DRAFT

EMISSION FACTOR TEST PROTOCOL

$PM_{2.5}$, $PM_{10-2.5}$, PM_{10}, and Total Particulate Matter from Truck Loading and Central Mix Operations

Ready Mixed Concrete Foundation

Prepared for:

Mr. Ed Herbert, III
Director of Environmental Affairs
National Ready Mixed Concrete Association
900 Spring Street
Silver Spring, Maryland 20910

Prepared by:

John Richards, Ph.D., P.E. and Todd Brozell, P.E.
Air Control Techniques, P.C.
301 E Durham Road
Cary, North Carolina 27513
(919) 460-7811

October 20, 2003
Air Control Techniques, P.C. File 877

TABLE OF CONTENTS

		Page Number
1.0	**PROJECT DESCRIPTION**	**3**
1.1	Purpose	**3**
1.2	Scope	3
1.3	Test Program Organization	3
2.0	**TEST PROGRAM DESCRIPTION**	**5**
2.1	Emission Factors Evaluated	5
2.2	Process Data	6
2.3	Meteorological Data	6
2.4	Teat Matrix	7
3.0	**PLANTS AND TEST LOCATION CHARACTERISTICS**	**8**
3.1	Plant Locations	8
3.2	Test Location Characteristics	8
4.0	**SAMPLING PROCEDURES AND EQUIPMENT**	**20**
4.1	Emission Sources	20
4.2	Filterable Total, $PM_{10,}$ $PM_{10-2.5}$, and $PM_{2.5}$ Particulate Concentration Measurements	20
4.3	Flue Gas Velocity and Volumetric flow Rate - EPA Method2	23
4.4	Flue Gas Composition and Molecular Weight - EPA Method 3	23
4.5	Flue Gas Moisture Content - EPA Method 4	23
4.6	Fugitive Dust Emission Concentration - EPA Method 5D and Ambient PM_{10} Compendium Method IO-1.3	24
5.0	**QUALITY ASSURANCE AND QUALITY CONTROL**	**25**
5.1	QA/QC Procedures for Sampling	25
5.2	QA/QC Checks for Data Reduction, Validation, and Reporting	26
6.0	**PROJECT SCHEDULE**	**28**
7.0	**HEALTH AND SAFETY**	**29**
8.0	**REPORT FORMAT**	**30**

1. PROJECT DESCRIPTION

1.1 Purpose

The overall goal of this project is to prepare an updated AP-42, Chapter 11.12 document through the compilation of accurate emission factors for total filterable particulate matter, filterable PM_{10}, filterable $PM_{10-2.5}$, and filterable $PM_{2.5}$ from various process operations at ready mixed concrete plants.

The goal will be achieved by developing an emission factor testing protocol that includes the use of EPA Preliminary Method 4 (previously termed Method 201B) and state-of-the art fugitive dust capture techniques. Prior to the start of the emission factor test program, Air Control Techniques, P.C. and representatives of NRMCA will meet with EPA personnel to discuss the scope and emission factor measurement techniques proposed for the study.

1.2 Scope

Tests will be conducted at six plants. Following the emission factor tests at three central mix and three truck mix operations, Air Control Techniques, P.C. will prepare a complete emission report summarizing the results from all six test programs. This report will include the proposed emission factors and fugitive dust capture efficiencies for the tested sources. Air Control Techniques, P.C. will prepare a revised draft of AP-42 Section 11.12 and the associated background support document. This will be provided to EPA for their review and inclusion into the EPA AP-42 database.

1.3 Test Program Organization

The National Ready Mixed Concrete Project Manager for this testing project is Mr. Ed Herbert, III. The Air Control Techniques, P.C. project manager is Mr. John Richards, Ph.D., P.E. Addresses and phone numbers of these individuals are provided below.

Mr. Ed Herbert, III
Director of Environmental Affairs
National Ready Mixed Concrete Association
900 Spring Street
Silver Spring, Maryland 20910
Tel: (240) 485-1154
eherbert@nrmca.org

Mr. John Richards, Ph.D., P.E.
Air Control Techniques, P.C.
301 E. Durham Road
Cary, North Carolina, 27513
Tel: (919) 460-7811 Fax: (919) 460-7897
john.richards@aircontroltechniques.com

Dr. Richards will be responsible for project management and coordination with NRMCA. Mr. Todd Brozell, P.E. will assist Mr. Richards in project management and test program coordination.

Resolution Analytics and/or Research Triangle Institute will perform the particulate sample analyses. The project managers for these laboratories are listed on the following page.

Mr. Todd Ennis
Research Triangle Institute
P.O. Box 12194
Research Triangle Park, NC
Tel: (919) 541-7226

Mr. Bruce Nemet
Resolution Analytics, Inc.
2733 Lee Avenue
Sanford, NC 27332
Tel: (919) 774-5557

2. TEST PROGRAM DESCRIPTION

2.1 Emission Factors Evaluated

This emission factor testing program will concern particulate matter emissions from mixer loading (central mix) and truck loading (truck mix) operations. The presently applicable emission factors for total particulate matter and PM_{10} particulate matter for these two sources are listed in Tables 2-1 and 2-2. No emission factors for $PM_{2.5}$ and $PM_{10-2.5}$.are presently available.

