

## **PM2.5 Technology Assessment and Characterization Study in New York (PMTACS-NY)**

A Technical Proposal in response to the RFA Particulate Matter "Supersites" Program, U.S.  
Environmental Protection Agency

**Submitted by**  
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**in Collaboration with the**  
**New York State Department of Environmental Conservation**  
**and**  
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**Aerosol Dynamics, Inc.**  
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**NYS Department of Health**  
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**Rupprecht and Patashnick Co., Inc.**

### **III. PROGRAM GOALS, OBJECTIVES, SCIENCE POLICY RELEVANCE AND HYPOTHESIS**

#### ***III.1 PROGRAM GOALS***

The PM2.5 Technology Assessment and Characterization Study in New York (PMTACS-NY) is a highly leveraged measurement, technology development and evaluation program with the following principal goals.

- Demonstrate through strategic measurement studies the impact of on-going control technologies on NYC PM2.5 and related air quality
- Develop, deploy and demonstrate advanced measurement technologies to characterize the PM/co-pollutant complex, its formation processes and source attribution
- Evaluate and transfer technologies to enhance NYS infrastructure and science capacity to effectively monitor and manage air quality impacting the health and welfare of its citizens

To meet the goals of PMTACS, the program has been designed around three major components:

- 1. A field measurement component** that includes the enhancement and operation of a select set of fixed monitor sites in the NY metropolitan and upstate regions of the State and two major field intensive studies to be performed in the summer of 2001 and the winter of 2003. The enhanced measurement sites, which constitute the "Baseline Supersite Network," will be operated through the participation and collaboration of university, public and private partners.

2. **An in-use vehicle emission characterization and control technology evaluation component** that will utilize advanced measurement technologies including TILDAS remote sensing and a mobile flux measurement platform to assess the perturbation of new emission control technologies being introduced in the New York City metropolitan area.
3. **An instrumentation evaluation and tech-transfer activity** to assure that the most successful and useful measurement techniques are effectively put in the hands of the monitoring community.

*Basic strategy underlying the execution of the baseline measurement program*

The program design builds upon existing research and operational PM<sub>2.5</sub>/precursor monitoring sites, performing mandated EPA PM<sub>2.5</sub> and criteria pollutant measurements, by introducing new and advanced measurement technologies to enhance the temporal and chemical resolution of PM<sub>2.5</sub> and related precursor species at these sites. The new technologies will be deployed in a staged manner in New York City and across the State. First considering operationally robust and complimentary measurements to the EPA mandated PM<sub>2.5</sub> measurements; followed by research measurement technologies with a high probability for technology transfer (i.e. training, field demonstration and established QA and SOPs) and routine operation. Research platforms, unlikely to be transferable for routine measurement operation, will be utilized in mission-specific intensive field studies for advanced chemical characterization measurements to address precursor relationships, process formation mechanisms, and source attribution issues as well as, in some instances, assist in the evaluation of the other measurement technologies.

(Note: standard measurement sites and techniques referenced in this section are discussed in detail in Table 1. on pages 16-19 and advanced measurement techniques as explained in Table 2. on pages 20-24). A synopsis of the overall program is provided in the "Project at a Glance" section that follows:

PMTACS-NY "PROJECT AT A GLANCE"

PROJECT SITES	Major Activities by Year				
	2000	2001	2002	2003	2004
<b>New York City:</b>					
<b>Mabel Dean Bacon</b> Special Studies: <sup>a</sup>	----- Deploy and operate EPA designated criteria measurements <sup>1</sup> -----> ----- Deploy and operate PM enhanced measurements <sup>2</sup> -----> -OH/HO <sub>2</sub> <sup>3</sup> -> -OH/HO <sub>2</sub> <sup>3</sup> -> -AMS/SPLAT <sup>4</sup> -> -AMS/SPLAT <sup>4</sup> -> -----APS <sup>5</sup> -----> -----APS <sup>5</sup> -----> --HONO/HNO <sub>3</sub> <sup>6</sup> --> --HONO/HNO <sub>3</sub> <sup>6</sup> --> -- R&P 8400NS Field Testing & Evaluation <sup>7</sup> -----> ----Low T/Dryer TEOM Field Testing & Evaluation <sup>8</sup> -----> ---- R&P DDET Field Testing & Evaluation <sup>9</sup> ----->				
<b>Queensborough CC</b>	----- Deploy and operate EPA designated criteria measurements <sup>1</sup> -----> ----- Deploy and operate PM enhanced measurements <sup>2</sup> -----> -- R&P 8400NS Field Testing & Evaluation <sup>7</sup> -----> -PAMS <sup>10</sup> --> -PAMS <sup>10</sup> --> -PAMS <sup>10</sup> --> -PAMS <sup>10</sup> --> -PAMS <sup>10</sup> -->				
<b>South Bronx</b>	----- Deploy and operate EPA designated criteria measurements <sup>1</sup> -----> ----- Deploy and operate PM enhanced measurements <sup>2</sup> -----> -- R&P 8400NS Field Testing & Evaluation <sup>7</sup> ----->				
<b>CEPEX-NYC</b> Special Studies:	-Mobile Meas. <sup>11</sup> -> -Open Path <sup>12</sup> --->	-Mobile Meas. <sup>11</sup> -> -Open Path <sup>12</sup> --->		-Mobile Meas. <sup>11</sup> -> -Open Path <sup>12</sup> --->	
<b>Upstate/Regional:</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>	<b>2004</b>
<b>Pinnacle State Park</b> Special Studies:	----- Deploy and operate research grade baseline measurements <sup>3</sup> -----> ----- Deploy and operate PM enhanced measurements <sup>4</sup> -----> -- R&P 8400NS Field Testing & Evaluation <sup>7</sup> -----> ----Low T/Dryer TEOM Field Testing & Evaluation <sup>8</sup> -----> ---- R&P DDET Field Testing & Evaluation <sup>9</sup> ----->				

**PMTACS-NY "Project at a Glance" (continued)**

PROJECT SITES	Major Activities by Year				
	2000	2001	2002	2003	2004
Upstate/Regional:					
<b>Whiteface Mountain</b>	----- Deploy and operate research grade baseline measurements <sup>2</sup> ----->				
	----- Deploy and operate PM enhanced measurements <sup>4</sup> ----->				
	----- -OH/HO <sub>2</sub> <sup>3</sup> ----->				
	-- R&P 8400NS Field Testing & Evaluation <sup>7</sup> ----->				
Special Studies:	---Low T/Dryer TEOM Field Testing & Evaluation <sup>8</sup> ----->				
	---- R&P DDET Field Testing & Evaluation <sup>9</sup> ----->				

<sup>a</sup> Special intensive studies will be performed at one of the three urban sites identified in NYC, final selection will be made early in 2000 in consultation with NYSDEC, EPA and special study collaborators.

<sup>1</sup> Measurements to be performed and specifications are summarized in Table 1.

<sup>2</sup> Enhanced measurements to be performed and specification are summarized in Table 1 and details of the new technologies are described in Table 2.

<sup>3</sup> PSU GTHOS OH/HO<sub>2</sub> intensive study measurement, details of the new technology are described in Table 2.

<sup>4</sup> Single particle aerosol chemical composition as a function of size, intensive study measurement, details of the new technologies are described in Table 2

<sup>5</sup> Aerosol size distribution intensive study measurements

<sup>6</sup> NYSDOH HONO/HNO<sub>3</sub> Analyzer intensive study measurement, details of the new technology are described in Table 2.

