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Midwest Research Institute
Kansas City, MO

1994

MRI REPC

AP-42 Section Reference 9.9.1
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Tests of Oil Suppression of PM-10 At Grain Elevators

Test Report

For Robert McCrackan
Emission Measurement Branch
U.S. Environmental Protection Agency

EPA Contract No. 68-D2-0165
Work Assignment No. 2-32
MRI Project No. 3802-32

November 15, 1994

MIDWEST RESEARCH INSTITUTE 425 Volker Boulevard, Kansas City, MO 64110-2299 • (816) 753-7600

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MRI REPORT

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PREFACE

This report presents the emission test results from a scoping field test program conducted during August 1994 at a grain elevator in Greenwood, Nebraska. The report was prepared for Mr. Robert McCrackan, Emission Measurement Branch, Technical Support Division, Office of Air Quality Planning and Standards, U.S. Environmental Protection Agency, Research Triangle Park, North Carolina, under EPA Contract No. 68-D2-0165, Work Assignment Nos. 1-30 and 2-32. Dr. Gregory E. Muleski, Work Assignment Leader, prepared this report.

Approved for:

MIDWEST RESEARCH INSTITUTE

John Hosenfeld
Program Manager
Applied Engineering Department

for Charles F. Holt, Ph.D., Director
Applied Engineering Department

November 15, 1994

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SECTION 1

INTRODUCTION

This report presents the results of a "scoping" field study performed by Midwest Research Institute (MRI) at a grain elevator in Greenwood, Nebraska. The study addressed particulate emissions generated by transferring grain onto a gallery belt. A total of 16 runs were performed during the week of August 22, 1994.

A major objective of the study was to develop quantitative information on the effectiveness of mineral oil suppression. The study considered two grains (milo and corn); tests of controlled and uncontrolled emissions for each grain were performed.

Grain	Test condition	Run No.
Milo	Unoiled (i.e., uncontrolled)	BC-1,2,3
Milo	Oiled at 25 psi pressure setting	BC-5,6
Milo	Oiled at 20 psi pressure setting	BC-7,8
Corn	Unoiled (i.e., uncontrolled)	BC-9,10
Corn	Oiled at 25 psi pressure setting	BC-11,12
Corn	Oiled at 20 psi pressure setting	BC-13,14
None	Background (i.e., belt moving but no grain transferred)	BC-15
None	Blank runs	BC-17,18

Two airborne particle size fractions are of interest in this report:

PM-10 Particulate matter (PM) no greater than 10 μm (microns) in aerodynamic diameter

TP Total airborne particulate matter (i.e., regardless of size)

The remaining sections of this report present (a) the test methodology, (b) the test results obtained, and (c) conclusions derived from the testing program.

SECTION 2

TEST METHODOLOGY

Emission testing was the major topic of discussion during meetings and site presurveys in the Lincoln, Nebraska, area during the week of June 20, 1994. Attendees included representatives of the USEPA (both the Emission Inventory and Emission Measurement Branches), MRI, the Nebraska Grain and Feed Association, and the Nebraska Department of Environmental Quality.

The group generally agreed that "exposure profiling" represents the most appropriate means to measure fugitive (i.e., nonducted) emission sources at elevators. Exposure profiling requires simultaneous multipoint sampling over the effective cross-section of the dust source plume. The method relies on a mass balance scheme similar to testing methods (such as EPA Method 5 for total particulate or Method 201[A] for PM-10) used for conventional ducted sources. Currently available emission factors (especially those in AP-42 Section 9.9.1)[1] for grain elevators and mills are based on data obtained with these conventional methods.

Exposure profiling samples emissions borne by ambient winds (at 5 to 10 mph) rather than inducing a strong draft to capture particulate for conventional sampling methods. The current version of AP-42 Section 9.9.1 notes that although imposing a strong draft (with airflows of 25 mph or more) provides "a reasonable estimate of the emissions at the control device inlet . . . the emission factor is likely to be biased high for uncontrolled emissions at operations not equipped with ventilation systems."[1]

2.1 TEST SITE SELECTION

On June 21, 1994, EPA and MRI representatives conducted presurveys of four elevators in three locations near Lincoln. Of particular interest in the surveys was locating a suitable test site for a scoping study of mineral oil suppression. Of the four elevators inspected, only the Greenwood, Nebraska, elevator had an oil suppression system in operation. The interested parties agreed to conduct scoping tests of bin-to-bin transfers of stored grain during the period between the July and September harvests. This would allow for the testing schedule called for in the work assignment while not interfering with harvest activities.

The Greenwood elevator applies food grade mineral oil (Amoco Superla DCO) through a spray system supplied by InterSystems of Omaha, Nebraska. A cost of

$288.50 was quoted for a 55-gal drum of the oil during an October 1994 telephone conversation.

