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

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Title: Results of the October 23 and 24, 1979 Particulate Emission Compliance Tests on the Coarse Crusher Discharge, Crusher Dump Pocket Discharge and North Loading Tunnel at the Eveleth Taconite Company Thunderbird Mine

Interpoll, Inc.

Interpoll, Inc.

November 1979

Re: Bl 4-40

AP-42 Section 11.23
Reference —
Report Sect. 4
Reference 40

NO PROCESS DATA

Interpoll Inc.
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RESULTS OF THE OCTOBER 23 AND 24, 1979 PARTICULATE EMISSION COMPLIANCE TESTS ON THE COARSE CRUSHER DISCHARGE, CRUSHER DUMP POCKET DISCHARGE AND NORTH LOADING TUNNEL AT THE EVELETH TACONITE COMPANY THUNDERBIRD MINE

Submitted to:

EVELETH TACONITE 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 9-658
November 28, 1979

RGF BR 4-40

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1 INTRODUCTION

On October 23 and 24, 1979, Interpoll Inc. personnel conducted a series of particulate emission compliance tests on the Coarse Crusher aghouse Discharge, the Crusher Dump Pocket Baghouse Discharge and the North Loading Baghouse Discharge at the Eveleth Taconite Company - Thunderbird Mine. On-site testing was performed by E. Trowbridge and D. VanHoever. Coordination between plant operation and testing activities was provided by D. Jarvis of Eveleth Taconite Company. The tests were not witnessed by a member of the Minnesota Pollution Control Agency.

Particulate determinations 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). Preliminary determinations of the gas linear velocity profile were made on each of the three sources before the start of the first particulate determination to allow selection of the appropriate nozzle diameter required for isokinetic sample withdrawal. Interpoll sampling trains which meet or exceed specifications in the above-cited references were 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 duct leading to the blower. Testing protocol on each source was based upon EPA Method 1 specifications. A visible emission determination was also performed on each source by a certified observer.

The important results of the test 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.

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.

Table 1. Summary of the Results of the October 23, 1979 Particulate Emission Compliance Test on the Coarse Crusher Discharge Stack at the Eveleth Taconite Company - Thunderbird Mine

ITEM	PRELIMINARY	RUN 1	RUN 2	RUN 3	AVG.
Date of test	10-23-79	10-23-79	10-23-79	10-23-79	
Time of test (HRS)	0900	1230-1340	1355-1545	1600-1705	
Volumetric flow					
ACTUAL (ACFM)	13700	13100	13200	13300	13,200
STANDARD (DSCFM)	12600	12200	12200	12300	
Gas temperature (DEG-F)	50.	50.	50.	50.	50
Gas moisture content (% v/v)	1.34	1.34	1.34	1.34	
Gas composition (% v/v, dry)					
carbon dioxide		.03	.03	.03	
oxygen		20.90	20.90	20.90	
nitrogen		79.07	79.07	79.07	
Time-averaged velocity weighted oxygen (% v/v, dry)		0	0	0	
Particulate concentration					
ACTUAL (GR/ACF)		.007	.007	.007	.007
STANDARD (GR/DSCF)		.008	.007	.007	.0073
Isokinetic variation (%)		106.7	104.0	104.0	
Particulate emission rate (LB/HR)		.83	.78	.77	0.79

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2 SUMMARY AND DISCUSSION

The important results of the particulate emission compliance test are summarized in Tables 1, 2 and 3. As will be noted, the measured particulate concentrations ranged from .004 to .008 GR/DSCF.

No difficulties were encountered in the field or in the laboratory evaluation of the 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 emission rates reported herein are accurate and closely reflect the actual values which existed at the time the tests were performed.

Table 3. Summary of the Results of the October 24, 1979 Particulate Emission Compliance Test on the North Loading Tunnel Stack at the Eveleth Taconite Company - Thunderbird Mine

ITEM	PRELIMINARY	RUN 1	RUN 2	RUN 3	AVG
Date of test	10-24-79	10-24-79	10-24-79	10-24-79	
Time of test (HRS)	0720	0740-0843	1110-1212	1618-1720	
Volumetric flow					
ACTUAL (ACFM)	37800	38400	38400	38800	38533
STANDARD (DSCFM)	37300	37800	37800	38200	
Gas temperature (DEG-F)	35.	40.	40.	40.	40
Gas moisture content (% v/v)	.88	.88	.88	.88	
Gas composition (% v/v, dry)					
carbon dioxide		.03	.03	.03	
oxygen		20.90	20.90	20.90	
nitrogen		79.07	79.07	79.07	
Time-averaged velocity weighted oxygen (% v/v, dry)		0	0	0	
Particulate concentration					
ACTUAL (GR/ACF)		.005	.004	.004	.0043
STANDARD (GR/DSCF)		.005	.004	.004	.0043
Isokinetic variation (%)		100.9	102.0	100.4	
Particulate emission rate (LB/HR)		1.48	1.28	1.40	1.39

