Project Status Report for: September 2000

Project Title: Ultra Low NOx Integrated System for Coal-Fired Power Plants

Project Number: 91890460 **Project Manager:** John Marion

Customer Name: U.S. DOE / Performance Projects **Project Leader:** Charles Maney

GOALS AND OBJECTIVES:

Develop low cost, retrofit NO_x control technologies to address current and anticipated, near term emissions control legislation for existing coal fired utility boilers. Specific goals include:

- Achieve < 0.15 lb/MMBtu NO_x for eastern bituminous coals
- Achieve < 0.10 lb/MMBtu NO_x for western sub-bituminous or lignitic coals
- Achieve economics at least 25% less than SCR-only technology
- Validate NOx control technology through large (15 MWt) pilot scale demonstration
- Evaluate the engineering feasibility and economics for representative plant cases
- Provide input to develop commercial guidelines for specified equipment
- Provide input to develop a commercialization plan for the resultant technologies

WORK PLANNED FROM PREVIOUS REPORT:

Task 2.1 – Test Fuels Characterization

- Determine high temperature volatile matter yield from a 200x400-mesh size cut in the DTFS-1 in nitrogen gas at 2650 ºF and ~ 0.5 sec. residence time
- Determine fuel nitrogen evolution from three size cuts -- 200x400-mesh, 270x400-mesh, and -400 mesh -- in the DTFS-1 in argon gas at 2650 ºF and ~ 0.5 sec. residence time.

Task 2.4 – Advanced Control System Design

- Install and check-out Coal Flow sensors
- Obtain field data set and begin NOx-heat rate and carbon in ash neural net modeling
- Initiate evaluation of the economic benefits of advanced control system

Task 3.1 -- Test Planning & Facility Preparation

Plumbing / Mechanical

- Prepare coal transport and storage systems
- Install ignitor fan ducting
- Repair economizer tubes (as needed)
- Repair BSF refractory
- Seal the 5ft duct
- Insulate the BSF hopper
- Begin coal pulverization
- Service scrubber system

Electrical

- Calibrate BSF O2 sensor
- Calibrate U-tube heat flux probe flow meters
- Install flue gas heat exchanger level control
- Complete all other identified tasks to allow shakedown of DCS system
- Confirm the BSF DCS system operability

Task 8 -- Project Management

- Hold internal project status review meeting; make go / no go decision for Combustion Test Period #1

ACCOMPLISHMENTS FOR REPORTING PERIOD:

Task 2.1 – Test Fuels Characterization

- *Determine high temperature volatile matter yield from a 200x400-mesh size cut in the DTFS-1 in nitrogen gas at 2650 ºF and ~ 0.5 sec. residence time.*
- *Determine fuel nitrogen evolution from three size cuts -- 200x400-mesh, 270x400-mesh, and -400 mesh -- in the DTFS-1 in argon gas at 2650 ºF and ~ 0.5 sec. residence time.*

Three size cuts (200x400-mesh, X_{mean} ~ 55 μm; 270x400-mesh, X_{mean}~ 40 μm; and 100% -400-mesh, X_{mean} ~ 20 μm) were prepared from the above noted medium volatile coal sample. Each size cut has been tested in the Drop Tube Furnace System-1 (DTFS-1) and samples have been sent to the chemistry lab for analysis. Results are expected to be available for the October report.

- *Send out a representative coal sample to an independent lab for petrographic analysis.*

A sample of the medium volatile bituminous test coal was sent to an independent lab for petrographic analysis and results of the same were received by PPL. Previous work at PPL has shown a correlation between the petrographic results, in particular those relating to the vitrinite reflectance, and the measured amount of unburned carbon in the fly ash for a given coal based on Drop Tube Furnace testing (see Figure 1).

As shown in Figure 1, the medium volatile bituminous test coal, with a relatively high vitrinite reflectance, is expected to have significantly worse unburned carbon emissions than similarly tested high volatile bituminous coals. These results are consistent with the expectations that the chosen test fuel is a difficult fuel to burn and will present a challenge with regard to maintaining unburned carbon emissions under staged conditions during the pilot-scale test campaign.