The system sprays oil through inspection ports on the elevator legs. The spray system contains a check valve and cannot operate with the oil pressure less than 20 psi. Facility personnel stated that they typically operate the system at 25 psi. A representative of InterSystems stated that the spray tip used (No. 8001) delivers 0.076 gal/min at 80°F and 20 psi and 0.1 gal/min at 80°F and 40 psi.

2.2 DESCRIPTION OF THE SOURCE

Tests were conducted in the southwest gallery at the Greenwood elevator. The gallery is a long concrete room approximately 12 ft wide by 8 ft high in cross-section. The room contains a conveyor that is fed by the grain distributor in the headhouse. The conveyor discharges into storage bins through a belt tripper. The tested emission source was the first belt transfer point (i.e., where grain enters from the distributor), which occurs within a small inclined metal "transition" room that connects the headhouse building with the gallery.

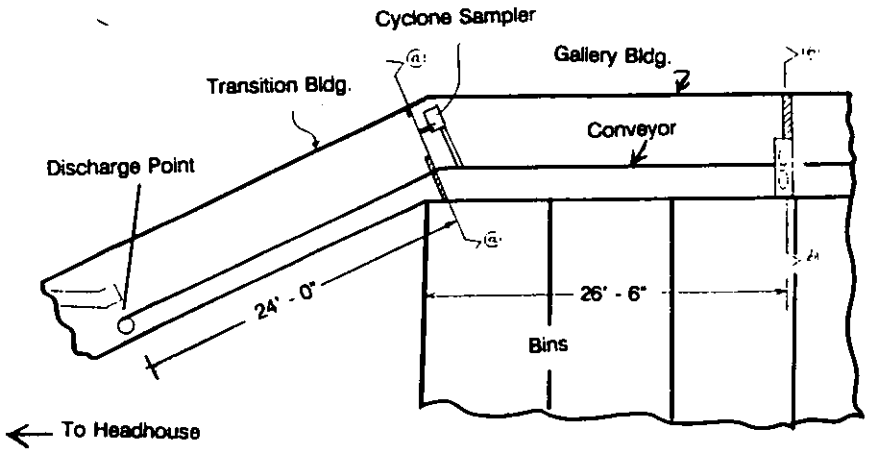
Figure 1 shows a schematic of the test site.

Sampling relied on the use of two 48-in propeller fans to draw a slight draft through the gallery. The fans were fitted with explosion-proof (XP) motors. Section b-b (Figure 1[b]) shows the location of fans and the air barriers constructed. Electrical power to fans was provided by two 3.6-kW gasoline generators placed on the bin deck, one located along each side of the gallery. This placement was chosen to avoid potential explosion hazard.

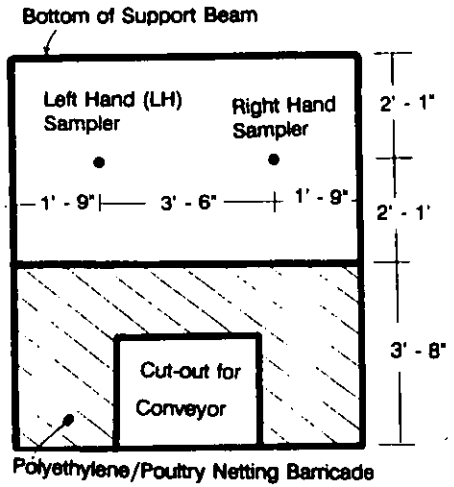
Air sampling made use of two high-volume ("hi-vol") samplers fitted with cyclone preseparators (Figure 2). Samplers were powered by a duplex 110-VAC outlet in the headhouse building. The number of samplers and wind monitoring equipment was limited because of available electrical power. In addition, power was unavailable to sample "upwind" concentrations during a test; for this reason, MRI conducted a "background" run (BC-15) during which the belt ran but no grain was transferred. Finally, because of the potential explosion hazard, the hi-vol blower exhaust was ducted out a window.

The sampling plane is shown as Section a-a (Figure 1[b]) and was located at a point where the transition and gallery meet. During equipment setup, MRI measured the average wind speed through the 50-in by 84-in opening as 10.2 mph. Measurement made use of a Biram vane anemometer.

