

## **Title Page**

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**“Sensor for Individual Burner Control of Coal Firing Rate,  
Fuel-Air Ratio and Coal Fineness Correlation”**

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## **Abstract**

The project's overall objective is to develop a commercially viable dynamic signature based sensing system that is used to infer the flow rate and fineness of pulverized coal. This eighteen month effort will focus on developments required to transfer the measurement system from the laboratory to a field ready prototype system. This objective will be achieved through the completion of the laboratory development of the sensor and data algorithm followed by full scale field tests of a portable measurement system. The sensing system utilizes accelerometers attached externally to coal feeder pipes. Raw data is collected from the impingement of the coal particles as well as the acoustic noise generated from the flow and is transformed into characteristic signatures through proper calibration that are meaningful to the operator.

The laboratory testing will use a portable version of the sensing system to collect signature data from a variety of flow conditions including coal flow rates, flow orientations, and coal particle characteristics. This work will be conducted at the Coal Flow Measurement Laboratory that is sponsored by EPRI and operated by Airflow Sciences. The data will be used to enhance the algorithm and neural network required to perform real time analysis of the non-specific signature data. The system will be installed at two full scale power plants to collect data in a real time operating scenario. These short term duration tests will evaluate the ability of the algorithm to accurately infer coal flow rates and determine if the measurement system can be used effectively in an active control loop for combustion diagnostics and burner balancing.

At the completion of this project, prototype versions of both a portable system and a permanent installation will be available for final packaging and commercialization by one of the team members. Both types of systems will be marketed for conducting combustion diagnostics and balancing of individual flows to pulverized coal burners. The benefits sought through the use of this system include improvements to a plant's feed utilization rate as well as the overall efficiency of a pulverized coal combustion system.

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## Executive Summary

The initial test equipment and data acquisition software was assembled and delivered by Foster-Miller to Airflow Sciences, the test contractor. Airflow Sciences hosted a kickoff meeting at the new flow test facility that they built for the Electric Power Research Institute. Airflow Sciences will test this project's sensors after they complete shakedown of the new facility.

## Test Facilities

The coal flow test facilities are shown in the next four pictures taken at the project kickoff meeting. This facility in Livonia, Michigan, was built and is being operated by Airflow Sciences Corporation for The Electric Power Research Institute, the cost share partner on this project. Figure 1 is the coal and air feed, metering, and measurement system that produces known mass flows of air and pulverized coal to test sections. Figure 2 shows a transparent section of pipe with rotoprobe sampling port in an upflow location following two elbows. Figure 3 is a picture of the CRT system schematic and control loop. Figure 4 is a closer view of this transparent test section showing a swirling flow of silicon dust used in shakedown tests of this new facility.



