FINAL REPORT

Measurement and Characterization of Aerosols Generated from A Consumer Spray Product-Pilot Study

for

The Soap and Detergent Association

Battelle Study No. N003043A

by

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Toxicology Northwest
900 Battelle Blvd.
Richland, WA 99352

FINAL REPORT

Measurement and Characterization of Aerosols Generated from A Consumer Spray Product-Pilot Study

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COMPLIANCE STATEMENT

This study was conducted in the spirit of EPA Good Laboratory Practices Regulations (40 CFR, Part 792) for the conduct of non-clinical studies. The study was not listed on Battelle's list of regulated studies. All records that would be required to reconstruct the study will be maintained. All data generated from any portion of this study will be retained at Battelle until acceptance of the final report, when all materials will be returned to the archival facility designated by the Sponsor.

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1.0 INTRODUCTION

The purpose of this study was to characterize aerosols present in the breathing zone of a potential user after simulating delivery of a laundry product with the presence of enzyme. The aerosol was generated from a trigger sprayer attached to a bottle containing the detergent formulation. This study was designed to evaluate size distribution of the aerosols suspended in air and the relative mass loading of the particles under reasonable foreseeable heavy usage situations. The experimental data will provide the information regarding the particle size distribution, relative mass concentration and its decay patterns, and estimation of the mass balance between the material sprayed from the containers and that caught on the fabrics. The tests were conducted by actuating the trigger sprayer 6 inches from cloth targets which were oriented either horizontally or vertically. An aerodynamic particle sizer (Aerosizer, API) was used to measure the aerosol size distribution, the peak of relative mass concentration and its decay pattern during a spray episode.

The characteristics of trigger sprayers were also evaluated using a Malvern Diffraction Particle Sizer (Malvern Instrument, Inc.) to avoid the possibility of picking an abnormal trigger sprayer for the experiment.

The study was conducted first at Battelle Columbus facility, and later was transferred to the Battelle Richland facility. The study protocol was prepared by Battelle and approved by the Sponsor's study monitor, Dr. Jenan Al-Atrash of the Soap and Detergent Association. Mr. Thomas Vinci served as the study director for the project conducted at Battelle Columbus, and Mr. John Decker served as the study director after the project was transferred to the Battelle Richland Facility. The signed protocol and the amendments are attached in Appendix D. The study was conducted as Battelle Study Number N003043A. The Study was initiated on December 29, 1997 with the signing of the protocol.

2.0 MATERIALS AND METHODS

2.1 Test Articles

2.1.1 Prespotter

The test material was SDA Generic Laundry Prespotter (formulation 14979-H-4-4) contained in plastic bottles. The identity, purity, stability and composition of the test article were the responsibility of the Sponsor. A description of formulation 14979-H-4-4 is attached as Appendix E. The MSDS for the test article is included in the Appendix F.

A total of 6 bottles were received at Battelle Columbus and Richland facilities. Two bottles contained the prespotter with no enzyme and four bottles contained the prespotter with enzyme (Savinase 16.0L EX manufactured by Novo Nordisk) at a stated concentration of 0.5% by weight. Savinase contains 0.0405 grams of pure enzyme per gram of Savinase. Therefore there is 0.203 mg of enzyme per gram of prespotter product. The details of the shipments are listed in Table 2.1. Lot numbers 15024-H-47-1 and 2 were sub lots from the formulation 14979H4-4. For ease in discussion, each lot number has been assigned an inventory ID as shown in Table 2.1. In each case the two bottles with the same lot number were labeled as #1 and #2.

Table 2.1 Prespotter Inventory

Date Received	Lot Number (Formulation)	Inventory ID	Stock Number	Number of Bottles	Formulation Description
12-18-97	14979H 4-4	A	BA02604877	2	0.5% Savinase
07-09-98	15024-H-47-1	B	13249-040-CSTF	2	Without enzyme
07-09-98	15024-H-47-2	C	13249-040-CSTF	2	0.5% Savinase

The prespotters were stored under refrigeration (2-8°C) upon receipt. The storage condition was appropriate for the stability of the test material according to the information provided by the Sponsor. The prespotters were allowed to come to room temperature for about 24 hours before use. No precipitate was observed prior to use. The expiration date for the test material was not given.

2.1.2 Fabric and Detergent

A total of two shipments of the fabric were received at both Battelle Columbus and Richland facilities. The fabric shipment received at Battelle Columbus was 65/35 cotton/polyester blend material. The fabric was washed (2 wash cycles with detergent and 1 wash cycle with water only), then ironed and cut into 18" x 18" pieces. The fabric received at Battelle Richland was 65/35 Khaki cotton/polyester blend material that required pre-washing. A total of 60 yards x 45 inches of the fabric was received at Battelle Richland facility on July 8, 1998.

The detergent used for pre-washing the fabric at Battelle was received at the Battelle Richland facility on July 7, 1998. The detergent was manufactured by Lever Brothers Company, and was labeled as Ultra "all"@ Free Clear Laundry Detergent (Batch No. 835; Section LHD). The

identity, purity, stability and composition of the material were the responsibility of the Sponsor. The detergent was stored under room temperature condition during the study.

The fabric used at Battelle Richland facility was pre-washed according to the Standard Operation Procedure (SOP BE.I-006-00) developed by Battelle and approved by the Sponsor (Appendix H). Following washing, the fabric was cut into 18" x 18" targets that were used throughout the experiment.

2.1.3 Trigger Sprayers

The identity of the trigger sprayers was the responsibility of the Sponsor. Six trigger sprayers (TS800) manufactured by Calmar Dispensing System, Inc. were received at Battelle Richland facility on July 7, 1998. The specifications for these trigger sprayers are included in Appendix G. The specified average output of the sprayers, based on water at 90 strokes per minute, is no less than 0.75 mL per stroke. The specified spray pattern, also based on water, is a nearly circular pattern with a diameter of no less than four inches at a distance of approximately eight inches. The spray pattern is considerably smaller when used in the stream mode which was used for dispensing the prespotter. These specifications are dependent on the viscosity and surface tension of the test article. The six trigger sprayers were evaluated to determine emitted aerosol size distribution, output per stroke and spray pattern in order to avoid choosing a trigger sprayers with abnormal characteristics for the experiment. The trigger sprayers were stored under room temperature condition during the study.

2.2 Experimental Methods

2.2.1 Test Chamber

All spray tests with the exception of the evaluation of the aerosol size distribution of the primary spray from the trigger sprayers were performed in a ~13 cubic meter test chamber with internal dimensions of 88 inches in height, 94 inches in depth, and 94 inches in width. A door was located on the left front of the chamber. Windows in the front and right sides of the chamber allowed external viewing and video taping of the test procedures. The chamber was equipped with a high volume (~2000 cfm) re-circulating HEPA filtration system that was used between spray episodes to eliminate residual aerosol inside the chamber and to reduce aerosol background level. The filtration system was operated for about 5 minutes with the chamber door closed prior to each spray test. During the spray test, efforts were taken to maintain minimal air currents by sealing the chamber, turning off all HVAC system and minimizing human movement. A 36-inch tall x 48-inch wide x 30-inch deep table with a 6-inch tall backsplash was located at the right side of the room. All of the spray test apparatus was assembled on the top of the table.

2.2.2 Breathing Zone Aerosol Measurement

Relative aerosol mass and particle size distribution in the simulated breathing zone were measured using an aerodynamic particle sizer (Aerosizer Model LD, Amherst Process Instruments, Amherst, MA). The Aerosizer was set up for continuous measurement of aerosol

concentration with a sampling period of either 15 seconds (at Columbus) or 30 seconds (at Richland). The Aerosizer output that followed each 30-second sampling period included the relative mass loading and mass median aerodynamic diameter (MMAD), which were dependent on the time after spraying.

The Aerosizer was attached to the Aero-Diluter, which was operated at a sampling flow rate of 2 liters/min. The Aero-Dilute operates by controlling the mass flow of sheath air supplied to the Aerosizer. The total airflow through the Aerosizer nozzle remains constant at approximately 6 liters/min because it is operated at a choke flow condition. This total flow is the combination of sampling airflow and filtered sheath airflow. By regulating the sheath airflow, the sampling airflow can be determined by the difference between the total airflow and the sheath airflow. The calibration procedure for the Aero-Diluter was followed each day of testing after the device reached its normal operating temperature. The normal warm up time for the Aero-Diluter is about 2 hours. A small nozzle was used in the Aerosizer during the experiments. The size measurement range for the small nozzle is 0.1-200 μm.

2.2.3 Evaluation of Trigger Sprayers

The aerosol size distribution, mass output and spray pattern of six trigger sprayers were evaluated prior to choosing a single representative trigger sprayer to be used for the evaluation of the aerosol in the breathing zone. The test article containing no enzyme (Inventory ID B) was used for these tests.

2.2.3.1 Aerosol Size Distribution from the Trigger Sprayers

Size distribution of aerosols generated from the six trigger sprayers was measured using a laser diffraction particle sizer (Mastersizer Model X, Malvern Instruments Ltd). A 300mm receiving lens was used which covers the particle size range of 1.2-600 μm. The experimental configuration for the measurement of the particle size distribution (PSD) is shown in Figure 2.1. The exit of the trigger sprayer was positioned at 20 mm from the lens to the center of the device to avoid vignetting, and 120 mm from the laser beam axis to the tip of the trigger sprayer to avoid its interference with the laser beam. The measurements were repeated 5 times for each sprayer with a total of six sprayers. The refractive index of the formulation was measured using a refractometer (ABBE MARK II, Leica). The refractive index of the formulation is required by the Malvern Diffraction Particle Sizer to calculate the aerosol size distribution.

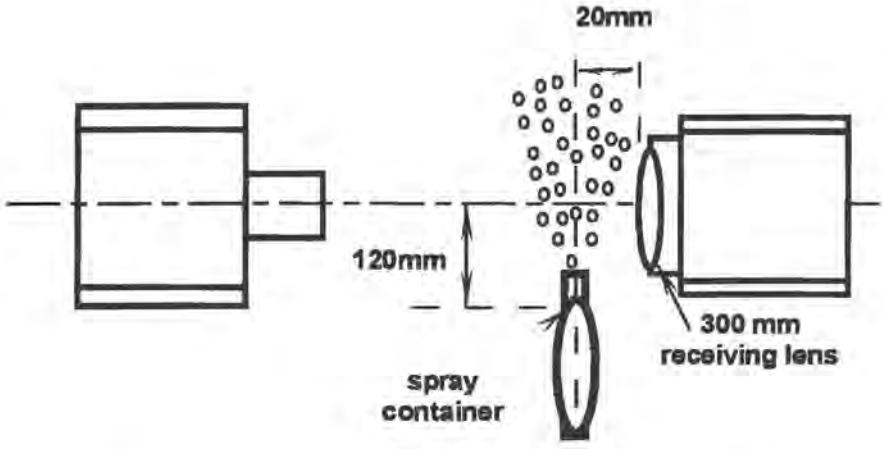


Figure 2.1 The Experimental Configuration for the Size Distribution Measurement without the USP Induction Port.

2.2.3.2 Characterization of Spray Pattern

The spray pattern and mass balance of the aerosol from the trigger sprayers were also characterized in order to identify a trigger sprayer to be used throughout the prespotter testing. The test article containing no enzyme (Inventory ID B) was used with the trigger sprayers during the testing. The mass balance was determined by weighing the containers before and after the spray episode, and weighing the mass caught on the fabric.

The fabric targets were supported on the table in a vertical orientation as shown in the Figure 2.2. Each fabric target was backed with a single layer of plastic-backed absorbent paper (19"x19"), and supported with the top edge 19.25 inches from the tabletop, and 6 inches from the front edge of the tabletop. A pan was placed below the fabric target to catch any test article that may drip from the target. The pan was raised 1.75 inches from the tabletop by a spacer. The trigger sprayer was located 10.25 inches above and at a 90-degree angle to the tabletop and 6 inches from the surface of the target. The fabric target was weighed together with the pan before and after the spray episode. The spray episode was repeated three times for each trigger sprayers (a total of six trigger sprayers).

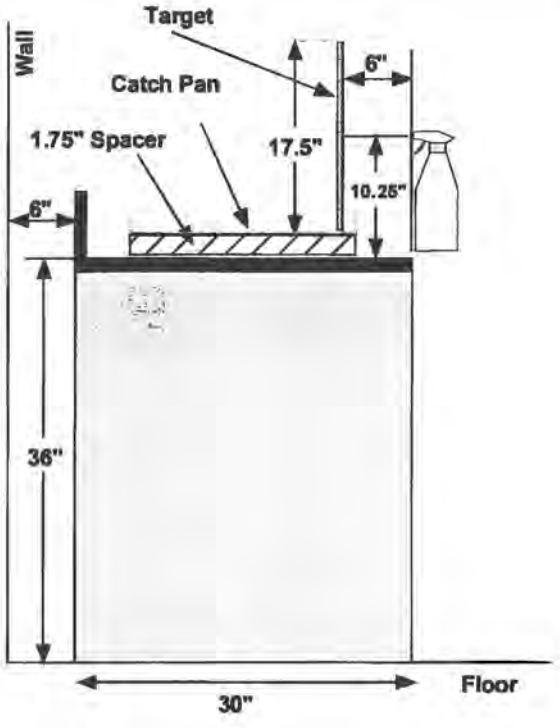


Figure 2.2 Relative Orientation of Table, Trigger Sprayer, Vertical Target (side view)

2.2.4 Evaluation of the Prespotters: Horizontal Target

The configuration and locations of the trigger sprayer, the fabric target and the sample port were intended to simulate potential regions of likely human exposure. The fabric target was placed on a layer of plastic-backed absorbent paper, which was laid on a tabletop surface at 36 inches above the floor. The front edge of the plastic-backed absorbent paper was approximately aligned with the front edge of the tabletop. The trigger sprayer was located at a 45-degree angle 6 inches from the center of the prespotter "stain" in the vertical plane perpendicular to the surface of the fabric target, perpendicular to the front edge of the tabletop and passing through the center of the target. The detailed relative orientation of the table, trigger sprayer, and the sampling port is depicted in Figures 2.3 (side view) and 2.4 (top view).

The aerosol size distributions and relative mass concentrations were measured using the aerodynamic particle sizer (Aerosizer, API).

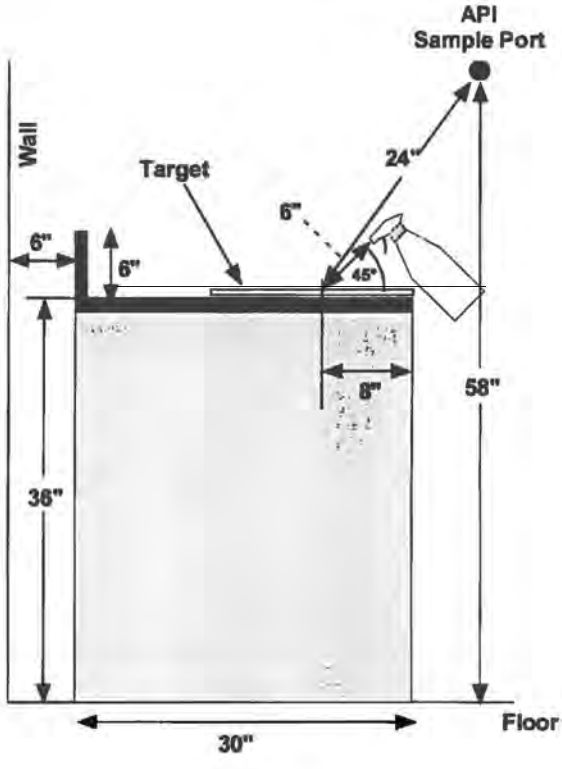


Figure 2.3 Relative Orientation of Table, Trigger Sprayer, Horizontal Target, and Sampling Port (side view)

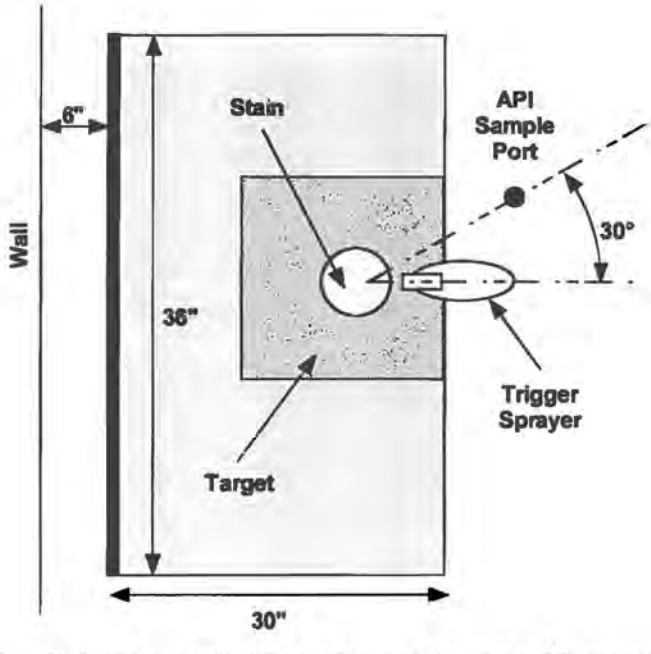


Figure 2.4 Relative Orientation of Table, Trigger Sprayer, Horizontal Target, and Sampling Port (top view)

The HEPA air filtration system was turned on about 5 minutes with the door of the testing chamber closed, followed by the measurement of aerosol concentration in the air using Aerosizer to check the background of the testing chamber. After finishing the background check, the spray episode was begun by turning on the Aerosizer, and waiting for one minute to start actuation. The actuation sequence was manually controlled to provide a uniform force that delivered five sprays to the fabric target at a rate of one stroke per second. This was repeated again for a total of six fabric targets with a 10-second lag between targets. After finishing the spray, the aerosol concentration in the testing chamber was continuously measured for a total of 11 minutes to observe the decay pattern of mass median aerodynamic diameter as a function of time, as well as to determine the peak and the duration of the aerosol concentration in the testing chamber.

The experiment was repeated 5 times both for container #1 and container #2 of the test article (Inventory ID C). The total mass output during the spray episode was determined by weighing each container before and after the above mentioned time-controlled actuation sequence as well as weighing the fabric targets collected in a plastic pan. The information of the mass balance was obtained by comparing the net loss from the containers and net gain on the fabric targets together with the material collected in the plastic pan.

2.2.5 Evaluation of the Prespotters: Vertical Target

The relative orientation of the table, trigger sprayer, fabric targets, and sampling port for the vertical orientation experiment is shown in Figure 2.5. Each fabric target was backed with a single layer of plastic-backed absorbent paper (19"x19"), and supported with the top edge 19.25 inches from the tabletop, and 6 inches from the front edge of the tabletop. A pan was placed below the fabric target to catch any test article that may drip from the fabric target. The pan was raised 1.75 inches from the tabletop by a spacer. The trigger sprayer was located 10.25 inches above and at a 90-degree angle to the tabletop and 6 inches from the surface of the fabric target. All other experiment procedures were the same as the horizontal configuration described in section 2.2.3 above.

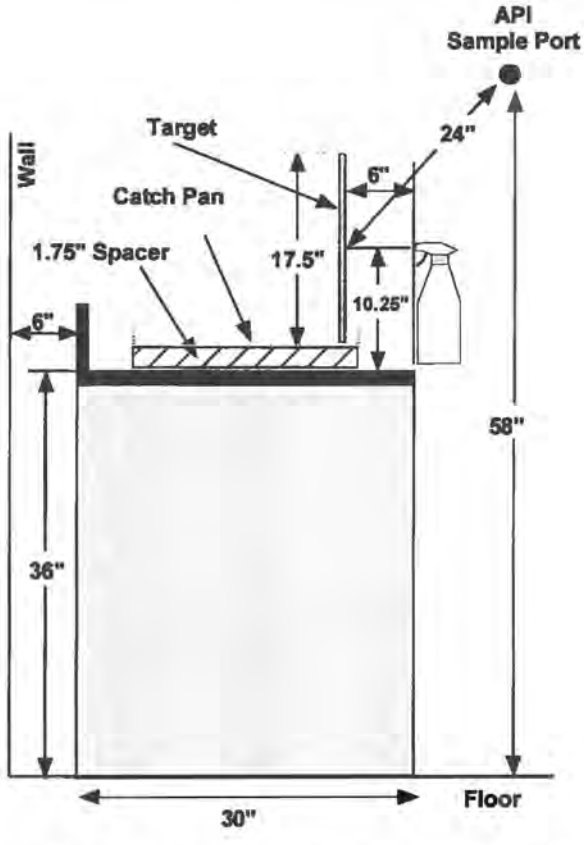


Figure 2.5 Relative Orientation of Table, Trigger Sprayer, Vertical Target, and Sampling Port (side view)

3.0 STATISTICAL METHODS AND DATA CALCULATIONS

3.1 Statistical Methods

The average value (mean) and standard deviation (SD) of the experimental data were calculated according to the following equations:

$$\text{Mean}= \frac{\sum x}{n}, \quad (1)$$

$$\text{SD}= \sqrt{\frac{n\sum x^2 - \left(\sum x\right)^2}{n(n-1)}}. \quad (2)$$

3.2. Particle Size Calculations

The particle size distribution measured by API Aerosizer is represented by the aerodynamic mass median diameter (MMAD) and and the geometric standard deviation (GSD). The MMAD is the diameter of the unit density particle that has the same setting velocity as the particle in question. Mass median diameter (MMD) is defined as the diameter at which 50% of the sample is smaller and 50% is large than the MMD, and is expressed as d (v, 50). The relationship between the MMD and the MMAD can be expressed as

$$\text{MMAD}= \text{MMD}\sqrt{\rho}$$

where ρ is the density of the particle, which was assumed to be 1.0 g/cm^3 for this study.

Under assumption of lognormal distribution for the aerosol, the geometric standard deviation (GSD) can be expressed by:

$$\text{GSD}= \frac{d(v,84.1)}{d(v,50)}$$

where the d(v, 84.1) is the mass median diameter at which 84.1% of the sample is smaller than indicated diameter.

4.0 RESULTS AND DISCUSSIONS

4.1 Spray Pattern and Mass Balance from Trigger Sprayers

The spray patterns from six trigger sprayers can be observed from the video recorded during the experiment. A copy of the video is included as part of this report. The mass balance between the loss from the spray container and the mass caught on the fabric target are shown in Table 4.1.

Table 4.1 Spray Pattern and Mass Balance from Six Trigger Sprayers. The vertical orientation (Figure 2.2) was used for these tests

Trigger Sprayer	Net loss from container (g)	Net gain on fabric (g)	%MD[a]	Circular diameter (mm)	Shape of pattern
Sprayer 1	4.7	4.4	6.38	14.5	circle
	4.9	4.7	4.08	15.0	circle
	5.0	4.6	8.00	14.5	circle
Mean (SD)	**4.9 (0.2)**	**4.6 (0.2)**	**6.15 (2.0)**	**14.7 (0.3)**	
Sprayer 2	4.3	4.4	0.00	21.0	circle
	4.4	4.3	2.27	20.0	circle
	4.4	4.4	0.00	20.5	circle
Mean (SD)	**4.4 (0.1)**	**4.4 (0.1)**	**0.77 (1.3)**	**20.5 (0.5)**	
Sprayer 3	4.3	3.9	9.30	14.0	circle
	4.4	4.2	4.55	14.5	circle
	4.4	4.3	2.27	14.0	circle
Mean (SD)	**4.4 (0.1)**	**4.1 (0.2)**	**5.37 (3.6)**	**14.2 (0.3)**	
Sprayer 4	4.3	4.3	0.00	17.0	circle
	4.1	4.1	0.00	18.5	circle
	4.1	4.0	2.44	17.5	circle
Mean (SD)	**4.2 (0.1)**	**4.1 (0.2)**	**0.81 (1.4)**	**17.7 (0.8)**	
Sprayer 5	4.0	4.1	0.00	18.0	circle
	4.2	4.1	2.38	17.5	circle
	4.0	3.9	2.50	17.5	circle
Mean (SD)	**4.1 (0.1)**	**4.1 (0.2)**	**1.63 (1.4)**	**17.7 (0.3)**	
Sprayer 6	5.6	5.1	8.93	17.5	oval
	4.2	4.0	4.76	17.5	oval
	4.0	3.8	5.00	16.5	oval
Mean (SD)	**4.6 (0.9)**	**4.3 (0.7)**	**6.23 (2.3)**	**17.2 (0.6)**	

[a] %MD (Percent of Mass Difference) = (Net loss from the container-Net gain on the fabric) x100%/Net loss from the container.

As can be seen from the above table, the spraying patterns from the sprayers were circular shapes except one sprayer (Sprayer 6) that had an oval shape. The circular diameter varied from 14 mm to about 20 mm. The percentage of mass difference was also calculated according to the equation shown at the footnote of Table 4.1. The difference varied

significantly from 0 to about 9%, which might be due in part to the low resolution of the balance used with respect to the mass weighed.

The particle size distribution from six trigger sprayers was also measured using Malvern Diffraction Particle Sizer as described previously. A 300mm lens was used during the experiment. This lens resolves particles in the size range from 1.2 – 600 μm. The Malvern accurately evaluated the particles from the trigger sprayers that were within this range. However, particles generated by the trigger sprayer that were larger than 600 μm were not resolved by the Malvern. Therefore only the resolvable portion of the size distribution was presented in the figures (refer to Appendix C). It would provide misleading information if one were to calculate the mass median aerodynamic diameter based upon this partial aerosol size distribution. Therefore, these calculations were not done and the evaluation of the trigger sprayers was based on a visual compaison of the particle size distribution figures.

Within the particle sizes that could be resolved by the Malvern, all six trigger sprayers varied from one spray episode to the next. Several showed a marked bimodal particle size distribution. Trigger sprayer # 4 was chosen to be used for all of the breathing zone tests because it was similar to sprayers 1 through 6 with respect to mass output, the spray pattern was circular in shape, and the diameter was about in the middle range of the diameters from other trigger sprayers. Trigger sprayer #4 also had the most consistent particle size distribution within different spray episodes.

4.2 Results of Mass Balance

The experiment was initiated at Battelle Columbus and finished at the Battelle Richland facility. The experimental data were recorded at both locations, and are presented according to their locations.

4.2.1 Data Obtained at Columbus

Table 4.2 Experimental Data of Mass Balance Obtained from Columbus

Sample	Container			Fabric			%MD[a]
	Pre-Weight (g)	Post-Weight (g)	Net-Weight (g)	Pre-Weight (g)	Post-Weight (g)	Net-Weight (g)	
Container 1	876.4	848.2	28.2	943.6	970.5	26.9	4.61
Inventory ID A	848.2	820.5	27.7	945.1	972.2	27.1	2.17
Horizontal	820.5	792.5	28.0	946.8	973.9	27.1	3.21
	792.5	765.1	27.4	941.4	968.5	27.1	1.09
	765.1	737.4	27.7	944.4	971.4	27.0	2.53
	737.4	709.9	27.5	951.3	978.2	26.9	2.18
Mean (SD)			**27.8 (0.3)**			**27.0 (0.1)**	**2.63 (1.2)**
Container 2	760.8	735.9	24.9	819.4	843.6	24.2	2.81
Inventory ID A	735.9	709.1	26.8	821.0	846.9	25.9	3.36
Vertical	709.1	683.7	25.4	822.3	847.0	24.7	2.76
	683.7	658.1	25.6	824.2	848.9	24.7	3.52
	[b]658.1	632.5	25.6	680.3	704.9	24.6	3.91
Mean (SD)			**25.7 (0.7)**			**24.8 (0.6)**	**3.27 (0.5)**

[a]%MD (Percent of Mass Difference) = (Net loss from the container-Net gain on the fabric) x 100% /Net loss from the container.
[b] only three fabric targets used, each with double sprays.

The experimental data of the mass emitted from the container and the mass caught on the fabric targets is shown in Table 4.2. It can be observed that the mass balance data was relatively consistent between different trials. The average material lost from the containers was about 27.8 grams and 25.7 grams for horizontal and vertical targets, respectively. The material caught on the fabric targets was 27.0 and 24.8 grams, respectively. The percentage of mass difference between the containers and fabric targets ranged from 1.1 to about 4.6%. It can also be seen that the container at the horizontal orientation delivered slightly more material as compared to that at the vertical orientation. However there was no apparent difference in the percentage of mass difference for both orientations. This is different from what we observed during the experiment conducted at Richland.

4.2.2 Data Obtained at Richland

Table 4.3 Experimental Data of Mass Balance Obtained from Richland

Sample	Container			Fabric			%MD[a]
	Pre-Weight (g)	Post-Weight (g)	Net-Weight (g)	Pre-Weight (g)	Post-Weight (g)	Net-Weight (g)	
Container 1	413.9	385.4	28.5	322.1	350.5	28.4	0.35
Inventory ID C	385.4	355.9	29.5	321.1	350.0	28.9	2.03
Horizontal	355.9	326.7	29.2	324.0	352.3	28.3	3.08
	326.7	297.1	29.6	322.8	352.0	29.2	1.35
	297.1	268.8	28.3	324.4	351.7	27.3	3.53
Mean (SD)			**29.0 (0.6)**			**28.4 (0.7)**	**2.07 (1.3)**
Container 2	665.9	636.5	29.4	322.7	351.8	29.1	1.02
Inventory ID C	636.5	607.2	29.3	321.0	349.8	28.8	1.71
Horizontal	595.0	566.0	29.0	322.1	350.3	28.2	2.76
	566.0	536.9	29.1	322.7	351.6	28.9	0.69
	536.9	507.7	29.2	323.1	351.6	28.5	2.40
Mean (SD)			**29.2 (0.2)**			**28.7 (0.4)**	**1.72 (0.9)**
Container 1	555.9	531.5	28.4	429.3	457.2	25.9	8.80
Inventory ID C	531.5	502.8	28.7	429.5	456.4	24.9	13.2
Vertical	502.8	474.0	28.8	430.2	456.7	26.5	7.99
	474.0	445.5	28.5	428.5	455.6	27.1	4.91
	445.5	416.9	28.6	427.6	455.5	27.9	2.45
Mean (SD)			**28.6 (0.2)**			**26.5 (1.1)**	**7.47 (4.1)**
Container 2	507.6	479.1	28.5	429.6	456.6	27.0	5.26
Inventory ID C	479.1	451.0	28.1	429.4	456.0	26.6	5.34
Vertical	451.0	422.6	28.4	430.5	457.1	26.6	6.34
	422.6	393.9	28.7	430.8	457.9	27.1	5.57
	393.9	365.1	28.8	429.8	456.5	26.7	7.29
Mean (SD)			**28.5 (0.3)**			**26.8 (0.2)**	**5.96 (0.9)**

[a]%MD (Percent of Mass Difference) = (Net loss from the container-Net gain on the fabric) x 100% /Net loss from the container.

The experimental data of mass balance for both containers (lot # 14025-H-47-2) obtained from the Richland facility are depicted in Table 4.3. There was no difference between the average values for different containers as well as the orientations. The mass outputs of the

spray at the horizontal orientation were 29 and 29.2 grams for both containers, and the masses caught on the fabric targets are 28.4 and 28.7 grams respectively. However there was a difference in the percentage of mass difference between the horizontal and vertical targets. The material recovered from the fabric target was less in the vertical orientation as compared with that in the horizontal orientation. Therefore one would expect that more droplets were suspended in the air for the vertical orientation than that in horizontal orientation.

There are several reasons that might contribute to the difference observed between the experiments conducted at the Columbus and Richland facilities. The difference may be due to the different trigger sprayers used in different locations. It is also a possibility that there is some differences in the experimental set up between two locations. The less movement of the fabric targets in the vertical orientation at the Richland facility, which was improved by using a layer of plastic-paper as back up, may play an important role in the difference between the experimental data.

4.3 Measurement Results of Horizontal Orientation

The experimental set up has been discussed in the previous section. The experiment conducted at Columbus used two bottles of material (lot # 14979H 4-4, Inventory ID A), which were shipped to Columbus when the project was initiated. The material used at Richland was two new bottles (lot # 15024-H-47-2, Inventory ID C) supplied by the SDA, and shipped directly to the Richland facility.

4.3.1 Data Obtained at Columbus

The relative aerosol mass concentration emitted from the trigger sprayer as a function of time

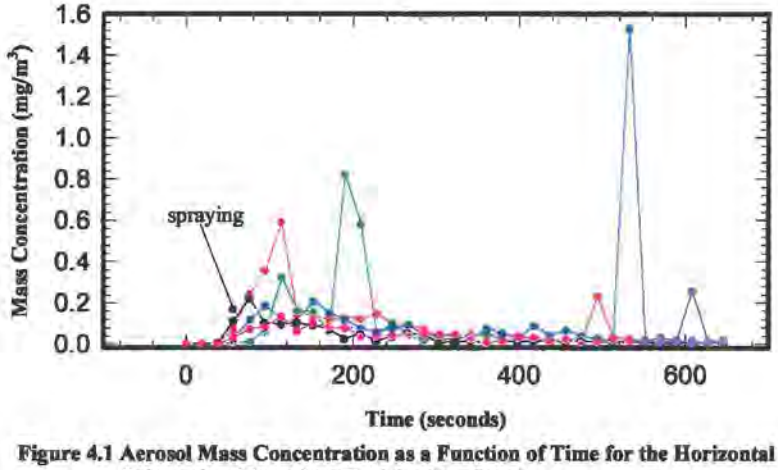


Figure 4.1 Aerosol Mass Concentration as a Function of Time for the Horizontal Orientation (Container#1, Columbus Data).

is plotted in Figure 4.1. The Aerosizer measurement period was set for 15 seconds, and measured the aerosol continuously for about 10 minutes. The spray episode started one minute after the beginning of the Aerosizer sampling (about four measurement points). As can be

seen from the figure, the aerosol concentration started to rise after spraying, and decayed gradually to the background level. However the experimental data showed several late occuring peaks after about 400 seconds, apparently caused by personnel movement inside the exposure chamber.

The aerosol size distribution as a function of time after spraying is shown in Figure 4.2. The size distribution measurements were taken at the same time as the mass concentration measurements. Each data point presented in Figure 4.2 corresponds to a data point shown in Figure 4.1. The mass median aerodynamic diameter increased as a result of spraying from about 2 μm (background) to about 8 μm, and decreased gradually to about 3 μm after 10 minutes sampling. The trend of the aerosol size distribution can also be easily visualized before and after the spraying episode.

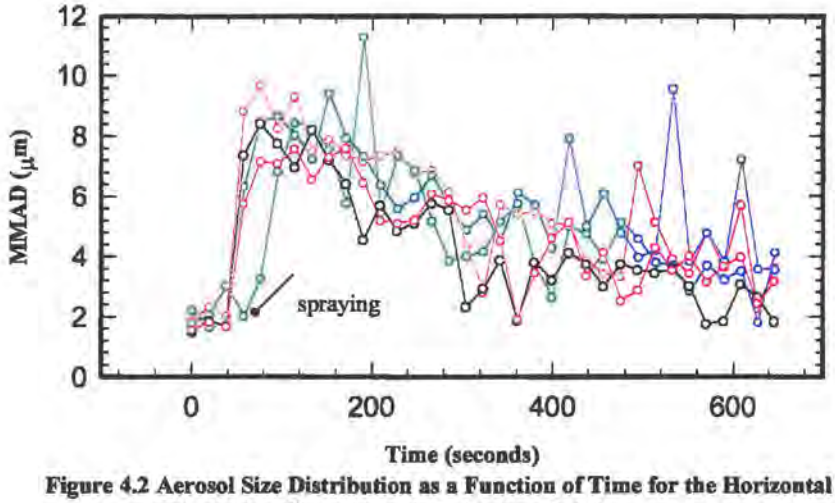


Figure 4.2 Aerosol Size Distribution as a Function of Time for the Horizontal Orientation (Container #1, Columbus Data).

4.3.2 Data Obtained at Richland

The data obtained at the Richland facility of the relative aerosol mass concentrations for the horizontal targets as a function of time is depicted in Figures 4.3 and 4.4, which illustrate the experimental data for containers #1 and #2, respectively. The relative mass concentration measured by the Aerosizer increased immediately from the background level after spraying, and then gradually decreased to the background level. The mass concentration level during the background check was maintained close to zero for both containers, and the peak of the mass concentration level was about 0.12 mg/m^3 for the horizontal orientation.

It should be noted that the aerosol mass concentration level from the spray was a relative value because of the particle loss in the measuring region of the Aerosizer.

As can be clearly seen, the decay pattern of aerosol mass concentration was similar between the two containers. There were two decay rates for the aerosol mass concentration after spraying. One was the rapid decay rate that took about one minute for the mass concentration level to reach around 0.04 mg/m^3 and the other was a slow decay rate that reduced the mass concentration from 0.04 mg/m^3 to background level.

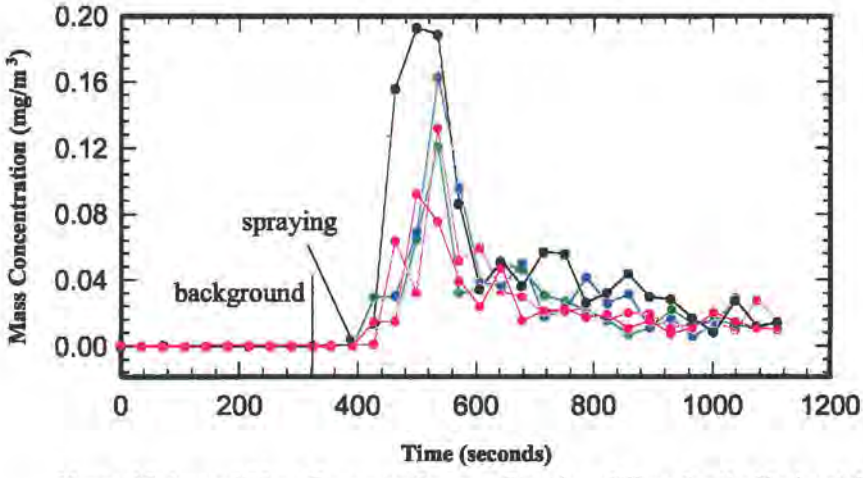


Figure 4.3 Aerosol Mass Concentration as a Function of Time for the Horizontal Orientation (Container #1, Richland Data).

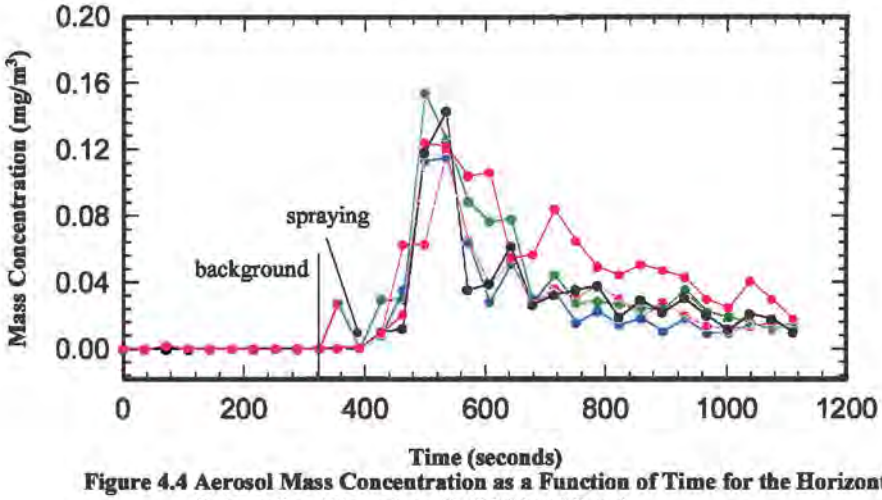


Figure 4.4 Aerosol Mass Concentration as a Function of Time for the Horizontal Orientation (Container #2, Richland Data).

The aerosol size distributions for the horizontal orientation of both containers measured by the Aerosizer are shown in Figures 4.5 and 4.6. The Aerosizer measurement period was set to be 30 seconds, and continuously sampled for about 11 minutes. The spray was triggered after one minute sampling, which produced two data points. As can be seen from Figure 4.5 the mass median aerodynamic diameter for the background particles was about 1-2 μm. However the background data of aerosol size distribution may involve some errors because the number of particles was too low to be statistically accurate.

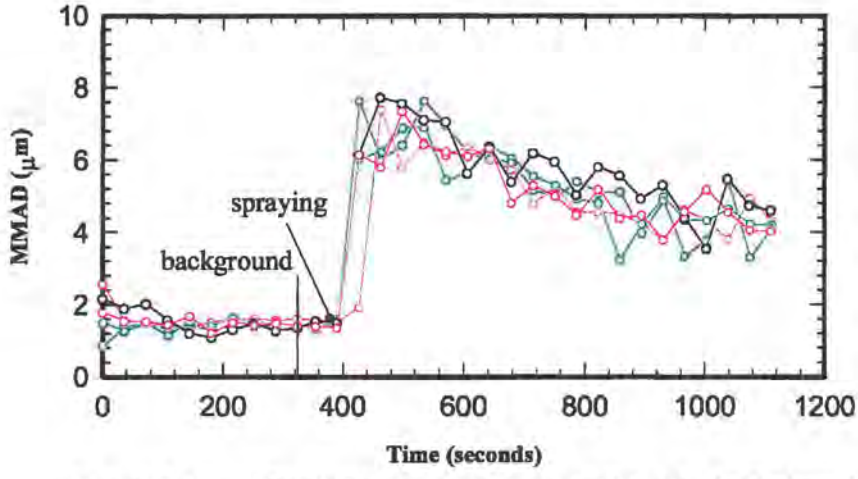


Figure 4.5 Aerosol Size Distribution as a Function of Time for the Horizontal Orientation (Container #1, Richland).

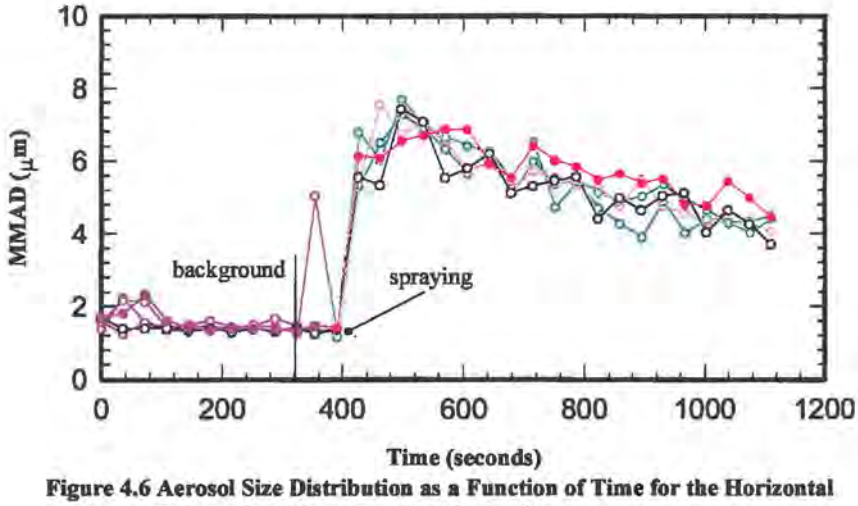


Figure 4.6 Aerosol Size Distribution as a Function of Time for the Horizontal Orientation (Container #2, Richland).

The mass median aerodynamic diameter increased immediately after the spraying, and then gradually decreased to about 4 μm at the end of the 11 minutes sampling. The largest MMAD during the spray episode was about 6-8 μm for the horizontal orientation, which occurred about 30 seconds after spraying. The experiments for the horizontal orientation were repeated 5 times each with six targets and the experimental results were quite consistent between the five trials. The mass median aerodynamic diameters were also reduced at almost the same decay rate after reaching the highest point during each spray episode.

The experimental results obtained were consistent for both containers as shown in Figures 4.5 and 4.6.

4.4 Measurement Results of Vertical Orientation

The experimental data for the vertical orientation also contains the results from both locations at Battelle Columbus and Richland. The experiments were conducted at the Columbus facility, and then repeated at the Richland facility.

4.4.1 Data Obtained at Columbus

The experiment conducted at Battelle Columbus used container #2 for the vertical orientation; container #1 for the horizontal orientation.

The relative aerosol mass concentration as a function of time for the vertical orientation is shown in Figure 4.7 including both background measurement and spray episode. One of the experiments had an extremely high concentration after spraying, which was about 1.2 mg/m^3. The vertical scale of the figure was reduced to 0.4 mg/m^3 in order to illustrate information of the entire experiment in detail. The trend of the aerosol mass concentration after spraying can

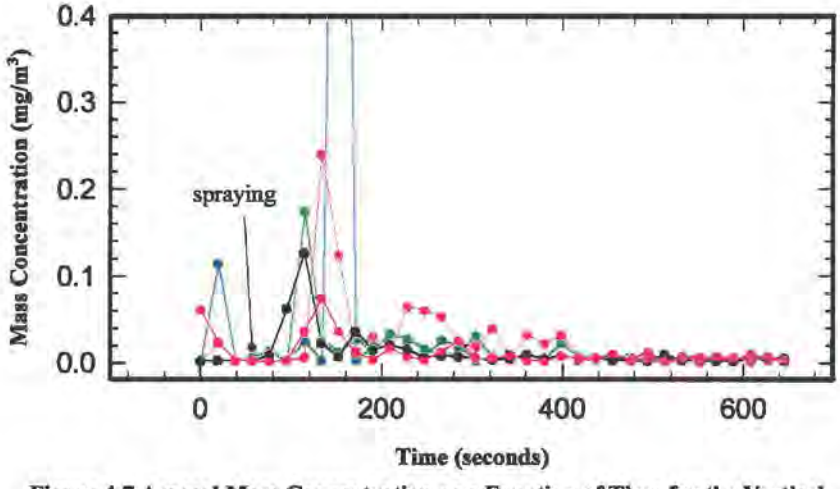


Figure 4.7 Aerosol Mass Concentration as a Function of Time for the Vertical Orientation(Container #2, Columbus).

be observed from the figure, however the experimental data fluctuated greatly between different trials.

The MMAD for vertical orientation is shown in Figure 4.8. The MMAD for the background particle was about 2 μm, and increased after spraying. The peak value of the MMAD was between 8-10 μm as can be seen from the figure. However there is large variation in the experimental data between the different trials, and it is difficult to track the decay pattern of the MMAD as a function of time for the vertical orientation.

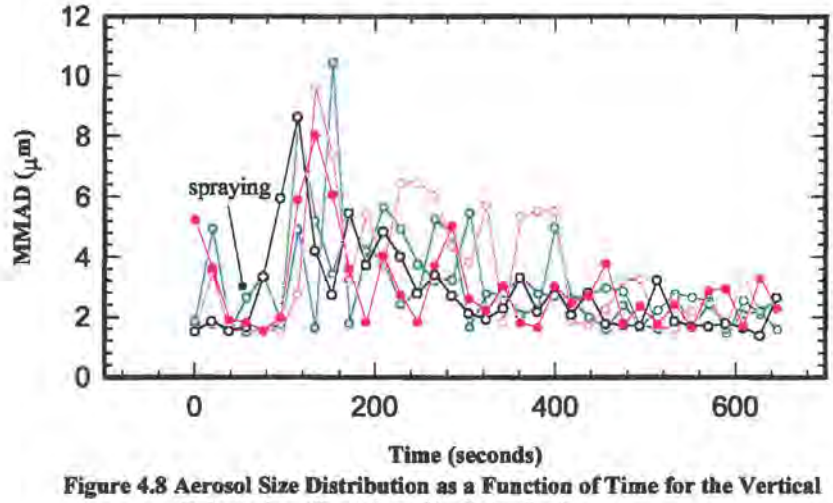


Figure 4.8 Aerosol Size Distribution as a Function of Time for the Vertical Orientation (Container #2, Columbus).

4.4.2 Data Obtained at Richland

The relative aerosol mass concentrations of the vertical orientation are shown in Figures 4.9 and 4.10 for containers #1 and #2, respectively. The relative mass concentration measured by the Aerosizer increased immediately from the background level after spraying, and then gradually decreased to the background level. The mass concentration level during the background check was maintained close to zero for both containers, and the peak of the mass concentration level was about 0.4-0.8 mg/m^3 for different trials of both containers.

As can be clearly seen, the decay pattern of aerosol mass concentration was similar between the two containers. There were two decay rates for the aerosol mass concentration after spraying. One was the rapid decay rate that took about one minute for the mass concentration level to reach around 0.2 mg/m^3 and the other was a slow decay rate that reduced the mass concentration from 0.2 mg/m^3 to background level.

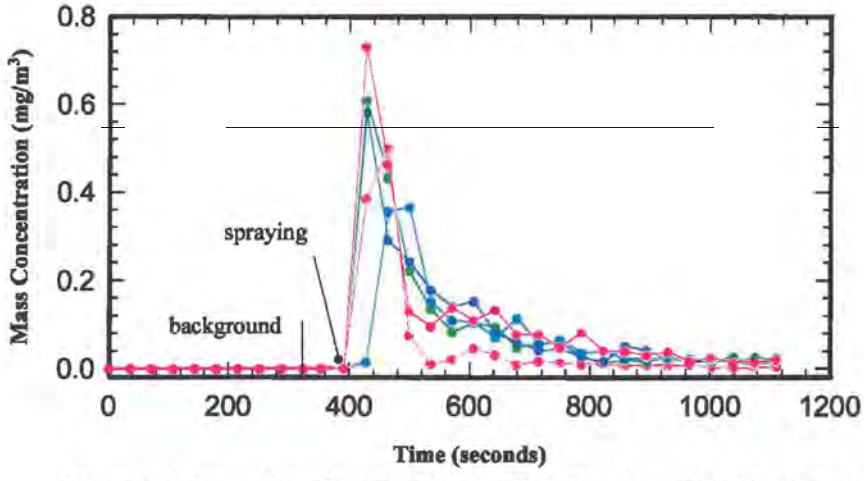


Figure 4.9 Aerosol Mass Concentration as a Function of Time for the Vertical Orientation(Container #1, Richland).

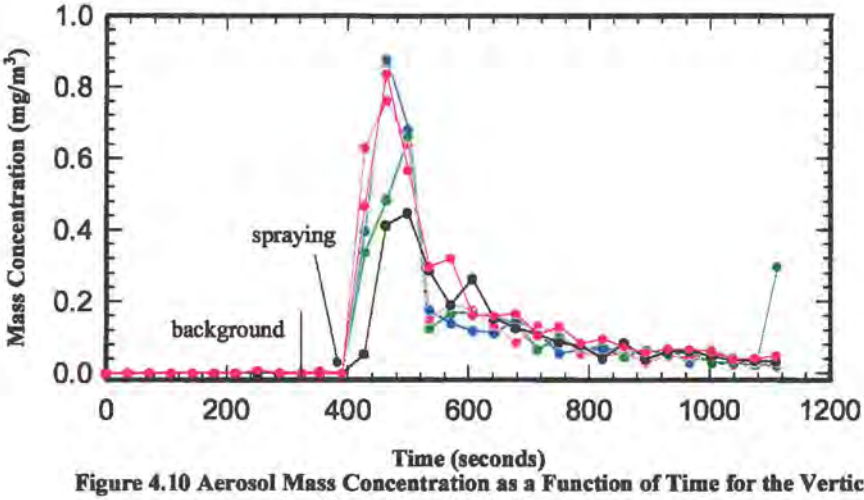


Figure 4.10 Aerosol Mass Concentration as a Function of Time for the Vertical Orientation (Container #2, Richland).

The mass median aerodynamic diameters of the vertical orientation are shown in Figures 4.11 and 4.12 for both containers, respectively. The largest MMAD was about 10 µm after spraying, and decreased to about 4-6 µm at the end of the measurement.

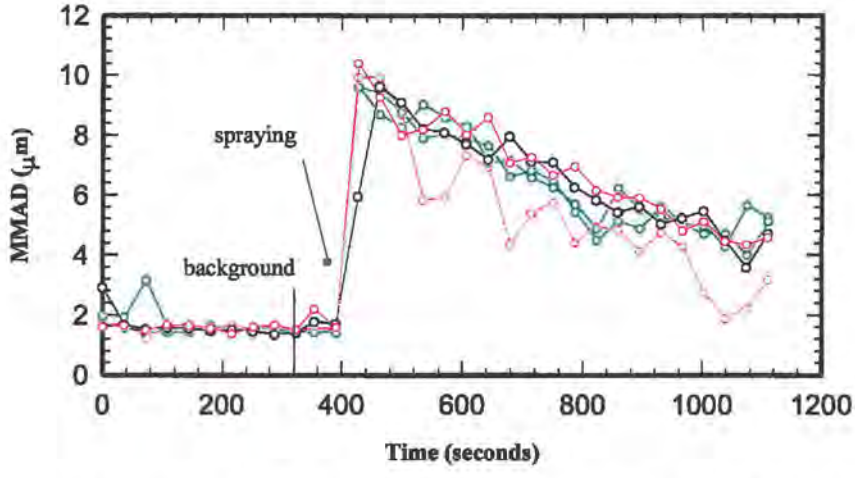


Figure 4.11 Aerosol Size Distribution as a Function of Time for the Vertical Orientation (Container #1, Richland).

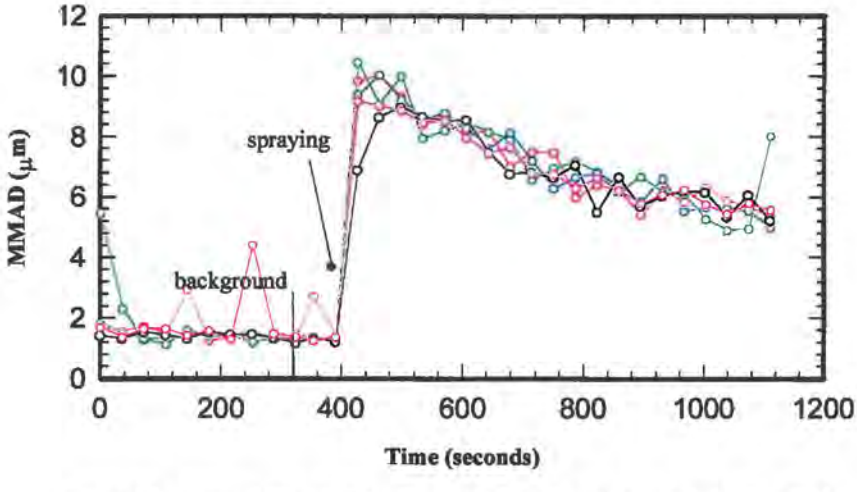


Figure 4.12 Aerosol Size Distribution as a Function of Time for the Vertical Orientation (Container #2, Richland).

4.5 Comparison Between Different Orientations

The experimental data for the mass balance obtained at both locations were slightly different between horizontal and vertical orientations as can be seen from Tables 4.2 and 4.3. From the experimental data shown in the tables, the mass recovered after spraying was higher for the horizontal orientation as compared to that of vertical orientation. There was no significant difference in the experimental data of percentage of mass difference obtained at Columbus between horizontal and vertical orientations. However the experimental data obtained at Richland (Table 4.3) showed a relatively large difference in the percentage of mass difference between two orientations. Another observation made from both the Columbus and Richland data was that the mass delivered from the sprayer for the horizontal orientation was slightly higher than that of the vertical orientation.

The experimental data of relative aerosol mass concentration obtained at Columbus had almost no difference between two orientations, however the experimental data obtained from Richland showed considerable difference between horizontal and vertical orientations. The peak relative aerosol mass concentration (average of all tests) was about 0.14 mg/m^3 for the horizontal orientation, and was about 0.6 mg/m^3 for the vertical orientation. This difference may have been caused by the different formation of aerosol cloud after spraying. The phenomena can also be seen from the experimental data of aerosol mass balance, in that the mass loss from vertical orientation was higher as compared with that of the horizontal orientation. The increase in aerosol mass concentration after spraying was also slightly different in that the aerosol mass concentration increased almost immediately for the vertical orientation and took about 30 seconds longer for aerosol mass concentration to rise in the horizontal orientation. However the result is not conclusive since the sampling resolution of the Aerosizer was 30 seconds.

The mass median aerodynamic diameter was also different between the horizontal and vertical orientations. The peak value of MMAD was 6-8 μm for the horizontal orientation and about 10 μm for the vertical orientation.

5.0 SUMMARY

This study evaluated the time profile of the particle size distribution and relative mass of aerosols near the breathing zone of a potential user resulting from simulated spray delivery of an SDA Generic Laundry Spay Detergent (formulation 14979H4-4). Test article with the addition of 0.5% Savinase (16.0L EX manufactured by Novo Nordisk) was tested using two test configurations; a vertical and a horizontal fabric target. In both configurations the spray nozzle was 6 inches from the fabric target. The fabric targets were 18 inch square desized 65/35 Khaki cotton/polyester blend backed with plastic-backed absorbent paper. The test article was sprayed from Calmar Dispensing Systems, Inc. Standard TS800 trigger sprayers. Six spray triggers were characterized for particle size distribution, spray pattern and mass output. One spray trigger, characteristic of the six, was chosen for the breathing zone tests.

Tests were run at two sites; Battelle Columbus and Battelle Richland. The results of the Richland tests are summarized below. The breathing zone tests were conducted on two bottles of test article (lot number 14979H4-47-2), both containing Savinase. The same spray trigger was used for each bottle. Each test was repeated 5 times for each bottle and each configuration. Each breathing zone test consisted of a manually controlled actuation sequence of five sprays at a rate of one spray per second repeated six times per cloth target with a 10-second lag between targets (a total of 35 sprays per target over a period of approximately 80 seconds). Aerosol measurements were made using an API Model LD Aerosizer. Aerosol measurements began one minute prior to the actuation sequence to measure the background and continued for 11 minutes following the actuation sequence to measure the time course of the aerosol concentration and particle size distribution. In addition to the aerosol measurements, the total mass lost from the spray trigger and the total mass deposited on the cloth targets were measured during each actuation sequence.

The spray trigger chosen for the tests had a circular spray pattern with an approximate diameter of 18 mm from a nozzle to target distance of 6 inches. The average output of the spray trigger was 4.2 grams

The average mass output for the six spray sequences is shown in the Table 5.1.

