New York State Electric & Gas Corporation
Micronized Coal Reburn
Demonstration Project
Upgrade to Eastman Kodak Boiler #15

EER Job No. 8882
Kodak Contract No. LH-68X-94207X

STARTUP AND TESTING PLAN

Prepared by

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January 28, 1997

REVISION PAGE

Revision 0	October 17, 1996

Initial release.

Revision 1	January 28, 1997

Miscellaneous editorial changes

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1.0 INTRODUCTION

The Energy and Environmental Research Corporation (EER) is a subcontractor to Eastman Kodak Company on a Clean Coal Technology project entitled, "Micronized Coal Reburning Demonstration Project." This project is co-funded by the U.S. Department of Energy, Kodak and others. The project provides for evaluation of advanced flue gas treatment technology referred to as "Micronized Coal Reburning" for control of the acid rain precursor, NO_x by 50%. The evaluation is performed on an existing cyclone-fired boiler, Kodak Boiler #15, located in Rochester, New York. EER's workscope, as conducted under the terms of the Kodak Specification, includes the following:

- Establish the baseline performance of the facility.
- Perform cold flow modeling to establish the furnace flow patterns under baseline operation and evaluate the mixing patterns of alternate coal and overfire air injection configurations.
- Conduct a pilot scale micronized coal reburning test using a scale model of the coal micronizer and a sample of the coal currently fired on the facility.
- Design and engineer a micronized coal reburning system for the facility, including injector arrangements, piping and instrumentation diagrams, control system logic diagrams, and instrument parameters.
- Supply eight micronized coal reburn fuel injectors, four overfire air injectors, one coal flow splitter, one coal rope breaker, and eight coal flow dampers.

Kodak has requested EER to submit a proposed workscope and price to support the checkout/startup/testing phase of the micronized coal reburning system. In support of this request, EER has prepared this Test Plan Summary which describes the startup and testing requirements and delineates EER's proposed workscope.

1.1 Purpose of the Startup and Testing Plan

The test program for Boiler #15 is designed to (1) evaluate the impacts of micronized coal reburning on gaseous emissions, boiler performance and operability, particulate emissions, and operating costs, and (2) determine the boiler set points required to reduce the NO_x emissions to 0.6 $lb/10^6$ Btu. The Startup and Testing Plan identifies EER's involvement in the checkout, startup and testing phases of the project. EER's effort will supplement that of Eastman Kodak, Fuller Minerals, Parsons Power, and others. EER will perform the following activities:

Off-Line Checkout -- This activity consists of checking the installation and operation equipment prior to startup of the boiler (EER home office support only).

On-Line Checkout -- This activity consists of verifying the operation of equipment after startup of the boiler and assuring that the new equipment poses no detriment to boiler operation (EER home office support only).

System Startup -- This activity is the actual startup of the coal micronizer reburning system and includes establishing FGR flow, determining the operating boundaries of the coal micronizer regarding capacity and coal fineness, and balancing the eight coal lines to the injectors.

Parametric/Optimization Testing -- In this activity a series of pre-planned parametric tests are performed on the reburning system to establish the boundaries of system operation and verify the ability to control the system in the automatic mode. Additional tests are performed to determine the reburning set points for optimum operation.

Guarantee Test -- *This activity, performed by others, involves verifying that the* reburning system reduces NO_x emissions to 0.6 lb/10^6 Btu.

1.2 Coal Reburning System Description

A schematic of the coal reburning system in shown in Appendix A. The major equipment items are described below.

Micronizer -- Preparation of the reburning fuel is performed using two MicroMill systems supplied by Fuller Mineral Process Inc. The MicroMill reduces the size of the coal particles thru collision with larger particles, aided by rotating blades in the impact zone of the mill. Static classifiers are used for final particle size distribution. The size distribution is controlled by the amount of FGR flow diverted to the classifier (stripping air). At zero stripping air, the coal output is at its finest condition.

Coal Transportation and Injection -- A slipstream of flue gas (FGR) is extracted from *the boiler just downstream of the precipitator and is boosted by a single fan to feed* both coal micronizers and classifiers. FGR is used to transport coal to the boiler and also boost its injection momentum to ensure that the reburn fuel is mixed effectively in the furnace.

