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

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

Background Report Reference

AP-42 Section Number: 11.23

Background Chapter: 4

Reference Number: 38

Title: Results of the January 23 and 24, 1979 Particulate Emissio Compliance Tests on the 2A Waste Gas, the Kiln Cooler and the Grate Feed End Stacks at teh Eveleth Expansion Company Plant

Interpoll, Inc.

Interpoll, Inc.

February 1979

RE AP-42 Section 11.23
Reference —
Report Sect. 4
Reference 38

NO RECORD DATA

Interpoll Inc.
1996 West County Road C
St. Paul, Minnesota 55113

(612) 636-6866

RESULTS OF THE JANUARY 23 & 24, 1979 PARTICULATE EMISSION COMPLIANCE TESTS ON THE 2A WASTE GAS, THE KILN COOLER AND THE GRATE FEED END STACKS AT THE EVELETH EXPANSION COMPANY PLANT

Submitted to:

Eveleth Expansion Company
P. O. Box 180
Eveleth, Minnesota 55734

Attention: D. S. Coyle
Chief Metallurgist

Approved by:

Perry Lonnes

Perry Lonnes, Ph.D.
Director of Environmental
Measurements Section

Report Number 8-546
February 9, 1979

Ref BL 4-38

NO PROCESS DATA

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1996 West County Road C
St. Paul, Minnesota 55113

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RESULTS OF THE JANUARY 23 & 24, 1979 PARTICULATE EMISSION COMPLIANCE TESTS ON THE 2A WASTE GAS, THE KILN COOLER AND THE GRATE FEED END STACKS AT THE EVELETH EXPANSION COMPANY PLANT

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SYMBOLS AND ABBREVIATIONS

ACFM	actual cubic feet per minute
DSCFM	standard cubic foot of dry gas per minute
DEG-F	degrees Fahrenheit
FT/SEC	feet per second
GR/ACF	grains per actual cubic foot
GR/DSCF	grains per dry standard cubic foot
g	gram
HRS	hours
IN.	inches
IN. H.G.	inches of mercury
IN. W.C.	inches of water
LB	pound
LB/HR	pounds per hour
LB/10^6BTU	million British Thermal Units heat input
microns (μm)	micrometer
MIN	minutes
SQ. FT.	square feet
v/v	percent by volume
mg/DSCM	milligrams per dry standard cubic meter
LB/DSCF	pounds per dry standard cubic foot
MWH	megawatt hours
ohm-cm	ohm-centimeter
HP	horsepower
PSI	pounds per square inch
w/w	percent by weight

Standard conditions are defined as 68 ^{o}F (20 ^{o}C) and 29.92 in. of mercury pressure.

1 INTRODUCTION

On January 23 and 24, 1979, Interpoll Inc. personnel conducted a series of particulate emission compliance tests on the No. 2A Waste Gas, the Kiln Cooler Exahust and the Grate Feed End Stacks at the Eveleth Taconite Company Plant located near Eveleth, Minnesota. On-site testing was performed by Messrs. J. Stock, J. Sloan and D. Werlein. Coordination between plant operation and testing activities was provided by Harry Vaughn and Dan Jarvis of Eveleth Taconite Company. The tests were not witnessed by a member of the Minnesota Pollution Control Agency.

Particulate evaluations were performed in accordance with EPA Methods 1-5, CFR Title 40, Part 60, Appendix A and the revisions to these methods, FR 42(160). A preliminary determination of the gas linear velocity profile was made on each source before the start of the first particulate determination to allow selection of the appropriate nozzle diameter required for isokinetic sampling. An Interpoll sampling train which meets or exceeds specifications in the above-cited references was used to isokinetically extract particulate samples by means of a heated stainless steel-lined probe.

Testing on each of the three sources was conducted from existing test ports located on the stack. The testing protocol on each source was bases upon EPA Method 1 recommendations. A visible emission determination was also performed on each source by J. Stock, a currently EPA-certified observer.

The important results of the tests are summarized in Section 2. Detailed results are presented in Section 3. Results of preliminary measurements, field data and all other supporting information are presented in the appendices.