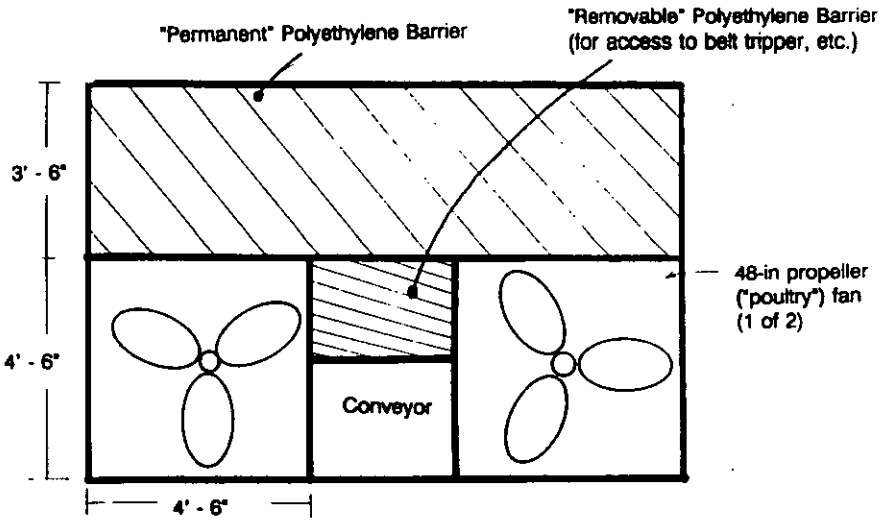
Further detail on the sampling method is provided in the next section.



NORTHWEST ELEVATION
(a)



SECTION a-a
(b)



SECTION b-b
(c)

Figure 1. Test site schematic.

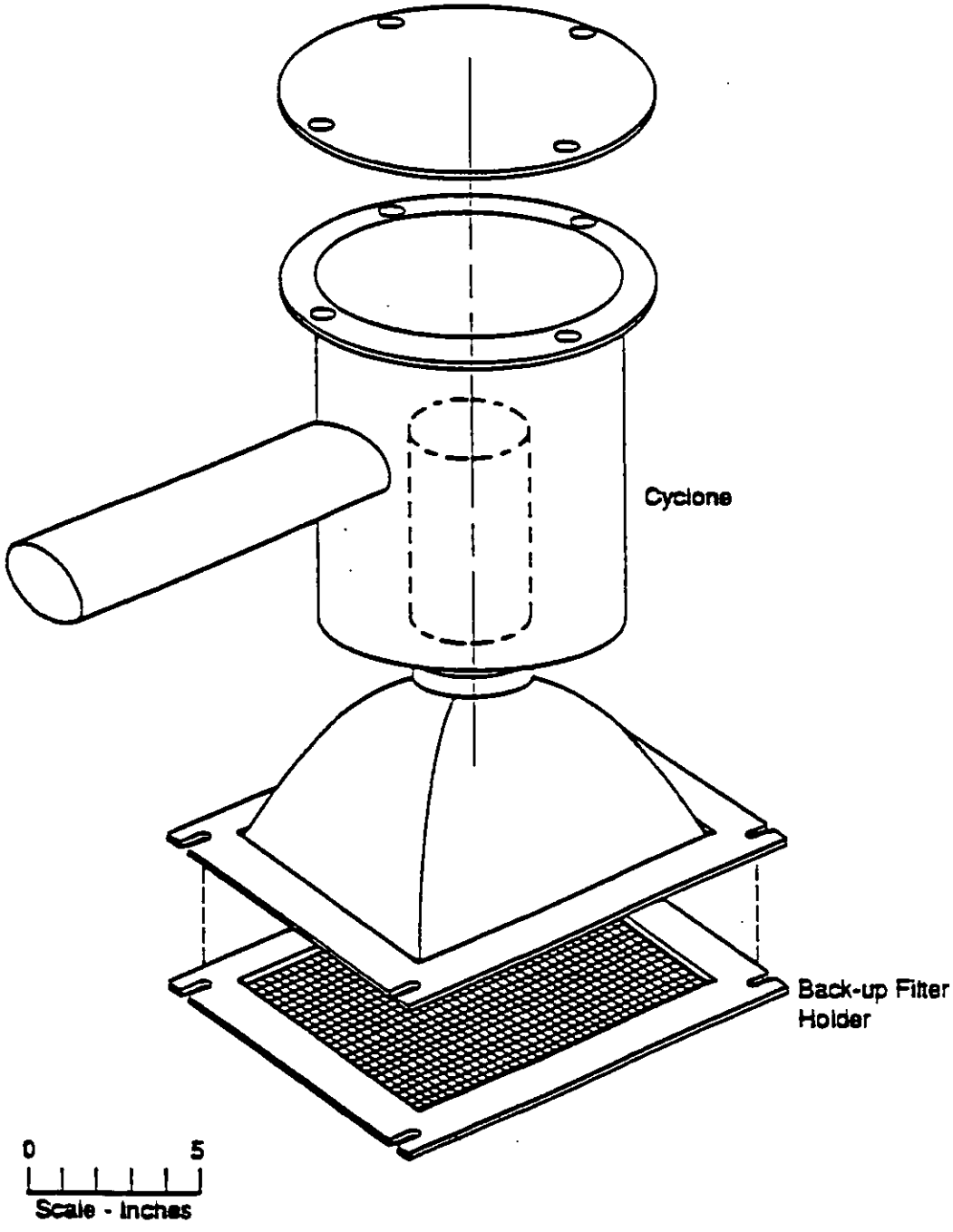


Figure 2. Cyclone preseparator.

