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# Coal Reburning for Cyclone Boiler $NO_x$ Control Demonstration

## Quarterly Report No. 8

## January, February, and March, 1992

DOE Agreement No.: DE-FC22-90PC89659

B&W CRD Agreement No.: CRD-1229

**DISCLAIMER**



Prepared by:

Babcock & Wilcox
a McDermott Company

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# 1.0 EXECUTIVE SUMMARY

The Coal Reburning for Cyclone Boiler $NO_x$ Control Demonstration project (DOE Agreement No. DE-FC22-90PC89659) progress for January, February, and March 1992 is identified in this eighth quarterly report and pertains to the on-going activities of Phase IIB - Construction and Start-up and Phase III - Operation and Disposition. The project involves retrofitting/testing the reburning technology at Wisconsin Power & Light's 100 MWe Nelson Dewey Unit #2 in Cassville, Wisconsin to determine the commercial applicability of this technology to reduce $NO_x$ emission levels.

Under Phase IIB - Fabrication, Installation, Start-Up and Shakedown, shakedown activities resulted in a number of modifications to the reburn system to improve operation. These included installation of a guillotine damper in the primary air duct between the primary air fan and pulverizer to prevent coal dust migration into the primary air system during a pulverizer trip sequence. Three air cannons were added to the coal silo discharge to prevent pulverizer shut down due to loss of coal feed when wet coal hangs up in the silo. Finally, a modification was made to the existing airheater plenum to access hotter air as the primary air source for the pulverizer. The system now operates reliably in the manual control mode as performance testing is carried out. Additional tuning of the control system is necessary prior to operation in the full automatic mode.

Phase III - Operation and Disposition activities emphasized parametric optimization testing to characterize the reburn system and provide information for use in the automatic control system. A total of 50 test conditions where characterized by B&W/WP&L personnel. Acurex has arrived on site and is preparing a Continuous Emissions Monitor as well as setting up for precipitator inlet and outlet dust loadings. Those conditions of greatest significance will be retested with Acurex on site to verify results.

Results as of the end of the quarter indicates that the $NO_x$ reduction goals of the project (50% reduction) are being met or exceeded. No major adverse impacts to overall boiler operation have been identified to date except for unburned carbon on ash which preliminarily appears to have increased. Degree of increase and impact on overall efficiency will be determined after all sample analyses are complete, including Acurex measurements yet to be performed.

## 2.0 INTRODUCTION

As per the Cooperative Agreement No. DE-FC22-90PC89659 dated April 2, 1990, the following quarterly report has been prepared for the Coal Reburning for Cyclone Boiler $NO_x$ Control Demonstration Project. The period covered by this quarterly report is January through March 1992. This report represents the eighth three-month period of the project.

The subject of this report identifies progress during the quarter for Phase IIB - Construction and Start-up and Phase III - Operation and Disposition.

Phase IIB construction activities are complete. As part of Start-Up, a number of modifications to the reburn system have been carried out during the quarter. These are documented in this quarterly report. Under Phase III - Operation and Disposition, extensive parametric optimization testing has been performed. The test conditions explored during this quarter are summarized in this report.

## 3.0 PROJECT DESCRIPTION

### 3.1 PROJECT OVERVIEW

The current energy policy of the United States includes the expanded use of coal in utility and industrial applications. However, the increased use of coal must not conflict with environmental goals and thus requires development of cost-effective technology to control the pollutants resulting from coal combustion. Of major concern is the problem of oxides of nitrogen in the Northeastern United States and portions of Canada.

The reduction of $NO_x$ and $SO_2$ emissions from fossil fired boilers has been a major objective of the DOE, the EPA, and all of the major boiler and burner manufacturers for many years. This is demonstrated by a number of concurrent efforts that have been and are being conducted to develop lower $NO_x$ burners for pulverized coal applications. Reduction of $NO_x$ emissions via combustion modifications presents many options for most coal-fired utility boilers, but not for the 26,000 MWe of cyclone boiler generating capacity. The operating characteristics of a cyclone boiler do not lend themselves to delayed mixing or staged combustion which are the two major low-$NO_x$ alternatives for coal-fired boilers. The reburning process is the best known technically and economically feasible low-$NO_x$ alternative via combustion modification for cyclone boilers. Back-end $NO_x$ removal systems, such as Selective Catalytic Reduction (SCR) technology offers promise of $NO_x$ control for cyclones but at high capital and operating costs.

