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DOE/ET/40291-2

Report TE4278-146-80

**DEMONSTRATION OF THE
ENVIRONMENTAL DATA CORPORATION
SPECTRAL FUEL CONSERVATION SYSTEM
(Contract No. DE-AC02-79CS40291)**

**QUARTERLY REPORT
October 1979 - December 1979**

Submitted to

**Division of Industrial Energy Conservation
U.S. Department of Energy**

Submitted by

**Environmental Data Corporation
Monrovia, California**

January 18, 1980

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ABSTRACT

This quarterly report covers the period October 1979 through December 1979. The program is on schedule.

A program plan was prepared and submitted to the Department of Energy in November 1979. The criteria that must be satisfied by the host site for a successful demonstration of the Spectral Fuel Conservation System have been developed and are included in this report. The process of demonstration site selection is underway and is expected to be completed on schedule by March 31, 1980. Preliminary discussions with Union Carbide indicate that the coal-fired boilers at the company's specialty chemicals plant in Institute, West Virginia appear to satisfy all the major site criteria. Exchanges of drawings are now in progress for further evaluation prior to undertaking a site inspection visit. Finally, a literature search has been initiated to determine the distribution by size and type of coal-fired boilers in the industrial sector as background to the energy savings analysis required in Task 11.

1.0 PURPOSE OF THE PROGRAM

The purpose of this program is to demonstrate and quantify the fuel saved as a result of using EDC's Spectral Fuel Conservation System (SFCS) in a coal-fired industrial boiler. The effort is aimed at demonstrating boiler operation at higher efficiency due to a reduced amount of excess air and/or a more uniform distribution of air and fuel among the burners. The scope of work includes the installation, operation, and performance analysis of an SFCS in a front-fired, multi-burner industrial boiler utilizing pulverized coal as its sole or primary fuel.

This program addresses an inherent difficulty associated with firing coal under conditions of optimum efficiency and minimum pollution; that is, the heretofore inevitable imbalance of fuel and air at individual burners.

2.0 PROGRESS TO DATE

2.1 TASK 1: PROGRAM MANAGEMENT

As part of its management responsibilities, Thermo Electron contacted a number of industrial firms to explore the possibility of undertaking the demonstration tests at one of their facilities. The Union Carbide specialty chemicals plant at Institute, West Virginia appears to be the most likely host site at this time. Preliminary discussions between Union Carbide, EDC, and Thermo Electron revealed that the coal-fired boilers in the No. 2 Steam Plant at Institute appear to satisfy all the major site criteria. In addition, Union Carbide expressed keen interest and a willingness to participate in the project. Exchanges of drawings and more detailed information on the boilers are now in progress for further evaluation.

A second likely host company which expressed interest is the Celanese Chemical Company which is currently evaluating the program. The Dow Chemical Company's only coal-fired boilers in Midland, Michigan were found to be incompatible with the fuel and optical access criteria (see Appendix A). Modifications are impractical because the company intends to retire the boilers in 1982 and purchase steam from the local utility.

The program is proceeding according to schedule as shown in Figure 1. The milestones for the next quarterly reporting period are the commencement of baseline data acquisition due March 1, 1980 and the final site selection due March 31, 1980.

2.2 TASK 2: DEMONSTRATION SITE CRITERIA

During this reporting period, EDC has concentrated on completing the formulation of the criteria that need to be satisfied by the host site for a successful demonstration test. The criteria, given in Appendix A, are broadly classified into two groups: those whose satisfaction is mandatory for the consideration of proposed boilers and those that are not mandatory but highly desirable. It is possible that some changes in these criteria will be found necessary as the process of site selection continues.

Figure 4.2 Program Schedule

2.3 TASK 3: DEMONSTRATION SITE SELECTION

EDC has prepared a comparison sheet or "score card" (Appendix B) to be used in the decisionmaking process. The sheet lists the necessary qualifications of an acceptable demonstration site and includes a rating column for the comparative evaluation of different candidate sites based on the EDC requirements.

2.4 TASK 6: EQUIPMENT SELECTION AND PROCUREMENT

EDC has received the sapphire windows to be used in the demonstration tests.

APPENDIX A

DEMONSTRATION SITE CRITERIA

A.1 FUEL AND LOAD REQUIREMENTS

1. Fuel: (a) (mandatory)

The boiler must be capable of burning pulverized coal as its primary fuel over an extended time period. It is estimated that the test period will last at least six (6) months during which time coal must be the only fuel burned at the test boiler.

(b) (desirable)

In order to generate the best possible comparison data during the test period, it would be helpful if the type and grade of the coal used not vary significantly during this time. This would require either an adequate reserve of the coal or a constant guaranteed supply of the coal for the duration of the program.

2. Load: (a) (mandatory)

A medium output boiler is required; that is, one with an output in the range of 200,000 to 500,000 lb/hr of steam. The test program calls for generation of data at several different loads. Therefore, the host site should be capable of varying the output of the boiler as required by the project team, with minimum disruption of normal plant operations and without incurring high extraordinary costs. With this in mind, the test boiler should probably be part of a multi-boiler system so that the desired load changes can be made with minimum effect on overall plant performance.

