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INTEGRATED DRY NO_x/SO₂ EMISSIONS CONTROL SYSTEM

QUARTERLY REPORT NO. 7

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TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
<u>DISCLAIMER</u>	1
1.0 EXECUTIVE SUMMARY	2
2.0 INTRODUCTION	4
3.0 PROJECT DESCRIPTION	6
3.1 BACKGROUND	6
3.2 PROCESS DESCRIPTION	6
3.3 PARTICIPANTS	9
4.0 PROJECT STATUS	10
4.1 PHASE I - ENGINEERING AND DESIGN	10
4.2 PHASE IIA - PROCUREMENT	11
4.3 PHASE IIB - CONSTRUCTION AND STARTUP	11
4.4 PHASE III - OPERATIONS	13
5.0 PLANNED ACTIVITIES	15
6.0 SUMMARY	16
7.0 REPORT DISTRIBUTION	17

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1.0 EXECUTIVE SUMMARY

This Quarterly Report summarizes the Integrated Dry NO_x/SO₂ Emissions Control System Project (DOE Agreement No. DE-FC22-91PC90550) progress for the months of July, August, and September 1992.

Public Service Company of Colorado (PSCC) activities focused on completion of all construction for the dry sorbent injection and humidification systems and the initiation of Phase III Operations. A short summary of the items completed are listed below. Section 4.0 of this report contains additional details of the project status.

Low-NO_x Burners and Overfire Air System

The system has been operating without problems since the original startup on May 30, 1992. The major change to system operation has been the requirement for additional air at low loads to maintain steam temperature. Phase III Operations began August 3, 1992 with the beginning of combustion modification testing. Preliminary results indicate that NO_x emissions have been reduced 60 to 70% from the original baseline without negatively affecting unburned carbon or carbon monoxide emissions. Combustion testing will continue through late October 1992.

Dry Sorbent Injection System

All mechanical and electrical construction of the dry sorbent injection system is complete. All equipment has been operated and minor repairs have been complete. No sorbents have been injected but plans are to receive material next quarter for final system startup. A few minor punch list items remain but these will be completed in the near future. The system is ready for operation.

Humidification System

No additional progress was completed on the humidification system this quarter. Items remaining are the tie-in of the seal air fan and insulation of the system piping. No outage has occurred this quarter so PSCC has been unable to complete the fan tie-in. **Operation and testing of the humidification system are not planned until spring 1993. If an unscheduled outage has not occurred by that time, an outage will be scheduled. The insulation work will be completed next quarter.**

Flyash Storage System

System construction was completed and dry ash was pulled for the first time on July 17, 1992. Although the system was operational, it was decided to continue wet ash disposal until all major punch list items could be completed. Painting of the ash silo and associated equipment was completed August 28, 1993. The system began continuous operation on

September 17, 1992. A few punch list items remain but these are nearing completion. Installation of the truck weigh scale began on September 23, 1992.

Urea Injection System

Initial testing of the urea injection system with the original burners has shown that aqueous ammonia was more effective at lower loads. A contract has been issued to Noell, Inc. to design and supply a system to convert urea to ammonia based compounds on-line. This system will allow improved NO_x removal and reduced ammonia slip at low loads. The work is within the original scope of work and will be completed within the existing budget. Material will be delivered in October and construction of the modifications will begin in November. Work will be completed to allow testing during Phase III operations of the urea injection system.

Distributed Control System

The distributed control system has continued to function without problem throughout the quarter. Some minor tuning has been completed to allow for more efficient operation. Equipment to allow remote diagnostic was ordered in August. This equipment will reduce the number of service calls required.

Miscellaneous

It was decided last quarter by all parties to expand the scope of work to measure air toxics at Arapahoe 4. A specification has been prepared and released for bidding. A contract is expected in October and baseline sampling will begin in November.

The project remains on schedule and within the original budget. No major problems have developed and the preliminary results are very encouraging.

