission concentrations are calculated by:

$$C_{sd} = \frac{15.43}{V_{m(std)}} \times \sum_{i}^{n} m_i \qquad (1$$

where C_{sd} is the particulate concentration - grains/dscf.
Σm_i is particulate mass gained in sampling train - grams.
15.43 is a conversion factor - grains/grams

Correcting particulate concentration to 7% O_2 is done by:

$$C_{sd@7\%} = C_{sd} \times \frac{20.9 - 7.0}{20.9 - \%O_2} \qquad (2$$

where $C_{sd@7\%}$ is the particulate concentration at 7% O_2 - grains/dscf
$\%O_2$ is the percent volume of oxygen within the flue gas.

Correcting particulate concentration to 12% CO_2 involves:

$$C_{sd@12\%} = C_{sd} \times \frac{12}{\%CO_2} \qquad (3$$

where $C_{sd@12\%}$ is the particulate concentration at 12% CO_2 - grains/dscf.
$\%CO_2$ is the volume percent of carbon dioxide in the flue gas.

The particulate concentration corrected to 50% excess air is:

$$C_{sd@50\%EA} = C_{sd} \times \frac{100 + \%EA}{150} \qquad (4)$$

where $C_{sd@50\%}$ is concentration at 50% excess air - grains/dscf.
%EA is volume percent excess air.

The mass emissions rate on a time basis is calculated by:

$$M_p = \frac{C_{sd} \times Q_{sd} \times 60}{7000} \quad (5)$$

where M_p is the time based mass particulate emissions rate - lb/hr
Q_{sd} is the standardized volumetric - dscfm
60 is a conversion factor - min/hr
7000 is a conversion factor - grains/lb

Mass emissions based upon fuel usage is calculated by:

$$M_{pf} = \frac{C_{sd} \times Q_s \times F_d}{7000} \times \frac{20.9}{(20.9 - \%O_2)} \quad (6)$$

where M_{pf} fuel based particulate mass emissions - lb/MMBtu
20.9 is ambient volumetric percent oxygen - %
F_d is the dry basis fuel factor - dscf/MMBtu

Percent Isokinetics (%Iso) are derived by the following:

$$\%Iso = \frac{0.09450 \times (T_s + 460) \times V_{m(std)}}{P_s \times v_s \times A_n \times time \times (1 - B_{ws})} \quad (7)$$

where T_s is the stack temperature - °F
$V_{m(std)}$ is the standardized sample volume - dscf
P_s is the average stack pressure - in. Hg
v_s is average stack gas velocity - ft/s
A_n is the nozzle cross section area - ft^2
time is defined as the net Method 5 sampling time - min
B_{ws} is volumetric water vapor fraction of the flue gas
460 converts degrees Fahrenheit to Rankine.

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

FACILITY Roanoke Electric Steel TEST LOCATION #4 Baghouse Stack DATE 07-20-92

START TIME 10:35 POLLUTANT Particulate RUN I.D. #405-M5B-R1

	Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp. Inlet	Meter Temp. Outlet	Filter Temp.	Imp. Temp.	Meter Vac.
C	1	0	10:35		179	.80	1.15	220.447	81	81	250	60	2.5
		5.5			~~196~~ 175	.87	1.23	223.9	80	80	245	54	2.5
	2	11		-.48	218	1.2	1.68	227.3	83	81	247	51	3
		16.5			224	1.2	1.68	231.3	87	83	246	51	3
	3	22			223	1.1	1.58	235.3	84	80	247	52	3
		27.5			226	1.1	1.58	239.4	88	83	247	54	3
	4	33			226	1.1	1.58	243.3	87	83	248	54	3
		38.5			234	1.0	1.40	247.2	88	83	248	55	2.8
	5	44			197	.92	1.30	250.9	88	83	247	55	2.8
		49.5			229	.95	1.38	254.6	89	84	251	53	2.8
	6	55		-.46	238	~~.95~~	1.38	258.2	90	85	248	53	2.8
		60.5			232	.96	1.39	261.9	90	85	248	53	2.8
		66	11:41					265.528					
D	1	66	11:48		198	1.0	1.40	265.528	86	85	250	58	2.8
		71.5			195	1.0	1.40	269.1	86	85	252	56	2.8
	2	77			176	1.3	1.80	272.9	88	85	250	55	3.1
		82.5			200	1.1	1.58	277.0	88	87	252	55	2.8
	3	88		-.65	219	1.0	1.40	281.0	90	86	244	54	2.8
		93.5			209	1.1	1.58	284.6	89	86	248	53	2.8
	4	99			210	.99	1.39	288.4	88	84	248	54	2.8
		104.5			218	1.0	1.40	292.2	91	85	252	55	2.8
	5	110			200	1.1	1.58	296.0	92	86	253	56	2.8
		115.5			204	.95	1.38	299.7	90	85	247	55	2.8
	6	121			227	.95	1.38	303.2	88	85	246	55	2.8
		126.5			238	.78	1.09	306.0	87	85	253	56	2.3

CHAIN OF CUSTODY INFORMATION

Container Number	Sample I.D.	Description
1	100	Filter
2	101	Acetone Rinse
3	102	Imp 1
4	103	Imp 2 & 3
5	104	Silica Gel