Table 5.1 Mass Balance Summary

Test Configuration	Container Net-Weight Loss (g)	Fabric Net-Weight Gain (g)
Container 1; Horizontal Configuration	**29.0 (0.6)**	**28.4 (0.7)**
Container 2; Horizontal Configuration	**29.2 (0.2)**	**28.7 (0.4)**
Container 1; Vertical Configuration	**28.6 (0.2)**	**26.5 (1.1)**
Container 2; Vertical Configuration	**28.5 (0.3)**	**26.8 (0.2)**

The average output for the spray trigger for each of the four tests was consistent at 28.5 to 29.2 grams per test or about 0.81 to 0.83 grams per spray trigger actuation. The average mass captured on the fabric targets was about 2 grams less in the vertical configuration than in the horizontal configuration. Therefore, one might expect that more droplets were suspended in the air for the vertical configuration than the horizontal configuration.

The time course of the mass concentration measured by the aerosol monitor at the breathing zone was plotted for each of the tests. The average peak relative concentration and the time to reach this mass from the onset of spraying is shown in Table 5.2

Table 5.2 Peak Relative Aerosol Concentration and Time to Reach Peak Concentration Measured at the Breathing Zone for Each Container and Configuration (average of 5 tests)

Test Configuration	Average Peak Relative Concentration[1] (mg/m^3)	Average Time to Reach Peak Concentration[1] (sec)
Container 1; Horizontal Configuration	**0.14**	**166**
Container 2; Horizontal Configuration	**0.13**	**166**
Container 1; Vertical Configuration	**0.56**	**94**
Container 2; Vertical Configuration	**0.72**	**122**

[1] Average of all tests for each container

The peak relative concentration detected during vertical configuration tests was considerably greater than the peak concentration detected during the horizontal tests. The time to reach the peak concentration was shorter in the vertical than the horizontal configuration tests. These data are consistent with the finding that less test article was captured on the fabric targets in the vertical than the horizontal configuration tests. One possible explanation for these findings is that the spray was pointed down and away from the breathing zone sample location in the horizontal test configuration. In this situation, particles would have tended to be carried away from the breathing zone by both momentum and gravity. The affect of both momentum and gravity in carrying the particles away from the breathing zone would be expected to decrease as the angle between the spray direction and the breathing zone sample location decreased as was the case for the vertical configuration.

ACKNOWLEDMENTS

Members of Battelle's research staff whose signatures appear in the report or in the study records are acknowledged for their participation in the conduct of this study. The names of the principal contributors in this study are listed below:

Participant	Title
J. R. Decker, Jr., B.S.	Study Director, Richland
T. Vinci	Study Director, Columbus
J. Y. Ding, Ph.D.	Principal Research Scientist
W. C. Forsythe	Researcher
M. J. Cockburn	Technician

Appendix A. Experimental Raw Data Obtained from Columbus

Columbus Data

Date: 01/17/98

Run name: :ontrol Run . sda1

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
1	0	0.0076400	2.82	1315
3	19	0.0032000	1.840	1151
5	38	0.0035300	2.017	1065
7	57	0.0034500	2.030	1083
9	76	0.0030900	1.857	1106
11	95	0.0954000	4.766	2518
13	114	0.0026300	1.906	861
15	133	0.0081700	3.064	1075
17	152	0.0032300	1.889	1063
19	171	0.0097100	3.138	1212
21	190	0.0026800	1.881	912
23	209	0.0022800	1.859	803
25	228	0.0126000	3.789	1316
27	247	0.0067400	2.848	1182
29	266	0.0027200	1.811	1021
31	285	0.0036700	2.238	960
33	304	0.0051400	2.294	1205
35	323	0.0061200	2.630	1150
37	342	0.0041100	2.191	1100
39	361	0.0077200	2.896	1256
41	380	0.0026500	1.773	1036
43	399	0.0023200	1.636	1069
45	418	0.0042800	2.532	648
47	437	0.0026200	1.823	966
49	456	0.0036200	1.980	1083
51	475	0.0027400	1.765	1068
53	494	0.0027500	1.797	1007
55	513	0.0040100	2.069	1189
57	532	0.0044400	2.358	1085
59	551	0.0033300	1.987	1109
61	570	0.0062100	2.510	1353
63	589	0.0031200	1.846	1166
65	608	0.0032500	2.083	935
67	627	0.0023100	1.764	902
69	646	0.0022900	1.872	806
71	665	0.0020100	1.704	869
73	684	0.0024600	1.787	1010

Columbus Data

Date: 01/17/98
Run name: Horiz Run 1 sda2

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
1	0	0.0024700	1.874	865
3	19	0.0034200	2.329	884
5	38	0.0042400	2.019	1109
7	57	0.0725000	8.842	966
9	76	0.2410000	9.699	1912
11	95	0.3560000	8.269	3245
13	114	0.5910000	9.323	3907
15	133	0.1440000	7.488	1869
17	152	0.1410000	7.909	1921
19	171	0.1180000	7.383	1772
21	190	0.1260000	7.183	1857
23	209	0.1220000	7.359	1798
25	228	0.1480000	7.469	1822
27	247	0.0970000	6.776	1887
29	266	0.0927000	6.880	1689
31	285	0.0722000	6.149	1913
33	304	0.0287000	4.378	1516
35	323	0.0169000	2.836	2084
37	342	0.0496000	5.725	1606
39	361	0.0440000	5.414	1637
41	380	0.0521000	5.505	1757
43	399	0.0378000	5.110	1643
45	418	0.0305000	5.056	1359
47	437	0.0235000	3.891	1561
49	456	0.0138000	3.420	1284
51	475	0.0147000	3.351	1434
53	494	0.2330000	7.030	4357
55	513	0.0327000	5.163	1504
57	532	0.0244000	3.931	1698
59	551	0.0132000	3.448	1260
61	570	0.0319000	4.807	1749
63	589	0.0165000	3.662	1460
65	608	0.0030700	5.723	2154
67	627	0.0054200	2.284	1220
69	646	0.0143000	3.641	1337

Columbus Data

Date: 01/17/98

Run name: Horiz Run 2 sda3

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
1	0	0.0021100	1.779	878
3	19	0.0028100	2.090	886
5	38	0.0052200	3.041	879
7	57	0.0034400	2.027	980
9	76	0.0097800	3.272	1298
11	95	0.0632000	6.836	1594
13	114	0.3220000	8.464	3421
15	133	0.1600000	8.277	1895
17	152	0.1530000	7.592	2217
19	171	0.0604000	5.797	1946
21	190	0.8220000	11.320	3210
23	209	0.5790000	5.477	1914
25	228	0.0485000	7.371	1280
27	247	0.0987000	6.880	2067
29	266	0.0436000	5.186	1633
31	285	0.0201000	3.877	1395
33	304	0.0225000	4.018	1415
35	323	0.0255000	4.178	1534
37	342	0.0381000	5.183	1450
39	361	0.0502000	5.772	1610
41	380	0.0185000	3.736	1427
43	399	0.0088800	2.653	1359
45	418	0.0261000	5.002	1194
47	437	0.0172000	4.762	1118
49	456	0.0213000	3.928	1606
51	475	0.0333000	5.144	1539
53	494	0.0280000	4.602	1646
55	513	0.0145000	3.816	1256
57	532	0.0166000	3.728	1529
59	551	0.0099800	2.868	1508
61	570	0.0148000	3.716	1337
63	589	0.0114000	3.249	1456
65	608	0.0138000	3.538	1443
67	627	0.0029500	1.826	1008
69	646	0.0179000	4.151	1430

Columbus Data

Date: 01/17/98

Run name: Horiz Run 3 sda4

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
1	0	0.0030100	2.223	950
3	18	0.0019200	1.659	863
5	37	0.0023600	1.813	870
7	56	0.0316000	6.345	1091
9	75	0.1180000	8.499	1755
11	94	0.1870000	8.672	1990
13	113	0.1200000	8.045	1862
15	132	0.1080000	7.270	1992
17	151	0.2070000	9.451	1855
19	170	0.1500000	7.940	1846
21	189	0.1210000	7.349	2087
23	208	0.0741000	6.400	1921
25	227	0.0594000	5.602	1826
27	246	0.0755000	5.975	1996
29	265	0.0933000	6.711	1878
31	284	0.0444000	5.716	1661
33	303	0.0367000	4.897	1558
35	322	0.0457000	5.425	1666
37	341	0.0267000	4.525	1454
39	360	0.0749000	6.140	1986
41	379	0.0523000	5.728	1700
43	398	0.0250000	4.300	1532
45	417	0.0876000	7.950	1631
47	436	0.0405000	5.017	1949
49	455	0.0669000	6.120	1563
51	474	0.0364000	4.801	1961
53	493	0.0193000	3.977	1455
55	512	0.0215000	4.217	1551
57	531	1.5300000	9.576	5031
59	550	0.0205000	3.868	1725
61	569	0.0300000	4.799	1734
63	588	0.0186000	3.849	1612
65	607	0.2570000	7.240	3299
67	626	0.0141000	3.600	1404
69	645	0.0138000	3.586	1469

Columbus Data

Date: 01/17/98

Run name: Horiz Run 4 sda5

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
1	0	0.0014600	1.523	777
3	19	0.0029900	1.875	1133
5	38	0.0021900	1.703	992
7	57	0.1130000	7.391	1944
9	76	0.2220000	8.440	2655
11	95	0.1030000	7.778	1700
13	114	0.0989000	6.987	2026
15	133	0.1050000	8.225	1545
17	152	0.0913000	7.243	1873
19	171	0.0725000	6.433	1873
21	190	0.0260000	4.579	1591
23	209	0.0508000	5.715	2016
25	228	0.0158000	4.880	1354
27	247	0.0339000	5.129	1466
29	266	0.0523000	5.785	1811
31	285	0.0469000	5.573	1585
33	304	0.0065900	2.341	1346
35	323	0.0108000	2.950	1477
37	342	0.0179000	3.888	1387
39	361	0.0037100	1.874	1220
41	380	0.0173000	3.821	1419
43	399	0.0119000	3.231	1354
45	418	0.0166000	4.148	1442
47	437	0.0129000	3.755	1142
49	456	0.0099200	3.007	1420
51	475	0.0159000	3.768	1414
53	494	0.0124000	3.568	1245
55	513	0.0121000	3.469	1414
57	532	0.0123000	3.596	1287
59	551	0.0079400	3.041	1165
61	570	0.0034800	1.777	1302
63	589	0.0035600	1.866	1248
65	608	0.0087700	3.093	1253
67	627	0.0065500	2.663	1188
69	646	0.0035500	1.849	1195

Columbus Data

Date: 01/17/98

Run name: Horiz Run 5 sda6

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
1	0	0.0016800	1.576	822
3	19	0.0023100	1.822	877
5	38	0.0018200	1.680	811
7	57	0.0299000	5.766	1229
9	76	0.0719000	7.174	1625
11	95	0.0844000	7.096	1602
13	114	0.1340000	7.582	2129
15	133	0.0641000	6.568	1631
17	152	0.1020000	7.311	1801
19	171	0.0782000	7.612	1470
21	190	0.0792000	6.470	1762
23	209	0.0381000	5.205	1545
25	228	0.0363000	5.117	1633
27	247	0.0393000	5.216	1529
29	266	0.0470000	6.093	1417
31	285	0.0494000	5.869	1576
33	304	0.0472000	5.561	1644
35	323	0.0467000	5.972	1562
37	342	0.0234000	4.541	1407
39	361	0.0035500	1.910	1091
41	380	0.0128000	3.471	1283
43	399	0.0275000	4.630	1569
45	418	0.0303000	5.143	1587
47	437	0.0123000	3.357	1289
49	456	0.0213000	4.149	1532
51	475	0.0068600	2.536	1317
53	494	0.0098400	2.885	1461
55	513	0.0191000	4.309	1349
57	532	0.0132000	3.555	1443
59	551	0.0142000	4.022	1297
61	570	0.0088700	3.177	1217
63	589	0.0121000	3.697	1252
65	608	0.0147000	4.003	1201
67	627	0.0048500	2.446	1059
69	646	0.0095200	3.193	1287
71	665	0.0501000	9.233	52869

Columbus Data

Date: 01/18/98

Run name: ontrol Run sda7

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
1	0	0.0031700	1.867	1434
3	18	0.0022000	1.527	1306
5	37	0.0024000	1.468	1491
7	56	0.0020900	1.538	1199
9	75	0.0027300	1.755	1300
11	94	0.0024700	1.610	1327
13	113	0.0027300	1.680	1375
15	132	0.0028900	1.592	1568
17	151	0.0027100	1.572	1472
19	170	0.0028500	1.795	1334
21	189	0.0037800	2.040	1564
23	208	0.0030800	1.631	1609
25	227	0.0029600	1.644	1513
27	246	0.0037300	2.175	1273
29	265	0.0028600	1.590	1510
31	284	0.0027200	1.774	1290
33	303	0.0034400	2.026	1350
35	322	0.0028700	1.781	1323
37	341	0.0042900	2.057	1683
39	360	0.0029600	1.702	1412
41	379	0.0038500	2.001	1499
43	398	0.0041800	2.036	1575
45	417	0.0025300	1.496	1564
47	436	0.0019400	1.445	1227
49	455	0.0020200	1.401	1397
51	474	0.0028500	1.621	1466
53	493	0.0024900	1.673	1262
55	512	0.0031200	1.864	1348
57	531	0.0030000	1.783	1416
59	550	0.0030700	1.914	1302
61	569	0.0018100	1.355	1265
63	588	0.0025400	1.630	1355
65	607	0.0021700	1.535	1281
67	626	0.0019400	1.385	1330
69	645	0.0023800	1.479	1524

Columbus Data

Date: 01/18/98
Run name: Vert Run 1 sda8

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
1	0	0.0023700	1.534	1298
3	19	0.0234000	3.493	1925
5	38	0.0025100	1.532	1399
7	57	0.0029700	1.546	1681
9	76	0.0034000	1.578	1791
11	95	0.0024500	1.563	1342
13	114	0.0066900	2.761	1608
15	133	0.2400000	9.623	2886
17	152	0.1240000	7.399	2675
19	171	0.0134000	3.259	1966
21	190	0.0302000	5.461	2103
23	209	0.0155000	3.696	1904
25	228	0.0650000	6.450	2155
27	247	0.0606000	6.458	2202
29	266	0.0535000	6.042	2142
31	285	0.0230000	4.346	1967
33	304	0.0188000	3.802	1826
35	323	0.0398000	5.734	1890
37	342	0.0042600	1.840	1547
39	361	0.0324000	5.351	1876
41	380	0.0224000	5.527	1709
43	399	0.0322000	5.545	1665
45	418	0.0043300	1.881	1540
47	437	0.0034200	1.719	1440
49	456	0.0062400	2.264	1712
51	475	0.0074400	3.223	1700
53	494	0.0117000	3.283	1800
55	513	0.0028400	1.636	1417
57	532	0.0034700	1.624	1747
59	551	0.0058300	2.195	1785
61	570	0.0079600	2.644	1856
63	589	0.0034100	1.678	1602
65	608	0.0107000	3.399	1794
67	627	0.0051600	2.107	1693
69	646	0.0032000	1.635	1530

Columbus Data

Date: 01/18/98
Run name: Vert Run 2 sda9

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
1	0	0.0026700	1.681	1289
3	19	0.0033700	1.784	1490
5	38	0.0024600	1.567	1330
7	57	0.0068300	2.669	1659
9	76	0.0143000	3.380	1869
11	95	0.0034100	1.871	1403
13	114	0.1750000	8.605	2490
15	133	0.0255000	5.215	1573
17	152	0.0133000	3.446	1688
19	171	0.0281000	5.303	1718
21	190	0.0154000	4.082	1750
23	209	0.0337000	5.673	1938
25	228	0.0277000	4.937	1942
27	247	0.0170000	3.768	1913
29	266	0.0104000	3.216	1668
31	285	0.0116000	3.247	1801
33	304	0.0314000	5.479	1881
35	323	0.0053900	2.202	1612
37	342	0.0100000	2.866	1890
39	361	0.0049900	2.094	1568
41	380	0.0055700	2.269	1612
43	399	0.0230000	4.993	1912
45	418	0.0084000	2.614	2035
47	437	0.0071100	2.759	1566
49	456	0.0089000	2.981	1640
51	475	0.0065800	2.863	1497
53	494	0.0029900	1.689	1348
55	513	0.0049200	2.242	1467
57	532	0.0080200	2.778	1635
59	551	0.0072800	2.673	1629
61	570	0.0054500	2.531	1400
63	589	0.0025600	1.474	1431
65	608	0.0062300	2.565	1553
67	627	0.0041100	2.101	1485
69	646	0.0032800	1.585	1648

Columbus Data

Date: 01/18/98
Run name: Vert Run 3 sda10

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size .mean	sum channels
1	0	0.0033900	1.875	1532
3	18	0.1150000	4.968	3777
5	37	0.0028200	1.727	1385
7	56	0.0026900	1.514	1523
9	75	0.0030300	1.603	1559
11	94	0.0034000	1.765	1554
13	113	0.0252000	4.915	1756
15	132	0.0028600	1.659	1379
17	151	1.3000000	10.470	3971
19	170	0.0040800	1.812	1521
21	189	0.0200000	4.222	1871
23	208	0.0166000	3.891	1743
25	227	0.0059300	2.439	1436
27	246	0.0083100	2.822	1622
29	265	0.0266000	5.261	1788
31	284	0.0198000	4.712	1659
33	303	0.0031700	1.683	1388
35	322	0.0080800	2.787	1623
37	341	0.0075200	2.812	1431
39	360	0.0099200	3.332	1481
41	379	0.0070300	2.790	1495
43	398	0.0080500	2.721	1715
45	417	0.0063200	2.553	1470
47	436	0.0039400	2.016	1349
49	455	0.0023800	1.627	1147
51	474	0.0048900	2.401	1307
53	493	0.0031900	1.725	1401
55	512	0.0029900	1.624	1472
57	531	0.0063600	2.672	1534
59	550	0.0034100	1.664	1572
61	569	0.0061300	2.452	1578
63	588	0.0029900	1.612	1494
65	607	0.0042400	2.105	1482
67	626	0.0042600	2.216	1323
69	645	0.0061800	2.572	1533

Columbus Data

Date: 01/18/98
Run name: Vert Run 4 sda11

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
1	0	0.0026600	1.535	1411
3	19	0.0034400	1.882	1289
5	38	0.0025500	1.567	1329
7	57	0.0031200	1.696	1338
9	76	0.0094000	3.347	1435
11	95	0.0628000	5.974	2120
13	114	0.1270000	8.666	1872
15	133	0.0228000	4.227	1897
17	152	0.0076300	2.765	1436
19	171	0.0368000	5.495	1807
21	190	0.0164000	3.746	1574
23	209	0.0216000	4.853	1378
25	228	0.0162000	4.033	1617
27	247	0.0075400	2.810	1330
29	266	0.0089500	3.414	1401
31	285	0.0077800	2.729	1447
33	304	0.0059400	2.138	1683
35	323	0.0042900	1.940	1389
37	342	0.0060300	2.318	1485
39	361	0.0103000	3.331	1474
41	380	0.0054500	2.196	1596
43	399	0.0083800	3.022	1435
45	418	0.0047700	2.094	1426
47	437	0.0068500	2.847	1335
49	456	0.0034600	1.803	1314
51	475	0.0033900	1.762	1369
53	494	0.0030300	1.728	1297
55	513	0.0101000	3.241	1503
57	532	0.0036000	1.888	1290
59	551	0.0032200	1.716	1347
61	570	0.0027800	1.713	1167
63	589	0.0031000	1.805	1225
65	608	0.0031000	1.671	1414
67	627	0.0058800	1.407	1427
69	646	0.0058800	2.664	1354

Columbus Data

Date: 01/18/98
Run name: Vert Run 5 sda12

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
1	0	0.0619000	5.249	2432
3	18	0.0241000	3.632	1625
5	37	0.0027000	1.918	973
7	56	0.0026400	1.820	1052
9	75	0.0020500	1.555	1061
11	94	0.0034700	1.989	1179
13	113	0.0367000	5.899	1450
15	132	0.0745000	8.045	1438
17	151	0.0362000	6.085	1570
19	170	0.0118000	3.605	1272
21	189	0.0039700	1.852	1325
23	208	0.0178000	4.045	1360
25	227	0.0074700	2.751	1282
27	246	0.0038200	1.848	1294
29	265	0.0135000	3.730	1306
31	284	0.0259000	5.025	1469
33	303	0.0067000	2.612	1272
35	322	0.0060600	2.225	1548
37	341	0.0088600	3.038	1370
39	360	0.0031500	1.809	1115
41	379	0.0025200	1.662	1080
43	398	0.0085800	3.035	1425
45	417	0.0056600	2.479	1219
47	436	0.0058200	2.716	1118
49	455	0.0113000	3.794	1279
51	474	0.0029900	1.763	1160
53	493	0.0055400	2.383	1303
55	512	0.0030900	1.757	1192
57	531	0.0065800	2.429	1399
59	550	0.0024300	1.660	1079
61	569	0.0076100	2.901	1452
63	588	0.0067000	2.949	1268
65	607	0.0026600	1.697	1169
67	626	0.0078100	3.307	1253
69	645	0.0044700	2.295	1331
71	664	0.2030000	9.992	89881

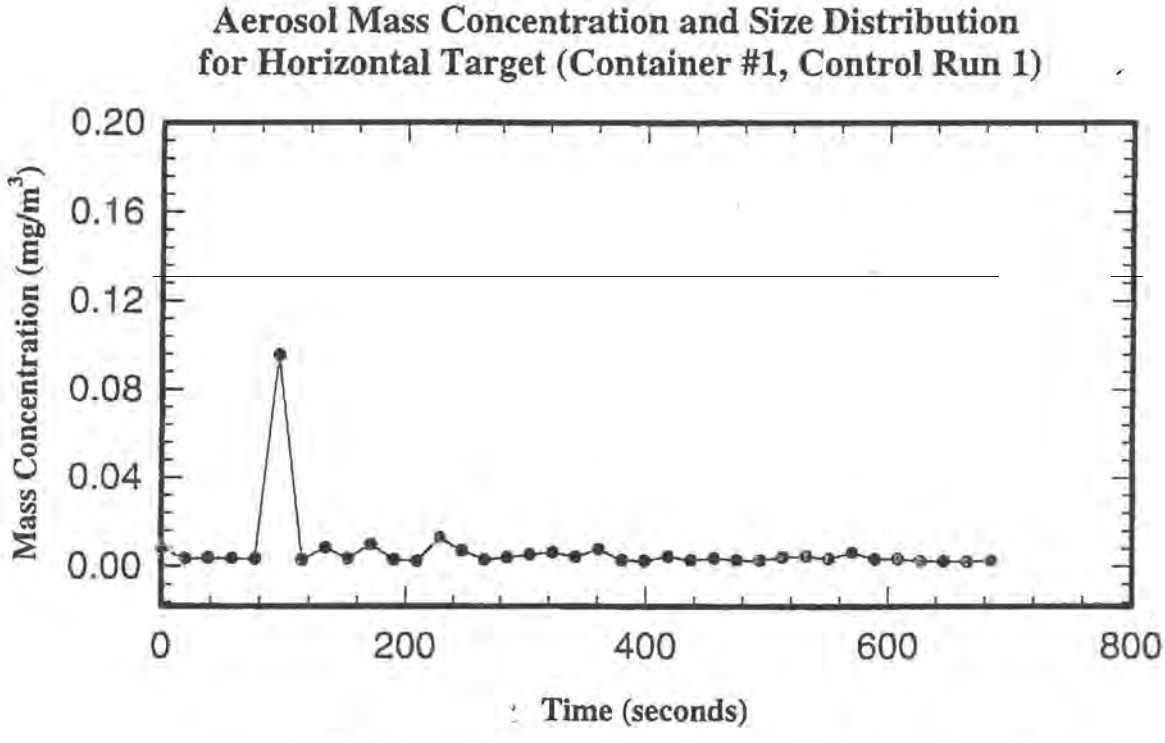


Figure A-1. Aerosol Mass Concentration as a Function of Time.

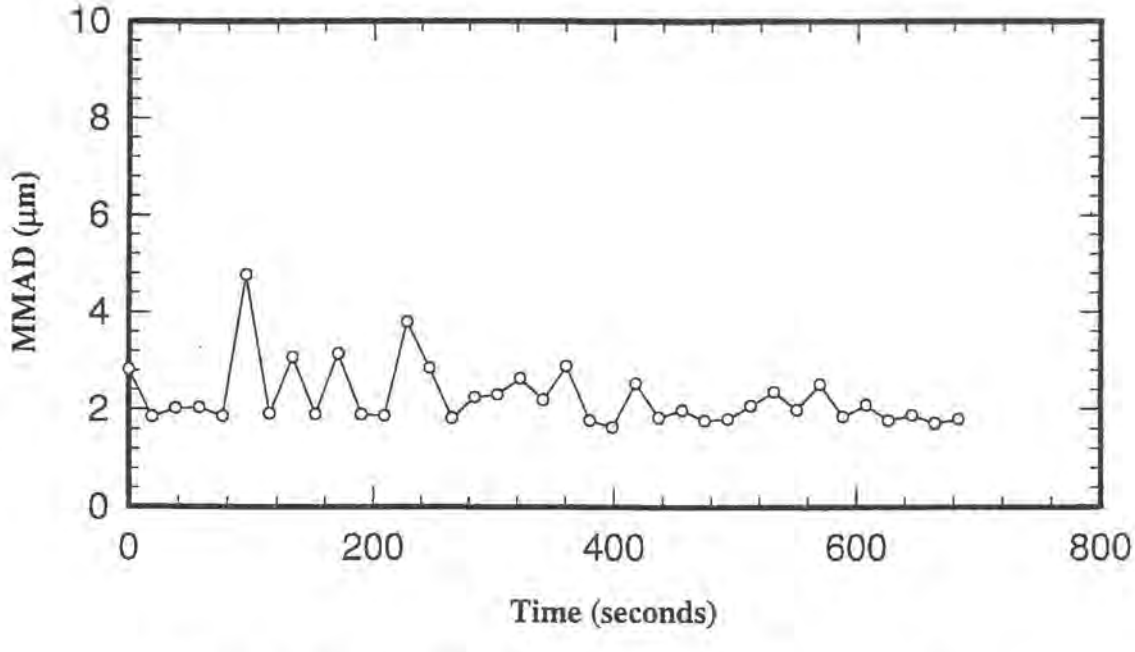


Figure A-2. Aerosol Size Distribution as a Function of Time.

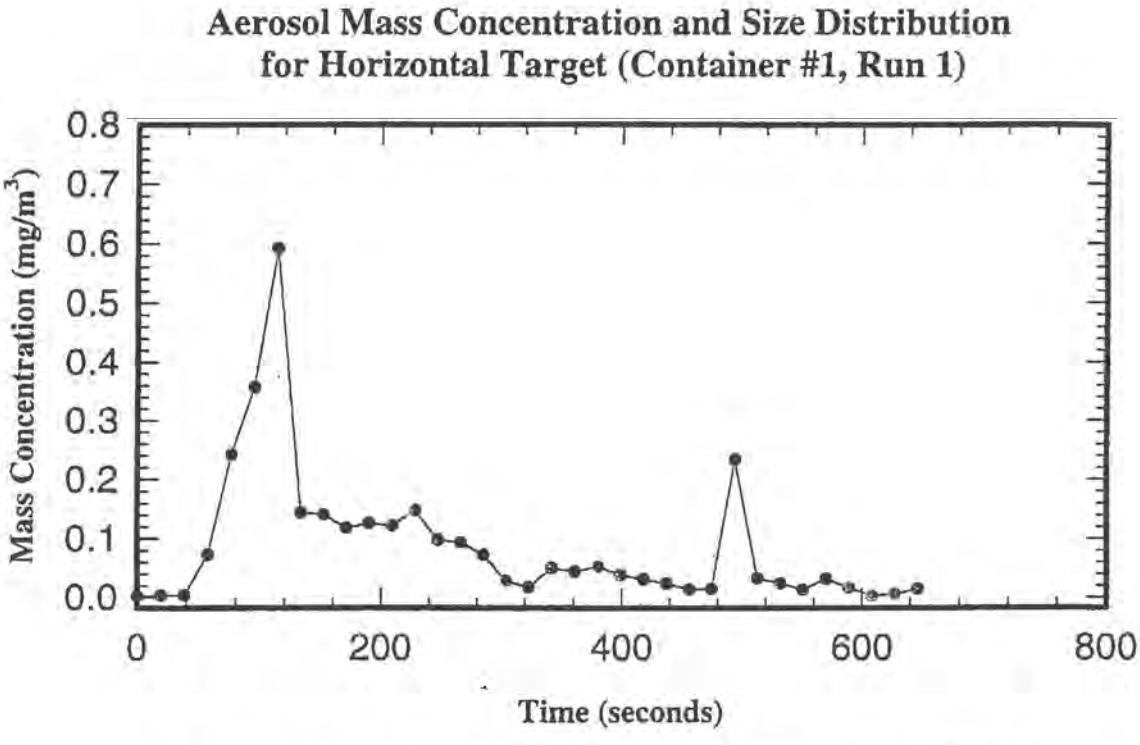


Figure A-1. Aerosol Mass Concentration as a Function of Time.

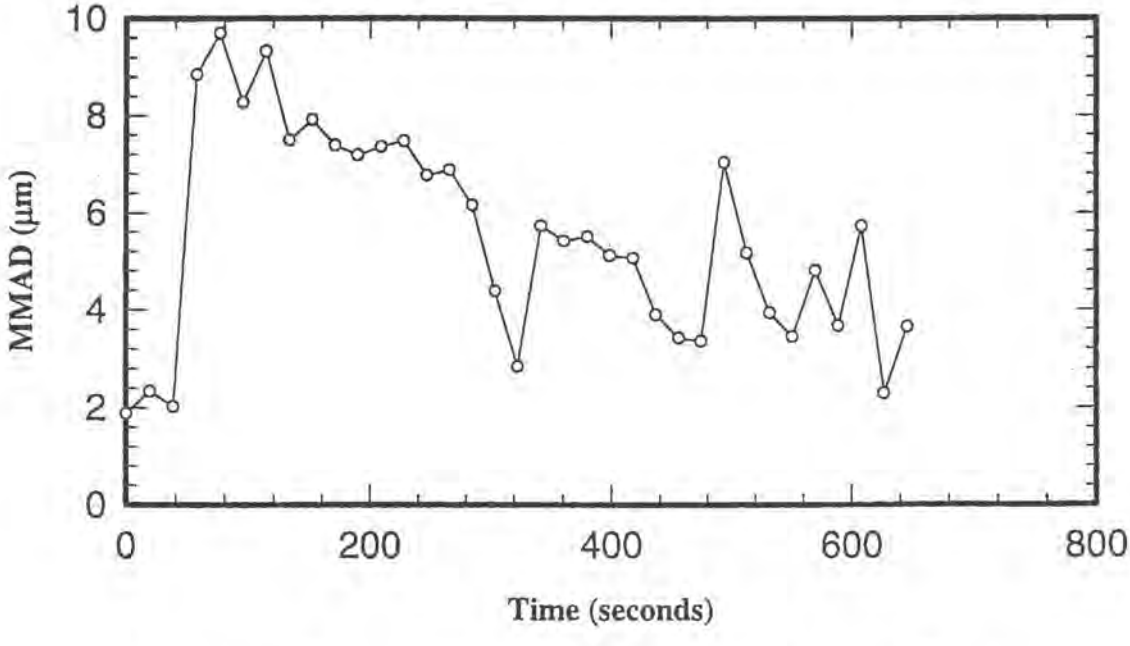


Figure A-2. Aerosol Size Distribution as a Function of Time.

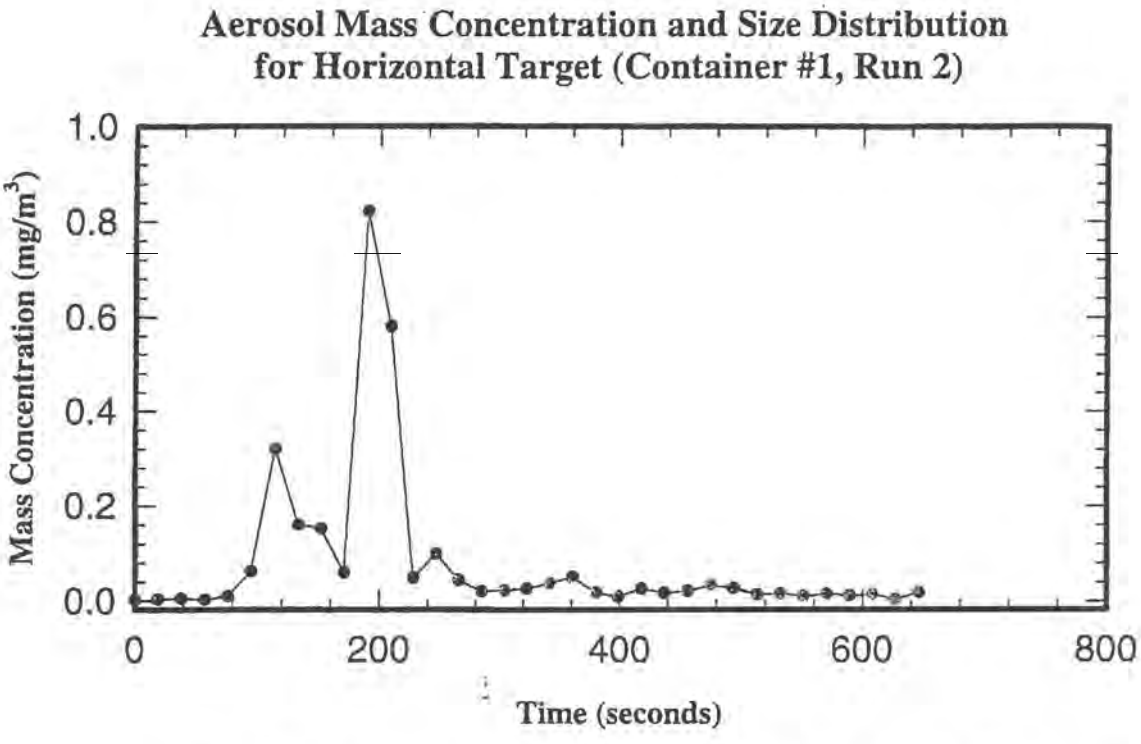


Figure A-1. Aerosol Mass Concentration as a Function of Time.

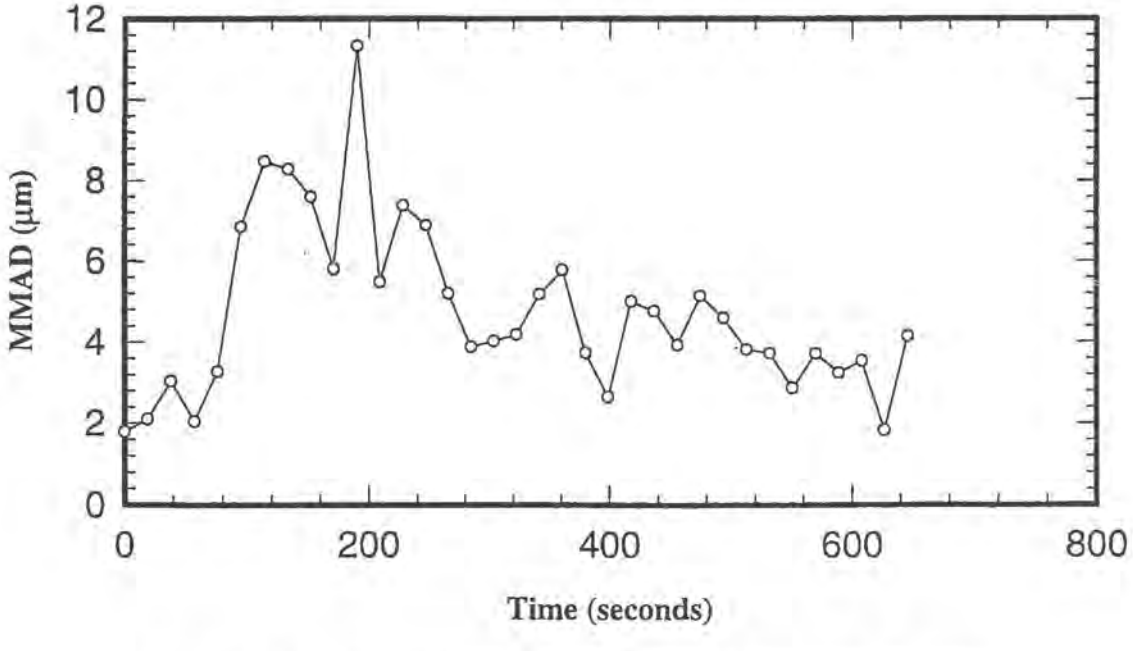


Figure A-2. Aerosol Size Distribution as a Function of Time.

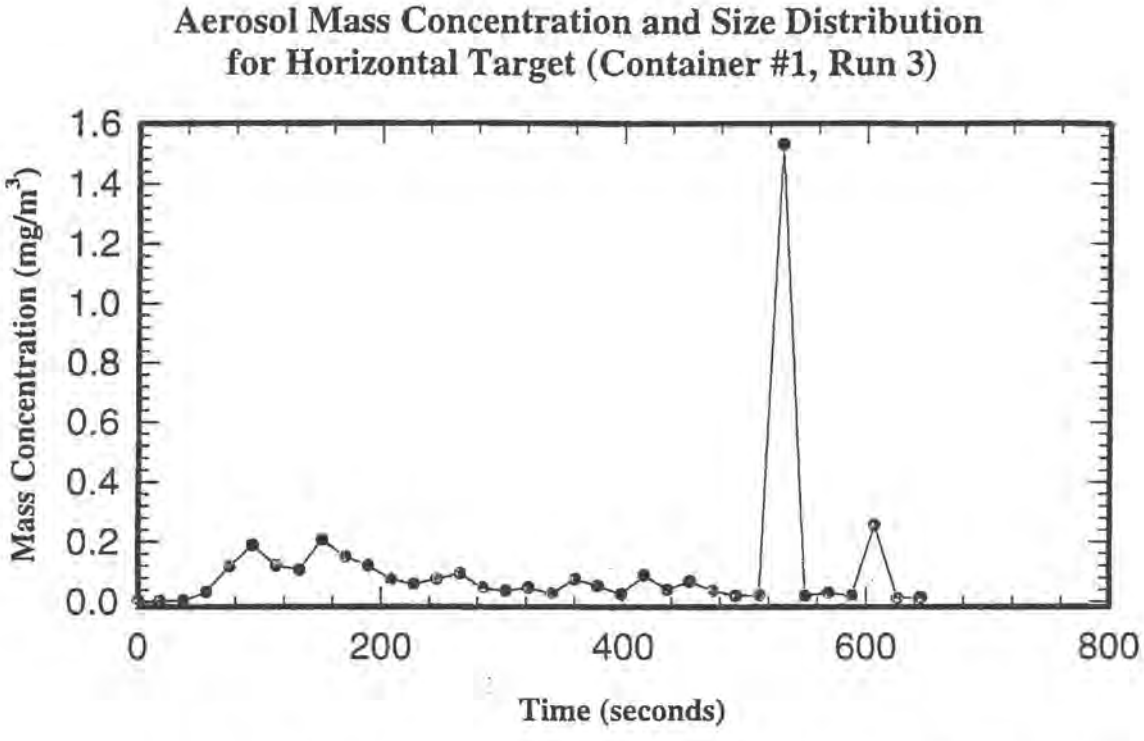


Figure A-1. Aerosol Mass Concentration as a Function of Time.

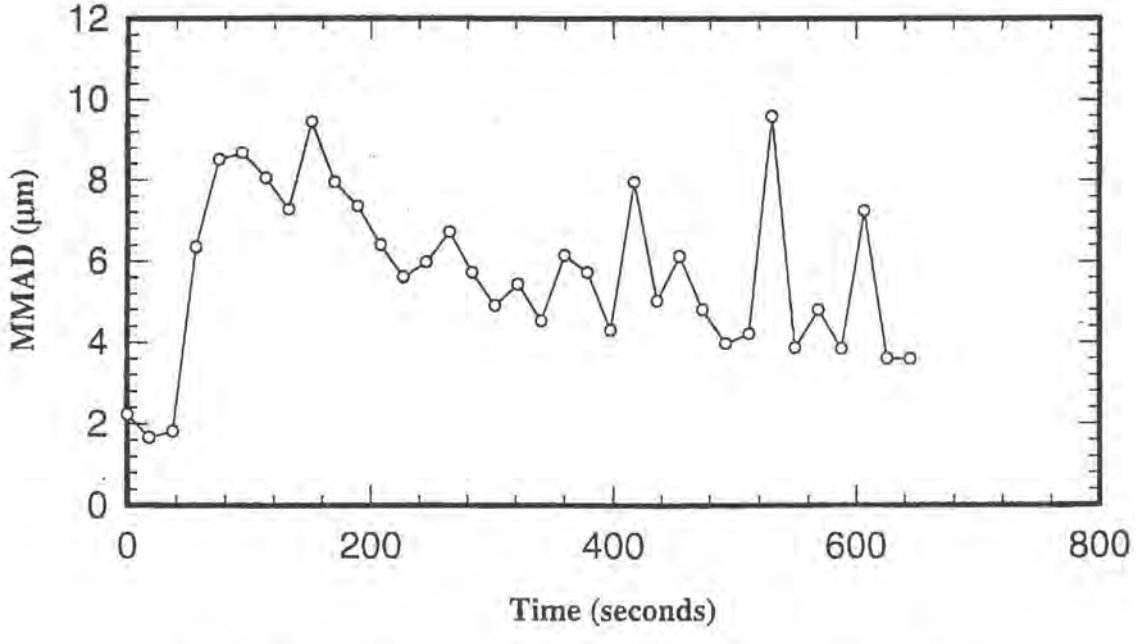


Figure A-2. Aerosol Size Distribution as a Function of Time.

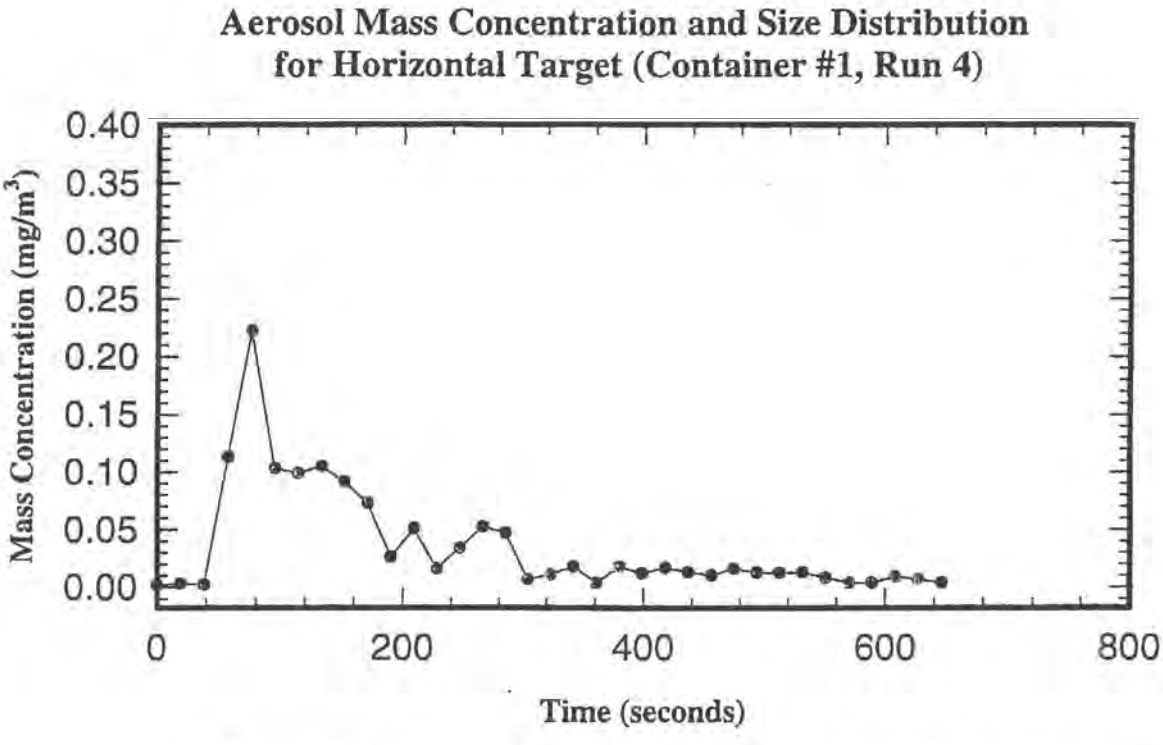


Figure A-1. Aerosol Mass Concentration as a Function of Time.

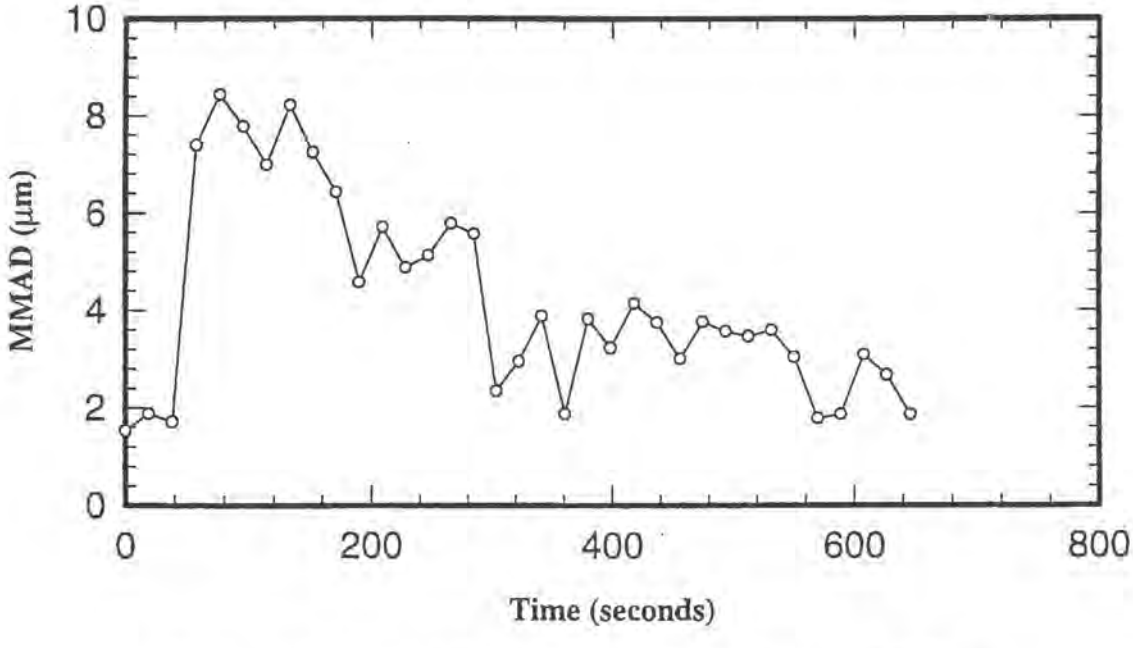


Figure A-2. Aerosol Size Distribution as a Function of Time.

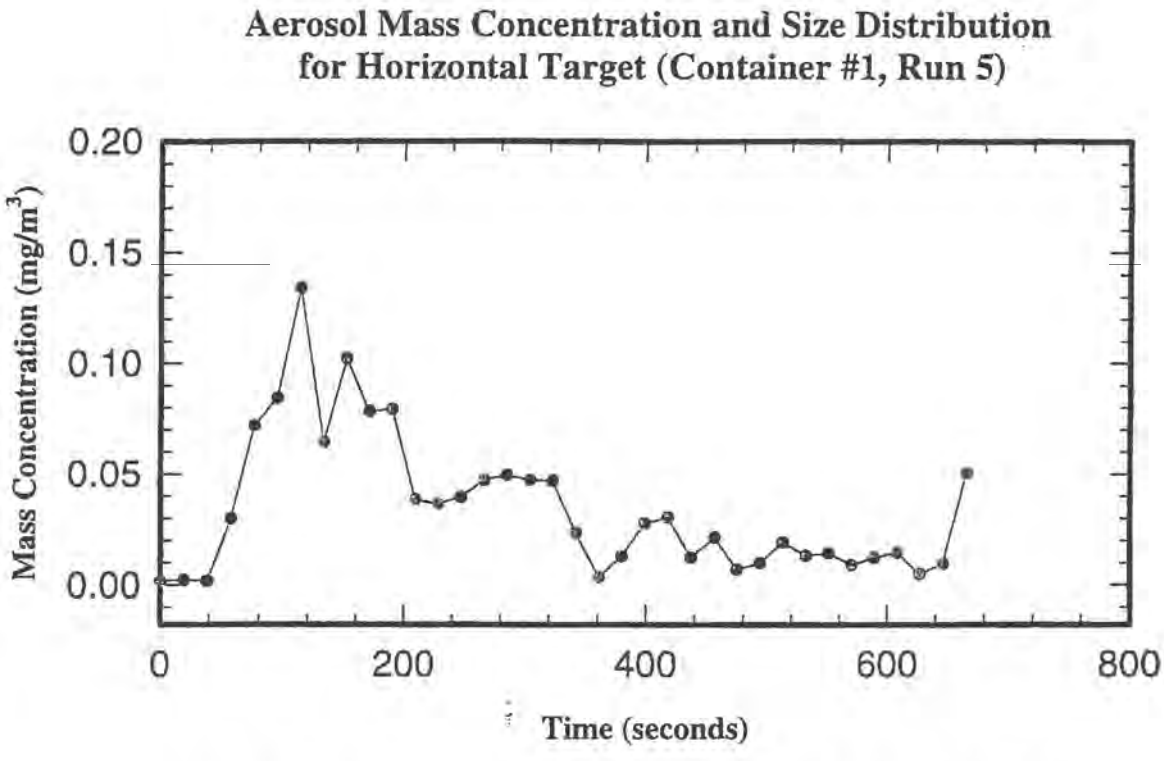


Figure A-1. Aerosol Mass Concentration as a Function of Time.

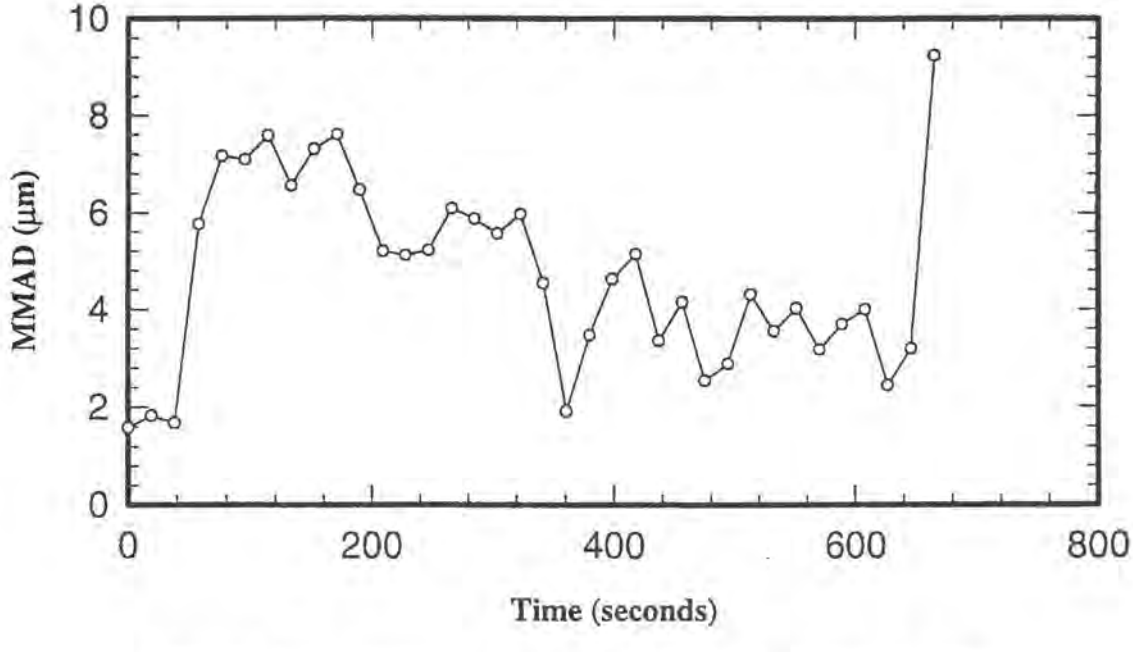


Figure A-2. Aerosol Size Distribution as a Function of Time.

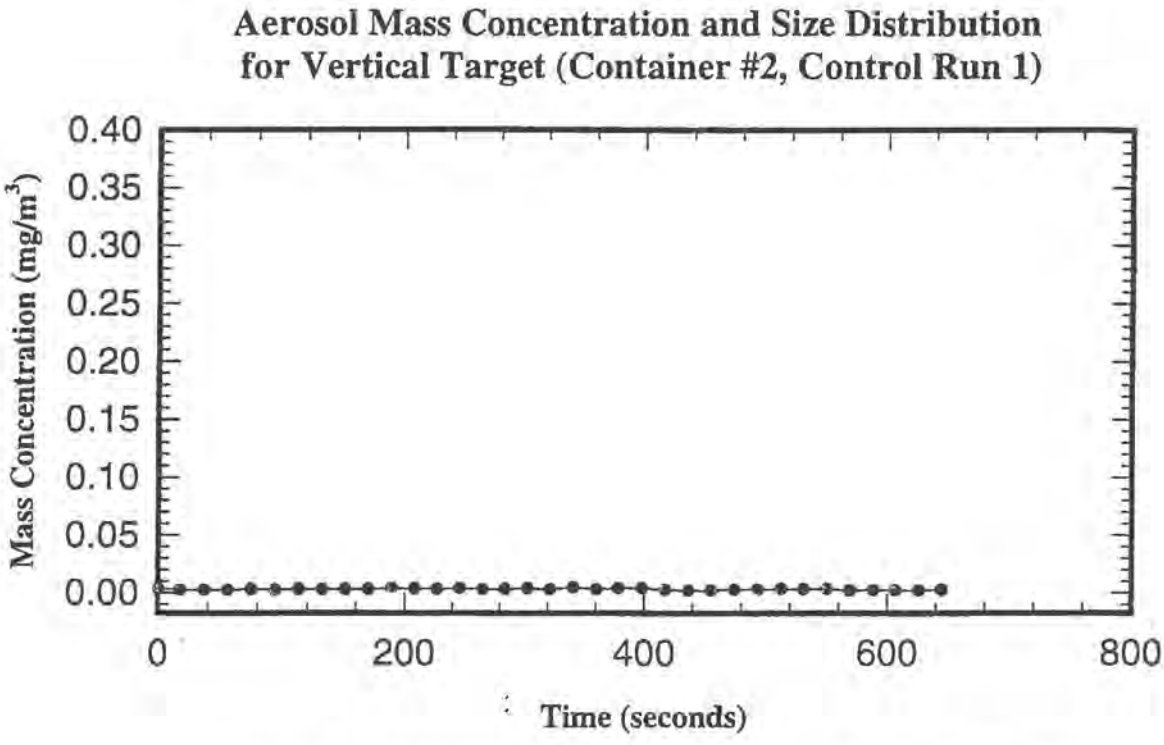


Figure A-1. Aerosol Mass Concentration as a Function of Time.

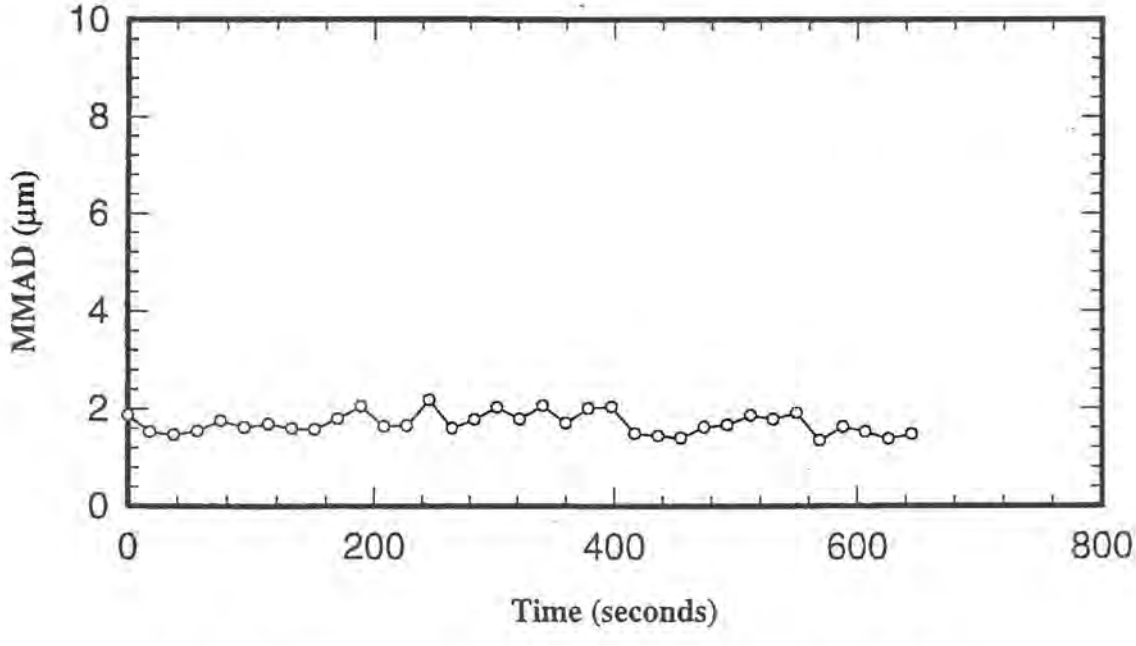


Figure A-2. Aerosol Size Distribution as a Function of Time.

