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TABLE OF CONTENTS

1. SUMMARY .......................... 1

2. PROJECT DESCRIPTION 3
   2.1. Objectives 3
   2.2. Technical Approach 3
       2.2.1. Overview of the Work 3
       2.2.2. Task Description 5

3. PROJECT STATUS 6
   3.1. Task 5: Site Demonstration 6
       3.1.1. Modifications and Installation 8
       3.1.2. Combustor-Boiler Tests 10

4. EFFORT OF THE NEXT QUARTER 12

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1. SUMMARY

In the first quarter of calendar year 1996, 9 days of combust-boiler tests were performed. Between these tests, modifications and improvements that were indicated by these tests were implemented. In January and early February, the modifications and installations indicated by the 6 days of testing in December 1995 were implemented. This was followed by 6 additional consecutive test days in mid-February. This was in turn followed by additional modifications, followed by a series of 3 one day, coal fired tests at end of March. These latter tests were the first ones in which slagging conditions were achieved in the combustor. The maximum thermal input was 13 MMBtu/hr, which equals two-thirds of the rated boiler heat input. The measured thermal, combustion, and slagging performance achieved in the combustor was superior to that achieved in the final series of tests conducted in Williamsport in 1993. The combustor-boiler facility is now ready for implementation of the task 5 test effort.

To date a total of 15 days of combustor operation have been completed, primarily with oil fuel, with gradually increasing coal input in successive tests. In the most recent tests, the coal input was two-thirds of the 13 MMBtu/hr total heat input. The task 5 effort involves testing the combustor over extended periods under conditions that fully simulate commercial operation and that meet the combustion and environmental specifications for this project. To meet this project objective within the current work scope requires up to 500 hours of testing. This equals 63 days of one shift per day of testing. Thus, the 15 test days represent about 25% of the task 5 test days. These number of tests compare with a total of 24 test days implemented in the final full year of testing on the prior 20 MMBtu/hr combustor in Williamsport. The present tests were implemented with one-third of the personnel used in Williamsport.

The following are highlights of the work and accomplishments in the present quarterly reporting period. Details are given in Section 3.

a) Improvements in the operation of the water cooling of the combustor were made, especially in the areas of start up, shutdown, and emergency shutdown.

b) A brief test of coal grinding in the refurbished coal mill was performed.

c) Based on a cost tradeoff, a decision was made to utilize off site pulverized coal for much of the task 5 testing, instead of grinding the coal on site. This conclusion is based on the results of tests on alternative methods of loading pulverized coal into the 4 ton pulverized coal bin located adjacent to the test building. The option of using a 20 ton tanker truck for delivering pulverized coal, as was used in Williamsport, is not economical in Philadelphia. From these tests, it was tentatively concluded to have the coal delivered in 1 ton supersacks.

d) The installation of the control system for feeding the coal from the 4 ton bin to the combustor was completed.

e) An improved mechanical slag tap breaker system was installed, and tested.
f) A chemical feed system for treating the boiler feedwater with the current once through steam blowoff operation was installed and the necessary chemicals were procured. The feed system was then modified to correct problems with sludge formation in the chemicals.

g) Repairs were implemented after the IR flame detector system became inoperable.

h) An improved boiler furnace pressure control circuit was installed.

i) The in-house designed stack damper control system was installed and perfected.

j) A rented diesel engine driven air compressor was used for the December and February tests. Due to its high cost, a search was successfully conducted for a low cost, electrically driven air compressor. It was installed in time for the combustor tests performed at the end of March tests. With its acquisition, all the equipment needed to conduct combustor tests is now in place, and combustor operation is now determined primarily by fuel delivery.

k) A series of 6 consecutive, one day, combustor tests were implemented in mid-February and a series of 3 consecutive, one day tests were performed at the end of March. By the last test, thermal input reached 13 MMBtu/hr, of which up to two-thirds of the thermal input was from coal. Excellent slagging was achieved in the last combustor test series. The slag removal system from the combustor, which had been an area of considerable development and operational difficulties in Williamsport, functioned perfectly. The combustor's thermal performance was superior to the Williamsport unit, with considerably lower wall heat transfer rates. Also, visual observations of ash deposits inside the boiler indicated that the combustion efficiency was better than previously.