Figure 1. EPRI & Airflow Sciences Pulverized Coal and Air Supply System



Figure 2. Transparent Coal and Air Test Section

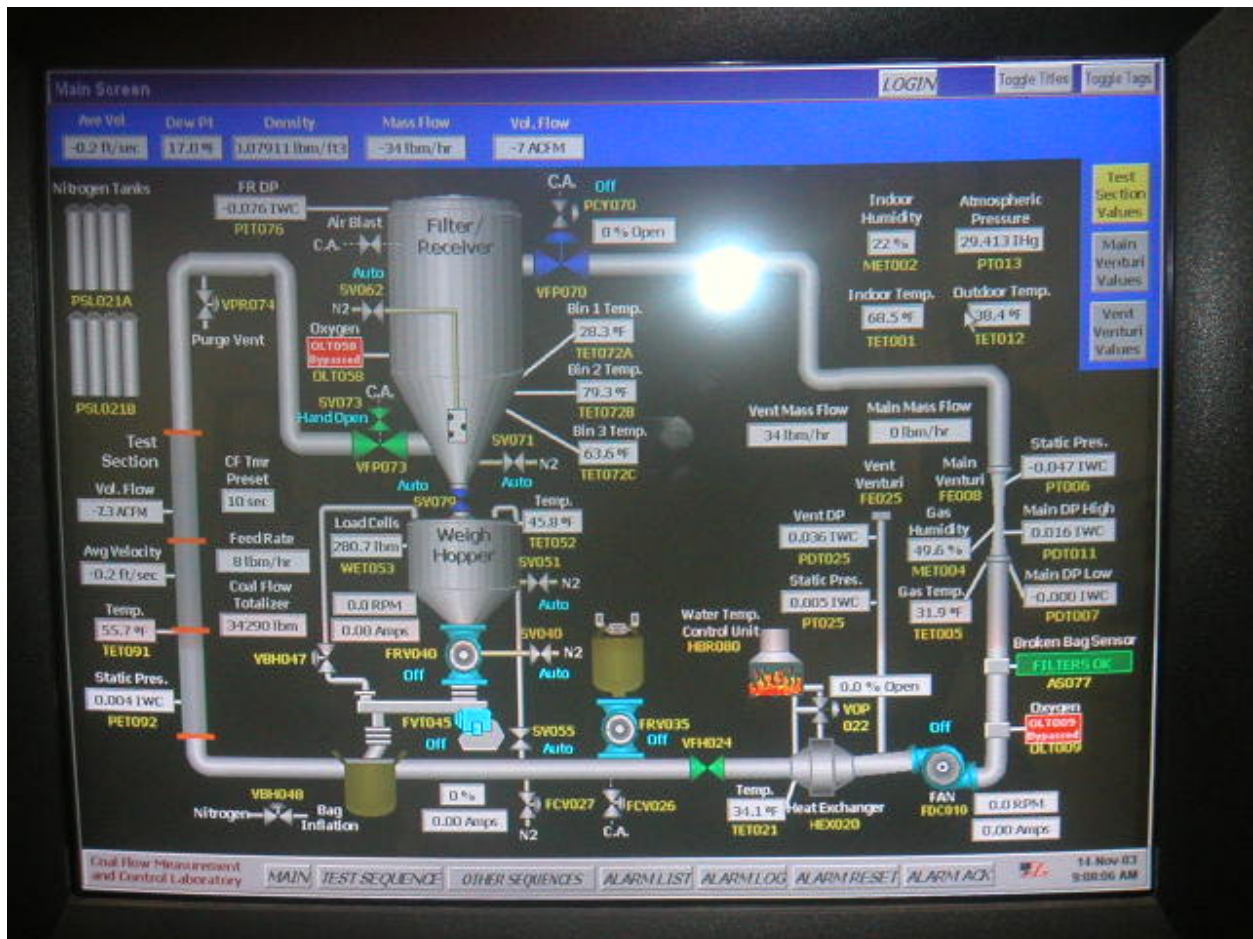


Figure 3. CRT display of Coal Flow Loop schematic, instrumentation and controls



Figure 4. Test Section flowing Silicon and Air  
Offset elbows upstream used to induce swirl flow

### **Phase I Instrument Package by Foster-Miller**

The coal flow measurement test package that will be used in preliminary testing at the Coal Flow Test Loop comprises four main components:

- An Endevco Model 7259 uniaxial accelerometer with high frequency response (its bandwidth very conservatively quoted as 30 kHz) and 10 mV/g sensitivity.
- A Kistler isotronic signal conditioning amplifier.
- A filter/amplifier module featuring a Krohn-Hite 100 kHz low-pass filter and amplifier.
- A transportable computer with a Microstar Data Acquisition Processor board.

The Endevco accelerometer is a particularly fine instrument, with a frequency response that is as high as or higher than almost any transducer one might envision employing in the coal flow measurement application. By low-pass filtering the signal to eliminate behaviors above 100 kHz, and sampling the result at 300 kHz, we will capture the entire dynamics of the accelerometer response. This will permit performing extensive post-test analysis of the data to



examine the influences of sensor response, filtering, and data sampling rate on the information content of the data. This will be used to select instrument configuration variables to be carried forward in further laboratory and plant testing.

Also provided with the test package was a choice of mounts for the accelerometer:

- An insulated mounting stud, to be threaded into a hole in the pipe wall, and
- A magnetic mount to be applied manually.

Our analysis indicates that the magnetic mount should provide very similar accelerometer response to the direct threaded mount, because its size is small compared with the physical wavelength of a pipe wall vibration at the transducer resonant frequency of 90 kHz. If the preliminary testing bears this out, this would provide a means for streamlining later testing both in the lab and in the field: transducers could be applied to the piping at will, without drilling holes in pipes (to which the utilities are understandably resistant, particularly for casual R&D purposes).

### **Test Preparation by Airflow Sciences**

A project kickoff meeting was held at Airflow Sciences on November 14, 2003. The objectives, technical approach, and schedule were reviewed. Foster Miller provided training on the set-up and operation of the acoustic flow meter and data acquisition system. Airflow Sciences reviewed the status of the Coal Flow Loop construction and demonstrated its operation.

The group discussed potential locations and methods of mounting the accelerometer on the piping. A list of test parameters was drafted.

The Coal Flow Loop is still in its commissioning phase, so no actual data has been recorded with the acoustic device. Airflow Sciences has spent some time getting familiarized with the instrumentation as preparation for the test program.

### **Conclusion**

Operation of the new EPRI test facility is a pacing item in the program at this point. The instrumentation package is ready to use once the facility is operating consistently. The facility is being commissioned at no cost to the DoE program so that only the DoE schedule is impacted.