2 SUMMARY AND DISCUSSION

The important results of the particulate emission compliance tests for the No. 2A Waste Gas Stack, the Kiln Cooler Exhaust Stack and the Grate Feed End Stack are summarized in Tables 2, 3 and 4, respectively. The average particulate loading and volumetric flow rate for each of the three sources are presented in Table 1 below together with the maximum allowable particulate loading for sources of these respective volumetric flow rates.

Table 1. Comparison of Measured Particulate Concentrations with State Standards.

Test No.	Source Name	Average Measured Particulate Loading (GR/DSCF)	Volumetric Flow Rate (DSCFM)	Maximum Allowable Particulate Loading* (GR/DSCF)
1	2A Waste Gas	.059	267000	.031
2	Kiln Cooler Exhaust	.155	141000	.038
3	Grate Feed End	.0077	27200	.065

*Minnesota State Regulation APC 5, Table 2

No difficulties were encountered in the field or in the laboratory evaluation of the particulate samples. On the basis of this fact and a complete review of the entire data and results, it is our opinion that the particulate concentrations and volumetric flow rates reported herein are accurate and closely reflect the actual values which existed at the time the tests were conducted.

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Table 2. Summary of the Results of the January 23, 1979 Particulate Emission Compliance Test on the 2A Waste Gas Stack at the Eveleth Expansion Company.

ITEM	PRELIMINARY	RUN 1	RUN 2	RUN 3
Time of test (HRS)	0740	0753-0859	0930-1042	1121-1233
Volumetric flow				
ACTUAL (ACFM)	336000	342600	342700	350200
STANDARD (DSCFM)	259900	264500	264600	270600
Gas temperature (DEG-F)	113	114	114	114
Gas moisture content (% v/v)	10.38	10.39	10.39	10.36
Gas composition (% v/v, dry)				
carbon dioxide		1.90	1.77	1.94
oxygen		17.80	18.55	18.11
nitrogen		80.30	79.68	79.95
Particulate concentration				
ACTUAL (GR/ACF)		.050	.048	.039
STANDARD (GR/DSCF)		.065	.062	.051
Isckinetic variation (%)		99.6	99.6	99.0
Particulate emission rate (LB/HR)		146.7	140.9	116.8

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Table 3. Summary of the Results of the January 23, 1979 Particulate Emission Compliance Test on the Kiln Cooler Exhaust Stack at the Eveleth Expansion Company.

ITEM	PRELIMINARY	RUN 1	RUN 2	RUN 3
Time of test (HRS)	1310	1324-1448	1508-1633	1704-1837
Volumetric flow				
ACTUAL (ACFM)	291500	144700 ?	300400	309700
STANDARD (DSCFM)	133200	144700	139100	140500
Gas temperature (DEG-F)	610	611	594	591
Gas moisture content (% v/v)	.96	.84	1.19	.86
Gas composition (% v/v, dry)				
carbon dioxide		.03	.03	.03
oxygen		20.90	20.90	20.90
nitrogen		78.03	78.03	78.03
Particulate concentration				
ACTUAL (GR/ACF)		.075	.073	.068
STANDARD (GR/DSCF)		.163	.159	.145
Isokinetic variation (%)		97.0	97.1	97.5
Particulate emission rate (LB/HR)		198.6	185.8	172.2

S-01345

Table 4. Summary of the Results of the January 24, 1979 Particulate emission Compliance Test on the Grate Feed End Stack at the Eveleth Expansion Company.

ITEM	PRELIMINARY	RUN 1	RUN 2	RUN 3
Time of test (HRS)	0730	0800-0902	0913-1015	1031-1133
Volumetric flow				
ACTUAL (ACFM)	31300	28500	29700	29000
STANDARD (DSCFM)	29200	26700	27800	27100
Gas temperature (DEG-F)	65	64	64	64
Gas moisture content (% v/v)	2.15	2.15	2.15	2.15
Gas composition (% v/v, dry)				
carbon dioxide		.03	.03	.03
oxygen		20.90	20.90	20.90
nitrogen		78.03	78.03	78.03
Particulate concentration				
ACTUAL (GR/ACF)		.0095	.0058	.0064
STANDARD (GR/DSCF)		.0101	.0061	.0068
Isokinetic variation (%)		99.7	98.8	98.5
Particulate emission rate (LB/HR)		2.31	1.45	1.58

3 RESULTS

The results of all field and laboratory evaluations are presented in this section. Gas composition results for each source are presented first, followed by the particulate emission and opacity data for each source. Preliminary measurements including traverse point description are given in Appendix A and Appendix B.