LEAK CHECK

Vacuum	7"				
Rate	0.004				

IMPINGER VOLUMES

	Initial	Final
#1	100	153
#2	100	97
#3	0	15
#4		
#5		
#6		

NOZZLE SIZE	.203
METER BOX I.D.	#7
GAMMA	0.9923
DELTA H@	1.8357
BAR. PRESS.	29.99
FILTER I.D.	91-421
OPERATOR	C. Figueroa

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

RUN I.D. #463-MSD-R 1

Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp Inlet	Meter Temp Outlet	Filter Temp.	Imp Temp.	Meter Vac.
	132	12:54					309.427					
1	132	12:59		225	.95	1.38	309.427	89	89	238	58	2.8
	137.5			205	.83	1.14	313.0	93	89	251	57	2.5
2	143			209	1.0	1.4	316.6	95	91	251	55	3.0
	148.5			227	.99	1.39	320.5	100	93	252	54	3.0
3	154			205	1.0	1.4	324.1	98	92	250	53	3.0
	159.5			181	1.0	1.4	327.8	94	92	252	52	3.0
4	165		-.44	203	.95	1.38	331.6	94	92	252	52	2.8
	170.5			224	1.0	1.4	335.2	92	91	252	53	3.0
5	176			227	1.0	1.4	339.0	95	91	250	54	3.0
	181.5			215	.85	1.19	342.7	94	92	250	53	2.5
6	187			~~224~~	~~.85~~	~~1.19~~	346.2	99	95	254	53	2.5
	192.5			224	.83	1.14	349.7	98	93	248	54	2.5
	198	14:05					353.082					
B 1	198	14:12		203	.91	~~1.28~~	353.082	89	85	257	63	2.8
	203.5			226	.85	1.19	356.6	94	92	252	59	2.5
2	209		-.47	209	1.2	1.68	360.1	99	94	251	56	3.0
	214.5			194	1.1	1.58	364.1	102	95	251	53	2.8
3	220			214	1.1	1.58	368.1	103	96	249	52	2.8
	225.5			212	1.1	1.58	372.0	102	96	246	54	2.8
4	231		-.52	216	1.1	1.58	376.1	99	96	248	55	2.8
	236.5			211	1.0	1.4	379.9	98	95	246	55	2.8
5	242			231	.95	1.38	383.6	98	96	248	56	2.8
	247.5			219	1.1	1.58	387.3	97	95	248	56	2.8
6	253			203	.90	1.25	391.0	99	96	250	57	2.5
	258.5			214	.95	1.38	394.8	97	93	247	58	2.8
	264	15:18					398.387					

LEAK CHECK

Vacuum	7.5"				
Rate	.001				

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

PAGE 1

FACILITY Roanoke Electric Steel TEST LOCATION #4 Bypass Stack DATE 07-20-92

START TIME 15:55 POLLUTANT Particulate RUN I.D. #4BS-MSB-R2

	Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp. Inlet	Meter Temp. Outlet	Filter Temp.	Imp. Temp.	Meter Vac.
B	1	0	15:55		212	.88	1.22	398.722	92	91	254	66	3.0
		5.5			225	.75	1.07	401.3	93	91	250	63	2.8
	2	11			227	1.0	1.40	405.7	96	93	253	60	3.3
		16.5		-.47	221	1.1	1.57	409.4	99	95	255	59	3.8
	3	22			193	1.2	1.65	413.4	101	96	256	59	4
		27.5			194	1.1	1.57	417.5	102	97	253	57	3.8
	4	33			196	1.1	1.57	421.4	100	96	256	56	3.8
		38.5			211	1.0	1.40	425.4	100	94	253	55	3.3
	5	44			232	.96	1.35	429.1	99	95	253	55	3.3
		49.5			240	1.0	1.40	432.7	100	96	259	54	3.5
	6	55			208	.87	1.21	436.5	104	98	258	52	3.2
		60.5			225	.92	1.3	440.2	103	100	258	52	3.3
		66	17:01					443.61					
A	1	66	17:05		200	1.0	1.4	443.61	100	99	259	63	3.3
		71.5			203	.91	1.29	447.3	96	95	259	59	3.1
	2	77		-.46	214	.96	1.35	451.0	101	97	255	58	3.3
		82.5			216	.87	1.21	454.7	98	96	255	56	3.2
	3	88			217	1.0	1.4	458.3	97	97	258	56	3.3
		93.5			190	1.2	1.65	462.3	98	97	257	57	4.0
	4	99			182	1.0	1.4	466.1	99	98	254	56	3.3
		104.5			178	1.0	1.4	469.9	107	101	256	55	3.7
	5	110			174	.89	1.3	474.1	108	102	253	54	3.5
		115.5			168	1.0	1.4	477.3	108	102	251	53	3.3
	6	121	18:05		165	1.2	1.6	481.3	109	103	253	54	
		126.5											

