

OPERATION, MODIFICATION, AND MAINTENANCE  
OF  
DOE/PETC 700 H.P. COMBUSTION TEST FACILITY  
CONTRACT NO. EW-78-C-02-4740

QUARTERLY ACTIVITY REPORT  
For The Period  
July 2, 1979 to September 30, 1979  
THIRD QUARTER

Performed By  
General Electric Company  
Management and Technical Services Company  
626 Cochran Mill Road  
Clairton, PA 15025

Prepared for the United States  
Department of Energy

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## BACKGROUND

The General Electric Company (MATSCO) was awarded the contract to operate, modify, and maintain the DOE/PETC 700 H.P. Combustion Test Facility. The 700 H.P. Combustion Test Facility was designed and built by the Department of Energy at Pittsburgh Energy Research Center and its ultimate success is the responsibility of DOE/PETC. G. E. Co/MATSCO will provide support to assist in the goal of successful operation of this pilot plant facility. The primary objective of the DOE/PETC 700 H.P. CTF is to establish the practicality of coal oil slurry combustion as a technically, economically, and environmentally feasible retrofit technology.

## WORKSCOPE SUMMARY

The Contractor shall provide all things necessary for the operation, modification, and maintenance of the plant as provided in the Operating/Maintenance Manual, and carry out the experimental and developmental operations in said plant as directed by the DOE Technical Project Officer.

The operation, modification, and maintenance of the 700 H.P. CTF shall be in accordance with all applicable safety, health codes, standards, and regulations of DOE. The operation, modification, and maintenance shall include the following phases:

- a) Phase I - Preparatory Work - includes personnel staffing and training, preparation of detailed operating, maintenance, and safety manuals, purchase of tools, spare parts and initial operating supplies.
- b) Phase II - Start-Up and Adjustment Period - Check out and activation of all plant systems and subsystems including run-in adjustment and lubrication of all components, chemical cleaning and flushing of systems and lines, and any other activities necessary to achieve steady-state operating conditions.
- c) Phase III - Process Investigation Operations - Experimental establishment of the effect of applicable process variables and changes in configuration on plant parameters to determine optimum conditions and configuration for technical, economical and environmental analysis. This includes varying feed rates of consumables, varying temperatures and pressures, and accomplishing plant configuration changes necessary to investigate and all of the operating alternatives outlined in the Operating Manual as directed by DOE.

PROGRESS DURING THIS REPORT PERIOD  
700 H.P. COMBUSTION TEST FACILITY

The coal-oil mixture (COM) parametric combustion test program in the 700 H.P. Combustion Test Facility has successfully been completed for the 30, 40, and 50 percent coal-oil concentrations.

A total of 4 experimental and 15 formal combustion tests were conducted using #6 oil, 30%, 40% and 50% COM at both three quarter and full load rates. In almost all of the tests only the excess oxygen was varied between 2.4 to 3.0%. Slight fuel temperature adjustments were made to compensate for the differences in viscosities of oil and COM.

A number of measurements were made inside the 700 H.P. boiler and at the stack to assess the performance of the combustor. The boiler was instrumented to permit detailed heat balances, emission measurements and flame characterization. The particulate level in the stack was monitored using isokinetic stack samples and was compared to opacity data obtained from the transmissometer. The size distribution of the particulate matter in the stack was monitored by a cascade impactor. The average emissivity of the flame was determined using various targets and optical pyrometers.

Flue gas desulfurization tests are being conducted concurrently with the COM combustion tests to study the effectiveness of injection of dry sodium bicarbonate in the removal of SO<sub>2</sub> from the flue gas.

