APPENDIX H

Previous Evaluation of EMEP Instrument Development Projects

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The Section below is an excerpt from the **New York Energy $mart Program Evaluation and Status Report, Final Report, May 2005, Chapter 8 Research and Development Program Area.**

Continuous Ambient Particulate Monitor Development and Innovative Instrument for Ambient Air Particles Projects

NYSERDA's Environmental Monitoring, Evaluation, and Protection Program (EMEP) has recently supported two product developments to improve continuous monitoring of fine particulate matter (PM) mass in ambient air—the air that people breathe. These products are based on the use of the Tapered Element Oscillating Microbalance (TEOM®) inertial mass measurement method. The two goals of these efforts were (1) to increase correlation with measurements made using the Federal Reference Method (FRM), a 24-hour filter-based method; and (2) to develop a continuous measurement system that more closely represents the mass of fine particles found in ambient air, rather than that found following the techniques described in the FRM.

To achieve the first goal, a sample equilibration system (SES) was developed to reduce the moisture content of the sampled ambient air stream so that the temperature of the TEOM filter could be reduced from 50°C to 30°C, which is closer to the typical ambient collection temperature of the FRM. The lower temperature also reduces the loss of semivolatile components of PM mass. Performance of the SES-TEOM was assessed both under controlled laboratory conditions and in a year-long side-by-side field test by Atmospheric Sciences Research Center (ASRC) of the State University of New York at Albany.

To achieve the second goal, a new measurement concept—the Differential TEOM Mass Monitoring System, or Differential TEOM—was developed and tested. In this system, sharing SES components, an electrostatic precipitator (ESP) is inserted between the sample inlet and the TEOM mass sensor, operated at 30°C, but theoretically at ambient temperature. The ESP is regularly cycled on and off to selectively remove particles from the sample stream. The sampled ambient air stream first passes through a size-selective inlet that allows small particles to enter the monitoring system. Mass measurements made with the ESP on (when particles are trapped before reaching the sample filter-mass sensor), are subtracted from those made with the ESP off (when particles are collected on the filtermass sensor) to track gain or loss of semivolatile materials on the filter, providing a more detailed time-series record of PM mass.

The performance of the Differential TEOM was assessed at several research institutions through subcontracts and cooperative agreements:

- University of Duisburg, Germany, which used laboratory-generated aerosols to assess the effect of the SES dryer on particle measurement.

- Clarkson University, which, using a similar approach, assessed the efficiency of the ESP and its effect on particle measurement.
- University at Albany Institute of Materials, which focused on the ESP electrode performance relating to material buildup, wear, and cleaning methods.
- Atmospheric Sciences Research Center of the State University of New York at Albany, which conducted: (1) controlled laboratory aerosol testing using a variety of aerosols; (2) and ambient field measurements with the Differential TEOM, other co-located monitoring systems, and FRM PM samplers.

The Differential TEOM was deployed in Albany and Queens (New York City), as well as Claremont and Rubidoux in California. The devices were shown to have the potential to provide real-time fine particle mass data that can be used to improve the quality of health effect studies and verify the impact of state implementation plans for controlling PM, as well as to reduce monitoring costs.

These projects resulted in two major advances in real-time monitoring of fine particles. These include reducing the moisture content of the sampled ambient air so that the temperature of the device could be reduced from 50°C to 30°C, and developing an innovative approach to account for the loss of semivolatile materials on the filter surface. The devices have the potential to provide highly time resolved and accurate fine particle mass data that can be used to improve health effects studies, verify the impact of state implementation for controlling PM2.5, as well as to reduce monitoring costs.
As follow-on work to the Differential TEOM development, based on use of an ESP, the Filter Dynamics Measurement System (FDMS) was developed using a chilled-filter as a filter-based version of the Differential TEOM monitor. The FDMS is designed for agencies that need a routine monitoring network. The new Series 8500 FDMS has been approved by the Air Resources Board of California for both PM10 and PM2.5 sampling. The outlook for increasing use of this technology appears to be excellent. Sales of the SES and the FDMS (introduced in 2000 and 2002, respectively) are approaching multimillion-dollar levels as anticipated to arise over the product's life cycle. There is growing indication that the FDMS may become an accepted method by EPA for regulating ambient monitoring.

The following is a partial list of additional accomplishments that were achieved through the project:

- Three patents were granted to Rupprecht and Patashnick (R&P), the primary contractor
- More than a dozen documents were created and distributed to share the project results with key industry and government stakeholders
- The results were also shared at several conferences and workshops
- A successful business model was created for R&P

The following realized and potential economic and environmental benefits are attributable to this project:

*Realized Economic Benefit*s

- With earlier NYSERDA support for a carbon-in-ash stack monitor in 1981, R&P has grown from 5 people in 1981to more than a 100 employees in 2004 specializing in developing, manufacturing, and selling particulate mass measurement instruments.
- All manufacturing of the SES and FDMS products is carried out in NYS. As with most private corporations the specific dollars in labor income is proprietary information. However it can be stated that because of the SES and FDMS projects more sustained labor was necessary to meet the volume of production needs for these two commercial products while keeping up with production of other standard products. All of this production is performed currently in our East Greenbush, New York facility. Since production forecasts vary from month to month one cannot earmark the number of production units and support employees for these specific products.
- Approaching multimillion dollars in sales of SES-TEOM and FDMS monitors after 5 years in the market.

Potential Economic Benefits

- The potential economic benefit from these two commercial products can be estimated in multimillions of dollars over the anticipated production life cycle. The labor to support this sales level is commensurate, but the specific relationship cannot be provided.

Realized Environmental and Health Benefits

- The TEOM accurately provides greater time-series resolution of ambient data than the FRM. (non-quantifiable benefit)

Potential Environmental and Health Benefits

- Recent studies have shown that acute exposure to PM2.5 can cause more significant adverse health effects compared to chronic exposure, which underscores the importance of real-time measurement. The real-time measurement provided by the FDMS-TEOM could therefore be extremely valuable in assessing the impact of policies and regulations (should they be developed) on mitigating these exposures.