2.3 AIR SAMPLING EQUIPMENT AND TECHNIQUES

2.3.1 Sampling Equipment

The exposure profiling technique used for the tests in this study is based on the isokinetic profiling concept that is used in conventional source testing. The passage of airborne pollutant immediately downwind of the source was measured directly by means of simultaneous multipoint sampling over the effective cross-section of the open dust source plume. This technique used a mass-balance calculation scheme similar to EPA Method 5 stack testing, rather than requiring indirect calculation through the application of a generalized atmospheric dispersion model.

The equipment deployment is shown in Figure 1. The primary air sampling device in this study was a hi-vol air sampler fitted with a cyclone preseparator (Figure 2). The cyclone exhibits an effective 50% cutoff diameter (D_{50}) of approximately 10 μmA when operated at a nominal flow rate of 40 acfm (68 m^3/h).[2]

During each test, wind speed was monitored at the downwind sampling sites by a Biram vane anemometer.

2.3.2 Particulate Sample Handling and Analysis

The sampling and analysis procedures followed in this field testing program were subject to certain QA guidelines. These guidelines will be discussed in conjunction with the activities to which they apply. These procedures met or exceeded the requirements specified in the reports entitled "Quality Assurance Handbook for Air Pollution Measurement Systems, Volume II—Ambient Air Specific Methods" (EPA 600/4-77-027a) and "Ambient Monitoring Guidelines for Prevention of Significant Deterioration" (EPA 450/2-78-019).

As part of the QA program for this study, routine audits of sampling and analysis procedures were performed. The purpose of the audits was to demonstrate that measurements were made within acceptable control conditions for particulate source sampling and to assess the source testing data for precision and accuracy. Examples of items audited include gravimetric analysis, flow rate calibration, data processing, and emission factor calculation. The mandatory use of specially designed reporting forms for sampling and analysis data obtained in the field and the laboratory aided in the auditing procedure. Further details on specific sampling and analysis procedures are provided in the following sections.

Particulate samples were collected on Whatman Grade AH glass fiber filters. Prior to the initial weighing, the filters were equilibrated for 24 h at constant temperature and humidity in a special weighing room. During weighing, the balance was checked at frequent intervals with standard (Class S) weights to ensure accuracy. The filters remained in the same controlled environment for another 24 h, after which

a second analyst reweighed them as a precision check. Ten percent of the filters used in the field served as blanks. The QA guidelines pertaining to preparation of sample collection media and equipment operations are presented in Tables 1 and 2, respectively.

To prevent particulate losses, the exposed media were carefully transferred at the end of each run to protective containers for transportation. The interior surfaces of cyclone preseparators were washed with distilled water; particulate matter that collected on the interior surfaces of cyclone preseparators during sizing tests was rinsed into separate sample jars which were then capped and taped shut. In the field laboratory, exposed filters were placed in individual glassine envelopes and then into numbered file folders. When exposed filters and the associated blanks were returned to the MRI laboratory, they were equilibrated under the same conditions as the initial weighing. After reweighing, 10% were audited to check weighing accuracy.

To determine the sample weight of particulate collected on the interior surfaces of samplers, the entire wash solution was passed through a Büchner-type funnel holding an 11-cm glass fiber filter under suction. This ensured collection of all suspended material on the filter. (The 11-cm filters were substituted for standard 47-mm filters because of the large amount of material collected in the cyclone.)

All wash filters were weighed with a 100% audit of tared and a 10% audit of exposed filters. Blank values were determined by washing "clean" (unexposed) cyclone preseparators in the field and following the above procedures.

2.3.3 Emission Factor Calculation Procedures

To calculate emission rates from exposure profiling test data, a conservation of mass approach is used. The passage of airborne particulate (i.e., the quantity of emissions per unit of source activity) is obtained by spatial integration of distributed measurements of exposure (mass/area) over the effective cross-section of the plume. Exposure is the point value of the flux (mass/area-time) of airborne particulate integrated over the time of measurement, or equivalently, the net particulate mass passing through a unit area normal to the mean wind direction during the test.