26 Equipment Time

CHAIN OF CUSTODY INFORMATION

Container Number	Sample I.D.	Description
1	105	
2	106	
3	107	
4	108	
5	109	

LEAK CHECK

Vacuum						
Rate						

IMPINGER VOLUMES

	Initial	Final
#1		
#2		
#3		
#4		
#5		
#6		

NOZZLE SIZE	.203
METER BOX I.D.	#9
GAMMA	0.9923
DELTA H@	1.8357
BAR. PRESS.	
FILTER I.D.	91-922
OPERATOR	C. Ferguson

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

FACILITY Roanoke Elec. Steel TEST LOCATION Unit 4 Baghouse Stack DATE 07-21-92

START TIME 10:16 POLLUTANT Particulate RUN I.D. U4BS-M5B-R3

	Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp. Inlet	Meter Temp. Outlet	Filter Temp.	Imp. Temp.	Meter Vac.
A	1	0	10:16	[illegible]	154	.83	1.12	484.884	81 [illegible]	81 [illegible]	242	59	[illegible]3
		5.5			174	.85	1.15	488.2	83	81	248	56	3.2
	2	11			224	1.0	1.36	491.5	86	83	248	55	3.8
		16.5			235	.97	1.31	495.1	89	84	249	54	3.7
	3	22		-.44	240	1.0	1.36	498.6	92	85	248	53	3.8
		27.5			218	1.0	1.36	502.3	94	87	248	53	3.8
	4	33			212	1.0	1.36	505.9	96	87	247	53	3.9
		38.5			221	1.0	1.36	509.5	98	89	247	54	3.9
	5	44			212	.89	1.2	513.1	98	89	247	54	3.5
		49.5			227	.96	1.30	516.8	98	89	243	55	3.8
	6	55			217	.88	1.19	520.1	98	90	242	55	3.7
		60.5			222	.87	1.18	523.6	98	90	241	56	3.7
		66	11:22					527.029					
B	1	66	11:27		197	1.0	1.36	527.029	96	93	246	60	4
		71.5			184	1.1	1.46	530.6	101	95	243	58	4.3
	2	77		-.49	199	1.2	1.57	534.5	103	96	243	57	4.5
		82.5			211	1.2	1.57	538.5	104	97	245	55	4.5
	3	88			208	1.2	1.57	542.5	104	97	243	55	4.5
	4	93.5			224	1.1	1.46	546.5	105	97	242	55	4.3
	4	94			232	1.0	1.36	550.2	105	97	242	56	4
		104.5			232	1.0	1.36	553.9	105	98	245	57	4
	5	110			211	1.1	1.46	557.6	104	97	241	57	4.3
		115.5			229	.97	1.28	561.4	105	98	243	57	4
	6	121			240	1.0	1.36	565.0	105	98	243	53	4
		126.5			231	.93	1.24	568.7	105	99	240	51	3.8

CHAIN OF CUSTODY INFORMATION

Container Number	Sample I.D.	Description
1 [illegible]	110	filter
2 [illegible]	111	Acetone Rinse
3 [illegible]	112	Imp 1
4 [illegible]	113	Imp 2+3
5 [illegible]	114	Silica Gel

LEAK CHECK

Vacuum						
Rate						

IMPINGER VOLUMES

	Initial	Final
#1	100	58
#2	100	128
#3	0	6
#4		
#5		
#6		

NOZZLE SIZE	.203
METER BOX I.D.	#9
GAMMA	0.9921
DELTA H@	1.8357
BAR. PRESS.	29.54
FILTER I.D.	[illegible]
OPERATOR	C. Fejfar

~~H 476~~ 91-7

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

RUN I.D. 6405 -M5D-R 3

Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp Inlet	Meter Temp Outlet	Filter Temp.	Imp Temp	Meter Vac.
~~00~~	132	~~12:33~~					572.359					
01	132	12:41		226	1.0	1.36	572.359	100	99	242	59	3.9
	137.5			224	1.0	1.36	576.0	102	99	241	56	3.9
2	143			211	1.2	1.57	579.7	103	98	238	55	4.1
	148.5		-.50	193	1.3	1.74	583.7	106	100	240	54	4.5
3	154			184	1.1	1.46	587.7	107	100	239	53	4.0
	159.5			176	1.0	1.36	591.6	108	101	240	53	3.9
4	165			176	1.0	1.36	595.2	108	101	239	52	3.9
	170.5			203	1.0	1.36	598.8	109	102	241	51	3.9
5	176			214	1.0	1.36	602.5	109	102	240	51	3.9
	181.5			206	.98	1.32	606.1	110	103	242	52	3.9
6	187			216	1.0	1.36	609.8	110	103	241	53	3.9
	192.5			223	.98	1.32	613.5	109	103	239	53	3.9
	198	13:47					617.215					
1	198	13:53		200	1.0	1.36	617.215	107	102	245	59	3.9
	203.5			212	.98	1.32	620.8	107	103	244	58	3.9
2	209			229	1.1	1.46	624.5	109	104	245	55	4.1
	214.5			236	1.2	1.57	628.3	108	103	239	54	4.2
3	220		-.69	199	1.3	1.74	632.2	108	102	243	54	4.8
	225.5			213	1.1	1.46	636.3	109	102	243	54	4.1
4	231			229	1.0	1.36	640.2	109	102	240	55	4
	236.5			231	1.1	1.46	644.0	108	101	240	55	4.1
5	242			224	.98	1.32	647.8	109	102	241	54	3.9
	247.5			236	1.0	1.36	651.5	111	104	241	54	4
6	253			227	.90	1.18	655.2	113	104	241	53	3.5
	258.5			241	.94	1.28	658.7	114	106	237	53	3.8
	264	14:59					662.387					