2.0 INTRODUCTION

According to the requirements of Cooperative Agreement No. DE-FC22-91PC90550 dated March 11, 1991, Public Service Company of Colorado has prepared the following quarterly report for Phases I, IIA, IIB, and III of the Integrated Dry NO_x/SO₂ Emissions Control System Project. This project includes low-NO_x burners with NO_x ports (overfire air injection), humidification and dry sorbent injection. This report covers the quarterly period July, August, and September 1992 which is the seventh quarter of the project.

The subject of this report is the project progress during the quarter for Phase I - Engineering and Design, Phase IIA - Procurement, Phase IIB - Construction and Startup, and Phase III - Operations.

Phase I, engineering and design, is complete. Some minor engineering has been completed this quarter to improve system operation and support remaining construction activities. Minor work will continue such as correcting operating problems as they develop and modifying all drawings to document the as-built systems.

Phase IIA, procurement, is now complete except for the addition of an ammonia conversion system for the urea injection system. Testing during the original startup activities for the urea injection system showed poor performance at low load. A short test of aqueous ammonia showed that, due to a short reaction time and a lower temperature window, ammonia compounds provided higher NO_x removal and lower ammonia slip at low load. Noell, Inc. was issued a contract to modify the existing urea injection system with equipment that will convert urea to ammonia compounds immediately before injection into the boiler. This equipment will be delivered in October 1992.

Phase IIB, construction, was completed in August 1992 except for a few punch list items and the addition of the ammonia conversion system. The seal air fan for the humidification system has not been installed on the outlet flue gas ductwork. This tie-in will require a unit outage. No construction delays have affected the test schedule. Other punch list items that remain are paving of the construction areas and insulation and heat tracing of the dry sorbent injection and humidification system piping. It is expected that all work will be completed next quarter.

Phase III, operations, was officially begun on August 3, 1992 with the beginning of testing for the combustion modifications. Testing is proceeding on schedule and preliminary results indicate that the system is very successful with NO_x reductions of up to 70% possible. These reductions have occurred without negatively affecting carbon monoxide or unburned carbon in the fly ash. Initial testing of the combustion modifications will be completed in late October and testing of the urea injection system will begin in late December. Air toxics testing has been added to the original scope of work and PSCC is currently working on hiring a contractor to perform this work. The first phase of air toxics testing will be

completed in November with additional testing planned during urea injection, calcium injection, and sodium injection. The project remains on schedule and budget.

3.0 PROJECT DESCRIPTION

3.1 BACKGROUND

The goal of this project is to demonstrate the removal of up to 70% of the NO_x and 70% of the SO_2 emissions from coal fired utility boilers. It will establish an alternative emissions control technology integrating a combination of several processes, while minimizing capital expenditures and limiting waste production to dry solids that are handled with conventional ash removal equipment. These processes include low- NO_x burners, NO_x ports (overfire air), and urea injection for NO_x control, sodium or calcium based sorbent injection for SO_2 control, and flue gas humidification to enhance the reactivity of the SO_2 control compound.

The low- NO_x burners reduce NO_x formation by a combination of coal/air combustion staging and the use of NO_x ports. Urea injection downstream of the burners reacts chemically with NO_x to form nitrogen and water.

Sodium and calcium based reagents react with the SO_2 in the flue gas to form sulfites and sulfates, lowering the emissions of SO_2 . Humidification of the flue gas increases the reactivity of the calcium reactants. The solid reacted sorbent is removed with the flyash in the existing fabric filter.

A sodium based injection system can convert nitrogen oxide (NO) to nitrogen dioxide (NO_2) which is one component of NO_x , and is visible in the stack plume under certain conditions. Ammonia, from the urea injection, reduces the NO_2 concentration by reacting with the NO_2 . Thus, system integration may alleviate a potential undesirable side effect of SO_2 removal.

The demonstration program is directed at down-fired boilers, but the process can be utilized on other types of boilers. This project will be the first United States application of low- NO_x burners to a down-fired boiler.

