Background Report Reference

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Title: Grain Particulate Study for Eastern Washington Grain Handling Facilities

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GRAIN PARTICULATE STUDY FOR EASTERN WASHINGTON GRAIN HANDLING FACILITIES

by

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ABSTRACT

This study describes two documents that have conflicting results for emission factors for grain handling facilities. This study describes the sequence of sampling events that lead to a procedure for measuring the particulate level in grain. This procedure has measured the particulate level in grain, that is less than or equal to 180 microns, to be 1.15 pounds of particulate per ton of grain.

BACKGROUND

1. Environmental Protection Agency Emission Factors

The Environmental Protection Agency (EPA) document AP-42, Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point And Area Sources, Section 6.4, Grain Elevators and Processing Plants, lists emission factors for three main types of uncontrolled grain elevators. Table 6.4-1, which is enclosed, lists the types of operation and the emission factors for country elevators, inland (river) terminal elevators, and export elevators.

Country elevators and inland (river) terminal elevators are the types of elevators in operation in eastern Washington. These elevators generally conduct the types of operations given in Table 6.4-1 with the exception of drying and cleaning. Eliminating the drying and cleaning operations, the total emission factor for country elevators is 3.4 pounds per ton, and the total emission factor for the inland terminal elevators is 5.2 pounds per ton. Using these emission factors, for grain facilities under the jurisdiction of the Eastern Regional Office, resulted in the potential for one country elevator and eleven inland terminal elevators to be considered major sources and candidates for the Title V operating permit program. More elevators could potentially be added to this major source status upon the submittal and subsequent verification of detailed information from specific elevators.

Mr. Bernard Brady of Washington State Department of Ecology conducted research into the origin and update of these AP-42 grain emission factors. Apparently the emission factors were originally published in 1977-1978. The emission factors were reviewed for update in 1987 but no update was conducted and they remained unchanged. Mr. Brady's research included an interview with the author of the AP-42 grain emission factors. The conclusion drawn from Mr. Brady's research is that the AP-42 grain emission factors are higher than actual emission factors for grain handling in Washington state and an updated study is needed.

2. 1975 Washington State Department of Ecology Grain Particulate Study

In 1975, a study conducted by Mr. Jay Willenberg of the Department of Ecology concluded that a general emission factor for all operations at country grain elevators is 0.5 pounds per ton and for all operations at inland terminal elevators is 0.4 pounds per ton. The study used particulate sampling, cyclone catch measurements, and visual observation

to derive these emission factors. Using Mr. Willenberg's grain emission factors would result in no country elevator and no inland terminal elevator being considered major sources and, thus, would not be candidates for the Title V operating permit program.

The Willenberg study was detailed and thorough. It is unknown if the results of this study were published or accepted for determination of source emission levels for the purposes of fees or categorization in federal or state programs. It is not known how much visual observation factored into the total emission factors. It is concluded that the results of this study can be substantiated by taking the study one step further by using Mr. Willenberg's idea of relating emissions to grain dockage and by conducting site by site assessments of grain elevators.

3. 1994 Washington State Department of Ecology Grain Particulate Study

Detailed Inspections were conducted on all of the inland terminal elevators in the Department of Ecology's Eastern Region Office's (ERO) jurisdiction. Inspections in themselves resulted in a better understanding of the interface between the emission factors and actual facility make-up and operation. Although several, if not many, of the elevators could potentially be removed from major source status by these inspections alone, a determination was made that emission factors more representative of the grain that is handled in eastern Washington, as opposed to the studies conducted for AP-42 emission factors, must be found. Determining a more representative emission factor for grain elevators in eastern Washington would remove the need for guesswork, approximations, and engineering judgement calls. A process to study grain particulate that is more representative of eastern Washington grain follows.

PROCESS - TEST METHOD NUMBER 1

Grain handling emissions could not possibly be greater than the amount of dust that is part of the grain makeup. The portion of grain that is considered foreign material is called dockage. This dockage is generally the foreign material that consists of matter that is lighter, larger, or smaller than grain. This study entails using the quantitative measurement of a portion of the dockage and deriving a maximum level of particulate associated with grain.

An approved method to measure total dockage exists in the United States Department of Agriculture Grain Inspection Handbook, Book II, dated October 1, 1990. This method uses a Carter Dockage Tester machine, as shown in Figure 1. This machine uses aspiration and a combination of riddles and sieves to prepare grain samples for official grading by removing the readily separable foreign material. Aspiration removes the matter lighter than grain, the riddle removes the matter larger than grain, and the sieves remove the matter smaller than grain. These three removed portions are added together and weighed to report the dockage of the grain. The dockage is reported on an official certificate under the State of Washington, United States Grain Standards Act. Table 1 gives dockage measurements, conducted by Washington State Department of Agriculture, and what the emission factors would be if total dockage was

used as an upper limit for an emission factor.

After observing this approved methodology and measurement, it was determined that the riddle portion of the dockage and the sieved portion of the dockage should not be considered particulate air pollution due to the size and weight of the material. Furthermore, it was determined that the larger portions of the aspirated portion of the dockage is not considered particulate air pollution because of its size. Therefore the portion of the dockage remaining that may be considered particulate air pollution consists of the physically small particles in the aspirated portion.

A meeting was held with Washington State Department of Ecology and the Pacific Northwest Feed and Grain Association on June 30, 1994 to discuss using dockage as an approach to determining more representative emission factors for grain in eastern Washington. An agreement was made that this was a correct approach. Stuart Magoon of Manchester Laboratory was consulted to ensure that the suggested measuring techniques were acceptable.

The method of measuring the small, air entrainable portion of the dockage is as follows: after the grain sample was run through the Carter Dockage Tester machine, the aspirated portion of the dockage was placed in a 425 micron (very conservative) sieve and placed on a mechanical shaker for twenty seconds. The sieved portion is weighed. Then the grain and the rest of the dockage is placed in the 425 micron sieve and placed on a mechanical shaker for twenty seconds. This sieved portion is also weighed. The two sieved portions are added together and make up the total particulate portion of the wheat.

Fifty samples of wheat were measured in this manner. The State Department of Agriculture offices in Spokane and Colfax provided the wheat samples and the facilities for the testing. Wheat was the grain chosen for this study because the majority of the grain handled in eastern Washington is wheat. The results are given in Table 2.

