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Generic Effluent Monitoring System Certification for AP-40 Exhauster Stack

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

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(a) Waste Management Federal Services of Hanford, Inc.
(b) Numatec Hanford Co.

Summary

Tests were conducted to verify that the Generic Effluent Monitoring System (GEMS), as applied to the AP-40 exhauster stack, meets all applicable regulatory performance criteria for air sampling systems at nuclear facilities. These performance criteria address both the suitability of the air sampling probe location and the transport of the sample to the collection devices. The criteria covering air sampling probe location 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 the report. The tests demonstrated that the GEMS/AP-40 system meets all applicable performance criteria.

The contaminant mixing tests were conducted by Pacific Northwest National Laboratory (PNNL) at the wind tunnel facility, 331-H Building, using a mockup of the actual stack. The particle sample transport tests were conducted by PNNL at the Numatec Hanford Company's 305 Building. The AP-40 stack is typical of several 10-in. diameter stacks that discharge the filtered ventilation air from tank farms at the U.S. Department of Energy's Hanford Site in Richland, Washington. The GEMS design features a probe with a single shrouded sampling nozzle, a sample delivery line, and sample collection system. The collection system includes a filter holder to collect the sample of record and an in-line detector head and filter for monitoring beta radiation-emitting particles.

Unrelated to the performance criteria, it was found that the record sample filter holder exhibited symptoms of sample bypass around the particle collection filter. This filter holder should either be modified or replaced with a different type.

Acknowledgments

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1.0 Introduction

Tests were conducted to verify that the Generic Effluent Monitoring System (GEMS), as applied to the AP-40 exhauster stack, meets the performance criteria developed for air sampling systems at nuclear facilities. The performance criteria address both the suitability of the air sampling extraction location and the transport of the sample to the collection devices. Contaminants in the stack must be well mixed with the airflow at the sampling probe location. This ensures that the extracted sample represents the whole. Also, the sample must be transported with minimal loss to the collection devices.

The stack/sampling system configuration tested (296-A-40, 241-AP Tank Farm) is typical of several stacks that provide airborne effluent control for the U.S. Department of Energy's radioactive waste storage tanks at the Hanford Site in Richland, Washington. The unit includes a stack section containing the sampling probe and another stack section containing the airflow, temperature, and humidity sensors. The GEMS design features a probe with a single shrouded sampling nozzle, a sample delivery line, and sample collection system. The collection system includes a filter holder to collect the sample of record and an in-line detector head and filter for monitoring beta radiation-emitting particles. The contaminant mixing tests were conducted by Pacific Northwest National Laboratory (PNNL) at the wind tunnel facility, 331-H Building, using a mockup of the actual stack. The particle sample transport tests were conducted by PNNL at the Numatec Hanford Company's 305 Building.

The following sections describe the regulatory and research background that constitute the basis for the performance tests and performance criteria and the GEMS/AP-40 Exhauster system. Test methods and results are discussed in Section 2.0, and conclusions are presented in Section 3.0. 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 requires the use of isokinetic[a] sampling nozzles as described in ANSI N13.1-1969 (American National Standards Institute 1982). More recent research (Rodgers et al. 1996; Glissmeyer and Ligotke 1995) indicates poor performance for isokinetic nozzles relative to that of the shrouded nozzle. The

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

U.S. Environmental Protection Agency (EPA) has approved a U.S. Department of Energy (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).

To meet the need for upgraded air sampling systems compliant with the FRD, a Generic Effluent Monitoring System (GEMS) was developed so the probe and instrumentation could be used at exhaust stacks of any size, with appropriate adaptation. The design features a single shrouded sampling nozzle, a short sample delivery line, and a sample collection system. The collection system includes a filter holder to collect the sample of record and an in-line detector head for monitoring beta and gamma radiation-emitting particles. It is the application of this system to the AP-40 Exhauster Stack that is the subject of this report.

1.2 Performance Criteria

Certifying the compliance of new air samplers with the requirements of the FRD consists of two phases. The first phase is to demonstrate contaminant mixing at the sample extraction location, 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 are conducted at the mean and extremes of flowrate.

The performance criteria are as follows:

1. Angular Flow - Sampling probe nozzles are generally aligned with the axis of the stack. If the air travels up the stack in cyclonic fashion, the air velocity vector may be approaching the nozzle at an angle severe enough to impair the extraction of particles. The acceptance criterion for the absence of angular or cyclonic flow is that the average air velocity angle shall not exceed 20° relative to the long axis of the stack.

2. Air Velocity Uniformity - It is important that the gas momentum across the stack cross section where the sample is extracted be well mixed or uniform. 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 be ≤20% across the center two-thirds of the area of the stack.

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

3. Gaseous Tracer Concentration Uniformity - 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. The acceptance criteria are that 1) the COV of the tracer gas concentration is ≤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 >30%.

4. Particle Tracer Concentration Uniformity - Uniformity in contaminant concentration at the sampling plane is tested using tracer particles of 10-μ aerodynamic diameter (AD)[a]. This particle size is large enough to exhibit inertial effects. The acceptance criterion requires that the COV of particle concentration is ≤20% across the center two-thirds of the sampling plane.

5. Sample Extraction and Transport System Performance - The criteria are that 1) nozzle transmission ratio for a 10-μ AD particle is 0.8 to 1.3, 2) nozzle aspiration ratio for a 10-μ AD particle is 0.8 to 1.5, and the 3) test particle penetration through transport system is ≥50% for 10-μ AD particles.

1.3 System Testing

Contaminant uniformity at the sampling location was tested using a mockup of the 296-A-40 stack as shown in Figure 1. It consists of two angle-discharge fans, 45° angled ducts, and a 110-in. tall stack with a 10 in. inside diameter. The tests were done at an elevation of 85 in. above the junction of the 45° angled duct and the stack. Only one fan is used at a time, so only one was used in the mockup, and the extra angled duct was blanked off. The actual stack contains an egg crate-style flow straightener in the stack, just above the point where the air from the fan enters the stack. Some tests included the flow straightener until it was concluded that the performance criteria could not be met with it installed. The mockup stack is diagrammed in Figure 1.

The particle transport tests were performed in a different mockup stack (Glissmeyer and Maughan 1997) using the same range of air velocity, stack diameter, and a GEMS sampling unit. Because the particle transport through the sampler tubing and probe is independent of the stack configuration, the results are directly applicable. They are included here.

Figure 2 diagrams the GEMS unit sampling cabinet, which contains a sample flow splitter, a record sample filter holder, a beta/gamma particle continuous air monitor (CAM) filter holder and sensing head, flowmeters, and automated flowrate control valves. The vacuum pumps and control systems are located in other cabinets. Attached to the sampling cabinet is the shrouded sampling nozzle (Figure 3) and sample transport line. The shrouded sampling nozzle, coupled to a short transport system, was shown to be

---

(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.

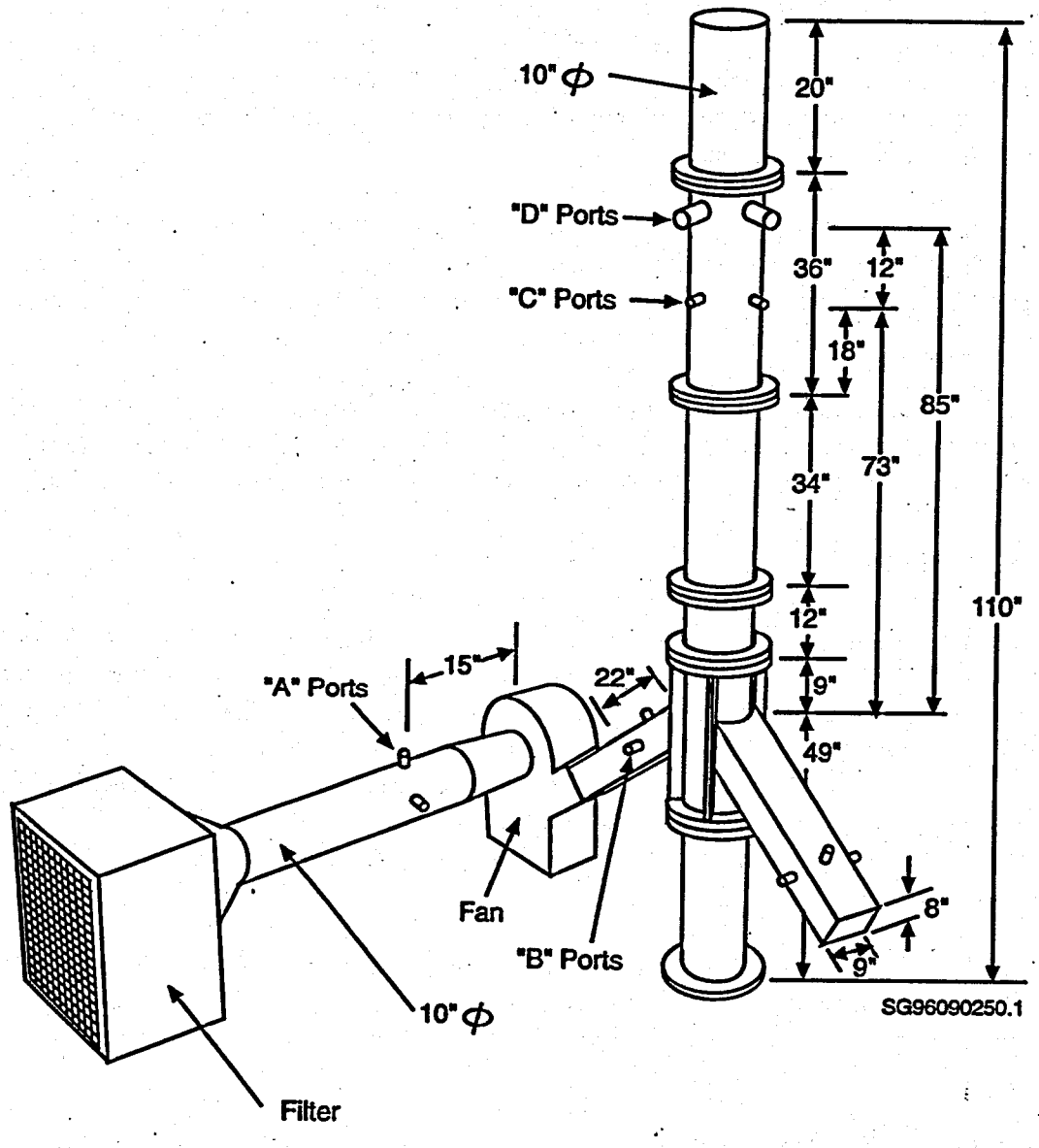

Figure 1. Mockup of AP-40 Exhauster Stack

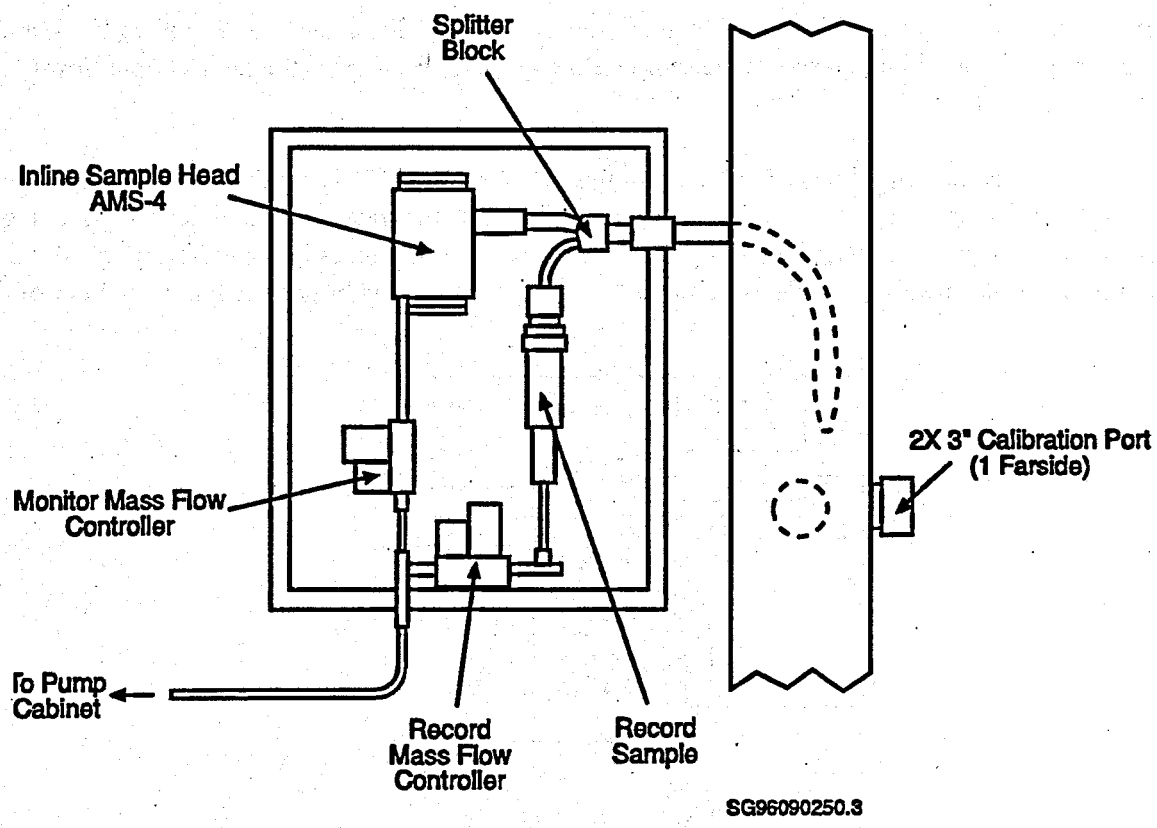

Figure 2. GEMS Sampling Cabinet

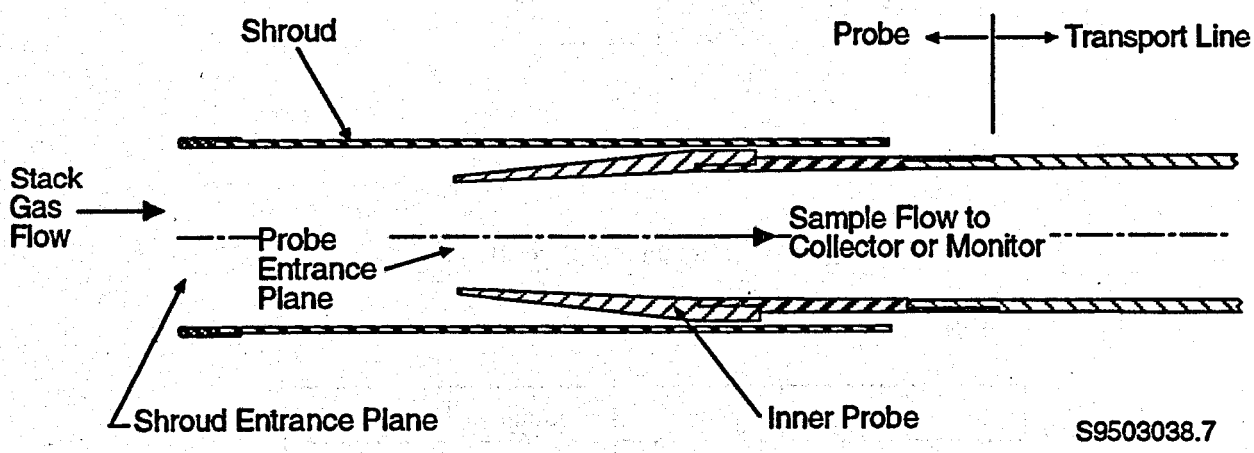

Figure 3. Configuration of Shrouded Nozzle

superior to systems using traditional isokinetic nozzles in tests by Glissmeyer and Ligotke (1995) and Rodgers et al. (1996). Figure 4 shows the sample flow splitter, which splits the total sample flow (2 scfm) into two equal parts.

The airflow conditions observed at the existing stack (Crummel 1994) are listed in Table 1. The stack is served by two fans, one in use and the other on standby. The flowrate is not intentionally varied, so the observed variation may be caused either by filter loading or by differences in the performance of the two fans as they are alternately used. These establish the range of flow conditions used in the battery of tests.

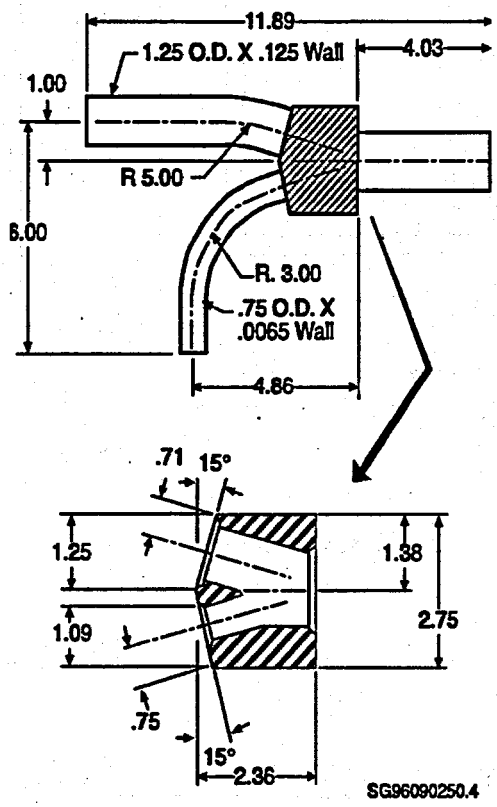

Figure 4. Diagram of Splitter Block

Table 1. Airflow Conditions Observed in the Existing Stack

	cfm	ft/min	m/s
Minimum	710	1301.76	6.61
Average	955	1750.96	8.89
Maximum	1167	2139.65	10.87

2.0 Certification Tests

The following subsections provide methods and results for the five certification tests. 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

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 average and extremes of flowrate in the existing stack using a type-S pitot tube, a slant tube manometer, and a protractor level attached to the pitot tube. The flow angle was measured at the elevation in the stack where the sampling nozzle would be located (test ports in Figure 1). The measurement grid 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.

2.1.2 Results

The average flow angles observed with and without the flow straightener differed slightly, as shown in Table 2. The acceptance criterion for the absence of substantial angular or cyclonic flow is that the average flow angle shall not exceed 20 degrees (relative to the long axis of the stack). This criterion was met in all flowrate cases. Data sheets for the tests are included in Appendix A.

Table 2. Mean Air Velocity Flow Angle Results

Fan Control Setting, Hz	Mean Angle, Degrees, with Flow Straightener	Mean Angle, Degrees without Flow Straightener
17	0.7	0.0
23	3.2	1.5
29	3.5	3.3

2.2 Air Velocity Uniformity

2.2.1 Method

The uniformity of air velocity in the cross section of the stack 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 an electronic manometer. The procedure is detailed in Appendix B.

2.2.2 Results

The acceptance criterion is that the air velocity COV is ≤20% across the center two-thirds of the area of the stack. Table 3 summarizes the test results. The air velocity measurements exhibited greater variability and bias with the flow straightener present than when it was absent. The results with the flow straightener installed were borderline failures because the COVs were just slightly greater than 20%. With the flow straightener removed, the COVs ranged from 6 to 11%, thus meeting the acceptance criterion. For most of the remaining tests, the flow straightener was removed.

Figure 5 shows surface plots of velocity measurements with and without the flow straightener. (The data were normalized such that the maximum velocity measured is represented as 100% and the minimum as 0%. The only actual data are along the north-south and east-west axes. The remainder of the surface is interpolated.) Data sheets for this test are included in Appendix B.

Table 3. Air Velocity Qualification Tests

Fan Control Setting, Hz	With Flow Straightener			Without Flow Straightener		
	Mean Velocity, m/s	Flow rate, cfm	COV	Mean Velocity, m/s	Flow rate, cfm	COV
17	6.2	666	20.4	6.5	698	5.1
23	8.7	934	21.0	9.1	977	6.3
29	11.2	1202	20.3	11.6	1245	6.3

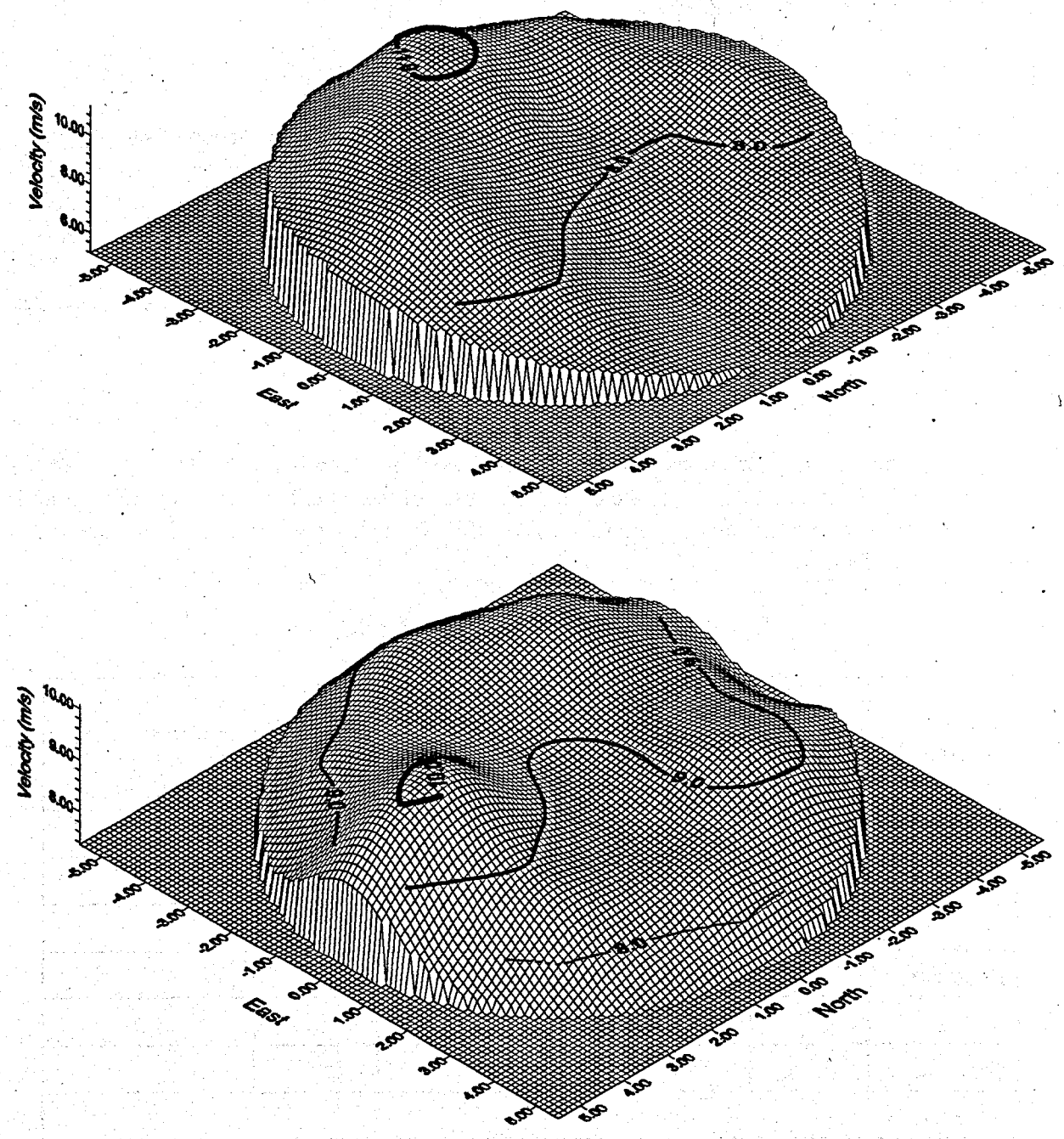

Figure 5. Velocity Profile with (top) and without (bottom) the Flow Straightener (fan setting 23 Hz)

2.3 Gaseous Tracer Uniformity

2.3.1 Method

A uniform contaminant concentration at the sampling plane enables the extraction of samples that represent the true concentration. The concentration profile uniformity was demonstrated using sulfur hexafluoride as a tracer gas. The tracer gas was injected into the air upstream of the stack, and the concentration was measured at points in the sampling plane using a gas analyzer. The grid of measurement points was the same as that used for the velocity characterization tests described above. The gas analyzer used was a Bruel and Kjaer (Naerum, Denmark) Model 1302 calibrated for the tracer gas. The procedure is detailed in Appendix C.

2.3.2 Results

Table 4 summarizes test conditions and results. The acceptance criteria are that 1) the COV of the tracer gas concentration be ≤20% across the center two-thirds of the sampling plane, and 2) no point in the sampling varies from the mean concentration by >30%. Data sheets for individual test runs are included in Appendix C.

Table 4. Tracer Gas Mixing Results

Tracer Injection Position	% Coefficient of Variation at Flow Given					
	150 cfm	698 cfm	977 cfm	1245 cfm	2300 cfm	934 cfm w/Straightener
Before Fan						
Center		0.5	0.5	0.4		
Top		0.6	0.6	0.3		
North side		0.9	0.3	0.9		
Bottom		0.6	0.4	0.5		1.9
South side		0.5	0.4	0.4		
After Fan						
Center			6.1			
Top			4.6			
West side	9.6	9.7	10.6	9.5	9.7	42.2
Bottom			7.7			
East side			2.4			

When the tracer was injected upstream of the fan, the mixing was complete, as evidenced by the COVs all being <1%. In one instance with the flow straightener installed, the COV was only slightly higher, at 1.9%. When the tracer was injected between the fan and the stack, mixing was slightly less complete, but the COVs ranged from 2 to 11%, thus meeting the criterion for uniformity. In one instance with the straightener installed, the COV was 42%, exhibiting poor uniformity and mixing. In this case, the tracer was intentionally injected near the duct wall to yield worst case mixing. The flow straightener caused the poor mixing to persist well up in the stack. Without the straightener, the additional turbulence promoted mixing. Figure 6 shows surface plots for the gas concentration with and without the flow straightener installed and when the west injection point after the fan was used.

2.4 Particle Tracer Uniformity

2.4.1 Method

The particle tracer uniformity test is conceptually similar to the gaseous tracer uniformity test. The gaseous tracer is replaced with a monodispersed aerosol of 10 μm AD particles and the gas analyzer with optical particle counters (OPC). The acceptance criterion is that the COV of the tracer particle concentration be ≤20% across the center two-thirds of the sampling plane. The tracer particles may be introduced at only one location, the centerline of the stack or duct as far upstream as possible from the sampling location, but downstream of the filters, fans, or feeder ducts.

Monodisperse (single-sized) test aerosol particles of oleic acid tagged with a fluorescent dye (uranine) were created from methanol-based solutions using a vibrating orifice aerosol generator (VOAG). In the VOAG, the solution passes through an approximately 20-μm circular orifice to form a cylindrical jet. A piezoelectric crystal positioned on the orifice assembly oscillates at known frequency to cause the liquid jet to break into uniformly sized droplets. The droplets are dispersed from the orifice by flowing air to minimize droplet coagulation and maximize evaporation of the methanol.

The particle stream was piped to the injection point the centerline of the 45° angle duct between the fan and stack. The stack air flowrate was 977 ft^3/ min. Particle concentration was measured at the stack using two OPCs (Met-One Model A2408, Grants Pass, OR). Each OPC had separate sampling probes designed to concurrently sample from the same elevation within the stack as used for the other tests. The probe of one OPC was set at a fixed location while the probe of the mobile OPC was moved to each traverse point in a random order. The fixed OPC recorded the particle concentration as a function of time in case the output of the VOAG varied. The traversing OPC and its probe was moved from point to point, first in one traverse direction and then the other. The layout of sampling points was the same as for the other tests, except that the size of the probe did not permit sampling as close to the stack wall. The detailed procedure is included in Appendix D.

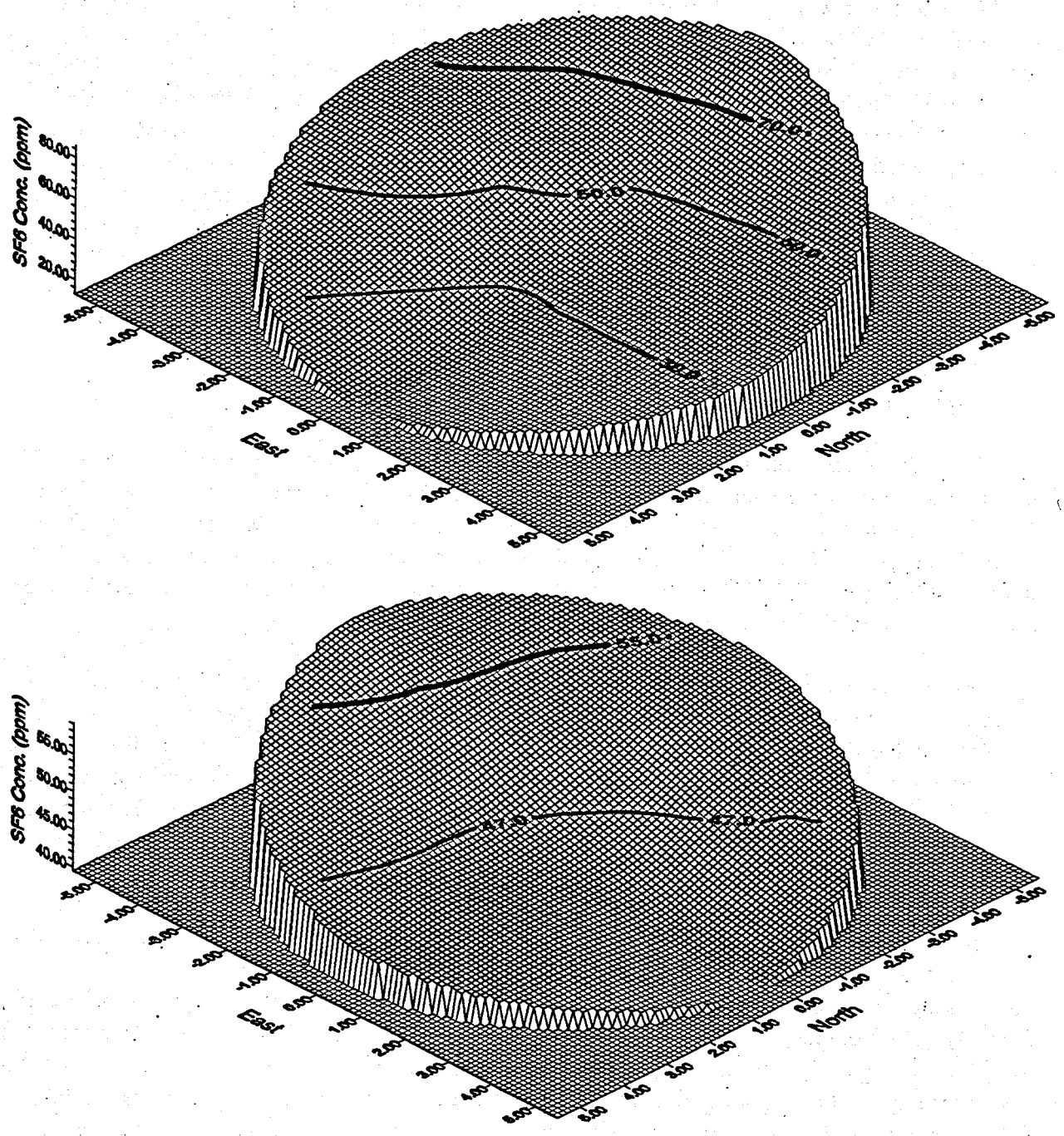

Figure 6. Tracer Gas Concentration Profile with (top) and without (bottom) the Flow Straightener Installed

2.4.2 Results

Three tests were conducted to investigate the repeatability of the results. The data sheets for each run are included in Appendix D. The tests were conducted outdoors in early winter and late in the afternoon when the temperature was falling. A decline in the particle concentration measured by the OPCs was observed to correlate with the falling temperature. The OPC vendor was contacted and indicated that the OPC operating range is 55 - 80°F and that outside of this range, the alignment of the optical elements was affected. Consequently, we were unable to determine whether the decline in concentration was caused by the aerosol delivery system or the OPCs. Therefore, measures were taken to insulate and heat the OPCs, probes, and aerosol delivery piping. These measures were ineffective in the face of severe weather.