Below are listed the completed formal tests:

JULY

Test No. 700-C5FASTS - FLNNN-1 (oil) FLNNN-1 (50% COM)  
COFMNNN-1 (oil) C5FMNNN-2 (50% COM)

AUGUST

Test No. 700-C5FASTS - C4FMNNN-2 (40% COM) C4FMNNN-2 (oil)  
C4FLNNN-1 (40% COM) C4FLNNN-1 (oil)  
C3FLNNN-1 (30% COM) C3FLNNN-1 (oil)  
C3FLNNN-3 (30% COM) C3FLNNN-3 (oil)  
C3FMNNN-1 (30% COM) C3FMNNN-1 (oil)  
C5TLNNN-1 (50% COM) C5TLNNN-1 (oil)  
COFMNNN-3 (oil) COFLNNN-3 (oil)  
COTLNNN-1 (oil)  
C5TLNNN-2 (50% COM)

SEPTEMBER

Test No. 700-C5FASTS - C5FMNNN-3 (50% COM) C5FMNNN-3 (oil)  
C5FLNNN-3 (50% COM) C5FLNNN-3 (oil)  
C5FLNNN-4 (50% COM) C5FLNNN-4 (oil)

Two preliminary 50% COM tests.

Two experimental COM tests.

All data for these tests were submitted to D.O.E. personnel.

The boiler operated successfully during most of these investigations. The only apparent problems observed especially during the 50% COM tests were accumulations of pulverized coal percipitate from the mixture in the nozzle. On several occasions, the nozzles were changed during the test when it was obvious plugging was noted. Also observed was nozzle hole wear which resulted in an increase of .020" to .025" conical diametrical wear after 73 hours of slurry testing. This resulted in a spray pattern that caused clinkers to form on the boiler ceramic burner flame oven immediately adjacent to the burner. Clinkers were also more prevalent at low levels of excess oxygen. It is theorized that the lower velocity of air allows the flame pattern to widen and impinge on the cone surface. Two experimental tests were run in effort to eliminate the clinker problem and flame impingement on the furnace walls. It was finally concluded that new burner nozzles were the solution to improved flame patterns and the elimination of clinkers.

Maintenance and modifications were performed throughout the facility during this time period. Listed below are some of the major items performed on various equipment in an effort to improve the reliability of the data and test facility.

#### A. Raw Coal Acquisition

The quest to obtain drier coal during this test period resulted in selecting another supplier. Although the new supplier (84 Industries) assured us the coal was Pittsburgh Seam coal, the ash content was close to a 15% level instead of the 8-10% supplied by Consolidated. It has been determined that the 84 Industry coal was unwashed which accounted for the higher ash content. Excellent pulverization and gravimetric feeding results were obtained with this drier coal.

#### B. Pulverizer Area

Screening, support steel and a grate magnet have been received for installation in the 700 H.P. raw coal. These articles will help remove large foreign objects and tramp metal. Installation of this equipment will be scheduled when the hopper is empty.

#### C. COM Fuel Transport

##### 1. Mass Flow Meter

A mass flow meter manufactured by the Micro Motion Corp. was installed in the fuel train between the slurry feed pump and the boiler. Once firmly anchored to the concrete floor, the COM piping was connected to the flow meter with flexible lines. This meter measures the coriolis force exerted on a vibrating "U" tube by the material flowing through the tube. The flow tube is like one tine of a tuning fork, and two diagonal struts form the other tine. Vibration is caused by a drive coil mounted on the diagonal strut interacting with a magnet attached to the flow tube. As the mass is set in motion, a twist is imparted to the tube. The amount of twist is proportional to the amount and velocity of the mass in motion. With no flow, each leg is moving up and down in unison. The flow causes the tube to

deviate from a single axis vibration causing their signals to differ and ultimately become the analog output signal which is then converted to pounds per minute and totalized. The rate and pounds are both shown on a digital readout.

Once calibrated, the flow meter was found to be extremely accurate and repeatable. In addition to accurately determining flow, it has been very useful in determining wear problems in the Moyno pump and plugging problems in the burner nozzles. The output signal has been wired to a recorder on the main control panel which aids in analyzing boiler performance. The digital readout has been located next to the remote fuel controller which provides more sensitive fuel adjustments.