In examining the Carter Dockage Tester machine aspirator, it was determined that even though by weight, a large portion of the air entrainable dockage is quantified, as determined by a certified United States Department of Agriculture procedure, a significant portion of the particulate matter of interest is not being collected for measurement. Therefore, a different method needed to be found. In addition, it was determined that 425 microns is too large of a particle diameter in which to establish a grain particulate ceiling.

Table 2 is given for informational purposes only. The data derived by Process - Test Method Number 1, contained in Table 2, will not be used for a final determination in the grain particulate study.

TEST METHOD 1 RESULT: 0.19 POUNDS OF PARTICULATE PER TON OF GRAIN

PROCESS - TEST METHOD NUMBER 2

Using the idea from Test Method Number 1, specifically, measuring both the aspirated, sieved portion of the dockage from the Carter Dockage Tester machine, and the sieved portion of the remainder of the sample, a more refined, controlled and accurate method of determining the fine dockage that would represent total particulate was devised.

A combination of an aspiration section and a column of sieves was set up that emulated the Carter Dockage Tester machine, only with no leaks that would cause a loss of material. The tester was set up as follows: Sieves were placed in a series. Grain would be introduced onto a #4 sieve (4750 microns). Grain and other material would then flow down through a #8 sieve (2360 microns), a #10 sieve (2000 microns), and finally a #80 sieve (180 microns). A collection pan on the bottom collected particles that were 180 microns and smaller. On top of the #4 grain introduction sieve was a #80 sieve (180 micron). The #80 sieve (180 microns) had an adaptor to its lid that connected to a hose that led to a Total Suspended Particulate (TSP) monitor machine. The column of sieves are placed in a Rainhart Company laboratory sifter. As the column of sieves were mechanically shaken to separate out 180 micron and smaller particles to the bottom pan, the TSP vacuum pump took a suction on the top of the column and collected any airborne particles that were 180 microns and smaller. Susan Davis of Manchester Laboratory was contacted and approved of the method described.

Figure 2 shows a diagram of test equipment setup.

Wheat grain samples from many areas of eastern Washington were tested using this improved method. It was decided and requested that the grain to be sampled should come directly from the grain trucks as they delivered the loads to the elevators. Grain that had already been extensively handled, tested, or cleaned was not to be included in this study because of the obvious loss of dust with each evolution. This loss of dust would skew the results, as the reason for this study is to find the dust makeup of grain.

The facilities or companies providing the samples and the number of samples provided are as follows:

State Department of Agriculture in Colfax -	25 samples
State Department of Agriculture in Pasco -	8 samples
Connell Grain Growers -	10 samples
Almota Elevator Company -	13 samples
Rosalia Producers, Inc. -	8 samples
Columbia County Grain Growers, Inc. -	20 samples
Central Washington Grain Growers -	18 samples
Stegners Grain and Seed Company -	8 samples

Table 3 gives the results of this test.

TEST METHOD 2 RESULT: 1.15 POUNDS OF PARTICULATE PER TON OF GRAIN

QUALITY CONTROL TECHNIQUES AND STANDARDIZED TEST PROCEDURES

1. An important segment of this testing is to determine the appropriate shaking time. Enough shaking time must be allotted in order to ensure that sieving is done to completion. Too much shaking time must be avoided in order not to create additional dust by breaking down the grains. It is recognized that some dust will be created in the physical action of the grain and dockage upon itself, however this can be accounted for in the handling of grain in real situations at the grain elevators. No attempt was made in this study to determine the percentage of dust that is or can be created by the physical interaction of the grain and dockage upon itself.

   A series of shaking tests were conducted under the observation of Mr. Max Patterson, the Washington State Department of Transportation Eastern Region Materials Engineer Supervisor in Spokane, Washington. Four equal grain samples of approximately 1000 grams were formed using a splitter. Shaking times of two, four, six, and eight minutes were conducted. Each sieve was weighed each time. Percentages of the catch were calculated each time. It was determined that five minutes would be the optimum shaking time. Table 4 shows these results.

2. For samples containing enough wheat, as close to 1000 grams as possible were weighed out for testing. Several samples were delivered at less than 1000 grams. Even though the shaking time of five minutes was determined on 1000 gram samples, it is determined that shaking a smaller sample for the same time duration will not effect the results.

3. A scale accurate to 0.1 grams was used to weigh the grain samples.

4. A scale accurate to at least 0.01 grams was used for weighing the collected dust from the bottom sieve collection pan.

5. Proper TSP filter paper preparation and weighing techniques were carried out using approved procedures.

6. A brush was used to delicately sweep the collected dust from the bottom sieve pan onto a scale pan. Caution was taken to avoid allowing the dust to become airborne and lost from measurement.

7. Careful practices were observed in the grain handling and the filter paper handling.

8. A background air sample was taken to determine if the dust in the air would have any appreciable effect on the grain sampling for test method 2. The TSP sampler was disconnected from the shaking apparatus in order to take a laboratory background air sample in the three rooms that the testing was conducted. The sampler was run for approximately five minutes to simulate the time duration of the actual grain sampling. The filter paper was weighed in the

same manner that the grain sampling filter papers were weighed. The results showed that the background contribution to the grain measurements was approximately one percent. The background contribution is negligible and no special effort to disregard the background contribution was made. See Table 5.

9. An unintentional check on the procedure occurred when, due to a communication error, 25 samples of grain were sent from the Department of Agriculture Grain Inspection Laboratory in Colfax, Washington, that had already in part been sent through a Carter dockage machine or had been cleaned in some way. The collected dust averaged 0.46 pounds per ton. This is only 40 percent of the particulate factor of 1.15 pounds per ton for samples that were collected as requested. This being recognized, a follow-up call was made which revealed the samples had been violated. This event had value in that it substantiated an empirical sensitivity in the sampling method. The 25 samples from the Department of Agriculture in Colfax, Washington were discarded from the study and not used to obtain the average of 1.15 pounds of particulate per ton of grain. See Table 6.

