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"Nuisance Dusts" – Validation and Application of a Novel Dry Deposition Method for Total Dust Fall

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1. Introduction

Nuisance dust complaints received from residents living in the vicinity of a coal fired power plant in the eastern United States prompted development of a monitoring program to quantify the frequency of incidents as well as the magnitude of the problem (if any). Nuisance dusts (in this context defined as visible dust deposits on solid surfaces) while regulated by some state and local agencies, have no quantitative standards or guidelines associated with them that define acceptable levels (concentrations) in ambient air or deposited on surfaces. Methods historically used to measure and/or characterize airborne dusts have included manual (Wheeler, J.P. and J.P. Stancliffe, 1998., ASTM D6966-08.) and automatic wipe sampling techniques (Wheeler, J.P. and J.P. Stancliffe, 1998.) use of adhesive tapes (Wheeler, J.P. and J.P. Stancliffe, 1998.) passive sampling using open faced containers (Estokova, A, N. Stevulova and L. Kubincova, 2010, ASTM D-1739-98, Reapproved 2004., James P. Lodge, Jr, Editor Lewis Publishers, 1989.) and vacuum or suction sampling apparatus (Byrne, M.A., 2000., ASTM D-5438-05, 2005.) While all of these techniques have been employed for collection of surface dusts they were not suitable for the current application for one or more of the following reasons: 1) not suitable for gravimetric measurements (wipe sampling for example) , 2) designed for the collection of wet and dry dusts combined and not dry surface dusts only (passive collection in open faced containers for example), 3) qualitative characterization only of dry dusts present on surfaces (adhesive tape sampling for example 4) ease in deployment and recovery at multiple stations simultaneously.

In order to meet the needs of the monitoring program the preferred method was characterized as follows: 1) ease in deployment and recovery of dust collection devices at multiple stations simultaneously, 2) samples represent passive dry dust fall on surfaces (these types of dusts were the basis for the nuisance complaints), 3) inexpensive, 4) citizens/homeowners could participate with minimal training 5) ability to collect gravimetric data (weight of particulate per unit time and unit surface area), 6) field samples after gravimetry were suitable for further chemical analyses employing non destructive techniques without the need for pretreatment (filter based device). As a result, a pre-existing filter sampling technique (Dzubay, T. and R. Barbour, 1983**.)** was selected for use in dust fall monitoring. The filter sampling technique was modified and a monitoring program designed to meet the above characteristics.

The total dust fall monitoring program included measures for validation of the customized monitoring method as well as collection of data defining what constitutes background particulate levels in the study area. These background levels were needed as a "benchmark" in assigning significance to the program's collected data in the absence of published regulatory values. The monitoring program was designed to measure total dust fall (non-respirable) as surface dust deposits and relied on passive particulate collection devices. Preconditioned and pre-weighed filter media were deployed at ten (10) sites in the metropolitan area. Residential hosts who agreed to participate in the program on a voluntary basis operated the majority of the sites used. Criteria for site selection included coverage of all wind vectors in the vicinity of coal handling processes at the power plant as well as residential properties where nuisance dust complaints had been recorded previously. Filter collection media were employed for sampling events expected to last one calendar week or seven (7) days. This provided an exposure period that maximized collection of particulate matter, and yet limited non-detected values. All residential hosts received training in filter deployment, recovery, handling and shipping procedures.

2. Program purpose and objectives

The primary purpose of the program was to conduct a total particulate or "total dust fall" monitoring program in the vicinity of the coal fired power plant employing passive dry deposition techniques. It was anticipated that the results of this program would assist the facility in determining the fate of dusts potentially released during coal handling events at the facility, as well as, in the identification of likely sources of dust deposits observed in off-site residential properties.

3. Experimental methods

3.1 Approach and methodology

The method employed in the collection of passive dry dust-fall was not a standard reference method. EPA Federal Register or sanctioned methods were not available for use in collection of the type of measurements needed for this program. This is attributable to the fact that nuisance dusts are not currently regulated at the EPA or federal level. While there are National Ambient Air Quality Standards (NAAQS) for $PM_{10,}$ $PM_{2.5}$ previously for TSP or Total Suspended Particulate there are no promulgated standards for total particulate or visible dusts. While nuisance dusts are regulated by some state and local agencies no quantitative standards or guidelines exist for defining acceptable levels of these types of dusts in ambient air. The method employed in the conduct of the validation and subsequent field program represents a novel or unique approach for the monitoring of total dust fall or particulate.

Preconditioned and pre-weighed filter media were deployed at ten (10) sites in the metropolitan area where the coal fired power plant was located. The majority of the sites used were operated by residential hosts who agreed to participate in the program on a voluntary basis. Criteria for site selection included coverage of all wind vectors in the vicinity of the power plant as well as properties where nuisance dust complaints had been made previously.

Filter collection media were deployed for sampling events expected to last one calendar week or seven (7) days. This sampling period was selected so as to provide an exposure period to maximize collection of particulate matter and limit non-detected values. All site hosts received training in filter deployment, recovery, handling and shipping procedures. It was particularly important that filters be recovered in the event that precipitation took place during a sampling event. Filters were then re-deployed after the precipitation had passed. Samples were subsequently recovered and packaged for shipment to TRC. After inspection all valid samples were shipped to the laboratory for gravimetry.

3.2 Method validation - program design

The primary purpose of the method validation study was to collect performance data representative of the sample collection and analyses method used during the term of the dust fall monitoring program. Accordingly it was necessary that the method validation exercise be performed under actual field conditions. Specific objectives of the method validation program were as follows:

- Examine what influences if any are associated with the sample collection process itself. For example, what influences are associated with exposure of the filter media and cassette to sunlight and other environmental factors such as temperature?
- What influences if any are associated with the sample shipping and handling process? This includes all of the following factors: initial filter preparation and weighing process, packaging and shipping to field, field deployment and sample collection, recovery, repackaging and return shipment to lab, lab handling and final weighing process.
- Fate of particulate matter collected on filters as a result of the passive collection field sampling process. This includes the % recovery of known quantities of particulate matter deposited on filters prior to field deployment.