## 2. Small Moyno Pump

Erratic boiler performance was noted as a result of connecting rod wear in the small Moyno pump. As the rotor turned, the elongated holes in the connecting rod results in horizontal movement of the rotor causing cyclic flow conditions.

## 3. Fuel System Piping

Additional piping modifications were made to the discharge of the small and large Moyno pump to enable the calibration of the Floco meter and the Micro Motion mass flow meter without having to circulate fuel throughout the fuel system.

A one inch line was piped into the suction pipe to the large Moyno. This line allowed the large Moyno to operate on #6 oil and recirculate COM with the Viking pump at the same time. It also provided a fool proof means of switching from oil to COM without losing the boiler.

## 4. Burner Nozzle Wear and Deposits

Burner nozzle wear continues to be a problem. A 440 C stainless steel COM burner nozzle cap used approximately 73 hours during 40% and 50% COM combustion tests resulted in a 0.020"-0.025" increase in diametral wear. The nozzle has no measurable wear on the inside end of the nozzle. Most of the wear takes a modified cone-shape. This wear eventually causes a poor spray pattern which causes clinkers to form on the furnace flame oven adjacent to the nozzle. New nozzles will be constructed of erosion resistant metals in effort to eliminate this problem.

## D. Boiler Problems

### 1. Boiler Fire Box Hot Spot

Early detection of a hot spot observed on top of the boiler prevented extensive boiler damage. Efforts were made to save the test that was in progress by installing a thermocouple and digital temperature readout to monitor the hot spot. When the temperature increased dramatically, the test was aborted and repairs were made.

## 2. Boiler Firebrick Repair

An inspection of the firebox, July 9, revealed a row of fire brick on the front wall directly below the burner flame oven had crumbled. New refractory was used to repair this area. The repair job had stood up extremely well with no signs of deterioration even at this time. An inspection by a local boiler vendor in September confirmed our decision to continue operating.

### E. Isokinetic Dust Sampling

Isokinetic dust sampling during one of the combustion tests was inaccurate as the pump could not draw a sufficient flow rate for sampling; thus, the calculated dust load was low. The vacuum pump was overhauled, and a condenser was rebuilt with new, larger tubing and a smaller nozzle used for the thimble holder. These improvements afforded more accurate samples to be taken and longer sampling times. The new methods worked well for the remaining tests except for a leak in the condenser which occurred during one of the tests. The procedure was modified to include a leak test of the sample prior to each test.

Very low dust samples (0.5 lb./hr.) were obtained during isokinetic sampling for oil tests. The use of thimbles for this procedure was discontinued as it was not considered worthwhile. To obtain dust samples for carbon content, several high volume tests were run.

### F. Stack Blower Sheaves

The sheaves of the stack blower have been changed to increase blower rotor speed to increase draft. The rotor speed was increased from 1360 RPM to 1550 RPM. This speed increase was necessary to satisfy the 50% COM due to the greater quantity of particulates. It became very difficult to maintain 1.5" H<sub>2</sub>O and was resolved when the blower rotor speed was increased. This in turn increased the noise level emitting from the exhaust stack. An exhaust gas silencer had been purchased for this eventuality and will be installed prior to the 500 hour endurance run.

### G. Sodium Bicarbonate Injection

Several sodium bicarbonate injection tests were cancelled because of bridging or lumping of sodium bicarbonate in the bin above its rotary airlock feed valve. It was necessary to replace the USP grade #1 with USP grade #4 which is more granular. Although the new batch of sodium bicarbonate fed without any further problems, a new system which will utilize an adjustable screw feeder mounted on a weigh scale and will be installed prior to the 500 hour duration test.

#### H. Rotary Valves - Problems

Problems associated with the rotary air lock valves continued to occur in the main baghouse and the pulverizer baghouse.

The pulverizer baghouse rotary valve had been repaired and provisions are being made to prevent the reoccurrence of this problem. Smaller batches of COM are being mixed to prevent an accumulation of pulverized coal at the rotary when a batch is being prepared.

Hot ashes have burnt the rubber rotors on the main baghouse rotary valve. This has been remedied temporarily with the use of high temperature flexible rotor blades.