The installation is now ready for regular coal fired operation, and the most recent results indicate that the task 5 test objectives will be met.
2. PROJECT DESCRIPTION

2.1. Objectives

The primary objective of the present Phase 3 effort is to perform the final testing, at a 20 MMBtu/hr commercial scale, of an air cooled, slagging coal combustor for application to industrial steam boilers and power plants. The focus of the test effort is on combustor durability, automatic control of the combustor's operation, and optimum environmental control of emissions inside the combustor. In connection with the latter, the goal is to achieve 0.4 lb/ MMBtu of SO$_2$ emissions, 0.2 lb./MMBtu of NO$_x$ emissions, and 0.02 lb. particulates/MMBtu. To meet the particulate goal a baghouse will be used to augment the slag retention in the combustor. The NO$_x$ emission goal will require a modest improvement over maximum reduction achieved to date in the combustor to a level of 0.26 lb./MMBtu. To reach the SO$_2$ emissions goal may require a combination of sorbent injection inside the combustor and sorbent injection inside the boiler, or stack.

The original plan was to meet the project objectives by a series of increasingly longer duration tests totaling up to 800 hours, with over 500 hours in the task 5 "Site Demonstration" effort. In the implementation of the first three project tasks, it was determined that this objective could be met by daily cycling of the combustor in these three tasks, and by focusing the test effort on fuel flexibility and optimized combustion and environmental performance. Cycling without combustor refurbishment between cycles provides a more stringent test of combustor durability. In task 5, the steam output will be blown off. However, the option has been added to use the steam for process heat or steam turbine power generation if a means for generating revenue from this energy is developed during task 5. This last option will only be implemented after the completion of the required testing under the present project.

The final objective is to define suitable commercial power or steam generating systems to which the use of the air cooled combustor offers significant technical and economic benefits. In implementing this objective both simple steam generation and combined gas turbine-steam generation systems will be considered.

2.2. Technical Approach

2.2.1. Overview

The work of this Phase 3 project will be implemented on Coal Tech's patented, 20 MMBtu/hr, air cooled cyclone coal combustor that is installed on an oil designed, package boiler. The task 2 and task 3 testing were performed at a manufacturing plant in Williamsport, PA, where this combustor was installed in 1987. The task 5 tests will be implemented at a new site in Philadelphia, PA which was selected after the completion of the task 3 tests. The combustor has undergone development and demonstration testing since 1987. The primary fuel has been coal. Other tests, including combustion of refuse derived fuels and vitrification of fly ash, have been successfully performed.
The combustor's novel features are air cooling and internal control of SO$_2$, NO$_x$, and particulates. Air cooling, which regenerates the heat losses in the combustor, results in a higher efficiency and more compact combustor than similar water cooled combustors. Internal control of pollutants is accomplished by creating a high swirl in the combustor which traps most of the mineral matter injected in the combustor and converts it to a liquid slag that is removed from the floor of the combustor. SO$_2$ is controlled by injecting calcium oxide based sorbents into the combustor to react with sulfur emitted during combustion. The spent sorbent is dissolved in the slag and removed with it, thereby encapsulating the sulfur in slag. Part of the sorbent exits the combustor with the combustion products into the boiler where it can react with the sulfur. The spent sorbent either deposits in the boiler or it is removed in the stack particle scrubber. NO$_x$ is controlled by staged, fuel rich combustion inside the combustor. Additional reductions are achievable by reburning in the boiler or by ammonia injection if the stack gases. Neither of the latter two procedures has been attempted in this project to date, but they may be required to meet the task 5 operating conditions at the site selected for this effort. Final combustion takes place in the boiler.