The results have been calculated on a CDC 3300 computer using standard Fortran programs. EPA-published equations have been used as the basis of the calculation techniques in these programs. It should be noted in interpreting these results that the particulate emission rates have been calculated by both the "concentration X flow" and the "ratio of areas" methods and the average reported. The average is the best estimate of the true value, since the bias introduced by anisokinetic sampling is approximately equal but of opposite sign in the two calculation techniques and thus cancels in the average.

3.1.1 TEST NO. 1 2A WASTE GAS - STACK

RESULTS OF GAS ANALYSES -- METHOD 3 (PERCENT BY VOLUME)

	RUN 1	RUN 2	RUN 3
DATE OF RUN	01/23/79	01/23/79	01/23/79
DRY BASIS (ORSAT)			
CARBON DIOXIDE	1.90	1.77	1.94
OXYGEN	17.80	18.55	18.11
CARBON MONOXIDE	0	0	0
NITROGEN	80.30	79.68	79.95
WET BASIS (ORSAT)			
CARBON DIOXIDE	1.70	1.59	1.74
OXYGEN	15.95	16.62	16.23
CARBON MONOXIDE	0	0	0
NITROGEN	71.95	71.40	71.67
MOISTURE CONTENT	10.39	10.39	10.36
DRY MOLECULAR WEIGHT	29.02	29.03	29.03
WET MOLECULAR WEIGHT	27.87	27.88	27.89
SPECIFIC GRAVITY (RELATIVE TO AIR)	.9627	.9630	.9635
VELOCITY WEIGHTED AND TIME-AVERAGED OXYGEN DURING METHOD 5 RUNS	N/A	17.83	17.77

** CONDENSED WATER VAPOR IN GAS STREAM; MOISTURE CONTENT CALCULATED FROM AVERAGE STACK GAS TEMPERATURE ASSUMING SATURATION.

3.1.2 TEST NO. 2 KILN COOLER EXHAUST

RESULTS OF GAS ANALYSES -- METHOD 3 (PERCENT BY VOLUME)

	RUN 1	RUN 2	RUN 3
DATE OF RUN	01/23/79	01/23/79	01/23/79
DRY BASIS (ORSAT)			
CARBON DIOXIDE	.03	.03	.03
OXYGEN	20.90	20.90	20.90
CARBON MONOXIDE	0	0	0
NITROGEN	78.03	78.03	78.03
WET BASIS (ORSAT)			
CARBON DIOXIDE	.03	.03	.03
OXYGEN	20.72	20.65	20.72
CARBON MONOXIDE	0	0	0
NITROGEN	77.38	77.10	77.36
MOISTURE CONTENT	.84	1.19	.86
DRY MOLECULAR WEIGHT	28.55	28.55	28.55
WET MOLECULAR WEIGHT	28.46	28.42	28.46
SPECIFIC GRAVITY (RELATIVE TO AIR)	.9831	.9818	.9830
VELOCITY WEIGHTED AND TIME-AVERAGED OXYGEN DURING METHOD 5 RUNS	20.90	20.90	20.90

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3.1.3 TEST NO. 3 GRATE FEED END

RESULTS OF GAS ANALYSES -- METHOD 3 (PERCENT BY VOLUME)

	RUN 1	RUN 2	RUN 3
DATE OF RUN	01/24/79	01/24/79	01/24/79
DRY BASIS (ORSAT)			
CARBON DIOXIDE	.03	.03	.03
OXYGEN	20.90	20.90	20.90
CARBON MONOXIDE	0	0	0
NITROGEN	78.03	78.03	78.03
WET BASIS (ORSAT)			
CARBON DIOXIDE	.03	.03	.03
OXYGEN	20.45	20.45	20.45
CARBON MONOXIDE	0	0	0
NITROGEN	76.35	76.35	76.35
MOISTURE CONTENT	2.15	2.15	2.15
DRY MOLECULAR WEIGHT	28.55	28.55	28.55
WET MOLECULAR WEIGHT	28.32	28.32	28.32
SPECIFIC GRAVITY (RELATIVE TO AIR)	.9783	.9783	.9783
VELOCITY WEIGHTED AND TIME-AVERAGED OXYGEN DURING METHOD 5 RUNS	20.90	20.90	20.90

** CONDENSED WATER VAPOR IN GAS STREAM; MOISTURE CONTENT CALCULATED FROM AVERAGE STACK GAS TEMPERATURE ASSUMING SATURATION.