Table 2-1. Present Total Particulate Matter AP-42 Emission Factors

Source (SCC)	Uncontrolled		Controlled		AP-42 References
	Total PM, Lbs./Ton	Emission Factor Rating	Total PM, Lbs./Ton Loaded	Emission Factor Rating	
Mixer Loading (central mix) (3-05-011-09)	0.22	E	0.011	E	9
Truck Loading (truck mix) (3-05-011-10)	0.61	D	0.21	D	9

Table 2-2. Present PM_{10} Particulate Matter AP-42 Emission Factors

Source (SCC)	Uncontrolled		Controlled		AP-42 References
	Total PM, Lbs./Ton Loaded	Emission Factor Rating	Total PM, Lbs./Ton Loaded	Emission Factor Rating	
Mixer Loading (central mix) (3-05-011-09)	0.078	E	0.0038	E	9, 10
Truck Loading (truck mix) (3-05-011-10)	0.15	D	0.051	D	9, 10

The report titled "Emission Factor Documentation for AP-42 Section 11.12 - Concrete Batching" available at www.epa.gov/ttn/CHIEF indicates that the AP-42 Section 11.12 Reference 9 and 10 (termed references 1 and 2 in the Documentation report) emission tests of controlled emissions were rated "A", and the emissions data for uncontrolled emissions were rated "B." The uncontrolled factors were ranked lower because a subjective visual observation procedure was used to determine the capture efficiency.

The test program described in this protocol will involve the measurement of the following analytes.

- $PM_{2.5}$ (termed "fine particulate matter")
- $PM_{10-2.5}$ (termed "coarse particulate matter")
- PM_{10} (total of fine and coarse particulate matter)
- Total particulate matter.

All of these particulate matter samples will be obtained in an EPA Preliminary Method 4 dual cyclone sampling train.

The test program will provide emission data for these analytes at the following locations at ready mixed concrete plants.

- Outlet of the fabric filter collector serving the mixing operation
- Inlet to the fabric filter collector serving the mixing operation
- Inlet to the mixing operation (fugitive emissions)

The outlets and inlets of the fabric filters will be tested using conventional stack sampling procedures. Where necessary, the outlet "stacks" of the fabric filters will be extended using temporary ductwork to ensure that the sampling locations conform with U.S. EPA Method 1 criteria.

Fugitive particulate matter from the mixing operation will be measured using a tapered electrode oscillating microbalance (TEOM) meeting EPA ambient particulate matter concentration monitoring requirements. The TEOM will be used to measure PM_{10} concentrations only. The data from the TEOM will be compared with the PM_{10} data for the inlet to the fabric filter to quantify the capture efficiency of the plant hood system.

A Method 5D sampling array will by mounted on one or more sides of the mixer loading area to measure the PM_{10} concentration in the ambient air passing through the area of the array. The mass flux of particulate matter will be determined by multiplying the ambient wind speed (adjusted for wind direction) by the PM_{10} concentration.

2.2 Process Data

During each of the test runs, Air Control Techniques, P.C. will compile data concerning the process operating conditions and the characteristics of the materials handled. The data and information will include the following.

- Material moisture content
- Material particle size distribution (sieve analyses)
- Number of batches mixed
- Quantity of material mixed (in yards of concrete)

2.3 Meteorological Data

Previous tests conducted at ready mixed concrete plants have indicated that the capture efficiency can vary as a function of wind speed. As part of this testing program, Air Control Techniques, P.C. will install a meteorological monitoring station that measures the following parameters.

- Average and maximum wind speeds
- Wind direction
- Ambient temperature
- Rain fall (during test only)

Due to the use of a Method 5D type fugitive dust capture system, Air Control Techniques, P.C. will stop the tests if (1) the ambient wind speed is less than 1 mph., (2) the average wind speed exceeds 10 mph, (3) the wind gusts exceed 15 mph, or (4) the wind direction does not allow for proper movement of fugitive emissions through the sampling array.

2.4 Test Matrix

The test matrix for each of the plants tested is presented in Table 2-1. The test run times listed are preliminary values. These will be adjusted as necessary to achieve adequate data quality.

Table 2-1. Example Phase I Plant Test Matrix

Test Location	Test Method	Analyte	# of Runs	Test Run Length	Analytical Method
Outlet of Fabric Filter	Preliminary Method 4	Total filterable PM, PM_{10}, $PM_{2.5}$, and $PM_{10-2.5}$	3	2 Hours	Gravimetric
	Methods 2-4	Gas Flow Rate, Molecular Weight, and Moisture Content	3	2 Hours	N/A
Inlet of Fabric Filter	Preliminary Method 4	Total filterable PM, PM_{10}, $PM_{2.5}$, and $PM_{10-2.5}$	3	2 Hours	Gravimetric
	Methods 2-4	Gas Flow Rate, Molecular Weight, and Moisture Content	3	2 Hours	N/A
Fugitive Emissions	Method 5D and TEOM	PM_{10}	3	2 Hours	Continuous analyzer

3. PLANTS AND TEST LOCATION CHARACTERISTICS

3.1 Plant Locations

The National Ready Mixed Concrete Association has provided a list of 6 plants (Table 3-1) that are participating in this emission factor testing program. The criteria used by NRMCA in choosing these plants included (1) the availability of process equipment representative of the U.S. Ready Mixed Concrete Industry, (2) location within 400 miles of Raleigh, N.C. to minimize travel related costs, and (3) sufficient anticipated plant throughput at the time of the test program.

Table 3-1. Plant Locations

Company Name	Location	Type of Unloading System	Notes
Ready Mixed Concrete Company	Wake Forest, NC	Central Mix & Truck Mix	Dual process single fabric filter
S.T. Wooten Corporation	Raleigh, NC	Central Mix	
Loflin Concrete Company	Kernersville, NC	Truck Mix	
Concrete Supply Company	Rock Hill, SC	Truck Mix	Dual inlet fabric filter
Hardaway Concrete Co., Inc.	Columbia, SC	Truck Mix	
Chandler Concrete Company	Troutville, VA	Truck Mix	Sidewall present

All of these plants have fugitive dust capture systems and fabric filters that are representative of the U.S. Ready Mixed Concrete Industry.

