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Department of Energy
Quarterly Progress Report

NO_x Control Options and Integration for US Coal Fired Boilers

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Cooperative Agreement Number: DE-FC26-00NT40753

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Contract Start Date: February 14, 2000

October 31, 2000

Introduction

This report summarizes the research that has been performed by Reaction Engineering International (REI) during the last three months on demonstrating and evaluating low NO_x control strategies and their possible impact on boiler performance for firing US coals.

The focus of our efforts during the last six months have been on:

- Field Tests for RRI at the Conectiv BL England Station Unit #1, a 130 MW cyclone fired boiler
- Extending our Computational Fluid Dynamics (CFD) based NO_x model to accommodate the chemistry for Rich Reagent Injection (RRI) in cyclone fired boilers
- Applying the NO_x model to evaluate RRI systems integrated into a boiler with Over Fired Air (OFA) and Selective Non-Catalytic Reduction (SNCR)
- Field Tests of the REI Corrosion Probe at the Conectiv BL England Station Unit #1
- Commence engineering study of ammonia adsorption mechanisms for Fly Ash
- Presentation of current program accomplishments and plans for future work to DoE staff members at NETL-FE (Pittsburgh)
- Presentation of preliminary field test results for RRI to EPRI CNCIG.

Each of these topics is discussed in the following sections. The topic discussions are grouped by the corresponding task from the detailed work plan presented in the proposal. For reference, we have reproduced a summary of our work plan in Appendix A.

Task 1 – Program Management

This task will be an on-going item throughout the course of our program.

Reporting

On October 18, 2000, Dr. Mike Bockelie, Dr. Stan Harding and Dr. Brad Adams conducted a program review meeting at the DoE NETL facility in Pittsburgh, PA. The meeting was attended by DoE staff members Dr. Soung Kim, Tom Feeley, Tony Mayne and Phil Goldberg and Masood Ramezan of SAIC. Dr. Adams started the meeting with a short presentation that provided a brief background on REI and highlighted how REI transfers technologies developed under DoE sponsored programs to industry. Dr. Harding followed with a presentation on: REI's PRDA program (DE-AC22-95PC95103); a detailed description of the corrosion probe development work performed as part of the PRDA; results of a shakedown field tests of the corrosion probe performed at the Conectiv BL England station; and the tie-in between the PRDA and the current PSA program. The meeting concluded with a presentation by Dr. Bockelie that contained an overview of the PSA program, accomplishments during the last six months and the plans for the next six to twelve months. The presentation provided by Dr. Bockelie forms the basis of this report.

Team Coordination

To prepare for the DoE review meeting, and to accommodate recent staff changes at REI, the project schedule for this program was updated and resources planned for accordingly.

Industry Involvement

On October 4, 2000, REI provided to utility representatives a formal presentation summarizing the modeling and preliminary field test results for the Rich Reagent Injection (RRI) tests conducted at the Conectiv BL England Station. The presentation was attended by representatives from Alliant, Ameren, Conectiv, NIPSCO, TVA and BGE. The presentation was part of an EPRI Cyclone NOx Control Interest Group (CNCIG) meeting held at the BL England Station. The focus of the meeting was SNCR based NOx control strategies for cyclone fired boilers. Our initial field test results have been received with great enthusiasm. Since the meeting, we have had inquiries from Alliant, Ameren, BGE and Conectiv about performing an engineering study to determine the potential benefits of installing RRI systems at specific plants. In addition, there has been significant interest expressed from the meeting attendees on the possibility of integrating RRI into PC Boilers.

REI has held informal meetings with EPRI senior staff members Tony Fachiano (EPRI Target Manager, Boiler Performance and NOx Control) and Dave O'Connor (EPRI Project Manager, Combustion Performance), in which we have highlighted our progress on this program, potential commercialization efforts for RRI and to receive further background information on the interest level from EPRI members on the work performed to date.

Future Plans: We plan to hold a program review meeting at the REI offices in Salt Lake City, Utah in February, 2000. The meeting will include all members from the project team and representatives from DoE, utilities and EPRI.

Task 2 – NOx Control – LNFS/SNCR/Reburning

The objective of this task is to improve and apply design and analysis procedures for evaluating different layered NOx control strategies. This will provide the utility industry with the capability to evaluate these different NOx control technologies in a reliable, cost effective and timely manner. Of particular interest is the use of Rich Reagent Injection (RRI), a NOx reduction strategy that is based on injecting urea or anhydrous ammonia into fuel rich regions in the lower furnace. The utility industry has expressed significant interest in the possibility of employing RRI in conjunction with other NOx control techniques such as LNFS, OFA, SNCR and Lean Gas Reburn.

