In-Depth Survey Report:

Control Technology for Agricultural Environmental Enclosures

at

Nelson Manufacturing Co.. Inc.

REPORT WRITTEN BY:
Ronald M. Hall
William Heitbrink
James McGlothlin

REPORT DATE:
July 2, 1997

REPORT NO.
ECTB 223-11b

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control and Prevention
National Institute for Occupational Safety and Health
Division of Physical Sciences and Engineering
4676 Columbia Parkway, R5
Cincinnati, Ohio 45226

PLANT SURVEYED:	Nelson Manufacturing Co. Inc. 2860 Colusa Highway Yuba City, CA 95993
SIC CODE:	5083
SURVEY DATE:	October 9-11, 1996
SURVEY CONDUCTED BY:	Ronald Hall William Heitbrink James McGlothlin
EMPLOYER REPRESENTATIVES CONTACTED:	Bob Nelson Jim Bennette
EMPLOYEE REPRESENTATIVES CONTACTED:	No Union
MANUSCRIPT PREPARED BY:	Robin Smith

DISCLAIMER

Mention of company names or products does not constitute endorsement by the Centers for Disease Control and Prevention.

INTRODUCTION

Agriculture is one of our Nation's most dangerous occupations. Agricultural workers and their families experience a disproportionate share of injuries and diseases associated with numerous chemical, biological, and physical hazards.[1] Some of these diseases include asthma, hypersensitivity pneumonitis, chronic and acute bronchitis, and organic dust toxic syndrome.

This study was conducted to provide information on the effectiveness of agricultural cabs designed to protect workers from pesticides and other agriculture air contaminants and identify improvements to enhance the enclosure's efficacy. Survey reports will be distributed to various agencies and persons according to standard procedures in 41 CFR 85a and will be available from National Technical Information Service (NTIS).

STUDY OBJECTIVES

The main goal of the agricultural enclosures project is to evaluate the ability of enclosures on agricultural vehicles to reduce operator exposure to pesticides and other agriculture air contaminants. The major objectives for the laboratory and field evaluation were to:

- evaluate the effectiveness of the filter system
- identify aerosol size distribution inside and outside the enclosure
- evaluate air infiltration into the cab by identifying potential leak sources
- evaluate the protection factor (outside concentration / inside concentration) for agricultural cabs

CAB DESIGN

Nelson Manufacturing Co., Inc. designs and manufactures retrofit cabs to fit various tractors including John Deere, Ford, Massey Ferguson, and Kubota. The tractor cabs manufactured by Nelson Manufacturing meet the requirements of California EPA as an enclosed cab that can be used in place of respiratory protection. This field evaluation was performed on a Nelson Spray Cab® designed to fit on a Massy Ferguson 396 tractor. The cab is designed to pull fresh air into the ventilation system from the front top portion of the cab. The fresh air flows through a filter system that consist of 3 separate filters. The first is a pre-filter (paper filter to remove larger particles) that is followed by a High Efficiency Particulate Air filter (HEPA filters are designed to be at least 99.97% efficient at filtering aerosol of size 0.3 μm) and an activated carbon filter. After the air passes through the filters it is then blown into the cab through louvers located behind the operator seat and maintains positive pressure inside the cab. Figure 1 is a schematic for the air flow into the cab.