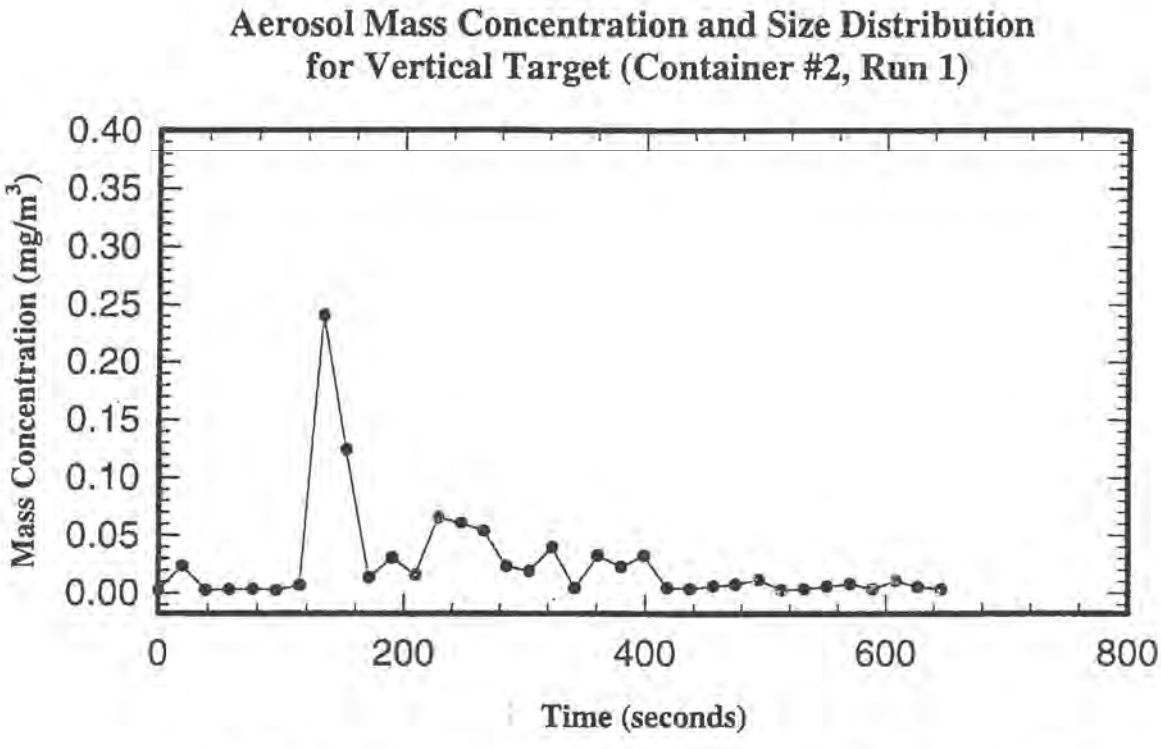


Figure A-1. Aerosol Mass Concentration as a Function of Time.

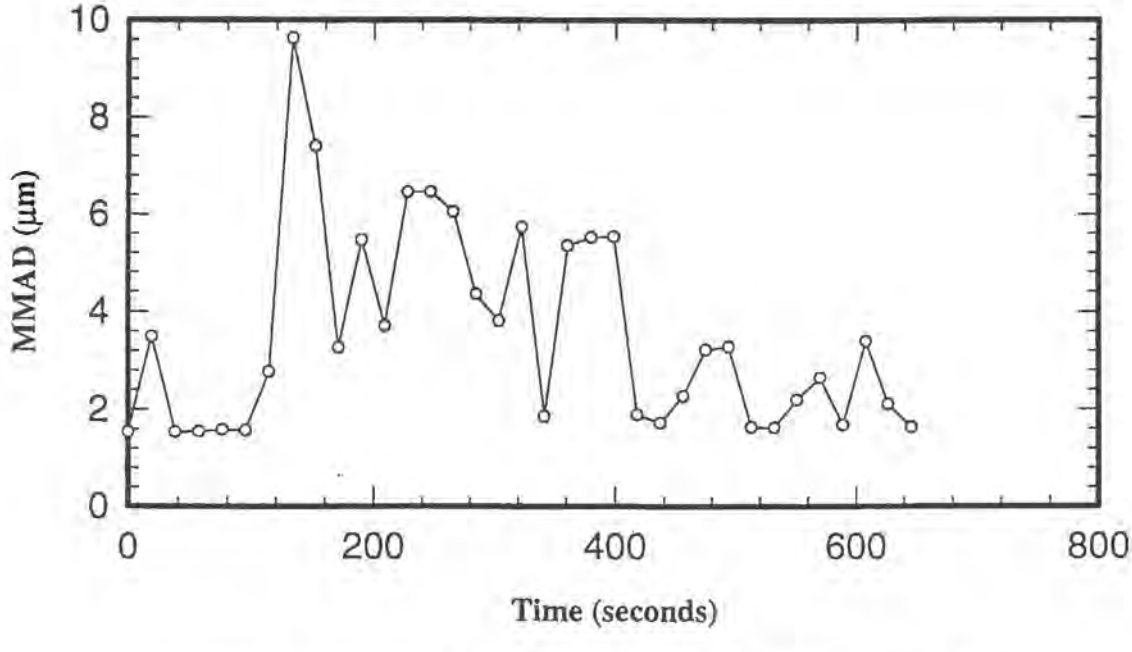


Figure A-2. Aerosol Size Distribution as a Function of Time.

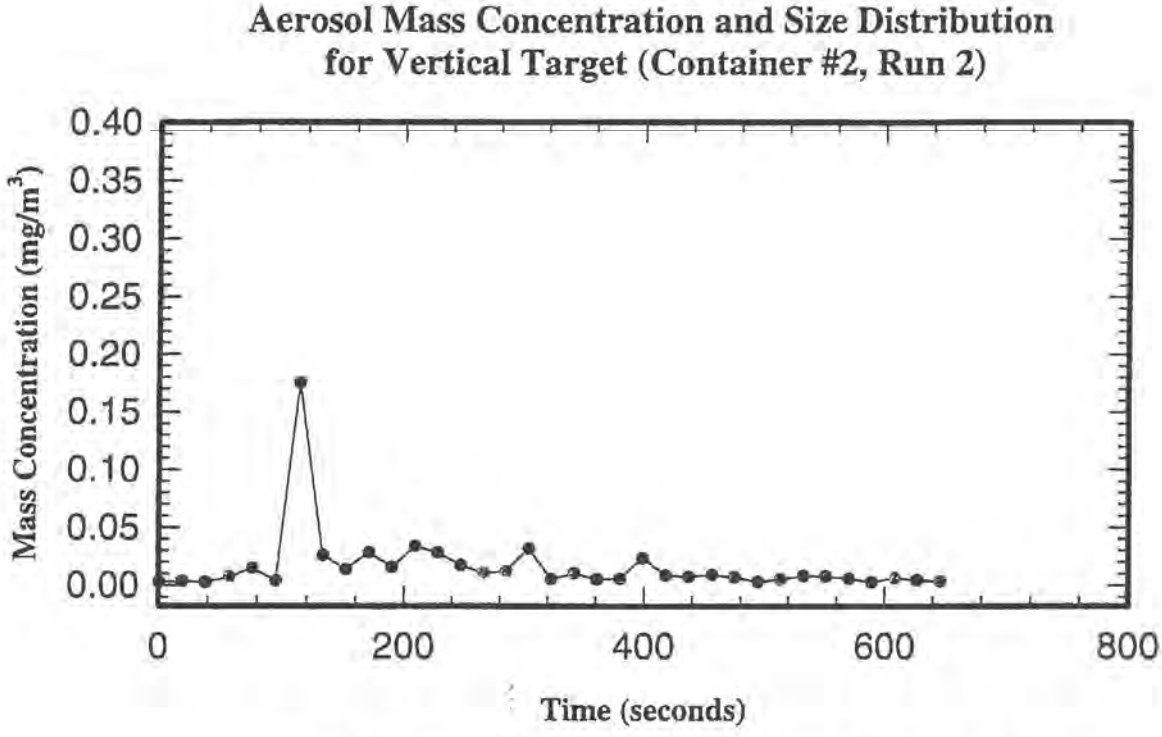


Figure A-1. Aerosol Mass Concentration as a Function of Time.

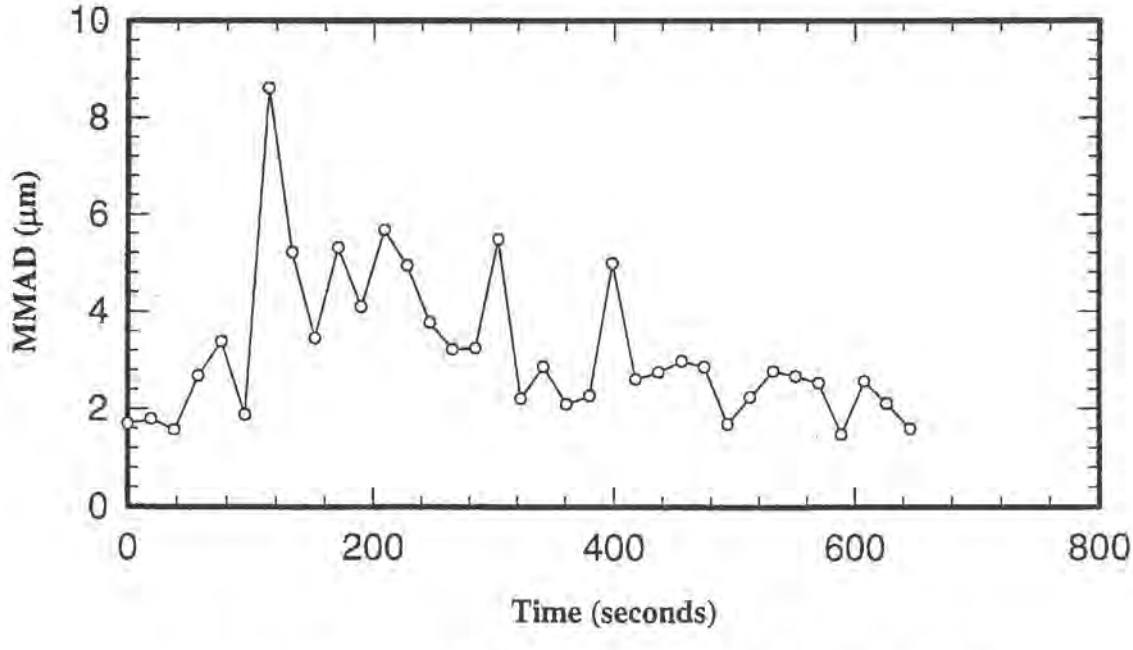


Figure A-2. Aerosol Size Distribution as a Function of Time.

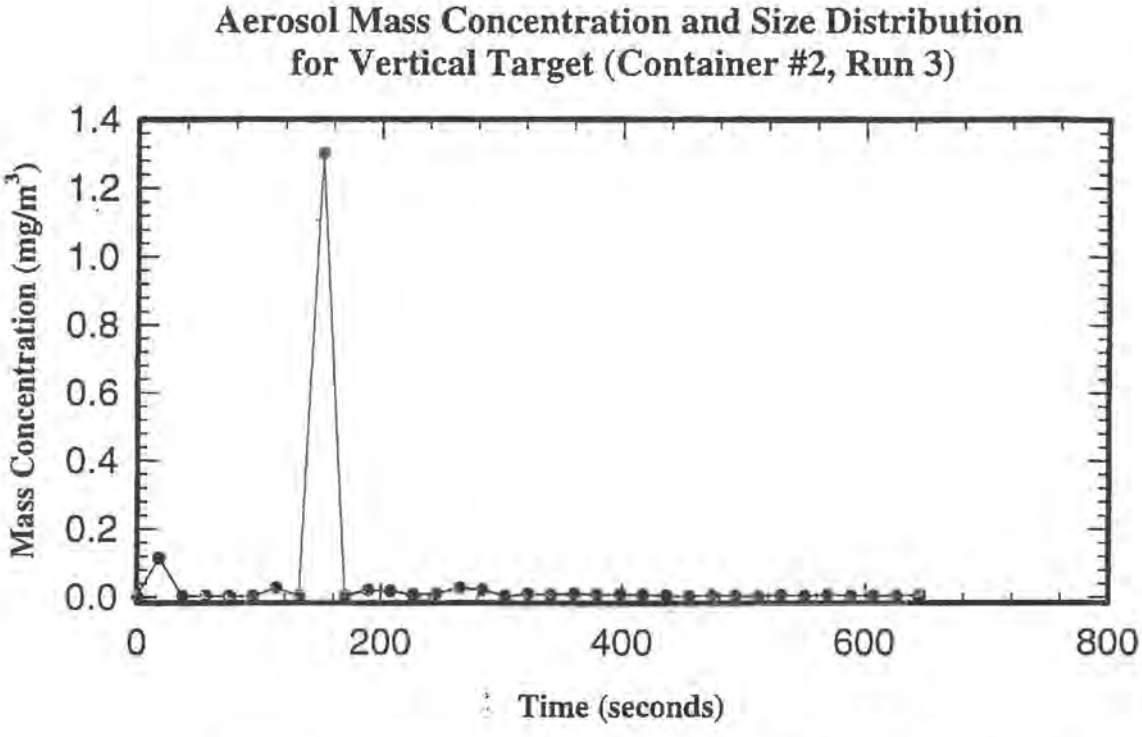


Figure A-1. Aerosol Mass Concentration as a Function of Time.

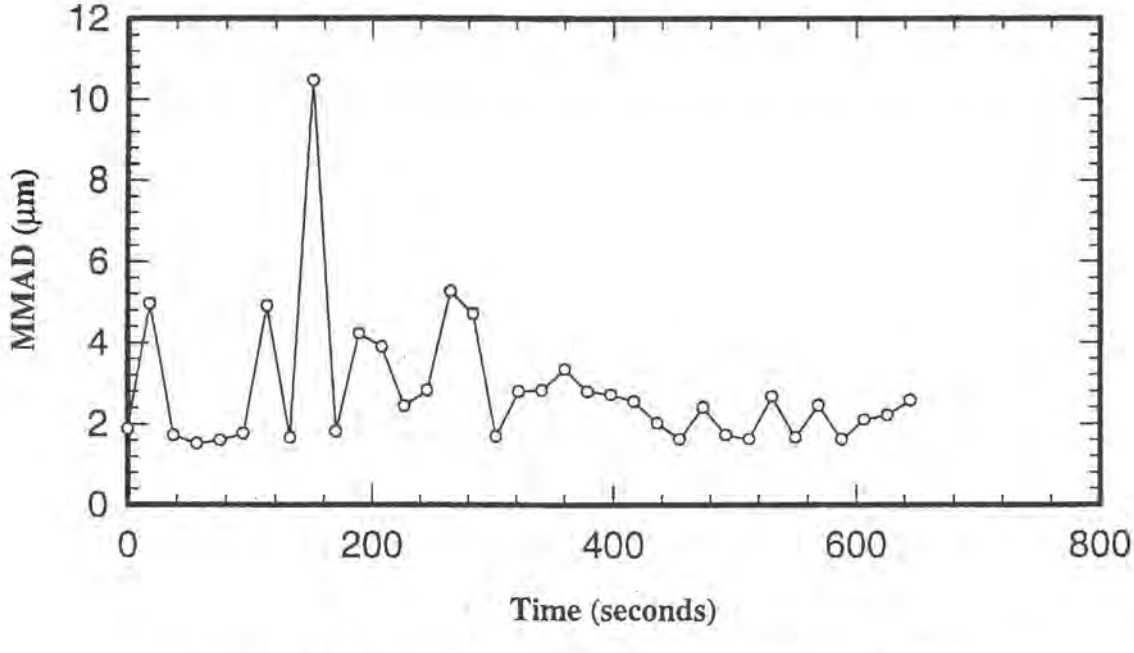


Figure A-2. Aerosol Size Distribution as a Function of Time.

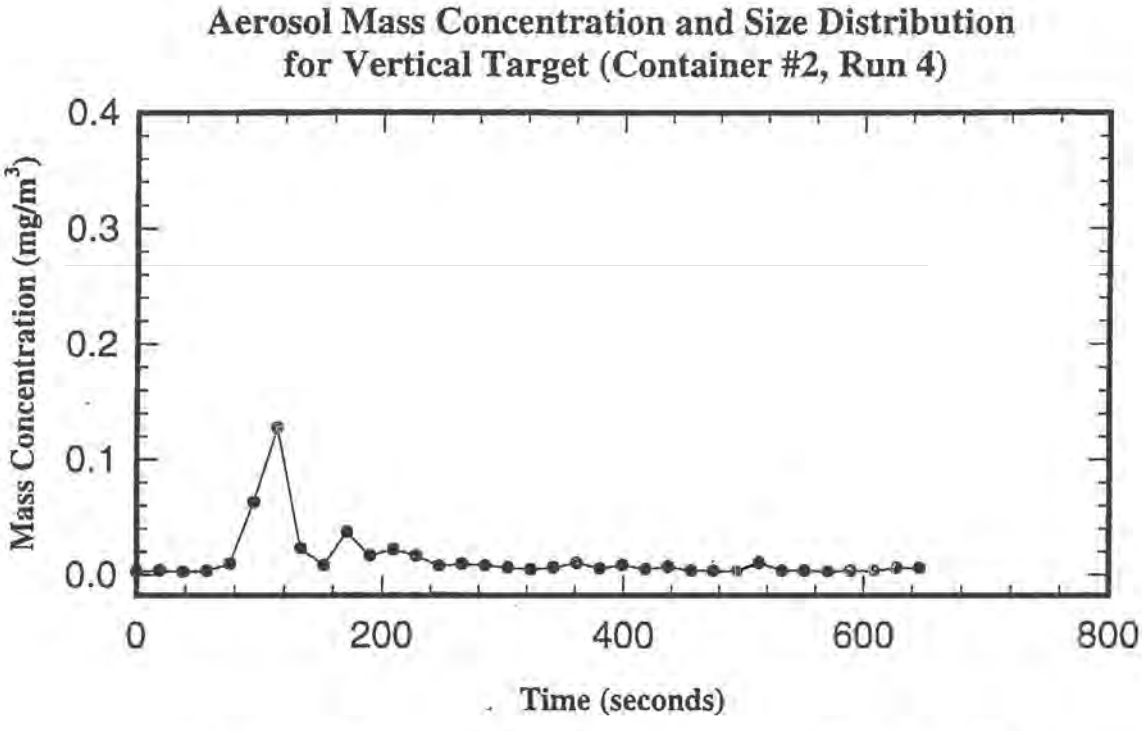


Figure A-1. Aerosol Mass Concentration as a Function of Time.

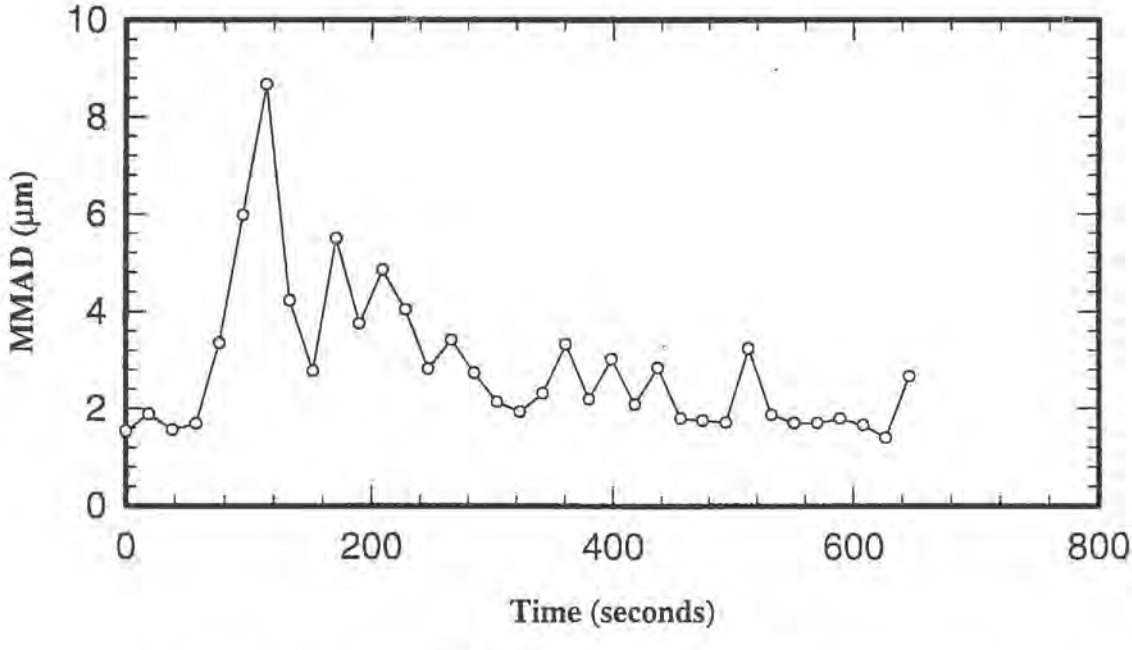


Figure A-2. Aerosol Size Distribution as a Function of Time.

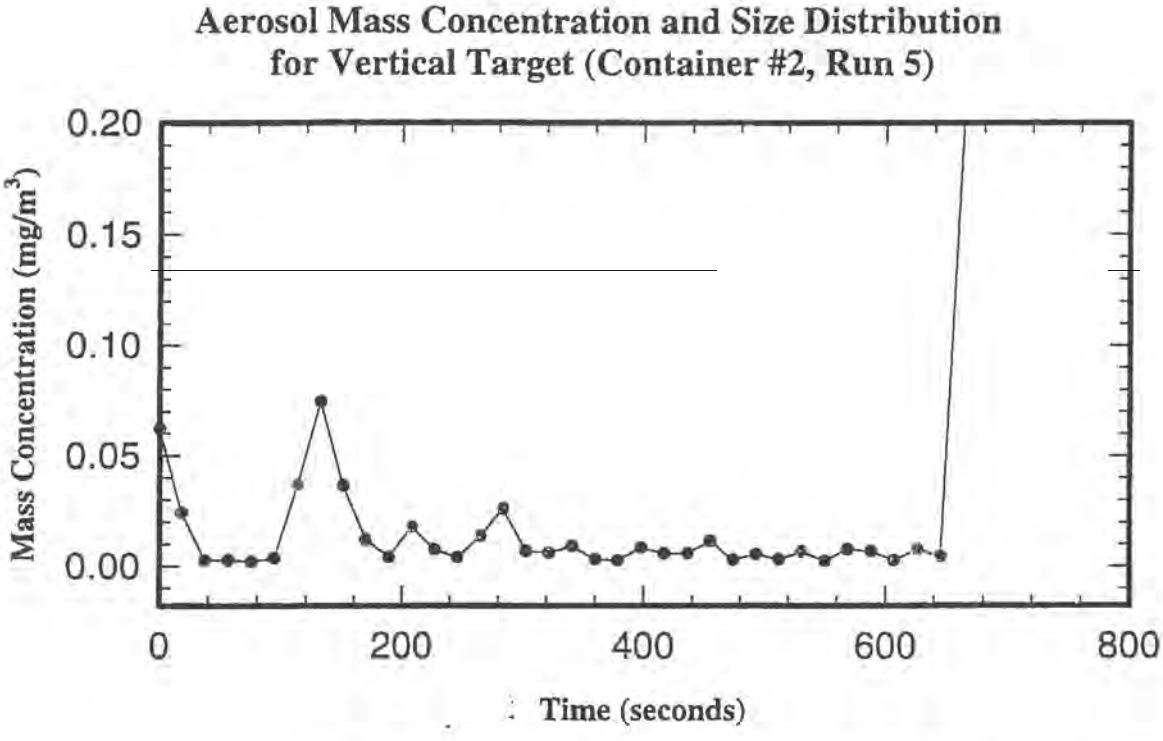


Figure A-1. Aerosol Mass Concentration as a Function of Time.

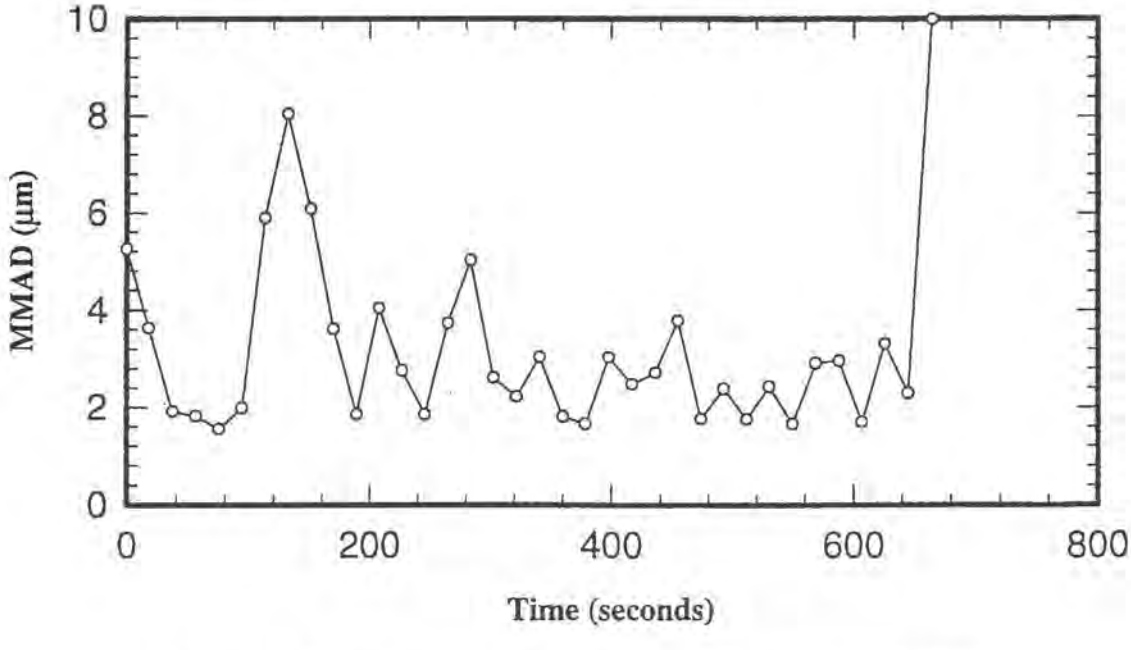


Figure A-2. Aerosol Size Distribution as a Function of Time.

Appendix B. Experimental Raw Data Obtained from Richland

Richland Data

Date: 7/23/98
Run name: CON1H-B1 Mimic

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
13	0	0.0001260	1.782	115
15	36	0.0002850	1.574	263
17	72	0.0001490	1.509	178
19	108	0.0002280	1.436	272
21	144	0.0001310	1.367	167
23	180	0.0003890	1.526	404
25	216	0.0002570	1.587	266
27	252	0.0003940	1.607	374
29	288	0.0004930	1.571	505
31	324	0.0006080	1.603	591

Date: 7/24/98
Run name: CON2H-B1 Mimic

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
357	0	0.0000616	1.397	78
359	36	0.0003110	2.252	119
361	72	0.0002470	1.580	256
363	108	0.0001330	1.439	178
365	144	0.0002280	1.516	290
367	180	0.0003720	1.613	368
369	216	0.0001940	1.463	255
371	252	0.0003660	1.480	446
373	288	0.0003410	1.680	348
375	324	0.0002640	1.475	355

Date: 7/23/98
Run name: CON1H-T1 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
33	0	0.0005760	1.575	602
35	36	0.0007320	1.536	786
37	72	0.0011600	1.931	835
39	108	0.0638000	7.397	1642
41	144	0.0325000	5.802	2281
43	180	0.1320000	6.476	5068
45	216	0.0521000	6.130	2899
47	252	0.0595000	6.364	2386
49	288	0.0331000	6.028	2209
51	324	0.0300000	5.736	2186
53	360	0.0208000	4.797	2237
55	396	0.0217000	5.248	2200
57	432	0.0227000	4.554	2605
59	468	0.0156000	4.569	2190
61	504	0.0204000	4.510	2368
63	540	0.0199000	4.232	2730
65	576	0.0112000	3.810	2288
67	612	0.0131000	4.604	2131
69	648	0.0144000	4.328	2517
71	684	0.0101000	3.816	2224
73	720	0.0279000	4.942	2191
75	756	0.0144000	4.330	2072

Date: 7/24/98
Run name: CON2H-T1 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
377	0	0.0003970	1.324	588
379	36	0.0005320	1.396	700
381	72	0.0093000	5.472	885
383	108	0.0629000	7.554	1590
385	144	0.0628000	6.758	2799
387	180	0.1180000	7.039	3704
389	216	0.0655000	6.521	2734
391	252	0.0388000	5.770	2678
393	288	0.0527000	5.935	2850
395	324	0.0265000	5.243	2276
397	360	0.0365000	5.736	2614
399	396	0.0303000	5.526	2261
401	432	0.0384000	5.330	2897
403	468	0.0300000	5.257	2567
405	504	0.0187000	4.782	2209
407	540	0.0280000	5.491	2281
409	576	0.0200000	4.750	2451
411	612	0.0134000	4.579	2286
413	648	0.0124000	4.308	2091
415	684	0.0135000	4.621	2167
417	720	0.0155000	4.294	2355
419	756	0.0133000	4.068	2259

Richland Data

Date: 7/23/98
Run name: CON1H-B2

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
77	0	0.0000126	0.870	46
79	36	0.0001230	1.386	148
81	72	0.0001230	1.502	150
83	108	0.0001960	1.349	283
85	144	0.0003060	1.448	335
87	180	0.0001640	1.304	253
89	216	0.0002570	1.416	344
91	252	0.0003110	1.384	378
93	288	0.0003580	1.473	427
95	324	0.0004640	1.403	598

Date: 7/24/98
Run name: CON2H-B2

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
421	0	0.0000594	1.585	92
423	36	0.0001190	1.271	207
425	72	0.0001900	1.578	224
427	108	0.0001620	1.375	219
429	144	0.0003050	1.329	431
431	180	0.0002800	1.411	385
433	216	0.0003130	1.419	422
435	252	0.0002680	1.304	408
437	288	0.0002620	1.309	413
439	324	0.0003710	1.474	468

Date: 7/23/98
Run name: CON1H-T2 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
97	0	0.0003640	1.340	507
99	36	0.0005530	1.481	658
101	72	0.0133000	6.037	1150
103	108	0.0162000	6.234	1108
105	144	0.0651000	6.898	2440
107	180	0.1210000	6.911	3663
109	216	0.0326000	5.451	2161
111	252	0.0343000	5.641	2329
113	288	0.0505000	6.387	2338
115	324	0.0464000	6.047	2287
117	360	0.0308000	5.554	2029
119	396	0.0273000	5.304	2234
121	432	0.0218000	4.936	2508
123	468	0.0160000	4.817	2049
125	504	0.0071500	3.241	2084
127	540	0.0115000	4.246	1845
129	576	0.0223000	4.977	2320
131	612	0.0132000	4.330	1985
133	648	0.0161000	4.329	2422
135	684	0.0129000	4.656	1925
137	720	0.0108000	4.243	1911
139	756	0.0151000	4.192	2217

Date: 7/24/98
Run name: CON2H-T2 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
441	0	0.0002660	1.246	413
443	36	0.0003830	1.417	506
445	72	0.0297000	6.799	1335
447	108	0.0302000	6.040	1693
449	144	0.1540000	7.701	3072
451	180	0.1260000	7.009	3949
453	216	0.0885000	6.657	3419
455	252	0.0767000	6.427	3059
457	288	0.0780000	6.266	3111
459	324	0.0280000	5.101	2814
461	360	0.0445000	5.987	2526
463	396	0.0277000	5.384	2317
465	432	0.0286000	5.475	2408
467	468	0.0271000	5.145	2570
469	504	0.0248000	4.906	2499
471	540	0.0239000	5.033	2387
473	576	0.0358000	5.355	2631
475	612	0.0225000	4.979	2363
477	648	0.0192000	4.658	2504
479	684	0.0158000	4.288	2519
481	720	0.0111000	4.036	2204
483	756	0.0162000	4.418	2370

Richland Data

Date: 7/23/98
Run name: CON1H-B3

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
141	0	0.0000737	1.493	102
143	36	0.0000713	1.278	114
145	72	0.0002190	1.485	238
147	108	0.0000789	1.151	144
149	144	0.0001110	1.535	120
151	180	0.0001990	1.439	247
153	216	0.0002950	1.649	312
155	252	0.0001900	1.513	223
157	288	0.0001730	1.447	217
159	324	0.0002100	1.413	291

Date: 7/24/98
Run name: CON2H-B3

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
485	0	0.0001310	1.606	140
487	36	0.0004570	2.186	267
489	72	0.0013800	2.148	1003
491	108	0.0002950	1.425	402
493	144	0.0001850	1.494	230
495	180	0.0002480	1.436	307
497	216	0.0003060	1.403	402
499	252	0.0003190	1.506	410
501	288	0.0003450	1.429	440
503	324	0.0002480	1.296	410

Date: 7/23/98
Run name: CON1H-T3 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
161	0	0.0002660	1.332	395
163	36	0.0003270	1.582	346
165	72	0.0302000	7.628	912
167	108	0.0304000	6.006	1548
169	144	0.0693000	6.420	2767
171	180	0.1630000	7.636	2811
173	216	0.0958000	6.976	2546
175	252	0.0391000	6.173	2041
177	288	0.0365000	6.044	1947
179	324	0.0505000	5.924	2492
181	360	0.0180000	5.175	1669
183	396	0.0223000	4.972	2251
185	432	0.0418000	5.412	2577
187	468	0.0261000	5.099	2191
189	504	0.0316000	5.127	2189
191	540	0.0114000	3.974	1851
193	576	0.0169000	4.880	1829
195	612	0.0059000	3.353	1749
197	648	0.0136000	3.804	2154
199	684	0.0293000	5.378	1840
201	720	0.0108000	3.309	2676
203	756	0.0094200	4.119	1621

Date: 7/24/98
Run name: CON2H-T3 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
505	0	0.0275000	5.059	1274
507	36	0.0002830	1.164	530
509	72	0.0082200	5.324	1030
511	108	0.0358000	6.513	1567
513	144	0.1130000	7.286	3136
515	180	0.1150000	6.892	3559
517	216	0.0641000	6.328	2751
519	252	0.0282000	5.670	1966
521	288	0.0510000	6.270	2074
523	324	0.0297000	5.500	2463
525	360	0.0339000	6.521	2038
527	396	0.0156000	4.737	1904
529	432	0.0226000	5.442	2108
531	468	0.0147000	4.722	1938
533	504	0.0184000	4.285	2472
535	540	0.0106000	3.913	2121
537	576	0.0182000	4.895	2283
539	612	0.0093600	4.030	1855
541	648	0.0098500	4.410	1767
543	684	0.0146000	4.326	2257
545	720	0.0118000	4.336	1974
547	756	0.0150000	4.500	2073

Richland Data

Date: 7/23/98
Run name: CON1H-B4

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
205	0	0.0002430	2.164	129
207	36	0.0001530	1.902	143
209	72	0.0004140	2.020	252
211	108	0.0001750	1.585	182
213	144	0.0000608	1.220	112
215	180	0.0000616	1.097	122
217	216	0.0001310	1.327	212
219	252	0.0001630	1.485	221
221	288	0.0001030	1.278	199
223	324	0.0002500	1.380	339

Date: 7/24/98
Run name: CON2H-B4

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
549	0	0.0000930	1.695	93
551	36	0.0001100	1.407	152
553	72	0.0002000	1.410	259
555	108	0.0002050	1.422	275
557	144	0.0001250	1.381	179
559	180	0.0002300	1.409	309
561	216	0.0001940	1.310	286
563	252	0.0003340	1.392	449
565	288	0.0003410	1.366	467
567	324	0.0004010	1.408	525

Date: 7/23/98
Run name: CON1H-T4 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
225	0	0.0004130	1.539	473
227	36	0.0002710	1.509	343
229	72	0.0150000	6.148	720
231	108	0.1560000	7.737	2863
233	144	0.1930000	7.574	4024
235	180	0.1890000	7.122	4853
237	216	0.0863000	7.064	2576
239	252	0.0349000	5.645	2231
241	288	0.0516000	6.367	2568
243	324	0.0366000	5.399	2400
245	360	0.0572000	6.207	2407
247	396	0.0560000	5.966	2339
249	432	0.0267000	5.046	2225
251	468	0.0324000	5.816	2124
253	504	0.0441000	5.581	2517
255	540	0.0302000	4.939	2515
257	576	0.0285000	5.311	2380
259	612	0.0172000	4.409	2305
261	648	0.0087700	3.554	1915
263	684	0.0280000	5.485	1951
265	720	0.0121000	4.753	1585
267	756	0.0147000	4.612	1812

Date: 7/24/98
Run name: CON2H-T4 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
569	0	0.0003380	1.272	520
571	36	0.0004090	1.370	580
573	72	0.0101000	5.571	975
575	108	0.0124000	5.346	1401
577	144	0.1180000	7.449	3135
579	180	0.1430000	7.086	4289
581	216	0.0356000	5.555	2502
583	252	0.0393000	5.809	2608
585	288	0.0617000	6.215	2641
587	324	0.0267000	5.139	2410
589	360	0.0326000	5.330	2705
591	396	0.0354000	5.482	2439
593	432	0.0380000	5.584	2448
595	468	0.0192000	4.421	2446
597	504	0.0294000	4.993	2753
599	540	0.0222000	4.663	2329
601	576	0.0305000	5.056	2841
603	612	0.0202000	5.136	2304
605	648	0.0116000	4.059	2100
607	684	0.0210000	4.661	2262
609	720	0.0183000	4.291	2494
611	756	0.0102000	3.727	2139

Richland Data

Date: 7/23/98
Run name: CON1H-B5

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
269	0	0.0008740	2.571	275
271	36	0.0000592	1.545	80
273	72	0.0000945	1.530	115
275	108	0.0001850	1.456	223
277	144	0.0002400	1.679	231
279	180	0.0002590	1.217	442
281	216	0.0004200	1.507	476
283	252	0.0002930	1.440	370
285	288	0.0002960	1.482	376
287	324	0.0002960	1.406	366

Date: 7/24/98
Run name: CON2H-B5

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
613	0	0.0002590	1.704	214
615	36	0.0002210	1.824	165
617	72	0.0017000	2.345	1447
619	108	0.0003190	1.620	321
621	144	0.0001740	1.424	242
623	180	0.0002580	1.358	359
625	216	0.0002180	1.400	299
627	252	0.0004190	1.399	556
629	288	0.0002150	1.359	310
631	324	0.0002870	1.359	413

Date: 7/23/98
Run name: CON1H-T5 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
289	0	0.0006800	1.395	874
291	36	0.0003190	1.365	467
293	72	0.0149000	6.156	831
295	108	0.0153000	5.811	1037
297	144	0.0924000	7.351	2212
299	180	0.0754000	6.436	3345
301	216	0.0396000	6.222	1950
303	252	0.0242000	6.106	1694
305	288	0.0477000	6.326	2135
307	324	0.0156000	4.815	1664
309	360	0.0216000	5.299	1685
311	396	0.0227000	5.006	2045
313	432	0.0175000	4.481	2039
315	468	0.0193000	5.191	1811
317	504	0.0109000	4.386	1719
319	540	0.0157000	4.484	2400
321	576	0.0075900	3.804	1730
323	612	0.0113000	4.573	1721
325	648	0.0203000	5.186	1994
327	684	0.0150000	4.560	1941
329	720	0.0111000	4.061	1782
331	756	0.0103000	4.046	1929

Date: 7/24/98
Run name: CON2H-T5 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
633	0	0.0004470	1.496	555
635	36	0.0004190	1.411	515
637	72	0.0096800	6.131	750
639	108	0.0206000	6.088	1418
641	144	0.1240000	6.566	3822
643	180	0.1220000	6.714	4202
645	216	0.1040000	6.877	3114
647	252	0.1060000	6.865	3182
649	288	0.0548000	5.941	2889
651	324	0.0566000	5.542	3630
653	360	0.0839000	6.427	2941
655	396	0.0648000	6.021	3158
657	432	0.0494000	5.854	2893
659	468	0.0446000	5.504	2899
661	504	0.0507000	5.660	3081
663	540	0.0472000	5.397	3186
665	576	0.0432000	5.522	3095
667	612	0.0299000	4.829	3248
669	648	0.0248000	4.766	2668
671	684	0.0407000	5.447	3013
673	720	0.0299000	4.982	3006
675	756	0.0181000	4.476	2350

Richland Data

Date: 7/22/98
Run name: CON1V-B1

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
585	0	0.0001650	1.675	146
587	36	0.0002390	1.709	218
589	72	0.0000975	1.261	164
591	108	0.0003390	1.600	343
593	144	0.0004350	1.703	372
595	180	0.0003850	1.533	436
597	216	0.0004060	1.649	356
599	252	0.0003710	1.508	427
601	288	0.0004400	1.644	378
603	324	0.0003800	1.470	473

Date: 7/24/98
Run name: CON2V-B1

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
1	0	0.0003580	1.763	315
3	36	0.0003230	1.571	336
5	72	0.0001530	1.729	130
7	108	0.0002830	1.500	328
9	144	0.0007160	2.950	398
11	180	0.0001600	1.263	266
13	216	0.0004250	1.376	590
15	252	0.0005350	1.478	636
17	288	0.0003490	1.323	507
19	324	0.0004230	1.346	591

Date: 7/22/98
Run name: CON1V-T1 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
605	0	0.0007270	1.549	774
607	36	0.0007490	1.561	806
609	72	0.3870000	9.919	3576
611	108	0.5010000	9.923	4851
613	144	0.0756000	8.715	2458
615	180	0.0105000	5.823	1339
617	216	0.0205000	5.940	1818
619	252	0.0467000	7.327	1562
621	288	0.0311000	6.945	1673
623	324	0.0087100	4.366	1458
625	360	0.0172000	5.392	1560
627	396	0.0135000	5.753	1560
629	432	0.0096500	4.413	1573
631	468	0.0110000	4.952	1506
633	504	0.0085900	4.844	1385
635	540	0.0073500	4.143	1496
637	576	0.0068300	4.766	1336
639	612	0.0092800	4.284	1675
641	648	0.0031400	2.743	1594
643	684	0.0017400	1.897	1442
645	720	0.0030600	2.212	1705
647	756	0.0050000	3.182	1820

Date: 7/24/98
Run name: CON2V-T1 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
21	0	0.0054900	2.713	1682
23	36	0.0006140	1.414	796
25	72	0.6300000	9.854	5858
27	108	0.7610000	10.030	6538
29	144	0.6370000	9.331	6656
31	180	0.1480000	8.431	2474
33	216	0.1940000	8.750	2897
35	252	0.1750000	8.232	3430
37	288	0.1290000	8.141	2762
39	324	0.0857000	7.022	2589
41	360	0.1340000	7.498	3296
43	396	0.1070000	7.483	2764
45	432	0.0557000	5.995	3157
47	468	0.0516000	6.413	2527
49	504	0.0537000	6.232	2808
51	540	0.0306000	5.420	2368
53	576	0.0487000	6.230	2601
55	612	0.0430000	5.858	2706
57	648	0.0595000	6.312	3545
59	684	0.0253000	5.893	2231
61	720	0.0400000	5.686	2753
63	756	0.0331000	5.344	2724

Richland Data

Date: 7/22/98
Run name: CON1V-B2

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
649	0	0.0003010	1.693	267
651	36	0.0002180	1.575	233
653	72	0.0003620	1.471	402
655	108	0.0003210	1.417	388
657	144	0.0002030	1.440	260
659	180	0.0003090	1.657	301
661	216	0.0003670	1.493	398
663	252	0.0004080	1.552	405
665	288	0.0004440	1.549	454
667	324	0.0003880	1.451	428

Date: 7/24/98
Run name: CON2V-B2

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
65	0	0.0004300	5.477	157
67	36	0.0003560	2.326	228
69	72	0.0001150	1.297	185
71	108	0.0000923	1.152	171
73	144	0.0002430	1.613	258
75	180	0.0003440	1.397	448
77	216	0.0003300	1.469	407
79	252	0.0002040	1.213	349
81	288	0.0002380	1.340	370
83	324	0.0004650	1.459	599

Date: 7/22/98
Run name: CON1V-T2 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
669	0	0.0004860	1.424	585
671	36	0.0005790	1.490	678
673	72	0.6100000	9.607	5565
675	108	0.4330000	9.394	4756
677	144	0.2220000	8.766	3279
679	180	0.1350000	7.905	2853
681	216	0.0832000	8.033	2535
683	252	0.1050000	7.856	2197
685	288	0.0932000	7.658	2196
687	324	0.0480000	6.621	2242
689	360	0.0573000	6.819	2304
691	396	0.0590000	6.467	2503
693	432	0.0277000	5.460	2249
695	468	0.0140000	4.504	2053
697	504	0.0199000	5.150	1959
699	540	0.0154000	4.891	1980
701	576	0.0265000	5.649	2404
703	612	0.0192000	5.053	2054
705	648	0.0165000	4.980	2199
707	684	0.0162000	4.297	2136
709	720	0.0266000	5.658	1901
711	756	0.0212000	5.247	1842

Date: 7/24/98
Run name: CON2V-T2 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
85	0	0.0003790	1.331	563
87	36	0.0004420	1.377	612
89	72	0.3370000	10.460	2691
91	108	0.4840000	9.081	6077
93	144	0.6610000	10.010	5605
95	180	0.1250000	7.950	2882
97	216	0.1670000	8.211	2933
99	252	0.1670000	8.460	2967
101	288	0.1610000	8.162	3176
103	324	0.1350000	7.925	2820
105	360	0.0665000	6.579	2696
107	396	0.1030000	6.948	3063
109	432	0.0676000	7.190	2505
111	468	0.0766000	6.840	2561
113	504	0.0469000	6.165	2542
115	540	0.0662000	6.684	2588
117	576	0.0522000	6.165	2401
119	612	0.0615000	6.098	3423
121	648	0.0285000	5.267	2378
123	684	0.0288000	4.916	2886
125	720	0.0226000	4.968	2161
127	756	0.2980000	8.017	6775

Richland Data

Date: 7/22/98
Run name: CON1V-B3

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
713	0	0.0003860	1.971	208
715	36	0.0001760	1.927	131
717	72	0.0006940	3.166	297
719	108	0.0001420	1.543	148
721	144	0.0002870	1.686	299
723	180	0.0002810	1.543	301
725	216	0.0004270	1.548	446
727	252	0.0003130	1.391	382
729	288	0.0004180	1.462	478
731	324	0.0002770	1.428	341

Date: 7/24/98
Run name: CON2V-B3

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
129	0	0.0000700	1.816	58
131	36	0.0002190	1.515	253
133	72	0.0001870	1.336	264
135	108	0.0001720	1.358	260
137	144	0.0002420	1.446	296
139	180	0.0002760	1.529	288
141	216	0.0004060	1.476	485
143	252	0.0003050	1.478	384
145	288	0.0003360	1.376	457
147	324	0.0003740	1.407	485

Date: 7/22/98
Run name: CON1V-T3 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
733	0	0.0003870	1.417	464
735	36	0.0004010	1.402	540
737	72	0.5820000	9.605	4911
739	108	0.2920000	8.691	4411
741	144	0.2440000	8.253	4252
743	180	0.1780000	9.017	2778
745	216	0.1420000	8.574	2279
747	252	0.1530000	8.286	2790
749	288	0.0802000	7.101	2441
751	324	0.0616000	7.165	2364
753	360	0.0415000	6.584	2332
755	396	0.0454000	6.266	2624
757	432	0.0258000	5.697	2118
759	468	0.0161000	4.882	1995
761	504	0.0520000	6.239	2468
763	540	0.0413000	5.517	2912
765	576	0.0204000	5.299	2133
767	612	0.0227000	4.997	2465
769	648	0.0182000	4.728	2183
771	684	0.0264000	4.713	2969
773	720	0.0120000	4.007	2491
775	756	0.0251000	5.128	2787

Date: 7/24/98
Run name: CON2V-T3 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
149	0	0.0002720	1.326	398
151	36	0.0005140	1.416	662
153	72	0.3980000	9.388	4068
155	108	0.8770000	10.040	8236
157	144	0.6810000	9.222	7428
159	180	0.1760000	8.582	2728
161	216	0.1390000	8.783	2626
163	252	0.1190000	8.251	2854
165	288	0.1130000	7.610	3125
167	324	0.1500000	8.125	2892
169	360	0.1120000	7.204	3014
171	396	0.0553000	6.293	2830
173	432	0.0673000	6.665	2572
175	468	0.0645000	6.797	2462
177	504	0.0717000	6.399	2956
179	540	0.0429000	5.852	2475
181	576	0.0612000	6.619	2498
183	612	0.0300000	5.553	2679
185	648	0.0658000	5.680	2855
187	684	0.0438000	5.635	2630
189	720	0.0279000	5.549	2207
191	756	0.0202000	5.005	2383

Richland Data

Date: 7/22/98
Run name: CON1V-B4

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
777	0	0.0003780	2.935	183
779	36	0.0001730	1.693	141
781	72	0.0002700	1.534	258
783	108	0.0002750	1.580	277
785	144	0.0002910	1.568	296
787	180	0.0003440	1.474	372
789	216	0.0002980	1.515	325
791	252	0.0003550	1.447	395
793	288	0.0003180	1.368	415
795	324	0.0003260	1.411	393

Date: 7/24/98
Run name: CON2V-B4

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
193	0	0.0000672	1.439	92
195	36	0.0002270	1.353	342
197	72	0.0003130	1.560	350
199	108	0.0001750	1.449	221
201	144	0.0002840	1.342	397
203	180	0.0002620	1.559	293
205	216	0.0003670	1.467	424
207	252	0.0003220	1.496	391
209	288	0.0003480	1.375	478
211	324	0.0001710	1.194	325

Date: 7/22/98
Run name: CON1V-T4 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
797	0	0.0009630	1.784	750
799	36	0.0008200	1.717	667
801	72	0.0155000	5.953	1064
803	108	0.3570000	9.626	3477
805	144	0.3670000	9.093	4503
807	180	0.1520000	8.217	2707
809	216	0.1090000	8.099	2308
811	252	0.1060000	7.702	2578
813	288	0.0702000	7.197	2258
815	324	0.1150000	7.962	2780
817	360	0.0562000	7.140	2262
819	396	0.0662000	7.100	2549
821	432	0.0372000	6.273	2127
823	468	0.0392000	5.845	2476
825	504	0.0242000	5.447	2034
827	540	0.0253000	5.626	2293
829	576	0.0206000	5.056	2266
831	612	0.0193000	5.241	2102
833	648	0.0221000	5.479	1978
835	684	0.0148000	4.508	2064
837	720	0.0088900	3.596	1992
839	756	0.0170000	4.731	2235

Date: 7/24/98
Run name: CON2V-T4 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
213	0	0.0003180	1.345	476
215	36	0.0003290	1.231	530
217	72	0.0552000	6.900	1851
219	108	0.4140000	8.655	5390
221	144	0.4480000	8.997	5433
223	180	0.2870000	8.678	3348
225	216	0.1910000	8.529	3019
227	252	0.2650000	8.566	3820
229	288	0.1540000	7.496	3370
231	324	0.1280000	6.775	3796
233	360	0.1100000	6.820	3367
235	396	0.0870000	6.645	3139
237	432	0.0777000	7.068	2648
239	468	0.0432000	5.512	2751
241	504	0.0853000	6.672	3111
243	540	0.0414000	5.720	2815
245	576	0.0611000	6.052	2920
247	612	0.0653000	6.213	3066
249	648	0.0486000	6.183	2714
251	684	0.0366000	5.363	2855
253	720	0.0356000	6.072	2631
255	756	0.0334000	5.237	2886

Richland Data

Date: 7/22/98
Run name: CON1V-B5

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
841	0	0.0001350	1.616	141
843	36	0.0003810	1.653	374
845	72	0.0002540	1.506	270
847	108	0.0002800	1.678	221
849	144	0.0003170	1.646	278
851	180	0.0004080	1.558	410
853	216	0.0002740	1.376	331
855	252	0.0004140	1.600	407
857	288	0.0005300	1.655	469
859	324	0.0004740	1.499	521

Date: 7/24/98
Run name: CON2V-B5

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
257	0	0.0001870	1.704	154
259	36	0.0002540	1.378	339
261	72	0.0003710	1.648	339
263	108	0.0002620	1.654	250
265	144	0.0002640	1.435	329
267	180	0.0003310	1.586	324
269	216	0.0001890	1.317	294
271	252	0.0078400	4.430	1281
273	288	0.0004710	1.491	544
275	324	0.0004060	1.385	495

Date: 7/22/98
Run name: CON1V-T5 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
861	0	0.0024800	2.188	1037
863	36	0.0006490	1.587	601
865	72	0.7310000	10.400	5268
867	108	0.4630000	9.269	4989
869	144	0.1300000	8.000	2600
871	180	0.0961000	8.196	2057
873	216	0.1380000	8.791	2242
875	252	0.1100000	8.027	2485
877	288	0.1330000	8.589	2420
879	324	0.0774000	7.076	2581
881	360	0.0783000	7.273	2722
883	396	0.0480000	6.672	2085
885	432	0.0825000	6.956	3184
887	468	0.0411000	6.159	2252
889	504	0.0392000	5.942	2442
891	540	0.0302000	5.915	2334
893	576	0.0384000	5.548	2666
895	612	0.0180000	4.816	2060
897	648	0.0249000	5.131	2268
899	684	0.0141000	4.470	2128
901	720	0.0146000	4.357	2283
903	756	0.0202000	4.596	2627

Date: 7/24/98
Run name: CON2V-T5 Spray test

Run Numbers	Time seconds	Mass Loading mg/m^3	Particle Size mean	sum channels
277	0	0.0003120	1.269	486
279	36	0.0004620	1.384	583
281	72	0.4670000	9.185	5034
283	108	0.8350000	9.011	9266
285	144	0.5670000	8.869	6505
287	180	0.2970000	8.445	4178
289	216	0.3210000	8.548	4270
291	252	0.1630000	7.970	3607
293	288	0.1610000	7.459	3429
295	324	0.1660000	7.651	3749
297	360	0.1060000	6.791	3494
299	396	0.1320000	6.759	3986
301	432	0.0835000	6.304	3606
303	468	0.0963000	6.642	3611
305	504	0.0743000	6.227	3397
307	540	0.0584000	5.807	3343
309	576	0.0685000	6.079	3252
311	612	0.0677000	6.247	3438
313	648	0.0611000	5.756	3277
315	684	0.0397000	5.440	2928
317	720	0.0424000	5.800	2824
319	756	0.0485000	5.564	2987

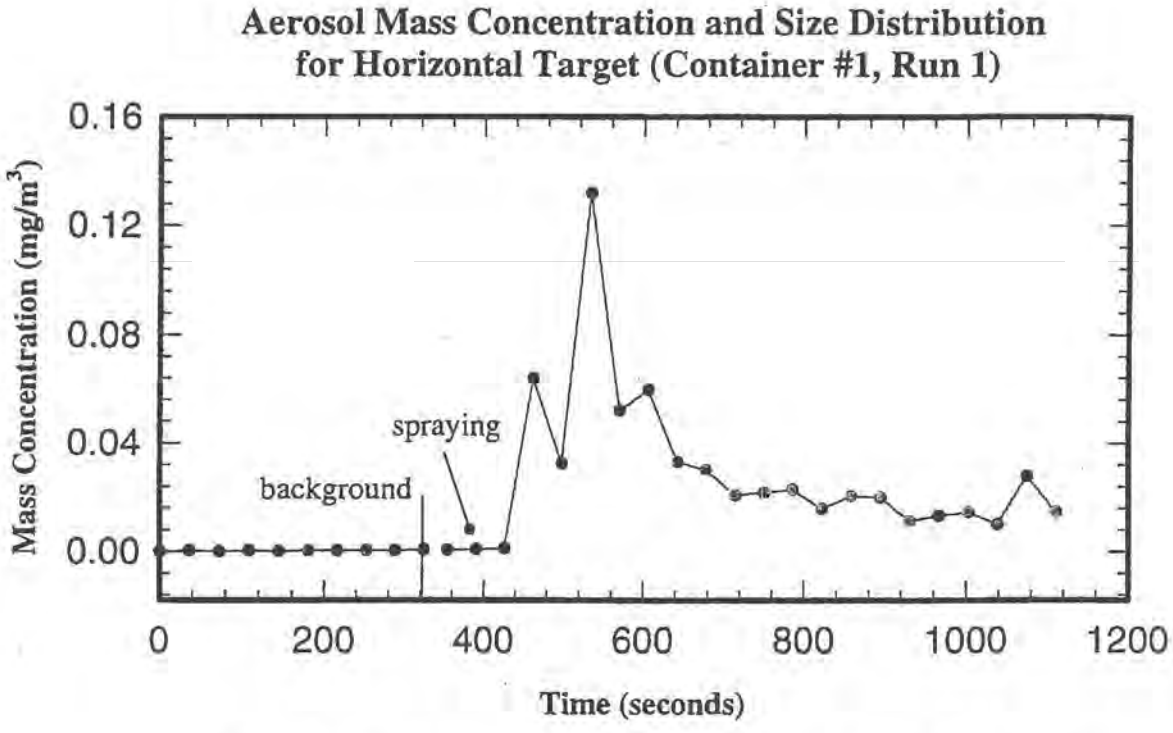


Figure B-1. Aerosol Mass Concentration as a Function of Time.

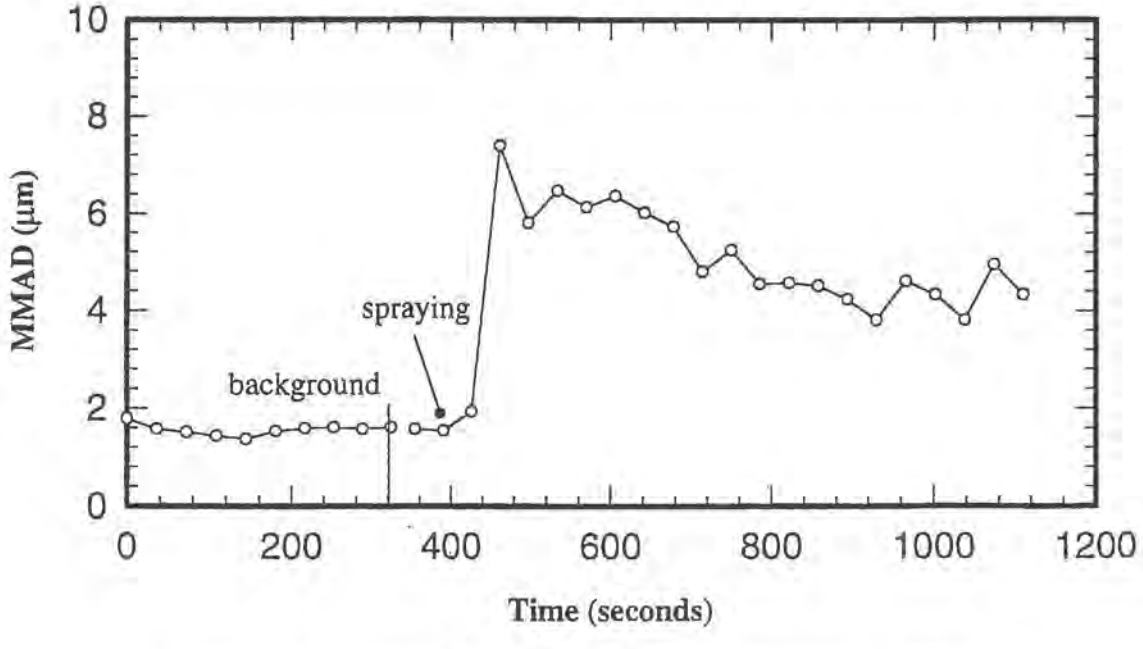


Figure B-2. Aerosol Size Distribution as a Function of Time.

