IN-DEPTH SURVEY REPORT:

CONTROL TECHNOLOGY FOR ENVIRONMENTAL ENCLOSURES-THE EFFECT OF WIND SPEED UPON AEROSOL PENETRATION INTO AN ENCLOSURE

AT

Clean Air Filter
Defiance, Iowa

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DISCLAIMER

ABSTRACT

The effect of wind speed upon aerosol penetration into an idealized enclosure was studied The idealized enclosure was a painted plywood box that was 1 2X1 2 X1 meters in volume Two fans supplied 1 7 m^3 /min of filtered air to this enclosure at a static pressure of 2 8 mm of water The enclosure had a 7 5 cm diameter vent port which was isolated from the air flow around the enclosure To simulate holes in real enclosures, three 1 6-cm diameter holes were drilled on the front and back sides of the enclosure This simulated enclosure was placed in a tunnel-like structure The air flow from an ultra-light air craft was directed at the front of the enclosure The air speeds were varied between 14 and 36 km/hr as measured by rotating vane anemometer Static pressure in the enclosure was measured with an electronic manometer Two optical particle counters measured the particle number concentration of particles between the 0 35 to 0 5 µm inside and outside of the enclosure Aerosol penetration into the enclosure was computed as the ratio of the aerosol concentration inside the enclosure to the concentration outside of the enclosure The enclosure static pressures measured increase from 2 8 to 3 4 mm of water (P=0 0001) Aerosol penetration into the enclosure increased linearly with air velocity above 20 km/hr Theoretically estimated penetrations were correlated with observed penetration into the simulated enclosure When simple linear regression was used to model the observed penetration as a function of the estimated penetration, the value of the slope was 0 69±0 12 and the P value for the regression model was less than 0 0001 These results indicate that enclosure static pressure needs to be higher than the wind's velocity pressure in order to minimize aerosol penetration into these enclosures

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH), a federal agency located in the Centers for Disease Control and Prevention under the Department of Health and Human Services, was established by the Occupational Safety and Health Act of 1970   This legislation mandated NIOSH to conduct research and education programs separate from the standard setting and enforcement functions conducted by the Occupational Safety and Health Administration (OSHA) in the Department of Labor   An important area of NIOSH research deals with methods for controlling occupational exposure to potential biological, chemical, and physical hazards

The Engineering Control Technology Branch (ECTB) of the Division of Physical Sciences and Engineering (DPSE) has been given the lead within NIOSH to study the engineering aspects relevant to the control of hazards in the workplace   Since 1976, ECTB has assessed control technology found within selected industries or used for common industrial processes   ECTB has also designed new control systems where current industry control technology was insufficient   The objective of these studies has been to document and evaluate effective control techniques (e g , isolation or the use of local ventilation) that minimize risk of potential health hazards and to create an awareness of the usefulness and availability of effective hazard control measures

One area identified for ECTB control studies is air contaminant penetration into environmental enclosures   Prior research conducted by ECTB has focused upon environmental enclosures has been used to protect workers from pesticide spray mist   NIOSH researchers conducted a field evaluation of tractor enclosures used for pesticide application by using optical particle counters to measure exposure reduction as a function of particle size [1,2] To conduct the tests, the tractors equipped with environmental enclosures were simply driven over unpaved surfaces and the ambient aerosol and dust generated by the tractor were used to challenge the enclosure   In addition, such enclosures can be used to protect heavy equipment operators from crystalline silica exposures during surface mining and other earth moving operations [3]

As a result of the applications to surface mining, researchers from the NIOSH Pittsburgh Research Laboratory (PRL) collaborated in this study   The PRL is responsible for conducting research on means of controlling safety and health hazards in the mining environment   During surface mining operations, many workers are positioned in cabs for earth moving equipment, rock drilling equipment, and rock trucks   Excessive crystalline silica exposures are reported among surface mining workers [4] (Ed could you help out with a reference) Appropriate cabin filtration and pressurization appears to have the potential for controlling worker exposure to respirable crystalline silica

These enclosures are generally constructed from impervious materials so that workers are protected from dermal and respiratory exposures   A fan is used to suck air through filters which efficiently remove air contaminants and to pressurize the enclosure   Downstream of the fan, the air flows past an air-conditioning evaporator coil which can be used to temper the air   In these enclosures, a second fan can be used to recirculate air through a second set of filters and the air conditioner evaporator coil The air flows out of the enclosure through leaks or a vent port which is intended to allow air to leave the enclosure at a location which is shielded from the effects of the wind These enclosures will have leakage There is a need for electrical and mechanical connections between these enclosures and the rest of the equipment These vent ports are generally somewhat isolated from the direct impact of the ambient wind

Based upon the ECTB evaluation of tractor-mounted enclosures, the American Society of Agricultural Engineers (ASAE) has developed ASAE S525, which is a consensus standard This consensus standard specifies requirements for environmental enclosures that are used for controlling applicator exposure to pesticide spray mist[5,6] Cabs, which are certified under this standard, may be used instead of respirators to meet the requirements of Worker Protection Standard[7] Three important specifications in this consensus describe the performance of these enclosures for particulate air contaminant

1 The static pressure in the enclosure must be at least 6 mm of water,
2 The penetration (ratio of concentration inside the enclosure to outside the enclosure) shall be less than 0 02 for particles larger than 3 µm, and,
3 The filtration efficiency shall be at least 99 percent for particles larger than 3 µm