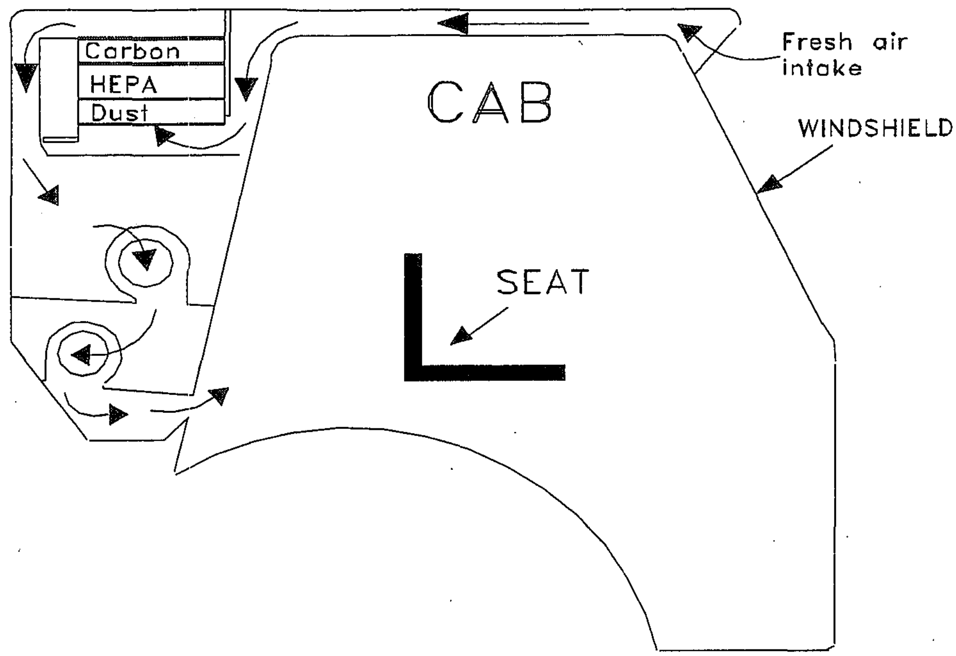

Figure 1. Diagram of air flow through filters and into cab.[2]

METHODS

Preliminary surveys were conducted on three different agriculture enclosures. Two of these enclosures have been approved for respiratory protection in the state of California. The results obtained during the preliminary surveys identified the need for a field evaluation of an environmental enclosure to help identify any potential aerosol leaks into the cab. This field evaluation was performed on a Nelson Spraycab® attached to a Massey Ferguson 396 tractor. All measurements taken inside and outside of the cab were collected while the tractor was driven on a dirt lot. The tractor was driven around the dirt lot in an effort to assess how well the cab remains sealed and it's ability to remove particulate in field conditions.

The tractor was driven over bumps in the lot to simulate actual field conditions. The tractor was also driven in circles to stir up dust. Dust was generated in an effort to help increase the ambient particle concentration and provide a larger challenge aerosol outside the cab.

The following instrumentation was used to measure the concentration of ambient aerosol outside and inside of the cab:

1. Hand-held Particle Counter (Model 227b, Met-One Inc, Grants Pass, OR) counts the number of individual particles larger than 0.3 μm. The Hand-held Particle Counter (HPC) was used with a sampling rate of 2.8 liters per minute (lpm), a sampling period of 14 seconds, and a time between sampling periods of 1 second. Two channels were used

to store the number of particle counts in a time interval. One channel stored the total number of particles counted greater than 0.3µm. The second channel stored the total number of particles larger than 3.0 µm. This instrument sizes the particles based upon the amount of light scattered by individual particles.[3]

2. Portable Dust Monitor (Model 1106, Grimm Labortechnik GmbH & CoKg, Ainring, Germany) counts the individual number of particles in eight size channels between 0.3 and 6.5 µm. Particles are sized based upon the amount of light scattered by individual particles. The Portable Dust Monitor (PDM) operates at a flow rate of 1.2 lpm.[4]

3. PortaCount® Plus (Model 8020, TSI Incorporated, St. Paul, MN) was used to measure ambient particle concentration inside and outside of the enclosure. The ratio of the two measurements was used to calculate a protection factor. Particles enter the PortaCount® Plus through a saturator tube where they are combined with alcohol vapor. The particles then pass through a condenser where the alcohol condenses on the particles, which increases the particle size. The enlarged particles then pass through a laser beam that produces flashes of light that are detected by a photodetector. Particle concentrations are determined by the amount of light flashes. The PortaCount® Plus has a particle range of 0.02 to greater than 1 µm with a flow rate of 0.1 lpm (TSI Incorporated, St. Paul, MN).[5]

The PortaCount® Plus was used to measure leakage of particles (in the range of 0.02 - 1.0 µm) into the cab. Condensation nuclei were measured in the ambient air outside the cab and inside the cab while the tractor was driven around the dirt lot. The PortaCount® Plus is equipped with two sampling probes. One sampling probe was used to collect aerosol concentrations inside the cab and the other sampling probe was used to collect ambient aerosol concentrations outside the cab. This test was performed in an effort to evaluate the protection factor of the cab during field operations.