The plants being tested are located in a three-state area in the Southeast. NRMCA and Air Control Techniques, P.C. believe that these sites are representative of the entire U.S. based on the following facts: (1) ready mixed processes are highly uniform from region-to-region in the U.S. due to state DOT and other customer product specifications, (2) processing equipment manufactured for ready mixed plants is highly consistent throughout the U.S., and (3) the types of control systems are very similar throughout the U.S. The present edition of AP-42 Section 11.12 does not include geographical categories for emission factors. This is appropriate due to the characteristics of the industry.

If there are unanticipated changes in production levels at these plants, it might be necessary to substitute an alternative site having higher and/or more consistent production rates. Only plants that are representative of the entire U.S. industry will be substituted. This protocol will be revised to address any future substitutions in test locations.

3.2 Test Location Characteristics

Each of the plants listed in Table 3-1 has been visited by Air Control Techniques, P.C. to obtain sampling location data. Air Control Techniques, P.C. has also confirmed that the selected sites are representative of the Ready Mixed Concrete Industry and that the locations can be safely tested. Descriptions of each of the test locations are provided in the sections below.

3.2.1 Plant 1 - Ready Mixed Concrete Company, Wake Forest, NC

This plant has a central and truck mixing operation. The truck loading areas can be tested using the Method 5D testing arrays. The fabric filter inlet and outlet ducts can be tested using Preliminary

Method 4 with a single measurement point. The sampling locations will be installed to conform as closely to Method 1 as possible.

Table 3-2. Plant 1 Test Location Characteristics		
Test Location		
Fabric filter outlet	Duct configuration rectangular	19” X 24”
	Convert to duct diameter	12”
	Distance to upstream flow disturbance	8’
	Distance to downstream flow disturbance	2’
Fabric filter inlet, truck mix	Duct diameter	14”
	Distance to upstream flow disturbance	6’
	Distance to downstream flow disturbance	3’
Fabric filter inlet, central mix	Duct diameter	14”
	Distance to upstream flow disturbance	8’
	Distance to downstream flow disturbance	4’
Mixer loading area both truck and central mixes	Truck entry direction	2
	Exposed sides	4
	Number of Method 5D sampling arrays needed	2
	Adequacy of dominant wind direction	OK

Figure 3-1a. Plant 1 Truck Loading Area

Figure 3-1b. Plant 1 Fabric Filter Inlet Duct Test Location

Figure 3-1c. Plant 1 Fabric Filter Outlet Duct Test Location (stack location to be built.)

3.2.2 Plant 2 - S.T. Wooten Corporation, Raleigh, NC

This plant has a central mixing operation. The truck loading areas can be tested using the Method 5D testing arrays. The fabric filter inlet and outlet ducts can be tested using Preliminary Method 4 with a single measurement point. The sampling locations will be installed to conform as closely to Method 1 as possible.

Table 3-3. Plant 2 Test Location Characteristics

Test Location		
Fabric filter outlet	Duct configuration rectangular	19" X 24"
	Duct diameter	12"
	Distance to upstream flow disturbance	8'
	Distance to downstream flow disturbance	2'
Fabric filter inlet	Duct diameter	14"
	Distance to upstream flow disturbance	8'
	Distance to downstream flow disturbance	4'
Mixer loading area	Truck entry direction	2
	Exposed sides	3
	Number of Method 5D sampling arrays needed	2
	Adequacy of dominant wind direction	OK

Figure 3-2a. Plant 2 Truck Loading Area

Figure 3-2b. Plant 2 Fabric Filter Inlet Duct Test Location

Figure 3-2c. Plant 2 Fabric Filter Outlet Duct Test Location (stack extension to be built.)

3.2.3 Plant 3 - Loflin Concrete Company, Kernersville, NC

This plant has a truck mixing operation. The truck loading areas can be tested using the Method 5D testing arrays. The fabric filter inlet and outlet ducts can be tested using Preliminary Method 4 with a single measurement point. The sampling locations will be installed to conform as closely to Method 1 as possible.

Table 3-4. Plant 3 Test Location Characteristics

Test Location		
Fabric filter outlet	Duct configuration rectangular	18” X 24”
	Duct diameter	12”
	Distance to upstream flow disturbance	8’
	Distance to downstream flow disturbance	2’
Fabric filter inlet	Duct diameter	14”
	Distance to upstream flow disturbance	2’
	Distance to downstream flow disturbance	2’
Mixer loading area	Truck entry direction	1
	Exposed sides	3
	Number of Method 5D sampling arrays needed	2
	Adequacy of dominant wind direction	OK

+

3.2.4 Plant 4 - Concrete Supply Company, Rock Hill, SC

This plant has a truck mixing operation. The truck loading areas can be tested using the Method 5D testing arrays. The fabric filter inlet and outlet ducts can be tested using Preliminary Method 4 with a single measurement point. The sampling locations will be installed to conform as closely to Method 1 as possible.

Table 3-5. Plant 4 Test Location Characteristics		
Test Location		
Fabric filter outlet	Duct configuration rectangular	12" X 19"
	Duct diameter	12"
	Distance to upstream flow disturbance	8'
	Distance to downstream flow disturbance	2'
Fabric filter inlet	Duct diameter	14"
	Distance to upstream flow disturbance	4'
	Distance to downstream flow disturbance	2'
Mixer loading area	Truck entry direction	2
	Exposed sides	3
	Number of Method 5D sampling arrays needed	2
	Adequacy of dominant wind direction	OK

Figure 3-3a. Plant 4 Truck Loading Area

Figure 3-3b. Plant 4 Fabric Filter Inlet Duct Test Location

Figure 3-3c. Plant 4 Fabric Filter Outlet Duct Test Location (Stack extension to be built.)