Aerosol penetration into the enclosure is evaluated by using optical particle counters to measure the concentration of particles in the 2-4 µm range inside and outside of the equipment The testing is conducted by driving the vehicle mounted enclosure over an unpaved surface at 3-5 km/hr This equipment can be tested and evaluated under relatively calm air conditions without regard to wind speed In order to prevent the drift of pesticides, spray pesticide application is conducted when wind speeds are less than 16 km/hr[8] In order to prevent wind from increasing air infiltration into an enclosure, the ASAE standard specifies that an enclosure must have a static pressure of 6 mm of water Based upon a straightforward application of Bernoulli's equation, air flow into the enclosure will occur when the velocity pressure of the wind exceeds the static pressure of the enclosure The relationship between air velocity ($V_{km/hr}$) in km/hr and velocity pressure(VP) in mm of water is

$$V_{KM/HR} = 14.5\sqrt{VP} \tag{1}$$

At a wind speed of 35 km/hr, the velocity pressure is 6 mm of water Because of regulatory restrictions, spraying can not be done when wind speeds exceed 16 km/hr During spraying, applicator speeds will be under 5 km/hr This suggests that a static pressure of 3 mm of water should be sufficient to prevent air infiltration into the enclosure from the ambient wind Consequently, researchers from the NIOSH Engineering Control Technology Branch and the Clean Air Filter Company collaborated to evaluate the effect wind velocity upon aerosol penetration into a simulated enclosure The simulated enclosure, shown in Figures 2 and 3, was simply a box with circular holes used to simulate leakage

THEORETICAL CONSIDERATIONS

Air flow through holes in an enclosure can be modeled as air flow through an orifice. A mechanical energy balance, sometimes called Bernoulli's equation, can be used to state the relationship between air flowing through the orifice, the air velocity in the orifice[9]

$$0.5\rho v_1^2 + p_1 - (0.5\rho v_2^2 + p_2) = 0.5h\rho v_o^2 \qquad (2)$$

Where

v = air velocity subscripts 1 - outside the enclosure, 2-inside the enclosure, o-in the orifice throat (m/sec),
p = static pressure subscripts 1-outside the enclosure, 2 - inside the enclosure (kg/m/sec^2),
h = energy loss factor for the orifice (dimensionless), and,
ρ = density of air (kg/m^3)

The terms involving "$0.5\ \rho v^2$" are the velocity pressures outside and inside the enclosure. The pressure terms (p_1 and p_2) are the static pressures outside and inside the enclosure. The velocity pressure inside the enclosure is assumed to be negligibly small (essentially 0) and the static pressure outside of the enclosure is taken to be zero. The term "$0.5h\rho v_o^2$" accounts for the energy loss attributed to flow through the orifice. The value of h was taken to be 2.68 in order to be consistent with the published coefficient of discharge for a sharp edged orifice.[10] This larger than the value of 1.98 published elsewhere.[11] The higher value of h was used because holes drilled in the enclosure probably involve more friction than an ideal orifice. Solving for the air velocity in the orifice (v_o), an equation resembling the equation for the flow of an incompressible fluid through a sharp edged orifice is obtained[12]

$$v_o = 0.61\sqrt{2(0.5\rho v_1^2 - p_2)/\rho} \qquad (3)$$

In the preceding formula, "$0.5\rho v_1^2$" is literally the wind's velocity pressure and p_2 is the static pressure in the enclosure. The infiltration air flow is the product of v_o and the area through which the fluid flows. For air to enter the enclosure, the winds velocity pressure must be greater than the enclosure's static pressure. When the static pressure is greater than the velocity pressure, air can not flow into the enclosure regardless of the open area through which the fluid flows.

EXPERIMENTAL PROCEDURES

In order to evaluate whether this criteria is appropriate, the effect of wind upon aerosol penetration into a simulated enclosure was studied experimentally The wind was supplied by using an ultralight air craft The wind speed was varied by changing the engine rpm and the distance from the front of the simulated In order to control the wind direction, the air flow from the ultra light air craft was directed through a tunnel which was open on both sides The dimensions of the tunnel are shown in Figure 2 The simulated enclosure was set inside of this tunnel

The simulated cab is shown in Figures 2 and 3 This box had three 1 6 cm diameter holes on the front and rear walls of the box The box was positioned so that one side faced the wind As shown in Figures 2 and 3, the box was 1 2 x 1 2 x 1 meters in volume Two fans (model 3540, Jabsco, Costa Mesa, CA) was used to pressurize the inside of this box The air flowed through a filter, through the fan, a second filter just downstream of the fan, a three inch diameter piper and into the box The filters (GL910, Clean Air Filter) had a face area of 40cm x 22 cm and contained media that was 99 percent efficient against 0 3 μm particles The air could flow out of the box through the 1 6 cm diameter holes or through another 7 5 cm (3 inch) diameter pipe which discharged the air at a location which was shielded from the wind outside of the tunnel The air flow into the enclosure was 1 7 m^3/min This flow rate was measured using a six point pitot tube traverse Under calm conditions, the static pressure in the enclosure was 2 8 mm of water static pressure Velocity pressures and static pressures were measured with an electronic manometer (model MP20SR, Neutronics, Herts, UK) A velometer (Velocicalc, TSI Inc) was used to monitor the center line velocity in the pipe through which supplied air to the enclosure This measurement indicated that the flow rates had a coefficient of variation of 3 percent

The aerosol penetration into the simulated enclosures was obtained by measuring the ambient aerosol concentrations inside and out of the enclosure Two optical particle counters (Grimm PDM, model 1106, Ainring Germany) were used to measure aerosol concentration inside and outside the simulated cab One was placed in the simulated cab and one was placed outside of the simulated cab between the walls of the simulated cab and the walls of the enclosures These instruments were used with their omni directional sampling inlets The Grimm PDM counts individual particles and sizes each particle, based upon the amount of light scatted, into one of eight channels In this work, particles in the smallest channel, 0 35 to 0 5 μm Aerosol penetration into the cab was the ratio of the concentration inside the enclosure to the concentration outside of the enclosure

AIR FLOW MEASUREMENTS

A portable weather station (Wind Monitor model ER 100, Young, Traverse City, MI) was used to measure air speed and direction The sensing elements were located about 0 5 meters above the box During the experiments, wind direction kept within 5° a line bisecting the long axis of the tunnel A rotating vane anemometer (Model HTA4200, Pacer Industries, Chippewa Falls, WI) was used to measure wind speed near the holes in the enclosure This location is shown in Figure 2 These speeds were manually recorded every 15 seconds