10. A simplified statistical analysis was conducted on the data from Test Method Number 2. 93 percent of The Particulate Factors fell within two standard deviations of the mean. 67 percent of the Particulate Factors fell within one standard deviation of the mean. 49 percent of the Particulate Factors fell within two thirds of a standard deviation of the mean. These percentages yield a frequency histogram that is very close to a normal distribution curve of 95 percent, 68 percent, and 50 percent respectively. It is determined that statistically the data is correct and that enough samples were tested. See Table 7 and Figure 3.

CONCLUSION

Using the maximum particulate content of grain handled in Eastern Washington that was calculated from testing at 1.15 pounds of particulate matter per ton of grain throughput, and assuming that all of this grain particulate content escaped to the atmosphere, and assuming that a facility employs no pollution controls, a standard type of facility would have to have an annual throughput of 173,913 tons of grain handled in Eastern Washington to reach 100 tons of particulate matter emissions in a year. Since elevators use particulate matter controls to some degree, the emission factor for grain elevators is less than 1.15 pounds of particulate matter per ton of grain. This may verify the Willenberg study of 0.5 pounds of particulate matter per ton of grain handled by country elevators and 0.4 pounds of particulate matter per ton of grain handled by terminal elevators.

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Jerry Scheibner - Washington State Department of Ecology (Spokane)
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Ron Edgar - Spokane County Air Pollution Control Authority
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Sandy Phillips - Spokane County Air Pollution Control Authority
Kent Hansen - Connell Grain Growers
Dan Hart - Almota Elevator Company
Shawn Nolph - Washington State Department of Ecology (Spokane)
Greg Hannahs - Washington State Department of Ecology (Spokane)
Kevin Whitehall - Central Washington Grain Growers
Neil Tacke - Stegners Grain and Seed Company
Ed Hays - Spokane County Air Pollution Control Authority

FIGURES

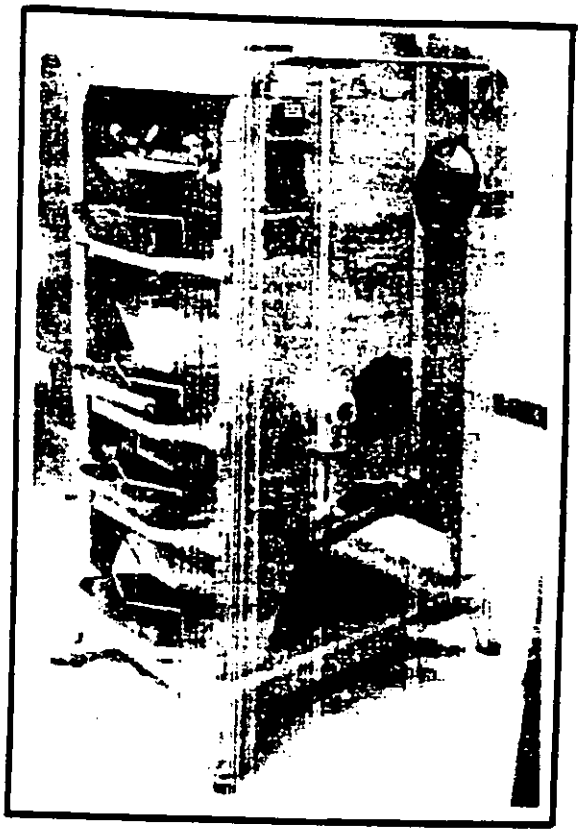


Figure 1
CARTER DOCKAGE TESTER

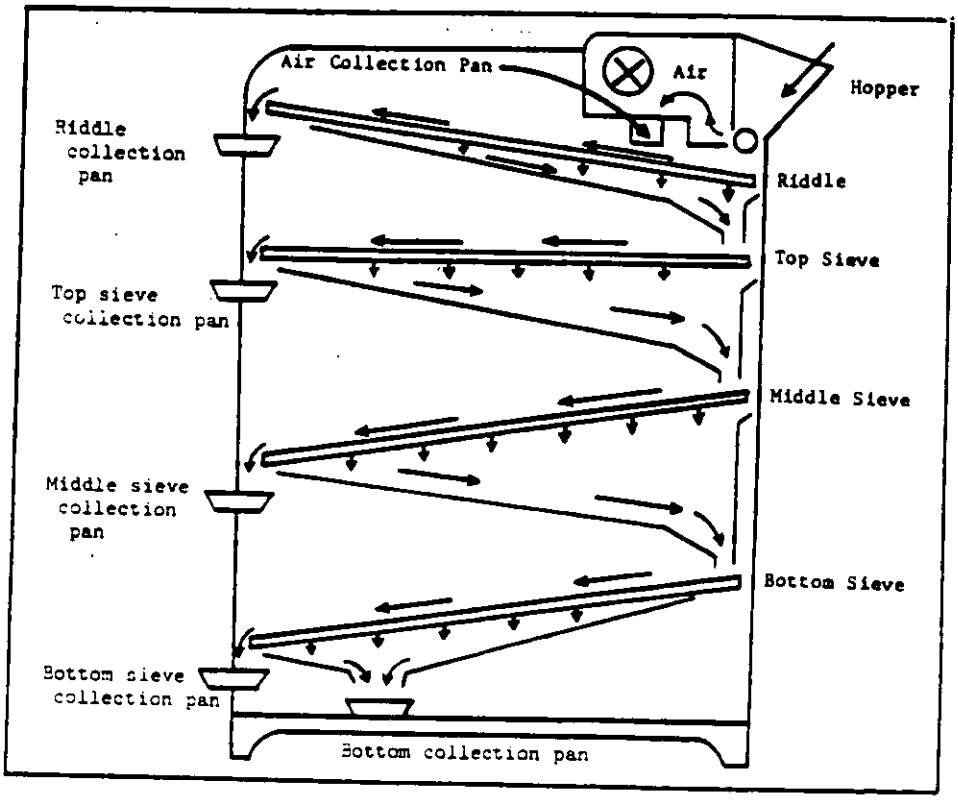
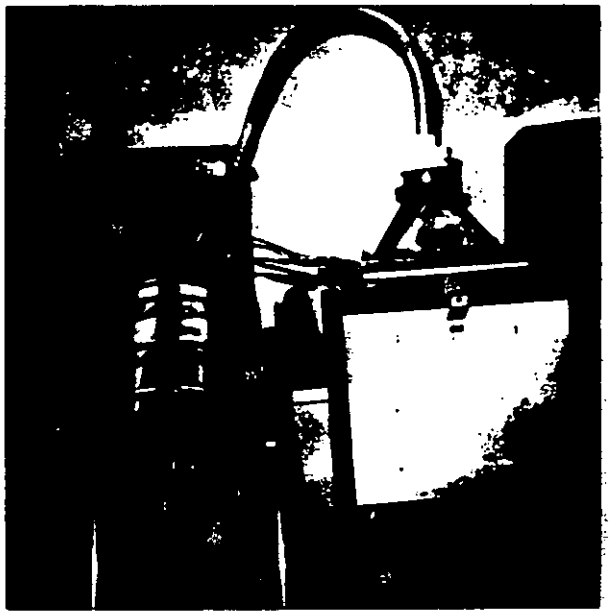


