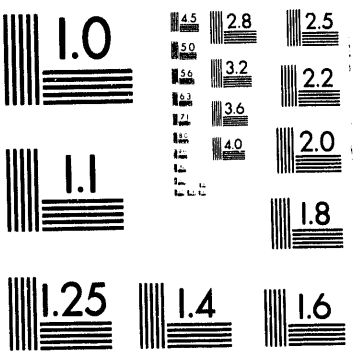
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1 of 1

Full-Scale Demonstration

Low-NO_x Cell™ Burner Retrofit

Quarterly Report No. 8

for the period - July 1, 1992 through September 30, 1992

DOE Agreement No.: DE-FC22-90PC90545

B&W CRD Agreement No.: CRD-1250

Patents Cleared by Chicago on April 14, 1993

Prepared by:

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a McDermott Company

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1.0 **EXECUTIVE SUMMARY**

The Full Scale Demonstration Low-NO_x Cell™ Burner (LNCB™) Project (DOE Agreement No. DE-FC22-90PC90545) progress from July 1, 1992 through September 30, 1992 is identified in this, the Eighth Quarterly Report. The Report centers on Phase III - Operation Status.

The LNCB™ project involves retrofitting the two-nozzle cell burners at Dayton Power & Light's, 605 MWe J.M. Stuart Unit #4 boiler near Aberdeen, Ohio with LNCB™ (a burner and integral NO_x port). Previous pilot-scale tests have shown such an arrangement to achieve 50% reduction in NO_x emission levels. This full-scale project will determine the commercial applicability of this technology.

Monthly reports covering the time period of this report and a draft copy of the Technical Progress Report No. 7 was completed and issued to DOE PETC. An LNCB™ project technical paper was presented at the EPRI workshop in Boston, MA on July 7, 1992.

Long-term testing via a Continuous Emissions Monitor (CEM) began in August, 1992. CEM testing will continue until Spring of 1993 when Unit #4 comes off line for its annual outage which at this time is scheduled for April 4, 1993.

A key item remaining to be evaluated as part of the long term testing is furnace tube wall corrosion. H_2S probing similar to optimized test probing was repeated during the week of August 17, 1992. During the Spring '93 outage, ultrasonic testing of the furnace wall tubes as well as destructive examination of samples from the corrosion test panel will be accomplished.

B&W presented current data analysis results from the parametric and optimization testing phase of the program at the fifth Advisory Committee meeting held on September 10, 1992 in Cincinnati, Ohio. Advisory Committee members were encouraged by the NO_x reduction results. However, they are concerned about the potential for H_2S formation in the lower furnace. The Advisory Committee members felt that the success of the LNCB™ project regarding NO_x reduction must be tempered until results on the corrosion work can be completed in the Spring 1993.

2.0 **INTRODUCTION**

Under Phase III Operation, Task 1 - Management & Reporting work accomplished during this quarter involved submittal of draft copies of the Technical Progress Report No. 7 to DOE PETC. LNCB™ project technical papers were presented at the EPRI workshop in Boston, MA on July 7, 1992, and at the first annual DOE Clean Coal Technology Conference, September 22-24, 1992 in Cleveland, Ohio. Task 2 - Preliminary Testing, saw completion of the fabrication and installation of the lower burner inversion and shallower angled impellers, Unit #4 start-up, and preliminary testing. Task 3 - Parametric and Optimization Testing work was completed with the last of the testing concluding on June 30, 1992. Task 4 - Long-Term Testing utilizing a Continuous Emissions Monitor (CEM) was initiated in August, 1992 and will continue until the Stuart Unit #4 outage which at this time is scheduled for April 4, 1993.

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.