A series of filter samples were placed on a rectangular wood board surface (16 ¼" by 17 ½") and deployed in a residential suburban location for an approximate one-week period; the term of an actual sampling event during the field program performed in the vicinity of the coal fired power plant. Twenty filter samples were arranged on the board surface as shown in the schematic provided as Figure 1. As shown in the filter placement schematic (Figure 1) four types of filters were used in the field validation program. Field or trip blanks were also part of the program but these were not deployed in the actual sample collection process. As shown in the schematic a total of twenty (20) samples were collocated representing four (4) distinct types or categories of samples.

Each category or filter type was comprised of five (5) identical filters. The four (4) filter types and the significance of each were as follows:

Regular Exposed Filters – These filters were identical to those used in the dustfall monitoring program itself. Data from these filters represented actual dustfall deposited on the filters by passive deposition from the atmosphere. The results from this five (5) sample set represented the precision or repeatability of the sample collection and analyses process. As such these data complemented the collocated filter sample data collected on a station specific basis during the actual field program. These data were used to define method performance in terms of precision.

Coal Spiked Exposed Filters – These filters were identical to the regular exposed filters with the exception that the filter surface on each has been spiked with a known amount of coal dust. Actual coal dust used at the host power plant was placed manually on the surface of a pre-weighed filter by the laboratory and the net weight of dust deposited was calculated. These filters were deployed as shown in Figure 1. This filter set represented a classic matrix spike employing the technique of standard additions. The results of these filters provide some measure on the accuracy of the method in actual field use.

Regular Unexposed – These filters were deployed while in the shipping package and were not exposed to the atmosphere. The covered filters were exposed, however, to direct sunlight and other environmental factors in place during the sample collection period such as temperature variability. While unexposed this filter set was not subject to any environmental effects such as wind and rain or filter tampering attributable to birds or small animals.
Coal Spike Unexposed – These filters were identical to the regular unexposed filters with the exception that the filter surface on each has been spiked with a known amount of coal dust. Actual coal dust used at the host power plant was placed manually on the surface of a pre-weighed filter and the net weight of dust deposited was calculated. These filters were deployed as shown in Figure 1. The results from this set provided recovery data for known quantities of particulate deposited on filters and subjected to the filter handling, shipping and weighing processes.

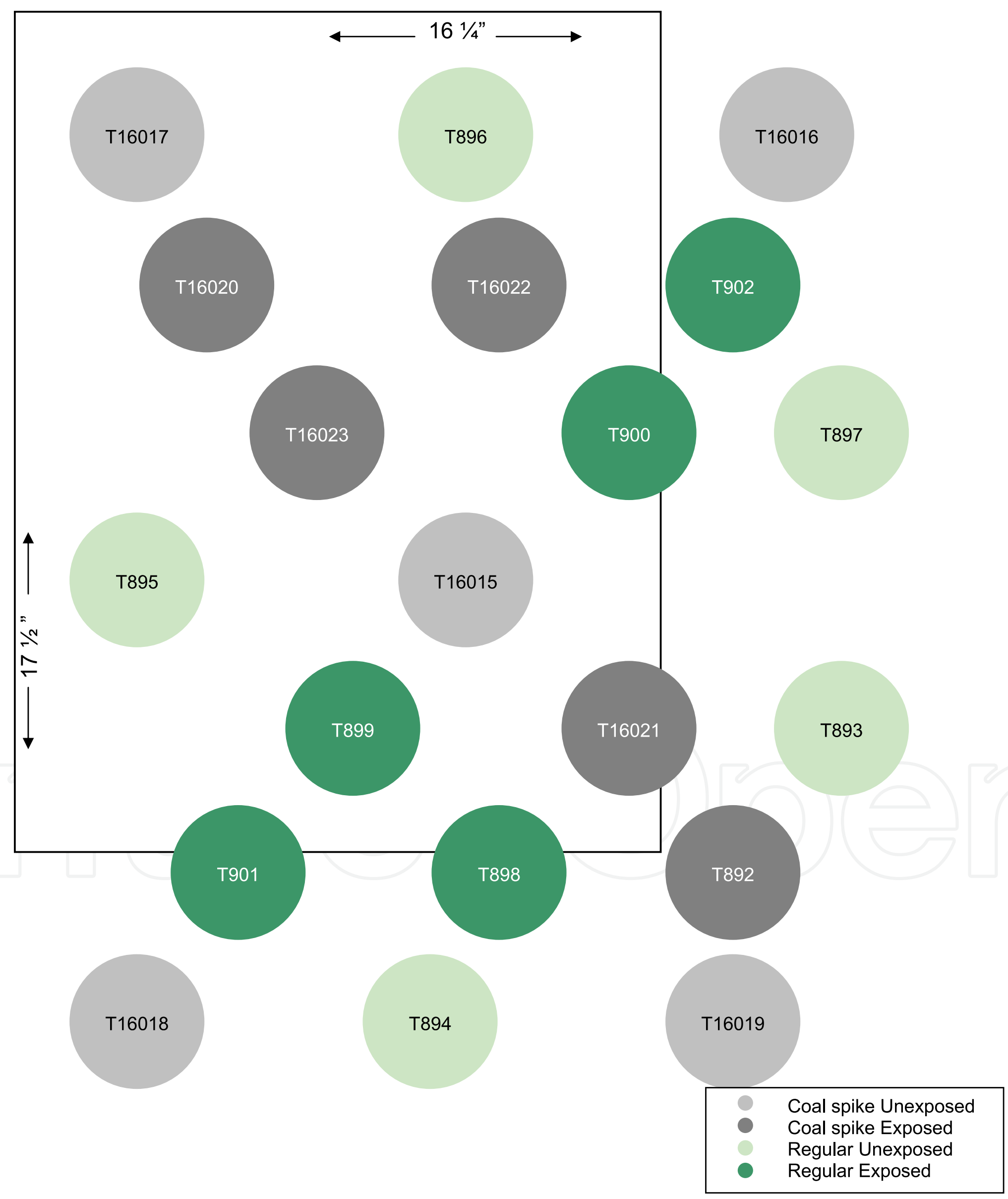

Fig. 1. Total Dust Fall Method Validation – Field Performance Study/Filter Placement Schematic

3.3 Gravimetry

Gravimetry for all filters was performed at Chester Lab Net Tigard, Oregon). Before sampling, the filters were equilibrated at constant temperature and relative humidity conditions and weighed. After sampling, the filters were again equilibrated at constant temperature and humidity conditions and weighed to obtain a net total dust fall mass. The filter weighing procedure employed by Chester Lab Net was based upon the Federal Register method in place for PM2.5 (40CFR50 Appendix L).