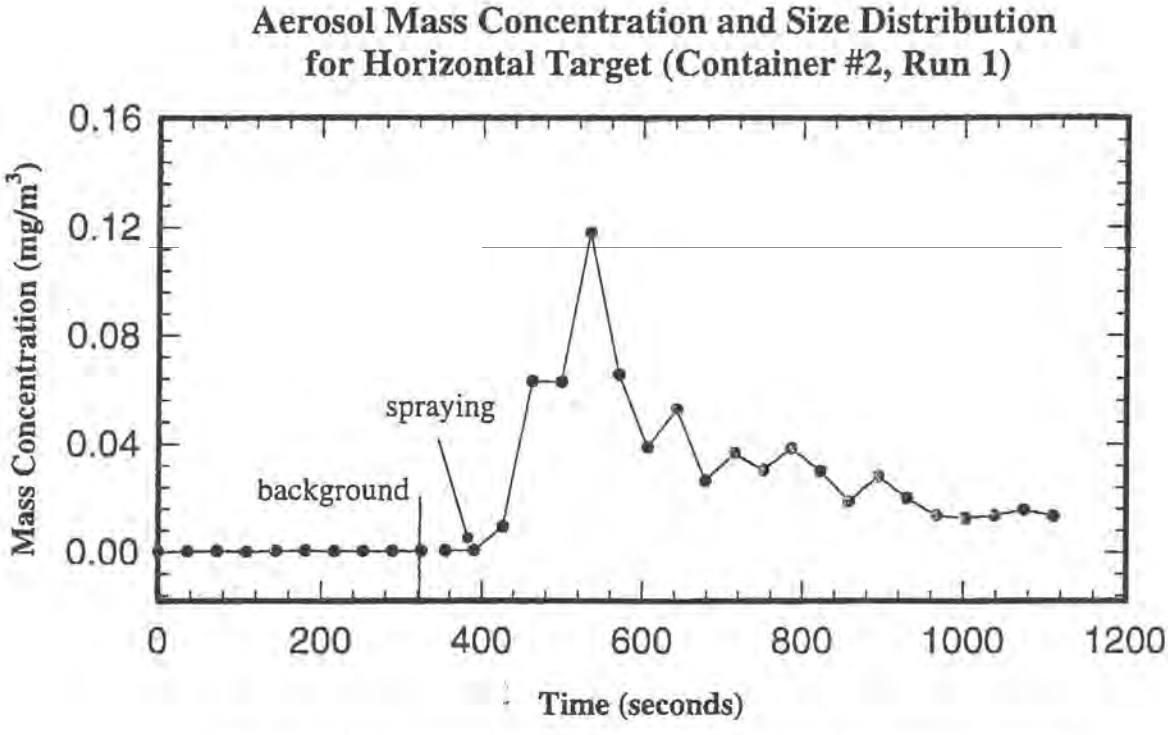


Figure B-3. Aerosol Mass Concentration as a Function of Time.

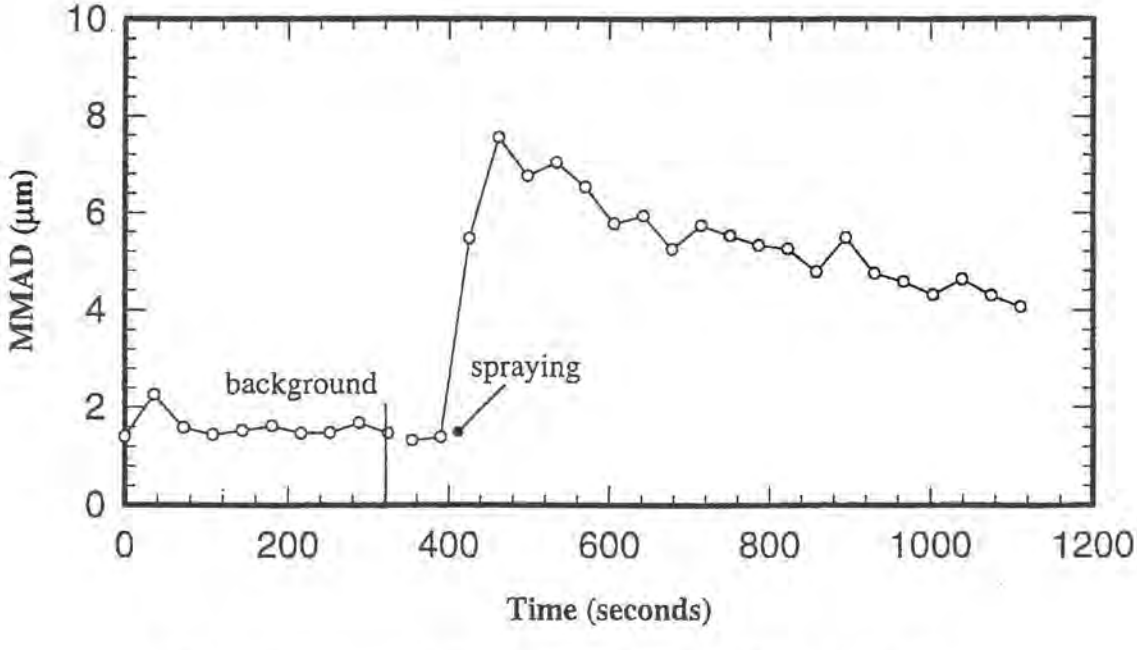


Figure B-4. Aerosol Size Distribution as a Function of Time.

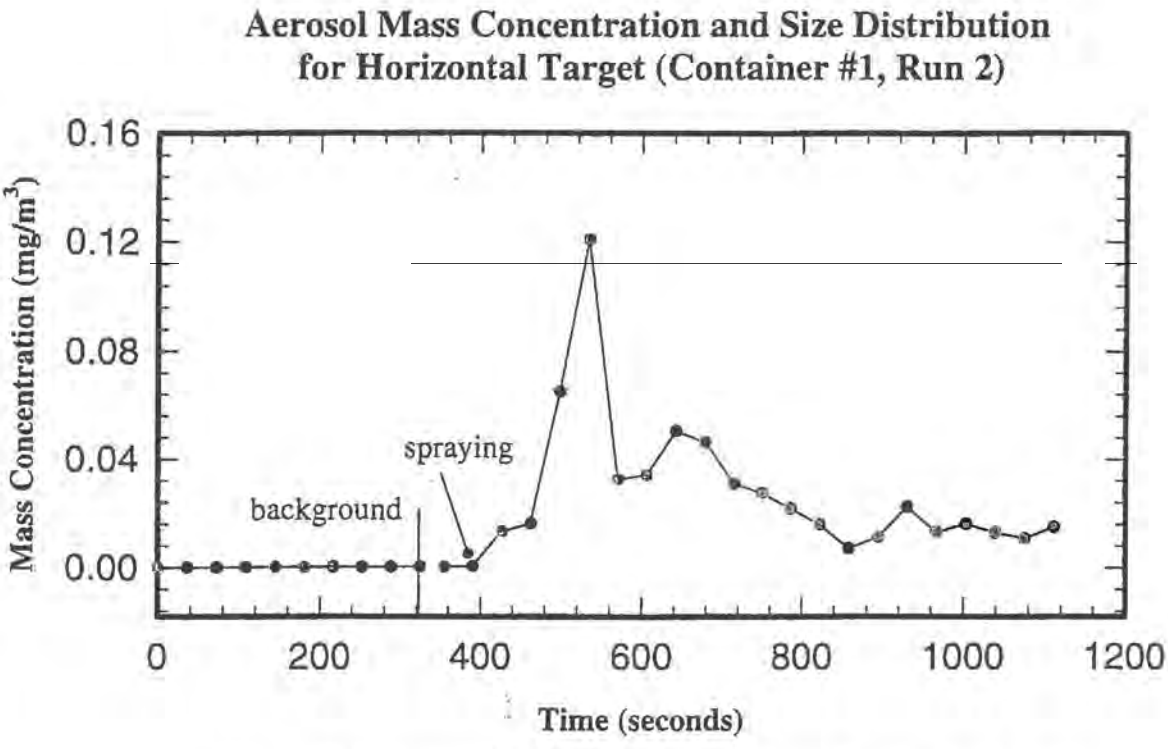


Figure B-5. Aerosol Mass Concentration as a Function of Time.

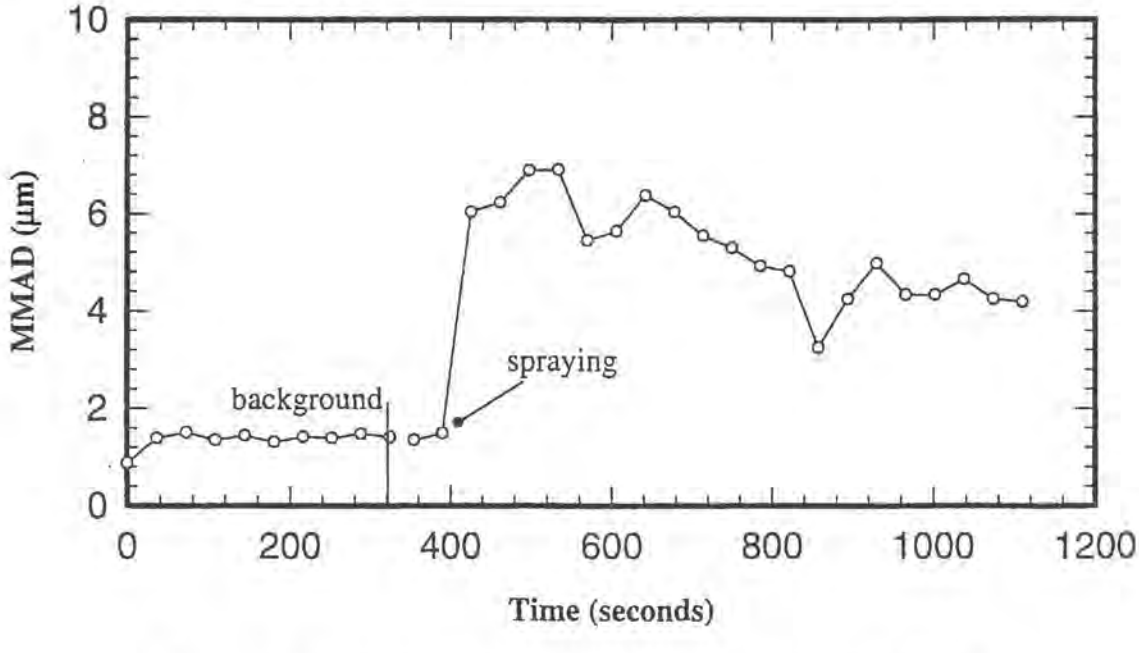


Figure B-6. Aerosol Size Distribution as a Function of Time.

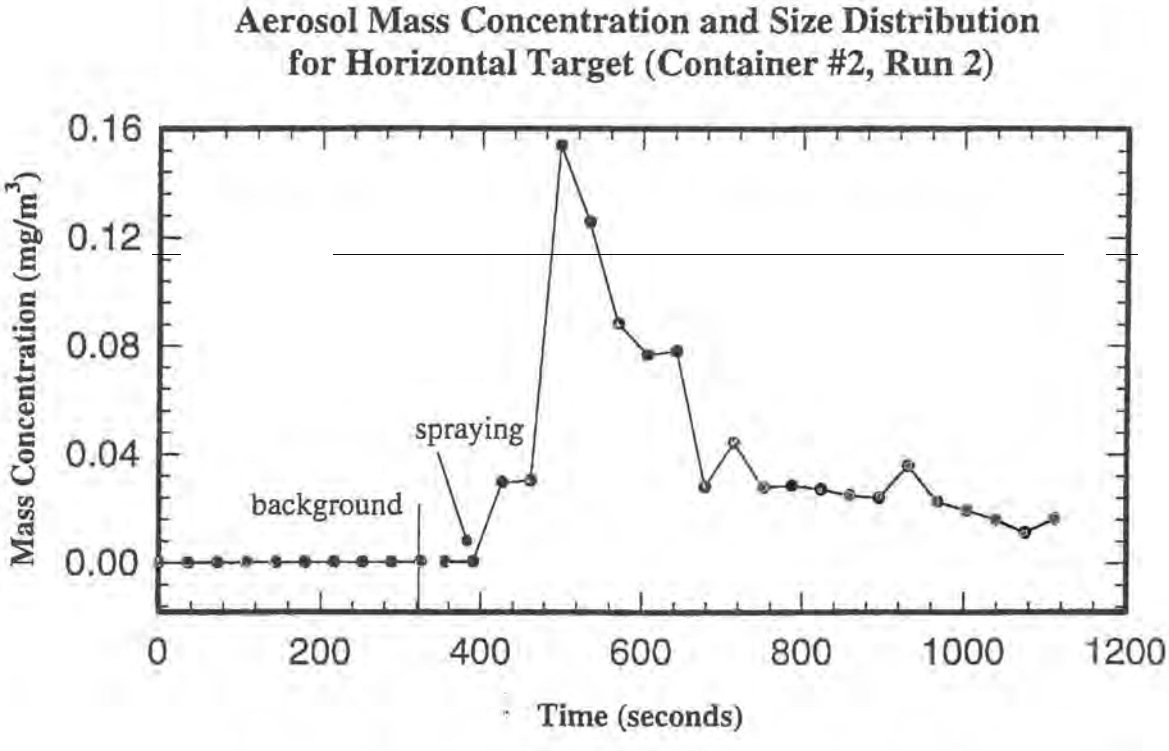


Figure B-7. Aerosol Mass Concentration as a Function of Time.

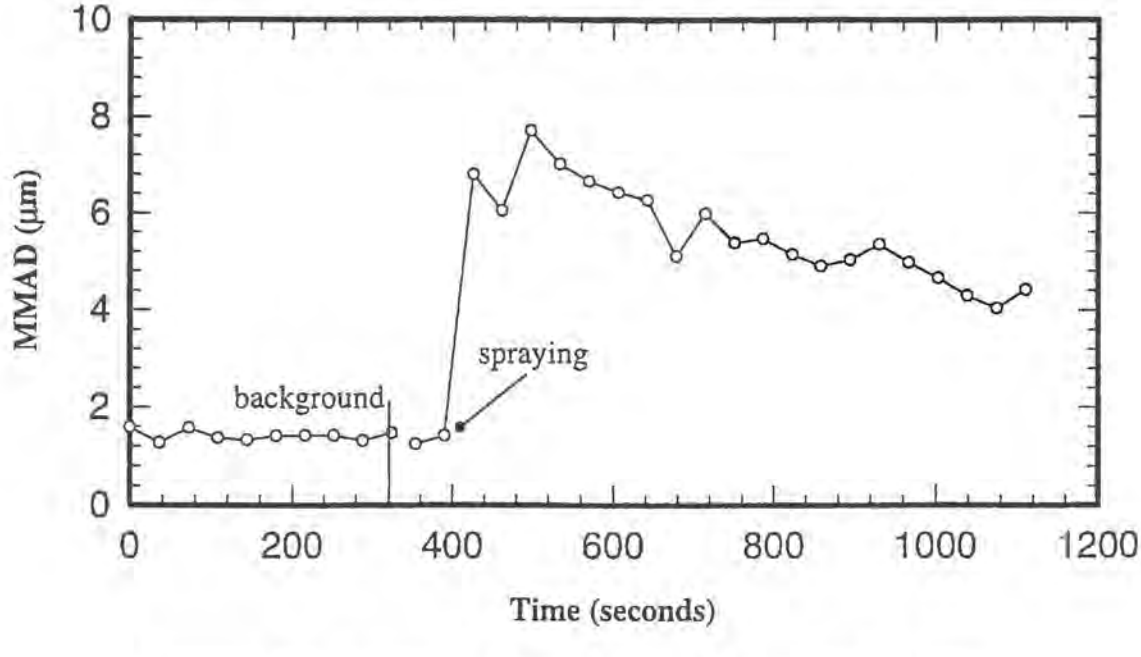


Figure B-8. Aerosol Size Distribution as a Function of Time.

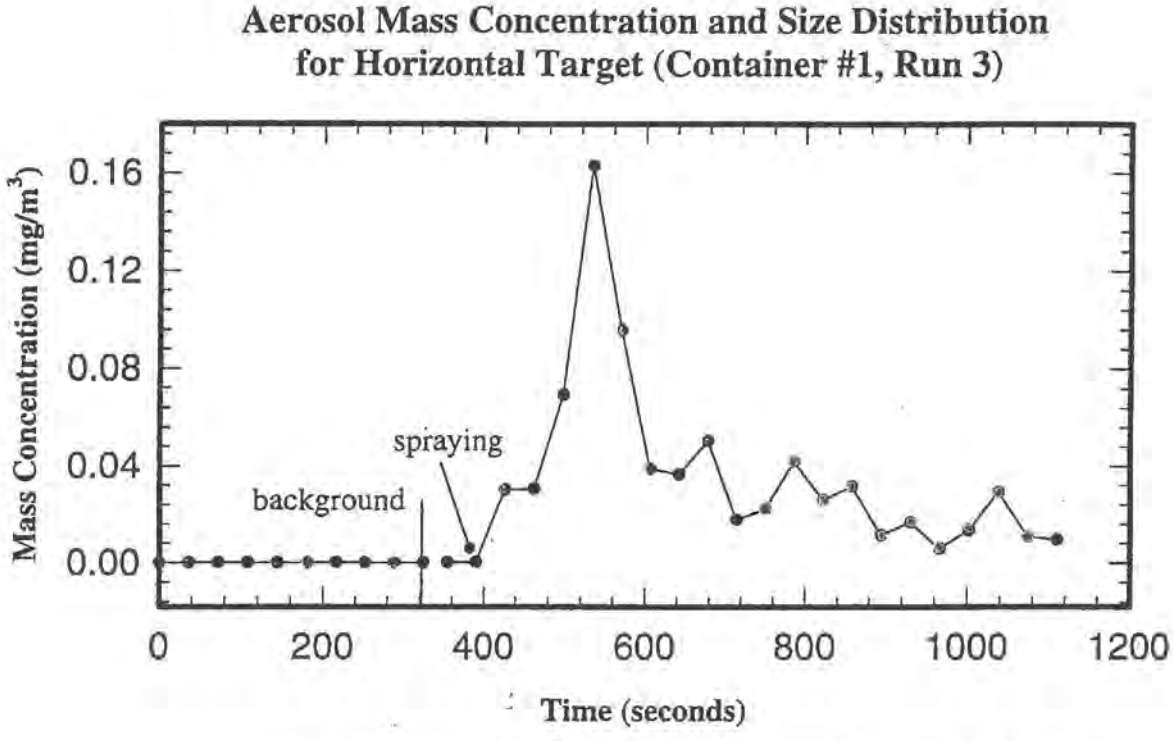


Figure B-9. Aerosol Mass Concentration as a Function of Time.

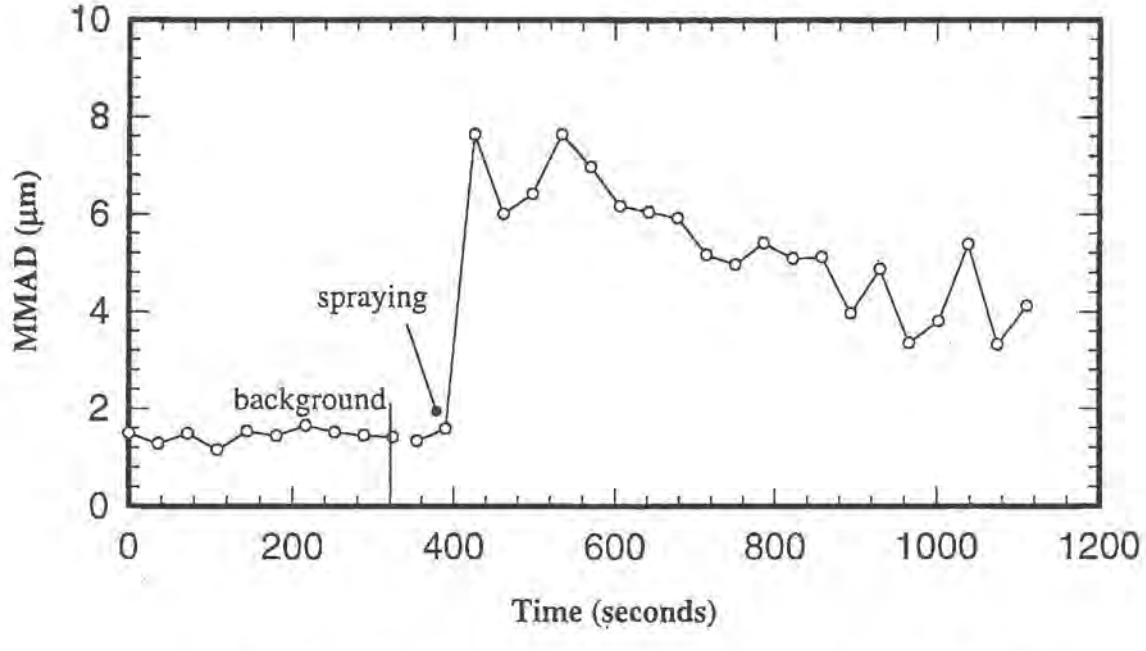


Figure B-10. Aerosol Size Distribution as a Function of Time.

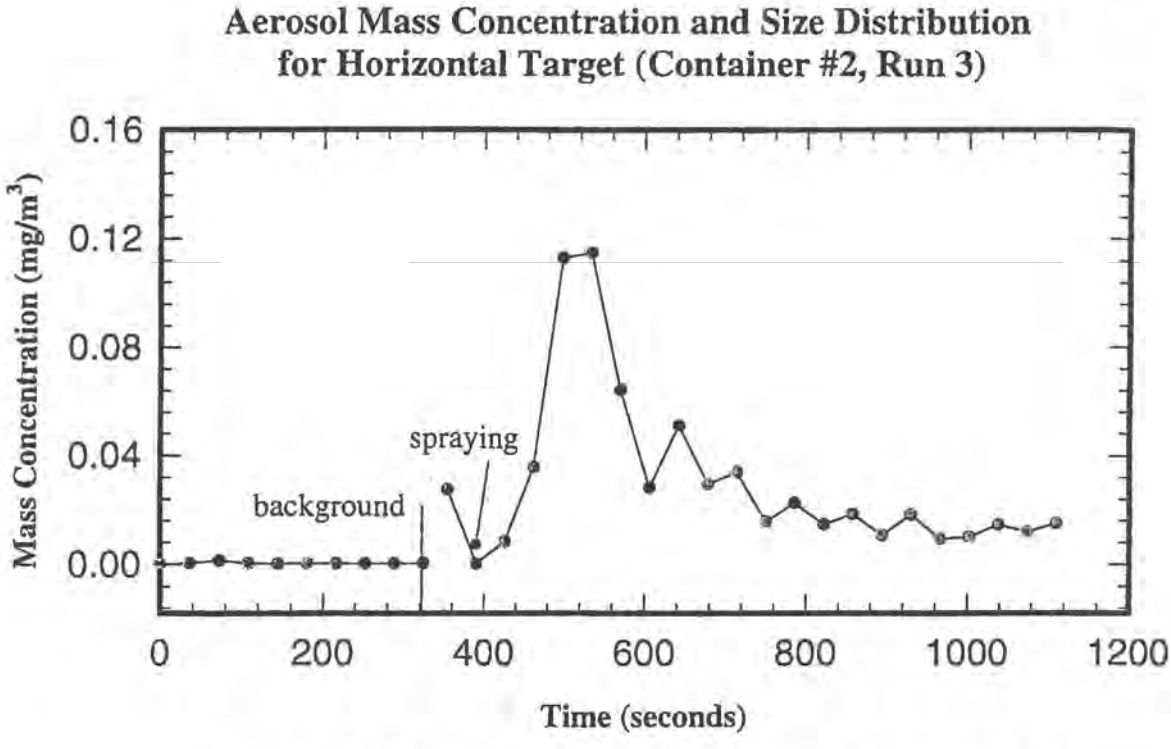


Figure B-11. Aerosol Mass Concentration as a Function of Time.

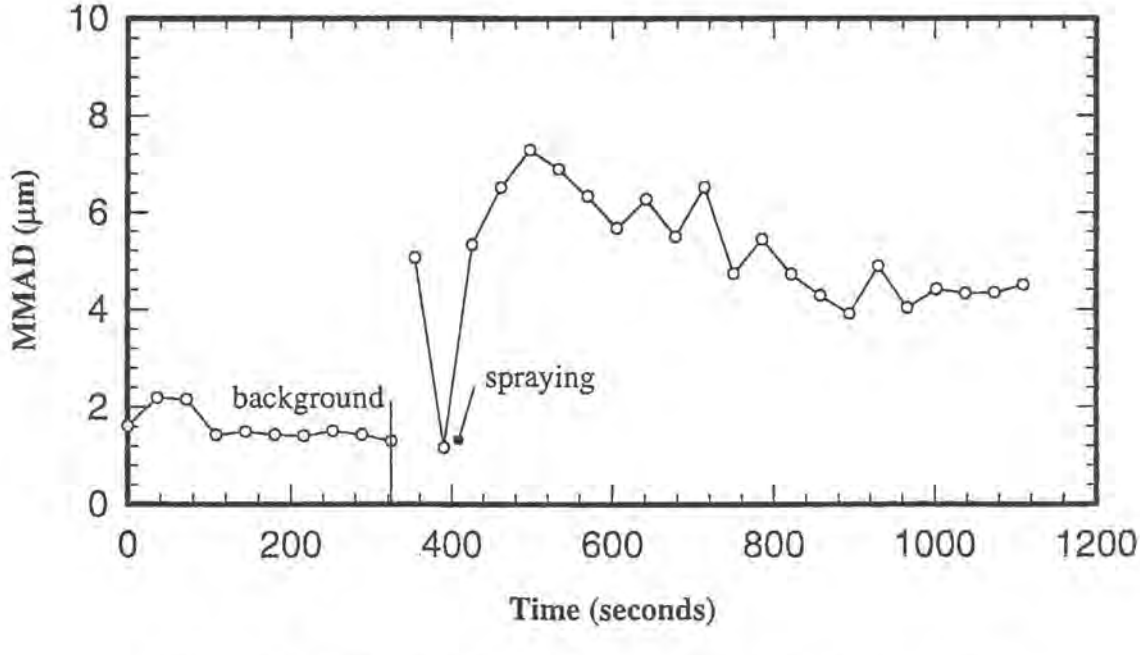


Figure B-12. Aerosol Size Distribution as a Function of Time.

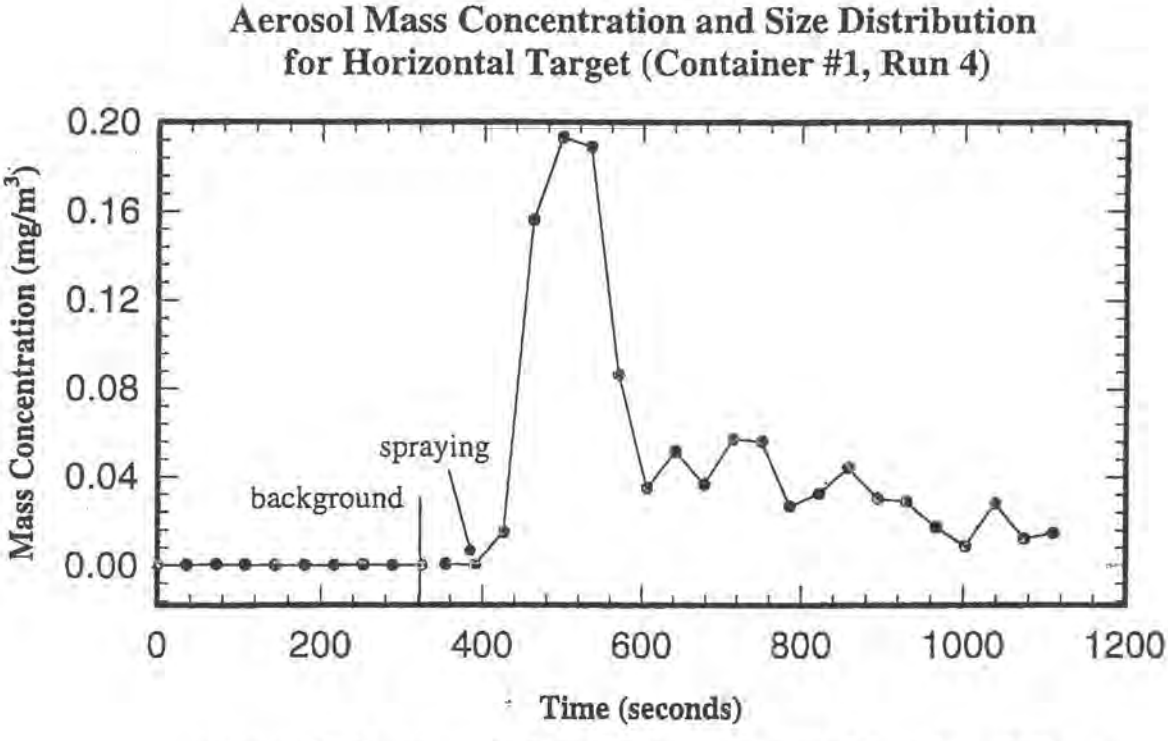


Figure B-13. Aerosol Mass Concentration as a Function of Time.

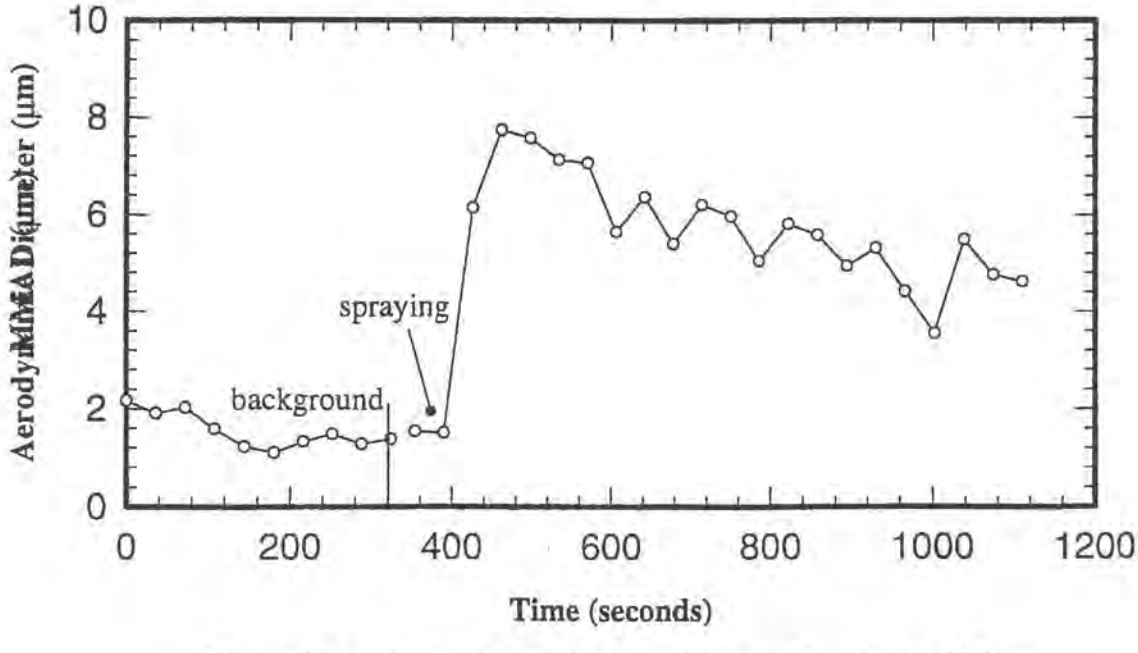


Figure B-14. Aerosol Size Distribution as a Function of Time.

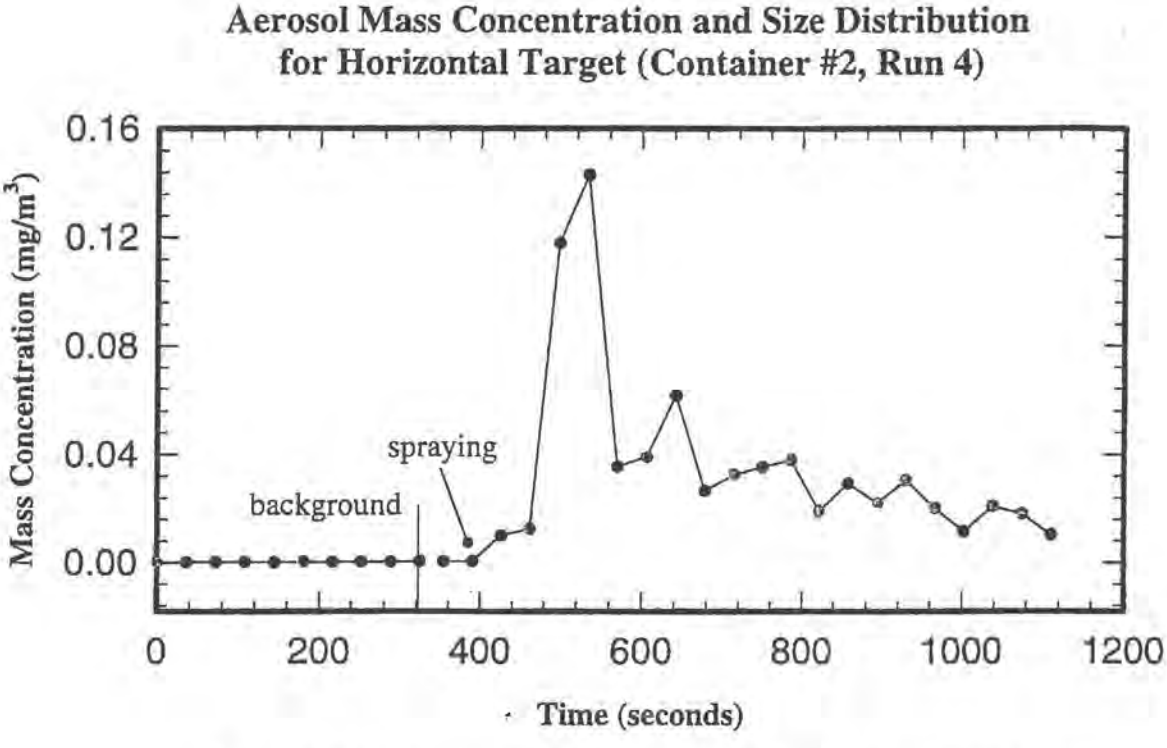


Figure B-15. Aerosol Mass Concentration as a Function of Time.

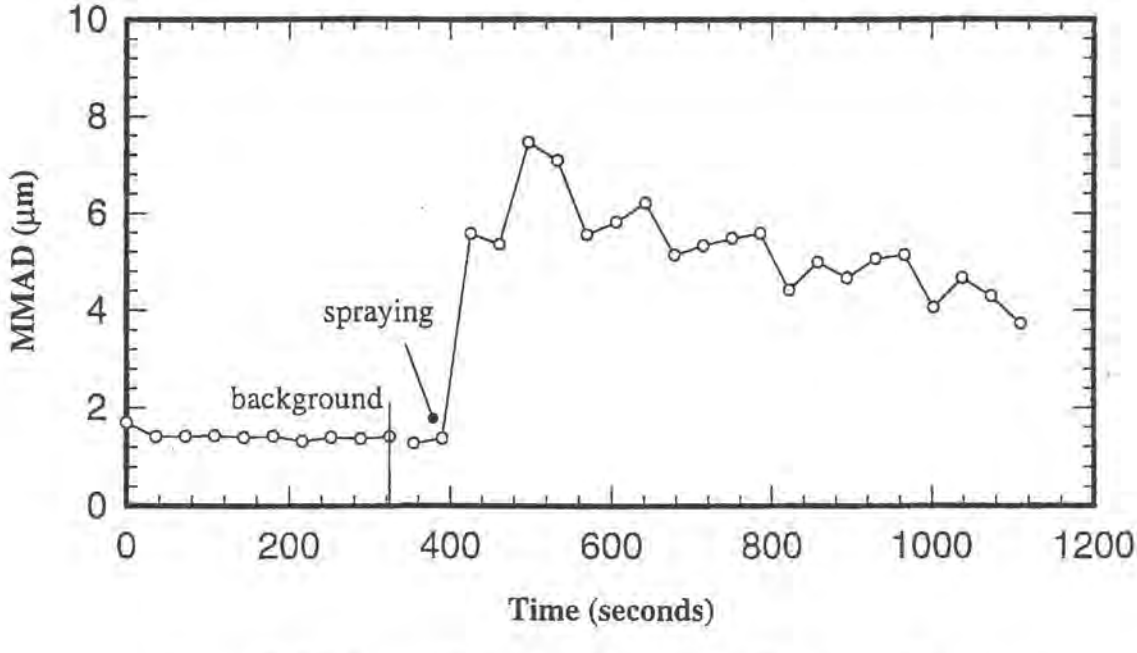


Figure B-16. Aerosol Size Distribution as a Function of Time.

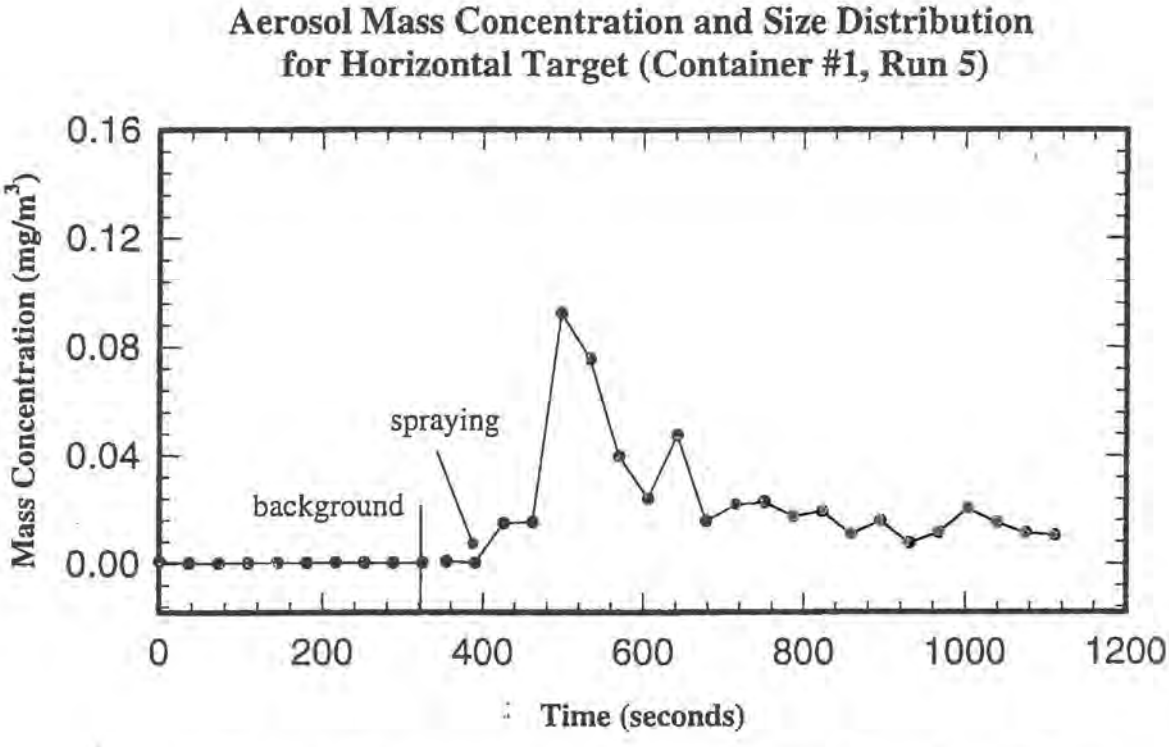


Figure B-17. Aerosol Mass Concentration as a Function of Time.

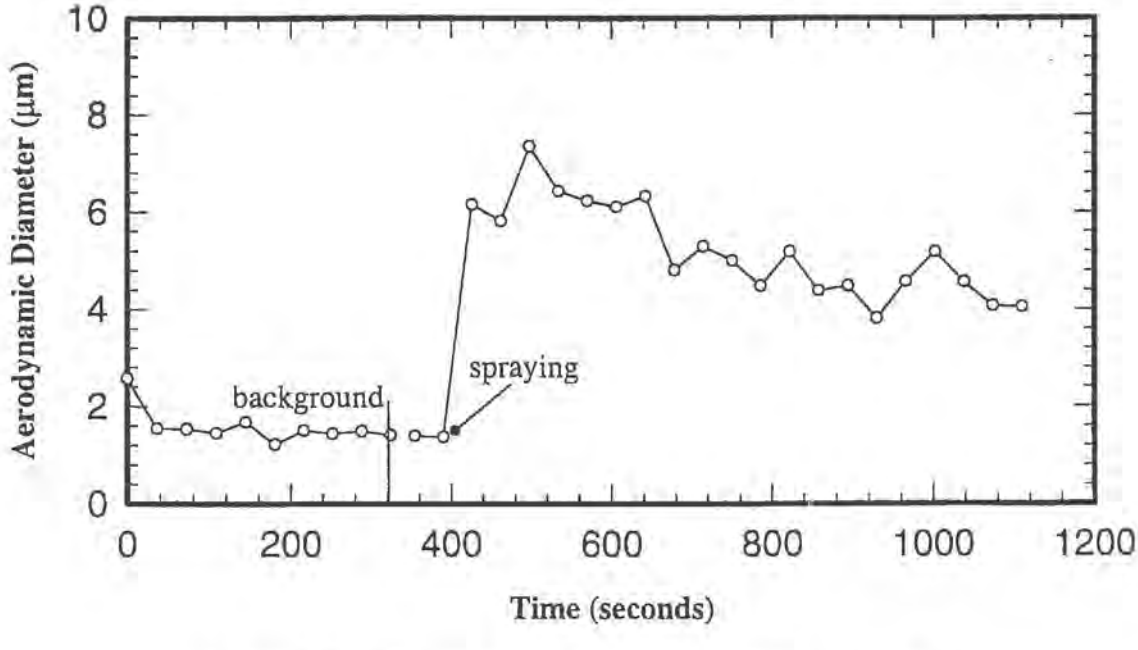


Figure B-18. Aerosol Size Distribution as a Function of Time.

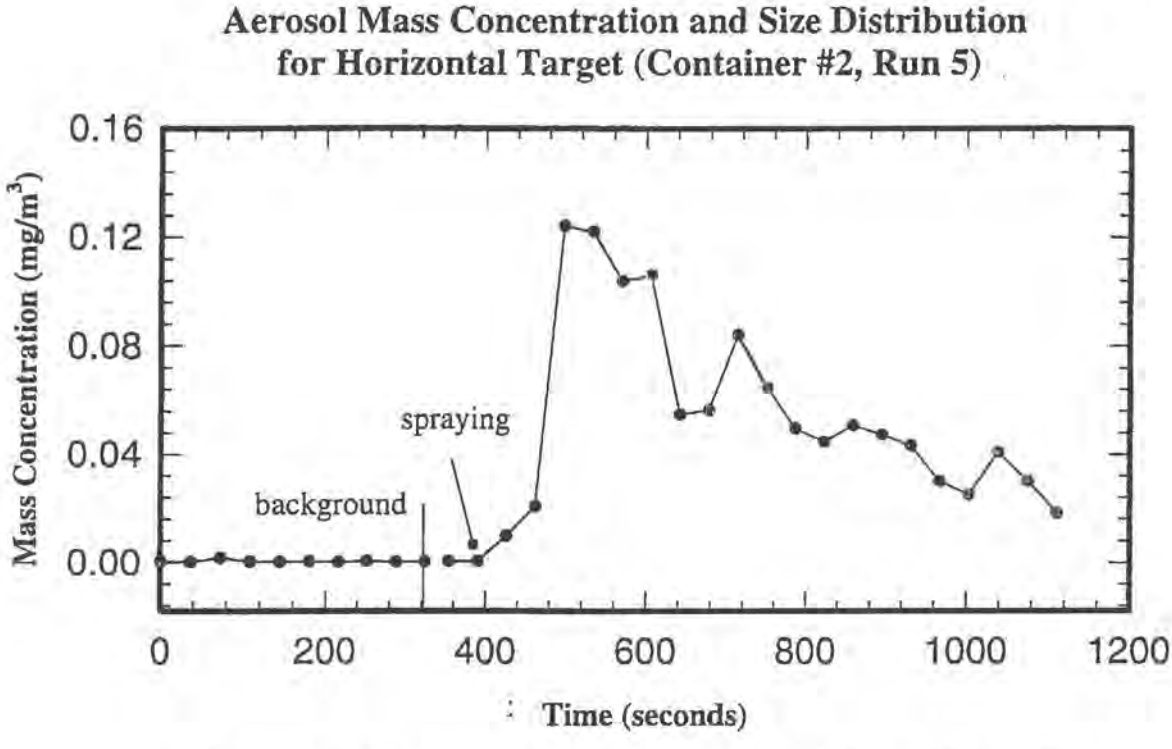


Figure B-19. Aerosol Mass Concentration as a Function of Time.

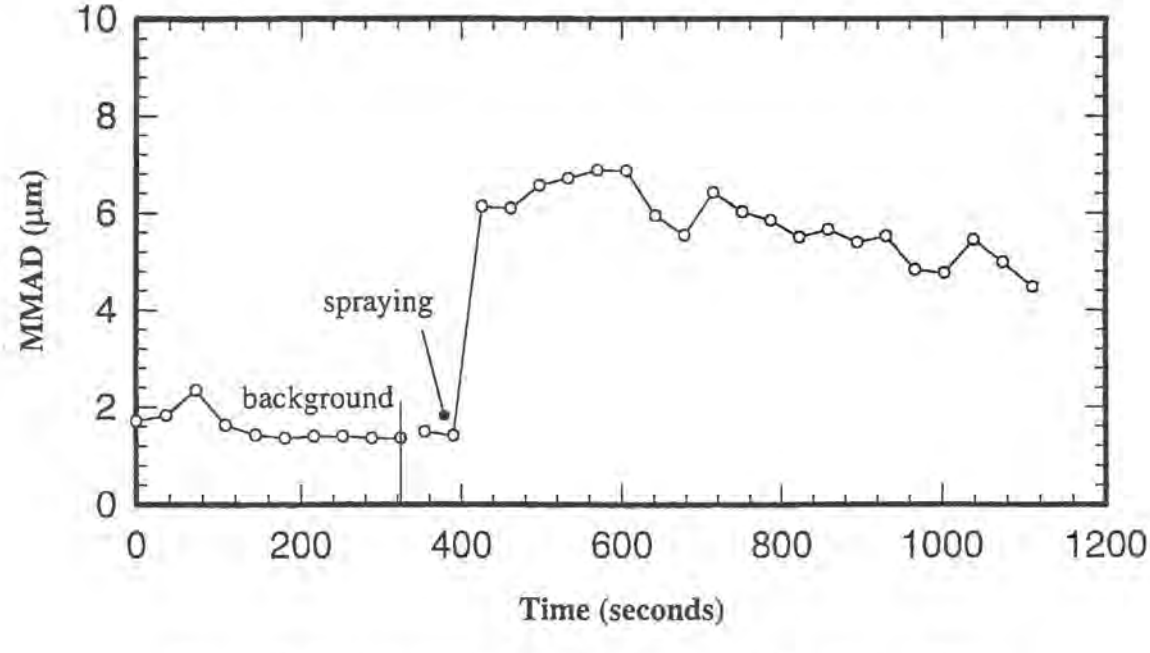


Figure B-20. Aerosol Size Distribution as a Function of Time.

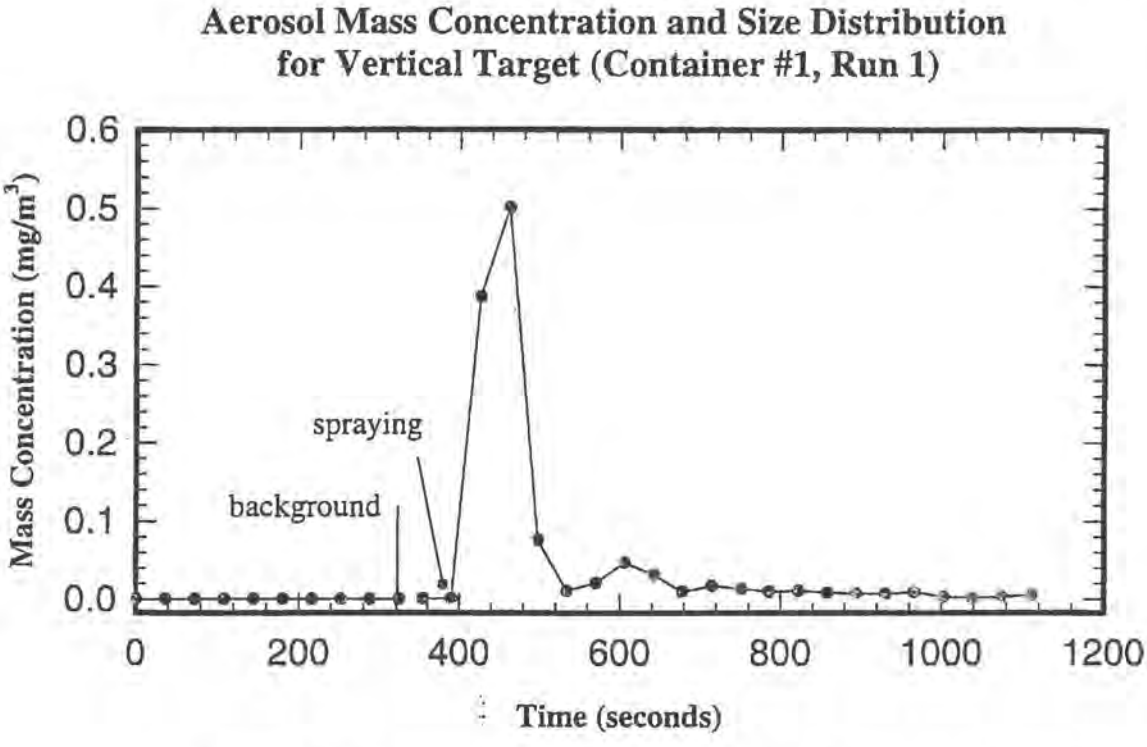


Figure B-21. Aerosol Mass Concentration as a Function of Time.

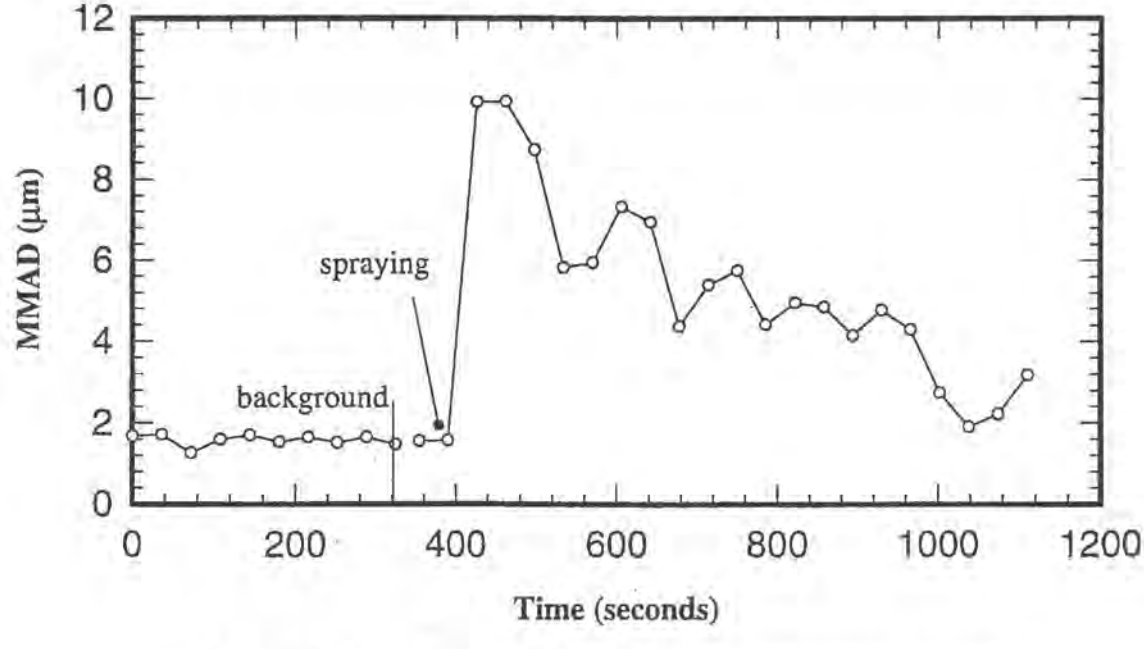


Figure B-22. Aerosol Size Distribution as a Function of Time.

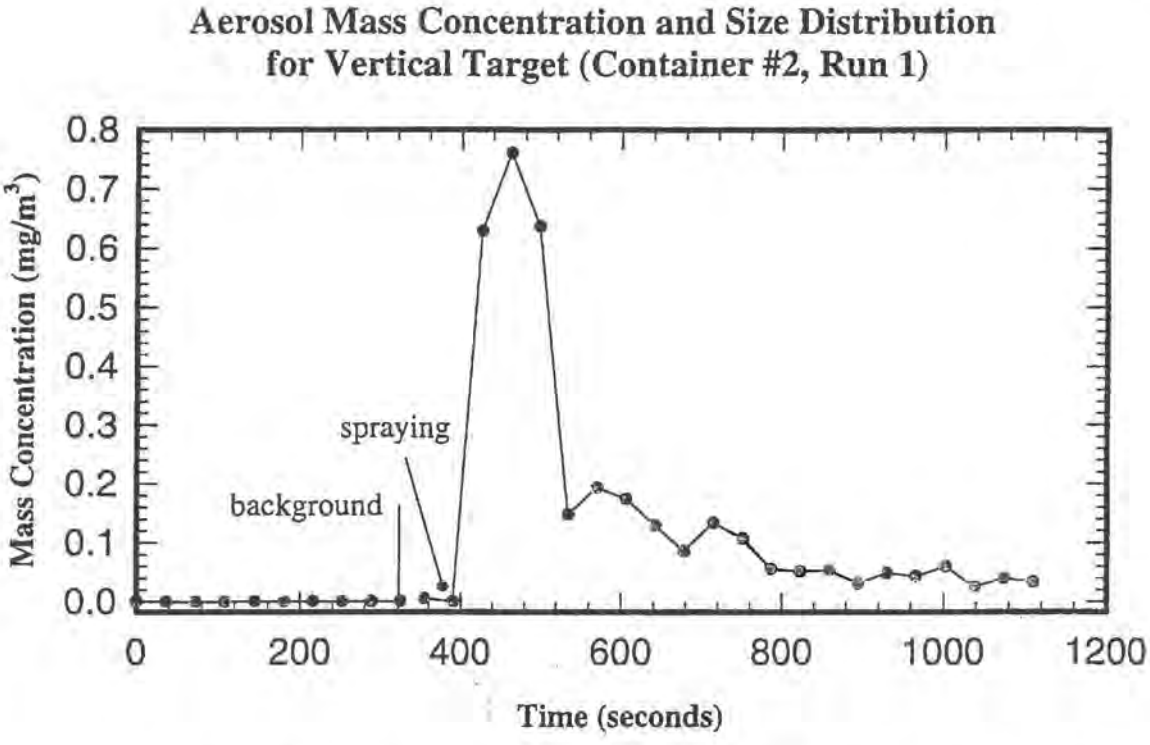


Figure B-23. Aerosol Mass Concentration as a Function of Time.

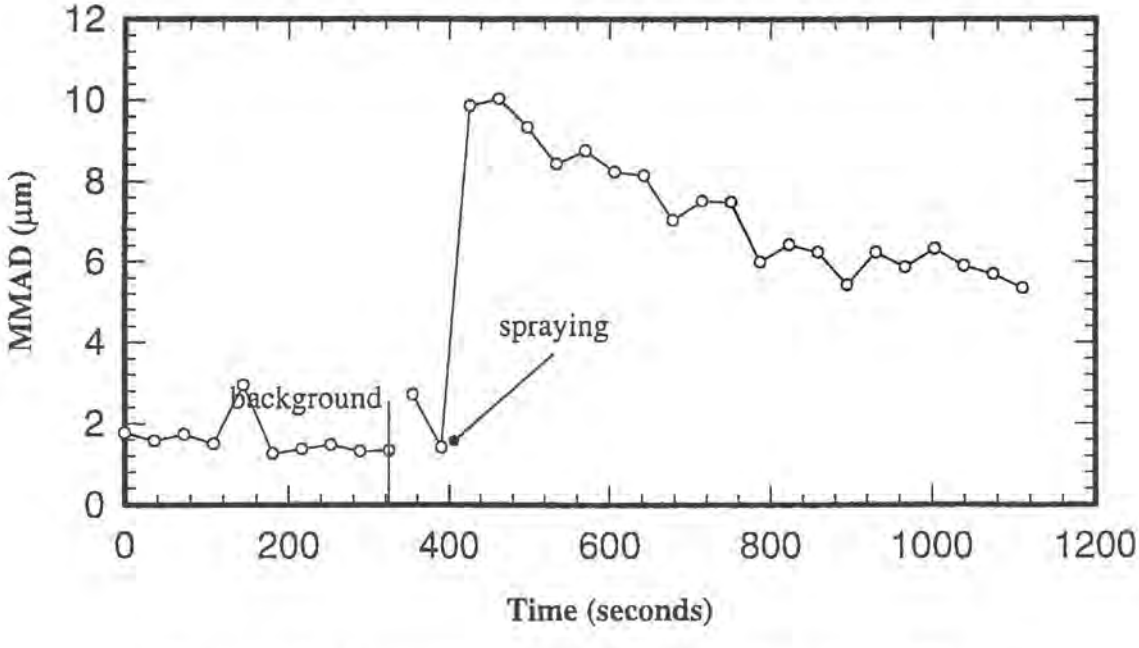


Figure B-24. Aerosol Size Distribution as a Function of Time.

