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# Coal Reburning for Cyclone Boiler NOx Control Demonstration

## Quarterly Report No. 7

## October, November, and December 1991

DOE Agreement No.: DE-FC22-90PC89659

B&W CRD Agreement No.: CRD-1229

### DISCLAIMER



Prepared by:

Babcock & Wilcox
a McDermott Company

## Table of Contents

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# 1.0 EXECUTIVE SUMMARY

The Coal Reburning for Cyclone Boiler NOx Control Demonstration project (DOE Agreement No. DE-FC22-90PC89659) progress for October, November, and December 1991 is identified in this seventh quarterly report and pertains to the on-going activities of Phase I - Design and Permitting, Phase IIA - Long Lead-Time Item Procurement, 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 NOx emission levels.

Phase I - Design and Permitting and Phase IIA - Long Lead-Time Procurement activities are essentially complete.

Under Phase IIB - Fabrication, Installation, Start-Up and Shakedown Project Management activities included approval by DOE to move into Phase III testing activities. DOE/PETC personnel visited the Nelson Dewey plant on December 5 and 6 to review construction and observe initial system operation.

Azco Hennes, the mechanical/structural contractor completed construction work and demobilized the site in early November. The boiler was restarted by the end of October as planned. Construction work completed during the quarter included pressure part modifications at the burner and overfire air port locations, installation of four (4) reburn burners and four (4) overfire air ports, burner lighters and control system and field routed piping and valving necessary for water/air/steam supply to reburn system components. Also, electrical work was completed.

Initial start-up of the system was carried out on December 4, 1991, after instrument calibrations were completed. Burner flame stability was very good and the flame scanning system operated as desired. Initial attempts at NOx reduction during early operation reached 40% at a boiler load of 90MW. Reburn operation was stopped on December 16, 1991, to modify dampers in an effort to reduce leakage which proved to be a problem during operation. This work was completed during a WP&L boiler outage the last week of December in preparation for operation in early January, 1992.

Phase III - Operation and Disposition activities emphasized preparation for parametric optimization testing. Post retrofit baseline tests were performed to verify that baseline test information developed in April/May 1990 is still valid representation of unit operation. Agreement of the new data with the original data was good. As part of B&W's commitment to investigate possible corrosion problems associated with reburn technology, ultrasonic thickness testing was performed at five (5) elevations within the furnace prior to restart of the boiler at the end of October.

## 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 NOx Control Demonstration Project. The period covered by this quarterly report is October through December 1991. This report represents the seventh three-month period of the project.

The subject of this report identifies progress during the quarter for Phase I - Design and Permitting, Phase IIA - Long Lead-Time Item Procurement, Phase IIB - Construction and Start-up and Phase III - Operation and Disposition.

Both Phase I and Phase IIA activities are complete. Under Phase IIB, construction activities are complete and those performed during this quarter are summarized in this report. The boiler was restarted at the end of October as scheduled. Start-up and shakedown activities for the reburn system are documented in this quarterly report. Conditions under which NOx reduction was achieved and preliminary information on degrees of reduction are also provided. This is the first quarterly report on progress in Phase III Operation and Disposition. A summary of Phase III planning activities and test preparation activities is provided as well as the details of ultrasonic thickness testing in the furnace.

# 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 NOx 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 NOx burners for pulverized coal applications. Reduction of NOx 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-Nox alternatives for coal-fired boilers. The reburning process is the best known technically and economically feasible low-NOx alternative via combustion modification for cyclone boilers. Back-end NOx removal systems, such as Selective Catalytic Reduction (SCR) technology offers promise of NOx 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 NOx 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 NOx 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 NOx 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 NOx 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 NOx control by offering:

- A technically and economically feasible low-NOx alternative for cyclone boilers to achieve a 50% to 60% NOx 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 NOx 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 NOx 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 NOx 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 NOx 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 NOx 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 NOx emissions. It is estimated that 21% of the total NOx 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 NOx 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 NOx from these units, but at high capital and operating cost. Reburning is therefore a promising alternative NOx reduction approach for cyclone equipped units at a more reasonable operating cost.

Reburning is a process by which NOx 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 NOx. 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

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:

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 #7 is October, November, and December 1991. Progress will be discussed on a task basis for each of the Phase I, Phase IIA, Phase IIB, and Phase III activities.

## 4.1 PHASE I - DESIGN AND PERMITTING

Activities in Phase I include the following tasks: Management and Reporting, review of the Reburn Technology, Reburn System Design, and Permitting.