Excellent progress had been made prior to the start of the present project in meeting several of these combustor performance objectives. One of the most important objectives of this technology development effort is to demonstrate very high SO$_2$ reduction in the combustor. Prior to the start of the present Phase 3 project, the peak SO$_2$ reduction achieved with sorbent injection in the combustor had been 56%, (+/-) 5%. Of this amount a maximum of 11% of the total coal sulfur was trapped in the slag. On the other hand, up to 81% SO$_2$ reduction has been measured with sorbent injection in the boiler immediately downstream of the combustor. Tests in the past several years have revealed the critical role played by optimum operating conditions in the SO$_2$ reduction process. Specifically, combustor operation must be automatically controlled, and solids feed and air-solids mixing in the combustor must be optimized. Progress in both areas has been accomplished in the past 5 years by using a microcomputer to control the combustion process and by testing various methods of feeding and mixing the coal and sorbents. In the summer of 1992, tests performed in a prior project indicated that in excess of 90% SO$_2$ reduction could be achieved by sorbent injection in the combustor. However, to date this result has not been duplicated, in part due to focus on other areas of combustor testing. In general, 70% SO$_2$ reduction has consistently obtained in tasks 2 and 3 at Ca/S ratios between 3 and 4.

Combustor durability is an essential requirement for commercial utility of the combustor. Due to the aggressive nature of the combustion process and the need to utilize refractory materials inside the combustor to withstand the 3000F gas temperatures, durability has been one of the key challenges in the development process. Here also the use of computer control has been the means whereby this problem is being solved. Since introduction of computer control four years ago, the need for frequent refractory liner patching inside the combustor has been sharply reduced. The durability issue can be addressed by accumulating running time in daily cyclic operation without combustor refurbishment between runs. This approach has been used in the latter task 2 and task 3 effort. All tests between May 1 and December 2, 1993, consisting of 26 hours of operation in task 2 and 185 hours in task 3, have been performed without significant internal combustor refurbishment.
The final project objective of placing the combustor in a viable industrial steam or power generating system was accomplished by detailed engineering analysis on the use of the combustor in one or more steam generating cycles. This effort included an assessment of the requirements for commercializing the combustor for several industrial application. To assure commercialization of this technology, the final project task is being implemented in a system that duplicates a commercial prototype power plant utilizing the air cooled coal combustor technology.

2.2.2. Task Description

Task 1: Design, Fabricate, and Integrate Components

This task consists of components design, component fabrications, and components integration, and shakedown tests. The 20 MMBtu/hr combustor will be modified to allow safe and environmentally compliant operation for periods of up to 100 hours. This task is complete.

Task 2: Preliminary Systems Tests

The modified combustor system will undergo a series of one day parametric tests of total duration of up to 100 hours to validate the design changes introduced in task 1, and to accomplish the project objectives and goals. This task is complete.

Task 3. Proof of Concept Tests

The durability of the combustor will be determined in a series of tests of between 50 and 100 hours of accumulated operation with no combustor refurbishment between tests. The total test period will be up to 200 hours. This task is complete.

Task 4. Economic Evaluation & Commercialization Plan

The economics of one or at most two different industrial scale steam based cycles using the combustor will be evaluated. A commercialization plan will be developed for marketing the combustor in an industrial environment both in the US and overseas. This task is complete.

Task 5. Conduct Site Demonstration

This task will be the final test activity in the project. Its objective will be to demonstrate the durability and hence the commercial readiness of the combustor for its intended industrial application(s). The effort will consist of two sub-tasks. In the first one any changes required as a result of prior tests will be made to the combustor. In the second one, a series of tests, each of up to 100 hours of continuous coal fired operation will be performed, with a total test time of 500 hours. This task is now in the initial test phase.

Task 6. Decommissioning Test Facility

The test facility will be removed from the boiler installation and disposed in accordance with required regulations.
3. PROJECT STATUS.

3.1. Task 5. Site Demonstration

The installation of the combustor-boiler facility has been divided into two phases. The first phase, which consists of preparing the facility to operate with off site pulverized coal, was completed in the previous quarter, (9/1 to 12/31/95).

