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Pacific Northwest National Laboratory

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Airborne Effluent Monitoring System Certification for New B-Plant Ventilation Exhaust Stack

J.A. Glissmeyer
A.D. Maughan

September 1998

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

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Summary

Tests were conducted to verify that the effluent monitoring system for the new B-Plant ventilation exhaust stack meets all applicable regulatory performance criteria for air sampling systems at nuclear facilities. These performance criteria address both the suitability of the location for the air-sampling probe and the transport of the sample to the collection devices. The criteria covering the location for the air-sampling probe ensure that the contaminants in the stack are well mixed with the airflow at the probe location such that the extracted sample represents the whole. The sample-transport criteria ensure that the sampled contaminants are quantitatively delivered to the collection device. The specific performance criteria are described in detail in this report. The tests demonstrated that the B-Plant ventilation exhaust air monitoring system meets all applicable performance criteria.

Pacific Northwest National Laboratory conducted the testing using a scale model of the new B-Plant exhaust stack at the Numatec Hanford Company's 305 Building. The stack/sampling system configuration tested was designed to enable accurate measurements of airborne radioactive emissions from the B-Plant, a retired reactor-fuel processing facility at the U.S. Department of Energy's (DOE's) Hanford Site near Richland, Washington. The new air-exhaust system, built under the W059 Project, replaces the former main stack. Because the facility is decommissioned, the normal exhaust airflow is 30% (15,000 cfm) of the previous airflow. The system includes dual air-cleanup trains with bag-in/bag-out HEPA filters. The air sampling system features a probe with a single shrouded sampling nozzle, a sample delivery line, and a filter holder to collect the sample.

Acknowledgments

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1.0 Introduction

Tests were conducted to verify that the effluent monitoring system for the new B-Plant ventilation exhaust stack meets all applicable regulatory performance criteria for air sampling systems at nuclear facilities. These performance criteria address both the suitability of the location for the air-sampling probe and the transport of the sample to the collection devices. The criteria covering the location for the air-sampling probe ensure that the contaminants in the stack are well mixed with the airflow at the probe location such that the extracted sample represents the whole. The sample transport criteria ensure that the sampled contaminants are adequately delivered to the collection device. The specific performance criteria are described in detail in the report. The tests demonstrated that the B-Plant ventilation exhaust air monitoring system meets all applicable performance criteria.

The stack/sampling system configuration tested was designed to enable accurate measurements of airborne radioactive emissions from the B-Plant, a retired reactor fuel-processing facility at the U.S. Department of Energy's (DOE's) Hanford Site near Richland, Washington. The new air exhaust system, built under the W059 Project, replaces the former main stack. Because the facility is decommissioned, the normal exhaust airflow is 30% (15,000 cfm) of the previous airflow. The system includes dual air-cleanup trains with bag-in/bag-out high-efficiency particulate air (HEPA) filters. The air-sampling system consists of a probe with a single shrouded sampling nozzle, a sample delivery line, and a filter holder to collect the sample. Pacific Northwest National Laboratory conducted the testing using a scale model of the new stack. The scale model tests were validated in the field on the actual stack before it was connected to the B-Plant.

The following report presents the regulatory and research background that constitutes the basis for the performance tests, the test methods, the results, and the conclusions. The detailed test procedures and data sheets are included in the appendices.

1.1 Background

On December 15, 1989, 40 CFR 61, Subpart H, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities," came into effect. This regulation governs portions of the design and implementation of facility effluent air sampling. Further, 40 CFR 61 H requires the use of isokinetic sampling nozzles as described in American National Standards Institute's ANSI N13.1-1969 (ANSI 1982).[a] More recent research (Rodgers et al. 1996;

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[a]Air samples are extracted from the bulk airflow through a probe having a round orifice that is aerodynamically designed. The opening is generally pointed directly into the airflow. The term isokinetic means that the air velocity through the probe orifice matches that of the approaching airstream. This theoretically ensures that the sample airstream has the same concentration of particles of all sizes per unit air volume as the bulk airstream. If the probe orifice air velocity is lower than that of the bulk airstream, it is operating "subisokinetically." In this case, particles with significant inertia will be present in the

Glissmeyer and Ligotke 1995) indicates poor performance for isokinetic nozzles relative to that of the shrouded nozzle. The U.S. Environmental Protection Agency (EPA) has approved a DOE alternative method petition that allows the use of a sampling probe with a single shrouded nozzle in applications that previously required a probe with several isokinetic nozzles.[a] This single-point sample-extraction approach is applicable where the potential contaminants in the effluent are of a uniform concentration at the sampling location. The alternative method is a significant departure from the ANSI N13.1-1969 approach in that the sampling system must meet specific performance criteria. The approach taken in the alternative method was incorporated in a functional requirements document (FRD) for air sampling systems (Glissmeyer et al. 1994) and in the Draft HPS/ANSI N13.1 to be published soon.

1.2 Performance Criteria

Two phases are required to demonstrate the compliance of new air samplers. The first is to qualify the location for extracting the sample, and the second is to demonstrate delivery of the sample to the collection devices. If the stack flowrate is expected to vary by >25% from the mean, the battery of tests is conducted over the flowrate range. Additional criteria apply if scale model tests are conducted.

The sampling location qualification criteria are as follows:

1. Angular Flow - Sampling nozzles are usually aligned with the axis of the stack. If the air travels up the stack in cyclonic fashion, the air-velocity vector approaching the nozzle could be misaligned with the sampling nozzles enough to impair the extraction of particles. Consequently, the flow angle is measured in the stack at the elevation of the sampling nozzle. The average air-velocity angle must not deviate from the axis of the sampling nozzle by more than 20°.

2. Uniform Air Velocity - It is important that the gas momentum across the stack cross section where the sample is extracted be well mixed or uniform. Consequently, the velocity is measured at several points in the stack at the elevation of the sampling nozzle. The uniformity is expressed as the variability of the measurements about the mean. This is expressed using the relative coefficient of variance (COV), which is the standard deviation divided by the mean and expressed as a percentage. The lower the percent COV value, the more uniform the velocity. The acceptance criterion is that the COV of the air velocity must be ≤20% across the center two-thirds of the area of the stack.

3. Uniform Concentration of Tracer Gas - A uniform contaminant concentration in the sampling plane enables the extraction of samples that represent the true concentration. This is first tested using a tracer gas injected just downstream of the fan. The fan is a good mixer, so injecting the tracer downstream of the fan provides worst-case results. The acceptance criteria are that 1) the COV of the measured tracer gas concentration is ≤20% across the center two-thirds of the sampling plane,

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sample airstream in a concentration greater than in the bulk airstream.

[a]U. S. Environmental Protection Agency. 1994. Letter from Mary Nichols to Raymond Pelletier (11/21/94). EPA, Washington.

and 2) the concentration at any point in the sampling plane does not vary from the overall mean concentration by >30%.

4. Uniform Concentration of Tracer Particles - Uniformity in contaminant concentration at the sampling elevation is further demonstrated using tracer particles large enough to exhibit inertial effects. Particles of 10-μm aerodynamic diameter[a] (AD) are used by default unless it is known that larger particles are present in the airstream. The acceptance criterion is that the COV of particle concentration is ≤20% across the center two-thirds of the sampling plane.

Because a scale model was used to qualify the stack-sampling location, the following additional criteria from the Draft HPS/ANSI N13.1 apply:

1. The model is geometrically similar to the actual stack.
2. The model meets all of the qualification requirements
3. The actual sampling location is geometrically similar to the model
4. The product of mean velocity times the hydraulic diameter for the actual stack and the scale model within a factor of 6
5. The velocity uniformity of the actual stack meets the qualification requirements
6. The difference between the actual and model stack velocity COVs is not more than 5%
7. The flow angle of the actual stack meets the requirements.

Field measurements of the flow angle and velocity uniformity are used to validate the applicability of the model. The air velocity used in the tests on the model should be about the same as in the actual stack.

There are several advantages to using a scale model. Access to test ports on a stack can involve work in a contaminated area, construction of a work platform, or use of a manlift. A scale model can be assembled in the horizontal position, eliminating the need for work platforms. The model can often be constructed before the stack and modifications identified can then be incorporated into the stack design. The testing work can also proceed quicker and with fewer staff in a laboratory environment. Furthermore, if difficulties are found with the sampling site, a new one can be readily tested.

The second phase of the compliance demonstration is to show that the extracted sample reaches the sample filter. The sample transport system is required to deliver more than 50% of 10-μm AD particles from the stack to the sample collector. Also, the sampling nozzle must have the following characteristics:

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[a]The aerodynamic diameter of a particle of arbitrary shape and density is the diameter of a spherical water droplet that has the same sedimentation velocity in quiescent air as the arbitrary particle. Particles with the same aerodynamic diameter will exhibit the same aerodynamic behavior even if they vary in shape and density.

- transmission ratio at 10 μm is 0.8 to 1.3
- nozzle aspiration ratio[a] at 10 μm is 0.8 to 1.5.

The nozzle characteristics are inherent in the design and were verified in wind tunnel tests (McFarland et al. 1989; Glissmeyer and Ligotke 1995) and in the manufacturer's submittals. The overall particle transport is required to be verified experimentally or with the DEPOSITION code (Riehl et al. 1996).

1.3 Sampling System Description

The air-sampler qualification tests were done on a scale-model of the exhauster stack assembled at the Numatec Hanford Company's 305 Building. Figure 1.1 depicts the configurations of the new B-Plant exhaust stack and the scale model. The dimensions shown in parentheses are those of the scale model. The stack has an internal diameter of 31.125 inches and is 90 feet tall. There are two fans, one of which is used at a time. Upstream of the fans (not shown) is a pair of HEPA filter housings that function in parallel, each with a 9,000-cfm capacity.

The sampling nozzle inlet is about 24.4 feet above the top of the duct entering the stack at a 45° upward angle. There is about 9.4 stack diameters from the inlet duct to the inlet nozzle of the sampling probe. Below the probe is a pair of inspection ports. Above the probe is a stack-flow sensor, manual velocity-traverse ports, temperature transmitter, and the sampling-system discharge.

Airflow is manually set with vane dampers at the inlet to each fan. Separate dampers are used to isolate the filter housings for maintenance. The design airflow is 18,000 cfm, and the normal operating airflow is expected to be 15,000 cfm. During maintenance of a filter housing, the minimum airflow is estimated to be 7,500 cfm. The corresponding air velocities and model airflows are listed in Table 1.1.

Table 1.1. Expected Operating Flow Conditions for the Ventilation System

	Actual stack flowrate, cfm	ft/min	m/s	Model stack flowrate, cfm
Low (maintenance)	7,500	1,419	7.2	1,114
Normal	15,000	2,839	14.4	2,228
High	18,000	3,407	17.3	2,674

[a]The nozzle aspiration ratio is the ratio of aerosol concentration at the the nozzle inlet plane divided by the aerosol concentration in the undisturbed flow at the point where the nozzle is located.

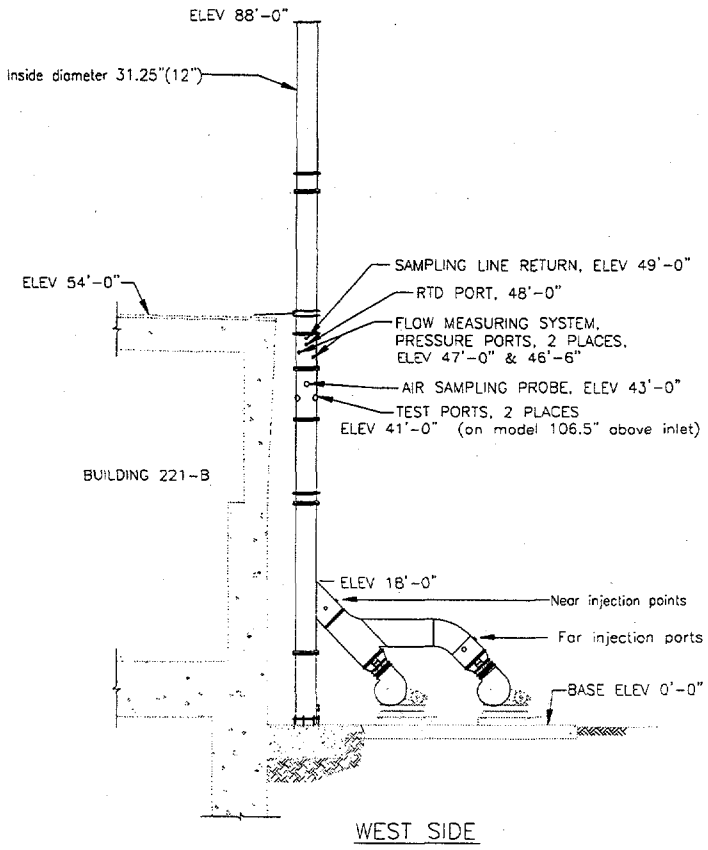


Figure 1.1. Mockup of B-Plant Exhauster Stack

The sampling system includes the probe, transport tubing, and the filter holder. The sampling probe has a shrouded nozzle (Andersen Model RF-111) connected to a 9-inch-radius 90°bend and short horizontal tube and is supported from a 6-inch flange. External to the stack is another short horizontal tube, a 7.5-inch-radius 90° bend and a 37.6-ft-long vertical tube connected to the filter holder inside the sampling cabinet at the base of the stack. The combined length of the horizontal tube inside and outside the stack is about 24 inches. The sample filter holder is a Gelman Model 2220 modified with an inlet the same internal diameter as the vertical tube. The sample delivery tubing from the nozzle to the filter holder has an outside diameter of 1.5 inches and an inside diameter of 1.37 inches. The sample flowrate is controlled at 2 cfm by a PLC and a mass-flowmeter with an automatic control valve. The sampling probe, tubing, and filter holder are stainless steel. The vacuum pumps and control systems are located in other cabinets.

The shrouded sampling nozzle, Figure 1.2, was used instead of isokinetic nozzles because they have proven to be superior to systems using traditional isokinetic nozzles in tests by Glissmeyer and Ligotke (1995) and Rodgers et. al. (1996).

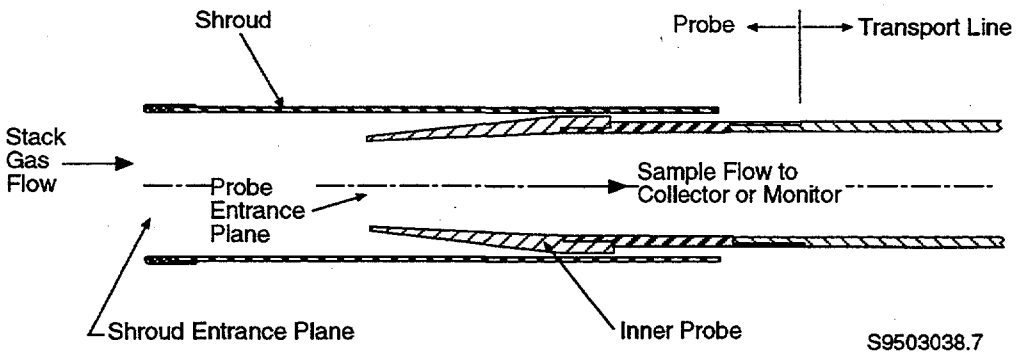


Figure 1.2. Configuration of Shrouded Nozzle

The scale-model stack was fabricated of light-gauge sheet metal. The inside diameter was 12 inches, so all of the length dimensions were scaled down by the ratio of 12:31.125. The model included all portions from the fan discharges to the elevation of the sampling probe. Only one fan was used, and it was moved from one discharge point to the other as dictated by the test plan. The fan discharge point not in use was blanked-off. Additional sections of 12-inch straight and flexible duct were attached to the discharge end of the stack as needed to vent the tracers outside of the building to prevent tracer recirculation. The model was mounted in the horizontal position for convenient testing. Because the residence time of the air in the model stack was so short, the settling of 10 μm AD particles in the stack was not significant. The model flowrates were scaled to maintain the same velocity as the actual stack, as listed in Table 1.1. When the fan position farthest from the stack was used in tests, the tracer injection points were located a few inches from the outlet of the fan. When the fan position nearest to the stack was used, the tracer was injected in the inlet duct 45° to the stack.

2.0 Qualification Tests

The qualification test methods and results are described below. Tests were conducted to determine compliance with performance criteria covering angular flow, air-velocity uniformity, gaseous-tracer uniformity, particle-tracer uniformity, and particle penetration.

2.1 Angular Flow

The following discussion describes the method for measuring the flow angle of the air and the results of these tests.

2.1.1 Method

The air-velocity vector approaching the sample nozzle should be aligned with the axis of the nozzle within an acceptable angle so sample-extraction performance is not degraded. The test method used was based on 40 CFR 60, Appendix A, Method 1, Section 2.4, "Verification of the Absence of Cyclonic Flow."

This test was conducted at the extremes of flowrate in both the model and actual stacks. Measurements were made using a type-S pitot tube, a slant tube or electronic manometer, and a protractor level attached to the pitot tube. The flow angle was measured at the elevation of the sampling nozzle. The measurement grid of 25 points, in an "x"-shaped pattern, was laid out in accordance with the EPA procedure. The pitot tube was rotated until a null differential pressure reading was obtained, and the angle of rotation was then recorded. Appendix A provides the detailed procedure and the data sheets.

2.1.2 Results

The grid of measurement points on the model stack was originally aligned in the north/south and east/west directions and at the sampling probe elevation (scaled). It was later found that the test ports on the actual stack were installed on the northwest and southwest sides, so the tests on the model were repeated with the measurement grid rotated 45° to be aligned along these directions. These latter results for average flow angles are shown in Table 2.1. The <20° flow-angle acceptance criterion was met in all cases, and the flow angles measured on the actual stack were slightly lower than those observed on the scale model. The average angle measured on the actual stack ranged from 0.7° to 2.1°, compared with 2.3° to 4.9° on the scale model. The scale-model results were similar for both measurement grid orientations. They are included in Appendix A.

Table 2.1. Results of Testing for Mean-Flow Angle With Measurement Grid Rotated to Match Actual Stack

Flow Setting	Scale Model Stack			Actual Stack		
	Run	Flow Rate cfm	Mean Absolute Angle	Mean Absolute Angle	Flow Rate cfm	Run
Fan nearest to stack						
low	AFJul13_1	1,001	3.4	0.7	9,079	AFJun30_1
high	AFJul13_2	2,705	2.3	2.1	19,123	AFJun30_2
Fan farthest from stack						
low	AFJul13_3	984	4.9	1.8	9,479	AFJul1_2
high	AFJul13_4	2,658	4.8	0.7	20,035	AFJul1_1

2.2 Uniformity of Air Velocity

The following discussion describes the method for measuring the velocity of the air and the results of these tests.

2.2.1 Method

The uniformity of air velocity in the stack cross section where the air sample is being extracted ensures that the air momentum in the stack is well mixed. To determine uniformity, air velocity was measured at the same points as those used for the angular flow test. The method used was based on 40 CFR 60, Appendix A, Method 1. The equipment included a standard Prandtl-type pitot tube and a calibrated electronic manometer. The procedure is detailed in Appendix B.

2.2.2 Results

As in the flow angle test, the grid of measurement points on the model stack was originally aligned in the north/south and east/west directions and at the sampling-probe elevation. After it was found that the test ports on the actual stack were installed on the northwest and southwest sides, the tests on the model were repeated with the measurement grid rotated to be aligned along these directions. These final results for air-velocity uniformity are summarized in Table 2.2. The results for the other orientation are similar and are summarized in Appendix B.

The criterion that the air velocity COV be ≤20% across the center two-thirds of the area of the stack was met, being less than 5% in all cases. The maximum difference between corresponding tests on the scale model and the actual stack was 2.2% COV, meeting the additional criterion that the model and actual stack results are the same within 5% COV.

Table 2.2. Results of Testing for Uniform Air Velocity With Measurement Grid Rotated to Match Actual Stack

Flow Setting	Scale Model Stack			Actual Stack		
	Run	Flow Rate cfm	% COV	% COV	Flow Rate cfm	Run
Fan nearest to stack						
low	VTJul11_4	1,001	2.1	2.5	9,079	VTJun30_1
high	VTJul11_3 VTJul21_1	2,705 2,701	2.8 5.0	4.2	19,123	VTJun26_1
Fan farthest from stack						
low	VTJul11_2, VTJul21_2	984 980	4.9 3.1	2.7	9,479	VTJul1_2
high	VTJul11_1	2,658	3.2	1.7	20,035	VTJul1_1

The air velocity at the tracer injection points was also measured. These results are also included in Appendix B. With the fan in the far position, the tracer injection point is close to the fan outlet, and the velocity profile is non-uniform, but the peak velocity is in the center of the duct. With the fan in the near position, the injection point is comparatively farther from the fan, and the velocity profile is more uniform.

2.3 Uniformity of Tracer Gas

The following discussion describes the method for measuring the concentration uniformity of a tracer gas in the model stack and the results of these tests.

2.3.1 Method

A uniform contaminant concentration at the sampling plane enables the extraction of samples that represent the true concentration. The uniformity of the concentration of gaseous contaminants was demonstrated using sulfur hexafluoride as a tracer gas. The tracer gas was injected into the air just downstream of each fan discharge. The tracer concentration was measured at points in the sampling

plane using a Bruel and Kjaer (Naerum, Denmark) Model 1302 gas analyzer calibrated for the tracer gas. The procedure is detailed in Appendix C.

The grid of measurement points was the same as that used for the other tests described above; however, on the actual stack, the sampling probe is mounted on the west side. Thus, the probe position can only be adjusted in the east/west direction if a problem with tracer mixing was found. Therefore, the measurement grid for the tracer tests was aligned along the north/south and east/west directions.

The tracer injection plane denoted as "far" was located a few inches downstream of the fan outlet farthest from the stack. The tracer injection plane denoted as "near" was located in the inlet duct to the stack and was used when the fan was connected to the fan position nearest the stack. These locations are marked in Figure 1.1. The cross section of the scale-model duct was the same size at both injection planes (15.5 x 7.75 in.). At both planes, the tracer was injected in the center, and 0.5 inches (approximately 5% of a hydraulic diameter) from the side walls and the corners. The tests were done at the extremes of the scale-model flowrate.

2.3.2 Results

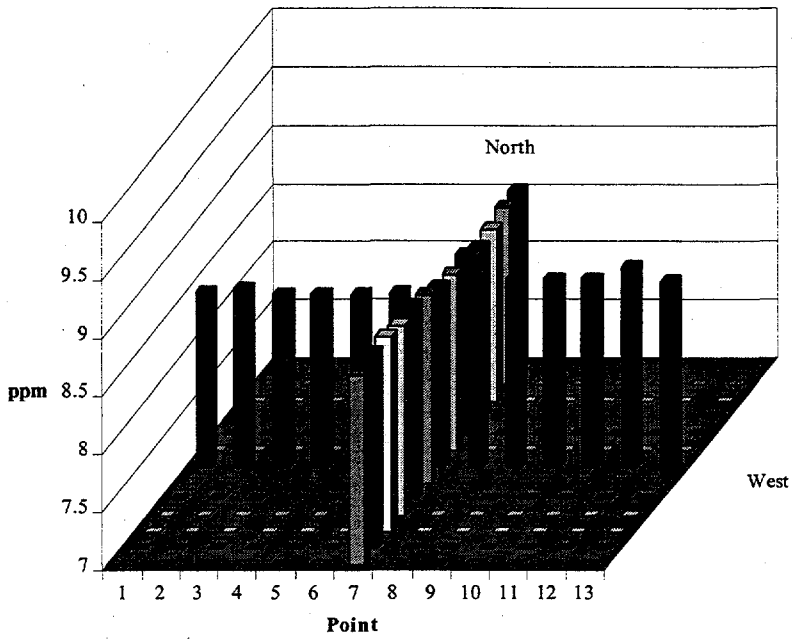
Table 2.3 summarizes the results, and the data sheets for the individual test runs are included in Appendix C. The acceptance criteria are that 1) the COV of the tracer-gas concentration must be ≤20% across the center two-thirds of the sampling plane and 2) at none of the measurement points does the average concentration differ from the mean concentration by >30%. The largest COV results ranged from 0.9% to 7.3% for the center 2/3 of the stack, and the largest deviation of any single point concentration from the mean concentration in any run ranged from 2.5 to 17.9%. The acceptance criteria were met in all cases.

There was no consistent difference between the results at the extremes of flowrate. Also, because the COV results were consistently lowest (indicating better mixing) when the tracer was injected at the far injection plane, some of the possible combinations of test conditions were not used.

Figure 2.1 is a comparison of tracer concentrations measured at each point while the injection was at the bottom/left corner of the duct in both the near and far injection planes. The vertical axis is exaggerated to enhance the differences. The ratio of maximum to minimum concentration is only 1.2:1. When the tracer was injected in the bottom/left corner of the inlet duct, the concentration in the north and west areas of the stack were slightly higher than on the other regions.

Table 2.3. Tracer-Gas Uniformity Results

Tracer Injection Position	% Coefficient of Variation at Flowrate Given			
	Fan nearest to stack		Fan farthest from stack	
	Low cfm	High cfm	Low cfm	High cfm
Center	6.4, 5.9	7.3, 5.1, 5.3	1.3	1.2
Bottom	4.7	2.7		
Top	3.8, 5.2	3.6		
Right	5.7	3.4		
Left	4.0	2.1		
Bottom/left	6.2		1.0	
Bottom/right	3.2		0.9	
Top/left	4.4			
Top/right	6.3			



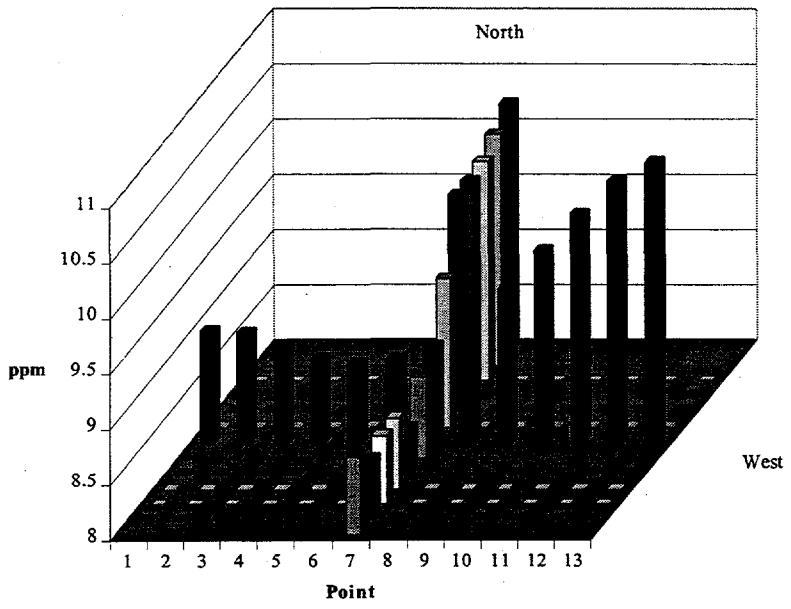


Figure 2.1. Gaseous-Tracer Concentration with the Injection at the Bottom/left Corners of Near (bottom) and Far (top) Fan Positions

2.4 Uniformity of Tracer Particles

The following discussion describes the method for measuring the uniformity of tracer particles and the results of these tests.

2.4.1 Method

The test to measure the uniformity of tracer particles is similar to the test for measuring the uniformity of tracer gas. The general approach is to inject particles of a range of sizes, including the size of interest, into the test stack just downstream of the fan. The concentration of the particles of the size of interest is then measured at several points in the cross section of the sampling plane using an optical particle counter (OPC, Met-One Model A2408, Grants Pass, Oregon). The particles were made by spraying vacuum pump oil through a nozzle.

The tracer injection planes were the same as for the gaseous tracer, except only the centerline injection is required by the Draft ANSI N13.1. The layout of sampling points was the same as for the gaseous tracer tests, except that the size of the probe did not permit sampling as close to the inside of the stack wall. The grid of points was aligned in the north/south direction, like in the gaseous tracer tests.

A simple probe was used to extract the sample and transport it to the OPC. The OPC and its probe were moved from point to point in random order, first in one traverse direction and then the other. Because the generation rate for tracer particles may vary with time, a second OPC was used to observe the particle concentration from a fixed point in the stack. The data from the mobile OPC can then be adjusted if there is a temporal trend observed with the fixed OPC.

The OPCs sort the number of particles into six size channels. Each concentration reading was the count of particles collected in the 9- to 11-μm channel. Three readings were taken at each point and averaged. The coefficient of variance of the average concentration readings at each point was calculated, and the result compared to the acceptance criterion for uniformity. The particle mixing is acceptable if the COV of the tracer 10-μm-AD particles is less than 20% across the center two-thirds of the sampling plane. The detailed procedure is included in Appendix D.

2.4.2 Results

The particle-concentration uniformity was measured at extremes of the scale-model flowrate. The data sheets for each run are included in Appendix D, and Table 2.4 summarizes the test results. The row labeled "raw data" shows results without any normalization with time. The results after normalization are also shown. The normalization method adjusted all of the concentration readings by the same amount so that the centerpoint readings taken via the two traverse directions equaled their average. Regardless of which way the data were treated, the acceptance criterion was met.

Mixing was apparently better when the tracer was injected just downstream of the fan farthest from the stack. When the injection was in the inlet duct, the tracer concentration was less well mixed at the

higher flow than at the low-flow condition. Repeatability of results was good in the one instance attempted.

Table 2.4. Tracer-Particle Uniformity Results over the Center Two-Thirds of the Stack

	% Coefficient of Variation at Flowrate Given			
	Fan nearest to stack		Fan farthest from stack	
	Low cfm	High cfm	Low cfm	High cfm
Raw data	9.0	14.9, 13.3	5.2	4.8
Normalized	7.9	12.8, 11.9	3.9	4.7
Run	PTJul10_2	PTJul10_1 PTJul28_1	PTJul10_3	PTJul11_1

Figure 2.2 shows a comparison of the particle-concentration map when the tracer injection was at the near-fan and at the far-fan position. The ratio of maximum to minimum concentration was 1.6:1 in the former case and 1.2:1 in the latter case. The probe of the actual stack is located 13 inches from the west side of the stack; thus, it would favor the region of highest particle concentration.

Figure 2.3 shows plots of the velocity of gas and particle concentrations for the conditions of high-flow, center-injection, and near-fan positions. Though the air velocity is approximately axially symmetric, neither gas nor particle concentrations are axially symmetric. This illustrates that the results of one type of test do not necessarily predict the results of another. The COVs are 3.1%, 7.3%, and 11.9% for the velocity, gas, and tracer tests respectively, and all meet the acceptance criteria. The increasing values indicate that the tracer with the greater inertia j(i.e., particles) mixes slower. This underscores the value of the separate tests because the results of one test do not predict those of the others.

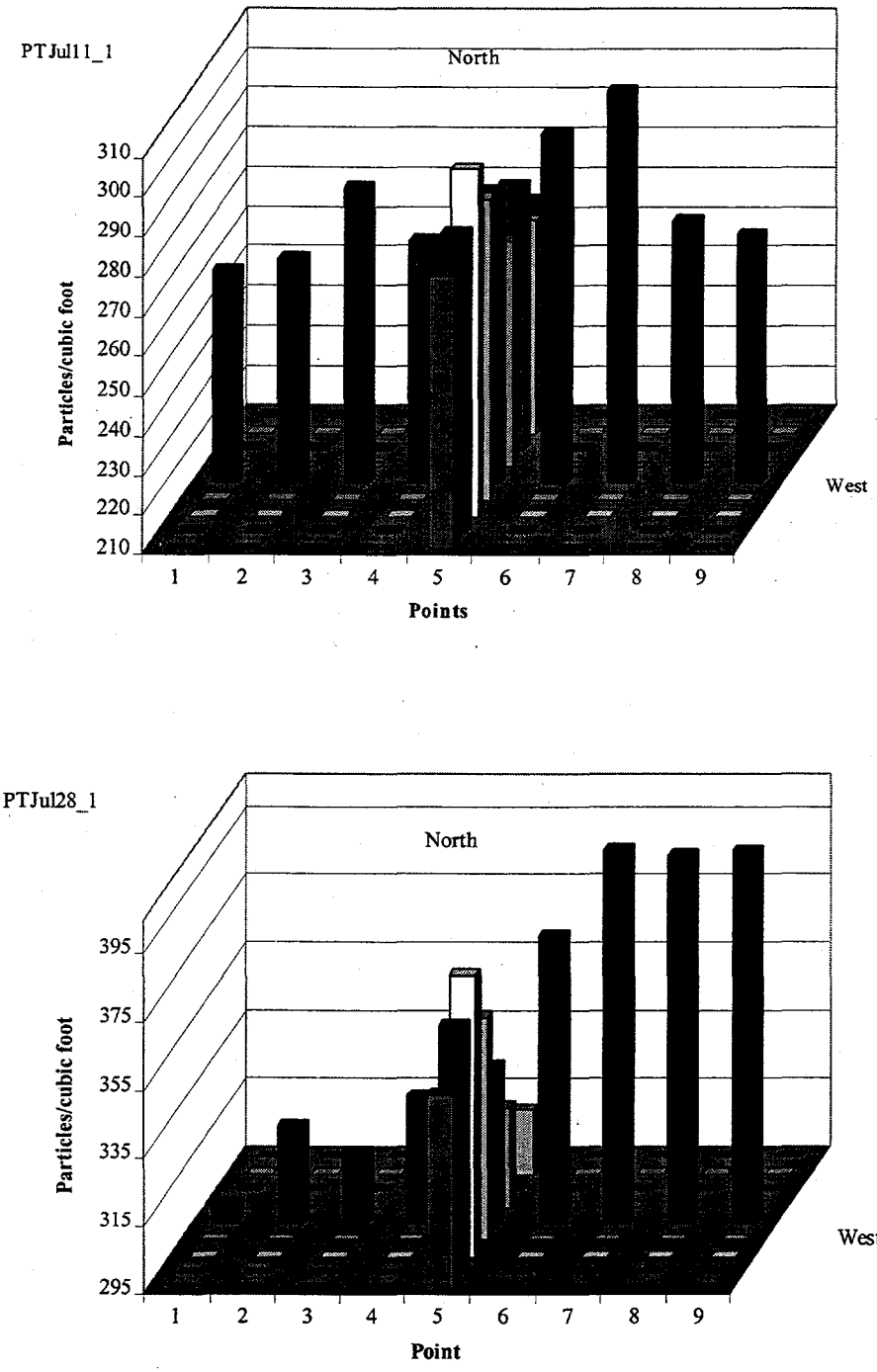


Figure 2.2. Concentration of Tracer Particles When Injected at the Near (bottom) and Far (top) Fan Positions

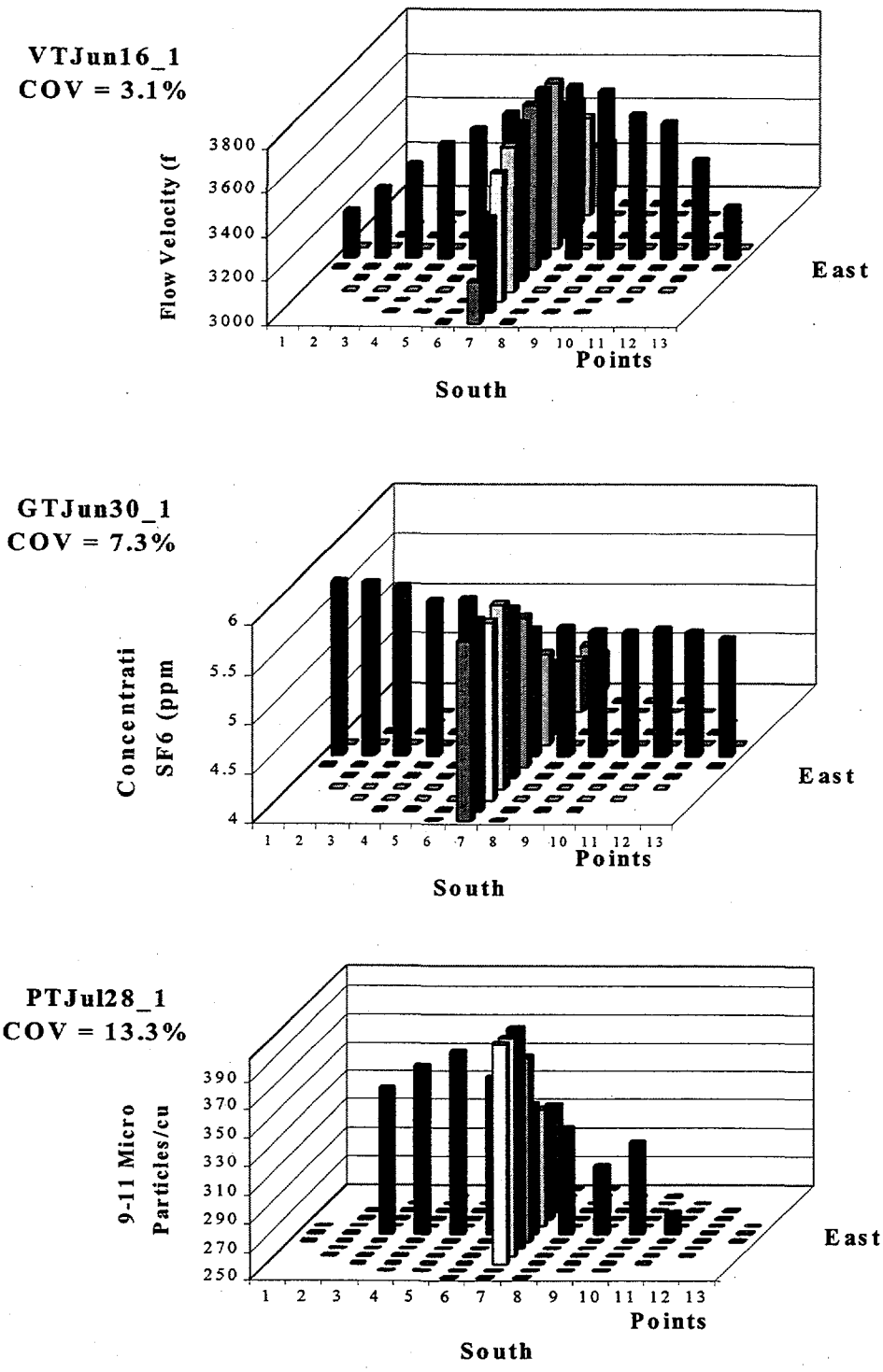


Figure 2.3. Comparison of Uniformity of Velocity, Gas, and Particle-Tracer Concentrations at the Same Conditions

2.5 Particle Penetration

The DEPOSITION code was used to model the penetration of 10-μm AD particles through the entire sampling system from the probe nozzle to the filter holder. The overall results were penetrations of 87% and 82% for the stack flowrates of 15,000 and 7,500 cfm, respectively. These exceed the minimum penetration of 50%. The output details of the code runs are shown in Appendix E.