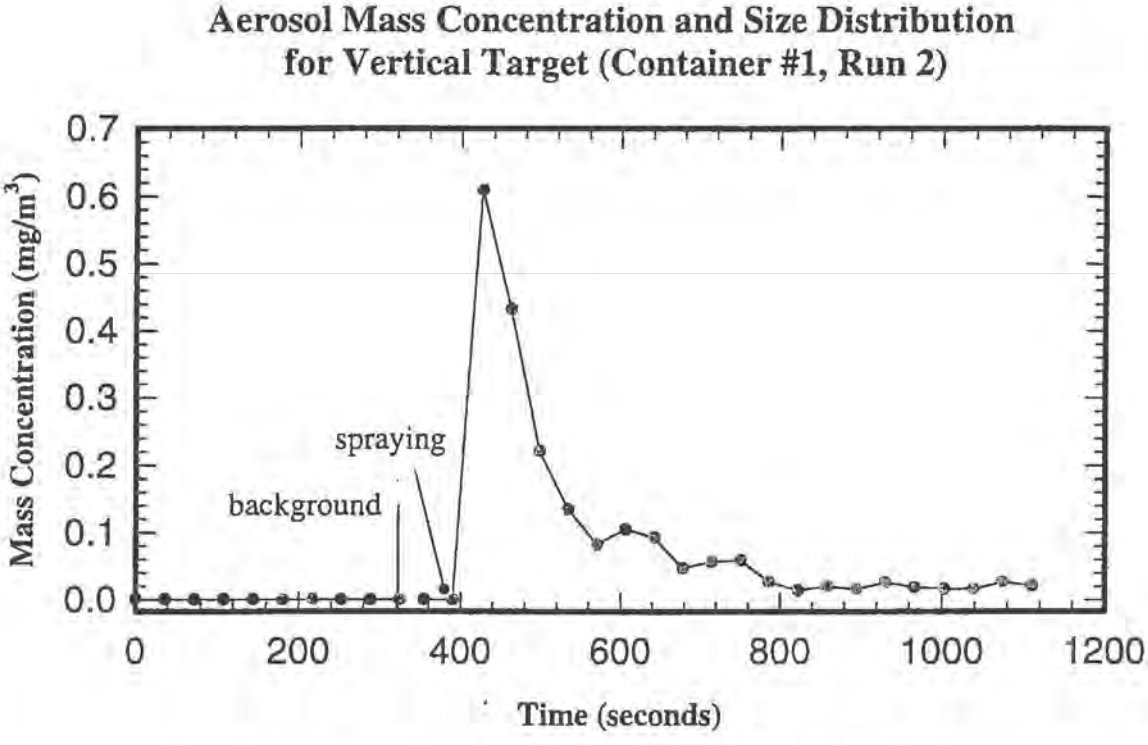


Figure B-25. Aerosol Mass Concentration as a Function of Time.

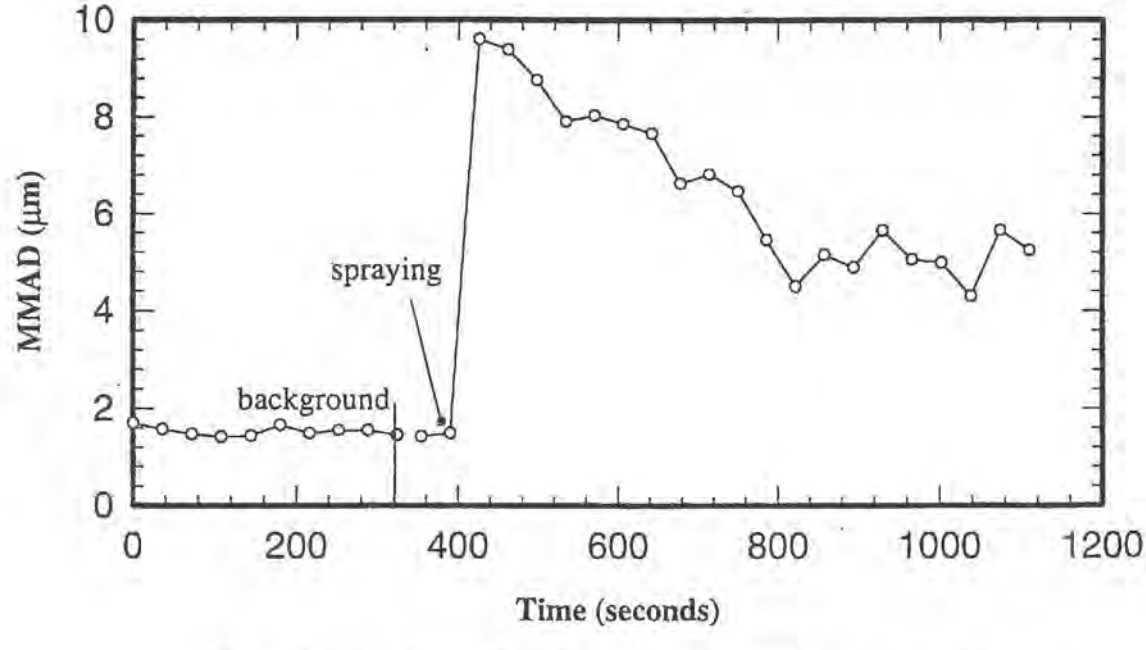


Figure B-26. Aerosol Size Distribution as a Function of Time.

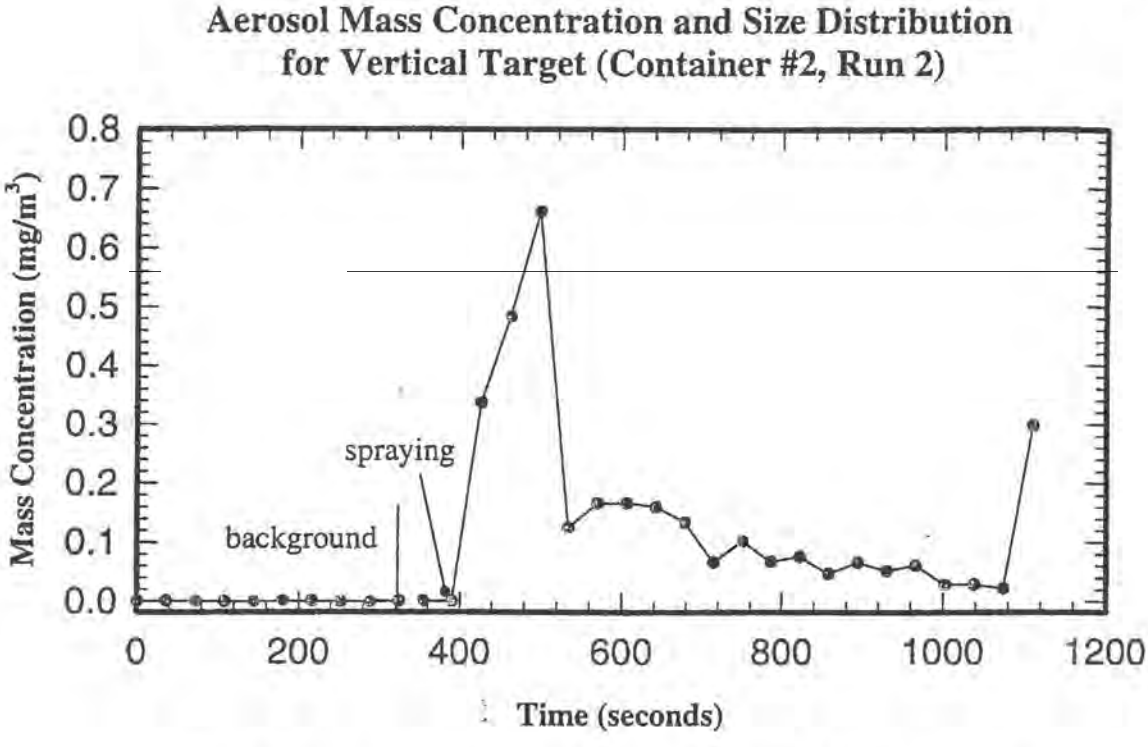


Figure B-27. Aerosol Mass Concentration as a Function of Time.

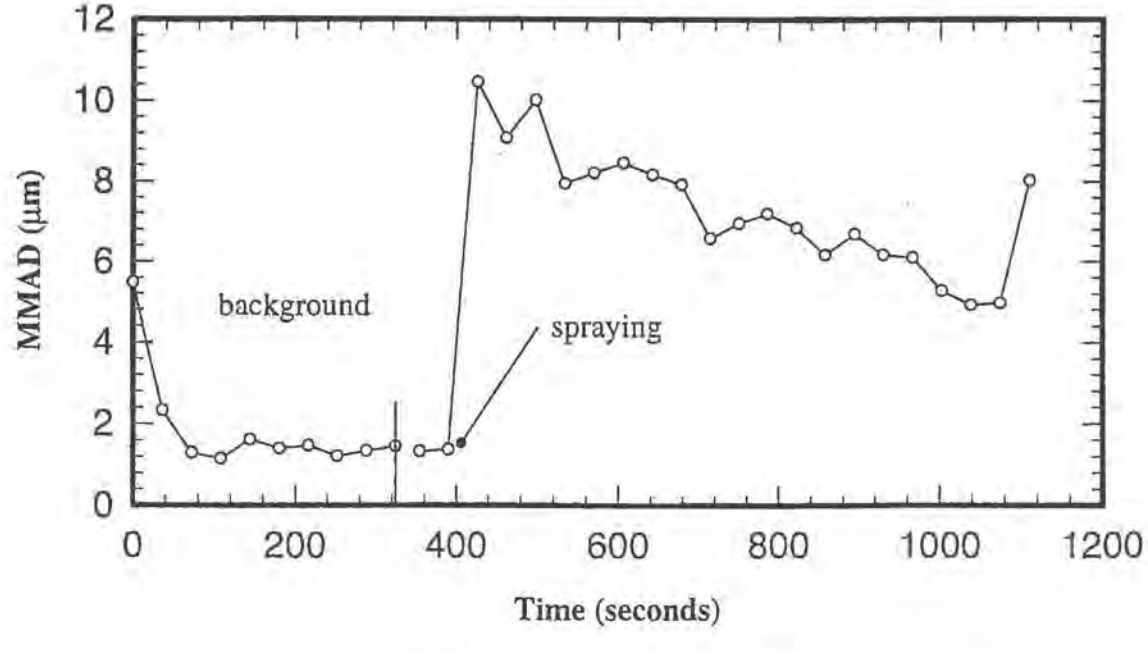


Figure B-28. Aerosol Size Distribution as a Function of Time.

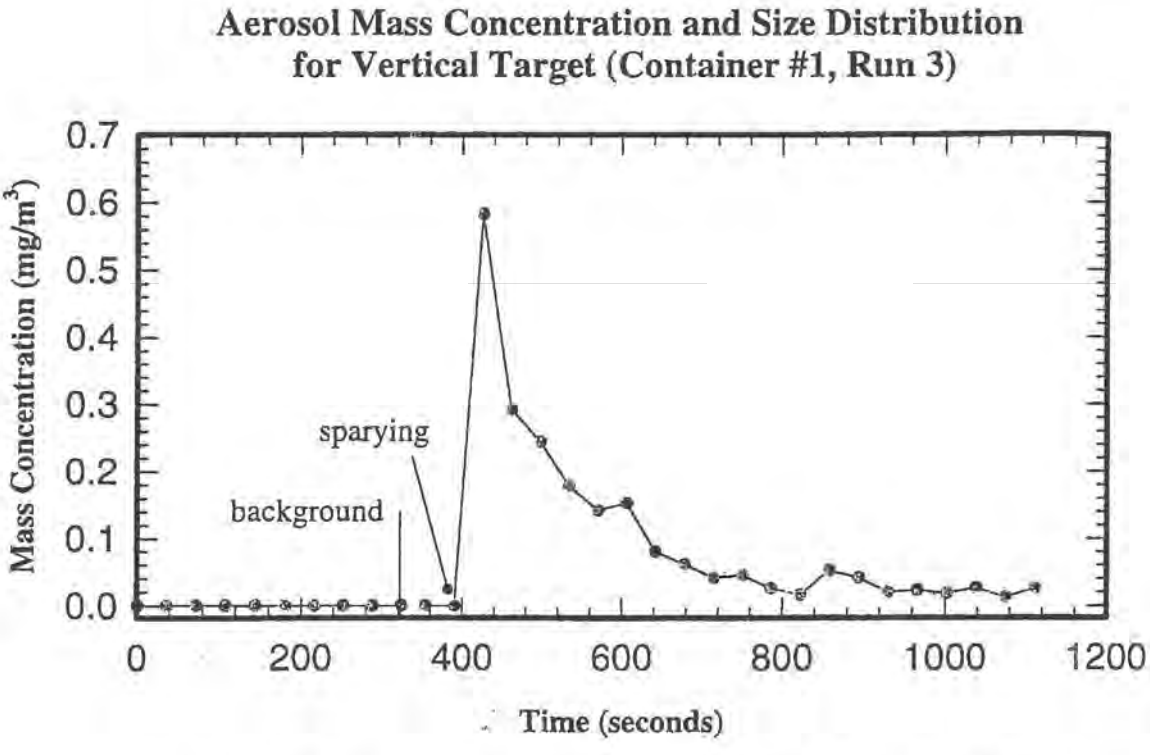


Figure B-29. Aerosol Mass Concentration as a Function of Time.

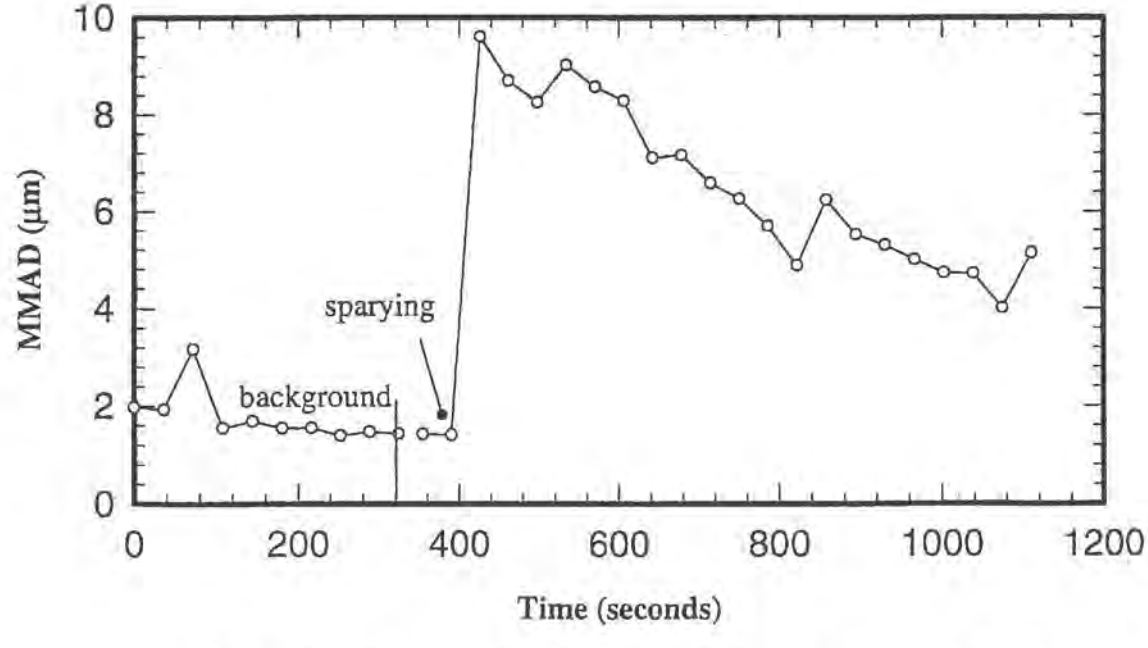


Figure B-30. Aerosol Size Distribution as a Function of Time.

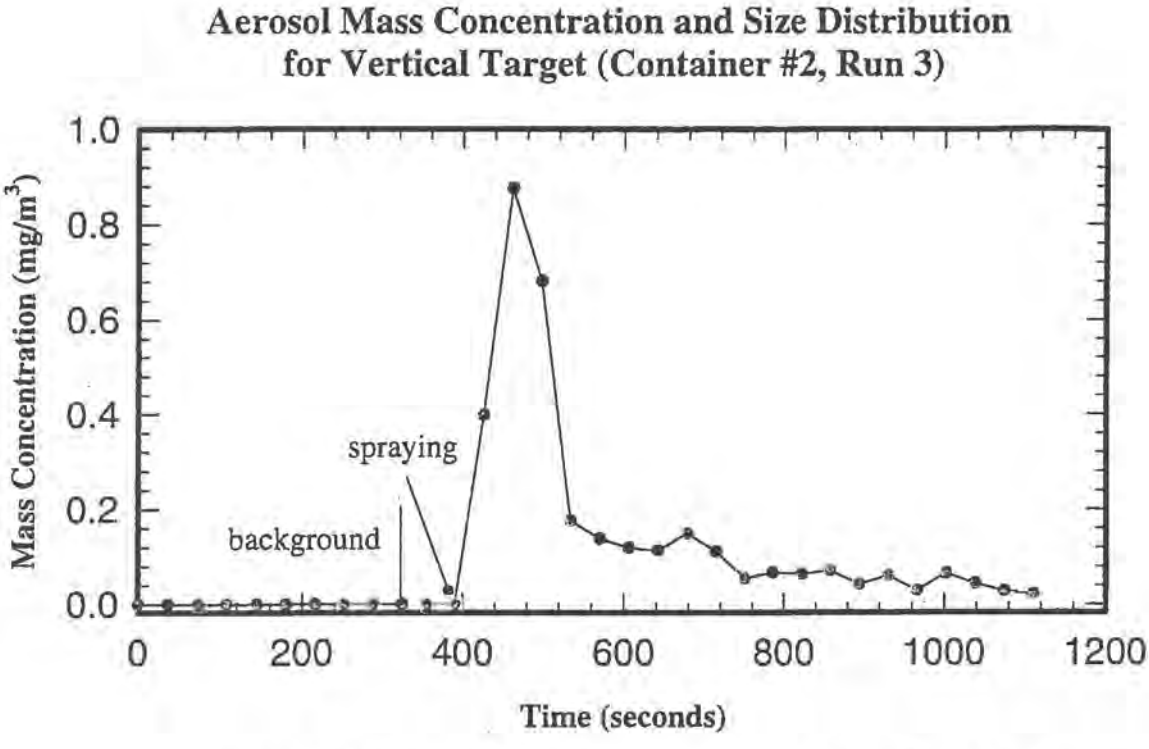


Figure B-31. Aerosol Mass Concentration as a Function of Time.

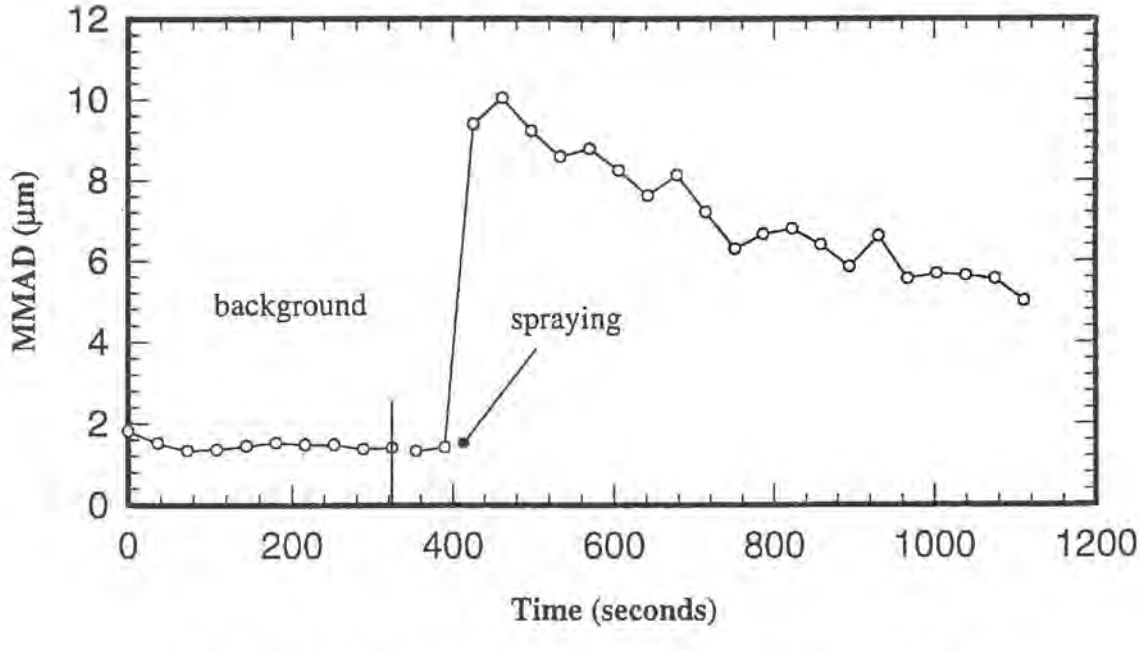


Figure B-32. Aerosol Size Distribution as a Function of Time.

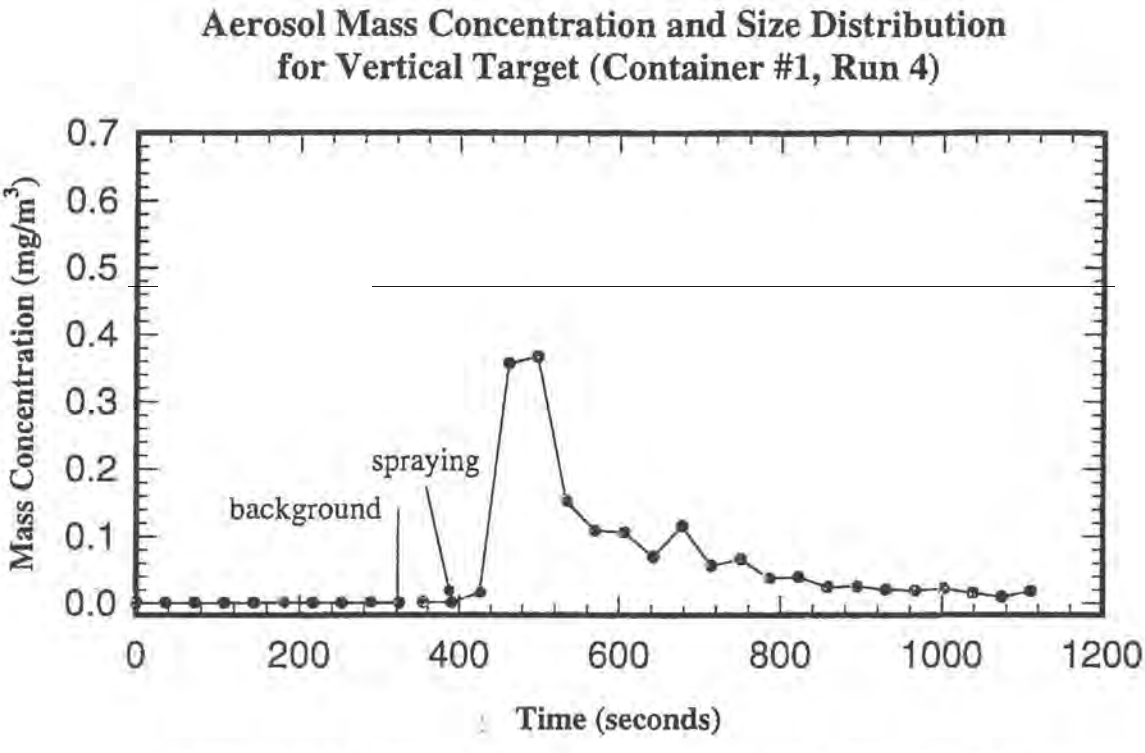


Figure B-33. Aerosol Mass Concentration as a Function of Time.

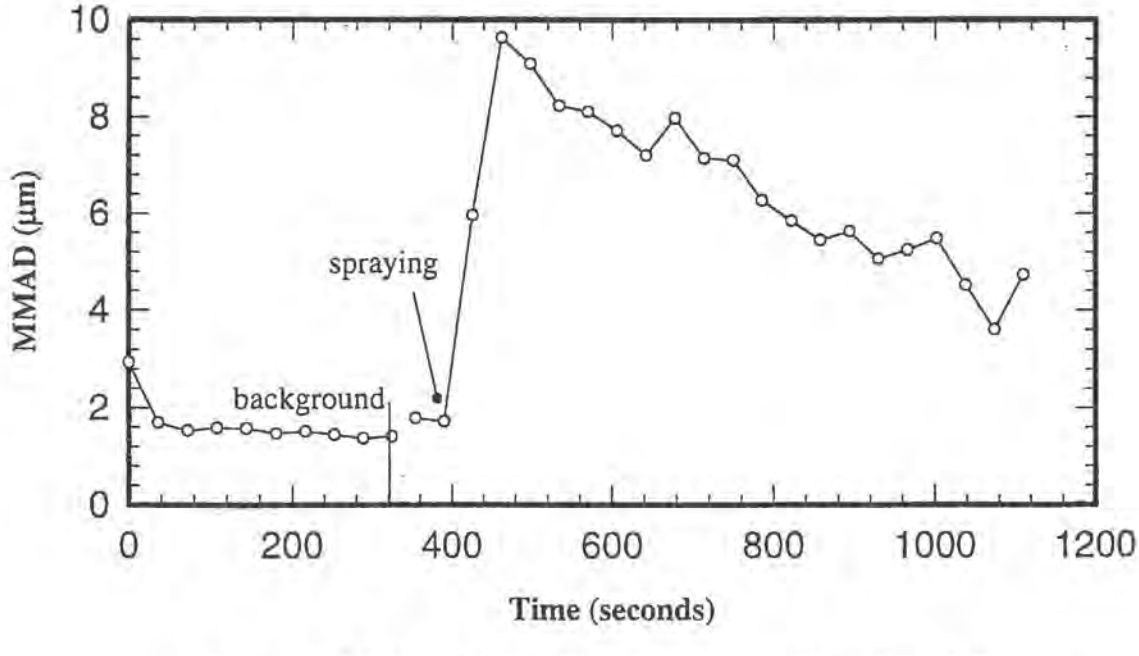


Figure B-34. Aerosol Size Distribution as a Function of Time.

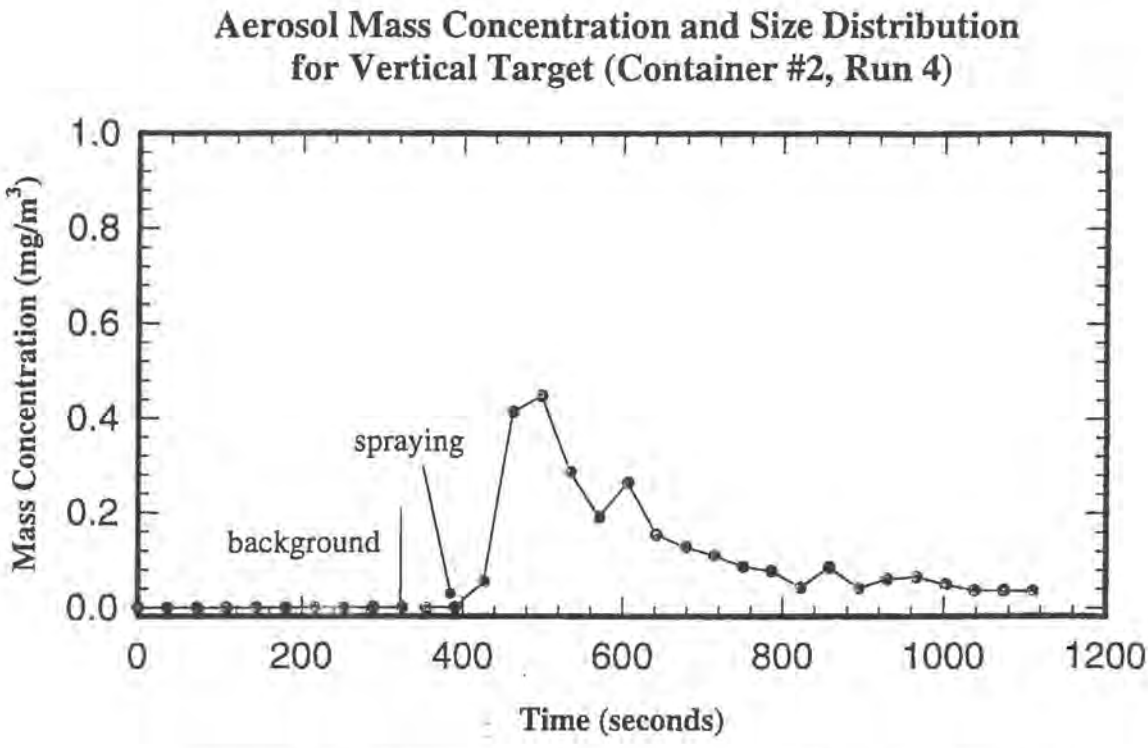


Figure B-35. Aerosol Mass Concentration as a Function of Time.

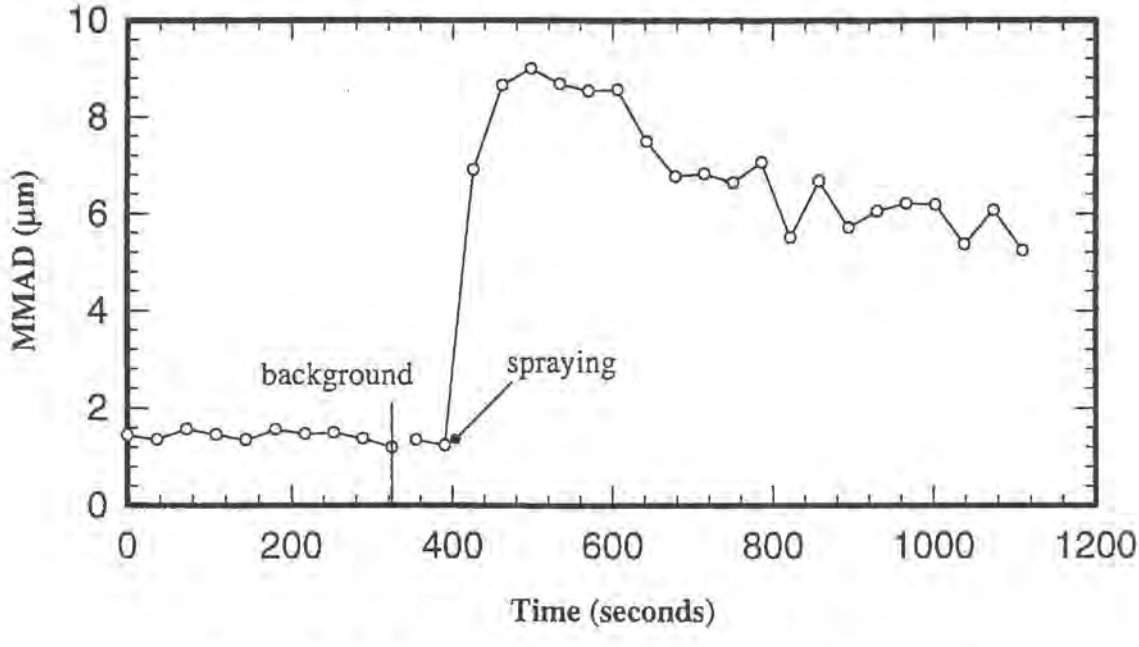


Figure B-36. Aerosol Size Distribution as a Function of Time.

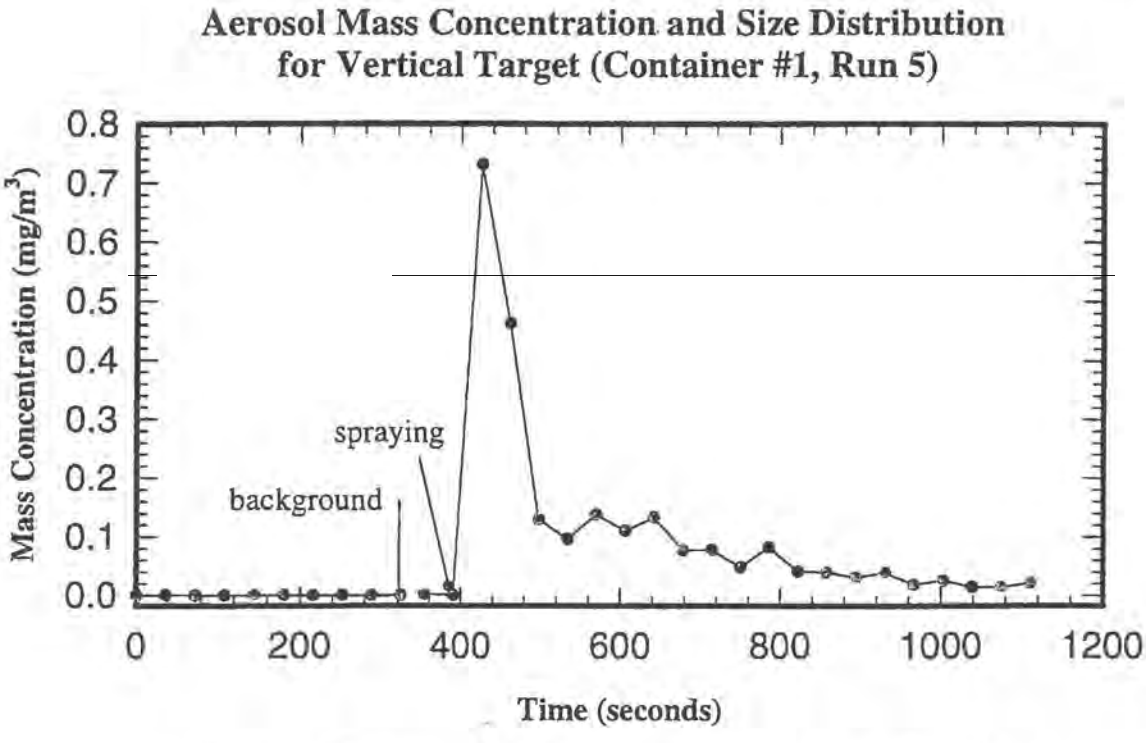


Figure B-37. Aerosol Mass Concentration as a Function of Time.

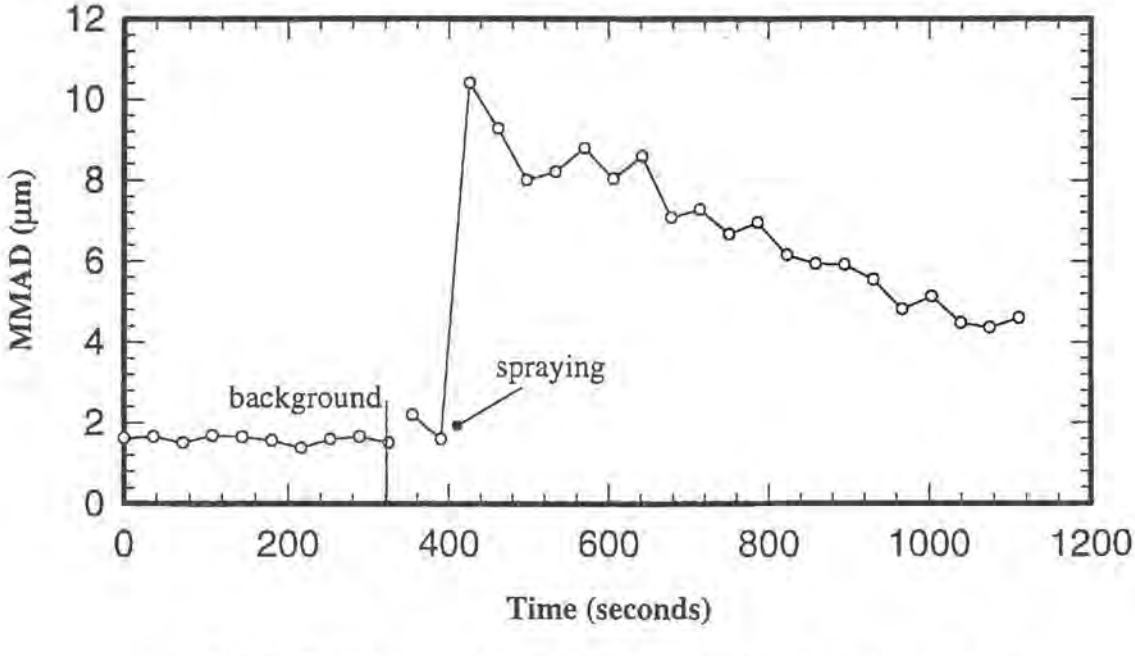


Figure B-38. Aerosol Size Distribution as a Function of Time.

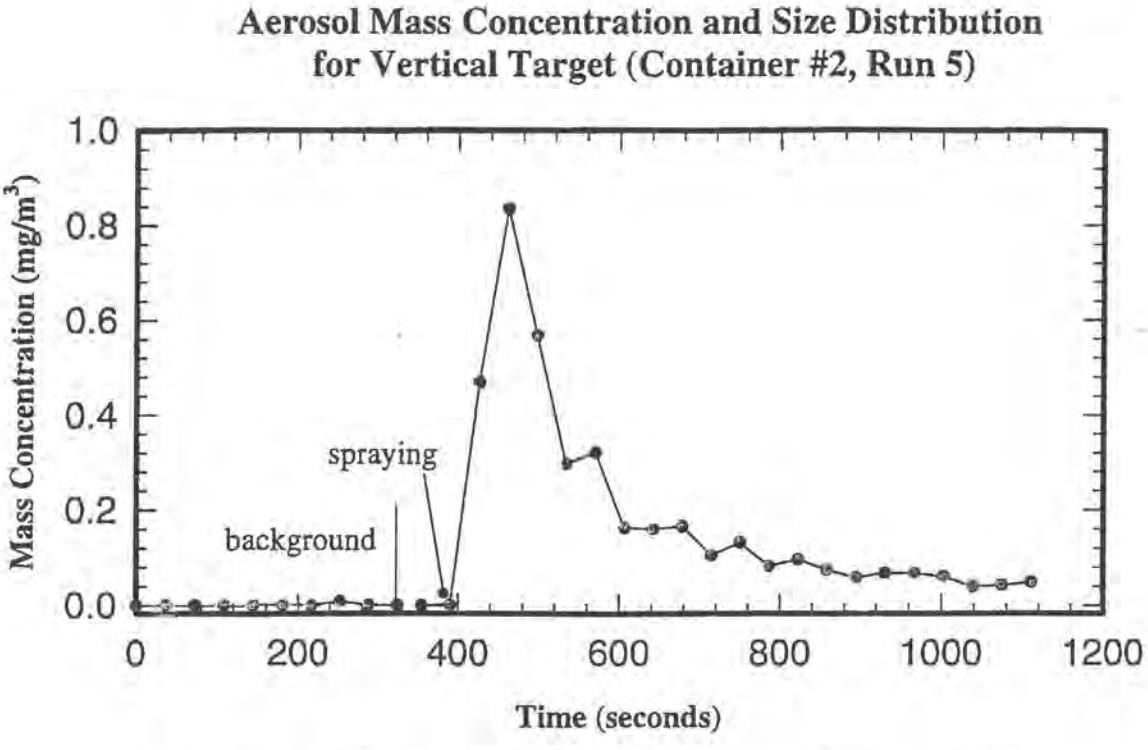


Figure B-39. Aerosol Mass Concentration as a Function of Time.

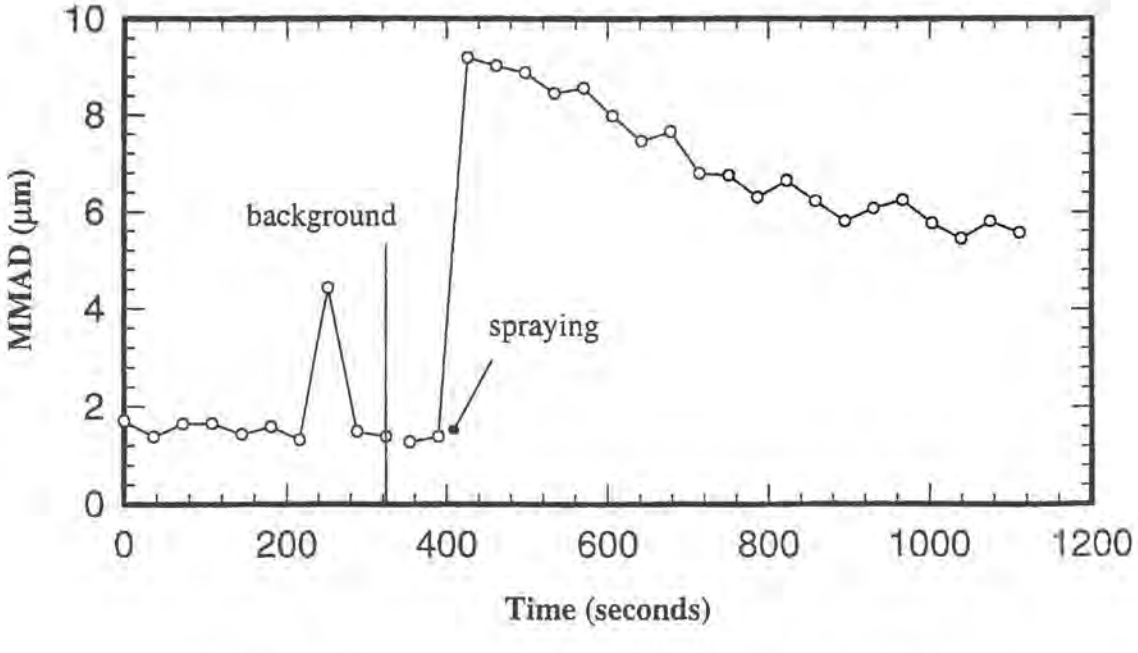


Figure B-40. Aerosol Size Distribution as a Function of Time.

Appendix C. Size Distribution Measured by the Malvern

MALVERN MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 1
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 1 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 1
Record Number: 1

Measured: Wed Jul 15 1998 1:35PM
Analysed: Wed Jul 15 1998 1:35PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 11.7 %
Residual: 2.429 %

Result Statistics

Distribution Type: Volume
Mean Diameters:
D [4, 3] = 394.39 um

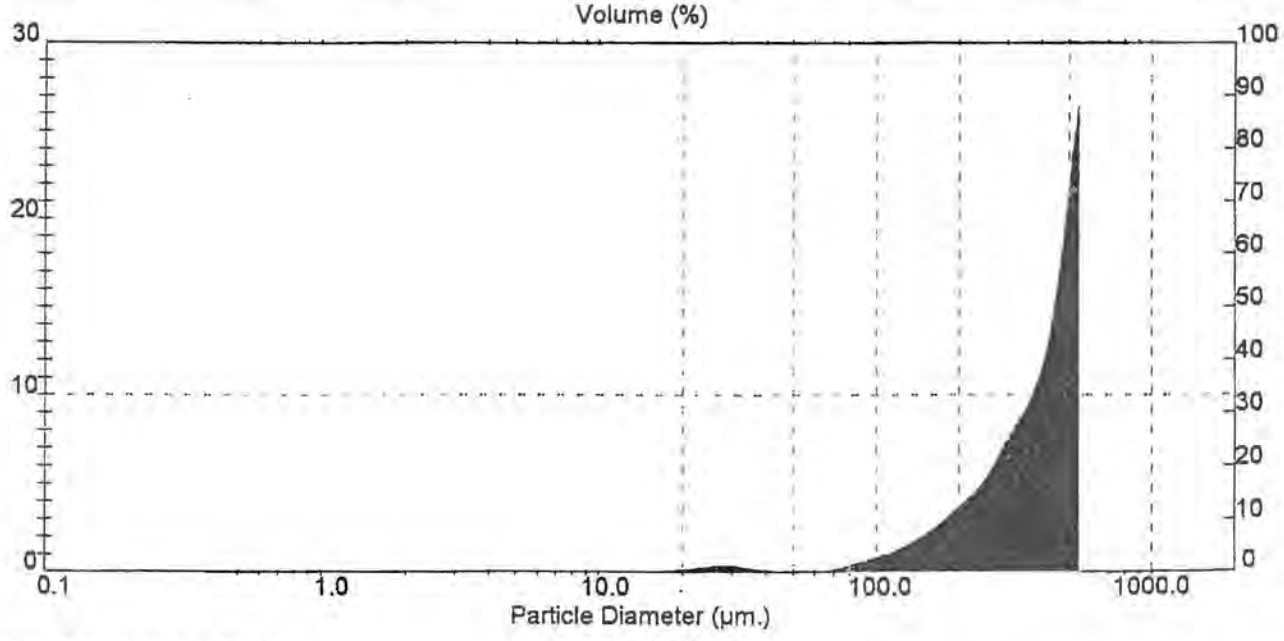
Concentration = 0.4722 %Vol
D (v, 0.1) = 178.83 um
D [3, 2] = 273.71 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 428.05 um
Span = 9.112E-01

Specific S.A. = 0.0219 sq. m / g
D (v, 0.84) = 550.50 um
Uniformity = 2.808E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.00	14.08	0.00
14.08	0.09	17.15	0.09
17.15	0.22	20.90	0.31
20.90	0.40	25.46	0.71

Size Low (um)	In %	Size High (um)	Under%
25.46	0.51	31.01	1.22
31.01	0.38	37.79	1.60
37.79	0.12	46.03	1.71
46.03	0.00	56.09	1.72
56.09	0.07	68.33	1.79
68.33	0.43	83.26	2.21
83.26	0.95	101.44	3.16
101.44	1.49	123.59	4.65
123.59	2.38	150.57	7.03
150.57	3.50	183.44	10.53
183.44	5.03	223.51	15.56
223.51	6.83	272.31	22.40
272.31	9.82	331.77	32.21
331.77	13.00	404.21	45.24
404.21	20.57	492.47	65.86
492.47	34.22	600.00	100.00



MALVERN INSTRUMENTS MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 1
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 1 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 2
Record Number: 2

Measured: Wed Jul 15 1998 1:39PM
Analysed: Wed Jul 15 1998 1:39PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 16.3 %
Residual: 2.507 %

Result Statistics

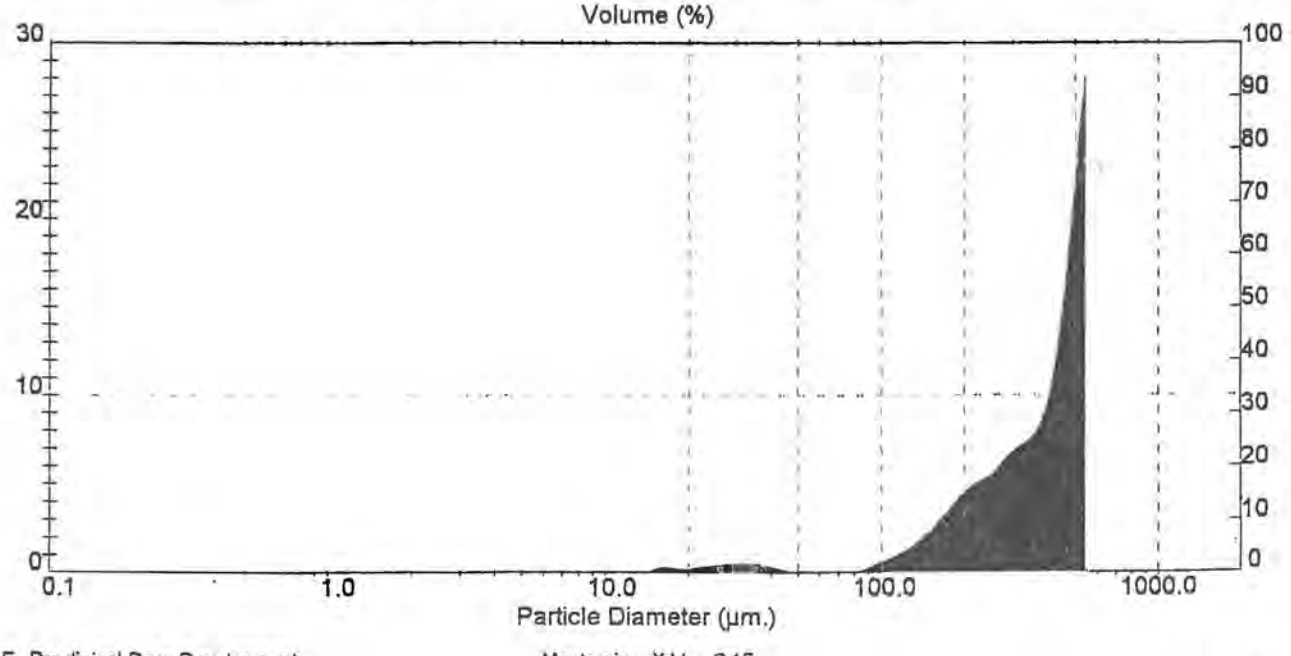
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 392.92 um

Concentration = 0.5981 %Vol
D (v, 0.1) = 173.01 um
D [3, 2] = 243.02 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 436.16 um
Span = 9.126E-01

Specific S.A. = 0.0247 sq. m / g
D (v, 0.84) = 553.94 um
Uniformity = 2.871E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.00	14.08	0.01
14.08	0.41	17.15	0.41
17.15	0.37	20.90	0.78
20.90	0.53	25.46	1.31
25.46	0.71	31.01	2.01
31.01	0.70	37.79	2.71
37.79	0.38	46.03	3.09
46.03	0.03	56.09	3.12
56.09	0.00	68.33	3.12
68.33	0.00	83.26	3.13
83.26	0.54	101.44	3.66
101.44	1.26	123.59	4.93
123.59	2.40	150.57	7.34
150.57	4.09	183.44	11.42
183.44	6.04	223.51	17.46
223.51	7.17	272.31	24.64
272.31	8.93	331.77	33.56
331.77	10.67	404.21	44.26
404.21	19.42	492.47	63.74
492.47	36.35	600.00	100.00



MALVERN INSTRUMENTS MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 1
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 1 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 3
Record Number: 3

Measured: Wed Jul 15 1998 1:41PM
Analysed: Wed Jul 15 1998 1:41PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

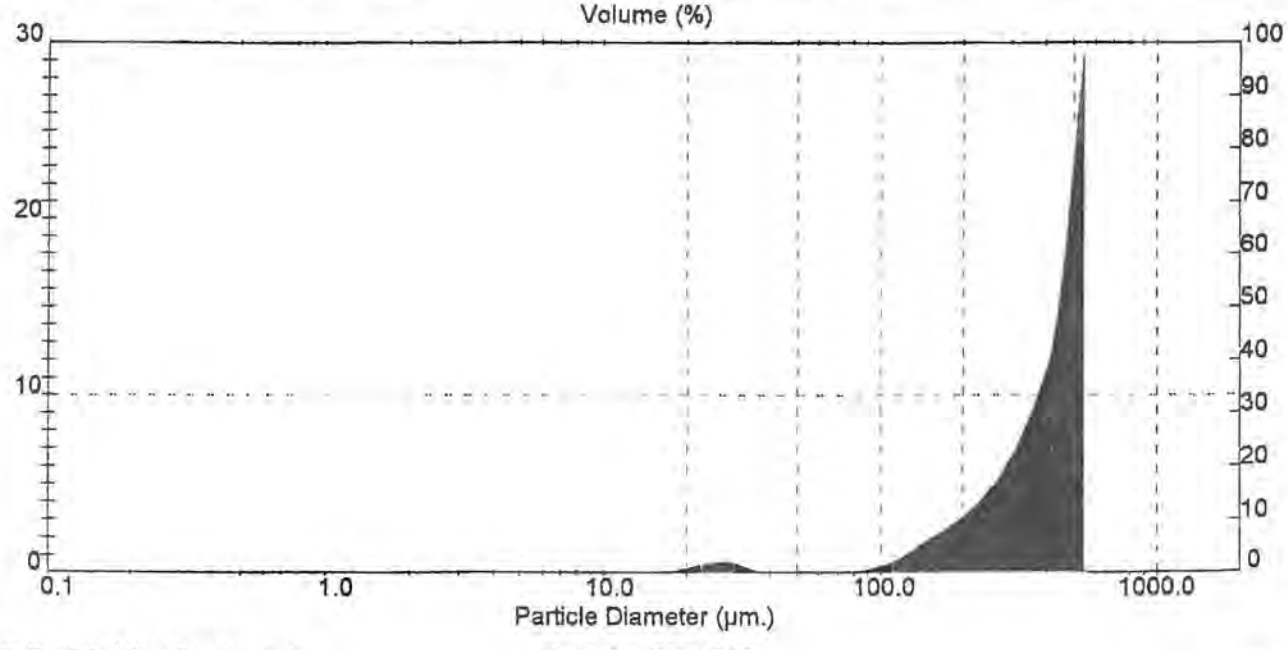
Sampler: None

Obscuration: 14.9 %
Residual: 3.600 %

Result Statistics

Distribution Type: Volume
Concentration = 0.6054 %Vol
Density = 1.000 g / cub. cm
Specific S.A. = 0.0221 sq. m / g
Mean Diameters:
D (v, 0.1) = 196.36 um
D (v, 0.5) = 448.24 um
D (v, 0.84) = 555.83 um
D [4, 3] = 408.62 um
D [3, 2] = 271.30 um
Span = 8.385E-01
Uniformity = 2.501E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.00	14.08	0.00
14.08	0.13	17.15	0.13
17.15	0.33	20.90	0.46
20.90	0.70	25.46	1.16
25.46	0.83	31.01	1.99
31.01	0.33	37.79	2.32
37.79	0.00	46.03	2.32
46.03	0.00	56.09	2.32
56.09	0.00	68.33	2.32
68.33	0.00	83.26	2.33
83.26	0.36	101.44	2.68
101.44	0.92	123.59	3.60
123.59	2.01	150.57	5.62
150.57	3.06	183.44	8.68
183.44	4.30	223.51	12.98
223.51	6.07	272.31	19.05
272.31	8.79	331.77	27.82
331.77	12.88	404.21	40.73
404.21	21.28	492.47	62.07
492.47	38.02	600.00	100.00



MALVERN INSTRUMENTS

MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 1
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 1 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 4
Record Number: 4

Measured: Wed Jul 15 1998 1:43PM
Analysed: Wed Jul 15 1998 1:43PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 13.0 %
Residual: 6.756 %

Result Statistics

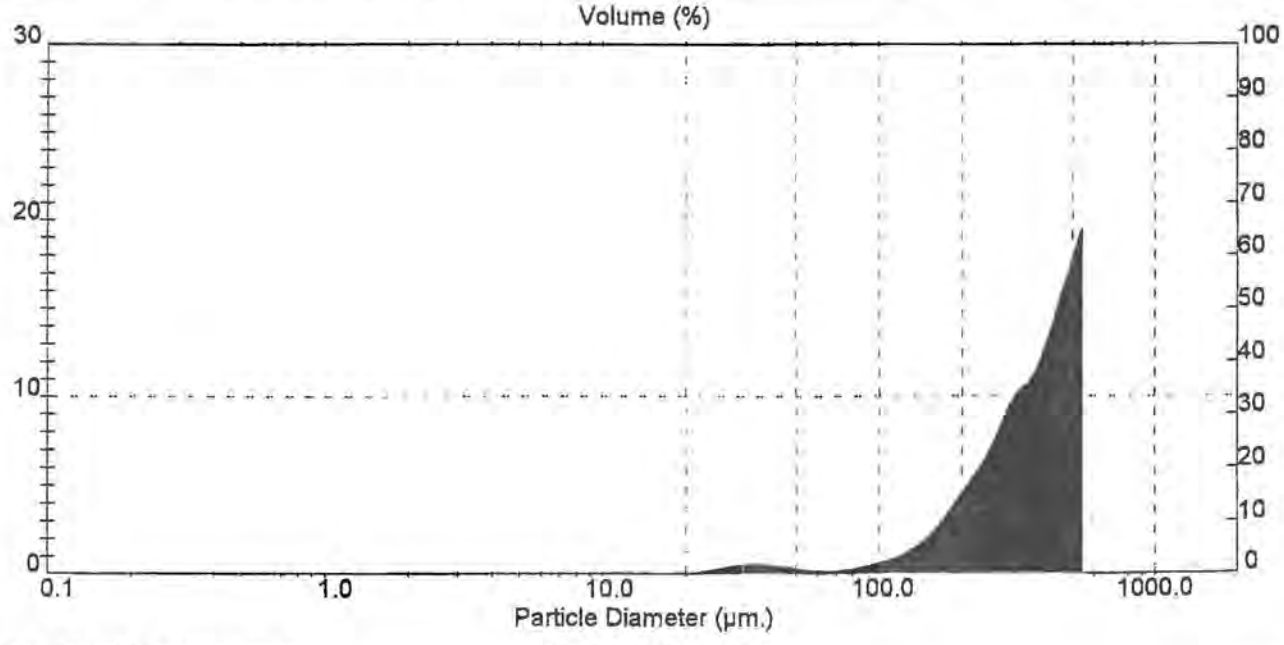
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 368.66 um

Concentration = 0.4878 %Vol
D (v, 0.1) = 172.47 um
D [3, 2] = 252.69 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 383.00 um
Span = 1.002E+00

Specific S.A. = 0.0237 sq. m / g
D (v, 0.84) = 530.89 um
Uniformity = 3.158E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.00	14.08	0.00
14.08	0.00	17.15	0.00
17.15	0.10	20.90	0.10
20.90	0.30	25.46	0.40
25.46	0.58	31.01	0.98
31.01	0.77	37.79	1.75
37.79	0.67	46.03	2.42
46.03	0.42	56.09	2.84
56.09	0.29	68.33	3.13
68.33	0.37	83.26	3.50
83.26	0.70	101.44	4.20
101.44	1.22	123.59	5.42
123.59	2.15	150.57	7.57
150.57	3.88	183.44	11.45
183.44	6.30	223.51	17.76
223.51	9.02	272.31	26.79
272.31	12.68	331.77	39.46
331.77	15.06	404.21	54.53
404.21	20.26	492.47	74.80
492.47	25.23	600.00	100.00