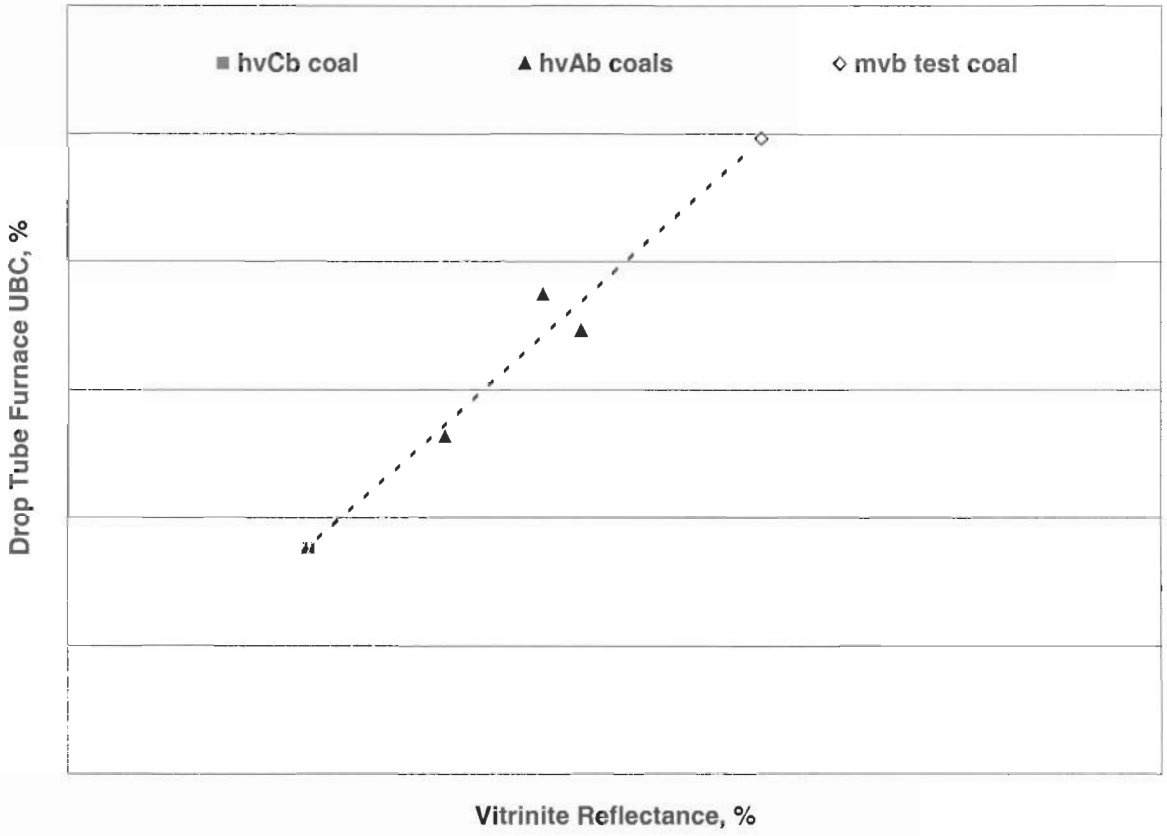

Figure 1 – % UBC in the Fly Ash v. Vitrinite Reflectance

Task 2.4 – Advanced Control System Design

- *Install and checkout Coal Flow sensors.*

The coal flow sensors to be used during the large pilot scale combustion testing were received during the month of September (Figure 2). To date, the sensors have been physically mounted and electrical installation initiated. The vendor (ABB Kent Taylor) will be onsite in the month of October to complete the electrical connections and support commissioning of the test system.

In addition, a proprietary device for control over the coal flow split to each of the 12 coal nozzles on the large pilot test facility was fabricated and installed. Orifice plates and thermocouples were also added to the coal piping to independently measure the air flow to each coal nozzle under clean (no coal) and dirty (with coal) conditions.