Data collection involved four sets of experimental runs The location of the OPCs was switched during each set of experimental runs During each set of experimental runs, aerosol penetration was measured at four nominal wind speeds 0, 3 6, 5 8 and 11 m/sec (0, 8, 13, 25 mph) The position and the engine speed of the ultralight air craft were adjusted to roughly obtain the desired nominal wind speed Before data collection began, five minutes were allowed for particle concentrations to reach steady state

RESULTS AND STATISTICAL ANALYSIS

For each experimental run, the raw data is tabulated in Appendix 1 The data are presented graphically in Figures 4 and 5 This study was designed as a controlled experiment with replications at different air velocities However, air velocities were not very controllable because data collection was taken outdoors As a result, regression analysis, using the SAS General Linear Models Procedure,[13] was performed The experimental data was fit to a linear model

$$y = mx + b + \varepsilon \qquad (4)$$

where

y = dependent variable
x = independent variable
m = slope
b = intercept
ε = the residual, the difference between the observed and modeled value of y

These regression analysis terms and their values are listed in Table I Table I also lists the following statistics

R^2 - the fraction of the variability in the dependent variable explained by the regression model

s_ε - the standard error of estimate This is the square root of the variance about the regression line

Prob>F - the probability of obtaining the observed regression line by chance

Prob<W - low probabilities indicate that the residuals from the regression analysis did not come for a normal distribution This is the probability for the Shapiro-Wilke statistic obtained from the SAS Univariate Procedure [14]

In Figure 4, static pressure is plotted as a function of air velocities measured with the rotating vane anemometer. As noted in Table I, air velocity significantly increased the static pressure in the enclosure.

In Figure 5, observed penetration is plotted as a function of air velocity as measured by the rotating vane anemometer. The average velocities have coefficients of variation of 10-20 percent. The mean and standard deviation for the aerosol penetration into the enclosure under calm air conditions was 0.001and 0.007, respectively. Under calm conditions, aerosol penetration into the enclosure is probably due to leakage and aerosol generation in the air handling system. These combined sources of experimental error are termed background penetration. An upper 99 percent confidence limit on this background penetrations is the sum of the mean and three standard deviations. Thus an upper limit on this background penetration is 0.003. For air velocity larger than 20 km/hr, the measured penetration exceeded 0.003 and it was modeled as a linear function of air speed. Regression analysis showed that air velocity had a significant affect upon penetration into the enclosure. In Figure 5, penetration appears to increase linearly with air velocity above 20-21 km/hr. Based upon an enclosure static pressure of 2.8 mm of water, one would have expected air velocities above 24 km/hr to cause increased penetration into the cab. Because air velocities were variable, some individual velocity measurement exceeded the expected threshold velocity and penetration may have occurred during a fraction of the sampling period.

To address the variability in the velocity measurements and the fact instantaneous velocity measurements were not consistently above the threshold for air flow through the holes, the volume of air flowing into the enclosure due to wind pressure was estimated from the product of the velocities estimated using equation 2 and the area of the three holes. Two estimates of air flow into the enclosure were obtained by using the static pressure obtained under calm air conditions and by using the static pressure recorded during the experimental run. The expected penetration is the ratio of the estimated air flow through the three holes and the air flow supplied by the fan.

Figure 6 shows the relationship between the observed penetration and the penetration estimated based upon the static pressure measured under calm air conditions. This static pressure was 2.8 mm of water. The penetration estimated from a static pressure of 2.8 mm of water consistently overestimates the observed penetration. In Figure 6, the slope of the regression line shown is 0.55±0.15 and the intercept was 0.002±0.005 (95 percent confidence interval). With one exception, the observed penetrations were all less than the expected penetration. In this case, the difference between the observed penetration and expected penetrations was less than the standard error of estimate (a standard deviation for the regression equation) and this probably reflects random experimental variability. The residuals from this regression analysis did not appear to be normally distributed ($\text{Prob} < W = 0.001$). This could indicate some lack of fit of the regression model to the experimental data.

Figure 7 shows the relationship between the observed penetration and the penetration estimated based upon the actual static pressure in the enclosure during data collection In Figure 7, the slope of the regression line is 0 69±0 12 indicating that the observed penetration is being significantly over estimated Of all the regression models for the observed penetration, this model had the highest R^2 and the smallest s_e The residuals from the regression analysis appeared to be normally distributed ($Prob< W = 0\ 1$) As expected from equation 3, air flow though the enclosure varies with both air velocity and enclosure static pressure

DISCUSSION

The data presented in Figure 6 and 7 indicates that there was aerosol penetration into the enclosures at average air velocities which are smaller than expected threshold for aerosol penetration into this enclosure However, values of penetration estimated from equation 3 appeared to consistently overestimate the observed penetration into the enclosure However, these estimated penetrations were predictive of the observed penetrations ($P<0\ 0001$) The difference between the observed and expected penetration could be due to an inaccurately known value of the term "h" which was mentioned in equation 2 The holes in the enclosure were modeled as a sharp edged orifice flow metes Orifice flow meters assume a very smooth hole that are much smoother than the holes produced by drilling through plywood Also, the discharge coefficients (which are proportional to $h^{-0\ 5}$) are experimentally reported to decrease as the orifice Reynolds number decreases below 2000[9] In this study, as penetration decreases from 7 percent to 1 percent, the orifice Reynolds number decreases from 3500 to 350 This indicates that the concept that air infiltration is prevented as long as the static pressure is higher than the wind's velocity pressure is correct However, it is probably impractical to estimate the amount of aerosol penetration because the surface area and the value of "h" are probably not predictable in actual practice

Thus, the results in this study indicate that threshold leakage into a enclosure pressurized at 2 8 mm of water is 20-21 km/hr This indicates that as along as the combined speed of the wind and the vehicle remains below 21 km/hr, wind pressure will not cause air infiltration into an enclosure In comparison, an enclosure static pressure of 6 mm of water seems somewhat excessive However, there needs to be a margin of safety between the threshold for air infiltration and the static pressure at which the enclosure operates

