

**2nd Generation PFBC Systems R&D
Phase 2 AND Phase 3**

MONTHLY TECHNICAL REPORT

Reporting Period Start Date: 10/01/1999 End Date: 10/31/1999

Author: Archie Robertson

Report Issue Date 12/15/1999

DE-AC21-86MC21023

**Foster Wheeler Development Corporation
12 Peach Tree Hill Road
Livingston, NJ 07039**

"This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe upon privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof."

**TECHNICAL PROGRESS REPORT NUMBER 21023R46
FOR MONTH 139 (OCTOBER 1999) -- PHASE 2**

When DOE funds were exhausted in March 1995, all Phase 2 activities were placed on hold. In February 1996 a detailed cost estimate was submitted to the DOE for completing the two remaining Phase 2 Multi Annular Swirl Burner (MASB) topping combustor test campaigns; in August 1996 release was received from FETC to proceed with the two campaigns to:

1. test the MASB at proposed demonstration plant full to minimum load operating conditions
2. identify the lower oxygen limit of the MASB
3. demonstrate natural gas to carbonizer fuel gas switching.
4. demonstrate operation with "low temperature" compressor discharge air rather than high temperature (. 1600EF) vitiated air.

The 18 in. MASB was last tested at the University of Tennessee Space Institute (UTSI) in a high-oxygen configuration and must be redesigned/modified for low oxygen operation. A second-generation PFB combustion plant incorporating an MASB based topping combustor will be constructed at the City of Lakeland's McIntosh Power Plant under the U.S. DOE Clean Coal V Demonstration Plant Program. This plant will require the MASB to operate at oxygen levels that are lower than those previously tested. Preliminary calculations aimed at defining the operating envelope of the demonstration plant MASB have been completed.

The previous MASB tests were performed in a UTSI facility constructed to support the development of MHD power generation. Because of a loss of MHD funding, the UTSI facility closed October 1998. On February 2, 1999, Siemens Westinghouse proposed a 12-week study that would identify the cost of modifying the MASB for Lakeland low oxygen operating conditions and conducting tests 3 and 4 above at the Arnold Engineering Development Center (AEDC). On February 22, 1999, Siemens Westinghouse was given release to proceed with this study and results/recommendations were received on April 22, 1999. Siemens Westinghouse recommended a two-phase test effort.

The first test effort would entail two 6-hour tests beginning November 1999 with the MASB operated with natural gas and "cold" compressor air. The MASB would be tested at full Lakeland pressure using the physical configuration planned for operation at lower pressure at Wilsonville in September 1999. As a result, the MASB test specimen would be a totally new unit (not a modification of a previously UTSI tested unit). The MASB would be installed in an existing AEDC test shell. Although the internals currently installed within the shell would have to be removed and reinstalled at the completion of the first test phase, no major facility modifications external to the shell are needed, and the effort was estimated to cost \$1.2 million.

Although the second test effort was not the subject of the initial study, Siemens Westinghouse envisioned it being conducted in another AEDC test cell that is currently mothballed. The facility has been well preserved and it would be modified to permit syngas testing with both cold and hot vitiated air; these tests would not be conducted until the fall 2000 and were estimated to cost \$3.2 million.

Review of the proposed programs has revealed that they exceed existing funding limits, and all further MASB efforts have been placed on hold.

"This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe upon privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof."

**TECHNICAL PROGRESS REPORT NUMBER 21023R47
FOR MONTH 108 (OCTOBER 1999) -- PHASE 3**

Commercial Plant Design Update

The Second-Generation PFB Combustion Plant conceptual design prepared in 1987 is being updated to reflect the benefit of pilot plant test data and the latest advances in gas turbine technology. The updated plant is being designed to operate with 95 percent sulfur capture and a single Siemens Westinghouse (SW) 501G gas turbine. Using carbonizer and gas turbine data generated by Foster Wheeler (FW) and SW respectively, Parsons Energy and Chemicals Group prepared preliminary plant heat and materials based on carbonizer operating temperatures of 1700 and 1800EF and found the former to yield the higher plant efficiency. The reason for this is that the amount of char produced by the 1700EF carbonizer – and subsequently the amount of waste thermal energy available to the PCFBC – best balances the thermal energy contained in the gas turbine exhaust. As such, the energy in both the PCFBC and HRSG can be used more effectively than the complimentary energy generated with the 1800EF carbonizer. With the 1800EF carbonizer, a greater amount of energy is transferred to the syngas per pound of coal carbonized, thus resulting in reduced char production and lower amounts of waste heat to the PFBC. This requires a relatively greater amount of steaming in the HRSG, resulting in a pinch temperature limitation and a high HRSG gas exit temperature (340EF).

The HRSG gas exit temperature is too low to generate a significant amount of crossover steam. Although steam could be generated at a pressure lower than crossover and introduced to the L/P turbine through an induction, this configuration was found to be inferior to the 1700EF carbonizer case. As an alternative, fresh coal could be added to the PCFBC, but doing so produced even lower system efficiencies because prime fuel energy was going directly into the less efficient bottoming cycle.

Having selected 1700EF as the preferred operating condition for the carbonizer, the previous first cut plant heat and material balance was refined and is presented in Figure 1. The plant operates at 47.7% efficiency (HHV) and has a net power output of 421 MWe. Plant auxiliary load requirements were estimated based on earlier Phase II work and more recent work performed by Parsons on other PFBC-type projects. The plant auxiliary load was estimated to be 23.48 MWe or 5.26% of the gross plant power. A transformer loss of 1.52 MWe has also been imposed in determining the net plant power. Coal drying is through natural gas combustion, and the thermal energy input of the natural gas has been included in the heat rate calculation.

As the reporting period ended, the Figure 1 balance was transmitted to FW and SW for review.