Each micronizer is supplied coal from a bunker thru a screw feeder. The FGR system assists in the micronizing process and in operation of the classifiers. The mills are capable of operating singly or as a pair, although, due to capacity limitations, both may be required to produce the targeted NO_x reduction.

The micronized coal exiting the two mills is merged into a single 18-inch pipe for transportation to the boiler. The line is then divided into eight 6-inch segments by a coal flow splitter supplied by EER. The splitter is designed to apportion the coal into equal segments without incurring any pressure drop. Downstream of the splitter are eight FlowMastEER® dampers that are used to perform final adjustments to the coal flow balance. The dampers can also be used to create flow biasing.

Eight micronized coal injectors are installed, six on the rear wall and one on each side wall near the rear wall. The injectors utilize the considerable momentum provided by the FGR transport gas plus additional design features to enhance coal penetration. Each injector is equipped with a variable swirl device to control the mixing characteristics of each fuel jet as it enters the furnace. Inserting the swirler rod into the injector increases the degree of swirling.

Overfire Air System -- Located on the front wall are four dual-concentric overfire air injectors. The injectors are designed to provide good jet penetration as well as good lateral dispersion across the boiler depth and width. Each injector is equipped with an integral damper to maintain the desired injection velocity as load changes and two swirlers which, when adjusted, provide for optimum mixing in the burnout zone. Inserting the swirler rods into the injector increases the degrees of swirling.

Controls -- Kodak installed a new Coen burner management system and replaced the complete boiler control system with a Westinghouse WDPF distributed digital control system. The new controls operate both the existing equipment and the micronized coal reburning system, with all normal start/stop/modulate operator actions occurring in the control room. Critical operations are interlocked to prevent inadvertent operation of equipment when such operation may present an operating hazard or other undesirable condition. The controls are designed to shut down the reburning system while maintaining operation of the boiler.

Operation -- During operation of the reburning system, the total fuel to the boiler is the sum of the fuel to the cyclones plus the fuel to the reburn injectors. Any change in the amount of reburn fuel must be balanced by a converse change in the amount of fuel to the cyclones. During normal operation, the boiler generates steam at rates between 300,000 and 400,000 lb/hr. The lower limit of 300,000 lb/hr is based on the amount of bottom ash required to prevent slag freezing. The range of reburn fuel injection is based on the following two factors:

- The minimum reburn fuel injection rate is based on the lower operational limit of the coal preparation equipment (coal feeder, micronizer, classifier, etc.).

- The maximum reburn fuel injection rate is that amount required raise the boiler load from the cyclone minimum operating level (300,000 lb/hr steam) to the boiler maximum operating level (400,000 lb/hr steam). Note that the minimum cyclone operating level may be lower than 300,000 lb/hr during reburning since reburn fuel ash also contributes to the bottom ash total for slag tap control. The maximum amount of reburn fuel that can be injected is estimated to be 25% of the total heat input.

At boiler full load and with maximum operation of reburning, boiler load is reduced by lowering the injection rate of the reburn fuel. The load on the cyclones remains constant.

1.3 Schedule

The work described in the Startup and Testing Plan is based on the schedule shown in Appendix B.

1.4 Organization

EER test engineers and technicians are assigned to the project to support both on-site testing and off-site data evaluation. During parametric/optimization testing, an on-site EER engineer is assigned as a Test Manager who will report to the EER Project Manager. The test manager will direct the test program and serve as the field liaison between EER and Kodak. Throughout the testing, data is reduced by both on-site and off-site personnel and reviewed by the Project Manager and a review committee consisting of selected EER senior managers.

The following personnel have been assigned to the project:

Don Engelhardt -- Project Manager
    Rick Dean -- Site Manager
        Dale Wilson -- Site Technician

Dave Moyeda -- Performance Engineering
Quang Nguyen -- Site Data Analysis

2.0 OFF-LINE CHECKOUT

2.1 Description

This activity occurs following construction, but prior to startup. The goal is to verify the operation of all installed equipment prior to restart of the boiler to assure that there are no detriments to boiler continuous operation. Work activities include the following:

- Assure free movement of the micronized coal injector swirl vanes.
- Check the coal injector thermocouples for temperature indication.
- Assure free movement of the coal flow control trimming damper (Flow MastEER Damper) adjustment rods.
- Assure free movement of the inner air damper plug assemblies and swirl vanes on the overfire air injectors. Stroke the sliding sleeve dampers using the Jordan Drives to assure free movement; calibrate the transmitter. Check the thermocouple for temperature indication.