3.2.5 Plant 5 - Hardaway Concrete Co., Inc., Columbia, SC

This plant has a truck mixing operation. The truck loading areas can be tested using the Method 5D testing arrays. The fabric filter inlet and outlet ducts can be tested using Preliminary Method 4 with a single measurement point. The sampling locations will be installed to conform as closely to Method 1 as possible.

Table 3-6. Plant 5 Test Location Characteristics		
Test Location		
Fabric filter outlet	Duct configuration rectangular	13.5" X 22"
	Duct diameter	12
	Distance to upstream flow disturbance	8'
	Distance to downstream flow disturbance	2'
Fabric filter inlet	Duct diameter	10"
	Distance to upstream flow disturbance	4'
	Distance to downstream flow disturbance	2'
Mixer loading area	Truck entry direction	2
	Exposed sides	4
	Number of Method 5D sampling arrays needed	2
	Adequacy of dominant wind direction	OK

Figure 3-4a. Plant 5 Truck Loading Area

Figure 3-4b. Plant 5 Fabric Filter Inlet Duct Test Location

Figure 3-4c. Plant 5 Fabric Filter Outlet Duct Test Location (Stack extension to be built.)

3.2.6 Plant 6 - Chandler Concrete Company, Troutville, VA

This plant has a truck mixing operation. The truck loading areas can be tested using the Method 5D testing arrays. The fabric filter inlet and outlet ducts can be tested using Preliminary Method 4 with a single measurement point. The sampling locations will be installed to conform as closely to Method 1 as possible.

Table 3-6. Plant 6 Test Location Characteristics

Test Location		
Fabric filter outlet	Duct configuration rectangular	17” x 20”
	Duct diameter	12”
	Distance to upstream flow disturbance	8’
	Distance to downstream flow disturbance	2’
Fabric filter inlet	Duct diameter	14”
	Distance to upstream flow disturbance	5’
	Distance to downstream flow disturbance	2’
Mixer loading area	Truck entry direction	1
	Exposed sides	2
	Number of Method 5D sampling arrays needed	1
	Adequacy of dominant wind direction	OK

Figure 3.5-a. Plant 6 Truck Loading Area

Figure 3-5b. Plant 6 Fabric Filter Inlet Duct Test Location

Figure 3-5c. Plant 6 Fabric Filter Outlet Duct Test Location (Stack extension to be built.)

4. SAMPLING PROCEDURES AND EQUIPMENT

4.1 Emission Sources

During testing of central mix and truck mix operations, Air Control Techniques, P.C. will test (1) the fabric filter outlet, (2) the fabric filter inlet, and (3) fugitive emissions not captured by the loading operation wind screens. This approach will allow for the determination of controlled and uncontrolled emissions from these operations. It will also allow for the determination of the fugitive dust capture efficiency. The test program includes three central mixers and three truck mixers. There will be a total of three tests (three runs per test) at each of the six plants at the inlets and outlets of the fabric filters. The tests will include (1) total filterable particulate matter, (2) filterable PM_{10}, (3) filterable $PM_{10-2.5}$, and (4) filterable $PM_{2.5}$. Air Control Techniques, P.C. will use a state-of-the art particulate matter mass continuous monitor (TEOM) to measure fugitive emissions from the tested units. A sampling array will be constructed at each test site to allow for the capture of fugitive dust escaping the intake points for the mixing operations.

The particulate matter continuous monitor will measure PM_{10} in the sampling system gas stream. Accordingly, the fugitive dust emission capture efficiency of the units tested will be evaluated based on the ratio of captured and fugitive PM_{10} emissions.

4.2 Filterable Total, PM_{10}, $PM_{10-2.5}$, and $PM_{2.5}$ Particulate Concentration Measurements

The sampling system to be used for the inlet and outlet of the loading operation particulate matter control device will consist of a PM_{10} cyclone followed by a $PM_{2.5}$ cyclone. A 47 mm filter (Teflon® or glass fiber) will be mounted after the $PM_{2.5}$ cyclone. This sampling train is identical to the EPA Method 201A (40 CFR Part 60, Appendix A, Method 201A) sampling train except that a $PM_{2.5}$ cyclone is inserted between the PM_{10} cyclone and the filter. Both cyclones and the filter are coupled closely together so that the entire sampling head shown in Figure 1 can be positioned entirely in the gas stream. Due to the anticipated small size of some of the ducts, modifications to the configuration of the sampling head will probably be required for testing in the Ready Mixed Industry.

Preliminary Method 4 was originally developed by Air Control Techniques, P.C. in 1996 based on EPA research conducted in the mid-1980s. A complete summary of the method is available in the Portland Cement Association R&D Publication, Serial No. 2081 and in the Preliminary Methods section of EPA's website. EPA promulgation of the method is in-progress.