### 4.1.1 Task 1 - Management and Reporting

All major activities in Phase I are complete. Accordingly this task is also complete.

### 4.1.2 Task 2 - Review of Reburning Technology and Pilot-Scale Cyclone Boilers Tests

All activities are complete.

### 4.1.3 Task 3 - Numerical and Physical Flow Modeling

All activities are complete.

### 4.1.4 Task 4 - Baseline Characterization Tests

All activities are complete.

### 4.1.5 Task 5 - Design of Reburning System and Development of Test Plan

All activities are complete.

### 4.1.6 Permitting

All permits required for the project to proceed are being acquired as necessary by Wisconsin Power & Light.

Acurex will provide the revised Environmental Monitoring Plan in January, 1992.

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

Activities of Phase IIA include Management and Reporting, and Long Lead-Time Item Procurement.

### 4.2.1 Task 1 - Management and Reporting

This activity concentrated on long lead-time item procurement to support the planned installation schedule of June through October, 1991.

### 4.2.2 Task 2 - 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 October, November, and December, 1991, 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 have occurred in three distinct segments: 1) Foundation work in November and December, 1990, as outlined in Quarterly Report No. 3 2) Spring outage activities in March, 1991, as outlined in Quarterly Report No. 4 and 3) Reburn system installation through September, 1991. As outlined in Quarterly Reports #5 and 6.

Reburn system installation was divided into two separate periods: pre-outage activities (June 3, 1991 through September 12, 1991) and outage activities (September 12, 1991 through October 31, 1991). The activities for October are outlined below.

Pre-outage Activities

These activities were completed in the previous quarter as outlined in Quarterly Report #6.

Outage Activities

Construction activities continued throughout the month of October in an effort to meet WP&L's unit start-up schedule.

Accordingly, reburn construction activities were completed and Nelson Dewey Unit #2 was restarted on October 31, 1991. Items included in October's construction were:

1) Installation of pressure part modifications at the burner level (four (4) openings) and at the overfire air port level (four (4) openings) were completed. The unit was hydrostatically pressure tested on October 4, 1991.

2) Installation of the four (4) coal reburning burners was completed.

3) Installation of the four (4) overfire air ports was completed.

4) Tie-in of the coal piping, secondary air/gas recirculation ducting and overfire air ducting to the burners and overfire air ports was finished.

5) Seal air system installation was completed.

6) Modification of the tripper conveyor system to allow filling of the reburning coal storage silo was carried out.

7) Installation of field routed piping and valving necessary for cooling water, plant air, instrument air and steam supply requirements was completed.

8) The burner lighter package and associated control valves and fuel oil piping to the lighters were completed.

9) Electrical installation of the various components of the reburn system was completed as was tie in to the Bailey Net 90 reburn control system. Loop checks on each of the reburn subsystems were completed.

10) Installation of lighting in the reburn building as well as heaters and ventilation fans was completed.

11) Insulation and lagging for the reburn system were installed.

Major items were also checked out prior to start-up. The following are some of the items checked out:

1) Allen-Bradley variable frequency drive for the primary air fan.

2) The pulverizer motor.

3) Hydraulic drive system for the pulverizer rotating classifier.

4) The rotating classifier.

5) The lube oil system for the pulverizer gear drive.

6) The lube oil system for the hydraulic drive of the rotating classifier.

7) All dampers (including torque and limit switches).

8) Gravimetric feeder.

9) Pulverizer inerting and clearing system.

10) Burner flame scanner system and scanner cooling air system.

Once the construction work was completed, start-up activities were formally initiated by B&W on October 29, 1991.

Operator Training

A series of five training sessions were provided by B&W and WP&L for the Nelson Dewey plant operators prior to initiation of reburn system operation. The five sessions were:

1) General Overview

This session provided an overview of the reburn system including background and emphasizing reburn combustion equipment (burners flame scanners, ignitors).

2) Pulverizer Training

This session consisted of classroom instruction emphasizing MPS pulverizer operation and safety. The pulverizer hydraulic and lubrication systems were also reviewed.

3) Inerting and Clearing Procedure

This session consisted of hands-on operation of the pulverizer inerting and clearing system as well as the pyrite removal system.

4) Reburn Auxiliary Equipment

Topics for this hands-on session were the seal air system, the rotating classifier lube set, hydraulic loading system and the primary air fan variable frequency drive operation.