The project objectives also include demonstrating the cost effectiveness of the process and determining any possible negative effects on normal boiler operation or creation of any other unwanted releases of gaseous or solid emissions.

3.2 PROCESS DESCRIPTION

The Integrated Dry NO_x/SO_2 Emissions Control System is a multi-part process in which low- NO_x burners, NO_x ports, and urea injection are used to control NO_x . Sodium based sorbent injection or calcium based sorbent injection, combined with in-duct humidification is used for SO_2 removal.

B&W DRB-XCL™ Burner

The total NO_x formed during the combustion of fossil fuels, consists of NO_x formed from fuel bound nitrogen, thermal NO_x , and prompt NO_x . NO_x formed from fuel bound nitrogen results from the oxidation of nitrogen that is bonded to the fuel molecules. Thermal NO_x forms when nitrogen in the combustion air dissociates and oxidizes at flame temperatures in excess of 2800°F. Prompt NO_x forms during the combustion process when hydrocarbon radicals dissociate atmospheric nitrogen, which then oxidizes. The majority of NO_x consists of fuel bound nitrogen and thermal NO_x while prompt NO_x occurs at a much smaller rate.

The B&W DRB-XCL™ burner achieves increased NO_x reduction effectiveness by incorporating fuel staging along with air staging. Most low- NO_x burners reduce NO_x by the use of air staging. Air staging reduces the amount of combustion air during the early stages of combustion. Fuel staging involves the introduction of the fuel downstream of the flame under fuel-rich conditions, causing hydrocarbon radicals to be generated. These radicals reduce NO_x levels. This is accomplished by the coal nozzle/flame stabilizing ring design of the burner. In addition, combustion air is accurately measured and regulated to each burner to provide balanced air and fuel distribution for optimum NO_x reduction and combustion efficiency. Further, the burner assembly is equipped with adjustable burner vanes to provide swirl for flame stabilization and fuel/air mixing.

NO_x Ports

NO_x ports are used in conjunction with low- NO_x burners to increase the effectiveness of air staging. NO_x ports provide the final air necessary to ensure complete combustion. Conventional single jet NO_x ports are not capable of providing adequate mixing across the entire furnace. The B&W dual zone NO_x port incorporates a central zone that produces an air jet that penetrates across the furnace and a separated outer zone that diverts and disperses the air in the area of the furnace near the NO_x port. The central zone is provided with a manual air control disk for flow control and the outer zone incorporates manually adjustable spin vanes for air swirl control.

The combined use of the B&W DRB-XCL™ burners and dual zone NO_x ports is expected to reduce NO_x emissions by up to 70%.

Urea Injection

NO_x reduction in utility boilers can also be accomplished by injecting urea into the furnace. The urea reacts with the NO_x and oxygen in the gases and forms nitrogen, carbon dioxide and water. A urea injection system is capable of removing 40% to 50% of the remaining NO_x from the combustion process.

The optimum urea injection reaction temperature range is between 1700°F and 1900°F. At lower temperatures, side reactions can occur, resulting in the undesirable formation of ammonia. At higher temperatures, additional NO_x is formed.

The urea is generally injected into the boiler as an aqueous solution through atomizers. The atomizing medium can be either air or steam. The urea and any additive are stored as a liquid and pumped into the injection atomizers.

Dry Sorbent Injection

The dry sorbent injection system consists of equipment for storing, conveying, pulverizing, and injecting sodium based products into the flue gas between the air heater and the particulate removal equipment or calcium products between the superheat section and the economizer. The SO₂ formed during the combustion reacts with the sodium or calcium based reagents to form sulfates and sulfites. These reaction products are collected in the particulate removal equipment with the flyash and the unreacted reagent and removed for disposal. The system is expected to remove up to 70% SO₂ while using sodium based products and maintaining high sorbent utilization.