Table 5 summarizes the results from the three tests. The upper half of Table 5 shows the temperature range during the tests and the mean particle concentrations and standard deviations for each OPC and each traverse. The mean particle concentrations were noticeably lower and the COVs higher during the coldest test, PT-5, relative to the other two tests. In all three tests, the mean fixed OPC particle concentrations differed during the two traverses and showed a decline in particle concentration with time. The standard deviations are much lower for the fixed OPC than for the mobile one. The standard deviation in the fixed OPC results is assumed to be caused by the variability in aerosol concentration over time and the variability in the response of the OPC. This would represent the minimum level of variability achievable using this test procedure without an independent determination of the contributions to the variability. It is assumed that the higher standard deviation in the mobile OPC readings is caused by the concentration variation across the stack.

Several simple methods were used to normalize the mobile OPCs readings to account for the apparent change in the observed particle concentration with time. These are listed in the bottom half of Table 5. The resulting percent COV for each normalization method and test also are listed. The results for no normalization are included for comparison. In the first three methods, the mobile readings are normalized by making use of the fixed OPC readings to correct for time variability. The next two methods make no use of the fixed OPC readings, but correct the mobile readings so the common centerpoint reading is equalized. Test PT-4, the only one conducted near the operational temperature range for the OPCs, produced results satisfying the criterion. Figure 7 shows the surface plot for the particle concentration measured in Test PT-4.

2.5 Particle Penetration

The FRD requires that the sample transport system deliver more than 50% of 10-μm AD particles from the stack to the sample collector. The desired nozzle characteristics are as follow:

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

Table 5. Tracer Particle Mixing Results Over the Center Two-Thirds of the Stack

Characteristic	Test PT-1	Test PT-4	Test PT-5
Each data point represents mean of:	two 1-min counts	five 1-min counts	five 1-min counts
Ambient temperature during test, °F	50 - 46	56 - 47	48 - 45
Mobile OPC			
North/south mean particles/ft^3	110	88	49
West/east mean particles/ft^3	89	167	43
North/south standard deviation	29	19	12
West/east standard deviation	14	29	14
Fixed OPC			
North/south mean particles/ft^3	59	67	67
West/east mean particles/ft^3	76	135	45
North/south standard deviation	6	10	10
West/east standard deviation	5	13	10
Overall Mobile OPC % COV per Normalization Method			
A. Each mobile OPC reading divided by the fixed OPC reading corresponding in time	24	24	43
B. Each mobile OPC reading in a traverse is divided by the mean of the fixed OPCs readings for that same traverse	24	19	32
C. Second mobile traverse readings adjusted y adding the difference between the mean fixed OPC readings for each traverse	20	16	27
D. Second traverse readings adjusted by the amount needed to make its centerpoint equal to that of the first traverse	30	15	25
E. Mobile traverse readings adjusted by adding the amount needed to make the centerpoints equal their own average	28	19	28
F. None	24	37	27

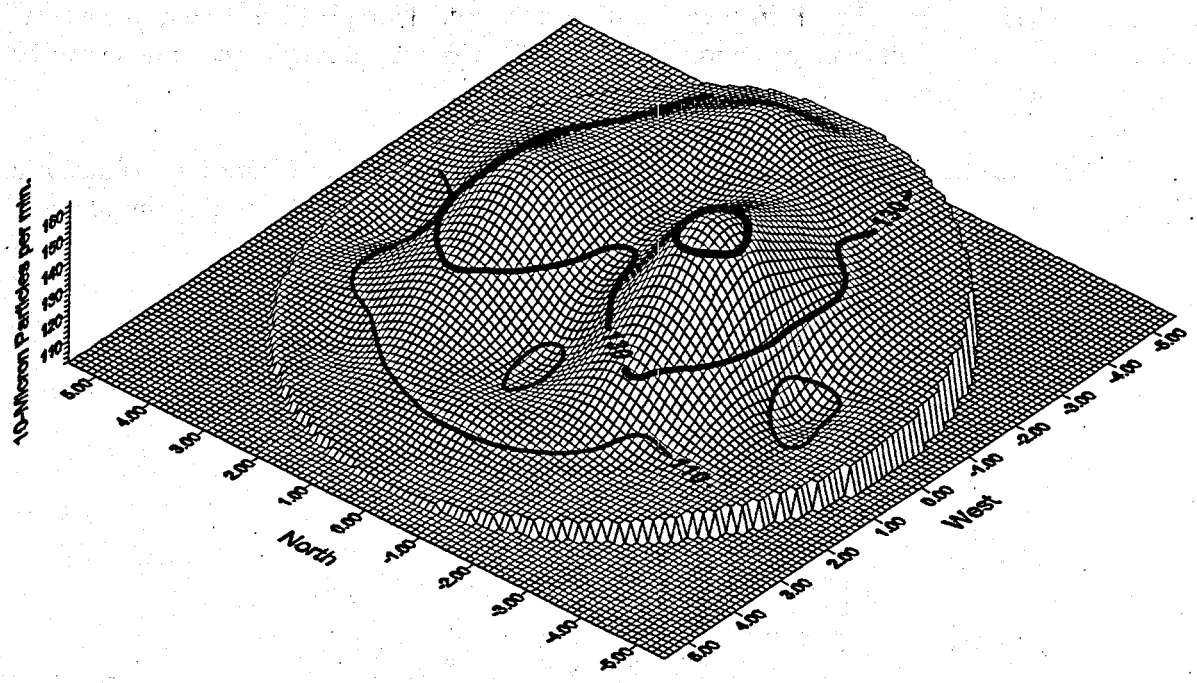

Figure 7. Surface Plot of Particle Concentration Data from Test PT-4

The nozzle characteristics are inherent in the design and were verified by the designers during wind tunnel tests (McFarland et al. 1989). The FRD requires that the particle transport be verified either experimentally or by using the DEPOSITION code (Riehl et al. 1996).

The manufacturer's analysis of particle penetration through the GEMS system is included in Appendix E. The analysis of the transport lines was performed using the DEPOSITION code. The analysis of the splitter was done by analogy to tests of a similar splitter reported by Glissmeyer and Ligotke (1995). The analysis showed that the penetration of 10-μm AD particles through the system, excluding the splitter, would be 66% at the low flow conditions and 94% at the high flow conditions. The worst case penetration through the splitter was estimated at 74%. Combined, the penetration should range from 49 to 70%. Because these tests were run on the first such unit received, the overall particle penetration was verified experimentally.

2.5.1 Method

A reference sampler, located in the stack at the same elevation as the shrouded nozzle, was used to measure the particle concentration in the stack. The reference sampler differed from the GEMS sampling system primarily by having a sharp-edged inlet nozzle followed immediately by a 47-mm glass fiber filter (Gelman Sciences Type A/E, Ann Arbor, MI). The flowrate through the reference sampler was adjusted so it operated isokinetically over the range of air flowrates. During each test, the reference

sampler was moved through two or more positions to help ensure that the average concentration was measured. Identical glass fiber filters were installed in the record sample filter holder, in the beta CAM in-line head, as well as in the reference sampler. The flowrate through each of these was held at approximately 1 scfm.

The first three tests were performed on a mockup stack different from Figure 1 as diagrammed in Figure 8. For the last two tests, the 10-in. pipe stack was replaced with a 10-in. sheet metal stack

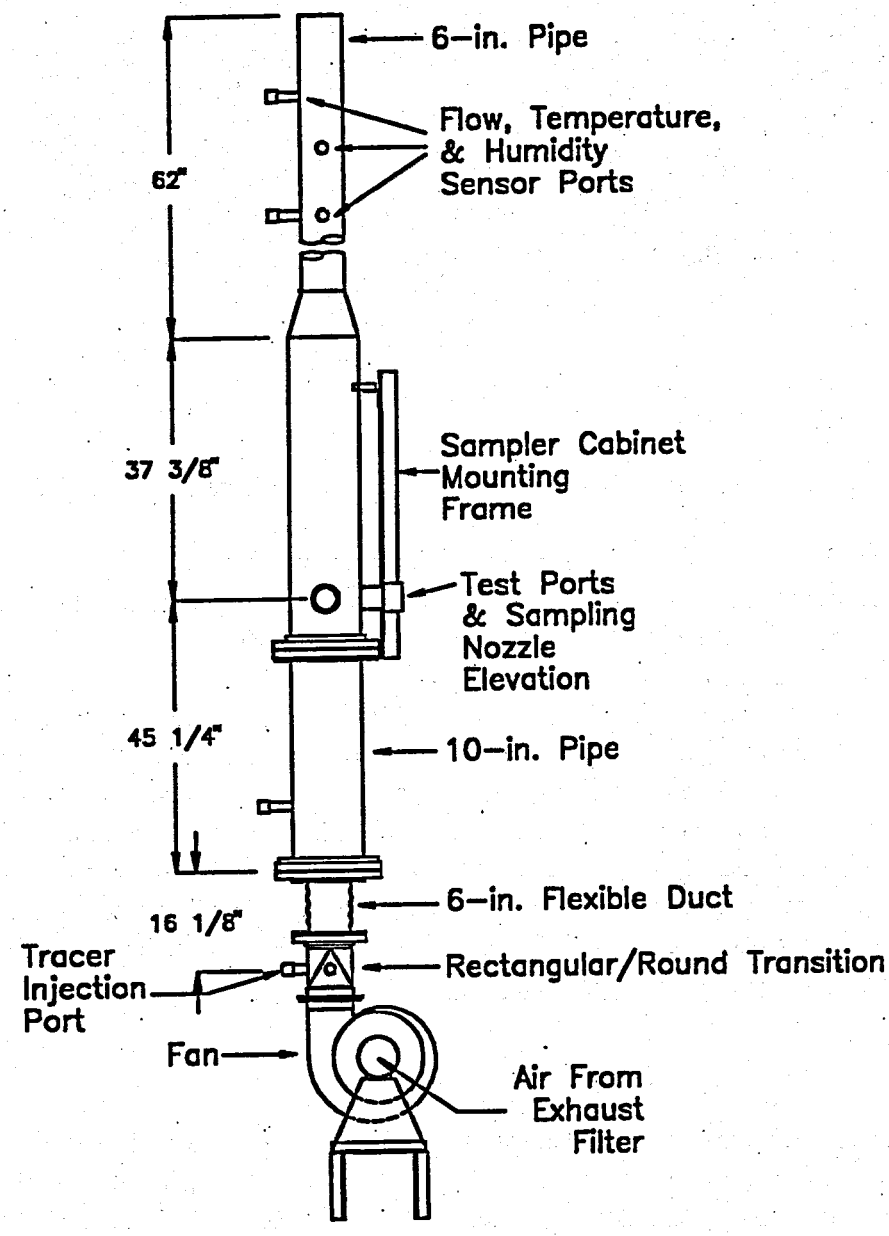

Figure 8. Mockup Stack Used for Particle Penetration Tests

without the necked-down or tapered discharge at the top. (The inside diameter of the sheet metal stack was 10 in., up slightly from 9.75 in. for the pipe stack.) Additional velocity traverses were done to measure flowrates through the different mockups.

The 10-μm AD test particles were injected along the centerline of the rectangle/round transition between the fan and the stack. The reference and the GEMS samplers were operated over the same time period. After each test, the internal components and nozzles of the systems were washed with methanol to remove the deposited particles. The sample filters were repeatedly leached in methanol to obtain the deposited uranine dye. The solutions were analyzed for fluorescent tracer content using a Perkin Elmer LS-50B Luminescence Spectrophotometer.

Electrical noise from the fan's motor speed controller interfered with the readings of the GEMS sample flowmeters, and, in some cases, the indicated flowrates varied significantly from the 1-scfm control point. Consequently, the GEMS flowmeters were calibrated under test conditions against the calibrated flowmeter used for the reference sampler, and the GEMS readings were adjusted accordingly.

2.5.2 Results

Table 6 summarizes results of the mass balance of particles collected by GEMS relative to the reference sampler. The unsatisfactory penetration results for the record sample and poor mass balance results for tests PEN-1 and PEN-3 are indicative of internal leakage or bypass found in the GEMS system. For example, the particle deposition pattern on the record sample filter (when viewed with a black light) was a thin arc stretching over one-third of the perimeter near the filter clamping ring. This record filter holder was found to leak significantly. It was temporarily repaired after test PEN-3, but the results were variable as shown for runs PEN-4 and PEN-6. Also, the deposition pattern on the filter paper was improved, but was still more pronounced around the clamping ring. This may indicate some remaining leakage. In contrast, the particle deposition patterns on the CAM and reference filters were much more uniform. The poor mass balance in some runs also could indicate an inadequate component washing procedure or sampling bias at the nozzles. Data sheets and analysis results for each run are included in Appendix F.

The first four runs were conducted with a shrouded nozzle designed for use with an air velocity of 8 - 16 m/s. In tests PEN-1 and PEN-4, the approach air velocity was in the 8 - 16 m/s range for which the nozzle was designed. The last run was conducted with a shrouded nozzle designed for a 2.5 - 8.5 m/s air velocity range.

The highest deposition in the splitter was 2.7% of the expected mass compared to 0.8% for the splitter tested by Glissmeyer and Ligotke (1995). This is considered acceptably low. Probe losses were in the 0.5 - 18% range compared with the less than 3% found in the wind tunnel tests by Glissmeyer and Ligotke (1995) for a similar configuration. The measured penetration exceeded the predicted penetration in three of the runs. Had the record sample filter holder not been leaky, the measured penetration probably would have been better in all cases.

Table 6. Collection of 10-μm AD Tracer Particles Relative to the Reference Sample

Characteristic	Run PEN-1	Run PEN-2	Run PEN-3	Run PEN-4	Run PEN-6
Stack flow, cfm	491	1028	213	894	232
Mean stack air velocity, m/s	4.81	10.07	2.09	8.34	2.34
% of Expected Mass at CAM					
Filter	53.9	119.6	59.3	81.7	55.2
Probe	5.6	18.1	5.3	9.2	0.5
Splitter	0.8	2.7	1.8	2.5	0.6
Filter holder	0.3	0.9	2.5	9.0	0.9
Unaccounted	39.5	-41.3	31.2	-2.5	37.9
% of Expected Mass at Record Sample					
Filter	46.3	76.1	46.2	92.6	65.7
Probe	5.5	13.2	6.4	8.7	0.5
Splitter	0.8	2.0	2.2	2.4	0.5
Filter holder	2.2	5.3	3.1	2.9	0.1
Unaccounted	45.2	3.5	42.2	-6.7	33.2

3.0 Conclusions

The application of the GEMS to the AP-40 exhauster stack was shown to comply with the five performance criteria given in the FRD. These included absence of cyclonic flow in the stack in the plane of the sample probe, uniformity of air velocity in the plane of the sample probe, uniformity of gaseous tracer concentration in the plane of the sample probe, uniformity of particulate tracer concentration in the plane of the sample probe, and penetration of the sample to the collectors.

Initially, with a flow straightener located at the point where the air flows into the stack, the system failed the velocity and gaseous tracer uniformity tests. These tests were successful with the straightener removed. With the straightener gone, there was sufficient turbulence to promote mixing.

The first particle tracer uniformity test was unsuccessful. It was concluded that the optical particle counter's readings were more erratic when they were used at temperatures below 50°F. Efforts to heat the sampling probes and particle counters were unsuccessful. The test was only successful when the ambient temperature was greater than 50°F. The particle counter manufacturer lists the minimum operating temperature as 55°F.

It was found that the record sample filter holder exhibited symptoms of sample bypass around the particle collection filter. This was the cause of the initial inconsistent particle penetration tests. This filter holder should either be modified or replaced with a different type.

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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Crummel, G. M. 1994. *Tank Farm Stack Sampling System Configuration and Efficiency Study.* WHC-SD-WM-ES-291, Rev. 1, Westinghouse Hanford Company, Richland, Washington.

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Appendix A

Angular Flow Test

Procedure for Angular Flow Test

February 6, 1997

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). The reason 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 15%), 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. Perform two or three repetitions at each flowrate condition, two if it looks highly repeatable, three if not so repeatable. Fill out one of the attached data sheets for each flowrate. The top half of the sheet is for one traverse direction, the bottom half for the other direction. The climatological data are not needed to evaluate the results.

Equipment

Type-S pitot tube
Calibrated manometer or electronic manometer
Device for reading angle of pitot tube relative to long axis of the stack

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 in. of water or less).

Method

Select measurement points following Method 1 in 40 CFR 60, Appendix A as a guide to determine the minimum number of sample points. If a fluid-filled manometer is used, it must be leveled. Connect the manometer to the pitot tube. Position the pitot tube at each velocity 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. If the average of the rotation angles at all traverse points is less than 20°, then the test criterion is satisfied.

ANGULAR FLOW TEST DATA FORM

Site	AP40 Mockup	Run No.	ANG-1A
Date	4/15/96	Stack Temp	
Tester	GW Dennis	Stack RH%	45
Stack Dia.	10	Baro Press	996 mbar
Stack X-Area	78.5	Fan Setting	17 Hz
Elevation		Offset to index	
El. above disturbance	71 in.		

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	0	0		0	0	
2	0.67	0	0		0	0	
3	1.18	0	0		0	0	
4	1.77	0	0		0	0	
5	2.50	0	0		0	0	
6	3.56	0	0		0	0	
7	6.44	0	0		0	0	
8	7.50	0	0		0	0	
9	8.23	0	0		0	0	
10	8.82	0	0		5	5	
11	9.33	0	0		10	10	
12	9.79	-	-		-	-	

						All
Average of all data	0.0	0.0		1.4	1.4	0.7
w/o points by wall	0.0	0.0		1.5	1.5	0.8
Centerpoint	0	0		0	0	

Center 2/3 with centerpoint					All
Mean	0.0	0.0		0.6	0.6	0.28

Instuments Used:	Cal Exp. Date:
Dwyer 0-1" water slant tube manometer Model 400-5-L	NA
"S" pitot tube	NA

ANGULAR FLOW TEST DATA FORM

Site	AP40 Mockup	Run No.	ANG-1B
Date	4/15/96	Stack Temp	
Tester	GW Dennis	Stack RH%	45
Stack Dia.	10	Baro Press	996 mbar
Stack X-Area	78.5	Fan Setting	23 Hz
Elevation		Offset to index	
El. above disturbance	71 in.		

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	0	0	0	0	0	0
2	0.67	0	0	0	0	0	0
3	1.18	14	10	12	0	0	0
4	1.77	11	8	10	0	0	0
5	2.50	11	10	10	0	0	0
6	3.56	4	6	6	0	0	0
7	6.44	3	4	4	0	0	0
8	7.50	3	4	4	0	0	0
9	8.23	3	3	3	4	4	3
10	8.82	2	3	2	5	5	6
11	9.33	1	2	1	10	10	10
12	9.79	-	-	-	-	-	-

							All
Average of all data	4.7	4.5	4.7	1.7	1.7	1.7	3.2
w/o points by wall	5.2	5.0	5.2	1.9	1.9	1.9	3.5
Centerpoint	3	5	5	0	0	0	

Center 2/3 with centerpoint							All
Mean	6.0	5.9	6.2	1.0	1.0	1.0	3.52

Instuments Used:	Cal Exp. Date:
Dwyer 0-1" water slant tube manometer Model 400-5-L	NA
"S" pitot tube	NA

ANGULAR FLOW TEST DATA FORM

Site	AP40 Mockup	Run No.	ANG-1C
Date	4/15/96	Stack Temp	
Tester	GW Dennis	Stack RH%	45
Stack Dia.	10	Baro Press	996 mbar
Stack X-Area	78.5	Fan Setting	29 Hz
Elevation		Offset to index	
El. above disturbance	71 in.		

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	11	10	10	0	0	0
2	0.67	13	12	14	0	0	0
3	1.18	12	10	10	0	0	0
4	1.77	10	10	10	0	0	0
5	2.50	5	7	7	0	0	0
6	3.56	2	3	2	0	0	0
7	6.44	2	2	2	2	2	0
8	7.50	2	2	2	5	4	4
9	8.23	2	1	2	5	3	4
10	8.82	2	0	1	5	4	4
11	9.33	0	0	0	4	3	5
12	9.79	-	-	-	-	-	-

							All
Average of all data	5.5	5.2	5.5	1.9	1.5	1.5	3.5
w/o points by wall	5.0	4.7	5.0	2.1	1.6	1.7	3.4
Centerpoint	2	2	2	0	0	0	
Center 2/3 with centerpoint							All
Mean	4.3	4.1	4.2	1.9	1.4	1.3	2.89

Instuments Used:	Cal Exp. Date:
Dwyer 0-1" water slant tube manometer Model 400-5-L	NA
"S" pitot tube	NA

ANGULAR FLOW TEST DATA FORM

Site	AP40 Mockup	Run No.	ANG-2A
Date	5/2/96	Stack Temp	
Tester	GW Dennis	Stack RH%	20
Stack Dia.	10	Baro Press	999.9 mbar
Stack X-Area	78.5	Fan Setting	17 Hz
Elevation		Offset to index	
El. above disturbance	71 in.		

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	0	0		0	0	
2	0.67	0	0		0	0	
3	1.18	0	0		0	0	
4	1.77	0	0		0	0	
5	2.50	0	0		0	0	
6	3.56	0	0		0	0	
7	6.44	0	0		0	0	
8	7.50	0	0		0	0	
9	8.23	0	0		0	0	
10	8.82	0	0		0	0	
11	9.33	0	0		0	0	
12	9.79	-	-		-	-	

						All
Average of all data	0.0	0.0		0.0	0.0	0.0
w/o points by wall	0.0	0.0		0.0	0.0	0.0
Centerpoint	0	0		0	0	

					All
Center 2/3 with centerpoint					
Mean	0.0	0.0		0.0	0.0	0.00

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

Dwyer 0-1" water slant tube manometer Model 400-5-L	NA
"S" pitot tube	NA

ANGULAR FLOW TEST DATA FORM

Site	AP40 Mockup	Run No.	ANG-2B
Date	5/2/96	Stack Temp	
Tester	GW Dennis	Stack RH%	20
Stack Dia.	10	Baro Press	999.9 mbar
Stack X-Area	78.5	Fan Setting	23 Hz
Elevation		Offset to index	
El. above disturbance	71 in.		

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	0	0	0	16	15	16
2	0.67	0	0	0	5	6	4
3	1.18	0	0	0	0	0	0
4	1.77	0	0	0	0	0	0
5	2.50	0	0	0	0	0	0
6	3.56	0	0	0	0	0	0
7	6.44	0	0	0	0	0	0
8	7.50	0	0	0	0	0	0
9	8.23	4	4	5	0	0	0
10	8.82	5	5	5	0	0	0
11	9.33	3	3	2	0	0	0
12	9.79	-	-	-	-	-	-

							All
Average of all data	1.1	1.1	1.1	1.9	1.9	1.8	1.5
w/o points by wall	1.2	1.2	1.2	0.5	0.6	0.4	0.9
Centerpoint	0	0	0	0	0	0	

Center 2/3 with centerpoint							All
Mean	1.0	1.0	1.1	0.0	0.0	0.0	0.52

Instuments Used:	Cal Exp. Date:
Dwyer 0-1" water slant tube manometer Model 400-5-L	NA
"S" pitot tube	NA

ANGULAR FLOW TEST DATA FORM

Site	AP40 Mockup	Run No.	ANG-2C
Date	5/2/96	Stack Temp	
Tester	GW Dennis	Stack RH%	20
Stack Dia.	10	Baro Press	999.9 mbar
Stack X-Area	78.5	Fan Setting	29 Hz
Elevation		Offset to index	
El. above disturbance	71 in.		

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	0	0	0	11	10	12
2	0.67	10	7	9	5	5	7
3	1.18	10	9	12	5	4	4
4	1.77	0	0	0	0	0	0
5	2.50	0	0	0	0	0	0
6	3.56	0	0	0	0	0	0
7	6.44	0	0	0	0	0	0
8	7.50	4	4	3	2	3	2
9	8.23	4	4	2	4	4	5
10	8.82	4	3	5	5	5	5
11	9.33	4	4	4	5	4	6
12	9.79	-	-	-	-	-	-

							All
Average of all data	3.3	2.8	3.2	3.4	3.2	3.7	3.3
w/o points by wall	3.6	3.1	3.5	2.6	2.5	2.9	3.0
Centerpoint	0	0	0	0	0	0	

Center 2/3 with centerpoint							All
Mean	2.4	2.2	2.4	1.8	1.8	1.8	2.07

Instuments Used:	Cal Exp. Date:
Dwyer 0-1" water slant tube manometer Model 400-5-L	NA
"S" pitot tube	NA

Appendix B

Air Velocity Uniformity Test

Procedure to Calibrate Fan Controller and Conduct Velocity Traverses

February 6, 1997

Fan Controller Calibration

The purpose is to determine the fan speed controller frequency setting versus stack flowrate. 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 traverses will be made at various frequency settings. Frequency settings can vary from 0 to 60 Hz.

1. Seal off all stack and duct openings, remove the top stack cover, and remove the inlet filter cover. Obtain a calibrated micro-manometer and 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 on a data sheet, and add a center point. Place a strip of masking tape along the barrel of the pitot tube, and mark each traverse point, including the offset to the index point. Attach fittings to the traverse port so that there will be a seal around the pitot tube barrel. Prepare an adequate number of copies of the data sheet. Call the weather station to get the barometric pressure and humidity for the location. Air temperature can be measured in the stack with a calibrated instrument during the velocity traverses.

2. At a frequency setting of 30, perform a full velocity traverse along both directions, repeating each traverse three times. Record the data, calculate the mean velocity, and determine a location where the velocity, measured is closest to the calculated mean. 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.

3. Measure the average velocity in the stack corresponding to settings on the fan controller. Space the fan controller settings at 5-Hz increments over the range of 5- to 60-Hz. Place the pitot tube at the location of the average velocity reading determined above. Record the velocity reading for each controller setting. Repeat three times. Calculate the average of the three readings at each controller setting. Plot the average reading versus controller frequency.

Velocity Traverse

Complete a velocity traverse following the method in Step 1 for each stack flowrate for which the angular flow, gas, and particle mixing tests will be conducted. From the plot of velocity versus controller frequency, select the frequency values corresponding to the test flowrates. At each flowrate, conduct a complete velocity traverse. Repeat three times. Change the controller setting between each traverse so the results will reflect the variability of the controller. Calculate the average velocity, omitting data from the center point and points closer to the wall than 0.5 in.

Calculate the coefficient of variance for the data from the above three velocity traverses. Omit the values for points closest to the wall, and include the center point. 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.

VELOCITY TRAVERSE DATA FORM
Fan Controller Cal Test

Site	AP40 Mock Up		Run No.	VELT1	
Date	3/20/96		Stack Temp	16.4°C/13.4°C	
Tester	GW Dennis		Stack RH%	34	
Stack Dia.	10	in	Baro Press	1008mbar	29.76 in Hg
Stack X-Area	78.5	in2	Fan Setting	30Hz	900rpm
Elevation			Offset to index	1.0625	
El. above disturbance	71	in	Center 2/3 from	1.98	10.14
			Points in Center 2/3	3	10

Traverse-->		West-East	West-East	West-East	West-East		
Trial --->		1	1	2	2	3	3
Point	Depth in	Delta P	Velocity	Delta P	Velocity	Delta P	Velocity
1	0.21	-	12.0	0.24	10.5		
2	0.67	0.40	12.7	0.39	12.7		
3	1.18	0.38	12.8	0.42	13.0		
4	1.77	0.37	11.4	0.33	12.3		
5	2.50	0.36	11.7	0.34	11.9		
6	3.56	0.27	10.7	0.34	11.2		
7	6.44	-	12.2	0.35	11.8		
8	7.50	-	13.2	0.40	13.1		
9	8.23	-	13.3	0.42	13.3		
10	8.82	-	13.0	0.40	12.8		
11	9.33	-	11.5	0.26	11.8		
12	9.79	0.22	10.0	0.24	10.1		
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
Count			12.00		12.00		0
Subtotal			144.50		144.50		0
Average			12.04		12.04		#DIV/0!
Center	5	0.37	11.7	0.30	11.0		

Instruments Used: **Cal Exp. Date:**

Solomat Zephyr Ser# 12951472 Cal# 521-28-09-001 3/1/97

Notes: Between Velocity readings fan setting was moved up to 36Hz. Moved back to 30HZ prior to second set of readings. Temp readings taken at end of traverse. Next traverse check to be from north to south.

VELOCITY TRAVERSE DATA FORM

Fan Controller Cal Test

Site	AP40 Mock Up		Run No.	VELT2	
Date	3/21/96		Stack Temp	15.0°C/15.8°C	
Tester	GW Dennis		Stack RH%	34	
Stack Dia.	10	in	Baro Press	1016mbar	
Stack X-Area	78.5	in2	Fan Setting	30Hz	900rpm
Elevation			Offset to index	1.0625	
El. above disturbance	71	in	Center 2/3 from	1.98	10.14
			Points in Center 2/3	3	10

Traverse-->		North-South	North-South	North-South	North-South		
Trial --->		1	1	2	2	3	3
Point	Depth in	Delta P	Velocity m/s	Delta P	Velocity m/s	Delta P	Velocity
1	0.21		6.0		6.5		
2	0.67		7.1		7.1		
3	1.18		7.2		7.3		
4	1.77		7.5		7.3		
5	2.50		7.8		7.7		
6	3.56		9.3		8.7		
7	6.44		13.7		13.6		
8	7.50		14.8		14.7		
9	8.23		15.0		15.1		
10	8.82		14.5		15		
11	9.33		11.4		13.7		
12	9.79		10.9		11.9		
13							
14							
15							
16							
17							
18							
19							
20							
21							
22							
23							
24							
Count			12.00		12.00		0
Subtotal			125.20		128.60		0
Average			10.43		10.72		#DIV/0!
Center	0		11.3		11.1		

Instruments Used: **Cal Exp. Date:**

Solomat Zephyr Ser# 12951472 Cal# 521-28-09-001 3/1/97

Notes: Between Velocity readings fan setting was moved up to 36Hz. Moved back to 30HZ prior to second set of readings. Temp readings taken at end of traverse.