Figure 1
CARTER DOCKAGE TESTER FLOW CHART



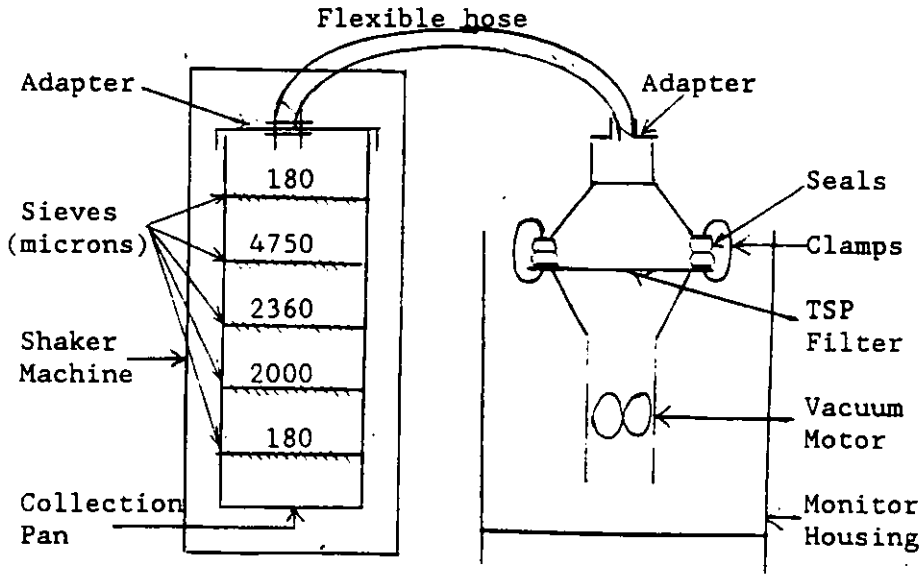
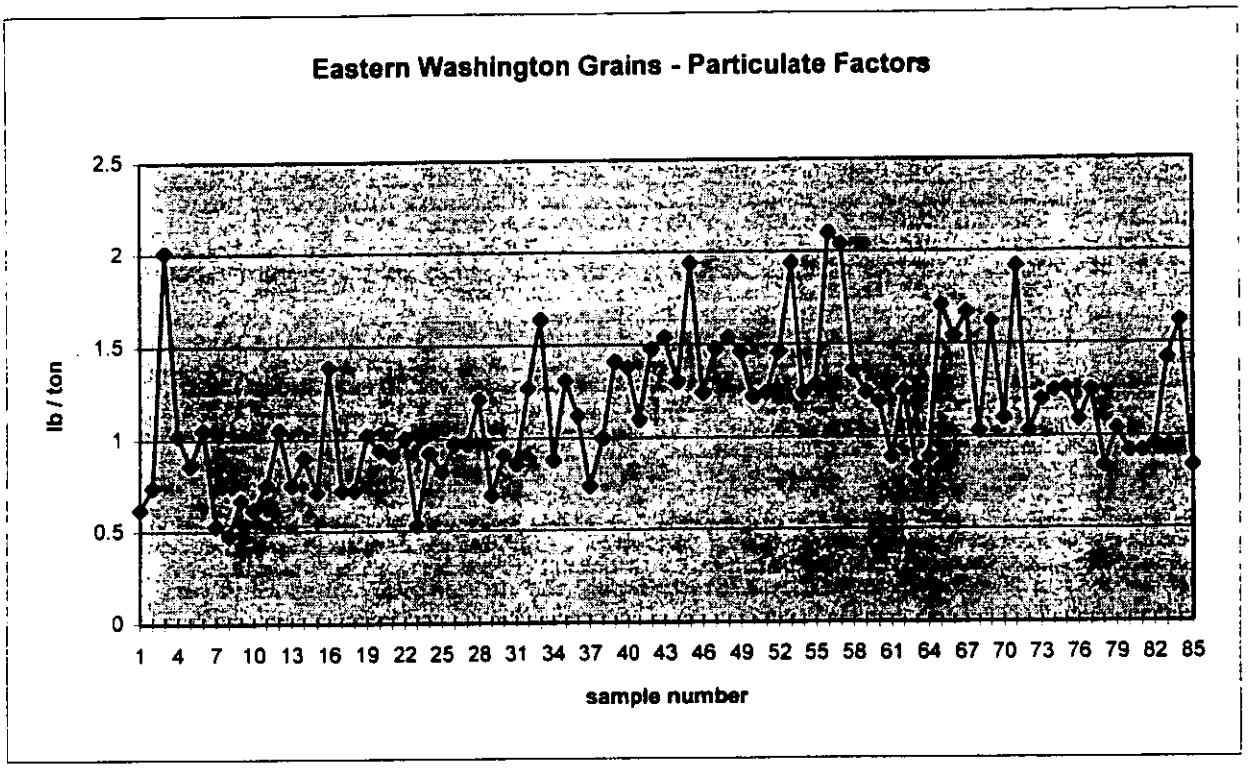