LEAK CHECK

Vacuum	10"				
Rate	.010				

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

FACILITY Roanoke Electric Steel TEST LOCATION #4 Baghouse Stack DATE 07-21-92

START TIME 15:55 POLLUTANT Particulate RUN I.D. #403-M5D-R4

Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp. Inlet	Meter Temp. Outlet	Filter Temp.	Imp. Temp.	Meter Vac.
1	0	15:55		~~180~~ 184	~~1.0~~	1.36	663.449	100	100	240	60	4.1
	5.5			193	~~1.1~~	~~1.50~~	666.8	102	101	245	59	4.8
2	11			221	1.2	~~1.50~~ 1.64	670.9	106	102	249	57	4.9
	16.5			~~238~~ 233	1.31	~~1.80~~ 1.64	674.9	104	100	249	58	4.3
3	22			191	1.3	~~1.74~~ 1.64	678.8	104	100	249	59	4.3
	27.5			225	1.25	1.45	~~682.5~~	107	101	252	56	4.9
4	33		-.66	234	1.0	1.36	686.3	109	101	255	55	4.1
	38.5			239	1.0	1.36	690.1	111	103	253	55	4.1
5	44			230	1.0	1.36	693.9	108	101	249	56	4.1
	49.5			230	1.0	1.36	697.6	108	101	250	54	4.1
6	55			223	1.0	1.36	701.5	107	101	247	54	4.1
	60.5			211	1.0	1.36	705.3	106	101	249	55	4.1
	66	17:01					709.130					
1	66	17:07		177	1.0	1.36	709.130	102	101	252	62	4.1
	71.5			188	1.1	1.46	712.7	99	99	246	59	4.3
2	77			215	1.3	1.74	716.6	102	100	246	57	5
	82.5			217	1.3	1.74	720.7	100	99	245	57	5
3	88		-.57	203	1.2	1.57	724.8	101	99	247	56	4.8
	93.5			223	1.2	1.57	728.9	97	97	246	56	4.8
4	99			237	1.0	1.36	732.8	99	98	246	55	4.2
	104.5			217	1.1	1.46	736.6	98	97	246	55	4.6
5	110			220	.97	1.31	740.3	100	98	248	55	4
	115.5			230	.94	1.24	744.0	99	98	248	56	4
6	121			231	.98	1.32	747.6	101	99	247	56	4.1
	126.5			222	1.0	1.36	751.3	97	95	230	54	4.2

CHAIN OF CUSTODY INFORMATION

Container Number	Sample I.D.	Description
1	115	Filter
2	116	Acetone Rinse
3	117	Imp 1 cont.
4	118	Imp 2,3 cont.
5	119	Silica gel

LEAK CHECK

Vacuum					
Rate					

IMPINGER VOLUMES

	Initial	Final
#1	100	138
#2	100	173
#3	0	1
#4		
#5		
#6		

NOZZLE SIZE	.203
METER BOX I.D.	#9
GAMMA	0.9927
DELTA He	1.8357
BAR. PRESS.	29.54
FILTER I.D.	~~#5~~
OPERATOR	C. Fowler

91-797

FIELD DATA SHEET FOR ISOKINETIC SAMPLING

RUN I.D. #465-M50-R4

Point	Sample Time	Clock Time	Static	Stack Temp.	Stack dP	Meter dH	Meter Volume cu.ft.	Meter Temp Inlet	Meter Temp Outlet	Filter Temp	Imp Temp	Meter Vac.
	122	18:13					755.077					
1	132	18:16		179	1.0	1.36	755.077	89	89	241	64	4.1
	138.5			161	.94	1.24	758.7	85	87	237	61	4
2	143			210	1.2	1.57	762.3	84	86	237	60	4.7
	148.5		-.56	215	1.3	1.74	766.2	82	84	240	58	5
3	154			199	1.3	1.74	770.3	83	83	239	57	5
	159.5			169	1.2	1.57	774.4	84	83	244	57	4.7
4	165			196	1.1	1.46	778.4	87	83	246	58	4.3
	170.5			217	1.1	1.46	782.2	86	84	247	57	4.3
5	176			225	1.0	1.36	786.0	88	84	246	56	4.1
	181.5			201	1.0	1.36	789.6	87	84	249	55	4.1
6	187			228	.96	1.30	793.2	90	86	246	53	4.0
	192.5			201	1.0	1.36	796.8	90	86	247	53	4.1
	198	19:22					800.584					
1	198	19:26		185	1.0	1.36	800.584	89	88	250	58	4.1
	203.5		-.39	171	1.0	1.36	804.3	91	88	247	55	4.1
2	209			175	1.0	1.36	808.0	92	89	247	53	4.1
	214.5			205	1.0	1.36	811.7	93	89	247	52	4.1
3	220		-.49	200	1.1	1.46	815.4	90	88	241	52	4.3
	225.5			208	1.2	1.57	819.2	90	88	243	52	4.8
4	231			209	1.1	1.46	823.1	92	89	243	53	4.4
	236.5			214	1.0	1.36	827.0	94	90	245	53	4.1
5	242			209	1.0	1.36	830.7	93	90	243	53	4.1
	247.5			217	.97	1.31	834.4	94	90	243	54	4
6	253			224	.89	1.22	838.0	95	91	243	54	3.8
	258.5			209	1.0	1.36	841.5	94	91	239	54	4.1
	264	20:32					845.154					

LEAK CHECK

Vacuum	10"				
Rate	.006				

E T S , I N C .