Dry sorbent injection systems reduce SO₂ emissions. However, NO₂ formation has been observed in some applications. NO₂ is a red/brown gas. A visible plume may form as the NO₂ in flue gas exits the stack. Previous tests have shown that when ammonia based compounds are present during the SO₂/sodium chemical reaction, the amount of NO₂ emitted from the stack is reduced. Thus by combining dry sorbent injection with urea boiler injection it is expected that both NO₂ and NH₃ emissions will be reduced substantially from those emissions that would occur if the two systems are operated separately.

In certain areas of the country, it may be more economically advantageous to use calcium based reagents, rather than sodium based reagents, for SO₂ removal. SO₂ removal using calcium based reagents involves the dry injection of the reagent into the furnace at a point where the flue gas temperature is approximately 1000°F. Calcium based materials can also be injected into the flue gas ductwork downstream of the air heater, but at reduced SO₂ removal effectiveness.

Humidification

In addition to the selection of the proper injection point, the effectiveness of the calcium based reagent in reducing SO₂ emissions can be increased by flue gas humidification. Flue gas conditioning by humidification involves injecting water into the flue gas stream downstream of the air heater and upstream of any particulate removal equipment. The water is injected into the duct by dual fluid atomizers which produce a fine spray that can be directed downstream and away from the duct walls. The subsequent evaporation causes the flue gas to cool, thereby decreasing its volumetric flow rate and increasing its absolute

humidity. It is important that the water be injected in a way that prevents it from wetting the duct walls and to ensure complete evaporation before the gas enters the particulate removal equipment or contacts the duct turning vanes. Since calcium-based reagents are not as reactive as sodium-based reagents, the presence of water in the flue gas, which contains unreacted reagent, provides for additional SO₂ removal. Up to 50% SO₂ removal is expected when calcium reagents are used in conjunction with flue gas humidification.

3.3 PARTICIPANTS

Public Service Company of Colorado is the Project Manager, and is responsible for all aspects of project performance. PSCC will engineer the dry sorbent injection system and the modifications to the flyash system, provide the host site, train the operators, provide selected site construction services, provide start-up services and maintenance and assist in the testing program.

Babcock & Wilcox is responsible for engineering, procurement, fabrication, installation, and shop testing of the DRB-XCL™ burners, NO_x ports, humidification equipment, and associated controls, will assist in the testing program, and will provide for the commercialization of the technology. Noell, Inc. is responsible for the engineering, procurement and fabrication of the urea system. Fossil Energy Research Corp. will conduct the testing program. Western Research Institute will characterize the waste materials and recommend disposal options. Colorado School of Mines will provide research in the areas of bench scale chemical kinetics for the NO_x formation reaction. Stone & Webster Engineering Corporation will assist PSCC with the engineering efforts. Coastal Chemical, Inc. will supply the urea for the project.

4.0 PROJECT STATUS

This project Quarterly Report Number 7 covers the period for July, August, and September 1992. This report discusses progress by task for Phases I, IIA, IIB, and III. The numbers after the task descriptions below have been assigned by PSCC for accounting purposes and relate to the original scope of work for the project.

4.1 PHASE I - ENGINEERING AND DESIGN

4.1.1 Flyash System 1211: Some minor engineering was completed to add an additional area drain near the ash silo. A survey was completed to design paving in the area of the fly ash storage silo, the dry sorbent injection system, and the urea injection system. Minor engineering is continuing to solve minor operating problems with the system. A specification for painting of the ash silo and miscellaneous project piping was released for bids in July.

4.1.2 Dry Sorbent Injection System 1212: Some minor engineering was completed this quarter to support construction of the system. A specification was released in August for heat tracing of all piping for the Dry Sorbent Injection system, the humidification system, and the fly ash system.

4.1.3 Humidification System 1213: This task is complete

4.1.4 Urea Injection System 1220: Drawings for the urea injection rest room were issued for construction in July. Noell completed preliminary engineering for the addition of an ammonia conversion system in August. Specifications for all major equipment related to the conversion were also completed in August.