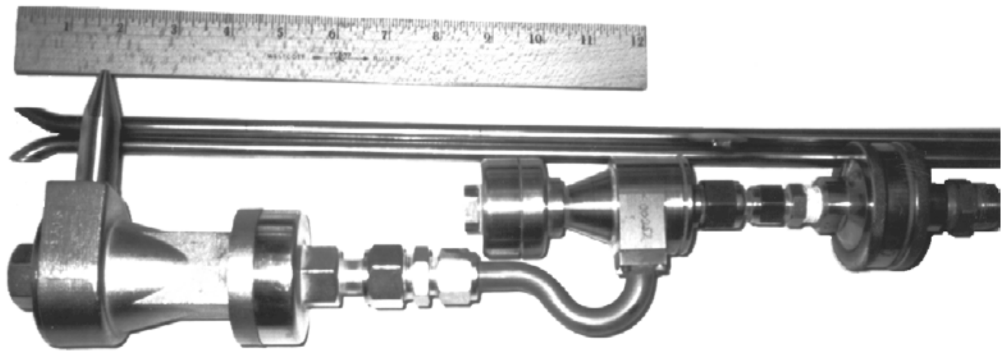

Figure 4-1. EPA Preliminary Method 4 Sampling Head

As with Method 201A, the Preliminary Method 4 sampling system is a constant sampling rate technique. It is critical to maintain the actual sample gas flow rate in each of the cyclones at a rate that provides the desirable particle collection efficiencies. The PM_{10} cyclone must collect particles that have a D_{50} (particle size collected with 50% efficiency) between 9.0 and 11.0 micrometers in order to be consistent with Method 201A. The $PM_{2.5}$ cyclone (the second cyclone in Figure 1) should optimally have a cut diameter between 2.25 and 2.75 micrometers. Using the cyclone performance curves, Air Control Techniques, P.C. has calculated the sampling rates necessary to simultaneously satisfy the PM_{10} cyclone and cyclone $PM_{2.5}$ D_{50} ranges. The area between the two solid lines in Figure 4-2 demonstrates that this range is relatively small for sources operating at near-ambient gas temperatures.

Sample times will be relatively long to ensure that catch weights of both the PM_{10} and $PM_{2.5}$ cyclones can be analyzed gravimetrically. All sample times will be based on 2 hours. These sampling times are considerably longer than the one-hour runs typically used in EPA Methods 5 and 17 for the measurement of total filterable particulate matter. These long sampling times will be needed due to the relatively low particulate matter concentrations in the $PM_{2.5}$ size range.

Air Control Techniques will use Preliminary Method 4 to determine the total, PM_{10}, and $PM_{2.5}$ filterable particulate emissions from all three sources included in the scope of the testing program. The filterable $PM_{10-2.5}$ emissions will be determined directly based on the difference between the PM_{10} and $PM_{2.5}$ emission rates.

Preliminary Method 4 will be conducted on the emission sources in accordance with all applicable EPA sampling and quality assurance requirements. Each test will consist of a set of three runs each per test location.

4.2.1 Sample Collection. Samples will be withdrawn isokinetically (100% ±20%) from the test location. The sampling train will consist of a nozzle and the dual cyclone configuration followed by a 47mm filter holder (as seen in Figure 4-1), a Teflon® or stainless steel lined probe with a S-type pitot tube attached, four chilled impingers, and a metering console. The particulate matter sample will be collected on a Teflon® or glass fiber filter supported by a stainless steel frit.

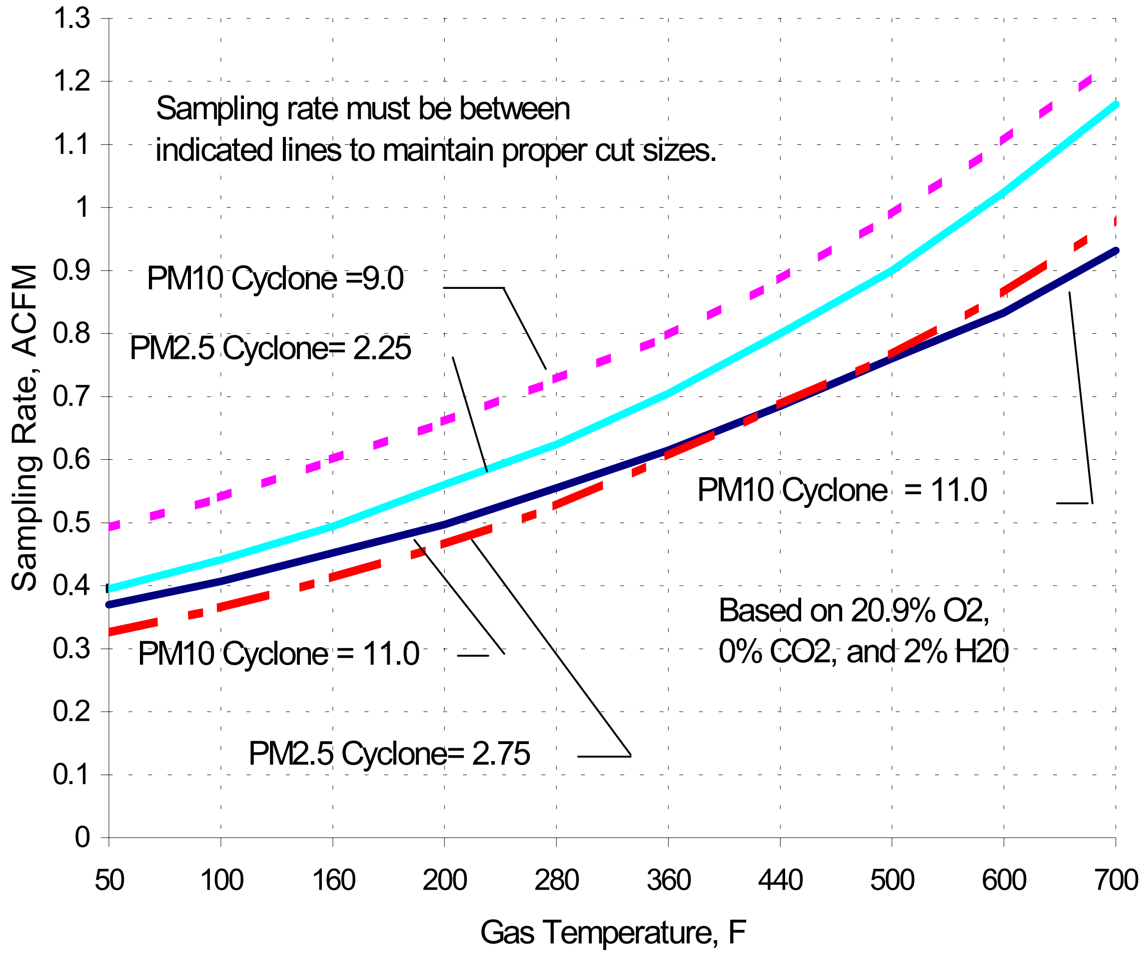

Figure 4-2. Sampling Rate Requirements of Preliminary Method 4

The Preliminary Method 4 sampling train will contain 100 ml of deionized, distilled (DI) water in the first three impingers, and the fourth will contain preweighed silica gel.