Improvement of Design Procedures

The focus of this sub-task has been to extend the REI CFD based NOx model to account for the chemistry involved with using RRI for cyclone-fired furnaces. A key aspect to RRI is injecting the reagent into the lower furnace with the barrels operating at fuel rich conditions.

The impact of the amine reagent on the NOx chemistry is modeled using reduced chemical kinetic mechanisms. Preliminary calculations have shown that for fuel rich conditions, reduced mechanisms can provide much more accurate predictions for NOx reduction than can be obtained using global mechanisms. For modeling a cyclone furnace, we typically assume that only hot, partially combusted gases exit the barrel and enters the furnace proper; that is, we assume all of the solid fuel (coal, TDF, RDF) burns in the barrel and neglect the ash exiting the barrel into the furnace. Having only a gas phase stream entering the furnace from the barrel simplifies the implementation of the reduced mechanisms into our CFD model.

In the last six months we have significantly reduced the turn-around time required for performing a NOx analysis for RRI applications. At the beginning of this project, it would take weeks to obtain a solution for a NOx case – when a converged solution could be obtained. Now, the same NOx case requires three to four days to run on a high-end PC, and has a high likelihood of converging. The combination of reduced computer time and increased reliability has resulted in REI now having a reliable tool that can be used to evaluate RRI designs for utility boiler applications. During the remainder of this project we will continue to investigate modeling techniques that can improve the accuracy of the model and further reduce the time to perform a single CFD case. In addition, we will investigate emerging technologies that could potentially reduce the number of CFD cases that need to be performed and thereby further reduce the turn-around time and cost to generate a boiler RRI design.

Integrated System Design Analysis

The focus of this sub-task is to *apply* REI's CFD modeling capability to design an optimized RRI injector system for a full-scale boiler.

The main lesson that has been learned within this effort is the need to perform a thorough analysis of the integrated system within the targeted boiler. Experience has shown that general guidelines are not adequate. To obtain good NOx reduction with RRI, the reagent must be injected in the correct location within the furnace. The reagent droplets must have adequate residence time to vaporize and simultaneously pass through regions of the furnace that are fuel

rich and at the correct temperature. To achieve these characteristics requires conducting a large number of parametric variations, including spray characteristics (e.g., droplet size, droplet initial velocity and initial direction), reagent concentration and the normalized stoichiometric ratio. Illustrated in Figure 2.1 are the predicted NO_x levels in the lower portion of the BL England Station boiler for three different conditions: no RRI injection (baseline); horizontal nozzles; and nozzles angled upward at 30 degrees. From the color scale on the right hand side of the figure the improved NO_x results can be seen. A more careful accounting shows that relative to the baseline configuration, the two CFD cases illustrated in Figure 2.1 provide 12% and 28% NO_x reduction, respectively. Model predictions indicate that using additional injectors higher in the furnace and altering the reagent flow could produce up to 35% NO_x reduction, with no NH₃ slip.

Figure 2.1. Predicted NO_x levels for no RRI, straight tips and tips angle upward

Nozzle Characterization Tests: During the course of the CFD modeling of the integrated RRI system for BL England, sensitivity studies for different nozzle conditions demonstrated the need to have an accurate characterization of the nozzles that would be used in the field tests. The existing SNCR nozzles were (purchased by Conectiv for the field test) were characterized at Combustion Components Associates (CCA) in Danbury, Connecticut. Parametric tests were performed for a range of atomization and spray properties. The nozzle characteristics were then plugged into the CFD model. The new CFD results showed that the existing nozzles would not be acceptable. The nozzles were subsequently re-engineered by CCA to REI's specifications. The re-designed were tested again by CCA to confirm the nozzles met the desired specifications.

Most importantly, the re-designed nozzles performed as expected in the field tests, resulting in NOx reductions that agreed well with the predicted values.

The modeling work performed in support of the BL England Station field tests highlighted the importance of properly modeling, and understanding, the near field properties of the reagent injection nozzles. Thus, during the next twelve months of this program REI will conduct a set of experiments in the L1500 pilot scale test furnace at the University of Utah. These tests will allow for careful comparison of CFD model predictions and test data for well characterized nozzles that are not possible to perform for full boiler applications. The planned tests will allow for studying reagent injection for low energy, atomized sprays (droplets) used in urea based systems and for high energy, gas jets used in anhydrous ammonia injection systems.