3.0 Conclusions

The tests conducted on the scale model demonstrated that the air-monitoring system for the new B-Plant ventilation exhaust stack meets all applicable regulatory performance criteria for air sampling systems at nuclear facilities. The field verifications of the flow angle and uniformity of air velocity waere completed at the actual stack and validated the results of the scale-model tests. The conclusions are summarized for each performance criterion. The individual criteria were explained earlier in the report.

The performance criteria and conclusions are as follows:

1. Angular Flow - The acceptance criterion was that the average air velocity angle must not exceed 20° relative to the long axis of the stack or sampling nozzle. Tests indicated the average air velocity angle to be ≤4.9° for the scale model and ≤2.1° for the actual stack. The flowrate ranges covered were 984 to 2,705 cfm for the scale model and 9,079 to 20,035 cfm for the actual stack.

2. Uniformity of Air Velocity - The acceptance criterion was that the percent COV of the air velocity must be ≤20% across the center two-thirds of the area of the stack. The results met the criterion: ≤5% for the scale model and ≤4.2% for the actual stack. The flowrate ranges covered were 980 to 2,705 cfm for the scale model and 9,079 to 20,035 cfm for the actual stack.

3. Uniform Concentration of Tracer Gas - The acceptance criteria were that 1) the COV of the measured tracer gas concentration be ≤20% across the center two-thirds of the sampling plane and 2) at no point in the sampling nozzle elevation does the concentration vary from the mean by >30%. The COV ranged from 0.9% to 7.3%, depending on the fan location and the injection point used on the scale model. The largest deviation of any single point concentration from the mean concentration in any run ranged from 2.5 to 17.9%. The flowrate ranges covered were 980 to 2,705 cfm for the scale-model stack.

4. Uniform Concentration of Tracer Particles - The acceptance criterion was that the COV of particle concentration be ≤20% across the center two-thirds of the sampling plane. The results met the criterion with the COV ranging from 3.9% to 14.9% ,depending on the fan location and the flowrate used on the scale model.

5. Sample Transport - The acceptance criterion was that the sample-transport system must deliver more than 50% of 10-μm-AD particles from the stack to the sample collector. The particle penetration results from the DEPOSITION code ranged from 87% to 82% for the stack flowrates of 15,000 and 7,500 cfm, respectively.

6. Sampling Nozzles - The acceptance criteria for nozzles were that the transmission be in the 0.8 to 1.3 range and that the aspiration ratio be in the 0.8 to 1.5 range for 10-μm-AD particles. The nozzle

characteristics are inherent in the design and were verified in wind tunnel tests (McFarland et al. 1989; Glissmeyer and Ligotke 1995) and in the manufacturer's submittals.

Because a scale model was used to qualify the stack-sampling location, the following additional criteria from Draft HPS/ANSI N13.1 applied:

1. The model is geometrically similar to the stack. The model is a scale replica of the actual stack.

2. The model meets all of the qualification requirements. This was satisfied as exhibited in the above conclusions.

3. The actual sampling location is geometrically similar to the model. Again, the model was a scale replica of the actual stack.

4. The product of mean velocity times the hydraulic diameter for the actual stack is within a factor of 6 of the model. The factors for these tests were 3.5 at the low flow and 2.8 at the high flow.

5. The velocity uniformity of the actual stack meets the qualification requirements. This too was satisfied as exhibited in the above conclusions.

6. The difference between the actual and model COVs for stack-velocity uniformity is not more than 5%. The maximum difference in these tests was 2.2%.

7. The flow angle of the actual stack meets the requirements. This too was satisfied as exhibited in the above conclusions.

All of the criteria for validating the use of the scale model were met.

There are some additional conclusions that were expected and unrelated to the performance criteria. The particle tracer does not mix as well as the gaseous tracer. This was expected because of the inertia of the 10-μm-AD particles. The mixing of either tracer was best when the tracer was injected at the fan outlet farthest from the stack. This was expected because of the greater distance traveled and because the two 45° bends create large-scale eddys that aid mixing.

4.0 References

40 CFR 60, Appendix A, Method 1, U.S. Environmental Protection Agency, "Method 1 - Sample and Velocity Traverses for Stationary Sources." *Code of Federal Regulations*.

40 CFR 61, Subpart H, U.S. Environmental Protection Agency, "National Emission Standards for Emissions of Radionuclides Other than Radon from Department of Energy Facilities." *Code of Federal Regulations*.

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Riehl, J. R., V. R. Dileep, N. K. Anand, and A. R. McFarland. 1996. *DEPOSITION 4.0: An Illustrated User's Guide.* Aerosol Technology Laboratory Report 8838/7/96, Department of Mechanical Engineering, Texas A&M University, College Station, Texas.

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Appendix A

Description and Data for Angular Flow Tests

Appendix A: Description and Data for Angular Flow Tests

Procedure for Angular Flow Test

May 19, 1998

Angular Flow Test

The acceptance criterion for the absence of angular or cyclonic flow is that the average flow angle shall not exceed 20° (relative to the long axis of the stack). This is so the air-velocity vector approaching the sample nozzle is within an acceptable angle so sample extraction performance is not degraded. The test method is that of 40 CFR 60, Appendix A, Method 1, Section 2.4, "Verification of the Absence of Cyclonic Flow."

If the maximum and minimum stack flowrates differ by no more than a small percentage (assume less than 25%), then conduct this test at the average flowrate. If there is a greater range of stack flowrates, then conduct the test at the minimum and maximum conditions and optionally at the average. Fill out a data sheet for each test. The climatological data are not needed to evaluate the results.

Equipment

Type-S pitot tube
Slant tube manometer or calibrated electronic manometer
Device for reading angle of pitot tube (a protractor level is convenient)
(A three-dimensional directional velocity probe capable of measuring both pitch and yaw angles of gas flows is also acceptable equipment. The method outlined below would then be modified accordingly.)

Method

Lay out the measurement points following Method 1 in 40 CFR 60, Appendix A, and add the centerpoint. Prepare a data sheet for recording operating parameters and two or more measurements for each point.

If a fluid-filled manometer is used, it must be leveled. The manometer should be checked to verify that it reads zero when the pressure differential across it is zero. It should also read non-zero when the pressure differential is non-zero (on the order of 0.01 inches of water or less). Connect the manometer to the pitot tube. The pitot tube should be inserted into the stack and the opening sealed.

Position the pitot tube at each measurement point, in succession, so that the face openings of the pitot tube are perpendicular to the stack cross-sectional plane. In this position, it is at "0" reference. Note the differential pressure reading. If the reading is not zero at "0" reference, rotate the pitot tube (up to a 90° yaw angle) until a null reading is obtained. Record the rotation angle to the nearest degree. Assign the value of 0° to those points for which no rotation was required. Assign positive values for rotation in the clockwise direction and negative for rotation in the other direction. Perform two or three repetitions at each measurement point, two if it is highly repeatable, three if not so repeatable.

Calculate the average of the absolute values of the rotation angles at all traverse points. If the result is less than 20°, then the test criterion is satisfied.

Exceptions taken to this method should be noted on the data sheets.

Table A.1 Flow-Angle Results With Measurement Grid Oriented North/South on Scale Model

Flow Setting	Run	Flow rate, cfm	Mean Absolute Angle
Fan nearest to stack			
low	AFJun10_3	994	3.1
low	AFJun22_2	1,152	2.9
high	AFJun10_4	2,488	3.1
high	AFJun17_2	2,756	4.0
Fan farthest from stack			
low	AFJun10_2	994	1.6
low	AFJun19_1	1,152	2.9
high	AFJun10_1	2,488	2.5
high	AFJun18_2	2,728	2.8

ANGULAR FLOW TEST RESULTS

Site	WO59 12-in Stack, Bldg. 305		Run No.	**AFJun10_1**
Date	6/10/98		Stack Temp	73 deg F
Tester	Maughan		Stack RH%	NA
Stack Dia.	12	in	Baro Press	NA
Stack X-Area	113.1	in^2	Fan Setting	64 Hz
Elevation	42	ft	Fan input port	FAR
El. above disturbance	106.5	in	Units	degrees (clockwise > pos. nos.)

		vertical			horizontal			
Traverse-->		E>W			S>N			
Trial ---->		1	2	3	1	2	3	
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	
1	0.50	0.5	-1	-1.5	-2.5	-4	-2	
2	0.80	-1.5	0	-1	-6	-7	-6	
3	1.42	0	-1.5	-1	5	6	6	
4	2.12	-1	-1	-1.5	3	3	3.5	
5	3.00	-1	-2	-1.5	2.5	3	3	
6	4.27	-2	-2	-1.5	1.5	1	1	
7	7.77	-2	-2	-2	-1	-2	-1	
8	9.00	-2	-2	-2	-2	-1	-1.5	
9	9.88	-2	-2	-3	-2	-1.5	-2	
10	10.58	-2	-2.5	-2	-2	-2.5	-2.5	
11	11.20	-6	-6	-6.5	-3	-3	-2.5	
12	11.50	-4	-2.5	-2	-3.5	-5	-4	
		west			north			All
Absolute Average of all		2.0	2.0	2.1	2.8	3.3	2.9	2.5
w/o points by wall		2.0	2.1	2.2	2.8	3.0	2.9	2.5
Centerpoint	6.00	-3	-3	-2	0	0	0	
Center 2/3 with centerpoint								All
Absolute Average		2.3	2.5	2.5	2.8	3.0	3.0	2.7

Instuments Used: **Cal Exp. Date:**

Parallel-tube pitot with 90-deg bends at sample ends, 24-inches in length. NA
Dwyer Instruments 0 to 5 inch inclined manometer with red guage oil
zero'd and leveled (with connecting tubes open to room atmosphere).
Angles (at horizontal port) made using Empire #36 circular protractor.
Angles (at vertical port) made using a custom-made protractor (circular protractor
would not function in this position).

Notes:

To ensure similar hose connections between the manometer and pitot tube, rotating
the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).
E-W readings 1 to 5 were highly variable (+/- ~3 deg); readings 6 to 12 were moderately variable.
N-S readings 1 to 5 were very stable (+/- ~3 to 5 deg); gave approximately the same reading.
N-S readings 6 to 12 were reasonably stable at ~ +/- 1 deg.

ANGULAR FLOW TEST RESULTS

Site	WO59 12-in Stack, Bldg. 305		Run No.	**AFJun10_2**
Date	6/10/98		Stack Temp	72 deg F
Tester	Maughan		Stack RH%	NA
Stack Dia.	12	in	Baro Press	NA
Stack X-Area	113.1	in^2	Fan Setting	25 Hz
Elevation	42	ft	Fan input port	FAR
El. above disturbance	106.5	in	Units	degrees (clockwise > pos. nos.)

		vertical			horizontal			
Traverse-->		E>W			S>N			
Trial ---->		1	2	3	1	2	3	
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	
1	0.50	2	1	1.5	-1	1	-1	
2	0.80	1	1	1.5	-6	-1	-7	
3	1.42	0	1	-0.5	5	5	3	
4	2.12	0.5	-1	1	6	3	4	
5	3.00	0	-1	0	3	3	3	
6	4.27	0	-1.5	-0.5	1	2	2	
7	7.77	-2	-3	-2	0	1	1	
8	9.00	-1.5	-2	-2	0	0	0	
9	9.88	-3.5	-3	-3.5	-1	-0.5	0	
10	10.58	-1	0.5	-0.5	0	-1	-1	
11	11.20	-2	-1	-1.5	-1.5	-1	-1.5	
12	11.50	1.5	-0.5	0	-2	-2	-2	
		west			north			All
Absolute Average of all		1.3	1.4	1.2	2.2	1.7	2.1	1.6
w/o points by wall		1.2	1.5	1.3	2.4	1.8	2.3	1.7
Centerpoint	6.00	-1.5	-2	-2	2	1	1	
Center 2/3 with centerpoint								All
Absolute Average		1.2	1.5	1.3	2.5	1.8	2.3	1.7

Instuments Used: **Cal Exp. Date:**

Parallel-tube pitot with 90-deg bends at sample ends, 24 inches in length. NA
Dwyer Instruments 0- to 5-inch inclined manometer with red guage oil
zero'd and leveled (with connecting tubes open to room atmosphere).
Angles (at horizontal port) made using Empire #36 circular protractor.
Angles (at vertical port) made using a custom-made protractor (circular protractor
would not function in this position).

Notes:

To ensure similar hose connections between the manometer and pitot tube, rotating
the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).
E-W readings 1 to 5 were variable (+/- ~2 deg); readings 6 to 12 were very stable (i.e., little change).
N-S readings 1 to 5 were very unstable (+/- ~3 to 5 deg) and difficult to read.

ANGULAR FLOW TEST RESULTS

Site	WO59 12-in Stack, Bldg. 305		Run No.	**AFJun10_3**
Date	6/10/98		Stack Temp	73 deg F
Tester	Maughan		Stack RH%	NA
Stack Dia.	12	in	Baro Press	NA
Stack X-Area	113.1	in^2	Fan Setting	25 Hz
Elevation	42	ft	Fan input port	NEAR
El. above disturbance	106.5	in	Units	degrees (clockwise > pos. nos.)

		vertical			horizontal			
Traverse-->		E>W			S>N			
Trial ---->		1	2	3	1	2	3	
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	
1	0.50	-3	-4	-3.5	-7.5	-5	-5	
2	0.80	-5	-5.5	-5	-11	-9	-8	
3	1.42	-3	-3	-3	-7	-5	-6	
4	2.12	-3	-2.5	-2	-4	-3	-1.5	
5	3.00	0	-2	-2	-3	0	0	
6	4.27	1	1	0	-1	1	2	
7	7.77	2	-1	-1	-1	-1	0	
8	9.00	0	2	2	-2	-2	0	
9	9.88	-1	0	-0.5	-2.5	-2.5	-2	
10	10.58	2	3.5	2.5	-4	-4	-2	
11	11.20	5	4	4	-6	-5	-4	
12	11.50	-2	0	-2	-8	-6	-6	
		west			north			All
Absolute Average of all		2.3	2.4	2.3	4.8	3.6	3.0	3.1
w/o points by wall		2.2	2.5	2.2	4.2	3.3	2.6	2.8
Centerpoint	6.00	1	0	-0.5	0	0	0	

Center 2/3 with centerpoint							All
Absolute Average	2.2	2.1	2.1	4.5	3.6	2.6	2.8

Instuments Used: **Cal Exp. Date:**

Parallel-tube pitot with 90-deg bends at sample ends, 24 inches in length. NA
Dwyer Instruments 0- to 5-inch inclined manometer with red guage oil
zero'd and leveled (with connecting tubes open to room atmosphere).
Angles (at horizontal port) made using Empire #36 circular protractor.
Angles (at vertical port) made using a custom-made protractor (circular protractor
would not function in this position).

Notes:

To ensure similar hose connections between the manometer and pitot tube, rotating
the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).
E-W readings 8 to 12 were very stable (i.e., the reading within +/- ~2 deg).
N-S readings 1 to 5 were unstable (number +/- ~3 to 4 deg).
N-S readings 6 to 12 were stable to read, but the number varied +/- 1 to 3 deg.

ANGULAR FLOW TEST RESULTS

Site	WO59 12-in Stack, Bldg. 305		Run No.	**AFJun10_4**
Date	6/10/98		Stack Temp	72 deg F
Tester	Maughan		Stack RH%	NA
Stack Dia.	12	in	Baro Press	NA
Stack X-Area	113.1	in^2	Fan Setting	64 Hz
Elevation	42	ft	Fan input port	NEAR
El. above disturbance	106.5	in	Units	degrees (clockwise > pos. nos.)

		vertical			horizontal		
Traverse-->		E>W			S>N		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw
1	0.50	-4.5	-3	-4	-9	-6	-7
2	0.80	-4	-3	-3	-10	-9	-9
3	1.42	-2	-2	-2	-7	-7	-6
4	2.12	-2	-2	-1.5	-1	-1	2
5	3.00	-1.5	-2	-1.5	1	2	1
6	4.27	-1.5	-1	-1.5	1	1.5	1.5
7	7.77	-2	-1.5	-1	-0.5	0	0
8	9.00	-1.5	-2	-2	-2	-2	-2
9	9.88	-2	-2	-2	-3	-3	-3
10	10.58	-0.5	-1.5	-1.5	-4	-4	-4
11	11.20	0	-0.5	0	-7	-6	-7
12	11.50	-4	-3	-3	-8	-7.5	-7.5
		west			north		All
Absolute Average of all		2.1	2.0	1.9	4.5	4.1	4.2	3.1
w/o points by wall		1.7	1.8	1.6	3.7	3.6	3.6	2.6
Centerpoint	6.00	-1.5	-1.5	-1.5	0.5	1	0	
Center 2/3 with centerpoint								All
Absolute Average		1.7	1.9	1.7	4.2	4.2	4.1	2.9

Instuments Used: **Cal Exp. Date:**

Parallel-tube pitot with 90-deg bends at sample ends, 24-inches in length. NA
Dwyer Instruments 0 to 5 inch inclined manometer with red guage oil
zero'd and leveled (with connecting tubes open to room atmosphere).
Angles (at horizontal port) made using Empire #36 circular protractor.
Angles (at vertical port) made using a custom-made protractor (circular protractor
would not function in this position).

Notes:

To ensure similar hose connections between the manometer and pitot tube, rotating
the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).
E-W readings 1 to 4 were highly variable (+/- ~3 deg); readings 8 to 12 were stable.
N-S readings 1 to 4 were variable (+/- ~1-2 deg); center readings were stable.
N-S readings 9 to 12 were difficult to read because several numbers zero'd the manometer.

ANGULAR FLOW TEST RESULTS

Site	WO59 12-in Stack, Bldg. 305		Run No.	**AFJun17_2**
Date	6/17/98		Stack Temp	72 deg F
Tester	Maughan		Stack RH%	NA
Stack Dia.	12	in	Baro Press	NA
Stack X-Area	113.1	in^2	Fan Setting	60 Hz
Elevation	42	ft	Fan input port	NEAR
El. above disturbance	106.5	in	Units	degrees (clockwise > pos. nos.)

		vertical			horizontal		
Traverse-->		E>W			S>N		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw
1	0.50	-6	-6	-5	-3	-2	-4
2	0.80	-5	-4.5	-5	-8	-5	-3
3	1.42	-3	-4	-4	1	2	-1
4	2.12	-2	-3.5	-2	1	0	0
5	3.00	-1.5	-3	-3	1	0	-1
6	4.27	-2	-2	-2	-1	-1	1
7	7.77	-4	-4	-3	-1	0	0
8	9.00	-7.5	-7.5	-9	0	0	0
9	9.88	-4.5	-7.5	-7	0	-1	0
10	10.58	-5	-3.5	-7	-1	-1	-1
11	11.20	-19	-19	-18	-1	-1	0
12	11.50	-18	-19	-18	0	0	0
		west			north		All
Absolute Average of all		6.5	7.0	6.9	1.5	1.1	0.9	4.0
w/o points by wall		5.4	5.9	6.0	1.5	1.1	0.7	3.4
Centerpoint	6.00	-2	-3	-4	-1	0	0	
Center 2/3 with centerpoint								All
Absolute Average		6.9	7.7	9.9	1.5	1.0	0.6	4.6

Instuments Used: **Cal Exp. Date:** NA

Parallel-tube pitot with 90-deg bends at sample ends, 24 inches in length.
Dwyer Instruments 0- to 5-inch inclined manometer with red guage oil
zero'd and leveled (with connecting tubes open to room atmosphere).
Angles (at horizontal port) made using Empire #36 circular protractor.
Angles (at vertical port) made using a custom-made protractor (circular protractor would not function in this position).

Notes:

To ensure similar hose connections between the manometer and pitot tube, rotating the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).
E-W readings 1 to 4 were highly variable (+/- ~3 deg); readings 8 to 12 were stable but not sensitive.
N-S readings 1 to 4 were variable (+/- ~1 to 2 deg), center readings were stable, and readings 9 to 12 were highly stable, but not sensitive (+/- 3- to 4-deg probe rotation made small change in meniscus setting).

ANGULAR FLOW TEST RESULTS

Site	WO59 12-in Stack, Bldg. 305		Run No.	**AFJun18_2**
Date	6/18/98		Stack Temp	72 deg F
Tester	Maughan		Stack RH%	NA
Stack Dia.	12	in	Baro Press	NA
Stack X-Area	113.1	in^2	Fan Setting	60 Hz
Elevation	42	ft	Fan input port	FAR
El. above disturbance	106.5	in	Units	degrees (clockwise > pos. nos.)

		vertical			horizontal			
Traverse-->		E>W			S>N			
Trial ---->		1	2	3	1	2	3	
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	
1	0.50	-9	-12	-11	0	0	-1	
2	0.80	-8	-8	-8	0	0	-3	
3	1.42	-6	-7	-7	-2	-2	-2	
4	2.12	-4	-6	-5	-2	-2	-2	
5	3.00	-4	-2	-4	-2	-2	-2	
6	4.27	-2	-3	-3	-1	-1	-1	
7	7.77	-3	-3	-2	1	-1	0	
8	9.00	-2	-3	-2	1	1	1	
9	9.88	-2	-3	-3	2	2	1	
10	10.58	-2	-1.5	-1	2	3	2	
11	11.20	-1.5	-2	-1.5	2	2	3	
12	11.50	-2	-2	-1	3	3	2	
		west			north			All
Absolute Average of all		3.8	4.4	4.0	1.5	1.6	1.7	2.8
w/o points by wall		3.5	3.9	3.7	1.5	1.6	1.7	2.6
Centerpoint	6.00	-2	-3	-2.5	-1	-1	1	
Center 2/3 with centerpoint								All
Absolute Average		3.7	4.2	3.8	1.6	1.8	1.7	2.8

Instuments Used: **Cal Exp. Date:**

Parallel-tube pitot with 90-deg bends at sample ends, 24 inches in length. NA
Dwyer Instruments 0- to 5-inch inclined manometer with red guage oil
zero'd and leveled (with connecting tubes open to room atmosphere).
Angles (at horizontal port) made using Empire #36 circular protractor.
Angles (at vertical port) made using a custom-made protractor (circular protractor
would not function in this position).

Notes:

To ensure similar hose connections between the manometer and pitot tube, rotating
the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).
E-W readings 1 to 4 were slightly variable (+/- ~1 deg), readings 8 to 12 were stable, but not too sensitive.
N-S readings 1 to 4 were also slightly variable (+/- ~1 deg); center readings were stable; readings 9 to 12
were somewhat stable and sensitive (+/- 0.5- to 1-deg probe rotation).

ANGULAR FLOW TEST RESULTS

Site	WO59 12-in Stack, Bldg. 305		Run No.	**AFJun19_1**
Date	/19-22/1998		Stack Temp	72 deg F
Tester	Maughan		Stack RH%	NA
Stack Dia.	12	in	Baro Press	NA
Stack X-Area	113.1	in^2	Fan Setting	25 Hz
Elevation	42	ft	Fan input port	FAR close-coupled fan
El. above disturbance	106.5	in	Units	degrees (clockwise > pos. nos.)

		vertical			horizontal			
Traverse-->		E>W			S>N			
Trial ---->		1	2	3	1	2	3	
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	
1	0.50	2	2	2.5	-7	-8	-7	
2	0.80	3	2	3	-9	-10	-12	
3	1.42	2.5	3	4	-7	-7	-7	
4	2.12	3	4	3	-3	-4	-4	
5	3.00	3	3	4	-2	-2	-2	
6	4.27	3	4	5	-1	-1	-1.5	
7	7.77	3	3	3	1	1	0	
8	9.00	3	3	3	0	1	0	
9	9.88	2	2	2	0	1	1	
10	10.58	3	3	3	1	2	0	
11	11.20	3	2	0	0.5	2	1	
12	11.50	1	-1	2	0.5	2	1	
		west			north			All
Absolute Average of all		2.6	2.7	2.9	2.7	3.4	3.0	2.9
w/o points by wall		2.9	2.9	3.0	2.5	3.1	2.9	2.9
Centerpoint	6.00	3	3	3	1	0	0	
Center 2/3 with centerpoint								All
Absolute Average		3.3	3.3	3.4	2.5	3.0	2.8	3.0

Instuments Used: **Cal Exp. Date:**

Parallel-tube pitot with 90-deg bends at sample ends, 24 inches in length. NA
Dwyer Instruments 0- to 5-inch inclined manometer with red guage oil
zero'd and leveled (with connecting tubes open to room atmosphere).
Angles (at horizontal port) made using Empire #36 circular protractor.
Angles (at vertical port) made using a custom-made protractor (circular protractor
would not function in this position).

Notes:

To ensure similar hose connections between the manometer and pitot tube, rotating
the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).
E-W readings (Jun 19): variability in readings 1 to 4 = +/- 2 deg, 5 to 9 +/- ~1 deg, 9 to 12 +/- 4 deg.
N-S readings (Jun 22) 1 to 8 were +/- ~1 deg, remainder were +/- ~ 3 deg.
Tests were rerun to evaluate the effects of close coupling the fan to stack air inputs.

ANGULAR FLOW TEST RESULTS

Site	WO59 12-in Stack, Bldg. 305		Run No.	**AFJun22_2**
Date	6/22/98		Stack Temp	72 deg F
Tester	Maughan		Stack RH%	NA
Stack Dia.	12	in	Baro Press	NA
Stack X-Area	113.1	in^2	Fan Setting	25 Hz
Elevation	42	ft	Fan input port	NEAR close-coupled fan
El. above disturbance	106.5	in	Units	degrees (clockwise > pos. nos.)

		vertical			horizontal			
Traverse-->		E>W			S>N			
Trial ---->		1	2	3	1	2	3	
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	
1	0.50	-5	-5	-5	0	-1	-2	
2	0.80	0	2	1	-7	-7	-7	
3	1.42	5	6	5	-3	-4	-3	
4	2.12	4	3.5	3.5	-2	-2	-2	
5	3.00	3.5	4	4	-1	-2	-2	
6	4.27	4	4.5	5	-0.5	-1	-1	
7	7.77	6	4.5	6	-0.5	0	-1	
8	9.00	5	5	6	0	-1	-1	
9	9.88	4	4	3.5	-2	-1.5	-2	
10	10.58	4	4	4	-1	-1	-1.5	
11	11.20	2	3	3	-1.5	-2	-1.5	
12	11.50	3	2.5	3	-1	-1	-1	
		west			north			All
Absolute Average of all		3.8	4.0	4.1	1.6	2.0	2.0	2.9
w/o points by wall		3.8	4.1	4.1	1.9	2.2	2.2	3.0
Centerpoint	6.00	5	4	5	0.5	0	-1	
Center 2/3 with centerpoint								All
Absolute Average		5.1	5.3	5.3	1.8	2.1	2.2	3.6

Instuments Used: **Cal Exp. Date:**

Parallel-tube pitot with 90-deg bends at sample ends, 24 inches in length. NA
Dwyer Instruments 0- to 5-inch inclined manometer with red guage oil
zero'd and leveled (with connecting tubes open to room atmosphere).
Angles (at horizontal port) made using Empire #36 circular protractor.
Angles (at vertical port) made using a custom-made protractor (circular protractor
would not function in this position).

Notes:

To ensure similar hose connections between the manometer and pitot tube, rotating
the pitot tube assembly clockwise drives the meniscus to the right (to higher pos. numbers).
Tests were rerun to evaluate the effects of close-coupling the fan to stack air inputs.
Straight stack.

ANGULAR FLOW TEST RESULTS

Site	Actual W059 stack		Run No.	**AFJun30_1**
Date	6/30/98		Stack Temp	94.5 F
Tester	Knutson of FDH		Stack RH%	20.8% RH
Stack Dia.	31.25	in	Baro Press	29.23 in Hg
Stack X-Area	767.0	in^2	Fan Setting	8200
Elevation	42	ft	Fan input port	Near
El. above disturbance	106.5	in	Units	degrees (clockwise > pos. nos.)

Traverse-->		Southwest			Northwest		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw
1	1		1	-1	1	0	0
2	2 2/16		1	-1	0	0	0
3	3 11/16	0	1	-1	-1	0	0
4	5 9/16	1	1	0	0	-1	0
5	7 13/16	1	1	0	0	-1	1
6	11 2/16	2	1	2	-1	-1	0
7	20 2/16	1	1	0	1	1	-1
8	23 7/16	0	0	1	0	1	1
9	25 12/16	1	1	1	1	1	1
10	27 9/16	1	1	1	1	1	1
11	29 3/16	1	0	1	0	1	0
12	30 4/16	1	0	1	0	1	0

	Northeast			Southeast			All
Absolute Average of all	0.8	0.8	0.8	0.5	0.8	0.4	0.7
w/o points by wall	0.8	0.8	0.8	0.5	0.8	0.5	0.7

Centerpoint	15 10/16	1	1	1	0	0	1	

Center 2/3 with centerpoint							All
Absolute Average	0.8	0.8	0.8	0.4	0.7	0.5	0.7

Instuments Used:	**Cal Exp. Date:**
Neotronics Micromanometer 702-28-09-014	8/20/98
Hygrometer 799-32-01-001	6/12/98

Notes:
Measurements performed by Fluor Daniel Hanford Vent & Balance staff.

ANGULAR FLOW TEST RESULTS

Site	Actual W059 stack		Run No.	**AFJun30_2**	
Date	6/30/98		Stack Temp	103.5 F	
Tester	Knutson of FDH		Stack RH%	13.40 % RH	
Stack Dia.	31.25	in	Baro Press	29.2 Hg	
Stack X-Area	767.0	in^2	Fan Setting	18000	
Elevation	42	ft	Fan input port	Near	
El. above disturbance	106.5	in	Units	degrees (clockwise > pos. nos.)	

Traverse-->		Southwest			Northwest		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw
1	1	0	-1	0	-1	1	-2
2	2 2/16	1	-3	-2	-5	0	-4
3	3 11/16	3	4	4	-4	1	2
4	5 9/16	3	4	3	5	2	4
5	7 13/16	3	4	3	2	2	3
6	11 2/16	3	4	5	-1	1	1
7	20 2/16	0	0	-1	0	0	1
8	23 7/16	0	-1	-1	-1	-1	0
9	25 12/16	0	-1	-1	-1	-1	-2
10	27 9/16	-1	-4	-2	-2	-3	-2
11	29 3/16	-2	-3	-3	-2	-3	-3
12	30 4/16	-3	-4	-3	-2	-3	-3

	Northeast			Southeast			All
Absolute Average of all	1.6	2.8	2.3	2.2	1.5	2.3	2.1
w/o points by wall	1.6	2.8	2.5	2.3	1.4	2.2	2.1
Centerpoint 15 10/16	1	1	1	1	1	1	

Center 2/3 with centerpoint							All
Absolute Average	1.6	2.8	2.5	2.3	1.4	2.3	2.2

Instuments Used:	**Cal Exp. Date:**
Neotronics Micromanometer 702-28-09-014	8/20/98
Hygrometer 799-32-01-001	6/12/98

Notes:
Measurements performed by Fluor Daniel Hanford Vent & Balance staff.

ANGULAR FLOW TEST RESULTS

Site	Actual W059 stack		Run No.	**AFJul1_1**
Date	6/30/98		Stack Temp	87.6 F
Tester	Knutson of FDH		Stack RH%	30.6 % RH
Stack Dia.	31.25	in	Baro Press	29.18
Stack X-Area	767.0	in^2	Fan Setting	18000
Elevation	42	ft	Fan input port	Far
El. above disturbance	106.5	in	Units	degrees (clockwise > pos. nos.)