3.2 Results of Particle Concentration Determinations

EVELETH EXPANSION COMPANY

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3.2.1 TEST NO. 1 2A WASTE GAS - STACK

RESULTS OF PARTICLE CONCENTRATION DETERMINATION -- METHOD 5(BE)

	RUN 1	RUN 2	RUN 3	
DATE OF RUN	01/23/79	01/23/79	01/23/79	AVG see p. A-1
TIME RUN START/END(HRS)	753/ 859	930/1042	1121/1233	
PITOT TUBE COEFFICIENT	.840	.840	.840	
TOTAL MOISTURE IN GAS SAMPLE (GRAMS)	118.0	118.0	119.6	
TOTAL PARTICULATE MATERIAL COLLECTED(GRAMS) *	.2018	.1938	.1602	
VOLUME THROUGH GAS METER (CF AT METER COND.)	47.84	48.29	49.48	
TOTAL SAMPLING TIME (MIN)	64.0	64.0	64.0	
NOZZLE DIAMETER (IN)	.243	.243	.243	
AVERAGE STACK GAS TEMPERATURE DURING DETERMINATION (DEG-F)	114.	114.	114.	114 (113)
VOLUMETRIC FLOW**				
ACTUAL ..... (ACFM)	342532	342694	350226	345,151
DRY STANDARD ... (DSCFM)	264470	264595	270581	266,599
ISOKINETIC VARIATION (%)	99.6	99.6	99.9	
PARTICLE CONCENTRATION				
ACTUAL ..... (GR/ACF)	.0502	.0482	.0392	
DRY STANDARD ... (GR/DSCF)	.0648	.0623	.0506	
PARTICLE MASS FLOW (LB/HR)	146.73	140.94	116.02	

* DRY CATCH ONLY

** CALCULATED ON THE BASIS OF VELOCITY PRESSURES MEASURED DURING THIS PARTICULATE DETERMINATION.

3.2.2 TEST NO. 2 KILN COOLER EXHAUST

RESULTS OF PARTICLE CONCENTRATION DETERMINATION — METHOD 5(BE)

ALSO PA-3

AVG

	RUN 1	RUN 2	RUN 3	
DATE OF RUN	01/23/79	01/23/79	01/23/79	
TIME RUN START/END(HRS)	1324/1448	1508/1633	1704/1837	
PITOT TUBE COEFFICIENT	.847	.847	.847	
TOTAL MOISTURE IN GAS SAMPLE (GRAMS)	8.0	11.0	8.0	
TOTAL PARTICULATE MATERIAL COLLECTED(GRAMS) *	.4707	.4405	.4091	
VOLUME THROUGH GAS METER (CF AT METER COND.)	44.32	43.09	42.48	
TOTAL SAMPLING TIME (MIN)	80.0	80.0	80.0	
NOZZLE DIAMETER (IN)	.373	.373	.373	
AVERAGE STACK GAS TEMPERATURE DURING DETERMINATION (DEG-F)	611	594.	591.	599
VOLUMETRIC FLOW**				
ACTUAL ..... (ACFM)	316345	300439	301653	306,146
DRY STANDARD ... (DSCFM)	144662	139139	140507	141,436
ISOKINETIC VARIATION (%)	97.0	97.1	97.3	
PARTICLE CONCENTRATION				
ACTUAL ..... (GR/ACF)	.0746	.0734	.0677	
DRY STANDARD ... (GR/DSCF)	.1625	.1580	.1448	0.1551
PARTICLE MASS FLOW (LB/HR)	198.47	185.77	172.20	

* DRY CATCH ONLY

** CALCULATED ON THE BASIS OF VELOCITY PRESSURES MEASURED DURING THIS PARTICULATE DETERMINATION.

3.2.3 TEST NO. 3 GRATE FEED END

RESULTS OF PARTICLE CONCENTRATION DETERMINATION --- METHOD 5(BE)