B&W engineering studies followed by pilot-scale testing has developed/confirmed the potential of utilizing gas, oil or coal reburning as a viable $NO_x$ reduction technology. To date, two U.S. sponsored programs promote natural gas/oil as a reburning fuel because it was believed that gas/oil will provide significantly higher combustion efficiency than using coal at the reburn zone. Although B&W has shown that gas/oil reburning will play a role in reducing $NO_x$ emissions from cyclone boilers, B&W coal reburning research has also shown that coal as a reburning fuel performs nearly as well as gas/oil without deleterious effects on combustion efficiency. This means that boilers using reburning for $NO_x$ control can maintain 100% coal usage instead of switching to 20% gas/oil for reburning. As a result of the B&W performed coal reburning research, the technology has advanced to the point which it is now ready for demonstration on a commercial scale.

The coal reburning equipment is to be installed in the furnace of the boiler, downstream of the cyclone burners. The equipment consists of coal reburning burners and overfire air ports and associated control systems. Outside of the boiler, a coal pulverizer will be installed as well as coal piping to the reburn burners. The reburn system will inject 20% to 30% of the coal feed directly into the boiler, bypassing the cyclones and reducing cyclone load to 80% to 70% of normal. An increase in ash particulate, which is substantially removed in the cyclones will occur within the boiler, increasing ash collection requirements at the precipitator. The majority of plant's precipitators should be capable of handling the increased ash loading.

The coal reburning for cyclone boiler $NO_x$ control system consists of commercially available equipment, such as a pulverizer, burners, a pneumatic coal transfer system, overfire air ports and a control system, all of which are well proven, reliable equipment that can be readily installed. Extensive power plant modification is not required to implement the reburn technology which will increase the potential for commercialization.

The coal reburning technology will be a desirable alternative for cyclone boiler $NO_x$ control by offering:

- A technically and economically feasible low-$NO_x$ alternative for cyclone boilers to achieve a 50% to 60% $NO_x$ reduction where one currently does not exist.

- Significant reductions in emission-levels of oxides of nitrogen achieved at a low capital cost and very low operating costs (compared to the SCR technology).

- No need for a supplemental fuel. Reburn will be carried out using the present boiler fuel which is coal.

- A system that will maintain boiler reliability, operability, and steam production performance after retrofit.

The coal reburning for cyclone boiler $NO_x$ control demonstration project will be carried out at the Nelson Dewey Station Unit No. 2 of Wisconsin Power and Light in Cassville, Wisconsin. Unit No. 2 is small enough (100 MWe) to limit project costs, but large enough to assure that the reburning technology can be successfully applied to the cyclone-fired utility boiler population. As part of the project, B&W's 6 million Btu/hr SBS pilot facility will be utilized to duplicate the operating practices of WP&L's Nelson Dewey Unit #2. The coal which is fired at Nelson Dewey will be fired in the SBS cyclone and will also be utilized as the reburn fuel. During the field test phase at Nelson Dewey Station, emission and performance data will be acquired and analyzed before and after the coal reburn conversion to determine the $NO_x$ reduction and impact on boiler performance. Combining these combustion test results with physical and numerical flow modeling of the technology as applied to Dewey Unit #2, will provide a comprehensive test program not only for successful application of WP&L's Unit, but for the cyclone population as a whole.

## 3.2 OBJECTIVES

It is the objective of the Coal Reburning for Cyclone Boiler $NO_x$ Control Project to fully establish that the coal reburning clean coal technology offers cost-effective alternatives to cyclone operating electric utilities for overall oxides of nitrogen control. The project will evaluate the applicability of the reburning technology for reducing $NO_x$ emissions in full scale cyclone-fired boilers which use coal as a primary fuel. The performance goals while burning coal are:

- Greater than 50 percent reduction in $NO_x$ emissions, as referenced to the uncontrolled (baseline) conditions at full load.
- No serious impact on cyclone combustor operation, boiler efficiency or boiler fireside performance (corrosion and deposition), or boiler ash removal system performance.

## 3.3 BACKGROUND

Boilers equipped with cyclone furnaces have many important advantages over conventional pulverized-coal-fired boilers, such as the capability to burn a range of low-grade fuels and simpler, more economical coal preparation and feeding system. However, cyclone units utilize extremely fast mixing between the coal and combustion air and, therefore, inherently promote well mixed combustion and elevated $NO_x$ emissions. It is estimated that 21% of the total $NO_x$ emissions from coal fired power stations in the U.S. come from cyclone fired boilers. The majority of the existing 26,000 MW of cyclone boiler generating capacity will probably continue to operate for the next 20 years. Thus, cyclone boilers are prime candidates for mandated reduction in the emissions of oxides of nitrogen. Currently there is no proven retrofit low $NO_x$ combustion control technology for cyclone boilers. The previous attempts to apply staged combustion have not been successful due to operational problems (cyclone corrosion).