2.2 EER Workscope

EER will provide home office support of Kodak and others in performing final inspection and calibration on installed equipment, checking out the control system and instrument responses, and performing troubleshooting.

2.3 Schedule

This activity is performed near the end of the construction phase and is coordinated with installation of the injectors and coal flow dampers.

2.4 Personnel

EER will provide no on-site support.

3.0 ON-LINE CHECKOUT

3.1 Description

This activity occurs immediately following re-start of the boiler. The goal is to verify the operation of all installed equipment to assure that the new equipment will not result in any boiler detriment. Work activities include the following:

- Verify cooling air flow to the coal injectors. The dampers are adjusted to positions that permit the minimum air flow for maintaining injector temperature. Maximum permissible temperature is 1200 °F.
- Verify cooling air flow to the overfire air injectors. Adjust dampers to a position that permits the minimum flow for maintaining cooling air flow. Maximum permissible temperature is 600 °F.

3.2 EER Workscope

EER will provide home office support of Kodak and others in verifying proper operation of the control system and preparing the reburning system for startup.

3.3 Schedule

Kodak has scheduled this activity to begin on January 13. It is estimated to continue for two weeks.

3.4 EER Personnel

EER will provide no on-site support.

4.0 SYSTEM STARTUP

4.1 Description

System startup is performed with the boiler on line and prior to testing. The goals of startup are as follows:

- Establish the minimum operational load of the boiler.
- Establish FGR flow (by Kodak)

- Determine the operating boundary of the micronizer regarding capacity and coal fineness (by Kodak/Fuller)
- Balance the eight coal lines to the injectors

4.2 EER Workscope

EER will assist Kodak and others to perform the following activities:

- Determine the maximum turndown capability of the cyclones by reducing load to minimum and monitoring the effects on the boiler. This activity establishes the maximum heat input capability of the coal micronizer system.
- Start up the FGR fan and establish flow to the micronizers and coal injectors.
- Calibrate flow meters.
- Start up the coal micronizer and achieve acceptable coal fineness.
- Verify acceptable transportation of coal to the injectors.
- Operate the system in both single- and double-mill configurations to establish the operating boundaries and parametric relationships of the variables. It is EER's understands that the micromill capacity, coal fineness, total FGR flow rate, FGR flow distribution between the mill and classifier, and electrical power requirements are all interconnected. EER recommends that a full understanding of these relationships be developed prior to proceeding with parametric testing.
- Determine the range of total FGR flow.
- Verify operation of the FGR bypass system.
- Check out the control system with the reburning system on-line.

Specific EER responsibility includes the following:

- Balance the FGR flow among the eight coal transport lines. This is performed by setting the eight isolation dampers to fully open positions. Kodak will direct all FGR flow thru the micronizers and set the FGR flow to maximum. Balance is achieved by adjusting the coal flow control trimming dampers (Flow MastEER

Dampers). Verification of balance is performed using the pressure indicators located on the coal injectors. All indicators should read in the same relative position.

- Monitor the coal injectors during initiation of micronized coal flow and adjust the flow balance in the coal lines if required.

4.3 Schedule

Kodak has scheduled this activity to begin on January 27. It is estimated to continue for two weeks.

4.4 Personnel

EER will assign one test engineer for a duration of two weeks.

5.0 PARAMETRIC/OPTIMIZATION TESTING

5.1 Description

The objectives of the coal reburning parametric/optimization test program are to *identify the boiler set points or range of set points required to achieve the optimal level* of NO_x emissions reduction at full load operation. The set points shall not compromise the plant performance or operability. A pre-planned series of parametric tests are performed to identify and quantify the impacts of various boiler and reburning system operating parameters. The information generated by these tests are then used to fine tune (optimize) the reburning system in terms of NO_x reduction and operating costs, and develop boiler master curves used in the control system.

5.2 Parametric Testing

The purpose of parametric testing is to define the relationships that exist between the controlling parameters (micronized coal flow rate, coal fineness, FGR flow rate, overfire air flow rate, coal flow biasing, and sootblowing frequency) and the boiler outputs (stack emissions, carbon-in-ash, electrical power, etc.). These relationships are then used to approximate the boiler set points required for optimum reburning performance. The approach utilizes a formalized test matrix consisting of a series of pre-planned tests that vary one parameter at a time (see Appendix C). It should be noted that the matrix functions as a guide only and modifications to the test matrix may be required as events dictate.