5) Controls and Interlocks

Reburn equipment start and stop sequences were reviewed and training was provided at the main control board to experience interlocks and alarm indications.

Boiler Start-up

Prior to boiler start-up, cold air flow calibrations were performed on each of the new reburn systems flow paths in order to assure accurate air monitor indications. The following ducts were tested at various flow rates: overfire air (OFA), gas recirculation to the burners, secondary air, and also the primary air. Based upon initial indications, leakage rates for the control dampers appeared to exceed specification. The damper vendor was notified. Subsequent to these tests, the boiler start-up was initiated.

With the boiler in operation, cooling air flow rates for the reburn burners and overfire air (OFA) ports were optimized to maintain acceptable metal temperatures. The air control dampers' limit switches were set to stop the dampers from closing beyond the minimum position for adequate flow. In addition, the boiler economizer outlet oxygen analyzer utilized in the control system to trim boiler air flow was reset to accommodate the extra air flow required for cooling the reburn system components.

With the systems at operating temperature, hot air flow calibrations of the same instruments previously tested on cold air flow were carried out. Inconsistencies between the measured flow rates and the air monitor indications were identified for a few of the systems and investigations commenced to identify the problems. Other activities carried out to ready the reburn system for operation included check out of the reburn burner oil lighters and flame scanners. This system was successfully started-up and debugged as oil and air pressures were optimized to minimize lighter BTU input while maintaining successful operation. This was done to minimize impacts on boiler operation during reburning start-up and lighter system operation. Also, as part of burner and lighter system start-up, verification of all the control interlocks was completed to assure safe operation.

Reburn System Start-up

The reburn system initial start-up occurred at a boiler load of 90 MW. The system was successfully operated for approximately one hour on December 4, 1991. High air flow to the reburn burners was maintained along with support fuel oil from the lighters. The goals of this activity were achieved in as much as the components of the reburn system operated successfully. Due to a feeder void condition (plugged coal silo due to wet coal), the system tripped after the one hour period of operation. During operation, the following key observations were made:

- The existing cyclone feeders reacted acceptably when the reburn system was put into operation. A smooth transition was observed during reburn start-up.

- The pulverizer outlet temperatures were lower than designed (180°F design versus 147°F observed).

- No CO or opacity emission impacts were noted.

On December 6, 1991, the reburn system was again successfully started at 90 MW boiler load. It ran for about 55 minutes with the oil lighters in service. Because of wet coal, the plant lost two (2) cyclones due to pluggages. This condition (two (2) cyclones off line) is designated to automatically shut down the reburn system. The interlock functioned, according to control philosophy and a successful reburn system trip was executed.

Subsequently, the reburn system was restarted and, ran for approximately 75 minutes. During this episode, the oil lighters were shut off for the first time during the final 10 minutes of operation. Burner stability was good and flame scanner signals remained strong. The reburn system was then shut down due to a coal leakage problem at the pulverizer. To this point no efforts to reduce NOx were emphasized, although slight reductions were measured.

On December 9, 1991, with the unit firing 100% Lamar bituminous coal, the reburn system was operated at 10 tons/hr. of coal while varying air streams within the system to observe the impact. With high reburn air flows, a NOx reduction of 20% was observed with less than 100 ppm CO and no opacity changes. At 12 tons/hr of coal flow rate through the reburn system, a reduction of 27% was observed the following day.

December 11, 1991, saw the first attempt to operate the cyclone secondary air dampers in manual and reduce the air flow rates to each cyclone with the intent of reaching a cyclone stoichiometry of 1.1. With a 75/25% cyclone/reburn fuel split and an approximate reburn burner stoichiometry of 0.5, a 32% reduction in NOx was observed.

Operation continued in the manual control mode during the day shift for the next few days to explore the impacts on system performance of changing operating parameters such as gas recirculation and reburn heat input. A NOx reduction of as high as 40% was achieved. All operation was performed at a boiler load not exceeding 90 MW. Once the system characteristics are explored, boiler load will be increased to the normal 110 MW level.

After operation on December 16, 1991, problems in the primary air system were apparent during mill shutdown and the inerting and cleaning sequence due to leakage through the isolation damper at the inlet to the PA fan. This created a path for fine coal in the pulverizer to find its way into the PA ductwork forming deposits there and creating a potentially dangerous situation during operation when in contact with hot air. It was decided to take

advantage of a short boiler outage later that week to have the damper manufacturer inspect the damper and modify it to achieve the specified leakage rates. Also, during this time a number of minor problems with installation which became apparent during operation of the system were corrected. 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.

