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ENHANCING THE USE OF COALS BY
GAS REBURNING-SORBENT INJECTION

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The objective of this project is to evaluate and demonstrate a cost effective emission control technology for acid rain precursors, oxides of nitrogen (NO_x) and sulfur (SO_x), on two coal fired utility boilers in Illinois. The units selected are representative of pre-NSPS design practices: tangential and cyclone fired. Work on a third unit, wall fired, has been stopped because of funding limitations. The specific objectives are to demonstrate reductions of 60 percent in NO_x and 50 percent in SO_x emissions, by a combination of two developed technologies, gas reburning (GR) and sorbent injection (SI).

With GR, about 80-85 percent of the coal fuel is fired in the primary combustion zone. The balance of the fuel is added downstream as natural gas to create a slightly fuel rich environment in which NO_x is converted to N_2 . The combustion process is completed by overfire air addition. SO_x emissions are reduced by injecting dry sorbents (usually calcium based) into the upper furnace. The sorbents trap SO_x as solid sulfates that are collected in the particulate control device.

This project is conducted in three phases at each site: (1) Design and Permitting, (2) Construction and Startup, and (3) Operation, Data Collection, Reporting and Disposition. Technology transfer to industry is accomplished through the formation of an industry panel. Phase I of the project commenced on June 5, 1987. Phases I and II have been completed and Phase III is now in progress at both sites.

In phase AIII at Hennepin - Testing, Data Collection, Reporting and Disposition - Gas Reburning runs were made that indicate as high as 77% reduction in NO_x emission using about 18% gas. Gas Reburning - Sorbent Injection test results indicated as high as 62% reduction in SO_2 . These results are significantly higher than the project emission reduction goals of 60% NO_x and 50% SO_2 and provide a wide safety margin for maintaining the 60% and 50% emission reductions during long term routine testing. A year of long term testing was completed in October, 1992. During late October and November of 1992, Hennepin Unit 1 was down for a scheduled outage. Ultrasonic tube thickness measurements were made to determine wear rates

in the various areas of the boiler. In December 1992, and January 1993, a series of parametric tests was conducted on three promoted sorbents with significantly improved SO₂ capture and calcium utilization.

Phase CII at Lakeside, Task 1 - Project Management: Project management activities continued throughout the quarter.

Phase CIII at Lakeside, Task 2 - Technology Demonstration: Gas Reburn and Sorbent Injection parametric testing were completed in the third quarter. GR/SI combined parametric tests are scheduled for the beginning of the next quarter, to be followed by the long term GR/SI demonstration.

Key Words

SO _x	Ash	Emission
SO ₂	Coal	Control
NO _x	Gas	Boiler
NO	Sorbent	Precipitator (ESP)
Pond	Construction	Flue Gas
Startup	Instrumentation	Contracts
CEMS	Industry Panel	Ducts
Reburning	Injection	PromiSORB™
Humidification	BPMS	

The specific goal of this project is to demonstrate NO_x and SO_x emission reductions of 60 percent and 50 percent, respectively, on two coal fired utility boilers having the design characteristics mentioned above. Host Site Agreements have been signed by EER and utility companies in the State of Illinois: Illinois Power Company (Test Site A, Hennepin Unit 1, 71 MW_{net} tangentially fired boiler in Hennepin), and City Water Light and Power (Test Site C, Lakeside Unit 7, 33 MW_{net} cyclone fired boiler in Springfield).

To achieve the objectives of the project, it is being conducted in the following three phases at each host site.

Phase I: Design and Permitting

Phase II: Construction and Startup

Phase III: Operation, Data Collection, Reporting and Disposition

Phase I is complete

Phase II is complete

Phase III: Phase AIII GP/SI Long Term Testing was completed at Hennepin, followed by Alternate Sorbents tests. Phase CIII parametric testing of Gas Reburning and Sorbent Injection systems has occurred.

During the past quarter the principal objectives of the work performed were as follows:

A. Hennepin Unit 1

1. Continue project management activities.
2. Complete detail drawings of IP's GR retention/SI restoration requirements.
3. Complete restoration and retention subcontractor scope and specifications.
4. Obtain subcontractor proposals, evaluate bids, let restoration and retention contract(s), anticipating October 16 - November 7, 1993 Unit 1 outage.
5. Continue data evaluation and preparation of the Long Term and Alternate Sorbents testing report.
6. Issue draft of Hennepin Report for participant review on September 8, 1993.