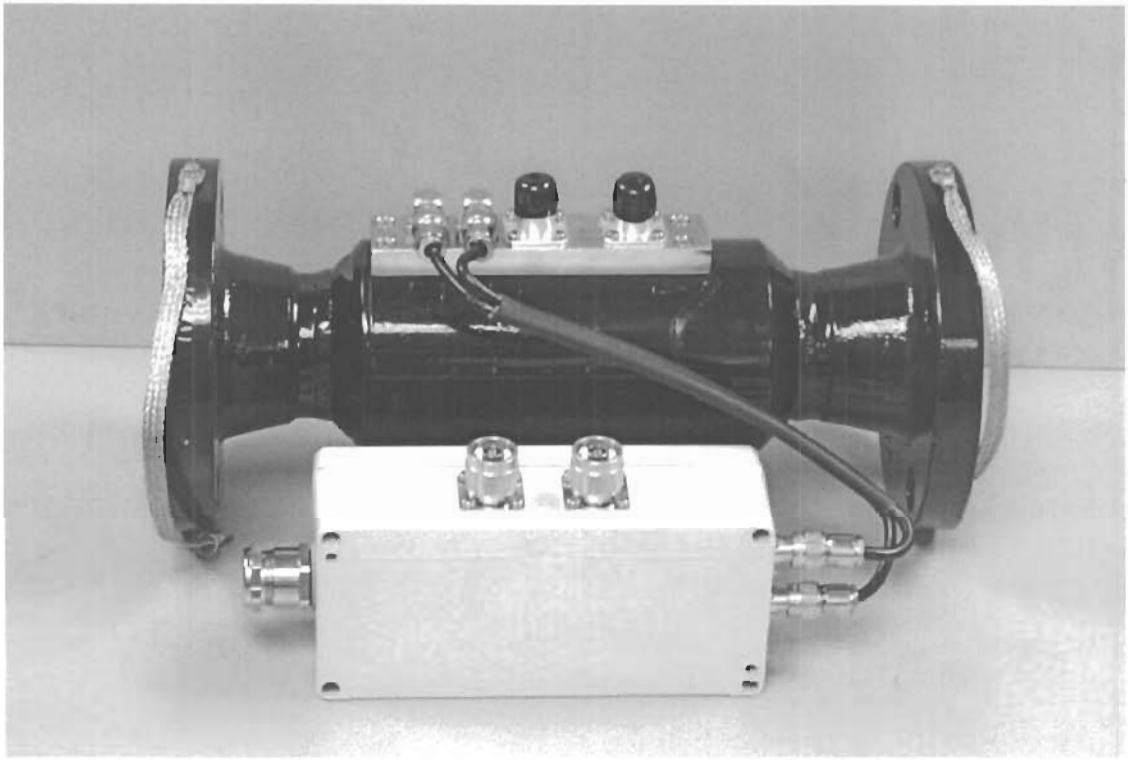

Figure 2 – Large Pilot Test Coal Flow Sensor

- *Obtain field data set and begin NOx-heat rate and carbon in ash neural net modeling.*

A field data set was received for a tangentially fired pulverized coal utility boiler and neural network modeling of NOx, unburned carbon, and heat rate was initiated. The subject boiler is approximately 200 MWe and fires an Eastern bituminous coal through an ALSTOM Power overfire air based low NOx firing system.

The steady state data set contains approximately 45,000 total data records recorded from approximately 200 parameters over a two week test period during which time the unit was operated at a variety of loads and boiler conditions. The test matrix was specifically designed to gather data for neural network modeling to support NOx - heat rate optimization. In addition, a smaller (approximately 20,000 data records) dynamic data set has also been acquired.

- *Initiate evaluation of the economic benefits of advanced control system.*

This task has been delayed to maintain focus on execution of the large pilot scale combustion testing.

Task 3.1 – Test Planning & Facility Preparation

- *The following work will be completed in September for Task 3.1:*

  Plumbing / Mechanical

  - *Prepare coal transport and storage systems*
  - *Begin coal pulverization*

On the mechanical side, the coal transport and storage systems were serviced. Approximately 300 tons of raw coal was received and stored on site in order to support the start of coal pulverization in October. In addition, twenty-four tons of microfine coal, sized to 99% -325 mesh, was received in 243 x 55-gallon drums. To date approximately half of this quantity has been aspirated into a pulverized coal storage silo for use during the combustion testing campaign.

- Install ignitor fan ducting

Ducting from the ignitor fan to the BSF was installed.

- Repair economizer tubes (as needed)

When the flue gas isolation plate work was removed from the simulated economizer section of the BSF it became apparent that the entire section was corroded, and in need of replacing. Instead of patching or replacing a few tubes, it was necessary to replace the entire section. As a result, the existing economizer section was removed in September, and a bid was accepted to complete installation of a new section by October 13 in an effort to meet the planned mid to late October testing date.