The use of Selected Catalytic Reduction (SCR) technology offers promise of controlling $NO_x$ from these units, but at high capital and operating cost. Reburning is therefore a promising alternative $NO_x$ reduction approach for cyclone equipped units at a more reasonable operating cost.

Reburning is a process by which $NO_x$ produced in the cyclone is reduced (decomposed to molecular nitrogen) in the main furnace by injection of a secondary fuel. The secondary (or reburning) fuel creates an oxygen deficient (reducing) region which accomplishes decomposition of the $NO_x$. Since reburning can be applied while the cyclone operates under its normal oxidizing condition, it effects on cyclone performance can be minimized. Sometime ago, B&W performed a feasibility analysis for applying reburn technology to utility cyclone-fired boilers, and the results were very encouraging. Based on the results of the feasibility analysis, pilot scale evaluation of cyclone reburn was undertaken. B&W's 6 million Btu/hr Small Boiler Simulator (SBS) was utilized to perform the pilot-scale cyclone reburning tests. Three different reburning fuels, natural gas, #6 oil, and pulverized coal were utilized. The results indicate that 50 to 80% $NO_x$ reduction from baseline conditions can be achieved while utilizing 15 to 25% reburning fuel. Additionally, the tests revealed that the potential side effects of the technology (e.g., changes in combustion efficiency, deposition, and corrosion) would not adversely affect boiler performance.

### 3.4 HOST SITE BOILER

The host site is Wisconsin Power and Light's Nelson Dewey Unit No. 2. The following is a summary of pertinent information.

- UTILITY: Wisconsin Power & Light
- UNIT ID: Nelson Dewey Unit No. 2
- LOCATION: County Trunk VV, Cassville, Grant County, Wisconsin 53806
- NAME PLATE RATE: 100 MWe
- TYPE: Steam Turbine
- PRIMARY FUEL: Bituminous Coal
- OPERATION DATE: October 1962 - Unit No. 2
- BOILER ID: B&W RB-369
- BOILER CAPACITY: Nominal 110 MWe
- BOILER GENERAL CONDITION: Good
- BOILER MANUFACTURER: Babcock & Wilcox
- BOILER TYPE: Cyclone Fired RB Boiler
- REBURNING DEMONSTRATION FUEL: Indiana (Lamar) Bituminous Coal, Medium Sulfur (1.87%)
- BURNERS: Three B&W Vortex-Type Burners, Single-wall fired
- PARTICULATE CONTROL: Research Cottrell ESP
- BOILER AVAILABILITY: 90% Availability

### 3.5 PROJECT TEAM

The Coal Reburning Project organization consists of the U.S. Department of Energy, The Babcock & Wilcox Company, Wisconsin Power & Light and the Electric Power Research Institute (EPRI). Team members from B&W represent the Research and Development Division (R&DD), the Fossil Power Division (FPD), The Energy Service Division (ESD) and the Contract Research Division (CRD).

Major subcontractors are Acurex and Sargent & Lundy. Acurex has been designated to perform continuous emissions monitoring activities as well as various analytical requirements during the testing program. Sargent & Lundy will perform those activities pertaining to the coal handling system supplying coal to the coal pulverizer in addition to various structural steel and electrical design specification activities.

A summary of the overall project organization is as follows:

<u>Project Organization</u>

- Department of Energy - 50% funding co-sponsor
- Babcock & Wilcox - Prime contractor and project manager
- Wisconsin Power & Light - Host site utility and funding co-sponsor
- EPRI - Technical advisor and funding co-sponsor
- State of Illinois - funding co-sponsor
- Utility funding co-sponsors
- Acurex Corporation - testing subcontractor
- Sargent & Lundy - architect engineer subcontractor

### 3.6 PROJECT PHASES

The coal reburn project, which is a $10.65 million project, consists of four separate phases which are planned to occur over a 43 month period. These are:

- Phase I - Design and Permitting

  During this phase, collection of baseline emissions and performance data, along with performance of general boiler system assessment, will be completed at WP&L's Nelson Dewey Unit #2 prior to the coal reburning retrofit. The coal reburn system will be designed based upon B&W's pilot-scale combustion tests, physical and numerical flow modeling tests, and experience/knowledge of full-scale burner/OFA port/control system retrofits.

- Phase IIA - Long Lead-Time Item Procurement

  In order to meet the construction schedule, long lead-time equipment will be ordered during the design and permitting phase. To facilitate the funding of this procurement activity, Phase II is divided into two parts, Phase IIA and Phase IIB.

- Phase IIB - Construction and Start-up

  The coal reburn system will be fabricated and installed at Nelson Dewey No. 2 and started up to provide a fully operational system prior to testing.