TABLE 1. QUALITY ASSURANCE PROCEDURES FOR SAMPLING MEDIA

Activity	QA check/requirement
Preparation	Inspect and imprint glass fiber media with identification numbers.
Conditioning	Equilibrate media for 24 h in clean controlled room with relative humidity of 45% (variation of less than ±5% RH) and with temperature of 23°C (variation of less than ±1°C).
Weighing	Weigh hi-vol filters to nearest 0.1 mg.
Auditing of weights	Independently verify final weights of 10% of filters (at least four from each batch). Reweigh batch if weights of any hi-vol filters deviate by more than ±2.0 mg. For tare weights, conduct a 100% audit. Reweigh tare weight of any filters that deviate by more than ±1.0 mg. Follow same procedures for impactor substrates used for sizing tests. Audit limits for impactor substrates are 1.0 and 0.5 mg for final and tare weights, respectively.
Correction for handling effects	Weigh and handle at least one blank for each 1 to 10 filters of each type used to test.
Calibration of balance	Balance to be calibrated once per year by certified manufacturer's representative. Check prior to each use with laboratory Class S weights.

TABLE 2. QUALITY ASSURANCE PROCEDURES FOR SAMPLING EQUIPMENT

Activity	QA check/requirement[a]
Maintenance • All samplers	Check motors, gaskets, timers, and flow measuring devices at each plant prior to testing.
Operation • Timing	Start and stop all downwind samplers during time span not exceeding 1 min.
• Isokinetic sampling (cyclones)	Adjust sampling intake orientation whenever mean wind direction dictates. Change the cyclone intake nozzle whenever the mean wind speed approaching the sampler falls outside of the suggested bounds for that nozzle. This technique allocates no nozzle for wind speeds ranging from 0 to 10 mph, and unique nozzles for four wind speed ranges above 10 mph.
• Prevention of static mode deposition	Cover sampler inlets prior to and immediately after sampling.

[a] "Mean" denotes a 3- to 15-min average.

The concentration of particulate matter measured by a sampler is given by:

$$C = \frac{m}{Qt}$$

where: C = particulate concentration (mass/volume)
m = particulate sample weight (mass)
Q = sampler flow rate (volume/time)
t = duration of sampling (time)

The isokinetic flow rate (IFR) is the ratio of a directional sampler's intake air speed to the mean wind speed approaching the sampler. It is given by:

$$IFR = \frac{Q}{aU}$$

where: Q = sampler flow rate (volume/time)
a = intake area of sampler (area)
U = mean wind speed at height of sampler (length/time)

This ratio is of interest in the sampling of total particulate, since isokinetic sampling ensures that particles of all sizes are sampled without bias. The cyclone has an intake velocity of 880 ft/min (10 mph) when operated at 40 cfm. IFR values ranged from 0.70 to 0.92 for the left-hand sampler and 0.79 to 0.89 for the right-hand sampler. Note, however, that because the primary interest in this program was directed to PM-10 emissions, sampling under moderately nonisokinetic conditions posed no difficulty. PM-10 particles have weak inertial characteristics at normal wind speeds and therefore are relative unaffected by anisokinesis.[3]

The net particulate flux represents net passage of mass per unit area and is found by:

$$F = (C - C_b) \cdot U$$

where: F = net particulate flux (mass/area/time)
C = average concentration measured by LH (left-hand) and RH (right-hand samplers (mass volume)
C_b = average "background" concentration from Run BC-15 (mass/volume)
U = mean wind speed (length/time) through measurement plane (i.e., Section a-a of Figure 1) (measured as 10.2 mph)

The total mass flow rate M through the sampling plane is:

$$M = A \cdot F$$

where: M = mass flow rate (mass/time)
F = particulate flux (mass/area/time)
A = area of measurement plane
= 29 ft^2 = 2.7 m^2 = (7 ft 0 in x 4 ft 2 in)

Dividing M by a 4,500 bu/h throughput and assuming each grain weighs 60 lb/bu yields the emission factor in lb/ton.

SECTION 3

TEST RESULTS

This section describes results obtained from the scoping study.

3.1 EMISSION MEASUREMENTS

Table 3 presents the test site parameters associated with each run. Table 4 presents a spreadsheet that lists, for each run, individual filter catches and concentration values for the left- and right-hand samplers. Table 5 contains the PM-10 and TP emission factors calculated for each run, and Table 6 summarizes the findings by presenting the geometric mean emission factors for each grain/oil combination.

Note that results presented here lend credence to the notion that certain factors in Section 9.9.1 may overstate actual emissions. AP-42 Table 9.9.1-3 offers an uncontrolled PM emission factor of 0.11 lb/ton for gallery belt transfer of "various" grains at inland/export terminals.* This value is 12 to 15 times greater than the uncontrolled emission factors found in this study, even though milo and corn are known as fairly "dusty" grains.

3.2 CONTROL EFFECTIVENESS

The following control efficiency values can be calculated from results in Table 6:

	Control efficiency (%)			
	Oil at 25 psi		Oil at 20 psi	
Grain	PM-10	TP	PM-10	TP
Milo	57	56	33	21
Corn	69	48	79	57

* Note that an early draft of Section 9.9.1 mistakenly contained "0.011" lb/ton for gallery belt transfer of Table 9.9.1-3.