Traverse-->		Southwest			Northwest		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw
1	1	0	0	0	0	0	0
2	2 2/16	0	1	1	0	0	-1
3	3 11/16	0	0	0	0	0	-1
4	5 9/16	0	0	1	0	0	1
5	7 13/16	0	1	-1	-1	0	0
6	11 2/16	3	2	3	0	0	0
7	20 2/16	1	1	1	1	1	1
8	23 7/16	1	1	1	1	1	0
9	25 12/16	2	1	2	1	1	2
10	27 9/16	1	0	1	0	0	1
11	29 3/16	1	-1	0	0	-1	0
12	30 4/16	0	-1	-1	-1	-1	-1

	Northeast			Southeast			All
Absolute Average of all	0.8	0.8	1.0	0.4	0.4	0.7	0.7
w/o points by wall	0.9	0.8	1.1	0.4	0.4	0.7	0.7

Centerpoint	15 10/16	2	3	2	1	1	0

Center 2/3 with centerpoint							All
Absolute Average	1.0	1.0	1.2	0.4	0.4	0.6	0.8

Instuments Used:	**Cal Exp. Date:**
Neotronics Micromanometer 702-28-09-014	8/20/98
Hygrometer 799-32-01-001	6/12/98

Notes:
Measurements performed by Fluor Daniel Hanford Vent & Balance staff.

ANGULAR FLOW TEST RESULTS

Site	Actual W059 stack	Run No.	**AFJul1_2**
Date	7/1/98	Stack Temp	100.7 F
Tester	Knutson of FDH	Stack RH%	18.4 % RH
Stack Dia.	31.25 in	Baro Press	29.18 in Hg
Stack X-Area	767.0 in^2	Fan Setting	8000
Elevation	42 ft	Fan input port	Far
El. above disturbance	106.5 in	Units	degrees (clockwise > pos. nos.)

Traverse-->		Southwest			Northwest		
Trial --->		1	2	3	1	2	3
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw
1	1	0	0	1	0	1	0
2	2 2/16	0	0	0	0	2	2
3	3 11/16	1	-1	0	-1	-1	0
4	5 9/16	1	2	2	3	3	3
5	7 13/16	-1	3	4	3	3	3
6	11 2/16	-2	3	4	1	3	2
7	20 2/16	0	1	0	0	0	-1
8	23 7/16	2	1	-1	1	-1	-1
9	25 12/16	3	1	-1	-1	-1	-1
10	27 9/16	3	-4	-2	-1	-3	-2
11	29 3/16	-5	-3	-4	-1	-3	-3
12	30 4/16	-5	-5	-5	-1	-4	-3
			Northeast			Southeast		All
Absolute Average of all		1.9	2.0	2.0	1.1	2.1	1.8	1.8
w/o points by wall		1.8	1.9	1.8	1.2	2.0	1.8	1.8
Centerpoint	15 10/16	-1	0	1	-2	-2	0	
Center 2/3 with centerpoint								All
Absolute Average		2.2	1.8	1.8	1.3	2.1	1.7	1.8

Instuments Used:	**Cal Exp. Date:**
Neotronics Micromanometer 702-28-09-014	8/20/98
Hygrometer 799-32-01-001	6/12/98

Notes:
Measurements performed by Fluor Daniel Hanford Vent & Balance staff.

ANGULAR FLOW TEST RESULTS

Site	W059 model stack, Bldg. 305		Run No.	**AFJul13_1**
Date	7/13/98		Stack Temp	73 deg F
Tester	Maughan		Stack RH%	NA
Stack Dia.	12	in	Baro Press	NA
Stack X-Area	113.1	in^2	Fan Setting	22 Hz
Elevation	42	ft	Fan input port	NEAR
El. above disturbance	106.5	in	Units	degrees (clockwise > pos. nos.)

Traverse-->		Southwest			Northwest		
Trial --->		1	2	3	1	2	3
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw
1	0.50	-7	-7	-5	-4	-3	-5
2	0.80	-2	-1	0	-2	-3	0
3	1.42	-3	0	-1	3	2	3
4	2.12	-5	-3	-3	2	0	1
5	3.00	-3	-4	-2	-1	-2	-2
6	4.27	-1	-2	-1	-3	-2	-2
7	7.77	0	0	-1	-4	-3	-3
8	9.00	-2	-3	-2	-5	-5	-4
9	9.88	-4	-3	-4	-5	-4	-4
10	10.58	-7	-5	-5	-4	-5	-4
11	11.20	-7	-7	-7	-5	-4	-4
12	11.50	-10	-10	-8	-3	-2	-2

	Northeast			Southeast			All
Absolute Average of all	4.3	3.8	3.3	3.4	2.9	2.8	3.4
w/o points by wall	3.4	2.8	2.6	3.4	3.0	2.7	3.0
Centerpoint (6)	-2	-1	-1	-2	-3	-2	

Center 2/3 with centerpoint							All
Absolute Average	5.3	3.6	3.8	4.7	4.4	3.7	4.3

Instuments Used: **Cal Exp. Date:**

Parallel-tube pitot with 90-deg bends at sample ends, 24 inches in length. NA

Dwyer Instruments 0- to 5-inch inclined manometer (leveled on a table) with red guage oil zero'd (with connecting tubes open to room atmosphere). Tubes were connected between the manometer and the pitot tube so that rotation of the pitot tube in a clockwise direction drives the meniscus to the right on the inclined manometer and to higher positive numbers.

Angles of 45 deg (at NW and SW ports) made using a custom-made protractor (circular protractor would not function in these positions).

Notes:

Test run with fan inlet filters and 5-foot stack extension installed.

ANGULAR FLOW TEST RESULTS

Site	W059 model stack, Bldg. 305		Run No.	**AFJul13_2**
Date	7/13/98		Stack Temp	73 deg F
Tester	Maughan		Stack RH%	NA
Stack Dia.	12	in	Baro Press	NA
Stack X-Area	113.1	in^2	Fan Setting	60 Hz
Elevation	42	ft	Fan input port	NEAR
El. above disturbance	106.5	in	Units	degrees (clockwise > pos. nos.)

Traverse-->		Southwest			Northwest		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw
1	0.50	0	-3	-1	-2	-2	-2
2	0.80	2	1	1	0	2	3
3	1.42	2	1	0	3	3	3
4	2.12	0	-2	-2	1	2	1
5	3.00	0	0	-2	-1	0	-1
6	4.27	0	-2	0	-3	-2	-2
7	7.77	1	-1	1	-3	-5	-3
8	9.00	-1	-2	-3	-4	-4	-3
9	9.88	-2	-2	-2	-3	-3	-4
10	10.58	-3	-3	-3	-3	-3	-3
11	11.20	-5	-6	-7	-2	-2	-3
12	11.50	-6	-7	-7	0	1	0

	Northeast			Southeast			All
Absolute Average of all	1.8	2.5	2.4	2.1	2.4	2.3	2.3
w/o points by wall	1.6	2.0	2.1	2.3	2.6	2.6	2.2
Centerpoint (6)	-1	-2	-1	-3	-5	-4	

Center 2/3 with centerpoint							All
Absolute Average	1.8	2.3	2.3	2.9	3.4	3.5	2.7

Instuments Used: **Cal Exp. Date:**

Parallel-tube pitot with 90-deg bends at sample ends, 24 inches in length. NA

Dwyer Instruments 0- to 5-inch inclined manometer (leveled on a table) with red guage oil zero'd (with connecting tubes open to room atmosphere). Tubes were connected between the manometer and the pitot tube so that rotation of the pitot tube in a clockwise direction drives the meniscus to the right on the inclined manometer and to higher positive numbers.

Angles of 45 deg (at NW and SW ports) made using a custom-made protractor (circular protractor would not function in these positions).

Notes:

Test run with fan inlet filters and 5-foot stack extension installed.

ANGULAR FLOW TEST RESULTS

Site	W059 model stack, Bldg. 305		Run No.	**AFJul13_3**
Date	7/13/98		Stack Temp	73 deg F
Tester	Maughan		Stack RH%	NA
Stack Dia.	12	in	Baro Press	NA
Stack X-Area	113.1	in^2	Fan Setting	22 Hz
Elevation	42	ft	Fan input port	FAR
El. above disturbance	106.5	in	Units	degrees (clockwise > pos. nos.)

Traverse-->		Southwest			Northwest		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw
1	0.50	2	2	2	-6	-7	-4
2	0.80	4	5	6	-7	-8	-7
3	1.42	3	3	4	2	3	3
4	2.12	0	0	0	3	3	3
5	3.00	1	1	2	-3	0	-1
6	4.27	2	1	2	-4	-3	-3
7	7.77	0	1	2	-7	-6	-7
8	9.00	-3	-3	2	-8	-8	-8
9	9.88	-4	-4	-3	-7	-7	-6
10	10.58	-8	-7	-5	-8	-8	-7
11	11.20	-10	-9	-9	-9	-9	-9
12	11.50	-9	-9	-9	-11	-12	-11

	Northeast			Southeast			All
Absolute Average of all	3.8	3.8	3.8	6.3	6.2	5.8	4.9
w/o points by wall	3.5	3.4	3.5	5.8	5.5	5.4	4.5

Centerpoint	6	1	1	2	-7	-6	-7

Center 2/3 with centerpoint							All
Absolute Average	5.6	5.2	4.4	10.6	10.2	9.0	7.5

Instuments Used: **Cal Exp. Date:**

Parallel-tube pitot with 90-deg bends at sample ends, 24 inches in length. NA

Dwyer Instruments 0- to 5-inch inclined manometer (leveled on a table) with red guage oil zero'd (with connecting tubes open to room atmosphere). Tubes were connected between the manometer and the pitot tube so that rotation of the pitot tube in a clockwise direction drives the meniscus to the right on the inclined manometer and to higher positive numbers.

Angles of 45 deg (at NW and SW ports) made using a custom-made protractor (circular protractor would not function in these positions).

Notes:

Test run with fan inlet filters and 5-foot stack extension installed.

ANGULAR FLOW TEST RESULTS

Site	W059 model stack, Bldg. 305		Run No.	**AFJul13_4**
Date	7/13/98		Stack Temp	73 deg F
Tester	Maughan		Stack RH%	NA
Stack Dia.	12	in	Baro Press	NA
Stack X-Area	113.1	in^2	Fan Setting	60 Hz
Elevation	42	ft	Fan input port	FAR
El. above disturbance	106.5	in	Units	degrees (clockwise > pos. nos.)

Traverse-->		Southwest			Northwest		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw	degrees cw
1	0.50	3	2	3	-7	-4	-4
2	0.80	7	7	7	-9	-9	-8
3	1.42	4	4	4	2	3	3
4	2.12	2	0	2	0	2	2
5	3.00	0	1	0	-2	1	0
6	4.27	0	0	0	-3	-3	-3
7	7.77	-2	0	0	-6	-6	-5
8	9.00	-4	-4	-2	-7	-8	-7
9	9.88	-6	-4	-4	-7	-7	-6
10	10.58	-7	-6	-5	-8	-8	-8
11	11.20	-9	-8	-7	-8	-9	-9
12	11.50	-9	-9	-9	-9	-10	-10

	Northeast			Southeast			All
Absolute Average of all	4.4	3.8	3.6	5.7	5.8	5.4	4.8
w/o points by wall	4.1	3.4	3.1	5.2	5.6	5.1	4.4
Centerpoint (6)	0	0	0	-5	-5	-6	

Center 2/3 with centerpoint							All
Absolute Average	7.0	4.8	4.2	9.8	10.2	9.1	7.5

Instuments Used: **Cal Exp. Date:**

Parallel-tube pitot with 90-deg bends at sample ends, 24 inches in length. NA

Dwyer Instruments 0- to 5-inch inclined manometer (leveled on a table) with red guage oil zero'd (with connecting tubes open to room atmosphere). Tubes were connected between the manometer and the pitot tube so that rotation of the pitot tube in a clockwise direction drives the meniscus to the right on the inclined manometer and to higher positive numbers.

Angles of 45 deg (at NW and SW ports) made using a custom-made protractor (circular protractor would not function in these positions).

Notes:

Test run with fan inlet filters and 5-foot stack extension installed.

Appendix B

Test to Determine Uniformity of Air Velocity

Appendix B: Test to Determine Uniformity of Air Velocity

Procedure to Calibrate Flow Controller and Determine the Uniformity of Air Velocity

May 20, 1998

Calibration of Fan Controller

A fan speed or flow controller should be used if the qualification tests are to be conducted at various flowrates. The purpose of this procedure is to determine the stack flowrate versus flow-controller setting and to enable rapid and repeatable changes in stack flow. This procedure is written specifically for the use of a variable-frequency drive controller. If a variable-frequency drive is not used, this procedure may be adapted to other flow or fan controllers.

The fan speed will be indicated by the frequency setting on the variable-frequency controller. A calibration of approximate stack flow versus frequency will enable quicker execution of subsequent experiments. It is acknowledged that as the inlet filter loads, the calibration may change and may need to be repeated. A series of velocity and flow measurements should be made at various frequency settings. Frequency settings can vary from 0 to 60 Hz.

Use the following procedure to calibrate the fan controller:

1. Obtain a calibrated slant tube or electronic manometer and a pitot tube. Measure the stack inside diameter and the distance (offset) from the external index point at the traverse ports. Lay out the velocity traverse points per 40 CFR 60, Appendix A, Method 1, and add a center point. Mark the pitot tube for each traverse point. Prepare a data sheet for recording operating parameters and two or more measurements for each point.

2. At a midpoint control setting for the expected operating range (e.g., a frequency setting of 30), perform a full velocity traverse along both directions. Seal off all stack and duct openings, remove the top stack cover, and remove the inlet cover.

3. Call the weather station to obtain the barometric pressure for the location. Air temperature can be measured in the stack with a calibrated instrument during the velocity traverses. Attach the manometer to the pitot tube. Insert the pitot tube in the stack, and seal the opening around the pitot tube.

4. Position the pitot tube at each measurement point, in succession, so that the face opening of the pitot tube is aligned with the axis of the stack. Record the velocity or differential pressure reading at each measurement point. If the electronic manometer has an averaging feature, record the average

reading of a series of several readings. Perform two or three repetitions of the measurements in each traverse direction, two if it is highly repeatable, three if not so repeatable. Fill out a data sheet for each test. Label the columns of traverse data by the direction of the traverse. For example, if the first reading is closest to the east port, and the last reading is closest to the west port, then label the traverse east-west.

5. Calculate the mean velocity, and identify a location where the measured velocity is closest to the calculated mean.

6. Place the pitot tube at the location of the average velocity reading determined above. Record the velocity reading for several fan-controller settings covering the control range (e.g., at 5-Hz increments over the range of 5- to 60-Hz). Repeat three times. Calculate the average velocity and flow at each controller setting. Plot the average reading versus controller frequency.

Determination of Uniform Velocity

From the plot of flow versus controller setting, select the control settings corresponding to the desired test flowrates for which the angular-flow, gas, and particle-mixing tests will be conducted. At each flowrate, conduct a velocity traverse as in Steps 1, 3, and 4 above. Calculate the average velocity and flowrate, omitting the data from the center point.

For each flow setting or test condition, calculate the coefficient of variance for each velocity traverse using the average velocity data from all points in the inner two-thirds of the cross-section area (including the centerpoint). The acceptance criterion for the COV is $\leq 20\%$ for the inner two-thirds of the stack diameter. The COV is 100 times the mean divided by the standard deviation.

Exceptions to this method should be noted on the data sheets.

Table B.1 Velocity-Uniformity Results with Measurement Grid Oriented North/South on Scale Model

Flow Setting	Run	Flow rate, cfm	COV
Fan nearest to stack			
Low	VTJun11_4	994	3.6
High	VTJun11_3	2,488	4.1
High	VTJun16_1	2,756	3.1
Fan farthest from stack			
Low	VTJun16_2	1,152	3.0
High	VTJun18_1	2,728	2.8

VELOCITY vs. FREQUENCY DATA FORM

Site	W059 12-inch Stack, Bldg. 305	Run No.	**VFMay27_1**
Date	5/27/98	Stack Temp	72 deg. F
Tester	D. Maughan	Stack RH%	49 % outdoor
Stack Dia.	12	Baro Press	1001+1.9 mbar static
Stack X-Area	113.1	Fan Setting	60Hz
Elevation		Fan input point	Near
El. above disturbance	106.5 in		

Reference point used from velocity traverses:

Pt.10 on S>N Transect

Velocity Readings, units = fpm

	Velocity, fpm							
Hz	1	2	3	Mean	StDev	2 StDev	Flow, cfm	
5	287	274	264	275.0	11.5	23.1	216	static P = 1.9
10	595	598	583	592.0	7.9	15.9	465	
15	886	890	883	886.3	3.5	7.0	696	
20	1183	1207	1206	1198.7	13.6	27.2	941	
25	1530	1536	1528	1531.3	4.2	8.3	1203	
30	1816	1808	1790	1804.7	13.3	26.6	1417	static P = 1.9
35	2139	2092	2157	2129.3	33.6	67.1	1672	
40	2413	2392	2433	2412.7	20.5	41.0	1895	
45	2708	2715	2734	2719.0	13.5	26.9	2136	
50	3034	2992	2989	3005.0	25.2	50.3	2360	
55	3273	3304	3300	3292.3	16.9	33.7	2586	
60	3550	3548	3614	3570.7	37.5	75.1	2804	static P = 1.9
Repeats:								
30	1804	1793	1813	1803.3	10.0	20.0	1416	static P = 0.53
30	1783	1819	1815	1805.7	19.7	39.5	1418	static P = 0.53

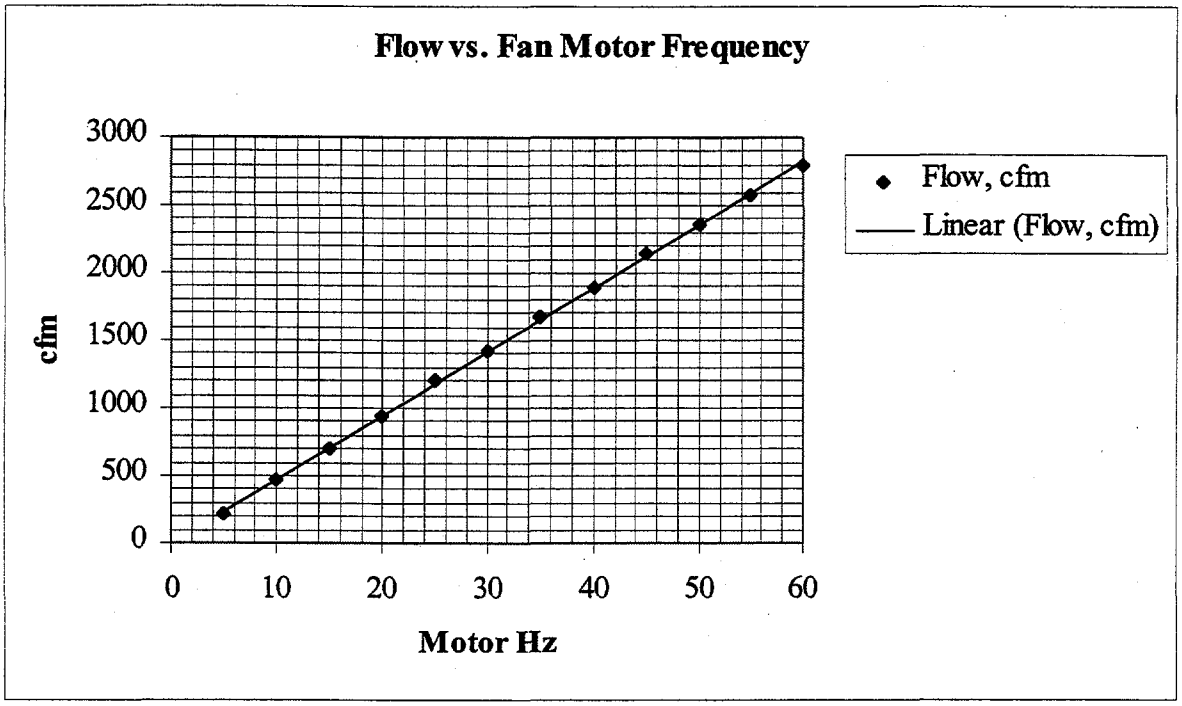
Notes:

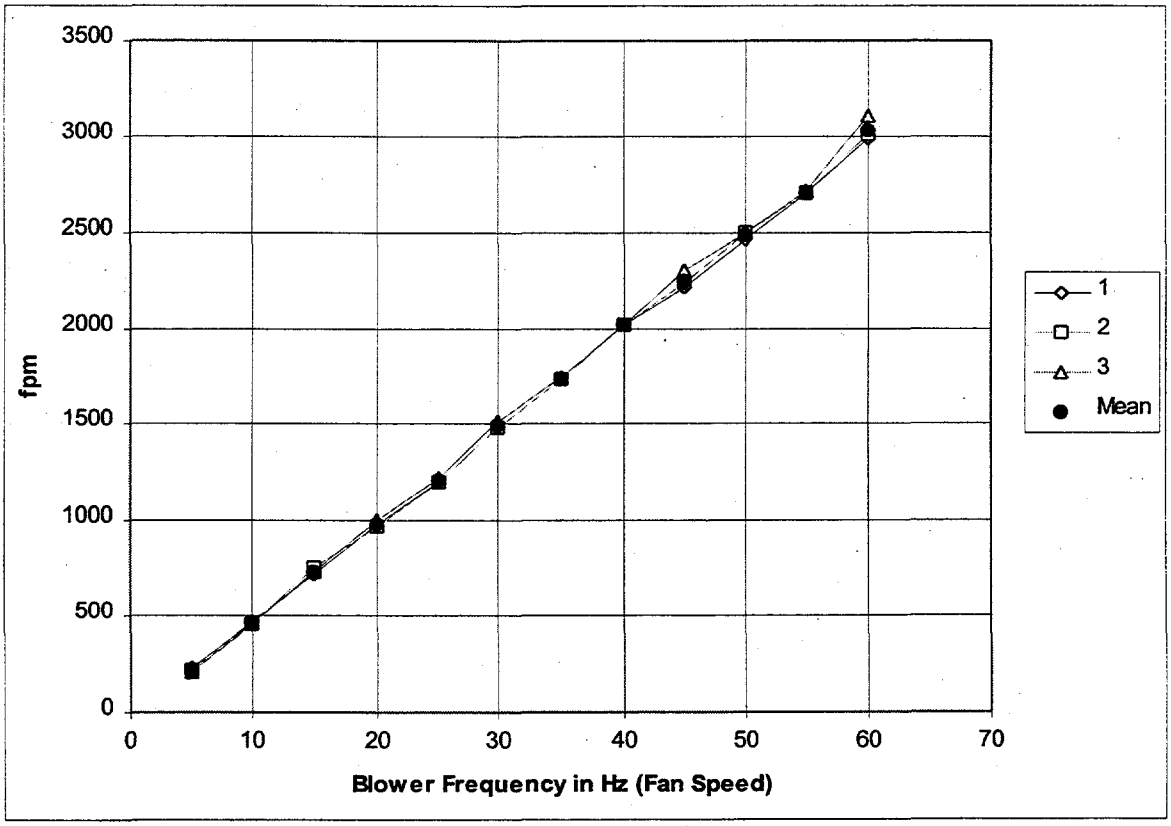
Each reading is the running average of approximately 40 points.

Blower connected to the "near" in-flow port.

Instuments Used: **Cal Exp. Date:**

Solomat Zephyr Ser# 12951472, Cal# 521-28-09-001 5/1/99


Flow vs. Fan Motor Frequency
3000
2500
2000
1500
1000
500
0
cfm
0
10
20
30
40
50
60
Motor Hz
Flow, cfm
Linear (Flow, cfm)


3500
3000
2500
2000
1500
1000
500
0
fpm
0
10
20
30
40
50
60
70
Blower Frequency in Hz (Fan Speed)
1
2
3
Mean

VELOCITY vs. FREQUENCY DATA FORM

Site	W059 12-inch Stack, Bldg 305	Run No.	VFJun1_1
Date	6/1/98	Stack Temp	74 F
Tester	Maughan/Glissmeyer	Stack RH%	
Stack Dia.	12 in.	Baro Press	994.3 + 1.93 mbar
Stack X-Area	113.1	Fan Setting	Various
Elevation		Fan input point	Near
El. above disturbance	106.5 inches		

Reference point used from velocity traverses: point 10 on E>W Transect

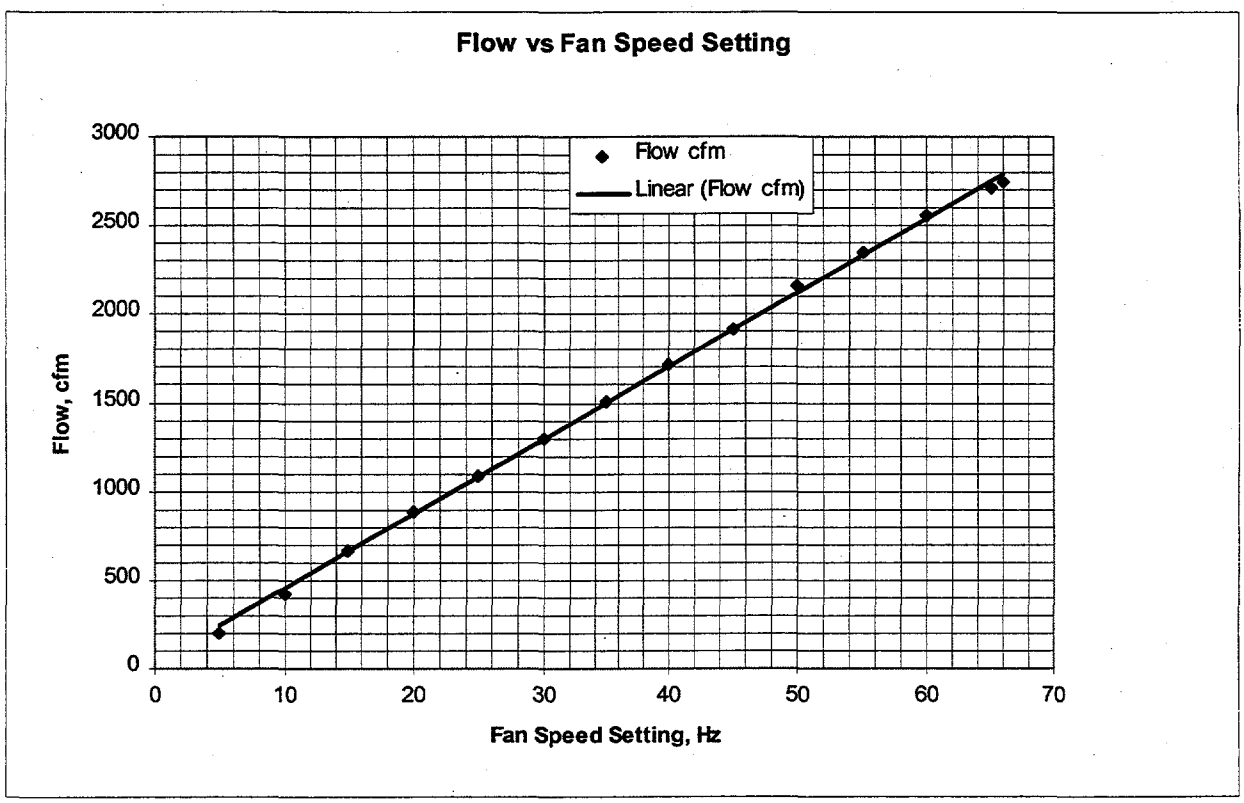
Velocity Readings, units = fpm

		Velocity, fpm						
rpm	Hz	1	2	3	Mean	StDev	2 StDev	Flow cfm
145	5	253.0	243.0	284.0	260.0	21.4	42.8	204
290	10	544.0	524.0	545.0	537.7	11.8	23.7	422
435	15	834.0	842.0	854.0	843.3	10.1	20.1	662
580	20	1122.0	1121.0	1127.0	1123.3	3.2	6.4	882
725	25	1381.0	1377.0	1378.0	1378.7	2.1	4.2	1083
870	30	1661.0	1633.0	1672.0	1655.3	20.1	40.2	1300
1015	35	1958.0	1933.0	1872.0	1921.0	44.2	88.5	1509
1160	40	2187.0	2155.0	2233.0	2191.7	39.2	78.4	1721
1305	45	2441.0	2453.0	2425.0	2439.7	14.0	28.1	1916
1450	50	2770.0	2737.0	2719.0	2742.0	25.9	51.7	2154
1595	55	2998.0	2960.0	2986.0	2981.3	19.4	38.9	2342
1740	60	3249.0	3254.0	3272.0	3258.3	12.1	24.2	2559
1885	65	3432.0	3496.0	3429.0	3452.3	37.8	75.7	2711
1914	66	3530.0	3467.0	3494.0	3497.0	31.6	63.2	2747

Notes:
This calibration was done after modifying the fan controller, straightening the flexible ductwork, and changing the fan inlet screen to a more open mesh.

Instuments Used:
Solomat Zephyr Ser# 12951472, Cal# 521-28-09-001

Cal Exp. Date:
5/1/99


Flow vs Fan Speed Setting
Flow cfm
Linear (Flow cfm)
Flow, cfm
3000
2500
2000
1500
1000
500
0
0
10
20
30
40
50
60
70
Fan Speed Setting, Hz

VELOCITY TRAVERSE DATA FORM

Site	W059 12-inch Stack, Bldg. 305	Run No.	**VTJun11_1**
Date	6/11/98	Stack Temp	72 deg F
Tester	Maughan	Stack RH%	44% 300 Area station
Stack Dia.	12 in.	Baro Press	999.1 station, 0.28 mbar static
Stack X-Area	113.1 in^2	Fan Setting	25 Hz
Elevation		Fan input point	FAR
El. above disturbance	106.5 in	Center 2/3 from	1.10 to: 10.90
Units	fpm	Points in Center 2/3	3 to: 10

		vert.			horizontal			
Traverse-->		E-W			S-N			
Trial ---->		1	2	3	1	2	3	
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity	
1	0.50	1298	1245	1268				
2	0.80	1308	1339	1354				
3	1.42	1420	1380	1413				
4	2.12	1394	1432	1441				
5	3.00	1406	1404	1412				
6	4.27	1376	1416	1395	(This test and VTJun11_2 run first			
7	7.73	1381	1377	1374	for E-W transect with it planned to			
8	9.00	1412	1363	1366	then setup for N-S tests, but it			
9	9.88	1344	1339	1349	became necessary to verify the			
10	10.58	1326	1321	1367	Solomat's performance)			
11	11.20	1256	1248	1271				
12	11.50	1236	1184	1203				
		west			north			Avg.
Average of all data		1346.4	1337.3	1351.1	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
w/o points by wall		1362.3	1361.9	1374.2	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Centerpoint	6.00	1400	1421	1400				

Center 2/3 with centerpoint							Avg
Mean	1384.3	1383.7	1390.8	#DIV/0!	#DIV/0!	#DIV/0!	1386.3
Std. Dev.	31.5	38.1	29.1	#DIV/0!	#DIV/0!	#DIV/0!	32.0
COV %	2.3	2.8	2.1	#DIV/0!	#DIV/0!	#DIV/0!	2.3

Flow #DIV/0! cfm

Flow #DIV/0! m^3/hr

Instuments Used: **Cal Exp. Date:**

Solomat Zephyr S/N 12951472 Cal #521-28-09-001 5/1/99

Note: the above Solomat readings were averages of 30 to 42 separate readings.

VELOCITY TRAVERSE DATA FORM

Site	W059 12-inch Stack, Bldg. 305	Run No.	**VTJun11_2**
Date	6/11/98	Stack Temp	72 deg F
Tester	Maughan	Stack RH%	44% 300 Area station
Stack Dia.	12 in.	Baro Press	999.1 station, 1.53 mbar static
Stack X-Area	113.1 in^2	Fan Setting	64 Hz
Elevation		Fan input point	FAR
El. above disturbance	106.5 in	Center 2/3 from	1.10 to: 10.90
Units	fpm	Points in Center 2/3	3 to: 10

		vert.			horizontal			
Traverse-->		E-W			S-N			
Trial ---->		1	2	3	1	2	3	
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity	
1	0.50	3200	3168	3157				
2	0.80	3314	3305	3257				
3	1.42	3402	3515	3401				
4	2.12	3438	3476	3468				
5	3.00	3442	3541	3479				
6	4.27	3477	3545	3491	Solomat fell from platform			
7	7.73	3496	3480	3489	(Stopped test to verify performance)			
8	9.00	3455	3452	3463				
9	9.88	3414	3442	3486				
10	10.58	3400	3501	3328				
11	11.20	3280	3308	3371				
12	11.50	3142	3132	3214				
		west			north			Avg.
Average of all data		3371.7	3405.4	3383.7	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
w/o points by wall		3411.8	3456.5	3423.3	#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
Centerpoint	6.00	3512	3499	3457				
Center 2/3 with centerpoint								Avg
Mean		3448.4	3494.6	3451.3	#DIV/0!	#DIV/0!	#DIV/0!	3464.8
Std. Dev.		40.3	35.9	53.8	#DIV/0!	#DIV/0!	#DIV/0!	47.4
COV %		1.2	1.0	1.6	#DIV/0!	#DIV/0!	#DIV/0!	1.4

Flow #DIV/0! cfm

Flow #DIV/0! m^3/hr

Instuments Used: **Cal Exp. Date:**

Solomat Zephyr S/N 12951472 Cal #521-28-09-001 5/1/99

Note: the above Solomat readings were averages of 30 to 42 separate readings.

VELOCITY TRAVERSE DATA FORM

Site	W059 12-inch Stack, Bldg. 305	Run No.	**VTJun11_3**
Date	6/11/98	Stack Temp	72.5 probe deg F
Tester	Maughan	Stack RH%	44% 300 Area station
Stack Dia.	12 in.	Baro Press	999.1 station, 1.53 mbar static
Stack X-Area	113.1 in^2	Fan Setting	64 Hz
Elevation		Fan input point	NEAR
El. above disturbance	106.5 in	Center 2/3 from	1.10 to: 10.90
Units	fpm	Points in Center 2/3	3 to: 10

		vert.			horizontal		
Traverse-->		E-W			S-N		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.50	2894	2924	2963	2927	2870	2976
2	0.80	3014	2983	3025	3092	3114	3094
3	1.42	3113	3127	3039	3222	3268	3261
4	2.12	3114	3179	3180	3298	3288	3300
5	3.00	3250	3222	3287	3369	3377	3315
6	4.27	3398	3370	3357	3358	3414	3362
7	7.73	3492	3495	3476	3280	3309	3285
8	9.00	3437	3477	3403	3284	3193	3183
9	9.88	3342	3305	3415	3076	3102	3093
10	10.58	3224	3291	3241	3005	3029	2941
11	11.20	3192	3133	3186	2957	2828	2909
12	11.50	2915	2966	2910	2804	2867	2713

	west			north			Avg.
Average of all data	3198.8	3206.0	3206.8	3139.3	3138.3	3119.3	3168.1
w/o points by wall	3257.6	3258.2	3260.9	3194.1	3192.2	3094.0	3209.5

Centerpoint	6.00	3446	3465	3409	3441	3373	3383

Center 2/3 with centerpoint							Avg
Mean	3312.9	3325.7	3311.9	3259.2	3261.4	3235.9	3284.5
Std. Dev.	143.5	135.2	139.1	140.1	130.5	141.9	136.1
COV %	4.3	4.1	4.2	4.3	4.0	4.4	4.1

Flow 2488 cfm

Flow 4228 m^3/hr

Instuments Used: **Cal Exp. Date:**

Solomat Zephyr S/N 12951472 Cal #521-28-09-001 5/1/99

Note: the above Solomat readings were averages of 30 to 42 separate readings.