Figure 2
Test Equipment Setup



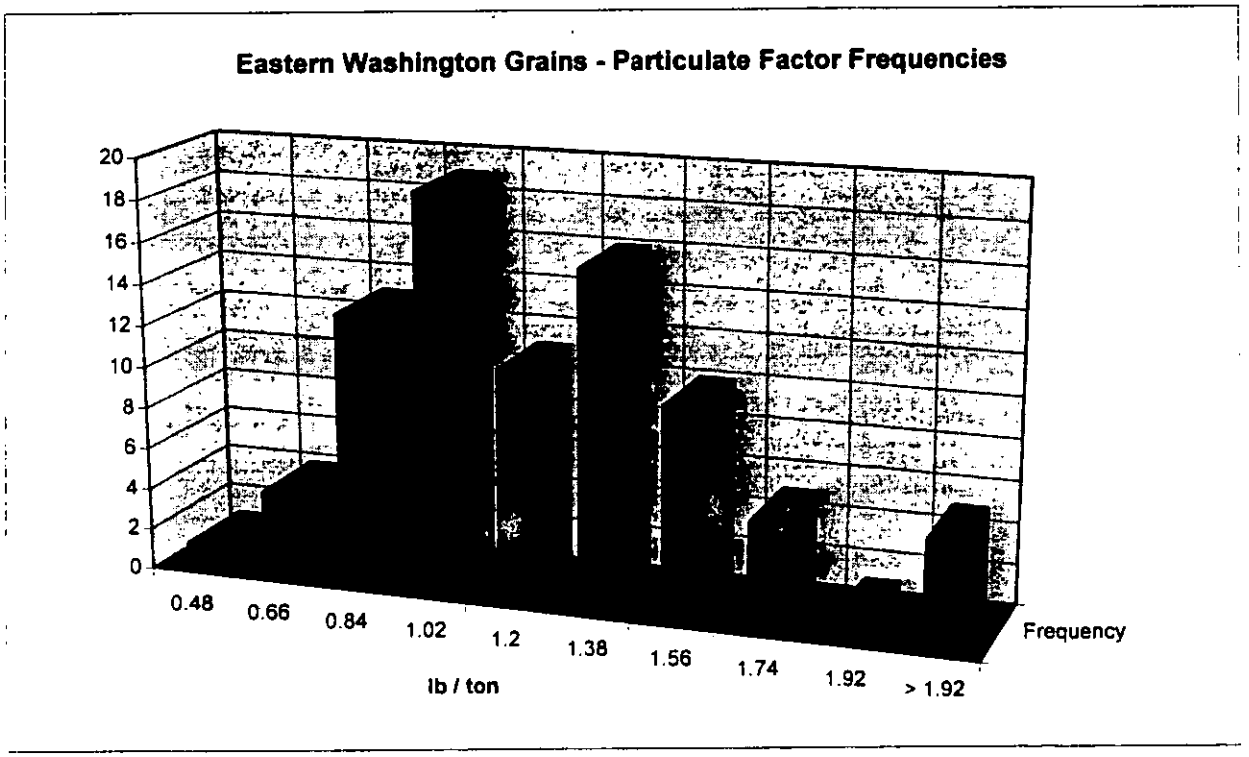


Figure 3
Sample Distribution & Sample Histogram

TABLES

TABLE 6.4-1. TOTAL PARTICULATE EMISSION FACTORS FOR UNCONTROLLED GRAIN ELEVATORS[a]

EMISSION FACTOR RATING: B

Type of Operation	Total particulate	
	kg/Mg	lb/ton
Country elevators		
Unloading (receiving)	0.3	0.6
Loading (shipping)	0.2	0.3
Removal from bins (tunnel belt)	0.5	1.0
Drying[b]	0.4	0.7
Cleaning[c]	1.5	3.0
Headhouse (legs)	0.8	1.5
		7.1 - 3.7 = 3.4
Inland terminal elevators		
Unloading (receiving)	0.5	1.0
Loading (shipping)	0.2	0.3
Removal from bins (tunnel belt)	0.7	1.4
Drying[b]	0.6	1.1
Cleaning[c]	1.5	3.0
Headhouse (legs)	0.8	1.5
Tripper (gallery belt)	0.5	1.0
		9.3 - 4.1 = 5.2
Export elevators		
Unloading (receiving)	0.5	1.0
Loading (shipping)	0.5	1.0
Removal from bins (tunnel belt)	0.7	1.4
Drying[b]	0.5	1.1
Cleaning[c]	1.5	3.0
Headhouse (legs)	0.8	1.5
Tripper (gallery belt)	0.5	1.0
		10.0

[a]Expressed as weight of dust emitted/unit weight of grain handled by each operation. For inland terminal and export elevators, Reference 5; for drying, References 2, 6; for country elevators, Reference 5 and additional test data in References 7-10.

[b]References 6, 11. Based on 0.9 kg/Mg for uncontrolled rack dryers and 0.15 kg/Mg for uncontrolled column dryers, prorated on the basis of the distribution of these two types of dryers.

[c]Reference 11. Average of values, from 0.3 kg/Mg for wheat to 3.0 kg/Mg for corn.

TABLE 1
TOTAL DOCKAGE

WAREHOUSE	TYPE	DOCKAGE	LB/TON	WAREHOUSE	TYPE	DOCKAGE	LB/TON
CENTRAL GG	3SW	0.8%	16	S&R GRAIN	1SW	0.4%	8
COOP TERM	1SW	0.6%	12	S&R GRAIN	1SW	0.6%	12
UNITED GG	1CL	0.4%	8	ALMOTA	1SW	0.5%	10
POMEROY GG	1SW	0.3%	6	ALMOTA	2SW	1.2%	24
ROCKFORD	2SW	0.9%	18	ALMOTA	2SW	1.4%	28
R R	1SW	0.5%	10	ALMOTA	2SW	0.5%	10
POMEROY GG	1SW	1.3%	26	COLUMBIA	2SW	1.3%	26
CENTRAL GG	2SW	0.6%	12	POMEROY	2SW	0.8%	16
CENTENNIAL	1SW	0.7%	14	POMEROY	1SW	0.2%	4
ROCKFORD	3SW	0.5%	10	ALMOTA	1SW	0.2%	4
COOP TERM	1SW	0.6%	12	POMEROY	SG	0.7%	14
ALMIRA	1CL	0.5%	10	ALMOTA	1SW	0.5%	10
ODESSA	5SW	1.0%	20	POMEROY	1SW	0.5%	10
UNITED GG	1SW	0.3%	6	POMEROY	2SW	0.3%	6
ROSALIA	1SW	0.3%	6	ALMOTA	2SW	1.3%	26
COOP TERM	1SW	0.8%	16	POMEROY	1CL	0.4%	8
FUHRMANS	1SW	0.4%	8	COLUMBIA	2SW	0.8%	16
FAIRFIELD	1SW	0.2%	4	FAIRFIELD	2SW	0.3%	6
ODESSA	1SW	1.1%	22	ALMOTA	2SW	1.0%	10
FUHRMANS	2SW	0.6%	12	ALMOTA	5SW	0.3%	6
UNITED GG	1SW	2.4%	48	ALMOTA	2SW	1.7%	34
ODESSA	1SW	0.4%	8	POMEROY	1CL	0.5%	10
CENTRAL GG	1SW	0.4%	8	ALMOTA	SG	1.0%	20
ROCKFORD	3SW	3.2%	64	POMEROY	1CL	0.8%	16
CENTRAL GG	1SW	0.5%	10	ALMOTA	2SW	0.8%	16
COOP TERM	1SW	0.2%	4	WASHTUCNA		0.3%	6
ALMIRA	1CL	0.6%	12	PRESCOTT		0.3%	6
ROCKFORD	1BR	1.0%	20	WAITSBURG		0.4%	8