TABLE 3. EXPOSURE PROFILING TEST PARAMETERS

Run	Date	Test start	Duration (min)	Ambient air temp.		Sampler approach velocity (ft/min)	
				°C	°F	LH	RH
BC-1	8/23/94	15:55	25	28	83	NA	NA
BC-2	8/24/94	08:48	17	24	75	616	704
BC-3	8/24/94	09:18	30	24	76	760	736
BC-5	8/24/94	15:25	60	31	88	792	772
BC-6	8/24/94	16:43	62	32	89	712	740
BC-7	8/25/94	08:44	49	27	80	756	752
BC-8	8/25/94	09:43	46	27	81	768	732
BC-9	8/25/94	11:19	22	29	85	752	776
BC-10	8/25/94	11:51	21	29	85	768	700
BC-11	8/25/94	14:20	62	32	89	748	712
BC-12	8/25/94	15:32	64	32	90	732	732
BC-13	8/26/94	08:45	45	23	73	724	692
BC-14	8/26/94	09:47	46	24	75	812	780

TABLE 4. PM-10 SAMPLING DATA AND RESULTS

A	B	C	D	E	F	G	H	I	J	K	L	M	N
Run	Date	Sampler Location	Sampler ID	Grain Start Time	Grain Stop Time	Grain Time (min)	Run Start Time	Run Stop Time	Run Time (min)	Avg. Temp. (deg. F)	Avg. B.P. (in. Hg)	Avg. Filter Pressure (in. H2O)	Avg. Flowrate (ft^3/min)
BC-1	8/23/94	LHS	78	15:50	16:25	35	15:55	16:20	25	83	28.80	14.09	41.31
		RHS	69						25			14.17	42.05
BC-2	8/24/94	LHS	78	08:47	09:04	17	08:48	09:05	17	75	29.05	13.85	41.08
		RHS	69						17			13.88	41.82
BC-3	8/24/94	LHS	78	09:16	09:48	32	09:18	09:48	30	76	29.05	14.27	41.07
		RHS	69						30			13.92	41.85
BC-5	8/24/94	LHS	78	15:21	16:25	64	15:25	16:25	60	88	28.90	14.15	41.48
		RHS	69						60			14.52	42.18
BC-6	8/24/94	LHS	78	16:42	17:44	62	16:43	17:45	62	89	28.93	14.40	41.47
		RHS	69						62			14.39	42.21
BC-7	8/25/94	LHS	78	08:29	09:32	63	08:44	09:33	49	80	28.90	13.75	41.25
		RHS	69						49			14.06	41.95
BC-8	8/25/94	LHS	78	09:42	10:29	47	09:43	10:29	46	81	28.90	14.26	41.24
		RHS	69						46			14.11	41.98
BC-9	8/25/94	LHS	78	11:14	11:41	27	11:19	11:41	22	85	28.95	13.94	41.42
		RHS	69						22			14.03	42.12
BC-10	8/25/94	LHS	78	11:50	12:12	22	11:51	12:12	21	85	28.95	14.22	41.38
		RHS	69						21			14.03	42.12
BC-11	8/25/94	LHS	78	14:04	15:21	77	14:20	15:22	62	89	28.95	13.97	41.56
		RHS	69						62			14.27	42.26
BC-12	8/25/94	LHS	78	15:31	16:36	65	15:32	16:36	64	90	28.95	14.32	41.55
		RHS	69						64			14.34	42.29
BC-13	8/26/94	LHS	78	08:38	09:30	52	08:45	09:30	45	73	28.80	14.02	40.97
		RHS	69						45			13.67	41.75
BC-14	8/26/94	LHS	78	09:46	10:33	47	09:47	10:33	46	75	28.85	13.64	41.08
		RHS	69						46			13.99	41.78
BC-15	8/26/94	LHS	78	10:43	13:07	144	10:44	13:07	143	79	28.90	14.04	41.18
		RHS	69						143			13.83	41.96
BC-17	8/26/94	LHS	78										
		RHS	69										
BC-18	8/26/94	LHS	78										
		RHS	69										

TABLE 4 (Continued)