VELOCITY vs. FREQUENCY DATA FORM

Site	AP40 Mock Up	Run No.	VELFR01
Date	3/22/96	Stack Temp	18.4/20.0/17.4°C
Tester	GW Dennis	Stack RH%	48%
Stack Dia.	10 in	Baro Press	1004mbars
Stack X-Area	78.5 in2	Fan Setting	Various
Elevation		Offset to index	1.0625 in
El. above disturbance	71 in		

Reference point used from velocity traverses: 5.0 in / West Port

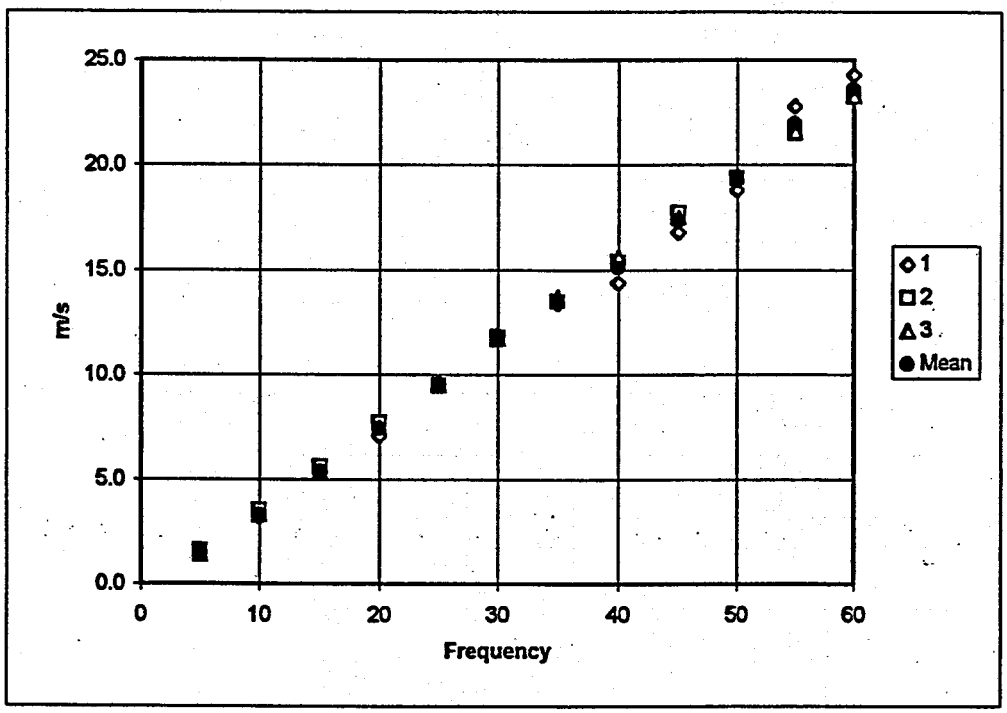
Velocity Readings, units = m/s

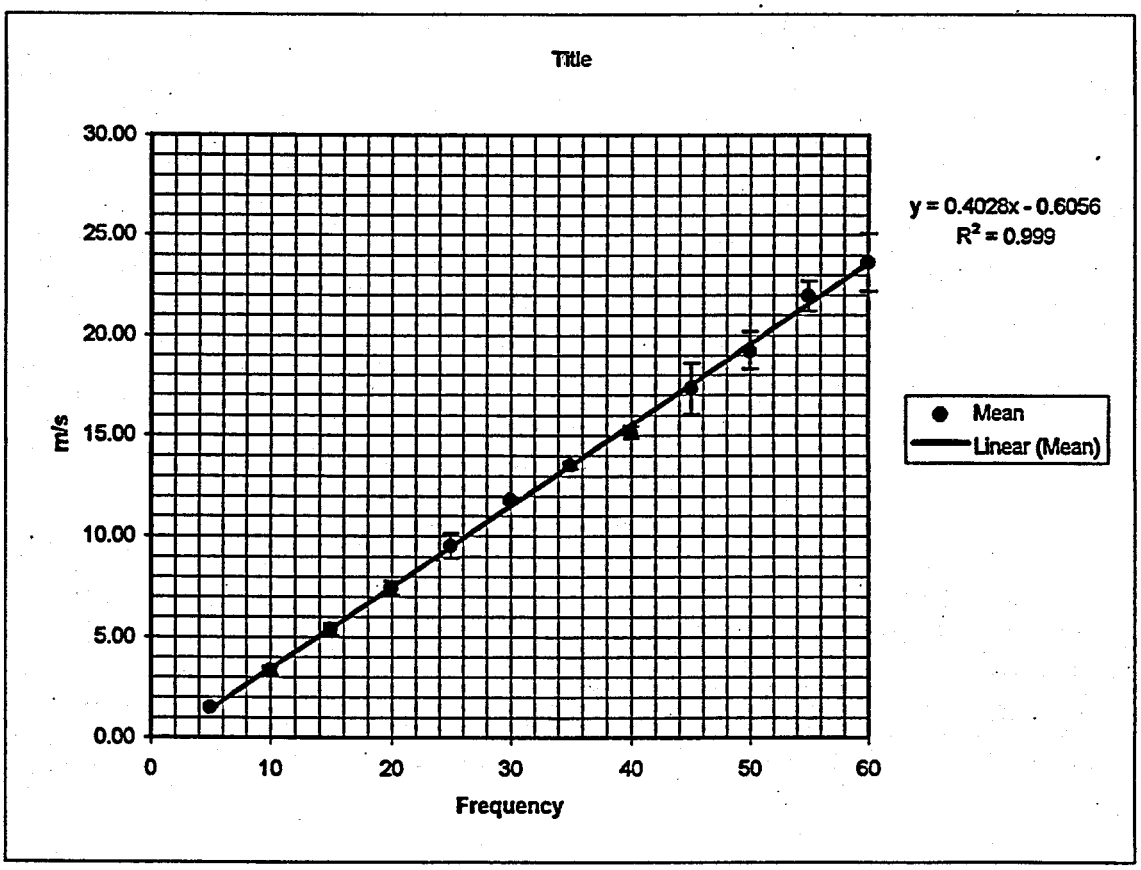
rpm	Hz	1	2	3	Mean	StDev	2 StDev
150	5	1.5	1.6	1.4	1.50	0.10	0.20
300	10	3.2	3.5	3.3	3.33	0.15	0.31
450	15	5.3	5.6	5.3	5.40	0.17	0.35
600	20	7.1	7.7	7.5	7.43	0.31	0.61
750	25	9.6	9.5	9.5	9.53	0.06	0.12
900	30	11.9	11.8	11.7	11.80	0.10	0.20
1050	35	13.4	13.5	13.7	13.53	0.15	0.31
1200	40	14.4	15.4	15.6	15.13	0.64	1.29
1350	45	16.8	17.7	17.5	17.33	0.47	0.95
1500	50	18.8	19.4	19.5	19.23	0.38	0.76
1650	55	22.8	21.5	21.6	21.97	0.72	1.45
1800	60	24.3	23.3	23.3	23.63	0.58	1.15

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

Solomat Zephyr Ser# 12951472, Cal# 521-28-09-001 3/1/96

Notes: 25Hz/750rpm motor vibrates. First two runs up the scale, last run down scale. Pitot tube braced inplace at 5 inch mark, not move for the whole test. Rpm recorded first run, verified next two. Motor Vibration could be a problem, fan may not be balanced at that rpm.


25.0
20.0
15.0
10.0
5.0
0.0
m/s
0
10
20
30
40
50
60
Frequency
1
2
3
Mean


Title
30.00
25.00
20.00
15.00
10.00
5.00
0.00
m/s
0
10
20
30
40
50
60
Frequency
y = 0.4028x - 0.6056
R² = 0.999
Mean
Linear (Mean)

VELOCITY TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	VELT3
Date	4/12/96	Stack Temp	17.4 C- 16.4 C
Tester	GW Dennis/Glissmeyer	Stack RH%	39.4
Stack Dia.	10	Baro Press	998 mbar
Stack X-Area	78.5	Fan Setting	17 Hz w/straightener
Elevation		Offset to index	
El. above disturbance	71 in.	Center 2/3 from	0.92 to: 9.08
		Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.21	6.6	6.5	6.5	3.6	3.3	3.3
2	0.67	6.9	6.8	6.7	3.7	3.7	3.8
3	1.18	6.7	6.7	6.7	4	3.9	3.9
4	1.77	6.4	6.1	6.3	4	3.9	4
5	2.50	6	6	5.9	4.2	4.1	4.1
6	3.56	5.8	5.9	5.8	4.9	4.7	4.9
7	6.44	7	6.8	6.8	7.3	7.5	7.5
8	7.50	6.8	6.9	6.8	8	8	8.1
9	8.23	6.8	7	7	8	8	8.1
10	8.82	6.7	6.8	6.8	7.5	7.7	7.5
11	9.33	6.4	6.3	6.5	6.5	6.5	6.6
12	9.79	6	6.2	6.1	6	5.9	5.8

							Avg.
Average of all data		6.5	6.5	6.5	5.6	5.6	5.6	6.1
w/o points by wall		6.6	6.5	6.5	5.8	5.8	5.9	6.2
Centerpoint		6.2	6.1	6.2	6.5	6.3	5.9	
Center 2/3 with centerpoint								Avg
Mean		6.5	6.5	6.5	6.0	6.0	6.0	6.25
Std. Dev.		0.411	0.441	0.438	1.754	1.849	1.822	1.273
COV %		6.3	6.8	6.8	29.0	30.8	30.4	20.4

Instuments Used:	Cal Exp. Date:
Solomat Zephyr S/N 12951472 Cal #521-28-09-001	3/1/97

VELOCITY TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	VELT4
Date	4/12/96	Stack Temp	17.4 C- 16.4 C
Tester	GW Dennis/Glissmeyer	Stack RH%	39.4
Stack Dia.	10	Baro Press	998 mbar
Stack X-Area	78.5	Fan Setting	23 Hz w/straightener
Elevation		Offset to index	
I. above disturbance	71 in.	Center 2/3 from	0.92 to: 9.08
		Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.21	8.8	8.5	8.7	5.3	5	4.9
2	0.67	9.5	9.4	9.4	5.3	5.3	5.4
3	1.18	9.6	9.5	9.7	5.5	5.5	5.6
4	1.77	9.2	9	9.1	5.5	5.6	5.6
5	2.50	8	8.2	8.1	5.9	5.7	6.1
6	3.56	8	8	8.2	6.7	6.8	6.8
7	6.44	9.1	9.3	9.2	10.6	10.5	10.3
8	7.50	10	10.2	10	11.3	11.2	11.2
9	8.23	10.1	10.4	10.3	11.3	11.4	11.4
10	8.82	9.7	9.5	9.4	11.2	11	11.3
11	9.33	8.4	8.6	8.5	9.3	9.3	9.7
12	9.79	8	7.9	8.1	8.2	8.4	8.1

							Avg.
Average all		9.0	9.0	9.1	8.0	8.0	8.0	8.5
w/o points by wall		9.2	9.2	9.2	8.3	8.2	8.3	8.7
Centerpoint		8.8	8.6	8.6	8.7	8.6	8.7	
Center 2/3 with centerpoint								Avg.
Mean		9.2	9.2	9.2	8.5	8.5	8.6	8.85
Std. Dev.		0.783	0.827	0.768	2.632	2.600	2.556	1.857
COV %		8.5	9.0	8.4	30.9	30.7	29.9	21.0

Instuments Used:	Cal Exp. Date:
Solomat Zephyr S/N 12951472 Cal #521-28-09-001	3/1/97

VELOCITY TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	VELT5
Date	4/12/96	Stack Temp	17.4 C- 16.4 C
Tester	GW Dennis/Glissmeyer	Stack RH%	39.4
Stack Dia.	10	Baro Press	998 mbar
Stack X-Area	78.5	Fan Setting	29 Hz w/straightener
Elevation		Offset to index	
El. above disturbance	71 in.	Center 2/3 from	0.92 to: 9.08
		Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S			
Trial --->		1	2	3	1	2	3	
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity	
1	0.21	11.1	11	11.2	6.4	6	6.2	
2	0.67	12.3	12.2	12.2	6.7	6.7	6.7	
3	1.18	11.6	11.5	11.7	7.2	7.1	7	
4	1.77	11.2	11.3	11.2	7.4	7	7.2	
5	2.50	11.3	11.2	11.2	7.4	7.7	7.5	
6	3.56	10.6	10.6	10.8	9	8.7	8.5	
7	6.44	12.2	12	12.1	13.4	13.6	13.2	
8	7.50	12.4	12.5	12.5	14.4	14.2	14.4	
9	8.23	13	12.8	12.7	14.5	14.5	14.7	
10	8.82	12.4	12.2	12.2	14.1	14.1	14.2	
11	9.33	11	10.9	10.8	12.5	13	12.9	
12	9.79	10.5	10.6	10.4	11.4	11	11	
								Avg.
Average all		11.6	11.6	11.6	10.4	10.3	10.3	11.0
w/o points by wall		11.8	11.7	11.7	10.7	10.7	10.6	11.2
Centerpoint		11.4	11.3	11.3	10.6	11.3	11.3	
Center 2/3 with centerpoint								Avg.
Mean		11.8	11.7	11.7	10.9	10.9	10.9	11.32
Std. Dev.		0.756	0.708	0.662	3.232	3.284	3.340	2.303
COV %		6.4	6.0	5.6	29.7	30.1	30.7	20.3

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

Solomat Zephyr S/N 12951472 Cal #521-28-09-001 3/1/97

VELOCITY TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	VELT 6
Date	4/30/96	Stack Temp	21.4 °C
Tester	GW Dennis	Stack RH%	25
tack Dia.	10 in.	Baro Press	1007 mbars
Stack X-Area	78.5 in2	Fan Setting	17Hz w/o straightener
Elevation		Offset to index	1.0625
El. above disturbance	71 in.	Center 2/3 from	1.98 10.14
		Points in Center 2/3	3 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.21	5.2	5.4	5.1	5.1	5.2	5.1
2	0.67	6	5.7	5.9	5.5	5.4	5.7
3	1.18	6.3	6	6.3	5.9	6.1	6.2
4	1.77	6.3	6.4	6.5	5.9	6	6.3
5	2.50	6.4	6.6	6.4	6.3	6.4	6.4
6	3.56	6.4	6.5	6.3	6.3	6.1	6.3
7	6.44	6.6	6.5	6.7	6.4	6.6	6.7
8	7.50	6.8	7	6.7	6.5	6.5	6.6
9	8.23	7.1	7.2	7.3	6.8	6.7	6.9
10	8.82	7.1	7	7.3	6.8	7	6.7
11	9.33	6.7	6.6	6.7	6.4	6.5	6.6
12	9.79	6.2	6	6.4	5.5	5.4	5.5

								Avg.
Average of all data		6.4	6.4	6.5	6.1	6.2	6.3	6.3
w/o points by wall		6.6	6.6	6.6	6.3	6.3	6.4	6.5
Centerpoint	5.00	6.4	6.5	6.4	6.5	6.3	6.5	
Center 2/3 with centerpoint								Avg
Mean		6.6	6.6	6.7	6.4	6.4	6.5	6.5
Std. Dev.		0.324	0.371	0.394	0.327	0.326	0.232	0.335
COV %		4.9	5.6	5.9	5.1	5.1	3.6	5.1

Instuments Used:	Cal Exp. Date:
Solomat Zephyr S/N 12951472 Cal #521-28-09-001	3/1/97

VELOCITY TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	VELT 7
Date	4/30/96	Stack Temp	21.6 °C
Tester	GW Dennis	Stack RH%	25
tack Dia.	10 in.	Baro Press	1007 mbars
Stack X-Area	78.5 in2	Fan Setting	23Hz w/o straightner
Elevation		Offset to index	1.0625
El. above disturbance	71 in.	Center 2/3 from	1.98 10.14
		Points in Center 2/3	3 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.21	7	7.8	7.3	7.4	7	7.6
2	0.67	8.2	8	8.4	8.1	7.9	8.2
3	1.18	8.5	8.8	8.7	8.5	8.6	8.3
4	1.77	8.8	9.1	9	8.4	9	8.8
5	2.50	8.8	8.6	9.3	8.5	8.3	8.9
6	3.56	8.9	9.2	9	8.5	9.1	8.7
7	6.44	9.2	9.5	9	9.3	9.4	9.6
8	7.50	9.9	10.3	10.4	9.5	9.9	9.7
9	8.23	10	9.7	10.3	9.8	10	9.7
10	8.82	9.9	9.6	10.1	9.7	9.5	9.9
11	9.33	9.3	9.5	9.8	8.9	9	9.3
12	9.79	8.8	8.9	9.1	8.2	8.6	8.3

								Avg.
Average of all data		8.9	9.1	9.2	8.7	8.9	8.9	9.0
w/o points by wall		9.2	9.2	9.4	8.9	9.1	9.1	9.1
Centerpoint	5.00	8.9	8.3	9	9.1	9	8.7	
Center 2/3 with centerpoint								Avg
Mean		9.2	9.2	9.4	9.0	9.2	9.1	9.2
Std. Dev.		0.571	0.616	0.655	0.568	0.561	0.579	0.576
COV %		6.2	6.7	7.0	6.3	6.1	6.3	6.3

Instuments Used:	Cal Exp. Date:
Solomat Zephyr S/N 12951472 Cal #521-28-09-001	3/1/97

VELOCITY TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	VELT 8
Date	4/30/96	Stack Temp	21.1 °C
Tester	GW Dennis	Stack RH%	25
Stack Dia.	10 in.	Baro Press	1007 mbars
Stack X-Area	78.5 in2	Fan Setting	29Hz w/o straightener
Elevation		Offset to index	1.0625
El. above disturbance	71 in.	Center 2/3 from	1.98 10.14
		Points in Center 2/3	3 10

Traverse-->		W/E			N/S		
Trial -->		1	2	3	1	2	3
Point	Depth	Velocity	Velocity	Velocity	Velocity	Velocity	Velocity
1	0.21	8.8	9.1	8.7	9	8.5	9.1
2	0.67	10.2	10	9.9	10.3	9.8	10.4
3	1.18	10.9	11.2	10.8	10.6	10.9	10.5
4	1.77	11.2	11.5	11	10.8	10.6	11
5	2.50	11.2	11	11.4	11.1	11.3	10.9
6	3.56	11.3	11.3	11.5	11	11.5	11.6
7	6.44	12.3	12.1	12.3	11.8	11.9	12.3
8	7.50	12.5	12.9	12.4	12.2	12	12.5
9	8.23	12.9	13.2	13.1	12.8	13	12.8
10	8.82	12.5	12.2	12.8	12.1	11.9	12.2
11	9.33	11.9	11.5	12.2	11.8	11.6	11.7
12	9.79	10.5	10.7	10.2	11.3	10.9	10.6

								Avg.
Average of all data		11.4	11.4	11.4	11.2	11.2	11.3	11.3
w/o points by wall		11.7	11.7	11.7	11.5	11.5	11.6	11.6
Centerpoint	5.00	11.3	11.6	11.4	11.5	11.8	11.3	
Center 2/3 with centerpoint								Avg
Mean		11.8	11.9	11.9	11.5	11.7	11.7	11.7
Std. Dev.		0.747	0.769	0.816	0.735	0.698	0.806	0.736
COV %		6.3	6.5	6.9	6.4	6.0	6.9	6.3

Instuments Used:	Cal Exp. Date:
Solomat Zephyr S/N 12951472 Cal #521-28-09-001	3/1/97

Appendix C

Gaseous Tracer Uniformity Test

Procedure for Gas Concentration Uniformity Test

February 6, 1997

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%.

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 concentrations at the measurement points. The instrument's response should be checked against a calibration standard.

The calibration check equipment consists of the calibration standard sulfur hexafluoride gas, the gas regulator, valve, and a tee with one leg feeding the flowmeter and the other leg attached to the inlet of the Model 1302. 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

Lay out the sampling points using the same method as for a velocity traverse (40 CFR 60, Appendix A, Method 1). Add a center point, which is not called for in the EPA method cited.

The injection equipment consists of a cylinder of pure sulfur hexafluoride gas, a gas regulator, flowmeter, valve, flexible tubing, and an injection probe (short length of ¼ in. stainless steel tubing with 90° bend at the gas exit 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.

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 - 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 - 100% of the concentration of the calibration gas according to the following equation:

$$\textit{injection flowrate} = \textit{stack flowrate} \times \frac{\textit{target ppmv}}{10^6}$$

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

$$\textit{rotameter reading} = k \times \textit{actual flowrate}$$

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, fan 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 fan 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. Then, successively position the analyzer's probe at each traverse point. Record at least two analyzer readings for each traverse point. Repeat the entire traverse.

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.

After the conclusion of the test, calculate the COV of the tracer gas concentrations in the stack.

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 are observed at the facility. For any given injection plane, five injection points should be used, including the centerline and 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 recirculation of the tracer to the inlet of the fan. This may result in a false indication of good mixing.

CAUTION

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

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav1
Date	4/26/96	Injection point	Fan inlet duct: 1.76" from bottom
Tester	Glissmeyer/Dennis	Fan Setting	23 Hz, 8.7 m/s midpoint
Stack Dia.	10	Stack Temp	16.6 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

With Straightener

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	46.9	45.4		48.0	46.9	
2	0.67	46.9	45.4		47.7	47.2	
3	1.18	46.8	45.4		47.8	47.2	
4	1.77	46.4	45.4		47.6	47.2	
5	2.50	46.5	45.5		47.2	47.4	
6	3.56	46.1	45.5		47.0	48.1	
7	6.44	46.2	45.8		47.4	48.0	
8	7.50	46.6	45.8		47.2	48.3	
9	8.23	46.5	46.0		47.4	48.4	
10	8.82	47.0	46.0		47.6	48.5	
11	9.33	46.8	45.8		47.6	47.6	
12	9.79	46.6	46.0		47.8	47.8	

						All
Average of all data	46.6	45.7		47.5	47.7	46.9
w/o points by wall	46.6	45.7		47.5	47.8	46.9
Centerpoint	47.4	47.6		47.6	47.0	

Center 2/3 with centerpoint					All
Mean	46.6	45.9		47.4	47.8	46.93
Std. Dev.	0.404	0.685		0.254	0.586	0.891
COV %	0.9	1.5		0.5	1.2	1.9

	Start	Finish	
Tracer tank pressur	200	200	psig
Ambient Temp	17.6	18.6	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	2.7	lpm
Ambient pressure	1011	1010	mbar
Ambient humidity	42%	25%	
Wind @ 2m	3.4	3.9	m/s
Direction	150 sw		

Gas analyzer checked on: 4/19/96

Duct was 8.8" diameter and the fitting offset was 3.9". 80% of the depth is 7.04", or 1.76 " from the bottom.

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

Normalization Temp set to 21 C. Centerline background SF6 reading was about 20 ppb. By completion of the 2nd W/E traverse, the injection flowmeter dropped to 50, so it was adjusted back to 54 when started the N/S.

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav2
Date	4/26/96	Injection point	Fan outlet, west side, depth 1"
Tester	Glissmeyer/Dennis	Fan Setting	23 Hz, 8.5 - 9.5 m/s midpoint
Stack Dia.	10	Stack Temp	
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

With Straightener

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	87.0	87.5	86.5	33.6	34.2	32.8
2	0.67	84.6	82.2	82.2	34.1	32.8	31.5
3	1.18	75.6	74.5	73.5	34.3	32.1	34.2
4	1.77	67.6	65.8	67.4	35.0	35.7	34.6
5	2.50	60.2	60.4	60.0	35.4	34.7	35.0
6	3.56	49.2	48.4	49.0	34.6	34.2	34.5
7	6.44	27.4	28.2	27.4	49.8	47.8	48.6
8	7.50	20.4	20.6	20.6	61.4	62.1	62.8
9	8.23	17.0	16.4	16.6	67.4	65.8	65.8
10	8.82	13.8	14.4	14.8	66.5	66.0	67.0
11	9.33	12.4	13.2	13.0	65.2	67.4	65.7
12	9.79	12.0	11.3	12.8	69.6	66.4	64.4
Water comp.		Yes	No	No	No	No	Yes

							All
Average of all data	43.9	43.6	43.7	48.9	48.3	48.1	46.1
w/o points by wall	42.8	42.4	42.5	48.4	47.9	48.0	45.3
Centerpoint	36.4	38.2	37.5	38	37.5	37	

Center 2/3 with centerpoint							All
Mean	40.8	40.8	40.8	46.9	46.2	46.6	43.69
Std. Dev.	23.148	22.551	22.563	14.518	14.545	14.672	18.421
COV %	56.7	55.3	55.4	30.9	31.5	31.5	42.2

	Start	Finish	
Tracer tank pressur	250	225	psig
Ambient Temp	20	18.5	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	1009	1007	mbar
Ambient humidity	24%	25%	
Wind @ 2 m	5.8	5.8	m/s
	SW	SW	
Centerline vel	8.5	9	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299	NA
Sierra 110 Constant flow air sampler	NA

Duct is 8.8 in. square

Some traverses were done without water compensation in the analyzer to test it's significance. It is quicker to not compensate, and there seemed to be no impact on the means and std. dev.

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav3
Date	5/14/96	Injection point	Fan inlet duct: 1.76" from bottom
Tester	GW Dennis	Fan Setting	23 Hz, 8.8 m/s midpoint
Stack Dia.	10	Stack Temp	20.2 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	46.5	46.2		46.2	46.7	
2	0.67	46.6	46.2		46.5	46.7	
3	1.18	46.6	46.4		46.5	46.6	
4	1.77	46.6	46.2		46.5	46.6	
5	2.50	46.7	46.4		46.5	46.7	
6	3.56	46.7	46.5		46.4	46.5	
7	6.44	46.7	46.3		46.3	46.6	
8	7.50	46.6	46.4		46.4	46.4	
9	8.23	46.6	46.5		46.2	46.5	
10	8.82	46.8	46.3		46.6	46.6	
11	9.33	46.7	46.6		46.3	46.4	
12	9.79	46.8	46.5		46.4	46.4	

							All
Average of all data		46.7	46.4		46.4	46.6	46.5
w/o points by wall		46.7	46.4		46.4	46.6	46.5
Centerpoint		47	46.4		46.4	46.2	

Center 2/3 with centerpoint					All
Mean	46.7	46.4	46.4	46.5	46.51
Std. Dev.	0.132	0.097	0.120	0.148	0.174
COV %	0.3	0.2	0.3	0.3	0.4

	Start	Finish	
Tracer tank pressur	200	200	psig
Ambient Temp	19.5	22.8	C
Injection flowmeter	54	53	
Sampling flowmeter	2 lpm	3 lpm	
Ambient pressure	991	990	mbar
Ambient humidity	54%	40%	

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav4
Date	5/15/96	Injection point	Fan outlet duct: 1" from top
Tester	GW Dennis	Fan Setting	23 Hz, 8.8 m/s midpoint
Stack Dia.	10	Stack Temp	16.4 - 20.7 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	47.3	46.6		50.4	50.3	
2	0.67	46.6	46.5		49.9	50.4	
3	1.18	46.8	46.9		50.4	49.5	
4	1.77	47.6	47.2		50.3	49.6	
5	2.50	47.9	47.3		49.5	49.5	
6	3.56	47.9	47.8		48.7	48.9	
7	6.44	48.6	48.4		45.8	45.9	
8	7.50	47.7	47.2		44.3	45.4	
9	8.23	45.9	46.2		43.2	43.5	
10	8.82	45.7	45.8		42	42.2	
11	9.33	44.7	44.6		41.7	41.7	
12	9.79	45.1	44.5		41	41.1	

						All
Average of all data	46.8	46.6		46.4	46.5	46.6
w/o points by wall	46.9	46.8		46.6	46.7	46.7
Centerpoint	48.8	48.5		48.1	47.9	

Center 2/3 with centerpoint					All
Mean	47.4	47.3	46.9	46.9	47.14
Std. Dev.	1.091	0.903	3.180	2.800	2.147
COV %	2.3	1.9	6.8	6.0	4.6

	Start	Finish	
Tracer tank pressur	200	200	psig
Ambient Temp	14.9	22.8	C
Injection flowmeter	54	52	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	991	991	mbar
Ambient humidity	79%	59%	
Centerline vel. m/s	8.8	8.8	

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav5
Date	5/15/96	Injection point	Fan outlet duct: west side, depth 1"
Tester	GW Dennis	Fan Setting	23 Hz, 8.8 m/s midpoint
Stack Dia.	10	Stack Temp	20.7 - 22.4 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	54.0	52.8		39.7	39.7	
2	0.67	54.3	52.7		40.0	41.0	
3	1.18	53.9	52.0		39.8	41.3	
4	1.77	52.5	53.3		41.0	42.1	
5	2.50	51.1	52.2		42.2	42.5	
6	3.56	48.4	48.7		44.3	44.3	
7	6.44	45.1	44.3		50.3	51.4	
8	7.50	45.1	44.8		54.0	54.3	
9	8.23	45.1	45.2		55.1	56.3	
10	8.82	44.0	45.1		57.6	57.8	
11	9.33	43.4	44.0		58.5	59.6	
12	9.79	44.0	43.5		59.8	60.2	

							All
Average of all data		48.4	48.2		48.5	49.2	48.6
w/o points by wall		48.3	48.2		48.3	49.1	48.5
Centerpoint		45.9	46.3		46.9	47.4	

Center 2/3 with centerpoint					All
Mean	47.9	48.0	47.9	48.6	48.10
Std. Dev.	3.714	3.628	6.601	6.490	5.083
COV %	7.8	7.6	13.8	13.4	10.6

	Start	Finish	
Tracer tank pressur	200	200	psig
Ambient Temp	22.7	22.6	C
Injection flowmeter	54	56	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	991	991	mbar
Ambient humidity	59%	33%	
Centerline vel. m/s	8.8	8.9	

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav6
Date	6/5/96	Injection point	Fan inlet duct: top, depth 1"
Tester	GW Dennis	Fan Setting	23 Hz
Stack Dia.	10	Stack Temp	19 - 24 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	46.6	46.2		46.7	46.9	
2	0.67	46.5	46.6		46.7	46.5	
3	1.18	46.3	46.6		46.3	46.5	
4	1.77	46.6	46.5		46.7	46.2	
5	2.50	46.5	46.5		46.3	46.5	
6	3.56	46.7	46.6		46.3	46.3	
7	6.44	46.9	46.7		46.4	46.4	
8	7.50	47.0	47.0		46.2	46.4	
9	8.23	47.0	47.0		46.4	46.5	
10	8.82	47.2	47.1		46.2	46.2	
11	9.33	47.0	47.1		46.2	46.3	
12	9.79	47.1	47.3		46.1	46.4	

							All
Average of all data		46.8	46.8		46.4	46.4	46.6
w/o points by wall		46.8	46.8		46.4	46.4	46.6
Centerpoint		46.5	46.8		47.1	46.7	

Center 2/3 with centerpoint					All
Mean	46.7	46.8	46.4	46.4	46.59
Std. Dev.	0.296	0.230	0.292	0.162	0.292
COV %	0.6	0.5	0.6	0.3	0.6

	Start	Finish	
Tracer tank pressure	0/10	0/15	psig
Ambient Temp	18.4	24	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	1007	1019	mbar
Ambient humidity	39%	26%	%RH
Wind @ 2 m	2.5	4.0	m/s
Wind direction	123	11	degrees
Centerline vel.	8.7	8.7	m/s

Gas analyzer checked on: 4/19/96

Ran out of gas during N/S traverse. Cylinder was changed and the N/S traverse was started over. The data shown here are the final data. The tank pressure data shows the readings on the tank gage followed by the outlet gage. It is unclear why the tank gage reads zero on the fresh tank.