<sup>7</sup> PM2.5 nitrate and sulfate analyzer under commercial development by R&P, details of the new technology are described in Table 2, deployment beyond 2001 assumes acceptable performance based on 2000-2001 field testing and evaluation.

<sup>8</sup> PM2.5 T&RH modified R&P TEOM, details of the new technology are described in Table 2, deployment beyond 2001 assumes acceptable performance based on 2000-2001 field-testing and evaluation.

<sup>9</sup> PM2.5 Differential Dual EPS TEOM, under commercial development by R&P, details of the new technology are described in Table 2, deployment beyond 2001 assumes acceptable performance based on 2000-2001 field testing and evaluation.

<sup>10</sup> Photochemical Assessment Monitoring Station, measurements to be performed and specifications are summarized in Table 1.

<sup>11</sup> Aerodyne Research, Inc mobile laboratory intensive study measurements, details of the new technology are described in Table 2.

<sup>12</sup> TILDAS open path crossroad remote measurements; details of the new technology are described in Table 2.

### **III.2 PMTACS - OBJECTIVES**

PMTACS-NY is designed to address a series of science policy relevant questions related to hypotheses to be tested using measurement data collected under the program. The objectives and major science policy relevant issues and hypothesis are provided below. The list is likely to expand over the course of the program as measurement data and research findings provide further insights into the characterization PM2.5 and sources.

***Objective I. Measure the temporal and spatial distribution of the PM2.5/co-Pollutant complex including: SO<sub>2</sub>, CO, VOCs/air toxics, NO, NO<sub>2</sub>, O<sub>3</sub>, NO<sub>y</sub>, H<sub>2</sub>CO, HNO<sub>3</sub>, HONO, PM2.5 (mass, SO<sub>4</sub><sup>-</sup>, NO<sub>3</sub><sup>-</sup>, OC, EC, trace elements), single particle aerosol composition, CN, OH and HO<sub>2</sub> to support regulatory requirements to develop cost-effective mitigation strategies for PM2.5 and its co-pollutants and to establish trends in the relevant precursor concentrations to assess the impact of recent and future emission reductions in terms of emission control effectiveness and air quality response.***

#### **Science Policy Relevant Questions:**

Will urban/regional atmospheres have a non-linear response of PM10/PM2.5 mass or composition to changes in precursor source gases (NO<sub>x</sub>, SO<sub>2</sub>, VOCs)?

H1. Trends in historical and PMTACS measurements of PM mass and SO<sub>4</sub><sup>-</sup> and NO<sub>3</sub><sup>-</sup> species composition data provide direct evidence for a nonlinear response to Title IV emission reductions. – Correlate trends in seasonal average PM10 SO<sub>4</sub><sup>-</sup> with Title IV SO<sub>2</sub> Phase I and Phase II CEM emissions.

H2. PM10/PM2.5 sulfate and nitrate production efficiencies are directly proportional with ozone production efficiencies. - Compare correlation of hourly measurements of O<sub>3</sub> vs. (NO<sub>y</sub> - NO<sub>x</sub>) and/or O<sub>3</sub> vs. CO with PM SO<sub>4</sub> vs. (NO<sub>y</sub>-NO<sub>x</sub>) and/or PM SO<sub>4</sub> vs. CO.

H3. Urban summertime SO<sub>4</sub> production is dominated by local SO<sub>2</sub> gas to particle transformation. - Calculate the production of SO<sub>4</sub> using OH and SO<sub>2</sub> measurements and gas phase kinetic rate constant for the OH + SO<sub>2</sub> reaction and compare with single particle SO<sub>4</sub> measurements (AMS and SPLAT-MS) and continuous PM2.5 sulfate measurements.

Can chemical source signatures be effectively applied to attribute specific source contributions to monitored species components (e.g. SO<sub>4</sub><sup>-</sup>, NO<sub>3</sub><sup>-</sup> or carbon)?

H3. PM Fe/Mg ratios provide an effective signature of oil derived combustion aerosol. - Apply chemical mass balance models, utilizing detailed trace elemental analysis of routine filter mass measurements (24-hr) and special study measurements (6-hr) collected at an urban and regional site.

Can source attribution and/or multivariate/factor analysis techniques distinguish the contribution of local production versus regionally transported PM2.5 mass?

H4. PM V/Se ratios provide an effective signature of coal vs. oil derived aerosol on the regional scale. - Apply chemical mass balance models, utilizing detailed trace elemental analysis of routine filter mass measurements (24-hr) and special study measurements (6-hr) collected at regional site.

H5. PM As/Se ratios provide an effective signature of mid-western vs. Canadian derived aerosols. (same as above)

H6. Enhanced PM composition and gas phase measurements provide an effective means for distinguishing the contribution of local vs. regional source types/classes within the study region. - Apply factor/multivariate analysis techniques, utilizing detailed trace elemental analysis of routine filter mass measurements (24-hr), special study measurements (6-hr), continuous PM mass and species and gas phase measurements, to distinguish source type/class contributions within the study region.

What are the sources of PM<sub>2.5</sub> affecting NY City/Upstate NY regional air quality? What fraction of the urban/regional PM<sub>2.5</sub> mass is semi-volatile organic matter? What is the chemical composition of the semi-volatile organic matter and what are its sources? Are biogenic emissions a significant source of the semi-volatile organic matter PM<sub>2.5</sub> mass fraction found in urban/regional atmospheres?

H7. Enhanced PM composition and gas phase measurements provide an effective means for distinguishing the contribution of source types/classes within the urban study region. - Apply factor/multivariate analysis techniques, utilizing detailed trace elemental analysis of routine filter mass measurements (24-hr), special study measurements (6-hr), continuous PM mass and species and gas phase measurements, to distinguish urban source type/class contributions.

H8. Biogenic hydrocarbons represent a significant source of the semi-volatile organic matter mass fraction of warm season regional PM<sub>2.5</sub> mass. - Correlate collocated measurements of natural hydrocarbon species (e.g. isoprene and  $\alpha$ -,  $\beta$ -pinene) and select oxidized carbonyl products with continuous carbon particulate mass measurements (R&P 5400 carbon particulate analyzer), with differential  $\Delta T$  TEOM mass, with differential dual ESP TEOM mass measurements.

Is NH<sub>3</sub> concentration a limiting reagent in the production of NH<sub>4</sub>NO<sub>3</sub> in the urban/regional environment? If so, will reductions in SO<sub>2</sub> through Title IV controls and proposed reductions in sulfur in fuels result in an increased fraction of PM<sub>2.5</sub> mass as nitrate?

H9. Changes in ambient PM sulfate mass fraction are anti-correlated with changes in the ambient PM nitrate mass fraction. - Correlate trends in seasonal average measurements of PM mass, SO<sub>4</sub>, NO<sub>3</sub> and NH<sub>4</sub> composition at regional and urban sites and their fractional contributions to total PM mass.

Can the "co-benefits" of on-going NO<sub>x</sub>/VOC and sulfur control programs be demonstrated through the tracking of selected precursors measurements in PMTACS urban supersite network?