4.1.5 Burners and NO_x Ports 1230: This task is complete.

4.1.6 Continuous Emissions Monitor 1241: All continuous emissions monitoring work was complete last quarter except for the flow monitor.

4.1.7 Distributed Control System 1242: This task is complete.

4.1.8 Project Management 1251: All project management activities related to the design of the system were completed this quarter. Future project management activities will be collected against phase III project management.

4.1.9 Consulting 1252: This task is complete.

4.1.10 Engineering Research 1260: This task is complete.

4.2 PHASE IIA - PROCUREMENT

4.2.1 Flyash System 1311: A contract was issued to complete painting of the ash silo and related structural steel in July. A contract was issued in July to enclose the unloader area of the silo. Plant management has requested that the siding also be extended to the north and south sides of the lower level. A contract is in routing to complete paving for the ash silo, urea injection, and dry sorbent injection areas.

4.2.2 Dry Sorbent Injection System 1312: All procurement activities related to the Dry Sorbent Injection were completed this quarter. Procurement consisted of minor piping and fittings necessary to complete construction.

4.2.3 Humidification System 1313: This task is complete.

4.2.4 Urea Injection System 1320: Initial testing of the urea injection system complete in February 1993 showed that aqueous ammonia was more effective at NO_x reduction at lower boiler loads. A contract was issued to Noell Inc. in August to design and supply a system that will convert urea into ammonia based compounds immediately before being injected into the boiler. This work is within the original scope of work and will be done within the original project budget.

4.2.5 Burners and NO_x Ports 1330: This task is complete.

4.2.6 Continuous Emissions Monitor 1341: This activity is complete except purchase of a flow monitor. This purchase has been delayed while waiting for final EPA regulations concerning flue gas flow monitors.

4.2.7 Distributed Control System 1342: A supplement purchase order was issued to obtain a Remote Technical Center in August. This equipment will allow diagnostic functions to be performed by Westinghouse from their Pittsburgh office. This activity is now complete.

4.3 PHASE IIB - CONSTRUCTION AND STARTUP:

4.3.1 Flyash System 1411: Initial startup of the flyash system occurred on July 17. Although the system was operational, it was decided to continue pond disposal of the ash while minor modifications were completed to the silo. These modifications were complete and the system began full time operation on September 17. The unloader level was enclosed on September 14. A few punch list items remain, but construction is nearing completion. Painting of the ash silo and other outdoor equipment was completed on August 28 and the contractor moved off-site. Installation of the truck scale began on September 24.

4.3.2 Dry Sorbent Injection System 1412: Construction of the dry sorbent injection system was completed in August. A punch list has been issued and PSCC Construction department is continuing with minor modifications. Indoor painting of the DSI equipment began on September 8 and was completed by the end of the month. All equipment has been operated but no reagent has been injected. Minor control modifications were completed during system startup. All electrical work on the system was also completed in August. Heat tracing and insulation will be completed next quarter. Fire alarms were installed and wired on all new buildings including the dry sorbent injection, humidification, urea, and control buildings. This activity is now complete except any minor repairs required after the system is operated with reagent.

4.3.3 Humidification System 1413: Other than insulation and tie-in of the seal air fan, all construction of the humidification system is complete.

4.3.4 Urea Injection System 1420: A restroom was added to the urea injection control room. Work was begun on August 8 and was completed by the end of September. Further work will be required in November and December 1992 to install the ammonia conversion system.

4.3.5 Burners and NO_x Ports 1430: All burner construction work has been previously completed. Some difficulties have been encountered with the flame scanners. Three false pulverizer trips have occurred due to scanner problems. Coen, the scanner supplier, was called out to investigate the problem. Coen found no problems with the scanners and cannot explain the false trips. B&W has recommended that ignitors be used when coal flow is reduced below 40% as false scanner trips will not occur with the lighters on. PSCC continues working on the problem as lighter operation at these high loads is an unacceptable solution.