When considering the use of an environmental enclosure, wind speed is an important consideration In this study, it affected the aerosol penetration into the enclosure and the static pressure in the enclosure What may provide acceptable protection under relatively calm conditions, may not be acceptable when the wind increases For example, it is likely that enclosure static pressures, which are suitable for agricultural pesticide application, might be too low for surface mining operations under windy conditions One can provide protection under high wind conditions by using a static pressure which is higher than the wind's velocity pressure based upon the sum of the vehicle speed and the wind speed Once the wind's velocity pressure exceeds the enclosures static pressure, leakage will occur Such information needs to be included in equipment manuals so that users and operators understand the equipment's capabilities and limitations

When evaluating the adequacy of an enclosure's maintenance and/or integrity, enclosure static pressure is a consideration Because wind speed can affect enclosure static pressure, this static pressure needs to be measured under calm conditions Changes in enclosure static pressure can not be clearly interpreted in the presence of wind An increased static pressure could mean that the enclosure has been appropriately sealed or it could also indicate that there is so much leakage that the wind is pressurizing the enclosure During this study, wind did cause a 10-20 percent increase in the static pressure of the enclosure

A more refined study could be done to evaluate the effect of enclosure static pressure and wind speed and orientation upon air contaminant penetration into an environmental enclosure This study was performed under relatively uncontrolled circumstances and a reasonably good agreement between expected and observed penetration was obtained The expected and observed threshold velocity for penetration into the enclosure were respectively 24 and 20-21 km/hr A difference of 15-20 percent could simply be the result of error propagation Perhaps, more precise data could be collected under carefully controlled experimental conditions However, the macroscopic mechanical energy balance (Bernoulli's equation) is a well-established engineering principle, and it is the basic design equation for incompressible liquid and air handling systems The experimental findings do not indicate any surprising departures from what was expected Thus, further experimental experiment work would essentially result in the reaffirmation of well-established engineering principles

CONCLUSION

Wind speed is an important consideration when evaluating the applicability of environmental enclosures The available data shows that there is a threshold affect When the wind's velocity pressure exceeds the enclosures static pressure, aerosol penetration into the enclosure increases with wind velocity

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Table I
Regression Analysis Statistics

Figure Number for Data Plot	4	5	6	7
Dependent Variable (y)	Enclosure Static Pressure (mm of water)	Observed Penetration (for Velocities > 20 *km/hr*	Observed Penetration	Observed Penetration
Independent Variable (x)	Velocity(km/hr)	Average Velocity (km/hr)	Estimated from Static Pressure for Calm Air	Estimated from Static Pressure During Run
Standard Error of Estimate	0.13	0.009	0.0092	0.0068
R^2	0.57	0.77	0.75	0.865
Prob > F	0.00002	0.0001	0.0001	0.0001
Slope (m)	0.012±0.006	0.0036±0.0014	0.55±0.15	0.69±0.12
Intercept (b)	2.8±0.1	-0.07±0.03	0.0017±0.005	0.003±0.004
Degrees of Freedom	21	13	21	21
Prob < W	0.11	0.24	0.001	0.1