It was planned to operate the first 100 hours of the 500 hours of the task 5 combustor tests with off-site pulverized coal. The final 400 hours were to be performed using the on site raw coal storage and pulverization system. It was planned to complete the installation of the raw coal system during the period of the first 100 hours of combustor operation. However, during the past quarter, an economic tradeoff analysis was performed which showed that using off site pulverized coal for the bulk of the task 5 tests is more cost effective than completing the on-site pulverization system. The current status of the raw coal system is as follows: The refurbished coal mill has been assembled and tested. A 12 ton raw coal storage bin, a raw coal conveyor to this bin, the hot gas ducting fan, and additional baghouse needed to grinding and convey the coal to the 4 ton pulverized coal bin, remains to be acquired and installed.

In the past quarter, in the course of developing means for loading the pulverized coal into the 4 ton pulverized coal bin, a low cost and simple method for loading the pulverized coal into this bin was developed. As a result, it became much more economical to purchase pulverized coal in 1 ton supersacks and loading this coal into the 4 ton bin. This changed the economics in favor of purchasing pulverized coal, instead of installing the balance of the on site raw coal system.

Nevertheless, it is of considerable interest to test the suitability and durability of the present low cost coal mill for use with the Coal Tech combustor. The motivation for using this mill were discussed in the previous quarterly report. Therefore, an alternate design is being explored to allow use of mill with a reduced storage capacity system to accomplish this last objective. However, it is not planned at this time to conduct a significant fraction of the task 5 tests with the raw coal system. This conclusion may change if planned tests in the next month uncover difficulties in handling the supersacks containing pulverized coal.

The phase 1 effort was further divided into two stages. In the first stage, the combustor was to be operated by manual control in order to develop the input parameters to program the computer control of the combustor. In the second stage of phase 1, computer control of the combustor will be used. This first stage was essentially completed with the combustor tests at the end of March. While additional manual control tests will be performed, conversion to the computer operation will commence in the next quarter.

In the following sub-sections, the progress made in the past quarter will be summarized. The discussion will be in general terms because several aspects involve potentially proprietary and patentable designs and procedures.
3.1.1. Modifications and Installations

**Boiler**: A boiler furnace pressure alarm system was installed to provide both low and high pressure alarm. In Williamsport, it only provided high pressure alarm. In the present installation both alarms are important because at high pressure the room fills up rapidly with smoke due to the absence of the draft from an open stack as was the case in Williamsport. At too much negative draft, costly fan power is wasted.

**Boiler Feedwater Treatment**: A batch of four chemicals mixtures were purchased to treat the boiler feedwater. The boiler is operated in a once-through mode with municipal fresh water at temperatures below 100°F. All the steam produced is blown off. As a result, the boiler is subject to high concentrations of alkalis and oxygen. The former coats the inner boiler tubes and lowers the heat transfer, while the latter corrodes the inner water wall of the boiler. It is, therefore, necessary to inject high concentrations of chemicals to remove and dissolve these compounds. A chemical metering pump and storage system were procured and integrated with the feedwater supply train. While this system functioned properly in the February combustor-boiler tests, problems were soon encountered because one of the chemicals turned into a sludge after several days of storage. The sludge could not be pumped. The sludge was dissolved by adding water and repiping the chemical feed to accommodate the added higher feedrate. Regular boiler blowdown and analysis of the boiler water chemistry are being used during the test effort. To date it has been possible to maintain the chemistry within acceptable levels. However, it is planned to open the boiler after about 50 hours of operation to determine the effectiveness of the chemicals in controlling corrosion and scale deposits.

**Air Compressor**: Compressed air is used to control various valves and for other functions such as oil atomization. In the December and February combustor tests, a diesel compressor was rented on a weekly basis. Due to its high cost, a search was made for an electric powered compressor. After some effort, a used electrically driven, 25 hp screw compressor was purchased. Its acquisition costs was equivalent to three months rental of the previous diesel powered compressor. Due to the high cost of electricity in Philadelphia, its power cost is several times greater than for the diesel unit. However, when combined with its capital cost, the electric unit has a much lower operating cost. Of greater importance, with the compressor, all the equipment needed to run the facility is now on hand, and it is not necessary to schedule tests based on compressor availability. The compressor was delivered in the third week in March and it was installed and tested at the end of March.