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav7
Date	6/5/96	Injection point	Fan inlet duct: top, 1" from North side
Tester	JA Glissmeyer	Fan Setting	23 Hz
Stack Dia.	10	Stack Temp	23. 7 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	47.4	47.7		47.4	47.3	
2	0.67	47.2	47.1		47.1	47.4	
3	1.18	46.9	46.8		47.3	47.1	
4	1.77	46.9	46.9		47.2	47.1	
5	2.50	46.9	46.9		47.4	47.0	
6	3.56	47.0	46.9		47.1	47.2	
7	6.44	47.1	47.2		46.8	47.1	
8	7.50	47.2	46.9		47.3	47.3	
9	8.23	47.3	47.2		47.3	47.3	
10	8.82	46.9	47.1		47.0	47.2	
11	9.33	47.4	47.1		47.2	46.7	
12	9.79	47.2	47.6		47.2	47.2	

						All
Average of all data	47.1	47.1		47.2	47.2	47.1
w/o points by wall	47.1	47.0		47.2	47.1	47.1
Centerpoint	47.2	47.1		47.2	47.2	

Center 2/3 with centerpoint					All
Mean	47.0	47.0	47.2	47.2	47.10
Std. Dev.	0.159	0.150	0.186	0.100	0.165
COV %	0.3	0.3	0.4	0.2	0.3

	Start	Finish	
Tracer tank pressure	0/15	0/15	psig
Ambient Temp	24	24	C
Injection flowmeter	54	53	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	1019	1018	mbar
Ambient humidity	26%	24%	%RH
Wind @ 2 m	4.0	3.0	m/s
Wind direction	11	37	degrees
Centerline vel.	8.7	8.6	m/s

Gas analyzer checked on: 4/19/96

The tank pressure data shows the readings on the tank gage followed by the outlet gage. It is unclear why the tank gage reads zero on a nearly fresh tank.

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 8
Date	6/6/96	Injection point	Center Fan Inlet Duct 4 1/4"
Tester	GW Dennis	Fan Setting	23 Hz
Stack Dia.	10	Stack Temp	23. 8 C 24.6 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
El. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	47.0	47.1		46.7	46.6	
2	0.67	47.2	47.2		46.9	46.9	
3	1.18	46.9	47.0		46.8	46.9	
4	1.77	47.0	46.8		46.8	46.7	
5	2.50	47.0	46.9		46.5	46.6	
6	3.56	46.9	46.9		46.7	46.5	
7	6.44	47.1	47.0		46.7	46.5	
8	7.50	47.0	47.2		46.7	46.9	
9	8.23	47.2	47.1		46.8	46.5	
10	8.82	47.0	47.0		46.6	46.6	
11	9.33	47.2	47.3		46.9	46.5	
12	9.79	46.9	47.2		46.2	46.4	

							All
Average of all data		47.0	47.1		46.7	46.6	46.9
w/o points by wall		47.1	47.0		46.7	46.7	46.9
Centerp	0.50	47.6	47.4		47.0	46.9	

Center 2/3 with centerpoint					All
Mean	47.1	47.0	46.7	46.7	46.88
Std. Dev.	0.217	0.180	0.141	0.179	0.249
COV %	0.5	0.4	0.3	0.4	0.5

	Start	Finish	
Tracer tank pressure	0/15	0/15	psig
Ambient Temp	24.3	26.5	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	1004	1003	mbar
Ambient humidity	30%	25%	%RH
Wind @ 2 m	1.8	2.3	m/s
Wind direction	345	27	degrees
Centerline vel.	8.6	8.7	m/s

Gas analyzer checked on: 4/19/96

The tank pressure data shows the readings on the tank gage followed by the outlet gage. It is unclear why the tank gage reads zero on a nearly fresh tank.

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 9
Date	6/19/96	Injection point	1" Southside Inlet
Tester	GW Denni TK O'Neil	Fan Setting	23 Hz
Stack Dia.	10	Stack Temp	18 C 20 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
El. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	46.5	46.4		46.3	46.3	
2	0.67	46.4	46.4		46.2	46.3	
3	1.18	46.4	46.3		46.4	46.3	
4	1.77	46.6	46.3		46.3	46.1	
5	2.50	46.4	46.4		45.9	46.2	
6	3.56	46.2	46.3		46.2	46.3	
7	6.44	46.3	46.2		46.1	46.3	
8	7.50	46.2	46.5		46.1	46.2	
9	8.23	46.4	46.4		46.0	45.8	
10	8.82	46.1	46.0		45.9	45.9	
11	9.33	46.1	46.1		46.0	46.0	
12	9.79	46.1	45.7		45.9	46.0	

						All
Average of all data		46.3	46.3	46.1	46.1	46.2
w/o points by wall		46.3	46.3	46.1	46.1	46.2
Centerpoint	0.50	46.5	46.5	46.2	46.6	

Center 2/3 with centerpoint					All
Mean	46.3	46.3	46.1	46.2	46.24
Std. Dev.	0.159	0.156	0.172	0.237	0.199
COV %	0.3	0.3	0.4	0.5	0.4

	Start	Finish	
Tracer tank pressure	300/10	300/10	psig
Ambient Temp	15	20	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	1006	1005	mbar
Ambient humidity	40%	34%	%RH
Wind @ 2 m	24.0	2.5	m/s
Wind direction	90	110	degrees
Centerline vel.	8.6	8.7	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 10
Date	6/19/96	Injection point	1" Bottom Inlet Duct
Tester	GW Denni TK O'Neil	Fan Setting	17 Hz
Stack Dia.	10	Stack Temp	20 C 21 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	66.4	66.4		65.7	66.2	
2	0.67	66.7	65.9		66.1	66.0	
3	1.18	66.4	66.3		65.9	65.7	
4	1.77	66.5	66.1		66.2	65.6	
5	2.50	66.4	66.0		65.7	64.9	
6	3.56	65.9	66.2		66.1	65.9	
7	6.44	66.0	65.8		65.5	66.0	
8	7.50	65.4	66.9		66.2	66.2	
9	8.23	66.3	66.4		66.7	66.3	
10	8.82	66.1	66.4		66.3	65.7	
11	9.33	66.0	66.1		66.7	66.0	
12	9.79	66.6	66.0		66.4	66.3	

								All
Average of all data		66.2	66.2		66.1	65.9		66.1
w/o points by wall		66.2	66.2		66.1	65.8		66.1
Centerpoint	0.50	66.4	66.3		66.7	66.2		

Center 2/3 with centerpoint					All
Mean	66.2	66.3	66.1	65.8	66.10
Std. Dev.	0.350	0.308	0.407	0.430	0.396
COV %	0.5	0.5	0.6	0.7	0.6

	Start	Finish	
Tracer tank pressure	300/10	300/10	psig
Ambient Temp	20	22	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	1005	1004	mbar
Ambient humidity	34%	29%	%RH
Wind @ 2 m	2.5	3.4	m/s
Wind direction	110	96	degrees
Centerline vel.	6.3	6.4	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 11
Date	6/19/96	Injection point	1" Top Inlet Duct
Tester	GW Denni TK O'Neil	Fan Setting	17 Hz
Stack Dia.	10	Stack Temp	21 C 21 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
El. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	65.6	65.9		65.6	66.0	
2	0.67	65.3	65.7		65.9	65.7	
3	1.18	65.7	65.7		65.9	65.9	
4	1.77	65.5	65.9		65.2	65.5	
5	2.50	65.8	65.9		65.1	65.3	
6	3.56	66.0	65.6		65.4	65.3	
7	6.44	66.0	66.4		65.1	65.5	
8	7.50	66.3	66.3		65.3	65.0	
9	8.23	65.8	66.1		65.1	65.2	
10	8.82	66.2	66.5		65.8	65.7	
11	9.33	66.5	65.8		65.7	65.7	
12	9.79	65.3	66.0		65.8	65.6	

							All
Average of all data		65.8	66.0		65.5	65.5	65.7
w/o points by wall		65.9	66.0		65.5	65.5	65.7
Centerpoint	0.50	66.0	65.9		66.1	65.5	

Center 2/3 with centerpoint					All
Mean	65.9	66.0	65.4	65.4	65.71
Std. Dev.	0.249	0.312	0.388	0.269	0.405
COV %	0.4	0.5	0.6	0.4	0.6

	Start	Finish	
Tracer tank pressure	300/10	300/10	psig
Ambient Temp	22	22	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	1004	1003	mbar
Ambient humidity	29%	27%	%RH
Wind @ 2 m	3.4	4.0	m/s
Wind direction	96	100	degrees
Centerline vel.	6.4	6.5	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 12
Date	6/20/96	Injection point	1" North Side Inlet
Tester	GW Denni TK O'Neil	Fan Setting	17 Hz
Stack Dia.	10	Stack Temp	17 C 18 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	67.3	67.0		66.1	66.5	
2	0.67	66.8	66.9		66.4	66.2	
3	1.18	66.8	66.5		66.2	65.8	
4	1.77	66.7	66.7		66.0	65.7	
5	2.50	66.8	66.6		66.1	65.7	
6	3.56	66.7	66.5		65.6	65.4	
7	6.44	66.6	66.4		65.3	65.3	
8	7.50	66.6	66.6		65.4	65.5	
9	8.23	66.7	66.7		65.8	65.5	
10	8.82	66.5	66.6		65.8	65.4	
11	9.33	66.7	66.3		65.6	65.5	
12	9.79	66.4	66.7		65.8	65.6	

							All
Average of all data		66.7	66.6		65.8	65.7	66.2
w/o points by wall		66.7	66.6		65.8	65.6	66.2
Centerpoin	0.50	67.5	67.6		66.7	66.4	

Center 2/3 with centerpoint						All
Mean	66.8	66.7		65.9	65.6	66.24
Std. Dev.	0.292	0.355		0.432	0.332	0.606
COV %	0.4	0.5		0.7	0.5	0.9

	Start	Finish	
Tracer tank pressure	290/10	290/10	psig
Ambient Temp	17	19	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	998	998	mbar
Ambient humidity	44%	44%	%RH
Wind @ 2 m	1.5	1.6	m/s
Wind direction	68	86	degrees
Centerline vel.	6.5	6.4	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 13
Date	6/20/96	Injection point	Center Inlet Duct
Tester	GW Denni TK O'Neil	Fan Setting	17 Hz
Stack Dia.	10	Stack Temp	18 C 22 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	67.0	66.9		66.7	66.4	
2	0.67	66.6	66.9		66.8	66.5	
3	1.18	66.6	66.5		66.8	66.5	
4	1.77	67.0	66.6		66.6	66.5	
5	2.50	67.1	66.3		66.7	66.4	
6	3.56	66.6	66.6		66.6	66.8	
7	6.44	66.9	66.9		66.5	66.3	
8	7.50	67.0	66.6		66.3	66.5	
9	8.23	66.4	66.8		66.6	66.1	
10	8.82	66.7	67.1		66.2	66.4	
11	9.33	66.9	67.0		66.3	65.8	
12	9.79	67.0	67.2		66.7	65.6	

							All
Average of all data		66.8	66.8		66.6	66.3	66.6
w/o points by wall		66.8	66.7		66.5	66.4	66.6
Centerpoint	0.50	67.5	67.3		67.2	66.7	

Center 2/3 with centerpoint					All
Mean	66.9	66.7	66.6	66.5	66.67
Std. Dev.	0.332	0.313	0.289	0.206	0.315
COV %	0.5	0.5	0.4	0.3	0.5

	Start	Finish	
Tracer tank pressure	290/10	290/10	psig
Ambient Temp	19	23	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	998	996	mbar
Ambient humidity	44%	29%	%RH
Wind @ 2 m	1.6	3.1	m/s
Wind direction	86	325	degrees
Centerline vel.	6.4	6.5	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 14
Date	6/20/96	Injection point	1" South Side
Tester	GW Denni TK O'Neil	Fan Setting	17 Hz
Stack Dia.	10	Stack Temp	22 C 23 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	67.0	67.4		66.9	66.0	
2	0.67	67.0	67.0		66.3	66.5	
3	1.18	66.9	66.8		66.7	66.3	
4	1.77	67.1	66.9		66.1	66.7	
5	2.50	66.9	67.0		66.4	66.3	
6	3.56	66.9	67.0		66.4	66.8	
7	6.44	67.0	66.7		66.8	66.7	
8	7.50	66.4	67.0		66.2	66.4	
9	8.23	66.2	66.6		66.3	66.2	
10	8.82	66.5	66.3		66.3	65.9	
11	9.33	66.8	66.5		66.3	66.2	
12	9.79	66.3	66.2		66.4	66.2	
							All
Average of all data		66.8	66.8		66.4	66.4	66.6
w/o points by wall		66.8	66.8		66.4	66.4	66.6
Centerpoint	0.50	67.1	67.4		67.1	66.8	

Center 2/3 with centerpoint					All
Mean	66.8	66.9	66.5	66.5	66.64
Std. Dev.	0.327	0.309	0.323	0.313	0.353
COV %	0.5	0.5	0.5	0.5	0.5

	Start	Finish	
Tracer tank pressure	290/10	290/10	psig
Ambient Temp	23	24	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	996	996	mbar
Ambient humidity	29%	25%	%RH
Wind @ 2 m	3.1	2.3	m/s
Wind direction	325	17	degrees
Centerline vel.	6.5	6.3	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 15
Date	6/20/96	Injection point	1" Bottom Inlet Duct
Tester	GW Dennis TK O'Neil	Fan Setting	29 Hz
Stack Dia.	10	Stack Temp	23 C 25 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	37.3	37.4		36.9	37.0	
2	0.67	37.2	37.1		36.8	36.8	
3	1.18	37.0	37.1		36.9	36.7	
4	1.77	37.2	37.2		36.7	36.8	
5	2.50	37.1	37.0		36.8	36.8	
6	3.56	37.0	36.9		36.9	37.0	
7	6.44	37.0	36.9		37.0	36.9	
8	7.50	37.2	37.0		36.9	37.0	
9	8.23	36.9	37.1		36.9	36.9	
10	8.82	37.2	37.0		37.1	37.2	
11	9.33	36.9	37.0		37.2	37.2	
12	9.79	37.0	37.0		37.1	37.2	

						All
Average of all data		37.1	37.1	36.9	37.0	37.0
w/o points by wall		37.1	37.0	36.9	36.9	37.0
Centerpoint	0.50	37.4	37.5	37.1	37	

Center 2/3 with centerpoint					All
Mean	37.1	37.1	36.9	36.9	37.01
Std. Dev.	0.154	0.186	0.130	0.148	0.173
COV %	0.4	0.5	0.4	0.4	0.5

	Start	Finish	
Tracer tank pressure	290/10	290/10	psig
Ambient Temp	24	25	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	996	995	mbar
Ambient humidity	25%	20%	%RH
Wind @ 2 m	2.3	2.4	m/s
Wind direction	17	59	degrees
Centerline vel.	11.5	11.4	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 16
Date	6/26/96	Injection point	1" from Top
Tester	GW Dennis TK O'Neil	Fan Setting	29 Hz
Stack Dia.	10	Stack Temp	19 C 19 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	36.8	36.7		36.8	36.8	
2	0.67	36.7	36.7		36.8	36.8	
3	1.18	36.8	36.5		36.8	36.7	
4	1.77	36.7	36.5		36.7	36.7	
5	2.50	36.6	36.7		36.6	36.6	
6	3.56	36.7	36.6		36.5	36.7	
7	6.44	36.6	36.7		36.7	36.7	
8	7.50	36.7	36.6		36.8	36.7	
9	8.23	36.6	36.7		36.9	36.9	
10	8.82	37.7	36.7		36.7	36.6	
11	9.33	37.7	36.9		36.6	36.8	
12	9.79	37.8	36.9		36.7	36.8	
							All
Average of all data		37.0	36.7		36.7	36.7	36.8
w/o points by wall		36.9	36.7		36.7	36.7	36.7
Centerpoint	0.50	36.8	36.8		36.9	36.8	

Center 2/3 with centerpoint					All
Mean	36.8	36.6	36.7	36.7	36.72
Std. Dev.	0.346	0.101	0.132	0.093	0.197
COV %	0.9	0.3	0.4	0.3	0.5

	Start	Finish	
Tracer tank pressure	290/10	290/10	psig
Ambient Temp	19	20	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	993	994	mbar
Ambient humidity	52%	48%	%RH
Wind @ 2 m	1.7	1.4	m/s
Wind direction	120	99	degrees
Centerline vel.	11.3	11.4	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 17
Date	6/26/96	Injection point	1" North Side
Tester	GW Denni TK O'Neil	Fan Setting	29 Hz
Stack Dia.	10	Stack Temp	19 C 22 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	36.9	36.9		36.5	36.5	
2	0.67	36.7	36.8		36.4	36.3	
3	1.18	36.8	36.8		36.4	36.2	
4	1.77	36.9	36.9		36.2	36.3	
5	2.50	36.8	36.8		36.3	36.3	
6	3.56	36.9	37.0		36.2	36.3	
7	6.44	37.0	36.9		36.3	36.2	
8	7.50	37.0	36.8		36.5	36.3	
9	8.23	37.0	36.9		36.4	36.3	
10	8.82	36.8	36.9		36.5	36.4	
11	9.33	36.9	36.7		36.6	36.4	
12	9.79	36.7	36.7		36.4	36.4	

						All
Average of all data		36.9	36.8	36.4	36.3	36.6
w/o points by wall		36.9	36.9	36.4	36.3	36.6
Centerpoint	0.50	37.2	37.2	36.7	36.5	

Center 2/3 with centerpoint					All
Mean	36.9	36.9	36.4	36.3	36.64
Std. Dev.	0.132	0.127	0.162	0.093	0.317
COV %	0.4	0.3	0.4	0.3	0.9

	Start	Finish	
Tracer tank pressure	290/10	290/10	psig
Ambient Temp	20	23	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	994	993	mbar
Ambient humidity	48%	40%	%RH
Wind @ 2 m	1.4	1.7	m/s
Wind direction	99	70	degrees
Centerline vel.	11.4	11.4	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 18
Date	6/26/96	Injection point	1" Center Inlet Duct
Tester	GW Dennis TK O'Neil	Fan Setting	29 Hz
Stack Dia.	10	Stack Temp	22 C 23 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	37.1	37.0		37.0	37.2	
2	0.67	37.0	36.8		36.7	36.7	
3	1.18	37.0	36.9		36.9	36.8	
4	1.77	36.8	37.1		36.8	36.8	
5	2.50	37.0	36.9		36.8	36.9	
6	3.56	36.8	37.0		36.9	36.9	
7	6.44	37.2	37.0		36.7	36.6	
8	7.50	37.0	36.9		36.8	36.9	
9	8.23	37.0	36.9		36.7	36.9	
10	8.82	36.9	37.1		36.9	36.7	
11	9.33	37.1	37.0		36.5	36.5	
12	9.79	37.0	36.9		36.9	36.8	

							All
Average of all data		37.0	37.0		36.8	36.8	36.9
w/o points by wall		37.0	37.0		36.8	36.8	36.9
Centerpoint	0.50	37.2	37.1		37.1	36.9	

Center 2/3 with centerpoint					All
Mean	37.0	37.0	36.8	36.8	36.91
Std. Dev.	0.145	0.093	0.124	0.109	0.139
COV %	0.4	0.3	0.3	0.3	0.4

	Start	Finish	
Tracer tank pressure	290/10	290/10	psig
Ambient Temp	23	21	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	993	992	mbar
Ambient humidity	40%	34%	%RH
Wind @ 2 m	1.7	2.3	m/s
Wind direction	70	96	degrees
Centerline vel.	11.4	11.3	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run with water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 19
Date	6/26/96	Injection point	1" South Inlet
Tester	GW Dennis TK O'Neil	Fan Setting	29 Hz
Stack Dia.	10	Stack Temp	26 C 25 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	37.2	37.0		37.2	37.0	
2	0.67	37.2	37.0		37.1	36.9	
3	1.18	37.1	37.1		37.0	37.0	
4	1.77	37.3	37.2		37.1	37.1	
5	2.50	37.3	37.3		37.0	37.1	
6	3.56	37.2	37.2		37.0	37.0	
7	6.44	37.2	37.2		37.0	36.9	
8	7.50	37.2	37.1		36.9	37.0	
9	8.23	37.1	37.0		36.8	36.8	
10	8.82	37.0	37.1		36.8	36.7	
11	9.33	36.8	36.8		36.7	36.6	
12	9.79	36.8	36.8		36.7	36.8	

						All
Average of all data		37.1	37.1	36.9	36.9	37.0
w/o points by wall		37.1	37.1	36.9	36.9	37.0
Centerpoint	0.50	37.1	37.2	37.4	37.2	

Center 2/3 with centerpoint					All
Mean	37.2	37.2	37.0	37.0	37.08
Std. Dev.	0.100	0.088	0.180	0.156	0.157
COV %	0.3	0.2	0.5	0.4	0.4

	Start	Finish	
Tracer tank pressure	290/10	290/10	psig
Ambient Temp	26	27	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	991	990	mbar
Ambient humidity	32%	30%	%RH
Wind @ 2 m	1.9	1.6	m/s
Wind direction	90	40	degrees
Centerline vel.	11.4	11.3	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run without water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 20
Date	6/26/96	Injection point	1" Bottom Outlet
Tester	GW Denni TK O'Neil	Fan Setting	23 Hz
Stack Dia.	10	Stack Temp	25 C 25 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	41.4	41.3		50.4	49.1	
2	0.67	40.5	40.3		51.2	50.8	
3	1.18	41.1	41.2		48.6	49.3	
4	1.77	42.9	42.0		50.9	50.8	
5	2.50	43.4	42.6		49.5	49.7	
6	3.56	44.0	45.0		48.0	47.2	
7	6.44	48.6	49.2		45.5	45.9	
8	7.50	51.8	50.6		45.4	44.5	
9	8.23	53.6	53.0		44.1	44.1	
10	8.82	53.1	54.3		45.2	44.2	
11	9.33	55.9	54.6		43.5	43.8	
12	9.79	55.1	57.1		43.2	42.1	

				All
Average of all data	47.6	47.6	47.1	46.8	47.3
w/o points by wall	47.5	47.3	47.2	47.0	47.2

Centerpoi	0.50	48.2	46.6		47.3	47.2	

Center 2/3 with centerpoint					All
Mean	47.4	47.2	47.2	47.0	47.18
Std. Dev.	4.742	4.861	2.273	2.520	3.632
COV %	10.0	10.3	4.8	5.4	7.7

	Start	Finish	
Tracer tank pressure	290/10	290/10	psig
Ambient Temp	27	27	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	990	989	mbar
Ambient humidity	30%	28%	%RH
Wind @ 2 m	1.6	1.6	m/s
Wind direction	40	10	degrees
Centerline vel.	8.9	8.8	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	**Cal Exp. Date:**
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run without water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 21
Date	8/6/96	Injection point	1" East Side After Fan
Tester	GW Dennis TK O'Neil	Fan Setting	23 Hz
Stack Dia.	10	Stack Temp	21 C 21 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	46.5	47.4		48.3	49.4	
2	0.67	46.5	46.3		50.0	49.8	
3	1.18	47.2	46.8		49.4	49.3	
4	1.77	47.2	46.9		49.3	49.1	
5	2.50	46.7	47.1		48.9	49.0	
6	3.56	48.4	47.8		48.9	48.3	
7	6.44	49.4	49.7		47.8	48.1	
8	7.50	49.6	49.1		47.8	46.8	
9	8.23	50.1	49.5		47.0	47.4	
10	8.82	50.1	49.1		45.5	46.2	
11	9.33	49.5	49.0		45.9	45.3	
12	9.79	48.9	48.9		46.3	45.0	

							All
Average of all data		48.3	48.1		47.9	47.8	48.1
w/o points by wall		48.5	48.1		48.1	47.9	48.1
Centerpoi	0.50	48.9	49.1		48.7	48.2	

Center 2/3 with centerpoint					All
Mean	48.6	48.3	48.1	48.0	48.29
Std. Dev.	1.313	1.183	1.270	1.064	1.180
COV %	2.7	2.4	2.6	2.2	2.4

	Start	Finish	
Tracer tank pressure	300/20	300/20	psig
Ambient Temp	24	24	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	1005	1006	mbar
Ambient humidity	48%	39%	%RH
Wind @ 2 m	2.0	3.5	m/s
Wind direction	131	190	degrees
Centerline vel.	9.3	9.1	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run without water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 22
Date	8/6/96	Injection point	1" Center Outlet
Tester	GW Dennis TK O'Neil	Fan Setting	23 Hz
Stack Dia.	10	Stack Temp	21 C 21 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	46.3	47.3		42.1	41.3	
2	0.67	47.5	47.0		41.5	42.1	
3	1.18	47.0	47.6		42.2	42.7	
4	1.77	46.8	47.6		41.8	42.2	
5	2.50	46.8	47.4		42.8	42.9	
6	3.56	46.9	46.8		44.0	44.2	
7	6.44	46.5	45.9		48.3	48.1	
8	7.50	46.5	47.6		50.5	50.1	
9	8.23	47.8	47.6		50.6	51.1	
10	8.82	48.0	49.2		52.4	53.8	
11	9.33	48.3	49.0		54.2	53.6	
12	9.79	48.7	49.9		54.8	53.9	

							All
Average of all data		47.3	47.7		47.1	47.2	47.3
w/o points by wall		47.2	47.6		46.8	47.1	47.2
Centerpoin	0.50	46.2	45.7		46.6	46.3	

Center 2/3 with centerpoint					All
Mean	46.9	47.3	46.6	46.8	46.90
Std. Dev.	0.596	1.045	4.052	4.187	2.856
COV %	1.3	2.2	8.7	8.9	6.1

	Start	Finish	
Tracer tank pressure	300/20	300/20	psig
Ambient Temp	24	24	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	1006	1006	mbar
Ambient humidity	39%	34%	%RH
Wind @ 2 m	3.5	5.2	m/s
Wind direction	190	188	degrees
Centerline vel.	9.1	9.2	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	**Cal Exp. Date:**
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run without water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 23
Date	8/12/96	Injection point	Fan Outlet West Side 1"
Tester	GW Denni TK O'Neil	Fan Setting	5
Stack Dia.	10	Stack Temp	25 C 25 C
Stack X-Area	78.5	Offset to Index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	375.0	389.0		321.0	265.0	
2	0.67	384.0	363.0		273.0	301.0	
3	1.18	375.0	378.0		272.0	306.0	
4	1.77	363.0	386.0		284.0	269.0	
5	2.50	334.0	365.0		292.0	298.0	
6	3.56	327.0	374.0		320.0	305.0	
7	6.44	328.0	329.0		333.0	317.0	
8	7.50	301.0	299.0		356.0	328.0	
9	8.23	310.0	308.0		343.0	341.0	
10	8.82	281.0	286.0		337.0	362.0	
11	9.33	291.0	298.0		336.0	373.0	
12	9.79	298.0	306.0		360.0	371.0	

							All
Average of all data		330.6	340.1		318.9	319.7	327.3
w/o points by wall		329.4	338.6		314.6	320.0	325.7
Centerpoint	0.50	314.0	313		313	325	

Center 2/3 with centerpoint					All
Mean	325.9	337.6	316.7	316.8	324.22
Std. Dev.	29.345	38.338	28.758	26.729	30.991
COV %	9.0	11.4	9.1	8.4	9.6

	Start	Finish	
Tracer tank pressure	300/20	300/20	psig
Ambient Temp	26	27	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	1005	1005	mbar
Ambient humidity	31%	26%	%RH
Wind @ 2 m	1.3	2.7	m/s
Wind direction	21	96	degrees
Centerline vel.	1.4	1.4	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run without water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 24
Date	8/12/96	Injection point	Fan Outlet West Side 1"
Tester	GW Dennis TK O'Neil	Fan Setting	17
Stack Dia.	10	Stack Temp	25 C 25 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
El. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	66.6	68.5		53.7	49.6	
2	0.67	67.9	66.5		50.8	51.3	
3	1.18	65.3	67.2		52.3	52.1	
4	1.77	66.2	63.0		52.8	51.9	
5	2.50	63.3	64.8		54.8	52.9	
6	3.56	61.9	61.6		54.4	56.4	
7	6.44	61.7	59.7		62.2	62.8	
8	7.50	60.8	60.5		67.4	66.6	
9	8.23	63.2	58.8		70.8	72.0	
10	8.82	62.2	58.2		73.4	74.4	
11	9.33	62.4	61.7		76.0	75.8	
12	9.79	61.1	62.4		77.5	77.5	

							All
Average of all data		63.6	62.7		62.2	61.9	62.6
w/o points by wall		63.5	62.2		61.5	61.6	62.2
Centerpoint	0.50	58.9	59.5		60	59.4	

Center 2/3 with centerpoint					All
Mean	62.6	61.5	60.9	60.9	61.48
Std. Dev.	2.222	3.001	8.047	8.562	5.936
COV %	3.5	4.9	13.2	14.0	9.7

	Start	Finish	
Tracer tank pressure	300/20	300/20	psig
Ambient Temp	27	28	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	1005	1004	mbar
Ambient humidity	26%	26%	%RH
Wind @ 2 m	2.7	2.0	m/s
Wind direction	96	84	degrees
Centerline vel.	6.2	6.2	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run without water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 25
Date	8/12/96	Injection point	Fan Outlet West Side 1"
Tester	GW Denni TK O'Neil	Fan Setting	29
Stack Dia.	10	Stack Temp	26 C 27 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	39.7	39.6		35.8	36.0	
2	0.67	39.5	40.3		29.6	29.5	
3	1.18	39.5	40.5		31.4	30.8	
4	1.77	39.4	39.3		31.0	31.1	
5	2.50	38.6	38.6		31.4	31.0	
6	3.56	36.6	36.3		32.0	31.5	
7	6.44	34.8	34.8		33.5	33.2	
8	7.50	35.5	36.0		38.6	37.4	
9	8.23	35.7	35.7		40.2	40.1	
10	8.82	37.2	36.2		42.5	43.3	
11	9.33	35.9	37.1		43.2	44.3	
12	9.79	36.4	36.7		45.3	46.8	

							All
Average of all data		37.4	37.6		36.2	36.3	36.9
w/o points by wall		37.3	37.5		35.3	35.2	36.3
Centerpoi	0.50	35.6	34.6		35.3	35.8	

Center 2/3 with centerpoint					All
Mean	37.0	36.9	35.1	34.9	35.97
Std. Dev.	1.786	2.074	4.322	4.549	3.417
COV %	4.8	5.6	12.3	13.0	9.5

	Start	Finish	
Tracer tank pressure	300/20	300/20	psig
Ambient Temp	28	29	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	1004	1003	mbar
Ambient humidity	26%	23%	%RH
Wind @ 2 m	2.0	1.9	m/s
Wind direction	84	80	degrees
Centerline vel.	11.1	11	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run without water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 26
Date	8/13/96	Injection point	Fan Outlet West Side 1"
Tester	GW Denni TK O'Neil	Fan Setting	60 Hz
Stack Dia.	10	Stack Temp	22 C C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
El. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	20.2	20.3				
2	0.67	20.1	20.6				
3	1.18	19.9	19.9				
4	1.77	19.6	19.3				
5	2.50	18.9	19.3				
6	3.56	18.4	18.6				
7	6.44	16.9	16.8				
8	7.50	Overheated					
9	8.23						
10	8.82						
11	9.33						
12	9.79						

						All
Average of all data		19.1	19.3	#DIV/0!	#DIV/0!	#DIV/0!
w/o points by wall		19.0	19.1	#DIV/0!	#DIV/0!	#DIV/0!
Centerpoi	0.50	17.7	17.5			

Center 2/3 with centerpoint					All
Mean	18.6	18.6	#DIV/0!	#DIV/0!	18.57
Std. Dev.	1.141	1.193	#DIV/0!	#DIV/0!	1.113
COV %	6.1	6.4	#DIV/0!	#DIV/0!	6.0

	Start	Finish	
Tracer tank pressure	300/20		psig
Ambient Temp	17.2		C
Injection flowmeter	54		(1 lpm)
Sampling flowmeter	3		lpm
Ambient pressure	1003		mbar
Ambient humidity	52%		%RH
Wind @ 2 m	2.4		m/s
Wind direction	339		degrees
Centerline vel.	24.5		m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	**Cal Exp. Date:**
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run without water correction	NA

TRACER GAS TRAVERSE DATA FORM

Site	AP40 Mockup	Run No.	Gastrav 27
Date	8/14/96	Injection point	Fan Outlet West Side 1"
Tester	GW Denni TK O'Neil	Fan Setting	55Hz
Stack Dia.	10	Stack Temp	37 C 37 C
Stack X-Area	78.5	Offset to index	
Elevation		Center 2/3 from	0.92 to: 9.08
l. above disturbance	71 in.	Points in Center 2/3	3 to: 10

Traverse-->		W/E			N/S		
Trial --->		1	2	3	1	2	3
Point	Depth	Conc.	Conc.	Conc.	Conc.	Conc.	Conc.
1	0.21	21.8	20.9		16.1	16.2	
2	0.67	21.5	21.6		16.4	16.2	
3	1.18	21.3	21.5		16.7	16.3	
4	1.77	21.1	21.5		16.6	16.5	
5	2.50	20.4	20.9		16.9	16.6	
6	3.56	19.7	19.9		16.6	17.2	
7	6.44	18.5	18.4		17.8	17.8	
8	7.50	18.1	18.4		20.4	20.4	
9	8.23	18.5	18.1		21.4	21.8	
10	8.82	18.2	17.7		22.3	22.3	
11	9.33	17.7	18.4		22.8	23.5	
12	9.79	17.8	18.4		24.3	23.8	

							All
Average of all data		19.6	19.6		19.0	19.1	19.3
w/o points by wall		19.5	19.6		18.8	18.9	19.2
Centerpoint	0.50	19.1	18.9		19.3	18.9	

Center 2/3 with centerpoint					All
Mean	19.4	19.5	18.7	18.6	19.06
Std. Dev.	1.246	1.504	2.246	2.333	1.853
COV %	6.4	7.7	12.0	12.5	9.7

	Start	Finish	
Tracer tank pressure	300/20	300/20	psig
Ambient Temp	36.6	37.7	C
Injection flowmeter	54	54	(1 lpm)
Sampling flowmeter	3	3	lpm
Ambient pressure	998	998	mbar
Ambient humidity	21%	18%	%RH
Wind @ 2 m	3.5	2.1	m/s
Wind direction	191	215	degrees
Centerline vel.	21.7	21.7	m/s

Gas analyzer checked on: 4/19/96

Instuments Used:	Cal Exp. Date:
Solomat Zephyr #12951472	3/1/97
B & K Model 1302 #1765299, run without water correction	NA

Appendix D

Particle Tracer Uniformity Test

Procedure for Particle Concentration Uniformity Test

February 7, 1997

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 gaseous and particulate contaminant concentrations. This procedure deals with the particle concentration uniformity test.

