Southern Fine Particulate Monitoring Project

Third Quarterly Progress Report

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This is the third quarterly progress report of the “Southern Fine Particulate Monitoring Project”, funded by the U.S. Department of Energy’s National Energy Technology Laboratory under DOE Cooperative Agreement No. DE-FC26-00NT40770 to Southern Research Institute (SRI). In this two year project SRI will conduct detailed studies of ambient fine particulate matter in the Birmingham, AL metropolitan area. Project objectives include:

- \$ Augment existing measurements of primary and secondary aerosols at an established urban southeastern monitoring site
- \$ Make a detailed database of near-continuous measurements of the time variation of fine particulate mass, composition, and key properties (including particle size distribution)
- \$ Apply the measurements to source attribution, time/transport properties of fine PM, and implications for management strategies for PM_{2.5}
- \$ Validate and compare key measurement methods used in this study for applicability within other PM_{2.5} research by DOE-FE, EPA, NARSTO, and others.

Summary of Technical Progress

During the third project quarter, the new SRI air monitoring shelter and additional instruments were installed at the site. Details include:

- Installation of Radiance Research M903 Nephelometer
- Installation of SRI air monitoring shelter at North Birmingham Site
- Relocation of instruments from SEARCH shelter to SRI shelter
- Installation of Rupprecht & Patashnick 8400 Sulfate Monitor
- Assembly and initial laboratory testing for particulate sulfate monitor of Harvard design
- Efficiency testing of particle sizing instrument package at SRI lab
- Preparation for the Eastern Supersite July measurement intensive program
- Continued monitoring with TEOM and particle sizing instruments

Plans for Next Quarter

- \$ July measurement intensive with Eastern Supersite program
- \$ Installation of particulate sulfate monitor of Harvard design; onsite comparative measurements with R&P 8400S
- \$ Prepare July data in general format for modeling study
- \$ Continue onsite monitoring with continuous monitoring instruments
- \$ Continue analysis of initial continuous particulate data

Problems and Assessment for Future Progress

Minor computer difficulties caused some data loss for the TEOM, nephelometer, and particle sizing package. The data losses were intermittent and not significant to our collection of data. Preparation for the Eastern Supersite July monitoring intensive prevented the deployment of the Harvard School of Public Health (HSPH) sulfate monitor within the third quarter. The deployment of the HSPH sulfate monitor to the North Birmingham site is planned for August 2001.

Detailed Progress Narrative

During the third project quarter, preparations continued for the arrival and installation of the SRI shelter. The Radiance Research M903 nephelometer and the R&P 8400S sulfate analyzer were deployed and assembled at the North Birmingham station and monitoring was initiated. These activities are described in detail below.

As reported last quarter, it became evident after project initiation that additional shelter space was needed to accommodate all anticipated instruments for the project. As a result, an 8' x 12' shelter was purchased to accommodate current and future instruments for the duration of the project. Infrastructure changes (power, phone lines, building platform, and fencing) were coordinated with Jefferson County Health department and subcontractors. The shelter arrived June 11 and was placed adjacent to the SEARCH shelter in the North Birmingham ambient monitoring station. On June 14 our instrument package was relocated from the SEARCH shelter into the SRI shelter. After the plumbing and inlets were installed, continuous monitoring resumed on June 18. Figure 1 is a photograph of the 8400S and particle sizing instruments after installation in the SRI shelter.

Figure 1: R&P 8400S particulate sulfate monitor and TSI 3320/3496 particle sizing instrument package as deployed inside SRI sampling shelter.

Assembly of instrumentation and Data collection

On April 13 the Radiance Research M903 Nephelometer was installed in the ARA shelter and continuous monitoring began. The PM_{2.5} TEOM, nephelometer and particle sizing package ran near continuously throughout April and May. The TEOM data were flagged at the end of May until mid June due to flow malfunctions. Once the TEOM was relocated, adjustments were made to eliminate the flow problem. At the end of May, the particle size package (TSI models 3320 APS and 3934 SMPS) was moved from the North Birmingham site to the SRI laboratory to complete efficiency experiments using polystyrene latex standards. The particle size package was reinstalled at the monitoring station early July.

Following the arrival of the SRI shelter, the TEOM and nephelometer were relocated and reassembled in the shelter on June 14. Once the shelter was modified for the ambient analyzers, continuous ambient measurements resumed June 18. The Rupprecht & Pataschnick 8400S sulfate analyzer arrived at SRI on June 2. After initial laboratory testing, an R&P representative trained the SRI team on the operation, maintenance and calibrations for the 8400S. The representative then assisted with the installation of the sulfate analyzer at the North Birmingham site on June 19. Ambient sulfate measurements were initiated that evening.