B. Lakeside Unit 7

1. Continue project management activities.
2. Install replacement sootblower lance for IK-8 and repair IK-7 sootblower.
3. Complete the Gas Reburning operational and control debugging.
4. Complete the Gas Reburning parametric tests.
5. Complete the Sorbent Injection parametric tests.
6. Combine GR/SI system operation.

3.0

PROJECT DESCRIPTION

Within the final phase of the project, the following tasks will be performed to demonstrate the cost effective control of NO_x and SO_x emissions from pre-NSPS coal fired utility boilers:

Phase III: OPERATION, DATA COLLECTION, REPORTING AND DISPOSITION

Task 1 - Project Management

- Continuation of Phases 1 and 2 project management activities.
- Conducting final project review at conclusion of project.

Task 2 - Technology Demonstration

Subtask 2.1 - Optimization Testing

- Evaluation of effects of process variables on emission control performance.
- Determination of operating conditions for optimum overall performance.

Subtask 2.2 - Evaluation of Alternative Coals and Sorbents

- Evaluation of performance of alternative sorbents:
 - Selection of sorbents from modified high surface area hydrated limes.

Subtask 2.3 - Long-Term Testing

- Operation of GR-SI equipment under optimized conditions for approximately one-year duration at each host site.
- Measurement of emission control system performance.
- Determination of boiler impacts.

Task 3 - Evaluation of Demonstration Results

- Analysis of test data.
- Preparation of guideline manuals for application of GR-SI technology, including design recommendations, cost projection and comparisons with competing technologies.

Task 4 - Restoration

- Disposition of GR-SI equipment installation:
 - To be retained by host site or removal and restoration work.

Task 5 - Technology Transfer

- Continuation of technology transfer activities from Phases I and II.
- Meeting with Industry Panel at one host site to review results obtained there and plans for other two host sites.
- Meeting with Industry Panel at completion of project.

4.0 PROJECT STATUS

4.1 Task 1 - Project Management

Monthly and other reporting activities were fulfilled according to the reporting requirements of the Cooperative Agreement.

Work Progress was monitored continuously. Coordination with IP and CWLP took place at monthly meetings and by telephone. The project co-funders were apprised of progress and developments through telephone conferences and meetings.

Meetings with the host utilities were held in Hennepin and Springfield to review details of Illinois Power's Gas Reburn retention and Sorbent Injection removal; and to update CWLP on startup progress and plans for Gas Reburn and Sorbent Injection parametric testing.

4.2 Task 2 - Technology Demonstration

Hennepin - In mid-April, EER delivered a report to Illinois Power which provided an overview of (Gas Reburn, Sorbent Injection, and GR/SI) performance, operating costs, and impacts on furnace, boiler, ESP, and chimney. Emission control performance and cost comparisons were made for promoted sorbents as well as the standard calcium hydrate.

On May 14, 1993, Illinois Power announced a decision to retain the Gas Reburning system, but to remove/restore the Sorbent Injection system. Restoration drawings and bid specifications have been prepared and bid in order to do the removal and restoration during the Unit 1 scheduled outage from October 16 through November 7, 1993.

Lakeside - The operational equipment and control debugging was completed satisfactorily. Approximately 75 gas reburning parametric tests (including a number of replicates) were completed. The EPA Toxicity Characteristic Leaching Procedure (TCLP) tests on fly ash sampled during a six hour sorbent injection run were satisfactory and the permit for landfill disposal as a special waste (non-hazardous) was approved by Illinois EPA. Ash disposal was begun on September 9, 1993. This allowed sorbent injection tests to begin. To date 20 sorbent injection operational and parametric tests have been completed. Performance was sufficiently close to expectations such that we were able to successfully combine the two processes on September 30, 1993. The first GR/SI run was at 27 MW_e with 25% gas and Ca/S of 2.25; 65% NO_x reduction and 63% SO₂ reduction were achieved in a one hour steady state run. A series of optimization tests of the combined GR/SI system is currently underway.

The test program encountered significant delays during this quarter and therefore EER was not able to achieve the milestone of commencing long term testing before October 1, 1993 as planned. These delays associated with the boiler had numerous causes including; continuing cyclone flame scanner problems (safety related permissives require both cyclones seeing a flame), boiler steam flow and pressure controls, cyclone air transmitters drifting, record-setting summer peak loads which precluded testing due to CWLP's concerns that testing might cause a boiler trip, and other minor boiler system problems. A few short delays resulted from GR/SI process equipment, control instrumentation or emissions sampling and monitoring equipment problems.