Lean Gas Reburn

There is substantial interest within the utility industry to investigate the use of RRI for a PC fired boiler. At issue is whether RRI in a PC unit could provide NOx reductions similar to what has been predicted for cyclone fired systems (e.g., ~35%). To date we have focused our efforts on demonstrating the use of RRI in cyclone fired units due to the potential for short term success. During the remainder of this program we intend to put substantial effort into addressing the issues associated with evaluating RRI for a PC fired system.

To test the concept will require making significant enhancements to our NOx model to allow using reduced chemical kinetic mechanisms for heterogeneous combustion applications. In addition, we will need to use the CARM software package to generate reduced kinetic chemical mechanisms for fuel Lean Gas Reburn and Amine Enhanced fuel Lean Gas Reburn chemistry. After completing the required model development, we will test the use of RRI in a PC fired boiler by performing a virtual demonstration, consisting of CFD modeling only, for a unit that we have previously modeled. This will allow establishing the benefit, if any, of integrating the use of RRI with other more conventional NOx control strategies for PC units.

Task 3 – Minimization of Impacts

The objective of this task is to study the possible impacts on boiler performance of using low NO_x firing conditions and amine reagent based NO_x control strategies

Waterwall Wastage

The main accomplishment under this task was the completion of an extended field test of the REI corrosion probe at the Conectiv BL England Station Unit #1. This is a 130 MW, 3 barrel cyclone fired furnace. The tests were performed in early October and lasted a total of about two weeks (A shakedown field test was performed at BL England back in July, 2000). During this time period the boiler was “up and down” several times. The probe was placed directly opposite one of the lower barrels.

The BL England tests have provided invaluable information about test procedures for boiler field tests. Prior to these tests the probe had only been used in “cool” sections downstream of the main boiler and in laboratory/pilot scale furnaces. The tests provided experience in on-site trouble shooting for items such as interfacing the probe to the boiler control system and the importance of maintaining proper cooling to the probe. Other lessons learned included the need to minimize the impact on probe performance of variations in the boiler operating conditions, slagging and variable boiler surface conditions near the probe face and electrical fields from other plant equipment. Last, but not least, the tests demonstrated the importance of using instrument technicians to install the probe into the boiler.

The BL England tests in combination with earlier pilot and laboratory scale tests have highlighted the need to “harden” the probe design. During the next six months the probe will be re-engineered to be more boiler and technician friendly. In particular, the diameter of the probe head will be reduced to allow for boiler web penetration. More shielding and an improved cooling method will be implemented to make the probe more resistant to noise and heat. In addition, portions of the re-design will focus on making the probe easier to assemble/disassemble in the field. The probe re-design should be completed and a second probe available for testing by about February, 2001.

Figure 3.1. Probe output – steady operation

Figure 3.2. Probe output – boiler startup/outage/restart

The data reduction for the long term tests performed at BL England is still in progress. However, some preliminary results are shown in Figures 3.1 and 3.2 above. The key points to note are that the probe predicts only modest wastage (~6 mils/year) for continuous operating conditions and a much higher wastage rate (>150 mils/year) for boiler startup conditions. Qualitatively, these results are within the expected range for waterwall wastage rates for the conditions tested.

In addition to re-designing the probe, during the next twelve months there will be a significant effort placed on *quantifying* the waterwall wastage values predicted by the corrosion probe. At present, we are comfortable with the qualitative trends indicated by the probe. However, quantitative correlations will require further laboratory scale testing. These tests will be performed using the University of Utah facilities.

Future Field Tests: REI is working closely with the utility industry and EPRI to locate opportunities for additional field tests. Some possible sites are:

- the Ameren Sioux Plant, Unit #1. This is a 480 Mwe, 10 barrel cyclone fired unit. The possible test time is Spring, 2001;
- First Energy Eastlake Plant. This is a PC fired unit. REI currently has a contract in place to perform these tests, under sponsorship by the Ohio Coal Development Office. The tests are scheduled for Spring, 2001; and
- PEPCO Morgantown Plant. REI has submitted a solicited RFP to potentially perform tests in this PC fired unit during Winter, 2001.