(b) (desirable)

The host boiler should show a good operational record. This includes a minimum amount of unscheduled downtime and minimal uptime operational problems over a wide range of loads.

(c) The load ranges discussed above will be from approximately 1/3 maximum boiler output to maximum boiler output, in increments of 25,000 to 50,000 lb/hr steam change.

A.2 PHYSICAL PLANT REQUIREMENTS

1. Boiler: (a) (mandatory)

The test boiler should have at least four (4) and not more than six (6) burners, located on the front wall or the rear wall of the boiler. This makes it possible to adequately test the ability of the Spectral Flame System to monitor and correct individual burner operations. At the same time, this number of burners minimizes equipment cost requirements while at the same time ensuring a reasonable expenditure of time and effort for installation, etc.

(b) (mandatory)

Proper viewing ports at each burner are necessary. These ports are the openings through which the SFA units sample the spectra of their respective flames. These ports must be positioned such that each SFA unit can view a discrete, individual flame. If appropriate ports are not present, it will be necessary to arrange for their inclusion into the front structure of the boiler.

(c) (desirable)

It should be possible to install the Spectral Flame System on a permanent basis at the boiler.

(d) (mandatory)

A good operational O₂ control system is an essential element in the SFCS control scheme. By "good" it is meant that the O₂ control be capable of regulating excess O₂ levels to within $\pm 0.5\%$ with a minimum amount of hysteresis. This requirement may involve updating or repairing the O₂ control system at the host boiler.

(e) (mandatory)

The test boiler must be equipped with or have the capability to have installed, secondary air control dampers at the individual burners. It is essential for the utilization of the SFCS for fuel savings that secondary air to each burner be controllable. A highly desirable addition to this requirement would be that this control be sophisticated enough to allow it to be interfaced with the SFCS.

(f) (mandatory)

The test boiler should not be one that utilizes tertiary air in combustion of the coal, as this would: (1) create another variable to be measured in the program, and (2) make stoichiometric related determinations much less accurate.

(g) At the test boiler it must be possible to perform the ASME Abbreviated Efficiency Test both before and during testing.

2. Stack

(a) (mandatory)

The stack must be equipped with, or have the capacity to accommodate, an EDC DIGA system for monitoring flue gas concentrations. It is essential that this system have the capacity to measure CO concentrations, as the SFCS operation depends on biasing the O₂ set point with respect to the CO level. The ability to monitor CO₂, NO, SO₂, and opacity are also extremely desirable since these are generally the primary parameters monitored in pollution control procedures. The DIGA system would have to be equipped with an EDA zero pipe so that real-time zero and span measurements can be taken on a periodic basis. The above mentioned accommodation also includes the installation of power jacks for the system components and the installation of output leads from the instrument to the control room.

3. Control Room

(a) (mandatory)

The control room must have the capacity to accommodate the control, recording, and other electronic equipment associated with the SFCS/DIGA system. It should be possible to eventually interface the boiler control apparatus with the SFCS/DIGA system.

A.3 ACCESSIBILITY AND AVAILABILITY

1. Accessibility and Travel

(a) (desirable)

The test site should be within reasonable distance of an EDA service office or equivalent. Access to a major international airport is also desirable to minimize travel, time and shipment costs. EDC

presently maintains offices in Baton Rouge, LA; Concord, CA; Crestwood, NY; Englewood, CO; Fall River, MA; Joliet, IL; LaGrange, TX; Pittsburgh, PA; and Riverdale, MD.

2. Availability

(a) (mandatory)

Prospective test sites must be made available for a preliminary inspection of the facilities by the test group.

(b) (mandatory)

If a given boiler is taken under serious consideration for testing, it must then be made available for installation and demonstration of a single unit SFA at one burner. This must be done in order to determine the feasibility of installing the total system at the proposed site. The timing of this test would be the decision of the test group, based upon consultation with plant management.

(c) (mandatory)

The final test site must be operationally available to the test group for a period of at least six (6) months after the installation of all required apparatus and the necessary upgrading of existing systems has been completed. The time required for this preliminary work is estimated to be at least five (5) months.

(d) It is the intent of EDC to earn the cooperation of the host plant from the earliest stages of program development. Total cooperation between test group personnel and host plant personnel is fundamental to the success of the demonstration.

APPENDIX B
DEMONSTRATION SITE SELECTION FORM

PLANT NAME: _____

CRITERION	DESCRIPTION	COMMENTS	RATING
LOCATION			
AGE			
PRINCIPAL FUEL			
LOAD RESTRICTIONS			
NUMBER OF BURNERS			
SECONDARY AIR DAMPERS?			
O ₂ CONTROL?			
TERTIARY AIR?			
STACK/DUCT DIMENSIONS			
MAINTENANCE PERIODICITY			
UNSCHEDULED DOWNTIME (Last 2 Years)			
FLY ASH OUTPUT			
SCRUBBER CAPACITY			
SPECIAL CREWS?			
MANAGEMENT			
TOTAL RATING:			