4.2.2 Sample Recovery. The combined cyclone sampling head will be recovered using a nylon brush and an ultra-pure acetone rinse. The particulate matter will be divided into four separate sample jars.

Sample Jar #1, Particulate Matter > 10 micrometers

- Solids and acetone rinse from cyclone I cup
- Acetone rinse of nozzle
- Acetone rinse of cyclone I

Sample Jar #2, Particulate Matter ≤ 10 micrometers and > 2.5 micrometers

- PM_{10} cyclone turnaround cup (above inner downcomer line)
- Brushed and acetone rinsed solids from downcomer line
- Solids from the $PM_{2.5}$ cyclone cup
- Acetone rinse of the $PM_{2.5}$ cyclone

Sample Jar #3, Particulate Matter ≤ 2.5 micrometers

- Brushed and acetone rinsed solids from downcomer line
- Acetone rinse from front half of filter holder

Sample Jar #4, Particulate Matter ≤ 2.5 micrometers

- Filter

The total filterable particulate is the sum of all the particulate matter recovered from the combined cyclone sampling assembly. PM_{10} particulate matter is all of the solids recovered from sample jars #2, #3, and #4. $PM_{2.5}$ particulate matter is determined based on the quantity of solids recovered from sample jars #3 and #4. $PM_{10-2.5}$ is all of the material recovered in sample jar #2. An acetone blank will be analyzed and subtracted from the particulate matter catch weights using the volume of acetone rinse used for each sample jar.

The DI water reagent will be returned to the original 1,000 ml glass jar and weighed. The weight will be recorded on the label, and the liquid level will be marked. The silica gel will be returned to the original tared container and weighed. The weight will be recorded on the label. The volume of water vapor condensed in the impingers and the volume of water vapor collected in the silica gel will be summed and entered into moisture content calculations.

4.2.3 Sample Analysis. EPA Method 5 analytical procedures will be used to analyze the filter and three front half acetone rinses for particulate matter. The Preliminary Method 4 filters will be archived to permit possible future Method 29 laboratory analyses for metals (same as AP-42 Section 11.12 except nickel and chromium not included). Metals analyses are not presently included in the scope of work.

4.3 Flue Gas Velocity and Volumetric Flow Rate - EPA Method 2. The flue gas velocity and volumetric flow rate during the Preliminary Method 4 tests will be determined according to the procedures outlined in U.S. EPA Reference Method 2. Velocity measurements will be made using S-type pitot tubes conforming to the geometric specifications outlined in Method 2. Accordingly, each pitot will be assigned a coefficient of 0.84. Velocity pressures will be measured with fluid manometers. An electronic micro-manometer will be used as necessary for extremely low flue gas velocities. Effluent gas temperatures will be measured with chromel-alumel thermocouples equipped with hand-held digital readouts. A cyclonic flow check will be performed prior to the modified Method 201A tests at each sampling location.

4.4 Flue Gas Composition and Molecular Weight - EPA Method 3. Flue gas analyses and calculation of flue gas dry molecular weight will be performed in accordance with EPA Method 3. Multi-point, integrated sampling will be used to obtain a flue gas sample concurrent with any isokinetic testing. A stainless steel probe will be affixed to the isokinetic sampling probe for this purpose. Moisture will be removed from the sample gas by means of a knockout jar located prior to the aspirator. Oxygen and carbon dioxide will be determined using a Fyrite® apparatus.

4.5 Flue Gas Moisture Content - EPA Method 4. The flue gas moisture contents during the Preliminary Method 4 tests will be determined in conjunction with each sample train according to the sampling and analytical procedures outlined in EPA Method 4. The impingers will be connected in series and will contain reagents as listed earlier in this proposal. The impingers will be contained in an ice bath to assure condensation of the flue gas stream moisture. Any moisture that is not condensed in the impingers is captured in the silica gel; therefore all moisture can be weighed and entered into moisture content calculations.

4.6 Fugitive Dust Emission Concentration - Ambient PM_{10} Compendium Method IO-1.3

Air Control Techniques, P.C. will use a downwind sampling array mounted vertically on the side walls of the truck loading area and at the inlet of central mixing operations to measure the fugitive dust mass flux through a defined area. There will be a minimum of thirty sampling points in the array to be consistent with the sampling methodology in U.S. EPA Method 5D. The area monitored by the sampling array will exceed the area subject to dispersion of the uncaptured particulate matter mounted on the on the downwind side of the central mixer or truck mixer. This array will consist of manifolds having equally spaced holes for sampling. Each array will consist of a minimum of at least three horizontal and three vertical sampling manifolds. The gas transport velocities through all sampling tubes and ductwork will be maintained at a minimum of 3,500 feet per minute to prevent any settling of dust in the tubes and ductwork. The sampling manifolds and ductwork will be visually inspected using sealable inspection ports after each test run. Method 22 visual observations will be conducted during the run to confirm that fugitive emissions from the mixer loading areas are passing through the sampling array.

Each of the sampling manifolds will be ducted together to yield a single sample gas stream. This gas stream will be directed past an enlarged duct with the intake for an ambient TEOM meeting the requirements of Method IO-1.3. The gas flow rate through this enclosure will be maintained at less than 5 mph. This instrument will have a PM_{10} sampling head and will operate at a flow rate of 16.67 liters per minute. The TEOM will be operated in accordance with Method IO-1.3. The instrument will be calibrated in accordance with Section 12.1 of Method IO-1.3.