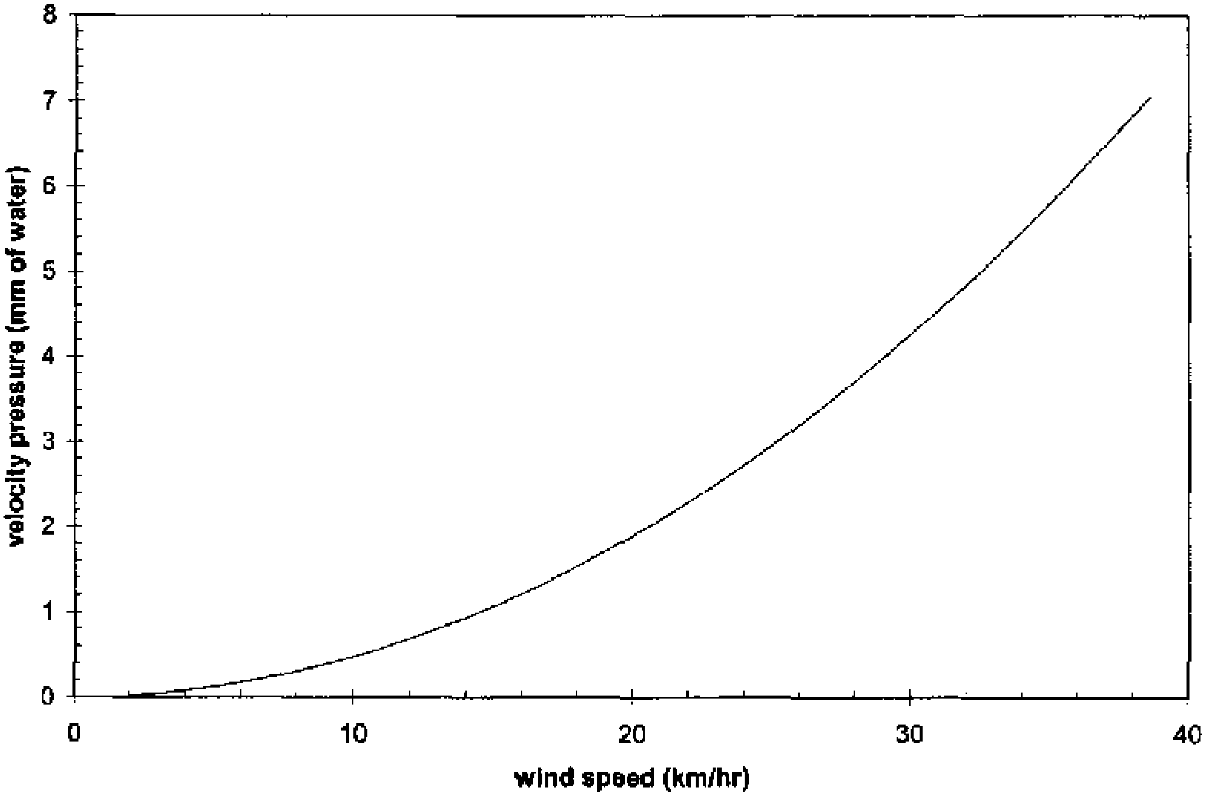

Figure 1 Velocity pressure plotted as a function of wind speed

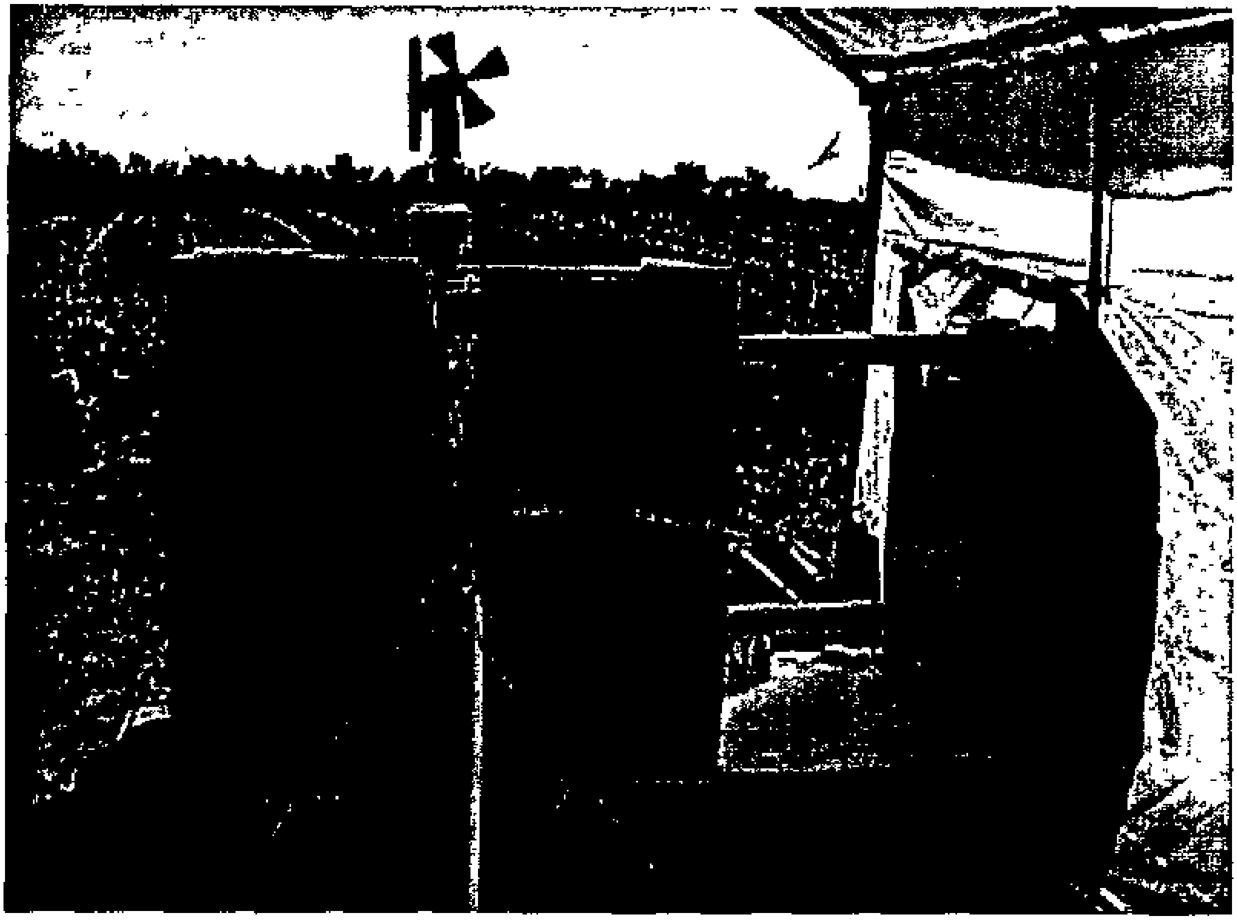

Figure 2 Front view of test stand

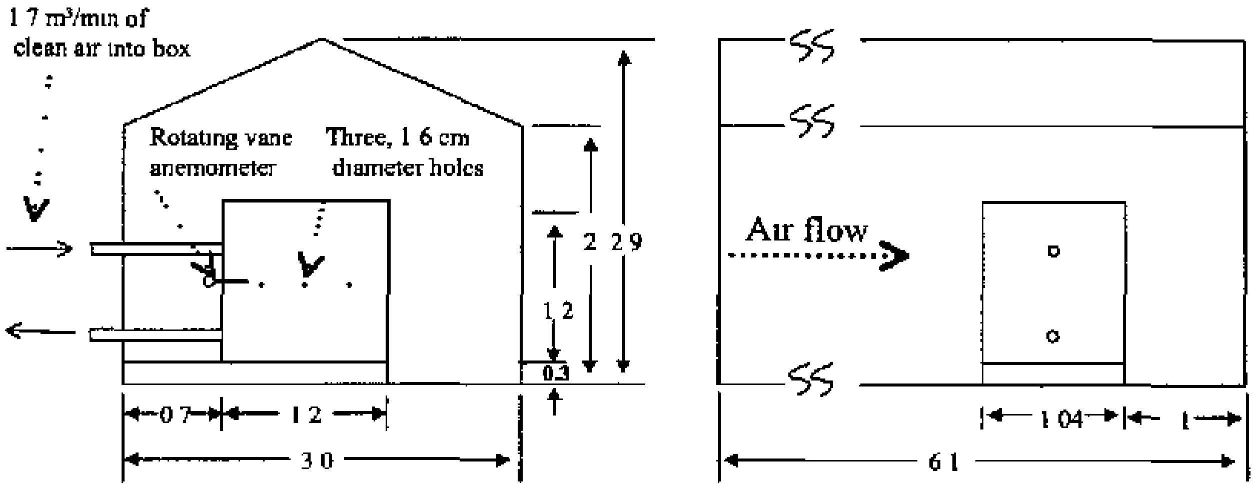