VELOCITY TRAVERSE DATA FORM

Site	W059 12-inch Stack, Bldg. 305	Run No.	**VTJun11_4**
Date	6/11/98	Stack Temp	72.5 probe deg F
Tester	Maughan	Stack RH%	44% 300 Area station
Stack Dia.	12 in.	Baro Press	999.1 station, 0.28 mbar static
Stack X-Area	113.1 in^2	Fan Setting	25 Hz
Elevation		Fan input point	NEAR
El. above disturbance	106.5 in	Center 2/3 from	1.10 to: 10.90
Units	fpm	Points in Center 2/3	3 to: 10

		vert.			horizontal		
Traverse-->		E-W			S-N		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.50	1163	1136	1114	1102	1164	1113
2	0.80	1164	1178	1171	1211	1240	1232
3	1.42	1249	1252	1230	1340	1299	1284
4	2.12	1260	1282	1256	1337	1328	1340
5	3.00	1280	1293	1253	1342	1362	1351
6	4.27	1306	1348	1320	1390	1354	1355
7	7.73	1388	1393	1348	1352	1352	1338
8	9.00	1386	1336	1352	1303	1324	1274
9	9.88	1380	1352	1361	1254	1239	1300
10	10.58	1294	1305	1300	1231	1264	1225
11	11.20	1256	1260	1271	1182	1146	1158
12	11.50	1140	1178	1167	1077	1114	1101
		west			north		Avg.
Average of all data		1272.2	1276.1	1261.9	1260.1	1265.5	1255.9	1265.3
w/o points by wall		1296.3	1299.9	1286.2	1294.2	1290.8	1232.0	1283.2
Centerpoint	6.00	1383	1330	1358	1373	1341	1369	
Center 2/3 with centerpoint								Avg
Mean		1325.1	1321.2	1308.7	1324.7	1318.1	1315.1	1318.8
Std. Dev.		58.6	42.6	51.1	52.8	42.7	47.3	47.5
COV %		4.4	3.2	3.9	4.0	3.2	3.6	3.6

Flow 994 cfm

Flow 1689 m^3/hr

Instuments Used: **Cal Exp. Date:**

Solomat Zephyr S/N 12951472 Cal #521-28-09-001 5/1/99

Note: the above Solomat readings were averages of 30 to 42 separate readings.

VELOCITY TRAVERSE DATA FORM

Site	W059 12-inch Stack, Bldg. 305	Run No.	**VTJun16_1**		
Date	6/16/98	Stack Temp	72 deg F		1000.1 Sta.
Tester	Maughan	Stack RH%	34% 300 Area station		2.2
Stack Dia.	12 in.	Baro Press	1002 station, 2.2 mbar static		
Stack X-Area	113.1 in^2	Fan Setting	60 Hz		
Elevation		Fan input point	NEAR		
El. above disturbance	106.5 in	Center 2/3 from	1.10	to:	10.90
Units	fpm	Points in Center 2/3	3	to:	10

		vert.			horizontal		
Traverse-->		E-W			S-N		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.50	3259	3198	3230	3193	3157	3199
2	0.80	3406	3448	3475	3457	3386	3415
3	1.42	3596	3633	3597	3585	3567	3581
4	2.12	3686	3575	3677	3686	3624	3635
5	3.00	3800	3734	3721	3720	3701	3684
6	4.27	3795	3756	3770	3731	3784	3706
7	7.73	3648	3646	3660	3729	3713	3792
8	9.00	3617	3568	3558	3584	3581	3626
9	9.88	3492	3525	3515	3573	3528	3566
10	10.58	3386	3436	3427	3472	3394	3440
11	11.20	3297	3323	3306	3241	3250	3293
12	11.50	3217	3223	3182	3262	3216	3202
		west			north		Avg.
Average of all data		3516.6	3505.4	3509.8	3519.4	3491.8	3511.6	3509.1
w/o points by wall		3572.3	3564.4	3570.6	3577.8	3552.8	3415.0	3542.2
Centerpoint	6.00	3812	3730	3729	3713	3777	3770	

Center 2/3 with centerpoint							Avg
Mean	3648.0	3622.6	3628.2	3643.7	3629.9	3644.4	3636.1
Std. Dev.	145.6	107.2	112.6	92.7	127.4	109.1	111.8
COV %	4.0	3.0	3.1	2.5	3.5	3.0	3.1

Flow 2756 cfm

Flow 4683 m^3/hr

Instuments Used: **Cal Exp. Date:**

Solomat Zephyr S/N 12951472 Cal #521-28-09-001 5/1/99

Note: the above Solomat readings were averages of 30 to 42 separate readings.

The E>W points were determined on Jun 17th. [997.9 + 1.8 = 999.7 or 1000 mbar]

VELOCITY TRAVERSE DATA FORM

Site	W059 12-inch Stack, Bldg. 305	Run No.	**VTJun16_2**		
Date	6/16-19/1998	Stack Temp	72 deg F	1000.1	Sta.
Tester	Maughan	Stack RH%	34% 300 Area station	0.3	
Stack Dia.	12 in.	Baro Press	1000 station, 0.3 mbar static		
Stack X-Area	113.1 in^2	Fan Setting	25 Hz		
Elevation		Fan input point	FAR w/ close-coupled fan		
El. above disturbance	106.5 in	Center 2/3 from	1.10 to:	10.90	
Units	fpm	Points in Center 2/3	3 to:	10	

		vert.			horizontal		
Traverse-->		E-W			S-N		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.50	1356	1347	1358	1341	1319	1312
2	0.80	1432	1470	1463	1427	1389	1400
3	1.42	1535	1502	1520	1530	1489	1489
4	2.12	1535	1536	1562	1511	1548	1513
5	3.00	1580	1582	1497	1568	1533	1558
6	4.27	1571	1558	1509	1592	1557	1553
7	7.73	1510	1555	1542	1577	1565	1553
8	9.00	1503	1512	1482	1571	1516	1552
9	9.88	1492	1485	1458	1518	1506	1500
10	10.58	1426	1409	1454	1433	1404	1451
11	11.20	1393	1403	1400	1387	1388	1376
12	11.50	1282	1301	1270	1309	1321	1298
		west			north		Avg.
Average of all data		1467.9	1471.7	1459.6	1480.3	1461.3	1462.9	1467.3
w/o points by wall		1497.7	1501.2	1488.7	1511.4	1489.5	1400.0	1481.4
Centerpoint	6.00	1537	1529	1531	1578	1577	1570	
Center 2/3 with centerpoint								Avg
Mean		1521.0	1518.7	1506.1	1542.0	1521.7	1526.6	1522.7
Std. Dev.		46.0	51.0	37.0	50.1	52.7	40.2	45.6
COV %		3.0	3.4	2.5	3.3	3.5	2.6	3.0

Flow 1152 cfm

Flow 1958 m^3/hr

Instuments Used: **Cal Exp. Date:**

Solomat Zephyr S/N 12951472 Cal #521-28-09-001 5/1/99

Note: the above Solomat readings were averages of 30 to 42 separate readings.

VELOCITY TRAVERSE DATA FORM

Site	W059 12-inch Stack, Bldg. 305	Run No.	**VTJun18_1**		
Date	6/18/98	Stack Temp	72 deg F		996.7
Tester	Maughan	Stack RH%	25% 300 Area station		2.1
Stack Dia.	12 in.	Baro Press	999 station, 2.1 mbar static		
Stack X-Area	113.1 in^2	Fan Setting	60 Hz		
Elevation		Fan input point	FAR close-coupled fan		
El. above disturbance	106.5 in	Center 2/3 from	1.10	to:	10.90
Units	fpm	Points in Center 2/3	3	to:	10

		vert.			horizontal		
Traverse-->		E-W			S-N		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.50	3176	3138	3143	3291	3250	3311
2	0.80	3364	3315	3243	3484	3470	3471
3	1.42	3385	3383	3361	3587	3519	3485
4	2.12	3491	3419	3492	3622	3654	3599
5	3.00	3523	3474	3515	3643	3640	3641
6	4.27	3571	3563	3617	3681	3665	3627
7	7.73	3656	3570	3704	3656	3603	3597
8	9.00	3694	3679	3668	3526	3578	3473
9	9.88	3670	3650	3650	3469	3436	3466
10	10.58	3537	3588	3568	3358	3383	3400
11	11.20	3455	3436	3513	3251	3285	3254
12	11.50	3343	3304	3277	3125	3204	3223
		west			north		Avg.
Average of all data		3474.4	3473.9	3462.3	3488.8	3459.9	3479.3	3473.1
w/o points by wall		3527.7	3523.3	3501.3	3534.6	3507.7	3243.0	3472.9
Centerpoint	6.00	3623	3682	3647	3663	3657	3656	

Center 2/3 with centerpoint							Avg
Mean	3573.9	3573.3	3548.3	3576.7	3553.7	3581.2	3578.5
Std. Dev.	104.8	106.1	92.1	102.9	106.5	109.1	100.7
COV %	2.9	3.0	2.6	2.9	3.0	3.0	2.8

Flow 2728 cfm

Flow 4635 m^3/hr

Instuments Used: **Cal Exp. Date:**

Solomat Zephyr S/N 12951472 Cal #521-28-09-001 5/1/99

Note: the above Solomat readings were averages of 30 to 42 separate readings.

VELOCITY TRAVERSE DATA FORM

Site	W059 Actual Stack	Run No.	VTJun26_1
Date	6/26/98	Stack Temp	74 F
Tester	Carrick & Sparks	Stack RH%	32.2
Stack Dia.	31.25 in.	Baro Press	29.26 Hg
Stack X-Area	767.0 in^2	Fan Setting	17,800 scfm
Elevation	42 ft	Fan	Near EF101
El. above disturbance		Center 2/3 from	2.87 to: 28.38
Units	fpm	Points in Center 2/3	3 to: 10

Traverse-->		Southwest			Northwest		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	1	3146	3255	3308	3273	3273	3255
2	2 2/16	3562	3579	3646	3530	3562	3546
3	3 11/16	3784	3815	3769	3876	3830	3845
4	5 9/16	3784	3876	3800	4023	4008	3920
5	7 13/16	3769	3891	3830	3994	3950	3920
6	11 2/16	3738	3784	3707	3965	3860	3845
7	20 2/16	3706	3675	3659	3675	3659	3707
8	23 7/16	3627	3595	3579	3611	3595	3611
9	25 12/16	3595	3530	3579	3594	3530	3530
10	27 9/16	3446	3412	3513	3446	3530	3480
11	29 3/16	3325	3308	3378	3395	3377	3395
12	30 4/16	3109	3109	3219	3146	3146	3201
			Northeast			Southeast		Avg.
Average of all data		3549.2	3569.0	3582.2	3627.3	3609.9	3604.5	3590.4
w/o points by wall		3633.6	3646.4	3646.0	3710.9	3690.1	3679.8	3667.8
Centerpoint	15 10/16	3691	3691	3691	3800	3769	3784	
Center 2/3 with centerpoint								Avg
Mean		3682.2	3696.4	3680.8	3775.9	3747.9	3738.0	3720.19
Std. Dev.		110.935	162.487	108.549	204.331	178.341	165.244	155.445
COV %		3.0	4.4	2.9	5.4	4.8	4.4	4.2

Flow 19123 cfm

Flow 32495 m^3/hr

Instuments Used: **Cal Exp. Date:**

Neotronics Micromanometer 702-28-09-019	8/20/98
Hygrometer 799-32-03-001	6/12/98
Measurements performed by Vent & Balance staff	

VELOCITY TRAVERSE DATA FORM

Site	W059 Actual Stack	Run No.	VTJun30_1
Date	6/30/98	Stack Temp	94.5
Tester	Knutson	Stack RH%	20.80%
Stack Dia.	31.25 in.	Baro Press	
Stack X-Area	767.0 in^2	Fan Setting	8200 scfm
Elevation	42 ft	Fan	Near
El. above disturbance		Center 2/3 from	2.87 to: 28.38
Units	fpm	Points in Center 2/3	3 to: 10

Traverse-->		Southwest			Northwest		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	1	1230	1249	1220	1032	1072	1049
2	2 2/16	1668	1594	1594	1739	1704	1739
3	3 11/16	1704	1739	1668	1808	1808	1808
4	5 9/16	1739	1739	1739	1841	1841	1841
5	7 13/16	1739	1774	1704	1808	1808	1841
6	11 2/16	1739	1774	1739	1808	1774	1774
7	20 2/16	1808	1808	1808	1808	1774	1808
8	23 7/16	1873	1841	1841	1808	1808	1774
9	25 12/16	1841	1841	1841	1774	1739	1739
10	27 9/16	1873	1808	1774	1739	1739	1774
11	29 3/16	1774	1774	1774	1704	1704	1668
12	30 4/16	1632	1632	1668	1556	1556	1594

	Northeast			Southeast			Avg.
Average of all data	1718.3	1714.4	1697.5	1702.1	1693.9	1700.8	1704.5
w/o points by wall	1775.8	1769.2	1748.2	1783.7	1769.9	1776.6	1770.6

Centerpoint	15 10/16	1774	1774	1739	1808	1774	1739

Center 2/3 with centerpoint						Avg
Mean	1787.8	1788.7	1761.4	1800.2	1785.0	1788.7	1785.296
Std. Dev.	63.358	38.412	59.714	28.420	34.128	38.412	45.018
COV %	3.5	2.1	3.4	1.6	1.9	2.1	2.5

Flow 9079 cfm

Flow 15427 m^3/hr

Instuments Used: **Cal Exp. Date:**

Neotronics Micromanometer 702-28-09-004	8/20/98
Hygrometer 799-32-01-001	6/12/98
Measurements performed by Fluor Daniel Hanford Vent & Balance staff	

VELOCITY TRAVERSE DATA FORM

Site	W059 Actual Stack	Run No.	VTJul1_1
Date	7/1/98	Stack Temp	90 F
Tester	Knutson	Stack RH%	30.69%
Stack Dia.	31.25 in.	Baro Press	29.18 in Hg
Stack X-Area	767.0 in^2	Fan Setting	18000 scfm
Elevation	42 ft	Fan	Far
El. above disturbance		Center 2/3 from	2.87 to: 28.38
Units	fpm	Points in Center 2/3	3 to: 10

Traverse-->		Southwest			Northwest		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	1	3751	3159	3536	3637	3362	3553
2	2 2/16	3846	3536	3767	3719	3620	3620
3	3 11/16	3892	3702	3830	3830	3735	3735
4	5 9/16	3877	3877	3908	3861	3799	3830
5	7 13/16	3954	3861	3892	3877	3861	3892
6	11 2/16	3877	3939	3846	3861	3877	3830
7	20 2/16	3939	4014	3923	3939	3954	3939
8	23 7/16	3954	3954	3908	3939	3923	3892
9	25 12/16	3861	3877	3877	3861	3861	3861
10	27 9/16	3799	3783	3830	3799	3783	3719
11	29 3/16	3719	3620	3485	3702	3653	3604
12	30 4/16	3450	3216	3362	3433	3502	3344
			Northeast			Southeast	Avg.
Average of all data		3826.6	3711.5	3763.7	3788.2	3744.2	3734.9	3761.5
w/o points by wall		3871.8	3816.3	3826.6	3838.8	3806.6	3792.2	3825.4
Centerpoint	15 10/16	3939	3969	3923	3846	3814	3846	
Center 2/3 with centerpoint								Avg
Mean		3899.1	3886.2	3881.9	3868.1	3845.2	3838.2	3869.796
Std. Dev.		52.095	97.441	37.985	46.096	69.392	72.045	66.185
COV %		1.3	2.5	1.0	1.2	1.8	1.9	1.7

Flow 20035 cfm

Flow 34044 m^3/hr

Instuments Used: **Cal Exp. Date:**

Neotronics Micromanometer 702-28-09-014	8/20/98
Hygrometer 799-32-01-001	6/12/98
Measurements performed by Fluor Daniel Hanford Vent & Balance staff	

VELOCITY TRAVERSE DATA FORM

Site	W059 Actual Stack	Run No.	VTJul1_2
Date	7/1/98	Stack Temp	102 F
Tester	Knutson	Stack RH%	18.40%
Stack Dia.	31.25 in.	Baro Press	29.18 in Hg
Stack X-Area	767.0 in^2	Fan Setting	8200 scfm
Elevation	42 ft	Fan	Far
El. above disturbance		Center 2/3 from	2.87 to: 28.38
Units	fpm	Points in Center 2/3	3 to: 10

Traverse-->		Southwest			Northwest		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	1	1821	1568	1528	1214	1312	1288
2	2 2/16	1787	1681	1753	1568	1644	1644
3	3 11/16	1821	1787	1821	1753	1753	1753
4	5 9/16	1888	1821	1855	1787	1787	1855
5	7 13/16	1855	1855	1855	1753	1787	1821
6	11 2/16	1888	1888	1855	1821	1855	1855
7	20 2/16	1920	1888	1888	1920	1888	1920
8	23 7/16	1855	1855	1888	1888	1920	1920
9	25 12/16	1821	1821	1787	1888	1920	1888
10	27 9/16	1787	1753	1821	1855	1888	1920
11	29 3/16	1753	1753	1753	1821	1821	1855
12	30 4/16	1568	1606	1681	1681	1681	1681

	Northeast			Southeast			Avg.
Average of all data	1813.7	1773.0	1790.4	1745.8	1771.3	1783.3	1779.6
w/o points by wall	1837.5	1810.2	1827.6	1805.4	1826.3	1843.1	1825.0

Centerpoint	15 10/16	1888	1888	1888	1821	1855	1888

Center 2/3 with centerpoint							Avg
Mean	1858.1	1839.6	1850.9	1831.8	1850.3	1868.9	1849.926
Std. Dev.	42.339	48.037	35.445	60.512	61.323	55.539	50.411
COV %	2.3	2.6	1.9	3.3	3.3	3.0	2.7

Flow 9479 cfm

Flow 16106 m^3/hr

Instuments Used:	**Cal Exp. Date:**
Neotronics Micromanometer 702-28-09-014	8/20/98
Hygrometer 799-32-01-001	6/12/98
Measurements performed by Fluor Daniel Hanford Vent & Balance staff	

VELOCITY TRAVERSE DATA FORM

Site	W059 12-inch Stack, Bldg. 305	Run No.	**VTJul11_1**
Date	7/11/98	Stack Temp	72 deg F
Tester	Maughan	Stack RH%	30% 300 Area station
Stack Dia.	12 in.	Baro Press	999.9 station, 1.93 mbar static
Stack X-Area	113.1 in^2	Fan Setting	60 Hz with filter
Elevation		Fan input point	FAR close-coupled fan
El. above disturbance	106.5 in	Center 2/3 from	1.10 to: 10.90
Units	fpm	Points in Center 2/3	3 to: 10

Traverse-->		Southeast			Southwest		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.50	3413	3443	3360	3417	3319	3306
2	0.80	3488	3473	3426	3446	3373	3440
3	1.42	3511	3558	3547	3489	3491	3504
4	2.12	3552	3571	3597	3608	3596	3540
5	3.00	3521	3528	3613	3611	3544	3603
6	4.27	3571	3554	3549	3576	3604	3581
7	7.73	3403	3410	3423	3421	3486	3444
8	9.00	3478	3346	3415	3361	3308	3429
9	9.88	3367	3340	3293	3243	3323	3215
10	10.58	3243	3271	3223	3241	3222	3267
11	11.20	3147	3180	3222	3094	3185	3248
12	11.50	2910	3074	3088	2975	2980	3111

	Northwest			Northeast			Avg.
Average of all data	3373.5	3369.3	3390.7	3383.7	3395.7	3396.3	3384.8
w/o points by wall	3409.0	3413.2	3427.1	3428.1	3423.1	3426.0	3421.1

Centerpoint	6.00	3496	3515	3493	3559	3562	3560

Center 2/3 with centerpoint							Avg
Mean	3449.6	3454.3	3452.9	3467.2	3460.0	3468.9	3469.0
Std. Dev.	143.9	136.6	133.5	109.4	118.0	138.9	112.3
COV %	4.2	4.0	3.9	3.2	3.4	4.0	3.2

Flow 2658 cfm

Flow 4517 m^3/hr

Instuments Used: **Cal Exp. Date:**

Solomat Zephyr S/N 12951472 Cal #521-28-09-001 5/1/99

Note: the above Solomat readings were averages of 30 to 42 separate readings.

VELOCITY TRAVERSE DATA FORM

Site	W059 12-inch Stack, Bldg. 305	Run No.	**VTJul11_2**
Date	7/11/98	Stack Temp	72 deg F
Tester	Maughan	Stack RH%	30% 300 Area station
Stack Dia.	12 in.	Baro Press	999.7 station, 0.3 mbar static
Stack X-Area	113.1 in^2	Fan Setting	22 Hz with filter
Elevation		Fan input point	FAR, close-coupled fan
El. above disturbance	106.5 in	Center 2/3 from	1.10 to: 10.90
Units	fpm	Points in Center 2/3	3 to: 10

Traverse-->		Southeast			Southwest		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.50	1280	1286	1277	1244	1238	1285
2	0.80	1304	1316	1303	1269	1264	1278
3	1.42	1350	1302	1324	1296	1309	1315
4	2.12	1347	1334	1363	1323	1305	1336
5	3.00	1342	1344	1344	1336	1360	1360
6	4.27	1323	1346	1331	1341	1315	1347
7	7.73	1296	1261	1203	1250	1272	1274
8	9.00	1218	1209	1248	1264	1233	1253
9	9.88	1190	1197	1175	1201	1199	1197
10	10.58	1192	1178	1203	1199	1163	1197
11	11.20	1144	1166	1117	1169	1148	1189
12	11.50	1136	1090	1121	1121	1130	1089

	Northwest			Northeast			Avg.
Average of all data	1251.1	1244.7	1260.0	1260.2	1252.4	1250.8	1253.2
w/o points by wall	1264.8	1256.8	1274.6	1270.6	1265.3	1303.0	1272.5

Centerpoint	6.00	1291	1281	1305	1291	1318	1304

Center 2/3 with centerpoint						Avg
Mean	1277.9	1270.8	1287.1	1283.2	1276.6	1277.2	1280.3
Std. Dev.	53.6	62.1	61.2	66.2	67.0	70.7	62.1
COV %	4.2	4.9	4.8	5.2	5.2	5.5	4.9

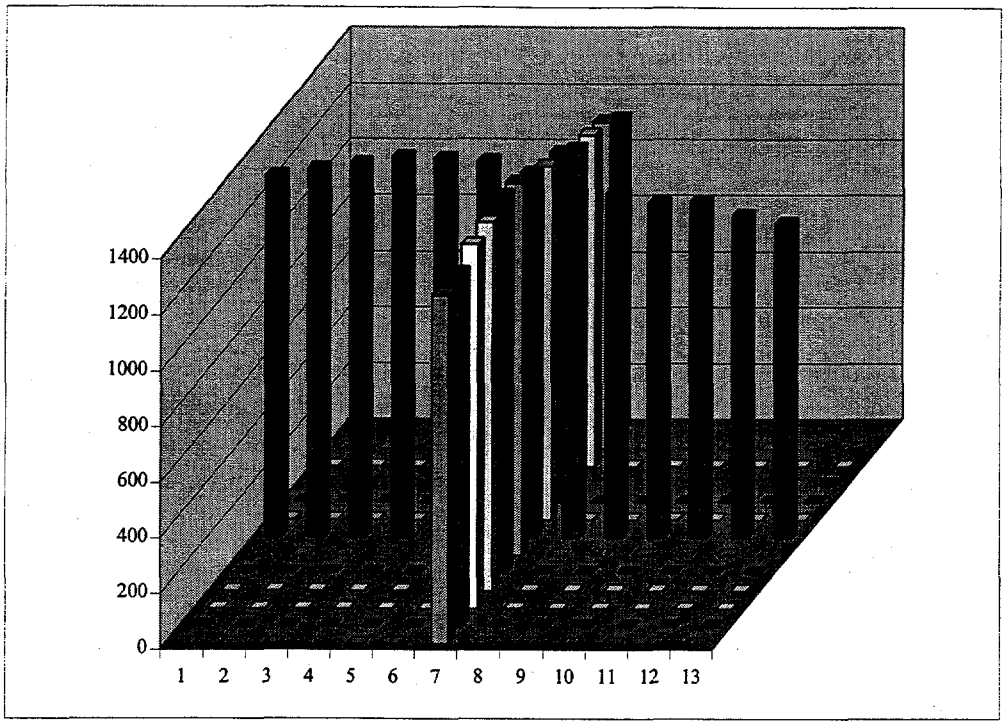
Flow 984 cfm

Flow 1672 m^3/hr

Instuments Used: **Cal Exp. Date:**

Solomat Zephyr S/N 12951472 Cal #521-28-09-001 5/1/99

Note: the above Solomat readings were averages of 30 to 42 separate readings.



Northwest

Southwest

VTJul11_2
22 Hz with filter
FAR, close-coupled fan

984 cfm
1253.2 fpm

4.9 COV

Normalized Centerpoints

VELOCITY TRAVERSE DATA FORM

Site	W059 12-inch Stack, Bldg. 305	Run No.	**VTJul11_3**
Date	7/11/98	Stack Temp	72 deg F
Tester	Maughan and Sparks	Stack RH%	30% 300 Area station
Stack Dia.	12 in.	Baro Press	999.7 station + 1.93 mbar static
Stack X-Area	113.1 in^2	Fan Setting	60 Hz with filter
Elevation		Fan input point	NEAR close-coupled fan
El. above disturbance	106.5 in	Center 2/3 from	1.10 to: 10.90
Units	fpm	Points in Center 2/3	3 to: 10

Traverse-->		Southeast			Southwest		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.50	3362	3450	3525	3373	3351	3420
2	0.80	3460	3490	3492	3515	3467	3490
3	1.42	3520	3508	3513	3594	3635	3561
4	2.12	3587	3566	3601	3681	3638	3652
5	3.00	3550	3639	3650	3696	3711	3687
6	4.27	3617	3569	3608	3706	3699	3839
7	7.73	3616	3633	3618	3448	3386	3429
8	9.00	3528	3545	3557	3394	3350	3342
9	9.88	3502	3463	3401	3258	3280	3279
10	10.58	3255	3410	3324	3298	3241	3198
11	11.20	3089	3181	3076	3253	3205	3164
12	11.50	3165	3119	3088	3154	3176	3144

	Northwest			Northeast			Avg.
Average of all data	3447.5	3428.3	3433.8	3437.6	3464.4	3454.4	3444.3
w/o points by wall	3484.3	3461.2	3464.1	3472.4	3500.4	3492.0	3479.1

Centerpoint	6.00	3625	3646	3675	3604	3424	3566

Center 2/3 with centerpoint						Avg
Mean	3522.2	3509.6	3518.0	3531.0	3528.6	3537.6	3544.0
Std. Dev.	175.7	191.3	216.4	112.1	83.8	108.5	99.8
COV %	5.0	5.5	6.1	3.2	2.4	3.1	2.8

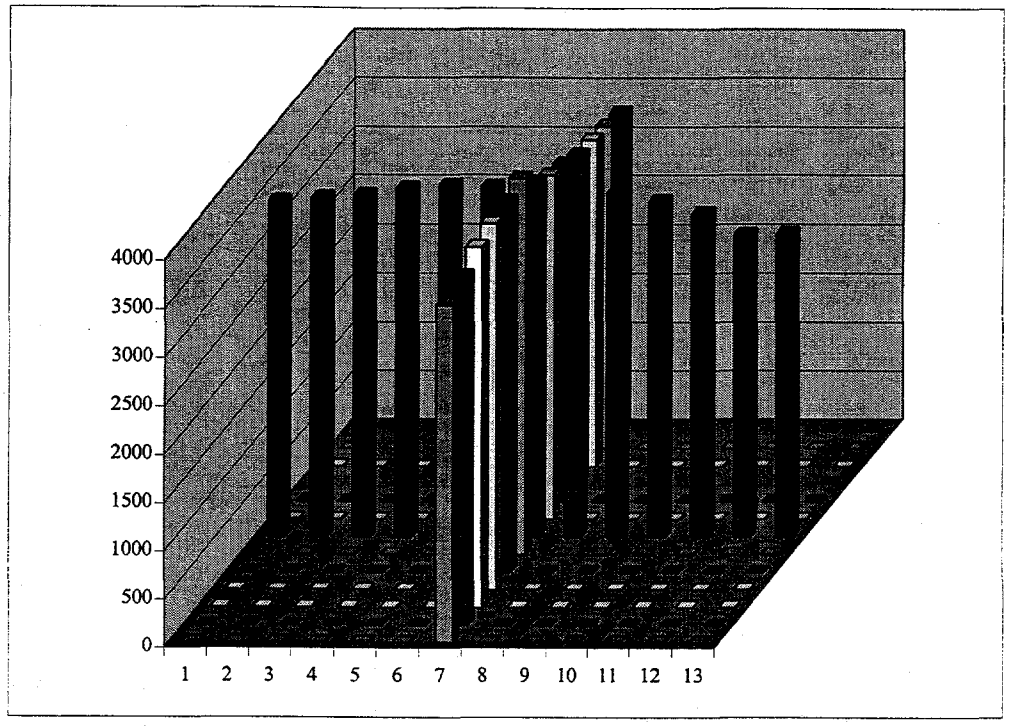
Flow 2705 cfm

Flow 4597 m^3/hr

Instuments Used: **Cal Exp. Date:**

Solomat Zephyr S/N 12951472 Cal #521-28-09-001 5/1/99

Note: the above Solomat readings were averages of 35 to 42 separate readings.


4000
3500
3000
2500
2000
1500
1000
500
0
1 2 3 4 5 6 7 8 9 10 11 12 13
Northwest
Southwest

VELOCITY TRAVERSE DATA FORM

Site	W059 12-inch Stack, Bldg. 305	Run No.	**VTJul11_4**
Date	7/11/98	Stack Temp	72 deg F
Tester	Maughan and Sparks	Stack RH%	30% 300 Area station
Stack Dia.	12 in.	Baro Press	999.7 station + 0.3 mbar static
Stack X-Area	113.1 in^2	Fan Setting	22 Hz with filter
Elevation		Fan input point	NEAR close-coupled fan
El. above disturbance	106.5 in	Center 2/3 from	1.10 to: 10.90
Units	fpm	Points in Center 2/3	3 to: 10

Traverse-->		Southeast			Southwest		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.50	1242	1301	1235	1238	1264	1243
2	0.80	1258	1318	1285	1309	1358	1286
3	1.42	1310	1295	1299	1309	1342	1344
4	2.12	1292	1350	1301	1383	1371	1354
5	3.00	1342	1328	1321	1398	1408	1376
6	4.27	1354	1308	1339	1375	1350	1366
7	7.73	1327	1365	1336	1274	1277	1245
8	9.00	1311	1339	1310	1235	1250	1222
9	9.88	1312	1312	1251	1184	1155	1184
10	10.58	1281	1313	1233	1220	1194	1200
11	11.20	1178	1171	1202	1175	1132	1152
12	11.50	1151	1161	1155	1081	1150	1132
		Northwest			Northeast		Avg.
Average of all data		1265.1	1270.9	1258.7	1279.8	1296.8	1272.3	1273.9
w/o points by wall		1286.2	1283.7	1272.9	1296.5	1309.9	1285.0	1289.0
Centerpoint	6.00	1322	1315	1330	1319	1323	1318	

Center 2/3 with centerpoint						Avg
Mean	1300.0	1295.8	1291.2	1316.4	1325.9	1300.9	1315.2
Std. Dev.	77.0	83.9	77.3	22.7	22.2	36.3	27.4
COV %	5.9	6.5	6.0	1.7	1.7	2.8	2.1

Flow 1001 cfm

Flow 1700 m^3/hr

Instuments Used: **Cal Exp. Date:**

Solomat Zephyr S/N 12951472 Cal #521-28-09-001 5/1/99

Note: the above Solomat readings were averages of 35 to 42 separate readings.

VELOCITY TRAVERSE DATA FORM

Dup. of VTJul11_3

Site	W059 12-inch Stack, Bldg. 305	Run No.	**VTJul21_1D**
Date	7/21/98	Stack Temp	70 deg F
Tester	Maughan	Stack RH%	37% 300 Area station
Stack Dia.	12 in.	Baro Press	1000.4 + 2.05 static = 1002 corrected
Stack X-Area	113.1 in^2	Fan Setting	60 Hz with filter
Elevation		Fan input point	NEAR, close-coupled fan
El. above disturbance	106.5 in	Center 2/3 from	1.10 to: 10.90
Units	fpm	Points in Center 2/3	3 to: 10

Traverse-->		Southeast			Southwest		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.50	2931	2986	2958	3488	3405	3455
2	0.80	2947	3089	3095	3629	3524	3560
3	1.42	3136	3065	3044	3616	3690	3629
4	2.12	3351	3285	3224	3777	3777	3786
5	3.00	3442	3373	3315	3788	3800	3742
6	4.27	3427	3460	3496	3769	3782	3751
7	7.73	3629	3564	3621	3461	3471	3495
8	9.00	3660	3580	3609	3342	3369	3327
9	9.88	3520	3576	3554	3316	3414	3340
10	10.58	3535	3578	3568	3301	3414	3307
11	11.20	3580	3515	3479	3280	3269	3300
12	11.50	3483	3411	3476	3200	3221	3208
		Northwest			Northeast		Avg.
Average of all data		3497.3	3511.3	3491.7	3386.8	3373.5	3369.9	3438.4
w/o points by wall		3527.9	3551.0	3523.7	3422.7	3408.5	3095.0	3421.5
Centerpoint	6.00	3577	3529	3541	3640	3635	3575	

Center 2/3 with centerpoint							Avg
Mean	3549.7	3582.9	3546.4	3482.2	3457.3	3445.1	3470.3
Std. Dev.	202.8	178.2	192.1	167.3	186.2	203.4	172.3
COV %	5.7	5.0	5.4	4.8	5.4	5.9	5.0

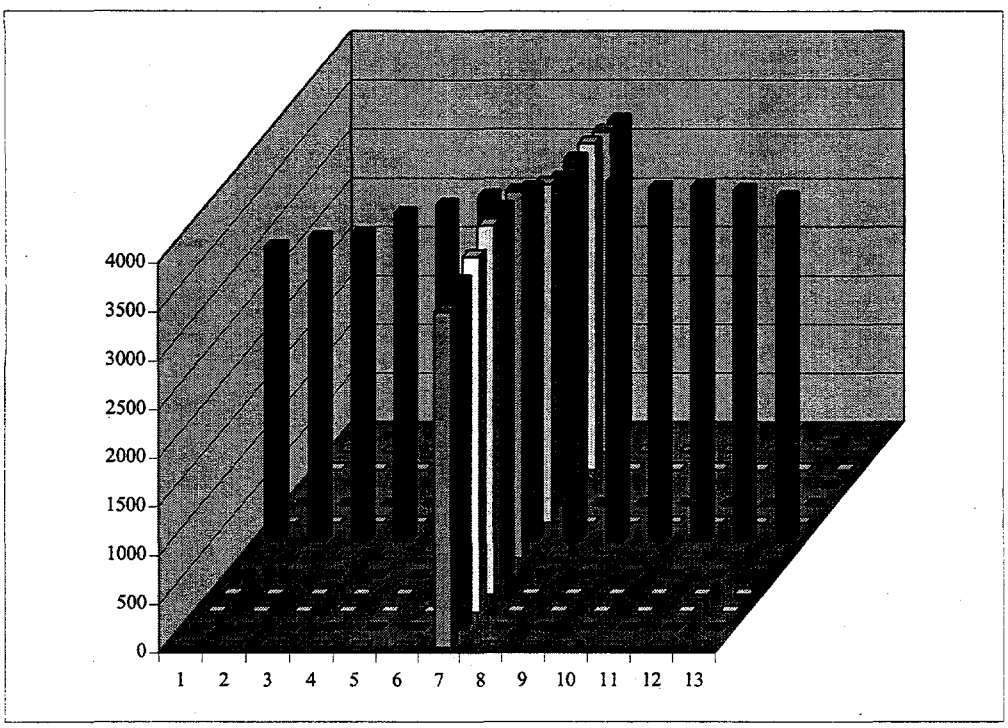
Flow 2701 cfm

Flow 4589 m^3/hr

Instuments Used: **Cal Exp. Date:**

Solomat Zephyr S/N 12951472 Cal #521-28-09-001 5/1/99

Note: the above Solomat readings were averages of 30 to 42 separate readings.