The general approach is to inject particles of a known size into the test stack just downstream of the fan. The concentration of the particles are 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 observes 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.

Equipment

Vibrating orifice aerosol generator (VOAG) system (or other suitable aerosol generator)
Two optical particle counters (OPC)
Sampling probes for the particle counters
Particle injection probe
Aerosol feed solution (oleic acid in methanol)

Optical Particle Counter Setup

The absolute calibration of the OPC is not as 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 precision with which the tracer particles of a known size are consistently counted in the same OPC particle size channel. This can be determined during testing or before. However, the favorable comparison of particles obtained by the OPC with those observed on a flurad-coated microscope slide will lend to acceptable test results.

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 designed for subisokinetic operation because these optimize the collection of larger (10 μ) particles called for here. 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.

VOAG Setup

The VOAG should be located as close as possible to the injection port. The equipment arrangement should approximate that shown in Figure D.1. The Krypton-85 aerosol charge neutralizer may be needed if the particles are to be transported more than a couple of meters. The neutralizer minimizes deposition

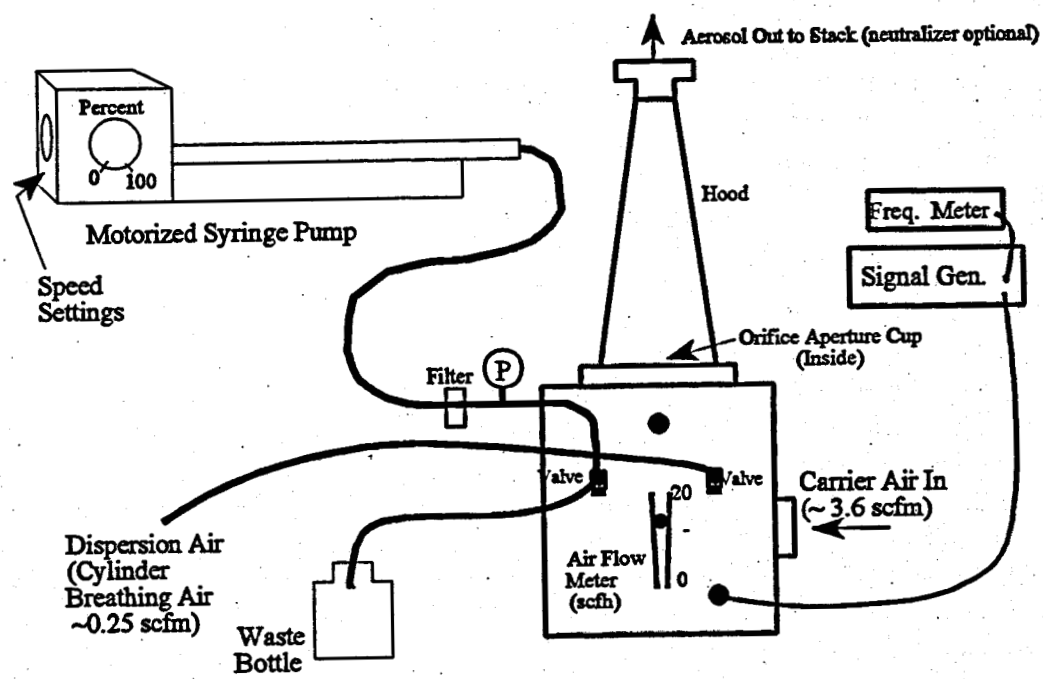


Figure D.1. Vibrating Orifice Aerosol Generator

caused by the static charge of the particles. The neutralizer should be located in a radiological control area. The syringe pump should be filled with an oleic acid and methanol solution, and the operational parameters configured for generating 10 μm AD particles.

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.

Measurements

On the data record sheet, record the test conditions of injection point, fan 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 VOAG is started.

Position the injection probe as directed for the test conditions. Start the injection of the tracer particles. Proceed quickly with the OPC traverses as the VOAG may have a limited operating time.

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 showed borderline acceptable mixing, suggested additional points would 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 will be performed at the average stack flowrate as a minimum. The test plan may also include the extremes of stack flowrates that are observed at the facility.

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 recirculation of the tracer to the inlet of the fan, which may result in a false indication of good mixing.

CAUTION

Observe appropriate precautions and procedures for using and handling the aerosol charge neutralizer and the aerosol feed solution.

TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-1
Testers:	glissmeyer/maughan	Date	10/23/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	0.92 to: 9.08
		Points in Center 2/3	3 to: 10

Each OPC data point includes: average of two 1-min. readings counts/ft3
normalized point-by- point

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Norm N/S
2	na						
3	1.27	75.5	88.5	1.17	65	113	1.74
4	1.77	77	91.5	1.19	56.5	103.5	1.83
5	2.50	77.5	119.5	1.54	53.5	68.5	1.28
6	3.56	65.7	116.5	1.77	58.5	103	1.76
Center	5	77.5	105.5	1.36	58.5	118	2.02
7	6.44	72.5	117.5	1.62	58.5	123.5	2.11
8	7.50	84	121	1.44	51.5	44	0.85
9	8.23	81	126.5	1.56	71.5	64.5	0.90
10	8.82	74.5	102	1.37	60.5	66.5	1.10
11	9.33	80	115	1.44	65	87	1.34
Center 2/3	Mean	76.13	109.83	1.45	59.33	89.39	1.51
	Std. Dev.	5.19	13.56	0.20	5.99	28.64	0.48
	C.O.V	6.81	12.34	13.70	10.09	32.04	31.90
All Points	Mean	76.52	110.35	1.45	59.90	89.15	1.49
	Std. Dev.	5.04	12.89	0.19	5.92	27.02	0.46
	C.O.V	6.59	11.68	12.93	9.89	30.30	30.64

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	67.73	99.61	1.48
	Std. Dev.	10.21	24.15	0.36
	C.O.V	15.07	24.24	24.27
All Points	Mean	68.21	99.75	1.47
	Std. Dev.	10.07	23.30	0.34
	C.O.V	14.76	23.35	23.20

NOTES:

	Start	Finish	
Stack centerline vel.	8.8	8.7 m/s	
Stack Temp	12	13 C	
Wind @ 10 m	3.0	4.0 mph	per met station 300 area readings
Wind direction	wnw	sse	per met station 300 area readings
Ambient Temp	10	8 C	per met station 300 area readings

Instuments Used:		Cal Exp. Date:
Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "A" 25% insertion	1 scfm	
Mobile OPC "B"	1 scfm	

TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-1
Testers:	glissmeyer/maughan	Date	10/23/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	0.92 to: 9.08
		Points in Center 2/3	3 to: 10

Each OPC data point includes: average of two 1-min. readings counts/ft3
normalized ratio of fixed means

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Mob W/E	Fix N/S	Mob N/S	Norm N/S
2	na						
3	1.27	75.5	88.5	88.50	65	113	138.84
4	1.77	77	91.5	91.50	56.5	103.5	127.17
5	2.50	77.5	119.5	119.50	53.5	68.5	84.17
6	3.56	65.7	116.5	116.50	58.5	103	126.56
Center	5	77.5	105.5	105.50	58.5	118	144.99
7	6.44	72.5	117.5	117.50	58.5	123.5	151.75
8	7.50	84	121	121.00	51.5	44	54.06
9	8.23	81	126.5	126.50	71.5	64.5	79.25
10	8.82	74.5	102	102.00	60.5	66.5	81.71
11	9.33	80	115	115.00	65	87	106.90
Center 2/3	Mean	76.13	109.83	109.83	59.33	89.39	109.83
	Std. Dev.	5.19	13.56	13.56	5.99	28.64	35.20
	C.O.V	6.81	12.34	12.34	10.09	32.04	32.04
All Points	Mean	76.52	110.35	110.35	59.90	89.15	109.54
	Std. Dev.	5.04	12.89	12.89	5.92	27.02	33.20
	C.O.V	6.59	11.68	11.68	9.89	30.30	30.30

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	67.73	99.61	109.83
	Std. Dev.	10.21	24.15	25.87
	C.O.V	15.07	24.24	23.56
All Points	Mean	68.21	99.75	109.94
	Std. Dev.	10.07	23.30	24.51
	C.O.V	14.76	23.35	22.29

NOTES:

	Start	Finish	
Stack centerline vel.	8.8	8.7 m/s	
Stack Temp	12	13 C	
Wind @ 10 m	3.0	4.0 mph	per met station 300 area readings
Wind direction	wnw	sse	per met station 300 area readings
Ambient Temp	10	8 C	per met station 300 area readings

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

Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "A" 25% insertion	1 scfm	
Mobile OPC "B"	1 scfm	

TRACER PARTICLE TRAVERSE DATA FORM

Site: AP-40 Mockup
Testers: glissmeyer/maughan
Stack Dia. 10 in.
Stack X-Area 78.54 in2
Measurement elevation ____ in.
El. above disturbance 71 in.
Injection Point: centerline fan outlet

Run No. PT-1
Date 10/23/96
Particle Dp 10.5 micron
Particle AD 10 micron
Aerosol Solution 26
Fan Setting 23 Hz
Center 2/3 from 0.92 to: 9.08
Points in Center 2/3 3 to: 10

Each OPC data point includes: average of two 1-min. readings counts/ft3
normalized difference of fixed means

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Mob W/E	Fix N/S	Mob N/S	Norm N/S
2	na						
3	1.27	75.5	88.5	88.50	65	113	129.62
4	1.77	77	91.5	91.50	56.5	103.5	120.12
5	2.50	77.5	119.5	119.50	53.5	68.5	85.12
6	3.56	65.7	116.5	116.50	58.5	103	119.62
Center	5	77.5	105.5	105.50	58.5	118	134.62
7	6.44	72.5	117.5	117.50	58.5	123.5	140.12
8	7.50	84	121	121.00	51.5	44	60.62
9	8.23	81	126.5	126.50	71.5	64.5	81.12
10	8.82	74.5	102	102.00	60.5	66.5	83.12
11	9.33	80	115	115.00	65	87	103.62
Center 2/3	Mean	76.13	109.83	109.83	59.33	89.39	106.01
	Std. Dev.	5.19	13.56	13.56	5.99	28.64	28.64
	C.O.V	6.81	12.34	12.34	10.09	32.04	27.02
All Points	Mean	76.52	110.35	110.35	59.90	89.15	105.77
	Std. Dev.	5.04	12.89	12.89	5.92	27.02	27.02
	C.O.V	6.59	11.68	11.68	9.89	30.30	25.54

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	67.73	99.61	107.92
	Std. Dev.	10.21	24.15	21.83
	C.O.V	15.07	24.24	20.23
All Points	Mean	68.21	99.75	108.06
	Std. Dev.	10.07	23.30	20.73
	C.O.V	14.76	23.35	19.19

NOTES:

	Start	Finish	
Stack centerline vel.	8.8	8.7 m/s	
Stack Temp	12	13 C	
Wind @ 10 m	3.0	4.0 mph	per met station 300 area readings
Wind direction	wnw	sse	per met station 300 area readings
Ambient Temp	10	8 C	per met station 300 area readings

Instuments Used:

		Cal Exp. Date:
Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "A" 25% insertion	1 scfm	
Mobile OPC "B"	1 scfm	

TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-1
Testers:	glissmeyer/maughan	Date	10/23/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	0.92 to: 9.08
		Points in Center 2/3	3 to: 10

Each OPC data point includes: average of two 1-min. readings counts/ft3
normalized difference of centerpoints

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Mob W/E	Fix N/S	Mob N/S	Norm N/S
2	na						
3	1.27	75.5	88.5	88.50	65	113	100.50
4	1.77	77	91.5	91.50	56.5	103.5	91.00
5	2.50	77.5	119.5	119.50	53.5	68.5	56.00
6	3.56	65.7	116.5	116.50	58.5	103	90.50
Center	5	77.5	105.5	105.50	58.5	118	105.50
7	6.44	72.5	117.5	117.50	58.5	123.5	111.00
8	7.50	84	121	121.00	51.5	44	31.50
9	8.23	81	126.5	126.50	71.5	64.5	52.00
10	8.82	74.5	102	102.00	60.5	66.5	54.00
11	9.33	80	115	115.00	65	87	74.50
Center 2/3	Mean	76.13	109.83	109.83	59.33	89.39	76.89
	Std. Dev.	5.19	13.56	13.56	5.99	28.64	28.64
	C.O.V	6.81	12.34	12.34	10.09	32.04	37.25
All Points	Mean	76.52	110.35	110.35	59.90	89.15	76.65
	Std. Dev.	5.04	12.89	12.89	5.92	27.02	27.02
	C.O.V	6.59	11.68	11.68	9.89	30.30	35.25

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	67.73	99.61	93.36
	Std. Dev.	10.21	24.15	27.57
	C.O.V	15.07	24.24	29.53
All Points	Mean	68.21	99.75	93.50
	Std. Dev.	10.07	23.30	26.89
	C.O.V	14.76	23.35	28.76

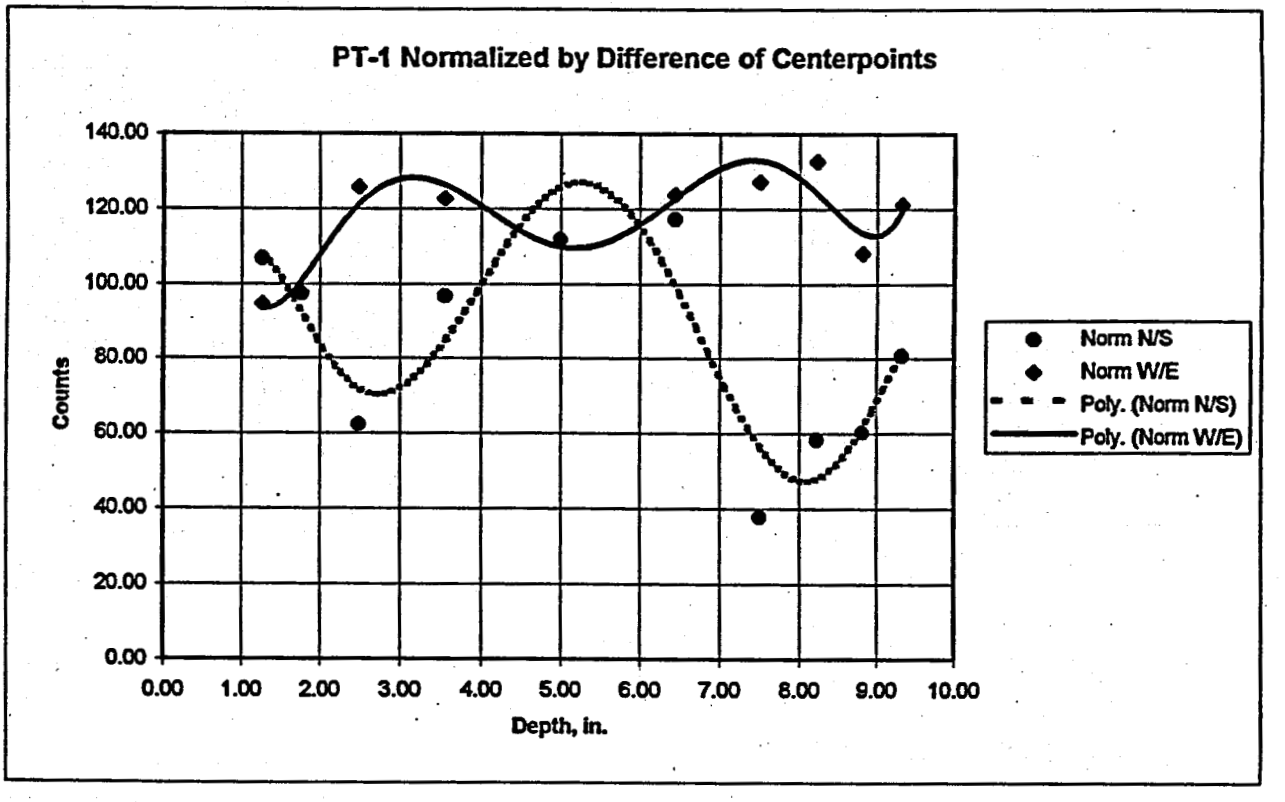
NOTES:

	Start	Finish	
Stack centerline vel.	8.8	8.7 m/s	
Stack Temp	12	13 C	
Wind @ 10 m	3.0	4.0 mph	per met station 300 area readings
Wind direction	wnw	sse	per met station 300 area readings
Ambient Temp	10	8 C	per met station 300 area readings

Instuments Used:

		Cal Exp. Date:
Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "A" 25% insertion	1 scfm	
Mobile OPC "B"	1 scfm	

Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Norm N/S
1.27	75.50	88.50	94.75	65.00	113.00	106.75
1.77	77.00	91.50	97.75	56.50	103.50	97.25
2.50	77.50	119.50	125.75	53.50	68.50	62.25
3.56	65.70	116.50	122.75	58.50	103.00	96.75
5.00	77.50	105.50	111.75	58.50	118.00	111.75
6.44	72.50	117.50	123.75	58.50	123.50	117.25
7.50	84.00	121.00	127.25	51.50	44.00	37.75
8.23	81.00	126.50	132.75	71.50	64.50	58.25
8.82	74.50	102.00	108.25	60.50	66.50	60.25
9.33	80.00	115.00	121.25	65.00	87.00	80.75



TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-1
Testers:	glissmeyer/maughan	Date	10/23/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	0.92 to: 9.08
		Points in Center 2/3	3 to: 10

Each OPC data point includes: average of two 1-min. readings counts/ft3
normalized so centerpoints equal average

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Norm N/S
2	na						
3	1.27	75.5	88.5	94.75	65	113	106.75
4	1.77	77	91.5	97.75	56.5	103.5	97.25
5	2.50	77.5	119.5	125.75	53.5	68.5	62.25
6	3.56	65.7	116.5	122.75	58.5	103	96.75
Center	5	77.5	105.5	111.75	58.5	118	111.75
7	6.44	72.5	117.5	123.75	58.5	123.5	117.25
8	7.50	84	121	127.25	51.5	44	37.75
9	8.23	81	126.5	132.75	71.5	64.5	58.25
10	8.82	74.5	102	108.25	60.5	66.5	60.25
11	9.33	80	115	121.25	65	87	80.75
Center 2/3	Mean	76.13	109.83	116.08	59.33	89.39	83.14
	Std. Dev.	5.19	13.56	13.56	5.99	28.64	28.64
	C.O.V	6.81	12.34	11.68	10.09	32.04	34.45
All Points	Mean	76.52	110.35	116.60	59.90	89.15	82.90
	Std. Dev.	5.04	12.89	12.89	5.92	27.02	27.02
	C.O.V	6.59	11.68	11.05	9.89	30.30	32.59

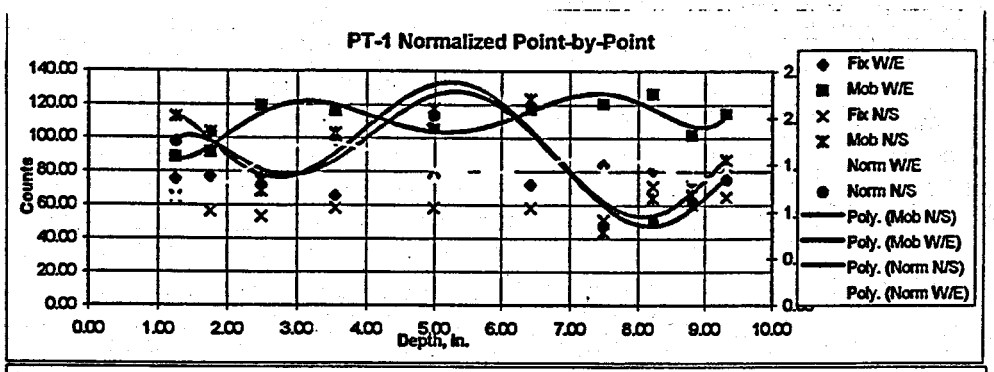
		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	67.73	99.61	99.61
	Std. Dev.	10.21	24.15	27.57
	C.O.V	15.07	24.24	27.67
All Points	Mean	68.21	99.75	99.75
	Std. Dev.	10.07	23.30	26.89
	C.O.V	14.76	23.35	26.96

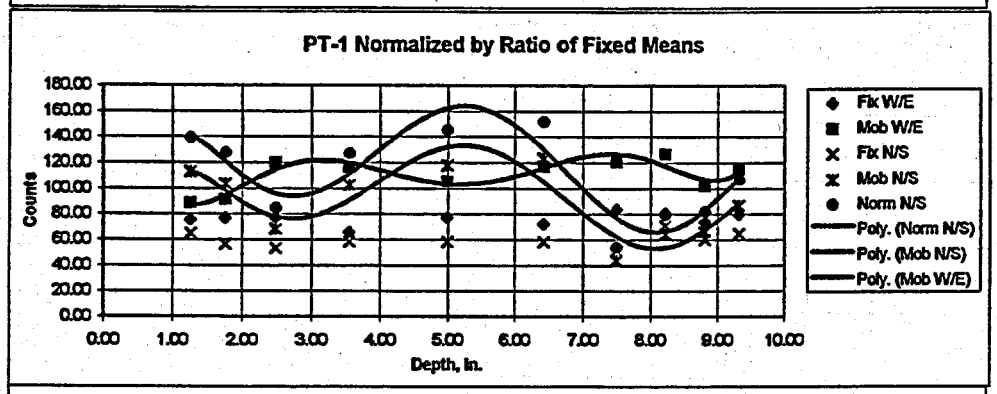
NOTES:

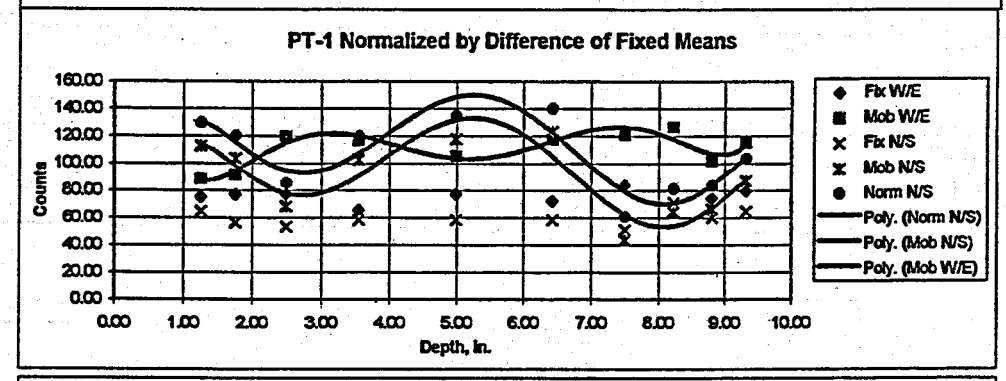
	Start	Finish		
Stack centerline vel.	8.8	8.7	m/s	
Stack Temp	12	13	C	
Wind @ 10 m	3.0	4.0	mph	per met station 300 area readings
Wind direction	wnw	sse		per met station 300 area readings
Ambient Temp	10	8	C	per met station 300 area readings

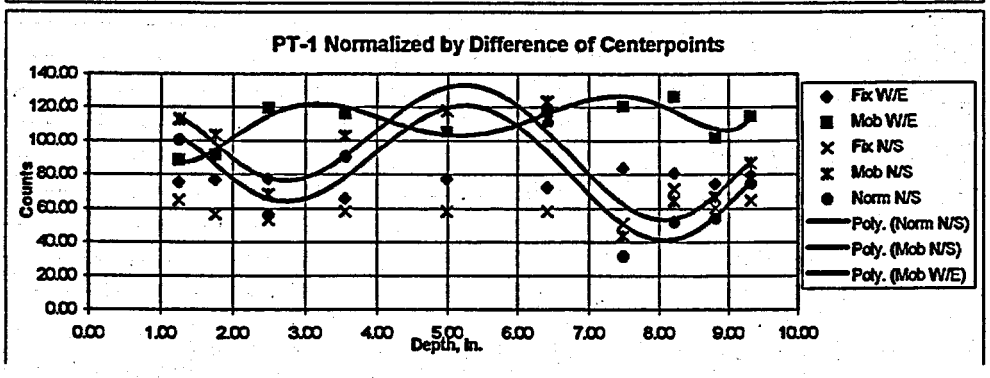
Instuments Used: Cal Exp. Date:

Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "A" 25% insertion	1 scfm	
Mobile OPC "B"	1 scfm	


PT-1 Normalized Point-by-Point
Counts
Depth, in.
Fix W/E
Mob W/E
Fix N/S
Mob N/S
Norm W/E
Norm N/S
Poly. (Mob N/S)
Poly. (Mob W/E)
Poly. (Norm N/S)
Poly. (Norm W/E)


PT-1 Normalized by Ratio of Fixed Means
Counts
Depth, in.
Fix W/E
Mob W/E
Fix N/S
Mob N/S
Norm N/S
Poly. (Norm N/S)
Poly. (Mob N/S)
Poly. (Mob W/E)


PT-1 Normalized by Difference of Fixed Means
Counts
Depth, in.
Fix W/E
Mob W/E
Fix N/S
Mob N/S
Norm N/S
Poly. (Norm N/S)
Poly. (Mob N/S)
Poly. (Mob W/E)


PT-1 Normalized by Difference of Centerpoints
Counts
Depth, in.
Fix W/E
Mob W/E
Fix N/S
Mob N/S
Norm N/S
Poly. (Norm N/S)
Poly. (Mob N/S)
Poly. (Mob W/E)

TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-1
Testers:	glissmeyer/maughan	Date	10/23/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	0.92 to: 9.08
		Points in Center 2/3	3 to: 10

Each OPC data point includes: average of two 1-min. readings counts/ft3
normalized by dividing mobile by fixed mean for that traverse

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Norm N/S
2	na						
3	1.27	75.5	88.5	1.16	65	113	1.90
4	1.77	77	91.5	1.20	56.5	103.5	1.74
5	2.50	77.5	119.5	1.57	53.5	68.5	1.15
6	3.56	65.7	116.5	1.53	58.5	103	1.74
Center	5	77.5	105.5	1.39	58.5	118	1.99
7	6.44	72.5	117.5	1.54	58.5	123.5	2.08
8	7.50	84	121	1.59	51.5	44	0.74
9	8.23	81	126.5	1.66	71.5	64.5	1.09
10	8.82	74.5	102	1.34	60.5	66.5	1.12
11	9.33	80	115	1.51	65	87	1.47
Center 2/3	Mean	76.13	109.83	1.44	59.33	89.39	1.51
	Std. Dev.	5.19	13.56	0.18	5.99	28.64	0.48
	C.O.V	6.81	12.34	12.34	10.09	32.04	32.04
All Points	Mean	76.52	110.35	1.45	59.90	89.15	1.50
	Std. Dev.	5.04	12.89	0.17	5.92	27.02	0.46
	C.O.V	6.59	11.68	11.68	9.89	30.30	30.30