The PortaCount® Plus collected twelve separate samples during each field test run. Four separate field test runs were completed. Each of the twelve separate samples (obtained during a field test run) were collected over a 60 second period. A protection factor (ratio between particle concentrations outside and inside the enclosure) was calculated for each sample. A low protection factor is an indicator of particle leakage into the cab or an indicator of particle generation sources inside the cab (e.g., from blower or operator movement inside the cab).

During this evaluation, one HPC and PDM were placed inside the tractor cab to count particles. These instruments were used to evaluate the enclosure's overall ability to protect the worker from aerosol exposure. Another HPC and PDM were placed directly outside the cab near the air intake. During this evaluation, the instruments were switched to obtain additional readings. The instruments located inside the cab were placed outside, and the instruments located outside the cab were placed inside. The HPCs and PDMs were run for approximately 30 minutes and then switched. This process was repeated 4 times, both to collect enough data for analysis and to limit the effect of instrument bias.

Data Analysis and Evaluation

All data collected from the HPC and PDM were downloaded into a portable computer and placed in a spreadsheet for analysis. Penetration of different size aerosols, efficiency of the filter system, and protection factors were determined by comparing data collected (with the HPC and PDM) inside the enclosure with data collected directly outside the enclosure.

Ventilation Measurements

The air velocity into the fresh air inlet and out the exhaust of the louvers (inside the cab) were measured with a velometer. An autozero digital micromanometer, MP series 4 (Solomat, a Neotronics company, Norwalk, CT), was used during the field test to measure air pressure inside the cab. A metrosonic dl-3200 data logger (Metrosonic Inc., Rochester, NY) was used to record the data output of the digital micromanometer throughout the field evaluation.

RESULTS

Results of the HPC are summarized in Figure 2. The HPC raw particle counts are listed in Appendix A. The HPC counts naturally occurring ambient particles in the size range of 0.3 - 3.0 µm and particles grater than 3.0 µm. The HPC results during this survey indicate that the filter system in the cab was 86% efficient at removing particles in the size range between 0.3 and 3.0 µm with a mean protection factor (outside concentration/inside concentration) of 7 in this size range. The HPC results also indicated that the ventilation system in the cab was 99.6% efficient at removing particles larger than 3.0 µm with a mean protection factor of 250 for this size range.

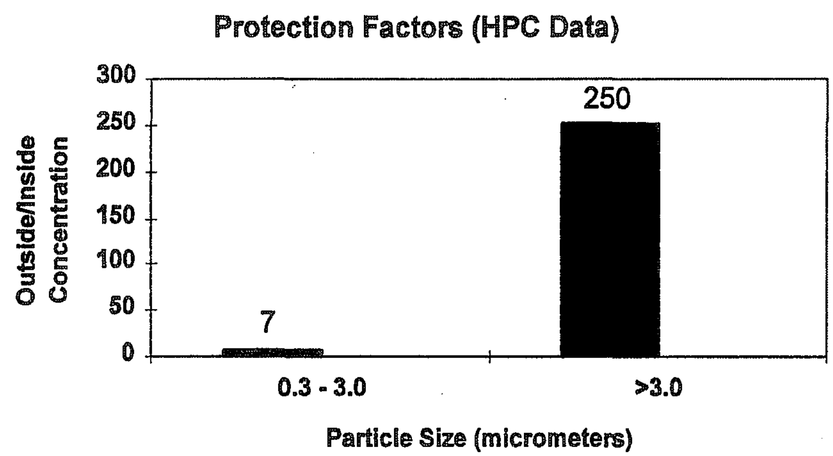

Figure 2. HPC Data Protection Factors.

The PDM raw particle counts are listed in Appendix B. PDM results indicated that the ventilation system on the cab was 99% efficient at removing particles larger than 2.6 µm. The filtration efficiency of the cab at each different size range measured by the PDM are listed in Table 1.

Table 1. Filtration Efficiency by particle size as shown by the PDM.