AVERAGE DOCKAGE = 0.7%

AVERAGE LB/TON = 14 LB/TON

TABLE 2
TEST METHOD NUMBER 1 RESULTS

WAREHSE	STATION	COUNTY	TYPE	SHAKE ASPIRATED <=425 MICRON LB/TON	SHAKE GRAIN + RIDDLE + 5/64 SIEVE <=425 MICRON LB/TON	TOTAL LB/TON
CENT WA GG	WEN	CHELAN	3 SW	0.08	0.02	0.10
COOP TERM ASSN	WAUKON	LINCLON	1 SW	0.10	0.02	0.12
UNITED GG	CRESTON	LINCLON	1 CLB	0.06	0.02	0.08
POMEROY GG			1 SW	0.08	0.04	0.12
ROCKFRD GG			2 SW	0.08	0.04	0.12
R R	R R TANK		1 SW	0.08	0.02	0.10
POMEROY GG			1 SW	0.16	0.04	0.20
CENT WA GG	ALMIRA	LINCOLN	2 SW	0.04	0.02	0.06
CENTNNL FLOUR MILLS			1 SW	0.98	0.08	1.06
ROCKFRD GG			3 SW	0.08	0.04	0.12
COOP TERM ASSN	REARDAN	LINCOLN	1 SW	0.14	0.06	0.20
ALMIRA FARMERS WHSE			1 CLB	0.04	0.02	0.06

WAREHSE	STATION	COUNTY	TYPE	SHAKE ASPIRATED <=425 MICRON LB/TON	SHAKE GRAIN + RIDDLE + 5/64 SIEVE <=425 MICRON LB/TON	TOTAL LB/TON
ODESSA TRADING CO			5 SW	0.28	0.04	0.32
UNITED GG	WAUKON	LINCOLN	1 SW	0.24	0.06	0.30
RSAILIA PROD		WHITMAN	1 SW	0.06	0.04	0.10
COOP TERM ASSN	DOWNS		1 SW	0.06	0.04	0.10
FUHRMAN			1 SW	0.02	0.02	0.04
FAIRFLD GG			1 SW	0.04	0.02	0.06
ODESSA TRADING CO	WARDEN	GRANT	1 SW	0.10	0.04	0.14
FUHRMAN			2 SW	0.10	0.04	0.14
UNITED GG	SPRAGUE	LINCOLN	1 SW	0.14	0.04	0.18
ODESSA TRADING CO	WARDEN	GRANT	1 SW	0.02	0.02	0.04
CENT WA GG			1 SW	0.02	0.04	0.05
ROCKFRD GG			3 SW	0.10	0.12	0.22
CENT WA GG	ALMIRA	LINCOLN	1 SW	0.02	0.04	0.06
S&R GRAIN COMPANY	STATELNE		1SW	0.10	0.02	0.12

WAREHSE	STATION	COUNTY	TYPE	SHAKE ASPIRATED <=425 MICRON LB/TON	SHAKE GRAIN + RIDDLE + 5/64 SIEVE <=425 MICRON LB/TON	TOTAL LB/TON
S&R GRAIN COMPANY	STATELNE		1SW	0.14	0.02	0.16
ALMOTA ELEV CO.			1SW	0.30	0.04	0.34
ALMOTA ELEV CO.			2SW	0.26	0.06	0.32
ALMOTA ELEV CO.			2SW	0.14	0.04	0.18
ALMOTA ELEV CO.			SG	0.18	0.04	0.22
COLMBIA GRAIN INTL	COLUMBIA BASIN		2SW	0.12	0.06	0.18
POMEROY GRAIN GROWERS			2SW	0.24	0.12	0.36
POMEROY GRAIN GROWERS			1SW	0.12	0.04	0.16
ALMOTA ELEV CO.			1SW	0.08	0.04	0.12
POMEROY GRAIN GROWERS			SG	0.16	0.04	0.10
ALMOTA ELEV CO.			1SW	0.24	0.04	0.28

WAREHSE	STATION	COUNTY	TYPE	SHAKE ASPIRATED <=425 MICRON LB/TON	SHAKE GRAIN + RIDDLE + 5/64 SIEVE <=425 MICRON LB/TON	TOTAL LB/TON
POMEROY GRAIN GROWERS			1SW	0.16	0.02	0.18
POMEROY GRAIN GROWERS			2SW	0.24	0.06	0.30
ALMOTA ELEV CO.			2SW	0.46	0.06	0.52
POMEROY GRAIN GROWERS			1SW	0.08	0.02	0.10
COLMBIA GRAIN INTL			2SW	0.16	0.04	0.20
FAIRFLD GRAIN GROWERS			2SW	0.06	0.04	0.10
ALMOTA ELEV CO.	PALOUSE		2SW	0.06	0.04	0.10
ALMOTA ELEV CO.	PINE CITY		5SW	0.06	0.02	0.08
ALMOTA ELEV CO.	PALOUSE		2SW	0.22	0.04	0.26
POMEROY GRAIN GROWERS			1CL	0.08	0.04	0.12
ALMOTA ELEV CO.			SG	0.22	0.06	0.28