3.4 Filter preparation

Teflon filters (47 mm diameter) were received from the manufacturer and stored in a climate controlled weigh room. Temperature of the filters and room were kept at 70 ± 2°F, and at 35 ± 5% relative humidity. All filters were subsequently coated with a light layer of mineral oil to enhance adhesion of coarse particulate matter to the filter matrix. Teflon filters were placed in a chamber designed to nebulize a mineral oil solution under nitrogen purge. The filter was attached to a vacuum, and the nebulized oil was driven onto the filter by both the vacuum source behind the filter and the positive pressure of the nitrogen purge in front of the filter. The oil coating solution consisted of a commercial grade mineral oil dissolved in reagent grade hexane. The concentration of mineral oil in hexane solution was approximately 0.025 % (w/w). The mineral oil reagent was procured commercially as Kaydol. (Synonyms: Drakeol, Parol, Peneteck, Slab Oil or White Mineral Oil). The oil coating procedure employed by Chester was based upon a prior procedure published by Dzubay.

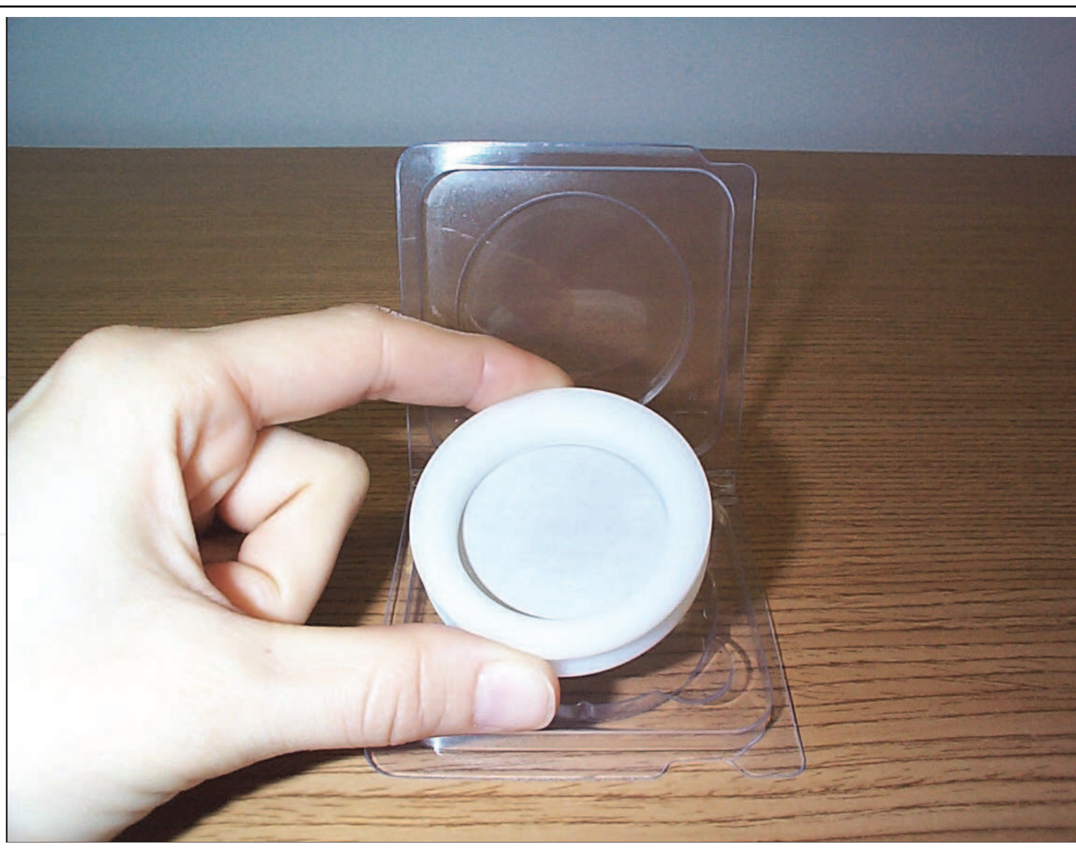

Fig. 2. Teflon Filter (47mm) Oil Coated in Sampling Cassette with Shipping Container (Ready for Field Use)

All filters after coating were reweighed to determine the weight of the oil coating. For 47 mm filters, the weight of oil should be 300 ± 50 mg. A higher concentration of mineral oil may be used. The greater the concentration of oil, the less time is required during the actual coating and therefore the greater the chance for error during the coating process. This concentration (0.025%) was recommended for beginning the process. If greater concentrations are needed, they can be made later. An actual photograph of an oil coated Teflon filter used during the field monitoring program is shown in Figure 2.

4. Results and discussions

4.1 Collocated filters (unexposed)

Results for the five (5) sample set are summarized in Table 1. This includes tare and gross weights for each of the filters as well as % recovery values. As shown the mean recovery value was 100%. These data represent a quantitative recovery of the filter tare weight. As a result of the sample preparation, shipping and weighing processes there were no noticeable gains or losses in filter weight. These data suggest that losses and gains in filter tare weights while unexposed to the atmosphere were not a factor during the course of the field program. Further, any observed losses or gains in filter weights were directly attributable to passive dry deposition of atmospheric particulate matter.