Particle Size (µm)	0.42	0.61	0.87	1.41	2.65	4.18	5.7	6.5
Efficiency of Cab	85.3%	91.0%	93.1%	98.1%	99.1%	99.7%	99.7%	99.7%

The PDM results were also used to calculate protection factors at each separate particle size. These protection factors are shown in Figure 3. The protection factor increased as the particle size increased. Protection factors were larger than 100 for particles greater than 2.65 µm.

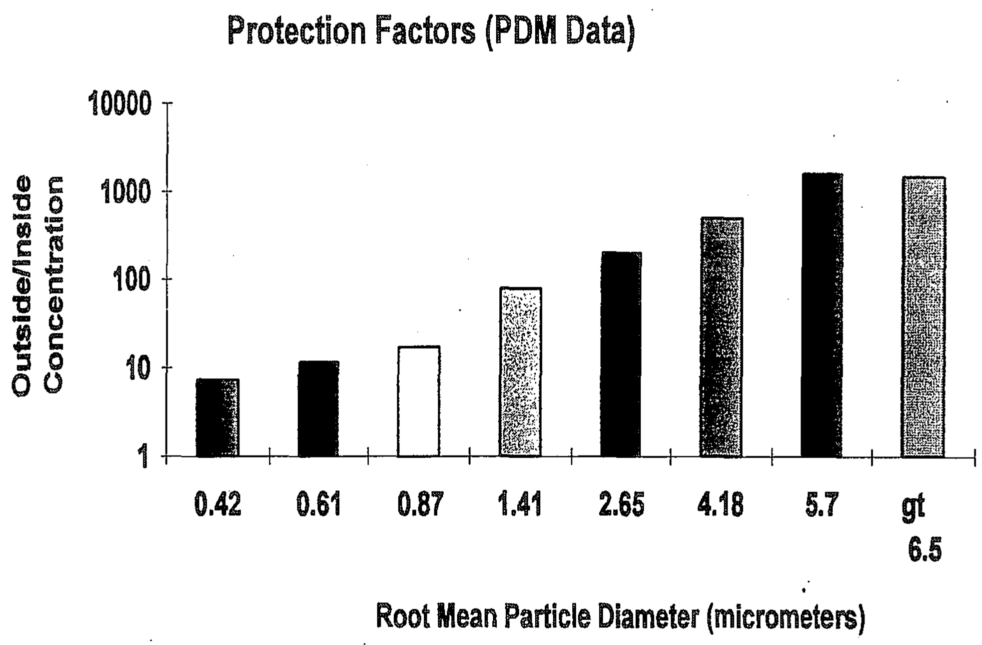

Figure 3. PDM protection factors at each separate particle size.

The PortaCount® Plus results confirmed the data collected with the HPC and PDM. The PortaCount® Plus counts particles smaller than 1 µm. As indicated by the HPC and PDM, the filtration system on the cab was less efficient for removing smaller particles. Three separate test runs were conducted with the PortaCount® Plus. Each of these test runs consisted of 12 individual protection test. The mean protection factor for all the tests was 16 (outside concentration/inside concentration).

Ventilation measurements were collected at the air louvers inside the cab. These air louvers are located in the back of the cab behind the operator. The area of the opening in the air louvers is 0.2 square feet. The average air velocity exiting these openings was 1300 fpm which resulted in an air volume of 260 cfm. Pressure measurements inside the cab were collected with an autozero digital micromanometer. The data output of the micromanometer was recorded with a data logger. The pressure remained positive inside the cab during our evaluation with an average pressure reading of 0.3 inches of water.

CONCLUSIONS

The HPC and the PDM both indicated that the cab is more than 99% efficient at removing aerosols larger than 3.0 µm in diameter and provides protection factors greater than 250 for particles larger than 3.0 µm. The results obtained with the PortaCount® Plus indicate that the cab provided a mean protection factor of 16 for aerosols smaller than 1.0 µm in diameter. As the particle size decreases (< 2 µm), the filtration efficiency of the cab decreases (see Table 1), which indicates that there may be some leakage of small particles into the cab.

The pressure measurements collected inside the cab indicated that the cab remained under positive pressure during our evaluation at an average of 0.3 inches of water. The positive pressure inside the cab reduces the possibility of aerosols entering the cab through leak sources other than around the filters in the ventilation system. Therefore, any leakage of small particles (<2 µm) into the cab may be a result of these small particles penetrating around the seals used to hold the filters in place in the ventilation system. There is also a possibility that some of the small aerosols (inside the cab) could be generated by the blowers or generated from the operator movement inside the cab.