F I E L D S A M P L E L O G

Contract No. 92-727
Job I.D.
Test Method 5

Print Date 07/22/92 Time 15:31:59

Sample No.	Container No.	Other I.D.	Run I.D.	Sample Type	Volume,ml no Rinses	Volume,ml w/ Rinses	Analyst	Date	Comment
00100	F1	91-0921	U4B-M5 -R1	Fiberglass Filters					
00101	F2		U4B-M5 -R1	FH Acetone Rinse			TLP	07/22/92	
00102	F3		U4B-M5 -R1	Impinger 1 Cont.			TLP	07/22/92	
00103	F4		U4B-M5 -R1	Impingers 2+3			TLP	07/22/92	
00104	F5		U4B-M5 -R1	Imp. 4 Silica Gel			TLP	07/22/92	
00105	F1	91-0922	U4B-M5 -R2	Fiberglass Filters			TLP	07/22/92	VOID
00106	F2		U4B-M5 -R2	FH Acetone Rinse			TLP	07/22/92	VOID
00107	F3		U4B-M5 -R2	Impinger 1 Cont.			TLP	07/22/92	VOID
00108	F4		U4B-M5 -R2	Impingers 2+3			TLP	07/22/92	VOID
00109	F5		U4B-M5 -R2	Imp. 4 Silica Gel			TLP	07/22/92	VOID
00110	F1	91-0796	U4B-M5 -R3	Fiberglass Filters					
00111	F2		U4B-M5 -R3	FH Acetone Rinse			TLP	07/22/92	
00112	F3		U4B-M5 -R3	Impinger 1 Cont.			TLP	07/22/92	
00113	F4		U4B-M5 -R3	Impingers 2+3			TLP	07/22/92	
00114	F5		U4B-M5 -R3	Imp. 4 Silica Gel			TLP	07/22/92	
00115	F1	91-0797	U4B-M5 -R4	Fiberglass Filters			TLP	07/22/92	
00116	F2		U4B-M5 -R4	FH Acetone Rinse			TLP	07/22/92	
00117	F3		U4B-M5 -R4	Impinger 1 Cont.			TLP	07/22/92	
00118	F4		U4B-M5 -R4	Impingers 2+3			TLP	07/22/92	
00119	F5		U4B-M5 -R4	Imp. 4 Silica Gel			TLP	07/22/92	
00121	F2		-M5 -R0	FH Acetone Rinse			TLP	07/22/92	BLANK

GRAVIMETRIC LABORATORY DATA SUMMARY

JOB NAME	Roanoke Electric Steel	COMMENTS
JOB NUMBER	92-727	
COMPUTER FILE NAMES		
TOTAL NUMBER RUNS IN JOB		
TOTAL NUMBER OF PROBE WASHES IN JOB		
TOTAL NUMBER OF FILTERS IN JOB		
TOTAL NUMBER OF BACK-HALFS IN JOB		
ANALYSIS COMPLETED ON		

SAMPLE I.D.	RUN NUMBER	BEAKER FILTER	NUMBER	LIQUID VOLUME ml	TARE FILTER WT.-gm	TARE BEAKER WT.-gm	FINAL BEAKER WT.-gm	TARE-FINAL BEAKER WT.-gm
100	U4B-MS-R1	B F	6/8/92-22 91-921	—	0.42233	67.51542	67.93721	-0.00054
101	U4B-MS-R1	B F	6/8/92-23	65	—	64.45366	64.46289	0.00923
110	U4B-MS-R2	B F	6/8/92-24 91-796	—	0.40504	66.96241	67.36673	-0.00072
111	U4B-MS-R3	B F	6/8/92-25	100	—	64.63679	64.64322	0.00643
115	U4B-MS-R4	B F	6/8/92-26 91-797	—	0.40549	64.81538	65.21968	-0.00119
116	U4B-MS-R4	B F	6/8/92-27	80	—	65.52576	65.53187	0.00611
121	Blank	B F	6/8/92-28	100	—	64.71303	64.71302	-0.00001
		B F						
		B F						
		B F						
		B F						
		B F						
		B F						
		B F						
		B F						
		B F						
		B F						
		B F						
		B F						