One steam load condition is tested: 400,000 lb/hr. Kodak, at their discretion, may elect to test reburning at lower loads or the peak load of 440,000 lb/hr, but this testing has not been included in the EER workscope. Note that some lower load testing is included in the optimization testing. The following tests are planned:

Test 1 -- The most important stoichiometric ratio in the process is that of the reburning zone. Overall NO_x reductions are highest when this ratio is in the region of 0.9. The reburning zone stoichiometric ratio is directly proportional to the percentage of micronized coal heat input, at a fixed boiler load and primary zone stoichiometric ratio.

Coal flow to the reburning injectors is measured as percentage of total heat input to the boiler. The maximum reburning coal flow is constrained by (1) the capacity of two-mill operation, (2) the lowest attainable operating level of the cyclones, and (3) the maximum boiler load. It is anticipated that the maximum allowable micronized coal flow will be 25%.

The variable for this test series is micronized coal flow to the coal injectors. The tests are designed to establish the relationship between micronized coal heat input and NO_x emissions. Four heat inputs are planned, varying between 10% and 25% of total boiler heat input. Coal fineness (fine) and burnout zone stoichiometric ratio are fixed. During testing the cyclones are operated at the selected boiler load, with no micronized coal flow. The cyclones loads are then decreased as micronized coal flow increases until the desired flow is achieved, while maintaining the prescribed boiler load.

Test 2 -- The finer the coal grind, the better the control over carbon-in-ash. However, finer grinds require increased power from the micronizers and potentially reduced capacity. The grind size is controlled by balancing the FGR flow in the micromill system between the micromill and the classifier. The maximum fineness is attainable when there is no FGR flow to the classifier. Introducing FGR flow to the classifier will reduce fineness. During startup, Fuller Minerals will establish the range of coal fineness and capacity attainable with the mills. The power consumption will also be assessed.

The variable for this test series is coal fineness. The tests are designed to establish the relationship between micronized coal fineness and carbon-in-ash. Three fineness conditions are planned: fine (80% passing thru 325 mesh, tested in Test 1), mid (level selected by test personnel), and coarse (70% passing thru 200 mesh, pulverized coal). Micronized coal heat input (25%) and burnout zone stoichiometric ratio are fixed. The test has economic implications; therefore, Kodak should record micronizer power requirements at these three tests for use in the economic optimization evaluation.

Test 3 -- Overfire air (OFA) is injected into the boiler to complete the combustion. OFA is typically 15-20 percent of the total air flow. When applying reburning, it is desirable to minimize the overall excess air level in order to maintain the thermal efficiency of the unit. However, the OFA must also be adjusted to minimize CO emissions and unburned carbon-in-fly ash. The OFA flow capacity is bounded by (1) the minimum air requirements to consume the remaining combustibles, and (2) the maximum air available from the FD fan.

The variable for this test series is the overfire air flow rate. The tests are designed to establish the relationship between burnout zone stoichiometric ratio and CO emissions. Three tests are planned, varying the ratio from 1.10 to 1.20. Note that the test of 1.15 is performed in Test 1. Micronized coal heat input (25%) and coal fineness (fine) are fixed.

Test 4 -- Due to the slagging characteristics of the cyclones, the normal operating primary zone stoichiometric ratio of approximately 1.15 is maintained throughout most of the parametric testing. However, if this ratio can be reduced, the result will be a lower level of micronized coal required to meet the NO_x emissions reduction goal.

The variable for this test is the primary zone stoichiometric ratio. The test is designed to determine the lower limit of the ratio and assess the impact on NO_x emissions. The impact on the slag tap is also evaluated. The results of the test will dictate the upper limit of micronized coal heat input at full load (within the bounds of the micronizer capacity). The test is performed at both 15% and 25% micronized coal heat input. The coal fineness (fine) and burnout zone stoichiometric ratio are fixed.

Test 5 -- This test is performed to study the effects of sootblowing on fire-side deposits, gas-side pressure drop, heat transfer efficiency/distribution, and NO_x emissions with the reburning system in operation. The micronized coal heat input (25%), coal fineness (fine), and burnout zone stoichiometric ratio are fixed.