**Power**: The installation of the wiring for the compressor was performed by Coal Tech. During the installation process, a number of improper power switches and motor starter components were observed and corrected. Also, current meters were installed to properly monitor the performance of the various motors used in the facility. It should be noted that even with the addition of the compressor, the total needed power capacity is only 82 kW. This compares with a total required power capacity of 166 kW in Williamsport.

**Controls**: The initial phase of the combustor tests using manual control of the combustor is essentially complete. The computer control software needed to control the combustor is being
upgraded from the program used in Williamsport. As part of this effort, the latest version of the underlying process control software has been purchased. Most of the upgrading of the prior control program is nearing completion, and it is anticipated that the work will be completed early in the second quarter of 1996. This program is critical to proper operation and durability of the combustor.

Cooling Water System: The propane and oil fired combustion tests conducted in December revealed that additional fine tuning of the cooling water system was necessary. Control components were added to maintain a low level of cooling water flow after combustor shutdown until the combustor cools down. In addition improvements were made to allow rapid removal of trapped air, which not only reduces the heat transfer rate, but also makes pump startup difficult.

As noted previously, a water-water heat exchanger is used in the combustor cooling circuit. Analysis of the cooling water data with combustion up to 13 MMBtu/hr heat input showed that it was found below the range measured in prior tests in Williamsport. While the heat load to from the combustor to the heat exchanger was consistent in all the 15 tests conducted to date, a heat balance to the municipal cooling side of the circuit is not in balance. The analysis of the municipal cooling side is made difficult by the fact that this side is also used for feeding the boiler and for boiler blowdown. Additional temperature sensors are being added to allow direct measurement of the heat exchanger efficiency.

Stack Damper: Considerable effort was devoted to assuring proper operation on the control of the stack gas flow damper. The stack damper is critical in the present facility because it is necessary to maintain a negative draft in the boiler to prevent combustion gas leakage into the room. This means that at startup, in the absence of a stack damper, the furnace draft would be too negative. In Williamsport, a open boiler stack, which bypassed the scrubber, was used for startup on gas and oil. In the present facility, there is no stack bypass from the boiler, and all exhaust flow is through the induced stack fan. Several changes to the stack damper control system were made before proper damper operation was achieved.

Coal Mill: The refurbishment of the used coal mill was completed. A brief test of the mill with 1 inch top size coal and without the use of its air blown classifier yielded a product containing considerable coarse granules. The operation of the classifier requires the installation of the entire raw coal handling system. However, following the successful coal firing tests in February, attention focused on installing a system to load off-site pulverized coal in the 4 ton coal bin.

In Williamsport, a 20 ton tanker truck was filled with pulverized coal by a local supplier and pneumatically loaded into the 4 ton bin. Since there is no local supplier of pulverized coal, alternate ways of procuring and loading the pulverized coal were explored. One method is to purchase coal in 50 or 100 lb bags, and lift them to the top of the 21 ft high, 4 ton bin and manually empty the bags. Another option was to procure the coal in 1 ton supersacks, lift them with a gantry crane to the top of the bin and empty them. This approach, which requires installing a cage ladder, railing on top of the 20 ft high bin, and a crane on the top of the bin, is quite costly. As an alternate, several methods of pneumatically blowing the coal from ground level into the bin were tested. A simple and very low procedure was developed which allows pneumatically filling the 4
ton bin with coal at the rate of about 1.5 tons/hr. The test were performed using 50 lb bags of pulverized coal. These tests will be repeated with a 1 ton capacity supersack. It is planned to use this procedure to load the coal for most of the tests in task 5. The coal will be ordered in quantities of 16 to 20 one ton supersacks from a pulverized coal supplier. A gantry crane will be used to lift the supersacks from the delivery truck and store them in the alley next to the building. Another gantry will lift the sacks to a position for pneumatic filling of the 4 ton bin.