- Phase III - Operation and Disposition

  Parametric/optimization and performance tests will assess the potential of the technology from both the resulting emission reductions and boiler performance capability aspects. Both full load and reduced load operations will be evaluated for the cyclone reburn technology. Finally, readiness for commercialization will be determined from both a technical and economic viewpoint.

# 4.0 PROJECT STATUS

The time period covered by this Quarterly Report No. 8 is January, February, and March 1992. Progress will be discussed on a task basis for each of the Phase IIB and Phase III activities.

## 4.1 PHASE I - DESIGN AND PERMITTING

All major activities in Phase I are complete.

## 4.2 PHASE IIA - LONG LEAD-TIME ITEM PROCUREMENT

The long lead-time item procurement process is complete.

## 4.3 PHASE IIB - FABRICATION, INSTALLATION, START-UP AND SHAKEDOWN

Activities in Phase IIB include Management and Reporting Procurement and Fabrication of the Reburning System and Installation Start-Up and Shakedown of the equipment. A description of activities expected in each task is provided, followed by reported activity.

### 4.3.1 Task 1 - Management and Reporting

Monthly reports covering the time period of January, February, and March, 1992, were completed and issued to DOE/PETC on schedule.

### 4.3.2 Task 2 - Procurement and Fabrication of the Reburning System

This task consists of procurement of materials necessary for fabrication of systems and subsequent release for fabrication of those items.

Activities under this task are complete.

### 4.3.3 Task 3 - Installation and Start-Up/Shakedown

The activities of this task are installation of the reburn system and subsequent start-up and shakedown or elimination of equipment operating problems.

System installation activities were complete as of early November, 1991. Additional activity incurred as a result of process revisions and requirements for better operation are also covered under this task.

As explained in Quarterly Report No. 7 for October through December, 1991, fine coal deposits in the expansion joint at the discharge of the PA fan caused damage to the joint due to smoldering of the coal. It was decided to take advantage of a short boiler outage at the end of December to repair the joint and have the damper manufacturer inspect the existing isolation damper at the PA fan inlet and modify it to achieve the specified leakage rates. This work was completed during the period December 18 through December 23, 1991, making the system ready for operation during the week of January 6, 1992.

On January 6, 1992, the B&W crew returned to the plant site to restart the reburn system. WP&L personnel had started the inert and clear system on January 3, 1992 and observed no steam/moisture leaking past the PA isolation damper indicating that the damper manufacturer's modifications seem to improve the situation. Seal welding on the primary air fan to minimize leakage was completed.

The following day, the reburn system was started with the intent of operating all day and then performing a deliberate trip in order to assess the benefits of the above mentioned modifications. The major results observed throughout reburn operation for the day are as follows:

- Adjusting burner impellers improved the CO emission levels. Adjustments included moving the side, upper and lower quadrants to improve flame stability.
- All burner spin vanes were moved to various positions with no apparent change in operation or emission results.
- The Secondary superheater thermocouple for the middle tube alarmed intermittently at a load of 90 MW. Temperature ranged between 909°F and 914°F, close to the 911°F alarm level but not significantly in excess of it.
- A total 45-47% $NO_x$ reduction (best to this point) was observed.
- Gas recirculation to the reburn burners was initiated at a very low rate with no apparent change in reburn system operation or emissions.

On January 8, the ductwork between the PA fan and pulverizer was checked to identify if the modification work had minimized the coal migration back toward the PA fan during a mill trip condition. Unfortunately, coal was found to be accumulating on the duct floor. It was determined that a guillotine damper at the pulverizer inlet was needed to prevent the coal migration. Additional items in need of modification included cutting back the inerting steam flow and shutting down the hydraulically driven rotating classifier during a trip condition.

On January 9, after cleaning the coal out of the ductwork, the plan was to start reburning and operate all day. Shutdown was to occur in the normal mode (i.e., no trip condition) to evaluate whether problems exist during a normal shutdown. After a short operating period the reburn system had to be shut down due to the observation of sparklers coming from a hole in a second expansion joint (directly above the PA fan). It was decided to shut down the reburn system until all the modifications to prevent migration of coal into the primary air system could be completed.

These modifications consisted of five items based on a review of system design by B&W.

(1) The addition of a guillotine damper between the fan and pulverizer.

(2) Installation of a metallic expansion joint downstream of the fan.

(3) Installation of an upgraded fabric and pillow block on the joint at the inlet of the fan.

(4) Shutoff of the rotating classifier during a mill trip sequence (prevents agitation of dust in the mill during trip).

(5) Reduction in inerting steam flow (reducing the tendency to blow dust back into the PA duct during inert and clear sequences).