Figure 3 Schematic of test stand The dimensions in this drawing are in meters

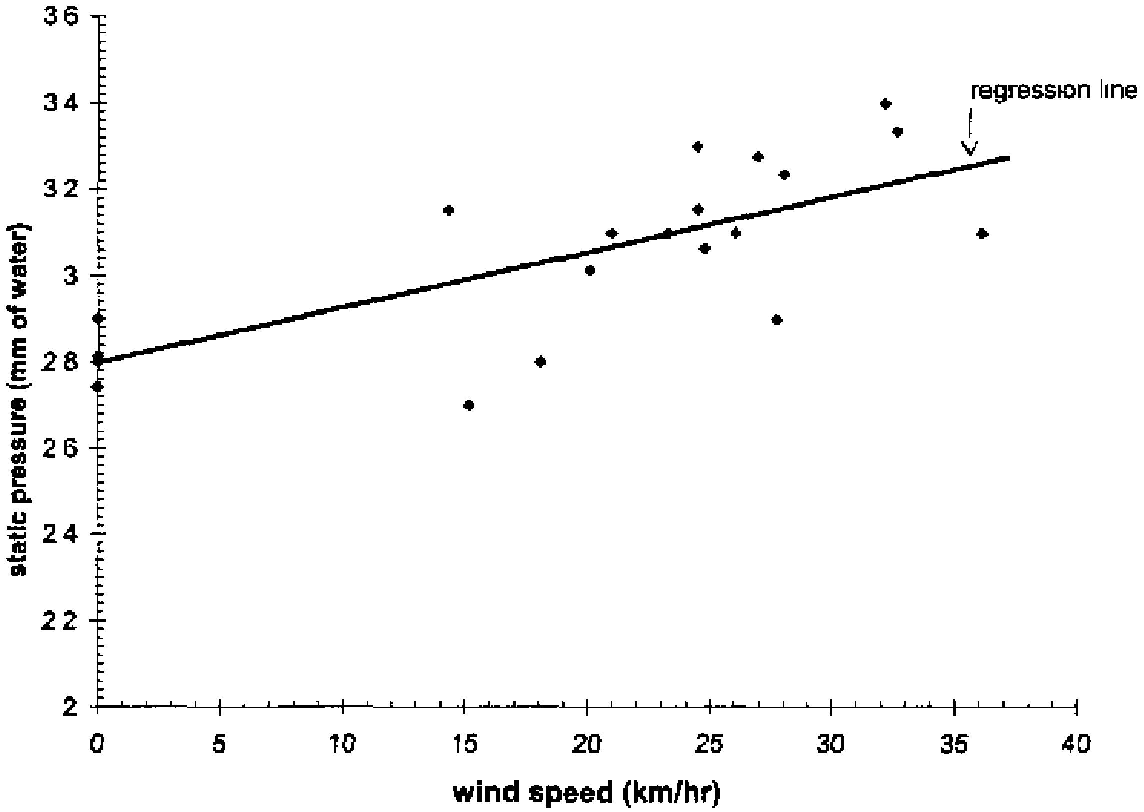

Figure 4 Static pressure plotted as a function of wind speed

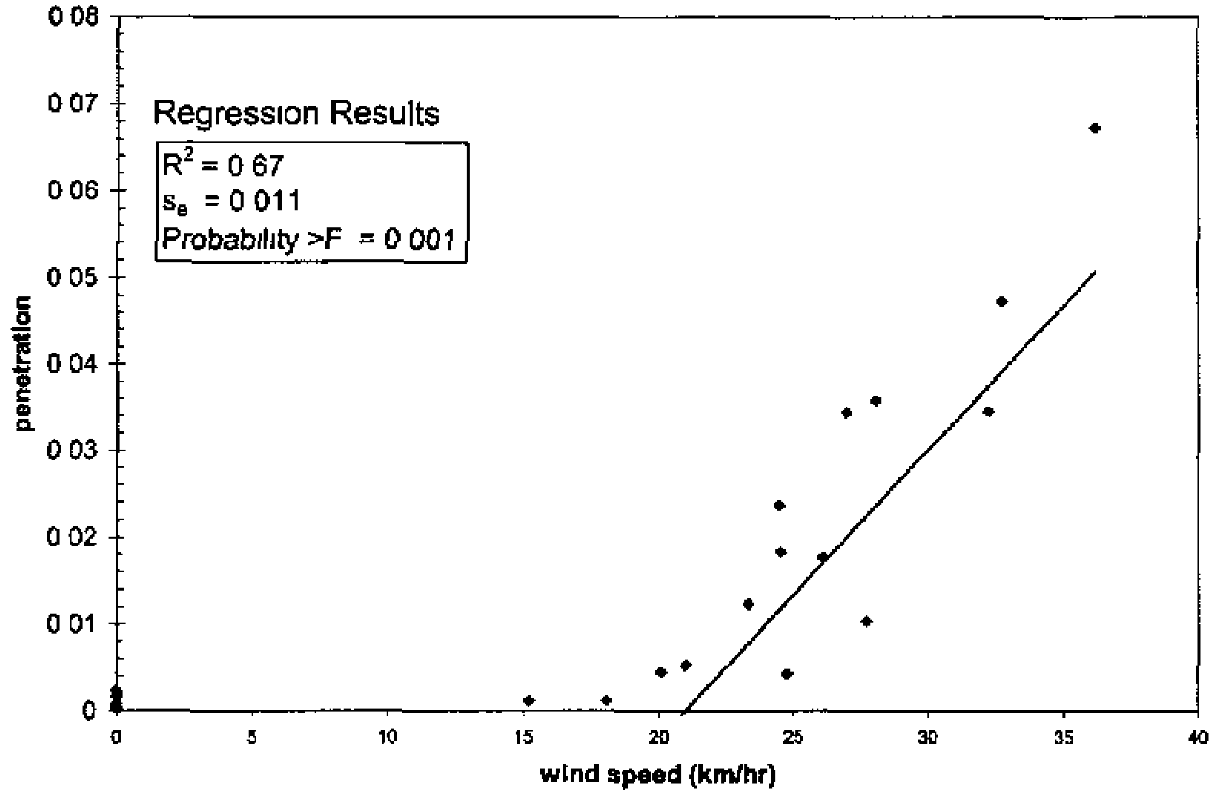

