Coal Reburning for Cyclone
Boiler NOx Control Demonstration

Quarterly Report No. 9
April, May, and June, 1992

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1.0 EXECUTIVE SUMMARY

The Coal Reburning for Cyclone Boiler NO\textsubscript{x} Control Demonstration project (DOE Agreement No. DE-FC22-90PC89659) progress for April, May, and June 1992 is identified in this ninth 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\textsubscript{x} emission levels.

Under Phase IIB - Fabrication, Installation, Start-Up and Shakedown, additional tuning of the control system was completed and operation in the full automatic mode was carried out in May, 1992 in anticipation of long-term testing. Phase IIB was complete at that point.

Phase III - Operation and Disposition activities emphasized completion of parametric optimization testing to characterize the reburn system. As of May 21, 1992, long-term testing with WP&L operating the reburn system in full automatic in a load following mode, was under way.

Preliminary results indicate that NO\textsubscript{x} emissions reductions of 50% and greater have been achieved as a result of reburn operation at full load. Furnace exit gas temperature (FEGT) has been reduced by 150°F as a result of reburn operation, again at full load. This effect is less significant at lower loads. No adverse impact on slagging and fouling has been observed and precipitator performance remains essentially unchanged. Unburned carbon on ash losses appear to have increased during reburn operation. Prelimarily at full load, boiler thermal efficiency is reduced because of higher unburned carbon by between 0.3% and 0.7% in the worst case. Efficiency losses appear to be higher at low loads. This effect will be further quantified with long-term performance test data to be taken in September, 1992.
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\textsubscript{x} Control Demonstration Project. The period covered by this quarterly report is April through June 1992. This report represents the ninth 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.

Under Phase IIB - Construction and Start-Up tuning of the controls was completed and operation in the automatic mode initiated. For Phase III - Operation and Disposition, extensive parametric optimization testing was completed. Data analysis has been ongoing and preliminary results are discussed in this report. Additionally, long-term testing was initiated and activities under that task are discussed.
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\textsubscript{x} and SO\textsubscript{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\textsubscript{x} burners for pulverized coal applications. Reduction of NO\textsubscript{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\textsubscript{x} alternatives for coal-fired boilers. The reburning process is the best known technically and economically feasible low-NO\textsubscript{x} alternative via combustion modification for cyclone boilers. Back-end NO\textsubscript{x} removal systems, such as Selective Catalytic Reduction (SCR) technology offers promise of NO\textsubscript{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\textsubscript{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\textsubscript{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\textsubscript{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\textsubscript{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\textsubscript{x} control by offering:

- A technically and economically feasible low-NO\textsubscript{x} alternative for cyclone boilers to achieve a 50% to 60% NO\textsubscript{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\textsubscript{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\textsubscript{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.

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3.2 OBJECTIVES

It is the objective of the Coal Reburning for Cyclone Boiler NO\textsubscript{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\textsubscript{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\textsubscript{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\textsubscript{x} emissions. It is estimated that 21% of the total NO\textsubscript{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\textsubscript{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\textsubscript{x} from these units, but at high capital and operating cost. Reburning is therefore a promising alternative NO\textsubscript{x} reduction approach for cyclone equipped units at a more reasonable operating cost.

Reburning is a process by which NO\textsubscript{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\textsubscript{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% NOx 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


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:

Project Organization

- 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. 9 is April, May and June 1992. Progress will be discussed on a task basis for 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 April, May, and June 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.

In general, start-up activities were essentially complete as of Quarterly Report No. 8 and the equipment operated as expected during the quarter. The system has demonstrated the integrity to allow performance testing and technology evaluation to continue. Operation in the full-automatic mode, the only activity remaining to be completed, as of Quarterly Report No. 8, was demonstrated in early May, 1992.
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 April, May, and June, 1992 were completed and issued to DOE/PETC.

4.4.2 Task 2 - Parametric Optimization Tests of the Reburn System

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

Progress for the quarter was extensive with data collected for additional separate test conditions with Acurex Environmental on site to collect and verify emissions data. 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. Parametric testing was completed on May 20, 1992.

4.4.2.1 PRELIMINARY RESULTS AT NELSON DEWEY UNIT NO. 2

The focus of this demonstration project's testing program was to determine the maximum NOx reduction capabilities without adversely impacting plant performance, operation, or maintenance. In particular, the prototype evaluations were designed to confirm and expand upon the results of the SBS pilot test programs performed as part of Phase I activities.
Test Plan Variables

Numerous variables are associated with the reburn system and a day-to-day test matrix was set up to proceed from one parameter to another during parametric optimization testing. The test variables included in the matrix along with the range tested are:

1. Reburn burner stoichiometry (≈0.35 to 0.70)
2. Percent of heat input through the reburn system (≈25 to 35%)
3. Reburn zone stoichiometry (0.85 to 0.95)
4. Fineness of pulverized coal to the burners (75% ≤ 200 mesh to 96% < 200 mesh)
5. Burner spin vane and impeller adjustments
6. Overfire air port spin vane/sliding disk adjustments
7. Boiler load (40 MW to 110 MW)
8. Economizer outlet O₂% (2 to 4%)
9. Gas recirculation rates to the reburn burners (0 to 4%)