An additional reburn system modification to the discharge of the coal silo was carried out during this period. The modification consisted of adding three air cannons. These were added to the cone of the silo to break up blockages of coal before a loss of feed to the pulverizer can initiate a trip sequence. The air cannons are automatically controlled by a coal detector at the inlet to the gravimetric feeder. Lack of coal in the feed line initiates cannon operation.

The guillotine damper to allow isolation of the pulverizer from the primary air system arrived on site and was installed at the pulverizer inlet. Appropriate control system modifications were carried out to activate damper operation. All other modifications were completed as well by February 10, 1992, when reburn system operation was resumed. A mill trip sequence was carried out to check the effectiveness of the new guillotine damper. The system operated as desired and no evidence of coal migration to the primary air system was noted.

The reburn system was subsequently operated on a daily basis in the manual control mode through March 5, 1992 at various boiler conditions. Operation was carried out particularly at 110 MW and 82 MW (100% and 75% of boiler full load) to characterize system performance. Also, information necessary to implement full automatic operation was collected. Operation at 55 MW (50% of full load) experienced burner instability problems.

On March 6, 1992 WP&L shut down Nelson Dewey Unit No. 2 for a planned spring maintenance outage which lasted until March 23, 1992. During the outage, a few minor reburn system changes were made. These were:

(1) An air heater outlet plenum revision to get higher air temperatures at the pulverizer inlet. This consisted of an additional duct added inside the existing plenum to draw hotter air in the center of the plenum directly into the reburn primary air system.

(2) Relocation of the flame scanner cooling air source to prevent contamination with inerting steam during a pulverizer trip condition. Under a pulverizer trip condition, inerting steam has been observed to flow back through the primary air ductwork to the point where the scanner cooling air take off is located. Subsequently, condensation causes problems with the scanners' signals, leading to additional trip sequences. Relocation of the air source will eliminate this problem which apparently occurs even with the guillotine damper in operation.

During operation after March 23, 1992, at 70 to 110 MW, reburn burner flame stability was very good and $NO_x$ reductions at or exceeding project goals were achieved. At loads below 70 MW, flame stability suffered and required higher air flows to operate well. The higher air flows and associated higher reburn zone stoichiometries compromised $NO_x$ reduction. At 50% load, $NO_x$ reductions of 25% to 30% were achieved with good burner stability.

Higher reductions were achieved at this low load but flame stability was below that considered good operating practice. B&W is considering minor modifications to the reburn burners' impellers and spin vanes to enhance low load stability and improve $NO_x$ reductions.

As of April 1, 1992, the coal reburning system is operating reliably in the manual control mode as performance testing is conducted. Problems with coal migration into the primary air system appear to be eliminated by the guillotine damper. Mill trip sequences as a result of coal blockages in the silo with wet coal have been effectively mitigated by the use of the air cannons. Pulverizer primary air inlet temperature has been increased by the internal air plenum modification.

Pulverizer operation has been excellent with no significant problems to date. The burners exhibit good flame stability at 100% and 75% load while achieving $NO_x$ reductions in excess of project goals. At 55% load, burner stability is adequate but at lesser $NO_x$ reduction levels. Flame scanners at the burners are operating very well, providing a reliable indication of flame characteristics.

Regarding operation of the boiler, itself, the introduction of reburn technology has, to this point, shown no significant adverse impact. The unit is capable of pre-retrofit steam generation capability. Metals temperatures in the secondary and reheat superheaters, originally thought to be potential limits on boiler capacity with reburn in operation have shown no significant problems (temperatures are maintained within alarm limits). Along these same lines, upgraded attemporator spray capacity, added during construction as insurance, has not proven to be necessary.

In general, start-up activities are essentially complete and the equipment is now operating as expected. The system has demonstrated the integrity to allow performance testing and technology evaluation to proceed. Only operation in the full-automatic mode remains to be demonstrated before long-term testing can be initiated.

## 4.4 PHASE III: OPERATION AND DISPOSITION

Activities in Phase III include Management and Reporting Parametric Optimization Testing, Long-Term Performance Testing, Performance, Economic and Application Studies, the Final Report and Disposition. A description of activities expected in each task is provided followed by reported activity.

### 4.4.1 TASK 1 - PROJECT MANAGEMENT AND REPORT

The purpose of this task is to account for the management and reporting activities and cost monitoring that apply to all tasks collectively in Phase III.

This task provides for overall project coordination, reporting, and supervision for Phase III of the Coal Reburning project. Additionally, this task includes a single point contact within B&W for DOE on the Coal Reburning project for reporting and resolution of technical and cost issues.

Monthly reports for the period of January, February, and March, 1992 were completed and issued to DOE/PETC.