U.S.-installed steam generating units (ie. boilers) equipped with pulverized-coal-fired, cell-type burners account for approximately 26,000 MW of electric power generating capacity. Ten thousand MW of generating capacity is located in Ohio. The balance is located primarily in the Midwest and Northeast, but also in the South and West. coal-fired generating units equipped with cell-type burners produce about 20% of the Pre-New Source Performance Standards (NSPS) utility NO_x emissions with an uncontrolled emission rate of approximately 1,000,000 t/yr NO_x as NO_2. Replacement of the standard cell burners with Low-NO_x Cell™ Burners (LNCB™) can potentially reduce NO_x emissions by 50% per boiler, or 500,000 - 600,000 tons per year if applied to all pre-NSPS boilers of this type.

Currently there is no other commercially-available technology that can achieve NO_x emission reductions on the order of 50% in cell-fired utility boilers without resorting to pressure part modifications. The unique cell burner configuration precludes the use of commercially-available low-NO_x burner designs. This is due to the proximity of the burner throats and the relatively small burner throat openings typical of the pre-NSPS cell burner design. Low-NO_x burner designs operating on the principle of delayed combustion require larger throat openings, i.e., lower burner air velocities, to inhibit the formation of volatile NO_x in the early stages of combustion. Furthermore, optimum NO_x reduction with unit volume is minimized. The existing cell burner configuration does not lend itself to either of these requirements.

Realizing the need, Babcock & Wilcox and the Electric Power Research Institute (EPRI) have invested a large amount of resources in the research and development of an unique, "plug-in" Low-NO_x Cell™ Burner for retrofitting these existing boilers equipped with standard cell burners.

3.2 PROJECT BACKGROUND

The Low-NO_x Cell™ Burner operates on the principle of staged combustion. The lower burner of each two-nozzle cell is modified to accommodate all the fuel input previously handled by two nozzles. Secondary air, less than theoretically required for complete combustion, is introduced to the lower burner. The remainder of secondary air is directed to the upper "port" of each cell to complete the combustion process.

B&W/EPRI have thoroughly tested the LNCB™ at two pilot scales (6 million Btu per hour and 100 million Btu per hour), and tested a single full-scale burner in a utility boiler. Combustion tests at two scales have confirmed NO_x reduction with the low-NO_x cell on the order of 50% relative to the standard cell burner at optimum operating conditions. The technology is now ready for full unit, full-scale demonstration.

From the standpoint of cost-effective NO_x reduction technology the Low-NO_x Cell™ Burner is, by design, ideally suited for retrofit to existing two-nozzle cell burner installations. The "plug-in" design will fit existing wall tube openings eliminating outage time and material/labor expense associated with pressure part modifications and burner relocations. Potentially, this burner can be installed on all utility boilers currently equipped with two-nozzle cell burners, and can be adapted to units with three-nozzle cell burners.

Since pressure part changes are not required for the replacement, Low-NO_x Cell™ Burners are the most cost-effective NO_x control alternative for boilers equipped with standard cell burners. The cost effectiveness (dollars per ton NO_x removal) for the Low-NO_x Cell Burners™ is about one-half of that for conventional low-NO_x burners, and one-tenth that for selective catalytic reduction.

The Low-NO_x Cell™ Burner retrofit is expected to be compatible with all U.S. Coals currently being burned in the original cell burners. No loss to domestic coal sourcing will be recognized. Utilities representing 70% of the potential Low-NO_x Cell™ Burner retrofit market (capacity basis) are participating in the project.

To accelerate commercialization of this promising technology in controlling NO_x levels in pre-NSPS power plants, a full-scale retrofit of a complete boiler system is to be performed. This project at Dayton Power & Light's J.M. Stuart Unit #4, located along the Ohio River between Manchester and Aberdeen, Ohio, will permit actual full-scale NO_x levels to be quantified and demonstrate the ability of the equipment to reliably meet conservative utility industry standards.

Unit No. 4 is a supercritical Universal Pressure, single-reheat, Carolina-type boiler, fired with pulverized coal. The unit is designed for a maximum continuous capacity of 4,400,000 lbs steam/hr delivered to a 3500 psig (nominal) General Electric turbine-generator for a maximum gross generating capacity of 605 MWe.