The instrument will be mounted on a secure base. The instrument will be protected from unusual vibration and ambient temperature changes. The instrument will equilibrate a minimum of one hour prior to the start of the first test run each test day.

The fugitive PM_{10} emissions (uncaptured) will be measured by multiplying the measured ambient PM_{10} concentration by the ambient air flow rate through the sampling array. A Davis Instruments, Inc. meteorological monitoring station will be located within 20 feet of the sampling array and at the same elevation as the sampling array to measure the wind direction and wind speed through the array.

All of the particulate matter measured by the TEOM during the time that the equipment being tested is operating will be assumed to originate as fugitive emissions from the mixing operation being tested. This approach introduces a bias to lower-than-true capture efficiency due to the presence of ambient PM_{10} in the ambient air upwind of the plant and due to other fugitive PM_{10} sources in the plant area (i.e. roadways). There is no practical means to identify and correct for these other sources of PM_{10} on a continuous basis.

5. QUALITY ASSURANCE AND QUALITY CONTROL

5.1 QA/QC Procedures for Sampling

All of the tests will be conducted using QA/QC procedures established by the EPA and Air Control Techniques, P.C. for Preliminary Method 4. Complete records concerning the QA/QC procedures will be prepared during the tests. Problems encountered before a test run will be identified and corrected prior to sampling.

5.1.1 Leak Checks. Pretest and posttest leak checks will be conducted on each sampling train used in all Preliminary Method 4 tests. The observed leak rates must be below 0.02 actual cubic feet per minute to be acceptable. Posttest leak checks will be completed with the dual cyclone removed. This is a standard Preliminary Method 4 procedure to ensure that the particles in the cyclone catch cups are not re-entrained into subsequent stages.

5.1.2 S-Type Pitot Tube Calibration. All S-type pitot tubes used in this project will conform with EPA guidelines concerning construction and geometry. Pitot tubes will be inspected prior to use. If the specified guidelines are met, a pitot tube coefficient of 0.84 will be used. Information pertaining to S-type pitot tubes is presented in detail in Section 3.1.1 of EPA Publication No. 600/4-77-027b. Only S-type pitot tubes meeting the required EPA specifications will be used in this project.

5.1.3 Sample Nozzle Calibration. Stainless steel nozzles will be used for isokinetic sampling. All nozzles will be thoroughly cleaned, visually inspected, and calibrated according to the procedure outlined in Section 3.4.2 of EPA Publication No. 600/4-77-027b.

5.1.4 Temperature Monitor Calibration. The thermocouples used in this project will be calibrated using the procedures described in Section 3.4.2 of EPA Publication No. 600/4-77-027b. Each temperature sensor will be calibrated at a minimum of 3 points over the anticipated range of use against an NIST-traceable mercury in glass thermometer.

5.1.5 Dry Gas Meter Calibration. All dry gas meters will be fully calibrated to determine the volume correction factor prior to field use. Post-tests calibration checks will be performed as soon as possible after the equipment has been returned to the shop. Pre-and post-test calibrations should agree within ±5 percent. The calibration procedure is documented in Section 3.3.2 of EPA Publication No. 600/4-77-237b.

5.1.6 Moisture Scale Calibration. The scales used at the test location to determine flue gas moisture content will be calibrated using a standard set of weights.

5.1.7 Particulate Sampling Using Preliminary Method 4. Standard operating procedures described in the PCA protocol and EPA Preliminary Method 4 will be followed. Prior to conducting the test, the sampling trains will be tested to confirm proper operation and to determine the sampling nozzles that will be needed to achieve isokinetic sampling conditions. The gas flow velocities at the sampling locations will be measured using EPA Method 2. An S-type pitot tube will be used for these velocity measurements. The S-type pitot tube will be visually inspected before each run. Each leg of the pitot tube will be leak checked before and after each run. Proper orientation of the S-type pitot tube will be maintained throughout each measurement. The yaw and the pitch axis of the S-type pitot tube will be maintained 90 degrees to the air flow. Checks for cyclonic flow will be completed at each sampling location before the start of the first test run.

5.1.8 Daily Quality Audits Daily quality audits will be conducted using data quality indicators that require the review of the recording and transfer of raw data, calculations, and documentation of testing procedures. All data and calculations for air flow rates and isokinetic sampling rates will be recorded manually and then transferred to a portable computer. The calculations will be verified by independent, manual checks. Any suspect data or outliers will be noted and identified with respect to the nature of the problem and potential effect on data quality. Upon completion of the testing, the project manager will be responsible for preparing a data summary and compiling all calculations sheets and raw data sheets.

The emission test report submitted will include QA/QC summaries reporting the QC data collected and the results of any audits. All QA/QC results will be reviewed internally before release.

5.2 QA/QC Checks for Data Reduction, Validation and Reporting

Daily quality audits will be conducted using data quality indicators that require the review of the recording and transfer of raw data, calculations, and documentation of testing procedures. All data and calculations for air flow rates and isokinetic sampling rates will be recorded manually and then transferred to a portable computer. The calculations will be verified by independent, manual checks.

Any suspect data or outliers will be noted and identified with respect to the nature of the problem and potential effect on data quality. Upon completion of the testing, the project manager will be responsible for preparing a data summary and compiling all calculations sheets and raw data sheets.

The emission test report submitted will include QA/QC summaries reporting the QC data collected and the results of any audits. All QA/QC results will be reviewed internally before release.

5.2.1 Sample Recovery and Custody All filter samples and impinger samples will be recovered by Air Control Techniques personnel using standard EPA procedures. Sample recovery will be performed in the Air Control Techniques, P.C. mobile laboratory. All sampling equipment will be sealed to prevent contamination during transport to the laboratory.