Northwest

Southwest

VTJul21_1D
60 Hz with filter
NEAR, close-coupled fan
5.0 COV
2701 cfm
3438.4 fpm

(Dup. of VTJul11_3 where:
COV = 2.8,
cfm = 2705)

Figure with normalized centerpoints and equally-spaced bars, which is inconsistent with the actual measurements.

VELOCITY TRAVERSE DATA FORM

Dup. of VTJul11_2

Site	W059 12-inch Stack, Bldg. 305	Run No.	**VTJul21_2**
Date	7/21/98	Stack Temp	72 deg F
Tester	Maughan	Stack RH%	<37% 300 Area station
Stack Dia.	12 in.	Baro Press	1001 station.
Stack X-Area	113.1 in^2	Fan Setting	22 Hz with filter
Elevation		Fan input point	FAR, close-coupled fan
El. above disturbance	106.5 in	Center 2/3 from	1.10 to: 10.90
Units	fpm	Points in Center 2/3	3 to: 10

Traverse-->		Southeast			Southwest		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.50	1095	1097	1159	1243	1213	1185
2	0.80	1119	1163	1172	1276	1257	1251
3	1.42	1190	1194	1188	1336	1310	1257
4	2.12	1281	1288	1224	1352	1344	1369
5	3.00	1286	1308	1296	1342	1323	1333
6	4.27	1295	1299	1334	1350	1350	1351
7	7.73	1318	1283	1323	1304	1256	1285
8	9.00	1303	1293	1274	1173	1228	1199
9	9.88	1337	1260	1261	1205	1224	1235
10	10.58	1261	1253	1244	1215	1186	1193
11	11.20	1228	1249	1244	1221	1172	1157
12	11.50	1178	1218	1219	1138	1104	1152
		Northwest			Northeast		Avg.
Average of all data		1262.9	1247.3	1247.3	1240.9	1242.1	1244.8	1247.5
w/o points by wall		1277.4	1265.0	1263.0	1261.8	1259.0	1172.0	1249.7
Centerpoint	6.00	1306	1305	1278	1284	1308	1299	

Center 2/3 with centerpoint							Avg
Mean	1287.0	1280.7	1277.8	1283.9	1276.2	1271.4	1279.1
Std. Dev.	70.0	58.8	63.7	41.6	36.3	47.5	39.2
COV %	5.4	4.6	5.0	3.2	2.8	3.7	3.1

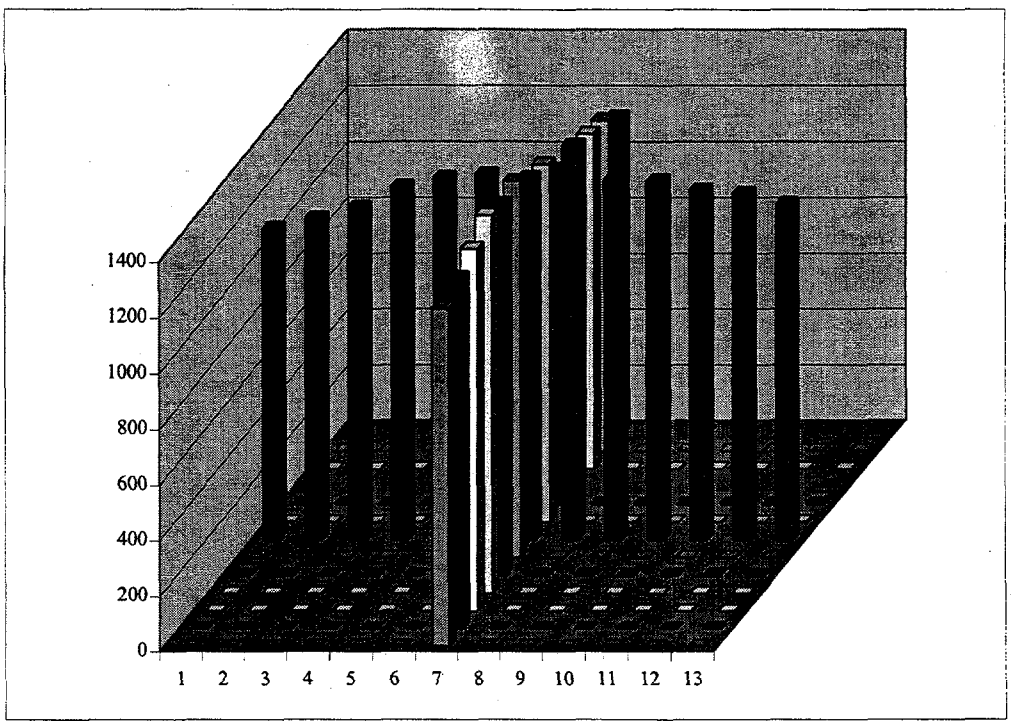
Flow 980 cfm

Flow 1665 m^3/hr

Instuments Used: **Cal Exp. Date:**

Solomat Zephyr S/N 12951472 Cal #521-28-09-001 5/1/99

Note: the above Solomat readings were averages of 30 to 42 separate readings.



Northwest

Southwest

Figure with normalized centerpoints and equally-spaced bars, which is inconsistent with the actual measurements.

VTJul21_2
22 Hz with filter
FAR, close-coupled fan
3.1 COV
980 cfm
1247.5 fpm

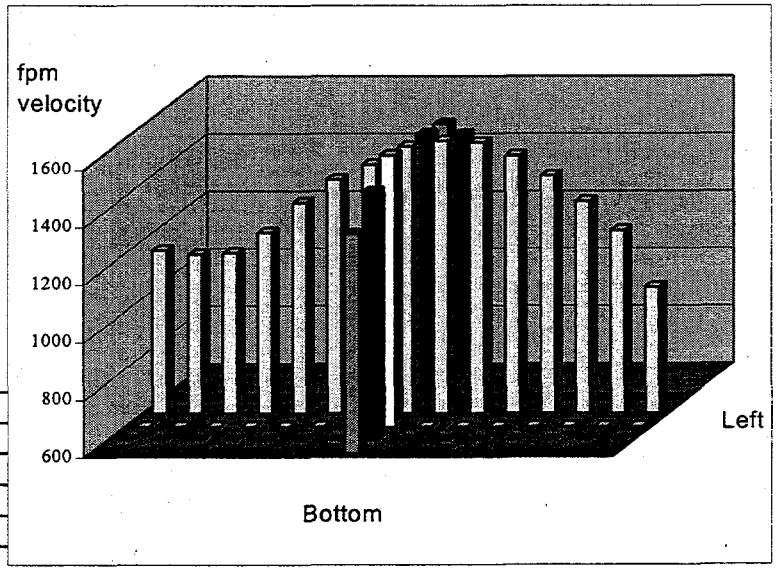
(Dup. of VTJul11_2 where:
COV = 4.9,
cfm = 984)

VELOCITY TRAVERSE DATA FORM

Site	W059 12-inch Stack, Bldg. 305	Run No.	**FanVTJul21_3**
Date	7/21/98	Stack Temp	72 deg F
Tester	Maughan	Stack RH%	<37% 300 Area station
		Baro Press	1001 station.
Flue XS Area	115.3 in^2	Fan Setting	22 Hz with filter
		Fan input point	FAR, close-coupled fan
El. Dist. to disturbance	23 in		
Units	fpm		

Traverse-->		Top (w)			Right (s)			
Trial ---->		1	2	3	1	2	3	
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity	
1	1"	1338	1321	1371	1146	1187	1159	
2	2"	1439	1414	1415	1171	1139	1141	
3	3"	1426	1432	1438	1144	1164	1157	
4	4"	1436	1437	1433	1197	1239	1247	
5	5"	1441	1464	1449	1321	1320	1352	
6	6"	1392	1369	1364	1395	1416	1427	
7	7"	1284	1303	1253	1441	1506	1448	
8	8"				1516	1513	1553	
9	9"				1581	1531	1530	
10	10"				1553	1549	1521	
11	11"				1497	1498	1495	
12	12"				1427	1441	1409	
13	13"				1340	1335	1338	
14	14"				1219	1194	1292	
15	15"				1029	1002	1082	
		Bottom (e)			Left (n)			Avg.
Average of all data		1393.7	1391.4	1389.0	1331.8	1335.6	1343.4	1364.2

Fan outlet A 115.3 in^2
Flow Fan out 1092 cfm
1856 m^3/hr



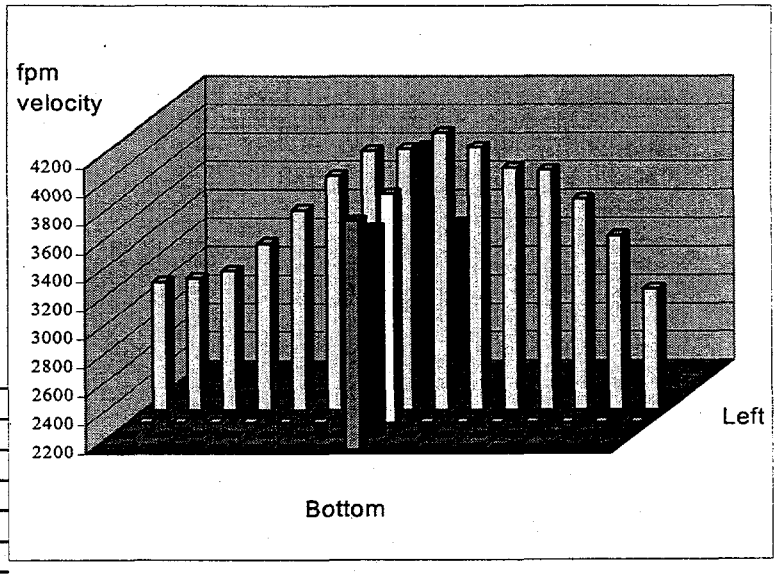
Instuments Used:
Solomat Zephyr S/N 12951472
Cal #521-28-09-001,
Cal. Expires 5/1/99.
Note: the above Solomat readings were averages of 30 to 42 separate readings.
Directions viewed toward stack.

VELOCITY TRAVERSE DATA FORM

Site	W059 12-inch Stack, Bldg. 305	Run No.	**FanVTJul22_1**
Date	7/22/98	Stack Temp	72 deg F
Tester	Maughan	Stack RH%	<20% 300 Area station
		Baro Press	997 + 4 = 1001 station.
Flue XS Area	115.3 in^2	Fan Setting	60 Hz with filter
		Fan input point	FAR, close-coupled fan
El. Dist. to disturbance	23 in		
Units	fpm		

Traverse-->		Top (w)			Right (s)			
Trial ---->		1	2	3	1	2	3	
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity	
1	1"	3126	3083	3174	3119	3101	3060	
2	2"	3635	3650	3726	3124	3121	3113	
3	3"	3824	3794	3878	3178	3168	3166	
4	4"	3930	3897	3896	3382	3374	3343	
5	5"	3596	3730	3740	3585	3632	3591	
6	6"	3602	3395	3627	3811	3879	3843	
7	7"	3792	3531	3743	4022	4031	4004	
8	8"				3988	4103	4013	
9	9"				4180	4096	4160	
10	10"				4056	4020	4054	
11	11"				3903	3890	3912	
12	12"				3872	3891	3893	
13	13"				3679	3657	3696	
14	14"				3462	3368	3432	
15	15"				3094	3105	2938	
		Bottom (e)			Left (n)			Avg.
Average of all data		3643.6	3582.9	3683.4	3630.3	3629.1	3614.5	3630.6

Fan outlet A 115.3 in^2
Flow Fan out 2907 cfm
4940 m^3/hr



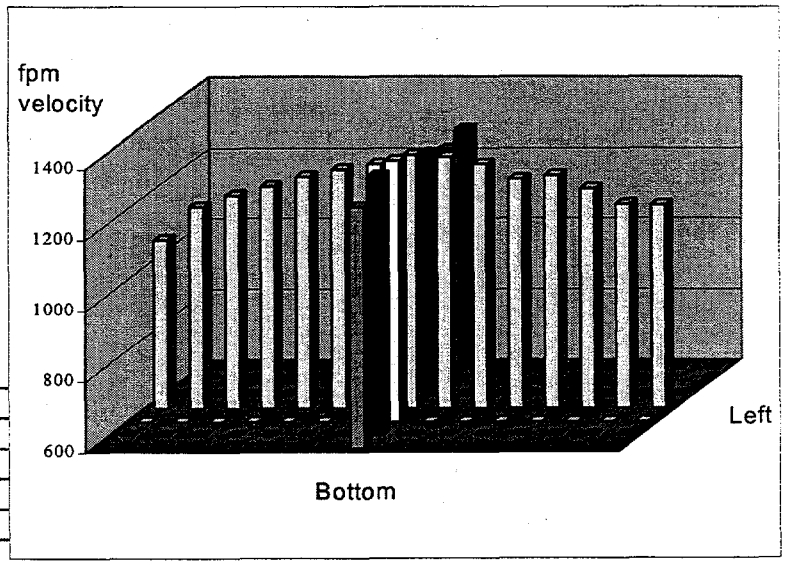
Instuments Used:
Solomat Zephyr S/N 12951472
Cal #521-28-09-001,
Cal. Expires 5/1/99.
Note: the above Solomat readings were averages of 30 to 42 separate readings.
Directions viewed toward stack.

VELOCITY TRAVERSE DATA FORM

Site	W059 12-inch Stack, Bldg. 305	Run No.	**FanVTJul23_1**
Date	7/23/98	Stack Temp	72 deg F
Tester	Maughan	Stack RH%	<40% 300 Area station
		Baro Press	995.6 + 0.337 = 996 station.
Flue XS Area	115.3 in^2	Fan Setting	22 Hz with filter
		Fan input point	NEAR, close-coupled fan
El. Dist. to disturbance	43 in		
Units	fpm		

Traverse-->		Top (w)			Right (s)		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	1"	1279	1283	1268	993	1009	1041
2	2"	1254	1259	1263	1119	1088	1101
3	3"	1305	1284	1264	1138	1141	1121
4	4"	1316	1313	1322	1137	1178	1158
5	5"	1330	1360	1327	1195	1183	1171
6	6"	1338	1345	1314	1210	1193	1202
7	7"	1334	1284	1227	1211	1209	1228
8	8"				1240	1239	1241
9	9"				1241	1229	1234
10	10"				1227	1223	1197
11	11"				1197	1146	1188
12	12"				1200	1157	1201
13	13"				1148	1154	1152
14	14"				1124	1100	1104
15	15"				1081	1142	1098
		Bottom (e)			Left (n)		Avg.
Average of all data		1308.0	1304.0	1283.6	1164.1	1159.4	1162.5	1230.3

Fan outlet A	115.3	in^2
Flow Fan out	985	cfm
	1674	m^3/hr



Instuments Used:

Solomat Zephyr S/N 12951472
Cal #521-28-09-001,
Cal. Expires 5/1/99.
Note: the above Solomat readings were averages of 30 to 42 separate readings.
Directions viewed toward stack.

VELOCITY TRAVERSE DATA FORM

Site W059 12-inch Stack, Bldg. 305
Date 7/23/98
Tester Maughan

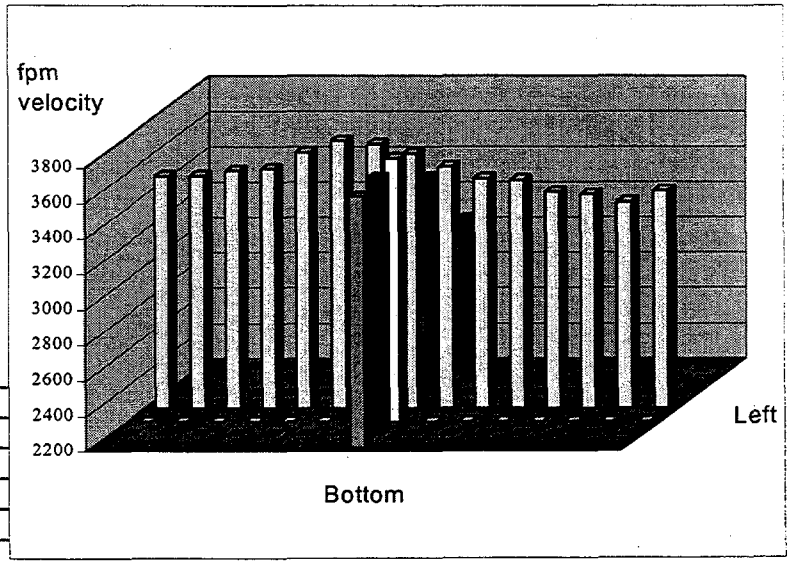
Flue XS Area 115.3 in^2

El. Dist. to disturbance 43 in
Units fpm

Run No. **FanVTJul23_2**
Stack Temp 72 deg F
Stack RH% <40% 300 Area station
Baro Press 995.6 + 3.29 = 999 station.
Fan Setting 60 Hz with filter
Fan input point NEAR, close-coupled fan

Traverse-->		Top (w)			Right (s)		
Trial ---->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	1"	3015	3123	2998	3389	3560	3536
2	2"	3252	3115	3273	3473	3492	3525
3	3"	3445	3428	3408	3465	3597	3519
4	4"	3646	3582	3678	3512	3556	3547
5	5"	3668	3661	3723	3659	3608	3620
6	6"	3669	3607	3667	3754	3719	3612
7	7"	3678	3599	3574	3672	3662	3695
8	8"				3584	3616	3664
9	9"				3578	3557	3513
10	10"				3507	3516	3426
11	11"				3449	3447	3528
12	12"				3409	3432	3375
13	13"				3410	3384	3384
14	14"				3367	3348	3336
15	15"				3339	3388	3514
		Bottom (e)			Left (n)		Avg.
Average of all data		3481.9	3445.0	3474.4	3504.5	3525.5	3519.6	3491.8

Fan outlet A 115.3 in^2
Flow Fan out 2796 cfm
4751 m^3/hr



Instuments Used:
Solomat Zephyr S/N 12951472
Cal #521-28-09-001,
Cal. Expires 5/1/99.
Note: the above Solomat readings were averages of 30 to 42 separate readings.
Directions viewed toward stack.

Appendix C

Test to Determine Uniformity of Tracer Gases

Appendix C: Test to Determine Uniformity of Tracer Gases

Procedure to Determine Concentration of Tracer Gases

May 20, 1998

A uniform contaminant concentration at the sampling plane enables the extraction of samples that represent the true concentration. This will be tested first using a tracer gas. The acceptance criteria are that 1) the coefficient of variance (COV) of the tracer gas concentration is within ±20% across the center two-thirds of the sampling plane, and 2) at no point in the sampling plane does the concentration vary from the mean by more than 30%.

Potential Test Conditions

This test can be repeated using various tracer injection points to determine if the COV is sensitive to "streaming" at the point where contaminants can be released downstream of the final ventilation filters. The test should include the range of stack flowrates that is observed at the facility. For any given injection plane, five injection points should be used, including the centerline and a point within 20% of a diameter from the wall at four orthogonally spaced points. Initial tests can be performed at the average stack flowrate with tracer injection at the centerline of the duct.

If the purpose of a given run is to investigate the sensitivity of the COV determination to the tracer-injection location, the test may be invalid if the ending ambient concentration is elevated above that at the start of the test. This would indicate poor dispersion away from the test site and recirculating of the tracer to the inlet of the fan. This may result in a false indication of good mixing.

Equipment

Sulfur hexafluoride calibration gas (Matheson 100 ppmv in air)
Sulfur hexafluoride bulk gas (Matheson Instrument purity)
Gas analyzer calibrated for sulfur hexafluoride (Bruel and Kjaer Model 1302)
Gas regulator and flowmeter for metering sulfur hexafluoride
Sampling probe for intake to gas analyzer
Gas injection probe

Check Gas Analyzer

The absolute calibration of the Model 1302 Gas Analyzer is not as important as its general response because the concentration data are used in a relative manner in calculating the COV and plotting the con-

centrations at the measurement points. The instrument's response should be checked each day of testing against a calibration standard.

The calibration check equipment consists of the calibration standard sulfur hexafluoride gas, the gas regulator, the valve, and a tee with one leg feeding the flowmeter and the other leg attached to the inlet of the Model 1302. To begin, set the Model 1302's clock (part 4.4.2 in manual). Although the Model 1302 has a gas-concentration display, it is convenient to record the data on a printer or computer. See the Manual Part 12 (especially Part 12.2.5) for connecting to a printer in data log mode.

Check the zero and calibration of the gas analyzer with the sulfur hexafluoride calibration gas using either the calibration procedure in the analyzer's manual (Part 2.2.4 and 2.5) or using the Model 1302 in continuous measurement mode. To set up for continuous measurements, follow the manual procedures starting in Part 4.2. The measurements should be done using the SF_6 filter (Filter B) with (except in dry climates) water vapor correction. Set up the units of measurement as in Part 4.2.3. Enter the barometric pressure, standard temperature (that used by the calibration gas vendor), and the sampling tube length into the environmental setup (Part 4.2.4). Set up a continuous monitoring task (4.2.5), and initiate monitoring (4.2.6). Monitor room conditions, and record the data for several measurements. The SF_6 concentration in the room should be several orders of magnitude below the calibration-gas content. The humidity should be close to ambient. Set the calibration gas flow just enough to excess a slight amount of the gas into the outdoor atmosphere (keep the float in the rotameter up while the analyzer is pulling its sample). The SF_6 reading should be within 10% of the calibration-gas concentration, and the water content should be much lower than ambient.

Setup for Stack Measurements

Use the same layout of measurement points as used for the velocity uniformity test (40 CFR 60, Appendix A, Method 1), including a center point.

The injection equipment consists of a cylinder of pure sulfur hexafluoride gas, a gas regulator, flow-meter, valve, flexible tubing, and an injection probe (short length of ¼ in. stainless steel tubing with a 90° bend at the discharge end) attached to an injection port on the stack mockup. The connections must be made using fittings that will ensure that the connections cannot be inadvertently broken. It would be prudent to leak check the delivery system.

The sampling equipment consists of a stainless steel probe with enough length to reach across the inside diameter of the stack, allowing for fittings. The intake end should have a 90° bend so that the open end of the tube faces into the flow in the stack. The outlet end of the probe should terminate in a tee. One leg of the tee connects by flexible tubing to a rotameter, valve, and vacuum pump. The rotameter and vacuum pump should be sized for about a 2- to 3-lpm flow of air. The other leg of the tee connects via flexible tubing to a coarse in-line filter (47-mm-diameter glass fiber filter) and then to the Model 1302 gas analyzer inlet. To minimize tubing length, locate the gas analyzer and printer near the test port on the stack.

Mark the sampling probe so the inlet can be placed at each successive measurement point. Prepare a data sheet on which to enter gas concentration readings and other information relevant to the test.

Estimate the SF_6 injection rate so the average diluted concentration will be within the range of 10 to 100% of the concentration of the calibration gas according to the following equation:

$$injection\ flowrate = stack\ flowrate \times \frac{target\ ppmv}{10^6} \quad \text{(C-1)}$$

The rotameter reading should be adjusted for the density of the SF_6. The air equivalent reading is

$$rotameter\ reading = k \times actual\ flowrate \quad \text{(C-2)}$$

where k is 2.25 for SF_6. For example, for a stack flowrate of 955 cfm (27,046 lpm) and a target concentration of 35 ppmv, the injection flowrate should be about 0.95 lpm. For an injection flowrate of about 1 lpm SF_6, the rotameter reading will be about 2.25 lpm air.

Measurements

On the data record sheet, record the test conditions, including the injection point, stack flow control setting, starting pressure in the tracer gas tank, date, time, ambient temperature, pressure, and humidity. Also record the equipment used and names of the test operators. With the flow controller set as needed for the test conditions, verify the centerline air velocity at the sampling plane.

Start the sampling train and the analyzer to warm it up and achieve equilibrium. The probe can be in any position in the stack. Using the analyzer, record the background level of the tracer gas after the readings stabilize. Do not proceed with the test if the background exceeds 5% of the anticipated average concentration in the stack. Readings also can be made with and without water-vapor correction. If the air is dry enough where the water vapor contribution is negligible, the balance of the readings can be done without the correction, thus reducing the time to make each run.

Position the injection probe as directed in the test conditions. Start the injection of the tracer gas at the desired flowrate. Observe the concentration readings in the stack. When they stabilize, adjust the injection rate if the readings are not within 50% of the target concentration.

Position the probe at each measurement point, in succession, so that the face opening of the probe is aligned with the axis of the stack. Record the reading of the tracer gas concentration at each measurement point. Perform two or three repetitions of the measurements in each traverse direction, two if it is highly repeatable, three if not so repeatable. Fill out a data sheet for each test. Label the columns

of traverse data by the direction of the traverse. For example, if the first reading is closest to the east port, and the last reading is closest to the west port, then label the traverse east-west.

At the end of the test, record a measurement of the ambient concentration of the tracer. Record the climatic conditions if they have changed. Also record the rotameter settings, the elapsed time since the start of injection, and the final pressure in the tracer gas tank. Deviations from the procedure should be noted on the data sheet.

For each test condition, calculate the coefficient of variance for each tracer concentration traverse using the average concentration data from all points in the inner two-thirds of the cross section area (including the centerpoint). The acceptance criterion for the COV is ≤20% for the inner two-thirds of the stack diameter. The COV is 100 times the mean divided by the standard deviation. Another acceptance criterion is that no point differ from the mean by more than 30%. This is determined by inspection of the average concentration at each measurement point.

Exceptions to this method should be noted on the data sheets.

CAUTION

The American Conference of Governmental Industrial Hygienists (ACGIH) time-weighted average limit for human exposure to sulfur hexafluoride gas is 1000 ppm. It is colorless and odorless.

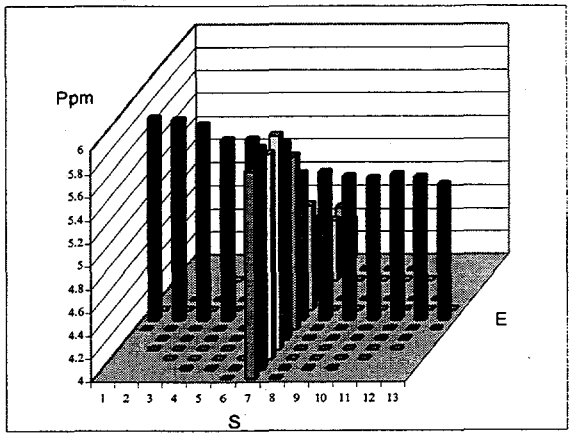
TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJun30_1**
Date	6/30/98	Injection point	**Center in E-W line**
Tester	Maughan	Fan Setting	**60 Hz**
Stack Dia.	12 in.	Stack Temp	71 deg F
Stack X-Area	113.1 in.	Fan	Near
Elevation		Center 2/3 from	1.10 to: 10.90
El. above disturbance	106.5	Points in Center 2/3	3 to: 10
Concentration units	ppm SF_6		

Traverse-->		East			South		
Trial --->		East 1	2	3	South 1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	5.56	5.56	5.48	5.80	5.73	5.88
2	0.80	5.69	5.41	5.46	5.81	5.98	5.95
3	1.42	5.40	5.47	5.56	5.83	5.71	5.80
4	2.12	5.34	5.35	5.35	5.94	5.82	5.80
5	3.00	5.36	5.44	5.26	5.78	5.61	5.70
6	4.27	5.13	5.37	5.08	5.59	5.46	5.46
Centerpoint	6.00	5.12	5.01	5.08	5.26	5.26	5.28
7	7.73	5.12	5.02	5.11	4.97	4.85	4.92
8	9.00	5.09	5.00	5.05	4.64	4.70	4.77
9	9.88	5.10	5.07	4.93	4.62	4.47	4.68
10	10.58	5.13	5.09	4.97	4.71	4.40	4.46
11	11.20	5.02	4.99	5.12	4.50	4.55	4.60
12	11.50	5.06	5.00	4.88	4.37	4.27	4.44
		West			North		All
Average of all data		5.24	5.21	5.18	5.22	5.14	5.21	5.20
Min								4.27
Max								5.98
Center 2/3								All
Mean		5.20	5.20	5.15	5.26	5.14	5.21	5.19
Std. Dev.		0.127	0.200	0.201	0.542	0.548	0.515	0.382
COV %		2.5	3.8	3.9	10.3	10.6	9.9	7.3

	Start	Finish	
Tracer tank pressure	310	310	psig
Ambient temp	71	71	F
Injection flowmeter	26	26	lpm [glass ball in meter]
Sampling flowmeter (Sierr	10	10	lpm
Ambient pressure	751	751	mbar
Ambient humidity	38%	38%	RH

Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99
B & K Model 1302 #1765299
Sierra Inc. Constant Flow Air Sampler

TRACER GAS TRAVERSE DATA FORM

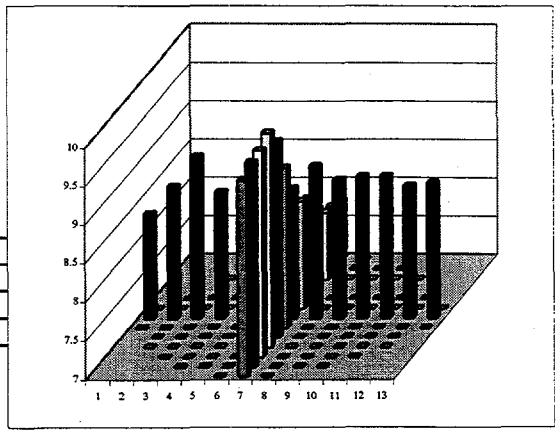
Site	W059 Model in 305 Building		Run No.	**GTJul1_1**	
Date	7/1/98		Injection point	**E/W Center**	
Tester	Maughan		Fan Setting	**22 Hz**	
Stack Dia.	12	in.	Stack Temp	73	
Stack X-Area	113.1	in.	Fan	Near	
Elevation			Center 2/3 from	1.10	to: 10.90
El. above disturbance	106.5		Points in Center 2/3	3	to: 10
Concentration units	ppm SF_6				

Traverse-->		West			South		
Trial ---->			2	3		2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	8.59	8.19	8.27	9.00	9.59	9.50
2	0.80	8.64	8.55	8.94	9.28	9.64	9.48
3	1.42	8.87	9.08	9.31	9.55	9.98	8.97
4	2.12	8.46	8.39	9.05	9.59	9.89	9.34
5	3.00	8.70	8.70	8.80	9.30	9.62	9.21
6	4.27	8.66	8.75	8.72	9.03	9.12	8.59
Centerpoint	6.00	8.92	8.85	8.29	8.66	8.50	8.43
7	7.73	9.26	8.73	8.91	8.46	8.39	7.87
8	9.00	8.75	8.64	8.99	8.98	8.00	7.48
9	9.88	8.56	8.93	9.03	8.31	7.62	7.78
10	10.58	8.93	8.76	8.84	7.96	7.64	7.58
11	11.20	8.74	8.65	8.76	8.00	7.35	7.70
12	11.50	8.83	8.54	8.91	7.97	7.32	7.60

	East			North			All
Average of all data	8.76	8.67	8.83	8.78	8.67	8.43	8.69
Min							7.32
Max							9.98

Center 2/3							All
Mean	8.79	8.76	8.88	8.87	8.75	8.36	8.74
Std. Dev.	0.238	0.192	0.281	0.565	0.933	0.713	0.560
COV %	2.7	2.2	3.2	6.4	10.7	8.5	6.4

	Start	Finish		
Tracer tank pressure	310	310	psig	Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98
Ambient temp	73	73	F	
Injection flowmeter	12	12	lpm [glass ball in meter]	
Sampling flowmeter	5	5	lpm	
Ambient pressure	748.689	748.689	mbar	
Ambient humidity	35%	35%	RH	



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

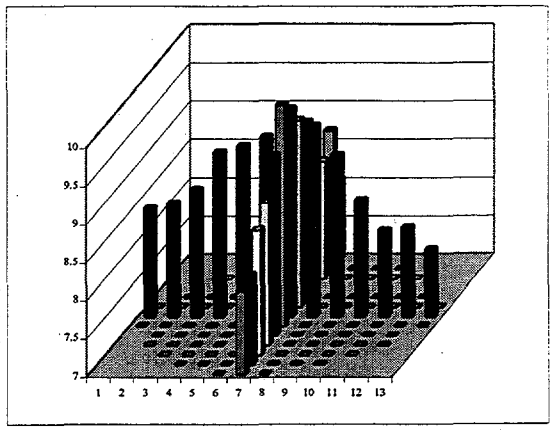
Sierra Inc. Constant Flow Air Sampler

TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building		Run No.	**GTJul1_2**	
Date	7/1/98		Injection point	**East**	
Tester	Maughan		Fan Setting	**22 Hz**	
Stack Dia.	12	in.	Stack Temp	73	deg. F
Stack X-Area	113.1	in.	Fan	Near	
Elevation			Center 2/3 from	1.10	to: 10.90
El. above disturbance	106.5		Points in Center 2/3	3	to: 10
Concentration units	ppm SF_6				

Traverse-->		West			South		
Trial ---->			2	3		2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	8.93	8.31	8.02	7.95	7.93	7.98
2	0.80	8.76	8.25	8.44	8.06	8.15	7.91
3	1.42	9.17	8.70	8.13	8.55	8.49	8.46
4	2.12	9.11	9.01	9.34	8.56	8.80	8.80
5	3.00	9.38	9.02	9.31	9.23	9.25	9.11
6	4.27	9.51	8.92	9.62	9.85	9.36	9.99
Centerpoint	6.00	9.83	9.73	9.60	9.40	9.63	9.64
7	7.73	9.23	9.28	9.75	8.80	9.52	9.55
8	9.00	9.00	9.23	9.12	9.36	9.53	8.54
9	9.88	8.51	8.63	8.44	8.49	9.21	9.22
10	10.58	7.98	8.44	7.99	8.16	8.51	8.53
11	11.20	8.22	8.22	8.08	8.52	8.85	8.62
12	11.50	7.79	7.98	7.87	7.72	7.76	8.29
		East			North		All
Average of all data		8.88	8.75	8.75	8.67	8.85	8.82	8.78
Min								7.72
Max								9.99
Center 2/3								All
Mean		9.08	9.00	9.03	8.93	9.14	9.09	9.05
Std. Dev.		0.549	0.389	0.672	0.551	0.438	0.552	0.512
COV %		6.0	4.3	7.4	6.2	4.8	6.1	5.7