LabNet ID	Tare Wt.(mg)	Gross Wt.(mg)	Percent Wt. Recovered (%)
04-T893	164.439	164.435	100.00
04-T894	159.15	159.142	99.99
04-T895	152.172	152.165	100.00
04-T896	155.106	155.096	99.99
04-T897	149.193	149.181	99.99
		Average:	100.00

Table 1. Method Validation - Field Performance Data Unexposed Filters – No Coal Spike Percent Recovery Data

4.2 Coal spiked filters (unexposed)

Results for the five (5) sample set are summarized in Table 2. This includes filter tare weights as well net weights of coal applied and recovered on a filter specific basis. As shown the mean recovery value was >99%. These data represent a quantitative recovery of the amounts of coal dust deposited on each of the filters. The quantities of coal dust applied to the filter surface (see Table 2) expressed as dust fall rates were variable ranging from 127.6 μg/24hrs to 216 μg/24hrs (based upon 7 days or 168 hours per sampling event). The mean dust fall rate of 177.8 μg/24hrs applied to the filters is approximately 40% higher than the mean dust fall rate of 126.1 μg/24hrs observed at the Fire Station Site (Station 10) downtown in the metropolitan area around the power plant. As a result of the sample preparation, shipping and weighing processes there were no noticeable gains or losses in filter gross weight. These data suggest that losses and gains in filter weights attributable to coal or other types of particulate deposited on the filter surface while unexposed to the atmosphere were not a factor during the course of the field program. Further, any observed losses or gains in filter weights were directly attributable to passive dry deposition of atmospheric particulate matter. These data also provide evidence on the overall integrity of the handling, shipping and weighing processes applied to all filter samples after completion of the field sampling or filter exposure period.

LabNet ID	Tare Wt.(mg)	Gross Wt (mg) After Coal Spike	Net Wt (ug) of Coal	Gross Wt.(mg) After Exposure	Net Wt (ug) After Exposure	Percent Recovery (%)
03-T16015	144.507	145.400	893	145.415	908	101.68
03-T16016	152.854	154.051	1197	154.056	1202	100.42
03-T16017	145.923	147.435	1512	147.383	1460	96.56
03-T16018	145.954	147.336	1382	147.304	1350	97.68
03-T16019	148.827	150.066	1239	150.075	1248	100.73
					Average % Recovery:	**99.41**

Table 2. Method Validation - Field Performance Data Coal Spiked Filters – Unexposed – Percent Recovery Data

4.3 Filters un-spiked (exposed)

Five (5) identical unexposed filter samples were deployed as shown in Figure 1. These samples essentially represented a set of five (5) collocated filter samples. The results of these analyses are summarized in Table 3. As shown the mean concentration of the set expressed as a net weight of particulate was 272.2 µg with a standard deviation of 57.08 µg; the mean expressed as a dust fall rate was 39.34 µg/24hrs with a standard deviation of 8.25 µg/24hrs. These standard deviation values expressed as a % of the mean is approximately 21%. This value is in good agreement with much of the method precision data to follow for collocated filter samples. Average % difference data derived from analyses of collocated filter pairs for the majority of the sites ranged from 20-25 %.

LabNet ID	Tare Wt.(mg)	Gross Wt.(mg)	Net Wt.(ug)	Rate of Deposition ug/24 Hours
04-T898	148.632	148.938	306	44.22
04-T899	140.626	140.803	177	25.58
04-T900	143.334	143.645	311	44.94
04-T901	143.687	144.017	330	47.69
04-T902	145.85	146.087	237	34.25
	Average:		**272.20**	**39.34**
	Standard Deviation:		**57.08**	**8.25**

Table 3. Method Validation - Field Performance Data - Exposed Filters (166 Hours of Exposure)

4.4 Coal spiked filters (exposed)

This filter set represents a "classic matrix spike" employing the technique of standard additions. The results of these filters provided some measure on the accuracy of the method in actual field use. These filters were deployed as shown in Figure 1. The results of these analyses are summarized in Table 4. The net weight values shown for this set of filter samples represents both the amount of coal applied to each filter initially with the addition of atmospheric particulate deposited while the filters were exposed on location during the week-long sampling event. Recovery data were therefore calculated on the basis of background corrected weights. The latter value was derived on a filter specific basis employing the average or mean particulate weight shown in Table 3 as a correction factor. The background corrected weight in combination with the net weight of coal dust applied initially was the basis for calculation of the % recovery data shown in Table 4. Recovery data for the five (5) sample set ranged from 71.7 % to 85.2 % with a calculated mean of 78.8 %. These data suggest an approximate loss of 20% of the particulate deposited on the filter surface during the filter exposure period.

These losses were likely attributable to environmental factors such as periodic rainfall during the week-long exposure period. The field logs for the method validation exercise document a limited amount of rainfall exposure that was experienced during the sampling event when the filter array was unattended and not accessible to the field operator. These data suggest a negative bias of approximately 20% associated with the sample collection process. Accordingly, dust fall rates measured during the actual field program may be understated when rainfall takes place during a sampling event and the filter is not covered and/or secured indoors by the site operator as required.

LabNet ID	Tare Wt. (mg)	Gross Wt (mg) After Coal Spike	Net Wt (ug) of Coal	Gross Wt. (mg)	Net Wt. (ug)	Rate of Deposition ug/24Hrs	Background* Corrected Net Wt.(ug)	Percent Recovery (%)
03-T16020	145.702	147.243	1541	147.179	1477	213.44	1204.8	78.18
03-T16021	156.139	157.522	1383	157.403	1264	182.66	991.8	71.71
03-T16022	155.404	156.856	1452	156.866	1462	211.27	1189.8	81.94
03-T16023	149.854	150.800	946	150.932	1078	155.78	805.8	85.18
04-T892	150.486	151.735	1249	151.72	1234	178.32	961.8	77.01
							Average % Recovery:	**78.80**

*Refer to Table 3

Table 4. Method Validation - Field Performance Data Coal Spiked Filters – Exposed Matrix Spikes (166 Hours of Exposure)

4.5 Filters un-spiked (exposed) - July 26-30 2004

Results of the initial method validation indicated that dust fall rates may be influenced by rainfall that takes place during a sampling event. Dust fall rates, as a result of rain fall events may be understated. More specifically, rainfall may cause dust already deposited on the filter surface to migrate to the perimeter of the sampling cassette and/or be lost from the filter surface. In order to examine this finding further the field method validation program was repeated during the calendar period July 26-30 2004. The method validation repeat was limited to an array of exposed filters only, including both spiked and un-spiked sets.