MALVERN INSTRUMENTS MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 1
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 1 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 5
Record Number: 5

Measured: Wed Jul 15 1998 1:45PM
Analysed: Wed Jul 15 1998 1:45PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 13.4 %
Residual: 4.929 %

Result Statistics

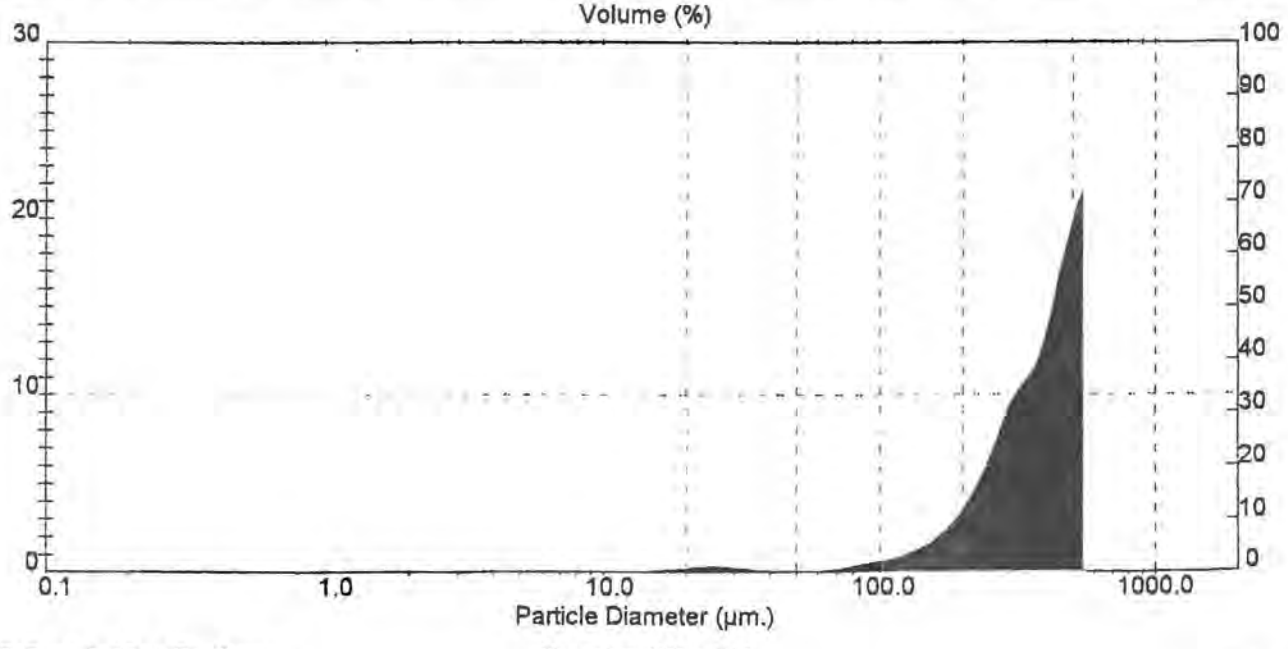
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 384.56 um

Concentration = 0.5227 %Vol
D (v, 0.1) = 194.80 um
D [3, 2] = 263.25 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 403.82 um
Span = 9.046E-01

Specific S.A. = 0.0228 sq. m / g
D (v, 0.84) = 537.05 um
Uniformity = 2.866E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.08	14.08	0.08
14.08	0.18	17.15	0.26
17.15	0.33	20.90	0.59
20.90	0.48	25.46	1.07
25.46	0.44	31.01	1.51
31.01	0.26	37.79	1.78
37.79	0.09	46.03	1.87
46.03	0.04	56.09	1.91
56.09	0.14	68.33	2.05
68.33	0.40	83.26	2.45
83.26	0.71	101.44	3.16
101.44	1.05	123.59	4.21
123.59	1.71	150.57	5.92
150.57	2.85	183.44	8.77
183.44	4.91	223.51	13.69
223.51	8.37	272.31	22.08
272.31	12.62	331.77	34.68
331.77	15.38	404.21	50.09
404.21	22.14	492.47	72.22
492.47	27.81	600.00	100.00



MALVERN INSTRUMENTS MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 2
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 2 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 1
Record Number: 6

Measured: Wed Jul 15 1998 1:49PM
Analysed: Wed Jul 15 1998 1:49PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 18.9 %
Residual: 4.981 %

Result Statistics

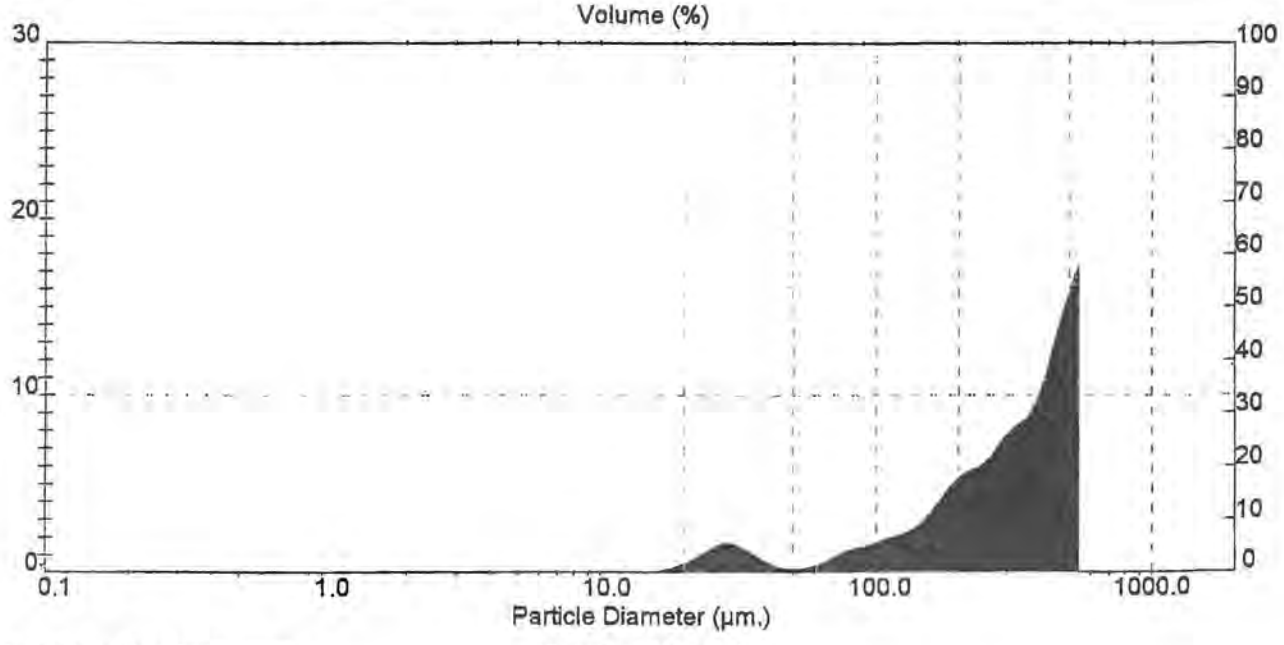
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 331.32 um

Concentration = 0.4807 %Vol
D (v, 0.1) = 89.56 um
D [3, 2] = 166.02 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 343.98 um
Span = 1.342E+00

Specific S.A. = 0.0361 sq. m / g
D (v, 0.84) = 522.88 um
Uniformity = 4.171E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.00	14.08	0.00
14.08	0.17	17.15	0.17
17.15	0.60	20.90	0.77
20.90	1.48	25.46	2.25
25.46	2.18	31.01	4.43
31.01	1.59	37.79	6.02
37.79	0.63	46.03	6.65
46.03	0.34	56.09	6.99
56.09	0.73	68.33	7.73
68.33	1.57	83.26	9.30
83.26	2.05	101.44	11.34
101.44	2.62	123.59	13.96
123.59	3.34	150.57	17.31
150.57	5.17	183.44	22.47
183.44	7.13	223.51	29.60
223.51	8.14	272.31	37.75
272.31	10.25	331.77	47.99
331.77	12.07	404.21	60.08
404.21	17.46	492.47	77.53
492.47	22.49	600.00	100.00



MALVERN MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 2
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 2 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 2
Record Number: 7

Measured: Wed Jul 15 1998 1:51PM
Analysed: Wed Jul 15 1998 1:51PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 18.7 %
Residual: 3.267 %

Result Statistics

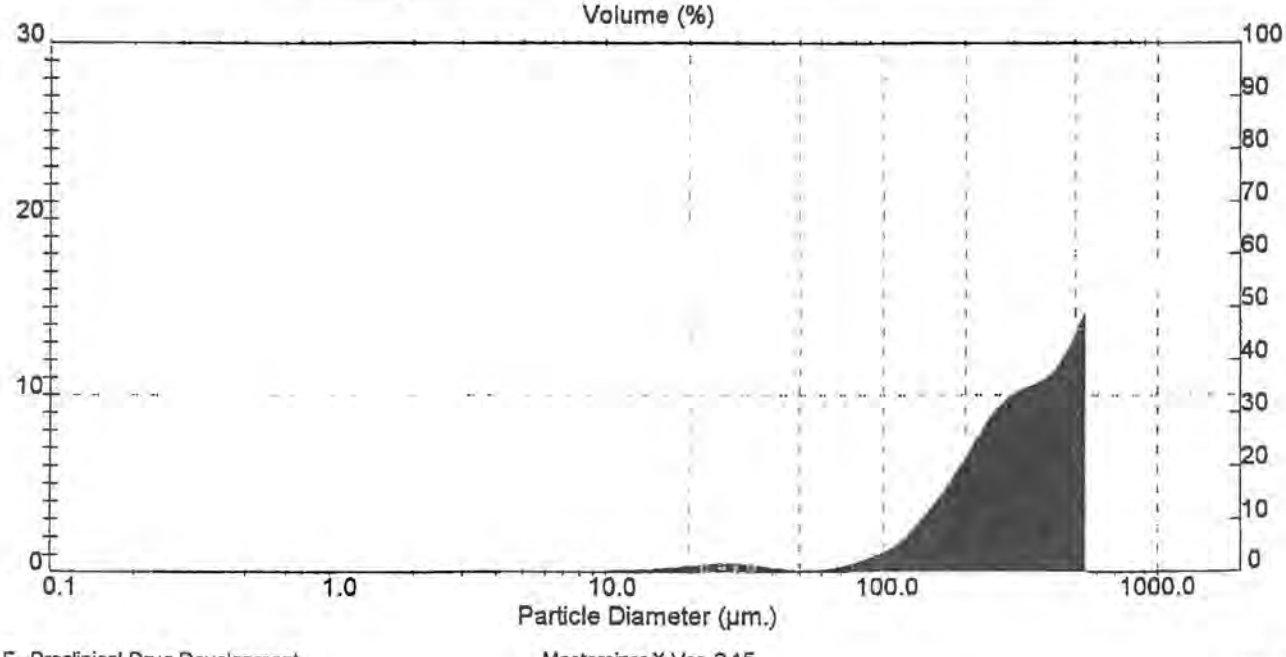
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 329.87 um

Concentration = 0.5516 %Vol
D (v, 0.1) = 138.00 um
D [3, 2] = 192.85 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 324.35 um
Span = 1.246E+00

Specific S.A. = 0.0311 sq. m / g
D (v, 0.84) = 508.54 um
Uniformity = 3.919E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.18	11.55	0.18
11.55	0.23	14.08	0.42
14.08	0.34	17.15	0.76
17.15	0.48	20.90	1.24
20.90	0.65	25.46	1.88
25.46	0.72	31.01	2.60
31.01	0.57	37.79	3.17
37.79	0.33	46.03	3.50
46.03	0.20	56.09	3.70
56.09	0.28	68.33	3.97
68.33	0.63	83.26	4.61
83.26	1.23	101.44	5.84
101.44	2.18	123.59	8.02
123.59	3.99	150.57	12.02
150.57	6.17	183.44	18.19
183.44	8.78	223.51	26.97
223.51	11.48	272.31	38.45
272.31	13.10	331.77	51.54
331.77	13.90	404.21	65.45
404.21	15.66	492.47	81.12
492.47	18.90	600.00	100.00



MALVERN MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 2
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 2 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 3
Record Number: 8

Measured: Wed Jul 15 1998 1:52PM
Analysed: Wed Jul 15 1998 1:52PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 13.4 %
Residual: 4.491 %

Result Statistics

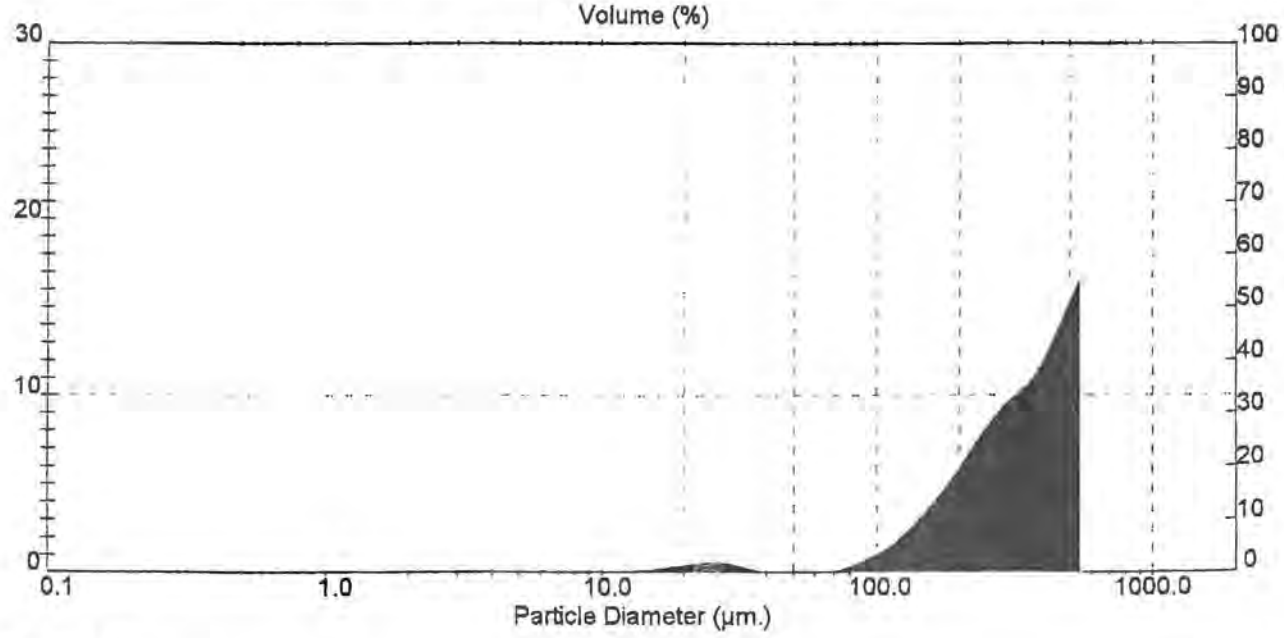
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 346.12 um

Concentration = 0.4310 %Vol
D (v, 0.1) = 151.47 um
D [3, 2] = 217.02 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 348.71 um
Span = 1.138E+00

Specific S.A. = 0.0276 sq. m / g
D (v, 0.9) = 548.30 um
Uniformity = 3.596E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.11	14.08	0.11
14.08	0.30	17.15	0.40
17.15	0.53	20.90	0.93
20.90	0.74	25.46	1.68
25.46	0.71	31.01	2.39
31.01	0.36	37.79	2.75
37.79	0.00	46.03	2.75
46.03	0.00	56.09	2.75
56.09	0.00	68.33	2.76
68.33	0.32	83.26	3.08
83.26	1.08	101.44	4.15
101.44	2.06	123.59	6.22
123.59	3.64	150.57	9.86
150.57	5.63	183.44	15.49
183.44	7.99	223.51	23.48
223.51	10.58	272.31	34.05
272.31	12.55	331.77	46.60
331.77	14.31	404.21	60.92
404.21	17.75	492.47	78.67
492.47	21.35	600.00	100.00



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Mastersizer X Ver. 2.15
Serial Number: 32736-31

MALVERN INSTRUMENTS MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 2
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 2 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 4
Record Number: 9

Measured: Wed Jul 15 1998 1:54PM
Analysed: Wed Jul 15 1998 1:54PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 16.5 %
Residual: 4.665 %

Result Statistics

Distribution Type: Volume
Mean Diameters:
D [4, 3] = 350.44 um

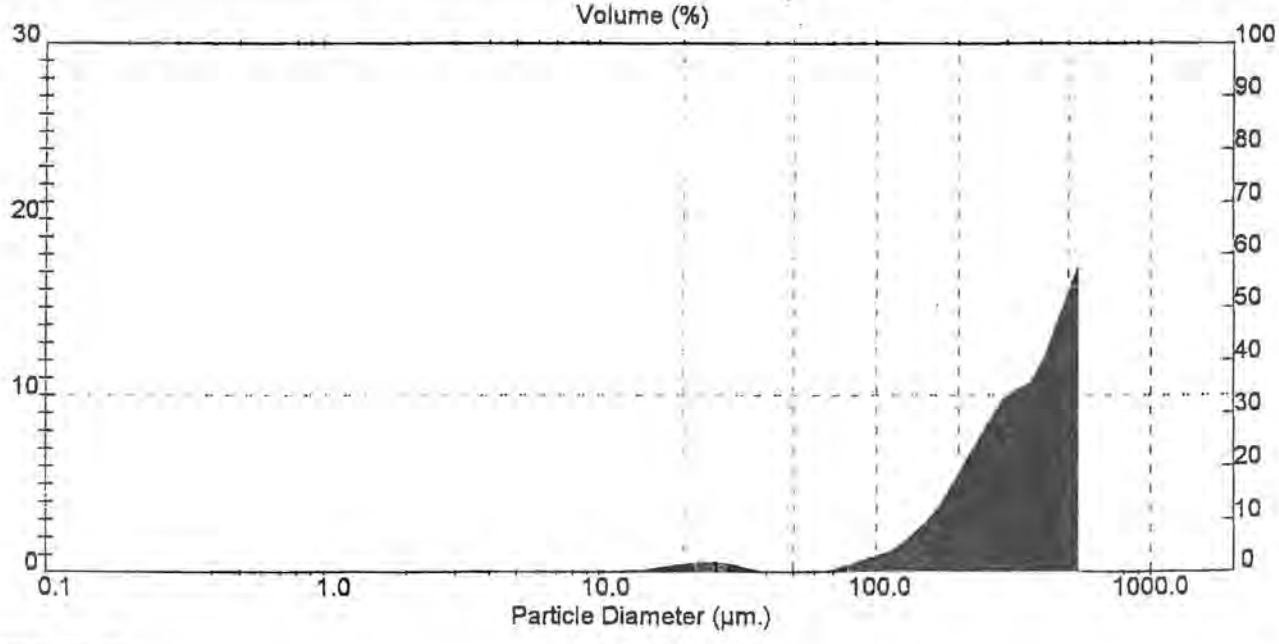
Concentration = 0.5256 %Vol
D (v, 0.1) = 154.99 um
D [3, 2] = 211.32 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 354.58 um
Span = 1.116E+00

Specific S.A. = 0.0284 sq. m / g
D (v, 0.9) = 550.53 um
Uniformity = 3.519E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.01	11.55	0.01
11.55	0.16	14.08	0.17
14.08	0.37	17.15	0.54
17.15	0.64	20.90	1.18
20.90	0.82	25.46	2.00

Size Low (um)	In %	Size High (um)	Under%
25.46	0.74	31.01	2.73
31.01	0.37	37.79	3.11
37.79	0.02	46.03	3.13
46.03	0.00	56.09	3.13
56.09	0.05	68.33	3.18
68.33	0.49	83.26	3.67
83.26	1.07	101.44	4.74
101.44	1.69	123.59	6.43
123.59	2.99	150.57	9.43
150.57	4.85	183.44	14.27
183.44	7.65	223.51	21.93
223.51	10.54	272.31	32.47
272.31	12.98	331.77	45.44
331.77	14.20	404.21	59.65
404.21	18.09	492.47	77.74
492.47	22.26	600.00	100.00



MALVERN INSTRUMENTS MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 2
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 2 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 5
Record Number: 10

Measured: Wed Jul 15 1998 1:55PM
Analysed: Wed Jul 15 1998 1:55PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 18.9 %
Residual: 4.300 %

Result Statistics

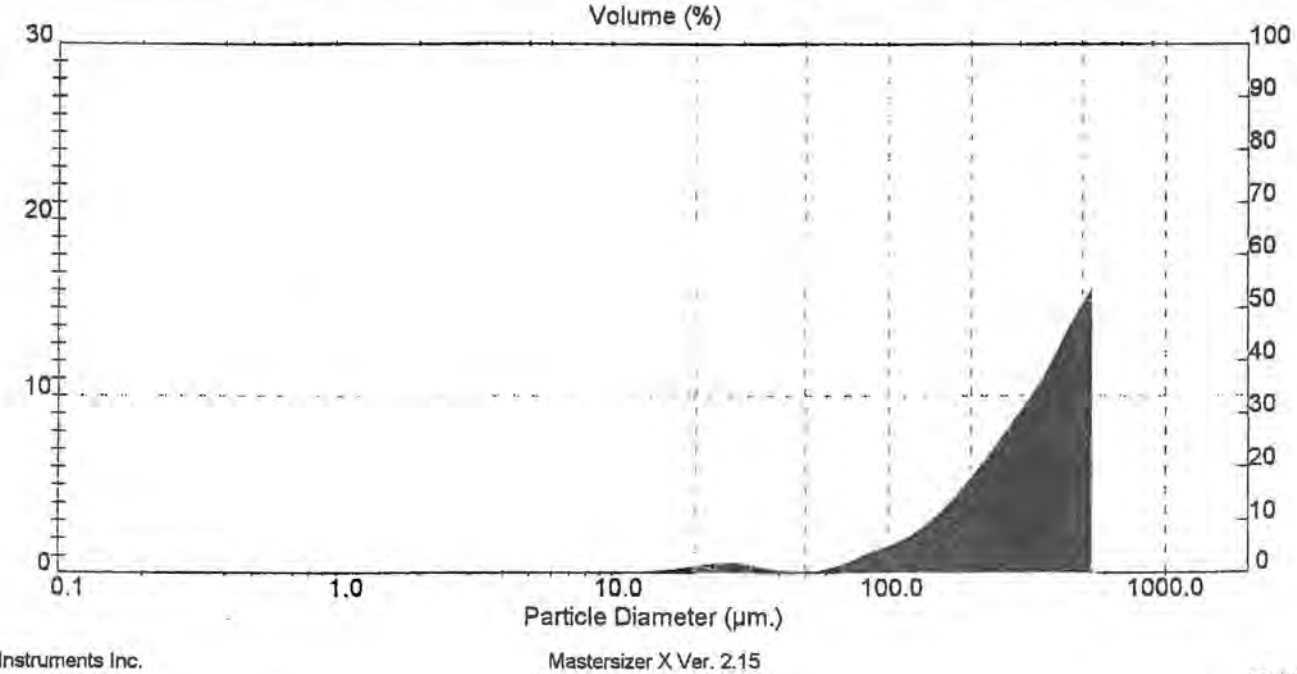
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 340.55 um

Concentration = 0.5875 %Vol
D [3, 2] = 202.43 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 348.37 um
Span = 1.193E+00

Specific S.A. = 0.0296 sq. m / g
D (v, 0.9) = 546.37 um
Uniformity = 3.707E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.15	14.08	0.15
14.08	0.30	17.15	0.46
17.15	0.53	20.90	0.99
20.90	0.76	25.46	1.74
25.46	0.76	31.01	2.50
31.01	0.46	37.79	2.96
37.79	0.17	46.03	3.14
46.03	0.15	56.09	3.29
56.09	0.45	68.33	3.74
68.33	1.12	83.26	4.86
83.26	1.78	101.44	6.64
101.44	2.47	123.59	9.11
123.59	3.65	150.57	12.76
150.57	5.21	183.44	17.97
183.44	7.22	223.51	25.19
223.51	9.53	272.31	34.72
272.31	11.95	331.77	46.66
331.77	14.60	404.21	61.27
404.21	18.03	492.47	79.30
492.47	20.71	600.00	100.00



MALVERN INSTRUMENTS

MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 3
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 3 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 1
Record Number: 11

Measured: Wed Jul 15 1998 1:59PM
Analysed: Wed Jul 15 1998 1:59PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 25.3 %
Residual: 4.674 %

Result Statistics

Distribution Type: Volume
Mean Diameters:
D [4, 3] = 347.39 um

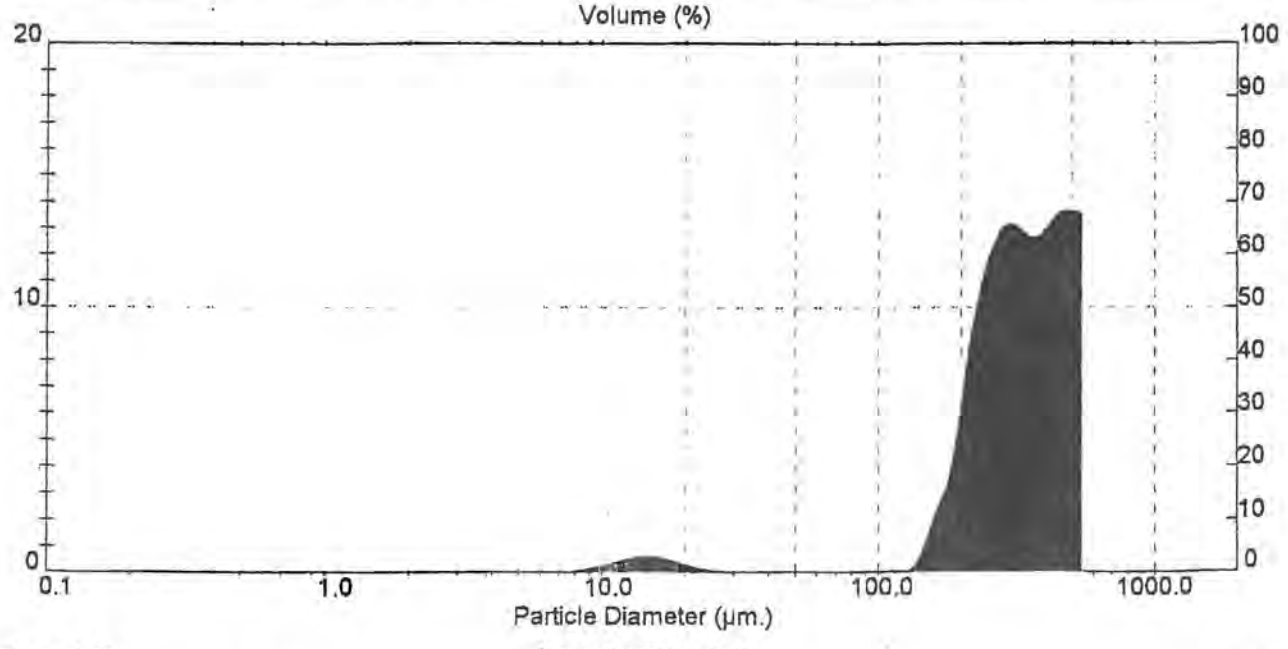
Concentration = 0.7597 %Vol
D (v, 0.1) = 198.80 um
D [3, 2] = 188.46 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 337.28 um
Span = 9.990E-01

Specific S.A. = 0.0318 sq. m / g
D (v, 0.9) = 535.74 um
Uniformity = 3.251E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.04	7.78	0.04
7.78	0.20	9.48	0.24
9.48	0.45	11.55	0.69
11.55	0.76	14.08	1.45
14.08	0.80	17.15	2.24
17.15	0.54	20.90	2.79
20.90	0.23	25.46	3.02

Size Low (um)	In %	Size High (um)	Under%
25.46	0.08	31.01	3.11
31.01	0.03	37.79	3.13
37.79	0.00	46.03	3.14
46.03	0.00	56.09	3.14
56.09	0.00	68.33	3.14
68.33	0.00	83.26	3.14
83.26	0.00	101.44	3.14
101.44	0.00	123.59	3.14
123.59	0.64	150.57	3.79
150.57	3.44	183.44	7.23
183.44	9.29	223.51	16.53
223.51	15.18	272.31	31.70
272.31	16.93	331.77	48.63
331.77	16.39	404.21	65.02
404.21	17.49	492.47	82.50
492.47	17.49	600.00	100.00



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MALVERN INSTRUMENTS MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 3
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 3 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 2
Record Number: 12

Measured: Wed Jul 15 1998 2:01PM
Analysed: Wed Jul 15 1998 2:01PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 23.0 %
Residual: 4.808 %

Result Statistics

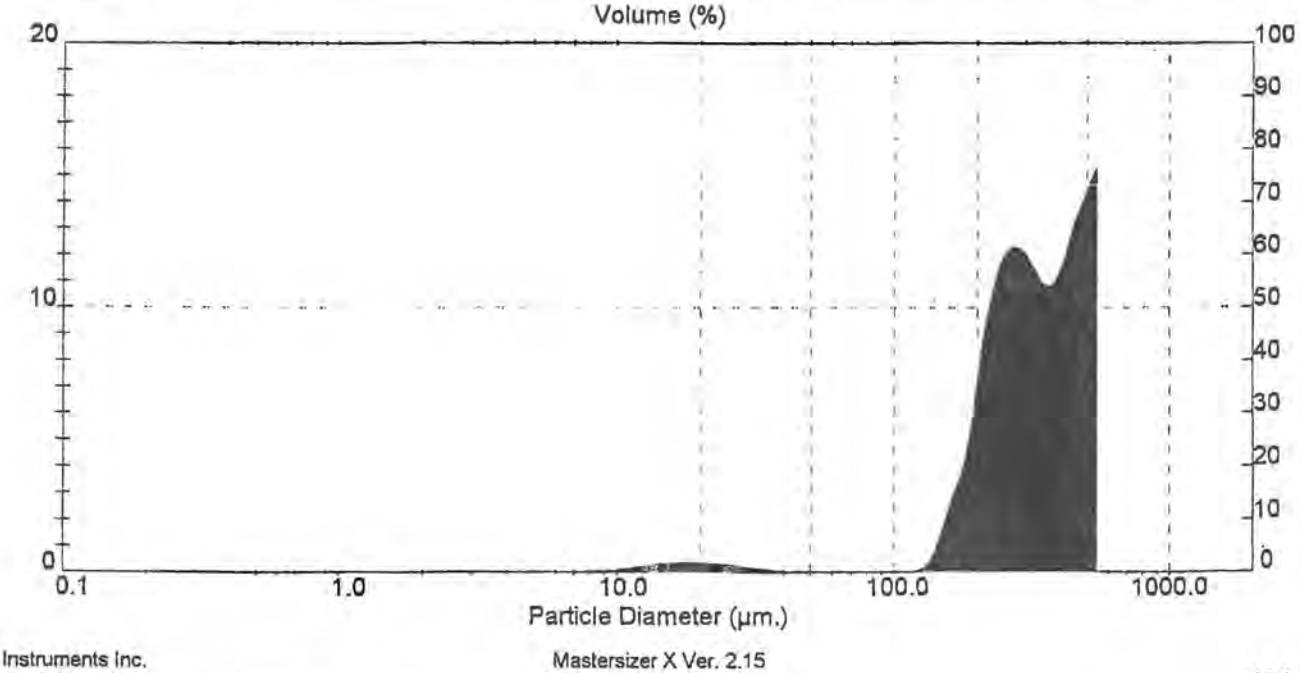
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 348.60 um

Concentration = 0.7453 %Vol
D (v, 0.1) = 192.95 um
D [3, 2] = 205.76 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 335.62 um
Span = 1.046E+00

Specific S.A. = 0.0292 sq. m / g
D (v, 0.9) = 543.86 um
Uniformity = 3.437E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00	25.46	0.35	31.01	2.67
1.32	0.00	1.60	0.00	31.01	0.20	37.79	2.87
1.60	0.00	1.95	0.00	37.79	0.07	46.03	2.93
1.95	0.00	2.38	0.00	46.03	0.00	56.09	2.94
2.38	0.00	2.90	0.00	56.09	0.00	68.33	2.94
2.90	0.00	3.53	0.00	68.33	0.00	83.26	2.94
3.53	0.00	4.30	0.00	83.26	0.00	101.44	2.94
4.30	0.00	5.24	0.00	101.44	0.03	123.59	2.96
5.24	0.00	6.39	0.00	123.59	0.98	150.57	3.96
6.39	0.04	7.78	0.04	150.57	4.21	183.44	8.17
7.78	0.13	9.48	0.17	183.44	10.34	223.51	18.51
9.48	0.24	11.55	0.40	223.51	15.31	272.31	33.80
11.55	0.40	14.08	0.80	272.31	15.37	331.77	49.17
14.08	0.51	17.15	1.32	331.77	14.06	404.21	63.25
17.15	0.54	20.90	1.86	404.21	17.02	492.47	80.27
20.90	0.47	25.46	2.33	492.47	19.74	600.00	100.00



MALVERN INSTRUMENTS MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 3
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 3 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 3
Record Number: 13

Measured: Wed Jul 15 1998 2:02PM
Analysed: Wed Jul 15 1998 2:02PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 21.2 %
Residual: 5.975 %

Result Statistics

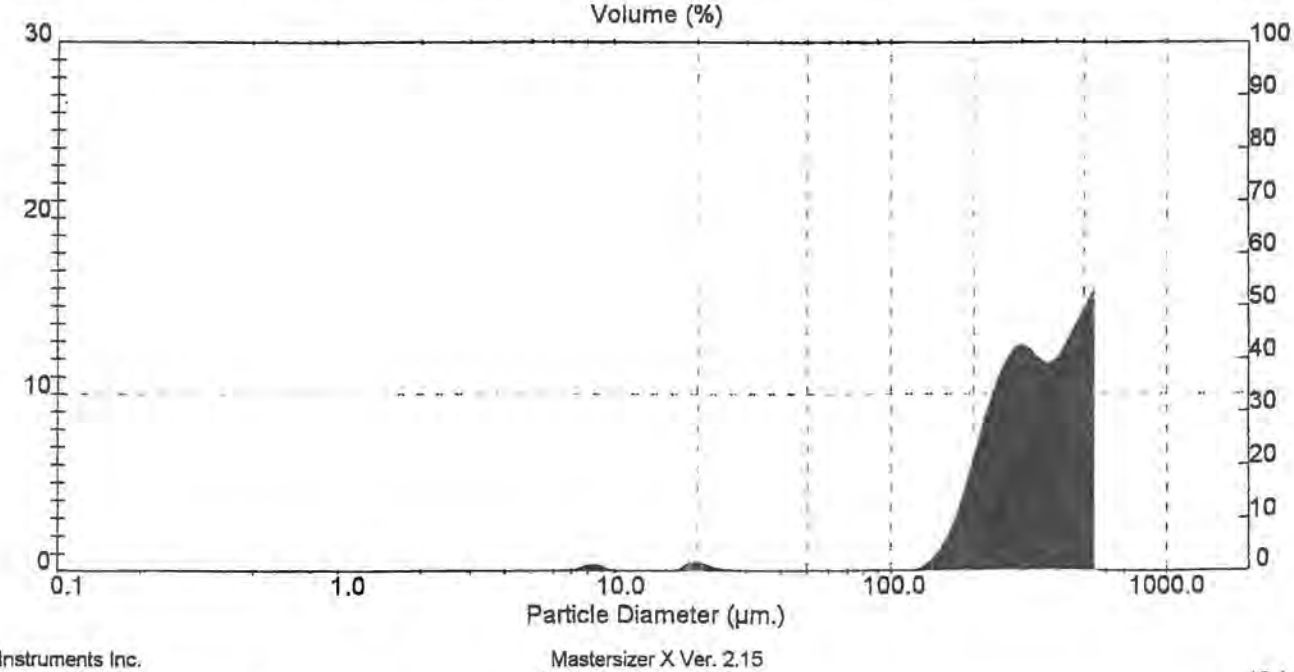
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 357.05 um

Concentration = 0.7100 %Vol
D (v, 0.1) = 200.88 um
D [3, 2] = 214.17 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 346.02 um
Span = 9.980E-01

Specific S.A. = 0.0280 sq. m / g
D (v, 0.9) = 546.21 um
Uniformity = 3.217E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.06	6.39	0.06
6.39	0.20	7.78	0.26
7.78	0.54	9.48	0.79
9.48	0.00	11.55	0.80
11.55	0.00	14.08	0.80
14.08	0.00	17.15	0.82
17.15	0.72	20.90	1.52
20.90	0.33	25.46	1.85
25.46	0.14	31.01	1.99
31.01	0.05	37.79	2.04
37.79	0.01	46.03	2.05
46.03	0.00	56.09	2.05
56.09	0.00	68.33	2.05
68.33	0.00	83.26	2.05
83.26	0.00	101.44	2.05
101.44	0.00	123.59	2.06
123.59	0.80	150.57	2.86
150.57	3.63	183.44	6.48
183.44	9.26	223.51	15.75
223.51	14.52	272.31	30.27
272.31	16.44	331.77	46.70
331.77	15.28	404.21	61.99
404.21	17.47	492.47	79.47
492.47	20.55	600.00	100.00



MALVERN INSTRUMENTS MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 3
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 3 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 4
Record Number: 14

Measured: Wed Jul 15 1998 2:03PM
Analysed: Wed Jul 15 1998 2:04PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 17.3 %
Residual: 2.848 %

Result Statistics

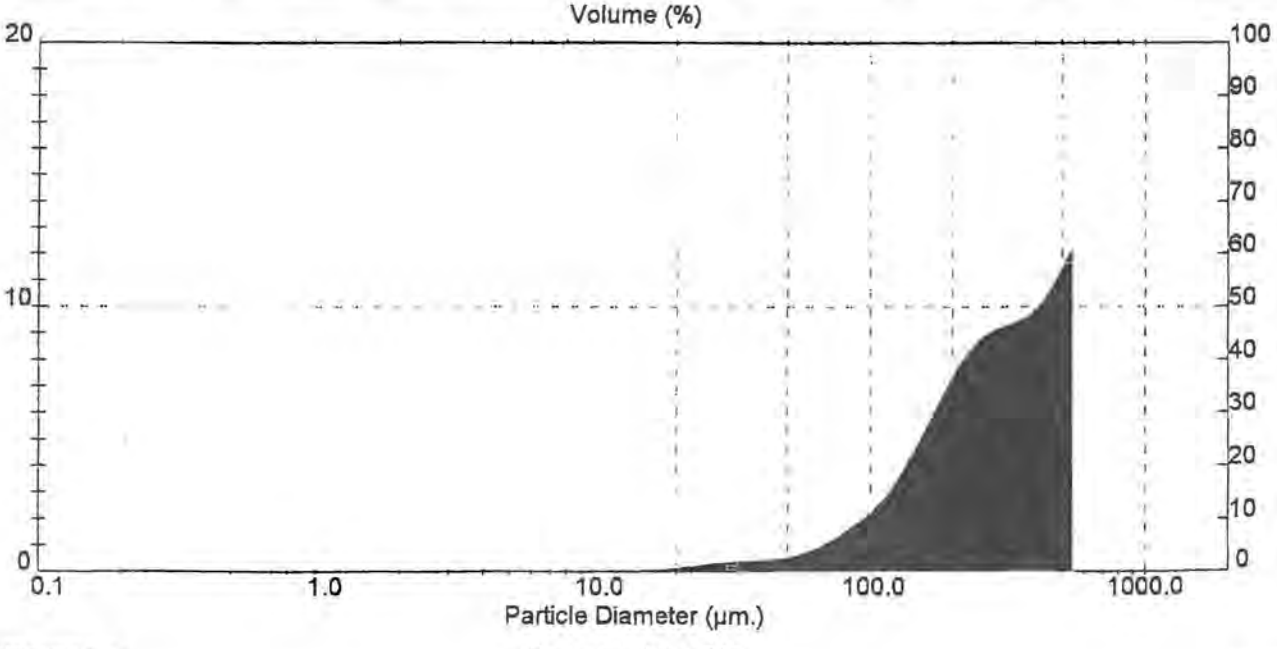
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 304.96 um

Concentration = 0.5152 %Vol
D (v, 0.1) = 110.66 um
D [3, 2] = 195.19 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 290.08 um
Span = 1.446E+00

Specific S.A. = 0.0307 sq. m / g
D (v, 0.9) = 530.11 um
Uniformity = 4.444E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.00	14.08	0.00
14.08	0.13	17.15	0.13
17.15	0.20	20.90	0.33
20.90	0.35	25.46	0.68
25.46	0.48	31.01	1.16
31.01	0.56	37.79	1.72
37.79	0.63	46.03	2.35
46.03	0.78	56.09	3.13
56.09	1.14	68.33	4.27
68.33	1.75	83.26	6.02
83.26	2.54	101.44	8.56
101.44	3.66	123.59	12.22
123.59	5.43	150.57	17.66
150.57	7.57	183.44	25.23
183.44	9.74	223.51	34.97
223.51	11.26	272.31	46.23
272.31	11.94	331.77	58.17
331.77	12.43	404.21	70.60
404.21	13.71	492.47	84.32
492.47	15.69	600.00	100.00



MALVERN INSTRUMENTS MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 3
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 3 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 5
Record Number: 15

Measured: Wed Jul 15 1998 2:07PM
Analysed: Wed Jul 15 1998 2:07PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
{Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300}

Sampler: None

Obscuration: 16.5 %
Residual: 2.902 %

Result Statistics

Distribution Type: Volume
Mean Diameters:
D [4, 3] = 310.74 um

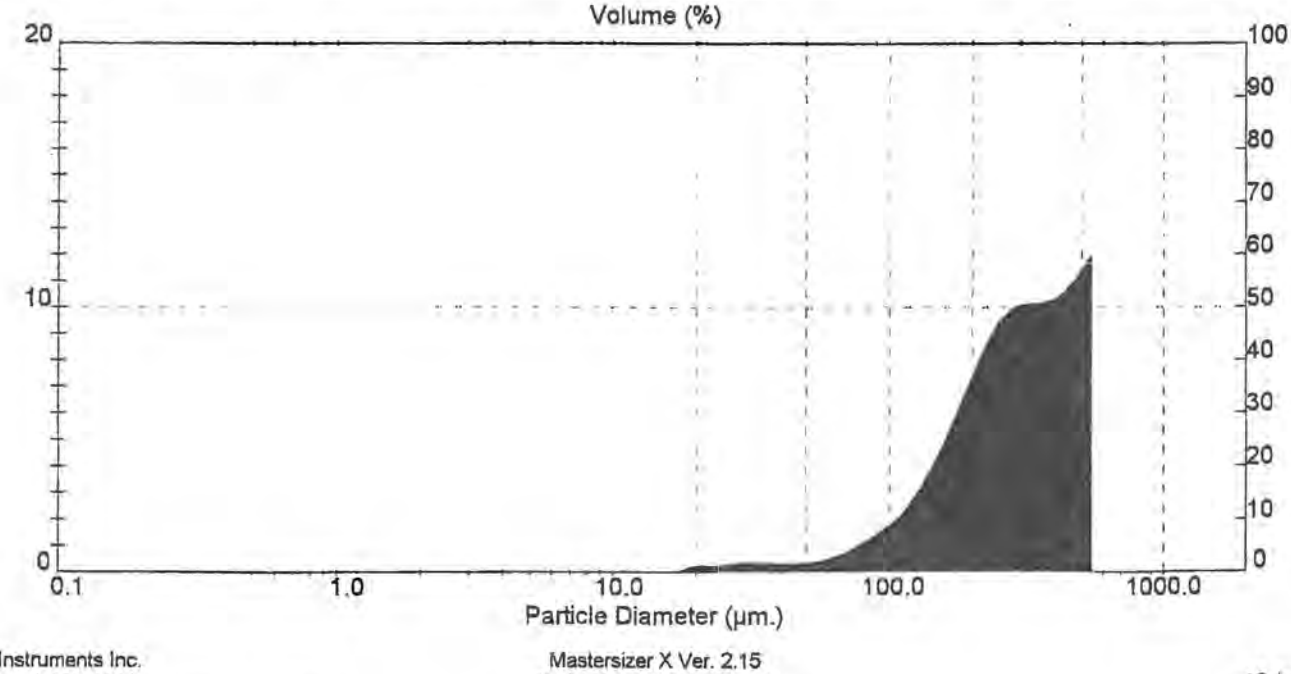
Concentration = 0.5156 %Vol
D (v, 0.1) = 123.48 um
D [3, 2] = 205.78 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 296.91 um
Span = 1.365E+00

Specific S.A. = 0.0292 sq. m / g
D (v, 0.9) = 528.84 um
Uniformity = 4.157E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.00	14.08	0.00
14.08	0.00	17.15	0.00
17.15	0.30	20.90	0.30
20.90	0.38	25.46	0.69

Size Low (um)	In %	Size High (um)	Under%
25.46	0.50	31.01	1.19
31.01	0.53	37.79	1.72
37.79	0.49	46.03	2.21
46.03	0.53	56.09	2.75
56.09	0.78	68.33	3.53
68.33	1.33	83.26	4.86
83.26	2.07	101.44	6.93
101.44	3.09	123.59	10.02
123.59	4.88	150.57	14.91
150.57	7.26	183.44	22.16
183.44	9.98	223.51	32.14
223.51	12.19	272.31	44.32
272.31	13.05	331.77	57.37
331.77	13.17	404.21	70.54
404.21	14.00	492.47	84.55
492.47	15.46	600.00	100.00



MALVERN INSTRUMENTS

MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 4
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 4 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 1
Record Number: 16

Measured: Wed Jul 15 1998 2:12PM
Analysed: Wed Jul 15 1998 2:12PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 15.1 %
Residual: 2.878 %

Result Statistics

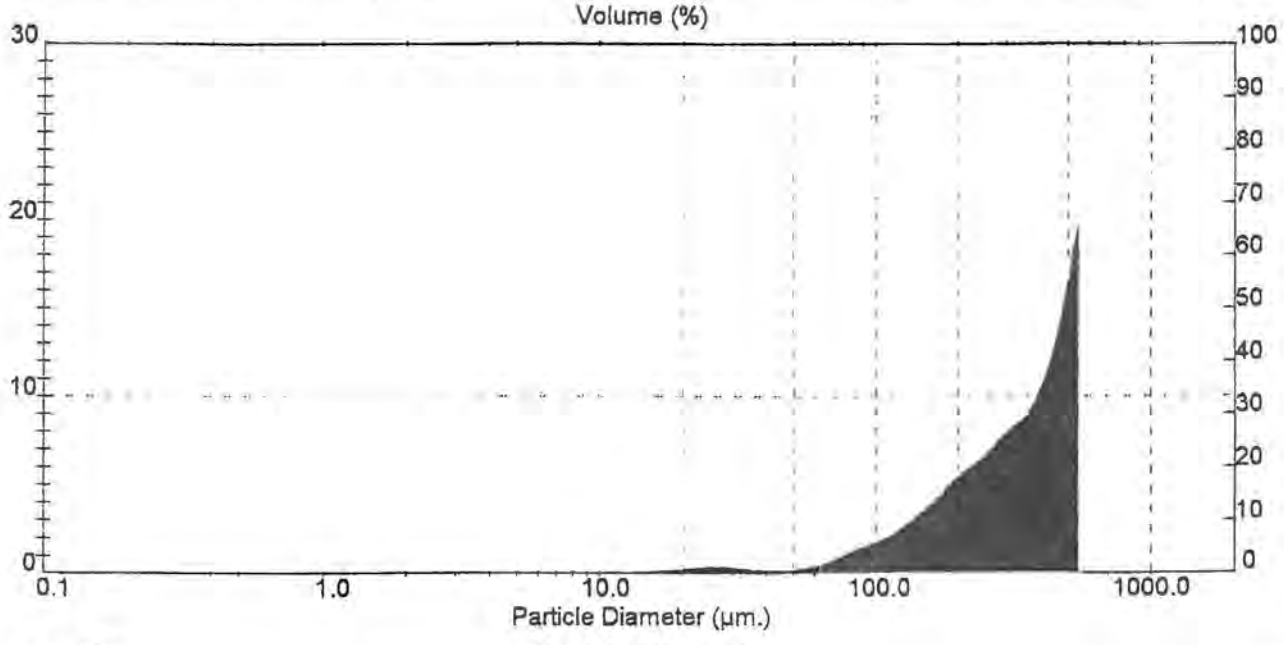
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 348.24 um

Concentration = 0.4929 %Vol
D (v, 0.1) = 127.91 um
D [3, 2] = 216.89 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 360.14 um
Span = 1.193E+00

Specific S.A. = 0.0277 sq. m / g
D (v, 0.9) = 557.68 um
Uniformity = 3.773E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00	25.46	0.51	31.01	1.60
1.32	0.00	1.60	0.00	31.01	0.36	37.79	1.96
1.60	0.00	1.95	0.00	37.79	0.24	46.03	2.20
1.95	0.00	2.38	0.00	46.03	0.30	56.09	2.50
2.38	0.00	2.90	0.00	56.09	0.66	68.33	3.16
2.90	0.00	3.53	0.00	68.33	1.34	83.26	4.50
3.53	0.00	4.30	0.00	83.26	2.09	101.44	6.59
4.30	0.00	5.24	0.00	101.44	2.81	123.59	9.40
5.24	0.00	6.39	0.00	123.59	4.04	150.57	13.44
6.39	0.00	7.78	0.00	150.57	5.57	183.44	19.01
7.78	0.00	9.48	0.00	183.44	7.26	223.51	26.27
9.48	0.00	11.55	0.00	223.51	8.62	272.31	34.90
11.55	0.09	14.08	0.09	272.31	10.40	331.77	45.29
14.08	0.19	17.15	0.28	331.77	12.23	404.21	57.53
17.15	0.33	20.90	0.61	404.21	17.14	492.47	74.70
20.90	0.48	25.46	1.09	492.47	25.35	600.00	100.00



MALVERN MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 4
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 4 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 2
Record Number: 17

Measured: Wed Jul 15 1998 2:13PM
Analysed: Wed Jul 15 1998 2:14PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 10.7 %
Residual: 2.541 %

Result Statistics

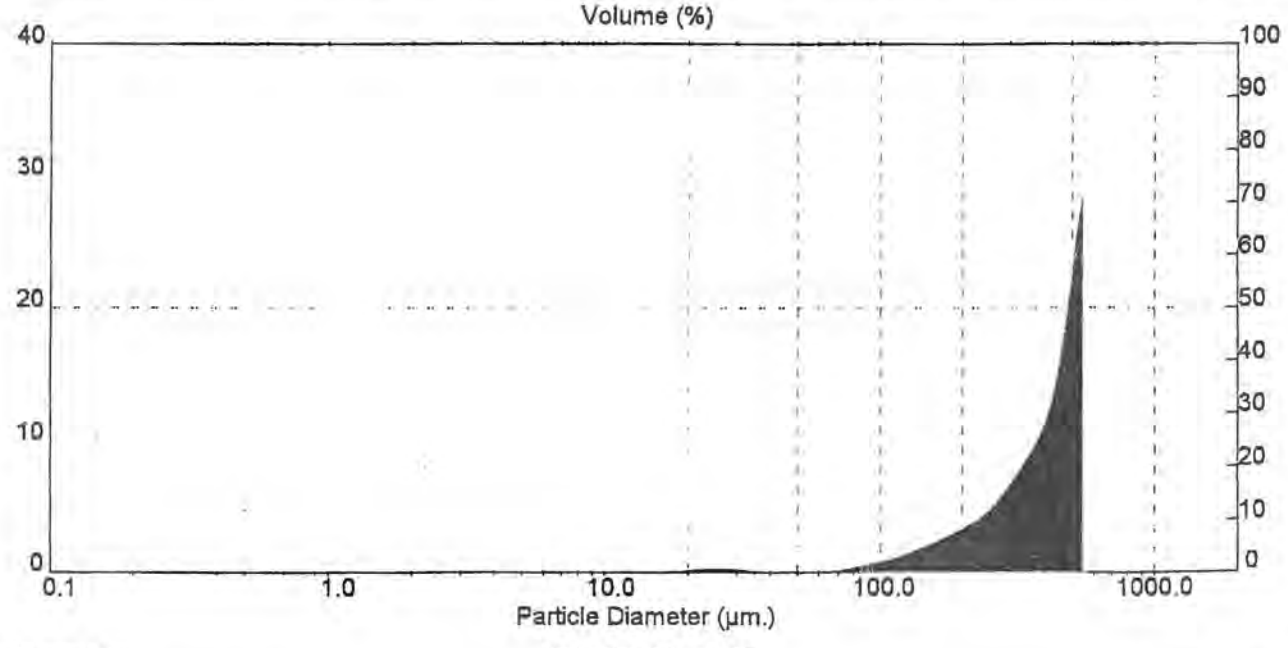
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 400.97 um

Concentration = 0.4248 %Vol
D (v, 0.1) = 178.81 um
D [3, 2] = 270.38 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 440.34 um
Span = 8.906E-01

Specific S.A. = 0.0222 sq. m / g
D (v, 0.9) = 570.98 um
Uniformity = 2.662E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.05	14.08	0.05
14.08	0.15	17.15	0.20
17.15	0.30	20.90	0.50
20.90	0.48	25.46	0.98
25.46	0.48	31.01	1.45
31.01	0.26	37.79	1.72
37.79	0.05	46.03	1.77
46.03	0.00	56.09	1.77
56.09	0.10	68.33	1.87
68.33	0.46	83.26	2.33
83.26	0.97	101.44	3.30
101.44	1.49	123.59	4.79
123.59	2.39	150.57	7.18
150.57	3.31	183.44	10.49
183.44	4.48	223.51	14.97
223.51	6.09	272.31	21.07
272.31	8.93	331.77	29.99
331.77	12.62	404.21	42.63
404.21	20.87	492.47	63.56
492.47	36.52	600.00	100.00



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MALVERN INSTRUMENTS

MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 4
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 4 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 3
Record Number: 18

Measured: Wed Jul 15 1998 2:15PM
Analysed: Wed Jul 15 1998 2:15PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 16.9 %
Residual: 2.613 %

Result Statistics

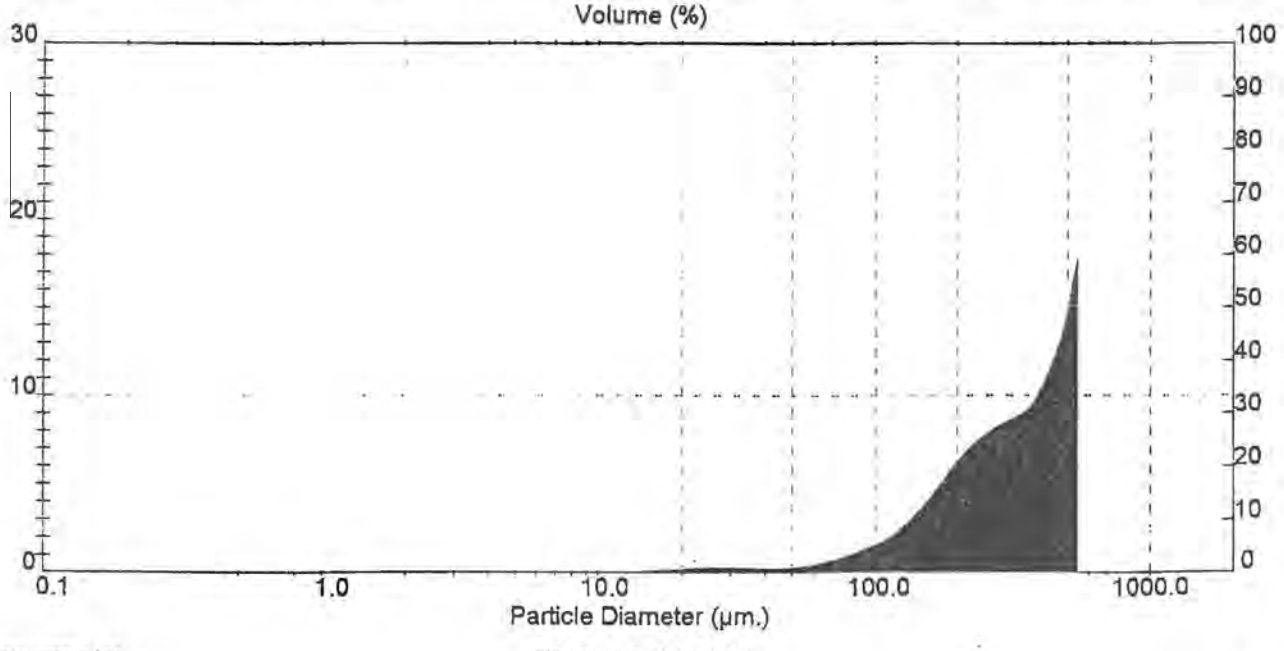
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 339.52 um

Concentration = 0.5613 %Vol
D (v, 0.1) = 132.52 um
D [3, 2] = 219.35 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 339.42 um
Span = 1.242E+00

Specific S.A. = 0.0274 sq. m / g
D (v, 0.9) = 554.06 um
Uniformity = 3.967E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.00	14.08	0.01
14.08	0.20	17.15	0.20
17.15	0.29	20.90	0.48
20.90	0.39	25.46	0.87
25.46	0.43	31.01	1.31
31.01	0.38	37.79	1.68
37.79	0.34	46.03	2.03
46.03	0.41	56.09	2.44
56.09	0.67	68.33	3.10
68.33	1.16	83.26	4.27
83.26	1.81	101.44	6.08
101.44	2.65	123.59	8.73
123.59	4.17	150.57	12.90
150.57	6.18	183.44	19.07
183.44	8.44	223.51	27.52
223.51	10.06	272.31	37.58
272.31	11.09	331.77	48.67
331.77	12.33	404.21	61.01
404.21	15.97	492.47	77.00
492.47	23.04	600.00	100.00



MALVERN INSTRUMENTS MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 4
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 4 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 4
Record Number: 19

Measured: Wed Jul 15 1998 2:17PM
Analysed: Wed Jul 15 1998 2:17PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 17.5 %
Residual: 2.409 %