Test 6 -- Front wall-to-side wall coal injector biasing may have an impact on NO_x reduction. The variable for this test series is the distribution of micronized coal to the injectors. The conditions are established by adjusting the coal flow trimming dampers and verifying the flow bias using the pressure gauges mounted on the coal injectors. The test is designed to assess the impact on NO_x emissions and carbon-in-ash vs. a biased flow condition. In the first test, an increased level of micronized coal is injected thru the side-wall injectors. In the second test, a decreased level of micronized coal is injected thru the side-wall injectors. The micronized coal heat input (25%), coal fineness (fine), and burnout zone stoichiometric ratio are fixed. Comparisons are made between the balanced and biased conditions. The degree of bias is selected by test personnel.

Test 7 -- The results of the parametric tests are used to approximate the set points for optimum reburning performance. This test is performed at these selected set points and adjusted as required to establish a baseline for optimization testing. Kodak is requested to work with EER to define the optimum condition in terms of stack emissions, carbon-in-ash, and electrical power requirements for the micronizer.

For information, the material balance at maximum boiler load (440,000 lb/hr) is provided as follows (ref. Process Design Report):

Gas Side	
Coal combustion air	298,779 lb/hr
	65,008 scfm
Reburning fuel transport	32,000 lb/hr
Overfire air	138,884 lb/hr
	30,218 scfm
Flue gas to stack	473,445 lb/hr
	94,825 scfm
Solid Side	
Primary fuel, coal	26,539 lb/hr
Inerts	1,898 lb/hr
Reburning fuel transport	12,000 lb/hr
Inerts	858 lb/hr
Boiler bottom ash	1,424 lb/hr
Economizer hopper ash	38 lb/hr
Precipitator ash	1,295 lb/hr

Alternate Test -- The FGR system is designed for a flow rate of 32,000 lb/hr. During startup, Fuller will test the mills to determine the minimum required FGR flow requirement. In the event the flow is lower than design, a range of FGR flows may be tested in order to assess variances in coal injection velocity. The test is designed to establish relationships among coal injection velocity, NO_x emissions and carbon-in-ash.

Initial Equipment Set Positions -- Prior to initiating coal flow for parametric testing, the following operations must be performed:

Set the swirlers on the micronized coal injectors to the fully retracted position.

Set the inner air damper plug assemblies on the OFA injectors to the fully retracted position.

Sliding sleeve dampers on the OFA injectors should be in the fully closed position. Dampers will open automatically as flow increases.

Set the swirlers on the OFA injectors to the fully retracted position.

Measurements -- During the testing, the following measurements are taken:

Control room data -- Boiler and precipitator data displayed and/or generated in the control room are recorded at the beginning of the test, every half hour, and at the end of the test. Appendix E contains a sample data sheet that is used to record data.

Reburning system data -- All pertinent data related to the set points of operation are recorded including the following:

- Micronizer configuration (one mill or two)
- Micronizer electrical power required
- FGR flow rate (lb/hr)
- Micronized coal flow (lb/hr)
- Estimated coal fineness (prior to fineness testing)

- Coal injector configuration (unbiased, degree of bias)
- Coal injector swirler position (percent inserted)
- Overfire air flow rate (lb/hr)
- Overfire air injector swirler position (percent inserted)

Coal Samples -- During each test, Kodak will extract one coal sample from downstream of the micronizers using an ASME probe or EER-supplied rotorprobe. The samples should be sealed in airtight containers. Coal samples shall be analyzed by Kodak for fineness using the ASTM method of sieving to determine size distribution. The coal samples shall also be tested by Kodak for proximate and ultimate analyses as required.

Ash Samples -- Near the end of each test, Kodak will extract one ash sample from the economizer outlet, isokinetically if possible. At selected times, EER will request a bottom ash sample. The samples should be sealed in airtight containers. Ash samples shall be analyzed by Kodak for carbon-in-ash content.

Continuous Emission Monitoring System -- EER will utilize the data from the guarantee tester's CEM system to obtain NO_x, CO, CO_2 and O_2 measurements continuously throughout the test. Kodak is requested to coordinate the transfer of data from the guarantee tester to EER. All CEMS equipment shall be calibrated both prior to and following each test. Kodak shall have the CEMS certified via RATA testing prior to the parametric testing.