**Objective II.** *Monitor the effectiveness of new emission control technologies [i.e. Compressed Natural Gas (CNG) bus deployment and Continuously Regenerating Technology (CRT)] introduced in New York City and its impact on ambient air quality, through remote open path roadside, mobile platform, and fixed site measurements of CO<sub>2</sub>, CO, NO, H<sub>2</sub>CO, HONO, CN and aerosol chemical composition.*

**Science Policy Relevant Questions:**

Can emission control technology impacts (i.e. @ CNG and @ CRT emission changes) on ambient air quality (CO, NO, SO<sub>2</sub>, H<sub>2</sub>CO, HONO, and PM) be demonstrated and tracked using a combination of open path and mobile instrumented platforms. Are these impacts observable with a limited fixed site network?

H10. The introduction of CNG-fueled buses in New York City will show measurable reductions of in-use vehicle NO, SO<sub>2</sub> and PM emissions as compared with their diesel counterparts. - Calculate exhaust emissions of CO, NO, H<sub>2</sub>CO and CO<sub>2</sub> and aerosol chemical species using mobile and open path cross road measurements of in-use standard diesel buses and their CNG replacements along their operational bus routes and at deployment stations.

H11. The introduction of CRT control technology and low sulfur fuels in retrofitted diesel buses in New York City will cause measurable reductions in-use vehicle NO, SO<sub>2</sub> and PM emissions as compared with standard diesel buses. - (same as above).

Are there observable changes in NO, SO<sub>2</sub>, H<sub>2</sub>CO and PM air quality as a result of the CNG/CRT bus fleet deployments?

H12. The introduction of CNG-fueled and CRT-retrofitted diesel buses show measurable reductions in ambient NO, SO<sub>2</sub>, H<sub>2</sub>CO and PM concentrations at the one or more of the PMTACS urban monitoring sites. - Correlate concentration measurements of NO, SO<sub>2</sub>, H<sub>2</sub>CO and PM at the three urban sites with deployment patterns and operations of the CNG/CRT buses fleets.

**Objective III.** *Test and evaluate new measurement technologies and provide tech-transfer of demonstrated operationally robust technologies for network operation in support of the development of process science and observation-based analysis tools and health-based exposure assessments.*

**Science Policy Relevant Questions:**

Is the EPA designate FRM for PM<sub>2.5</sub> mass an exact measurement of the actual mass of atmospheric PM<sub>2.5</sub>? Does the measurement method have any systematic bias and if so, is it species correlated?

H13. The EPA designated filter based reference method underestimates the actual atmospheric PM<sub>2.5</sub> mass by more than 30% as a result of volatile species losses. - EPA FRM mass measurements are to be compared with 1) R&P TEOM mass measurements operating at 30°C with a Nafion dryer and 2) mass measurements from a differential dual ESP TEOM systems (description in Table 2). In addition chemical analysis of FRM filters for SO<sub>4</sub><sup>=</sup>, NO<sub>3</sub><sup>-</sup> and total organic will be compared with integrated average data of continuous PM<sub>2.5</sub> SO<sub>4</sub><sup>=</sup> and PM<sub>2.5</sub> NO<sub>3</sub><sup>-</sup> (R&P 8400NS) and carbon particulate (R&P 5400) measurements.

H14. Water management and temperature control of existing continuous automated mass, total sulfur and nitrogen species measurement systems represent a major improvement in PM<sub>2.5</sub> measurement technology and are the measurement technologies of the future. - Perform collocated comparisons of continuous mass measurements from a standard R&P TEOM at 50°C, a TEOM operating at 30°C with a Nafion dryer, and differential dual ESP TEOM system (description in Table 3) and continuous PM<sub>2.5</sub> SO<sub>4</sub><sup>=</sup> and PM<sub>2.5</sub> NO<sub>3</sub><sup>-</sup> (R&P 8400NS) and carbon particulate (R&P 5400) measurements.

H15. Measurements of the optical properties of the atmosphere (light scattering and absorption) used fixed and remote sensing systems provide an effective means for verifying the existence and extent of regional haze and correlated with surface measurements of PM. - Correlate PMTACS-NY PM and optical measurements with satellite measurements from appropriate sensors.

Are aerosols an effective delivery mechanism for specific gaseous pollutants (e.g. air toxics, oxidants) into the deep lung? What is the role of liquid water in this delivery mechanism?

H16. Quantitative amounts of gaseous pollutants (e.g. PAH, H<sub>2</sub>CO, xylene, trichlorethylene, etc.) are absorbed on PM and are detectable by Aerosol Mass Spectrometer(AMS) and Single Particle Laser Ablation Time of Flight Mass Spectrometer(SPLAT-MS) analytical techniques. - Correlate continuous (40-min integrated) C<sub>2</sub>-C<sub>10</sub> hydrocarbon and air toxic measurements with PM measurement analyses by thermal volatilization MS and by laser ablation MS.

H17. PM chemical composition varies by aerodynamic size, which in turn varies in time, and with temperature and season resulting in complex variations in chemical inhalation exposures. – Measure chemical species composition as a function of aerosol size, and over the summer and winter season using AMS and SPLAT-MS techniques and apply in a lung inhalation model to estimate relative exposures.

H18. Heterogeneous processes contributed to the oxidizing capacity of the atmosphere resulting in significant production in PM<sub>2.5</sub> mass. – Correlate PM SO<sub>4</sub><sup>=</sup> vs. O<sub>3</sub> concentrations for high and low relative humidity periods by season. Correlate PM SO<sub>4</sub><sup>=</sup> vs. OH concentrations for high and low relative humidity periods.

## IV. APPROACH

### IV.1 PMTACS Measurement Sites

Comprehensive measurement of PM<sub>2.5</sub> mass, chemical speciation and gaseous precursors will be collected at six monitoring sites located in the New York City metropolitan area and at regional representative locations in upstate NY. These sites shown in the map in Figure 3 include two research regional monitoring sites, Whiteface Mountain (Wilmington, NY) operational since 1973 and Pinnacle State Park (Addison, NY) operational since 1995 and three urban monitoring sites (see map in Figure 4), Mable Dean Bacon (Manhattan, NY), Intermediate School I.S. 155 (South Bronx, NY) and Queensborough Community College (Queens, NY).