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Table 2. Summary of the Results of the October 23, 1979 Particulate Emission Compliance Test on the Crusher Dump Pocket Discharge Stack at the Eveleth Taconite Company - Thunderbird Mine

ITEM	PRELIMINARY	RUN 1	RUN 2	RUN 3	AVG.
Date of test	10-23-79	10-23-79	10-24-79	10-24-79	
Time of test (HRS)	1655	1718-1835	0955-1100	1230-1335	
Volumetric flow					
ACTUAL (ACFM)	41500	39800	39600	39400	39,600
STANDARD (DSCFM)	39700	38200	38400	38200	
Gas temperature (DEG-F)	50.	50.	45.	45.	46.7
Gas moisture content (% v/v)	1.14	1.29	1.07	1.07	
Gas composition (% v/v, dry)					
carbon dioxide		.03	.03	.03	
oxygen		20.90	20.90	20.90	
nitrogen		79.07	79.07	79.07	
Time-averaged velocity weighted oxygen (% v/v, dry)		0	0	0	
Particulate concentration					
ACTUAL (GR/ACF)		.005	.004	.008	.0057
STANDARD (GR/DSCF)		.005	.004	.008	.0057
Isokinetic variation (%)		104.1	103.8	103.5	
Particulate emission rate (LB/HR)		1.70	1.38	2.56	1.88

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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 an isokinetic sampling is approximately equal but of opposite sign in the two calculation techniques and thus cancels in the average.

3.1.2 TEST NO. 2 CRUSHER DUMP POCKET DISCHARGE

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

	RUN 1	RUN 2	RUN 3
DATE OF RUN	10/23/79	10/24/79	10/24/79
DRY BASIS (ORSAT)			
CARBON DIOXIDE	.03	.03	.03
OXYGEN	20.90	20.90	20.90
CARBON MONOXIDE	0	0	0
NITROGEN	79.07	79.07	79.07
WET BASIS (ORSAT)			
CARBON DIOXIDE	.03	.03	.03
OXYGEN	20.63	20.68	20.68
CARBON MONOXIDE	0	0	0
NITROGEN	78.05	78.22	78.22
MOISTURE CONTENT	1.29	1.07	1.07
DRY MOLECULAR WEIGHT	28.84	28.84	28.84
WET MOLECULAR WEIGHT	28.70	28.72	28.72
SPECIFIC GRAVITY (RELATIVE TO AIR)	.9914	.9922	.9922

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

JOB: EXCO - NORTH THUNDERBIRD

INTERPOLL REPORT NO. 9-658

3.1.1 TEST NO. 1 COARSE CRUSHER DISCHARGE

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

	RUN 1	RUN 2	RUN 3
DATE OF RUN	10/23/79	10/23/79	10/23/79
DRY BASIS (ORSAT)			
CARBON DIOXIDE	.03	.03	.03
OXYGEN	20.90	20.90	20.90
CARBON MONOXIDE	0	0	0
NITROGEN	79.07	79.07	79.07
WET BASIS (ORSAT)			
CARBON DIOXIDE	.03	.03	.03
OXYGEN	20.62	20.62	20.62
CARBON MONOXIDE	0	0	0
NITROGEN	78.01	78.01	78.01
MOISTURE CONTENT	1.34	1.34	1.34
DRY MOLECULAR WEIGHT	28.84	28.84	28.84
WET MOLECULAR WEIGHT	28.70	28.70	28.70
SPECIFIC GRAVITY (RELATIVE TO AIR)	.9912	.9912	.9912

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

3.2 Results of Particle Concentration Determination

3.1.3 TEST NO. 3 NORTH LOADING TUNNEL

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

	RUN 1	RUN 2	RUN 3
DATE OF RUN	10/24/79	10/24/79	10/24/79
DRY BASIS (ORSAT)			
CARBON DIOXIDE	.03	.03	.03
OXYGEN	20.90	20.90	20.90
CARBON MONOXIDE	0	0	0
NITROGEN	79.07	79.07	79.07
WET BASIS (ORSAT)			
CARBON DIOXIDE	.03	.03	.03
OXYGEN	20.72	20.72	20.72
CARBON MONOXIDE	0	0	0
NITROGEN	78.37	78.37	78.37
MOISTURE CONTENT	.88	.88	.88
DRY MOLECULAR WEIGHT	28.84	28.84	28.84
WET MOLECULAR WEIGHT	28.75	28.75	28.75
SPECIFIC GRAVITY (RELATIVE TO AIR)	.9929	.9929	.9929