The final version of the Environmental Monitoring Plan for Phase III testing was provided to DOE/PETC in January, 1992.

### 4.4.2 TASK 2 - PARAMETRIC OPTIMIZATION TESTS OF THE REBURN SYSTEM

Activities of this task will emphasize exploration of the capabilities of the coal reburning system. Various operating parameters will be explored to determine impact on operation. Ultimately the optimized conditions developed in this task will be utilized in Task 3 Long Term Performance Testing.

Progress for the quarter was extensive with data collected for a total of 50 separate test conditions. Parameters such as coal rate to the reburn burners, reburn zone stoichiometry and level of flue gas recirculation (GR) to the burners were varied over a number of load conditions. The tests are summarized in Table 4-1.

Results as of the end of the quarter indicate that the goals of the project with respect to $NO_x$ reductions (50% reduction) are being achieved or exceeded. Carbon Monoxide in the flue gas is generally in the range of 80 to 100 ppm at full load under optimized conditions; not significantly different from baseline conditions. Information on unburned carbon (UBC) in the precipitator ash will be available once sample analyses are completed. It is expected that some increase in UBC will be observed.

To more effectively utilize Acurex time on site and minimize cost overruns, parametric optimization data collection during the quarter was performed solely by B&W/WP&L personnel. The objective was to understand the performance characteristics of the technology and to develop operating information for use with the automatic control system. Once B&W is comfortable with system operation, parametric testing at meaningful conditions will be carried out with Acurex involvement. This includes verification of gaseous emissions levels and measurement of precipitator inlet and outlet ash loadings as well as ash resistivity. In this manner, changes with unremarkable consequences need not be rerun with Acurex on site.

Accordingly Acurex arrived on site at the end of March to set up for the testing defined in their scope. In addition, set up of a Continuous Emissions Monitoring System (CEMS) was also under way as of the end of the quarter.

### 4.4.3 Task 3 - Long Term Performance Testing

During this task the boiler will be operated in a load demand following mode with reburn in operation as would be the normal practice at Nelson Dewey. The reburn system will be set up based on the optimized parameters determined in Task 2 and under automatic control. The objectives of this task are to determine long term reburn system operability and impact on boiler operation in a load varying mode.

The only activity under this task is the set up of the Continuous Emissions Monitoring system by Acurex. This system will also be used to verify gaseous emissions during the final parametric optimization and performance testing as outlined previously in Task 2.

#### 4.4.4 Task 4 - Performance, Economic, and Application Studies

No activity is scheduled to occur as yet.

#### 4.4.5 Task 5 - Final Report

No activity is scheduled to occur as yet.

#### 4.4.6 Task 6 - Disposition

No activity is scheduled to occur as yet.