CO Monitor -- EER will provide a CO monitor and perform CO measurements at the economizer outlet continuously throughout the test. Kodak is requested to assist EER in connecting this equipment. All CEMS equipment shall be calibrated both prior to and following each test.

HVT -- EER will provide a HVT for in-furnace temperature measurements and flue gas extraction for CO stratification measurements at selected tests. The sampling locations are shown in Appendix F. Kodak is requested to assist EER in setting up the HVT equipment and in identifying a location for cooling water supply and return.

Test Protocol -- Normal boiler operating conditions are used in order to minimize the impact to plant operations and load requirements. No testing shall be started without prior approval of Kodak, although the EER test engineer will signal the beginning and end of each test. The EER test engineer will determine if test conditions have reached steady state. If sootblowing becomes necessary, Kodak is requested to minimize its frequency.

Data Analysis -- Data analysis is performed by EER using the CEM data, coal and ash samples, HVT data, and control room data. EER will adjust the data to 3% O_2 and develop data plots to display the relationships that exist among the test matrix variables. The plots are used to establish the boundaries of operation and approximate the set points for optimum reburning operation. EER will also determine the change in thermal efficiency. All are compared against the baseline test results. Data analysis is performed both on- and off-site. The on-site analysis will focus on immediate evaluation of the system performance and emissions. The off-site analysis will focus on developing overall performance trends and evaluating overall boiler impacts.

Stoichiometric Ratios -- The equations used to calculate the stoichiometric ratios in each zone are included in Appendix D.

Boiler heat loss efficiency -- The primary measurement to be used for thermal efficiency is the heat loss method detailed in ASME Power Test Code 4.1, Section 5, 1979.

EER will provide input to the final report to document all aspects of the testing including the test log, actual test conditions, test methods and procedures, summary and raw test data, personnel involved in the test, and quality assurance results. The submittal will include all test data gathered; the averages and summaries of the data in a logical presentation; all test conclusions and results; calculations procedures; formulas, tables etc; the written test procedures and test agreements; a description along with location of all test points; and other relevant data/documentation to assist with comprehension of the report.

5.3 Optimization Testing

The specific goals of optimization testing are as follows:

- Determine the reburning set points for optimum operation of the system.
- Establish the reburning set points required to meet a NO_x emissions limit of 0.6 lb/10^6 Btu.

The relationship data plots generated in the parametric testing are used to approximate the optimum set points. Minor adjustments to the test matrix variables (micronized coal flow, injection velocity, coal fineness, overfire air level, coal flow biasing, etc.) are made as required to rough tune the system.

Subsequent to establishing the optimum set points, additional testing is performed to fine tune the reburning system. The variables involved in this testing include the coal injector swirler position, the overfire air swirler positions, and the overfire air distribution.

Coal injector swirler position -- The impact of this adjustment is judged by evaluating the changes in NO_x, CO and carbon-in-ash. Alternate swirler designs may be tested.

Overfire air injector air swirler positions -- The overfire air injector contains a double-concentric nozzle which produces two air streams that can be controlled for good mixing and operational flexibility. The distribution is adjusted to a position that results in the best control of CO.

Load ramp test -- After the reburning set points for optimum operation have been established, a load ramp test is performed. The test is initiated at full load at the optimum set points. Then the load is lowered by reducing the flow rate of micronized coal while maintaining the load on the cyclone. The test is designed to establish the relationships between load and stack emissions (NO_x, CO, etc.).

5.4 Schedule

This activity is estimated to begin on February 17 and continue for two weeks. HVT testing will occur during the second week.

5.5 Personnel

EER will assign two test engineers for a duration of two weeks. One additional test technician will be assigned for HVT testing for a duration of one week. Work is based on five days per week.

6.0 GUARANTEE TEST

6.1 Description

EER has a contractual obligation to Kodak to design a reburning system that will meet a NO_x emissions guarantee of 0.3 lb/10^6 Btu at 400,000 lb/hr steam, while limiting the reduction in boiler efficiency to 2%. There must also be no significant impact on the boiler proper such as fouling or slag build-up on the boiler tubes that would impact the reliability or availability of the boiler. There must be no measurable decrease in the steam temperature exiting the superheater.

The goal of the guarantee test is to verify that these guarantees have been met. The guarantee test is performed by others.

6.2 EER Workscope

EER is on site serving in a consulting role only.