	Start	Finish		
Tracer tank pressure	310	310	psig	Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98
Ambient temp	73	73	F	
Injection flowmeter	12	12	lpm [glass ball in meter]	
Sampling flowmeter (Sierr	5	5	lpm	
Ambient pressure	748.689	748.689	mbar	
Ambient humidity	35%	35%	RH	



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler

TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJul2_1**		
Date	7/2/98	Injection point	**West**		
Tester	Maughan	Fan Setting	22	Hz	
Stack Dia.	12 in.	Stack Temp	72 & 74	deg. F	
Stack X-Area	113.1 in.	Fan	Near		
Elevation		Center 2/3 from	1.10	to:	10.90
El. above disturbance	106.5	Points in Center 2/3	3	to:	10
Concentration units	ppm SF_6				

Traverse-->		West			South		
Trial --->			2	3		2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	8.87	9.18	9.17	8.72	9.04	9.29
2	0.80	9.06	8.82	8.66	9.22	9.39	9.42
3	1.42	8.45	8.52	8.61	8.85	9.01	9.05
4	2.12	9.05	8.34	8.63	8.99	8.93	9.04
5	3.00	8.39	8.58	8.75	9.00	8.59	9.28
6	4.27	8.27	8.04	8.30	8.71	8.54	8.67
Centerpoint	6.00	8.14	8.26	7.91	8.43	8.22	8.62
7	7.73	8.53	8.59	8.32	8.24	8.00	8.14
8	9.00	8.83	8.77	8.38	7.90	8.20	7.98
9	9.88	8.56	9.02	8.64	8.15	8.28	8.61
10	10.58	8.92	8.82	8.68	8.11	8.48	8.31
11	11.20	9.16	9.26	8.88	8.84	8.66	8.43
12	11.50	9.06	9.17	8.70	8.62	8.53	8.96
		East			North		
Average of all data		8.71	8.72	8.59	8.60	8.61	8.75
Min							
Max							

Center 2/3							All
Mean		8.57	8.55	8.47	8.49	8.47	8.63	8.53
Std. Dev.		0.305	0.303	0.267	0.413	0.338	0.438	0.338
COV %		3.6	3.5	3.2	4.9	4.0	5.1	4.0

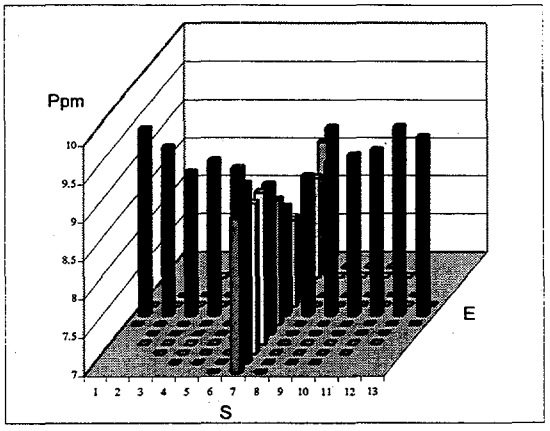
	Start	Finish		
Tracer tank pressure	300	301	psig	Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98
Ambient temp	72 & 74	73 & 74	F	
Injection flowmeter	11	11	lpm [glass ball in meter]	
Sampling flowmeter (Sierr	5	5	lpm	
Ambient pressure	747.789	747.789	mbar	
Ambient humidity	42%	42%	RH	

Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler



TRACER GAS TRAVERSE DATA FORM

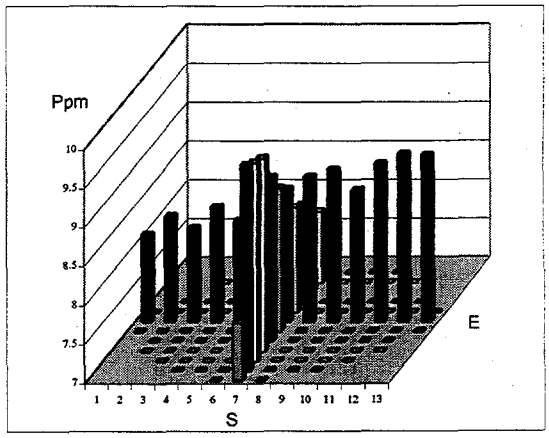
Site	W059 Model in 305 Building	Run No.	**GTJul2_2**		
Date	7/2/98	Injection point	**N/S Center**		
Tester	Maughan	Fan Setting	**22 Hz**		
Stack Dia.	12 in.	Stack Temp	72	deg F	
Stack X-Area	113.1 in.	Fan	Near		
Elevation		Center 2/3 from	1.10	to:	10.90
El. above disturbance	106.5	Points in Center 2/3	3	to:	10
Concentration units	ppm SF_6				

Traverse-->		West			South		
Trial --->			2	3		2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	7.93	7.70	8.15	7.80	7.52	7.90
2	0.80	8.03	7.74	8.69	9.23	10.10	9.60
3	1.42	8.50	7.45	8.06	9.65	9.66	9.33
4	2.12	8.12	8.24	8.46	9.54	9.60	9.30
5	3.00	8.13	8.17	8.01	9.17	9.01	9.15
6	4.27	8.14	8.43	8.30	9.02	8.99	8.51
Centerpoint	6.00	8.36	8.59	8.53	8.58	8.85	8.68
7	7.73	8.50	8.71	8.74	8.50	8.42	8.11
8	9.00	8.85	8.80	8.57	8.09	8.48	8.20
9	9.88	8.56	8.52	8.37	7.93	8.09	7.75
10	10.58	8.58	8.80	9.04	7.80	8.13	7.82
11	11.20	8.96	9.22	8.62	7.58	7.78	7.31
12	11.50	8.97	9.01	8.77	7.26	7.44	7.82

	East			North			All
Average of all data	8.43	8.41	8.49	8.47	8.62	8.42	8.47
Min							7.26
Max							10.10

Center 2/3							All
Mean	8.42	8.41	8.45	8.70	8.80	8.54	8.55
Std. Dev.	0.250	0.425	0.322	0.686	0.577	0.616	0.503
COV %	3.0	5.1	3.8	7.9	6.6	7.2	5.9

	Start	Finish		
Tracer tank pressure	300	300	psig	Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98
Ambient temp	72	72	F	
Injection flowmeter	11	11	lpm [glass ball in meter]	
Sampling flowmeter	5	5	lpm	
Ambient pressure	747.789	747.789	mbar	
Ambient humidity	42%	42%	RH	



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler

TRACER GAS TRAVERSE DATA FORM

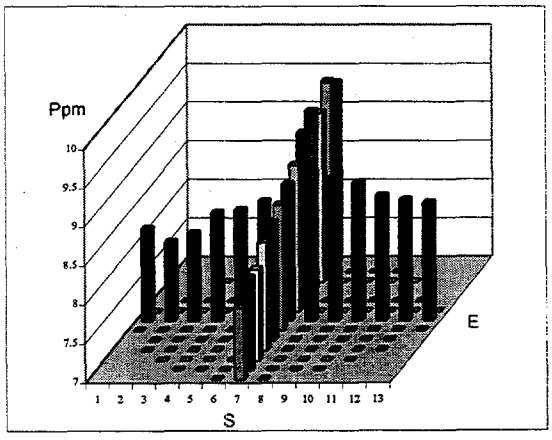
Site	W059 Model in 305 Building	Run No.	**GTJul7_1**		
Date	7/7/98	Injection point	**South**		
Tester	Maughan	Fan Setting	**22 Hz**		
Stack Dia.	12 in.	Stack Temp	72 F		
Stack X-Area	113.1 in.	Fan	Near		
Elevation		Center 2/3 from	1.10	to:	10.90
El. above disturbance	106.5	Points in Center 2/3	3	to:	10
Concentration units	ppm SF_6				

Traverse-->		West			South		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	8.54	8.15	7.87	7.57	7.70	7.97
2	0.80	7.80	8.12	8.14	7.93	8.11	7.98
3	1.42	7.96	8.41	8.01	7.84	8.08	8.04
4	2.12	8.47	8.26	8.44	8.10	8.28	8.24
5	3.00	8.30	8.43	8.56	8.15	8.35	8.47
6	4.27	8.67	8.42	8.53	8.36	8.45	8.49
Centerpoint	6.00	8.76	8.68	8.83	8.47	8.52	8.70
7	7.73	8.76	8.79	8.78	8.62	8.63	8.82
8	9.00	8.99	8.89	8.69	8.82	9.10	9.00
9	9.88	8.82	8.75	8.78	9.25	8.99	9.14
10	10.58	8.76	8.68	8.40	8.89	8.97	9.10
11	11.20	8.67	8.64	8.37	9.34	9.05	9.39
12	11.50	8.48	8.66	8.43	8.86	9.19	9.31

	East			North			All
Average of all data	8.54	8.53	8.45	8.48	8.57	8.67	8.54
Min							7.57
Max							9.39

Center 2/3							All
Mean	8.61	8.59	8.56	8.50	8.60	8.67	8.59
Std. Dev.	0.316	0.214	0.257	0.443	0.354	0.386	0.325
COV %	3.7	2.5	3.0	5.2	4.1	4.5	3.8

	Start	Finish			
Tracer tank pressure	300	300	psig	Gas analyzer checked on:	5/29/98, 6/10/98, 8/27/98
Ambient temp	72	72	F		
Injection flowmeter	11	11	lpm [glass ball in meter]		
Sampling flowmeter	5	5	lpm		
Ambient pressure	751.1	751.1	mbar		
Ambient humidity	59%	59%	RH		



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler

TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJul7_2**
Date	7/7/98	Injection point	**North**
Tester	Maughan	Fan Setting	**22 Hz**
Stack Dia.	12 in.	Stack Temp	71 F
Stack X-Area	113.1 in.	Fan	Near
Elevation		Center 2/3 from	1.10 to: 10.90
El. above disturbance	106.5	Points in Center 2/3	3 to: 10
Concentration units	ppm SF_6		

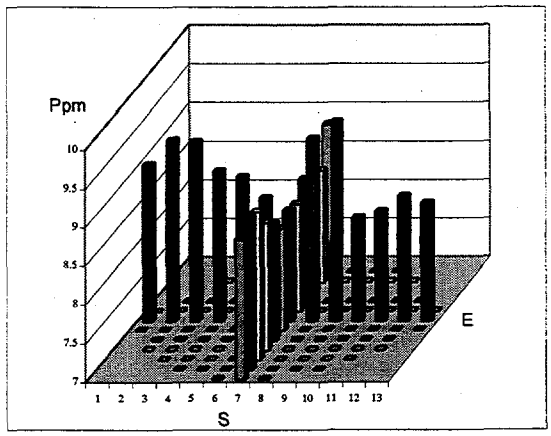
Traverse-->		West			South		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	9.05	8.79	9.23	8.63	8.39	8.64
2	0.80	9.23	9.53	9.24	8.68	8.82	8.70
3	1.42	9.32	9.17	9.45	8.49	8.72	8.78
4	2.12	8.75	9.21	8.85	8.53	8.50	8.15
5	3.00	8.67	9.10	8.83	8.39	8.27	8.13
6	4.27	8.57	8.77	8.44	8.13	7.96	8.15
Centerpoint	6.00	8.44	8.52	8.35	8.50	7.77	8.31
7	7.73	8.14	8.21	7.84	8.76	8.01	7.69
8	9.00	8.25	7.87	7.89	8.68	8.40	7.95
9	9.88	8.70	8.15	8.15	8.60	8.73	8.84
10	10.58	8.36	8.50	8.40	8.06	8.47	8.10
11	11.20	8.83	8.54	8.49	8.52	9.08	8.39
12	11.50	8.45	8.46	8.67	8.48	8.63	8.59

	East			North			All
Average of all data	8.67	8.68	8.60	8.50	8.44	8.34	8.54
Min							7.69
Max							9.53

Center 2/3							All
Mean	8.58	8.61	8.47	8.46	8.31	8.23	8.44
Std. Dev.	0.348	0.485	0.511	0.234	0.339	0.369	0.397
COV %	4.1	5.6	6.0	2.8	4.1	4.5	4.7

	Start	Finish	
Tracer tank pressure	310	310	psig
Ambient temp	71	71	F
Injection flowmeter	11	11	lpm [glass ball in meter]
Sampling flowmeter (Sierr	5	5	lpm
Ambient pressure	751.1	751.1	mbar
Ambient humidity	59%	59%	RH

Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler

TRACER GAS TRAVERSE DATA FORM

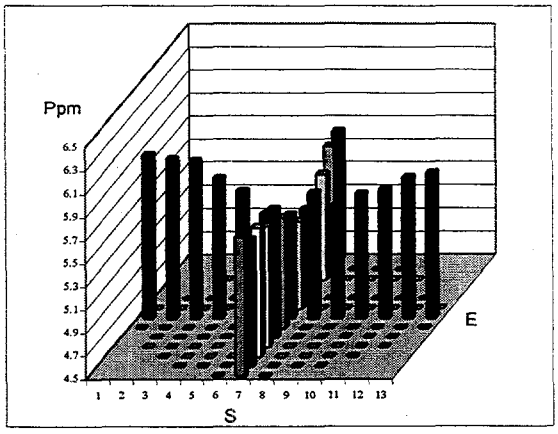
Site	W059 Model in 305 Building		Run No.	**GTJul7_3**	
Date	7/7/98		Injection point	**North**	
Tester	Maughan		Fan Setting	**60 Hz**	
Stack Dia.	12	in.	Stack Temp	86 F	
Stack X-Area	113.1	in.	Fan	Near	
Elevation			Center 2/3 from	1.10	to: 10.90
El. above disturbance	106.5	in.	Points in Center 2/3	3	to: 10
Concentration units	ppm SF_6				

Traverse-->		East			South		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	5.74	5.75	5.91	5.78	5.77	5.57
2	0.80	5.54	5.78	5.97	5.70	5.58	5.52
3	1.42	5.75	5.61	5.90	5.68	5.64	5.54
4	2.12	5.61	5.52	5.68	5.59	5.53	5.52
5	3.00	5.54	5.37	5.57	5.58	5.64	5.61
6	4.27	5.25	5.25	5.41	5.44	5.51	5.42
Centerpoint	6.00	5.19	5.33	5.37	5.45	5.42	5.32
7	7.73	5.29	5.34	5.35	5.30	5.29	5.19
8	9.00	5.37	5.43	5.34	5.33	5.28	5.22
9	9.88	5.50	5.46	5.45	5.33	5.34	5.33
10	10.58	5.47	5.48	5.58	5.49	5.39	5.36
11	11.20	5.54	5.68	5.62	5.65	5.55	5.51
12	11.50	5.76	5.76	5.43	5.69	5.75	5.41

	West			North			All
Average of all data	5.50	5.52	5.58	5.54	5.51	5.42	5.51
Min							5.19
Max							5.97

Center 2/3							All
Mean	5.44	5.42	5.52	5.47	5.45	5.39	5.45
Std. Dev.	0.182	0.110	0.186	0.132	0.138	0.144	0.149
COV %	3.3	2.0	3.4	2.4	2.5	2.7	2.7

	Start	Finish		
Tracer tank pressure	310	310	psig	Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98
Ambient temp	71	71	F	
Injection flowmeter	26	26	lpm [glass ball in meter]	
Sampling flowmeter	10	10	lpm	
Ambient pressure	750.83	750.83	mbar	
Ambient humidity	37%	37%	RH	



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler

TRACER GAS TRAVERSE DATA FORM

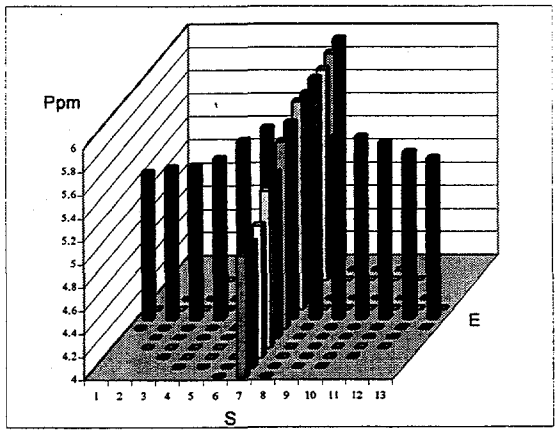
Site	W059 Model in 305 Building	Run No.	**GTJul7_4**		
Date	7/7/98	Injection point	**South**		
Tester	Maughan	Fan Setting	**60 Hz**		
Stack Dia.	12 in.	Stack Temp	73	deg F	
Stack X-Area	113.1 in.	Fan	Near		
Elevation		Center 2/3 from	1.10	to:	10.90
El. above disturbance	106.5 in.	Points in Center 2/3	3	to:	10
Concentration units	ppm SF_6				

Traverse-->		West			South		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	5.23	5.34	5.13	5.05	5.02	5.09
2	0.80	5.26	5.33	5.23	5.07	5.05	5.11
3	1.42	5.31	5.22	5.32	5.18	4.99	5.25
4	2.12	5.40	5.35	5.29	5.38	5.29	5.40
5	3.00	5.53	5.46	5.50	5.45	5.35	5.48
6	4.27	5.68	5.59	5.55	5.70	5.45	5.68
Centerpoint	6.00	5.68	5.67	5.61	5.72	5.60	5.76
7	7.73	5.59	5.61	5.57	5.78	5.77	5.83
8	9.00	5.56	5.52	5.54	5.84	5.74	5.77
9	9.88	5.53	5.45	5.60	5.77	5.87	5.85
10	10.58	5.48	5.48	5.48	5.74	5.84	5.89
11	11.20	5.38	5.45	5.37	5.85	5.91	5.89
12	11.50	5.27	5.47	5.31	5.90	5.98	5.89

	East			North			All
Average of all data	5.45	5.46	5.42	5.57	5.53	5.61	5.51
Min							4.99
Max							5.98

Center 2/3							All
Mean	5.53	5.48	5.50	5.62	5.54	5.66	5.55
Std. Dev.	0.121	0.138	0.116	0.226	0.297	0.226	0.200
COV %	2.2	2.5	2.1	4.0	5.4	4.0	3.6

	Start	Finish			
Tracer tank pressure	310	310	psig	Gas analyzer checked on:	5/29/98, 6/10/98, 8/27/98
Ambient temp	71	71	F		
Injection flowmeter	26	26	lpm [glass ball in meter]		
Sampling flowmeter (Sierr	10	10	lpm		
Ambient pressure	750.83	750.83	mbar		
Ambient humidity	37%	37%	RH		



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler

TRACER GAS TRAVERSE DATA FORM

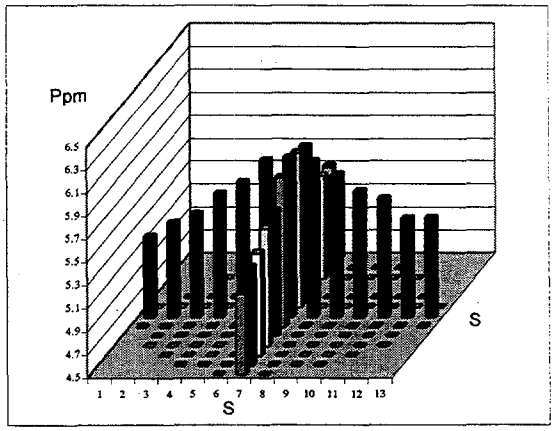
Site	W059 Model in 305 Building	Run No.	**GTJul7_5**		
Date	7/7/98	Injection point	**East**		
Tester	Maughan	Fan Setting	**60 Hz**		
Stack Dia.	12 in.	Stack Temp	73 F		
Stack X-Area	113.1 in.	Fan	Near		
Elevation		Center 2/3 from	1.10	to:	10.90
El. above disturbance	106.5	Points in Center 2/3	3	to:	10
Concentration units	ppm SF_6				

Traverse-->		West			South		
Trial ---->		1	2	3	South 1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	5.10	5.16	5.07	5.20	5.28	5.12
2	0.80	5.22	5.26	5.21	5.35	5.34	5.35
3	1.42	5.35	5.31	5.27	5.46	5.35	5.35
4	2.12	5.40	5.52	5.52	5.51	5.45	5.58
5	3.00	5.45	5.70	5.58	5.63	5.54	5.58
6	4.27	5.66	5.76	5.87	5.83	5.82	5.73
Centerpoint	6.00	5.72	5.80	5.84	5.89	5.88	5.87
7	7.73	5.84	5.62	5.80	5.83	5.84	5.86
8	9.00	5.71	5.52	5.67	5.71	6.03	5.70
9	9.88	5.70	5.36	5.45	5.56	5.74	5.50
10	10.58	5.50	5.44	5.37	5.49	5.37	5.32
11	11.20	5.37	5.23	5.20	5.46	5.35	5.36
12	11.50	5.32	5.39	5.11	5.32	5.15	5.24

	East			North			All
Average of all data	5.49	5.47	5.46	5.56	5.55	5.50	5.50
Min							5.07
Max							6.03

Center 2/3							All
Mean	5.59	5.56	5.60	5.66	5.67	5.61	5.61
Std. Dev.	0.170	0.174	0.214	0.164	0.247	0.199	0.191
COV %	3.0	3.1	3.8	2.9	4.4	3.6	3.4

	Start	Finish			
Tracer tank pressure	310	310	psig	Gas analyzer checked on:	5/29/98, 6/10/98, 8/27/98
Ambient temp	73	73	F		
Injection flowmeter	26	26	lpm [glass ball in meter]		
Sampling flowmeter	10	10	lpm		
Ambient pressure	750.83	750.83	mbar		
Ambient humidity	37%	37%	RH		



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler

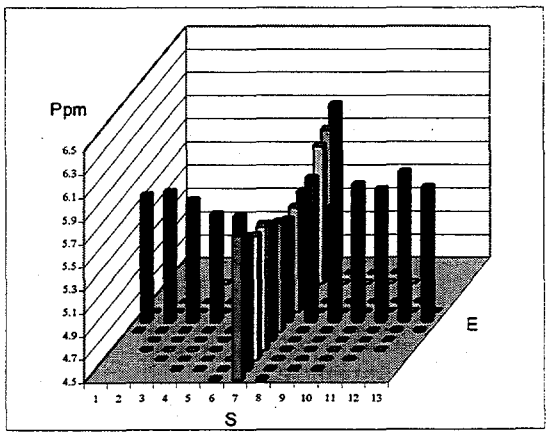
TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building		Run No.	**GTJul7_6**	
Date	7/7/98		Injection point	**West**	
Tester	Maughan		Fan Setting	**60 Hz**	
Stack Dia.	12	in.	Stack Temp	73	deg F
Stack X-Area	113.1	in.	Fan	Near	
Elevation			Center 2/3 from	1.10	to: 10.90
El. above disturbance	106.5		Points in Center 2/3	3	to: 10
Concentration units	ppm SF_6				

Traverse-->		West			South		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	5.60	5.56	5.55	5.84	5.64	5.75
2	0.80	5.68	5.62	5.50	5.69	5.65	5.65
3	1.42	5.50	5.50	5.58	5.65	5.59	5.50
4	2.12	5.49	5.28	5.45	5.63	5.57	5.52
5	3.00	5.43	5.38	5.37	5.58	5.54	5.42
6	4.27	5.35	5.35	5.27	5.57	5.43	5.34
Centerpoint	6.00	5.37	5.34	5.37	5.49	5.28	5.37
7	7.73	5.42	5.45	5.40	5.39	5.44	5.39
8	9.00	5.45	5.48	5.52	5.44	5.46	5.48
9	9.88	5.74	5.58	5.67	5.57	5.46	5.44
10	10.58	5.63	5.58	5.65	5.64	5.67	5.73
11	11.20	5.75	5.76	5.79	5.74	5.79	5.70
12	11.50	5.66	5.59	5.66	5.82	5.95	5.84
		East			North		All
Average of all data		5.54	5.50	5.52	5.62	5.57	5.55
Min							5.27
Max							5.95

Center 2/3						All
Mean	5.49	5.44	5.48	5.55	5.49	5.47	5.49
Std. Dev.	0.126	0.107	0.138	0.092	0.114	0.116	0.116
COV %	2.3	2.0	2.5	1.7	2.1	2.1	2.1

	Start	Finish		
Tracer tank pressure	310	310	psig	Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98
Ambient temp	73	73	F	
Injection flowmeter	26	26	lpm [glass ball in meter]	
Sampling flowmeter (Sierr	10	10	lpm	
Ambient pressure	750.83	750.83	mbar	
Ambient humidity	37%	37%	RH	



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler

TRACER GAS TRAVERSE DATA FORM

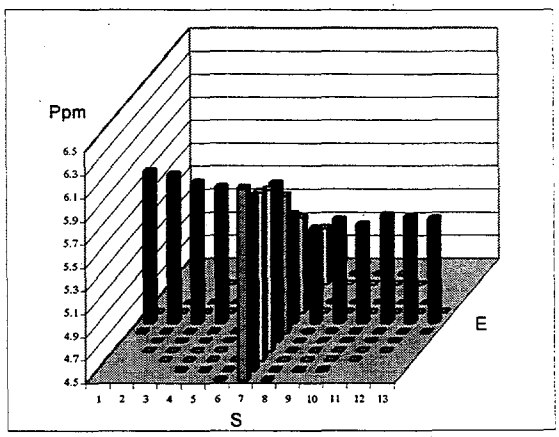
Site	W059 Model in 305 Building		Run No.	**GTJul7_7**	
Date	7/7/98		Injection point	**N/S Center**	
Tester	Maughan		Fan Setting	**60 Hz**	
Stack Dia.	12	in.	Stack Temp	73	deg F
Stack X-Area	113.1	in.	Fan	Near	
Elevation			Center 2/3 from	1.10	to: 10.90
El. above disturbance	106.5		Points in Center 2/3	3	to: 10
Concentration units	ppm SF_6				

Traverse-->		West			South		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	5.56	5.84	5.94	6.18	6.27	6.03
2	0.80	5.54	5.91	5.81	5.95	6.13	5.92
3	1.42	5.63	5.64	5.78	5.92	5.93	6.03
4	2.12	5.47	5.79	5.67	5.92	5.89	5.88
5	3.00	5.70	5.60	5.41	5.83	5.87	5.90
6	4.27	5.37	5.50	5.57	5.65	5.73	5.66
Centerpoint	6.00	5.36	5.49	5.39	5.43	5.46	5.42
7	7.73	5.21	5.38	5.28	5.34	5.26	5.39
8	9.00	5.28	5.38	5.43	5.06	5.09	5.15
9	9.88	5.29	5.36	5.32	4.97	5.03	5.00
10	10.58	5.34	5.38	5.49	4.89	5.05	5.00
11	11.20	5.45	5.40	5.33	4.95	4.76	4.84
12	11.50	5.38	5.35	5.39	4.73	4.56	4.89

	East			North			All
Average of all data	5.43	5.54	5.52	5.45	5.46	5.47	5.48
Min							4.56
Max							6.27

Center 2/3							All
Mean	5.41	5.50	5.48	5.45	5.48	5.49	5.47
Std. Dev.	0.164	0.149	0.164	0.408	0.383	0.395	0.289
COV %	3.0	2.7	3.0	7.5	7.0	7.2	5.3

	Start	Finish		
Tracer tank pressure	310	310	psig	Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98
Ambient temp	73	73	F	
Injection flowmeter	26	26	lpm [glass ball in meter]	
Sampling flowmeter	10	10	lpm	
Ambient pressure	750.83	750.83	mbar	
Ambient humidity	37%	37%	RH	



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler

TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJul8_3**		
Date	7/8/98	Injection point	**Far E/W Center**		
Tester	Maughan	Fan Setting	**22 Hz**		
Stack Dia.	12 in.	Stack Temp	70	deg F	
Stack X-Area	113.1 in.	Fan	**Far**		
		Center 2/3 from	1.10	to:	10.90
El. above disturbance	106.5	Points in Center 2/3	3	to:	10
Concentration units	ppm SF_6				

Traverse-->		West			South		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	8.90	8.92	8.75	8.90	8.93	8.99
2	0.80	9.14	8.77	8.82	8.77	8.89	8.84
3	1.42	8.99	8.84	8.74	8.70	8.78	8.79
4	2.12	8.83	8.74	8.86	8.74	8.79	8.75
5	3.00	8.81	8.64	8.57	8.60	8.71	8.64
6	4.27	8.67	8.60	8.54	8.57	8.54	8.70
Centerpoint	6.00	8.57	8.62	8.47	8.67	8.53	8.61
7	7.73	8.54	8.58	8.46	8.54	8.67	8.62
8	9.00	8.50	8.53	8.48	8.53	8.59	8.75
9	9.88	8.58	8.68	8.67	8.87	8.55	8.56
10	10.58	8.61	8.69	8.54	8.60	8.55	8.70
11	11.20	8.63	8.67	8.58	8.60	8.68	8.76
12	11.50	8.64	8.67	8.66	8.65	8.68	8.68
		East			North		All
Average of all data		8.72	8.69	8.63	8.67	8.68	8.72	8.69
Min								8.46
Max								9.14
Center 2/3								All
Mean		8.68	8.66	8.59	8.65	8.63	8.68	8.65
Std. Dev.		0.164	0.093	0.137	0.110	0.105	0.077	0.116
COV %		1.9	1.1	1.6	1.3	1.2	0.9	1.3

	Start	Finish		
Tracer tank pressure	310	310	psig	Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98
Ambient temp	70	70	F	
Injection flowmeter	11	11	lpm [glass ball in meter]	
Sampling flowmeter	5	5	lpm	
Ambient pressure	749.8	749.8	mbar	
Ambient humidity	62%	62%	RH	

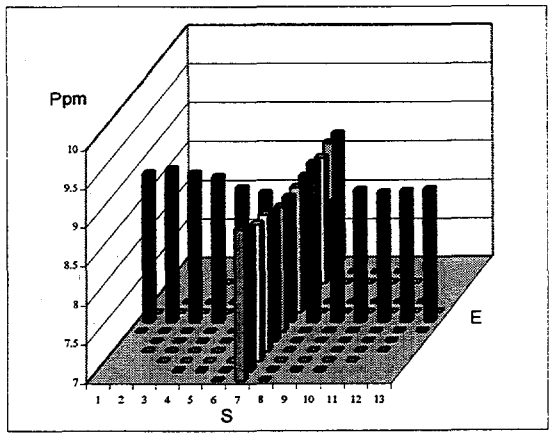
B&K vapor correction No

Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler



TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJul9_1**
Date	7/9/98	Injection point	R Center in E-W
Tester	Maughan	Fan Setting	**60 Hz**
Stack Dia.	12 in.	Stack Temp	72 deg F
Stack X-Area	113.1 in.	Fan	FAR
		Center 2/3 from	1.10 to: 10.90
El. above disturbance	106.5	Points in Center 2/3	3 to: 10
Concentration units	ppm SF_6		

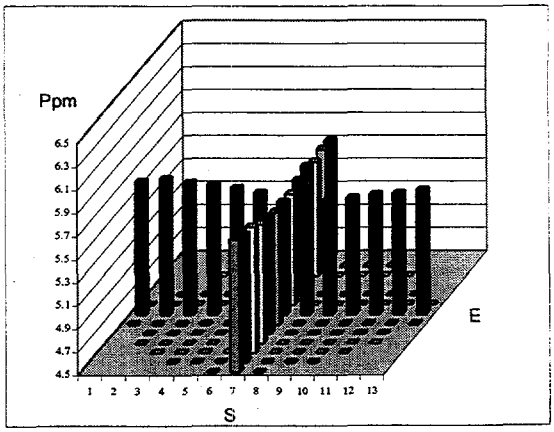
Traverse-->		East			South		
Trial ---->		East 1	2	3	South 1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	5.50	5.53	5.59	5.63	5.69	5.63
2	0.80	5.47	5.55	5.66	5.57	5.69	5.56
3	1.42	5.46	5.57	5.57	5.63	5.62	5.53
4	2.12	5.49	5.52	5.54	5.53	5.56	5.50
5	3.00	5.46	5.53	5.47	5.47	5.54	5.50
6	4.27	5.40	5.44	5.50	5.46	5.46	5.49
Centerpoint	6.00	5.33	5.37	5.42	5.44	5.50	5.49
7	7.73	5.35	5.38	5.42	5.47	5.43	5.48
8	9.00	5.37	5.41	5.40	5.47	5.49	5.53
9	9.88	5.34	5.41	5.46	5.53	5.53	5.54
10	10.58	5.41	5.43	5.46	5.46	5.53	5.47
11	11.20	5.40	5.48	5.44	5.50	5.58	5.47
12	11.50	5.45	5.47	5.49	5.50	5.52	5.50

	West			North			All
Average of all data	5.42	5.47	5.49	5.50	5.55	5.51	5.49
Min							5.33
Max							5.69

Center 2/3							All
Mean	5.40	5.45	5.47	5.50	5.52	5.50	5.47
Std. Dev.	0.058	0.071	0.057	0.059	0.056	0.024	0.066
COV %	1.1	1.3	1.0	1.1	1.0	0.4	1.2

	Start	Finish	
Tracer tank pressure	310	310	psig
Ambient temp (Bldg. 305)	72	72	F
Injection flowmeter	26	26	lpm [glass ball in meter]
Sampling flowmeter (Sierr	10	10	lpm
Ambient pressure	747.1	747.1	mm Hg
Ambient humidity	61%	61%	RH
Centerline vel.	3533	3534	fpm
B&K vapor correction	No		

Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler

TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJul9_2**
Date	7/9/98	Injection point	**NW Corner**
Tester	Maughan	Fan Setting	**22 Hz**
Stack Dia.	12 in.	Stack Temp	72 deg F
Stack X-Area	113.1 in.	Fan	FAR
		Center 2/3 from	1.10 to: 10.90
El. above disturbance	106.5	Points in Center 2/3	3 to: 10
Concentration units	ppm SF_6		

Traverse-->		East			South		
Trial --->		East 1	2	3	South 1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	8.48	8.54	8.57	8.46	8.52	8.53
2	0.80	8.46	8.59	8.54	8.48	8.60	8.52
3	1.42	8.43	8.46	8.56	8.62	8.42	8.42
4	2.12	8.52	8.43	8.46	8.46	8.51	8.50
5	3.00	8.58	8.41	8.65	8.43	8.47	8.53
6	4.27	8.53	8.48	8.55	8.47	8.51	8.51
Centerpoint	6.00	8.56	8.57	8.54	8.63	8.49	8.54
7	7.73	8.60	8.69	8.59	8.66	8.54	8.59
8	9.00	8.68	8.70	8.65	8.65	8.61	8.59
9	9.88	8.61	8.72	8.58	8.58	8.60	8.67
10	10.58	8.78	8.61	8.67	8.70	8.50	8.65
11	11.20	8.79	8.61	8.69	8.77	8.69	8.69
12	11.50	8.60	8.65	8.65	8.62	8.54	8.62
		West			North		All
Average of all data		8.59	8.57	8.59	8.59	8.54	8.57	8.57
Min								8.41
Max								8.79
Center 2/3								All
Mean		8.59	8.56	8.58	8.58	8.52	8.56	8.56
Std. Dev.		0.100	0.123	0.066	0.099	0.060	0.078	0.089
COV %		1.2	1.4	0.8	1.2	0.7	0.9	1.0