Information collected to evaluate performance of the technology is as follows:

1. Impact on NOₓ reduction by the itemized test variables
2. Furnace temperature and heat absorption profiles
3. Unburned combustibles loss
4. Boiler thermal efficiency
5. Corrosion potential
6. Slagging and fouling
7. Electrostatic precipitator operation
8. Operations experience

During parametric optimization testing, a total of approximately 90 test conditions were investigated while using the Lamar coal. Sample and data analyses are under way but are not complete as of this writing. Preliminary results are presented here.

NOₓ Emissions

NOₓ emissions during operation of the reburning system are reduced by 35 to 60% from baseline test levels (NOₓ levels without reburn, same day, same load) over the range of operating conditions evaluated.

Figure 4.1 represents NOₓ emissions in parts per million (ppm), corrected to 3.0% O₂, as a function of reburn zone stoichiometry, all at full load (110 MW). As can be seen in the Figure, NOₓ is reduced from 609 ppm down to 233 ppm over the range of 1.15 to 0.83 in reburn zone stoichiometry. Reductions 50% or greater are achieved below a stoichiometry of approximately 0.92. During these tests at full load, Cyclone stoichiometry is maintained as close to 1.1 (10% excess air) as possible to minimize potential Cyclone operating concerns.
Figure 4.2 presents the preliminary results for NO\textsubscript{x} emission levels as a function of load (110 MW to 40 MW). These data were collected during performance testing operation in the fully automatic control mode. Reductions in NO\textsubscript{x} of greater than 50% are achieved from 110 MW to approximately 70 MW (64% of full load). Below 70 MW, NO\textsubscript{x} reductions varied between 35 to 50%, because of the operating conditions required to maintain reburning stability.

The automatic control system has been tuned to maximize NO\textsubscript{x} reduction while avoiding potential for operating problems which would result due to air/fuel flow upsets. High carbon monoxide (CO) or unburned carbon emission levels can result if air/fuel imbalances occur during operation. To avoid such problems, a combustion air safety margin is designed into the automatic control system in order to accommodate the day to day boiler operation.

Finally, it should be noted the reburn system is operated down to a unit load of 40 MW in the automatic mode. NO\textsubscript{x} emission levels are about 324 ppm (corrected to 3% O\textsubscript{2}) at the low load but an exact percent reduction is unclear since baseline NO\textsubscript{x} emissions at this low load were never measured. Additionally, work is continuing in order to improve the NO\textsubscript{x} reduction at the lower loads via reducing cooling air flows to idle Cyclones.

Furnace Exit Gas Temperature

FEGT has changed from baseline to reburning operation. At full load with reburn in operation, a reduction in FEGT is observed. The difference between baseline FEGT and reburn values vary between approximately 50 and 150°F. This effect becomes less significant at lower loads.

The rational for this effect is under examination via mathematical modeling studies. This effect is reproducible and consistent with reburn in operation. Whether or not it can be expected in other Cyclone units remains to be determined via ongoing analyses and potentially may not be ascertained until future Cyclone reburn retrofits confirm the phenomenon.

Unburned Combustibles Loss

Preliminary analyses indicate that there is an impact on UBC loss in the precipitator ash. Baseline measures of carbon in the ash ranged from 9% at 4% excess O\textsubscript{2} to 18% at 2% excess O\textsubscript{2} at full load. With reburn in operation, UBC levels range from about 13 to 22%. However, due to the typically low baseline ash loading and the inherent increase in ash loading due to Cyclone coal reburning, the boiler efficiency loss due to UBC has been increased. Quantifying this effect has not, as yet, been completed since data variability from day to day under similar operating conditions has occurred.
Particulate loadings at the precipitator inlet and carbon content of the collected ash are being reviewed to develop a correlation. Worst case impact on boiler efficiency will be discussed below.

The reburn process does not appear to have a major adverse impact on CO generation under optimum operating conditions. Flue gas CO concentrations are generally less than 100 ppm with reburn in operation, not significantly different than baseline levels.

**Boiler Thermal Efficiency**

Preliminary analyses indicate that boiler thermal efficiency with reburn in operation is adversely impacted by UBC loss in the ash. An efficiency loss of approximately 0.5 to 0.7% due to reburn operation UBC loss has been determined at full load conditions at different reburn coal fineness and percentage heat input. Overall, at full load, boiler efficiency during baseline testing averaged about 88.2%. With reburn in operation, boiler efficiency averaged between 87.5 to 88.1%. These efficiencies are presently being reviewed to assure that no other parameters have changed to mask the effects of reburning operation.

At lower loads, an efficiency loss of approximately 0.8 to 1.5% has been determined on a preliminary basis.