TABLE 4-1

| SUMMARY OF PARAMETRIC OPTIMIZATION TESTING CONDITIONS | | | | |
|---|---|---|---|---|
| *Date* | *Test #* | *Time* | *MW* | *Condition* |
| 2/12 | 1 | 1730 | 110 | 14 T/HR, REBURN ON W/GAS RECIRC. TO BURNERS |
| 2/13 | 2 | 0900 | 110 | BASELINE,W/NO GAS RECIRC. FAN |
| 2/13 | 3 | 1709 | 110 | 13.7 T/HR REBURN,W/NO GAS RECIRC. TO BURNER (ESP INLET DUST LOADING) |
| 2/13 | 4 | 1920 | 110 | 13.7 T/HR REBURN,W/GAS RECIRC. TO BURNERS (ESP INLET DUST LOADING) |
| 2/14 | 5 | 1030 | 110 | 14.1 T/HR REBURN,W/NO GAS RECIRC. TO EURNERS |
| 2/14 | 6 | 1600 | 111 | 14 T/HR REBURN,W/NO GAS RECIRC. TO BURNERS (IN-FURNACE PROBING) |
| 2/15 | 7 | 1000 | 110 | 14 T/HR REBURN,NO GAS RECIRC. TO BURNERS |
| 2/15 | 8 | 1140 | 110 | 14 T/HR REBURN,W/REBURN TO BURNERS |
| 2/15 | 9 | 1515 | 110 | 14 T/HR REBURN,W/NO GAS RECIRC. TO BURNERS |
| 2/15 | 10 | 1610 | 110 | 14 T/HR REBURN,W/GAS RECIRC. TO BURNERS |
| 2/16 | 11 | 0800 | 81 | BASELINE W/NO REBURNING |
| 2/16 | 12 | 1215 | 82 | 11.5 T/HR REBURN,W/GAS RECIRC. TO BURNERS |
| 2/16 | 13 | 1500 | 83 | 11.5 T/HR REBURN,W/GAS RECIRC. TO BURNERS (ESP IN/OUT DUST LOADING - 140 ROT CLASSIFIER SPEED) |
| 2/16 | 14 | 1805 | 82 | 11.5 T/HR REBURN,W/GAS RECIRC. TO BURNERS (ESP IN/OUT DUST LOADING - 160 ROT CLASSIFIER SPEED) |
| 2/17 | 15 | 1040 | 110 | 14.5 T/HR REBURN,W/NO GAS RECIRC. TO BURNERS |
| 2/17 | 16 | 1145 | 110 | 14.5 T/HR REBURN,W/GAS RECIRC. TO BURNERS |
| 2/17 | 17 | 1740 | 110 | 14.5 T/HR REBURN,W/GAS RECIRC. TO BURNERS (ESP IN/OUT DUST LOADING) |
| 2/18 | 18 | 0945 | 110 | 14 T/HR REBURN,W/GAS RECIRC. TO BURNERS (IN-FURNACE PROBING) |
| 2/18 | 19 | 1020 | 110 | 14 T/HR REBURN,W/GAS RECIRC. TO BURNERS (IN-FURNACE PROBING) |
| 2/18 | 20 | 1715 | 110 | 14 T/HR REBURN,W/GAS RECIRC. TO BURNERS (IN-FURNACE PROBING) |
| 2/19 | 21 | 0850 | 110 | BASELINE W/NO REBURN,NO GAS RECIRC. FAN |
| 2/19 | 22 | 1115 | 110 | 14 T/HR REBURN,W/NO GAS RECIRC. FAN (ESP IN/OUT DUST LOADING) |
| 2/19 | 23 | 1830 | 110 | 14 T/HR REBURN,W/GAS RECIRC. TO BURNERS (ESP IN/OUT DUST LOADING) |
| 2/20 | 24 | 0950 | 110 | 14 T/HR REBURN,W/NO GAS RECIRC. FAN |
| 2/20 | 25 | 1450 | 110 | 16 T/HR REBURN,W/NO GAS RECIRC. FAN (ESP IN/OUT DUST LOADING) |
| 2/21 | 26 | 1020 | 110 | 12.2 T/HR REBURN,W/GAS RECIRC. TO BURNERS (ESP IN/OUT DUST LOADING) |
| 2/21 | 27 | 1620 | 110 | 11.5 T/HR REBURN,W/GAS RECIRC. TO BURNERS (ESP IN/OUT DUST LOADING) |

**SUMMARY OF PARAMETRIC OPTIMIZATION TESTING CONDITIONS**

| *Date* | *Test #* | *Time* | *MW* | *Condition* |
|---|---|---|---|---|
| 2/22 | 28 | 1050 | 82 | 11.5 T/HR REBURN,W/GAS RECIRC. TO BURNERS (ESP IN/OUT DUST LOADING) |
| 2/22 | 29 | 1830 | 82 | 11.5 T/HR REBURN,W/GAS RECIRC. TO BURNERS (IN-FURNACE PROBING) |
| 2/23 | 30 | 0840 | 55 | BASELINE W/NO REBURN |
| 2/24 | 31 | 1230 | 110 | 16 T/HR REBURN,W/NO GAS RECIRC. FAN (IN-FURNACE PROBING) |
| 2/24 | 32 | 1500 | 110 | 16 T/HR REBURN,W/GAS RECIRC. TO BURNERS (ESP IN DUST LOADING/IN-FURN PROBING) |
| 2/24 | 33 | 2150 | 82 | BASELINE W/NO REBURN |
| 2/24 | 34 | 2240 | 82 | 11.5 T/HR REBURN,W/GAS RECIRC. TO BURNERS |
| 2/25 | 35 | 0105 | 70 | 11.5 T/HR REBURN,W/GAS RECIRC. TO BURNERS |
| 2/25 | 36 | 1150 | 101 | 13 T/HR REBURN W/DECKER COAL |
| 2/25 | 37 | 2100 | 70 | BASELINE W/NO REBURN |
| 2/25 | 38 | 2130 | 70 | 11.5 T/HR REBURN,W/NO GAS RECIRC. TO BURNERS |
| 2/25 | 39 | 2400 | 70 | 11.5 T/HR REBURN,W/GAS RECIRC. TO BURNERS (ESP IN DUST LOADING/IN-FURN PROBING) |
| 2/26 | 40 | 0545 | 55 | 8.4 T/HR REBURN,W/NO GAS RECIRC. TO BURNERS |
| 2/26 | 41 | 0615 | 55 | 8.4 T/HR REBURN,W/NO GAS RECIRC. TO BURNERS |
| 2/27 | 42 | 1230 | 71 | 11 T/HR REBURN,W/NO GAS RECIRC. TO BURNERS (ESP IN DUST LOADING/IN-FURN PROBING) |
| 2/27 | 43 | 0530 | 55 | 8 T/HR REBURN,W/MIN GAS RECIRC. TO BURNERS (ESP INLET DUST LOADING) |
| 2/28 | 44 | 2000 | 65 | 10 T/HR REBURN,W/MIN GAS RECIRC. TO BURNERS |
| 3/2 | 45 | 1550 | 86 | 12 T/HR REBURN,W/GAS RECIRC. TO BURNERS (ESP IN DUST LOADING/ECON OUT PT BY PT) |
| 3/3 | 46 | 1020 | 82 | 11.5 T/HR REBURN,W/NO GAS RECIRC. TO BURNERS (ESP IN DUST LOADING/ECON OUT PT BY PT) |
| 3/3 | 47 | 1245 | 83 | 11.5 T/HR REBURN,W/GAS RECIRC. TO BURNERS (ESP IN DUST LOADING/IN-FURN PROB/ECON PT) |
| 3/3 | 48 | 2035 | 57 | 7.9 T/HR REBURN,W/MIN GAS RECIRC. TO BURNER (ESP IN DUST LOADING/IN-FURN PROB/ECON PT) |
| 3/4 | 49 | 1100 | 82 | 12.8 T/HR REBURN,W/GAS RECIRC. TO BURNERS (ESP IN DUST LOADING/ECON OUT PT BY PT) |
| 3/5 | 50 | 1030 | 110 | 14 T/HR REBURN, W/GAS RECIRC. TO BURNER (ESP IN DUST LOADING/ECON PT - 150 RPM) |