Figure 5 Penetration increases with average wind speed above 20 km/hr

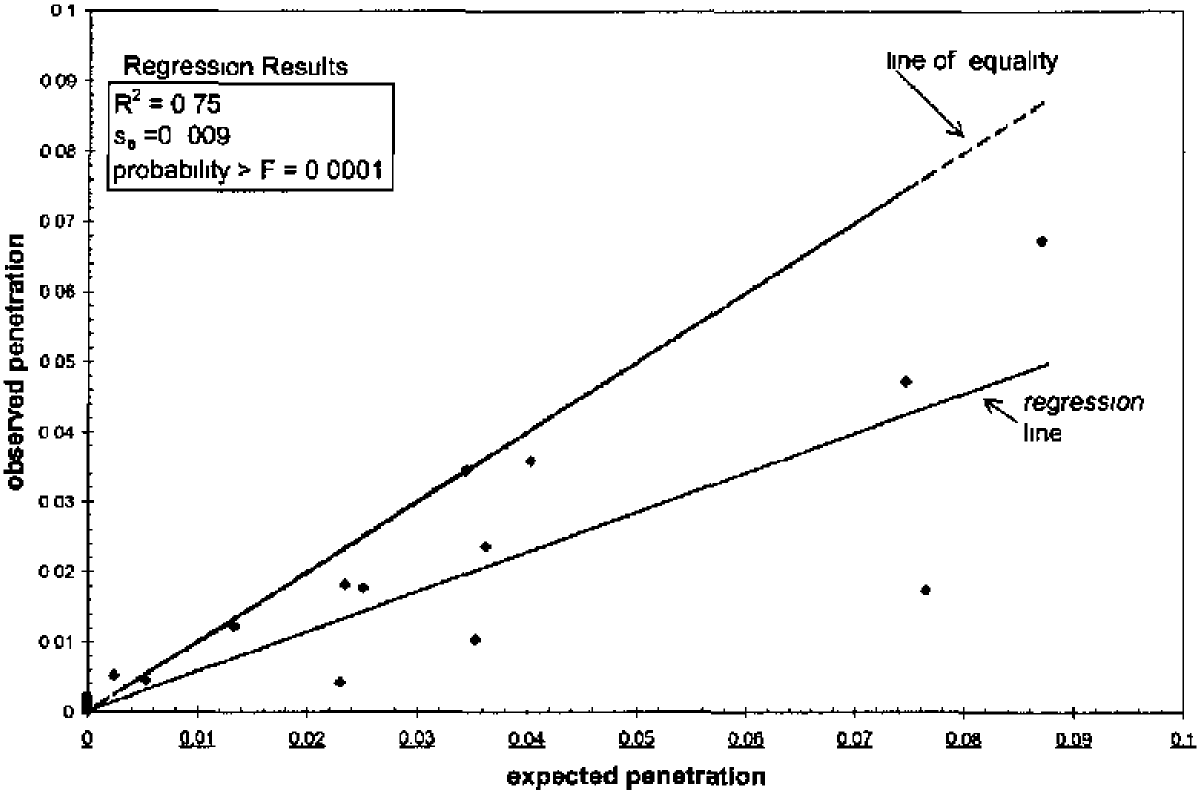

Figure 6 Observed penetration plotted as a function of expected penetration based upon formula 2