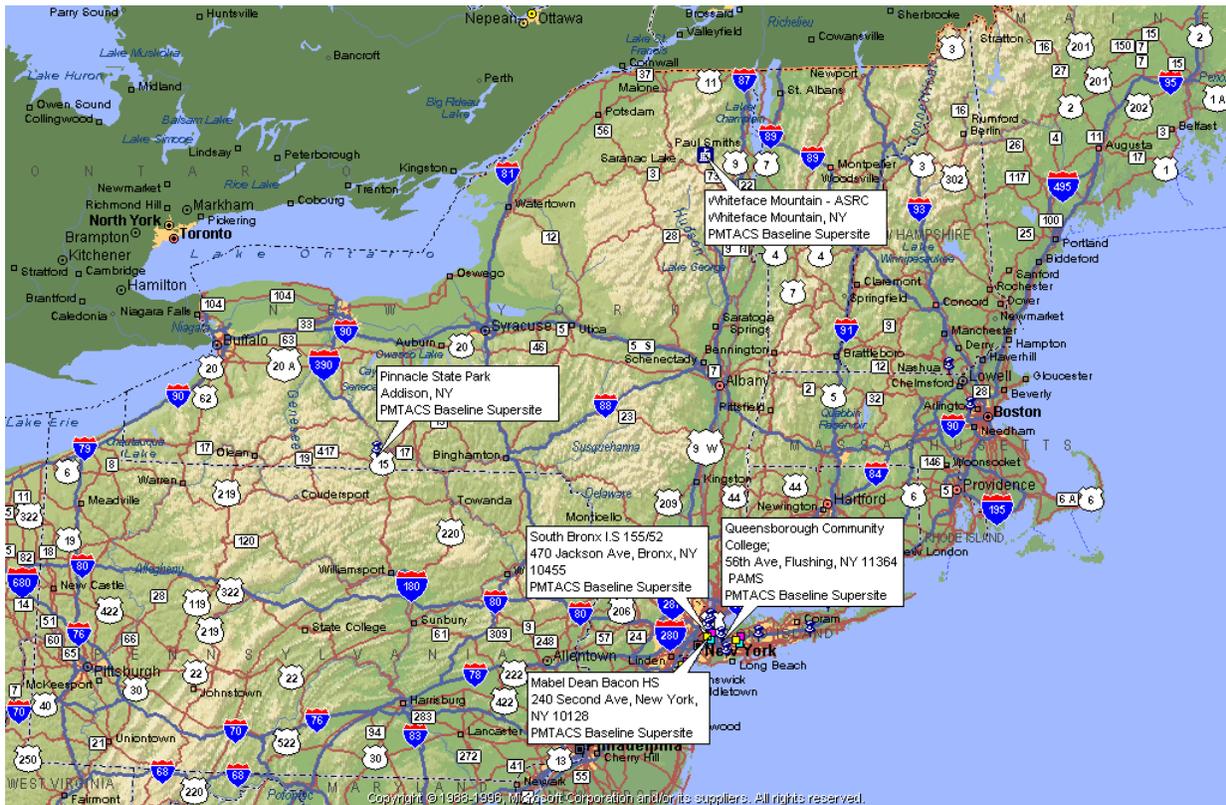


Figure 3. PMTACS-NY Supersite Network

These measurement sites constitute the backbone of the PM<sub>2.5</sub> "Supersites Network". In addition to standard routine measurements of criteria pollutants and the mandated PM<sub>2.5</sub> mass and chemical speciation measurements, these sites will be operating advance instrumentation that will compliment and provide more chemical and temporal specificity of the air quality at these locations. Details regarding siting, measurement parameters, and techniques are discussed in the Site Selection section of this proposal. The highly relevant measurements provided over the course of this program fill a substantial data need associated with the characterization of the chemical composition of PM<sub>2.5</sub> within New York City and the transport-impacted regional background of upstate NY.



Figure 4. PMTACS-NY Urban Superites

#### IV.2 PMTACS Special Intensive Field Studies

In addition to the PMTACS, PM<sub>2.5</sub> Supersite measurement network, which will operate throughout the entire 5 year program period as described in Table 1, two special intensive field studies will also be carried out. The first study will occur in the summer of 2001 and the second in the winter of 2003. Both studies will be deployed from a host site that will likely be one of the backbone urban measurement sites shown in Figure 4. The intensive field studies will be 4-6 weeks in duration, involving several research groups performing research grade measurements using emerging measurement technologies. These measurements will provide detailed real-time chemical and physical characterization of the PM/co-pollutant complex to 1) help elucidate the operative gas-to-particle transformation processes occurring in urban centers; 2) enhance the chemical source signature data base in support of source attribution studies; and 3) intercompare emerging technologies and evaluate their performance and in comparison with the operational routine measurement systems. Participating research groups include: Aerodyne Research, Inc., Aerosol Dynamics, Inc, Brookhaven National Laboratories, Clarkson University, Penn State University, NYS Department of Environmental Conservation, NYS Department of Health, Rupprecht and Patashnick, Co., Inc., and the University at Albany/SUNY. The new measurement technologies to be deployed as part of the PMTACS special studies are summarized in Table 2. The specific objectives/hypotheses associated with the special studies program have been identified in Section III.2

### ***IV.3 CNG/CRT Emission Perturbation Experiments (CEPEX)***

In the next several years, a major opportunity exist to evaluate the impact of two emission control strategies on the ambient air in New York City, resulting from the current phased conversion of the Metropolitan Transit Authority (MTA) bus fleet to compressed natural gas (CNG) and the prototype testing of new emission control technology, continuously regenerating technology (CRT), for heavy duty diesel.

In late 1996, the New York State government, the Natural Resources Defense Council (NRDC) and the Metropolitan Transportation Authority (MTA) reached a landmark agreement to commit to purchase 500 alternative fuel buses for the New York City Transit fleet. A demonstration program comparing the performance of 34 natural gas buses with that of similar model diesel-powered buses was completed in 1998. The MTA has redesigned the Jackie Gleason bus depot in Brooklyn to accommodate natural gas refueling and has purchased and will deploying 210 CNG fueled buses from this depot by the year 2000. In addition, 250 CNG fueled buses have been purchased and will be deployed from the Coliseum Depot in the Bronx by the 1<sup>st</sup> quarter of 2001. The incremental costs associated with the purchase of the alternative fuel buses and the remodeling of depots with refueling equipment will be over \$50 million.

In another New York project, the Clean Diesel Vehicle Program, a demonstration study of the viability of a new emission control technology for diesel-fueled buses, Continuously Regenerating Technology (CRT) is about to be initiated. The exhaust after-treatment technology under development by Johnson Matthey Catalytic Systems Division will be retrofitted to 50 MTA buses that will operate in normal service over five different bus routes in the Bronx and Manhattan. The retrofit fleet will be deployed from the Mother Clara Hale Depot at 721 Lenox Avenue. Implementation of the technology requires use of very low sulfur diesel fuel, currently unavailable commercially. As a result, Equilon Enterprises LLC has been contracted to produce and supply the low sulfur fuel to be used during the one-year demonstration study. Twice during the course of the study, a sample of buses will be subject to comprehensive chassis dynamometer emissions test will be performed at Environment Canada in Ottawa, Ontario, Canada.

The introduction of these two emission reduction technologies into the operational environment provides an outstanding target of opportunity to evaluate and assess the performance and impact of these control technologies while in-use. The CEPEX studies proposed will be designed to monitor on-road vehicle emissions of the CNG/CRT modified buses and that of the traditional diesel-fueled buses to be replaced using open-path roadside remote sensing and a mobile measurement platform. In addition, enhanced fixed-site monitors as part of the urban PMTACS baseline network will be used to discern changes in ambient air quality as a result of the implementation of these emission control technologies.

The first prototype study will be carried out in the vicinity of the CNG bus depot deployment in Brooklyn (see Figure 5) and will consist of three measurement components.

1. An open path tunable infra-red laser differential absorption spectrometer (TILDAS) remote sensing system will be deployed across one or more roadways representative of the routes

traveled by the MTA CNG bus fleet. The TILDAS system will be configured to monitor CO<sub>2</sub>, CO, NO under one set of experiments and CO<sub>2</sub>, H<sub>2</sub>CO and SO<sub>2</sub> under a second set of experiments.