Five (5) identical unexposed filter samples were deployed as shown previously in Figure 1. These samples essentially represented a second set of five (5) collocated filter samples. The results of these analyses are summarized in Table 5. As shown the mean concentration of the set expressed as a net weight of particulate was 53.5 µg with a standard deviation of 6.26 µg; the mean expressed as a dust fall rate was 22.48 µg/24hrs with a standard deviation of 2.63 µg/24hrs. These standard deviation values expressed as a % of the mean is approximately 11.7 %. This value is better than the 21% value reported for the collocated filter set in the initial method validation event and the method precision data reported for collocated filter samples. Average % difference data derived from analyses of collocated filter pairs for the majority of the sites ranged from 20-25 %.

It should be noted that the dust fall data from the second set of filter samples represents an exposure period of fifty-seven (57) hours during the during the calendar period July 26-30 2004. Based upon field sampling records filters were not exposed to rainfall during this sampling event. These data were subjected to statistical analyses for the purpose of identifying outliers in the five (5) collocated filter sample set. As a result of these analyses, results from one of the five samples (Lab ID 04-T952) was identified as an outlier and eliminated from the mean and standard deviation reported in Table 5. The mean net weight for the remaining four (4) samples of 53.5 µg was used for background correction of the filter set spiked with coal dust and reported in Table 6 to follow.

July 26-30, 2004 (57 Hours of Exposure)					
LabNet		**Tare**	**Gross**	**Net**	**Rate of Deposition**
ID		**Wt.(mg)**	**Wt.(mg)**	**Wt.(µg)**	**µg/24 Hours**
04-T951		173.828	173.873	45	18.91
04-T952 *		168.638	168.747	109 *	45.8 *
04-T953		157.497	157.557	60	25.21
04-T954		166.394	166.444	50	21.01
04-T955		158.848	158.907	59	24.79
		Average:		**53.5**	**22.48**
		Standard Deviation:		**6.26**	**2.63**

*This sample was determined to be an outlier, and was not included in the average and standard deviation calculations.

Table 5. Method Validation - Field Performance Data Exposed Filters

4.6 Coal dust spiked filters (exposed) - July 26-30 2004

This second set of five (5) filters was deployed as shown in Figure 1. The results of these analyses are summarized in Table 6. The net weight values shown for this set of filter samples represents both the amount of coal applied to each filter initially with the addition of atmospheric particulate deposited while the filters were deployed on location. Recovery data were therefore calculated on the basis of background corrected weights. The latter value was derived on a filter specific basis employing the average or mean particulate weight of 53.5 μg shown in Table 5 as a correction factor. The background corrected weight in combination with the net weight of coal dust applied initially was the basis for calculation of the % recovery data shown in Table 6. Recovery data for the five (5) sample set ranged from 97.1 % to 99.6% with a calculated mean of 98.5 %. These data represent a complete quantitative recovery of the coal dust applied in the laboratory to the set of five (5) filter samples. These data indicate that a quantitative recovery of dust can be expected when measures are taken to protect filters from rainfall during sampling events. Furthermore, these recovery data serve to further validate the combined sample collection and analyses procedures employed during the actual dust fall monitoring program. This includes filter preparation, gravimetry, shipping, handling, field deployment and exposure.

July 26-30, 2004 (57 Hours of Exposure)								
LabNet ID	**Tare Wt. (mg)**	**Gross Wt (mg) After Coal Spike**	**Net Wt (μg) of Coal**	**Gross Wt.(mg)**	**Net Wt. (μg)**	**Rate of Deposition μg/24Hrs**	**Background* Corrected Net Wt. (μg)**	**Percent Recovery (%)**
04-T946	168.621	169.535	914	169.562	941	395.38	887.5	97.10
04-T947	166.525	167.527	1002	167.566	1041	437.39	987.5	98.55
04-T948	175.078	176.462	1384	176.51	1432	601.68	1378.5	99.60
04-T949	183.463	184.579	1116	184.614	1151	483.61	1097.5	98.34
04-T950	166.61	167.737	1127	167.778	1168	490.76	1114.5	98.89
Average % Recovery 98.50								

*Refer to Table 5

Table 6. Method Validation - Field Performance Data Coal Spiked Filters – Exposed Matrix Spikes

4.7 Field blanks

A pair of filters were identified as field blanks. These filters were identical to the unexposed category with the exception that they were not deployed as part of the field validation study. The field blank results are indicative of the sample preparation, handling shipping and gravimetry processes. The results of the field blank analyses indicated identical weights for both filters prior to field deployment and upon completion of the sample collection process.

4.8 Total dust fall data

Total dust fall measurements were collected during the entire term of the program spanning from February 18 2003 through February 4 2004. All samples were collected as weekly sampling events and results reported in units of μg/24 hours of sample collection. The numbers of sampling events collected at each of the eleven (11) stations employed in the network at full expansion however varied due to the fact that all stations were not employed for the entire duration of the program. This coupled with the fact that not all samples collected met sample validation and acceptance criteria resulted in different numbers of valid data sets at each of the locations. Table 7 summarizes total dust fall rates on a site-specific basis. The data provided includes mean deposition rates for each of the sites, the maximum deposition rate observed at each site and the number of data points per site. These same data are shown graphically in Figure 3 in bar graph format. This includes average or mean deposition rates on a station specific basis. The numbers of data points included in each of the mean rates is also shown.

Station #	Site Description/Location	(N=)*	Dates of Operation**	X	Max
Station 1	Residential/ ½ Mile NW of Facility	8	2/18/03 - 4/15/03	82.5	247.8
Station 2	Residential/1000 Feet W of Facility	30	2/18/03-11/4/03	123.2	658.1
Station 3	Residential/ ⅓ Mile W of Facility	21	2/18/03-8/19/03	84.5	392.6
Station 5	Background Residential/1 Mile SW of facility (Over Water)	25	2/18/03-10/7/03	72.0	203.0
Station 6	Residential/ 8/10 Mile E of Facility (Over Water)/ Remote Setting/Regional Background.	28	2/18/03-1/27/04	27.1	109.0
Station 7	On Facility Property /1000 Feet N Coal Storage and Handling Processes	32	2/18/03-1/27/04	40.4	166.4
Station 8	Residential/2000 Feet N of Facility	22	6/10/03-2/3/04	40.0	176.8
Station 9	Residential/2000 Feet NW Facility	10	6/10/03-2/3/04	28.1	67.0
Station 10	Urban Background Downtown/Fire Station/8/10 Mile SW Facility (Upwind)	24	6/10/03-1/27/04	126.1	249.9
Station 11	Residential/ 2000 Feet SW Facility	7	9/9/2003-12/23/03	19.0	34.4
		206	**2/18/03-2/3/04**	**69.1**	