WAREHSE	STATION	COUNTY	TYPE	SHAKE ASPIRATED <=425 MICRON LB/TON	SHAKE GRAIN + RIDDLE + 5/64 SIEVE <=425 MICRON LB/TON	TOTAL LB/TON
POMEROY GRAIN GROWERS			1CL	0.12	0.06	0.18
ALMOTA ELEV CO.			2SW	0.08	0.10	0.18
AVERAGE				0.144	0.043	0.187

AVERAGE PARTICULATE FACTOR = 0.19 POUNDS PER TON

CL - CLUB
SW - SOFR WHITE
SG - SAMPLE GRADE SOFT WHITE
1,2,3,4,5 - GRADE

TABLE 3
TEST METHOD NUMBER 2 RESULTS

Warehouse/ Station	Farm/ Location	Sample Wt. (grams)	Pan Wt. (grams)	Filter Wt. (grams)	Particulate Factor (LB/TON)
Connell		802.1	0.09	0.16	0.62
Connell		892.2	0.13	0.20	0.74
Lind		705.2	0.44	0.27	2.01
Lind		610.3	0.15	0.16	1.02
Plymouth		556.0	0.07	0.17	0.86
Plymouth		516.1	0.09	0.18	1.05
Hatton		562.5	0.04	0.11	0.53
Pasco		625.0	0.08	0.07	0.48
Hatton	Kleinbach	1038.7	0.11	0.24	0.67
Welch DNR	Tres	1030.7	0.08	0.24	0.62
Hatton	Loeber	1040.0	0.10	0.29	0.75
Hatton	Hartland	955.6	0.19	0.31	1.05
Hatton	Amber	1032.5	0.13	0.28	0.75
Hatton	Rehco	1071.9	0.19	0.29	0.90
Moro	Loeber	1039.2	0.11	0.26	0.71
Butte 86DNS	Herron	1049.6	0.61	0.12	1.39
Hatton	Hudlow	1028.8	0.09	0.28	0.72
Weston	Pepiot	1053.9	0.08	0.30	0.72
Almota Elev	Union	1021.6	0.21	0.31	1.02
Almota Elev	Mockenema	1019.0	0.12	0.36	0.94
Almota Elev	Mockenema	1029.1	0.14	0.33	0.91
Almota Elev	Broweleit	1017.0	0.13	0.38	1.00
Almota Elev	Kimbels	1018.2	0.10	0.17	0.53
Almota Elev	Hickman	1018.3	0.13	0.34	0.92
Almota Elev	Lockhart	1021.3	0.11	0.31	0.82
Almota Elev	Nafziger	1006.3	0.08	0.41	0.97
Almota Elev	Conrad	1006.0	0.08	0.41	0.97
Almota Elev	Broweleit	1011.4	0.10	0.51	1.21
Almota Elev	Davis Fms	1020.6	0.07	0.28	0.69
Almota Elev	Gunn/Repp	1010.0	0.08	0.38	0.91
Almota Elev	Kroll	1020.1	0.08	0.36	0.86
Rosalia Prod	Spring Val	1001.3	0.23	0.41	1.27
Rosalia Prod	Balder	1000.6	0.35	0.47	1.64
Rosalia Prod	Plaza	1005.3	0.09	0.35	0.88
Rosalia Prod	Whit. Co.	1008.8	0.21	0.45	1.31
Rosalia Prod	Plaza	1000.2	0.10	0.46	1.12
Rosalia Prod	McCoy	1000.1	0.08	0.29	0.74
Rosalia Prod	Pine City	1000.4	0.14	0.36	1.00
Rosalia Prod	Whit. Co.	962.1	0.25	0.43	1.41
Columbia Co GG	Dayton	1000.3	0.16	0.53	1.38
Columbia Co GG	Dayton	999.9	0.14	0.41	1.10
Columbia Co GG	Dayton	1000.1	0.46	0.28	1.48
Columbia Co GG	Dayton	1000.1	0.22	0.55	1.54
Columbia Co GG	Dayton	1001.1	0.15	0.50	1.30

Warehouse/ Station	Farm/ Location	Sample Wt. (grams)	Pan Wt. (grams)	Filter Wt. (grams)	Particulate Factor (LB/TON)
Columbia Co GG	Dayton	999.7	0.36	0.61	1.94
Columbia Co GG	Dayton	999.4	0.17	0.45	1.24
Columbia Co GG	Dayton	1001.2	0.14	0.60	1.48
Columbia Co GG	Dayton	999.9	0.19	0.58	1.54
Columbia Co GG	Dayton	1001.2	0.23	0.50	1.46
Columbia Co GG	Dayton	1000.6	0.11	0.50	1.22
Columbia Co GG	Dayton	1001.5	0.12	0.50	1.24
Columbia Co GG	Dayton	1000.5	0.11	0.62	1.46
Columbia Co GG	Dayton	1000.2	0.28	0.69	1.94
Columbia Co GG	Dayton	1000.0	0.14	0.48	1.24
Columbia Co GG	Dayton	1000.1	0.16	0.48	1.28
Columbia Co GG	Dayton	1000.2	0.28	0.77	2.10
Columbia Co GG	Dayton	1000.1	0.32	0.70	2.04
Columbia Co GG	Dayton	1000.3	0.25	0.43	1.36
Columbia Co GG	Dayton	1000.2	0.16	0.46	1.24
Cent Wa GG	Farmer	956.1	0.20*	0.37	1.19
Cent Wa GG	Douglas	1006.5	0.20*	0.25	0.89
Cent WA GG	Withrow	927.0	0.20*	0.38	1.25
Cent Wa GG	Supplee	989.8	0.20*	0.21	0.83
Cent Wa GG	Waterville	1007.4	0.20*	0.25	0.89
Cent Wa GG	Almira	1003.5	0.20*	0.66	1.71
Cent Wa GG	Almira	1001.7	0.16	0.61	1.54
Cent WA GG	Almira	1003.4	0.18	0.66	1.67
Cent Wa GG	Almira	1101.7	0.29	0.28	1.03
Cent Wa GG	Almira	1000.6	0.13	0.68	1.62
Cent WA GG	Hartline	1004.5	0.11	0.44	1.10
Cent WA GG	Hartline	1000.7	0.32	0.64	1.92
Cent WA GG	Hartline	990.7	0.11	0.40	1.03
Cent WA GG	Hartline	1001.8	0.18	0.42	1.20
Cent WA GG	Hartline	927.3	0.15	0.43	1.25
Cent WA GG	Hartline	1018.1	0.12	0.52	1.26
Cent WA GG	Hartline	1009.0	0.09	0.46	1.09
Cent WA GG	Hartline	1004.0	0.19	0.44	1.25
Stegners	Nezperce	998.1	0.13	0.29	0.84
Stegners	Whitman	1004.0	0.18	0.34	1.04
Stegners	Whitman	1004.1	0.13	0.33	0.92
Stegners	Whitman	1000.0	0.13	0.33	0.92
Stegners	Whitman	1000.5	0.15	0.33	0.96
Stegners	Garfield	1000.1	0.20	0.51	1.42
Stegners	Garfield	1000.5	0.29	0.52	1.62
Stegners	Nezperce	1000.1	0.14	0.28	0.84