2. A mobile measurement platform equipped to perform real time mobile measurements of multiple trace gases and particulate with stationary trace gaseous species, particulate and meteorological data collection in combination with a global positioning system. The instrumented mobile laboratory provides real time, fast response (1 sec), simultaneous measurement of multiple trace gases as well as particulate matter under normal driving conditions and can map background pollutant levels as well as characterize on-road emissions from selected mobile sources. Fast response measurements allow the detection of discrete changes in pollutant levels with location and the opportunity to react immediately to probe further into those changes. In this case the mobile measurement system will be used specifically to follow standard diesel buses and their compressed natural gas replacements along their operational bus routes and at stations sampling their exhaust emissions for CO, NO, H<sub>2</sub>CO and

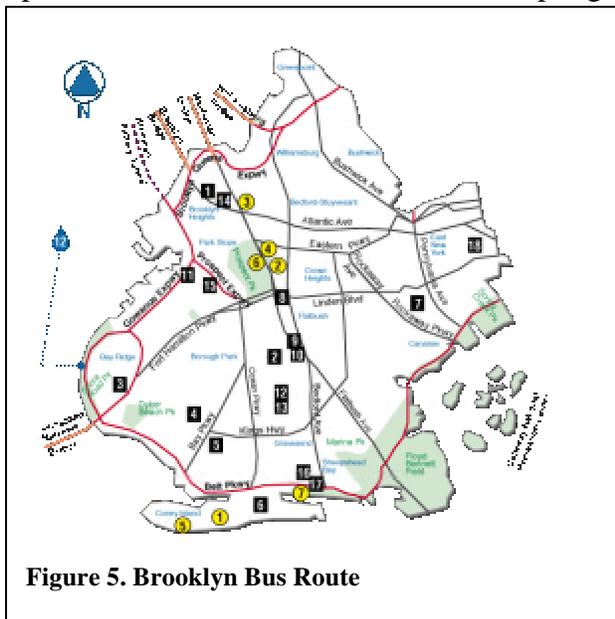


Figure 5. Brooklyn Bus Route

CO<sub>2</sub> and aerosol chemical species and ultrafine CN. The measured species will be normalized to fuel consumption (CO<sub>2</sub> output) allowing emissions to be determined as a function of time and by vehicle type; revealing as well, dependencies on operating and environmental parameters such as speed, grade, and ambient temperature. The experiments provide the opportunity to directly measure emission changes in CO, NO, H<sub>2</sub>CO, aerosol chemical composition and ultrafine CN for standard in-use vehicles and their new control technology counterparts.

The mobile measurement system will also be deployed for concentration surveys to identify and map major emission sources in the

metropolitan area. [e.g. Lamb et al., 1995, Shorter et al, 1998]. Concentration surveys include a coarse set of traverses in an area to identify major emission sources, while concentration maps are a fine set of traverses designed for more detailed identification of source location or trends in concentration with location. The concentration data are combined with the GPS position record to create a “map” of trace gas concentrations. The data set is also available for model based inversion to determine source strengths. A description of measurement parameters and instrumentation available in the mobile laboratory is summarized in Table 2.

3. Fixed site measurements of SO<sub>2</sub>, CO, NO, NO<sub>2</sub>, H<sub>2</sub>CO, PM<sub>2.5</sub>, SO<sub>4</sub><sup>2-</sup>, NO<sub>3</sub><sup>-</sup>, C, ultrafine CN as part of the PMTACS urban network will be evaluated to determine if emission perturbations are observable in the overall ambient urban air quality.

In addition, the NYS DEC Emissions Division is performing chassis dynamometer studies to measure source profiles of in-use heavy-duty diesel vehicles in NYC. The studies are specifically interested in the characterization of the physical and chemical make-up of PM using advanced measurement techniques. These include: scanning electron microscopy; R&P Model 5100 Carbon analyzer for PM characterization on individual vehicle/engine tests; Eco-Chem PAS Analyzer with 1,000-to-1 variable dilution system for detection of PM-bound poly-nuclear aromatic hydrocarbons; Dekati Ltd.- Electrical Low Pressure Impactor (ELPI) for PM aerodynamic size measurements from 30 nm – 10 microns; Thermo-Systems Inc. - Scanning Mobility Particle Sizer (SMPS) for PM mobility size generation and measurement, and real-time particle size distributions from 5-1000 nm; E-Flow total exhaust flow measurement instrument for application to ultra-low emission vehicle measurements using only raw exhaust w/o dilution Sensors Inc., Lambda Master for real-time vehicle combustion air/fuel analysis.

**TABLE 1. PMTACS-NY Sites, Measurement Parameters And Specifications**

Parameter/Method	Sites*	Operator**	Period	Averaging	Frequency
<b><i>PM Filter Mass and Chemistry</i></b>					
PM2.5 mass, sulfate, nitrate /Ion Chromatograph	WFML	DEC, ASRC	April 1, 2000 - December 1, 2004	24-hr	daily
PM2.5 (Chemical Species Measurements, as outlined in EPA, 1999)	QCC	DEC Analytical Lab (to be decided)	April 1, 2000 – December 1, 2004	24-hr	3 <sup>rd</sup> day
PM10 mass, sulfate, nitrate /Ion Chrom	WFML, MDB, SB	DEC, ASRC	April 1, 2000 – December 1, 2004	24-hr	6 <sup>th</sup> day
PM2.5 mass (FRM-R&P Partisol Sampler)	PSP, WFML, MDB, SB, QCC	DEC, ASRC	April 1, 2000 – December 1, 2004	24-hr	daily
PM2.5 metals Mg, Al, K, Ca, V, Cr, Mn, Ni, Fe, Zn, As, Se, Cd, Sb, Hg, and Pb /ICP/AES, ICP/MS, & neutron activation	PSP, MDB, SB, QCC, NNJ	DEC, ASRC, DOH	July 1, 2000 – June 30, 2001	24-hr	daily
PM2.5 SO <sub>4</sub> <sup>-</sup> , NO <sub>3</sub> <sup>-</sup> , NO <sub>2</sub> <sup>-</sup> , Cl <sup>-</sup> , Br <sup>-</sup> /Ion Chromatograph	PSP, MDB, SB, QCC, NNJ	DEC, ASRC, DOH	July 1, 2000 – June 30, 2001	24-hr	daily
PM2.5 metals Mg, Al, K, Ca, V, Cr, Mn, Ni, Fe, Zn, As, Se, Cd, Sb, Hg, and Pb/ XRF	PSP, MDB, SB, QCC, NNJ	DEC, ASRC	July 1, 2001 – December 1, 2003	24-hr	6 <sup>th</sup> day
PM2.5 SO <sub>4</sub> <sup>-</sup> , NO <sub>3</sub> <sup>-</sup> , NO <sub>2</sub> <sup>-</sup> , Cl <sup>-</sup> , Br <sup>-</sup> /Ion Chromatograph	PSP, MDB, SB, QCC, NNJ	DEC, ASRC	July 1, 2001 – December 1, 2003	24-hr	6 <sup>th</sup> day
PM2.5 metals Mg, Al, K, Ca, V, Cr, Mn, Ni, Fe, Zn, As, Se, Cd, Sb, Hg, and Pb /ICP/AES, ICP/MS, & neutron activation	PSP, MDB, SB, QCC, NNJ	DEC, ASRC, NYSDOH	Intensive: 4 weeks ea. Summer 2001 Winter 2003	6-hr	daily
PM2.5 SO <sub>4</sub> <sup>-</sup> , NO <sub>3</sub> <sup>-</sup> , NO <sub>2</sub> <sup>-</sup> , Cl <sup>-</sup> , Br <sup>-</sup> /Ion Chromatograph	PSP, MDB, SB, QCC, NNJ	DEC, ASRC, DOH	Intensive: 4 weeks ea. Summer 2001 Winter 2003	6-hr	daily
PM10/PM2.5 Particle Concentrator (R&P ChemTox Model 2400)	PSP MDB or SB	DEC, ASRC	Seasonal year 2000 Seasonal 2001-2003	variable	variable