*Includes only valid sampling sessions

**Ending date indicates completion of last valid sampling session

Table 7. Total Dust Fall Data Summary – Site Specific Basis - μg/24 Hours – February 2003 – February 2004

4.9 Total dust fall levels- background assignments and contributions

Three (3) stations well beyond the immediate vicinity of the power plant were designated as representative of different background environments for analyses of dust fall data. These stations and associated dust fall rates were as follows: Station 6- Remote (mean = 27 μg/24hrs), Station 10 Fire Station Urban (mean = 126 μg/24hrs) and Station 5 Shoreline (72 μg/24 hrs).

Wind trajectory data were examined for all sampling events. Based upon these analyses criteria were developed for assignment of specific samples as predominantly upwind or downwind of the coal handling processes during each weekly sampling event. These criteria (upwind greater than 20% and downwind less than 5%) were used to identify samples representing upwind only or background dust fall levels in the vicinity of the power plant. Background data for the immediate vicinity of the power plant were identified from examination of all data collected at stations 1,2,3,5,7,8,9 and 11. There were 30 samples that met the pre established predominantly upwind criteria. The mean concentration for this data set is 65.9 µg/24 hrs. Three different dust fall rates corroborate this as a representative number for background in the Metropolitan area as follows: Station 6/10 average all events = 78.9 µg/24 hrs (pool of all data from stations with highest and one of the lowest dust fall rates), average all samples 69.1 µg/24hrs (N=206) and Shore Drive Station 5 = 72 µg/24 hrs. The latter site was situated approximately one mile due south/southwest of the facility over open water and removed from the Metropolitan Area.

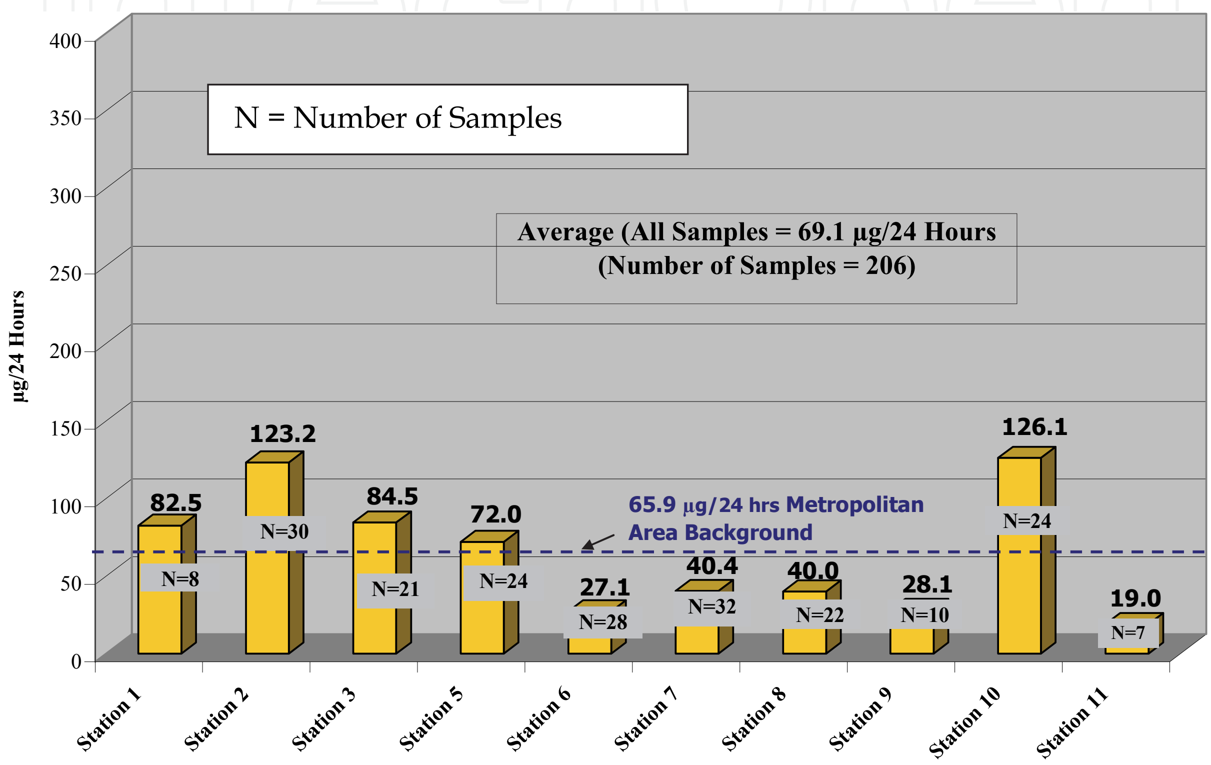

Fig. 3. Total Dust Fall Program – Average Rate of Deposition – Site Specific Basis – February 18, 2003-February 4, 2004

4.10 Collocated total dust fall filter samples

Collocated filter sample media were deployed at eight (8) of the sites in the network. Initially filter pairs were collected only at the Berm Site (Station 7) but as the program evolved over a longer time period this feature was expanded to include all active sites in the network. The use of collocated filter samples was expanded to all sites still active in the August-September time period. Two (2) of the ten (10) sites included in the network were not in active use at this time as the site host had withdrawn from the program. This included Sites 1 and 3. The data set available for Site 7 includes a total of twenty-seven (27) valid sampler pairs representing the calendar period February 25 2003-January 27, 2004. The results of these analyses are displayed in bar graph format in Figure 4. As shown the average % difference (% RPD) for Station 7 was 20.3 %. Collocated sampler results for Station 10 are displayed graphically in Figure 5. The average % difference (%RPD) for the sixteen (16) samples collected at Station 10 was 20.0 %. This value is equivalent to performance data collected at the Berm Site discussed previously.