For this task, REI will be assisted by Dr. Stan Harding (N.S.Harding & Associates). Dr. Harding is the technical organizer for the EPRI biennial International Conference on Coal Quality Effects on Power Plants and is the Chairman of the ASME Deposit and Corrosion Committee. He is an expert witness on coal quality effects on power plants and has directed projects throughout the world on the design and proper use of pilot test facilities to assess fuel.

Soot

The goal of this sub-task is to establish the firing conditions and potential impact on boiler operation of soot formation/destruction. This sub-task will include:

- conducting experiments in the University of Utah L1500 pilot scale test furnace to determine the controlling parameters for soot formation/destruction;
- using these results and comparisons with current low NO_x combustion modifications to evaluate the potential for soot formation in coal fired boilers;
- develop/validate models for soot formation/destruction applicable to coal-fired boilers; and
- incorporating the developed models into a CFD code to perform scoping studies of the potential impact on boiler performance (e.g., CIA, deposition and heat flux patterns) due to the formation/destruction of soot.

The soot measurements taken in the L1500 will use a photoacoustic analysis method developed by the Desert Research Institute under SERDP funding. A schematic of the photoacoustic instrument and example data are illustrated in Figure 3.3.

For this task, REI will make use of the considerable talents of Prof. Adel Sarofim (REI and U. of Utah), a recognized expert in coal combustion.

The work effort on this task is scheduled to begin December, 2000.

Figure 3.3. Soot measurements and instrumentation.

Task 4 – SCR Catalyst Testing

The objective of this task is to develop inexpensive SCR catalyst testing/evaluation techniques. The principle concerns are possible poisoning of the catalyst. This task will build upon earlier work performed by REI and the University of Utah for the EPA and NASA on catalyst testing.

As a part of this study:

- a catalyst test rig at the University of Utah will be upgraded/modified to include sodium and arsenic in the simulated flue gas;
- procedures for extended life cycle testing will be developed and validated;
- two commercially available catalysts (i.e., oxide, zeolite) from two different manufacturers will be obtained and tested; and
- a CFD model of a SCR system will be developed. A key aspect of the CFD model will be to couple the flow field and surface chemistry.

The combined experimental and modeling capabilities will provide the utility industry with cost effective techniques for verifying manufacturer claims about catalyst performance and provide them with tools that can be used to help troubleshoot operational problems associated with fuel switching or operational changes.

For this task REI will be able to draw upon the considerable talents of Prof. Maria Flytzani-Stephanopoulos (Tufts University) and Prof. Larry Baxter (BYU, formerly Sandia-CRF), both of whom are experts in the field of catalysts. In addition, we will pursue ways to collaborate with Dr. Zygarlicke at the EERC (U. of N. Dakota) on the catalyst research he is conducting.

The work effort on this task is scheduled to begin by December, 2000.

Task 5 – Fly Ash Management/Disposal

The goal of this task is to develop process concepts with commercial potential for management of the unwanted ammonia adsorbed on fly ash during SCR/SNCR operation. The work effort for this task is being lead by Dr. Bob Hurt of Brown University.

Ammonia Adsorption Mechanisms

The purpose of this sub-task is to determine what factors contribute to the ammonia contamination of ash from advanced NO_x control technologies. Specific items to investigate are the importance of fuel selection, fuel sulfur, extent of ammonia, slip, duct temperatures and unburned carbon content. In addition, this subtask will attempt to address how utilities might control ash contamination through new operating strategies.

The procedure we are using to address these issues is to generate basic engineering data on the adsorption process to understand the role of: ammonia concentration (partial pressure); ash properties (particle size and carbon content); sulfur content; and adsorption temperature. We can determine these items through laboratory experiments using: (1) class C and F field ash samples selected from Browns sample bank of 75 commercial ashes, as well as some laboratory-generated carbons and ash samples as model materials; (2) automated vapor adsorption apparatus retrofitted for ammonia studies (new seals needed due to ammonia corrosivity); and (3) idealized vapor environments (e.g. ammonia in helium) and simulated flue gases containing key impurities (moisture and sulfur).

The accomplishments in the last six months include:

1. Completing the retrofit of the automated vapor adsorption apparatus. The retrofitted device allows rapid determination of complete isotherms (amounts adsorbed over wide ranges in ammonia partial pressure).
2. Successfully measured ammonia adsorption isotherms in the absence of sulfur compounds. *Preliminary results indicate that ammonia adsorption on ash in the absence of sulfur is dominated by the unburned carbon content in most cases, due to the high total surface of the porous carbonaceous fraction of the ash.*

Future work will examine if the reported trend (i.e., adsorption dominated by unburned carbon) still holds in the presence of highly acid sites associated with adsorbed SO₂

Ash Post Processing

The purpose of this sub-task is to investigate novel methods to economically remove ammonia from the fly ash (either by destruction or stripping) to recover ash salability.