REFERENCES

1. [1991] Novello, Antonia C. Papers and Proceedings, Surgeon General's Conference on Agricultural Safety and Health, A Charge to the Conference.

2. Nelson Manufacturing Co. Inc, Diagram of Air Flow, Yuba City, CA .

3. Met One, Inc. Model 227 Hand-Held Particle Counter, Operating Guide, Met One, Inc. Grants Pass, Oregon.

4. Grimm. Dust Monitor Instruction Manual, Series 1.100 v.5.10 E, Grimm Labortechnik GmbH & Co. KG, Ainrin, Germany.

5. TSI [1993]. PortaCount®Plus Model 8020, Operation and Service Manual, Rev.C, TSI Incorporated, St. Paul, MN.

APPENDIX A

	HPC Particle Count Data			
time	par/cc	par/cc	Par/cc	par/cc
sec	inside	outside	inside	outside
	>3.0	>3.0	0.3-3.0	0.3-3.0
1	0.074311	0.98121	11.63348	171.2841
2	0.054596	0.729462	11.56978	162.6427
3	0.025781	0.758277	11.13605	168.3131
4	0.028815	0.71733	9.376848	163.809
5	0.037914	0.71733	9.241875	142.2072
6	0.028815	0.747661	9.522437	142.2921
7	0.042463	0.785575	9.774185	151.4445
8	0.036397	0.699131	9.111451	159.2244
9	0.040947	0.656668	9.414762	146.4793
10	0.057629	0.823488	10.67198	148.0217
11	0.074311	0.834104	10.71445	135.8741
12	0.165304	0.319993	10.51426	95.08182
13	0.053079	0.303311	10.78118	98.00573
14	0.030331	0.333642	10.82819	101.0237
15	0.036397	1.320918	10.48242	95.02419
16	0.050046	0.39582	11.41055	94.84827
17	0.051563	2.716147	10.70535	91.53308
18	0.072795	1.73797	10.62194	91.10542
19	0.045497	0.285112	10.91463	97.22319
20	0.042463	0.300278	10.51881	95.44882
21	0.04853	0.370039	7.829964	93.52887
22	0.053079	0.603588	8.127208	89.64043
23	0.074311	0.641502	9.733238	90.04231
24	0.063695	0.453449	9.166047	87.19726
25	0.022748	0.370039	8.019533	87.68559
26	0.016682	0.298761	8.501797	89.79208
27	0.056112	0.656668	9.40263	85.11655
28	0.059146	0.298761	10.03048	90.00743
29	0.057629	0.653634	9.981953	87.63706
30	0.036397	0.820455	10.73113	90.47605
31	0.027298	0.553542	11.14212	88.93068
32	0.037914	0.36094	11.11633	88.52576
33	0.033364	0.310893	11.02231	84.46443
34	0.030331	0.271463	10.51881	91.23736
35	0.036397	0.304827	10.43692	89.65256
36	0.030331	0.797707	10.73113	83.83961
37	0.028815	0.586906	9.893993	86.42533
38	0.024265	0.652118	8.136308	84.10501
39	0.016682	2.170188	8.570042	77.71577
40	0.042463	1.560533	9.736271	81.40402
41	0.018199	1.804698	9.916741	82.24571
42	0.060662	1.357315	10.76298	79.16104
43	0.050046	0.280562	11.66078	85.18328