GRAVIMETRIC LABORATORY DATA

FINAL BEAKER WEIGHTS

JOB NUMBER 92-727 RES

#	Beaker # / Sample # / Run I.D. / Volume/Filter #	Tare Weight (GM) / Weight (GM)	Date / Time / Weight (GM)	Weight (GM)	Constant Weight (GM)
1	6/8/92-22	TARE 7/23 1540	7/24 0824		
2	100 F PV	67.51542	67.93721		
3	U4B-MS-R1	67.93724			67.93721
4	91-921				
1	6/8/92-23	TARE 7/23 1548	7/24 0822		
2	101 F PV	64.45366	64.46289		
3	U4B-MS-R1	64.46296			64.46289
4	65ml				
1	6/8/92-24	TARE 7/23 1546	7/24 0820		
2	110 F PV	66.96241	67.36673		
3	U4B-MS-R3	67.36676			67.36673
4	91-796				
1	6/8/92-25	TARE 7/23 1552	7/24 0816		
2	111 F PV	64.63679	64.64322		
3	U4B-MS-R3	64.64344			64.64322
4	100ml				
1	6/8/92-26	TARE 7/23 1550	7/24 0826		
2	115 F PV	64.81538	65.21968		
3	U4B-MS-R4	65.21967			65.21963
4	91-797				
1	6/8/92-27	TARE 7/23 1542	7/24 0825		
2	116 F PV	65.52576	65.53187		
3	U4B-MS-R4	65.53181			65.53187
4	80ml				
1	6/8/92-28	TARE 7/23 1544	7/24 0818		
2	121 F PV	64.71303	64.71302		
3	Blank	64.71324			64.71302
4	100ml				
1		TARE			
2	F PV				
3					
4					
1		TARE			
2	F PV				
3					
4					

92-727
RES

SILICA GEL WEIGH SHEET

SAMPLE No.	RUN NUMBER	COLOR	WEIGHTS (grams) TARE	FINAL
104	U4B-M5-R1	Pink	20.0	232.35
114	U4B-M5-R2	Lilac	✓	225.68
119	U4B-M5-R3	Pink	✓	223.57

RES NO. 5 EAF STACK TEST ON JULY 20 - 21, 1992

Process Weight Rate - Furnace Output in Tons/Hour

Stack Test Run No. 1: 1035 - 1518 on July 20, 1992

Melting Heat Start	Finish	Output Pounds	Heat Number	Grade of Steel
1035	1153	184,788	3400	A-36
1201	1322	178,524	3401	A-36
1331	1504	184,788	3402	A-36
1508	1630	169,128	3403	A-36

Total Melting Time: 355 minutes
Total Output : 717,228 pounds

717,228 lbs. x 1/2000 = 358.614 Tons x 1/355 min. x 60min./hr. = 60.6 Tons/hr.

Stack Test Run No. 2: 1016 - 1459 on July 21, 1992
Stack Test Run No. 3: 1555 - 2032 on July 21, 1992

Melting Heat Start	Finish	Output Pounds	Heat Number	Grade of Steel
1016	1132	181,656	3413	A-36
1135	1252	161,788	3414	A-36
1311	1416	181,052	3415	A-36
1418	1549	160,920	3416	A-36
1555	1658	184,788	3417	A-36
1706	1817	160,788	3418	A-36
1819	1935	175,392	3419	A-36
1935	2112	159,732	3420	A-36

Total Melting Time: 656 minutes
Total Output: 1,366,116 pounds

1,366,116 lbs. x 1/2000 = 683.06 Tons x 1/656 min. x 60 min./hr. = 62.5 Tons/hr.

Three Run Test Average:
(60.6 + 62.5 + 62.5)/3 runs = 61.9 Tons/hr.

No. 5 EAF Monitoring of Operations
July 20 - 21, 1992

No. 5 EAF Internal Pressure Range:	-1.5 to -2.6 Inches
No. 5 EAF Fan Motor Amps Range:	370 to 410 Amps
No. 5 EAF Damper Position Range:	100 %
No. 5 EAF Baghouse Temperature Range:	185 to 250 Farenheit
No. 5 EAF Baghouse Pressure Range:	7.2 to 10.5 Inches

7-20-92

1ST TEST

GRADE A-36

7-20-92

1ST HEAT - ~~3300~~ 3400

TIME	WT.	DELAYS	KW	O_2 in DOOR
10:35	90,000	10:35 - 10:37	103	
10:55	50,000	10:54 - 10:57	209	11:04 - 11:09
11:17	55,000	11:05 - 11:10 (K.O. HIGH TEMP. DUST Control)		11:25 - 11:45
	195,000	~~11:13~~ 11:15 - 11:20		
		11:31 - 11:33 (K.O. DUST Control)		
		11:45 - 11:48 HIGH TEMP (CRANE)		
		11:49 - 11:51		

22 min DELAY

TAP	KW	SI	MN	6930# LIME	3000# LIME
11:51	391	1700	1000	WEIGHT - 184,788 - 92.3	
11:53	GUNNING FUR. — 11:54 — 12:01			7 min	

76 min START TO TAP 22 min DELAY

2nd HEAT - 3401

1ST TEST

GRADE A-36

TIME	WT	DELAY	KW	O_2 IN DOOR
12:01	75,000	12:01 - 12:02	74	
12:15	59,000	12:14 - 12:17	162	
12:35	40,000	12:30 - 12:37		12:40 - 12:45
12:46	20,000	12:44 - 12:47	211	
	185,000	12:50 - 12:57 (K.O. DUST & TEMP HIGH TEMP)		12:48 - 1:02
		1:01 - 1:05 (ADD LIME)		1:06 - 1:16
		1:16 - 1:17 (DUST CONTROL K.O. HIGH TEMP)		
		1:20 - 1:22		