Result Statistics

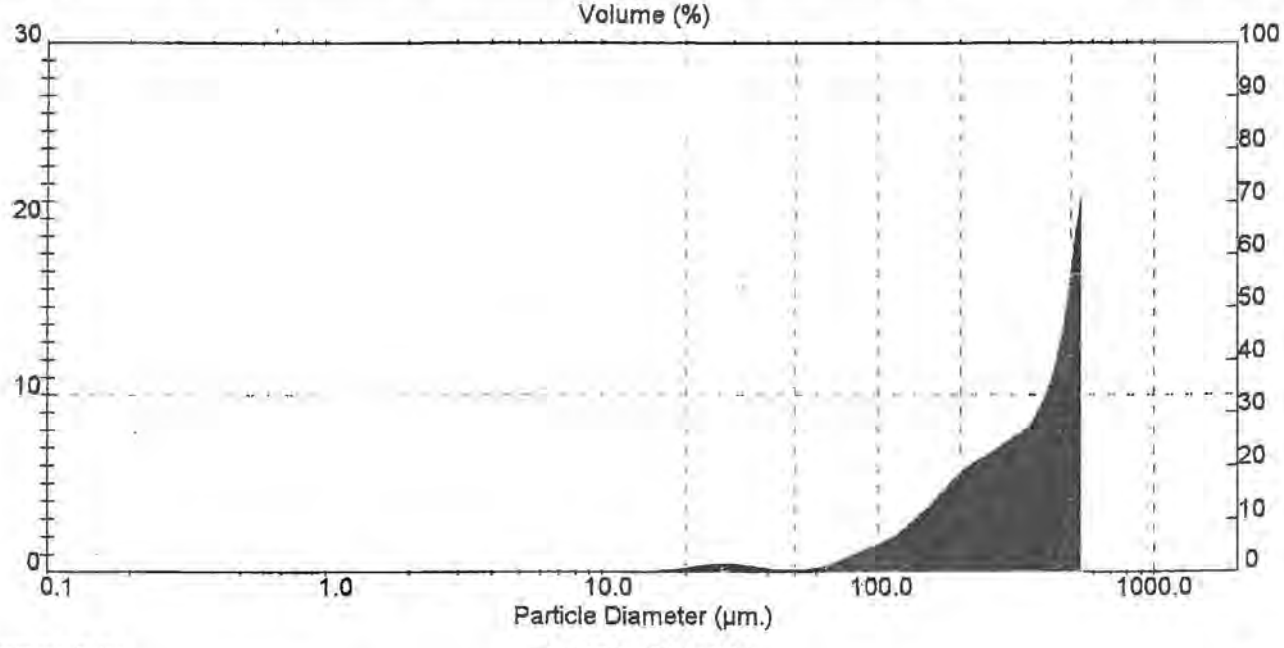
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 351.75 um

Concentration = 0.5737 %Vol
D (v, 0.1) = 130.54 um
D [3, 2] = 215.21 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 366.00 um
Span = 1.177E+00

Specific S.A. = 0.0279 sq. m / g
D (v, 0.9) = 561.33 um
Uniformity = 3.769E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.03	14.08	0.03
14.08	0.17	17.15	0.20
17.15	0.35	20.90	0.55
20.90	0.60	25.46	1.14
25.46	0.73	31.01	1.87
31.01	0.55	37.79	2.42
37.79	0.31	46.03	2.73
46.03	0.24	56.09	2.98
56.09	0.47	68.33	3.45
68.33	1.09	83.26	4.54
83.26	1.85	101.44	6.38
101.44	2.65	123.59	9.03
123.59	4.06	150.57	13.09
150.57	5.73	183.44	18.82
183.44	7.50	223.51	26.32
223.51	8.63	272.31	34.95
272.31	9.75	331.77	44.70
331.77	11.43	404.21	56.14
404.21	16.52	492.47	72.71
492.47	27.35	600.00	100.00



MALVERN INSTRUMENTS MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 4
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 4 (X=23mm, Y=117mm)
Measured with 2JHD with 300mm len

Run Number: 5
Record Number: 20

Measured: Wed Jul 15 1998 2:18PM
Analysed: Wed Jul 15 1998 2:19PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 16.1 %
Residual: 2.990 %

Result Statistics

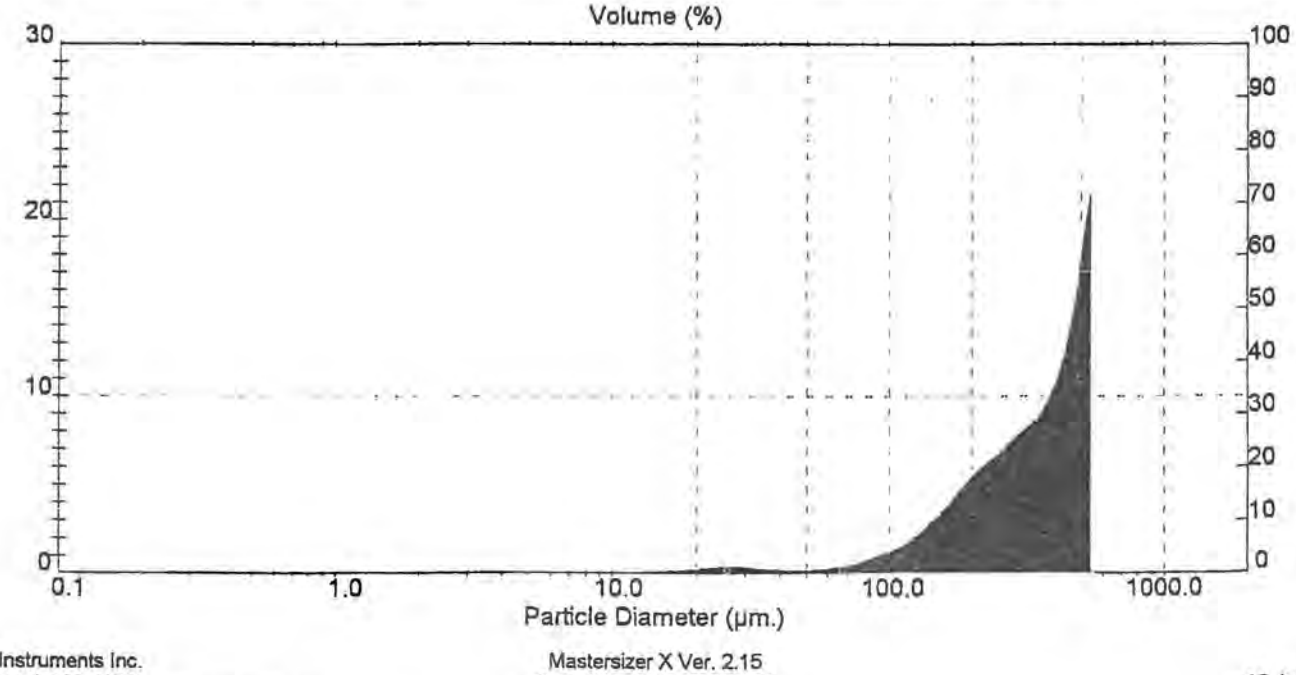
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 359.86 um

Concentration = 0.5400 %Vol
D (v, 0.1) = 143.94 um
D [3, 2] = 221.99 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 376.81 um
Span = 1.109E+00

Specific S.A. = 0.0270 sq. m / g
D (v, 0.9) = 561.70 um
Uniformity = 3.553E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.10	11.55	0.10
11.55	0.12	14.08	0.22
14.08	0.20	17.15	0.43
17.15	0.33	20.90	0.76
20.90	0.48	25.46	1.23
25.46	0.50	31.01	1.74
31.01	0.39	37.79	2.13
37.79	0.30	46.03	2.43
46.03	0.30	56.09	2.73
56.09	0.44	68.33	3.16
68.33	0.76	83.26	3.93
83.26	1.38	101.44	5.30
101.44	2.13	123.59	7.44
123.59	3.50	150.57	10.94
150.57	5.28	183.44	16.22
183.44	7.25	223.51	23.46
223.51	8.72	272.31	32.18
272.31	10.34	331.77	42.52
331.77	12.21	404.21	54.74
404.21	17.48	492.47	72.27
492.47	27.79	600.00	100.00



MALVERN MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 5
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 5 (X=22mm, Y=110mm)
Measured with 2JHD with 300mm len

Run Number: 1
Record Number: 21

Measured: Wed Jul 15 1998 2:23PM
Analysed: Wed Jul 15 1998 2:23PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 14.1 %
Residual: 6.238 %

Result Statistics

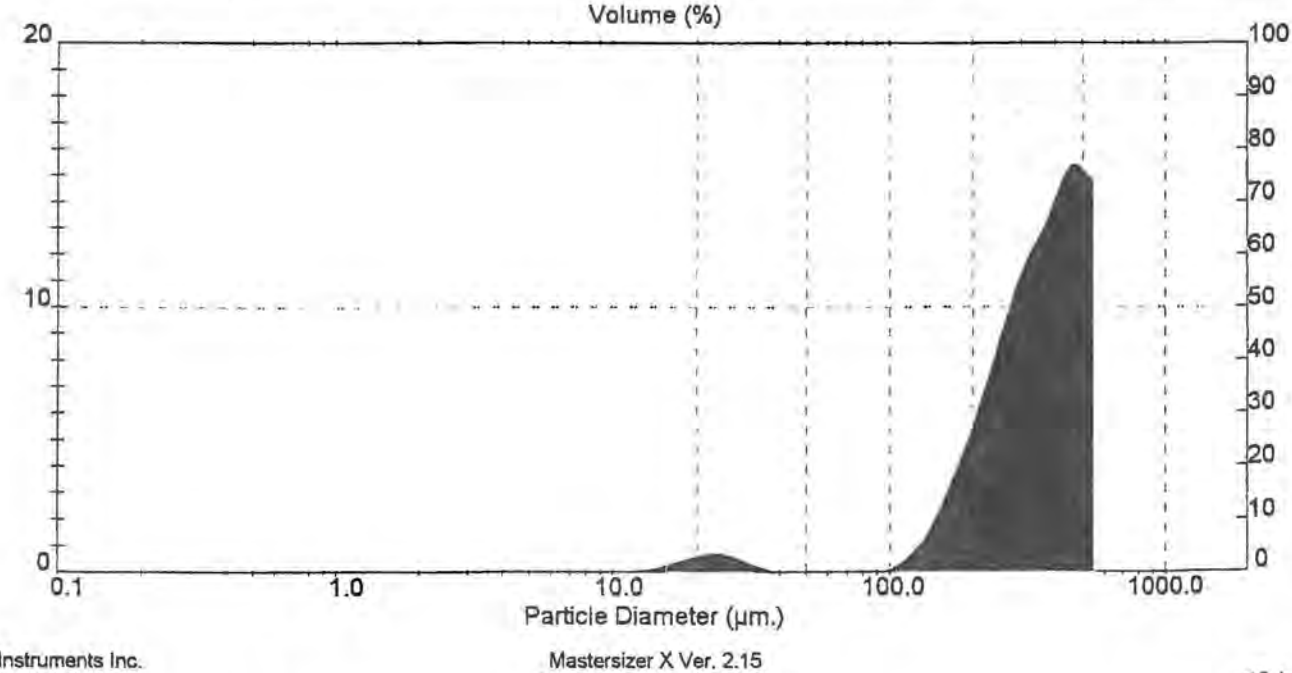
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 353.71 um

Concentration = 0.4583 %Vol
D (v, 0.1) = 180.68 um
D [3, 2] = 218.75 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 356.42 um
Span = 1.009E+00

Specific S.A. = 0.0274 sq. m / g
D (v, 0.9) = 540.26 um
Uniformity = 3.164E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.14	14.08	0.14
14.08	0.40	17.15	0.55
17.15	0.76	20.90	1.31
20.90	0.95	25.46	2.25
25.46	0.68	31.01	2.94
31.01	0.26	37.79	3.19
37.79	0.00	46.03	3.20
46.03	0.00	56.09	3.20
56.09	0.00	68.33	3.20
68.33	0.00	83.26	3.20
83.26	0.05	101.44	3.25
101.44	0.64	123.59	3.90
123.59	2.05	150.57	5.95
150.57	4.50	183.44	10.44
183.44	7.57	223.51	18.02
223.51	11.32	272.31	29.34
272.31	14.76	331.77	44.08
331.77	17.15	404.21	61.25
404.21	19.71	492.47	80.93
492.47	19.06	600.00	100.00



MALVERN INSTRUMENTS

MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 5
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 5 (X=22mm, Y=110mm)
Measured with 2JHD with 300mm len

Run Number: 2
Record Number: 22

Measured: Wed Jul 15 1998 2:25PM
Analysed: Wed Jul 15 1998 2:25PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 16.6 %
Residual: 5.368 %

Result Statistics

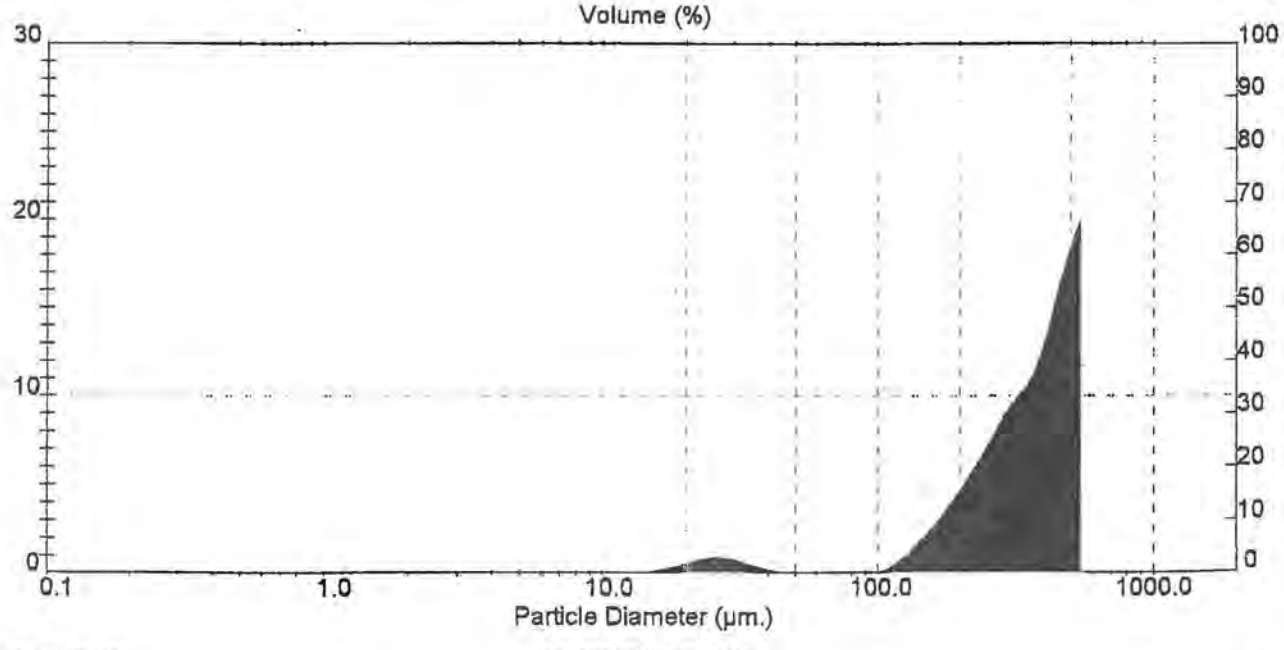
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 370.55 um

Concentration = 0.5507 %Vol
D (v, 0.1) = 177.70 um
D [3, 2] = 219.04 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 387.49 um
Span = 9.789E-01

Specific S.A. = 0.0274 sq. m / g
D (v, 0.9) = 556.99 um
Uniformity = 3.139E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.03	14.08	0.03
14.08	0.26	17.15	0.29
17.15	0.65	20.90	0.94
20.90	1.12	25.46	2.06
25.46	1.15	31.01	3.20
31.01	0.67	37.79	3.88
37.79	0.21	46.03	4.09
46.03	0.00	56.09	4.09
56.09	0.00	68.33	4.09
68.33	0.00	83.26	4.09
83.26	0.00	101.44	4.10
101.44	0.60	123.59	4.69
123.59	2.09	150.57	6.79
150.57	4.01	183.44	10.80
183.44	6.44	223.51	17.25
223.51	9.25	272.31	26.50
272.31	12.23	331.77	38.72
331.77	14.81	404.21	53.55
404.21	20.72	492.47	74.27
492.47	25.75	600.00	100.00



MALVERN INSTRUMENTS MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 5
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 5 (X=22mm, Y=110mm)
Measured with 2JHD with 300mm len

Run Number: 3
Record Number: 23

Measured: Wed Jul 15 1998 2:26PM
Analysed: Wed Jul 15 1998 2:26PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 21.6 %
Residual: 5.811 %

Result Statistics

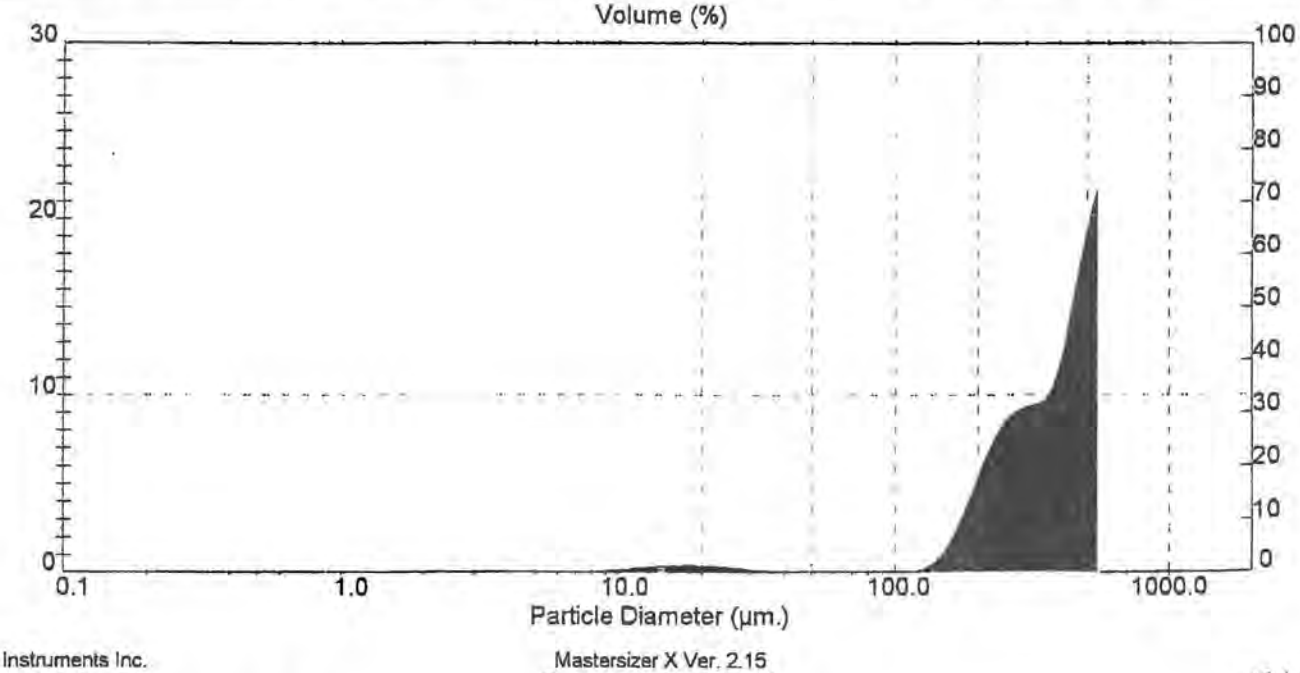
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 379.94 um

Concentration = 0.7124 %Vol
D (v, 0.1) = 200.07 um
D [3, 2] = 211.00 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 397.84 um
Span = 9.065E-01

Specific S.A. = 0.0284 sq. m / g
D (v, 0.9) = 560.71 um
Uniformity = 3.004E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.01	6.39	0.01
6.39	0.05	7.78	0.06
7.78	0.15	9.48	0.21
9.48	0.28	11.55	0.49
11.55	0.45	14.08	0.94
14.08	0.55	17.15	1.49
17.15	0.58	20.90	2.07
20.90	0.49	25.46	2.55
25.46	0.32	31.01	2.87
31.01	0.14	37.79	3.02
37.79	0.03	46.03	3.05
46.03	0.00	56.09	3.05
56.09	0.00	68.33	3.05
68.33	0.00	83.26	3.05
83.26	0.00	101.44	3.05
101.44	0.04	123.59	3.09
123.59	0.79	150.57	3.89
150.57	3.32	183.44	7.21
183.44	7.54	223.51	14.75
223.51	10.92	272.31	25.66
272.31	12.12	331.77	37.78
331.77	13.47	404.21	51.28
404.21	20.78	492.47	72.06
492.47	27.97	600.00	100.00



MALVERN INSTRUMENTS

MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 5
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 5 (X=22mm, Y=110mm)
Measured with 2JHD with 300mm len

Run Number: 4
Record Number: 24

Measured: Wed Jul 15 1998 2:28PM
Analysed: Wed Jul 15 1998 2:28PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 17.7 %
Residual: 8.787 %

Result Statistics

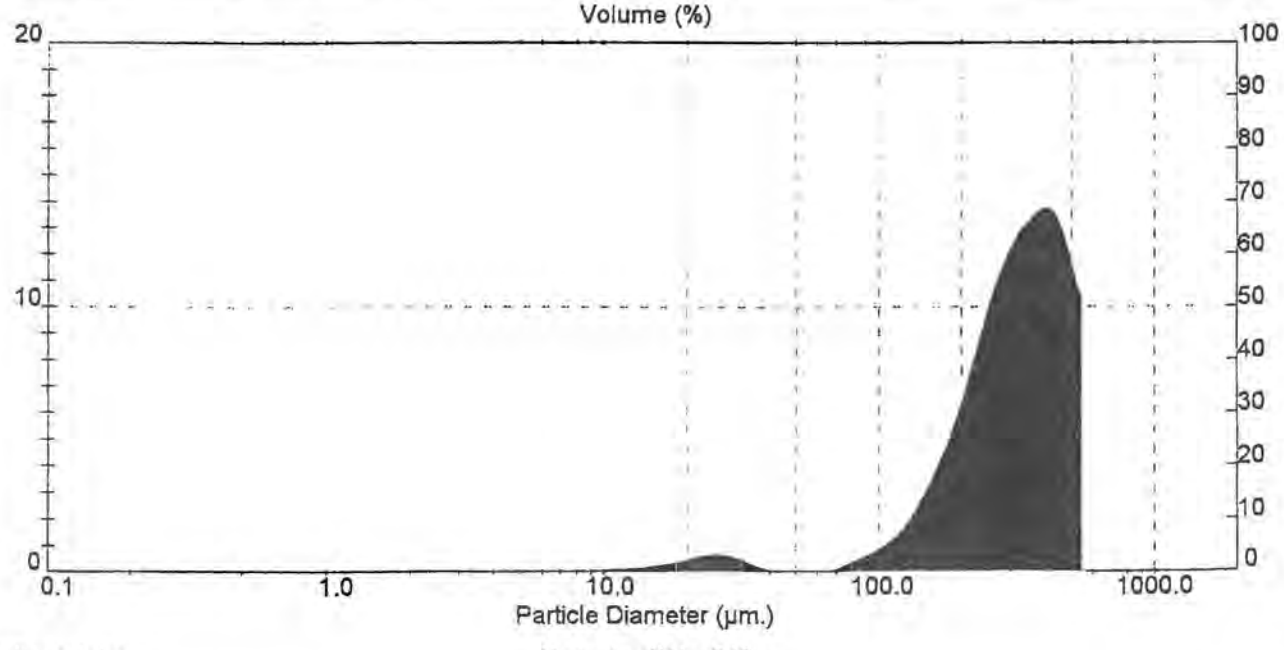
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 326.16 um

Concentration = 0.5380 %Vol
D (v, 0.1) = 154.78 um
D [3, 2] = 199.45 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 323.13 um
Span = 1.115E+00

Specific S.A. = 0.0301 sq. m / g
D (v, 0.9) = 515.15 um
Uniformity = 3.486E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00	25.46	0.80	31.01	2.86
1.32	0.00	1.60	0.00	31.01	0.40	37.79	3.26
1.60	0.00	1.95	0.00	37.79	0.05	46.03	3.31
1.95	0.00	2.38	0.00	46.03	0.00	56.09	3.31
2.38	0.00	2.90	0.00	56.09	0.01	68.33	3.32
2.90	0.00	3.53	0.00	68.33	0.37	83.26	3.69
3.53	0.00	4.30	0.00	83.26	0.90	101.44	4.59
4.30	0.00	5.24	0.00	101.44	1.65	123.59	6.24
5.24	0.00	6.39	0.00	123.59	3.15	150.57	9.39
6.39	0.00	7.78	0.00	150.57	5.49	183.44	14.88
7.78	0.00	9.48	0.00	183.44	8.74	223.51	23.63
9.48	0.15	11.55	0.15	223.51	12.80	272.31	36.42
11.55	0.20	14.08	0.35	272.31	15.82	331.77	52.23
14.08	0.34	17.15	0.69	331.77	17.41	404.21	69.64
17.15	0.55	20.90	1.24	404.21	17.04	492.47	86.65
20.90	0.82	25.46	2.06	492.47	13.32	600.00	100.00



MALVERN INSTRUMENTS MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 5
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 5 (X=22mm, Y=110mm)
Measured with 2JHD with 300mm len

Run Number: 5
Record Number: 25

Measured: Wed Jul 15 1998 2:30PM
Analysed: Wed Jul 15 1998 2:30PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 12.2 %
Residual: 6.386 %

Result Statistics

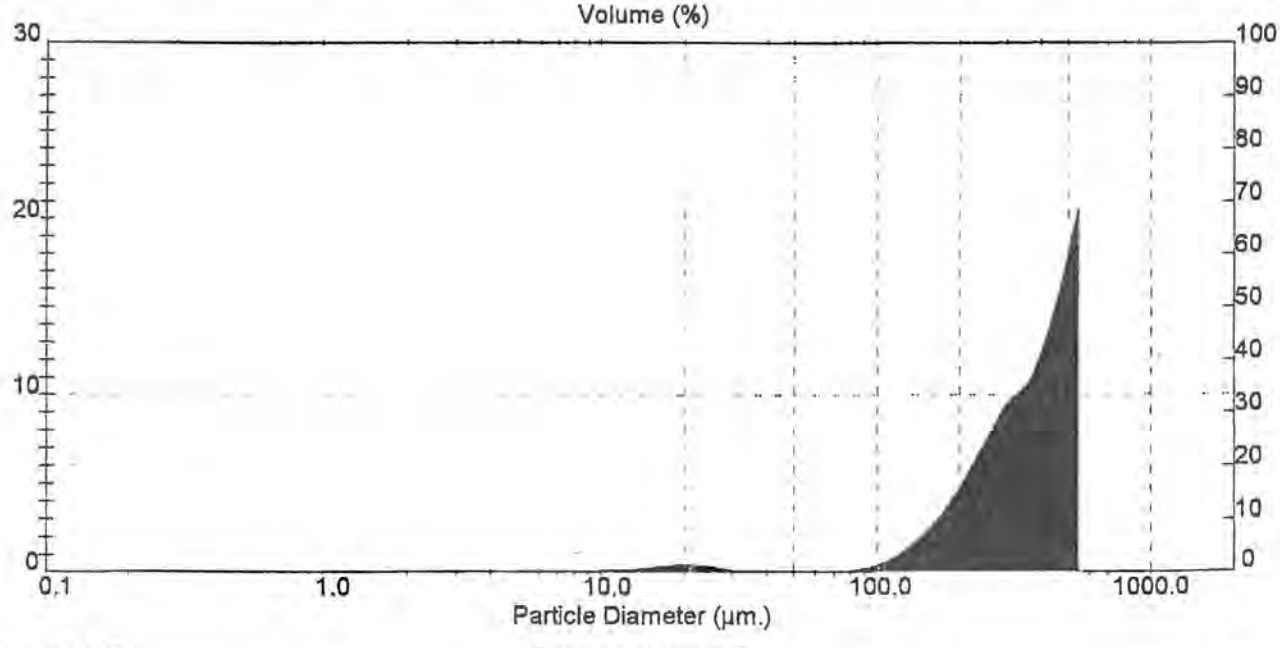
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 372.76 um

Concentration = 0.4016 %Vol
D (v, 0.1) = 180.64 um
D [3, 2] = 223.76 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 386.93 um
Span = 9.779E-01

Specific S.A. = 0.0268 sq. m / g
D (v, 0.9) = 559.03 um
Uniformity = 3.128E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.03	7.78	0.03
7.78	0.08	9.48	0.11
9.48	0.17	11.55	0.28
11.55	0.25	14.08	0.53
14.08	0.42	17.15	0.95
17.15	0.59	20.90	1.54
20.90	0.54	25.46	2.08
25.46	0.30	31.01	2.38
31.01	0.09	37.79	2.48
37.79	0.00	46.03	2.48
46.03	0.00	56.09	2.48
56.09	0.00	68.33	2.48
68.33	0.08	83.26	2.56
83.26	0.40	101.44	2.97
101.44	1.04	123.59	4.00
123.59	2.32	150.57	6.32
150.57	4.07	183.44	10.39
183.44	6.60	223.51	17.00
223.51	9.61	272.31	26.62
272.31	12.44	331.77	39.05
331.77	14.52	404.21	53.58
404.21	19.82	492.47	73.41
492.47	26.62	600.00	100.00



MALVERN INSTRUMENTS

MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 6
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 6 (X=24mm, Y=115mm)
Measured with 2JHD with 300mm len

Run Number: 1
Record Number: 26

Measured: Wed Jul 15 1998 2:35PM
Analysed: Wed Jul 15 1998 2:35PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 16.7 %
Residual: 5.981 %

Result Statistics

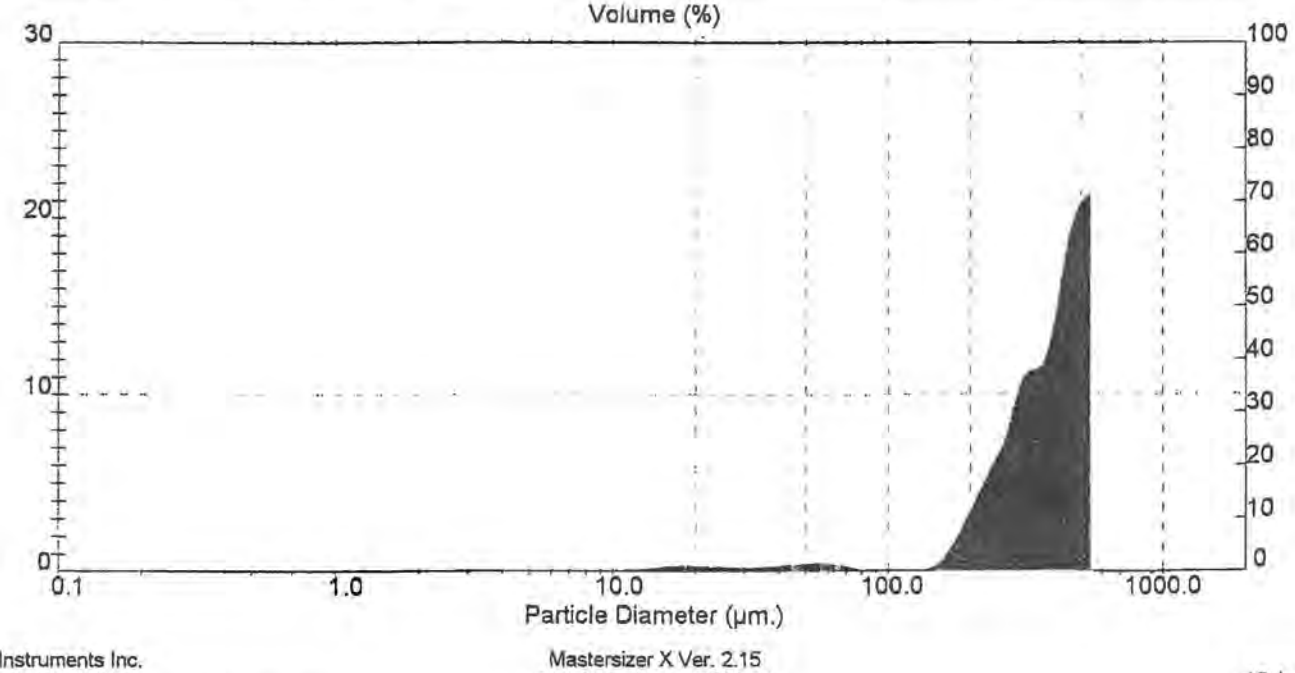
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 389.61 um

Concentration = 0.5974 %Vol
D (v, 0.1) = 216.44 um
D [3, 2] = 235.86 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 410.58 um
Span = 8.342E-01

Specific S.A. = 0.0254 sq. m / g
D (v, 0.9) = 558.93 um
Uniformity = 2.715E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.02	7.78	0.02
7.78	0.05	9.48	0.08
9.48	0.12	11.55	0.19
11.55	0.22	14.08	0.41
14.08	0.40	17.15	0.81
17.15	0.46	20.90	1.27
20.90	0.39	25.46	1.66
25.46	0.32	31.01	1.98
31.01	0.35	37.79	2.33
37.79	0.48	46.03	2.82
46.03	0.60	56.09	3.42
56.09	0.58	68.33	4.00
68.33	0.26	83.26	4.25
83.26	0.00	101.44	4.26
101.44	0.00	123.59	4.26
123.59	0.17	150.57	4.43
150.57	1.66	183.44	6.09
183.44	4.95	223.51	11.05
223.51	8.36	272.31	19.44
272.31	13.54	331.77	32.94
331.77	15.50	404.21	48.49
404.21	23.95	492.47	72.39
492.47	27.61	600.00	100.00



MALVERN INSTRUMENTS

MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 6
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 6 (X=24mm, Y=115mm)
Measured with 2JHD with 300mm len

Run Number: 2
Record Number: 27

Measured: Wed Jul 15 1998 2:37PM
Analysed: Wed Jul 15 1998 2:37PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 20.8 %
Residual: 5.998 %

Result Statistics

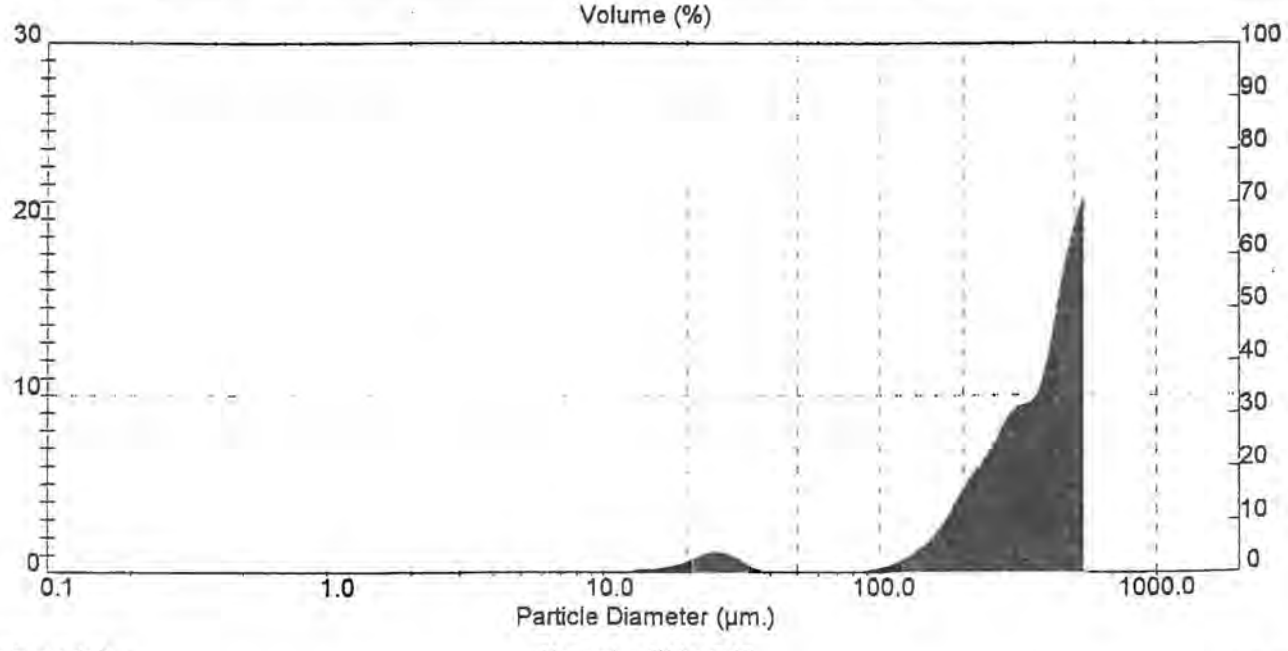
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 372.89 um

Concentration = 0.6557 %Vol
D (v, 0.1) = 176.21 um
D [3, 2] = 204.06 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 396.55 um
Span = 9.660E-01

Specific S.A. = 0.0294 sq. m / g
D (v, 0.9) = 559.27 um
Uniformity = 3.151E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.00	11.55	0.00
11.55	0.20	14.08	0.20
14.08	0.38	17.15	0.59
17.15	0.72	20.90	1.31
20.90	1.43	25.46	2.74
25.46	1.39	31.01	4.13
31.01	0.48	37.79	4.61
37.79	0.01	46.03	4.62
46.03	0.00	56.09	4.62
56.09	0.00	68.33	4.62
68.33	0.00	83.26	4.63
83.26	0.27	101.44	4.89
101.44	0.70	123.59	5.60
123.59	1.77	150.57	7.37
150.57	3.58	183.44	10.95
183.44	6.51	223.51	17.46
223.51	8.94	272.31	26.42
272.31	11.84	331.77	38.23
331.77	13.23	404.21	51.52
404.21	21.26	492.47	72.75
492.47	27.27	600.00	100.00



MALVERN INSTRUMENTS

MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 6
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 6 (X=24mm, Y=115mm)
Measured with 2JHD with 300mm len

Run Number: 3
Record Number: 28

Measured: Wed Jul 15 1998 2:38PM
Analysed: Wed Jul 15 1998 2:38PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 13.9 %
Residual: 6.350 %

Result Statistics

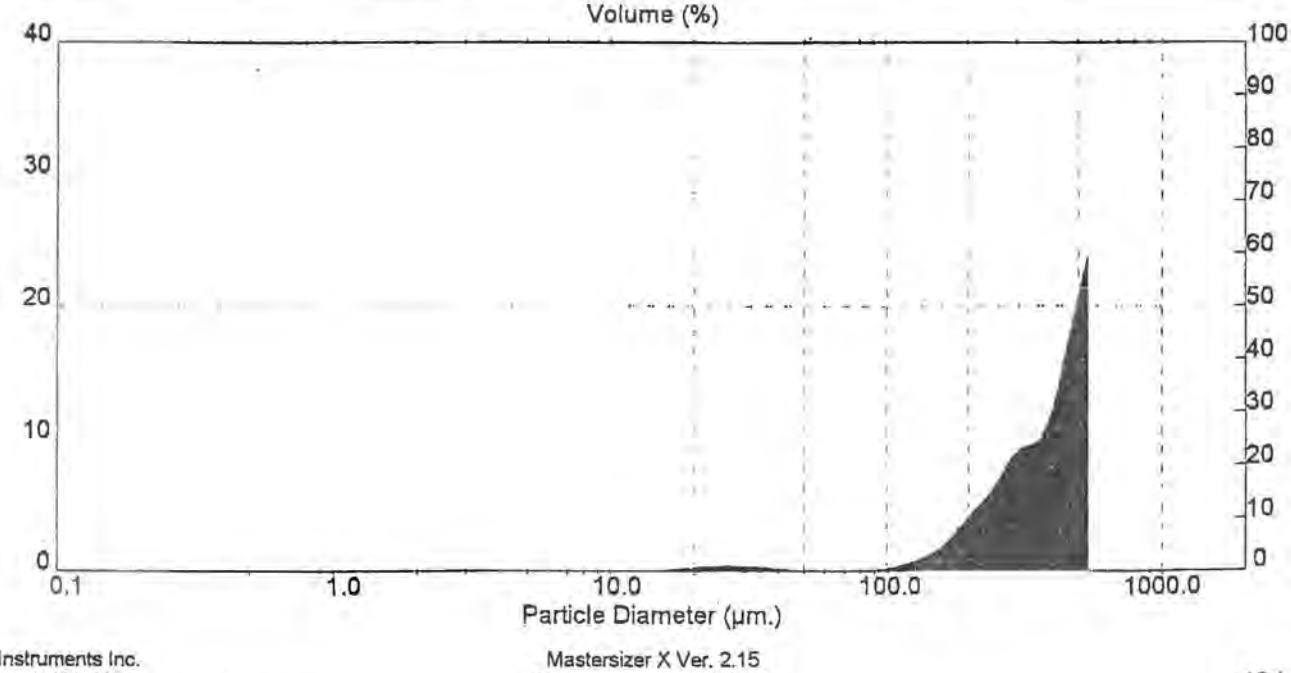
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 389.28 um

Concentration = 0.5207 %Vol
D (v, 0.1) = 195.79 um
D [3, 2] = 251.27 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 415.80 um
Span = 8.869E-01

Specific S.A. = 0.0239 sq. m / g
D (v, 0.9) = 564.54 um
Uniformity = 2.847E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00	25.46	0.65	31.01	1.99
1.32	0.00	1.60	0.00	31.01	0.55	37.79	2.54
1.60	0.00	1.95	0.00	37.79	0.32	46.03	2.87
1.95	0.00	2.38	0.00	46.03	0.06	56.09	2.93
2.38	0.00	2.90	0.00	56.09	0.00	68.33	2.93
2.90	0.00	3.53	0.00	68.33	0.00	83.26	2.93
3.53	0.00	4.30	0.00	83.26	0.23	101.44	3.16
4.30	0.00	5.24	0.00	101.44	0.67	123.59	3.83
5.24	0.00	6.39	0.00	123.59	1.51	150.57	5.34
6.39	0.00	7.78	0.00	150.57	3.08	183.44	8.41
7.78	0.00	9.48	0.00	183.44	5.66	223.51	14.08
9.48	0.00	11.55	0.00	223.51	8.37	272.31	22.46
11.55	0.06	14.08	0.06	272.31	11.76	331.77	34.20
14.08	0.22	17.15	0.28	331.77	13.38	404.21	47.62
17.15	0.45	20.90	0.73	404.21	21.61	492.47	69.24
20.90	0.62	25.46	1.35	492.47	30.81	600.00	100.00



MALVERN MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 6
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 6 (X=24mm, Y=115mm)
Measured with 2JHD with 300mm len

Run Number: 4
Record Number: 29

Measured: Wed Jul 15 1998 2:40PM
Analysed: Wed Jul 15 1998 2:40PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 14.6 %
Residual: 5.829 %

Result Statistics

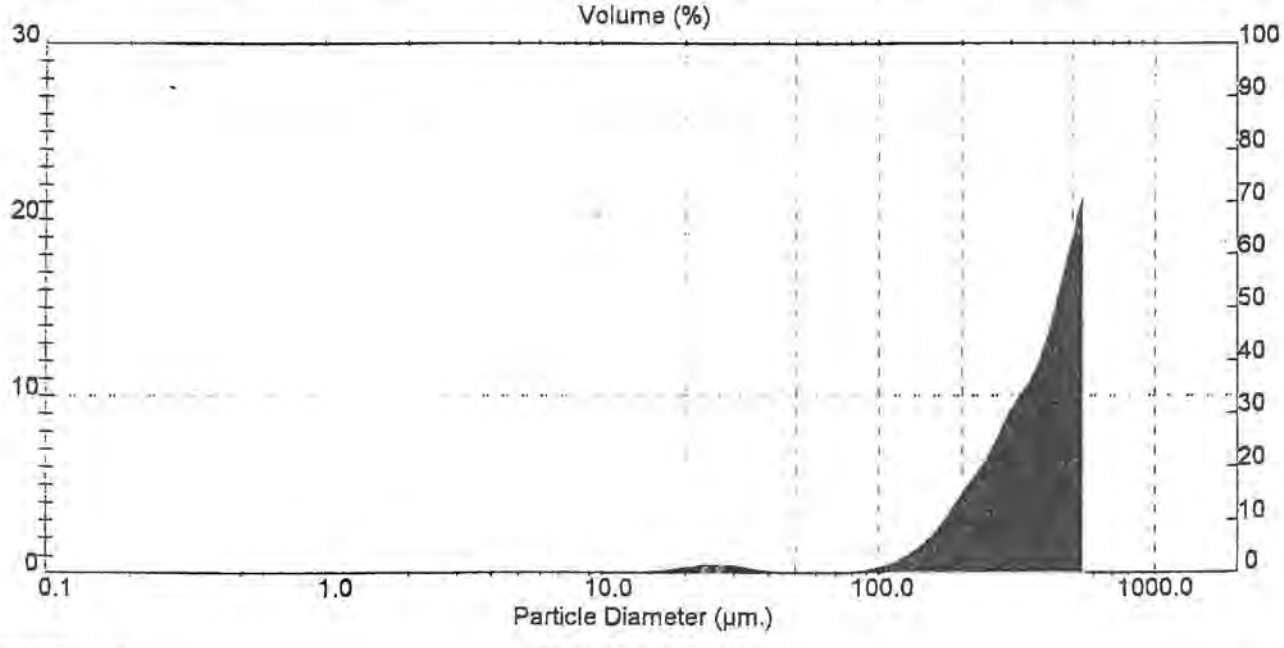
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 379.20 um

Concentration = 0.5420 %Vol
D (v, 0.1) = 187.70 um
D [3, 2] = 247.83 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 396.93 um
Span = 9.374E-01

Specific S.A. = 0.0242 sq. m / g
D (v, 0.9) = 559.77 um
Uniformity = 2.991E-01

Size Low (um)	In %	Size High (um)	Under%	Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00	25.46	0.65	31.01	2.03
1.32	0.00	1.60	0.00	31.01	0.42	37.79	2.45
1.60	0.00	1.95	0.00	37.79	0.15	46.03	2.60
1.95	0.00	2.38	0.00	46.03	0.00	56.09	2.60
2.38	0.00	2.90	0.00	56.09	0.00	68.33	2.60
2.90	0.00	3.53	0.00	68.33	0.04	83.26	2.64
3.53	0.00	4.30	0.00	83.26	0.34	101.44	2.98
4.30	0.00	5.24	0.00	101.44	0.85	123.59	3.83
5.24	0.00	6.39	0.00	123.59	1.92	150.57	5.75
6.39	0.00	7.78	0.00	150.57	3.65	183.44	9.40
7.78	0.00	9.48	0.00	183.44	6.20	223.51	15.61
9.48	0.00	11.55	0.00	223.51	8.76	272.31	24.38
11.55	0.08	14.08	0.08	272.31	12.16	331.77	36.53
14.08	0.22	17.15	0.30	331.77	15.04	404.21	51.59
17.15	0.43	20.90	0.73	404.21	21.08	492.47	72.68
20.90	0.64	25.46	1.38	492.47	27.35	600.00	100.00



MALVERN MASTERSIZER

Result: Analysis Report

Sample Details

Sample ID: Nozzle 6
Sample File: SDA
Sample Path: C:\SIZERX\DATA\
Sample Notes: SDA Nozzle 6 (X=24mm, Y=115mm)
Measured with 2JHD with 300mm len

Run Number: 5
Record Number: 30

Measured: Wed Jul 15 1998 2:41PM
Analysed: Wed Jul 15 1998 2:42PM
Result Source: Analysed

System Details

Range Lens: 300 mm
Presentation: 2JHD
Analysis Model: Polydisperse
Modifications: None

Beam Length: 2.40 mm
[Particle R.I. = (1.3566, 0.1000); Dispersant R.I. = 1.3300]

Sampler: None

Obscuration: 14.5 %
Residual: 4.687 %

Result Statistics

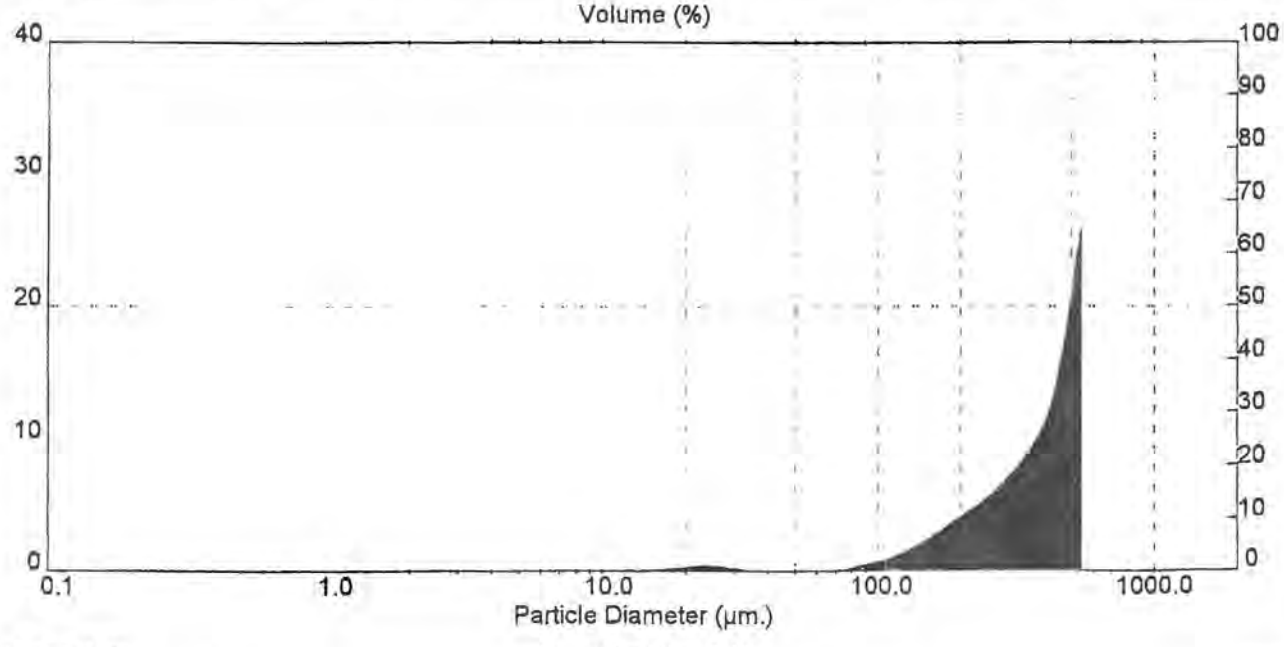
Distribution Type: Volume
Mean Diameters:
D [4, 3] = 388.80 um

Concentration = 0.5255 %Vol
D (v, 0.1) = 171.80 um
D [3, 2] = 242.82 um

Density = 1.000 g / cub. cm
D (v, 0.5) = 422.17 um
Span = 9.393E-01

Specific S.A. = 0.0247 sq. m / g
D (v, 0.9) = 568.34 um
Uniformity = 2.947E-01

Size Low (um)	In %	Size High (um)	Under%
0.50	0.00	1.32	0.00
1.32	0.00	1.60	0.00
1.60	0.00	1.95	0.00
1.95	0.00	2.38	0.00
2.38	0.00	2.90	0.00
2.90	0.00	3.53	0.00
3.53	0.00	4.30	0.00
4.30	0.00	5.24	0.00
5.24	0.00	6.39	0.00
6.39	0.00	7.78	0.00
7.78	0.00	9.48	0.00
9.48	0.04	11.55	0.04
11.55	0.15	14.08	0.20
14.08	0.29	17.15	0.48
17.15	0.50	20.90	0.98
20.90	0.68	25.46	1.66
25.46	0.51	31.01	2.16
31.01	0.17	37.79	2.34
37.79	0.00	46.03	2.34
46.03	0.00	56.09	2.34
56.09	0.00	68.33	2.34
68.33	0.29	83.26	2.63
83.26	0.83	101.44	3.46
101.44	1.46	123.59	4.93
123.59	2.59	150.57	7.52
150.57	3.97	183.44	11.49
183.44	5.61	223.51	17.10
223.51	7.23	272.31	24.34
272.31	9.51	331.77	33.85
331.77	12.68	404.21	46.54
404.21	19.91	492.47	66.51
492.47	33.57	600.00	100.00



Malvern Instruments Inc.
Southborough MA, USA
Tel:+[1] 508-480 0200 Fax:+[1] 508-460 9692

Appendix D. Study Protocol

BATTELLE STUDY PROTOCOL

MEASUREMENT AND CHARACTERIZATION OF AEROSOLS GENERATED FROM A CONSUMER SPRAY PRODUCT - PILOT STUDY

Prepared For:

The Soap and Detergent Association

Battelle
. . . Putting Technology To Work

MEASUREMENT AND CHARACTERIZATION OF AEROSOLS GENERATED FROM A CONSUMER SPRAY PRODUCT – PILOT STUDY

APPROVED, BATTELLE:

Tom Vinci — 12/29/97

Thomas M. Vinci, B.S.
Study Director — Date

Merrill R. Osheroff — 12/19/97

Merrill R. Osheroff, Ph.D., D.A.B.T.
Senior Program Director — Date

APPROVED, SPONSOR:

[signature] — 12/17/97

Study Monitor — Date
JENAN AL-ATRASHI, Dr. PH
DIRECTOR, HUMAN HEALTH & SAFETY
SDA

MEASUREMENT AND CHARACTERIZATION OF AEROSOLS GENERATED FROM A CONSUMER SPRAY PRODUCT – PILOT STUDY

1.0 PRINCIPALS

1.1 Sponsor

Soap and Detergent Association
New York, NY

1.1.1 Sponsor's Project Monitor

Dr. Jenan Al-Atrash
Human Health and Safety Director

1.2 Performing Laboratory

1.2.1 Facility

Battelle
505 King Avenue
Columbus, OH 43201-2693

1.2.2 Study Director

Thomas M. Vinci
Preclinical Drug Development

2.0 STUDY CONDUCT

This protocol will be the controlling document in case of discrepancies between the protocol and SOPs. This study will be conducted in compliance with the EPA Good Laboratory Practices Regulations (40 CFR, Part 792) for the conduct of non-clinical studies. This study will be listed on Battelle's list of non-regulated studies. All records that would be required to reconstruct the study will be maintained. All data generated from any portion of this study will be retained at Battelle until acceptance of the final report, when all materials will be returned to the designated archival facility.

3.0 OBJECTIVE

The purpose of this study is to characterize aerosols present in the breathing zone of a potential user after simulating delivery of a laundry enzyme trigger spray product. This pilot study will evaluate the impact of various design and sampling variables on measurement of enzyme aerosol concentrations under reasonable foreseeable heavy usage situations.

4.0 DESIGN OVERVIEW

The pilot study is designed to evaluate three sampling methods using a single product and fabric type. The purpose would be: (1) to determine when an aerosol concentration peak begins and its duration during a spray episode and (2) the distribution of particle sizes. Upon finalization of the study, Battelle will give to the Sponsor and its authorized representatives a presentation of the results. Additionally the Sponsor will have the option to review the results and decide whether or not to proceed with additional testing.

All experimentation will be performed in a test chamber that conforms with three requirements. First, laboratory personnel will not be exposed to discharged vapors and particles. Gloves, a long-sleeved lab coat, eye protection and respiratory protection equipment should be worn during this study to prevent any potential for skin irritation and the development of respiratory allergies. Second, the experimental region will remain unaffected by air currents and activity in the laboratory. Third, the test chamber will be cleared of any residual test compound before discharge of the next test compound. The inside volume of the test chamber which will be used during this study is approximately 14 cubic meters.

5.0 PRODUCT EVALUATION PROCEDURES

5.1 Test Product

The SDA will provide a prototype spray laundry product.

5.2 Product use simulation

The trigger sprayer will be actuated a distance of 6 inches from the spray nozzle to a target. The target will be a double layer piece of fabric on which a marked area 8 inches from the edge of the fabric, represents the "stain". The fabric type will be a polyester/cotton blend material (approximately 18 inches × 18 inches) and will be supplied to Battelle by the SDA.

There will be two product use simulation layouts; see Figures 1, 2 and 3.

Horizontal Target

The target will be placed on a surface (table-top or washing machine) at 36 inches above the floor. The nozzle will be placed 40.5 inches above the floor, at a 45 degree angle 6 inches from the center of the stain in the vertical plane perpendicular to the surface of the target through the center of the stain.

Vertical Target

The target is supported so that the bottom of the target material touches the horizontal surface (36 inches). The center of the "stain" will then be 45 inches above the floor. The nozzle will be 6 inches from the target on the axis perpendicular to the center of the target.

Once the initial set of analyses are completed, for both targets, the reproducibility of the results will be reported to the Sponsor for assessment of precision.

Based on the precision of the data, the Sponsor will decide whether to include an additional variable in the study. If precision is judged to be appropriate by the Sponsor, then the impact of movement of the target during spraying will be assessed. The target will be moved during spraying to simulate the potential movement that may be encountered during consumer use. To simulate this movement, the target will be oriented vertically and rotated within the vertical plane at a rate of approximately 0.25 revolutions per second. The sprayer head will be pointed just off center of the rotation such that the area covered by the spray of the rotating target is approximately 50 percent greater than the area covered by the spray when the stationary target is used. Thus, if the spray area is 8 in^2 for the stationary target then the spray area of the moving target should be approximately 12 in^2. All other aspects, distance of sprayer from target, positioning of air sampler etc., will be similar to that described for the vertical target.

Sampler Location

For both test layouts, the center of the sampler inlet will be at 58 inches above the floor, at a distance of 24 inches from the target stain. The sampler inlet will be placed in a plane 30 degrees to the side of the line between the sprayer and target stain and will be tipped 45 degrees from the vertical towards the target.

The dispensing procedure will simulate consumer use. The trigger sprayer will be pre-weighed, placed in its location in the testing chamber and the dispensing procedure will begin. The actuation sequence will be manually controlled to provide a uniform force which will deliver five sprays to the target at a rate of one stroke per second. There will be a 10-second lag between targets. This is repeated again with a new target for a total of six targets.

The configuration and locations of the sprayer trigger sprayer, the target and the sampler are intended to simulate potential regions of likely human exposure.

5.3 Measurement Methods

The total mass output per unit time of the trigger sprayer will be determined by weighing each trigger sprayer before and after the above time-controlled actuation sequence during each of the sampling experiments.

Aerosizer particle measuring device will be operated with a flow rate of 2 L/min. The aerosizer particle measuring system is capable of measuring individually the size of particles in the range of less than 0.2 to 700 μM. The sampled particles may be in the form of a dry powder, may be suspended in a gas, or may be sprayed from a liquid suspension. When the particles enter the sensor region, they are in the form of an air suspension.