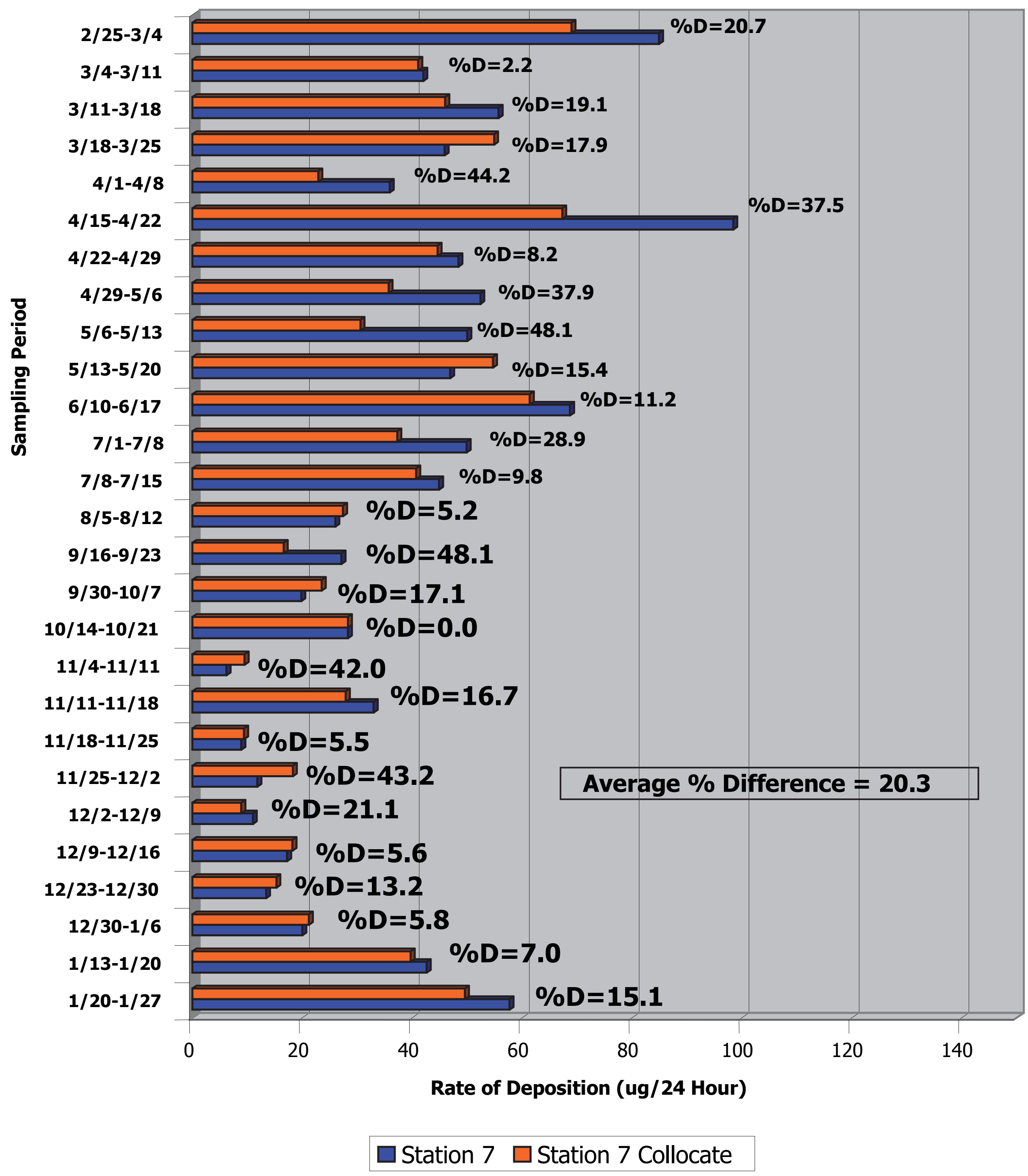

Fig. 4. Total Dust Fall Program Station 7 – Collocated Sample Precision Data – February 25, 2003 – January 27, 2004

The average % difference for the majority of the sites ranged from 20-25 %. The observed variability in the precision of collocated filter pairs is likely attributable to one or more of the following:

- Indicative of actual variability in particulate loadings collected by passive deposition on each of the samples in the pair. The filters although they are side by side are not truly collocated in the same air space and do not obviously occupy identical places on the horizontal collection surface.

- Indicative of host attentiveness to filter placement and perhaps filter deployment and recovery process. Two of the stations with the lowest average % difference data were the Berm (Station 7) and the Fire Station (Station 10). Filters at these stations were deployed and recovered by TRC personnel on a regular basis.
- Particulate loadings on the filters themselves were a factor. As with any sampling and analyses method as concentrations/gravimetric loadings decrease and approach the method sensitivity the variability in the measurement is higher. This is particularly true in comparison of data from Station 10 (Fire Station) to data collected at Station 6. The highest particulate loadings were observed at the Fire Station concurrent with one of the lowest average % difference values. Conversely, the lowest particulate loadings were observed at the Station 6 concurrent with the highest average % difference. This value approached 56 % for the complete data set.