44	0.030331	1.264805	12.17034	79.03214
45	0.021232	1.82138	12.53886	77.61568
46	0.019715	2.192936	12.85582	76.36755
47	0.019715	1.061587	12.5146	77.48525
48	0.027298	3.419827	12.35233	78.40883
49	0.025781	27.67558	12.55706	77.79463
50	0.025781	55.94261	12.18702	82.35187
51	0.027298	21.31212	11.73206	104.3707
52	0.022748	3.850529	11.09965	112.1036
53	0.015166	1.926023	10.88582	123.593
54	0.037914	2.532644	10.79938	129.4727
55	0.027298	1.941188	10.73113	129.1497
56	0.019715	2.18232	10.15939	126.3562
57	0.021232	3.410728	9.625563	122.5966
58	0.022748	2.585723	8.738379	122.2706
59	0.015166	0.62937	9.319219	121.1301
60	0.022748	0.809839	9.429928	207.5054
61	0.069761	2.057963	10.32621	151.6083
62	0.071278	1.044905	11.11482	111.086
63	0.042463	0.350324	12.32351	85.05437
64	0.027298	0.194119	11.89281	72.65048
65	0.022748	0.398853	11.77452	84.42803
66	0.031848	0.253264	11.10117	91.87582
67	0.040947	0.79619	10.42024	126.8127
68	0.019715	0.13649	9.519404	44.48202
69	0.027298	0.128907	8.924915	43.31579
70	0.013649	0.12739	8.72473	44.5169
71	0.010616	0.118291	8.563976	46.92367
72	0.031848	0.142556	9.338934	44.04525
73	0.030331	0.134973	9.094769	44.59576
74	0.047013	2.471982	8.357725	41.36854
75	0.021232	0.203218	7.728355	42.64093
76	0.018199	0.116775	7.902759	41.28664
77	0.04398	0.159238	11.16335	41.26845
78	0.045497	1.273905	10.83577	37.32692
79	0.069761	0.398853	10.66744	197.9678
80	0.107675	2.074645	10.81757	114.932
81	0.054596	4.667951	11.32259	47.99587
82	0.024265	0.878084	11.30287	35.79369
83	0.025781	0.62482	11.48486	35.73454
84	0.060662	0.177437	11.88219	36.89319
85	0.054596	0.12739	10.89795	38.79646
86	0.057629	0.148622	11.23614	37.58474
87	0.045497	0.168337	12.42664	36.97053
88	0.03943	0.13194	12.35688	38.39913
89	0.037914	0.142556	11.30742	37.65905
90	0.034881	0.241132	11.42268	37.80919
91	0.040947	0.479231	10.63095	38.29903
92	0.025781	0.354873	9.833331	36.95233

93	0.021232	0.406436	9.495139	36.19406
94	0.042463	1.213243	8.683783	36.23046
95	0.031848	0.210801	8.256116	38.75097
96	0.060662	0.286629	8.626154	37.88956
97	0.045497	1.625745	8.59734	36.11975
98	0.019715	1.090402	9.035624	35.01873
99	0.016682	0.412502	8.879419	34.9156
100	0.027298	0.285112	8.891551	34.68357
101	0.028815	0.652118	8.310711	42.61818
102	0.012132	1.046422	8.392605	35.99842
103	0.036397	0.172887	9.35865	33.91165
104	0.030331	0.121324	9.128134	33.14579
105	0.051563	0.979693	9.640729	34.16794
106	0.028815	0.599039	10.4081	33.6508
107	0.021232	0.335158	11.24827	33.61137
108	0.025781	1.442242	11.37415	32.17368
109	0.015166	1.02974	11.13605	37.38759
110	0.028815	2.337008	11.29225	48.43113
111	0.016682	0.253264	11.40751	29.21488
112	0.031848	1.489255	9.783285	31.51549
113	0.025781	0.467098	9.39808	31.00138
114	0.009099	0.828038	9.293438	31.89918
115	0.016682	0.843204	9.35865	41.84625
116	0.007583	6.23	8.530612	81.96515
117	0.021232	0.501979	8.862737	32.58618
118	0.015166	0.726429	8.917333	31.34715
119	0.019715	1.924506	8.303129	31.51094
120	0.019715	0.497429	7.058038	30.49333
121	0.025781	2.694915	6.751695	45.27821
122	0.019715	2.14289	6.886668	42.327
123	0.016682	0.517145	6.763827	31.11967
124	0.025781	0.885667	6.929131	29.8215
125	0.036397	2.711597	7.412912	35.89681
126	0.031848	9.128134	8.800558	60.84411
127	0.034881	0.552025	8.143891	29.5561
128	0.025781	0.562641	8.369857	28.49148
129	0.027298	2.091327	8.809657	30.08842
130	0.028815	0.467098	8.524545	29.31194
131	0.028815	1.16168	9.100836	30.1324
132	0.031848	0.737045	9.328319	29.97922
133	0.024265	0.693065	10.2883	32.57708
134	0.028815	4.363123	11.10269	84.32491
135	0.034881	0.680932	10.58402	37.73033
136	0.031848	0.98576	10.10631	39.73976
137	0.034881	15.67358	10.261	52.12242
138	0.034881	10.13664	10.72658	45.34646
139	0.016682	2.872352	10.89643	30.93314
140	0.030331	1.434659	10.69928	29.3908
141	0.012132	2.08981	10.55521	30.40537