	Start	Finish	
Tracer tank pressure	310	310	psig
Ambient temp (Bldg. 305)	72	72	F
Injection flowmeter	11	11	lpm [glass ball in meter]
Sampling flowmeter	8	8	lpm
Ambient pressure	747.1	747.1	mm Hg
Ambient humidity	61%	61%	RH
Centerline vel.	1297	1298	fpm
B&K vapor correction	No		

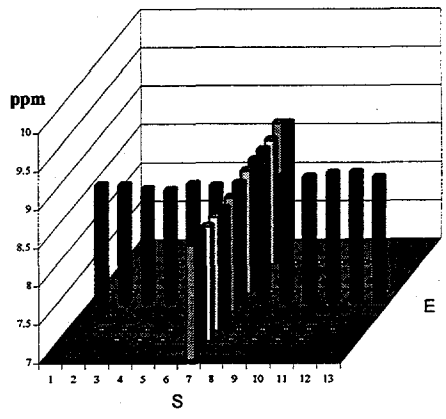
Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98

Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler



TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJul9_3**		
Date	7/9/98	Injection point	**NE Corner**		
Tester	Maughan	Fan Setting	**22 Hz**		
Stack Dia.	12 in.	Stack Temp	72 deg F		
Stack X-Area	113.1 in.	Fan	FAR		
		Center 2/3 from	1.10	to:	10.90
El. above disturbance	106.5 in.	Points in Center 2/3	3	to:	10
Concentration units	ppm SF_6				

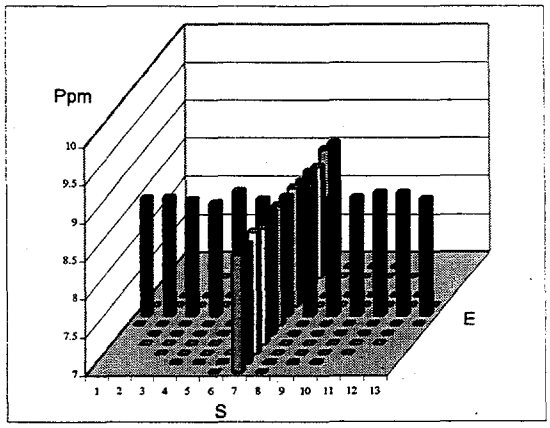
Traverse-->		West			South		
Trial ---->			2	3		2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	8.51	8.48	8.59	8.51	8.54	8.58
2	0.80	8.53	8.52	8.58	8.56	8.53	8.56
3	1.42	8.53	8.48	8.51	8.55	8.62	8.62
4	2.12	8.44	8.47	8.49	8.46	8.56	8.55
5	3.00	8.58	8.64	8.65	8.49	8.60	8.74
6	4.27	8.54	8.52	8.49	8.50	8.57	8.64
Centerpoint	6.00	8.58	8.51	8.58	8.47	8.61	8.60
7	7.73	8.68	8.59	8.56	8.47	8.57	8.61
8	9.00	8.55	8.57	8.53	8.33	8.58	8.60
9	9.88	8.61	8.50	8.50	8.51	8.49	8.53
10	10.58	8.69	8.55	8.56	8.46	8.39	8.50
11	11.20	8.62	8.59	8.59	8.59	8.50	8.58
12	11.50	8.54	8.50	8.52	8.50	8.47	8.54
		East			North		
Average of all data		8.57	8.53	8.55	8.49	8.54	8.59
Min							
Max							

	All
Average of all data	8.55
Min	8.33
Max	8.74

Center 2/3							All
Mean	8.58	8.54	8.54	8.47	8.55	8.60	8.55
Std. Dev.	0.077	0.056	0.053	0.060	0.072	0.070	0.074
COV %	0.9	0.7	0.6	0.7	0.8	0.8	0.9

	Start	Finish	
Tracer tank pressure	310	310	psig
Ambient temp (Bldg. 305)	72	72	F
Injection flowmeter	11	11	lpm [glass ball in meter]
Sampling flowmeter (Sierr	5	5	lpm
Ambient pressure	747.1	747.1	mm Hg
Ambient humidity	61%	61%	RH
Centerline vel.	1348	1348	fpm
B&K vapor correction	No		

Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler

TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJul15_1**
Date	7/15/98	Injection point	**Bottom Left**
Tester	Maughan	Fan Setting	**22 Hz**
Stack Dia.	12 in.	Stack Temp	72 deg F
Stack X-Area	113.1 in.	Fan	NEAR
Elevation		Center 2/3 from	1.10 to: 10.90
El. above disturbance	106.5	Points in Center 2/3	3 to: 10
Concentration units	ppm SF_6		

Traverse-->		Northwest			Southwest		
Trial ---->			2	3		2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	8.67	8.74	8.87	8.15	8.19	8.16
2	0.80	8.89	8.94	8.55	8.32	8.12	8.39
3	1.42	8.01	8.42	8.07	7.92	8.02	7.97
4	2.12	8.26	8.38	8.58	8.02	8.11	8.01
5	3.00	8.11	8.16	8.11	8.04	7.95	8.01
6	4.27	8.43	8.11	8.25	8.06	7.93	7.95
Centerpoint	6.00	8.20	8.39	8.33	8.18	8.21	8.45
7	7.73	8.42	8.27	8.74	8.96	8.93	8.90
8	9.00	8.40	8.43	8.53	9.52	9.66	9.25
9	9.88	8.24	8.63	8.67	9.62	9.67	9.98
10	10.58	8.67	8.74	8.89	9.99	9.61	9.86
11	11.20	8.87	9.13	8.72	9.86	10.20	9.95
12	11.50	9.15	8.87	9.14	10.00	10.00	9.89

	Southeast			Northeast			All
Average of all data	8.49	8.55	8.57	8.82	8.82	8.83	8.68
Min							7.92
Max							10.20
Center 2/3							All
Mean	8.30	8.39	8.46	8.70	8.68	8.71	8.54
Std. Dev.	0.198	0.203	0.288	0.824	0.786	0.824	0.591
COV %	2.4	2.4	3.4	9.5	9.1	9.5	6.9

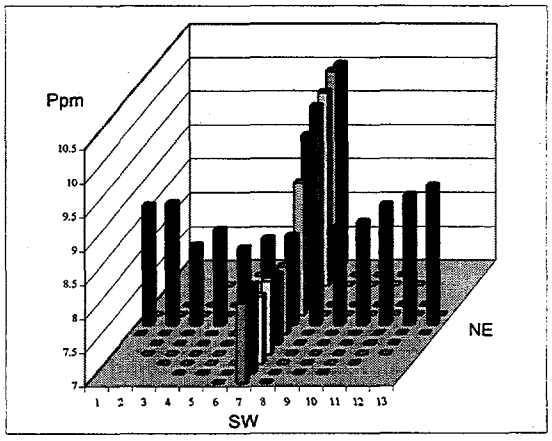
	Start	Finish		
Tracer tank pressure	310	310	psig	Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98
Ambient temp	72	72	F	
Injection flowmeter	11	11	lpm [glass ball in meter]	
Sampling flowmeter (Sierr	5	5	lpm	
Ambient pressure	751.6	751.6	mm Hg	
Ambient humidity	40%	40%	RH	
Centerline vel.	1362	1342	m/s	
B&K vapor correction	No			

Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler



TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJul15_2**		
Date	7/15/98	Injection point	**Bottom Right**		
Tester	Maughan	Fan Setting	**22 Hz**		
Stack Dia.	12 in.	Stack Temp	71 deg F		
Stack X-Area	113.1 in.	Fan	NEAR		
Elevation		Center 2/3 from	1.10	to:	10.90
El. above disturbance	106.5	Points in Center 2/3	3	to:	10
Concentration units	ppm SF_6				

Traverse-->		Northwest			Southwest		
Trial ---->			2	3		2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	9.13	9.51	9.27	8.73	8.81	8.98
2	0.80	9.41	9.36	9.28	8.84	8.97	8.98
3	1.42	9.05	9.01	9.53	8.84	9.00	8.91
4	2.12	9.27	9.01	9.35	8.68	8.85	8.86
5	3.00	9.06	9.17	9.16	8.74	8.76	8.69
6	4.27	8.78	8.77	8.84	8.81	8.84	8.63
Centerpoint	6.00	8.40	8.76	8.72	8.65	8.68	8.79
7	7.73	8.34	8.56	8.60	8.56	8.71	8.71
8	9.00	8.30	8.36	8.43	9.01	8.78	9.08
9	9.88	8.19	8.29	8.36	8.75	8.87	8.90
10	10.58	8.15	8.15	8.26	9.04	8.96	8.86
11	11.20	8.30	8.21	8.38	9.02	8.95	9.16
12	11.50	8.27	8.41	8.27	8.79	9.00	8.87

	Southwest			Northeast			All
Average of all data	8.67	8.74	8.80	8.80	8.86	8.88	8.79
Min							8.15
Max							9.53

Center 2/3							All
Mean	8.62	8.68	8.81	8.79	8.83	8.83	8.76
Std. Dev.	0.427	0.357	0.452	0.159	0.107	0.137	0.305
COV %	5.0	4.1	5.1	1.8	1.2	1.6	3.5

	Start	Finish	
Tracer tank pressure	310	310	psig
Ambient temp	71	71	F
Injection flowmeter	11	11	lpm [glass ball in meter]
Sampling flowmeter (Sierr	5	5	lpm
Ambient pressure	751.6	751.6	mm Hg
Ambient humidity	40%	40%	RH
Centerline vel.	1342	1339	m/s
B&K vapor correction	No		

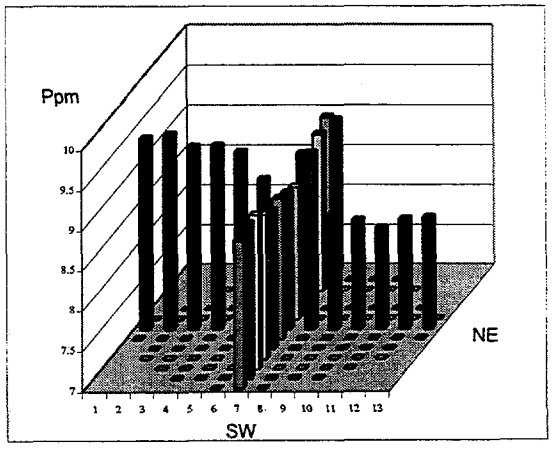
Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98

Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler



TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJul15_3**
Date	7/15/98	Injection point	**Top Left**
Tester	Maughan	Fan Setting	**22 Hz**
Stack Dia.	12 in.	Stack Temp	71 deg F
Stack X-Area	113.1 in.	Fan	NEAR
Elevation		Center 2/3 from	1.10 to: 10.90
El. above disturbance	106.5	Points in Center 2/3	3 to: 10
Concentration units	ppm SF_6		

Traverse-->		Northwest			Southwest		
Trial ---->			2	3		2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	9.20	9.33	9.43	7.96	8.21	8.25
2	0.80	9.00	9.13	9.20	7.95	8.21	8.26
3	1.42	8.97	9.30	9.29	8.33	8.25	8.34
4	2.12	9.00	8.90	9.25	8.36	8.32	8.46
5	3.00	9.10	8.84	9.02	8.37	8.41	8.72
6	4.27	9.02	8.67	8.79	8.65	8.67	8.63
Centerpoint	6.00	8.95	8.97	9.07	8.94	8.86	8.70
7	7.73	8.71	8.94	9.11	9.35	9.35	9.00
8	9.00	8.81	8.79	8.79	9.23	9.46	9.31
9	9.88	8.65	8.70	8.65	9.64	9.83	9.48
10	10.58	8.56	8.72	8.64	9.48	9.90	9.61
11	11.20	8.57	8.59	8.64	9.68	9.29	9.44
12	11.50	8.24	8.52	8.31	9.50	9.81	9.63

	Southeast			Northeast			All
Average of all data	8.83	8.88	8.94	8.88	8.97	8.91	8.90
Min							7.95
Max							9.90
Center 2/3							All
Mean	8.86	8.87	8.96	8.93	9.01	8.92	8.92
Std. Dev.	0.188	0.193	0.247	0.518	0.646	0.457	0.397
COV %	2.1	2.2	2.8	5.8	7.2	5.1	4.4

	Start	Finish	
Tracer tank pressure	310	310	psig
Ambient temp	71	71	F
Injection flowmeter	11	10.5	lpm [glass ball in meter]
Sampling flowmeter	5	5	lpm
Ambient pressure	751.6	751.6	mm Hg
Ambient humidity	40%	40%	RH
Centerline vel.	1339	1329	m/s
B&K vapor correction	No		

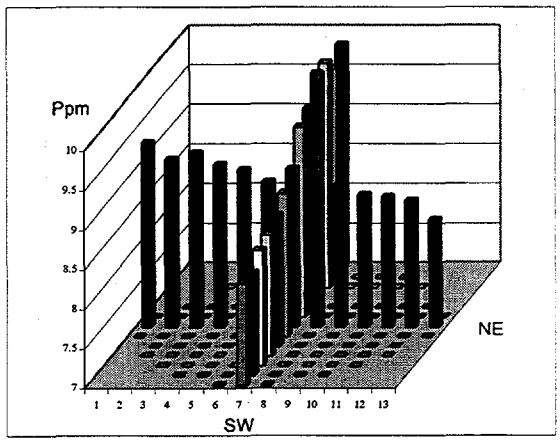
Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98.

Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler



TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJul15_4**
Date	7/15/98	Injection point	**Top Right**
Tester	Maughan	Fan Setting	**22 Hz**
Stack Dia.	12 in.	Stack Temp	72 deg F
Stack X-Area	113.1 in.	Fan	NEAR
Elevation		Center 2/3 from	1.10 to: 10.90
El. above disturbance	106.5	Points in Center 2/3	3 to: 10
Concentration units	ppm SF_6		

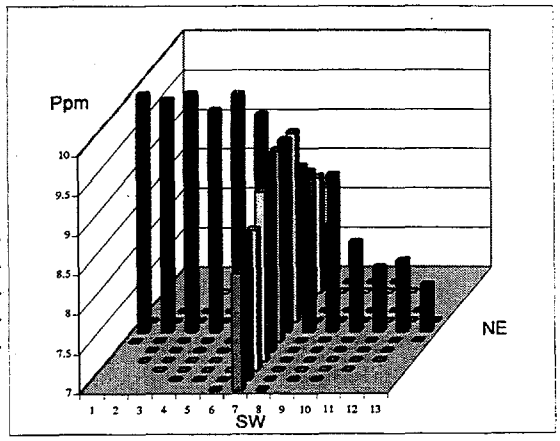
Traverse-->		Northwest			Southwest		
Trial ---->			2	3		2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	10.10	10.00	9.88	8.50	8.41	8.51
2	0.80	9.94	9.71	10.10	8.90	8.88	8.68
3	1.42	10.10	10.20	10.30	8.71	8.75	8.85
4	2.12	10.20	9.69	9.50	9.17	9.31	8.90
5	3.00	10.10	10.10	10.30	9.52	9.44	9.44
6	4.27	9.91	9.60	9.73	9.28	9.51	9.41
Centerpoint	6.00	9.46	9.48	9.30	9.49	9.32	9.40
7	7.73	8.98	8.74	8.24	9.56	9.63	8.95
8	9.00	8.62	8.15	8.29	8.99	8.93	8.56
9	9.88	8.11	8.13	8.13	8.69	8.65	8.58
10	10.58	7.79	7.98	7.65	8.83	8.34	8.19
11	11.20	7.89	7.83	7.95	8.25	8.30	8.05
12	11.50	7.62	7.44	7.69	8.15	8.10	8.42

	Southeast			Northeast			All
Average of all data	9.14	9.00	9.00	8.93	8.89	8.76	8.95
Min							7.44
Max							10.30

Center 2/3							All
Mean	9.25	9.12	9.05	9.14	9.10	8.92	9.10
Std. Dev.	0.917	0.879	0.993	0.348	0.446	0.437	0.693
COV %	9.9	9.6	11.0	3.8	4.9	4.9	7.6

	Start	Finish	
Tracer tank pressure	310	310	psig
Ambient temp	72	72	F
Injection flowmeter	11	11	lpm [glass ball in meter]
Sampling flowmeter (Sierr	5	5	lpm
Ambient pressure	753.5	753.5	mm Hg
Ambient humidity	45%	45%	RH
Centerline vel.	1329	1297	m/s
B&K vapor correction	No		

Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler

TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJul16_1**		
Date	7/16/98	Injection point	**Top Right**		
Tester	Maughan	Fan Setting	**22 Hz**		
Stack Dia.	12 in.	Stack Temp	72 deg F		
Stack X-Area	113.1 in.	Fan	NEAR		
Elevation		Center 2/3 from	1.10	to:	10.90
El. above disturbance	106.5	Points in Center 2/3	3	to:	10
Concentration units	ppm SF_6				

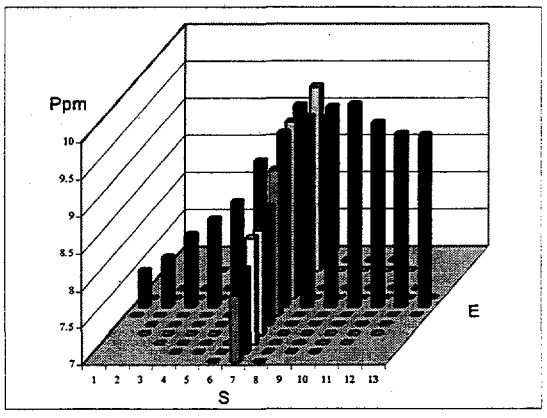
Traverse-->		West			South		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	7.41	7.65	7.41	7.78	7.88	7.83
2	0.80	7.76	7.51	7.73	8.13	7.88	8.13
3	1.42	7.98	7.96	8.00	7.96	8.61	8.47
4	2.12	8.24	8.06	8.24	8.15	8.53	8.32
5	3.00	8.42	8.45	8.38	8.24	8.80	8.49
6	4.27	9.14	9.13	8.62	8.85	8.95	8.82
Centerpoint	6.00	9.51	8.94	9.57	9.25	9.30	9.19
7	7.73	9.63	9.37	9.53	9.44	9.26	9.14
8	9.00	9.54	9.67	9.53	9.32	9.33	9.48
9	9.88	9.43	10.00	9.76	9.03	9.18	9.09
10	10.58	9.00	9.80	9.63	9.07	9.72	9.36
11	11.20	9.44	8.98	9.56	8.69	8.49	9.25
12	11.50	9.39	9.56	8.97	8.80	8.85	8.95
		East			North		
Average of all data		8.84	8.85	8.84	8.67	8.83	8.81
Min							
Max							

	All
Average of all data	8.81
Min	7.41
Max	10.00

Center 2/3							All
Mean	8.99	9.04	9.03	8.81	9.08	8.93	8.98
Std. Dev.	0.623	0.750	0.704	0.554	0.384	0.420	0.567
COV %	6.9	8.3	7.8	6.3	4.2	4.7	6.3

	Start	Finish	
Tracer tank pressure	310	310	psig
Ambient temp	72	72	F
Injection flowmeter	11	11	lpm [glass ball in meter]
Sampling flowmeter (Sierr	5	5	lpm
Ambient pressure	753.5	753.5	mm Hg
Ambient humidity	45%	45%	RH
Centerline vel.	1326	1326	m/s
B&K vapor correction	None		

Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler

TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJul20_1**		
Date	7/20/98	Injection point	**Top Left**		
Tester	Maughan	Fan Setting	**22 Hz**		
Stack Dia.	12 in.	Stack Temp	72 deg F		
Stack X-Area	113.1 in.	Fan	NEAR		
Elevation		Center 2/3 from	1.10	to:	10.90
El. above disturbance	106.5	Points in Center 2/3	3	to:	10
Concentration units	ppm SF_6				

Traverse-->		West			South		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	8.51	8.65	8.62	8.29	8.30	8.36
2	0.80	8.55	8.72	8.86	8.33	8.23	8.39
3	1.42	8.73	8.59	8.83	8.41	8.38	8.37
4	2.12	8.79	8.61	8.71	8.54	8.50	8.62
5	3.00	8.81	9.12	8.87	8.57	8.66	8.47
6	4.27	8.91	8.78	8.79	8.60	8.80	8.71
Centerpoint	6.00	9.13	8.81	9.06	8.86	9.13	9.11
7	7.73	9.32	9.03	9.17	9.11	9.19	9.27
8	9.00	9.21	8.86	9.34	9.33	9.56	9.42
9	9.88	9.29	9.43	9.22	9.39	9.59	9.59
10	10.58	9.51	9.39	9.55	9.83	9.72	9.93
11	11.20	9.06	9.56	9.15	9.89	10.20	10.20
12	11.50	9.34	9.42	9.03	9.88	10.10	9.96

	East			North			All
Average of all data	9.01	9.00	9.02	9.00	9.10	9.11	9.04
Min							8.23
Max							10.20

Center 2/3							All
Mean	9.08	8.96	9.06	8.96	9.06	9.05	9.03
Std. Dev.	0.277	0.308	0.283	0.484	0.499	0.542	0.397
COV %	3.1	3.4	3.1	5.4	5.5	6.0	4.4

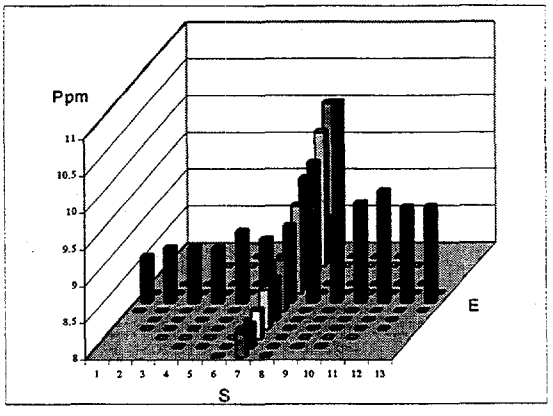
	Start	Finish			
Tracer tank pressure	310	310	psig	Gas analyzer checked on:	5/29/98, 6/10/98, 8/27/98
Ambient temp	72	72	F		
Injection flowmeter	11	11	lpm [glass ball in meter]		
Sampling flowmeter (Sierr	5	5	lpm		
Ambient pressure	750.99	750.99	mm Hg		
Ambient humidity	57%	57%	RH		
Centerline vel.	1279	1323	m/s		
B&K vapor correction	None				

Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler



TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJul20_2**
Date	7/20/98	Injection point	**Bottom Right**
Tester	Maughan	Fan Setting	**22 Hz**
Stack Dia.	12 in.	Stack Temp	72 deg F
Stack X-Area	113.1 in.	Fan	NEAR
		Center 2/3 from	1.10 to: 10.90
El. above disturbance	106.5	Points in Center 2/3	3 to: 10
Concentration units	ppm SF_6		

Traverse-->		West			South		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	9.55	9.73	9.71	9.66	9.25	9.41
2	0.80	9.60	9.58	9.52	9.41	9.11	9.25
3	1.42	9.50	9.41	9.55	9.12	9.13	8.97
4	2.12	9.52	9.26	9.36	9.22	8.85	8.77
5	3.00	9.15	9.13	9.39	9.23	9.13	9.01
6	4.27	8.90	8.89	9.04	8.87	8.88	8.87
Centerpoint	6.00	8.92	8.83	8.56	8.82	8.76	8.89
7	7.73	8.95	8.74	8.82	8.60	8.91	8.87
8	9.00	8.99	8.66	8.99	8.81	8.46	8.88
9	9.88	8.70	8.70	9.08	9.54	9.52	9.26
10	10.58	8.95	8.85	9.36	9.44	9.72	9.38
11	11.20	9.16	9.42	9.19	9.56	9.73	9.62
12	11.50	9.17	9.09	9.35	9.86	9.54	9.61

	East			North			All
Average of all data	9.16	9.10	9.22	9.24	9.15	9.14	9.17
Min							8.46
Max							9.86

Center 2/3							All
Mean	9.06	8.94	9.13	9.07	9.04	8.99	9.04
Std. Dev.	0.278	0.264	0.316	0.316	0.388	0.202	0.291
COV %	3.1	3.0	3.5	3.5	4.3	2.2	3.2

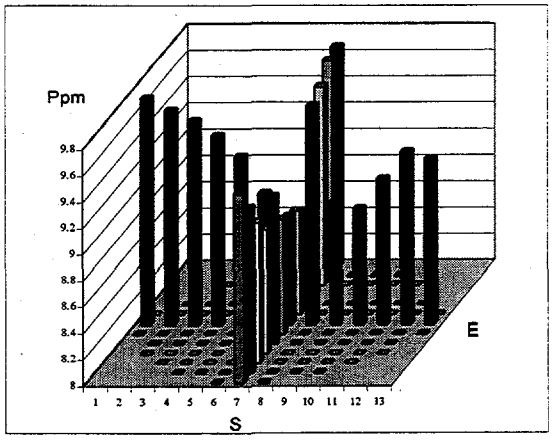
	Start	Finish		
Tracer tank pressure	310	310	psig	Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98
Ambient temp	72	72	F	
Injection flowmeter	11	10.5	lpm [glass ball in meter]	
Sampling flowmeter (Sierr	5	5	lpm	
Ambient pressure	751	751	mm Hg	
Ambient humidity	57%	57%	RH	
Centerline vel.	1323	1331	m/s	
B&K vapor correction	None			

Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler



TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJul20_3**
Date	7/20/98	Injection point	**Bottom Left**
Tester	Maughan	Fan Setting	**22 Hz**
Stack Dia.	12 in.	Stack Temp	72 deg F
Stack X-Area	113.1 in.	Fan	NEAR
		Center 2/3 from	1.10 to: 10.90
El. above disturbance	106.5	Points in Center 2/3	3 to: 10
Concentration units	ppm SF_6		

Traverse-->		West			South		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	8.69	8.52	8.59	8.98	8.93	9.12
2	0.80	8.47	8.48	8.37	9.01	8.95	9.01
3	1.42	8.42	8.47	8.65	8.80	8.89	8.91
4	2.12	8.49	8.65	8.45	8.77	8.88	8.61
5	3.00	8.28	8.47	8.18	8.79	8.66	8.67
6	4.27	8.77	8.44	8.64	8.69	8.77	8.79
Centerpoint	6.00	8.74	8.87	8.63	8.92	8.90	8.75
7	7.73	8.96	9.44	9.26	9.09	9.03	8.39
8	9.00	10.10	9.71	9.71	9.41	9.09	9.64
9	9.88	9.87	9.98	9.63	9.51	9.72	9.96
10	10.58	9.98	9.69	9.91	10.10	10.10	10.00
11	11.20	10.00	10.10	9.81	10.40	10.40	10.30
12	11.50	9.99	9.92	10.40	10.20	10.60	10.80

	East			North			All
Average of all data	9.14	9.13	9.09	9.28	9.30	9.30	9.21
Min							8.18
Max							10.80

Center 2/3							All
Mean	9.07	9.08	9.01	9.12	9.12	9.08	9.08
Std. Dev.	0.718	0.622	0.629	0.469	0.477	0.615	0.567
COV %	7.9	6.8	7.0	5.1	5.2	6.8	6.2

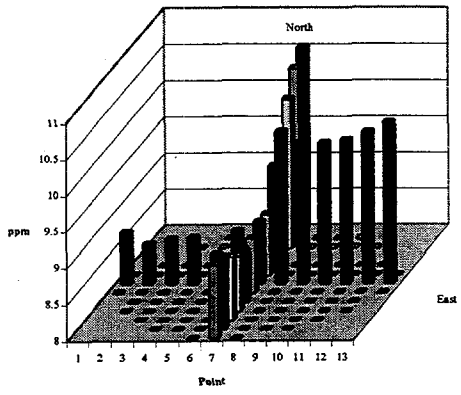
	Start	Finish		
Tracer tank pressure	310	310	psig	Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98
Ambient temp	72	72	F	
Injection flowmeter	11	11	lpm [glass ball in meter]	
Sampling flowmeter (Sierr	5	5	lpm	
Ambient pressure	751	751	mm Hg	
Ambient humidity	57%	57%	RH	
Centerline vel.	1331	1279	m/s	
B&K vapor correction	None			

Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler



TRACER GAS TRAVERSE DATA FORM

Site	W059 Model in 305 Building	Run No.	**GTJul20_4D**	Dup. of	GTJun30_1
Date	7/20/98	Injection point	**CENTER E-W Port input**		
Tester	Maughan	Fan Setting	**60 Hz**		
Stack Dia.	12 in.	Stack Temp	72 deg F		
Stack X-Area	113.1 in.	Fan	NEAR		
		Center 2/3 from	1.10	to:	10.90
El. above disturbance	106.5	Points in Center 2/3	3	to:	10
Concentration units	ppm SF_6				

Traverse-->		West			South		
Trial ---->		1	2	3	1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	6.08	6.15	6.28	6.00	5.86	6.08
2	0.80	6.07	6.14	6.04	5.79	5.99	6.07
3	1.42	6.08	6.13	6.17	5.85	5.95	5.97
4	2.12	6.17	6.20	6.04	5.79	5.91	6.00
5	3.00	6.00	6.03	6.04	5.79	5.85	5.86
6	4.27	6.02	5.91	5.98	5.83	5.73	5.83
Centerpoint	6.00	5.83	5.76	5.78	5.60	5.51	5.56
7	7.73	5.65	5.62	5.71	5.44	5.42	5.51
8	9.00	5.74	5.57	5.66	5.25	5.32	5.42
9	9.88	5.62	5.70	5.79	5.19	5.19	5.23
10	10.58	5.56	5.68	5.62	5.07	5.22	5.16
11	11.20	5.63	5.50	5.71	4.95	5.18	5.14
12	11.50	5.53	5.73	5.69	5.13	5.07	5.03

	East			North			All
Average of all data	5.84	5.86	5.89	5.51	5.55	5.60	5.71
Min							4.95
Max							6.28

Center 2/3							All
Mean	5.85	5.84	5.87	5.53	5.57	5.62	5.71
Std. Dev.	0.223	0.231	0.196	0.305	0.300	0.314	0.291
COV %	3.8	4.0	3.3	5.5	5.4	5.6	5.1

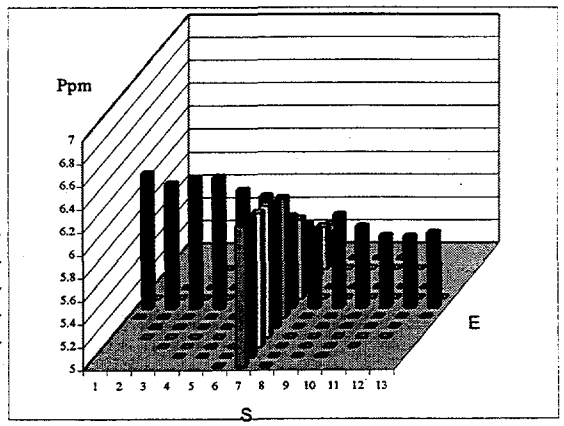
	Start	Finish		
Tracer tank pressure	310	310	psig	Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98
Ambient temp	72	72	F	
Injection flowmeter	26	26	lpm [glass ball in meter]	
Sampling flowmeter (Sierr	10	10	lpm	
Ambient pressure	751.108	751.108	mm Hg	
Ambient humidity	38%	38%	RH	
Centerline vel.	3550	3550	m/s	
B&K vapor correction	None	None		
Sierra flow setting	10	10	lpm	

Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler



TRACER GAS TRAVERSE DATA FORM

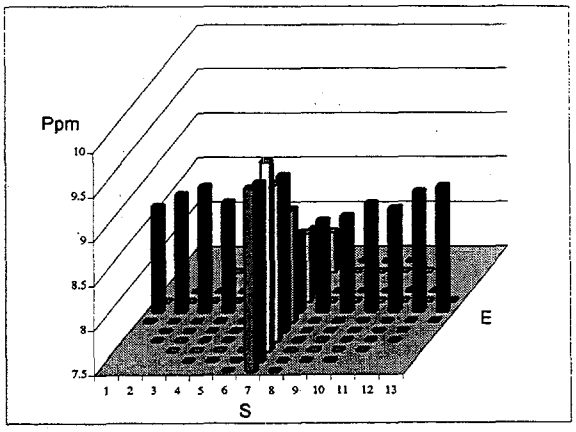
Site	W059 Model in 305 Building	Run No.	**GTJul20_5D**	Dup. of	GTJul7_1
Date	7/20/98	Injection point	**Top**		
Tester	Maughan	Fan Setting	**22 Hz**		
Stack Dia.	12 in.	Stack Temp	73 deg F		
Stack X-Area	113.1 in.	Fan	NEAR		
		Center 2/3 from	1.10	to:	10.90
El. above disturbance	106.5 in.	Points in Center 2/3	3	to:	10
Concentration units	ppm SF_6				

Traverse-->		West			South		
Trial --->		1	2	3	1	2	3
Point	Depth, in.	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.50	8.58	8.85	8.63	9.43	9.66	9.27
2	0.80	8.78	8.85	8.82	9.60	8.91	9.69
3	1.42	9.01	8.84	8.86	9.62	9.50	9.45
4	2.12	8.75	8.68	8.76	9.53	8.96	9.02
5	3.00	8.64	8.44	8.93	9.24	9.02	9.20
6	4.27	8.62	8.69	9.00	8.67	8.66	8.68
Centerpoint	6.00	8.15	8.49	8.51	8.27	8.19	8.42
7	7.73	8.41	8.70	8.45	8.27	8.13	8.14
8	9.00	8.41	8.88	8.43	8.01	8.14	8.19
9	9.88	8.87	8.59	8.68	8.18	7.80	8.00
10	10.58	8.59	8.59	8.81	8.00	8.03	7.57
11	11.20	8.73	9.02	8.79	7.71	7.67	7.66
12	11.50	8.66	9.16	8.89	7.41	7.27	7.40

	East			North			All
Average of all data	8.63	8.75	8.74	8.61	8.46	8.51	8.62
Min							7.27
Max							9.69

Center 2/3							All
Mean	8.61	8.66	8.71	8.64	8.49	8.52	8.61
Std. Dev.	0.260	0.146	0.210	0.652	0.568	0.616	0.443
COV %	3.0	1.7	2.4	7.5	6.7	7.2	5.2

	Start	Finish		
Tracer tank pressure	310	310	psig	Gas analyzer checked on: 5/29/98, 6/10/98, 8/27/98
Ambient temp	73	73	F	
Injection flowmeter	11	11	lpm [glass ball in meter]	
Sampling flowmeter	5	5	lpm	
Ambient pressure	751	751	mm Hg	
Ambient humidity	38%	38%	RH	
Centerline vel.	1294	1312	m/s	
B&K vapor correction	None			



Instuments Used:

Solomat Zephyr #12951472. Cal. exp. date: 5/1/99

B & K Model 1302 #1765299

Sierra Inc. Constant Flow Air Sampler

Appendix D

Test to Determine the Uniformity of Tracer Particles

Appendix D: Procedure to Test the Uniformity of Particle Concentrations

Using a Polydispersed Aerosol

July 9, 1998

A uniform contaminant concentration at the sampling plane (i.e., the plane of the sampling-probe nozzle) enables the collection of samples that represent the true concentration. This uniformity is demonstrated by measuring the mixing or uniformity of air momentum and the concentrations of gas and particle contaminants. This procedure addresses the particle-concentration uniformity test.