**Corrosion Potential**

As part of the project's commitment to investigate possible corrosion problems (as a result of the reducing atmosphere in the areas of the burners), ultrasonic thickness testing of the furnace wall tubes was conducted prior to reburn system start-up. Readings were taken at five elevations on each of the four walls of the furnace for a total of approximately 1800 measurements. Results of the testing indicated the furnace walls have experienced negligible wall thinning since original start-up in 1961. None of the inspected tubes were below B&W wall thickness guidelines for required repair. In September/October 1992, this testing will be repeated to determine if a corrosion problem exists with reburn system operation.

To further evaluate the corrosion potential and possible solutions, two bi-metallic (carbon steel with a stainless cladding) furnace wall throat openings were installed to monitor the affects of the reducing atmosphere at the reburn burner throat region on two of the four burners. The other two burner throat regions were made of standard carbon steel tubes. Impact of the reducing atmosphere, if any, on the two materials will be established. Additionally, thicker tube wall samples have been placed at various locations within the lower furnace region to access simulated higher tube wall temperatures on corrosion rate.
As a possible indication of corrosion potential, measurements of \( \text{H}_2\text{S} \) concentration at the walls of the furnace in the reburn zone have been made during testing. No significant levels of \( \text{H}_2\text{S} \) have been detected thus far.

**Slagging and Fouling**

Minimal changes in slagging and fouling characteristics were expected as a result of reburn operation. However, WP&L has indicated that the unit now appears cleaner in the convection pass areas, based on a recent outage and inspection, than was previously the case. Since FEGT has decreased, no additional major slagging problems have been encountered. Due to the higher dust loading conditions with reburning, sootblowing cycles were monitored, but no increase in frequency or capacity has yet been required.

**Precipitator Performance**

Precipitator particulate collection performance has apparently not degraded due to reburn operation. Additionally, under normal circumstances, opacity improves slightly. Actual inlet and outlet dust loadings, as well as ash resistivity data, are not yet available. This information will be used to quantify precipitator performance with the reburn system in operation. Based on observations to date, no significant adverse impact is expected to be seen in the data.

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.

This activity was initiated on May 21, 1992. Wisconsin Power & Light operated the system in the full automatic mode in a load following manner. The Acurex Continuous Emissions Monitoring System provides emissions data during long-term operation.

Smooth transition from non-reburn to reburn operation has been WP&L's experience thus far. This observation, in conjunction with no additional problems with precipitator performance, slagging/fouling, and FEGT, make the reburn system an acceptable system to date.

Figure 4.3, developed from the data acquisition system in the control room, illustrates the effect of reburn operation on \( \text{NO}_x \) and \( \text{CO} \) emissions versus boiler load capability. As can be seen in the
Figure, boiler load was increased to full load at about 7:15 am and remained there for reburn testing, initiated at about 9:45 am. When the reburn system was started, no interruption of unit generating capacity was encountered. Emissions of NO\textsubscript{X} fell from the 600 ppm level down to the 260 ppm range for a total NO\textsubscript{X} reduction of about 57%. During the same time frame, CO emissions remained relatively constant, below 100 ppm.

4.4.4 Task 4 - Performance, Economic, and Application Studies

Data reduction and analysis continued with preliminary results, as discussed under 4.4.2 - Parametric Optimization Tests, becoming available.

4.4.5 Task 5 - Final Report

The general format of the final report was drafted. Data analysis and reduction continues as information for the report is assembled.

4.4.6 Task 6 - Disposition

No activity is scheduled to occur as yet.
5.0 PLANNED ACTIVITIES

Planned activities for the next quarter, July, August, and September 1992 will focus on continuation of the long-term testing to verify reburn performance in the full-automatic mode. Preparations will be made to begin the final series of performance tests to complete long-term testing.

The possibility of performing Hazardous Air Pollutant testing will be investigated through preparation of a specification and collection of bid prices as well as determination of funding availability to perform the work. Both the U.S. Department of Energy and EPRI have requested this testing.
6.0 SUMMARY

The coal reburning for cyclone boiler NO\textsubscript{x} control demonstration project's ninth Quarterly Report covering the time period of April, May, and June 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 tuning of the control system to allow operation in the full automatic mode.

Phase III activities experienced completion of parametric optimization testing. As of May 21, 1992 long-term testing was under way with WP&L operating the reburn system in automatic in a load following manner.

Preliminary results indicate that NO\textsubscript{x} emissions reductions of 50% and greater have been achieved as a result of reburn operation at full load. Furnace exit gas temperature (FEGT) has been reduced by 150°F as a result of reburn operation, again at full load. This effect is less significant at lower loads. No adverse impact on slagging and fouling has been observed and precipitator performance remains essentially unchanged. Unburned carbon on ash losses appear to have increased during reburn operation. Preliminarily at full load, boiler thermal efficiency is reduced by between 0.3% and 0.7% in the worst case. Efficiency losses appear to be higher at low loads. This effect will be further quantified with long-term performance test data to be taken in September, 1992.
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