TAP	KW	SI	MN	6695# LIME	3000# LIMES
1:20	~~395~~ 408	1700	1000	WEIGHT - 178,524 - 89.267	
1:22	GUNNING FUR.	1:24 -			

79 min START TO TAP 22 min delay

3rd 3402 — 1ST TEST — GRADE A-36 — 7-20-92

ng.	Time	Wt	Delays	KW	O2 in Door
st	1:31	70,000	1:[illegible] - 1:32	87	
nd	1:49	45,000	1:45 - 1:50	169	
rd	2:08	55,000	2:01 - 2:03 (Pitch Control High Temp)		2:11 - 2:22
th	2:29	20,000	2:04 - 2:09	256	2:32 - 2:42
		190,000	2:22 - 2:30		
			2:48 - 2:51		
			3:00 - 3:01		
			3:[illegible] - 3:04		

Tap	KW	SI	MN
RT - 3:03	445	1700	1000
ISH - 3:04			

1500# Limestone
6930#'s Lime
GUNNING FOR. —
WEIGHT - 184,788
92 min START TO TAP 25 min Delay 92.39 To

4th HEAT 3403 — 1ST TEST — BLOCED - GRADE A-3

ng.	Time	Wt	Delay	KW	O2 in Door
st	3:08	70,000	3:08 - 3:09	72	
nd	3:21	45,000	3:20 - 3:23	145	
rd	3:36	45,000	3:34 - 3:37	216	3:58 - 4:02
th	3:50	80,000	3:48 - 3:51		
		180,000	[illegible] 4:13 - 4:21		
			4:27 4:30		

6340#'s Lime 1500#'s Limestone
END TEST No. 1 - 3:18
STARTED TEST 2 - 3:55
WEIGHT 169,128 - 84.56 To

Tap	Time	KW	SI	MN
RT -	4:28	408	1100	1600
ISH -	4:30			

80 min START TO TAP 18 min Delay

7-20-92

2nd TEST

GRADE A-36

HEAT - 3404

	TIME	WT.	DELAY	KW	O_2 IN DOOR
1st Ladle	4:32	75,000	~~7:56~~ 4:32-4:34	80	
2nd	4:50	60,000	4:45-4:51	182	5:23-5:26
	5:09	60,000	5:06-5:10		
			5:26- (CASTING MACHINE)		
		195,000			

3000 #s/Hr.

TAP	TIME	KW	SI	MN
START				
FINISH				

DISCONTINUED TEST 2 AT 6:30

WEIGHTS HEAT No. 3400 - 184,788 #s - 92.39 TONS

3401 - 178,524 #s - 89.26 TONS

3402 - 184,788 #s 92.39 TONS

3403 - 169,128 #s 84.56 TONS

358.30 TONS

6 HRS PRODUCTION TIME

$\frac{358.30}{6} = 59.72$ TONS/HR.

1ST TEST

1ST HEAT - 3413 BEGAN 10:16

7-21-92

GRADE - A-36

Hq.	TIME	WT	DELAYS	KW	O_2 IN DOOR
	10:18	110,000	10:29-10:30 BURNERS 10:31-10:32 KICKED OFF 10:34-10:35	141	10:55 - 10:57
	10:45	70,000	10:39 DUST CONTROL 10:42 K.O. HIGH TEMP.	217	11:05 - 11:11
	11:00	20,000	10:47 10:58 - 11:01		11:14 - 11:15
		200,000	11:28 - 11:32		11:22 - 11:25
					11:26 - 11:27

GUNNING FOR 11:33 - 11:35

TAP	TIME	KW	SI	MN	6810 #'s LIME	3000 #'s LIMES
START	11:30	411	1500	1600	WEIGHT - 181,656 - 90.8 T	
FINISH	11:32					

74 MIN START TO TAP DELAY 16 min

HEAT - 3414 1ST TEST GRADE A-36

Hq.	TIME	WT	DELAY	KW	O_2 IN DOOR
1st	11:35	70,000	11:35 - 11:36 11:49 - 11:53	83	12:05 - 12:10
2nd	11:52	80,000	12:07 - 12:09 (DUST CONTROL K.O. HIGH TEMP) 12:11 - 12:15	200	12:17 - 12:24
	12:14	45,000	12:24 - 12:26 (DUST CONTROL K.O. HIGH TEMP) 12:34 - 12:36 (DUST CONTROL K.O. HIGH TEMP)		12:27 - 12:28
		195,000			12:30 - 12:31
			GUNNING FURNACE - 12:52 - 1:07		12:40 - 12:46

TAP	TIME	KW	SI	MN	6065 #'s LIME	3000 #'s LIMES
START -	12:51	429	1500	1600		
FINISH -	12:52				WEIGHT - 161,788 - 80.89 Tc	

76 Min START TO TAP 15 min DELAY

1ST TEST 7-21-92

3RD HEAT-3415 GRADE A-36

Hq.	Time	WT.	Delays	KW	O2 IN DOOR
ST	1:11	100,000	12:55-1:10 (ELECTRODE PROBLEM)	86	1:39-1:46
nd	1:30	95,000	1:28-1:31		1:57-1:59
		195,000	1:59-2:01 (POWER DEMAND)		2:05-2:07
			2:10-2:11 DUST CONTROL K.O. HIGH TEMP.		
			2:12-2:16		