**Table 1. PMTACS-NY Sites, Measurement Parameters and Specifications (continued)**

<i>Continuous PM Mass and Chemistry</i>					
PM2.5 mass (heated R&P TEOM 1400AB)	PSP, WFML, MDB, SB, QCC	DEC,ASRC	June 1, 2000 – December 1, 2004	10-min	daily
PM10 mass (heated R&P TEOM 1400AB)	MDB, SB	DEC,ASRC		10-min	daily
PM2.5 mass (T/RH modified R&P TEOM 1400AB)	PSP, WFML, MDB	DEC,ASRC	June 1, 2000 – May 31, 2003	10-min	daily
PM2.5 mass (Differential ESP R&P TEOM )	PSP, MDB	ASRC	June 1, 2001 – December 31, 2004	5-min	daily
PM2.5 nitrate and sulfate (R&P flash volatilization 8400NS)	PSP, WFML, MDB, SB, QCC	DEC,ASRC	(3) June 1, 2000 - (2) June 1, 2001 – December 1, 2004	10-min	daily
PM2.5 Organic and elemental carbon (R&P 5400)	PSP, WFML, MDB, SB, QCC	DEC,ASRC	June 1, 2001 – December 1, 2004	1-hr	daily
Single particle chemical speciation (Aerodyne, Inc Aerosol Mass Spectrometer [AMS])	MDB/QCC	ASRC	Intensive: 4 weeks ea. Summer 2001 Winter 2003	TBD	TBD
Single particle chemical speciation (BNL Single Particle Laser Ablation Time of Flight Mass Spectrometer [SPLAT-MS])	MDB/QCC	BNL	Intensive: 4 weeks ea. Summer 2001 Winter 2003	TBD	TBD
<i>Gases</i>					
NO - TECO 42s	PSP, WFMS, MDB, SB, QCC	DEC,ASRC	April 1, 2000 – December 1, 2004	5-min	daily
NO2-photolytic titration modified TECO 42s	PSP, WFMS, MDB, SB, QCC	DEC,ASRC	June 1, 2000 – December 1, 2004	5-min	daily
NOy Moly. Modified TECO 42s	PSP, WFMS, MDB, SB, QCC	DEC,ASRC	June 1, 2000 – December 1, 2004	5-min	daily
SO2 TECO 43b	PSP, WFMS, MDB, SB, QCC	DEC,ASRC	April 1, 2000 – December 1, 2004	5-min	daily
O3 TECO	PSP, WFML, MDB, SB, QCC	DEC,ASRC	April 1, 2000 – December 1, 2004	5-min	daily

**Table 1. PMTACS-NY Sites, Measurement Parameters and Specifications (continued)**

CO Modified TECO 48s	PSP, WFMS, MDB, SB, QCC	DEC,ASRC	June 1, 2000 – December 1, 2004	5-min	daily
NO/CO or H2CO/HONO open path TILDAS	MDB/QCC	DEC,ASRC, Aerodyne	Intensive: 4 weeks ea. Summer 2001 Winter 2003	5-min	daily
OH/HO2 LIF	WFM MDB/QCC	PSU	Intensives: 4 weeks ea. Summer 2000 – WFM Summer 2001 - MDB Winter 2003 - MDB	10-min	daily
HONO/HNO3 scrubbed derivatization HPLC	MDB/QCC	DOH	Intensive: 4 weeks ea. Summer 2001 Winter 2003	5-min	daily
Hydrocarbons C2-C10 Canisters GC/FID	WFMS, WFML	ASRC	May 15, 2000 – December 1, 2004	3-hr integrated	2 <sup>nd</sup> day in Summer; weekly in winter
Hydrocarbons C2-C10 PE Auto GC	PSP, QCC	ASRC, DEC	May 15 - October 15 2000-2004	40-min	daily summer
H2CO /AEROLaser 14001A and/or TexasTech	PSP, WFML, MDB, SB, QCC	DEC, ASRC	12 week Summer Intensives: 2000-04 6 week Winter Intensives: 2000-2003	5-min	daily
Air Toxics	MDB/QCC; SB	DEC	Seasonal 2000-04	24-hr	3 <sup>rd</sup> day

**Table 1. PMTACS-NY Sites, Measurement Parameters and Specifications (continued)**

<i>Particle Number, Size &amp; Optical Properties</i>					
Condensation Nuclei Counter/ TSI 3025A (0.003 $\mu$ m to 1 $\mu$ m)	MDB, SB, QCC	DEC	April 1, 2000 – December 1, 2004	5-min	daily
Condensation Nuclei Counter/ GE	PSP, WFML	ASRC	April 1, 2000 – December 1, 2004	5-min	daily
Aerosol Size Distribution (0.003 $\mu$ m to 1 $\mu$ m) / TSI 3934	PSP, MDB/SB	ASRC	4 week Summer Intensives: 2000-2003 4 week Winter Intensives: 2000-2003	5-min	daily
Aerodynamic Particle Sizer Spectrometer (0.37 $\mu$ m to 20 $\mu$ m) / TSI 3320	PSP, MDB/SB	ASRC, DEC	4 week Summer Intensives: 2000-2003 4 week Winter Intensives: 2000-2003	5-min	daily
Aerosol Light Absorption/ Aethalometer (elemental carbon)	PSP, MDB/SB	ASRC, DEC	January 1, 2001 – December 31, 2003	5-min	daily
Aerosol Light Scattering: 3-color integrating nephelometer /TSI 3563 or equivalent system	PSP, MDB/QCC	ASRC, DEC	January 1, 2001 – December 31, 2003	5-min	daily
<i>Meteorological Measurements</i>					
Wind speed and direction, temperature, barometric pressure, relative humidity	PSP, WFMS, MDB, SB, QCC	DEC,ASRC	April 1, 2000 – December 31, 2004	5-min	daily

**\*Sites -**

Whiteface Mountain Summit and Lodge: WFMS, WFML  
Pinnacle State Park: PSP  
Mable Dean Bacon: MDB  
I.S. 155 South Bronx: SB  
Queensborough Community College: QCC  
Northern NJ site to be designated

**\*\* Operators –**

Aerodyne Research, Inc: ARI  
Atmospheric Sciences Research Center: ASRC  
Brookhaven National Laboratories: BNL  
NYS Department of Environmental Conservation: DEC  
NYS Department of Health: DOH  
Pennsylvania State University: PSU