4.2.1 Contracts

Hennepin - Contracts were let to the following to perform restoration work at Hennepin. McCartin Mechanical was selected to perform the mechanical portions of the restoration and Harding Electric was selected to perform the electrical portion. Both contracts were awarded on September 27, 1993.

Lakeside - A contract continues with Johnson Controls to perform calibration of instruments and minor systems modifications as needed.

4.2.2 Construction Drawings

Hennepin - Restoration drawings identifying electrical/instrumentation to be removed, and for the humidification duct restoration were completed during this quarter.

Lakeside - No activity was required on drawings this quarter.

4.2.3 Equipment Purchasing

Hennepin - Purchase orders placed during this quarter were largely in support of the restoration activities which will take place during the next quarter.

Lakeside - Purchase orders placed during the quarter were largely in support of the testing program and the disposal of sorbent-ash to a permitted landfill.

4.2.4 Miscellaneous

Hennepin - Harding Electric will not be able to perform the electrical portion of the restoration work as bid and awarded, due to serious internal problems. Therefore EER has resubmitted bids to other electrical contractors and will have an electrical contractor on site by the October 16, 1993 outage.

Lakeside - Based upon the Toxicity Characteristic Leaching Procedure and other analysis of sorbent-ash generated during a Unit 7 sorbent injection run, an Illinois EPA permit was issued for disposal at a designated landfill.

4.3 Task 3 - Evaluation of Results

Hennepin - Data evaluation activities continued throughout the quarter. This included Long Term testing, Alternate Sorbent Testing data, boiler degradation evaluation (UT results), and the preparation of Hennepin final reports. A first draft of the report was issued for comment on September 8, 1993.

Lakeside - NO_x and SO₂ removal results during parametric testing exceeded the 60% and 50% reduction goals.

4.4

Task 4 - Restoration

Hennepin - Following the restoration decision by IP regarding GR/SI equipment retention or removal and unit restoration, EER has completed engineering activity to detail electrical, instrument, and other work for restoration contracts and equipment sales. Drawings will also be updated to provide "as left" records for Illinois Power's incorporation into the Hennepin plant drawings.

Contractors for the restoration work have been selected and will mobilize before the start of the outage on October 16, 1993.

Lakeside - No activity took place during this quarter.

4.5

Task 5 - Technology Transfer

A technical paper titled " Gas Reburning-Sorbent Injection Results" was presented at the EPRI/EPA/DOE SO₂ Control Symposium, in Boston Massachusetts, August 24 - 27, 1993.

CCT Topical report #3 "Reduction of NO_x and SO₂ Using Gas Reburning, Sorbent Injection and Integrated Technologies" was delivered for printing August 26, 1993.

A technical paper titled "Enhancing the Use of Coals by Gas Reburning and Sorbent Injection" was presented at the Second Annual Clean Coal technology Conference, in Atlanta, Georgia, September 7 - 9, 1993.

A technical paper titled "Gas reburning and Its Integrated Technologies for NO_x, SO₂ and CO₂ Control" was presented at the Second Annual Conference on U.S. - Eastern Europe Electrical Power Technologies, in Budapest, Hungary, September 19 - 22, 1993.

Three papers were presented at the Pittsburgh Coal Conference, in Pittsburgh, Pennsylvania, September 20 - 24, 1993. The first was titled "HCl-HF Removal by Sorbent Injection", the second was titled "Advanced NO_x Control Technologies", and the third was titled "Cost Effective ESP Performance Enhancement by Flue Gas Humidification".

5.0 PLANNED ACTIVITIES

During the next quarter (October through December, 1993) the following work is planned.

A. Hennepin Unit 1

1. Continue project management activities.
2. Complete SI removal/restoration work.
3. Dispose of equipment removed from Unit 1.
4. Revise drafts and issue Hennepin Final Report.

B. Lakeside Unit 7

1. Continue project management activities.
2. Begin long term GR/SI operation under load dispatch conditions.
3. Present results to date at the 5th Industry Panel Meeting in Kansas City on October 21 - 22, 1993.
4. A non-dispatch period of approximately one month will interrupt testing until December, 1993 when winter loads will again activate Lakeside Unit 7.
5. The Lakeside Unit 7 parametric testing environmental report will be drafted.

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