6.0 EXPERIMENTAL DESIGN

The sampling will begin 1 minute before application and will continue for 5 minutes after spraying cessation. Sampling will include only the aerosizer particle measuring device.

Actual room volume, air flows, temperature and humidity values must be known and recorded. Room air flow will be only due to passive leakage during application (i.e. no open doors or windows, and any HVAC equipment turned off). Target humidity: 25-50 percent. Target temperature: 70°F (65 to 75° acceptable). Actual weight of product applied per target cloth and/or per spraying episode will be recorded. The sampling time will be based on mass analysis data to assure that aerosol "peak" is sampled.

Five replicates of the experiment will be run. In addition, a preliminary experimental run will be performed to investigate background conditions prior to the start of each compound evaluation. The aerosizer will be used and will sample for approximately one minute. Reproducibility of the results will be reported to the Sponsor for assessment of precision and for determine if variability is acceptable.

All experiments will be performed in the same test chamber. During sampling, the chamber will have no air movement other than that created by drawing the samples. Between experimental runs the chamber will be flushed with fresh air for a sufficient time to rid the simulated breathing zone of any unwanted particles and vapors. Verification of removal of aerosols and build-up will be conducted prior to the start of the test. Thereafter, periodic spot checking will be made. Period of time chamber is flushed with fresh air will be recorded.

The actual test will be recorded on video tape (VHS).

7.0 REPORTS

Upon completion of the study, a draft final report shall be prepared and delivered to the Sponsor within 4 weeks of the last experiment. The report will include but not be limited to the following:

- Objectives and procedures as stated in the approved protocol.

- Descriptions of the setup and procedures used to generate and monitor aerosols
- Descriptions of the total sprayer trigger sprayer output measurement setup and procedures used to generate and monitor aerosols
- Tabulation of the raw and processed data including: gravimetric evaluations of spray trigger sprayers and particle size distribution evaluations of the aerosol.
- General summary of statistical results: mean, median, standard deviation, coefficient of variation and distribution of variability will be reported.

For the mass analyzer, data presented in the study should include:

1. Plot the total volume of droplets captured over time for each replicate.
2. Plot the droplet size distribution for each time interval for each replicate.
3. Plot the average volume of droplets captured over time for each of the two fabric orientations.
4. Express the preceding item (on the same or different plots) in terms of concentration units of ng/m^3.

The SDA will submit comments, if any, on the draft report to the Study Director within 30 days of receipt of the draft report. The final report will be submitted to the SDA within 30 days of receipt of the Sponsor's comments on the draft report.

Upon approval of the final report, all study file data, raw and processed will be sent, along with the final report to the Sponsor.

Figure 1. Relative Orientation of Sprayer, Horizontal Target, and Sampler: Side View

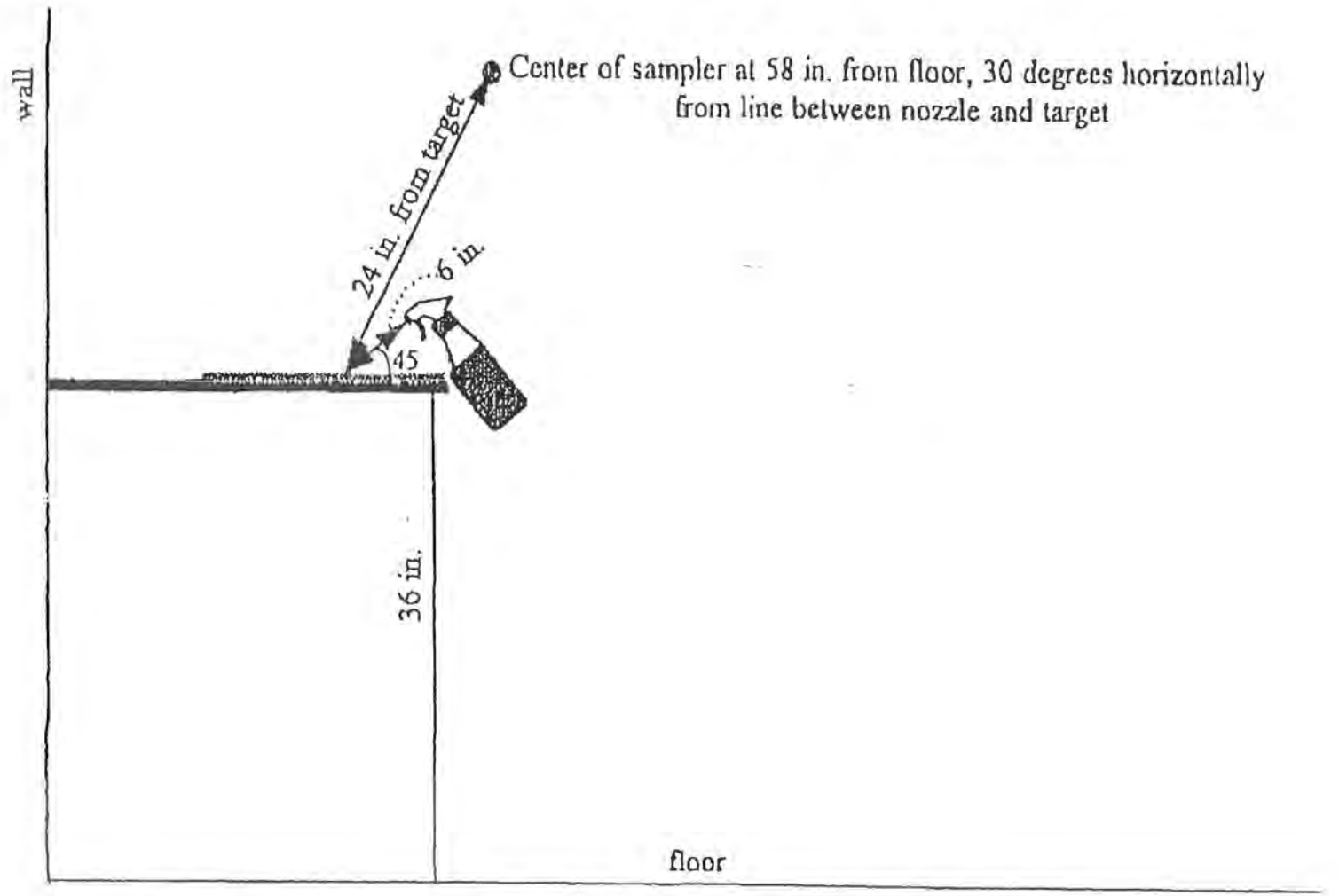


Figure 2. Relative Orientation of Sprayer, Vertical Target, and Sampler:
Side View

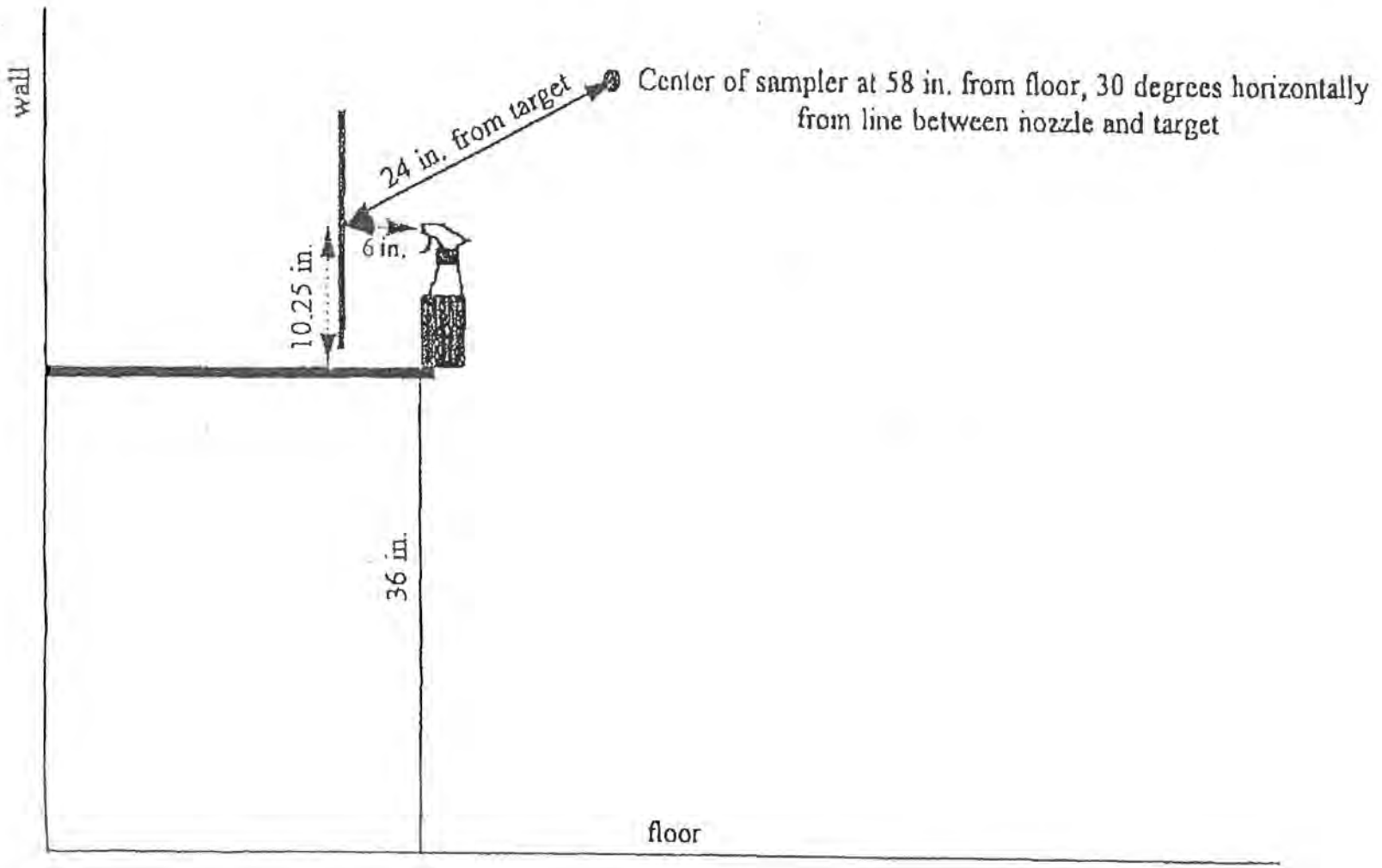
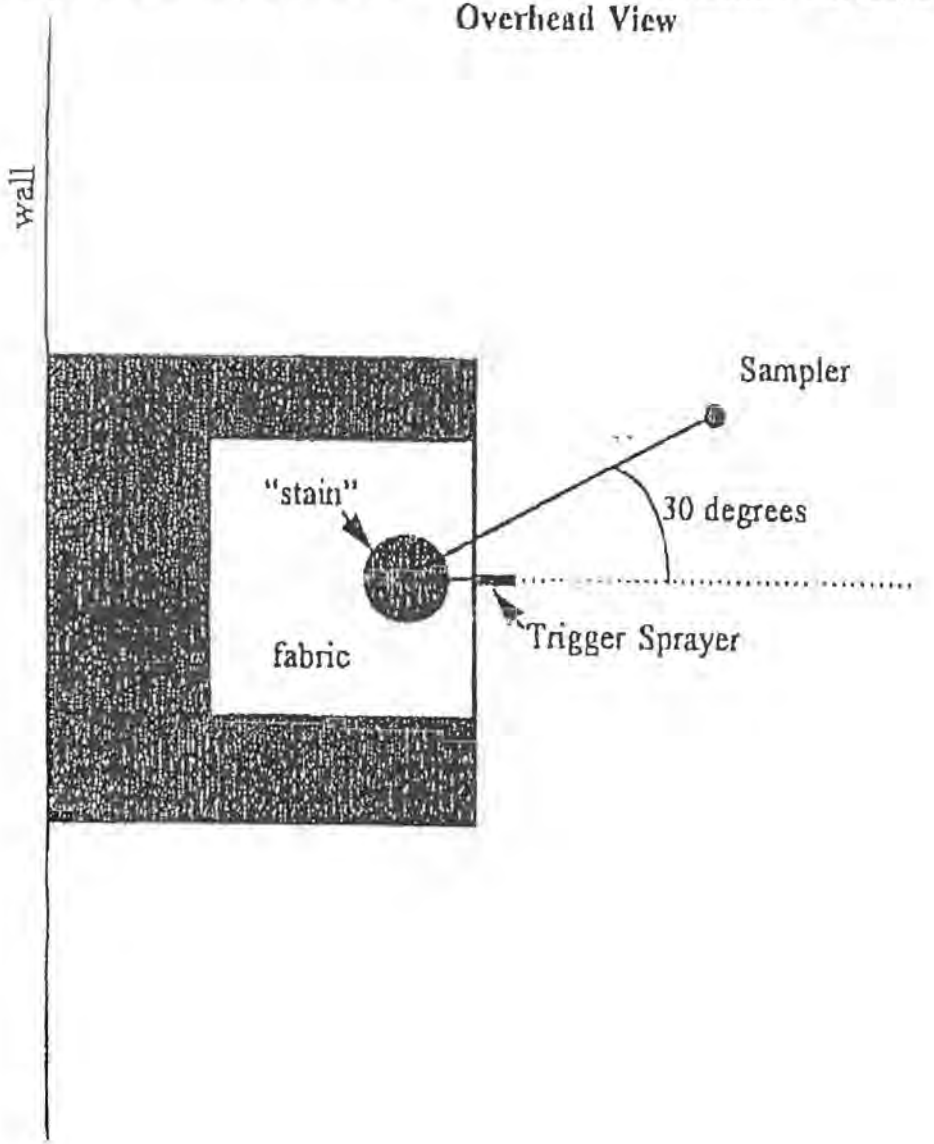


Figure 3. Relative Orientation of Sprayer, Horizontal Target, and Sampler: Overhead View



PROTOCOL AMENDMENT NUMBER 1

Battelle Study Number: N003043
"Measurement and Characterization of Aerosols Generated from a Consumer Spray Product-Pilot Study"
Effective Date: January 14, 1998

1. **Part to be Changed: Page 3, Section 1.1, Sponsor**

Change:	Soap and Detergent Association New York, NY
To:	Soap and Detergent Association 475 Park Avenue South New York, NY 10016
Justification:	A complete address is necessary for GLP protocol compliance.

2. **Part to be Changed: Page 3, Section 2.0, Study Conduct**

Change:	This study will be conducted in compliance with the EPA Good ...
To:	This study will be conducted in compliance with the EPA Good Laboratory Practices Regulations (40CFR, Part 792) for the conduct of non-clinical studies, with the following exception; this study will not be listed on Battelle list of regulated studies.
Justification:	Clarification of Battelle's list of regulated studies.

3. **Part to be Changed: Page 4, Section 5.2, Product Use Simulation, Paragraph 1**

Change:	The target will be a double layer piece of fabric on which....
To:	The target will be a single layer piece of fabric on which....
Justification:	There is very little breakthrough from one piece of fabric to another in the "vertical target" arrangement. For the "horizontal target" arrangement the fabric will be separated by layers of plastic-backed absorbent paper.

4. **Part to be Changed: Page 4, Section 5.2, Product Use Simulation, Horizontal Target**

Change:	The nozzle will be placed 40.5 inches above the floor at a 45 degree angle 6 inches from the center of the stain....
To:	The nozzle will be placed 41.5 inches above the floor at a 45 degree angle 6 inches from the center of the stain.

Justification: Due to the size of the table, the container is not able to be below the surface of the table. To fulfill the requirements of: a 45 degree angle to the target and 6 inches from the target, the nozzle to floor dimension was raised slightly.

5. **Part to be Changed: Page 5, Section 5.2, Product Use Simulation, Vertical Target**

Change: The entire contents of Paragraph 3

To: Delete Paragraph 3 from the protocol.

Justification: No target movement will be performed.

6. **Part to be Changed: Page 6, Section 5.3, Measurement Methods, Paragraph 2**

Change: The aerosizer particle measuring system is capable of measuring individually the size of particles in the range of less than 0.2 to 700 microns.

To: The aerosizer particle measuring system is capable of measuring individually the size of particles in the range of 0.2 to 200 microns.

Justification: When using the diluter to monitor for mass concentration, a smaller size nozzle is required, thereby reducing the particle sizing range from 0.2 to 200 microns.

7. **Part to be Changed: Page 6, Section 6.0, Experimental Design, Paragraph 1**

Change: The sampling will begin 1 minute before application and will continue for 5 minutes after spraying cessation.

To: The sampling will begin 1 minute before application and will continue for 9 minutes after spraying cessation.

Justification: The sampling duration after the spraying episode was increased.

8. **Part to be Changed: Page 6, Section 6.0, Experimental Design, Paragraph 2**

Change: Actual weight of product applied per target cloth and/or per spraying episode will be recorded.

To: Actual weight of the product applied to all six cloths during each spraying episode will be recorded, at the conclusion of the spraying episode.

Justification: Individual cloth weights are not necessary.

9. Part to be Changed: Page 6, Section 6.0, Experimental Design, Paragraph 3

Change: In addition, a preliminary experimental run will be performed....

To: In addition, two preliminary experimental runs will be performed to investigate the background conditions prior to the start of each compound evaluation. The aerosizer will be used sample for approximately one minute during a "no activity" period. Two additional runs will consist of sampling for a total of ten minutes for the horizontal target and ten minutes for the vertical target, performing all of the motion activities of a typical spraying run, however without spraying product to the cloths.

Justification: To monitor the background during various activities, which are involved during the two spraying routines.

10. Part to be Changed: Page 7, Section 7.0, Reports, Item 4

Change: Express the preceding item (on the same or different plots) in terms of concentration units of ng/m^3.

To: Express the preceding item (on the same or different plots) in terms of concentration units.

Justification: Units for concentration will be adjusted with relevance to the data.

Thomas Vinci
Study Director

Date

Jenan Al-Atrash, ~~PhD~~ Dr. PH
Director,
Human Health & Safety , SDA

1/16/98
Date

PROTOCOL AMENDMENT NUMBER 2
Battelle Study Number: N003043
"Measurement and Characterization of Aerosols Generated from a Consumer Spray Product – Pilot Study"
Effective Date: May 11, 1998

1. **Part to be Changed: Page 3, Section 1.2.1**

   Change: Facility
   Battelle
   505 King Avenue
   Columbus, OH 43201-2693

   To: Facility
   Battelle
   9000 Battelle Blvd.
   Richland, WA 99352

   Justification: The study will be completed at the Battelle Richland facility

2. **Part to be Changed: Page 3, Section 1.2.2**

   Change: Study Director
   Thomas M. Vinci
   Preclinical Drug Development

   To: Study Director
   John R. Decker
   Preclinical Drug Development

   Justification: The Study Director at the new site will be John Decker

3. **Part to be Changed: Page 5, Section 5.2, Vertical Target, Paragraph 3.**

   Change: Delete Paragraph 3

   Justification: The impact of movement on the target during spraying may be determined in later studies.

4. Part to be Changed: Page 6, Section 6, Paragraph 1

Change: The sampling will begin 1 minute before application and will continue for 5 minutes after spraying cessation. Sampling will include only the aerosizer particle measuring device.

To: The sampling will begin 1 minute before application and will continue for *10* minutes after spraying cessation. Sampling will include only the aerosizer particle measuring device. The aerosizer sampling and analysis window will be 30 seconds.

Justification: The increased sampling time will assure that the full time profile of the aerosol is captured.

5. Part to be Changed: Page 6, Section 6, Paragraph 3

Change: Five replicates of the experiment will be run. In addition, a preliminary experimental run will be performed to investigate the background conditions prior to the start of each compound evaluated. The aerosizer will be used and will...

To: Five replicates of each product evaluation procedure will be run. In addition, prior to each product evaluation procedure, a background evaluation procedure will be performed without spraying the product to investigate the background conditions. The background test procedures will be run identically to the product evaluation procedures with the exception that no product will be placed in the sprayer. The aerosizer will be used and will...

Justification: Running five replicates of the procedure without spraying the product will provide a better evaluation of non-product aerosol contributed by motion in the test system.

J R Decker Jr
John R. Decker
Study Director

6/15/98
Date

Jenan Al-Atrash
Jenan Al-Atrash, Dr. PH
Director
Human Health & Safety, SDA

6/15/98
Date

SDA The Soap and Detergent Association

July 13, 1998

Mr. John R. Decker
Manager, Bioengineering and Aerosol Technology
Preclinical Drug Development - Northwest Operations
Battelle
900 Battelle Boulevard MS K4-16
Richland, WA 99352

Dear Mr. Decker:

Attached is a signed copy of Amendment 3 of the Protocol "Measurement and Characterization of Aerosols Generated from a Consumer Spray Product - Pilot Study." Also, please note that SDA is in agreement with the Standard Operating Procedure for "Fabric Pre-Washing Procedures for the Characterization of Consumer Spray Product". It is my understanding that study start date is July 13, 1998.

Thank you for your cooperation.

Sincerely,

Jenan Al-Atrash, Dr. PH
Human Health & Safety Director

JA:em
Enc.

PROTOCOL AMENDMENT NUMBER 3
Battelle Study Number: N003043
"Measurement and Characterization of Aerosols Generated from a Consumer Spray Product – Pilot Study"
Effective Date: July 10, 1998

1. **Part to be Changed: Page 4, Section 5.1**

   Change:

   5.1 Test Product

   The SDA will provide a prototype spray laundry product.

   To:

   5.1 Test Product

   The SDA will provide two bottles of approximately 650 ml each of a prototype spray laundry product, two bottles of approximately 650 ml each of control product, and six spray triggers.

   Each spray trigger from the group of six spray triggers will be analyzed for mass output per actuation, particle size distribution, and diameter of spray pattern. The vertical target setup (Figure 2) will be used for both mass output and spray pattern measurements. Mass output will be determined as the average mass collected on a fabric target from 5 consecutive actuations. These measurements will be repeated 3 times for each trigger. The particle size distribution from each spray trigger from the group of six spray triggers will be analyzed using the Malvern Diffraction Particle Sizer. A single representative spray trigger will be chosen for all product evaluation procedures.

   Justification: Choosing a spray trigger typical of a group of production triggers will assure that the product evaluations are not done with a trigger with unusual spray characteristics.

2. **Part to be Changed: Page 5, Section 5.2, Paragraph 1**

   Change:

   The fabric type will be a polyester/cotton blend material (approximately 18 inches x 18 inches) and will be supplied to Battelle by SDA.

   To:

   The fabric type will be a polyester/cotton blend material (approximately 18 inches x 18 inches) of a color that will show the sprayed area. The material will be identified and

purchased by SDA. Battelle will prewash the material following a Standard Operating Procedure to be provided by SDA.

Products will be tested on a 36 inch tall x 48 inch wide x 30 inch deep table with a 6 inch tall backsplash. The table will be located 6 inches from the back wall of the test chamber.

Justification: Identification by SDA of a "standard" material and prewash procedure will allow Battelle to prewash material for all tests by a defined standard.

3. **Part to be Changed: Page 4, Section 5.2, Horizontal Target.**

Change: Paragraph 1 to read as follows

To:

The target will be placed on a layer of plastic-backed absorbent paper on a tabletop surface at 36 inches above the floor. The front edge of the target will be approximately aligned with the front edge of the tabletop. The spray nozzle will be located at a 45-degree angle 6 inches from the center of the "stain" in the vertical plane perpendicular to the surface of the target, perpendicular to the front edge of the tabletop and passing through the center of the target.

Justification: This wording eliminates an error in the description of the respective location of the target and spray nozzle and defines the backing to be placed beneath each target.

4. **Part to be Changed: Page 5, Section 5.2, Vertical Target.**

Change: Paragraph 1 to read as follows:

To:

The target will be backed with a single layer of plastic-backed absorbent paper. The target will be supported with the top edge 19.25 inches from the tabletop and the surface parallel to and 6 inches from the front edge of the tabletop. A pan will be placed below the target to catch any test article that may drip from the target. The pan will be raised 1.75 inches from the table top by a spacer. The spray nozzle will be located 10.25 inches above and at a 90-degree angle to the tabletop and 6 inches from the surface of the target.

Justification: This defines the backing to be placed behind each target similar to the horizontal target. The backing will help prevent movement of the target during spraying. The location of the target with respect to the tabletop and catchpan will allow about ½ inch of the target to touch the bottom of the catchpan also helping to eliminate target motion during spraying.

5. **Part to be Changed: Page 6, Section 6, 2nd Paragraph.**

   Change:

   Add the following sentence to the beginning of paragraph 2...

   All experiments will be performed in a test chamber with internal dimensions of 7 feet 4 inches high x 7 feet 10 inches deep x 7 feet 10 inches wide. A door is located on the left front of the enclosure.

Justification: Define the size of the test chamber

6. **Part to be Changed: Page 6, Section 6, 4th Paragraph.**

   Change:

   Eliminate the first sentence of this paragraph and change the following sentence:

   Between experimental runs the chamber will be flushed with fresh air for a ...

   To:
   Between experimental runs the chamber will be flushed with fresh HEPA-filtered air for a ...

   Justification: HEPA filtering the test chamber air between experimental runs will reduce the background aerosol that may be present in the room air.

7. **Part to be Changed: Attached Figures**

   Change:
   Change attached Figures 1, 2 and 3 as shown below

   Justification: Figures corrected to match changes in text.

Figure 1. Relative Orientation of Table, Sparyer, Horisontal Target, and Sampler: Side View

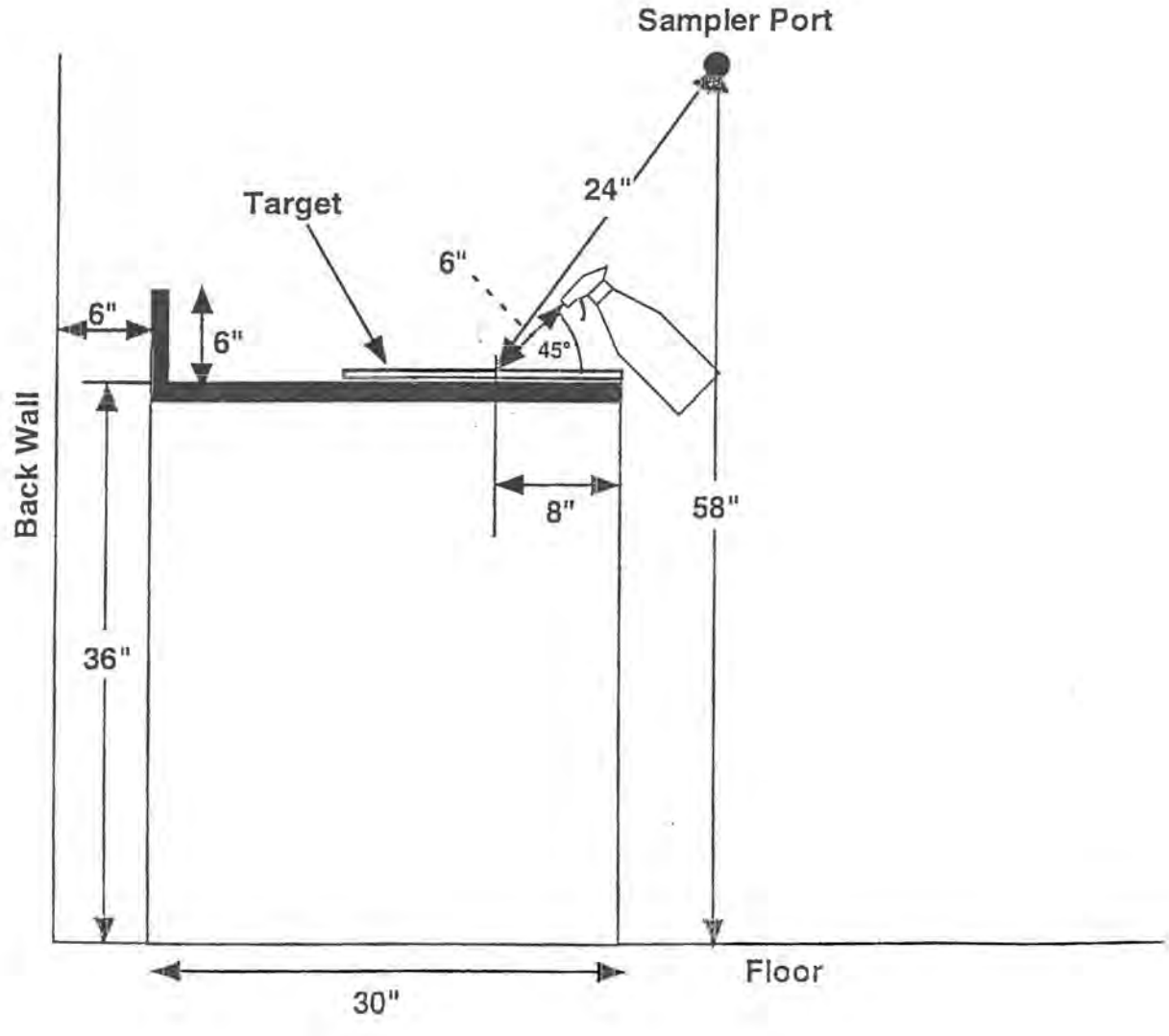


Figure 2. Relative Orientation of Table, Sparyer, Vertical Target, and Sampler: Side View

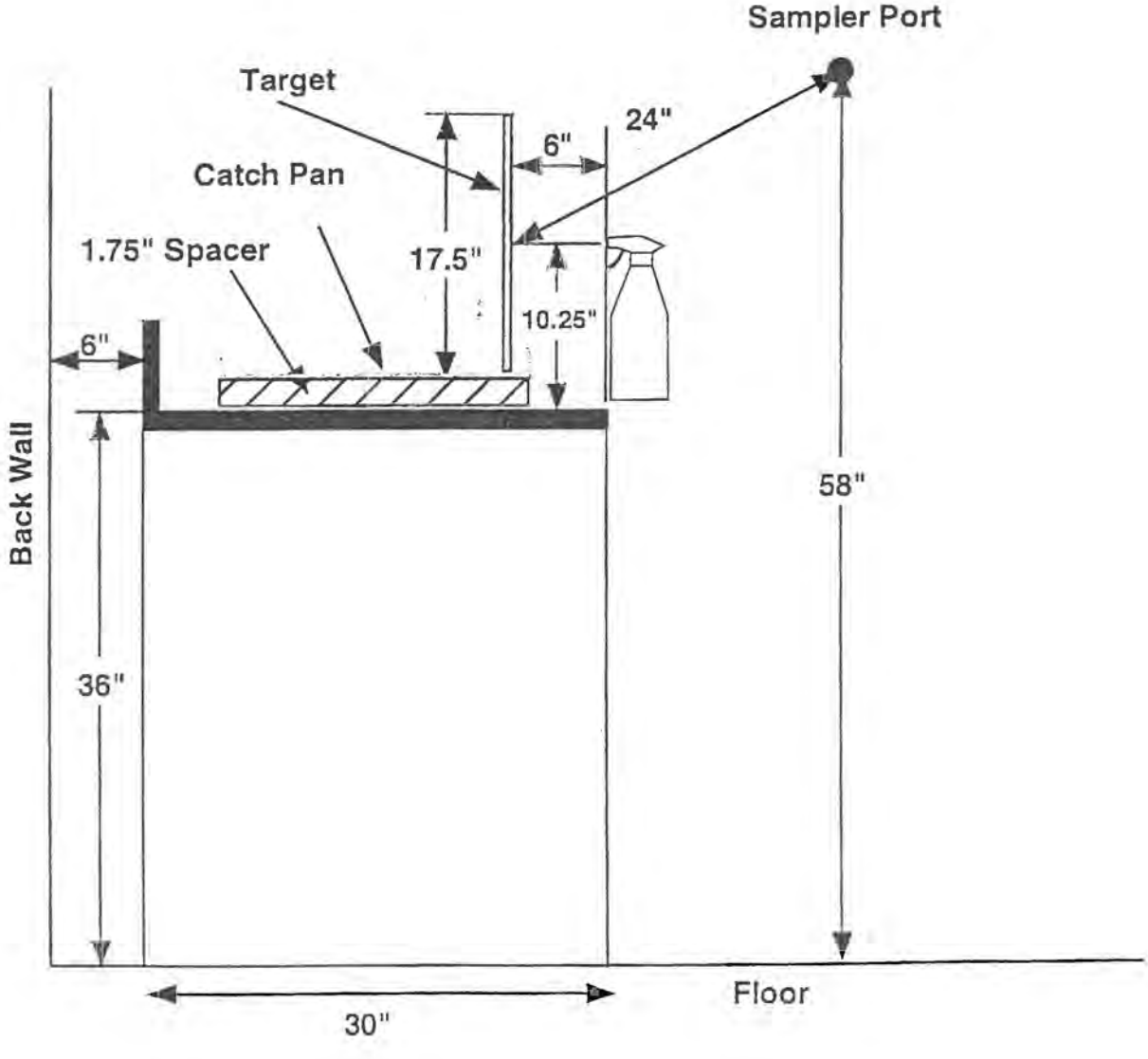
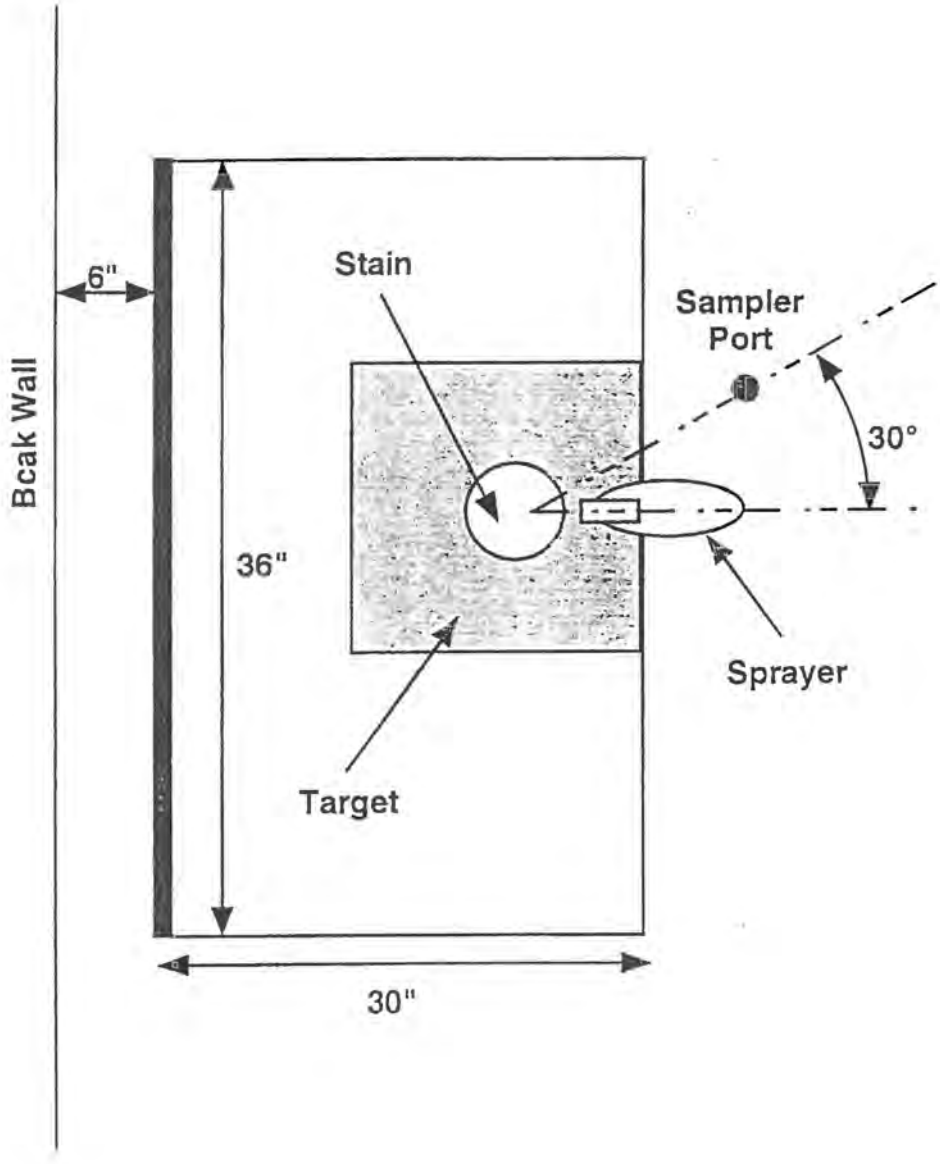


Figure 3. Relative Orientation of Table, Sparyer, Horizontal Target, and Sampler: Top View



John R. Decker
Study Director

7-7-98
Date

Jenan Al-Atrash, Dr. PH
Director
Human Health & Safety, SDA

7/10/98
Date

Appendix E. Specifications for SDA Generic Laundry Prespotter Formulation 14979 H-4-4

SC Johnson Wax
Worldwide Consumer Products
Home Cleaners Product Development

September 23, 1997

Ms. Mary Frike
The Procter & Gamble Co.
Ivorydale Technical Center
5299 Spring Grove Avenue
Cincinnati, OH 45217

Mr. James Wiersig
The Clorox Company
P O Box 493
Pleasanton, CA 94566-5642

Ms. Carol Resch
Unilever Research U.S.
45 River Road
Edgewater, NJ 07020

I am sending, under separate cover, the following formulation. I've taken most of your suggestions except for the Ca at 200ppm. Instead, I used our Racine tap water which has a hardness of 140 ppm and in our testing, helps stabilize the enzymes versus deionized water. If you would still like to add Ca to it, please let me know what salt and how much.

The formulation is as follows:

Material	14979H4-4
Tap Water	78.50
Borax, 5 Mol	0.5
Sodium Citrate	1.00
Surfonic L24-4	10.00
Propylene Glycol	10.00
Total	**100.00%**

I would recommend that the enzyme of choice be added by Battelle to the base just before testing to ensure compatibility as timing may get longer than desired.

The sample uses a Calmar trigger that was selected to be inbetween the soil & stain removers on the market for spray characteristics and still be consumer acceptable. I have also sent another sprayer along for you to see how variable the sprayer will be.

Please review the formulation and spray the sample to determine it's acceptability.
If you have any comments or questions, please give me a call at 414-260-2737.

Regards,

Jeanne O'Brien
Technology Specialist

Appendix F. MSDS for Test Article

MATERIAL SAFETY DATA SHEET

MSDS # 22545

SDA GENERIC LAUNDRY PRESPOTTER

Date Issued: 23Jul1998 **Supersedes: 05Dec1997**

US MANUFACTURER:
S.C. Johnson & Son, Inc.
Phone: (800) 725-6737
Racine, Wisconsin 53403-2236
Emergency Phone: (888) 779-7920
International Emergency Phone:
(414) 886-1480

CANADIAN MANUFACTURER:
S.C. Johnson and Son, Limited
Phone: (800) 725-6737
1 Webster Street
Brantford, Ontario N3T 5R1
Transportation Emergency:
CANUTEC (collect) (613) 996-6666
Poison Control: (888) 779-7920

HAZARD RATING	HMIS	HAZARD	NFPA
4-Very High	1	Health	1
3-High	0	Flammability	0
2-Moderate	0	Reactivity	0
1-Slight		Special	
0-Insignificant			

DISTRIBUTED IN CANADA BY:
S.C. Johnson and Son, Limited
Phone: (800) 725-6737
1 Webster Street
Brantford, Ontario N3T 5R1

SECTION 1 - PRODUCT IDENTIFICATION

PRODUCT NAME..... SDA GENERIC LAUNDRY PRESPOTTER
REASON FOR CHANGE..... No significant changes. Section 2.
PRODUCT USE..... Household: Laundry care

SECTION 2 - INGREDIENT INFORMATION

INGREDIENT	WEIGHT%	EXPOSURE LIMIT/TOXICITY
Enzyme (CAS# 9014-01-1).....	<1.0	0.00006 mg/m³ CEILING ACGIH/OSHA (SUBTILINS)
Sodium Citrate (CAS# 68-04-2).....	0.5-1.5	NOT ESTABLISHED
Alkoxylated Linear Alcohols (CAS# 68439-50-9).	7-13	NOT ESTABLISHED
Propylene Glycol (CAS# 57-55-6).....	7-13	NOT ESTABLISHED
Water (CAS# 7732-18-5).....	75-90	NOT ESTABLISHED

SECTION 3 - HEALTH HAZARDS IDENTIFICATION (Also See Section 11)

ROUTE(S) OF ENTRY..... Eye contact. Skin contact.
EFFECTS OF ACUTE EXPOSURE:
EYE..... May cause: Mild eye irritation.
SKIN..... None known.
INHALATION..... None known.
INGESTION..... None known.
MEDICAL CONDITIONS..... None known.
GENERALLY RECOGNIZED AS BEING AGGRAVATED BY EXPOSURE

SECTION 4 - FIRST AID MEASURES

EYE CONTACT..... Flush immediately with plenty of water for at least 15 to 20 minutes. If irritation persists, get medical attention.
SKIN CONTACT..... Rinse with plenty of water.
INHALATION..... No special requirements.
INGESTION..... Immediately drink 1-2 glasses of water or milk. Seek immediate medical attention.

SECTION 5 - FIRE AND EXPLOSION INFORMATION

MATERIAL SAFETY DATA SHEET

 MSDS # 22545

SDA GENERIC LAUNDRY PRESPOTTER

Date Issued: 23Jul1998 **Supersedes: 05Dec1997**

SECTION 5 - FIRE AND EXPLOSION INFORMATION (continued)

FLAMMABLE LIMITS.....	Not applicable.
AUTOIGNITION..... TEMPERATURE	Not applicable.
EXTINGUISHING MEDIA....	Foam. CO2. Dry chemical. Water fog.
SPECIAL FIREFIGHTING... PROCEDURES	Normal fire fighting procedure may be used.
UNUSUAL FIRE AND..... EXPLOSION HAZARDS	Container may melt and leak in heat of fire.

SECTION 6 - PREVENTIVE RELEASE MEASURES

STEPS TO BE TAKEN IN... CASE MATERIAL IS RELEASED OR SPILLED	Dike large spills. Absorb with oil-dri or similar inert material. Sweep or scrape up and containerize.

SECTION 7 - HANDLING AND STORAGE

PRECAUTIONARY..... INFORMATION	May be: Eye irritant. Avoid contact with eyes. If such contact occurs, flush immediately with plenty of water for at least 15 to 20 minutes. If irritation persists, seek medical aid. Keep out of reach of children.
OTHER HANDLING AND..... STORAGE CONDITIONS	Wash thoroughly after handling. Keep from freezing.

SECTION 8 - SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION.	No special requirements under normal use conditions.
VENTILATION.....	No special requirements.
PROTECTIVE GLOVES.....	No special requirements under normal use conditions.
EYE PROTECTION.....	No special requirements under normal use conditions.
OTHER PROTECTIVE..... MEASURES	No special requirements.

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

COLOR.....	Opaque to Translucent White
PRODUCT STATE.....	Viscous Liquid.
ODOR.....	Odorless
pH.....	7.8-8.2
ODOR THRESHOLD.....	Not available.
SOLUBILITY IN WATER....	Complete
SPECIFIC GRAVITY..... (H2O=1)	1.01-1.02
VISCOSITY.....	Not available
VAPOR DENSITY (AIR=1)..	Not available.
EVAPORATION RATE (BUTYL ACETATE=1)	Not available.
VAPOR PRESSURE (mm HG).	Not available.
BOILING POINT.....	Not available.
FREEZING POINT.....	Not available.
COEFFICIENT OF..... WATER/OIL	Not available.
PERCENT VOLATILE BY.... VOLUME (%)	Not available.

MATERIAL SAFETY DATA SHEET

 MSDS # 22545

SDA GENERIC LAUNDRY PRESPOTTER

Date Issued: 23Jul1998 **Supersedes: 05Dec1997**

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES (continued)

VOLATILE ORGANIC COMPOUND (VOC)	Not available.
THEORETICAL VOC (LB/GAL)	Not available.

SECTION 10 - STABILITY AND REACTIVITY

STABILITY	Stable
STABILITY - CONDITIONS. TO AVOID	Not applicable.
INCOMPATIBILITY	None known.
HAZARDOUS DECOMPOSITION PRODUCTS	When exposed to fire: Produces normal products of combustion.
HAZARDOUS POLYMERIZATION	Will not occur.
HAZARDOUS POLYMERIZATION - CONDITIONS TO AVOID	Not applicable.

SECTION 11 - TOXICOLOGY INFORMATION (Also See Section 3)

LD50 (ACUTE ORAL TOX)..	Not available.
LD50 (ACUTE DERMAL TOX)	Not available.
EFFECTS OF CHRONIC EXPOSURE	None known.
SENSITIZATION	None known.
CARCINOGENICITY	None known.
REPRODUCTIVE TOXICITY..	None known.
TERATOGENICITY	None known.
MUTAGENICITY	None known.

SECTION 12 - ECOLOGICAL INFORMATION

ENVIRONMENTAL DATA	Not available.

SECTION 13 - DISPOSAL CONSIDERATIONS

WASTE DISPOSAL INFORMATION	No special method. Observe all applicable Federal/ Provincial/ State regulations and Local/ Municipal ordinances regarding disposal of non-hazardous materials.

SECTION 14 - TRANSPORTATION INFORMATION

US DOT INFORMATION	Not applicable.
CANADIAN SHIPPING NAME.	SDA GENERIC LAUNDRY PRESPOTTER
TDG CLASSIFICATION	Not applicable.
PIN/NIP	Not applicable.
PACKING GROUP	Not applicable.
EXEMPTION NAME	Not applicable.

SECTION 15 - REGULATORY INFORMATION

WHMIS CLASSIFICATION...	Not applicable.

MATERIAL SAFETY DATA SHEET

 MSDS # 22545

SDA GENERIC LAUNDRY PRESPOTTER

Date Issued: 23Jul1998 Supersedes: 05Dec1997

SECTION 15 - REGULATORY INFORMATION (continued)

All ingredients of this product are listed or are excluded from listing on the U.S. Toxic Substances Control Act (TSCA) Chemical Substance Inventory.

All ingredients in this product comply with the New Substances Notification requirements under the Canadian Environmental Protection Act (CEPA).

This product is not subject to the reporting requirements under California's Proposition 65.

SECTION 16 - OTHER INFORMATION

ADDITIONAL INFORMATION. Use as directed.
EPA REGISTRATION #..... Not applicable.

PREPARATION INFORMATION

PREPARED BY..... Manufacturer's Technical Support Department. Refer to page 1 (Manufacturer) for contact information.

This document has been prepared using data from sources considered technically reliable. It does not constitute a warranty, express or implied, as to the accuracy of the information contained herein. Actual conditions of use and handling are beyond seller's control. User is responsible to evaluate all available information when using product for any particular use and to comply with all Federal, State, Provincial and Local laws and regulations.
PRINT DATE: 23Jul1998

Appendix G. Specifications for Calmar Dispensing Systems TS800 Standard Trigger Sprayer

UNCONTROLLED COPY

Calmar Inc. dispensing systems

Finished Item Specification for TS800 - Standard

1. PURPOSE

This document defines the final specifications of the standard TS800 Trigger Sprayers.

2. SCOPE

This specification applies to all standard TS800 Trigger Sprayers.

3. POLICY

All materials and components will conform to the appropriate specifications and requirements outlined below. Note: Special requirements will be called out on the workorder per the customer's request. To ensure compliance, Inspection personnel will test trigger sprayers using the test methods listed below and inspect trigger sprayers against criteria included in the Classification of Defects.

4. DEFINITIONS

Not Applicable

5. REFERENCES

CS410501	*Molded Item Nozzle Specification*
CS411301	*Molded Item Piston Specification*
CS412201	*Purchased Item Spring Specification*
CS412601	*Molded Item Closure Specification*
CS412901	*Extruded Item Tube Specification*
CS413201	*Molded Item Trigger Specification*
CS415101	*Molded Item Discharge Valve Specification*
CS417901	*Molded Item Valve Body Specification*
CS418301	*Molded Item Shroud Specification*
CS419701	*Molded Item Tube Retainer/Ball Seat Specification*
CSXX2001	*Purchased Item Valve Ball Specification*
CSXX2303	*Purchased Item Specification for Stainless Steel Ball Valves*
CSXX3901	*Purchased Item Gasket Specification*
CXXMTF08	*Calmar Approved Materials List*
L41QAT01	*TS800 Product Inspection Reference*
PD04100	*TS800 General Specification Drawing*
PSXX0001	*Finished Product Packing Specification*

6. SPECIFICATIONS

Type	Requirement	References
Materials of Construction	• All materials of construction are outlined in the Calmar Approved Materials list.	CXXMTF08
Components	• All components will be produced in accordance with the Component Specifications listed in Section 5 of this document.	
Style, Design & Construction	• The TS800 Trigger Sprayer will conform in style, design, and construction to the current revision of the Calmar General Specification Drawing	PD04100
	• Closures The closure shall be fully fitted onto the valve body and will turn without excessive interference and/or drag.	TMXXXX66
	• Tube Insertion: – for units not using the "Anti-Blow-Out" tube retainer will be no less than .312" (10/32) and no more than .532" (17/32). – for units using the "Anti-Blow-Out" tube retainer, part # 006203, will be no less than .406" (13/32) and no more than .594" (19/32). Units	TMXXXX15
	• Tube Length: – for units not using the "Anti-Blow-Out" tube retainer will be measured, with the tube fully extended, from the bottom surface of the retainer flange and tubes will be cut to the specified nominal within ± 1/16". – for units using the "Anti-Blow-Out" tube retainer, part # 006203, will be measured, with the tube fully extended, from the bottom surface of the gasket and tubes will be cut to the specified nominal within ± 1/16".	TMXX2901
	• Tube Cuts will be cut at an angle to the longitudinal axis to allow unimpaired delivery with the tube touching the container wall.	
	• Nozzle/Valve Body Fit requires that the nozzle be fully-fitted onto the valve body without distortion and with no visible gap between the nozzle and the shroud.	
	• Gasket Fit requires that the gasket fit snugly against the retainer and shall be retained above the tube retainer flange.	
	• Anti-Blowout Tube Retainer configuration requires that the gasket is held into place by the crimped flange.	
	• Trigger/Valve Body Fit requires that the trigger be fully fitted at the two points onto the valve body and be free of unrestricted movement when in the REST position. When actuated, the trigger should return without resistance.	
	• Tube Retainer/Valve body Fit The tube retainer shall be inserted into the valve body, and the tube retainer flange shall be no more than .030 from valve body receptacle.	TM419701
	• Tube Retention will withstand an instantaneous direct pull of no less than five pounds.	TMXXXX65

Type	Requirement	References
Style, Design & Construction	• **Foamer Attachment Fit** requires that the foamer attachment be fully fitted into the nozzle, and be free of unrestricted movement when switching from SPRAY to FOAM positions. • **Lubricant** The quantity of lubricant used shall be the minimum needed to accomplish the intended purpose. • **Freedom from Foreign Matter** The sprayer shall be free of foreign matter including, but not limited to: grease, dirt, lint, chaff, debris, and plastic chips. • **Workmanship** must be first class throughout the process to ensure that the trigger sprayer is free of any defect that will affect its quality image.	
Functional Tests	• **Actuation Force** is not specified. • **Strokes-to-Prime**, tested at 90 strokes per minute, shall occur prior to the tenth stroke. Tubes longer than 12" will take more strokes to prime than shorter tubes. • **Output-per-Stroke**, tested in the spray position at 90 strokes per minute, will produce an average output-per-stroke of no less than .75 milliliter. • **Spray/Stream Pattern**, when tested in the SPRAY position at a distance of approximately 8 inches, will be a nearly circular pattern of no less than four inches in diameter; when tested in the STREAM position at approximately 8 inches, the trigger sprayer should produce pattern that is noticeably narrower than the pattern produced in the spray position. • **Leakage:** – **During Actuation**, shall not incur one falling drop from sprayer during 10 continuous strokes. – **Static**: at 3 psig shall not incur one falling drop in 10 seconds.	TMXXXX05 TMXXXX37 TMXXXX05 TMXXXX05 TMXXXX09
Packing, Shipping & Storage	• **Liners** (one-mil polyethylene) used to store freshly assembled trigger sprayers must be clean and, when filled, should be folded so as to prevent entrance of foreign matter during routine handling and storage. • **Cartons** will be of a design and construction sufficient to ensure the protection of finished product during handling, storage, and delivery. • **Packing** Finished assemblies will be packed in accordance with the applicable Packing Specification	PSXX0001

Type	Requirement	References
	• Markings will be applied by means of a gummed label placed in the printed square in the lower right corner of one of the container's end panels. Each label will indicate: • Calmar Sales Order No and Customer P.O. No • Calmar Item Description (e.g., TS800) • Closure Size and Description • Quantity • Tube Length • Customer Part Number. Note: Containers being shipped to California will include the following warning: **Warning: This product contains a chemical known to the State of California to cause cancer.** The carton will be free of any ambiguous or contradictory markings.	

Appendix H. Target Prewash Standard Operating Procedure

STANDARD OPERATING PROCEDURE

FABRIC PRE-WASHING PROCEDURES FOR THE CHARACTERIZATION OF CONSUMER SPRAY PRODUCT

Originated by: _____ Date: 7-10-98
J. Y. Ding, Principal Research Scientist

Approved by: _____ Date: 7/10/98
W. C. Forsythe, Technical Reviewer

Approved by: _____ Date: 7-10-98
J. R. Decker, Jr., Technical Center Manager

Reviewed and Registered by QAU:
_____ Date: 7/10/98

Battelle
Preclinical Drug Development
Northwest Operations
LSL II Building, 900 Battelle Blvd.
Richland, Washington 99352

TABLE OF CONTENTS

I. SCOPE/PURPOSE

This Standard Operation Procedure (SOP) describes the procedures for the fabric per-washing specifications of the characterization of a consumer spray product by the Bioengineering and Aerosol Technology Group in Battelle, Northwest Operations.

II. REFERENCES

(1) Battelle Study Protocol N003043A
(2) EPA Good Laboratory Practices Regulations (40 CFR, PART 792)

III. DEFINITIONS

Washing machine is General Electric Heavy Duty extra large capacity, and the model number is WWA8360 GAL WH (Serial Number: TSI 57043G)

IV. PROCEDURES

1. Rinsing the Washing Machine

Materials:
(1) GE heavy duty washing machine
(2) Calibrated Thermometer (ERTCO ASTM 12C-FC)

Procedures:
(1) Check the outside of the washing machine so that the machine is clean of detergent residue and other dirt.
(2) Set water level at "extra high level", and the temperature level at the "hot water".
(3) After filling the machine with water, measured the water temperature and then record the data. (The rinsing temperature is controlled at 130°F (+/-) 10°F).
(4) Agitate the washing machine for 2 minutes and then drain the water from the washing machine.
(5) Check the washing machine to make sure that all visible residues are removed.
(6) Repeat the step (3) to (5) if necessary.

2. Rinsing the Washing Procedures

Materials:
(1) GE heavy duty washing machine
(2) Polyester/cotton blend fabric supplied by SDA (65/35/ Khaki 45", Textile Innovators Corp.)
(3) Detergent supplied by SDA (Ultra "all" Free Clear Laundry Detergent, Lever Brothers Co.)
(4) Balance (Mettler PE 6000)
(5) Calibrated thermometer (ERTCO ASTM 12C-FC)

Procedures:
(1) Choose the normal cycle on the washing machine and set the machine at "extra high" water level.
(2) Set the "hot water" temperature for washing (130°F (+/-) 10°F), and "cold water" temperature for rinsing (70°F (+/-) 10°F),
(3) Check the Calibration of the balance with two sets of standard weights (100g, 2000g).
(4) Weigh out 139.1 gram of SDA supplied detergent using the balance.
(5) Add the detergent as the water is filling the machine.
(6) Weigh out approximately 3400g (7.5 pounds) of the fabric provided by SDA (1pound is about 453.6 grams).

(7) Measure the water temperature with the thermometer and record the data after water has stopped filling the machine.
(8) Put the fabric into water and start washing.
(9) Allow the machine to proceed through the entire rinsing cycle at the "cold water" temperature setting.
(10) Repeat the step (3) to (9) for a total of 5 cycles.
(11) Rinse one more time after the washing machine completes 5 washing cycles, and then observe the rinse water, which should be clean and free of suds.
(12) If there is still suds in the water, repeat step (11) and (12) to eliminate residual suds.

3. Drying Procedures

(1) Line dry the fabric after the completion of the washing cycle.

Washing Machine Model # WWA8360 GAL WH Serial # TSI 57043G
Detergent ID #:_____ Cloth ID #:_____

Cloth Load # 1	Wash Number	Cloth Weight	Detergent Weight	Wash Cycle Temp (Hot)	Rinse Cycle Temp (Cold)
Date: _____ Initial: _____	1	kg	g	°C	°C
	2		g	°C	°C
	3		g	°C	°C
	4		g	°C	°C
	5		g	°C	°C
				Extra rinse	°C

Cloth Load # 2	Wash Number	Cloth Weight	Detergent Weight	Wash Cycle Temp (Hot)	Rinse Cycle Temp (Cold)
Date: _____ Initial: _____	1	kg	g	°C	°C
	2		g	°C	°C
	3		g	°C	°C
	4		g	°C	°C
	5		g	°C	°C
				Extra rinse	°C

Cloth Load # 3	Wash Number	Cloth Weight	Detergent Weight	Wash Cycle Temp (Hot)	Rinse Cycle Temp (Cold)
Date: _____ Initial: _____	1	kg	g	°C	°C
	2		g	°C	°C
	3		g	°C	°C
	4		g	°C	°C
	5		g	°C	°C
				Extra rinse	°C

Cloth Load # 4	Wash Number	Cloth Weight	Detergent Weight	Wash Cycle Temp (Hot)	Rinse Cycle Temp (Cold)
Date: _____ Initial: _____	1	kg	g	°C	°C
	2		g	°C	°C
	3		g	°C	°C
	4		g	°C	°C
	5		g	°C	°C
				Extra rinse	°C

Balance ID#: _____ Cal exp date: _____

Calibration Wt. Set (1g-1kg) ID # 442-86-02-022 Exp: 4/28/99

	Actual	Measured
Cal Wt.	g	g
Cal Wt.	g	g
Cal Wt.	g	g

Comments: All Cloth to be line dried after washing cycle.