**Table 2. PMTACS-NY - New Measurement Technology Deployment**

Measurement Technology/Description	Testing & Evaluation	Operational Status
<p><b>R&amp;P TEOM (modified Low T/dryer)</b>                      A continuous mass monitor based on the tapered element oscillating has been modified to operate at 30°C and sample a de-humidified ambient air stream passed through a Nafion dryer.</p>	<p>Laboratory &amp; Field Evaluation                      QA and SOPs available</p>	<p>To be deployed as part of the enhanced operational network in June 2000</p>
<p><b>R&amp;P Differential Dual ESP TEOM (DDET)</b>                      The instrument is based on the direct mass reading and real-time capability of the TEOM system. A matched pair of TEOM sensors (A and B) is run at ambient temperature. Downstream from a common size selective inlet and ahead of each TEOM sensor is an electrostatic precipitator (ESP). The ESP's are alternately switched on and off and out of phase with each other. Each ESP is on or off for a time period, <math>\Delta t</math>. Frequency data are collected for both TEOM sensors on a continuous basis. The effective mass is the mass that is calculated from the frequency of the TEOM sensor including all sources that affect the frequency during the given time period. The difference between the effective masses of the TEOM A and B sensors provides a direct measure of the non-volatile and volatile component of particle mass collected during the time interval.</p>	<p>Laboratory &amp; Field Evaluation                      QA and SOPs to be developed</p>	<p>To be deployed as part of the enhanced operational network in June 2001</p>
<p><b>R&amp;P 8400NS (PM2.5 Nitrate &amp; Sulfate Analyzer)</b>                      This automated monitor for semi-continuous measurement of nitrate and sulfate is based on the method of Stolzenburg and Hering (1998, 1999). Particles are collected by a humidified impaction process and analyzed in place by flash vaporization. The approach is based on the manual method that has been used for over twenty years to measure the size distribution of sulfate aerosols (Hering and Friedlander, 1982). In the new instrument design, particle collection and analysis have been combined into a single, integrated collection and vaporization cell, allowing the system to be automated. Particles are humidified prior to impaction to eliminate the rebound of particles from the collection surface without the use of grease (Winkler, 1974 and Stein et al 1994). Interference from vapors such as nitric acid is minimized by use of a denuder upstream of the humidifier. The flow system is configured such that there are no valves on the aerosol sampling line. Analysis is done by flash-vaporization with quantitative detection of the evolved gases. For sulfate the evolved gases are analyzed for SO<sub>2</sub>, as described by Roberts and Friedlander, (1974). For nitrate the evolved vapors are analyzed for nitrogen oxides (Yamamota and Kosaka,1994).</p>	<p>Laboratory &amp; Field Evaluation                      QA and SOPs available (using liquid standards). Laboratory/field aerosol calibration system must be developed for generating known quantities (number/size) of nitrate/sulfate aerosols.</p>	<p>To be deployed as part of the enhanced operational network in June 2000and 2001</p>

<p><b>Aerodyne Research, Inc. (AMS)</b> Ambient aerosol particles in the size range 0.05 to 2 to 5 micrometers are focused into a high vacuum system. Particle velocity measurements determine particle aerodynamic diameter. Volatile and semivolatile chemical components are thermally vaporized and detected via electron impact ionization quadrupole mass spectrometry. Detection sensitivity for the base system corresponds to aerosol loading of 0.1 to 1 microgram/m<sup>3</sup>, depending on the molecular mass interferences and background levels.</p>	<p>Laboratory &amp; Field Evaluation/Intercomparison Research Method: QA and SOPs under development. Laboratory/field aerosol calibration system must be developed for generating known quantities (number/size) of aerosols of known chemical composition.</p>	<p>To be deployed as part of intensive study programs in summer of 2001 and winter 2003</p>
<p><b>BNL Single Particle Laser Ablation Time of Flight Mass Spectrometer [SPLAT-MS]</b> Designed to be a universal tool for characterizing the size and composition of individual aerosols from ~10 nm up to tens of micrometers. It utilizes two continuously operative detection modes; VUV photoionization and more conventional light scattering for small and large particle detection respectively. These will be used to synchronize the ablation laser with the particle's arrival for all sizes. Ambient aerosols are focused by the aerodynamic lens system, and accelerated during supersonic expansion through a nozzle to velocities between 100 and 400 m/sec, depending on particle size. Two stages of optical detection are used to indicate the presence of particles larger than 100 nm and for velocity/size determination. To maximize the contrast between particle and gas, the signal is integrated for ~1 microsecond and a requirement for a coincidence between the two laser beams. A continuous VUV light source is used for nanoparticle charging by photoemission and electron detection allows detection and size characterization for particle smaller than 100 nm. An excimer laser is used to ablate particles and generate ions. Operating an excimer laser at 157 nm the system allows in-resonance particle ionization as opposed to off-resonance process for longer wavelengths. A Reflectron time of flight mass spectrometer is used for single particle composition analysis.</p>	<p>Field Evaluation/Intercomparison Research Method: QA and SOPs under development.  Laboratory/field aerosol calibration system must be developed for generating known quantities (number/size) of aerosols of known chemical composition.</p>	<p>To be deployed as part of intensive study programs in summer of 2001 and winter 2003</p>
<p><b>Aerodyne Research, Inc. (TILDAS)</b> The tunable diode laser system for cross-road vehicle measurements of motor vehicle exhaust gases uses infrared laser differential absorption spectroscopy to determine the absolute fractional absorption by the gaseous medium between the laser source and a remotely placed retro-reflector mirror system. Spectroscopic constants of the gases of interest are applied to the measured fractional absorption to calculate the pertinent absolute column densities. Multiple species concentrations are determined by spatially combining two laser beams from separate laser diodes. Ratios of gases, such as NO/CO<sub>2</sub>, may</p>	<p>Field Evaluation QA and SOPs available</p>	<p>To be deployed as part of intensive study programs in summer of 2001 and winter 2003</p>

<p>be used to directly determine the emission indices for individual motor vehicles at highway speeds. Detection sensitivity of ~ with a measurement precision as small as 3 ppmv for NO in the vehicle exhaust have been demonstrated. The system is capable of measuring small molecules including NO, NO<sub>2</sub>, N<sub>2</sub>O, HONO, NH<sub>3</sub>, CO, H<sub>2</sub>CO, and SO<sub>2</sub> using different laser diodes. The time resolution of 0.02 seconds is sufficient to resolve the plumes from individual automobiles. The range of greater than 100 meters is sufficient to make measurements across multiple lane highways without impeding traffic flow. Extended ranges up to 1 km may be used with longer time averaging to obtain integrated column measurements of urban pollutants using open-path infrared absorption. A more detailed description of the instrument may be found in (Nelson, et al., 1998); (Jiménez, et al., 1999); and (Nelson, et al., 1999).</p>		
<p><b>Aerodyne Research, Inc. Mobile Laboratory</b>  The mobile laboratory has a series of sensitive, specific, real-time (~1 second response) sensors for aerosol and ozone precursor trace gases and fine particulates; a global positioning system (GPS) ; and a central data logging computer. Specifically, the sensors include: an ARI two-color tunable infrared laser differential absorption spectrometer (TILDAS), capable of measuring between 2 and 4 trace gases simultaneously, such as carbon monoxide (CO), nitrogen oxides ( NO, NO<sub>2</sub>), nitrous acid (HONO), formaldehyde(CH<sub>2</sub>O), and sulfur dioxide (SO<sub>2</sub>).; a Licor NDIR instrument to measure carbon dioxide (CO<sub>2</sub>); a aerosol mass spectrometer (AMS) to measure particulate number densities, size distributions (0.05 to ~2.5 μm), and volatile and semi-volatile chemical composition as a function of particle size. CN counter to measure particulate number densities (0.003 to 1). The real-time instruments have been described in detail previously [see Lamb et al. (1995), Nelson et al., (1996), Zahniser (1995), and Jayne et al., 1999]. Data from the individual instruments are logged on a central computer, enabling all data streams to be stored synchronously. A Trimble GPS system with real-time differential correction collects position information at 1 Hz.</p>	<p>Field Evaluation</p> <p>QA and SOPs for individual instrument systems available or under development</p> <p>QA field experiments (1-2 days) during which calibration/ intercomparisons performed with collocated systems measuring the same chemical parameter.</p>	<p>To be deployed in 2000 as part of the CEPEX and in the summer of 2001 intensive study program. Deployment in the winter 2003 intensive study will be optional and dependent on additional cost sharing resources</p>
<p><b>AEROLaser 1401 &amp; Texas Tech H<sub>2</sub>CO Analyzers</b>  Gaseous formaldehyde is scrubbed from ambient air into solution with the reagents 2,4-pentanedione and ammonium acetate (Dasguta et al., 1988) to form stoichiometrically the product derivative 3,5-diacetyl 1,4-dihydrolutidine (DDL). DDL is detected via fluorescence using 254nm radiation from a Hg lamp. The fluorescence signal is calibrated against known concentrations of formaldehyde generated by an internal permeation source and may also be calibrated using external liquid standards.</p>	<p>Field Evaluation/Intercomparison  QA and SOPs available or under development</p>	