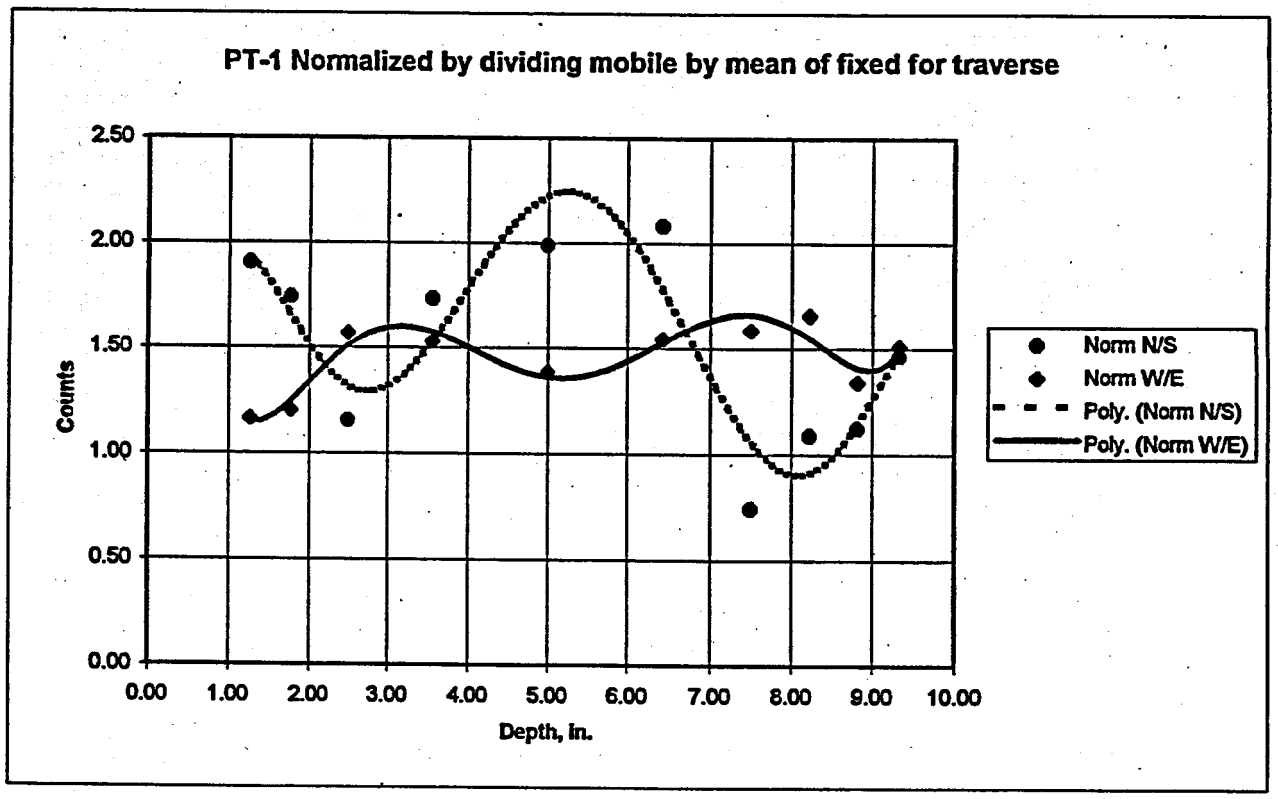
		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	67.73	99.61	1.47
	Std. Dev.	10.21	24.15	0.35
	C.O.V	15.07	24.24	24.04
All Points	Mean	68.21	99.75	1.48
	Std. Dev.	10.07	23.30	0.34
	C.O.V	14.76	23.35	22.73

NOTES:

	Start	Finish		
Stack centerline vel.	8.8	8.7	m/s	
Stack Temp	12	13	C	
Wind @ 10 m	3.0	4.0	mph	per met station 300 area readings
Wind direction	wnw	sse		per met station 300 area readings
Ambient Temp	10	8	C	per met station 300 area readings

Instuments Used:		Cal Exp. Date:
Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "A" 25% insertion	1 scfm	
Mobile OPC "B"	1 scfm	

Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Norm N/S
1.27	75.50	88.50	1.16	65.00	113.00	1.90
1.77	77.00	91.50	1.20	56.50	103.50	1.74
2.50	77.50	119.50	1.57	53.50	68.50	1.15
3.56	65.70	116.50	1.53	58.50	103.00	1.74
5.00	77.50	105.50	1.39	58.50	118.00	1.99
6.44	72.50	117.50	1.54	58.50	123.50	2.08
7.50	84.00	121.00	1.59	51.50	44.00	0.74
8.23	81.00	126.50	1.66	71.50	64.50	1.09
8.82	74.50	102.00	1.34	60.50	66.50	1.12
9.33	80.00	115.00	1.51	65.00	87.00	1.47



TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-4
Testers:	glissmeyer/maughan	Date	11/14/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	65.27 to: 65.27
		Points in Center 2/3	3 to: 10

Each OPC data point includes: Average of five 1-min counts in 9 micron channel
Normalized point-by-point

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Norm N/S
2	na						
3	1.27	108.2	151.6	1.401	53.4	65.6	1.228
4	1.77	121.6	128.2	1.054	84	81.2	0.967
5	2.50	126.8	190	1.498	77.4	72	0.930
6	3.56	145.6	211	1.449	75.8	66.8	0.881
Center	5	150.8	161.8	1.073	70.4	86	1.222
7	6.44	140	194.4	1.389	60.8	91.8	1.510
8	7.50	138.4	184	1.329	59.6	104.2	1.748
9	8.23	143.6	156.6	1.091	63.4	119.6	1.886
10	8.82	138.2	127.4	0.922	59.8	106.2	1.776
11	9.33	104.8	144.8	1.382	62.2	93.4	1.502
Center 2/3	Mean	134.80	167.22	1.25	67.18	88.16	1.35
	Std. Dev.	13.45	29.48	0.21	10.18	18.92	0.39
	C.O.V	9.98	17.63	16.85	15.15	21.46	29.02
All Points	Mean	131.80	164.98	1.26	66.68	88.68	1.37
	Std. Dev.	15.84	28.68	0.20	9.72	17.92	0.37
	C.O.V	12.02	17.38	16.09	14.58	20.20	27.28

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	100.99	127.69	1.30
	Std. Dev.	36.67	47.25	0.31
	C.O.V	36.31	37.00	23.86
All Points	Mean	99.24	126.83	1.31
	Std. Dev.	35.77	45.54	0.30
	C.O.V	36.04	35.90	22.62

NOTES:
VOAG 90 KhZ
Carrier air 6.1 cfm
Dispersion air 18 cfh
Pressure 10 psi
Pump gear 7, 20%

	Start	Finish	
Stack centerline vel.		8.8	m/s
Stack Temp		12	C
Wind @ 10 m	9.0	6.0	mph
Wind direction	240	180	
Ambient Temp	56	47	F

per met station 300 area readings

Repeat readings for points were:

Point	Fixed	Mobile	Ratio

Instuments Used:

		Cal Exp. Date:
Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "B" 25% insertion	1 scfm	
Mobile OPC "A"	1 scfm	

TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-4
Testers:	glissmeyer/maughan	Date	11/14/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	65.27 to: 65.27
		Points in Center 2/3	3 to: 10

Each OPC data point includes: Average of five 1-min counts in 9 micron channel
Normalized N/S by ratio of fixed opc means

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Mob W/E	Fix N/S	Mob N/S	Norm N/S
2	na						
3	1.27	108.2	151.6	151.6	53.4	65.6	129.665
4	1.77	121.6	128.2	128.2	84	81.2	160.500
5	2.50	126.8	190	190	77.4	72	142.316
6	3.56	145.6	211	211	75.8	66.8	132.037
Center	5	150.8	161.8	161.8	70.4	86	169.988
7	6.44	140	194.4	194.4	60.8	91.8	181.452
8	7.50	138.4	184	184	59.6	104.2	205.962
9	8.23	143.6	156.6	156.6	63.4	119.6	236.402
10	8.82	138.2	127.4	127.4	59.8	106.2	209.915
11	9.33	104.8	144.8	144.8	62.2	93.4	184.615
Center 2/3	Mean	134.80	167.22	167.22	67.18	88.16	174.25
	Std. Dev.	13.45	29.48	29.48	10.18	18.92	37.40
	C.O.V	9.98	17.63	17.63	15.15	21.46	21.46
All Points	Mean	131.80	164.98	164.98	66.68	88.68	175.29
	Std. Dev.	15.84	28.68	28.68	9.72	17.92	35.41
	C.O.V	12.02	17.38	17.38	14.58	20.20	20.20

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	100.99	127.69	170.74
	Std. Dev.	36.67	47.25	32.86
	C.O.V	36.31	37.00	19.25
All Points	Mean	99.24	126.83	170.13
	Std. Dev.	35.77	45.54	31.81
	C.O.V	36.04	35.90	18.69

NOTES:
VOAG 90 KhZ
Carrier air 6.1 cfm
Dispersion air 18 cfh
Pressure 10 psi
Pump gear 7, 20%

	Start	Finish	
Stack centerline vel.		8.8	m/s
Stack Temp		12	C
Wind @ 10 m	9.0	6.0	mph
Wind direction	240	180	
Ambient Temp	56	47	F

per met station 300 area readings

Repeat readings for points were:

Point	Fixed	Mobile	Ratio

Instuments Used: Cal Exp. Date:

Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "B" 25% insertion	1 scfm	
Mobile OPC "A"	1 scfm	

TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-4
Testers:	glissmeyer/maughan	Date	11/14/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	65.27 to: 65.27
		Points in Center 2/3	3 to: 10

Each OPC data point includes: Average of five 1-min counts in 9 micron channel
normalized N/S by difference between fixed opc means

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Mob W/E	Fix N/S	Mob N/S	Norm N/S
2	na						
3	1.27	108.2	151.6	151.6	53.4	65.6	130.720
4	1.77	121.6	128.2	128.2	84	81.2	146.320
5	2.50	126.8	190	190	77.4	72	137.120
6	3.56	145.6	211	211	75.8	66.8	131.920
Center	5	150.8	161.8	161.8	70.4	86	151.120
7	6.44	140	194.4	194.4	60.8	91.8	156.920
8	7.50	138.4	184	184	59.6	104.2	169.320
9	8.23	143.6	156.6	156.6	63.4	119.6	184.720
10	8.82	138.2	127.4	127.4	59.8	106.2	171.320
11	9.33	104.8	144.8	144.8	62.2	93.4	158.520
Center 2/3	Mean	134.80	167.22	167.22	67.18	88.16	153.28
	Std. Dev.	13.45	29.48	29.48	10.18	18.92	18.92
	C.O.V	9.98	17.63	17.63	15.15	21.46	12.34
All Points	Mean	131.80	164.98	164.98	66.68	88.68	153.80
	Std. Dev.	15.84	28.68	28.68	9.72	17.92	17.92
	C.O.V	12.02	17.38	17.38	14.58	20.20	11.65

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	100.99	127.69	160.25
	Std. Dev.	36.67	47.25	25.08
	C.O.V	36.31	37.00	15.65
All Points	Mean	99.24	126.83	159.39
	Std. Dev.	35.77	45.54	23.97
	C.O.V	36.04	35.90	15.04

NOTES:
VOAG 90 KhZ
Carrier air 6.1 cfm
Dispersion air 18 cfh
Pressure 10 psi
Pump gear 7, 20%

	Start	Finish
Stack centerline vel.		8.8 m/s
Stack Temp		12 C
Wind @ 10 m	9.0	6.0 mph
Wind direction	240	180
Ambient Temp	56	47 F

per met station 300 area readings

Repeat readings for points were:

Point	Fixed	Mobile	Ratio

Instuments Used:

		Cal Exp. Date:
Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "B" 25% insertion	1 scfm	
Mobile OPC "A"	1 scfm	

TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-4
Testers:	glissmeyer/maughan	Date	11/14/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	65.27 to: 65.27
		Points in Center 2/3	3 to: 10

Each OPC data point includes: Average of five 1-min counts in 9 micron channel
normalized N/S by adding counts to make centerpoints equal

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Mob W/E	Fix N/S	Mob N/S	Norm N/S
2	na						
3	1.27	108.2	151.6	151.6	53.4	65.6	141.400
4	1.77	121.6	128.2	128.2	84	81.2	157.000
5	2.50	126.8	190	190	77.4	72	147.800
6	3.56	145.6	211	211	75.8	66.8	142.600
Center	5	150.8	161.8	161.8	70.4	86	161.800
7	6.44	140	194.4	194.4	60.8	91.8	167.600
8	7.50	138.4	184	184	59.6	104.2	180.000
9	8.23	143.6	156.6	156.6	63.4	119.6	195.400
10	8.82	138.2	127.4	127.4	59.8	106.2	182.000
11	9.33	104.8	144.8	144.8	62.2	93.4	169.200
Center 2/3	Mean	134.80	167.22	167.22	67.18	88.16	163.96
	Std. Dev.	13.45	29.48	29.48	10.18	18.92	18.92
	C.O.V	9.98	17.63	17.63	15.15	21.46	11.54
All Points	Mean	131.80	164.98	164.98	66.68	88.68	164.48
	Std. Dev.	15.84	28.68	28.68	9.72	17.92	17.92
	C.O.V	12.02	17.38	17.38	14.58	20.20	10.89

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	100.99	127.69	165.59
	Std. Dev.	36.67	47.25	24.09
	C.O.V	36.31	37.00	14.55
All Points	Mean	99.24	126.83	164.73
	Std. Dev.	35.77	45.54	23.27
	C.O.V	36.04	35.90	14.13

NOTES:
VOAG 90 KhZ
Carrier air 6.1 cfm
Dispersion air 18 cfh
Pressure 10 psi
Pump gear 7, 20%

	Start	Finish
Stack centerline vel.		8.8 m/s
Stack Temp		12 C
Wind @ 10 m	9.0	6.0 mph
Wind direction	240	180
Ambient Temp	56	47 F

per met station 300 area readings

Repeat readings for points were:

Point	Fixed	Mobile	Ratio

Instuments Used:

		Cal Exp. Date:
Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "B" 25% insertion	1 scfm	
Mobile OPC "A"	1 scfm	

TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-4
Testers:	glissmeyer/maughan	Date	11/14/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	65.27 to: 65.27
		Points in Center 2/3	3 to: 10

Each OPC data point includes: Average of five 1-min counts in 9 micron channel
normalized both by adding counts to make centerpoints equal to average

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Mob W/E	Fix N/S	Mob N/S	Norm N/S
2	na						
3	1.27	108.2	151.6	113.7	53.4	65.6	103.5
4	1.77	121.6	128.2	90.3	84	81.2	119.1
5	2.50	126.8	190	152.1	77.4	72	109.9
6	3.56	145.6	211	173.1	75.8	66.8	104.7
Center	5	150.8	161.8	123.9	70.4	86	123.9
7	6.44	140	194.4	156.5	60.8	91.8	129.7
8	7.50	138.4	184	146.1	59.6	104.2	142.1
9	8.23	143.6	156.6	118.7	63.4	119.6	157.5
10	8.82	138.2	127.4	89.5	59.8	106.2	144.1
11	9.33	104.8	144.8	106.9	62.2	93.4	131.3
Center 2/3	Mean	134.80	167.22	129.32	67.18	88.16	126.06
	Std. Dev.	13.45	29.48	29.48	10.18	18.92	18.92
	C.O.V	9.98	17.63	22.79	15.15	21.46	15.01
All Points	Mean	131.80	164.98	127.08	66.68	88.68	126.58
	Std. Dev.	15.84	28.68	28.68	9.72	17.92	17.92
	C.O.V	12.02	17.38	22.57	14.58	20.20	14.15

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	100.99	127.69	127.69
	Std. Dev.	36.67	47.25	24.09
	C.O.V	36.31	37.00	18.86
All Points	Mean	99.24	126.83	126.83
	Std. Dev.	35.77	45.54	23.27
	C.O.V	36.04	35.90	18.35

NOTES:
VOAG 90 KhZ
Carrier air 6.1 cfm
Dispersion air 18 cfh
Pressure 10 psi
Pump gear 7, 20%

	Start	Finish	
Stack centerline vel.		8.8	m/s
Stack Temp		12	C
Wind @ 10 m	9.0	6.0	mph
Wind direction	240	180	
Ambient Temp	56	47	F

per met station 300 area readings

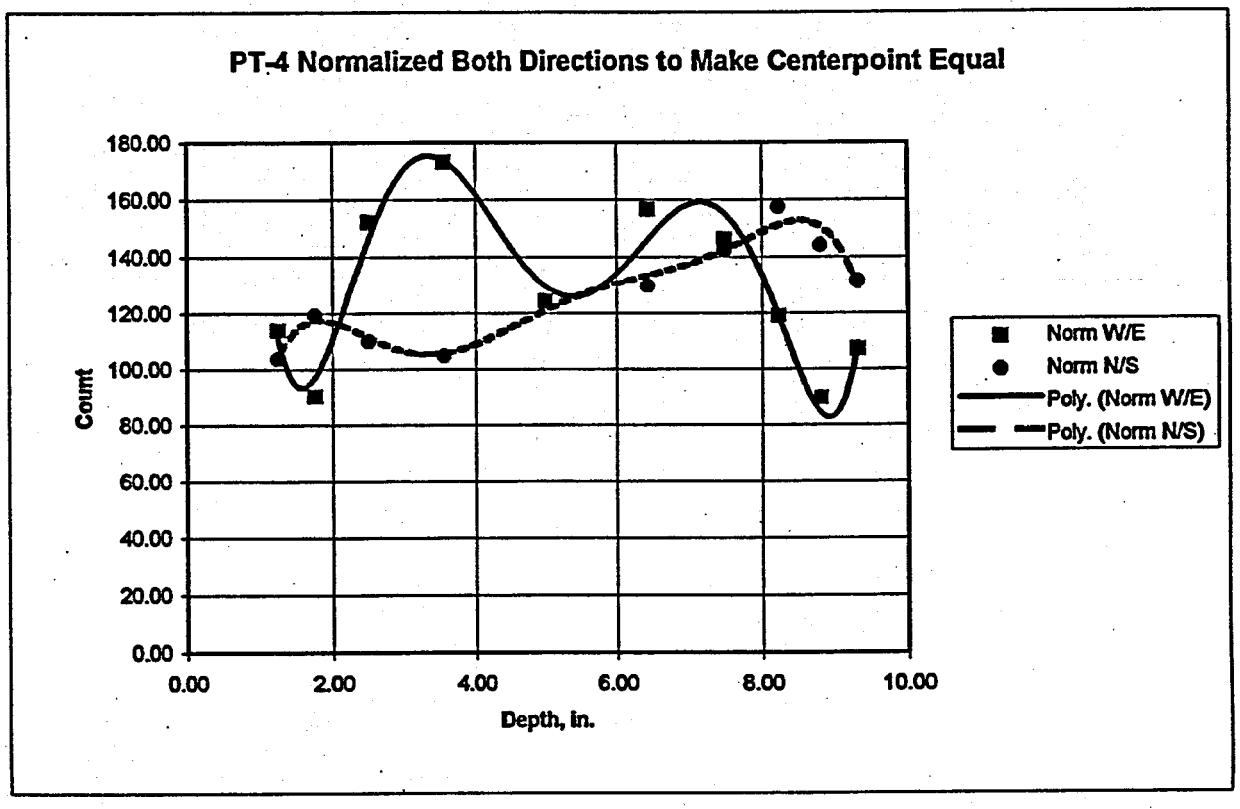
Repeat readings for points were:

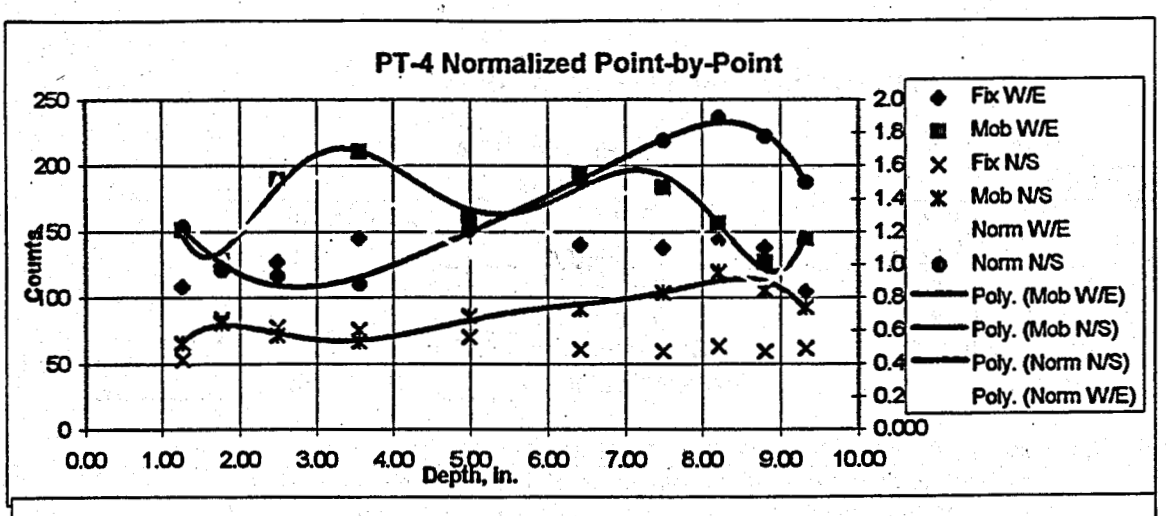
Point	Fixed	Mobile	Ratio

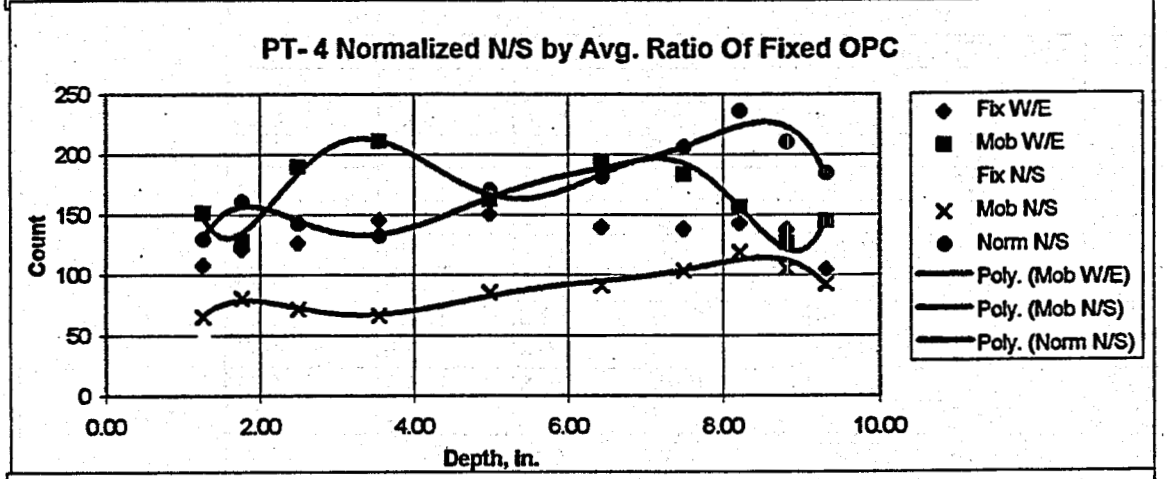
Instuments Used:

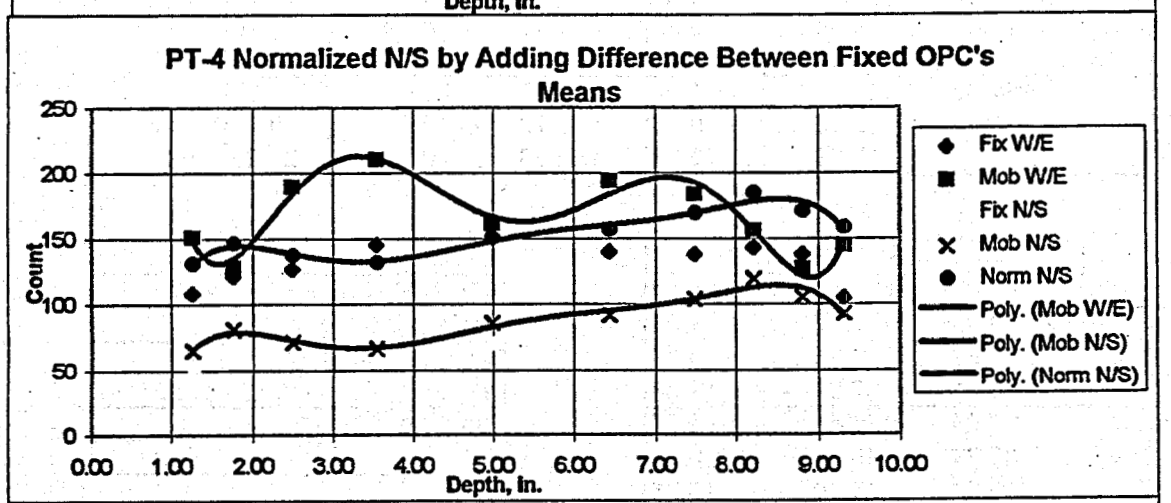
		Cal Exp. Date:
Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "B" 25% insertion	1 scfm	
Mobile OPC "A"	1 scfm	

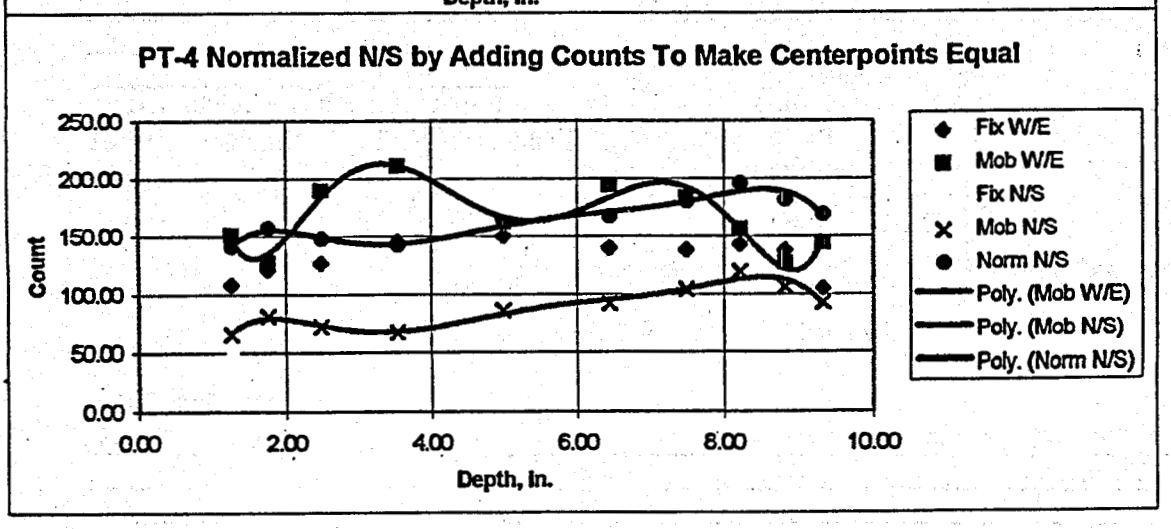
Point	Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Norm N/S
3	1.27	108.20	151.60	113.70	53.40	65.60	103.50
4	1.77	121.60	128.20	90.30	84.00	81.20	119.10
5	2.50	126.80	190.00	152.10	77.40	72.00	109.90
6	3.56	145.60	211.00	173.10	75.80	66.80	104.70
Center	5.00	150.80	161.80	123.90	70.40	86.00	123.90
7	6.44	140.00	194.40	156.50	60.80	91.80	129.70
8	7.50	138.40	184.00	146.10	59.60	104.20	142.10
9	8.23	143.60	156.60	118.70	63.40	119.60	157.50
10	8.82	138.20	127.40	89.50	59.80	106.20	144.10
11	9.33	104.80	144.80	106.90	62.20	93.40	131.30
Center 2/3	Mean	134.80	167.22	129.32	67.18	88.16	126.06
	Std. Dev.	13.45	29.48	29.48	10.18	18.92	18.92
	C.O.V	9.98	17.63	22.79	15.15	21.46	15.01




PT-4 Normalized Point-by-Point
Counts
Depth, in.
Fix W/E
Mob W/E
Fix N/S
Mob N/S
Norm W/E
Norm N/S
Poly. (Mob W/E)
Poly. (Mob N/S)
Poly. (Norm N/S)
Poly. (Norm W/E)


PT- 4 Normalized N/S by Avg. Ratio Of Fixed OPC
Count
Depth, in.
Fix W/E
Mob W/E
Fix N/S
Mob N/S
Norm N/S
Poly. (Mob W/E)
Poly. (Mob N/S)
Poly. (Norm N/S)


PT-4 Normalized N/S by Adding Difference Between Fixed OPC's Means
Count
Depth, in.
Fix W/E
Mob W/E
Fix N/S
Mob N/S
Norm N/S
Poly. (Mob W/E)
Poly. (Mob N/S)
Poly. (Norm N/S)


PT-4 Normalized N/S by Adding Counts To Make Centerpoints Equal
Count
Depth, in.
Fix W/E
Mob W/E
Fix N/S
Mob N/S
Norm N/S
Poly. (Mob W/E)
Poly. (Mob N/S)
Poly. (Norm N/S)

TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-4
Testers:	glissmeyer/maughan	Date	11/14/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	65.27 to: 65.27
		Points in Center 2/3	3 to: 10

Each OPC data point includes: Average of five 1-min counts in 9 micron channel normalized by dividing mobile by average of fixed for the traverse

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Mob W/E	Fix N/S	Mob N/S	Norm N/S
2	na						
3	1.27	108.2	151.6	1.12	53.4	65.6	0.98
4	1.77	121.6	128.2	0.95	84	81.2	1.21
5	2.50	126.8	190	1.41	77.4	72	1.07
6	3.56	145.6	211	1.57	75.8	66.8	0.99
Center	5	150.8	161.8	1.20	70.4	86	1.28
7	6.44	140	194.4	1.44	60.8	91.8	1.37
8	7.50	138.4	184	1.36	59.6	104.2	1.55
9	8.23	143.6	156.6	1.16	63.4	119.6	1.78
10	8.82	138.2	127.4	0.95	59.8	106.2	1.58
11	9.33	104.8	144.8	1.07	62.2	93.4	1.39
Center 2/3	Mean	134.80	167.22	1.24	67.18	88.16	1.31
	Std. Dev.	13.45	29.48	0.22	10.18	18.92	0.28
	C.O.V	9.98	17.63	17.63	15.15	21.46	21.46
All Points	Mean	131.80	164.98	1.22	66.68	88.68	1.32
	Std. Dev.	15.84	28.68	0.21	9.72	17.92	0.27
	C.O.V	12.02	17.38	17.38	14.58	20.20	20.20

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	100.99	127.69	1.28
	Std. Dev.	36.67	47.25	0.25
	C.O.V	36.31	37.00	19.38
All Points	Mean	99.24	126.83	1.27
	Std. Dev.	35.77	45.54	0.24
	C.O.V	36.04	35.90	18.86

NOTES:
VOAG 90 KhZ
Carrier air 6.1 cfm
Dispersion air 18 cfh
Pressure 10 psi
Pump gear 7, 20%

	Start	Finish	
Stack centerline vel.		8.8	m/s
Stack Temp		12	C
Wind @ 10 m	9.0	6.0	mph
Wind direction	240	180	
Ambient Temp	56	47	F