The general approach is to inject particles of a range of sizes, including the size of interest, into the test stack just downstream of the fan. The concentration of the particles of the size of interest is then measured at several points in the cross section of the sampling plane using an optical particle counter (OPC). A simple sampling probe will extract an aliquot of the stack airflow for counting by the OPC. Because the generation rate for tracer particles may vary with time, a second OPC may optionally be used to observe the particle concentration from a fixed point in the stack. The data from the traversing OPC can then be adjusted if there is a temporal trend observed with the fixed OPC. Several particle injection points and stack flowrates may be tested as additional parameters affecting the mixing determination. The coefficient of variance of the concentration readings at the individual points is calculated and the result compared to the acceptance criterion for uniformity. The particle mixing is acceptable if the coefficient of variance (COV) of the tracer 10-μm aerodynamic diameter (AD) particles is less than 20% across the center two-thirds of the sampling plane.

Potential Test Conditions

For any given injection plane, use a particle injection point at the duct centerline as a minimum. Where the tracer-gas tests show borderline acceptable mixing, suggested additional points should be within 20% of a diameter from the wall at four orthogonally spaced points. This test can be repeated using various tracer injection points to determine if the COV is sensitive to "streaming" at the point where contaminants can be released downstream of the final ventilation filters. Initial tests should be performed at the average or the extremes of the stack flowrate range.

Equipment

Aerosol generator
Two calibrated OPCs
Sampling probes for the particle counters
Particle injection probe
Aerosol generator feed oil

Setup for Optical Particle Counter

The absolute calibration of the OPC is not especially important because the concentration data are used in a relative manner to calculate the COV and to plot the particle concentrations at the measurement points. The instrument's response may be checked against calibrated standard particles (e.g., polystyrene latex spheres from Duke Scientific) to address relative accuracy. Here, it is assumed sufficient to determine the accuracy with which the tracer particles of a known size are consistently counted in the same OPC particle-size channel. This can be determined by an annual factory calibration of the OPC channels.

The sampling probes for both OPCs should be identical and of a simple design. The elevation of the intake nozzle of the traversing unit should be the same as the sampling plane. The intake nozzle for the fixed unit may be located anywhere within the stack at an elevation near that of the sampling plane. The two probes should not interfere with each other, either physically or by causing flow disturbances for each other. The intake nozzles may be of subisokinetic or shrouded design to optimize the collection of the 10-μm particles. Mark the traversing OPC's sampling probe to aid in placing the inlet at each measurement point.

The aerodynamic characteristics of the probes for both OPCs should be the same and have similar line-loss (penetration) values. A flexible tube probe could have changing shape, which would result in variable line-loss problems during the tests. To keep the line loss fixed and comparable, the probes should be of a fixed and rigid configuration. The use of the traversing OPC is facilitated by mounting it on a sliding platform, allowing movement along the axis of the sampling port.

The settings for the parameters and operation of the OPCs and aerosol generator are detailed in other procedures. The OPC data can be recorded initially on either the internal paper tape or using the RS232 connection to a computer serial port.

Setup for Aerosol Generator

The aerosol generator consists of a spray nozzle with a compressed air and oil reservoir. The compressed air supply should be filtered and controlled by a regulator. A non-hazardous oil with a low vapor pressure (such as vacuum pump oil) should be used in the reservoir. The level in the oil reservoir should cover the intake screen. The nozzle is mounted in a large diameter pipe (4-inches diameter or larger). The compressed air passing through the nozzle draws the oil into the nozzle and conveys the aerosol out the end of the pipe and to the injection tube. The quantity of aerosol is controlled by the compressed air pressure. The oil reservoir should be mounted to avoid spills. The aerosol generator output should connect to an injection tube with an inside diameter of at least 0.5 inches.

Setup for Stack Measurements

Lay out the sampling points using the same method as for a velocity traverse (40 CFR 60, Appendix A, Method 1) with the addition of the center point. These can be the same points as those used for

the gaseous tracer experiment. Points closer to the stack wall than one-half the width of the traversing OPC's sampling probe should be omitted. As a minimum, the points in the central 2/3 of the duct area must be sampled.

Measurements

On the data record sheet, record the test conditions of injection point, stack-flow control setting, date, time, and stack temperature. Also record the equipment used and the names of test operators. After the fan controller is set as needed for the test conditions, verify the centerline air velocity at the sampling plane using a pitot tube or other anemometer. At the end of the test, re-record any test parameters if they have changed.

Start the OPCs and make a series of measurements of the background level of aerosol in the stack after the readings stabilize. Do not proceed with the test if the background exceeds 5% of the anticipated average concentration in the stack when the aerosol generator is started.

Position the injection probe as directed for the test conditions. Start the injection of the tracer particles. Adjust the aerosol generator output so the particle count is well above background and at least 200 particles per cubic foot.

Position the probe of the traversing OPC at each measurement point, in succession, so that the face opening of the probe is aligned with the axis of the stack. Record the reading for the concentration of tracer particles at each measurement point in the 9- to 11-μm channel of the OPC. Perform two or three repetitions of the measurements in each traverse direction, two if it is highly repeatable, three if not so repeatable. Fill out a data sheet for each test. Label the columns of traverse data by the direction of the traverse. For example, if the first reading is closest to the east port, and the last reading is closest to the west port, then label the traverse east-west.

At the end of the test, turn off the aerosol generator and record the background particle count in the stack. The test may be invalid if the ending ambient concentration is elevated above that at the start of the test. This would indicate poor dispersion away from the test site and recirculating of the tracer to the inlet of the fan, which may result in a false indication of good mixing. The use of an inlet filter upstream of the fan should significantly reduce the background.

For each test, calculate the coefficient of variance for each tracer-concentration traverse using the average concentration data from all points in the inner two-thirds of the cross section area (including the centerpoint). The acceptance criterion for the COV is ≤20% for the inner two-thirds of the stack diameter. The COV is 100 times the mean divided by the standard deviation.

Exceptions to this method should be noted on the data sheets.

CAUTION - The American Conference of Governmental Industrial Hygienists (ACGIH) time weighted average limit for human exposure to mineral oil mist is 5 mg/m^3.

PARTICLE TRAVERSE RESULTS SUMMARY

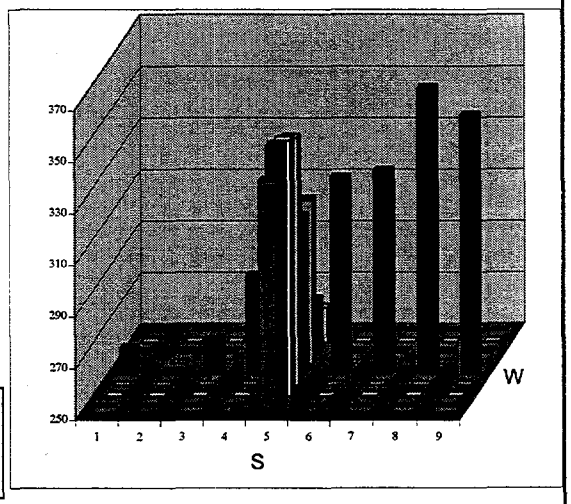
Site	W059 Scale Model Stack in 305	Run No.	PTJUl10_1
Testers:	Glissmeyer & Maughan	Date	7/10/98
Stack Dia.	12 in.		
Stack X-Area	113.10 in^2	Oil	Fisherbrand 19
Measurement elevation	in.	Fan Position	Near
El. above disturbance	106.5 in.	Fan Setting	60 Hz
Injection Point:	Centerline Near	Center 2/3 from	1.10 inches to: 10.90
		Points in Center 2/3	3 to: 10

Each OPC data point includes: 1 min concentration counts/ft3 in 9 - 11 micron channel

	South				East			
Point	1	2	3	Avg.	1	2	3	Avg.
3	275	275	315	288.3	270	262	248	260.0
4	296	287	307	296.7	245	246	263	251.3
5	280	316	288	294.7	260	261	268	263.0
6	306	289	281	292.0	291	287	286	288.0
Center	257	274	258	263.0	321	306	307	311.3
7	241	272	281	264.7	331	343	304	326.0
8	206	240	240	228.7	326	337	323	328.7
9	226	200	241	222.3	353	328	402	361.0
10	191	209	234	211.3	353	340	358	350.3
	North				West			
Center 2/3								**Grand**
Mean	253.11	262.44	271.67	262.41	305.56	301.11	306.56	304.41	283.41
Std. Dev.	40.02	38.44	29.82	33.77	40.35	38.20	49.08	40.60	42.18
C.O.V	15.81	14.65	10.98	12.87	13.21	12.69	16.01	13.34	14.88

Adjusted so Centerpoints Equal

	South		East		
Point	Avg.	Adj.	Avg.	Adj.	
3	288.3	312.5	260.0	235.8	
4	296.7	320.8	251.3	227.2	
5	294.7	318.8	263.0	238.8	
6	292.0	316.2	288.0	263.8	
Center	263.0	287.2	311.3	287.2	
7	264.7	288.8	326.0	301.8	
8	228.7	252.8	328.7	304.5	
9	222.3	246.5	361.0	336.8	
10	211.3	235.5	350.3	326.2	
	North		West		
Center 2/3					**Grand**
Mean	262.4	286.6	304.4	280.2	283.4
Std. Dev.	33.8	33.8	40.6	40.6	36.4
C.O.V	12.9	11.8	13.3	14.5	12.8



Mobile divided by Fixed Readings

	South				East				
Point	1	2	3	Avg.	1	2	3	Avg.	
3	1.81	1.56	1.78	1.72	2.48	2.18	1.60	2.09	
4	1.83	1.85	1.71	1.79	2.19	1.82	2.14	2.05	
5	1.87	1.99	1.60	1.82	2.36	2.29	2.23	2.30	
6	1.87	1.86	1.82	1.85	2.53	2.21	2.09	2.28	
Center	1.49	1.81	1.51	1.60	2.63	2.28	2.33	2.41	
7	1.59	1.79	1.71	1.70	3.09	2.49	2.29	2.62	
8	1.26	1.34	1.40	1.33	3.05	3.27	2.18	2.83	
9	1.63	1.32	1.32	1.42	3.10	2.78	3.35	3.08	
10	1.18	1.33	1.19	1.23	2.97	3.12	2.82	2.97	
	North				West				
Center 2/3									**Grand**
Mean	1.61	1.65	1.56	1.61	2.71	2.49	2.34	2.51	2.06
Std. Dev.	0.26	0.27	0.22	0.23	0.35	0.47	0.49	0.38	0.56
C.O.V	16.21	16.08	14.20	14.11	12.79	18.99	21.09	15.08	26.99

PARTICLE TRAVERSE RESULTS SUMMARY

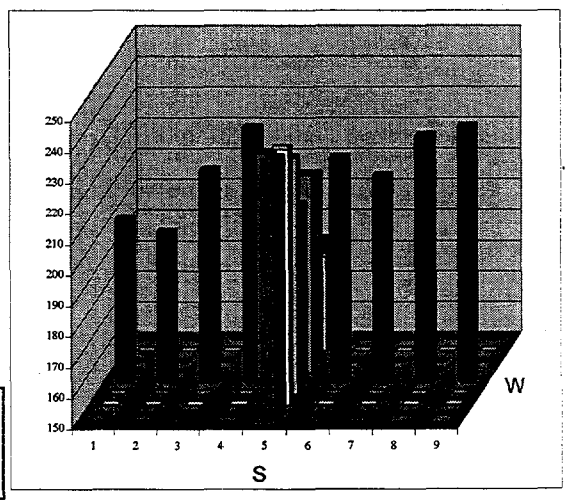
Site	W059 Scale Model Stack in 305	Run No.	PTJUl10_2
Testers:	Maughan	Date	7/10/98
Stack Dia.	12 in.		
Stack X-Area	113.10 in^2	Oil	Fisherbrand 19
Measurement elevation	in.	Fan Position	Near
El. above disturbance	106.5 in.	Fan Setting	22 Hz
Injection Point:	Centerline Near	Center 2/3 from	1.10 inches to: 10.90
		Points in Center 2/3	3 to: 10

Each OPC data point includes: 1 min concentration counts/ft3 in 9 - 11 micron channel

	South				East			
Point	1	2	3	Avg.	1	2	3	Avg.
3	203	227	240	223.3	210	207	192	203.0
4	221	227	209	219.0	193	218	186	199.0
5	205	236	214	218.3	243	209	206	219.3
6	222	209	206	212.3	196	248	255	233.0
Center	224	163	197	194.7	212	207	205	208.0
7	222	177	203	200.7	232	219	219	223.3
8	195	186	211	197.3	212	224	216	217.3
9	181	163	163	169.0	221	222	248	230.3
10	183	158	172	171.0	220	229	251	233.3
	North				West			
Center 2/3								**Grand**
Mean	206.22	194.00	201.67	200.63	215.44	220.33	219.78	218.52	209.57
Std. Dev.	17.12	31.10	22.86	20.09	15.89	12.98	25.85	12.88	18.78
C.O.V	8.30	16.03	11.33	10.01	7.38	5.89	11.76	5.89	8.96

Adjusted so Centerpoints Equal

	South		East		
Point	Avg.	Adj.	Avg.	Adj.	
3	223.3	230.0	203.0	196.3	
4	219.0	225.7	199.0	192.3	
5	218.3	225.0	219.3	212.7	
6	212.3	219.0	233.0	226.3	
Center	194.7	201.3	208.0	201.3	
7	200.7	207.3	223.3	216.7	
8	197.3	204.0	217.3	210.7	
9	169.0	175.7	230.3	223.7	
10	171.0	177.7	233.3	226.7	
	North		West		
Center 2/3					**Grand**
Mean	200.6	207.3	218.5	211.9	209.6
Std. Dev.	20.1	20.1	12.9	12.9	16.5
C.O.V	10.0	9.7	5.9	6.1	7.9



PARTICLE TRAVERSE RESULTS SUMMARY

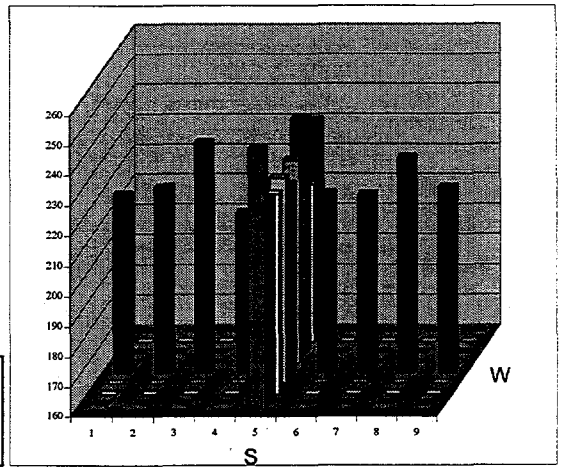
Site	W059 Scale Model Stack in 305	Run No.	PTJUI10_3
Testers:	Maughan	Date	7/10/98
Stack Dia.	12 in.		
Stack X-Area	113.10 in^2	Oil	Fisherbrand 19
Measurement elevation	in.	Fan Position	Far
El. above disturbance	106.5 in.	Fan Setting	22 Hz
Injection Point:	Centerline Far	Center 2/3 from	1.10 inches to: 10.90
		Points in Center 2/3	3 to: 10

Each OPC data point includes: 1 min concentration counts/ft3 in 9 - 11 micron channel

	South				East			
Point	1	2	3	Avg.	1	2	3	Avg.
3	219	220	235	224.7	212	222	223	219.0
4	218	191	211	206.7	225	209	230	221.3
5	205	186	223	204.7	219	242	248	236.3
6	222	217	180	206.3	209	222	208	213.0
Center	213	196	195	201.3	248	222	197	222.3
7	188	232	197	205.7	234	200	224	219.3
8	223	223	199	215.0	247	205	205	219.0
9	191	196	189	192.0	233	228	233	231.3
10	203	219	203	208.3	244	209	211	221.3
	North				West			
Center 2/3								**Grand**
Mean	209.11	208.89	203.56	207.19	230.11	217.67	219.89	222.56	214.87
Std. Dev.	13.13	16.59	17.05	8.96	14.77	13.12	16.03	7.04	11.12
C.O.V	6.28	7.94	8.38	4.33	6.42	6.03	7.29	3.16	5.18

Adjusted so Centerpoints Equal

	S/N Traverse		E/W Traverse		
Point	Avg.	Adj.	Avg.	Adj.	
3	224.7	235.2	219.0	208.5	
4	206.7	217.2	221.3	210.8	
5	204.7	215.2	236.3	225.8	
6	206.3	216.8	213.0	202.5	
Center	201.3	211.8	222.3	211.8	
7	205.7	216.2	219.3	208.8	
8	215.0	225.5	219.0	208.5	
9	192.0	202.5	231.3	220.8	
10	208.3	218.8	221.3	210.8	
Center 2/3					**Grand**
Mean	207.2	217.7	222.6	212.1	214.9
Std. Dev.	9.0	9.0	7.0	7.0	8.3
C.O.V	4.3	4.1	3.2	3.3	3.9



PARTICLE TRAVERSE RESULTS SUMMARY

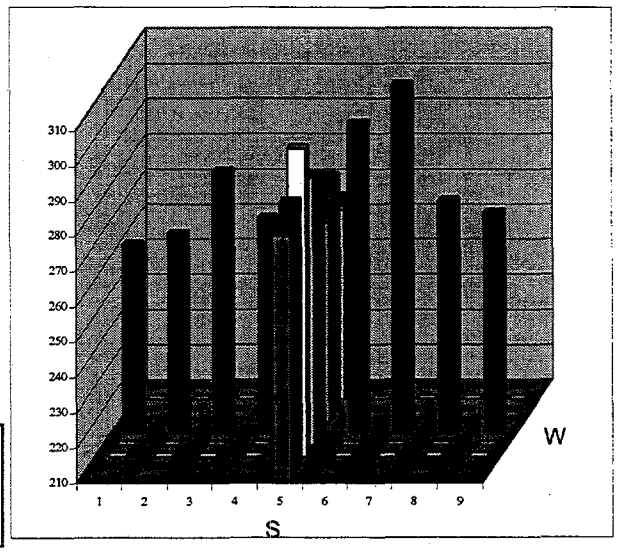
W059 Scale Model Stack in 305		Run No.	PTJUI11_1
Maughan		Date	7/11/98
	12 in.		
a	113.10 in^2	Oil	Fisherbrand 19
nt elevation	in.	Fan Position	Far
sturbance	106.5 in.	Fan Setting	60 Hz
int:	Centerline Far	Center 2/3 from	1.10 inches to: 10.90
		Points in Center 2/3	3 to: 10

ata point includes: 1 min concentration counts/ft3 in 9 - 11 micron channel

South				East			
1	2	3	Avg.	1	2	3	Avg.
277	308	252	279.0	298	238	232	256.0
284	302	271	285.7	261	283	233	259.0
286	319	288	297.7	308	261	260	276.3
270	291	297	286.0	286	242	262	263.3
288	294	268	283.3	299	255	272	275.3
269	271	260	266.7	318	277	274	289.7
266	297	267	276.7	338	287	276	300.3
271	270	250	263.7	312	244	249	268.3
237	288	268	264.3	275	274	246	265.0
North				West			
							Grand
272.00	293.33	269.00	278.11	299.44	262.33	256.00	272.59	275.35
15.39	15.97	15.35	11.52	23.24	18.65	16.90	14.60	13.07
5.66	5.44	5.71	4.14	7.76	7.11	6.60	5.35	4.75

Adjusted so Centerpoints Equal

South		East		
Avg.	Adj.	Avg.	Adj.	
279.0	275.0	256.0	260.0	
285.7	281.7	259.0	263.0	
297.7	293.7	276.3	280.3	
286.0	282.0	263.3	267.3	
283.3	279.3	275.3	279.3	
266.7	262.7	289.7	293.7	
276.7	272.7	300.3	304.3	
263.7	259.7	268.3	272.3	
264.3	260.3	265.0	269.0	
North		West		
				Grand
278.1	274.1	272.6	276.6	275.4
11.5	11.5	14.6	14.6	12.8
4.1	4.2	5.4	5.3	4.66



PARTICLE TRAVERSE RESULTS SUMMARY

Dup. of PTJul10_1

Site	W059 Scale Model Stack in 305	Run No.	PTJUl23_1D
Testers:	Maughan	Date	7/23/98
Stack Dia.	12 in.		
Stack X-Area	113.10 in^2	Oil	Fisherbrand 19
Measurement elevation	in.	Fan Position	NEAR
El. above disturbance	106.5 in.	Fan Setting	60 Hz
Injection Point:	Centerline NEAR	Center 2/3 from	1.10 inches to: 10.90
		Points in Center 2/3	3 to: 10

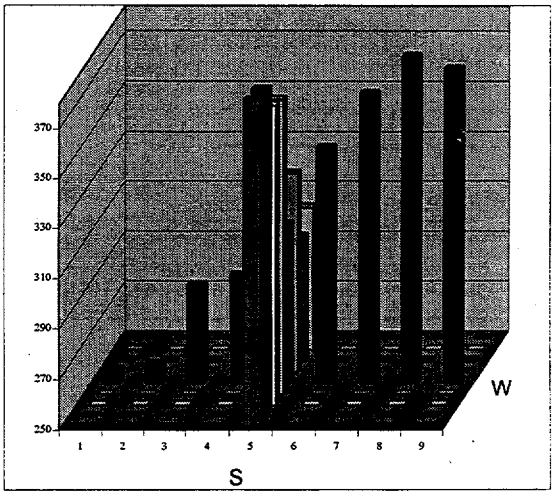
Each OPC data point includes: 1 min concentration counts/ft3 in 9 - 11 micron channel

	South				East			
Point	1	2	3	Avg.	1	2	3	Avg.
3	252	265	265	260.7	249	258	258	255.0
4	281	226	276	261.0	254	253	265	257.3
5	254	266	240	253.3	264	294	308	288.7
6	263	271	222	252.0	306	284	288	292.7
Center	219	220	205	214.7	310	327	302	313.0
7	221	225	231	225.7	334	364	333	343.7
8	206	221	189	205.3	370	373	353	365.3
9	206	222	203	210.3	358	396	386	380.0
10	193	201	211	201.7	350	394	381	375.0
	North				West			
Center 2/3								**Grand**
Mean	232.78	235.22	226.89	231.63	310.56	327.00	319.33	318.96	275.30
Std. Dev.	30.42	25.21	29.19	24.89	46.19	56.91	47.03	48.94	58.63
C.O.V	13.07	10.72	12.86	10.75	14.87	17.40	14.73	15.34	21.30

Note: In this run the N-S avg. differs significantl This run duplicating PTJul10_1 was again rerun from the average of the E-W transect. It was as PTJul23_1D. PTJul_1 COV = 14.88
found that the aerosol generator needs to run
for some 25-plus minutes to properly equilibrate.

Adjusted so Centerpoints Equal

	South		East	
Point	Avg.	Adj.	Avg.	Adj.
3	260.7	309.8	255.0	205.8
4	261.0	310.2	257.3	208.2
5	253.3	302.5	288.7	239.5
6	252.0	301.2	292.7	243.5
Center	214.7	263.8	313.0	263.8
7	225.7	274.8	343.7	294.5
8	205.3	254.5	365.3	316.2
9	210.3	259.5	380.0	330.8
10	201.7	250.8	375.0	325.8
	North		West	
Center 2/3				**Grand**
Mean	231.6	280.8	319.0	269.8	275.3
Std. Dev.	24.9	24.9	48.9	48.9	38.1
C.O.V	10.7	8.9	15.3	18.1	13.8



Mobile divided by Fixed Readings

	South				East				
Point	1	2	3	Avg.	1	2	3	Avg.	
3	1.81	1.56	1.78	1.72	2.48	2.18	1.60	2.09	
4	1.83	1.85	1.71	1.79	2.19	1.82	2.14	2.05	
5	1.87	1.99	1.60	1.82	2.36	2.29	2.23	2.30	
6	1.87	1.86	1.82	1.85	2.53	2.21	2.09	2.28	
Center	1.49	1.81	1.51	1.60	2.63	2.28	2.33	2.41	
7	1.59	1.79	1.71	1.70	3.09	2.49	2.29	2.62	
8	1.26	1.34	1.40	1.33	3.05	3.27	2.18	2.83	
9	1.63	1.32	1.32	1.42	3.10	2.78	3.35	3.08	
10	1.18	1.33	1.19	1.23	2.97	3.12	2.82	2.97	
	North				West				
Center 2/3									**Grand**
Mean	1.61	1.65	1.56	1.61	2.71	2.49	2.34	2.51	2.06
Std. Dev.	0.26	0.27	0.22	0.23	0.35	0.47	0.49	0.38	0.56
C.O.V	16.21	16.08	14.20	14.11	12.79	18.99	21.09	15.08	26.99

PARTICLE TRAVERSE RESULTS SUMMARY

Site	W059 Scale Model Stack in 305	Run No. **PTJUI28_1D**	Dup. of PTJul10_1
Testers:	Maughan	Date 7/28/98	
Stack Dia.	12 in.		
Stack X-Area	113.10 in^2	Oil Fisherbrand 19	
Measurement elevation	in.	Fan Position NEAR	
El. above disturbance	106.5 in.	Fan Setting 60 Hz	
Injection Point:	E-W Centerline NEAR	Center 2/3 from 1.10 inches to:	10.90
		Points in Center 2/3 3 to:	10

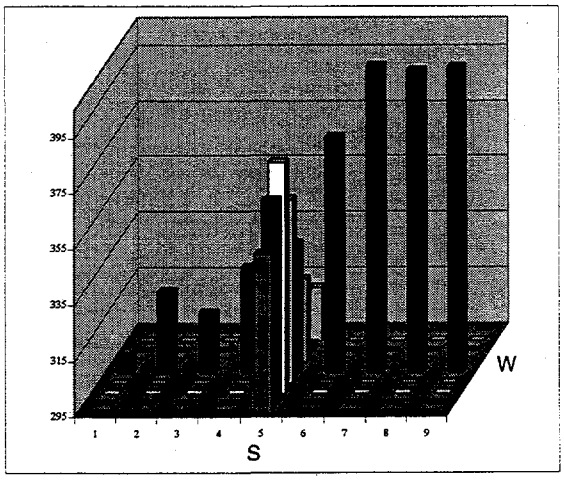
Each OPC data point includes: 1 min concentration counts/ft3 in 9 - 11 micron channel

	South				East			
Point	1	2	3	Avg.	1	2	3	Avg.
3	315	341	333	329.7	307	309	286	300.7
4	345	310	377	344.0	316	340	315	323.7
5	374	340	346	353.3	326	319	303	316.0
6	323	350	339	337.3	322	350	326	332.7
Center	306	348	303	319.0	354	342	327	341.0
7	284	303	324	303.7	386	360	392	379.3
8	272	285	278	278.3	422	413	405	413.3
9	300	296	285	293.7	394	420	396	403.3
10	242	241	259	247.3	416	384	414	404.7
	North				West			
Center 2/3								**Grand**
Mean	306.78	312.67	316.00	311.81	360.33	359.67	351.56	357.19	334.50
Std. Dev.	39.18	36.18	37.63	34.38	44.99	38.87	49.52	43.16	44.47
C.O.V	12.77	11.57	11.91	11.03	12.49	10.81	14.08	12.08	13.30

Optical Partical Counter."A" warmed-up, post-count average = 4.7 (9-11 micron range). PTJul10_1 COV = 14.88

Adjusted so Centerpoints Equal

	South		East		
Point	Avg.	Adj.	Avg.	Adj.	
3	329.7	340.7	300.7	289.7	
4	344.0	355.0	323.7	312.7	
5	353.3	364.3	316.0	305.0	
6	337.3	348.3	332.7	321.7	
Center	319.0	330.0	341.0	330.0	
7	303.7	314.7	379.3	368.3	
8	278.3	289.3	413.3	402.3	
9	293.7	304.7	403.3	392.3	
10	247.3	258.3	404.7	393.7	
	North		West		
Center 2/3					**Grand**
Mean	311.8	322.8	357.2	346.2	334.5
Std. Dev.	34.4	34.4	43.2	43.2	39.7
C.O.V	11.0	10.7	12.1	12.5	11.9



Mobile divided by Fixed Readings

	South				East				
Point	1	2	3	Avg.	1	2	3	Avg.	
3	1.81	1.56	1.78	1.72	2.48	2.18	1.60	2.09	
4	1.83	1.85	1.71	1.79	2.19	1.82	2.14	2.05	
5	1.87	1.99	1.60	1.82	2.36	2.29	2.23	2.30	
6	1.87	1.86	1.82	1.85	2.53	2.21	2.09	2.28	
Center	1.49	1.81	1.51	1.60	2.63	2.28	2.33	2.41	
7	1.59	1.79	1.71	1.70	3.09	2.49	2.29	2.62	
8	1.26	1.34	1.40	1.33	3.05	3.27	2.18	2.83	
9	1.63	1.32	1.32	1.42	3.10	2.78	3.35	3.08	
10	1.18	1.33	1.19	1.23	2.97	3.12	2.82	2.97	
	North				West				
Center 2/3									**Grand**
Mean	1.61	1.65	1.56	1.61	2.71	2.49	2.34	2.51	2.06
Std. Dev.	0.26	0.27	0.22	0.23	0.35	0.47	0.49	0.38	0.56
C.O.V	16.21	16.08	14.20	14.11	12.79	18.99	21.09	15.08	26.99

Appendix E

Particle Penetration Test

Appendix E: Particle Penetration Test

Estimated Penetration for W059 Air Sampling System
Results of DEPOSITION 4.0 Analysis

For a 1.5-Inch-Diameter Tube, 15,000 cfm Stack Flow

Deposition 4.0. Fri Apr 03 12:24:12 1998

Exit Stokes #	Exit Reynolds #	Total Penetration
0.0086	2209	87.4%

Element # Element	Penetration	Stokes #	Reynolds #	Notes
1. Probe	101.1%	0.0086	2209	Probe diameter: 0.00 mm, Shroud diameter: 2.00 mm, Velocity reduction ratio 0.000
2. Bend	96.2%	0.0086	2209	Bend angle: 90.000 degrees
3. Tube	93.6%	0.0086	2209	Length: 0.600 m, At 0.000 degrees from horizontal
4. Bend	96.2%	0.0086	2209	Bend angle: 90.000 degrees
5. Tube	99.9%	0.0086	2209	Length: 11.460 m, At 90.000 degrees from horizontal

Ambient temperature (deg.C): 25.0
Ambient pressure (mm Hg): 760.0
Flow rate (L/min): 56.6
Free stream velocity (m/s): 13.6
Particle diameter (μm): 10.0

NOTES

Calculations were made with the best possible extrapolations of the model(s).

For a 1.5-Inch-Diameter Tube, 7,500 cfm Stack Flow

Deposition 4.0. Fri Apr 03 12:26:10 1998

Exit Stokes #	Exit Reynolds #	Penetration
0.0086	2209	81.6%

Element # Element	Penetration	Stokes #	Reynolds #	Notes
1. Probe	94.4%	0.0086	2209	Probe diameter: 0.00 mm, Shroud diameter: 2.00 mm, Velocity reduction ratio 0.000
2. Bend	96.2%	0.0086	2209	Bend angle: 90.000 degrees
3. Tube	93.6%	0.0086	2209	Length: 0.600 m, At 0.000 degrees from horizontal
4. Bend	96.2%	0.0086	2209	Bend angle: 90.000 degrees
5. Tube	99.9%	0.0086	2209	Length: 11.460 m, At 90.000 degrees from horizontal

Ambient temperature (deg.C): 25.0
Ambient pressure (mm Hg): 760.0
Flow rate (L/min): 56.6
Free stream velocity (m/s): 6.8
Particle diameter (μm): 10.0

NOTES

Calculations were made with the best possible extrapolations of the model(s).

As a Function of Tube Inside Diameter

Deposition 4.0. Fri Apr 03 12:27:16 1998

Tube Diameter (mm): vary from 25.000 to 50.000 with 25 intervals
Flow Rate (L/min): 56.600 # of components: 5
Particle Density (g/mL): 1.000

MONODISPERSED Particle Distribution: 10.00 micrometers.

Element 1: Shrouded PROBE with 18.20-mm Probe Diameter, 52.50-mm Shroud Diameter, 3.00 Velocity Reduction Ratio

Element 2: 90.00-degree BEND

Element 3: 0.600-m TUBE at 0.000 degrees from horizontal

Element 4: 90.00 degree BEND

Element 5: 11.460-m TUBE at 90.000 degrees from horizontal

			Component % Penetration					
Tube ID (mm)	Stokes#	Reynolds#	Total	1	2	3	4	5
25.000	0.0231	3066	77.2	101.1	90.1	95.3	90.1	98.7
26.000	0.0205	2948	79.1	101.1	91.2	95.1	91.2	99.0
27.000	0.0183	2839	80.8	101.1	92.1	95.0	92.1	99.3
28.000	0.0164	2737	82.2	101.1	92.9	94.8	92.9	99.5
29.000	0.0148	2643	83.3	101.1	93.5	94.6	93.5	99.6
30.000	0.0134	2555	84.4	101.1	94.2	94.4	94.2	99.7
31.000	0.0121	2472	85.2	101.1	94.7	94.3	94.7	99.7
32.000	0.0110	2395	85.9	101.1	95.2	94.1	95.2	99.8
33.000	0.0100	2323	86.6	101.1	95.6	93.9	95.6	99.8
34.000	0.0092	2254	87.1	101.1	95.9	93.7	95.9	99.9
35.000	0.0084	2190	87.6	101.1	96.3	93.5	96.3	99.9
36.000	0.0077	2129	87.9	101.1	96.6	93.4	96.6	99.9
37.000	0.0071	2072	88.3	101.1	96.8	93.2	96.8	99.9
38.000	0.0066	2017	88.6	101.1	97.1	93.0	97.1	99.9
39.000	0.0061	1965	88.8	101.1	97.3	92.8	97.3	99.9
40.000	0.0056	1916	89.0	101.1	97.5	92.7	97.5	100.0

Tube ID (mm)	Stokes#	Reynolds#	Component % Penetration					
			Total	1	2	3	4	5
41.000	0.0052	1869	89.1	101.1	97.7	92.5	97.7	100.0
42.000	0.0049	1825	89.3	101.1	97.8	92.3	97.8	100.0
43.000	0.0045	1782	89.4	101.1	98.0	92.1	98.0	100.0
44.000	0.0042	1742	89.4	101.1	98.1	92.0	98.1	100.0
45.000	0.0040	1703	89.5	101.1	98.2	91.8	98.2	100.0
46.000	0.0037	1666	89.5	101.1	98.3	91.6	98.3	100.0
47.000	0.0035	1631	89.6	101.1	98.4	91.4	98.4	100.0
48.000	0.0033	1597	89.6	101.1	98.5	91.3	98.5	100.0
49.000	0.0031	1564	89.5	101.1	98.6	91.1	98.6	100.0
50.000	0.0029	1533	89.5	101.1	98.7	90.9	98.7	100.0

NOTES

Calculations were made with the best possible extrapolations of the model(s).

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