One operational change that has occurred is that it is more difficult to maintain the design steam temperature of 1000°F at all loads. At lower loads steam temperatures have been slightly reduced. In order to maintain the design temperature additional air flow is required. It is believed that the boiler is experiencing less slagging in the furnace section. This has been verified by the elimination of sootblowing in the furnace section. Other than original testing of the control system and sootblowing in the area of the overfire ports, the furnace has not been sootblown since coming on line in May. With the original burners, it was common to sootblow approximately monthly. Less slag increases the heat transferred to the waterwalls and thus reduces the flue gas temperature. With reduced flue gas temperature less heat transfer is possible in the superheat section of the boiler and steam temperature will drop. Further investigation will be required to determine if any improvements could be accomplished to reduce excess air at the lower loads.

4.3.6 Continuous Emissions Monitor 1441: All electrical wiring of the CEM to the distributed control system was completed in July. A certification test of the CEM was conducted in September. Preliminary results show that the monitor was not correctly reading NO_x emissions. It is believed that a problem existed with the certification

test and a second test will be conducted to verify NO_x emission accuracy. The activity is complete except installation of the flow monitor.

4.3.7 Distributed Control System 1442: All installation was completed last quarter. Minor tuning of the control system continued through the initial operation period.

4.3.8 Project Management 1451: PSCC worked throughout the quarter coordinating the construction activities, tracking budgets, and completing the required reporting. The project remains on budget for construction. This activity is now complete and further project management will be accumulated in phase III. A project review meeting occurred on September 16, 1992 in Denver. An overview of the construction activities was presented and preliminary results from phase III activities currently in progress were provided. Other participants also reported on their progress to date and future plans.

4.3.9 Consulting 1452: No consulting activities to report this quarter.

4.3.10 Construction Management 1453: This activity is complete.

4.3.11 Engineering Research 1460: Colorado School of Mines (CSM) continues work on the batch reactor vessel for NO_x formation research. They are continuing to have difficulties measuring nitrogen oxide emissions. They are now investigating a different monitor that will provide more accurate results. This activity is now complete and remaining work will be compiled against phase III Engineering Research Activity 1530.

4.3.12 Testing 1471: This activity is complete.

4.3.13 Operations and Maintenance 1472: This activity is complete.

4.4 PHASE III - OPERATIONS:

4.4.1 Project Management 1511: PSCC began project management of phase III of the project on August 8, 1992. Work continues on scheduling, budgeting, and reporting activities. The project remains on schedule and on budget.

4.4.2 Consulting 1512: No activity this period.

4.4.3 Testing 1521: FERCO moved on site July 27, 1992 to begin setup activities for the Low- NO_x Burner testing. Testing of the burners began on August 3, 1992. Testing began by striving to optimize burner registers and burner sliding disk damper positions. Preliminary results indicate that a setting of 25° for both the inner and outer registers provided the best operation of the burners and an acceptable balance between NO_x reduction and carbon burnout. At higher register positions, NO_x was not greatly affected but unburned carbon in the fly ash was significantly higher. A significant amount of time was spent balancing fuel and air at full load by adjusting the burner sliding disk. This appeared

to provide little if any benefit to either NO_x emissions or carbon burnout. It was decided that the windbox at Arapahoe is already balanced sufficiently to provide acceptable air/fuel ratios at the burner. The sliding disk damper would be more effective to help solve the problems in an unbalanced windbox.

NO_x emission reductions from 60 to 70% have occurred with minimal effects to either carbon monoxide or unburned flyash carbon. Figure 1 shows a comparison of the NO_x emissions with the new equipment compared to the original system. Note that the NO_x after the retrofit is shown with both minimum and maximum overfire air. The overfire air ports are located in an area with significant radiation heat transfer. In order to keep the ports cool, a minimum air flow of approximately 15% is required at full load. Due to this cooling air requirement, it is not

Figure 1

possible to operate without overfire air. The maximum overfire air is with all dampers fully open and is approximately 25% of the total combustion air. No operating problems have been experienced with the combustion modifications and the system has been a very successful installation. Testing will continue to better define the effect of overfire air and further optimize the burners for maximum NO_x reduction.