## 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 October, November, and December were completed and issued to DOE/PETC.

A review meeting was held at B&W's main offices in Barberton, Ohio with Acurex, B&W and DOE/PETC personnel to review the initial draft of the Environmental Monitoring Plan for Phase III testing. Comments were provided and Acurex will complete the final version in January, 1992.

DOE/PETC received approval to proceed with Phase III activities from Headquarters and subsequently provided approval to B&W to begin Phase III work during the quarter. DOE/PETC personnel visited the Nelson Dewey plant on December 5 and 6 to review construction and observe initial system operation.

### 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 primarily in planning and coordination activities as well as preparation of testing equipment at B&W's facilities and at the Nelson Dewey site. Equipment necessary to carry out the hot and cold air flow calibrations throughout the reburn system as described under Phase IIB, Task 3 Start-up and Shakedown was prepared, transported to the site and activated as part of this task. In addition, the B&W economizer outlet gas analysis grid and gas analyzers were returned to the site and made

operational during the quarter. Without Acurex on site, this gas analysis system is the most significant tool available in observing impacts of parameter variations on reburn performance. Other activity regarding preparation for testing was checkout of the B&W boiler performance model, currently tied into the Black and Veatch data acquisition system. With the model in operation, on line boiler performance information is available.

Once the field installation of testing equipment and calibration of that equipment was completed, post retrofit baseline testing was carried out to verify that the information developed in the baseline test work of April/May 1990 is representative of current operation.

Post Retrofit B&W Baseline Tests

Post-retrofit baseline tests were performed to measure NOx, $O_2$, CO, and $CO_2$ at the economizer outlet, in-furnace gas species/temperatures and particulate inlet/outlet measurements for loading/unburned carbon determinations. These measurements were obtained at 110 MW, 82 MW and 55 MW - identical to test conditions established during the original 1990 baseline tests. In general, the post-retrofit baseline emission levels compared well with the previous testing performed prior to the retrofit. Problems were encountered during the particulate loading testing making additional tests for particulate loading verification necessary later in the testing program. Boiler performance determinations will be available at a later date. One interesting observation was that reduced attemperation (spray flow) was seen during these post-retrofit tests as compared to 1990 data.

Ultrasonic Thickness Testing - Phase III

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 during the week of October 21, 1991 as part of Phase III testing but before restart of the boiler. Readings were taken at five (5) elevations on each of the four walls of the furnace for a total of approximately 1800 measurements. The elevations were at 696'-6", 688'-0", 678'-1", 670'-6" and 633'-0".

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 Babcock & Wilcox wall thickness guidelines for required repair.

### 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.

No activity is scheduled to occur as yet.

### 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.

## 5.0 PLANNED ACTIVITIES

Planned activities for the next quarter, January, February, and March 1992 will focus on completion of start-up and shakedown of the reburn system. Also, the parametric optimization tests with Acurex on site to verify and document reburn performance should be well under way by the end of the quarter.

## 6.0 SUMMARY

The coal reburning for cyclone boiler NOx control demonstration project's seventh Quarterly Report covering the time period of October, November, and December 1991 involves the work performed in Phase I - Design and Permitting, Phase IIA - Long Lead-Time Item Procurement, Phase IIB - Fabrication, Construction, Start-Up, and Shakedown, and Phase III - Operation and Disposition.

Phase I - Design and Permitting and Phase IIA - Long Lead-Time Item Procurement activities were completed.

Phase IIB - Fabrication, Installation, and Start-up activities witnessed completion of structural/mechanical work by Azco Hennes, Inc. and completion of electrical work. The boiler was restarted at the end of October as scheduled by WP&L. Start-up activities included operation of the system. The coal reburn burners operated well with good flame stability and the flame scanner system functioned well. Initial attempts at NOx reduction saw as high as 40% on a preliminary basis at a boiler load on 90 MW. Reburn operation was stopped on December 16, 1991 to repair leaky dampers and minor problems with installation. This work was complete by the end of the year. Plans are to be on line again in early January.

Phase III - Operation and Disposition was initiated during the quarter after DOE approval to proceed was received. Planning and site preparation activities as well as post retrofit baseline testing was the bulk of activity in the phase. Ultrasonic thickness testing of the furnace tubes was completed prior to restart of the boiler at the end of October.

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