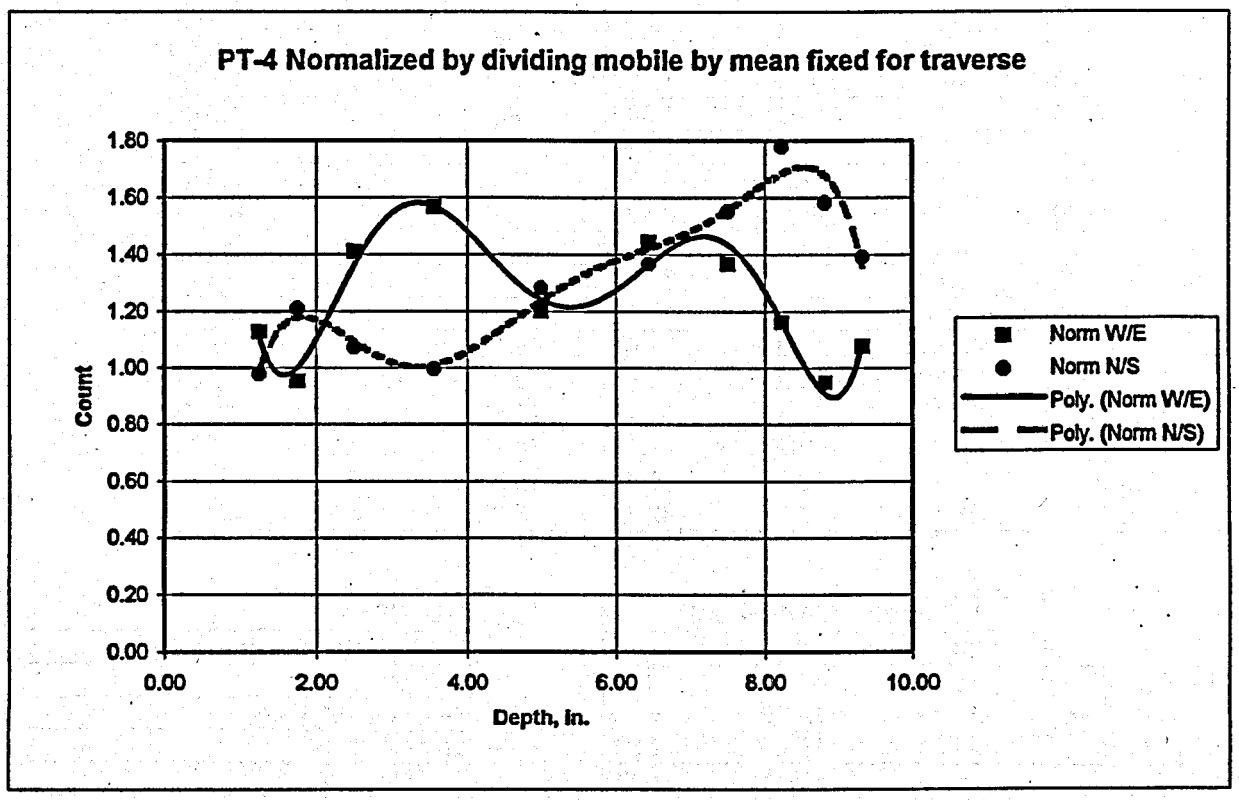
per met station 300 area readings

Repeat readings for points were:

Point	Fixed	Mobile	Ratio

Instuments Used:		Cal Exp. Date:
Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "B" 25% insertion	1 scfm	
Mobile OPC "A"	1 scfm	

Point	Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Norm N/S
3	1.27	108.20	151.60	1.12	53.40	65.60	0.98
4	1.77	121.60	128.20	0.95	84.00	81.20	1.21
5	2.50	126.80	190.00	1.41	77.40	72.00	1.07
6	3.56	145.60	211.00	1.57	75.80	66.80	0.99
Center	5.00	150.80	161.80	1.20	70.40	86.00	1.28
7	6.44	140.00	194.40	1.44	60.80	91.80	1.37
8	7.50	138.40	184.00	1.36	59.60	104.20	1.55
9	8.23	143.60	156.60	1.16	63.40	119.60	1.78
10	8.82	138.20	127.40	0.95	59.80	106.20	1.58
11	9.33	104.80	144.80	1.07	62.20	93.40	1.39
Center 2/3	Mean	134.80	167.22	1.24	67.18	88.16	1.31
	Std. Dev.	13.45	29.48	0.22	10.18	18.92	0.28
	C.O.V	9.98	17.63	17.63	15.15	21.46	21.46



TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-5
Testers:	glissmeyer/maughan	Date	11/15/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	65.27 to: 65.27
		Points in Center 2/3	3 to: 10

Each OPC data point includes: **average of five 1-min. counts in the 9 micron channel**

N/S was done first

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Norm N/S
2	na						
3	1.27	29.2	54.8	1.877	59.4	47.8	0.805
4	1.77	43.8	63	1.438	53	52.5	0.991
5	2.50	44.6	59	1.323	57.4	60.2	1.049
6	3.56	47	47.4	1.009	60.4	61.2	1.013
Center	5	53.4	38.6	0.723	71	46.2	0.651
7	6.44	50	23.6	0.472	77.6	66.6	0.858
8	7.50	57	38.8	0.681	77.2	37	0.479
9	8.23	52.2	32.4	0.621	66	37.2	0.564
10	8.82	30.6	30	0.980	79	31.2	0.395
11	9.33	31.2	40	1.282	80.8	40.6	0.502
Center 2/3	Mean	45.31	43.07	1.01	66.78	48.88	0.76
	Std. Dev.	9.70	13.74	0.46	9.79	12.28	0.24
	C.O.V	21.41	31.89	*45.01*	14.66	25.11	*32.22*
All Points	Mean	43.90	42.76	1.04	68.18	48.05	0.73
	Std. Dev.	10.18	12.99	0.44	10.24	11.87	0.24
	C.O.V	23.18	30.37	42.14	15.02	24.69	33.29

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	56.04	45.97	0.88
	Std. Dev.	14.54	12.99	0.38
	C.O.V	25.94	28.25	*42.80*
All Points	Mean	56.04	45.41	0.89
	Std. Dev.	15.93	12.41	0.38
	C.O.V	28.43	27.33	42.90

NOTES:

VOAG settings: 10 psi
Carrier 6.1 cfm
Dispersion 18 cfh
Gear 7, 22%
90 kHz

After the last reading, tried heat tape on fixed opc probe.

	Start	Finish	
Stack centerline vel.	8.9	8.8 m/s	
Stack Temp	12.8	12.2 C	
Wind @ 10 m	4.0	3.0 mph	per met station 300 area readings
Wind direction	80	140 deg	""
Ambient Temp	48	45 F	""
Time			

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

Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "B" 25% insertion	1 scfm	
Mobile OPC "A"	1 scfm	

TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-5
Testers:	glissmeyer/maughan	Date	11/15/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	65.27 to: 65.27
		Points in Center 2/3	3 to: 10

Each OPC data point includes: **average of five 1-min. counts in the 9 micron channel**

N/S was done first. W/E normalized by ratio of average fixed opc readings

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Mob N/S
2	na						
3	1.27	29.2	54.8	85.1	59.4	47.8	47.8
4	1.77	43.8	63	97.8	53	52.5	52.5
5	2.50	44.6	59	91.6	57.4	60.2	60.2
6	3.56	47	47.4	73.6	60.4	61.2	61.2
Center	5	53.4	38.6	59.9	71	46.2	46.2
7	6.44	50	23.6	36.7	77.6	66.6	66.6
8	7.50	57	38.8	60.3	77.2	37	37
9	8.23	52.2	32.4	50.3	66	37.2	37.2
10	8.82	30.6	30	46.6	79	31.2	31.2
11	9.33	31.2	40	62.1	80.8	40.6	40.6
Center 2/3	Mean	45.31	43.07	66.89	66.78	48.88	48.88
	Std. Dev.	9.70	13.74	21.33	9.79	12.28	12.28
	C.O.V	21.41	31.89	*31.89*	14.66	25.11	*25.11*
All Points	Mean	43.90	42.76	66.41	68.18	48.05	48.05
	Std. Dev.	10.18	12.99	20.17	10.24	11.87	11.87
	C.O.V	23.18	30.37	30.37	15.02	24.69	24.69

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	56.04	45.97	57.88
	Std. Dev.	14.54	12.99	19.26
	C.O.V	25.94	28.25	*33.27*
All Points	Mean	56.04	45.41	57.23
	Std. Dev.	15.93	12.41	18.66
	C.O.V	28.43	27.33	32.60

NOTES:

VOAG settings: 10 psi
Carrier 6.1 cfm
Dispersion 18 cfh
Gear 7, 22%
90 kHz

After the last reading, tried heat tape on fixed opc probe.

	Start	Finish		
Stack centerline vel.	8.9	8.8	m/s	
Stack Temp	12.8	12.2	C	
Wind @ 10 m	4.0	3.0	mph	per met station 300 area readings
Wind direction	80	140	deg	""
Ambient Temp	48	45	F	""
Time				

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

Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "B" 25% insertion	1 scfm	
Mobile OPC "A"	1 scfm	

TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-5
Testers:	glissmeyer/maughan	Date	11/15/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	65.27 to: 65.27
		Points in Center 2/3	3 to: 10

Each OPC data point includes: **average of five 1-min. counts in the 9 micron channel**

N/S was done first. W/E normalized by difference of average fixed opc readings

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Mob N/S
2	na						
3	1.27	29.2	54.8	79.1	59.4	47.8	47.8
4	1.77	43.8	63	87.3	53	52.5	52.5
5	2.50	44.6	59	83.3	57.4	60.2	60.2
6	3.56	47	47.4	71.7	60.4	61.2	61.2
Center	5	53.4	38.6	62.9	71	46.2	46.2
7	6.44	50	23.6	47.9	77.6	66.6	66.6
8	7.50	57	38.8	63.1	77.2	37	37
9	8.23	52.2	32.4	56.7	66	37.2	37.2
10	8.82	30.6	30	54.3	79	31.2	31.2
11	9.33	31.2	40	64.3	80.8	40.6	40.6
Center 2/3	Mean	45.31	43.07	67.35	66.78	48.88	48.88
	Std. Dev.	9.70	13.74	13.74	9.79	12.28	12.28
	C.O.V	21.41	31.89	***20.40***	14.66	25.11	***25.11***
All Points	Mean	43.90	42.76	67.04	68.18	48.05	48.05
	Std. Dev.	10.18	12.99	12.99	10.24	11.87	11.87
	C.O.V	23.18	30.37	19.37	15.02	24.69	24.69

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	56.04	45.97	58.11
	Std. Dev.	14.54	12.99	15.81
	C.O.V	25.94	28.25	***27.21***
All Points	Mean	56.04	45.41	57.55
	Std. Dev.	15.93	12.41	15.54
	C.O.V	28.43	27.33	27.00

NOTES:

VOAG settings: 10 psi
Carrier 6.1 cfm
Dispersion 18 cfh
Gear 7, 22%
90 kHz

After the last reading, tried heat tape on fixed opc probe.

	Start	Finish		
Stack centerline vel.	8.9	8.8	m/s	
Stack Temp	12.8	12.2	C	
Wind @ 10 m	4.0	3.0	mph	per met station 300 area readings
Wind direction	80	140	deg	""
Ambient Temp	48	45	F	""
Time				

Instuments Used:

		Cal Exp. Date:
Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "B" 25% insertion	1 scfm	
Mobile OPC "A"	1 scfm	

TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-5
Testers:	glissmeyer/maughan	Date	11/15/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	65.27 to: 65.27
		Points in Center 2/3	3 to: 10

Each OPC data point includes: **average of five 1-min. counts in the 9 micron channel**

N/S was done first. W/E normalized adding counts to make centerpoints equal.

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Mob N/S
2	na						
3	1.27	29.2	54.8	62.4	59.4	47.8	47.8
4	1.77	43.8	63	70.6	53	52.5	52.5
5	2.50	44.6	59	66.6	57.4	60.2	60.2
6	3.56	47	47.4	55.0	60.4	61.2	61.2
Center	5	53.4	38.6	46.2	71	46.2	46.2
7	6.44	50	23.6	31.2	77.6	66.6	66.6
8	7.50	57	38.8	46.4	77.2	37	37
9	8.23	52.2	32.4	40.0	66	37.2	37.2
10	8.82	30.6	30	37.6	79	31.2	31.2
11	9.33	31.2	40	47.6	80.8	40.6	40.6
Center 2/3	Mean	45.31	43.07	50.67	66.78	48.88	48.88
	Std. Dev.	9.70	13.74	13.74	9.79	12.28	12.28
	C.O.V	21.41	31.89	***27.11***	14.66	25.11	***25.11***
All Points	Mean	43.90	42.76	50.36	68.18	48.05	48.05
	Std. Dev.	10.18	12.99	12.99	10.24	11.87	11.87
	C.O.V	23.18	30.37	25.79	15.02	24.69	24.69

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	56.04	45.97	49.77
	Std. Dev.	14.54	12.99	12.67
	C.O.V	25.94	28.25	***25.46***
All Points	Mean	56.04	45.41	49.21
	Std. Dev.	15.93	12.41	12.16
	C.O.V	28.43	27.33	24.72

NOTES:

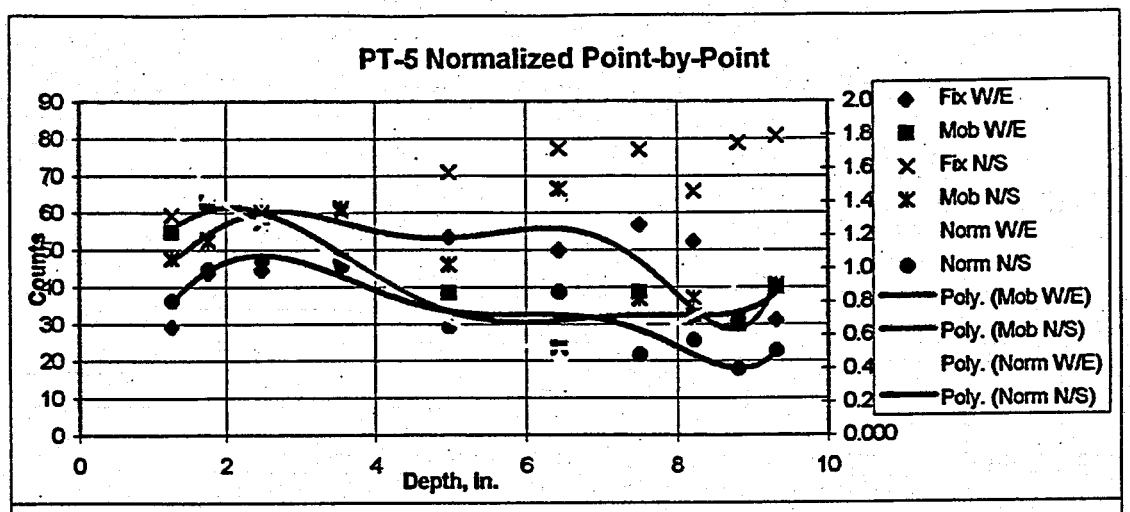
VOAG settings: 10 psi
Carrier 6.1 cfm
Dispersion 18 cfh
Gear 7, 22%
90 kHz

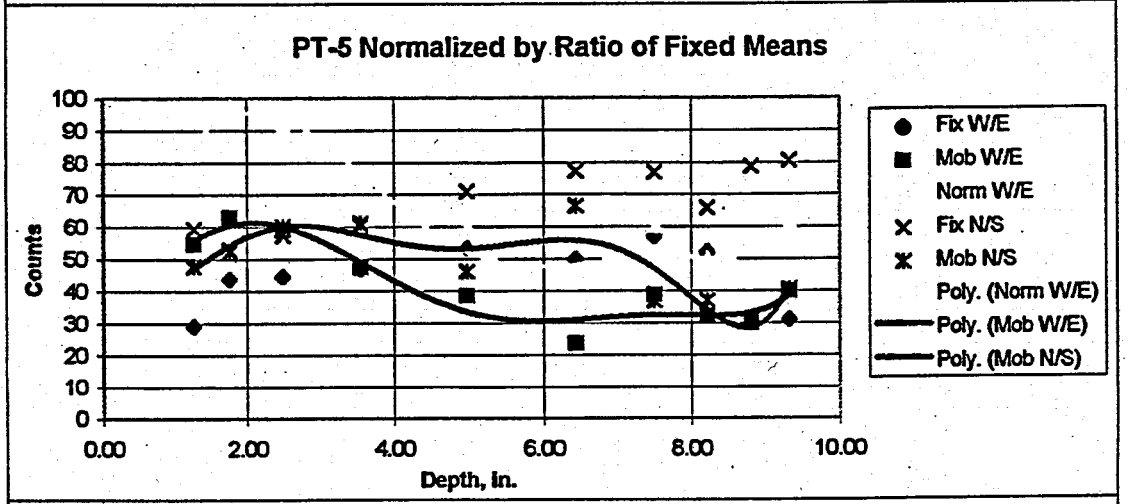
After the last reading, tried heat tape on fixed opc probe.

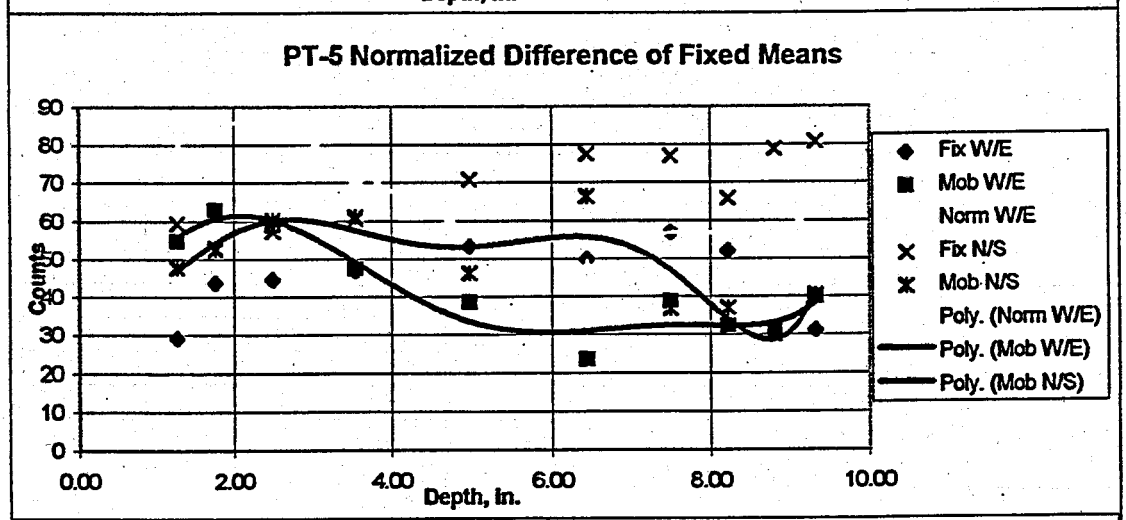
	Start	Finish		
Stack centerline vel.	8.9	8.8	m/s	
Stack Temp	12.8	12.2	C	
Wind @ 10 m	4.0	3.0	mph	per met station 300 area readings
Wind direction	80	140	deg	""
Ambient Temp	48	45	F	""
Time				

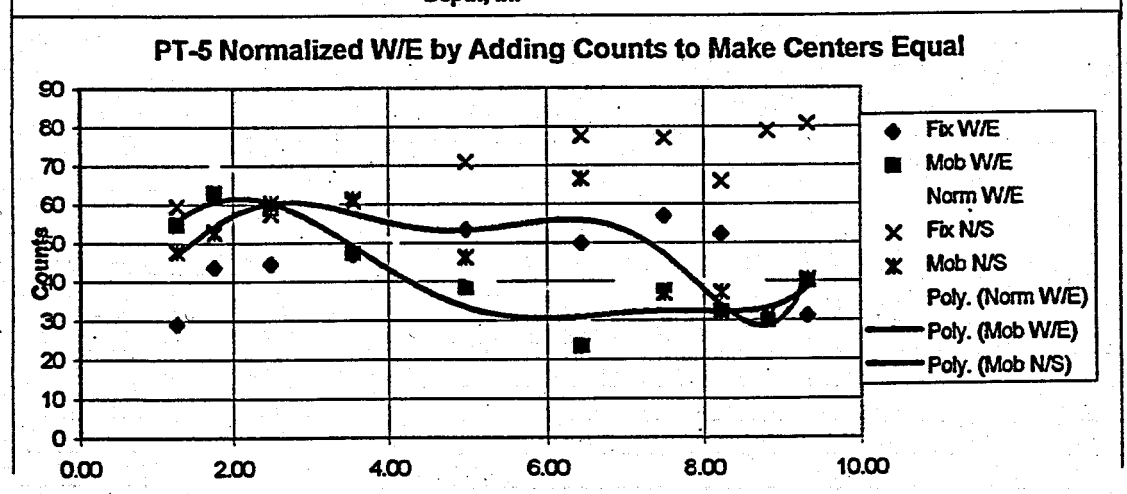
Instuments Used: **Cal Exp. Date:**

Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "B" 25% insertion	1 scfm	
Mobile OPC "A"	1 scfm	


PT-5 Normalized Point-by-Point
Counts
Depth, in.
Fix W/E
Mob W/E
Fix N/S
Mob N/S
Norm W/E
Norm N/S
Poly. (Mob W/E)
Poly. (Mob N/S)
Poly. (Norm W/E)
Poly. (Norm N/S)


PT-5 Normalized by Ratio of Fixed Means
Counts
Depth, in.
Fix W/E
Mob W/E
Norm W/E
Fix N/S
Mob N/S
Poly. (Norm W/E)
Poly. (Mob W/E)
Poly. (Mob N/S)


PT-5 Normalized Difference of Fixed Means
Counts
Depth, in.
Fix W/E
Mob W/E
Norm W/E
Fix N/S
Mob N/S
Poly. (Norm W/E)
Poly. (Mob W/E)
Poly. (Mob N/S)


PT-5 Normalized W/E by Adding Counts to Make Centers Equal
Counts
Fix W/E
Mob W/E
Norm W/E
Fix N/S
Mob N/S
Poly. (Norm W/E)
Poly. (Mob W/E)
Poly. (Mob N/S)

TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-5
Testers:	glissmeyer/maughan	Date	11/15/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from	65.27 to: 65.27
		Points in Center 2/3	3 to: 10

Each OPC data point includes: **average of five 1-min. counts in the 9 micron channel**

N/S was done first. Both normalized to mean centerpoint

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Mob N/S
2	na						
3	1.27	29.2	54.8	58.6	59.4	47.8	44
4	1.77	43.8	63	66.8	53	52.5	48.7
5	2.50	44.6	59	62.8	57.4	60.2	56.4
6	3.56	47	47.4	51.2	60.4	61.2	57.4
Center	5	53.4	38.6	42.4	71	46.2	42.4
7	6.44	50	23.6	27.4	77.6	66.6	62.8
8	7.50	57	38.8	42.6	77.2	37	33.2
9	8.23	52.2	32.4	36.2	66	37.2	33.4
10	8.82	30.6	30	33.8	79	31.2	27.4
11	9.33	31.2	40	43.8	80.8	40.6	36.8
Center 2/3	Mean	45.31	43.07	46.87	66.78	48.88	45.08
	Std. Dev.	9.70	13.74	13.74	9.79	12.28	12.28
	C.O.V	21.41	31.89	*29.31*	14.66	25.11	*27.23*
All Points	Mean	43.90	42.76	46.56	68.18	48.05	44.25
	Std. Dev.	10.18	12.99	12.99	10.24	11.87	11.87
	C.O.V	23.18	30.37	27.89	15.02	24.69	26.82

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	56.04	45.97	45.97
	Std. Dev.	14.54	12.99	12.67
	C.O.V	25.94	28.25	*27.56*
All Points	Mean	56.04	45.41	45.41
	Std. Dev.	15.93	12.41	12.16
	C.O.V	28.43	27.33	26.79

NOTES:

VOAG settings: 10 psi
Carrier 6.1 cfm
Dispersion 18 cfh
Gear 7, 22%
90 kHz

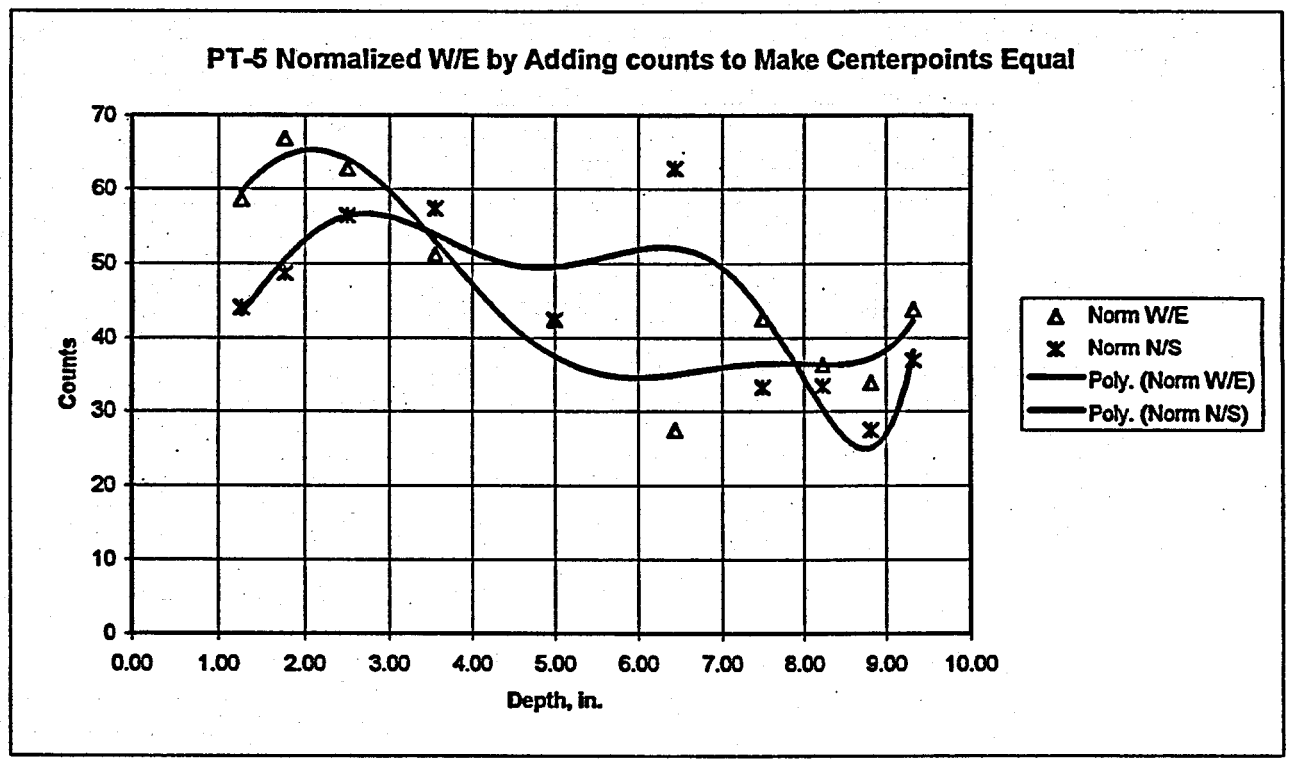
After the last reading, tried heat tape on fixed opc probe.

	Start	Finish		
Stack centerline vel.	8.9	8.8	m/s	
Stack Temp	12.8	12.2	C	
Wind @ 10 m	4.0	3.0	mph	per met station 300 area readings
Wind direction	80	140	deg	""
Ambient Temp	48	45	F	""
Time				

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

Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "B" 25% insertion	1 scfm	
Mobile OPC "A"	1 scfm	

Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Norm N/S
1.27	29.2	54.8	58.6	59.4	47.8	44
1.77	43.8	63	66.8	53	52.5	48.7
2.50	44.6	59	62.8	57.4	60.2	56.4
3.56	47	47.4	51.2	60.4	61.2	57.4
5.00	53.4	38.6	42.4	71	46.2	42.4
6.44	50	23.6	27.4	77.6	66.6	62.8
7.50	57	38.8	42.6	77.2	37	33.2
8.23	52.2	32.4	36.2	66	37.2	33.4
8.82	30.6	30	33.8	79	31.2	27.4
9.33	31.2	40	43.8	80.8	40.6	36.8



TRACER PARTICLE TRAVERSE DATA FORM

Site	AP-40 Mockup	Run No.	PT-5
Testers:	glissmeyer/maughan	Date	11/15/96
Stack Dia.	10 in.	Particle Dp	10.5 micron
Stack X-Area	78.54 in2	Particle AD	10 micron
Measurement elevation	in.	Aerosol Solution	26
El. above disturbance	71 in.	Fan Setting	23 Hz
Injection Point: centerline fan outlet		Center 2/3 from 65.27	to: 65.27
		Points in Center 2/3 3	to: 10

Each OPC data point includes: average of five 1-min. counts in the 9 micron channel

N/S was done first. Normalized by dividing mobile by mean of fixed for traverse

		W/E Traverse			N/S Traverse		
Point	Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Mob N/S
2	na						
3	1.27	29.2	54.8	1.21	59.4	47.8	0.72
4	1.77	43.8	63	1.39	53	52.5	0.79
5	2.50	44.6	59	1.30	57.4	60.2	0.90
6	3.56	47	47.4	1.05	60.4	61.2	0.92
Center	5	53.4	38.6	0.85	71	46.2	0.69
7	6.44	50	23.6	0.52	77.6	66.6	1.00
8	7.50	57	38.8	0.86	77.2	37	0.55
9	8.23	52.2	32.4	0.72	66	37.2	0.56
10	8.82	30.6	30	0.66	79	31.2	0.47
11	9.33	31.2	40	0.88	80.8	40.6	0.61
Center 2/3	Mean	45.31	43.07	0.95	66.78	48.88	0.73
	Std. Dev.	9.70	13.74	0.30	9.79	12.28	0.18
	C.O.V	21.41	31.89	*31.89*	14.66	25.11	*25.11*
All Points	Mean	43.90	42.76	0.94	68.18	48.05	0.72
	Std. Dev.	10.18	12.99	0.29	10.24	11.87	0.18
	C.O.V	23.18	30.37	30.37	15.02	24.69	24.69

		Combined W/E & N/S		
		Fixed	Mobile	Normalized
Center 2/3	Mean	56.04	45.97	0.84
	Std. Dev.	14.54	12.99	0.27
	C.O.V	25.94	28.25	*31.85*
All Points	Mean	56.04	45.41	0.83
	Std. Dev.	15.93	12.41	0.26
	C.O.V	28.43	27.33	31.14

NOTES:

VOAG settings: 10 psi
Carrier 6.1 cfm
Dispersion 18 cfh
Gear 7, 22%
90 kHz

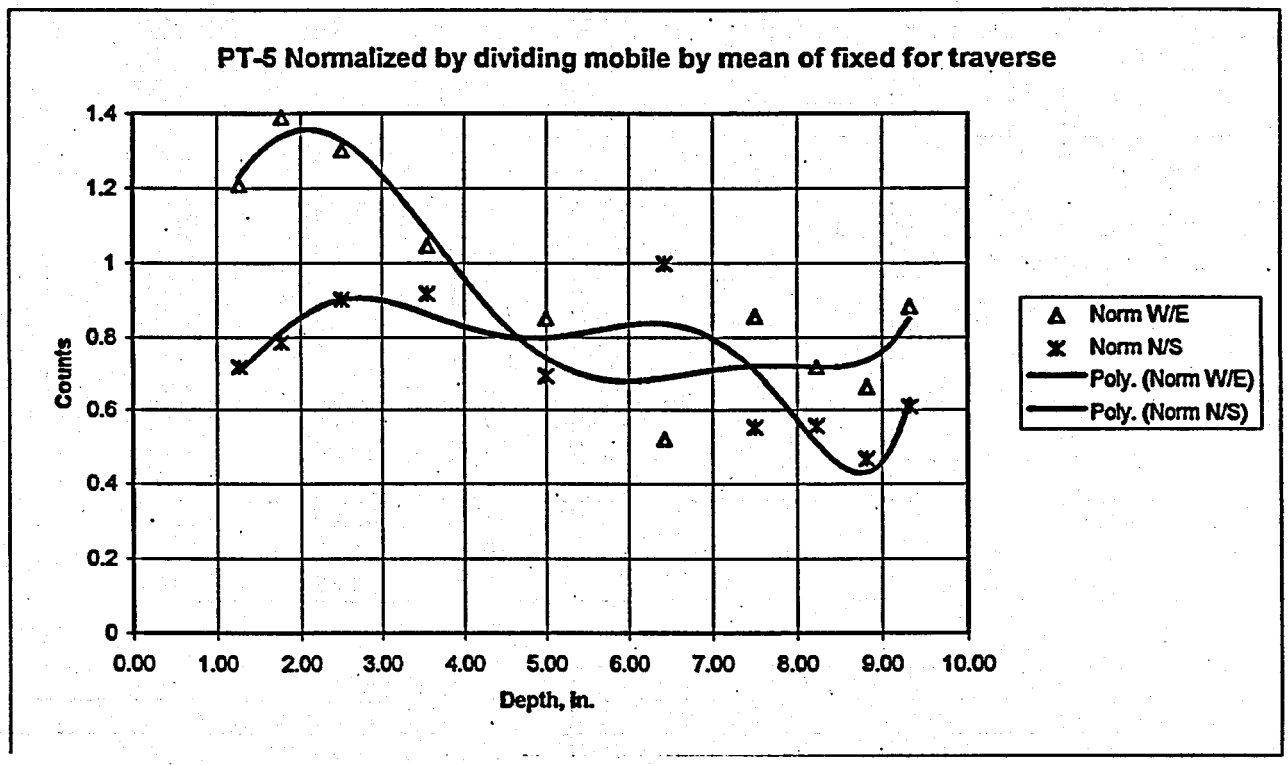
After the last reading, tried heat tape on fixed opc probe.