A photo of the installation of the new economizer tube section is given in Figure 3.

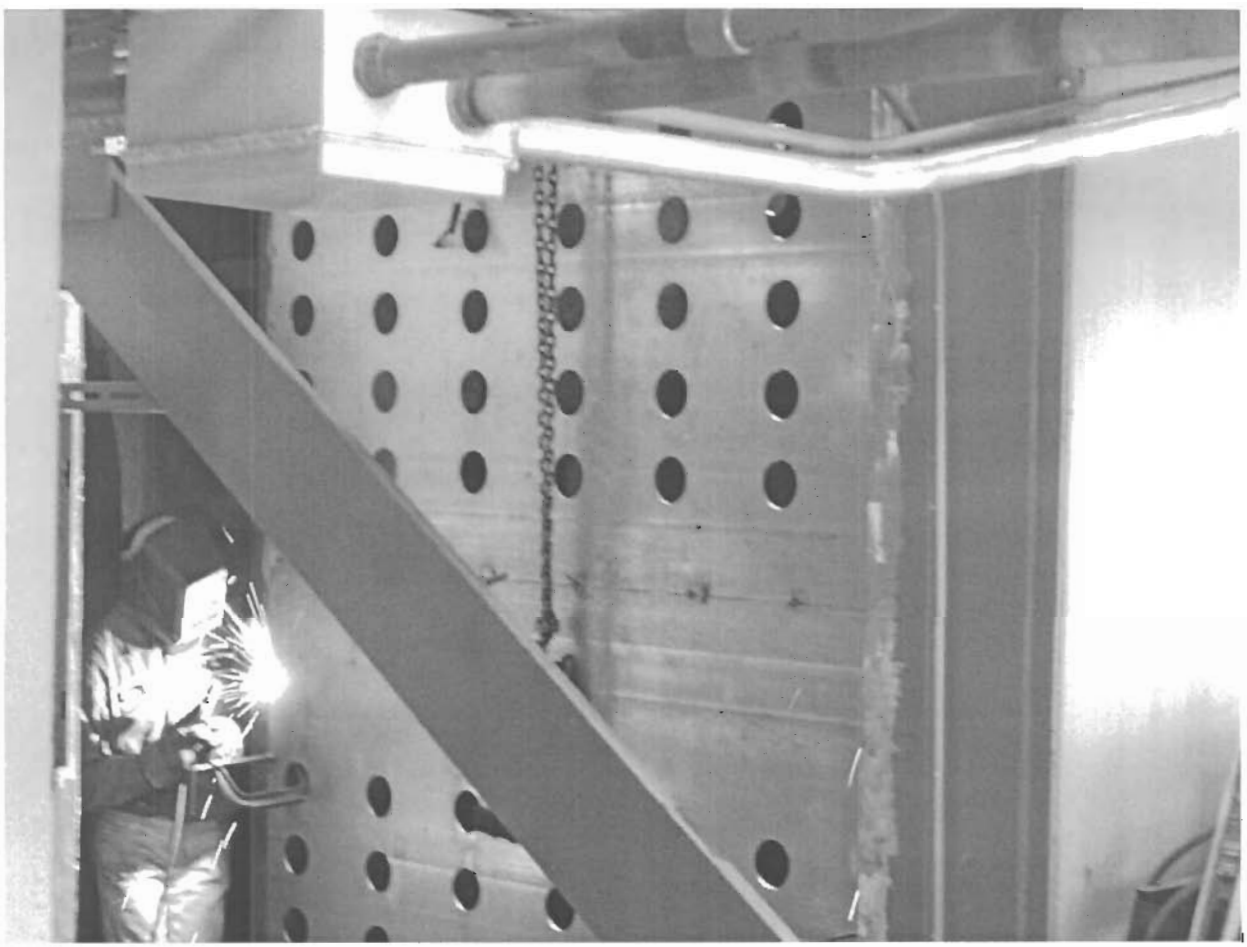

Figure 3 – BSF Economizer Installation

- *Repair BSF refractory*
- *Seal the 5ft duct*
- *Insulate the BSF hopper*
- *Service scrubber system*

All repairs were made to the BSF refractory and the 5ft duct was sealed to prevent infiltration of tramp air from facilities sharing the flue gas ductwork. The BSF ash hopper and lid were studded and insulated. The scrubber system was evaluated and most of the repairs have been completed.