A cost tradeoff showed that, for all the task 5 tests, the above method of supplying off site pulverized coal to the combustor costs about the same as installing the balance of the components for processing raw coal with the refurbished mill. Nevertheless, since we are interested in determining the economic advantages of this low cost coal mill, we plan to install a simplified duct system that will allow operation of the mill with a limited amount of coal and with a minimal expenditure in additional equipment for the raw coal system.

_Slag Tap Heating System:_ In Williamsport, a heating system for the slag tap did not function properly. It was extremely difficult to ignite. Therefore, that ignition always had to precede main combustor startup, which wasted fuel. Also, the flame safety control did not function properly. As reported in the previous Quarterly Report, considerable attention was devoted in the present task 5 to assuring proper operation of the slag tap heating system. During the February and March combustor tests, the slag heater were successfully ignited and sustained in each of the tests with coal firing. Ignition was initiated only after coal firing commenced.

_Main Gas Pilot Combustion System:_ UV detectors are used primarily for oil and gas, an IR detector is used for coal firing. During a brief checkout test in January, the IR detector system failed, and considerable delays were encountered in obtaining service from the manufacturer, who does not supply detailed servicing manuals on this unit. We plan to explore alternate means to the IR detector for maintaining flame safety during coal firing.

We finally determined that the failure was caused by a shorted cable, and not as suspected in the detector head or control box. However, in the March tests, the UV portion of the IR detector failed and in the process of checking the circuit we caused a combustor shutdown. We have therefore purchased a spare unit for use until we develop an alternate coal flame safety system.

_Stack Baghouse Operation:_ A key element in the baghouse specification was the selection of low temperature bags whose cost is 3 to 6 times less than bags capable of operating at the boiler outlet gas temperatures. To use the low cost bags, the stack gases must be cooled upstream of the baghouse. One key objective in the shakedown tests was to test several methods for cooling the stack gases. A water spray method used initially proved effective in cooling the gases but also resulted in excessive ash laden water flow out of the base of the baghouse. Various alternate methods were tested in the February, which led to a new approach to cooling the stack gases in the March tests. This new method proved effective without the prior adverse effects.
3.1.2. Combustor-Boiler Tests:

Combustor tests were performed on February 12, 13, 14, 16, 19 and 20. On each day, test operations proceeded for one half shift, or more. The tests of the 12th through the 14th were with oil and gas, while those of the remaining three days also included coal firing.

One factor in limiting the test duration was the winter weather. A number of hours were required on several days to clear frozen outdoor control lines. On the 16th, the test was shutdown in mid-afternoon due to arrival of a major snowstorm.

In the first few days, difficulties were experienced on gas and oil startup. This was due to using different personnel than in Williamsport. For example, failure to sustain initial ignition on gas was caused by excessive air fuel ratios during startup. Other factors in the startup difficulties were due to operating outside the range of automatic shutoff switches. These are not inherent operation problems, and they have been eliminated by modifying startup procedures.

As described above, one major objective in these tests was to develop proper procedures for reducing the stack gas temperature to a level that was compatible with the low temperature bags used in the stack particle baghouse. The results of these tests led to several ideas in controlling stack gas temperatures. They were successfully implemented in the March tests.

During the last three test days in February, coal was injected into the combustor with oil and a small amount of gas. The total heat input was up to 11 MMBtu/hr, or somewhat over 50% of total rated input of the boiler. Compared to the Williamsport unit, the wall heat transfer rate was substantially lower and no slagging occurred on the combustor walls. However analysis of the ash collected in the baghouse indicated that good combustion efficiency was attained as the unburned carbon was equal to the ash, by weight. The same level of unburned carbon had been consistently attained in Williamsport, with good combustion efficiency. Since the stack gas analysis meters were not connected, no details of the combustion efficiency are available. All combustion proceeded with excess air of 50% greater than stoichiometric ratio.

Both the water and air cooling sections in the combustor performed satisfactorily. Only one flameout occurred following oil fired startup. This occurred as a result of inadequate feedwater flow to the boiler. It was caused by excessive boiler steam pressure, which reduced the water feed rate below that needed to sustain the operating heat input.

The coal feed system performed satisfactorily. Coal fired test duration was limited by fuel supply and by weather and personnel availability.