Existing combustion equipment consists of 24 two-nozzle cell burners, 6 MPS-89K pulverizers, and 6 gravimetric feeders. The burners are arranged in an opposed-fired configuration with 12 cell burners on each wall, 2 high by 6 wide. The existing burner throat openings are 38 inches in diameter.

3.3 PROJECT OBJECTIVES

The overall objectives of the full-Scale Low-NO_x Cell™ Burner (LNCB™) Retrofit project is to demonstrate the cost-effective reduction of NO_x generated by a large, base-loaded (70% capacity factor or greater), coal-fired utility boiler. Specific objectives include:

- At least 50% NO_x reduction over standard two-nozzle cell burners, without degradation of boiler performance or life.
- Acquire and evaluate emission and boiler performance data before and after the retrofit to determine NO_x reduction and impact on overall boiler performance.
- Demonstrate that the LNCB™ retrofits are the most cost-effective alternative to emerging, or commercially-available NO_x control technology for units equipped with cell burners.

The focus of this demonstration is to determine maximum NO_x reduction capabilities without adversely impacting plant performance, operation and maintenance. In particular, the prototype evaluations will resolve many technical issues not possible to address fully in the previous pilot-scale work and the single full-scale burner installation. These include low-NO_x combustion system impact on:

(1) boiler thermal efficiency
(2) furnace temperature and heat absorption profiles
(3) slagging and fouling
(4) waterwall corrosion
(5) gaseous and particulate emissions
(6) boiler operation considerations

3.4 HOST SITE BOILER

The host site is an existing utility boiler owned by Dayton Power & Light Company, Cincinnati Gas & Electric Company, and Columbus Southern Power Company. The following is a summary of pertinent information.

- OPERATING UTILITY: The Dayton Power & Light Company
- UNIT ID: J.M. Stuart No. 4
- LOCATION: Route 52, P.O. Box 468
  Aberdeen, Adams County, Ohio 45101
- NAME PLATE RATING: 605 MW NDC
- TYPE: Tandem Steam Turbine
- PRIMARY FUEL: Eastern Bituminous Pulverized Coal
  from Ohio, West Virginia, and Kentucky
- OPERATION DATE: 1974

- BOILER ID: Babcock & Wilcox UP No. 106
- BOILER GENERAL CONDITION: Commercial Operation/Good Condition
- BOILER TYPE: Supercritical, Once-Through
- DEMONSTRATION FUEL: Eastern Bituminous Pulverized Coal
- BURNERS: 24 Two-Nozzle Cells, to be replaced with Low-NO_x Cell™ Burners
- PARTICULATE CONTROL: Electrostatic Precipitators
- PAST EMISSIONS MONITORING: Precipitators - 99+% collection efficiency NO_x (full load) - 1.2 lb/10^6 Btu

3.5 **PROJECT TEAM**

The Low NO_x Cell™ Burner Project Team consists of the U.S Department of Energy, The Babcock & Wilcox Company, Dayton Power & Light, 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 Services Division (ESD) and the Contract Research Division (CRD).

Major subcontractors are Acurex and Enerfab. Acurex has been designated to perform continuous emissions monitoring activities as well as various analytical requirements during the testing program. The installation subcontractor is Enerfab. They are the Dayton Power & Light - J.M. Stuart Station maintenance contractor. They will perform pre-outage, outage, and start-up work necessary to install the Low-NO_x Cell™ Burners and its associated equipment.