Figures 4 and 5 were taken inside the BSF before the facility was sealed for combustion testing. Figure 4 is a view from the bottom of the facility looking up at the North (right) wall and the facility roof. The main windbox and SOFA compartments can be seen in the corners, while some of the in-furnace sampling ports can be seen on the walls. Some of the repairs to the BSF refractory can also be seen in Figure 4.

The U-tube heat exchangers, used to measure lateral convective flue gas energy distribution at the entry to the facility backpass, can be seen in Figure 5, which was taken looking over the nose of the BSF looking into the simulated convective pass.

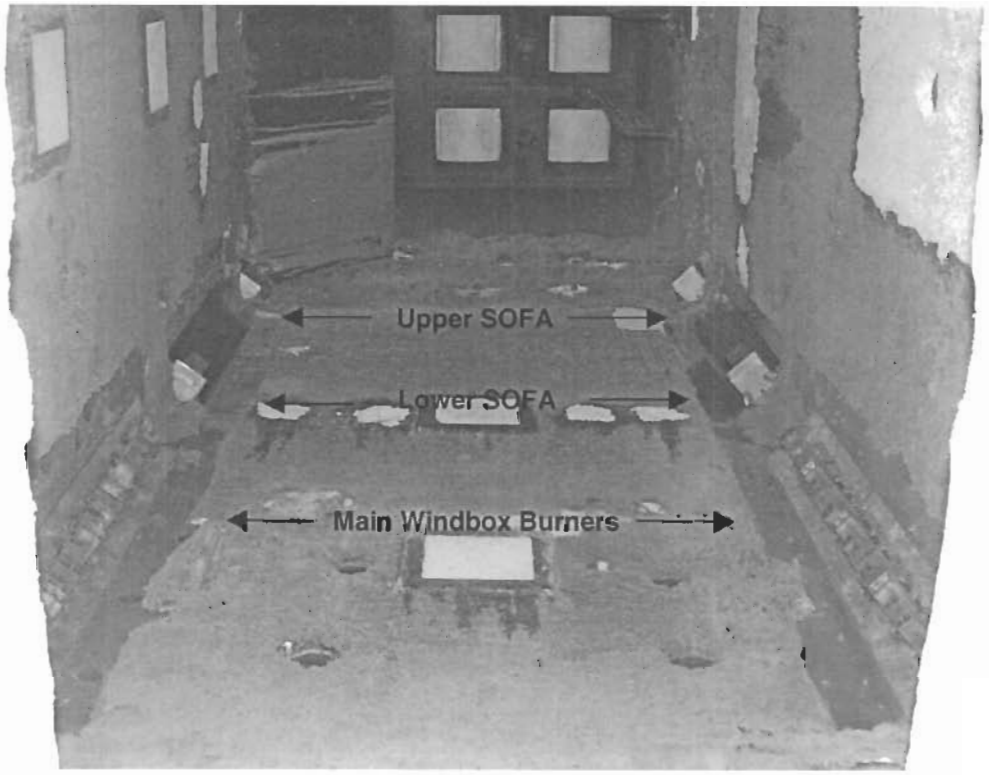

Figure 4 – Inside View of North (Right) Wall of the BSF

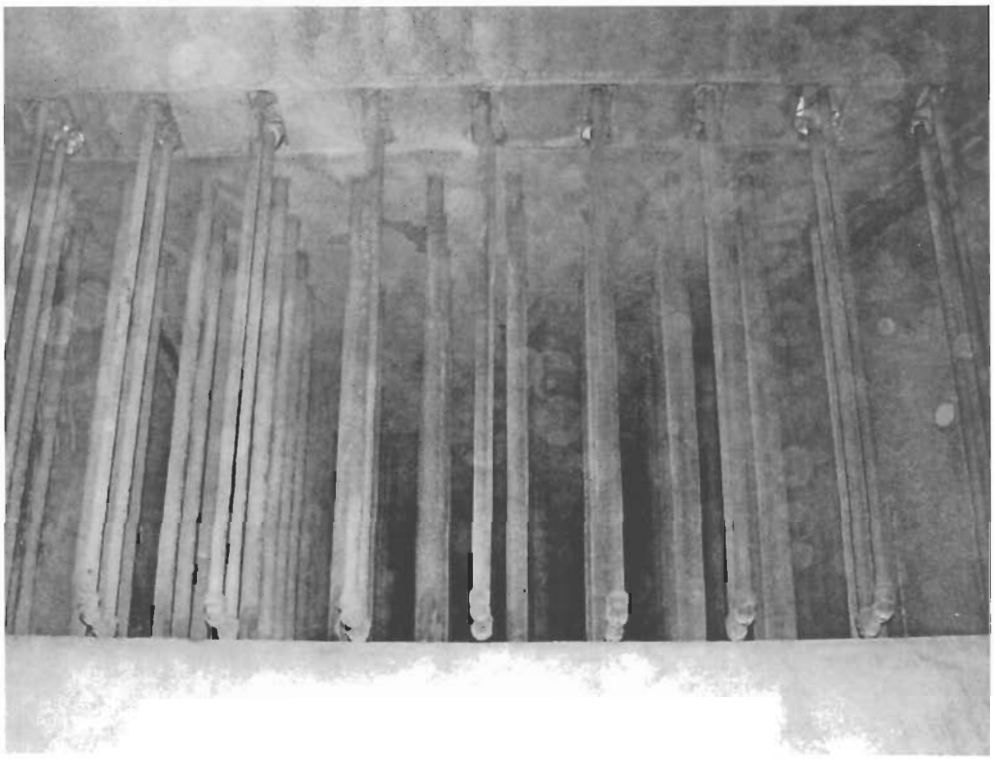

Figure 5 – View of U-tube Heat Exchangers at Entry to the Convective Pass of the BSF

Electrical

- *Calibrate BSF O2 sensor,*
- *Calibrate U-tube heat flux probe flow meters,*
- *Install flue gas heat exchanger level control,*
- *Complete all other identified tasks to allow shakedown of DCS system,*
- *Confirm the BSF DCS system operability,*

On the electrical side, the U-tube heat flux probe flow meters were calibrated and installed, and installation of the flue gas heat exchanger level control was completed. In addition, the control components for the sootblowers were replaced and tested and the warm-up burner and direct fired air heater (Maxon) burner ignitors were refurbished.

All remaining facility sensors have been calibrated and, where possible, components of the DCS system have been tested in preparation for shakedown testing of the facility and related subsystems during the week of October 16.

Task 8 – Project Management