## 5.0 PLANNED ACTIVITIES

Planned activities for the next quarter, April, May, and June 1992 will focus on completion of the parametric optimization tests with Acurex on site to verify and document reburn performance. Additionally, the reburn system will be operated in the full-automatic mode after tuning of the reburn burner fuel controls which interact with the existing control system for the cyclones.

The fourth Advisory Committee Meeting and plant tour will be held during the next quarter.

## 6.0 SUMMARY

The coal reburning for cyclone boiler $NO_x$ control demonstration project's eighth Quarterly Report covering the time period of January, February, and March 1992 involves the work performed in Phase IIB - Fabrication, Construction, Start-Up, and Shakedown, and Phase III - Operation and Disposition.

Phase IIB - Fabrication, Installation and Start-Up/Shakedown activities witnessed modifications to the reburn system to improve operation. A guillotine damper was added at the pulverizer inlet for better isolation. Air cannons were added to the silo to facilitate flow of wet coal and the primary air source was modified to gain access to a hotter air supply. The control system is in the process of being tuned but is not yet ready for full automatic operation. Performance testing is being carried out in the manual control mode.

Phase III activities has escalated extensively. A total of 50 test conditions have been explored to characterize the system. Acurex has arrived on site to begin performance of their testing scope. In addition, Acurex is setting up a Continuous Emissions Monitor to verify gaseous emissions.

Thus far, the reburn technology has met or exceeded the $NO_x$ reduction goals (50%) of the project. Unburned carbon on ash appears to have increased on a preliminary basis but analyses of samples must be completed before the effect can be quantified. Otherwise, no significant adverse impact to boiler operation is evident as of the end of the quarter.

## 7.0 REPORT DISTRIBUTION LIST

(1) Mr. Ronald W. Corbett
PETC Technical Project Manager
Mail Stop 920-L
U.S. Department of Energy/PETC
P.O. Box 10940
Pittsburgh, PA 15236

(2) Mr. David L. Hunter
Contracting Specialist
AD-21, Mail Stop 921-165
U.S. Department of Energy/PETC
P.O. Box 10940
Pittsburgh, PA 15236

(3) Dr. C. Lowell Miller
Associate Deputy Assistant
Secretary for Clean Coal Technology
FE-22, 3E-042, Forrestal
U.S. Department of Energy
Washington, DC 20585

(4) Office of Patent Counsel
U.S. Department of Energy
9800 South Cass Avenue
Argonne, Il 60439

(5) Department of Energy (1)
Office of Technology Transfer
Mail Stop 58-MEZZ
Pittsburgh Energy Technology Center
P.O. Box 10940
Pittsburgh, PA 15236

(6) Dr. S. N. Roger Rao
Burns and Roe Technical Group
Manager
P.O.Box 18288
Pittsburgh, PA 15236

(7) Mr. George Lynch
HQ DOE Program Manager
SE-221, 3E-042, Forrestal
U.S. Department of Energy
Washington, DC 20585

# END

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