4.4.4 Operation and Maintenance 1522: No activity this quarter.

4.4.5 Air Toxics Testing 1523: An additional work item to test air toxics emissions was added upon approval of the continuation application. A specification was prepared and issued to three vendors for this work. Bids are being evaluated and a contract for this work will be issued in October 1992.

4.4.5 Engineering Research 1530: No activity this quarter.

4.4.6 Waste Characterization 1540: Western Research Institute began work on the waste characterization in August. Currently they are providing more detailed plans and are reviewing the scope of work. Samples will not be obtained until the second phase of urea injection that is expected in 1993.

4.4.7 Restoration 1550: No activity this quarter.

5.0 PLANNED ACTIVITIES

The planned activities for the next quarter, October, November and December, include the following:

1. All punch list items for the dry ash collection system, the dry reagent injection, and the humidification system will be completed next quarter. All paving in the construction area will be completed. The electrical contractor will complete all punchlist items and move off-site. Noell will complete the design of the ammonia conversion system and deliver all construction drawings and material. PSSC Construction will begin and complete the installation of the ammonia conversion system for the urea injection system. A contract will be issued and work will begin to insulate the humidification and dry sorbent injection piping.
2. Startup of the humidification system air compressors will be completed and if an unscheduled outage occurs the humidification seal air fan will be tied-in. A load of sodium reagent will be received and injected through the system to ensure all equipment is operating correctly.
3. Testing of the burner and overfire air system will be completed. A contract will be issued and sampling for the first phase of the air toxic testing will be completed. Laboratory analysis of the air toxic data will begin. The second phase of urea injection testing will begin.

6.0 SUMMARY

Public Service Company of Colorado is continuing management of the Integrated Dry NO_x/SO₂ Emissions Control System. The major emphasis this quarter has been on completion of the remaining construction of the system and startup and checkout of the equipment.

The low-NO_x burners have operated since their startup on May 30, 1992 without problem and no unit outages have been experienced due to their operation. All combustion system punch list items have been complete and plant management is very happy with the operation of the new system. Phase III operations began on August 3, 1992 with the initiation of testing of the combustion modifications. Preliminary results indicate that the modifications have been very effective and NO_x emissions have been reduced by nearly 70% to approximately 0.4 lb/MMBtu. These reductions were possible while not negatively affecting fly ash unburned carbon or carbon monoxide emissions. Testing of the burner system will continue through October 1992.

Construction of the dry sorbent injection system is now complete and the equipment is ready for operation. A few punchlist items remain but these will not affect system operations. All equipment has been operated dry without injecting reagent. A shipment of reagent will be received next quarter when final system startup will occur.

Major construction of the humidification system is complete. However, a unit outage will be required to tie the seal air fan into the fabric filter outlet duct. This work was not completed during the unit outage because of a lack of time. No outages occurred this period so the work could not be complete. Operation of the system is scheduled for early 1993. If an unplanned outage does not occur by this time, an outage will be scheduled to complete this work.

The dry ash system was completed this quarter and has operated continuously from mid September. Minor operating problems have been experienced and some changes have been completed to correct these problems. Work will continue until Arapahoe operating personnel are confident that the system is working correctly.

All project work is continuing at the scheduled rate and has remained within the project budget. No major problems affecting cost and scheduled have occurred nor are any expected. All accessory equipment is functioning as expected and the project is proceeding smoothly through the closeout of design and construction work and into the final operations and testing phase.

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WESTERN RESEARCH INSTITUTE
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ELECTRIC POWER RESEARCH INSTITUTE
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COASTAL CHEM, INC.
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END

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