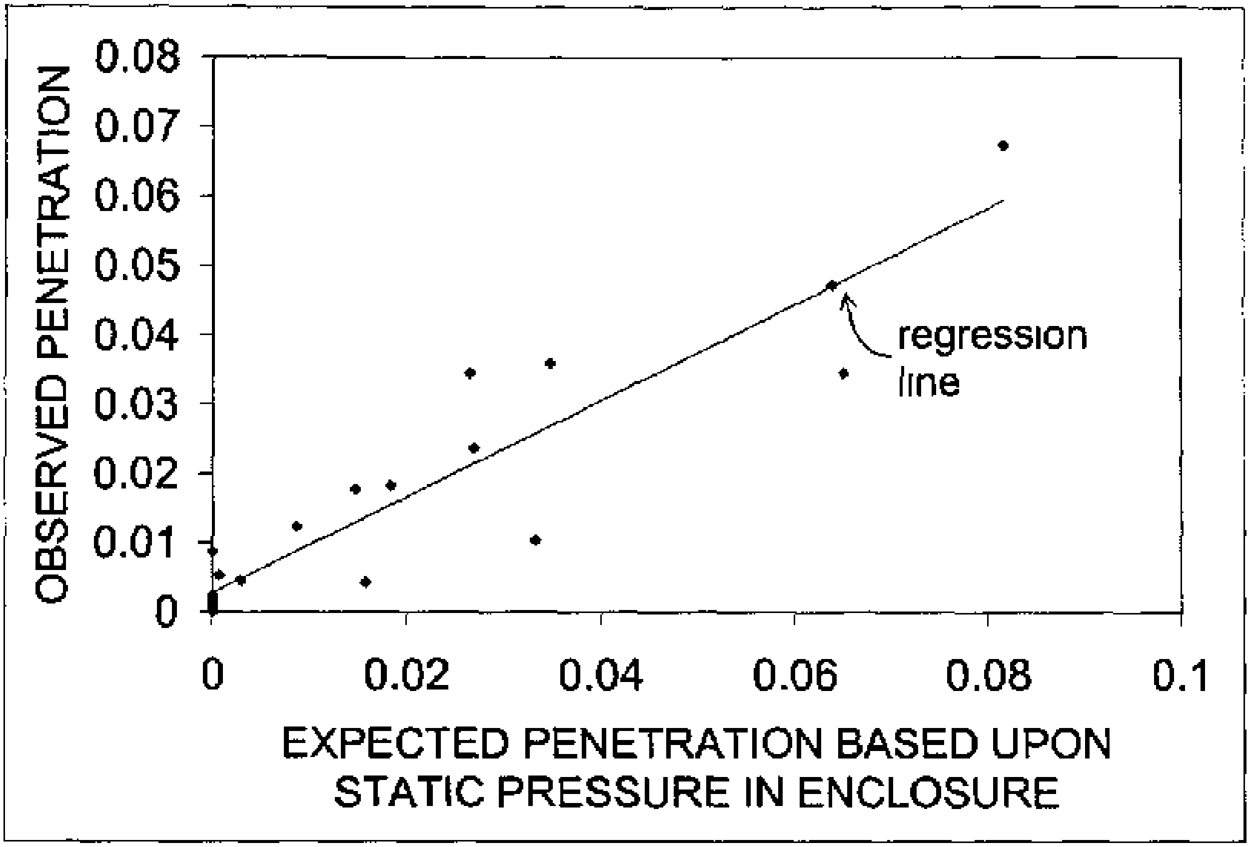

Figure 7 Observed penetration as a function of expected penetration computed based upon static pressure in enclosure Static pressure in enclosure was observed to experimentally increase with air velocity The observed penetrations are less than the expected penetrations

Appendix Raw Data

Raw Data – Wind Speed

Run ID	Date	Nominal Speed (mph)	Weather Station Mean Speed (mph)	Weather Station Standard Deviation of Wind Speed (mph)	Weather Station, Mean Direction (Degrees)	Weather Station, Standard Deviation of Wind Direction (Degrees)	Rotating Vane Anemometer Mean Speed (fpm)	Rotating Vane Anemometer, Standard Deviation of Mean Wind Speed (fpm)
2	19-Oct	0	0	0			0	0
3	19-Oct	25	28 33	3 41	237*	5 14	1977 5	471 3
4	19-Oct	13	15 37	3 79	238 65*	4 67	1515 9	348 1
5	19-Oct	9	8 78	1 24	240 86*	3 53	988 6	150 4
6	19-Oct	0					0 0	
7	19-Oct	9	7 03	0 98	226 06*	2 78	832 9	79 1
8	19-Oct	13	13 50	1 53	222 07*	5 00	1427 1	141 1
9	19-Oct	25	25 48	2 58	220 95*	1 88	1761 2	108 7
10	19-Oct	0						
11	21-Oct	0						
12**	21-Oct	13	12 72	2 46	181 72	3 35	784 7	350 3
13	21-Oct	25	25 64	2 53	180 87	3 03	1339 0	408 7
14	21-Oct	9	9 91	2 09	176 73	2 79	1148 1	165 0
15	21-Oct	11 00	12 36	2 88	176 03	2 59	1274 7	180 1
17	21-Oct	9	9 40	2 49	176 51	4 30	1099 2	254 9
18	21-Oct	13	13 72	2 88	175 67	2 19	1355 4	142 5
19	21-Oct	13	12 98	2 79	179 29	4 20	1341 2	244 9
20	21-Oct	13	18 51	3 36	178 82	3 44	1534 0	281 1
21	21-Oct	25	25 88	5 65	176 31	3 34	1788 5	243 2
22	21-Oct	0	1 47	1 05				
23	21-Oct	17	17 32	4 35	176 27	4 19	1474 5	242 8
24	21-Oct	0						

* - absolute orientation of weather station not recorded, visually, the mean direction of the wind was along the axis of the tunnel On 21 October, the orientation was visually set so that the orientation would read 180 degrees

** - data from this run was excluded from the data analysis because of the anemometer and weather station velocity measurements were not consistent

Raw Data – Times Static Pressure and Penetration

Run ID	Start Time	Stop Time	Enclosure Static Pressure (mm of water)	Air Flow into Chamber Measured by Velocicalc	0 35-0 5 µm Particles Counted Inside Enclosure	0 35-0 5 µm Particles Counted Outside of Enclosure	Penetration of 0 35-0 5 µm Particles into the Enclosure
2	17 20	17 26	2 8	62 00	80	405308	1 97E-04
3	17 33	17 38	3 1	61	69731	1055767	6 74E-02
4	17 56	18 01	2 9	63	6567	632919	1 04E-02
5	18 18	18 23	2 8	63	429	358079	1 20E-03
6	18 50	18 55	2 8	60	218	219508	1 66E-03
7	19 03	19 08	2 7	61	1040	531417	1 17E-03
8	19 19	19 26	3 1	61 5	14701	829450	1 77E-02
9	19 40	19 45	3 4	59 5	11482	221391	3 46E-02
10	19 57	20 03	2 9	59 5	104	261197	3 98E-04
11	10 38	10 46	2 8	59 5	393	170290	2 31E-03
12	10 59	11 04	3 2	59	4201	484131	8 68E-03
13	11 23	11 28	3 3	58 5	4720	199525	2 37E-02
14	12 05	12 10	3 1	59 5	6836	1299887	5 26E-03
15	12 17	12 22	3 1	59	6587	536050	1 23E-02
17	14 08	14 13	3 0	58	4717	1050014	4 49E-03
18	14 19	14 24	3 1	57 5	4468	1050014	4 26E-03
19	14 32	14 37	3 2	58 5	12083	661579	1 83E-02
20	14 48	14 53	3 2	57 5	8859	370200	3 59E-02
21	14 59	15 04	3 3	57	7216	152693	4 73E-02
22	15 10	15 20	2 7	58 5	168	187001	8 68E-04
23	15 29	15 34	3 3	58 5	20349	589983	3 45E-02
24	15 42	15 52	2 7	59	128	187426	8 20E-04