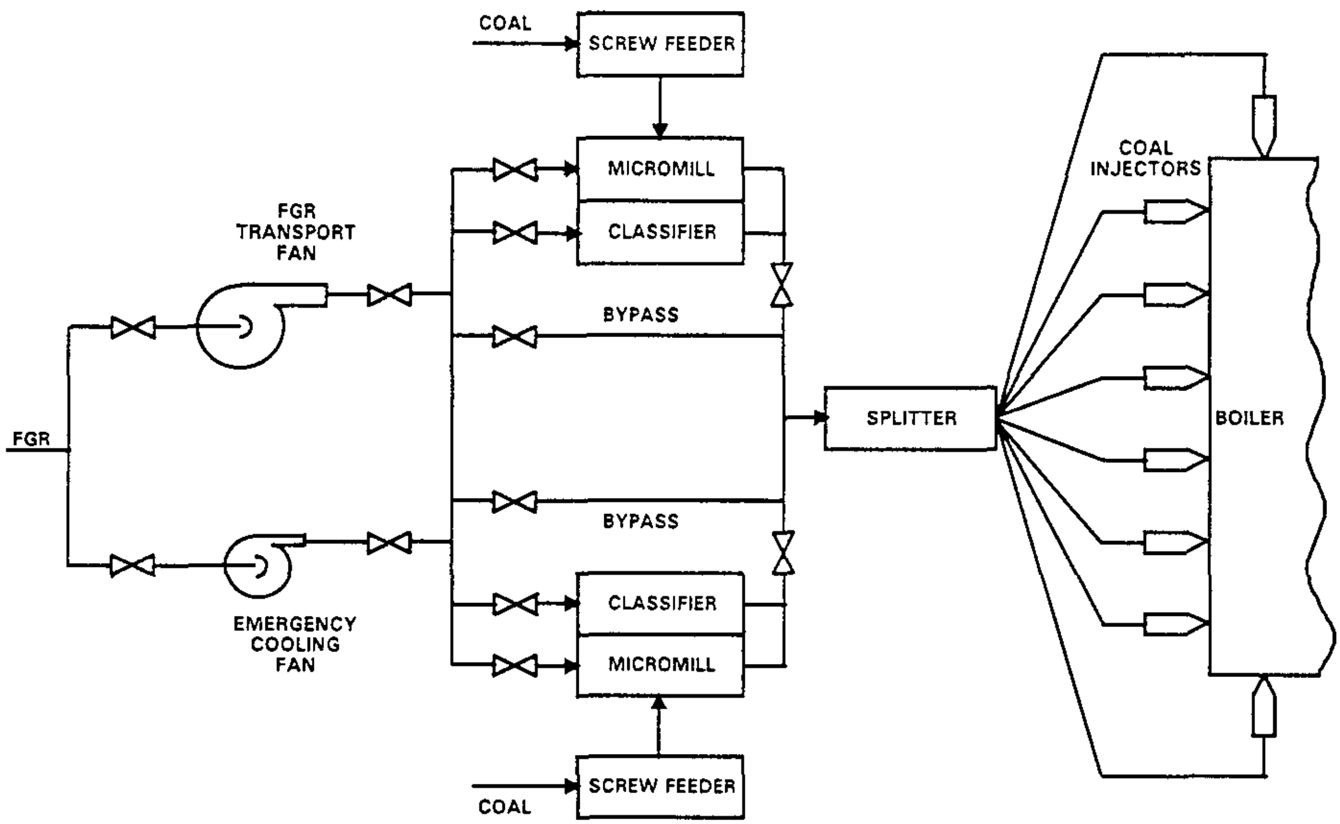
6.3 Schedule

This activity is estimated to begin on March 3 and continue for one week.

6.6 Personnel

EER will assign one test engineer for a duration of one week.