	Start	Finish	
Stack centerline vel.	8.9	8.8 m/s	
Stack Temp	12.8	12.2 C	
Wind @ 10 m	4.0	3.0 mph	per met station 300 area readings
Wind direction	80	140 deg	"
Ambient Temp	48	45 F	"
Time			

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

Solomat Zephyr #12951472 for stack center velocity		3/1/97
Fixed OPC "B" 25% insertion	1 scfm	
Mobile OPC "A"	1 scfm	

Depth, in.	Fix W/E	Mob W/E	Norm W/E	Fix N/S	Mob N/S	Norm N/S
1.27	29.2	54.8	1.2094164	59.4	47.8	0.71580699
1.77	43.8	63	1.3903874	53	52.5	0.78618968
2.50	44.6	59	1.3021089	57.4	60.2	0.9014975
3.56	47	47.4	1.046101	60.4	61.2	0.91647255
5.00	53.4	38.6	0.8518882	71	46.2	0.69184692
6.44	50	23.6	0.5208436	77.6	66.6	0.99733777
7.50	57	38.8	0.8563021	77.2	37	0.55407654
8.23	52.2	32.4	0.7150564	66	37.2	0.55707155
8.82	30.6	30	0.6620893	79	31.2	0.4672213
9.33	31.2	40	0.8827857	80.8	40.6	0.60798669



Appendix E

Particle Penetration Test

Procedure for Particle Penetration Test

February 7, 1997

It is necessary that the contaminant sample extracted from the stack be quantitatively delivered to the collection device. The deposition of particles in the sample transport tubing is a strong function of particle size for particles larger than 1 μm. An assessment of the particle size and activity distribution in the effluent stream upstream of the filtration devices will establish an upper bound size that may have a significant contribution to the effluent concentration. In the absence of such a determination, the default criterion of ≥50% penetration of 10 μm AD particles from the free stream in the stack to the collector is used. Acceptable assessment tools include the DEPOSITION code (Riehl et al. 1996) or experimental measurement. This procedure provides a method for the experimental measurement. This method is applicable after a demonstration of particle concentration uniformity in the sampling plane.

The general approach is to inject 10 μm AD particles into the test stack just downstream of the fan in the centerline of the duct. The airstream is simultaneously sampled with an in-stack air sampler and the subject system, and the results compared. Particles tagged with a fluorescent dye are used, and the samples are analyzed with a fluorimeter. Besides comparing the results of particles collected, the deposition of particles optionally may be measured if needed to explain the results.

Equipment

Vibrating orifice aerosol generator (VOAG) system (or other suitable aerosol generator)
Particle injection probe
Aerosol feed solution (fluorescent dye tagged oleic acid in methanol)
In-stack reference sampling system (IRSS)
The tested sampling system (TSS)
Optional optical particle counter (OPC) to confirm the quality of the particles generated
Optional sampling probe for the OPC

Tested Sampling System

The tested sampling system is installed and operated according to the system design and operating manuals with the possible exception that the sample filter be identical to that used in the IRSS. If the TSS contains a continuous air monitor (CAM), the CAM can be replaced with an in-line filter holder to remove the effects of particle deposition in the CAM from the test results. It is important to cross calibrate the flowmeters in both the IRSS and TSS to eliminate biasing the results based on separate flowmeter measurements.

In-Stack Reference Sampling System

The IRSS differs from the tested sampling system primarily by having a sharp-edged inlet nozzle followed within several centimeters by a 47-mm Gelman glass fiber filter. The sampling flowrate is adjusted so it is always operated isokinetically. Consequently, negligible sampling bias and internal losses are exhibited, and analysis of the filter will indicate a true measure of the relative aerosol concentration in the stack. The nozzle and filter holder are located in the stack. The balance of the sampling train consists of a mass flowmeter, valve, and vacuum pump.

The IRSS nozzle should be located in the stack far enough away from the TSS nozzle in order to avoid physical and aerodynamic interference. It also should be positioned at the same stack elevation as used in the other tests. Multiple IRSS's may be used and the results averaged, or the position of the IRSS may be changed during a run to obtain an average concentration of particles.

VOAG

The VOAG should be located as close as possible to the injection port. The Krypton-85 aerosol charge neutralizer may be needed if the particles are to be transported more than a couple of meters to minimize deposition caused by the static charge of the particles. The neutralizer should be located in a radiological material area. The syringe pump should be filled with the aerosol solution, and the operational parameters configured for generating 10 µm AD particles.

In the VOAG, the aerosol solution passes through an ~20-µm circular orifice to form a cylindrical jet. A piezoelectric crystal positioned on the orifice assembly is oscillated at known frequencies to cause the liquid jet to break up into uniformly sized droplets. As the methanol in the droplets evaporate, an air jet disperses the particles to avoid coagulation.

The final diameter of the monodisperse particles is calculated from the solute (oleic acid and uranine) concentration, the solution flow rate, and the frequency of oscillation. Particle size and quality are checked using one or both of two diagnostic methods (survey of particles deposited to a coated slide using a light microscope and measurement of optical particle size and particle size distribution using a clean room counter). Particle quality is determined as the ratio of doublet particles (formed when two particles collided and coagulated) to singlet particles. Final particle density (oleic acid and uranine) is calculated and used to determine the aerodynamic size of the monodisperse particles during each test. An optical particle counter may also be used to verify particle quality.

Measurements

On the data record sheet, record the test conditions of particle injection point, fan control setting, aerosol generator settings, aerosol solution, stack centerline velocity, date, time, TSS and IRSS sample flowrates, and stack temperature. Also record the equipment used and the names of the test operators.

At the end of the test, re-record any test parameters if they have changed. Position the injection probe as directed in the test conditions. Start the injection of the tracer particles.

Potential Test Conditions

If stack or sample flows are expected to vary by more than 25%, the test conditions should include the extremes (and optionally the average). This test should be repeated to estimate the precision of the measurements. A sample run includes one set of operating conditions. Precision can be quickly estimated by changing the collection filters three or more times during a sample run.

Sample Analysis

Samples are analyzed fluoroscopically to determine the relative number of particles collected on internal probe surfaces and on filters. The interior surfaces of the nozzles and probes are rinsed two or three times with 20- to 30-mL aliquots of methanol to remove deposited particles. (Ninety-nine percent of the dye usually is removed after three rinses.) In the case of filters, 4 to 5 mL of methanol is added to the filter in a beaker, and the filters are gently agitated for a few seconds. This procedure is repeated three to four times. The fluorescence of the resulting methanol solutions are then measured on a fluorometer typically between 15 and 60 min after the methanol is added. The readings are repeated three times consecutively and averaged. Because the filter media can cause a measurable background fluorescence, two blank filters should be included with every batch of filter samples. The total quantity of fluorescent dye in the filter samples, in units of fluorescence, is determined by correcting the average reading by the average quantity of fluorescence in the two blank filter solutions. Fluorometer scale factors of 1X, 10X, and 50X are used to increase the range of the instrument and are factors included in determining the quantity of fluorescent particulate matter in the samples. No blank correction is usually necessary for the internal nozzle and probe surfaces; however, the fluorometer is zeroed using blank methanol before analyzing all samples. The fluorometer zero is confirmed periodically during each batch of samples.

CAUTION

Observe appropriate precautions and procedures for using and handling the aerosol charge neutralizer, methanol, and aerosol feed solution as well as during laboratory analyses.

GEMS PENETRATION ANALYSES — Density 0.7914 — Fluorescence Analysis

PENetrate Sample ID	Run	Description	Sample Date	Analysis Date	Other	Vol.	Dilution 1 : xx	Order for Analyses	Peak Area	Gross Wt. (w/sample)	Tare	Liquid Sample Wt	Sample Vol	Spectra File
0		Alcohol Blank		28-May-97				0	-14.5					
1	2	IRRS filter sample	2-May-97	28-May-97	Clearly visible yellow center spot, ~1.5cm dia.		1:9.295	12	13356	26.7029	16.6733	10.0296	12.67	a-p1d001.sp
2	2	CAM-AMS filter sample	2-May-97	28-May-97	slight yellowed center w/ distinct outter edge		1:3.1271	7	17245	24.6625	16.4748	8.1877	10.35	a-p02001.sp
3	2	Record filter sample	2-May-97	28-May-97	difficult to see any yellow but w/ coloration at edge exposed by filter ring		1:9.9857	8	4405	25.2716	16.5141	8.7575	11.07	a-p3d001.sp
4	2	Splitter wash	2-May-97	28-May-97	clear liquid	1 3/4"		4	499	191.8281	123.4664	68.3617	86.38	a-p04001.sp
5	2	Record wipe (wash)	2-May-97	28-May-97				1	5950	24.3007	16.6364	7.6643	9.68	a-p05001.sp
6	2	IRRS Wash	2-May-97	28-May-97	clear liquid	3/4"		6	5685	146.4264	123.5027	22.9237	28.97	a-p06001.sp
7	2	CAM-AMS wash	2-May-97	28-May-97	clear liquid	3/4"		5	229	147.9467	123.6601	24.2866	30.69	a-p07001.sp
8	2	Shrouded Probe wash	2-May-97	28-May-97	clear liquid	1 3/8"		2	4333	176.2404	123.8383	52.4021	66.21	a-p08001.sp
9	1	CAM-AMS filter sample	1-May-97	28-May-97	~2 cm center yellowed spot w/ darker perimeter		1:10.8738	9	3716	27.6309	16.4534	11.1775	14.12	a-p9d001.sp
10	1	IRRS filter sample	1-May-97	28-May-97	filter had considerable debris w/ yellowed spot		1:118.932 1:6.3290	11	283 15704	27.7777	16.6104	11.1673	14.11	apd10001.sp ap10d001.sp

GEMS PENETRATION ANALYSES — Density 0.7914 — Fluorescence Analysis

PENetrate Sample ID	Run	Description	Sample Date	Analysis Date	Other	Vol.	Dilution 1 : xx	Order for Analyses	Peak Area	Gross Wt. (w/sample)	Tare	Liquid Sample Wt	Sample Vol	Spectra File
11	1	Record filter sample	1-May-97	28-May-97	difficult to see any yellow but w/ coloration at edge exposed by filter ring		1:9.342 1:94.381	10	3809 160	27.8436	16.7211	11.1225	14.05	a11d001.sp ad11d001.sp
12	3	Methanol blank	5-May-97		clear liquid	3/4"		1	-13	147.7900				
13	3	CAM-AMS blank filter	5-May-97					2	-2					
14	3	IRRS blank filter	5-May-97											
15	3	Sample splitter wash	5-May-97		clear liquid	11/16"		7	2245	144.6524	123.888	20.7644	26.24	
16	3	IRSS wash	5-May-97		clear liquid	3/8"		6	13152	129.319	123.711	5.608	7.09	
17	3	GEMs probe wash	5-May-97		clear liquid	9/16"		4	9052	138.8147	123.598	15.2167	19.23	
18	3	CAM wash	5-May-97		clear liquid	5/8"		5	1561	144.0869	123.6877	20.3992	25.78	
19	3	Record filter holder wash	5-May-97		clear liquid	11/16"		3	1568	144.5477	123.4257	21.122	26.69	
20	3	IRSS filter sample	5-May-97		slight yellowed center		1:11	10	8669			0	0.00	
21	3	CAM filter sample	5-May-97		light yellow center darker at circle perimeter		1:11 1:1000	9	9817 15			0	0.00	
22	3	Record filter sample	5-May-97		hardly detectable yellow, but yellowed edge		1:11 1:1000	8	6339 -10			0	0.00	
STD A			7-May-97											
STD B			7-May-97											
STD C			7-May-97											
23	4	IRSS Wash	9-May-97					7	7475	131.7669	122.8682	8.8987	11.24	pn23_001.sp
24	4	Probe Wash	9-May-97					4	2462	160.6825	123.419	37.2635	47.09	pn24_001.sp
25	4	Splitter wash	9-May-97					5	754	155.5694	122.1222	33.4472	42.26	pn27_001.sp
26	4	Record wash	9-May-97					3	462	156.2622	122.9461	33.3161	42.10	pn26_001.sp

GEMS PENETRATION ANALYSES — Density 0.7914 — Fluorescence Analysis

PENetrate Sample ID	Run	Description	Sample Date	Analysis Date	Other	Vol.	Dilution 1 : xx	Order for Analyses	Peak Area	Gross Wt. (w/sample)	Tare	Liquid Sample Wt	Sample Vol	Spectra File
27	4	CAM wash	9-May-97					6	1976	146.4142	123.5957	22.8185	28.83	p27a_001.sp
28	4	IRSS filter sample	9-May-97			~15	1:10 1:100	10	14636 590	26.8297	16.7809	10.0488	12.70	p28c_001.sp p28d_001.sp
29	4	Record filter sample	9-May-97			~9	1:10 1:100	9	8795 296	22.2865	16.7636	5.5229	6.98	p29c_001.sp p29d_001.sp
30	4	CAM filter sample	9-May-97		First syringe filter dissolved > milky soln. Refiltered w/ corr. type	~11		8	6036	23.5903	16.8366	6.7537	8.53	p30d_001.sp
31	4	IRSS Field Blank filter	5-May-97		Filter dissolved as above. Also PEN 14	~11		1	27.34	23.1836	16.7401	6.4435	8.14	pn31_001.sp
32	4	Blank methanol						2	-13					pn32_001.sp
33	5	Probe Wash	2-Jun-97	4-Jun-97	clear liquid			5	574	160.5833	123.594	36.9893	46.74	p33--001.sp
34	5	Record wash	2-Jun-97	4-Jun-97	clear liquid			3	65	160.4544	123.4367	37.0177	46.77	p34--001.sp
35	5	Ref (IRSS) wash	2-Jun-97	4-Jun-97	clear liquid			6	6585	129.5447	123.7122	5.8325	7.37	p35--001.sp
36	5	Record wash	2-Jun-97	4-Jun-97	fairly even color distr. across filter			-		25.6658	15.1632	10.5026	13.27	
37	5	CAM filter sample	2-Jun-97	4-Jun-97	Central spot w/ darker perimeter			-		25.5821	15.155	10.4271	13.18	
38	5	Ref (IRSS) filter	2-Jun-97	4-Jun-97	Central spot w/ out distinct edges			-		25.6923	15.1992	10.4931	13.26	
36D	5	dilution of Record f.					1:9.8055	9	14656		15.0733			p36D-001.sp
37D	5	dilution of CAM filter					1:9.8475	8	11793		15.1705			p37D-001.sp
38D	5	dilution of Ref. filter					1:8.809	7	11374		15.2492			p38D-001.sp
39	5	Splitter wash	2-Jun-97	4-Jun-97	clear liquid			4	554	168.809	123.8864	44.9226	56.76	p39--001.sp
40	5	Methanol blank	2-Jun-97	4-Jun-97	clear liquid			1	-6.9	-	123.8128			p40--001.sp

GEMS PENETRATION ANALYSES | Density 0.7914 | Fluorescence Analysis

PENetrate Sample ID	Run	Description	Sample Date	Analysis Date	Other	Vol.	Dilution 1 : xx	Order for Analyses	Peak Area	Gross Wt. (w/sample)	Tare	Liquid Sample Wt	Sample Vol	Spectra File
41	5	CAM wash	2-Jun-97	4-Jun-97	clear liquid			2	798	149.1897	123.6964	25.4933	32.21	p41--001.sp

Analyst		Method		Slit Abs	2.5 Emisson
Date	Method Description				
Notes:	C:\FLDM\Data\Paul\Export				
Notes:					

Penetration Test Results
Straight 10-inch stack

Run: PEN-1
Stack flow 500 cfm
Fan setting 24 Hz

pectral analysis date: 5/28/97
Stack sample date: 5/1/97
Solvent density: 0.7914 g/cc

Sample #	Reference filter 10	Ref nozzle wash 6	Combined Ref Total	CAM filter 9	Record filter 11	Probe wash 8	Splitter wash 4	CAM holder wash 7	Record holder wash 5	Combined GEMS Total	
Elapsed time, min	123			123	123						
Referenced Flowrate, lpm	35.5			26.1	26.6						
Air Vol L	4367		4367	3210	3272					6482.1	
Bottle gross wt., g	27.7777	146.4264		27.6309	27.8436	176.2404	191.8281	147.9467	24.3007		
Bottle Tare, g	16.6104	123.5027		16.4534	16.7211	123.8383	123.4664	123.6601	16.6364		
Liq vol in bottle, ml	14.11	28.97		14.12	14.05	66.21	86.38	30.69	9.68		
Dilution (1 to x.xxx)	6.3296	0.2351		10.8738	9.342	0.4120	0.4120	0.4120	0.4120		
Peak area	15704	5685		3716	3809	4333	499	229	5950		
Conc. in Liq., mg/ml	4.96E-04	1.80E-04		1.17E-04	1.20E-04	1.37E-04	1.58E-05	7.24E-06	1.88E-04		
Adj. for dilutn., mg/ml	3.14E-03	4.22E-05		1.28E-03	1.12E-03	5.64E-05	6.50E-06	2.98E-06	7.75E-05		
mg collected	4.43E-02	1.22E-03	4.55E-02	1.80E-02	1.58E-02	3.74E-03	5.61E-04	9.15E-05	7.50E-04	3.90E-02	
% collected, mg	97.3%	2.7%		46.3%	40.5%	9.6%	1.4%	0.2%	1.9%		
Measured air concentration, mg/L			1.04E-05	5.62E-06	4.83E-06					6.01E-06	
% of Reference Conc.				53.9%	46.3%						Unaccounted
Expected in GEMS, mg										0.067613	
% Total Expected				26.7%	23.4%	5.5%	0.8%	0.1%	1.1%	57.6%	42.4%
Expected on CAM, mg				3.35E-02							
% Total Expected				53.9%		5.6%	0.8%	0.3%		60.5%	39.5%
Expected on Record, mg					3.41E-02						
% Total Expected					46.3%	5.5%	0.8%		2.2%	54.8%	45.2%

Notes:
Perkin Elmer LS-50 B Luminescence Spectrophotomer
Spectral Range (nm) 500 - 720 of emission curve
Excitation band (nm) 493
Scan speed 120
Slit width 2.5
3.5 ml cuvette

Test done with high velocity range shrouded nozzle.
The shape of the inlet to the Record filter prevents washing the particles off.
The washes were done after Run PEN-2 and the amounts apportioned between the two runs by the ratio of sample volumes. The apportioning is accounted for in the dilution.

Cal. curve to convert area to mg/ml

Slope	3.16E-08
Intercept	0.00E+00
CAM flow, lpm	29.149
Record flow, lpm	29.149
Reference flow, lpm	35.5

Penetration Test Results
Straight 10-inch stack

Run: PEN-2
Stack flow 1000 cfm
Fan setting 48 Hz

pectral analysis date: 5/28/97
Stack sample date: 5/2/97
Solvent density: 0.7914 g/cc

Sample #	Reference filter 1	Ref nozzle wash 6	Combined Ref Total	CAM filter 2	Record filter 3	Probe wash 8	Splitter wash 4	CAM holder wash 7	Record holder wipe 5	Combined GEMS Total	Unaccounted
Elapsed time, min	196			196	196						
Referenced Flowrate, lpm	72.5			19.9	27.3						
Air Vol, L	14210		14210	3900	5351					9251.2	
Bottle gross wt., g	26.7029	146.4264		24.6625	25.2716	176.2404	191.8281	147.9467	24.3007		
Bottle Tare, g	16.6733	123.5027		16.4748	16.5141	123.8383	123.4664	123.6601	16.6364		
Liq vol in bottle, ml	12.67	28.97		10.35	11.07	66.21	86.38	30.69	9.68		
Dilution (1 to x.xxx)	9.295	0.7649		3.127	9.986	0.5880	0.5880	0.5880	0.5880		
Peak area	13356	5685		17245	4405	4333	499	229	5950		
Conc. in Liq., mg/ml	4.22E-04	1.80E-04		5.45E-04	1.39E-04	1.37E-04	1.58E-05	7.24E-06	1.88E-04		
Adj. for dilutn., mg/ml	3.92E-03	1.37E-04		1.70E-03	1.39E-03	8.05E-05	9.27E-06	4.26E-06	1.11E-04		
mg collected	4.97E-02	3.98E-03	5.37E-02	1.76E-02	1.54E-02	5.33E-03	8.01E-04	1.31E-04	1.07E-03	4.03E-02	
% collected, mg	92.6%	7.4%		43.7%	38.1%	13.2%	2.0%	0.3%	2.7%		
Measured air concentration, mg/L			3.78E-06	4.52E-06	2.87E-06					4.36E-06	
% of Reference Conc.				119.6%	76.1%						
Expected in GEMS, mg										0.034959	
% Total Expected				50.4%	44.0%	15.2%	2.3%	0.4%	3.1%	115.4%	-15.4%
Expected on CAM, mg				1.47E-02							
% Total Expected				119.6%		18.1%	2.7%	0.9%		141.3%	-41.3%
Expected on Record, mg					2.02E-02						
% Total Expected					76.1%	13.2%	2.0%		5.3%	96.5%	3.5%

Notes:
Perkin Elmer LS-50 B Luminescence Spectrophotomer
Spectral Range (nm) 500 - 720 of emission curve
Excitation band (nm) 493
Scan speed 120
Slit width 2.5
3.5 ml cuvette

Test done with high velocity range shrouded nozzle.
The washes were done after Run PEN-2 and the amounts apportioned between the two runs by the ratio of sample volumes. The apportioning is accounted for in the dilution.

Cal. curve to convert area to mg/ml	
Slope	3.16E-08
Intercept	0.00E+00
CAM flow, lpm	22.73433
Record flow, lpm	28.583
Reference flow, lpm	72.5

Penetration Test Results
Straight 10-inch stack

Run: PEN-3
Stack flow 213 cfm
Fan setting 12 Hz

Spectral analysis date: 5/7/97
Stack sample date: 5/5/97
Solvent density: 0.7914 g/cc

Sample #	Reference filter 20	Ref nozzle wash 16	Combined Ref Total	CAM filter 21	Record filter 22	Probe wash 17	Splitter wash 15	CAM holder wash 18	Record holder wash 19	Combined GEMS Total	Unaccounted
Elapsed time, min	72			72	72						
Referenced Flowrate, lpm	15.26			26.3	21.8						
Air Vol, L	1098.7		1098.7	1893.6	1569.6					3463.2	
Bottle gross wt., g		129.3190				138.8147	144.6524	144.0869	144.5477		
Bottle Tare, g		123.7110				123.5980	123.8800	123.6877	123.4257		
Liq vol in bottle, ml	9	7.09		9	9	19.23	26.25	25.78	26.69		
Dilution	11	1		11	11	1	1	1	1		
Peak area	8669	13152		9817	6339	9052	2245	1561	1568		
Conc. in Liq., mg/ml	2.7E-04	4.2E-04		3.1E-04	2.0E-04	2.9E-04	7.1E-05	4.9E-05	5.0E-05		
Adj. for dilutn., mg/ml	3.0E-03	4.2E-04		3.4E-03	2.2E-03	2.9E-04	7.1E-05	4.9E-05	5.0E-05		
mg collected	2.7E-02	2.9E-03	3.0E-02	3.1E-02	2.0E-02	5.5E-03	1.9E-03	1.3E-03	1.3E-03	6.0E-02	
% collected, mg	90.2%	9.8%		50.8%	32.8%	9.1%	3.1%	2.1%	2.2%		
Measured air concentration, mg/L			2.7E-05	1.6E-05	1.3E-05					1.7E-05	
% of Reference Conc.				59.3%	46.2%						
Expected in GEMS, mg										0.094766	
% Total Expected				32.4%	20.9%	5.8%	2.0%	1.3%	1.4%	63.8%	36.2%
Expected on CAM, mg				5.18E-02							
% Total Expected				59.3%		5.3%	1.8%	2.5%		68.8%	31.2%
Expected on Record, mg					4.30E-02						
% Total Expected					46.2%	6.4%	2.2%		3.1%	57.8%	42.2%

Notes:
Perkin Elmer LS-50 B Luminescence Spectrophotomer
Spectral Range (nm) 500 - 720 of emission curve
Excitation band (nm) 493
Scan speed 120
Slit width 2.5
3.5 ml cuvette

Test done with high velocity range shrouded nozzle.
The shape of the inlet to the Record filter prevents washing the partilces off.

Cal. curve to convert area to mg/ml	
Slope	3.16E-08
Intercept	0.00E+00
CAM flow, lpm	28.10
Record flow, lpm	23.32
Reference flow, lpm	15.26

Penetration Test Results
Straight 10-inch stack

Run: PEN-4
Stack flow 894 cfm
Fan setting 40 Hz

pectral analysis date: 5/9/97
Stack sample date: 5/8/97
Solvent density: 0.7914 g/cc

Sample #	Reference filter 28	Ref. nozzle wash 23	Combined Ref. Total	CAM filter 30	Record filter 29	Probe wash 24	Splitter wash 25	CAM holder wash 27	Record holder wash 26	Combined GEMS Total	Unaccounted
Elapsed time, min	233			233	233						
Referenced Flowrate, lpm	90			29.2	30.7						
Air Vol, L	20970		20970	6804	7153					13956.7	
Bottle gross wt., g	26.8297	131.7669		23.5903	22.2865	160.6825	155.5694	146.4142	156.2622		
Bottle Tare, g	16.7809	122.8682		16.8366	16.7636	123.4190	122.1222	123.5957	122.9461		
Liq vol in bottle, ml	12.70	11.24		8.53	6.98	47.09	42.26	28.83	42.10		
Dilution (1 to x.xx)	10	1		10	10	1	1	1	1		
Peak area	14636	7475		6036	8795	2462	754	1976	462		
Conc. in Liq., mg/ml	4.62E-04	2.36E-04		1.91E-04	2.78E-04	7.78E-05	2.38E-05	6.24E-05	1.46E-05		
Adj. for dilutn, mg/ml	4.62E-03	2.36E-04		1.91E-03	2.78E-03	7.78E-05	2.38E-05	6.24E-05	1.46E-05		
mg collected	5.87E-02	2.66E-03	6.14E-02	1.63E-02	1.94E-02	3.66E-03	1.01E-03	1.80E-03	6.15E-04	4.28E-02	
% collected, mg	95.7%	4.3%		38.1%	45.4%	8.6%	2.4%	4.2%	1.4%		
Measured air concentration, mg/L			2.93E-06	2.39E-06	2.71E-06					3.06E-06	
% of Reference Conc.				81.7%	92.6%						
Expected in GEMS, mg										0.040853	
% Total Expected				39.8%	47.5%	9.0%	2.5%	4.4%	1.5%	104.7%	-4.7%
Expected on CAM, mg				1.99E-02							
% Total Expected				81.7%		9.2%	2.5%	9.0%		102.5%	-2.5%
Expected on Record, mg					2.09E-02						
% Total Expected					92.6%	8.7%	2.4%		2.9%	106.7%	-6.7%

Notes:
Perkin Elmer LS-50 B Luminescence Spectrophotomer
Spectral Range (nm) 500 - 720 of emission curve
Excitation band (nm) 493
Scan speed 120
Slit width 2.5
3.5 ml cuvette

Test done with high velocity range shrouded nozzle.
The shape of the inlet to the Record filter prevents washing the partilces off.

Cal. curve to convert area to mg/ml	
Slope	3.16E-08
Intercept	0.00E+00
CAM flow, lpm	30.60
Record flow, lpm	30.22
Reference flow, lpm	90.03

Penetration Test Results
Straight 10-inch stack

Run: PEN-6
Stack flow 213 cfm
Fan setting 12 Hz

pectral analysis date: 6/4/97
Stack sample date: 6/2/97
Solvent Density: 0.7914 g/cc

Sample #	Reference filter 38	Ref nozzle wash 35	Combined Ref Total	CAM filter 37	Record filter 36	Probe wash 33	Splitter wash 39	CAM holder wash 41	Record holder wash 34	Combined GEMS Total	
Elapsed time, min	79			79	79						
Referenced Flowrate, lpm	15.04			30.3	31.7						
Air Vol, L	1188		1188	2394	2504					4898.0	
Bottle gross wt., g	25.6923	129.5447		25.5821	25.6658	160.5833	168.809	149.1897	160.4544		
Bottle Tare, g	15.1992	123.7120		15.1550	15.1632	123.5940	123.8860	123.6960	123.4370		
Liq vol in bottle, ml	13.26	7.37		13.18	13.27	46.74	56.76	32.21	46.77		
Dilution (1 to x.xx)	8.809	1		9.8475	9.8055	1	1	1	1		
Peak area	11374	6585		11793	14656	574	554	798	65		
Conc. in Liq., mg/ml	3.59E-04	2.08E-04		3.73E-04	4.63E-04	1.81E-05	1.75E-05	2.52E-05	2.05E-06		
Adj. for dilutn., mg/ml	3.17E-03	2.08E-04		3.67E-03	4.54E-03	1.81E-05	1.75E-05	2.52E-05	2.05E-06		
mg collected	4.20E-02	1.53E-03	4.35E-02	4.84E-02	6.03E-02	8.48E-04	9.94E-04	8.12E-04	9.61E-05	1.11E-01	
% collected, mg	96.5%	3.5%		43.4%	54.1%	0.8%	0.9%	0.7%	0.1%		
Measured air concentration, mg/L			3.66E-05	2.02E-05	2.41E-05					2.27E-05	
% of Reference Conc.				55.2%	65.7%						Unaccounted
Expected in GEMS, mg										0.179375	
% Total Expected				27.0%	33.6%	0.5%	0.6%	0.5%	0.1%	62.1%	37.9%
Expected on CAM, mg				8.77E-02							
% Total Expected				55.2%		0.5%	0.6%	0.9%		57.1%	42.9%
Expected on Record, mg					9.17E-02						
% Total Expected					65.7%	0.5%	0.5%		0.1%	66.8%	33.2%

Notes:
Perkin Elmer LS-50 B Luminescence Spectrophotomer
Spectral Range (nm) 500 - 720 of emission curve
Excitation band (nm) 493
Scan speed 120
Slit width 2.5
3.5 ml cuvette

Sample and Record filters ruptured during Run-5.
Test done with low velocity range shrouded nozzle.
The shape of the inlet to the Record filter prevents washing the partilces off.

Cal curve to convert area to mg/ml

Slope	3.16E-08
Intercept	0.00E+00
CAM flow, lpm	31.53
Record flow, lpm	30.97
Reference flow, lpm	15.04

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