- *Hold internal project status review meeting; make go / no go decision for Combustion Test Period #1 (Note: this activity may be delayed into September to correspond with the postponement of the first combustion test period).*

The internal project review meeting was held on September 12 and the decision was made to proceed with the first combustion test period as planned.

As noted previously, the focus of the first combustion test campaign will be to evaluate the performance of enhancements to the TFS 2000R low NOx firing system as applied to a difficult to burn, medium volatile bituminous coal to determine the limit of NOx reduction for low reactivity coals. To be evaluated parameters include:

1 Transport Air & Fuel Flow Balance
2 MBZ Stoichiometry
3 Subcompartmentalization
4 SOFA Velocity
5 SOFA Elevation
6 Transport Air to Fuel Ratio
7 SNCR
8 Staged Residence Time
9 Coal Fineness
10 Excess O2 / Final Stoichiometry
11 Boiler Load

Currently it is planned to perform the first combustion test period during the either week of October 22 or 29, 2000, pending the outcome of planned shakedown testing during the week of October 16, 2000.

WORK PLANNED FOR NEXT REPORTING PERIOD:

Task 2.1 – Test Fuels Characterization

- Complete the detailed characterization of the medium volatile test fuel.

Task 2.4 – Advanced Control System Design

- Complete installation of testing of coal flow meters
- Install and test advanced flame scanners

Task 3.1 – Test Planning & Facility Preparation

- Complete all facility preparation tasks, including coal pulverization, to permit combustion testing in the BSF to occur during the month of October.

Task 3.3 – Combustion Testing and Cleanup

- Complete the first combustion test period in the BSF.