A summary of the overall project organization is as follows:

Project Organization

- Department of Energy - 48.4% funding co-sponsor
- Babcock & Wilcox - Prime contractor, project manager, and funding co-sponsor
- Dayton Power & Light - Host site utility and funding co-sponsor
- EPRI - Technical advisor and funding co-sponsor
- Ohio Coal Development Office - Advisory committee member and funding co-sponsor
- Utility advisory committee members and funding co-sponsors

  Allegheny Power System
  Centerior Energy Corporatior - Funding thru EPRI

Duke Power Company - Funding thru EPRI
New England Power Company - Funding thru EPRI
Tennessee Valley Authority - Funding thru EPRI

- Acurex Corporation - testing subcontractor

- DP&L Stuart Station Maintenance Contractor - LNCB™ installation

3.6 PROJECT PHASES

The LNCB™ project, which is a $10 million project, consists of four separate phases which are planned to occur over a 38-month period. These are:

- Phase I - Design

  During this phase, the Low-NO_x Cell™ Burner (LNCB™) System will be designed based upon B&W's pilot-scale combustion tests, and experience/knowledge of full-scale burner/OFA port/control system retrofits. Additionally, collection of baseline emissions and performance data, along with performance of general boiler system assessment, will be completed at DP&L's J.M. Stuart Unit #4 prior to the LNCB™ retrofit.

- Phase IIA - Procurement & Fabrication

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

- Phase IIB - Installation

  The LNCB™ system will be installed and started up to provide a fully operational system prior to testing.

- Phase III - Operation

  Parametric/optimization and long term 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 LNCB™ 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 project quarterly report #8 is July 1, 1992 through September 30, 1992. Progress will be discussed on a task basis for Phase III activities. Phase I, Phase IIA, and Phase IIB are complete.

4.1 **PHASE I - DESIGN**

Activities in Phase I include the following tasks: Management and Reporting, Test Plan Development, Pre-Retrofit Testing, Functional Engineering, Detailed Design Engineering, and Permitting.

PHASE I WORK IS COMPLETE!

4.2A **PHASE IIA - PROCUREMENT AND FABRICATION**

Activities in Phase IIA include the following tasks: Management and Reporting, Procurement, and Manufacturing and Fabrication.

PHASE IIA WORK IS COMPLETE!

4.2B **PHASE IIB - INSTALLATION**

Activities in Phase IIB include the following tasks: Management & Reporting, Pre-Outage Construction, Installation of LNCB™ Equipment, and Start-up & Shakedown.

PHASE IIB WORK IS COMPLETE!

4.3 **PHASE III - OPERATION**

Activities in Phase III include the following tasks: Management & Reporting, Preliminary Testing, Optimization Testing, Long Term Testing, Data Analysis, Final Report, and Disposition.

4.3.1 Task 1- Management and Reporting

Monthly reports covering the time period of this report were completed and issued to DOE PETC.

B&W submitted a draft of the technical progress report #7 for the period July 1,1992 through September 30, 1992 along with drafts of Environmental Monitoring reports #1 & #2 for the periods November 1, 1991 through March 31, 1992 and April 1,1992 through June 30, 1992, respectively.

B&W and DP&L gave a technical presentation of the preliminary project test results at the EPRI workshop in Boston, MA on July 7, 1992.

The fifth Advisory Committee meeting was held September 10, 1992. B&W presented current data analysis results from the parametric and optimized testing phase of the program at this meeting. The Advisory Committee members were encouraged by the NO_x reduction results. However, they are concerned about the potential for H_2S formation in the lower furnace. The Advisory Committee members felt that the success of the LNCB™ project regarding NO_x reduction must be tempered until results on the corrosion work can be completed in the Spring of 1993.

DP&L and B&W presented a technical paper on the LNCB™ at the first annual DOE Clean Coal Technology Conference, September 22-24, 1992 in Cleveland, Ohio. Plans call for technical presentations at the Pittsburgh Coal Conference in Pittsburgh, Pennsylvania; the ASME International Joint Power Generation Conference in Atlanta, Georgia; and the Power-Gen 92 Conference in Orlando, Florida. Both the Pittsburgh Coal Conference and Joint Power Generation Conference are scheduled in October 1992, while the Power-Gen '92 Conference is scheduled for November 1992.

4.3.2 Task 2 - Preliminary Testing

Fabrication and installation of all materials for the burner inversion and impeller change was completed during the previous quarter, along with a successful boiler inspection, start-up, and preliminary testing.

PHASE III, TASK 2 WORK IS COMPLETE!