Ammonia can be removed by heat, moisture, or oxidizing agents. However, the most economic processing conditions must be identified by experiment. In our original work plan, we stated that we would investigate:

- ammonia-loaded field ashes from units with SCR or ESP conditioning; and
- other field ash samples loaded with ammonia in the laboratory through vapor adsorption or physical addition of sulfate salts.

The targeted processing conditions included:

- dry, reactive processing (with ozone)

- wet, ambient temperature processing (with water or humid air)
- thermal processing (heating in dry air)
- combinations of the above three techniques

During the last six months, our progress on this sub-task include:

1. completing a preliminary evaluation of ammonia destruction by ozonation. Preliminary results indicate that ozone destroys ammonia, but the ozone requirements are relatively high. Thus our immediate future work will focus on other removal methods.
2. completing a study of ammonia adsorption and desorption in the presence of saturated water vapor. Preliminary results indicate that in high humidity environments, ammonia adsorption behaves according to the rules expected for aqueous solutions - i.e. it adsorbs readily and desorbs poorly for acidic ashes, and adsorbs poorly and desorbs readily for basic (high pH) ashes. This result suggests the economic removal of ammonia with controlled amounts of moisture at or near room temperature, with pH modifying additives for acidic ashes (these are the minority).

Task 6 – Field Validation of Integrated Systems

The objective of this task is to perform field validation tests of NO_x control strategies identified within this program as being cost effective technologies of interest to the utility industry. The principle accomplishments to date have been field tests of RRI in a utility scale boiler. The field tests showed that RRI and RRI+SNCR can provide, respectively, up to 35% and 60% NO_x reduction in comparison to OFA only operation. This represents an impressive NO_x reduction and in some instances would be adequate to justify the installation of a combined RRI+SNCR system rather than a SCR system.

BL England Station Field Test

Preliminary field tests have been completed at the Conectiv BL England Station Unit #1 (Atlantic City, NJ). This unit is a 130MW, three-barrel cyclone furnace that had been previously retrofitted to include OFA and SNCR. REI had performed the CFD modeling analysis used to guide the OFA design and thus is quite familiar with this particular unit. CFD modeling was used very extensively in designing the installed RRI system (see Task 2).

The relative locations of the RRI injectors in the boiler are shown in Figure 6.1. The final RRI design employed eight injectors. Six of the injectors were placed in opposing positions on the sidewalls at the same elevation as the top edge of the lower barrels. The other two injectors were placed on the backwall a small distance above the upper barrel exit. The location of the injectors were largely dictated by blockages and structural elements outside the boiler and thus are not necessarily in the optimal locations for maximum NO_x reduction.

Figure 6.1 Boiler schematic with injector locations.

Two sets of field tests were performed during Summer, 2000. The first tests were essentially shakedown tests to ensure that the reagent injection system and data measurement methods were functioning correctly. After completing the shakedown tests, a matrix of short-term tests were performed. In these tests a large number of injector and boiler parameters were varied and the boiler exit conditions measured. Due to boiler operational problems, these tests were performed in sets over a several week time period. In general, each test lasted less than one hour.

The short-term test matrix included parametric tests for varying:

- Injector tips: Angled Cone (AC), Angled Fan (AF), Straight Cone (SC)
- Normalized stoichiometric ratio (NSR)
- Reagent Concentration
- Nozzles out of service (NOOS)
- Cyclone barrel SR
- Injector atomization air pressure (20 - 80 psig)

An issue encountered in analyzing test results is whether we have accurately estimated the cyclone barrel stoichiometric ratio (Barrel SR). This value is not directly measured but rather must be estimated using an approximate coal feed rate (based on plant supplied correlations for the volumetric feeder) and estimated airflow rates. Thus there could be some inaccuracy in the reported values for the barrel.

The results from the tests are very encouraging. The tests indicate that combining OFA, RRI and SNCR can result in NO values in the 0.25 lb/MMBtu range.