The key result from this second 6 day test was that they showed that the combustor could be brought on line on a daily basis.

Following additional modifications and the purchase of the 25 hp air compressor, as described above, combustion tests resumed on March 29. Three one day tests were performed on March 29, April 1 and 2. More extensive coal firing was undertaken. The thermal input rate was
increased from the maximum of 10 MMBtu/hr attained in February, to 13 MMBtu/hr. Also the coal feed rate was increased to over 600 lb/hr, or equal to two-thirds of the total heat input. Combustor performance was good. The combustor wall heat transfer rate was substantially below the levels measured in Williamsport for the same thermal input levels.

A very most important result was that excellent slagging was achieved for the first time in the combustor. The entire internal wall of the combustor was covered with a thin layer of slag.

Another important result was that the slag removal system from the combustor operated perfectly. This includes the slag tap burners, the slag tap mechanical breaker, and a newly modified slag conveyor for removing the slag from the slag tank. Each one of these components caused considerable operational difficulties in Williamsport. Proper slag removal is one of the key performance requirement of this combustor.

Post test examination of the furnace section and convective section of the boiler showed only fine ash deposits on the floor. This contrasts with considerable coarse ash and char particles observed in Williamsport. While it is too early to draw conclusions, the fine ash indicates that good combustion is being attained in the combustor.

As the stack gas sampling and measuring equipment were not installed, no analysis of the combustion efficiency is available. This equipment is now being refurbished and it will be installed in April to measure, CO2, CO, NOx, SO2, and O2

Slag samples were removed from the combustor’s slag tap and they were submitted for analysis. Ash from the baghouse was also collected. The operation of the baghouse was excellent and the proper pressure drop across the baghouse was readily maintained.

There were only three flameouts during the three days of testing. All were caused by the operator personnel. In one case, the flame safety control was turned off by mistake as a result of misreading of the signal from one of the flame detectors. In the second case, the system shut down because the boiler steam pressure rose above the cutoff point during a boiler blowdown operation. In the third case, boiler blowdown was initiated with the boiler water level near the bottom of its cycle. As a result, the water level dropped below the combustion shutdown cutoff point. These shutdown experiences are positive results in that they show that the boiler and flame safety systems function properly.

These three days of combustor tests showed that the combustor performance is now superior to the best level achieved in the final tests in Williamsport in late 1993. The results are the initial confirmation that the redesigned combustor is superior to the one used in Williamsport.

Conclusions from the Test Effort: 15 days of combustor tests have been completed since early December 1995. These tests were designed to achieve the goal of coal fired operation with good slagging in the combustor. The desired slagging condition was first achieved in the April 1 and 2 tests, and the combustor is now ready for regular coal fired operation. An order for 6 tons of pulverized coal has been placed for delivery in the second week of April. At that time coal fired
operation will resume, as well as further testing of the procedure for off-loading and delivering pre-pulverized coal to the 4 ton coal bin.

The 500 hours of planned tests require 63 days of single shift combustor operation. The 15 days of combustor testing conducted to date thus represent a substantial fraction of the total number of planned tests days. These tests were conducted in a 3-1/2 month period. This compares with a total of 24 test days throughout 1993, the last full year in which the facility was operational in Williamsport. The most recent two days of testing were performed at thermal inputs and coal feed rates that approach those used in a number of tests in 1993, and the results indicate that the present combustor performance is superior to that observed in Williamsport.

Therefore, the combustor-boiler test facility is now fully operation for coal firing. The results to date on the operation of the entire combustor-boiler system indicate that a successful task 5 test effort will be implemented this year.

4. Effort of the Next Quarter

The task 5 demonstration test effort will continue in the next quarter. Off site pulverized coal will be used as was the case in Williamsport. Equipment will be installed to allow delivery and off-loading of 1 ton coal filled supersacks to fill the 4 ton coal bin. Since all the equipment needed to operate the combustor is on site and no leased equipment is needed, more numerous tests and a more intense test rate will be implemented than was the case in the prior Williamsport operation. By the end of the next quarter, the task 5 combustor tests will be well underway.