GUNNING FOR. 2:16-2:18

TAP	Time	KW	SI	MN	6790#'s Lime 3000#'s Limes
TART -	2:14	344	1500	1650	
NISH -	2:16				WEIGHT-181,052 -90,537

63 MIN START TO TAP 21 min DELAY.

4TH HEAT 3416 1ST TEST GRADE - A-36

Hq.	Time	WT	Delays	KW	O2 IN DOOR
ST	2:18	85,000	2:34-2:38	95	2:42-2:52
nd	2:37	85,000	2:50-2:52 (DUST CONTROL K.O. HIGH TEMP)		3:00-3:08
rd	2:57	15,000	2:54-2:58 "	186	3:14-3:17
th	3:12	10,000	3:09-3:13		3:19-3:20
		195,000	3:23-3:25	256	3:22-3:27
			3:29-3:31 (DUST CONTROL K.O. HIGH TEMP)		3:35-3:37
			3:44-3:48		3:40-3:44
			3:47-3:49		3:45-3:46

COMPLETED TEST NO. 1 - 2:59

GUNNING FOR. - 3:50-3:55

TP	Time	KW	SI	MN	6035#'s Lime 3000#'s Limes
RT -	3:47	471	1500	1650	
NISH -	3:49				WEIGHT-160,920 - 80,461

89 Min START TO TAP 30 min DELAY

START TEST No. 2 – 3:55

2nd TEST

1ST HEAT – 3417

7-21-92

GRADE – A36

Chg.	Time	WT	Delays	KW	O_2 in Dec
1st	3:55	100,000	3:55 – 3:57	101	4:21 – 4:33
2nd	4:16	105,000	4:13 – 4:20		4:36 – 4:40
		205,000	4:37 – 4:40 (Dust Control K.O. High Temp.)		4:43 – 4:46
			4:55 – 4:58		

GUNNING FUR. 4:58 – 5:06

Tap	Time	KW	SI	MN	
START –	4:56	326	700	1500	300#'s Lime 6930#s Lime
FINNISH –	4:58				WEIGHT – 184,788.97

61 MIN START TO TAP 14 min Delay.

2nd HEAT – 3418

2ND TEST

GRADE A-36

Chg	Time	WT	Delays	KW	O_2 in Dec
1st	5:06	100,000	5:06 – 5:08	110	5:33 – 5:4
2nd	5:30	75,000	5:27 – 5:31	196	5:50 – 6:0
3rd	5:46	25,000	5:44 – 5:49		6:02 – 6:0
		200,000	6:15 – 6:17		

GUNNING FURNACE – 6:17 – 6:19

Tap	Time	KW	SI	MN	
START –	6:15	376	1100	1600	3000#'s Limes 6030#'s Lime
FINNISH –	6:17				WEIGHT – 160,788 – 80.3

69 MIN START TO TAP – 13 min DELAY

TEST 2

3rd HEAT - 3419 — 7-21-92 — GRADE A-36

CHg	TIME	WT	DELAYS	KW	O2 IN DOOR
1st	6:19	95,000	6:19-6:23	90	6:50-7:0
			6:38-6:48 (STATIC VALV SYSTEM OUT)		
2nd	6:41	75,000	7:06-7:10	219	7:11-7:18
3rd	7:08	40,000	7:28-7:31		7:22-7:2
			7:33-7:35		
		200,000			

GUNNING FURNACE - 0

TAP	TIME	KW	SI	MN	
START -	7:33	363	1100	1800	3000 #'s LIME
FINISH	7:35				6580 #'s LIME
					WEIGHT - 175,392 - 87.76

74 MIN. START TO TAP 23 MIN DELAYS

4th HEAT - 3420 — TEST 2 — GRADE A-36

CHg.	TIME	WT	DELAYS	KW	O2 in Do
1st	7:35	70,000	7:35-7:37	85	7:57-8
			7:54-7.57	176	
2nd	7:56	75,000	8:20-8:22 (DUST COMING K.O. HIGH TEMP	~~76~~	8:14-8
3rd	8:27	20,000	8:25-8:30	230	
			8:42-8:47		
4th	8:44	20,000	8:50-8.59 (ELEC PROB.)		
		185,000	9:10-9:12		

COMPLETED TEST NO. 2 8:32

TAP	TIME	KW	SI	MN	
~~START~~	9:10	~~#46~~	1100	1600	6000 #'s LIME 3000 #'s LIME
FINISH	9:12				WEIGHT - 159,732
					79.87 TO

97 MIN. START TO TAP. 30 min DELAY

WEIGHTS - TEST 1 & 2 7-21-90

HEAT NO.	WEIGHT (lbs)	- TONS
3413	181,656	90.83
3414	161,788	80.89
3415	181,052	90.53
3416	160,920	80.46
3417	184,788	92.39
3418	160,788	80.39
3419	175,392	87.70
3420	159,732	79.87
		683.06

TIME 10:16 TO 9:10 = 654 min

$\frac{683.06}{654}$ = 62.64 TONS/HR.