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

3.2.2 TEST NO. 2 CRUSHER DUMP POCKET DISCHARGE

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

	RUN 1	RUN 2	RUN 3
DATE OF RUN	10/23/79	10/24/79	10/24/79
TIME RUN START/END(HRS)	1718/1835	955/1100	1230/1335
PITOT TUBE COEFFICIENT	.844	.844	.844
TOTAL MOISTURE IN GAS SAMPLE (GRAMS)	13.0	10.8	10.7
TOTAL PARTICULATE MATERIAL COLLECTED(GRAMS) *	.0158	.0128	.0237
VOLUME THROUGH GAS METER (CF AT METER COND.)	46.28	45.75	45.58
TOTAL SAMPLING TIME (MIN)	72.0	72.0	72.0
NOZZLE DIAMETER (IN)	.243	.243	.243
AVERAGE STACK GAS TEMPERATURE DURING DETERMINATION (DEG-F)	50.	45.	45.
VOLUMETRIC FLOW**			
ACTUAL ..... (ACFM)	39818	39585	39371
DRY STANDARD ... (DSCFM)	38201	38440	38232
ISOKINETIC VARIATION (%)	104.1	103.8	103.5
PARTICLE CONCENTRATION			
ACTUAL ..... (GR/ACF)	.0050	.0041	.0076
DRY STANDARD ... (GR/DSCF)	.0052	.0042	.0078
PARTICLE MASS FLOW (LB/HR)	1.73	1.41	2.61

AVG. 39591

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

JOB: EXCO - NORTH THUNDERBIRD

INTERPOLL REPORT NO. 9-658

3.2.3 TEST NO. 3 NORTH LOADING TUNNEL

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

	RUN 1	RUN 2	RUN 3	
DATE OF RUN	10/24/79	10/24/79	10/24/79	
TIME RUN START/END(HRS)	740/ 843	1110/1212	1618/1720	
PITOT TUBE COEFFICIENT	.870	.870	.870	
TOTAL MOISTURE IN GAS SAMPLE (GRAMS)	8.3	8.4	8.3	
TOTAL PARTICULATE MATERIAL COLLECTED(GRAMS) *	.0130	.0114	.0122	
VOLUME THROUGH GAS METER (CF AT METER COND.)	42.98	43.30	43.44	
TOTAL SAMPLING TIME (MIN)	60.0	60.0	60.0	
NOZZLE DIAMETER (IN)	.184	.184	.184	
AVERAGE STACK GAS TEMPERATURE DURING DETERMINATION (DEG-F)	40.	40.	40.	
VOLUMETRIC FLOW**				AVG.
ACTUAL ..... (ACFM)	38425	38439	38838	38567
DRY STANDARD ... (DSCFM)	37809	37822	38215	
ISOKINETIC VARIATION (%)	100.9	102.0	100.4	
PARTICLE CONCENTRATION				
ACTUAL ..... (GR/ACF)	.0045	.0039	.0042	
DRY STANDARD ... (GR/DSCF)	.0046	.0040	.0043	
PARTICLE MASS FLOW (LB/HR)	1.49	1.30	1.40	

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

3.3 Results of Opacity Determinations

3.3.1 TEST NO. 1 SOURCE: COARSE CRUSHER DISCHARGE

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
		TIME AVERAGE

OBSERVER: E. TROWBRIDGE
CERTIFICATION DATE: 6-6-79
DATE OF OBSERVATION: 10-23-79
TIME OF OBSERVATION: 0815-0915

3.3.2 TEST NO. 2 SOURCE: COARSE CRUSHER DUMP POCKET

RESULTS OF OPACITY OBSERVATIONS - EPA METHOD 9

PERCENT OPACITY	OPTICAL DENSITY	RELATIVE FREQUENCY (%)
0	0	65
5	.0223	35
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
		TIME AVERAGE

OBSERVER: E. TROWBRIDGE
CERTIFICATION DATE: 6-6-79
DATE OF OBSERVATION: 10-24-79
TIME OF OBSERVATION: 1340-1440

3.3.3 TEST NO. 3 SOURCE: NORTH LOADING TUNNEL

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
		TIME AVERAGE

OBSERVER: E. TROWBRIDGE
CERTIFICATION DATE: 6-6-79
DATE OF OBSERVATION: 10-23-79
TIME OF OBSERVATION: 1510-1610