Illustrated in Figure 5.2 is a “shotgun” plot of the measured NO for a variety of test conditions. The plot shows measured values for OFA-only (i.e., baseline conditions), for OFA + RRI and for running the boiler with OFA+RRI+SNCR. From the plot it can be seen that, on average, running the boiler with OFA-only produces about 0.55 lb/MMBtu of NO_x for the target conditions of about a barrel SR=0.85. Adding RRI to the OFA system reduces the exit NO to about 0.40 lb/MMBtu. If OFA, RRI and SNCR are all used together then the NO_x level drops to about 0.20-0.25 lb/MMBtu. It should be noted that prior to installing OFA and SNCR a few years ago, NO_x emissions from this boiler were approximately 1.3 lb/MMBtu.

Figure 6.2. Plot of measured NO values for parametric tests at BL England.

Illustrated in Figure 6.3 is the NO *reduction* relative to the baseline conditions (i.e., OFA-only). This plot includes test data shown in Figure 6.2 and values predicted with our CFD model.

Figure 6.3. NO reduction for field tests and model predictions for BL England

Two points should be noted from Figure 6.3.

- First, the plotted test data demonstrates that using OFA+RRI can provide up to 30% NO reduction and that using OFA+RRI+SNCR can provide 50-60% NO reduction.
- Second, comparison of the predicted and measured values shows that the CFD model agrees quite well with the measured values. This provides strong evidence of model “verification” and thus provides confidence that a RRI system designed with our CFD model will provide the predicted performance.

A long term field test, consisting of about 10 days of continuous boiler operation, is currently in progress and should be completed by the end of October, 2000.

Conclusions: Although the results of the field tests for RRI at BL England are still preliminary, the following conclusions can be made:

- RRI can provide significant NOx reduction;
- RRI did not increase the ammonia slip for this application;
- CFD modeling tests indicated that using ten injectors, rather than eight, could provide additional NOx reduction for the same reagent usage;
- Using both RRI and SNCR provided over 50% NOx reduction with approximately 5 ppm of ammonia slip; and
- Overall, the CFD model predictions and the field measurements are in good agreement.

Future Field Tests

A field test of RRI was scheduled to be performed at the Ameren Coffeen plant in November, 2000. This is a 650 MW, fourteen barrel cyclone fired furnace. Ameren has chosen to cancel this test due to other operational problems at the plant.

Ameren has offered to perform a field test of RRI at their Ameren Sioux Unit #1. This is a 480 MW, ten barrel cyclone furnace. The boiler is not currently equipped with OFA or SNCR,. However, Ameren plans to install OFA into the boiler and SNCR before the RRI field tests. REI is currently performing CFD simulations to support the RRI and SNCR designs. At present, the RRI tests are scheduled for Spring, 2001.

Appendix A - Program Tasks

Highlighted below are the tasks and principle sub-tasks to be performed in this program.

Task 1: Program Management

The purpose of this task is to coordinate the efforts of all project team members, generate contractually required reports and keep DoE and interested Industrial partners abreast of program progress and accomplishments.

- Reporting
- Team Coordination
- Industry Involvement

Task 2: NOx Control

The goal of this task is to develop and apply computer models for evaluating NOx control strategies in coal fired boilers using one or more of the following: Low NOx firing systems, SNCR, OFA and Reburning. Of particular interest is the use of Rich Reagent Injection (RRI) – a SNCR based technology that can be applied in the lower furnace.

- Improve Design Procedures
- Reagent System Injection Design
- OFA with Lean Gas Reburning

Task 3: Minimization of Impacts

The goal of this task is to develop real-time monitoring methods for measuring furnace corrosion and to investigate soot generation for low NOx firing conditions.

- Waterwall Wastage
- Soot

Task 4: SCR Catalyst Testing

The goal of this task is to develop procedures for evaluating catalyst poisoning and evaluate a range of catalysts to determine the expected lifetime for different coals.

- Equipment modification
- Develop and Validate Measurement Procedures
- Catalyst Testing
- Develop SCR CFD model and Demonstrate On A Full Scale Boiler

Task 5: Fly Ash Management / Disposal

The goal of this task is to develop process concepts with commercial potential for management of the unwanted ammonia adsorbed on fly ash during SCR/SNCR operation.

- Engineering study of Ammonia Adsorption Mechanisms
- Study of novel Ammonia removal techniques

Task 6: Field Validation of Integrated Systems

The purpose of this task is to perform field tests of different amine based reagent systems.

- Urea based systems
- Anhydrous based systems