As reported last quarter, we made arrangements to assemble a sulfate monitor on the design of George Allen from the Harvard School of Public Health (HSPH). During the third quarter the parts for the design were ordered and assembled for laboratory testing. The SRI model of the design began initial testing in mid-June after receipt of most of the needed system components. Initial testing concentrated on optimizing the reactor length and materials and on determining the relative response of different reactor configurations and operating temperatures. Following the ARA design changes, stainless steel tubing heated in a tube furnace was used for all reactor configurations. Parallel testing of dual tube/furnace configurations allowed independent variation of tube geometry and temperature effects. Limited side-by-side comparisons of the unit with the new R&P 8400S unit were made before the 8400S was deployed at the site on June 19. After the laboratory tests on the HSPH design unit are completed, a field model will be installed at the North Birmingham site, planned sometime in August 2001. Once the instrument is deployed, a more detailed comparison study can be made for the R&P 8400S and the HSPH sulfate analyzer. Results of these studies will be presented in a future report.

In preparation for the July Eastern Supersite intensive, the TSI particle sizing package was brought from the North Birmingham monitoring station to the SRI laboratory in June for maintenance and efficiency testing. Aerosols of various sized polystyrene latex beads were generated to verify the sizing accuracy and sampling efficiencies of the TSI 3320 APS and 3934 SMPS in the overlapping region of 0.4 – 1.0 μ m particle diameter. The results from these experiments are currently being analyzed and will be presented in a future report. After the lab testing, the devices were configured for the new sampling location and installed in the new SRI shelter in North Birmingham. Calibrations and routine maintenance procedures were performed on the PM_{2.5} TEOM, nephelometer, and 8400S in preparation for the July intensive. After the move into the SRI shelter, these procedures were completed to ensure each instrument was operating to its potential and also to minimize data loss throughout the July study.

Results/ Data analysis

Hourly averages of the continuous particulate measurements are presented on Figures 2 - 6. The data are plotted together for a meaningful comparison between instruments and data sets. The figures contain the $PM_{2.5}$ mass concentrations measured by the TEOM, 8400S sulfate monitor and integrated size fractions measured by the particle sizing devices. Included are total (submicron) mass concentration as derived from the SMPS measurements, and integrated mass concentrations in the 1 - 2.5 and 2.5 - 10 μm size ranges from the APS measurement data. The $PM_{2.5}$ light scattering extinction coefficient as measured by the M903 nephelometer is plotted on the second Y-axis. In addition, hourly average PM_{10} concentration data were obtained from the Jefferson County Health Department as measured by the county TEOM monitor at the site.

Figures 2 and 3 display the variables associated with the measurements in the fine particulate region. The data sets displayed are the $PM_{2.5}$ TEOM, SMPS total concentration, the 1 - 2.5 μm APS fraction and the nephelometer. The figures present the same four variables over the months April and May, respectively. Figures 4 and 5 represent the variables associated with particulate measurements in the coarse size region, including the PM_{10} TEOM, 2.5 – 10 μm APS fraction, and as well as the $PM_{2.5}$ TEOM concentrations for reference. Figures 4 and 5 display the collected data from April and May respectively. Figure 6 compares the data collected in June, including the 8400S sulfate monitor after its installation. During this period the particle sizing instruments were unavailable.

The data in Figures 2 – 6 show a distinct daily pattern, with a tendency for high concentration “spikes” in the morning hours. To depict this trend, the $PM_{2.5}$ TEOM mass concentration hourly averages were averaged with the corresponding hour for each day throughout each month. Figure 7 displays this comparison for each month data has been collected at the North Birmingham site. For all but one of the months studied, the average hourly $PM_{2.5}$ concentration during the workday hours (8AM – 6PM) was relatively constant, and fell with the 17-22 $\mu g/m^3$ range. Overnight values were higher than daytime values for each month; with the maximum hourly concentration typically in the 6 – 7AM period. The amount of additional nighttime concentration varied from month to month, and was highest in April and May.

Figure 2: Hourly averaged fine particle data from the North Birmingham site during the period of April 1 – April 30, 2001.

Figure 3: Hourly averaged fine particle data from the North Birmingham site during the period of May 1 – May 31, 2001.

Figure 4: Hourly averaged fine particle data from the North Birmingham site during the period April 1 – 30, 2001. Also included are PM₁₀ concentrations reported by Jefferson County.

Figure 5: Hourly averaged fine particle data from the North Birmingham site during the period May 1 – 31, 2001. Also included are PM_{10} concentrations reported by Jefferson County

Figure 6: Hourly averaged fine particle data from the North Birmingham site during the period June 1 – 30, 2001. Also included are PM_{10} concentrations reported by Jefferson County

Figure 7: PM_{2.5} TEOM hourly time of day averages for each month of data collected at the North Birmingham site.