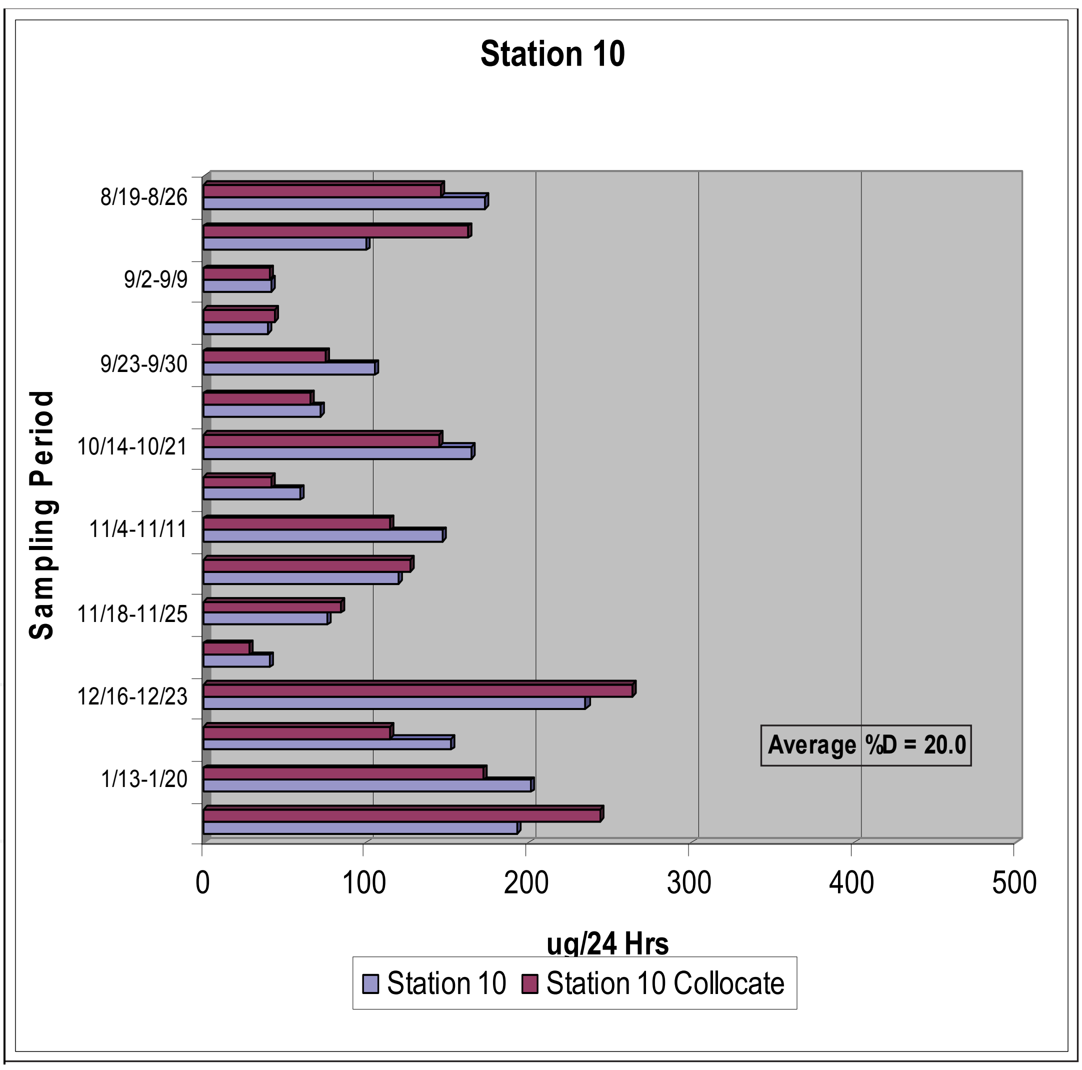

Fig. 5. Collocated Sampler Precision Data

The collocated sampler precision data were employed during this program to evaluate the validity of a particular sampling session. More specifically, if there was significant variability in the precision of collocated sampler data in a particular session (> 20-25 %) for all sample pairs this would suggest that the samples and data from the affected session not be used in the program data set. As a result samples from a number of sampling sessions were deemed invalid and not incorporated into the final program data population and hence not used in subsequent data analyses. In instances where there was significant disparity in the gravimetric results from a single collocated pair the higher loading or concentration would be used for comparison to background. This represents a more conservative approach. In all cases where collocated filter data were deemed valid the two samples were averaged in representing the dust fall loading at a given site during all sampling events.

5. Conclusions

The use of Teflon filters coated with mineral oil represents a cost effective and reliable approach for passive collection and measurement of total particulate or dust fall. Field validation of this novel approach indicates that dusts can be collected quantitatively with little or no losses of dusts deposited on the filter surfaces attributable to field deployment and recovery as well as shipping and handling procedures. The overall precision of the sample collection and analysis procedure (as defined by collocated sampling devices) has been determined to be +/- 20-25% (RPD).

The filter sampling devices can be readily deployed and recovered at numerous locations simultaneously and require little operator training. As a result citizen participants represent candidate field sampling personnel for programs conducted in response to "nuisance dust" complaints. Since the method has been designed and optimized for the collection of passive particulate deposition particular attention must be paid to recovery of all filters prior to precipitation events or periods of inclement weather conditions.

The method was applied for monitoring of "nuisance dusts" in an Eastern United States urban setting in which a coal fired power plant was located. The results of this field program conducted during the calendar period February 2003 - February 2004 indicated that background concentrations for total dust fall in the subject metropolitan area were in the range of 65-70 ug/24 hr (based upon surface area of 47mm Teflon filter).

Field samples are readily suited for gravimetric analyses as well as other non destructive analytical procedures for use in forensics analyses of particulate deposited on the filter surface. These applications include qualitative and semi-quantitative elemental analyses (XRF) as well as microscopic examination (PLM, TEM and SEM). Further analyses such as these can prove valuable in a determination of the sources or origins of the particulate matter deposited on filter surfaces.

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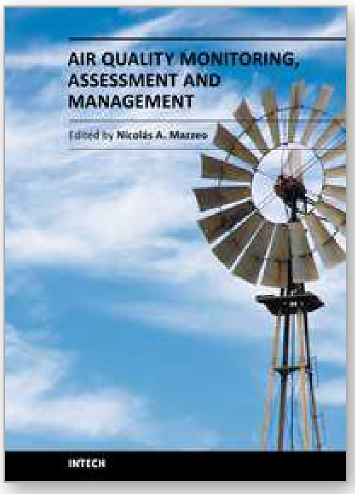

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Human beings need to breathe oxygen diluted in certain quantity of inert gas for living. In the atmosphere, there is a gas mixture of, mainly, oxygen and nitrogen, in appropriate proportions. However, the air also contains other gases, vapours and aerosols that humans incorporate when breathing and whose composition and concentration vary spatially. Some of these are physiologically inert. Air pollution has become a problem of major concern in the last few decades as it has caused negative effects on human health, nature and properties. This book presents the results of research studies carried out by international researchers in seventeen chapters which can be grouped into two main sections: a) air quality monitoring and b) air quality assessment and management, and serves as a source of material for all those involved in the field, whether as a student, scientific researcher, industrialist, consultant, or government agency with responsibility in this area.