4.3.3 Task 3 - Parametric & Optimization Testing

The optimization testing phase of the project was concluded on June 30, 1992, and all testing crews were off site by July 2, 1992. Representative results from the optimization testing indicate that the Low NO_x Cell™ burners are achieving better than 50% NO_x reduction at full load (less than 0.6 lbs $NO_x/10^6$ Btu heat input) and approximately 50% reduction at reduced loads.

The continuous monitoring equipment for long term testing is operational and will continue to be in use until the Spring of 1993 when Unit #4 comes off line for its annual outage.

Modifications made to the H_2S probe equipment were successful. The probing work during Optimization testing progressed very smoothly. There was no H_2S recorded through the probe sampling ports which are located below the bottom burner row. Only three of the four port locations were operational. The front wall port on the right hand side could not be used because the aspirating air opening was plugged. H_2S was detected through the sampling ports in the corrosion test panel which is located on the right hand sidewall. The highest level was detected near the centerline of the sidewall, just above the lower burner NO_x port.

The B&W corrosion team returned to Stuart Station the week of

The B&W corrosion team returned to Stuart Station the week of August 17, 1992 for additional testing. DP&L had unplugged the above mentioned probe port to make it operational prior to B&W's arrival. B&W performed lower furnace probing to measure H_2S levels with DP&L firing their normal blended coals. The initial results showed that the H_2S levels were higher than those levels recorded when firing the low sulfur test coal during Optimization testing. The B&W test crew also performed a parametric series of tests to see if NO_x port louver adjustments would dissipate the H_2S levels. By modulating the NO_x port louver settings of the lower burners adjacent to the sidewall, the H_2S levels were brought down to less than 100 ppm adjacent to the corrosion test panel. The H2S probe which is approximately 2 feet away from the sidewall also recorded reductions in H_2S levels. Complete analysis of the corrosion work is not possible until the spring of 1993 when destructive examination of the corrosion test panel will be performed.

4.3.4 Task 4 - Long-Term Testing

The Continuous Emissions Monitoring (CEM) system for long term testing is operational and will continue until Spring of 1993 when Unit #4 comes off line for its annual outage which at this time is scheduled for April 4, 1993. Recordings from the CEM system show that the level of NO_x reduction is still greater than 50%.

DP&L reported that one of the coal impellers broke loose from the rod and ended up in the bottom ash hoppers. B&W thinks that the impeller is from one the mills normally taken out of service at reduced loads. We suspected that the impeller failed due to overheat because there was not enough cooling when the burner was out of service. B&W has recommended that either the PA fan remain in operation for the out of service mill or that DP&L retract the impellers back into the coal nozzle when not in operation. DP&L reported that a second coal impeller broke loose and ended up in the bottom ash hoppers. This differed from the first in that the impeller had a section of rod attached to it. Over half of the burners are equipped with split rods to accommodate removal due to tight withdrawal clearance. B&W concluded that the second impeller is from one of these burners and that the connecting pin linking the split rods had failed. DP&L replaced the two missing impellers identified as burners D1 and F6 during a forced outage in September, 1992. They also inspected the impellers of adjacent burners to see if the causes for the failures could be identified. No reason for the isolated failure was evident.

Another key item remaining to be evaluated as part of the long term testing is furnace tube wall corrosion. During the April 1993 outage for Unit #4, ultrasonic thickness testing of the furnace wall tubes will be performed along with destructive examination of samples obtained from the corrosion test panel.

5.0 PLANNED ACTIVITIES

Planned activities for the next quarter, October, November, and December 1992 will focus on the following:

Management & Reporting will include technical presentations on the LNCB™ technology at the Pittsburgh Coal Conference, October 12-15, 1992; the ASME International Joint Power Conference, October 18-22, 1992; and the Power-Gen '92 Conference, November 17-19, 1992.

Phase III, Task 4 - Continue long term testing.

Phase III, Task 5 - Continue data analysis from optimized testing.

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END