#### I. COM Test Loop

The construction of the COM test loop was completed during this test period. The pressure transmitters and differential pressure transmitters were calibrated and there was reasonable agreement between the local readouts and the computer output. It was, however, noted that the pressure transmitter's zero point drifted as much as 4% of full scale (0-500 psi); whereas, the DP transmitters were within 2%. When the Ron Petco pressure transducers were connected to the transmitters and #6 fuel oil was pumped through the lines, half the six readings obtained were unsatisfactory. There is definitely a problem in changing the Ron Petcos pressure transducers.

It may be necessary to send the transmitter back to the manufacturer if the drifting problem cannot be solved. Also, some thought should be given to separating the system from the 700 H.P. boiler so it will not interfere with the 500 hour endurance test and other combustion tests.

#### 100 H.P. and 20 H.P. Units

Mr. Darrell Wheat of the Johnson Boiler Company arrived on site on Monday, September 17, 1979, for the 20 H.P. boiler startup. The boiler had been successfully hydro tested prior to the above date. Several small problems were ironed out prior to startup. A new Fireye controller was purchased by Johnson Boiler, and a misplaced ground wire was removed from the Fireye controller. The boiler started up properly on Tuesday afternoon, September 18, 1979. A boiler class will be conducted by Mr. Wheat for operating personnel upon his return for 100 H.P. boiler startup

Daily, weekly, bi-weekly, monthly, and annual boiler maintenance charts have been assembled for both the 20 H.P. boiler and the 100 H.P. boiler. The maintenance charts are posted in their respective boiler operations booklets.

A State boiler inspection on the 700 H.P., 100 H.P., and the 20 H.P. boilers is scheduled to be conducted on October 9, 1979.

A facility equipment safety review inspection by the Hartford Steam Boiler Inspection and Insurance Company is set up for October 4 and 5. This facility inspection would qualify as an independent safety review. Results of this review and a written report will be received from Hartford within 30 days after October 5, 1979. D.O.E. Safety will receive a copy of this report.

Both the inspection certificates and the manufacturer's data reports for the 20 H.P. and 100 H.P. boilers have been received from Hoffman Engineering Company.

A twenty-four item monthly maintenance checklist has been compiled. The September safety checklist has been completed. A joint safety meeting between the MHD and the coal slurry units has been set up for the large conference room on October 12, 1979.

Boiler startup, emergency shutdown and troubleshooting procedures for the 20 H.P. boiler have been received from Hoffman Engineering. These procedures have been laminated and are posted on the 20 H.P. boiler. The same type procedures will be received from Hoffman for the 100 H.P. boiler before its startup.

Capacity charts for the fuel oil tank, mix tank, and hold tank for the 20 and 100 H.P. boiler have been made up.

Mechanical erection and installation have been completed on the 20 H.P. boiler. Mechanical erection of 100 H.P. and its ancillaries is 90% complete.

Electrical installation has been completed on the 20 H.P. boiler with the exception of ongoing modifications. Electrical installation on the 100 H.P. and its support equipment is 90% complete.

#### 700 H.P. Combustion Test Unit Quarterly Forecast

The 700 H.P. unit is scheduled for a 500 hour endurance test during the fourth fiscal quarter. Several 100-20 H.P. operating personnel have been scheduled to support the 700 H.P. activity. A heavy concentration of effort will be placed on those areas that would interfere with the continuous 24 hour type of operation planned for the 500 hour endurance test.

Several new promising approaches to solving the COM test loop problems will be attempted.

#### 100 H.P. and 20 H.P. Combustion Units Quarterly Forecast

Process fuel lines will be electrically heat traced and insulated. Boiler feed water lines will be insulated.

Eight tests are scheduled to be completed on the 20 H.P. boiler by the end of the Fourth Fiscal Quarter.

Continued mechanical and electrical installation is scheduled for the 100 H.P. boiler and its support equipment.

David Lunifeld  
Program Manager