* Scale malfunction; 0.20 grams is a conservative estimate based on observation and a measurement check on a scale accurate to 0.10 grams.

AVERAGE PARTICULATE FACTOR = 1.15 POUNDS PER TON

TABLE 4
DETERMINATION OF SHAKE TIME

Sample 1

Time = 2 minutes
Sample Weight = 1169.2 grams

Sieve Size (microns)	Amount Retained (grams)	Percent Passed Through
4750	3.1	99.74
2360	1150.6	1.33
2000	7.8	0.66
180	7.1	0.05
PAN	0.14	0.00

Sample 2

Time = 4 minutes
Sample Weight = 1075.1 grams

Sieve Size (microns)	Amount Retained (grams)	Percent Passed Through
4750	2.4	99.78
2360	1052.9	1.84
2000	11.2	0.80
180	8.2	0.04
PAN	0.19	0.00

Sample 3

Time = 6 minutes
Sample Weight = 1011.1 grams

Sieve Size (microns)	Amount Retained (grams)	Percent Passed Through
4750	3.3	99.67
2360	986.9	2.07
2000	11.7	0.91
180	8.6	0.06
PAN	0.20	0.00

Sample 4

Time = 8 minutes
Sample Weight = 1045.0 grams

Sieve Size (microns)	Amount Retained (grams)	Percent Passed Through
4750	2.2	99.79
2360	1020.0	2.18
2000	12.8	0.96
180	9.3	0.07
PAN	0.22	0.00

TABLE 5
DETERMINATION OF BACKGROUND PARTICULATE CONTRIBUTION
TEST METHOD 2

Room	Date	No. of Samples	Ave. Pan Wt.	Ave. Filter Wt.	Background Wt.	Percentage
1	9-01	7	0.23	0.52	0.0074	0.99%
2	9-16	18	0.18	0.45	0.0039	0.62%
3	9-23	8	0.17	0.37	0.0083	1.54%

AVERAGE PERCENTAGE = 1.05%

TABLE 6
TESTING PROCEDURE SENSITIVITY CHECK

Warehouse/ Station	Farm/ Location	Sample Wt. (grams)	Pan Wt. (grams)	Filter Wt. (grams)	Particulate Factor (LB/TON)
Almota	Farmington	997.8	0.04	0.14	0.36
Oaksdale GG	Jones	998.1	0.26	0.19	0.90
Whitman Co GG	Maning	1002.0	0.09	0.08	0.34
Central Ferry	Terminal	999.4	0.04	0.11	0.30
Almota Elev	Gallagher	998.4	0.06	0.10	0.32
Lacross GG		998.9	0.04	0.15	0.38
Stateline	Tekoa	998.7	0.12	0.17	0.58
Almota Elev	Whitman Co	996.2	0.09	0.18	0.54
Almota Elev	Gallagher	1000.6	0.06	0.13	0.38
Columbia Grain		996.4	0.06	0.14	0.40
Central Ferry	Rockford	996.9	0.10	0.16	0.52
Central Ferry	Rockford	1000.7	0.07	0.12	0.38
Almota Elev	Tyler Fms	1000.3	0.06	0.14	0.40
Columbia Grain	Dole	999.1	0.04	0.12	0.32
S&R Grain	Tekoa	999.6	0.05	0.12	0.34
Central Ferry	Rockford	998.4	0.10	0.17	0.54
Columbia Grain	Tekoa	995.3	0.08	0.14	0.44
Almota	Farmington	1001.6	0.15	0.27	0.84
Sherm-Clyde	Moscow	998.2	0.05	0.15	0.40
Central Ferry	Rockford	999.3	0.06	0.13	0.38
Central Ferry	Rockford	1000.7	0.08	0.15	0.46
Columbia Grain	Lamont	998.2	0.06	0.18	0.48
Columbia Grain		995.4	0.21	0.19	0.80
Columbia Grain		993.5	0.10	0.13	0.46
Central Ferry	Rockford	999.4	0.05	0.12	0.34

AVERAGE PARTICULATE FACTOR = 0.46 POUNDS PER TON

TABLE 7
STATISTICAL ANALYSIS OF DATA
TEST METHOD 2

MEAN (AVERAGE)	= 1.15	LB/TON
MODE (VALUE THAT OCCURS THE MOST)	= 1.24	LB/TON
MEDIAN (VALUE THAT OCCURS IN THE MIDDLE)	= 1.09	LB/TON
RANGE	= 1.62	LB/TON
MINIMUM	= 0.48	LB/TON
MAXIMUM	= 2.10	LB/TON
STANDARD DEVIATION	= 0.37	LB/TON
VARIANCE (STANDARD DEVIATION SQUARED)	= 0.14	

NUMBER OF VALUES WITHIN THE MEAN
PLUS/MINUS TWO TIMES THE STANDARD DEVIATION = 79
PERCENTAGE OF VALUES = 92.94%

NUMBER OF VALUES WITHIN THE MEAN
PLUS/MINUS ONE STANDARD DEVIATION = 57
PERCENTAGE OF VALUES = 67.06%

NUMBER OF VALUES WITHIN THE MEAN
PLUS/MINUS 2/3 OF A STANDARD DEVIATION = 42
PERCENTAGE OF VALUES = 49.41%