142	0.028815	0.251748	10.21247	27.6225
143	0.036397	4.229667	11.80637	32.06752
144	0.037914	8.15764	13.27742	116.7185
145	0.075828	1.792566	13.73391	59.02425
146	0.059146	2.611505	14.06451	61.02155
147	0.024265	5.29732	12.89374	41.51868
148	0.03943	12.02627	12.54189	52.3317
149	0.050046	23.97974	12.17489	73.29653
150	0.019715	14.98506	10.97681	74.88891
151	0.022748	2.629703	10.84639	40.9985
152	0.018199	1.833513	10.94193	65.78201
153	0.016682	1.234474	10.59161	55.61201
154	0.013649	1.422527	9.698358	197.2414
155	0.015166	0.79619	9.426895	121.1438
156	0.022748	0.583873	8.930982	107.1551
157	0.045497	0.503496	7.995268	77.00299
158	0.040947	1.170779	7.496322	68.21305
159	0.018199	1.639394	5.562717	53.77849
160	0.045497	1.078269	6.777476	65.39984
161	0.037914	1.784983	7.08837	170.4151
162	0.021232	1.395229	7.014058	174.3172
163	0.040947	0.548992	6.716814	80.48651
164	0.028815	0.552025	6.742595	139.3637
165	0.037914	0.588423	6.662218	166.2521
166	0.022748	0.574774	6.72743	164.4793
167	0.037914	0.451933	7.062588	136.828
168	0.025781	0.909932	7.246091	168.4966
169	0.012132	5.590015	7.575183	59.60206
170	0.007583	17.48586	7.701057	40.78618
171	0.009099	32.93195	7.876977	56.57957
172	0.012132	27.25701	8.300096	43.18688
173	0.006066	7.842096	8.189387	33.48094
174	0.009099	26.61248	8.409287	47.64707
175	0.015166	1.95787	9.000743	26.26822
176	0.013649	0.650601	8.864253	24.81233
177	0.03943	0.878084	8.160573	24.79716
178	0.021232	3.850529	7.597931	30.58888
179	0.016682	45.08561	7.538786	48.48117
180	0.068245	90.91281	8.01195	84.60395
181	0.04853	29.55156	7.675276	35.2265
182	0.037914	16.88379	7.564567	35.04603
183	0.047013	58.93477	8.090811	61.24145
184	0.022748	51.52034	8.541227	76.00055
185	0.03943	64.63095	8.477532	67.51998
186	0.068245	74.4112	9.669543	75.95808
187	0.080377	27.78022	9.526987	50.53004
188	0.04398	4.190236	8.738379	31.2137
189	0.030331	97.45826	8.357725	76.77399
190	0.036397	43.72829	8.010434	72.11969