O	P	Q	R	S	T	U	V	W	X
	Run	Filter Number	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)	Wt. after Blank Correction	PM10 Concentration (ug/m^3)	Average Concentration (background corrected)	PM10 Emission Factor lb PM10 / ton grain)
8	BC-1	9433001	3307.40	3404.05	96.65	95.51	3266	2972	0.00211
9		9433002	3307.30	3400.35	93.05	91.91	3087		
10									
11	BC-2	9433003	3312.75	3351.25	38.50	37.36	1889	1143	0.00081
12		9433004	3319.90	3337.25	17.35	16.21	805		
13									
14	BC-3	9433005	3314.85	3533.05	218.20	217.06	6221	4624	0.00328
15		9433006	3305.85	3429.10	123.25	122.11	3434		
16									
17	BC-5	9433009	3320.10	3428.30	108.20	107.06	1519	1124	0.00080
18		9433010	3295.20	3377.80	82.60	81.46	1137		
19									
20	BC-6	9433011	3310.05	3404.95	94.90	93.76	1288	1011	0.00072
21		9433012	3301.55	3387.30	85.75	84.61	1142		
22									
23	BC-7	9433013	3293.75	3442.00	148.25	147.11	2570	2042	0.00145
24		9433014	3301.40	3414.45	113.05	111.91	1922		
25									
26	BC-8	9433015	3302.25	3384.95	82.70	81.56	1518	1361	0.00097
27		9433016	3291.90	3381.15	89.25	88.11	1611		
28									
29	BC-9	9433017	3280.60	3370.15	89.55	88.41	3426	2836	0.00201
30		9433018	3262.75	3333.55	70.80	69.66	2654		
31									
32	BC-10	9433019	3278.00	3381.70	103.70	102.56	4167	3671	0.00260
33		9433020	3272.65	3363.55	90.90	89.76	3583		
34									
35	BC-11	9433021	3273.55	3360.50	86.95	85.81	1176	907	0.00064
36		9433022	3284.85	3363.60	78.75	77.61	1046		
37									
38	BC-12	9433023	3273.30	3362.70	89.40	88.26	1172	1097	0.00078
39		9433024	3263.85	3374.60	110.75	109.61	1430		
40									
41	BC-13	9433025	3281.25	3324.60	43.35	42.21	808	548	0.00039
42		9433026	3282.25	3320.45	38.20	37.06	697		
43									
44	BC-14	9433027	3284.10	3344.25	60.15	59.01	1103	799	0.00057
45		9433028	3287.70	3338.00	50.30	49.16	903		
46									
47	BC-15	9433029	3272.10	3304.20	32.10	30.96	186		
48		9433030	3267.25	3306.25	39.00	37.86	223		
49									
50	BC-17	9433033	3272.90	3274.85	1.95				
51		9433034	3262.25	3264.30	2.05				
52									
53	BC-18	9433035	3269.40	3269.40	0.00				
54		9433036	3272.00	3272.55	0.55				

T8=S8-R8
U8=T8-1.14
V8=(U8*1000)/(N8*J*0.02832)
W8=(V8+V9)/2-204
Y8=(724/(1000000*453.6)*W8*J8)/(60*4500/60*J8/2000)

TABLE 4 (Continued)

Y	Z	AA	AB	AC	AD	AE	AF	AG	AH
	Run	Wash Filter Number	Tare Wt. (mg)	Final Wt. (mg)	Net Wt. (mg)	Wt. after Blank Correction	TP Concentration (ug/m^3)	Average Concentration (background corrected)	TP Emission Factor (lb TP / ton grain)
8	BC-1	9436001	346.69	748.27	401.58	395.93	16803	13926	0.00988
9		9430001	854.20	1121.70	267.50	255.61	11673		
10									
11	BC-2	9430021	852.45	997.05	144.60	132.71	8599	5843	0.00415
12		9430018	867.90	938.30	70.40	58.51	3711		
13									
14	BC-3	9430002	844.40	1232.75	388.35	376.46	17010	12996	0.00922
15		9430004	863.30	1094.65	231.35	219.46	9607		
16									
17	BC-5	9430005	843.05	1198.35	355.30	343.41	6391	4966	0.00352
18		9430003	831.70	1060.60	228.90	217.01	4164		
19									
20	BC-6	9430014	860.55	1146.65	286.10	274.21	5054	3949	0.00280
21		9430013	864.50	1048.90	184.40	172.51	3469		
22									
23	BC-7	9430017	835.90	1543.45	707.55	695.66	14723	11796	0.00837
24		9430022	848.80	1301.45	452.65	440.76	9494		
25									
26	BC-8	9430015	840.90	1122.65	281.75	269.86	6541	5498	0.00390
27		9430020	829.15	1030.65	201.50	189.61	5078		
28									
29	BC-9	9430019	850.40	1094.45	244.05	232.16	12422	10684	0.00758
30		9430026	815.95	1009.30	193.35	181.46	9569		
31									
32	BC-10	9430016	833.30	1188.30	355.00	343.11	18110	15799	0.01121
33		9430006	829.35	1105.00	275.65	263.76	14113		
34									
35	BC-11	9430010	834.60	1394.50	559.90	548.01	8686	6371	0.00452
36		9430023	827.50	1109.10	281.60	269.71	4681		
37									
38	BC-12	9430008	873.60	1470.50	596.90	585.01	8940	7267	0.00516
39		9430009	840.25	1219.20	378.95	367.06	6219		
40									
41	BC-13	9430012	832.60	1157.95	325.35	313.46	6812	4983	0.00353
42		9430025	849.75	1025.60	175.85	163.96	3778		
43									
44	BC-14	9430011	855.05	1210.55	355.50	343.61	7523	6209	0.00440
45		9430024	865.50	1128.60	263.10	251.21	5519		
46									
47	BC-15	9436005	116.69	141.85	25.16	18.55	297		
48		9436006	110.92	135.12	24.20	17.59	326		
49									
50	BC-17	9430007	841.50	849.50	8.00				
51		9436009	116.90	130.06	13.16				
52									
53	BC-18	9436007	111.03	116.02	4.99				
54		9436008	117.15	119.37	2.22				
55									
56	Lab blank	9436004	110.35	109.81	-0.54				
57	Lab blank	9430027	874.45	879.40	4.95				
58	Lab blank	9430028	840.30	844.95	4.65				
59	Lab blank	9436010	119.74	119.33	-0.41				