Appendix A
Reburning System Schematic



Appendix B

Test Schedule

Calendar Year	1997								
Calendar Week	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
STARTUP BOILER		■	■						
STARTUP REBURNING SYSTEM				■	■				
RATA TESTING						■			
PARAMETRIC/OPTIMIZATION TESTING							■	■	
ACCREDITATION									■

Appendix C
Test Matrix

Test No.	Boiler Steam Load (1000 lb/hr)	Micron. Coal (%)	Coal Flow (lb/hr)	Coal Fineness Level	SR1 Primary Zone	SR2 Reburn Zone	SR3 Burnout Zone	Coal Injector Bias	Sootblower Frequency	Notes
Micronized Coal Flow/Reburning Zone Stiochiometric Ratio Parametric Tests										
1a	400	10	4,130	Fine	1.15	1.05	1.15	None	Normal	1
1b	400	15	6,190	Fine	1.15	1.00	1.15	None	Normal	
1c	400	20	8,260	Fine	1.15	0.95	1.15	None	Normal	
1d	400	25	10,320	Fine	1.15	0.90	1.15	None	Normal	
Coal Fineness Parametric Tests; Baseline: Test 1d										
2a	400	25	10,320	**Mid**	1.15	0.90	1.15	None	Normal	2
2b	400	25	10,320	**Coarse**	1.15	0.90	1.15	None	Normal	3
Burnout Zone Stoichiometric Ratio Parametric Tests; Baseline: Test 1d										
3a	400	25	10,320	Fine	1.15	0.90	**1.10**	None	Normal	
3b	400	25	10,320	Fine	1.15	0.90	**1.20**	None	Normal	
Primary Zone Stoichiometric Ratio Parametric Tests; Baseline: Test 1d										
4a	400	15	10,320	Fine	**1.13**	0.98	1.15	None	Normal	
4b	400	25	10,320	Fine	**1.13**	0.88	1.15	None	Normal	
Sootblower Parametric Tests										
5	400	25	10,320	Fine	1.15	0.90	1.15	None	**Test**	4
Micronized Coal Injector Configuration Parametric Tests; Baseline: Test 1d										
6a	400	25	10,320	Fine	1.15	0.90	1.15	**High Side**	Normal	5
6b	400	25	10,320	Fine	1.15	0.90	1.15	**Low Side**	Normal	6
Test Run at Optimum Set Points										
7	400	optimum	optimum	optimum	optimum	optimum	optimum	optimum	Normal	7

1. 80% minimum passing thru 325 mesh.
2. Fineness selected in field.
3. 70% passing thru 200 mesh.
4. Study effects of sootblowing on boiler conditions and NOx reduction.
5. Increased coal flow to sidewall injectors, decreased coal flow to rearwall injectors.
6. Decreased coal flow to sidewall injectors, Increased coal flow to rearwall injectors.
7. The optimum set points are established thru evaluation of Tests 1 thru 6.

Alternate test: Repeat test no. 1d with variations in FGR flow rate.

Appendix D
Equations for Calculating Zone Stoichiometric Ratios

Primary Zone

$$SR_1 = \frac{TA - OFA}{CC \times ThA}$$

Reburning Zone

$$SR_2 = \frac{TA - OFA}{(CC \times ThA) + (MC \times ThA)}$$

Burnout Zone

$$SR_3 = \frac{TA}{(CC \times ThA) + (MC \times ThA)}$$

Legend

TA = Total Air Flow (scfh)
OFA = Overfire Air Flow (scfh)
ThA = Theoretical Air (scf/lb)
CC = Cyclone Coal Flow (lb/hr)
MC = Micronized Coal Flow (lb/hr)

Note

The incremental change in the reburning zone stoichiometric ratio due to the addition of the FGR is assumed as insignificant and therefore neglected.

Appendix E

Control Room Data Sheet

Group	Tag Name	Unit	Comments
Reburn System	Reburn Coal Flow	lbs/hr	
	Reburn Transport FGR Flow	SCFM	Including carrier and mixing FGR
	Overfire Air Flow	SCFM	
Feedwater Entering Economizer	Mass Flow	lbs/hr	
	Temperature	°F	
	Pressure	psig	
Attemperator Spray Water	Mass Flow	lbs/hr	
	Temperature	°F	
	Pressure	psig	
Main Steam Leaving Secondary Superheater	Mass Flow	lbs/hr	
	Temperature	°F	
	Pressure	psig	
Power Generation	Net or Gross MWe	MWe	

Appendix E (con't)

Control Room Data Sheet

Group	Tag Name	Unit	Comments
Flue Gas Side	Gas Temperature Leaving Air Preheater	°F	
	Flue Gas Compositions for CO, CO2, O2, NOx at Economizer Exit	% or ppm	Preferred on a dry basis.
	Carbon in Ash	%	For both baseline and reburn operation.
Air Side	Air Temperature Entering Air Preheater	°F	

Appendix F
Furnace Sampling Ports