191	0.054596	57.14221	8.745962	75.14066
192	0.115258	38.22776	10.13512	54.23649
193	0.053079	58.2963	9.149365	57.77461
194	0.054596	125.2885	8.369857	79.99363
195	0.08796	30.93162	7.808732	55.38452
196	0.08341	35.1628	6.525728	51.96773
197	0.189569	80.99607	9.307087	60.00849
198	0.098576	70.03594	9.249458	79.21867
199	0.054596	7.735938	9.285855	41.86293
200	0.08341	83.09801	8.968895	76.62992
201	0.139523	73.35264	10.15181	79.08067
202	0.089477	39.40763	9.742338	52.41511
203	0.138006	90.74599	10.62497	70.07992
204	0.077344	75.31051	10.16242	70.46361
205	0.080377	113.7718	10.16242	79.17014
206	0.059146	66.58578	9.771152	80.60025
207	0.08341	7.382581	10.17304	36.79006
208	0.103126	40.60268	11.51367	85.26062
209	0.097059	50.4997	10.71596	56.47037
210	0.066728	113.9098	10.51578	80.32424
211	0.125874	95.91744	12.63895	87.4945
212	0.113741	35.80734	12.78151	61.58571
213	0.247198	3.974886	13.68689	31.97652
214	0.27298	11.04051	14.69388	40.51623
215	0.186536	2.139857	12.21735	26.76868
216	0.100093	2.722213	10.22308	28.77205
217	0.162271	25.32492	11.56372	59.97361
218	0.101609	24.31641	9.417795	73.51795
219	0.062179	47.71228	8.621605	68.66649
220	0.109192	100.4989	9.871245	93.86554
221	0.169854	49.96891	11.29225	75.70482
222	0.113741	72.50641	10.07143	83.78805
223	0.150139	21.94604	11.19671	70.30286
224	0.159238	110.8798	11.38325	76.3448
225	0.110708	4.252415	9.951622	32.04477
226	0.068245	2.437101	8.839988	35.1628
227	0.08341	11.30287	8.571559	37.98662
228	0.072795	57.36666	7.65556	104.0083
229	0.08796	31.63985	7.766269	48.57975
230	0.145589	45.10684	8.222751	50.87429
231	0.153172	71.43724	7.550918	57.93536
232	0.104642	3.947588	6.728946	35.75274
233	0.089477	1.568116	7.44021	27.33587
234	0.045497	1.945738	6.609139	27.2009
235	0.12739	1.836546	8.677717	27.31464
236	0.103126	9.169081	8.369857	36.10155
237	0.112225	4.789275	9.196378	30.93162
238	0.116775	1.901758	9.675609	25.55089
239	0.116775	2.916332	9.848496	28.1078

240	0.216867	8.510896	11.16486	34.7776
241	0.201702	1.164713	11.01624	24.38921
242	0.110708	1.546884	10.8843	24.62276
243	0.204735	2.470465	13.74907	24.90939
244	0.260847	2.838988	14.41029	27.26611
245	0.242649	2.832921	14.54071	27.16753
246	0.18047	25.29004	12.75421	50.70141
247	0.063695	44.72315	11.19368	61.32183
248	0.068245	0.909932	10.40659	23.13502
249	0.301794	6.392272	15.92836	29.93373
250	0.371556	7.485706	17.24473	34.48339
251	0.18047	9.947072	12.78151	40.71945
252	0.086444	23.60212	11.03899	72.10452
253	0.089477	60.51957	10.57341	102.0079
254	0.081894	52.96865	9.757503	88.4833
255	0.086444	5.1214	9.912192	33.95259
256	0.054596	151.6705	9.592199	90.06203
257	0.027298	11.08752	9.272206	43.35067
258	0.057629	50.30559	9.068988	63.83627
259	0.054596	91.1403	9.48149	70.05111

APPENDIX B

		Particle Counts Inside the Cab During 4 Seperate Runs						
Particle Size	0.42	0.61	0.87	1.41	2.65	4.18	5.70	gt 6.5
Run1 Avg Counts	7713.08	1129.08	155.25	53.50	16.67	4.08	2.50	4.67
Run2 Avg Counts	5600.18	863.82	116.76	47.00	10.59	4.00	1.29	1.24
Run3 Avg Counts	4938.00	1035.00	282.00	134.00	52.00	21.00	2.00	5.00
Run4 Avg Counts	8591.69	2085.92	747.08	415.12	144.96	47.65	14.58	6.73
		Particle Counts Outside the Cab During 4 Seperate Runs						
Particle Size	0.42	0.61	0.87	1.41	2.65	4.18	5.70	gt 6.5
Run1 Avg Counts	76490.17	13742.08	3350.42	2871.42	1602.67	1183.00	511.17	650.58
Run2 Avg Counts	35784.18	8435.00	2774.12	1482.12	659.06	566.29	273.47	528.65
Run3 Avg Counts	48485.85	18308.74	4390.70	24106.52	25913.33	23278.22	10972.33	16462.85
Run4 Avg Counts	37399.52	15265.85	6151.81	19488.89	19501.78	18615.15	8154.81	12314.37