	RUN 1	RUN 2	RUN 3
DATE OF RUN	01/24/79	01/24/79	01/24/79
TIME RUN START/END(HRS)	800/ 902	913/1015	1031/1133
PITOT TUBE COEFFICIENT	.849	.849	.849
TOTAL MOISTURE IN GAS SAMPLE (GRAMS)	19.1	19.8	19.2
TOTAL PARTICULATE MATERIAL COLLECTED(GRAMS) *	.0270	.0169	.0183
VOLUME THROUGH GAS METER (CF AT METER COND.)	43.47	45.23	44.08
TOTAL SAMPLING TIME (MIN)	60.0	60.0	60.0
NOZZLE DIAMETER (IN)	.243	.243	.243
AVERAGE STACK GAS TEMPERATURE DURING DETERMINATION (DEG-F)	64.	64.	64.
VOLUMETRIC FLOW**			
ACTUAL ..... (ACFM)	28486	29707	28973
DRY STANDARD ... (DSCFM)	26667	27810	27123
ISOKINETIC VARIATION (%)	99.7	98.8	98.5
PARTICLE CONCENTRATION			
ACTUAL ..... (GR/ACF)	.0095	.0058	.0064
DRY STANDARD ... (GR/DSCF)	.0101	.0061	.0068
PARTICLE MASS FLOW (LB/HR)	2.31	1.45	1.58

* DRY CATCH ONLY

** CALCULATED ON THE BASIS OF VELOCITY PRESSURES MEASURED DURING THIS PARTICULATE DETERMINATION.

3.3 Results of Opacity Observations - EPA Method 9

3.3.1 TEST NO. 1 - 2A WASTE GAS

RESULTS OF OPACITY OBSERVATIONS - EPA METHOD 9

PERCENT OPACITY	OPTICAL DENSITY	RELATIVE FREQUENCY (%)
0	0	100
5	.0223	0
10	.0458	0
15	.0706	0
20	.0969	0
25	.1249	0
30	.1549	0
35	.1871	0
40	.2219	0
45	.2596	0
50	.3010	0
55	.3468	0
60	.3979	0
65	.4559	0
70	.5229	0
75	.6021	0
80	.6990	0
85	.8239	0
90	1.000	0
95	1.301	0
100		0
0	0	TIME AVERAGE

OBSERVER: J. STOCK
CERTIFICATION DATE: NOV. 1, 1978
DATE OF OBSERVATION: 1-23-79
TIME OF OBSERVATION: 1500-1600

3.3.2 TEST NO. 2 - KILN COOLER STACK

RESULTS OF OPACITY OBSERVATIONS - EPA METHOD 9

PERCENT OPACITY	OPTICAL DENSITY	RELATIVE FREQUENCY (%)
0	0	100
5	.0223	0
10	.0458	0
15	.0706	0
20	.0969	0
25	.1249	0
30	.1549	0
35	.1871	0
40	.2219	0
45	.2596	0
50	.3010	0
55	.3468	0
60	.3979	0
65	.4559	0
70	.5229	0
75	.6021	0
80	.6990	0
85	.8239	0
90	1.000	0
95	1.301	0
100		0
0	0	TIME AVERAGE

OBSERVER: J. STOCK
CERTIFICATION DATE: NOV. 1, 1979
DATE OF OBSERVATION: 1-23-79
TIME OF OBSERVATION: 1500-1600

3.3.3 TEST NO. 3 - GRATE FEED END

RESULTS OF OPACITY OBSERVATIONS - EPA METHOD 9

PERCENT OPACITY	OPTICAL DENSITY	RELATIVE FREQUENCY (%)
0	0	100
5	.0223	0
10	.0458	0
15	.0706	0
20	.0969	0
25	.1249	0
30	.1549	0
35	.1871	0
40	.2219	0
45	.2596	0
50	.3010	0
55	.3468	0
60	.3979	0
65	.4559	0
70	.5229	0
75	.6021	0
80	.6990	0
85	.8239	0
90	1.000	0
95	1.301	0
100		0
0	0	TIME AVERAGE

OBSERVER: J. STOCK
CERTIFICATION DATE: NOV. 1, 1978
DATE OF OBSERVATION: 1-23-79
TIME OF OBSERVATION: 1600-1700