AD8=AC8-AB8
AE8=AD-7.09-"lab blank value depending on filter type"
AF8=(AE8*1000)/(N8*J8*0.02832)+V8
AG8=(AF8+AF9)/2-312
AH8=(724/(1000000*453.6)*AG8*J8)/(60*4500/60*J8/2000)

TABLE 5. EXPOSURE PROFILING TEST RESULTS

Run	Grain type	Oil pressure (psi)	Grain transferred (tons)	Emission factor (lb/ton)	
				PM-10	TP
BC-1	Milo	No oil	56.3	0.0021	0.0099
BC-2	Milo	No oil	38.3	0.00081	0.0042
BC-3	Milo	No oil	67.5	0.0033	0.0092
BC-5	Milo	25	135	0.00080	0.0035
BC-6	Milo	25	140	0.00072	0.0028
BC-7	Milo	20	110	0.0015	0.0084
BC-8	Milo	20	104	0.00097	0.0039
BC-9	Corn	No oil	49.5	0.0020	0.0076
BC-10	Corn	No oil	47.3	0.0026	0.011
BC-11	Corn	25	140	0.00064	0.0045
BC-12	Corn	25	144	0.00078	0.0052
BC-13	Corn	20	101	0.00039	0.0035
BC-14	Corn	20	104	0.00057	0.0044

TABLE 6. MEAN EMISSION FACTORS

Test condition	Geometric mean (lb/ton)	
	PM-10	TP
Milo—no oil	0.0018	0.0073
Milo—25 psi oil	0.00076	0.0031
Milo—20 psi oil	0.0012	0.0057
Corn—no oil	0.0023	0.0091
Corn—25 psi oil	0.00071	0.0048
Corn—20 psi oil	0.00047	0.0039

It should be noted that the mineral oil control efficiency values obtained during this scoping study may be lower than that which can be achieved at other installations. This statement is based upon the fact that the Greenwood elevator applies the oil to grain in the leg. As a result, not all of the oil adheres to the grain and only a limited amount of mixing can occur before the grain hits the gallery belt. Other installations designed to spray oil during active grain tumbling are expected to exhibit higher control efficiency.[4]

SECTION 4

CONCLUSIONS

The following conclusions have been drawn from this scoping study:

1. Measured PM-10 emission factors ranged from 0.00081 to 0.0033 lb/ton for uncontrolled gallery belt transfers. The corresponding range for total particulate was 0.0042 to 0.011 lb/ton.

2. The TP measurements ranged from 10 to 26 times smaller than the AP-42 Section 9.9.1 factor for gallery belt transfer of "various" grains at inland/export terminals. This supports the commonly held view that factors based on testing upstream of control system may overstate emissions that occur at operations without control devices.

3. The mineral oil suppression system, as typically operated (i.e., 25 psi) at the Greenwood elevator, controlled, on average, approximately 60% of PM-10 and TP emissions from the gallery belt transfer of milo. For the transfer of corn, typical operation results in 69% and 48% control of PM-10 and TP emissions, respectively.

4. For the handling of corn, the oil suppression system functioned as well at 20 psi as at 25 psi. For milo, on the other hand, the lower oil pressure resulted in far less control.

5. The control efficiency values obtained during this scoping study may be lower than that which can be achieved at other installations which are designed to spray oil during active grain tumbling.

6. Future testing efforts should use a different means to measure the coarse particle size fraction. This could be accomplished by either (a) using standard high-volume air samplers to collect TSP (total suspended particulate) to capture coarser particulate on a filter or (b) recovering cyclone catches by brushing rather than washing.

SECTION 5

REFERENCES

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