<p><b>NYS Department of Health HONO/HNO<sub>3</sub> Analyzer</b> - The gaseous analytes are sampled by two coil samplers. The scrubbed nitric acid in channel 2 is converted to nitrite using a Cd-reductor: <math>\text{NO}_3^- + \text{Cd}_{(s)} + 2\text{H}^+ \rightarrow \text{NO}_2^- + \text{Cd}^{++} + \text{H}_2\text{O}</math>. The nitrite in the two channels is converted to a highly light-absorbing azo dye by a two step derivatization with sulfanilamide (SA) and N-(1-naphthyl)-ethylenediamine (NED), which proceeds in on-line derivatization coils with 5 min, The derivative azo dye is preconcentrated on two on-line C18 reversed-phase cartridges on a 10-port injection valve, and is separated with a reversed-phase C<sub>18</sub> HPLC column and detected with an absorbance detector at 540 nm. The auto-injection valve is controlled by a PC-based HPLC software and the valve position is switched every 5 min, resulting in a 10-min sampling cycle with a 5-min sampling integration time for both channels. The method detection limits are 3 ppt and 10 ppt for HONO and nitric acid, respectively.</p>	<p>Field Evaluation/Intercomparison</p> <p>QA field experiments (1-2 days) during which calibration/ intercomparisons performed with collocated systems measuring the same chemical parameters.</p>	<p>To be deployed as part of intensive study programs in summer of 2001 and winter 2003</p>
<p><b>Penn State University GTHOS (Ground-based Tropospheric Hydrogen Oxides Sensor)</b>  GTHOS uses laser-induced fluorescence (LIF) to measure OH and HO<sub>2</sub> simultaneously (Mather et al., 1997). OH is both excited and detected with the <math>\text{A}^2\Sigma^+ (v'=0) \rightarrow \text{X}^2\Pi (v''=0)</math> transition near 308 nm. HO<sub>2</sub> is first reacted with reagent NO to form OH and is then detected with LIF. The ambient air is pulled by a vacuum pump through a small upward facing inlet (1mm diameter), down a short, sampling tube, and into two low-pressure multipass White cell detection cells. The first cell is for OH and the second for HO<sub>2</sub>. Detection occurs in each detection cell at the intersection of the airflow, the laser beam, and the detector field-of-view. The pulsed laser has a 3 kHz repetition frequency, 28 ns long pulses, and produces about 10-20 mW of tunable UV near 308 nm. The laser is tuned on and off resonance with the OH transition in a 20-second cycle; the OH fluorescence is the difference between the signal on resonance and the signal off resonance. The detector is gated to detect the OH fluorescence after each laser pulse has cleared the detection cell. A reference cell containing OH indicates when the laser is on and off resonance with the OH transition. The absolute uncertainty, which is determined in the laboratory and maintained with power and signal monitors and weekly <i>in situ</i> calibrations is <math>\pm 40\%</math>, although planned advances in the calibration technique over the next year should reduce this uncertainty to <math>\pm 25\%</math>. The minimum detectable mixing ratio (S/N=2, 60 seconds) is 0.015 pptv (<math>3.5 \times 10^5 \text{ cm}^{-3}</math>) for OH and 0.06 pptv for HO<sub>2</sub>. Because the signals obey Poisson statistics, the OH detection limit is about <math>10^5 \text{ cm}^{-3}</math> in 10 minutes.</p>	<p>Field Evaluation</p> <p>Research Method: QA and SOPs are under development; no direct calibration standard exists.</p> <p>Previous field tests include: PROPHET summertime intensive in 1998 and Nashville, TN as part of the 1999 Southern Oxidant Study (SOS).</p>	<p>To be deployed as part of intensive study programs in summer of 2001 and winter 2003 and in the summer 2002 at Whiteface Mountain.</p>

**TABLE 3.A PMTACS-NY PROJECT SCHEDULE 2000 – 2001**

Year	2000				2001			
	1 <sup>st</sup> Qrt	2 <sup>nd</sup> Qrt	3 <sup>rd</sup> Qrt	4 <sup>th</sup> Qrt	1 <sup>st</sup> Qrt	2 <sup>nd</sup> Qrt	3 <sup>rd</sup> Qrt	4 <sup>th</sup> Qrt
Task:	1 <sup>st</sup> Qrt	2 <sup>nd</sup> Qrt	3 <sup>rd</sup> Qrt	4 <sup>th</sup> Qrt	1 <sup>st</sup> Qrt	2 <sup>nd</sup> Qrt	3 <sup>rd</sup> Qrt	4 <sup>th</sup> Qrt
Planning and coordination meetings	→				→			
Preparation of QA Project Plan	→	→						
Order major permanent equipment for Supersite network	→							
Build NO <sub>2</sub> measurement system (Photolytic Titration)	→	→						
Initiate operation of urban monitoring sites for criteria pollutant measurements, (see Table 1 for deployment details)		→	→	→	→	→	→	→
Site renovations and power up grades as needed	→	→						
Initiate enhanced measurement systems: (see Table 1 for deployment details)			→	→	→	→	→	→
CEPEX site selection/ preparation (TILDAS) and selection of deployment routes for mobile laboratory	→	→						
CEPEX intensive measurement studies			→				→	
QA experiments/intercomparison studies		→				→		
Special Intensive Field Studies							→	
Data quality assessment and management of site measurements	→	→	→	→	→	→	→	→
Annual Data Summary Report					→			
Presentation and Publication of Scientific Findings and Results					→			

**TABLE 3.B PMTACS-NY PROJECT SCHEDULE 2002 - 2004**

Task:	Year	2002				2003				2004			
		1 <sup>st</sup> Qrt	2 <sup>nd</sup> Qrt	3 <sup>rd</sup> Qrt	4 <sup>th</sup> Qrt	1 <sup>st</sup> Qrt	2 <sup>nd</sup> Qrt	3 <sup>rd</sup> Qrt	4 <sup>th</sup> Qrt	1 <sup>st</sup> Qrt	2 <sup>nd</sup> Qrt	3 <sup>rd</sup> Qrt	4 <sup>th</sup> Qrt
Planning and coordination meetings		→				→	→			→			
Data Assessment and Analysis Workshop		→								→			
Continue operation of urban monitoring sites for criteria pollutant measurements: (see Table 1 for deployment details)		—————→											
Continue operation of enhanced measurement systems: (see Table 1 for deployment details)		—————→											
CEPEX intensive measurement studies								→					
QA experiments/intercomparison studies			→				→						
Special Intensive Field Studies								→					
Data quality assessment and management of site measurements		→	→	→	→	→	→	→	→	→	→	→	→
Annual Data Summary Report		→								→			→
Final Quality Assurance Report													→
Project Final Report													→
Presentation and Publication of Scientific Findings and Results					→				→			→	