All chemicals used for sampling train preparation and sample recovery will be American Chemical Society ACS, High Performance Liquid Chromatography (HPLC) or pesticide grade. Deionized, distilled water will meet or exceed the American Society for Testing Materials (ASTM) specifications for Type I reagent water.

The list of the samples recovered from each of the reference method tests are summarized below.

<u>Preliminary Method 4</u>

- Sample Jar #1, Particulate Matter > 10 micrometers
- Sample Jar #2, Particulate Matter ≤ 10 micrometers and > 2.5 micrometers
- Sample Jar #3, Particulate Matter ≤ 2.5 micrometers
- Sample Jar #4, Filterable Particulate Matter ≤ 2.5 micrometers
- Acetone blank (1 per acetone lot)
- Silica gel (impinger 4 for moisture determination)

All of the samples will be labeled immediately after recovery. The samples will be packed in numbered boxes and sealed. A chain of custody record and sample log will be maintained during the emissions study. The sample boxes will be shipped by Air Control Techniques to Cary, N.C. The samples will be delivered to the laboratory along with the appropriate chain of custody record forms.

5.2.2 Sample Identification

The test runs will be identified using the procedures described in Table 5-1 for one of the plants. For example, the first Preliminary Method 4 run at the inlet to the Plant 1 fabric filter would be designated as 1-FFIn-Pre4-1.

Table 5-1. Sample Identification

Location	Method	Runs	Run Numbers
Plant 1 - FF Inlet	Pre-4	3	1-In-Pre4-1,2,3
Plant 1 - FF Outlet	Pre-4	3	1-Out-Pre4-1,2,3
Plant 1 - Fugitive	IO-1.3	3	1-Fug-1,2,3

6. PROJECT SCHEDULE

Air Control Techniques, P.C. will conduct the project in accordance with the schedule provided in Table 6-1.

Table 6-1. Project Schedule

Air Control Techniques, P.C. Activity	Date (2003-2004)
Prepare draft protocol	October 20
Tests at Plant 1	December 2-3
Tests at Plant 2	December 9-10
Complete emission test report	December 31
Tests at Plant 3	February 4-5
Tests at Plant 4	February 11-12
Complete emission test report	March 4
Tests at Plant 5	April 16
Tests at Plant 6	April 23
Complete emission test report	May 15
Prepare draft materials for AP-42 Section 11.12	May 30

7. HEALTH AND SAFETY

The primary purpose of this section is to establish a practical and effective system for the prevention of accidents, injuries, and illnesses. It also assigns specific responsibilities for the execution of the safety requirements of the Mine Safety and Health Administration (MSHA) as well as other applicable regulations.

7.1 Responsibilities

Project Management - The Air Control Techniques, P.C. health and safety manager for this project will be Dr. John Richards. He will have the primary authority for implementation of this Health and Safety Plan and for the overall test program. Questions concerning health and safety issues raised during the test program should be directed to Dr. John Richards, Ph.D. P.E., President, Air Control Techniques, P.C.

Employees - Each employee has the responsibility to fully comply with all Air Control Techniques, P.C., host facility, OSHA, and MSHA requirements. This responsibility includes the reporting of any possible health and safety problems.

7.2 Safety Procedures

7.2.1 Moving Equipment – All sampling equipment, power lines, and hoisting ropes will be kept out of the line of travel of concrete trucks loading and moving through the facility. No enclosures, curtains, or other obstacles will be erected that totally block the view of loading operations from plant operating personnel.

7.2.2 Electrical Cords - All electrical cords necessary to power the sampling trains will be kept as short as possible and will be mounted along the access walkways in such a way as to minimize trip hazards. Any electrical cords that are frayed or partially cut will be discarded.

7.2.3 Ropes - Only ropes in good physical condition will be used. For hoisting service, the ropes will be greater than 5 inches in diameter. Any ropes that are “thinned”, chemically contaminated, or have been subjected to a “shock” load will be discarded.

7.2.4 Personal Protection Equipment

Eye Protection - Personnel will wear safety glasses with side shields at all times while in the plant. Goggles or full-face shields are required in specifically designated areas of the plant.

Hard Hats - Hard hats are required in all areas of the facility.

Safety Shoes - Steel toe safety shoes are required. These will be equipped with slip resistant soles in good condition.

Respiratory Protection - Personnel will use respirators in accordance with the established Respiratory Program. Personnel are allowed to wear only those respirators for which they have passed a qualitative fit test. Respirators will be worn as required. Respirators will be inspected before and after each day’s use. They are cleaned, disinfected, and properly stored at the end of each use.

7.3 General Procedures

Smoking - Smoking is not permitted in sample clean-up areas. Smoking is permitted only in areas designated by plant personnel.

Eating - Eating is prohibited except in those areas specified by plant personnel.

8. REPORT FORMAT

The scope of this test report will include, but will not necessarily be limited to the following.

- Summary of emission factor test results
- Plant equipment operating conditions
- Descriptions of test locations and fugitive capture systems
- Descriptions of EPA reference method emission measurement techniques
- Summary of emission test quality assurance procedures and results
- Field data sheets
- Calibration results
- Chain of custody sheets
- Calculations
- Laboratory results sheets
- Lists of emission test crew participants, agency observers, and industry observers

The emission factor data will be compiled into a revised version of the Section 11.12 Background Support Document. A revised Section 11.12 AP-42 will also be prepared. These documents will be submitted along with the complete emission test report to EPA's Emission Inventory Branch. Based on previous experience, Air Control Techniques, P.C. anticipates that EPA will provide these materials to one of their contractors for routine processing. Air Control Techniques, P.C. will maintain contact with EPA and their contractor during this review process. Following EPA contractor review, EPA will update the AP-42 section to include the newly compiled and reviewed emission factors.